Electricity Generation from Geothermal Resources on the Fort Peck Reservation in Northeast Montana

DOE Grant Number: DE-EE0002511

Final Report
April 30, 2015

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This grant was funded by the U.S. Department of Energy under the Tribal Energy Program's fiscal year 2009 funding opportunity announcement titled "Assessing the Feasibility of Renewable Energy Development and Energy Efficiency Deployment on Tribal Lands."

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Garry Carlson has been responsible for the operations, logistics, contracts design, implementation, and interpretation of more than 500 geophysical and geological investigations throughout North and South America.

His has directed geophysical surveys for mining companies and geothermal exploration companies throughout the Americas. Mr. Carlson's company pioneered new advanced field methods for delineating geothermal resources in both fracture and magma geothermal systems. It also uses the latest computer techniques for geothermal exploration, including three-dimensional modeling, advanced GIS capability, and state-of-the-art color map plotting. Mr. Carlson has worked on projects in Montana, Idaho and Nevada utilizing deep electrical surveys for identification of deep geothermal and mineral targets. Other work includes working with state-of-the-art computer inversion software for geophysics, and developing a fast acquisition gravity technique for ground based gravity surveys.

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Jeff Birkby has worked close to 30 years on sustainable development, smart growth, energy efficiency and renewable energy projects for state, regional and national organizations. Mr. Birkby supervised energy outreach programs for the Montana Department of Natural Resources and Conservation, and managed the Montana Geothermal Program, evaluating the state's geothermal energy resources.

Birkby has also managed a variety of renewable and sustainable energy projects for the National Center for Appropriate Technology (NCAT). Birkby also authored the *Montana Geothermal Handbook—A Guide to Agencies, Regulations, Permits, and Financial Aids for Geothermal Development*, published by Montana DNRC in 1981. Birkby also wrote *Guide to Geothermal Energy Development in Montana* for the Montana Department of Environmental Quality, published in 2012.

ABSTRACT

Tribal lands owned by Assiniboine and Sioux Tribes on the Fort Peck Indian Reservation, located in Northeastern Montana, overlie large volumes of deep, hot, saline water. Our study area included all the Fort Peck Indian Reservation occupying roughly 1,456 sq miles. The geothermal water present in the Fort Peck Reservation is located in the western part of the Williston Basin in the Madison Group complex ranging in depths of 5500 to 7500 feet. Although no surface hot springs exist on the Reservation, water temperatures within oil wells that intercept these geothermal resources in the Madison Formation range from 150 to 278 degrees F.

ACKNOWLEDGMENTS

This Research funded by US Department of Energy Tribal Energy Grant #DE-EE00052511.
Walter Whitetail Feather, Director, Fort Peck Tribes Economic Development Office, Tashina Tibbitts, and Shawn Olson, Fort Peck Tribes Economic Development Office, Larry M Munson, consulting geologist / GIS specialist for the Fort Peck Tribes, Lyn Becker, geologist for Fort Peck Energy Company, Johnny Doney Sr., IT/GIS specialist for the Fort Peck Tribes, Forrest Smith, Director Fort Peck Tribes Minerals Department, and Jay Gunderson, Senior Research Scientist, Montana Bureau of Mines and Geology.

I. Summary of our Study

A. Temperatures for Geothermal Potential

We have discovered higher temperatures than previously reported in the oil wells at the Fort Peck reservation, Montana. Our study indicates the highest water temperatures in Montana outside the Yellowstone Park complex. The oil wells are usually tested using the temperature at the bottom of the well; this is termed Bottom Hole Temperatures (BHT); The data base is comprehensive consisting of new and old BHT's as well as monthly averaged flow rates of water in producing oil wells. We have compiled BHT's and plotted our results on color contour maps that are geo-referenced and can be used as "layers". Our results have found large areas of high BHT's greater than 200 degree F in the eastern half of the Fort Peck Reservation, in particular, the Northeast oil fields, and the Poplar Dome oil field consisting of the West Poplar field and East Poplar field.

Oil well data gathered and compiled for this study was referenced from the Montana Board of Oil and Gas (MBOG) through the Department of Natural Resources and Conservation of Montana's (DNRC), and the Montana Bureau of Mines and Geology's (MBMG) Groundwater Information Center. In our compilation and evaluation of our database, we found over 150 oil wells with BHT's ranging from 200 to 278 degrees F with an average temperature of 221 degrees F in the Fort Peck Reservation. Thirty-five of those oil wells were located in the East Poplar oil field including the highest recorded temperature of 278 degrees F over the southern limb of the Poplar Dome, an elongated 30+ mile long and 25+ mile wide North-South orientated structure with Cretaceous rocks located at its' surface and Mississippian oil producing layers at its core. The East Poplar field is a priority area for further evaluation based upon the concentration of oil wells with hot water, the infrastructure of oil fields with connecting pipelines, and the close location to population centers in need of energy resources.

B. Water well flow rates

Past studies have suggested flow rate from these hot water wells is significant, with estimates conducted in the 1970s as exceeding 40,000 barrels per day of potential production of 265 degree F. water. In our study of collected monthly averaged flow rates of water in producing oil wells we found the individual flow rates to be significantly less than the original 13 oil wells in the East Poplar oil field that were reported with an individual well average of about 4,000 barrels of water per day in the 1979 Geothermal Space Heating Applications study by the PRC Toups Corporation. Since the information comes from a coproduced oil well – meaning producing both oil and water, we relied on the water flow rate information reported from the oil production level and not from water production level. Therefore, these rates may be on the "lower" spectrum in regards to the potential water flow rate. If they were drilled and constructed as water wells the flow rate may be higher.

Combining all 13 oil wells water flow rates would produce a total close to 50,000 barrels of geothermal fluid per day. In our compilations we found individual average flow rates in the East Poplar oil fields average around 320 barrels of water per day based on 88 oil wells with current or historic production rates recorded by the Montana Board of Oil and Gas. Combining all 88 oil wells' water flow rates would produce a total around 28,000 barrels of geothermal fluid per day. This recent compilation is the result of new drilling undertaken recently in the now famous Bakken fields of the Williston Basin. It shows production flow rates do not compared to previously predicted and drill stem test flow rates gathered in the 1979 report, most likely because in the previous study, 1) the wells were "stimulated" to provide greater flow, 2) their tests did not last long enough to show true, consistent flow. Our field checks indicated these "older" wells to be in poor condition.

C. Electrical Generation

Over the last ten years, rapid advancements in the geothermal power plant design has increased capabilities of geothermal electricity generation to include lower temperature geothermal waters. Geothermal power plants can now produce electricity geothermal water with temperatures as low as 170 degree F. For example, in 2008 the major geothermal power a skid-mounted geothermal power generation unit was installed near in a Wyoming oil field that produces 250 kilowatts of electricity from geothermal waters ranging in temperature 180 and 200 degrees F. This temperature range is actually cooler than the collected geothermal energy resources we found on the Fort Peck Indian Reservation in Montana. The high temperatures and the fact that there is a dramatic increase in drilling for oil in the Bakken formation, indicate the high upside potential for electrical power generation on the Fort Peck Indian Reservation.

D. Advantages for Fort Peck Tribes

The purpose of the study was to provide the Tribes the latest information on the possibility to develop their extensive geothermal energy resource for electrical production, provide energy savings to the tribal members, reduce the use of fossil fuels, and hopefully provide employment opportunities for power plant management.

This study has produced the foundation for the future development of the geothermal resources on the Fort Peck Reservation. We increased the information on geothermal potential by orders of magnitude, having located and plotted over 150 drilling sites with geothermal waters greater than 200 degrees F geothermal fluid temperatures. New flow rates of these wells need to be substantiated to determine feasibility of utilizing a geothermal power plant for electrical generation. Further research should further evaluate the flow rates of these high temperature oil wells with the idea of stimulating a well, or tying into several wells for increasing flow, as well as examine the economic, technical, environmental, social, and tribal issues involved in developing geothermal resources of the Fort Peck Tribes.

II. Background

A. Fort Peck Reservation

The Fort Peck Tribe's Reservation (FTPR) lies in northeastern, Montana, consisting of nearly 1,456 square miles (931,792 acres) within four large counties; Valley, Roosevelt, Daniels, and Sheridan counties (Figure 1 below). The reservation is bounded by the Missouri River defining the southern boundary, Porcupine Creek on the western boundary and Big Muddy Creek on the eastern boundary. The northern boundary is defined by section lines as the northernmost second tier of sections through township 33 N., outlined on the west side of Range 39 E. and to the east side of Range 55 E.

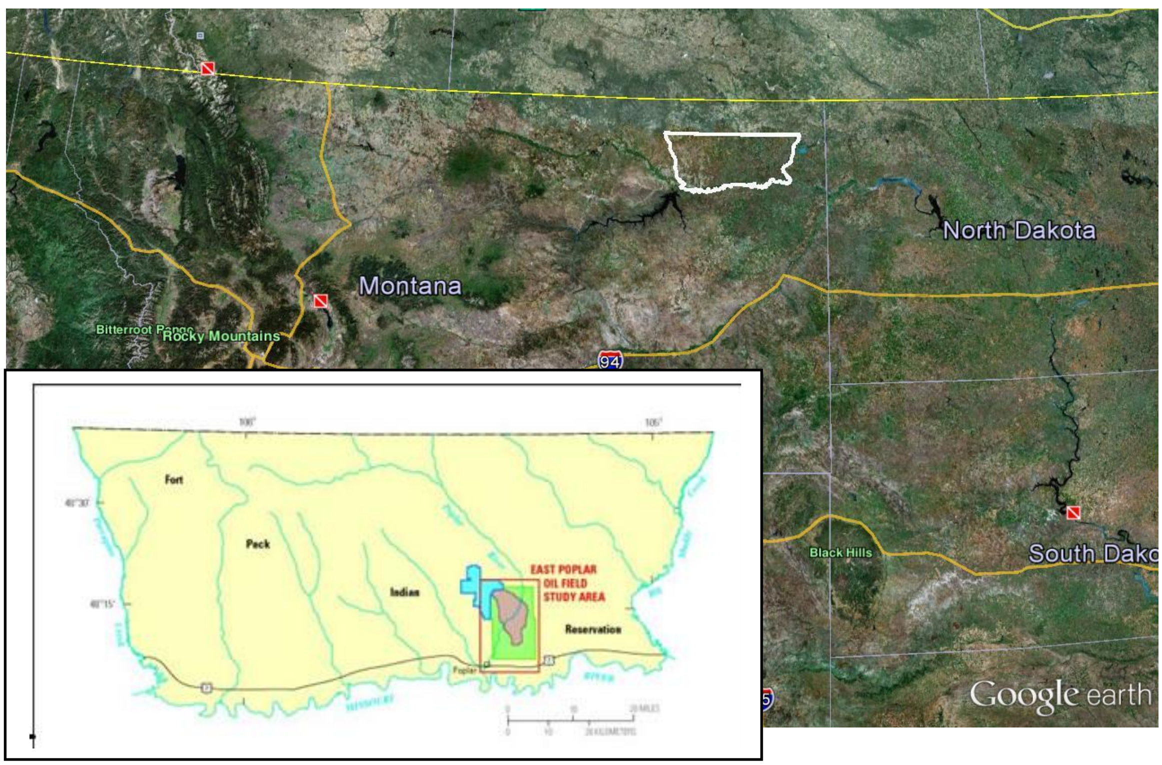


Figure 1 The Fort Peck Reservation boundary. Outlined in white, on a Google Earth Pro Image created by Gradient Geophysics. The Reservation is located in the northeast corner of the state of Montana. Insert to the left is a physiographic map of the Reservation (modified from the USGS) along with a rectangular boundary in the southern part denoting the Poplar Dome oil fields. There has been a significant increase in oil drilling within the last few years due to the Bakken "discovery".

Figure 2 Roads, water ways and topography. Modified from a presentation given to the Fort Peck Tribal Council by Gradient Geophysics, Inc in January, 2012; Reservation boundary in white within a Google Earth Pro Image. Map to the left (insert) shows roads along with major water ways. To the right the rolling hills show the general topography on the Reservation.

B. Geography

Topography of the reservation is typical of the Northern Great Plains with rolling hills and uplands with elevation ranging from a high of 3,050 feet in the northwestern part to slightly below 1,900 feet in the southeastern part. The hills are dissected by the Missouri and Poplar Rivers and their tributaries. The Missouri is bounded by on the western end by the mighty Fort Peck dam, is the biggest river in the Plains, flowing eastward with a reported gradient of approximately 1 foot per mile. The Poplar River flows south across the central part of the reservation and meets the Missouri River at Poplar.

C. Population centers

Poplar is the center of the Tribal governing buildings, offices and facilities. It is the location of Fort Peck Community College. The Fort Peck Reservation is composed of two different tribes, the Sioux and Assiniboine Tribes are the Native American Tribes within the Fort Peck Reservation. There is a slight split in demographics between the eastern part and western part; where the Sioux are settled mostly in the eastern part and the Assiniboine are primarily in the west.

As with town of Poplar the tribal government center, the main population centers are along U.S. Highway 2 which generally follows the Missouri River Valley (Figure 2); the largest city is Wolf Point and the largest nearby city is Glasgow lying just outside the reservation, about 15 miles west of the southwest corner of the reservation near the Fort Peck Dam.

D. Industry

Cattle grazing, sugar beet and wheat farming, extensive in the upland areas, form the main agriculture which is the primary industry within the reservation boundary. Of secondary economic importance is found in oil production mainly in the central and northeastern oil fields, however, this industry is evolving quickly as numerous oil companies moving in to drill in the Bakken.

The recent, dramatic increase in oil drilling has taken place in the Bakken formation within the Williston Basin, Montana – North Dakota. This has contributed greatly to the new information for geothermal in the area, including the geothermal information from newly drilled oil wells at the Fort Peck Tribes Reservation.

E. Expansion of oil exploration (Bakken)

The Bakken, a Late Devonian – Early Missippippian, and relatively thin (40 meters at most) rock unit, lies completely under the surface within the Williston Basin oil field extending through North Dakota, Montana and Canada (see Figure 3 below).

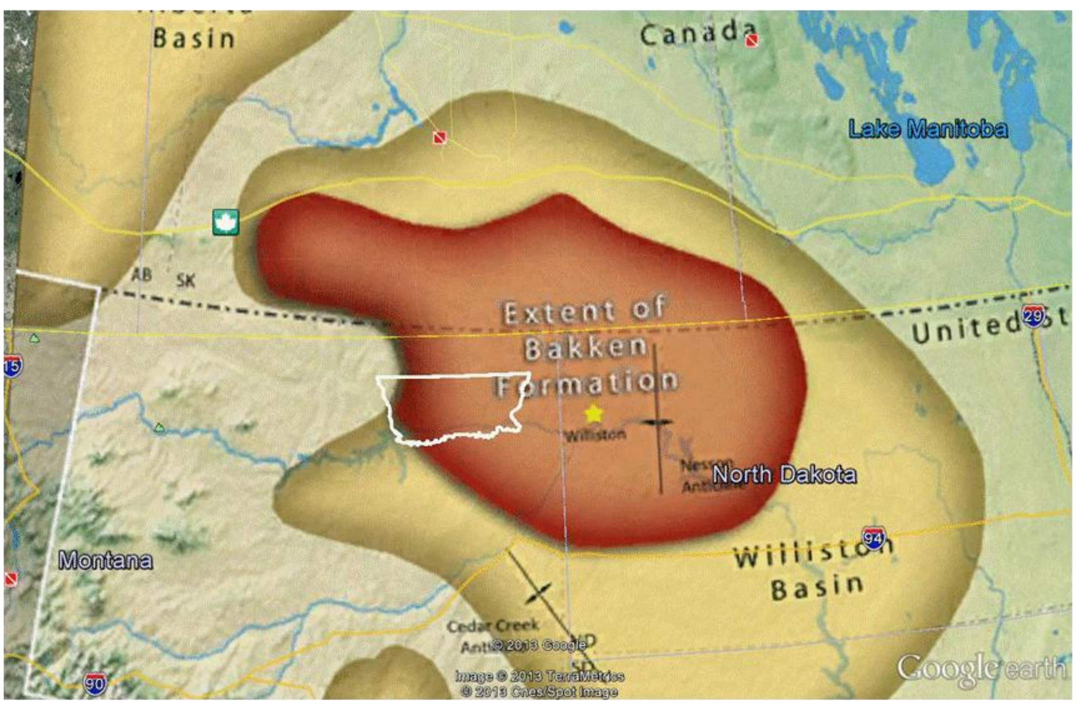


Figure 3 Extent of the Bakken Formation within the Williston Basin. The Fort Peck Reservation is outlined in white. The extent of the Bakken covers nearly 200,000 square miles from North Dakota – Montana into Canada.

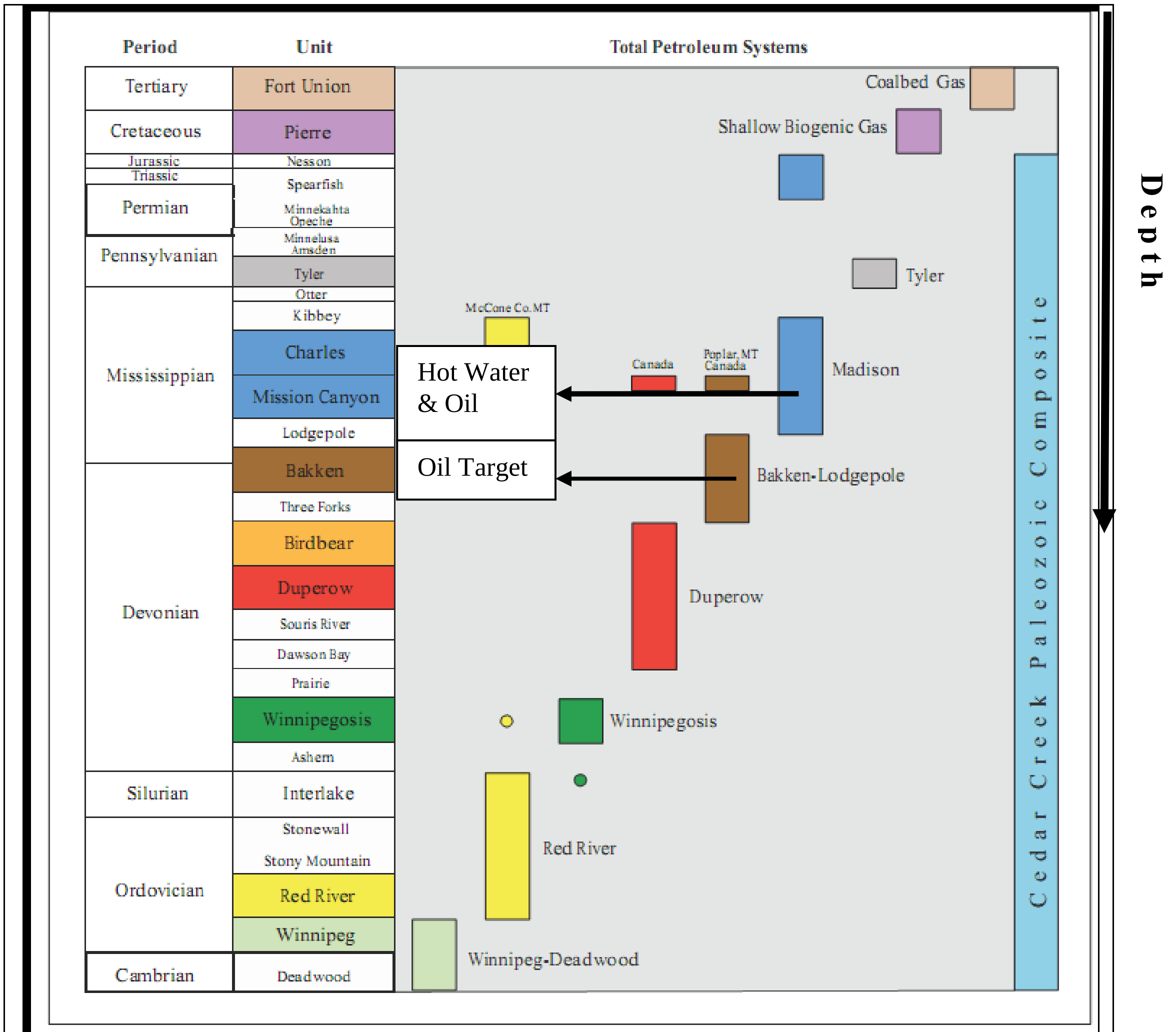


Figure 4 Stratigraphic column within Williston Basin. Modified after Ana, L.O, et. al., 2010, USGS. Note under column on left – Total Petroleum Systems, Madison overlies the Bakken-Lodgepole. Illustrates that drilling into the Bakken for oil would intersect the Madison with potential for hot water – geothermal. Thus the Bakken drilling is creating more geothermal potential for the Williston Basin.

The Madison formation appears to contain the greatest amount of hot water and thus has the greatest potential for geothermal production (not always the case, RMOTC is exploiting the adjacent rock unit, but also suggests a high increase in electrical power generation if the system can tie into additional hot water from nearby wells in Madison). All oil wells targeting the Bakken have to intersect the Madison formation (see figure 4 above). The dramatic increase in drilling for oil in the Bakken will increase potential access to geothermal waters in the Madison formation.

As new drilling expands westward into Montana and the Fort Peck Reservation to exploit the Bakken, it follows that the amount of available sites for potential geothermal should expand. The Madison still remains a target for oil production on the Reservation (as in the past).

III. Initial Objectives

Garry Carlson of Gradient Geophysics, Inc and Jeff Birkby of Birkby Consulting LLC analyzed the geothermal potential of coproduced oil and gas wells on the Fort Peck Tribes Reservation (FTPR) in northeastern Montana. This study, which lasted over two years, was funded by US Department of Energy, Tribal Energy program consisted of:

- Reviewing older studies of geothermal, geology and geophysics.
- Field visits to well sites and the FTPR for well locations and conditions.
- Maintaining contact with the geothermal community by conference and community presentations.
- Compiling new information, in particular on oil well drilling in the newly discovered Bakken formation within the Williston Basin.
- Computer compiling, plotting, and modeling the new results utilizing advanced GIS software as overlying layers over maps of logistical and cultural importance.
- Evaluating the feasibility of electrical power generation utilizing hot water coproduced from oil well production.

We undertook the investigation with initial objectives, some previous information, and a plan. This was presented to the Fort Peck Tribal Council in January, 2012 and summarized below:

- Evaluate the digital information in order to locate and potential, existing oil well that contains enough hot water and flow for electrical power generation.
- If we cannot locate an existing well, then locate an area with the greatest geothermal potential to drill a new well – using the wealth of information gathered from years of drilling.
- Take the analysis to the next level in developing an exploration "geothermal favorability map, or area including the possible identification of "new" areas.
- Select an area for a small geothermal power plant for the initial test, or other uses such as greenhouse heating or parasitic energy transfer to the oil fields.
- Propose the best fit for a geothermal power plan to provide a blueprint in future geothermal expansion for the Fort Peck Tribal community.

In the oil fields the coproduction of water and oil certainly provides the distinct economic advantage of utilizing wells that already exist, and avoid the expense of drilling. The water and oil are separated and the water is usually re-injected into the ground through injection wells. Theoretically, this "circuit" can be tapped into to draw the heat from the hot water (temperature and flow dependent) to power a binary fluid power plant. In addition, an oil field has a wealth of geologic information in order to expand the geothermal for the area. A lot of the exploration has been done by the oil companies. It is a matter of obtaining that information.

A. Economy of geothermal in oil field

Within these oil fields there are four (4) possibilities of exploiting the oil well drilling for geothermal:

- Utilizing hot water of an existing well at the separation cycle
- Tapping into a circuit of hot water and flow via re-injection sites
- Drilling a new well – but with much of the exploration done by oil drilling and exploration – piggybacking on the oil companies evaluations
- Reconditioning an old or abandoned well that has a good reported intercept

Figure 6 Field trip Fort Peck Reservation. Jeff Birkby of Birkby Consulting and Tashina Tibbits from Fort Peck Tribes Economic Development, inspecting area for evidence of older, oil wells.

Figure 5 Field Trip reviewing old wells on Fort Peck Reservation. Same field trip as in the figure left, January 12, 2012, (Right) Garry Carlson of Gradient Geophysics, Inc, (Left) Jeff Birkby, Birkby Consulting inspecting the location of an older "hot" oil well, now abandoned.

B. Economic Issues

The primary objective from this study was to determine the economic viability of the conversion of geothermal energy and waste from oil wells to convert heat to electrical power. Is there enough hot water and flow to power a geothermal power plant? And if so, what are the logistical considerations here? In addition to the technological challenges, but what may be the economic and cultural issues, for limiting or proceeding with a power plant at a favorable site? Some of these can be addressed by reviewing digital map layers such as Land Status maps with respect to land ownership and land issues over prospective geothermal sites.

IV. Past Studies

A. Two past studies

There are two (2) main studies that lead us in a positive direction for geothermal at the FPTR. Both studies looked at coproduced oil wells drilled in the past for the geothermal source. These are the PRC Toups study done in 1979 for indirect geothermal use, and the Black Mountain Technology study done in 2005 suggesting enhancing hot water flow in the hot wells and utilizing newer binary cycle power generation:

1) PRC TOUPS STUDY IN 1979 (PRCT study)
   - First study done on the FPTR for geothermal
   - Provided a wealth of background information from earlier drilling
   - Identified the East Poplar Field (oil field) for geothermal potential

2) BLACK MOUNTAIN TECHNOLOGY STUDY OF 2005 (BMT study)
   - Reviewed the PRC TOUPS data in light of newer, binary power plant geothermal technology
   - Suggested improving the geothermal potential of oil wells by well-stimulation to create greater water flow

The following is a list of positive factors gleaned from the past work that were "taken-away" and used and tested in the initial stages of our geothermal study: Note, within parenthesis denotes the study attributed to their conclusions and suggestions for the FTPR.

- HOT BHT's FROM OIL WELLS DRILLED INTO THE MADISON FORMATION (PRCT, BMT)
- GREATER THAN 260 F GEOTHERMAL WATER (PRCT, BMT)
- DEPTHS OF 5500 to 8200 FEET TO THE GEOTHERMAL WATERS (PRCT, BMT)
- 20,000 BARRELS PER DAY OF GEOTHERMAL WATERS (PRCT)
- THIS FLOW MAY BE DOUBLED WITH WELL STIMULATION (BMT)
- STRONGLY SUGGEST POTENTIAL FOR ELECTRICAL GENERATION (BMT)
- DIRECT US IN A LOCALITY – POPLAR DOME, EAST POPLAR FIELD (PRCT, BMT)
- DIRECT US TOWARDS A GEOLOGIC FORMATION – MADISON (PRCT, BMT)
- SUGGEST THERE IS ADDED POTENTIAL – DEEPER SOURCE (PRCT, BMT)
- SUGGEST THERE COULD BE A FRACTURE SYSTEM (PRCT, BMT)

B. Gaps from previous studies

The PRC Toups (PRCT), 1979 study was undertaken on the FPTR primarily to examine geothermal energy for space heating and greenhouses. The Black Mountain Technology (BMT) study in 1995 used that information to suggested the using the binary technology which permits the use of lower temperatures (other than steam) such as found on the FPTR. These technologies did not exist in 1979. BMT indicated the water flow could be increased in the hotter wells to a level that meets the requirement to run a geothermal binary power plant, keeping in mind that we need both high temperatures and high water flow for geothermal electrical power generation. However, there were gaps to fill, especially in light of the new drilling information on the FPTR (following):

First Study's gaps to fill:
PRC TOUPS SURVEY:

- MAIN PROBLEM – IT IS A 1979 SURVEY (33 years old)
- THEY DID NOT HAVE THE MODERN GEOTHERMAL TECHNOLOGY
- THERE IS A LOT MORE INFORMATION OVER THE LAST 3 DECADES
- THERE IS A MUCH BETTER SCIENTIFIC ANALYSES OF PUTTING TOGETHER INFORMATION – for decisions

Second study's problems:
BLACK MOUNTAIN TECH STUDY:

- MORE RECENT, BUT STILL 7 YEARS OLD – 2005
- NO IDENTIFIABLE DRILL HOLE OR TARGET ALTHOUGH THEY HAD SEVERAL EXCELLENT SUGGESTIONS ON HOT WATER FOR POTENTIAL ELECTRICAL (coproduced oil wells)
- NO EVIDENCE OR REPORTS WITH DIGITAL DATA – THERE NEEDS TO BE GOOD SPATIAL DATA MANAGEMENT

V. Current studies

The data from these older studies are too scattered or incomplete to make a reasonable scientific evaluation and interpretation on which to base an electrical generation project. The gaps needed to be filled are an issue of spatial data management, the digital outline and overlays we need to put together a comprehensive and cohesive evaluation. We used as a blueprint, two (2) current geothermal projects in the coproduced oil fields, which are very similar to our study on the FPTR:

- UNIVERSITY OF NORTH DAKOTA – WILLISTON BASIN (UND)
  - Within the Williston Basin in neighboring North Dakota, Will Gosnold and UND have identified several potential oil wells for binary cycle geothermal power plants.
  - UND is working in the Williston basin with co-produced wells owned by oil companies; these same issues are present at the Fort Peck Reservation
  - The geology is essentially the same – most of the hot water comes from the geologic formation - the Madison Formation.

- ROCKY MOUNTAIN OILFIELD TESTING CENTER – (RMOTC)
  - Successfully installed a power plant on a coproduced oil site.
  - Area in Wyoming using old oil field with co-produced wells.
  - Also in the similar geologic formations with hot water

A. University of North Dakota

Will Gosnold, leading the geothermal at the University of North Dakota has several sites that appear to have the hot water and water flow to economically fit a small binary cycle geothermal power plant. This would be the second fitted on a oil field with coproduction. The work that UND has done will provide an economic "blueprint" for geothermal power in the Williston Basin. This will be covered in detail in the next section (Power Plant Economics) in this report.

B. RMOTC, Wyoming

The Rocky Mountain Oilfield Center or RMOTC has geothermal energy within a coproduced field, the Teapot Dome oil field in northeastern, Wyoming (see figure below). Located on Naval Petroleum Reserve #3 (NPR-3) RMOTC is a 10,000 acre site operated by the Department of Energy (DOE) to test renewable energy technologies. It has a cluster of oil wells with coproduced hot waters with a strikingly similar geologic setting as the Polar Dome Oil Field on the Reservation – with hot water intersected in the Madison Formation, among others. The area showed a success story in the fitting a geothermal power plant to a coproduced oil and water site, very similar to the FTPR and using it to generate electrical power. Ormat Technologies successfully fitted a 250 KW, Organic Rankin cycle power plant as a demonstration project.

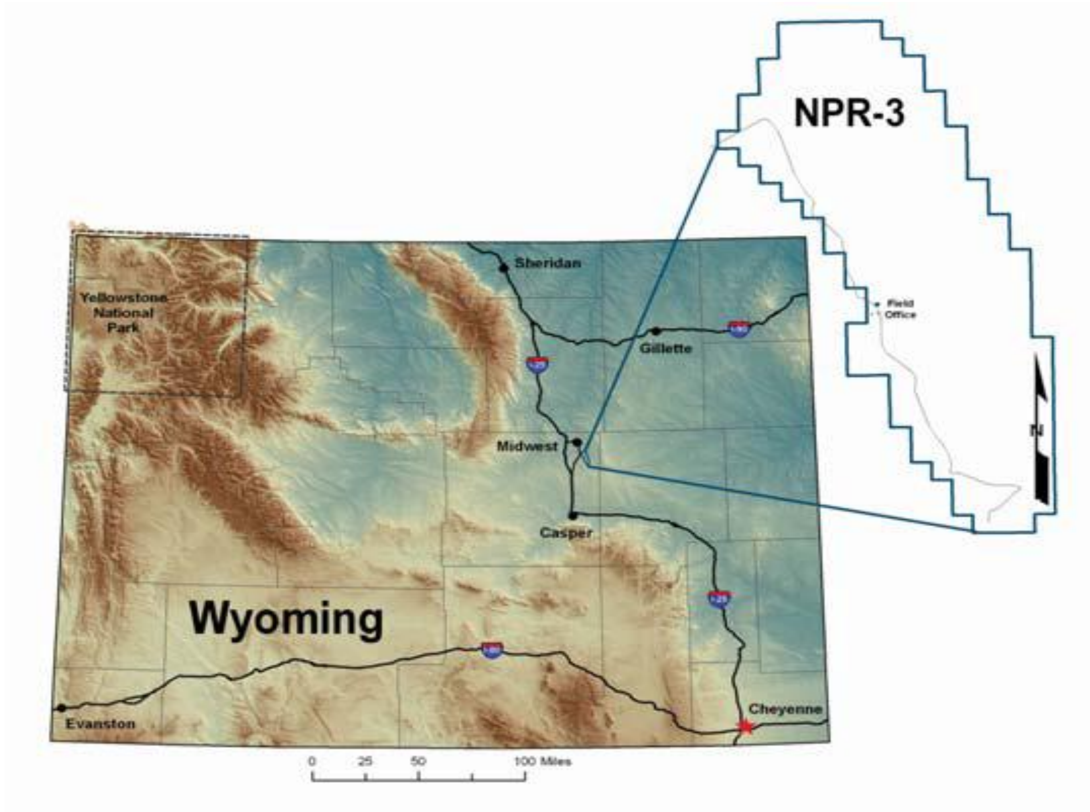


Figure 7 RMOTC test site. Location of renewable energy test site. First site for electrical power generation on coproduced fields from geothermal waters. Taken from RMOTC 2008 presentation.

RMOTC recognized the need to put together a comprehensive picture of the geothermal potential. They emphasized basing the study was critical on good Spatial Data Management (SDM) for further exploration and evaluation. The "older" data could not be relied on with older hand drawn maps and locations that were not accurate.

See figure 6 below; RMOTC emphasized in their 2008 slide presentation, “Where we’ve been” that SDM is necessary. Past evaluations could not proceed because; wells were incorrectly located on maps that were hand drawn and “other” data were plotted using AutoCAD drawings with non-standardized coordinate system.

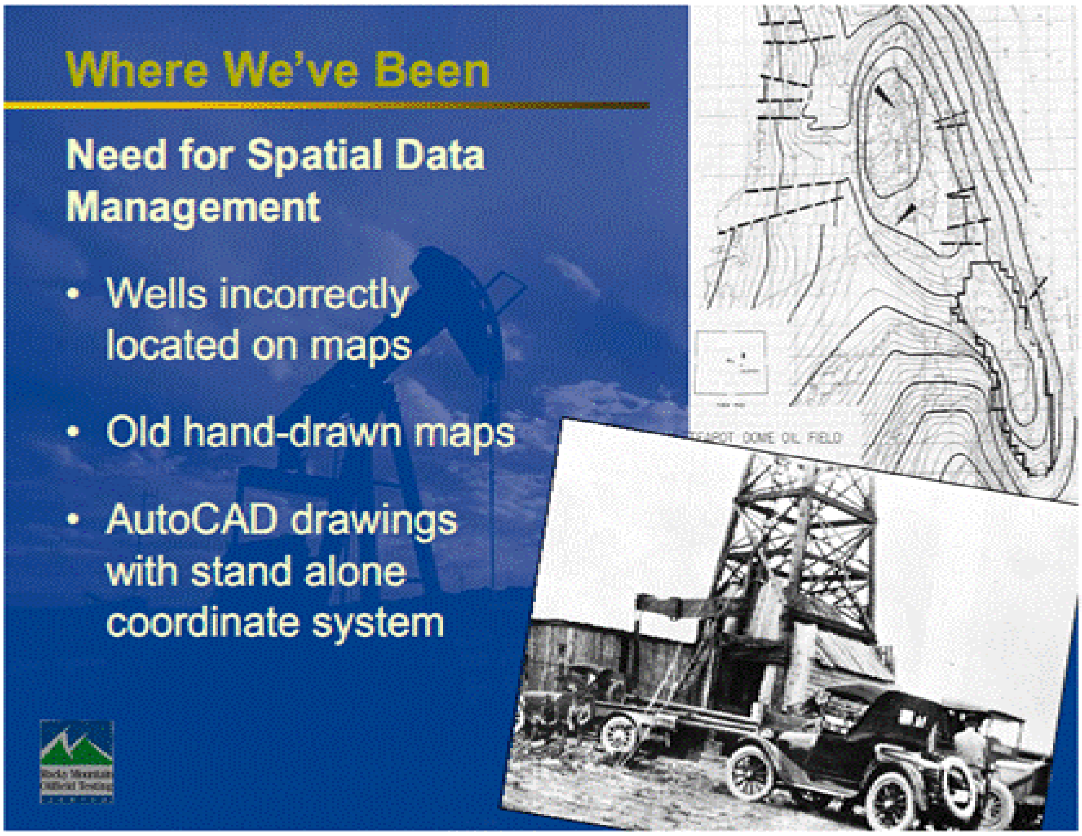


Figure 8 ROMTC, need for Spatial Data Management. From RMOTC slide show, 2008 indicating the problems going forward with geothermal evaluation.

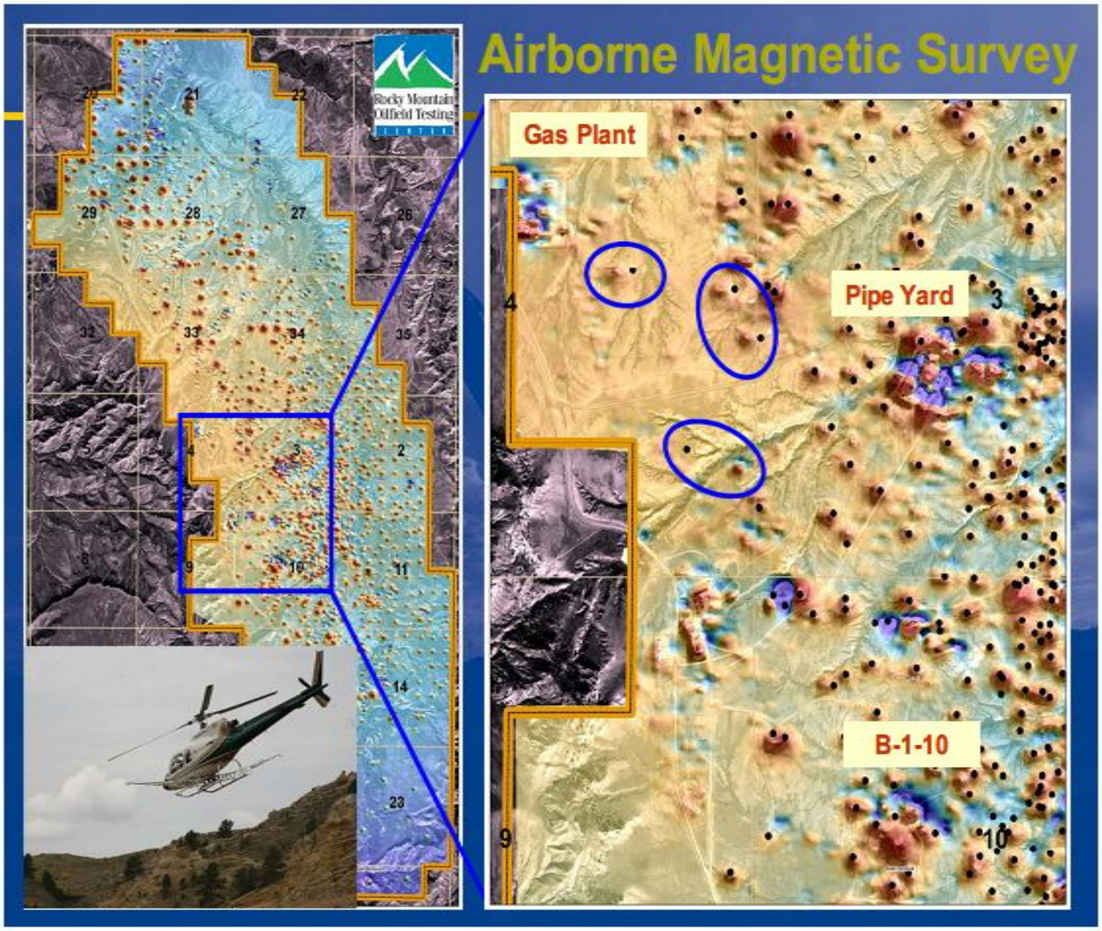


Figure 9 Airborne magnetic results over RMOTC. From a 2008 presentation showing the magnetic responses from well sites. Results were collected by magnetometer and electromagnetic equipment flown by helicopter (as seen on insert, bottom-left).

Figure 10 Identifying oil wells, RMOTC. The maps provided by the magnetometer survey show well sites, bridges and storage facilities can be accurately mapped (2008, RMOTC)

RMOTC, as one of their first steps, commissioned an airborne magnetic survey over their test sites in order to locate oil wells (new and old), storage facilities, drill rigs and even mapped a bridge crossing at Teapot Creek (see above). With the magnetic survey, they were able to locate "older" oil wells that did not exist on any previous maps.

RMOTC made great progress in evaluation of geothermal area mapping geologic and cultural features (such as drill sites) with an airborne magnetic survey. The data allowed them to locate drill sites and plot with accuracy with the magnetic data. The fact that we have airborne magnetics as wells as electromagnetics (EM) from the 2004 USGS survey, we used RMOTC as a blueprint for the initial SDM.

VI. Additional studies: Geophysical and Geological

A. USGS Geophysical survey over the East Polar oil field

A geophysical study by the UGSG was undertaken in 2004 to investigate possible contaminant plumes of water with the shallow aquifer at the East Poplar Oil Field. Airborne geophysics consisting of: 1) High Resolution Magnetics and, 2) Electromagnetics (EM). The study area is outlined below (Figure 11, red rectangle in south).

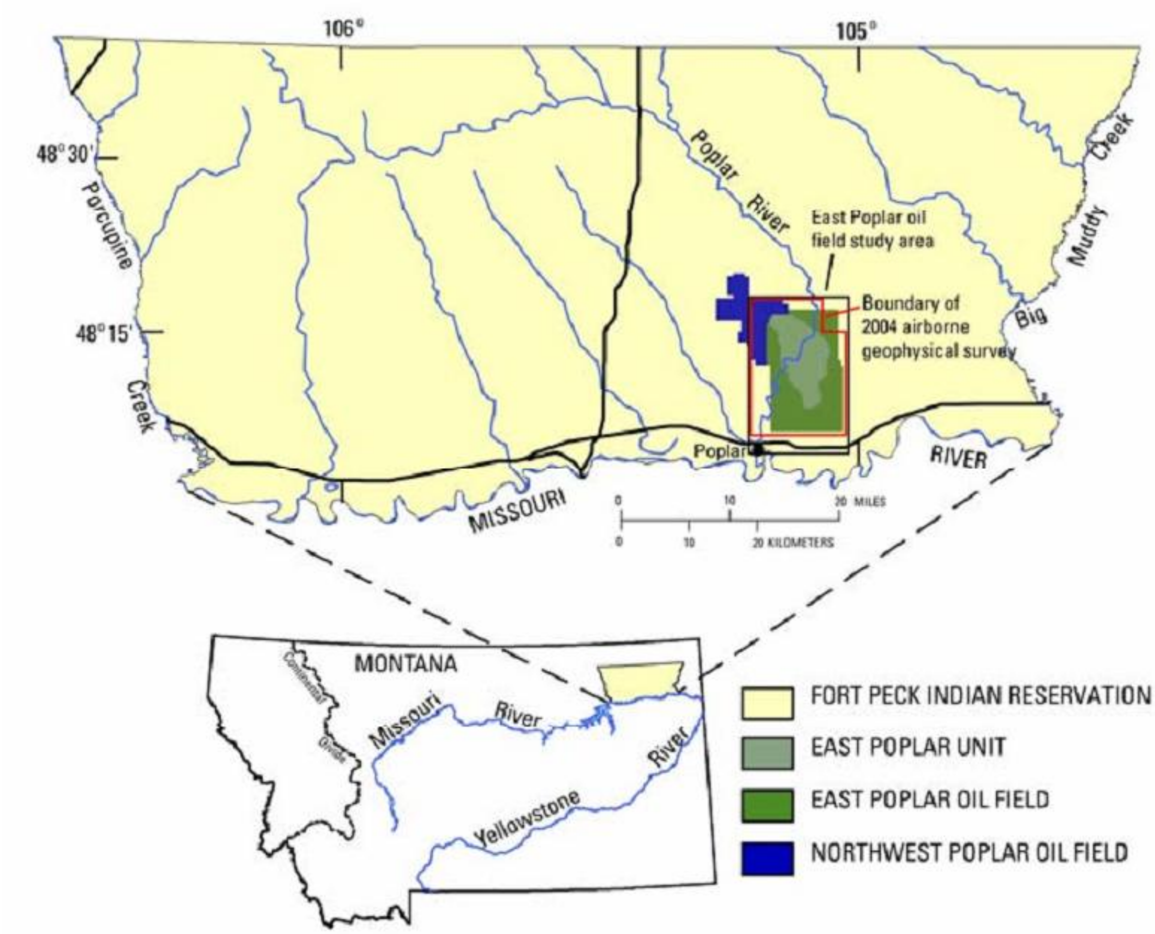


Figure 11 Location map for USGS geophysical survey. Detailed helicopter magnetometer and electromagnetic surveys were collected by the USGS over t the East Polar Oil Field and the Northwest Polar Oil Field outlined by red rectangle. See Smith, B. D. et. al., 2006 provide a detailed description for the survey and results.

Although this airborne geophysics survey was conducted for an environmental study by the USGS, the magnetics data collected over the Poplar Dome was of equal quality, or better than the RMOTC survey (described above). In addition, EM data were collected using 6 different frequencies for varying depths of detection and a coaxial and coplanar coils (for detection of vertical and horizontal resistive features). The EM data were of little use for our geothermal study (other than the plot of 60 Hz power line monitor), because they responded the near surface soil features. The technical details of the survey including techniques and equipment are beyond the scope of this report, for that information refer to: Smith, B. D. et. al. or Smith, B.D., Thamke, J.N., Cain, M.J, Tyrrell, C., Hill, P.L., 2006.

1. Magnetics

In our geothermal study, we utilized the data (primarily magnetics) to identify targets related to our objectives in evaluating the areas for geothermal potential (customized). We used the magnetics data for SPD, much in the way RMOTC did which provided an excellent baseline of cultural and geologic information. Since the USGS collected the data for the Fort Peck Tribes; magnetics data, results, maps, and grids were available on the USGS web site. Below is a color contour image of the magnetics from the 2006 USGS report for the East Poplar Field- a priority site for geothermal on the FPTR.

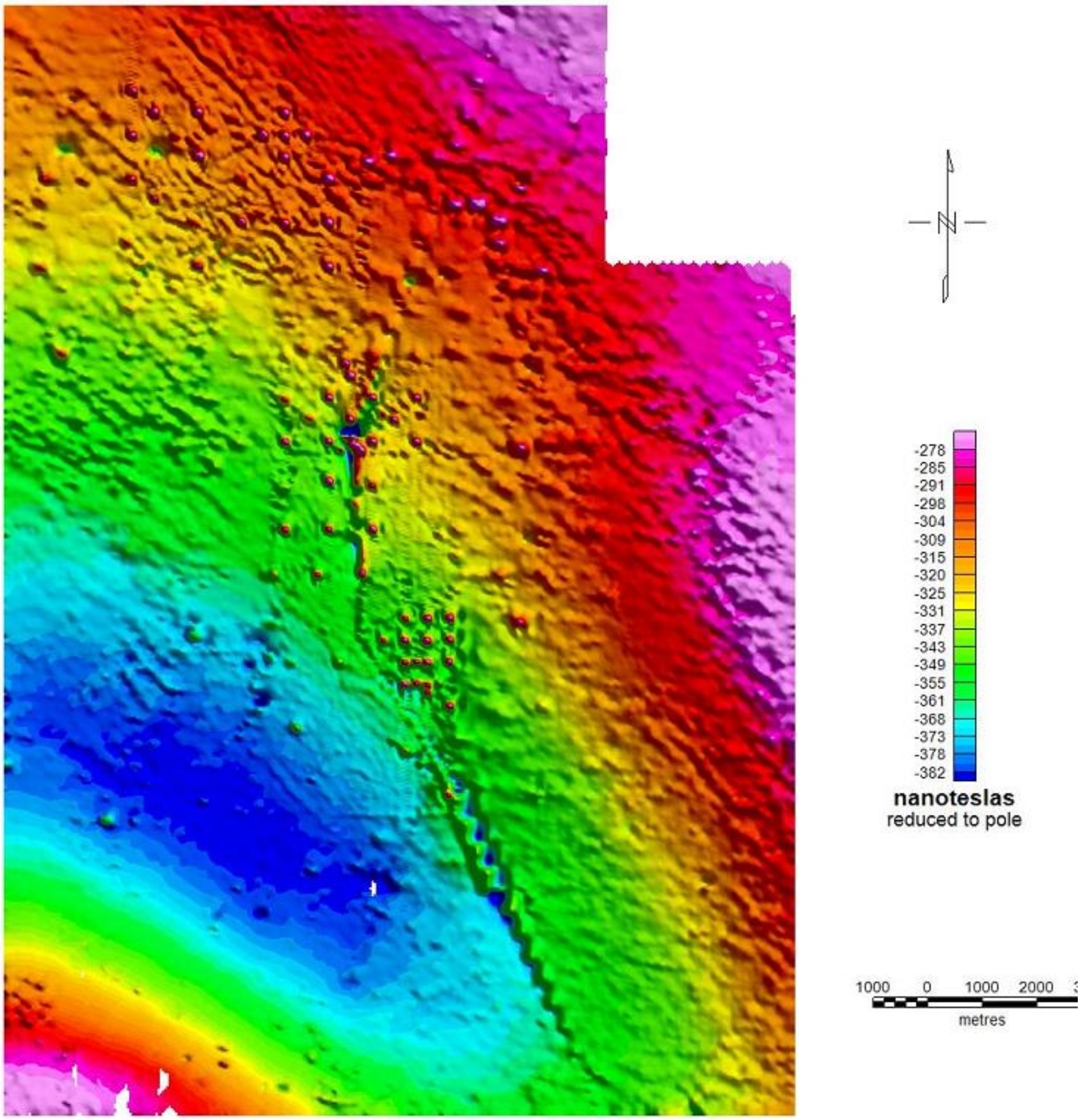


Figure 12 Total Field Magnetics for East Poplar Oil Fields. From the USGS helicopter, geophysical survey in 2004 (Smith, B D., et. al., 2006). This a Reduced-to-Pole filtered map provided by the USGS.

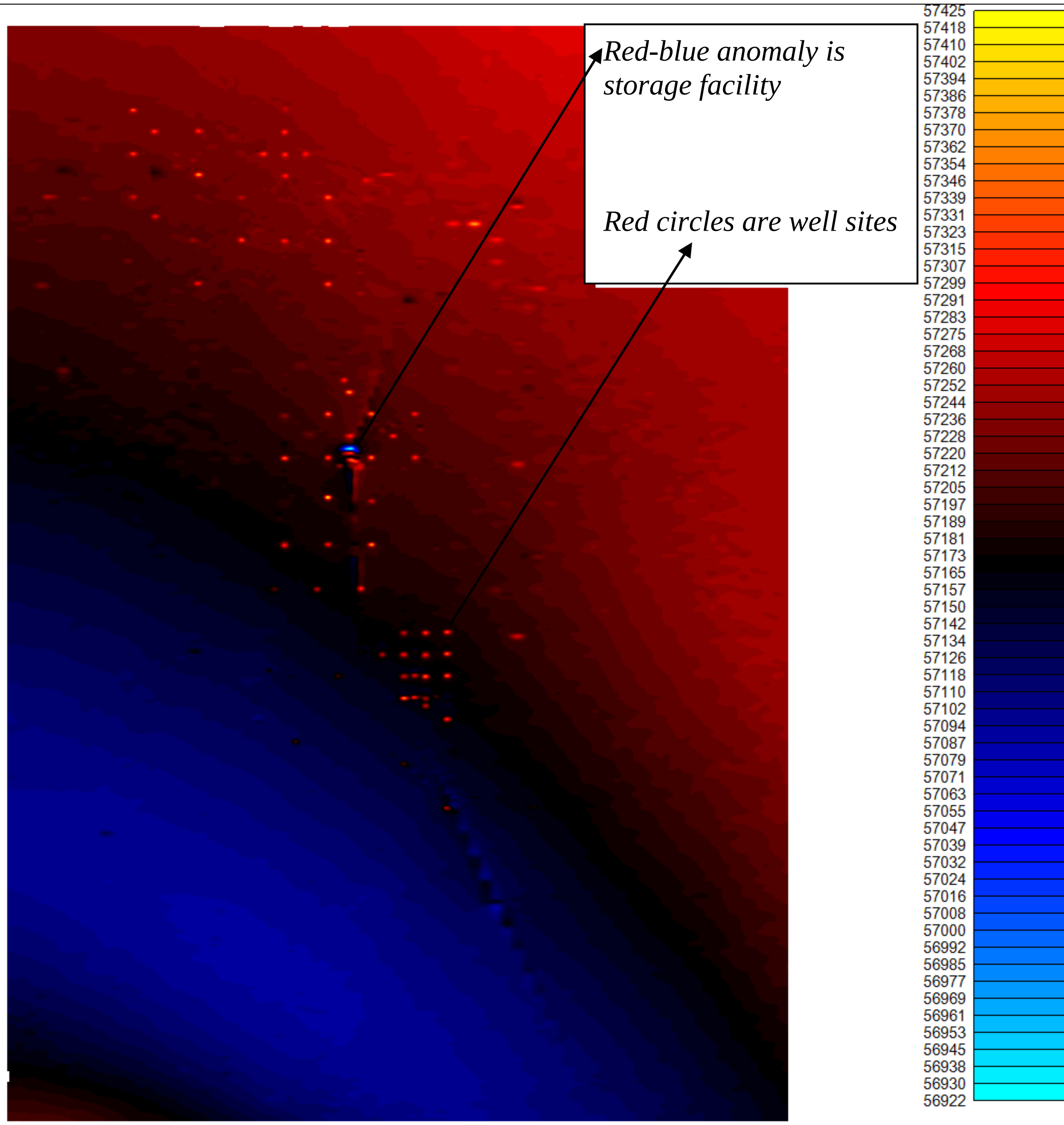


Figure 13 Color contour map of magnetics of East Poplar Field by Gradient Geophysics, Inc. Note red circles above, some forming a grid, denotes oil well sites (as of 2004). Red and blue, dipolar anomaly in center represents storage facility, Color plot derived by using Geosoft – hot-cold color gridding scheme to highlight the high frequency (smaller) features such as drill sites (cultural metal) Right scale bar is in nanoTeslas. Higher magnetic responses are in warm colors – yellow to red, lower magnetic responses are in cooler colors – blue to aqua. Gradient gridded and customized the plotted magnetics data for target identification. All data above are airborne magnetics data (Line data in Geosoft xyz format) derived from the USGS 2004 survey.

We (Gradient Geophysics, Inc.) incorporated the airborne data to derive our own grids and plots, tailored to outline targets of particular interest, for example, plotting and locating exact locations of oil infrastructure, or deciphering geologic faults by enhancing linear magnetic lows (blue). We used extensively our licensed copy of the Geosoft program for geophysical and geologic evaluations, which enabled us to perform a variety of gridding, digital filtering and plotting capabilities all towards producing a “library” of geo-referenced color maps. These geo-referenced, digital “maps” then were used as “layers” or overlays in the SPD of this geothermal study.

We customized the color contour plot (figure 13) to highlight certain targets that we were focusing on in the East Polar Field. The plot above is derived using Geosoft – hot-cold color gridding scheme to highlight the high frequency (smaller) features such as drill sites (cultural metal).

Locations of oil wells stand out as bright orange-red circles, and in some cases show the drilling scheme that was used (refer to lower arrow in figure 13). Note, we were able to delineate larger cultural features, such as the storage facility for a series of reinjection sites (see northernmost arrow in figure 13 that outlines a dipolar red-blue anomaly). We “ground-truthed” these magnetic anomalies a field visit using a hand-held GPS. They proved to be “exactly-on” for our purposes.

All plots of the airborne magnetic data to follow in this report, Gradient gridded and plotted utilizing airborne magnetics data (Line data in Geosoft xyz format) from the USGS 2004 survey. The USGS geophysics data is available on line in Geosoft xyz and Geosoft grid, and Geosoft map formats (see Smith B. D., et. al, 2006)

2. EM data and results from USGS 2004 survey

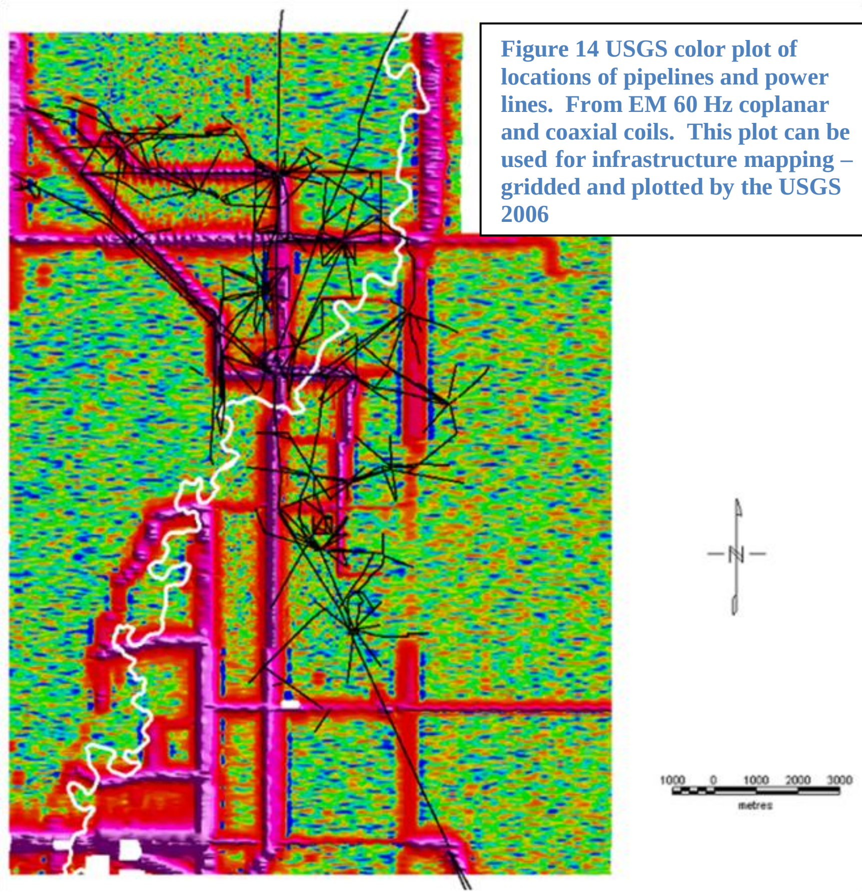


Figure 14 USGS color plot of locations of pipelines and power lines. From EM 60 Hz coplanar and coaxial coils. This plot can be used for infrastructure mapping – gridded and plotted by the USGS 2006

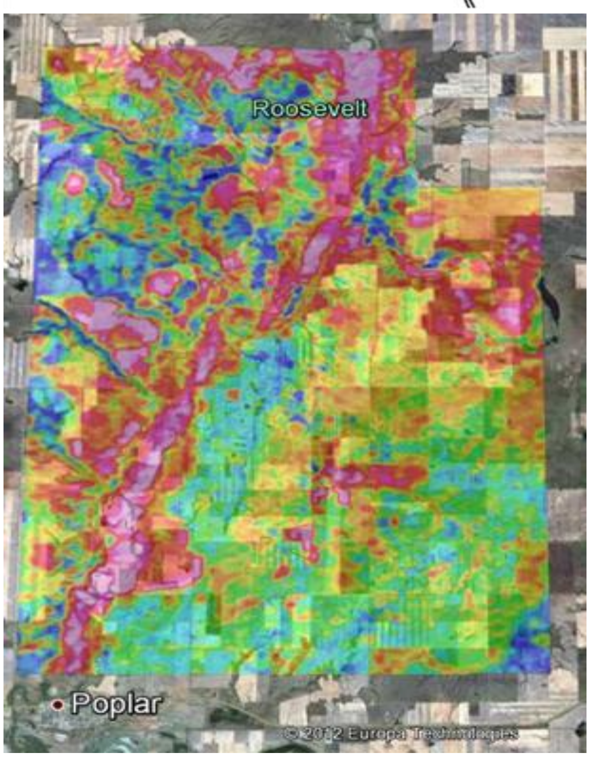


Figure 15 Color contour plot of EM data 8200 Hz. Data from USGS EM survey over East Poplar Field, Gradient gridded and plotted using Geosoft program then overlaying on Google Earth Pro

From the USGS site, the line data was provided in Geosoft format; we took the line data and performed our own gridding and plotting. These plots then could be seamlessly overlain, or used as a "layer" and displayed on Google Earth Pro.

B. Geologic information - Bakken oil boom – new BHT information

The Bakken oil "find" provided the impetus for increased drilling in the FTPR. New drill holes in the Bakken will have to intercept the overlying Madison formation which contains some of the hottest geothermal waters.

The new drill hole data was deposited in the DNRC web site of the MBOG as database information including a) drill hole locations, b) BHT's, c) formation tops of main rock units that the drill bottomed in, and water and oil flow (sometimes) among other information. We also plotted and utilized the main rock unit information to plot the tops and the thicknesses of rock units for geologic information. The database grew rapidly as drilling expanded during our study, so that it was sometimes difficult to take a "snapshot" in time. The rapid increase in data base information provided a wealth of geologic information on rock units (described in Evaluation below). The "snapshot" of data used for the Evaluation is listed below:

Data Analysis—as of end 2012

- *760 bottom hole temperatures*
- *Precise location of drill holes*
- *Flow rates for existing wells*
- *Reinjection well locations*
- *Infrastructure near best wells*
- *Land Status – identify favorable land*
- *Well intercept stratigraphy*
- *Formation thickness*
- *Airborne magnetometer and EM data*
- *Not only flow rates for wells, but water quality rates as well*

VII. Evaluation

A. Temperatures

We compiled a large data base of over 750 Bottom Hole Temperatures (BHT's) from the MBOG site during the time of this study (as of January, 2013). These well data were sorted, organized and analyzed from an area covering almost 1500 square miles. Geographically, the data set was defined by digitizing the FPTR boundary – and include those data contained within those UTM coordinates.

Figure 16 below is a color plot of the culmination of BHT's for the FPTR. This map can be used to show the overall geothermal potential (a "Geothermal Potential Map") of the FPTR, where the highest temperatures are depicted by the "hotter" colors from gold (highest), to yellow, to red. The lower temperatures are indicated by the "cooler" colors of blue, with a shading of lighter-blue to illustrate the range – grading to the lowest temperatures.

Note: generally the higher temperature areas are located in the eastern part of the FTPR where the oil drilling has focused. The lower temperature areas are located in the western area, and away from the focus of recent oil drilling. The temperatures above 200 degrees F (figure 16 scale bar of degrees F on the right), are among highest temperature recorded for geothermal waters recorded in Montana for such a broad area.

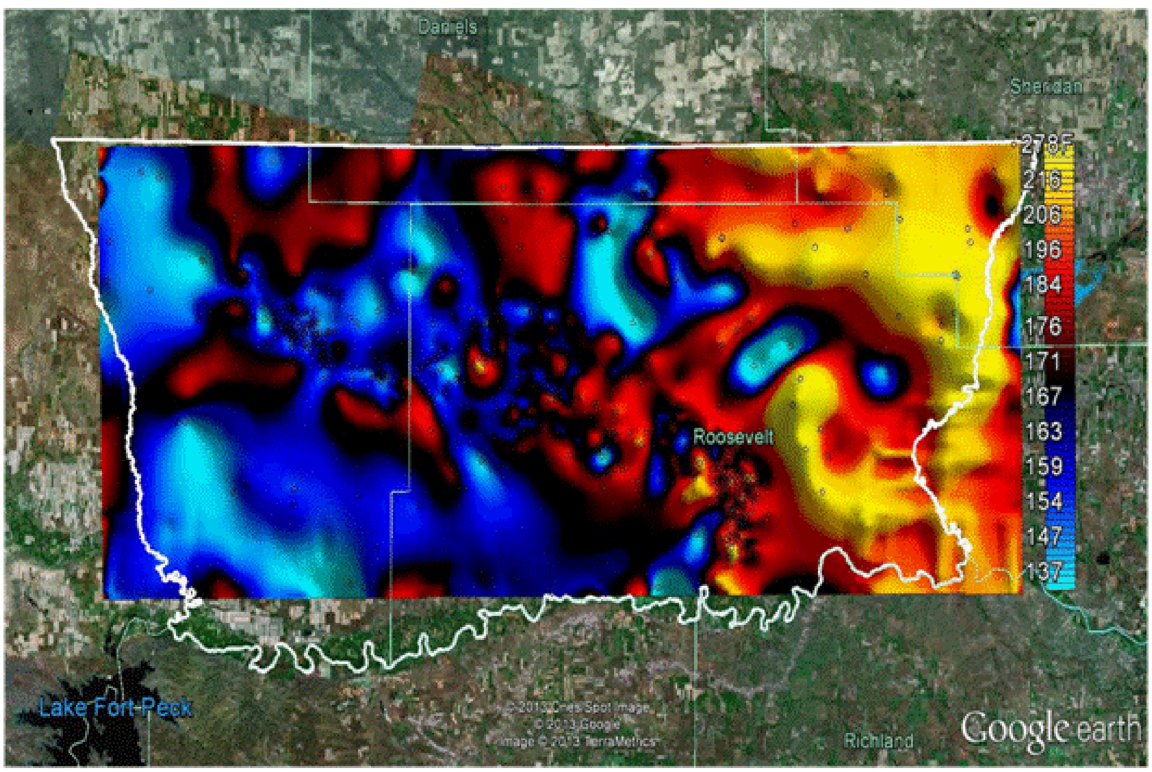


Figure 16 Color contour map of Bottom Hole Temperatures for the Fort Peck Tribes Reservation. This map can be viewed as a general "Geothermal Favorability Map" for the Tribes.

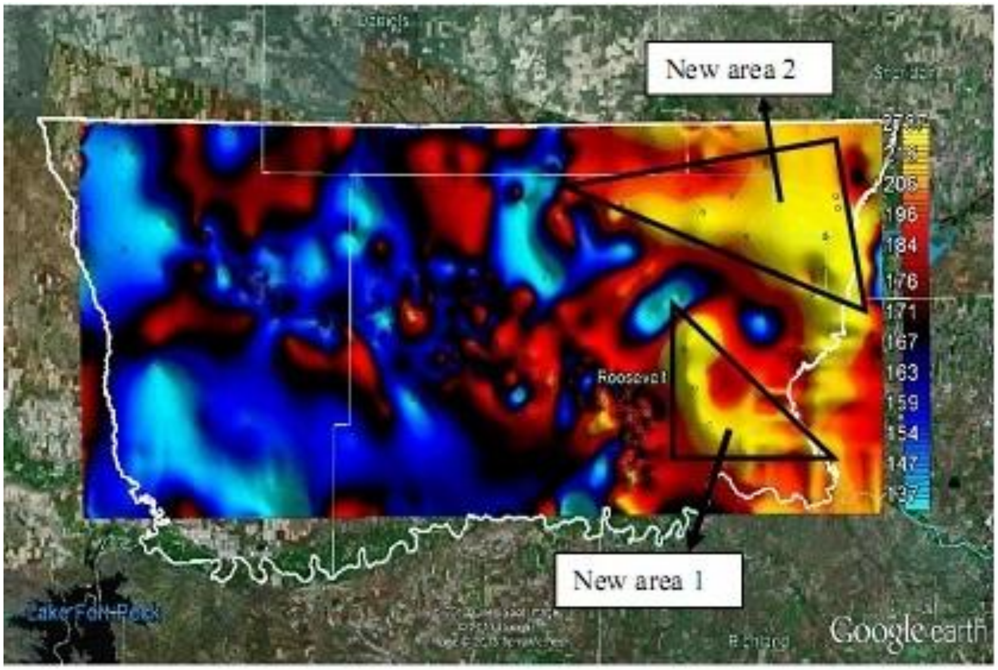


Figure 17 Map of total Bottom Hole Temps with 2 new areas outlined

The two (2) new areas of significantly higher temperature areas in the east are a surprise (see figure 17 above). They suggest a new area (eastern FPTR) of unrecognized geothermal potential. However, the sparse and scattered drilling here does not provide enough attention at this time to evaluate this new area in detail. With the drilling boom there will be new drilling in this area – these areas - with the high temperatures of > 200 degrees F certainly indicates a much greater potential for geothermal in the future on the FPTR.

B. Poplar Dome

The major oil drilling is located within the Polar Dome area just north of the town of Poplar; where the most drill holes that have intersected the hot water in the Madison formation. Since there are more drill holes here, the variation in temperatures are greater -   thus the color contours are somewhat diffused in the large scale color plot above by the shallower wells that did not intersect hot waters in the Madison formation (as opposed to New Area 1 which has only 5 wells in a larger area).

Figure 18 below shows where the area of the Poplar Dome is relative to drill hole data. The figure on the left shows the division into West Poplar Field and East Poplar Fields (EPF).

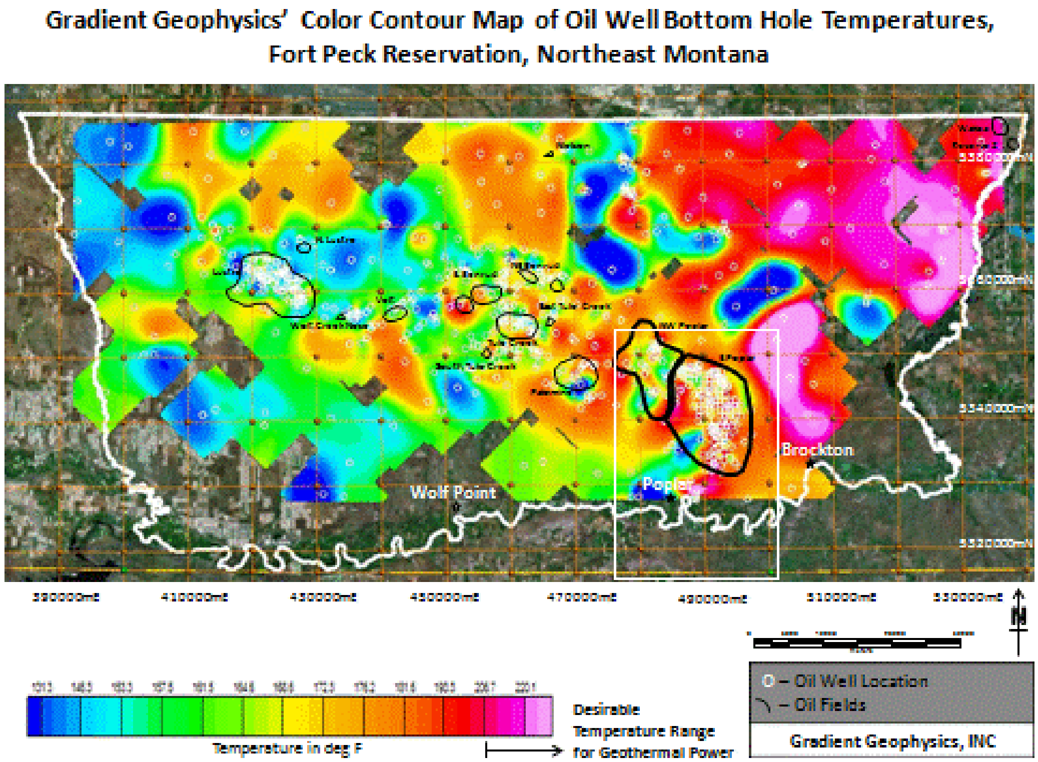


Figure 18 Different Version of color contour map. South area showing East Polar Oil field and West Poplar Oil Field

C. East Poplar Field (EPF)

The EPF is where most of the drilling has been concentrated and also has the highest potential in regards to temperature, water flow and infrastructure such as a network of wells. This network included important "tie-in" locations for several wells into one area or re-injection at the EPF. These were effectively "mapped" by the results of the airborne magnetometer survey conducted in 2004. Locations of oil wells later than that 2004, were filled-in by plotting drill hole sites from the FPTR data base. Data for this area was extracted in evaluated in more detail to focus in on the geothermal for the wells here.

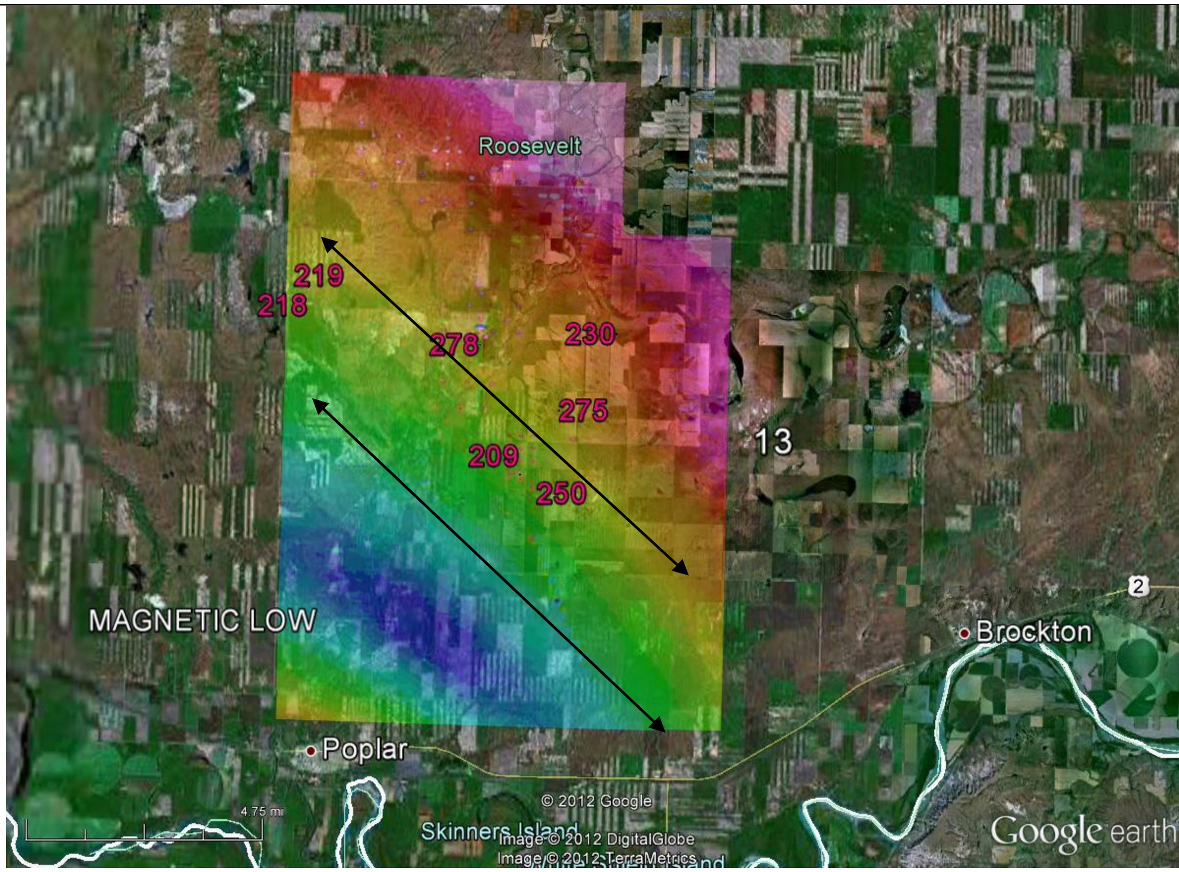


Figure 19 Plot of high temperatures (BHT) in degrees F and marked in red in the EPF oil field area over the results of the airborne magnetic survey in Roosevelt County. Note the very high temperatures of 278 F and 275 F. Arrows denote general trend of magnetics and subtle trend of high temperatures. (The number 13 in white refers to UTM spatial datum zone for this area)

The locations of the highest BHT's are depicted over the color contour map of the magnetics as seen if figure 19 above. Note the trend in shades of color, in particular the magnetic low outline in blue just north of Poplar – trending from northwest to southeast. There appears to be a similar, but more subtle trend in the high temperatures. This may indicate a large – scale, deep seated, geologic structure.

Near the high temperatures posted on the plot above, are subtle, red circles. These are particularly evident around the 278 F temperature. These circles are from the magnetic responses of iron (drill steel, etc), and designate locations of drill holes as of 2004 when the magnetometer survey was conducted. Upon closer examination (see figure xx, below) the drill holes stand out and the exact drill sites can be mapped.

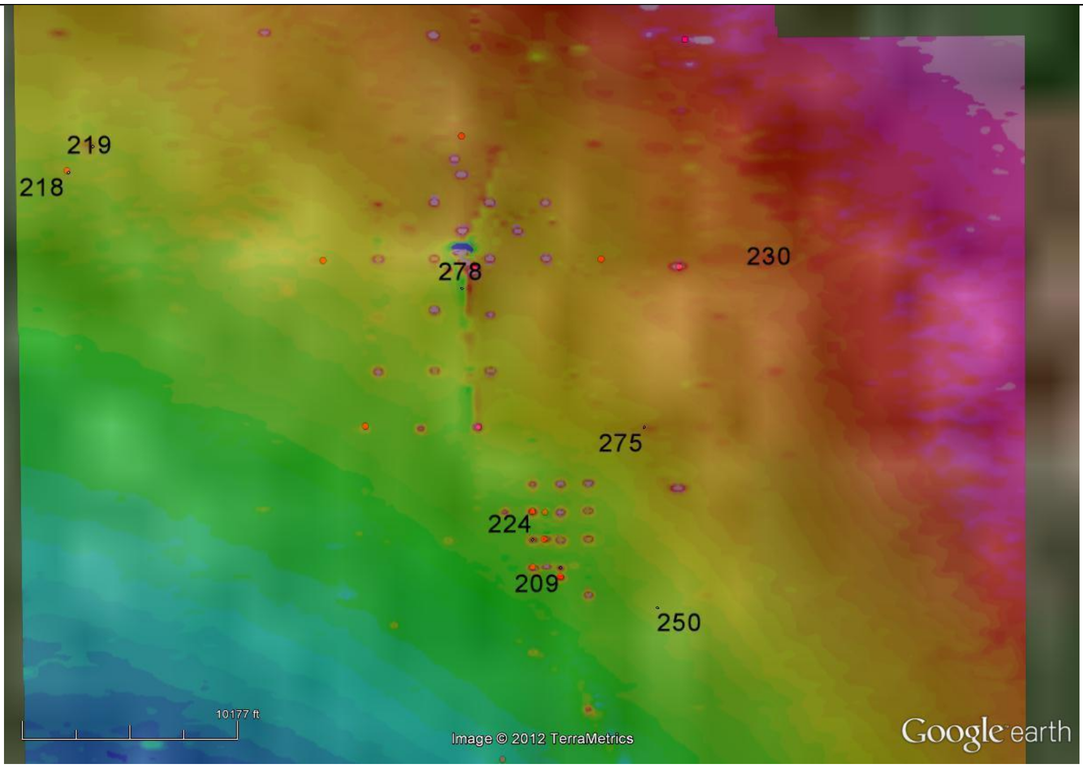


Figure 20 Plot of high Bottom hole temperatures with underlying color contour map of magnetics within East Polar Field. In the central area- 278 is 278 degrees F, the red-blue dipolar magnetic anomaly just north of the high is a storage facility; the red circles indicating oil well sites. Re-injection sites, important for tying water flow (increase) are depicted as fluorescent orange (brighter)

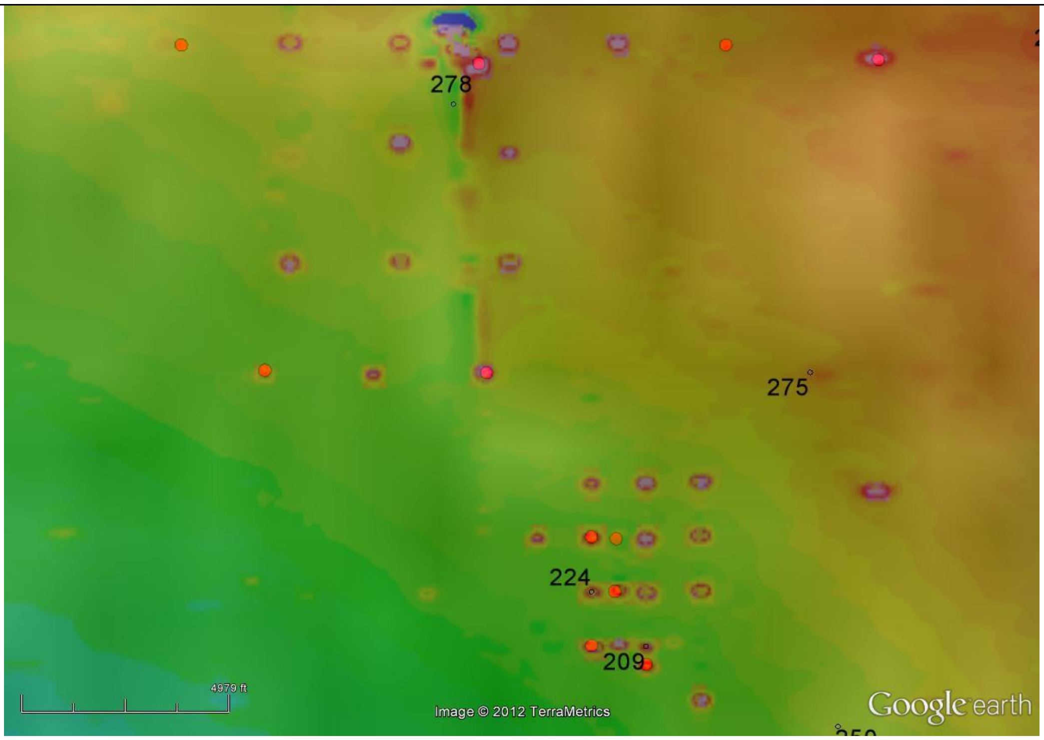
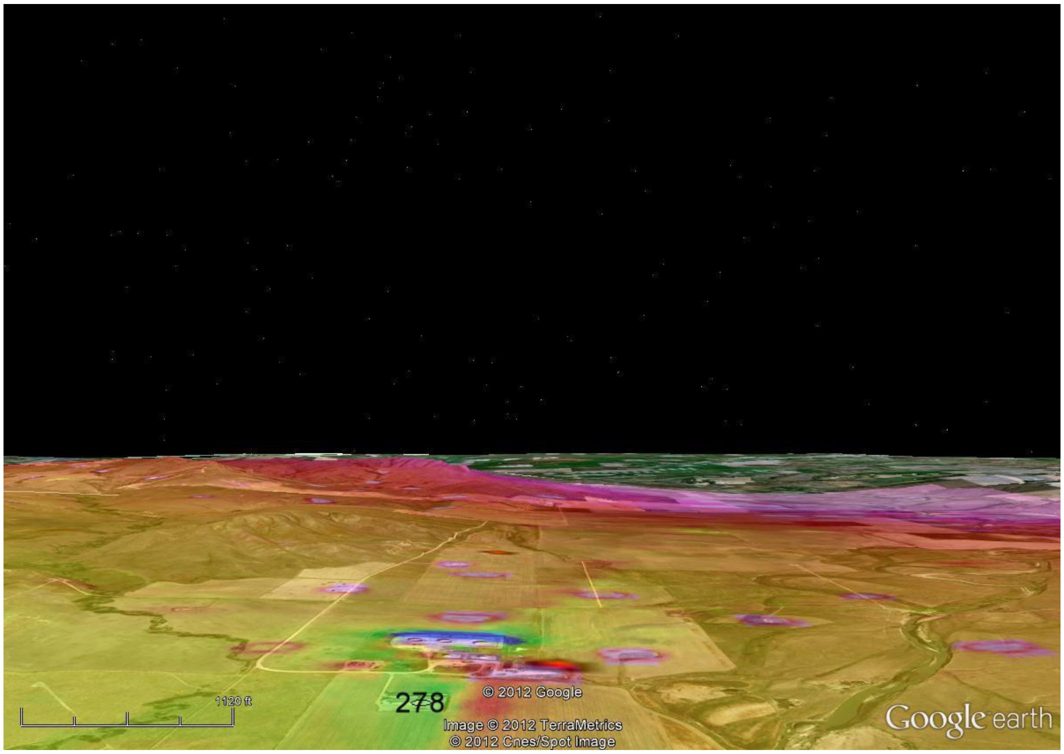


Figure 21 Plot of high temperatures over magnetics in oil field. A closer view, with bright orange circles showing location of re-injection points.

Figure 22 Hot well of 278 F. The well is plotted over the color contour map which is "layered" over a Google Earth Pro image. This show topography as well as infrastructure. Night sky image for contrast.



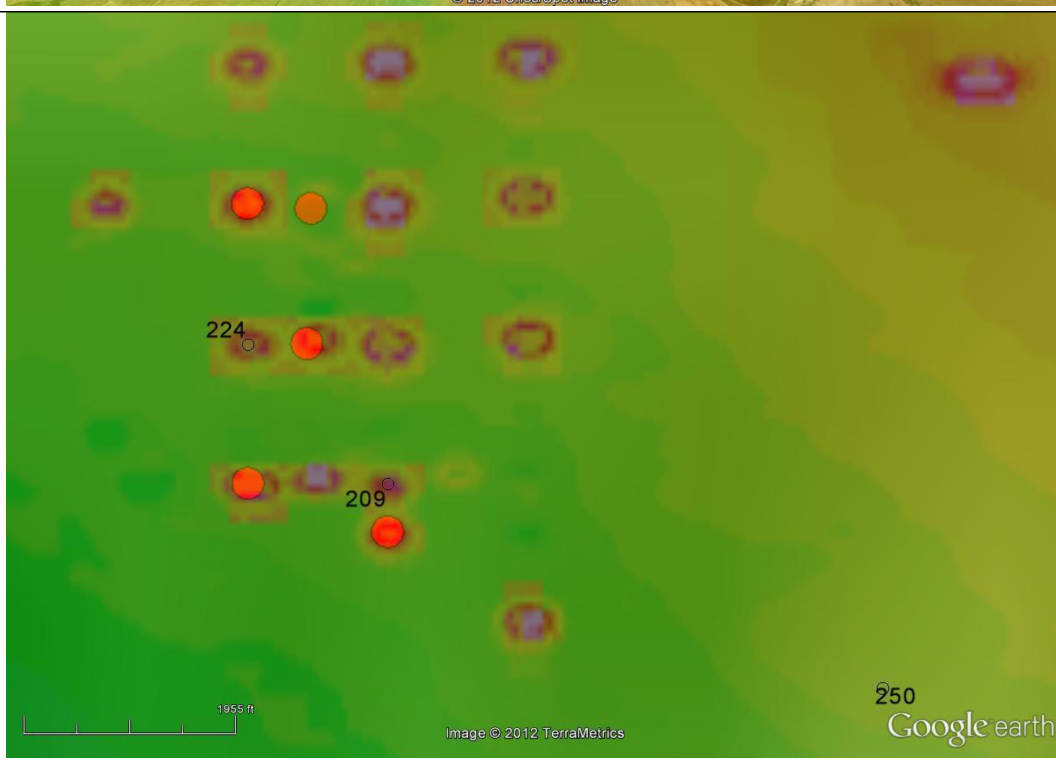


Figure 23 Plan view of the southern area of well grid. The plot shows the network of re-injection wells (in fluorescent orange) and the "older" well sites in subtle red circles (from magnetic response. North in figure 8, is the north half of the network of wells – with an inclined view.

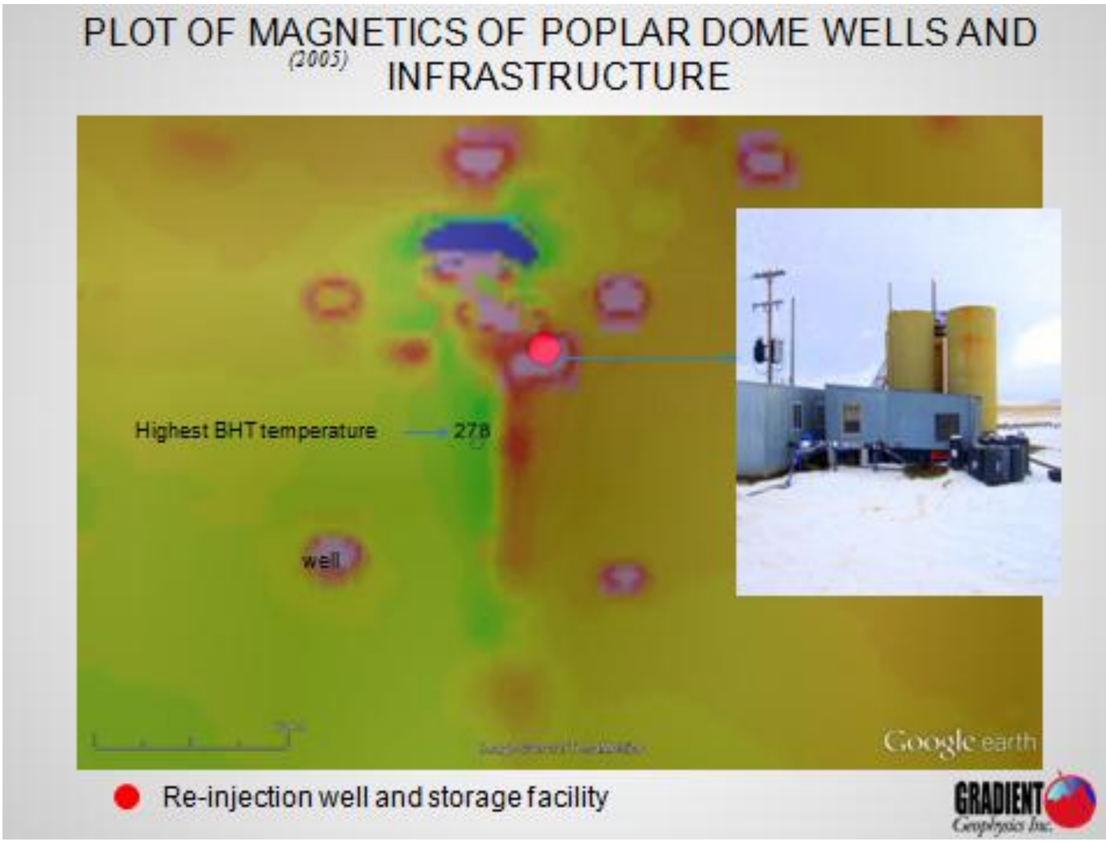


Figure 23 Map view of magnetics indicating water storage facility. The high temperature well - 278 F - is plotted. Inset show photo of facility. This area was field checked after plotting the magnetics and overlaying the BHT's

D. Summarizing Temperatures

Through a series of steps, we were able to focus in an area with excellent geothermal potential considering temperature and well tie-in and excluding water flow. New oil drilling appears to be taking place on the grid of "older" wells in one of the subset of fields of the East Poplar Field.

We mapped the network of wells and infrastructure through magnetics and ground-truthed the area during a site visit. There are several wells that tie-into one re-injection site. The water appears hot enough, but the water flow is still a question as far as far as generating electricity form a binary cycle geothermal power plant.

VIII. Water in Wells

A. Water Flow

The water flow from the oil wells at the FPTR appears relatively low – about 50 gallons per minute for the highest wells. The figure below shows the top sites picked based upon temperature and water flow, which happen to be located in the EPF. The highest flow rates, average around 25 gallons per minute, once gridded, or merged with flow rate data. The gridding process of these data are somewhat unfair, because some wells get up to 50 gallons per minute, and there are many fewer wells with flow information on the FPTR than wells with BHT's. However, the problem still exists. Perhaps the flow rate can be increase using a tie-in of wells, such as found near the storage facility as described above (in the EPF).

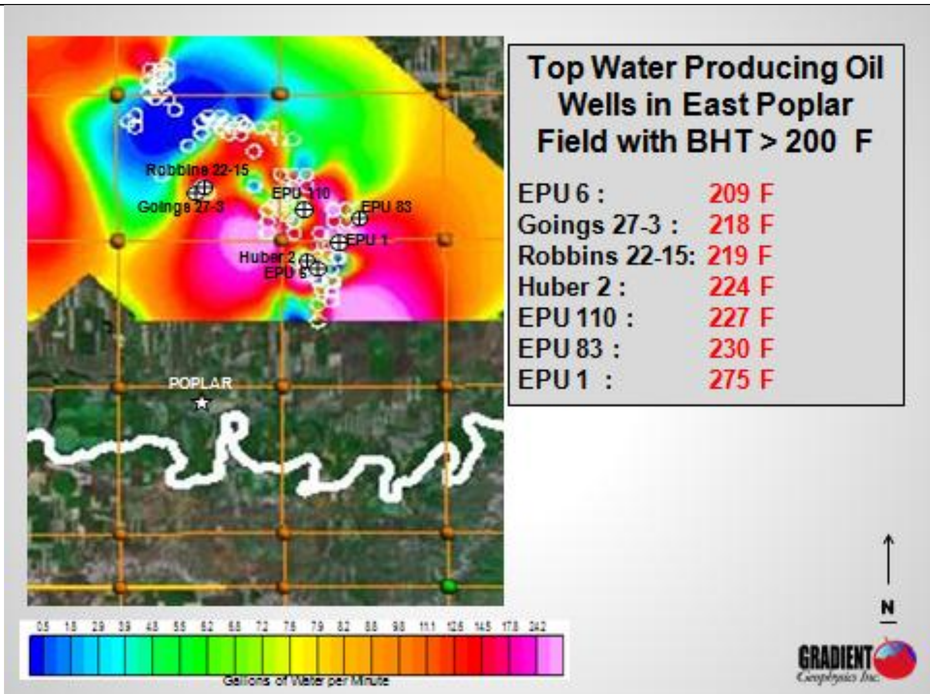


Figure 24 Top wells for East Polar Dome, based on temperature and water flow. Scale below 'pegs" out at 25 gallons per minute (due to gridding). Top wells for water flow are around 50 gallons per minute.

Below lists temperatures and flow rates for top 4 picks of wells with these attributes in the East Poplar Field. The top 100 wells based upon flow rates can be found in the Appendix.

LAT NAD 83	LONG	County	Well Name	Bottom Hole Depth (TD)	Bottom Hole Temp (deg F)	Depth at Temp Gauge	Production Flow Rate (water Gallons/min)(Last Measurement)
48.1922	-105.11040	Roosevelt	EPU 6	5786	209	5788	53.34
48.2103	-105.094137	Roosevelt	EPU 1	9163	275	9127	33.82
48.2464	-105.200115	Roosevelt	ROBBINS 22-15	6030	219	6026	18.96
48.4744	-104.630448	Roosevelt	WESSNER 1-41R	11410	222	11410	14.32

Figure 25 Top 4 wells in East Poplar Dome based upon water flow and temperatures.

B. Summarizing water flow

Previous studies (PRC Toups) have indicated water flows of up to 20,000 gallons per minute, but they also qualified that as “appears to be provided by operations of the Murphy Oil Company” (see below). They also say that other wells were reported to average 20 gpm (see below).

“Independent evidence that significant production of hot water can be obtained from the Madison appears to be provided by operations of the Murphy Oil Company which reports that presently wells of the Poplar Oil Field produce a total of from 18,000 to 20,000 barrels of hot water per day from 180°F to 210°F. Other data provided by Murphy Oil Company for sixteen wells show production of hot water ranging from 5 gpm to 81 gpm with an average of 20 gpm” (from PRC Toups, 1979).”

- The “higher” numbers for flow rates reported by PRC Toups in the EPF were most likely based upon a very favorable well (that now is abandoned) and the short duration of the pump tests that were performed decades ago.
- Black Mountain Technology suggested “enhancing” the well for greater water flow. One producing oil well would need to be located and with “owners’ permission, increase the water flow by enhancing that well. This is unlikely on the FPTR.
- A probable scenario to increase water flow is to “tie-into” an area with multiple wells. A most likely place would be at an injection well site that takes in water from multiple wells (see Figure 20 above for injection sites).

In light of the lower water flows reported by PRC Toups, our database suggests the lower water flows are “in-line” for what is expected for co-produced oil wells on the FTPR, if the well is operated for oil. Special adjustments would have to be made on any well to develop the flow, i.e. enhancing an existing oil well as suggested in the Black Mountain Study.

C. Water Quality

It is noted that the water has a great amount of salts and dissolve solids as first reported by the PRC Toups study, 1979:

“Total dissolved solids range widely, varying between about 59,000 to about 288,000 ppm. The average is about 102,000 ppm. All analyses show concentrations from about that of present sea water to as much as eight times the concentration of sea water.”

Our compilation of water quality supports this report of high salinity and also that the waters are highly caustic (refer to figure 26). This will need to be addressed in any geothermal plan.

Figure 26 Water quality of some wells on the Fort Peck Reservation from USGS

Oil Well Names	Lat (NAD 27)	Long	Land-surface elevation (ft)	Depth to top sample interval (ft) below LSD (72015)	Specific conductance, wat unf uS/cm at 25 deg C (00095)	Noncarb hardness, wat unf field, mg/L as CaCO3 (00902)	Dissolved solids, sum of constituents, mg/L (70301)
JEROME (TRIBAL) 1	48.102	105.151	1958	5784	184000	28000	203000
JENSEN #2	48.181	105.051	2135	6025	60000	2600	50000
EPU 24	48.189	105.084	2179	5913	*	3000	201000
EPU 6	48.192	105.112	2087	*	117000	*	99500
MACDONALD 1	48.273	105.210	2383	6172	25500	940	19300
*	48.277	105.123	2111	5784	62200	4000	54300
TRIBAL 1	48.291	105.254	2636	6446	136000	17000	210000
MCCAULEY 1	48.315	104.278	2295	8664	216000	23000	244000
SETHRE A-1	48.334	105.497	2603	6705	66500	2200	58200
L. COUCHENE 1	48.399	105.614	2721	6586	226000	6100	282000
TRIBAL 1	48.414	105.426	2683	6397	*	1900	20800
NESBIT UNIT 1	48.472	105.080	2644	7160	207000	6400	285000
M. NESBIT 1	48.476	105.085	2658	7121	116000	4000	142
TRIBAL-13 1	48.515	105.276	2420	6828	30700	1600	24200
TONG 10-13	48.526	105.281	2423	6537	*	2700	43500
EPU 93	48.254	- 105.146	2176	*	*	*	18761
MCGOWAN 1	48.275	- 105.205	2395	*	*	*	38221
R.W. LOWE 1	48.178	- 105.202	2111	*	*	*	11617
*	48.569	105.299	2684	7313	53800	4800	79100
*	48.501	104.069	*	7959	*	37000	325000
*	48.638	104.381	2235	7442	220000	2300	296000
*	48.648	104.414	2229	7730	159000	4600	163000
*	48.988	104.103	2201	6439	*	16000	295000
*	48.167	104.719	2127	4450	5800	1200	5010
*	48.345	105.807	2745	5930	202000	33000	310000
*	48.366	106.043	2805	5564	37000	2100	27800
*	48.436	105.828	2905	6638	29200	1700	26000
*	48.613	106.099	2844	6159	4150	1000	3980

IX. Land Status

Land status, or ownership factors in the selection for favorable geothermal determination. The land status map shows land ownership broken out into 3 different categories based upon color: 1) *Tribal Land* colored in red 2) *Allotted Land* in blue and, 3) *Private Land* in white. These are in order of higher favorability. *Tribal land* is higher in favorability since it theoretically takes one entity – for example the tribal government to pass a resolution, say as opposed to *Private Land* which usually results in a set of agreements with several private landowners. This is an assumption at this time, it remains to be further investigated with factors in mind such 1) politics of the tribal government and, 2) underlying mineral rights. As to the latter, it assumed that the Land Status map reflects surface land ownership and not necessarily mineral rights (below the surface). In land where these rights are split off the land may be more complicated by different owners – one surface and another mineral rights. This factor needs to be further evaluated for future power generation.

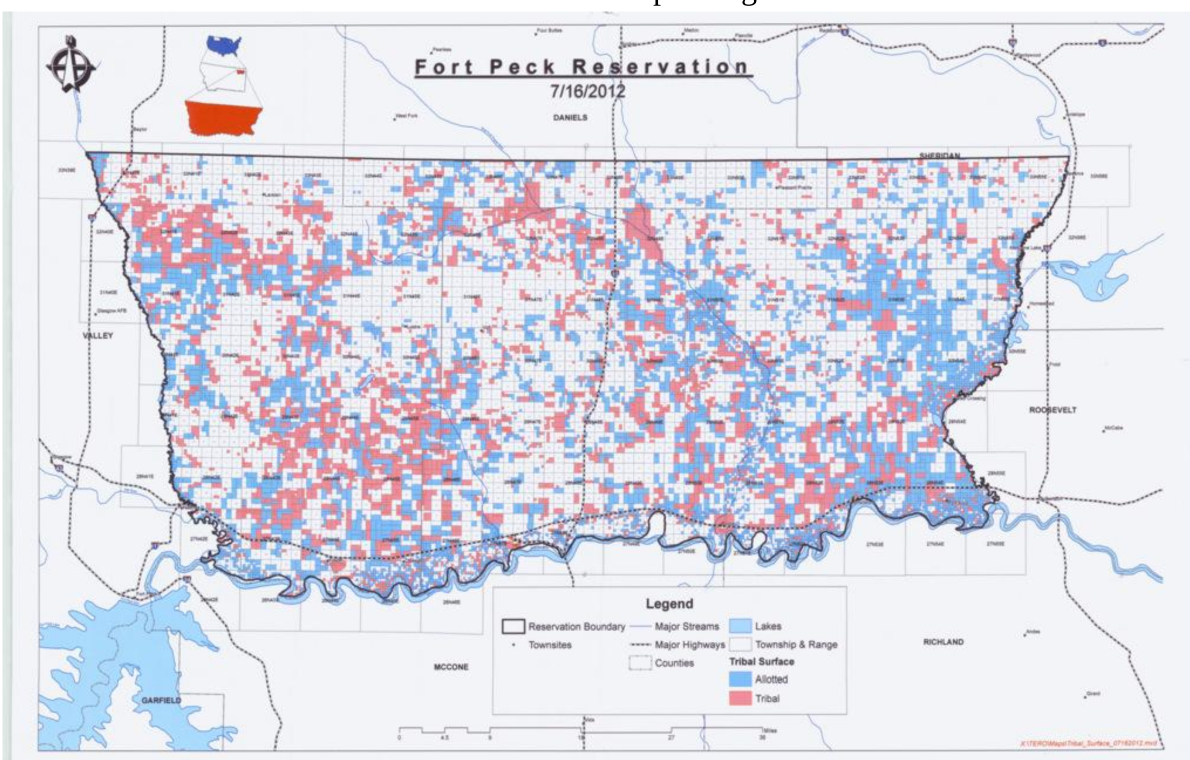


Figure 27 Land Status overlay for Fort Peck Tribes

Prioritizing the top ten wells using the Land Status map, the order is listed below:
1) 250 F well in south, in *Tribal Land*, southeast 1/4 of Section 11, 28N51E.
2) 219 F well in the northwest, on *Tribal Land*, southeast 1/4 of section 22, 29N50E.
3) 275 F well in the east, on *Allotted Land*, northeast ¼ of section 2, 28N51E.
4) 218 F well in the northwest, on *Allotted Land*, northern ½ of section 27, 29N50E.

X. Summary and Conclusions

We provided information that shows a high upside potential for geothermal on the Fort Peck Tribal lands within co-produced oil and gas fields.

We focused on heat (BHT's), and water flow, along with infrastructure. Within the East Polar Field, we have located a network of wells that show geothermal potential at the Fort Peck Reservation considering the high temperatures (>275 degrees F), a "tie-in" to several oil wells with good water production is a viable option. The land and oil well ownership is the significant factor.

Our data analysis and evaluation included:

Data Analysis--2012

- *760 bottom hole temperatures*
- *Precise location of drill holes*
- *Flow rates for existing wells*
- *Reinjection well locations*
- *Infrastructure near best wells*
- *Land Status – identify favorable land*
- *Well intercept stratigraphy*
- *Formation thickness*
- *Airborne magnetometer and EM data*
- *Not only flow rates for wells, but water quality rates as well*

XI. Geothermal Power Generation

Oil and gas wells such as those in eastern Montana are typically thousands of feet deep, and often produce very hot brine. Most oil and gas wells produce large quantities of hot water that have to be separated from the fossil fuel. This waste water is usually reinjected deep below domestic aquifers.

For several decades Montana was thought to have little potential for producing electrical power for geothermal energy. Although several wells in eastern Montana produce water between 200 and 280 degrees F, electric generation technology in the past required water in the 300 degree F range or above. But new technologies have been developed that may allow the hot water from Montana's oil wells to be used to economically generate electricity.

Figure 28 Drilled in the 1950s, this abandoned well 30 miles north of Miles City in Eastern Montana produces over 1000 gallons per minute of 185 degree F. water.

Since the mid-1990s, breakthroughs in geothermal system designs using new turbines and secondary working fluids have significantly lowered the temperatures needed for power generation. Geothermal fluids as cool as 165 degrees F are now being used for electric power generation. And these lower geothermal temperatures are available in many areas in

Montana, which opens up the possibility of geothermal electrical generation in the near future.

Newer geothermal electric generation systems, called binary cycle plants, do not directly use geothermal fluids to run a turbine. Instead, these power plants use heat exchangers to extract the energy from the geothermal water that is pumped to the surface. The hot water is used to boil a second working fluid that has a boiling point much lower than that of the hot water coming out of the well.

After the vaporized secondary fluid passes through the turbine blades to generate electricity, the vapor is cooled with cold water or with outside air, which turns the vapor back into a fluid. The fluid is then recycled through the loop. The cooled geothermal water is usually pumped back into the ground after it passes through the heat exchanger.

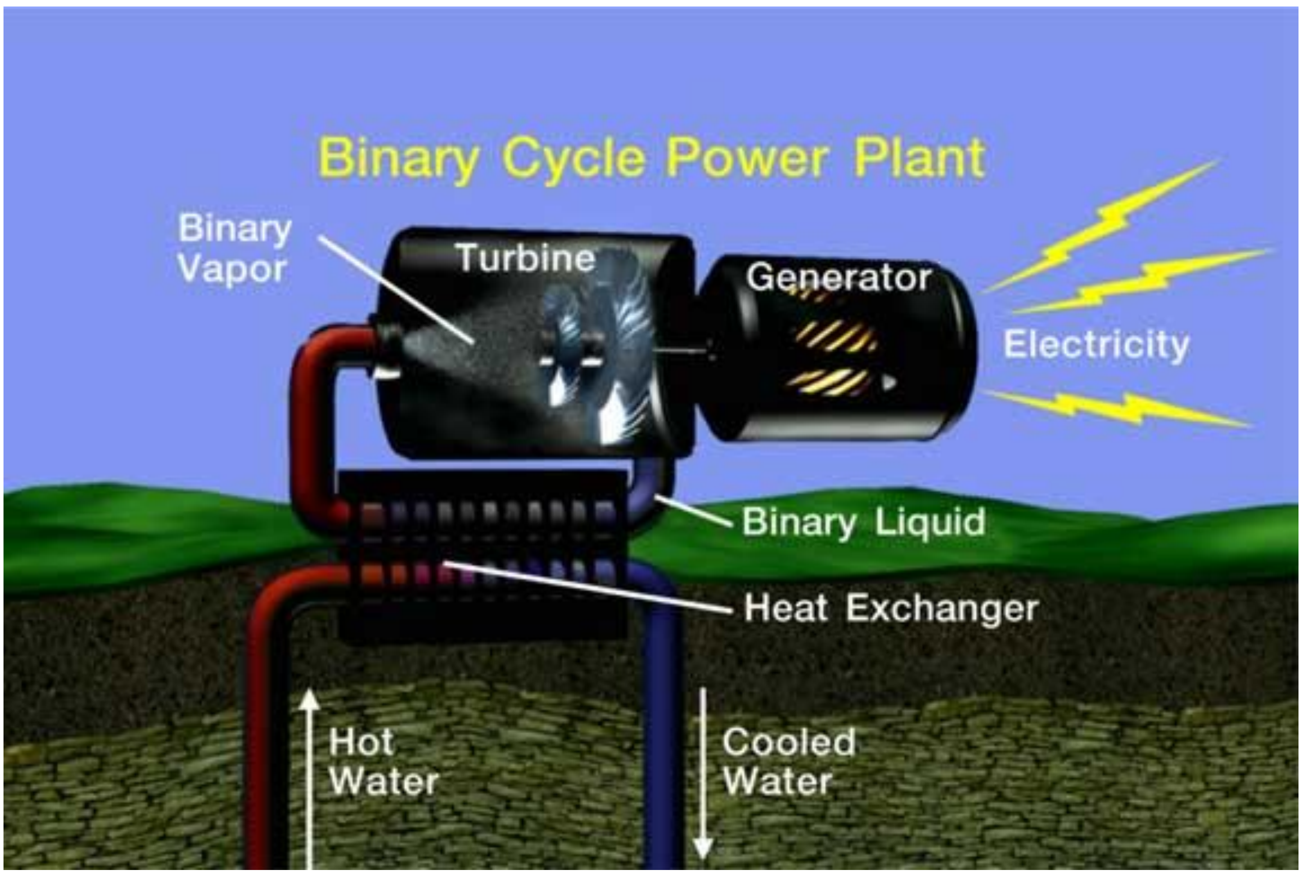


Figure 29: Diagram of Binary Cycle Power Plant (Source—Geothermal Education Office)

Several manufacturers produce geothermal power generators utilizing the binary cycle. At least three of these manufacturers have developed generators in the past five years that produce electrical power off of lower-temperature and lower-flow geothermal resources similar to what is found on the Fort Peck Reservation. Generators from the following three manufacturers were considered in system design for the Fort Peck Reservation.

- UTC Power Purecycle System
- Access Energy
- Electratherm Green Machines

Diagrams, photos and specifications of the oilfield geothermal generators of these three manufacturers are shown on the following pages.

After reviewing the specifications and installations of these generators, we chose Electratherm as the unit most likely to match the geothermal resource characteristics of the Fort Peck Reservation. The Electratherm Green Machine units are significantly smaller than units of the other manufacturers, with generators that can produce 50 kilowatts or less. To use the relatively low flow rates of geothermal brines recorded at the Fort Peck Reservation (often under 50 gallons per minute per well), the Electratherm units seemed to be the best match. In addition, the Electratherm units are turnkey self-enclosed units, complete with remote monitoring systems. An Electratherm generation unit can be installed at a wellhead or collection point in less than a week.

The Access Energy generation units are also worth considering, although they require more input flow than may be available at Fort Peck. A new generation of 125 kilowatt units have been developed by Access Energy, and a demonstration project in western North Dakota will test the feasibility of these units in an operating oilfield. A March 2015 article, attached below, describes this demonstration project (funded with a $3.4 million DOE grant through the University of North Dakota).

MODEL 280
PureCycle® System

UTC Power
A United Technologies Company

Emission-free energy from a renewable resource:

Introducing the PureCycle® Model 280 Energy Solution.

UTC Power is a world leader in developing and producing energy solutions for on-site power, transportation, space and defense applications. We are committed to providing high-quality solutions for the distributed energy market that increase energy productivity, energy reliability and operational savings for our customers. With a technology built on decades of United Technologies Corporation's innovation and operating experience, UTC Power is pleased to introduce the PureCycle® Model 280 advanced power solution to the commercial marketplace.

The PureCycle® Model 280 energy solution harnesses the Earth's own heat to power a turbine, turning a renewable resource into 280 kW of electrical power with zero emissions. This modular energy solution can operate on a wide range of fluid resource temperatures starting as low as 195°F (91°C). Based on a thermodynamic cycle known as the organic Rankine cycle, the PureCycle® power system converts low to moderate temperature resource fluids to electric power through the vaporization and expansion of a working fluid in a closed system. This energy solution offers expanded bottoming opportunities and can operate in co-produced fluid applications. In the ultimate recycling loop, all water extracted for power is returned to the Earth for reheating and reuse. Such dependable, renewable fuel means secure base load energy production and freedom from reliance on oil, natural gas, high wind and sunny weather, without sacrifice of precious water resources.

Sustainability makes good economic sense. And it's achievable today with the PureCyle® Model 280 energy solution.

Specifications

Performance Characteristics

Electric power (gross)	280 kW
Electric power (net)	225 to 250 kW*
Voltage	480V/3 phase/60 Hz
Ambient operation	-22° to 122°F (-30° to 50°C)
Power factor	Greater than 0.95 lagging
Total harmonic distortion	Less than 5%
Emissions	Zero (closed binary cycle)
Noise	78 dBA at 33 ft (10m)

Design Attributes

Plumbing	ASME B31.1
Turbine	Radial inflow
Generator	Induction
Heat exchangers	ASME Section VIII
Enclosure; electrical	NEMA 4
Design life	20 years
Lubrication	Integrated internal oil lubrication
UL components	UL 1995, 984, and 1741
Transient voltage/surge suppression at utility interface	IEEE C 62.41-1980 (R1995)
Utility grid-connect protective relaying function	IEEE 1547

System Description

Working fluid	R245fa (Pentafluoropropane)**
Heat source	Hot water 195° to 300°F (91° to 149°C)
Cooling requirement	Water 40° to 110°F (4° to 43°C)
Controls	Carrier Netlink II PLC
Remote monitoring	Web-based gateway
Operation	Designed for unattended operation
Enclosure	Not required
Manufacture	Factory assembled
Shipping	Single drop flatbed truck

energy Reinvented

PureCycle

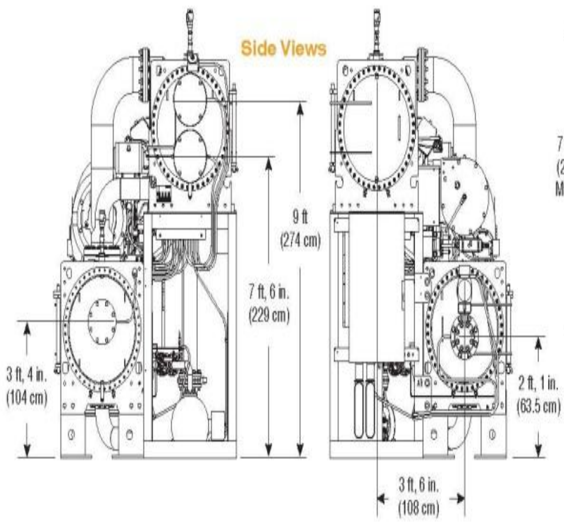
MODEL 280
PureCycle® System

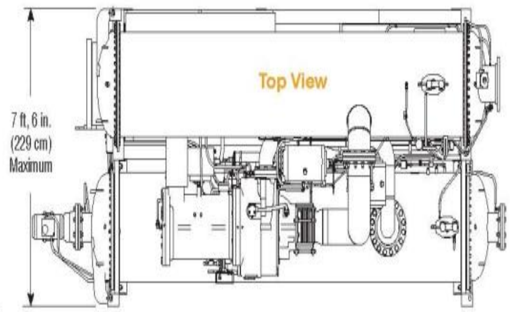
* Resource water and cooling water dependent. ** R245fa is a non-flammable, non-toxic, and non-ozone-depleting working fluid.

MODEL 280
PureCycle® System

Physical Characteristics

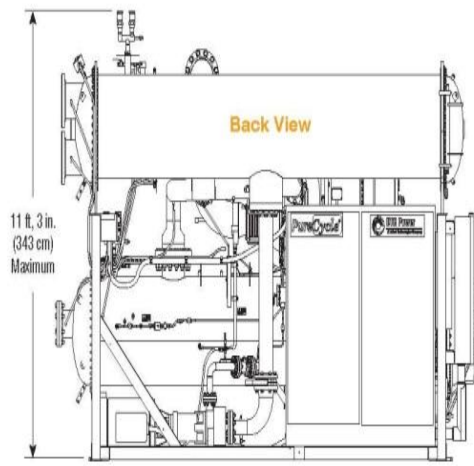
System

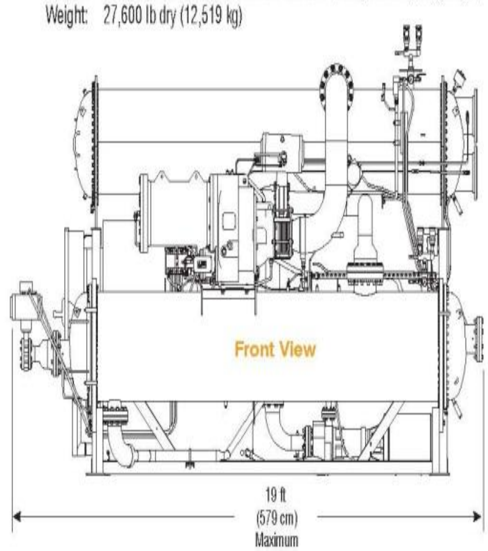




Equipment Dimensions

Length: 19 ft (579 cm) – Maximum
Width: 7 ft, 6 in. (229 cm) – Maximum
Height: 11 ft, 3 in. (343 cm) – Maximum installed (10 ft, 4 in. shipping height)
Weight: 27,600 lb dry (12,519 kg)





The manufacturer reserves the right to change or modify, without notice, the design or equipment specifications without incurring any obligation either with respect to equipment previously sold or in the process of construction. The manufacturer does not warrant the data on this document. Warranted specifications are documented separately.

UTC Power
A United Technologies Company
195 Governor's Highway . South Windsor, CT 06074 . Phone: (866) 900-POWER . Fax: (860) 727-2319 . www.utcpower.com

DS0116 R09/30/08

UTC Power
A United Technologies Company

MODEL 280
PureCycle® System

ACCESSENERGY
A CALNETIX COMPANY

Procore™ for Oil and Gas Wells

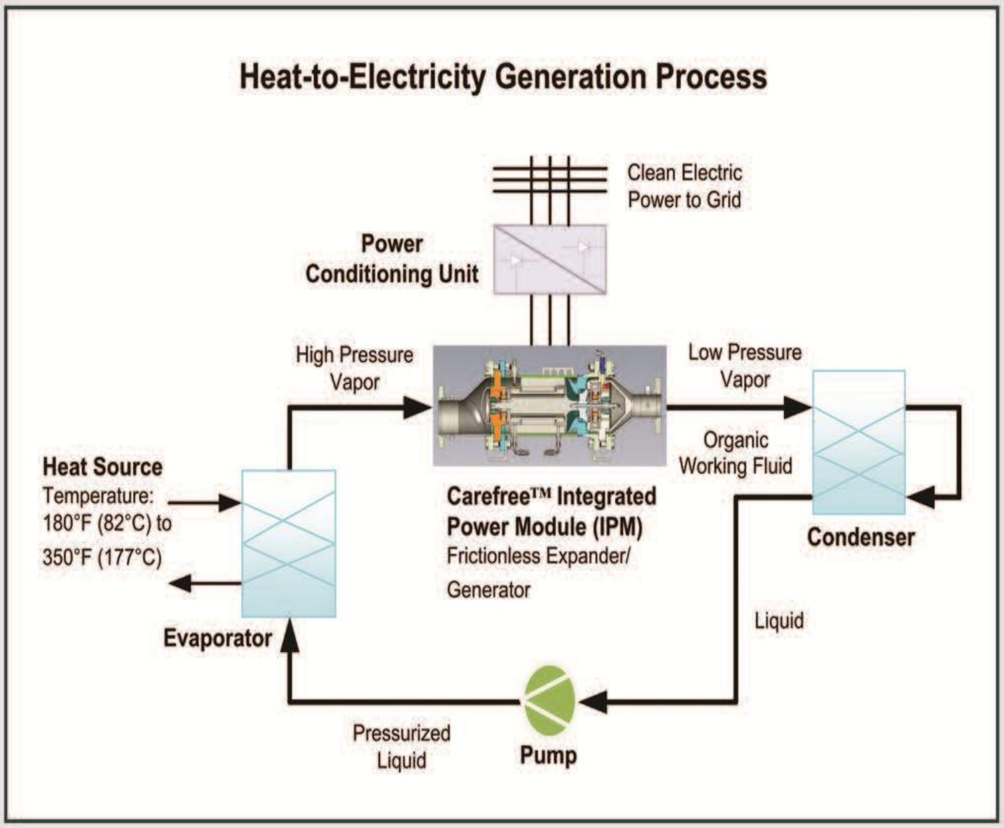
The Portable Organic Rankine Cycle (ORC) System for Generating Electricity from Warm Brine Coproduced at Oil and Gas Wells

ZERO RISK. TRIPLE PAYBACK.

At Access Energy™, our sole focus is enabling oil and gas companies to easily access and capitalize on existing renewable and waste heat energy sources. We produce the safest, lowest cost ORC systems for small-scale oil and gas applications.

Procore™ for Oil and Gas Wells generates up to 125kW of power using low and medium temperature brine from existing coproduction (brine and oil/gas) wells. The fully integrated system utilizes our patented Carefree™ Integrated Power Module (IPM) Technology, which consists of a high-speed turbine expander and high-efficiency generator in one sealed unit.

ACCESSENERGY
A CALNETIX COMPANY



Key Benefits

Lowest Cost and Fastest Payback

» Greatly reduces onsite electricity consumption
» Extra power can be sold to the grid
» Renewable energy credits or emissions reductions credits can be earned
» Pays for itself in less than 48 months

Turn-key System

» Packaged specifically for oil and gas wells
» Plug-and-play, portable system
» Built-in, utility-friendly interconnection

Zero Disruption

» Absolutely no disruption to production or processing activities

Proven, Risk-free Technology

» Numerous ORC units deployed in multiple applications
» Same core technology used in *Calnetix* automotive, aerospace, energy, industrial, medical and semiconductor products
» Same ORC technology licensed to *GE Power & Water*

Zero Emissions or Risk of Contamination

» Clean energy generation- no fuel or oil lubrication needed
» Closed-loop, hermetically sealed system with no rotating seals
» Safe working fluid- environmentally friendly, non-combustible and non-flammable

High Availability and Reliability

» No downtime
» Very low maintenance
» Very low operating costs

High Efficiency

» Self-centering magnetic bearings
» No contact or friction between rotating parts

THE

GREEN MACHINE

4010

4010

SPECIFICATION SHEET

Green Machine 4010 - Up to 65kWe

DESCRIPTION

ElectraTherm's Green Machine produces fuel-free, emission-free power from low grade waste heat using the Organic Rankine Cycle (ORC) and proprietary technology. The company's proven, patented twin screw expander enables its heat-to-power generating system to make electricity from waste heat instead of fossil fuel. Small and robust, this clean technology can operate with cold water or air condensing to provide reliable power output.

ElectraTherm's twin screw expander offers distinct advantages for small-scale ORCs. These advantages include simple design, low speed operation with partial load capability, no gear box or oil pump, attractive payback and proven technology. ElectraTherm's Green Machine represents a dramatic change from radial or axial turbine technologies, providing a more cost efficient, robust machine to generate emission-free electricity from existing unused heat without added fuel.

Green Machine 4010 - Up to 65kWe

SPECIFICATIONS

PERFORMANCE CHARACTERISTICS	
Nominal Rating	up to 65kWe* @ 380-500V / 3 phase / 50 & 60 Hz
Ambient Operation	0°C to 38°C (32°F to 100°F)**
Power Factor Correction	Load and Site Dependent - from 0.9 to 1
Total Harmonic Distortion	2% for Voltage; 10% for Current
Emissions	Zero (Closed Binary Cycle)
DESIGN ATTRIBUTES	
Refrigerant Plumbing	Built to ASME and CE Standards
Energy Block	Patented Twin Screw Expander
Generator	Grid-Tied Induction (Brushless Construction, Asynchronous)
Heat Exchangers	Compact, Brazed Plate Construction
Design Life	20 Years
Lubrication	Process Lubrication
Transient Voltage/Surge Suppression	Basic Protections are Standard
Grid Protective Relay (GPR)	External Additional GPR Interface Included
SYSTEM DESCRIPTION	
Working Fluid	R245fa (Pentafluoropropane)***
Heat Source	Hot Water 77°C to 116°C (170°F - 240°F)
Cooling Requirement	Water 4°C to 43°C (40°F to 110°F)
Controls	Custom Controls Software using Standard Programmable Logic Controller
Remote Monitoring	Will Support Internet Protocol, 3G Cellular, Satellite Communications, Wireless
Operation	Designed for Unattended Operation
Cabinet	NEMA 3R Outdoor Rated /IP 54 Compliant
Shipping	Ships from Reno, NV, USA
Dimensions	Various Configurations Available (see next page)
Weight	Various Configurations Available (see next page)
Sound Pressure	80db at 1 meter. Sound Attenuated Option: <72db at 1 meter

* Output depends on hot and cold resources.
** Extreme environments require optional equipment.
*** R245fa is a non-flammable, non-toxic and non-ozone depleting working fluid.
**** In addition to water cooling, a direct-condensing air cooler option is available.

FEATURES INCLUDE:

- Automated Control System
- Remote Monitoring
- Low Maintenance
- Modular and Scalable
- Robust, Twin Screw Expander Power Block
- CE Certified
- Zero Emissions, Zero Toxic By-products and Zero Fossil Fuel Requirements

ELECTRATHERM

ElectraTherm, Inc. - 4750 Turbo Circle Reno, Nevada 89502 USA
P: +01 775-398-4680 - Toll Free: 1-877-883-7101 - www.electratherm.com

THE

GREEN MACHINE

4010

4010

Green Machine 4010 - Up to 65kWe

CONFIGURATIONS

4010

Stand alone

- Smallest footprint available at 2.4 x 1.8 x 2.2 m, Weight: 3600 kg
- Customizable balance of plant
- Indoor or outdoor installation

4010-F

20 ft. ISO frame

- Small footprint at 6.1 x 2.4 x 2.6 m, Weight: 8380 kg
- Multiple condensing options
- Easy to install
- No concrete foundation required
- Dry cooler mounting integrated

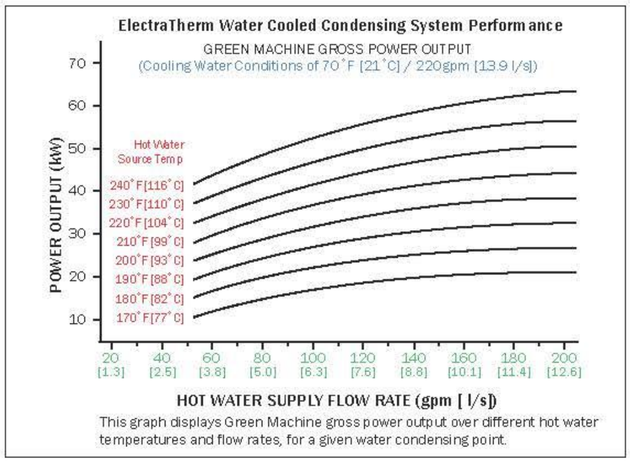
4010-F

40 ft. ISO frame

- Dimensions: 12 x 2.4 x 2.6 m, Weight: 9400 kg
- Turnkey inc. liquid loop radiator, all piping/pumps, no concrete foundation required, minimal engineering
- Plug and play

PERFORMANCE PARAMETERS

Hot Water Input Parameters	Hot water input temp range	°F	170-240
		[°C]	[77-116]
	Thermal input range	MMBTU/hr	1.37-2.94
		[kWth]	[400-860]
	Flow rate range	gpm	50-200
		[l/s]	[3.2-12.6]
Water Cooled Condensing Parameters	Cooling water input temp range	°F	40-110
		[°C]	[4-43]
	Heat rejected to cooling water range	MMBTU/hr	1.30-2.72
		[kWth]	[380-795]
	Cooling water flow rate	gpm	220
		[l/s]	[13.9]
Direct Air Condensing Conditions	Ambient air temp	°F	<100
		[°C]	[<38]
	Heat rejected to condenser	MMBTU/hr	1.30-2.72
		[kWth]	[380-795]



THIS IS SMART POWER™

HEAT TO POWER APPLICATIONS

ElectraTherm's Green Machine generates electricity from various heat sources, including:

Stationary Engines

Biomass/Biogas

Boilers & Process Heat

Oil & Gas, Geothermal

Solar Thermal

ELECTRATHERM
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Turning Bakken Oil Well Waste Water into Clean Geothermal Power

Bloomberg Business Magazine

by Jeremy Van Loon
April 22, 2015

http://www.bloomberg.com/news/articles/2015-04-22/turning-bakken-oil-well-waste-water-into-clean-geothermal-power

Researchers stand at the site in North Dakota where geothermal generators are being installed.
Source: University of North Dakota, Will Gosnold via Bloomberg

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Oil fracking companies seeking to improve their image and pull in a little extra cash are turning their waste water into clean geothermal power.

For every barrel of oil produced from a well, there's another seven of water, much of it boiling hot. Instead of letting it go to waste, some companies are planning to harness that heat to make electricity they can sell to the grid.

Companies such as Continental Resources Inc. and Hungary's MOL Group are getting ready to test systems that pump scalding-hot water through equipment that uses the heat to turn electricity-generating turbines before forcing it back underground to coax out more crude.

Though the technology has yet to be applied broadly, early results are promising. And if widely adopted, the environmental and financial benefits could be significant. Drillers in the U.S. process 25 billion gallons (95 billion liters) of water annually, enough to generate as much electricity as three coal-fired plants running around the clock -- without carbon emissions.

“We can have distributed power throughout the oil patch,” said Will Gosnold, a researcher at the University of North Dakota who’s leading Continental Resources’ project well.

Geothermal power also holds out the promise of boosting frackers’ green credentials after years of criticism for being the industry’s worst polluters, says Lorne Stockman, research director at Oil Change International, an environmental organization that promotes non-fossil fuel energy.

“This is one way to make it look like the industry cares about the carbon issue,” he said. Even if steam generates less carbon than other oil field power sources, “if you’re in the business of oil and gas, you’re not part of the solution.”

Cheap Oil

Then there’s the money. With crude at less than $50 a barrel, every little bit can help lower costs. At projects like the one being tested by Continental Resources in North Dakota, a 250 kilowatt geothermal generator has the potential to contribute an extra $100,000 annually per well, according to estimates from the U.S. Energy Department.

That’s not big money and the $3.4 million cost to test the technology is still too much to apply to each of Continental’s hundreds of wells. Yet if the company can lower the costs of the technology, it will not only generate electricity it will also extend the economic life of wells, making them more profitable, said Greg Rowe, a production manager with Continental Resources.

University Projects

Continental Resources’s project began with the work of researchers at the University of North Dakota who were looking for ways to use geothermal resources from the thousands of wells being drilled in recent years, spurred on by new horizontal drilling technology. An existing relationship with the university triggered Continental Resources’s interest in the project.

The team took off-the-shelf geothermal generators and hooked them to pipes carrying boiling waste water. They’re set to flip the switch any day. When they do, large pumps will drive the steaming water through the generators housed in 40-foot (12-meter) containers, producing electricity that could either be used on site or hooked up to power lines and sold to the electricity grid.

Valuing Land

To take advantage of plentiful geothermal energy in oil wells, petroleum companies needs to change the way drilling and wells are planned to include the benefits of geothermal energy after most of the fossil fuels have been extracted, said Alison Thompson, chair of the Canadian Geothermal Energy Association and a former engineer at Suncor Energy Inc.

“We don’t value land here the same way that others do,” Thompson said, highlighting projects in Germany and Hungary where geothermal resources are considered part of the total opportunity to earn money from a well.

With $50 oil testing producers’ ability to make money, Gosnold is convinced that the idea will pay off if enough water can be pumped through the generators.

“The economics makes a lot of sense over the lifetime of a field,” he said.

***

XII. Geothermal Development Scenarios

Geothermal power generation from producing oil wells on the Fort Peck Reservation presents some unique challenges. Measured geothermal well temperatures vary from 200 degrees F. to slightly under 280 degrees F. These temperatures are comparable to temperatures at other geothermal locations in the US that are currently producing geothermal power with small binary generators. However, the geothermal brine production from oil wells at Fort Peck is quite low, with individual well brine flow rates often running much less than 50 gallons per minute. Realistically, a minimum flow rate 200 gpm to 350 gpm is needed at a temperature over 200 degrees F. to economically produce electrical power in a binary generator.

Although the individual well flow rate at Fort Peck may be insufficient for geothermal power generation, it may be possible to tap into the combined flow rates of several wells at a central collection center in an oilfield. These collection centers may service more than a half-dozen wells, and the combined wastewater from these wells is piped to a central reinjection well. Installing a heat exchanger at the collection point before the water is reinjected could be a feasible way to tap into this combined flowrate, which could exceed 200 gallons per minute.

Two development scenarios and cost analyses are presented below. We chose to work with Electratherm, due to their compact unit designs that could handle lower flow rates than many other binary units. The Electratherm units also provide turnkey installation and monitoring, with minimal training needed of Tribal staff to operate and maintain the units. The Electratherm units are also off-the-shelf, with minimal lead time needed to order and install the units onsite.

The first development scenario (for an Electratherm model 4400 Green Machine) presumed a flow rate of 200 gpm and a fluid temperature of 240 degrees F. This scenario would result in an average net production of 44 kWe. Presuming a buyback rate of $0.08 per kilowatt hour and a total installed cost of about $315,000, this development would show a payback of approximately 11 years.

The second development scenario (for an Electratherm model 6500 Green Machine) presumed a higher flow rate of 350 gpm, with a fluid temperature again of 240 degrees F. This scenario results in an average net production of 83 kWe. Presuming again a buyback rate of $0.08 per kilowatt hour and a total installed cost of $439,000, we would expect a payback on the installation to be approximately 9.5 years.

Paybacks of 9.5 to 11 years to recover the investments in the development may be reasonable, but there are uncertainties that impact these calculations. If the buyback rate for the power from the local utility is less than $0.08 per kWh, then the time for payback would increase. Also using lower temperatures and/or lower flow rates in the binary generators would produce less net power than the ideal scenarios above, which means electricity sales would be less. Finally the production well life needs to be considered. If the geothermal installation has a payback of 9 to 11 years, and the production wells are abandoned or plugged before the end of that payback term, then the economics of the project would be impacted. However, the Electratherm unit could easily be moved to a more productive well or collection point, and be up and running on a new site within a couple of weeks.

If indeed a reliable geothermal flow rate of 200 to 350 gpm can be confirmed, and if the temperature of this resource is approximately 200 to 240 degrees F., then it quite feasible to install a binary generating facility on the Fort Peck Reservation. Total investment to realize a working project would be between $320,000 and $500,000, depending on the size of the confirmed geothermal resource. It may be likely that a US Department of Energy demonstration grant could be obtained to fund this demonstration unit.

The two Electratherm design scenarios and cost calculations for the Fort Peck Reservation are presented below, along with the payback scenarios.

Fort Peck- 4400 Model Green Machine

Birkby Consulting

Other Heat Source
Radiator

Project Evaluation

3/27/2014

The project assessment program contains default input values intended for internal system use. Input values will vary depending on technology, geographic location, and site dependent variables e.g.: water temperature and flow. The following reports serve as a guide only. Due to volatility of incentive policies/availability, electric prices and technology some of projected values may be out of date or inaccurate. Before submitting for a report, review data and verify that they are correct for your analysis.

v. 19.1.3, 4010

ELECTRATHERM

Project Input	
Project Name:	Fort Peck- 4400 Model Green Machine
Project Company:	Birkby Consulting
Heating Source:	Other Heat Source
Cooling Source:	Radiator
Annual Runtime:	8000 Hours
Project Service Lifetime:	20 Years
External GM Cooling Pump + GM Fan Parasitic Load:	11 kW
Price per kWh:	0.08 U.S.D.
Jacket Water Temperature:	---
Hot Water Temperature into the Green Machine:	240°F
Hot Water Flow into the Green Machine:	200 GPM
Average Ambient Temperature:	43°F
Approach Temperature:	21°F
Average Available Thermal Power:	2.56 MMBTU/hr
Green Machine Size:	Up to 65 kWe
Green Machine Generator Frequency:	60 Hz

Electrical Output*	
Average GM Gross Power Output:	61.6 kWe
Average Total Net Power Output:	44.5 kWe
Avg. Total Internal & External Parasitic Load:	17.1 kWe
Average GM Internal Parasitic Load:	6.1 kWe
Average External to GM Fan Parasitic Load:	8 kWe
Average External to GM Cooling Pump Parasitic Load:	3 kWe
Annual Gross Energy Output:	493 MWh
Annual Net Energy Output:	356 MWh

Thermal Balance*	
Average Heat Consumed:	2.45 MMBTU/hr
Maximum Heat Consumed:	2.56 MMBTU/hr
Average Heat Rejected:	2.07 MMBTU/hr
Maximum Heat Rejected:	2.18 MMBTU/hr
Hot Water Inlet Temperature:	240°F
Hot Water Outlet Temperature:	215°F

Hot Water Temperature Comparison

Temperature	Gross Power	Net Power
200°F	39.2 kWe	25.9 kWe
220°F	52 kWe	37 kWe
240°F	***61.6 kWe***	***44.5 kWe***

*consumed heat, rejected heat, and electrical output values are based on measured ElectraTherm test data. Small errors in measuring temperature and flow due to instrumentation tolerances can induce a noticeable error in thermal measurement. This document is a guideline only, and the thermal error on heat rejected and heat consumed can be up to +/- 80kW

Engineer's Notes

1. Weather Data from Glasgow, Montana, 2013.

2. This evaluation is for a 4400 model Green Machine.
   (Previously referred to as a 4010 model Green Machine)

3. Optimal 4400 GM inlet conditions used as input parameters, as requested by Birkby Consulting. Once actual input parameters are finalized, please notify ElectraTherm to obtain an updated power output estimate.

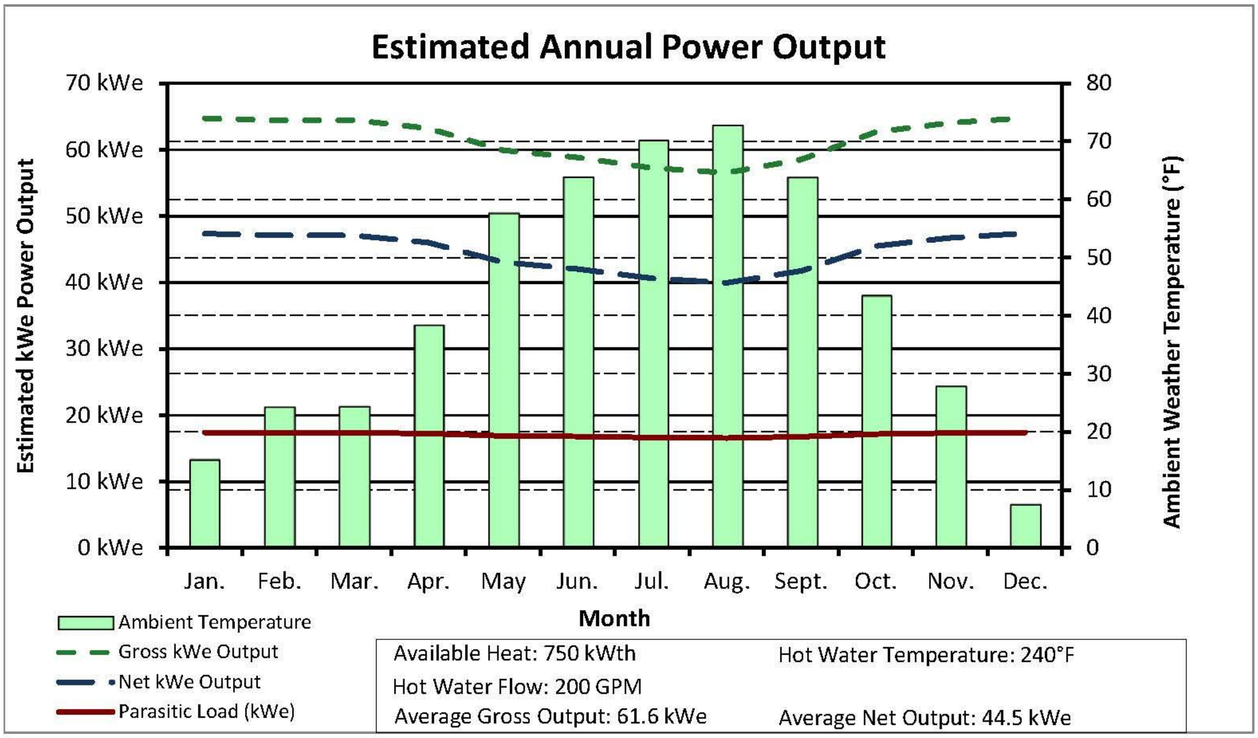
4. ElectraTherm does not provide heat exchangers; however, we can help you contact a heat exchanger manufacturer for this project.

5. Estimated temperatures, heats, and flows used in analysis are based on information provided via correspondence with Birkby Consulting. The customer should validate actual heat exchanger performance data against this evaluation. Re-evaluation of the project will be necessary if designed performance of exhaust gas heat exchanger differs from estimate.

6. The condensing source is 220 GPM and 40% glycol.

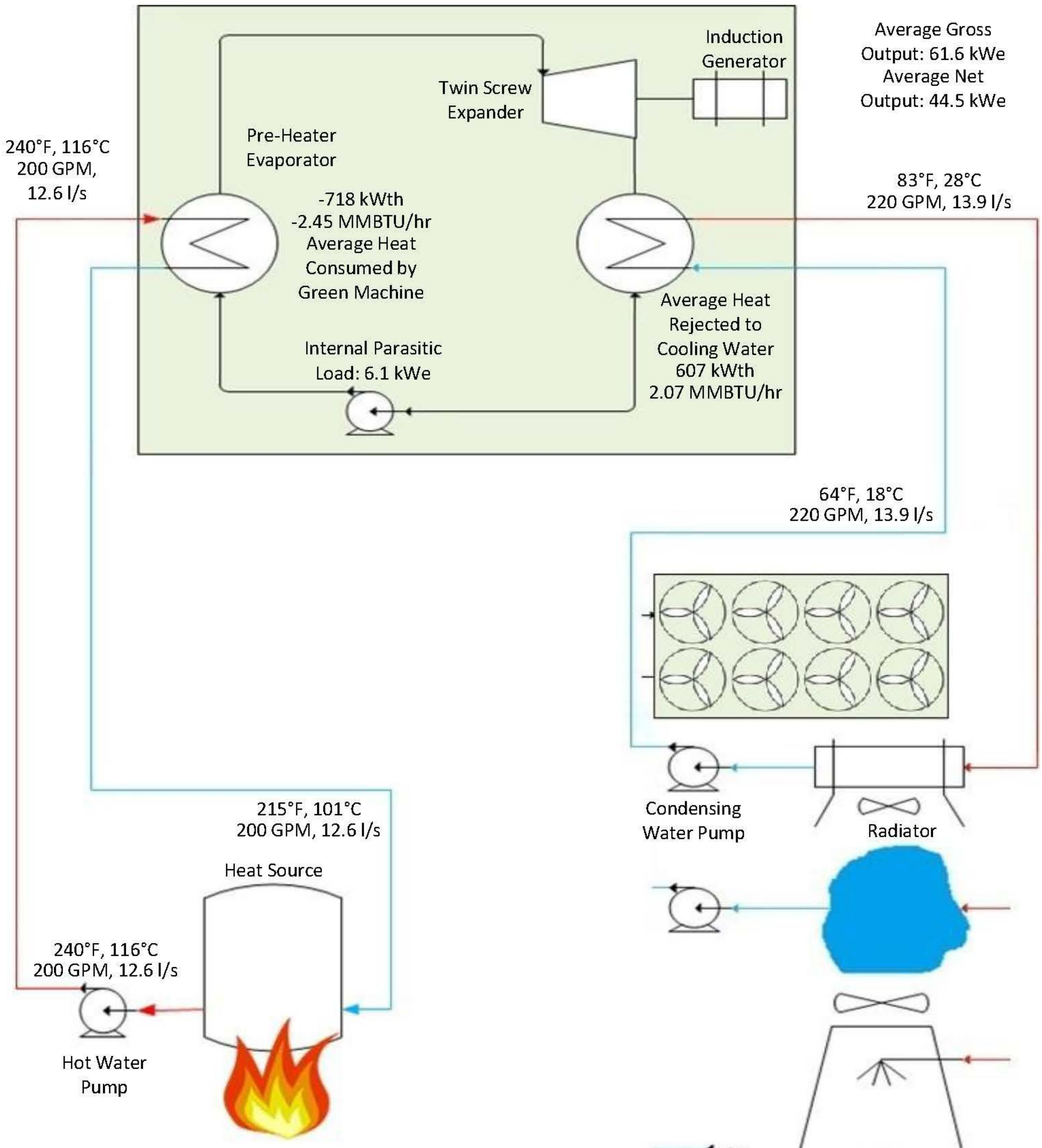
7. An approach temperature of 21°F was used for the liquid loop radiator.

8. The estimated external parasitics for the cooling pump and liquid loop radiator fans are 3kWe and 8kWe, respectively. Other external parasitic loads, if applicable, will need to be accounted for.



Estimated Annual Power Output
Estimated kWe Power Output
70 kWe
60 kWe
50 kWe
40 kWe
30 kWe
20 kWe
10 kWe
0 kWe
Ambient Weather Temperature (°F)
80
70
60
50
40
30
20
10
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
Month
Ambient Temperature
Gross kWe Output
Net kWe Output
Parasitic Load (kWe)
Available Heat: 750 kWth
Hot Water Temperature: 240°F
Hot Water Flow: 200 GPM
Average Gross Output: 61.6 kWe
Average Net Output: 44.5 kWe

One Line Heat Balance Diagram



Fort Peck- 6500 Model Green Machine

Birkby Consulting

Other Heat Source
Radiator

4020 Project Evaluation

3/27/2014

The project assessment program contains default input values intended for internal system use. Input values will vary depending on technology, geographic location, and site dependent variables e.g.: water temperature and flow. The following reports serve as a guide only. Due to volatility of incentive policies/availability, electric prices and technology some of projected values may be out of date or inaccurate. Before submitting for a report, review data and verify that they are correct for your analysis.

v. 19.1.4, 4020

ELECTRATHERM

Project Input	
Project Name:	Fort Peck- 6500 Model Green Machine
Project Company:	Birkby Consulting
Heating Source:	Other Heat Source
Cooling Source:	Radiator
Annual Runtime:	8000 Hours
Project Service Lifetime:	20 Years
External GM Cooling Pump + GM Fan Parasitic Load:	15 kW
Price per kWh:	0.08 U.S.D.
Jacket Water Temperature:	---
Hot Water Temperature into the Green Machine:	240°F
Hot Water Flow into the Green Machine:	350 GPM
Average Ambient Temperature:	43°F
Approach Temperature:	21°F
Average Available Thermal Power:	4.1 MMBTU/hr
Green Machine Size:	Up to 110 kWe
Green Machine Generator Frequency:	60 Hz

Electrical Output*	
Average GM Gross Power Output:	105 kWe
Average Total Net Power Output:	82.5 kWe
Avg. Total Internal & External Parasitic Load:	22.5 kWe
Average GM Internal Parasitic Load:	7.5 kWe
Average External to GM Fan Parasitic Load:	11 kWe
Average External to GM Cooling Pump Parasitic Load:	4 kWe
Annual Gross Energy Output:	840 MWh
Annual Net Energy Output:	660 MWh

Thermal Balance*	
Average Heat Consumed:	4.08 MMBTU/hr
Maximum Heat Consumed:	4.1 MMBTU/hr
Average Heat Rejected:	3.41 MMBTU/hr
Maximum Heat Rejected:	3.54 MMBTU/hr
Hot Water Inlet Temperature:	240°F
Hot Water Outlet Temperature:	216°F

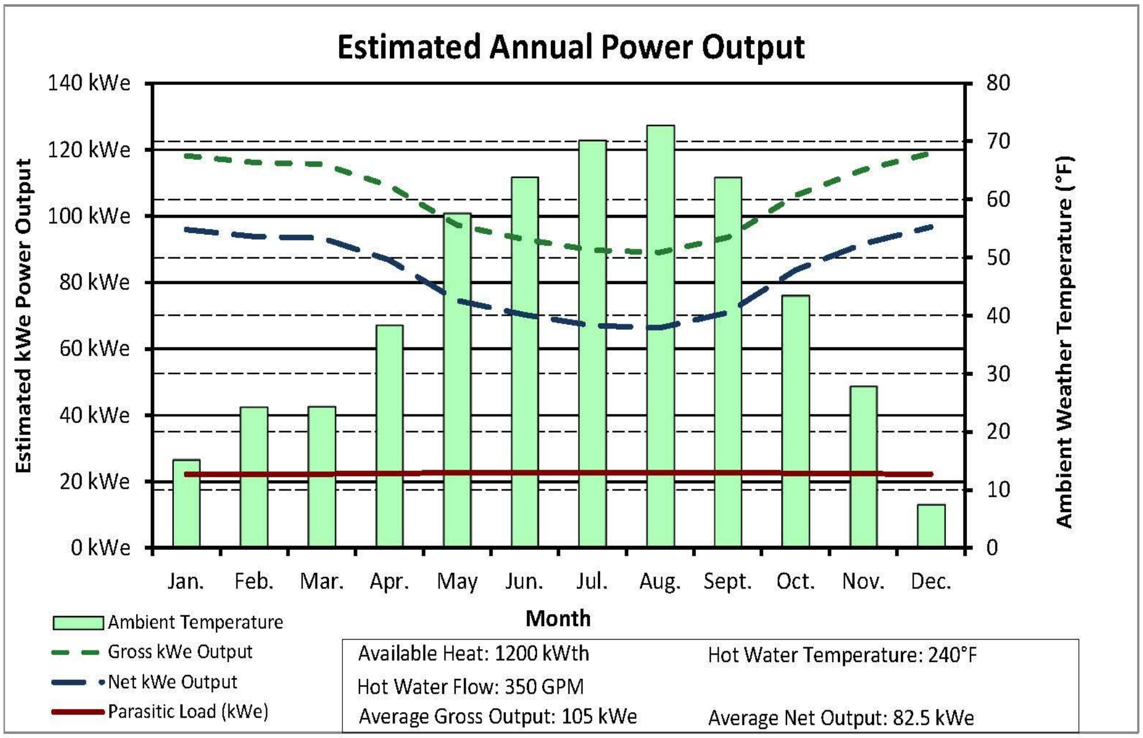
Hot Water Temperature Comparison

Temperature	Gross Power	Net Power
200°F	60.5 kWe	42.6 kWe
220°F	85.3 kWe	65.4 kWe
240°F	***105.3 kWe***	***82.8 kWe***

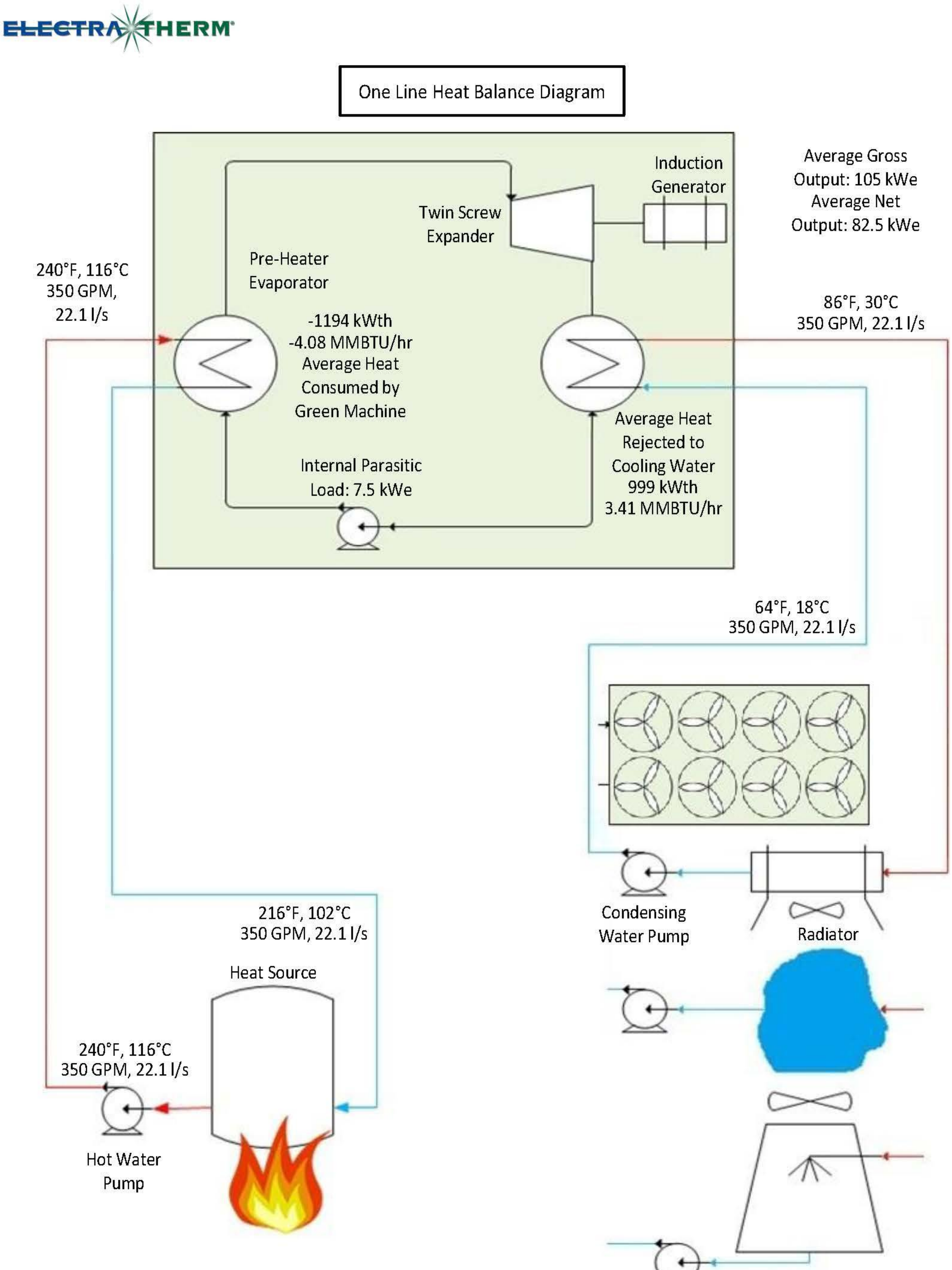
*consumed heat, rejected heat, and electrical output values are based on measured ElectraTherm test data. Small errors in measuring temperature and flow due to instrumentation tolerances can induce a noticeable error in thermal measurement. This document is a guideline only, and the thermal error on heat rejected and heat consumed can be up to +/- 80kW

Engineer's Notes

1. Weather Data from Glasgow, Montana, 2013.
2. This evaluation is for a 6500 model Green Machine. (Previously referred to as a 4020 model Green Machine)
3. Optimal 6500 GM inlet conditions used as input parameters, as requested by Birkby Consulting. Once actual input parameters are finalized, please notify ElectraTherm to obtain an updated power output estimate.
4. ElectraTherm does not provide heat exchangers; however, we can help you contact a heat exchanger manufacturer for this project.
5. Estimated temperatures, heats, and flows used in analysis are based on information provided via correspondence with Birkby Consulting. The customer should validate actual heat exchanger performance data against this evaluation. Re-evaluation of the project will be necessary if designed performance of exhaust gas heat exchanger differs from estimate.
6. The condensing source is 350 gpm and 40% glycol.
7. An approach temperature of 21°F was used for the liquid loop radiator.
8. The estimated external parasitics for the cooling pump and liquid loop radiator fans are 4kWe and 11kWe, respectively. Other external parasitic loads, if applicable, will need to be accounted for.



Estimated Annual Power Output
140 kWe
120 kWe
100 kWe
80 kWe
60 kWe
40 kWe
20 kWe
0 kWe
Estimated kWe Power Output
80
70
60
50
40
30
20
10
0
Ambient Weather Temperature (°F)
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
Month
Ambient Temperature
Gross kWe Output
Net kWe Output
Parasitic Load (kWe)
Available Heat: 1200 kWth
Hot Water Temperature: 240°F
Hot Water Flow: 350 GPM
Average Gross Output: 105 kWe
Average Net Output: 82.5 kWe


One Line Heat Balance Diagram
Induction Generator
Average Gross Output: 105 kWe
Average Net Output: 82.5 kWe
Twin Screw Expander
Pre-Heater Evaporator
240°F, 116°C
350 GPM,
22.1 l/s
-1194 kWth
-4.08 MMBTU/hr
Average Heat Consumed by Green Machine
86°F, 30°C
350 GPM, 22.1 l/s
Average Heat Rejected to Cooling Water
999 kWth
3.41 MMBTU/hr
Internal Parasitic Load: 7.5 kWe
64°F, 18°C
350 GPM, 22.1 l/s
Condensing Water Pump
Radiator
216°F, 102°C
350 GPM, 22.1 l/s
Heat Source
240°F, 116°C
350 GPM, 22.1 l/s
Hot Water Pump

Prepared for Birkby Consulting: Green Machine Installation Payback Estimates

<u>Payback Estimate for a 4400-FS, 20' framed, Green Machine Installation</u>

- *Assuming 97% runtime*

<u>Includes costs for:</u>

- **<u>4400-FS, 20' framed, Green Machine</u>**
  - 4400 Green Machine
  - 20' High cube Frame
  - Interconnect plumbing & pump
  - Refrigerant
  - 650 kWth Liquid Loop Radiator (LLR)
  - Commissioning and startup of GM (Please note, additional costs may be applicable for commissioning in remote locations. Additional Costs typically expected to be under $5000)
- Shipping costs (any shipping upcharges or credits, TBD before actual delivery date)
- Refrigerant Bottle Deposit- cost assumed (*REFUNDABLE*)
- Heat Exchanger- $30,000 cost assumed **[heat exchanger not sold or provided by ElectraTherm].**

ELECTRATHERM

Expand All

Collapse All

Payback Estimator

Expand Total CapEx | Expand Simple Payback in Years

Exp. CapEx + Incentives | Expand Projected Lifetime Net Revenue

Expand Total Value of Power per kWh | Expand IRR

CONFIDENTIAL

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	U.S. Dollars	
Estimated Total Capital Expenditure (CapEx)	$ 314,170	Estimated Total CapEx for this Project
Total value of power per kWh	$ 0.08	Average value of kWh produced
Total Net Annual Power Output	44.5	Total Net Annual Power Output (GM Net Output + Cooling Savings)
Simple Payback in Years	12.65	Years (this does account for 0% increase $/kWh for electricity

revision Date 20140327

<u>Does not include:</u>

- BOP requirement costs
- Electrical components and hookup

Payback Estimate for a 6500-FS, 20' framed Green Machine Installation

- *Assuming 97% runtime*

Includes costs for:

- **6500-FS, 20' framed Green Machine**
  - 6500 Green Machine
  - 20' High cube Frame
  - Interconnect plumbing & pump
  - Refrigerant
  - 800 kWth Liquid Loop Radiator (LLR)
  - Commissioning and startup of GM (Please note, additional costs may be applicable for commissioning in remote locations. Additional costs typically expected to be under $5000)
- Upcharge for 1000 kWth LLR (since ~1000 kWth heat rejected by LLR. Please refer to respective power output assessment for details)
- Shipping costs (any shipping upcharges or credits, TBD before actual delivery date)
- Refrigerant Bottle Deposit-cost assumed (*REFUNDABLE*)
- Heat Exchanger- $45,000 cost assumed **[heat exchanger not sold or provided by ElectraTherm]**

ELECTRATHERM

Expand All | Collapse All

Payback Estimator

Expand Total CapEx | Expand Simple Payback in Years | Exp. CapEx + Incentives | Expand Projected Lifetime Net Revenue | Expand Total Value of Power per kWh | Expand IRR

CONFIDENTIAL

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	U.S. Dollars	
Estimated Total Capital Expenditure (CapEx)	$ 438,710	Estimated Total CapEx for this Project
Total value of power per kWh	$ 0.08	Average value of kWh produced
Total Net Annual Power Output	82.5	Total Net Annual Power Output (GM Net Output + Cooling Savings)
Simple Payback in Years	9.52	Years (this does account for 0% increase $/kWh for electricity

revision Date 20140327

Does not include:

- BOP requirement costs
- Electrical components and hookup

XIII. Geothermally Heated Greenhouses

Providing fresh, local foods to rural areas of Northeastern Montana, especially during winter months, is a difficult undertaking. Lack of fresh food has been linked to diabetes, obesity, and other diseases. Even when fresh foods are available, the cost of transportation to rural areas is often prohibitive, putting them out of reach of low-income customers.

Producing tomatoes, lettuce, and other fresh vegetables from local greenhouses has been examined as a way to help provide nutritious fresh food. However, the harsh winter climate in the Northern U.S. has limited this approach, because the cost of greenhouse heating with natural gas or other fossil fuel is prohibitive.

The oil and gas boom in eastern Montana and western North Dakota ("the Bakken") and the influx of new workers coming into the area has added additional pressure on local food availability and cost. Tribal reservations in rural areas near oil and gas exploration areas are also feeling pressure on the cost and availability of local foods. But the boom in well drilling also presents a unique opportunity—providing fresh local food from greenhouses heated with the hot wastewater from these wells.

Heating greenhouses with geothermal energy in the United States is not new—existing commercial greenhouse operations in Oregon, Idaho, New Mexico, Alaska, and other states are successfully using geothermal energy for their heating needs. But there are currently no known greenhouses in the United States that utilize geothermal energy from existing oil and gas wells in remote rural areas, rather than drilling expensive new wells solely for greenhouse heating.

Using existing hot water from operating oil wells would provide a distinct advantage to greenhouse heating, because it immediately eliminates the substantial capital costs of drilling the production and reinjection wells, in addition to eliminating the costs of installing new piping and pumping systems.

Greenhouse heating is one of the most common uses of geothermal resources in the nation. Because of the significant heating requirements of greenhouses and their ability to use low-temperature fluids, they could be a natural application in the Fort Peck tribal lands. A wide variety of plants are grown in geothermal greenhouses, including roses, tomatoes, lettuce, cucumbers, and other vegetables.

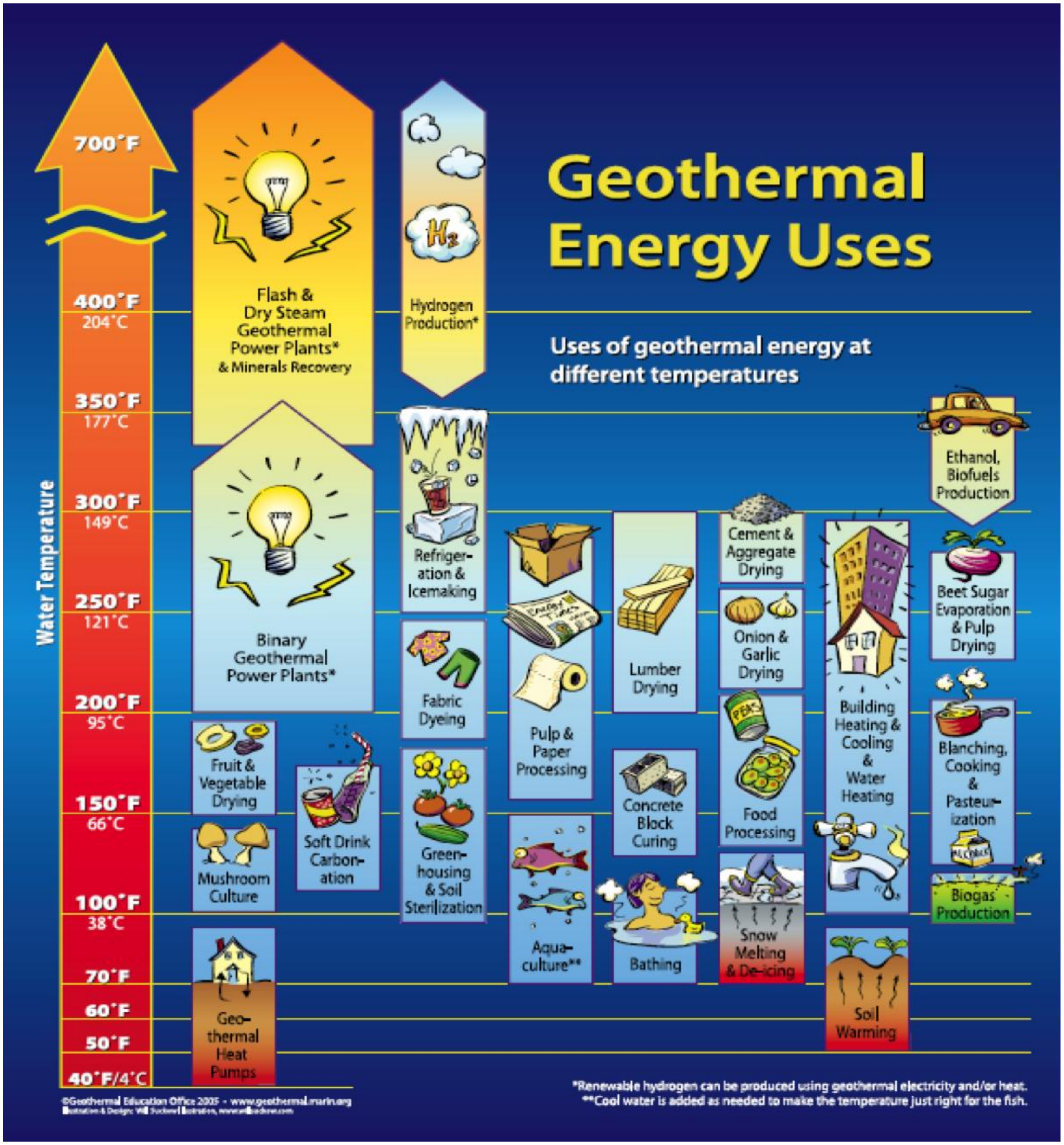


Figure 2912 Geothermal Energy Uses at different temperature ranges. Geothermal greenhouse heating can be accomplished with fairly low-temperature resources (100 to 200 degrees F). (Source—Geothermal Education Office)

A greenhouse using geothermal wastewater from a producing oil well on the Fort Peck Reservation would require the following:

- a heat exchanger to interface between the oil well wastewater and the circulating greenhouse heating water;
- a pumping and distribution system to bring the greenhouse heating water to the greenhouse;
- a heating distribution system within the greenhouse

Specific Considerations for a Geothermally Heated Greenhouse at Fort Peck:

- **Cascaded use of Geothermal Resource**—A geothermally heated greenhouse could "piggyback" on the development of a power generation system on an existing, producing oil well. The closed heat exchanger loop costs would be borne by the power generator, as well as all pumping and disposal costs. After the geothermal water is used for power generation, and before it is disposed of underground, the waste water will still have ample heat to supply the heating needs of a greenhouse.

- **Reliability and dependability of geothermal resource**. Geothermally heated greenhouses on the Fort Peck Reservation, especially in winter, must have a constant supply of heat. Temperatures during the winter may drop to 20 below zero F. or more, and a crop growing in a greenhouse that suddenly loses its geothermal heating source would be in danger of freezing. The Fort Peck Tribe should consider signing an agreement with an oil company to provide a consistent quantity of hot water from a chosen oil well or collection/separation unit to the greenhouse heat exchanger. In addition, an automatic backup heating system should be included in the greenhouse design, to take over greenhouse heating in case of unplanned loss of the geothermal heating resource.

- **Lifetime of producing oil well.** A geothermally heated greenhouse at Fort Peck will depend on the availability of the geothermal fluid from an actively pumped oil well or collection station. Oil wells may be plugged and abandoned, either temporarily or permanently, as market conditions change or the oil resource is depleted. The Fort Peck Tribe could negotiate with the oil company to plan for this contingency, and require that the company give the Tribe ample notification of an impending shutdown of a well or collection unit.

- **Greenhouse mobility:** The Fort Peck Tribe might consider a greenhouse design that could be moved to a new well location, if the existing well supplying geothermal heat is abandoned.

- **Greenhouse Security:** Since a geothermally heated greenhouse needs to located in close proximity to an existing oil well, it is likely that any new greenhouse on the Fort Peck Reservation will be built in isolated locations several miles from the nearest occupied building. The Tribe should consider what security measures it will undertake to prevent vandalism of the greenhouse structure or the theft of the crop from this remote location. Some security measures might include remote video monitoring, motion sensors, or on-site caretakers.

Geothermal Greenhouse Feasibility Checklist

- What plants do I want to grow? (Tomatoes, herbs, cut flowers, other vegetables.)
- How much can I produce in my geothermal greenhouse, given my local climate, available daylight, and the greenhouse temperatures I can maintain with the geothermal heating system?
- Do I have experience growing greenhouse crops? Who will I rely on for growing expertise?
- Do I have the business and marketing skills to run a greenhouse operation? Can I learn them or hire experts?
- What is the market for my greenhouse product? Do I have a special market niche (organic, low-spray, specialty crops, local)? How far away is the market? Is it a local Montana market? It is seasonal? Year-round?
- Who is my competition? What makes my product different, better, unique?
- How much will I be paid for my product? How much are others with similar products paid? Do I need to guarantee delivery of a certain amount of product on a regular basis?
- How much will it cost to produce this product? Do I clearly understand the total costs of running a geothermal greenhouse operation?
- Finally, given the costs, resources, market, and projected sales, will I make enough money to make a profit?

(Adapted from *Geothermal Greenhouse Information Package,* Tonya Boyd, Oregon Institute of Technology, 2008)

Geothermal Greenhouse Examples

Following are a few examples of existing geothermal greenhouses, as well as community greenhouses in a tribal setting:

- Geothermally heated greenhouse at Chico Hot Springs, Montana: hwww.builditsolar.com/Projects/Sunspace/ChicoHS/ChicoHS.htm
- ChenaFresh—Geothermally Heated Greenhouse at Chena Hot Springs, Alaska www.chenahotsprings.com/chena-fresh/
- Tribal Greenhouse in Alaska: www.inuvikgreenhouse.com/index.html
- Athabascan Nation (Alaska) Community Greenhouse: www.chickaloon.org/about/greenhouse-689/
- Geothermal Greenhouse Information Package-- http://geoheat.oit.edu/pdf/green.pdf

Figure 30   The Milgro Nurseries greenhouse near New Castle, Utah, is one of the approximately 40 greenhouses nationwide that benefit from the direct use of geothermal energy. (Photo from National Renewable Energy Laboratory)

Appendix 1

Presentations Given in Support of the DOE Fort Peck Geothermal Energy Project 2012 – 2014

13th Annual Harvesting Clean Energy Conference
Presentation Title: "Geothermal Energy from Northeast Montana Oil Wells"
February 4, 2014
Helena, Montana
Presenter—Jeff Birkby
Attendees—Jeff Birkby, Garry Carlson

Geothermal Energy and Waste Heat to Power: Utilizing Oil and Gas Plays
Presentation Title: "Geothermal Potential of Oil and Gas Wells on the Fort Peck Reservation in Northeast Montana"
March 12-14, 2013
Southern Methodist University, Dallas, Texas
Presenter—Garry Carlson
Attendees—Garry Carlson, Jeff Birkby

Initial Meeting/Presentation
Presentation Title "Geothermal Feasibility Study for Possible Electrical Power Generation Fort Peck Tribes"
Poplar, Montana
January 25, 2012
Presenter—Garry Carlson

[Slides of each of these three presentations are shown on the following pages of this appendix]

Geothermal Potential of Oil and Gas Wells on the Fort Peck Reservation in Northeast Montana

Geothermal Energy and Waste Heat to Power:
Utilizing Oil and Gas Plays

Southern Methodist University

March 14 -15, 2013

Birkby Consulting LLC

Garry Carlson, Gradient Geophysics, Inc.
Jeff Birkby, Birkby Consulting LLC

Gradient Geophysics Inc.

Funded by
US Department of Energy
Tribal Energy Program

Grant #DE-EE00052511

OBJECTIVES

- Identify Suitable Existing Oil Wells for Electrical Power Generation (water flow/temperature/access)
- Identify Geothermal Potential in Undrilled Areas of Fort Peck Reservation
- Conduct Economic Feasibility Study of Power Generation and Greenhouse Heating Options on Targeted Oil Wells

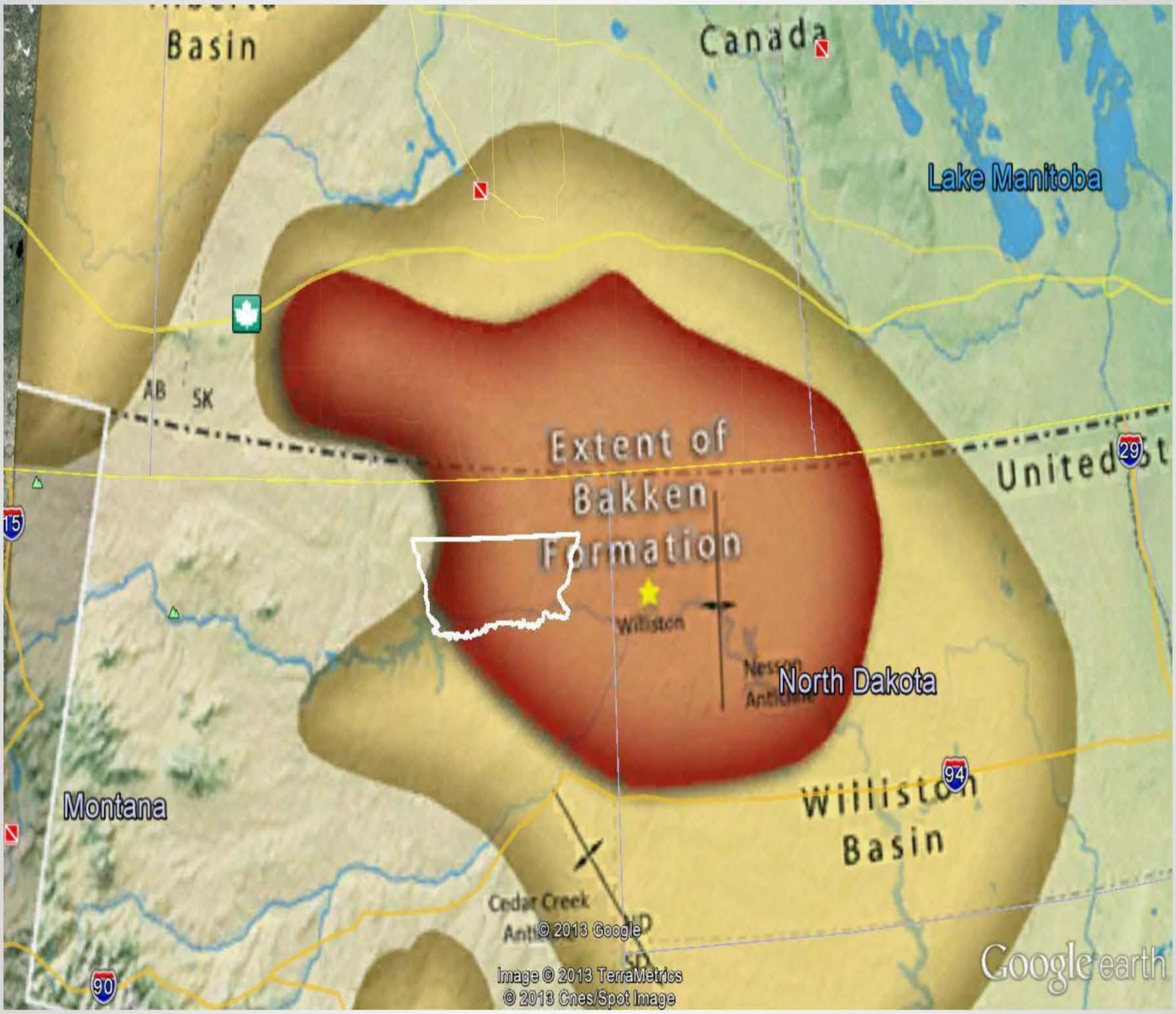
GRADIENT Geophysics Inc.


Fort Peck Reservation
FT. PECK TRIBES
ASSINIBOINE
SIOUX
North Dakota
Montana
Bitterroot Range
Rocky Mountains
94
CANADA
USA
24
13
16
MONTANA
NORTH DAKOTA
Fort
Peck
Indian
Reservation
Medicine Lake
Glasgow
Fort Peck
Nashua
Wolf Point
Poplar
2
Culbertson
River
Missouri
Fort Peck Dam
South Dako
oogle earth
GRADIENT
Geophysics Inc.

WHY IS THIS AREA IMPORTANT?

- ***COPRODUCED OIL AND GAS WELLS***
- ***HIGH TEMPERATURE WATER – many wells over 200 F***
- ***LARGE EXTENT – and GETTING BIGGER with MORE DRILLING***
- ***EASY ACCESS – Wells completed, on Tribal Lands – more control over geothermal***
- ***MADISON FORMATION – hottest water – is intercepted when drilling through to Bakken***

GRADIENT Geophysics Inc.


Basin
Canada
Lake Manitoba
AB
SK
Extent of
Bakken
Formation
United
Williston
North Dakota
Montana
Williston
Basin
Cedar Creek
© 2013 Google
Image © 2013 TerraMetrics
© 2013 Cnes/Spot Image
Google earth

Previous Geothermal Research on the Fort Peck Reservation

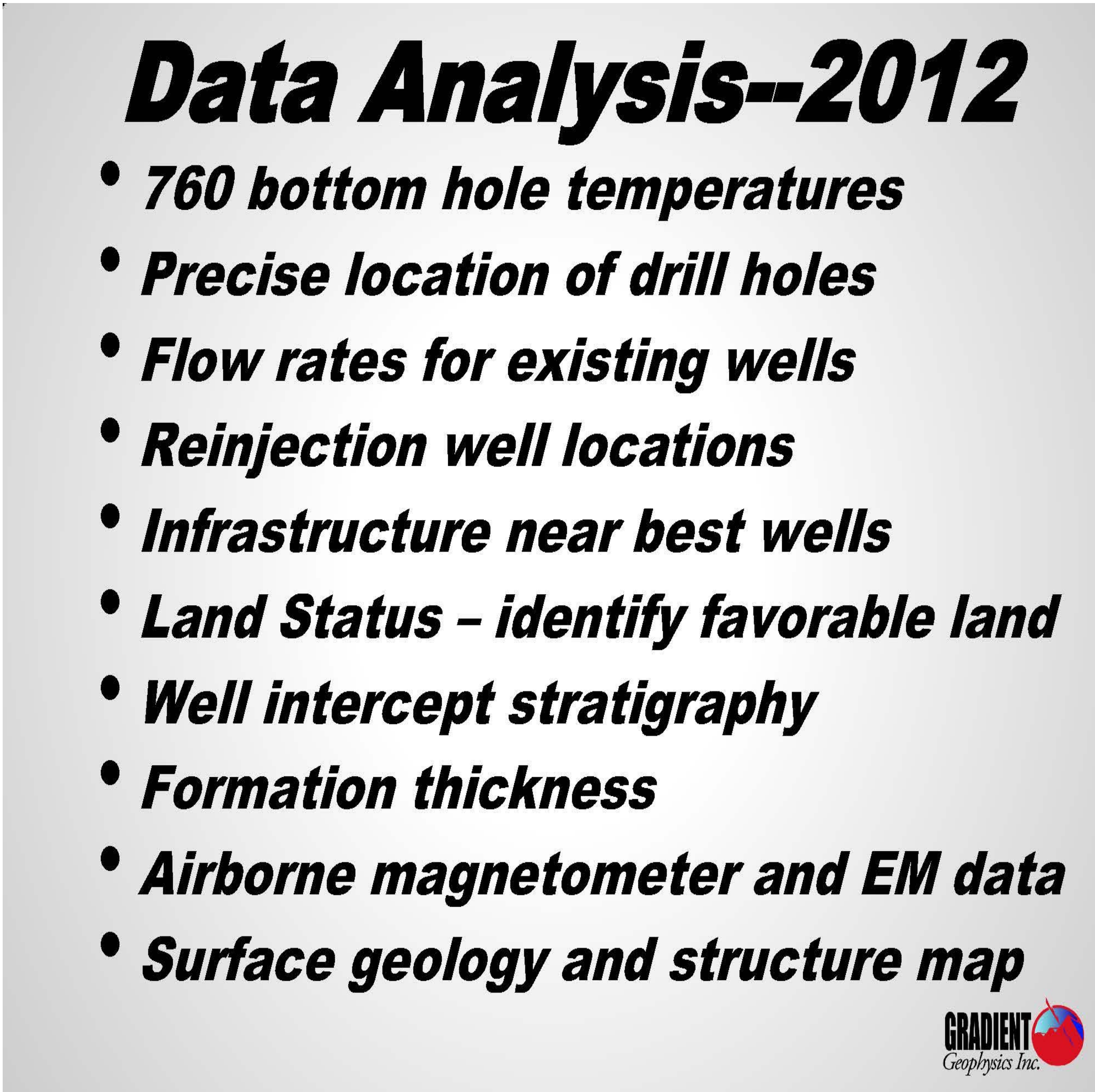
- ***1979—PRC Toups***

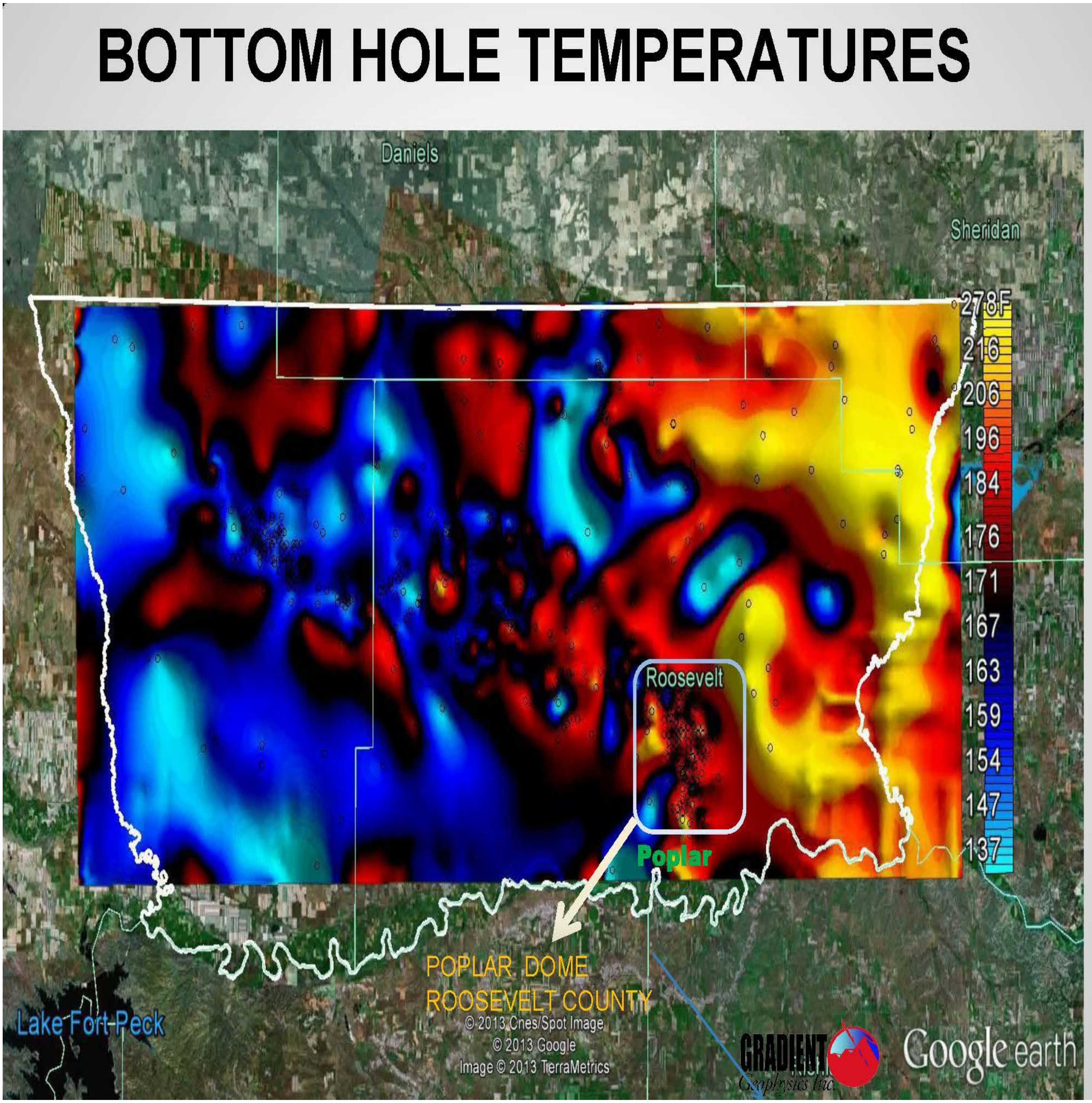
  Geothermal Space Heating Applications for the Fort Peck Indian Reservation – a DOE funded grant **- relied on 1950's data**

- ***2005—Black Mountain Technology***

  Geothermal Power Generation Potential: East Poplar Dome Oil Field – before latest oil boom

GRADIENT Geophysics Inc.


Data Analysis--2012
• 760 bottom hole temperatures
• Precise location of drill holes
• Flow rates for existing wells
• Reinjection well locations
• Infrastructure near best wells
• Land Status – identify favorable land
• Well intercept stratigraphy
• Formation thickness
• Airborne magnetometer and EM data
• Surface geology and structure map
GRADIENT
Geophysics Inc.


BOTTOM HOLE TEMPERATURES
Daniels
Sheridan
278F
216
206
196
184
176
171
167
163
159
154
147
137
Roosevelt
Poplar
POPLAR DOME
ROOSEVELT COUNTY
Lake Fort Peck
© 2013 Cnes/Spot Image
© 2013 Google
Image © 2013 TerraMetrics
GRADIENT
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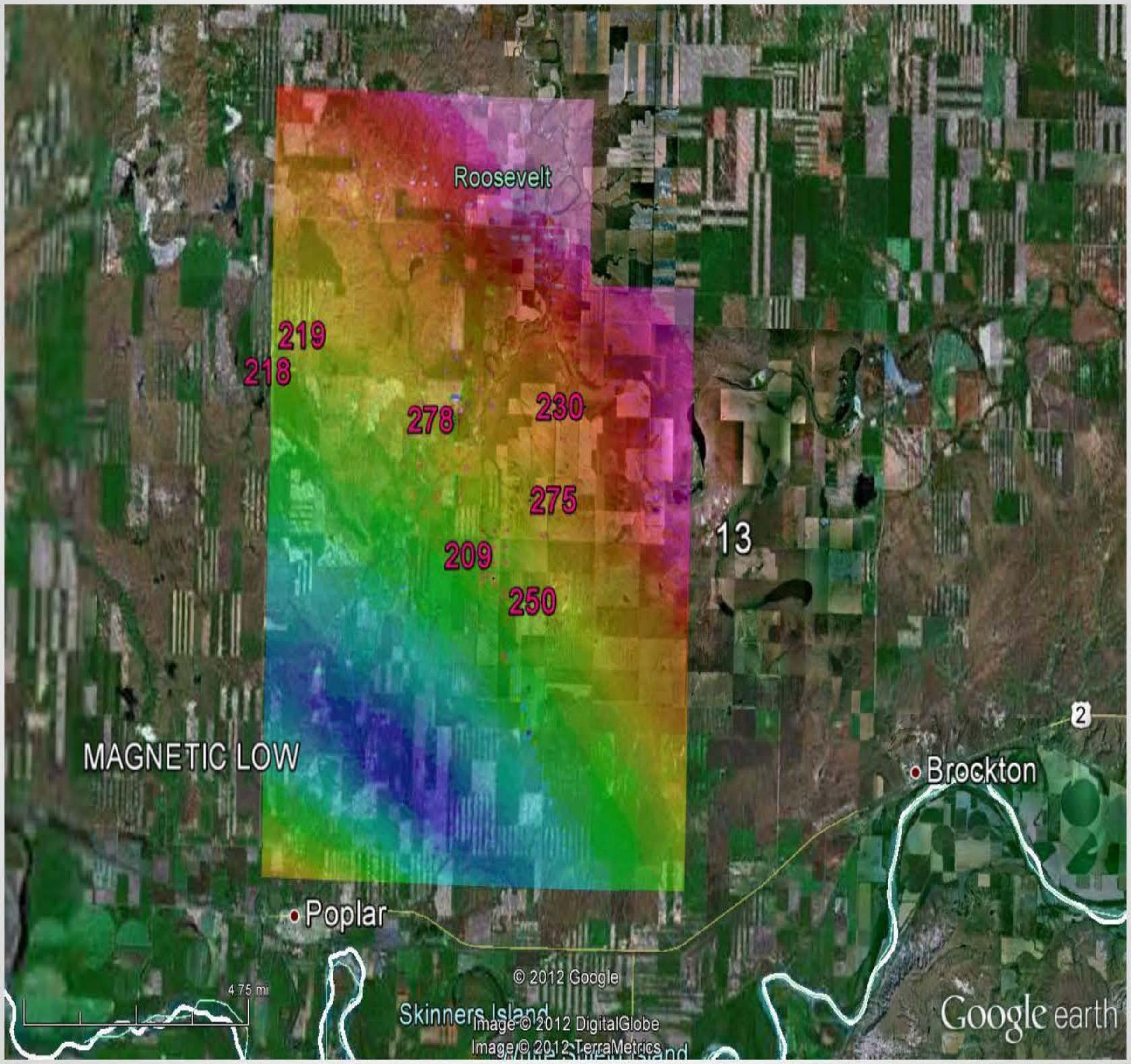
Google earth

Airborne magnetics plot with hot temps



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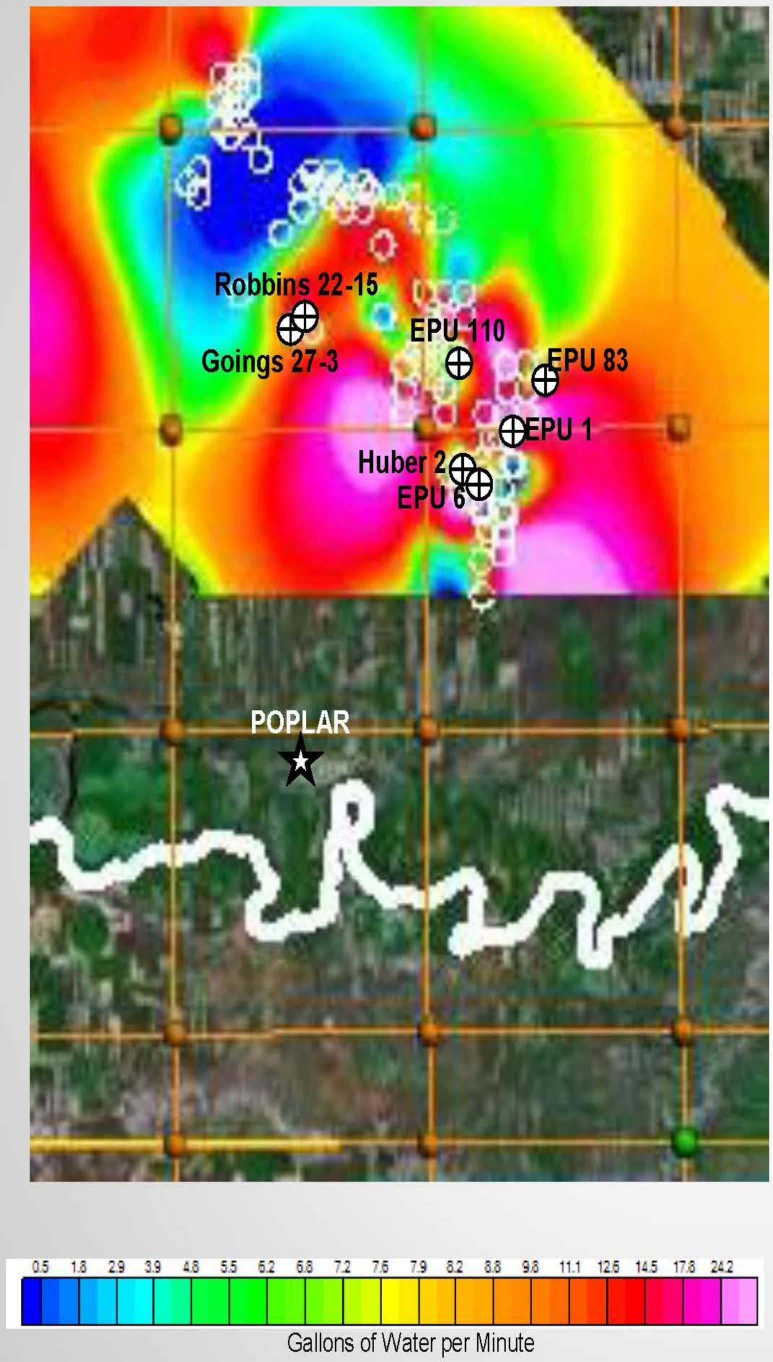
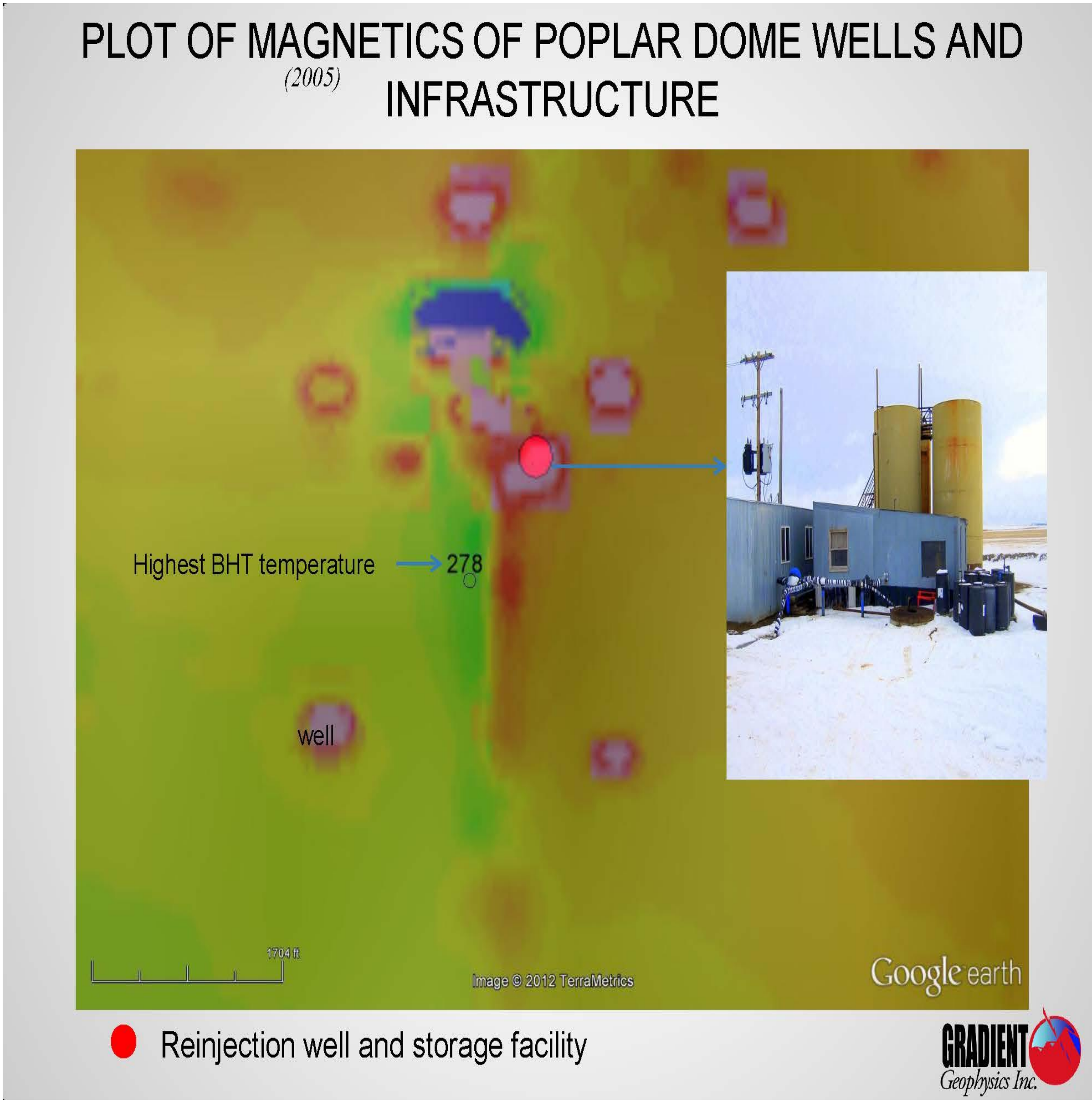


Top Water Producing Oil Wells in East Poplar Field with BHT > 200 F

EPU 6 :	209 F
Goings 27-3 :	218 F
Robbins 22-15:	219 F
Huber 2 :	224 F
EPU 110 :	227 F
EPU 83 :	230 F
EPU 1 :	278 F

N

GRADIENT Geophysics Inc.


PLOT OF MAGNETICS OF POPLAR DOME WELLS AND
(2005)
INFRASTRUCTURE
Highest BHT temperature
278
well
1704 ft
Image © 2012 TerraMetrics
Google earth
Reinjection well and storage facility
GRADIENT
Geophysics Inc.

ADVANCEMENTS MADE IN OUR PROJECT

- Identified the highest geothermal temperature ever recorded in Montana: 278 F !

- Compiled nearly 90 Bottom Hole Temperatures (BHT) equal or greater than 200 F

- Identified important new areas of geothermal potential

- Evaluated significant amount of new drill hole data available from Bakken exploration

Birkby Consulting LLC

Gradient Geophysics Inc.

Gradient Geophysics Inc.
PO Box 18214
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406 360-3456
garryjcarlson@gmail.com
www.gradientgeo.com

Birkby Consulting LLC
238 East Sussex Avenue
Missoula, MT 59801
406-723-7163
jeff@birkbyconsulting.com
www.birkbyconsulting.com

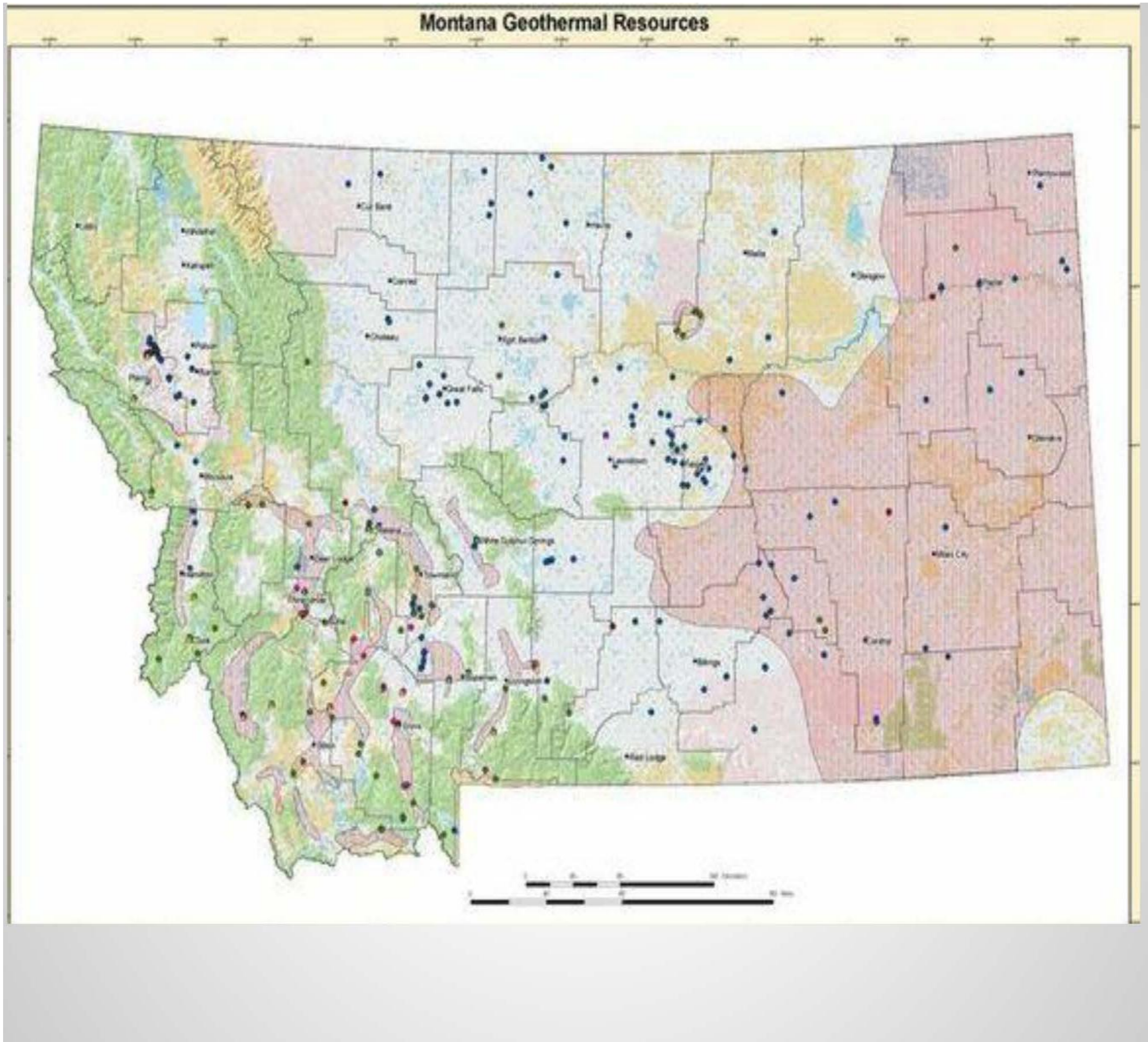
Electric Generation from Geothermal Energy in Northeast Montana Oil Wells

Harvesting Clean Energy Conference:

Helena, Montana

February 4, 2014

Jeff Birkby, Birkby Consulting LLC
Garry Carlson, Gradient Geophysics, Inc.


Montana Geothermal Resources

US Department of Energy Tribal Energy Program

Grant #DEEE00052511


GRADIENT
Geophysics Inc.
BIRKBY
CONSULTING
LLC

Fort Peck Reservation
FT. PECK TRIBES
ASSINIBOINE
SIOUX
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Bitterroot Range
Rocky Mountains
South Dako
94
CANADA
USA
24
13
16
MONTANA
NORTH DAKOTA
Fort
Peck
Indian
Reservation
Medicine Lake
Glasgow
Nashua
Wolf Point
Poplar
2
Culbertson
Fort Peck
River
Missouri
Fort Peck Dam
oogle earth

WHY IS THIS AREA IMPORTANT?

- **COPRODUCED OIL AND GAS WELLS**
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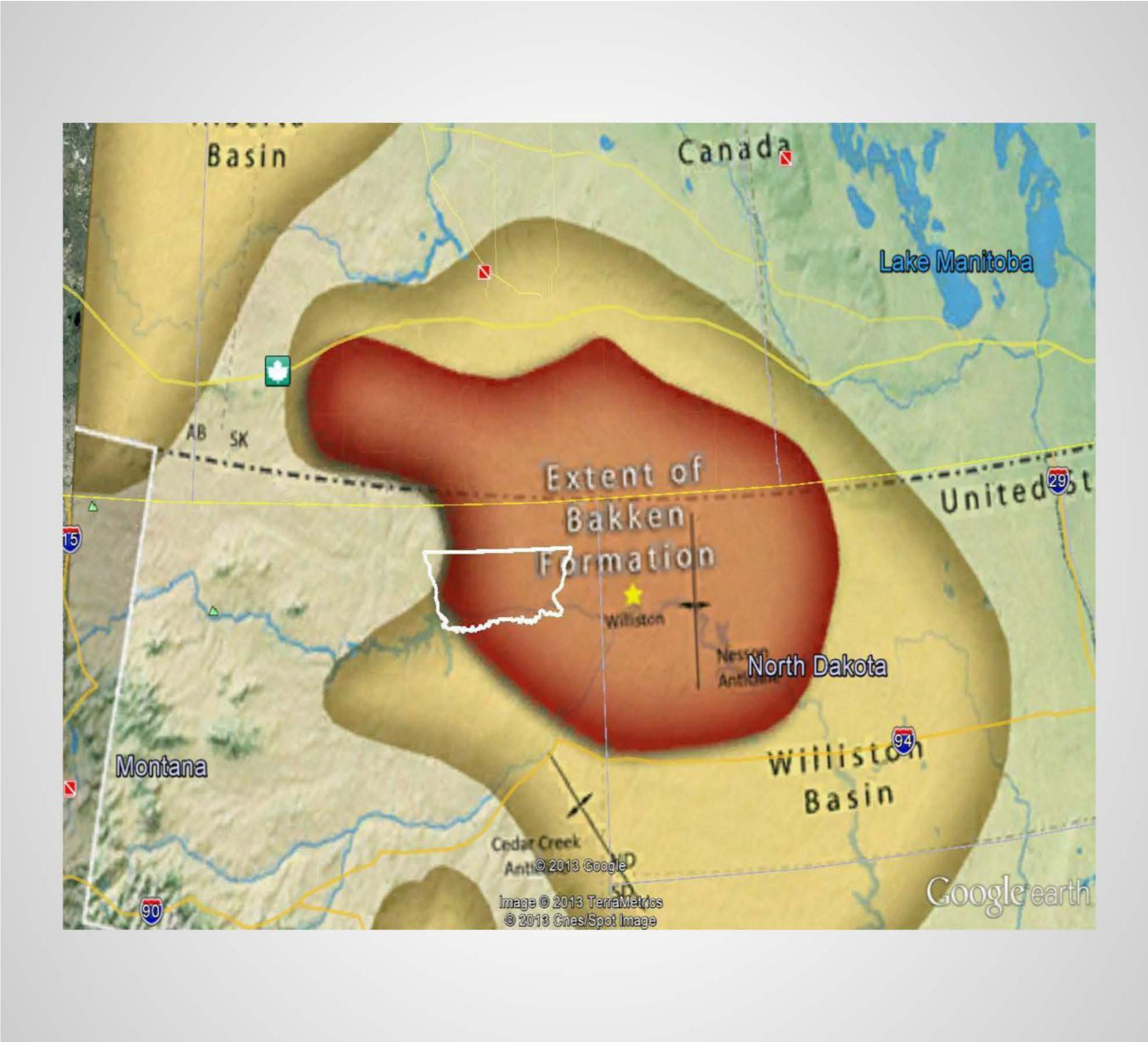
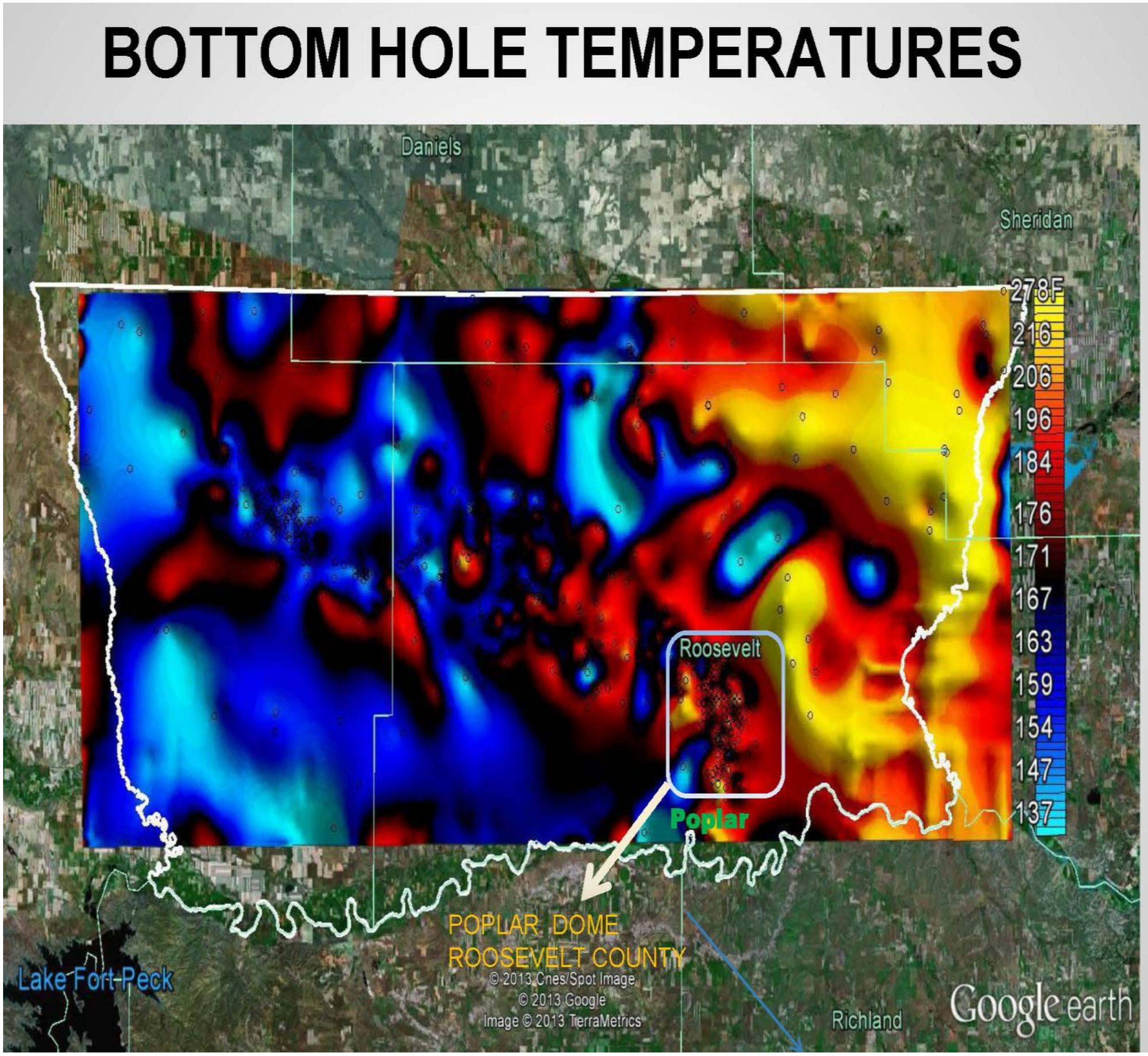


Basin
Canada
Lake Manitoba
AB
SK
Extent of Bakken Formation
United St
Williston
North Dakota
Nesson Anticline
Montana
Williston Basin
Cedar Creek Anti
ND
SD
© 2013 Google
Image © 2013 TerraMetrics
© 2013 Cnes/Spot Image
Google earth

Data Analysis

- *760 bottom hole temperatures*
- *Precise location of drill holes*
- *Flow rates for existing wells*
- *Reinjection well locations*
- *Infrastructure near best wells*
- *Land Status – identify favorable land*
- *Formation thickness*
- *Airborne magnetometer and EM data*
- *Surface geology and structure map*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Lake Fort Peck
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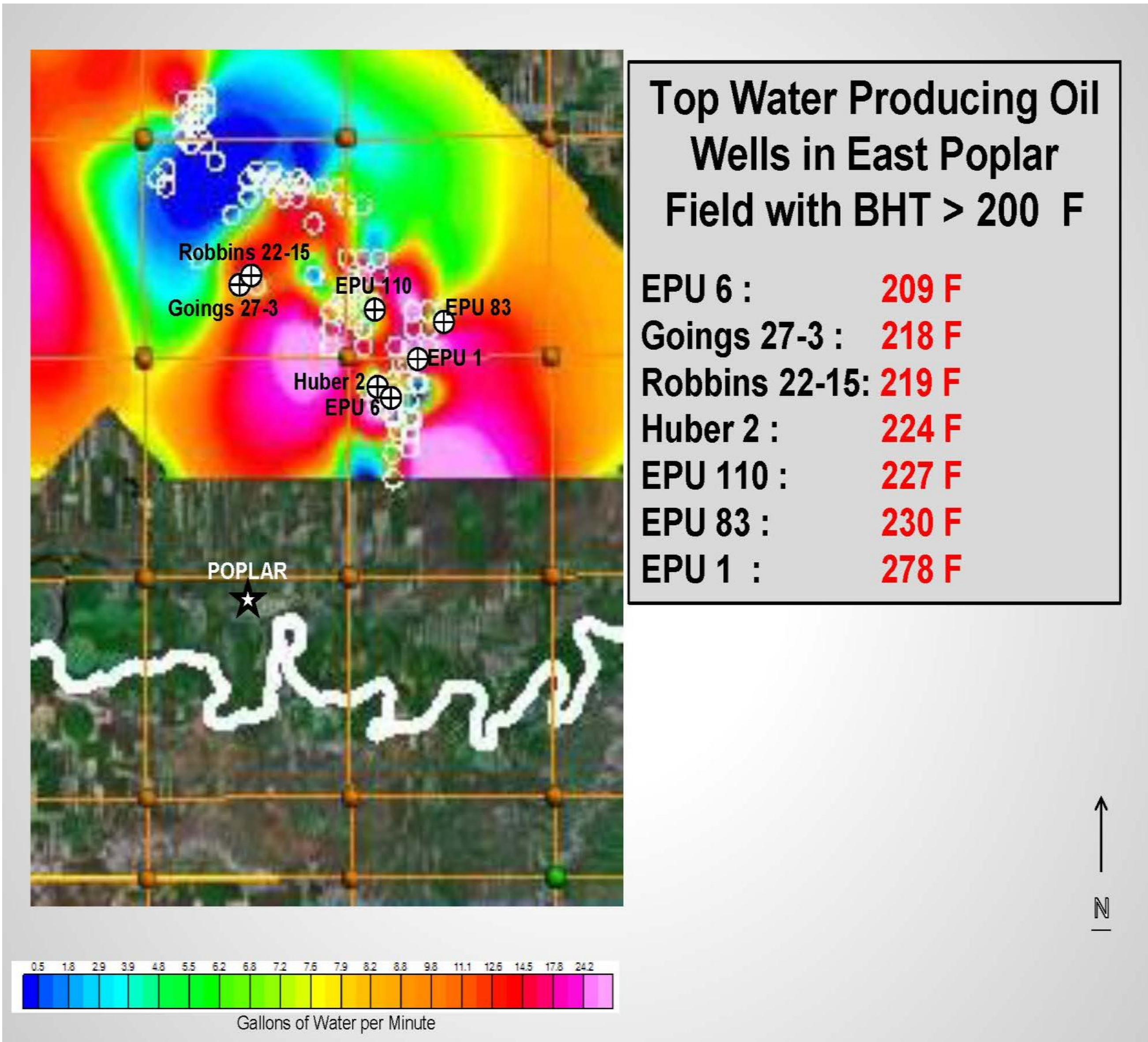
Image © 2013 TerraMetrics
Richland
Google earth



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EPU 1 : 278 F
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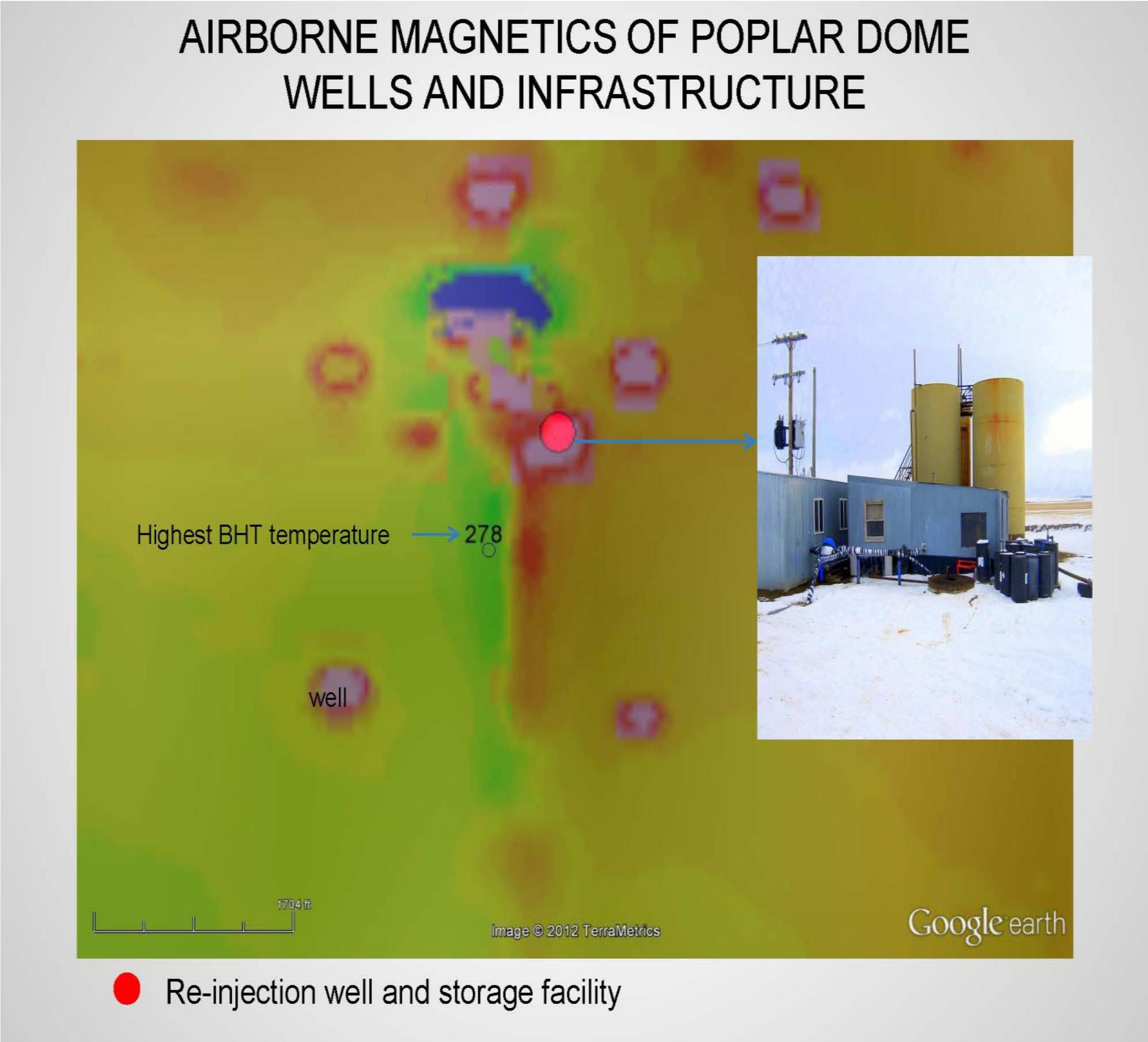
Goings 27-3
EPU 110
EPU 83
EPU 1
Huber 2
EPU 6
POPLAR
N
0.5 1.8 2.9 3.9 4.8 5.5 6.2 6.8 7.2 7.6 7.9 8.2 8.8 9.8 11.1 12.6 14.5 17.8 24.2
Gallons of Water per Minute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WELLS AND INFRASTRUCTURE
Highest BHT temperature
278
well
1704 ft
Image © 2012 TerraMetrics
Google earth
Re-injection well and storage facility

Results so Far (January 2014)

- Evaluated large amount of new drill hole data available due to Bakken exploration
- Confirmed one of highest geothermal well temps recorded in Montana: 278 F !
- Compiled nearly 90 Bottom Hole Temperatures (BHT) equal or greater than 200 F
- Identified important new areas of geothermal potential on Fort Peck Reservation

Remaining Objectives

- Pinpoint Oil Wells and Collection Points suitable for Electrical Power and Greenhouse Heating
- Conduct Economic Feasibility Study of Power Generation and Greenhouse Heating Options on Targeted Oil Wells and Collection Points
- Identify environmental, technical, institutional and social barriers to power generation and greenhouse development


Access Energy 125XLT Binary Unit
Carefree™ Integrated Power Module (IPM)
Programmable Logic Controller (PLC) and Magnetic Bearing Controller (MBC)
Receiver
Power Electronics
Variable Speed Fluid Pump

Electratherm 4010 Low Temp Unit

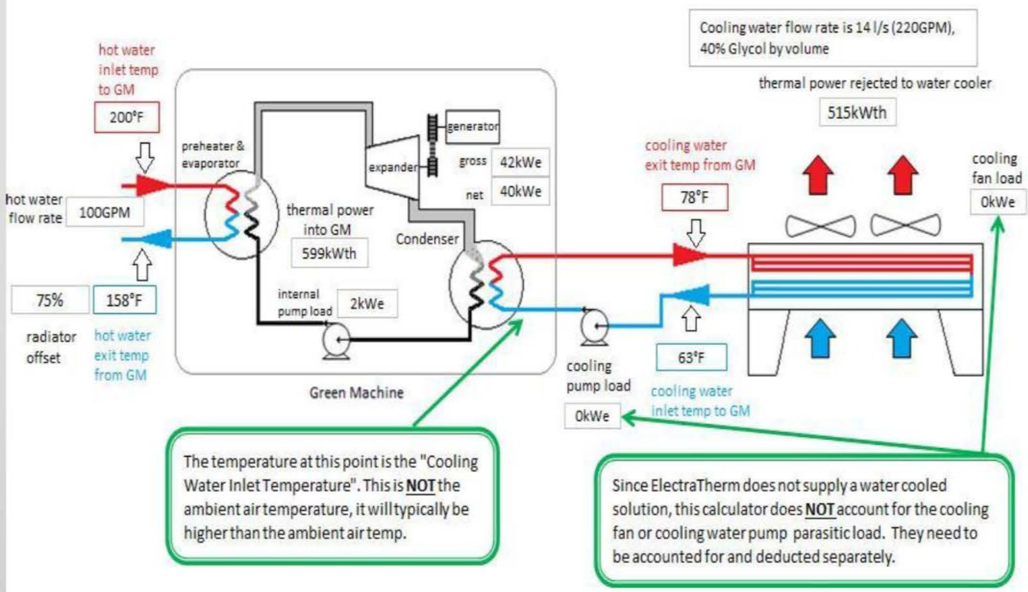
ELECTRATHERM® 4020

Inputs		
200.0	°F	Hot Water Inlet Temperature
100.0	GPM	Hot Water Flow Rate
800.0	kWth	Available Thermal Power
63.0	°F	Cold Water Inlet Temperature
Yes		Derate

4020 Evaluation

->> Click to Calculate ->>

Outputs*			Imperial Units of Heat	
42	kWe	Gross Power Output		
2	kWe	Internal Parasitic Load		
40	kWe	Net Power Output		
599	kWth	Thermal Power into GM	2.04569	MMBTU/hr
201	kWth	Remaining Thermal Power	0.68645	MMBTU/hr
158	°F	Hot Water Exit Temperature		



Initial Meeting/Presentation
Fort Peck Tribes
Poplar, Montana
January 25, 2012

Presenter—Garry Carlson

Gradient Technology

Who are we?

Garry J. Carlson, owner, founder of Gradient Geophysics, 1985:

- OVER 30 YEARS EXPERIENCE IN GEOPHYSICS, GEOLOGY and GEOTHERMAL EXPLORATION, WORLDWIDE
- DIRECTLY IN CHARGE OF OVER 600 PROJECTS, WORLDWIDE IN THE LAST 27 YEARS THROUGH GRADIENT
- OVER THE LAST 4 YEARS CONDUCTED EXPLORATION ON OVER 45 GEOTHERMAL PROSPECTS AND PROJECTS IN THE WESTERN US
- CURRENTLY WORKING ON 3 GRANTS: ONE COMPLETED

4/21/2015

GEOTHERMAL FEASIBILITY STUDY *for* POSSIBLE ELECTRICAL POWER GENERATION

Fort Peck Tribes

Garry J Carlson

Gradient Geothermal

www.gradientgeothermal.com

4/21/2015

Gradient Technology

What is the plan?

OBJECTIVES FOR FEASIBILITY STUDY:

- FIND AN EXISTING OIL WELL THAT CONTAINS ENOUGH HOT WATER and FLOW FOR ELECTRICAL POWER GENERATION
- IF NONE EXISTS, FIND AN AREA THAT MAY BE DRILLED
- TAKE THE ANALYSIS TO THE NEXT LEVEL. SELECT AN AREA THAT FAVORS A SMALL GEOTHERMAL POWER PLANT
- PROPOSE THE BEST FIT OF GEOTHERMAL PLANT (next level)

4/21/2015

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What do we know so far?

PAST STUDIES:

- TWO MAIN STUDIES LEAD US IN A POSITIVE DIRECTION
- PRC TOUPS STUDY IN 1979
- BLACK MOUNTAIN TECHNOLOGY STUDY OF 2005

4/21/2015

Gradient Technology

What do we know so far?

KEEP IN MIND, HIGH TEMP + HIGH WATER FLOW:

- HEAT FROM OIL WELLS DRILLED INTO THE MADISON FORMATION
- GREATER THAN 260 F GEOTHERMAL WATER
- DEPTHS OF 5500 FEET to 8200 FEET TO THE GEOTHERMAL WATERS
- 20,000 BARRELS PER DAY OF GEOTHERMAL WATERS AND FLOW MAY BE DOUBLED WITH WELL STIMULATION

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What do we know so far?

POSITIVE RESULTS:

- STRONGLY SUGGEST POTENTIAL FOR ELECTRICAL GENERATION
- DIRECT US IN A LOCALITY – POPLAR DOME, EAST POPLAR FIELD
- DIRECT US TOWARDS A GEOLOGIC FORMATION – MADISON
- SUGGEST THERE IS ADDED POTENTIAL – DEEPER SOURCE
- SUGGEST THERE COULD BE A FRACTURE SYSTEM

4/21/2015

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First study's problems?

PRC TOUPS SURVEY:

- MAIN PROBLEM HERE – IT IS A1979 SURVEY (33 years old)
- THEY CERTIANLY DID NOT HAVE THE MODERN GEOTHERMAL TECHNOLOGY
- THERE IS A LOT MORE INFORMATION OVER THE LAST 3 DECADES
- THERE IS A MUCH BETTER SCIENTIFIC ANALYSES OF PUTTING TOGETHER INFORMATION – for decisions

4/21/2015

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Second study's problems?

BLACK MOUNTAIN TECH STUDY:

- MORE RECENT, BUT STILL 7 YEARS OLD – 2005

- NO IDENTIFIABLE DRILL HOLE OR TARGET ALTHOUGH THEY HAD SEVERAL EXCELLENT SUGGESTIONS ON HOT WATER FOR POTENTIAL ELECTRICAL (coproduced oil wells)

- NO EVIDENCE OR REPORTS WITH DIGITAL DATA – THERE NEEDS TO BE GOOD SPATIAL DATA MANAGEMENT

4/21/2015

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The conclusions and what to do?

DATA MANAGEMENT:

- CURRENT RESULTS FROM THESE OLDER STUDIES ARE TOO **SCATTERED** OR ***INCOMPLETE***
- CANNOT MAKE A REASONABLE SCIENTIFIC ***EVALUATION*** AND ***INTERPRETATION*** ON WHICH TO BASE AN ELECTRICAL GENERATION PROJECT GIVEN THE DATA FROM THE STUDIES
- NEED ***DATA MANAGEMENT*** TO PUT TOGETHER A COMPREHENSIVE AND COHESIVE EVALUATION

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Other successful projects?

TWO PROJECTS:

- ROCKY MOUNTAIN OILFIELD TESTING CENTER – RMOTC
  - Successfully installed a power plant
  - Area in Wyoming using old oil field with co-produced wells
  - Also in the Madison Formation

- UNIVERSITY OF NORTH DAKOTA – WILLISTON BASIN
  - Successful in that is well-funded and well ahead
  - Area also in the Williston basin with co-produced wells
  - In the Madison Formation

4/21/2015

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ROCKY MOUNTAIN OILFIELD TESTING CENTER
RMOTC

- A SUCCESS STORY USING
  - DATA MANAGEMENT (ARCGIS TYPE)
  - EVALUATION AND EXPLORATION
  - FITTING A GEOTHERMAL POWER PLANT ON OLD OIL WELLS

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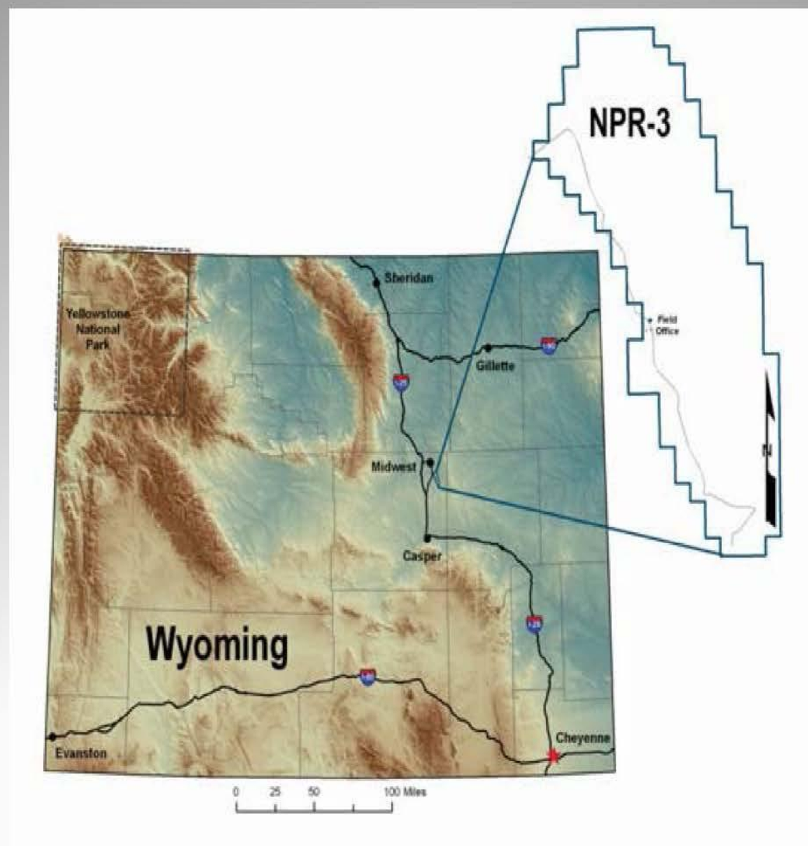

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WHAT ROMTC EMPHASIZED IN THEIR SLIDE PRESENTATION, 2008

"Where we've been"

"Need for Spatial Data Management

- Wells incorrectly located on maps

- Old hand-drawn maps

- AutoCAD drawings with stand alone coordinate system"

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WHAT RMOTC HAS DONE (see their below)

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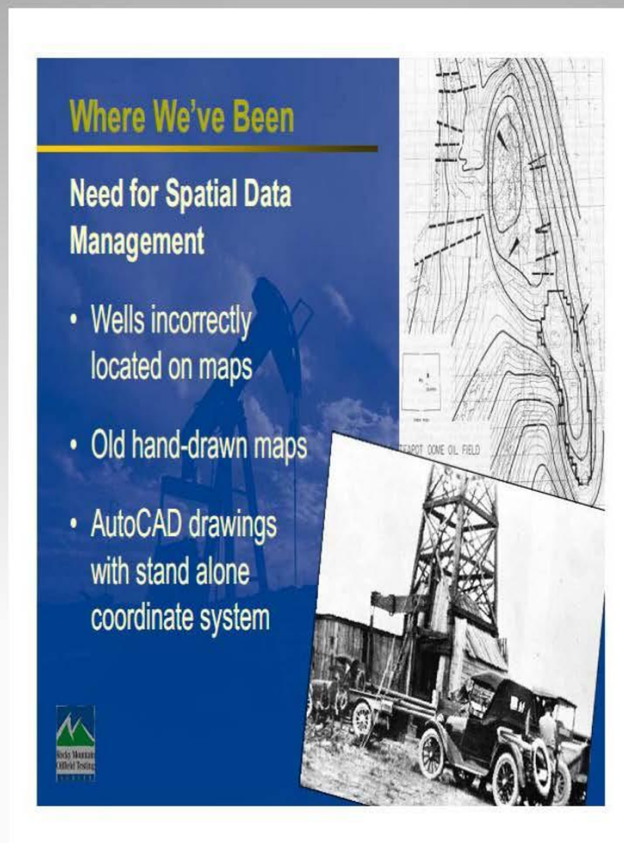

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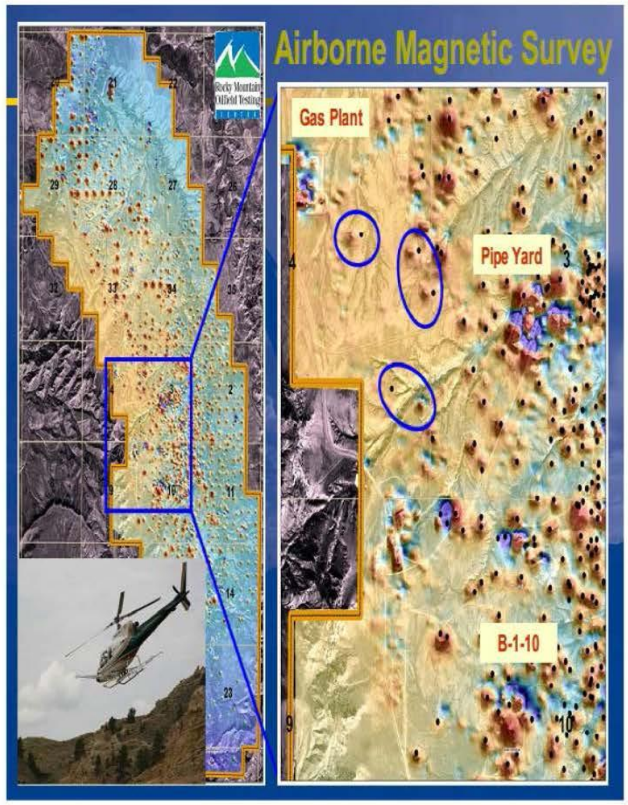
AIRBORNE MAGNETIC SURVEY (see below)

SLIDES COPIED FROM RMOTC SITE FOR COMPARISON



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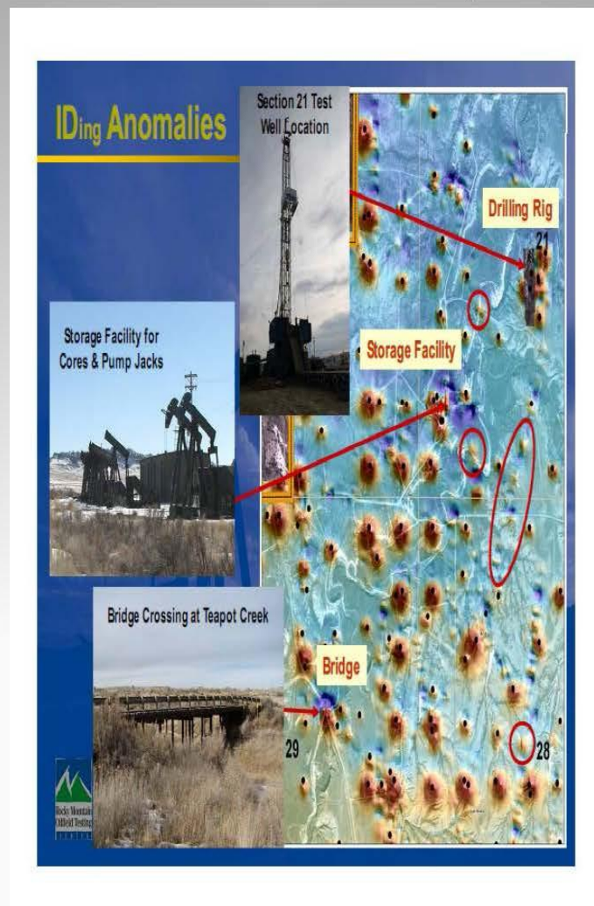
AIRBORNE MAGNETIC SURVEY (see below)

SLIDES COPIED FROM RMOTC SITE FOR COMPARISON

USED TO IDENTIFY OIL WELLS



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<u>The initial steps in data management</u>

Overlays of information:

- RMOTC MADE GREAT PROGRESS ONCE USING DATA MANAGEMENT – GIS-type
- AIRBORNE MAGNETICS WAS A BIG PART – almost all rocks contain magnetite; oil wells can be mapped - iron
- OUR DATA EVALUATION ON THE EAST POPLAR FIELD HAS AIRBORNE MAGNETICS
- THIS WILL PROVIDE A VERY USEFUL TOOL IN EVALUATION
  - geologic information
  - modern cultural features as well as archeological features

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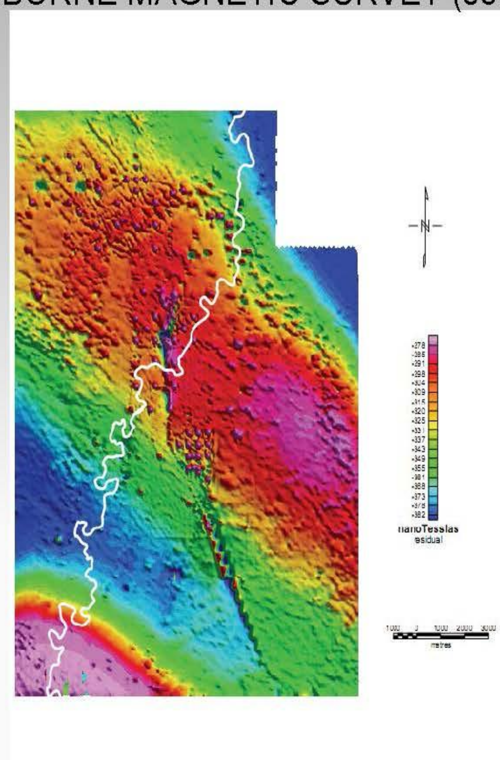
Access historic data?

DATA MANAGEMENT:

AIRBORNE MAGNETIC SURVEY (see below)

AIRBORNE SURVEY OVER EAST POPLAR FIELD

270 square kilometers of data



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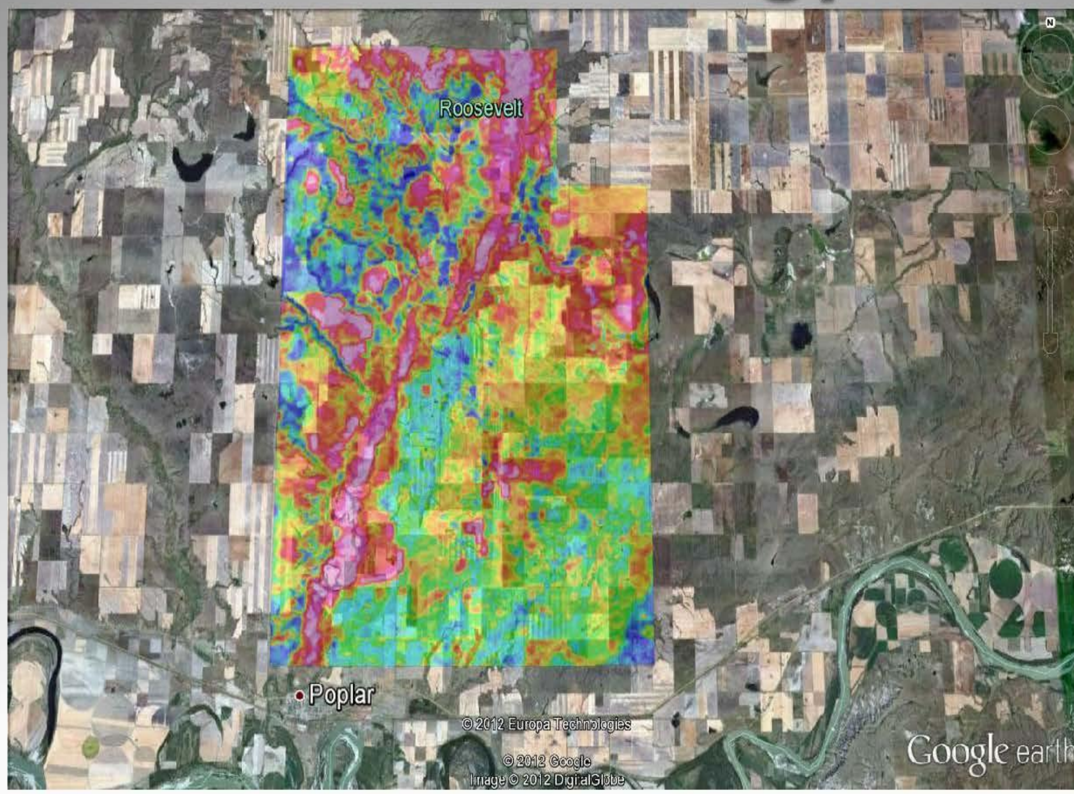

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Some options in exploration:

Overlays of information:

- MAGNETICS – maps the magnetite content of rocks
  - -modern cultural features as well as archeological features
- TEMPERATURE ROD SURVEYS – measures hot spots
- ELECTRICAL RESISTIVITY SOUNDINGS – measures favorable areas of alteration – geothermal alteration.
- SHALLOW TEMPERATURE INTEGRATED PROBE
  - - geologic information, faults
  - - stratigraphic traps

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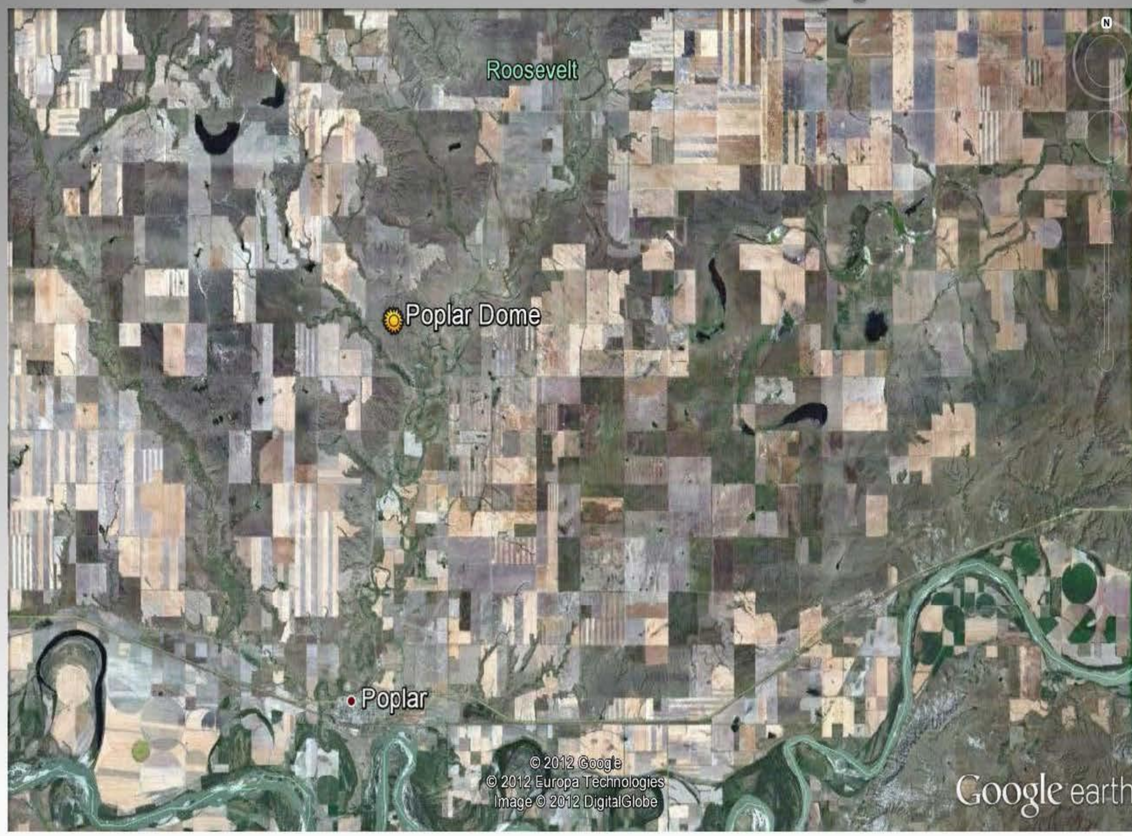

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GEOTHERMAL EVALUATION for POSSIBLE ELECTRICAL POWER GENERATION

- Co-produced oil wells with hot water
- We have heat for potential geothermal
- Need to prioritize results using data from files, archives, etc.
- The information available will be the driving factor in determining the power capability of the geothermal field

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BAKKEN PLAY

- IMPORTANT NOTE! Bakken geologic formation lies below the Madison formation.
- This means any new drilling will have to intersect the 'hot' water of the Madison formation.

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From USGS

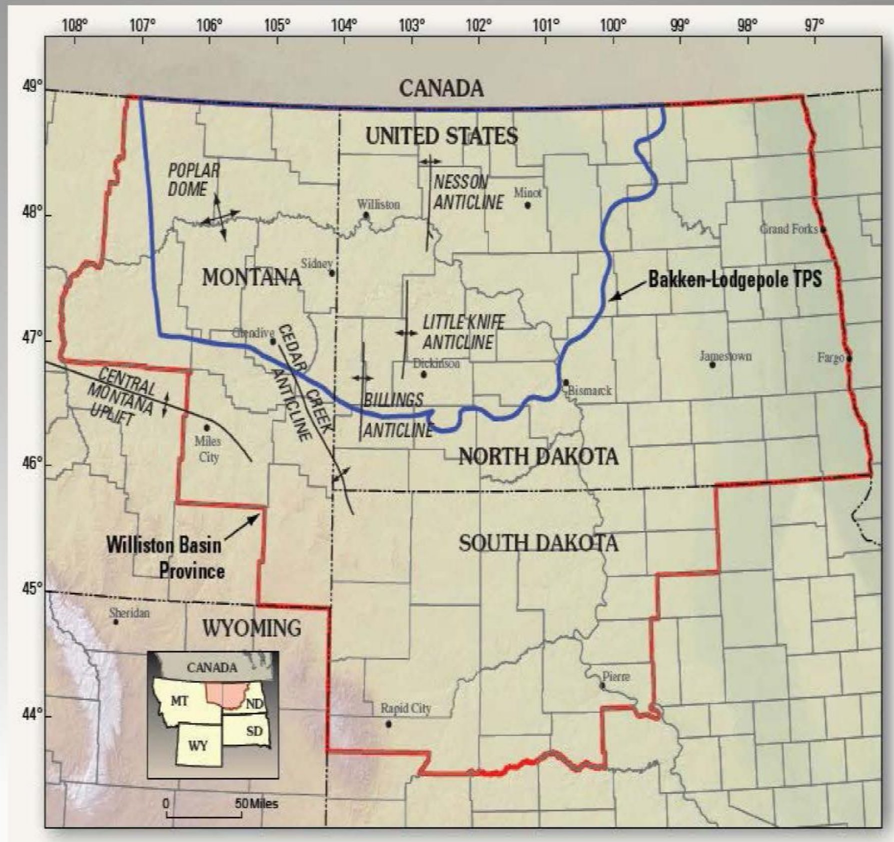

Figure 1. *Map showing Williston Basin Province boundary (in red), Bakken-Lodgepole Total Petroleum System (TPS) (in blue), and major structural features in Montana, North Dakota, and South Dakota.*

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What is the plan?

- Collecting all pertinent geothermal data from files from Tribal entities
- Compiling existing geothermal data into a Geo-database
- Prioritizing based upon correlation with the geothermal system
- Identifying and prioritize geothermal resource targets
  - Data analyses through plotting
  - Exploration on the ground (possible)
- Proceeding with the overall geothermal resource assessment

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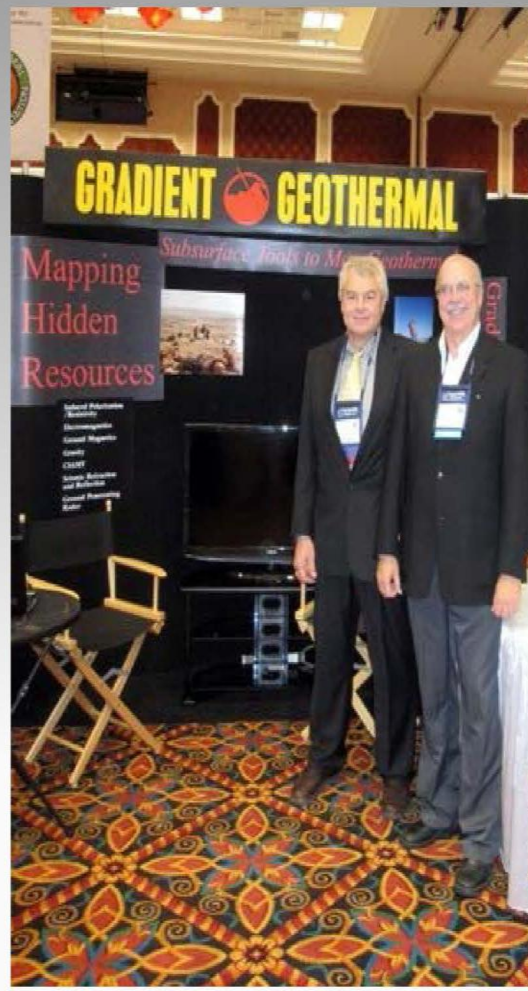
Gradient at the Geothermal Conference

Reno, NV 2009



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Appendix 2

Feasibility Checklist
for
Montana Geothermal Electricity Generation

There are four areas to consider when evaluating the potential success of an electrical power generation project using Montana's geothermal resources:

1. **Geologic Issues – Does the resource exist?**
2. **Legal Issues – Can the resource be legally harnessed?**
3. **Engineering Issues – Can the resource be efficiently harnessed?**
4. **Financial Issues – Can the project be financed? Does it make sense economically?**

These four areas are discussed in detail below:

1. Geologic Issues — Does the Geothermal Resource Exist?

This is the starting block for any Montana geothermal venture, simply because you need to identify a geothermal resource and its characteristics before you can develop it.

- ✓ What is the geology of the area?
- ✓ Are any local well logs available?
- ✓ Is seismic information available?
- ✓ Is a chemical analysis of the fluids available?
- ✓ What is the current knowledge of the geothermal resource?
- ✓ Where is the geothermal resource, at what depth, in what geologic formation?
- ✓ What is the temperature, pressure, formation thickness, and flow rate of the resource?
- ✓ What is the estimated size and producing potential of the formation?
- ✓ Are there geological risks involved?
- ✓ Seismic or other geologic factors that may present a risk to wells and production.
- ✓ What is the produced water chemistry, i.e., amount of total dissolved solids, pH, and mineral content?
- ✓ What is the likelihood of cooling the formation when it is pumped?
- ✓ Is the geothermal resource sustainable on a long-term basis?
- ✓ Does the resource replenish itself naturally, or is injection into the original formation necessary?
- ✓ Where should an injection well be located as to not thermally impact the reservoir?
- ✓ How long is the reservoir expected to sustain production rates – 10, 20, 30, 100 years?
- ✓ Where will the produced fluids be dispensed?
- ✓ At what depth will the fluid be reinjected?
- ✓ What is the chemistry of the formation that is being injected into?
- ✓ What is the risk posed by production fluid chemistry?
- ✓ What's the size of the disposing formation?
- ✓ Are there geological risks related to disposing into this formation?
- ✓ Can the spent fluids be used for secondary recovery?
- ✓ Will coproduction of hydrocarbons and geothermal fluids from the same well occur?
- ✓ Is there oil, gas, or both in the production formation?
- ✓ Have you reviewed all relevant geologic and water resource records from Montana agencies, including DEQ, MBMG, and DNRC?

Appendix 2 – *continued*

3. Engineering Issues — Can the Resource be Efficiently Harnessed? – *continued*

- ✓ How much cooling fluid is needed and where will it come from?
- ✓ In the wells, pipes, and plant systems, what chemicals will be used to eliminate issues of scaling?
- ✓ What electrical, computer, and other systems are required in order to run the plant at its highest efficiency?
- ✓ What personnel will be needed to run the plant?
- ✓ What backup/emergency systems will be installed in the case of a malfunction?
- ✓ How will I transport the energy from the plant to the desired market?
- ✓ Where is the closest utility transfer station?

4. Financial Issues — Can the Project be Financed?

Answering this question will be the true "make or break" test of your Montana geothermal power generation venture. If the budget numbers don't make sense, then the geothermal project won't make sense.

Opportunity Analysis

- ✓ Who is going to buy your energy?
- ✓ What is the most profitable target market for the generated power: selling to the grid, distributed energy, coproduction, a combination?
- ✓ If gas or oil is produced in a coproduced well, will it be sold to a pipeline, used in a fuel cell, or used in a turbine?
- ✓ How much energy is needed to satisfy the energy needs of the binary generator?
- ✓ Can a Power Purchase Agreement be secured? At what price, for how long?
- ✓ How will this project be financed (debt/equity)?
- ✓ What is the source of capital?
- ✓ What is the cost of capital?
- ✓ What financial risks are associated with the project?
- ✓ What is the anticipated plant performance?

Profit Analysis

- ✓ What is the estimated Cost of Capital?
- ✓ Where will the funding come from?
- ✓ What is the Net Present Value?
- ✓ What is the Future Value?
- ✓ What is the Required Rate of Return?
- ✓ What discount rate is used to account for risk?
- ✓ How many years does the project need to be in production to produce the required rate of return?
- ✓ How dependent are the estimates based on commodity prices?
- ✓ What is the effect of raising or lowering commodity prices?
- ✓ Are there government incentives that may affect the calculations?
- ✓ How much do I expect to make from the project?
- ✓ What is the project timeline?
- ✓ What are the risks associated with not being on schedule?
- ✓ Given the calculations, the expected budget, and the potential payback, does the project make financial sense?
- ✓ Is there a potential for "cap and trade"/carbon-credit earnings for this project?
- ✓ Can you include the earnings from oil/gas sales if using geothermal energy from existing oil/gas wells?

Appendix 2 *– continued*

4. Financial Issues — Can the Project be Financed? *– continued*

Cost Analysis

What are the exploration and development costs?

- ✓ Seismic surveys, well logs and data, geologic analysis, chemical analysis of geothermal fluids, etc.
- ✓ Short and long term flow tests, disposal and/or reinjection tests?
- ✓ What are the drilling costs? What are the costs for the drill rig, well fracturing, personnel, casing, etc.?
- ✓ Can you recomplete an existing well?
- ✓ What is the cost to recomplete a well?
- ✓ What is the lifespan of a well?
- ✓ New production well: drilling costs, casing costs, emplacement of the wellhead, preparing the site for power plant installation.
- ✓ Existing production well: work-over costs of well, perforation of casing, formation fracturing.
- ✓ Injection well designed and drilled to necessary depth, casing, injection pump, etc.

What are the legal costs?

- ✓ Legal costs associated with zoning, siting, drilling permits and mineral right procurement.
- ✓ Legal costs associated with rules and regulations of how to properly case and prepare a well for production use.
- ✓ What are the permitting costs and procedures?

What are the development costs for infrastructure on and off site?

- ✓ Purchase (or design and manufacturing) of the power plant, shipping, and installment costs.
- ✓ Connection of pipes to other necessary infrastructure to the plant (separator, injection well, sound muffler, etc).
- ✓ What are the installation costs for equipment, transmission wires and cables, cost of machinery, and personnel to install and test run the plant?

What are the production costs?

- ✓ Taxes and interconnection tariffs?
- ✓ Cost of day-to-day plant operation, obtaining personnel?
- ✓ What are the operation and maintenance costs associated with running the plant?
- ✓ Costs of routine yearly maintenance and monitoring, chemicals for injection, and to prevent scaling and corrosion?
- ✓ What is the total budget for fully developing the resource, completing the project, and running it over a specific time frame.

Adapted from "Questions to Consider Before Starting a Geothermal Venture," by Maria Richards, Southern Methodist University, 2009. www.smu.edu/geothermal

Appendix 3: Relevant Contacts – Geothermal Feasibility Studies

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APPENDIX 4: DATABASES for GEOTHERMAL EVALUATION

BOTTOM HOLE TEMPERATURES ABOVE 200 F DEGREES

LAT (NAD 83)	LONG	County	Well Name	Elev Drill Floor (ft)	**Bottom Hole Temp (deg F)**	Depth at Temp Gauge
48.228414	-105.129528	Roosevelt	EPU 119	2009	**278**	*
48.210331	-105.094137	Roosevelt	EPU 1	2123	**275**	9127
48.322527	-104.982999	Roosevelt	WELLIN> 1-29-3A	2339	**271**	10465
48.195800	-105.113524	Roosevelt	HUBER 5-D	2090	**270**	7307
48.262552	-104.685859	Roosevelt	DAMM 1-15	2051	**265**	11654
48.250015	-104.657220	Roosevelt	DAMM F-33 23-P	2209	**263**	11890
48.230994	-105.087125	Roosevelt	ZIMMERMAN EPU 114	2171	**261**	8254
48.691706	-105.756462	Daniels	STATE OF MON<>1	2566	**260**	8065
48.353645	-104.967451	Roosevelt	GOBBS 1-16-4B	2303	**260**	10575
48.299755	-104.516914	Roosevelt	Triplett 1	2121	**259**	11900
48.232860	-104.560263	Roosevelt	SUNDHEIM 1-27	2313	**258**	12046
48.829064	-104.877244	Sheridan	LOUCKS 1 SWD	2443	**258**	10842
48.129631	-104.503017	Roosevelt	A. LEWIS 1	1945	**257**	11926
48.731213	-104.681336	Sheridan	GOLTERMAN 1-5	2213	**254**	10548
48.227129	-104.565670	Roosevelt	KRUEGER-A 1	2305	**250**	12060
48.187170	-105.091775	Roosevelt	EPU 34-11H	2188	**250**	*
48.269874	-104.955930	Roosevelt	SWANSON 8-16	2117	**249**	10350
48.141514	-105.121132	Roosevelt	LOCKMAN 3-34	2137	**248**	7951
48.352761	-104.537040	Roosevelt	REUD 1-14	2005	**246**	11700
48.478079	-104.630611	Sheridan	FEDERAL 36-44R	2125	**244**	11970
48.108921	-105.153530	Roosevelt	OGLE 1	1975	**243**	8940
48.275359	-104.644361	Roosevelt	SCHNITZLER 1	2069	**242**	11715
48.289809	-104.609380	Roosevelt	FEDERAL 1-6	2112	**242**	11703

48.152384	-105.115736	Roosevelt	FED. UNIT #63	2162	**242**	8521
48.431017	-104.633187	Roosevelt	SCHNITZLER #1	2099	**240**	11256
48.227131	-104.553929	Roosevelt	KRUEGER 21-34R	2335	**240**	12250
48.235572	-104.565689	Roosevelt	BARRY ROGNEY A-1	2267	**240**	11963
48.239175	-104.559291	Roosevelt	HEKKEL 1-27	2297	**239**	12153
48.174405	-104.508251	Roosevelt	ROGNEY 4-17	2151	**238**	11400
48.132614	-104.519564	Roosevelt	32-28-56-12	1922	**238**	12010
48.278215	-104.630581	Roosevelt	SAND CREEK 1	2133	**237**	11719
48.307930	-104.533163	Roosevelt	LADD FED. 35-23	2146	**237**	11969
48.202351	-105.087486	Roosevelt	EPU 116	2209	**237**	7499
48.159543	-104.505782	Roosevelt	HAGE 44-20	1955	**236**	11915
48.525104	-105.286602	Roosevelt	TONG 10-13	2428	**234**	9727
48.378591	-104.505947	Roosevelt	PRIEBE 10X-1	2010	**234**	11670
48.436415	-104.503148	Sheridan	TYLER 1	2063	**230**	11552
48.257260	-104.592878	Roosevelt	SCHNITZLER 2-20	2205	**230**	12032
48.138730	-104.510863	Roosevelt	MOORE 32-28-56 #1R	1924	**230**	11864
48.253900	-105.183968	Roosevelt	MCGOWAN 23-1	2365	**230**	7782
48.398428	-104.663045	Roosevelt	HAR.-GRAY 1-35	2102	**230**	11375
48.232309	-105.069811	Roosevelt	EPU 83	2193	**230**	5989
48.222163	-104.543989	Roosevelt	WALDOW 9-34-29-55	2324	**229**	12166
48.298250	-104.523736	Roosevelt	SUNDVOLD 1-2	2178	**228**	11950
48.858028	-104.801307	Sheridan	J.C. TANGE 1	2347	**228**	9950
48.235652	-105.118575	Roosevelt	EPU 110	2014	**227**	5777
48.275359	-104.644156	Roosevelt	BIG MUDDY 1	2278	**227**	8883
48.554029	-104.500335	Sheridan	SEIDENSTICKER 1	1980	**224**	11219
48.195798	-105.115821	Roosevelt	HUBER 2	2098	**224**	5782
48.510551	-104.934126	Roosevelt	ASSINI TRIBE B1	2577	**224**	11128
48.510551	-104.934126	Roosevelt	ASSINI TRIBE B1	2577	**224**	11128
48.449370	-	Sheridan	OLSON 1	1957	**223**	11381

	104.538489					
48.232041	-105.081045	Roosevelt	EPU 57	2163	**223**	8919
48.218663	-104.919294	Roosevelt	CLEVELND 15-35	2056	**223**	8700
48.474461	-104.630448	Roosevelt	WESSNER 1-41R	2095	**222**	11410
48.278902	-105.113553	Roosevelt	SMITH-GOVT. 1	2063	**222**	5984
48.190954	-105.110405	Roosevelt	EPU 110-XD	2102	**222**	7360
48.638294	-104.521897	Sheridan	N. ANDERSON 1-4	2245	**221**	11132
48.474294	-104.625003	Sheridan	BOBBY DALE 1-6	2082	**221**	11060
48.222737	-104.547438	Roosevelt	WALDOW 33-34 1	2318	**220**	12150
48.576114	-105.302183	Daniels	TONG 1	2686	**220**	10009
48.333628	-105.498574	Roosevelt	SETHRE A-1	2616	**220**	9385
48.677038	-104.568924	Sheridan	OVERBY 1-30	2420	**220**	11160
48.554094	-104.532268	Sheridan	LARSEN FARMS<>1	2033	**220**	11090
48.283743	-105.163635	Roosevelt	IRON BEAR #2	2447	**220**	7783
48.543232	-104.750209	Sheridan	FORT PECK 1	2398	**220**	11023
48.166875	-105.094111	Roosevelt	FED. UNIT #26	2202	**220**	5940
48.253729	-105.124020	Roosevelt	EPU 84	2055	**220**	7244
48.514873	-104.597951	Sheridan	EPIDOTE 1-20	2115	**220**	11100
48.369292	-105.666268	Roosevelt	E. T. HANSEN 1	2586	**220**	7750
48.470104	-104.947550	Roosevelt	CRAIGIE 1	2290	**220**	10800
48.684737	-105.428754	Daniels	BENSON 1	2288	**220**	9211
48.478031	-104.825679	Roosevelt	SPOTTED D<>33-1	2236	**219**	11030
48.246466	-105.200115	Roosevelt	ROBBINS 22-15	2262	**219**	6026
48.165558	-104.507765	Roosevelt	CONSOLIDATED STATE 42-20	2123	**219**	12090
48.322357	-105.227039	Roosevelt	NW POPLAR 1-D SWD	2490	**218**	9428
48.427442	-104.754923	Roosevelt	MASTERS 1	2222	**218**	11060
48.243141	-105.204845	Roosevelt	GOINGS 27-3	2257	**218**	7912
48.594626	-104.769405	Sheridan	DENZER 1-22	2188	**217**	10860
48.217963	-105.145634	Roosevelt	RICHARDS 115	1999	**216**	7321

48.531409	-104.603174	Sheridan	M<>WALLING 4-17	2170	**215**	11134
48.611956	-105.057961	Daniels	HIGGINS 12-16	2618	**215**	10455
48.407961	-104.652197	Roosevelt	SCHNITZLER 1	2118	**214**	11375
48.235252	-105.194634	Roosevelt	HIBL 27-9	2189	**214**	5997
48.246523	-105.091498	Roosevelt	EPU 47	2110	**214**	5918
48.247386	-105.140951	Roosevelt	EPU 109	2105	**214**	7645
48.631245	-104.501295	Sheridan	LUND TRIB<>1-10	2267	**213**	11190
48.494780	-105.166436	Roosevelt	VOORHEES 1-25	2648	**212**	10475
48.673464	-104.801293	Sheridan	SEBASTIAN 1	2468	**212**	10875
48.246463	-105.183644	Roosevelt	DUPREE 1	2255	**212**	6021
48.690696	-104.572124	Sheridan	CYBULSKI 19-1	2434	**212**	10955
48.250482	-105.237824	Roosevelt	CLARK 20-9	2316	**212**	9041
48.727702	-104.975326	Sheridan	BLASE 1	2491	**212**	10158
48.276087	-105.307507	Roosevelt	HORNUNG 1-011	2360	**211**	9199
48.647320	-104.969984	Sheridan	FRENCH FEE 6-4	2445	**211**	10545
48.588946	-104.539550	Sheridan	EIDSNESS A 1	2128	**211**	11040
48.503621	-105.283676	Roosevelt	TRACY 1-25	2320	**210**	10268
48.232013	-104.560261	Roosevelt	SUNDHEIM 2-27	2328	**210**	12016
48.275384	-105.405974	Roosevelt	STANSBERRY 1	2531	**210**	9250
48.569665	-104.921549	Sheridan	SOTA WAPKANA 1	2608	**210**	11008
48.680656	-104.569469	Sheridan	OVERBY 34-19	2484	**210**	11170
48.485362	-105.091640	Roosevelt	NEES 1	2648	**210**	10552
48.210945	-105.219148	Roosevelt	HRON ETUX 1	2181	**210**	7605
48.832682	-104.882716	Sheridan	H.D.LOUCKS 2	2428	**210**	9935
48.188580	-105.083307	Roosevelt	EPU 24	2176	**210**	5939
48.192201	-105.110404	Roosevelt	EPU 6	2101	**209**	5788
48.163217	-105.137447	Roosevelt	ALLOTTED 3047 1	2071	**209**	5966
48.525105	-105.281151	Roosevelt	GRIMM 1	2437	**208**	9761
48.166862	-	Roosevelt	BUCKLES A-1	2095	**208**	5942

	105.121208					
48.270960	-105.103728	Roosevelt	BROUGH 1	2036	**207**	5870
48.239275	-105.113132	Roosevelt	UNIT 25	2015	**206**	5772
48.574530	-104.779565	Sheridan	THORNWOOD<>1-33	2293	**206**	10900
48.372925	-105.643914	Roosevelt	MIKE FACHNER 1	2721	**206**	7985
48.315174	-105.362611	Roosevelt	BARDELL 1-33	2404	**206**	8142
48.239998	-104.568532	Roosevelt	ALPAR STATE A 1-28	2246	**206**	11813
48.394591	-105.135086	Roosevelt	SWANK 31 1R	2220	**205**	8726
48.522166	-105.135267	Roosevelt	MARGARET G<>1-R	2666	**205**	10295
48.598816	-104.544996	Sheridan	JC HENDERSON 1	2132	**205**	11303
48.521618	-105.135266	Roosevelt	GEORGE 1	2663	**205**	10300
48.641075	-105.762506	Daniels	SHIPSTEAD 43X-1	2620	**204**	8994
48.532241	-104.864295	Roosevelt	QUITMEYER 1	2603	**204**	11000
48.481737	-105.091636	Roosevelt	NORDWICK 1	2663	**204**	9665
48.669708	-104.500571	Sheridan	MURRAY 1-27	2046	**204**	10760
48.729777	-104.730082	Sheridan	MANN 1-1	2320	**204**	10640
48.862976	-104.881866	Sheridan	FEDERAL 23-3	2254	**204**	9870
48.425848	-105.071396	Roosevelt	BEALE 1-22	2352	**204**	10220
48.239176	-104.571118	Roosevelt	STATE A 2-28	2228	**203**	8840
48.648359	-105.625488	Daniels	RHODES F-11-6	2698	**203**	9374
48.459921	-104.878275	Roosevelt	P. FIZER 1-7	2301	**203**	10840
48.293522	-104.923332	Roosevelt	MOE 1	2139	**203**	7635
48.698927	-105.969614	Daniels	STATE 16-1	2873	**202**	8735
48.655313	-104.529874	Sheridan	MURRAY 33-23	2220	**202**	11101
48.836530	-105.177740	Daniels	FRENCH 1-33	2682	**202**	9820
48.155989	-105.126610	Roosevelt	FEDERAL 1-27	2087	**202**	5853
48.239254	-105.134842	Roosevelt	EPU 56	2039	**202**	5746
48.615750	-105.167141	Daniels	C.M. WILSON 1	2608	**202**	10100
48.333261	-105.443891	Roosevelt	ARNIE SOLHEIM 1	2516	**202**	7732

48.771534	-105.030078	Sheridan	HAGAN 1	2510	**201**	10006
48.673794	-105.975032	Daniels	STATE 1	2852	**200**	8350
48.811144	-105.128394	Daniels	ROOS 1	2724	**200**	10120
48.354116	-105.496933	Roosevelt	RED FOX #1	2706	**200**	7774
48.646050	-104.523265	Sheridan	LUND RANCH 4-32	2296	**200**	11100
48.790530	-104.685290	Sheridan	Luella C. Miller 1-17	2216	**200**	10380
48.676161	-104.758946	Sheridan	KROGSTAD 1-27	2410	**200**	10934
48.847738	-105.439891	Daniels	HUGHES 1-28	2394	**200**	9265
48.199417	-105.115826	Roosevelt	HUBER 4	2091	**200**	6063
48.416528	-104.660885	Roosevelt	HARVEY/GRAY 21-26H	2115	**200**	8942
48.412926	-105.102501	Roosevelt	HAGEN 1	2321	**200**	10129
48.743621	-104.572339	Sheridan	H. FURST 1	2221	**200**	10730
48.181352	-105.115800	Roosevelt	EPU 32	2088	**200**	5821
48.275452	-105.118626	Roosevelt	EPU 30	2064	**200**	5932

ALL WELLS ON FORT PECK RESERVATION – BOTTOM HOLE TEMPERATURES:

LAT NAD 83	LONG	County	Well Name	**Bottom Hole Temp (deg F)**	Depth at Temp Gauge (feet)
48.228414	-105.129528	Roosevelt	EPU 119	**278**	*
48.210331	-105.094137	Roosevelt	EPU 1	**275**	9127
48.322527	-104.982999	Roosevelt	WELLIN> 1-29-3A	**271**	10465
48.195800	-105.113524	Roosevelt	HUBER 5-D	**270**	7307
48.230994	-105.087125	Roosevelt	ZIMMERMAN EPU 114	**261**	8254
48.353645	-104.967451	Roosevelt	GOBBS 1-16-4B	**260**	10575
48.187170	-105.091775	Roosevelt	EPU 34-11H	**250**	*
48.269874	-104.955930	Roosevelt	SWANSON 8-16	**249**	10350
48.141514	-105.121132	Roosevelt	LOCKMAN 3-34	**248**	7951
48.478079	-104.630611	Sheridan	FEDERAL 36-44R	**244**	11970
48.108921	-105.153530	Roosevelt	OGLE 1	**243**	8940
48.152384	-105.115736	Roosevelt	FED. UNIT #63	**242**	8521
48.431017	-104.633187	Roosevelt	SCHNITZLER #1	**240**	11256
48.202351	-105.087486	Roosevelt	EPU 116	**237**	7499
48.525104	-105.286602	Roosevelt	TONG 10-13	**234**	9727
48.253900	-105.183968	Roosevelt	MCGOWAN 23-1	**230**	7782
48.398428	-104.663045	Roosevelt	HAR.-GRAY 1-35	**230**	11375
48.232309	-105.069811	Roosevelt	EPU 83	**230**	5989
48.235652	-105.118575	Roosevelt	EPU 110	**227**	5777
48.554029	-104.500335	Sheridan	SEIDENSTICKER 1	**224**	11219
48.195798	-105.115821	Roosevelt	HUBER 2	**224**	5782
48.510551	-104.934126	Roosevelt	ASSINI TRIBE B1	**224**	11128
48.232041	-105.081045	Roosevelt	EPU 57	**223**	8919
48.218663	-104.919294	Roosevelt	CLEVELND 15-35	**223**	8700
48.474461	-104.630448	Roosevelt	WESSNER 1-41R	**222**	11410

48.278902	-105.113553	Roosevelt	SMITH-GOVT. 1	**222**	5984
48.190954	-105.110405	Roosevelt	EPU 110-XD	**222**	7360
48.474294	-104.625003	Sheridan	BOBBY DALE 1-6	**221**	11060
48.576114	-105.302183	Daniels	TONG 1	**220**	10009
48.333628	-105.498574	Roosevelt	SETHRE A-1	**220**	9385
48.554094	-104.532268	Sheridan	LARSEN FARMS<>1	**220**	11090
48.283743	-105.163635	Roosevelt	IRON BEAR #2	**220**	7783
48.543232	-104.750209	Sheridan	FORT PECK 1	**220**	11023
48.166875	-105.094111	Roosevelt	FED. UNIT #26	**220**	5940
48.253729	-105.124020	Roosevelt	EPU 84	**220**	7244
48.514873	-104.597951	Sheridan	EPIDOTE 1-20	**220**	11100
48.369292	-105.666268	Roosevelt	E. T. HANSEN 1	**220**	7750
48.470104	-104.947550	Roosevelt	CRAIGIE 1	**220**	10800
48.478031	-104.825679	Roosevelt	SPOTTED D<>33-1	**219**	11030
48.246466	-105.200115	Roosevelt	ROBBINS 22-15	**219**	6026
48.322357	-105.227039	Roosevelt	NW POPLAR 1-D SWD	**218**	9428
48.427442	-104.754923	Roosevelt	MASTERS 1	**218**	11060
48.243141	-105.204845	Roosevelt	GOINGS 27-3	**218**	7912
48.594626	-104.769405	Sheridan	DENZER 1-22	**217**	10860
48.217963	-105.145634	Roosevelt	RICHARDS 115	**216**	7321
48.531409	-104.603174	Sheridan	M<>WALLING 4-17	**215**	11134
48.611956	-105.057961	Daniels	HIGGINS 12-16	**215**	10455
48.235252	-105.194634	Roosevelt	HIBL 27-9	**214**	5997
48.246523	-105.091498	Roosevelt	EPU 47	**214**	5918
48.247386	-105.140951	Roosevelt	EPU 109	**214**	7645
48.631245	-104.501295	Sheridan	LUND TRIB<>1-10	**213**	11190
48.494780	-105.166436	Roosevelt	VOORHEES 1-25	**212**	10475
48.250482	-105.237824	Roosevelt	CLARK 20-9	**212**	9041
48.276087	-	Roosevelt	HORNUNG 1-011	**211**	9199

	105.307507				
48.588946	-104.539550	Sheridan	EIDSNESS A 1	211	11040
48.503621	-105.283676	Roosevelt	TRACY 1-25	210	10268
48.275384	-105.405974	Roosevelt	STANSBERRY 1	210	9250
48.569665	-104.921549	Sheridan	SOTA WAPKANA 1	210	11008
48.485362	-105.091640	Roosevelt	NEES 1	210	10552
48.210945	-105.219148	Roosevelt	HRON ETUX 1	210	7605
48.188580	-105.083307	Roosevelt	EPU 24	210	5939
48.192201	-105.110404	Roosevelt	EPU 6	209	5788
48.163217	-105.137447	Roosevelt	ALLOTTED 3047 1	209	5966
48.525105	-105.281151	Roosevelt	GRIMM 1	208	9761
48.166862	-105.121208	Roosevelt	BUCKLES A-1	208	5942
48.270960	-105.103728	Roosevelt	BROUGH 1	207	5870
48.239275	-105.113132	Roosevelt	UNIT 25	206	5772
48.574530	-104.779565	Sheridan	THORNWOOD<>1-33	206	10900
48.372925	-105.643914	Roosevelt	MIKE FACHNER 1	206	7985
48.315174	-105.362611	Roosevelt	BARDELL 1-33	206	8142
48.394591	-105.135086	Roosevelt	SWANK 31 1R	205	8726
48.522166	-105.135267	Roosevelt	MARGARET G<>1-R	205	10295
48.598816	-104.544996	Sheridan	JC HENDERSON 1	205	11303
48.521618	-105.135266	Roosevelt	GEORGE 1	205	10300
48.532241	-104.864295	Roosevelt	QUITMEYER 1	204	11000
48.481737	-105.091636	Roosevelt	NORDWICK 1	204	9665
48.425848	-105.071396	Roosevelt	BEALE 1-22	204	10220
48.459921	-104.878275	Roosevelt	P. FIZER 1-7	203	10840
48.293522	-104.923332	Roosevelt	MOE 1	203	7635
48.155989	-105.126610	Roosevelt	FEDERAL 1-27	202	5853
48.239254	-105.134842	Roosevelt	EPU 56	202	5746
48.615750	-105.167141	Daniels	C.M. WILSON 1	202	10100

48.333261	-105.443891	Roosevelt	ARNIE SOLHEIM 1	**202**	7732
48.354116	-105.496933	Roosevelt	RED FOX #1	**200**	7774
48.199417	-105.115826	Roosevelt	HUBER 4	**200**	6063
48.416528	-104.660885	Roosevelt	HARVEY/GRAY 21-26H	**200**	8942
48.412926	-105.102501	Roosevelt	HAGEN 1	**200**	10129
48.181352	-105.115800	Roosevelt	EPU 32	**200**	5821
48.275452	-105.118626	Roosevelt	EPU 30	**200**	5932
48.311502	-105.232445	Roosevelt	LONG CREEK 133 #1	**199**	7741
48.170481	-105.115789	Roosevelt	BUCKLES B 1	**199**	5906
48.289848	-105.145282	Roosevelt	TRIBAL 1-A	**198**	6204
48.156009	-105.094095	Roosevelt	SIOUX 1-26	**198**	6038
48.268203	-105.124038	Roosevelt	EPU 34	**196**	6300
48.473227	-106.159089	Valley	BETH B. GAUNCHE FEDERAL 1	**196**	8395
48.210505	-105.148072	Roosevelt	UNIT #59	**195**	5754
48.163234	-105.126686	Roosevelt	BIERE 1-22	**195**	5845
48.557781	-105.253436	Roosevelt	STENTOFT A 1	**194**	8660
48.539519	-104.977743	Roosevelt	SOO TRIBAL 1	**194**	10837
48.532289	-105.384736	Roosevelt	FORT PECK TR<>1	**194**	9274
48.217566	-105.069779	Roosevelt	EPU 43	**194**	5974
48.232037	-105.113133	Roosevelt	UNIT 28	**193**	5788
48.199419	-105.121214	Roosevelt	UNIT 11	**193**	5795
48.583200	-105.603668	Daniels	TRIBAL 1-29	**192**	9059
48.275381	-105.259609	Roosevelt	MASON 7-16	**192**	7877
48.475400	-105.087546	Roosevelt	M. NESBIT 1	**192**	9676
48.287507	-105.366153	Roosevelt	IND. TRUST 1-8	**192**	7914
48.191423	-105.035680	Roosevelt	RED WHITEFEATHER 11-8	**191**	6056
48.582631	-105.078708	Daniels	NINA MARTH 1	**191**	9607
48.195834	-105.072876	Roosevelt	FEDERAL #61	**191**	5943
48.232044	-	Roosevelt	EPU 29-D	**191**	5876

	105.102291				
48.291625	-105.297839	Roosevelt	TRBL 29-49-1 #1	**190**	7794
48.579568	-105.521815	Daniels	SUCHY 44-26	**190**	9308
48.402000	-105.369070	Roosevelt	LONGEE 1	**190**	9485
48.297060	-105.242864	Roosevelt	LONG CREEK 1-5	**190**	7779
48.315066	-105.546715	Roosevelt	GEORGE TRACK 2	**190**	7650
48.371091	-105.477372	Roosevelt	ANDERSON 8-9	**190**	7918
48.387626	-104.789724	Roosevelt	ALLEN 2-1	**190**	8920
48.583099	-105.210782	Daniels	TRIBAL 1	**189**	7259
48.263730	-105.465481	Roosevelt	RADA 1-15	**189**	7952
48.290359	-105.368040	Roosevelt	TRIBAL-BEAR 2	**188**	7900
48.290013	-105.384229	Roosevelt	TRIBAL BEAR 14-5	**188**	7650
48.199586	-105.110410	Roosevelt	HUBER 3	**188**	5810
48.239279	-105.080644	Roosevelt	EPU 81	**188**	5920
48.224786	-105.145635	Roosevelt	EPU 77	**188**	5751
48.246764	-105.134857	Roosevelt	EPU 19	**188**	6218
48.561410	-105.183778	Roosevelt	T. MCGOWAN 1	**187**	10196
48.292875	-105.759075	Roosevelt	SMITH 4-1	**187**	8729
48.568529	-104.926957	Sheridan	L. SEVERSON 1	**187**	8000
48.286259	-105.167238	Roosevelt	IRON BEAR 3	**187**	6330
48.279007	-105.145672	Roosevelt	EPU 65	**187**	6058
48.224809	-105.091463	Roosevelt	EPU 4	**187**	5872
48.242879	-105.129431	Roosevelt	EPU 105	**187**	5809
48.376564	-105.547134	Roosevelt	BACH 1	**187**	7672
48.239710	-105.378860	Roosevelt	ALLOTTED HALL 2-29	**187**	7900
48.603849	-105.435701	Daniels	SUMMER NIGHT 21-1	**186**	6784
48.304209	-105.579281	Roosevelt	RUSCHE 1-35	**186**	7461
48.568635	-105.281705	Daniels	PAULSON #1	**186**	8320
48.351235	-105.546722	Roosevelt	MCKEE 1	**186**	9075

48.304285	- 105.232427	Roosevelt	LONG CREEK 333 #1	**186**	6368
48.195807	- 105.104989	Roosevelt	EPU 7	**186**	5811
48.530879	- 105.283380	Roosevelt	DARCHUK 1	**186**	8500
48.376236	- 105.292046	Roosevelt	BROWN EST. 1-1	**186**	8000
48.217293	- 105.058928	Roosevelt	UNIT 52	**185**	5947
48.387436	- 105.601075	Roosevelt	MYERS 1	**185**	7656
48.260971	- 105.124032	Roosevelt	EPU 91	**185**	5807
48.188572	- 105.094177	Roosevelt	EPU 100	**185**	5925
48.195829	- 105.132061	Roosevelt	UNIT #67	**184**	5843
48.291717	- 105.386170	Roosevelt	TRIBAL-BEAR 1	**184**	8087
48.246766	- 105.349150	Roosevelt	TRIBAL 21-34	**184**	7728
48.470871	- 105.080752	Roosevelt	NESBIT UNIT 1	**184**	9072
48.275196	- 105.156804	Roosevelt	EPU 71	**184**	6064
48.203035	- 105.115828	Roosevelt	EPU 12	**184**	5802
48.217549	- 105.145631	Roosevelt	EPU 102	**184**	5742
48.183421	- 105.102272	Roosevelt	EPU 101	**184**	6256
48.239469	- 105.069522	Roosevelt	UNIT 51	**183**	5935
48.253270	- 105.243249	Roosevelt	MASON 20-7	**183**	7572
48.260967	- 104.907077	Roosevelt	KRALL 1	**183**	7550
48.279193	- 105.199746	Roosevelt	GOINGS 1-10	**183**	6250
48.152370	- 105.072428	Roosevelt	G. MORSE #1	**183**	6383
48.145108	- 105.061832	Roosevelt	A.HEIRS #1	**183**	6062
48.246447	- 105.367973	Roosevelt	ZIMMERMAN 1-20	**182**	7925
48.174109	- 105.077872	Roosevelt	UNIT 74	**182**	5930
48.290131	- 105.336192	Roosevelt	TRIBAL 3 #1	**182**	7663
48.365521	- 106.046031	Valley	TRIBAL 2633-1	**182**	8581
48.105333	- 105.153530	Roosevelt	TRIBAL 1	**182**	5925
48.343758	- 105.807388	Valley	SCHULTZ H-1	**182**	9012
48.615665	-	Daniels	NYHUS 15-1	**182**	8727

	105.281740				
48.415729	-105.502161	Roosevelt	MOSBY UNIT 1	**182**	7761
48.268187	-105.205311	Roosevelt	MACDONALD 2	**182**	6139
48.354950	-105.338167	Roosevelt	HOOD EST. 1-15	**182**	8147
48.305870	-105.487248	Roosevelt	FORT PECK 1	**182**	7546
48.232023	-105.145648	Roosevelt	EPU 70	**182**	5762
48.271571	-105.113223	Roosevelt	EPU 40	**182**	5895
48.232622	-105.318107	Roosevelt	DOLEZILEK 1	**182**	7604
48.612316	-106.209276	Valley	COOL 1-15	**182**	8446
48.246454	-105.378872	Roosevelt	ZIMMERMAN 2-20	**181**	7988
48.279095	-105.096970	Roosevelt	SPINDLER 1	**181**	6514
48.257328	-105.199949	Roosevelt	ROBBINS 1	**181**	7967
48.260420	-105.085890	Roosevelt	OWENS SIMONS 1	**181**	5850
48.301074	-105.237849	Roosevelt	LONG CREEK 25 #1	**181**	6442
48.470822	-105.254596	Roosevelt	HODSON 1	**181**	8153
48.217556	-105.134821	Roosevelt	EPU 41	**181**	5743
48.260638	-105.205678	Roosevelt	BENSON> 15-14	**181**	6224
48.224804	-105.102284	Roosevelt	UNIT 86	**180**	5869
48.430712	-106.186853	Valley	TWETEN 1-19	**180**	8445
48.159621	-105.115750	Roosevelt	TRIBAL UNIT #72	**180**	5899
48.373482	-105.400748	Roosevelt	TRIBAL 7-3	**180**	7945
48.492209	-106.188231	Valley	TRIBAL 1-31	**180**	7753
48.421405	-105.466267	Roosevelt	THUNDER 8-22	**180**	7825
48.432232	-105.528567	Roosevelt	TAYLOR 2	**180**	7884
48.512231	-105.567540	Roosevelt	STOUX TRI<>23-7	**180**	8586
48.326329	-105.410949	Roosevelt	SOLHEIM 1-4225	**180**	8112
48.275463	-105.113239	Roosevelt	SMITH 1	**180**	5982
48.338506	-105.950058	Valley	RAYMOND YELLOW OWL 24-23	**180**	7190
48.418688	-105.631827	Roosevelt	MCWHIRTER 1-20	**180**	8214

48.513899	-105.916220	Valley	MARY SAUBAK 1	**180**	7154
48.500556	-105.475378	Roosevelt	LARRY ROSEBUD 1	**180**	8297
48.285659	-105.158698	Roosevelt	IRON BEAR 4	**180**	6264
48.242840	-105.194480	Roosevelt	GOINGS 27-1	**180**	6057
48.307003	-105.477770	Roosevelt	FEDERAL 1	**180**	7844
48.188577	-105.104991	Roosevelt	EPU 9	**180**	5837
48.232030	-105.123986	Roosevelt	EPU 78	**180**	5757
48.225412	-105.134834	Roosevelt	EPU 69	**180**	5746
48.239313	-105.123915	Roosevelt	EPU 60	**180**	5742
48.210296	-105.083301	Roosevelt	EPU 3	**180**	5928
48.210330	-105.099569	Roosevelt	EPU 18	**180**	5809
48.561473	-105.542080	Roosevelt	DALTON PALMER 1	**180**	9114
48.289862	-105.362615	Roosevelt	CLARK 1-M4	**180**	7576
48.148761	-105.099495	Roosevelt	CATLIN 1	**180**	5624
48.242344	-105.372130	Roosevelt	ALLOTTED HALL 1-29	**180**	7799
48.246475	-105.145658	Roosevelt	92 TRIBAL	**180**	5855
48.475892	-106.049747	Valley	WILSON HEIRS 1	**179**	6916
48.325902	-106.284116	Valley	USEMAN 1	**179**	8115
48.304238	-105.525835	Roosevelt	JENSEN 15-31	**179**	7930
48.181343	-105.051356	Roosevelt	JENSEN #2	**179**	6287
48.347636	-105.530426	Roosevelt	J.H. HERTING 1	**179**	7748
48.380030	-105.986340	Valley	HENRY BEIER B 2	**179**	5865
48.173824	-105.104967	Roosevelt	EPU 22	**179**	5911
48.235649	-105.129420	Roosevelt	EPU 106	**179**	5792
48.228514	-105.392404	Roosevelt	BIA FED. 31-41	**179**	8038
48.467344	-105.741889	Roosevelt	ZERBE 1	**178**	8010
48.206700	-105.067053	Roosevelt	UNIT #76	**178**	5917
48.286754	-105.390253	Roosevelt	TRIBAL 41-7	**178**	7667
48.535876	-	Roosevelt	STRAND-HI<>1-10	**178**	8076

	105.455007				
48.279094	-105.107820	Roosevelt	SMITH 2	**178**	6083
48.322470	-105.762565	Roosevelt	R. SCOTT 29-1	**178**	7830
48.284238	-105.624314	Roosevelt	R. CLARK 5-9	**178**	7900
48.544136	-105.601307	Roosevelt	MANN 1-10	**178**	8000
48.343807	-105.823643	Valley	IRON CLOUD 1	**178**	7278
48.449065	-105.511990	Roosevelt	GARWOOD 1	**178**	7925
48.192207	-105.115820	Roosevelt	EPU 8-D	**178**	5783
48.224823	-105.037250	Roosevelt	DUPREE 1	**178**	6069
48.387429	-105.525434	Roosevelt	BIGTRACK LIT> 1	**178**	7606
48.210329	-105.072492	Roosevelt	TRIBAL UNIT #99	**177**	5910
48.379730	-105.655212	Roosevelt	T. PETERSON 1	**177**	8075
48.271628	-105.567989	Roosevelt	RENSVALD 1-14	**177**	7474
48.325702	-105.839904	Valley	QUAM TRUST 1	**177**	8036
48.322554	-105.405557	Roosevelt	GREYBEAR PIPE 1	**177**	7610
48.418073	-106.023606	Valley	BLACK MAGIC 1-29	**177**	6392
48.333337	-105.489275	Roosevelt	ZIMMERMAN 14-21	**176**	8062
48.452137	-105.616800	Roosevelt	STENSLAND 1-9	**176**	8383
48.137906	-105.099471	Roosevelt	LOCKMAN 1	**176**	6026
48.317006	-105.875480	Valley	LEFTHAND 1-33	**176**	7275
48.217556	-105.102689	Roosevelt	EPU 85	**176**	5859
48.279021	-105.167397	Roosevelt	EPU 111	**176**	6210
48.279070	-105.118633	Roosevelt	CORNEJO 3	**176**	6027
48.237987	-105.710714	Roosevelt	BEND TRIBAL 26 1	**176**	8419
48.394002	-105.531392	Roosevelt	A.M. STAI 1	**176**	7750
48.412331	-106.067347	Valley	WM CLARK A 2	**175**	6046
48.283351	-105.394396	Roosevelt	TRIBAL BIRD 1	**175**	7632
48.329658	-105.373078	Roosevelt	R. DUPREE 1	**175**	7699
48.528741	-105.286602	Roosevelt	MILLER 1	**175**	6581

48.315393	-105.237468	Roosevelt	LONG CREEK 432 #1	**175**	6445
48.321776	-105.227909	Roosevelt	LONG CREEK 128-1X	**175**	6500
48.388443	-105.964974	Valley	HAWLEY 2-32	**175**	7155
48.351317	-105.308336	Roosevelt	H. IRON BEAR 1	**175**	6871
48.250089	-105.204662	Roosevelt	GRAYBULL 22-11	**175**	6000
48.268444	-105.610212	Roosevelt	FLB-TOAVS 1-16	**175**	8028
48.463222	-105.720734	Roosevelt	EVA RAUCH 1	**175**	7622
48.253750	-105.113181	Roosevelt	EPU 90	**175**	5802
48.210323	-105.126257	Roosevelt	EPU 80-D	**175**	5831
48.275315	-105.124417	Roosevelt	EPU 58	**175**	5967
48.268437	-105.102649	Roosevelt	EPU 49	**175**	5866
48.260954	-105.134884	Roosevelt	EPU 33	**175**	5882
48.217568	-105.091453	Roosevelt	EPU 16	**175**	5887
48.546523	-106.176217	Valley	E SONSTENG 1	**175**	7759
48.116119	-104.953797	Roosevelt	CLEVELAND 1	**175**	6975
48.368790	-106.056841	Valley	CARRIER 7-23	**175**	6168
48.394654	-105.541277	Roosevelt	BLACKTAIL 1	**175**	7680
48.400841	-105.521226	Roosevelt	B. GRUNOW 1-31	**175**	7750
48.590394	-105.429100	Daniels	ANDERSON 27-1	**175**	7660
48.289717	-105.562958	Roosevelt	WATTERS 44-2	**174**	7600
48.315126	-105.498124	Roosevelt	PATTERSON 32-1	**174**	7699
48.268237	-105.092887	Roosevelt	MARTIN 6	**174**	5780
48.351393	-105.557195	Roosevelt	L.W. LOUGH 3	**174**	7834
48.398968	-105.610972	Roosevelt	L. COUCHENE 1	**174**	7645
48.322314	-105.139734	Roosevelt	HORNUNG 1	**174**	6500
48.384586	-105.685355	Roosevelt	GESS 1	**174**	7965
48.126986	-105.164368	Roosevelt	DANIELSON-GREER 1	**174**	6514
48.418653	-105.541262	Roosevelt	CAMPBELL 16-24	**174**	7861
48.354087	-	Roosevelt	BROWN 5-14	**174**	7904

	105.449798				
48.419805	-106.013528	Valley	BELLONGER-CLARK 2	**174**	6220
48.371136	-105.554866	Roosevelt	SETHRE 12-1	**173**	7727
48.513147	-105.628526	Roosevelt	PIGG 1-20	**173**	8156
48.409215	-105.449418	Roosevelt	HAWBAKER 1-26	**173**	7834
48.101723	-105.045776	Roosevelt	GEORGE NICK 1	**173**	6087
48.419524	-106.056519	Valley	CRAWFORD A-2	**173**	6106
48.311446	-105.552151	Roosevelt	CHARLES TRACK 1	**173**	7670
48.579721	-106.040209	Valley	BELLING 1	**173**	7255
48.369316	-105.617342	Roosevelt	BARKER 1	**173**	8063
48.561586	-105.960663	Valley	WILDMAN 1-2	**172**	7280
48.282644	-105.173152	Roosevelt	WAR CLUB 2	**172**	6251
48.588906	-105.676892	Daniels	TEIGEN 1	**172**	7600
48.270955	-105.098305	Roosevelt	REHDER 7	**172**	5770
48.318733	-105.242166	Roosevelt	LONG CREEK 129 #1	**172**	6473
48.405518	-105.557612	Roosevelt	L. MYERS 1	**172**	7640
48.300217	-105.459976	Roosevelt	INDIAN 3-29-48	**172**	7734
48.341203	-105.545186	Roosevelt	HOUG 7-24	**172**	7780
48.275024	-105.194515	Roosevelt	GOINGS 10-16	**172**	6242
48.253992	-105.134868	Roosevelt	EPU 27	**172**	5885
48.412848	-105.433151	Roosevelt	BROOKMAN 1	**172**	7916
48.329606	-105.492723	Roosevelt	BOX ELDER 1	**172**	7775
48.272063	-105.177838	Roosevelt	BAKER COULTER 1	**172**	6147
48.177690	-105.201898	Roosevelt	R.W. LOWE 1	**171**	6618
48.366398	-105.779024	Roosevelt	ORTMAN-DEMARRIAS UNIT 1	**171**	7480
48.417551	-105.656809	Roosevelt	N. SANDEEN 2-30	**171**	7671
48.264063	-105.421157	Roosevelt	MATEJOVSKY 1	**171**	7702
48.347614	-105.552129	Roosevelt	L.W. LOUGH 2	**171**	7751
48.270764	-105.408204	Roosevelt	K. D. ZIMMERMAN 1	**171**	7750

48.260992	-105.113196	Roosevelt	EPU 98	**171**	5811
48.224793	-105.123992	Roosevelt	EPU 36	**171**	5764
48.253691	-105.232816	Roosevelt	BROWN HUNT 21-5	**171**	6201
48.380314	-105.434498	Roosevelt	BERNER 2-9	**171**	7885
48.260998	-105.093603	Roosevelt	UNIT 53	**170**	5825
48.307363	-105.671760	Roosevelt	TOAVS 31-1	**170**	7650
48.315068	-105.595586	Roosevelt	TOAVS 21-34	**170**	7429
48.343808	-105.833888	Valley	REDEKOPP 1	**170**	7217
48.579755	-106.171074	Valley	PETERS AARON 1	**170**	6921
48.357910	-105.339939	Roosevelt	O'CONNOR 1	**170**	8095
48.354934	-105.227124	Roosevelt	NELLO BLAIR 1	**170**	8072
48.575844	-105.559416	Daniels	MITCHELL 1-34	**170**	7701
48.420045	-105.631708	Roosevelt	MCWHIRTER 34-20	**170**	7711
48.419144	-105.477596	Roosevelt	MCALPIN 1	**170**	7936
48.604626	-105.467777	Daniels	MANTERNACH 20-1	**170**	6754
48.264616	-105.092592	Roosevelt	M. LOZAR 1	**170**	5860
48.304268	-105.243284	Roosevelt	LONG CREEK 332 #1	**170**	6382
48.433163	-105.546419	Roosevelt	LILLEBOE 15-13	**170**	7900
48.550390	-106.262353	Valley	LENTZNER 1	**170**	8377
48.295812	-105.412694	Roosevelt	KIRVEN 1A-4-1	**170**	7782
48.362043	-105.861102	Valley	HARVEY GREY BEAR HEIRS 1	**170**	7138
48.333235	-105.481886	Roosevelt	FORT PECK 15-21	**170**	7800
48.284389	-105.485823	Roosevelt	FEDERAL 778 #1	**170**	7605
48.246515	-105.113171	Roosevelt	EPU 97	**170**	5781
48.224799	-105.069799	Roosevelt	EPU 89	**170**	6036
48.260935	-105.167412	Roosevelt	EPU 75	**170**	5996
48.195739	-105.094145	Roosevelt	EPU 68	**170**	5961
48.224804	-105.080625	Roosevelt	EPU 66	**170**	5932
48.246483	-	Roosevelt	EPU 23	**170**	5915

	105.156531				
48.203055	-105.088725	Roosevelt	EPU 17	**170**	5908
48.334957	-105.574842	Roosevelt	DANIELS 1	**170**	7725
48.282605	-105.151073	Roosevelt	CUT HAIR 1	**170**	5992
48.444629	-105.488557	Roosevelt	BROOKMAN 1-16	**170**	7904
48.355864	-105.455768	Roosevelt	BRIDGES 1	**170**	7728
48.170443	-105.212730	Roosevelt	TRIBAL 1-24	**169**	7476
48.434283	-106.048370	Valley	SURPRISE TRIBAL 1	**169**	7219
48.405587	-105.471141	Roosevelt	RUSH 1	**169**	7974
48.289875	-105.194514	Roosevelt	RICHARDS 3-1	**169**	6264
48.286261	-105.199947	Roosevelt	REID 10-1	**169**	6225
48.419976	-105.546701	Roosevelt	LONG 15-24	**169**	7758
48.409211	-105.460295	Roosevelt	HAWBAKER 1	**169**	7976
48.619490	-105.972180	Daniels	GOOD BROS 4-16	**169**	7675
48.370957	-105.437537	Roosevelt	FED ARROYO 11-7	**169**	7810
48.275417	-105.134901	Roosevelt	EPU 73	**169**	5994
48.257377	-105.086092	Roosevelt	EPU 62	**169**	5865
48.376725	-104.794019	Roosevelt	DOME-RICKEL 1	**169**	7989
48.282517	-105.145726	Roosevelt	BUCK ELK 2	**169**	5953
48.268240	-105.096937	Roosevelt	BEASLEY 5	**169**	5751
48.336349	-105.492573	Roosevelt	ZIMMERMAN 1-21	**168**	7800
48.419357	-106.066845	Valley	WILLIAM CLARK A-1	**168**	5995
48.260387	-105.546699	Roosevelt	TWO BULLS A-1	**168**	7406
48.398508	-105.556252	Roosevelt	TRIBAL KODA WAS-TE 1	**168**	7790
48.139653	-105.288462	Roosevelt	TRIBAL 2-32	**168**	7961
48.420663	-105.502790	Roosevelt	TRIBAL 15376 #1	**168**	7864
48.409172	-105.487440	Roosevelt	TRIBAL 1-28	**168**	7800
48.484892	-105.801878	Roosevelt	T.S.F.<> 1	**168**	7365
48.289878	-105.183661	Roosevelt	RICHARDS 2-1	**168**	6312

48.437896	-106.056907	Valley	REDSTONE 1	**168**	6248
48.297002	-105.525190	Roosevelt	RED EAGLE 32-6	**168**	7718
48.361863	-105.755711	Roosevelt	RED DOG 3-16	**168**	7319
48.528740	-105.297539	Roosevelt	RASMUSON 2	**168**	6520
48.304274	-105.492673	Roosevelt	PATTERSON 1-33	**168**	7669
48.141529	-105.131973	Roosevelt	PATCH 1	**168**	5952
48.405513	-105.552173	Roosevelt	MY-TRIBAL 14-25	**168**	7780
48.347612	-105.562994	Roosevelt	J.H. BARACKER 2	**168**	7747
48.362096	-105.541287	Roosevelt	HOUG FARMS 1-12	**168**	7770
48.380278	-105.470478	Roosevelt	FT. PECK 1-3	**168**	8000
48.253697	-105.145635	Roosevelt	EPU 93	**168**	5975
48.264618	-105.096925	Roosevelt	EPU 50	**168**	5840
48.239285	-105.102291	Roosevelt	EPU 103	**168**	5829
48.405527	-105.568489	Roosevelt	ELLINGSON 1-26	**168**	7750
48.412026	-106.056758	Valley	CRAWFORD A-1	**168**	6348
48.372063	-105.531775	Roosevelt	ANDERSON 1-7	**168**	7780
48.154310	-105.471492	Roosevelt	SCHWINDEN 1-25	**167**	7515
48.405573	-105.671788	Roosevelt	PETERSON 20-30	**167**	7600
48.286257	-105.189097	Roosevelt	MCGOWAN 3	**167**	6210
48.365763	-106.327175	Valley	FIREMOON 1	**167**	8243
48.217567	-105.080611	Roosevelt	EPU 88	**167**	5949
48.339675	-105.508324	Roosevelt	EAGLE 6-20	**167**	7780
48.260884	-105.449246	Roosevelt	DORIS BROWN 1	**167**	7560
48.369137	-105.831795	Valley	BUCK ELK 1	**167**	8300
48.390861	-105.991795	Valley	TIESZEN-TOEWS 1	**166**	7264
48.281523	-105.428941	Roosevelt	STENSLAND L&L 12B-3-1	**166**	7760
48.389979	-105.726104	Roosevelt	SCHULTES 3-2	**166**	7577
48.448638	-105.546708	Roosevelt	KERMIT TJON 1	**166**	7870
48.401717	-	Valley	HENRY BEIER 2	**166**	6350

	105.997248				
48.553953	-105.476837	Roosevelt	FT PECK <>1-434	**166**	8043
48.246910	-105.102890	Roosevelt	EPU 96	**166**	5827
48.380612	-105.754252	Roosevelt	COURCHENE 1	**166**	7395
48.412838	-105.443984	Roosevelt	BROOKMAN A-1	**166**	7818
48.378509	-105.424941	Roosevelt	BERNER 1	**166**	7865
48.375865	-106.001804	Valley	BEARHILL 9-41	**166**	6372
48.246477	-105.216118	Roosevelt	YELLOW OWL 1	**165**	7596
48.344185	-105.519577	Roosevelt	TRIBAL 41-19	**165**	7800
48.415965	-105.513187	Roosevelt	TRIBAL 11-29	**165**	7815
48.276153	-105.442520	Roosevelt	STENSLAND ALLOTTED 1	**165**	7686
48.451568	-105.577874	Roosevelt	STENSLAND 12-11	**165**	7840
48.380181	-105.563024	Roosevelt	SETHRE 9-2	**165**	7750
48.474507	-105.097074	Roosevelt	NESBIT 1	**165**	8670
48.318739	-105.232458	Roosevelt	LONG CREEK 228 #1	**165**	6470
48.101315	-105.153546	Roosevelt	JEROME 1	**165**	5999
48.101726	-105.153545	Roosevelt	JEROME (TRIBAL) 1	**165**	5989
48.535976	-105.297546	Roosevelt	GERT PETERSON 1	**165**	6552
48.314675	-105.617266	Roosevelt	FORT PECK 3-33	**165**	7517
48.231819	-105.156189	Roosevelt	EPU 46	**165**	5864
48.217563	-105.123979	Roosevelt	EPU 39	**165**	5794
48.358902	-105.859917	Valley	DARLENE 1-15	**165**	7295
48.401954	-106.035439	Valley	C. REDDIG 1	**165**	6246
48.286240	-105.145698	Roosevelt	BUCK ELK 3	**165**	5987
48.417494	-105.556221	Roosevelt	BOX ELDER 11-25	**165**	7729
48.268151	-105.400479	Roosevelt	ZIMMERMAN A-1	**164**	7749
48.398935	-105.553155	Roosevelt	TRIBAL A 1	**164**	7804
48.289759	-105.482298	Roosevelt	TRIBAL 34-4	**164**	7595
48.416660	-105.546988	Roosevelt	TRIBAL 25-1	**164**	7750

48.372946	- 105.568452	Roosevelt	SETHRE 1	**164**	7726
48.283351	- 105.618559	Roosevelt	RENSVOLD 1-9	**164**	7567
48.353772	- 105.505575	Roosevelt	RED FOX 1-17	**164**	8300
48.586766	- 105.374494	Daniels	PHILIPS 25-1	**164**	7636
48.363846	- 105.553131	Roosevelt	MARTIN SETHRE 1	**164**	7855
48.315121	- 105.227023	Roosevelt	LONG CREEK 233 #2	**164**	6500
48.307867	- 105.248109	Roosevelt	LONG CREEK 232 #1	**164**	6465
48.395326	- 105.595454	Roosevelt	L-OLSON A 1-W	**164**	7612
48.437887	- 106.072780	Valley	IRON BEAR HEIRS 2	**164**	5921
48.408297	- 105.454856	Roosevelt	HAWBAKER 9-27	**164**	7796
48.394480	- 105.986384	Valley	H. MARTENS 1	**164**	5914
48.300667	- 105.482238	Roosevelt	DAVID-FEDERAL 1	**164**	7620
48.358570	- 105.471052	Roosevelt	CULBERTSON 1	**164**	7686
48.340476	- 105.479200	Roosevelt	COUNTER 1	**164**	7801
48.343341	- 105.567271	Roosevelt	BUCK ELK 31-23	**164**	7790
48.137748	- 105.357977	Roosevelt	AULT 1	**164**	7478
48.304254	- 105.275764	Roosevelt	W. POPLAR UN. 5	**163**	6944
48.289834	- 105.265654	Roosevelt	VICKERS 6-15 SWD	**163**	6504
48.148965	- 105.510506	Roosevelt	TRIBAL 11-27	**163**	7849
48.333145	- 105.655321	Roosevelt	TOAVS 15-19	**163**	7525
48.427071	- 105.709813	Roosevelt	THOMPSON 1	**163**	7600
48.554096	- 104.537722	Sheridan	LARSEN #1	**163**	8515
48.405195	- 106.057123	Valley	J. CLARK A 1	**163**	6115
48.409208	- 105.465709	Roosevelt	HAWBAKER 27-1	**163**	7833
48.394479	- 105.991801	Valley	H. BEIER 1	**163**	6087
48.275406	- 105.183673	Roosevelt	GOINGS GOVT. 1	**163**	6120
48.282375	- 105.964538	Valley	FROSTBITE 1-11	**163**	6390
48.283517	- 105.254588	Roosevelt	FOOTE 8-5	**163**	6437
48.163239	-	Roosevelt	EPU 55	**163**	5932

	105.104941				
48.232030	-105.134832	Roosevelt	EPU 31	**163**	5753
48.412951	-106.181806	Valley	BUEN 1	**163**	6194
48.347678	-105.509042	Roosevelt	ZIMMERMAN 1	**162**	7777
48.354726	-105.693489	Roosevelt	WOLF CREEK 13-1	**162**	7570
48.626404	-105.636358	Daniels	WILCOXON #1	**162**	7410
48.416426	-105.479320	Roosevelt	WHITE MTN. 1	**162**	7801
48.400097	-105.564031	Roosevelt	TRIBAL 42X-35	**162**	7670
48.415708	-105.553170	Roosevelt	TRIBAL 21X-25	**162**	7700
48.344165	-105.091525	Roosevelt	STANOLIND 1	**162**	6756
48.246708	-106.385533	Valley	SPRING CR.1-27	**162**	7752
48.300616	-105.529951	Roosevelt	RED EAGLE 3-6	**162**	7720
48.320499	-105.542890	Roosevelt	RED EAGLE 2-25	**162**	7750
48.365512	-105.872519	Valley	O'TOOLE 1-9	**162**	7384
48.416427	-105.633746	Roosevelt	MAHLUM 2	**162**	7811
48.357926	-105.448362	Roosevelt	LILLIAN UNIT 1	**162**	7610
48.450974	-105.595716	Roosevelt	KNUTSON 10-1	**162**	7805
48.532676	-105.689484	Roosevelt	GLADYS HAYES 1	**162**	7232
48.354673	-105.883288	Valley	GARY 1-16	**162**	7345
48.268180	-105.134881	Roosevelt	EPU 94	**162**	5899
48.268154	-105.156484	Roosevelt	EPU 48	**162**	5973
48.398285	-105.525463	Roosevelt	B. CAMRUD 1	**162**	7650
48.400097	-105.476570	Roosevelt	ANDERSON 1	**162**	7799
48.358480	-105.573878	Roosevelt	ALLOTTEE 21-14	**162**	7730
48.416051	-106.072924	Valley	WM CLARK A #4	**161**	5988
48.311144	-105.633549	Roosevelt	WELTON 1-32	**161**	7670
48.430663	-106.051573	Valley	SURPRI TRIBAL 2	**161**	6249
48.416423	-105.671786	Roosevelt	R. W. GESS A-1	**161**	7662
48.361906	-106.039975	Valley	OLFERT CAT>1-17	**161**	6458

48.253677	- 105.253516	Roosevelt	MASON 20-5	**161**	6189
48.420666	- 105.513657	Roosevelt	LOVES HIM #1	**161**	7779
48.376406	- 105.970850	Valley	HERINGER 11-21	**161**	6394
48.224504	- 105.682629	Roosevelt	GOVT.-INDIAN 33-36	**161**	7725
48.253765	- 105.102740	Roosevelt	EPU 38	**161**	5863
48.369085	- 105.777464	Roosevelt	DEMARRIAS 1	**161**	7703
48.401990	- 106.093825	Valley	CRANSTON ETAL 1	**161**	6090
48.286580	- 105.259919	Roosevelt	COX 7-1	**161**	6493
48.340471	- 105.487311	Roosevelt	ZIMMERMAN B-1	**160**	7849
48.431112	- 106.094124	Valley	W. REDSTONE 1	**160**	5926
48.264540	- 105.275736	Roosevelt	W POPLAR UNIT 1	**160**	7676
48.619387	- 105.483773	Daniels	VEIS 18-1	**160**	7720
48.429153	- 105.533100	Roosevelt	TAYLOR 1	**160**	7840
48.311474	- 105.519808	Roosevelt	SPENCER A-1	**160**	7727
48.347658	- 105.519907	Roosevelt	SLETVOLD 1-30	**160**	8478
48.318469	- 105.851058	Valley	SHELL-FEE 1	**160**	7380
48.336616	- 105.498581	Roosevelt	SETHRE 1-20	**160**	7679
48.463247	- 105.981029	Valley	SANDVICK 2-10	**160**	6200
48.394935	- 106.116580	Valley	REUTERSTAHL 1	**160**	6145
48.437735	- 106.050857	Valley	REDSTONE 2	**160**	6259
48.391174	- 106.110924	Valley	R & J SCOTT 1	**160**	6129
48.445181	- 106.142989	Valley	OWEN 22-16	**160**	5735
48.427276	- 105.666349	Roosevelt	MCLACHLAN A-1	**160**	7665
48.419140	- 105.645977	Roosevelt	MCLACHLAN 14-20	**160**	7657
48.395050	- 106.105729	Valley	MARIE STANDING HEIRS 1	**160**	6085
48.416425	- 105.628315	Roosevelt	MAHLUM 41-29	**160**	7760
48.406220	- 105.632732	Roosevelt	MAHLUM 1	**160**	7650
48.318677	- 105.617269	Roosevelt	LOUIS TOAVS 1	**160**	7522
48.306296	-	Roosevelt	LOUIS BOXER 1	**160**	7665

	105.552143				
48.311496	-105.243302	Roosevelt	LONG CREEK 132 #1	**160**	6405
48.300661	-105.227612	Roosevelt	IVERSON-MASON 4-2	**160**	6355
48.394478	-105.997238	Valley	HENRY BEIER 3	**160**	6148
48.420045	-105.479082	Roosevelt	HANAL NO. 1	**160**	7820
48.380217	-105.641501	Roosevelt	H. KORGSTAD 1	**160**	7650
48.282395	-105.286272	Roosevelt	G. WALLETTE 1	**160**	7701
48.397991	-106.046827	Valley	G. E. WILDER 2	**160**	6086
48.239287	-105.091477	Roosevelt	EPU 79	**160**	5911
48.210319	-105.137507	Roosevelt	EPU 45	**160**	5768
48.175918	-105.094136	Roosevelt	EPU 104	**160**	5957
48.389845	-105.535698	Roosevelt	E.V. STAI 1 SWD	**160**	7607
48.304285	-105.481837	Roosevelt	DEEDS FEDERAL 1	**160**	7625
48.375667	-105.765116	Roosevelt	D.L. TRIMBLE 1	**160**	7437
48.307901	-105.237249	Roosevelt	CHASKE 43-32	**160**	6421
48.463730	-105.649735	Roosevelt	CAMRUD 1	**160**	8200
48.408936	-106.047456	Valley	C. REDDIG 2	**160**	6424
48.340400	-105.530427	Roosevelt	BJORGEN 1	**160**	7755
48.362210	-105.362671	Roosevelt	BEN HOLTE 1	**160**	7979
48.401809	-105.503495	Roosevelt	BACH 2-32	**160**	7752
48.286063	-105.595825	Roosevelt	B. WATTERS 1	**160**	7558
48.347449	-105.720635	Roosevelt	A. HEGTVEDT 1	**160**	7528
48.231845	-105.059243	Roosevelt	UNIT 64	**159**	6028
48.159629	-105.083276	Roosevelt	TRIBAL UNIT #44	**159**	5975
48.202791	-106.051511	Valley	TRIBAL 1-9	**159**	5884
48.328525	-105.622133	Roosevelt	TOAVS D-28	**159**	7470
48.315068	-105.607162	Roosevelt	TOAVS 33-1	**159**	7430
48.387243	-105.986773	Valley	TIESZEN-TOEWS 2	**159**	6356
48.311467	-105.530660	Roosevelt	SPENCER 1	**159**	7720

48.307827	-105.563000	Roosevelt	R. FORSNESS 1	**159**	7735
48.282436	-105.638959	Roosevelt	J.A. TOAVS A-1	**159**	7877
48.351205	-105.454775	Roosevelt	CLYDE UNIT 1	**159**	7642
48.409016	-105.422394	Roosevelt	BROOKMAN B-1	**159**	7867
48.413456	-105.621877	Roosevelt	A.F. TOAVS 1	**159**	7650
48.416130	-106.039306	Valley	WHITE EAGLE A 2	**158**	6226
48.434675	-106.078207	Valley	WETAN HEIRS 1	**158**	6000
48.279025	-105.178247	Roosevelt	WAR CLUB 1	**158**	6236
48.311516	-105.492688	Roosevelt	THUNDER 1	**158**	7656
48.308861	-105.736296	Roosevelt	T. PLENTY 1-34	**158**	7880
48.329535	-105.590144	Roosevelt	RUSCHE 2-27	**158**	7561
48.440568	-106.242382	Valley	RODGER 1	**158**	6707
48.476732	-106.126529	Valley	REDDIG RANCH 1	**158**	6887
48.363903	-105.511878	Roosevelt	MORRIS 1	**158**	7772
48.354855	-105.552136	Roosevelt	L.W. LOUGH 1	**158**	7730
48.268191	-105.216158	Roosevelt	KOHL 1-H16	**158**	6224
48.365711	-105.546721	Roosevelt	HOUG FARMS 12-1	**158**	7765
48.372946	-105.546719	Roosevelt	HOUG 1	**158**	7760
48.387447	-105.579330	Roosevelt	HAUGE 11-2	**158**	7750
48.332986	-106.029685	Valley	E.J. LANDER 1	**158**	6348
48.383641	-106.013494	Valley	D.R. TODD 1	**158**	6149
48.412383	-106.078752	Valley	CAMPBELL 2	**158**	5913
48.514254	-105.276085	Roosevelt	TRIBAL-13 1	**157**	7250
48.293765	-105.221599	Roosevelt	TRIBAL 4-10	**157**	6349
48.278291	-105.697910	Roosevelt	TOAVS 1	**157**	7735
48.306932	-105.545365	Roosevelt	LOUIS BOXER 2	**157**	7793
48.282622	-105.155972	Roosevelt	IRON BEAR 1	**157**	6181
48.369330	-105.541595	Roosevelt	HERBERT HOUG 1	**157**	7780
48.425257	-	Valley	GLEN DALEY A-1	**157**	6085

	106.136017				
48.250115	-105.129447	Roosevelt	EPU 107	**157**	5823
48.376090	-105.981072	Valley	BEIER B A/C 2-4	**157**	6005
48.372520	-105.986326	Valley	BEIER A/C B 2-3	**157**	6352
48.350598	-105.529421	Roosevelt	ALMA HERTING 1	**157**	7732
48.434252	-105.829103	Valley	UNRUH A #1	**156**	7500
48.423427	-106.008145	Valley	UNRAU-SCHMITT 1	**156**	6128
48.296826	-105.568625	Roosevelt	TRIBAL #1	**156**	7500
48.390862	-105.980937	Valley	TIESZEN-TOEWS 4	**156**	5997
48.344028	-105.525328	Roosevelt	SLETVOLD B-1	**156**	7706
48.354859	-105.541288	Roosevelt	MCKEE SWD 1	**156**	7762
48.437877	-106.083640	Valley	IRON BEAR 1	**156**	5828
48.214038	-105.912446	Valley	GREUFE 1	**156**	7281
48.291236	-105.577353	Roosevelt	DAVIS 19-2	**156**	7453
48.404667	-106.083908	Valley	CRAWFORD A-3	**156**	6000
48.376027	-105.992339	Valley	BEIER B A/C 2-6	**156**	5838
48.419789	-106.089094	Valley	SYLVIA ROBERTS 2	**155**	5793
48.441719	-105.606590	Roosevelt	STENSLAND 1	**155**	7953
48.354897	-105.519924	Roosevelt	SLETVOLD 2-D	**155**	7777
48.434282	-106.029866	Valley	PANKRATZ 1	**155**	6246
48.396368	-106.002678	Valley	OLFERT B 2	**155**	6202
48.362092	-105.563010	Roosevelt	N. W. HAUGE 1	**155**	7745
48.426707	-106.077554	Valley	M.V. CAMPBELL 2	**155**	5997
48.423134	-106.083655	Valley	M. V. CAMPBELL 1	**155**	5954
48.409005	-105.688370	Roosevelt	LUND 1	**155**	7626
48.305988	-105.530438	Roosevelt	JENSEN 14-31	**155**	7650
48.532352	-105.302994	Roosevelt	JENS-A 1	**155**	6600
48.405399	-106.052024	Valley	J. CLARK 1	**155**	6247
48.376346	-105.747794	Roosevelt	HARRY CARLSON 31-9	**155**	7361

48.366671	-105.790140	Roosevelt	H. ORTMANN 1-7	**155**	7500
48.401717	-105.986392	Valley	H. MARTENS 2	**155**	5995
48.105138	-105.884213	Valley	GREENWOOD 1	**155**	7198
48.575879	-105.298091	Daniels	E.E. TONG #1	**155**	6750
48.481648	-105.692562	Roosevelt	DOLORES ENIX 1	**155**	7480
48.282641	-105.183668	Roosevelt	COWAN WESTERN LAND 1	**155**	6223
48.379973	-105.742368	Roosevelt	COURCHENE 2-D	**155**	7256
48.474520	-105.113404	Roosevelt	A.J. MANNING 1	**155**	8649
48.351286	-105.514483	Roosevelt	ZIMMERMAN 2	**154**	7771
48.347489	-105.693491	Roosevelt	WOLF POINT 1	**154**	6703
48.381014	-105.975471	Valley	TIESZEN 3	**154**	5958
48.430676	-105.715257	Roosevelt	THOMPSON B-1	**154**	7645
48.626780	-106.132987	Valley	SMITH 7-9	**154**	6997
48.152056	-105.873626	Valley	REDEKOPP 33-26	**154**	6403
48.389836	-106.015198	Valley	OLFERT CATTLE 1	**154**	6197
48.300606	-106.305817	Valley	NYBAKKEN 1-6	**154**	6670
48.224518	-106.154077	Valley	NASHUA TRIB1-32	**154**	5919
48.202786	-105.782349	Roosevelt	N. BUCK ELK 1	**154**	6292
48.412850	-105.428783	Roosevelt	MANN 1	**154**	7699
48.474343	-106.149097	Valley	LOZAR 1	**154**	5976
48.329626	-105.471019	Roosevelt	HIGH BACKBONE 1	**154**	7823
48.359108	-105.786586	Roosevelt	HEINRICH 1-18	**154**	7476
48.275402	-105.166774	Roosevelt	EPU 95	**154**	6109
48.401713	-106.008123	Valley	D. OLFERT 2	**154**	6218
48.409196	-106.050917	Valley	CLARK TRIBAL 1	**154**	6075
48.246737	-105.243676	Roosevelt	CLARK 20-15	**154**	6167
48.412573	-106.013834	Valley	BELLONGER-CLARK 1	**154**	6217
48.455992	-105.953817	Valley	A. E. WALL 1-12	**154**	6401
48.463273	-	Valley	RECETTE HEIRS 1	**153**	6082

	106.154275				
48.539597	-105.297541	Roosevelt	PETERSON 2	153	6587
48.424223	-106.093662	Valley	LILY PUENTES 1	153	5834
48.368833	-105.926153	Valley	JOSEPH 1-7	153	6671
48.409404	-106.061742	Valley	J. CLARK B-1	153	5744
48.405318	-106.046093	Valley	C. REDDIG 3	153	6090
48.382883	-105.996385	Valley	BEIER B A/C #1	153	5973
48.354852	-105.563006	Roosevelt	BARACKER 1	153	7764
48.405321	-106.029835	Valley	A. REDDIG 1	153	6134
48.394002	-105.553148	Roosevelt	WETSIT 1 (A-1)	152	7830
48.368968	-105.992489	Valley	TODD INDIAN #1	152	6076
48.461438	-105.981028	Valley	SANDVICK 1-10	152	6180
48.320481	-105.556165	Roosevelt	RED EAGLE 1-25	152	7700
48.427044	-105.931447	Valley	RAYMOND SONSTENG 1-19	152	6440
48.412556	-106.035222	Valley	OLFERT C 2	152	6135
48.428211	-105.640604	Roosevelt	MCLACHLAN 1	152	7842
48.464174	-106.187596	Valley	M.A. NUTTER 1	152	5739
48.365787	-105.907425	Valley	KENNETH DAHL 1-8 SWD	152	6213
48.434286	-106.008150	Valley	HUEBERT 1-21	152	6295
48.495874	-105.216493	Roosevelt	GERTRUDE RYAN 1	152	7046
48.268154	-105.145884	Roosevelt	EPU 37	152	5994
48.589458	-105.423869	Daniels	ANDERSON 27-2	152	6605
48.286072	-105.622631	Roosevelt	R. CLARK 4-9	151	7575
48.513912	-106.451048	Valley	ICEMAN-BROWN 1	151	6363
48.419567	-105.754671	Roosevelt	HEINRICHS 1	151	7530
48.405335	-105.980958	Valley	H. MARTENS 3	151	5995
48.249877	-105.611750	Roosevelt	G. GRAYSON 1	151	7669
48.268167	-105.167920	Roosevelt	EPU 54	151	5950
48.221085	-106.051018	Valley	BERG 15-31	151	5908

48.437975	-105.677235	Roosevelt	A. EGGUM 1	**151**	7007
48.373310	-105.765852	Roosevelt	TRIMBLE 2	**150**	7222
48.344435	-105.515047	Roosevelt	SETHRE B-1	**150**	7754
48.275423	-105.205322	Roosevelt	MCGOWAN 1	**150**	6274
48.369067	-105.980390	Valley	MARTIN 1-10	**150**	6119
48.427369	-106.041343	Valley	LOWRY A-1	**150**	6295
48.423588	-106.257030	Valley	KUMMERFELDT 1	**150**	6788
48.339952	-105.731375	Roosevelt	EVER>-KING 1-22	**150**	7538
48.231985	-105.264927	Roosevelt	CHARLES OWEN 1	**150**	6719
48.409188	-105.964254	Valley	BERG 26-1	**150**	6308
48.383626	-105.980502	Valley	BEIER B A/C 1-5	**150**	5974
48.101722	-105.158953	Roosevelt	WILKE 1	**149**	5949
48.376792	-105.974638	Valley	TIESZEN 1	**149**	6340
48.441508	-106.067330	Valley	PANKRATZ B 1	**149**	5998
48.271810	-105.210741	Roosevelt	MACDONALD 1	**149**	6171
48.408954	-105.975523	Valley	C. BAERG 1	**149**	6095
48.369086	-105.764116	Roosevelt	TRIMBLE 1	**148**	7323
48.358271	-105.867078	Valley	SUSIE 1-15	**148**	6021
48.331684	-105.754643	Roosevelt	RED EAGLE 1	**148**	7257
48.394029	-105.589220	Roosevelt	MATHIAS 1	**148**	7653
48.408953	-105.980962	Valley	KLIEWER 1	**148**	6196
48.358276	-105.872511	Valley	KATHRYN HAWKINS 1	**148**	7292
48.203040	-105.110410	Roosevelt	EPU 14	**148**	5832
48.572263	-105.303542	Daniels	E. MCILLECE #1	**148**	6791
48.353107	-105.927717	Valley	DAHL 1	**148**	7134
48.467212	-106.457305	Valley	AKERS 1-16	**148**	6138
48.105157	-105.288283	Roosevelt	A.A. WERNER 1	**148**	6531
48.455591	-105.970135	Valley	SANDVICK 2-11	**147**	6264
48.408940	-	Valley	D. OLFERT C 3	**147**	5848

	106.029839				
48.390835	-106.056565	Valley	TELEP 21-6	**146**	5908
48.394052	-106.029210	Valley	SUN TRIBAL 2	**146**	6092
48.394505	-106.024819	Valley	SUN TRIBAL 1	**146**	6226
48.430664	-106.029861	Valley	PANKRATZ 2	**146**	6027
48.412560	-106.024403	Valley	OLFERT C 4	**146**	5935
48.354976	-105.860282	Valley	J.R. 1-15	**146**	5973
48.354715	-105.986310	Valley	E. LENTZNER 1	**146**	6353
48.362201	-105.449354	Roosevelt	USA BERNR 14-11	**145**	6213
48.474464	-105.232799	Roosevelt	PAULSON 1	**145**	7004
48.457210	-106.363763	Valley	M.B. GERLING 1	**145**	5185
48.380050	-105.693497	Roosevelt	LANDON 1	**145**	6560
48.439693	-106.122141	Valley	JOSEPHINE I. BEAR 1	**145**	5612
48.419810	-105.916050	Valley	FRANZ 1	**145**	5584
48.415987	-106.061387	Valley	CRAWFORD A-4	**145**	6042
48.387901	-105.746841	Roosevelt	BLUE HORSE 1	**145**	6080
48.409015	-106.072011	Valley	WILLIAM CLARK A-3	**144**	5992
48.361896	-105.840268	Valley	REDEKOPP 1-14	**144**	5949
48.394669	-106.008393	Valley	OLFERT B 1	**144**	6356
48.339006	-105.831716	Valley	KNAPP 1	**144**	7176
48.408949	-106.008132	Valley	K. UNRAU 2	**144**	6320
48.353835	-105.872505	Valley	DAHL 9-16	**144**	6136
48.387246	-105.975489	Valley	TIESZEN 2	**143**	5948
48.612308	-106.100446	Valley	SAM SMITH 1	**143**	6288
48.481451	-106.165118	Valley	REDDIG FA<>1-32	**143**	5813
48.398071	-106.056939	Valley	WILDER 1	**142**	5616
48.419968	-106.045041	Valley	WHITE EAGLE A 1	**142**	6179
48.357368	-105.854871	Valley	RUGGLES 1-15	**142**	5946
48.347694	-105.498192	Roosevelt	RED FOX 16-17	**142**	7876

48.275428	- 105.216173	Roosevelt	MCGOWAN 2	**142**	6147
48.456002	- 106.013580	Valley	KROEKER #1-9	**142**	6400
48.408405	- 105.997254	Valley	KLIEWER UNIT 1	**142**	6341
48.417999	- 106.008139	Valley	K. UNRAU TRUST 1	**142**	6301
48.390739	- 106.023848	Valley	J. REDDIG 1	**142**	6119
48.597429	- 106.384559	Valley	FUHRMAN W P 1	**142**	6998
48.354719	- 105.698675	Roosevelt	FAST 1	**142**	6448
48.561384	- 105.286631	Roosevelt	E PAULSON 1	**142**	6772
48.467254	- 105.145652	Roosevelt	THOMAS CLOUD 1	**141**	5714
48.415764	- 106.094531	Valley	SYLVIA ROBERTS 1	**141**	5925
48.406238	- 106.002690	Valley	OLFERT 1	**141**	5986
48.419812	- 106.002702	Valley	UNRAU 1	**140**	5592
48.373107	- 104.793074	Roosevelt	RICKEL A #1	**140**	6840
48.532358	- 105.297543	Roosevelt	RASMUSON 1	**140**	6532
48.622907	- 105.292670	Daniels	NYHUS 5813-1	**140**	6905
48.579499	- 105.303550	Daniels	CARL TONG #1	**140**	6830
48.217274	- 106.180713	Valley	ZVONAR 4-3	**139**	5517
48.463393	- 105.108288	Roosevelt	TRINDER 1	**138**	5766
48.565029	- 105.303536	Daniels	H. MARTELL #1	**138**	6774
48.354708	- 105.704356	Roosevelt	FAST 2	**138**	6579
48.434266	- 105.872586	Valley	BECKER 1	**137**	5700
48.427245	- 105.498352	Roosevelt	D.J.MCLACHLAN 1	**136**	6403
48.434635	- 106.457064	Valley	ECHART LAND24-1	**135**	5010
48.416183	- 106.018966	Valley	BELLONGER CLARK 3	**135**	5855
48.572258	- 105.292632	Daniels	TONG-TRB. #1	**134**	6850
48.351142	- 105.866245	Valley	SUZANNE 1-15	**134**	5971
48.300580	- 106.284104	Valley	NYBAKKEN 5-8	**134**	5513
48.184969	- 105.142891	Roosevelt	HUBER 1	**134**	5850
48.590566	-	Valley	FUHRMAN E & H 1	**134**	7003

	106.345557				
48.423419	-106.018970	Valley	UNRAU-SCHMIDT 2	**133**	6244
48.365521	-105.736913	Roosevelt	H. CARLSON 1	**132**	6414
48.181336	-105.094132	Roosevelt	EPU 20	**132**	5905
48.360160	-105.883832	Valley	DAHL 1-16	**132**	6297
48.257078	-105.649742	Roosevelt	HESER 1	**131**	5553
48.359514	-105.700736	Roosevelt	CRAWFORD 1	**123**	6680
48.401148	-106.062150	Valley	WILDER CLARK 1	**122**	5521
48.420047	-105.635973	Roosevelt	LICKAPAW 34-20	**121**	7710
48.108616	-105.927719	Valley	ARCHDALE 1	**120**	5076
48.169525	-105.189672	Roosevelt	20105 JV-P LOCKMAN 1	**120**	2025
48.492337	-106.251139	Valley	L.&G. REDDIES#1	**118**	6683
48.423557	-106.115275	Valley	MCKAY 1-22	**110**	5988
48.392150	-104.987809	Roosevelt	STATE 2	**104**	2600
48.435370	-105.542664	Roosevelt	JUEL 1-13G	**101**	3485
48.243215	-105.204927	Roosevelt	GOINGS 1 SWD	**100**	1185
48.105254	-105.272062	Roosevelt	A. WERNER 1A	**96**	2600
48.369537	-105.066725	Roosevelt	ASSINIBOINE 1-10G	**95**	2110
48.531102	-105.377299	Roosevelt	SIOUX 1-17G	**94**	1855
48.421196	-105.326456	Roosevelt	MURDOCK ESTATE 1-22G	**92**	2000
48.261974	-105.392178	Roosevelt	ZIMMERMAN 1-18G	**90**	3170
48.483567	-105.797122	Roosevelt	TREASURE> 1-31G	**90**	3200

TOP 100 Wells for Water Flow rates:

LAT (NAD 83)	LONG	Well Name	County	Bottom Hole Depth (TD)	Bottom Hole Temp (deg F)	Production Flow Rate (oil+water BBls/day)(Last Measurment)	Production Flow Rate (water BBls/day)(Last Measurment)	Production Flow Rate (water Gal/min) (Last Measurment
48.1922	-105.1104	EPU 6	Roosevelt	5786	209	1835.5	1828.9	53.3
48.4307	-106.0299	PANKRATZ 2	Valley	6043	146	1736.5	1725.0	50.3
48.2320	-105.0915	EPU 42	Roosevelt	5890	not reported	1661.3	1649.8	48.1
48.2175	-105.1456	EPU 102	Roosevelt	5742	184	1588.0	1579.2	46.1
48.2465	-105.1240	EPU 21	Roosevelt	5750	192	1454.2	1445.8	42.2
48.2176	-105.0806	EPU 88	Roosevelt	5950	167	1455.0	1444.9	42.1
48.1958	-105.1050	EPU 7	Roosevelt	5810	186	1341.3	1330.0	38.8
48.2761	-105.4425	Stensland Allotted 1	Roosevelt	7686	165	1345.4	1324.4	38.6
48.3559	-105.4558	Bridges 1	Roosevelt	7738	170	1310.8	1301.0	37.9
48.3734	-105.7542	Trimble 1	Roosevelt	7273	148	1271.1	1259.2	36.7
48.3477	-105.5199	Sletvold 1-30	Roosevelt	8478	160	1201.6	1190.9	34.7
48.3806	-105.7543	COURCHENE 1	Roosevelt	7395	166	1240.4	1165.0	34.0
48.2103	-105.0941	EPU 1	Roosevelt	9163	275	1172.6	1159.4	33.8
48.2834	-105.3944	Tribal Bird 1	Roosevelt	7640	184	1187.3	1126.5	32.9
48.3514	-105.5572	L.W. Lough 3	Roosevelt	7834	174	1032.8	1019.1	29.7
48.1759	-105.0941	EPU 104	Roosevelt	5957	160	1016.1	1010.3	29.5
48.3733	-105.7659	Trimble 2	Roosevelt	7222	150	1028.8	989.2	28.9
48.3989	-105.5532	TRIBAL "A" 1	Roosevelt	7804	164	997.2	955.0	27.9
48.3476	-105.5630	J.H. BARACKER 2	Roosevelt	7747	168	904.9	883.9	25.8
48.2875	-105.3662	IND. TRUST 1-8	Roosevelt	7925	192	845.5	828.5	24.2
48.1813	-105.0941	EPU 20	Roosevelt	5900	132	836.4	827.5	24.1
48.2176	-105.0914	EPU 16	Roosevelt	5887	175	835.7	824.5	24.0
48.2464	-105.3680	Zimmerman 1-20	Roosevelt	7970	182	777.0	756.0	22.1
48.1872	-105.0918	EPU 34-11H	Roosevelt	9382	250	737.0	725.2	21.2

48.3187	-105.2422	Long Creek 129 #1	Roosevelt	6475	172	719.1	711.0	20.7	
48.2958	-105.4127	KIRVEN 1A-4-1	Roosevelt	7779	170	715.4	700.5	20.4	
48.2175	-105.1027	EPU 85	Roosevelt	5859	176	686.5	686.5	20.0	
48.4089	-106.0407	Olfert "C" 1	Valley	7121	160	680.2	672.0	19.6	
48.2465	-105.2001	ROBBINS 22-15	Roosevelt	6030	219	662.8	650.0	19.0	
48.2423	-105.3721	Allotted Hall 1-29	Roosevelt	7800	180	619.8	613.7	17.9	
48.2465	-105.1132	EPU 97	Roosevelt	5781	170	599.9	597.5	17.4	
48.3513	-105.5145	Zimmerman 2	Roosevelt	7771	154	590.4	589.7	17.2	
48.2682	-105.1565	EPU 48	Roosevelt	5973	162	518.4	516.2	15.1	
48.2103	-105.0996	EPU 18	Roosevelt	5815	180	515.9	515.9	15.0	
48.4745	-104.6304	WESSNER 1-41R	Roosevelt	11410	222	519.4	490.9	14.3	
48.2176	-105.1240	EPU 39	Roosevelt	5792	165	481.3	476.4	13.9	
48.2790	-105.1674	EPU 111	Roosevelt	6212	176	478.4	471.2	13.7	
48.2868	-105.3902	Tribal 41-7	Roosevelt	7685	178	470.6	455.0	13.3	
48.5540	-104.5003	Seidensticker 1	Sheridan	11219	224	457.7	450.0	13.1	
48.4128	-105.4332	BROOKMAN 1	Roosevelt	7916	172	458.7	448.3	13.1	
48.2540	-105.1349	EPU 27	Roosevelt	5889	172	440.3	436.7	12.7	
48.3333	-105.4893	Zimmerman 14-21	Roosevelt	8062	176	438.4	430.9	12.6	
48.2248	-105.0915	EPU 4	Roosevelt	5883	187	416.8	416.8	12.2	
48.2904	-105.3680	Tribal-Bear 2	Roosevelt	7899	188	410.5	402.5	11.7	
48.3154	-105.2375	Long Creek 432 #1	Roosevelt	6445	175	399.6	385.6	11.2	
48.3592	-105.8727	K. Hawkins 1-16HZ	Valley	9460	no info	392.3	378.7	11.0	
48.3916	-105.5306	Stai 1	Roosevelt	7609	no info	389.1	375.0	10.9	
48.1632	-105.1049	EPU 55	Roosevelt	5937	163	363.3	362.1	10.6	
48.2790	-105.1776	War Club 1R	Roosevelt	6055	not reported	373.3	360.8	10.5	
48.2361	-105.1396	EPU 112	Roosevelt	5953	no info	362.6	355.5	10.4	
48.2431	-105.2048	GOINGS 27-3	Roosevelt	7910	218	350.0	350.0	10.2	
48.3951	-106.1057	Marie Standing Heirs 1	Valley	6085	160	354.1	344.0	10.0	
48.1994	-105.1050	EPU 15	Roosevelt	5817	not reported	331.8	328.3	9.6	
48.2826	-105.1403	BUCK ELK 1	Roosevelt	5951	167	329.3	325.7	9.5	
48.3580	-105.8887	Dahl 3-16A	Valley	7405	no info	349.6	324.8	9.5	
48.2323	-105.0698	EPU 83	Roosevelt	5989	230	327.3	322.8	9.4	

48.2356	-105.1294	EPU 106	Roosevelt	5792	179	324.0	316.4	9.2
48.2397	-105.3789	Allotted Hall 2-29	Roosevelt	7907	187	324.2	306.8	8.9
48.2826	-105.1731	War Club 2	Roosevelt	6250	172	318.5	303.7	8.9
48.1958	-105.1158	HUBER 2	Roosevelt	5782	224	302.9	301.8	8.8
48.2320	-105.1457	EPU 70	Roosevelt	5763	182	297.2	292.3	8.5
48.3945	-105.9864	H. MARTENS 1	Valley	5940	164	316.3	284.8	8.3
48.2030	-105.1050	EPU 5	Roosevelt	5824	no info	289.3	284.5	8.3
48.2284	-105.1295	EPU 119	Roosevelt	7224	278	288.1	282.9	8.3
48.2030	-105.1158	EPU 12	Roosevelt	5800	184	292.7	275.3	8.0
48.2900	-105.3842	Tribal Bear 14-5	Roosevelt	7650	188	282.8	268.9	7.8
48.3187	-105.2325	Long Creek 228 #1	Roosevelt	6470	165	269.6	263.1	7.7
48.2450	-105.1310	EPU 44-19H	Roosevelt	8940	not reported	266.3	261.5	7.6
48.2429	-105.1294	EPU 105	Roosevelt	5808	187	264.4	261.4	7.6
48.1834	-105.1023	EPU 101	Roosevelt	6255	184	253.6	249.5	7.3
48.2393	-105.1290	EPU 10	Roosevelt	5797	no info	252.6	248.0	7.2
48.4126	-106.0138	Bellonger-Clark 1	Valley	6225	154	260.5	247.7	7.2
48.2248	-105.1456	EPU 77	Roosevelt	5752	188	252.3	246.7	7.2
48.4379	-106.0836	IRON BEAR 1	Valley	5354	157	272.3	246.2	7.2
48.4160	-106.0614	Crawford A-4	Valley	6050	145	267.9	244.0	7.1
48.4181	-106.0236	Black Magic 1-29	Valley	6387	177	252.8	240.0	7.0
48.2428	-105.1945	GOINGS 27-1	Roosevelt	6067	180	246.5	239.5	7.0
48.4754	-105.0875	M. NESBIT 1	Roosevelt	9676	192	242.5	235.0	6.9
48.4011	-106.0621	Wilder Clark 1	Valley	5524	122	249.4	233.8	6.8
48.2754	-105.1349	EPU 73	Roosevelt	5994	169	224.4	219.1	6.4
48.4129	-105.4288	Mann 1	Roosevelt	7699	154	228.3	211.0	6.2
48.4253	-106.1360	GLEN DALEY A-1	Valley	6100	157	241.8	209.2	6.1
48.6295	-104.4653	Holje A-2	Sheridan	10179	218	208.0	207.8	6.1
48.2826	-105.1511	CUT HAIR 1	Roosevelt	5987	170	207.0	202.1	5.9
48.3688	-105.9262	Joseph 1-7	Valley	6670	153	199.9	198.9	5.8
48.3874	-105.5254	Bigtrack Little 1	Roosevelt	7606	178	200.3	195.0	5.7
48.2357	-105.1186	EPU 110	Roosevelt	5777	227	188.9	187.4	5.5
48.2320	-105.1348	EPU 31	Roosevelt	5753	163	189.6	187.2	5.5

48.3556	-105.8740	Dahl 2-16	Valley		no info	217.7	185.4	5.4
48.3981	-106.0569	Wilder 1	Valley	5615	142	195.1	182.2	5.3
48.2753	-105.1244	EPU 58	Roosevelt	5970	175	175.6	174.2	5.1
48.4053	-106.0461	C. Reddig 3	Valley	6090	153	176.6	173.0	5.0
48.1738	-105.1050	EPU 22	Roosevelt	5942	179	172.4	172.4	5.0
48.2393	-105.1348	EPU 56	Roosevelt	5762	202	177.9	170.1	5.0
48.4454	-105.4918	TRIBAL 1	Roosevelt	7910	182	183.8	167.6	4.9
48.4090	-105.9810	Kliewer 1	Valley	6200	148	166.5	163.0	4.8
48.3115	-105.2433	Long Creek 132 #1	Roosevelt	6400	160	168.8	162.5	4.7
48.3801	-105.7227	Schultes 1	Roosevelt	7515	168	200.6	161.2	4.7
48.4092	-106.0509	CLARK TRIBAL 1	Valley	6090	154	163.3	159.0	4.6