PUNA GEOTHERMAL VENTURE
An ORMAT Company

January 13, 2023

Darin Lum
Clean Air Branch
Environmental Management Division
State Department of Health
2827 Waimano Home Road
Hale Ola Building, Room 130
Pearl City, Hawaii 96782

SUBJECT: NOTIFICATION OF COMMENCEMENT TO DRILL KAPOHO STATE 22 (KS-22)

Dear Mr. Lum:

In accordance with the Noncovered Source Permit (NSP) No. 0008-02-N, Attachment IIB, Section D.1, Puna Geothermal Venture (PGV) hereby submits its written plan in accordance with said provision. PGV intends to commence drilling production well KS-22 February 15, 2023, or shortly thereafter.

PGV requests approval from the Hawaii Department of Health (HDOH) for the plan outlined above.

Should you have any questions or need additional information, please do not hesitate to contact me at (808) 896-8551 or Ron Quesada at (808) 430-8679

Sincerely,

For
Jordan Hara
Plant Manager

Enclosures: KS-22 Drilling Plan

We certify that this document and all attachments are true, accurate, and complete, pursuant to HAR 11-60.1-4.

PUNA GEOTHERMAL VENTURE
14-3860 Kapoho Pahoa Road, Pahoa, HI 96778-0030, USA • +1-808-965-6233 • ormat@ormat.com ormat.com

PUNA GEOTHERMAL VENTURE

An ORMAT Company

PUNA GEOTHERMAL VENTURE DRILLING PROGRAM

GEOTHERMAL WELL KS-22

January 7, 2023

PUNA GEOTHERMAL VENTURE (PGV)
P.O. Box 30
14-3860 Kapoho Pahoa Road
Pahoa, Hawaii 96778-0030
(808) 965-6233

APPLICATION FOR PERMIT TO DRILL
GEOTHERMAL WELL KAPOHO STATE 22 (KS-22)
ON RESERVED LANDS, KAPOHO, PUNA HAWAII

In compliance with the Hawaii Department of Land and Natural Resources (DLNR) Administrative Rule, Title 13, Chapter 183, Section 65, Puna Geothermal Venture (PGV) is herein applying to the Hawaii Board of Land and Natural Resources for a **Permit to Drill** a new geothermal well designated as **Kapoho State 22 (KS-22)**.

PGV proposes to: (1) directionally drill KS-22 to a total depth (TD) of approximately 6900 feet (ft); (2) measure the well's temperature profiles; (3) perform a water loss test to determine permeability; and (4) based on temperature and permeability, make a determination for the well to either be a production or a reinjection well.

1. **Applicant:**

Puna Geothermal Venture
P.O. Box 30
14-3860 Kapoho Pahoa Road
Pahoa, Hawaii 96778-0030
(808) 965-6233

PUNA GEOTHERMAL VENTURE (PGV)
Ronald Quesada
Ronald Quesada
By: For
Jordan Hara
Plant Manager
Puna Geothermal Venture

2. **Owner of Mining Rights:** State of Hawaii. A multi-well drilling bond ($250,000) has previously been filed with the State of Hawaii.
3. **Land Owner:** Kapoho Land and Development Company, Limited
4. **Proposed Well Designation:** Kapoho State 22 (KS-22) off Wellpad E. Figures provided below include:

- A Tax Key map, showing the approximate location of the KS-22 drill site off Well pad E located on State Geothermal Mining Lease R-2;
- A topographic map, showing the approximate surface elevation at Well pad E of 619 feet above mean sea level; and
- A PGV Project map, designating the relative locations of KS-22 and Well pad E.

The proposed PGV geothermal well KS-22 will be drilled to a depth of approximately 6900 feet true vertical depth (TVD). The well will not approach closer than 100 feet from the vertical boundary line of the leased property. Depending on the permeability and temperature at the planned TVD, the well will then be designated for production or reinjection. A production well would provide additional production capacity and a reinjection well would be used for the processing of geothermal fluids and gases. The

development of either production or reinjection wells are permitted under the Plan-of-Operation approved March 10, 1989, by the Board of Land and Natural Resources.

5. **Compliance:** Puna Geothermal Venture agrees to perform such drilling activities as outlined in this application and agrees to maintain the well in accordance with Title 13, Chapter 183, State of Hawaii, and all Federal and County geothermal regulations and meet requirements in the Plan of Operations.

6. **General Information**

a.	Well Designation:	Kapoho State 22 (KS-22)
b.	Location:	TMK 1-04-01:19
	Kapoho, Puna, Hawaii	(Figure 1)
c.	State Geothermal Mining Lease:	R-2
d.	Owner of Mineral Rights:	State of Hawaii
e.	Subleased to:	Puna Geothermal Venture
f.	Operator:	PGV (affiliate of Ormat Nevada Inc., ONI).

7. **Well Data**

a.	Well Site:	Well Pad E
b.	Well map coordinates:	154°53'28"W
		19°28'32"N
c.	Well Type:	Development Well
d.	Surface Elevation:	620 feet RSL
e.	Total Depth (TD):	6900 feet

DRILLING PROGRAM
PUNA GEOTHERMAL VENTURE (PGV)
GEOTHERMAL WELL KS-22

1 PROJECT DESCRIPTION

This section summarizes the drilling, well construction and environmental protection programs. Figures follow this section. See the following Appendices for additional project details:

Appendix A: General Drilling Procedures
Appendix B: Directional Drilling Plan
Appendix C: Mud Program
Appendix D: Cementing Program
Appendix E: Emergency Plans and Contacts
Appendix F: Blowout Prevention and Action Plans
Appendix G: Rig Safety Inspection Form
Appendix H: Reporting Criteria
Appendix I: DLNR Formation Integrity Test (FIT)

1.1 Introduction and Location

Puna Geothermal Venture (PGV) proposes to conduct a geothermal well drilling program on leased lands at the Puna geothermal power plant facility. The purpose of the drilling program is to locate, drill, complete, test, and ultimately, to decide whether the geothermal well will be utilized as a production well or a reinjection well. The general location of the well is shown on Figure 1. 30-in. conductor will be installed.

1.2 Proposed Well Site and Access Roads

The proposed well site is located on fee land leased by PGV in the Puna geothermal field. The general surface hole location (SHL) where 30-in. conductor will be installed is 154°53'28"W, 19°28'32"N. As shown in Figure 1, the well site is located on an existing well pad that contains multiple other wells, so only very limited new surface disturbance will be required:

1. Clearing: The existing pad will be graded and leveled, as needed.
2. Earthwork: Some cut and fill slopes will be required.
3. Drainage: The site has been graded to direct runoff from the pad into the cellar which will be pumped to the containment basin. Therefore, incidental or accidental uncontrolled spills of oil, fuel, and drilling fluids will be prevented from leaving the site.
4. Containment Basin(s): Exists onsite. Drilling mud and cuttings will be temporarily stored in this basin.
5. Well Site Access: The access road to the well site will be improved if necessary.
6. Water: Water will be used for site construction, dust control and drilling. Water will be obtained from the on-site water well.

1.3 Drilling Process

Figure 2 depicts the proposed well design. For this program, PGV proposes to: (1) directionally drill the new well to a total measured depth of approximately ±6900 feet (ft); (2) measure the well's temperature profiles; (3) measure the well's permeability; and (4) utilize the well as a production or reinjection well. If the well is unsuccessful as a producer or injector, it will be redrilled (sidetracked) to an alternative target. PGV anticipates drilling to commence as soon as the rig is available to move onto the location.

The subsurface geology is anticipated to consist of the following units:

Depth (MD):	Formation:
0 - 620 ft.	Unsaturated subaerial basalt flows and intercalated cinder scoria.
620 ft. GL	Water Table
620 - 3000 ft.	Saturated subaerial basalt flows and intercalated cinder scoria; rare dikes.
3000 - 4000 ft.	Interbedded hyaloclastite deposits and minor subaerial grading into submarine basalt flows; localized dike swarms.
4000 - 6900 ft.	Submarine basalt flows cross-cut by basalt dikes and possibly high-permeability, near-vertical fractures, especially after 4800 ft.

The hole will be drilled with a normal rotary drilling rig such as those previously used in the Puna field. The rig will be equipped with diesel engines, storage tanks, mud pumps, and other typical auxiliary equipment. During drilling, the top of the derrick will be approximately 175 ft above ground level.

A gel, or gel and polymer, drilling fluid (drill mud) will circulate in the wellbore to bring rock cuttings to the surface. The cuttings are separated and captured in a containment basin and the mud is recirculated. See Appendix C for mud program details.

Conductor will be installed by a separate drilling rig. The primary drilling rig will then be mobilized and positioned over the conductor, and a conventional bottom-hole assembly will be used to drill a 26-in. hole into the water table to a depth of approximately 700 ft KB. Then a casing drilling assembly will be utilized to drill a 22-in. hole to approximately **1150 ft KB** (see Appendix A for drilling details) with 18-5/8" casing. Casing (18-5/8 in.) will be cemented in place and blowout prevention equipment (BOPE) will be installed. After testing the BOPE, a 17-1/2-in. hole will be drilled to approximately **3000 ft KB**, enlarged to 20-in. and 16-in. casing will be cemented in place. After testing the BOPE, a 14-3/4-in. hole will be drilled to approximately **4000 ft KB** and 11-7/8-in. casing will be cemented in place.

Consistent with the wellbore diagram shown in Figure 2, following installation and testing of the BOPE, a 10-5/8-in. hole will be drilled to a total depth of approximately **6900 ft MD / 6879 ft TVD KB**. A 8-5/8-in. perforated/slotted liner will be ran from ±100 inside the previous casing string to approximate TD and a geothermal water loss test will be performed to assess permeability. Once permeability is confirmed acceptable, this liner will be set on the bottom of the hole. If the well is designated as a producer, the rig will be rigged down and released for other work. If the well is designated to be an injector, a 8-

5/8-in. hang down liner will be run from the surface to just above the approximate top of the slotted liner. Then, the rig will be rigged down and released for other work.

NOTE: #13-183-76(b): All casing strings shall be pressure tested after cementing and before commencing any other operations on the well. Minimum casing test pressure shall be approximately one-third of the manufacturer's rated internal yield pressure; provided that the test pressure shall not be less than six hundred pounds per square inch and not greater than 1500 pounds per square inch. In cases where combination strings are involved, the above test pressures shall apply to the lowest pressure-rated casing used. Test pressures shall be applied for a period of thirty minutes. If a drop of more than ten percent of the test pressure should occur, the casing or cement job shall be considered defective and corrective measures shall be taken before commencing any further operations on the well.

1.4 Blowout Prevention Equipment (BOPE)

A 21-1/4-in. 2M API double gate with annular preventer and flow tee (banjo box) will be used from **±1150 ft to ±3000 ft** (Figure 3). A 5M BOP stack consisting of two-double gates with pipe and blind rams, an annular preventer, and rotating head will be used below **±3000 ft** to total depth (see Figures 4 and 5).

1.5 Personnel Requirements

Approximately 9 to 18 workers will be on location at any given time. The drilling crews will not be living on location.

PGV agrees to provide one (1) experienced Staff geologist full-time at any hydrologic change or prior to 3000 ft under the following conditions:

- PGV shall provide Mud Loggers who have experience mud logging in Hawaii.
- PGV shall provide a geologist full-time (defined as an 8-hour working day plus on call for 24 hours/day).

1.6 Abandonment Program

When required, the hole will be abandoned appropriately per an abandonment design as specified by PGV and approved by the regulatory agencies.

2 PROTECTION OF THE ENVIRONMENT

All PGV and drilling contractor personnel will be informed of PGV's policy regarding undue degradation of the environment. These measures are intended to prevent all unacceptable impacts from occurring because of these drilling operations.

2.1 Fire Prevention

The well site and access road will be cleared of all vegetation. The cleared area will be maintained during drilling operations. Fire extinguishers will be available on the sites and around the drilling rig. Water that is used for drilling will also be available for firefighting.

Personnel will be allowed to smoke only in designated areas. Any special permits required for welding, etc., will be applied for.

2.2 Prevention of Soil Erosion

Minimal soil erosion is anticipated because the existing well pad site is flat. Cut and fill slopes have been minimized near the well pad and plant site. Where needed, runoff will be channeled to energy dissipaters to minimize erosion.

2.3 Surface and Ground Water Quality Protection

The site has been designed to minimize the potential for surface water pollution from runoff during construction, drilling, and testing. Only non-toxic, non-hazardous drilling mud will be utilized during drilling operations. Drilling mud and drill cuttings will be stored in the lined containment basin. Any runoff from the surface will also be directed into the containment basin.

Impacts to both surface water and shallow ground water (the water table is expected at 620 ft RSL) will be prevented by the well's design, which includes installation of cemented steel casing strings through and below these zones. This cemented casing will prevent interzonal migrations of fluids and reduce the possibility of blowouts. Based on the water levels observed at the Puna production and Geothermal wells, no over-pressured or gas-rich zones are expected to be above 3000 ft. Below 3000 ft, pressures encountered may be as high as 2060 psig.

NOTE: When drilling a new well, upon drilling to a depth of the ground water, (usually at sea level), a representative sample of the ground water is required to be taken, analyzed, and results reported to the DLNR.

2.4 Air Quality Protection

Fugitive dust generation during construction and use of access road and well site will be minimized by watering as necessary. PGV will comply with any requirements concerning emissions of air pollutants from drilling equipment and non-condensable gases from the geothermal fluid during flow testing.

To limit NOx emissions to less than 250 pounds per day, the total diesel fuel consumption will not exceed an average of 1200 gallons per day. Discharge of hydrogen sulfide (H_2S)

into the atmosphere will not exceed 2.5 kilograms per hour. If H_2S emissions exceed this limit, abatement equipment and technology will be utilized.

2.5 Noise Prevention

To abate noise pollution, mufflers will be utilized on engine-driven equipment and noise mitigation installed around the rig.

2.6 Protection of Public Health and Safety

In addition to the emergency contingency plans (see Appendix E), public health and safety will be protected through instructions to work crews and contractors regarding compliance with regulations.

2.7 Protection of Fish, Wildlife, and Botanical Resources

Direct impacts to wildlife habitat and botanical resources will be limited because the well site is an existing pad. Fish habitats are not anticipated to be affected as there are no fish in the existing pad or adjacent areas. However, prevention of erosion will be implemented.

2.8 Protection of Cultural Resources

The drilling site will be monitored for cultural resources. None are expected.

2.9 Waste Disposal

Containment basins are located onsite, and all used mud and cuttings will be contained therein. After drilling operations are complete, the mud and associated drilling liquids be tested and disposed of onsite.

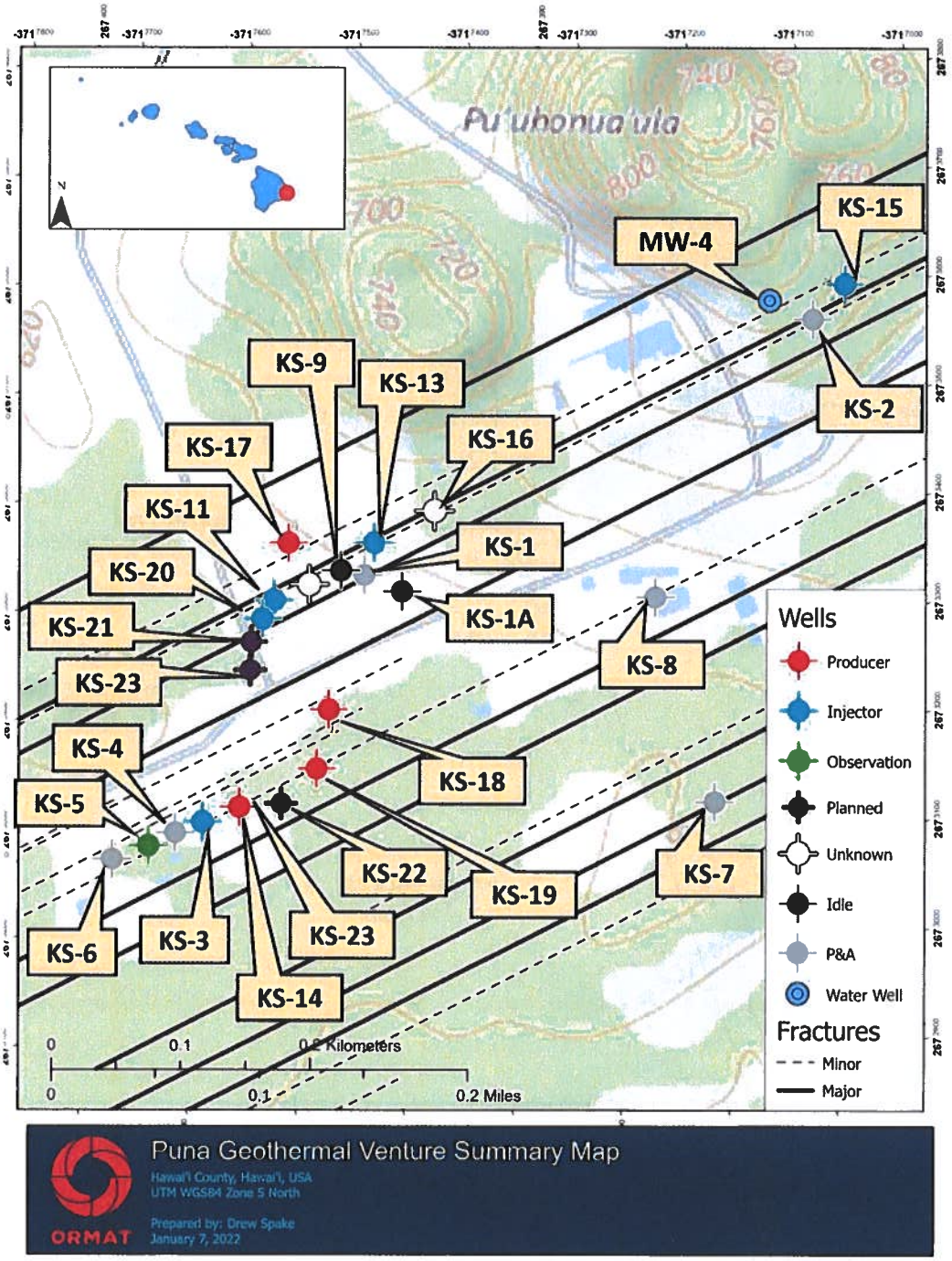
Solid waste materials (trash) will be deposited at an authorized landfill by a disposal contractor. Portable chemical sanitary facilities will be used by all personnel. These facilities will be maintained by a local contractor.

2.10 Environmental Monitoring

Regular, routine visual inspections of the drill site and access road will be conducted by the onsite operational personnel, and/or the Puna Environmental Specialist, to quickly detect and correct any operational problems that could lead to environmental problems. The drilling fluid and cuttings will be monitored by visual inspection and chemical analyses by the drilling personnel, the well-site geologist, and the contract mud engineer to detect any problems which may be occurring downhole.

FIGURES

Figure 1. Well Location Map



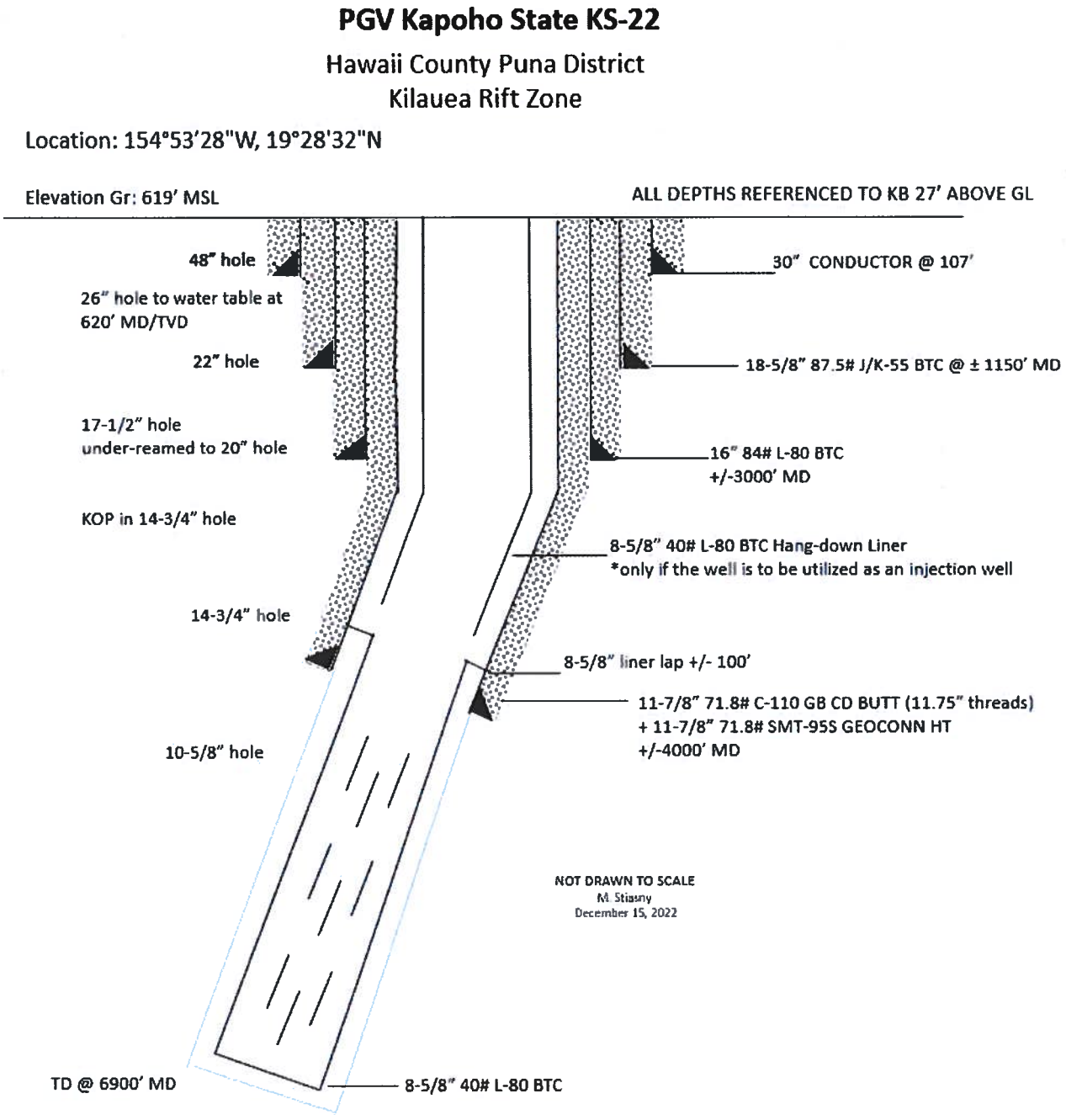


Figure 2. Primary Well Construction Schematic

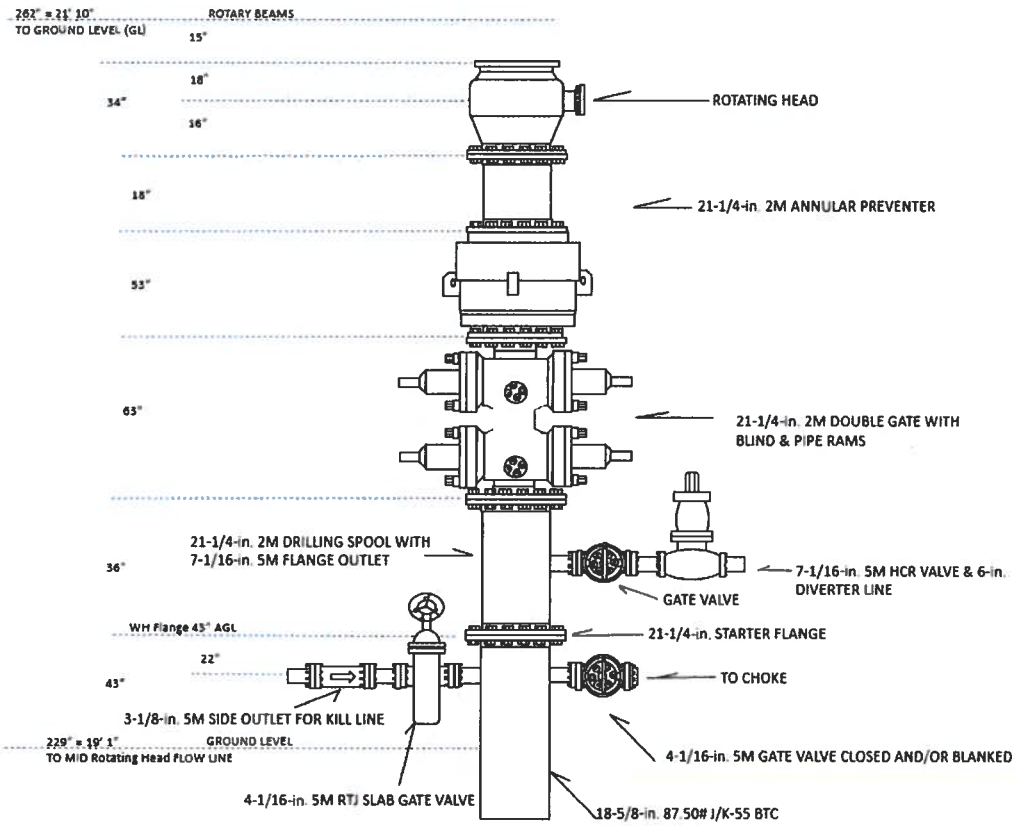


Figure 3. 21-1/4-inch BOPE for 18-5/8-inch casing while drilling 17-1/2-inch hole.

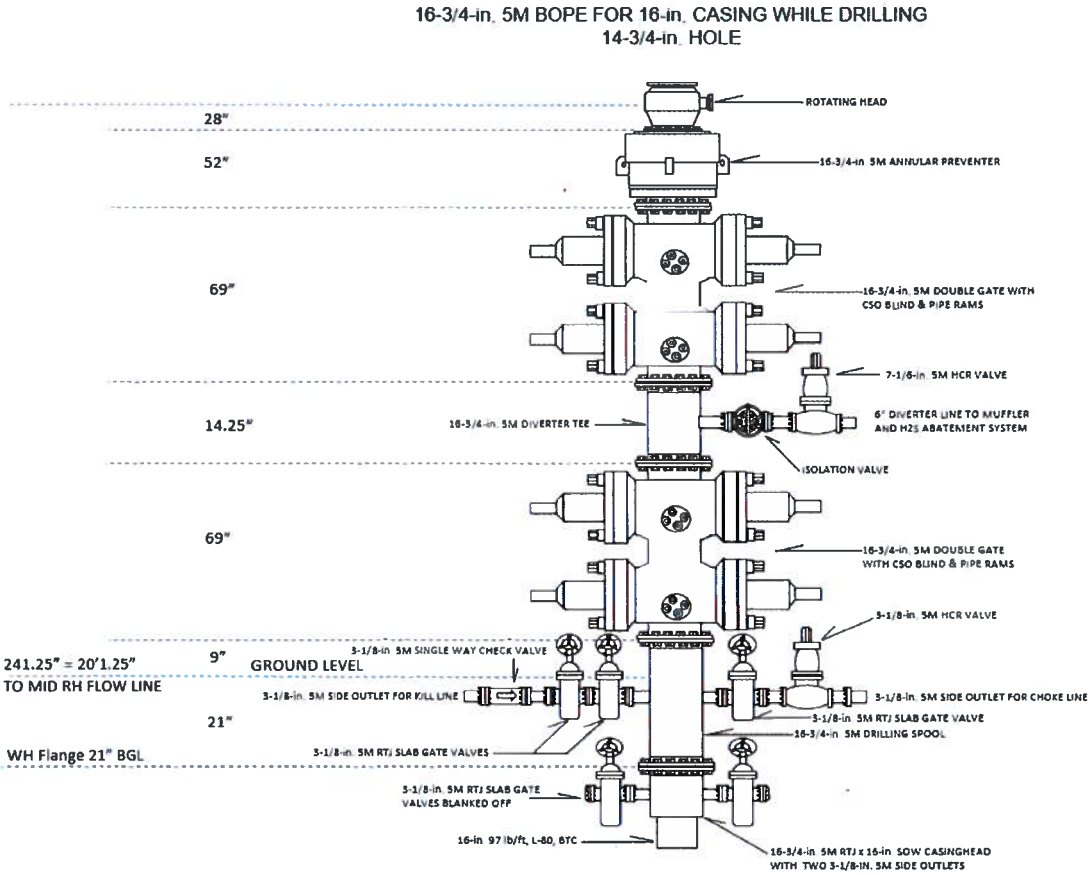


Figure 4. 16-3/4-inch BOPE for 16-inch casing while drilling 14-3/4-inch hole.

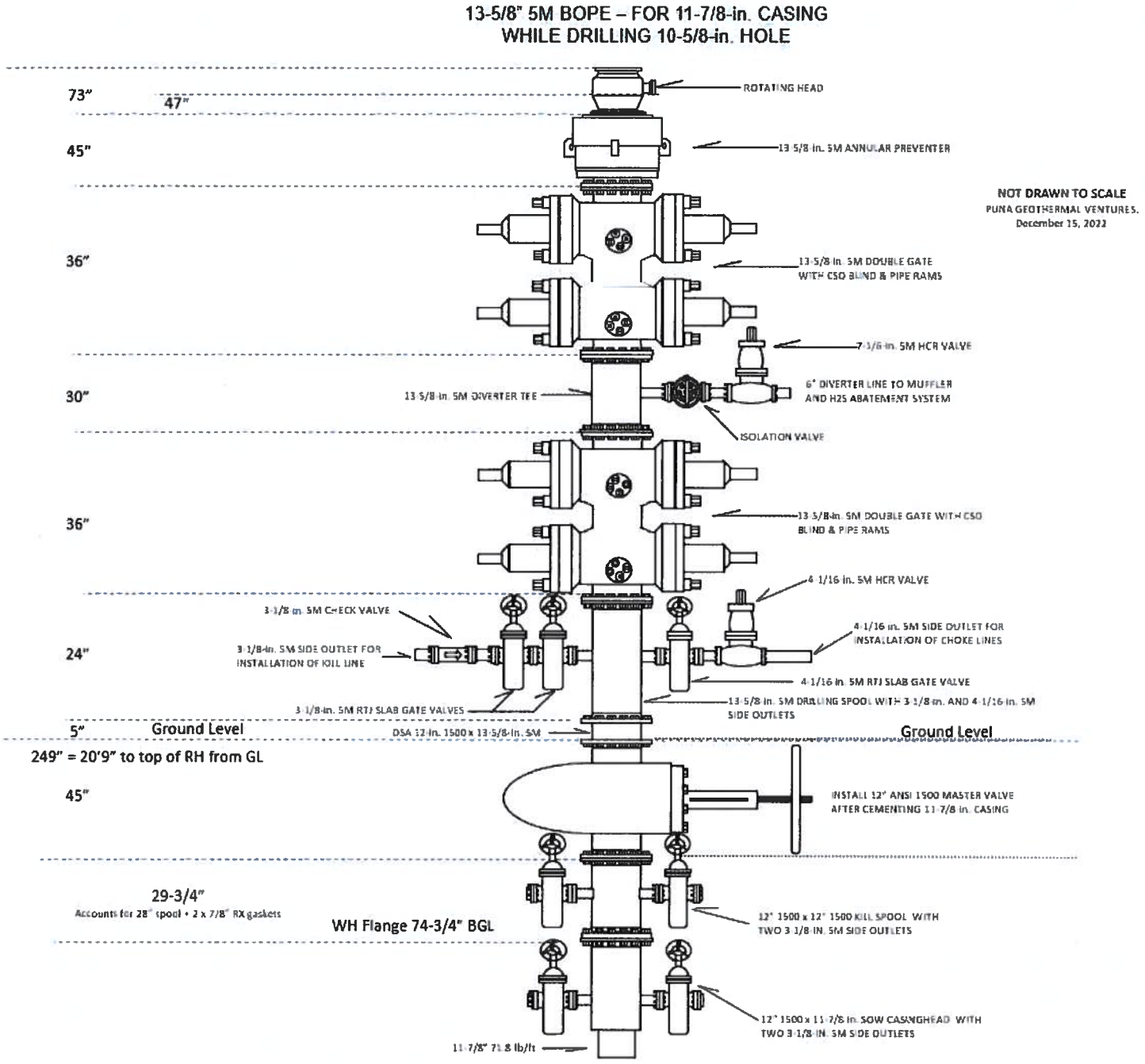


Figure 5. 13-5/8-inch 5M BOPE for 11-7/8-inch casing while drilling 10-5/8-inch hole.

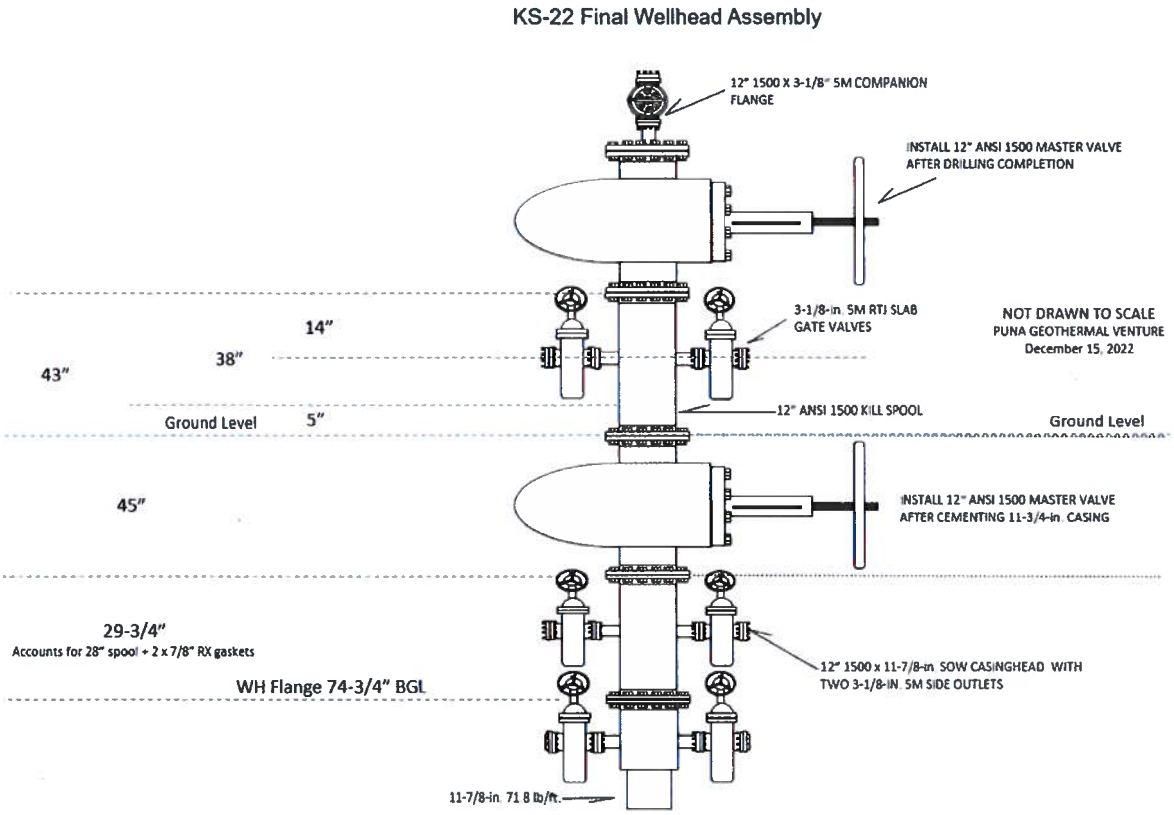


Figure 6. Proposed KS-22 wellhead assembly

APPENDIX A
DETAILED DRILLING PROCEDURES

(All depths referenced to KB unless specified)

Location:	UTM Coordinates (NAD 83) Grid E (m) **301505** Grid N (m) **2154540**
Ground Elevation:	620 ft MSL
KB:	Rig#1 27 ft above ground
KB Elevation:	647 ft MSL
Objective:	Drill a new geothermal well in the Puna field, Hawaii
Status:	New Well – See Figure 2 for proposed well schematic and Figure 6 for final proposed wellhead assembly.
Regulatory Agency:	Hawaii Department of Land and Natural Resources (DLNR)

Well Pad and Set Cellar

1. Level/grade the existing pad as needed. The area adjacent to the pad contains the containment basin. The pad has been constructed to standard industry specifications that include soil compaction suitable to support the rig's gross dead-weight plus 750,000 pounds of live loads, and capable of supporting heavy and frequent traffic. The pad may be re-contoured to ensure drain into the well cellar from the area around the rig. A fence will be installed around the containment basin on the three sides away from rig.
2. A concrete cellar has been installed according to the rig specifications with 11 ft depth.

30-inch Conductor

3. Utilizing a rat-hole drilling rig, a 48-in. hole will be drilled to approximately 80 ft below ground level and 80 ft of 30-in diameter. 0.75-in. wall line-pipe will be installed and cemented to surface to serve as conductor. Note Rig #1's KB is 27', so bottom of conductor will be at 107' RKB.

Move In and Rig Up Drill Rig

4. Move in rotary drilling rig and associated drilling equipment. Rig up all equipment.
5. Post well sign, all applicable permits, and emergency telephone numbers at the rig. All drill pipe, drill collars, and cross-overs must have passed an IADC-API Class II inspection since last used.
6. Move in and rig up mud-logging unit that includes a two-sensor hydrogen sulfide and CO2 alarm system. Hydrogen sulfide and CO2 sensors will be placed on rig floor and at the mud-return pit.
7. Install direct communications between rig floor, rig manager, mud loggers, mud engineer, and company man. **A real-time monitoring system with monitors will be installed and personnel will be trained on the system.**
8. Hold safety meeting regarding equipment, procedures for well control, hydrogen sulfide, CO2 general safety, and environmental protection. At meeting, discuss drilling program,

geological prognosis, directional program, chain of command, emergency procedures (including telephone numbers), and other issues related to previous wells drilling performance. Drill Site Manager (DSM) and Rig Manager must complete rig safety inspection form (Appendix G). **The rig will not be allowed to spud until both the DSM and Rig Manager have signed the Safety Inspection form.**

9. Install all required water supply, mud handling, piping, and mud cleaning equipment. Ensure that all mud-cleaning equipment is in good running condition.

Drill 26-inch Hole to 650 ft.

10. Make up 26-in BHA and drill to **±650 ft**. Directional surveys are not required.

11. **Upon drilling to depth of the ground water, a representative sample of the ground water will be collected and analyzed.**

12. **Notify DLNR 24-hours prior to sampling.**

Drill 22-inch Hole with 18-5/8" casing to 1150 ft. (Casing while Drilling)

13. Make up 22-in casing bit and stab-in float collar onto the 18-5/8" casing string and drill to **±1150 ft**. A stab-in float collar will be placed one joint above the 22" bit.

    13.1. A casing running tool (CRT) will be utilized to transmit torque to the casing and serve as a seal to the circulations system at the top drive. This will allow circulation of the well while drilling ahead prior to making connections.

    13.2. A pump-in sub will be available to maintain circulation on the hole in the event of a downtime or rig-repair occurrence.

    13.3. This technique will be utilized to significantly increase annular velocity (AV) and increase wellbore stability through a plastering effect on the borehole wall. Given the historical trouble with stuck-pipe and hole stability in this interval, this approach will be attempted to alleviate the risk and impact of such events. In addition to reducing stuck pipe and stability risk, this technique also eliminates the need to trip out of the hole and run in the hole with casing. Once the interval has been drilled to TD, casing is also landed.

14. Final casing point to be determined by well-site geologist. Land casing +/-5 ft. off bottom.

Cement 18-5/8-inch Casing

15. Run in hole with 5" drill pipe and stab into float collar. Note: cement returns are not expected at surface and a top job(s) will likely be required. Reference Appendix D for calculated cement volumes and pump schedule, which will be adjusted based on actual hole depth and condition.

    Upon completing cement displacement, pull out of the hole with stab-in tool. The estimated static temperature at 1150 ft is 110°F. Keep water out of 18-5/8-in. x 30-in. annulus to allow top jobs. Rig down cementing unit.

*Note***Slurry Design may be optimized for bottom-hole static temperature (BHST); $CaCl_2$ or retarder may be required if BHST changes*

16. If cement has fallen, perform top job. Wait six hours and repeat top job if necessary.

Nipple Up and Test 21-1/4-inch 2M BOPE

17. Cut off 30-in. conductor pipe to 6-in. above cellar floor (Check with PGV Wellfield/Gary Dahl to confirm cut-off depths). Cut off 18-5/8-in. casing 49-in. (Company Man to confirm) above the ground level to allow space for proper positioning of the BOPE stack. Weld on 21-1/4-in. 2M by 18-5/8-in. starter flange with two 3-1/8-in. 5M side-outlet valves. Nipple up 21-1/4-in. BOP per Figure 3. Function test BOP and related equipment per the standards specified in Section V of Circular C-125: "Hawaii Geothermal Blowout Prevention Manual" (HI C-125).

18. Test BOPE and 18-5/8-in casing to 200psi low and 750 psi high for 30 minutes. Report all tests on tour sheet and have mud loggers prepare pressure plots. DLNR to witness testing in person and approve final pressure plots onsite, if possible. Charts to be provided to DLNR upon completion of testing.

Formation Integrity Test in Formation Outside 18-5/8-inch Casing Shoe

19. Make up 17-1/2" drilling BHA and drill out shoe track and at least 1' into NEW formation (below any rathole) to perform Formation Integrity Test (FIT). Attempt FIT to 0.65 psi/ft. gradient. Evaluate LOT value, and expected max temperature at next casing point with Reno office and DLNR. Record Formation Integrity Test pressure and mud weight. Follow DLNR's Recommended Practice for Running FIT tests, included in Appendix I.

Drill 17-1/2-inch Hole with Mud Motor to 3000 ft

20. Upon successful FIT/LOT, drill 17-1/2-in. hole using directional drilling assembly. Drill to approximately 3000 ft. Cement plugs may be required. Casing point is to be decided by the geologist.

21. Pull out of the hole with 17-1/2-in. drilling assembly and pick up 20-in. hole opener/underreamer. Run in the hole and underream the hole to interval TD.

Set and Cement 16-inch Casing

22. Run **±3000 ft** of 16-in. 97# (special drift), L-80 BTC casing with stab-in float collar and float shoe.

23. Run in hole with 5" drill pipe and stab into float collar. Reference Appendix D for calculated cement volumes and pump schedule, which will be adjusted based on actual hole depth and condition.

    The estimated static temperature at 3000 ft is ~468°F.

24. If no cement returns are observed during cement displacement, immediately flush annulus with water and prepare for top squeeze / top fill jobs.

25. Wait on cement (WOC) per Resource UCA. Tag top of cement in annulus. If cement has fallen back do not perform top fill jobs at this time.

Install and Test 16-3/4-inch 5M BOPE

26. Nipple down 21-1/4-in. BOP and nipple up 16-3/4-in. BOPE according to Figure 4.

27. Test BOPE and 16-in casing to 200psi low and 1700 psi high for 30 minutes. Report all tests on tour sheet and have mud loggers prepare pressure plots. DLNR to witness testing in person and approve final pressure plots onsite, if possible. Charts to be provided to DLNR upon completion of testing.

Formation Integrity Test in Formation Outside 16-inch Casing Shoe

28. MU 14-3/4-in. BHA and drill out of cement and at least 1' into NEW formation (below any rathole) to perform Formation Integrity Test (FIT) to 0.65psi/ft. Evaluate LOT value, and expected max temperature at next casing point with Reno office and DLNR. Record FIT pressure and mud weight. Follow DLNR's Recommended Practice for FIT tests, included in Appendix I.

Drill 14-3/4-inch Hole with Mud Motor to 4000 ft

29. Upon successful FIT/LOT, drill 14-3/4-in. hole using directional drilling assembly. Drill to approximately 4000 ft. Cement plugs may be required. Casing point is to be decided by the geologist.

Set and Cement 11-7/8-inch Casing

30. Run **±4000 ft** of 11-7/8-in., 71.8#, C-110, GB CD Butt & 11-7/8" 71.8# SMT-95S Geoconn HT casing with stab-in float collar and float shoe.

31. Run in hole with 5" drill pipe and stab into float collar. Reference Appendix D for calculated cement volumes and pump schedule, which will be adjusted based on actual hole depth and condition.

    The estimated static temperature at 4000 ft is ~580°F.

32. If no cement returns are observed during cement displacement, immediately flush annulus with water and prepare for top squeeze / top fill jobs.

33. Wait on cement (WOC) per Resource UCA. Tag top of cement in annulus. If cement has fallen back do not perform top fill jobs at this time.

Install and Test 13-5/8-inch 5M BOPE

34. Nipple down 16-3/4-in. BOP and nipple up 13-5/8-in. BOPE according to Figure 5.

35. Test BOPE and 11-7/8-in casing to 200 psi low and 2200 psi high for 30 minutes. Report all tests on tour sheet and have mud loggers prepare pressure plots. DLNR to witness testing in person and approve final pressure plots onsite, if possible. Charts to be provided to DLNR upon completion of testing.

Formation Integrity Test in Formation Outside 11-7/8-inch Casing Shoe

36. Make up 12-1/4-in. BHA and drill out of cement and at least 1' into NEW formation (below any rathole) to perform Formation Integrity Test (FIT) to 0.65psi/ft. Evaluate LOT value, and expected max temperature at next casing point with Reno office and DLNR. Record FIT pressure and mud weight. Follow DLNR's Recommended Practice for FIT tests, included in Appendix I.

Drill 12-1/4-inch Hole with Directional Tools to 6900 ft

37. Upon successful FIT/LOT, directionally drill 12-1/4-in. hole to approximately **6900 ft MD / 6879 ft TVD KB.**

Run 8-5/8-inch Slotted Liner

38. Circulate hole and prepare mud for liner. Run **±4000** ft of 8-5/8-in., 40# L-80 with liner adapter and guide shoe. Make up the liner adapter and run liner in the hole on drill pipe. Set liner on bottom with liner hanger +/-100' above 11-7/8" shoe. Release the liner adapter and pull out of hole.

Water-Loss Test (for permeability)

39. Prepare for Water-Loss Test. A detailed procedure will be provided by Ormat Resource Engineer. Rig up wire-line unit for running Pressure-Temperature tool.

Run 8-5/8-inch Hang-down Liner

40. Only if the well is to be utilized for injection, run **±3400** ft of 8-5/8-in., 40# L-80 liner with hanger assembly. Set liner in hanger profile located below the 12" 1500 master valve. Once hanger is set, pull the setting assembly out of the hole and close the master valve.

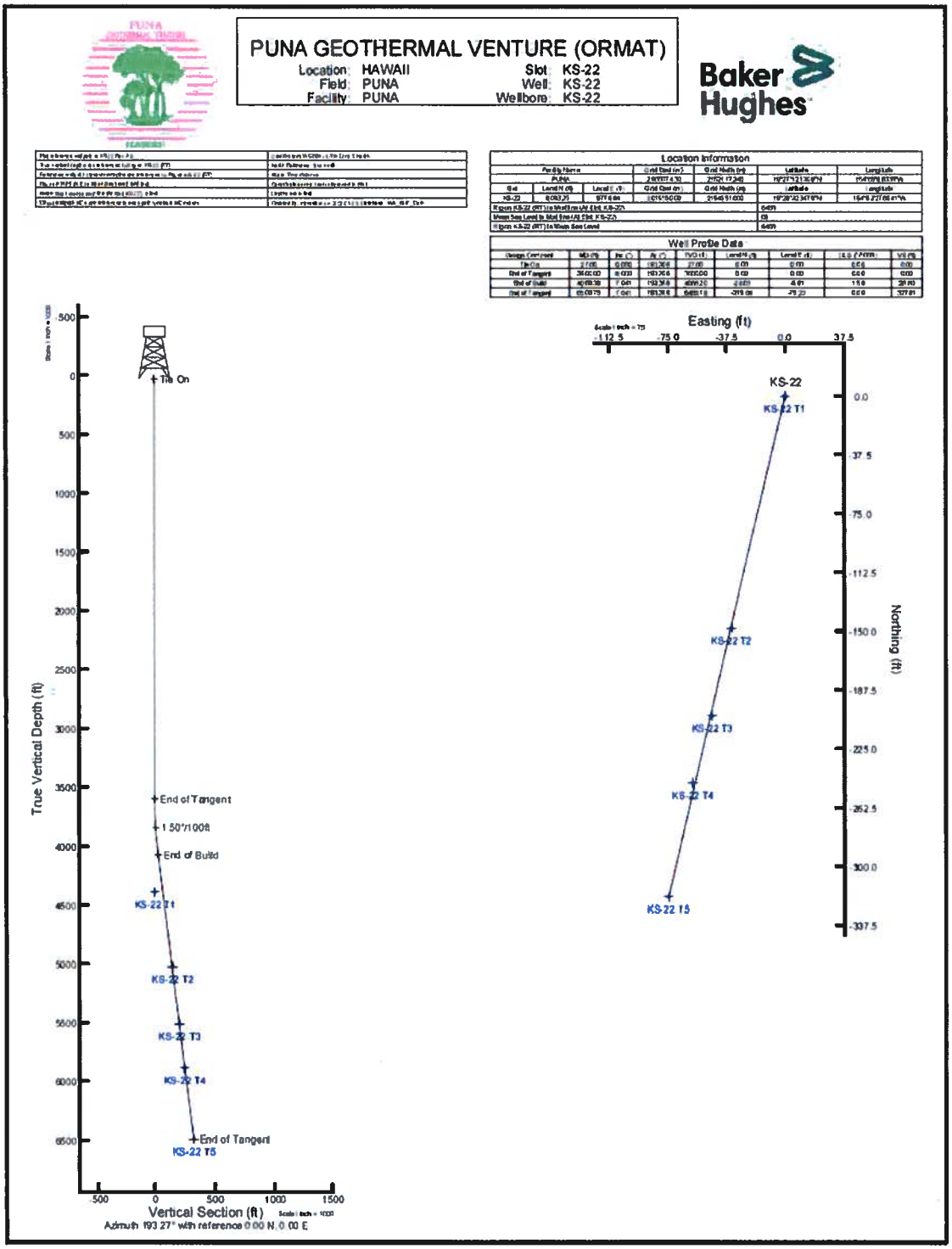
Rig Down

41. Rig down mud logging unit. Rig down and release drilling equipment. Lock wellhead valve.

Post-Commission Casing Integrity Monitoring

42. On a biennial basis (once every two years), well logs will be performed to monitor the integrity of the 11-7/8" production casing. Casing corrosion and degradation will be tracked over time and remediation plans made in attempt to account for integrity concerns prior to failure.

APPENDIX B
DIRECTIONAL DRILLING PLAN



APPENDIX C
MUD PROGRAM

A. MUD PROGRAM GENERAL GUIDELINES:

Use low-solids, non-dispersed mud with additives as necessary for system control. The following parameters should be maintained:

0-±6900 ft

Mud Weight:	≤9.2 pounds per gallon (ppg) unless it is necessary to weight up to control artesian flow.
Funnel Viscosity:	35 to 45 sec/qt
API FL:	8 to 10 ml/30 min
PV:	9 to 12 cps
YP:	7 to 15 lbs/100 ft ^{2}
Initial Gel:	3 to 6 sec
pH:	10 to 10.5

Mud-Cleaning Equipment: Mud Cleaner. Continuously use mud-cleaning equipment to remove solids.

Maintain sufficient barite on location to control well at all times. Monitor well for flow, CO_2, and H_2S at all times and increase mud weight to control. Maintain H_2S-control chemicals on site.

B. DETAILED MUD PROGRAM PER GEO DRILLING FLUIDS, INC:

107 ft-1150 ft: No circulation is expected while drilling this section. Maintain a 35 – 45 vis in the suction pit at all times with gel and Benex. In the pill pit, have a 60 – 70 vis pill with 10 ppb LCM ready to be used as needed. Mix fresh gel and water (in the suction pit) to a 35 - 45 sec/qt funnel viscosity w/ minimal additions of Drispac R. Sweep hole as often as necessary with 60 – 70 vis pill with 10 ppb Fiberseal.

At total depth, pump 2-70 bbl high viscosity sweeps prior to pulling out of the hole to run casing. Sweep to consist of base mud, 10 ppb Fiberseal and 0.1 to 0.2 ppb Lime.

1110 ft-4000 ft: Pre-treat for cement drillout with 6 sacks Bicarbonate of Soda. Continue to compound mud pumps at maximum outputs.

Drill out casing and reduce filtrate loss to 7-8 cc's with 1 ppb Drispac R. Add fresh Gel and Zanflow/Flowzan to increase funnel viscosity to ~50-55 sec/qt with a minimum yield point of 20 lbs/100 ft^2.

In the pill pit have a 60 – 70 vis pill with gel, Zanflow/Flowzan, and 10 ppb Fiberseal ready to pump as needed for lost circulation or hole cleaning.

Mud coolers will be operational and utilized at or before outlet temperatures reach 150° F.

Compound mud pumps to achieve maximum annular velocities.

Mud Weight: Maintain mud weight at ≤9.2 ppg. Run centrifuge on a 24-hour basis. Run the mud cleaner at all times while circulating mud. The mud cleaner should be equipped with ≥250-mesh screens. If the mud weight exceeds 9.4 ppg then a dump and dilute program should be instituted.

Viscosity: Maintain a minimum yield point of 15-18 lbs/100 ft^2 with fresh Gel, Zanflow/ Flowzan and LP-701 as needed. It is estimated that this will require a funnel viscosity ≥45-sec/qt. In the pill pit, increase viscosity to 75-100 sec/qt and add 10 ppb Fiberseal, and sweep hole every 500 ft drilled. Time and monitor sweeps for dilution and excess cuttings. Include in the analysis any additional solids discharge from mud cleaner. Viscosity should be a minimum of 35 sec/qt greater than the base fluid. If the sweep comes back diluted ≥20 seq/qt, then the volume and viscosity should be increased. If sweeps continue to produce unacceptable volumes of cuttings, then increase yield point. In the event of bit balling sweep hole with walnut hulls and DMS.

Filtrate Loss: Maintain filtrate loss at 7-8 cc's with tourly treatments of Drispac R. Treatments should be designed to maintain a ~1.25 ppb concentration. The filter-cake should be scrutinized daily. A thin, pliable, slick filter-cake is desired. Occasional fresh bentonite treatments may be necessary to provide the proper base material if the previously described properties are not achieved.

pH: Maintain a 10 – 10.5 pH with lime and soda ash for H_2S abatement. Amber HS may also be utilized.

Solids: Maintain solids at 8% or less. Shakers should be fitted with screens that allow mud travel 2/3 of the screen length. Mud cleaner should be fitted with 325-mesh screens, if possible. The centrifuge should be run on a 24-hour basis. If necessary, dump and dilute. Discuss dump-and-dilute program with Drill Site Manager before taking action.

Mud Weight	Viscosity	Filtrate	pH	Solids
9.0-9.2 ppg	≥45 sec/qt	7-8 cc's	10-10.5	4-8%

4000 ft – 6900 ft: Pre-treat for cement drill-out with 2 sacks Bicarbonate of Soda. Continue to compound mud pumps at maximum outputs.

In this geothermal section, reduce the gel content to a maximum of 5 ppb bentonite and maintain a 35-38 vis in the suction pit with 5 ppb gel, 0.5 ppb Drispac R, and 1.0 ppb Zanflow/Flowzan. Also in this section, maintain 3-4 ppb Fiberseal (micronized cellulose) in the suction pit to minimize lost circulation. In the event of total lost circulation, drilling blind with water and utilizing sweeps as often as directed by Company Man may be implemented.

Mud Weight: Maintain mud weight at ≤9.2 ppg. Run centrifuge on a 24-hour basis. Run the mud cleaner at all times while circulating mud. The mud cleaner should be equipped with ≥350-mesh screens. If the mud weight exceeds 9.4 ppg then a dump-and-dilute program should be instituted.

Viscosity: Maintain a minimum yield point of 10 -12 lbs/100 ft2 with fresh Gel, Zanflow/ Flowzan as needed. It is estimated that this will require a funnel viscosity ≥35 sec/qt. In the pill pit, increase vis to 75-100 sec/qt and sweep hole with 10 ppb Fiberseal every 500 ft drilled. Time and monitor sweeps for dilution and excess cuttings. Include in the analysis any additional solids discharge from mud cleaners. Viscosity should be a minimum of 35 sec/qt greater than the base fluid. If the sweep comes back diluted ≥20 sec/qt, then the volume and viscosity should be increased. If sweeps continue to produce unacceptable volumes of cuttings, then increase yield point. In the event of bit balling, sweep hole with walnut hulls and DMS.

Filtrate Loss: Maintain filtrate loss at 7-8 cc's with hourly treatments of Drispac R. Treatments should be designed to maintain a ~1.25 ppb concentration. The filter-cake should be scrutinized daily. A thin, pliable, slick filter-cake is desired. Occasional fresh bentonite treatments may be necessary to provide the proper base material if the previously described properties are not achieved.

pH: Maintain a 10 – 10.5 pH with lime and soda ash for H_2S abatement. Amber HS may also be utilized.

Solids: Maintain solids at 6% or less. Shakers should be fitted with screens that allow mud travel 2/3 of the screen length. Mud cleaner should be fitted with 325-mesh screens if possible. The centrifuge should be run on a 24 hour basis. If necessary, dump and dilute. Discuss dump-and-dilute program with Drill Site Manager before taking action.

Mud Weight	Viscosity	Filtrate	pH	Solids
9.0-9.2 ppg	35-38 sec/qt	7-8 cc's	10-10.5	4-6%

APPENDIX D
CEMENTING PROGRAM

Refer to Cementing Program by Resource Cementing for Details

Job Calculations

KS-22

18-5/8" Surface Casing

Previous Casing:	**30" Conductor Casing**	Equiv. ID:	28.750 in	Annular Fill Factor:	2.6162 ft3/ft	0.4659 bbl/ft
Depth:	107 ft				2.6162 ft3/ft	0.4659 bbl/ft
Previous Casing OD:	30.000 in					
Previous Casing ID:	28.750 in					
Excess:	0%					
Open Hole ID:	22.000 in	Equiv. ID:	22.000 in	Annular Fill Factor:	0.7478 ft3/ft	0.1332 bbl/ft
Excess:	0%				0.7478 ft3/ft	0.1332 bbl/ft
Casing Size:	**18-5/8" 87.5# K-55 Surface Casing**			Capacity Factor:	1.7194 ft3/ft	0.3062 bbl/ft
Depth:	1150.00 ft					
Casing OD:	18.625 in					
Casing ID:	17.755 in					
Shoe Track Length:	40.00 ft					
DP Inner String:	**5" 19.5 lb/ft Drill Pipe**			Capacity Factor:	0.0997 ft3/ft	0.01776 bbl/ft
DP OD:	5.000					
DP ID:	4.276					
AHV Inside Casing:	279.93 ft3		49.86 bbl			
AHV Inside Open Hole:	779.97 ft3		138.91 bbl			
Total AHV:	**1059.91 ft3**		**188.77 bbl**			
Annular Excess:	0.00 ft3		0.00 bbl			
Shoe Track Volume:	68.77 ft3		12.25 bbl			
Total Cement Volume:	**1128.68 ft3**		**201.02 bbl**			
Casing Volume:	1908.50 ft3		339.90 bbl			
Drill Pipe Volume:	**110.69 ft3**		**19.71 bbl**	**(Displacement Volume)**		
Top of Lead Cement:	**0 ft**					
Lead Cement Density:	15.00 lb/gal					
Lead Cement Yield:	1.88 ft3/sk					
Lead Cement Water Req:	8.14 gal/sk					
Lead Mix Water Volume:	4886.95 gals		116.36 bbl			
Lead Cement Volume:	**1128.68 ft3**		**201.02 bbl**	**600 sacks**		
Top Out Cement:	**0 ft**					
Lead Cement Density:	13.00 lb/gal					
Lead Cement Yield:	2.75 ft3/sk					
Lead Cement Water Req:	12.39 gal/sk					
Lead Mix Water Volume:	5085.22 gals		121.08 bbl			
Lead Cement Volume:	**1128.68 ft3**		**201.02 bbl**	**410 sacks**		

Job Calculations

KS-22

16" Intermediate Casing

Previous Casing:	**18-5/8" Surface Casing**	Equiv. ID:	18.887 in	Annular Fill Factor:	0.3231 ft3/ft	0.0575 bbl/ft
Depth:	**1100.00 ft**			(w/ Excess):	0.5493 ft3/ft	0.0978 bbl/ft
Previous Casing OD:	18.625 in					
Previous Casing ID:	17.755 in					
Excess:	70%					
Open Hole ID:	**20.000 in**	Equiv. ID:	22.379 in	Annular Fill Factor:	0.7854 ft3/ft	0.1399 bbl/ft
Excess:	70%			(w/ Excess):	1.3352 ft3/ft	0.2378 bbl/ft
Casing Size:	**16" 84# Intermediate Casing**			Capacity Factor:	1.2288 ft3/ft	0.2189 bbl/ft
Depth:	**3000.00 ft**					
Casing OD:	16.000 in					
Casing ID:	15.010 in					
Shoe Track Length:	40.00 ft					
DP Inner String:	**5" 19.5 lb/ft Drill Pipe**			Capacity Factor:	0.0997 ft3/ft	0.01776 bbl/ft
DP OD:	5.000					
DP ID:	4.276					
AHV Inside Casing:	355.41 ft3	63.30 bbl				
AHV Inside Open Hole:	1492.26 ft3	265.77 bbl				
Total Annular Volume:	**1847.67 ft3**	**329.07 bbl**				
Annular Excess:	1293.37 ft3	230.35 bbl				
Shoe Track Volume:	49.15 ft3	8.75 bbl				
Total Req. Cement Volume:	**3190.19 ft3**	**568.17 bbl**				
Casing Capacity:	3637.31 ft3	647.81 bbl				
Drill Pipe Capacity:	**295.19 ft3**	**52.57 bbl**		**(Displacement Volume)**		
Lead Cement:	**Top of Cement:**	**0 ft**				
Lead Cement Density:	15.00 lb/gal					
Lead Cement Yield:	1.87 ft3/sk					
Lead Cement Total Fluid:	8.11 gal/sk					
Lead Mix Water Volume:	8601.08 gals	204.79 bbl				
Lead Cement Volume:	**1983.23 ft3**	**353.21 bbl**		**1061 sacks**		
Latex Tail Cement	**Top of Cement:**	**1526 ft**				
Tail Cement Density:	15.00 lb/gal					
Tail Cement Yield:	1.88 ft3/sk					
Tail Cement Total Fluid:	8.18 gal/sk					
Tail Mix Water Volume:	5251.56 gals	125.04 bbl				
Tail Cement Volume:	**1206.96 ft3**	**214.96 bbl**		**642 sacks**		

Job Calculations

KS-22

11-7/8" Production Casing

Previous Casing:	**16" Intermediate Casing**	Equiv. ID:	16.736 in	Annular Fill Factor:	0.4597 ft3/ft	0.0819 bbl/ft
Depth:	**3000.00 ft**			(w/ Excess):	0.7585 ft3/ft	0.1351 bbl/ft
Previous Casing OD:	16.000 in					
Previous Casing ID:	15.010 in					
Excess:	65%					
Open Hole ID:	**14.750 in**	Equiv. ID:	16.350 in	Annular Fill Factor:	0.4175 ft3/ft	0.0744 bbl/ft
Excess:	65%			(w/ Excess):	0.6889 ft3/ft	0.1227 bbl/ft
Casing Size:	**11-7/8" 71.8# Production Casing**			Capacity Factor:	0.6257 ft3/ft	0.1114 bbl/ft
Depth:	**4000.00 ft**					
Casing OD:	11.875 in					
Casing ID:	10.711 in					
Shoe Track Length:	40.00 ft					
DP Inner String:	**5" 19.5 lb/ft Drill Pipe**			Capacity Factor:	0.0997 ft3/ft	0.01776 bbl/ft
DP OD:	5.000					
DP ID:	4.276					
AHV Inside Casing:	1379.10 ft3	245.62 bbl				
AHV Inside Open Hole:	417.50 ft3	74.36 bbl				
Total Annular Volume:	**1796.60 ft3**	**319.97 bbl**				
Annular Excess:	1167.79 ft3	207.98 bbl				
Shoe Track Volume:	25.03 ft3	4.46 bbl				
Total Req. Cement Volume:	**2989.42 ft3**	**532.42 bbl**				
Casing Capacity:	2477.89 ft3	441.31 bbl				
Drill Pipe Capacity:	**394.91 ft3**	**70.33 bbl**	**(Displacement Volume)**			
Lead Cement:	**Top of Cement:**	**0 ft**				
Lead Cement Density:	15.00 lb/gal					
Lead Cement Yield:	1.87 ft3/sk					
Lead Cement Total Fluid:	8.11 gal/sk					
Lead Mix Water Volume:	7758.19 gals	184.72 bbl				
Lead Cement Volume:	**1788.88 ft3**	**318.60 bbl**	**957 sacks**			
Tail Cement	**Top of Cement:**	**1184 ft**				
Tail Cement Density:	15.00 lb/gal					
Tail Cement Yield:	1.87 ft3/sk					
Tail Cement Total Fluid:	8.11 gal/sk					
Tail Mix Water Volume:	5206.62 gals	123.97 bbl				
Tail Cement Volume:	**1200.54 ft3**	**213.82 bbl**	**642 sacks**			

CEMENT PARAMETERS

Job Summary

KS-22

18-5/8" Surface Casing

Fluid Schedule

Fluid 1:	**30 bbls Fresh Water**	**Density:**	**8.33 lb/gal**
Spacer		**Volume:**	**30.00 bbls**
Fluid 2:	**13 bbls Sodium Silicate Preflush •**	**Density:**	**11.6 lb/gal**
Reactive Spacer		**Volume:**	**13 bbls**
Fluid 3:	**5 bbls Fresh Water**	**Density:**	**8.33 lb/gal**
Spacer		**Volume:**	**5.00 bbls**
Fluid 4:	**642 sacks RC-ThermaTail (2 % $CaCl_2$)**	**Density:**	**15.0 lb/gal**
Lead Cement	**40% Silica Flour**	**Slurry Yield:**	**1.88 ft3/sk**
	10% Micro Silica	**Water Requirement:**	**8.10 gal/sk**
	0.5% CFL-115	**Total Mix Water Volume:**	**123.81 bbl**
	0.5% CDI-33	**Slurry Volume:**	**1206.96 ft3**
	0.2% FL-24		**214.96 bbl**
	2% Calcium Chloride	**Calculated Top of Cement:**	**0 ft**
Fluid 5:	**19.71 bbls Fresh Water Displacement**	**Density:**	**8.33 lb/gal**
Displacement		**Volume:**	**19.71 bbls**
Fluid 6:	**428 sacks RC-ThermaLite-THX (3 % $CaCl_2$)**	**Density:**	**13.0 lb/gal**
Top Out Cement	**40% Silica Flour**	**Slurry Yield:**	**2.75 ft3/sk**
	10% Micro Silica	**Water Requirement:**	**12.39 gal/sk**
	10 lb/sk Cenospheres	**Total Mix Water Volume:**	**126.26 bbl**
	0.5% CFL-115	**Slurry Volume:**	**1177.00 ft3**
	5 lb/sk Gypsum		**209.62 bbl**
	3% Calcium Chloride		

Note: Pump specified cement volume for primary job. Upon no cement returns at surface, wait on cement, and then perform top job down annulus using thixotropic cement while adding sodium silicate into annulus at approximately 0.2 gal per bbl of cement.

Job Summary

KS-22

16" Intermediate Casing

Fluid 1:	**50 bbls Fresh Water**	**Density:**	**8.33 lb/gal**
Spacer		**Volume:**	**50.00 bbls**
Fluid 2:	**20 bbls RC Mud Clean**	**Density:**	**8.4 lb/gal**
Pre-Flush		**Volume:**	**20.00 bbls**
Fluid 2:	**5 bbls Fresh Water**	**Density:**	**8.33 lb/gal**
Spacer		**Volume:**	**5.00 bbls**
Fluid 3:	**13 bbls Sodium Silicate**	**Density:**	**11.60 lb/gal**
Reactive Spacer		**Volume:**	**13.00 bbls**
Fluid 4:	**5 bbls Fresh Water**	**Density:**	**8.33 lb/gal**
Spacer		**Volume:**	**5.00 bbls**
Fluid 5:	**642 sacks RC-ThermaTail-HT Cement**	**Density:**	**15.00 lb/gal**
Excess Cement	**40% Silica Flour**	**Slurry Yield:**	**1.87 ft3/sk**
	10% Micro Silica	**Water Requirement:**	**8.10 gal/sk**
	0.5% CFL-115	**Total Mix Water Volume:**	**123.81 bbl**
	0.2% FWCA	**Slurry Volume:**	**1200.54 ft3**
	0.3% CR-270 Retarder		**213.82 bbl**
Fluid 6:	**428 sacks RC-ThermaTail-HT Cement**	**Density:**	**15.00 lb/gal**
Lead Cement	**40% Silica Flour**	**Slurry Yield:**	**1.87 ft3/sk**
	10% Micro Silica	**Water Requirement:**	**8.10 gal/sk**
	0.5% CFL-115	**Total Mix Water Volume:**	**82.54 bbl**
	0.2% FWCA	**Slurry Volume:**	**800.36 ft3**
	0.5% CR-180 Retarder		**142.54 bbl**
		Calculated Top of Cement:	**0 ft**
Fluid 7:	**642 sacks RC-ThermaTail-L Cement**	**Density:**	**15.00 lb/gal**
Latex Tail Cement	**40% Silica Flour**	**Surface Slurry Yield:**	**1.88 ft3/sk**
	10% Micro Silica	**Water Requirement:**	**8.15 gal/sk**
	0.5% CFL-115	**Total Mix Water Volume:**	**124.58 bbl**
	0.2% FWCA	**Slurry Volume:**	**1206.96 ft3**
	Liquid Latex Additives		**214.96 bbl**
		Calculated Top of Cement:	**1526 ft**
Fluid 8:	**52.57 bbls Fresh Water Displacement**	**Density:**	**8.33 lb/gal**
Displacement		**Volume:**	**52.57 bbls**

Tail Latex Water Mixing Instructions	
RC Latex	717 gal
CDI-33 Dispersant (Dry, added to Water)	506 lb
TCA200L Defoamer	72 gal
Fresh Water	120 bbl
Total Yield	**140 bbl**

Note: If no cement returns at surface during primary cement job, then after job immediately flush annulus with 100 bbl of fresh water in preparation for top squeeze cement job using the cement shown below. A minimum of 8 hours waiting on cement is recommended prior to performing top squeeze.

Fluid 9:	**321 sacks RC-ThermaTail-HT Cement**	**Density:**	**15.00 lb/gal**
Top Squeeze	**40% Silica Flour**	**Surface Slurry Yield:**	**1.87 ft3/sk**
Cement	**10% Micro Silica**	**Water Requirement:**	**8.11 gal/sk**
	0.5% CFL-115	**Total Mix Water Volume:**	**61.98 bbl**
	2% Calcium Chloride (Added to Mix Water)	**Slurry Volume:**	**600.27 ft3**
			106.91 bbl

Job Summary

KS-22

11-7/8" Production Casing

Fluid 1:	**50 bbls**	**Fresh Water**	**Density:**	**8.33 lb/gal**
Spacer			**Volume:**	**50.00 bbls**
Fluid 2:	**20 bbls**	**RC Mud Clean**	**Density:**	**8.4 lb/gal**
Pre-Flush			**Volume:**	**20.00 bbls**
Fluid 2:	**5 bbls**	**Fresh Water**	**Density:**	**8.33 lb/gal**
Spacer			**Volume:**	**5.00 bbls**
Fluid 3:	**13 bbls**	**Sodium Silicate**	**Density:**	**11.60 lb/gal**
Reactive Spacer			**Volume:**	**13.00 bbls**
Fluid 4:	**5 bbls**	**Fresh Water**	**Density:**	**8.33 lb/gal**
Spacer			**Volume:**	**5.00 bbls**
Fluid 5:	**957**	**sacks RC-ThermaTail-HT Cement**	**Density:**	**15.00 lb/gal**
Lead Cement		**40% Silica Flour**	**Slurry Yield:**	**1.87 ft3/sk**
		10% Micro Silica	**Water Requirement:**	**8.10 gal/sk**
		0.5% CFL-115	**Total Mix Water Volume:**	**184.56 bbl**
		0.2% FWCA	**Slurry Volume:**	**1789.59 ft3**
		0.3% CR-270 Retarder		**318.73 bbl**
Fluid 6:	**642**	**sacks RC-ThermaTail-HT Cement**	**Density:**	**15.00 lb/gal**
Tail Cement		**40% Silica Flour**	**Slurry Yield:**	**1.87 ft3/sk**
		10% Micro Silica	**Water Requirement:**	**8.10 gal/sk**
		0.5% CFL-115	**Total Mix Water Volume:**	**123.81 bbl**
		0.2% FWCA	**Slurry Volume:**	**1200.54 ft3**
		0.4% CR-180 Retarder		**213.82 bbl**
			Calculated Top of Cement:	**1184 ft**
Fluid 7:	**70.33 bbls**	**Fresh Water Displacement**	**Density:**	**8.33 lb/gal**
Displacement			**Volume:**	**70.33 bbls**

Note: If no cement returns at surface during primary cement job, then after job immediately flush annulus with 300 bbl of fresh water in preparation for top squeeze cement job using the cement shown below. A minimum of 8 hours waiting on cement is recommended prior to performing top squeeze.

Fluid 9:	**963**	**sacks RC-ThermaTail-HT Cement**	**Density:**	**15.00 lb/gal**
Top Squeeze		**40% Silica Flour**	**Surface Slurry Yield:**	**1.87 ft3/sk**
Cement		**10% Micro Silica**	**Water Requirement:**	**8.11 gal/sk**
		0.5% CFL-115	**Total Mix Water Volume:**	**185.95 bbl**
		2% Calcium Chloride (Added to Mix Water)	**Slurry Volume:**	**1800.81 ft3**
				320.72 bbl

APPENDIX E
EMERGENCY PLANS AND CONTACTS

A. Injury Contingency Plan

1) In the event injuries occur in connection with a PGV operation, specific and immediate attention will be given to proper transportation to a medical facility.

Ambulance and/or Paramedics
911

Hilo Medical Center – Main
1190 Waianuenue Ave, Hilo, HI 96720
(808) 932-3000

B. Blowout Contingency Plan (Also see Appendix F for detailed Blowout Plans)

Blowout-prevention equipment (BOPE) will be kept in operating condition and tested in compliance with Hawaii regulations and industry standards. Standard kick and blowout drills will be conducted on BOPE before the spud and periodically after spud. These drills will be noted on the tour sheets.

In addition, cold water and barite will be stored at the well site 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 Drill Site Manager is to initiate appropriate control procedures, as follows:

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) Secure and maintain control of access roads to the area to eliminate entry of unauthorized personnel.
3) Contact the Drilling Engineer and advise of the situation. The Drill Site Manager 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 Drilling Engineer.
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 required 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 of 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 firefighting equipment.

2) A roster of emergency phone numbers will be available on-site so that the appropriate firefighting 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 a 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.

c) 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.

d) 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 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:

a) 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.

b) 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 clean up the spill, as above, and notify personnel as listed below.

c) Notification

(1) The Drilling Supervisor will, as quickly as practicable:
- Call out contractor(s), as required.
- Notify the Drilling Engineer and PGV Plant Manager.
- Notify the local law enforcement agencies if the public safety is threatened.
- Advise local population and affected property owners if spill affects residents or property.

d) 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 DLNR.

(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, PGV 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.

e) Confirm telephone notification to agencies and regulatory bodies. Telephone notification shall be confirmed by the Drilling Engineer in writing within two weeks of telephone notification. Written confirmation will contain:

(1) Reason for the discharge or spillage.

(2) Duration and volume of discharge or spillage.
(3) Steps taken to correct problem.
(4) Steps taken to prevent recurrence of problem.

E. Hazardous Gas Contingency Plan

1) There is a possibility of encountering hazardous non-condensable gases while drilling and testing. The three main gases expected in this area are steam, hydrogen sulfide (H2S), and carbon dioxide (CO2).

2) 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.

3) All personnel will be trained in warning signs, signals, first aid, and responsibilities in case of hazardous gases. The site will have two briefing areas positions such 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.

4) All vehicles will be parked with the front towards the exit road. A normal-size first-aid kit, stokes litter, wind-direction apparatus, and portable hand-held H2S and CO2 detectors will be available on the location. There will also be H2S-scavenger chemicals on the location for treating the mud. Warning signs will be posted on the access road to the location.

5) 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 downwind from venting steam. Note: liquid phase water as hot as 220°F may be present in the testing tanks. If a person receives a burn injury, remove them from the site and cool the burned area on their skin. Transport them to the hospital.

6) 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 (see Table 1, below). 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, H_2S 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 while using the proper protective equipment; the driller will then travel to the briefing area). Remember: at concentrations above 100 ppm, personnel cannot 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.

7) CO_2 is a colorless odorless gas. At concentrations above 50,000 ppm personnel risk affliction. Exposure to concentrations above 80,000 ppm (8%) causes loss of consciousness. The same procedure should be utilized as the H_2S procedure.

8) If a person becomes unconsciousness due to a hazardous gas, do not attempt to remove him without proper protective equipment. You May Also Become A Victim. Do not attempt a rescue without proper protective equipment. If you have 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 or onsite medic arrives. Even if the symptoms pass, transport the victim to a hospital and place him under the care of a doctor.

9) After a hazardous gas has been detected, operations will proceed as follows:

a) Condition – **POTENTIAL DANGER**

H_2S concentration <10 ppm
CO_2 concentration <5,000 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 Drill Site Manager, Rig Manager, 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 – **MODERATE DANGER**

H_2S concentration 10 ppm to 20 ppm
CO_2 concentration 5,000 ppm to 50,000 ppm
STEAM >190°F
All personnel will be immediately notified of the danger. The mud loggers will immediately notify the Drill Site Manager, Rig Manager, 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 authorized personnel only. Warning signs will be posted.

c) Condition – **EXTREME DANGER**

H_2S concentration >20 ppm
CO_2 concentration >50,000 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 Project Manager, Company Drilling Supervisor, Rig Manager, 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 cannot be controlled, the Emergency Plan will be initialized.

TABLE 1: PHYSICAL EFFECTS OF HYDROGEN SULFIDE

CONCENTRATION (ppm)	**EXPOSURE TIME**		
	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 and sleepiness	Throat and eye irritation
450	Eye irritation	Respiration difficult	Serious respiratory disturbance
1000	Unconsciousness	Death	Death

Emergency Personnel and Telephone Numbers

Fire	**911**
Pahoa Fire	(808) 965-2708
Law Enforcement	**911**
Pahoa Police	(808) 935-3311 (808) 966-7432
Hospital	
Hilo	(808) 932-3000
Company Representative	
Ormat Nevada Inc. (PGV affiliate)	(775)-356-9029 (office)
Mike Kaleikini (Senior Director, Hawai'i Affairs)	(808) 936 8161 (cell)

PGV (Ormat) Project Managers

Paul Spielman (Chief Resource Engineer)	(775) 843-3901 (cell)
James Tennison (Director, Drilling Services)	(760) 550-3459 (cell)
Jesse Carranza (Drilling Operations Manager)	(775) 327-5406 x 42121 (760) 791-3771 (cell)
Matt Stiasny (Senior Drilling Engineer)	(775) 300-0903 (cell)
Jordan Hara (PGV Plant Manager)	(808) 965-6233 x 52835 (office) (808) 494-8882 (cell)
Puna Control Room	(808) 965-2832 (808) 938-0907 (cell)

Hawaii Department of Land and Resources (DLNR)

James Kurata	(808) 587-0324 (office)
Phil Nigro	(512) 718-0096 (cell)

APPENDIX F
BLOWOUT PREVENTION AND ACTION PLANS

To Be Posted In Doghouse

1 PREVENTION PLAN

1) Fill drill pipe before attaching a circulating head or Kelly and re-establishing circulation

2) Pull drill pipe from the well at a speed which does not induce the swabbing of fluid from the well or a reduction of down-hole pressures to less than static formation-fluid pressures.

3) Fill well with liquid when pulling the drill string from the well

4) Cool the drilling fluid adequately prior to circulating down the drill string

5) Pump at an adequate rate to cool the well

6) Refrain from pumping a drilling fluid that contains air or gas

7) Use a drilling fluid with adequate density to give down-hole pressures in the hole which are more that reservoir fluid pressures at the same depth (that is, drilling in an over-balanced condition).

8) Leave hole or part of the hole filled with fluid which has sufficient density and gel strength to avoid becoming gas cut over a period of time. (for example, a pilot hole during the period required to open the full length of the pilot hole to the desired diameter).

9) Reduce the rate of penetration to allow gas or heat to be circulated out when drilling through softer formations which may contain gas or high-temperature fluids.

10) Pump water to the annulus outside the drill string when drilling without fluid returns.

11) Circulate drilling fluid in stages when running drill string into a hot well to remove heat from the well.

12) Maintain a kill sheet with slow and fast pumping pressure readings.

BLOWOUT ACTION PLAN

To Be Posted In Doghouse

A. INDICATIONS OF A KICK (INFLUX)

1) Change in the total volume of drilling fluid.

2) Signs of formation gas in the drilling returns.

3) Increase in the temperature of the drilling fluids.

4) Increase in the flow rate of the drilling fluid returns.

5) Rapid increase in penetration rate or pumping pressure, or a drilling break (where the hole is advanced rapidly with little or no weight on the bit).

6) Loss of circulation. Note: When drilling without returns, a greater loss circulation may be indicated by a rapid loss of pumping pressure.

7) An apparent loss of drill-string weight while drilling, which is inconsistent with the rate of feed of the drill string into the well. Note: An influx of hot fluids into the well will cause the drill string to expand, resulting in an increase in the weight on the bit.

8) Contamination of the drilling fluids as indicated by a reduction in density or an increase in dissolved solids.

B. GEOTHERMAL KILL PROCEDURES

While drilling a geothermal well, the following procedures should be followed in the event that a kick is possible or is occurring.

1) If there is drill string on bottom, pull off bottom to avoid becoming stuck, and space out to ensure a tool joint is not across the BOP. If stabilizers or other BHA components are across the BOP stack, pick up a kill stand and run in to properly space out.

2) Ensure that the choke line is open, and close an appropriate BOP (that is, blind rams if there is no drill string in the well, pipe rams if the rams are opposite drill pipe, or annular preventer if neither apply).

3) Pump cold water or drilling fluid to fill and cool the well. Note: If the drill string is in the well, pumping down the drill string via the Kelly or a circulating head is more effective than pumping down the annulus, but pumping down both may be most effective.

4) Control the well head pressure by gradually opening or closing the choke line while pumping caustic to abate H_2S. Note: The wellhead pressure should be limited so as to not exceed the pressure rating of any wellhead component (including casing), and also not to exceed a pressure which is likely to cause breakdown of the formation below the shoe of the deepest cemented casing. Conversely, allowing the wellhead pressure to drop too rapidly to a low value will allow further influx of gas and heat and may induce hole collapse.

5) If pumping of cold water or drilling fluid does not cool and control the well flow, then proceed to follow the steps in the Driller's Methods, preferred, (below), or Wait-and-Weight method at Drilling Engineer's discretion.

6) If a kick is observed while running casing and cementing, space out, install a TIW valve and close the annular preventer.

7) If well starts to flow while running slotted liner, move liner to put blank section of pipe in annular, install TIW valve, and close annular."

8) If a kick occurs when drilling below the intermediate casing, maintain pressure at the shoe below known or estimated (if not known) fracture gradient by relieving pressure through choke or diverter line. Pump heavy mud to increase pressure gradient between shoe and high-pressure zone so surface pressure can be reduced zero with pressure at shoe below the fracture gradient.

Note: Fluids in a geothermal well (including drilling fluids) will be heated to temperatures significantly above 212°F (100°C). When the pressure on such hot fluids reduces, the water in the fluid will start boiling to steam. The steam will reduce the density of the fluid column in the well causing further reduction in down-hole pressures and resulting in boiling additional portions of the liquid column. Such boiling can be self-sustaining and can accelerate until boiling occurs over most of or all of the well depth. This phenomenon is distinctly different from the rising, expanding gas bubble considered as the basis for the kick control in oil and gas drilling and conventional BOP-operating procedures.

C. DRILLER'S METHOD (PREFERRED)

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

   a) In the case that the hole is experiencing lost circulation, bull-heading cold water will be the preferred method of well control. Cold water, as it pertains to this process, will be water that has been processed through the mud cooling system on location.

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 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 ensure 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 will be 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 float-sub and full-opening safety (TIW) valve with wrench must be immediately available on the rig floor.

10) A blowout-prevention drill will be conducted by the rig manager 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: for example, mud mixing assigned to floor man, operating pumps assigned to derrick man, 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:

a) Pull kelly above the rotary table and stop pumps.
b) Check the well for flow.
c) Close the blowout preventer and shut the well in completely.
d) Record pit level, shut-in drill pipe pressure (Psidp) and shut-in casing pressure (Psicg).
e) Inform the Drilling Supervisor as soon as possible and proceed with appropriate kick-control measures as follows.

Shut-in Procedure While Tripping:

a) Set slips with tool joint in rotary table.
b) Install full-opening safety valve.
c) Close safety valve.
d) Close blowout preventer.
e) Install the kelly.
f) Record shut-in drill-pipe pressure and casing pressure.
g) Inform the Drilling Supervisor.

12) Run drill string in hole as far as practical after first installing safety (TIW) valve and/or float-sub and re-opening it, and/or proceed with appropriate kick-control measures as follows.

D. KICK-CONTROL MEASURES FOR DRILLER'S METHOD

First Circulation

1) Select a pump speed for the kill operation. This will usually be the previously recorded slow pump rate. It is important to maintain the pump at a constant stroke-per-minute (SPM) value throughout the kill operation.
2) Start the pump and open the choke to maintain the casing pressure (Pcg) constant as the pump is brought up to the desired SPM value ("kill speed"). Once the kill speed is reached, observe the new drill-pipe pressure (Pdp). Record the drill-pipe pressure.
3) Pump one full circulating volume at constant SPM value while operating the choke to maintain the drill-pipe pressure constant.
4) 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.

Second Circulation

1) Calculate the kill-weight mud density in lb./gal.

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

where TVD = true vertical depth (in feet) at bottom of hole. A trip margin may be added if desired, but management approval is required for a trip margin in excess of 0.2 ppg.

2) 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.
3) After pumping one drill-string volume of the kill-weight mud, maintain the pump speed constant and record the circulating drill-pipe pressure.
4) 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.
5) Stop the pump and check for flow.

E. WAIT-AND-WEIGHT METHOD (DRILLING ENGINEER'S DISCRETION)

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 blowout preventer check list.

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

5) Fill hole at 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 ensure that the volume of mud displaced by the drill pipe is not exceeded.

7) The drill pipe will be run in the hole to the shoe of the casing and a TIW valve will be 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 pump rate daily and after each bit change.

9) An approved float-sub and full-opening safety (TIW) valve with wrench must be immediately available on the rig floor.

10) A blowout-prevention drill will be conducted by the rig manager 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 for mud mixing assigned to floor man, operating pumps assigned to derrick man, 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:

   <u>While Drilling:</u>

   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 re-close choke line.

   d) Record shut-in drill-pipe pressure (Pdp) and casing pressure (Pcg). Maximum allowable casing pressure is dependent on casing depth and burst rating. Allowable pressure for each string is to be posted and noted in driller's instructions and on well-control data sheet.

   Inform the Drilling Supervisor as soon as possible and proceed with appropriate kick-control measures as follows in Step 12.

   <u>While Tripping:</u>

   a) Install full-opening safety valve.

   b) Open choke-line valve(s).

   c) Close safety valve.

   d) Close blowout preventer and gradually re-close choke-line valve(s).

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

f) Maximum allowable casing pressure is dependent on casing depth, mud weight and burst rating.

g) Inform the Drilling Supervisor. Run drill string in hole as far as practical after first installing safety valve and/or float sub and re-opening it, 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 =

$$\frac{\text{Pdp}}{\text{Drill string depth (ft.)} \times 0.052} + 0.4 \text{ lb./gallon}$$

Where Pdp = shut-in drill pipe pressure in psig.

13) When sufficient volume of proper-weight mud has been prepared, start pumping increased-weight mud down drill pipe at constant kick-control SPM, which will lower circulating pressure gradually from Pi (initial drill-pipe circulating pressure, as calculated on the well-control worksheet) to Pf (final drill-pipe circulating pressure) when drill pipe is filled with weighted mud. Thereafter, hold drill pipe 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) As a last resort to kill well: drill new directional hole.

1.

APPENDIX G
RIG SAFETY INSPECTION FORM

Company: _____ Rig Number: _____ Inspection Date: _____

Toolpusher: _____ Driller: _____ Inspection Made by: _____

( ) If OK
(-) If not applicable
(X) If correction is needed.
Refer to the back for details.

I. DRILL SITE
- a. AUTHORIZED PERSONNEL signs posted
- b. HARD HAT/SAFETY GLASSES signs posted
- c. NO SMOKING / SMOKING areas designated
- d. NO PARKING near rig
- e. H2S controls if applicable
- f. Over head lines flagged 6' above ground
- g. Toilet Facilities provided
- h. Hard hats/safety glasses available for visitors
- i. Toolpusher's trailer (bunk house) grounded
- j. Toolpusher's trailer tied down
- k. Regulatory Safety, etc. Posters posted as required
- l. Employee training records available as needed
- m. Containers properly marked to contents
- n. Company policies posted
- o. Forklift / misc. hoisting & lifting equipment
- p. Bench grinders properly guarded, tool rest adjusted, PPE available, Safety signs posted

II. DOG HOUSE(S)
- a. Adequate exits, doors installed properly, operate freely
- b. Approved heaters used
- c. Hazard communication/M.S.D.S. on site
- d. First aid kit and facilities
- e. Crew trained in first aid
- f. Emergency phone numbers posted
- g. Outside communications provided
- h. Safety equipment available
- i. Crew wearing hard hats and safety glasses
- j. Crew wearing hard-toed shoes (boots)
- k. Proper clothing worn by crew
- l. No hazardous jewelry worn
- m. NO SMOKING rules observed
- n. Accidents posted on OSHA or other incident log
- o. Ton miles logged _____
- p. Gas detector fully charged and sensors working
- q. B.O.P. drills, test logged _____
- r. Safety meetings logged _____
- s. Driller or competent person at or near controls
- t. Toolpusher/Rig Manager at rig location
- u. Approved and adequate lighting
- v. General Housekeeping

III. DRILLING FLOOR AREA
- a. Rotary table area
- b. Kelly bushing guard used
- c. Kelly Safety Controls adequate if no guard used
- d. Rotary chain drive guarded
- e. All unused floor holes covered
- f. Lighting
- g. Pipe / collar slips, dies, handles, pins, keepers
- h. Racking floor area
- i. Vee door gate provided - in place
- j. Makeup and breakout tongs
- k. Tong snubbing lines, clamps
- l. Tong counter weights (sheave assemblies)
- m. Tong body and jaws condition
- n. Tong safety handle pin secured
- o. Tong dies sharp, keeper used
- p. Air hoist line, guide, guarded
- q. Catheads surface smooth, anti-rope fouling device
- r. Catline(s)
- s. Kelly cock, wrench accessible
- t. Jerk and Spinning chain, headache post
- u. Breakout tong pull back cable, guide rollers
- v. Crown-O-Matic device, operating
- w. Drilling line
- x. Drawworks and overrunning clutch
- y. Driller's controls
- z. Hand tools
- aa. Drawworks Drum Drill Line Anchor secure
- bb. Drawworks Brake Linkage
- cc. Drawworks Guards
- dd. Proper electrical wiring provided as required
- ee. Fire extinguishers properly marked, inspected
- ff. Safety signs posted as needed
- gg. General housekeeping

IV. STAIRS, WALKWAYS, HANDRAILS, GUARDRAILS
- a. Adequate stairs provided off rig
- b. Stairs level, secure, no obstructions
- c. Adequate handrails provided (stairs)
- d. Stair treads uniform, of non-skid type
- e. Guardrails, mid-rails, toe boards
- f. Handrails used

V. SUBSTRUCTURE
- a. Safety Signs Posted as needed
- b. Approved and adequate lighting
- c. Substructure's beams and braces
- d. All assembly pins in place, secure
- e. Dead line properly anchored

VI. BLOWOUT PREVENTERS
- a. B.O.P. properly installed, tested
- b. Wheels and stems in place
- c. BOP Stack properly stabilized
- d. All hydraulic lines connected, no leaks/damage, & protected
- e. All unused lines capped
- f. Accumulator & Remote Control unit(s) properly located – Unobstructed
- g. Gauges properly located – in good condition
- h. Choke manifold and line, secured
- i. Blooey line used, pilot light used
- j. Approved wiring and lighting in use and adequate lighting
- k. Signage
- l. Scaffolding boards secured and in good condition
- m. Fall protection properly attached under rig floor protected clean
- n. BOP Remote control properly labeled and operating
- o. Fire extinguisher located near BOP Controls area
- p. Housekeeping, drainage

VII. PIPE RACK AREA
- a. Ends of pipe racks chocked
- b. Layers of pipe chocked, spacers used
- c. Pipe racks level, stable
- d. Pipe rack catwalk
- e. Stairs with hand rails provided
- f. Vee door slide, pipe stops used
- g. Pipe tubs and bindles
- h. Derrick stand and ladder
- i. Employees not on top of pipe
- j. Drilling line from anchor to spool elevated off the ground
- k. General housekeeping, lighting

VIII. DERRICK, DERRICK BOARD AREA & CROWN AREA
- a. Derrick ladder – good condition
- b. Derrick climber installed properly – good condition and used
- c. Climbing/Derrick board Safety Harness, safety catch
- d. Safety lines or lanyards used
- e. Derrick emergency escape line
- f. Derrick escape cart on line or escape assembly installed
- g. Pipe fingers and tools secured (finger safety line(s) attached)
- h. Standpipe(s) (mud, air, hydraulic, gas vent) secured
- i. Mud hose anubbed on both ends
- j. Derrick board & Stabbing board fall protection installed
- k. Derrick Board / Stabbing Board – good condition
- l. Derrick properly guyed if applicable
- m. Boom(s) and boom lines
- n. Sheaves & Shackles properly attached to the derrick (safety line(s) / clips attached)
- o. Approved and adequate lighting
- p. Derrick Crown Light operating and in good condition, secure
- q. Crown Saver blocks are in good condition & wrapped with expanded metal
- r. Handrails at crown in good condition
- s. Derrick, A-frame – pins in place, secured with keepers
- t. Elevators, bails
- u. Traveling Blocks, Top Drive, Swivel
- v. No loose ropes or other items in the derrick.
- w. General housekeeping

IX. MUD PUMP AREA
- a. Rotating Equipment, Drive Belts, Pony Rods guarded
- b. Head and valve covers fully bolted
- c. Shear pin pop-off valve covered/tested
- d. Ends of relief lines secured
- e. Ends of high pressure vibrator hose(s) anubbed
- f. Approved and adequate lighting
- g. Drip pans installed and cleaned as needed
- h. Tools & supplies stored in proper place
- i. General housekeeping

X. MUD MIXING AREA
- a. Bagged material properly stacked
- b. Caustic or acids properly stored separate from other materials
- c. Chemical mixing barrel
- d. Adequate personal protective equipment
- e. Signs posted & MSDS in mixing area(s)
- f. Adequate eyewash (shower) available
- g. Adequate ventilation in area
- h. Elevated loading door opening protected
- i. Approved and adequate lighting
- j. General Housekeeping

XI. MUD TANKS AND PITS
- a. Adequate stairs with handrails
- b. Walkways & guardrails in good condition
- c. Walkways free from obstruction/tripping hazards
- d. Gates seal, no leaks in tanks
- e. Adequate ventilation in area
- f. Guardrails provided on crossovers
- g. Approved adequate lighting
- h. Eye protection required warning signs
- i. Shale shaker belt & pulley drive guarded
- j. Desander, desilter, degasser units
- k. Explosive-proof equipment at shale shaker area
- l. Agitator shafts and couplings guarded
- m. Mud guns and jetting hoses secured
- n. General housekeeping

XII. GENERATOR AREA & ENGINE AREA
- a. Generators properly located
- b. All generator moving parts guarded
- c. Generators properly grounded
- d. Cover panels on electrical control boxes
- e. Electrical controls marked - lockout/tagout
- f. HIGH VOLTAGE warning signs used
- g. Insulating mats at electrical panels
- h. All electrical tools grounded
- i. Condition of electrical wiring
- j. Electrical wires properly strung
- k. Unused electrical outlets covered
- l. Air compressors properly guarded
- m. Air storage tanks equipped with pop-off
- n. Hearing Protection Signs Posted
- o. Hearing protection available & utilized
- p. S.C.R. house if available
- q. Lighting
- r. Engine drip pans installed in good condition
- s. General housekeeping

XIII. FUEL STORAGE TANKS
- a. Fuel storage tanks properly located
- b. All storage valves marked as to contents
- c. Discharge nozzles, hoses, valves
- d. Liquefied petroleum gas storage tanks
- e. Piping and fuel lines
- f. Stationary ladders on storage tanks
- g. NO SMOKING signs posted
- h. Tanks labeled as per hazard & contents
- i. Off road use only sign posted as needed
- j. Drip pans installed in good condition
- k. General housekeeping, lighting

XIV. FIRE PROTECTION
- a. Adequate fire extinguishers distributed around the rig and location, not obstructed
- b. Fire extinguishers fully charged, in good condition, current inspection
- c. NO SMOKING Signs posted as needed
- d. No open pit burning
- e. Flammables in U.L. safety cans
- f. Flare area clear of combustibles
- g. Boiler (air heater) and its safety controls
- h. Welding performed safely
- i. Fire Watch Posted
- j. Spark and heat arrester on engines

XV. SLEEPING QUARTERS/BUNK HOUSE
- a. Quarters / Bunk house clean & Orderly
- b. Restroom clean & sanitary, needed supplies available
- c. Smoke/Fire alarms available and working
- d. Food preparation area clean, food and dishes put away
- e. Fire Extinguishers available
- f. Two exits – unobstructed

Puna Unsatisfactory mark requires clarifying comment. _____

APPENDIX H
REPORTING CRITERIA

1. The Drill Site Manager (DSM) shall report day-to-day operations to the PGV Plant Manager.
2. Based on past experience at the Puna Geothermal Project, it is imperative that constant supervision of the well be accomplished once the drilling commences. PGV DSM's will be in charge of all activities on location.
3. DSM's will spend sufficient time together at the rig during change-out to exchange information on the current activities. The DSM's will be on the floor, on the pump truck, in the wireline unit, etc. for all critical operations.
4. The Drilling Engineer will be responsible for engineering programs with input from the DSM's. The Drilling Engineer will also advise and assist the DSM's.
5. Contractor's supervisors will report to the DSM on location. They will also be on the floor during all crew changes.
6. Reporting procedures for crews will be the responsibility of the contractor. Drillers will log all rig operations on the IADC daily tour report, including the depths of all work performed. Rig crew will assist service company personnel as directed by the contractor's supervisor. Standard kick and blowout drills should be conducted periodically; these drills should be noted on the tour sheets

APPENDIX I
DLNR RECOMMEDED PRACTICE FOR RUNNING A FORMATION-INTEGRITY TEST (FIT)

The following steps shall be taken in conducting a Formation-Integrity Test (FIT) to assess the ability of the formation around the shoe to withstand a desired minimum pressure and to ensure the mechanical integrity of the well.

1. Each casing depth needs to be specified in the drilling program; however, the actual depth of the casing shoe shall be dictated by the actual well conditions and not by the depth prescribed in the program or by a given length of pipe that is available at the site.
2. The shoe shall be set in competent formation, and the wellsite geologist shall be consulted about the competency of the formation where the shoe is to be properly set.
3. The shoe will be set as close as possible to the bottom of the drilled hole.
4. After cementing, the formation and the casing shoe will be tested, taking in consideration the following parameters:
    a. The shoe shall be drilled out to a minimum of 1 foot of formation (below any cement), or when the mud returns show 100% formation.
    b. Other than monitoring the mud returns, the ROP and WOB will be observed while drilling below the shoe, to determine if drilling is occurring in formation or cement.
5. The target pressure for conducting the FIT shall not be greater than the equivalent of a 0.65 psi/ft gradient.
6. The objective of the FIT is to assure that the formation can hold the highest anticipated Equivalent Mud Weight (EMW) for the next hole section, in case of a well-control event.

At any time during the drilling operation, the weakest point of the well would be at the bottom of the last cemented casing shoe. To ensure the best chance at improving the integrity of the well, the strength of the shoe should be a prime safety consideration in the construction of the well.