Murray & Associates, P. C. *Consulting Engineers*

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Juneau International Airport- Energy Analysis, 2014

Scope:

Murray and Associates, P. C. was hired by the City and Borough of Juneau (CBJ) to investigate, using current data, the energy savings brought about by the installation of the ground source heat pump (GSHP) system in 2009 and completed in 2011. This report will use data provided by the City and Borough of Juneau, AELP and other engineering firms associated with the 2010 Terminal Renovation.

Background:

The Juneau International Airport renovation started in 2008 with the renovation design of the large commercial carrier wing of the terminal and an addition of approximately 12,000 square feet of floor space. The newly renovated areas were converted from a conventional heating fuel system to a GSHP supplied by a loop field consisting of 108 vertical boreholes drilled to a depth of over 350 feet. Each borehole contains a single loop of 1" HDPE piping with a concentration of methanol and water. Overall, the loop field and associated plumbing includes 16 miles of piping. The field supplies the current 34 heat pumps located throughout the renovated portion of the terminal building. The GSHP system also allows for the heating, cooling, and ventilation of the renovated space. Additionally, this system supplies a snow melt system used for the front sidewalk, street crossing, and waiting area. Construction began in the fall of 2009 and was completed in early 2011. Overall, the 2010 Renovation cost approximately $11.2 million. Of which the geothermal loop field cost approximately $1.0 million.

Summary:

The analysis shows that the airport geothermal system is providing a direct savings of approximately $130,000 annually and a simple payback of less than 8 years. In addition, the system provides air conditioning of the 2010 renovation space and 7,000 square feet of heated sidewalks.

Limitations and Assumptions:

Cost of Electricity:

Data was provided on the billed prices for the airport terminal building from August 2013 until July 2014. These prices come from a new meter installed in 2013. This data showed an average cost per kWh at $0.085. As a conservative estimate, this report will assume all electrical costs are billed at $0.090. This will have minimal impact on the cost analysis.

Cost of Fuel:

Fuel costs were provided by the City and Borough of Juneau

Climatic Effects:

Climatic data was analyzed for the period of the study. It was found that there has been statistically zero change in heating days per year over the course of the study. From this, it is assumed that the building's environmentally affected heating requirements are unchanged.

Additional Benefits:

Energy usage also includes the sidewalk snowmelt system added with the renovation. The snowmelt system, which is heated by a dedicated GSHP, requires a significantly higher energy load. However, this system saves approximately $11,000.00 in yearly maintenance costs from labor, equipment, and chemicals. The heat pump system allows the ability to cool the terminal during the summer months.

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This benefit was not available before the renovation. While cooling does increase electrical consumption during the summer months the added cost is negligible.

Addition of Floor Space:

During the 2010 Renovation, approximately 12,000 sq. feet was added to the existing approximately 96,000 sq. feet of floor space for the entire terminal. This significantly increases the amount of heating needed for the building.

Electrical Load Changes:

Electrical upgrades and new lighting has changed heat loading contribution within the thermal envelope of the building. Upon consultation with the renovation electrical engineer; it was determined that several major energy improvements were made to the terminal. These include:

- All of the lighting within the departure lounge was converted from fluorescent to LED lighting with dimmable control. This has resulted in an approximately 50% decrease in energy consumption over the original system.
- Other lighting within the southern terminal was converted from T-12 type fluorescent tubes to T-5 type tubes. This has resulted in an estimated 12-15% energy savings.
- External flood lighting was converted from metal halide to LED, resulting in significant decreases in electrical costs.

Since the mechanical equipment located within the building is not individually metered, it is difficult to attribute costs directly to specific equipment. For this study, data will be limited to overall building energy loads. Lighting efficiency improvements within the building thermal envelope will require a slight increase in heating to compensate.

Thermal Envelope:

Some changes were made to thermal properties of the building envelope, but are considered insignificant for the sake of this report.

Remaining Fuel Oil Heated Areas:

Major portions of the terminal are still heated off of conventional heating fuel. These include:

- The northern commuter portion of the terminal.
- The jet ways and the baggage loading area. Though these systems are reportedly rarely used in the field.
- The Control Tower.

The appendix shows a schematic view of the different heating zones.

Data:

Full data is available from calendar year 2006 thru mid 2014. This analysis will be limited to the time frame of 2006 thru 2013. The data primarily consists of: fuel consumption, fuel costs, electrical consumption for the entire terminal building and electrical billing for the building for 2013 and part of 2014.

For this report, the data is chronologically broken into three sections. These include: pre-renovation (2006 to 2009), during renovation (2009 to 2011), and post renovation (2011 to 2014). Due to irregularities in energy consumption during the renovation the analysis of costs will be limited to before and after the terminal renovation.

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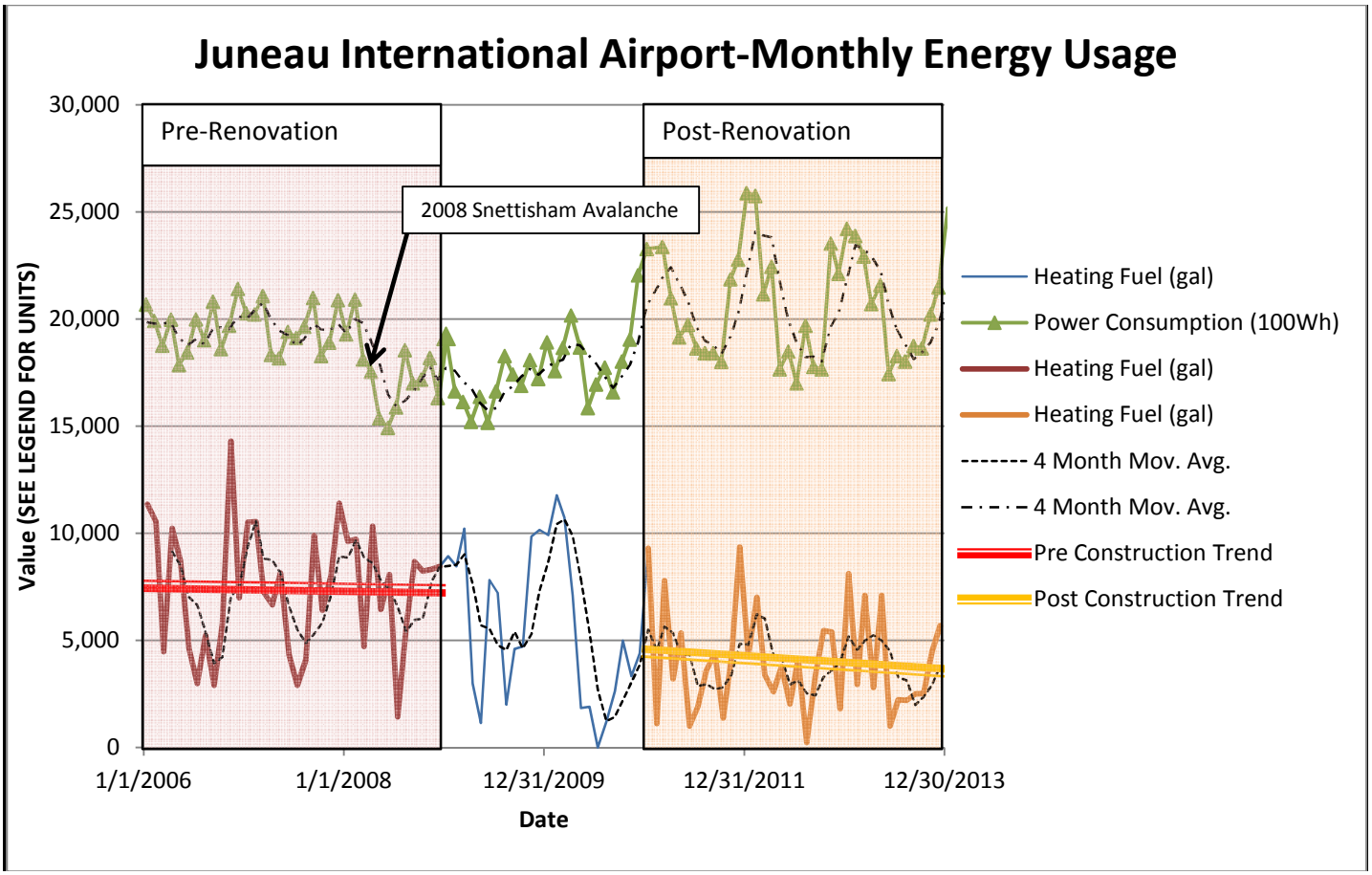

Figure 1:Monthly Energy Consumption

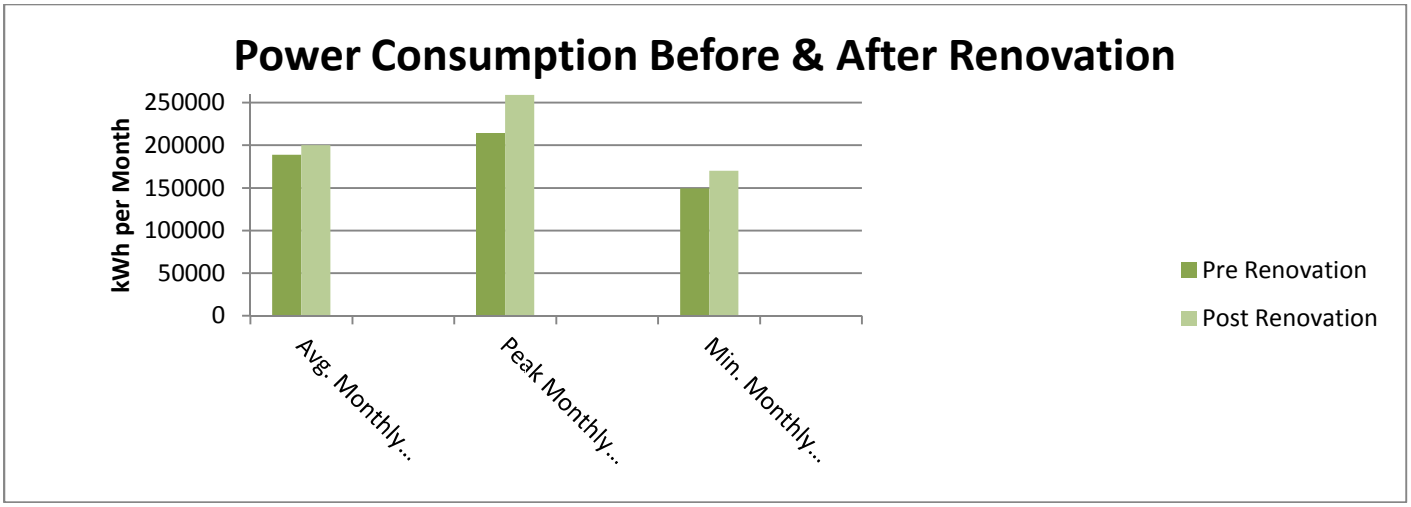

Figure 2: Power Consumption

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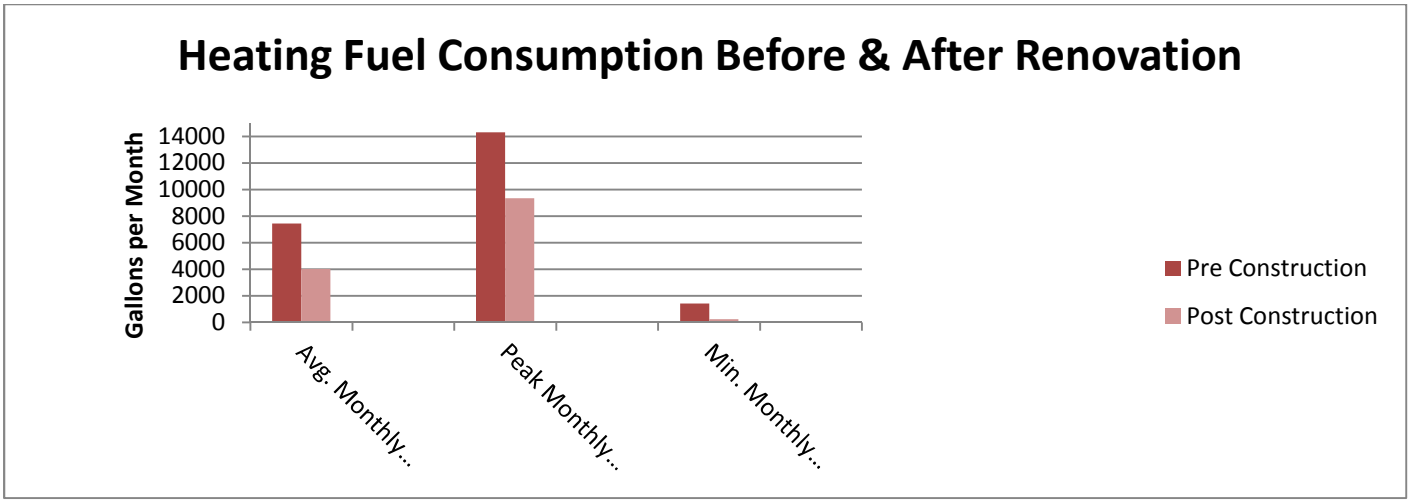

Figure 3: Heating Fuel Consumption

						Cost/kWh:
Annual Costs	Heating Fuel	Avg. Gallons	Cost	Electricity	Avg. kWh	$ 0.09
2006 thru 2008 Pre Reno.		89,331.33	$312,660		2,266,560.00	$203,990
2011 thru 2013 Post Reno.		48,259.00	$168,907		2,400,363.24	$216,032
	Difference:	54.02%	$143,753	Difference:	105.90%	$12,042
					Annual Savings:	**$131,711**

Table 1: Annual Savings

Results:

Electrical Usage:

As expected, the newly installed ground source heat pumps have resulted in a significant increase in electrical usage. The overall electrical consumption for the terminal building has increased an average of 6% after the renovation. Power consumption habits have also drastically changed after the renovation. As seen in Figure 1, electrical consumption now varies sinusoidally between the summer and winter months. This results in higher peak electrical usage during the winter months.

Fuel Consumption:

The large commercial carrier wing is now almost completely heated through the GSHP system and the commuter wing heated solely off of the original oil-fired boiler. After renovation, the total consumption for the building is about 46% less than pre-renovation levels.

Savings:

Based off of assumed costs, the terminal facility so far is saving over $130,000 in annual heating costs. Using just the $130,000 in energy savings; it represents a simple payback in less than 8 years of usage. This price does not include the additional benefits from the added snow melt system which is estimated to save $11,000 in yearly maintenance costs. Additionally, the new system has provided other benefits in the form of air conditioning for the large commercial carrier portion of the building and allows the transfer of excess heat via air conditioning to other zones of the renovated area.

END OF REPORT

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Appendix:

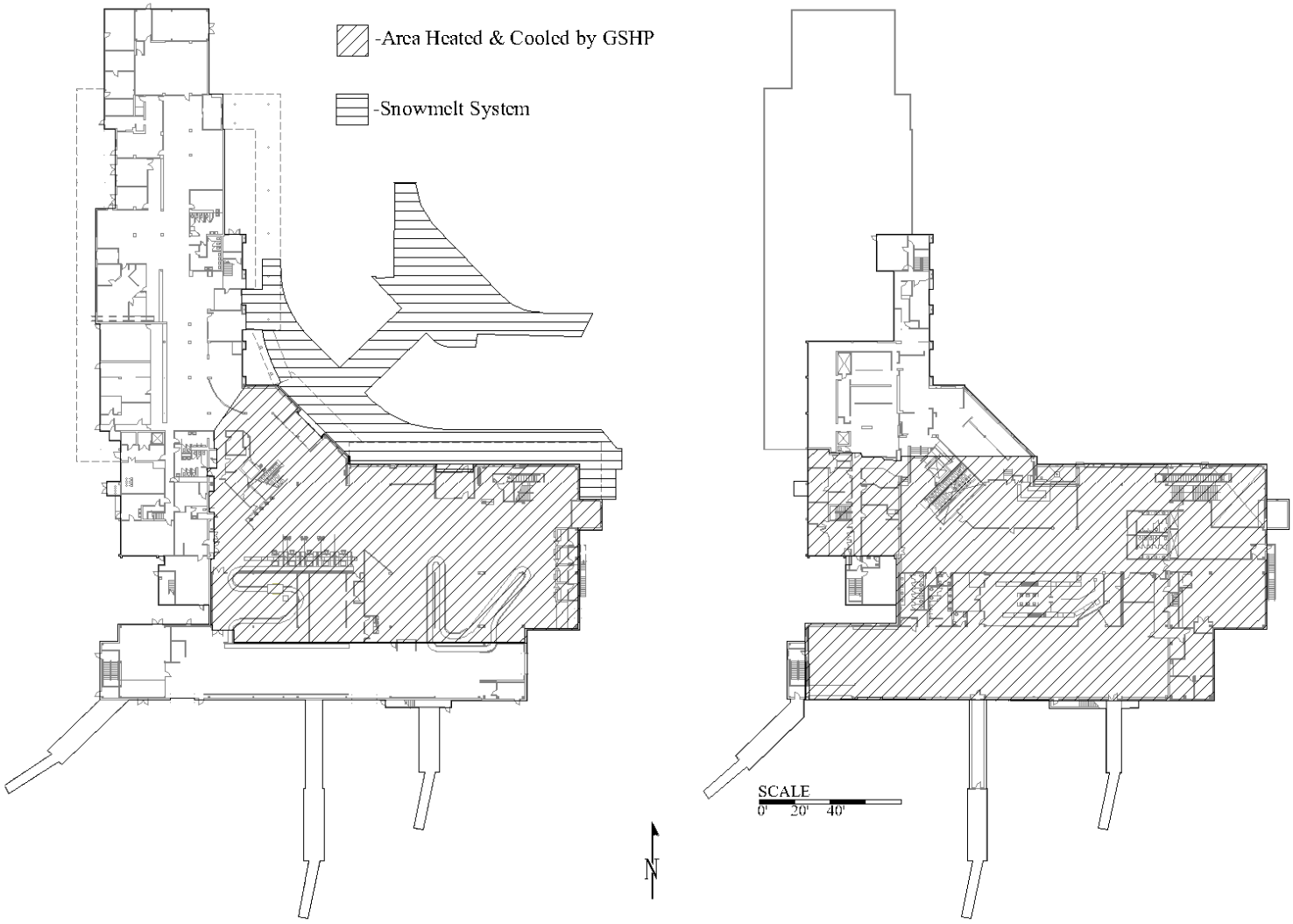

Figure 4: Renovation Area

Previous Reports:

- A report created by Alaska Energy Engineering, LLC from 2007 is available for reference in examining the life cycle cost between the GSHP and a fully oil heated scheme.
- A preliminary report was done by Murray & Associates, P.C. in 2012 with limited data.