Executive Summary:

Over the past two semesters there has been comprehensive analysis done on the Phoenixville Early Learning Center to determine how it meets codes, compares to other buildings in energy usage, and an in depth review of the schematics of the mechanical system within the building. These previous reports can be found on my website. This report consists of a multifaceted study on the Early Learning Center and how various systems perform better or worse on the same building. It should be noted the purpose of these studies is not to imply insufficiency of the current design, however, they are to be evaluated for educational purposes.

In the depth analysis three different systems are brought to the fore front, comparing the current water-source heat pump system with the following systems; geothermal heat pump system, centralized air handling unit, and variable refrigerant flow (VRF) with a DOAS ventilation system. Lifecycle cost analysis, feasibility, operating cost, space utilization, construction cost and energy usage studies were completed on the previously mentioned systems on a basis to provide educational insight on how the equipment would perform within the building. At the end of the analysis the geothermal heat pump system was chosen for recommendation to the board of the Phoenixville School Board.

The geothermal heat pump system had a discounted payback of 11.37 years as compared to the baseline, water-source heat pump system. The life cycle cost of the geothermal heat pump system is $7,444,722. An area around the site was chosen for a vertical well field orientation to support roughly 67,000 feet of pipe, or about 200 wells at 400 feet deep, to pump 600 gpm of ethylene glycol through the geothermal heat exchanger. This design proved to add an additional 42 days to the construction schedule and an added cost of 1.54 million dollars.

Despite low costs of rooftop air handling units, when compared to the water-source heat pump system the units did not payback. Similarly, the VRF system also did not pay back. The VRF system had the best response to mitigating mechanical space within the building however, fell short in the energy efficiency and cost categories.

Breadth analysis consisted of evaluating various building systems that will be influenced by the change in mechanical systems. The breadths confirmed scheduling and cost impacts on construction of a geothermal heat pump system increased the construction time and also increased construction costs. Extra crews as well as equipment needed to be brought onto the site to drill bore holes and construct the geothermal well field.

Electrical load analysis of a VRF system on the building revealed the VRF terminal and rooftop units had less of an electrical load than the water-source heat pump system. Wires, ground wires and conduit was able to be re-sized after solving for the amps of each component of the VRF system.

Overall, the owner should be satisfied with a system that meets his needs of energy efficiency, classroom space, ease of maintenance and payback period. A geothermal well field was designed to meet the school's needs and stay in budget. Students as well as faculty and staff will have an enjoyable work environment for many years to come.