PUNA GEOTHERMAL VENTURE
CONTROL PROCEDURES FOR THE KS-8 WELL

A. Establish communication with the bottom of the hole with minimum flow restriction in the drill pipe.

1. Transported from Houston, Texas, one Cudd Series 150 Hydraulic unit. This included the base unit, BOPE, chokes, associated piping and approximately 4,000 feet of 1 1/4-inch tubing work string. It also included expendables of bits, mills and fishing tools.

   The equipment arrived by chartered aircraft on July 28, 1991.

2. With materials on site, the rig-up was completed July 30, 1991.

3. Operations to drill out of the HWDP and DC's, recover plug, and drill through the bit began July 31,1991.

CURRENT ACTIVITY

At the present the 1 1/4-inch tubing and recovery tools are stuck in the drill pipe at 2420 feet and limit communication with the bottom of the hole.

The tools will be recovered or the drill pipe will be snubbed out of the hole to establish communications with minimum flow restriction.

At this point, the drill pipe will be open to the bottom of the hole and in a position to kill the well with weighted mud.

B-I. WEIGHTED MUD KILL APPROACH

This approach will use large quantities of 11.5 ppg to 12.5 ppg mud to kill the well. Flow rates are as high as the equipment will provide. The following program details the steps to be taken.

Pump water down the drill pipe and casing to cool the wellbore. The following pumping schedule details the material to be pumped, the equipment to be used, the pump rate and the volumes.

1. DRILL PIPE PUMPING SCHEDULE

	Equipment	Material	Pump Rate	Duration	Volume
a.	Howco (Pump Trucks)	Water	2 bpm	30 min	60 bbl
b.	Howco	25 bbl CaCl2 5 bbl mud 25 bbl Super Flush 5 bbl mud 25 bbl CaCl2	3 bpm	22 min	85 bbl
c.	Howco	11.5 to 13.5 ppg mud	8 bpm	25 min	200 bbl
d.	Howco	11.5 ppg mud	6-8 bpm	cont.	360 bphr
			Continuously until decision		

Decision Point Based on Circulation

Option A Circulate kill weight mud

Option B Lose circulation

Drill Pipe Pumping Schedule Options

Option A: Circulate kill weight mud

e.	Howco	11.5 ppg mud	4-5 bpm	from pits

Establish Circulation

	Howco	11.5 ppg mud	4-5 bpm	from pits

When the pressure is killed

Howco	Water	as required	10 bbls
Howco	Cement Blend	as required	50 ft^3
Howco	Water	as required	10 bbls

Option B: Lose Circulation

e.	Howco	11.5 ppg mud	8-10 bpm

If unable to circulate

f.	Howco	11.5 ppg mud	6-8 bpm	as required
g.	Howco	Water	as required	60 bbls
h.	Howco	Sand plug	Mix 50 ft^3 sand in jet mixer	
i.	Howco	Water	as required	60 bbls

Followed by water to keep well cool

j.	Howco	Cement blend	as required	50 ft^3

Fill hole or keep water going down hole.

Note: Cement blend to be used to plug well:
Hawaiian Cement
40% SSA - 1
Perlite 1:1
4% Bentonite
1.5% CFR-3 NF
1.0% Diacel LWL
1.0% HR - 15

This blend was tested at 400 F and 5000 psi for 2:15 pumping time.

2. CASING ANNULUS PUMPING SCHEDULE

a.	Howco	25 bbl CaCl2 5 bbl mud 25 bbl Super flush 5 bbl mud 25 bbl CaCl2	3 bpm	22 min	85 bbl
b.	PDC 231 Rig pumps	11.5 ppg mud	8 bpm	25 min	200 bbl
c.	PDC 231	11.5 ppg mud	3 bpm or greater Attempt to maintain casing annulus fluid level		
d.	PDC 231	11.5 ppg mud	3 bpm Continuously until decision	180 bphr	

Decision Point Based on Circulation

Option A Circulate kill weight mud

Option B Lose circulation

Casing Annulus Options

Option A: Circulate Kill Weight Mud

e. Stop pump. Monitor annulus level and circulation. Circulate and condition mud through pits.

f. Hold drill pipe pressure constant with choke on the annulus until able to pump 11.5 ppg mud at 4 bpm with LCM. Set plug.

Option B: Lose Circulation

g. 11.5 ppg mud / 4 bpm / continuously / 240 bbl/hr / PDC 231
Unable to circulate. Set plug.

h. 11.5 ppg mud / 6 - 10 bpm / 360 bbl/hr / PDC 231
Followed by water if unable to fill hole.

B-II. HIGH RATE-LONG TERM WATER KILL APPROACH

This kill approach is based on pumping water at as high a rate as possible (on the order of 45 bpm) for as long as water can be supplied to cool, choke and kill the well. The following steps can be taken after the water well MW-3 is completed if the mud kill is unsuccessful.

Pump water down the drill pipe and casing to cool the wellbore and kill the well.

The following are prerequisites for the high rate long term water kill:

- drill and equip an additional water well for total continuous well supply of 34 bpm.
- lay 8-inch water pipeline from MW-3 to KS-8.
- install pumps and transfer lines from supplemental water storage.
- rig up frac truck, and high pressure 3-inch piping which are now in transit from the mainland by barge.

Establish water storage volumes as follows:

Parker Drilling 231	700 bbl
4 Baker tanks (475 bbl)	1900 bbl
Additional Parker tanks	1350 bbl
Parker 3 U Mixer tank	350 bbl
Total	4300 bbl

Reserve pit delivery rate and storage volume

Well pad D reserve pit	KS-8	5 bpm	3,000 bbl
Well pad F reserve pit	KS-7	5 bpm	5,000 bbl
Total		10 bpm	8,000 bbl

Water Source Delivery

Water well MW 1	6.0 bpm
Water well MW 3	28.0 bpm
Total	34.0 bpm

Pumping Capacity

Parker Drilling 231	
2-F1000 @ 120 stks	20.0 bpm
2 Halliburton Cementing Trucks	
4.5" liners at 4000 psi	12.5 bpm
1 Halliburton Frac Truck	
at 4000 bps	12.5 bpm
Total	45.0 bpm

Following are the high rate-long term water kill details:

1. Manifold pumping units to water supply and water storage system. Manifold the pumping head.

2. Allocate pumping flow rates to the drill pipe and casing.

3. Pumping schedule is as follows:

   a. Drill pipe 25 bpm (pressure limited)

   b. Casing 20 bpm

   This approach allows for pumping at 45 bpm for 17 hours. After 17 hours the rate will be reduce to a total of 30 bpm until a decision is reached.

4. When the well is turned, pump sand and water plug, mixed in the Howco mixers until a 50-foot and 100-foot sand plug is created in the wellbore.

5. Pump a 60 foot^3 cement plug on bottom. Wait on cement. Repeat as necessary.

C. SECURE WELL WITH CASING

The expected result of the above effort is that there is now a cement plug blocking any inflow from below 3150 feet. The remainder of this part of the program details the steps to be taken to place additional cement plugs in the well and case it.

1. Place Super Flush and foam cement plug across the 13 3/8-inch shoe zone if required.

2. Drill through the shoe plug and drill the top of the cement plug as necessary.

3. Run and cement liner and tie-back.

    a. Run 9 5/8-inch liner from above the 13 3/8-inch shoe to the top of plug.

    b. Cement liner.

    c. Drill out cement above liner. Test the lap joint and squeeze if required.

    d. Nipple down, cut off 13 3/8-inch 900 Series casing head.

    e. Install 13 3/8-inch 1500 Series casing head.

    f. Run 9 5/8-inch tie-back liner.

    g. Cement the tie-back liner to the surface.

    h. Install expansion spool and master valve.

    i. Nipple up BOPE. Test BOPE.

    j. Test 9 5/8-inch tie-back, drill out tie-back shoe and test 9 5/8-inch liner.

4. Now ready to drill out liner shoe.

    a. Drill out shoe.

    b. Perform leak off test and squeeze shoe as required.

5. Well secured.

William Paty, Chairman
Department of Land and Natural Resources
PO Box 621
Honolulu, Hawaii 96809

Dear Chairman Paty, September 24, 1991

We understand that Mr. Dewey Milner who has been contracted by the State to oversee the securing of the KS-8 well on the PGV project site, is at present stationed on the Big Island. May we request that you consider an addition to his contract before he leaves.

As you are aware, many of the wells on the PGV project site have at present and in the past problems with gas leaks, casing failures, and wellhead failures. Enclosed is our Inventory of Wells in the Lower Puna District outlining a history of each of the wells drilled, compiled from State and County records. In our discussions with several experts, including Bill Craddick, Butch Clark, Dr. Wilson Goddard, Bob Reynolds, and Dewey Milner, requesting a second expert opinion on the adequacy of the SOH casing program and the wellhead equipment is appropriate at this time.

Mediation was requested by Bill Craddick to revise the original proposed drilling and casing plan and was agreed to by Dr. Olson per the Mediators Report of 7/11/89. On May 9, 1990 Dr. Harry Olson requested an amendment in the drilling plan for the SOH program, citing cost considerations. This revised plan has been applied to SOH 2. At present this well is cased from 0-202' with a 9-5/8" K-55/40# and 0-1896' with a 7" J-55/23#. We have several concerns regarding this casing and wellhead assembly:

1. The formation into which the 9-5/8" casing is set is "broken and poorly consolidated" (2/4/91), hard and fractured (2/5/91), cave encountered requiring several redrills (2/6/91), drill from 148-200 feet with water and no returns. On 2/9/91 at 202', the hole was straight enough to see bottom with light, numerous enlarged areas in hole also visible. Bill Craddick has warned that the casing has to be firmly attached to a competent formation to help prevent the possibility of blowouts.

2. The 7" casing is set to 1896', a few feet above a severe dogleg which caused the drilling crew continual problems with collars shearing off. On 3/13/91 the 7" casing was cemented in without returns to the surface, "but pump pressure increased to 600 psi while pumping, indicating cement moving up annulus above DV tool." This dogleg is believed to be a fracture that would correlate with the intersection of a known fault located approximately 400 feet north of SOH2 if the fault plane dip is 75-80 degrees to the south. According to Planning Commission testimony .. Bill Craddick (p 88) expressed concerns about the project proposal that drilling into the fractures is the same as

drilling into the reservoir. He also indicated there are no valves on any of these wells that will take pressures of 2000 psi which can build up after they are capped.

3. The rock formation below 1896' was continually fractured, with drilling fluids migrating away from the hole. Another fault zone was hit from 4883-4940'with the formation described as fractured and sandy. There is no casing in this depth.

4. The temperature at SOH 2 exceeds 650 degrees, but no exact bottom hole measurement was taken. The deviation survey was only taken up to 5400', with the remainder 1402' to bottom estimated in a S/E direction.

As residents who live in proximity to the SOH 2 well we would be adversely affected by failures attributed to deficiencies in the drilling program. Contracting Dewey Milner to review and inspect the drilling program and the wellhead assembly would greatly allay our fears that there are these deficiencies that could threaten the safety of the well.

Sincerely,

ENC.

cc: Harry Kim
Murray Towill
Dr. H. Olson
Norman Hayashi

Jennifer Perry
Box 537
Pahoa, HI 96778
965-8699

Jane Hedtke
Box 937
Pahoa, HI 96778
965-7299

Jennifer Perry Jane Hedtke

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P. O. BOX 621
HONOLULU, HAWAII 96809

August 30, 1991

MEMORANDUM

TO: Mr. Eric Tanaka

FROM: Manabu Tagomori

SUBJECT: DLNR Consultant – Mr. Duey Milner

Mr. Duey Milner of Bakersville, California has been retained by the Department of Land and Natural Resources to serve as technical consultant on the KS–8 control program. Mr. Milner will represent the Department on the KS–8 project. His duties and responsibilities are:

- Inspect and monitor field operations of PGV for conformance with approved control plan
- Participate in PGV's meetings on implementing control plan
- If public health, safety, and welfare is eminent as determined by Mr. Milner, a stop order of all control activities shall be issued immediately. Mr. Milner shall immediately notify higher authorities to resolve the problems
- Prepare daily activity reports for the Department of Land and Natural Resources
- Prepare a final report at the conclusion of the control program

You are to assist Mr. Milner in keeping a 24–hour watch of activities at the well site, attend meetings with Mr. Milner, and to make your office available to him to operate from during his stay on the island.

Please give Mr. Milner all the courtesies and support he needs to complete the job successfully. If for any reason, you have any questions on your role in this project, please call me directly at 548–7533.

Thanks for your help and keep up the good work.

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

REF:WRM-BM

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

AUG 20 1991

Mr. Maurice A. Richard
Regional Development Manager
Puna Geothermal Venture
101 Aupuni Street, Suite 1014B
Hilo, Hawaii 96720

Dear Mr. Richard:

The Department of Land and Natural Resource (DLNR) has reviewed your plans for controlling and securing geothermal well KS-8 and has no objections to the proposed scope of work outlined in your program.

We fully recognize that as field conditions change, modifications to your proposed well control program may be required. Please be advised that our DLNR field representative shall be duly notified of any contemplated changes to the proposed program and our Division of Water Resource Management notified in writing of those modifications.

Additionally, we request that a brief daily update concerning the well control operations and planned activities for well KS-8 be added to the MW-3 water well status reports regularly sent by PGV to Hawaii County Civil Defense.

As requested, copies of the KS-8 quenching ("kill") program has been distributed to the Hawaii County Planning Department, Hawaii County Civil Defense, Department of Health, and the Department of Business and Economic Development and Tourism for review and comment. Please be advised that subject to the other agencies' review of this plan, additional follow-up meetings may be required to further discuss the current status of well KS-8 and the proposed steps to completely control the well.

Should you have any questions, please contact me, or in my absence, Mr. Manabu Tagomori, Deputy Director, at 548-7533.

Very truly yours,

WILLIAM W. PATY

cc: Harry Kim, Hawaii County Civil Defense
Rodney Nakano, Hawaii County Planning Department
Bruce Anderson, DOH

PUNA GEOTHERMAL VENTURE
CONTROL PROCEDURES FOR THE KS-8 WELL

A. Establish communication with the bottom of the hole with minimum flow restriction in the drill pipe.

1. Transported from Houston, Texas, one Cudd Series 150 Hydraulic unit. This included the base unit, BOPE, chokes, associated piping and approximately 4,000 feet of 1 1/4-inch tubing work string. It also included expendables of bits, mills and fishing tools.

   The equipment arrived by chartered aircraft on July 28, 1991.

2. With materials on site, the rig-up was completed July 30, 1991.

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The tools will be recovered or the drill pipe will be snubbed out of the hole to establish communications with minimum flow restriction.

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This approach will use large quantities of 11.5 ppg to 12.5 ppg mud to kill the well. Flow rates are as high as the equipment will provide. The following program details the steps to be taken.

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1. DRILL PIPE PUMPING SCHEDULE

	Equipment	Material	Pump Rate	Duration	Volume
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c.	Howco	11.5 to 13.5 ppg mud	8 bpm	25 min	200 bbl
d.	Howco	11.5 ppg mud	6-8 bpm	cont.	360 bphr
			Continuously until decision		

Decision Point Based on Circulation

Option A Circulate kill weight mud

Option B Lose circulation

Drill Pipe Pumping Schedule Options

Option A: Circulate kill weight mud

e.	Howco	11.5 ppg mud	4-5 bpm	from pits

Establish Circulation

	Howco	11.5 ppg mud	4-5 bpm	from pits

When the pressure is killed

Howco	Water	as required	10 bbls
Howco	Cement Blend	as required	50 ft^3
Howco	Water	as required	10 bbls

Option B: Lose Circulation

e.	Howco	11.5 ppg mud	8-10 bpm

If unable to circulate

f.	Howco	11.5 ppg mud	6-8 bpm	as required
g.	Howco	Water	as required	60 bbls
h.	Howco	Sand plug	Mix 50 ft^3 sand in jet mixer	
i.	Howco	Water	as required	60 bbls

Followed by water to keep well cool

j.	Howco	Cement blend	as required	50 ft^3

Fill hole or keep water going down hole.

Note: Cement blend to be used to plug well:
Hawaiian Cement
40% SSA - 1
Perlite 1:1
4% Bentonite
1.5% CFR-3 NF
1.0% Diacel LWL
1.0% HR - 15

This blend was tested at 400 F and 5000 psi for 2:15 pumping time.

2. CASING ANNULUS PUMPING SCHEDULE

a.	Howco	25 bbl CaCl2 5 bbl mud 25 bbl Super flush 5 bbl mud 25 bbl CaCl2	3 bpm	22 min	85 bbl
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c.	PDC 231	11.5 ppg mud	3 bpm or greater Attempt to maintain casing annulus fluid level		
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Decision Point Based on Circulation

Option A Circulate kill weight mud

Option B Lose circulation

Casing Annulus Options

Option A: Circulate Kill Weight Mud

e. Stop pump. Monitor annulus level and circulation. Circulate and condition mud through pits.

f. Hold drill pipe pressure constant with choke on the annulus until able to pump 11.5 ppg mud at 4 bpm with LCM. Set plug.

Option B: Lose Circulation

g. 11.5 ppg mud / 4 bpm / continuously / 240 bbl/hr / PDC 231
Unable to circulate. Set plug.

h. 11.5 ppg mud / 6 - 10 bpm / 360 bbl/hr / PDC 231
Followed by water if unable to fill hole.

B-II. HIGH RATE-LONG TERM WATER KILL APPROACH

This kill approach is based on pumping water at as high a rate as possible (on the order of 45 bpm) for as long as water can be supplied to cool, choke and kill the well. The following steps can be taken after the water well MW-3 is completed if the mud kill is unsuccessful.

Pump water down the drill pipe and casing to cool the wellbore and kill the well.

The following are prerequisites for the high rate long term water kill:

- drill and equip an additional water well for total continuous well supply of 34 bpm.
- lay 8-inch water pipeline from MW-3 to KS-8.
- install pumps and transfer lines from supplemental water storage.
- rig up frac truck, and high pressure 3-inch piping which are now in transit from the mainland by barge.

Establish water storage volumes as follows:

Parker Drilling 231	700 bbl
4 Baker tanks (475 bbl)	1900 bbl
Additional Parker tanks	1350 bbl
Parker 3 U Mixer tank	350 bbl
Total	4300 bbl

Reserve pit delivery rate and storage volume

Well pad D reserve pit	KS-8	5 bpm	3,000 bbl
Well pad F reserve pit	KS-7	5 bpm	5,000 bbl
Total		10 bpm	8,000 bbl

Water Source Delivery

Water well MW 1	6.0 bpm
Water well MW 3	28.0 bpm
Total	34.0 bpm

Pumping Capacity

Parker Drilling 231	
2-F1000 @ 120 stks	20.0 bpm
2 Halliburton Cementing Trucks	
4.5" liners at 4000 psi	12.5 bpm
1 Halliburton Frac Truck	
at 4000 bps	12.5 bpm
Total	45.0 bpm

Following are the high rate-long term water kill details:

1. Manifold pumping units to water supply and water storage system. Manifold the pumping head.

2. Allocate pumping flow rates to the drill pipe and casing.

3. Pumping schedule is as follows:

   a. Drill pipe 25 bpm (pressure limited)

   b. Casing 20 bpm

   This approach allows for pumping at 45 bpm for 17 hours. After 17 hours the rate will be reduce to a total of 30 bpm until a decision is reached.

4. When the well is turned, pump sand and water plug, mixed in the Howco mixers until a 50-foot and 100-foot sand plug is created in the wellbore.

5. Pump a 60 foot^3 cement plug on bottom. Wait on cement. Repeat as necessary.

C. SECURE WELL WITH CASING

The expected result of the above effort is that there is now a cement plug blocking any inflow from below 3150 feet. The remainder of this part of the program details the steps to be taken to place additional cement plugs in the well and case it.

1. Place Super Flush and foam cement plug across the 13 3/8-inch shoe zone if required.

2. Drill through the shoe plug and drill the top of the cement plug as necessary.

3. Run and cement liner and tie-back.

    a. Run 9 5/8-inch liner from above the 13 3/8-inch shoe to the top of plug.

    b. Cement liner.

    c. Drill out cement above liner. Test the lap joint and squeeze if required.

    d. Nipple down, cut off 13 3/8-inch 900 Series casing head.

    e. Install 13 3/8-inch 1500 Series casing head.

    f. Run 9 5/8-inch tie-back liner.

    g. Cement the tie-back liner to the surface.

    h. Install expansion spool and master valve.

    i. Nipple up BOPE. Test BOPE.

    j. Test 9 5/8-inch tie-back, drill out tie-back shoe and test 9 5/8-inch liner.

4. Now ready to drill out liner shoe.

    a. Drill out shoe.

    b. Perform leak off test and squeeze shoe as required.

5. Well secured.

PLANNING COMMISSION

COUNTY OF HAWAII

PUBLIC HEARING

Application of the Hawaii Natural Energy Institute and Research Corporation of the University of Hawaii for a Geothermal Resource Permit (GRP) to allow the drilling of three scientific observation holes for Hawaii's Scientific Observation Hole Program	TMK: 1-2-10:01; 1-4-01:2; and 1-4-02:32

TRANSCRIPT OF PROCEEDINGS

A public hearing was held at the County Building, Conference Rooms A, B, and C, 75 Aupuni Street, Hilo, Hawaii, on Tuesday, May 9, 1989, commencing at 5:05 p.m., pursuant to Notice.

Vice-Chairman Fred Fujimoto chaired the hearing.

BEFORE:

Andrea H. Vasconcellos,
Notary Public, State of Hawaii

APPEARANCES:

Gary Mizuno, Chairman
Fred Fujimoto, Vice-Chairman
Dennis Holt, Commissioner
Tommy Ishimaru, Commissioner
Mike Luce, Commissioner
Tom Poy, Commissioner
Nemesion Sanches, Commissioner
Marion Bush, Commissioner
Duane Kanuha, Planning Director
Fred Giannini, Office of Corporation Counsel

the residents due to environmental issues. Thank you.

MR. CHAIRMAN: Any questions from the Commissioners? Thank you. Bill Craddick.

MR. CRADDICK: Mr. Chairman, Counsel members. My name is Bill Craddick and I'm here just to express -- I want to say that I am for geothermal development, but I would just like to express some of my concerns for this project they have here.

I read the proposal, I think it was last March, February, I believe it was in February, and there was several things that concerned me about that. They planned on only setting 1,000 feet of casing, and I didn't see anything in there saying what type of cement they would use to cement it.

But we know that when you drill down deep -- in their proposal they said they said they were -- they said they weren't going to go into the reservoir, they said they were going to go into the fractures. Well, that is one and the same thing. If you are in the fracture, you are in the reservoir.

Again you get temperatures of 600-plus degrees. And so when you hit that those wells become very active, and you can't shut them down and walk away from them and say, well, you've capped them. They don't stayed capped. They build up pressures until they get up around 2,000 pounds. There is no valves on any of these wells that will take this kind of pressure.

Another thing is there is only a 1,000 feet of casing. It will break out under the casing and break out and come up through the formation. You will have to -- if you are going to go into those kinds of temperatures, you are going to have to put casing and cement into the reservoir to be safe.

I know the worst thing that could happen to us here is have a well like that and even if they drill it and they don't have any trouble and walk away from it, three weeks later it could be exploding. That's the worst thing that could happen to us if they have a well they can't control. That will be the last of the geothermal projects on the island if that happens.

So anyway those are my concerns that I think should be addressed. Some how there should be some control on that. Have them stop when they get to a certain temperature which would be around 300 degrees and still be safe. The well still wouldn't be active, but if they are going on down to where they are getting the high temperatures, then it is a whole different story. That's all I wanted to let you know. There are dangers the way it is set up at the present time.

MR. CHAIRMAN: Any questions from the Commissioners?

MR. LUCE: Mr. Chairman?

MR. CHAIRMAN: Yes, Mr. Luce.

MR. LUCE: You mentioned a concern for the type of cement used in the casing. Is there -- is Portland cement

necessary? I imagine --

MR. CRADDICK: You use cement, but it is a mixture.

MR. LUCE: Is there not a high-temperature cement?

MR. CRADDICK: It's a blended cement, a specially blended cement that you use for high temperature which will not -- normal cement will turn more or less to clay after the heat has been around it for some time.

MR. LUCE: So your concern is that the special blend for high temperatures is not --

MR. CRADDICK: It is not specified. I didn't see it in the proposal that I read, unless it changed since that time.

MR. LUCE: Thank you.

MR. CHAIRMAN: Commissioner Poy.

MR. POY: Yes, your knowledge of just what you spoke about. Can you tell us your experience in drilling?

MR. CRADDICK: I was involved in all the geothermal wells that have been drilled here on this island. And I understand what the problems are there.

MR. NAKANO: Mr. Chairman?

MR. CHAIRMAN: Yes.

MR. NAKANO: Just as a point of information. The drilling specifics that is being discussed at the present time, is an area that is regulated, again by the Department of Land and Natural Resources. And in addition to this Geothermal Resource Permit that we are considering here, the

primary consideration before the Planning Commission is the surface activities and that all of the specifics that we are dealing with below -- beneath the ground in terms of the depth to which the casing must be in place as well as the specifics of the kinds of cement that needs to be used, they are all specifics that are considered specifically in another permit.

MR. CHAIRMAN: So that will be taken care of?

MR. NAKANO: Supposedly, yes.

MR. CRADDICK: My understanding of their responsibility to the county is above ground and for the state is all below ground. What happens below ground soon becomes a problem ground. So you can't divorce the two and cut a line and say this is mine and that's yours. It can't be done. You have the problem once the well is going wild.

MR. CHAIRMAN: Rodney, will this be handled properly at a later date? Below ground?

MR. NAKANO: Yes. They will not be able to proceed beyond the stage where they are at without first securing this Geothermal Resource Permit from this Planning Commission.

MR. CRADDICK: Is there public hearing on that? For their state permit? There is no hearing on that at all?

MR. NAKANO: There is no -- it is an administrative permit that is dealt with by the Board of Land and Natural Resources. It is not a discretionary permit as in the case of this Geothermal Resource Permit.

MR. CHAIRMAN: So we will not have any hearing.

MR. LUCE: Mr. Chairman? Rodney is there a proposed condition in this staff recommendations that ties activities at SOH 1, 2, and 4 into this state permitting process that you are talking about that deals with subsurface requirements?

MR. NAKANO: It is a legal requirement for them to get this permit from the Department of Land and Natural Resources.

MR. LUCE: So which of the proposed conditions would then tie that in? Usually we have a condition that says the applicant will comply with all --

MR. NAKANO: With all -- yes.

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MR. LUCE: So that's our link?

MR. NAKANO: Yes.

MR. LUCE: Thank you.

MR. KANUHA: Mr. Commissioner, I have a question.

MR. CHAIRMAN: Yes.

MR. KANUHA: Mr. Craddick, in your drilling experiences for the other geothermal wells, has your operation already drilled down into the depths which result in the kinds of

temperatures, 600 degrees, that you have mentioned.

MR. CRADDICK: Yes.

MR. KANUHA: So what you're testifying before this Commission is based on your experiences --

MR. CRADDICK: Experience and what has happened, yes.

MR. KANUHA: Thank you.

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MR. LUCE: So it is a deep hole?

MR. CRADDICK: Yes.

MR. LUCE: Thank you.

MR. CHAIRMAN: Thank you, Mr. Craddick. Kaeo Jones. Will you state your name into the microphone please.

MASTER JONES: Good evening. My name is Kaeo Jones.

MR. CHAIRMAN: What's the first name?

MASTER JONES: Kaeo.

MR. CHAIRMAN: How do you spell it?

MASTER JONES: K-A-E-O. I'm in favor of clean energy such as solar, wind, ocean, or stream water. I'm not in favor of geothermal development. If the state wants to spend money please put it into educating young minds, our greatest

5/19/89 Hawaii County Planning Commission GRP-1

the residents due to environmental issues. Thank you.

MR. CHAIRMAN: Any questions from the Commissioners? Thank you. Bill Craddick.

MR. CRADDICK: Mr. Chairman, Counsel members. My name is Bill Craddick and I'm here just to express -- I want to say that I am for geothermal development, but I would just like to express some of my concerns for this project they have here.

I read the proposal, I think it was last March, February, I believe it was in February, and there was several things that concerned me about that. They planned on only setting 1,000 feet of casing, and I didn't see anything in there saying what type of cement they would use to cement it.

But we know that when you drill down deep -- in their proposal they said they said they were -- they said they weren't going to go into the reservoir, they said they were going to go into the fractures. Well, that is one and the same thing. If you are in the fracture, you are in the reservoir.

Again you get temperatures of 600-plus degrees. And so when you hit that those wells become very active, and you can't shut them down and walk away from them and say, well, you've capped them. They don't stayed capped. They build up pressures until they get up around 2,000 pounds. There is no valves on any of these wells that will take this kind of pressure.

Another thing is there is only a 1,000 feet of casing. It will break out under the casing and break out and come up through the formation. You will have to -- if you are going to go into those kinds of temperatures, you are going to have to put casing and cement into the reservoir to be safe.

I know the worst thing that could happen to us here is have a well like that and even if they drill it and they don't have any trouble and walk away from it, three weeks later it could be exploding. That's the worst thing that could happen to us if they have a well they can't control. That will be the last of the geothermal projects on the island if that happens.

So anyway those are my concerns that I think should be addressed. Some how there should be some control on that. Have them stop when they get to a certain temperature which would be around 300 degrees and still be safe. The well still wouldn't be active, but if they are going on down to where they are getting the high temperatures, then it is a whole different story. That's all I wanted to let you know. There are dangers the way it is set up at the present time.

MR. CHAIRMAN: Any questions from the Commissioners?

MR. LUCE: Mr. Chairman?

MR. CHAIRMAN: Yes, Mr. Luce.

MR. LUCE: You mentioned a concern for the type of cement used in the casing. Is there -- is Portland cement

necessary? I imagine --

MR. CRADDICK: You use cement, but it is a mixture.

MR. LUCE: Is there not a high-temperature cement?

MR. CRADDICK: It's a blended cement, a specially blended cement that you use for high temperature which will not -- normal cement will turn more or less to clay after the heat has been around it for some time.

MR. LUCE: So your concern is that the special blend for high temperatures is not --

MR. CRADDICK: It is not specified. I didn't see it in the proposal that I read, unless it changed since that time.

MR. LUCE: Thank you.

MR. CHAIRMAN: Commissioner Poy.

MR. POY: Yes, your knowledge of just what you spoke about. Can you tell us your experience in drilling?

MR. CRADDICK: I was involved in all the geothermal wells that have been drilled here on this island. And I understand what the problems are there.

MR. NAKANO: Mr. Chairman?

MR. CHAIRMAN: Yes.

MR. NAKANO: Just as a point of information. The drilling specifics that is being discussed at the present time, is an area that is regulated, again by the Department of Land and Natural Resources. And in addition to this Geothermal Resource Permit that we are considering here, the

primary consideration before the Planning Commission is the surface activities and that all of the specifics that we are dealing with below -- beneath the ground in terms of the depth to which the casing must be in place as well as the specifics of the kinds of cement that needs to be used, they are all specifics that are considered specifically in another permit.

MR. CHAIRMAN: So that will be taken care of?

MR. NAKANO: Supposedly, yes.

MR. CRADDICK: My understanding of their responsibility to the county is above ground and for the state is all below ground. What happens below ground soon becomes a problem ground. So you can't divorce the two and cut a line and say this is mine and that's yours. It can't be done. You have the problem once the well is going wild.

MR. CHAIRMAN: Rodney, will this be handled properly at a later date? Below ground?

MR. NAKANO: Yes. They will not be able to proceed beyond the stage where they are at without first securing this Geothermal Resource Permit from this Planning Commission.

MR. CRADDICK: Is there public hearing on that? For their state permit? There is no hearing on that at all?

MR. NAKANO: There is no -- it is an administrative permit that is dealt with by the Board of Land and Natural Resources. It is not a discretionary permit as in the case of this Geothermal Resource Permit.

MR. CHAIRMAN: So we will not have any hearing.

MR. LUCE: Mr. Chairman? Rodney is there a proposed condition in this staff recommendations that ties activities at SOH 1, 2, and 4 into this state permitting process that you are talking about that deals with subsurface requirements?

MR. NAKANO: It is a legal requirement for them to get this permit from the Department of Land and Natural Resources.

MR. LUCE: So which of the proposed conditions would then tie that in? Usually we have a condition that says the applicant will comply with all --

MR. NAKANO: With all -- yes.

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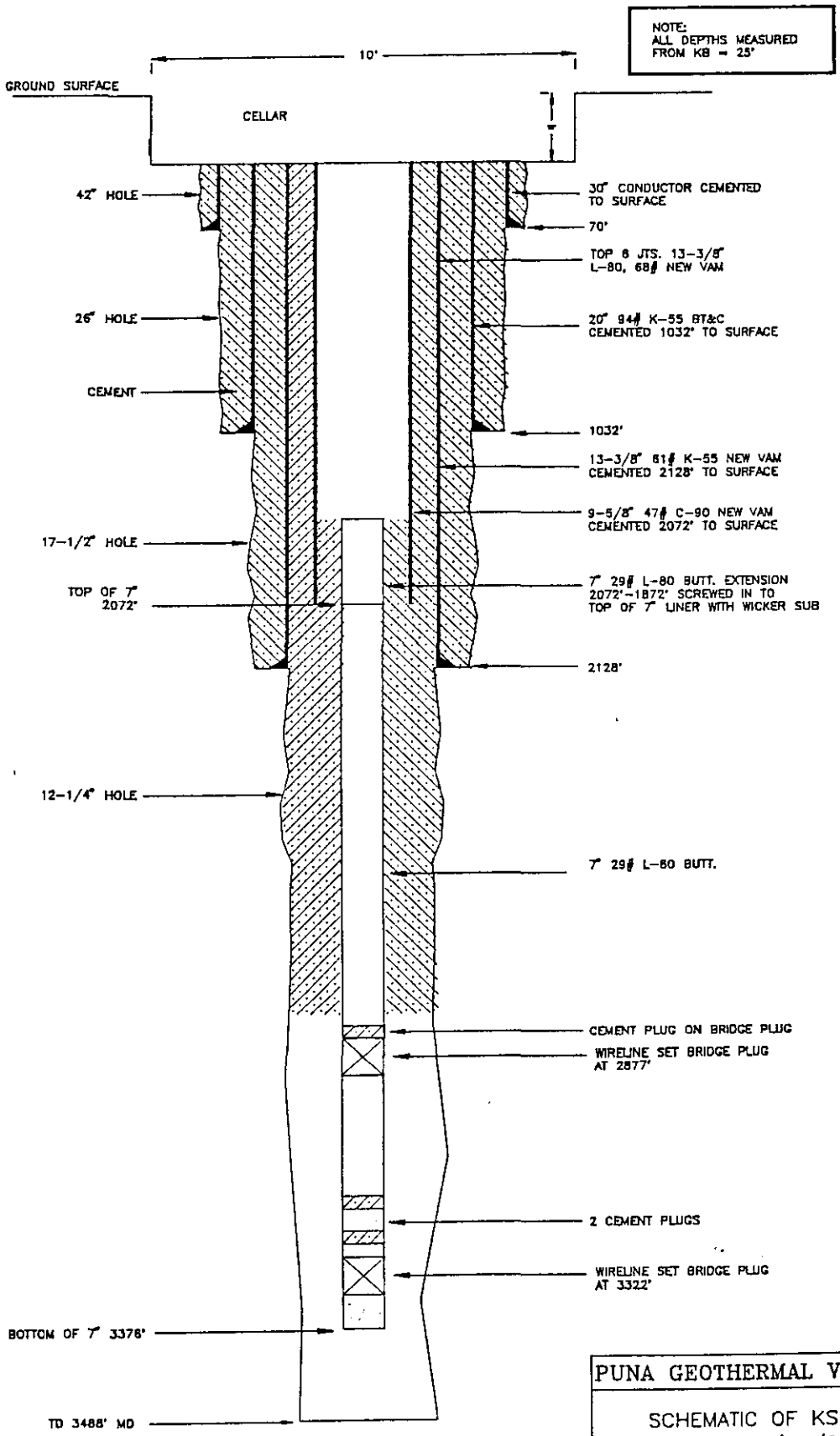

PUNA GEOTHERMAL VENTURE

SCHEMATIC OF KS-8
AS OF 9/26/91

DATE 9/23/91		REV. 1
BY W. TEPLOW	PGV\KS8STAT1	FIGURE NO. 9

Civil Defense Agency
920 Ululani St.• Hilo, Hawaii 96720 • (808) 935-0031 • Fax (808) 935-6460
Lorraine R. Ino
Mayor

doc0519L 08-30

PUNA GEOTHERMAL VENTURE
MW-3 AND KS-8 WELLS

This information is being provided to keep you informed on the operations of securing the KS-8 well at Puna Geothermal Venture's (PGV) Pohiki site.

The operations include two separate projects:

A. Water Well Project

1. Purpose

The mission of this water well is to make available approximately 1,200 gallons of water per minute for the purpose of securing and controlling Well KS-8.

2. Present Status

The drilling operations of the water well began on August 7, 1991, and was completed on August 30, 1991. The water well was flow-tested and meets the needs of this project. The drilling rig has been dismantled and removed from the site. The water lines connecting the water well to KS-8 have also been completed.

B. KS-8 Well Securing Project

It has been agreed by the private technicians and by PGV officials that Well KS-8 must be secured and controlled to ensure that no further uncontrolled emission of H2S occurs. To achieve this objective, the following actions are being taken:

1. PGV is pumping water into the well to keep things cooled and under control in preparation for securing the well.

2. The commencement of securing Well KS-8 will be on September 3, 1991 (approximately 8:00 a.m.). The project is divided into two main phases:

"KILL" PHASE

This phase involves the pumping of water at a high rate (1,000-1,200 gpm) to cool the well so as to enable the establishment of a plug that will prevent any inflow from below the 3,150 ft. level.

Commencement: September 3, 1991.
Completion: It is expected that this phase can be completed in two to three days.

Monitoring System

A command station will be established at the well site and will be monitored by PGV officials, state officials (Dept. of Health, Dept. of Land & Natural Resources) and private consultant (Dewey Milner) on a 24-hour basis.

Advisory

Noise

During this phase, noise levels are expected to increase but remain below the permitted levels at the boundary. During this phase, pumping operations (water, mud, cement) will be done by using mobile pump trucks with high horse power engines. The engines and other sources of noise will be shielded with noise blankets to minimize noise as best as possible.

a. Allowable noise levels for PGV:
   Daytime: 7:00 a.m. to 7:00 p.m.--55 DBA
   Nighttime: 7:00 p.m. to 7:00 a.m.--45 DBA

b. Noise levels shall not exceed the allowable noise levels for more than 10 percent of the time within any 20-minute period.

c. Allowable noise levels shall apply at any point along the boundary of the PGV project site, where potential noise impact on residences is anticipated.

Odor--H2S

The entire operation will be monitored to detect any emission of H2S. No venting of H2S is expected during this phase but Department of Health (DOH) personnel will be on site to monitor any possible emissions.

Lights

There will be no increase of lights at the project site.

"CASING" PHASE

Once the well has been cooled and plugged, cement casing of the well will commence.

The casing phase will begin once the well has been successfully cooled and plugged. The casing phase is expected to take approximately two to three weeks. No additional noise, lights, or emissions of any kind are expected during this final and securement phase but monitoring will be continued by Dept. of Health and Department of Land & Natural Resources personnel.

(todolist.91)

8/15/91

Manabu/Gordon:

Update of 8/14/91 meeting with DBED (M. Towill, M. Wong-Wilson, D. Anderson, J. Lesperance), DOH (B. Anderson, T. Arizumi, M. Ingoglia, J. Haruno, W. Nagamine, W. Sano), AG (C. Watanabe), DLNR (W. Paty, D. Nakano) regarding of implementation of the State Action Plan.

- o Tues. (8/20/91) at 8:30 am at DWRM, Room 227. State Task Force (DOH, DBED, DLNR) meeting (staff level) to finalize Action Plan for each agency. The State's Integrated Action Plan combining all agencies must be completed no later than Thurs. (8/22/91). Per Paty, Manabu to attend for DLNR. Need to confirm availability of conference room.

- o Tues. (8/20/91) at 1:30 pm at DBED, 11th Floor, Central Pacific Bank Bldg. State Task Force (Director/Division level) to meet with Hawaii County officials (B. Mizuno, H. Kim, R. Nakano) regarding joint State and County Action Plan. Per Paty, Manabu to attend for DLNR.

- o DLNR needs to look at hiring a "drilling" consultant to oversee geothermal operations and instruct staff. This should be done <u>before</u> Harry Kim/County decides to hire a consultant and chastise the State for not moving quickly enough or in a responsible manner. Need to determine scope of work and length of contractual period.

- o DLNR must prepare as soon as possible (before 8/22/91) a DLNR Action Plan which addresses the implementation of the Investigation Report's recommendations, the Asset Fund, Relocation, PGV's royalty waiver request and selection of a royalty calculation method, and Future legislation such as the need for statutory authority to direct HGP-A revenues to the Asset Fund. (See Agsalud memo, Anderson to Towill memo, and Tagomori to Paty memo for direction.)

  The DLNR Action Plan memo shall be prepared in the format provided by DBED (see DOH memo for example). The format will probably be as follows:

Part A: Those actions which must be undertaken by both the regulatory agency and the developer <u>before</u> resumption of drilling activity. The description of these action must include the following:

<u>Task/Action</u>	<u>Date</u>	<u>Cost/Source of Funds</u>	<u>Lead Agency</u>
(example)			
Revise Drilling/Casing program	ASAP	$0/ N/A	PGV
Revise permits	ASAP	$0/ N/A	DLNR

Part B: Those actions that can take place after drilling starts again.

Task/Action (example)	Date	Cost/Source of Funds	Lead/Support Agency
Hire staff	ASAP	$100,000/Unknown	DLNR

(Suggestion, for purposes of preparing the DLNR Action Plan, I would rewrite the memo from Tagomori to Paty and revise by adding completion dates for each task, estimated costs, etc. in the format instructed by DBED. Note: DBED has offered to assist DLNR in preparing the Action Plan.)

****

Update of recent (8/13/91) meeting with Hawaii County Civil Defense (Harry Kim), Mayor's Office (Barry Mizuno), DOH (Jerry Haruno and staff), County Planning Dept. (Rodney Nakano), DBED (Dean Anderson), and DLNR (Tanaka and Nakano) regarding water well MW-3 and control of well KS-8:

- Daily reports concering MW-3 and KS-8 activities prepared by PGV ~~will~~ be sent to all agencies thru Civil Defense Agency (CDA).

- Requirement for DLNR representation at weekly meetings in Hilo at the CDA office. All meetings scheduled for Tuesday at 10 am. Other agencies have been required to participate also.

- No decision has been made concering when the emergency proclamation status will be terminated. (i.e. When the bottom cement plug is set in KS-8, or after 9 5/8" casing is set, or after KS-7 is plugged, or even beyond ?)

- Harry Kim continues to question whether DLNR is capable and knowledgable enough to oversee the well control operations for KS-8. Kim and Mizuno repeatedly bring up the issue of hiring a consultant(s) to check on PGV operations who shall be paid by the State (i.e. DLNR) and not the County. County has indicated that if deemed necessary they will hire a consultant and try to tap the Governor's $1 million dollar emergency fund to pay for this expense.

- Harry Kim "requires" 24-hour monitoring by DOH for noise/air for the duration of the emergency which includes the water well drilling and well control of KS-8.

- A meeting with the County and DBED regarding the start-up of the SOH project did not go well. Although DLNR has no objections to DBED's plan to remove the plug in HGP-A and clean out the SOH holes, Harry Kim and the County had some concerns.

Presented below is a summary of things that are currently pending and which must be finalized as soon as possible:

GEOTHERMAL THINGS TO DO
(As of 8/15/91)

Note: Items are <u>not</u> listed by priority or in chronological order.

1) Finalize and process extension of primary 10-year term for geothermal resource mining leases R-1 and R-2.

2) Finalize and process extension of primary 10-year term for geothermal resource mining lease R-3. (Note: Land Mgt. will probably require AG review and approval of extension similar to that required for leases R-1 and R-2.)

3) Arrange for DLNR representative to attend regular State/County meetings scheduled every Tuesday at 10 am at the Hawaii County Civil Defense Headquarters in Hilo. These meetings concern the drilling of water well MW-3 and the well control operations for well KS-8, and will continue to be held until further notice. (Note: The next meeting has been rescheduled for Wednesday 8/21/91 at 10 am at Civil Defense in Hilo.)

4) Finalize Memorandum of Understanding (MOU) between DOH and DLNR authorizing DLNR to permit all geothermal wells (injection and production).

5) Decide on the hiring of consultants. Should discuss the consultant proposal submitted by Ralph Patterson and Associates. (Note: also received a call from Dick Whiting offering to assist DLNR in teaching staff and overseeing geothermal operations. The verbal offer included the following: A (2) man team comprised of Dick Whiting and Duey Milner who would alternate assignments on a 1-month on/1-month off basis whereby one member would be available at all times. Consultant rates are negotiable starting a $375/day plus expenses and airfare.) The other option to consider is the hiring of a consultant on a on-call basis, selection of that consultant to be determined.

6) Need to finalize DLNR "approval" of KS-8 well control program (reference 8/5/91 letter from PGV to Paty). Draft has been prepared stating that DLNR has no objections to the proposed plan, however, we should be aware of the concern of the County as it relates to DLNR's ability to properly regulate and monitor the operations. (Note: there is the strong possibilty that the County will hire its own consultant who may potentially contradict DLNR's "approval" of the PGV plan.)

7) Need to follow-up on Agsalud's Memo to DLNR (8/12/91) regarding on-going and planned activities and pay special attention to the timetables imposed by the memo. (See memo for specific details.)

HAWAII COUNTY'S COMMENTS

Proposed Action Plan
Geothermal Task Force

1. Action Plan needs to address all of the Investigator's recommendations including those not taken. For those recommendations not taken, rationale to support Task Force decision is required.

2. Noise and Air were combined by Reynolds and Goddard, but were reviewed separately by the CAB and NR resulting in sometimes conflicting recommendations. These conflicts need to be resolved.

3. UIC and DLNR review was similarly independent as evident by somewhat conflicting recommendations. These too need to be resolved.

ELEMENT I RECOMMENDATIONS

(1) Substantial changes in PGV's drilling procedures and supervision, (page 13-14)

1. NOT FOUND IN ACTION PLAN
2. See DLNR/Water (per investigation report) editing needed

(2) Several equipment modifications,

There are six areas which may have prevented the blowout

1. See DLNR/Water (per Tagomori memo) BOPE 1, 3
2. See DLNR/Water (per Tagomori memo) BOPE 2
3. See DLNR/Water (per Tagomori memo) Mud Pumps 1
4. See DLNR/Water (per Tagomori memo) Adequate water
5. See DLNR/Water (per Tagomori memo) Mud pumps 2
6. NOT FOUND IN ACTION PLAN

(3) Significant improvements in regulatory oversight.

There are five recommendations for improving oversight

1. See DLNR/Water (per Tagomori memo) Oversight 1
   See DOH Safe Drinking Water, UIC item C
2. See DLNR/Water (per Tagomori), item D 2
3. See DLNR/Water (per TAgomori), item E 1, E 2 for Reservoir Model

   See DLNR/Model (per Tagomori), Drilling BOPE and Casing Program items which conflict with "The casing program should be reviewed on a well-to-well basis, incorporating accumulated knowledge of the system.

4. See DLNR/Water (per Tagomori) Drilling Item C
5. See DLNR/Water (per Tagomori) Drilling Item D 1 which differs from recommendation.

RECOMMENDATIONS FOR SUPERVISORY PERSONNEL

See DLNR/Water (per investigation), drilling item A 1, also warning signals, item D 1.

Included in the Action Plan but not recommended:

1. DOH's UIC items A1, A2, and possibly A3
2. DLNR/Water (per Tagomori) Well oversight items D2, D3, D4, & D5.

ELEMENT II RECOMMENDATIONS

1. The DOH should complete a revised analysis of the hazard of an uncontrolled venting of the PGV Well. (NOT DISCUSSED IN ACTION PLAN)

2. DOH should complete a health review of the warning, alert, and emergency action levels for H2S. (NOT DISCUSSED IN ACTION PLAN)

3. DOH should complete a review of H2S monitoring capability and procedures for upset conditions. (NOT DISCUSSED IN ACTION PLAN)

4. Upon completion of 1 through 3 above the Hawaii State Emergency Response Commission and Hawaii County Local Emergency Planning Committee should review, revise and exercise the PGV Emergency Response Plan. (NOT DISCUSSED IN ACTION PLAN)

5. The Hawaii County Planning Department should resolve confusion over housing reimbursement and the function of the PGV employee alarm system.

RESPONSE

Paragraph 2's last sentence is incorrect, Condition 29 of the GRP states that the permittee shall bear all costs of evacuations caused by an emergency situation. Emergency Response Plan in Section 8.2 lists "Uncontrolled steam release from the reservoir containing H2S" as an upset condition requiring emergency response.

ACTION

Planning Department in conjunction with Civil Defense to work with PGV on clarifying evacuation housing reimbursement procedures.

Planning Department in conjunction with Civil Defense to work on procedures to inform community on evacuation procedures to minimize confusion.

6. PGV should review notification procedures and provide appropriate verbal and written notification to ensure compliance with the Emergency Planning and Community Right-to-Know Act of 1986. (NOT DISCUSSED IN ACTION PLAN)

ELEMENT III RECOMMENDATIONS

Reynolds Portion

2.1 Air Monitoring Network

1. The number of stations exceeds that necessary for compliance determination. (NOT DISCUSSED IN ACTION PLAN)

2. Unify the air monitoring efforts into a single comprehensive program managed and audited by the State, but which receives input and policy form a committee consisting of active environmentalists, industry and agency people. SPECIFIC ATTRIBUTES SUGGESTED (See DOH/CAB Sec A for some which have been included in Action Plan, Reynolds' list is more comprehensive)

   Also listed recommendation "Local firemen and other agencies likely to respond to a hazardous H2S event should have one or more safety systems for use with each responding crew which give numerical readout and audio alarm." (POLICE AND FIRE CREWS ARE EQUIPPED WITH----------)

3. Proposed station redistribution and possible reduction in number of stations. (See DOH/CAB Sec B, I(B) I(C) which conflicts with Goddard)

2.2 Geothermal Resources Permit and Noise Monitoring

1. One government office should be designated to receive and investigate complaints of noise. (Conflicts with statement on page 8 in section 2.3(2))

2. At least one mobile/portable unmanned monitor with shelter and modem access, that can be used at complainant homes is capable of determining compliance should be made available to Hawaii County or others. (NOT DISCUSSED IN ACTION PLAN)

3. Spot checks should be performed more frequently by an agency staff to add credibility. More frequent site inspections of PGV's effort and periodic comparison of calibrators could also add to the credibility and acceptance of the noise monitoring program. (See DOH/NR Sec A item I(B)1.

4. The present noise standard should be evaluated for effectiveness by reviewing all complaints and their resolution. Typically, noise assessments for source and BACT determinations are specialized. The Planning Director should, if he believes it is necessary, seek expert opinion

Coordinator

on BACT assessments from an independent consultant paid for by PGV but contracted with and reporting to the County. (GEOTHERMAL [redacted] JOB SPECS COULD WRITTEN TO REQUIRE OVERSEEING THIS FUNCTION FOR HAWAII COUNTY)

5. The monitoring effort should be directed to resolve complaints and identify source problem solutions. (See DOH/NR Sec A II(A)1-3)

6. There is too great an emphasis on monitoring sound and part of this effort is recommended to be directed at specific noise identification. (See DOH/NR Sec A, III(A)1-3))

7. Determination of BACT should be sensitive to the worker safety aspects, and not allow early choices of equipment to dictate subsequent noise control steps that unreasonably create a choice between a safety and noise problem. (NOT SPECIFICALLY INCLUDED IN ACTION PLAN, perhaps Geothermal Coord. [redacted] work could include this assignment)

2.3 Permit and Compliance Review Recommendations

1. The 100 ppbv one hour average limitation (AAQS) be evaluated from the experience of this incident and review. Evaluations of remaining health complaints should be performed by DOH as promptly as practical.(NOT DISCUSSED IN ACTION PLAN)

2. One government office designated to receive and investigate noise and air quality complaints believed to result from the project. The present practice of recording tape messages, reading back and referring complaint directly to PGV should cease. (See DOH/CAB Sec A II(B)1 which is in variance with DOH/NR Sec A II(A)1).

3. Resource characterizations required under Condition 20 of the ATC be performed as soon as practical and evaluated on a timely basis to better understand and estimate emissions, and determine if project design problems may result from any unexpected resource characteristic. (MAY NOT BE COVERED BY ACTION PLAN)

4. DOH staff should, actively participate in source tests, and develop the ability to independently quantify H2S emissions during drilling, stacking, and uncontrolled or controlled venting. Specifically, the following is also recommended for timely consideration.

   Measurement characterization of drift and trace toxics contained in particulate and gas phase must be performed during emission release events until such time as they are well documented and established. (NOT DISCUSSED IN ACTION PLAN)

   An emphasis should be placed on developing an accurate

and comprehensive emissions inventory and geothermal resource chemical constituent database specific to the project and individual wells. (NOT DISCUSSED IN ACTION PLAN)

Emissions limits and/or technology development and application to all known emission points based on BACT should be further developed, and tested for performance under good dispersion conditions before needed (start with the stacking control system). (NOT DISCUSSED IN ACTION PLAN)

The possible need and advisability of air drilling should be investigated and the restriction removed from the ATC permit if necessary to provide safety in drilling. (NOT FOUND IN ACTION PLAN)

The need to factually determine whether a pressure surge (gas pressured) from the bottom of the hole in the reservoir, or water/mud hammer, caused the "explosions" is critical to potential risk, and DOH staff should seek an expert final opinion explained to their satisfaction. (NOT FOUND IN ACTION PLAN)

The maximum accidental exposure to those in close residency should be re-evaluated, and where concern exists, the individual resident be educated as to risks, made aware of any bad circumstances or risky operations as early as possible, and given whatever assurance possible about DOH resolve to protect their air quality. (NOT DISCUSSED IN ACTION PLAN)

Goddard Portion

6.0 RECOMMENDATIONS

1. Emissions limits for H2S be vigorously and rigidly enforced by DOH personnel. (See DOH/CAB(Sec A) item II(B)2)

2. A Puna Air Monitoring Program (PAMP) be formed managed by DOH with participation by the developer, the local agencies, State agencies, local concerned organizations and local concerned citizens. (See DOH/CAB(Sec B) item II(B))

3. Modify station positions and install additional meteorological monitoring equipment and sites to further study the geothermal air pollution meteorology of the location and zone of impact as shown in Figure 6-1. Each of the station changes should be done sequentially starting with the present stations farthest from the PGV site. (See Reynolds 2.1(3) apparent conflict; DOH/CAB Sec B items I(A-C)

4. PAMP manage local and regional air transport studies in future geothermal explorations areas before initiation of geothermal development. (See DOH/CAB Sec B Goddard recomm)

5. The PAMP committee should quality assure monitoring data, document all quality assurance procedures and publish sufficient volumes of the monitoring documents that developers, engineers and environmental scientists have access to the documents. (See DOH/CAB Sec B Goddard recomm)

Included in the Action Plan but not recommended:
Two additional field personnel requiring $120,000. (See DOH/CAB Sec B I(D))

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER RESOURCE MANAGEMENT
P. O. BOX 373
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIR
BOARD OF LAND AND NATURAL F

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
DAN T. KOCHI

AQUACULTURE DEVELOPMEI PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMEN
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER RESOURCE MANAGEMENT

MEMORANDUM

TO: Mr. William W. Paty, Chairperson

FROM: Manabu Tagomori, Deputy Director

SUBJECT: Element I Investigation Report on the Puna Geothermal Venture Unplanned Steam Release of June 12, 13, 1991, Puna, Hawaii

Outlined below are some specific comments related to the findings and recommendations of the investigative report and suggestions concerning the implementation of those recommendations:

Comments on Element I Recommendations and Preliminary Follow-up Actions Proposed by DLNR:

1) Recommendations for equipment modifications and additional equipment (pg. 14).

Comments/Recommended Actions:

a) Aside from the recommendation for a larger flow relief line from the BOPE stack and the use of a cyclonic muffler, the existing BOPE for KS-8 was satisfactory. However, the BOPE can be improved by requiring an additional double gate preventer in the stack.

b) Implementation of the recommended BOPE modifications can be done immediately. The approved drilling and casing programs for the Geothermal Well Drilling Permits previously issued, but not drilled, will need to be modified (i.e. KS- 4,5,6,9,10,11).

PGV will be required to to submit a revised drilling and casing program for these wells to DLNR for review and approval. The revised drilling and casing programs should incorporate all applicable BOPE and equipment modifications recommended in the report.

c) Modifications to existing mud pumps and the addition of another mud cooler or the use of a more efficient mud cooling system, including a monitoring device for the driller should be implemented. Appropriate amendments to the current Plan of Operations addressing these recommended changes should be submitted by PGV to DLNR for review and approval.

d) The recommendation for an adequate water supply should be enforced. The Plan of Operations should also be amended to incorporate the drilling of an additional water well supply. (Note: A Well Construction and Pump Installation permit was issued on 8/1/91. However, the long term use of the water from MW-3 (beyond the immediate use for well control of KS-8) must be determined. In following with the investigation report's recommendations, an adequate supply of water for operational needs must be established.)

2) Recommendations for State Regulatory Agencies (pg. 15).

Comments/Recommended Actions:

a) In response to the recommendation for better regulatory oversight and control, a Memorandum of Understanding (MOU) between DLNR and DOH must be finalized whereby all geothermal wells (production and injection) will be permitted by DLNR.

This MOU should provide DLNR with lead status in reviewing for approval all drilling and casing programs, including the monitoring and inspection of geothermal wells. Should any geothermal well be proposed for use as an injection well after being initially permitted by DLNR, the operator will be required to apply for and secure the appropriate approval from DOH for the construction and operation of the well for injection/disposal purposes. If such an injection well is permitted by DOH, monitoring of injection operations shall be the responsibility of DOH.

b) With specific regard to the complete control of injection well KS-8, establishment of DLNR as the lead agency for regulating the "kill" operations for the well (including any required drilling) must be finalized. As such, DOH has been requested to prepare a memorandum agreeing to the transfer of regulatory authority to DLNR for the control/drilling operations of KS-8 and related technical review.

c) Concerning the pending application for a Geothermal Well Drilling Permit submitted by PGV to DLNR to permit injection well KS-8 as a production well, it is recommended that the application be deemed incomplete and

immediately returned to PGV for revision and re-submittal.

The applicant should be advised that all applicable BOPE recommendations described within the Element I investigation report should be incorporated within the revised drilling and casing program submitted to DLNR for approval. It is further recommended that the issuance of a DLNR geothermal well drilling permit for KS-8, if deemed appropriate, occur only after the well has been secured and total control has been established.

d) Implementation of the Element I report's recommendations regarding BOPE and casing requirements, as well as recommendations for drilling of the upper portion of the well from the surface to 2000' (pg. 13), can be done immediately. All future geothermal drilling operations will be required to follow these procedures and must be addressed in all permit applications submitted to DLNR for approval.

e) Since DLNR is currently amending its administrative rules on the leasing and drilling of geothermal resources (Chapter 13-183), revisions can be incorporated such that specific BOPE requirements and procedures are deleted from the rules and placed in a manual as recommended by the investigation report.

A Blowout Prevention Manual similar to that published by the California Department of Conservation, Division of Oil and Gas, can be drafted by DLNR for Hawaii geothermal operations.

As recommended in the investigation report, this manual together with a draft of DLNR's revised rules can be transmitted to the National Geothermal Drilling Organization (NGO) and the American Society of Testing of Materials (ASTM) for review and comment.

f) The report's recommendation concerning flexibility on the part of the regulatory agency already exists within DLNR's regulation and monitoring of daily geothermal operations. (It should be noted that the recommendation for a mechanism in the regulator/operator relationship to make onsite judgement calls regarding changes to the casing program or drilling operations applies specifically to the DOH regulation of injection well KS-8.)

The procedure for accepting, amending, or denying a proposal for modification in a timely manner (i.e. by sundry notice) is currently exercised by DLNR through our geothermal technician who monitors operations on a daily basis.

g) The recommendation for review and approval of casing programs on a well-to-well basis already takes place under DLNR procedures but apparently not

under DOH's UIC regulations as in the case of KS-8. The net effect of the recommended MOU between DLNR and DOH will provide for DLNR involvement in the casing approval process for injection wells.

h) The report also states that DLNR should be advised of any changes in the model of the geothermal reservoir, and should be concurrently developing their own model. Such data accumulation and analysis by DLNR is currently taking place.

An example of this effort is DLNR's participation in the adhoc Geothermal Technical Advisory Committee (GEO-TAC). One of the objectives of the GEO-TAC is the evaluation of geothermal resource data and the development of a management strategy for the resource.

Also attached for your information is a chronology and outline of the well drilling permits issued for the Puna Geothermal Venture (PGV) project.

PGV PROJECT STATUS
(As of 8/5/91)

GEOTHERMAL WELLS DRILLED BY PGV (as of July 1991):

Production Wells (Permitted by DLNR)

Kapoho State 1 (1981)
Kapoho State 2 (1982)
Kapoho State 1-A (1985)
Kapoho State 3 (1991)

(Note: per PGV, KS-3 is being proposed as an injection well, to date no application for a Well Modification Permit to change KS-3 from production to injection has been received by DLNR.)

Injection (UIC) Wells (Permitted by DOH)

Kapoho State 7 (1991)
Kapoho State 8 (1991)

(Note: Received PGV application on 6/4/91 to permit KS-8, "after the fact", as a production well. The application for a Geothermal Well Drilling Permit is currently under review by the Department. It should also be noted that a "blanket" Authority to Construct (ATC) Permit is issued by DOH for both production and injection wells. The ATC permit authorizes the construction of 14 wells.)

DLNR GEOTHERMAL WELL DRILLING PERMITS ISSUED (but not drilled):

Production Wells

Kapoho State 4 (issued 6/13/90, Planned for the Parker Drill Rig).

(Note: As of 7/1/91, KS-4 being proposed for use as an injection well. To date, no application for a Well Modification Permit to change from production to injection has been received by the Department.

Kapoho State 5 (issued 6/13/90, Planned for the Parker Drill Rig).

Kapoho State 6 (issued 6/13/90, Planned for the Parker Drill Rig).

Kapoho State 9 (issued 5/23/91, Planned for the True Geoth. Rig).

Kapoho State 10 (issued 5/23/91, Planned for the True Geoth. Rig).

Kapoho State 11 (issued 5/23/91, Planned for the True Geoth. Rig).

PENDING APPLICATIONS FOR DLNR GEOTHERMAL WELL DRILLING PERMITS (i.e. production wells):

Kapoho State 7-A (Received 6/12/91).

(Note: According to PGV's Plan of Operations (amended 5/23/91), KS-7A was originally proposed as an injection well.)

Kapoho State 12 (Received 6/12/91).

Kapoho State 13 (Received 6/12/91).

PENDING APPLICATION FOR DLNR WATER WELL CONSTRUCTION AND PUMP INSTALLATION PERMIT: For Water Well MW-3 (Received 7/10/91).

(Note: Proposed location is near existing well MW-1, target depth 700', proposed pump capacity 1200 gpm (1,728,000 gal/day).)

Well Construction and Pump Installation Permit issued 8/1/91.

(Note: Additional noise/lighting mitigation programs and a communications plan have been approved by the State and County - i.e. DOH, County Planning Department, and Hawaii Civil Defense.)

PERMITTING CHRONOLOGY FOR KS-7:

DOH (UIC) Approval to Construct Injection Well KS-7 issued 3/16/90.

(Note: DOH permit is a "blanket approval" to construct up to (3) dedicated injection wells.)

No DLNR Geothermal Well Drilling Permit was issued for KS-7.

Parker Drilling Co. started drilling KS-7 on 1/30/91.

KS-7 blowout incident occurred on 2/21/91.

PGV request for authorization to plug and suspend KS-7 received by DLNR on 2/25/91.

DLNR Geothermal Well Modification Permit issued to PGV on 3/13/91 authorizing the setting of a cement plug in the wellbore from a depth of 740' to 1277'.

KS-7 operations currently suspended, weekly monitoring of well being conducted by PGV and data submitted to DLNR.

PERMITTING CHRONOLOGY FOR KS-8:

DOH (UIC) Approval to Construct Injection Well KS-8 issued 3/16/90.

(Note: DOH permit is a "blanket approval" to construct up to (3) dedicated injection wells.)

No DLNR Geothermal Well Drilling Permit was issued for KS-8.

Parker Drilling Co. started drilling KS-8 on 5/2/91.

PGV application for a Geothermal Well Drilling Permit for KS-8 submitted to DLNR on 6/4/91 (i.e. to permit injection well KS-8, "after the fact", as a production well). The PGV application was under review by DLNR at the time of the blowout.

KS-8 blowout incident occurred on 6/12/91.

All PGV operations currently suspended.

Internal Review Only (9/15/91)

August 12, 1991

MEMORANDUM

TO: Murray E. Towill

FROM: Dean Anderson, Gerald Lesperance

SUBJECT: COMPILATION OF RECOMMENDATIONS FROM INVESTIGATION REPORTS

Element I - Drilling

Explicit Recommendations

1. Recommendations for Supervisory Personnel:

   * A mechanism should be established allowing the operator to request and the on-site regulator to approve specific well design modifications during drilling operations. (p.13).

   * Supervisory personnel should be present on the rig floor while all drilling is taking place and especially during crew tour changes to be sure the crew coming on tour is instructed and advised of any special instructions. (p.13).

   * All blowout prevention drills and operations of BOPE should be noted on the A.I.D.C. tour reports. (p. 16).

   * All toolpushers, drillers, and derrickmen should be schooled in the use of the recommended monitoring equipment. (p. 16).

2. Recommendations for Upper Portion of Well (Surface to 2000'):

   * Operators should be conservative and flexible in their approach to casing the well above 2000'. p. 13).

   * If the operator must drill below 500' without BOPE, he should: (a) run maximum bottom hole temperatures every connection; (b) take representative water samples and; (c) catch cutting samples every 10 feet and analyze. If it appears that a geothermal zone may be encountered soon, the

operator with approval of the DLNR, should be prepared to run casing, cement, and rig up with appropriate blowout protection. (p. 14).

3. Recommendations for equipment modifications and additional equipment:

* A larger diverter line (13-3/8") is needed to provide flow relief from the BOPE stack. The relief line should have a low pressure burst plate to automatically divert the flow so that the crew is able to secure the well. An additional double gate preventer should be included in the stack. (p. 14).

* At the discharge end of the 13 3/8" diverter line a silencer or muffler should be installed to reduce noise (p. 14).

* The mud pumps should be equipped with the maximum sized pump liners and should be used at maximum stroke when attempting to control a kick. (p. 14).

* Facilities for a cool water supply, sufficient to kill a kick in a large diameter hole, should be on location at all times while drilling. (p. 14).

* Either a larger mud cooler should be installed or another mud cooler should be added to the system. (p. 14).

* A monitoring device should be installed to give the driller quicker information regarding any downhole pressure changes. A pit alarm system should be included with this monitoring device to give the driller a chance to react to any changes and to allow the crew to operate the blowout prevention equipment to secure the well. (p. 15).

4. Recommendations for State Regulatory Agencies:

* DLNR and DOH should come to an agreement to jointly provide oversight and regulatory control over the drilling of all wells regardless of whether they are intended as injection or production wells. One possibility is or the agencies to enter into an MOU providing for DOH lead status in UIC review and DLNR lead status in drilling program review and inspection of all wells. (p. 15).

* There should be a mechanism in the regulator/operator relationship whereby the operator is permitted to make judgment calls to modify his casing program or drilling operations as required, and the regulatory agency should be prepared to accept, amend, or deny the proposal in a timely manner. What is needed is flexibility coupled with extreme vigilance because fluids and pressure may be found where not previously predicted. (p. 15).

* DLNR should be more involved in the casing approval for all wells. The casing program should be reviewed on a well-to-well basis, incorporating accumulated knowledge of the system. DLNR should also make sure that they are advised of any changes in the model of the reservoir and should concurrently be developing their own model. (p. 15).

* DLNR should minimize specific BOPE and casing requirements in the administrative regulations. Specific descriptions of BOPE and procedures could be placed in a manual and updated regularly. DLNR should allow flexibility in its requirements for BOPE and casings. These requirements should allow for modifications during drilling case-by-case based on local variations in geology and reservoir conditions (p. 16).

* The State of Hawaii should contact the National Geothermal Drilling Organization (NGO) and the Amercian Society of Testing of Materials (ASTM), ask for a review of current operations, and work toward establishing equipment and procedures standards for drilling geothermal wells in the state. (p. 16).

Implicit Recommendations

* "Killing" of KS-8 should be completed as soon as possible to avoid a possible surfacing of steam and fluids. The recommended method is to pump down cold water in large quantities (1,200 to 1,500 gals. per minute) for a day or two. (James Moore, oral comments - 7/24/91).

* Operators should be alert to warning signals such as: continuous flows of driling mud out of the wellbore; gains in mud volume while pulling stands; gas entries while circulating muds bottom up; and lost circulations below casing shoes. (Executive Summary).

* Operators should carefully weigh the benefits versus the potential problems when using heavy mud.

Element II - Emergency Response Plan

Explicit Recommendations

* DOH should complete a revised hazard analysis based on the uncontrolled venting of KS8. All H2S data from the incident should be compiled and reviewed. The revised hazard analysis should be included in the PGV Emergency Response Plan and should address horizontal venting. (p. 11).

* DOH should complete a health review of the warning, alert, and emergency action levels for H2S. These levels should be reevaluated for their adequacy as they relate to nuisance and to health effects for sensitive individuals. Other stressors such as noise and other pollutants in the well stream should be included in the review, which should also address possible HFD rescue of affected workers at the well site. (p. 11).

* DOH should complete a review of H2S monitoring capability and procedures for upset conditions. Timeliness of PGV monitoring at the site should be addressed. Specific monitoring by DOH and HFD should be considered. (p. 11).

* Upon completion of the foregoing (three) recommendations, PGV should update its Emergency Response Plan for review and exercise by the Hawaii State Emergency Response Commission and Hawaii County Local Emergency Planning Committee. The plan should be exercised (?) annually. (p. 11).

* The Hawaii County Planning Department should resolve confusion over temporary housing reimbursement, the applicability of the 3500' buffer zone, and the function of the PGV employee alarm system. The community should be informed of the outcome of this review. (p. 12).

* PGV should review its notification procedures and provide appropriate verbal and written notification to ensure compliance with the Emergency Planning and Community Right-to-Know Act of 1986. (p. 12).

Implicit Recommendations

* Hydrogen sulfide hazard analysis should include horizontal as well as vertical venting.

* An investigation should be conducted into the adequacy of procedures and personal protection equipment used by HFD and others to rescue injured personnel during a venting.

* The government's emergency response monitoring capability should be evaluated.

* Training is needed of HPD, HFD and DOH personnel concerning the hydrogen sulfide hazards to residents and themselves.

Element III, Part I

Explicit Recommendations (Air Quality)

* If the background level of H2S is consistently near zero, as it appears to be, the use of background monitoring equipment should be discontinued. The cost savings should be applied to source control and evaluation and to acquiring high quality portable field monitors. The number of stations (7) exceeds that necesary for compliance determination. (pp. 4-5).

* Air quality monitoring efforts should be combined into a single comprehensive program managed and audited by the State. A committee consisting of active environmentalists and industry and agency representatives should provide input and make policy. (p. 5, p. 12).

* The monitoring program should be expanded to verify the concentrations of other potentially toxic pollutants. (pp. 4-5).

* Each permanent H2S air monitoring station should have a meterological measurement system and remote access (modem) capability incorporated. (p. 5).

* A uniform, functional, short as possible, sampling intake, manifold, and monitor intake line should be used and cleaned regularly. (p. 5).

* A multi-sensor, 30 to 40 meter, meterological tower should be added at the Irvine site. (p. 5).

* A quality assurance program should be implemented at all stations with independent DOH staff performing quarterly audits. (p. 5, p. 12).

* Two additional field portable H2S monitors (Jerome equivalent) should be made available and properly maintained by the developer for use by DOH or other responding agency. (p. 6).

* Local firemen and other agencies likely to respond to a hazardous H2S event should have, for use by each responding crew, one or more safety systems which give numerical readouts and have an audio alarm. (p. 6).

* Monitoring stations should be maintained and upgraded as indicated on page 6, Part I of the Element III Report.

* Monitoring stations should be relocated or discontinued as indicated on page 6, Part I of the Element III Report. Only one station should be relocated at a time. (p. 6).

* The 100 ppbv one hour average limitation (AAQS) should be evaluated based on experience from this incident. (p. 8).

* Resource characterizations required under Condition 20 of the ATC should be performed as soon as practical and evaluated on a timely basis to better understand and estimate emissions. (p. 8).

* Evaluations of remaining health complaints should be performed by DOH as promptly as practical. (p. 8).

* DOH staff should actively participate in source tests and develop the ability to independently quantify H2S emissions during drilling, stacking and uncontrolled or controlled venting. (p. 8).

* The possible need and advisability of air drilling should be investigated and the restriction removed from the ATC permit if necessary to provide safety in drilling. (p. 9).

* The need to factually determine whether a pressure surge (gas pressured) from the bottom of the hole in the reservoir, or water/mud hammer, caused the "explosions" is critical to potential risk, and DOH staff should seek an expert final opinion explained to their satisfaction. (p. 9).

* The maximum accidental exposure to those in close residency should be evaluated, and where concern exists, the individual resident be educated as to risks, made aware of any bad circumstances or risky operations as early as possible, and given whatever assurance possible about DOH resolve to protect their air quality. (p. 9).

* Source testing and characterization of emissions is needed during ventings. (p. 4). Source testing should include gas phase HCL and possibly HF. (p. 25).

* Testing for components other than H2S is needed, including testing for trace toxic elements such as lead, chromium, mercury, boron, nickel and arsenic. (p. 4).

* A wet cyclone should be installed to abate noise, H2S, and particulate abatement. (p. 4). Consideration should be given to the type of abatement equipment used in air drilling. (p. 25).

* Air ambient standards (DOH) need to be made tougher and should be linked to an emissions rate.

* Monitoring stations should be redistributed with the new locations selected based on meteorological studies to be performed after the power plant is completed. (p. 7).

* The 100 ppbv one hour average limitation during upsets and planned ventings is too lax. A new ambient air standard of 25 ppbv should be imposed. (p. 8, R. Reynolds oral remarks, 7/25/91).

* DOH should measure, characterize, and document drift and toxic elements contained in the particulate and gas phases of emissions. (p. 8, p. 25).

Implicit Recommendations (Air Quality)

* The SAIC program should be used as a model for the operational procedures of the proposed combined air quality monitoring stations and for developing the recommended quality assurance program. (p. 5, p. 12).

* The recommended air quality monitoring program should be audited quarterly by independent DOH personnel using special equipment (equipment different from that used for station

calibration and precision checks). Auditing should be done from the intake probe once a year. (p. 12).

* The State and not the developer should contract for independent monitoring services. Industry should pay the costs. (p. 12-13).

* In order to gain greater public acceptance, extreme security measures, such as cyclone fences and razor wire) should not be used at air quality monitoring stations. (p. 12).

* A public education program should be implemented to explain that the monitoring stations are there for public benefit and that their results are valid. (p. 13).

* Past problems with monitoring efforts should be publicly acknowledged. (p. 13).

* Projects should be 1/2 mile from the nearest residence. (R. Reynolds, oral comments, 7/25/91).

* Modem access to the monitoring stations should be provided. (p. 14).

* Weekly cleaning of the intake probes and sample manifolds should be done. External intake probes should be directed downward. A coarse insect screen at the entrance to the manifold should be considered. A uniform sample probe assembly, as short as possible and incorporating an effective water droplet and insect trap, should be considered. It should be configured for easy leak checking and cleaning or for regular replacement. (p. 15).

* Written quality assurance procedures, using work sheets and forms, should be followed. A station log should be kept at the site. (p. 15).

* A natural emissions inventory should be carried out in the general area. Additional meteorological monitoring should be performed to determine the influence of VOG. (p. 16).

* Zero H2S should be used as the background value, and funds currently used for background monitoring should be redirected to improved meteorological monitoring, remote data access, source testing, and monitoring for other pollutants. (pp. 16-17).

* 10" dual trace charts operating in two ranges (0-100 ppbv and 0-500 ppbv) should be used. A 10% zero offset is recommended. (p. 17).

* DOH should convert to Jerome or Jerome-type monitors. (p. 23). Color Tech Rotorod is obsolete. (p. 24).

* Catchment samples taken during the incident should be compared with future samples. (p. 25).

Explicit Recommendations (Noise)

* One government office should be designated to receive and investigate noise and air quality complaints. (p. 7).

* At least one mobile/portable unmanned monitor with shelter and modem access should be provided. (p. 7).

* Spot checks for noise should be performed more frequently by agency staff to add credibility to the monitoring program. More frequent site inspections of PGV's effort and periodic comparison of calibrators could also add to the credibility and acceptance of the noise monitoring program. (p. 7, p. 19).

* The present noise standards should be evaluated for effectiveness by reviewing all complaints and their resolution. (p. 7).

* The monitoring program should be oriented to resolving complaints and identifying source problem solutions. (p. 8).

* The noise monitoring effort should be partially redirected to specific problem noise identification and less emphasis should be given to monitoring sound. (p. 8).

* Determinations of BACT should be sensitive to worker safety aspects and not allow early choices of equipment to dictate subsequent noise control steps that unreasonably create a choice between a safety and noise problem. (p. 8).

Implicit Recommendations (Noise)

* Reynolds is critical of the 55/45 limitation, especially the 10 dBA exceedance allowance 10% of the time; 20 minute basis). Night levels allowed interfere with sleep; day levels

may interfere with speaking. He doesn't however recommend an alternative.

* The complaint procedure for noise should be made less intimidating to the average person. DOH and the County need more noise monitors (while PGV has adequate monitors).

* The noise limits in the GRP need to be clarified. (p. 19).

* The County or DOH should have at least one monitor with shelter and modem access available to use at residences when there appears to be a conflict with the developer. (p. 19).

* Spot checks should be conducted. (p. 19).

* Periodic calibration checks should be done. (p. 19).

* Steamline pressure release valves should have mufflers and should be directed away from residences. (p. 19).

Recommendations (Event Avoidance and Monitoring)

* An H2S sensor with a quicker response time should be added to the mud monitoring operation. (p. 28).

* Drilling should be done slower; mud should be circulated more frequently; more careful monitoring of heat and volume changes should be done. (p. 28).

* A direct in-steam sample probe should be placed ahead of time to monitor a possible venting. (p. 28).

* The driller should be prepared to predict worst case plume path and probable H2S concentrations. (p. 28).

* Abatement equipment on-site should include: pressure relief valves, wet cyclones, and possibly, large capacity muffler or stack. Abatement equipment should be readily activated, designed with an overcapacity, directed away from residences, and have emissions sampling ports built-in. (p. 28).

* The ATC restriction on air drilling should be reconsidered. (p. 29).

* The ATC allowance of 7 minutes of uncontrolled venting should be reconsidered (reduced). (p. 29).

* Mathematical models should be used to predict plume paths once source testing is completed and emissions data obtained. (p. 29).

Recommendations (ATC Permit Conditions)

* Permit conditions relative to emissions should be reoriented to require the developer to meet ambient standards rather than to accomodate potential problems which the developer may encounter. (pp. 30-31).

* The 5 lb/hr emissions limit stipulated in Condition #17 needs to be clarified. (p. 31).

* The 100 ppbv ambient limit allowed during ventings should be lowered and the allowable duration shortened. (p. 32).

* The ATC ambient limit should be reduced to 25 ppbv. (R. Reynolds, oral remarks, 7/25/91).

Element III, Part II

Explicit Recommendations

* Emissions limits for H2S should be vigorously and rigidly enforced by DOH personnel. (Details provided on p. 42).

* A Puna Air Monitoring Program (PAMP) should be formed and managed by DOH with participation by the developer, the local agencies, State agencies, local concerned organizations, and local concerned residents. (Details on pp. 42-43).

* An Operational Management of Air Resources (OMAR) type system should be established to link all PAMP stations to a central computer to which an emergency response system is linked. (Details on p. 43).

* Air quality monitoring stations should be repositioned and additional meterological monitoring equipment installed to further study the geothermal air pollution meteorology of the location and zone of impact. (Details on pp. 43-45).

* The PAMP committee should manage local and regional air transport special studies. (Details on p. 46).

* The PAMP committee should quality assure monitoring data, document all quality assurance procedures and publish sufficient volumes of the monitoring documents and special studies so that developers, engineers and environmental scientists have access to the documents. (p. 46).

Implicit Recommendations

* A revised health safety limit for H2S of 24 ppbv is "suggested" for the general public. (p. 6).

* The government should perform a health survey. (W. Goddard, oral comments, 7/24/91).

* For any new resource, hour-by-hour quantification of the geo-chemistry of fluids should be performed (W. Goddard, oral comments, 7/25/91).

* During any vertical ventings, air monitoring stations should be "out in the community", not at the fence line. (W. Goddard, oral comments, 7/24/91).

* The 3500' buffer zone should be extended. (W. Goddard, oral comments, 7/25/91).

* State and County government should move away from the "mindset" that there is such a thing as an acceptable level of emissions. (W. Goddard, oral comments, 7/25/91).

* The emphasis of regulations should be on controlling the source of emissions. (W. Goddard, oral comments, 7/25/91).

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GEOTHERMAL ACTION PLAN

TASK	LEAD	SCHEDULE/COMMENTS
I. AIR MONITORING NETWORK		
A. Sampling Station Redistribution.		
1. Relocate PGV Woods station to Leilani Estates	PGV/CAB	CAB to meet with PGV by 9/15/91 to develop plans.
2. Relocate PGV Doutheast station more to southeast.	PGV/CAB	Same as above.
3. Drop CAB Alvarez station	CAB	Upon relocation of PGV Woods station to Leolani Estates.
B. Sampling Station Modifications.		
1. Convert ASAB Irvine station to multi-level meteorological station.	ASAB	Three months after funding is received.
2. Install meteorological equipment at ASAB Nanawale station.	ASAB	Three months after funding is received.
3. Modify intake lines at CAB stations and conduct regular cleaning.	CAB	By November 1, 1991
4. Install Meteorological equipment at PGV SE and Woods ~~SW~~ stations.	PGV/CAB	CAB to meet with PGV by 9/15/91.
C. Quality Assurance.		
1. Implement a quality assurance program.	ASAB	By November 1, 1991
2. Establish tolerances in the QA program that reflect the desired low concentration accuracy.	ASAB	By November 1, 1991
3. Conduct gas line audits.	ASAB	By November 1, 1991

GEOTHERMAL ACTION PLAN

TASK	LEAD	SCHEDULE/COMMENTS
C. Quality Assurance -Continued.		
4. Establish station logs and post at site.	CAB	By October 1, 1991
5. Improve written procedures, data handling and station equipment diagram.	CAB	By October 1, 1991
6. Calibrate and audit stations at a lower range of H2S then presently utilized.	PGV ASAB	By November 1, 1991
D. Data Handling.		
1. Add functional data loggers at ASAB stations.	ASAB	Upon purchase of equipment.
2. Add password level remote access into data. provide access to agencies needing information.	CAB ASAB PGV	This task needs to be discussed in conjuction with unification program.
3. Integrate data from all stations and prepare monthly tables showing hourly averages and daily peaks of H2S.	CAB	Same as above.
E. Portable Samplers.		
Developer to provide two Jerome equivalent protable H2S samplers for use by DOH and/or responsible agencies.	PGV/CAB	CAB to meet with PGV by 9/15/91.
II. Permits and Compliance Review.		
A. Permits.		
1. Evaluate 100 ppb one hour average limit.	CAB	Initiated, complete by 9/1/91.
2. Perform resource characterization evaluation required under Condition 20 of the ATC.	CAB	Initiated, complete by 9.1.91

GEOTHERMAL ACTION PLAN

TASK	LEAD	SCHEDULE/COMMENTS
II. Permits and Compliance Review - continued.		
B. Compliance.		
1. Designate one government official to receive and investigate noise and air quality complaints.	CAB N & R	By October 1, 1991
2. Enforce emission limits.	CAB	Initiated, forward draft to Deputy A.G. by 9/15/91.
III. Unification of Air Monitoring Network.		
A. Reynolds' Recommendation.		
Unify the the air monitoring efforts into a single comprehensive program managed and audited by the state, but receives and follows input and policy from a committee consisting of environmentalists, industry and agency people.		
Committee to also undertake the task of making recommendations for expansion of the monitoring network to include toxic pollutants.		
B. Goddard's Recommendation.		
Establish a Puna Air Monitoring Program (PAMP) to be formed by DOH with participation by the developer, local agencies, state agencies, local concerned organizations and local residents.		
PAMP would also do the following:		
1. Establish an Operational Management of Air Resources (OMAR) type system to link all PAMP stations to a central computer to which an emergency response team is linked.		

GEOTHERMAL ACTION PLAN

TASK	LEAD	SCHEDULE/COMMENTS

B. Goddard's Recommendation - continued.

2. Manage local and regional air transport studies.

3. Quality assure monitoring data, document all quality assurance procedures and publish sufficient volumes of the monitoring documents and special studies for access by developers, engineers and environmental scientists.

NOTE: The unification program is one we should do, however, we need to define the scope. Both Reynolds and Goddard have good recommendations. We need to take their good points and establish a program that is manageable.

COMMENTS TO ACTION PLAN:

1. Abbreviations used.

   CAB = Clean Air Branch

   ASAB = Air Surveillance and Analysis Branch (Air Lab)

   PGV = Puna Geothermal Venture (OESI)

2. CAB will oversee PGV's tasks.

   A meeting will be sheduled before 9/15/91 to develop a detailed plan of action.

3. Conversion of ASAB's stations to include meteorological equipment will require funding and acquisition of equipment.

4. Contact Wendell Sano, Supervisor of the Monitoring Section for the next two weeks, since I'll be on vacation.

Lorraine R. Inouye
Mayor

Barry T. Mizuno
Managing Director

David Fuertes
Deputy Managing Director

Office of the Mayor

County of Hawaii • 25 Aupuni Street, Rm. 213 • Hilo, Hawaii 96720 • (808) 961-8211 • Fax (808) 961-6553

August 12, 1991

Mr. Murray Towill
Director of Business, Economic Development
and Tourism
State of Hawaii
P. O. Box 2359
Honolulu, Hawaii 96804

Dear Murray:

Attached is a copy of what you and I worked on at the airport as a first cut attempt at the task force objective. I will be out of town on Wednesday, Thursday and Friday of this week, so may I suggest that you and I clean up the first cut document and work on a rough outline of the implementation process prior to having a conference call with the task force members on Tuesday sometime.

We will also need to formulate the subcommittee members and their tasks, and also a timetable for completion.

Very truly yours,

BARRY T. MIZUNO
Managing Director

BTM:asf
0704u
encl.

DRAFT -- 8-12-91

GOVERNOR/MAYOR TASK FORCE
PGV GEOTHERMAL ACCIDENT

MISSION STATEMENT

To develop and implement a plan utilizing the team reports, to insure the safety and assure fair treatment of nearby residents before allowing PGV to proceed with its project.

ACTION PLAN

1) Review team reports of experts.

2) Establish subcommittees to review recommendations.

   a) Determine action plan and resources necessary. (Include PGV.)

   b) Determine time line for implementation.

   c) Report back to task force.

3) Accumulate subcommittee reports and consilidate time line.

4) Determine other reviews necessary and time line.

5) Report to Governor and Mayor.

6) Implement plan.

7) Approve PGV request to continue construction.

SUBCOMMITTEES

Drilling - DLNR, Planning, DBED

Emergency Response - DOH, Civil Defense

Health - DOH, Civil Defense, Planning, DBED

BTM:asf
0705u

DRAFT

DRAFT

To: William Paty
From: John C. Lewin
Subject: Regulation of All Geothermal Well Drilling

In light of the past incidences with Puna Geothermal Venture regarding geothermal well drilling operations, the Underground Injection Control (UIC) program has made a recommendation to me that would serve to uniformly regulate all forms of geothermal well drilling regardless of the various geothermal well classifications that exist; classifications such as production, monitoring and reinjection. As it currently stands, it is my understanding that the well drilling operations of geothermal production wells and geothermal monitoring wells are distinctly regulated by your geothermal section. However, because the UIC program must regulate all forms of injection (reinjection) wells in the State of Hawaii, the well drilling operations of geothermal reinjection wells have not had the regulatory distinction of required compliance to the well drilling standards of your geothermal section. Inspite of this apparent regulatory override by the UIC program for reinjection wells, your geothermal section has put forth the extra effort to monitor the well constructin of the reinjection wells to verify their proper construction.

The UIC program has advised me that it would be prudent to arrange to have all geothermal well drilling operations, regardless of the well's classification, regulated by your geothermal section to assure that the design of the wells meets acceptable standards and that the wells are properly constructed. In pursuit of this objective, I recommend that the purview of your geothermal well construction permit be expanded to include geothermal reinjection wells. With this inclusion, the construction of <u>all</u> geothermal wells will be subject to your permit. The UIC permit will still be administered, when applicable, to address the environmental impacts of geothermal reinjection.

The implementation of this strategy will establish your geothermal well construction permit as being the "foundation" permit that regulates all types of geothermal well construction. The UIC permit will more appropriately serve as a "specialty" permit, in conjunction with your foundation permit, to address the environmental impact issues of reinjection - specifically addressing shallow groundwater contamination.

The logistics of simultaneous and/or sequential permit processing of the foundation permit and the UIC permit can be cooperatively developed by our staff. Once the procedures have been developed, I recommend that a brief informational letter be made to document our cooperative effort in this matter. The letter would contain our directives and could then be presented to any geothermal developer to inform them of their requirement to comply to our permits.

Please present this strategy to your geothermal section for their review and comment. Thank you for your assistance.

47. The permittee shall obtain, and comply with the provisions of, Authorities to Construct and Permits to Operate from the State Department of Health for all applicable project operations approved under this Geothermal Resource Permit.

48. The permittee shall secure all necessary approvals and clearances including Plan Approval pursuant to Chapter 25 of the Hawaii County Code, within one (1) year from the effective date of the Geothermal Resource Permit.

49. Construction shall commence within one (1) year from the date of receipt of Final Plan Approval.

50. The permittee shall submit a written semiannual status report to the Planning Commission on the permittee's best efforts to address/comply with the "Other Agreements and Recommendations" as contained in Section 5 of the final report on "Mediation of Geothermal Resource Permit Application 87-1" dated August 21, 1989, regarding but not limited to the collateral agreements and commitments the permittee made during the mediation process, and which the permittee considers to be contractual obligations subject to the issuance of a satisfactory Geothermal Resource Permit. The status report shall be submitted by February 15 (covering the preceding period of July 1 through December 31) and August 15 (covering the preceding period of January 1 through June 30) of each year.

51. Prior to the issuance of the first building/construction permit under this Geothermal Resources Permit (GRP) by the County of Hawaii, the State of Hawaii and the permittee shall each contribute towards a Geothermal Asset Fund or other appropriate existing fund for the purposes of geothermal impact mitigation efforts within the District of Puna. The permittee's initial contribution to the fund shall be a sum of $60,000, due within thirty (30) days after the effective date of this GRP permit, and annual sums of $50,000 due on or before the anniversary date of this GRP permit over a period of eight (8) consecutive years thereafter for a total of $460,000. Annual contributions thereafter shall be determined between the permittee and the State of Hawaii or $50,000 annually, whichever is greater. The State's initial annual contribution to the Geothermal Asset Fund shall be the net revenues derived from the resources generated by the HGP-A well, or a similar amount from other State funding sources

less any allocations entitled to the Office of Hawaiian Affairs and operations and maintenance costs. In the event that future enabling legislation provides for a percentage of the State's geothermal royalties to be allocated to the County, upon concurrence with the County Council, said royalties may also be deposited to the fund. The administration and expenditure of assets from this Geothermal Asset Fund shall be in accordance with rules, regulations and procedures developed for that purpose by the County in accordance with Chapter 91, Hawaii Revised Statutes, and with participation of Puna residents or representatives thereof, which shall include, but not be limited to, provisions and criteria to enable the first priority of distribution for temporary or permanent relocation of those property owners who are found, in accordance with criteria established in the rules, to be adversely impacted by the activities authorized, provided that such relief is applied for within a period of one (1) year of the impact. A priority list of impact mitigation projects may be established by the County Council or agency designated by the Council in conjunction with Puna residents or designated representatives thereof, with the exception of upgrading existing subdivisions in the Puna District to current subdivision standards and specifications of the County of Hawaii. Should any other district(s) of the County of Hawaii be proved to be negatively impacted by activities authorized under this or any other subsequent GRP, that district shall receive a pro rata share of the fund assets as may be determined by the County Council or agency designated by the Council with expenditures to follow a prioritized schedule determined as outlined above. The rights granted to the permittee shall not be conditioned upon any contribution or further participation by the State in the fund nor with respect to the creation, management, and operation of the fund other than set forth above.

Sincerely,

Gary Mizuno, Chairman
Planning Commission

cc: Mr. Peter Adler
Mediation Parties (list)
DBED
DOA
DLNR/Honolulu
DOH
Mr. Ralph Matsuda

PGV WAIVER PROPOSAL VS. DLNR RECOMMENDATION

YEAR	33% REV RESOURCE VALUED AT 33% OF PROCEEDS METHOD	PGV 60% WAIVER 40% OF ROYALTY BASED ON A RESOURCE VALUE OF 33% OF REVENUES	27% REV RESOURCE VALUED AT 27% OF PROCEEDS METHOD	PROP. PROFITS PGV PROPORTION OF PROFITS METHOD	NB/DPR CURRENT NETBACK DEPREC-IATION METHOD**	EXPANDED/NB NETBACK/DPR NO LIMIT 1.5 MULTIPLE PLUS RESOURC COSTS	REVENUE
1992	543477	217391	444663	395000	516233	0	16469000
1993	543477	217391	444663	391300	516567	0	16469000
1994	567435	226974	464265	413000	558428	0	17195000
1995	595848	238339	487512	433600	644299	0	18056000
1996	626109	250444	512271	455200	732470	365206	18973000
1997	658350	263340	538650	484000	827741	827741	19950000
1998	692670	277068	566730	509500	929012	929012	20990000
1999	729234	291694	596646	537200	1038083	1038083	22098000
TOTALS	4956600	1982641	4055400	3618800	5762833	3160042	150200000

*Proportion of Profits Method uses PGV 3/26/91 figures that include Resource Assets and other costs as allowable capital costs.

**The Expanded Netback Method uses S&P BBB bond Rate of 9%, Transmission Assets of $7 mil., Generating Assets of $60.165 mil., and includes Resource Assets (steam production costs) as allowable capital costs.

The Netback Method values resource by subtracting allowable project costs from the total project revenues. The Expanded Netback Method values the project as a whole by subtracting the reasonable cost of all aspects of the project, including steam production, from the total project revenues. This calculated project value is considered to be the amount available for royalty payments. If the amount is negative or less than the amount of royalty due, then all or a portion of the royalty is waived. The table below illustrates the concept of the Expanded Netback Method.

Concept of the Expanded Netback Method

	Year of Operation		
	1	2	3
Total Project Revenues	$ 1,000	$ 1,200	$ 1,300
Less:			
Transmissions Costs	60	60	60
Generating Costs	600	600	
Steamfield Costs	500	500	500
Total Costs	1,160	1,160	1,160
Project Value (amount available for royalties)	(60)	40	140
Calculated Royalty	34	54	64
Royalty paid to the State	0	40	64

The above table illustrates the three situations that can occur when using the Expanded Netback Method. In year 1, insufficient value exists to pay any of the royalties. Accordingly, the royalties are waived. In year 2, the project value is such that a portion of the royalties can be paid. In year 3, the project value is such that all of the royalties can be paid.

PUNA GEOTHERMAL VENTURE - CONSTRUCTION

P.O. BOX 1337, HILO, HI 96721-1337
TEL: (808) 961-2786 FAX: (808) 965-7254

FACSIMILE COVER PAGE

SENT TO: DLNR MSG #:
ATTENTION: MANABU TAGAMORI FAX #: 548-6461
FROM: BILL RICKARD DATE: 8-29-91
FILE #: CC: TANAKA, RICHARD, M

NUMBER OF PAGES (INCLUDING COVER SHEET): 9

IF YOU HAVE DIFFICULTIES RECEIVING THIS FAX PLEASE CALL (808) 961-2786 ASK FOR: BILL.

MR. TAGAMORI,

THIS IS THE REVISED KS-8 QUENCHING (KILL) PROGRAM. THIS REPLACES THE PROGRAM SENT TO MR. PATY BY MR. RICHARD ON AUGUST 5, 1991. THIS PROGRAM IS ALSO SUBJECT TO CHANGE, MODIFICATION AND/OR ALTERATION BASED ON THE CONDITIONS ENCOUNTERED DURING THE OPERATION. IF YOU HAVE ANY QUESTIONS I CAN BE REACHED AT 961-2786.

REGARDS,

WM Rickard

PUNA GEOTHERMAL VENTURES

TO: KS-8 FILE

RE: PROCEDURES TO CONTROL AND SECURE KS-8

FROM: DRILLING STAFF

DATE: August 29, 1991

I. OBJECTIVE: The interactive flow situation of KS-8 between the inflow zone at 3488' and outflow at the 2128' 13 3/8" casing shoe is to be stopped by killing through a 7" kill string. The kill procedure is a staged sequence using high pumping rates of water, weighted mud, barite plugging material and finally cement to stop the flow and control the well.

II. SITUATION: At the beginning of this kill procedure the drill pipe will have been snubbed out and the 7" kill string will have been snubbed into the hole. This provides a very favorable situation for pumping very high rates down the kill string. The pumping sequence will be planned assuming a successful kill with a barite plug followed immediately with a cement plug, or plugs, that will seal the hole from the reservoir fluids.

III. SUMMARY OF KILL OPERATION:

A. STAGED KILL APPROACH
This approach is to kill and plug off the downhole flow by pumping successive stages of water, weighted mud and cement. The program in Section IV details the steps to be taken.

It should be understood that the kill plan may be altered during the process based on the measurements and indicators observed. The nature of the alterations to the plan are to take advantage of this new information in real time.

The procedure is to pump very high rates of water down the kill string and down the annulus to cool the well and to possibly change the steam/water crossflow into a liquid column in the well. If a kill is obtained it is not likely that the kill can be maintained with water alone. It is necessary to have a static bottom hole condition for a cement plug to be effective and not cement in the 7" kill string.

If the well is controlled with cold water, then weighted mud will be used to control the downhole pressures in preparation for placing a cement plug on bottom. The weighted mud will contain barite weighting material. (See Appendix G) Barite will be pumped to bottom, thus forming a barite plug, isolating the inflow zone and controlling the pressure. A cement plug can then be placed on the barite plug. (See Appendix A) Care must be taken to maintain

the static condition of the cement plug until it sets.

If the high rate water kill only cools the hole then weighted mud designed to lose its suspending characteristic at high temperature will be pumped to deliver a barite plug to bottom. The depth of the top of the barite plug will be uncertain and may seal the 7" kill string in the hole. In such a case, perforations may be necessary to deliver the cement plug. Continual high rates of flow in the annulus will be used to maintain the static condition for the cement plug.

Diagnostic measurements in the form of pressure readings and downhole temperature surveys will be necessary to determine the state of the kill.

B. SECURE WELL WITH CASING

The expected result of the staged kill is that there will be a cement plug blocking any inflow from below 3150'. The program in Appendix B and H details the steps to be taken to place additional cement plugs in the well and case it.

IV. DETAILED KILL PROGRAM:

A. KS-8 KILL PROGRAM

1. Install piping for fluid supply and injection as shown in Appendix C, D, E, AND F. Hook up Halliburton instruments to monitor rates and pressures on annulus and kill string.

2. Maintain continuous 3 BPM water injection down annulus.

3. Snub 7" casing kill string in the hole to 3400'+-. Make up safety valve on top of each joint before it is picked up. Run 7" casing into well dry. Install 2 float collars above first joint. Install profile nipple above float collars.

4. Install 7-1/16" API 5M gate valve and frac head on top of kill string, and connect Halliburton lines to frac head.

5. Mix mud as follows in the new PDC mud tanks.
   400 bbls 12 ppg mud
   200 bbls 18 ppg mud
   100 bbls barite pill in the 3 U mixer

6. Pump water down kill string at 20 bpm for about 24 hours to verify communication and cool the hole. Start the pumping slow bringing the rate up to 20 bpm over 1/2 hour. Pump water down the annulus at 5 - 10 bpm during that period.

7. Run pressure/temperature survey as follows:

   a. At the conclusion of the 24 hr pumping period, run a pressure/temperature survey to the top of the float collar. Run the pressure/temperature survey while injecting water into the annulus at 5 - 10 bpm. No fluid needs to be injected into the 7" kill string. Run a 6 hr clock in the Kuster tools.

   b. The pressure/temperature tool will be pulled from the hole and the survey will be interpreted.

   c. The pressure/temperature survey should be run on the HLS wireline.

8. Perform test of high-rate water injection as follows:

   a. Fill PDC 231 mud tanks and two Baker tanks with water and prepare to divert full flow from MW-1 and MW-3 into the PDC 231 tanks and Baker tanks. Rig up to transfer water to the PDC 231 tanks from the KS 7 pit and KS 8 pit.

   b. Run pressure/temperature tool to the top of the float collar. Run 6 hour clocks in the Kuster tools.

c. Increase annulus injection to 10 bpm and kill string injection to 60 bpm. Start pumping slow and bring rate up to 20 bpm over 1/2 hour.

d. Maintain rates as long as water supply lasts (about 1 hour).

e. Reduce injection rates to 5 bpm down the annulus and 10 bpm down the kill string, and monitor surface pressures for several hours for indications of the downhole flow response.

f. Shut off flow completely to both annulus and 7" kill string. Keep Kuster tools on bottom for at least 3 hrs. after well is shut-in to observe pressure fall-off if well will stay dead.

g. Pull out of the hole with the Kuster tools and interpret pressure temperature survey.

9. Maintain low-rate injection (10 bpm annulus/10 bpm 7" kill string) and evaluate results of high-rate injection test. On the basis of the above results, make any needed adjustments to the kill program. Refill two Baker tanks and PDC 231 mud tanks with water.

10. Repeat high-rate water injection as in Step 7a-c.

11. Maintain 10 bpm water down the annulus, and reduce kill string injection to 30+- bpm water for the switch over to mud.

12. Pump 300+- bbls of 12 ppg weighted mud down kill string at 30+- bpm, and observe pressure on kill string and annulus. Pump 100+- bbls of 12 ppg mud at reduced rate of 20 bpm.

13. Pump 200 bbls of 18 ppg mud.

14. Follow with the 175 bbl barite pill and displace kill string immediately with 150 bbls of water.

15. Follow immediately with 25 bbls of cement and displace kill string down to 3250' with 120 bbls of water.

16. Continue pumping water down annulus. Run profile plug in 7" kill string and set in profile nipple above top float collar if required. Pressure test plug, break off frac lines and frac head.

17. Snub 7" kill string out of the hole using safety subs and proceed to Appendix H, "Post Kill Operations". If kill string is not free go to Step 18.

18. a. Rig up to snub inside of the 7" kill string.

b. Pull profile plug and drill out float collar.

c. Freepoint and cut the 7" string as deep as possible.

d. Snub out the 7" skill string.

e. Proceed to Appendix Section H, "Post Kill Operations".

V. APPENDIX

A. CEMENT COMPOSITION

There have been tests run on cement compositions up to 400 deg F. The compositions are for 400 deg F effective bottom hole temperatures. The following are the Halliburton test data. Tests are being run for cement compositions at 600 deg F.

Cement Designs for 400 deg F Circulating Temperature

Hawaiian Cement	Density - 13.45 ppg(13.96)
40 % SSA-1	Yield - 2.23 cuft/sk (2.15)
1 cuft Perlite	Water reqmt - 9.72 gal/sk
4 % Bentonite	Fluid loss - 40cc/30 min
1.5 % CFR-3NF	Free water - 0 %
1.0 % Diacel LWL	Thickening time @ 400 F and
1.0 % HR-15	5000 psi in 15 min - 2 hrs 15 min

Hawaiian Cement	Density - 13.45 ppg(13.96)
40 % SSA-1	Yield - 2.23 cuft/sk (2.15)
1 cuft Perlite	Water reqmt - 9.72 gal/sk
4 % Bentonite	Fluid loss - 40cc/30 min
1.5 % CFR-3NF	Free water - 0 %
1.0 % Diacel LWL	Thickening time @ 400 F and
2.5 % HR-15	5000 psi in 15 min - 5 hrs 30 min

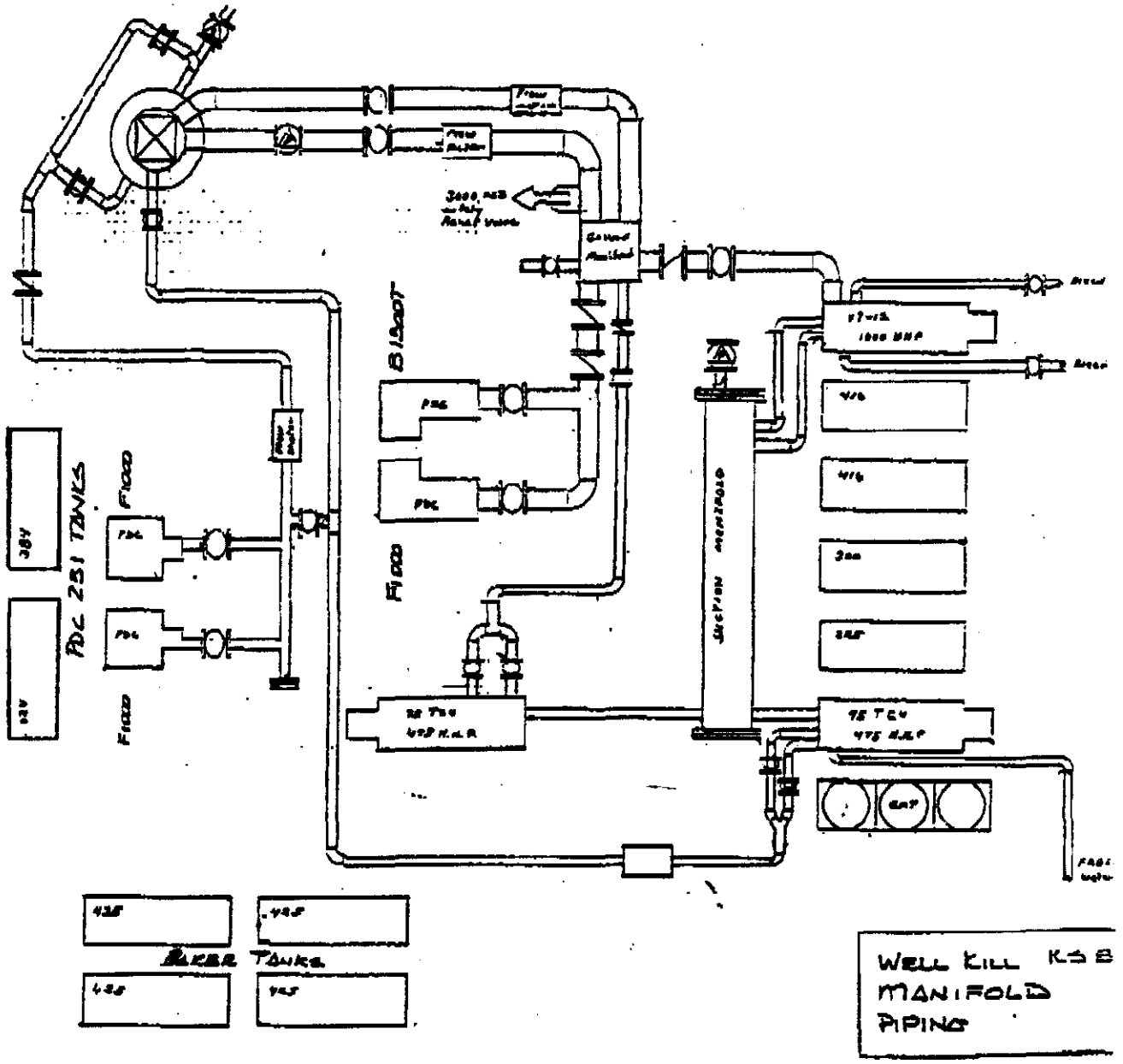
( ) Indicates downhole density and yield @ 2500 psi
Use the lower thickening time slurry if possible.

B. REDESIGN OF EXPANSION SPOOL AND WELLHEAD

The expected surface pressure and temperature at commercial production rates requires a change from ANSI 900 Series wellhead and production equipment to ANSI 1500 Series wellhead and production tree. The higher pressure and temperature of the resource will result in higher wellhead temperature and pressure than in previous Puna wells. The procedures stated here call for this change to be made in the rework of the wellhead and installation of the production tree.

C. MANIFOLDING

The attached sketch shows the manner of connecting the various elements of the kill equipment.



D. TANKAGE

Fluid storage volumes are as follows:	Effective
Parker Drilling 231	700 bbl
2 Baker tanks (475 bbl)	950 bbl
Additional Parker tanks	1000 bbl
Parker 3 U Mixer tank	200 bbl
	2850 bbl

Reserve pit delivery rate and storage volume			
Well pad D reserve pit	K6-8	5 bpm	3,000 bbl
Well pad F reserve pit	K8-7	5 bpm	5,000 bbl
Total		10 bpm	8,000 bbl

E. WATER SUPPLY

Water Source Delivery Rate	
Water well MW 1	6.0 bpm
Water well MW 3	28.0 bpm
Total	34.0 bpm

F. PUMPING CAPACITY

The pumping units are rated for hydraulic horsepower and maximum pumping capacity. The rates listed below are for the expected maximum pressures at which each unit will be used. When operating at maximum rated hydraulic horsepower, an increase in pressure will result in less flow rate.

It is expected that at 50 bpm of water the surface piping will have 700 psi pressure drop from the trucks to the wellhead. This will be taken into account when running the kill procedure.

Pumping Capacity--	
Parker Drilling 231	
2-F1000 @ 120 stks	20.0 bpm @ 2500 psi
Parker extra pumps	
1 Skytop-Brewster B 1300 T	
1100 ihp / 120 stks	11.5 bpm @ 3000 psi
F1000	
825 ihp / 130 stks	10.0 bpm @ 2500 psi
2 Halliburton Cementing Trucks	13.0 bpm @ 3000 psi
1 Halliburton Frac Truck	15.0 bpm @ 3000 psi
Total	69.5 bpm

G. DRILLING FLUID CONSIDERATIONS

The mud to be used in the kill operations is designed to provide 1) weighted mud for the kill and the base mud for carrying the barite to the hole.

The mud is to be a low gel polymer mud varying in weight from 12 ppg to greater than 18 ppg. At most the gel will be 10 to 12 ppb. This is done to avoid thermal gelation. The polymer will begin with Drispac for the lower barite concentrations and temperatures and change over to XC Polymer for the higher concentrations. The barite plug itself will be barite and water.

The weighted muds, especially the 16 ppg and 18 ppg will be designed to fall apart with high temperature.

H. POST KILL OPERATIONS

The expected result of the above effort is that there is now a cement plug blocking any inflow from below 3150'. The remainder of this part of the program details the steps to be taken to place additional cement plugs in the well and case it.

1. Place Super Flush and foam cement plug across the 13 3/8" shoe zone if required.
2. Drill through the shoe plug and drill the top of the cement plug.
3. Run and cement liner and tie-back.
   a. Run 9 5/8" liner.
   b. Cement liner.
   c. Test the lap joint and squeeze if required.
   d. Run a casing inspection log in the 13 3/8" casing from as deep as temperature will allow to the surface.
   e. Nipple down, cut off 13 3/8" 900 Series casing head.
   f. Install 13 3/8" 1500 Series casing head.
   g. Run tie-back liner.
   h. Cement the tie-back liner to the surface.
   i. Install 1500 Series expansion spool and master valve.
   j. Nipple up BOPE.
   k. Test 9 5/8" tie-back, drill out to the float collar and test 9 5/8" liner.
4. Now ready to drill out liner shoe.
   a. Drill out shoe.
   b. Perform leak off test and squeeze shoe if required.
5. Well is secured.

KILLPROG.828
August 29, 1991

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

REF:WRM-BM

AUG 20 1991

Mr. Maurice A. Richard
Regional Development Manager
Puna Geothermal Venture
101 Aupuni Street, Suite 1014B
Hilo, Hawaii 96720

Dear Mr. Richard:

The Department of Land and Natural Resource (DLNR) has reviewed your plans for controlling and securing geothermal well KS-8 and has no objections to the proposed scope of work outlined in your program.

We fully recognize that as field conditions change, modifications to your proposed well control program may be required. Please be advised that our DLNR field representative shall be duly notified of any contemplated changes to the proposed program and our Division of Water Resource Management notified in writing of those modifications.

Additionally, we request that a brief daily update concerning the well control operations and planned activities for well KS-8 be added to the MW-3 water well status reports regularly sent by PGV to Hawaii County Civil Defense.

As requested, copies of the KS-8 quenching ("kill") program has been distributed to the Hawaii County Planning Department, Hawaii County Civil Defense, Department of Health, and the Department of Business and Economic Development and Tourism for review and comment. Please be advised that subject to the other agencies' review of this plan, additional follow-up meetings may be required to further discuss the current status of well KS-8 and the proposed steps to completely control the well.

Should you have any questions, please contact me, or in my absence, Mr. Manabu Tagomori, Deputy Director, at 548-7533.

Very truly yours,

WILLIAM W. PATY

cc: Harry Kim, Hawaii County Civil Defense
Rodney Nakano, Hawaii County Planning Department
Bruce Anderson, DOH

PUNA GEOTHERMAL VENTURE
CONTROL PROCEDURES FOR THE KS-8 WELL

A. Establish communication with the bottom of the hole with minimum flow restriction in the drill pipe.

1. Transported from Houston, Texas, one Cudd Series 150 Hydraulic unit. This included the base unit, BOPE, chokes, associated piping and approximately 4,000 feet of 1 1/4-inch tubing work string. It also included expendables of bits, mills and fishing tools.

   The equipment arrived by chartered aircraft on July 28, 1991.

2. With materials on site, the rig-up was completed July 30, 1991.

3. Operations to drill out of the HWDP and DC's, recover plug, and drill through the bit began July 31,1991.

CURRENT ACTIVITY

At the present the 1 1/4-inch tubing and recovery tools are stuck in the drill pipe at 2420 feet and limit communication with the bottom of the hole.

The tools will be recovered or the drill pipe will be snubbed out of the hole to establish communications with minimum flow restriction.

At this point, the drill pipe will be open to the bottom of the hole and in a position to kill the well with weighted mud.

B-I. WEIGHTED MUD KILL APPROACH

This approach will use large quantities of 11.5 ppg to 12.5 ppg mud to kill the well. Flow rates are as high as the equipment will provide. The following program details the steps to be taken.

Pump water down the drill pipe and casing to cool the wellbore. The following pumping schedule details the material to be pumped, the equipment to be used, the pump rate and the volumes.

1. DRILL PIPE PUMPING SCHEDULE

	Equipment	Material	Pump Rate	Duration	Volume
a.	Howco (Pump Trucks)	Water	2 bpm	30 min	60 bbl
b.	Howco	25 bbl CaCl2 5 bbl mud 25 bbl Super Flush 5 bbl mud 25 bbl CaCl2	3 bpm	22 min	85 bbl
c.	Howco	11.5 to 13.5 ppg mud	8 bpm	25 min	200 bbl
d.	Howco	11.5 ppg mud	6-8 bpm	cont.	360 bphr
			Continuously until decision		

Decision Point Based on Circulation

Option A Circulate kill weight mud

Option B Lose circulation

Drill Pipe Pumping Schedule Options

Option A: Circulate kill weight mud

e.	Howco	11.5 ppg mud	4-5 bpm	from pits

Establish Circulation

	Howco	11.5 ppg mud	4-5 bpm	from pits

When the pressure is killed

Howco	Water	as required	10 bbls
Howco	Cement Blend	as required	50 ft^3
Howco	Water	as required	10 bbls

Option B: Lose Circulation

e.	Howco	11.5 ppg mud	8-10 bpm

If unable to circulate

f.	Howco	11.5 ppg mud	6-8 bpm	as required
g.	Howco	Water	as required	60 bbls
h.	Howco	Sand plug	Mix 50 ft^3 sand in jet mixer	
i.	Howco	Water	as required	60 bbls

Followed by water to keep well cool

j.	Howco	Cement blend	as required	50 ft^3

Fill hole or keep water going down hole.

Note: Cement blend to be used to plug well:
Hawaiian Cement
40% SSA - 1
Perlite 1:1
4% Bentonite
1.5% CFR-3 NF
1.0% Diacel LWL
1.0% HR - 15

This blend was tested at 400 F and 5000 psi for 2:15 pumping time.

2. CASING ANNULUS PUMPING SCHEDULE

a.	Howco	25 bbl CaCl2 5 bbl mud 25 bbl Super flush 5 bbl mud 25 bbl CaCl2	3 bpm	22 min	85 bbl
b.	PDC 231 Rig pumps	11.5 ppg mud	8 bpm	25 min	200 bbl
c.	PDC 231	11.5 ppg mud	3 bpm or greater Attempt to maintain casing annulus fluid level		
d.	PDC 231	11.5 ppg mud	3 bpm Continuously until decision	180 bphr	

Decision Point Based on Circulation

Option A Circulate kill weight mud

Option B Lose circulation

Casing Annulus Options

Option A: Circulate Kill Weight Mud

e. Stop pump. Monitor annulus level and circulation. Circulate and condition mud through pits.

f. Hold drill pipe pressure constant with choke on the annulus until able to pump 11.5 ppg mud at 4 bpm with LCM. Set plug.

Option B: Lose Circulation

g. 11.5 ppg mud / 4 bpm / continuously / 240 bbl/hr / PDC 231
Unable to circulate. Set plug.

h. 11.5 ppg mud / 6 - 10 bpm / 360 bbl/hr / PDC 231
Followed by water if unable to fill hole.

B-II. HIGH RATE-LONG TERM WATER KILL APPROACH

This kill approach is based on pumping water at as high a rate as possible (on the order of 45 bpm) for as long as water can be supplied to cool, choke and kill the well. The following steps can be taken after the water well MW-3 is completed if the mud kill is unsuccessful.

Pump water down the drill pipe and casing to cool the wellbore and kill the well.

The following are prerequisites for the high rate long term water kill:

- drill and equip an additional water well for total continuous well supply of 34 bpm.
- lay 8-inch water pipeline from MW-3 to KS-8.
- install pumps and transfer lines from supplemental water storage.
- rig up frac truck, and high pressure 3-inch piping which are now in transit from the mainland by barge.

Establish water storage volumes as follows:

Parker Drilling 231	700 bbl
4 Baker tanks (475 bbl)	1900 bbl
Additional Parker tanks	1350 bbl
Parker 3 U Mixer tank	350 bbl
Total	4300 bbl

Reserve pit delivery rate and storage volume

Well pad D reserve pit	KS-8	5 bpm	3,000 bbl
Well pad F reserve pit	KS-7	5 bpm	5,000 bbl
Total		10 bpm	8,000 bbl

Water Source Delivery

Water well MW 1	6.0 bpm
Water well MW 3	28.0 bpm
Total	34.0 bpm

Pumping Capacity

Parker Drilling 231	
2-F1000 @ 120 stks	20.0 bpm
2 Halliburton Cementing Trucks	
4.5" liners at 4000 psi	12.5 bpm
1 Halliburton Frac Truck	
at 4000 bps	12.5 bpm
Total	45.0 bpm

Following are the high rate-long term water kill details:

1. Manifold pumping units to water supply and water storage system. Manifold the pumping head.

2. Allocate pumping flow rates to the drill pipe and casing.

3. Pumping schedule is as follows:

   a. Drill pipe 25 bpm (pressure limited)

   b. Casing 20 bpm

   This approach allows for pumping at 45 bpm for 17 hours. After 17 hours the rate will be reduce to a total of 30 bpm until a decision is reached.

4. When the well is turned, pump sand and water plug, mixed in the Howco mixers until a 50-foot and 100-foot sand plug is created in the wellbore.

5. Pump a 60 foot^3 cement plug on bottom. Wait on cement. Repeat as necessary.

C. SECURE WELL WITH CASING

The expected result of the above effort is that there is now a cement plug blocking any inflow from below 3150 feet. The remainder of this part of the program details the steps to be taken to place additional cement plugs in the well and case it.

1. Place Super Flush and foam cement plug across the 13 3/8-inch shoe zone if required.

2. Drill through the shoe plug and drill the top of the cement plug as necessary.

3. Run and cement liner and tie-back.

    a. Run 9 5/8-inch liner from above the 13 3/8-inch shoe to the top of plug.

    b. Cement liner.

    c. Drill out cement above liner. Test the lap joint and squeeze if required.

    d. Nipple down, cut off 13 3/8-inch 900 Series casing head.

    e. Install 13 3/8-inch 1500 Series casing head.

    f. Run 9 5/8-inch tie-back liner.

    g. Cement the tie-back liner to the surface.

    h. Install expansion spool and master valve.

    i. Nipple up BOPE. Test BOPE.

    j. Test 9 5/8-inch tie-back, drill out tie-back shoe and test 9 5/8-inch liner.

4. Now ready to drill out liner shoe.

    a. Drill out shoe.

    b. Perform leak off test and squeeze shoe as required.

5. Well secured.