Executive Summary

This thesis analyzed two major changes to the existing mechanical system and the effects those changes would have on the rest of the building. A dedicated outdoor air system was installed in all areas of the building except for the pools. The ventilation rates were lowered to more closely meet ASHRAE standards. An energy recovery wheel was installed on the DOAS units to precondition the incoming air, and the DOAS units now supply air at room neutral conditions to further decrease the required load. These techniques provided more accurate ventilation while reducing energy use.

The second change was using ground source heat pumps to condition the building, instead of the combination of gas furnaces and DX cooling currently being used. The new system uses water to provide heating and cooling, and uses the steady temperature of the ground as a heat sink. The ground source heat pumps eliminate the need to burn natural gas, and still manage to lower the total building's electrical demand. Extra piping and excavation will be required to install the GSHP system, but the energy savings offset that cost.

As a result of the above changes, the existing air handlers were replaced with heat pumps. The heat pumps use the water from the GSHP system to provide heating and cooling to the building. The existing air handlers were consolidated into eight heat pumps and two large air handlers for the pools.

The cost of the pool water heating was also reduced as a result of the changes in the mechanical system. The new pool air handlers recover energy using a dehumidification coil to collect energy and preheat the water during the cooling seasons. Excess heat in the building water loop during the heating season will completely cover the heating needs of the pools during the winter. The use of these energy saving techniques helped cut the pool utility costs in half.

With the changing of the mechanical equipment, the electrical system had to be adjusted to handle the new loads. Overall, the electrical demand on the building was reduced by over thirty percent. Each panel board was analyzed for load changes, and the differences in wire sizing led to over $86,000 in savings.

The structural system was analyzed to see if it could support the weight of the new mechanical equipment. The structural system had to be changed only slightly to accommodate the new loads. Two joists were increased in size to handle the weight of one of the heat pumps, and the cost of the change was less then $100.

As a result of all of these changes, the energy use in the building was reduced dramatically. The annual utility costs dropped from $141,404 to $69,944. That is an annual savings of $71,460, or about fifty-one percent. Natural gas usage for the boilers and air handlers was reduced from 48,000 therms to just under 6,600 therms, an eighty-six percent reduction. The additional initial costs to change the mechanical, electrical, and structural systems were calculated at $530,828, less then two percent of the total building construction cost. From the additional investment and the annual savings, a simple payback of 7.43 years was calculated.

The Kroc Center was built and is operated by the Salvation Army. This facility was meant to service the community of Salem, Oregon for the next several decades, so making a change that will pay for itself in seven and a half years is a good option. The proposed mechanical system reduces natural gas usage, saves energy, and saves money. It accomplished all three goals of this thesis; it was very successful.