10.0 Breadth Areas:

The two main breadth analysis areas proposed for the South Jefferson High School redesign were chosen because of the direct effect the analyses have on one another. The results of improving some of the lighting systems will directly affect the mechanical systems by decreasing cooling loads and building energy consumption. Also, the redesign of the mechanical systems at South Jefferson High School will have effects on some of the building's cost and scheduling concerns.

10.1 Lighting:

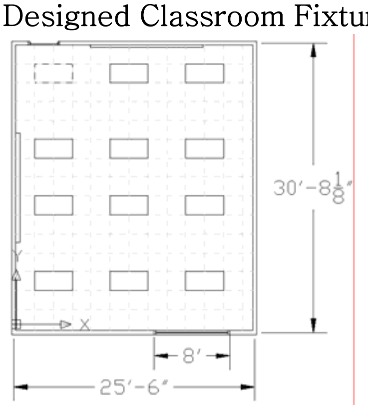
Research has shown that information presented visually is absorbed faster and retained more reliably than information presented orally. In order to promote learning, the classroom environment must be designed so that teachers and students can perform their visual tasks comfortably, quickly and accurately. Lighting is a main component that impacts the performance of teachers and students. High quality, energy effective lighting is great way to help improve a school.

Efficient Classroom Lighting Fixtures:

A significant amount (approximately 20%) of the annual HVAC energy consumption is conditioning of lighting. Classrooms and corridors lighting fixtures account for over half of South Jefferson's total lighting fixtures. Providing the classrooms and corridors energy efficient light fixtures to maintain lower watt per square foot values would consequently reduce cooling loads and considerably help annual energy costs. A summary of the existing total lighting fixture wattage is provided in Appendix G.

The highly efficient lighting fixture, lamp, and ballast combination chosen for each classroom and corridor are designed to guarantee enough illuminance for proper task lighting. The lighting calculations in Appendix G were generated for a typical South Jefferson classroom to ensure adequate task lighting. A layout of the lighting fixtures for the typical classroom can be seen in Figure 4.

Figure 4 – Designed Classroom Fixture Layout



The reduction in energy generated by the classroom and corridor lighting fixtures resulted in 0.10 W/S.F. decrease for the entire building. This will save 19,971 W in electrical service and would likely downscale electrical equipment. The energy to condition the lighting is reduced by 474.2 x 10^6 BTU's per year. The reduced loads effectively reduce HVAC equipment size. If the high efficiency lighting is used in the ground source heat pump alternative, the total building energy cost is $133,348. The result is nearly a $9000 per year savings over a ground source heat pump system with the existing light fixtures.

10.2 Construction Management:

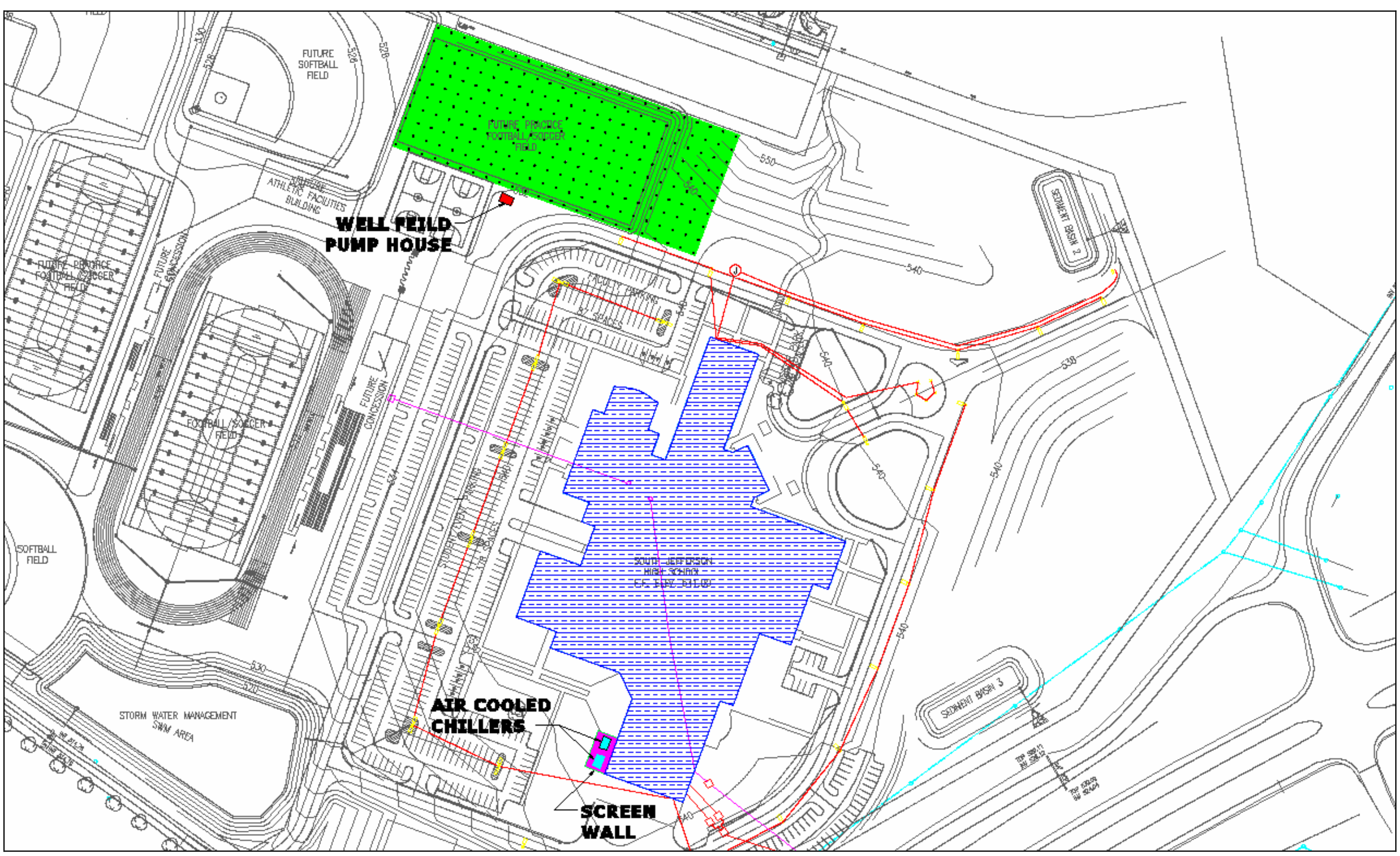
Utilizing a chiller water system or ground source heat pump system will directly affect the scheduling for the projects construction manager. Each alternative directly affected the construction of the buildings site. The chilled water plant would need to be constructed. While the ground source heat pump system requires the construction of a well field and pump house.

Construction Scheduling:

-VAV with Chilled Water Plant:

Adding a chilled water plant to a building affects usable space either inside or outside the building. In this case, an exterior site was selected because it has the least effect on the architecture of the building. The most practical location for the two 300 ton air-cooled chillers was by the loading docks outside the kitchen area. This location is hidden from view of a passersby driving on the main road, and is an easily accessible location for the maintenance staff. The addition of a screen wall also helps conceal the chillers and alleviate many of the screw chillers' noise concerns. The location of the air cooled chillers can be seen in Figure 5.

Figure 5 – Alternatives Site Impact



In comparison to a packaged roof top unit construction schedule, constructing an exterior chilled water plant does not effect duration and/or stop and start time of construction. All HVAC equipment construction would all be performed at the same times as the original system. The base construction schedule can be seen in Appendix H. The two air-cooled chillers would be installed replacing the 15 roof top condensing units. Also, four pipes need to be installed instead of two for the main heating and cooling hydronic distribution system. In each case, the construction would require more man power but no additional time is necessary to construct the system.

For chillers to operate efficiently, commissioning of the chilled water plant is necessary in the construction schedule. Sensors such as chilled water flow, chilled water supply and return temperatures, and chiller electric demand must all be properly calibrated. This will ensure that all data collected is correct and can be used to help the school save energy. The commissioning for a chilled water plant is more centralized but adds more complexity. Consequently, no additional time was either added or detracted from the base construction schedule for commissioning.

-Ground Source Heat Pump:

The site work construction is the component of construction scheduling intrinsically affected by the use of a ground source heat pump system in a building. This is because the construction of the geothermal well field is such a main constituent in the ground source heat pumps design. South Jefferson's well field requires 240 bore holes taking up an area of 96,000 square feet. The football and soccer practice fields were chosen as the best location for the geothermal well field. Here, the well field would avoid impacting any other construction on the site. The site locations can be seen on the previous page in Figure 2.

Since the well field does not impact any other construction, it can be constructed concurrently with the rest of the buildings site work. The South Jefferson High School ground source heat pump project would begin in the spring of 2007. The area of the future practice fields would be excavated and prepared for the installation of 240 boreholes. These wells will be drilled using two commercial drilling rigs, each drilling two holes a day, or 10 holes a week for 25 weeks. Each well hole will receive two 475 foot long pieces of polypropylene tubing attached by a "U-joint" at the bottom of the well. Each well will be connected in series, creating a large closed-loop geothermal space conditioning system. The well-field uses technology developed by the natural gas industry, including the ability to "field-splice" the polypropylene tubing as it is being assembled in the well-field. The well field manifold house will serve as a focal point for data generation and collection. From there, the loop is connected to the main pumps, also housed in the pump room. These variable speed 25 H.P. pumps control the speed of the water used to transport the water in the loop field.

During installation, all debris and small animals should have been kept out of the piping, but to ensure proper performance the geothermal well field should still be cleaned and tested. Each supply and return circuit will be flushed and purged with a water velocity of 2 ft/s. The lines will be left filled with clean water and then pressure tested. If connection to the manifold is not immediate, piping must be capped.

After the well field is deemed usable, the well field contractor must coordinate with the mechanical contractor on propylene glycol antifreeze installation. The mechanical contractor is responsible for the propylene glycol antifreeze. Once the propylene glycol is filled in the system to the proper percentage, the geothermal well field can be implemented into the rest of the ground source heat pump system.

Commissioning for the ground source heat pump system is done twice, once in the winter and once in the summer. This is to ensure that the system is operating properly and supplying proper water temperatures to condition the building. If the well field is not rejecting or receiving enough heat from the ground, expensive alterations to the system will occur.