

EXECUTIVE SUMMARY

The following report is a study based on the renovation and addition to Stengel Hall-Center for Academic Excellence, an integral part of the Linden Hall School for Girls. The report examines the existing mechanical system and proposes alternatives to the designed mechanical system. The goal of the evaluated alternatives is to provide a more sustainable and maintainable mechanical system. Not only was Stengel Hall evaluated in this report but the entire Linden Hall Campus was included to determine the feasibility of a campus-wide heating and cooling system. The proposed alternatives included a geothermal heating and cooling system utilizing water-source heat pumps and a wood-fired biomass boiler.

Before evaluating either of these alternatives the peak heating and cooling demand loads were determined using Trane Trace and DesignBuilder. The peak heating and cooling loads determined for Stengel Hall were 764 kBTU/hr and 1087 kBTU/hr respectively. The evaluation estimated that the campus peak heating demand could be at 3190 kBTU/hr and peak cooling demand is 4525.2 kBTU/hr.

The geothermal study calculated the required ground loop piping loop for both Stengel Hall alone and the entire Linden Hall campus. The calculation resulted in heating dominant bore lengths of about 25,000 feet for Stengel Hall and about 109,000 feet for the entire campus. An energy study on the proposed ground source heat pump alternative for Stengel Hall resulted in an annual building energy savings of about 330,000 kBtu/year; an approximate 40% reduction. However, this only resulted in an annual utility cost savings of approximately \$5,700 and a payback period of over 30 years.

The research conducted on biomass boilers concluded that the best choice application of biomass energy is a wood-fired boiler that uses green wood chips mixed with the equestrian waste produced on campus. This alternative did not prove to be cost effective to the school due to the high initial cost.

The construction management breath focused on estimating the initial cost of the proposed alternatives. The estimate concluded that the geothermal system proposed for Stengel Hall would cost about \$465,000.00; an increase of about \$285,000 over the existing mechanical design. The initial cost estimate for the wood-fired boiler was over 2.8 million dollars due to the extensive repairs necessary to the existing steam system. An electrical breadth study evaluated the increased electric load and suggested larger panel boards to handle the loads incurred by the geothermal system.

Of the two proposed alternatives, the final recommendation is to implement the ground source heat pump alternative because it was the most cost effective and showed reductions in the energy consumption of Stengel Hall. Likewise, the other campus buildings may also see similar reductions in energy.