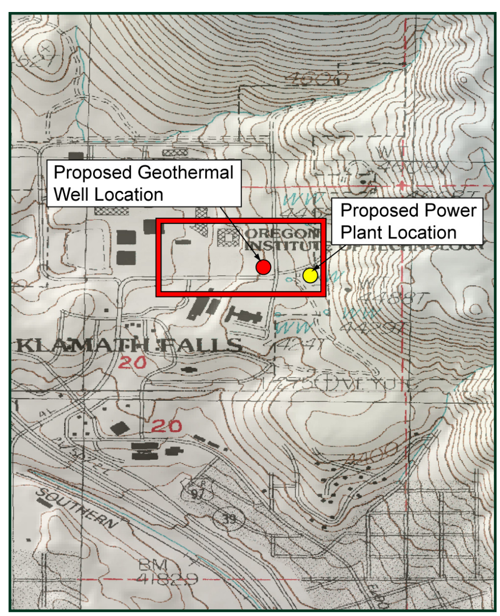
Oregon Institute of Technology (OIT) Deep Geothermal Well and Power Plant Project

Draft Environmental Assessment



August 2008

Prepared for:
U.S. Department of Energy
1617 Cole Boulevard
Golden, CO 80401

Prepared by:
MHA Environmental Consulting, An RMT Business
4 West Fourth Avenue, Suite 303
San Mateo, CA 94402
www.mha-inc.com - www.rmtinc.com

Geo-Heat Center
Oregon Institute of Technology (OIT)
Klamath Falls, OR 97601

Oregon Institute of Technology (OIT) Deep Geothermal Well and Power Plant Project

Draft Environmental Assessment

August 2008

Prepared for:
U.S. Department of Energy
1617 Cole Boulevard
Golden, CO 80401

Prepared by:
MHA Environmental Consulting, An RMT Business
4 West Fourth Avenue, Suite 303
San Mateo, CA 94402
www.mha-inc.com - www.rmtinc.com

Geo-Heat Center
Oregon Institute of Technology (OIT)
Klamath Falls, OR 97601

TABLE OF CONTENTS

List of Figures

List of Tables

1: INTRODUCTION

1.1 Project Overview

The US Department of Energy (DOE) is preparing an Environmental Assessment (EA) for the construction and operation of a deep geothermal well and small-scale, approximately 1.2 megawatt (MW), geothermal power plant. The well and plant would be located on the Oregon Institute of Technology's (OIT) Klamath Falls campus (Figure 1.1-1 and Figure 1.1-2) within the Klamath Falls Known Geothermal Resources Area (KGRA) (Figure 1.1-3). The project would be constructed entirely on previously disturbed lands.

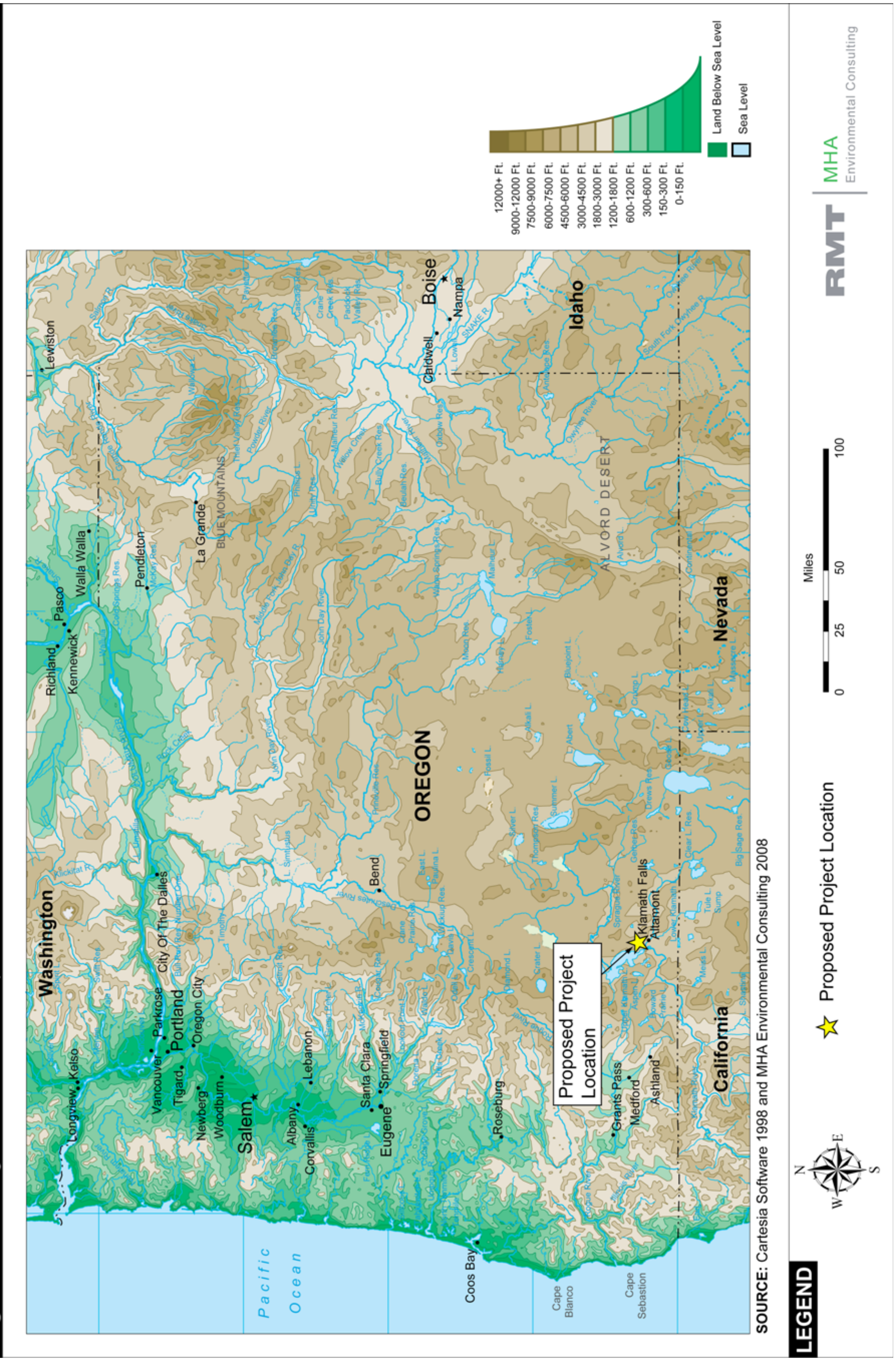
The proposed project includes the following elements:

- Installation of a 5,000 to 6,000 foot deep geothermal well to be drilled into a fault along the east side of campus that would encounter an estimated 300 degree Fahrenheit (°F) geothermal resource,
- Construction of a 1.2 megawatt (MW) power plant that would be of a binary (organic Rankine cycle) type, and
- Construction of a pipeline connecting the new well to the new power plant.

In response to a 2007 Congressional Directive, DOE would provide financial assistance for the drilling and testing of the proposed geothermal well. Granting of DOE financial assistance for this project would constitute a major federal action as defined by NEPA. DOE must consider the possible environmental impacts from the project before committing to provide funding. In accordance with the provisions of NEPA and CEQ and DOE implementing regulations, DOE has determined that an EA must be completed for the proposed project to evaluate the potential environmental impacts that could result from the award of the funding and any connected actions (i.e., the construction and operation of the geothermal power plant).

This EA has been prepared in accordance with the requirements of NEPA, which requires environmental review of the proposed action to aid the decision maker in review of the proposed project. The DOE Golden Field Office Manager will make the decision concerning this proposed project.

Figure 1.1-1: Regional Location Map

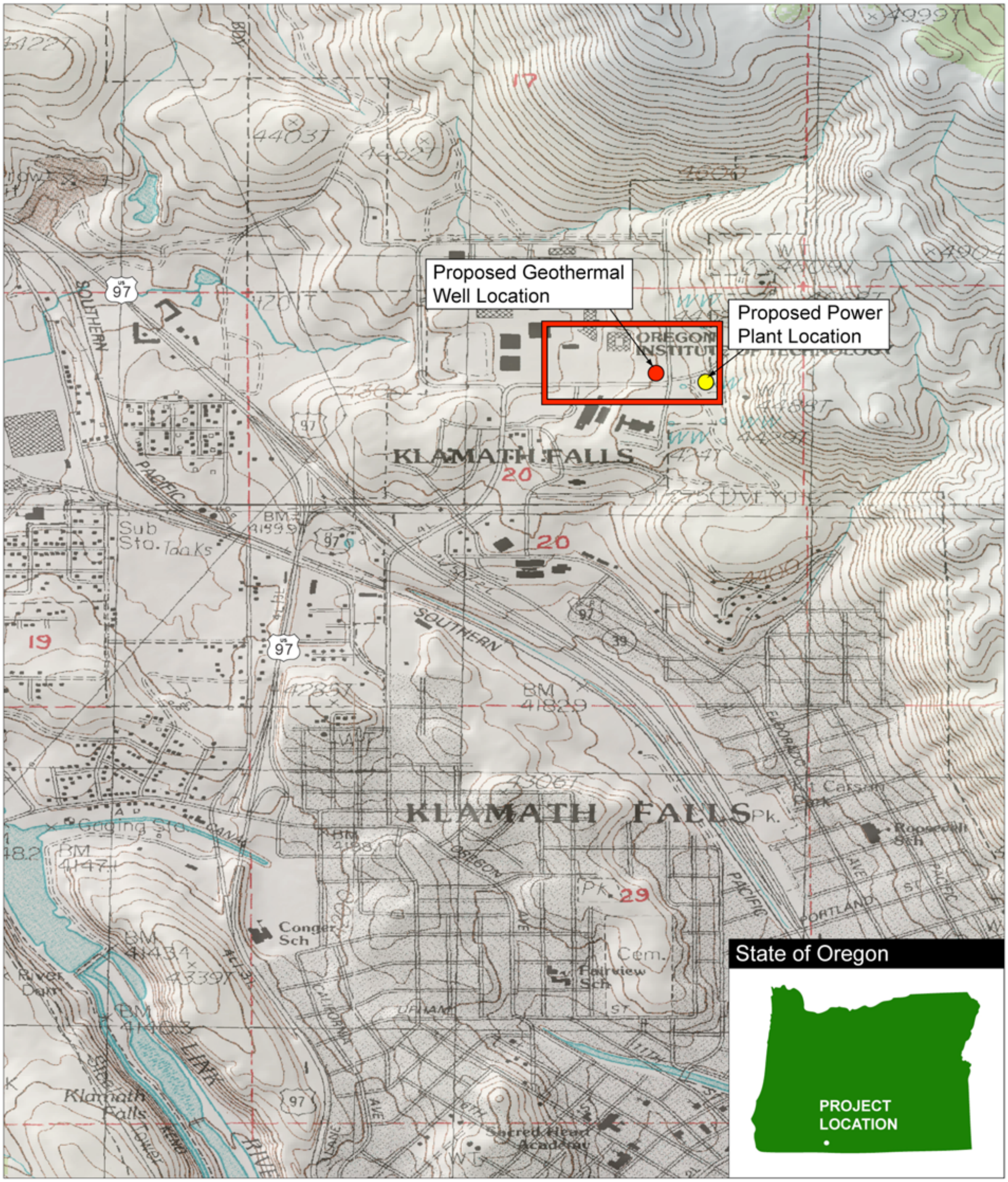


SOURCE: Cartesia Software 1998 and MHA Environmental Consulting 2008

LEGEND

Proposed Project Location

Figure 1.1-2: Topographic Map of the Project Area



SOURCE: USGS Eros Data Center 2005 and MHA Environmental Consulting 2008

LEGEND

- Project Area
- Proposed Geothermal Well Location
- Proposed Power Plant Site
- U.S. Highway

Mile
0 0.5 1

RMT | MHA Environmental Consulting

Figure 1.1-3: Klamath Falls KGRA

1.2 Purpose and Need

DOE's proposed action is to match $948,000 in financial assistance to OIT in support of the drilling and testing of the proposed geothermal well. The proposed action would support DOE's mission to reduce dependency on fossil fuels. By providing financial assistance to support this project, DOE would support national energy needs and the development of alternative fuel sources.

The project would provide approximately $500,000 in annual utility savings for OIT. Any excess generated electricity would be sold into the grid through a net metering system. This plant could be the first geothermal power plant in Oregon and would serve as a demonstration site and as an educational training facility.

Recent events in electricity and gas demands have suggested the need for alternative sources of power. Renewable energy sources, such as geothermal energy, already supply a significant amount of energy in western states, especially California. Oregon has passed a renewable portfolio standard (RPS) that will require the largest utilities in Oregon to provide 25 percent of their retail sales of electricity from clean, renewable sources of energy by 2025. The proposed project would serve as a model to utilities in Oregon and introduce clean, renewable energy into the grid. Development and construction would provide a training opportunity for professionals in the field of geothermal power plant engineering and business management.

The geothermal Steam Act of 1970 encouraged geothermal development as a means of diversifying energy supplies in the United States. In April 2008, President Bush announced a national goal to stop the growth of greenhouse gas (GHG) emissions by 2025. The proposed project would help Oregon and the United States reach their goals by eliminating OIT's need for non-renewable energy sources that produce GHG emissions.

1.3 Public Involvement

Comments on the scope of this EA were sought from the public, regulatory agencies, and other interested parties as part of the NEPA process. A letter describing the scope of the project was sent out to all parties on the project's distribution list on June 4, 2008 (Appendix A). Copies of the letters, distribution list, and responses are included in Appendix A to this EA. All comments have been considered during the preparation of this Pre-Decisional Draft EA.

A letter was sent by DOE to the Klamath Tribes (Klamath, Modoc, and Yahooskin) Tribal Representative to initiate a nation-to-nation consultation.

The US Fish and Wildlife Service (USFWS) and the Oregon State Historic Preservation Office (SHPO) have been contacted per requirements of Section 7 of the Endangered Species Act, and Section 106 of the National Historic Preservation Act.

1.4 Organization of this EA

This EA has been prepared pursuant to NEPA and DOE guidelines and:

- Describes the existing environment,
- Presents an analysis of the environmental consequences of the proposed project drilling and testing, and power plant construction and operation,
- Describes the effects of the no action alternative,
- Addresses any concerns expressed by interested parties.

The information presented in this environmental analysis was obtained from personal communications with interested parties, a site reconnaissance visit, background data and information on the project and similar projects, and environmental reports for similar projects in and around Klamath Falls.

2: PROPOSED ACTION AND ALTERNATIVES

2.1 Overview

This chapter describes the Proposed Action and the No Action Alternative. The Proposed Action consists of DOE's decision to provide funding for drilling, testing, and completing a geothermal production well. If the well proves to be successful, then OIT would construct and operate a small scale power plant utilizing the well. DOE may consider providing financial assistance for the power plant in the future, under a separate financial assistance agreement.

The No Action Alternative is described in Section 2.5.

2.2 Project Location

The proposed project would be located on OIT's Klamath Falls, Oregon, campus. Figure 1.1-1 and Figure 1.1-2 illustrate the project region.

The project components would be located in Section 20, Range 9 East, and Township 38 South, of the Willamette Base and Meridian. The proposed production well would be located in an existing campus parking lot, adjacent to Campus Drive, and southeast of an existing campus residence hall (Figure 2.2-1). The production well was sited using data collected during a seismic survey of the area. The well would be located near the most eastern entrance to the parking lot. The power plant would be located adjacent to the existing heat exchange building on the southeast corner of campus near existing geothermal production wells. A short pipeline would be built under an existing access road between the well and the power plant. The distance between the proposed geothermal production well and the power plant is approximately 500 feet.

The proposed well and power plant would be located entirely on campus-owned lands, and would be constructed on previously disturbed areas.

Figure 2.2-1: OIT Geothermal System

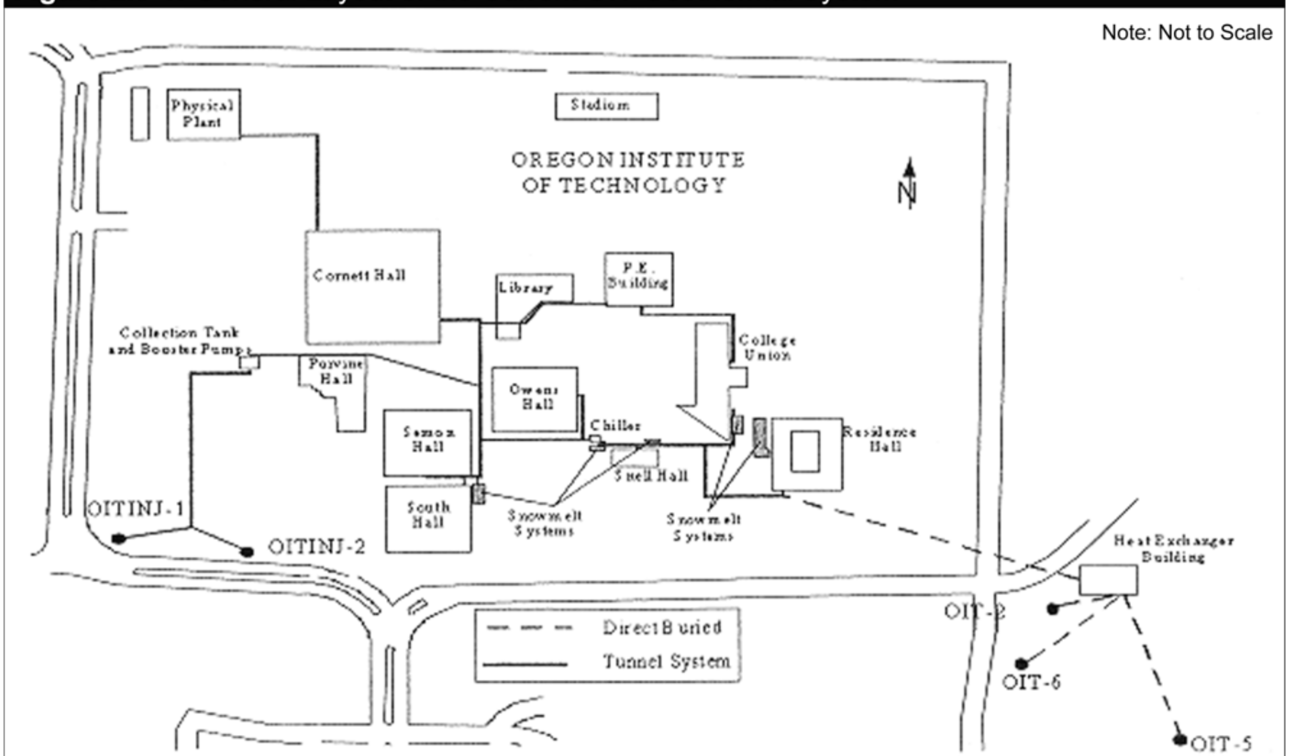
2.3 Existing Facilities

Historically, the geothermal resource in Klamath Falls was used by Native Americans and early settlers. Currently, more than 600 wells are used to directly heat homes, businesses, churches, and public and governmental facilities. The resource is used to heat swimming pools and sidewalks (for snow melting) as well as a greenhouse facility.

OIT is located on an east-to-west gently sloping hill in the northeastern part of Klamath Falls. The campus has been using geothermal water for its heating and domestic hot water needs since it was relocated to this location in 1963. The system has been in continuous operation for 45 years and currently heats 12 buildings (~764,000 ft^2).

The geothermal water for the campus is currently supplied from three existing wells located on the southeast corner of campus (see Figure 2.3-1). Geothermal water for the system is produced from these three wells at a temperature of 192 ^{0}F. The wells vary in depth from about 1,300 to 1,800 feet. The water is pumped individually from each well and the total maximum flow capacity from all wells is about 980 gallons per minute (gpm). The wells are not always pumped to their maximum capacity. Typical summer pumping is about 100 gpm and winter pumping is about 500 gpm. The water is then collected in a 4,000 gallon settling tank in the heat exchange building (see Figure 2.3-1 for the location of the heat exchange building) before it is delivered to each campus building via gravity flow through the distribution system. The heat is then distributed though plate heat exchangers in each building and finally collected at a central collection point before being piped to the injection wells (see Figure 2.3-1).

Figure 2.3-1: General Layout of the Current OIT Geothermal System



SOURCE: Boyd 1999

RMT | MHA Environmental Consulting

The City of Klamath Falls passed an ordinance in 1990 that banned surface disposal of geothermal water. OIT installed two injection wells at topographical low points on the southwestern side of campus to comply with this ordinance. All geothermal water is injected back into the geothermal reservoir via a pipeline from a central collection point after heating the buildings out to these injections wells. The maximum injection rate of one of the wells is 600 gpm while the other well is estimated to be able to handle as much as 2,500 gpm (William E. Nork, Inc. 1992).

2.4 Proposed Action

2.4.1 OVERVIEW OF THE PROPOSED ACTION

As discussed in chapter 1, DOE proposes to fund OIT's drilling and testing of a geothermal production well, and the potential construction and operation of a geothermal power plant, as described below.

OIT is proposing to install a small-scale, high-temperature geothermal power plant on the OIT campus, powered by fluid from the proposed geothermal production well. The power plant would be approximately 1.2 megawatts (MW) gross in generating capacity and would be a binary (organic Rankine cycle) type. This plant would use high-temperature geothermal water/steam (estimated to be around 300 ^{0}F) from the proposed deep geothermal well of up to 6,000 feet. The well would be drilled into a fault along the east side of campus (see Figure 2.4-1). Recent seismic survey results (Optim, Inc. 2008) indicated the best location for the well, and that it would intersect the fault at 3,000- to 4,000-foot depth.

The power plant would be located adjacent to the existing heat exchange building on the southeast corner of campus (as shown in Figure 2.2-1). Cooling water would be supplied to a cooling tower from nearby the Coldwater wells 1 and 2 (see Figure 2.2-1). The plant would be a stock system. The pad for the power plant and cooling tower would be 80 feet by 50 feet in size. A summary of project components, their function and location is provided in Table 2.4-1.

The plant would provide 100 percent of the electricity demand on campus saving approximately $500,000 annually (Ebsen personal communication 2008), with any excess electricity sold into the grid through a net metering system.

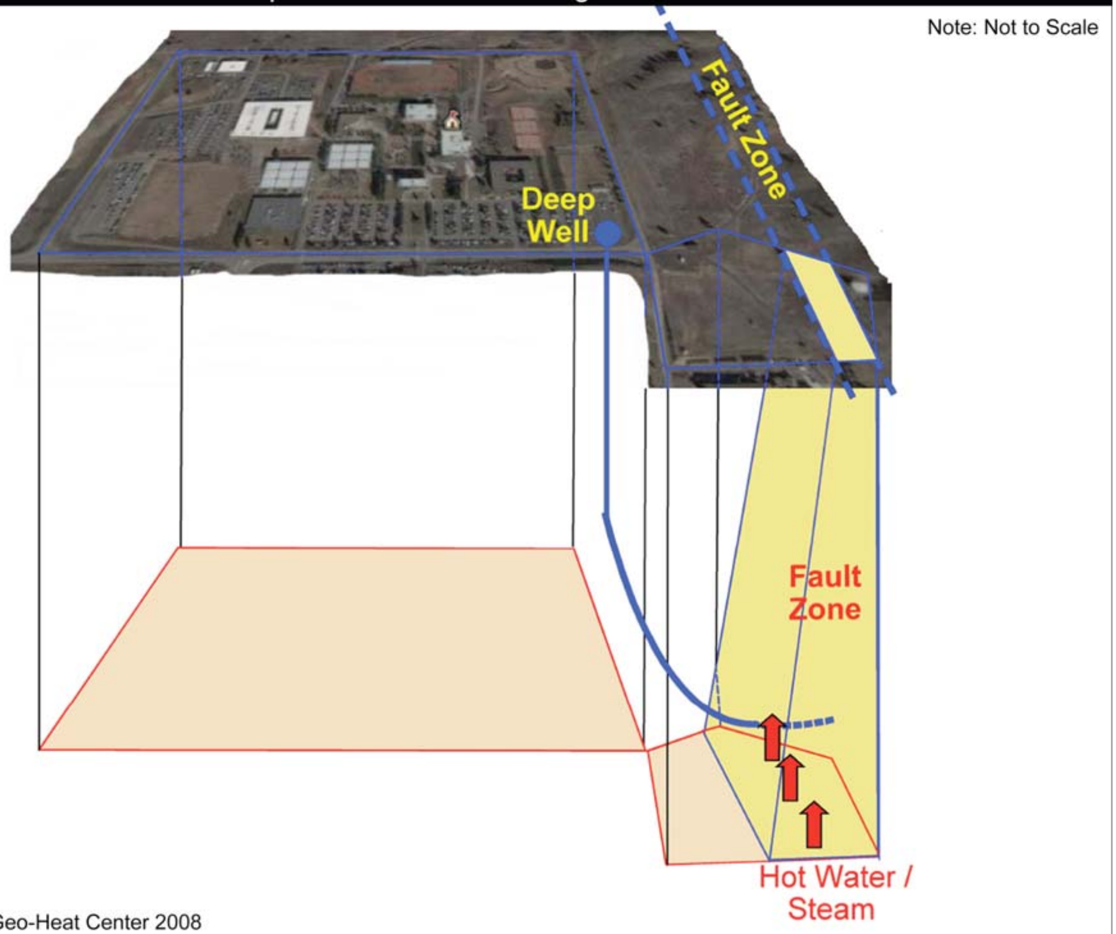
2.4.2 GEOTHERMAL WELL

Description

The production well is expected to produce up to 1,500 gpm at a temperature of about 300°F. The well would operate 24 hours per day and would be connected to the control system located at the power plant site in the heat exchange building. The well would be housed in a 10 foot by 20 foot structure. The structure would include the well head, pump motor, variable frequency drive, oil drip system to lubricate the bearings in the line-shaft pump, and a short length of pipe from the well head for mounting temperature gauges. The pipe would then be installed underground to where it would connect with the power plant.

The power requirement for pumping the geothermal fluid up from the well to the power plant is expected to be approximately 75 kW and would be metered through the existing power connection. The well would be powered through a connection to the existing power system in the Heat Exchange Building. The connection would be made via an underground cable installed in a new duct bank. The duct bank would be placed 36 inches underground and would extend from the proposed well location to the heat exchange building. The duct bank would be placed in the same 5 foot wide trench as the geothermal pipeline, but 1 foot deeper and 18 inches to the side of the

Figure 2.4-1: Fault Zone and Proposed Directional Drilling



SOURCE: OIT Geo-Heat Center 2008

RMT | MHA Environmental Consulting

Table 2.4-1: Summary of Project Components

Component Name	Size	Location	Function
Geothermal Production Well			
Geothermal Production Well	Approximately 4,000- to 6,000-feet deep, located on a pad of approximately 150 feet by 230 feet during drilling and later housed in a building 10 feet by 20 feet in size	In the existing parking lot adjacent to Campus Drive and Bryant Williams Drive	To produce geothermal fluid at a rate of approximately 1,500 gallons per minute (gpm) and approximately 300^{0}F in temperature to be supplied to the proposed power plant
Geothermal Power Plant			
Power Plant	Approximately 80 by 50 feet in size on an approximately 0.10 acre site (which also includes the cooling tower)	Adjacent to the eastside of the existing heat exchange building on campus	To generate 1.2 MW of gross power to supply the OIT campus with electricity
Geothermal Fluid Pipeline	The 10-inch diameter pipeline would be approximately 500 feet long, installed underground	Between the proposed production well and the proposed power plant	To transport the produced fluid from the well to the power plant

Table 2.4-1 *(Continued)*: Summary of Project Components			
Component Name	**Size**	**Location**	**Function**
Cooling Tower	On a skid approximately 20 by 30 feet in size. The tower would be 24 feet tall	Adjacent to the power plant	To cool the working fluid of the binary plant
Cooling Water Pipeline	The 2-inch pipeline would connect directly from the heat exchange building	From the heat exchange building to the proposed power plant site	To supply make-up water to the cooling tower at a rate of 30 gpm
Power Line Connection	A 1,700-foot long underground power line would be installed	Between the power plant and the existing mechanical building by Owens Hall	To connect the power generated from the plant to the OIT electrical system

geothermal pipeline. The power system in the heat exchange building is controlled by a frequency drive, which also controls the other campus wells. Electricity needed for the new well would therefore be on the same meter as the existing wells on campus.

Drilling

Overview

The deep geothermal well would be drilled in the parking lot along the east side of the campus, as shown in Figure 2.2-1, in order to tap the expected high temperature (around 300^{o}F) geothermal water that is estimated to be available upwelling along the fault system on the east side of campus (Figure 2.4-1).

The production well would be 20 inches in inside diameter at the surface and would taper to 9 $^{5}/_{8}$ inches at total depth. The well would have conductor casing, which is 30 inches in diameter. The conductor casing serves as a support during drilling operations, to flowback returns during drilling and cementing of the surface casing, and to prevent collapse of the loose soil near the surface. It can normally vary from sizes such as 18" to 30".

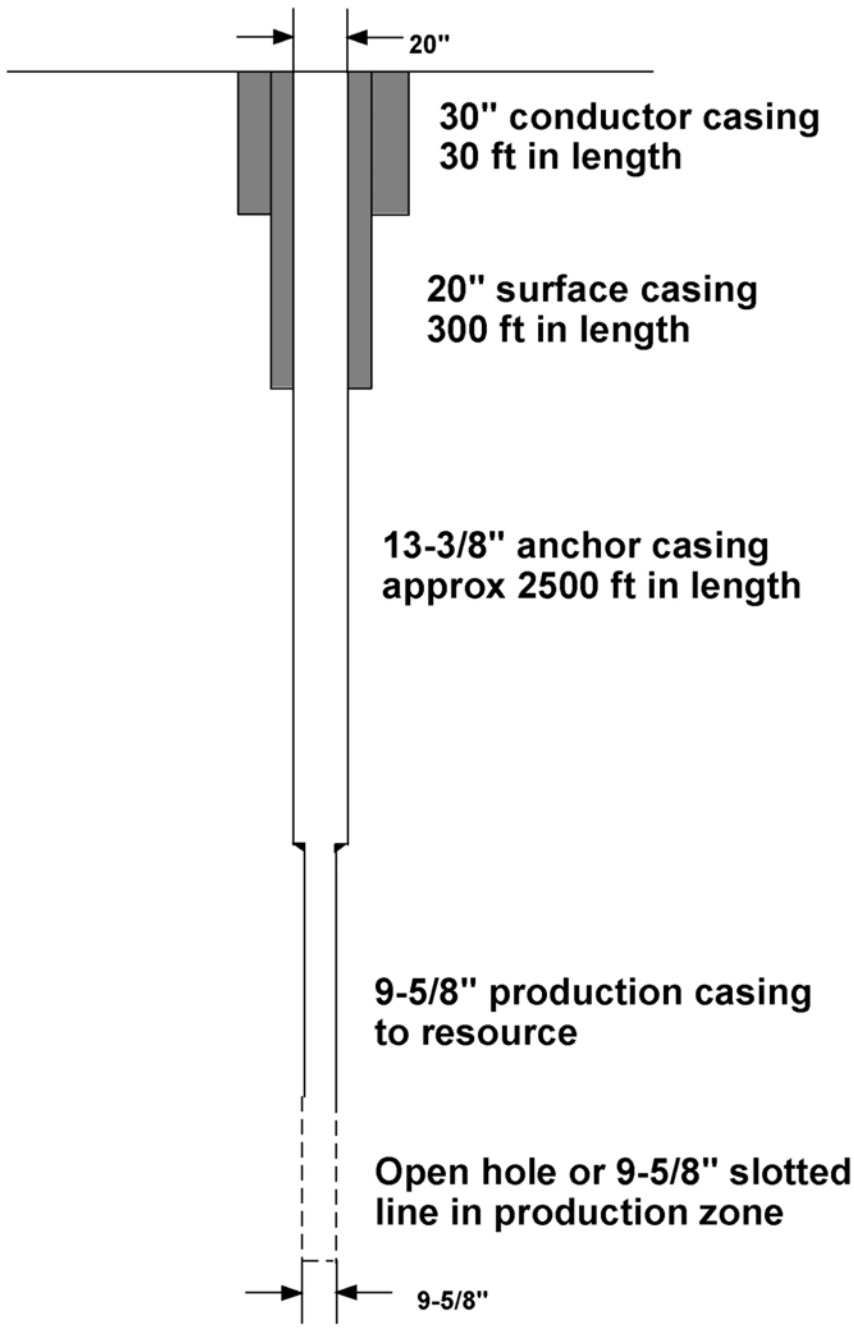
The well is expected to be about 3,000 to 4,000 feet deep and would not exceed 6,000 feet in depth. The well may need to be directionally drilled to intersect the fault system at a right angle. A profile of the well is shown in Figure 2.4-2.

Equipment and Drilling Process

Production well drilling would be conducted from a drill pad of approximately 230 by 150 feet in size on the existing paved parking lot, as shown in Figure 2.4-2. Set up of the pad would primarily be required for mobilizing the equipment and drill rig, and building a chain-link type security fencing around the drilling site. The layout of equipment needed for drilling of the well is included in Figure 2.4-3.

The production well would be drilled using a large rotary drill rig. During drilling, the top of the drill rig mask may be as tall as 135 feet above the ground surface. A sample rig is shown in Figure 2.4-4. The rig would be equipped with diesel engines, fuel, and drilling mud storage tanks, mud pumps, and other typical ancillary equipment. It is anticipated that the type of drill rig used would be a Super Single, which is a hydraulic top-drive rig (Capuano pers. comm. 2008). Metal mixing tanks would be used to mix water and drilling mud. An estimated 6 tanks will be needed to store a total of 126,900 gallons of mud. The well would be drilled using air and/or mud to circulate the drill hole cuttings to the surface. The well would be fitted with blowout prevention equipment (BOPE).

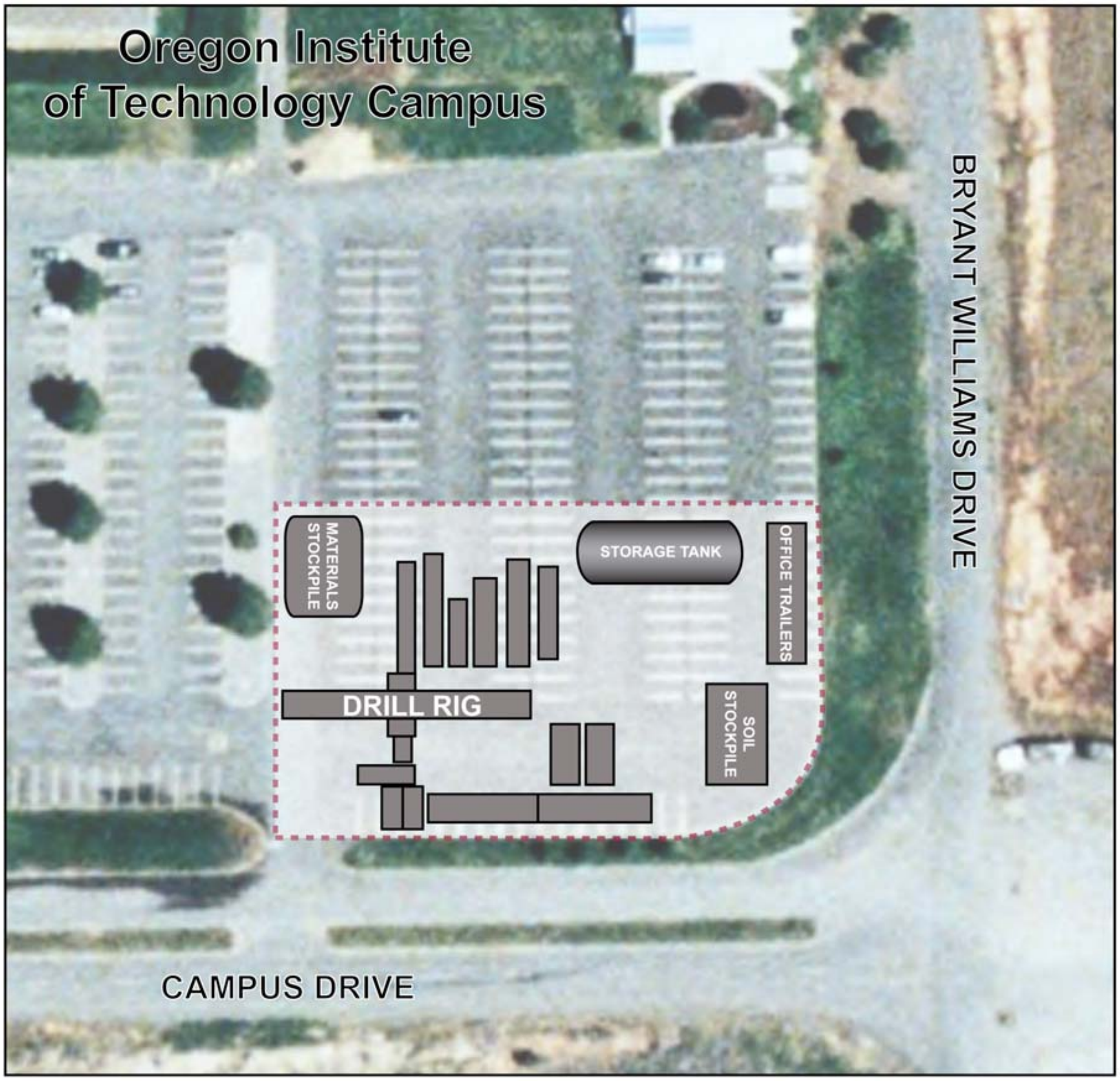
Figure 2.4-2: Well Profile



SOURCE: OIT Geo-Heat Center 2008

NOTE: Not to scale

Figure 2.4-3: Location of Well Pad on Parking Lot and Schematic Configuration of Equipment



SOURCE: Google Earth Pro 2008 and MHA | RMT 2008

LEGEND

N W E S

Proposed Geothermal Well Pad Location

FEET

0 100

RMT | MHA Environmental Consulting

Figure 2.4-4: Example Drilling Rig

Note: Not to Scale

SOURCE: Worldoil.com 2004

RMT | MHA Environmental Consulting

The well bore would be drilled using non-toxic, temperature-stable drilling mud composed of a bentonite clay-water or polymer-water mix for all wells. Variable concentrations of additives would be added to the drilling mud as needed to increase mud weight, prevent corrosion and prevent mud loss. Additional drilling mud would be mixed and added to the mud system as needed to maintain the required quantities.

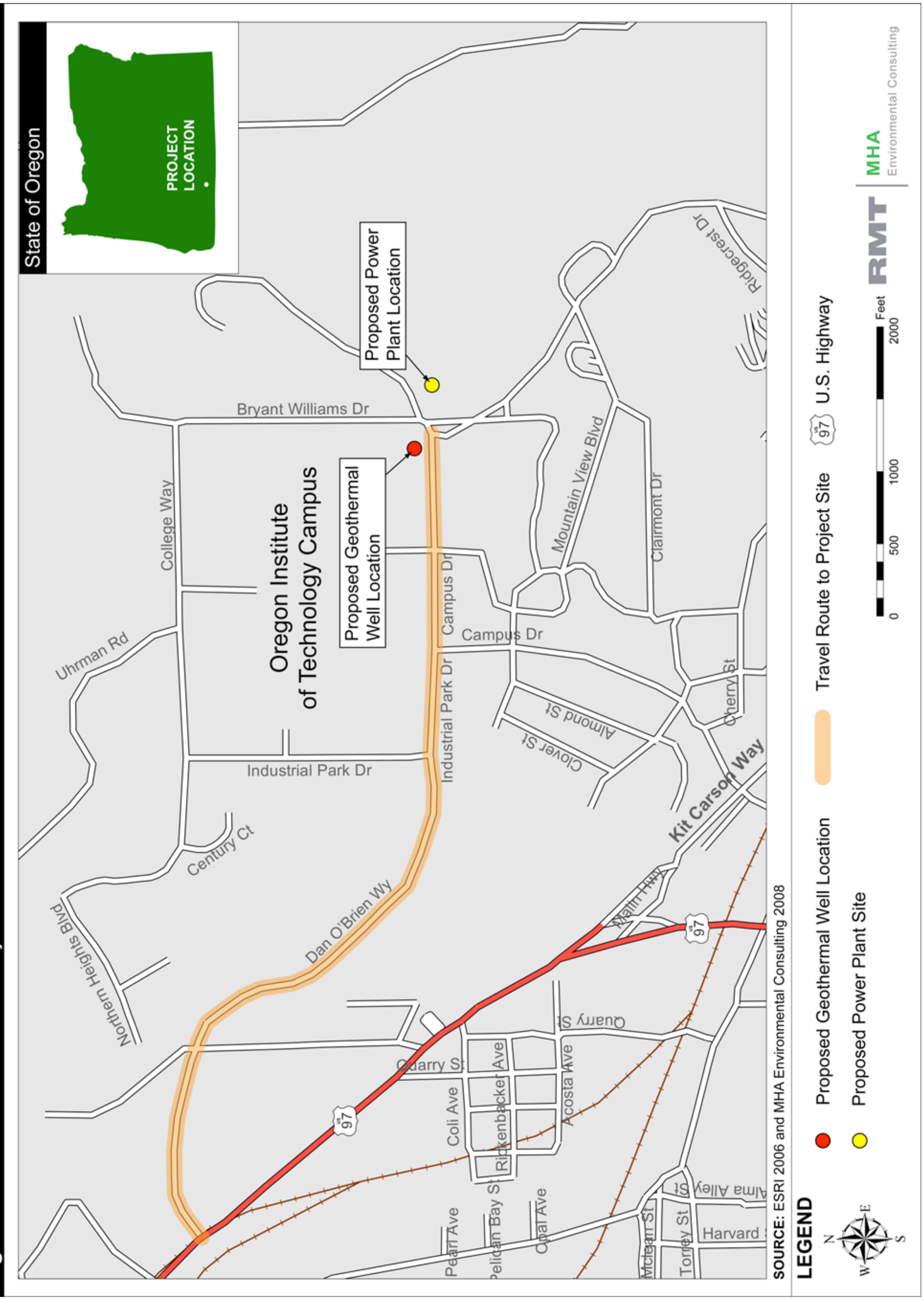
The production well may need to be worked over or redrilled if mechanical or other problems that prevent proper completion of the well in the targeted geothermal reservoir are encountered while drilling or setting casing. Depending on the circumstances, working over the well may consist of lifting the fluid in the well column with air or gas or stimulation of the formation using dilute acid Well redrilling may consist of reentering and redrilling the existing well bore, reentering the existing well bore and drilling and casing a new well bore, or moving the rig over a few feet and drilling and casing a new well bore.

The drill rig and all equipment and supplies would be brought to the project site on trucks. Transport to the project site would be via existing roads such as State Highway 97 to Dan O'Brian Way to Campus Drive, as shown in Figure 2.4-5.

Estimated truck traffic during the one month long drilling processes is as follows:

- 70 large trucks (48 to provide and remove the drill rig, 6 to bring in and remove the mud, 4 to bring in cement, 12 to bring in casing)
- 5 cars per day (150 total) for pickups and deliveries and to bring workers to and from the site

Figure 2.4-5: Travel Routes to Project Site



Well Testing and Logging

Short-term flow tests would be performed on the new well after its completion. The flow tests would last approximately 48-72 hours. A lineshaft turbine pump would be installed in the well bore for the well test. The test would consist of pumping the geothermal fluids from the well through on-site test equipment. The on-site test equipment would include standard flow metering, recording, and sampling apparatus. Well logging would the installation of pressure, temperature, and spinner production loggers during the well testing. Pressure, temperature, and spinner production logging equipment would be installed in the wells during the well testing. This equipment does not include any nuclear or radioactive devices (Baxter, personal communication 2008).

Geothermal fluids produced from the well would flow through various testing apparatus, including a weir box to measure the volume of fluid flow and accumulate in an above ground storage tank. The fluid would then be transferred by approximately 500 feet of temporary piping for injection in the existing 4,000-gallon settling/peaking tank inside the heat exchange building. All surface test equipment and temporary pipelines would be removed at the completion of testing.

Reserve Tank and Waste Disposal

A reserve tank would be located adjacent to the drilling site and would contain the drill cuttings, waste drilling mud, and storm water runoff from the drilling area. The solid contents remaining in the reserve tank would typically consist of non-hazardous, non-toxic drilling mud (bentonite additive and mud) and rock cuttings. Reserve tank waste would be sampled for hazardous contaminants before disposal at an appropriate landfill. The tank would be 5 feet deep by 20 feet wide by 80 feet long in size and would be located next to the testing storage tank on the well pad. The tank would have a 60,000 gallon capacity. Approximately 130,000 gallons of waste will be generated and the tank would be emptied about 3 times during the drilling process. A back-up tank would be set on the well pad site while the tank is being emptied. The two tanks would be rotated such that there would always be a tank on-site.

Water Sources

Water would be supplied from nearby cold water wells through a connection in the heat exchange building. Up to 20,000 gallons of water are needed per day for drilling. A 10,000 gallon water truck would remain on-site for storage of water and emergency use. The existing cold water wells supply a total average of about 200 gpm of water in September and October. The wells' combined capacity is about 550 gpm and would have sufficient flow to meet current demand as well as construction demand.

Stormwater Collection

The drilling pad would be constructed to direct stormwater to collect in the reserve tank (described above) in case of potential contamination. Drainage interception would be set up on the downhill slope. A drainage ditch will be trenched on the downhill side the width of the drill pad to collect any stormwater. The ditch would be at least 150 ft by 3 ft wide and 2 feet deep. This would hold approximately 6,800 gallons of water, which is enough to hold 0.3 inches of rain on the drill pad at one time. The annual rain fall in Klamath Falls is 12 inches, with the vast majority of that amount falling as snow in the winter. Drilling would likely be completed before the winter. In the event of contamination of the well pad, drainage would be collected at the drainage interception point and pumped using an electric portable pump to the reserve tank.

Well Completion

Well completion would include installation of a

- 30 inch conductor casing to 30 feet

- 20 inch surface casing placed to 300 feet depth
- 13-$^{3}/_{8}$ inch anchor casing placed to approximately 2,500 feet,
- 9$^{5}/_{8}$ inch production casing placed to the estimated production zone

A slotted liner may be installed in the production zone, or the zone may be unlined, depending on zone characteristics, which will be determined after flow testing. If the well is found to be sub commercial (e.g., not adequate for a 1.2 MW binary plant) the well would be used to augment the existing space heating system (direct use system). The project would be the same as proposed in terms of drilling and installation of pipeline; however, no power plant and transmission would be installed.

If the well is not viable for either power generation or the existing space heating system, the well would be abandoned in conformance with all requirements of the Oregon Department of Geology and Mineral Industries (DOGAMI). Abandonment typically involves plugging the well bore with cement sufficient to ensure that fluids do not move across into different aquifers.

Construction Crew and Schedule

Drilling would occur for 24 hours per day, 7 days per week, by a crew of about 4 workers. Drilling would take approximately 30 days to complete.

2.4.3 GEOTHERMAL POWER PLANT

Description

Power Plant

The proposed 1.2 MW gross binary power plant would use existing technology that has been used with geothermal fluids in many parts of the world. The power plant would be a standard stock supplied system. Figure 2.4-6 shows the layout of a binary Rankine cycle plant. Figure 2.4-7 shows the location of the power plant facilities by the heat exchange building. The “power block” occupies an area of approximately 50 feet by 80 feet. The power block includes the evaporator-condenser assembly, turbine-generator skid, feed pump, blowdown tank, water storage tank, a pentane storage tank, and the cooling tower. The controls would be located in the existing heat exchange building. The skid for the power plant would be 40 feet by 60 feet.

The geothermal power plant would be landscaped in accordance with the Oregon Institute of Technology Landscaping Master Plan (December 2007).

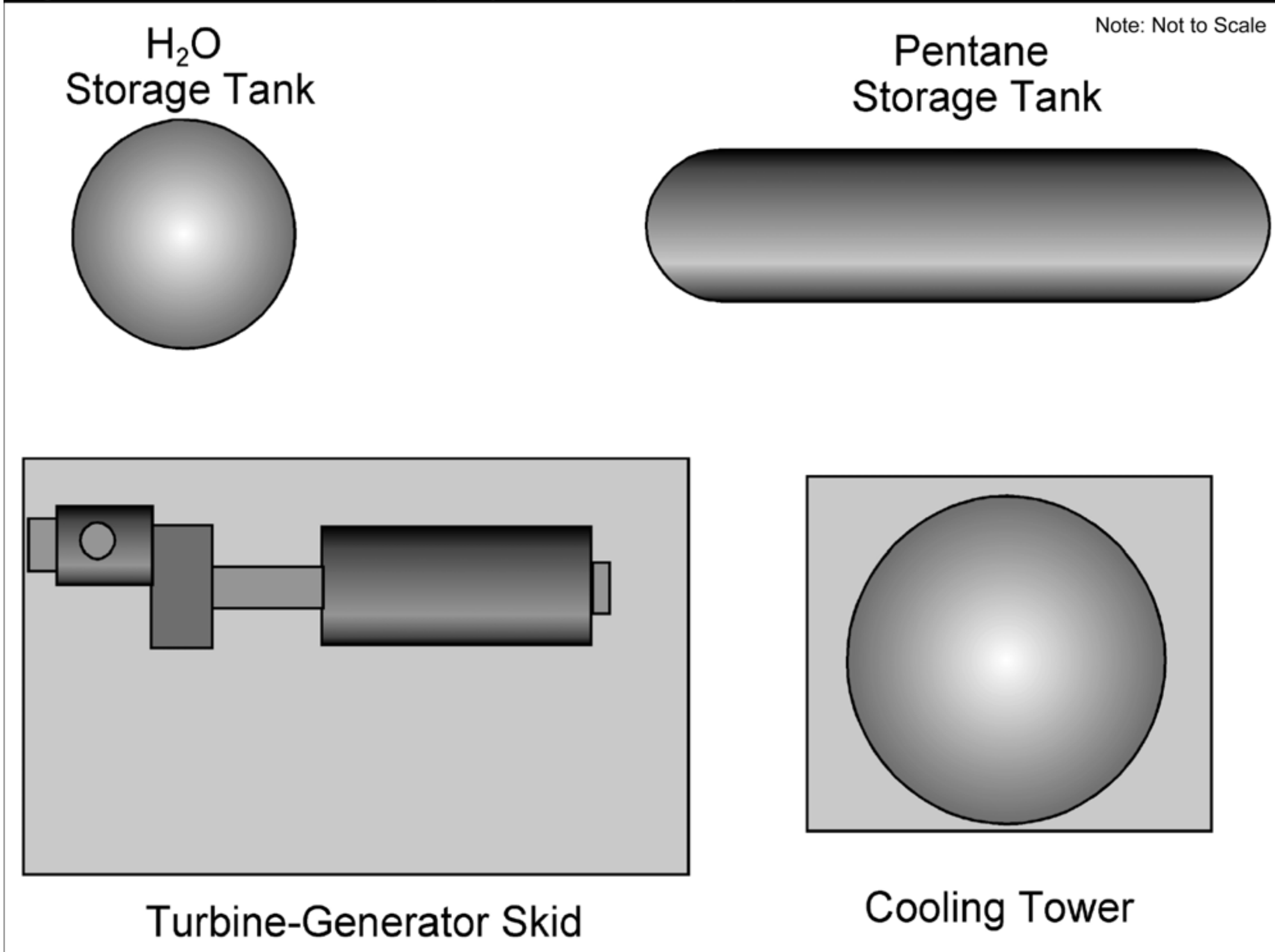
The power plant site would drain to the existing storm drainage system for the campus.

The plant would be located near the existing well field adjacent to the east side of the present heat exchange building.

For the binary, organic Rankine cycle power plant (with a resource around 300 ^{0}F), geothermal water would be pumped from the production well, passed through a heat exchange and then injected back in the ground in a closed system. A secondary working fluid (pentane) would pass through the other side of the heat exchange and be boiled by the heat from the geothermal fluid. The vapor (from a low boiling point hydrocarbon) would then pass through the turbine to turn the generator. The vapor would then be condensed and recycled in a closed loop back through the heat exchange to be vaporized again. Water cooling would be used to condense the working fluid.

A Rankine cycle plant is shown in Figure 2.4-8. The cooled geothermal fluid passing through a binary plant would also be hooked into the existing injection system and would either be used in the space heating system or placed straight into the injection system. No geothermal water mass is lost in the Rankine cycle.

Figure 2.4-6: Power Plant Facility Layout for Rankine Cycle Plant



SOURCE: OIT Geo-Heat Center 2008

RMT | MHA Environmental Consulting

A Rankine cycle plant would require hydrocarbon storage capacity. The hydrocarbon would be pentane and would be stored in a single tank that would have a volume of 2,000 gallons or fewer. The tank would be surrounded by a berm high enough to contain any spill, as specified in the SCCP.

Cooling Tower

The power plant would require one cooling tower, placed on a skid as shown in Figure 2.2-1. A cooling tower skid would occupy an area approximately 20 feet by 30 feet, located adjacent to the proposed power plant (Figure 2.4-7). The cooling tower would be 24 feet high and would be used to cool the secondary working fluid for recirculation through the power system.

The cooling tower would use evaporative cooling to cool water circulated through a condenser that would condense the vapor exiting the turbine. The cooling tower would use fresh well water as makeup. The flow rate for this system is 30 gpm into the cooling towers. The cooling tower water is recirculated through the condensing heat exchanger and only the 30 gpm lost through evaporation would be needed as makeup water (Lund personal communication 2008).

Figure 2.4-7: Location of Power Plant Facilities

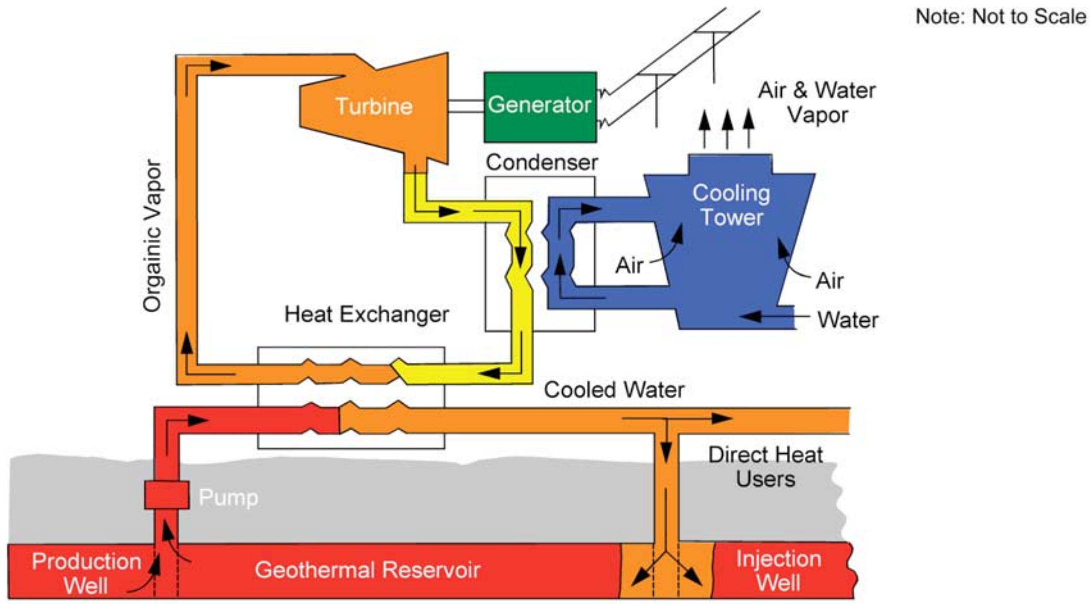
SOURCE: Google Earth Pro 2008 and MHA | RMT 2008

The cooling tower would use fresh well water as make up water to replace the water in the tower lost to vapor. The expected water loss from the cooling tower is estimated at 30 gpm. The cooling tower would not have emissions; however, water vapor may still billow above the tower. This vapor is generated by the cooling systems and represents the waste heat that could not be converted to useful work. The steam is invisible until it comes into contact with cool, saturated air, at which point it condenses and forms the white billowy clouds seen leaving the cooling tower.

Pipelines to the Power Plant

The project would require several different pipelines. A 500-foot pipeline that is 10 inches in diameter would connect the proposed production well to the proposed power plant site. This pipeline would be sited to avoid conflicting with existing utilities/pipelines/cables, etc. A second

Figure 2.4-8: Schematic Drawing of Binary Geothermal Power Plant Power Generation



SOURCE: OIT Geo-Heat Center 2008

RMT | MHA Environmental Consulting

pipeline would connect the cooling tower to the cold water connection in the heat exchange building. This connection is a 2-inch pipeline that comes in at the northwest corner of the heat exchange building. A short pipe would also connect the power plant to the existing space heating piping system in the heat exchange building.

Power Line Connection

The power plant would be connected to the existing mechanical building by Owens Hall with a buried power line. The power plant would be supplying power to the mechanical building (see schematic diagram in Figure 2.4-9. The power line would be 1,700 feet long (see Figure 2.2-1). The power line connection would be made through an interconnection and/or net metering agreement with the local utility (Pacific Power).

Construction

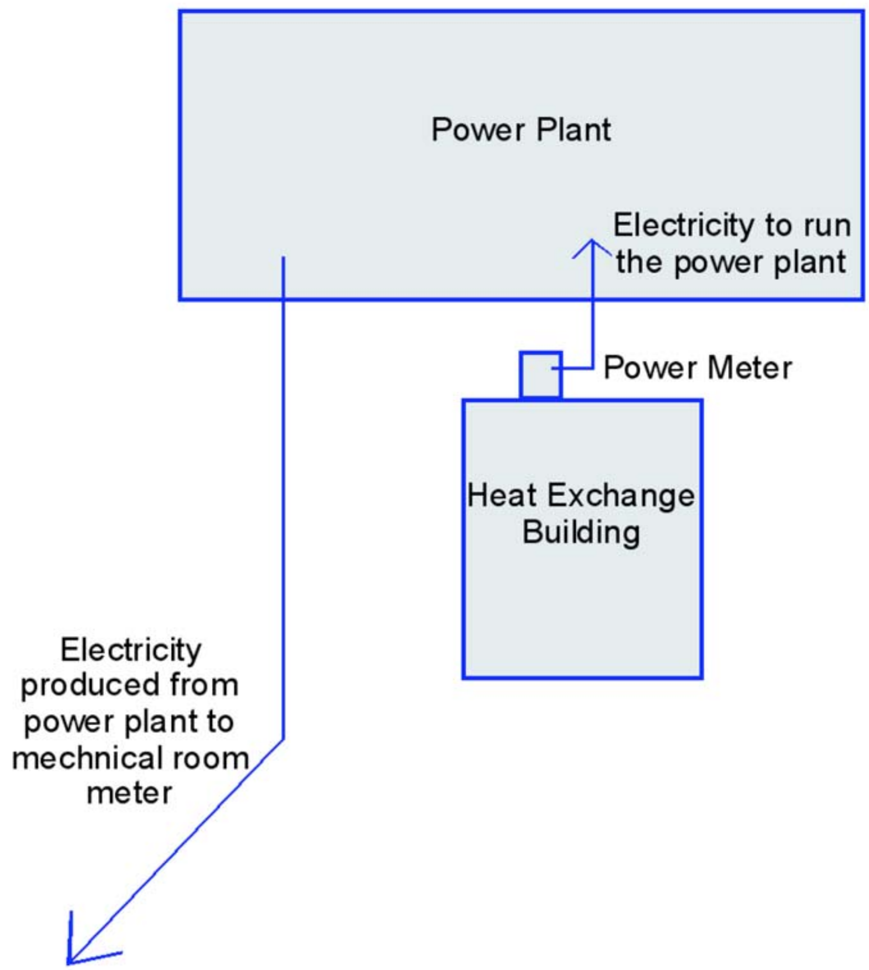
Power Plant and Cooling Tower

The proposed power plant and cooling tower would be constructed within a 0.10 acre area approximately 80 by 50 feet, as shown in Figure 2.4-7.

The plant and cooling tower would be built to the east of the existing heat exchange building. The plant would be covered by a roof, while the cooling tower would remain uncovered. The plant would be purchased from a stock provider and shipped to the project site in components that would be assembled on-site.

Grading for the plant site would proceed after plant layout has been established. Prior to grading of the site, clearing and grubbing would take place. The disposal of the brush and slash would be in

Figure 2.4-9: Power Flow Schematic



SOURCE: OIT Geo-Heat Center 2008

accordance with local requirements. Topsoil would be stockpiled to aid in revegetation of any temporarily disturbed areas (e.g. staging areas). The plant would be built to balance cuts and fills. Excess excavated material not required as fill will be disposed of or stockpiled at the discretion of OIT.

The power plant and any associated cover structure would be installed on native soil. Compaction of the soils would be in accordance with the recommendations in the geotechnical report. Gravel surfacing would be placed after final grading of the site.

All disturbed lands not required for plant operations would be revegetated upon completion of construction. All visible structures would be painted a muted color to minimize the visual impacts in the area.

All equipment would be brought to the project site on trucks. The power plant construction site would be accessed from local highways, such as Highway 97 to Dan O'Brien Way to Campus Drive, as shown on Figure 2.4-5.

Landscaping would require replacement of all removed topsoil and planting of vegetation around the power plant site. The building housing the well in the parking lot would not require landscaping.

Construction of drainage would occur during construction of the plant. Perforated pipe would be placed around the perimeter of the plant to drain water away from the plant. The pipe would be covered by the gravel or concrete foundation.

Pipelines to the Power Plant

A pipeline would need to be constructed from the proposed geothermal well to the power plant, a distance of about 500 feet. The pipeline would be 10 inches in diameter and would be constructed underground in a trench 5 feet deep. It would be a steel pipe insulated with polyurethane foam insulation and protected with a fiber-wound fiber reinforced polymer (FRP) jacket. Standard trenching equipment would be used to construct the trench. Installation of the pipeline would require removal of pavement in the parking lot and across the existing access road between the parking lot and the proposed power plant location. Road crossings would be installed by trenching through the road, laying the pipeline, and then repairing the road. Siting of the pipeline would prevent conflict with existing utilities/cables/pipeline/etc. Metal plates would be placed over open trenches to allow cars and vehicles to have access as needed. The road may be closed for up to 30 minutes at a time to allow construction work to be completed sufficiently to safely allow traffic to pass. An alternative route around the north side of the campus is available.

Removed topsoil would be stockpiled for replacement in unpaved areas. All paved areas disturbed for pipeline installation would be repaved after construction of the pipeline.

Geothermal water passed through the power plant heat exchanger would be connected to the injection well system in the heat exchange building to be reinjected into the geothermal reservoir after providing supplemental heat to the campus buildings. Construction would require building a pipe from the power plant into the heat exchange building. The pipe would likely enter the building through the wall, above ground, and would be constructed by drilling a hole through the wall.

A pipeline connection from the cooling tower to the cold water connection in the northwest corner of the heat exchange building would also be needed to supply water for the cooling tower. This connection would likely occur above ground through the wall of the current building. The plant would be connected to the existing freshwater system by shutting off existing pipes and installing connections.

Power Line Connection

The 1,700 foot long power line would be buried or installed in a tunnel from the power plant site to Owens Hall. As shown of Figure 2.2-1, a portion of the path of the power line would be constructed underground. This portion would be installed near the existing underground geothermal pipeline. The next portion of the power line would be located within an existing tunnel, which also houses the existing geothermal pipeline and other utilities. The power line would tunnel directly into the mechanical building from this tunnel. Trenching would be required to bury the power line. All pavement removed for trenching or installing the line in the tunnel would be replaced after completion of construction. The existing power system would be de-energized to hook in the new system and reenergized after completion of construction.

Construction Crew and Schedule

After post drilling evaluation, power plant construction would occur during daytime hours by a crew of up to 10 workers. Equipment would include standard grading equipment as well as trucks to move power plant parts to the site and possibly a crane to install the plant. Construction of the pipeline, power lines, and power plan is expected to take 6 months to complete. Three truckloads would bring the power plant to the site and two trucks would be needed to bring in pipeline, valves, and other equipment necessary to energize the power plant.

2.5 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. No information pertinent to small-scale geothermal power plants would be developed from this location.

It is possible that other sources of funding, including private funds, could be obtained by OIT to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway.

2.6 Related Actions

Other related actions have been proposed by OIT in the proposed action area. One potential action includes building a low-temperature power plant next to the proposed high temperature power plant. The power plant would be a binary or organic Rankine cycle type in the 300 kW generating capacity range. The plant would use the existing geothermal water and/or water coming off of the high temperature plant as a bottoming cycle. Geothermal water from either source could subsequently be used in the space heating system or sold for a fee to adjacent land owners. OIT is also considering construction of two geothermal greenhouses on campus and an aquaculture facility. These are all currently speculative projects that are not currently funded by DOE and are therefore not evaluated in this EA. These actions would undergo their own review under NEPA if these proposals were further developed under a DOE funding program. These sections are considered in Chapter 4: Cumulative Impacts.

2.7 Safety and Risk Assessment

Appendix B provides a detailed description of OIT's emergency plans for:

- Injuries
- Well blowouts
- Fire
- Spill or discharge contingencies (for drilling mud, geothermal fluid, lubricants, fuels, etc.)
- Hazardous gas control
- Drilling safety and action plans

The purpose of these plans is to provide guidance to field personnel and management in the event of an uncontrolled well flow (e.g., "blowout") or other field related emergency. The plans are intended to be comprehensive in that they describe the nature of various hazards or problems that might be encountered and specify appropriate preventive or anticipatory actions and equipment, as well as specific responses, notifications and follow up procedures that are required in the event of such a field emergency. In addition to blowouts, emergencies such as accidents and injuries are covered, as are fire hazards management and risk assessment.

2.8 Permitting

Table 2.8-1 lists the permits, reviews, consultation, and approvals required for the proposed project, as well as the status of the permits and/or timing of acquisition.

Table 2.8-1: Permitting Requirements and Status

Agency	Permit/Approval	Status or Timing
City of Klamath Falls	Geothermal Well Registration	Completed and approved
DOGAMI	Application to Drill Geothermal Well	Completed and waiting for approval
City of Klamath Falls	Conditional Use Permit	After the EA is approved, an application would be submitted.
Klamath County	Building Permit	When the Conditional Use Permit is approved, the Building Permit application would be submitted.
Oregon DEQ	Underground Injection Control	The project is exempt at this time for 750 gpm. After the well is completed and the resource characteristics are determined, a new application would be submitted.
	Authority to Construct Permit	The permit has not yet been filed but would be filed a month prior to construction.
	National Pollutant Discharge Elimination General Construction Permit	This permit would be applied for just prior to construction.

2.9 Environmental Protection Measures

The specific environmental protection measures listed by activity or environmental resource area below are incorporated into the applicant's proposed action as integral components of the proposed project. Refer to Appendix C for written confirmation of these environmental commitments.

Air Quality

1) Prior to ground disturbance, any dry soils shall be watered to reduce fugitive dust emissions. Soils shall be monitored and continued to be watered throughout the project if dust begins to generate. Other measures that shall be implemented to minimize dust include:
   - Application of asphalt, oil, water, or suitable chemicals on dirt roads, material stockpiles, and other surfaces which can give rise to airborne dust
   - Use of water, chemicals, venting, or other precautions to prevent particulate matter from becoming airborne in handling dusty materials to open stockpiles and mobile equipment
   - Maintenance of roadways in a clean condition

2) Hydrogen sulfide concentrations in the air shall be monitored at the drill site during drilling and flow testing. H_2S concentrations in the produced geothermal fluid and preliminary flow will be measured during the flow test. If these measurements suggest that the H_2S emissions approach 10 ppm for an 8 hour day, a chemical abatement (such as NaOH) standard for the geothermal industry will be injected into the discharge line to abate the gas. A trailer-mounted abatement skid with a storage tank for NaOH, a pump, and appropriate monitoring equipment shall be kept on site. The discharge line shall be appropriately valued to provide for abatement at any time if needed. Personnel on site during periods of possible well discharge will be trained in the use of masks and air tanks and shall wear H_2S monitors at all times.

Geology and Soils

1) Topsoil shall be stockpiled and covered to minimize erosion. Topsoil shall be reapplied to the surface after completion of construction, as appropriate.

Biological Resources

1) Monitoring and treatment of the parking lot and access roads for invasive, non-native species shall be required for the duration of exploration. Any weeds found in the roads or parking lot would be removed completely and discarded in an appropriate manner.
2) During construction, construction crews shall stay within the designated construction areas. All pipelines shall be capped at night to ensure that rabbits do not enter stockpiled equipment. Equipment shall be checked in the morning for rabbits or other animals. If wildlife is found in equipment they shall be allowed to leave the project area prior to moving equipment.

Water Resources

1) Containment berms shall be constructed around all hazardous or potentially hazardous materials storage areas. Containment berms shall be 110 percent of storage volume.
2) A Spill Prevention Control and Countermeasure Plan (SPCC) shall be prepared and kept on-site during construction and operation. The plans shall identify equipment and procedures used for containment and recovery of accidental spills.

Noise

1) Noise screening would be used during drilling to reduce noise heard by sensitive receptors. All equipment used shall have the appropriate mufflers and noise abatement equipment necessary. A temporary noise wall shall be installed around the drilling pad. The wall shall not be greater in height than the base of the drill rig to minimize visual impacts. The wall shall be removed after drilling is complete. All neighboring properties shall be informed in writing of the proposed drilling schedule and estimated noise levels 30 days prior to commencing drilling operations. The notification shall also include the name and number of a contact person who shall receive noise complaints and respond to any local complaints about drilling or construction noise.

   In the event of a complaint, the contact shall determine the cause of the noise complaint and institute reasonable measures warranted to correct the problem.
2) Power plant, pipeline, and electrical interconnect construction shall only occur between 7:00 a.m. and dusk. All neighboring properties shall be informed in writing of the proposed drilling schedule and estimated noise levels 30 days prior to commencing drilling operations. The notification shall also include the name and number of a contact person who shall receive noise complaints and respond to any local complaints about drilling or construction noise.

3) In the event of a complaint, the contact shall determine the cause of the noise complaint and institute reasonable measures warranted to correct the problem.

Human Health and Safety and Risk Assessment

1) Temporary safety fencing during construction or repairs to restrict or prevent public access to active on-site construction materials or chemicals.
2) Safety signage, placed as appropriate along the construction corridor during construction or repairs, to warn of risks associated with on-site construction materials and outline measures to be taken to ensure safe use of facilities near construction areas and avoidance of construction materials.
3) Safety plan, developed by OIT prior to project commencement, will include appropriate methods (i.e. Best Management Practices) and approved combustion prevention and response practices for pentane. The plan will insure that all fire hazards (i.e. spark-inducing activities such as welding, and improperly disposed cigarettes) are kept away from the pentane storage tank.
4) The following fire prevention measures would be implemented during construction:
    - Fire extinguishers and shovels will be available on-site.
    - All brush build-up around mufflers, radiators, and other engine parts must be avoided; periodic checks must be conducted to prevent this build-up.
    - Smoking would only be allowed in designated smoking areas; all cigarette butts would be placed in appropriate containers and not thrown on the ground or out windows of vehicles.
    - Cooking, campfires, or fires of any kind would not be allowed.
    - Portable generators used in the Project Area would be required to have spark arresters.
5) A fire break of at least 15 feet will be constructed between the pentane storage tank and any vegetation, landscaping or combustible materials.

3: AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Introduction

This chapter of the EA includes a discussion of both the affected environment and the potential environmental consequences from the proposed action.

The discussion of the affected environment is prepared to a level of detail commensurate with the potential for environmental impacts to each resource. The environmental consequences are discussed for both project construction and operation.

3.2 Climate/Air Resources

3.2.1 AFFECTED ENVIRONMENT

Climate

Klamath County has a semiarid winter-rainfall climate type characterized by mild summers and cold winters. Klamath Falls is at an elevation of approximately 4,100 feet. Klamath County lies within both Climate Division 5 (High Plateau) and Climate Division 7 (South Central Oregon) as determined by the National Climatic Data Center (Taylor 2008). The town of Klamath Falls lies within Climate Division 7.

The average annual precipitation for Klamath Falls from 1971 through 2000 was 13.95 inches (Taylor 2008). The average annual maximum temperature for the same date range was 61.8 degrees Fahrenheit (°F). The average annual minimum temperature was 35.3°F and the average annual monthly mean temperature was 48.6°F (Taylor 2008).

The Klamath Basin is a predominantly flat area of a former lakebed that is now drained by the Klamath River. Occasional hills and a system of elongated ridges confine the basin and the greater Klamath Falls area to the east and west. Most of the Klamath Falls residential area, especially the south suburban area, is located in the basin. Klamath Falls can experience very strong and shallow nighttime air inversions that break up during the day. In the winter, frigid arctic air masses frequently move down Upper Klamath Lake and invade the Klamath Basin. Temperatures can remain well below freezing for several weeks at a time in Klamath Falls.

Air Quality Regulatory Setting

Air quality in Oregon is regulated by the Department of Environmental Quality (DEQ). DEQ implements local programs as well as operates the federal environmental program within the state for implementation of the Federal Clean Air Act, as delegated by the US Environmental Protection Agency (EPA). The air pollutants of greatest concern in Oregon are:

- Ground-level ozone, commonly known as smog
- Fine particulate matter (mostly from wood smoke or other combustion sources, cars and dust) known as
  - PM_{10} (10 microns and smaller in diameter) and
  - $PM_{2.5}$ (2.5 microns and smaller in diameter)
- Hazardous air pollutants (also called Air Toxics)
- Carbon monoxide (mostly from motor vehicles)

DEQ also is concerned about greenhouse gases and, along with the Oregon Department of Energy (ODOE), is working on strategies to mitigate their release. Greenhouse gases cause global warming and according to an ODOE report (DEQ 2001):

> *"The impacts of such changes on Oregon citizens, businesses and environmental values are likely to be extensive and destructive. Coastal and river flooding, snow pack declines, lower summer river flows, impacts to farm and forest productivity, energy cost increases, public health effects, and increased pressures on many fish and wildlife species are some of the effects anticipated by scientists at Oregon and Washington universities."*

The State of Oregon has adopted the federal air quality standards from the Clean Air Act. The federal and state standards are the same. These standards fall into two general categories:

- Ambient standards that limit air pollution levels in a given area, and
- Emission standards that apply to direct sources

The national ambient air quality standards (NAAQS) are defined as levels of specific air pollutants above which detrimental effects on human health and welfare may result. Pollutants for which ambient air quality standards have been established are known as federal "criteria" pollutants. Since the US EPA updated the NAAQS in 1997, there are ambient air quality standards for eight criteria pollutants. Ambient standards are listed in Table 3.2-1 for criteria pollutants that the proposed project could potentially emit. The standards are expressed in terms of different averaging times; for example, annual, 24-hour, and 3-hour (DEQ 2001).

An area that is found to be in violation of NAAQS is called a "non-attainment area." Pollution sources contributing to non-attainment areas are subject to tighter restrictions.

Table 3.2-2 lists the emission standards that apply to direct sources of pollutants.

Table 3.2-1: Ambient Air Quality Standards			
Pollutant	**Averaging Time**	**Federal Standard**	**State Standard**
PM_{10}	Annual Average	50 μg/m^3	50 μg/m^3
	3-yr Average of 99^{th} percentile of 24-hr	150 μg/m^3	150 μg/m^3
$PM_{2.5}$	Annual Average	15 μg/m^3	15 μg/m^3
	3-yr Average of 99^{th} percentile of 24-hr	65 μg/m^3	65 μg/m^3
Total Suspended Particulate (TSP)	Annual Geometric Mean	NA	150 μg/m^3
	24 hours	NA	0.08 μg/m^3
Ozone	3-yr. Average of the yearly 4^{th} highest	0.08 μg/m^3	0.08 μg/m^3
Carbon Monoxide	8 hours	9 ppm	9 ppm
	1 hour	35 ppm	35 ppm
Sulfur Dioxide	Annual Arithmetic Mean	0.03 ppm	0.02 ppm
	24 hours	0.14 ppm	0.10 ppm
	3 hours	0.5 ppm	0.5 ppm
Nitrogen Dioxide	Annual Arithmetic Mean	0.053 ppm	0.053 ppm
Lead	Calendar Quarter	1.5 μg/m^3	1.5 μg/m^3

SOURCE: EPA 2004; DEQ 2008

Table 3.2-2: Significant Emission Rates for Pollutants Regulated Under the Clean Air Act	
Significant Pollutant	**Emission Rate**
Carbon Monoxide	100 tons/year
Nitrogen Oxides	40 tons/year
Particulate Matter	25 tons/year
PM_{10}	15 tons/year
Sulfur Dioxide	40 tons/year
Volatile Organic Compounds	40 tons/year
Lead	0.6 ton/year
Fluorides	3 tons/year
Sulfuric Acid Mist	7 tons/year
Hydrogen Sulfide	10 tons/year
Total Reduced Sulfide	10 tons/year

SOURCE: DEQ 2001

The Oregon DEQ requires businesses that release air pollutants to obtain permits to operate. Oregon implements the federal Title V Air Operating Permit Program. Under this program, major sources of air pollutants require a New Source Review. Major sources are defined as projects with the potential to emit:

- 100 tons per year of any Criteria pollutant or
- 10 tons per year of any individual hazardous air pollutant (HAP) or

- 25 tons per year of any combination of HAPs. HAPs are identified in the Clean Air Act (Amendments of 1990, Title III).

The proposed project is not expected to require a New Source Review because emissions would not exceed these thresholds.

Businesses that do not fall under the Title V permit program are permitted under the state Air Contaminant Discharge Permit program. This project may be permitted under this program.

Other permits that may apply to this project include:

- Notice of Construction and Approval of Plans
- Emission Standards for Hazardous Air Contaminants
- Highest and Best Practicable Treatment and Control
- Standards of Performance for new Stationary Sources

Applicability to this project would be determined by DEQ after an application for the proposed project has been submitted. OIT has not yet submitted a Notice of Intent to Construct to the DEQ. This permit application would be submitted about one to two months prior to construction. An air permit for operation is not necessary since the plant is a binary plant with no criteria pollutant (Messina, personal communication 2008).

Air Quality in Klamath Falls

High precipitation aids in maintaining relatively good air quality in the Klamath Falls area during the winter months. Temperature inversions occur in warmer months, however, which trap air pollution near the surface and lead to poor air quality. Natural sources such as wind-blown dust, pollen, and intermittent forest fires can occasionally contribute to local levels of pollutants in the atmosphere. Forest fires emit air pollutants such as nitrogen oxides, particulates, and unburned organic compounds. Together with natural sources, human activities can contribute to occasional locally elevated air pollution levels in the Klamath Falls area (DEQ 2001).

The criteria pollutants of greatest concern in the Klamath Falls area include $PM_{2.5}$, and ozone. Klamath Falls was designated attainment with the federal NAAQS for PM_{10} in December 2003 and has since maintained its attainment status (EPA 2008a). Klamath Falls is also in attainment for carbon monoxide (CO) emissions since submission of a CO Maintenance Plan in 2001 (DEQ 2001). Attainment status has not been established for the new criteria pollutant $PM_{2.5}$. Attainment status will be assigned in 2009 (based on 2004 to 2006 monitoring data) and Klamath Falls is expected to be designated as non-attainment at that time (DEQ 2001).

The Klamath County Environmental Health Department has placed burning restrictions on its residents for types of materials that can be burned and when stoves and fireplaces may be used (Klamath County 2001).

3.2.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

Drilling and Testing

Combustion Emissions

The drill rig would be powered by a large bore diesel engine. Table 3.2-3 shows a worst-case emissions scenario for a large bore stationary diesel engine based on estimated maximum daily fuel consumption at the well pad. Because of the variables in operating parameters of the engines,

Table 3.2-3: Estimated Emissions from Large Bore Diesel Engines[1]

Air Pollutant	Emission Factor (lbs/mmBTU)	Maximum Estimated Emissions		
		Hourly (lbs/hr)	24-hour (lbs/day)	1-month of Drilling total emissions (tons)
Carbon Monoxide (CO)	0.085	4.83	116.47	1.75
Carbon Dioxide (CO_2)	165.00	942.08	22,609.95	344.00
Total Organic Compounds (as Methane (CH_4))	0.09	0.51	12.33	0.19
Oxides of Nitrogen (NO_x)	3.20	18.27	438.49	6.67
Particulate Matter $\leq$10 microns (PM_{10})	0.0573	0.33	7.85	0.12
Oxides of Sulfur (as Sulfur Dioxide (SO_2))	0.0202	0.12	2.77	0.04

SOURCE: EPA 1996

emissions are expected to be significantly lower than the worst-case scenario. Additional generators and pumps may be required for the project, but these small sources would have a negligible impact on emissions. The emissions from diesel generation would be considerably less than standards (as shown in Table 3.2-2), especially since most impacts would only occur for 1 month during drilling. Combustion emissions would not be adverse.

Well Drilling Emissions

Production of geothermal fluid would result in release of water vapor (steam) and non-condensable gases to the atmosphere. The amount and ratio of the non-condensable gas constituents within the geothermal fluid are variable among geothermal resource areas and can be substantially different among individual wells within the same geothermal project area. However, the non-condensable gas content is typically comprised of carbon dioxide (CO_2) (usually accounting for about 95 to 98 percent of the total non-condensable gas content) with smaller amounts of methane (CH_4), hydrogen sulfide (H_2S), and trace amounts of ammonia (NH_3). Trace amounts of elements such as arsenic (As), mercury (Hg) and boron (B) may be present.

Water quality testing of the existing geothermal well fluids in 1990 showed arsenic levels of 0.041 mg/L and boron levels of 1.05 mg/L (national primary drinking water standards are 0.010 mg/L for arsenic. There are not primary standards for boron, but the World Health Organization (WHO) suggests drinking water should have no more than 0.5 mg/L boron (WHO 2003). Emissions would not be adverse because of the short duration of testing (72 hours) and the small quantities of constituents being released. Only constituents in the steam would be dispersed and most would remain in the geothermal fluid withdrawn during flow testing. This fluid would be disposed of from the reserve tank or be pumped back into the reservoir through the injection wells and would never have contact with the air. Emissions from the wells would be transported and dispersed by wind away from the well pad. The predominant wind direction in the area is north/northwest.

Of the non-condensable gas emissions anticipated from the geothermal fluid, the principal constituent of concern is hydrogen sulfide (H_2S). H_2S can be released from a well during drilling, and would be vented with the steam and non-condensable gases during flow-testing. H_2S is a colorless, non-condensable gas with a characteristic “rotten egg” odor. H_2S is toxic at certain levels and can cause negative human and animal health effects. Exposure to H_2S can cause dizziness,

[1] Values based on the assumption that a maximum of 1000 gallons of low sulfur (0.02%) diesel oil fuel will be used, and that the average heating value of the fuel is 19,300 BTU per pound of fuel with a density of 7.1 pounds per gallon.

headache, and nausea at 50 ppm and death from respiratory paralysis at 1,000 ppm. The OSHA indoor workplace standard for H_2S is 10 ppm for an 8-hour day (Klingberg 2005). Nuisance odor is of primary public concern since this distinctive odor can be easily detected at concentrations far below levels of health concern. Odor is detectable from about 0.008 ppm.

H_2S is typically encountered during the production zone drilling phase. The quantity of H_2S that would be encountered is unknown at this time. The existing geothermal wells on campus suggest some level of H_2S in the system, evidenced by a faint odor of "rotten eggs" smelled when standing within a few feet of the source. Sulfates were also identified in 1990 water samples from the existing geothermal wells. H_2S emissions from previously drilled wells in the area did not cause significant effects as odors from the existing wells can only be smelled within a few feet of the water. H_2S levels at the Glass Mountain Known Geothermal Resource Area in Siskiyou County, California (50 miles southwest of the project site) were approximately 2.8 lbs per hour (USFS et al 1998), well below state standards in California.

Federal standards for H_2S emissions are 10 tons per year. Total emissions from construction would be far less than 10 tons per year; however, given the odor and potential threat to human health from H_2S emissions, protection measures have been built into the project to reduce H_2S emissions as much as possible. H_2S control would be accomplished through use of properly weighted drilling mud, which is expected to keep the well from flowing during drilling. H_2S gas that may be entrained in the drilling mud and returned with the drilling cuttings to the solid separation process is expected to be neutralized by the high pH of the mud system. Proposed protection measures require monitoring devices to be installed and operated during all phases of drilling and testing and H_2S abatement systems to be installed if H_2S is being emitted at a rate higher than 10 ppm within an 8 hour period. The closest residences are within approximately 400 feet from the project site, a distance over which odors would dissipate. With monitoring and abatement, H_2S emissions would not cause adverse effects.

Greenhouse Gas Emissions and Global Warming

The DOE has not yet developed guidance regarding the discussion and analysis of greenhouse gases (GHGs) and global warming in EAs. The Golden Field Office has determined that the issue is relevant and should be included in this EA. GHGs are global pollutants, unlike criteria air pollutants and toxic air contaminants, which are pollutants of regional and local concern, respectively. The most prominent GHGs that have been identified as contributing to global warming are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorucarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of GHGs contributing to global climate change are attributable largely to human activities associated with the industrial/ manufacturing, utility, residential, and agricultural sectors. Transportation is also a large contributor of GHGs, particularly CO_2.

The proposed project has the potential to emit greenhouse gases during drilling. Emissions would be primarily from the diesel generator on the drill rig. Approximately 344 tons of emissions are estimated. Well drilling and testing would also emit a considerable amount of CO_2 from the geothermal steam. As previously stated, there are currently no standards for greenhouse gas emissions. The overall project would help to mitigate drilling emissions since it would provide energy that may replace fossil fuel energy sources. Fossil fuel combustion-related CO_2 accounts for 82 percent of the total United States human-made GHG emissions (NEIC 2007). A comparison of geothermal and fossil fuel CO_2 emissions from electrical generation is shown in Table 3.2-4. Emissions reported in the table are weighted average values for all geothermal capacity, including binary power plants that do not emit CO_2. Data cannot be reported by power plant type because some of it is proprietary in nature; but, binary plants represented only 14% of capacity in the weighted average (Bloomfield et al. 2003).

Table 3.2-4: Geothermal vs. Fossil Fuel CO_2 Emissions for Electrical Generation

	Geothermal	Coal	Petroleum	Natural Gas
Emissions (pounds CO_2 per kilowatt hour)	0.20	2.095	1.969	1.321

SOURCE: Bloomfield et al. 2003

Construction

Fugitive Dust

The primary pollutant of concern during construction activities for the proposed action would be emissions of particulates in the form of fugitive dust. Fugitive dust emissions would be generated by ground-disturbing activities related to transport of workers and equipment to the site, well pad construction, and grading for construction of the power plant facility.

Air quality impacts from construction activities for the well pad, pipelines, and power plant would be localized and temporary. The well pad would be constructed in an existing parking lot and would only require minimal pavement removal in the area where the well would be drilled. Installation of the pipeline would require some removal of soils. Grading for the installation of the power plant would also cause soil disturbance.

Particulate concentrations in the vicinity of the project would increase on a short-term basis (construction is estimated to last 6 months or less). Protection measures included in the project description that require watering and/or otherwise entraining dust on devegetated areas would be implemented to minimize any adverse impacts from particulate matter emissions during ground disturbance.

Combustion Emissions

Diesel combustion emissions would be emitted from construction equipment and vehicles used to access the project site. Combustion emissions of criteria pollutants and air toxics (small quantities of diesel PM, acetaldehyde, benzene, and formaldehyde) would be released during well pad, pipeline, and power plant construction by diesel-powered equipment. Given the small size of the construction area, and the small fleet of vehicles needed for construction (less than 10), emissions would be minimal and would not significantly contribute to or cause an exceedance of air quality standards.

Greenhouse Gas Emissions and Global Warming

Construction of the power plant and pipelines would result in the emission of some greenhouse gases (mostly from running equipment engines). The overall project would help to mitigate any construction emissions since it would provide energy that may replace fossil fuel energy sources as summarized in Table 3.2-4.

Operation

Project operation includes operation of the geothermal power plant and well. Emissions of criteria pollutants and other air pollutants could occur from the power plant and the well during project operation. Well emissions could occur during well maintenance. Maintenance could occur as frequently as once per year or as infrequently as once every 10 years. During maintenance, the well is "bled" by allowing it to vent a small amount of steam through the well head silencer. Bleeding is usually short term (a few hours) and emissions would include constituents in the geothermal fluid including very small amounts of boron, arsenic, and H_2S. The amounts would be so small and of short enough duration that they should not have an adverse effect on air quality or cause significant objectionable odors.

The plant would be a binary-type geothermal plant. Binary plants are closed systems and, therefore, do not result in any air emissions of constituents from the geothermal fluid. Minor amounts of pentane gas, which is used as a secondary fluid, may be emitted during power plant operation and during refilling of the pentane storage tank. Emissions would be sporadic and would be below the federal thresholds for VOCs emissions.

Steam could be periodically vented from the power plant during certain situations. During steam venting, geothermal steam is emitted directly to the atmosphere. Levels of emissions of dissolved solids and H_2S from steam venting would be low. Given the relatively good quality of the geothermal water, air emissions would not have an adverse effect on the environment. Steam is visible from a binary plant; however, the steam is a result of the contact of hot, moisture laden air with cooler air. The constituents of the steam would be the same as the fresh water supplied into the plant. This water has slightly elevated levels of naturally occurring arsenic; however, the trace amounts of arsenic would settle out of the steam in a short distance from the plant and would not result in adverse air quality impacts.

Operation of the power plant would also result in some emissions of carbon dioxide; however, this amount of emissions is considerably less than those of other fossil fuel energy sources (see Table 3.2-3). The project should have a beneficial effect on reducing GHG emissions on a global scale.

Air Conformity Analysis

The project is not located within any non-attainment areas and would not exceed any conformity requirements as dictated in the Environmental Protection Agency's (EPA) rule "Determining Conformity of General Federal Actions to State or Federal Implementation Plans" (40 CFR 93, Subpart B). The project would not contribute to any violation of federal ambient air quality standards.

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same.

It is possible, however, that other sources of funding, including private funds, could be obtained by OIT to develop the project. In such a case, the No Action Alternative would have impacts identical to those of the Proposed Action with respect to Air Quality. These impacts would not be considered adverse with implementation of protection measures identified in the project description.

3.3 Geology/Soils

3.3.1 AFFECTED ENVIRONMENT

Tectonics and Geology

The Oregon Institute of Technology (OIT) is located at the western boundary of the Basin and Range Province, north of the Medicine Lake Highlands and east of the Cascade Range (Prucha et al.1987; EGS 2006). It is located on a horst and graben structure[2]. The underlying Klamath graben complex reaches from Lower Klamath Falls northward to Crater Lake. The edge of the graben complex is marked by normal faults. The area first experienced faulting in the late Pliocene and continues to be seismically active as evident by three earthquakes of magnitudes greater than 5 occurring in late 1993 (Prucha et al. 1987; USGS 2008a). OIT is located on Pliocene and upper Miocene mudstone and sandstone (Figure 3.2-1). Normal faults to the east of the campus cut through rocks older than 1.8 million years (Oregon DOGAMI 2008).

There are four main geologic units in the Klamath Falls area. Pliocene basalt was encountered during previous well drilling at the OIT campus. The Pliocene Yonna Formation overlies the Pliocene basalt at an unconformity and consists of sandstone, basaltic tuff and breccia, thin basalt flows, fluvial and lacustrine tuffaceous siltstone, and diatomite. The Yonna Formation has been eroded extensively. An andesitic-basaltic flow overlies the Yonna Formation and outcrops representative of basalt eruptive centers have been mapped to the north of the Klamath Falls KGRA. Valley floors of the Klamath Basin typically are covered by Quaternary alluvium; however, there are Quaternary lacustrine deposits and fluvial terraces to the south of the KGRA (Prucha et al. 1987).

The extensional horst and graben complex is the dominant geologic influence in the vicinity of Klamath Falls. High-angle normal faults trend to the northwest and strike-slip cross-faults trend to the northeast. Nearly all northwest-trending faults dip to the southwest between vertical and 70 degrees while northeast-trending faults are at vertical or almost vertical.

The northeast-trending faults offset many northwest-trending faults. The varying direction of faulting forms a rhombic fracture pattern[3]. There is varying interpretation of why the rhombic fracture pattern forms. One theory suggests development of faulting happened simultaneously in a stress system with an east-west minimum principal stress and a north-south maximum principal stress. Another theory separates the Oregon component of the Basin and Range province into four strike-slip west-northwest fault zones. The rhombic fracture pattern results from the interaction between extensional faulting between fault zones and right-lateral movement at the boundary of fault blocks (Prucha et al. 1987).

The City of Klamath Falls is located on top of a principal northeast-trending fault zone. The geothermal activity under the OIT campus is bound to the east of campus by a normal, northwest-trending fault. The northern end of the KGRA is truncated by a structural shear zone, which cuts off a high-angle normal fault on the OIT campus. The flow of hot water to the surface may result from the tensional dilation of a northwest-trending zone (EGS 2006).

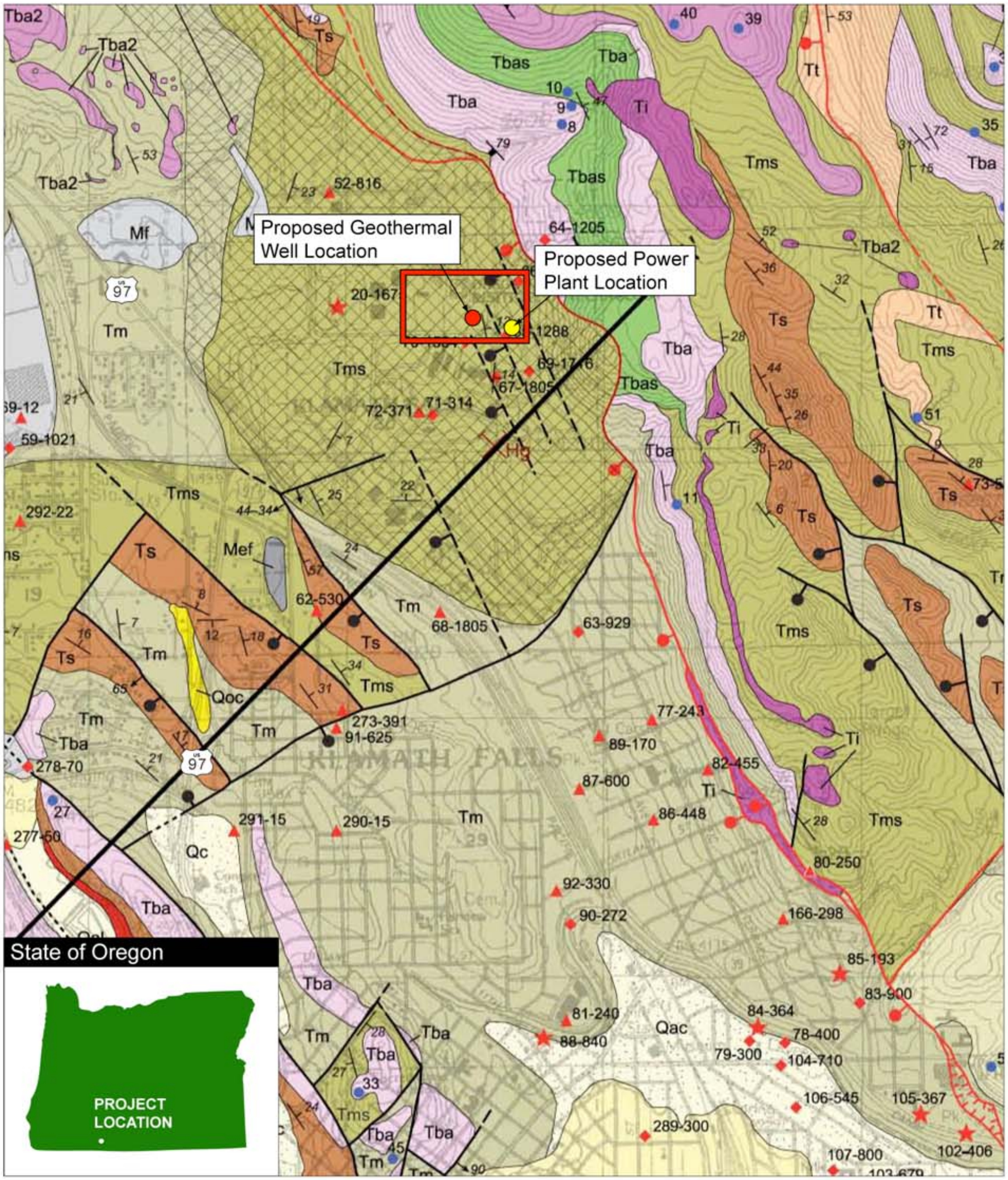
Seismicity

The largest recent earthquake in the project region occurred on September 20, 1993. The earthquake measured 6.0. The quake was centered about 15 miles due west of Klamath Falls. It was a typical Basin and Range Province type earthquake. Similar earthquakes occur about every 35 to 50 years (Lineau et al. 1993). The earthquake occurred on the normal fault on the opposite side of the Klamath graben; therefore, it was not likely associated with geothermal injection..

According to US Geological Survey seismic archival data, the City of Klamath Falls has experienced several microseismic events since 1978 (Lineau et al. 1993). There have been 257 events (126 between a magnitude of 1 and 3), with most occurring in 1993 and 1994 surrounding the 1993 big event. Appendix F includes the table of all earthquakes from the US Geological

[2] A region delineated by normal faults. A horst is a block that experiences relative upward movement; a graben is a block that experiences relative downward movement.
[3] Fractures in the ground due to faulting roughly form a rhombus.

Figure 3.2-1: Geologic Units in the Project Area



SOURCE: Oregon Department of Geology and Mineral Industries 2008 and MHA Environmental Consulting 2008

LEGEND

Project Area

97 U.S. Highway

*Geologic Unit Legend on back of map

Proposed Geothermal Well Location

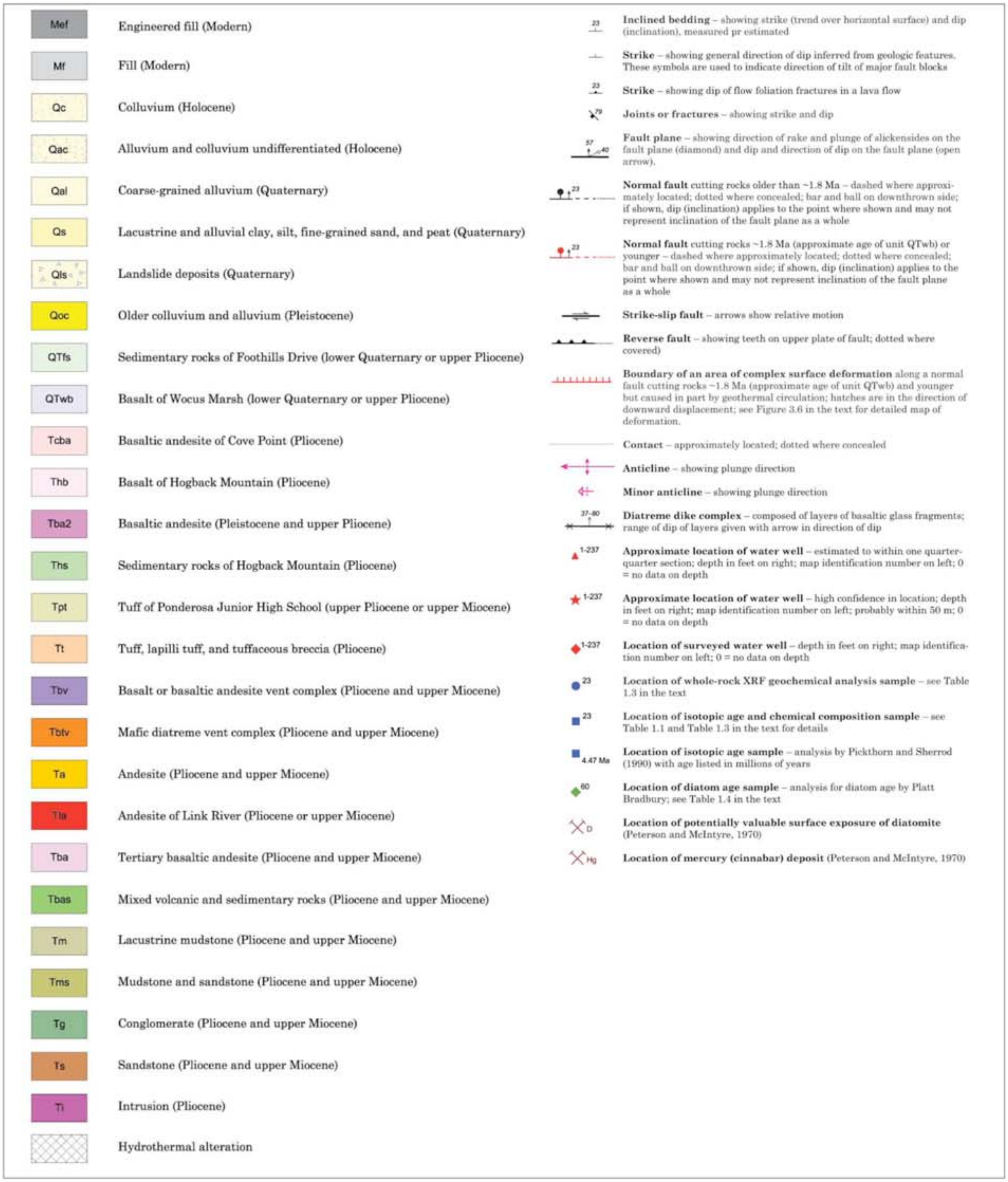
Proposed Power Plant Site

0 0.5 1 Mile

RMT

MHA Environmental Consulting

Figure 3.2-1 (continued): Geologic Units in the Project Area Legend



SOURCE: Oregon Department of Geology and Mineral Industries 2008 and MHA Environmental Consulting 2008

RMT | MHA Environmental Consulting

Survey Data base for a 100 km radius centered on the City of Klamath Falls, from 1978 to present. The appendix includes the magnitude of each event. Table 3.3-1, below, summarizes the microseismic event history; for years not listed in the table, no seismic activity was recorded.

Soils

The National Resources Conservation Service (NRCS) classifies the soils in the vicinity of the OIT campus as Deter clay loam, Harriman-Lorella complex soil, Lorella loam, and Lorella very stony loam. The location of the proposed well is in the southeast parking lot. There are three soil types present in this area: Deter clay loam, Lorella loam, and Lorella very stony loam. The geothermal power plant would be located on Lorella loam and in very close proximity to Lorella very stony loam. Descriptions of soil types in the area are as follows (USDA 2007):

- **Lorella loam**: It consists of tuffaceous and basaltic coarse-grained colluvium and residuum. The soil is well-drained and the water table depth is greater than 80 inches. It forms structural benches and is sloped 1 to 15 percent.
- **Lorella very stony loam**: It consists of coarse-grained basaltic and tuffaceous colluvium and residuum. The soil is well-drained and the water table depth is greater than 80 inches. It forms escarpments and is sloped 2 to 35 percent.
- Deter clay loam: It consists of very fine-grained clay lacustrine and alluvium sediment made from diatomite, basalt, and tuff. The soil is well-drained and the water table depth is greater than 80 inches. It forms terraces and is sloped 2 to 7 percent.
- **Harriman-Lorella complex**: It consists of lacustrine sediment derived from tuff, basalt, and diatomite, and residuum derived from tuff and basalt. The soil is well-drained and the water table depth is greater than 80 inches. It forms terraces, escarpments, and hill slopes, and is sloped 5 to 35 percent.

Table 3.3-1: Summary of Microseismic Events in Klamath Falls, Oregon

Year	Number of Microseismic Events
1978	36
1981	3
1988	5
1989	2
1993	166
1994	28
1995	1
1997	1
1998	1
1999	2
2002	3
2003	2
2005	1
2007	5

SOURCE: USGS 2008a

Mineral Resources

The KGRA is the sole mineral resource of regional economic importance in the immediate vicinity of Klamath Falls (City of Klamath Falls 1979). No other mineral resources are present.

Geothermal Resources

Geothermal heating is used extensively in the Klamath Falls area. The KGRA has been utilized to heat homes, schools, and businesses since the 1900s. More than 500 shallow-depth wells use the resource to heat over 600 buildings. Well depths range from 90 to 2,000 feet and measured water temperatures range from 100 to 230°F. Downhole heat exchanges are typically employed to utilize the geothermal resource. Large pumping systems use lineshaft vertical turbine pumps and plate heat exchangers (Lienau et al. 1989).

A geothermal heating system was constructed in 1981 to provide heat to downtown Klamath Falls. Currently, it heats 24 downtown buildings totaling 400,000 square feet (sq. ft.) and four greenhouses totaling 150,000 sq. ft., provides energy to melt snow from 105,000 sq. ft of sidewalks, and provides process heat for the Klamath Falls wastewater treatment plant (Brown 2006).

The downtown system consists of two geothermal wells about one mile from downtown Klamath Falls. Well #CW-1 descends 367 feet while well #CW-2 descends 900 feet. The temperatures of water in the wells are 226°F and 216°F, respectively. The system utilizes 50 hp vertical-line shaft well pumps rated at 500 gpm capacity to transmit geothermal water to the heat exchange building. The heat exchange building contains stainless-steel plate exchangers, which transfer heat from the water to the downtown heating loop. The circulating water is at a temperature of around 180°F. An injection well next to the heat exchange building pumps the water back into the ground (Brown 2006).

The creation of the downtown heating system required a large study of the underlying aquifer, as hundreds of well owners expressed concerns that the large system would affect the water level in their wells. These and other extensive drilling studies have recorded rock temperatures around 240°F, though the fluid phase is around 200°F. Studies on water temperature in the aquifer below 2,000 feet have been limited to the use of chemical geothermometry. Solutes in geothermal water are used to infer temperatures in deeper aquifers. Studies using this method have indicated temperatures in the range of 302-347°F (EGS 2006).The OIT Klamath Falls campus has been heated by geothermal water since 1963 (Lienau et al. 1989). The geothermal water is heated through deep circulation within the earth that then upwells along the fault on the east side of campus where the existing OIT wells tap into this water. The geothermal resource also provides heat to melt snow on campus walkways and energy to the campus cooling system, which utilizes an absorption chiller. The system operates in much the same fashion as the downtown Klamath Falls system. OIT employs three wells with water temperature in the wells at 192°F. The water is conveyed to a tank in the heat exchange building on campus and then circulated underground in fiberglass piping (Lienau 1996).

The geothermal water used for the OIT direct use system has been used for over 45 years with no change in temperature or flow rate. Based on investigations from geothermal geologists there is a high probability that the geothermal reservoir increases in temperature at depth (although it is all the same reservoir). The temperature of the same resource at greater depth is believed to be around 300^{o}F based on geochemistry. Temperatures above 350^{o}F are suitable for flash steam power generation whereas those below this temperature are best suited for binary (organic Rankine cycle) power generation.

3.3.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

Drilling and Testing

Tectonics and Geology

Drilling would not impact the tectonics or geology of the area and, even though the well would be drilled into an existing fault, drilling would not have effects on the fault or induce seismicity.

Soils

Drilling would have limited impacts on soils. Drilling would occur in the existing paved parking lot. No topsoil would be lost. No adverse impacts are expected. Removed muds would be properly disposed.

Mineral Resources

Under the proposed action, there will be no effect on mineral resources from drilling and testing.

Geothermal Resources

Drilling will occur to a depth of 3,000 to 6,000 feet to reach the geothermal resource. The well would be cased as it is drilled to prevent contamination (see Water Resources, below). After completion of drilling, up to 72 hours of flow testing may be implemented. Well logging equipment would be installed in the well during the production tests; however, the equipment used would not have any nuclear or radioactive components that could pose a threat to workers or the aquifers. The volume of water produced during flow testing would be small in comparison to what is currently drawn from the KGRA and would not impact the resource.

Construction

Tectonics and Geology

Construction would not have effects on tectonics or geology in the project region. Construction of the power plant and pipeline would require some ground disturbance but would not encounter bedrock. Construction would not induce seismicity.

Soils

The drilling of a geothermal production well, the construction of a power plant, and the construction of a geothermal fluid pipeline, cooling tower, and water pipeline would all result in ground disturbance.

The geothermal well pad would disturb an area approximately 150 feet by 230 feet in size (0.79 acres) on the existing parking lot. Pavement would only need to be removed in the area where the well would be drilled. The underlying soil in the parking lot was disturbed at the time the parking lot was paved.

The power plant and adjacent cooling tower, which would be located adjacent to the present heat exchanger building, would be built on an 80- by 50-foot parcel of land. Some removal of vegetation and grading to create a level pad would be necessary. Much of this area was previously graded during the construction of the heat exchange building and existing wells. New soil disturbance would be limited; however, topsoil could still be impacted. The stockpiling and reuse of topsoil would minimize any adverse effects.

The water pipeline, which would connect the geothermal well to the power plant and measure 500 feet in length, would be constructed in a 5-foot deep trench. The pipeline route would be constructed under the existing parking lot and access road to the proposed location of the geothermal power plant. Soil disturbance would largely affect soil that had been disturbed during prior construction. Following construction, any removed topsoil would be replaced.

The impacts on soils are minor due to the already-disturbed nature of the soils, and are limited to potential loss of topsoil. Stockpiling and reusing topsoil would minimize any adverse effects.

Mineral Resources

Under the proposed action, there will be no effect on mineral resources from construction.

Geothermal Resource

Project construction activities would occur at the surface and would have no impact on the geothermal resources.

Operation

Tectonics and Geology

The plant would be constructed to handle the maximum credible earthquake in the project area.

The injection of geothermal fluid back into the geothermal reservoir has the potential to cause microearthquakes[4] due to a pressure buildup at the point of injection. Other than in geothermal reservoirs, induced seismicity has been observed due to water behind dams, waste injections, and oil and gas operations. In general, seismicity because of geothermal injection increases as the rate of fluid injection increases. Seismicity is also dependent on the amount of fluid injected into the ground, the increase in pore pressure[5] in relation to the orientation of the stress field, the extensiveness of local faults, and the preexisting excess stress on the local faults (Majer 2008).

Injection would occur into the existing injection wells. The injection rate would be about 1,500 gallons per minute from the proposed project. OIT has been injecting its geothermal effluent since 1990. The highest recorded flow into the injection wells was around 720 gpm. The wells may have a maximum capacity of 3,200 gpm (Willian E. Nork, inc 1992). The City of Klamath Falls has been injecting since 1984 with a maximum flow rate of 1,200 gpm. There are about 15 other wells in the city that also all inject withdrawn water back into the system.

Injection has been occurring in Klamath Falls for over 15 years. Table 3.3-1 lists all seismic activity that has occurred in the project area since 1978. Except for a swarm of earthquake activity surrounding the 1993 major event, and a swarm surrounding the 1978 event near Mount Shasta, California, seismic activity has been minimal. Seismic activity observed is likely attributed to natural causes and not injection since injection has been occurring constantly over the last 15 years but earthquakes have been minimal since 1994. Since the project would include injection of up to an additional 1,500 gpm, which is considerably larger volume than currently injected, the potential for causing some microseismicity is unknown. The likelihood of inducing large or damaging seismic events is unlikely. The OIT injection wells do not intercept the fault. Local faults are not known to be extensive, and the injection wells are not deep (0.38 miles deep and 0.31 miles deep). Majer believes that injection needs to be greater than 3 miles deep to induce significant faulting (Majer 2008). The proposed action is therefore not likely to result in significant seismic activity that could cause damage or adverse impacts. Some microseismicity may occur even though only minimal has been recorded since 1995. Microseismic events do not cause structural damage or other adverse impacts.

---

[4] Microearthquakes are earthquakes of magnitude 3 or less.
[5] Pore pressure is the pressure of fluids in pores of rock, and is exerted on the rock.

Soils

Project operation would have no effects to soils. No soils would be disturbed after the initial construction of the project.

Mineral Resources

There will be no effect on mineral resources from operation, except for the effect on geothermal resources as discussed below.

Geothermal Resources

The proposed project could be the first geothermal power plant in Oregon and would tap into the high temperature resource in the Klamath Falls KGRA. The potential to affect the geothermal resource is minimal due to the small scale of the proposed project. The geothermal reservoir is connected from shallow to deep. Higher temperatures occur at greater depths (Lienau et al. 1989).

The high-temperature beneficial heat content of the Klamath Falls KGRA is estimated at 1.79 x 10^{18} Joules. The low-temperature zone is 0.122 x 10^{18} Joules (Lienau et al. 1989). The proposed power plant would generate 1.2MW gross electrical power per year. This is equivalent to extracting 3.27 x 10^{14} Joules/year from the resource, which is a very small fraction of the total heat content of the Klamath Falls KGRA (0.02%). Therefore, it is unlikely that the proposed use of geothermal fluid from the Klamath Falls KGRA would constitute an adverse impact to the geothermal reservoir in terms of affecting its quality as a geothermal resource for other users.

Because surface disposal of geothermal water is banned in the City of Klamath Falls, all spent geothermal water is returned to the aquifer through injection wells. A binary Rankine cycle power plant does not consume any of the geothermal fluid. The water would be returned directly to the aquifer or returned to the aquifer after circulation through the campus heating system. OIT installed two injection wells at topographical low points on the southwestern side of campus to comply with this ordinance. All geothermal water is injected back into the geothermal reservoir via a pipeline from a central collection point after heating the campus buildings to the injections wells. The geothermal reservoir is connected from shallow to deeper depths such that the injected water may return to the aquifer, although studies show that the injected water moves away from the production wells (William E. Nork, Inc. 1993). Evidence seems to support that the geothermal resource is not impacted by withdrawal since the existing wells have experienced no loss of water or heat over the last 45 years, despite injection only beginning about 15 years ago (Lund, personal communication 2008; William E. Norfolk, Inc. 1992). Effects of withdrawal from deeper depths and injection at shallower depths are not expected to cause an effect on the heat or constituent content of produced water. Impacts of the additional injection water on water quality in the groundwater aquifer are discussed under *Water Resources*.

The existing OIT wells intercept the same fault as the proposed well, just at a shallower depth. These wells have experienced no loss of water or heat over the last 45 years, despite injection only beginning about 15 years ago (Lund, personal communication 2008; William E. Norfolk, Inc. 1992).

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. No information pertinent to small-scale geothermal power plants would be developed from this location.

It is possible that other sources of funding, including private funds, could be obtained by OIT to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway.

3.4 Biological Resources

3.4.1 AFFECTED ENVIRONMENT

Vegetation

General Vegetative Communities

The proposed project area is immediately adjacent to an urbanized area. There are no wetlands or riparian habitat at the proposed project site or in the immediate vicinity. In the City of Klamath Falls, there are limited shrubs and trees, which are generally poplar or elm (City of Klamath Falls 1979).

Because of prior construction on the OIT campus, much of the original vegetation on the proposed project site has been covered by pavement, gravel or landscaping. Total project area disturbance is 1.2 acres, with only 0.09 acres covered in natural vegetation. Lawn turf is present around the perimeter of the parking lot. The heat exchange building is surrounded by grass and low-lying shrubs, decaying plant matter, and an access area covered by gravel. Two gravel access roads extend from the heat-exchange access area to the north- and southeast of the building. There are two juniper trees within the proposed project site and fewer than five trees around the perimeter of the proposed project site.

Invasive Species

Klamath County has formulated a list of noxious weeds that are to be destroyed in order to prevent their spread. This list is presented in Appendix D. The species are separated into three categories. The “A” designated weeds occur in small infestations in Klamath County, or appear in an adjacent county and are likely to spread to Klamath County. Eradication of these species is considered attainable. Actions are taken to control the weed whenever found. The “B” designated weeds are abundant, but have limited distribution throughout Klamath County; thus, county-wide control measures are impractical and the aggressiveness of control is determined for each individual case. The “C” designated weeds are abundant in a majority of Klamath County. These are not subject to regulation; education and recommendations for removal are the focus of control (Klamath County Board of Commissioners 2008).

Noxious weeds do not occur in the proposed well pad area, since this area is completely paved. Noxious weeds may occur in the grassy area around the heat exchange building.

Wildlife

The Klamath Basin, in which Klamath Falls is located, is home to 489 known animal species. The basin has abundant fish communities in Upper Klamath Lake and in the Klamath River that serve as prey for other animals (USFWS 2008a). The Klamath Basin is also an important location for bird migration. About 75% of all birds on the Western Flyway will stop at the Klamath Basin during the migratory season (Sustainable Northwest 2007). Wetlands, which are located sporadically in an area that extends from Chemult, Oregon to just south of Dorris, California (south of the project area), are the home to great numbers of birds in the spring and summer. The shores of Upper Klamath Lake are dotted with wetland areas; however, the most extensive wetland is on the north shore of Upper Klamath Lake. A portion of this area is designated as the Upper Klamath National Wildlife Refuge (WOU 2008). The Klamath Basin also has the largest concentration of wintering bald eagles in the coterminous United States. Amphibians are also abundant in the Klamath Basin, but are typically confined to wet or marshy areas. Reptiles are confined to dry, rocky areas (USFWS 2008a). Human impacts from dams and agriculture constitute the greatest threat to habitats in southeastern Oregon (Sustainable Northwest 2007).

The proposed project site is located on currently disturbed lands on the OIT campus in the immediate vicinity of the City of Klamath Falls. Animals found around the campus and in the city are generally limited to domestic dogs and cats, raccoons, lagomorphs, and rodents. Lower-density areas of the city are home to skunks and muskrats (City of Klamath Falls 1979). Common avian species in the Upper Klamath Basin include warblers, swallows, sparrows, terns, and orioles (Klamath Birding Trails 2008).

The proposed project area may support reptiles and rodents. Most wildlife would not be found in the immediate project area due to the level of disturbance in the area and lack of habitat and cover. Rodents, reptiles, and avian species may wander near the heat exchange building due to its proximity to undisturbed, hilly grassland to the east of the building (USFWS 2008a).

Protected and Sensitive Species

Protected and sensitive species that could occur in the project area were identified through literature searches. Ground surveys were not performed due to the heavily disturbed nature of the project area and the general lack of natural habitat.

The protected and sensitive species listed in Table 3.4-1 were compiled from two sources. The US Fish and Wildlife Service (USFWS) maintains a list of endangered, threatened, and candidate species as determined under the Endangered Species Act (ESA). A query under Section 7 of the ESA was made to determine what species could occur in the project area. The Oregon Natural Heritage Information Center (ORNHIC) maintains a list of rare, threatened, and endangered species as determined by the state of Oregon under the Oregon Endangered Species Act (OESA). The ORNHIC list was also queried. ORNHIC list numbers are also given and an explanation of the numbers is given below. The table also lists the potential for the species to occur at the proposed project site. Potential for occurrence was determined based on an evaluation of the type of habitat (or lack of habitat) at the project site. Special status designations are described further, below.

Federal Status

Federal status is based on a listing under the ESA. Species listed as “endangered” are at risk of extinction from all or some of their current range in the foreseeable future. Species listed as “threatened” are at risk of becoming endangered in the foreseeable future. A species listed as a “candidate” is a species for which the USFWS has adequate information to support a proposal to list the species under the ESA. A “species of concern” is under review for listing as a candidate. Species that are “not listed” do not have special status under the ESA.

State Status

State status is based on the OESA. Species listed as “endangered” are at risk of extinction from all or some of their current range in the foreseeable future. Species listed as “threatened” are at risk of becoming endangered in the foreseeable future. Species with “critical” status are species that would be listed as threatened or endangered if immediate actions of conservation are not taken. Species with “vulnerable” status do not require conservation efforts to prevent from becoming endangered; however, they could gain a “critical”, “threatened”, or “endangered” status if there are changes in habitat, threats, or populations. Species with “undetermined” status are species for which a status is unclear. Additional information would be needed to make a determination. Species that are “not listed” do not have special status under the OESA.

Table 3.4-1: Special Status Species with Potential to Occur in the Project Region

Common Name Scientific Name	Listing Status	Habitat Remarks	Potential to Occur on Site
Plants			
Salt heliotrope (*Heliotropium curassavicum*)	Federal Status: Not listed State Status: Not listed ORNHIC List: 2	Wetlands	None
Short-podded thelypody (*Thelypodium brachycarpum*)	Federal Status: Species of concern State Status: Not listed ORNHIC List: 2	Damp open flats and meadows with alkaline soils	None
Howell's thelypody (*Thelypodium howellii ssp. Howellii*)	Federal Status: Species of concern State Status: Not listed ORNHIC List: 2	Likely extirpated	None
Applegate's Milk vetch (*Astragalus applegatei*)	Federal Status: Endangered State Status: Not listed ORNHIC List: 4	Alkaline floodplain grasslands of the Klamath Basin that experience seasonal moisture	None
Invertebrates			
Montane peaclam (*Pisidium ultramontanum*)	Federal Status: Species of concern State Status: Not listed ORNHIC List: 1	Herbaceous wetland	None
Klamath duskysnail (*Colligyrus sp. 5*)	Federal Status: Not listed State Status: Not listed ORNHIC List: 1	River	None
Klamath pebblesnail (*Fluminicola sp. 5*)	Federal Status: Not listed State Status: Not listed ORNHIC List: 1	River	None
Archimedis springsnail (*Pyrgulopsis archimedis*)	Federal Status: Not listed State Status: Not listed ORNHIC List: 1	River	None
Klamath Lake springsnail (*Pyrgulopsis sp. 9*)	Federal Status: Not listed State Status: Not listed ORNHIC List: 1	Spring, freshwater	None
Black juga (*Juga nigrina*)	Federal Status: Not listed State Status: Not listed ORNHIC List: Not listed	Spring, freshwater	None
Scale lanx (snail) (*Lanx klamathensis*)	Federal Status: Not listed State Status: Not listed ORNHIC List: 1	River, freshwater	None
Great Basin ramshorn (snail) (*Helisoma newberryi newberryi*)	Federal Status: Not listed State Status: Not listed ORNHIC List: 1	Spring	None
Dall's ramshorn (snail) (*Vorticifex effuse dalli*)	Federal Status: Not listed State Status: Not listed ORNHIC List: 1	River	None
Klamath ramshorn (snail) (*Vorticifex klamathensis klamathensis*)	Federal Status: Not listed State Status: Not listed ORNHIC List: 1	River	None

Table 3.4-1 *(Continued)*: Special Status Species with Potential to Occur in the Project Region

Common Name Scientific Name	Listing Status	Habitat Remarks	Potential to Occur on Site
Mardon skipper butterfly (*Polites mardon*)	Federal Status: Candidate State Status: Not listed ORNHIC List: 1	Grassy openings in coniferous woodlands in mountainous regions	None
Reptiles			
Northern Pacific pond turtle (*Actinemys marmorata marmorata*)	Federal Status: Species of concern State Status: Critical ORNHIC List: 2	Shallow water	None
Amphibians			
Western toad (*Bufo boreas*)	Federal Status: Not listed State Status: Vulnerable ORNHIC List: 4	Shallow water, including desert springs and mountain wetlands. Burrows in loose soil	None
Oregon spotted frog (*Rana pretiosa*)	Federal Status: Candidate State Status: Critical ORNHIC List: 1	Shallow water, rarely ventures from stable body of water. Often on grassy bank of stream, lake, or marsh	None
Birds			
Harlequin duck (*Histrionicus histrionicus*)	Federal Status: Species of concern State Status: Undetermined ORNHIC List: 2	Spends winter in rough coastal waters; nests on rocky island or edge of fast-moving braided streams	None
Bald eagle (*Haliaeetus leucocephalus*)	Federal Status: Not listed State Status: Threatened ORNHIC List: 4	Prefers large, accessible trees. Breeding habitat is within 4 km of bodies of water	None
Purple martin (*Progne subis*)	Federal Status: Species of concern State Status: Critical ORNHIC List: 2	Frequently nests in buildings or near cities and water. Also nests in tree cavities	Low
Northern spotted owl (*Strix occidentalis caurina*)	Federal Status: Threatened State Status: Not listed ORNHIC List: 1	Typically old growth forests with large trees and large amounts of woody debris on ground	None
Yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	Federal Status: Candidate State Status: Not listed ORNHIC List: 2	Likely extirpated	None
Mammals			
Pallid bat (*Antrozous pallidus*)	Federal Status: Species of concern State Status: Vulnerable ORNHIC List: 2	Dry grasslands near rock outcrops. Roosts in buildings, rock crevices, or under bridges	Low
Pygmy rabbit (*Brachylagus idahoensis*)	Federal Status: Species of concern State Status: Vulnerable ORNHIC List: 2	Lands with dense chaparral and loose soils	Very low
American marten (*Martes Americana*)	Federal Status: Not listed State Status: Vulnerable ORNHIC List: 4	Dense deciduous, mixed, or coniferous forest. Also forested wetland	None

Table 3.4-1 *(Continued)*: Special Status Species with Potential to Occur in the Project Region

Common Name Scientific Name	Listing Status	Habitat Remarks	Potential to Occur on Site
Canada lynx (*Lynx canadensis*)	Federal Status: Threatened State Status: Not listed ORNHIC List: 2	Coniferous or mixed forest with dense groundcover. Will enter open areas to search for food	Very low
Fisher (*Martes pennanti*)	Federal Status: Candidate State Status: Not listed ORNHIC List: 2	Dense coniferous, mixed, and deciduous forests. Avoids areas with human activity	None
Fish			
Klamath largescale sucker (*Catostomus snyderi*)	Federal Status: Species of Concern State Status: Not listed ORNHIC List: 4	Freshwater	None
Shortnose sucker (*Chasmistes brevirostris*)	Federal Status: Endangered State Status: Endangered ORNHIC List: 1	Freshwater	None
Lost River sucker (*Deltistes luxatus*)	Federal Status: Endangered State Status: Endangered ORNHIC List: 1	Freshwater	None
Bull trout (*Salvelinus confluentus*)	Federal Status: Threatened State Status: Not listed ORNHIC List: 1	Freshwater	None

SOURCE: ORNHIC 2007; USFWS 2007; USFWS 2008b; NatureServe.org 2007

ORNHIC Listing

ORNHIC List One includes species that are threatened with extinction or presumed extinct from all previously-known habitats. List Two includes species that are threatened with extinction or presumed extinct from the state of Oregon. List Three contains species that may be endangered or threatened; more information is needed to make a definite finding. List Four contains species that are not endangered or threatened, but are a conservation concern.

3.4.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

Drilling and Testing

As illustrated in Figure 2.2-1, the geothermal well would be located on a paved area and partially on the lawn surrounding the parking lot. Drilling and testing would have no impact on biological resources.

Construction

Vegetation

General Vegetative Communities

All of the construction would take place on disturbed areas, including areas that have been paved. Disturbance to vegetative communities would be les than significant.

The proposed pipeline would be constructed from the parking lot to the heat exchange building, under an existing road. Trenching for construction would disturb some landscaped turf and some low quality grassy habitat near the heat exchange building.

The proposed power plant would be located near the heat exchange building in a disturbed, but grassy field. The vegetation in this area would be removed before construction of the power plant. Following construction, the area around the power plant and geothermal well would be landscaped according to the OIT Landscape Master Plan. This would include revegetation of all disturbed lands not required for plant operations. Removal of a small amount of low quality vegetation for construction of the power plant would not be considered an adverse effect to the general vegetative communities in the area. There is ample habitat to the east of the proposed project site that is of higher quality and is undisturbed.

Invasive Species

Project activities could contribute to the spread of invasive, nonnative species within the project area through surface disturbing activities and construction and drilling vehicles. The amount of land that is vegetated and/or undisturbed is minimal (0.09 acres). Weeds found during construction would be removed. Adverse impacts are not expected.

Wildlife

Most of the project area is located on paved or graveled surfaces. Only a small portion is vegetated and suitable for wildlife habitat (0.09 acres). The vegetated portion of the proposed project area supports limited habitat for a low diversity and low density of wildlife, limited primarily to rodents, lagomorphs, lizards, and snakes.

Removal of vegetation for the pipeline and power plant construction would likely displace common small mammals and reptiles; however, the surrounding habitat is plentiful and adequate to support these animals such that they would not be adversely impacted.

Several large pieces of equipment, as well as trucks and worker vehicles, would access the power plant site. Vehicles could crush or injure terrestrial wildlife. Keeping vehicles at low speeds would reduce the potential for wildlife mortality. Some mortality of common species such as lizards and voles would not be considered a significant adverse impact due to the abundance of these species.

Noise from construction, drilling, and testing may cause minor impacts to wildlife as the area is home to few wildlife species. Existing noise from the OIT campus, surrounding land uses (hospital, retirement home), and traffic on the adjacent road keep wildlife to a minimum in the project area. Increased noise levels could deter common small mammalian species from occupying the site; however, there is abundant land and habitat nearby for these animals. This impact would not be considered adverse.

Avian species could nest in the two juniper trees located near the heat exchange building; however, construction would occur outside of the nesting season for avian species (construction would occur in October and November, while nesting season is in the spring and summer). Avian species would not be adversely impacted by project activities.

Protected and Sensitive Species

No rare or sensitive plant species are expected to occur at the project site. Several wildlife species have a small potential for occurrence on the project site and could be impacted by project construction activities, as discussed below.

The Canada lynx (*Lynx canadensis*), a federal listed threatened species, may enter open areas if food is not abundant close to its habitat. However, population density of Canada lynx is naturally low, limited to about ten animals per 100 sq. km (NatureServe.org 2007), and the existing urbanized setting of the campus would likely deter the Canada lynx from approaching the proposed project site during construction. No adverse impacts to the Canada lynx or its habitat are expected.

The pygmy rabbit (*Brachylagus idahoensis*), a federal species of concern and state listed vulnerable species, has a very low potential for occurrence at the proposed project site. The pygmy rabbit typically lives among dense, large sagebrush that grows in loose soils. It digs small burrows that have three or more entrances (NatureServe.org 2007). The hillside several hundred feet east of the proposed project site provides adequate habitat for the Pygmy rabbit. The proposed project site itself is not an adequate habitat, but a rabbit from the nearby area may wander from the hillside. The rabbit would most likely disperse when construction commences in the mornings; however, any rabbit that could be located in stockpiled equipment could be harmed or injured by construction activities. Construction crews would stay within the designated construction areas. All pipelines would be capped at night to ensure that rabbits do not enter stockpiled equipment. Equipment would be checked in the morning for rabbits or other animals. If wildlife is found in equipment they would be allowed to leave the project area prior to moving equipment.

The pallid bat (*Antrozous pallidus*), a federal species of concern and state listed vulnerable species, roosts in buildings and rock crevices, and prefers to live in shrubland, and mixed and conifer woodland. No bats are known to roost in the heat exchange building. Adverse effects to the pallid bat are not expected.

The purple martin (*Progne subis*), a federal species of concern and state listed critical species, has a very low chance of occurring at the proposed project site. It roosts in abandoned woodpecker holes, tree cavities, rock crevices, and birdhouses. It frequently lives near towns and bodies of water. Suitable habitat for the purple martin does not exist on the project site. There are no crevices in the trees in the immediate vicinity of the proposed project area (Boyd 2008) and there are no nearby water sources. Noise from construction would discourage purple martins from entering the immediate project area. Adverse impacts are not expected.

Operation

Vegetation

General Vegetative Communities

The operation of the power plant and geothermal well would not have an adverse effect on general vegetative communities. Operation would not require removal of vegetation; access to and from the well and the power plant would be on gravel or paved access roads and pathways.

Invasive Species

The operation of the power plant and geothermal well would not cause the spread of invasive species, as access to the well and power plant would be on gravel or paved access roads and pathways.

Wildlife

Noise from the operation of the power plant may deter wildlife from entering the area; however, noise from the power plant would not be considerably greater than the existing noise in the area. General wildlife is acclimated to a moderate noise level and would not be adversely impacted.

Protected and Sensitive Species

There would be no threat to protected and sensitive species in the proposed project area during project operation. The project would not alter or extend into the nearby suitable habitat for the pygmy rabbit (*Brachylagus idahoensis*). The proposed project would not create suitable habitat for the pallid bat (*Antrozous pallidus*) due to the noise associated with the power plant. The project would not adversely affect bats.

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. No information pertinent to small-scale geothermal power plants would be developed from this location.

It is possible that other sources of funding, including private funds, could be obtained by OIT to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway.

3.5 Water Resources

3.5.1 AFFECTED ENVIRONMENT

Surface Water Hydrology

The closest body of water to Klamath Falls is Upper Klamath Lake, which lies approximately one mile to the west of the OIT campus. The lake's surface area ranges between 100 and 140 square miles (sq. mi.). The main streams discharging into Upper Klamath Lake are Williamson River, Wood River, and several small tributaries from the Cascade Range. The Klamath River flows out of Upper Klamath Lake. Flow out of Klamath Lake is restricted by a dam (USGS 2007). In 1982, daily mean discharge of the Link River south of Keno Canal, draining from Upper Klamath Lake, ranged from a low of 392 cubic feet/second in September to a high of 7,970 cubic feet/second in March (USGS 2008b). The Klamath River, draining from Lake Euwana, south of Upper Klamath Lake, is located about 4 miles south of the proposed project site. The proposed project area consists of well-drained soils and does not include any surface water bodies.

Groundwater Hydrology and Use

The hydrogeology of the Klamath Basin has been organized into four groups based on distinctive hydrologic characteristics.

- The ***Sedimentary Aquifer (SA)*** consists of alluvium and lacustrine deposits. The SA is common throughout the Klamath Basin. The thickest deposits of this unit are found in large valleys. Capacities in this unit range from 0.01 to 5 gallons per minute per foot (gpm/ft) of drawdown, enough for domestic application.
- The ***Volcanic Centers Aquifer (VCA)*** contains basalt, ash, cinders, and agglomerate. Typically the VCA is found in mountains, but it has been found locally in valleys. Capacities in this unit range from less than 1 to greater than 100 gpm/ft of drawdown.
- The ***Lower Basalt Aquifer (LBA)*** consists of mostly basalt. The water from the LBA is used for regional irrigation. It is highly permeable and its capacity ranges from 33 to 500 gpm/ft of drawdown.

- The ***Volcanic Ash Aquifer (VAA)***, which consists of tuff, breccia, volcanic ash, and basalt. The unit is the lowest stratigraphically of the four; thus, few wells have been drilled deep enough to reach it. In an area where it outcrops, capacity is similar to those of the SA (Shreve 1979).

The domestic water used on the OIT campus is obtained through two cold water wells located on the easternmost side of campus (north of the proposed power plant site) and tap into the sedimentary aquifer. Current demand on campus for potable water is 200 gpm. The capacity of the existing wells is 550 gpm.

The State of Oregon does not maintain many regulations regarding the operation of direct-use geothermal systems. Geothermal-well drilling and construction is regulated and permitted as normal groundwater use. Drilling a geothermal well that has a temperature of less than 250°F requires a start card and a well completion report that must be submitted to the Oregon Water Resources Department (WRD). Wells with a temperature greater than 250°F are under the control of the Oregon Department of Geology and Mineral Industries (DOGAMI). In both cases, a drilling log must be completed and filed to the WRD after the well has been drilled. If a well is located in Klamath Falls, then geothermal water must be injected back into the aquifer, per City of Klamath Falls regulation (OIT Geo-Heat Center 2005).

The geothermal resource is utilized in many direct-use applications such as space heating and snow melting in Klamath Falls. There are over 500 wells in the City of Klamath Fall, most under 1,000 feet deep, that utilize a resource less than 250^{0}F (OIT Geo-Heat Center 2005).

Water Quality

Regulations

Potable water in Klamath Falls is regulated by the Oregon Department of Human Health Drinking Water Program (DWP) Oregon Drinking Water Quality Act, and the EPA Safe Drinking Water Act. The State of Oregon has the responsibility for enforcing the Safe Drinking Water Act. The EPA and the State of Oregon annually agree on water quality activities to be completed with federal grant money (State of Oregon 2007).

The National Primary Drinking Water Regulations (NPDWR) Maximum Contaminant Level (MCL) is derived from regulations set forth by the Environmental Protection Agency (EPA). They are enforceable federal standards for public water systems. The Secondary Standard MCL is derived from the National Secondary Drinking Water Regulations (NSDWR) and is not enforceable, but the EPA recommends adherence to secondary standards. The NSDWR acts as a guideline to avoid contaminants that potentially lead to cosmetic or aesthetic effects.

Surface Water Quality

The closest body of water to the project site is Upper Klamath Lake, which is approximately one mile to the west of the OIT campus. A Total Maximum Daily Load (TMDL) has been established for Upper Klamath Lake and Agency Lake. Both lakes have high nutrient levels and are subject to algal blooms. The algal blooms alter water chemistry and can make water unsuitable for fish. The algal blooms often cause violations of Oregon’s water quality standards for dissolved oxygen, pH, and free ammonia (DEQ 2002). Upper Klamath Lake was listed as water-quality limited for resident fish and aquatic life, but was delisted in 2006 (DEQ 2006).

Groundwater Quality

Potable Water

The City of Klamath Falls obtains its potable water supply from deep, isolated aquifers, which lack the impurities and contaminates that are common in surface water. The City of Klamath Falls performs annual testing of its water supply. The water quality test performed in 2007 determined that the quality of Klamath Falls' potable water was consistent with federal and state drinking water regulations (City of Klamath Falls 2007).

OIT supplies its own potable water from two wells on the east side of the campus. These wells are not believed to be connected to the same fresh water aquifer as is utilized throughout the rest of the city. OIT treats its potable water for arsenic (Travis, personal communication 2008).

Geothermal Water

Geothermal water from the OIT production well was sampled and tested in March 1990 (see Appendix E). The water contains noticeably raised amounts of some dissolved solids and is therefore not currently used for any potable systems. Table 3.5-1 lists the concentration of NPDWR and secondary standard MCLs found in the existing geothermal wells on campus.

Elevated levels of sulfate or iron give water a salty taste. Additionally, sulfate gives water a strong odor. Arsenic can cause damage to the circulatory system and skin, and increase the risk of developing cancer (EPA 2008b).

Table 3.5-1: Quality of Production Well Water at OIT, 1990

Analysis	Concentration	EPA Secondary MCL or NPDWR MCL
Sulfate	490 mg/L	Secondary MCL: 250 mg/L
Iron	0.44 mg/L	Secondary MCL: 0.3 mg/L
Arsenic	0.048 mg/L	NPDWR MCL: 0.010 mg/L

SOURCE: Klamath Environmental Services 1990, EPA 2008b

3.5.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

Drilling and Testing

Surface Water Hydrology

There are no surface waters in the project area. Drilling and testing would not impact the hydrology of any surface water bodies. Water from testing would be collected and injected or disposed.

Groundwater Hydrology and Use

The drilling of the new deep production well and construction of the power plant would not impact groundwater hydrology. During drilling, up to 20,000 gallons of fresh water would be needed per day. A 10,000-gallon water truck would remain on site for storage of water and emergency use. The existing cold water wells supply an average of about 200 gpm of water. The wells' combined capacity is about 550 gpm and would therefore have sufficient flow to meet current demand as well as construction demand. The aquifer has sufficient supply for this temporary demand and adverse impacts to groundwater hydrology are not expected.

Construction

Surface Water Hydrology

There are no surface waters in the project area. The project construction would not impact the hydrology of any surface water bodies.

Groundwater Hydrology and Use

Construction would occur on the surface and would not impact groundwater hydrology or use.

Water Quality

The project site experiences very minimal overland flow (due to the well-drained nature of the soil). Water run-off follows manmade drainage paths in the parking lot. The total area of ground disturbance (not including disturbance of pavement in the parking lot) is less than 0.25 acres; however, the total project area is about 1.2 acres. A General Construction National Pollutant Discharge Elimination System (NPDES) permit would be required for this project. Enrollment under this general permit would be applied for just prior to construction.

Stormwater run-off could become contaminated with petroleum fuel, oil, or grease from construction vehicles and equipment and from drilling mud and fluids. Contamination of storm-water run-off at the drilling pad would be minimized through drainage and collection of run-off in the reserve tank. Contamination along the pipeline corridor and at the power plant site would be minimized through containment of any spills before they could be released into stormwater. OIT would implement a Spill Prevention, Control and Countermeasure Plan (SPCC) on-site to contain incidental drips and/or spills. Containment berms would be constructed around all hazardous material or potentially hazardous material storage for both construction and operation.

Effects to water quality from the proposed project would not be adverse.

Operation

Surface Water Hydrology

Project operation would not impact surface waters. Drainage patterns would be largely unchanged after construction except for a slight increase in surface-water runoff due to soil compaction and removal of vegetation from the proposed power plant location. There are no water bodies in the project area. Adverse effects to surface water hydrology are not expected.

Ground Water Hydrology and Use

Groundwater hydrology could be impacted by pumping of the proposed production well. Impacts could include groundwater drawdown in existing wells. Effects to the geothermal resource are addressed in Section 3.2 Geology and Soils.

Pumping tests were previously performed prior to the installation of the City of Klamath Falls' geothermal direct-use system in the 1970s. Pumping tests showed some groundwater drawdown on the order of less than 1 foot to 4 feet in wells surrounding a pumped well. Weather, such as rainfall and snowmelt, was found to affect well water levels to a greater degree than groundwater pumping. The studies also showed that the horizontal influence from well to well is limited, with greater influence in north-south directions than east-west directions. The drawndown in surrounding wells is proportional to the distance from the pumped well; the farther away a surrounding well is from the pumped well, the less draw down it experiences (City of Klamath Falls 1979).

The geothermal reservoir below Klamath Falls is highly permeable in both the vertical and horizontal directions and has circulation depths up to 14,000 feet. There are four geothermal production wells in the immediate vicinity of the proposed project area, three of which belong to OIT and the fourth, which belongs to the Sky Lakes Medical Center, located approximately 210 feet southeast of the proposed well site. The proposed OIT deep geothermal well would be the deepest well in Klamath Falls. Current pumping by Sky Lakes and OIT has not resulted in problematic well drawdown in existing wells (Lund personal communication 2008). The cold water supply for the OIT campus is located on the eastern side of the normal fault and is believed to be unconnected to the geothermal system and groundwater supply to the west of the fault. Long-term pumping of the proposed production well would not likely have an adverse effect on water levels and accessibility of other geothermal and groundwater wells given the depth of the proposed well and its proximity to other wells.

A binary Rankine cycle power plant does not consume any of the geothermal fluid; all geothermal fluid would be injected to the geothermal aquifer through the existing injection wells after passing through the direct use system (William E. Nork, Inc 1992). Cooling water would be supplied to a cooling tower at a rate of 30 gpm. This rate of withdrawal would not have an adverse effect on the groundwater aquifer.

Effects associated with groundwater quality from injection are addressed below.

Water Quality

Water quality impacts from project operation include potential hazardous material spills and impacts to surface waters from dispersed constituents from the power plant cooling towers. Groundwater quality could also be impacted by injection.

Hydrocarbon storage capacity would be required for a binary Rankine cycle power plant. The hydrocarbon (pentane) would be stored in a single tank that would have a volume of 2,000 gallons or less. The tank would be surrounded by a berm high enough to contain any spill. A SPCC plan would be kept at the power plant to contain any spills if they were to occur. The well also requires a 50-gallon barrel of oil to lubricate the well and pump parts. The well head would be contained in a shed and any spills would be contained within the shed. Adverse impacts to water quality from potential spills are not expected.

A binary plant would not have emissions of dissolved solids or heavy metals from the geothermal fluid. The fresh water make-up for the cooling tower contains very slightly elevated levels of naturally occurring arsenic. Any trace amounts of arsenic that disperse into the air with the steam would likely settle back to the ground within proximity to the power plant and would not have an adverse effect on any water body or on surface or groundwater quality.

Groundwater quality could be impacted by injection. The spent geothermal fluid would be injected through the existing injection system wells, which are shallower than the proposed production well. The water chemistry of the existing geothermal wells is presented in Appendix E. The proposed production well would intercept the same fault as the existing geothermal wells, but at a greater depth. There is a chance that the geothermal water from the proposed production well would have a higher concentration of total dissolved solids because it would have a higher temperature. Any greater TDS would precipitate; however, as the water cools in the power plant. The system would be designed to remove solids and constituents, as necessary. The estimated temperature of the water from the proposed well is 300 ^{0}F. About 100 ^{0}F would be converted to power by the binary plant. The resultant temperature of the water after passing through the power plant would be about 200 ^{0}F, which is comparable to the temperature in the direct use system. The chemistry of the water is expected to be the same as the direct use system water at that temperature. The specifications of the power plant and its design will depend upon the temperature flow and chemistry of the water. The design takes the chemical properties of the water into consideration to ensure that precipitation of solids will not foul the system and to ensure that the chemistry of the water leaving the system would be similar to the chemistry of the existing geothermal well water and therefore compatible. No mitigation is necessary.

After passing through the power plant, the cooled geothermal water would pass through the direct use system along with the water from the existing 3 wells. All buildings use plate heat exchangers to keep the geothermal water out of the heating systems. The heat exchangers are regularly serviced and cleaned and wastes properly disposed. After passing through the heating system, the water is then injected on the east side of campus. The water injected into the injection wells is expected to have the same chemistry as the water that is currently injected, since temperature would be the same as the fluid currently injected.

Impacts on water quality from injection were previously investigated. An evaluation of water quality impacts of injection for the existing system was prepared in 1993 by William E. Nork, Inc. The evaluations found that the thermal and cold-water aquifers may be coupled near the injection wells. The study investigated whether or not the effluent would impact the chemical quality of the groundwater down-gradient of the injection wells. Thermal effluent is hotter and higher in TDS, chloride, sulfate, arsenic, and boron. Water level contour maps were prepared in this study. Groundwater was found to flow southerly from the injection wells. The width of the thermal effluent plume for the maximum capacity of the wells was calculated using Darcy's Law. The analysis showed that none of the wells down-gradient from the injection wells would be impacted by the plume (William E. Nork, Inc. 1993). The study did note that some deeper thermal wells down gradient and within the plume would likely benefit from injection at OIT. Impacts to the quality of accessed groundwater are therefore not expected to be adverse.

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. No information pertinent to small-scale geothermal power plants would be developed from this location.

It is possible that other sources of funding, including private funds, could be obtained by OIT to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway.

3.6 Cultural Resources

3.6.1 AFFECTED ENVIRONMENT

Cultural and Historic Resources

Introduction

Cultural resources include landscapes and places, and archaeological sites and objects. Examples of cultural resources include, but are not limited to, the following:

- Mountain tops
- Rock art
- Refuse deposits
- Houses
- Railroads
- Lithic scatters
- Quarry sites
- Foundations
- Tailings
- Rails

A cultural resource must be more than 50 years old.

Cultural and Historical Resources Setting

The Klamath Basin was prehistorically occupied by the Klamath Indians. The Klamath, who call themselves maklaks, are an American Indian ethnic group located in southwestern Oregon. The Klamath derived most of their subsistence from rivers and marshes. Fish was the staple of their diet, and pond lily seeds were also important. Roots were gathered to some extent. Deer and other game were of minor dietary importance.

Permanent settlements of earth and mat lodges were located on the banks of rivers. These settlements were occupied during the winter months. They ranged in size from "several score" to one or two lodges. In the early spring, the people left the villages for fish runs. In the summer, small bands of two or three families occupied the prairies to collect roots and berries and other edible plants. Toward the end of the summer the pond lily seeds ripened, and the people gathered together at the marshes to harvest them. They returned to the same winter villages year after year. In spite of the fact that the environment had relatively abundant foodstuffs, the population was not very large. It has been estimated that aboriginally, the Klamath numbered between 800 and 1,400.

The Klamath's ancestral territory spanned from present-day south central Oregon down into northern California. There were five or six geographical divisions of the Klamath. The largest one was in the vicinity of Klamath Marsh. Other groups lived in the vicinity of Agency Lake, the lower Williamson River, Pelican Bay, Klamath Falls, and the Sprague River Valley. There was some tendency toward endogamy[6] within these divisions, but there was no political unity.

The Klamaths are closely related to the neighboring Modoc Indians. Both the Klamath and the Modoc speak the Lutuami language, which has been assigned to the Klamath-Sahaptin family of the Pneutian phylum. Originally, the Klamath-Modoc were situated in an area which abounded in marshes and streams. According to Stern (1965), the Klamath lived in a relatively isolated position, with the Cascades on the west, hills on the south and east, and rather harsh territory on the north.

Due to their isolation, the Klamaths escaped the great epidemics that victimized most tribes in the wake of European contact. Their history is not marred by a pattern of violent confrontations with white settlers. The Klamath were first contacted by white settlers in 1826. Since there were few fur-bearing animals in the area, white settlers remained uninterested in the Klamath for some time. It is reported that even by the middle of the nineteenth century, there was only one gun among the Klamath.

In 1864, the Klamath ceded most of their land to the US government and, with the Modoc and Paiute, were placed on the Klamath Reservation. Due to extensive intermarriage and migration, the Klamath constituted an "ethnic minority in the communities where they resided, even within the reservation." There were 2,118 members of the Klamath tribe in 1955, and 40 percent of them lived off the reservation. As of 1963, 70 percent of the members were less than one-half Indian, and less than one-sixth were full-bloods (Clifton and Levine 1963: 6). In 1954, the membership voted for termination of federal administration of the reservation (Martin 2008).

Historic Resources

The OIT campus has a recent history and was moved to its current location in 1963 in order to utilize the geothermal resources to heat the campus. There are no historic resources or buildings in the vicinity of the proposed project.

There are no known historic structures or archaeological resources on the proposed project site.

Native American Values

There are several Federal laws and policy which are applicable to the consideration of Native American values. Of particular importance are:

[6] The social practice of marrying another member of the same clan, people, or other kinship group

- American Indian Religious Freedom Act of 1978 (AIRFA): Requires federal agencies to take into account the effect of their actions on Native American traditional religious practices prior to actions being authorized.
- Native American Graves Protection and Repatriation Act of 1990 (NAGPRA): The intent of this legislation is to ensure that disposition of Native American human remains and associated funerary objects shall be controlled by individuals or groups determined to be most closely associated with the materials.
- Traditional Cultural Properties (TCP): National Register (US Department of the Interior) Bulletin 38 discusses properties that can be determined to be eligible for inclusion on the National Register of Historic Places because of their association with beliefs of cultural practices of a living community that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community.

The Native American tribes in the project area include the Modoc, Klamath, and Yahooskin tribes. The nearest reservation to the proposed project site is the XL Ranch, located in California about 75 miles southeast of the proposed project site (NPS 1996). There are no areas of known traditional cultural properties, traditional uses, or sacred sites in the vicinity of the proposed project.

The DOE has notified the Klamath Tribes of the proposed project and received no comments or concerns. .

3.6.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

Cultural and Historical Resources

The project would be constructed entirely within previously disturbed areas. The Oregon State Historic Preservation Office was consulted and it was determined that there is no likelihood of impacting historic properties (Poyser, personal communication 2008). There are no known archeological resources in the project area and construction and operation of the project would not impact any archaeological resource.

The OIT campus was built in 1963 and there are no historic buildings in the project vicinity. The project would have no adverse effects on historic properties.

Native American Values

There are no Native American TCPs or sacred sites within the proposed project area that would be affected by project construction or operation. The project would be located entirely within currently disturbed areas in an urban environment. The proposed project would not have an adverse impact on Native American properties or values.

No Action Alternative

There would be no impacts under the No Action alternative, because no cultural or historical resources or sensitive Native American values were identified in the project location.

3.7 Land Use

3.7.1 AFFECTED ENVIRONMENT

Fifty-five percent of Klamath County lands are publicly owned (federal or state). Land use in south-central Oregon is predominately open forest, with much of the land managed by the US Forest Service. The large percentage of forest lands in the Klamath Basin accounts for lumber and wood products comprising a sizable industry in the County (Oregon.com 2008). Some agricultural activity is found in rural areas. Keeping of livestock is the main agricultural activity that occurs in the project region. Beef cattle are the dominant livestock type. Other common livestock include sheep, dairy cows, horses, and swine. Field crops grown include potatoes, alfalfa, clover seed, wheat barely, and onions.

The project is located in the City of Klamath Falls. The City limits of Klamath Falls lies along the perimeter of the OIT campus. Land use and planning in the city is guided by the City of Klamath Falls Comprehensive Plan (City of Klamath Falls 1981), which is implemented by the Community Development Department.

The proposed project is located on the OIT campus, which is zoned as “public” by the City of Klamath Falls (City of Klamath Falls 1981). Sky Lake Medical Center is adjacent to the OIT campus on the south side. The medical center is zoned Medical Professional. Just east of the hospital and south of the proposed power plant location is Crystal Terrace Retirement Center, zoned Medium Density Residential.

Other nearby land uses include:

- Neighborhood Commercial
- General Commercial
- Apartment Residential
- Single Family Residential
- Light Industrial

Klamath County has jurisdiction over lands just to the north and east of the OIT campus. These lands are zoned by the County as Forest Range, High Density Residential, Non-Resource, and Rural Residential (Klamath County 2008).

3.7.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

The current land use around the proposed site is public university zoned as “public” by the City of Klamath Falls. The “public” designation includes “outright” permitting of public utilities (i.e. no Conditional Use provisions apply). The construction of the proposed project is therefore in compliance with the current zoning designation. Three existing geothermal wells are currently located on the campus and provide for a district heating system. The proposed project would not interfere with existing geothermal uses on campus or nearby. Construction and operation of the proposed deep geothermal well and power plant would not interfere with existing land uses and would not require a change in land use.

The project would meet all zoning code requirements for site standards. City zoning code requires 10-foot setbacks around the property boundaries and a 15-foot setback from residential zones. The proposed power plant would meet these requirements. The maximum building height is 70 feet for public facilities. The proposed cooling towers would be 24 feet tall, meeting all height restrictions. The facilities would comply with all zoning ordinances.

The project would result in the permanent loss of about 4 parking spaces. The City of Klamath Falls Community Development Ordinance has minimum parking requirements for buildings. Refer to section 3.9 Infrastructure for a discussion of temporary and permanent parking space reduction.

Adverse effects to land use and planning are not expected.

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or the power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. It is possible, however, that other sources of funding, including private funds, could be obtained by OIT to develop the project. In such a case, the No Action Alternative would have identical impacts as the Proposed Action in respect to Land Use. These impacts would not be considered adverse.

3.8 Noise

3.8.1 AFFECTED ENVIRONMENT

Noise Definitions

Noise is defined as unwanted sound. Sound becomes “noise” when it interferes with sleep or conversation and when it causes physical harm. Human perception of noise is subjective and varies considerably. Background noise is the average noise level caused by all noise sources in an area. The background noise level gradually changes in response to the level of activity nearby. Intrusive noise is caused by isolated events that clearly stand out from the background; these events are responsible for much of the annoyance caused by noise.

Airborne sound is a rapid fluctuation of air pressure above and below atmospheric pressure. Sound levels are usually measured and expressed in decibels (dB) with 0 dB corresponding roughly to the threshold of hearing. Decibels and other technical terms are defined in Table 3.8-1.

Most of the sounds that we hear in the environment do not consist of a single frequency, but a broad band of frequencies, with each frequency differing in sound level. The intensities of each frequency combine to generate a sound. The method commonly used to quantify environmental sounds consists of evaluating all of the frequencies of a sound in accordance with a filter that reflects the fact that human hearing is less sensitive at low frequencies and extremely high frequencies than in mid-range frequencies. This is called "A" weighting; the decibel level measured is called the A-weighted sound level (dBA). The level of a sound source is conveniently measured using a sound level meter that includes an electrical filter corresponding to the A-weighting curve. Typical A-weighted levels measured in the environment and in industry are shown in Table 3.8-2 for different types of noise.

Although the A-weighted noise level may adequately indicate the level of environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise includes a conglomeration of noise from distant sources, which create a relatively steady background noise in which no particular source is identifiable. To describe the time-varying character of environmental noise, the statistical noise descriptors, L_{01}, L_{10}, L_{50}, and L_{90}, are commonly used. They are the A-weighted noise levels equaled or exceeded during 1 percent, 10 percent, 50 percent, and 90 percent of a stated time period. A single number descriptor called the L_{eq} is also widely used. The L_{eq} is the average A-weighted noise level during a stated period of time.

In determining the daily level of environmental noise, it is important to account for the difference in response of people to daytime and nighttime noises. Exterior background noises are generally lower during the nighttime than during the daytime. Most household noise also decreases at night and exterior noise becomes very noticeable despite reduced noise level. Most people sleep at night and are very sensitive to noise intrusion. To account for human sensitivity to nighttime noise levels, a descriptor, L_{dn} (day/night average sound level), was developed. The L_{dn} divides the 24-

Table 3.8-1: Definition of Acoustical Terms Used in this Report

Terms	Definitions
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e.g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sound are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period. The hourly L_{eq} used for this report is denoted as dBA $L_{eq[h]}$.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 pm to 10:00 pm and after addition of 10 decibels to sound levels in the night between 10:00 pm and 7:00 am.
Day/Night Noise Level, L_{dn}	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content, as well as the prevailing ambient noise level.

SOURCE: Caltrans 1998

hour day into the daytime of 7:00 AM to 10:00 PM and the nighttime of 10:00 PM to 7:00 AM. The nighttime noise level is weighted 10 dB higher than the daytime noise level.

Noise Standards and Policies

Several federal government agencies and states have developed guidelines regarding the types of land uses that are acceptable within noise-impacted areas. Where state guidelines are unavailable, local governments normally rely on the federal standards.

The City of Klamath Falls has provisions in their City Code to protect the city's citizens from excessive noise, as listed below:

- Section 5.318 Unreasonable Noise. No person shall create, assist in creating, permit, continue, or permit the continuance of any unreasonably loud, disturbing, or unnecessary noise in the City.

Table 3.8-2: Typical Noise Levels in the Environment

Common Outdoor Noise Source	Noise Level (dBA)	Common Indoor Noise Source
	120 dBA	
Jet fly-over at 300 meters		Rock concert
	110 dBA	
Pile driver at 20 meters	100 dBA	
		Night club with live music
	90 dBA	
Large truck pass by at 15 meters		
	80 dBA	Noisy restaurant
		Garbage disposal at 1 meter
Gas lawn mower at 30 meters	70 dBA	Vacuum cleaner at 3 meters
Commercial/Urban area daytime		Normal speech at 1 meter
Suburban expressway at 90 meters	60 dBA	
Suburban daytime		Active office environment
	50 dBA	
Urban area night-time		Quiet office environment
	40 dBA	
Suburban night-time		
Quiet rural areas	30 dBA	Library
		Quiet bedroom at night
Wilderness area	20 dBA	
Most quiet remote areas	10 dBA	Quiet recording studio
Threshold of human hearing	0 dBA	Threshold of human hearing

SOURCE: Caltrans 1998

Section 8.280 of the City Code gives the city authority to attach conditions to well drilling permits that include restricting hours of well construction and/or requiring noise muffling to assure compatibility with surrounding land-uses (City of Klamath Falls 2008a). The city has a policy to respond to all noise complaints and generally allows construction noise during the daytime hours (between 7 a.m. and dusk), recognizing that construction may sometimes need to continue after typical construction hours. The city does not have defined numerical noise standards for construction (Slaughter, personal communication 2008a). The permit will be applied for after completion of the EA.

The Oregon DEQ has standards regarding new industrial or commercial noise sources located on previous industrial or commercial sites. The proposed project area is not an industrial site, but the power plant could be considered an “industrial noise source,” which is defined as any noise source that generates industrial-type noises (DEQ 2008). DEQ regulations provide that “No person owning or controlling a new industrial or commercial noise source located on a previously used industrial or commercial site shall cause or permit the operation of that noise source if the statistical noise levels generated by that new source and measured at an appropriate measurement point, specified in subsection (3)(b)[7] of this rule, exceed the levels specified in [Table 3.8-3]… (DEQ 2008).” Construction sites and equipment are exempt from these rules. DEQ standards would apply to the power plant operation.

Table 3.8-3: New Industrial and Commercial Noise Source Standards

Allowable Statistical Noise Levels in Any One Hour	
7 am – 10 pm	***10 pm – 7 am***
L_{50} – 55 dBA	L_{50} – 50 dBA
L_{10} – 60 dBA	L_{10} – 55 dBA
L_{1} - 75 dBA	L_{1} – 60 dBA

SOURCE: DEQ 2008

Noise Sources in Project Area

Noise sources in the project area are typical to an urban landscape. Noise sources include vehicles traveling along the highway (located approximately 0.6 miles from the project site) and construction in various areas. Jet flyovers, both commercial and military aircraft, likely produce the highest levels of intermittent acoustic noise in the City of Klamath Falls.

The project site would be located on the OIT campus. Noise levels at the OIT campus are currently higher than would be typical to a university campus due to construction of new buildings adjacent to the proposed project area (the extension of the Health Services Building). The Sky Lakes Medical Center, also adjacent to the OIT campus, recently conducted major construction of a new wing to the hospital, which resulted in elevated noise levels for the duration of the construction.

[7](3) Measurements

(b) Unless otherwise specified, the appropriate measurement point shall be that point on the noise sensitive property, described below, which is further from the noise source:

- 25 feet (7.6 meters) toward the noise source from that point on the noise sensitive building nearest the noise source;
- That point on the noise sensitive property line nearest the noise source.

Construction activities have been on-going in the immediate project area for various projects for approximately 2 years.

Sensitive receptors to noise at the proposed project location include the residents and employees of Sky Lakes Medical Center, the Crystal Terrace Retirement Center, and the on-campus dormitory at OIT. However, there is a 25-foot high bank between the drill site and Crystal Terrace Retirement Center blocking the sight and sound.

3.8.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

Drilling and Testing

Noise from drilling the deep geothermal well would have the most effect, as drilling must occur 24 hours per day. Noise impacts from drilling would be temporary. Sensitive noise receptors include the hospital, the retirement center, and the dormitory.

Table 3.8-4 shows the typical noise from various drilling activities at varying distances.

The closest sensitive receptors to the drilling site are the Sky Lakes Medical Center, the Crystal Terrace Retirement Center, and the dormitory, as shown in Table 3.8-5. The edge of the Sky Lakes Medical Center building is approximately 402 feet from the proposed drill pad. This table shows that noise heard by the three nearest sensitive receptors would be comparable to a suburban expressway at 90 meters (about 295 feet). Despite the temporary nature of the drilling, it could generate exterior noise from 62 to 69 dBA, noticeable to sensitive receptors during night hours. Standard construction typically provides about 15 dBA of noise reduction between exterior and interior noise levels with the windows partially open. The interior noise levels would therefore be about 47 to 54 dBA, which is above normally acceptable levels of 40 dBA for noise sensitive receptors. It should be noted that no patient rooms are located along the northern side of the hospital, closest to the drilling site; however, adverse noise effects could still result.

Table 3.8-4: Typical Noise from Geothermal Drilling Activities (dBA)

Activity	100 ft.	200 ft.	500 ft.	1,000 ft.	2,000 ft.	5,000 ft.
Site preparation and construction	78	73	66	58	50	38
Well drilling	75	68	60	53	44	30
Well clean out	75	68	58	50	41	25
Flow testing	78	73	66	59	52	42

NOTES: Identified noise levels are given for various distances from a proposed noise-generating source. These noise levels do not account for the topographical barriers throughout the project vicinity, which may absorb or deflect sound waves, thereby reducing noise levels.

SOURCE: CEGC 1994

Table 3.8-5: Sensitive Receptors and Estimated Noise Heard from Drilling

Name of Sensitive Receptor	Approximate Distance from Proposed Drilling Location	Estimated Noise Heard from Drilling Activities
Sky Lakes Medical Center	496 feet	66 dBA
Crystal Terrace Retirement Center	771 feet	62 dBA
Student on-campus housing	354 feet	69 dBA

Adverse effects would be reduced through installation of temporary noise screening equipment around the well pad site, as described in the proposed action.. The screening equipment would be no taller than the top of the base of the drill rig (about 12 feet high) to minimize visual impacts associated with the wall. Screening would provide a 5 to 15 dBA reduction in noise (USDOT 2000).

All neighbors would be contacted prior to construction regarding the timeframe and estimated noise levels from the proposed project and provided a hotline for answering noise complaints. The injection well for the Sky Lakes Medical Center was drilled about 20 years ago. The drilling took about 6 months and was conducted 24 hours per day. No noise issues were raised (Lund, personal communication 2008).

Construction

Construction and drilling noise levels, by their nature, can be difficult to quantify. The amount of construction and drilling noise is directly proportional to the amount of activity occurring and the level of sound energy produced by the equipment involved. On a construction project, the level of activity and type of equipment can be varying and difficult to predict. For these reasons, the ranges of noise levels of construction equipment are usually listed and typically, no effort is made to predict the specific level of construction noise. Land use activities that may be affected by construction noise should be noted. Identification of such land use activities can aid in consideration of construction noise abatement strategies.

General construction noise would result from the use of heavy equipment for construction of the pipeline and power plant. Maximum noise levels generated by construction activities typically range from about 85 to 90 dBA at a distance of 50 feet. Typical hourly average construction noise levels are about 10 dBA less during busy construction periods (e.g., while earth moving equipment is operating). Table 3.8-6 lists the estimated maximum construction noise at sensitive noise receptors.

Table 3.8-6: Sensitive Receptors and Estimated Noise Heard from Construction

Name of Sensitive Receptor	Approximate Distance from Proposed Power Plant Location	Estimated Maximum Noise Heard from Drilling Activities
Sky Lakes Medical Center	607 feet	64 dBA
Crystal Terrace Retirement Center	629 feet	64 dBA
Student on-campus housing	730 feet	62 dBA

Construction of the pipeline and power plant would only occur during typical working hours. Maximum noise would range from about 62 to 64 dBA, with hourly averages from about 52 to 54 dBA. Noise generation would be in the acceptable range for daytime hours (acceptable noise range for daytime is 55 to 75 dBA (Table 3.8-3)). Construction would not occur during the night time. Noise levels may be elevated during construction; however, general construction noise has been ongoing in the project area for several projects over the last few years. Impacts from construction are not expected to be adverse with implementation of measures that require noise screening, mufflers and noise abatement equipment on construction equipment, notification of all neighbors of construction, and a hotline for accepting noise complaints.

Operation

Project operation noise would be limited to noises generated by the power plant. The turbine and cooling fans of the proposed power plant would be the greatest source of long-term noise generated by the project.

Turbines and cooling tower fans can generate up to 85 dBA of noise at 3 to 5 feet from the turbines (DOE 2002). Students and professors at OIT studying the power plant facility up close would experience noise levels equivalent to a night club with loud music, according to Table 3.8-7. The Sky Lakes Medical Center, Crystal Terrace Retirement Center, and student on-campus residences are located at a great enough distance from the proposed power plant site that noise levels would not be adversely loud. Noise attenuates at a rate of 6 dBA for each doubling of distance from the receptor. Table 3.8-7 shows the approximate distances each sensitive receptor is from the proposed power plant site and the estimated noise heard at each receptor resulting from the turbines and cooling fans. The table shows that noise generated by the turbine and cooling tower fans would attenuate to safe levels before reaching the sensitive receptors. Noise would be attenuated to imperceptible on the interior of the building. Impacts related to operation would not be adverse and would not exceed recommended levels.

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or the power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. It is possible, however, that other sources of funding, including private funds, could be obtained by OIT to develop the project. In such a case, the No Action Alternative would have identical impacts as the Proposed Action in respect to Acoustic Noise. These impacts would be considered adverse regarding construction noise.

Table 3.8-7: Sensitive Receptors and Estimated Noise Heard from Operation

Name of Sensitive Receptor	Approximate Distance from Proposed Power Plant Location	Estimated Noise Heard from the Turbines and Cooling Towers
Sky Lakes Medical Center	607 feet	43 dBA
Crystal Terrace Retirement Center	629 feet	43 dBA
Student on-campus housing	730 feet	41 dBA

3.9 Infrastructure

3.9.1 AFFECTED ENVIRONMENT

Water

OIT currently supplies their own water from two cold water wells located near the heat exchange building on the east side of the OIT campus (see Figure 2.2-1). These wells have a combined capacity of 550 gpm. The wells supply an average of 200 gpm of water for current campus demands in the fall months. Groundwater requires treatment for high arsenic levels.

Wastewater

The OIT campus is currently connected to the City of Klamath Falls' sewer system. The Klamath City Wastewater Division of the Public Works Department (Division) manages wastewater and the sewage system in the city. The Division provides services to nearly 20,000 city residents and Klamath Basin area customers. The Division provides sewage collection/treatment and storm water collection services for the residents of Klamath Falls. The Division also provides sewage treatment services for a major residential development and a major destination resort/residential development that are outside of the city limits. The Division has recently upgraded the city's wastewater treatment plant (City of Klamath Falls 2008b).

Electricity

OIT currently receives its electricity from Pacific Power and Light Company (PP&L). Formed in 1910, PP&L started from several small electric companies and served 7,000 customers in Astoria and Pendleton, Oregon and Yakima and Walla Walla, Washington. PP&L acquired other companies, properties, and service areas once it was established. The utility began building transmission systems and extensions to serve rural customers in Oregon and Washington, and later, Wyoming, Montana and Northern California.

PP&L generates power from the following resources (PP&L 2008):

- Coal-fired plants
- Hydroelectric facilities
- Gas-fired plants
- Solar
- Wind projects

A PP&L transformer is located directly east of the heat exchange building on the OIT campus. A PP&L transmission line passes to the north of the heat exchange building. This transmission line is rated at 480 volts.

Natural Gas

OIT receives natural gas service from Avista Utilities. Avista was founded in 1998 and engages in energy production, transmission, and distribution, as well as other energy-rated activities. Avista provides electric and natural gas service to about 633,000 customers in a service territory of more than 30,000 square miles.

Avista Utilities delivers electricity from a mix of generation sources including hydro, natural gas, coal and biomass. Avista Utilities maintains over 2,100 miles of transmission line, 17,000 miles of distribution line and 6,100 miles of natural gas distribution mains.

Roads and Parking

Access roads within the OIT campus are shown in Figure 2.4-5. Campus Drive is the main access road to the campus. It approaches the campus from the south, extending 0.5 miles from Kit Karson Way (Interstate Highway 39) to the south side of campus. Dan O'Brien Way approaches the Campus from the east, 0.8 miles from the Dalles–California Highway (State Highway 97).

Several roads surround the OIT campus and belong to the university (i.e. are not in the city right-of-way). Campus Drive runs in an east-west direction along the south side of the campus and is 0.3 miles long. College Way extends around the east and north sides of the campus for approximately 1 mile. Industrial Drive skirts the west side of campus for a distance of about 0.3 miles.

Major utilities are housed under the roadways, including electrical cables, television cables, a 12-inch PVC water line, fiber optic lines, gas lines, and telecommunication lines.

OIT provides on-campus parking. The parking lot on which the geothermal well would be built is made of the Institutional Advancement, Residence Hall, and Snell Hall lots. The Institutional Advancement and Snell Hall lots are designated for general use, while the Residence Hall lot is designated for resident parking (OIT 2008). Together, the three lots contain about 770 parking spaces. The number of parking spaces on campus totals about 2,000.

3.9.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

Drilling and Testing

Water

Fresh water would be supplied from the existing wells on the OIT campus through a connection in the heat exchange building. Water demands for drilling would be up to 20,000 gallons of water per day (approximately 14 gpm). The current wells on campus have sufficient capacity to supply this increased demand without adversely impacting the water supply or compromising water use by other users. Current demand in the fall months is about 200 gpm. A 7 percent increase in pumping during construction would not have any adverse impacts. The wells have the capacity to pump as much as 550 gpm (Ebsen, personal communication 2008).

Wastewater

Drilling would generate drilling mud and fluid, which would be directed to a reserve tank. Water within the tank would be disposed of off-site at a facility authorized to receive such wastes. Wastewater disposal would, therefore, be under a contracted agreement and would be removed on an as-needed basis. Sanitary facilities are provided within the nearest buildings. A portable toilet would be placed on the drill pad site. Project construction would neither require a new connection to the existing city-operated sewer system nor have an adverse impact on the system.

Electricity

The drill rig and other facilities would be powered by diesel generators during construction. Drilling would not have an adverse impact on existing electrical facilities or electrical generation.

Natural Gas

The well pad and pipeline would be constructed to avoid any existing gas pipelines. There would be no adverse impacts.

Roads and Traffic

Drilling would not impact roads and would occur in a parking lot without disturbing roads. Parking would not impact roads. An average of about 5 personal and delivery vehicles would travel to the site daily during drilling, with up to 70 heavy vehicle trucks at the beginning and end of drilling. This is just a small fraction of the total number of vehicles traveling to and from the campus daily, which is in the thousands, and would not cause adverse traffic issues.

Parking

The total enrollment at OIT in 2006 was 3,157 students and the faculty employment was about 210. The total number of people enrolled at or working for OIT was about 3,500 (OIT 2006). There are about 450 people living in the residence hall (Boyd 2008).

According to City regulations, public colleges are required to provide one parking space for every four seats on the campus (City of Klamath Falls 2008a). If each person on campus has one seat, then the required number of parking spaces would be 875. This number is inflated because not all students, faculty, or staff are on campus at all times. Based on the number of on-campus residents, about 113 resident parking spots are needed.

The construction phase of the proposed project would result in a temporary loss of an estimated 86 parking spaces. About 52 of them would be resident parking spaces and about 34 would be general parking spaces. The total spaces available during construction would be just over 1,900. This number is much greater than the required 875. The spots that are currently zoned for resident parking would still meet the need for 100 resident parking spots.

There is a high probability that a sporting event (or other similar high-attendance event) would take place during construction. The loss of 86 parking spaces would not be considered an adverse effect in regards to the ability to accommodate cars. With current parking capacity, there are typically enough parking spaces to accommodate attendee vehicles. If necessary, however, there is an overflow parking area to the north of campus with 300 spaces (Boyd 2008). Adverse impacts to parking would not occur

The parking spots that would be lost to construction of the geothermal well, and the spots that would be lost to operation of the geothermal well would not be Americans with Disabilities Act (ADA)-accessible spots. No extra ADA-accessible spots would need to be designated. Adverse impacts to accessible parking would not occur.

Construction

Water

Construction of the power plant, pipeline, and ancillary facilities would require small amounts of water for dust control (1-2 gpm). The current wells on campus have sufficient capacity to supply this increased demand without adversely impacting the water supply or compromising water use by other users. Current demand in the fall months is about 200 gpm. The wells have the capacity to pump as much as 550 gpm (Ebsen, personal communication 2008).

Wastewater

Project construction would not generate wastewater. Portable facilities would be provided and the nearest university buildings would also be used.

Electricity

Construction would require generators for electrical equipment. Construction would not have an adverse impact on existing electrical facilities or electrical generation.

Natural Gas

Construction of the proposed project would not require or disrupt the use of natural gas on the OIT campus.

Roads and Traffic

Project construction would require approximately 500 feet of trenching, including through the existing parking lot and road, which contain a utility corridor. The pipeline would be sited to avoid any existing pipelines and cables so that utilities are not adversely impacted.

The pipeline construction would involve trenching across the road. One lane would remain open to traffic at all times in order to maintain emergency access and traffic flow. The road next to the heat exchange building has low vehicle usage. Alternative access is also available (see Figure 2.4-5).

Sections of road and parking lot dismantled by construction would be repaved immediately after completion of construction. No long-term adverse impacts to roads or traffic are expected.

Traffic impacts would include traffic associated with bringing in equipment such as the power plant and pipeline (5 vehicles) and about 5 daily passenger and delivery vehicles. This is just a small fraction of the total number of vehicles traveling to and from the campus daily, which is in the thousands, and would not cause adverse traffic issues.

Operation

Water

Project operation would require 30 gpm of make-up water to be supplied to the cooling towers. The existing campus wells would supply this water. The wells have a capacity of 550 gpm, which is not currently fully utilized. Water supplied to the campus would not be adversely impacted by operation of the proposed project.

Wastewater

Project operation would not generate any additional wastewater. The power plant and well would be unmanned and would only require occasional maintenance. No new wastewater connections would be required. The project operation would not adversely impact wastewater service.

Electricity

The project would serve OIT with 100 percent of its required power needs, providing OIT approximately $500,000 in savings per year. OIT would enter into agreement with PP&L in order to use existing transmission facilities to supply their campus with power. The project would have an overall beneficial impact on power supply in the region. The proposed well would require power for its pumps; however, the generation from the power plant would more than off-set demands by the well.

Operation of the power plant would not disrupt electrical service in the project region. Any surplus electricity generated by the project would be sold into the grid, providing the region with increased supply. The project would not have adverse impacts on electrical supply.

Natural Gas

Project operation would not require the use of any natural gas. The project would have no impact on natural gas supplies.

Roads and Parking

The number of parking spots occupied by the geothermal well building would be about 4 spaces, which is much less than during construction. The effects of the geothermal well building on parking capacity would be less than the effects of construction on parking capacity. A significant impact on parking would not occur.

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. It is possible, however, that other sources of funding, including private funds, could be obtained by OIT to develop the project. In such a case, the No Action Alternative would have identical impacts as the Proposed Action in respect to Infrastructure. These impacts would not be considered adverse.

3.10 Visual Resources

3.10.1 AFFECTED ENVIRONMENT

Regional Visual Setting

The project would be located in Klamath County, Oregon, on the southeastern boundary of the OIT campus. The proposed project is within the city limits of Klamath Falls.

The geography, geology, and climate of the area produce a diversity of shapes and colors in Klamath Falls. The area was historically stripped for lumber harvesting, followed by the establishment of the city (City of Klamath Falls 2008c). There are several natural and scenic vantage points within the city, each offering views of the urban area, the Klamath Basin, and the mountains. Views from the city include:

- The Cascades to the west/northwest
- Mount Shasta to the southwest
- Stukel Mountain to the southeast
- Hogback to the east; and
- Upper Klamath Lake, Lake Ewuana, Link River, and the broad flat lands of the Basin in between.

The Upper Klamath Lake area is surrounded by hills and mountains covered by pine, mixed fir, and hemlock forests with a grassy groundcover. Visibility in the region is good, though snow, precipitation, and localized topography can all reduce regional visibility.

Figure 3.10-1 demonstrates the view of the Klamath Basin from the hillside on the eastern edge of the city, looking west-northwest, above the OIT campus.

Local Visual Setting

Project Area

The OIT campus is located at an elevation of approximately 4,400 feet, about a mile to the east of Upper Klamath Lake. It is elevated slightly higher (~300 feet) than Upper Klamath Lake. The lake is visible from the campus looking west. The City of Klamath Falls lies to the south of the OIT campus. There is a small hill to the south between the city and the campus, which essentially prevents the campus from being seen from the city. There are also hills to the north and east.

Adjacent to the campus are commercial buildings, open space, and the Sky Lakes Medical Center (OIT 2007).

The campus is situated on graded terraces on a hill slope. Buildings are positioned in a geometric pattern, forming open spaces, quadrangles, and greens. Buildings are generally a few stories in height or less, and do not greatly obstruct the skyline. Parking lots are located around the edge of campus to make the center of campus pedestrian-oriented. Power lines extend through and around the campus. Roads circle the perimeter of the campus (OIT 2007).

Viewsheds

A viewshed is an area that can be seen from a given vantage point and viewing direction. A viewshed is composed of foreground items (items closer to the viewer) that are seen in detail and background items (items at some distance from the viewer) that frame the view. The area in-between is the mid-ground. The viewshed changes as a person moves along a roadway (a view corridor), with the foreground items changing rapidly and the background items remaining fairly consistent for a long period of time.

Figure 3.10-1: View of the Klamath Basin Looking West-northwest

SOURCE: City of Klamath Falls 2008

RMT | MHA Environmental Consulting

The viewshed at the project site is shaped by the regional features in the background and local land uses in the foreground. The viewshed at the project site includes the mountain ranges and lake in the background and the road, parking lots, existing construction, and other built features in the foreground and mid-ground. The background of the viewshed is more aesthetically pleasing than the foreground and mid-ground in the project area.

Sensitive Receptors

Sensitive receptors in the proposed project area include residents of the Crystal Terrace Retirement Center and workers and patients at the Sky Lakes Medical Center. Students, faculty, staff, and visitors to the OIT campus may be sensitive receptors depending upon their location on campus.

The proposed project site is visible from the entrance of campus and in the immediate vicinity of the southeast parking lot. The project area is also visible from a dormitory located adjacent to the parking lot. The site is not visible from many other locations on the campus due to obstruction by buildings, landscaping, and topography.

3.10.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

Drilling and Testing

Visual impacts from the proposed project would result from:

- Views of drilling equipment and facilities on the well pad
- View of the 135 foot tall drill rig for approximately 30 days
- View of steam plumes during well drilling and testing

The well pad construction site would be visible to surrounding land uses, including the hospital and retirement center. The well pad would be staged in the existing parking lot where foreground views do not have any scenic value (pavement, buildings, existing construction). The construction would be visible, but due to its temporary nature, and presence within the built environment lacking scenic value, impacts would not be adverse. The drill rig would not be visible from within the hospital due to the orientation of the windows of the hospital building. The drill rig would be visible from the area surrounding the hospital, and would interrupt scenic background views of the mountains and lake to the northwest. The drill rig would only be on site for 30 days, however, and the impact would not be considered adverse. Steam plumes from the drilling would also be visible but would not be large enough to block or obstruct background views. The remainder of the construction equipment would blend into the foreground and would not obstruct background views. Impacts from construction of the deep geothermal well would not be considered adverse.

Construction

Visual impacts from construction would result from:

- Views of construction equipment and facilities
- Views of disturbed ground during construction of the pipeline and power plant

Construction of the power plant would occur adjacent to and to the northeast of the existing 24 foot tall heat exchange building. The existing building would largely shield views of construction equipment from the retirement center, hospital, and campus. The power plant construction would be of a low profile and would generally blend into the existing environment. There are no homes or businesses to the east of the proposed power plant construction site and the area is largely shielded from viewers to the east by the surrounding hill. The power plant would be located on the eastern fringe of development on the campus. Construction of the pipeline would be visible to several receptors; however, construction would have a low profile and would be short in duration (approximately a month or less for construction of the pipeline). Impacts from construction would not be adverse.

Operation

Visual impacts from project operation include:

- Views of the shed that would house the new geothermal well in the parking lot
- Views of the power plant and associated steam plumes

Visual impacts during the operation phase are limited. The proposed deep geothermal well would be housed in a 10- by 20-foot building in the existing parking lot. The building would be about 10 feet tall and would be similar in appearance to the existing buildings that house the existing geothermal wells. The building color and design would be approved by the Facilities Director to match the existing campus buildings and themes. The building would not obstruct any background views from sensitive viewers and would blend in with the foreground views. The building would not have adverse visual impacts.

The power plant would have limited visibility to surrounding land users. The cooling towers would be the tallest component of the plant and would be about 24 feet tall, which is about the same height as the existing heat exchange building. The area where the power plant is proposed for construction is at the eastern-most limit of development for the city and the campus. The plant would be built adjacent to several existing facilities and would therefore blend into the developed foreground and mid-ground. The plant may be enclosed in a building similar to the heat exchange building, or it may be all open. In either case, it would blend with the surrounding development in the immediate area. The plant would not obstruct scenic background views. Steam plumes would be visible from the plant and may extend tens of feet into the air. Given the proposed proximity of the plant to the outer edge of the urban development on the east side and adjacency to a tall hill, the plume would not obstruct background views for any nearby viewers. Impacts on visual resources from the steam plume would not be adverse. The proposed pipeline and electric utility connection would be constructed underground and would not be visible after construction. Adverse visual impacts would not occur.

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. It is possible, however, that other sources of funding, including private funds, could be obtained by OIT to develop the project. In such a case, the No Action Alternative would have identical impacts as the Proposed Action in respect to Visual Resources. These impacts would not be considered adverse.

3.11 Socioeconomics

3.11.1 AFFECTED ENVIRONMENT

This section provides an outline of the social and economic situation of the City of Klamath Falls, Oregon. This is a suitable socioeconomic region of influence (ROI) because the majority of social and economic effects would occur within the immediate area of OIT and the City of Klamath Falls.

Social and economic conditions include a baseline description of affected communities, population, ethnicity, social groups, economic indicators, and community services and facilities.

Population and Demographic Characteristics

Klamath Falls is a city within Klamath County, Oregon. The population of the city was 19,462 in the 2000 census, with a 2006 estimate of 20,720 (Population Research Center 2006).

The demographic makeup of Klamath Falls is similar to that of the State of Oregon. The City of Klamath Falls, however, has a nearly 4 times greater population concentration of American Indians and Alaska Natives, and has a nearly 3 times less population concentration of Asians than the state as a whole (US Census Bureau 2000). Population and demographic statistics are shown in Table 3.11-1.

Economic Characteristics

The economic conditions in Klamath Falls, Oregon, are considerably different from state and national economic conditions. The unemployment rate in 2007 was significantly higher than both

Table 3.11-1: Population and Demographic Statistics for Klamath Falls, Oregon

Population Group	Klamath Falls, Oregon 2000	Oregon 2000	United States 2000
Total Population	**19,462**	**3,421,399**	**281,421,906**
White	85.1%	86.6%	75.1%
Black or African American	1.0%	1.6%	12.3%
American Indian and Alaska Native	4.4%	1.3%	0.9%
Asian	1.3%	3.0%	3.6%
Native Hawaiian or Other Pacific Islander	0.1%	0.2%	0.1%
Other Race	4.1%	4.2%	5.5%
Two or More Races	3.8%	3.1%	2.4%
Hispanic/Latino Origin (any race)	9.3%	8.0%	12.5%
White, Non-Hispanic/Latino Origin	81.2%	83.5%	69.1%

SOURCE: US Census Bureau 2000

state and national unemployment rates. The median household income was nearly $10,000 less than the state and national median household income.

Klamath Falls is also experiencing the effects of the national "housing crisis"; home values are decreasing and buyers are having a more difficult time getting loans. As a result of this crisis, two proposed housing developments in Klamath Falls have been discontinued (Ebsen personal communiation 2008).

The percent of individuals living in poverty was also significantly higher than the state and national rates. The poverty rate for children was much higher: 24.5 percent of children were classified as living below poverty standards in 2006.

Economic statistics are shown in Table 3.11-2.

Table 3.11-2: Economic Statistics for Klamath Falls, Oregon

Population Group	Klamath Falls, Oregon 2006	Oregon 2006	United States 2006
Unemployment Rate	7.0%	6.3%	4.6%
Personal Income per Capita	$26,908	$24,418	$25,267
Median Household Income	$37,420*	$46,230	$48,451
Individuals Living in Poverty	18.3%*	13.3%	13.3%
NOTES: *Data for Klamath County			

SOURCE: US Census Bureau 2006

The industries that provide the greatest number of jobs include:

- Retail trade
- Education
- Healthcare, and social assistance
- Manufacturing; and,
- Entertainment and travel-related business.

Community Resources and Social Services

The City of Klamath Falls is served by the City of Klamath Falls School District. There are five elementary schools, one junior high school, and two high schools. Outside the City boundary, the Klamath Falls area is served by the Klamath County School District (KCSD). There are three secondary schools serving a total of 1,505 students, and seven elementary schools serving a total of 2,720 students. Oregon Institute of Technology and Klamath Community College are the two institutions of higher education in Klamath Falls (KCSD 2008; KFCS 2008).

The Sky Lakes Medical Center is the only hospital in the City of Klamath Falls. It provides 925 full-time staff, 176 beds, primary and emergency care, and various specialties, such as a cancer treatment center, to most of Klamath and Lake Counties (Sky Lakes 2008).

Klamath Falls is served by the Klamath County Fire District (KCFD) #1. The fire district has six fire stations; the closest station to OIT is located 0.6 miles from campus. It staffs two firefighters and one captain 24 hours per day. KCFD #1 also operates ambulances serving Klamath County Ambulance Service Area #5 and a state-funded Hazardous Materials Team (KCFD 2008).

The Klamath Falls Police Department consists of a motorcycle patrol, street patrol, school resource officers, and K-9 units. The force is made up of 40 sworn officers and 25 reserve officers (KFPD 2007). The county is also served by the Klamath County Sheriff (KFPD 2007).

3.11.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

Potential impacts to socioeconomic resources are assessed by determining whether the action would:

- Substantially alter the location and distribution of populations,
- Change populations at a rate that exceeds historic rates,
- Decrease jobs so as to raise the regional unemployment rates or reduce income generation,
- Substantially affect the local housing market,
- Preclude the use of resources from other economically viable enterprises,
- Result in the need to construct new schools or medical facilities, or
- Affect the delivery of emergency and other community services.

Construction and operation of the proposed project would not result in any major socioeconomic changes. Construction would be performed by local companies, providing temporary work for drilling and power plant construction. Operation of the proposed power plant would not require permanent additions to the current workforce, and therefore, would have little or no direct effect on population, demographics, employment, or availability of housing or community services.

Operation of the new facilities, as proposed, would not require permanent additions in employees to the OIT campus. The project would provide a training facility for future engineers and business professionals interested in the area of geothermal development. This would be a positive socioeconomic effect of the project as the geothermal industry is expanding and knowledgeable professionals are in high demand.

This project would be the first geothermal power plant in the state of Oregon. The project would neither limit the ability for other power plants to be constructed nor impact other viable uses of the resource in the area (refer to Section 3.2 Geology and Soils). The project would also provide renewable energy to the OIT campus, resulting in as much as $500,000 savings in annual utility costs. This would have a positive socioeconomic effect for the school, which is a public university.

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. It is possible, however, that other sources of funding, including private funds, could be obtained by OIT to develop the project. In such a case, the No Action Alternative would have identical impacts as the Proposed Action in respect to Socioeconomics. These impacts would not be considered adverse.

3.12 Environmental Justice

3.12.1 AFFECTED ENVIRONMENT

President Bill Clinton issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*, on February 11, 1994. It calls for federal agencies to recognize and attend to minority and low-income groups that may be disproportionately affected by federal policies and programs. Consequences to consider when adhering to Executive Order 12898 include negative effects on health and environment.

In Klamath County, Oregon, the median household income was $37,420 in 2006 and the percentage of residents living in poverty was 18.3% (US Census Bureau 2006). The median household income of Klamath County was less than that of the average Oregon household and the average US household. The percentage of individuals living in poverty was also higher than the percentage of individuals living in poverty in Oregon or the United States. Several minority populations are present in the City of Klamath Falls.

3.12.2 ENVIRONMENTAL CONSEQUENCES

Proposed Action

Environmental justice impacts occur if there is any disproportionately high and adverse human health or environmental effects on minority or low-income populations.

No significant impacts are expected from the proposed project and no disproportionately high and adverse human health or environmental effects would be anticipated to affect minority or low-income populations in the project area, despite a higher rate of these populations.

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. It is possible, however, that other sources of funding, including private funds, could be obtained by OIT to develop the project. In such a case, the No Action Alternative would have identical impacts as the Proposed Action in respect to Environmental Justice. These impacts would not be considered adverse.

3.13 Human Health and Safety and Risk Assessment

3.13.1 AFFECTED ENVIRONMENT

In September 2007, Klamath County Emergency Services prepared a Hazards Analysis. It was amended in June 2008 to include Pandemic Flu and Category A Agents. The analysis contains a list of hazards and quantifies the risk of each hazard. The analysis allows jurisdictions to plan for hazards by focusing on where the risk is greatest.

The quantified risk of each hazard is listed in Table 3.13-1. The Hazards Analysis prepared by the County can be found in Appendix G. The analysis explains how the total hazard risk was quantified.

Hazardous Substances

There are no National Priorities List (Superfund) sites in Klamath County. There is one site in the Oregon State Environmental Health Assessment Program (EHAP). North Ridge Estates subdivision, located approximately 2 miles northeast of the OIT campus. The site contains abundant asbestos, which was used as insulation in now-demolished military buildings off of Old Fort Road (ODHS 2002).

Fire Hazards

Potential for fire near the OIT campus is greatest to the west where a naturally vegetated hillside abuts the developed campus. Fire potential in the area is moderate to high due to the low rainfall. The project area is serviced by KCFD #1. The fire district has six fire stations; the closest station to OIT is located 0.6 miles from campus. It staffs two firefighters and one captain 24 hours per day. KCFD #1 also operates ambulances serving Klamath County Ambulance Service Area #5 and a state-funded Hazardous Materials Team (KCFD 2008).

3.13.2 ENVIRONMENTAL CONSEQUENCES

Drilling and Testing

Overview of Hazards and Risks

The potential hazards associated with drilling and testing includes potential exposure to:

- Hazardous materials including fuels and lubricants
- Hazards from potential well blow-out
- Geothermal fluids
- H_2S emissions from the well
- High noise levels associated with equipment

Drilling would occur in an existing paved parking lot. Vegetation is limited in this area and likelihood of causing a fire is minimal. Well logging tools would be used during production testing; however, no nuclear or radioactive devices would be used.

Table 3.13-1: Relative Risk of Hazards for Klamath County

Hazard	Total
Severe Storm (Winter)	230
Pandemic Flu	224
Power Failure	222
Drought	222
Telecommunications Failure	222
Hazardous Materials	195
Transportation Incidents	195
Earthquake	187
Dam Failure	187
Terrorism	177
Wildland Fire	165
Flooding	159
Volcano	114
Category A Agents	100

SOURCE: KCES 2008

Exposure to Fuels and Lubricants

Drilling would involve hazardous material use. These materials would include, but would not be limited to, drilling additives and mud, diesel fuel, lubricants, solvents, oil, equipment/vehicle emissions, and geothermal fluids.

Hazardous materials that may be used include fuels and lubricants. OIT would comply with all local, state, and federal regulations regarding the use, transport, storage, and disposal of hazardous materials and wastes. OIT or their contractor would prepare a hazardous material spill and prevention plan to prevent adverse impacts to the environment from hazardous materials.

Drilling mud and fluid would be directed to the reserve tank. The contents would be tested and removed and disposed of off-site in a facility authorized to receive such wastes. Adverse impacts are not expected.

The drill site would be fenced/walled to prevent unauthorized access, which would minimize risks to the general public.

Exposure to Well Blowouts and Geothermal Fluid

Well blowouts and pipeline failures are rare occurrences during well drilling and can result in the release of drilling additives and fluids, as well as hydrogen sulfide gas (see section 3.2 Air Quality for more information on hydrogen sulfide) from the geothermal resource. Blowouts may also result in the surface release of geothermal fluids and steam containing heavy metals, acids, mineral deposits, and other pollutants (see the discussion above in air quality and hydrology).

OIT has submitted a detailed blow-out prevention plan in Appendix B. Measures include:

- Performing regular maintenance of wellhead, including corrosion control and inspection, pressure monitoring, and use of blowout prevention equipment such as shutoff valves;

- Preparing an emergency response plan for well blowout, including measures for containment of geothermal fluid spills
- Preparing a contingency plan for hydrogen sulfide release events, including all necessary aspects from evacuation to resumption of normal operations;
- Providing workers with a fact sheet about the potential human health and safety impacts from exposure to liquids and gases from the production well during a blowout.

With implementation of these plans and standard safety precautions, adverse impacts are not expected.

Exposure to H_2S

Steam encountered during drilling and testing would likely contain H_2S. The concentration of H_2S that will be encountered is not known at this time.

H_2S can be released from a well during drilling and would be vented with the steam and non-condensable gases during flow-testing. H_2S is a colorless, non-condensable gas with a characteristic “rotten egg” odor. H_2S is toxic at certain levels and can cause negative human and animal health effects. Exposure to H_2S can cause dizziness, headache, and nausea at 50 ppm and death from respiratory paralysis at 1,000 ppm. The OSHA indoor workplace standard for H_2S is 10 ppm for an 8-hour day (Klingberg 2005). Nuisance odor is of primary public concern since this distinctive odor can be easily detected at concentrations far below levels of health concern. Odor is detectable from about 0.008 ppm.

H_2S is typically encountered during the production zone drilling phase. The quantity of H_2S that would be encountered is unknown at this time. The existing geothermal wells on campus suggest some level of H_2S in the system, evidenced by a faint odor of “rotten eggs” smelled when standing within a few feet of the source. Sulfates were also identified in 1990 water samples from the existing geothermal wells. H_2S emissions from previously drilled wells in the area did not cause significant effects as odors from the existing wells can only be smelled within a few feet of the water. H_2S levels at the Glass Mountain Known Geothermal Resource Area in Siskiyou County, California (50 miles southwest of the project site) were approximately 2.8 lbs per hour (USFS et al 1998), well below state standards in California.

Exposure to Noise

Drilling could generate considerable noise. Workers would be required to wear hearing protection and other personal protection equipment (PPE) as required by the Occupational Health and Safety Organization (OSHA) to prevent injuries.

Construction

Overview of Hazards

Construction hazards and risks would include:

- Hazardous materials including fuels and lubricants
- Exposure to high noise levels

The potential for fire is moderate because the construction location is adjacent to undeveloped hillside dominated by dry grasses.

Exposure to Hazardous Materials

Some hazardous materials from project-related activities (i.e., fuels, oils) would be present on-site during construction activities. The likelihood of substantial spills and discharges in this area would be low due to the limited amount of chemicals that would be used or transported. Hazardous chemicals to be transported include fuels, oils, and lubricants used during construction. Discharge of oils or petroleum products could occur from equipment leakage and would involve a very small volume.

Contamination of storm-water run-off at the drilling pad would be minimized through drainage and collection of run-off in the reserve tank. Contamination along the pipeline corridor and at the power plant site would be minimized through containment of any spills before they could be released into stormwater. OIT would implement a Spill Prevention, Control and Countermeasure Plan (SPCC) on-site to contain incidental drips and/or spills. All hazardous material storage would be surrounded by containment berms.

Construction would also introduce potentially dangerous equipment. Should people gain access to the construction area, there would be a potential for accidents. The construction site would be fenced. Other protection measures also include alerting the public to the risks of on-site construction materials.

Exposure to Noise

Construction could generate considerable noise. Workers would be required to wear hearing protection and other personal protection equipment (PPE) as required by the Occupational Health and Safety Organization (OSHA) to prevent injuries.

Fire Hazards

Fire hazards would be minimized through the maintenance of an on-site water tank to put out any potential fires. Other measures include:

- Fire extinguishers and shovels will be available on-site.
- All brush build-up around mufflers, radiators, and other engine parts must be avoided; periodic checks must be conducted to prevent this build-up.
- Smoking would only be allowed in designated smoking areas; all cigarette butts would be placed in appropriate containers and not thrown on the ground or out windows of vehicles.
- Cooking, campfires, or fires of any kind would not be allowed.
- Portable generators used in the Project Area would be required to have spark arresters.

Operation

Operational impacts and hazards are related to the storage of pentane and potential for fire. The principal threat to human health and safety from the proposed project is pentane. Pentane would be stored at the proposed project site for use in the heat exchange. It would be used to absorb heat from geothermal fluid and would act as the agent to turn the generator. Pentane is a colorless liquid and is harmful if inhaled, ingested, or absorbed through the skin. It is also very flammable, and because of its high vapor pressure, can accumulate very rapidly as a gas in small spaces.

Pentane storage capacity would be required for a binary Rankine cycle power plant. Pentane would be stored in a single tank that would have a volume of 2,000 gallons or fewer. The tank would be surrounded by a berm high enough to contain any spill. A SPCC plan would be kept at the power plant to contain any spills if they were to occur. The well also requires a 50-gallon barrel of oil to lubricate the well and pump parts. The well head would be contained in a shed and any spills would be contained within the shed. Adverse impacts to human health and safety from potential spills are not expected.

Pentane also introduces the risk of explosion or unplanned combustion. A prevention and response plan would be prepared. The plan would include education of workers with information such as a Material Safety Data Sheet (MSDS), as well as stocking of any equipment for immediate response to an explosion.

A binary plant would not have emissions of dissolved solids or heavy metals from the geothermal fluid. The fresh water make-up for the cooling tower contains very slightly elevated levels of naturally occurring arsenic. Any trace amounts of arsenic that disperse into the air with the steam would likely settle back to the ground within proximity to the power plant and would not have an adverse effect on any water body or on surface or groundwater quality, and would not have an adverse effect on human health and safety. In order to prevent fires, a fire break of at least 15 feet will be maintained around the tank and surrounding vegetation and/or landscaping.

No Action Alternative

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. No information pertinent to small-scale geothermal power plants would be developed from this location. It is possible that other sources of funding, including private funds, could be obtained by OIT to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway.

4: CUMULATIVE IMPACTS

4.1 Introduction

NEPA requires that agencies consider the cumulative impacts of a proposed action or project. NEPA regulations define a cumulative effect as the effect on the environment that results from the incremental effect of the action when added to the effects of other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes the other actions and regardless of land ownership on which the other actions occur. An individual action when considered alone may not have a significant effect, but when its effects are considered in sum with the effects of other past, present, and reasonably foreseeable future actions, the effects may be significant (40 CFR 1508.7 and 1508.8, and FSH 1909.15 Section 15.1).

This cumulative impact analysis considers impacts of the proposed action and other projects that have been proposed, or are reasonably foreseeable to take place in the vicinity of the proposed action. The primary activities considered in the analysis of cumulative impacts are other geothermal projects and other activities in the project vicinity that may occur at the same time as the proposed action.

The geographic area considered for cumulative impacts is generally considered to be a 5-mile radius from the proposed project area, although boundaries of analysis are dependent upon the type of impact to be assessed and the extent of the proposed project's impacts. The proposed project would be constructed in the fall of 2008 (October-November).

The effects of geothermal projects vary with the type of activity (i.e., exploration, development, well drilling, or power plant operation) and the temperature of the geothermal resource. High temperature resources usually result in the development of power production facilities. Low temperature resources usually support direct-use projects such as district heating, aquaculture, or food drying; however, power can be produced from low temperature resources.

The effects of construction and operation related activities of the proposed project are described in Chapter 3 of this document.

4.2 Other Projects in the Area

The OIT Geo-Heat center has several projects pending for the campus. Each of these projects is summarized below. Other projects in the area include the ongoing construction of the Oregon Center for Health Professions on campus and a potential new residence hall facility. Two housing developments adjacent to the campus were proposed but have recently been discontinued due to the national housing crisis (Ebsen personal communication 2008).

4.2.1 LOW-TEMPERATURE POWER GENERATION

OIT's Geo-Heat Center is proposing to install a geothermal power plant using a low-temperature resource on the OIT campus. The power plant would be a binary or organic Rankine cycle (ORC) type in the 200 kilowatt (kW) generating capacity range. This plant would use the existing geothermal water that is presently supplied from wells used for heating the OIT campus. The process would take 15° F off of the top of OIT's 192° F resource. The remaining 177° F is sufficient to retain the existing heating use. The plant would be constructed inside the existing heat exchange building and cooling water would be provided by existing cold water wells on campus. The project would provide approximately 25 percent of the electricity demand on campus and save OIT $100,000 annually.

4.2.2 GREENHOUSE FACILITY

OIT would like to construct two geothermally-heated greenhouses on campus using the existing water supplied from existing geothermal wells. Each would be 100 feet by 60 feet (6,000 square feet). Each greenhouse would use a different heating and cooling system for observation as a research and demonstration project. All heating and cooling would be monitored and controlled by a computer. The greenhouses would be utilized in conjunction with the Klamath-Lake County Economic Development Association as incubator facilities for interested investors and developers to test the feasibility of growing their crop in a controlled environment utilizing geothermal energy.

4.2.3 AQUACULTURE FACILITY

OIT proposes to construct two geothermally-heated outdoor aquaculture ponds and a covered nursery tank facility on campus using existing water supplied from existing geothermal wells. The outdoor ponds would each be 100 feet by 30 feet (3,000 square feet) and the indoor covered facility would be the same size as the greenhouse construction,100 feet by 60 feet (6,000 square feet). Different heating systems would be provided to each pond as a research and demonstration project. The covered facility would consist of a series of fiberglass tanks heated by the geothermal water and would supplement overall space heating. All heating systems would be monitored and controlled by a computer. Various fish species, hard-shell aquatic species, and various algae could be tested. The aquaculture facility would be utilized in conjunction with the Klamath-Lake County Economic Development Association as an incubator facility for interested investors/developers to test the feasibility of growing their species in a controlled environment utilizing geothermal energy.

4.2.4 OREGON CENTER FOR HEALTH PROFESSIONALS

This project is in its second phase and is midway through completion. It is expected to be completed in April 2009. The project consists of a new three-story, 20,000 square-foot building to serve as an educational center for health professionals (Ebsen personal communication 2008). The building is being constructed west of the proposed well location, directly north of the Sky Lakes Medical Center.

4.2.5 RESIDENCE FACILITY

A new residence facility may be built in the future on the OIT campus to accommodate the needs of students. The new facility would include 264 beds and would be three stories tall and approximately 90,000 square feet. It would be located in the southeast quadrant of the campus, just north of the proposed geothermal well area. The existing residence hall would remain used as a residence on the top two floors, and the ground floor would be made into a student services and health center (Ebsen personal communication 2008).

4.2.6 HOUSING DEVELOPMENT PROJECTS

Two housing development projects were previously proposed for locations directly adjacent to the OIT campus. Each of these two projects has been terminated due to the housing crisis. It is unlikely that these projects will be revived unless the economics make the projects feasible again in the future (Ebsen personal communication 2008).

4.2.7 REDEVELOPMENT PROJECT

Preliminary discussions with the City of Klamath Falls Community Development Department have been initiated for a redevelopment project of a site approximately 3 to 4 blocks from the OIT Campus. Specific plans are unknown at this time and no formal permit applications have been submitted. This project is in very early stages and development is speculative at this time (Slaughter personal communication 2008b).

4.3 Cumulative Effects

4.3.1 OVERVIEW

The cumulative impacts of the proposed projects are described below. Measures are proposed as conditions of the project and would reduce all impacts to less than significant levels. The proposed project would have no impact on the following resources:

- Cultural Resources
- Land Use
- Socioeconomics
- Environmental Justice

The project would therefore have no cumulative impacts related to the resources stated above. The proposed project has potential impacts in the following resource categories and cumulatively considerable potential is discussed below.

4.3.2 PROPOSED ACTION

Air Quality

The proposed project would have some emissions during construction, including particulate matter and precursors to ozone, etc. The region is in attainment for particulate matter (PM_{10}); however, the proposed project would generate some PM_{10} and $PM_{2.5}$. Cumulative impacts could occur if projects occurring simultaneously also produced enough particulate matter to exceed ambient air quality standards. Projects that would involve ground disturbance that could occur at the same time as construction of the proposed project include the greenhouse and aquaculture facilities; however, these projects are not scheduled for at least a year. None of these projects would be expected to generate significant amounts of particulate matter and it is likely that measures would be enforced to reduce fugitive dust levels. Fugitive dust would also be controlled at the proposed project site through proposed environmental protection measures. Cumulative impacts would not occur.

The proposed project is not expected to generate significant air emissions during operation. Well venting may generate some H_2S emissions; however, no other projects in the vicinity of the proposed project would generate significant H_2S. Cumulative H_2S emissions are not expected.

Geology and Soils

The proposed project would involve minimal disturbance of soils, leading to a small potential for erosion. Cumulative impacts would occur if other projects involved significant amounts of ground disturbance that could, in conjunction with the proposed project, lead to severe erosion and cause siltation of a waterway or water body or slope instability. There are no water bodies in the immediate vicinity of the proposed project.

Some of the other construction projects would involve ground disturbance and could lead to erosion and slope instability depending on where the project takes place. Impacts from erosion are minimal and would only occur for a short period of time. All disturbed areas would be reclaimed to prevent future erosion at the project site. Cumulative impacts would not occur, as the proposed project does not have the potential for adverse effects.

The project would utilize the geothermal resource in the area. The proposed aquaculture and greenhouse projects on campus would also utilize the geothermal resource. These facilities would be built using the existing wells at some future date. The proposed project would only utilize a small percentage of the estimated energy provided in the Klamath Falls KGRA (0.02%). Geothermal water from all projects would be injected back into the geothermal reservoir. The proposed project in conjunction with other projects is not expected to have a cumulatively significant impact on the geothermal resource.

Biological Resources

The proposed project as proposed includes protection measures to avoid or reduce the impacts associated with invasive species and special status species. Cumulative impacts would occur if the project, in relation to another project, led to a massive spread of invasive species or threatened the existence of a special status species or its habitat. The construction of the greenhouse and aquaculture facilities would cause the removal of vegetation if they are sited in a vegetated area. Depending on the location of the facilities, the construction could affect special-status species and aid in the spread of invasive species. Measures would likely be defined for the project to reduce potential impacts.

The proposed project would only disturb a small area (fewer than 0.25 acres of vegetation) and with implementation of measures to minimize impacts to sensitive species and prevent the spread of invasive plants, the project would not have a significant contribution to the cumulative impact.

Water Resources

The proposed project would present a risk to water quality because of the use of hazardous materials; however, construction plans include measures to reduce the risk of a hazardous material spill or other potential contamination action.

Cumulative impacts would occur if water quality was seriously degraded due to a hazardous materials spill. The proposed project is confined to a specific area and all spills during construction and/or operation would be contained and cleaned. The chance of a hazardous materials spill being compounded by any of the other projects in the area is unlikely. Cumulative impacts to water quality would not occur.

The project would not impact groundwater use that could compound with other proposed projects. The greenhouse and aquaculture facilities would use the existing geothermal wells and system. New developments would require a freshwater source. The proposed project would consume some freshwater (30 gpm), which is a small enough quantity to not have cumulatively significant impacts with proposed projects.

Noise

The proposed project would have adverse noise impacts from drilling. Proposed strategies, including notifying neighboring properties of noise effects and installing a sound barrier attached to the drill rig, avoid adverse impacts. Cumulative impacts could occur if other noise is generated in the same area as the proposed project.

The Heath Services construction would occur at the same time as the proposed project. General construction noise from that building would compound with the drilling noise; however, construction would only occur during daytime hours. The measures proposed to minimize noise from the drilling and construction site would prevent the proposed project from having a significant incremental contribution to overall noise effects. Impacts from drilling would be temporary and response to noise complaints would minimize impacts of the proposed project in conjunction with other projects.

The operations phase of the project would have limited noise generation. Housing developments would be far enough away from the proposed project that noise generated from the power plant would not compound with any of these projects to generate a cumulatively considerable noise impact. Noise from the housing developments would be limited to sporadic noises such as for lawn maintenance. Cumulative noise impacts would not occur.

Infrastructure

The well drilling operation would temporary occupy up to 86 parking spaces. The campus has several other parking areas and an overflow lot; therefore, effects to parking should be minimal.

The current construction of the Health Services building does not block any parking spaces. Construction of the aquaculture facility and greenhouse facility is not expected to occur in parking areas and therefore would not further impact parking. The construction of the new residence hall may inhibit use of some of the existing parking; however, the construction of the residence hall is not likely to overlap with the 30 days of well drilling associated with the proposed project. After construction, the proposed project would only permanently remove about 4 spaces. Cumulative effects to parking are not expected.

The proposed project construction would cause temporary blockage of Bryant Williams Road during construction of the pipeline. Access would not be fully blocked. Other projects are not expected to block this road and cumulative impacts are not expected.

The proposed project would generate electricity, which would have a positive cumulative impact for new development or redevelopment in the area because there would be additional electricity available to support such developments. Cumulative impacts are not expected.

Visual Resources

The proposed project would have temporary impacts on visual resources during construction; however, most construction would occur in foreground views and would not impact the more scenic background views. The existing construction, including construction of the Health Services building and potential construction of a new residence hall would result in additional construction in foreground views. Since these views are not considered scenic, cumulatively significant effects on visual resources are not expected.

Project operation would have limited visual impacts, including a steam plume rising above the power plant. Given the location of the power plant to the far eastern edge of development, impacts from the steam plume are not considered significant. New housing developments would have some impact on visual resources in the area but the contribution of the proposed project to an overall significant impact is not expected.

Cumulative impacts would not occur for the proposed project, due to the temporary and minimal nature of its impacts on visual resources.

4.3.3 NO ACTION ALTERNATIVE

Under the No Action Alternative, DOE would not provide funds for the proposed well and/or power plant. The project would not be built as part of a Federal Action. The existing geothermal direct uses would continue as they currently operate. The use of the geothermal resource would remain the same. It is possible, however, that other sources of funding, including private funds, could be obtained by OIT to develop the project. In such a case, the No Action Alternative would have identical impacts and cumulative impacts as the proposed project, as previously described. No adverse cumulative impacts are expected with implementation of proposed protection measures.

4.4 Irreversible and Irretrievable Commitment of Resources

This section describes the major irreversible and irretrievable commitments of resources that can be identified at the level of analysis conducted for this EA. A commitment of resources is irreversible when its primary or secondary impacts limit the future options for a resource or limit those factors that are renewable only over long periods of time. Examples of nonrenewable resources are minerals, including petroleum, and cultural resources.

An irretrievable commitment of resources refers to the use or consumption of a resource that is neither renewable nor recoverable for use by future generations. Examples of irretrievable resources are the loss of production, harvest, or recreational use of an area. While an action may result in the loss of a resource that is irretrievable, the action may be reversible. For instance, paving over farmland results in the irretrievable loss of harvests from that land. However, the parking lot could be removed and crops could be grown again. Hence, the action is reversible.

The construction and operations of the deep geothermal well and the geothermal power plant on the OIT campus would require the irreversible and irretrievable commitment of building materials.

The cooling water used by the proposed power plant would be a minor, irretrievable consumption of water. Up to 30 gallons per minute of freshwater would be used in the cooling tower. Some would be reinjected; however, the remainder would be lost through evaporation. The use of geothermal water and heat represents a larger irretrievable impact to the geothermal resource. However, the same amount of geothermal fluid used would be reinjected and the resource’s heat production potential likely exceeds the proposed use. Both the geothermal fluid and heat would likely recover soon after the proposed use by OIT ceases.

5:
LIST OF AGENCIES AND PERSONS CONTACTED

5.1 Agencies/Persons Contacted

The following agencies and persons were contacted during the preparation of this document:

Tribes

Joseph Kirk	*Chairman, Klamath Tribes*

Oregon State Historic Preservation Office

Dr. Stephen Poyser	*Preservation Planner*
Roger Roper	*Deputy State Historic Preservation Officer*

Oregon State Department of Environmental Quality

Linda Hayes-Gorman	*Air Quality Manager*
Gregg Land	*Air Quality Planner*
Frank Messina	*Air Inspector*
Todd Hesse	*Water Quality Specialist*

Oregon Natural Heritage Information Center

Lindsey Koepke	*Assistant Information Manager*

Klamath County

Todd Pfeiffer	*Vegetation Manager*
Bruce Fitchtman	*GIS Analyst*

City of Klamath Falls

Randy Travis	*Water/Geothermal Operations Manager*

Oregon Institute of Technology

David Ebson	*Facilities Manager*

Applicant – Oregon Institute of Technology (OIT)

Dr. John W. Lund	*Director, Geo-Heat Center*
Tonya "Toni" Boyd	*Assistant Director, Geo-Heat Center*

6: REFERENCES

Baxter, Joe. 2008. Tiger Wireline. Personal communication with Toni Boyd. August 8, 2008.

Beckham, Stephen Dow. 2006. Historical Landscape Overview of the Upper Klamath River Canyon of Oregon and California. U.S. Department of the Interior, Bureau of Land Management, Cultural Resource Series No. 13.

Bloomfield, K., J.N. Moore, and R.M. Neilson Jr. 2003. *Geothermal Energy Reduces Greenhouse Gases.* Geothermal Research Council. GRC Bulletin, April 2003.

Boyd, Toni. 1999. General Layout of the Current OIT Geothermal System.

_____. 2008. Assistant Director, OIT Geo-Heat Center. Personal communication with Tania Treis. June 17 and 25, 2008.

Brown, B. 2006. Klamath Falls Geothermal District Heating System at 25 years. *Geothermal Resources Council Transactions*: 185-190.

Caltrans (California Department of Transportation). 1998. *Technical Noise Supplement, Traffic Noise Analysis Protocol.* October 1998.

Capuano, Louis. 2008. ThermaSource. Personal communication with Chrissy Spanoghe, MHA|RMT. May 30, 2008.

CEGC (California Energy General Corporation). Plan of Operations for Exploration Drilling, Glass Mountain Area, Siskiyou County, California. May 1994.

City of Klamath Falls. 2007. City of Klamath Falls 2007 Water Quality Report.

_____. 2008a. Klamath Falls City Code. March 2008.

_____. 2008b. Waste Water. Website: www.ci.klamath-falls.or.us/Departments/PublicWorks/WasteWater/tabid/3199/Default.aspx Accessed: May 29, 2008.

_____. 2008c. City of Klamath Falls, Oregon Website. Website: http://www.ci.klamath-falls.or.us/. Accessed: June 30, 2008.

_____. 1981. Community Development Ordinance.

City of Klamath Falls Planning Department. 1979. Environmental Report for the City of Klamath Falls Geothermal District Heating Project. January 1979.

Clifton, James and David Levine. 1963. A. Klamath personalities: ten Rorschach case studies. Lawrence, University of Kansas, Department of Sociology and Anthropology, 1963. 3, 80 p.

DEQ (Oregon Department of Environmental Quality). 2001. Air Quality Program; Division 200 Tables; Table 2 (OAR 340-200-0020). Revised May 4, 2001.

_____. 2002. Upper Klamath Lake Drainage Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP). May 2002.

_____. 2006. Oregon's 2004/2006 Integrated Report Database: Water Quality Assessment. Query: Klamath River/Upper Klamath Lake. Accessed: June 24, 2008.

_____. 2007. Oregon Air Quality Data Summaries. June 2007.

_____. 2008. Oregon Administrative Rules, Section 340, Division 35. May 2008.

DOE (US Department of Energy). 2002. Environmental Assessment for a Small-Scale Geothermal Power Plant and Direct-Use Geothermal Application at AmeriCulture Inc., Cotton City, NM. EA 1396. August 2002.

DOGAMI (Oregon Department of Geology and Mineral Industries). 2008. Geologic Map of the Klamath Falls Area, Klamath County, Oregon. GMS-118.

Ebsen, David. 2008. Personal Communication with Chrissy Spanoghe. June 27, 2008 and John Lund July 21, 2008.

EGS Inc. 2006. Feasibility Study: Deep Geothermal Well Project, Prepared for Oregon Institute of Technology. August 2006.

EPA (US Environmental Protection Agency). 1996. Website: http://www.epa.gov/ttn/chief/ap42/ch03/final/c03s04.pdf. Accessed: September 19, 2007.

_____. 2004. Air quality designations and classifications for the 8-hour ozone national ambient air quality standards; early action compact areas with deferred effective date. 40 CFR 81. April 15.

_____. 2008a. Green Book. Nonattainment Status for Each County by Year. March 12, 2008. Website: www.epa.gov/oar/oaqps/greenbk/anay.html Accessed: May 28, 2008.

_____. 2008b. Drinking Water Contaminants. Website: http://www.epa.gov/safewater/contaminants/. Accessed: May 30, 2008.

ESRI. 2006. Various GIS Data files.

Gleason, S.M. 2001. Site Specific Maps of Ethnobotanically Important Plants within the Upper Klamath River Canyon for Bureau of Land Management, Lakeview District, Klamath Falls Resource Area Office, Klamath Falls Oregon.

Google Earth Pro. 2008. Various maps.

Helfrich, Devere 1966. Klamath Echoes No. 3. Klamath County Historical Society, Klamath Falls, Oregon.

Hessig, Alice Overton 1978. The History of the Klamath Hot Springs. Written for the 1965 Siskiyou Pioneer with additions by Lottie Beswick in the 1963 Siskiyou Pioneer. Echoes-Klamath Basin 1977. Sanctioned by Klamath County Historical Society 3(8):63-66, Yreka, California.

KCES (Klamath County Emergency Services). 2008. Hazards, Risks and Vulnerabilities facing Klamath County, Oregon. June 2008.

Klamath Birding Trails. 2008. Best in the West: Klamath Birding Trails. Website: http://www.klamathbirdingtrails.com/sites/indexmap.shtml. Accessed: June 20, 2008.

Klamath County. 2001. Clean Air Ordinance. Last Revision August 23, 2001.

_____. 2008. Klamath County Landuse Zoning: Township 38S Range 9E. March 28, 2008.

Klamath County Board of Commissioners. 2008. In the Matter of Declaring Klamath County a Weed Control District and Declaring Noxious Weeds in Klamath County for 2008. Order Number 2008-056.

KCFD (Klamath County Fire District #1). 2008. Klamath County Fire District #1: About the District. Website: http://www.kcfd1.com/About_KCFD1/index.html. Accessed: June 3, 2008.

KCSD (Klamath County School District). 2008. Klamath County School District Home Page. Website: http://www.kcsd.k12.or.us/index.html. Accessed: June 3, 2008.

Klamath Environmental Services. 1990. Oregon Institute of Technology Production Well Test Data. Submitted March 5, 1990.

KFCS (Klamath Falls City Schools). 2008. Klamath Falls City Schools. Website: http://www.kfalls.k12.or.us/. Accessed: June 30, 2008.

KFPD (Klamath Falls Police Department). 2007. Klamath Falls Police Department. Website: http://www.kfpd.us/. Accessed: June 3, 2008.

Klingberg, Kevan. 2005. Livestock Facility Emissions and Odor Monitoring. Prepared for 2005 Wisconsin Fertilizer, Aglime and Pest Management Conference. January 2005.

Kroeber, A.L. 1925. Handbook of the Indians of California. Bureau of American Ethnology Bulletin 78.

Lienau, Paul J., Gene Culver, and John W. Lund. 1989. *Case History of Assessment, Development and Utilization*. Geothermal Resources Council Annual Meeting. Santa Rosa, CA. September 1989.

______. 1993. Groundwater Anomalies Associated with the Klamath Basin Earthquakes of September 20-24, 1993. November 1993.

Lienau, Paul J. 1996. OIT Geothermal System Improvements. Website: http://geoheat.oit.edu/bulletin/bull17-3/art23.htm. Accessed: May 29 2008. February 15 2007.

Lund, John. 2008. Personal communication with Tania Treis. June 23, 2008 and July 22, 2008.

Mack, Joanne M. 1995. Preliminary Report on the Upper Klamath River Canyon Project: Summer of 1994 Archaeological Testing, Site Evaluation Report, Historical Overview, and Ethnobotanical Report. Prepared for US Department of the Interior, Bureau of Land Management, Lakeview District, Klamath Falls Resource Area, Klamath Falls, Oregon.

Majer, E.L. 2008. White Paper: Induced Seismicity and Enhanced Geothermal Systems. Center for Computational Seismology, Ernest Orlando Lawrence Berkeley National Laboratory.

Martin, Marlene M. 2008. Cultural Summary of Klamath [from several sources]. Website: http://lucy.ukc.ac.uk/EthnoAtlas/Hmar/Cult_dir/Culture.7853. Accessed: June 27, 2008.

Messina, Frank. 2008. DEQ Air Quality Inspector. Personal communication with Kristi Black. July 23, 2008.

NatureServe.org. 2007. NatureServe Explorer. Website: www.natureserve.org/explorer. Accessed: May 29 and 30, and June 16 2008.

NEIC (National Energy Information Center). 2007. Energy Information Administration, US Department of Energy. Internet Web site: http://www.eia.doe.gov/environment.html. Accessed: June 13, 2008.

NPS (National Park Service). 1996. Map: Indian Reservations in the Continental United States. Website: http://www.nps.gov/history/nagpra/documents/resmap.htm. Accessed: June 24, 2008.

ODHS (Oregon Department of Human Services). 2002. Health Consultation: North Ridge Estates (a.k.a. Former Marine Recuperational Barracks). Final Release. CERCLIS #001002476.

Optim, Inc. 2008. Active source seismic investigation of geothermal resources at and in the vicinity of the Oregon Institute of Technology (OIT), Klamath Falls, Oregon. June 2008.

Oregon.com. 2008. Website: http://www.oregon.com/counties/klamath.cfm, Accessed: June 24, 2008.

OIT (Oregon Institute of Technology). 2006. Fast Facts and Figures About OIT. Website: http://www.oit.edu/glance. Accessed: June 25, 2008.

_____. 2007. Oregon Institute of Technology Landscape Master Plan. December 2007.

_____. 2008. Oregon Institute of Technology Campus Map. Website: http://www.oit.edu/Default.aspx?DN=36363f31-eb2d-4dc6-a70f-7668c172774e. Accessed: June 25, 2008.

OIT Geo-Heat Center. 2005. Geothermal Direct-Use Case Studies. Website: http://geoheat.oit.edu/casestudies.htm. Accessed: June 23, 2008. October 2005.

ORNHIC (Oregon Natural Heritage Information Center). 2007. Rare, Threatened and Endangered Species of Oregon. March 2007.

Population Research Center, Portland State University. 2006. Population Statistics. December 15, 2006.

Poyser, Dr. Stephen. 2008. Personal Communication with Chrissy Spanoghe. June 16, 2008.

PP&L (Pacific Power and Light Company). 2008. Website: www.pacificpower.net/Article/Article65125.html Accessed: May 29, 2008.

Prucha, R.H., Benson, S.M., and Witherspoon, P.A.. 1987. *Conceptual Model of the Klamath Falls, Oregon Geothermal Area*. Twelfth Workshop on Geothermal Reservoir Engineering. Stanford, CA. January 20-22, 1987.

Shreve, Jimmie H. 1979. Klamath County YMCA Geothermal Heating Project Environmental Assessment. July 10, 1979.

Silver, Shirley. 1978. Shastan Peoples. Handbook of North American Indians, Vol. 8, California, Robert F. Heizer, ed., pp. 211-224. Washington, D.C.: Smithsonian Institution.

Sky Lakes Medical Center. 2008. Sky Lakes Medical Center Facts. Website: http://www.skylakes.org/topnav/about/facts.htm. Accessed: June 3, 2008.

Slaughter, Joe. 2008a. Personal communication with Kristi Black. June 26, 2008.

_____. 2008b. Personal Communication with Chrissy Spanoghe. June 27, 2008.

Spier, Leslie. 1930. Klamath Ethnology. University of California Publications in American Archaeology and Ethnology, 30. Berkley.

State of Oregon. 2007. More Info: Drinking Water Program. Website: http://oregon.gov/DHS/ph/dwp/moreinfo.shtml. Accessed: June 23, 2008.

Stern, Theodore. 1965. The Klamath tribe; a people and their reservation. Seattle, University of Washington Press, 1965 [c.1966]. 16, 356 p. illus., maps.

Sustainable Northwest. 2007. Ecology and History. Website: http://www.sustainablenorthwest.org/klamath/klamath-ecology-history. Accessed: May 30, 2008.

Taylor, George. 2008. Oregon Climate Service. *Climate of Klamath County.* Website: www.ocs.orst.edu/county_climate/Klamath_files/Klamath.html. Accessed: May 28, 2008.

Travis, Randy. 2008. Operations Supervisor, City of Klamath Falls Water/Geothermal Division. Personal communication. June 24, 2008.

US Census Bureau. 2000. 2000 United States Census.

_____. 2006. 2006 American Community Survey.

USDA (US Department of Agriculture). 2007. National Resource Conservation Service. Soils Survey Data for Klamath County. May 29, 2008.

USDOT(US Department of Transportation)*. 2000. Highway Traffic Noise in the United States, Problem and Response,* April 2000.

USFS (US Forest Service) and BLM (US Bureau of Land Management). 1994. Newberry Geothermal Pilot Project: Final Environmental Impact Statement.

_____. 1998. Fourmile Hill Geothermal Development Project, Environmental Impact Statement: Volume 1: Final EIS/EIR. September 1998.

USFWS (US Fish and Wildlife Service). 2007. Listed, Proposed, and Candidate Species that May Occur in Klamath County, Oregon. August 15, 2007.

_____. 2008a. Wildlife Checklist: Klamath Basin National Wildlife Refuges and Environs. Website: http://www.fws.gov/klamathbasinrefuges/1kbnwrchecklist.pdf. Accessed: May 30, 2008.

_____. 2008b. Mardon Skipper Fact Sheet. Website: http://www.fws.gov/oregonFWO/Species/Data/MardonSkipper/default.asp. Accessed: May 30, 2008.

USGS (U.S. Geological Survey). 2008a. Historic Earthquakes: Klamath Falls Earthquake. Website: http://earthquake.usgs.gov/regional/states/events/1993_09_21.php. Accessed: May 28, 2008 and July 22, 2008.

_____. 2008b. USGS Real-Time Water Data for USGS 11507501 Link River below Keno Canal, Near Klamath Falls, Oregon. Website: http://waterdata.usgs.gov/or/nwis/dv?cb_00060=on&format=html&begin_date=1982-01-01&end_date=1982-12-31&site_no=11507501&referred_module=sw. Accessed: June 23, 2008.

WHO (World Health Organization). 2003. Boron in drinking-water. Background document for preparation of WHO Guidelines for drinking-water quality. Geneva, World Health Organization.

William E. Nork, Inc. 1992. Analysis of Pumping Tests on OIT Injection Well No. 2 and Aquifer Stress Test Results. January 31, 1992.

Worldoil.com. 2004. *Scaled-down new rig type for shallow gas drilling*. December 2004. Website: http://www.worldoil.com/magazine/magazine_link.asp?ART_LINK=04-12_RIG_18.htm. Accessed: June 18, 2008.

WOU (Western Oregon University. 2008. Klamath Basin Wetland Map. Website: http://www.wou.edu/las/physci/taylor/g473/klamath_wetland_map.jpg. Accessed: June 20, 2008.

APPENDIX A:
SCOPING DOCUMENTS

June 4, 2008

TO: Distribution List

SUBJECT: Notice of Scoping – Oregon Institute of Technology's Deep Geothermal Well and Power Plan Project

The U.S. Department of Energy (DOE) is proposing to provide Congressionally Directed Federal Funding to the Oregon Institute of Technology (OIT), in Klamath Falls, Oregon for their deep geothermal well project. Pursuant to the requirements of the National Environmental Policy Act (NEPA), the Council on Environmental Quality regulations for implementing the procedural provisions of NEPA (40 CFR Parts 1500-1508), and DOE's implementing procedures for compliance with NEPA (10 CFR Part 1021), DOE is preparing a draft Environmental Assessment (EA) to:

- Identify any adverse environmental effects that cannot be avoided should this proposed action be implemented.
- Evaluate viable alternatives to the proposed action, including a no action alternative.
- Describe the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.
- Characterize any irreversible and irretrievable commitments of resources that would be involved should this proposed action be implemented.

Under the current DOE award contract, DOE proposes to fund OIT's proposed deep geothermal well project; the power plant will not be constructed with DOE or cost share funding but will be included, as a connected action, in the project scope for the Environmental Assessment.

Project Description

OIT is proposing to drill a deep geothermal well (up to 6,000 feet deep) on the OIT campus. Based on seismic tests performed on campus, the well would target the high angle normal fault on the eastern edge of the campus where geothermal fluids are known to be present and are presently used for the campus' direct-use heating system. A pipeline would connect the geothermal well to the proposed power plant. The pipeline would be installed underground near existing pipelines that are used for the direct-use system.

The geothermal fluids and its energy from the deep well, estimated to be around 300 degree Fahrenheit, would be used to power an approximate 1.2 megawatt (MWe) proposed geothermal power plant that would provide electricity to the campus. The power plant would be installed next to an existing heat exchange building on the southeastern end of campus. The plant would be either a binary plant (organic Rankine cycle) or a flash steam plant, depending upon the temperature of the resource encountered. Spent geothermal fluids would be injected back into the geothermal reservoir via the existing geothermal injection wells located on campus.

Project Location

The proposed project area is located on the OIT campus which is situated on the northern edge of the City of Klamath Falls in Section 20, Range 9 East, Township 38 South of the Willamette Base and Meridian. The well and power plant would be installed on the campus, in currently disturbed areas.

Probable Environmental Effects/Issues Scoped for the Environmental Assessment (EA)

The EA will describe all potential impacts on the environment caused by the project and will identify possible mitigation measures to reduce or eliminate those impacts. The EA will describe the potentially affected environment and the impacts that may result to:

- Meteorology/Air Quality
- Geology/Soils
- Mineral Resources (including geothermal)
- Biological Resources
- Water Resources
- Cultural Resources
- Land Use
- Noise
- Infrastructure
- Aesthetics
- Socioeconomics (including Mineral Rights)

Development of a Reasonable Range of Alternatives

DOE is required to consider a reasonable range of alternatives to the proposed action during the environmental review. The definition of alternatives is governed by the “rule of reason.” An EA must consider a reasonable range of options that could accomplish the agency’s purpose and need and reduce environmental effects. Reasonable alternatives are those that may be feasibly carried out based on environmental, technical, and economic factors.

The No Action alternative will be addressed. The need for project redesign, or a project alternative, will be determined during the course of environmental review.

Public Scoping

This letter will be available to all interested state, local, and federal agencies to supply input on issues to be discussed in the EA. Agencies should identify the issues, within their statutory responsibilities, that should be considered in the EA. The general public is also invited to submit comments on the scope of the EA on or before Friday, July 4th, 2008. No formal public scoping meeting is currently planned for this project. Please send your comments regarding the scope and content of the EA, along with the name and address of an appropriate contact person to:

Tania Treis
c/o MHA Environmental Consulting, An RMT Business
4 West Fourth Avenue, Suite 303, San Mateo, CA 94402
tania.treis@rmtinc.com

This letter and the draft EA, when available, will be posted to the Golden Field Office electronic reading room: http://www.eere.energy.gov/golden/reading_room.aspx.

Thank you for your participation in the environmental review process.

Sincerely,

Steve Blazek

NEPA Compliance Officer

Attachments:

NOTICE OF SCOPING

The U.S. Department of Energy (DOE) is requesting public input on the scope of environmental issues and alternatives to be addressed in the:

Environmental Assessment
Deep Geothermal Well and Power Plan Project
Klamath Falls, Oregon

The Oregon Institute of Technology, Klamath Falls, is proposing to construct and develop a Deep Geothermal Well and Power Plan Project with Congressionally directed federal funding from DOE. An Environmental Assessment (EA) will be prepared by DOE pursuant to the requirements of the National Environmental Policy Act (NEPA). The notice of scoping and description of the proposed project is available for review at the DOE Electronic Public Reading Room at :
http://www.eere.energy.gov/golden/Reading_Room.aspx.

Public comments on the NEPA process, proposed action and alternatives, and environmental issues will be accepted until July 04, 2008. Please send comments to MHA Environmental Consulting, An RMT Business, c/o Tania Treis, 4 West Fourth Avenue, Suite 303, San Mateo, CA 94402 or by e-mail to tania.treis@rmtinc.com.

NOTICE OF SCOPING

The U.S. Department of Energy (DOE) is requesting public input on the scope of environmental issues and alternatives to be addressed in the:

Environmental Assessment
Deep Geothermal Well and Power Plan Project
Klamath Falls, Oregon

The Oregon Institute of Technology, Klamath Falls, is proposing to construct and develop a Deep Geothermal Well and Power Plan Project with Congressionally directed federal funding from DOE. An Environmental Assessment (EA) will be prepared by DOE pursuant to the requirements of the National Environmental Policy Act (NEPA). The notice of scoping and description of the proposed project is available for review at the DOE Electronic Public Reading Room at:
http://www.eere.energy.gov/golden/Reading_Room.aspx.

Public comments on the NEPA process, proposed action and alternatives, and environmental issues will be accepted until July 04, 2008. Please send comments to MHA Environmental Consulting, An RMT Business, c/o Tania Treis, 4 West Fourth Avenue, Suite 303, San Mateo, CA 94402 or by e-mail to tania.treis@rmtinc.com.

NOTICE OF SCOPING

The U.S. Department of Energy (DOE) is requesting public input on the scope of environmental issues and alternatives to be addressed in the:

Environmental Assessment
Deep Geothermal Well and Power Plan Project
Klamath Falls, Oregon

The Oregon Institute of Technology, Klamath Falls, is proposing to construct and develop a Deep Geothermal Well and Power Plan Project with Congressionally directed federal funding from DOE. An Environmental Assessment (EA) will be prepared by DOE pursuant to the requirements of the National Environmental Policy Act (NEPA). The notice of scoping and description of the proposed project is available for review at the DOE Electronic Public Reading Room at :
http://www.eere.energy.gov/golden/Reading_Room.aspx.

Public comments on the NEPA process, proposed action and alternatives, and environmental issues will be accepted until July 04, 2008. Please send comments to MHA Environmental Consulting, An RMT Business, c/o Tania Treis, 4 West Fourth Avenue, Suite 303, San Mateo, CA 94402 or by e-mail to tania.treis@rmtinc.com.

NOTICE OF SCOPING

The U.S. Department of Energy (DOE) is requesting public input on the scope of environmental issues and alternatives to be addressed in the:

Environmental Assessment
Deep Geothermal Well and Power Plan Project
Klamath Falls, Oregon

The Oregon Institute of Technology, Klamath Falls, is proposing to construct and develop a Deep Geothermal Well and Power Plan Project with Congressionally directed federal funding from DOE. An Environmental Assessment (EA) will be prepared by DOE pursuant to the requirements of the National Environmental Policy Act (NEPA). The notice of scoping and description of the proposed project is available for review at the DOE Electronic Public Reading Room at :
http://www.eere.energy.gov/golden/Reading_Room.aspx.

Public comments on the NEPA process, proposed action and alternatives, and environmental issues will be accepted until July 04, 2008. Please send comments to MHA Environmental Consulting, An RMT Business, c/o Tania Treis, 4 West Fourth Avenue, Suite 303, San Mateo, CA 94402 or by e-mail to tania.treis@rmtinc.com.

Scoping Letter Contact List

Oregon Water Resources Department

Vern Church, District 17 Watermaster
5170 Summers Lane
Klamath Falls, OR 97603
541-883-4182

Tim Wallin, Water Rights Manager
725 Summer Street, NE Suite A
Salem, OR 97301
503-986-8091

Mike Zwart, Groundwater Geologist
725 Summer Street, NE, Suite A
Salem, OR 97301
503-986-0844

Oregon Department of Geology and Mineral Industries

Vickie McConnell
Oregon Department of Geology and Mineral Industries
800 NE Oregon St. #28, suite 965
Portland OR, 97232
971-673-1555

Bob Houston, Natural Resource Specialist
Mineral Land Regulation & Reclamation Program
229 Broadalbin Street SW
Albany, OR 97321
541-967-2080

Bob Brinkmann, RG, Hydrogeologist
Mineral Land Regulation & Reclamation Program
229 Broadalbin Street SW
Albany, OR 97321
541-967-2068

Department of State Lands

Louise C. Solliday, Director
755 Summer Street NE Suite 100
Salem, OR 97301-1279
503-986-5224

Nancy Pustis
Eastern Region Manager
Department of State Lands Eastern Region
1645 NE Forbes Rd., Suite 112
Bend, OR 97701
541-388-6112

Department of Environmental Quality

811 SW 6th Avenue
Portland, OR 97204-1390
503-229-5696

Underground Injection Control
811 SW 6th Avenue
Portland, OR 97204-1390
503-229-5945

Klamath County Permitting Department

Les Wilson
County Planning Signoff
305 Main Street
Klamath Falls, OR 97601
541-883-5121

Klamath Falls City Planning Department
226 5th St.
Klamath Falls, OR 97601

Klamath County Fire District #1
143 Broad St.
Klamath Falls, OR 97601

Surrounding Property Owners

Jeff Ball, City Manager
City of Klamath Falls
PO Box 237
Klamath Falls, OR 97601
(541) 883-5316

Jon Harder, President
Re: Crystal Terrance
Sunwest Management
PO Box 237

Salem, OR 97302
(503) 375-9016

John O Connor
JBO Properties
20100 Cheyne Rd.
Klamath Falls, OR 97601
(541) 798-5372

Frank Goodson
Paradise Hill Development
PO Box 223
Klamath Falls, OR 97601
(541) 882-4478

Sky Lakes Medical Center
2865 Daggett
Klamath Falls, OR 97601

Gregory Schechtel
3815 Thicket Ct.
Klamath Falls, OR 97601
(541) 885-9903

Joseph Bartlett
Tuttle Kenneth L ME and Bartlett William H Trust
2100 NE Wyatt Ct. Ste 110
Bend, OR 97701
(541) 317-9555

Oregon Department of Energy
625 Marion St. NE
Salem, OR 97301-3737

Michael Grainey, Director

Carel DeWinkel, Renewable Energy (Geothermal)

David Ripma, Chair
Energy Facility Siting Council

Betsy Kauffman
Energy Trust of Oregon, Inc.
851 SW Sixth Ave., Suite 1200
Portland, OR 97204

APPENDIX B:
OIT DEEP GEOTHERMAL WELL PROJECT EMERGENCY PLANS

EMERGENCY PLANS

1. Injury Contingency Plan

In the event injuries occur in connection with the Oregon Institute of Technology Deep Geothermal Well Project, specific and immediate attention will be given to proper transportation to a medical facility.

Ambulance
911

Sky Lakes Medical Center
2865 Daggett Ave.
Klamath Falls, OR 97601
541-882-6311

2. Blowout Contingency Plan (Also see Blowout Action Plan)

Blowout prevention equipment will be kept in operating condition and tested in compliance with Oregon Department of Geology and Mineral Industries (DOGAMI) regulations and industry standards.

In addition, cold water and barite will be stored at the wellsite for use in killing the well in case of an emergency.

In the event of an emergency, such as a blowout, immediate efforts will be taken to shut surface valves and blowout preventer system.

If the means to shut-in or control the flow from the well is lost, the Drilling Supervisor is to:

1. Initiate appropriate control procedures.

    1. Arrange for any injured persons to be taken by the fastest transportation available to the nearest medical facility, as shown in the Injury Contingency Plan.

    2. If there is a threat to any local residents, the Klamath Falls City Police and Campus Security will be notified as soon as possible.

       Klamath Falls City Police
       Klamath Falls, OR
       911 or (541) 883-5336

       Oregon Institute of Technology Campus Security
       (541)885-1111 or (541) 885-0911

2. Secure and maintain control of access roads to the area to eliminate entry of unauthorized personnel.

3. Contact the Project Manager and advise of the situation. The Drilling Supervisor will follow the same procedures stated in the Spill or Discharge Plan.

4. Initiate any further or supplemental steps that may be necessary or advisable, based on consultation with the Project Manager.

5. Be certain that all safety practices and procedures are being followed and that all members of the drilling crew are performing their assigned duties correctly.

6. Attempt to control the well at the rig site with rig personnel and supervisors.

7. If fluid flow is of an uncontained nature, attempt containment with required equipment by constructing sumps and/or dikes as rapidly as possible and as needed.

8. Attempt to construct and/or fabricate and install any wellhead facilities require to contain fluid flow at the well or casing head.

9. Maintain a continuing inspection of the pad area immediately around the well site subject to erosion that may cause failure to the drilling rig structure. Take necessary steps to avert areas of possible erosion by excavation and rebuilding of the area as necessary.

10. Following complete containment of the well, initiate steps to return the area to its normal state prior to the blowout or fluid flow, such as reseeding with similar and approved vegetation.

C. Fire Contingency Plan

1. Any small fires which occur around the well pad during drilling and/or testing operations should be able to be controlled by rig personnel utilizing on-site fire fighting equipment.

2. The Klamath County Fire District #1 (911) will be notified of any fire, even if the available personnel can handle the situation or the fire poses no threat to the surrounding area.

3. A roster of emergency phone numbers will be available on-site so that the appropriate fire fighting agency can be contacted in case of a fire.

D. Spill or Discharge Contingency Plan

1. Potential Sources of Accidental Spills or Discharges

a. Geothermal Fluid

Accidental geothermal fluid spills or discharges are very unlikely because the hole will be cased and blowout prevention equipment will be utilized. However, accidental discharges or spills could result from any of the following:

i. Loss of well control (blowout)

b. Drilling Muds

Muds are a mixture of water, non-toxic chemicals and solid particles used in the drilling operations to lubricate and cool the bit in the hole, to carry cuttings out of the hole, to maintain the hole condition and to control formation pressure. Drilling muds are prepared and stored in metal tanks at the drilling site. Waste drilling mud and cuttings are discharged into the reserve pit, which is open and is adequately sized to hold the volume necessary for the operation. Accidental discharges of drilling mud are unlikely, but could occur by:

1) overflow of the reserve pit

2) reserve pit wall seepage or wall failure.

3) discharge from equipment failure on location.

4) shallow lost circulation channeling to the surface.

3. Lubricating or Fuel Oils and Petroleum Products

A discharge of this type would probably be very small and be from equipment used in the field. Potential locations for accidental spills are:

(1) drilling equipment and machinery at and around the drilling location.

(2) other miscellaneous equipment and machinery at well site and roads.

4. Construction/Maintenance Debris

Typically a minor consideration, one which is usually able to be cleaned up on the job. Potential locations are the same as for lubricating or oils listed in Item 3, above.

2. Plan for Cleanup and Abatement

In the event of discharge of formation fluids, drilling muds, petroleum products or construction debris, the person responsible for the operation will make an immediate investigation, then contact the Drilling Supervisor and advise him of the spill. The Drilling Supervisor will in turn call out equipment, regulate field operations, or do other work as applicable for control and clean up of the spill, as follows:

1. Action - Small, Containable Spill

   If the spill is small (i.e., less than 250 gallons) and easily containable without endangering the watershed, the Drilling Supervisor will direct and supervise complete cleanup and return to normal operations.

2. Action - Large or Uncontainable Spill

   If the spill is larger than 250 gallons, or is not easily contained, or endangers, or has entered the watershed, the Drilling Supervisor will proceed to take necessary action to curtail, contain and cleanup the spill, as above, and notify personnel as listed below.

3. Notification

   (1) The Drilling Supervisor will, as quickly as practicable:

   - Call out contractor(s), as required.
   - Notify the Project Manager.
   - Notify the local law enforcement agencies if the public safety is threatened.

   (2) The Project Manager will notify the following as soon as practical and work closely with them in all phases of the curtailment, containment and cleanup operations:

   Robert Houston
   Oregon Department of
   Geology and Mineral Industries
   Mineral Land Regulation and Reclamation
   229 Broadalbin St. SW
   Albany, OR 97321
   (541) 967-2080

   DEQ Eastern Region
   Todd Hesse – Water (ext. 245)
   Frank Messina – Air (ext. 226)(need to verify)
   300 SE Reed Market Road
   Bend, OR 97702-2237
   (541) 388-6146

The Drilling Supervisor will also advise local population and affected property owners if spill affects residents or property.

1. Specific Procedures

(1) For geothermal fluid spills:

- Contain spillage with dikes if possible and haul to disposal site by vacuum or water trucks or dispose of in a manner acceptable to the OWRD or DOGAMI.

(2) For drilling mud:

- Repair sump or contain with dikes. Haul liquid to another sump, available tanks or approved disposal site.

(3) For petroleum products:

- Contain spill with available manpower. Use absorbents and dispose of same in approved disposal area.

For (1) through (3) above, Oregon Institute of Technology will have the source of spill repaired at the earliest practical time, and continue working crews and equipment on cleanup until all concerned agencies are satisfied.

5. Confirm telephone notification to agencies and regulatory bodies. Telephone notification shall be confirmed by the Project Manager in writing within two weeks of telephone notification.

Written confirmation will contain:

Reason for the discharge or spillage.

Duration and volume of discharge or spillage.

Steps taken to correct problem.

Steps taken to prevent recurrence of problem.

E. Hazardous Gas Contingency Plan

There is a very limited possibility of encountering hazardous non-condensable gases while drilling and testing. Although noxious or dangerous amounts of gases have not been associated with other geothermal wells drilled in the area, it is prudent to be prepared. The three main gases expected in this area are steam, hydrogen sulfide (H_2S), and carbon dioxide (CO_2).

3. The effectiveness of this plan is dependent upon the cooperation and effort of each person who enters the site during drilling or testing operations. Each person must know their responsibilities under stressful emergency operating conditions. All personnel must see that their safety equipment is stored and functional in addition to the location and operation of safety equipment.

4. All personnel will be trained in warning signs, signals, first aid, and responsibilities in case of hazard gases. The site will have two briefing areas so that one is upwind from the well and containment basin at all times. Before drilling or testing commences, all personnel will be advised of escape routes. Weekly drills will be conducted.

5. All vehicles will be parked with the front towards the exit road. A normal size first aid kit, stokes litter, wind direction apparatus, portable hand-held H_2S and CO_2 detectors will be available on the location. There will also be H_2S scavenger chemicals on the location for treating the mud. Warning signs will be posted on the access road to the location.

6. Steam is hot water in the gas form. It causes burns to the skin. It is possible that steam temperatures may exceed 300˚F during flow tests. All personnel must stay away and down wind from venting steam. Note water as hot as 220˚F may be present in the testing tanks. If a person is burnt, remove them from the site and cool the burnt area. Transport to the hospital.

7. H_2S is a colorless gas with a rotten egg odor in concentrations under 100 ppm. Above a concentration of 100 ppm, H_2S will cause health problems including death (Table 1). Above a H_2S concentration of 1000 ppm, death is instantaneous. H_2S is heavier than air and will accumulate in low spots. At high concentrations, H2S is combustible. Automatic H_2S detectors are stationed around the rig. At a 5 ppm concentration, a red light will flash. At this concentration, workers can continue their jobs for 8 hours. At a concentration above 10 ppm, a red light will flash and a warning horn sound. All personnel will immediately assemble at the upwind briefing area except for the driller who will shut the well in. He will then travel to the briefing area. Remember at concentrations above 100 ppm, personnel can not smell H_2S. Hand held detectors will be utilized to determine the H_2S concentration. Depending on the measured concentration, the Company Drilling Supervisor will assign duties.

8. CO_2 is a colorless odorless gas. At concentrations above 50000 ppm personnel risk affliction. At concentrations above 5%, CO_2 is combustible. The same procedure should be utilized as the H_2S procedure.

9. If a person becomes unconsciousness due to a hazardous gas, do not attempt to remove him without proper protective equipment. <u>You May Also Become A Victim.</u> Do not attempt a rescue without proper protective equipment. If the proper protective equipment, move the victim to a safe area. If the victim has been affected by H_2S or CO_2, apply artificial respiration until the paramedics arrive. Even if the symptoms pass, transport the victim to a hospital and place him under the care of a doctor.

10. After a hazardous gas has been detected, operations will proceed as follows:

A. Condition – <u>POTENTIAL DANGER</u>
H_2S concentration <10 ppm

CO_2 concentration <5000 ppm
STEAM >150˚F
All personnel will be immediately notified of the potential danger. Routine checking of the drilling fluid and monitoring equipment will alert mud loggers of possible danger. The mud loggers will immediately notify the Company Drilling Supervisor, Tool Pusher, Driller, Test Supervisor, and Mud Engineer. These personnel will immediately notify their crew members. All safety equipment, monitors, and alarms will be checked for correct operating conditions. A review of the emergency program and drills will be conducted before drilling continues.

B. Condition – <u>MODERATE DANGER</u>
H_2S concentration 10 ppm TO 20 ppm
CO_2 concentration 5000 ppm TO 50000 ppm
STEAM >190˚F
All personnel will be immediately notified of the danger. The mud loggers will immediately notify the Company Drilling Supervisor, Tool Pusher, Driller, Test Supervisor, and Mud Engineer. These personnel will immediately notify their crew members. The Driller will shut in the well if H_2S concentration exceeds 10 ppm. All personnel will meet at the briefing site. Selected personnel will take steps to locate the source of the hazardous gas. Drilling will not proceed until the gas is controlled. All nonessential personnel will be sent upwind and out of the potential danger zone. Gas concentrations around the well will be verified with hand held gas detectors. Access to the site will be limited to authorize personnel only. Warning signs will be posted.

C. Condition – <u>EXTREME DANGER</u>
H_2S concentration >20 ppm
CO_2 concentration >50000 ppm
STEAM >200˚F
All personnel will be immediately notified of the extreme danger by a honking horn. All personnel will immediately put on their protective gear. The mud loggers will immediately notify the Company Drilling Supervisor, Tool Pusher, Driller, Test Supervisor, and Mud Engineer. These personnel will immediately notify their crew members. The Driller will shut in the well. All personnel will meet at the upwind briefing site for evacuation. The Drilling Supervisor will assess the situation, outline a control program, and assign duties to control the situation. The proper agencies will be notified. Drilling will not proceed until the gas is controlled. All nonessential personnel will be sent upwind and out of the potential danger zone. Access to the site will be limited to authorized personnel wearing protective equipment. Warning signs will be

posted to limit access to the site. If the gas can not be controlled, the Emergency Plan will be initialized.

TABLE 1
PHYSICAL EFFECTS OF HYDROGEN SULFIDE

CONCENTRATION (ppm)	0-2 MINUTES	15-30 MINUTES	30-60 MINUTES
10-20	Rotten egg smell	Detectable	Maximum 8-hour exposure with protective mask
100	Coughing Loss of smell	Eye pain Sleepiness	Throat and eye irritation
450	Eye irritation	Respiration difficult	Serious respiratory disturbance
1000	Unconsciousness	Death	Death

5. Emergency Personnel and Telephone Numbers

Fire
Klamath county Fire District #1 911

Law Enforcement
Klamath Falls City Police 911 or (541) 883-5336
OIT Campus Security (541) 885-1111 or (541) 995-0911

Sky Lakes Medical Center 911 or (541) 882-6311

Agency Representatives
Oregon Department of Geology and Mineral Industries
Robert Houston (541) 967-2080

Oregon DEQ
Todd Hesse – Water (541) 388-6146 ext. 245
Frank Messina – Air (541) 388-6146 EXT. 226

Oregon Institute of Technology Project Managers

Drilling Project Manager Yet to be named

Dave Ebsen,
Facilites Director (541) 885-1600

John Lund (541) 885-1750

Toni Boyd (541) 885-1750

Oregon Institute of Technology Deep Geothermal Well Project

EMERGENCY PLANS

BLOWOUT ACTION PLAN

WAIT AND WEIGHT METHOD

To Be Posted at Well Pad Site

1. The hole is to be kept full of drilling or completion fluids at all times unless this becomes impossible due to lost circulation.

2. Before starting out of hole with drillpipe or tubing, circulate off bottom until mud is properly conditioned.

3. Close and open pipe rams once per day and log on tour sheet. Pressure test BOPE prior to drilling out of casing shoes and coincident with casing test. Log results on blowout preventer check list.

4. Close blind rams when out of hole and log on tour sheet.

5. Fill hole at five (5) stand intervals or less while pulling drillpipe out of hole. Count pump strokes or use chart attached to the pit volume indicator to determine the volume required to fill the hole.

6. Watch pit flow or pit level indicator when running in the hole to insure that the volume of mud displaced by the drillpipe is not exceeded.

7. The drillpipe will be run in the hole to the shoe of the casing and a TIW valve installed to perform any of the following operations:

   a. Slip or cut drilling line.
   b. Repair equipment (if possible).
   c. Any foreseen delay.

8. Record reduced circulating pressure at 30 strokes per minute (SPM) or other suitable kick control SPM daily and after each bit change.

9. An approved inside blowout preventer and full opening safety valve with wrench must be immediately available on the rig floor.

10. A blowout prevention drill will be conducted by the rig tool pusher under the supervision of the Drilling Supervisor for each drilling crew to ensure that each person is properly trained to carry out emergency procedures. Assign kick control duties in advance: i.e. mud mixing assigned to floorman, operating pumps assigned to derrickman, etc.

11. At first indication of gain in pit level (or other sign of possible blowout), the driller will immediately do what is necessary to control the well. In most cases this action

should be:

While Drilling:

a. Pull kelly up out of rotary table and stop pumps.
b. Open valve(s) on choke line.
c. Close the blowout preventer and gradually reclose choke line.
d. Record shut-in drillpipe (Pdp) and casing (Pcg) pressure. Maximum allowable casing pressure to be dependent on casing depth and burst rating. Allowable pressure for each string to be posted and noted in driller's instructions and on well control data sheet.

Inform the Drilling Supervisor and/or proceed with appropriate kick control measures as follows in Step 12.

While Tripping:

a. Install full opening safety valve.
b. Open valve on choke(s) line.
c. Close safety valve.
d. Close blowout preventer and gradually reclose choke valve(s).
e. Record shut-in drillpipe and casing pressure. Maximum allowable casing pressure to be dependent on casing depth, mud weight and burst rating.
f. Inform the Drilling Supervisor. Run drillstring in hole as far as practical after first installing inside BOP and reopening safety valve, and/or proceed with appropriate kick control measures as follows in Step 12.

12. Calculate and mix mud of weight necessary to keep well under control using the well control worksheet and attached monograph.

Mud weight increase in lb/gallon =

$$\frac{\text{Pdp}}{\text{Drillstring depth in feet} \times 0.052} + 0.4 \text{ lb/gallon}$$

Where Pdp = shut-in drillpipe pressure in psig.

13. When sufficient volume of proper weight mud has been prepared, start pumping increased weight mud down drillpipe at constant kick control SPM which will reduce circulating pressure downward gradually from Pi (initial drillpipe circulating pressure) as calculated on the well control worksheet to Pf (final drillpipe circulating pressure)

when drillpipe is filled with weighted mud. Therefore hold drillpipe pressure constant at Pf by adjusting choke until proper weight mud returns to surface.

14. When proper weight mud returns to surface, stop pumps, release any remaining pressure on casing, and check for additional kick before returning to normal operations.

15. Drill new directional hole as a last resort to kill well.

Oregon Institute of Technology Deep Geothermal Well Project
EMERGENCY PLANS

BLOWOUT ACTION PLAN
DRILLERS METHOD

To Be Posted at Well Pad Site

1) The hole is to be kept full of drilling or completion fluids at all times unless this becomes impossible due to lost circulation.

2) Before starting out of hole with drill pipe or tubing, circulate off bottom until mud is properly conditioned.

3) Close and open pipe rams once per day and log on tour sheet. Pressure test BOPE prior to drilling out of casing shoes and coincident with casing test. Log results on tour sheet.

4) Close blind rams when out of hole and log on tour sheet.

5) Fill hole at five (5) stand intervals or less while pulling drill pipe out of hole. Count pump strokes or use chart attached to the pit volume indicator to determine the volume required to fill the hole.

6) Watch pit flow or pit level indicator when running in the hole to insure that the volume of mud displaced by the drill string is not exceeded.

7) The drill pipe will be run in the hole to the shoe of the casing and a full opening safety valve installed to perform any of the following operations:

    a) Slip or cut drilling line.

    b) Repair equipment (if possible).

    c) Any foreseen delay.

8) Record on the tour sheet the reduced circulating pressure at 30 strokes per minute (SPM) or other suitable kick control pump rate daily and after each bit change.

9) An approved inside blowout preventer and full opening safety valve with wrench must be immediately available on the rig floor.

10) A blowout prevention drill will be conducted by the rig tool pusher and observed by the Drilling Supervisor for each drilling crew to ensure that each person is properly trained to carry out emergency procedures. Assign kick control duties in advance: i.e. mud mixing assigned to floorman, operating pumps assigned to derrickman, etc.

11) At first indication of gain in pit level (or other sign of possible blowout), the driller will immediately do what is necessary to control the well. In most cases this action should be:

Shut-In Procedure While Drilling:

12) Pull kelly above the rotary table and stop pumps.

13) Check the well for flow.

14) Close the blowout preventer and shut the well in completely.

15) Record pit level, shut-in drill pipe (P_{sidp}) and shut-in casing pressure (P_{sicg}).

16) Inform the Drilling Supervisor and/or proceed with appropriate kick control measures as follows.

Shut-in Procedure While Tripping:

17) Set slips with tool joint in rotary table.

18) Install full opening safety valve.

19) Close safety valve.

20) Close blowout preventer.

21) Install the kelly.

22) Record shut-in drill pipe and casing pressure.

23) Inform the Drilling Supervisor.

24) Run drill string in hole as far as practical after first installing inside BOP and reopening safety valve, and/or proceed with appropriate kick control measures as follows.

Kick Control Measures for Driller's Method

First Circulation

25) Select a pump speed for the kill operation. This will usually be the previously recorded slow pump rate. It is important to maintain a constant speed throughout the kill operation.

26) Start the pump and open the choke to maintain the casing pressure ($P_{cg)}$ constant as the pump is brought up to the desired kill speed. Once the kill speed is reached, observe the new drill pipe pressure (P_{dp}). Record the drill pipe pressure.

27) Pump one full circulating volume at constant pump speed while operating the choke to maintain the drill pipe pressure constant.

28) Stop the pump and shut the choke. At this point the new shut-in casing pressure and the shut-in drill pipe pressure should be equal. Record these pressures. If a drill pipe float is making it difficult to obtain drill pipe pressure readings, the new shut in casing pressure may be used in the calculation below.

<u>Second Circulation</u>

29) Calculate the kill-weight mud density.

$$\text{New Mud Weight} = \text{Current Mud Weight} + \frac{\text{Drill Pipe Pressure}}{0.052 * \text{TVD}}$$

A trip margin may be added if desired, but management approval is required for a trip margin in excess of
0.2 ppg.

30) Start the pump, bringing it up to the kill speed, and operate the choke as necessary to maintain the casing pressure constant. Continue operating the choke to keep the casing pressure constant until one drill string volume of kill weight mud has been pumped.

31) After pumping one drill string volume of the kill weight mud, maintain the pump speed constant and record the circulating drill pipe pressure.

32) Maintain the pump speed constant and operate the choke so as to maintain the drill pipe pressure constant until kill weight mud returns are measured at the surface.

33) Stop the pump and check for flow.

APPENDIX C:

COMMITMENT LETTER TO IMPLEMENT ENVIRONMENTAL PROTECTION MEASURES

GEO-HEAT CENTER

Oregon Institute of Technology   Klamath Falls, Oregon 97601   541/885-1750   FAX 541/885-1754

John W. Lund, Director
Tonya "Toni" Boyd

July 21, 2008

Mr. Steve Blazek
US Department of Energy
1617 Cole Boulevard
Golden, CO 80401

RE: Environmental Commitments for the OIT Deep Geothermal Well and Power Plant Project

Dear Mr. Blazek,

Attached is a list of environmental protection measures that have been incorporated into the project description of the OIT Deep Geothermal Well and Power Plant Project Environmental Assessment (EA). The Oregon Institute of Technology (OIT) agrees to implement all of these measures during implementation of the project. The measures have been incorporated into the project description of the EA prepared by MHA Environmental Consulting, an RMT Business as part of the proposed action.

This letter serves to document the concurrence of OIT to conduct the attached revised environmental protection measures as part of the project. If you have any questions, please contact me at 541-885-1750.

Sincerely,

Dr. John W. Lund, PE
Director of the Geo-Heat Center
Oregon Institute of Technology

Enclosure

Environmental Protection Measures

Air Quality

1) Prior to ground disturbance, any dry soils shall be watered to reduce fugitive dust emissions. Soils shall be monitored and continued to be watered throughout the project if dust begins to generate. Other measures that shall be implemented to minimize dust include:
   - Application of asphalt, oil, water, or suitable chemicals on dirt roads, material stockpiles, and other surfaces which can give rise to airborne dust
   - Use of water, chemicals, venting, or other precautions to prevent particulate matter from becoming airborne in handling dusty materials to open stockpiles and mobile equipment
   - Maintenance of roadways in a clean condition
2) Hydrogen sulfide concentrations in the air shall be monitored at the drill site during drilling and flow testing. H_2S concentrations in the produced geothermal fluid and preliminary flow will be measured during the flow test. If these measurements suggest that the H_2S emissions approach 10 ppm for an 8 hour day, a chemical abatement (such as NaOH) standard for the geothermal industry will be injected into the discharge line to abate the gas. A trailer-mounted abatement skid with a storage tank for NaOH, a pump, and appropriate monitoring equipment shall be kept on site. The discharge line shall be appropriately valued to provide for abatement at any time if needed. Personnel on site during periods of possible well discharge will be trained in the use of masks and air tanks and shall wear H_2S monitors at all times.

Geology/Soils

3) Topsoil shall be stockpiled and covered to minimize erosion. Topsoil shall be reapplied to the surface after completion of construction, as appropriate.

Biological Resources

4) Monitoring and treatment of the parking lot and access roads for invasive, non-native species shall be required for the duration of exploration. Any weeds found in the roads or parking lot would be removed completely and discarded in an appropriate manner.
5) During construction, construction crews shall stay within the designated construction areas. All pipelines shall be capped at night to ensure that rabbits do not enter stockpiled equipment. Equipment shall be checked in the morning for rabbits or other animals. If wildlife is found in equipment they shall be allowed to leave the project area prior to moving equipment.

Water Resources

6) Containment berms shall be constructed around all hazardous or potentially hazardous materials storage areas. Containment berms shall be 110 percent of storage volume.
7) A Spill Prevention Control and Countermeasure Plan (SPCC) shall be prepared and kept on-site during construction and operation. The plans shall identify equipment and procedures used for containment and recovery of accidental spills.

Noise

8) Noise screening would be used during drilling to reduce noise heard by sensitive receptors. All equipment used shall have the appropriate mufflers and noise abatement

equipment necessary. A temporary noise wall shall be installed around the drilling pad. The wall shall not be greater in height than the base of the drill rig to minimize visual impacts. The wall shall be removed after drilling is complete. All neighboring properties shall be informed in writing of the proposed drilling schedule and estimated noise levels 30 days prior to commencing drilling operations. The notification shall also include the name and number of a contact person who shall receive noise complaints and respond to any local complaints about drilling or construction noise.

In the event of a complaint, the contact shall determine the cause of the noise complaint and institute reasonable measures warranted to correct the problem.

9) Power plant, pipeline, and electrical interconnect construction shall only occur between 7:00 a.m. and dusk. All neighboring properties shall be informed in writing of the proposed drilling schedule and estimated noise levels 30 days prior to commencing drilling operations. The notification shall also include the name and number of a contact person who shall receive noise complaints and respond to any local complaints about drilling or construction noise.

10) In the event of a complaint, the contact shall determine the cause of the noise complaint and institute reasonable measures warranted to correct the problem.

Human Health and Safety and Risk Assessment

11) Temporary safety fencing during construction or repairs to restrict or prevent public access to active on-site construction materials or chemicals.

12) Safety signage, placed as appropriate along the construction corridor during construction or repairs, to warn of risks associated with on-site construction materials and outline measures to be taken to ensure safe use of facilities near construction areas and avoidance of construction materials.

13) Safety plan, developed by OIT prior to project commencement, will include appropriate methods (i.e. Best Management Practices) and approved combustion prevention and response practices for pentane. The plan will insure that all fire hazards (i.e. spark-inducing activities such as welding, and improperly disposed cigarettes) are kept away from the pentane storage tank.

14) The following fire prevention measures would be implemented during construction:

    - Fire extinguishers and shovels will be available on-site.
    - All brush build-up around mufflers, radiators, and other engine parts must be avoided; periodic checks must be conducted to prevent this build-up.
    - Smoking would only be allowed in designated smoking areas; all cigarette butts would be placed in appropriate containers and not thrown on the ground or out windows of vehicles.
    - Cooking, campfires, or fires of any kind would not be allowed.
    - Portable generators used in the Project Area would be required to have spark arresters.

15) A fire break of at least 15 feet will be constructed between the pentane storage tank and any vegetation, landscaping or combustible materials.

APPENDIX D:
INVASIVE SPECIES IN KLAMATH COUNTY

BOARD OF COUNTY COMMISSIONERS

IN AND FOR THE COUNTY OF KLAMATH, STATE OF OREGON

In the Matter of Declaring Klamath) County a Weed Control District and) Declaring Noxious Weeds in Klamath) County for 2008)	**ORDER NO. 2008-056**

THIS MATTER COMING ON AT THIS TIME TO BE HEARD before the Klamath County Board of Commissioners and it appearing that said Commissioners under ORS 570.525 may declare noxious weeds which are to be destroyed and prevented from producing seed within the County, and

IT FURTHER APPEARING that the Board of Commissioners has identified the following twenty-two weeds as: "A" designated weeds. A weed of known economic importance which occurs in the county in small enough infestations to make eradication/containment possible, or if not known to occur, but its presence in neighboring counties make future occurrence in Klamath County seem imminent.

Recommended Action: Infestations are subject to intensive control when and where found.

CAPER SPURGE *Euphorbia lathyris*
CUTLEAF TEASEL *Dipsacus laciniatus*
DIFFUSE KNAPWEED *Centaurea diffusa*
DYER'S WOAD *Isatis tinctoria*
FIELD DODDER *Cuscuta campestris*
HOUNDSTONGUE *Cynoglossum officiale*
MATGRASS *Nardus Stricta*
MEADOW KNAPWEED *Centaurea pratensis*
PHEASANT'S EYE *Adonis aestivalis*
PLUMELESS THISTLE *Carduus acanthoides*
PUNCTUREVINE *Tribulus terrestris*
PURPLE LOOSESTRIFE *Lythrum salicaria*
RUSSIAN KNAPWEED *Acroptilon repens*
SCOTCH BROOM non-ornamental *Cytisus scoparius*
RUSH SKELETONWEED *Chondrilla juncea*
SPINY COCKELBUR *Xanthium spinosum*
SPOTTED KNAPWEED *Centaurea maculosa*
SQUARROSE KNAPWEED *Centaurea virgata*
SULFUR CINQUEFOIL *Potentilla recta*
TAURIAN THISTLE *Onopordum tauricum*
TANSY RAGWORT *Senecio jacobaea*
YELLOW TOADFLAX *Linaria vulgaris*

IT FURTHER APPEARING that the Board of Commissioners has identified the following thirteen weeds as: "B" designated weeds. A weed of economic importance which in some parts of the county is abundant, but may have limited distribution in other parts of the county. Where implementation of a fully-integrated county wide management plan is infeasible, biological control shall be the main control approach.

Recommended Action: Control levels as determined on a case by case basis.

CANADA THISTLE *Cirsium arvense*
DALMATION TOADFLAX *Linaria genistifolia*
HOARY CRESS *Cardaria draba*
LEAFY SPURGE *Euphorbia esula*
MEDITERRANEAN SAGE *Salvia aethiopsis*
MUSK THISTLE *Carduus nutans*
MYRTLE SPURGE *Euphorbia Myrsinites*
PERENNIAL PEPPERWEED *Lepidium latifolium*
POISON HEMLOCK *Conium maculatum*
SCOTCH THISTLE *Onopordum acanthium*
ST. JOHNSWORT *Hypericum perforatum*
(KLAMATH WEED)
YELLOW FLAG IRIS *Iris pseudacorus*
YELLOW STARTHISTLE *Centaurea solstitialis*

.

IT FURTHER APPEARING that the Board of Commissioners has identified the following six weeds as: “C” designated weeds. A weed which in most parts of the county is abundant. While not subject to enforcement regulations, these species can cause similar economic and ecological impacts as other noxious weed species. Education and control recommendations will be the main approach.

Recommended Action: Control levels as determined on a case by case basis.

BULL THISTLE *cirsium vulgare*
COMMON MULLEIN *Verbascum thapsus*
CREEPING BUTTERCUP *Ranunculus repens*
MEDUSAHEAD *Taeniatherum caput-medusae*
MAYWEED CHAMOMILE *Anthemis cotula*
WESTERN WATERHEMLOCK *Cicuta douglasii*

NOW THEREFORE, IT IS HEREBY ORDERED that all of Klamath County is declared a Weed Control District and the above named weeds are declared noxious and are to be controlled as indicated through their “A”, “B”, “C”, designations within the boundaries of Klamath County in the calendar year 2008.

KLAMATH COUNTY BOARD OF COMMISSIONERS

______________________	______________________	______________________
Chairman	**Commissioner**	**Commissioner**
Approved____________	**Approved**_______________	**Approved**_________________
Denied______________	**Denied**_________________	**Denied**___________________
Date________________	**Date**___________________	**Date**_____________________

APPENDIX E:

RESULTS OF GEOTHERMAL WATER TESTING FROM THE OIT PRODUCTION WELL DATED MARCH 1990

KLAMATH ENVIRONMENTAL SERVICES

ENVIRONMENTAL CONSULTING, HAZARDOUS WASTE
MANAGEMENT, WATER ANALYSIS, GROUND WATER MONITORING
200 EAST MAIN - KLAMATH FALLS, OR 97601 - 503 / 882-8677
OREGON STATE APPROVED LABORATORY #17
STATE OF CALIFORNIA APPROVED
EPA CERTIFIED

April 10, 1990

Oregon Institute of Technology
Receiving
3201 Campus Drive
Klamath Falls, OR 97601-8801

RE: Laboratory #:90-C218

The analysis of the water sample submitted on March 5, 1990, shows the following results:

ANALYSIS (mg/l)*	OIT ~~INJECT~~ Prod. WELL 90-C218
TEMPERATURE °C	52.2
pH (UNITLESS)	8.27
CONDUCTIVITY (µmhos/cm)	990
TOTAL DISSOLVED SOLIDS	737
ARSENIC	0.048
BORON	73.6
CALCIUM	25
CARBONATE	12.8
BICARBONATE	27.3
CHLORIDE	37.0
FLOURIDE	1.23
IRON	0.44
MAGNESIUM	0.15
MANGANESE	<0.01
POTASSIUM	8.0
SILICA	8.6
SODIUM	394 ?, 39.4
SULFATE	490

MASS BAL = $\frac{737}{1078}$ = 0.68

TOTAL COLIFORM = <2/100 mls

APPROVED BY: Joseph S. McBride

APPENDIX F:
USGS EARTHQUAKE DATA
FOR A 100KM RADIUS AROUND
KLAMATH FALLS, OREGON

NEIC: Earthquake Search Results

U. S. GEOLOGICAL SURVEY

EARTHQUAKE DATA BASE

FILE CREATED: Tue Jul 22 19:46:07 2008
Circle Search Earthquakes= 257
Circle Center Point Latitude: 42.223N Longitude: 121.777W
Radius: 100.000 km
Catalog Used: PDE
Data Selection: Historical & Preliminary Data

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNITUDE	IEFM NFPO TFS	DTSVNWG	DIST km
PDE	1978	06	11	190826.10	41.44	-121.88	2	3.00 MLBRK	.. .	....	87
PDE	1978	06	11	201203.90	41.44	-121.89	2	3.50 MLBRK	.. .	....	87
PDE	1978	06	12	030335.20	41.46	-121.86	2	3.00 MLBRK	.. .	....	84
PDE	1978	06	12	091844.10	41.46	-121.86	2	3.80 MLBRK	.. .	....	84
PDE	1978	08	01	090234.50	41.45	-121.88	2	4.60 MLBRK	5F .	....	86
PDE	1978	08	01	090510.20	41.40	-121.91	2	4.20 MLBRK	.. .	....	91
PDE	1978	08	01	090900.40	41.47	-121.86	2	3.40 MLBRK	.. .	....	83
PDE	1978	08	01	093550.60	41.41	-121.91	2	3.50 MLBRK	.. .	....	91
PDE	1978	08	01	093816.60	41.43	-121.89	2	3.90 mb GS	.. .	....	88
PDE	1978	08	01	094644.60	41.46	-121.87	2	5.10 Ms GS	4F .	....	85
PDE	1978	08	01	102632.50	41.46	-121.87	2	4.30 mb GS	.F .	....	85
PDE	1978	08	01	104727.10	41.44	-121.88	2	3.30 MLBRK	.. .	....	87
PDE	1978	08	01	111143.90	41.41	-121.91	2	3.10 MLBRK	.. .	....	90
PDE	1978	08	01	112243	41.40	-121.92	2	3.20 MLBRK	.. .	....	91
PDE	1978	08	01	141610.50	41.43	-121.89	2	3.60 MLBRK	.. .	....	88
PDE	1978	08	01	155320.50	41.44	-121.89	2	3.90 MLBRK	.F .	....	87

PDE	1978	08	01	182215.70	41.43	-121.89	2	3.30	MLBRK	.. . .	89
PDE	1978	08	01	183411.40	41.46	-121.86	2	3.30	MLBRK	.. . .	85
PDE	1978	08	01	210236.90	41.44	-121.88	2	3.30	MLBRK	.. . .	87
PDE	1978	08	02	000658	41.42	-121.90	2	3.80	MLBRK	.. . .	89
PDE	1978	08	02	021534	41.42	-121.89	2	4.10	mb GS	.. . .	89
PDE	1978	08	02	143147	41.44	-121.89	2	3.40	MLBRK	.. . .	88
PDE	1978	08	04	051852.90	41.44	-121.88	2	3.50	MLBRK	.. . .	86
PDE	1978	08	13	055548	41.43	-121.89	2	4.30	mb GS	5F	88
PDE	1978	08	13	055705	41.43	-121.89	2	4.10	MLBRK	.. . .	88
PDE	1978	08	13	055822	41.43	-121.89	2	4.30	MLBRK	.. . .	88
PDE	1978	08	13	062132	41.44	-121.88	2	3.30	MLBRK	.. . .	87
PDE	1978	08	13	070318.10	41.48	-121.85	2	3.70	mb GS	.. . .	82
PDE	1978	08	14	215241.60	41.42	-121.89	2	4.20	mb GS	.. . .	89
PDE	1978	08	15	041652.40	41.45	-121.88	2	3.30	MLBRK	.. . .	86
PDE	1978	08	15	043252.80	41.44	-121.89	2	3.40	MLBRK	.. . .	88
PDE	1978	08	17	075140	41.44	-121.89	2	3.30	MLBRK	.. . .	87
PDE	1978	08	19	173509.70	41.46	-121.86	2	3.90	MLBRK	.. . .	84
PDE	1978	08	20	082823.60	41.43	-121.89	2	3.10	MLBRK	.. . .	88
PDE	1978	08	20	094747	41.42	-121.89	2	3.60	MLBRK	.. . .	89
PDE	1978	08	20	101131.30	41.44	-121.89	2	3.10	MLBRK	.. . .	87
PDE	1978	08	21	130835.50	41.46	-121.86	2	3.20	MLBRK	.. . .	84
PDE	1981	01	09	064551.70	41.53	-121.84	5	3.30	MLBRK	.. . .	77
PDE	1981	01	09	124435.90	41.58	-121.92	8	3.20	MLBRK	.F	72
PDE	1981	01	10	003615.90	41.56	-121.88	5	3.60	MLBRK	.F	73
PDE	1988	09	29	150500.60	41.61	-121.56	2	3.40	MLBRK	.. . .	70
PDE	1988	09	30	000355.80	41.64	-121.51	1	3.40	MLBRK	.. . .	68
PDE	1988	09	30	003013.70	41.64	-121.54	2	4.40	mb GS	4F	67
PDE	1988	09	30	004003.40	41.61	-121.54	2	3.60	MLBRK	.. . .	70
PDE	1988	10	04	003408.20	41.61	-121.59	2	3.20	MLBRK	.. . .	69
PDE	1989	07	01	152753.81	42.08	-120.59	5	3.10	MLBRK	.. . .	99
PDE	1989	09	15	101631.50	41.60	-121.50	4	2.80	MLBRK	.. . .	72
PDE	1993	09	21	031654.91	42.31	-122.05	5	4.50	MLBRK	.F	24
PDE	1993	09	21	032855.42	42.31	-122.01	10	6.00	MwGS	7CFM ......M	21
PDE	1993	09	21	034711.56	42.28	-122.09	5	3.50	MLGS	.. . .	26
PDE	1993	09	21	035247.87	42.24	-122.08	5	3.00	MLGS	.. . .	25
PDE	1993	09	21	035806.86	42.29	-122.13	5	3.20	MLGS	.. . .	29
PDE	1993	09	21	040241	42.30	-122.00	5	3.70	MLGS	.. . .	20
PDE	1993	09	21	040412.80	42.40	-121.94	5	3.70	MLGS	.. . .	23
PDE	1993	09	21	040654.68	42.33	-122.11	0	2.90	MLGS	.. . .	29
PDE	1993	09	21	040738	42.30	-122.00	5	3.60	MLGS	.. . .	20
PDE	1993	09	21	041612.38	42.27	-122.03	5	4.50	MLBRK	.F	21
PDE	1993	09	21	042805.62	42.22	-122.11	5	3.20	MLGS	.. . .	27
PDE	1993	09	21	043120.87	42.42	-121.88	5	2.90	MDGS	.. . .	22
PDE	1993	09	21	043406.90	42.27	-122.08	5	4.20	MLBRK	.F	25

PDE	1993	09	21	043802.28	42.27	-122.08	5	3.80	MLGS	.. . .	25
PDE	1993	09	21	045529.09	42.27	-122.10	5	3.20	MLGS	.. . .	26
PDE	1993	09	21	045931.35	42.19	-122.11	5	3.20	MLGS	.. . .	27
PDE	1993	09	21	051131.33	42.24	-122.09	5	4.00	MLGS	.. . .	26
PDE	1993	09	21	052031.78	42.10	-122.16	5	3.00	MLGS	.. . .	34
PDE	1993	09	21	054009.12	42.23	-122.10	5	3.00	MLGS	.. . .	26
PDE	1993	09	21	054533.75	42.36	-122.04	5	6.00	MwHRV	.D M	26
PDE	1993	09	21	061350.77	42.31	-122.16	5	3.20	MLGS	.. . .	32
PDE	1993	09	21	061443.07	42.37	-122.01	5	5.00	mb GS	.F	25
PDE	1993	09	21	062358.01	42.29	-122.13	5	2.90	MLGS	.. . .	29
PDE	1993	09	21	062533.82	42.35	-122.10	5	3.50	MLGS	.. . .	29
PDE	1993	09	21	065414.17	42.34	-122.15	5	3.30	MLGS	.. . .	33
PDE	1993	09	21	070637.22	42.23	-122.13	5	3.40	MLGS	.. . .	29
PDE	1993	09	21	071643.03	42.25	-122.01	5	3.00	MLGS	.. . .	19
PDE	1993	09	21	071733.81	42.26	-122.13	5	2.90	MLGS	.. . .	29
PDE	1993	09	21	072816.37	42.38	-122.07	5	3.80	MLGS	.. . .	29
PDE	1993	09	21	074119	42.30	-122.00	5	3.00	MLGS	.. . .	20
PDE	1993	09	21	074629.21	42.32	-122.13	5	2.70	MDGS	.. . .	31
PDE	1993	09	21	075029.63	42.33	-122.14	5	2.90	MLGS	.. . .	32
PDE	1993	09	21	075557.77	42.26	-122.10	5	3.00	MLGS	.. . .	27
PDE	1993	09	21	081827.02	42.28	-122.12	5	2.90	MDGS	.. . .	29
PDE	1993	09	21	082507.14	42.22	-122.09	5	2.80	MLGS	.. . .	25
PDE	1993	09	21	083156.06	42.31	-122.25	5	3.00	MLGS	.. . .	39
PDE	1993	09	21	084522.20	42.46	-122.21	5	3.00	MLGS	.. . .	43
PDE	1993	09	21	090702.53	42.21	-122.13	5	3.10	MLGS	.. . .	29
PDE	1993	09	21	091012.71	42.10	-122.13	5	3.10	MLGS	.. . .	32
PDE	1993	09	21	092120.90	42.08	-122.17	5	3.00	MLGS	.. . .	36
PDE	1993	09	21	094103.34	42.20	-122.07	5	3.00	MLGS	.. . .	24
PDE	1993	09	21	100327.80	42.31	-122.09	5	2.90	MLGS	.. . .	27
PDE	1993	09	21	105033.45	42.15	-122.19	5			.. . .	34
PDE	1993	09	21	105325.21	42.28	-122.22	5	2.90	MLGS	.. . .	37
PDE	1993	09	21	110159.81	42.34	-122.16	5	3.10	MLGS	.. . .	33
PDE	1993	09	21	115316.92	42.32	-122.12	5	2.90	MLGS	.. . .	30
PDE	1993	09	21	1220	42.30	-122.00	5	2.60	MDGS	.. . .	20
PDE	1993	09	21	124100.53	42.29	-122.06	5	2.70	MLGS	.. . .	24
PDE	1993	09	21	130943.54	42.34	-122.22	5	2.50	MDGS	.. . .	38
PDE	1993	09	21	131837.10	42.31	-122.19	5	2.50	MDGS	.. . .	35
PDE	1993	09	21	140317.73	42.20	-122.16	5	3.00	MLGS	.. . .	31
PDE	1993	09	21	142849	42.30	-122.00	5	2.40	MDGS	.. . .	20
PDE	1993	09	21	145115.80	42.13	-122.16	5	2.80	MLGS	.. . .	33
PDE	1993	09	21	151102.58	42.33	-121.96	5	3.30	MLGS	.. . .	18
PDE	1993	09	21	173400.10	42.25	-122.14	5	3.50	MLBRK	.. . .	29
PDE	1993	09	21	174846.36	42.31	-122.09	5	2.80	MLGS	.. . .	27
PDE	1993	09	21	193815	42.30	-122.00	5	2.80	MLGS	.. . .	20

PDE	1993	09	21	194334.56	42.55	-122.05	5	2.60	MDGS	..	. ...	42
PDE	1993	09	21	204540.12	42.22	-122.11	5	2.70	MLGS	..	. ...	27
PDE	1993	09	21	215136.73	42.48	-122.06	5	2.70	MDGS	..	. ...	36
PDE	1993	09	21	221016.41	42.23	-122.13	5	2.80	MLGS	..	. ...	28
PDE	1993	09	21	221317.68	42.21	-122.10	5	3.30	MLGS	..	. ...	26
PDE	1993	09	21	234048.66	42.30	-122.09	5	2.70	MDGS	..	. ...	27
PDE	1993	09	21	234556.25	42.41	-122.01	5	2.50	MDGS	..	. ...	28
PDE	1993	09	22	004522.51	42.28	-122.05	5	2.90	MLGS	..	. ...	23
PDE	1993	09	22	010845.14	42.22	-122.07	5	2.60	MLGS	..	. ...	23
PDE	1993	09	22	015906.20	42.38	-121.96	5	3.00	MLGS	..	. ...	22
PDE	1993	09	22	022214.73	42.27	-121.99	5	3.10	MLGS	..	. ...	18
PDE	1993	09	22	035032.26	42.41	-122.04	5	2.50	MDSEA	..	. ...	29
PDE	1993	09	22	042508.43	42.42	-122.07	5	2.50	MDSEA	..	. ...	32
PDE	1993	09	22	052115.12	42.28	-122.02	5	3.20	MLGS	..	. ...	20
PDE	1993	09	22	054553	42.30	-122.00	5	2.70	MLGS	..	. ...	20
PDE	1993	09	22	055030.75	42.31	-122.02	5	2.70	MLGS	..	. ...	22
PDE	1993	09	22	055342.48	42.45	-122.03	5	2.50	MDGS	..	. ...	32
PDE	1993	09	22	060129	42.30	-122.00	5	2.40	MDGS	..	. ...	20
PDE	1993	09	22	063326	42.30	-122.00	5	2.40	MDGS	..	. ...	20
PDE	1993	09	22	064114.32	42.33	-121.95	5	2.90	MLGS	..	. ...	18
PDE	1993	09	22	065926	42.30	-122.00	5	2.20	MDGS	..	. ...	20
PDE	1993	09	22	072119.19	42.29	-122.16	5	2.90	MLGS	..	. ...	32
PDE	1993	09	22	072415.20	42.32	-122.12	5	3.60	MLGS	..	. ...	30
PDE	1993	09	22	090725.98	42.21	-122.07	5	3.30	MLGS	..	. ...	24
PDE	1993	09	22	122103.83	42.37	-122.11	5	2.50	MDGS	..	. ...	31
PDE	1993	09	22	135608.86	42.24	-122.08	5	3.30	MLGS	..	. ...	25
PDE	1993	09	22	141826.16	42.21	-122.14	5	2.80	MDGS	..	. ...	30
PDE	1993	09	22	152306.86	42.30	-122.01	5	3.10	MLGS	..	. ...	21
PDE	1993	09	22	163015.84	42.38	-122.07	5	2.90	MLGS	..	. ...	29
PDE	1993	09	22	163624.64	42.22	-122.13	5	2.60	MLGS	..	. ...	29
PDE	1993	09	22	175505.22	42.25	-122.03	5	3.30	MLGS	..	. ...	21
PDE	1993	09	22	183044.42	42.31	-122.15	5	2.80	MLGS	..	. ...	31
PDE	1993	09	22	194149.54	42.35	-122.05	5	2.80	MLGS	..	. ...	26
PDE	1993	09	22	201220.57	42.18	-122.06	5	3.40	MLBRK	..	. ...	23
PDE	1993	09	22	210707.25	42.26	-122.09	5	2.90	MLGS	..	. ...	26
PDE	1993	09	22	212559.72	42.33	-122.18	5	3.10	MLGS	..	. ...	35
PDE	1993	09	23	010059.48	42.25	-122.13	5	3.00	MLGS	..	. ...	29
PDE	1993	09	23	013354.68	42.20	-122.15	5	3.20	MLGS	..	. ...	31
PDE	1993	09	23	015925.78	42.18	-122.18	5	2.90	MLGS	..	. ...	33
PDE	1993	09	23	035203.59	42.31	-122.00	5	2.90	MLGS	..	. ...	20
PDE	1993	09	23	060536.30	42.33	-122.01	5	3.10	MLGS	..	. ...	22
PDE	1993	09	23	062110.46	42.28	-121.96	5	4.30	mb GS	.F	. ...	16
PDE	1993	09	23	114254.85	42.54	-121.96	5	2.60	MDGS	..	. ...	38
PDE	1993	09	23	150259.19	42.28	-122.10	5	2.70	MDSEA	..	. ...	27

PDE	1993	09	23	235407.47	42.15	-122.02	5	3.30	MLGS	.. . .	21
PDE	1993	09	24	015756.57	42.32	-122.14	5	3.80	MLGS	.. . .	31
PDE	1993	09	24	165330.54	42.33	-122.02	5	4.10	MLGS	4F	22
PDE	1993	09	24	172524.56	42.24	-122.04	5	3.50	MLGS	.. . .	21
PDE	1993	09	24	175055.22	42.29	-121.98	5	2.90	MLGS	.. . .	18
PDE	1993	09	24	212008.63	42.35	-121.99	5	3.00	MLGS	.. . .	22
PDE	1993	09	24	213447.03	42.19	-122.08	5	3.10	MLGS	.. . .	24
PDE	1993	09	25	011623	42.30	-122.00	5	2.80	MDGS	.. . .	20
PDE	1993	09	25	094800.11	42.31	-122.01	5	2.80	MLGS	.. . .	21
PDE	1993	09	25	194158.31	42.23	-122.09	5	3.00	MLGS	.. . .	26
PDE	1993	09	27	013433.13	42.22	-122.13	5	3.40	MLGS	.F	28
PDE	1993	09	28	234919.84	42.24	-122.08	5	3.30	MLGS	.. . .	24
PDE	1993	09	28	235811.86	42.24	-122.07	5	3.70	MLGS	.. . .	24
PDE	1993	09	29	032155.63	42.30	-122.00	5	2.30	MDGS	.. . .	20
PDE	1993	09	29	110114.87	42.37	-122.13	5	2.80	MLGS	.. . .	33
PDE	1993	10	01	114817.50	42.37	-122.01	5	2.60	MLGS	.. . .	25
PDE	1993	10	03	103258.05	42.23	-122.02	5	2.50	MLGS	.. . .	19
PDE	1993	10	11	234739.27	42.44	-122.01	15	3.40	MLGS	.. . .	30
PDE	1993	10	16	151729.68	42.27	-121.97	11	3.20	MLGS	.. . .	17
PDE	1993	10	22	140216.16	42.29	-122.02	5	3.20	MLGS	.F	21
PDE	1993	10	22	155142.71	42.26	-122.13	5	3.50	MLGS	.. . .	29
PDE	1993	11	01	073029.58	42.40	-122.05	6	2.80	MDGS	.. . .	29
PDE	1993	11	02	114101.64	42.24	-122.13	5	3.10	MLGS	.. . .	29
PDE	1993	11	03	100206.47	42.27	-122.12	5	2.50	MLGS	.. . .	28
PDE	1993	11	11	000340.04	42.26	-122.08	5	3.10	MLBRK	.. . .	25
PDE	1993	11	22	220301.30	42.29	-122.02	2	3.20	MLGS	.. . .	21
PDE	1993	11	26	064216.14	42.32	-122.09	5	3.00	MLGS	.. . .	27
PDE	1993	11	27	105018.46	42.31	-122.11	5	3.50	MLGS	.. . .	28
PDE	1993	11	30	025448.69	42.29	-121.99	8	3.30	MLGS	.. . .	18
PDE	1993	11	30	033036.69	42.29	-122.00	8	3.50	MLGS	.. . .	19
PDE	1993	12	04	221519.53	42.30	-122.01	8	5.40	MwHRV	7D M	21
PDE	1993	12	04	224501.98	42.16	-122.09	5			.. . .	27
PDE	1993	12	04	225421	42.30	-122.00	10	2.90	MLGS	.. . .	20
PDE	1993	12	04	232330.52	42.26	-121.99	6	3.80	MLBRK	.. . .	18
PDE	1993	12	04	234029.09	42.23	-122.10	5	2.60	MDGS	.. . .	26
PDE	1993	12	04	234413.23	42.26	-121.99	6	3.10	mb GS	.. . .	18
PDE	1993	12	04	235021.26	42.25	-121.96	10	4.00	MLGS	.. . .	15
PDE	1993	12	05	002708.51	42.22	-122.09	5	3.00	MLGS	.. . .	25
PDE	1993	12	05	003808.28	42.31	-122.04	0	2.60	MDSEA	.. . .	23
PDE	1993	12	05	021128.42	42.33	-121.99	5	2.80	MDGS	.. . .	20
PDE	1993	12	05	023600.50	42.28	-122.02	4	3.30	MLGS	.. . .	21
PDE	1993	12	05	032632.37	42.25	-122.02	5	3.70	MLGS	.. . .	19
PDE	1993	12	05	032656.69	42.30	-122.02	4	3.40	MDSEA	.. . .	21
PDE	1993	12	05	065839.42	42.30	-122.03	2	3.00	MLGS	.. . .	22

PDE	1993	12	05	074642.86	42.29	-122.03	2	2.80	MLGS	.. . .	22
PDE	1993	12	05	142253.51	42.28	-122.11	5	3.40	MLGS	.. . .	28
PDE	1993	12	05	152203.77	42.30	-121.95	5	3.00	MDGS	.. . .	16
PDE	1993	12	05	164955.93	42.29	-122.02	2	3.00	MLGS	.. . .	21
PDE	1993	12	05	225918.39	42.26	-121.99	6	2.70	MLGS	.. . .	18
PDE	1993	12	06	053604.45	42.29	-121.95	7	2.90	MLGS	.. . .	16
PDE	1993	12	06	133455.74	42.25	-121.96	9	2.90	MLGS	.. . .	15
PDE	1993	12	06	154420.35	42.28	-121.94	5	2.80	MLGS	.. . .	14
PDE	1993	12	10	194517.10	42.28	-122.02	6	2.80	MDSEA	.. . .	20
PDE	1993	12	11	120816.56	42.27	-121.97	5	3.10	MDGS	.. . .	16
PDE	1993	12	13	164410.40	42.28	-121.93	7	2.60	MDSEA	.. . .	14
PDE	1993	12	17	085022.68	42.34	-122.07	6	2.60	MDSEA	.. . .	27
PDE	1993	12	20	030350.26	42.29	-121.96	6	3.00	MDSEA	.. . .	16
PDE	1993	12	23	004139.08	42.24	-122.00	5	2.60	MDGS	.. . .	18
PDE	1993	12	23	113825.13	42.40	-122.03	11	2.80	MDSEA	.. . .	28
PDE	1993	12	25	121311.92	42.31	-121.98	3	3.40	MLGS	.. . .	18
PDE	1993	12	25	123329.15	42.28	-122.00	0	4.00	MDSEA	5F	19
PDE	1993	12	25	131026.11	42.30	-121.96	3	2.70	MDGS	.. . .	17
PDE	1993	12	25	131804.70	42.29	-121.93	7	2.70	MLGS	.. . .	14
PDE	1993	12	31	180845.12	42.30	-121.94	3	4.20	MLGS	2F	15
PDE	1993	12	31	185635.82	42.22	-122.01	5	2.70	MLGS	.. . .	19
PDE	1994	01	05	155704.07	42.38	-122.07	6	3.20	MLGS	.. . .	29
PDE	1994	01	07	093937.59	42.28	-121.91	7	4.10	MLGS	4F	12
PDE	1994	01	07	150707.25	42.28	-121.91	7	2.80	MLGS	.. . .	12
PDE	1994	01	08	025529.59	42.26	-121.90	7	3.80	MDSEA	.. . .	11
PDE	1994	01	09	015349.23	42.28	-121.95	6	3.30	MLBRK	.F	15
PDE	1994	01	09	034555.28	42.28	-121.92	7	3.20	MLGS	.. . .	13
PDE	1994	01	09	152730.97	42.28	-121.93	4	3.10	MLGS	.. . .	14
PDE	1994	01	09	190313.18	42.28	-121.93	5	4.20	MLGS	5F	13
PDE	1994	01	09	190605.44	42.26	-121.91	0	3.00	MLGS	.. . .	11
PDE	1994	01	12	175051.30	42.20	-121.96	5	2.80	MLGS	.F	15
PDE	1994	01	14	005040.21	42.27	-121.90	6	3.10	MDSEA	.. . .	11
PDE	1994	01	14	175836.27	42.28	-121.91	6	2.80	MDSEA	.. . .	12
PDE	1994	01	19	190405.34	42.26	-122.04	5	2.50	MLGS	.. . .	21
PDE	1994	01	19	222731.32	42.30	-121.96	6	4.40	MLGS	6D	17
PDE	1994	01	20	174911.83	42.27	-121.91	7	2.90	MLGS	.. . .	12
PDE	1994	01	20	224101.73	42.31	-121.94	5	2.80	MDSEA	.. . .	16
PDE	1994	01	21	041437.83	42.24	-122.03	5	3.30	MLBRK	.. . .	20
PDE	1994	01	21	151326.59	41.55	-121.88	4	2.70	MDGM	.. . .	75
PDE	1994	03	10	004008.84	42.24	-121.96	9	2.70	MDSEA	.. . .	15
PDE	1994	03	22	214128.73	42.29	-122.03	4	2.60	MDSEA	.. . .	22
PDE	1994	03	28	230815.53	42.28	-121.92	3	2.70	MDSEA	.. . .	12
PDE	1994	04	13	204136.43	42.24	-121.96	9	3.70	MLBRK	3F	15
PDE	1994	04	14	060655.55	42.38	-122.05	9	2.70	MDGS	.. . .	28

PDE	1994	11	01	030224.09	42.25	-121.96	7	3.30	MLBRK	.F	15
PDE	1994	11	17	202949.59	42.38	-122.04	7	4.40	MLBRK	4F	28
PDE	1994	12	29	002128.25	42.89	-122.12	1	2.30	MDSEA	.. . .	78
PDE	1994	12	29	002216.70	42.91	-122.09	1	2.60	MDSEA	4F	80
PDE	1994	12	29	004045	42.89	-122.11	5	2.40	MDSEA	4F	79
PDE	1995	10	27	161539.35	42.38	-122.04	9	2.70	MDSEA	.. . .	27
PDE	1997	01	11	170416.81	41.98	-122.14	16	3.30	MLBRK	.. . .	40
PDE	1998	03	05	232012.17	42.45	-122.68	0	2.70	MDSEA	.. . .	78
PDE	1999	07	18	024438.98	41.94	-121.95	11	3.00	MDGM	.. . .	34
PDE	1999	11	29	040415.37	42.33	-122.01	7	3.40	MDSEA	.F	22
PDE	2002	04	11	185018.57	41.44	-122.06	12	2.70	MDNC	.. . .	90
PDE	2002	05	15	175448.60	42.23	-121.90	8	4.30	MDSEA	4F M	10
PDE	2002	07	08	000438	42.20	-121.91	9	2.40	MDSEA	.. . .	11
PDE	2003	06	18	142421.61	41.49	-121.99	10	2.70	MDNC	.. . .	83
PDE	2003	11	13	005754	42.52	-122.58	15	2.90	MDSEA	.. . .	74
PDE	2005	06	29	231813.85	42.04	-121.62	0	2.70	MDSEA	.. . .	24
PDE	2007	03	25	231618.35	42.24	-121.94	7	2.70	MDSEA	.. . .	13
PDE	2007	04	04	223049.41	42.32	-121.82	2	2.80	MDSEA	.. . .	10
PDE	2007	06	19	180820.27	42.41	-122.82	0	2.80	MDSEA	.. . .	88
PDE	2007	07	26	2116	42.39	-121.48	12	2.80	MDSEA	.. . .	30
PDE	2007	08	14	202220.28	42.19	-121.81	0	2.70	MDSEA	.. . .	4

USGS National Earthquake Information Center
USGS Privacy Statement | Disclaimer

APPENDIX G:
KLAMATH COUNTY EMERGENCY PLAN

Klamath County Emergency Services

3300 Vandenberg Road • Klamath Falls, OR 97603
Admin. Office (541) 883-5130 ext. 215 • Fax (541) 883-4271
bthompso@co.klamath.or.us

HAZARDS, RISKS AND VULNERABLITIES FACING KLAMATH COUNTY, OREGON

June 2008

Klamath County, Oregon is located in the south central portion of Oregon bordered on the south by the State of California, to the west, by Jackson County, Oregon, to the northwest by Douglas and Lane Counties, Oregon and to the east by Lake County, Oregon.

The county has an estimated population of 70,035 as of 2007 and covers an area of 6,151 square miles. The principal population area is the City of Klamath Falls with a population of 21,390. The Klamath Falls Urban Growth Boundary has roughly twice the population of the city itself and covers twice the area.

Klamath County is exposed to two categories of hazards, natural and technological (man-made). These hazards generate a wide spectrum of potential emergencies or disasters that pose risks to the lives and properties of the citizens of, and visitors to, Klamath County.

TRANSPORTATION INCIDENTS

Klamath County is a west coast conduit for several transportation lines between the northwest and California. All rail traffic on the west's two principal Class I railroads (Union Pacific and Burlington Northern Santa Fe) travels the north-south route through the county. Much of the traffic for the two companies shares the same joint tracks, which concentrates the risk of major disruption. Amtrak's Seattle to Los Angeles daily passenger train travels the route twice a day with an average load factor of around 300 passengers and crew in each direction.

All natural gas from the northwest to California and Nevada comes down the Pacific Gas Transmission line through Klamath County.

Power transmission from and to California and the northwest is dependent on the Bonneville Power Administration (BPA) transmission lines crossing Klamath County. Malin, Klamath County, Oregon is the major hub for controlling all power between the two regions.

Any major disruption, natural or manmade, to these major transportation arteries would impact the entire west coast of the United States.

EARTHQUAKE

Klamath County, like the rest of Oregon, is considered a high-risk area for seismic activity, as confirmed by the Federal Emergency Management Administration and by the United States Geological Society.

The type of earthquake that has the most impact on Klamath County is shallow ground movement associated with the Klamath Basin and Cascade Mountain Ranger areas of the western United States.

On September 20, 1993, the Klamath Basin sustained a 6.0 earthquake, which took two lives and caused considerable damage in downtown Klamath Falls, including the total loss of the county courthouse. This is the highest recorded quake in Oregon history since settlement of the state by non-native Americans.

Un-reinforced masonry buildings represent a huge hazard to live and property in the Klamath County cities of Klamath Falls, Merrill, Malin and Chiloquin.

WILDLAND FIRES

All (or portions) of five National Forest jurisdictions exist in Klamath County, reflecting that vast portions of the county are covered in forests and subject to wild land fires. The vast majority of wild fires, a common enough occurrence, during the summer months, are man-caused. Compounding this issue is the rapid incursion of development into these forest lands resulting in a wild land/urban interface complication.

FLOODING

Klamath County is subject to three types of flooding. River floods occur when there is gradual periodic overflow of rivers and streams. Flash flooding is defined as quickly rising small streams after heavy rain and/or rapid snowmelt. Urban flooding is defined as an overflow of storm sewer systems usually due to poor drainage, following heavy rain and/or rapid snowmelt.

VOLCANO

Klamath County is home to a famous volcanic legacy with Crater Lake National Park's Mount Mazama as the centerpiece of a vast Cascadian region created by volcanic activity. The threats from volcanoes include lateral blast, pyroclastic flows, mud flows/floods, ash falls and lava flows. Other effects include; flooding, fire, earthquakes ands landslides.

DROUGHT

Klamath County knows all too well the effects of drought. In 2001, Klamath County was subject to both a natural and a manmade drought due to the response of federal agencies to a natural drought. The major effects from drought are: culinary water shortages, increased potential for wild land fires, damage or total loss of crops, civil unrest and economic consequences to all sectors of communities.

SEVERE STORM (WINTER)

Heavy snow, heavy rain, freezing rain, and high winds are a few winter storm conditions that Klamath County experiences. The major problems that a winter storm causes are power outages and traffic accidents. There is a very high probability that the Klamath Basin will be negatively affected by at least one winter storm condition on an annual basis.

HAZARDOUS MATERIALS

A hazardous material is defined as any substance that threatens people or property. This substance may be a toxic or poisonous chemical in any form. Hazardous materials include radioactive materials and waste, chemical materials and waste as well as communicable disease agents. The entire county is prone to a hazardous materials incident. Hundreds of users of hazardous materials have been identified throughout Klamath County.

The areas of greatest risk are on the transportation routes, which include railways, waterways and highways. All of Klamath County's major roads and railways are used for the transportation of hazardous materials. Planning for protection to communities from a hazardous materials incident must therefore, include both the transportation system and the many, many fixed facilities.

DAM FAILURE

A dam collapse or other failure of an impoundment that causes downstream flooding is a grave concern for Klamath County. Two dams, one creating Gerber Reservoir in Oregon and the other at Clear Lake, California, have inundation zones that impact the most populous areas of Klamath County. A failure of either or both would put up to one third of the county's citizens at risk. The Bonanza area, Langell Valley, and the suburban area of Klamath County and the city of Merrill would all be severely affected.

TELECOMMUNICATIONS FAILURE

The failure of data transfer, communications or processing brought about by: 1) physical destruction of computers or communications equipment, or 2) a performance failure of software running such equipment, either through poor design or sabotage. A failure of this type may cause severe economic damage and/or may pose life threatening situations to airport Radar, 9-1-1, and other critical communications infrastructure.

The dependence of society upon telecommunications and technology is ever increasing as the "Information Age" steadily expands. Klamath County, like any other county is vulnerable to this type of hazard.

POWER FAILURE

Power resources, both transmission and distribution, have become the most important element of infrastructure in our economy. The interruption of power causes widespread disruption of services immediately to any community. Klamath County is no exception.

TERRORISM

According to the Federal Bureau of Investigation (FBI), "Terrorism" is the unlawful use, or threat of use, of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objective.

Klamath County has a history of terrorist activities dating back to Black Panther "safe houses" and training grounds during the 60's and 70's and continuing to far right-wing militia activity and actions of the Environmental Liberation Front (ELF) in more recent times. There has been some evidence of elements of both international and regional terrorist activity in Klamath County since the Millennium. This year's Department of Justice/Office of Emergency Management Domestic Preparedness Survey requested of Klamath County points to serious concerns about the threat of terrorism and our ability to respond to it at all levels of government.

PANDEMIC FLU

"Three pandemics have occurred in the last 90 years, in 1918, 1957 and 1968. Scientists predict that another pandemic will happen, although they cannot say exactly when."[1] The 2006 Oregon Pandemic Influenza Plan builds on a planning effort that began in 2001. We anticipate that a significant portion of the population, approximately 35%, will become ill and the out break will occur in one or more waves. Thus, we now calculate that of the 3.6 million Oregonians, approximately 12,000 will require hospitalization and nearly 3,000 will die. If a pandemic occurs, the Oregon State Public Health Division will be the lead state agency in Oregon and will operate under a National Incident Management System compliant Incident Command System, in collaboration with Oregon's 34 local health departments as well as American Indian tribal jurisdictions.

CATEGORY A AGENTS

The State of Oregon's Public Health Hazard Vulnerability Working Group identified several biological agents as potential high-impact agents against our population. We used the same the following criteria: "1) public health impact based on illness and death; 2) delivery potential to large populations based on stability of the agent, ability to mass produce and distribute a virulent agent, and potential for person-to-person transmission of the agent; 3) public perception as related to public fear and potential civil disruption; and 4) special public health preparedness needs based on stockpile requirements, enhanced surveillance, or diagnostic needs."[2] Based on the overall criteria and weighting, agents were placed in categories for initial public health preparedness planning efforts.

From: The **CD Summary** (ISSN 0744-7035) is published biweekly, free of **CD SUMMARY** charge, by the Oregon Health Division, (Dept. of Human Services)

Category A

High-priority agents include organisms that pose a risk to national security because they 1) can be easily disseminated or transmitted person-to-person; 2) cause high mortality, with potential for major public-health impact; 3) might cause public panic and social disruption; and 4) require special action for public-health preparedness. Category A agents include
• Variola major (smallpox);
• *Bacillus anthracis* (anthrax);
• *Yersinia pestis* (plague);
• *Clostridium botulinum* toxin (botulism);
• *Francisella tularensis* (tularemia);
• the filoviruses, Ebola hemorrhagic fever and Marburg hemorrhagic fever;
and
• the arenaviruses, Lassa (Lassa fever), Junin (Argentine hemorrhagic fever), and related viruses.

SUMMARY

Klamath County Emergency Services has continued the emergency planning process by examining the hazards, which could affect our county.

Conducting a hazard analysis is a useful first step in planning for mitigation, response, and recovery. It doesn't predict the occurrence of a particular hazard, but does "quantify" the risk of one hazard as compared to another. By doing this analysis, planning can first be focused where the risk is greatest.

Total scores are not as important as how one hazard compares with the total score for other hazards facing the jurisdiction. By comparing scores, a jurisdiction can determine priorities.

Much assistance for the completion of this study was provided by the Oregon Office of Emergency Management.

Bill Thompson	Marilyn Sutherland	George E. Buckingham
Emergency Manager	Public Health Director	Ass't Emergency Manager
		Preparedness Coordinator

Hazard Analysis
Matrix Worksheet

JURISDICTION:
Klamath County, Oregon

HAZARD	HISTORY x2	VULNERABILITY x5	MAXIMUM X10	PROBABILITY X7	TOTALS -
Severe Storm (Winter)	5 x 2 = 10	10 x 5 = 50	10 x 10 = 100	10 x 7 = 70	= 230
Pan Flu	7x2=14	10x5=50	9x10=90	10x7=70	= 224
Power Failure	1 x 2 = 2	10 x 5 = 50	10 x 10 = 100	10 x 7 = 70	= 222
Drought	1 x 2 = 2	10 x 5 = 50	10 x 10 = 100	10 x 7 = 70	= 222
Telecommunications Failure	1 x 2 = 2	10 x 5 = 50	10 x 10 = 100	10 x 7 = 70	= 222
Hazardous Materials	10 x 2 = 20	1 x 5 = 5	10 x 10 = 100	10 x 7 = 70	= 195
Transportation Incidents	10 x 2 = 20	1 x 5 = 5	10 x 10 = 100	10 x 7 = 70	= 195
Earthquake	1 x 2 = 2	10 x 5 = 50	10 x 10 = 100	5 x 7 = 35	= 187
Dam Failure	1 x 2 = 2	10 x 5 = 50	10 x 10 = 100	5 x 7 = 35	= 187
Terrorism	1 x 2 = 2	1 x 5 = 5	10 x 10 = 100	10 x 7 = 70	= 177
Wildland Fire	10 x 2 = 20	5 x 5 = 25	5 x 10 = 50	10 x 7 = 70	= 165
Flooding	7 x 2 = 14	5 x 5 = 25	5 x 10 = 50	10 x 7 = 70	= 159
Volcano	1 x 2 = 2	1 x 5 = 5	10 x 10 = 100	1 x 7 = 7	= 114
Category A Agents	1x2=2	4x5=20	5x10=50	4x7=28	= 100

Date: June 30, 2008

Prepared by: Bill Thompson, Emergency Manager
Marilyn Sutherland, Public Health Director
George E. Buckingham, Ass't Emergency Manager
Preparedness Coordinator

Hazard Analysis Matrix Methodology

Sample Jurisdiction:	**HISTORY**	**VULNERABILITY**	**MAX THREAT**	**PROBABILITY**	**TOTALS**
HAZARD: WEIGHT FACTOR	2	5	10	7	=
Hazardous Materials	2 x 10 (H)= 20	5 X 10 (H) = 50	10 X 10 (H) = 100	7 X 10 (H) = 70	= 240
Flooding	2 x 10 (L) = 20	5 x 1 (L) = 5	10 x 5 (M) = 50	7 x 10 (H) = 70	= 145
Dam Failure	2 x 1 (L) = 2	5 x 10 (M) =50	10 x 10 (H) = 100	7 x 1 (L) = 7	= 159
Earthquake	2 x1 (L) = 2	5 x 10 (H) = 50	10 x 10 (H) = 100	7 x 1 (L) = 7	= 159
Wildland Fire	2 x 10 (H) = 20	5 x 1 (L) = 5	10 x 5 (M) = 50	7 x 10 (H) = 70	= 145

The following categories are used in determining the severity or risk factor:

Severity ratings are applied to the four categories of **History**, **Vulnerability**, **Maximum Threat** (worst-case scenario), and **Probability**. They are based as follows:

LOW = choose the most appropriate number between 1 to 3 points
MEDIUM = choose the most appropriate number between 4 to 7 points
HIGH = choose the most appropriate number between 8 to 10 points

Weight factors also apply to each of the four categories as shown below.

HISTORY (weight factor for category = 2)
History is the record of previous occurrences. Events to include in assessing history of a hazard in your jurisdiction are events for which the following types of activities were required:

- The EOC or alternate EOC was activated;
- Three or more EOP functions were implemented, e.g., alert & warning, evacuation, shelter, etc.
- An extraordinary multi-jurisdictional response was required; and/or
- A "Local Emergency" was declared.

LOW – score at 1 to 3 points based on… 0 - 1 event past 100 years
MEDIUM – score at 4 to 7 points based on… 2 - 3 events past100 years
HIGH – score at 8 to 10 points based on… 4 + events past100 years

VULNERABILITY (weight factor for category = 5)
Vulnerability is the percentage of population and property likely to be affected under an "average"

occurrence of the
hazard.

LOW – score at 1 to 3
points based on… <
1% affected
MEDIUM – score at 4 to 7 points based on… 1 - 10% affected
HIGH – score at 8 to 10 points based on… > 10% affected

MAXIMUM THREAT (weight factor for category = 10)
Maximum threat is the highest percentage of population and property that could be impacted under a worst-case scenario.

LOW – score at 1 to 3 points based on… < 5% affected
MEDIUM – score at 4 to 7 points based on… 5 - 25% affected
HIGH – score at 8 to 10 points based on… > 25% affected

PROBABILITY (weight factor for category = 7)
Probability is the likelihood of future occurrence within a specified period of time.

LOW – score at 1 to 3 points based on… one incident likely within 75 to 100 years
MEDIUM – score at 4 to 7 points based on… one incident likely within 35 to 75 years
HIGH – score at 8 to 10 points based on… one incident likely within 10 to 35 years

By multiplying the *weight factors* associated with the categories by the *severity ratings*, we can arrive at a sub score for history, vulnerability, maximum threat, and probability for each hazard. Adding the sub scores will produce a total score for each hazard.

For example, look at "landslide" on the "Sample Hazard Analysis Matrix" shown on page 6. The history of landslides is high in the sample jurisdiction. History has a weight factor of two (2), and in this case, high is scored with ten (10) points for the severity rating. 2 X 10 = subscore of 20. The vulnerability of the sample jurisdiction is medium. However, a landslide normally would not affect much more than 1% of the people and property in the jurisdiction. Vulnerability has a factor weight of five (5) and this team decided on four (4) points for the severity rating. 5 X 4 = subscore of 20. After figuring maximum threat and probability, the total score for landslides is 133. The total score isn't as important as how it compares with the total scores for other hazards the jurisdiction faces. By comparing scores, the jurisdiction can determine priorities: Which hazards should the jurisdiction be most concerned about? Which ones less so?