PacifiCorp

Power Generation, Geothermal Resource Study

FINAL REPORT
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1.0 Executive Summary

Black & Veatch and GeothermEx (BVG) contracted with PacifiCorp to review geothermal resource areas (GRAs) near PacifiCorp's service territory and to evaluate the attractiveness of these prospects for supplying reliable electricity. BVG first identified and mapped over 80 GRAs within 100 miles of existing PacifiCorp transmission lines. The total potential developable resource represented by this review was approximately 2,600 MW gross. This analysis is a high-level screen of potential geothermal resources in the PacifiCorp service territory and does not represent a detailed analysis of site specific issues that may affect final development and costs. Whether or not the conclusions and indications of commercial viability are ultimately verified may be dependent on other factors that have not been considered in this study and may be discovered through additional due diligence.

There are important development risks that reduce the geothermal resources that are realistically developable at reasonable cost and therefore ultimately available. Pre-commercial development progressively decreases this risk until a commercial bank is willing to lend to a project. Commercial development occurs after a commercial lender or bank is willing to lend. BVG screened the previously identified resource areas using a definition of commercial viability consistent with a description of the stages of geothermal development contained in a report entitled "New geothermal site identification and quantification," prepared for the Public Interest Energy Research (PIER) program of the California Energy Commission available on the web at http://www.energy.ca.gov/pier/project_reports/500-04051.html (GeothermEx, 2004).

The 2004 report distinguished between an exploration stage (up to the siting of the first deep, commercial-diameter well), a confirmation stage (including the drilling of a discovery well and follow-up drilling to demonstrate 25 percent of the anticipated generating capacity at the wellhead), and a development stage (comprising the remaining drilling and construction of surface facilities). Historically, financers of geothermal projects have considered some percentage of power at the wellhead (typically about 25 percent) as a threshold for proceeding with a construction loan. For the purposes of this study, BVG has assumed that only projects in the confirmation and development stages would have a level of resource risk sufficiently low to be considered commercially viable. This definition effectively treats the successful completion of a discovery well (that is, a well that demonstrates potential for geothermal production at commercial rates) as the primary criterion of commercial viability. This criterion is used for the purposes of this study only as a screen to identify resources for prioritization from the 80+ resources in and near PacifiCorp's service territory. Additional resource verification is required to establish final commercial viability at cumulative well capacities up to the full load of anticipated production.

Out of the more than 80 geothermal resource areas initially identified, eight geothermal resource areas met the commercial viability criterion. These eight areas have a total potential capacity of approximately 800 MW net. Figure 1-1, the map below shows these eight resources selected for in-depth analysis.

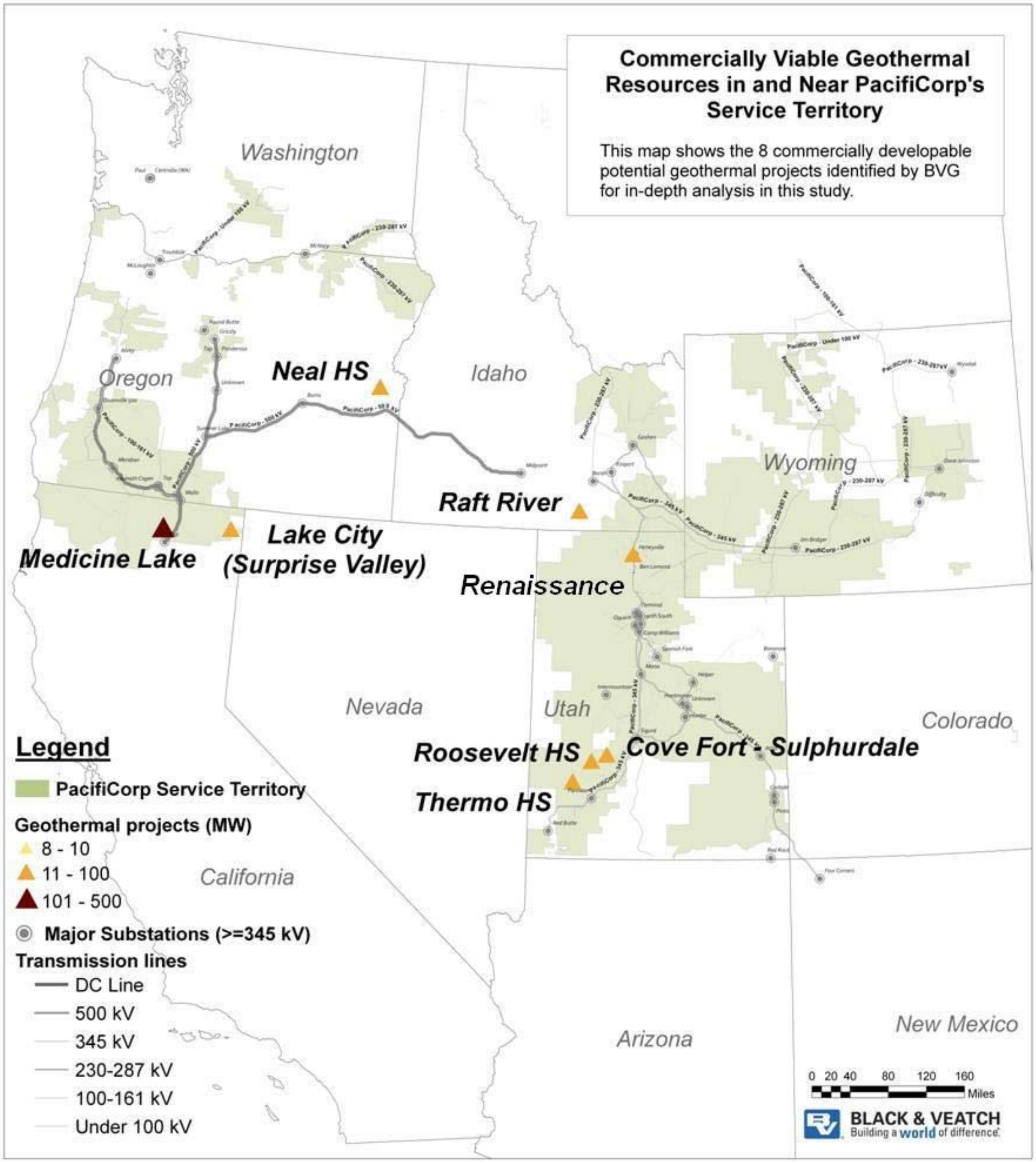


Figure 1-1. Geothermal Sites Selected for In-Depth Review.

BVG reviewed these eight resource areas to understand site ownership, distance to bulk transmission, environmental and permitting factors, water availability, applicable generation technology, existing commitments to Power Purchase Agreements (PPAs), and capital and O&M costs for the resource development (well field, gathering system, and plant construction, including a transmission tap line). Based on this analysis, it appears that Roosevelt Hot Springs (RHS) in Utah is one of the most potentially attractive geothermal sites for PacifiCorp. PacifiCorp already owns and operates geothermal plant at RHS (the Blundell plant) with a capacity of about 30 MW net. The resource is estimated to have the potential for additional capacity of about 80 MW net. While this much resource is estimated to be available, the resource should be developed in smaller increments to verify resource sustainability. The anticipated levelized cost of electricity (LCOE) from additional plant capacity at RHS is in the range of 4.6 to 5.1 cents per net kWh net, which is the lowest LCOE range for the projects considered. PacifiCorp would be its own customer for output from additional plant capacity at RHS; no third-party PPA is needed or expected. No unusual environmental issues are anticipated at RHS, and the site is already tied into PacifiCorp's transmission network.

In the near term, the second most attractive geothermal area for PacifiCorp is at Cove Fort - Sulphurdale, Utah. This resource (referred to herein as "Cove Fort" for the sake of brevity) is currently under development by Enel, and it has an estimated potential of about 80 net MW. Enel is in PPA negotiations to sell 17 to 20 MW of this resource, leaving 60 to 63 net MW potentially available to PacifiCorp. The LCOE for Cove Fort is anticipated to be in the range of 6.8 to 7.5 cents per net kWh, which is the second lowest LCOE range among the eight resource sites reviewed. However, Enel is already at an advanced stage of negotiation with another utility on a PPA for Cove Fort, so the opportunity for PacifiCorp to obtain a PPA for power from this site may be limited.

Another geothermal site with a relatively low LCOE value is US Geothermal's development at Neal Hot Springs in Oregon. However, power from US Geothermal's planned development at Neal Hot Springs is already committed to Idaho Power Company under a PPA for up to 25 MW. Similarly, additional capacity from Raser's project at Thermo Hot Springs, Utah, is already committed under a pre-paid PPA with the Southern California Public Power Authority for up to 110 MW.

Other geothermal potential available to PacifiCorp in the longer term could come from Lake City (Surprise Valley), California; Raft River, Idaho; Renaissance, Utah; and Medicine Lake, California. These projects have a combined capacity estimated at about 500 MW net, over 450 MW of which are not already reserved under PPAs or PPA negotiations and could potentially be available to PacifiCorp. However, the LCOE values for these sites are estimated to be higher than for RHS, so power from these sites can be expected to have correspondingly higher power prices.

Table 1-1 below shows the low and high LCOE estimates for each of the eight sites selected for in-depth review.

Table 1-1. Sites Selected for In-Depth Review.

Field Name	State	Additional Capacity Available (Gross MW)	Additional Capacity Available (Net MW)	Additional Capacity Available to PacifiCorp (Net MW)[a]	Anticipated Plant Type for Additional Capacity	LCOE (Low, $/MWh)[b,c]	LCOE (High, $/MWh)[b,c]
Lake City	CA	30	24	24	Binary	$83	$90
Medicine Lake	CA	480	384	384	Binary	$91	$98
Raft River	ID	90	72	43	Binary	$93	$100
Neal Hot Springs	OR	30	24	0	Binary	$80	$87
Cove Fort	UT	100	80	60 to 63	Binary	$68	$75
Renaissance	UT	30	24	0	Binary	$93	$100
Roosevelt HS	UT	90	81[d]	81[d]	Flash/Binary Hybrid	$46	$51
Thermo HS	UT	118	94	0	Binary	$91	$98
Totals	—	***968***	***783***	***592 to 595***	—	—	—

Source: BVG analysis for PacifiCorp.

Note:

[a] Calculated by subtracting the amount of resource under contract to or in contract negotiations with other parties from the estimated net capacity available.

[b] Net basis.

[c] These screening level cost estimates are based on available public information. More detailed estimates based on proprietary information and calculated on a consistent basis might yield different comparisons.

[d] While 81 MW net are estimated to be available, the resource should be developed in smaller increments to verify resource sustainability.

2.0 Review of Potentially Available Geothermal Resources

In the Renewable Energy Transmission Initiative (RETI) and Western Renewable Energy Zones (WREZ) projects performed by BVG all of the geothermal resource sites known in the West were identified and documented. For this study, BVG specifically identified a subset of these projects, approximately 80 prospects in a high-level review of geothermal resource potential within 100 miles of a PacifiCorp's transmission lines. These projects were identified based on lease sales, commercial interest, etc. A map of these 80 prospects is provided below. They have also been identified in tabular form in Appendix A. Resource capacity estimates in megawatts (MW) are based on studies for the RETI project (Lovekin and Pletka, 2009) and the WREZ project (Western Governors' Association, 2009), unless otherwise noted herein. The 80 projects add up to approximately 2,600 MW gross of potentially developable geothermal resource.

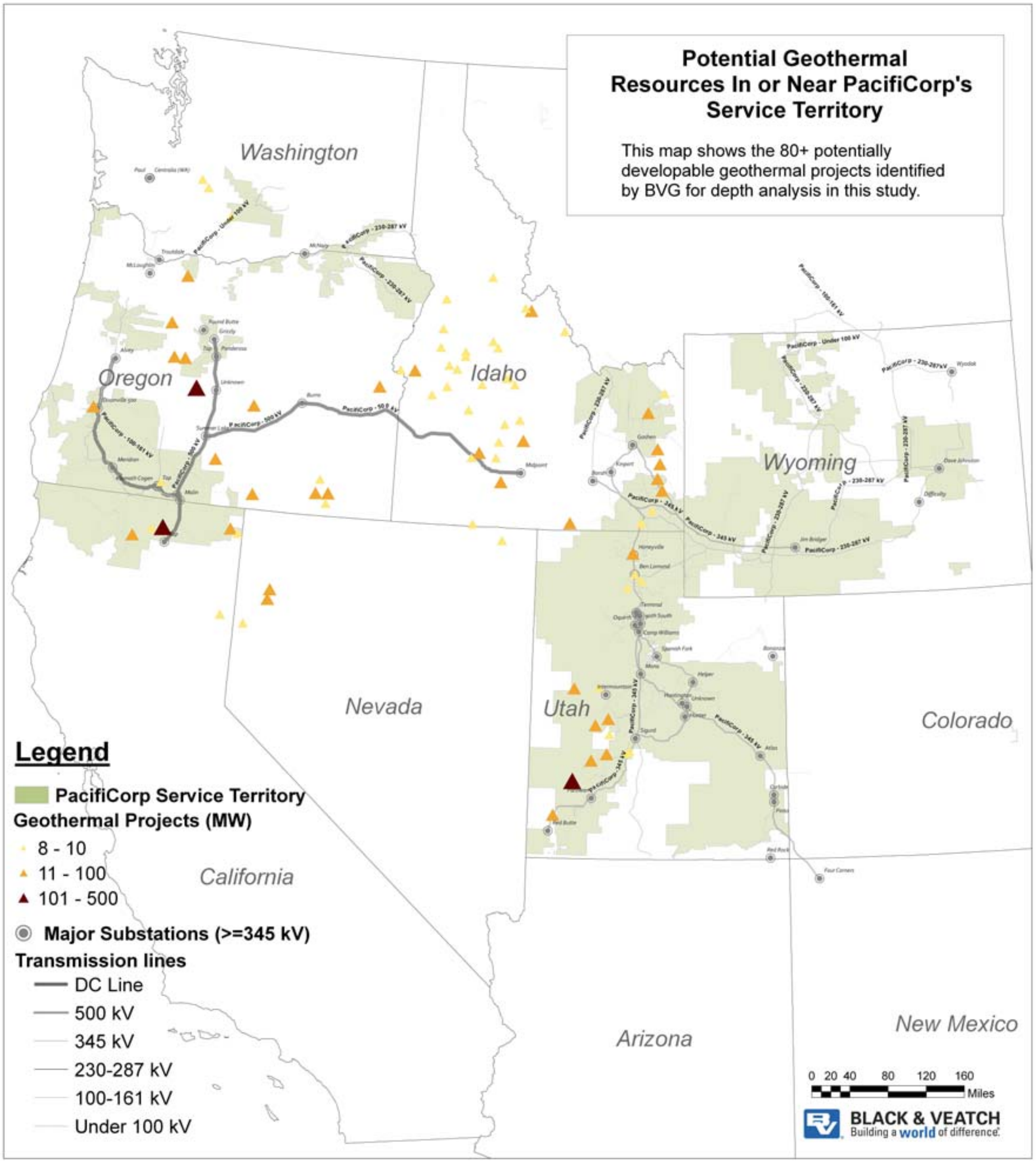


Figure 2-1. Geothermal Resources In or Near PacifiCorp's Service Territory.

3.0 Selection of Resources for In-Depth Review

This section of the report describes the process used by BVG to identify the eight commercially viable utility-scale geothermal projects from the original 80+ potential resources identified. It provides the definition of commercially viable that was used. It also describes the eight sites that were commercially viable and selected for review.

3.1 Definition of Geothermal Commercial Viability

There are important development risks that reduce the geothermal resources that are realistically developable at reasonable cost and therefore ultimately available. Pre-commercial development progressively decreases resource and other risk until the risk is at a level that a commercial bank is willing to lend to a project. It naturally follows that commercial development then occurs after a commercial lender or bank is willing to lend. Geothermal commercial viability may then be defined as a level of maturity in the development of a project such that a prudent commercial investor feels that the project can reasonably be expected to be profitable. The threshold of commercial viability is necessarily subjective, as it depends on the risk tolerance of any particular commercial lender/investor.

The first step in defining commercial viability is to describe the stages along the path to project maturity. A recognized summary of these stages is presented in a study performed for the Public Interest Energy Research (PIER) program of the California Energy Commission.[1] This study describes the following stages, which are consistent with GeothermEx's experience in the assessment of numerous geothermal projects on behalf of potential investors.

Exploration – This includes all activities up to the siting of the first full-diameter well to test the resource. It comprises activities that can be performed on the surface (such as geologic mapping, geochemical sampling of springs, and geophysical surveys). It also includes the drilling of small-diameter wells that are not intended for production but for measurement of sub-surface temperature gradients, which can define sub-surface thermal anomalies for targeting by full-diameter wells to follow.

[1] GeothermEx (2004). New geothermal site identification and quantification. Report prepared for the Public Interest Energy Research (PIER) program of the California Energy Commission, April 2004, Available: http://www.energy.ca.gov/pier/project_reports/500-04-051.html. The description of the stages of geothermal development is included in Appendices IV and VI of this report.

Confirmation – This comprises all activities associated with drilling full-diameter wells to confirm productivity of the resource, up to a level of 25 percent of the target MW capacity of the project. It includes an important milestone – the Discovery Well – which is the first well to demonstrate flow at commercial rates. In geothermal project financing, the threshold of commercial viability has generally been considered to occur somewhere in the confirmation stage. Depending on the risk profile of the investor and the size of the project, a single Discovery Well may suffice. Usually, however, investors will want the success of the Discovery Well to be repeated two or three times, to demonstrate that later wells can be consistently targeted. The 25 percent threshold has varied in recent years: during the credit crisis that started in 2007, some investors have required virtually 100 percent of power available at the wellhead; that is, they have accepted no drilling risk whatever. However, the trend now seems to be back toward a lower percentage, and prudent investors are agreeing to fund the balance of drilling as part of the financing plant construction. For purposes of the current evaluation on behalf of PacifiCorp, a 25 percent threshold of power available at the wellhead has been used as the transition point from the Confirmation phase to the Development phase.

Development – This comprises all activities associated with taking the project from the completion of confirmation drilling to the start-up of a commercial plant. It includes the drilling of the balance of required wells, up to a level including some spare well capacity (typically 5 percent spare). It also includes the construction of the plant and well-field pipelines, as well as connection to transmission at a local substation. Projects in the development stage as defined here are clearly beyond the threshold of commercial viability, inasmuch as someone has seen fit to fund power plant construction, with a certain amount of drilling thrown in.

For the purposes of the current study, projects in either the Confirmation stage or in the Development stage are considered to satisfy the criterion of commercial viability. Effectively, this means that any project in which a successful Discovery Well has been drilled has crossed the threshold of being potentially commercially viable. This criterion is used for the purposes of this study only as a screen to identify resources for prioritization from the 80+ resources in and near PacifiCorp’s service territory. Additional resource verification is required to establish final commercial viability at cumulative well capacities up to the full load of anticipated production.

There are additional considerations that affect whether a geothermal project is likely to be commercial. Such considerations would include:

- Is the project close enough to transmission to be viable?
- Is there adequate site control? That is, does the developer have geothermal development rights over a contiguous block that encompasses the thermal anomaly, and is the block of sufficient size to support the targeted MW capacity?
- Is the developer credible? That is, do they have a track record of developing successful geothermal projects? Do they have adequate financial resources in their own right to follow through if development costs are somewhat higher than expected?
- Is there a credible development plan? For instance, has the developer articulated a realistic program of production and injection well drilling, in terms of the number and spacing of wells? Has a realistic plant technology (flash or binary) been selected? Is the chemistry of the geothermal fluid benign, or are reasonable measures planned to prevent excessive scaling or corrosion?
- Is the project viable from the point of view of potential environmental or social constraints? For instance, is the project in an environmentally sensitive area or an area affected by Native American concerns?

A negative answer to any one of these questions may be enough to make a project non-commercial, even if the 25 percent threshold of MW available at the wellhead has been met. By the same token, a negative answer can at times be turned positive by the application of sufficient resources. For instance, a lack of site control by competing developers at a particular site may be resolved if one or more of the developers can be bought out and if their acreage positions can be consolidated. For purposes of this review for PacifiCorp, BVG has characterized each project that meets the criterion of commercial viability (that is, that has drilled a successful Discovery Well) as having a high or low level of concern with respect to these additional considerations. This characterization is summarized in tabular form in Appendix B.

3.2 Commercially Viable Resources Selected for In-Depth Review

Based on the definition above, eight sites were selected for in-depth review. A map of the locations of these sites is below. A table summarizing the characteristics of these sites can also be found below.

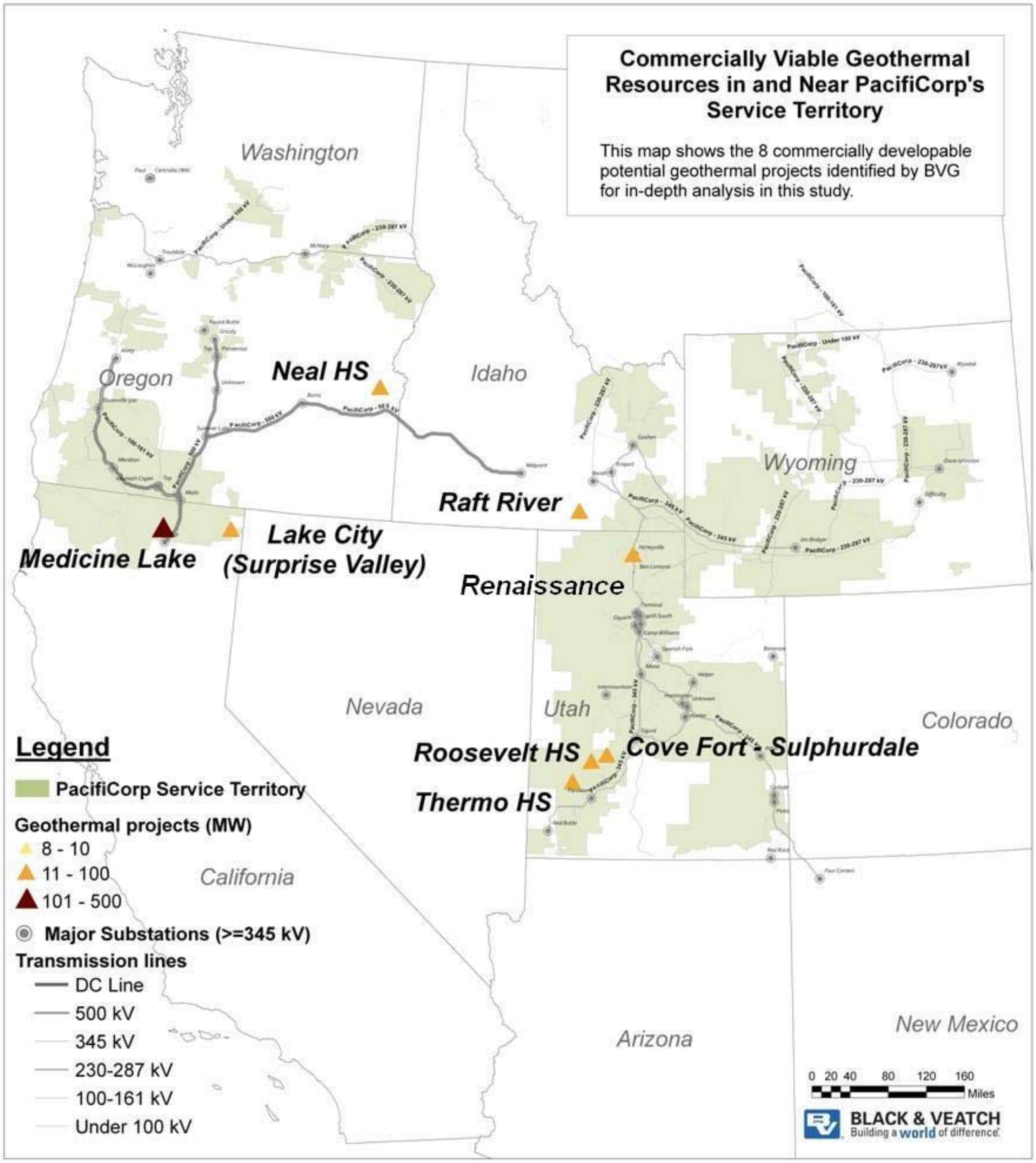


Figure 3-1. Geothermal Sites Selected for In-Depth Review.

Table 3-1. Sites Selected for In-Depth Review.

Field Name	State	Additional Capacity Available (Gross MW)	Additional Capacity Available (Net MW)	Additional Capacity Available to PacifiCorp (Net MW)*	Anticipated Plant Type for Additional Capacity	Developer(s)	Status
Lake City	CA	30	24	24	Binary	Enel; Vulcan	Development
Medicine Lake	CA	480	384	384	Binary	Calpine	Development
Raft River	ID	90	72	43	Binary	US Geothermal; Agua Caliente; Kodali Inc.; S4 Consultants	Development
Neal Hot Springs	OR	30	24	0	Binary	US Geothermal	Development
Cove Fort	UT	100	80	60 to 63	Binary	Enel	Development
Renaissance	UT	30	24	0	Binary	Idatherm & Shoshone Tribe	Confirmation
Roosevelt HS	UT	90	81**	81**	Flash/Binary Hybrid	PacifiCorp	Development
Thermo HS	UT	118	94	0	Binary	Raser; Magma Energy; Energy Minerals; Radion Energy	Development
Totals	—	***968***	***783***	***592 to 595***	—	—	—

Source: BVG analysis for PacifiCorp.

Note:

* Calculated by subtracting the amount of resource under contract to or in contract negotiations with other parties from the estimated net capacity available.

** While 81 MW net are estimated to be available, the resource should be developed in smaller increments to verify resource sustainability.

3.3 Descriptions of Specific Geothermal Resources

Individual descriptions of each of the eight sites are provided below. Each description is followed by a map of each site. Federal acreage blocks indicated on the maps are based on information from the LR2000 database available at the web site of the U.S. Department of Interior, Bureau of Land Management (BLM, 2010), unless otherwise noted.

3.3.1 Lake City, California

The Lake City GRA is located in northeastern California (Figure 3-1). Figure 3-2 shows the location of federal geothermal leases and lease nomination areas in the Lake City area. Historical interest in the geothermal potential of the area was sparked by a hydrothermal eruption at the Lake City Hot Springs in 1952 (GeothermEx, 2004). Exploration drilling near the Lake City Hot Springs began in the late 1950s, and a successful discovery well (Phipps No. 2) was drilled to 4,946 feet and tested in 1975.

Exploration efforts have focused primarily on private leases on the west side of Surprise Valley (the location of these leases is proprietary and is not shown in Figure 3-2). Geophysical surveys were conducted in the 1980s and 1990s, and additional temperature-gradient holes have been drilled since 2002. Reservoir temperatures are estimated to be in the range of 320°F to 350°F, and the MW capacity available from the Lake City resource has been estimated at 40 MW gross (Lovekin and Pletka, 2009). Enel North America ("Enel") holds private leases in the vicinity of Lake City Hot Springs, and expects to begin drilling full-diameter wells later in 2010 or in early 2011. Vulcan Power Company (Vulcan) holds a block of federal leases to the West of Enel's acreage. Enel plans to put a binary plant on line at Lake City in 2013 or 2014, with an anticipated capacity in the range of 17 to 20 MW net. Enel reports that a preliminary interconnect study for transmission has been done and that existing transmission lines in the area have sufficient capacity to accommodate the anticipated capacity of the first plant. Enel has had PPA discussions with several power purchasers, but no PPA commitment has been made.

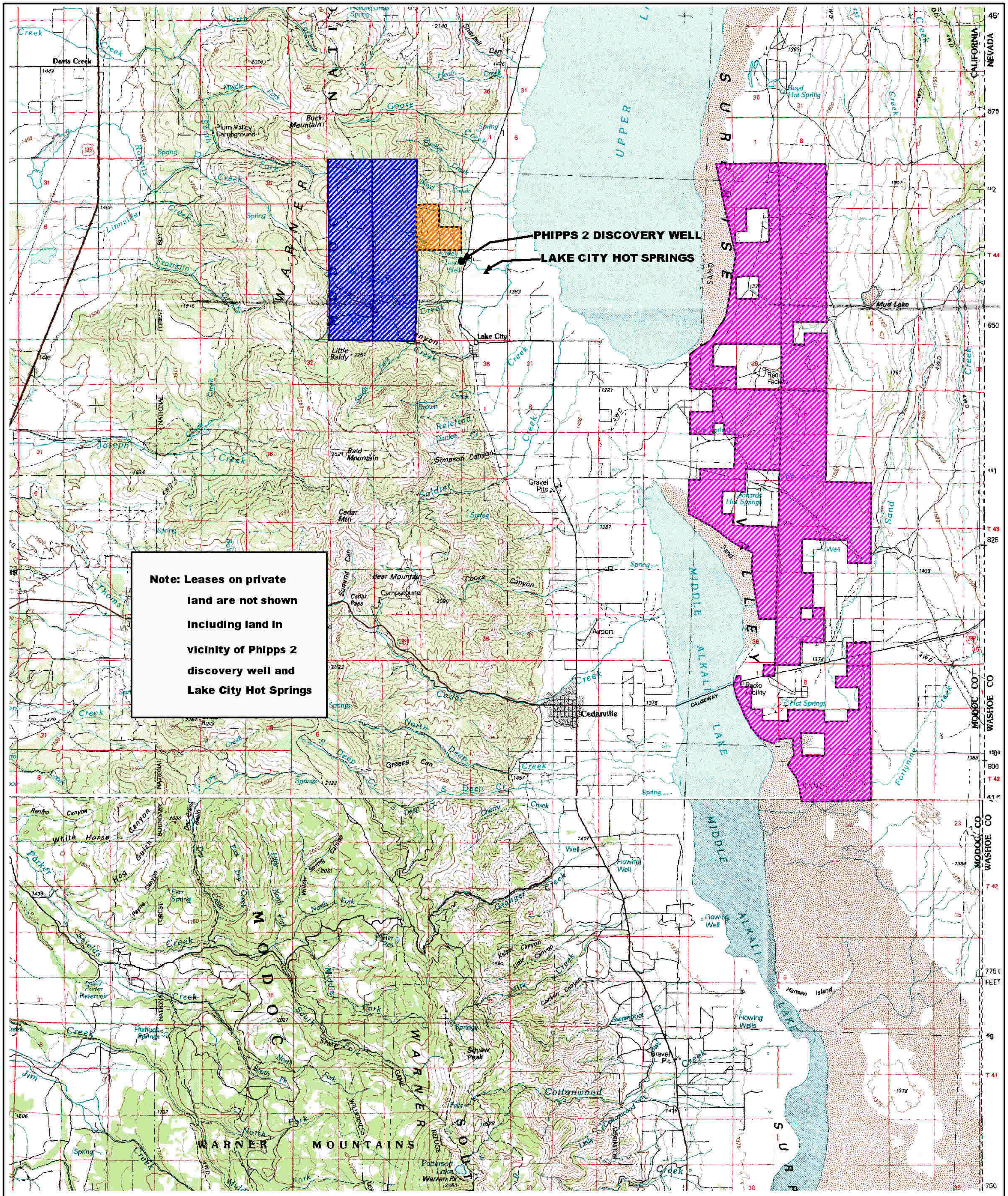


Figure 3-2. Lake City Geothermal Area (Surprise Valley)

Legend

- LAKE CITY GEOTHERMAL LLC (ENEL AFFILIATE)
- VULCAN POWER CO
- GEOTHERMAL NOMINATIONS

2010, GeothermEx, Inc.

3.3.2 Medicine Lake, California

The Medicine Lake GRA is located in northern California (Figure 3-1). The geothermal resource at Medicine Lake was delineated by drilling in the 1980s by Unocal, Phillips, and Occidental Petroleum. The drilling included two dozen temperature-gradient holes over a large area and three productive wells. The area was unitized for geothermal development in the 1980s as the "Glass Mountain Federal Unit," which is comprised entirely of federal land and is currently leased to Calpine (Figure 3-3). Resource temperatures are estimated to be in the range of 440°F to 490°F. Development efforts since the 1990s have focused on two project areas: Telephone Flat in the southeast and Fourmile Hill in the northwest. Other potential project areas exist within the Medicine Lake area, and the potential capacity at Medicine Lake overall has been estimated at 480 MW gross. The resource temperature would be suitable for development using flash-plant technology, which would yield a net capacity of about 90 percent of gross capacity, or 432 MW net. Calpine's current plans envision the use of flash plants. For the purposes of this report, however, it has been assumed that plants at Medicine Lake will use air-cooled binary plant technology, in order to avoid the visual impact of vapor plumes off cooling towers, which may be an environmental concern. The assumption of binary plant technology implies a net capacity of about 80 percent of gross capacity, or 384 MW net, as tabulated in Appendix B. The economic effect of this assumption is a reduction of approximately 11% in net MW available (from 90% to 80% of gross capacity) for each increment of plant capacity.

Geothermal development at Medicine Lake has long been stalled by environmental issues and Native American concerns, which have resulted in extensive litigation. As of July 2010, Calpine is awaiting a ruling by the 9th Circuit Court of Appeals, following which it plans to perform an updated Environmental Impact Statement (EIS) for geothermal development in the field. Assuming that the appeals court ruling allows development to proceed and that the new EIS is approved, Calpine projects power from Medicine Lake to come on line in several increments between 2017 and 2023. Costs of environmental compliance and high snowfall in the Medicine Lake area are expected to make geothermal development at Medicine Lake relatively expensive. However, exploration results to date indicate no significant technical challenges in terms of reservoir characteristics, and the field's large size and proximity to California markets are likely to make it the focus of significant development effort in the long term. At present, there are no PPA commitments for power from Medicine Lake.

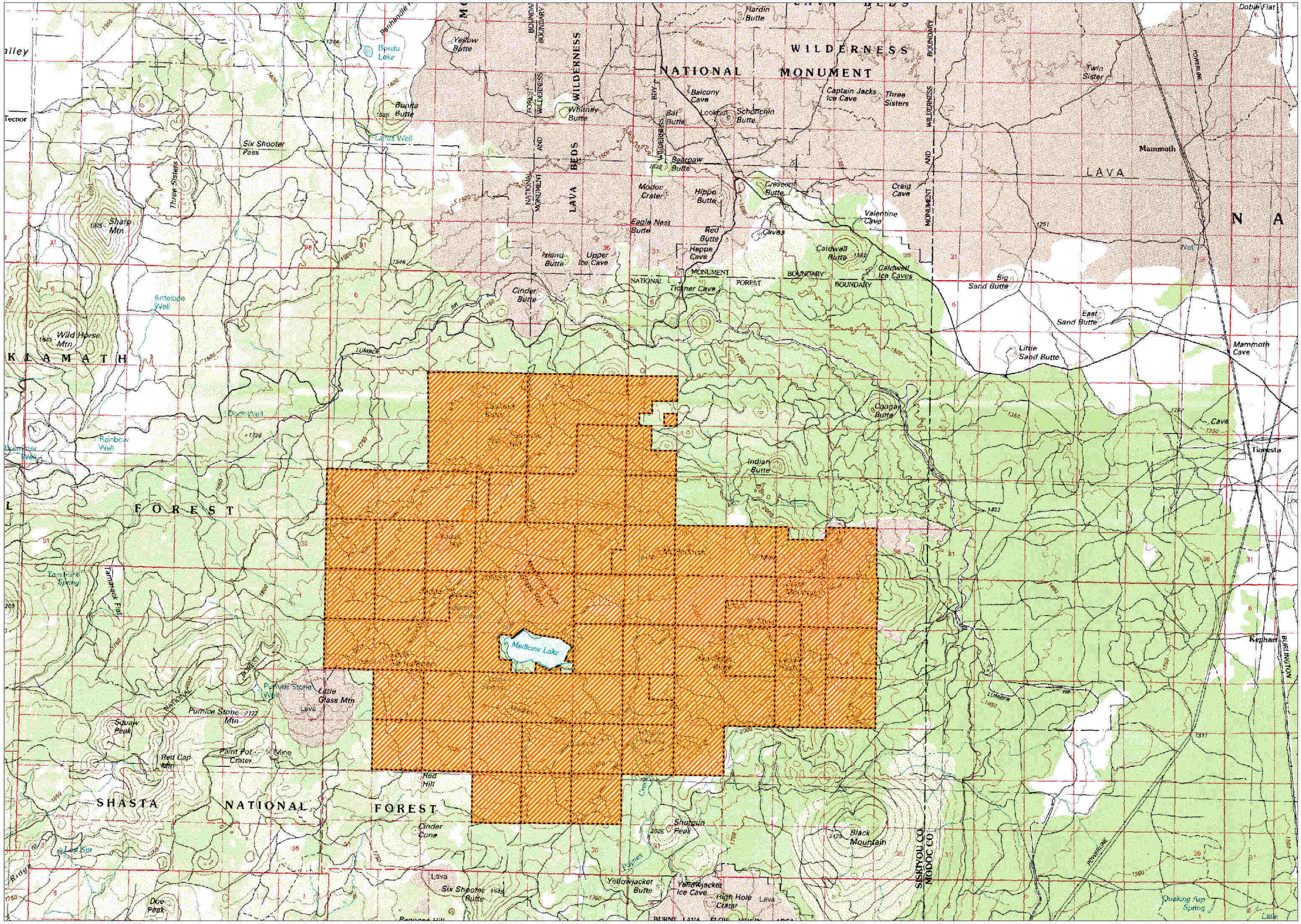


Figure 3-3. Medicine Lake Geothermal Area

Legend

Calpine

2010, GeothermEx, Inc.

3.3.3 Raft River, Idaho

The Raft River GRA is located in southern Idaho, near the Utah border (Figure 3-1). The site was initially developed by the US Department of Energy (DOE), which drilled wells starting in the 1970s and operated a 5-MW binary plant for demonstration purposes in the early 1980s (Clutter, 2010). The DOE facility was decommissioned when project funding ended, but the wells were left open. In 2007, US Geothermal began production from a new binary plant (Raft River Unit 1), utilizing several of the original DOE wells and a newly drilled injection well. Unit 1 has a capacity of 16 MW gross (13 MW net). It is currently operating below full capacity (at about 10 MW) due to a shortage of production fluids and cooler-than-expected temperatures from a production well with a leaking liner lap downhole. US Geothermal plans further drilling and work-overs to bring Unit 1 to full power and proceed with development of two more binary units at the site. The reservoir temperature is in the range of 275°F to 300°F, and the incremental capacity of the resource (beyond Unit 1) has been estimated at 90 MW gross (72 MW net).

Figure 3-4 shows the distribution of geothermal leases at Raft River. US Geothermal has utilized private leases for its development to date, and they have some federal acreage as well. Other development companies (Agua Caliente, Kodali, and S4 Consultants) have also obtained federal leases in the area. The size of the lease blocks appears to be adequate to allow the various operators to pursue their respective development plans without excessive interference between leases. Still, the potential for interference from offset operations introduces an element of resource risk at Raft River that needs to be carefully monitored and managed. In addition, the combination of relatively deep wells and relatively low reservoir temperatures tends to make the cost of geothermal development relatively high at Raft River.

US Geothermal sells power from Unit 1 under a PPA with Idaho Power Company (IPC). A PPA is already in place with the Eugene Water and Electric Board (EWEB) for power sales of up to 16 MW net from US Geothermal’s planned Unit 2. Power from the planned Unit 3 is not currently committed under any PPA (US Geothermal, personal communication, 21 July 2010). The timing of construction of Units 2 and 3 is uncertain, pending the achievement of full power output from Unit 1 and further progress on other US Geothermal projects (such as Neal Hot Springs). For the purposes of this report, an estimated on-line date of 2013 is reasonable for Raft River Unit 2.

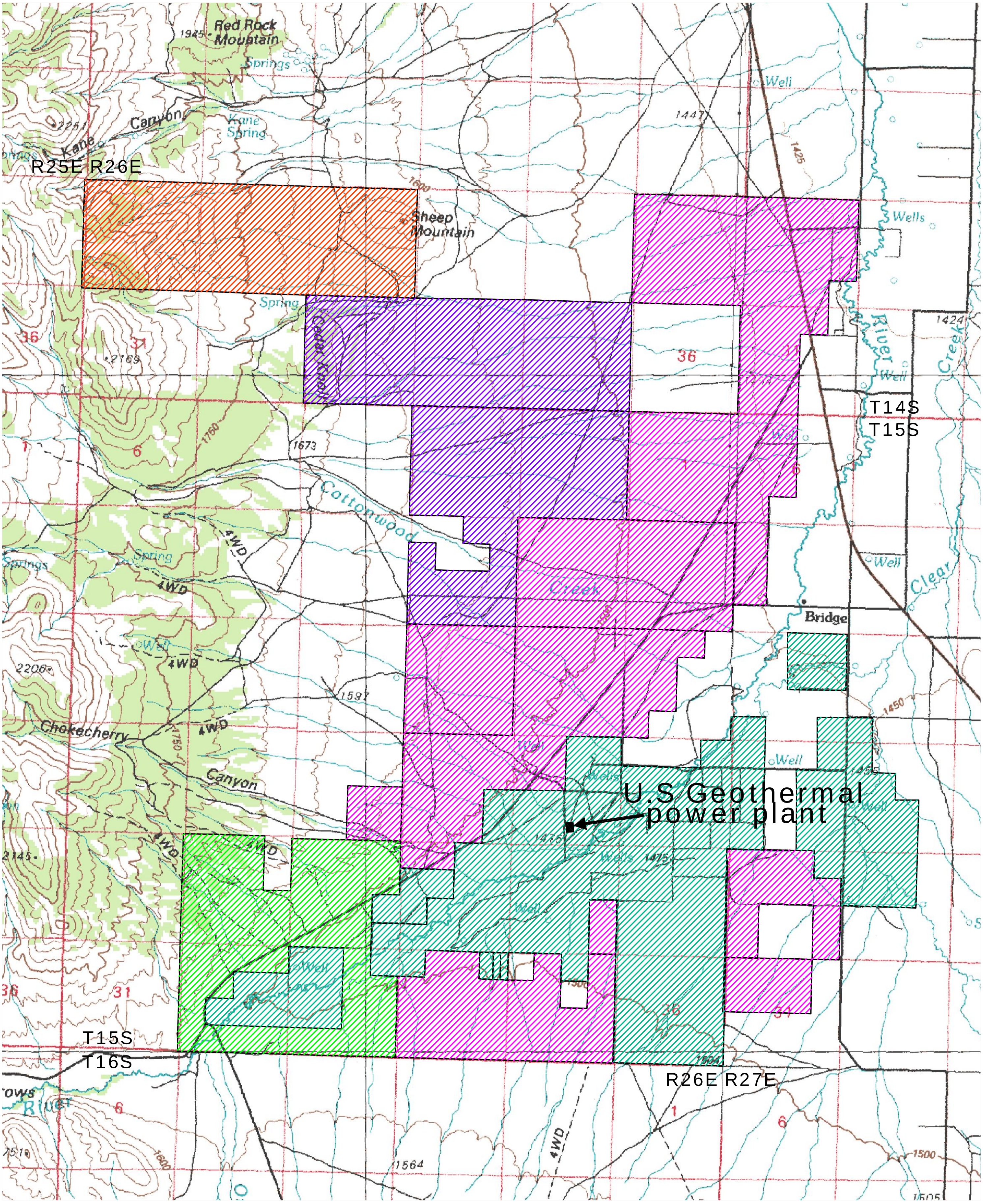


Figure 3-4.
Raft River Geothermal Area

Legend

- S4 CONSULTANTS INC
- KODALI INC
- AGUA CALIENTE LLC
- US GEOTHERMAL BLM LEASE
- US GEOTHERMAL PRIVATE LEASE

APP: JWL

PLOTDATE: 6 Jul 2010

DRAWN: JWM

GeothermEx, Inc.

3.3.4 Neal Hot Springs, Oregon

The Neal Hot Springs GRA is located in eastern Oregon, about 90 miles west of Boise, Idaho (Figure 3-1). Chevron drilled a discovery well at the site in 1979. US Geothermal acquired the project in 2006 and has since drilled two successful production wells, as well as additional temperature-gradient wells to delineate the resource. Figure 3-5 shows the area of federal surface ownership at Neal Hot Springs, based on the LR2000 database (BLM, 2010). US Geothermal reports that it has private leases on sub-surface geothermal development rights in the Neal Hot Springs area; the configuration of these private leases is proprietary and is not shown on Figure 3-5. The production wells have encountered temperatures of up to 287°F at depths in the range of 2,300 to 2,900 feet (Clutter, 2010). Geochemical analyses suggest temperatures in the range of 322°F to 350°F at greater depth. The relatively shallow depth of drilling at Neal Hot Springs is expected to contribute to relatively low capital costs for construction. US Geothermal plans to construct an air-cooled binary plant at Neal Hot Springs with a capacity of up to 25 MW net. It has signed a 25-year PPA with IPC for the output of this plant, and it expects the plant to be in commercial operation by the first quarter of 2012.

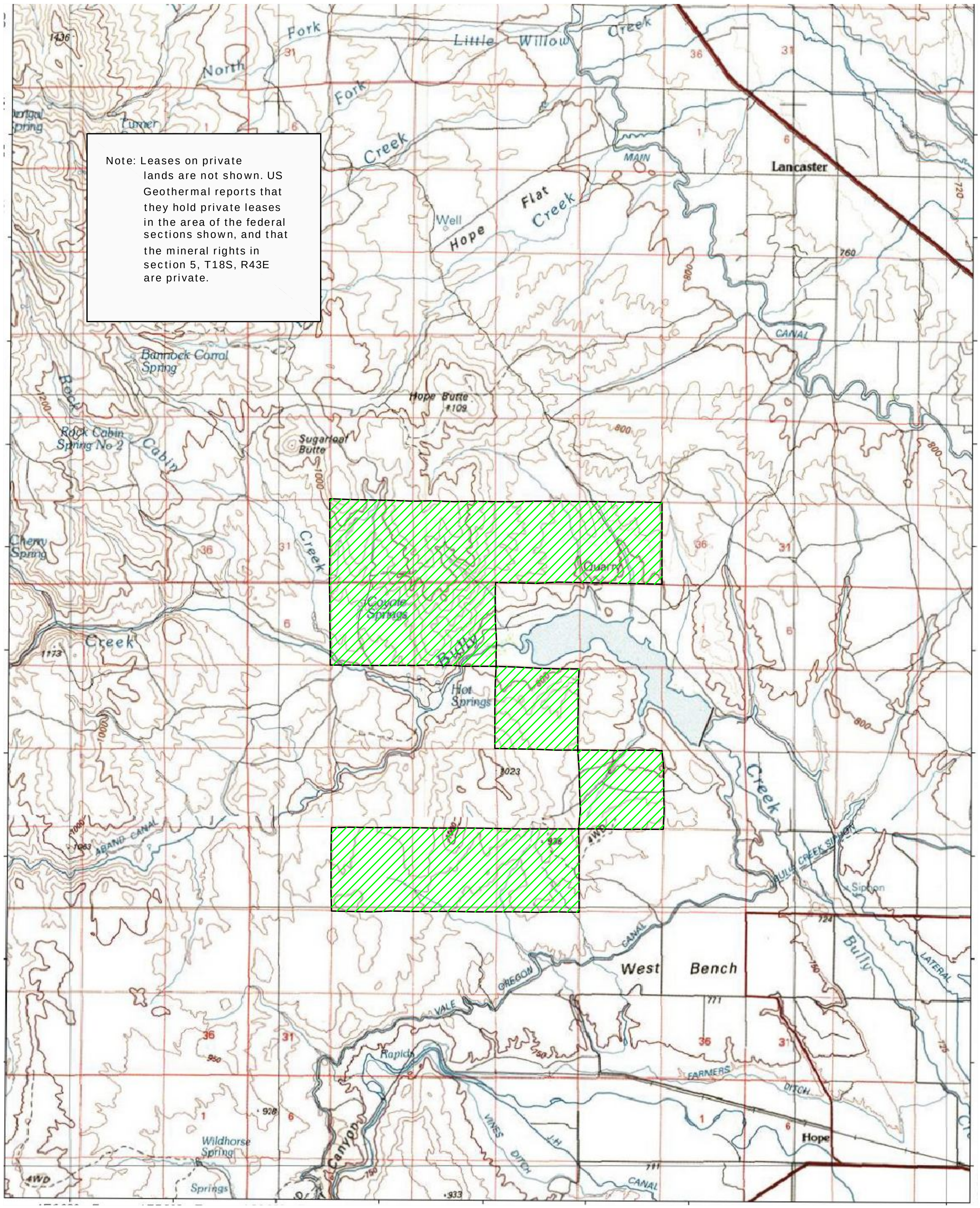


Figure 3-5.
Neal Hot Springs
Geothermal Area

Legend

Approximate area of federal surface ownership based on LR2000 database (BLM, 2010).
(entire sections shaded if they contain BLM acreage.)

	APP: JWL
PLOTDATE: 7 Jul 2010	DRAWN: JWM

GeothermEx, Inc.

3.3.5 Cove Fort - Sulphurdale, Utah

The Cove Fort - Sulphurdale GRA (referred to herein as "Cove Fort" for the sake of brevity) is located in southwestern Utah, near the intersection of Interstate Highways 15 and 70 (Figure 3-1). Cove Fort was explored by Unocal and others starting in the 1970s (GHC Bulletin, 2004). Mother Earth Industries built a small binary plant at the site in the late 1980s, with a capacity of 11 MW. AMP Resources acquired the project in 2003 and decommissioned the plant in anticipation of expanding the well field and building a larger plant with more efficient binary equipment. Enel purchased the project from AMP in 2007 and expanded its acreage ownership in a federal lease sale in 2008. The land ownership at Cove Fort is a mix of federal, state, and private leases, and Enel has the dominant land position, with minor holdings by Oski Energy ("Oski"). Figure 3-6 shows the federal leases in the Cove Fort area, all of which are held by Enel. The reservoir temperatures at Cove Fort are in the range of 315°F to 350°F, and the capacity available from the Cove Fort resource is estimated at 100 MW gross (80 MW net). Enel has been actively drilling since 2009 and expects to complete 8 to 9 new wells by early 2011. It plans to put a new binary plant (Unit 1) on line in 2012 with a capacity in the range of 17 to 20 MW net. Transmission rights have been reserved for up to 65 MW of field capacity. PPA negotiations with Southern California Edison for the sale of power from Unit 1 are at an advanced stage but are not yet finalized.

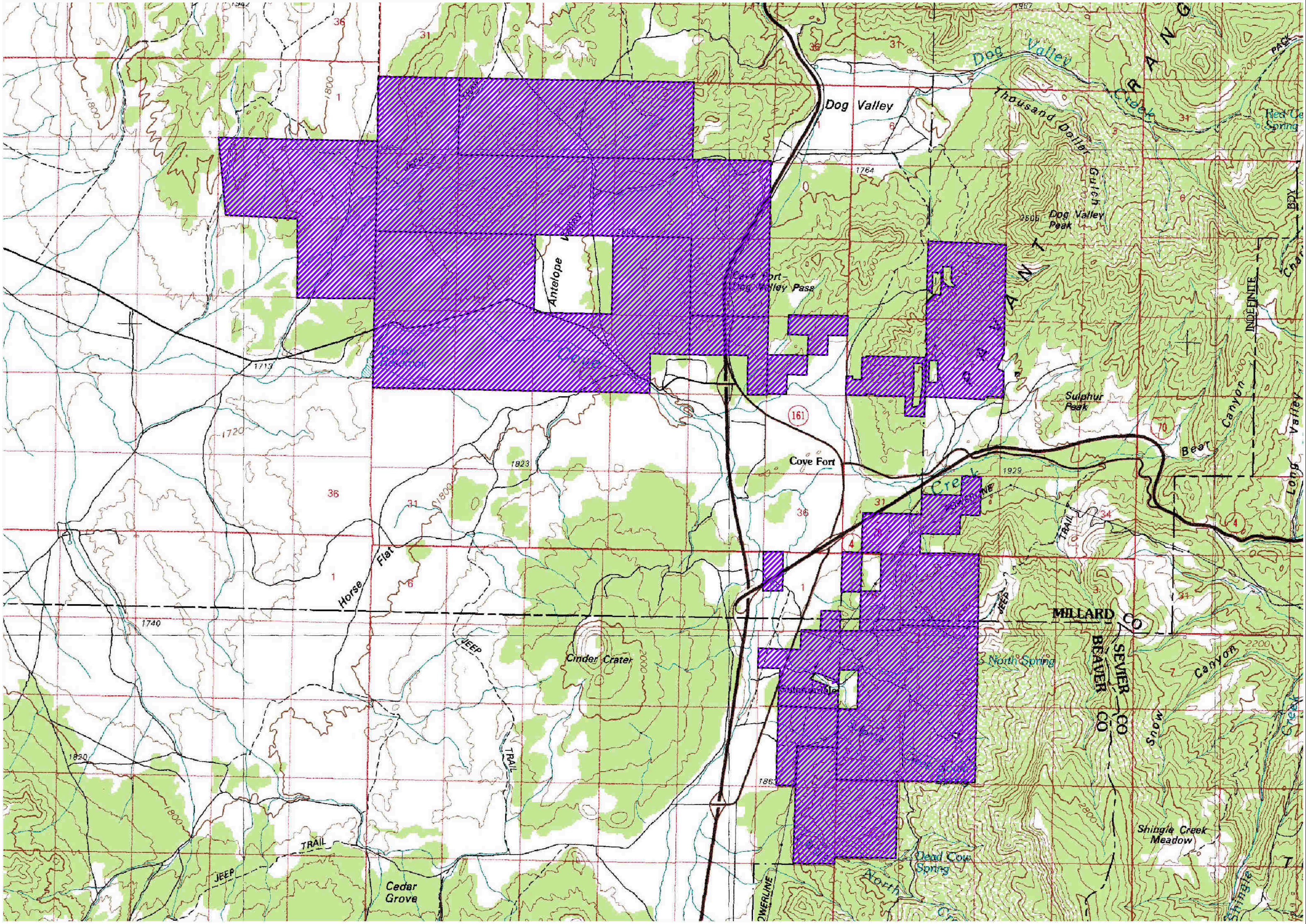


Figure 3-6. Cove Fort - Sulphurdale Geothermal Area

Legend
■ ENEL COVE FORT LLC

2010, GeothermEx, Inc.

3.3.6 Renaissance, Utah

The Renaissance GRA is located in north central Utah (Figure 3-1), about 7 miles northwest of Brigham City and about 4 miles south of Crystal-Madsen Hot Springs (Figure 3-7). A discovery well (Davis #1) was drilled in 1974 by Utah Power and Light and Geothermal Kinetics (Austin, 2007). This well reached a total depth of 11,005 feet and reportedly encountered flow of 3,500 gpm of fluid with surface temperature of 286°F while drilling at depth of about 8,200 ft. Geochemical analysis suggested source fluid temperatures in excess of 400°F (Austin et al., 2006). The Shoshone Nation in conjunction with Idatherm is reportedly planning a 100-MW geothermal development, with sales of 64 MW of power to the City of Riverside, California (McDermott, 2008). No information was available as of the date of this report regarding the acreage position of the project proponents; the location shown in Figure 3-7 is based on the location of the Davis #1 well. There is also not much public information to support the capacity estimate of 100 MW. For the purposes of this report, a resource capacity estimate of 30 MW gross (24 MW net) has been assumed. Because development of this resource appears to require deep drilling, relatively high capital costs can be anticipated.

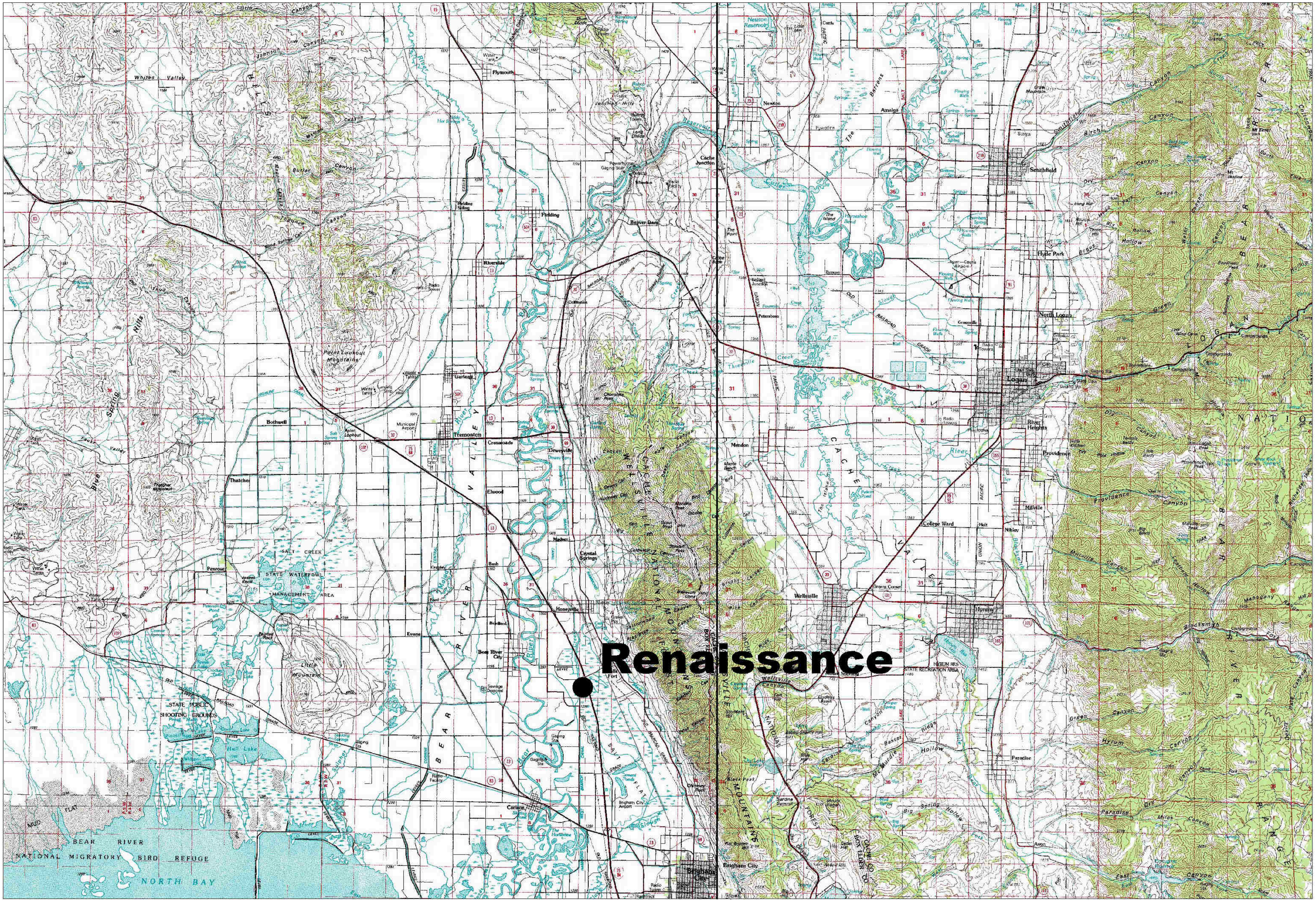
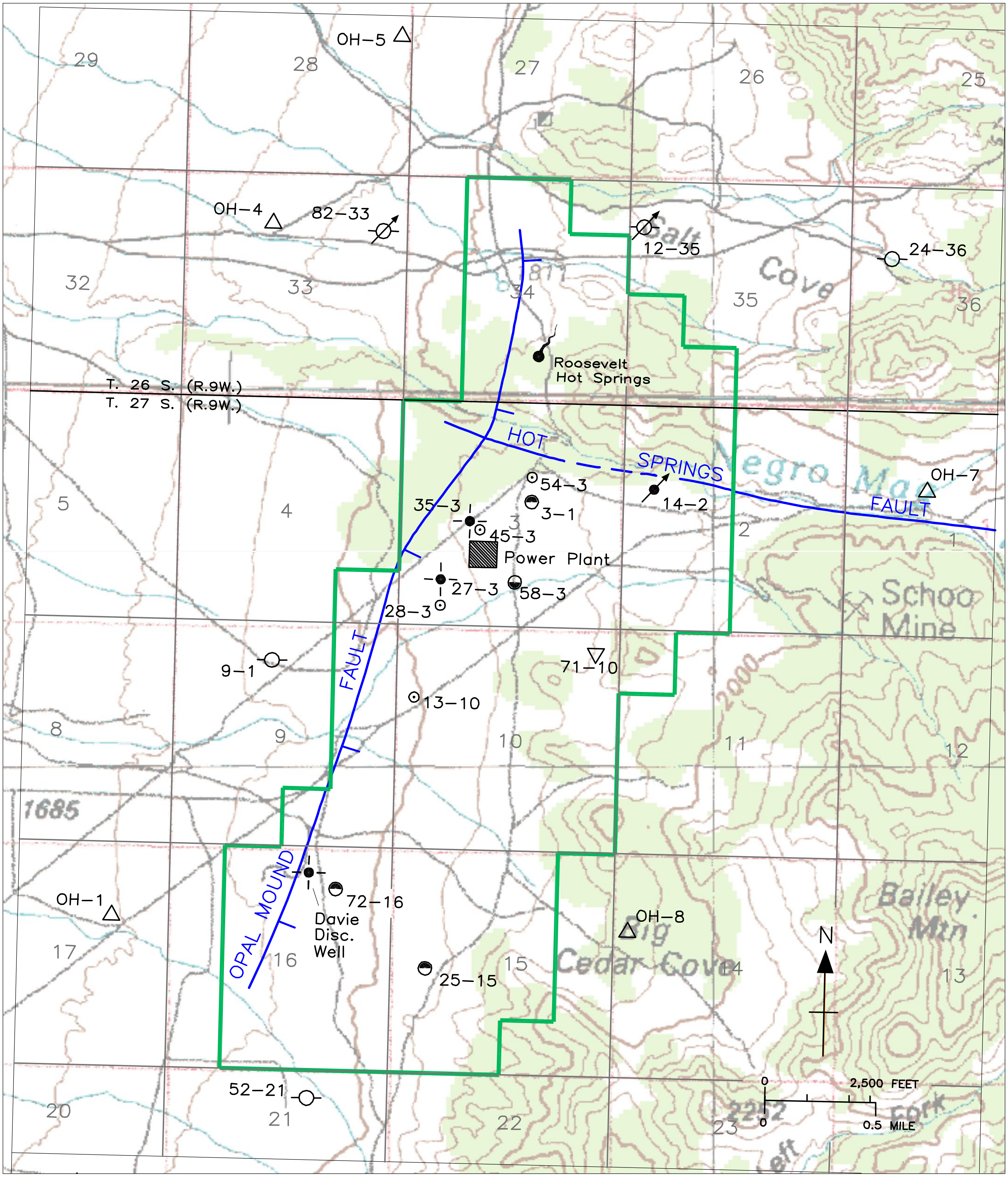


Figure 3-7. Renaissance Geothermal Area

2010, GeothermEx, Inc.

3.3.7 Roosevelt Hot Springs, Utah

The Roosevelt Hot Springs GRA is located in southwestern Utah, near the town of Milford (Figure 3-1). Drilling into the geothermal resource at Roosevelt began in 1967, and the field has produced power since 1985 (Berry, et al., 2009). Federal leases in the field have been consolidated into a geothermal unit, the Participating Area of which is shown in Figure 3-8. PacifiCorp owns and operates both the Roosevelt Hot Springs well field and the Blundell power plant. The power plant is a hybrid of a 26-MW flash plant (Unit 1, constructed in 1984) and an 11-MW binary bottoming cycle (Unit 2, added in 2007). Reservoir temperatures are in the range of 450°F to 500°F, and the incremental resource capacity at the site has been estimated at about 90 MW gross (81 MW net). While 81 MW net are estimated to be available, the resource should be developed in smaller increments to verify resource sustainability. In 2008, PacifiCorp drilled two new wells as part of a planned expansion: a producer (58-3) and an injector (71-10). Both wells were successful based on preliminary testing. Work on the expansion was suspended in 2009 due to unfavorable market conditions. Re-initiation of the proposed drilling program will be required to support additional capacity. The purpose of this drilling program (if pursued) will be to support a proposed Unit 3, with an anticipated capacity of about 35 MW net. Because of the relatively high resource temperature, the favorable history of the Roosevelt production wells, and the anticipated high capacity factor of the proposed hybrid plant (a flash-binary combination), the capital cost of this development on a per-kilowatt basis is anticipated to be cost effective compared to the other geothermal alternatives identified. Since PacifiCorp would be using the power produced in its own transmission system, no PPA would be needed for the new plant.



LEGEND

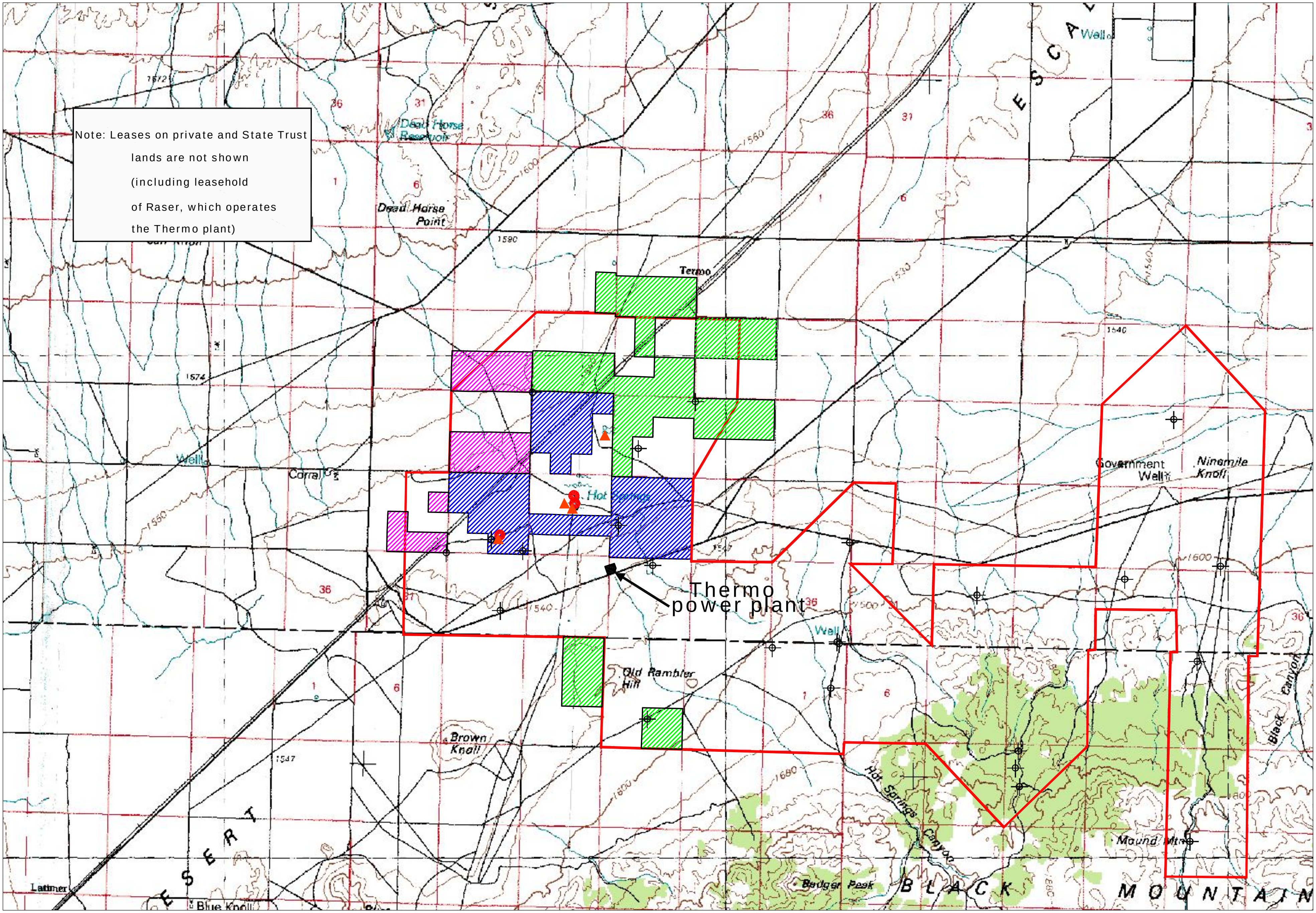
- Active producer
- Originally productive
- Originally productive but damaged
- Productive well drilled for proposed expansion (not yet online)
- Injector
- Injector drilled for proposed expansion (not yet online)
- Plugged and abandoned
- Strat test/gradient hole
- Dry hole
- Hot spring
- Participating Area

Figure 3–8. Roosevelt Hot Springs Geothermal Area

GeothermEx, Inc.	GEOTHERMAL EXPLORATION DEVELOPMENT AND OPERATIONS 3260 Blume Drive, Suite 220, Richmond, CA 94806 TEL (510) 527–9876 FAX (510) 527–8164 EMAIL MW@GEOTHERMEX.COM	PLOTDATE: 6 Jul 2010	SCALE: FIT	ARCHIVE: P2328	APP.: JWL
		FILE: PC RHS Fig.2.DWG	DRAWN: RRS	PAGE SETUP: ROOSEVELT	

3.3.8 Thermo Hot Springs, Utah

The Thermo Hot Springs GRA is located in southwestern Utah, near Cedar City (Figure 3-1). The area has been the focus of recent development efforts by Raser Technologies ("Raser"), which put a new binary facility on line in the spring of 2009. Raser's geothermal leases at Thermo are on a combination of private lands and State Trust Lands; the configuration of these leases is proprietary. Figure 3-9 shows federal leases in the area, as well as a schematic outline of a thermal anomaly inferred from temperature-gradient drilling (Berry et al., 2009). Three other developers (Magma Energy, Energy Minerals, and Radion Energy) have acquired federal leases offsetting Raser's leases, which would appear to complicate efforts for an integrated development of the thermal anomaly. The temperature of the reservoir exploited to date is relatively low (260°F to 280°F) though temperatures over 390°F have been predicted from geochemical thermometers (Berry et al., 2009). The Raser facility has a nominal capacity of 12 MW gross (8 MW net), comprising 50 small binary units manufactured by United Technologies Corporation (UTC) with a capacity of 0.24 MW (gross) apiece. Raser sells power from this facility to the California market under a PPA with the City of Anaheim. Considering the large area and the extent of the thermal anomaly, the incremental capacity of the overall resource at Thermo has been estimated at 118 MW gross (94 MW net). Raser has a pre-paid PPA with the Southern California Public Power Authority ("SCPPA") for the sale of up to 110 MW of additional power from the Thermo site, so power from further development is already committed, up to essentially the capacity of the resource. Therefore, although the field is considered to be in the development phase, power from the Raser Acreage at Thermo Hot Springs is not expected to be available to PacifiCorp.



Legend

- Magma Energy (US) Corp
- Radion Energy LLC
- Energy Minerals Inc
- Schematic outline of thermal anomaly >100°C/km (Source: Berry et. al., 2009)
- Thermal gradient boreholes >100°C/km
- Thermal well >50°C
- Thermal spring >50°C

Figure 3-9. Thermo Hot Springs Geothermal Area

2010, GeothermEx, Inc.

4.0 Identification of Appropriate Interconnection Points

Once the eight commercially viable sites were identified, BVG evaluated the distance from these sites to potential interconnection points along the bulk transmission system at a high level, consistent with the other publicly available GIS studies of the area with which we have been associated. This analysis consisted of two main analytical steps. First, BVG conducted a GIS analysis to determine appropriate interconnection points along the bulk transmission system in close proximity to the geothermal fields. Second, we determined the distance from each geothermal field to its nearest interconnection point and interconnection costs were estimated based on these distances.

4.1 Identification of Potential Interconnection Substations

In order to identify appropriate interconnection points along the transmission system for each geothermal field, BVG identified substations located close to each field which are of an appropriate size for interconnecting the resources in each field. Black & Veatch's Power Delivery group developed a simple set of assumptions for the California RETI study on which this analysis was based. We believe that these same assumptions are appropriate to use for this study's level of analysis.

Once appropriate interconnection points were identified along the transmission system for each geothermal field, BVG measured the straight line distance from each geothermal field to that interconnection point using GIS software. This provides a general estimate of the distance from the geothermal field to the bulk transmission system. BVG did not route transmission lines through or around specific areas. We believe that for this level of analysis, defining routes for interconnecting transmission lines is an inappropriate level of detail. If PacifiCorp and stakeholders desire adjustments be made to the distances measured, in order to account for nearby environmentally sensitive areas or land use concerns, we propose that simple distance multipliers are developed and applied to the calculated transmission line distances.

4.2 Analysis of Interconnection Costs

After determining the distance from each geothermal field to the nearest interconnection point of sufficient size, BVG created high-level estimates of the costs of building transmission lines and substations of the appropriate size and distance to interconnect each geothermal field. This analysis was based on simple assumptions that have been vetted and utilized in a number of public stakeholder processes such as the Western Renewable Energy Zones (WREZ) project, the California Renewable Energy

Transmission (RETI) project as well as the Utah Renewable Energy Zones (UREZ) project.

Generation tie-line costs were calculated for each geothermal field, based on the field's potential capacity in MW and the distance from the field to the interconnection point. The interconnecting generation tie-lines were assumed to be various voltages (according to potential capacity), which were chosen based on BVG's experience with transmission facilities of varying sizes. The per-mile cost of the tie-line was estimated based on the chosen voltage, and this was multiplied by tie-line distance to calculate total cost for the tie-line. These costs were then adjusted based on line length and terrain factors. The adjusted generation tie-line costs for the geothermal plants range from about $85/kW gross at Roosevelt to almost $620/kW gross at Neal Hot Springs.

Table 4-1. Interconnection Distances and Costs.

Field Name	Nearest Substation Voltage (kV)	Gen-tie Line Voltage (kV)	Distance to Sub-station (mi)	Gen-tie Line Cost ($M/mi)[a]	Site Substation Cost ($M)[a]	Total Cost ($M)[a,b]	Cost Per kW ($/kW)[a,c]
Lake City	69	69	9	$0.73	$5.2	$12	$395
Medicine Lake	500	230	33	$1.76	$10	$68	$141
Raft River	138	115	29	$0.59	$6.6	$24	$266
Neal Hot Springs	138	69	28	$0.47	$5.2	$19	$618
Cove Fort	138	115	3	$1.21	$6.6	$10	$98
Renaissance	345	69	2	$0.90	$5.2	$7	$229
Roosevelt HS	138	115	1	$1.16	$6.6	$8	$84
Thermo HS	138	115	17	$0.81	$6.6	$20	$170

Source: BVG Analysis for PacifiCorp.

Notes:

[a] These screening level cost estimates are based on available public information. More detailed estimates based on proprietary information and calculated on a consistent basis might yield different comparisons.

[b] Includes gen-tie line cost and site substation cost.

[c] Gross basis.

5.0 Ownership and Permitting Factors

BVG conducted an analysis of applicable ownership and environmental and land use permitting issues for each of the eight projects selected for in-depth review. This analysis was based on readily available public information, and, while not exhaustive, was appropriate for this screening level study. Our statements reflect a top level summary of currently known information. This section describes the methodology as well as the results of that analysis.

5.1 GIS Analysis

BVG performed an analysis of applicable environmental and land use permitting issues for each of the GRAs at a high level, consistent with the other publicly available GIS studies of the area with which we have been associated. We created a map of potentially environmentally sensitive or conflicting land use areas and overlaid the locations of the geothermal fields with these areas. We did this using GIS datasets that we assembled for the Western Renewable Energy Zones (WREZ) project. We then made determinations about whether or not environmentally sensitive or conflicting land use areas affected the commercial viability of geothermal fields located within them.

For this analysis, we used the publicly available GIS data on environmentally sensitive and conflicting land use areas that were gathered as part of the Western Renewable Energy Zones (WREZ) project. Black & Veatch was the primary contractor performing the GIS analysis for this project. We gathered and processed hundreds of environmental and land use layers that were identified as potentially conflicting with energy development by public stakeholders. These layers represent the most comprehensive GIS dataset on areas where a renewable energy project might face environmental and land use permitting issues in the western US. Most importantly, these areas have already been vetted and categorized by a diverse group of stakeholders through the WREZ project. This vetting consisted of a process in which stakeholders identified areas where energy development is prohibited by law or policy. Stakeholders also identified areas where development, while not prohibited by law, was determined to be inappropriate due to environmental sensitivity or other reasons. Once these areas were identified, the GIS data representing these areas was gathered by Black & Veatch.

All applicable environmental and land use layers were overlaid onto a map of the eight geothermal sites identified. Two levels of proximity were distinguished: 1) cases in which a site was within five miles of the boundary of an environmentally sensitive or conflicting land use area, and 2) cases in which a site was located inside the boundaries of an environmentally sensitive or conflicting land use area.

5.2 Anticipated Importance of Land Use Conflicts

Once BVG completed the GIS analysis, environmental permitting experts interpreted these results and their anticipated effects on the viability of geothermal project development in specific areas. This analysis is a high-level screen of potential environmental issues at each site, and does not represent legal judgments about the developability or feasibility of development at each site. Whether or not the environmental issues discussed here will have an effect on the commercial viability of each site is dependent on many other factors that are not considered in this study.

Table 5-1. Acronyms Used in this Section.

Agency/Initiative	Acronym
United States Forest Service	USFS
Bureau of Land Management	BLM
National Landscape Conservation System	NLCS
United States Geological Survey	USGS
National Parks Service	NPS
Western Renewable Energy Zones	WREZ
Utah Renewable Energy Zones	UREZ

5.2.1 Definitions of Environmental Areas Identified

Several types of areas are identified in the tables below. Some of these areas have legal standing and implications for development, while others do not.

USFS Proclaimed Forest Boundary

This is a historical definition, which does not necessarily mean more protection. The USFS website defines these areas as follows:[2]

[2] US Forest Service, Available: http://www.fs.fed.us/, date accessed: July 9, 2010.

> Proclaimed Forest Boundary - A feature class depicting the boundaries encompassing the National Forest System (NFS) lands within the original proclaimed National Forests, along with subsequent Executive Orders, Proclamations, Public Laws, Public Land Orders, Secretary of Agriculture Orders, and Secretary of Interior Orders creating modifications thereto, along with lands added to the NFS which have taken on the status of "reserved from the public domain" under the General Exchange Act. The following area types are included: National Forest, Experimental Area, Experimental Forest, Experimental Range, Land Utilization Project, National Grassland, Purchase Unit, and Special Management Area.

Citizen's Proposed Wilderness

This is a designation that is specifically used by The Wilderness Society, recently in the context of the RETI process. These areas are areas inventoried by various citizens groups, conservationists, and agencies due to the fact that they have "wilderness characteristics" and the ability to provide important habitat and ecosystem services. There is no legal standing apparent, however, the Wilderness Society states that "Development in Citizens' Proposed Wilderness areas would be ecologically irresponsible and would lead to high levels of conflict."[3] These are areas of concern that require additional investigation to determine if they may ultimately become a development barrier or if there will be a mitigation cost.

National Land Conservation System National Trails

These areas are defined by the Bureau of Land Management as follows:[4]

> The Bureau of Land Management is one of several agencies responsible for management of National Historic or Scenic Trails. In 1968, Congress established the National Trails System and designated the first national trails.
>
> National Historic Trails are extended trails that closely follow a historic trail or route of travel of national significance. Designation identifies and protects historic routes, historic remnants, and artifacts for public use and enjoyment. The Bureau of Land Management is responsible for over 5,343 miles of 11 National Historic Trails.
>
> National Scenic Trails are extended trails that provide maximum outdoor recreation potential and for the conservation and enjoyment of the various qualities – scenic, historical, natural, and cultural – of the areas they pass through. The Bureau of Land Management is responsible for over 668 miles of the Continental Divide, Pacific Crest, Potomac Heritage, Arizona, and Pacific Northwest National Scenic Trails.
>
> On March 30, 2009, the Omnibus Public Lands Management Act of March 30, 2009 (P.L.111-11) added three new trails and 40 miles to the NLCS. The new trails include the

[3] Alice Bond, the Wilderness Society, RE: Comments on the RETI Phase 2A Draft Report, July 10, 2009, Available: http://wilderness.org/files/Phase%202A%20Draft%20Report%20Comments%20TWS.pdf
[4] Bureau of Land Management, National Scenic and Historic Trails, Available: http://www.blm.gov/wo/st/en/prog/blm_special_areas/NLCS/Trails.html, Date accessed: July 9, 2010.

Arizona National Scenic Trail, Pacific Northwest National Scenic Trail, and the Washington Rochambeau Revolutionary Route National Historic Trail.

USFS Riparian Conservation Areas

This is a geographical definition, rather than a legal. However, if projects are located in or near these areas has been noted in this study.

5.2.2 Interpretation of Potential Land Use Conflicts

A list of the potential land use conflicts and notes on these potential conflicts are shown in tables below for each site.

Table 5-2. Lake City Environmental Areas.

Inside*	Nearby**	Notes
USFS boundary	NLCS National Trail (Applegate)	USFS is not as open to energy generation and transmission projects as BLM. Lake City is unincorporated, with private lands surrounded by USFS lands. Very close to the town; could be local support based on potential of economic development. Could also be concerns about geothermal-related odors and transmission lines. Alturas County is generally supportive of development.
USFS riparian conservation area	USFS Roadless Area	
NFS Proclaimed lands	Visual Resource Management Area	
Citizens' Proposed Wilderness	National Scenic Byways	

* The site is located within the identified boundary.

** The site is generally within 5 miles of the identified boundary. This column also notes when a site is qualitatively near a landscape feature.

Table 5-3. Medicine Lake Environmental Areas.

Inside*	Nearby**	Notes
USFS boundary	US Park Service National Monument	Difficult site to permit for geothermal development. Medicine Lake is a recreation area in Siskiyou County at the juncture of three national forests (Klamath, Shasta, and Modoc). The Medicine Lake area is also reported as an important site for regional tribes (Pitt, Modoc, Shasta, and others).
NFS Proclaimed lands	USFS Roadless Area	
	National Scenic Byways	
	Citizens proposed wilderness area	

* The site is located within the identified boundary.
** The site is generally within 5 miles of the identified boundary. This column also notes when a site is qualitatively near a landscape feature.

Table 5-4. Raft River Environmental Areas.

Inside*	Nearby**	Notes
	NLCS National Trail	No obstacles apparent from maps; Cassia County. The Raft River project was originally a federal geothermal plant (DOE). Area to the east has center pivot irrigation that is problematic for any additional transmission in that direction.
	City of Rocks Reserve	

* The site is located within the identified boundary.
** The site is generally within 5 miles of the identified boundary. This column also notes when a site is qualitatively near a landscape feature.

Table 5-5. Neal Hot Springs Environmental Areas.

Inside*	Nearby**	Notes
BLM lands	Visual Resource Management Area	Eastern Oregon lands sparsely populated; Malheur County BLM is generally more receptive to energy generation development that USFS. Local support likely for economic development.
	Bully Creek Reservoir	

* The site is located within the identified boundary.

** The site is generally within 5 miles of the identified boundary. This column also notes when a site is qualitatively near a landscape feature.

Table 5-6. Cove Fort - Sulphurdale Environmental Areas.

Inside*	Nearby**	Notes
USFS lands	Citizens' Proposed Wilderness	Fishlake National Forest is likely USFS jurisdiction. USFS is not as receptive to energy generation development as BLM. An existing geothermal plant operated within three miles of the proposed site until 2003 when it was decommissioned. This area might not be considered a greenfield.

* The site partially overlaps Fishlake National Forest.

** The site is generally within 5 miles of the identified boundary. This column also notes when a site is qualitatively near a landscape feature.

Table 5-7. Renaissance Environmental Areas.

Inside*	Nearby**	Notes
NLCS national trail	Citizens' Proposed Wilderness	Relatively developed area, small towns and agriculture. Compared to southern Utah, will be more difficult to permit.
Bear River and tributaries	USGS Wilderness and Wildlife areas	
	Roadless Areas	

* The site is located within the identified boundary.
** The site is generally within 5 miles of the identified boundary. This column also notes when a site is qualitatively near a landscape feature.

Table 5-8. Roosevelt Hot Springs Environmental Areas.

Inside*	Nearby**	Notes
WREZ wildlife "high sensitive" areas	Citizens' Proposed Wilderness	WREZ wildlife areas represent areas of some concern, requiring further study. They are areas that do not have legal standing but where there might be wildlife sensitivities. These areas were identified for the purpose of avoiding impacts from renewable energy development by environmental stakeholders in the WREZ process.
WREZ wildlife "avoid" areas	USGS wilderness and wildlife areas	
	Roadless areas	

* The site is located within the identified boundary.
** The site is generally within 5 miles of the identified boundary. This column also notes when a site is qualitatively near a landscape feature.

Table 5-9. Thermo Hot Springs Environmental Areas.

Inside*	Nearby**	Notes
WREZ wildlife "high sensitive" areas	WREZ wildlife "avoid" areas	WREZ wildlife areas represent areas of some concern, requiring further study. They are areas that do not have legal standing but where there might be wildlife sensitivities. These areas were identified for the purpose of avoiding impacts from renewable energy development by environmental stakeholders in the WREZ process. Compared to Roosevelt, Thermo might be easier to permit.

* The site is located within the identified boundary.
** The site is generally within 5 miles of the identified boundary. This column also notes when a site is qualitatively near a landscape feature.

5.3 Land Ownership Characteristics

Certain projects are being developed on government land and certain projects are being developed on private lands. This determination was made by BVG based on the environmental and land use conflict analysis. If a project is located within federal or state jurisdictions, it is noted that the project is being developed on government lands. GIS data from the WREZ process was the primary data source for this analysis, supplemented by web research, information from developers and data collected on the Bureau of Land Management website. If a project is not on either federal or state land, then it is assumed to be developed on private lands.

`

Table 5-10. GRAs and Land Ownership.

Field Name	Land Ownership
Lake City	Private and Federal (US Forest Service)
Medicine Lake	Federal (US Forest Service)
Raft River	Private and Federal
Neal Hot Springs	Private and Federal
Cove Fort	Private, Federal (US Forest Service) and State of Utah
Renaissance	Potentially Shoshone Tribal Lands, but unconfirmed
Roosevelt HS	Federal Geothermal Unit
Thermo HS	Private and Federal

Source: BVG analysis for PacifiCorp.

6.0 Water Availability

BVG views the availability of non-geothermal water as a feature that can enhance the viability of a geothermal resource but not as a "deal killer." "Non-geothermal" water is water obtained from sources other than the geothermal reservoir itself, e.g. water obtained from an ordinary well. The organic rankine cycle geothermal power plants that are dry-cooled with air suffer only a minor cost and performance penalty as compared to wet-cooled plants (i.e. plants cooled with non-geothermal water). In flash-steam geothermal power plants, an external source of non-geothermal water is not required at all, because they can use steam condensate for cooling purposes. Dry-cooled thermal power plants commonly suffer a cost penalty of 2 to 5 percent and a performance penalty of between 6 and 16 percent in comparison with wet-cooled power plants. BVG experience is that geothermal power plants fall within this range. Most sites within the western United States tend to have limited water availability. For those sites that have water available at favorable cost, this slightly improves project economics. Those without non-geothermal water require dry cooling and their economics suffer slightly. Thus, BVG did not conduct extensive reviews of water availability at all of the geothermal sites. We assumed dry-cooling unless the developer concerned advised us that non-geothermal water was available for cooling. The WREZ study assumed dry cooling for all projects unless water rights had already been acquired. For UREZ, all projects were assumed to utilize dry cooling or were flash-cycle plants.

Table 6-1. Water Requirements and Availability for GRAs.

Field Name	Planned Cooling Technology	Non-Geo Water Required	Water Available
Lake City	Dry cooling	No	No water required
Medicine Lake	Steam condensate	No	No non-geothermal water required
Raft River	Wet cooling	Yes	Yes
Neal Hot Springs	Dry cooling	No	No water required
Cove Fort	Wet cooling	Yes	Yes
Renaissance	Unknown	Unknown	Unknown
Roosevelt HS	Steam condensate	No	No non-geothermal water required
Thermo HS	Wet cooling	Yes	Yes

Source: BVG Analysis for PacifiCorp.

The table above provides summary information about each site; however, each site's situation with respect to water resources is unique. A description of each site's water resources situation is provided below:

- The Lake City site is expected to use dry cooling, so use of non-geothermal water is not necessary.
- The Medicine Lake site is expected to be developed using flash technology and the operator anticipates using steam condensate for cooling purposes.
- The Raft River site does have non-geothermal water available, and the operator plans to use it for wet cooling, as is already done at the existing plant.
- The Neal Hot Springs site is expected to use dry cooling, so use of non-geothermal water is not necessary
- The Cove Fort site has non-geothermal water available and the operator plans to use it for wet cooling.
- Water availability at the Crystal-Madsen site and the planned type of cooling technology are currently unknown.
- The existing plant at Roosevelt Hot Springs uses steam condensate for cooling, and the operator plans to take the same approach for subsequent plants.

- The existing binary plant at Thermo Hot Springs uses non-geothermal water for cooling, and the operator plans to take the same approach for subsequent plants.

7.0 Analysis of Project Economics

BVG estimated the capital and operating costs of each of the eight GRAs. Low and high estimates were developed for the capital costs of each project. The generation tie-line cost for each GRA was added to the low and high capital cost of each project. Then, BVG estimated the levelized cost of energy (LCOE) for each GRA on a net basis. LCOEs were estimated using a simplified cash flow model, which was developed for and publicly vetted in the RETI and WREZ studies. This analysis provides a high-level estimate of the cost of generation using a standard set of financial assumptions. Financial assumptions were received from PacifiCorp and represent the capital structure facing PacifiCorp were PacifiCorp to own these projects. It is important to note that these estimates are very sensitive to the financial assumptions used to develop them.

7.1 Levelized Cost of Energy Calculation

The cost of generation (including the generation tie line) was calculated as a levelized cost of generating power over the life of the resource. The levelized cost of energy (LCOE) was calculated on a $/MWh basis. The LCOE was calculated on a net basis, accounting for the parasitic load of the plant itself. This was done by increasing the capital cost per gross kW to reflect the fact that not all of each plant's capacity will be generating electricity that is sent to the grid. It is assumed that a binary plant consumes 20 percent and a flash plant uses 10 percent of a plant's capacity. As a result, net capital costs per kW are calculated by dividing each plant's gross capital cost per kW by 0.8 and 0.9, respectively.

LCOE values were calculated using a simple financial model that considers the project from the point of view of a developer, including the developer's direct costs, charges and incentives, as well as an expected rate of return on the equity. Specifically, it considered:

- Operations and maintenance costs
- Cost of equity investment in capital
- Cost of financing capital
- Taxes, including investment and production credits

Other costs, such as insurance, property taxes, development fees, interest during construction, and debt service reserve funds are included within these major categories. BVG strived to make the model as simple as possible while still maintaining an appropriate level of accuracy for comparing the relative generation cost of different projects. The simplifying assumptions allowed the model to serve its analytical purpose and still be streamlined enough to quickly evaluate multiple projects. Because of the simplifications, the model was not intended to simulate the exact financial performance of any one project. Use of the model in this way would be inappropriate.

Line items and calculations in the Cost of Generation Calculator are outlined below:

- **NPV for Equity Return**: A cost of equity is assumed as part of the financial assumptions. This number is treated as a hurdle which the project must reach. The project must generate sufficient income from power sales to obtain this return on equity. The Net Present Value (NPV) for Equity Return discounts all cash flows associated with the project by this prescribed return to generate a present value. If this metric is zero, the project is returning exactly the prescribed amount to equity investors. Higher values mean that the project generates too much money, and lower values mean that it does not generate enough.
- **Levelized Cost of Energy (LCOE)**: The actual cost of generation used in the model escalates over time. The levelized cost of energy is the constant cost (no escalation) that produces the same net present value as the actual modeled costs of generation over the life of the project. This single metric is the main output of the model.
- **Annual Generation**: The annual generation for the project is calculated based on an 8,760 hour year, the project capacity and the assumed capacity factor.
- **Cost of Generation**: The Year one cost of generation is chosen such that the NPV for Equity Return is zero. Costs of generation in later years are escalated by the assumed value.
- **Operations and Maintenance**: O & M is calculated from the assumed dollars per megawatt-hour, the annual generation and the assumed escalation value.
- **Debt Service**: Mortgage-style principal and interest payments are calculated for the proportion of the project that is assumed to be financed, the debt rate and the term of the financing.
- **Tax Depreciation**: Depreciation of project assets are calculated for tax purposes. These numbers are based on the Modified Accelerated Cost Recovery System (MACRS) depreciation schedules. Multiple depreciation schedules (5, 7, 15 or 20 years) can be applied to a single project.
- **Production Tax Credit (PTC)**: The production tax credit is modeled using three parameters: the dollars per megawatt-hour credit, the annual escalation of the credit, and the duration of PTC availability in years.

- **Investment Tax Credit (ITC)**: ITC eligible projects are credited the prescribed percent of their capital costs in year one.
- **Taxes**: Projects pay an all-in combined tax rate on their taxable income (operating revenue less operating expenses and depreciation) and are credited for applicable tax credits (PTC and ITC).
- **Total**: These are the cash flows associated with the project, including the equity investment portion of the overall capital costs (accounted for as a single value in year zero)

7.2 Financial Assumptions

Financial assumptions used in the cost of generation for this study were obtained directly from Jim Lacey at PacifiCorp. These financial assumptions represent the financing structure that would face PacifiCorp as a regulated entity if PacifiCorp were to own these projects. It is important to note that the results of the LCOE calculations are very sensitive to the financing assumptions that are used. A different financial structure, such as one representative of an independent power producer, would result in very different LCOE results. The financial assumptions used in the cost calculation for the GRAs in this study are shown below.

- Debt term (yrs) – 40
- Economic life (yrs) – 40
- Percent of capital costs depreciated under 5 yr MACRS - Geothermal plant costs, which are from 85 to 90 percent of total capital costs, dependent on site
- Percent 7 yr MACRS (%) – 0
- Percent 15 yr MACRS (%) – Gen-tie line costs for lines higher than 69 kV, which are from 0 to 3.5 percent of total capital costs, dependent on site
- Percent 20 yr MACRS (%) – Substation costs and gen-tie line costs for lines smaller than 69 kV, which are from 1 to 14 percent of total capital costs, dependent on site
- O&M ($/MWh) – 32.5 binary, 21 flash
- PTC value ($/MWh) – 22
- PTC term (yrs) – 10
- PTC escalation (%) – 1.9
- ITC percentage (%) – 0
- Capacity factor (%) – 80 for binary plants (all but Roosevelt), 90 for flash
- Discount rate (%) – 7.17, based on after tax WACC for regulated projects

- Debt percentage (%) – 47.43
- Debt rate (%) – 5.93
- Tax rate (%) – 37.95
- Cost of equity (%) – 10.32 (blended preferred and common)
- General escalation (inflation, %) - From 1.6 to 2 percent, dependent on year

The economic life is the useful life of the project from the developer's perspective. The forty year assumption is based on PacifiCorp's assumptions about geothermal plant life.

This financing structure is based on PacifiCorp's regulatory capital structure: 47.43 percent debt financed over 40 years at a rate of 5.93 percent, 52.27 percent common equity at a cost of 10.35 percent, and 0.3 percent preferred equity at a cost of 5.41 percent. This results in an after tax weighted average cost of capital of 7.17 percent.

7.3 Cost Analysis Results

The low and high capital costs, operating costs as well as the low and high LCOEs on a net basis were calculated for each of the GRAs. The results of this analysis are presented in the table below.

Table 7-1. Estimated Capital Costs, Operating Costs and LCOEs.

Field Name	Capital Cost (low, $/kW)[a]	Capital Cost (high, $/kW)[a]	Inter-connection Cost ($/kW)[b]	O&M ($/MWh)	LCOE (low, $/MWh)[c,d]	LCOE (high, $/MWh)[c,d]
Lake City	$4,645	$5,145	$395	$32.5	$83	$90
Medicine Lake	$5,391	$5,891	$141	$32.5	$91	$98
Raft River	$5,516	$6,016	$266	$32.5	$93	$100
Neal Hot Springs	$4,268	$4,768	$618	$32.5	$80	$87
Cove Fort	$3,748	$4,248	$98	$32.5	$68	$75
Renaissance	$5,479	$5,979	$229	$32.5	$93	$100
Roosevelt HS	$4,034	$4,534	$84	$21	$46	$51
Thermo HS	$5,420	$5,920	$170	$32.5	$91	$98

Source: BVG analysis for PacifiCorp.

Notes:

[a] Gross basis, includes gen-tie and site substation costs.

[b] Includes the cost of the site substation required for interconnection.

[c] Net basis.

[d] These screening level cost estimates are based on available public information. More detailed estimates based on proprietary information and calculated on a consistent basis might yield different comparisons.

8.0 Conclusions

Based on the analysis in this report, it appears that Roosevelt Hot Springs (RHS) in Utah is one of the most potentially attractive geothermal sites for PacifiCorp. PacifiCorp already owns and operates a geothermal plant at RHS (the Blundell plant) with a capacity of about 30 MW net. The resource is estimated to have the potential for additional capacity of about 80 MW net. While this much resource is estimated to be available, the resource should be developed in smaller increments to verify resource sustainability. The anticipated levelized cost of electricity (LCOE) from additional plant capacity at RHS is in the range of 4.6 to 5.1 cents per kWh net, which is the lowest LCOE range for the projects considered. PacifiCorp would be its own customer for output from additional plant capacity at RHS; no third-party PPA is needed or expected. No unusual environmental issues are anticipated at RHS, and the site is already tied into PacifiCorp's transmission network.

In the near term, the second most attractive geothermal area for PacifiCorp is at Cove Fort, Utah. This resource is currently under development by Enel, and it has an estimated potential of about 80 net MW. Enel is in PPA negotiations to sell 17 to 20 MW of this resource, leaving 60 to 63 net MW potentially available to PacifiCorp. The LCOE for Cove Fort is anticipated to be in the range of 6.8 to 7.5 cents per net kWh, which is the second lowest LCOE range among the eight resource sites reviewed. However, Enel is already at an advanced stage of negotiation with another utility on a PPA for Cove Fort, so the opportunity for PacifiCorp to obtain a PPA for power from this site may be limited.

Another geothermal site with relatively low LCOE value is US Geothermal's development at Neal Hot Springs in Oregon. However, power from US Geothermal's planned development at Neal Hot Springs is already committed to Idaho Power Company under a PPA for up to 25 MW. Similarly, additional capacity from Raser's project at Thermo Hot Springs, Utah, is already committed under a pre-paid PPA with the Southern California Public Power Authority for up to 110 MW.

Other geothermal potential available to PacifiCorp in the longer term could come from Lake City (Surprise Valley), California; Raft River, Idaho; Renaissance, Utah; and Medicine Lake, California. These projects have a combined capacity estimated at about 500 MW net, over 450 MW of which are not already reserved under PPAs or PPA negotiations and could potentially be available to PacifiCorp. However, the LCOE values for these sites are estimated to be higher than for RHS, so PPAs for power from these sites can be expected to have correspondingly higher power prices.

This analysis is a high-level screen of potential geothermal resources in the PacifiCorp service territory and does not represent a detailed analysis of site specific issues that may affect final development and costs. Whether or not the conclusions and indications of commercial viability are ultimately verified may be dependent on other factors that have not been considered in this study and may be discovered through additional due diligence.

9.0 References

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Appendix A. List of Potentially Available Geothermal Prospects in or near PacifiCorp Service Territory

State	Field name (HS = Hot Spring)	Alternate Name(s)	Location	Latitude	Longitude	Gross MW installed	Net MW installed	Anticipated plant type for additional capacity F = Flash B = Binary	Additional Resource Capacity Available (Gross MW)	Additional Resource Capacity Available (Net MW)	Developer(s)	Current "Maturity Index" for additional capacity 1 = Exploration 2 = Confirmation 3 = Development	Comments
CA	Haight Mountain		Northern California	41.5400	-121.8200	-	-	B	10	8		1	Between Medicine Lake and Mt Shasta. BLM acreage nominated for leasing in November 2009, but leases not yet issued as of July 2010.
CA	Honey Lake		NE California	40.3676	-120.2739	4	3	B	10	8	Amedee Geothermal Ventures;	1	
CA	Lake City		NE California	41.6725	-120.2460	-	-	B	40	32	Enel; Vulcan	3	See Appendix B
CA	Medicine Lake	Glass Mountain; Four-Mile Hill (project site in northwest); Telephone Flat (project site in southeast)	NE California	41.5800	-121.6000	-	-	B	480	384	Calpine	3	See Appendix B
CA	Mt Shasta		NE California	41.4102	-122.1876	-	-	F	50	45	formerly Vulcan	1	Vulcan has relinquished its former BLM leases.
CA	Surprise Valley East		NE California	41.6100	-120.0900	-	-		10	9		1	Nominated acrage, not yet leased
ID	Ashton Warm Springs		Eastern Idaho	44.0950	-111.4583	-	-	B	10	8		1	
ID	Banbury area		South Central Idaho	42.6880	-114.8256	-	-	B	15	12		1	
ID	Barron's HS		South Central Idaho	43.2917	-114.9067	-	-	B	10	8		1	
ID	Big Creek HS		Northern Idaho	45.3067	-114.3375	-	-	B	15	12	Ormat	1	
ID	Boiling Springs		West Central Idaho	44.3641	-115.8560	-	-	B	10	8	Ormat	1	
ID	Bonneville HS		West Central Idaho	44.1540	-115.3140	-	-	B	10	8		1	
ID	Cabarton HS		West Central Idaho	44.4167	-116.0283	-	-	B	10	8		1	
ID	China Cap		Eastern Idaho	42.8000	-111.6000	-	-	F	50	45	Idatherm	1	
ID	Crane Creek	Cove Creek	West Central Idaho	44.3064	-116.7447	-	-	B	50	40	Agua Caliente	1	
ID	Deer Creek HS		West Central Idaho	44.0917	-116.0500	-	-	B	10	8		1	
ID	East Basin Creek		West Central Idaho	44.2633	-114.8110	-	-	B	10	8		1	
ID	Idaho Bath		West Central Idaho	44.7211	-115.0144	-	-	B	10	8		1	
ID	Indian Creek HS		West Central Idaho	44.8129	-115.1229	-	-	B	10	8		1	
ID	Krigbaum HS		West Central Idaho	44.9658	-116.2031	-	-	B	10	8		1	
ID	Latty HS		South Central Idaho	43.1167	-115.3050	-	-	B	15	12		1	
ID	Magic Reservoir HS		South Central Idaho	43.3283	-114.3983	-	-	B	50	40	Ormat	1	
ID	Maple Grove HS		Eastern Idaho	42.3083	-111.7068	-	-	B	10	8		1	
ID	Molly's HS		West Central Idaho	44.6417	-115.6933	-	-	B	10	8		1	
ID	Murphy HS		South Central Idaho	42.0300	-115.3667	-	-	B	10	8		1	
ID	Neinmeyer HS		West Central Idaho	43.7550	-115.5708	-	-	B	10	8		1	
ID	Owl Creek HS		Northern Idaho	45.3439	-114.4631	-	-	B	10	8		1	
ID	Preston	Battle Creek HS; Wayland HS	Southeast Idaho	42.1331	-111.9276	-	-	B	10	8		1	
ID	Radio Towers area		South Central Idaho	43.0367	-115.4567	-	-	B	10	8		1	
ID	Raft River		South Central Idaho	42.1017	-113.3800	16	13	B	90	72	US Geothermal; Agua Caliente; Kodali Inc; S4 Consultants	3	See Appendix B
ID	Red River HS		Northern Idaho	45.7878	-115.1978	-	-	B	10	8		1	
ID	Rexburg		Eastern Idaho	43.8000	-111.8000	-	-	B	60	48		1	
ID	Riggins HS		Northern Idaho	45.4169	-116.1719	-	-	B	10	8		1	
ID	Roystone HS		West Central Idaho	43.9533	-116.3533	-	-	B	10	8		1	
ID	Sharkey HS		Northern Idaho	45.0133	-113.6050	-	-	B	10	8		1	
ID	Slate Creek HS		West Central Idaho	44.1710	-114.6240	-	-	B	10	8		1	
ID	Squaw HS		Eastern Idaho	42.1183	-111.9283	-	-	B	10	8	Idatherm	1	
ID	Sulphur Springs		Eastern Idaho	42.6200	-111.5000	-	-	B	25	20	Idatherm	1	
ID	Sunbeam HS		West Central Idaho	44.2678	-114.7478	-	-	B	10	8		1	
ID	Vulcan HS		West Central Idaho	44.5675	-115.6950	-	-	B	10	8		1	
ID	Warfield		South Central Idaho	43.6411	-114.4861	-	-	B	10	8		1	
ID	Weiser Area		West Central Idaho	44.2983	-117.0483	-	-	B	10	8	Standard Steam Trust	1	Standard Steam Trust has announced plans for temperature-gradient drilling at Weiser in 2010.
ID	White Arrow HS		South Central Idaho	43.0486	-114.9514	-	-	B	10	8		1	
ID	White Licks HS		West Central Idaho	44.6817	-116.2300	-	-	B	10	8		1	
ID	White Mountain	Blackfoot; Grays Lake	Eastern Idaho	43.0250	-111.5500	-	-	B	15	12	Eureka Green Energy	1	
ID	Willow Springs		Eastern Idaho	43.2500	-111.6000	-	-	F	100	90	Idatherm	1	
ID	Worswick HS		South Central Idaho	43.5636	-114.7986	-	-	B	10	8		1	

Appendix A. List of Potentially Available Geothermal Prospects in or near PacifiCorp Service Territory

State	Field name (HS = Hot Spring)	Alternate Name(s)	Location	Latitude	Longitude	Gross MW installed	Net MW installed	Anticipated plant type for additional capacity F = Flash B = Binary	Additional Resource Capacity Available (Gross MW)	Additional Resource Capacity Available (Net MW)	Developer(s)	Current "Maturity Index" for additional capacity 1 = Exploration 2 = Confirmation 3 = Development	Comments
NV	Fly Ranch		I-80 Corridor - West	40.8207	-119.3399	-	-	B	15	12		1	
NV	Gerlach		I-80 Corridor - West	40.6717	-119.3682	-	-	B	20	16	US Geothermal; Earth Power; Minera Cerro El Diablo Inc; Kodali	1	Four fields in Nevada are included in this list of potentially available prospects, because they are within 100 miles of PacifiCorp transmission lines, even though they are outside PacifiCorp's service territory.
NV	Jackrabbit		I-80 Corridor - West	40.2707	-119.8049	-	-	B	10	8	Jackrabbit Properties	1	
NV	Mineral HS		NE Nevada	41.8000	-114.7500	-	-	B	10	8	Caldera Geothermal / Geothermal Technical Partners	1	
OR	Alvord HS		SE Oregon	42.5440	-118.5330	-	-	B	10	8		1	
OR	Borax Lake		SE Oregon	42.3333	-118.6000	-	-	B	20	16	Raser	1	
OR	Crump's HS		S. Central Oregon	42.2259	-119.8810	-	-	B	40	32	Nevada Geothermal Power	1	Two shallow wells drilled in 1950s flowed intermittently ("geysered") but do not meet threshold of a discovery well. Developer (NGP) has sufficient contiguous acreage for viable project, but still considered in Exploration stage.
OR	Glass Buttes		S. Central Oregon	43.5600	-120.0400	-	-	B	20	16	Ormat	1	
OR	Klamath Falls		S. Central Oregon	42.2504	-121.7493	-	-	B	10	8	Raser; City of Klamath Falls	1	City of Klamath Falls has long-standing district heating system, but no identified "discovery well" suitable for electrical generation. Hence still considered exploration.
OR	Mickey HS		SE Oregon	42.3460	-118.3460	-	-	B	20	16		1	
OR	Mt Hood		Northern Oregon	45.3833	-121.7500	-	-	F	50	45		1	
OR	Mt Rose		SW Oregon	43.2359	-123.3220	-	-	F	50	45		1	
OR	Neal HS		E. Central Oregon	44.0233	-117.4604	-	-	B	30	24	US Geothermal	3	See Appendix B
OR	Newberry Caldera		Central Oregon	43.7257	-121.2671	-	-	F	200	180	Davenport Power (dba Newberry Geothermal Steam)	1	
OR	Summer Lake	Paisley	S. Central Oregon	42.6954	-120.7053	-	-	B	20	16	Vulcan; Surprise Valley Electrification Corp	1	
OR	Three Creeks Butte		Central Oregon	44.1507	-121.5770	-	-	B	20	16		1	
OR	Three Sisters		Central Oregon	44.1471	-121.8070	-	-	F	50	45		1	
OR	Trout Creek		SE Oregon	42.1882	-118.3776	-	-	B	10	8		1	
OR	Warm Springs		Central Oregon	44.6558	-121.9509	-	-	F	50	45	Susan Krohn Koe	1	
UT	Abraham HS	Baker HS; Crater HS	Southwestern Utah	39.6133	-112.7283	-	-	B	10	8		1	
UT	Cove Fort - Sulphurdale	Cove Fort	Southwestern Utah	38.6000	-112.5500	-	-	B	100	80	Enel, Oski	3	See Appendix B
UT	Drum-Whirlwind		Southwestern Utah	39.5909	-113.2058	-	-	B	50	40	Ormat, Raser	1	
UT	Hooper HS		North Central Utah	41.1330	-112.1818	-	-	B	10	8		1	
UT	Joseph HS		Southwestern Utah	38.6117	-112.1867	-	-	B	10	8		1	
UT	Meadow-Hatton		Southwestern Utah	38.9000	-112.5000	-	-	B	10	8		1	
UT	Monroe - Red Hill		Southwestern Utah	38.6480	-112.1041	-	-	B	10	8		1	
UT	Neels		Southwestern Utah	39.0372	-112.7770	-	-	B	25	20	Raser; Kodali	1	
UT	Newcastle		Southwestern Utah	37.6617	-113.5617	-	-	B	15	12	Renewable Energies LLC;	1	
UT	Ogden HS		North Central Utah	41.2444	-111.9090	-	-	B	10	8		1	
UT	Neels East Siding	Pavant Butte	Southwestern Utah	39.1363	-112.5290	-	-	B	20	16		1	
UT	Renaissance	Crystal-Madsen	North Central Utah	41.6590	-112.0900	-	-	B	30	24	Idatherm and Shoshone Tribe	2	See Appendix B
UT	Roosevelt HS		Southwestern Utah	38.5000	-112.8483	37	32	F	90	81	PacifiCorp	3	See Appendix B
UT	Thermo HS		Southwestern Utah	38.1833	-113.2033	12	8	B	118	94	Raser; Magma Energy (US) Corp; Energy Minerals, Inc;	3	See Appendix B
UT	Utah HS		North Central Utah	41.3409	-112.0411	-	-	B	10	8		1	
WA	Ohanapecosh HS		SW Washington	46.7373	-121.5613	-	-	B	10	8		1	
WA	Mount Adams		SW Washington	46.3444	-120.9940	-	-	F	10	9		1	
WA	Mount Rainier		SW Washington	46.8515	-121.7178	-	-	F	10	9		1	
					TOTALS:	**69**	**56**		**2,588**	**2,142**			

Appendix B: Sub-set of Geothermal Sites at Confirmation or Development Stages

State	Field name	Alternate Name(s)	Location	Latitude	Longitude	Gross MW installed	Net MW installed	Anticipated plant type for additional capacity F = Flash B = Binary	Additional Resource Capacity Available (Gross MW)	Additional Resource Capacity Available (Net MW)	Developer(s)	Reservoir temperature range (°F)	Typical depth of production / injection wells (feet)	Reservoir fluid chemistry B = benign C = challenging (If C, see comment)
CA	Lake City	Surprise Valley	NE California	41.6725	-120.2460	-	-	B	40	32	Enel; Vulcan	320 - 350	3,500-5,000	B
CA	Medicine Lake	Glass Mountain; Four-Mile Hill (project site in northwest); Telephone Flat (project site in southeast)	NE California	41.5800	-121.6000	-	-	B	480	384	Calpine	440-490	3,000-7,200	B
ID	Raft River		South Central Idaho	42.1017	-113.3800	16	13	B	90	72	US Geothermal; Agua Caliente; Kodali Inc.; S4 Consultants	275-300	4,500-6,000	B
OR	Neal Hot Springs		E. Central Oregon	44.0233	-117.4604	-	-	B	30	24	US Geothermal	280-320	2,300-2,900	B

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State	Field name	Alternate Name(s)	Location	Latitude	Longitude	Gross MW installed	Net MW installed	Anticipated plant type for additional capacity F = Flash B = Binary	Additional Resource Capacity Available (Gross MW)	Additional Resource Capacity Available (Net MW)	Developer(s)	Reservoir temperature range (°F)	Typical depth of production / injection wells (feet)	Reservoir fluid chemistry B = benign C = challenging (If C, see comment)
UT	Cove Fort - Sulphurdale	Cove Fort	Southwestern Utah	38.6000	-112.5500	-	-	B	100	80	Enel; Oski	315-350	1,800-5,000	B
UT	Renaissance	Crystal-Madsen	North Central Utah	41.6590	-112.0900	-	-	B	30	24	Idatherm and Shoshone Tribe	286-400	11,000	B
UT	Roosevelt Hot Springs		SW Utah	38.5000	-112.8483	37	32	F	90	81	Pacificorp	450-500	5,000-6,500	B

Appendix B: Sub-set of Geothermal Sites at Confirmation or Development Stages

State	Field name	Alternate Name(s)	Location	Latitude	Longitude	Gross MW installed	Net MW installed	Anticipated plant type for additional capacity F = Flash B = Binary	Additional Resource Capacity Available (Gross MW)	Additional Resource Capacity Available (Net MW)	Developer(s)	Reservoir temperature range (°F)	Typical depth of production / injection wells (feet)	Reservoir fluid chemistry B = benign C = challenging (If C, see comment)
UT	Thermo Hot Springs		SW Utah	38.1833	-113.2033	12	8	B	118	94	Raser; Magma Energy; Energy Minerals; Radion Energy	260-280	5000-6000	B

Appendix B: Sub-set of Geothermal Sites at Confirmation or Development Stages

State	Field name	Non-geothermal water available for cooling? [B&V input] (Y or N)	Active development under way? (e.g. exploration, financing, PPA negotiations, drilling for new MW)	BLM leases issued in 2009 or later? (Y = Yes)	Drilling rigs active 2008 or later? (Y = Yes)	Completion year for next increment of plant capacity	Current "Maturity Index" for additional capacity 1 = Exploration 2 = Confirmation 3 = Development	Within 100 miles of PacifiCorp transmission? (Y or N)	Distance to nearest sub-station (miles)	Degree of Site Control 1 = Poor 2 = Adequate 3 = Good	Developer experience 1 = no prev. project 2 = 1-2 projects 3 = 3 or more	Serious technical challenge? (Y or N) (If Yes, see comment)	Serious environmental or social constraints? (Y or N) (If Yes, see comment)
CA	Lake City	N	Y	N	Planned in late 2010 or early 2011	2013-2014	3	Y	9	3	3	N	N
CA	Medicine Lake	N	N	N	N	2017	3	Y	33	3	3	N	Y
ID	Raft River	Y	Y	N	Y	2013?	3	Y	29	2	3	N	N
OR	Neal Hot Springs	N	Y	N	Y	2012	3	Y	28	3	3	N	N

Appendix B: Sub-set of Geothermal Sites at Confirmation or Development Stages

State	Field name	Non-geothermal water available for cooling? [B&V input] (Y or N)	Active development under way? (e.g. exploration, financing, PPA negotiations, drilling for new MW)	BLM leases issued in 2009 or later? (Y = Yes)	Drilling rigs active 2008 or later? (Y = Yes)	Completion year for next increment of plant capacity	Current "Maturity Index" for additional capacity 1 = Exploration 2 = Confirmation 3 = Development	Within 100 miles of PacifiCorp transmission? (Y or N)	Distance to nearest sub-station (miles)	Degree of Site Control 1 = Poor 2 = Adequate 3 = Good	Developer experience 1 = no prev. project 2 = 1-2 projects 3 = 3 or more	Serious technical challenge? (Y or N) (If Yes, see comment)	Serious environmental or social constraints? (Y or N) (If Yes, see comment)
UT	Cove Fort - Sulphurdale	Y	Y	N	Y	2012	3	Y	3	3	3	N	N
UT	Renaissance	?	Y	N	N	2014?	2	Y	2	?	1	N	N
UT	Roosevelt Hot Springs	N	N	N	Y	2014	3	Y	1	3	3	N	N

Appendix B: Sub-set of Geothermal Sites at Confirmation or Development Stages

State	Field name	Non-geothermal water available for cooling? [B&V input] (Y or N)	Active development under way? (e.g. exploration, financing, PPA negotiations, drilling for new MW)	BLM leases issued in 2009 or later? (Y = Yes)	Drilling rigs active 2008 or later? (Y = Yes)	Completion year for next increment of plant capacity	Current "Maturity Index" for additional capacity 1 = Exploration 2 = Confirmation 3 = Development	Within 100 miles of PacifiCorp transmission? (Y or N)	Distance to nearest sub-station (miles)	Degree of Site Control 1 = Poor 2 = Adequate 3 = Good	Developer experience 1 = no prev. project 2 = 1-2 projects 3 = 3 or more	Serious technical challenge? (Y or N) (If Yes, see comment)	Serious environmental or social constraints? (Y or N) (If Yes, see comment)
UT	Thermo Hot Springs	N	Y	N	Y	2013?	3	Y	17	2	1	N	N

Appendix B: Sub-set of Geothermal Sites at Confirmation or Development Stages

State	Field name	Capital Cost Range ($ / kW) 5 = < $4000 4 = $4000 - $5000 3 = $5000 - $6000 2 = $6000 - $7000 1 = > $7000	Estimated operating cost ($ / MWh net)	Comments
CA	Lake City	4	30-35	Discovery well (Phipps 2) drilled by Magma Power in 1970s. Temperature gradient drilling by AMP in 2003-2005 yielded encouraging results. AMP sold project to Enel in 2005, and Enel has announced plans for a 17- to 20-MW project. Test results from Phipps 2 could be interpreted as meeting 25% threshold (5 MW), though well would need to be re-drilled. Hence, project can be considered in Development phase.
CA	Medicine Lake	3	30-35	Three productive wells (31-17, 68-6, and 87-13) drilled by Unocal in the 1980s. These wells are in the area that would supply Calpine's proposed 49.9-MW project at Telephone Flat. The combination of the three wells should be above the 25% threshold (12.5 MW), hence the project is considered in Development stage. However, there are ongoing challenges in meeting Native American concerns on Environmental Impact Statement. Extensive temperature-gradient drilling shows the overall potential at Medicine Lake is very large (on the order of 480 MW gross).
ID	Raft River	3	30-35	US Geothermal has operated Unit 1 (16 MW gross, 13 MW net) since Nov 2007, selling to Idaho Power. PPA with Eugene Water & Electric Board (EWEB) for Phase 2 (20 MW gross, 16 MW net) has been signed. PPAs for proposed Phase 3 (16 MW gross, 13 MW net) are still under negotiation. Once all 3 phases are committed, resource capacity of approximately 50 MW will have been reached for US Geothermal properties. Other expansion may be possible with offsetting developers (such as Agua Caliente). Total incremental capacity beyond existing US Geothermal Unit 1) is about 90 MW gross (72 MW net).
OR	Neal Hot Springs	5	30-35	Two successful production wells drilled, so threshold of 25% of announced 25-MW project has been met. Plant output of up to 25 MW is committed under PPA with Idaho Power Company.

Appendix B: Sub-set of Geothermal Sites at Confirmation or Development Stages

State	Field name	Capital Cost Range ($ / kW) 5 = < $4000 4 = $4000 - $5000 3 = $5000 - $6000 2 = $6000 - $7000 1 = > $7000	Estimated operating cost ($ / MWh net)	Comments
UT	Cove Fort - Sulphurdale	5	30-35	Previous plant with 11 MW capacity operated through 2003, then was retired as field field re-development got under way. Enel has been drilling in 2009 and 2010 and has announced plan for new plant in range of 17 to 20 MW. Results of new drilling have not been published, but capacity of wells that supplied the old plant are more than sufficient to meet 25% threshold of a 20-MW plant, so project is considered to be in development stage.
UT	Renaissance	3	30-35	Davis #1 well was drilled in 1974 about 4 miles south of Crystal-Madsen Hot Springs to a depth of 11,005 ft by UP&L and Geothermal Kinetics. The well reportedly encountered flow of 3,500 gpm of fluid with surface temperature of 286°F while drilling at depth of about 8,200 ft. Well was considered uneconomic at the time, but could be considered a "discovery well" based on current plant technology. Idatherm and Shoshone Tribe have announced plans to proceed with 100-MW development, with sales of power to Riverside, CA. Project is considered to be at "confirmation" stage (that is, after discovery well but not yet at 25% of planned capacity in terms of MW tested at the wellhead).
UT	Roosevelt Hot Springs	4	30-35	PacifiCorp drilled 2 successful wells in 2008 (one producer, one injector) as part of proposed expansion. A short-term flow test of the producer showed higher enthalpy than expected and flow conditions did not stabilize during the test. However, the producer seemed comparable to four other producers in the field, which have averaged almost 9 MW apiece since addition of bottoming cycle (35 MW gross plant capacity). So 25% threshold of a potential doubling of plant capacity is considered to have been met, and project is shown as still in development phase. Simulation study by GeothermEx in 2005 indicated that the field could support up to 79 MW of total plant capacity (44 MW above current output). Estimate of 90 MW incremental from WREZ study is based on heat-in-place considerations and would be dependent on drilling results.

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UT	Thermo Hot Springs	3	30-35	Existing Thermo 1 plant has been operating at below nominal 10-MW net capacity since start-up in 2009. Output from Thermo 1 is sold to City of Anaheim. Raser has a pre-paid PPA for 110 MW with the Southern California Public Power Authority (SCPPA) for projected output of later units, so power from further development is already committed, up to essentially the capacity of the resource. Therefore, although field is considered in development phase, power from Thermo is not expected to be available to PacifiCorp.