Agency: Commerce, Community and Economic Development

Grants to Municipalities (AS 37.05.315)

Grant Recipient: Unalaska

Project Title:

Unalaska - Geothermal Exploration

State Funding Requested: $ 1,500,000 **House District:** 37 - S

One-Time Need

Brief Project Description:

Exploration of the Makushin Valley for a geothermal energy source.

Funding Plan:

Total Cost of Project: $3,000,000

	Funding Secured		Other Pending Requests		Anticipated Future Need	
	Amount	*FY*	*Amount*	*FY*	*Amount*	*FY*
Local Funds	$1,500,000	2009				
Total	$1,500,000					

Detailed Project Description and Justification:

The City is pursuing a geothermal project for Unalaska / Dutch Harbor given the high cost of fuel and their desire to reduce their dependence on fossil fuels. A promising resource has been located on the flanks of Makushin Volcano, but there is a need for more exploration to see if the resource exists lower in the Makushin Valley. If the resource is found, project costs could be reduced by $25 million or more, making energy production using geothermal more realistic. It will cost $3 million to fly in the necessary equipment to drill several holes in the Makushin Valley. This project is an amazing opportunity for the entire State to learn from, and possibly emulate where feasible.

This possibility has been known about for twenty years and has been assessed numerous times. Past development plans have always been based on locating the power plant in the Upper Makushin Valley, 1,200 feet above sea level. This location is problematic due to the terrain of the Lower Valley. Environmental factors cause the technical and economic viability of this location problems.

Today, with the high cost of diesel fuel and new regulatory requirements for air quality, the City wishes to explore the possibility of developing Makushin on its own, a concept that has never been explored in the history of the project. The City's resource consultants believe that the geothermal fluid located in the test well is not trapped, but rather flows out of the area, likely through the Makushin Valley. Location of facilities in the Lower Valley would result in significant construction and operating costs savings. This project will determine whether any resource found in the Lower Valley remains hot enough for commercial purposes.

Project Timeline:

Exploration will take place this year with successful funding

For use by Co-chair Staff Only:

Contact Name: Adam Berg
Contact Number: 465-4451

4:06 PM 4/29/2008

Entity Responsible for the Ongoing Operation and Maintenance of this Project:

City of Unalaska

Grant Recipient Contact Information:

Contact Name: Chris Hladick
Phone Number: 581-1251
Address: PO Box 610, Unalaska, 99685
Email: chladick@ci.unalaska.ak.us

Has this project been through a public review process at the local level and is it a community priority? [X] Yes [ ] No

For use by Co-chair Staff Only:

4:06 PM 4/29/2008

Contact Name: Adam Berg
Contact Number: 465-4451

MAKUSHIN GEOTHERMAL PROJECT

(Briefing Update)

Past development plans of the proposed Makushin Geothermal Project ("Makushin") have always been based on locating the power plant in the Upper Makushin Valley at elevation 1,200 feet above sea level near the existing well drilled in 1982. Although the size and boundaries of the underground heat source are not well defined, the site was selected in an attempt to maximize the probability for the highest temperature resource.

The site is relatively inaccessible, and a steep slope with an 800-foot elevation differential must be traversed via a series of switchbacks. This slope creates environmental factors that cause the technical and economic viability of the proposed project to be problematic. Not only would construction and operating costs be higher, but the susceptibility of the transmission line to outages from avalanches and wind could bring into question the overall reliability of the project.

Since the time the existing well was drilled, a number of advancements in geothermal production technology have been made so that lower fluid temperatures can now be commercially viable. Given this advancement and the strong possibility that the geothermal fluid is flowing from the Upper into the Lower Valley, a prudent part of the development is to perform exploratory drilling in the Lower Valley. If a commercially viable fluid is located, <u>significant</u> savings can be achieved in both capital and operating costs. Preliminary estimates of capital cost savings are a minimum of $50 million.

The City of Unalaska is now ready to embark on a preliminary drilling program of small-diameter temperature gradient wells in the Lower Valley. This type of drilling can be accomplished with relatively small drill rigs and is the least-cost drilling that can be performed and still achieves meaningful results. If results indicate high enough temperatures, production-size wells can then be drilled.

The cost of the temperature gradient well drilling program is approximately $3 million. However, given that at least $50 million of capital costs plus substantial operating costs can be saved by locating the facilities in the Lower Valley, the costs of the exploratory drilling program is a prudent investment.

Future actions taken regarding the development of the Makushin Geothermal Project depend on the outcome of drilling the temperature gradient wells. If temperatures are high enough, production wells would be drilled to verify the volume of fluid. It is felt that a commercially viable resource can be built in the Lower Valley, and full resource development would in all likelihood follow the production wells.

If, on the other hand, temperatures are not high enough, a reassessment of the conceptual design, placement of production facilities, and capital/operating costs would follow to determine whether it is prudent to continue development.

CITY OF UNALASKA
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UNALASKA, ALASKA 99685-0610
(907) 581-1251 FAX (907) 581-1417

October 26, 2007

The Honorable Sarah Palin
Governor of Alaska
P.O. Box 110001
Juneau, AK 99811-0001

Re: City of Unalaska Capital Requests for FY09

Dear Governor Palin:

This letter is written to request your assistance with two projects critical to the continued health and stability of our hardworking community by placing $4 million dollars for Powerhouse Expansion and $1.5 million dollars for geothermal exploration in your Capital Budget.

The City's Electric Utility is in the process of building a new Powerhouse. This $23 million dollar project will replace existing, inefficient diesel units in an antiquated WWII era facility with two highly fuel efficient 5.2 MW Wartsila units in a new facility, allowing the City to rise above power capacity limits currently restricting industry and small businesses growth in the "Number One Fishing Port in the Nation." Unalaska will obtain long term financing of $14 million dollars, with another $5 million dollars coming from the City's General Fund for the long anticipated project. This leaves a need of $4 million dollars to complete the project without further burdening our rate payers.

Our community is also very supportive of the City Council pursuing a geothermal project for Unalaska/Dutch Harbor given the high cost of fuel and their desire to reduce our dependence on fossil fuels. A promising resource has been located on the flanks of Makushin Volcano but there is a need for more exploration to see if the resource exists lower in the Makushin Valley. If this is the case, the project costs could be reduced by $25 million or more, making energy production using a renewable resource more realistic. It will cost $3 million dollars, with the City Council contributing $1.5 million dollars to fly in the necessary equipment to drill several holes in the Makushin Valley. This project could be an amazing opportunity for the entire State to learn from, and possibly emulate where feasible.

Any assistance you can provide in this regard will be greatly appreciated. In advance, thank you for your time considering these two important projects to Unalaska.

Sincerely,

Shirley Marquardt
Mayor

Enclosures

cc: The Honorable Lyman Hoffman, State Senator
The Honorable Bryce Edgmon, State Representative
Mr. Mike Tibbles, Chief Of Staff
Karen Rehfeld, OMB Director

CITY OF UNALASKA
UNALASKA, ALASKA

RESOLUTION 2007-48

A RESOLUTION OF THE UNALASKA CITY COUNCIL IDENTIFYING THE CITY OF UNALASKA'S STATE LEGISLATIVE FUNDING PRIORITIES FOR THE FISCAL YEAR 2009.

WHEREAS, the City of Unalaska is in the final design and permitting phase of a new powerhouse to meet its existing and future power generation needs; and

WHEREAS, the City of Unalaska estimates construction costs for the powerhouse project to be approximately $23 million; and

WHEREAS, the City of Unalaska is fully responsible for all development costs, including a construction loan; and

WHEREAS, the City of Unalaska will have to fully fund the remaining costs to bring this needed project online.

WHEREAS, the City of Unalaska has been investigating geothermal potential for the last twenty years; and

WHEREAS, the City of Unalaska has been working with the Alaska Dept. of Energy to develop this project;

WHEREAS, with the high cost of fuel results in the Unalaska city Council wishes to revisit the feasibility of the geothermal project; and

WHEREAS, a proven geothermal resource exists on the flanks of Mt. Makushin volcano that could be developed if feasible; and

WHEREAS, the next step in the process is further exploratory drilling estimated at $3 million.

NOW THEREFORE BE IT RESOLVED that the City of Unalaska, by this resolution, hereby identifies its top legislative priorities for FY 2009 and requests legislative appropriations as follows:

Construction of new powerhouse	$4 million
Geothermal Drilling	$1.5 million

PASSED AND ADOPTED BY A DULY CONSTITUTED QUORUM OF THE UNALASKA CITY COUNCIL THIS 9th DAY OF Oct., 2007.

Katherine L. McGlashan
MAYOR -PRO TEM

ATTEST:

Delma Meade
CITY CLERK

MAKUSHIN GEOTHERMAL DRILLING PROJECT

Capital Project Request Criteria

Project Name: Makushin Geothermal Project. (See attached for more information)

Project Location and House District: Unalaska Island, House District 37

Amount of Funding Request: $1.5 million

Total Funding to Complete the Project: $3 million for this phase of the project. Current ROM numbers put the total project funding at over $80 million.

Number of years to complete the project: 12 months

Matching Funds available sources: $1.5 million from the City of Unalaska

Prior State Appropriations: None, however the State of Alaska has been involved in the project for over 20 years through various proposals.

In Governors Budget: No

Federal Funds grants or earmarks requested: Yes, we are looking for funding in Washington, DC through the Department of Energy.

Public Review Process: Over the past twenty years this project has been through many public meetings. The privately owned resource is said to be one of the best geothermal resources in Alaska. The public and industry is very much behind this project.

Is funding available for the project this year, who is responsible for providing ongoing maintenance?: The City has committed $1.5 million to the project. There will be no on-going maintenance of the project.

Economic Return to State of Alaska: This is the most important, innovative economic development project ever undertaken by the City of Unalaska. With the ever increasing cost of fuel and air quality permits for diesel power production, this project has the potential to provide a stable power structure for the Number One Commercial Fishing Port in the Nation and pave the way for future "Green Development." Stable power will allow this community to diversify while keeping our carbon footprint low. The economic activity, currently operating in Unalaska, contributes $27 million in taxes per year to State of Alaska coffers. Our contribution per capita is twice the State of Alaska average. Investment in Unalaska produces a two fold return to the State.

Legislator submitting request: Senator Lyman Hoffman and Representative Bryce Edgmon

Project Contact Information: City Manager Chris Hladick, City of Unalaska Box 610, 99685 chladick@ci.unlaska.ak.us, 907-581-7733

Makushin Geothermal Project

Project Description: This project consists of determining the feasibility of developing a 5+megawatt (MW) geothermal electric plant in Makushin Valley, which is located on the east side, at the base of Mount Makushin. If geothermal power production is determined to be feasible, consideration will be given to the development of other phases, such as permitting, constructing a generation plant, installing an underwater transmission line, developing a road, and creating a connection into the existing distribution system and any needed accessory infrastructure.

Project Purpose and Need: The City Powerhouse is currently operating at maximum capacity with no reserve. Utility power supply planning requires a utility to anticipate the loss of its largest generating plant (n-1), and the (n-1) plan determines the utility's ability to serve its peak load. The City's total available power is less than 6.2 MW, with about 5.0 MW considered "firm," or consistently reliable (note the attached chart "Installed Capacity"). The City can not serve the present firm load with a (n-1) condition. If the City were to lose two units (n-2), the system could encounter multiple hours of forced outage conditions.

Because of current economic development, the City now finds itself in a position to offer only non-firm contracts to new industrial and commercial accounts. For an alternate source of power, the City has recently interconnected with UniSea, which can transmit about 3.0 megawatt to the City grid. However, this power is on a non-firm basis.

Although the City is in the process of expanding its generation capacity with the development of a new powerhouse that has a minimum of two 5.2 megawatt generators, it is important to the community's overall economic development to find alternative methods, preferably with renewable resources, to cut the cost or power production.

History of the Project Over the past 20 years, the economic and financial feasibility of the Makushin Geothermal ("Makushin") Project has been assessed numerous times. Past development plans of the proposed Makushin Project have always been based on locating the power plant in the Upper Makushin Valley at an elevation of 1,200 feet above sea level, near the existing well drilled in 1982. Although the size and boundaries of the underground heat source are not well defined, the site was selected in an attempt to maximize the probability for the highest temperature resource. To reach the existing well access to the Upper Makushin Valley would be via a road from Nateekin Bay running through the Lower Makushin Valley. At the upper reaches of the valley, a series of switchbacks traverse the 800 foot elevation differential to the upper bench, where the road would continue to the proposed site. This area that connects the lower

and upper valleys is where environmental factors cause the technical and economic viability of the proposed project to be problematic. Not only would construction and operating costs be higher, but the susceptibility of the transmission line to outages from avalanches and wind could bring into question the overall reliability of the project.

Development Plan and Status: Although past assessments showed that, under certain circumstances, the project might be economically effective over its expected life, short-term rate impacts, the security required by lenders, and other factors created insurmountable obstacles to project development. Today, with the high cost of diesel fuel and new regulatory requirements for air quality, the City now wishes to explore the possibility of developing Makushin on its own, a concept that has never been explored in the history of the project. The City's resource consultants believe that the geothermal fluid located in the test well is not trapped, but rather flows out of the area, possibly down gradient. A likely avenue of escape is through the Makushin Valley. Locating the facilities in the Makushin Valley would result in significant construction and operating costs savings. In order to determine the feasibility of this project, the City must establish that the geothermal fluid is indeed escaping along the Makushin Valley and that the resource remains hot enough for commercial purposes. If a sufficient commercial resource can be found in the valley, then the City will make a general assessment of project's economics.

Relation to Other Scheduled Projects: This project will incorporate the proposed powerhouse expansion project which will serve as a back-up system to the geothermal plant.

Cost and Financing Data: The feasibility phase of this project has an estimated budget of $3,000,000.

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RICHMOND, CALIFORNIA 94804-5829

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E-MAIL: mw@geothermex.com

MEMORANDUM

To: Chris Hladick
City of Unalaska
sent via email: chladick@ci.unalaska.ak.us

Date: June 20, 2007

From: Roger Henneberger / Eduardo Granados

Subject: Geothermal Resources on Unalaska Island – Recommendations for Additional Investigations

Background

Investigations of the potential for geothermal energy development on Unalaska Island have taken place periodically over the past several decades. For the most part, these investigations have focused on an area on the eastern and southeastern flank of the Makushin volcano, where a number of fumarole fields provide evidence of a high-temperature geothermal system. The existence of the system was confirmed by exploratory drilling in the early 1980s; this effort included the drilling of a number of temperature gradient holes and, eventually, a slim-diameter well that encountered temperatures close to 200°C and produced more than 60,000 lb/hr of steam and water.

The exploratory drilling at the Makushin volcano was concentrated along a plateau that extends to the north and a shorter distance to the south of Fox Creek, at the upper end of the Makushin Valley (this is referred to as the "plateau area" hereafter in this memo). This pattern is a consequence of the distribution of the fumarole fields, which are located on the plateau and in zones further southwest on the volcano. Although the drilling was successful in demonstrating that a high-quality geothermal resource is present at Makushin, it did not fully delineate the geothermal field, which is likely to extend (through lateral flow of thermal waters) some distance beyond the limits defined by the fumaroles. Furthermore, the conditions of terrain and climate make geothermal development and the operation of a power plant in the plateau area extremely challenging with regard to technical difficulty and cost. Therefore, while the exploration at the Makushin volcano has been extremely successful in terms of resource identification, it has so far failed to demonstrate the economic feasibility of geothermal development on Unalaska.

During a meeting organized in Anchorage by the City of Unalaska in early June 2007, the cost of development and operation in the plateau area was discussed, with contributions by experts in the design and construction of roads, transmission lines, pipelines, and other facilities that would be required for a geothermal power generation project. It was concluded on a preliminary basis that, even if all technical obstacles can be overcome, the cost of developing and operating a

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small (10-12 MW) project in the plateau area would be several tens of millions of dollars greater than developing a comparable project in a lower-elevation area, such as the Makushin Valley. This large cost differential makes it more critical than usual to consider alternative approaches to geothermal development that could be accomplished at lower cost. Possible alternatives are discussed in the following section of this memo. The final section discusses a recommended approach to investigating these alternatives, as part of an overall program to evaluate the feasibility of geothermal energy development on Unalaska.

Exploration Alternatives

There are three areas on Unalaska that offer more favorable conditions for development than the plateau area, and a great enough possibility of the presence of an exploitable geothermal resource to merit additional investigation. These are:

- the floor of the Makushin Valley;
- the Driftwood Bay area (on the northern flank of the Makushin volcano); and
- the Summer Bay area, located about 3 miles to the east of Dutch Harbor.

The first two of these areas have been selected based on their proximity to the known Makushin geothermal resource, taking into account that lateral outflow from the high-temperature geothermal system is likely to create zones of lower-temperature but still exploitable hot water at some distance from the area where exploratory drilling has taken place and where access and construction conditions are less challenging. The location and extent of such outflow is unknown, but it is not unusual to encounter outflow zones up to several miles long associated with high-temperature geothermal reservoirs.

The Summer Bay area is too distant from the Makushin volcano to be associated with the known high-temperature geothermal system, but there is a warm (95°F) spring in the valley adjacent to Summer Bay Lake, and a very shallow exploratory well drilled near the spring encountered temperatures of about 122°F. There is therefore a possibility that an exploitable low to moderate-temperature is present in the area. The three areas are discussed in succession below.

Makushin Valley

The Makushin Valley extends inland about 5 miles from Broad Bay, with little elevation gain (less than 500 feet) from the coastline to the steep slope that leads to the plateau area. An existing road or track provides some access into the valley, and it is likely that numerous sites could be occupied by a small drilling rig for exploratory drilling.

The head of the valley is within about 2 miles of the nearest fumarole field and the nearest exploration holes on the Makushin Volcano. There are no direct indications that the geothermal

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reservoir extends this far, but there are several indirect indicators of possible thermal activity, including:

- soil mercury anomalies on the valley floor, identified in the exploratory work conducted during the 1980s; and
- anecdotal reports of springs near Broad Bay that do not freeze in the winter, suggesting possible elevated groundwater temperatures.

If there is geothermal outflow within the Makushin Valley, it probably occurs at a fairly shallow depth, based on the known elevation of the geothermal reservoir in the plateau area. Therefore, the presence or absence of adequate temperatures for power generation could possibly be confirmed by drilling to 1,000 feet or less. Two drillholes located in the upper part of the valley should be sufficient for this confirmation; if positive results are obtained, additional holes could eventually be drilled further down the valley to determine whether the geothermal resource extends to even more accessible areas.

Driftwood Bay

Like the Makushin Valley, the Driftwood Bay area, situated on the northern coast of Unalaska, is a possible location of outflow from the Makushin geothermal system. Again, there are no direct indications of geothermal activity, but there are indirect indicators including:

- a report of warm ground, in coincidence with a soil mercury anomaly, partway down the slope below Sugarloaf Cone; and
- some suggestion from geophysical surveys (principally self-potential) that the geothermal reservoir may be elongated in this direction.

In terms of resource potential, therefore, the Driftwood Bay area is similar to the Makushin Valley. However, in terms of logistics it is less favorable. In particular, a transmission line from Driftwood Bay would need to cross the same difficult terrain as a line from the plateau area. In addition, the topography and overall access conditions of the area are less attractive than in the Makushin Valley. Therefore, this area merits a somewhat lower priority for new exploration.

Summer Bay

Summer Bay is the most accessible of the three areas identified, and, though it is somewhat constrained by topography, there is enough near-level ground for development in the event that an exploitable resource is discovered. The warm spring in this area is located a short distance southwest of Summer Bay Lake, which is immediately adjacent to the coastline. In 1980, two wells were drilled to depths of 54 and 57 feet in the vicinity of the warm spring. Both wells encountered warm water under artesian pressure at a depth near 45 feet; the water temperature

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was measured at 122°F in one well and 111°F in the other. These results indicate the presence of a warm-water aquifer of some extent.

Higher temperatures are likely to be encountered by drilling to deeper levels, if a significant geothermal resource is present. The maximum resource temperature in the area can only be confirmed by drilling, but, because of the absence of an active volcanic heat source in the area, it is unlikely to be as high as the temperatures already confirmed in the Makushin field. The depth of the geothermal resource is similarly uncertain; however, one or more exploratory holes of 1,000 feet or less should be adequate to determine, from extrapolation of temperature gradients, whether attractive temperatures may exist at greater depth.

Recommended Strategy for Additional Investigations

Given the known high cost and technical difficulty of geothermal development in the plateau area, additional investigations aimed at confirming the presence or absence of exploitable geothermal resource in more accessible areas on Unalaska is justified. Although several types of investigations may be considered, exploratory drilling will ultimately be necessary for this confirmation, and therefore should be the principal or only component of this effort.

As discussed above, exploratory drillholes should be programmed to maximum depths of approximately 1,000 feet. The drilling equipment employed should be adequate to reach a minimum depth of 500-600 feet in each drillhole, in order to ensure that useful temperature gradients can be measured. For this objective (and taking into account the cost and feasibility of mobilization), a small diamond-coring rig may be the most effective; however, the optimal equipment should be selected based on availability, cost and functionality as the program is being planned and quotations for equipment and services are obtained. Similarly, the exact choice of drillhole design (e.g. temperature observation well vs. slim-diameter open-hole exploratory well) may be made as planning proceeds.

The priorities for drilling should be as follows, based on the apparent resource potential and relative accessibility of the different areas:

- Makushin Valley: 2 holes
- Summer Bay: 1 to 2 holes
- Driftwood Bay: 1 to 2 holes

Ideally, the available budget for the program should be sufficient to ensure that at least the first 3 of these holes can be drilled and evaluated, even in the event of unexpected drilling problems, and that 5 to 6 holes can be drilled if drilling goes smoothly. In more accessible regions elsewhere, a budget of approximately $1,000,000 could be adequate for reaching this objective.

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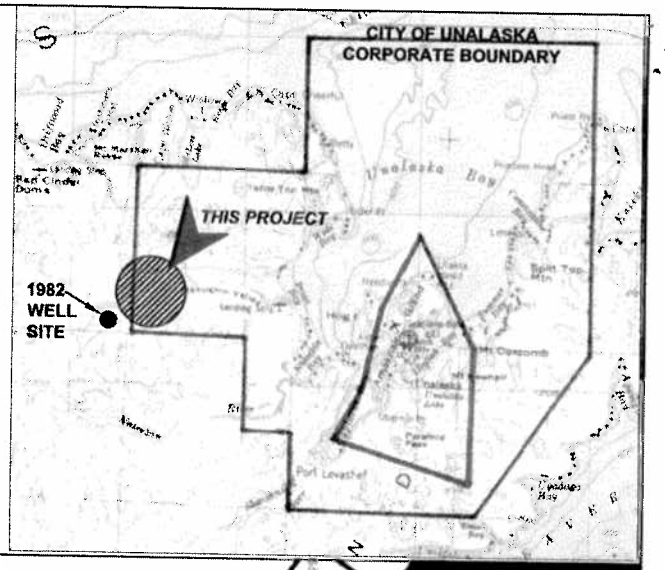
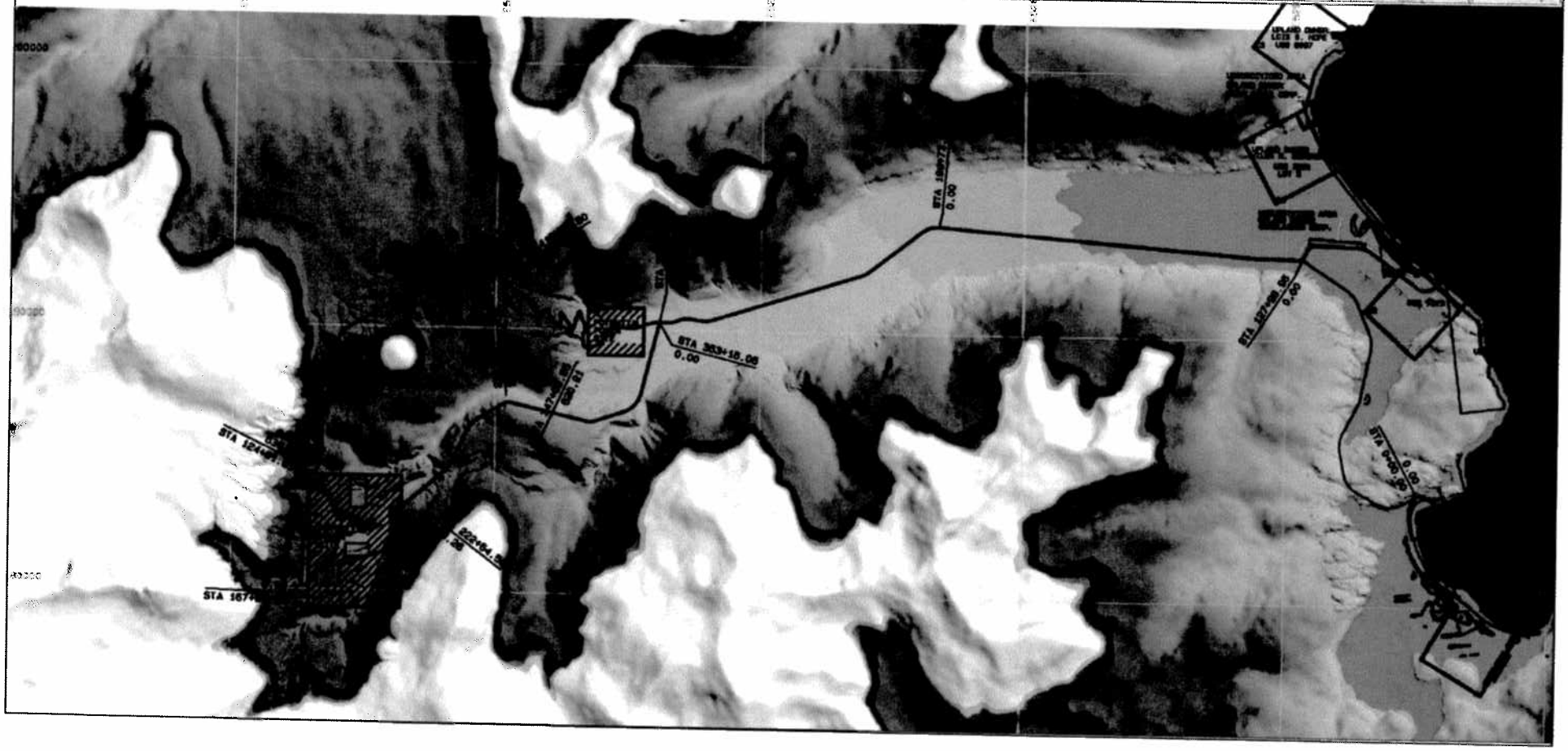
On Unalaska, where costs are higher for almost all components of this type of operation, a minimum budget of $3,000,000 is recommended.

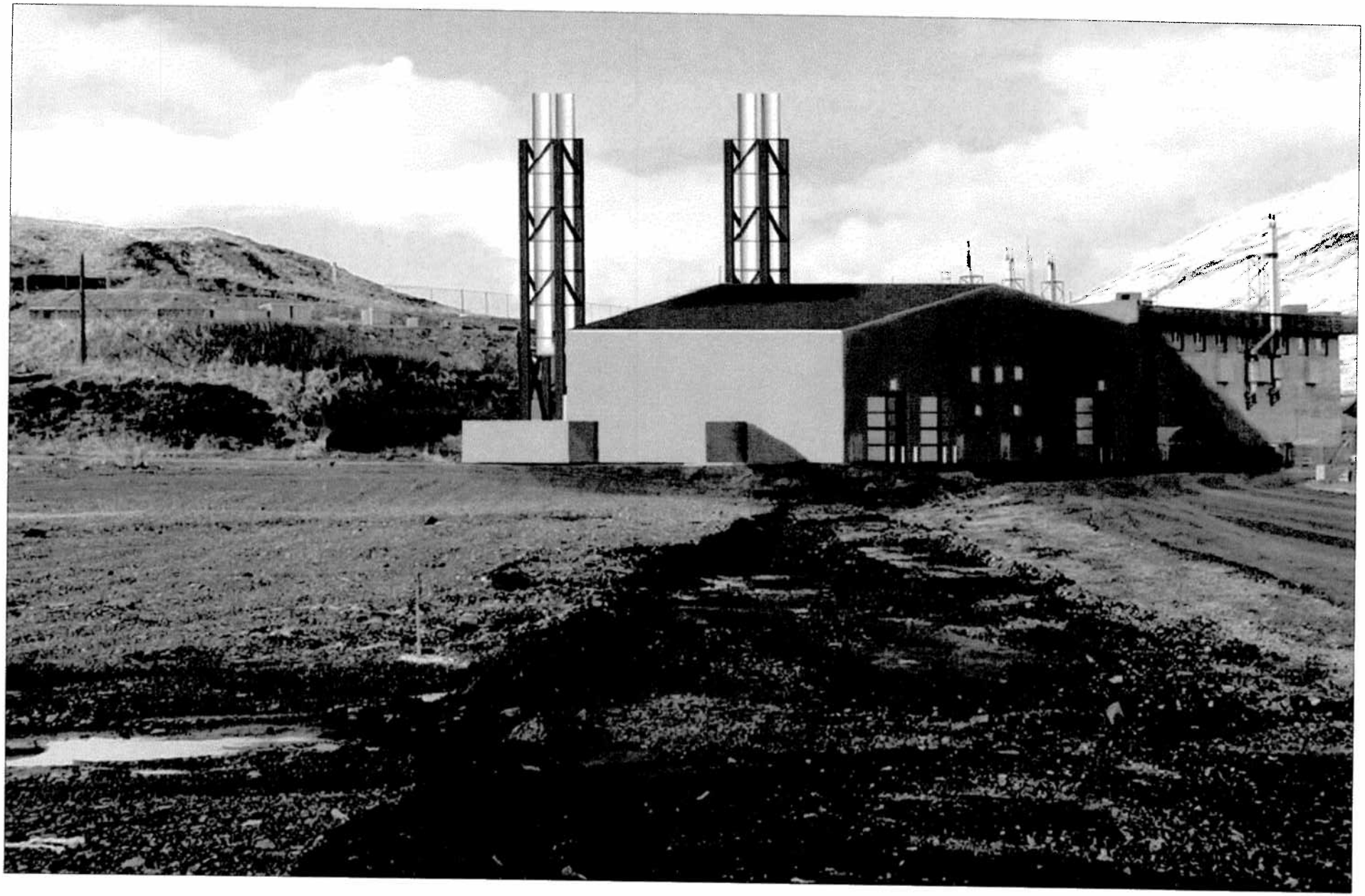
Once the exploratory holes have been drilled and evaluated, a decision can be made as to whether one or more of the areas merits additional investigation for geothermal resource exploitation. If so, then additional activities leading to determination of the feasibility of development in one of these relatively accessible areas can be designed and executed. If it is determined that there is no significant likelihood of geothermal potential in these areas, then a conclusive feasibility study of development in the plateau area can be carried out.

CITY OF UNALASKA
MAKUSHIN GEOTHERMAL
PROJECT





Switchbacks Leading
Out of
Makushin River Valley



CITY OF UNALASKA
POWER GENERATION
EXPANSION