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Memorandum

To: Joshua Craft, Alaska Energy Authority
Michael Weathers, Department of Energy

Date: 2 October 2015

From: Ray Mann, Program Manager

Subject: Transmittal of Permits for Drilling of City of Akutan Geothermal Well AK-3

Background

The City of Akutan is continuing efforts to develop a geothermal power system on Akutan Island in the eastern Aleutians, under Alaska Energy Authority (AEA) Grant Number 7040050, and U.S. Department of Energy (DOE) Grant Number DE-EE 0000329/0005. As a continuation of the project, the City is preparing to drill a 1,700 foot confirmation well in the Hot Springs Bay Valley (HSBV) area of Akutan Island during June-September 2016.

Well site targeting was completed in March, 2015, and the results were presented to a joint AEA-DOE Technical Monitoring Team (TMT) on 31 March 2015. After TMT review, the City was authorized to proceed with the "Permits and Property Rights" task, as defined in the grant agreements.

For the purpose of proceeding to Phase II of the project, "Logistical Support and Drilling", the City has completed the following sub-tasks:

1. Acquired all property rights necessary for drilling operations. Copies of the exploration agreements were previously provided to AEA and DOE.

2. Acquired all federal and State permits and authorizations for drilling the AK-3 well, as described in the drilling plan presented to AEA/DOE. A summary of actions taken to acquire permits and approvals is attached hereto.

3. Conducted additional geophysical data interpretations, and prepared supplemental information regarding the drilling target, and well prognosis.

Documentation and Deliverable

Pursuant to the tasking described above, and requirements of the existing grant agreements, the following information and documentation is provided herein, and copies of all required permits and associated reports are attached hereto.

- **NEPA Environmental Review** – A NEPA Categorical Exclusion was processed and issued by DOE, with a finding of no environmental effects on endangered species and critical habitat. The finding is on file.

- **Wetlands Determination** – The U.S. Army Corps of Engineers determined that no classified wetlands are affected by the project, and that no further action is required.

- **Archaeological and Historic Properties Review** – The Alaska State Historic Preservation Office (SHPO) issued a finding on 20 May 2015, that no significant archaeological or historic properties will be adversely affected by the project, and that no further action is required.

- **Fish Habitat and Water Discharge** – The Alaska Department of Fish and Game (ADF&G) has issued Fish Habitat Permit 15-11-082 for the project, which sets conditions for water withdrawal and discharge in or near anadromous (i.e., salmon bearing) streams located in the project area.

- **Hydrostatic and Aquifer Pump Testing** – The Alaska Department of Environmental Conservation (ADEC) has issued General Permit Number AKG003008 for discharge of fluids from drilling operations into the impoundment structure identified in the drilling plan.

- **Water Withdrawal** – The Alaska Department of Natural Resources (ADNR) has concurred with the water withdrawals required to support drilling and campsite operations. By policy, ADNR will generally withhold issuance of the withdrawal permit until immediately prior to the withdrawal in 2016. However, ADNR has provided a letter of explanation of the permitting process, and general concurrence with the withdrawal plan. The City anticipates that the permit will be issued as early as October 2015.

- **Drilling Permit** – Well design and technical specifications were submitted to the Alaska Oil and Gas Conservation Commission (AOGCC) in June 2015. On 13 August 2015, AOGCC issued Permit Number 215-080, API Number 50-295-20005-00-00, which authorizes drilling of AK-3. Permit conditions are as specified in the permit Letter of Transmittal. The City has accepted the conditions, as stated.

- **Supplemental Information** – As requested by the TMT, additional geophysical data interpretation has been completed, the results of which are set forth in the attached report from Geothermal Resource Group (GRG).

Request to Proceed with Phase II, Logistical Support and Drilling

The City has completed all permitting and property acquisition sub-tasks as required by AEA/DOE, and is prepared to move to Phase II of the project. It is hereby requested that AEA and DOE complete a review of the permits and documentation provided herewith, and authorize the City to proceed with the tasks and sub-tasks of Phase II, as detailed in the grant agreements. In order to maintain a viable schedule for logistical planning, procurement, mobilization, and startup of drilling operations, it is requested that authorization to proceed to Phase II be issued within 30 days.

Any questions or requirements for additional information should be directed to:

Ray Mann, Program Manager
RMA Consulting Group
raymann@rma-cg.com
206.290.2856

cc: Joe Bereskin, Mayor
Tuna Scanlan, City Administrator
Sean Skaling, Alaska Energy Authority
Casey Strickland, U.S. Department of Energy

Akutan Geothermal Project
2015 Environmental Permitting Summary

The NEPA Categorical Exclusion (CX) has been processed by the Department of Energy and issued for this project. One of the main issues addressed was that of endangered species, specifically Steller sea lions and their designated critical habitat. Based on the project details, it was determined that there would be "no effect" to Steller sea lions or their critical habitat and this allowed the project to remain covered by a CX instead of an Environmental Assessment or Impact Statement.

Based on field work conducted in October 2014, it was possible to avoid impacts to wetlands by placing the project features in uplands instead of wetlands. Because no wetlands were involved, there was no official correspondence from the Corps of Engineers, but the project description and data used for the determination were provided to the Corps for their information and to insure transparency. Likewise, field data from October 2014 led to a determination that no historic properties would be affected by the proposed project. The Alaska State Historic Preservation Officer concurred with this determination on May 20th, 2015.

Since there is a need to withdraw water from an anadromous (i.e. salmon bearing) stream during drilling and camp operations, a permit was required from the Alaska Department of Fish and Game. Fish Habitat Permit 15-II-082 was issued for this project on September 15th, 2015 and the permit will expire on December 31st, 2016. One permit stipulation that will require attention before and after drilling is the placement of temperature data loggers upstream of the water discharge site, adjacent to the discharge site, and downstream of the discharge site in 2016. These data will be downloaded and a report will be prepared for the Alaska Department of Fish and Game.

The Alaska Department of Environmental Conservation issued Hydrostatic and Aquifer Pump Testing general permit number AKG003008. This permit covers the discharge of water from drilling to land in the impoundment characterized in the project description.

Water withdrawal for the project is under the authority of the Alaska Department of Natural Resources (ADNR). ANDR typically issues the withdrawal permits in the year for which the activity is planned, but on September 22nd, 2015 they provided a letter stating that based on an initial review of the project they do not foresee any reason that the permit will not be issued. Coordination was made to insure the permit will be processed in 2015 instead of 2016 to keep the project on track in the award and acquisition phases. The actual permit should be issued in late October 2015 and will complete the environmental permits required for drilling in 2016.

THE STATE of ALASKA
GOVERNOR BILL WALKER

Department of Fish and Game

DIVISION OF HABITAT
Central Region Office

333 Raspberry Road
Anchorage, Alaska 99518-1565
Main: 907.267.2342
Fax: 907.267.2499

FISH HABITAT PERMIT 15-II-0082

ISSUED: September 15, 2015
EXPIRES: December 31, 2016

High Tide Environmental, LLC
Attn: Chris Hoffman
180 E. Hygrade Lane
Wasilla, Alaska 99654

—*representing*—

City of Akutan
3380 C Street, Suite 205
Anchorage, Alaska 99503

Dear Mr. Hoffman,

Re: Water Withdrawal and Geothermal Exploration – Unnamed Stream
Section 32, T. 69 S., R. 112 W., S. M.
Section 5, T. 70 S., R. 112 W., S. M.

Pursuant to AS 16.05.841(b), the Alaska Department of Fish and Game (ADF&G), Division of Habitat, has reviewed your proposal to continue geothermal exploration activities and to withdraw water from an unnamed stream near Akutan (see Proposed Project Components).

Project Description
You propose to begin Phase II of a three phase geothermal exploration project in Hot Springs Bay Valley near Akutan, which includes construction of a drill pad, retention pond, and field camp to support geothermal exploration activities, and to withdraw water from two locations on an unnamed stream for well drilling and camp use (see Proposed Project Components).

Drill Pad
The drill pad will be about 40 ft wide by 60 ft long, and will include a storage area and about a 10 sq ft by 6 ft deep sump pit. A slim-hole, core drilling rig will be used to drill a single well to a

depth of about 1,500 ft. The well will be flow tested to collect data for further characterization of the geothermal resource.

Water will be withdrawn from the unnamed stream for drill activities and the well flow test. Maximum withdrawal rate for the drill site will be 35 gpm, using a 2-inch screened intake pipe, with a total maximum daily withdrawal of 50,400 gallons. Water use will be lower most days, pumping as needed to keep up with the minimal losses from normal drilling, with an average of about 3,000 gpd. The minimum pump capacity is 14 gpm. The drilling period is estimated at 25 days.

Retention Pond

A horseshoe-shaped earthen berm will be constructed using on-site soils from the borrow area to create a retention pond about 10,000 sq ft in size (see Figure 1). The retention pond will be used to contain and cool subsurface water used during the well testing phase of this project. A silt fence will be placed about 5 ft downslope of the berm. The retention pond will be unlined to allow infiltration through the soils, with the exception of a PVC membrane on the uphill side of the berm to reduce seepage through and erosion of the berm. A pipeline will carry water from the well to the retention pond where it will be discharged onto a 10 sq ft timber splash guard to minimize scour and erosion. The pond will be monitored to maintain a minimum of 1 ft of freeboard. The berm is intended to remain in place for about 1 week. Best Management Practices have been developed for this portion of the project (see Best Management Practices Plan).

Temperature data loggers will be placed in the unnamed stream prior to flow testing the well to determine if infiltration of water from the retention pond influences the natural stream temperature. One data logger will be placed upstream of the retention pond and downstream of the drilling pad, one to two data loggers will be placed downslope of the retention pond, and one will be placed downstream of the retention pond. Data loggers will be placed to avoid natural hot springs/seeps in the stream.

Camp Site

A 16-person work camp about 30 ft wide by 50 ft long will be constructed, and water will be withdrawn from the unnamed stream to support the camp. Maximum withdrawal rate for the camp site will be 14 gpm using a 2-inch screened intake pipe, with a total maximum daily withdrawal of 1,000 gallons. Water withdrawal for camp use is anticipated to occur for about 30 to 45 days within four months.

A footbridge was previously placed over a tributary of the unnamed stream located between the retention pond and camp site (see Proposed Project Components). The tributary is about 2 ft wide by 2 ft deep, and the footbridge is placed from bank to bank above ordinary high water.

All equipment, supplies, material, and personnel for initial set up and demobilization will be transferred to and from the site by helicopter. Personnel will walk on foot from camp to work stations. During demobilization, excavated areas at the project site will be filled in and graded to match original contours, and revegetated with stockpiled vegetation mats. No materials will be left at the site. Project activities, including set up, drilling, testing, and demobilization are intended to occur during a four month period between July and December 2016.

Fish Resources
The unnamed stream supports coho and pink salmon, and Dolly Varden. Your project as proposed has the potential to obstruct the efficient passage and movement of fish. Coho and pink salmon have been observed in the unnamed stream and it will be nominated to the Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes, with an expected adoption date of July 1, 2016.

Fishway Act
In accordance with AS 16.05.841, project approval is hereby given subject to the project description above and the following stipulation:

1. To avoid entrainment, impingement, or injury to fish, a properly sized and screened structure must surround the water intake structure. The screen mesh size shall not exceed ¼-inch and the water velocity at the screen surface shall not exceed 0.5 feet per second at the screen surface. The intake screen shall be inspected for damage (torn or crushed screen, screen separated from intake ends, etc.) before and after each use. Any damage observed must be repaired prior to use of the intake structure.

You are responsible for the actions of contractors, agents, or other persons who perform work to accomplish the approved project. For any activity that significantly deviates from the approved plan, you shall notify the Division of Habitat and obtain written approval in the form of a permit amendment before beginning the activity. Any action that increases the project's overall scope or that negates, alters, or minimizes the intent or effectiveness of any stipulation contained in this permit will be deemed a significant deviation from the approved plan. The final determination as to the significance of any deviation and the need for a permit amendment is the responsibility of the Division of Habitat. Therefore, it is recommended you consult the Division of Habitat immediately when a deviation from the approved plan is being considered.

For the purpose of inspecting or monitoring compliance with any condition of this permit, you shall give an authorized representative of the state free and unobstructed access, at safe and reasonable times, to the permit site. You shall furnish whatever assistance and information as the authorized representative reasonably requires for monitoring and inspection purposes.

This letter constitutes a permit issued under the authority of AS 16.05.841 and must be retained on site during project activities. Please be advised that this determination applies only to activities regulated by the Division of Habitat; other agencies also may have jurisdiction under their respective authorities. This determination does not relieve you of your responsibility to secure other permits; state, federal, or local. You are still required to comply with all other applicable laws.

In addition to the penalties provided by law, this permit may be terminated or revoked for failure to comply with its provisions or failure to comply with applicable statutes and regulations. The department reserves the right to require mitigation measures to correct disruption to fish and game created by the project and which was a direct result of the failure to comply with this permit or any applicable law.

You shall indemnify, save harmless, and defend the department, its agents, and its employees from any and all claims, actions, or liabilities for injuries or damages sustained by any person or property arising directly or indirectly from permitted activities or your performance under this permit. However, this provision has no effect if, and only if, the sole proximate cause of the injury is the department's negligence.

Any questions or concerns about this permit may be directed to Habitat Biologist Jeanette Alas at 267-2805 or emailed to jeanette.alas@alaska.gov.

Sincerely,

Sam Cotten, Commissioner

By: Michael J. Daigneault
Regional Supervisor
Central Region Office

Enc: Proposed Project Components
Figure 1
Best Management Practices Plan

Ecc: R. Morrisett, AWT
A. Ott, ADF&G
D. Tracy, ADF&G
S. Schrof, ADF&G
H. Fitch, ADF&G
S. Ayers, ADF&G
A. Nakanishi, ADEC
M. Walton, ADNR
G. Schwartz, ADOA
A. Baldivieso, AIDEA
Regulatory, USACE

Best Management Practices Plan

Akutan Geothermal Project

Well Pumping Test

Background

As part of the Akutan geothermal test well program, upon completion of the drilling of the well, the well will be tested for its capacity. This will require pumping the well for about 12 to 16 hours at a rate of up to 20,000 gallons per hour. This discharge rate will require that Best Management Practices (BMP) be documented and implemented for the project.

BMPs

The following is a summary of the BMP that will be implemented on this project. The numbers correspond to the BMP features that appear on Figure 1.

1. The water pumped from the well will be discharged at near elevation +42 and will be discharged on to a timber plank splash pad to minimize erosion and scour at the point of discharge. The pad will be removed after testing and the area resorted as necessary.

2. The discharge water will then flow over the natural tundra vegetation and be allowed to infiltrate the surface. The soil profile at the site consists of about one foot of organic sandy soils underlain by fine to coarse sands with a trace of silt. The majority of the discharge water is expected to infiltrate as it is being pumped across the designated discharge area as shown on Figure 1. The infiltration details are presented below.

3. A containment berm will be constructed as shown on Figure 1 to contain any excess water that does not immediately infiltrate the overburden soils. This would essentially create an Infiltration Pond, described below, should the on-site soils not accept the volume of water discharged. The berm will be constructed of on on-site soil materials borrowed from just upstream of the berm. Only the borrow area will be disturbed to maintain as much surface vegetation as possible in the discharge area. Typical section of the berm and borrow area is presented on Figure 1.

4. A silt fence erosion barrier will be placed 5 feet downslope from the footprint of the berm to catch any sediment runoff. Vegetating the berm is not planned as the berm is anticipated to be in-place for no longer than one week which will not allow germination of seed to occur.

5. Upon completion of the pumping test, the berm will be leveled into the borrow area and the disturbed area restored and seeded with temporary and permanent seed.

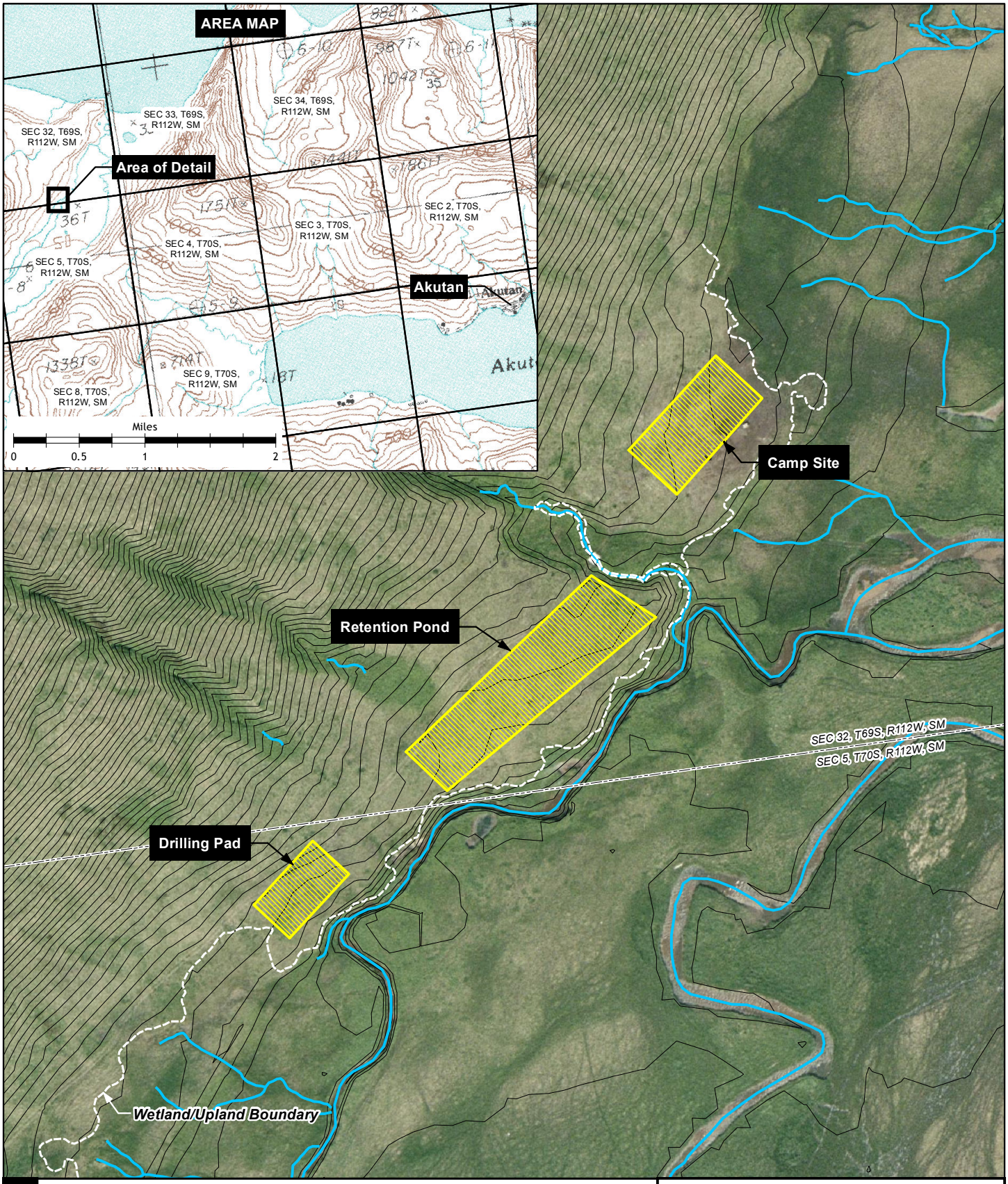
6. When constructing the berm, the organic tundra material will be isolated in the berm such that it can be salvaged and replaced over the disturbed area prior to seeding.

Infiltration Pond Design and Operation

Per Table 3-1 of the Alaska Storm Water Guide, the on-site soils may have an infiltration rate as high as 3.6 inches per hour. This would equate to 2.2 gallons per square foot. For the planned pond area of 10,000 square feet, the pond could possibly accept 22,000 gallons of water per hour with little or no retention. However, some zones of the surface soil maybe less permeable than others and some ponding is anticipated. The pond could hold up to 150,000 gallons of water with 1 foot of freeboard.

The upstream slope of the berm will be lined with a PVC membrane to reduce seepage through the berm and to protect the upstream slope from erosion.

During the pumping test the water level in the pond/discharge area will be closely monitored and a 1 foot minimum freeboard will be maintained. If the water level approached one foot of free board, the pumping test will be terminated until the water level has receded.



LEGEND

- Project Features
- Streams/Drainages
- 2 ft. Contours

Feet

0 37.5 75 150

Created by HDR, June, 09, 2015
Source: HDR 2015
Imagery Source: Aerometric 2010

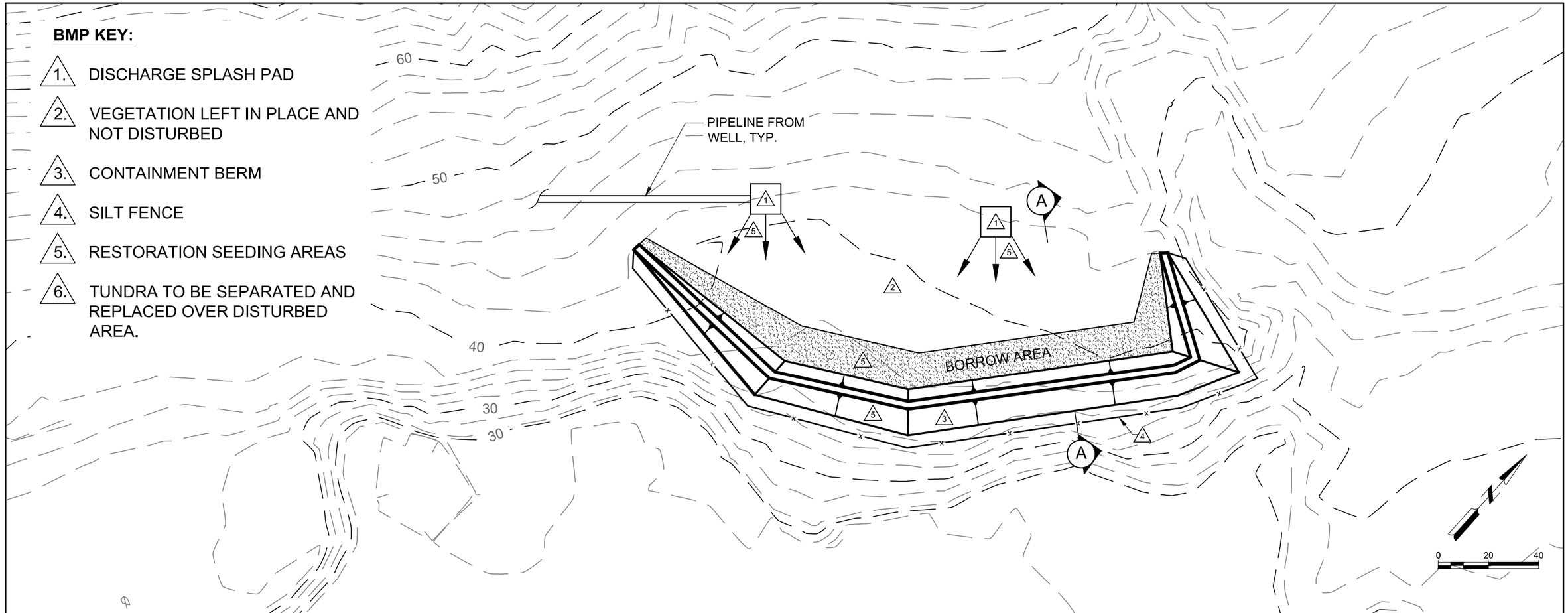
2015 DRILLING PROJECT AKUTAN GEOTHERMAL DEVELOPMENT PROJECT

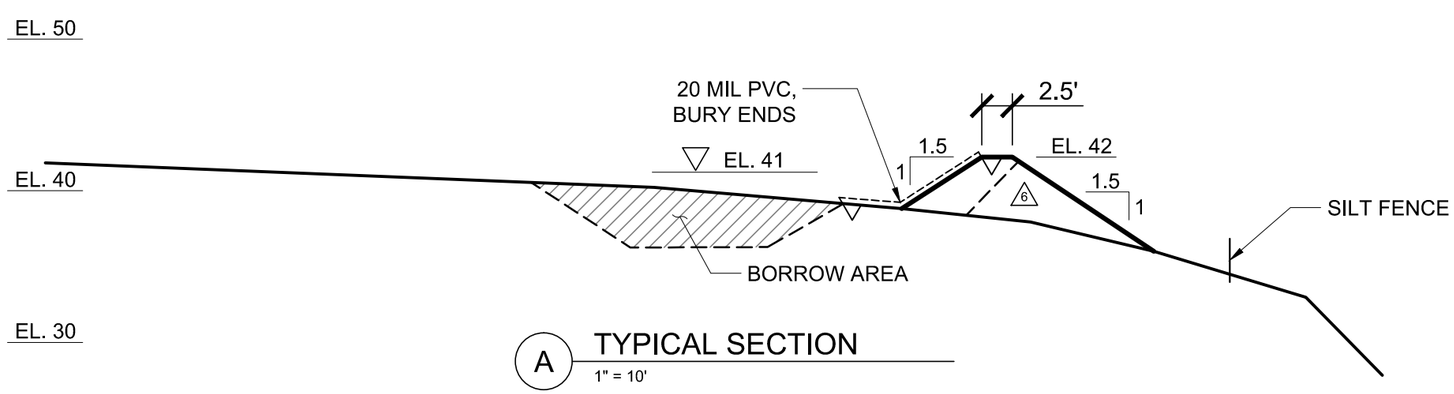
AKUTAN, ALASKA

PROPOSED PROJECT COMPONENTS

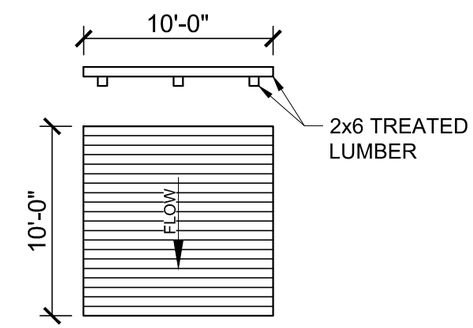
BMP KEY:

1. DISCHARGE SPLASH PAD
2. VEGETATION LEFT IN PLACE AND NOT DISTURBED
3. CONTAINMENT BERM
4. SILT FENCE
5. RESTORATION SEEDING AREAS
6. TUNDRA TO BE SEPARATED AND REPLACED OVER DISTURBED AREA.





A TYPICAL SECTION
1" = 10'



SPLASH PAD DETAIL
NOT TO SCALE

RMA CONSULTING
AKUTAN ISLAND
AKUTAN GEOTHERMAL PROJECT

3054300-100001.01
4/23/15

FIGURE 1: BMP PLAN

Mead & Hunt

5/4/2015 10:00:53 AM
X:\3054300\100001.01\0000411\TECH\CAD\AKUTAN ACCESS ROAD\EXHIBITS\FIGURE 1 - BMP PLAN.DWG

Best Management Practices Plan

Akutan Geothermal Project

Well Pumping Test

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During the pumping test the water level in the pond/discharge area will be closely monitored and a 1 foot minimum freeboard will be maintained. If the water level approached one foot of free board, the pumping test will be terminated until the water level has receded.

THE STATE of ALASKA
GOVERNOR BILL WALKER

Department of Environmental Conservation
DIVISION OF WATER
Wastewater Discharge Authorization Program

555 Cordova Street
Anchorage, Alaska 99501-2617
Main: 907.269.6285
Fax: 907.334.2415
www.dec.alaska.gov/water/wwdp

July 2, 2015

Herman Scanlan
City of Akutan
3380 C Street, Suite 205
Anchorage, Alaska 99503

Re: **Authorization AKG003008: Akutan Geothermal**

Dear Mr. Scanlan,

The Alaska Department of Environmental Conservation (DEC) has completed its review of your AKG003000 Hydrostatic and Aquifer Pump Testing Notice of Intent (NOI) for the Akutan Geothermal and is issuing authorization number AKG003008 for this project. The discharge from this project is authorized in accordance with the terms of the general permit and any site specific requirements in this authorization.

An electronic copy of the Hydrostatic and Aquifer Pump Testing general permit is available at http://dec.alaska.gov/water/wnpspc/stormwater/docs/AKG003000_Hydrostatic_GP_Permit.pdf and a copy of this authorization letter is posted to the DEC water permit search http://dec.alaska.gov/Applications/Water/WaterPermitSearch/ Search.aspx.

The authorization effective date is 7/2/2015.

The authorization to discharge expires upon submittal of a Notice of Termination, see Permit Part 7.

The authorized discharge location is to land as described in the NOI.

The following are site specific conditions:

- If evidence of an oily sheen or odor is observed during the project, the discharge shall cease. The permittee shall contact the Alaska Department of Environmental Conservation Contaminated Sites Program (269-3063) for approval to resume discharging.

The permittee is reminded of the following permit requirements:

- Compliance with Standards and Limits, see Permit Part 3.1 Requirements for all Projects.
- Control Measures, see Permit Parts 4.0 and 4.1 – Erosion and Sediment Control Measures.
- Limitations, Inspections, and Monitoring Requirements, see Permit Part 5.3 Land Disposal Discharges of Aquifer Pump Testing Water.
- Reporting and Recordkeeping, see Permit Part 6.

A copy of the General Permit AKG003000 and this authorization must be kept at the project site. This authorization does not relieve the permittee from other local, state, or federal government permitting requirements.

If you have any questions concerning this authorization, please call (907) 334-2288.

Sincerely,

James Rypkema
Program Manager, Storm Water and Wetlands

Cc: Merry Johnson, DNR- Water Resources Section
Christopher Hoffman, High Tide Environmental

For Agency Use

OASYS #: HAPT-0014

Permit #: AKG003008

Notice of Intent (NOI) for Hydrostatic or Aquifer Pump Testing Discharges to be authorized under an APDES Hydrostatic or Aquifer Pump Testing Discharges General Permit

Submission of this Notice of Intent (NOI) constitutes notice that the party identified in Section I of this form requests authorization to discharge pursuant to the APDES Hydrostatic or Aquifer Pump Testing Discharges GP. Submission of this NOI also constitutes notice that the party identified in Section I of this form meets the eligibility requirements of the Hydrostatic or Aquifer Pump Testing Discharges GP for the project identified in Section III of this form. Permit coverage is required prior to commencement of the hydrostatic or aquifer pump testing discharges activity until you are eligible to terminate coverage as detailed in the Hydrostatic or Aquifer Pump Testing Discharges GP. To obtain authorization, you must submit a complete and accurate NOI form, Best Management Practices (BMP) Plan, and application fee. Refer to the instructions at the end of this form.

I. Applicant Information

Organization:	City of Akutan					
Contact Person:	Herman Scanlan					
Mailing Address:	Street (PO Box):	3380 C Street, Ste 205				
	City:	Anchorage	State:	AK	Zip:	99503
	Phone:	907-274-7565	Fax (optional):			
	Email:	tuna.scanlan@akutanak.us				

II. Billing Contact Information

Organization:	City of Akutan					
Contact Person:	Mary Tesche					
Mailing Address:	Street (PO Box):	3380 C St., Suite 205				
	City:	Anchorage	State:	AK	Zip:	99503
	Phone:	907-777-1643	Fax (optional):			
	Email:	mary.tesche@akutanak.us				

III. Project/Site Information

Project/Site Name:	Akutan Geothermal					
Project Description:	This is a geothermal exploration project on Native-owned land in the Hot Springs Bay Valley on Akutan Island. At the completion of drilling, the well will be flow tested for the collection of flow and temperature data.					
Estimated Project Start Date:	07/16/2015	Estimated Project Completion Date:	11/30/2016			
Project Location	Street:	NA				
	City:	Akutan	State:	Alaska	Zip:	99553
	Borough or Similar Government Subdivision:	Aleutians East				
	Latitude:	54.150275	Determined By:	☑ GPS	☐ USGS topographic map	
	Longitude:	-165.862568	☐ Other:			
	If you used a USGS topographic map, what was the scale?					

IV. Discharge Information

Discharge Flow Rates:	Maximum anticipated discharge flow rate	320000	gallons per day (GPD)
	Average anticipated discharge flow rate	320000	gallons per day (GPD)
	Total anticipated discharge	320000	gallons
	Discharge velocity at the end of pipe	1	feet per second (fps)

General Description of **Hydrostatic** or **Aquifer Pump Testing** Activities:

Best Management Practices Plan
Akutan Geothermal Project
Well Pumping Test

Background

As part of the Akutan geothermal test well program, upon completion of the drilling of the well, the well will be tested for its capacity. This will require pumping the well for about 12 to 16 hours at a rate of up to

Is the discharge to land? ☑ Yes ☐ No

Identify the names(s) of waterbodies to which you will discharge to: *(Note, if the discharge is to land, please enter N/A - Not Applicable)* ☐ N/A

Not applicable. This is a discharge to land.

If you have **aquifer pump testing** discharges to **Waters of the U.S.**; have you submitted the required total metals analysis for the parameters listed in Table 5 with your NOI?	☐ Yes	☐ No	☐ NA
If "Yes" have you contacted the DEC-Contaminated Sites Group?	☐ Yes	☐ No	☐ NA
Do you have a**quifer pump testing discharges** either to land or water which are located within a 1,500 feet of an "Active DEC identified contaminated site or groundwater plume*"? **A contaminated site or groundwater plume with an "Active" or "Cleanup Complete-Institutional Controls" status identified by DEC Contaminated Sites Program. For Assistance in locating mapped contaminated sites and listing of groundwater plumes, see http://dec.alaska.gov/Water/wnpspc/stormwater/edhsgp.html.*	☐ Yes	☑ No	☐ NA

If Yes, describe the BMPs to be implemented in your certified BMP plan to insure pumping does not affect the contaminated area.

Has all permit required additional documentaion described in Part 2.2 of the permit for **aquifer pump testing** discharges located within 1,500 feet of an active DEC mapped contaminated site or plume been submitted with the NOI for review by DEC?	☐ Yes	☐ No	☑ NA

V. BMP Plan required to describe how the wastewater discharge will be managed

Has a BMP Plan been developed in accordance to Part 2.2.8 of the Hydrostatic and Aquifer Pump Testing general permit?	☑ Yes	☐ No	
Has the certified BMP Plan been submitted to DEC with the NOI?	☑ Yes	☐ No	

OASYS #: HAPT-0014

Permit #: AKG003008

VI. Certification Information

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Printed Name	Title	Organization
Hermann J Scanlan	City Administrator	City of Akutan

Signature	Date
E- Signed by: Hermann J Scanlan	6/24/2015

Phone	Email
907-274-7565	tuna.scanlan@akutanak.us

Application Preparer (Complete if NOI was prepared by someone other than the certifier)

Printed Name	Title	Organization
Christopher A Hoffman	Owner/CEO	High Tide Environmental

Phone	Email
9073543132	Chris@hightidealaska.com

VII. Documents Attachments

Documents attached with this application:

Best Management Practices Plan.pdf
Figure 1 - BMP Plan-MH11x17.pdf

Who Must File an NOI Form:
The following situations will require NOI and Best Management Practices (BMP) Plan submittal;

- applicants which discharge eligible hydrostatic or aquifer pump testing discharges to waters of the U.S., and
- aquifer pump testing discharges to the land of 30,000 gallons per day or greater, or
- aquifer pump testing located within a 1,500 feet of an active DEC mapped contaminated site or plume.

Completing the Form
Obtain and read a copy of the APDES Hydrostatic and Aquifer Pump Testing general permit. Type or print, in the appropriate areas only. "NA" can be entered in areas that are not applicable. If you have any questions about how or when to use this form, contact the DEC Storm Water Program at (907) 269-6285 or online at http://dec.alaska.gov/water/wnpspc/stormwater.

Section I. Applicant Information
The applicant that is conducting the hydrostatic or aquifer pump testing and has responsibility for on-site operations necessary to assure compliance to the permit shall complete and submit an NOI.

Section II. Billing Contact Information
Provide the name of the contact person, and the legal name of the firm, public organization, or any other entity that is responsible for accounts payable for this project. Also provide the billing contact's mailing address, telephone number, fax number (optional) and email address. Correspondence for billing purposes will be sent to this address. If the billing contact is that same as the applicant, check the box and continue to Section III Project/Site Information.

Section III. Project/Site Information
Enter the official or legal name and complete street address, including city, state, zip code, and borough or similar government subdivision of the project or site. If the project or site lacks a street address, indicate the general location of the site (e.g., Intersection of State Highways 1 and 2). Complete site information must be provided for permit coverage to be granted.

The applicant must also provide the latitude and longitude of the project area either in degrees, minutes, seconds; degrees, minutes, decimal; or decimal format. The latitude and longitude of your project area can be determined in several different ways, including through the use of global positioning system (GPS) receivers, U.S. Geological Survey (U.S.G.S.) topographic or quadrangle maps, and EPA's web-based siting tools, among others. Refer to http://cfpub.epa.gov/npdes/stormwater/latlong.cfm for further guidance on the use of these methodologies. For consistency, DEC requests that measurements be taken from the approximate center of the discharge point. Applicants must specify which method they used to determine latitude and longitude. If a U.S.G.S. topographic map is used, applicants are required to specify the scale of the map used. Enter the estimated start and completion dates using four digits for the year (i.e., 05/27/2009).

Section IV. Discharge Information
Enter the name(s) of receiving water bodies to which the hydrostatic or aquifer pump testing project will discharge. These should be the first bodies of water that the discharge will reach. (Note: If you discharge to more than one water body, please indicate all such waters in the space provided and attach a separate sheet if necessary.) For example, if the discharge leaves your site and travels through a roadside swale or a storm sewer and then enters a stream that flows to a river, the stream would be the receiving water body. Waters of the U.S. include lakes, streams, creeks, rivers, wetlands, impoundments, estuaries, bays, oceans, and other surface bodies of water within the confines of the U.S. and U.S. coastal waters. Waters of the U.S. do not include man-made structures created solely for the purpose of wastewater treatment. U.S.G.S. topographical maps may be used to make this determination. If the map does not provide a name, use a format such as "unnamed tributary to Cross Creek". If you discharge into a municipal separate storm sewer system (MS4), you must identify the water body into which that portion of the storm sewer discharges. That information should be readily available from the operator of the MS4.

Indicate the anticipated discharge flow rate, average flow rate, and the total anticipated discharge with your estimated discharge velocity at the discharge point. Information shall also be provided to determine if the discharge is to a land disposal area and if the aquifer pump testing discharge volume will equal or exceed 30,000 gallons per day. Additional state agency contact may be necessary which should be noted in the NOI.

Section V. BMP Plan
In accordance with Part 2.2.8 of the permit all hydrostatic testing including flushing and aquifer pump testing discharges which require NOI submittal are required to submit a BMP plan to describe how the wastewater discharge will be managed. Questions were added to the NOI to specify that a BMP plan shall be developed, certified, and submitted with the NOI.

Section VI. Certification Information
The NOI and BMP must be signed as follows:

(1) For a corporation, a responsible corporate officer shall sign the NOI, a responsible corporate officer means:

(A) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation; or

(B) the manager of one or more manufacturing, production, or operating facilities, if

(i) the manager is authorized to make management decisions that govern the operation of the regulated facility, including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental statutes and regulations;

(ii) the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and

(iii) authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

(2) For a partnership or sole proprietorship, the general partner or the proprietor, respectively; or

(3) For a municipality, state, or other public agency, either a principal executive officer or ranking elected official shall sign the application; in this subsection, a principal executive officer of an agency means

(A) The chief executive officer of the agency; or

(B) A senior executive officer having responsibility for the overall operations of a principal geographic unit or division of the agency.

Include the name, title, and email address of the person signing the form and the date of signing. An unsigned or undated NOI form will not be considered valid application for permit coverage. If the NOI was prepared by someone other than the certifier (for example, if the NOI

was prepared by a consultant for the certifier's signature), include the name, organization, telephone number and email address of the NOI preparer.

Where to File NOI form:
DEC encourages you to complete the NOI form electronically via the Internet. DEC's Online Application System (OASys) can be found at http://dec.alaska.gov/water/wnpspc/stormwater/APDESeNOI.html. Filing electronically is the fastest way to obtain permit coverage and help ensure that your NOI is complete. If you choose not to file electronically, you must send the NOI to the address listed below.

If you file by mail, please submit the original form with a signature in ink. DEC will not accept a photocopied signature for NOIs submitted by mail. Remember to retain a copy for your records.

NOIs sent by mail:

Alaska Dept. of Environmental Conservation
Wastewater Discharge Authorization Program
555 Cordova Street
Anchorage, AK 99501
Phone: (907) 269-6285

THE STATE of ALASKA
GOVERNOR BILL WALKER

Department of Natural Resources
DIVISION OF MINING LAND AND WATER/
WATER RESOURCES SECTION
Street Address, Suite 1080
Anchorage, AK 99501-3579
Main: 907.269.8641
Fax: 907.269.8904

September 22, 2015

Casey Strickland
Physical Scientist/NEPA Specialist
15013 Denver West Parkway
Golden, CO 80401
Phone: 720-356-1575

Dear Casey:

Per our earlier telephone conversation this morning, (September 14, 2015), I wish to confirm for you the status of the City of Akutan's pending Application for Temporary Water Use under file number TWUA A2015-68.

While this application was received on May 13, 2015, our office prioritizes applications based on the work start date. In the case of the City of Akutan's temporary water use application under TWUA A2015-68, our office was informed that the expected work start date was the summer of 2016. This would place the actual adjudication in the early spring of 2016. In this particular application, (for a test well in support of geothermal exploration), as the application has already passed initial screening, there are no apparent issues that would preclude the issuance of an authorization to withdraw water for this project. Furthermore, there do not appear to be any other subsurface water right holders within the proposed project area. This fact significantly reduces the impact of any objections to the proposed project and further increases the likelihood of a successful issuance.

While the Water Resources Section cannot and will not, guarantee an applicant the issuance of any application until the actual adjudication is completed; it is noteworthy that Alaska Statute 46.15, the Alaska Water Use Act is heavy on the use of "Shall" and "unless"; to date for application TWUA A2015-68, the "shalls" outnumber the "unlesses".

Sincerely,

Henry Brooks

Henry Brooks
Natural Resource Manager I
907-269-8641
cc: Lesli Schick, Natural Resources Specialist I

THE STATE of ALASKA
GOVERNOR BILL WALKER

Alaska Oil and Gas Conservation Commission
333 West Seventh Avenue
Anchorage, Alaska 99501-3572
Main: 907.279.1433
Fax: 907.276.7542
www.aogcc.alaska.gov

8/20/15

Hermann Scanlan
City Administrator
City of Akutan
3380 C Street, Suite 295
Anchorage, AK 99503

Re: Exploratory, Hot Springs Bay Valley, AK-3
City of Akutan
Permit No: 215-080
Surface Location: 2600' East Line, 70' from the North Line, T70S, R112W, Sec. 5, SM
Bottomhole Location: 2600' East Line, 70' from the North Line, T70S, R112W, Sec. 5, SM

Dear Mr. Scanlan:

Enclosed is the approved application for permit to drill the above referenced geothermal exploratory well.

This permit application is approved contingent upon the following conditions:

1. Well operations shall be conducted in accordance with 20 AAC 25.
2. Pursuant to 20 AAC 25.035 (h) (1), alternate BOPE is approved.
3. Pursuant to 20 AAC 25.035 (h) (2), the diverter requirement is waived.
4. Pursuant to 20 AAC 25.061 (c), the near surface survey requirement is waived.
5. Pursuant to 20 AAC 25.066 (d) (3), alternate gas detection equipment is approved. At least one methane detector and one H2S detector are required.
6. Test BOPE to 750 psi on a seven-day frequency.
7. Submit all LOT charts/data with final 10-407 report.
8. Core chips, core descriptions, core photographs and core analysis, if any analysis are conducted, are required to be submitted to the AOGCC per 20 AAC 25.071.
9. Flow or injection tests: pressure, temperature and flow charts and data (both qualitative and quantitative) recorded during every flow/injection test are required to be submitted to the AOGCC per 20 AAC 25.071.
10. Inclination Survey shall be conducted in the well to determine the inclination from vertical with surveys starting at 500 feet and no more than 500 feet apart to total depth per 20 AAC 25.050.
11. Fluid Samples: Geochemical analysis, if acquired, are to be submitted to the AOGCC per 20 AAC 25.071.

Pursuant to 20 AAC 25.071(b)(2), dry cuttings samples must be submitted to the Commission. The preferred sample interval is 10', with a maximum of 30'.

A final as-built survey plat showing the location of the well at the surface referenced to governmental section lines and expressed in Alaska State Plane coordinates referenced to NAD 27 must be filed with the Well Completion or Recompletion Report and Log. Survey must be conducted by a certified land surveyor.

This permit to drill does not exempt you from obtaining additional permits or approvals required by law from other governmental agencies, and does not authorize conducting drilling operations until all other required permits and approvals have been issued. In addition, the Commission reserves the right to withdraw the permit in the event it was erroneously issued. A weekly status report is required from the time the well is spudded until it is suspended or plugged and abandoned. The report should be a generalized synopsis of the week's activities and is exclusively for the Commission's internal use.

Operations must be conducted in accordance with AS 31.05 and Title 20, Chapter 25 of the Alaska Administrative Code unless the Commission specifically authorizes a variance. Failure to comply with an applicable provision of AS 31.05, Title 20, Chapter 25 of the Alaska Administrative Code, or a Commission order, or the terms and conditions of this permit may result in the revocation or suspension of the permit.

Sincerely,

Cathy P. Foerster
Chair

DATED this 13th day of August, 2015.

STATE OF ALASKA
ALASKA OIL AND GAS CONSERVATION COMMISSION

RECEIVED AUG 04 2015

PERMIT TO DRILL

20 AAC 25.005

—Revised—

1a. Type of Work:	1b. Proposed Well Class:			1c. Specify if well is proposed for:
Drill ☑ Lateral ☐	Stratigraphic Test ☐	Development - Oil ☐	Service - Winj ☐	Single Zone ☐	Coalbed Gas ☐ Gas Hydrates ☐
Redrill ☐ Reentry ☐	Exploratory ☑	Development - Gas ☐	Service - Supply ☐	Multiple Zone ☐	Geothermal ☑ Shale Gas ☐
		Service - WAG ☐	Service - Disp ☐		

2. Operator Name: City of Akutan

5. Bond: Blanket ☐ Single Well ☑ Bond No. 402-96

11. Well Name and Number: AK-3

3. Address: 3380 C Street Suite 295 Anchorage 99503-3952

6. Proposed Depth: MD: 1700 ft TVD: 1700 ft

12. Field/Pool(s): Hot Springs Bay Valley

4a. Location of Well (Governmental Section):
Surface: ~ 2600ft from East line, 70 ft. from north lineT70S R112W S005 Seward Meridian
Top of Productive Horizon: Same
Total Depth: Same

7. Property Designation (Lease Number): Surface - Akutan Corporation Subsurface - The Aleut Corporation

8. Land Use Permit: Exploration agreements attached

13. Approximate Spud Date: 21-Jul-15

9. Acres in Property: 1/4 Acre

14. Distance to Nearest Property:

4b. Location of Well (State Base Plane Coordinates - NAD 27):
Surface: x- ~~426726.1~~ 530976.68 y- ~~78180.6~~ 55919.03 Zone- 18

10. KB Elevation above MSL: 46 feet
GL Elevation above MSL: 41 feet

15. Distance to Nearest Well Open to Same Pool: none

16. Deviated wells: n/a Kickoff depth: n/a feet
Maximum Hole Angle: n/a degrees

17. Maximum Anticipated Pressures in psig (see 20 AAC 25.035)
Downhole: 750 Surface: 140

18. Casing Program:

Hole (")	Casing (")	Weight (ppf)	Grade	Coupling	Length (ft)	Top - Setting Depth - Bottom MD (ft)	TVD (ft)	MD (ft)	TVD (ft)	Cement Quantity (cuft) (including stage data)
10.75	8.625	24	J/K55	WELDED	40	0	0	40	40	18, with 100% excess, thru tremie
7.5	5.5	17	J/K55	VFJ	220	0	0	220	220	70, with 120% excess, single stage
4.834	4.5	11.7	J/K55	VFJ	800	0	0	800	800	30, with 120% excess, single stage
3.789	3.5	7.7	NW/HQ-4130	ROD THREAD	1700	700	700	1700	1700	n/a-Set on bottom
n/a	2.2	4.04	BQ-4130	ROD THREAD	800	0	0	800	800	n/a-Hang from surface if needed

19 **PRESENT WELL CONDITION SUMMARY** (To be completed for Redrill and Re-Entry Operations)

Total Depth MD (ft):	Total Depth TVD (ft):	Plugs (measured):	Effect. Depth MD (ft):	Effect. Depth TVD (ft):	Junk (measured):

Casing	Length	Size	Cement Volume	MD	TVD
Conductor/Structural					
Surface					
Intermediate					
Production					
Liner					

Perforation Depth MD (ft): Perforation Depth TVD (ft):

20. Attachments: Property Plat ☐ BOP Sketch ☑ Diverter Sketch ☐ Drilling Program ☑ Seabed Report ☐ Time v. Depth Plot ☑ Drilling Fluid Program ☑ Shallow Hazard Analysis ☐ 20 AAC 25.050 requirements ☐

21. Verbal Approval: Commission Representative: Date 29-Jun-15

22. I hereby certify that the foregoing is true and correct.

Contact 907-274-7565
Email tuna.scanlan@akutanak.us

Printed Name Hermann Scanlan Title City Administrator

Signature Phone 907-274-7565 Date 6/29/15

Commission Use Only

Permit to Drill Number: 215-080 API Number: 50-295-20005-00-00 Permit Approval Date: 8-13-15 See cover letter for other requirements.

Conditions of approval: If box is checked, well may not be used to explore for, test, or produce coalbed methane, gas hydrates, or gas contained in shales: ☑

Other: * See Transmittal Letter for "Conditions of Approval."

Cutting Samples req'd: Yes ☑ No ☐ Mud log req'd: Yes ☑ No ☐
H_2S measures: Yes ☑ No ☐ Directional svy req'd: Yes ☐ No ☑
Spacing exception req'd: Yes ☐ No ☑ Inclination-only svy req'd: Yes ☑ No ☐
cork chips required per 20 AAC 25.07

Approved by: COMMISSIONER APPROVED BY THE COMMISSION Date: 8-13-15

Form 10-401 (Revised 10/2012) This permit is valid for 24 months from the date of approval (20 AAC 25.005(g)) Submit Form and Attachments in Duplicate

DUPLICATE

RECEIVED
MAY 08 2015
AOGCC

STATE OF ALASKA
ALASKA OIL AND GAS CONSERVATION COMMISSION

PERMIT TO DRILL

20 AAC 25.005

1a. Type of Work:	1b. Proposed Well Class:			1c. Specify if well is proposed for:
Drill ☑ Lateral ☐	Stratigraphic Test ☐	Development - Oil ☐	Service - Winj ☐	Single Zone ☐	Coalbed Gas ☐ Gas Hydrates ☐
Redrill ☐ Reentry ☐	Exploratory ☑	Development - Gas ☐	Service - Supply ☐	Multiple Zone ☐	Geothermal ☑ Shale Gas ☐
		Service - WAG ☐	Service - Disp ☐		

2. Operator Name: City of Akutan	5. Bond: Blanket ☐ Single Well ☑ Bond No.	11. Well Name and Number: AK-3
3. Address: 3380 C Street Suite 295 Anchorage 99503-3952	6. Proposed Depth: MD: 1700 ft TVD: 1700 ft	12. Field/Pool(s): Hot Springs Bay Valley
4a. Location of Well (Governmental Section): Surface: ~ 2600ft from East line, 70 ft. from north lineT70S R112W S005 Seward Meridian	7. Property Designation (Lease Number): Surface - Akutan Corporation Subsurface - The Aleut Corporation	
Top of Productive Horizon: Same	8. Land Use Permit: Exploration agreements attached	13. Approximate Spud Date: 21-Jul-15
Total Depth: Same	9. Acres in Property: 1/4 Acre	14. Distance to Nearest Property:
4b. Location of Well (State Base Plane Coordinates - NAD 27): Surface: x- -126726.1 y- 78180.6 Zone- 7-8	10. KB Elevation above MSL: 46 feet GL Elevation above MSL: 41 feet	15. Distance to Nearest Well Open to Same Pool: none
16. Deviated wells: n/a Kickoff depth: n/a feet Maximum Hole Angle: n/a degrees	17. Maximum Anticipated Pressures in psig (see 20 AAC 25.035) Downhole: 750 Surface: 140	

18. Casing Program:

Hole (")	Casing (")	Weight (ppf)	Grade	Coupling	Length (ft)	Top - Setting Depth - Bottom MD (ft)	TVD (ft)	MD (ft)	TVD (ft)	Cement Quantity (cuft) (including stage data)
10.75	8.625	24	J/K55	WELDED	40	0	0	40	40	18, with 100% excess, thru tremie
7.5	5.5	17	J/K55	VFJ	220	0	0	220	220	70, with 120% excess, single stage
4.834	4.5	11.7	J/K55	VFJ	800	0	0	800	800	30, with 120% excess, single stage
3.789	3.5	7.7	NW/HQ-4130	ROD THREAD	1700	700	700	1700	1700	n/a-Set on bottom (Slotted)
n/a	2.2	4.04	BQ-4130	ROD THREAD	800	0	0	800	800	n/a-Hang from surface if needed

19 **PRESENT WELL CONDITION SUMMARY** (To be completed for Redrill and Re-Entry Operations)

Total Depth MD (ft):	Total Depth TVD (ft):	Plugs (measured):	Effect. Depth MD (ft):	Effect. Depth TVD (ft):	Junk (measured):

Casing	Length	Size	Cement Volume	MD	TVD
Conductor/Structural					
Surface					
Intermediate					
Production					
Liner					

Perforation Depth MD (ft): Perforation Depth TVD (ft):

20. Attachments: Property Plat ☐ BOP Sketch ☑ Drilling Program ☑ Time v. Depth Plot ☑ Shallow Hazard Analysis ☐
Diverter Sketch ☐ Seabed Report ☐ Drilling Fluid Program ☑ 20 AAC 25.050 requirements ☐

21. Verbal Approval: Commission Representative: Date

22. I hereby certify that the foregoing is true and correct. Contact

Email

Printed Name Hermann J. Tuna Scanlan D.P.A. Title City Administrator

Signature Phone 907-274-7565 Date 1-May-15

Supersedes Permit to Drill 214-080

Commission Use Only

Permit to Drill Number: 215-080	API Number: 50-295-20005-00-00	Permit Approval Date:	See cover letter for other requirements.

Conditions of approval : If box is checked, well may not be used to explore for, test, or produce coalbed methane, gas hydrates, or gas contained in shales: ☐

Other:

Samples req'd: Yes ☐ No ☐ Mud log req'd: Yes ☐ No ☐
H_2S measures: Yes ☐ No ☐ Directional svy req'd: Yes ☐ No ☐
Spacing exception req'd: Yes ☐ No ☐ Inclination-only svy req'd: Yes ☐ No ☐

Approved by: COMMISSIONER APPROVED BY THE COMMISSION Date:

DUPLICATE

Form 10-401 (Revised 10/2012) This permit is valid for 24 months from the date of approval (20 AAC 25.005(g)) Submit Form and Attachments in Duplicate

Geothermal Resource Group
TAPPING THE EARTH'S ENERGY

Geothermal Resource Group, Inc.
77530 Enfield Lane, Building E
Palm Desert, CA 92211
Phone: 760-341-0186

AK-3 - DRILLING PLAN FOR ALASKA OIL AND GAS CONSERVATION COMISSION PERMIT TO DRILL APPLICATION

City of Akutan

Prepared By: Geothermal Resource Group Inc.

April 29, 2015 (1st revision)

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List of Abbreviations

AGL - Above ground level

API - American Petroleum Institute

ASAP - As soon as possible

BGL - Below ground level

BHA - Bottom hole assembly

BHST – Bottom hole static temperature

BOP - Blow out prevention, preventer

BOPE - Blowout prevention equipment

BTC - Buttress threaded coupling

DLS - Dog leg severity

DP - Drill pipe

FG - Fracture gradient

HSBV- Hot Springs Bay Valley

GL - Ground level

IADC - International Association of Drilling Contractors

ID - Inner diameter

LCM - Lost circulation material

LOT - Leak off test

MD - Measured depth

MW - Mud Weight

MWD - Measurement while drilling

NMDC - Non-magnetic drill collar

NPT - National pipe thread taper

OD - Outer diameter

POH - Pull out of hole

PPB - Pounds per barrel

PPF - Pounds per foot

PPG - Pounds per gallon

RKB – Rotary Height

SOW - Slip on weld

TBD - To be discussed, determined

TD - Total (target) depth

TOC - Top of cement

TOL - Top of liner

TVD - True vertical depth

w/ - With

WOC - Wait on cement

WT - Wall Thickness

Introduction

A well location has been selected for a resource confirmation well to be drilled at the Akutan geothermal area located in Hot Springs Bay Valley (HSBV). A small diameter well will be drilled into the conceptualized resource outflow of the Akutan geothermal system. This will be the third exploration well drilled in HSBV. The goals of the project are:

- Identify a drilling target and well site within the hot springs area of HSBV
- Construct drilling site improvements and establish a base camp
- Drill and test a resource confirmation well at the approved target location
- Assess the probability of producing commercial quality geothermal resources from production wells
- Prepare a bankable feasibility study to support development investment/financing

To achieve these goals, a well was designed to intersect the resource at a depth at which the flow test and injection test are possible for resource characterization. All equipment and personnel will be transported by helicopter, limiting the rig size and, therefore, capability.

Site selection for the new well is based on data collected since 2009, including the data from the 2010 drilling campaign. Through reexamination of the data and reports, including reprocessing of the 2012 gravity survey data and building a 3D visualization in GOCAD software, the target site was selected close to the hot springs in lower HSBV located 450' southwest of TG-2 drilled in 2010.

Planned Wellhead Coordinates

WGS84 Zone 3 coordinates: 443969E 6000805N

Ground Elevation: 41' ASL (UTM)

Planned Drilling Equipment

Drilling Contractor: Major Drilling

Equipment List:

1. One (1) unitized heliportable LF-90 core drilling rig
2. One (1) supply pump with 3,000' waterline
3. One (1) light plant
4. One (1) substructure
5. One (1) mud circulation unit
6. One (1) mud mixing unit and tank
7. One (1) mud pump
8. 1,700 feet each of PQ and HQ size core rods and 850' BQ size core rods.

Planned Well Construction[1]

Hole (")	Casing (")	Weight (ppf)	Grade	Connection	Depth (')
10-3/4	8-5/8	16.96	J55 or K55	WELD	± 40
7-1/2	5-1/2	15.5	J55 or K55	VFJ	± 220
PQ (4.834)	4-1/2	11.6	J55 or K55	VFJ	± 800
HQ (3.789)	3-1/2	7.7	HQ Rod or NW casing (blank and perforated)	Q rod or WT	±700 - ±1,700 (100' blank liner lap)

Drilling Plan

Outline

1. Improve location, build cellar and sump.
2. Move in and rig up drilling rig and associated equipment. Install H_2S and Methane detectors.
3. Prepare for drilling operations.
4. Drill 10-3/4" hole to ±40' (core with PQ (4.834") bit, open to 10-3/4"). Use spud mud.
5. Run and cement 8" conductor. WOC. Perform top jobs if and as needed. → Need Survey LAT LONG
6. Drill 7-1/2" hole to ±220' (core with PQ (4.834") bit, open to 7-1/2"). Use spud mud and switch to gel/polymer mud (See Figure 1). → "No Diverter" WAIVER
7. Run and cement 5-1/2" casing. WOC. Perform top jobs if and as needed.
8. Install casing head, master valve, and BOP system. Install blow down and kill lines. Function test surface equipment.
9. Test 5 1/2" casing and BOPE to 750 psi (See Appendix A). Annular. 1st Test (submit form 10-424 BOPE report) Drill cement, 20' formation, and conduct LOT to a maximum of 1 psi/ft (See Appendix B). 230' x 1psi = 230 psi BHP (9.0 ppg mud = .46 psi ft = 107 psi)
10. Core PQ (4.834") hole to ±800'.
11. Run and cement 4-1/2" casing. WOC. Perform top jobs if and as needed.
12. Cut 5-1/2" and 4-1/2" casing stubs above ground level. Reinstall casing head and master valve. Install Flow tee and BOP system. Install blow down and kill lines. Function test surface equipment.
13. Test 4 1/2" casing and BOPE to 750 psi (See Appendix A). 2ND Test Drill cement, 20' formation, and conduct LOT to a maximum of 1 psi/ft (See Appendix B).
14. Core HQ (3.789") hole to 1,700'.
15. Run in hole to total depth and change hole over to clean water.
16. Rig up and run P/T surveys. Perform step-rate injection and water loss tests.

gh 8-13-15

[1] All depths in this plan are MD from RKB (5' AGL) unless specified otherwise

17. Run blank and perforated HQ Rod or NW (3-1/2") liner to 1,700'.
18. Nipple down BOP system and install permanent wellhead equipment (See Figure 10). Do not hang BQ (2.2") tubing if the well is deemed to flow without airlifting.
    → Close GATE VALVE
19. Shut well in.
20. Release rig and demobilize; or prepare for flow tests.

Casing Specifications

	Pipe Body									Connection	
Setting Depth (ft)	Size (")	Weight (ppf)	Grade	Nom. Wall Thickness (")	Nominal ID (")	Drift Diameter (")	Internal Yield (psi)	Collapse (psi)	Tensile Strength (lb)	Connection Type	Joint Tensile Strength
40	8-5/8	16.96	Line Pipe Grade B	0.188	8.250	n/a	2,620	510	176,900	Weld	n/a
220	5-1/2	15.5	J/K55	0.275	4.95	4.825	4,810	4,040	248,000	Valley Flush Joint	141,200 lb
800	4-1/2	11.6	J/K55	0.250	4	3.875	5,350	4,960	184,000	Valley Flush Joint	106,400 lb
800	3-1/2	7.7	HQ Rod	0.220	3.06	3.06	4,365	8,770	45,000	HQ Rod	105,000 psi
1,700	3-1/2	7.7	Perforated HQ Rod	0.220	3.06	3.06	n/a	n/a	n/a	HQ Rod	105,000 psi
800	2.2	4.04	BQ Rod	0.145	1.91	1.91	9,231	8,905	30,000	BQ Rod	115,000 psi

Cement Slurry Details

AK-3 Casing Cement Volume Calculations and Slurry Properties														
8" Conductor														
10.75 x 8.625	40	FT	X	0.2246	FT3/FT	=	8.984	FT3	X	100	%	=	17.97	FT3
												Total	134.4	GAL
													3.20	BBL
	18.00	BAGS	BLEND + 3% CaCl2				(1 Bag = 66.21 lb)							
8-5/8" Cement Slurry	Density:	13.5	lb/gal		Yield:		1	ft3/BAG		Water:		4.17	gal/BAG	
Blend: Class G Cement + 30% Silica Flour + 10% Micro-Silica + 10 Lb/Sk Cenosphere + 0.50% RFL-1 (Dispersant/Low fluid loss) + 0.20% FWCA (Free Water Control)												Slurry Volume:	134.7	GAL
												Slurry Volume:	18.0	FT3
												Slurry Volume:	**3.2**	BBL
												Mix Water Required:	75.1	GAL
5-1/2" Casing														
8" X 5-1/2"	40	FT	X	0.185295	FT3/FT	=	7.412	FT3	X	0	%	=	7.41	FT3
7-1/2" X 5-1/2"	180	FT	X	0.140375	FT3/FT	=	25.268	FT3	X	120	%	=	55.59	FT3
4.95"	40	FT	X	0.13476	FT3/FT	=	5.390	FT3	X	0	%	=	5.39	FT3
												Total	68.4	FT3
													511.6	GAL
													12.18	BBL
	69.0	BAGS	BLEND + 2% CaCl2				(1 Bag = 66.21 lb)							
5-1/2" Cement Slurry	Density:	13.5	lb/gal		Yield:		1	ft3/BAG		Water:		4.17	gal/BAG	
Blend: Class G Cement + 30% Silica Flour + 10% Micro-Silica + 10 Lb/Sk Cenosphere + 0.50% RFL-1 (Dispersant/Low fluid loss) + 0.20% FWCA (Free Water Control)												Slurry Volume:	516.2	GAL
												Slurry Volume:	69.0	FT3
												Slurry Volume:	**12.3**	BBL
												Mix Water Required:	287.7	GAL
4-1/2" Casing														
4.95" X 4-1/2"	220	FT	X	0.02246	FT3/FT	=	4.941	FT3	X	0	%	=	4.94	FT3
4.85" X 4-1/2"	580	FT	X	0.016845	FT3/FT	=	9.770	FT3	X	120	%	=	21.49	FT3
4"	40	FT	X	0.0870325	FT3/FT	=	3.481	FT3	X	0	%	=	3.48	FT4
												Total	29.9	FT3
													223.8	GAL
													5.33	BBL
	30.0	BAGS	BLEND + 2% CaCl2				(1 Bag = 66.21 lb)							
4-1/2" Cement Slurry	Density:	13.5	lb/gal		Yield:		1	ft3/BAG		Water:		4.17	gal/BAG	
Blend: Class G Cement + 30% Silica Flour + 10% Micro-Silica + 10 Lb/Sk Cenosphere + 0.50% RFL-1 (Dispersant/Low fluid loss) + 0.20% FWCA (Free Water Control)												Slurry Volume:	224.4	GAL
												Slurry Volume:	30.0	FT3
												Slurry Volume:	**5.3**	BBL
												Mix Water Required:	125.1	GAL

Drilling Fluid Details

AK-3 / DRILLING FLUID RECOMMENDATIONS									
Operation	Depth		Weight		Funnel Viscosity		Filtrate		Comments
	From	To	between		between		between		
Core PQ	0	40	8.5	9.2	38	50	<15		Freshwater - Gel system to drill surface holes for setting surface casing; High Yield Gel for viscosity and good hole cleaning, Soda Ash for pH 9-10. Note possible artesian flow through this interval. Use Calcium Chloride for increasing mud weight as needed. Maintain a stock of barite for emergency.
Open to 10-3/4"	0	40							
Core PQ	40	220							
Open to 7-1/2"	40	220							
Core PQ	220	800	8.5	9	32	38	5	15	Mix Gel/polymer coring fluid. Maintain 8-20 ppb Gel (always add Gel first), with 0.5-1.0 lb/1,000 gallon liquid polymer and 0.5-1.0 ppb Pac LV. Add 0.5-0.75 ppb Soda Ash for pH 9-10. Maintain viscosity at 32-38 sec/qt with Gel and polymers as needed; this will also provide lubricity for coring. Lubricators may be used for additional lubricity/rod chatter. Mix thinner if needed, and Defoamer, again, if needed. If artesian conditions are encountered, consider increasing mud weight with Calcium Chloride. Keep a stock of barite for emergency. If whole mud losses are encountered, try to keep fluid level and cool the wellbore by pumping water down the annulus and sweeping hole with high viscosity pills as needed.
Core HQ	800	1,700	8.34	8.7	32	38	5	15	Continue coring with water / polymer system, as above but without Gel, using Pac LV and Polyvis as needed for fluid loss and viscosity. Consider using <4 ppb gel premix only if polymers don't mix properly. Keep a stock of barite for emergency.

Notes:

0 - Baroid additives may be substituted with generic products after cross referencing.

I. Maintain minimum mud weight using shakers and hydrocyclones.

II. Artesian Conditions – Artesian conditions are possible during this project. Calcium Chloride can be premixed if desired, and stored for potential use. Barite or Calcium Chloride can both be mixed into the coring fluid.

III. Zinc Carbonate or Zinc Oxide should be maintained on location, in case of the presence of hydrogen sulfide. Barite must also be kept in case it is desired to increase mud weight above max Calcium Chloride solubility.

IV. Implement good coring practices, and monitor hole conditions closely to identify appropriate coring fluid properties.

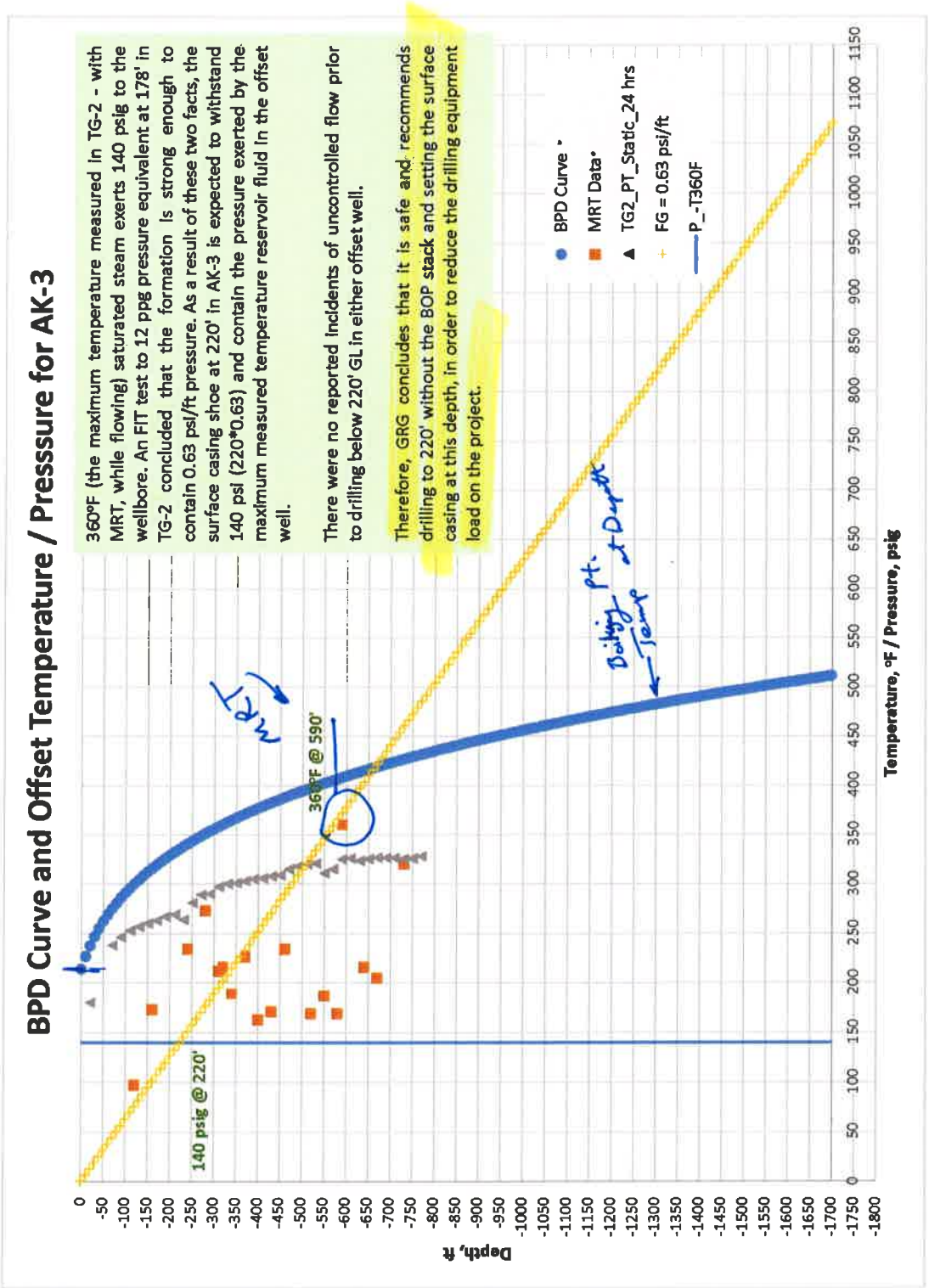


Figure 1: Engineering and geological factors per '20 AAC 25.030. Casing and cementing (b)-1' for AK-3 5-1/2" surface casing setting depth and maximum anticipated surface pressure.

Location Images

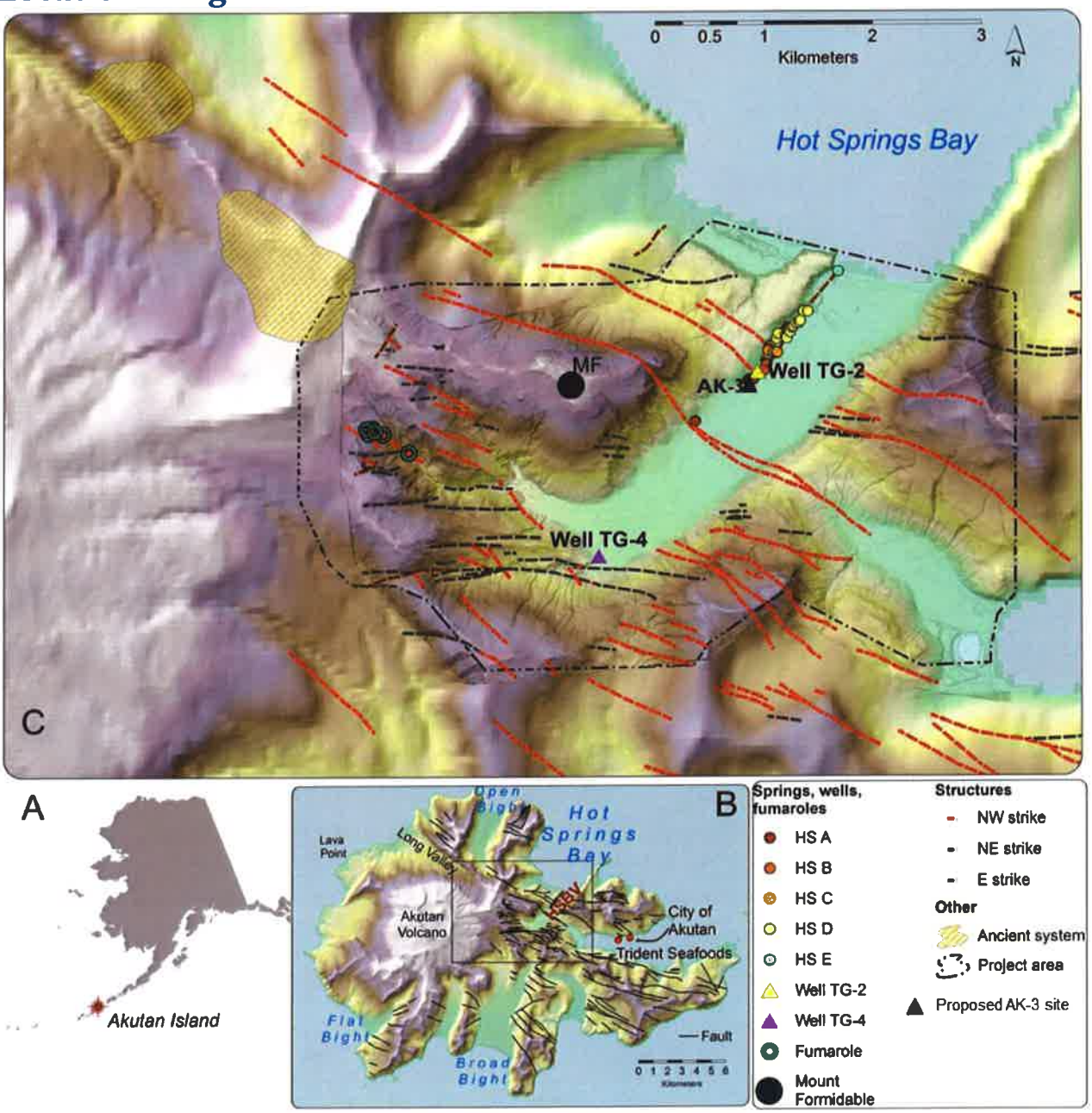


Figure 2: Akutan geothermal project base map showing the location of the proposed "AK-3" well as well as the locations of offset wells TG-2 and TG-4.

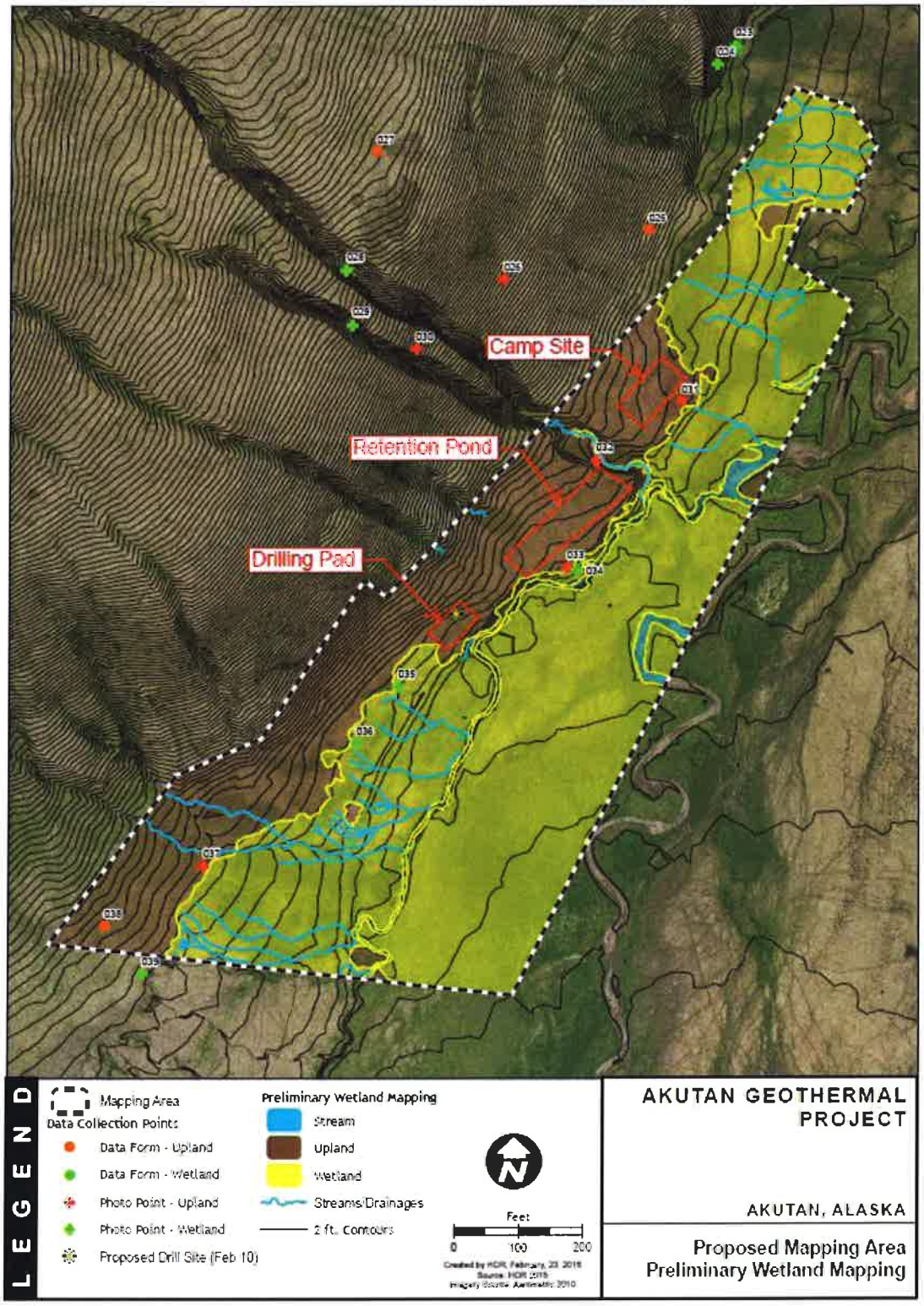


Figure 3: Site location for AK-3 relative in HSBV.

Figure 4: Image looking Southeast from approximate ground location of proposed AK-3. October 2014.

Figure 5: Drilling site of TG-2. August 2010.

Planned Days vs. Depth

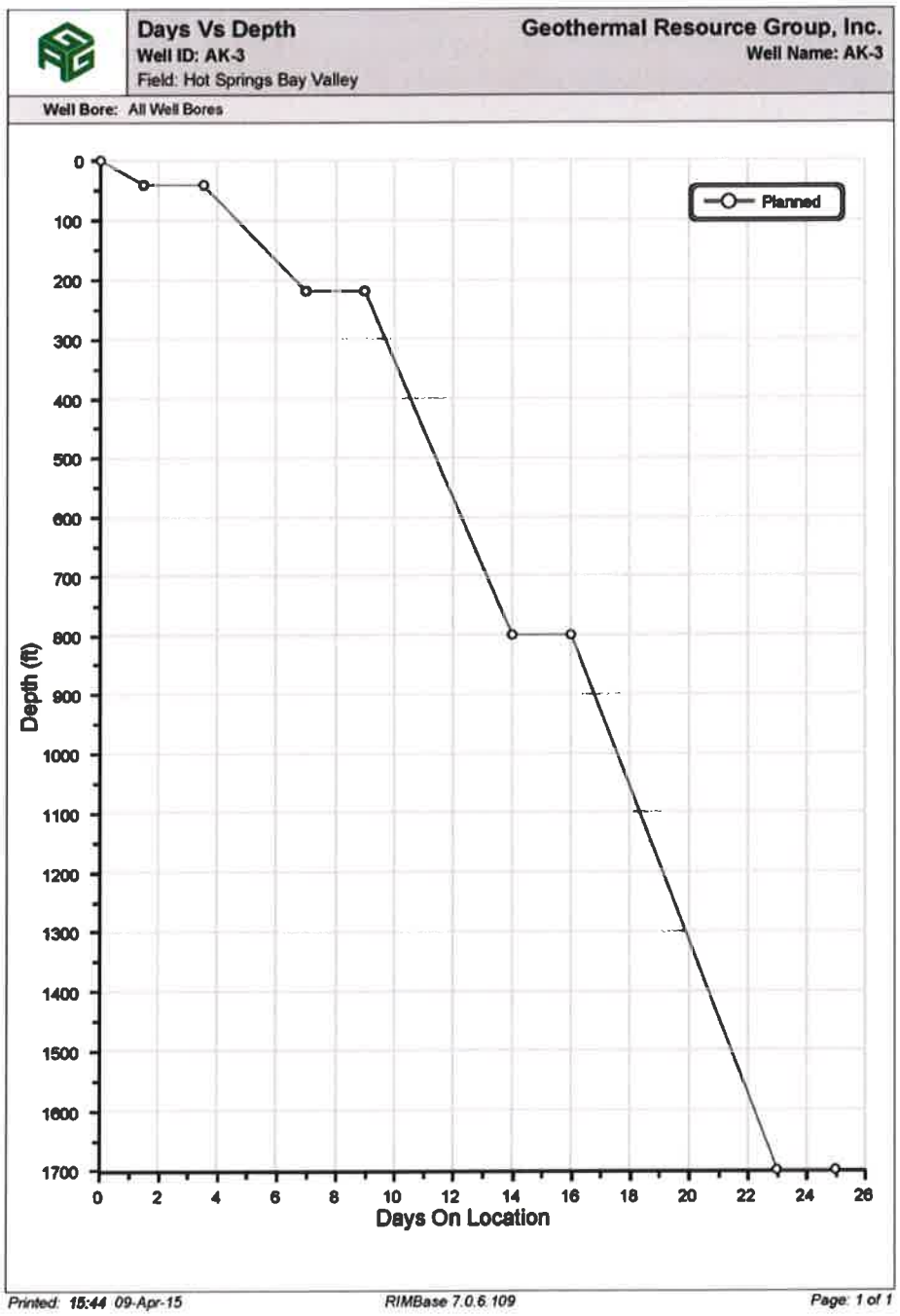


Figure 6: Planned days versus depth for AK-3.

Planned Well Schematic

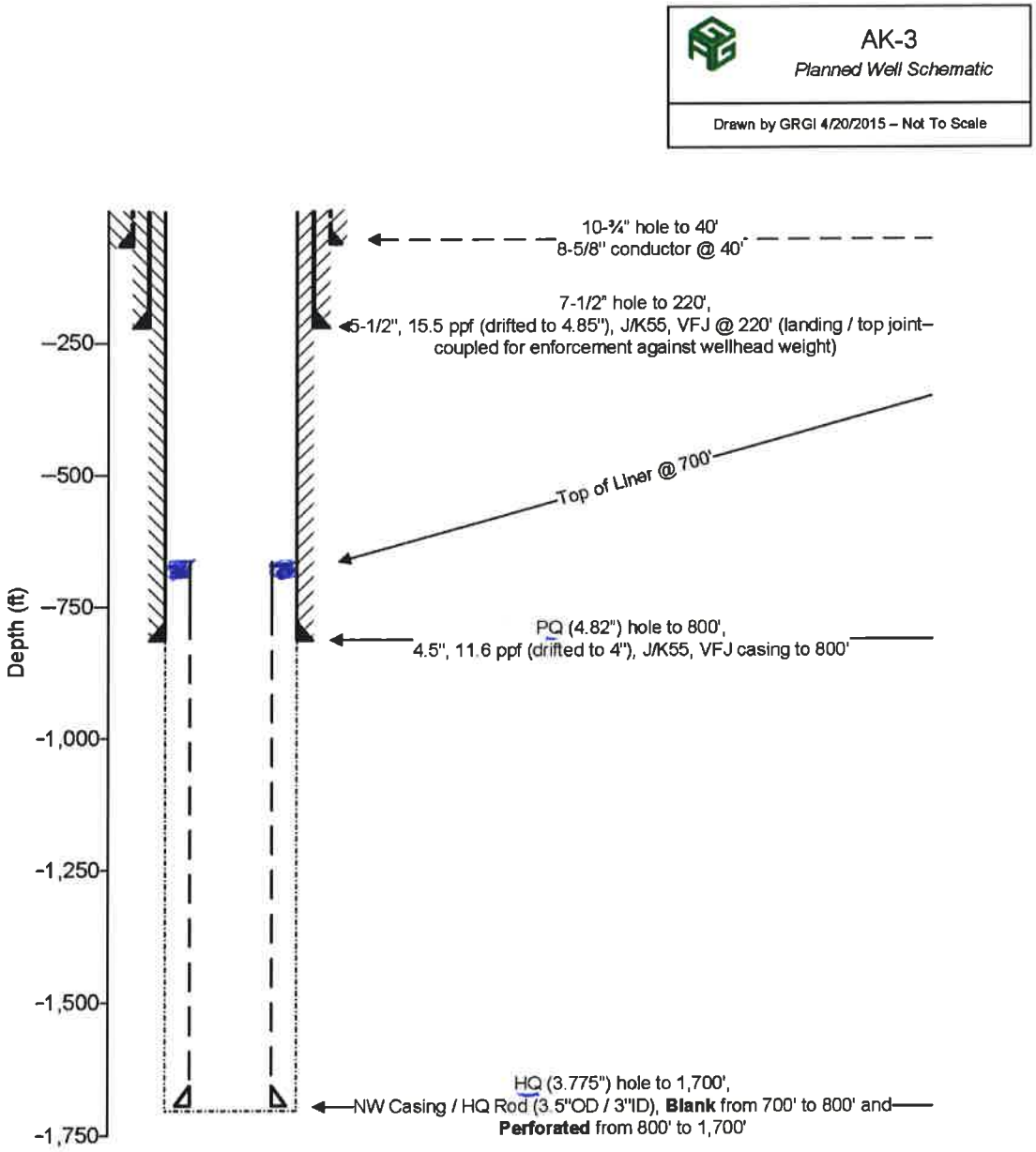


Figure 7: Planned well schematic of well AK-3.

Planned BOPE and Wellhead Sketches

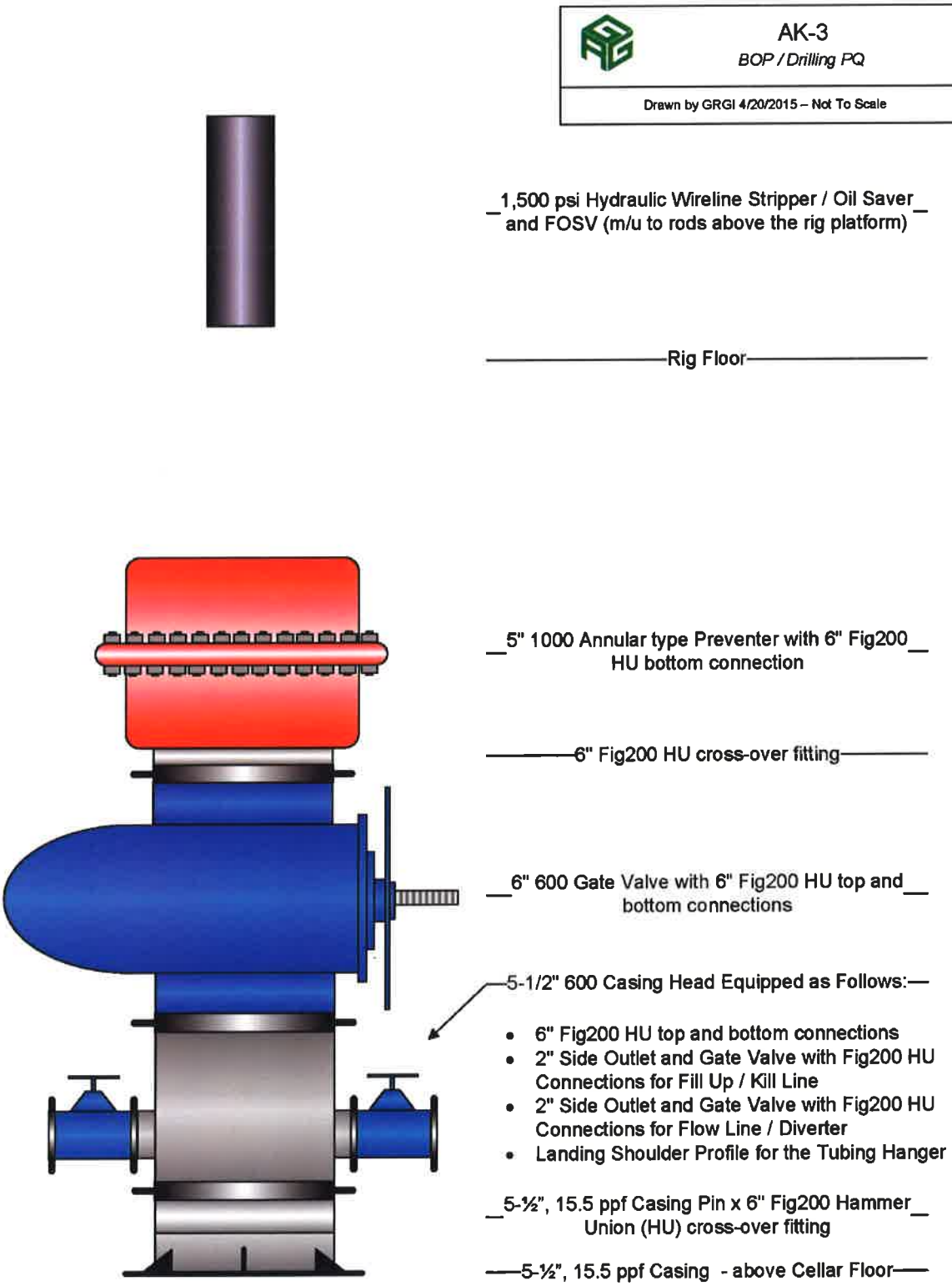


Figure 8: BOPE for drilling PQ section.

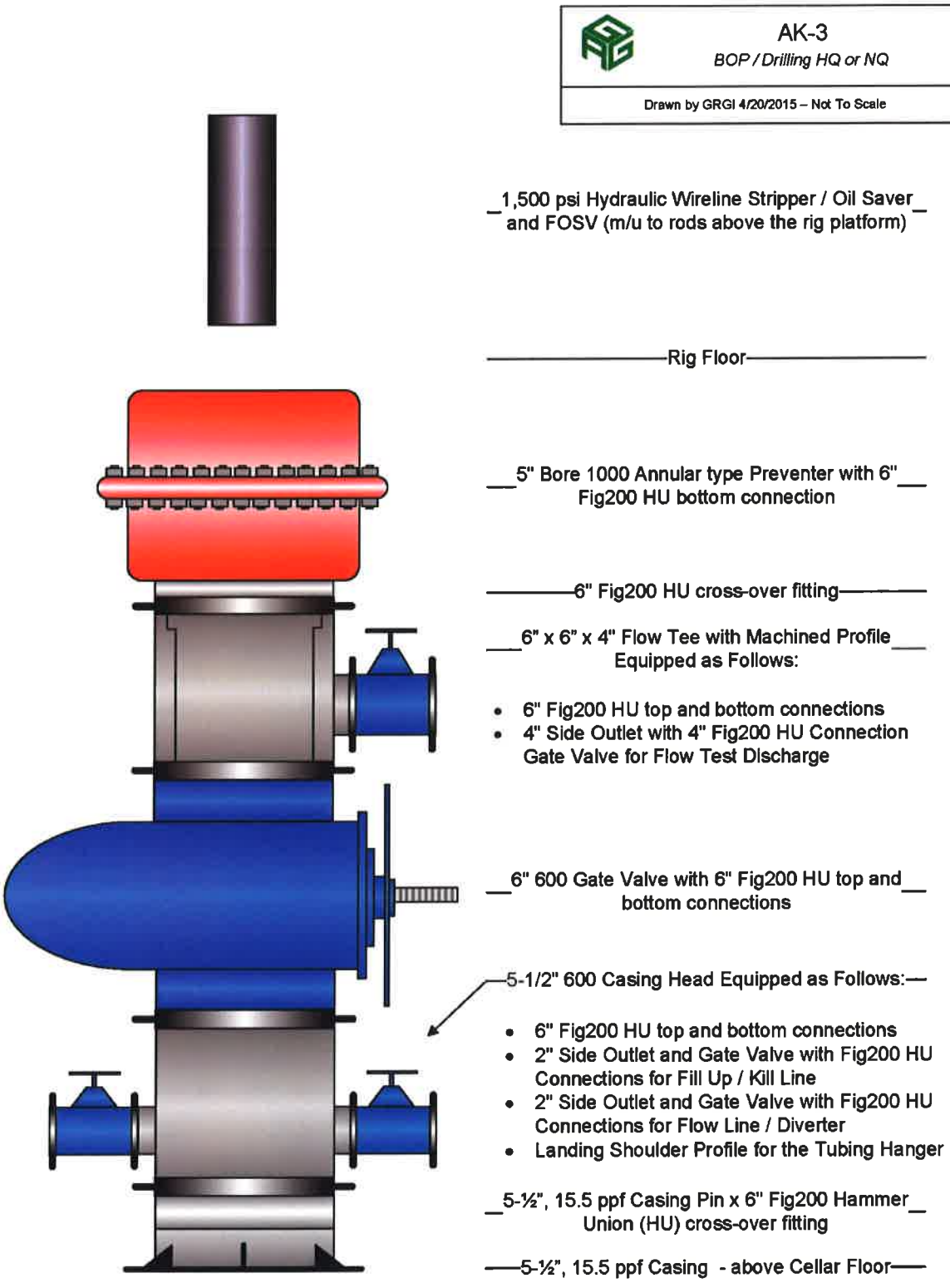


Figure 9: BOPE for drilling HQ section.

AK-3

BOP / Permanent Wellhead

Drawn by GRGI 4/20/2015 – Not To Scale

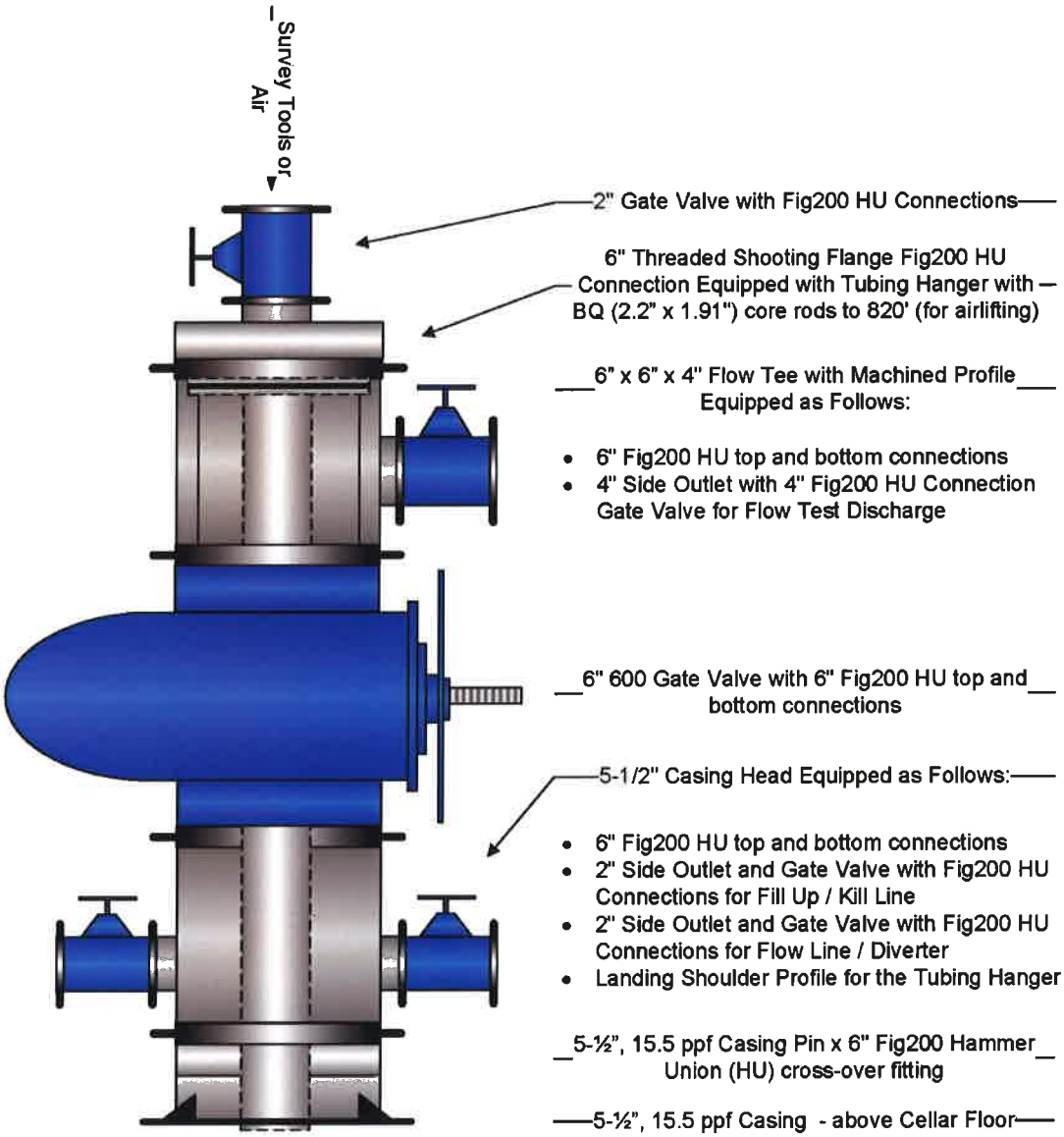
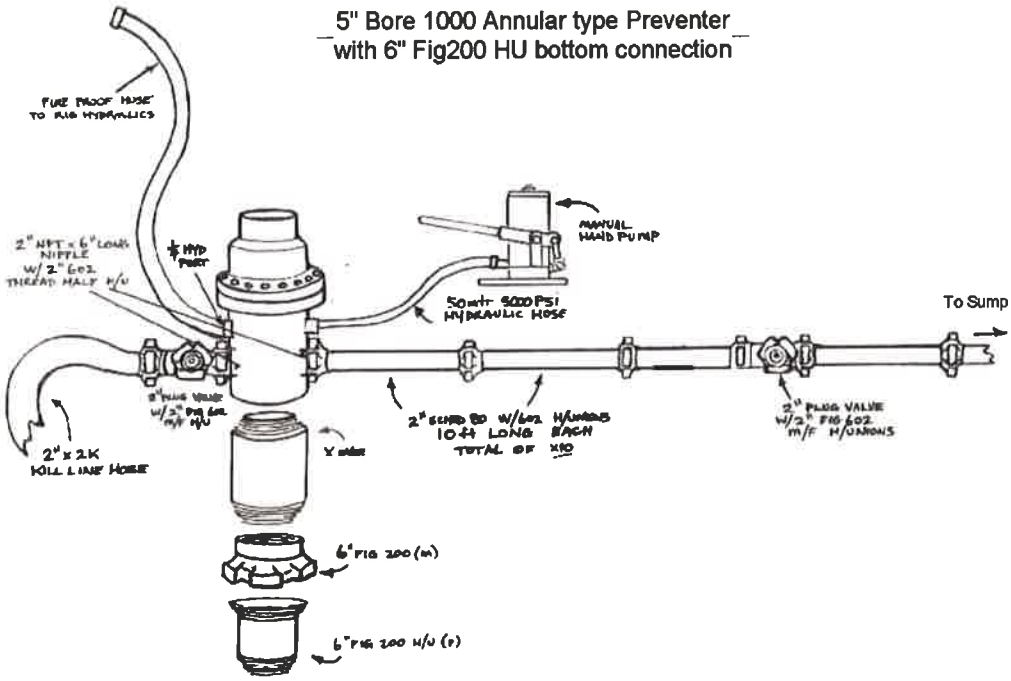


Figure 10: Permanent wellhead AK-3.



BOP with and Elastomer Element

Figure 11: BOP System sketch and Annular Preventer photo from the original vendor.

Variance Requests

The operator would like to request the variances from the following requirements due to the reasoning following the requests below.

✓ 1. Pursuant to 20 AAC 25.035 (h) (1), alternate BOPE to be approved.

The Type of BOPE proposed is detailed with drawings in the drilling permit application. The reason for proposing to use unions in wellhead and BOPE connections instead of flanges is the convenience of making up and breaking down this particular type of connection (more convenient and safer BOPE and wellhead nipple up and down operations in the limited area available below the core rig substructure and small cellar) as well as the lighter loads and smaller dimensions compared to API flanges. Fig200 type hammer union connections have 2,000 psi allowable operating pressure which is well above the Maximum Anticipated Surface Pressure; since the maximum casing test pressure is proposed to be 750 psig and the Maximum Anticipated Surface Pressure due to wellbore fluids is 140 psig. ↳ 8.5 ppg.

The operator would also like to use an annular preventer (1,000 psi rated) that is actuated by the drilling rig hydraulic system. This setup will provide a potentially unlimited volume of closing fluid and power to close and keep closed the unit through the rig hydraulic reservoir and pumps. The actuator system will be backed up by a manual hand pump. One other advantage of using this BOPE system is making the most out of limited clearance below the rig platform due to the small size of the this particular annular preventer compared to the flanged type annular preventers.

✓ 2. Pursuant to 20 AAC 25.035 (h) (2), the diverter requirement to be waived.

There was no uncontrolled flow incident reported while drilling to set the conductor to the same depth in TG-2 (offset well). Low temperature artesian flow was suppressed by increasing the drilling fluid weight with $CaCl_2$.

✓ 3. Pursuant to 20 AAC 25.061 (c), the near surface survey requirement to be waived.

The risk of encountering hydrocarbons is infinitely low in this well per the geologic environment, geophysical exploration, and offset well drilling results.

✓ 4. Pursuant to 20 AAC 25.066 (d) (3), alternate gas detection equipment to be approved.

The risk of encountering hydrocarbons is infinitely low in this well per the geologic environment, geophysical exploration and offset well drilling results. Nevertheless, at least one CH_4 detector and one CO_2 - H_2S detector will be installed at an appropriate location in the vicinity of the wellhead.

5. Pursuant to 20 AAC 25.035 (h) (1), Pressure-test BOPE only when installed, repaired, or changed; and Function-test BOPE on a seven-day frequency to be approved.
↳ pressure test

The risk of encountering hydrocarbons is infinitely low in this well per the geologic environment, geophysical exploration, and offset well drilling results.

Summary of Geologic Prognosis, Significant Depths, and Directions

Stratigraphy

The expected stratigraphy of AK-3 is based on the stratigraphy found in TG-2, located about northeast of the proposed site, and TG-4, also located in Hot Springs Bay Valley (Figure 2).

Depth Interval (ft.)	Rock type/Characteristics
0-25	Ash fall, unconsolidated till, clay, scoria
25-50	Volcanic breccia weakly consolidated
50-325	Andesite/basalt with minor overprint of propylitic (minor calcite, chlorite) and some argillic alteration at top of section
325-410	Basaltic conglomerate with interlayered tuff toward bottom of section tuff
410-800	Andesite/basalt with some alteration minerals calcite, chlorite minor epidote, prenite plus adularia deeper in section)
800-1500	Alternating andesite, basalt, basaltic conglomerate, tuff layers. Expect alteration minerals to become more evident deeper near expected fault zone. Likely to encounter thin <10' dacite somewhere below 1050 ft.

Expected Well Characteristics

The expected well characteristic for the top part of the hole are based on the experience of the offset well TG-2 located northeast of the proposed site. TG-2 was drilled with a core rig in 2010.

Depth (ft.)	Description
0-50	Controllable flowing zones through shallow saturated intervals, could be 120°F
50-150	Possibility of flowing zones, elevated temperature
150-400	Elevated temperature
400-800	Possibility of flow zones/loss of circulation at 420'to 800' (strat contacts? alteration at flow margins?), edges of reservoir
800-1500	Encounter fault zone in reservoir, expect lost circulation

Reservoir fluid chemistry is expected to be neutral NaCl brine, with TDS of ±5000 ppm. TDS values are variable in previous samples and likely diluted by meteoric waters.

Projected Fault Zone

The target of the AK-3 well is a northwest striking fault zone with an estimated 60° dip to the SW. The surface location is about 450' from the approximate surface projection of the fault. The table below shows an estimated depth of fault intersection with varied dip angles. These are simplified projections, considering the results of surface geologic mapping and indications from surface manifestations.

TG-2

Fault angle	Intersection depth
58	720
60	779
65	965
70	1236

Offset Information

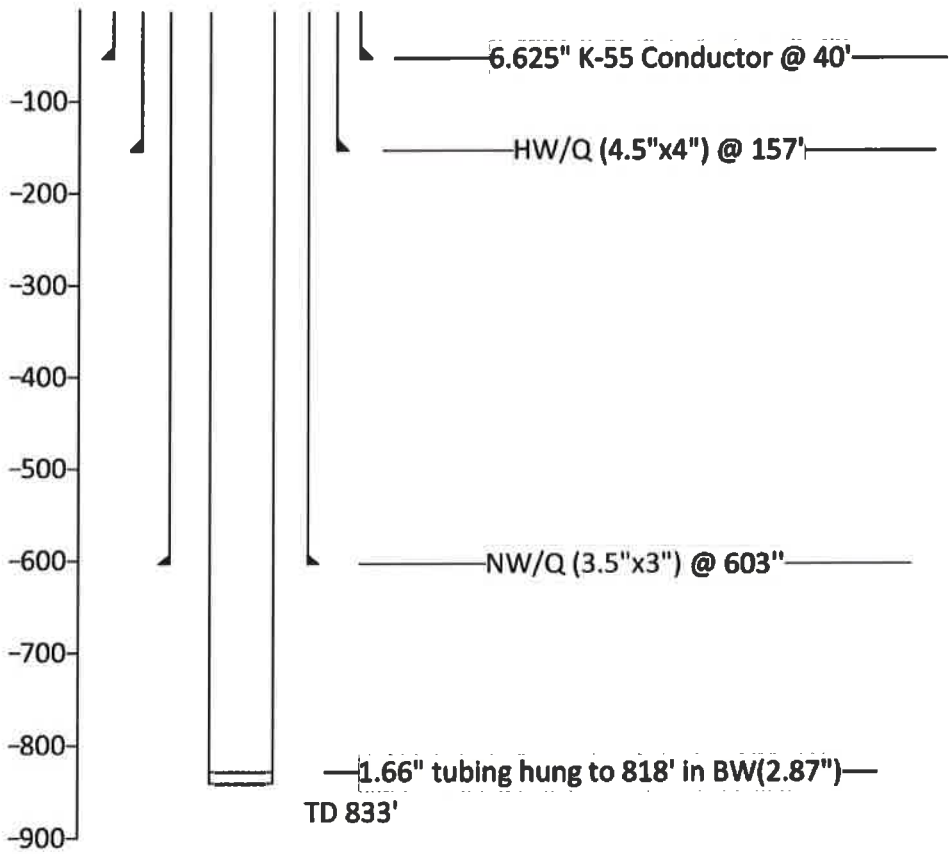


Figure 12: TG-2 well construction.

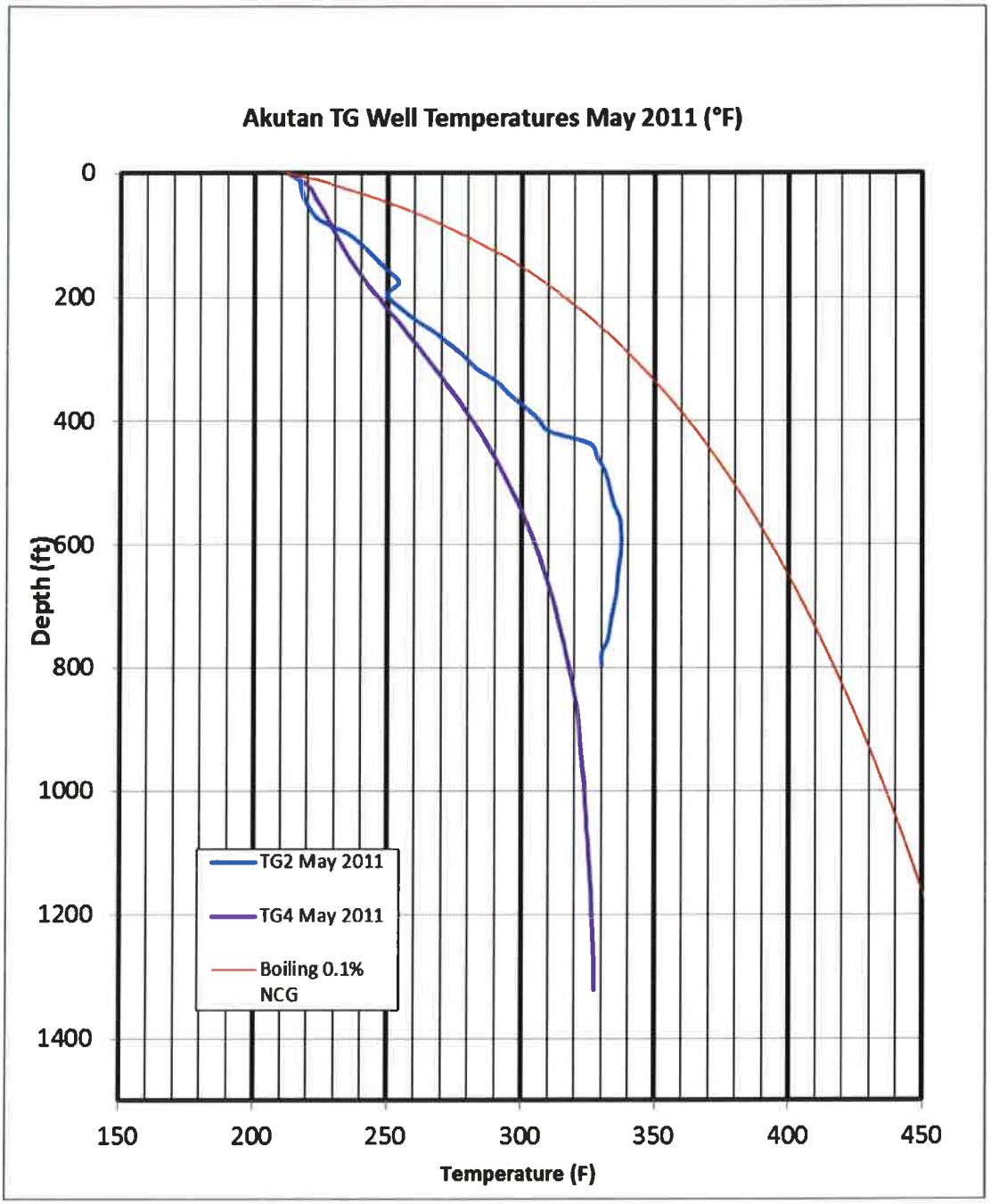


Figure 13: Equilibrated temperature surveys from TG-2 and TG-4.

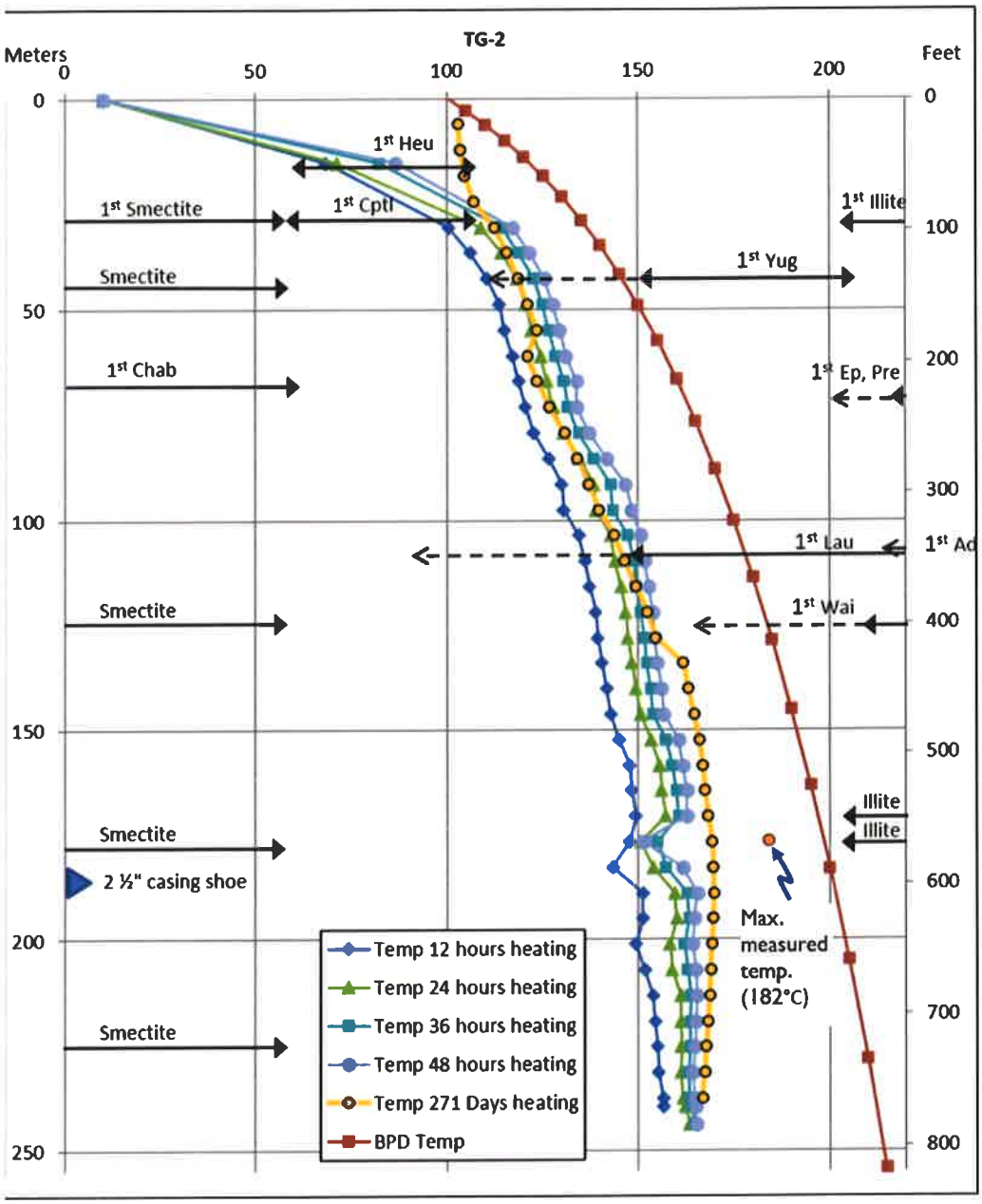


Figure 14: TG-2 temperature surveys and occurrence of alteration minerals.

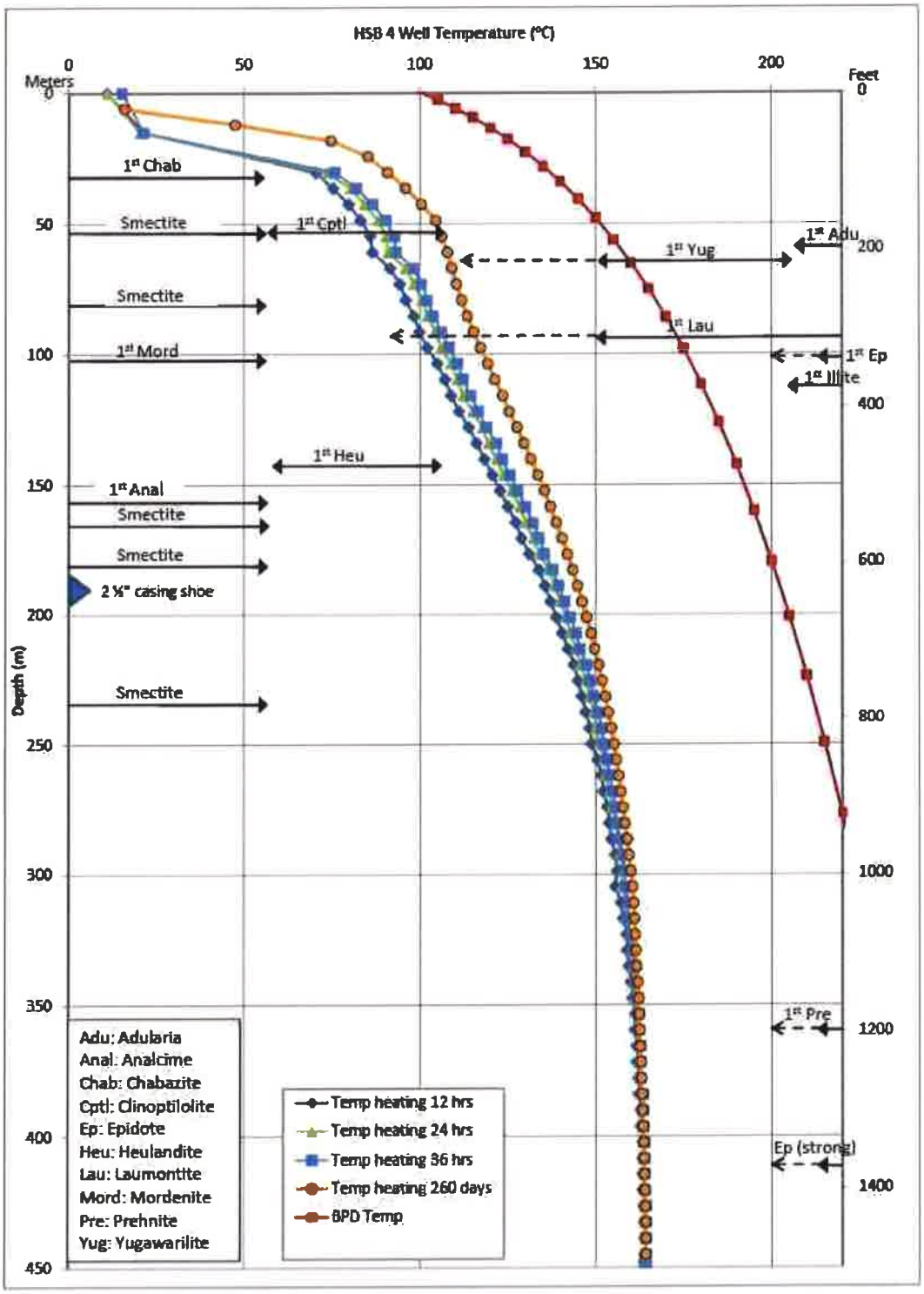


Figure 15: TG-2 temperature surveys and occurrence of alteration minerals.

AGP TG2		AGP TG2		AGP TG2		AGP TG2	
8/7/2010 12h		8/8/2010 24h		8/8/2010 36h		5/22/2011	
Run #1		Run #2		Run #3		One run	
Depth (ft)	Temp (°F)	Depth (ft)	Temp (°F)	Depth (ft)	Temp (°F)	Depth (ft)	Temp (°F)
46	160	46	180	46	188	16	217.3
96	228	96	238	96	243	36	218.3
116	238	116	246	116	251	56	220.5
136	245	136	253	136	258	76	224.5
156	249	156	257	156	262	96	234.3
176	252	176	260	176	265	116	240.4
196	256	196	263	196	268	136	245.3
216	259	216	267	216	273	156	249.7
236	262	236	269	236	273	176	254.3
256	267	256	274	256	279	196	249.7
276	274	276	281	276	287	216	254.3
296	281	296	289	296	296	236	260.1
316	282	316	290	316	299	256	267.3
336	289	336	297	336	303	276	273.2
356	291	356	300	356	305	296	278.7
376	294	376	301	376	307	316	283.5
396	296	396	303	396	309	336	290.7
416	297	416	305	416	310	356	295.3
436	299	436	306	436	311	376	300.9
456	301	456	308	456	313	396	306.2
476	303	476	309	476	314	416	310.2
496	308	496	315	496	321	436	325.6
516	312	516	318	516	323	456	328.2
536	313	536	320	536	325	476	330.8
556	315	556	321	556	325	496	332.4
576	303	576	311	576	304	516	333.5
596	309	596	315	596	323	536	334.8
616	319	616	325	616	329.7	556	336.8
636	320	636	326	636	328.3	576	337.3
656	317	656	323.7	656	327.5	596	337.5
676	318	676	325.2	676	329.1	616	337.2
696	322	696	326.7	696	329.6	636	336.5
716	322	716	326.5	716	329	656	336
736	322.3	736	326.3	736	328.5	676	335.7
756	321.9	756	325.6	756	327.6	696	334.9
776	322.9	776	325.9	776	328.3	716	333.9
796	326.15	796	328.2	796	329.4	736	333.2
798	326.22	798	328.2	798		756	332.3
796	326.15	796	328.2	796	329.4	776	330.2
798	326.22	798	328.2	798		796	330.2
						796	330.2

Figure 16: Temperature survey data from TG-2. Run 1-3 after circulation 12, 24, and 36 hours 8/7/2010 and 8/8/2010. Equilibrated survey 5/22/2011.

AGP TG4		AGP TG4		AGP TG4		AGP TG4	
8/22 12h		8/22 24h		8/23 36h		5/11/2011	
Run #1		Run #2		Run #3		One run	
Depth (ft)	Temp (°F)	Depth (ft)	Temp (°F)	Depth (ft)	Temp (°F)	Depth (ft)	Temp (°F)
50	71	50	69	50	71	20	60.9
100	159	100	165	100	169	40	117.5
120	168	120	177	120	180	60	166.9
140	176	140	184	140	188	80	185.7
160	182	160	191	160	195	100	195.7
180	187	180	195	180	199	120	204.8
200	188	200	196	200	200	140	212.9
220	197	220	205	220	209	160	220.2
240	202	240	209	240	213	180	223
260	205	260	213	260	216	200	226
280	209	280	216	280	219	220	228.3
300	212	300	220	300	223	240	230.7
320	216	320	223	320	227	260	233.3
340	221	340	228	340	231	280	236.1
360	225	360	231	360	234	300	239.4
380	228	380	234	380	238	320	242.9
400	232	400	239	400	242	340	246.8
420	237	420	244	420	246	360	250.1
440	241	440	247	440	251	380	254.3
460	245	460	251	460	254	400	257.7
480	249	480	255	480	258	420	261.6
500	253	500	259	500	262	440	265.1
520	257	520	263	520	266	460	268.7
540	261	540	266	540	270	480	272.3
560	264	560	270	560	273	500	275.7
580	268	580	273	580	276	520	278.8
600	273	600	278	600	280	540	281.9
620	276	620	281	620	283	560	284.9
640	279	640	284	640	286	580	287.6
660	282	660	287	660	289	600	290.3
680	285	680	289	680	292	620	292.7
700	288	700	292	700	294	640	295.1
720	291	720	294	720	297	660	297.4
740	293	740	297	740	299	680	299.7
760	295	760	299	760	301	700	301.5
780	297	780	301	780	303	720	303.5
800	299	800	302	800	305	740	305.3
820	300	820	304	800	306	760	306.9
840	303	840	306	820	308	780	308.4
860	305	860	307	840	308	800	309.9
880	306	880	309	860	309	820	311.4
900	308	900	310	880	311	840	312.7
920	309	920	312	900	312	860	313.8
940	310	940	313	920	313	880	314.9
960	312	960	314	940	314	900	316.1
980	313	980	316	960	316	920	317
1000	312	1000	315	980	317	940	318.1
1020	315	1020	318	1000	317	960	319.1
1040	316	1040	317	1020	319	980	319.9
1060	318	1060	319	1040	318	1000	320.8
1080	318	1080	320	1060	320	1020	321.4
1100	319	1100	321	1080	321	1040	321.8
1120	320	1120	321	1100	322	1060	322.1
1140	321	1140	322	1120	322	1080	322.5
1160	322	1160	323	1140	323	1100	322.9
1180	322	1180	323	1160	324	1120	323.5
1200	323	1200	324	1180	324	1140	323.9
1220	323	1220	324	1200	325	1160	324.1
1240	324	1240	325	1220	325	1180	324.5
1260	324	1260	325	1240	325	1200	324.6
1280	325	1280	326	1260	326	1220	325.1
1300	325	1300	326	1280	326	1240	325.3
1320	326	1320	326	1300	326	1260	325.7
1340	326	1340	326.6	1320	327	1280	325.9
1360	326	1360	326.7	1340	327	1300	326.3
1380	326	1380	326.9	1360	327.1	1320	326.4
1400	326.6	1400	327.2	1380	327.3	1340	326.5
1420	326.8	1420	327.3	1400	327.5	1360	326.7
1440	327	1440	327.4	1420	327.6	1380	326.9
1460	327.1	1460	327.4	1470	327.81	1400	327.1
1470	327.1	1470	327.8	1470	327.7	1420	327.3
1468	326.6	1470	326.9			1440	327.3
						1460	327.3
						1470	

Figure 17: Temperature survey data from TG-4. Run 1-3 after circulation 12, 24, and 36 hours on 8/7/2010 and 8/8/2010. Equilibrated survey completed 5/11/2011.

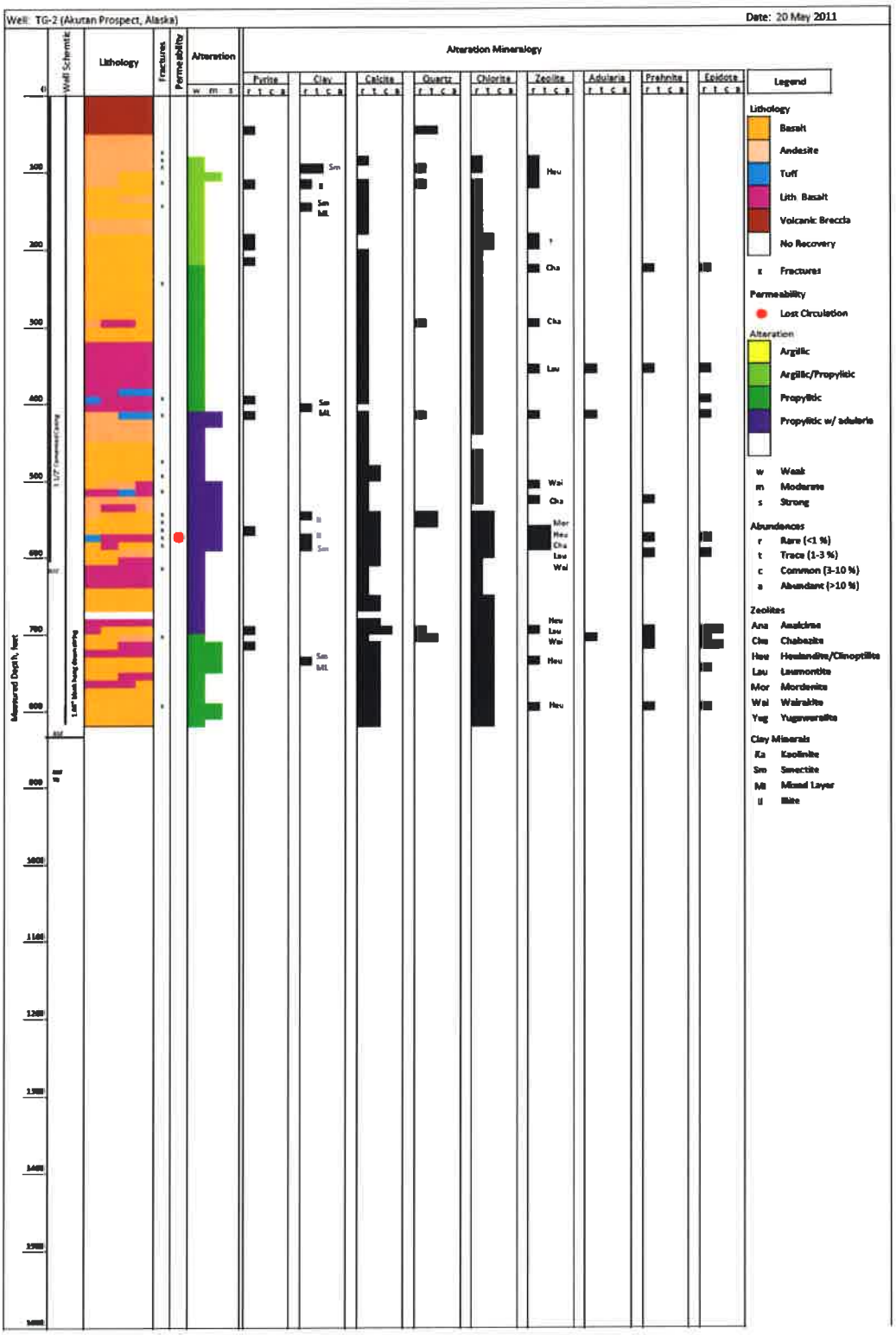


Figure 18: Lithology and alteration minerals from TG-2.

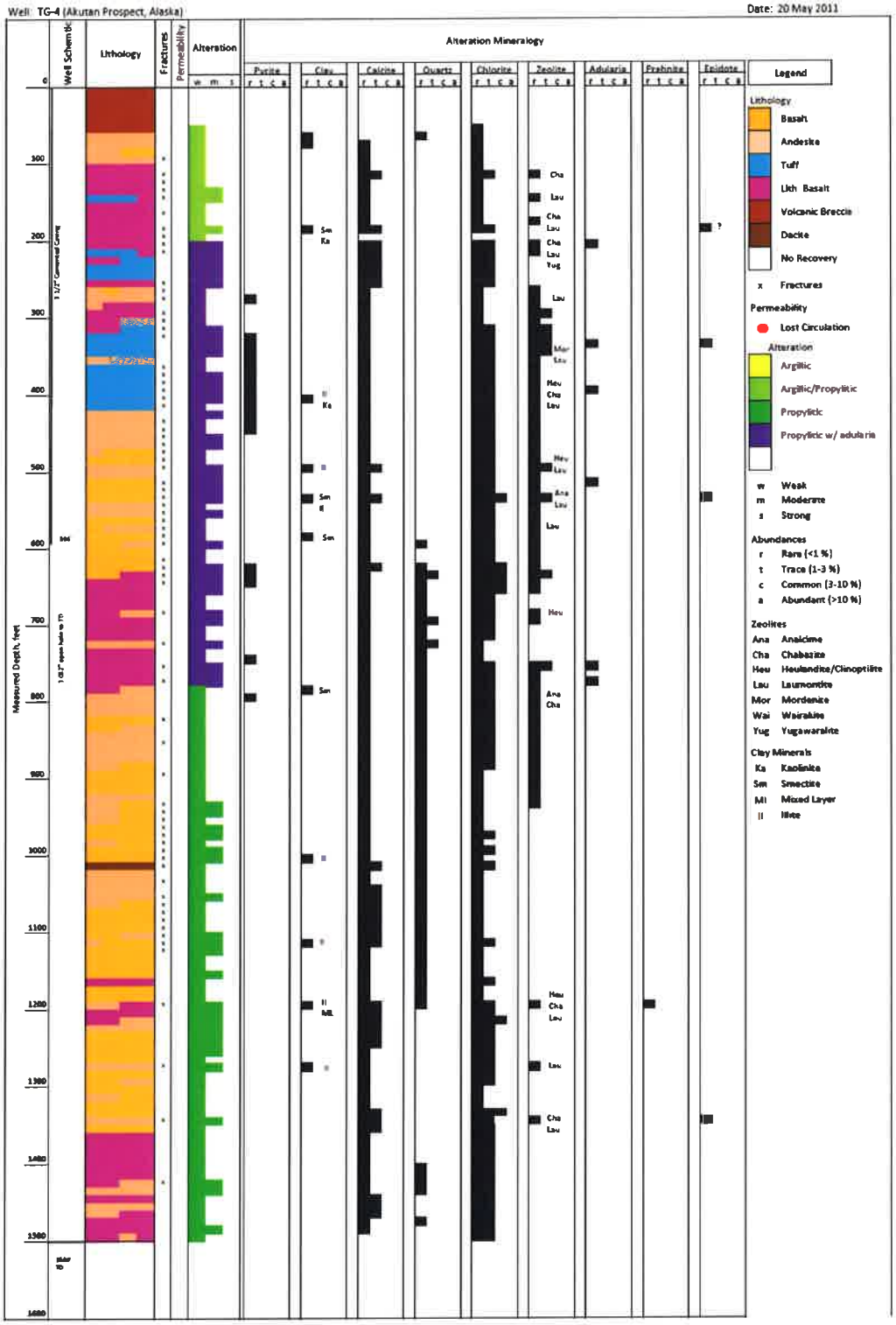


Figure 19: Lithology and alteration minerals from TG-4.

Depth	Mudlogger's notes
33'	Artesian flow 122 degF
414'	Drilling probs and well started flowing
588-590'	Loss zone
613'	Set casing shoe, LOT failed
733'	Twisted off, hole started flowing
786'	Ran survey, hole started flowing
Depth	**Driller's notes**
Above 479'	Full returns
479'	Hot water coned up annulus, well flowed at ~120 GPM. Killed well.
590'	Lost all returns
593'	Ran MRT. Well started flowing. Let well flow for 10 minutes to get sample, then killed w/ 203 deg F at surface, 50 GPM flow. MRT = 359F
613'	Cored 3-1/2" hole f/593 t/613' with no returns. BOP leak, failed squeeze test, frac gradient 0.74 psi/ft.
793'-833'	Cored 3.032" hole f/793' t/833'. Lost 2-3 bbl/hr.

Table 1. Table of zones of interest in TG-2, taken from driller's reports and mudlogs.

Figure 20: Selected mudlogger's and driller's notes from TG-2.

Appendix A – BOPE, Wellhead, and Casing Test Procedures

1st Test

BOPE, Wellhead, and Casing Test prior to Drilling PQ (4.8" OH / 4.5" csg)

1. Notify AOGCC ~~24~~ hours in advance 48 hr NOTICE
2. Install BOPE and wellhead assembly
3. Function test annular preventer, master, kill line, and diverter line valves
4. Line up one mud pump to the kill line
5. RIH with a plugged PQ rod joint and snub bottom of joint to bottom of the annular preventer
6. Close the annular preventer and pressure test annular preventer, casing head, master valve, kill line valve, and diverter line valve to 200 psig and 750 psig and hold 5 minutes each. Record test data, including time to pressure up, and forward to AOGCC for approval. → use form 10-424
7. While drilling the PQ section, the BOPE must be function tested every 7 days subsequent to the first test. Test the annular preventer against the master valve, pumping through a single PQ rod joint.

2nd Test

BOPE, Wellhead, and Casing Test prior to Drilling HQ (3.8" OH / 3.5" csg)

1. Notify AOGCC 24 hours in advance
2. Install BOPE and wellhead assembly
3. Function test annular preventer, master valve, kill line valve, diverter line valve, and flow tee valve
4. Line up one mud pump to the kill line
5. RIH with a plugged PQ rod joint and snub bottom of joint to bottom of the annular preventer
6. Close the annular preventer and pressure test annular preventer, casing head, master valve, kill line valve, diverter line valve, flow tee, and flow tee valve to 200 psig and 750 psig for 5 minutes each. Record test data and forward to AOGCC for approval. → use Form 10-424
7. While drilling the HQ section, the BOPE must be tested weekly subsequent to the first test. Test the annular preventer against the master valve, pumping through a single PQ rod joint.

Appendix B - Leak-Off Test Procedure

Important: Never test formation to greater than 1.0 psi/ft fracture gradient.

Prior to Testing

5 1/2" csg

Drill out the casing shoe. Clean out cement below the shoe. Make 20 feet of new hole. Spot a high viscosity pill with low water loss on bottom.

Use a sheet of linear graph paper to plot pressure on the vertical axis versus volume of fluid pumped on the horizontal axis. Don't begin this test without graph paper in hand! There is a sheet included at the end of this procedure. Record your name, well name, date and time, the mud weight and casing size on the graph paper. Mark the 1.0 psi/ft gradient on the graph paper and mark an estimated leak-off so you have the upper limit and some idea of where to expect leak-off.

During the leak-off test, graph the volume pumped versus the corresponding pressure. Use a straight edge to connect data points. Record all liquid pumped.

In general, the shoe formations in geothermal wells are brittle and weak. Therefore, it is necessary to find the leak-off pressure without breaking down the formation directly beneath the casing shoe.

Test Procedure

Slowly < 1/4 BBL/min

gh 8/13/15

Fill the stack and close the rams. Pump until pressure begins to register on pressure gauge. The starting point should be 0 psig starting pressure on the y-axis and 0 barrels injected on the x-axis. Graph the start pressure (Figure1).

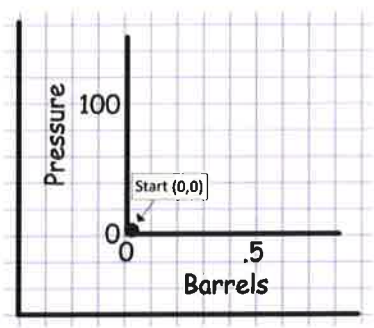


Figure 1. Log your volume pumped and start pressure before looking for leak-off. It will take some volume pumped before the pressure will come off zero.

Now you can begin pumping incremental volumes. All of the volumes should be the same size. In the following example the volume is 2/10ths of a barrel. It will take some volume pumped before a pressure greater than zero is recorded, but it is still necessary to record these volumes. Pump until a pressure is recorded, and start recording the pressure at the even increments subsequent to that. Between each incremental pumping, stop and graph the pressure on your graph paper and record the values (Figure 2).

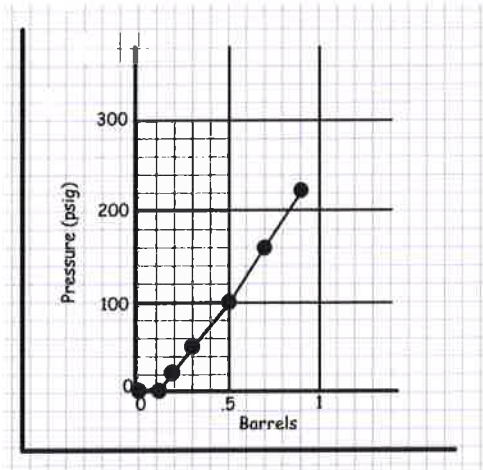


Figure 2. Initially, the pressure curve grows steeper with each pumping.

At first, the pressure vs. volume curve will grow steeper with each pumping. This is <u>not</u> what we are looking for. Instead, what we are looking for is a constant increase in pressure with each pumping increment. So instead of the pressure vs. volume curve growing steeper, it will appear as a constant slope – a straight line from point to point:

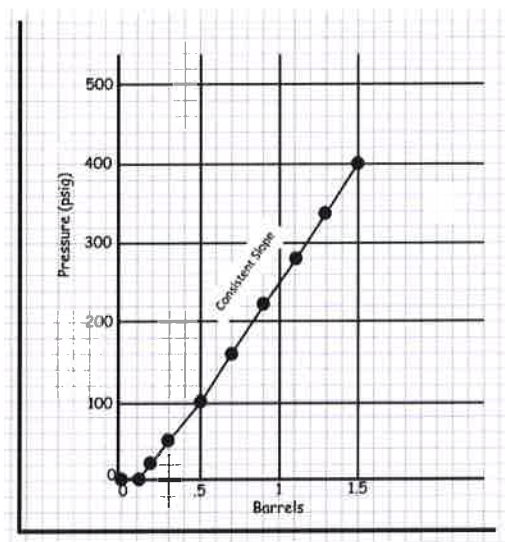


Figure 3. The slope becomes constant.

You are now looking for the most important part of the leak-off test –a decrease in the slope of pressure vs. volume curve (where the slope becomes less steep). This is the leak-off pressure and the point at which you want to stop pumping fluid. After reaching the leak-off pressure, the slope will change (Figure 4).

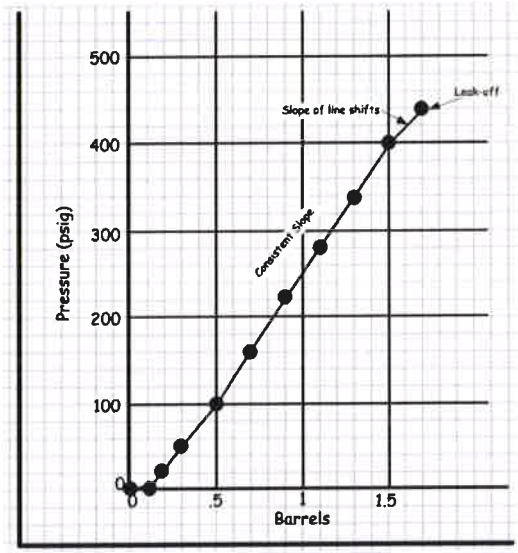


Figure 4. The slope has shifted. Leak-off has occurred!

Figure 4 suggests that leak-off occurred at 1.7 barrels and 440 psig. The actual leak-off was somewhere between 400 psig and 440 psig. The slow way we do the leak-off gives a very conservative leak-off pressure and the top of that change in slope is closer to the real leak-off than the lower part. Sometimes the change is very dramatic and easy to find. Other times it is more subtle, and more fluid has to be pumped to make sure leak-off has occurred.

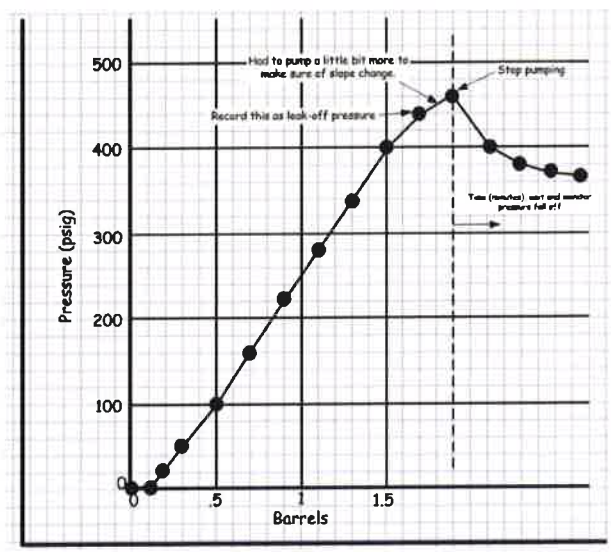


Figure 5. Record the pressure bleed-off in even time increments after stopping pumping. Record the fall off until it starts to level out.

Quite often the curve doesn't build up as neatly and you have to pump an extra increment or two to make sure you have a change of slope (Figure 5). The recorded leak-off still is the point at which the slope of the pressure vs. volume curve first started to decrease. Always record the bleed-off pressure in

even time increments from the time you stop pumping until it starts to level out. The bleed-off pressure is helpful in interpreting the test results and integrity.

Calculation of Results

To determine the fracture gradient, we must know the following:

- True vertical depth of the well
- Weight in pounds per gallon of the fluid in the well bore
- Leak-off pressure

Using this information, we will calculate the fracture gradient using the following formulas:

a) **Hydrostatic Pressure = Weight of Fluid in Wellbore (ppg) x 0.052 x TVD**
b) **Fracture Gradient = (Hydrostatic Pressure of the Fluid + Leak-off Pressure) / True Vertical Depth**
c) **Equivalent Mud Weight = (Fracture Gradient / 0.433) x 8.33**

For this example, we'll use 2,000' as the TVD and 9.0 ppg as the weight of the fluid. We have already determined the leak-off pressure as being 490 psig. The results of this calculation are:

a) Hydrostatic Pressure = 9.0 x 0.052 x 2000 = 936 psig
b) Fracture Gradient = (936 psig + 490 psig) / 2000 ft = 0.71 psi/ft
c) Equivalent Mud Weight = (0.71/0.433) X 8.33 = 13.66 ppg

Well Number:

Date:

Time:

Casing Size:

Mud Weight:

TVD:

STATE OF ALASKA
ALASKA OIL AND GAS CONSERVATION COMMISSION

PERMIT TO DRILL

20 AAC 25.005

1a. Type of Work: Drill ☑ Lateral ☐ Redrill ☐ Reentry ☐	1b. Proposed Well Class: Development - Oil ☐ Stratigraphic Test ☐ Development - Gas ☐ Exploratory ☑ Service - WAG ☐ Service - Winj ☐ Service - Supply ☐ Service - Disp ☐ Single Zone ☐ Multiple Zone ☐	1c. Specify if well is proposed for: Coalbed Gas ☐ Gas Hydrates ☐ Geothermal ☑ Shale Gas ☐
2. Operator Name: City of Akutan	5. Bond: Blanket ☐ Single Well ☑ Bond No.	11. Well Name and Number: AK-3
3. Address: 3380 C Street Suite 295 Anchorage 99503-3952	6. Proposed Depth: MD: 1700 ft TVD: 1700 ft	12. Field/Pool(s): Hot Springs Bay Valley
4a. Location of Well (Governmental Section): Surface: ~ 2600ft from East line, 70 ft. from north lineT70S R112W S005 Seward Meridian	7. Property Designation (Lease Number): Surface - Akutan Corporation Subsurface - The Aleut Corporation	
Top of Productive Horizon: Same	8. Land Use Permit: Exploration agreements attached	13. Approximate Spud Date: 21-Jul-15
Total Depth: Same	9. Acres in Property: 1/4 Acre	14. Distance to Nearest Property:
4b. Location of Well (State Base Plane Coordinates - NAD 27): Surface: x- -126726.1 y- 78180.6 Zone- 7	10. KB Elevation above MSL: 46 feet GL Elevation above MSL: 41 feet	15. Distance to Nearest Well Open to Same Pool: none
16. Deviated wells: n/a Kickoff depth: n/a feet Maximum Hole Angle: n/a degrees	17. Maximum Anticipated Pressures in psig (see 20 AAC 25.035) Downhole: 750 Surface: 140	

18. Casing Program:

Hole (")	Casing (")	Weight (ppf)	Grade	Coupling	Length (ft)	MD (ft)	TVD (ft)	MD (ft)	TVD (ft)	Cement Quantity (cuft) (including stage data)
10.75	8.625	24	J/K55	WELDED	40	0	0	40	40	18, with 100% excess, thru tremie
7.5	5.5	17	J/K55	VFJ	220	0	0	220	220	70, with 120% excess, single stage
4.834	4.5	11.7	J/K55	VFJ	800	0	0	800	800	30, with 120% excess, single stage
3.789	3.5	7.7	NW/HQ-4130	ROD THREAD	1700	700	700	1700	1700	n/a-Set on bottom
n/a	2.2	4.04	BQ-4130	ROD THREAD	800	0	0	800	800	n/a-Hang from surface if needed

19 **PRESENT WELL CONDITION SUMMARY** (To be completed for Redrill and Re-Entry Operations)

Total Depth MD (ft):	Total Depth TVD (ft):	Plugs (measured):	Effect. Depth MD (ft):	Effect. Depth TVD (ft):	Junk (measured):

Casing	Length	Size	Cement Volume	MD	TVD
Conductor/Structural					
Surface					
Intermediate					
Production					
Liner					

Perforation Depth MD (ft): Perforation Depth TVD (ft):

20. Attachments: Property Plat ☐ BOP Sketch ☑ Diverter Sketch ☐ Drilling Program ☑ Seabed Report ☐ Time v. Depth Plot ☑ Drilling Fluid Program ☑ Shallow Hazard Analysis ☐ 20 AAC 25.050 requirements ☐

21. Verbal Approval: Commission Representative: Date

22. I hereby certify that the foregoing is true and correct. Contact

Email

Printed Name Hermann J. Tuna Scanlan D.P.A. Title City Administrator

Signature Phone 907-274-7565 Date 1-May-15

Commission Use Only

Permit to Drill Number:	API Number: 50-	Permit Approval Date:	See cover letter for other requirements.

Conditions of approval : If box is checked, well may not be used to explore for, test, or produce coalbed methane, gas hydrates, or gas contained in shales: ☐

Other:

Samples req'd: Yes ☐ No ☐ Mud log req'd: Yes ☐ No ☐

H_2S measures: Yes ☐ No ☐ Directional svy req'd: Yes ☐ No ☐

Spacing exception req'd: Yes ☐ No ☐ Inclination-only svy req'd: Yes ☐ No ☐

Approved by: COMMISSIONER APPROVED BY THE COMMISSION Date:

STATE OF ALASKA
ALASKA OIL AND GAS CONSERVATION COMMISSION

PERMIT TO DRILL

20 AAC 25.005

1a. Type of Work: Drill ☑ Lateral ☐ Redrill ☐ Reentry ☐	1b. Proposed Well Class: Development - Oil ☐ Stratigraphic Test ☐ Development - Gas ☐ Exploratory ☑ Service - WAG ☐ Service - Winj ☐ Service - Supply ☐ Service - Disp ☐ Single Zone ☐ Multiple Zone ☐	1c. Specify if well is proposed for: Coalbed Gas ☐ Gas Hydrates ☐ Geothermal ☑ Shale Gas ☐
2. Operator Name: City of Akutan	5. Bond: Blanket ☐ Single Well ☑ Bond No.	11. Well Name and Number: AK-3
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Top of Productive Horizon: Same	8. Land Use Permit: Exploration agreements attached	13. Approximate Spud Date: 21-Jul-15
Total Depth: Same	9. Acres in Property: 1/4 Acre	14. Distance to Nearest Property:
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16. Deviated wells: n/a Kickoff depth: n/a feet Maximum Hole Angle: n/a degrees	17. Maximum Anticipated Pressures in psig (see 20 AAC 25.035) Downhole: 750 Surface: 140	

18. Casing Program:

Hole (")	Casing (")	Weight (ppf)	Grade	Coupling	Length (ft)	Top - Setting Depth - Bottom MD (ft)	TVD (ft)	MD (ft)	TVD (ft)	Cement Quantity (cuft) (including stage data)
10.75	8.625	24	J/K55	WELDED	40	0	0	40	40	18, with 100% excess, thru tremie
7.5	5.5	17	J/K55	VFJ	220	0	0	220	220	70, with 120% excess, single stage
4.834	4.5	11.7	J/K55	VFJ	800	0	0	800	800	30, with 120% excess, single stage
3.789	3.5	7.7	NW/HQ-4130	ROD THREAD	1700	700	700	1700	1700	n/a-Set on bottom
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Casing	Length	Size	Cement Volume	MD	TVD
Conductor/Structural					
Surface					
Intermediate					
Production					
Liner					

Perforation Depth MD (ft): Perforation Depth TVD (ft):

20. Attachments: Property Plat ☐ BOP Sketch ☑ Diverter Sketch ☐ Drilling Program ☑ Seabed Report ☐ Time v. Depth Plot ☑ Drilling Fluid Program ☑ Shallow Hazard Analysis ☐ 20 AAC 25.050 requirements ☐

21. Verbal Approval: Commission Representative: Date

22. I hereby certify that the foregoing is true and correct. Contact

Email

Printed Name Hermann J. Tuna Scanlan D.P.A. Title City Administrator

Signature Phone 907-274-7565 Date 1-May-15

Commission Use Only

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Other:

Samples req'd: Yes ☐ No ☐ Mud log req'd: Yes ☐ No ☐

H_2S measures: Yes ☐ No ☐ Directional svy req'd: Yes ☐ No ☐

Spacing exception req'd: Yes ☐ No ☐ Inclination-only svy req'd: Yes ☐ No ☐

Approved by: COMMISSIONER APPROVED BY THE COMMISSION Date:

Form 10-401 (Revised 10/2012) This permit is valid for 24 months from the date of approval (20 AAC 25.005(g)) Submit Form and Attachments in Duplicate

CC

A L A S K A

2012-000202-0

Recording Dist: 305 - Aleutian Islands
6/1/2012 11:20 AM Pages: 1 of 9

DO NOT DETACH

U2-0078

THIS COVER SHEET HAS BEEN ADDED TO THIS DOCUMENT BY:

FIDELITY TITLE AGENCY OF ALASKA TO PROVIDE SPACE FOR RECORDING DATA.

THIS COVER SHEET APPEARS AS THE FIRST PAGE OF THE DOCUMENT IN THE OFFICIAL PUBLIC RECORDS

This instrument is being recorded by Fidelity Title Agency of Alaska as an accommodation only. It has not been examined as to its effect, if any, on the title of the estate herein.

3150 "C"Street., Suite 220 Anchorage, Alaska 99503
Ph (907) 277-6601 Fax (907) 277-6613

Bureau of Land Management
Alaska State Office
May 31, 2012 Anchorage, Alaska
DATE
I hereby certify that this reproduction is a copy of the official record on file in this office.
AUTHORIZED SIGNATURE

T. 70 S., R. 108 W.,
Secs. 13 and 14;
Sec. 22, those lands lying on Tigalda Island;
Secs. 23 to 26, inclusive;
Sec. 27, those lands lying on Tigalda Island.

Containing 2,790 acres, as shown on protraction diagram S28-5 approved on November 2, 1977.

T. 68 S., R. 109 W.,
Sec. 19, those lands lying on Akun Island;
Sec. 21;
Secs. 28 to 31, inclusive;
Sec. 32, protracted W½.

Containing 2,599 acres, as shown on protraction diagram S31-1 approved on April 19, 1972.

T. 68 S., R. 110 W.,
Sec. 13;
Sec. 24, lots 1 and 3;
Secs. 25, 35, and 36.

Containing 2,076.43 acres, as shown on plat of survey officially filed September 22, 2006.

T. 69 S., R. 110 W.,
Secs. 4 to 7, inclusive;
Sec. 8, lots 1 and 2;
Sec. 9, lots 1 and 2;
Sec. 10;
Sec. 11, lots 1 and 2;
Secs. 12 to 24, inclusive;
Sec. 25, lots 1 and 2;
Secs. 26 to 35, inclusive.

Containing 15,814.21 acres, as shown on plat of survey officially filed September 22, 2006.

Bureau of Land Management
Alaska State Office
May 31, 2012 Anchorage, Alaska
DATE
I hereby certify that this reproduction is a copy of the official record on file in this office.
Gregory Parker
AUTHORIZED SIGNATURE

T. 70 S., R. 112 W.,
Secs. 1 to 9, inclusive;
Sec. 10, lots 1 and 2;
Sec. 11, lots 1 and 2;
Secs. 12 to 31, inclusive;
Sec. 32, lot 1;
Sec. 33;
Sec. 34, lot 1;
Secs. 35 and 36.

Containing 19,521.78 acres, as shown on plat of survey officially filed October 3, 2006.

T. 71 S., R. 112 W.,
Secs. 5 to 8, inclusive;
Sec. 18, lot 1.

Containing 1,706.45 acres, as shown on plat of survey officially filed October 3, 2006.

T. 69 S., R. 113 W.,
Sec. 2, lot 2;
Secs. 8 and 11;
Secs. 12, 13, and 14;
Secs. 17 to 20, inclusive;
Secs. 23, 24 and 25;
Sec. 29, W½NE¼NW¼, NW¼NW¼;
Sec. 30, N½N½.

Containing 5,210.13 acres, as shown on protraction diagram S31-2 approved on April 19, 1972, and the plat of survey officially filed on September 22, 2006.

T. 70 S., R. 113 W.,
Secs. 25 to 28, inclusive;
Secs. 30 to 36, inclusive.

Containing 6,800.31 acres, as shown on plat of survey officially filed September 22, 2006.

T. 71 S., R. 113 W.,
Sec. 1;
Sec. 2, lots 1 and 2;

EXCEPTING AND RESERVING TO THE UNITED STATES from the lands so granted:

1. The subsurface estate therein, and all rights, privileges, immunities, and appurtenances, of whatsoever nature, accruing unto said estate pursuant to the Alaska Native Claims Settlement Act of December 18, 1971, 43 U.S.C. § 1613(f); and

2. Pursuant to Sec. 17(b) of the Alaska Native Claims Settlement Act of December 18, 1971, 43 U.S.C. § 1616(b) (1976), the following public easements, referenced by Easement Identification Number (EIN) on the easement maps, copies of which can be found in the Bureau of Land Management's public land records, are reserved to the United States. All easements are subject to applicable Federal, State, or Municipal corporation regulation. The following is a listing of uses allowed for each type of easement. Any uses which are not specifically listed are prohibited.

Bureau of Land Management
Alaska State Office
May 31, 2012 Anchorage, Alaska
DATE
I hereby certify that this reproduction is a copy of the official record on file in this office.
AUTHORIZED SIGNATURE

25 Foot Trail - The uses allowed on a twenty-five (25) foot wide trail easement are: travel by foot, dogsleds, animals, snowmobiles, two- and three-wheeled vehicles, and small all-terrain vehicles (ATV's) (less than 3,000 lbs. Gross Vehicle Weight (GVW)).

One Acre Site - The uses allowed on a site easement are: vehicle parking (e.g., aircraft, boats, all-terrain vehicles (ATV's), snowmobiles, cars, trucks), temporary camping, and loading or unloading. Temporary camping, loading, or unloading shall be limited to 24 hours.

a. (EIN 6 C5) An easement twenty-five (25) feet in width for a proposed access trail from Lost Harbor in Sec. 6, T. 69 S., R. 110 W., Seward Meridian, northeasterly to public lands. The uses allowed are those listed above for a twenty-five (25) foot wide trail easement.

b. (EIN 7 C5) An easement twenty-five (25) feet in width for a proposed access trail from Akutan Village along the north shore of Akutan Harbor in Sec. 11, T. 70 S., R. 112 W., Seward Meridian, westerly to public lands. The uses allowed are those listed above for a twenty-five (25) foot wide trail easement.

c. (EIN 30a C6) A proposed one (1) acre site easement located on the northwest shoreline of Akutan Island in Sec. 17, T. 69 S., R. 113 W., Seward Meridian, Alaska. The uses allowed are those listed above for a one (1) acre site easement.

Further, pursuant to Sec. 17(b)(2) of the Alaska Native Claims Settlement Act of December 18, 1971 (ANCSA), 43 U.S.C. § 1616(b)(2) (1976), any valid existing right recognized by ANCSA shall continue to have whatever right of access as is now provided for under existing law; and

2. Requirements of Sec. 14(c) of the Alaska Native Claims Settlement Act of December 18, 1971, 43 U.S.C. § 1613(c), as amended, that the grantee hereunder convey those portions, if any, of the lands hereinabove granted, as are prescribed in said section.

IN TESTIMONY WHEREOF, the undersigned authorized officer of the Bureau of Land Management, in accordance with the provisions of the Act of June 17, 1948 (62 Stat. 476), has, in the name of the United States, caused these letters to be made Patent, and the Seal of the Bureau to be hereunto affixed.

GIVEN under my hand, in Anchorage, Alaska, the twenty-second day of June in the year of our Lord two thousand and eleven and of the Independence of the United States the two hundred and thirty-fifth.

By /s/ Richard Thwaites
Richard Thwaites
Chief, Land Transfer Adjudication II Branch

Bureau of Land Management
Alaska State Office
May 31, 2012, Anchorage, Alaska
DATE
I hereby certify that this reproduction is a copy of the official record on file in this office.
AUTHORIZED SIGNATURE

Return Recorded Document to:
LISA M. WILLIS
U.S. FISH + WILDLIFE
1011 E. TUDOR RD MS-211
ANCHORAGE, AK
99503

Patent No. 50-2011-0167

SURVEYED TOWNSHIP 70 SOUTH RANGE 112 WEST OF THE SEWARD MERIDIAN, ALASKA

SCALE in chains

10 5 0 10 20 30 40

WARNING:
This plat is the Bureau's interpretation of field and known to date only as a graphic display of the cadastral survey data. Bar code marks do not reflect the changes which may have been affected by leased monuments or meets or other bodies of water. Refer to the cadastral surveys for official survey information

STATUS OF PUBLIC DOMAIN LAND AND MINERAL TITLES AND ACQUIRED LANDS

MTP

FOR ORDERS EFFECTING DISPOSAL OR USE OF UNIDENTIFIED LANDS WITHDRAWN FOR CLASSIFICATION, MINERALS, WATER AND/OR OTHER PUBLIC PURPOSES REFER TO INDEX OF MISCELLANEOUS DOCUMENTS

P.L.O. 5183 was Act of July 6, 1971, effective upon conveyance pursuant to ANCSA

P.L. 96-487 was Act December 2, 1980 (Alaska Islands Subunit of the Alaska Islands Unit) effective 12

DURPLAT ID		Acq Sew Mer
3-20-2013		T 70 S
		R 112 W

ACAD

SURFACE USE AND EXPLORATION AGREEMENT

This Agreement is made by and between Akutan Corporation, hereafter referred to as "AC" and the City of Akutan, hereafter referred to as "City."

WITNESSETH:

WHEREAS, City wishes to have access to the surface estate of certain land on Akutan Island that it is owned by AC and specifically described herein for the purpose of undertaking exploration and development of the geothermal resources thereon; and

WHEREAS, if the results of the said exploration are favorable, City wishes to have the exclusive right to negotiate one or more long-term lease agreements or other agreements for the purpose of developing geothermal power generation, and to construct one or more plants for the development of geothermal energy; and

WHEREAS, AC owns title to the surface estate of the land on which the exploration and development will take place;

NOW, THEREFORE, in consideration of these premises and the mutual promises contained therein, the parties agree as follows:

Article A. EXPLORATION AND DEVELOPMENT

1. Definitions. Except as required otherwise by the context, the terms used in this agreement shall have the meanings indicated in this section:

   a. "AC" means Akutan Corporation.

   b. "City" means the City of Akutan, and when the context requires, its agents, employees, representatives, invitees and contractors.

   c. "Development" means any geothermal power generation system as well as thermal-chemical utilization processes established, consisting of geothermal well sites, wells, piping, transmission lines, roads, and other appurtenances required to produce and transmit, heat, electricity, and related energy forms from one location to another.

   d. "Energy Resources" means all forms of geothermal energy including indigenous steam, hot water, and hot brines; steam and other gases, hot water, and hot brines resulting from water, gas, or other fluids artificially introduced into subsurface formations; heat or associated energy found beneath the surface of the earth; and water from geopressurized zones.

   e. "Project Area" means the surface estate of the following described land which is depicted on the map attached as Exhibit A, to wit:

      i. Township 69 South, Range 112 West, S.M., sections 30-36.

ii. Township 70 South, Range 112 West, S.M., sections 4-9, and 16-18.

iii. Township 69 South, Range 113 West, S.M., sections 24 and 25.

And, both the surface and subsurface estate of the following land also depicted on Exhibit A, when it is acquired by AC from the United States, to wit:

iv. Township 69 South, Range 113 West, S.M., section 36.

v. Township 70 South, Range 113 West, S.M. sections 1 and 12.

f. "Significant Surface Disturbance" means the removal of more than one (1) contiguous surface acre of material or vegetation from any specific site, or more than a total of one hundred surface acres from the Project Area. Crossing and recrossing the Subject Lands with all-terrain vehicles, the blazing of trails, flagging of sampling sites, the establishment of temporary camps, and similar non-permanent activities of minimal nature shall not be deemed to constitute Significant Surface Disturbances.

2. Exploration and Development.

a. AC hereby grants to City all necessary access to enter the Project Area so long as it is conducting its activities in conformance with the terms of this Agreement.

b. AC hereby grants to City the right to explore the Project Area by geological, geophysical or other methods and, to the extent of AC's rights, to take water therefrom for operations hereunder. AC does not represent or warrant that it owns the water.

c. AC hereby grants City the right to use the surface for the purpose of supporting slim drill holes; geothermal gradient drill holes, exploratory holes, and production holes into the subsurface geothermal resource. City and AC will consult on the specific location of all such holes and City will not drill in any location that is unacceptable to AC; provided that AC will not unreasonably withhold its consent to any such location. City shall obtain the consent of the subsurface owner before drilling any holes or otherwise disturbing the subsurface estate.

d. AC hereby grants to City the right to enter the Project Area and to take such samples and measurements as may be reasonably necessary to determine the appropriate location for the establishment of appropriate infrastructure in the Project Area.

e. Notwithstanding the foregoing, City shall not have the right to undertake Significant Surface Disturbance or construct roads or make other

permanent improvements in the Project Area during the exploration period without the prior written approval of AC.

f. City may temporarily store equipment in the Project Area necessary for its activities hereunder and shall have ingress and egress to and from the Project Area to carry out its activities hereunder.

g. City shall obtain all required permits, permissions, consents, or licenses for any activities of City, and AC makes no representations or warranties as to the requirements for any such permits, permission, consents, or licenses or as to the availability of such.

h. Nothing herein shall prevent AC, or its employees, agents, representatives, shareholders or invitees from entering the Project Area for any purpose that is not inconsistent with City's activities hereunder, including but not limited to, subsistence activities, and AC shall have such reasonable access to the Project Area as is necessary to properly monitor and ensure compliance with this Agreement.

3. Term. The term of this Surface Use and Exploration Agreement shall be three (3) years from July 1, 2014 to June 30, 2017 unless sooner terminated pursuant to Article B.

4. Payment. For the rights granted under this Agreement City shall pay AC the sum of Five Thousand Dollars ($5,000.00) upon the execution of this agreement.

5. Insurance. Prior to entering AC's land for any purpose, City, its agents, representatives and contractors, shall provide AC with certificates for general liability and property damage insurances from companies acceptable to AC with limits of not less than $500,000 per occurrence and $1,000,000 Aggregate for Bodily Injury and Property Damage.

a. All such insurance policies and certificates shall include the following cancellation or change clause or a similar clause approved by AC:

> This insurance will not be canceled by this insurance company nor any changes made in the policy, without first giving thirty (30) days notice in writing to Akutan Corporation, P.O. Box 8, Akutan, Alaska 99553.

b. The insurance required under this Agreement shall be maintained in full force and effect throughout the term of this Agreement and any extension hereof. City shall provide AC with certificates of insurance before it or its agents, representatives, contractors or invitees enter AC's land for any purpose.

6. Operations.

a. City shall comply with all federal, state and local laws and regulations applicable to its operations hereunder, and shall conduct all operations so as to minimize disturbance of the surface estate.

b. City shall indemnify, save harmless and defend AC from and against any and all liens, claims, judgments, or suits whatsoever arising out of the activities or operations hereunder of City, its agents, representatives or contractors, other than those arising from AC's act or failure to act, and this section shall survive termination of this Agreement.

c. City will reclaim and restore any surface disturbances for which it or its agents, representatives, contractors or invitees are responsible by restoring the land form and vegetation as nearly as practicable to their shape and condition prior to reconnaissance and exploration.

7. Labor and Materials. All of the labor performed and all of the materials furnished in City's operations hereunder shall be at City's sole cost and expense unless otherwise specified herein, and AC shall not be chargeable with or liable for any part thereof.

8. Testing. City shall be entitled to flow and/or blow wells for testing purposes in accordance with paragraph 2.c above.

9. Data. AC shall have the right to copies of all reports and studies developed by City under this Agreement upon its request.

10. Agreements.

a. When the City's exploration is complete, the City will promptly present AC with a development plan that identifies prospective development options, and, if applicable, provide notice to AC of the City's intent to proceed with resource development. In the event that City intends to develop one or more Energy Projects, AC hereby grants City the exclusive rights to enter into a mutually acceptable lease with AC for land mutually identified by the parties.

b. AC shall lease to City, pursuant to a lease agreement and price that is mutually acceptable to the parties, the smallest practicable tracts of surface estate that are reasonably necessary to construct and operate said geothermal project and shall grant to City the exclusive right to use said land to drill for, produce, extract, take, and remove geothermal resources from said land. Additional agreements may also be entered into, from time-to-time, as appropriate to develop and market geothermal resources.

11. Notices. Any notice or other communication hereunder from AC to City shall be given in writing by sending the same by prepaid registered or certified mail with return receipt requested addressed as follows:

Hermann J. Tuna Scanlan, DPA
City Administrator
City of Akutan
3380 C Street, Suite 205
Anchorage, AK 99501

Any notice or other communication hereunder from City to AC shall be given in like manner to AC addressed as follows:

Jacob Stepetin, President
Akutan Corporation
P.O. Box 8
Akutan, Alaska 99553

Article B. Miscellaneous Provisions.

1. Termination. AC shall have the right to terminate this Agreement if City materially violates it. Failure to make any payments when due within a reasonable time thereafter, failure to provide proof of insurance, and failure to maintain required insurance policies shall, without limitation, constitute material violations of this Agreement. Pursuant to any material violation(s), AC shall have the right to terminate this Agreement upon thirty (30) days written notice to the City. City shall have the opportunity to begin in good faith to cure any such violation(s) during said 30-day period and to complete such remedial action within a reasonable period thereafter.

2. Force Majeure. City's obligations hereunder shall be suspended when City is prevented from complying therewith as the result of earthquakes, volcanic activity, tsunamis, strikes, lockouts, riots, action of the elements, delays in transportation, inability to secure labor or materials in the open market, laws, rules or regulations of any federal, state, municipal or other governmental agency, authority or representative having jurisdiction, litigation or administrative proceedings affecting title to lands covered hereby or operations thereon, or by other matters or conditions beyond the reasonable control of City, whether or not similar to the conditions or matters specifically enumerated in this section; provided, however, that unless otherwise agreed between the parties, City's obligations hereunder shall not be suspended for more than one year because of Force Majeure.

3. Waste and Environmental Contamination. City shall clean up and remove all waste and environmental contamination including but not limited to hazardous substances that are deposited on AC's land due to City's activities under this Agreement. "Waste" means without limitation all material for discard from City's activities, including but not limited to, human waste, trash, garbage, refuse, fuel containers, shot wire, survey stakes, explosives boxes, ashes and functional and nonfunctional property and equipment.

4. Fish and Wildlife. All activities hereunder shall be conducted so as not to adversely affect salmon, salmon streams, wildlife, fish and wildlife habitat, or the human and physical environment of AC's land.

5. Severability. If any part, portion or provision of this Agreement shall be found or declared null, void, or unenforceable for any reason whatsoever by a court or governmental agency of competent jurisdiction, then only such part, portion, or provision shall be affected thereby and the remainder of this instrument shall continue in full force and effect.

6. Binding Effect. This Agreement and all of the terms, covenants and conditions hereof shall extend to and be binding upon the parties and their agents, representatives, employees, invitees and contractors.

7. Assignment. This Agreement may not be assigned without the written approval of AC which may be withheld for any reason.

8. Venue and Attorney's Fees. The venue for any civil action hereunder shall be the superior court in Anchorage, Alaska. The prevailing party shall be entitled to reasonable attorney's fees.

9. Entire Agreement. This Agreement is completely integrated, represents the entire agreement with respect to the subject matter hereof, and supersedes any and all prior and contemporaneous contracts, agreements, promises, representations, warranties, inducements and covenants, oral or written, conditional or unconditional, expressed or unexpressed, recorded or unrecorded, which in any way arise out of, result from, are based upon or are connected with such subject matter.

10. Independent Counsel. Each party acknowledges that it had the advice and representation of competent independent legal counsel in negotiating, entering into, executing and delivering this Agreement; and the fact that this Agreement may have been drafted in whole or in part by one party's counsel shall not cause all or any part of this Agreement to be construed against such party.

11. Recording. This Agreement shall not be recorded without both parties' written consent.

IN WITNESS WHEREOF, the parties hereto have executed this instrument as of the date first above written.

AKUTAN CORPORATION

Jacob Stepetin

Attest: April Pelkey

STATE OF ALASKA

THIRD JUDICIAL DISTRICT

THIS IS TO CERTIFY that on this 29th day of May, 2015, before me, the undersigned, a Notary Public in and for the State of Alaska, duly commissioned and sworn as such, personally appeared Jacob Stepetin and April Pelkey known to me to be the President and Manager, respectively, of Akutan Corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal the day and year above written.

AKUTAN, ALASKA 99553
MAY 29 2015
USPS

Notary Public in and for Alaska
My Commission Expires: when retired

CITY OF AKUTAN

Joseph Bereskin, Mayor

Attest:

Amanda Tcheripanoff, City Clerk

STATE OF ALASKA

THIRD JUDICIAL DISTRICT

THIS IS TO CERTIFY that on this 28th day of May, 2015, before me, the undersigned, a Notary Public in and for the State of Alaska, duly commissioned and sworn as such, personally appeared Joseph Bereskin and Amanda Tcheripanoff, known to me to be the Mayor and City Clerk, respectively, of the City of Akutan.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal the day and year above written.

AKUTAN, ALASKA 99553
MAY 29 2015
USPS

Notary Public in and for Alaska
My Commission Expires: when retired

FIRST AMENDMENT TO
SUBSURFACE RESOURCES EXPLORATION AGREEMENT
BETWEEN THE ALEUT CORPORATION
AND
THE CITY OF AKUTAN

WHEREAS, The Aleut Corporation ("TAC") and the City of Akutan ("City") entered into that certain Subsurface Resources Exploration Agreement dated June 16, 2009 ("Agreement"); and

WHEREAS, TAC and City desire to extend the Agreement to June 30, 2017, and to extend the exclusive negotiations of a Production Agreement for a period of one year from the date the City completes its reconnaissance and exploration;

NOW THEREFORE BE IT RESOLVED, TAC and City hereby agree to amend that Agreement by modifying Section 1 and Section 4 to read as follows:

Section 1. Term. The term of this Subsurface Resources Exploration Agreement ("Subsurface Agreement") shall be from June 1, 2009 to June 30, 2017, unless sooner terminated pursuant to Section 7 of this Agreement.

Section 4. Production Agreement. When City's reconnaissance and exploration is complete, City will promptly present TAC with a development plan that identifies prospective geothermal resource development options, and, if applicable, provide notice to TAC of City's intent to proceed with resource development. In the event that City intends to develop one or more geothermal applications, TAC hereby grants City the exclusive rights to negotiate with TAC for development rights ("Production Agreement") for geothermal resources located within TAC's subsurface lands for a period up to one year from the date the City completes it reconnaissance and exploration, subject to the terms and conditions herein.

All other terms and conditions of the Agreement remain in effect, unchanged except as modified by the provisions of the Amendments.

IN WITNESS WHEREOF, the parties hereto have executed this instrument on this 21st day of October, 2014.

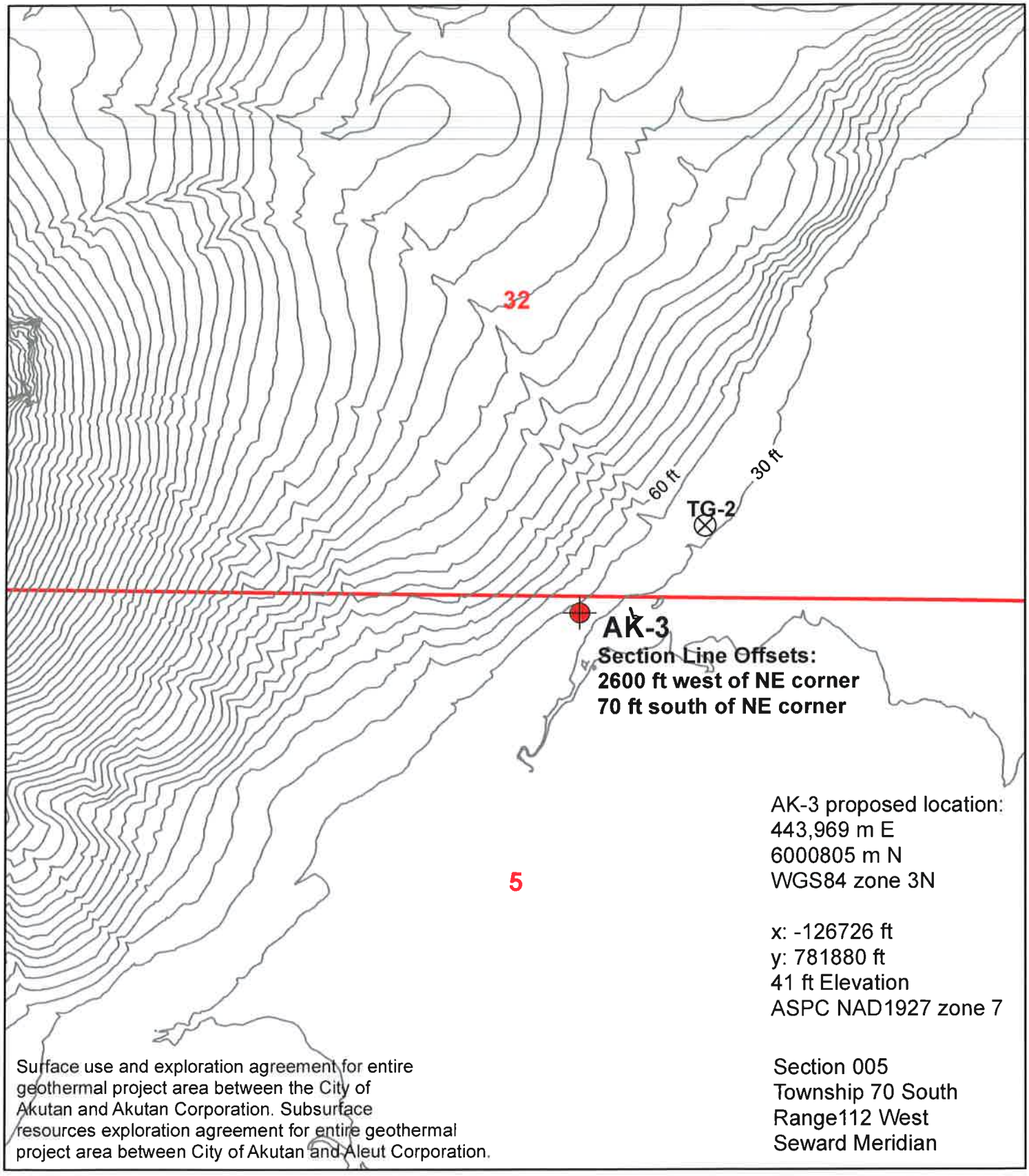
The Aleut Corporation

By: _____
Thomas Mack,
President

By: _____
Tracy Timothy Woo,
CFO & General Counsel

City of Akutan

By: _____
Joseph Bereskin,
Mayor



Akutan Geothermal Project
AK-3 Proposed Wellsite Location

0 250 500 1,000
Feet
Countour interval: 15 ft.

N

1:5,000
Date: 6/11/2015

Applicant:
City of Akutan
3380 C Street, Suite 205
Anchorage, AK 99503-3952

Bettis, Patricia K (DOA)

From: Mary Ohren <maryohren@geothermalresourcegroup.com>
Sent: Friday, June 12, 2015 8:57 AM
To: Bettis, Patricia K (DOA); Schwartz, Guy L (DOA)
Cc: 'R Mann' (raymann@rma-cg.com); 'K Mann' (kmmann@rma-cg.com); akutanadmin@gci.net
Subject: Akutan-3: Permit to Drill Application (215-080)
Attachments: Akutan_AK-3_Wellsite.pdf

Ms. Bettis,
Geothermal Resource Group, a technical consultant to the City of Akutan is providing in this e-mail and attachment the responses to items 5-8 from you e-mail copied below from 28 May 2015. The City of Akutan will provide the other required items separately.

5. As required by 20 AAC 25.005, the permit to drill application needs to provide a general description of how the operator plans to dispose of drilling mud and cuttings. This information was missing from the permit to drill application received May 8, 2015.

Fluids produced during drilling and testing of well AK-3 will be discharged into the retention pond that is seen in Figure 3 of the permit application. These fluids will be left to evaporate and then buried. Drilling mud and cuttings, will be buried in place.

6. As required by 20 AAC 25.005, an application for a permit to drill must include a plat identifying the property and the property's owners and show the coordinates of the proposed location of the well at the surface location, referenced to the state plane coordinate system. AOGCC's required coordinates are State Base Plane referenced to NAD 27.

Attached map.

7. MASP and Reservoir pressure - Please explain the graph on page 9 of the permit to drill. How did you come up with the 140 psi surface pressure? (The last well TG-2 had a MASP of 500 psi.) The formula and calculations need to be provided. You will have to request a variance to 20 AAC 25.005 (c)(4) to use an alternate calculation for MASP.

The operator requests a variance pursuant to 20 AAC 25.005 (c) (4) for an alternative formula for determination of the maximum anticipated surface pressure (MASP).
This variance is requested because of the known underground conditions from offset well TG-2 allow for a closer calculation of pressure exerted on the wellbore. This calculation is used for determination of casing depths, and installation of Blow Out Prevention Equipment (BOPE).
The flowing temperature of 360°F was measured with a Maximum Recorded Temperature (MRT) tool at 590' vertical foot depth in offset well TG-2. This is the expected reservoir temperature based on the geochemistry of sampled fluids. The steam tables indicate that at the saturation point the corresponding pressure is 138 psig. This is the maximum pressure on the wellbore. A Formation Integrity Test (FIT) to 12 ppg pressure equivalent performed at 178' in offset TG-2 concluded that the formation is strong enough to contain 0.63 psi/ft pressure. ✓
The AK-3 drilling plan indicates that at ±220' a 5-1/2" casing will be cemented in place, and an annular preventer installed for the drilling of the next well section. This setting depth was chosen so that the formation at the shoe would withstand the maximum expected shut in pressure. Prior to this no diverter or BOP will be used because there were no reported incidents of flow prior to drilling below 220' GL in either offset well TG-2 or TG-4. The surface casing shoe at 220' in AK-3

is expected to withstand the formation pressure (220'*0.63 psi/ft = 138.6 psi) and contain the pressure exerted by the maximum measured temperature reservoir fluid in the offset well (138 psi)..
Therefore, GRG concludes that it is safe and recommends drilling to 220' without a diverter and setting the surface casing at this depth, in order to reduce the drilling equipment load on the project. Below this depth an annular preventer will be installed. The annular preventer will be tested to 750 psi, at the next casing depth at 800' the MASP is 504 psi (800'*.63 psi = 504 psi.), well under the limit of the BOP equipment.

8. What does the BPD curve represent on the graphs Figures 14 and 15?

BPD stands for Boiling Point at Depth, and it represents the boiling temperature at depth in the well, which is a physical property of water. In Figures 14 and 15 the units are in Celsius along the top of the chart. This was provided as offset data from the TG-2 and TG-4 wells. This curve is also shown on Figure 1 of the permit application.

Feel free to contact the GRG along with the City of Akutan if you have further questions regarding the technical aspects of the drilling permit application for AK-3.

Mary Ohren
Project Geologist
Geothermal Resource Group, Inc.
maryohren@geothermalresourcegroup.com
760-341-0186 Office
775-527-8963 Cell
77530 Enfield Lane Bldg E, Palm Desert CA 92211

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From: Bettis, Patricia K (DOA) [mailto:patricia.bettis@alaska.gov]
Sent: Thursday, May 28, 2015 2:02 PM
To: akutanadmin@gci.net
Subject: Akutan-3: Permit to Drill Application (215-080)

From: Bettis, Patricia K (DOA)
Sent: Thursday, May 28, 2015 1:41 PM
To: 'akutanadmin@gci.com'
Cc: Colombie, Jody J (DOA); Schwartz, Guy L (DOA)
Subject: Akutan-3: Permit to Drill Application (215-080)

Good afternoon Mr. Scanlan,

The Alaska Oil and Gas Conservation Commission (AOGCC) received the permit to drill application for the Akutan-3 geothermal well on May 8, 2015. The following items and/or information are needed:

1. A copy of the exploration agreement needs to be submitted to the AOGCC. This was omitted in the attachments included with the permit to drill application for AK-3.

2. As required by 20 AAC 25.025, the City of Akutan must first establish a new bond with the AOGCC. *The AOGCC must receive and approve this bond before any other forms will be processed.* Please contact Jody Colombie at (907) 793-1221 or at jody.colombie@alaska.gov if you have questions concerning bonding.

3. As required by 20 AAC 25.020, a Designation of Operator form (Form 10-411) needs to be filed with the AOGCC designating the City of Akutan as operator. Per the instruction in Box 5 and Box 6 of the Form 10-411, a Power of Attorney or other evidence of authority must be attached for each person signing the form.

4. Form 10-401, Box 20/21, the contact name, email and telephone number is missing. Please provide the AOGCC will the name, email address and telephone number for the operations field contact for the AK-3 drilling program.

5. As required by 20 AAC 25.005, the permit to drill application needs to provide a general description of how the operator plans to dispose of drilling mud and cuttings. This information was missing from the permit to drill application received May 8, 2015.

6. As required by 20 AAC 25.005, an application for a permit to drill must include a plat identifying the property and the property's owners and show the coordinates of the proposed location of the well at the surface location, referenced to the state plane coordinate system. AOGCC's required coordinates are State Base Plane referenced to NAD 27.

7. MASP and Reservoir pressure - Please explain the graph on page 9 of the permit to drill. How did you come up with the 140 psi surface pressure? (The last well TG-2 had a MASP of 500 psi.) The formula and calculations need to be provided. You will have to request a variance to 20 AAC 25.005 (c)(4) to use an alternate calculation for MASP.

8. What does the BPD curve represent on the graphs Figures 14 and 15?

Please do not hesitate to call either myself or Guy Schwartz, drilling engineer, if you have any questions. Guy may be reached at (907) 793-1226.

Regards,

Patricia Bettis
Senior Petroleum Geologist
Alaska Oil and Gas Conservation Commission
333 West 7th Avenue
Anchorage, AK 99501
Tel: (907) 793-1238

CONFIDENTIALITY NOTICE: This e-mail message, including any attachments, contains information from the Alaska Oil and Gas Conservation Commission (AOGCC), State of Alaska and is for the sole use of the intended recipient(s). It may contain confidential and/or privileged information. The unauthorized review, use or disclosure of such information may violate state or federal law. If you are an unintended recipient of this e-mail, please delete it, without first saving or forwarding it, and, so that the AOGCC is aware of the mistake in sending it to you, contact Patricia Bettis at (907) 793-1238 or patricia.bettis@alaska.gov.

Geothermal Resource Group, Inc.
77530 Enfield Lane, Building E
Palm Desert, CA 92211
Phone: 760-341-0186

17 September 2015

To: Ray Mann
Program Manager
RMA Consultant Group

RE: Akutan Project Update for DOE - GRG scope of work

Well Drilling Permit

Geothermal Resource Group (GRG) provided the well design and technical specifications for a City of Akutan Drilling Permit for a geothermal confirmation well identified as "AK-3." Permit Number 215-080 was approved by the Alaska Oil and Gas Conservation Commission (AOGCC) on 13 August 2015, and received by the City of Akutan on 20 August 2015. The drilling permit conditions for AK-3 are listed on the Transmittal Letter received with the permit. These conditions are reasonable, including reporting requirements to the State of Alaska, data collection requirements, and safety and accident prevention methods to be followed.

Several variances were requested in the permit application, and were granted, based on previous drilling conducted in the Hot Springs Bay Valley of Akutan Island. These descriptions can be viewed in the attached permit.

Additional Targeting Information

At the Technical Monitoring Team (TMT) meeting on 31 March 2015, the project team presented information for the targeting of AK-3. The TMT requested that the team review the work and make additional statements regarding the drilling target and well prognosis. The discussion below provides supplemental information to the drilling targeting report presented at that meeting.

Geothermal Resource Group, assisted by Mira Geoscience, and contracted geologists for the project Nicolas Hinz and Pete Stelling, reviewed the 3D model built in 2014, for the purpose of reanalyzing the geoscience data that exists from the Hot Springs Bay Valley (HSBV) geothermal resource.

Geophysics

The geophysical data interpretations do not provide clear evidence for a fault in the vicinity of the new drill site. This shouldn't be taken to mean that a fault does not exist; surface geologic mapping and thermal features investigations provide evidence supporting the existence of a fault. Instead, it's more accurate to conclude that the two geophysical methods employed, magnetotellurics (MT) and gravity, did not reveal the presence of a fault.

One reason the gravity data wouldn't reveal a fault is the lack of sufficient gravity stations, since the soggy conditions in that part of the valley did not allow good access for taking gravity measurements.

Another reason that a fault cannot be resolved in this area is that there may be no distinct physical property contrast on either side of the fault, making it unlikely that geophysical techniques can reveal a

fault. Put more plainly, if there is a fault, but the offset is minimal, and the density or resistivity of the rocks on one side of the fault is the same as the rocks on the other side of the fault, then the gravity or resistivity methods will not be useful for fault detection.

The MT data reveals the resistivity contrast between altered and unaltered rock, for example, but will not resolve a subtle feature such as a fault with a small offset. It is likely that the body of rock on either side of such a fault is equally altered, so any resistivity feature would appear more as a sub-horizontal or rounded feature, not a distinct line that would become the target fault. It is clear from the MT data that there is an altered feature that occurs in that part of the valley, which we have interpreted to be the clay alteration resulting from water/rock interaction with hydrothermal fluids.

Two resistivity models have been developed for the HSBV resource, one a full 3D integration by GeoSystems in 2009, and a second 2D inversion that was stitched into a 3D interpretation done by Zonge in 2012. The Zonge model included additional stations from the 2012 field season. A slice from the 3D models, looking north and running through the AK-3 target location, are shown in Figure 2 and Figure 3. In the 2009 model, a resistive feature extends toward the surface to the east under the AK-3 location. In the 2012 model, a conductive lobe stretches to the east below the middle resistivity rock body that forms a band close to the surface. In either model, a 1700’ well would reach into the resistive structure that is thought to host the geothermal resource. The fact that both models show that there is a change at this location and depth, leads to an interpretation that there is a geologic feature in this area with attractive rock properties, which would otherwise be a mostly uniform pile of volcanic rocks.

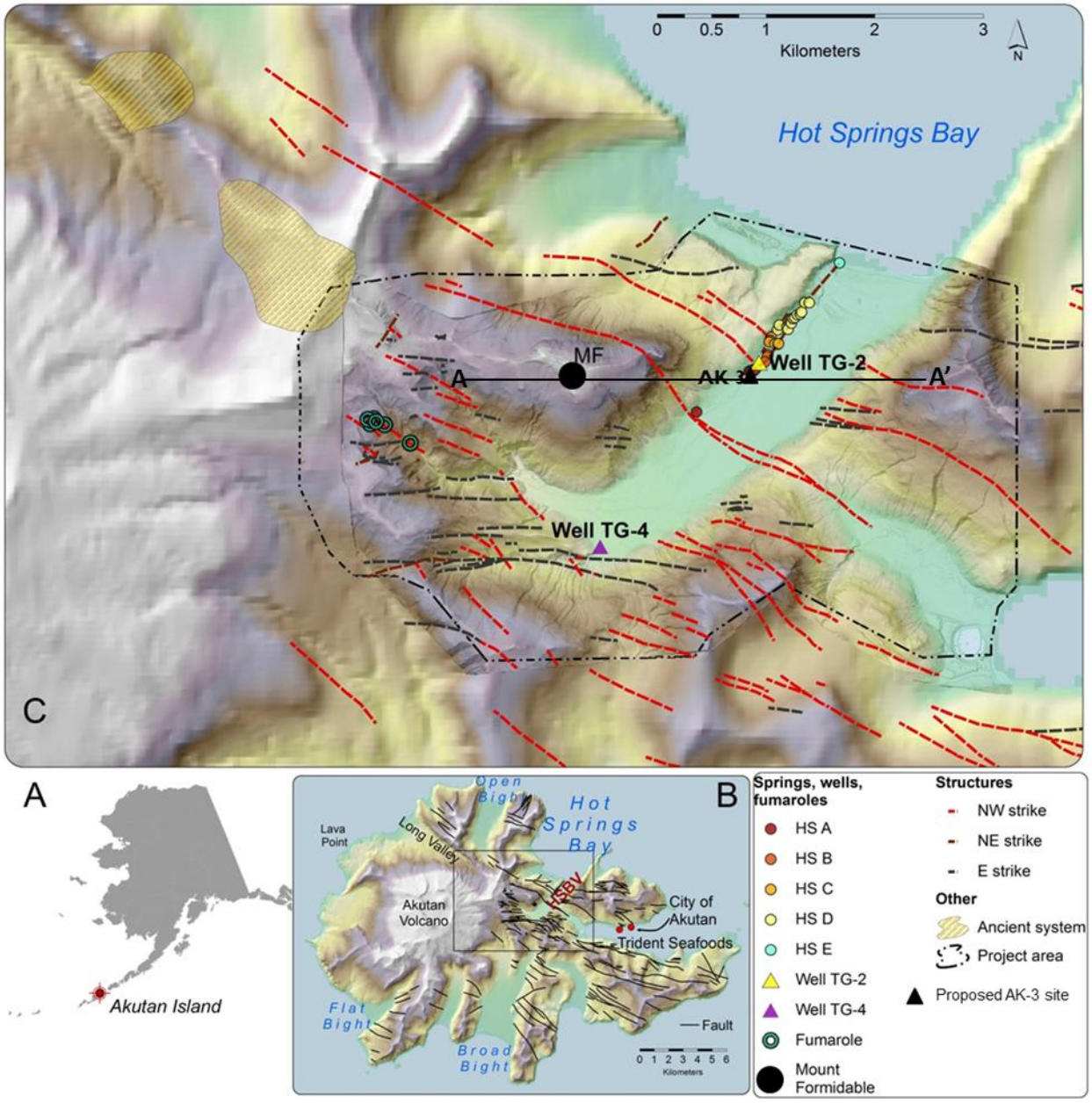


Figure 1: Reference map of HSBV showing proposed well AK-3, existing well locations TG-2 and TG-4, and cross-section A-A' shown in Figures 2-3.

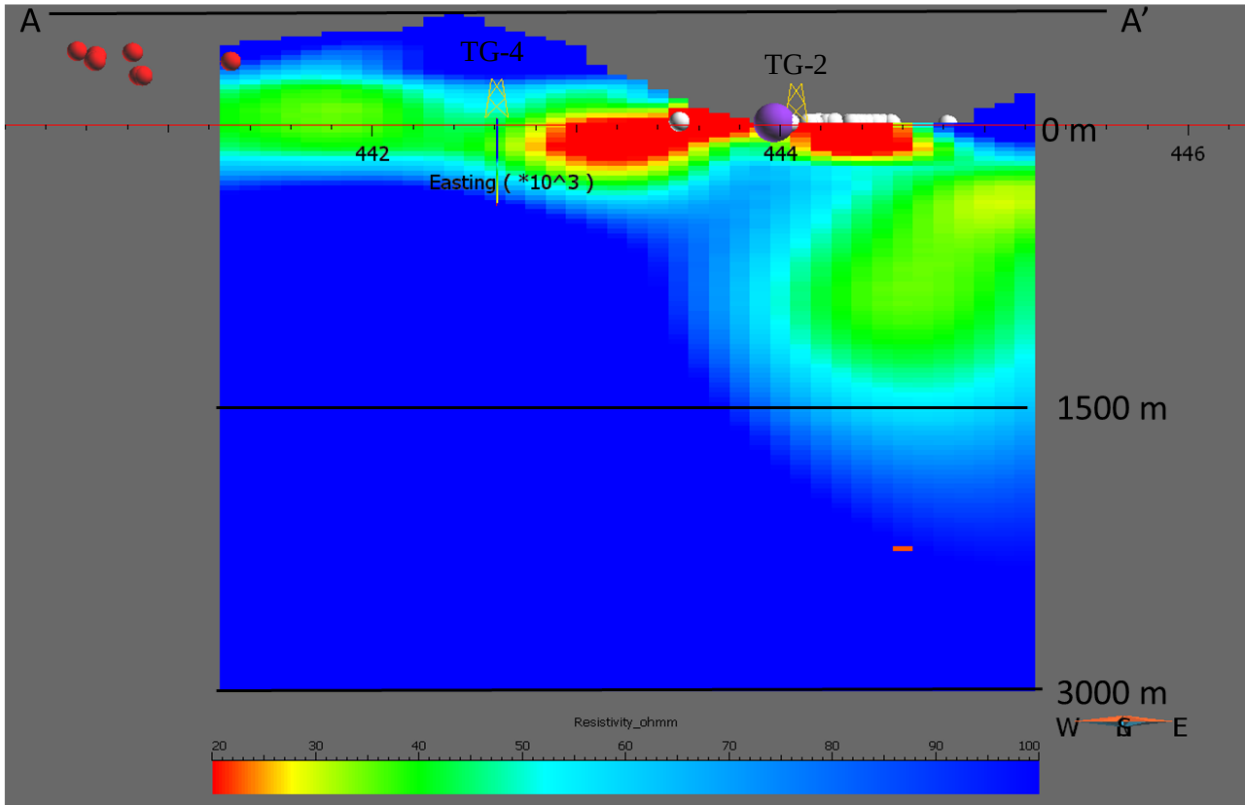


Figure 2: Slice from 3D model built in 2014 looking north through the proposed AK-3 location. The colored grid is the 2009 Geosystems 3D inversion results. Yellow hatched symbols are wells TG-2 and TG-4. TG-4, on the left, is out of the plane of the section. The purple circle is proposed AK-3 location near TG-2. White and red circles are hot spring locations, some of which are out of the plane of section. Description in text.

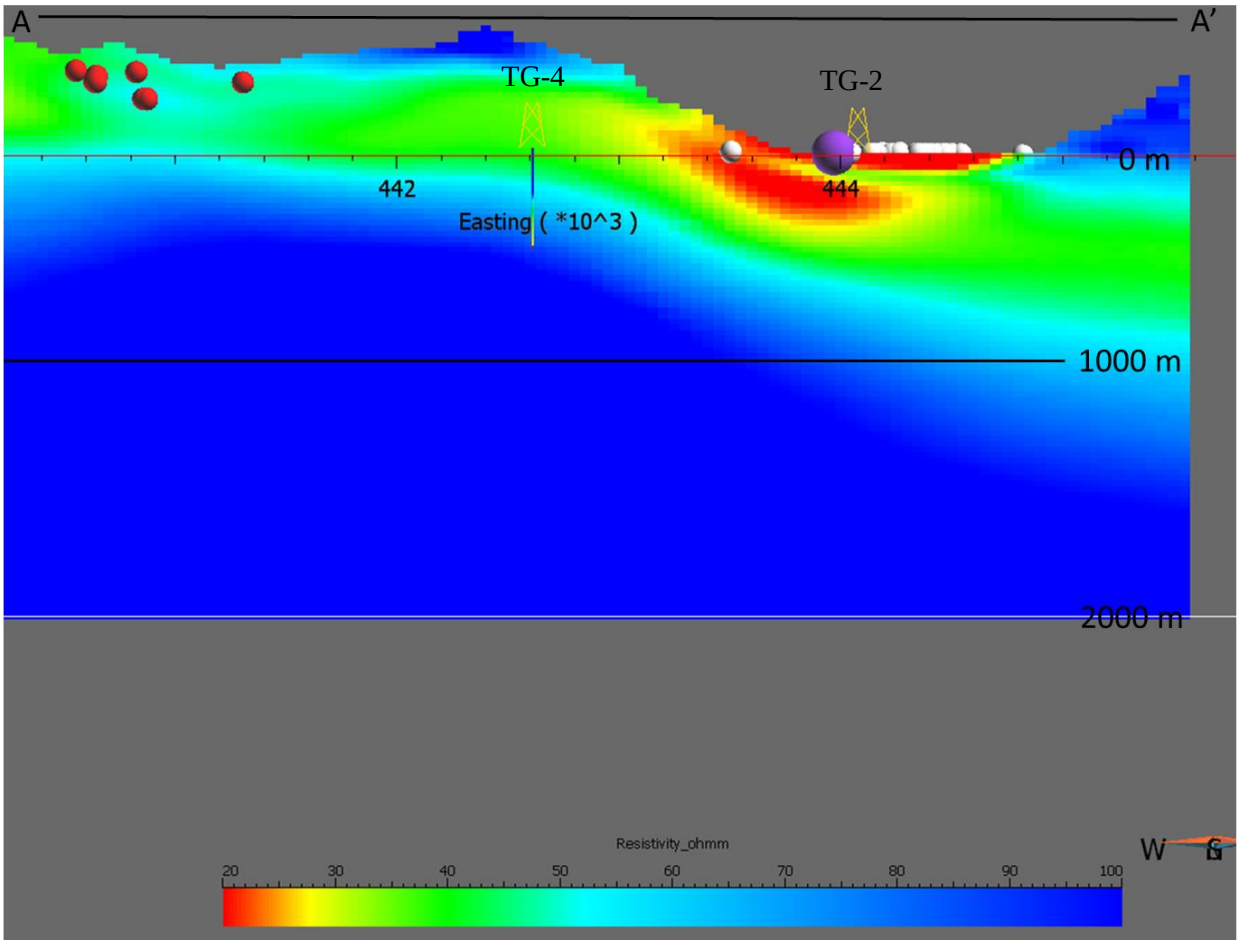


Figure 3: Slice from 3D model built in 2014 looking north through the proposed AK-3 location. The colored grid is the 2012 Zonge 2D "stitched" inversion results. Yellow hatched symbols are wells TG-2 and TG 4. TG-4 on the left is out of plane from the sections. Purple circle is proposed AK-3 location near TG-2. White and red circles are hot spring locations, some of which are out of the plane of section. Description in text.

Geology

The geology team revisited the geologic model in the target region, searching for evidence of faults and fault intersections that could be conduits for fluid from the hottest part of the geothermal system. A reference map for the remaining discussion is given in Figure 5.

The geologists made several observations in relation to the significance of NE versus WNW-striking normal faults relative to permeability, the dip of the NE and WNW-striking normal faults, and the implications and justification of the selected AK-3 drilling target.

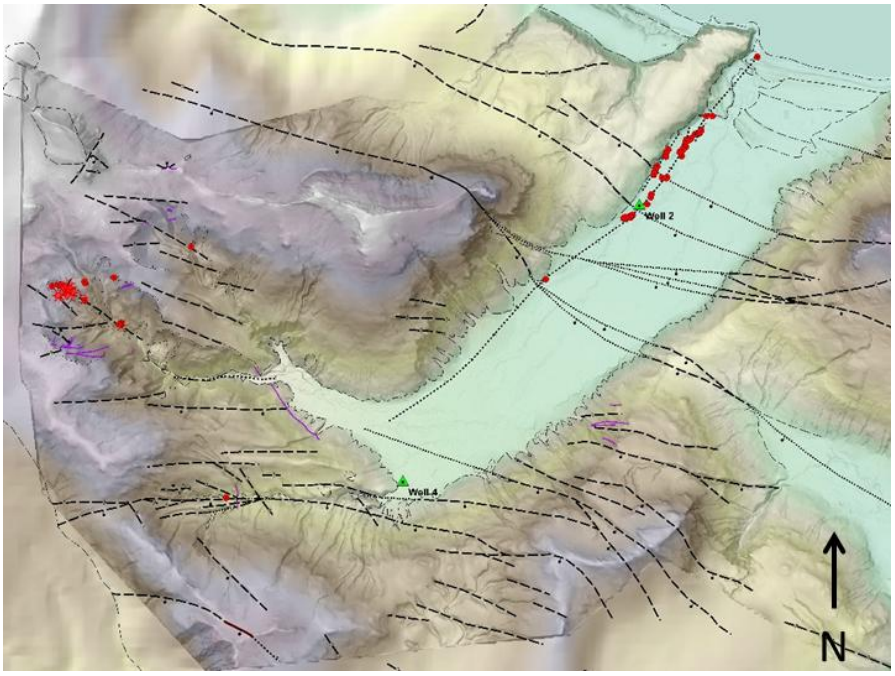


Figure 4: Reference map for mapped structures in HSBV, updated in 2015 with dashed fault links across lower HSBV.

Here is a list of the main observations:

1) Clusters of surface thermal features tend to be located at fault intersections
   - Hot spring clusters are co-located near where the NE-striking (valley-parallel) normal fault zone is intersected by WNW-striking (cross-valley) normal faults.
   - The hottest cluster of hot springs is located just up-valley of the WNW-striking fault.
   - Fumaroles in upper HSBV also aligned along intersection of WNW-striking fault ("Fumarole Valley") and a NE-striking fault.
2) NE-striking (valley-parallel) faults are important structural features, especially in lower HSBV
   - Although less abundant than WNW- to W-striking faults, the NE-striking faults have been mapped across Akutan Island from the south shore to the north shore.
   - Hot Springs in lower HSBV focused along inferred NE-striking (valley-parallel) fault zone.
   - Hot springs clusters aligned along local NNE-, NE- and ENE-trending lineaments along the greater NE-striking fault zone in lower HSBV
     - N10°E (2 clusters)
     - N25°E (1 cluster)
     - N45-50°E (3 clusters)
     - N60°E (2 clusters)
     - N80°E (2 clusters)
     - N80°W (1 cluster)

3) Dip of NE-striking faults
   - The specific dip of the specific NE-striking (valley parallel) fault zone in lower HSBV is unknown. There is no outcrop of this fault surface and it does not cross topography to gauge a V-shape dip relationship or calculate the dip with a 3-point method.
   - In upper HSBV, 16 NE-striking fault surfaces were measured (Figure 4)

- 11 (69%) dip SE
- 4 (25%) dip NW
- 1 (6%) sub-vertical (strike-slip)

- The field measured NE-striking faults in upper HSBV dip from 54° to 81°SE and average 73°SE. The geologists' expectation is that the NE-striking (valley-parallel) fault dips 65° to 75°SE. However, there is no direct evidence of dip along this valley-parallel fault. NW, SE, or vertical dips are all possible, but SE is slightly more favorable than NW.

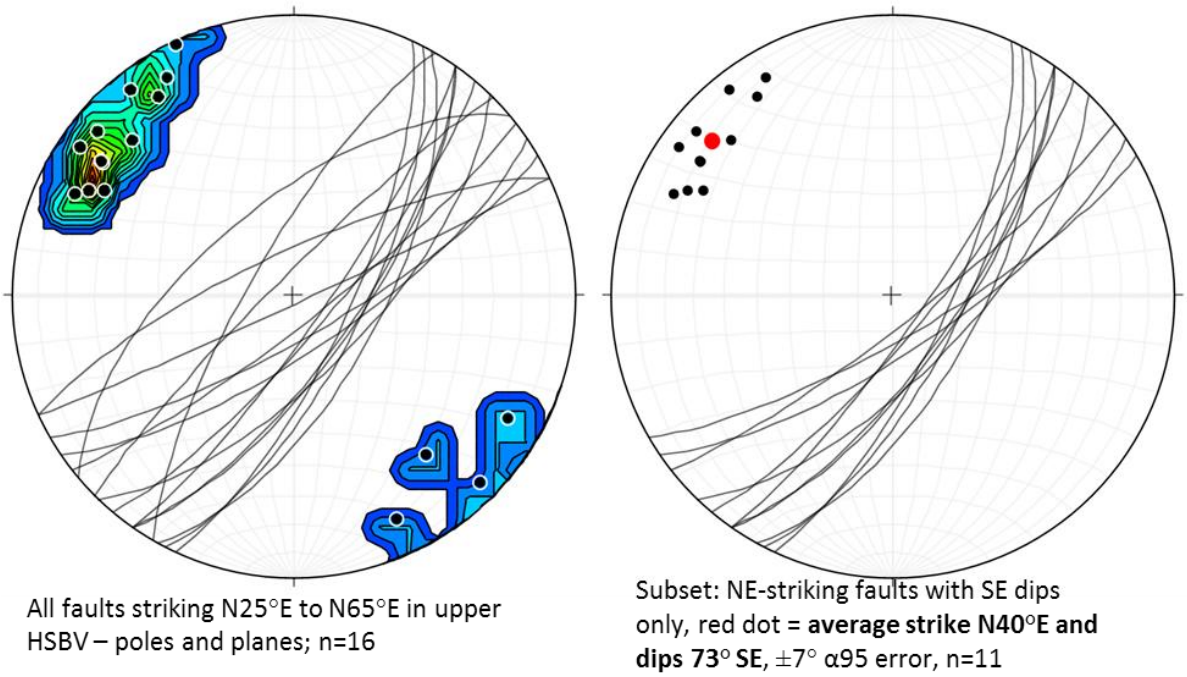


Figure 5: Left side shows all of the 16 fault surfaces (pole and planes) that were measured striking N25°E to N65°E in upper HSBV. Right side shows that 11 of these faults had a SE dip. The red pole dot indicates the average of these 11 fault surfaces has a strike N40°E and dips 73° SE.

4) Dip of WNW- and W-striking faults

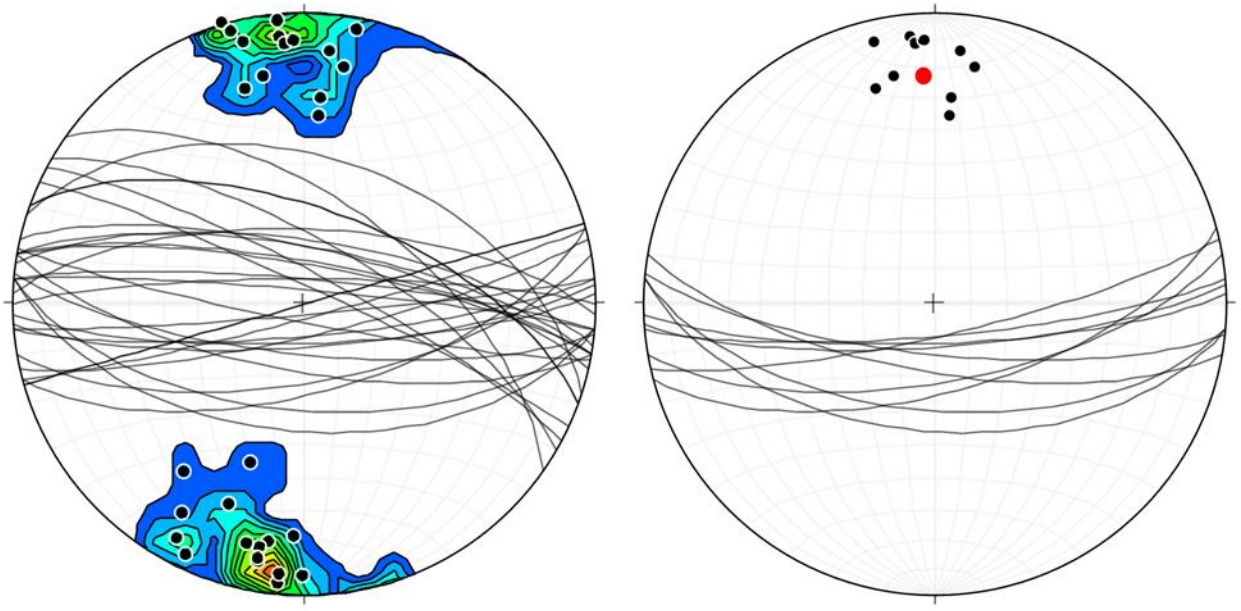
- WNW- and E-W striking faults predominantly dip south, as indicated by topographic V-relationships in numerous locations across the greater HSBV area. Prominent examples are present 600 m west of TG-2.

- View in the photograph (Figure 7) is as seen by standing on the fault as it crosses Mount Formidable, and looking ESE at the two splays, as they cross HSBV. Prominent up-valley V-pattern indicates that this fault dips south. Careful measurements sighted with a Brunton compass garnered a 62°S dip from this location. Three-point calculation on this fault yielded a dip of 69°S across Mount Formidable.

- The faults on either side of TG-2 have less striking V-relationships than the Mount Formidable fault shown in the photo. Nevertheless, these faults do exhibit a V-pattern indicative of south dips. A 3-point problem on the fault immediately adjacent (east

side) of TG-2 yielded a dip of 45°S, but because this fault does not cross much relief, this 3-point calculation is much less accurate than for the 3-point calculation of the fault that crosses Mount Formidable.

- 39 fault surfaces were measured in upper HSBV with WNW-, W-, and WSW-strikes, mostly near the fumarole area.
  - 11 (35%) dip S (average dip of these 11 faults is 68°S)
  - 9 (29%) dip sub-vertical (strike-slip faults)
  - 11 (35%) dip N
- The 11 field-measured, WNW- to WSW-striking, S-dipping normal faults had dips ranging from 54° to 81°S (identical range of dips for the NE-striking, SE-dipping faults!) with an average of 68°. The WNW-striking fault directly adjacent to TG-2 probably dips 60 to 75°S.
- Overall, the map pattern of faults in the fumarole area is much more complex than lower HSBV, with numerous small faults which could not be shown at map-scale. Map patterns for the WNW- to W-striking faults in lower HSBV are more consistently organized in lower HSBV with consistent south dips.



All faults striking N55°W to S104°W (49° spread) in upper HSBV – poles and planes; n=31

Subset: faults striking N55°W to S104°W with south dips in upper HSBV – poles and planes; red dot = **average strike N87E° and dips 68° S;** n=11

Figure 6: Left side shows the measurements of the 31 WNW- and W-striking surfaces that were measured in HSBV (primarily in the upper valley). Right side is the subset of these faults with dips to the south, with average dip of 68°.

Figure 7: View from Mount Formidable to the southeast across the HSBV. Two faults with ESE-striking splays are shown in white as they cross the valley. Prominent up-valley V-pattern indicates that this fault dips south. Careful measurements sighted with a Brunton compass garnered a 62°S dip from this location.

5) Implications for AK-3 drilling

- The nature of permeability in the reservoir at depth in the AK-3 target location is relatively unknown.
- Upflow in lower HSBV is associated with the NE-striking (valley-parallel) fault zone, and is concentrated where this zone is intersected by WNW-striking (cross-valley), south dipping faults.
- Based on regional data, the NE-striking (valley-parallel) fault may dip either SE (underneath the valley floor) or may dip NW. There is slight favorability for this fault to dip SE rather than NW, but moving the well location out into the valley floor is not realistic due to swampy conditions.
- Based on regional and local map data, the WNW-striking fault next to TG-2 dips south.
- The geology team's recommendation is to target AK-3 on the down dip segment of the WNW-striking (cross-valley) fault (close to TG-2), near the NE-striking (valley-parallel) fault zone for greater overall permeability. The permitted location and depth of AK-3 meets these criteria.
- In the event that the NE-striking (valley-parallel) fault dips NW, then we will also hit both faults with the currently permitted AK-3 well.