GLASS MOUNTAIN ENERGY CENTER
Hydrology Monitoring Plan

There are two geothermal development projects permitted in the Glass Mountain Known Geothermal Resource Area. The Telephone Flat Geothermal Project is located approximately 1.5 miles east of Medicine Lake, within the Medicine Lake Basin which is part of the Pit River Drainage Basin and within the district boundary of the Central Valley Regional Water Quality Control Board (CVRWQCB). The Fourmile Hill Project is located approximately 3 miles northwest of Medicine Lake, just outside of the Medicine Lake Basin, in the Klamath River drainage basin and within district boundary of the North Coast Regional Water Quality Control Board.

The intent of this Hydrology Monitoring Plan is to present a comprehensive monitoring plan that incorporates the findings of the Final Environmental Impact Statement/Environmental Impact Reports for the Telephone Flat and Fourmile Projects. This Joint Plan of Operations specifies the proposed program for monitoring ground water, surface water, and water quality in the Medicine Lake Basin and surrounding area. Each project will receive separate Waste Discharge Requirements from the respective California Regional Water Quality Control Boards. This monitoring plan will be modified to incorporate any additional requirements that may be specified in the individual projects Waste Discharge Requirements, or as appropriate to respond to any other applicable agency requirements or as data is collected on the basin's hydrology.

1.0 Introduction

The Telephone Flat Geothermal Project is a 48 MW flash geothermal power plant and Fourmile Hill is a 49.9 MW flash geothermal power plant, both with production wells, injection wells, a steam power plant, cooling tower and emission control system. Both projects are in the Glass Mountain Known Geothermal Resource Area ("Glass Mountain KGRA"), a federally designated geothermal lease area. Medicine Lake, the largest body of water within 10 miles of the project areas, is located at 1.5 miles west of the Telephone Flat Project and 3 miles southeast of the Fourmile Hill Project (Figure 1). The two geothermal projects are located on separate federal geothermal leases issued by the Bureau of Land Management ("BLM"). The leases for the Telephone Flat Project are within the Modoc National Forest and those for Fourmile Hill are within the Klamath and Modoc National Forests ("USFS").

The references used to develop the monitoring plant include:

- CalEnergy Plan of Operations: May 1997 and August 1996.
- Calpine Plan of Operations, 1997
- Fourmile Hill Geothermal Development Project Final Environmental Impact Statement, October, 1998.
- Telephone Flat Geothermal Development Project Final Environmental Impact Statement, January 1999.
- California Regional Water Quality Control Board, Central Valley Region, Waste Discharge Requirements for California Energy General Corporation, Board Order 95-199, August 1995
- California Regional Water Quality Control Board, Central Valley Region, Tentative Waste Discharge Requirements for Calpine Siskiyou Geothermal

Partners, L.P., and CPN Telephone flat, Inc., and USFS and BLM Exploration and Development Projects, February 2004

- California Regional Water Quality Control Board, North Coast Region, Waste Discharge Requirements for Calpine Corporation, Order No. R1-2002-0030, WDID no. 1A99019RSIS
- USGS Open File Report 95-750, Hydrologic Data and Description of a Hydrologic Monitoring Plan for Medicine Lake Volcano, California. 1995.
- USGS Open File Report 98-777, 3-Dimensional Visualization of the Medicine Lake Highlands, CA: Topography, Geology, Geophysics and Hydrology
- Mariner, R.H., and Lowenstern, J.B., 1999, The geochemistry of waters from springs, wells and snowpack on and adjacent to Medicine Lake volcano, northern California: Transactions Geothermal Resources Council, v. 23, p. 319-326.
- Weiss Associates, Baseline Hydrogeology Evaluation Report for Telephone Flat Geothermal Project, Medicine Lake, California, August 1997.
- Glass Mountain Unit Geothermal Exploration Project EA/IS, August 1995.

The Medicine Lake Highlands is a shield volcano on the Modoc Plateau east of Mt. Shasta Covering a 750 square mile area with approximately 140 cubic miles of superficial volcanic rocks. Medicine Lake Highlands stands above the general landscape and is generally perceived as a water source for streams, regional aquifers, springs and wells. This monitoring plan is designed to monitor the surface and groundwater near both the Telephone Flat Project and Fourmile Hill Project sites in potentially impacted areas identified by the Environmental Impact Statements ("EIS")/Environmental Impact Reports ("EIR") for each project.

The US Geological Survey ("USGS") developed a monitoring plan for the Medicine Lake area titled, Hydrologic Date and Description of a Hydrologic Monitoring Plan for Medicine Lake Volcano, CA, (Schneider and McFarland, USGS Open-File Report 95-750). The USGS suggested monitoring plan included measurements of water levels in wells, discharge rate from springs, and lake stage, as well as chemical analysis of well, spring, and lake water quality.

It is the Lessees intention to follow the general guidelines of a USGS regional groundwater hydrology monitoring program along with the input from the CVRWQCB. The monitoring plan will use a subset of the USGS suggested features that are within the collective air shed and ground water basins that reasonably might be impacted by combined developments. Additionally the Lessees intend to complete shallow groundwater monitoring wells close to the project sites to monitor groundwater chemistry for potential contamination from operations, spills, and air-born deposition. The number of shallow monitoring wells at each project will be specified in each project's Waste Discharge Requirements (3 proposed). Each project will also complete a deep groundwater monitoring well to monitor for influence between the geothermal reservoir and the regional groundwater system. This monitoring program is designed to monitor the geothermal project operations at the Telephone Flat and Fourmile Hill Projects and address the environmental concerns regarding hydrology. The primary emphasis of the hydrology monitoring program is to validate the conclusions of the environmental

analysis and to monitor not only each geothermal Project's impact on the surface and shallow groundwater system but the potential collective effect on the groundwater system of the Medicine Lake Highlands.

1.1 Medicine Lake Highlands Hydrogeologic System

Data presented in the EIR/EIS for both the Fourmile Hill and Telephone Flat projects indicate that, in its broader aspects, the groundwater hydrology of the Medicine Lake Highlands is controlled by the following:

1. Thick and highly permeable surficial deposits of lava flows, cinders and pumice which readily allow infiltration of precipitation (primarily as snow melt).
2. A saturated thickness (groundwater interval) that generally ranges from a few hundred feet to about 2000 feet.
3. An impermeable, high temperature gradient zone which underlies the groundwater saturated zone and forms a thick (1500 feet to several thousand feet) obstruction to flow between the groundwater aquifer and the geothermal system.
4. Radial outflow of groundwater away from the caldera rim of the Medicine Lake Highlands (i.e., down the regional hydrologic gradient).

On a smaller scale the movement of water in this volcanic setting is somewhat more complex and the result is a three-dimensional mosaic of aquifers, aquitards and other structures within a volcano that are overlain by soils and surface lava flows of highly variable permeability. These permeability variations affect both the surface and subsurface hydrogeology.

Within the Medicine Lake Basin, there are four lakes including Medicine, Little Medicine, Blanche and Bullseye, and six cold water springs including Schonchin, Crystal, Latunich, Payne and two un-named springs. The almost total absence of stream flow in the Medicine Lake Highlands results from the combination of relatively low precipitation (largely snow fall in the winter) and highly permeable volcanic soils and lava flows.

1.2 Regional Studies

The USGS has responsibility for regional groundwater supply studies. The Lessees will cooperate with and contribute to the USGS's baseline hydrologic data collections for the Modoc Plateau region by supplying existing and related geological, geochemical and meteorological data for the two Project areas. The USGS update to the 1995 Report, Open File Report 98-777, discusses the 3-Dimensional Visualization of the Medicine Lake Highlands (URL http://pubs.usgs.gov/of/1998/of98-777/).

The EIS/EIR documents for the approved Telephone Flat and Fourmile Hill Projects identified four ways that these projects could potentially impact surface and ground waters in the Medicine Lake Highlands.

2.0 Potential For Hydrologic and Water Quality Impacts

1) During the construction phase as a result of drilling of geothermal wells through shallow ground water formations, and from the production of ground water from the water well in the Arnica Sink area;
2) From plant operations resulting in cooling tower emissions, steam venting and during the processing of fluids at the power plant resulting in accidental fluids releases to the surface and shallow groundwater system;
3) During drilling, production of geothermal fluids from the subsurface as a consequence of well bore leakage into groundwater;
4) During the injection of fluids back into the geothermal reservoir resulting in well bore leakage to groundwater.

These potential impacts from each individual project and the potential for cumulative impacts were assessed in the referenced EIS/EIR documents for both Projects.

3.0 Monitoring Program

The monitoring plan envisions a combination of groundwater monitoring adjacent to each Project site and area wide baseline data collection/water quality monitoring which will occur twice annually, in the late spring and early fall, unless otherwise specified in the individual project Waste Discharge Requirements. Prior to startup, the Telephone Flat Project will complete a minimum of three shallow groundwater monitoring wells and the Fourmile Hill Project will complete up to three shallow groundwater monitoring wells (Figures 2 and 3). Also a deep groundwater monitoring well will be completed at each power plant site to monitor groundwater above the geothermal reservoir cap rock.

In addition to these project specific monitoring wells, several domestic water wells, natural springs and lakes within the Basin will also be monitored (Figure 1). After a baseline is established within the first three years the frequency of the monitoring program will be evaluated and adjusted as deemed appropriate. The surface springs, lakes and domestic wells that will be monitored were identified in USGS Open-File Report 95-750 and have been updated based on current availability and or existence in the fall of 2002 when some of the baseline sampling was done.

3.1 Hydrology Monitoring Wells

Prior to completion of construction, each project will complete shallow monitoring wells in each of the separate project areas. One of the shallow monitoring wells will be located in the power plant area which is the area with the greatest activity for handling geothermal fluids and other project related chemicals which could contaminate the groundwater. The shallow groundwater wells will be designed to monitor for possible shallow groundwater contamination in the project operations area. To achieve this goal the monitoring wells will be completed only into the upper part of the water table where the concentration of contaminants infiltrating with downward percolating groundwater would accumulate. The actual depths of each well will depend upon the site specific geology of each site and the number of water bearing formations encountered, if any,

during construction of the wells. The proposed locations of the shallow groundwater monitoring well for the Telephone Flat and Fourmile Hill Projects are shown on Figures 2 and 3, respectively.

The actual completion plan, perforation interval, and casing configuration of the shallow monitoring wells will be submitted to the BLM for approval and to the appropriate RWQCB office for review. Geological data from geotechnical bore holes drilled into the power plant area for purposes of defining the civil engineering criteria for the power plant facilities will be used to refine the casing configuration of the shallow monitoring well in the power plant area. Geological data from exploration wells will be used to refine the casing configuration for monitoring wells in the well field area.

Telephone Flat, which is located within the Medicine lake Basin, is in the Central Valley RWQCB district. At Telephone Flat it is proposed that three shallow wells be completed to at least 50 feet and no deeper than the equivalent of 50 feet deeper than the mean surface elevation of the surface of Medicine Lake which is believed to represent the regional water table in the Medicine Lake Basin (bottom elevation +/- 6620' average sea level). The Telephone Flat monitor wells will be spread through the development area on existing pads while the deep well will be centrally located on the power plant site. Well pad 87-13 was chosen for M-1 as it is the only existing well pad between the project and Paynes Springs. Well pad 31-17 was chosen for M-3 as it a proposed injection well location. Well pad 52-18, which will be constructed at the same time as the power plant location, is the location of M-2 so that it is near the power plant site. Fourmile Hill, which is outside the Medicine Lake Basin, is located in the North Coast RWQCB district. At Fourmile hill the depth to the water table ranges from about 600 to 800 feet and it is proposed that up to three shallow monitoring wells will be completed to penetrate approximately 30 feet below the water table. Each project will have one deep monitoring well which will have a casing configuration and perforation interval design that allows for sampling of the deeper water resources only.

The monitoring will include measurement of water levels in each of the monitoring wells and analysis of standard drinking water quality constituents and other constituents as specified by the RWQCB.

3.2 Meteorological Station and Snow Sample Baseline

A meteorological station in the Telephone Flat Project area at the US Forest Service gravel pit near well pad 87-13 collected two years of baseline data from November 20, 1993 to November 17, 1995. A meteorological station will be maintained during the development and operational phases of the project at a location approved the by the Siskiyou County Air Pollution Control District (SCAPCD) and will record precipitation, temperature, relative humidity, wind speed, wind direction, and net solar radiation. This information will be used to monitor climatic conditions that affect the hydrological water balance. A similar station ran in the Fourmile Hill Project area (at the 88-28 well site) from November 14, 1994 to November 17, 1995. A meteorological station will also be run for this project during its operational phase. Additionally, the lessee agreed to establish a meteorological and hydrogen sulfide monitoring station in the Forest Service Camp ground at Medicine Lake (it has been placed at the water tank above the campground), and the USFS will conduct periodic observations of the cooling tower

plume from Medicine Lake during the first year of Project operation. These observations will be anecdotal in nature and will not be statistically analyzed.

The California Water Resources Department also maintains a snow survey line in the Medicine Lake area at the west end of Medicine Lake and this data is made available on an annual basis. A snow core will be taken at each project location during development and prior to power plant operations to establish background levels of airborne contaminants in the annual snowpack. Snow core samples will be taken annually for the first three years of operations down wind (of the primary wind direction) of the cooling towers to monitor deposition rates of airborne contaminants (priority pollutant metals, particulates and pH). Snow cores were also taken by the USGS, 37 in April 1998 and 49 in April 1999 as part of their study of the geochemistry of the waters in northern California. The results are presented in the paper "The Geochemistry of Waters from Springs, Wells and Snowpack On and Adjacent to Medicine Lake Volcano, Northern California," Geothermal Resources Council Transactions, Volume 23, p. 319-326.

3.3 Geothermal Reservoir Monitoring

Pursuant to 43 CFR 3263.1., the Lessee will measure geothermal fluid production and injection in accordance with methods approved by the California State Office of the BLM. This information is proprietary and will be submitted monthly on a confidential basis to the BLM. In addition to production data, drilling and geologic records will be submitted. Well casing programs must be submitted to and approved by the BLM in order to assure safety and protect shallow water-bearing formations.

Certain chemistry and gas content analyses of the produced fluids and reservoir conditions are reported separately to the BLM and SCAPCD as part of on-going operations. These data are proprietary but the Lessee anticipates continuation of cooperation in providing access and data to the USGS for their regional hydrologic baseline data collection.

3.4 Hot Spot

The only known thermal surface feature in the Medicine Lake Highlands is the "Hot Spot." It occurs as two distinct gas vents on the northwest flank of Glass Mountain (T. 44 N., R. 4 E., Section 33ccd). The Lessee will record temperature and gas geochemistry at one of the vents. Observations will be made regarding the possible changes in the surrounding non-vegetated areas surrounding the Hot Spot. These data will be recorded semi-annually for the first three years of operations and annually thereafter, unless otherwise specified.

3.5 Lakes Within the Medicine Lake Basin

There are four lakes within the Medicine Lake Basin: Medicine, Little Medicine, Bullseye and Blanche (Figure 4). Medicine Lake is the largest, approximately 500 acres and 150 feet deep. Medicine Lake is the focus of this water quality monitoring program. Little Medicine, Blanche and Bullseye lakes are shallow and subject to significant natural

variations in temperature, elevation and possibly chemistry. It is proposed that "stage" measurements be taken only at Medicine Lake. However all the lakes will be monitored for chemistry. A staff gauge will be established at the public boat ramp on the east end of Medicine Lake and monitored twice annually. Water quality will be measured at Medicine, Little Medicine, Bullseye and Blanche lakes. The water quality of Medicine Lake will be sampled at its east end nearest the Telephone Flat project and at the west end nearest the Fourmile Hill Project. Water quality samples for these four lakes will be analyzed for nutrients, trace elements and major ion chemistry and ultra clean protocol sampling for Mercury twice annually for the first three years of Project development. A temperature profile of the sampling site will be taken to identify any stratification or thermalcline. The initial sampling will be timed to obtain samples during a stratified and unstratified condition. After three years of monitoring, the program will sample annually thereafter unless otherwise specified by the CVRWQCB, BLM or USFS.

Prior to power plant operations, baseline mud samples from the bottom of Medicine, Little Medicine, Bullseye, and Blanche lakes will be collected at designated monitoring sites. The mud samples will be split for chemical trace element and geological examination.

3.6 Springs In the Medicine Lake Area

Water chemistry and discharge rates from the selected springs will be monitored. In some instances the springs are on private land or must be accessed by private land. Thus, providing that the appropriate access is granted to the Lessee by the respective landowners, these springs will be sampled. The selected springs for groundwater monitoring are a subset of the springs identified by the USGS in 1992. These springs are shown in Figure 1 and are listed below:

o Payne Spring I	T 43N, R4E, Sec. 19bca
o Payne Spring II	T 43N, R4E, Sec. 19bdb
o Payne Spring III	T 43N, R4E, Sec 18cdcc
o South Schonchin Spring	T 43N, R4E, Sec. 03cdc (if this spring exists)
o Crystal Spring	T 43N, R4E, Sec. 15abd

During project operations, water chemistry samples and general discharge measurements on these springs will be made at least twice each year for the first three years of operations and annually thereafter, unless otherwise specified. Because Payne Springs is considered to be an outflow area of the Medicine Lake Basin shallow groundwater system, the following mitigation measure 4.3.1 will be followed from the Glass Mountain Geothermal Exploration Project (EA #CA027-EA95-06):

> *"In order to verify that no effects are occurring at Paynes Springs from implementation of wells at well pads 56-18 and 13-18, the lessee will collect water samples from the springs before drilling, during initial drilling, after drilling to 500 feet (the equivalent elevation to the springs), and after completion of these wells. If effects are identified after analysis of the samples, drilling at these wells will be halted until the hydrologic connection to the springs is better understood. BLM and USFS will compare the samples after they are analyzed."*

3.7 Shallow Wells In The Medicine Lake Basin

The following existing shallow groundwater wells will be monitored for water quality. In some instances the wells are on private land or must be accessed by private land. Thus, providing that the appropriate access is granted to the lessee by the respective landowners, these wells will be sampled. The selected groundwater wells for groundwater monitoring are a subset of the groundwater wells identified by the USGS in 1992. These groundwater wells are shown in Figure 1 and are listed below:

- Telephone Flat Supply Well — T 43N, R4E, Sec. 1dddd
- USFS Water Well — T 43N, R4E, Sec. 6ccbc
- USFS Campground Well — T 43N, R3E, Sec. 11dcd

These groundwater wells were identified by the USGS in 1992 as proposed sampling and monitoring locations for geothermal development in the Medicine Lake Basin. The USFS water well and the TF Supply water well are approximately 300 feet apart and produce from essentially the same groundwater zone. The monitoring program will monitor the consumption of water from the TF Supply well because this well will have the highest use.

The Telephone Flat Supply well and the USFS Campground wells have pumps and will be used to collect water quality samples. Water level will be measured twice each year for the first three years of the project to establish variations within the basin, and then once annually thereafter once a datum is established by the data. Groundwater temperature and specific conductance will be measured in the wells that are equipped with pumps when water levels are measured. Water samples will be collected for chemical analysis at the times the water levels are measured. Water level measurements will be taken during the early spring and late fall after prior to and after the heavy use period on the summer recreation season.

3.8 Sampling parameters at Monitoring Sites

The physical parameters and chemical constituents to be collected at monitoring sites were identified by the USGS in an appendix to Open File Report 95-750. The USGS recommended list of physical parameters and chemical constituents is enclosed in this monitoring plan as Appendix I. They have been added too as a result of input from the CVRWQCB including the update on ultraclean sampling protocol for mercury.

The analyses shall be made in accordance with the latest applicable EPA test methods or an alternate test procedure approved under the Code of Federal Regulations (40CFR 136) and be conducted by a laboratory certified by the CA State Department of Health Services. Some analysis that must be taken at the time of collection will be allowed by a Company representative or contractor with appropriate calibration and documentation.

Reporting

Monitoring well data will be reported quarterly by the beginning of the second month of the following quarter, to the BLM, USFS and RWQCB. Other raw data sets will not be included in the quarterly reports but will be available to responsible agencies upon request. A monitoring report will be prepared annually for the BLM, as well as the Central Valley and North Coast Regional Water Quality Control Boards. The annual report will summarize the results of the previous years', data collection and reporting. The report will be submitted in the first quarter of each year for the previous year's data collection. The report will be a public document.

In addition to the open file information provided in the annual Medicine Lake Basin Comprehensive Hydrology Monitoring Plan, both projects will be providing to the BLM the following proprietary reports:

- Well completion reports for each production and injection well
- Quarterly reports of production and injection rates
- Every two years the results of injection well casing mechanical integrity test

Each project is required under the Geothermal Resource Orders and RWQCB Waste Discharge Requirements to provide notice to the BLM and the RWQCB as soon as possible and to confirm in writing within two weeks after notification any of the following discharges:

- Discharge of drilling mud, additives, or geothermal fluids to surface drainage courses
- Discharge of noticeable petroleum products from storage tanks or the results of refueling operations or spills outside of containment basins
- Discharge of any toxic or hazardous materials outside of containment basins

The written information reporting discharges outside of approved containment areas shall include information explaining the reason for the discharge and shall indicate what steps were taken to correct the problem, and dates thereof, and what steps are being taken to prevent the problem from recurring.

The Lessee recognizes the importance the monitoring data and other proprietary geological data may have for the regional hydrological studies that are being conducted by the USGS. The Lessee proposes to continue cooperation with appropriate scientific agencies such as the USGS in the regional evaluation of the hydrology of the Medicine Lake Highlands. Copies of the annual report and raw data will be provided to the USGS under a separate Memorandum of Agreement between the Project Operators and the USGS. Based on a December 2005 conversation with USGS staff, this project, which was under the Volcano Hazards Program, has not been a priority in about 5 years and there is no new published information since the 1998 report.

Appendix 1

Physical Parameters and Chemical Constituents to be Collected at Monitoring Sites

A. Field parameters (measured with a multiparameter probe)
1) pH, alkalinity, temperature, specific conductance
2) Dissolved oxygen, when feasible (for instance, dissolved oxygen is not meaningful when samples are obtained from wells equipped with air-jet pumps)

B. Major chemistry (dissolved unless otherwise stated) and physical parameters (includes analytical methods)

1) Major ions:
   Ca, ICP/MS
   Mg, ICP/MS
   Na, ICP/MS
   K, ICP/MS
   HCO_3, titration, 1 mg/L
   Cl, ion chromatography, 1 mg/L
   $S0_4$, ion chromatography, 1 mg/L
   F, ion chromatography, 10 µg/L

2) Minor constituents:
   SiO_2, colorimetry, molybate blue, 0.1 mg/L
   Al, ICP/MS
   Fe, ICP/MS
   Mn, ICP/MS

3) Nutrients:
   Total P colorimetry, 10 µg/L
   Ortho P, colorimetry, 10 µg/L
   $NO_2 + NO_3$, ion chromatography (EPA 300.0)
   NH4, colorimetry, 0.01 mg/L

4) Dissolved Solids
   Residue on evaporation, 1 mg/L

5) Turbidity:
   nephelometry, 0.1 NTU

C. Trace elements (Total) ICP/MS unless specified otherwise:
a) As
b) Ag
c) B
d) Ba

e) Be
f) Cd
g) Total Cr
h) Cr VI ion chromatography EPA Method 218.6, if Total Cr is present
i) Cu
j) Hg, analysis by ultraclean protocol, CVAA-EPA Method 1631
k) Li
l) Mo
m) Ni
n) Pb
o) Sb
p) Se
q) Sr
r) Tl
s) Zn

D. Dissolved Gasses:
   a) CO_2, calibrated from alkalinity titration
   b) H_2S, calculated from total recoverable sulfide; total recoverable sulfide determined by iodometric titration with detection limit of 0.5 mg/L as S
   c) NH_3, calculated from ammonium ion concentration