

# Millennium Science Complex



## **Mechanical Technical Report I**

Building/Plant Energy Analysis & Systems Existing Conditions

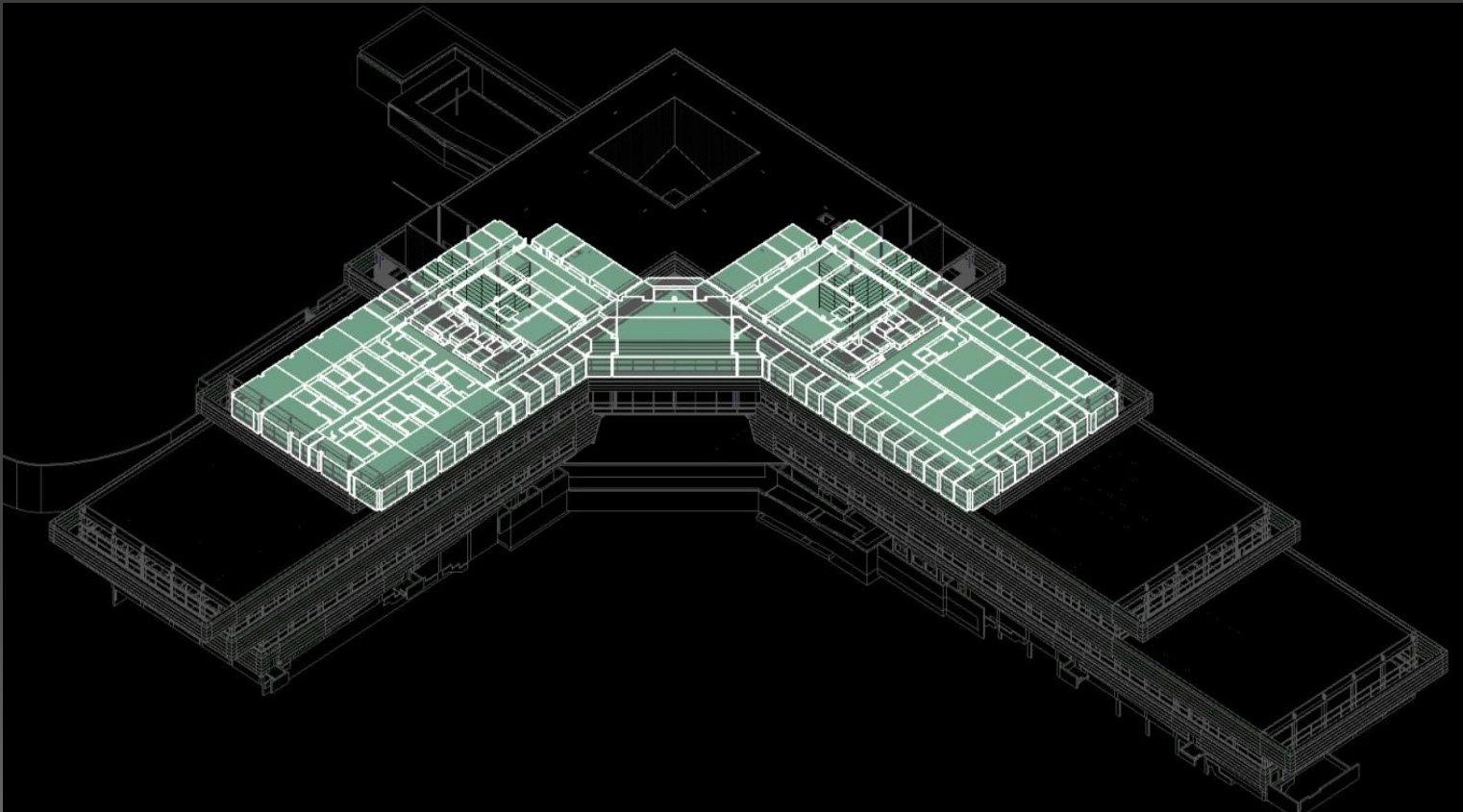
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Integrated Project Delivery / Building Information Modeling Thesis 2010-11

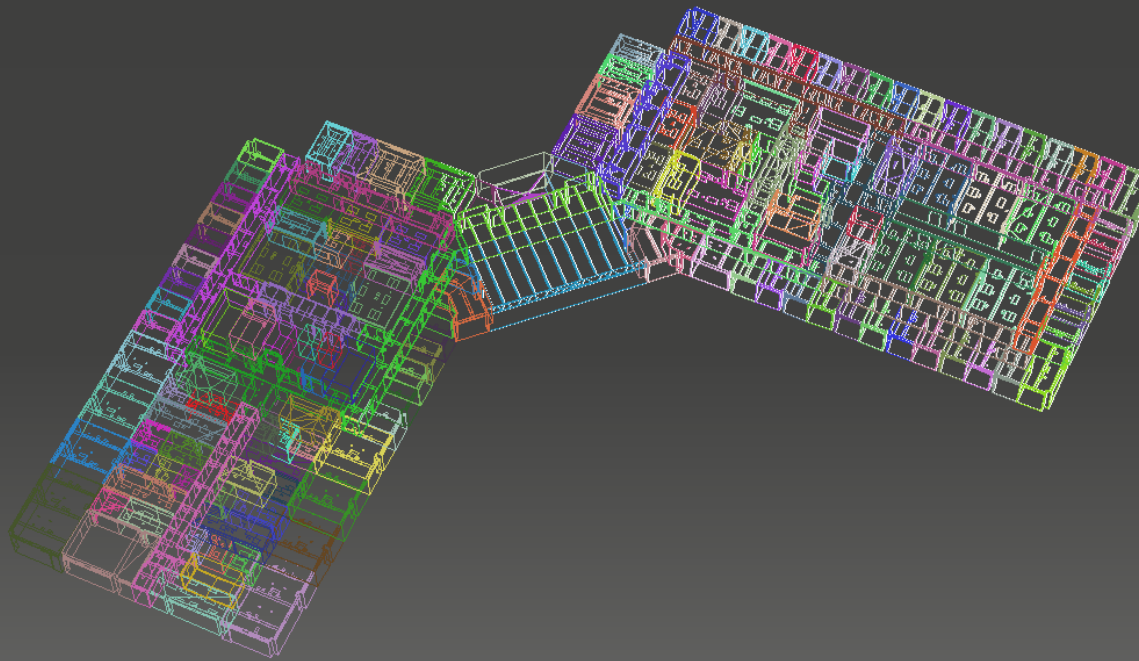
# Building Overview



# Revit Information Sharing



# GBXL Information Sharing



# Load Calculation Summaries

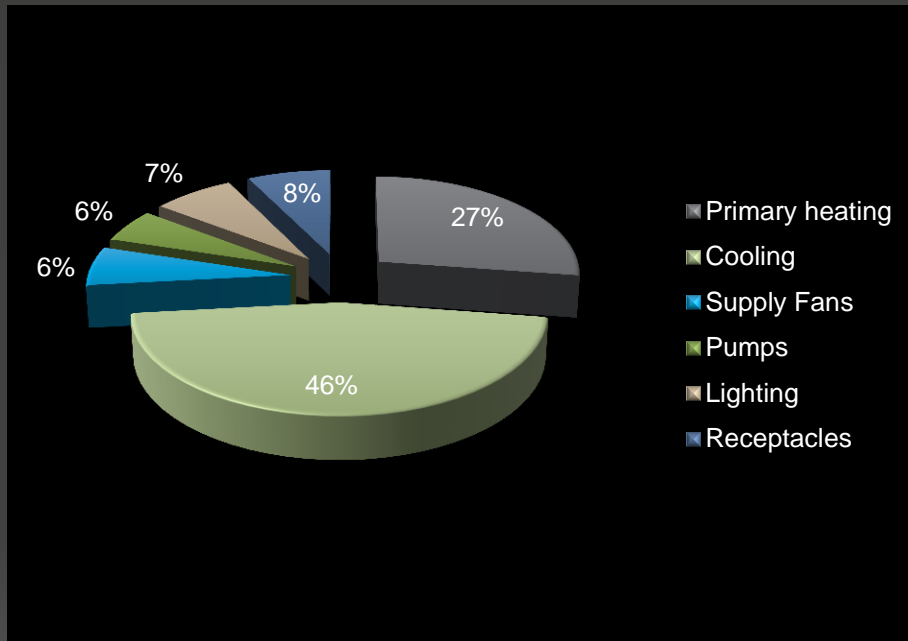
- **Table 8: Office Zone Load Summary**

	Cooling (tons)	Heating (MBTUh)	Supply Airflow (cfm)	Outside Air Percentage	cfm/ft <sup>2</sup>
Baseline 90.1	113.3	779.6	39,814	16.3	1.39
Existing Design	97.2	513.9	28,974	22.5	1.01

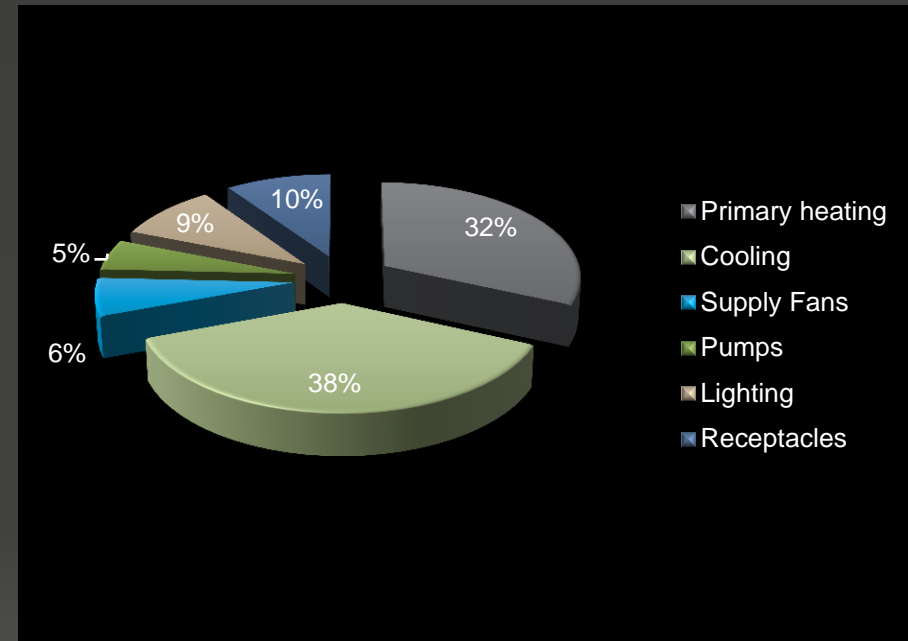
- **Table 9: Laboratory Zone Load Summary**

	Cooling (tons)	Heating (MBTUh)	Supply Airflow (cfm)	Outside Air Percentage	cfm/ft <sup>2</sup>
Baseline 90.1	295.8	3,151.4	34,078	100.0	2.19
Existing Design	217.7	2,409.2	25,588	100.0	1.64

# Equipment Energy Consumption



■ *Figure 3: ASHRAE 90.1*



■ *Figure 4: Existing Design*

# Summarized Annual Energy Consumption

▪ **Table 11: Summarized Annual Results**

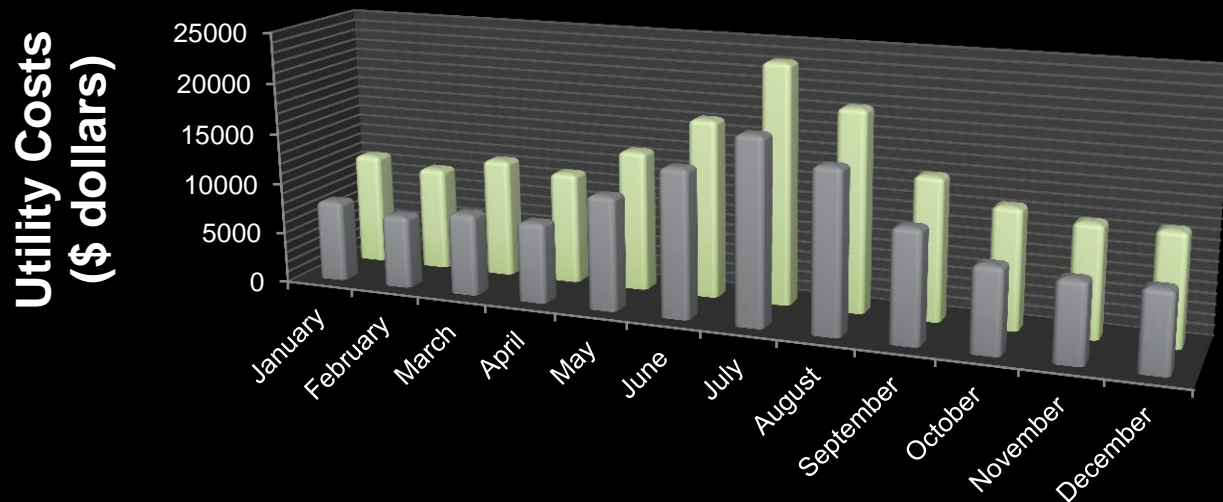
	ASHRAE 90.1	Existing Design	Percent Savings	Cost Savings
Electricity (kWh)	765,979	684,280	11%	\$6,141
Purchased Chilled Water (therms)	45,039	28,705	44%	\$29,891
Purchased Steam (therms)	26,694	24,119	9%	\$2,111
<b>Total Costs and Savings</b>	<b>\$161,889</b>	<b>\$123,745</b>	<b>23%</b>	<b>\$38,144</b>

▪ **Table 12: Comparison of Baseline and Existing Design Energy Intensities**

	Baseline ASHRAE 90.1	Existing Design
Energy Intensity ( kBTU/ft <sup>2</sup> - yr)	221.2	172.2
Cost	\$3.72/SF	\$2.85/SF

# Monthly Utility Costs

- **Figure 5: Comparison of Baseline and Existing Design Monthly Utility Costs**



■ PSU MSC: Existing Design

■ PSU MSC: Baseline ASHRAE 90.1

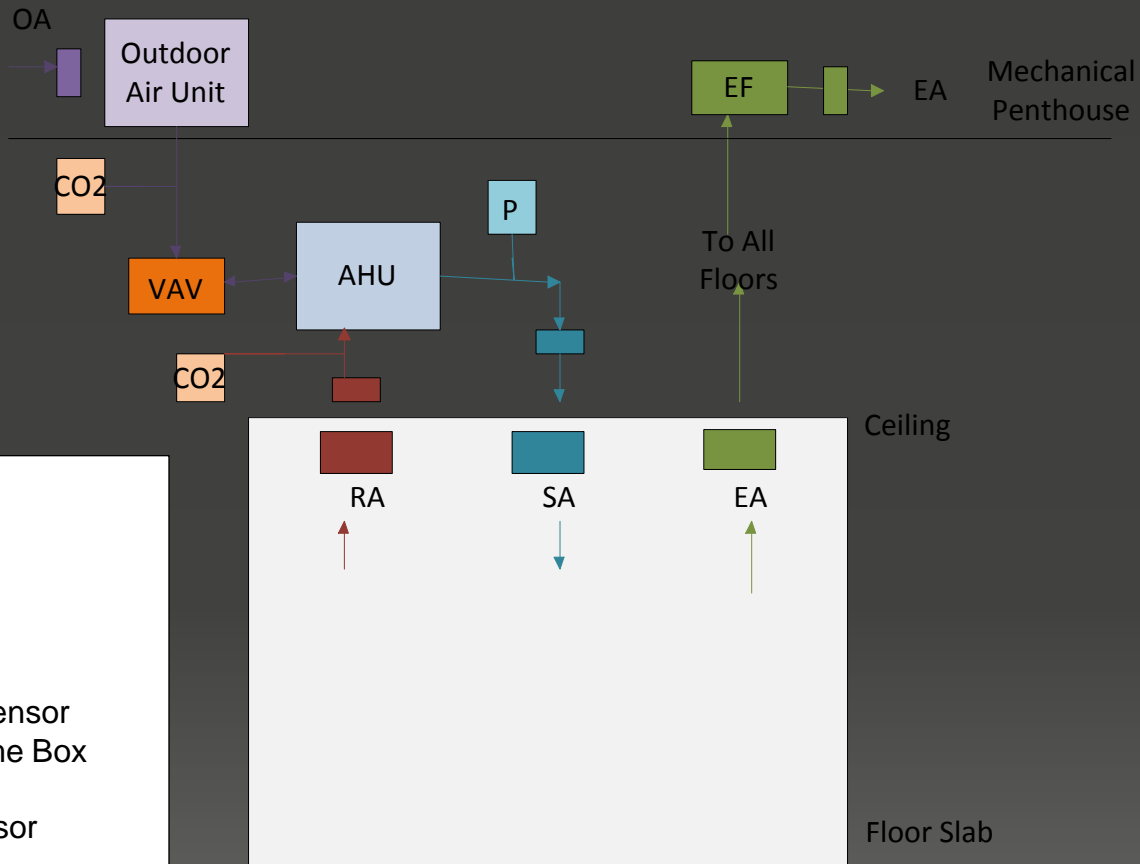


# Building Emission Rates

	ASHRAE 90.1 Standard Emissions	Existing Design
Total Building Energy (Btu/ft <sup>2</sup> -yr)	221,194	172,158
Total Source Energy (Btu/ft <sup>2</sup> -yr)	335,995	280,932
CO <sub>2</sub> (lbm/yr)	3,487,813	2,714,609
SO <sub>2</sub> (gm/yr)	26,966	20,988
NO <sub>x</sub> (gm/yr)	5,420	4,219

- **Table 14: Comparison of emission rates from Trane TRACE**

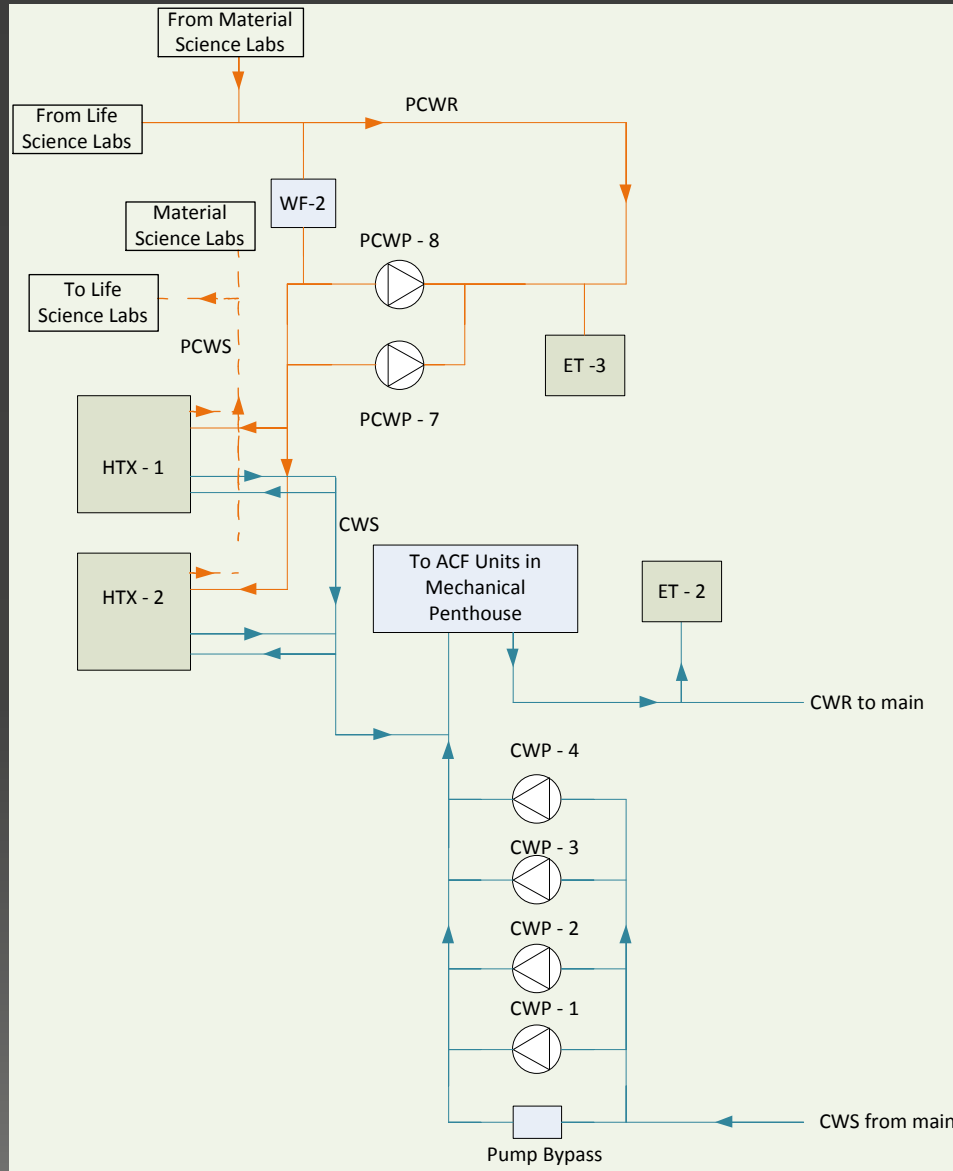
# Typical Airside Diagram for Spaces



## Legend

- RA: Return Air
- SA: Supply Air
- EA: Exhaust Air
- OA: Outside Air
- CO<sub>2</sub>: Carbon Dioxide Sensor
- VAV: Variable Air Volume Box
- EF: Exhaust Fan
- P: Static Pressure Sensor

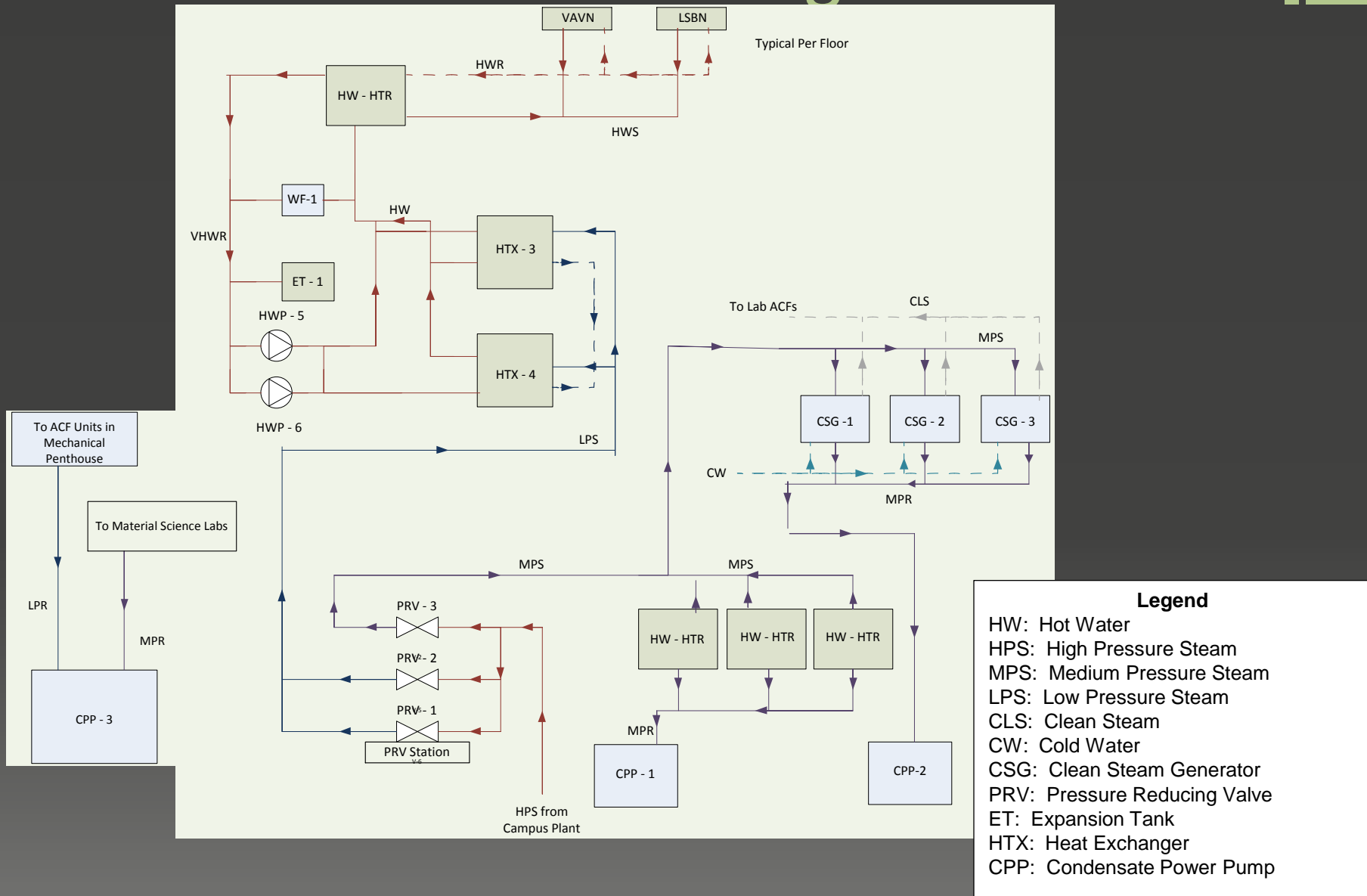
# Chilled Water Flow Diagram



## Legend

- HTX: Heat Exchanger
- ET: Expansion Tank
- CWP: Chilled Water Pump
- PCWP: Process Chilled Water Pump
- WF: Water Filter
- PCWS/R: Process Chilled Water Supply/Return
- CWS/R: Chilled Water Supply/Return

# Hot Water Flow Diagram



# Lost Usable Space

**Table 22: Lost Usable Area Breakdown**

Floor	Lost Usable Area
Basement	9,050 SF
1 <sup>st</sup> Floor	4,150 SF
2 <sup>nd</sup> Floor	1,175 SF
3 <sup>rd</sup> Floor	1,014 SF
4 <sup>th</sup> Floor: Mechanical Penthouse	27,287 SF
<b>Total Area Lost</b>	<b>42,676 SF</b>

# LEED Energy Credits

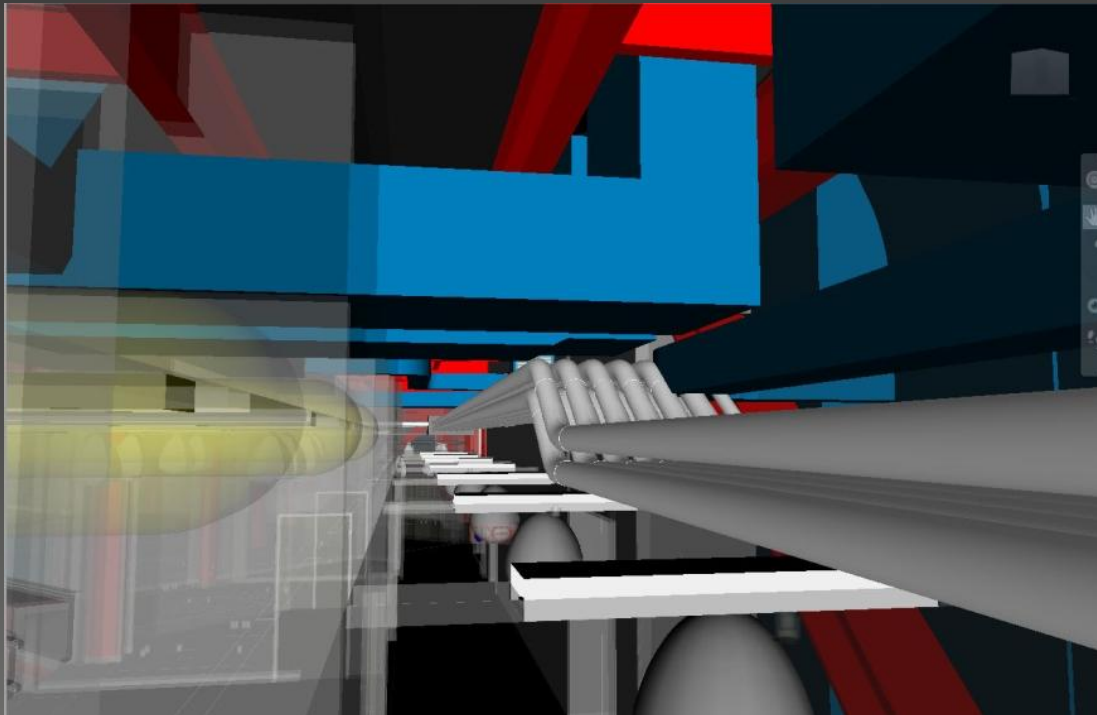


**Table 24: LEED Credit Breakdown**

Category	Possible Points
Sustainable Sites	11/14
Water Efficiency	3/5
Energy & Atmosphere	5/17
Materials & Resources	5/13
Indoor Environmental Quality	12/15
Innovation % Design Process	5/5
<b>TOTAL</b>	<b>41/69</b>

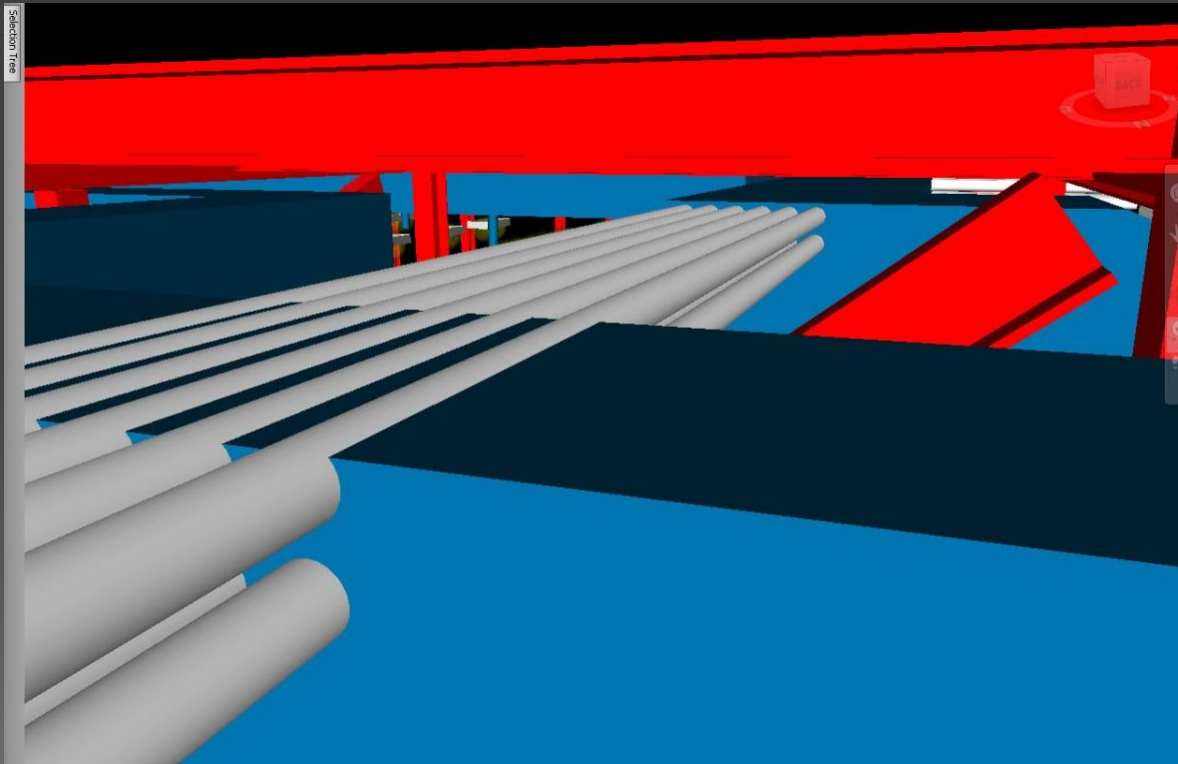
# Model Coordination

- *Revit Models to Navisworks Coordination*
  - *Architecture*
  - *Electrical*
  - *Structural*
  - *Mechanical*



# Mechanical Collisions

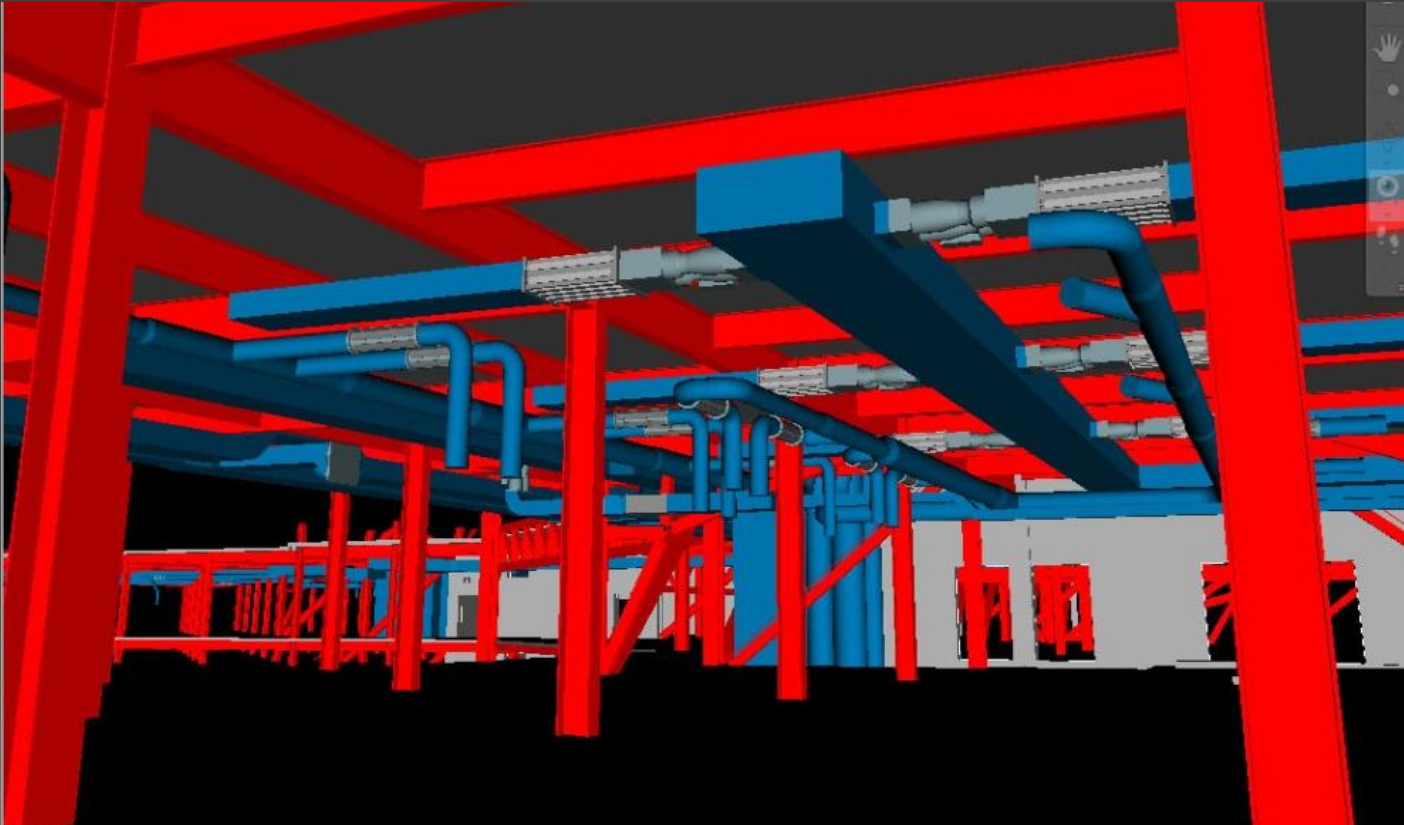
- *Use Coordination to Minimize Collisions*
  - *Only Main Ducts and Elements Currently Modeled*





# Laboratory Design Modeling

- *Unique Equipment and Room Arrangements*
  - *Many Elements Not Modeled*
    - *Piping, Gas Piping, Branch Ductwork*



# Conclusions

- *Energy Savings*
- *Discipline Coordination*

Any Questions???