I. Executive Summary

Purpose
The planned construction of the new Lancaster County Adult Detention Facility will require a considerable level of reliable thermal services. The critical nature of the facility supports the construction of a central plant to provide this service. District Energy Corporation has commissioned a feasibility study to determine the optimal mechanical system to be installed in a central plant constructed concurrently with the jail facility. The purpose of the study is to evaluate potential mechanical systems and offer a comparison and recommendation in terms of economic and technical feasibility.

Method
The study began with two phases, the Preliminary Analysis and the Final Analysis, and ultimately was expanded to include a Revised Analysis. The Preliminary and Final Analyses included heating and cooling loads calculated by the engineer during early stages of architectural design. These loads were calculated using several assumptions of the building’s architectural and mechanical design and as such were intentionally conservative. The Revised Analysis was requested after the building engineers had finalized the building and mechanical system design. The building engineer provided actual building load data for use in the Revised Analysis, greatly increasing the accuracy of the equipment sizing and energy consumption values.

Preliminary Analysis
The analysis began with a logistical analysis of the following ten mechanical system options:

Option #1 – Conventional System
Option #2 – Geothermal Heat Pump System
Option #3 – Thermal Storage
Option #4 – Condensing Boiler
Option #5 – Engine-Driven Chiller
Option #6 – Electric Boiler
Option #7 – Option #5 + Option #6
Option #8 – Heat Reclaim Chiller
Option #9 – Fuel Cell
Option #10 – Microturbine
Three options (#7, #9, and #10) were eliminated on the basis of technical or economic feasibility. The remaining seven options were subjected to economic analysis based on Life Cycle Cost.

The Life Cycle Cost analysis was calculated using a building model energy simulation, which due to the preliminary nature of architectural plans, was built with several assumptions and conservative factors. The Preliminary Economic Analysis annualized and summed the capital cost, energy cost, and operation and maintenance cost of each option to arrive at a Total Annual Cost for each. Option #1 was considered the Base Case, and all other options were compared to Option #1 to calculate the incremental costs and savings.

The results of the Preliminary Economic Analysis are shown below:

<table>
<thead>
<tr>
<th>Option</th>
<th>Capital Cost</th>
<th>Annual Energy Cost</th>
<th>Annual O&amp;M Cost</th>
<th>Total Annual Cost</th>
<th>Simple Payback (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1</td>
<td>$19,962,942</td>
<td>$395,354</td>
<td>$549,735</td>
<td>$2,361,509</td>
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<tr>
<td>Option #2</td>
<td>$22,423,442</td>
<td>$280,374</td>
<td>$439,788</td>
<td>$2,311,161</td>
<td>10.94</td>
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<td>Option #3</td>
<td>$20,525,942</td>
<td>$358,783</td>
<td>$549,735</td>
<td>$2,364,884</td>
<td>15.39</td>
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<tr>
<td>Option #4</td>
<td>$19,982,542</td>
<td>$364,335</td>
<td>$549,735</td>
<td>$2,331,881</td>
<td>0.63</td>
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<td>Option #4a</td>
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<td>$380,358</td>
<td>$549,735</td>
<td>$2,347,904</td>
<td>1.31</td>
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<td>Option #5</td>
<td>$20,766,942</td>
<td>$335,311</td>
<td>$566,227</td>
<td>$2,375,004</td>
<td>18.46</td>
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<tr>
<td>Option #6</td>
<td>$19,858,942</td>
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<td>$538,740</td>
<td>$2,451,605</td>
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<tr>
<td>Option #6a</td>
<td>$20,044,609</td>
<td>$366,709</td>
<td>$538,740</td>
<td>$2,327,664</td>
<td>2.06</td>
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<td>Option #8</td>
<td>$20,256,942</td>
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<td>$566,227</td>
<td>$2,419,462</td>
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</table>

Preliminary Recommendation
From the results of the Preliminary Analysis, Option #2 and Option #6a were selected for further evaluation in the Final Analysis. Option #2 was selected to be evaluated with one significant modification. The backup equipment included in the option was removed per DEC’s request. Option #1 was also reevaluated to provide the same means of comparison among the options.

Final Analysis
As the design of the detention facility progressed, details of the building and its internal mechanical systems offered the opportunity to replace conservation assumptions used in the Preliminary Analysis with more concrete information. New equipment sizing and energy consumption values

Lancaster County Detention Center
DEC Thermal Plant Feasibility Study
were calculated from new building loads resulting from the modified building model simulation. The revised capital costs, energy costs, and operation and maintenance costs were annualized and totaled, and equipment replacement costs were added as incurred. The Final Analysis calculated a 50 Year Life Cycle Cost as well as the Net Present Value of the Life Cycle Cost to serve as the comparison among the options. The results of the Final Economic Analysis are shown in the following table:

<table>
<thead>
<tr>
<th>Option</th>
<th>Capital Cost</th>
<th>Annual Energy Cost</th>
<th>Annual O&amp;M Cost</th>
<th>Total Annual Cost</th>
<th>50 Year Lifecycle Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1</td>
<td>$18,833,261</td>
<td>$260,921</td>
<td>$594,165</td>
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<td>Option #2</td>
<td>$20,819,961</td>
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<td>$472,659</td>
<td>$2,170,693</td>
<td>$147,519,793</td>
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<tr>
<td>Option #6a</td>
<td>$18,796,511</td>
<td>$241,121</td>
<td>$587,140</td>
<td>$2,179,170</td>
<td>$152,622,978</td>
</tr>
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</table>

**Non-Economic Considerations**
In addition to the analysis of the cost of each option, non-economic considerations were included in the Final Analysis. This part of the analysis allows for the fact that an option which may have the lowest calculated cost may have other factors that preclude its selection and recommendation.

**Final Recommendation**
In consideration of the economic analysis and the non-economic factors, Option #6a was recommended. This option was found to achieve economic advantage, although to a lesser degree than Option #2, but offer the additional benefits of reliability, flexibility, relative ease of operation and maintenance, and the opportunity to construct a more cohesive plant in the long term.

**Revised Analysis**
Due to the building design schedule, the building’s architectural and mechanical systems had not been finalized when the Preliminary and Final Analyses were performed. Therefore, the building loads, and consequently the Life Cycle Costs, were based on conservative assumptions about the building, its occupancy, and its mechanical systems. The design has since progressed to the point where more accurate heating and cooling loads could be calculated based on the actual characteristics of the building and its systems. The building design engineer prepared a building model and performed an energy simulation to obtain monthly peak loads and energy
consumption of each component of the mechanical system. These calculations form the basis of the Revised Analysis.

Option #1
In Option #1, the peak heating load of 4740 MBh, or 5200 lb/hr of steam at 50 psig, will be served by two (2) 100 BHP gas-fired firetube steam boilers, each with a capacity of 3450 lb/hr. An additional 100 BHP unit will be installed to provide firm capacity. The required auxiliary steam generation equipment is described in the Cost Estimate shown in Appendix A.

The peak cooling load of 677 tons will be served by two (2) 500 ton electric centrifugal chillers. (Although 400 ton units would be sufficient, a 500 ton unit with identical efficiency can be purchased at lower cost. Since the jail has planned expansions and the DEC plant has the potential to serve additional loads that may be constructed in the area, the larger capacity was selected.) The required auxiliary cooling and heat rejection equipment is listed in the Cost Estimate included in Appendix A.

Emergency electrical generation is proposed at the plant to serve emergency conditions at the plant and the jail facility. This same equipment will have the capability to export electricity back to the LES grid, however, this was not included in the economic analysis. The emergency electrical load requires the installation of four (4) 1875 kW generators.

The total capital cost of the equipment selected for the Option #1 Revised Analysis is detailed in Appendix A.

Option #2
Option #2 calls for the installation of ground source heat pumps to serve both the heating and cooling loads. The equipment selected consists of individual units combined with common piping and electrical connections in 5-unit modules. Each individual unit has two scroll compressors. The heat pumps are piped to underground vertical piping loops to provide heat exchange with the ground. The loop field was designed to handle the larger of the loads and includes compensation for long term ground temperature migration.
The 4740 MBh heating load will be served with two modules, each with a capacity of 3399 MBh. One additional module will be installed for redundancy. Heating load pumps and heating source pumps will be installed for each module.

The 677 ton cooling load will be served with three modules, each with a capacity of 244 tons. The additional module provided for heating redundancy will be piped to provide either heating or cooling backup. Cooling load pumps and cooling source pumps will be installed for each module.

The geothermal loop field will consist of two circuits for redundancy. Each circuit will require a vault to house valving and piping manifolds. Each vertical loop will be 300 feet deep, consisting of 3” pipe headers with 1” U-bends on 20 foot centers in a step-down, step-up reverse return configuration.

Option #2 includes the same provisions for emergency power as described for Option #1.

The incremental capital cost of the components of Option #2 compared to Option #1 are listed in Appendix A. Option #2 also includes a cost incurred by the jail to augment the mechanical systems within the building to heat with the 120°F water supplied by the heat pumps rather than the higher temperatures around which the jail had originally been designed.

Option #6a
Option #6a aims to provide the benefit of fuel flexibility in light of constantly changing utility rates by adding an electric boiler to the plant. The peak heating load will be served by the same two (2) 100 BHP gas-fired firetube boilers as in Option #1, but will also include the installation of a 255 kW electric boiler to take advantage of the demand ratchet imposed under the LES rate structure. This electric boiler is sized to use only the difference between the electric demand that is charged, the “billing demand”, and the demand actually used by plant equipment during non-peak months. Due to the lower loads in this analysis, the available demand was significantly less, decreasing the size of the electric boiler and ultimately diminishing the benefit of this option.
This option also includes the same provisions for emergency power as Option #1.

The incremental capital cost for the electric boiler and required additional electrical support are detailed in Appendix A.

As in the Preliminary and Final Analyses, the capital recovery costs, energy costs, operating and maintenance costs, and equipment replacement costs for each option were combined and escalated for each year and finally summed to obtain a Life Cycle Cost. The Life Cycle Cost was decreased to a 25 year period for the Revised Analysis as directed by DEC. The results of the economic analysis are detailed in Appendix B and summarized below:

<table>
<thead>
<tr>
<th>Option</th>
<th>Capital Cost</th>
<th>Annual Energy Cost</th>
<th>Annual O&amp;M Cost</th>
<th>Total Annual Cost</th>
<th>25 Year Lifecycle Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1</td>
<td>$17,101,062</td>
<td>$177,346</td>
<td>$344,853</td>
<td>$1,735,561</td>
<td>$58,826,456</td>
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<tr>
<td>Option #2</td>
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<td>$125,424</td>
<td>$298,853</td>
<td>$1,765,918</td>
<td>$55,076,239</td>
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<tr>
<td>Option #6a</td>
<td>$17,196,312</td>
<td>$170,549</td>
<td>$344,853</td>
<td>$1,735,523</td>
<td>$58,740,129</td>
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</tbody>
</table>

**Revised Recommendation**

Disregarding any provision for domestic hot water service, Option #2, the Geothermal Heat Pump System, achieves the lowest Life Cycle Cost. Non-economic factors that previously favored the other options are mostly diminished due to the decreased peak load. The size of the electric boiler is now such that fuel flexibility is no longer a notable advantage of Option #6a. The smaller load also means the well field will not occupy the entire available space on the site, leaving area for loopfield expansion to serve future facility expansions. It must be noted however, that this system does not include backup equipment as recommended in previous analyses to ensure reliability.

**Domestic Hot Water Service**

The jail facility has a significant and relatively constant domestic hot water load. This load can be served by the plant or by separate equipment installed at the jail site and maintained by jail staff. The Revised Analysis incorporates a secondary version of each option that includes the additional equipment and energy consumption required if the plant were to serve the domestic hot water load of the facility.
Option #1
To provide for the jail’s domestic hot water load under Option #1, the gas-fired boilers were upsized to serve the heating load and the domestic hot water load. The combined peak load is 14,740 MBh, or 16,167 lb/hr of steam at 50 psig. Two (2) 400 BHP gas-fired firetube boilers would be required to handle this peak load. Appendix C shows the incremental cost of the components required to modify Option #1 to include domestic hot water service.

Option #2
The geothermal heat pumps used in Option #2 provide only 120°F heating water to the jail. Therefore, this water can be used to preheat the domestic hot water at the jail where it will then be heated to service temperature by water heating equipment within the jail. When the heat pumps are used for the peak space heating load, the jail must supply virtually all the heat required for domestic hot water. The costs of the jail’s hot water heating equipment, as well as the energy costs incurred by the jail, are included in the economic analysis. The incremental costs in comparison to the modified Option #1 are listed in Appendix C.

Option #6a
For a true comparison to the other options, the demand limitation was removed from the electric boiler in Option #6a. The electric boiler was operated full time at full load to handle the heating load and domestic hot water load to its full capability. The remainder of the load was served by the gas-fired boilers. The installed equipment is identical to that in the modified Option #1 with the addition of the electric boiler and the required electrical support. Appendix C details the estimated capital costs.

Option #8
The Options in the Revised Analysis have been expanded to include Option #8, a heat recovery chiller, to serve the building heating, cooling, and domestic hot water loads. This option has its benefit in the use of the chiller’s heat rejection, which peaks in the summer. During the summer, the only significant heat load is domestic hot water. This option includes the installation of nine (9) 94 ton units, eight used for service and one reserved for backup. The condenser side of the unit has a leaving water temperature of 140°F. Due to the possibility that heat rejection to the building could be unavailable due
to unforeseen circumstances, the cooling tower remains in this option, but has been downsized. Like Option #2, there are times when hot water produced by the heat recovery chillers is at a minimum. During these times, the plant must provide space heating with boiler equipment, and the jail must heat the domestic hot water with equipment installed within the jail. The required equipment and the associated energy costs have been included in the economic analysis. The estimate for incremental equipment costs is shown in Appendix C.

Again, the capital recovery costs, energy costs, operating and maintenance costs, and equipment replacement costs for each option were combined and escalated for each year and finally summed to obtain a Life Cycle Cost. The Life Cycle Cost was performed for a 25 year period for the Revised Analysis. The results of the economic analysis are detailed in Appendix D and summarized below:

<table>
<thead>
<tr>
<th>Option</th>
<th>Capital Cost</th>
<th>Annual Energy Cost</th>
<th>Annual O&amp;M Cost</th>
<th>Total Annual Cost</th>
<th>25 Year Lifecycle Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1</td>
<td>$17,502,761</td>
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<tr>
<td>Option #6a</td>
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<tr>
<td>Option #8</td>
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<td>$341,453</td>
<td>$344,853</td>
<td>$1,947,954</td>
<td>$67,826,880</td>
</tr>
</tbody>
</table>

**Revised Recommendation**

Including the service of domestic hot water to the jail facility, Option #2 is again the most economically advantageous over the 25 year Life Cycle projection. Option #8 provides an excellent alternative at a very comparable cost while preserving the benefit of fuel flexibility.
APPENDIX A
Revised Preliminary Cost Estimates
<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>EQUIPMENT</th>
<th>QUANTITY</th>
<th>TOTAL COST/UNIT</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUILDING</td>
<td>THERMAL PLANT BUILDING</td>
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<td>2,025,000</td>
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<td>INTERIOR LIGHTING</td>
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<td>71,250.00</td>
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<td></td>
<td>DOCK DRAIN</td>
<td>1.00 LS</td>
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<td>3,500</td>
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<td>EQUIPMENT FOUNDATIONS</td>
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<td>45,000</td>
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<td></td>
<td>PLATFORM &amp; LADDERS</td>
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<td>60,000</td>
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<td></td>
<td>PLUMBING</td>
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<td>104,800</td>
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<tr>
<td></td>
<td>FIRE PROTECTION</td>
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<td>188,000.00</td>
<td>188,000</td>
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<td></td>
<td>LANDSCAPING, GRADING, &amp; PAVEMENT</td>
<td>1.00 LS</td>
<td>443,000.00</td>
<td>443,000</td>
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<td></td>
<td><strong>BUILDING TOTAL</strong></td>
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<td></td>
<td><strong>2,940,550</strong></td>
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<td>BOILER</td>
<td>BOILER (100 BHP GAS-FIRED)</td>
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<td></td>
<td>DEAERATOR W/ FEEDWATER PUMPS</td>
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<td></td>
<td>CONDENSATE SURGE TANK W/ TRANSFER PUMPS</td>
<td>1.00 EA</td>
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<td>34,478</td>
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<tr>
<td></td>
<td>STEAM PIPING, INSUL, VALVES, FITTINGS, &amp; HANGER</td>
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<td>237,200</td>
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<tr>
<td></td>
<td>BOILER BLOWDOWN TANK, PIPING</td>
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<td>18,000.00</td>
<td>18,000</td>
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<tr>
<td></td>
<td>CONTROL &amp; INSTRUMENTS</td>
<td>1.00 LS</td>
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<td>150,000</td>
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<td></td>
<td><strong>BOILER TOTAL</strong></td>
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<td>CHILLER</td>
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<td></td>
<td>CONDENSER WATER PUMP 1500 GPM</td>
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<td>54,750</td>
</tr>
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<td></td>
<td>CHILLED &amp; CONDENSER WATER PIPING</td>
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<td>555,000</td>
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<td></td>
<td>WATER TREATMENT</td>
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<td></td>
<td>VARIABLE FREQUENCY DRIVE</td>
<td>6.00 EA</td>
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<td></td>
<td>CONTROL &amp; INSTRUMENTS</td>
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<td></td>
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<td>SYSTEM</td>
<td>EQUIPMENT</td>
<td>QUANTITY</td>
<td>TOTAL COST/UNIT</td>
<td>TOTAL COST</td>
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<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------</td>
<td>----------</td>
<td>-----------------</td>
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<tr>
<td>FUEL HANDLING</td>
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<td>2.00 EA</td>
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<td>72,000</td>
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<tr>
<td></td>
<td>FUEL OIL TANK FOUNDATION, MONITORING, EXCAVATION</td>
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<td>68,000.00</td>
<td>68,000</td>
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<td></td>
<td>NO. 2 FUEL OIL PUMPS &amp; DOUBLE WALL PIPE</td>
<td>1.00 LS</td>
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<td>35,000</td>
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<td></td>
<td><strong>FUEL HANDLING TOTAL</strong></td>
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<td></td>
<td><strong>175,000</strong></td>
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<tr>
<td>DIRECT BURIED PIPING</td>
<td>STEAM PIPING</td>
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<td>DW/FIRE LINE TO CUP</td>
<td>220.00 LF</td>
<td>85.00</td>
<td>18,700</td>
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<tr>
<td></td>
<td>BLDG SANITARY SEWER TO CUP</td>
<td>220.00 LF</td>
<td>40.00</td>
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<tr>
<td></td>
<td>TRUCK DOCK STORM DRAIN FROM CUP</td>
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<tr>
<td></td>
<td>BLDG STORM DRAIN FROM CUP</td>
<td>300.00 LF</td>
<td>120.00</td>
<td>36,000</td>
</tr>
<tr>
<td></td>
<td>NATURAL GAS SERVICE TO CUP</td>
<td>250.00 LF</td>
<td>65.00</td>
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<td></td>
<td><strong>DIRECT BURIED PIPING TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>1,195,238</strong></td>
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<tr>
<td>ELECTRICAL-PLANT ONLY</td>
<td>BOILER AND CHILLER SYSTEMS ELECTRICAL</td>
<td>1.00 LS</td>
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<td></td>
<td>SWITCHGEAR AND FEEDERS</td>
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<tr>
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<td></td>
<td>CONCRETE TRANSFORMER PADS</td>
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<td>PROJECT MANAGEMENT FEE</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>17,101,062</strong></td>
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## Cost Estimates of Options

**Selected for Revised Economic Analysis**

**Option #2 - Ground Source Heat Pump**

<table>
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<tr>
<th>Capital Costs</th>
<th>Quantity</th>
<th>Cost/Unit</th>
<th>Total Cost</th>
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<td>Boiler (100 BHP Gas-Fired)</td>
<td>-3</td>
<td>$171,750</td>
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<td>Boiler Stack</td>
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<td>Condensate Surge Tank w/ Transfer Pumps</td>
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<td>Boiler Blowdown Tank, Piping</td>
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<td>No. 2 Fuel Oil Tank</td>
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<td>Fuel Oil Tank Foundation, Monitoring, Excavation</td>
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<td>No. 2 Fuel Oil Pumps and Double Wall Piping</td>
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<td>Cooling Tower (1500 gpm)</td>
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<td>Condenser Water Pumps (1500 gpm)</td>
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<td>VFDs</td>
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**Total Incremental Cost**

$1,807,954

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**Option #6a - Electric Steam Boiler, Gas-Fired Steam Boiler, and Centrifugal Chillers**

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<td>12470 V Feeder</td>
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**Total Incremental Costs**

$95,250
APPENDIX B
Revised Economic Analysis
### Option #1 - Gas-Fired Steam Boilers and Electric Centrifugal Chillers

#### Operating Costs

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<th>Month</th>
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<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
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<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
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<tbody>
<tr>
<td>LES (kWh/Month)*</td>
<td>30,915</td>
<td>25,084</td>
<td>19,142</td>
<td>31,361</td>
<td>74,231</td>
<td>161,448</td>
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<td>165,455</td>
<td>115,700</td>
<td>80,493</td>
<td>18,382</td>
<td>30,909</td>
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<td>270.749</td>
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<td>5,545</td>
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<td>Natural Gas Peak (therm/hr)</td>
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<td>10,891.84</td>
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<td>3,562.5</td>
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<td>301.05</td>
<td>1,128.52</td>
<td>2,417.78</td>
<td>9,019.00</td>
<td>24,286.69</td>
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</table>

#### Projected Annual Energy Costs

- **Electrical Energy**
  - 2009: 28,107.27
  - 2010: 177,345.97
- **Natural Gas**
  - 2009: 101,586.58
  - 2010: 177,345.97

#### Total Capital Cost
- 2009: $17,101,062

#### Total Annualized Costs

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<tr>
<td>Projected Annual Energy Cost</td>
<td>177,346</td>
<td>182,666</td>
<td>188,146</td>
<td>193,791</td>
<td>199,604</td>
<td>205,593</td>
<td>211,760</td>
<td>218,113</td>
<td>224,657</td>
<td>231,396</td>
<td>238,338</td>
<td>245,488</td>
<td>252,853</td>
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<td>Projected Annual O&amp;M Cost</td>
<td>344,853</td>
<td>355,199</td>
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<td>388,135</td>
<td>399,779</td>
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<td>424,126</td>
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<td>449,955</td>
<td>463,454</td>
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<td>1,957,883</td>
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</table>

#### Projected 25 Year LifeCycle Cost
- $58,826,456

#### Net Present Value of LCC
- $29,398,530

*LES Rate = General Service - Demand
## Option #2 - Water-to-Water Ground Source Heat Pump

### Operating Costs

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
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<th>December</th>
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<tbody>
<tr>
<td>LES (kW/Month)*</td>
<td>195,038</td>
<td>114,698</td>
<td>75,120</td>
<td>69,792</td>
<td>103,972</td>
<td>207,877</td>
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<td>212,905</td>
<td>152,066</td>
<td>116,928</td>
<td>72,776</td>
<td>167,906</td>
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<tr>
<td>LES (kW)**</td>
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<td>604.35</td>
<td>517.44</td>
<td>479.72</td>
<td>420.91</td>
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<td>7,228.10</td>
<td>5,791.01</td>
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<td>Demand Charge</td>
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<td>6,088.83</td>
<td>6,088.83</td>
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<td>7,988.92</td>
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<td>8,020.35</td>
<td>7,435.70</td>
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<td>201.9</td>
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<td>201.9</td>
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<tr>
<td>Total Monthly Electrical Charge</td>
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<td>8,359.78</td>
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<td>16,797.44</td>
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<td>11,773.80</td>
<td>9,052.83</td>
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<td>9,632.07</td>
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</table>

### Projected Annual Energy Costs

- **Electrical Energy**: 43,465.35
- **Electrical Demand**: 81,906.30
- **Natural Gas**: 0

Total Annual Energy Costs: $125,423.65

### Total Capital Cost

$18,909,015

### Total Annualized Costs

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<tr>
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<tbody>
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<tr>
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<td>141,165</td>
<td>145,400</td>
<td>149,762</td>
<td>154,255</td>
<td>158,883</td>
<td>163,649</td>
<td>168,559</td>
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### Total Projected Annual Costs

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<tbody>
<tr>
<td>Capital Recovery</td>
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<td>168,559</td>
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### Total 25 Year Lifecycle Cost

$55,076,239

### Net Present Value of LCC

$29,344,570

*LES Rate - Large Light and Power
### Operating Costs

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<th>January</th>
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<th>March</th>
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<th>September</th>
<th>October</th>
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<th>December</th>
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<tbody>
<tr>
<td>LES (kWh/Month)*</td>
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<td>78,962</td>
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<td>298.077</td>
<td>298.077</td>
<td>298.077</td>
<td>298.077</td>
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<td>340</td>
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<td>1,128.52</td>
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</table>

### Projected Annual Energy Costs

- **Electrical Energy**: $41,022.57
- **Electric Demand**: $47,652.12
- **Natural Gas**: $81,874.41

### Total Capital Cost

$17,196,312

### Total Annualized Costs

- **Capital Recovery**: $1,220,121

### Total Projected Annual Costs

- **Capital Recovery**: $1,220,121

### Total 25 Year LifeCycle Cost

$58,740,129

### Net Present Value of LCC

$29,961,959

*LES Rate = General Service - Demand*
APPENDIX C
Revised Preliminary Cost Estimates
Including Domestic Hot Water Service
<table>
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<tr>
<th>SYSTEM</th>
<th>EQUIPMENT</th>
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<th>TOTAL COST</th>
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### REVISED FINAL COST ESTIMATE - OPTION #1 WITH DHW

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## Cost Estimates of Options

Selected for Revised Economic Analysis  
(Including DHW Service)

### Option #2 - Ground Source Heat Pump Serving DHW

<table>
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<th>Quantity</th>
<th>Total Cost</th>
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<tbody>
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<td>Boiler (400 BHP Gas-Fired)</td>
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<tr>
<td>Boiler Stack</td>
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</tr>
<tr>
<td>Deaerator w/ Feedwater Pumps</td>
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<tr>
<td>Condensate Surge Tank w/ Transfer Pumps</td>
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</tr>
<tr>
<td>Boiler Blowdown Tank, Piping</td>
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<tr>
<td>No. 2 Fuel Oil Tank</td>
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<tr>
<td>Fuel Oil Tank Foundation, Monitoring, Excavation</td>
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<tr>
<td>No. 2 Fuel Oil Pumps and Double Wall Piping</td>
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<tr>
<td>Chiller (500 Ton Electric Centrifugal)</td>
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<tr>
<td>Cooling Tower (1500 gpm)</td>
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<tr>
<td>Condenser Water Pumps (1500 gpm)</td>
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<tr>
<td>CW Pump VFDs</td>
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<td>Loop Field Vaults</td>
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<td>Loop Field Pumps</td>
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<td>Hot Water Pumps</td>
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<tr>
<td>VFDs</td>
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<td>Water-to-Water Heat Pumps (250 Ton Package)</td>
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<td>Increased Cost for 120 deg HW (Jail)</td>
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<td><strong>Total Incremental Cost</strong></td>
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### Option #6a - Electric Steam Boiler, Gas-Fired Steam Boiler, and Centrifugal Chillers Serving DHW

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<td>12470 V Feeder</td>
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# Option #8 - Heat Recovery Chillers and Gas-Fired Boiler Serving DHW

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<tr>
<td>Boiler (400 BHP Gas-Fired)</td>
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<td>-$862,500</td>
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<td>Boiler Stack</td>
<td>-3</td>
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<td>-$54,000</td>
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<tr>
<td>Deaerator w/FW Pumps</td>
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<td>Condensate Surge Tank w/Pumps</td>
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<td>Chiller (500 Ton Electric Centrifugal)</td>
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<td>CW Pumps</td>
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<td>CW Pump VFDs</td>
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<td>Cooling Tower</td>
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<td>Chiller (94 Ton Electric Centrifugal w/Heat Recovery)</td>
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APPENDIX D
Revised Economic Analysis
Including Domestic Hot Water Service
### Operating Costs

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<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
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<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>LES (kWh/Month)*</td>
<td>39,100</td>
<td>27,837</td>
<td>21,222</td>
<td>32,520</td>
<td>74,969</td>
<td>161,831</td>
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<td>115,979</td>
<td>81,460</td>
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<td>38,326</td>
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<tr>
<td>LES (kW)*</td>
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<td>275,336</td>
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<td>468,090</td>
<td>401,860</td>
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<td>Customer Charge</td>
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### Projected Annual Energy Costs

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<td>2,193,475</td>
<td>2,222,023</td>
<td>2,251,428</td>
<td>2,281,715</td>
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### Total Capital Cost

- **$17,502,761**

### Total Annualized Costs

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<td>535,759</td>
<td>551,832</td>
<td>568,381</td>
<td>585,439</td>
<td>603,002</td>
<td>621,092</td>
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<td>658,916</td>
<td>678,664</td>
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<td>Projected Annual O&amp;M Cost</td>
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<td>365,925</td>
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<td>388,132</td>
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<td>411,773</td>
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<td>6,039,564</td>
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### Total 25 Year Lifecycle Cost

- **$72,409,190**

### Net Present Value of LCC

- **$36,666,813**

---

*LES Rate = General Service - Demand*
## Operating Costs

<table>
<thead>
<tr>
<th>Month</th>
<th>LES (kWh/Month)*</th>
<th>LES (kW)</th>
<th>Energy Charge</th>
<th>Demand Charge</th>
<th>Customer Charge</th>
<th>Total Monthly Electrical Charge</th>
<th>Natural Gas Consumption (therm)</th>
<th>Natural Gas Peak (therm/hr)</th>
<th>Natural Gas Charge</th>
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</thead>
<tbody>
<tr>
<td>January</td>
<td>241,579</td>
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<td>4,807.42</td>
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<td>8,940.09</td>
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<td>10,693.86</td>
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<td>September</td>
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<td>23,517.32</td>
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### Projected Annual Energy Costs

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<td>Electrical</td>
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### Total Capital Cost

- $19,235,316

### Total Capitalized Costs

- $19,235,316

### Capital Recovery

- $1,364,793

### Projected Annual Energy Cost

- $388,908

### Projected Annual O&M Cost

- $298,853

### Projected Annual Replacement Cost

- $3,367,864

### Total Projected Annual Costs

- $2,052,554

### Total Annualized Costs

- $2,052,554

### Capital Recovery

- $1,364,793

### Projected Annual Energy Cost

- $388,908

### Projected Annual O&M Cost

- $438,876

### Projected Annual Replacement Cost

- $3,367,864

### Total Projected Annual Costs

- $571,124

### Total Capitalized Costs

- $571,124

### Capital Recovery

- $1,364,793

### Projected Annual Energy Cost

- $571,124

### Projected Annual O&M Cost

- $438,876

### Projected Annual Replacement Cost

- $3,367,864

### Total Projected Annual Costs

- $2,374,793

### Total Capitalized Costs

- $2,374,793

### Capital Recovery

- $1,364,793

### Projected Annual Energy Cost

- $571,124

### Projected Annual O&M Cost

- $438,876

### Projected Annual Replacement Cost

- $3,367,864

### Total Projected Annual Costs

- $2,374,793

### Total Capitalized Costs

- $2,374,793

### Capital Recovery

- $1,364,793

### Projected Annual Energy Cost

- $571,124

### Projected Annual O&M Cost

- $438,876

### Projected Annual Replacement Cost

- $3,367,864

### Total Projected Annual Costs

- $2,052,554

### Total Capitalized Costs

- $2,052,554

### Capital Recovery

- $1,364,793

### Projected Annual Energy Cost

- $388,908

### Projected Annual O&M Cost

- $298,853

### Projected Annual Replacement Cost

- $3,367,864

### Total Projected Annual Costs

- $19,235,316

### Net Present Value of LCC

- $34,861,153

### Total 25 Year Lifecycle Cost

- $65,836,303

*LES Rate - Large Light and Power*
### Operating Costs

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<th>Operating Costs</th>
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<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
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</thead>
<tbody>
<tr>
<td>LES (kWh/Month)*</td>
<td>167,500</td>
<td>136,136</td>
<td>124,381</td>
<td>117,567</td>
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<td>222,482</td>
<td>190,507</td>
<td>158,723</td>
<td>145,762</td>
<td>115,959</td>
<td>160,074</td>
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<td>LES (kW)*</td>
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<td>419.862</td>
<td>530.336</td>
<td>655.745</td>
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<td>656,890</td>
<td>608,704</td>
<td>544,846</td>
<td>358,780</td>
<td>324,781</td>
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<td>5,181.79</td>
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<td>201.90</td>
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<td>Total Monthly Electrical Charge</td>
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<td>Natural Gas Consumption (therm)</td>
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<td>Natural Gas Peak (therm/hr)</td>
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### Projected Annual Energy Costs

<table>
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<tr>
<th>Option #6a - Demand Limit Electric Steam Boiler, Gas-Fired Steam Boiler, and Electric Centrifugal Chillers Serving DHW</th>
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<tbody>
<tr>
<td><strong>Projected Annual Energy Costs</strong></td>
</tr>
<tr>
<td><strong>Electrical Energy</strong></td>
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<tr>
<td><strong>Natural Gas</strong></td>
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<tr>
<td><strong>Total Annual Energy Costs</strong></td>
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### Total Capital Cost

| Total Capital Cost | $17,196,312 |

### Total Annualized Costs

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<td>562,832</td>
<td>579,717</td>
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<tr>
<td>Projected Annual O&amp;M Cost</td>
<td>344,853</td>
<td>355,199</td>
<td>365,855</td>
<td>376,830</td>
<td>388,135</td>
<td>399,779</td>
<td>411,773</td>
<td>424,126</td>
<td>436,849</td>
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<td>463,454</td>
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<tr>
<td>Projected Annual Replacement Cost</td>
<td>344,853</td>
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<td>365,855</td>
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<td>388,135</td>
<td>399,779</td>
<td>411,773</td>
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<td>491,676</td>
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<td>2,260,310</td>
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### Total 25 Year LifeCycle Cost

| Total 25 Year LifeCycle Cost | $89,167,767 |
| Net Present Value of LCC | $34,988,615 |

*LES Rate = Large Light and Power*
### Operating Costs

<table>
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<tr>
<th>LES (kWh/Month)</th>
<th>January</th>
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<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
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### Projected Annual Energy Costs

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### Total Capital Cost

$17,781,608

### Total Annualized Costs

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### Total 25 Year LifeCycle Cost

$67,826,880

### Net Present Value of LCC

$34,360,065

*LES Rate = Large Light and Power*