JUNEAU INTERNATIONAL AIRPORT
CITY & BOROUGH OF JUNEAU
ALASKA'S CAPITAL CITY

Ground Source Heat Pump Project Overview

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Project Description.
The use of geothermal energy at the Juneau International Airport Terminal is a part of an overall renovation and expansion project. A Ground Source Heat Pump (GSHP) system converts the current energy source for heating and cooling the Airport Terminal from its traditional system of oil fired boilers with large air handling units to a new geothermal system. The new system will use ground source heat pumps to exchange heat with the earth, replacing the current system that relies on outdoor air for combustion and make-up. It will also provide energy for heating water and maintain an exterior ice-melt system in sidewalks. The geothermal energy will work in conjunction with local renewable hydroelectric energy provided by Alaska Electric Light & Power to remove the Juneau Airport terminal from dependency on fossil fuel. The GSHP system will contribute to the reduction of carbon dioxide emissions, provide a system of substantially higher efficiencies, and will be offered to Alaska as a demonstration of viable alternative renewable energy and energy efficiencies.

A closed loop well system will be installed and will circulate an environmentally safe antifreeze liquid through piping that is located in 215 wells, each 175 ft. in depth. The fluid will absorb heat from the ground during the winter and transfer it to the heat pumps inside the building. The use of sophisticated electronic controls will allow the heat pumps to respond to specific heating and cooling needs of spaces in the terminal. They will be programmed according to the use patterns of the spaces, allowing much more efficiency than a traditional system that heats and cools according to the needs of large areas. The operational cost savings will be somewhat reduced due to the need for skilled maintenance of the heat pumps, but analysis indicates that the net energy cost savings will still be significant.

Background.
The JNU Airport Board initiated a planning study in 2003 that identified the deficiencies in the terminal. A building condition report was part of that study and concluded, “The facility will continue to require more extensive maintenance work with some major items currently in need of immediate attention.” The mechanical engineer noted the need to increase energy efficiency and improve the air quality throughout the terminal. The operational analysis accurately predicted

that escalating energy costs caused from rising oil prices would compound the inefficiencies of outdated equipment and systems.

By 2007, the terminal renovation project was able to move out of the planning phase, thanks to approximately $22 million in funded that was secured from a mix of local, state, and federal sources. Although the complete renovation and expansion is estimated at more than $50 million, the appropriation of initial funding allowed the highest needs of the terminal to be addressed. As the project moved into Conceptual Design, the project goals and priorities became clear. On top of the list of essential priorities was to "modernize worn out mechanical and electrical systems to reduce energy consumption."

As the overall renovation and expansion project began to take shape, discussions between the Airport staff and consultants began to question the traditional thinking of a central heating plant served from fuel oil. While only a few small geothermal installations have been constructed in Juneau, there was scientific confidence in the design of Ground Source Heat Pumps (GSHP) and a willingness by the Owner to pursue the study of such a system for the Juneau Airport.

Feasibility and Concepts.

In 2007, the Airport requested, and received, a $20,000 appropriation from the City & Borough of Juneau's Energy Improvements Fund to match Airport Terminal Renovation project funds to perform a Feasibility Study that included field investigation and comparison of the proposed (at that time) traditional oil-fired boiler system to a geothermal application. The study was authored by James Rehfeldt, PE, of Alaska Energy Engineering with input from Douglas Murray, PE, of Murray & Associates Mechanical Engineers. The results of the analysis entitled, "Ground Source Heat Pump Feasibility Study: Life Cycle Cost Analysis" were staggering. Triggered in part by a dramatic increase in heating fuel costs, the conclusion was clear that using geothermal energy in a heat pump configuration was feasible and desirable from multiple standpoints.

Combined with other energy improvements in the terminal, including improved R-values in the envelope and new lighting systems, the GSHP would begin an exciting move toward a more sustainable terminal building, and would set the tone for additional future modifications as funding becomes available. The biggest challenge was identified as the high upfront cost of construction of the well field and piping, primarily due to the lack of expertise of this technology among construction contractors in the Southeast Alaska region.

Well Field Site.

While several options of coupling to the ground were studied, the closed loop vertical well field was selected as the preferred option because it minimizes potential risk and has a demonstrated history as a dependable, proven scheme. Finding a readily available parcel of land that could be dedicated for a well field in perpetuity was not difficult at the airport. While much of Juneau's airfield is constructed on filled wetlands, the area adjacent to the terminal is uplands and not subject to environmental review and conditions. Also, early planning studies of the airport terminal (documented through a Master Plan adopted by the Airport Board in 2006) call for the terminal to stay in the same basic location over time. As demand dictates, the terminal is likely to

continue grow in the easterly and northerly directions, maintaining it's "L" shape, but it will not need to expand toward the current parking area for commuter planes. Thus, designating this area for a well field is a good long term decision. The well field has been sized to accommodate renovation and expansion of the entire terminal, as identified in the Master Plan. If additional wells are needed in the long term future, there will continue to be adequate space in the commuter plane parking area to install more.

Life Expectancy.
The life expectancy of the well field is infinite, as long as the piping remains undisturbed and the ground conditions do not change substantively. Juneau is not in a seismically active zone, so there is confidence in the ground condition's long term stability. As part of the initial study of GSHP, well records of the area gathered over the past 60 years were reviewed and reported virtually the same ground conditions that were found in the test well drilled for this project.

As for the heat pumps, the life expectancy for individual units is about 18 years. One of the advantages of the heat pump system is that unlike central heating plants, replacement of single units is a manageable task within operating budgets. It is expected that the airport terminal will continue to undergo modifications over time. The current renovation plan has focused on flexible, adaptable design that can allow changes with relative ease. Since the heat pumps will be zoned for small areas, they will have the ability to respond to changes in the architecture. Also, the system will be able to take advantage of expected new technologies in heat pumps as replacement of individual units occurs.

Total Capital Cost Estimate.
There will be a higher first cost of the GSHP system. The construction cost for a traditional system is estimated at $5.230 million, while the cost of a GSHP system is estimated at $6.051 million. The differential in estimated construction cost is, therefore, $821,000. Additional costs for design and administration are calculated at approximately 25% of the construction cost, and feasibility analyses already completed for the GSHP system has totaled approximately $50,000. Adding these to the estimated construction cost, the Total Capital Cost Estimate of the GSHP system is $1.076 million. The Airport is actively pursuing possible grant funds to assist with the added construction cost. The total life cycle cost of is also a consideration that makes the GSHP system worth considering even if additional funds are not found.

System Maintenance and Operation.
The Juneau Airport maintains a dedicated staff of building maintenance personnel that provide both custodial and skilled maintenance services to the terminal. The Airport Administration agrees with the Feasibility Study recommendation to employ a full time mechanic with expertise in heat pumps to maintain the new GSHP system. Expected lower energy costs will offset the operational cost of another mechanic, and will make a positive contribution to the existing Building Maintenance team.

Upon completion, training and orientation on the complete GSHP system will be provided to all

maintenance staff. Commissioning the GSHP system will involve scheduled visits by the appropriate design professionals, equipment specialists, and other experts to monitor the installation throughout the first year. Troubleshooting and warranty issues will be communicated with staff on a regular basis. The Airport Architect will also be closely involved with this process so as to fully understand successes and identify desired improvements for possible future GSHP projects at the Airport.

Documenting the energy improvements of the entire renovation project will also be done. A comparison of "before and after" data is expected to be particularly helpful in demonstrating the need to make continued improvements to the terminal.

Further Applications of the GSHP Project.

Word is rapidly spreading about Juneau's interest in geothermal energy. Inquiries about the project from other Alaskan communities as well as individuals within Juneau make it clear that people are excited to see the Airport take this step. Equally important, they are watching us to see if they can do the same.

GSHP systems are widely used throughout North America, but have been slow to be used in Alaska. Alaska's geology provides exciting potential for the use of geothermal energy. Rivers, ponds, and aquifers provide abundant quantities of water. Land is also aplenty around much of Alaska's built environment, making both vertical and horizontal piping loops worth considering.

Although it is not cutting edge, the engineering of GSHP systems requires specialized knowledge that is currently limited with the relatively small pool of mechanical engineers in the state. This is expected to change as more Owners express interest in alternative energy systems.

The lack of widespread use of GSHP in Alaska seems also to be a reflection of construction economics, especially costs relating to coupling the building to the ground. Special construction experience is often necessary due to physical constraints of the site. Further, as with design, contractors need specialized expertise that develops from repeated installations in order to offer lower construction prices. In essence, a "Catch 22" dilemma dominated by first cost hurdles has prevented building owners from choosing GSHP. However, even high construction costs are now being offset by the high operational cost of heating fuel. Conversion to GSHP, especially when associated with a stable supply of hydro-electric power is becoming economically attractive.

For public facilities, there are often fears associated with being pioneers of new technology. It can be politically difficult for public sector professionals to advocate for systems that are different than standard practice, even when the science is convincing. The construction community can also feel threatened by unfamiliar systems. In addition to higher costs noted above, this can also cause political conflict that most public bodies prefer to avoid.

We are confident that a geothermal project in Juneau will help owners throughout the state see their own potential, and will help contractors establish a knowledge base to bring down initial construction costs. Raising public awareness, understanding the science in the solutions, and empowering people to try new technologies requires leadership, innovation, and funding. The

Geothermal Energy Project at the Juneau International Airport offers significant opportunities to buildings at the airport, and has much potential to simultaneously serve as a public demonstration of energy conservation and alternative energy technologies.

Environmental Issues & Permits.
The Airport is located on a sensitive natural environment. Its beauty and importance in the ecosystem is balanced with the human need to have safe and modern air facilities. Extensive ongoing review of environmental issues occurs at the Airport that includes many local, state, and federal agencies and citizen groups.

This geothermal project further demonstrates Juneau's commitment to balancing natural and human needs. The system will capture the latent heat of the earth that will be transferred to the building for systems of human comfort. The GSHP will allow the use of oil heating fuel to be discontinued, and replaced with electricity that is generated from renewable hydro-electric power. Renovation also includes many energy conservation measures that will keep the demand for electrical power low for a building of this size.

The well field will be constructed on uplands, so no environmental permits are needed. Still, as with the test well and field reconnaissance work performed during the Feasibility Study, we will work closely with the Alaska Department of Natural Resources and other interested parties who want to learn more about geothermal systems. Historical records of past use of the well field area indicate it to be virgin undisturbed ground, except for the top 36" (approx) that has been compacted with high quality fill material to support the existing pavement. The construction documents will have provisions for addressing unforeseen conditions, should they arise during the drilling of the well field.

Local permits for construction will be obtained through the City & Borough of Juneau's Community Development Department. Permits will include review by the Planning Commission and its Building Code Division. A preliminary review with the CDD Director and staff was recently held. There was enthusiastic support for the GSHP system and the renovations at the terminal. The use of geothermal energy and reduction of carbon emissions is consistent with the current draft of the CBJ Comprehensive Plan that is undergoing substantial review by the Planning Commission. The project is also consistent with the Juneau Commission on Sustainability, an advisory body to the CBJ Assembly.

Project Schedule.
The design and construction of the GSHP system will run concurrent with the Airport Terminal

Renovation Project. This will allow systems to be integrated and construction components to be coordinated through a single General Contractor. The design will progress over the next several months, and at the completion of the Design Development phase (scheduled for mid-June, 2008) a Peer Review will be held. This is an opportunity to review detailed scope and cost estimates, and provide critical critique on the project. Final design adjustments at this stage will allow the Construction Documents to be completed efficiently, without interruption or added cost.

The airport will remain in full operation throughout the renovation. To accommodate this, multiple bid packages will be used. There are currently two bid packages planned. The first includes a limited scope of work to be done in Summer, 2008 that will isolate several components of the renovation. The construction documents for this work are currently under final review by the project team and scheduled to advertise for bids in March, 2008. The scope of this work includes a new roof, siding, and windows for the terminal and modifications to the main access road, Shell Simmons Drive. Separating out this work maximizes construction dollars by getting started with some of the work sooner, and it completes critical components that will allow the scope of bid package #2 to proceed with fewer logistical complications.

At this time, the project schedule assumes that the GSHP work will be bid in the same package as the major renovation work (bid package #2). If, at the close of the Design Development Peer Review, it is determined that a separate bid for the well field provides the best opportunity for controlling construction costs and addressing complex schedule issues around keeping the airport operational, then the well field work will be pulled into a separate set of bid documents and advertised accordingly.

Project Organization.

The Project Team will be led by Airport Manager, Dave Palmer while the project's day to day management will be done by Airport Architect, Catherine Fritz, AIA. The mechanical engineer of record will be Douglas Murray, PE, who will collaborate closely through all aspects of the GSHP design with James Rehfeldt, PE. A number of technical staff support people will also work on this project including drafters, office assistants, and field inspectors.

The architectural firm responsible for the overall renovation project is Jensen Yorba Lott Architects of Juneau. Antonio Yorba, AIA is the principal in charge. Other lead consultants include electrical engineer, Ben Haight, PE, civil engineer, Peter Hildre, PE of DOWL, Inc and structural engineer, Chris Gianotti, PE of PND Engineers. The project has also benefited from the aviation expertise of Joe Barden and Barton Drake, AIA of HNTB Corp. Finally, the Port of Seattle has generously contributed the expertise of Sea-Tac Airport Architect Dave Tomber who has worked with us as a Peer Review and technical expert via an inter-agency agreement. Additional information about the renovation project can be found at www.juneau.org/airport.

The successful design and construction of the geothermal alternative energy project will happen through the dedication and expertise of the entire project team. Our goal is to make this project exemplary in demonstrating the opportunities for energy efficiency and collaborative action.