



# Broad Institute Expansion: 75 Ames Street

*Cambridge, Massachusetts*

## Final Report:

*[Mechanical Systems*

*Alternate Evaluation]*

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# 75 AMES STREET

Cambridge, Massachusetts

NATHANIEL MOONEY  
ARCHITECTURAL ENGINEERING  
MECHANICAL OPTION

Building Type - Science and Technology

Construction Dates - January 2012-Early 2014

Cost - \$188,000,000

## Project Team

Owner : The Broad Institute  
Project Manager : Boston Properties  
Architect : ELKUS|MANFREDI ARCHITECTS  
MEP Engineers : Bard, Rao + Athanas  
Construction Manager : Suffolk Construction



## Architecture

- 15 story, 25000 SF, \$188,000,000, high-rise in Kendall Square, Cambridge, MA.
- Consolidates all of the Broad Institute's offices into one location
- Completes the frontage of Ames Street while interacting with the street life
- Areas include labs, offices, vivarium, and 4,000 SF of retail and restaurant space on the street level
- Facade is a mixture of stone, terra cotta, spandrel and vision glass



## Mechanical

- Four 115,000 CFM 100% outside air AHU's mounted in the mechanical penthouses
- Two 230,000 CFM dedicated exhaust air handling units on the roof exhausting through 8 air induction nozzles
- Non-lab zone uses constant or variable volume box with hot water heating coils
- Labs supplied with supply air valves using hot water reheat coils

## Heating Plant

- Two 500 BHP preheat fire tube boilers
- Four 120 BHP Reheats with one standby
- Two 215 BHP MPS boilers

## Chiller Plant

- Three 1000 ton centrifugal chillers
- Two 450 ton centrifugal chillers
- Five cooling towers on the roof

## Electrical

- Two 2000KW/2500KVA Generators
- NSTAR 13.8KV Switchgear
- One Generator Paralleling Switchgear
- Twelve switchboards & 43 Distribution panels
- Recessed linear T5 fluorescent fixtures in labs
- Suspended linear T5 fluorescent in offices



## Structural

- 48" to 60" diameter caissons
- High capacity drilled mini piles have minimum of 12" diameter with a high capacity of 280 tons
- Concrete floor slabs on metal deck
- Lateral loads resisted with HSS, concentric braced frame design
- Typical floor construction is 3/4" cover over varying concrete depth on composite decking

<http://www.engr.psu.edu/ae/thesis/portfolios/2013/njm5123>

## Executive Summary

The Broad Institutes new building at 75 Ames Street is set to be done with construction in early 2014. This building has been designed to hold half labs and half executive spaces such as offices and conference rooms. There is also retail space available on the Ames Street front property, and vivariums up on the 12<sup>th</sup> floor. The HVAC system is currently supplied by 4 Air handling units serving the first 11 floors or labs and offices in a ganged duct system, and another spate air handling unit serving the vivarium. The whole system is 100 % outside air due to the lab spaces and interior rooms are supplied by variable air volume boxes with reheat. The exterior spaces are supplied with VAV boxes and use baseboard heaters by the windows to heat the rooms. The purpose of this report is to see the effects of changing the rooms from a VAV reheat supply to a chilled beams system and the effects of putting the labs on a demand controlled ventilation system such as Aircuity Optinets sensing system.

The first mechanical depth studied the effect of just adding the Aircuity Optinet system to a few lab spaces. These lab spaces could then be turned down to ventilation levels of 4 to 2 ACH instead of the more common 6 to 12 ACH. The results in changing to this new system saved The Broad Institute \$189,042.74 a year compared to the original system. While only costing \$160,000 to install.

The second depth explored the economics and environmental effects of placing a chilled beam system. The chilled beams being added to both the labs and offices drastically decreased the supply air needed for each room and allowed the downsizing of air handling units supply fans. Although there was a premium cost of for the chilled beams, extra piping and added pump of \$743,167.79 the annual savings amount to \$532,217.29. This energy cost savings also translates to a high emissions reduction. The rates compared to the original system changed by up to 22%.

The third depth explored coupling the two systems together to make the saving even greater. For this third system the savings amounted to \$604,658.99 while the total cost was only 903,167.79. The emissions rate was also positively affected by the coupling of the two systems. The percent change went up to 24%.

The breadth study shows that that there is some effect to the lighting system in order to position the chilled beams in the most desirable space. But in studying the different lighting styles it was decided that the original lighting could still be utilized, or a more energy conscious LED system could be used., which cost more up front but could have more savings in the long run, f

After the investigation of the three different mechanical changes to the building it is recommended to add both the chilled beams and Aircuity-Optinets demand controlled ventilation system to maximize both the savings and environmental impact of the building. The Aircuity system will also create a better environment for the occupants of the labs ensuring that contaminants remain within a safe level.



## Acknowledgements

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### AE Class 2013

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## Building Overview

### Site

75 Ames Street is a new 250,000 sq. ft., 15-story high-rise addition to Kendall Square in Cambridge, Massachusetts (figure1 below). This building is designed to bring together the multiple Broad institute offices around the Cambridge area into one location attached to their main office at 7 Cambridge Center. Cambridge is a city just outside of Boston, home to such universities as MIT and Harvard. The site for 75 Ames Street now is just a parking garage and a parking lot. The garage will be incorporated into half of the first 5 floors and the other half will be built on the parking lot. Figure 1 shows the area where 75 Ames is to be build and what the street front view will look like.



Figure 1: A look at the location of 75 Ames Street in Cambridge (courtesy of ELKUS|MANFREDI ARCHITECTS)

### Architecture

ELKUS | MANFREDI Architects goal was to consolidate the many existing research and development labs and offices of the Broad Institute, which are spread throughout Kendall Square, to one location, 75 Ames Street. The result was a 15 story high rise on Ames Street incorporating an existing garage and a connection to the Broad Institutes current main offices at 7 Cambridge Center.

Windows push through a masonry assembly projected from a curtain wall on the Ames Street façade (top image left) of the building standing out from the surrounding structures without taking away from them. A light weight curtain wall is used on the Ames & Broadway corner (bottom image left) running to the very top emphasizing high. The three other façades reference the design of 7

Cambridge Center, connecting the existing Broad Institute office to this new expansion.

75 Ames worked to complete the streets frontage and interact with street life. This was done with the use of 4,000 SF of retail/restaurant space on the first floor. The upper floors are used for research and development offices and labs, and the top three floors, making up a cake like structure, house the mechanical equipment for the whole building.



Figure 2: Street front View 1

## Envelope

The exterior is mainly composed of a mixture of stone, terra cotta, Viracon vision glass and spandrel glass. 75 Ames is made up of 40% glass allowing as much natural light as possible into the building. The penthouse is primarily constructed of aluminum louvers and metal panels. The front façade adds to the vibrant community on Ames Street while the other three facades connect 75 Ames to the current Broad Institute main office next door at 7 Cambridge Center.



Figure 3: Street front view 2

## Structure

75 Ames is supported by 48" to 60" diameter caissons and high capacity mini piles with a minimum of 12" diameter with a high capacity of 280 tons. The Frame is typically of W24x94 girders for floors 1-5 floors 6-M3 typically use w18x35 steel and plg 72x30. The typical floor construction is 3"x18ga. Composite metal floor deck (galvanized) with 4 ½" normal weight concrete cover, total thickness 7.5" Reinforced with #4@18 EA. WAY TOP or 5 ¼" normal weight concrete on 3" x 16ga. Composite metal deck reinf. With 4x4-w4.0x40 WW. W14 steel columns are typical throughout the structures and HHS 10x10x5/8 and w14's are used in the braced frame system.

## Electrical

The electrical system of 75 Ames is supplied by 13.8KV switchgear connecting into an existing NSTAR wiring located on AMES Street. Two 2000KW/2500KVA, 277/480V, 3 phase, 4 wire, NO. 2 diesel engine drive generators are to be parallel to the switch gear with an automatic transfer/distribution switchboard. This power supply connects two five (5) 480 main switchboard line-ups. Three of the lineups are 4,000A for laboratory power and building mechanical equipment loads, one is rated 480V, 3-phase, 4-wire for the retail tenant services and the last is rated 480V, 3-phase, 3-wire for fire pump.

## Lighting

A low voltage lighting control system is provided as a component of the Building Automation System (BAS). This BAS consists of lighting control panels with individual relays, momentary contact switches, system photocells, and system integral time clocks. In general recessed linear T5 fluorescent fixtures are used in labs, suspended linear T5 fluorescent fixtures are used in offices and a mixture of recessed light slot fluorescent and recessed light slot LED lights are used in conference rooms.

## Mechanical System Overview

Level M2 hosts the heating plant consisting of two 500 BHP preheat fire tube boilers, four 120 BHP Reheats with one standby, two 215 BHP MPS boilers for humidification and process steam loads, and finally a pressure reducing LPS for humidifiers. Also on M2 is the chiller plant consisting of three 1000-ton chillers for cooling air handling units 1 through 4. Two 450-ton chillers to serve vivarium (AHU-5) and fan coil units, which serve freezer rooms, tell/data,

electrical, and the penthouse for spot cooling. Each chiller has a corresponding cooling tower located on the roof.

The ducting on each floor was taken with future floor plan changes in mind. In order to achieve this, air-handling units 1 through 4 each connect to a main ring on each floor. This can be seen in the following figures 5 & 4, which show the supply and exhaust duct respectively. These rings then supply air to each zone on their floor. Since they are serving both labs and offices together return air cannot be utilized since labs call for 100 % outside air. The only return air used in this building is 16000 CFM of air from the connector of 75 Ames Street to 7 Cambridge Center to level M1.

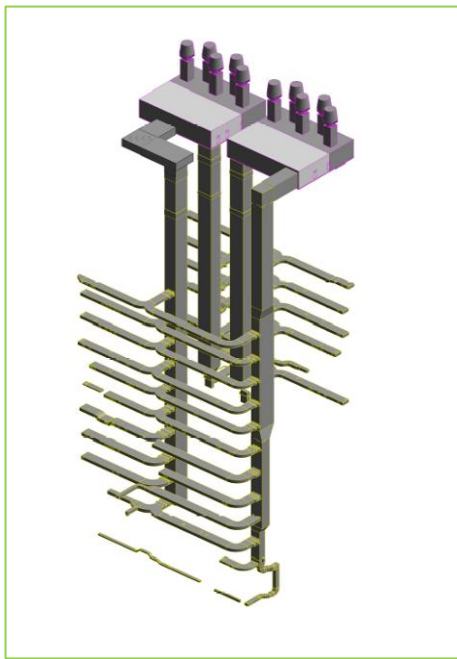


Figure 5: Exhaust Ganged Duct

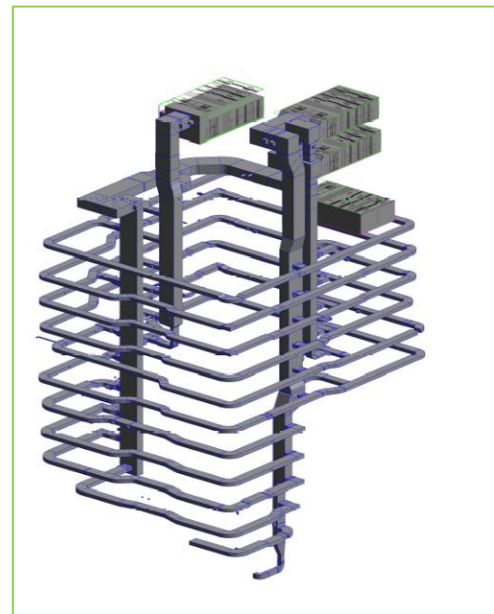


Figure 4: Supply Ganged Duct

## Mechanical System Design Requirements

This section is an in depth report of the mechanical design objectives, requirements and modeled conditions for 75 Ames Street. It will also look into energy usage and costs for these conditions.

### Design Objectives

75 Ames's mechanical design objective is to build a state of the art facility incorporating sustainable design principals of energy conservation that will achieve a United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) Silver Certification. The HVAC system must be designed and built to support the present building program but maintain flexibility for changes of this program in the future. Spaces to be supported are chemistry wet labs, tissue culture spaces, sequencing

spaces, a vivarium on level 12, administration areas, restaurant tenant on level one, and positions of possible future vivarium expansion.

All systems will be designed in accordance with Massachusetts State Building Code, City of Cambridge Ordinances, ASHRAE and other recognized standards, NFPA Standards and good engineering practices. As well an effort shall be put forward to design, layout and place equipment in areas of easy access to encourage routine maintenance. The use of isolation valves shall be implemented to enable easy servicing as well as expansion or renovation of any part of the existing facility without interrupting adjacent areas. Air Handling unit cross connection, ring duct or ganged duct, are used to provide redundancy throughout the facility to ensure environmental comfort to each space with in the building

## Design Conditions

### Exterior Design Conditions

For External conditions, 75 Ames Street is located in Cambridge Massachusetts, which is in the 5A weather region for ASHRAE. Below an exterior design winter and summer condition can be found in Table 1.

Table 1: Exterior Design Conditions

| Temperature                        |             |             |
|------------------------------------|-------------|-------------|
|                                    | Winter (°F) | Summer (°F) |
| <b>Exterior Design Temperature</b> | 0°          | 91 db/73 wb |

### Interior Design Conditions

The mechanical system in this project needs to meet the following criteria specified by the mechanical engineer to maintain comfortable conditions throughout the many spaces within 75 Ames Street. Interior design temperatures for the primary spaces are shown in table 2 and table 3 shows the relative humidity required.

Each space must use 30% MERV-8 pre-filters and 80-85% MERV 13 final filters for this project. In the Vivarium it is required that HEPA filtration is used for the AHU's the final filtration. Also in table 4 is the various air capacity allowances to each space type in the building.

Table 2: Interior Design Temperatures

| Temperature                      |             |                  |
|----------------------------------|-------------|------------------|
|                                  | Winter (°F) | Summer (°F)      |
| Offices/Conference Rooms/Lobbies | 72          | 75               |
| Laboratories                     | 72          | 75               |
| General spaces                   | 72          | 75               |
| Vivarium                         | 72          | 68-75(ADJ)       |
| Shell/Mech/ Elec. Spaces         | 60          | Ventilation Only |
| Loading Dock                     | 60          | Ventilation Only |

Table 3: Interior Design Humidity

| HUMIDITY       |              |              |
|----------------|--------------|--------------|
|                | Winter (%RH) | Summer (%RH) |
| Offices        | 25% (±5)     | 50 (+/-5)    |
| Laboratories   | 25% (±5)     | 50 (+/-5)    |
| General Spaces | 25% (±5)     | 50 (+/-5)    |
| Vivarium       | 25-40%(+/-5) | 50 (+/-5)    |

Table 4: Interior Design Air Capacity Allowances

|              | Air capacity Allowance |
|--------------|------------------------|
| Laboratories | 2.0 CFM/SF             |
| Vivarium     | 2.5 CFM/SF             |
| Chemistry    | 3.25 CFM/SF            |
| Office       | 1.25 CFM/SF            |

## Ventilation

In Appendix A, a spreadsheet for the 5 air-handling units results for minimum outdoor air intake using the calculations for ASHRAE Standard 62.1-2010 Section 6 for ventilation. Air handling units one through four are modeled as one unit in the spreadsheet due to the ganged duct design. Air handling unit 5 is modeled on its own since it only serves the vivarium on floor 12. A summary of what was found can be found in table 5 below.

Table 5: ASHRAE 62.1 Ventilation Compliance Summary

| ASHRAE 62.1 Ventilation Compliance Summary |          |               |            |                   |                        |         |
|--|----------|---------------|------------|-------------------|------------------------|---------|
| Air Handling Unit                          | Location | Floors Served | Design CFM | Design Min OA CFM | ASHRAE 62.1 Min OA CFM | Comply? |
| 1,2,3,4                                    | M2&M3    | M2&M3         | 460,000    | 460,000           | 74,213                 | Y       |
| 5  | M1       | 12            | 60,000     | 60,000            | 3,191                  | Y       |

As seen by table 5, 75 Ames Street is designed as a 100% outside air and completely complies with ASHRAE 62.1 Ventilation requirements. This is due to the fact that the ganged duct serves both laboratories and administration spaces, and each requiring different levels of ventilation. If it was ever desired to change this setup and design a return air system the following ventilation rates in Table 6 would be used.

**Table 6: Interior Design Ventilation Rates**

| Ventilation Rates                         |   |
|---|---|
| Space                                     | Ventilation   |
| Laboratories                              | 100% outside air, 6 -12 ACH (Occupied), reduced ACH during unoccupied |
| Tissue Culture Rooms                      | 100% outside air, 8-15 ACH  |
| Office Areas                              | 20 cfm/occupant minimum   |
| Auditorium/Seminar/Conference/Classrooms  | 15 cfm/occupant minimum   |
| Cage wash/Glass wash/Bottle wash          | 100% outside air, 15 – 20 ACH   |
| Equipment/Instrument Rooms                | 100% outside air, 10-20 ACH   |
| Animal Rooms                              | 100% outside air  |
| Animal Imaging Rooms                      | 20 cfm/person   |
| Toilets/Janitor Closets/Darkrooms/Lockers | 100% outside air  |
| Mechanical Spaces                         | 100% outside air (heated and ventilated)                              |

## Heating and Cooling Loads

Heating and cooling loads for 75 Ames Street was found using by taking each rooms design conditions, and construction and putting them in TRANE TRACE software. Below describes the heating and cooling system, and their size. Table 7 also provides a detailed summary of the cooling and heating load calculations from trace and compares them to the loads calculated in Equest by the mechanical engineers at BR+A . 75 Ames is going to primarily have a heating load due to Cambridge Massachusetts being a colder environment.

### Heating

The heating of 75 Ames is handled with three 500 Bhp gas fired hot water boilers on the upper mechanical penthouse level with one of the three functioning as stand-by. The hot water pumping system utilizes variable speed drives and shunt pumps for boilers to maintain minimum flow.



## Cooling

The cooling load is handled with three 1000-ton electrical centrifugal chillers to support chilled water system and then two 400-ton electrical centrifugal chillers to support the process chilled water system. These are all located on the upper mechanical penthouse level. These chillers each have a corresponding induced draft-cooling tower on the roof. A plate and frame heat exchanger is to be utilized in the winter to provide support to the processed chilled loads.

Table 7: Heating and Cooling Loads

|                     | AHU     | Area    | Supply Air Per Unit Area (CFM/SF) |         | TOTAL CFM |         | Capacity Per Area |                   | Total          |                |
|---------------------|---------|---------|-----------------------------------|---------|-----------|---------|-------------------|-------------------|----------------|----------------|
|                     |         |         | Cooling                           | Heating | Cooling   | Heating | Heating (Btuh/sf) | Cooling (tons/SF) | Heating (Btuh) | Cooling (Tons) |
| Calculated          | 1-2-3-4 | 244,902 | 1.608                             | 0.4217  | 393,868   | 103,283 | 15.86             | .0095             | 388,300        | 2,325.4        |
|                     | 5       | 20,817  | 1.57                              | 0.538   | 32,716    | 11,199  | 18.379            | .0098             | 382,600        | 204.7          |
| From Engineers BR+A |         |         |                                   |         | 458,821   | 359,690 |                   |                   | 27,970 MBTU/yr | 3,125          |

## Annual Energy Consumption & Cost Information

Below in Table 8 is the estimated annual energy consumption for 75 Ames Street this project is still under construction so no measured data is available. The engineers at Bard, Rao and Athanas came up with a comprehensive Equest energy model that provides the most insight into building performance against a base line designed building created in accordance with ASHRAE 90.1 minimum standards. The Equest model can be compared against another energy performance model designed in Trane Trace.

Table 8: Building Energy Costs

|             | Electricity (kWh) | Natural Gas (Therms) | Electricity Cost Per year | Natural Gas Cost per year | Total Cost Per Year |
|-------------|-------------------|----------------------|---------------------------|---------------------------|---------------------|
| Trace       | 9,985,524.00      | 107,047.00           | \$2,007,090.32            | \$170,954.06              | \$2,178,044.38      |
| BR+A        | 8,973,000.00      | 348,500.00           | \$1,803,573.00            | \$556,554.50              | \$2,360,127.50      |
| ASHRAE 90.1 | 11,490,000.00     | 421,600.00           | \$2,309,490.00            | \$673,295.20              | \$2,982,785.20      |

From Table 8 it can be seen that 75 Ames Street will perform around 20% better than the baseline ASHRAE 90.1 model. In comparing the two energy models electrical use seems to agree but natural gas usage differs by more than half which is a concern and the Trace Model shall be troubleshot to find the variable causing this difference.

## Mechanical Operation and Schematics

In this section of the report is a summary of mechanical equipment and single line drawings explaining system operations. There is also a discussion about the lost useable spaces due to duct chutes, and mechanical spaces and a discussion on the total first cost of the all the mechanical equipment used in the 75 Ames Project.

### Major Equipment

#### Airside

Below are two tables (table 9 and table 10) and two schematics (Figure 6 and figure 7) describing the airside system for supply and exhaust air. Air handling units 1-4 and exhaust units 1-2 provide ventilation and air conditioning to the basement through to level 11. These spaces include labs, offices and administration, and retail restaurant tenant on the first floor.

#### Supply

Air handlers are equipped with variable frequency drives and flow measuring stations to ensure the correct supply to each space. Figure 6 shows the typical flow of air from the air handling units to a space. Air handlers 1 through 4 each have a total of 115,000 CFM supply and are located on mechanical level 1 below the vivarium on level 12. 100% outside air is taken from louvers on the side of the building on level M1, to the air handlers. The air handlers are equipped with snow melt coils, cooling coils, hot water preheat/heat recovery coils, a humidifier, fans and filters. From here, since these four air handlers are ganged together by the duct system, the total supply to the building from the basement to floor 11 is 460,000 CFM. And the vivarium on floor 12 is served entirely by air handling unit 5 with 60,000CFM. These air-handling units are then ducted to various variable volume and constant volume terminal boxes to supply each space.

Table 9: Air Handling Units

| Air Handling Units |          |         |          |      |        |         |       |         |       |
|--------------------|----------|---------|----------|------|--------|---------|-------|---------|-------|
| AHU                | Location | CFM     | Fans     |      |        | Cooling |       | Heating |       |
|                    |          |         | Quantity | RPM  | Min SP | MBH     | LDB F | MBH     | LDB F |
| 1                  | M1       | 115,000 | 4        | 1750 | 7.5    | 6650    | 51.6  | 6650    | 52    |
| 2                  | M1       | 115,000 | 4        | 1750 | 7.5    | 6650    | 51.6  | 6650    | 52    |
| 3                  | M1       | 115,000 | 4        | 1750 | 7.5    | 6650    | 51.6  | 6650    | 52    |
| 4                  | M1       | 115,000 | 4        | 1750 | 7.5    | 6650    | 51.6  | 6650    | 52    |
| 5                  | M2       | 60,000  | 4        | 1750 | 7.5    | 3370    | 49.5  | 3370    | 52    |

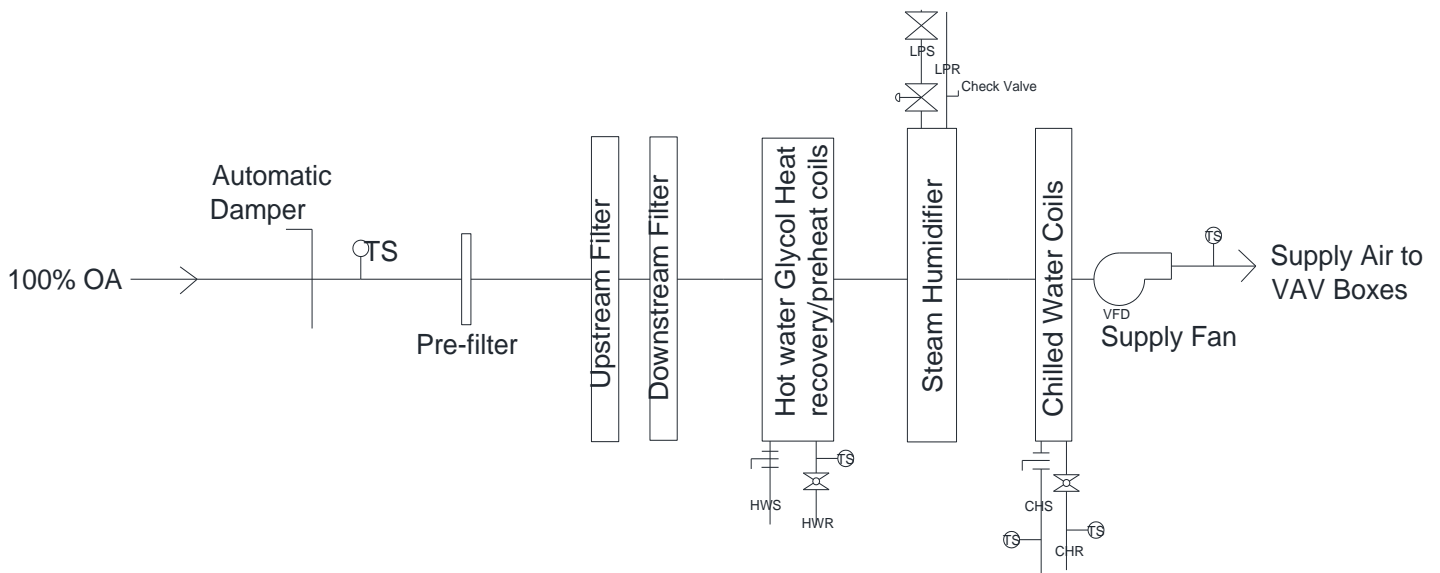


Figure 6: Typical air handling unit flow diagram

### Exhaust

The Exhaust system shall also be designed in a ganged design, same as the air-handling units. Exhaust units include a coil-to-coil heat recovery system, variable frequency drives, filters and fans. The exhaust units are located on the roof and discharge at a safe distance above the roof to minimize recirculation. The exhaust ducts use variable volume return boxes at the room level then rise up to the roof exhaust units for general exhaust. Dedicated exhausts are used in places where processes generate an airstreams incompatible with the ganged exhaust for example, radioactive hood or wet exhaust systems.

Table 10: Exhaust Air Handling Units

| Exhaust Handling Units |          |        |          |      |        |                  |
|------------------------|----------|--------|----------|------|--------|------------------|
| EAHU                   | Location | CFM    | Fans     |      |        | Heating Recovery |
|                        |          |        | Quantity | RPM  | Min SP | Capacity MBH     |
| 1                      | Roof     | 23000  | 5        | 770  | 5.3    | 7600             |
| 2                      | Roof     | 23000  | 5        | 770  | 5.3    | 7600             |
| 3                      | M3       | 60,000 | 3        | 1132 | 4.5    | 1620             |

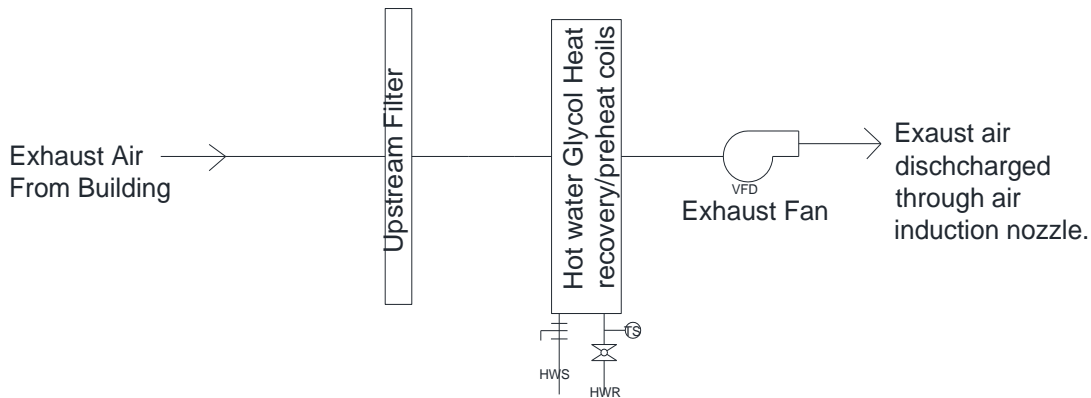


Figure 7: Typical exhaust air handling unit flow diagram

## Water Side

### Chilled Water

The chilled water system for 75 Ames Street is composed of 3 1000-ton centrifugal electric water chillers with one being on standby and 2 450-ton centrifugal electric water chillers with one being standby. The 1000-ton chillers in parallel serve air handlers 1 through 4 and the 450-ton chiller serves chilled water to air handling unit 5.

Each chiller has corresponding chilled water pumps and condenser water pumps shown in table 12. Each chilled water pump is on a variable frequency drive. The flow through the chiller depends on the load demanded by the air-handling units. Water enters the evaporator

at 56 °F, this is measured by a temperature sensor before entering. The water leaves the evaporator at 42°F and again the pressure and temperature are measured. Before heading to the cooling coils in the air-handling units the chilled water passes a minimum flow bypass assembly to insure that the minimum flow is supplied to each chiller.

The condenser pumps, seen in table 12, each pump the condenser water to the condenser. For chillers 1 through 3 the condenser water is then pumped to cooling towers 1 through 3, which are connected in parallel. A plate and frame heat exchanger is used with chillers 4 and 5 between condenser water return water and process chilled water return.

A flow diagram is provided below in figure 8 to show this process in more detail.

Table 11: Centrifugal Chillers

| Centrifugal Chiller |          |                  |            |        |           |      |
|---------------------|----------|------------------|------------|--------|-----------|------|
| Unit Number         | Nom tons | Electrical Volts | Evaporator |        | Condenser |      |
|                     |          |                  | LWT(F)     | GPM    | LWT(F)    | GPM  |
| CH-1                | 1,000    | 460              | 42         | 1712.3 | 94.37     | 3000 |
| CH-2                | 1,000    | 460              | 42         | 1712.3 | 94.37     | 3000 |
| CH-3                | 1,000    | 460              | 42         | 1712.3 | 94.37     | 3000 |
| CH-4                | 450      | 460              | 42         | 770    | 94.37     | 1350 |
| CH-5                | 450      | 460              | 42         | 770    | 94.37     | 1350 |

Table 12: Chilled Water and Condenser Water Pumps

| Chilled and Condenser Water Pumps |          |                         |            |        |                      |      |
|-----------------------------------|----------|-------------------------|------------|--------|----------------------|------|
| Unit Number                       | Location | Service                 | Type       | GPM    | TOTAL HEAD (FT, H2O) | VFD? |
| CHP-1                             | M2       | CHILLED WATER           | SPLIT CASE | 1712.3 | 100                  | Y    |
| CHP-2                             | M2       | CHILLED WATER           | SPLIT CASE | 1712.3 | 100                  | Y    |
| CHP-3                             | M2       | CHILLED WATER           | SPLIT CASE | 1712.3 | 100                  | Y    |
| CHP-4 (STAND-BY)                  | M2       | CHILLED WATER           | SPLIT CASE | 1712.3 | 100                  | Y    |
| CHP-5                             | M2       | PROCESSED CHILLED WATER | SPLIT CASE | 770    | 100                  | Y    |
| CHP-6                             | M2       | PROCESSED CHILLED WATER | SPLIT CASE | 770    | 100                  | Y    |
| CHP-7 (STAND-BY)                  | M2       | PROCESSED CHILLED WATER | SPLIT CASE | 770    | 100                  | Y    |
| CWP-1                             | M2       | CONDENSER WATER         | SPLIT CASE | 3000   | 75                   | N    |
| CWP-2                             | M2       | CONDENSER WATER         | SPLIT CASE | 3000   | 75                   | N    |
| CWP-3                             | M2       | CONDENSER WATER         | SPLIT CASE | 3000   | 75                   | N    |
| CWP-4 (STAND- BY)                 | M2       | CONDENSER WATER         | SPLIT CASE | 3000   | 75                   | N    |
| CWP-5                             | M2       | CONDENSER WATER         | SPLIT CASE | 1350   | 75                   | N    |

|                         |    |                 |            |      |    |   |
|-------------------------|----|-----------------|------------|------|----|---|
| <b>CWP-6</b>            | M2 | CONDENSER WATER | SPLIT CASE | 1350 | 75 | N |
| <b>CWP-7 (STAND-BY)</b> | M2 | CONDENSER WATER | SPLIT CASE | 1350 | 75 | N |

Table 13: Plate and Frame Heat Exchanger

| Plate and Frame Heat Exchanger |          |              |                    |         |                      |         |
|--------------------------------|----------|--------------|--------------------|---------|----------------------|---------|
| Unit                           | Location | Service      | Chilled Water Side |         | Condenser Water Side |         |
|                                |          |              | EWT (F)            | LWT (F) | EWT (F)              | LWT (F) |
| <b>HEX-1</b>                   | M2       | FREE COOLING | 56                 | 42      | 54                   | 48      |

Table 14: Cooling Towers

| Cooling Towers |           |     |     |      |      |      |
|----------------|-----------|-----|-----|------|------|------|
| Unit Number    | Nom. Tons | EWT | LWT | GPM  | Size |      |
|                |           |     |     |      | L    | H    |
| <b>CT-1</b>    | 1000      | 95  | 85  | 3000 | 22   | 14   |
| <b>CT-2</b>    | 1000      | 95  | 85  | 3000 | 22   | 14   |
| <b>CT-3</b>    | 1000      | 95  | 85  | 3000 | 22   | 14   |
| <b>CT-4</b>    | 450       | 95  | 85  | 1350 | 21   | 11.9 |
| <b>CT-5</b>    | 450       | 95  | 85  | 1350 | 21   | 11.9 |

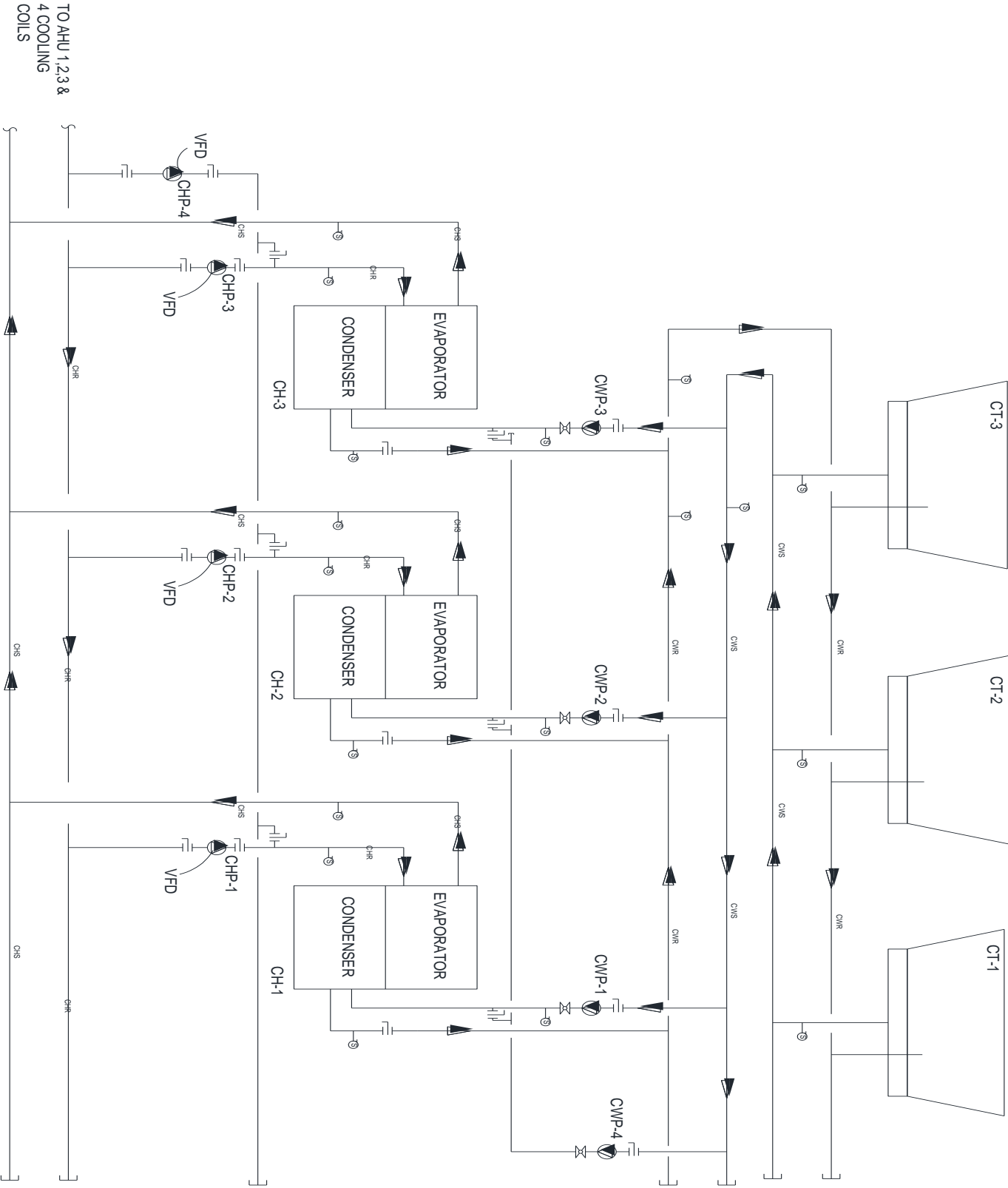


Figure 8: CHILLER 1, 2, & 3 FLOW DIAGRAM

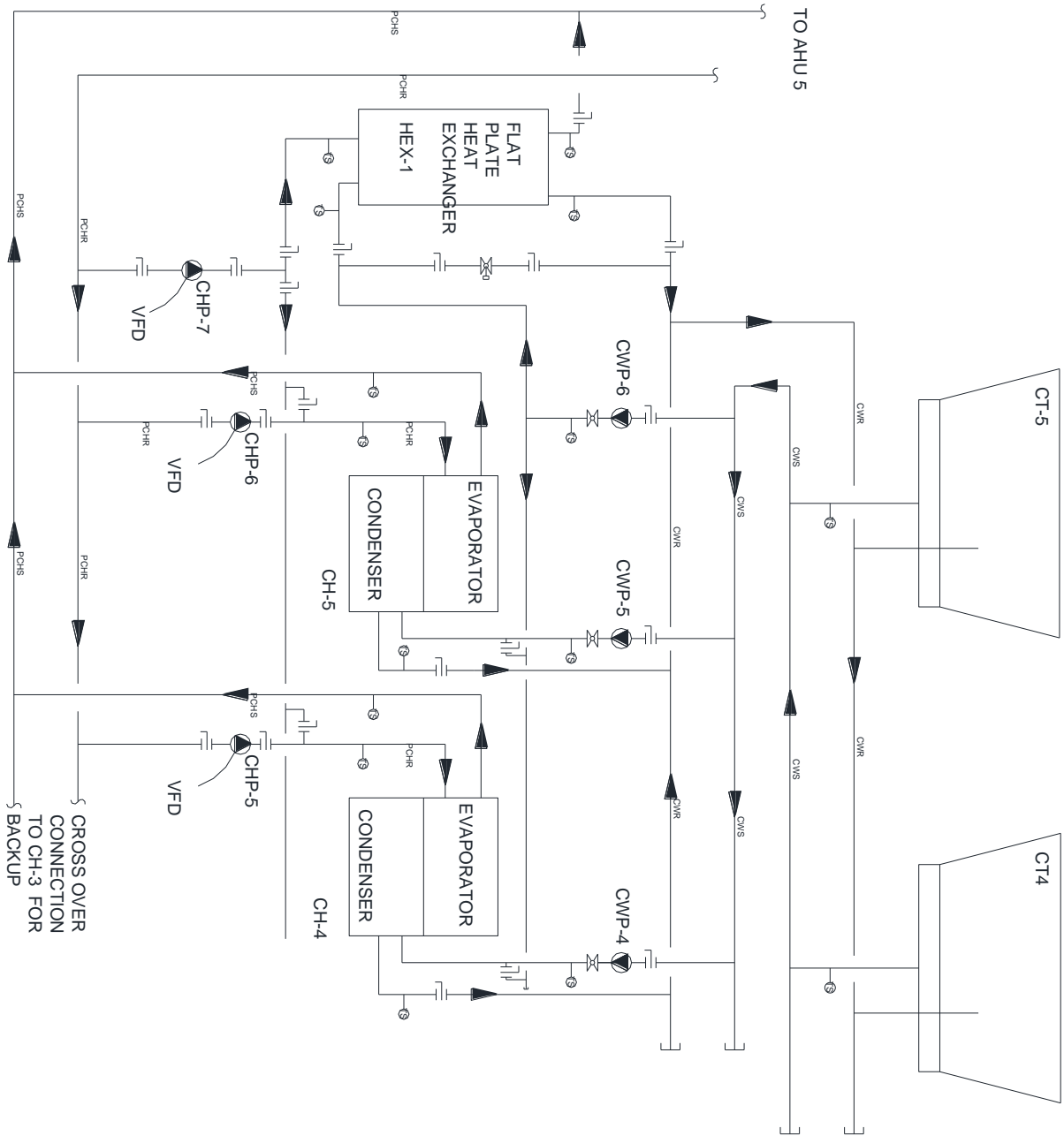


Figure 9: CHILLER 4 & 5 FLOW DIAGRAM



### Hot Water

The hot water system is located on level M2. Two 500 BHP fire tube boilers (table 15) are used in parallel for preheat or heat recovery of each air handling unit and heating and ventilating units in the mechanical penthouses. Four 116 BHP hot water condensing boilers (table 16) are used for reheat to supply the building terminal reheat.

For the hot water preheat boilers three pumps in parallel on variable frequency drives are used. Two shunt pumps are also used for each boiler to maintain a minimum flow. Temperature and pressure are measured before entering the boiler then leaving the boiler the hot water supply passes pressurized differential bypass sized for 25% of total flow. After passing this the hot water supply is taken to the heating and ventilating units, and air-handling units alighted in parallel. The temperature and pressure is again taken before reaching the units. The hot water return then passes an air eliminator before reaching the hot water boiler pumps once again.

The four hot water condensing boilers located in the mechanical room are arranged in parallel. Two hot water pumps on variable frequency drives are used to pull the hot water supply through an air eliminator through to the building terminal reheat loads. A 4" pressure differential bypass sized for 25% of the total flow.

Figure 10&11 gives a visual representation for the hot water preheat flow and hot water reheat flow discussed in the paragraphs above.

Table 15: Hot Water Boilers

| Hot Water Boiler |         |        |       |     |              |           |
|------------------|---------|--------|-------|-----|--------------|-----------|
| Unit Number      | Service | Output |       |     | Input        |           |
|                  |         | HP     | MBH   | LWT | Primary Fuel | Secondary |
| B-1              | PREHEAT | 500    | 16738 | 180 | NAT. GAS     | #2 OIL    |
| B-2              | PREHEAT | 500    | 16738 | 180 | NAT. GAS     | #2 OIL    |

Table 16: Hot water Condensing Boilers

| Hot Water Condensing Boiler |         |        |       |     |              |           |
|-----------------------------|---------|--------|-------|-----|--------------|-----------|
| Unit Number                 | Service | Output |       |     | Input        |           |
|                             |         | HP     | MBH   | LWT | Primary Fuel | Secondary |
| B-3                         | RE-HEAT | 116    | 3,880 | 140 | NAT. GAS     | #2 OIL    |
| B-4                         | RE-HEAT | 116    | 3,880 | 140 | NAT. GAS     | #2 OIL    |
| B-5                         | RE-HEAT | 116    | 3,880 | 140 | NAT. GAS     | #2 OIL    |
| B-6                         | RE-HEAT | 116    | 3,880 | 140 | NAT. GAS     | #2 OIL    |

Table 17: Hot water Pumps

| Hot Water Pumps     |          |                            |                |     |                       |      |
|---------------------|----------|----------------------------|----------------|-----|-----------------------|------|
| UNIT                | LOCATION | SERVICE                    | TYPE           | GPM | TOTAL HEAD<br>FT, H2O | VFD? |
| HWP-1               | M2       | HOT WATER<br>(BOILER)      | END<br>SUCTION | 850 | 50                    | Y    |
| HWP-2               | M2       | HOT WATER<br>(BOILER)      | END<br>SUCTION | 850 | 50                    | Y    |
| HWP-3<br>(STAND-BY) | M2       | HOT WATER<br>(BOILER)      | END<br>SUCTION | 850 | 50                    | Y    |
| HWP-4               | M2       | HOT WATER<br>(RE-HEAT-RAD) | SPLIT<br>CASE  | 975 | 50                    | Y    |
| HWP-5<br>(STAND-BY) | M2       | HOT WATER<br>(RE-HEAT-RAD) | SPLIT<br>CASE  | 975 | 50                    | Y    |
| HWP-6 A&B           | M2       | HW B-2<br>SHUNT PUMPS      | IN-LINE        | 135 | -                     | N    |
| HWP-7 A&B           | M2       | HW B-1<br>SHUNT PUMPS      | IN-LINE        | 135 | -                     | N    |
|                     |          |                            |                |     |                       |      |

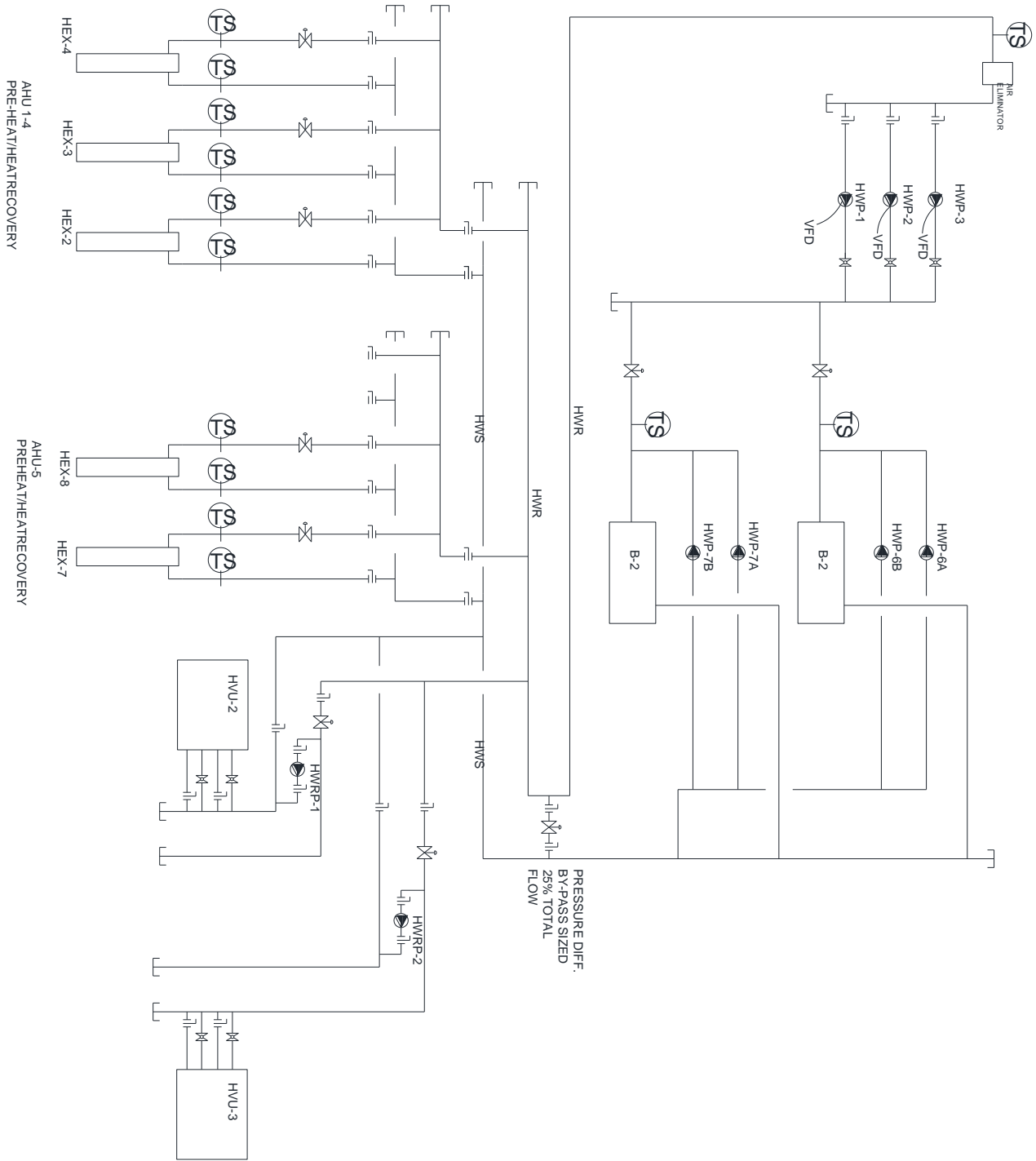


Figure 10: Hot Water Boiler Flow Diagram

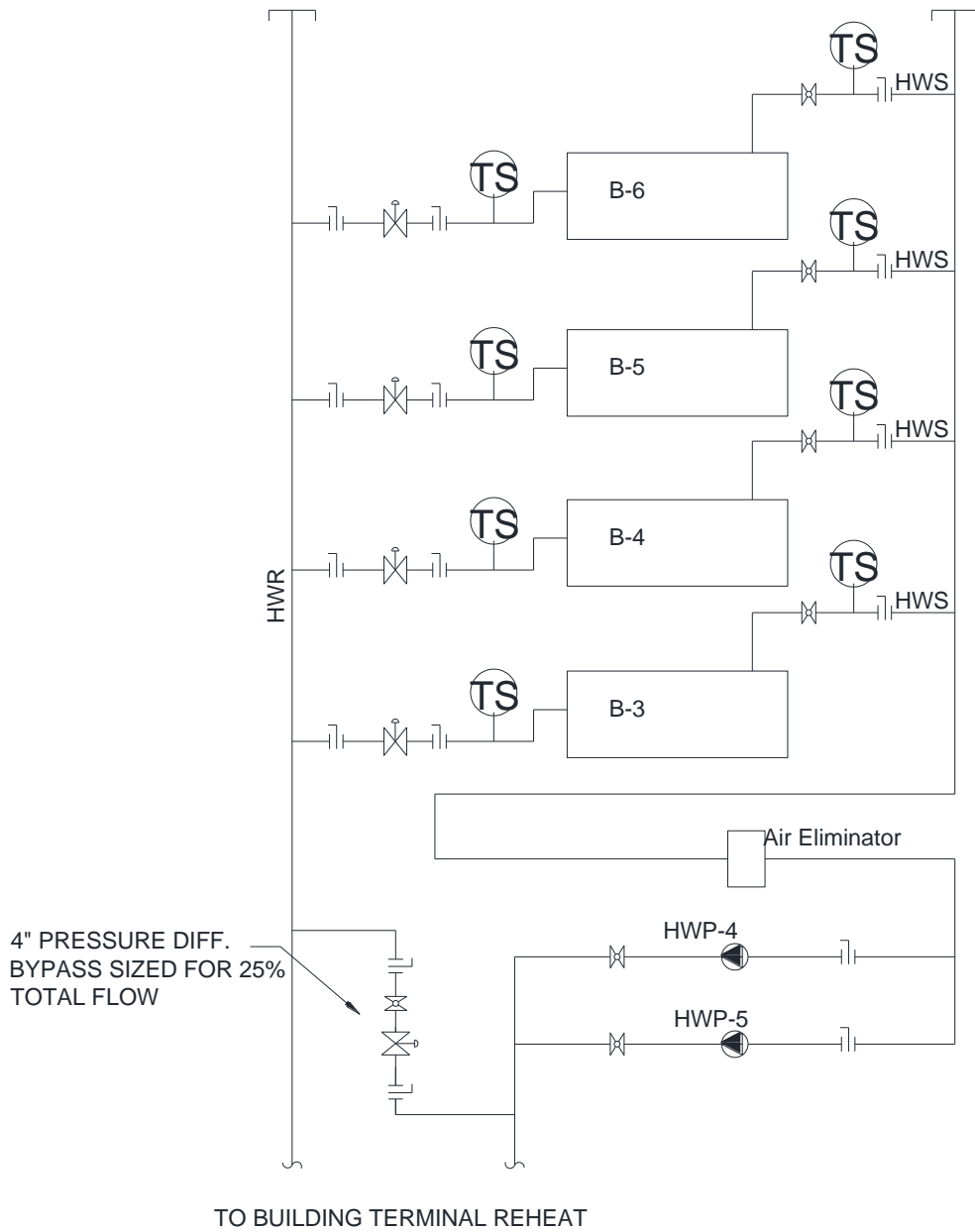


Figure 11: Hot Water Condensing Boiler Flow Diagram

## ASHRAE Standard 62.1

### Section 5: Systems and Equipment

#### 5.1 Ventilation Air Distribution

75 Ames Street is designed to meet the design requirements for ventilation air distribution as required by Section 6 of Standard 62.1. Each lab is split into multiple zones and supplied with supply air valves using hot water reheat coils. A separate variable or constant volume box supplies each non-lab zone with hot water heating coils sized to handle the heating load and minimum airflow rates.

#### 5.2 Exhaust Duct Location

All ganged general exhaust is discharged at a safe distance above the roof to minimize recirculation. This is done with two 230,000 CFM exhaust air handling units located on the roof serving floors 0-11 and a 60,000 CFM EAHU serving the vivarium on floor 12. A CFM offset is maintained to keep office zones positively pressurized with respect to adjacent lab areas. Exhaust ducts are held at minimum SMACNA pressure class of 8" H<sub>2</sub>O.

#### 5.3 Ventilation System Controls

A complete digital control system is utilized this allows shall be capable of operating at occupied and unoccupied mode of operation on a per-zone basis. All variable air volume boxes are based on an occupancy schedule with a supply damper modulating between flow rates in order to comply with Standard 62.1.

#### 5.4 Airstream Surfaces

All ductwork is constructed of galvanized sheet steel in accordance with (SMACNA). Therefore 75 Ames Street falls under the exception of sheet metal surfaces and metal fasteners.

### 5.5 Outdoor Air Intakes

Outdoor air intakes for AHU’s 1-5 are located inside on floors M1, M2, and M3 and designed in accordance with table 5-1 from ASHRAE 62.1 Section 5.5. All intakes are over 30’ from exhaust stacks.

**TABLE 5-1 Air Intake Minimum Separation Distance**

| Object  | Minimum Distance, ft (m) |
|---|--------------------------|
| Class 2 air exhaust/relief outlet (Note 1)  | 10 (3)                   |
| Class 3 air exhaust/relief outlet (Note 1)  | 15 (5)                   |
| Class 4 air exhaust/relief outlet (Note 2)  | 30 (10)                  |
| Plumbing vents terminating less than 3 ft (1 m) above the level of the outdoor air intake | 10 (3)                   |
| Plumbing vents terminating at least 3 ft (1 m) above the level of the outdoor air intake  | 3 (1)                    |
| Vents, chimneys, and flues from combustion appliances and equipment (Note 3)              | 15 (5)                   |
| Garage entry, automobile loading area, or drive-in queue (Note 4)                         | 15 (5)                   |
| Truck loading area or dock, bus parking/idling area (Note 4)                              | 25 (7.5)                 |
| Driveway, street, or parking place (Note 4)   | 5 (1.5)                  |
| Thoroughfare with high traffic volume   | 25 (7.5)                 |
| Roof, landscaped grade, or other surface directly below intake (Notes 5 and 6)            | 1 (0.30)                 |
| Garbage storage/pick-up area, dumpsters   | 15 (5)                   |
| Cooling tower intake or basin   | 15 (5)                   |
| Cooling tower exhaust   | 25 (7.5)                 |

Note 1: This requirements applies to the distance from the outdoor air intakes for one ventilation system to the exhaust/relief outlets for any other ventilation system.  
 Note 2: Minimum distance listed does not apply to laboratory fume hood exhaust air outlets. Separation criteria for fume hood exhaust shall be in compliance with NFPA 45<sup>5</sup> and ANSI/AIHA Z9.5.<sup>6</sup> Information on separation criteria for industrial environments can be found in the *ACGIH Industrial Ventilation Manual*<sup>7</sup> and in the *ASHRAE Handbook—HVAC Applications*.<sup>8</sup>  
 Note 3: Shorter separation distances shall be permitted when determined in accordance with (a) ANSI Z223.1/NFPA 54<sup>9</sup> for fuel gas burning appliances and equipment, (b) NFPA 31<sup>10</sup> for oil burning appliances and equipment, or (c) NFPA 211<sup>11</sup> for other combustion appliances and equipment.  
 Note 4: Distance measured to closest place that vehicle exhaust is likely to be located.  
 Note 5: Shorter separation distance shall be permitted where outdoor surfaces are sloped more than 45 degrees from horizontal or that are less than 1 in. (3 cm) wide.  
 Note 6: Where snow accumulation is expected, the surface of the snow at the expected average snow depth constitutes the “other surface directly below intake.”

**Figure 12: TABLE 5-1 ASHRAE Standard 62.1 Section 5**

Louvers located on floors M1, M2, and M3 open to an air plenums which serve each outdoor air intakes. These louvers (figure 13 below) contain welded mesh to prevent rain, snow and bird intrusion. The interior of the plenum has a 15 degree pitch to drain any possible water intrusion. This set up allows for 75 Ames to meet the requirements set by section 5.5.2, 5.5.2, and 5.5.3.

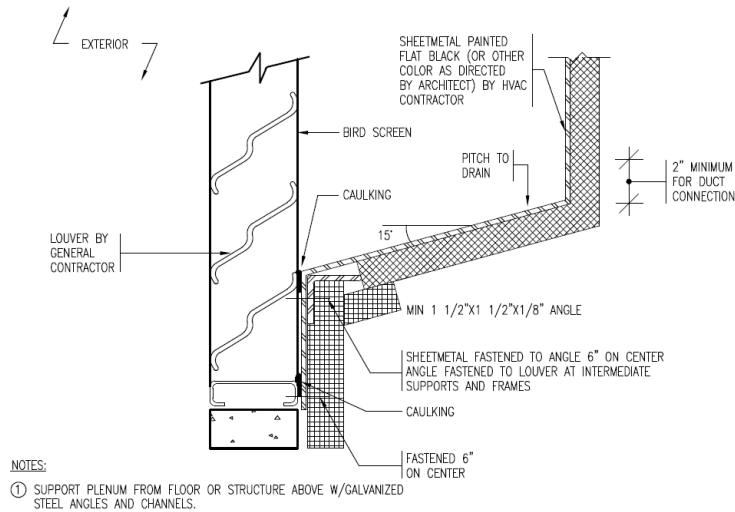


Figure 13: Louvers Supplying Outside Air To AHU's (courtesy BR+A)

### 5.6 Local Capture of Contaminants

Discharge of non-combustion equipment that captures the contaminants generated by the equipment is ducted directly outdoors per section 5.6.

### 5.7 Combustion Air

All fuel burning appliances are provided with sufficient air for combustion and are vented directly outside of the building in order to comply with Section 5.7. Fuel burning appliances include two hot water boilers, 4 hot water condensing boilers, 2 steam boilers, 2 generators.

### 5.8 Particulate Matter Removal

All air handling units use pre-filter with a MERV 8 rating, a secondary filter with MERV 14 and final filter with MERV 17 rating. Pre-filters with MERV rating of 8 are located upstream of all cooling coils and future installation of snow melt coils.

### 5.9 Dehumidification Systems

75 Ames is set to maintain 25% +/- 5 relative humidity in the winter and 50% +/- 5 in the summer. Standard 5.9 specifies 65% relative humidity or less therefore this requirement is satisfied.

**5.10 Drain Pans**

Drain pans shall provide a 1-1/2" deep stainless steel pan under any units with cooling coils and duct mounted humidifiers located above hung ceilings. Pans shall be 6" larger than equipment in all directions. Drain pans are to be piped to floor drains or utility sinks. Pans shall slope at a minimum of 1/8<sup>th</sup> in. per foot from the horizontal towards the drain outlet. Drain pan outlet(s) is the lowest point(s) of the pan with sufficient size to prevent overflow during normal conditions.

**5.11 Finned Tube Coils and Heat Exchangers**

Drain pans are specified for removal of condensate upstream or downstream of coils per section 5.10. All heat exchangers shall be of single-pass construction with all connections on the fixed frame plate to facilitate cleaning of the unit. An access space of 18 in is not specifically mentioned.

**5.12 Humidification and Water-Spray Systems**

The humidifiers receive steam at low pressure steam and discharge at atmospheric pressure. This steam came from a potable source, the city of Cambridge water supply. All air cleaners or ductwork obstructions are located downstream of the humidifier at a distance equal to or greater than 10 in., the absorption distance.

**5.13 Access for Inspection Cleaning & Maintenance**

Access doors allow access to outdoor intake plenums, mixed air plenums, upstream surface of each heating, cooling, and heat recovery coil as well as air cleaners, drain pans, fans, and humidifiers. Each heating coil in the air terminal boxes will provide an access door on each side, upstream and downstream. Below figure 14 shows a duct access door detail.

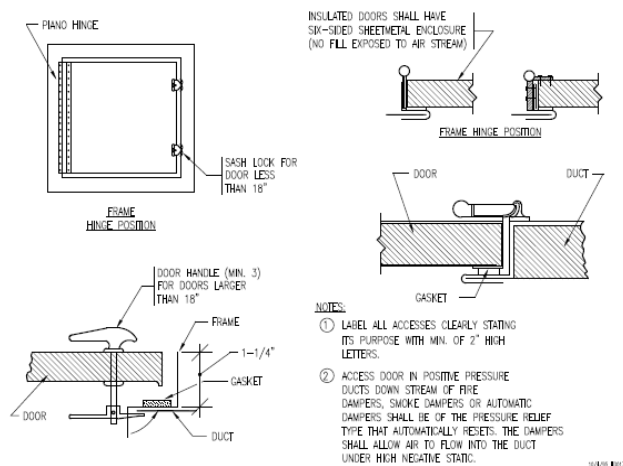


Figure 14: Duct Access Doors Detail (courtesy BR+A)



**5.14 Building Envelope and Interior Surfaces**

The building envelope contains a continuous vapor barrier and penetrations in this envelope are sealed to limit infiltration. Below Table 18 shows the various insulated piping, ductwork and equipment to comply with condensation on interior surfaces.

Table 18: Insulation For Piping Ductwork and Equipment (courtesy BR+A)

| Service   | Type Insulation & Thickness (Inches)             | Concealed Areas   | Finished Areas    |
|---|--|-------------------|-------------------|
| <b>Piping</b>   |  |                   |                   |
| Hot Water<br>Up to 2"<br>2 1/2" and up                              | Molded Fiberglass<br>1 1/2<br>2                  | ASJ<br>"<br>"     | ASJ<br>"<br>"     |
| Chilled Water<br>Up to 12"<br>14" and up                            | Molded Fiberglass<br>1<br>2                      | ASJ<br>ASJ<br>ASJ | ASJ<br>ASJ<br>ASJ |
| LPS Steam<br>Up to 1-1/2"<br>1-1/2" to 6"<br>6" & Up                | Molded Fiberglass<br>1-1/2<br>2<br>3-1/2         |                   |                   |
| Condensation Drains & Vents, Cold Water Make-Up                     | Molded Fiberglass<br>1                           | ASJ               |                   |
| Blowdowns & Condensate (All Pressures)<br>1/2" to 2"<br>2-1/2" & Up | Molded Fiberglass<br>1<br>1-1/2                  | ASJ<br>ASJ        |                   |
| Emergency Generator Exhaust Piping                                  | Hydrous Calcium Silicate<br>3-1/2                | ADJ-6             | ADJ-3b            |
| Piping with Heat Trace  | Molded Fiberglass<br>3"                          | ASJ               | ADJ-3b            |
| All Outdoor Piping  | Two times thickness scheduled except heat traced |                   | ADJ-3b            |
| All Pipe within Equipment Room with Chillers or Boiler Plant        | As Scheduled                                     |                   | ADJ-5             |

| Service  | Type Insulation & Thickness (Inches)                                     | Concealed Areas | Finished Areas               |
|--|--|-----------------|------------------------------|
| Others not Scheduled   | Molded Fiberglass<br>1   | ASJ             |                              |
| <b>Ductwork</b>  |  |                 |                              |
| All Concealed Supply Air Ductwork                                  | Flexible Fiberglass with Vapor Barrier<br>1                              | ---             | ---                          |
| Outside Air Intake Ducts & Exposed Supply Air Ducts                | Rigid Fiberglass (Flexible)<br>1   | ---             | ---                          |
| All Kitchen Hood Exhaust Ductwork                                  | Super Firetemp Type M System<br>3"                                       |                 |                              |
| Louver Blank-off Panels  | Rigid Fiberglass Board Insulation 3"                                     | FSKL            |                              |
| Outside Ductwork Supply, Exhaust, Return and Other                 | Rigid Fiberglass Board Insulation 2 times scheduled but not less than 2" | FSKL            | EPDM Roofing                 |
| <b>Equipment</b>   |  |                 |                              |
| Hot Water, Glycol, Expansion, Compression Tanks and Air Separators | Calcium Silicate Block 1   | ---             | Finishing Cement & Porterlag |
| Condensate Tanks   | Calcium Silicate Block 3   | ADJ-6           |                              |
| Hot Water Pumps  | Fiberglass 3   |                 | Same as piping               |
| Emergency Generator Exhaust  | Calcium Silicate Block 3   |                 | ADJ-3b                       |
| Emergency Generator Mufflers                                       | Calcium Silicate Block 3   | ---             | Finishing Cement & Porterlag |
| Breeching  | Calcium Silicate Block 3   |                 | ADJ-3b                       |
| Humidifier Steam Kettles, Deaerator Tank, Blowdown                 | Calcium Silicate Block 3   |                 | ADJ-6                        |

| Service                   | Type Insulation & Thickness (Inches) | Concealed Areas | Finished Areas                   |
|---------------------------|--------------------------------------|-----------------|----------------------------------|
| Tanks, Boiler Feed System |                                      |                 |                                  |
| Tanks                     | Calcium Silicate Block 3             |                 | ADJ-6                            |
| Boiler Feed System        | Calcium Silicate Block 3             |                 | ADJ-6                            |
| Blowdown Tanks            | Calcium Silicate Block 3             |                 | ADJ-6                            |
| Blowdown Separator        | Calcium Silicate Block 3             |                 | ADJ-6                            |
| Chilled Water Pumps       | Insulcote or Armaflex 2              | ---             | Formed Covers w/Velcro Fastening |

**5.15 Buildings with Attached Parking Garages.**

The basement through level 5 has an attached garage. The building is positively pressured when compared to the parking garage and a vestibule located on the ground floor is used to separate the garage from 75 Ames.

**5.16 Air Classification and Recirculation.**

Most zones are exhausted through two 230,000 CFM EAHU on the roof or directly exhausted through exhaust fans located on the roof with no recirculation. The only return air in the system is 16,000 CFM from the 7 Cambridge Center to 75 Ames street connector on floor two through seven that supply return air to level M1. The vivarium on floor 12 has its own dedicated exhaust air handing unit.

**5.17 Requirements for Buildings Containing ETS Areas and ETS-Free Areas.**

75 Ames St. is a non-smoking facility; therefore this section is not applicable.

## Section 6: Ventilation Rate Procedure Analysis

To verify compliance with ASHRAE Standard 62.1 Section 6 Ventilation Air Rate Procedure, all 5 AHU's were analyzed. All ducting is designed in a loop fashion allowing connections to multiple air handing units. This was chosen for flexibility of future designs as-well as ensuring the labs achieve appropriate ventilation levels needed. Below table 19 shows all 5 AHU's and the supplied air to each floor. Each AHU is 100% outside air due to the loop duct design and labs demanding 100% outside air. Below (table 19) is a helpful table of the airflow to each floor from each air handing unit to the main rings on each floor.

| Level               | AHU 1 (CFM) | AHU 2 (CFM) | AHU 3 (CFM) | AHU 4 (CFM) | AHU 5 (CFM) |
|---------------------|-------------|-------------|-------------|-------------|-------------|
| Level 12 (Vivarium) | 0           | 0           | 0           | 0           | 60,000      |
| Level 11            | 0           | 23,500      | 23,500      | 0           | 0           |
| Level 10            | 7,000       | 18,000      | 18,000      | 4,000       | 0           |
| Level 9             | 7,000       | 18,000      | 18,000      | 4,000       | 0           |
| Level 8             | 7,000       | 18,000      | 18,000      | 4,000       | 0           |
| Level 7             | 7,000       | 18,000      | 18,000      | 4,000       | 0           |
| Level 6             | 7,000       | 1,950       | 1,950       | 4,000       | 0           |
| Level 5             | 20,000      | 0           | 0           | 16,000      | 0           |
| Level 4             | 20,000      | 0           | 0           | 16,000      | 0           |
| Level 3             | 20,000      | 0           | 0           | 16,000      | 0           |
| Level 2             | 20,000      | 0           | 0           | 16,000      | 0           |
| Level 1             | 0           | 0           | 0           | 21,000      | 0           |
| Basement            | 0           | 0           | 0           | 10,000      | 0           |

Table 19: Air Supplied To Each Floor

To calculate the breathing zone outdoor airflow ( $V_{bz}$ ) the following equation, given by Equation 6-1 in Section 6.2.2.1 of Standard 62.1.

$$V_{bz} = (R_p \cdot P_z) + (R_a \cdot A_z)$$

Where:  $A_z$  = zone floor area: the net occupiable floor area of the ventilation zone ft<sup>2</sup> (m<sup>2</sup>)

$P_z$  = zone population: the number of people in the ventilation zone during typical usage.

$R_p$  = outdoor airflow rate required per person as determined from Table 6-1

$R_a$  = outdoor airflow rate required per unit area as determined from Table 6-1

The zone outdoor airflow ( $V_{oz}$ ) is the air that must be provided to the ventilation zone by the supply air distribution system. This is calculated using Equation 6-2 from Standard 62.1.

$$V_{oz} = V_{bz}/E_z$$

$E_z$  = zone air distribution effectiveness. For 75 Ames was found from table 6-2 to be 1

For 100% outside air system the outdoor air intake is given by Equation 6-4 of Standard 62.1, also shown below.

$$V_{ot} = \sum_{\text{all zones}} V_{oz}$$

$V_{oz}$  = zone outdoor air flow

The primary outdoor air fraction ( $Z_{pz}$ ), the minimum percent of supply air that is outdoor ventilation air, is calculated with the ratio of zone outdoor airflow and zone primary airflow shown in Equation 6.5 from Standard 62.1 below

$$Z_{pz} = V_{oz}/V_{pz}$$

$V_{pz}$  is the primary airflow rate supplied to the zone from an air handling unit where the outdoor intake is located. When used with variable air volume supply this primary airflow rate shall be the lowest expected primary airflow rate to the zone when fully occupied.

## ASHRAE Standard 62.1 Summary

Using the equations given above a spread sheet was used (Appendix A) to calculate the minimum outside air CFM to comply with ASHRAE 62.1. Since Air handling units one, two, three and four are all connected via ducting to one another they were analyzed as one system for the whole building. Air handling unit 5 was analyzed by itself since it only serves the vivarium on the 12<sup>th</sup> floor.

75 Ames Street is in complete compliance with ASHRAE Standard 62.1-2010 shown in table 20 below. This is since all air handling unit's supply 100% outside air. This building was designed to be easily retrofitted so in order to do this easily a ring ducting system was utilized serving all spacing including labs which are designed for 100% outside air. Thus all spaces must use 100% outside air. Future considerations could be to install return air ducting from and to offices and similar areas.

| ASHRAE 62.1 Ventilation Compliance Summary |          |               |            |                   |                        |         |
|--|----------|---------------|------------|-------------------|------------------------|---------|
| Air Handling Unit                          | Location | Floors Served | Design CFM | Design Min OA CFM | ASHRAE 62.1 Min OA CFM | Comply? |
| 1,2,3,4                                    | M2&M3    | 0-11          | 460,000    | 460,000           | 74,213                 | Y       |
| 5  | M1       | 12            | 60,000     | 60,000            | 3,191                  | Y       |

Table 20: Ventilation Compliance Summary

## ASHRAE Standard 90.1

### Section 5 Building Envelope

#### 5.1.4 Climate Zone

75 Ames Street is located in Cambridge Massachusetts, which can be seen in the figure15 below. This location classifies Ames Street as zone 5A a cold, moist climate.

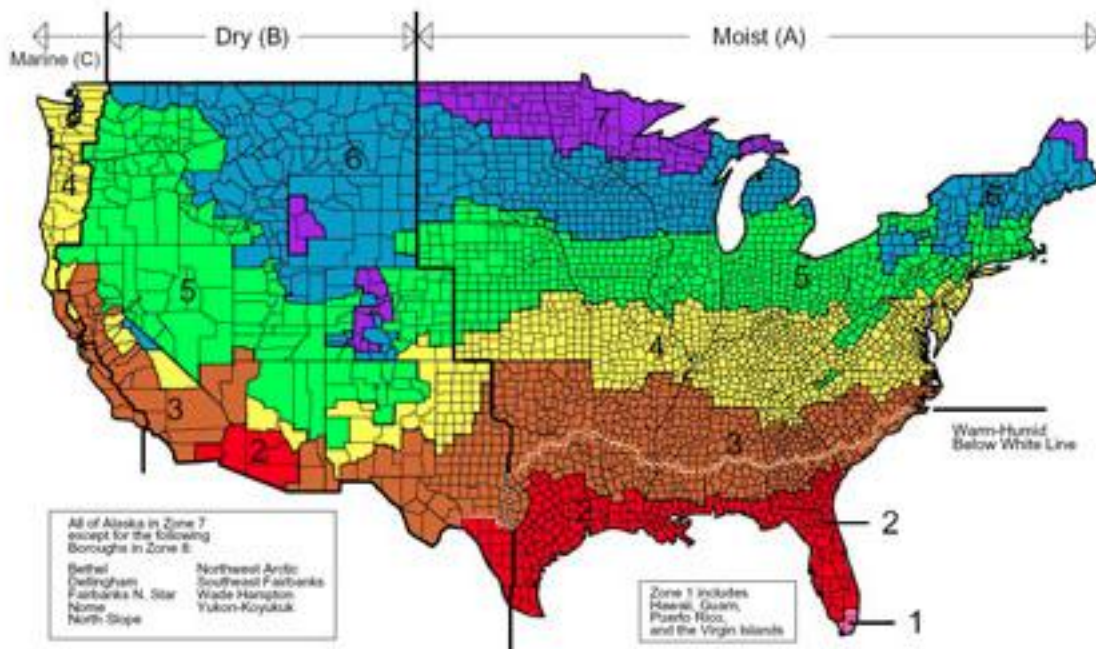


Figure 15 : Climate Zones for the United States (ASHRAE)

#### 5.4 Mandatory Provisions

75 Ames utilizes two vestibules for the main entrances from the attached garage and from the Ames Street side of the building both with self-closing devices attached. The entire building envelope is constructed with a continuous air barrier and any penetration to the exterior envelope to be sealed.

### 5.5 Prescriptive Building Envelope

Compliance was determined for the building envelope required by Standard 90.1 was done using the prescriptive building technique. Below are two tables. Table 21 matches various enclosure materials R, U and SHGC to those for a nonresidential building located in climate zone 5A. Table 22 assures compliance with Section 5.5.4.2.1 Vertical Fenestration Area, which states, “the total vertical fenestration area shall be less than 40% of the gross wall area”.

Table 21: Building Envelope Requirements

| Building Envelope Requirement for Nonresidential 5A       |            |                         |              |             |              |          |         |         |      |
|---|------------|-------------------------|--------------|-------------|--------------|----------|---------|---------|------|
| Element   | R-Value    | Insulation Min. R-value | U-Value      | Max U-Value | SHGC         | Max SHGC | Comply? |         |      |
|   |            |                         |              |             |              |          | U-Value | R-Value | SHGC |
| Roof Metal Deck Roof                                      | R= 20 c.i. | R=20 c.i.               | -            | -           | -            | -        | -       | Y       | -    |
| Walls, Above-Grade, Steel Famed                           | R=12 c.i.  | R-13.0 + R-7.5 c.i.     | -            | -           | -            | -        | -       | Y       | -    |
| Vertical Glazing, Metal framing (curtain wall/storefront) | -          | -                       | 0.29<br>0.26 | 0.50        | 0.38<br>0.40 | 0.40     | Y       | -       | Y    |

Table 22: Vertical Fenestration Area

| Vertical Fenestration Area |                              |                           |                 |          |
|----------------------------|------------------------------|---------------------------|-----------------|----------|
| Face                       | Glazing Area ft <sup>2</sup> | Wall Area ft <sup>2</sup> | Glazing %       | Comply?  |
| North                      | 16870.68                     | 34831.25                  | 48.43547        | -        |
| East                       | 30983.36                     | 51076                     | 60.66129        | -        |
| South                      | 7047.96                      | 40217.035                 | 17.52481        | -        |
| West                       | 13453.72                     | 48093.825                 | 27.9739         | -        |
| <b>Total</b>               | <b>68355.72</b>              | <b>174218.11</b>          | <b>39.23571</b> | <b>Y</b> |

As seen by the tables 75 Ames Street performance complies with or beyond the given prescription for the building envelope insulations and U-values. For fenestration even though some wall areas have over 40% glazing that is made up for by using much less glazing on other wall such as the south and west in order for the whole building enclosure to reach just below the 40% set by Standard 90.1.

## Section 6 Heating, Ventilating and Air Conditioning

### 6.2 Compliance Paths

75 Ames does not meet the height, square footage and HVAC system conditions to use the simplified approach option for HVAC systems. Because of this the Mandatory Provisions and Section 6.5 Prescriptive Path must be used.

### 6.4 Mandatory Provisions

Minimum equipment efficiencies from Tables 6.8.1A-K of ASHRAE 90.1 are met.

A combination digital/electric/electronic temperature control system and building automated system is to be utilized in this building. The system is comprised of digital controllers, electric/electronic control equipment, thermostats, sensors, controllers, valves, dampers, actuators, and other accessory equipment.

Generally only private/enclosed offices shall have open set point adjustments. Because of tampering concerns all other areas shall be sensor only. Room sensors shall have an accuracy of +/-2% at 70 F. The system will have setback controls for times when the building is unoccupied. As well rooms shall be fitted with CO2 occupancy sensors.

### 6.5 Prescriptive Path

All the AHU's that serve 75 Ames are 100% outside air units. Heat recovery is used with between each of the AHU's and EAHU's with a heat exchanger. As can be seen by the table 23, some fans do comply with Section 6.5.3.1.1 on fan power. For the fans which do not comply, this is because 75 Ames can fall under the exception having both laboratory systems and a vivarium that utilizes flow control devices on exhaust and return to maintain space pressure relationships necessary.



Table 23: Fan Power Limitation Compliance

| Fan Power Limitation Compliance |        |      |            |            |         |
|---------------------------------|--------|------|------------|------------|---------|
| Unit                            | CFM    | HP   | CFM*0.0011 | CFM*0.0015 | Comply? |
| AHU-1                           | 115000 | 224  | -          | 172.5      | N       |
| AHU-2                           | 115000 | 224  | -          | 172.5      | N       |
| AHU-3                           | 115000 | 224  | -          | 172.5      | N       |
| AHU-4                           | 115000 | 224  | -          | 172.5      | N       |
| AHU-5                           | 60000  | 112  | -          | 90         | N       |
| EAHU-1                          | 230000 | 320  | -          | 345        | N       |
| EAHU-2                          | 230000 | 320  | -          | 345        | N       |
| EAHU-3                          | 60000  | 80   | -          | 90         | Y       |
| EF-1                            | 20,000 | 6.6  | 22.0000    | -          | Y       |
| EF-2                            | 7,500  | 2.6  | 8.25       | -          | Y       |
| EF-4                            | 6,000  | 2.39 | 6.6        | -          | Y       |
| EF-5                            | 750    | 0.32 | 0.825      | -          | Y       |
| EF-7                            | 2,150  | 1.3  | 2.365      | -          | Y       |
| EF-10                           | 2,500  | 1.6  | 2.75       | -          | Y       |
| EF-11                           | 1,000  | 0.6  | 1.1        | -          | Y       |
| EF-12                           | 1,000  | 0.5  | 1.1        | -          | Y       |
| EF-13                           | 800    | 0.5  | 0.88       | -          | Y       |
| EF-14                           | 1,300  | 0.7  | 1.43       | -          | Y       |
| EF-15                           | 800    | 1.1  | 0.88       | -          | N       |
| EF-16                           | 1,700  | 0.9  | 1.87       | -          | Y       |
| EF-17                           | 800    | 0.4  | 0.88       | -          | Y       |
| EF-18                           | 7,500  | 3.6  | 8.25       | -          | Y       |
| EF-19                           | 1,500  | 1.5  | 1.65       | -          | Y       |

|             |        |      |      |   |          |
|-------------|--------|------|------|---|----------|
| <b>RF-1</b> | 16,000 | 8.7  | 17.6 | - | <b>Y</b> |
| <b>SF-1</b> | 27,000 | 14.6 | 29.7 | - | <b>Y</b> |
| <b>SF-2</b> | 18,000 | 9.0  | 19.8 | - | <b>Y</b> |
| <b>SF-3</b> | 7,500  | 2.8  | 8.25 | - | <b>Y</b> |
| <b>SF-4</b> | 2,500  | 1.0  | 2.75 | - | <b>Y</b> |
| <b>SF-5</b> | 7,000  | 2.6  | 7.7  | - | <b>Y</b> |

### 6.7 Submittals

100% construction drawings were supplied to the Broad Institute. These included locations, performance data, dimensions and general configurations of all HVAC equipment. Brochures shall be submitted that contain only information relative to the particular equipment.

## Section 7 Service Water Heating

### 7.4 Mandatory Provisions

Table 7.8 gives the minimum performance requirements for water heating equipment. The heating for 75 Ames is from two 16738 MBH hot water boilers and four 3880 MBH hot water condensing boilers. All necessary service hot water piping is insulated. The system utilizes service water heating controls for temperature. Sequencing ensures that if one boiler cannot maintain 140 F leaving water temperature then another boiler control valve shall open and its boiler shall be started.

## Section 8 Power

75 Ames Street specifications call for compliance with the National Electric Code (NEC). The National Electric Code specifies a maximum of 3% voltage drop for feeders and maximum of 5% voltage drop for branch circuits. This does not comply with Section 8 of ASHRAE 90.1 which states feeders should have a max voltage drop of 2% and branch circuits 3%.

## Section 9 Lighting

### 9.4 Mandatory provisions

Rooms are equipped with occupancy sensors in the ceilings to control the lighting for occupied/unoccupied times, along with manual controls on the wall.

**9.6 Alternate Compliance Path: Space-by-Space Method.**

Table 9.6.1 Lighting Power Densities Using the Space-by-Space Method was used to determine compliance with ASHRAE 90.1 Section 9. Below in Table 24 one can see a spreadsheet with space types total areas and allowed lighting power densities. The actual data is then compared against the ASHRAE standard. The percent under ASHRAE 90.1 is shown as well. 75 Ames goes beyond the ASHRAE 90.1 Standard reducing lighting power density by 30%.

Table 24:Space-by-Space LPD Compliance

| Space-By-Space LPD Compliance    |       |              |               |              |
|----------------------------------|-------|--------------|---------------|--------------|
| SPACE TYPE                       | AREA  | ALLOWED W/SF | ALLOWED WATTS | ACTUAL WATTS |
| STAIRS ACTIVE                    | 9802  | 0.69         | 6763.38       | 13051        |
| ELECTRICAL/MECHANICAL            | 79214 | 1.5          | 118821        | 25020        |
| ACTIVE STORAGE                   | 5809  | 0.63         | 3659.67       | 3494         |
| CORRIDOR/TRANSITION              | 51581 | 0.66         | 34043.46      | 28462        |
| WAREHOUSE                        | 1905  | 0.95         | 1809.75       | 767          |
| RESTROOMS                        | 6052  | 0.98         | 5930.96       | 7203         |
| OFFICE-ENCLOSED                  | 54448 | 1.11         | 60437.28      | 41878        |
| LOBBY                            | 5470  | 0.9          | 4923          | 11927        |
| CONFERENCE MEETING/MULTI-PURPOSE | 9324  | 1.23         | 11468.52      | 12174        |
| LOUNGE/RECREATION                | 17809 | 0.73         | 13000.57      | 18842        |
| LABORATORY                       | 74939 | 1.81         | 135639.59     | 108279       |
| ATRIUM                           | 4291  | 0.6          | 2574.6        | 6822         |
| CAGE WASH                        | 4059  | 1.2          | 4870.8        | 3960         |

|                                 |            |
|---------------------------------|------------|
| <b>TOTAL AREA:</b>              | 324703     |
| <b>ALLOWED WATTS:</b>           | 403943     |
| <b>ACTUAL WATTS:</b>            | 281878     |
| <b>WATTS/ SQUARE FOOT:</b>      | 0.87       |
| <b>PERCENT UNDER ASHRE 90.1</b> | <b>30%</b> |

**Section 10 Other Equipment**

Nominal motor efficiencies are specified to meet NEMA Standard MG 1 therefore, 75 Ames meets the requirements set by ASHRAE 90.1 Section 10. The Values used in Table 10.8C of ASHRAE 90.1 are based off of the values established by NEMA Standard MG 1.

## ASHRAE Standard 90.1 Summary

ASHRAE Standard 90.1 provides a baseline of rules and standards to make an energy efficient design. The standard goes detailed into building material, HVAC, heating, power, lighting and other equipment. By comparing a design to these baseline standards, conclusions may be drawn about the efficiency of a design.

Using the prescriptive method on 75 Ames Street with Standard 90.1, 75 Ames fared well especially in the lighting power density section where it preformed 30% better than the baseline model. The exterior envelope was on par with ASHRAE 90.1 having values at or better than those required and the total fenestration fell right to the max allowed 40% of the total wall area.

There were few areas of concern with comparing 75 Ames with Standard 90.1. The fan power section had a few fans that did not comply, but given the exception that 75 Ames is providing for labs and a vivarium those larger horsepower's are necessary.

## LEED Analysis

LEED, standing for Leadership in Energy and Environmental Design, is an internationally recognized program that sets a standard for rating the design, construction and operation of high performance green buildings. Buildings can apply for LEED certifications of certified, silver, gold, and platinum. The certifications are achieved by satisfying various credits and prerequisites each rewarding the project with a set number of points. The minimum number of points to be certified is 40 out of a total of 110-points.

It is very desirable to achieve LEED status on buildings to lead the way to a more sustainable future. LEED lowers operating costs of a building, conserves energy and water, reduces waste, is healthier for the building occupants, and lastly qualifies for tax rebates and other incentives.

At 75 Ames Street The Broad Institute is on route to achieving a LEED Silver status with 56 estimated points. Below you will find the various credits and prerequisites for LEED 2009 New Construction and Major Renovations with a summary of their intent. Below you will also find the number of points achieved for each credit 75 Ames is perusing. A 2009 LEED checklist is also provided in APPENDIX B.

## Sustainable Sites

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### SS Prerequisite 1: Construction Activity Pollution Prevention Required

**Intent:** Reduce the pollution that results from the construction.

Loss of soil during construction, sedimentation of storm sewers and receiving drains, and pollution of the air with dust and particulate matter were all prevented.

## SS Credit 1: Site Selection

**Achieved: 1 of 1 point**

**Intent:** To make sure the development is not on an inappropriate site and to reduce the environmental impact of the building location

75 Ames Street meets this credit by its location in Cambridge, there area no special areas to which this requirement would need to take effect.

## SS Credit 2: Development Density and Community Connectivity

**Achieved: 5 of 5 points**

**Intent:** To channel development to more urban areas with existing infrastructure, protect greenfields and preserve habitat and natural resources

This development is located in Kendal Square in Cambridge Massachusetts. This site is located on a previously developed area within half a mile from a residential area and from at least ten basic services. And finally there is pedestrian access. Therefor this construction meets the following requirements for this credit.

## SS Credit 3: Brownfield Redevelopment

**Achieved: 1 of 1 Point**

**Intent:** SS Credit 3 is intended to rehabilitate damaged sites where development is complicated by environmental contamination and to reduce pressure on undeveloped land.

This site was documented as contaminated by means of an ASTM E 1903-97 Phase II Environmental Site Assessment.

## SS Credit 4.1: Alternative Transportation—Public Transportation Access

**Achieved: 6 of 6 Points**

**Intent:** To reduce automobile use and thus the pollution and land development effects.

75 Ames Street is located roughly 500ft from the local Kendal/MIT train and bus stop. This is less than the ½ mile proximity denoted in the requirements for this credit.

## SS Credit 4.2: Alternative Transportation—Bicycle Storage and Changing Rooms

**Achieved: 0 of 1 Point**

**Intent:** To reduce automobile use and thus the pollution and land development effects.

No showers or changing facilities were provided for building occupants thus no points could be awarded.

### SS Credit 4.3: Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles

**Achieved: 3 of 3 Points**

**Intent:** To reduce automobile use and thus the pollution and land development effects.

Preferred location parking was provided for low emitting/fuel efficient vehicles equal to 5% of parking capacity.

### SS Credit 4.4: Alternative Transportation—Parking Capacity

**Achieved: 2 of 2 Points**

**Intent:** To reduce automobile use and thus the pollution and land development effects.

The parking does not exceed local zoning requirements. And preferred parking is given to carpools for 5% of the total parking.

### SS Credit 5.1: Site Development—Protect or Restore Habitat

**Achieved: 0 of 1 Point**

**Intent:** To conserve existing natural areas and restore damaged areas to provide biodiversity.

This credit was unable to be achieved for the Ames Street project. A minimum of 20% of the total site including the building footprint was not restored or protected with native or adaptive vegetation.

### SS Credit 5.2: Site Development—Maximize Open Space

**Achieved: 0 of 1 Point**

**Intent:** To provide a high ratio of open space to development footprint in order to promote biodiversity.

A vegetative roof area was unable to be utilized in the design of this building to allow the building to comply with 20% vegetated open space of the project open site.

### SS Credit 6.1: Storm water Design—Quantity Control

**Achieved: 1 of 1 Point**

**Intent:** To limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from storm water runoff and eliminating contaminants

Storm water management systems were put in place to achieve this credit. The pre and post site runoff rates are to be monitored to determine that the post peak discharge rate and quality does not exceed the predevelopment peak discharge rate and quality.

## SS Credit 6.2: Storm water Design—Quality Control

**Achieved: 1 of 1 Point**

**Intent:** To limit the disruption and the pollution of natural water flows by managing the storm water runoff.

75 Ames is on track to achieve this credit by having a storm water management plan that reduces the impervious cover, promotes infiltration and captures and treats the storm water runoff from 90% of the average annual rainfall. The best management practices are to be put in place capable of removing 80% of the average annual post development total suspended solids load based on existing monitoring reports.

## SS Credit 7.1: Heat Island Effect—Non-roof

**Achieved: 1 of 1 Point**

**Intent:** To reduce heat islands, minimizing the impacts on microclimates and human and wildlife habitats.

More than the minimum of 50% of parking spacing are under cover in a parking garage attached to 75 Ames Building. The roof SRI has a SRI of at least 29.

## SS Credit 7.2: Heat Island Effect—Roof

**Achieved: 1 of 1 Point**

**Intent:** To reduce heat islands, minimizing the impacts on microclimates and human and wildlife habitats.

75% of the roof has a solar reflectance index (SRI) greater than or equal to a value of 78 for low-sloped roofs.

## SS Credit 8: Light Pollution Reduction

**Achieved: 0 of 1 Point**

**Intent:** To minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction and reduce development impact from lighting on nocturnal environments.

This credit was unable to be achieved for this project.

## Water Efficiency

### WE Prerequisite 1: Water Use Reduction

#### Required

**Intent:** Reduce the burden on municipal water supply and wastewater systems by increasing the water efficiency within the building.

A baseline and design model of water use was designed and the current design building is set to use 20% less water than the baseline. The Baseline conditions are shown below.

Table 25: Baseline Condition for Water Reduction

| Commercial Fixtures, Fittings, and Appliances   | Current Baseline (Imperial Units)  |
|---|--|
| Commercial toilets  | 1.6 gallons per flush (gpf)<br>Except blow-out fixtures: 3.5 (gpf)   |
| Commercial Urinals  | 1.0(gpf)   |
| Commercial Lavatory (restroom) faucets  | 2.2 gallons per minute (gpm) at 60 pounds per square inch (psi), private applications only (hotel or motel guest rooms, hospital patient rooms)<br>0.5 (gpm) at 60 (psi) all others except private applications<br>0.25 gallons per cycle for metering faucets |
| Showerheads   | 2.5 (gpm) at 80 (psi) per shower stall   |
| For projects with commercial pre-rinse spray valves, the flow rate must comply with the ASME A112.18.1 standard of 1.6 gpm or less. |  |

### WE Credit 1: Water Efficient Landscaping

#### Achieved: 0 of 2–4 Points

**Intent:** To limit or eliminate the use of potable water or other natural surface or subsurface water resources available on or near the project site for landscape irrigation.

This credit was not sought after for 75 Ames Street because there is no need for an irrigation system.

### WE Credit 2: Innovative Wastewater Technologies

#### Achieved: 0 of 2 Points

**Intent:** Increasing the local aquifer recharge and reducing wastewater generation and potable water demand.

No points were achieved for this credit. Potable water use for the building sewage conveyance could not be cut by 50%.



## WE Credit 3: Water Use Reduction

### Achieved: 2 of 2–4 Points

**Intent:** To further increase water efficiency within buildings to reduce the burden on municipal water supply and waste water systems

Strategies have been implemented by 75 Ames that in aggregate use 30% less water than the water use baseline with the design shown in WE Prerequisite 1: Water Use Reduction.

## Energy & Atmosphere

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### EA Prerequisite 1: Fundamental Commissioning of Building Energy Systems

#### Required

**Intent:** This prerequisite verifies that the project's energy-related systems are all installed, and calibrated to perform to the owner's project requirements, basis of design and construction documents.

Commissioning processes and activities were completed by a project team to reduce energy use, lower operating costs, have fewer contractor callbacks, have better building documentation, have improved occupant productivity and verify that the system is operating in accordance with the owner's project requirements.

### EA Prerequisite 2: Minimum Energy Performance

#### Required

**Intent:** Prerequisite 2 establish the minimum level of energy efficiency for the proposed building and systems to reduce environmental and economic impacts associated with excessive energy use.

A whole building energy simulation was run to determine 75 Ames Streets performance when compared to ASHRAE Standard 90.1 baseline. An energy model indicates a 24% energy savings compared to the baseline.

### EA Prerequisite 3: Fundamental Refrigerant Management

#### Required

**Intent:** To prevent stratospheric ozone depletion.

Refrigerants R-134A and R-123 are used in this project in place of CFC refrigerants.

## EA Credit 1: Optimize Energy Performance

**Achieved: 5 of 1–19 Points**

**Intent:** To reduce environmental and economic impacts associated with excessive energy use by incentivizing buildings to be designed at increasing levels of energy performance beyond the prerequisite standard.

In the whole building energy simulation showed at least 20% better performance than the baseline design. From the table supplied by the LEED 2009 Rating for New Construction this corresponds with 5 points.

## EA Credit 2: On-site Renewable Energy

**Achieved: 0 of 1–7 Points**

**Intent:** To encourage, recognize and incentivize increasing levels of on-site renewable energy self-supply to reduce environmental and economical impacts associated with fossil fuel energy use.

There are no designs for on-site renewable energy for this project.

## EA Credit 3: Enhanced Commissioning

**Achieved: 2 of 2 Points**

**Intent:** To begin the commissioning process early in the process and execute additional activities after systems performance verification is complete.

In addition to EA Prerequisite 1 additional commissioning processes were added. Such as prior to the start of construction documents phase an independent commissioning authority was designated to lead, review, and oversee the completion of all commissioning process surfaces. This commissioning authority is documented as having commissioning authority experience in at least 2 building projects. More info can be found in the LEED Reference Guide For Green Building Design and Construction 2009.

## EA Credit 4: Enhanced Refrigerant Management

**Achieved: 2 of 2 Points**

**Intent:** To reduce ozone depletion and support early compliance with the Montreal Protocol and minimize the direct contributions to climate change.

Look too Appendix for detailed analysis of refrigeration management analysis.

## EA Credit 5: Measurement and Verification

**Achieved: 1 of 3 Points**

**Intent:** To provide for the ongoing accountability of building energy consumption over time.

An account was registered for this project on ENERGY STAR's Portfolio Manager Tool and the project is shared with the USGBC master account to meet MPR 6

## EA Credit 6: Green Power

**Achieved: 0 of 2 Points**

**Intent:** To encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

It was not sought after to engage in a 2-year renewable energy contract to provide 35% of the building's electricity from renewable resources. So this credit is not met.

## Materials & Resources

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### MR Prerequisite 1: Storage and Collection of Recyclables

**Required**

**Intent:** To facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills by providing recycling.

75 Ames complies with this Prerequisite. There will be dedicated recycling areas for collection and storage in the entire building. The recyclable materials include paper, cardboard, glass, plastics, and metals.

### MR Credit 1.1: Building Reuse—Maintain Existing Walls, Floors and Roof

**Achieved: 0 of 1–3 Points**

**Intent:** To extend the lifecycle of existing buildings, conserve resources, retain cultural resources, reduce wastes, and reduce the environmental impact of new buildings as they relate to materials manufacturing and transport.

An existing structure was not used for this project thus there were no existing walls, floors or roofs to reuse and this credit is not passed.

## MR Credit 1.2: Building Reuse—Maintain Interior Nonstructural Elements

**Achieved: 0 of 1 Point**

**Intent:** To extend the lifecycle of existing buildings, conserve resources, retain cultural resources, reduce wastes, and reduce the environmental impact of new buildings as they relate to materials manufacturing and transport.

An existing structure was not used for this project thus there were no existing nonstructural interior elements could be reused.

## MR Credit 2: Construction Waste Management

**Achieved: 2 of 1–2 Points**

**Intent:** To redirect recyclable materials from construction and demolition away from landfills and incineration facilities, and back to the manufacturing process and redirect the reusable materials to the appropriate sites.

75 Ames Street is planning on recycling/recovering 75% or the materials from construction and demolition.

## MR Credit 3: Materials Reuse

**Achieved: 0 of 1–2 Points**

**Intent:** To reuse building materials and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources.

The reuse of building materials is not an option for 75 AMES and thus the requirements for this credit cannot be met.

## MR Credit 4: Recycled Content

**Achieved: 1 of 1–2 Points**

**Intent:** To increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.

The sum of the post-consumer recycled content plus one half of the pre-consumer content constitutes 10%, based on cost, of the total value of materials in the project. This makes 75 Ames eligible for 1 point.

## MR Credit 5: Regional Materials

**Achieved: 1 of 1–2 Points**

**Intent:** To increase the demand for building materials and products that are extracted and manufactured close to the building and thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from the transportation of resources.

10%, based on cost, of the materials for 75 Ames are extracted, harvested, or recovered, as well as manufactured within 500 miles.

## MR Credit 6: Rapidly Renewable Materials

**Achieved: 0 of 1 Point**

**Intent:** To reduce use of and depletion of finite raw materials and long-cycle renewable materials. This is achieved by replacing these materials with rapidly renewable ones.

This project was unable to use 2.5% of the total value of building materials and products on rapidly renewable resources.

## MR Credit 7: Certified Wood

**Achieved: 0 of 1 Point**

**Intent:** To encourage environmentally responsible forest management.

50% wood, based on cost, was unable to be obtained in accordance with certified Forest Stewardship Council's principles and criteria.

## Indoor Environmental Quality

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### IE Q Prerequisite 1: Minimum Indoor Air Quality Performance

**Required**

**Intent:** To establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well being of the occupants.

The minimum requirements of ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality are met for the design of this building. Therefore 75 Ames passes this prerequisite.

## **IE Q Prerequisite 2: Environmental Tobacco Smoke (ET S) Control Required**

**Intent:** To prevent or minimize exposure of building occupants, indoor air distribution systems to environmental tobacco smoke.

Smoking is prohibited in the building and within 25 feet of entries, outdoor air intakes and operable windows. Signage is provided to allow smoking in designated areas, prohibit smoking in designated areas.

## **IE Q Credit 1: Outdoor Air Delivery Monitoring**

**Achieved: 1 of 1 Point**

**Intent:** To provide capacity for ventilation system monitoring to help promote occupant comfort and well-being.

A building automated system is used along with CO2 sensors to maintain design minimum requirements throughout the building. 75 Ames Street is a 100% outdoor air system therefore it complies with all ventilation regulations stated in ASHRAE Standard 62.1.

## **IE Q Credit 2: Increased Ventilation**

**Achieved: 1 of 1 Point**

**Intent:** To provide additional outdoor air ventilation to improve indoor air quality (IAQ) and promote occupant well being and comfort.

Ventilation calculations were made and 75 Ames far surpasses the ventilation needs being a 100% outside air building. The outdoor air ventilation sheet and a LEED summary Report are provided in APPENDIX A.

## **IE Q Credit 3.1: Construction Indoor Air Quality Management Plan—During Construction**

**Achieved: 1 of 1 Point**

**Intent:** To reduce indoor air quality (IAQ) problems resulting from construction or renovation and promote the comfort and well-being of construction workers and building occupants.

75 Ames is to follow the control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines For Occupied Buildings Under Construction. On site and installed absorptive materials are to be are protected from moisture. And permanently installed air handlers used during construction have a filtration media with a minimum efficiency reporting value (MERV) of 8 at each return grille. Filters are to be replaced before building occupancy.

### **IE Q Credit 3.2: Construction Indoor Air Quality Management Plan—Before Occupancy**

**Achieved: 1 of 1 Point**

**Intent:** To reduce indoor air quality (IAQ) problems resulting from construction or renovation and promote the comfort and well-being of construction workers and building occupants.

A management plan is to be put in place prior to occupancy with all interior finishes installed. New filtration media shall be installed and a building flush out is to be performed by supplying a total air volume of 14,000 cubic feet per minute of outdoor air per square foot of floor area while maintaining an internal temperature of at least 60 F and a relative humidity of 60%.

### **IE Q Credit 4.1: Low-Emitting Materials—Adhesives and Sealants**

**Achieved: 1 of 1 Point**

**Intent:** To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Adhesives and sealants used on the interior of 75 Ames Street Building comply with the following requirements in table 26

Table 26: Low Emitting Materials-Adhesives and Sealants

| Architectural Applications          | VOC Limit (g/L less water) | Specialty Applications                 | VOC Limit (g/L less water) |
|-------------------------------------|----------------------------|--|----------------------------|
| Indoor carpet adhesives             | 50                         | PVC welding                            | 510                        |
| Carpet pad adhesives                | 50                         | CPVC welding                           | 490                        |
| Wood flooring adhesives             | 100                        | ABS welding                            | 325                        |
| Rubber floor adhesives              | 60                         | Plastic cement welding                 | 250                        |
| Subfloor adhesives                  | 50                         | Adhesive primer for plastic            | 550                        |
| Ceramic tile adhesives              | 65                         | Contact adhesive                       | 80                         |
| VCT and asphalt adhesives           | 50                         | Special purpose contact adhesive       | 250                        |
| Drywall and panel adhesives         | 50                         | Structural wood member adhesive        | 140                        |
| Cove base adhesives                 | 50                         | Sheet applied rubber lining operations | 850                        |
| Multipurpose construction adhesives | 70                         | Top and trim adhesive                  | 250                        |
| Structural glazing adhesives        | 100                        |  |                            |
| Substrate Specific Applications     | VOC Limit (g/L less water) | Sealants                               | VOC Limit (g/L less water) |
| Metal to metal                      | 30                         | Architectural                          | 250                        |
| Plastic foams                       | 50                         | Roadway                                | 250                        |
| Porous material (except wood)       | 50                         | Other                                  | 420                        |
| Wood                                | 30                         |  |                            |
| Fiberglass                          | 80                         |  |                            |
| Sealant Primers                     | VOC Limit (g/L less water) |  |                            |
| Architectural, nonporous            | 250                        |  |                            |
| Architectural, porous               | 775                        |  |                            |
| Other                               | 750                        |  |                            |

Aerosol Adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements. The limit can be seen in table 27 below.

Table 27: Low Emitting Materials- Aerosol Adhesives and Sealants

| Aerosol Adhesives                             | VOC Limit          |
|---|--------------------|
| General purpose mist spray                    | 65% VOCs by weight |
| General purpose web spray                     | 55% VOCs by weight |
| Special purpose aerosol adhesives (all types) | 70% VOCs by weight |



## IE Q Credit 4.2: Low-Emitting Materials—Paints and Coatings

**Achieved: 1 of 1 Point**

**Intent:** To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Paints used within the building do not exceed the volatile organic compound content limits established in the Green Seal Standard GS-11, Paints, 1<sup>st</sup> edition. Any anti corrosive and anti-rust materials will not exceed VOC content limit of 250 g/L and clear wood finishes, floor coatings, stains, primers, sealers, and shellacs will not exceed the VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings.

## IE Q Credit 4.3: Low-Emitting Materials—Flooring Systems

**Achieved: 1 of 1 Point**

**Intent:** To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

This project achieves this credit by following the Carpet and Rug Institute Green Label program's testing and product requirements for installed carpets and requirements for carpet cushions. The carpet adhesives meet IEQ Credit 4.1 Adhesives and Sealants. The Floor Score standard is met for hard surface flooring. Any concrete, wood, bamboo and cork floor finishes (sealer, stain, and finish) meet the requirements of South Coast Air Quality Management District (SCAQMD) Rule 1113). Lastly all tile setting adhesives and grout meet SCAQMD Rule u68.

## IE Q Credit 4.4: Low-Emitting Materials—Composite Wood and Agrifiber Products

**Achieved: 0 of 1 Point**

**Intent:** To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

75 Ames building does not pass this credit. Composite wood and agrifiber products used in the building contain added urea-formaldehyde resin that disqualifies this project for the credit.

## IE Q Credit 5: Indoor Chemical and Pollutant Source Control

**Achieved: 1 of 1 Point**

**Intent:** To minimize occupant exposure to potentially hazardous particulates and chemical pollutants.

Cross contamination of regularly occupied areas by chemical pollutants is minimized. A MERV 13 is installed for all regularly occupied spaces. A permanent entryway system is to be provided. And Spaces with hazardous gases or chemicals are exhausted. In appendix D are the calculations for indoor chemical & pollutant source control.

## IE Q Credit 6.1: Controllability of Systems—Lighting

**Achieved: 1 of 1 Point**

**Intent:** To provide a high level of lighting systems control by individual occupants or groups in multi-occupant spaces and promote their productivity, comfort and well-being.

Individual lighting controls are provided to at least 90% of the building occupants to enable the adjustments to suit individual task needs and preferences. Lighting controls are also supplied to all shared spaces to make adjustments for group needs.

## IE Q Credit 6.2: Controllability of Systems—Thermal Comfort

**Achieved: 0 of 1 Point**

**Intent:** To provide a high level of lighting systems control by individual occupants or groups in multi-occupant spaces and promote their productivity, comfort and well-being.

Individual comfort controls were unable to be supplied for at least 50% of building occupants. Therefore this credit is not awarded.

## IE Q Credit 7.1: Thermal Comfort—Design

**Achieved: 1 of 1 Point**

**Intent:** To provide a comfortable thermal environment that promotes occupant productivity and well-being.

Heating ventilation and air conditioning are designed to comply with ASHRAE 55 – 2004 Thermal Comfort Conditions for Human Occupancy. A detailed narrative provided by the HVAC engineers at BR+A is provided in appendix E

## IE Q Credit 7.2: Thermal Comfort—Verification

**Achieved: 0 of 1 point in addition to IE Q credit 7.1**

**Intent:** To provide for the assessment of building occupant thermal comfort over time.

A permanent monitoring system will not be installed to track the building performance and ensure it meets desired comfort criteria as determined by IE Q 7.1 Thermal Comfort – Design. Therefore this credit is not met.

## IE Q Credit 8.1: Daylight and Views—Daylight

**Achieved: 0 of 1 Point**

**Intent:** To provide building occupants with a connection between indoors and outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

The applicable spaces of 75 Ames do not meet the day lighting criteria set by this credit of minimum daylight illuminance levels of 10 foot-candles and a maximum of 500 foot-candles in clear sky conditions.

## IE Q Credit 8.2: Daylight and Views—Views

**Achieved: 0 of 1 Point**

**Intent:** To provide building occupants a connection to the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

A direct line of sight to the outdoor environment via glazing between 30 inches and 90 inches above the finish floor for 90% of the building occupants could not be achieved for this project.

## Innovation in Design

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### ID Credit 1: Innovation in Design

**Achieved: 3 of 1–5 Points**

**Intent:** To provide design teams and projects the opportunity to achieve exceptional performance above the requirements set by LEED Green Buildings Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.

There are three ideas this project is looking at towards this credit though the use of pilot credits.

- 1) A comprehensive transport management plan is to be in place
- 2) Dispersion analysis as part of chemical management plan. A comprehensive approach will be taken to cover spills, access to the building, and handling protocols.
- 3) This building shall be used as an educational tool to provide public education focusing on green building strategies and solutions.

### ID Credit 2: LEED Accredited Professional

**Achieved: 1 of 1 Point**

**Intent:** To support and encourage the design integration required by LEED to streamline the application and certification process.

At least one principal participant of the project team is a LEED Accredited Professional.

## Regional Priority

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### RP Credit 1: Regional Priority

**Achieved: 4 of 1–4 Points**

**Intent:** To provide an incentive for the achievement of credits that address geographically specific environmental priorities.

75 Ames Street has met the regional priority credit by complying with credits SSc3, SSc6.1, SSc7.1 and SSc7.1. This qualifies the project for 4 regional priority credits.

## Overall Evaluation

75 Ames's mechanical system was designed well and met the requirements for the project type well. The total mechanical system has a cost of \$26,693,790.00, which is 16% of the total building cost. The main contributors to this cost were all the large mechanical equipment for the heating, and cooling plants, and the air handlers. This building is set to run relatively efficiently, 20% better than the ASHRAE Baseline Standard, and costing only \$2,360,127.50 per year to operate. Three floors were dedicated to the mechanical equipment, and mechanical shafts only took up 19,443 SF of the entire high-rise.

Being a 100% outside air building 75 Ames easily met the ASHRAE 62.1 Standards for ventilation. Although using return air from not critical spaces could be looked into to help more with energy savings. One dilemma with this would have to add in extra return duct risers to the structure, taking up more valuable square footage.

Another idea for energy savings could come from the use of an Aircuity Optinet System. This is a unique system, which takes samples of air remotely throughout a buildings space and routes them to a centralized sensor. By sampling the air quality the Optinet system can determine the needed ventilation rates throughout the building and allow for labs and other critical areas to be turned down in times where contamination is low. This may have an added up front cost to the entire system, but potentially this could lead to more energy savings and end up paying for itself over time.

75 Ames does a good job with it's mechanical design and is making a great effort to be LEED Silver. The idea of designing the building for future changes to the program limits the energy savings potential of the building. If instead 75 Ames was designed for day one the changes could result in less total cost per year. Also the use of an Aircuity Optinet system would be very helpful in lab areas to turn down ventilation rates but maintain comfort ability in the areas.

## Alternatives Considered

In preparation for the proposal several different ideas where considered to minimize operating costs and improve the reliability of the system. Below you will find the Ideas considered and a brief explanation of them.

### Solar Thermal Heating

A solar thermal system could be placed on the roof of the building to utilize solar energy for hot water heating. This could then lessen the heating bill and carbon footprint of the buildings. One barrier to consider is the amount of heating available depends upon the area available for the collectors and the clearness index of the area. Since 75 Ames is a 250,000 SF building using 348,500 therms of natural gas costing \$5.57K annually this could be a potential cost saver, but there does seem to be a lack of space for the collectors.

### Rain Water Collection

A rainwater harvesting system could help 75 Ames become a more sustainable building. By collecting rain for use in toilet flushing for example, a great deal of clean water can be saved. There is a roof area of roughly 29,000 SF that could be utilized for rainwater collection.

### Return Air from offices to be used.

75 Ames was designed for future renovations and it is because of this all areas are 100% outside air and no return air is utilized for any spaces. There is a large potential for energy savings here. In designing two separate systems, one for labs and one for administration, although the mechanical design will not be as flexible, it will be more efficient.

## Depth I Laboratory Demand Controlled Ventilation Alternate

### Objective

The goal of adding a demand control ventilation system such as an Aircuity Optinet was to enable labs to be turned down to a much lower air change rate (minimum 2 ACH) lowering the total air supplied to labs and the reheat needed. Typically labs utilize a high air change per hour rate, in this buildings case it was 6-12 ACH. This is to be able to keep the environment safe from any contaminations due to spills or ongoing experiments. A system such as Aircuity's Optinet can test the air quality of multiple rooms every 15 minutes ensuring a safe and comfortable environment. The system tests for VOC's, ammonia, chemical vapors and particulates. When contaminates are tested below the set point the air changes may be lowered. Instead of diluting clean air with clean air, the air is only supplied when needed. When contaminates are sensed higher air change rates 12-15 ACH are utilized to eliminate the risk as quickly as possible. Since large contaminations are not too common, this allows the normal state of ventilation to be much lower than normally designed leading to lower air and reheat, supplied to the space.

For labs just using occupancy sensors for DCV is not advised. With occupancy sensors for labs it will take much longer to significantly remove a contaminants from a space especially if using system turndowns at night where something may accidently spill. The most effective and safe way to ventilate labs is testing the air VOC frequently to determine the air change rate.

## Schematic

Figure 16 shows a typical arraignment for the Aircuity Optinet System. Multiple rooms can be sensed by the central sensor suite. Multiple rooms can be sensed by an air data router which then sends the sample to the sensor suite. The sensor suite is able to sense 15-20 areas every 15 minutes. Using a Photoionization detectors total volume of contaminants (PID TVOC) sensor hundreds of commonly used chemicals such as ammonia can be detected. A metal oxide sensor (MOD) is used to sense broader chemical contaminants, lasers are used to determine particle counts, CO<sub>2</sub> sensors are used and dew point or humidity sensors allow for greater control and monitoring. All this data is then sent to the building automated computer network where any changes to room ventilation may be made. This data is then also saved online to see the typical daily space contaminates. Knowing this information can ensure safe lab procedures are being utilized to minimize room contaminates and occupancy safety.

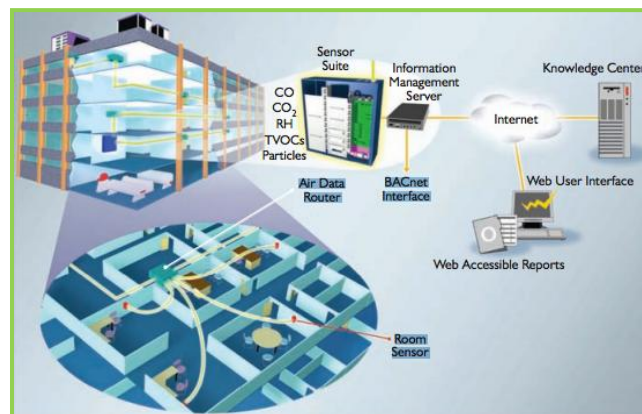


Figure 16: Aircuity Schematic courtesy of Aircuity

## Design Considerations

It must be noted that it was assumed that the Aircuity System did not add any additional load to the spaces in which it was placed.

One big design consideration is the first cost. An Aircuity system is generally budgeted at \$5000 per sensed location. For labs larger than 1200 square feet it is required that there is 1 sensor for every 1200 square feet. There is also an optional yearly maintenance cost of \$20963, which is waived the first year. Since there is this large upfront cost only the larger rooms were chosen to optimize the system's effect. The rooms chosen can be seen in Appendix F

To determine the savings TRANE TRACE 700 was used, most data stayed the same as the original model except for the minimum ventilation rates.

Table 28: Trane Trace 700 DCV Inputs

| TRANE TRACE 700 : 75 Ames Inputs |   |                     |                      |         |
|----------------------------------|---|---------------------|----------------------|---------|
| Location/Weather                 | Boston, Massachusetts   |                     |                      |         |
| System                           | VAV System with reheat (30% Min Flow)                                 |                     |                      |         |
| Room Set Points                  |   | Winter (°F)         | Summer (°F)          |         |
|                                  | Temperature   | 72                  | 75                   |         |
|                                  | Humidity  | 25% (±5)            | 50% (±5)             |         |
| Internal Loads                   |   | Lighting (Watts/SF) | Equipment (Watts/SF) |         |
|                                  | Office  | 1.2                 | 2                    |         |
|                                  | Labs  | 2                   | 10                   |         |
|                                  | Tissue Culture:   | 2                   | 20                   |         |
| Airside Components               | 100% Outside Air System   |                     |                      |         |
|                                  | Duct Supply air Temp Max (°F)   | 55                  |                      |         |
|                                  | Duct Supply air Min (°F)  | 52                  |                      |         |
|                                  | Humidity ratio difference (gr/lb.)                                    | 0.0012              |                      |         |
| Waterside Components             |   | EWT (°F)            | LWT (°F)             | ΔT (°F) |
|                                  | Chiller   | 56                  | 42                   | 14      |
|                                  | Evaporator  | 95                  | 85                   | 10      |
| Schedules                        | During unoccupied times ventilation rates are lowered. See Appendix G |                     |                      |         |
| Ventilation Rates                |   | Original            | Aircuity             |         |
|                                  | Labs  | 6 to 12 ACH         | 2 to 4 ACH           |         |
|                                  | Office  | 20 CFM Per Person   | -                    |         |

## Energy Usage Estimates

As seen in the table and below the Aircuity system met the expectation of lowering both electrical and gas power consumption. The Electrical is primarily due to a reduction in fans and the gas reduction is due to the reduction of reheat needed to heat up incoming air to ventilate the labs.

*The following results were obtained from the TRANE TRACE 700 model:*



Table 29: DCV Annual Energy Cost Comparison

|                        | Electricity (kWh) | Natural Gas (Therms) | Electricity Cost Per year | Natural Gas Cost per year | Total Cost Per Year |
|------------------------|-------------------|----------------------|---------------------------|---------------------------|---------------------|
| <b>Original System</b> | 9,985,524.00      | 107,047.00           | \$2,007,090.32            | \$170,954.06              | \$2,178,044.38      |
| <b>DCV</b>             | 9,059,513.00      | 105,222.00           | \$1,820,962.11            | \$168,039.53              | \$1,989,001.65      |
| <b>Difference</b>      | 926,011.00        | 1,825.00             | \$ 186,128.21             | \$2,914.53                | \$ 189,042.74       |
|                        |                   |                      |                           | <b>% Change</b>           | <b>-9%</b>          |

Table 29 above shows the potential energy savings in adding an Aircuity-Optinet system. Both natural gas heating and electricity cost are lowered due to less need to reheat the supplied air and from the fan running at lower levels. This system decreases the total energy usage by a total of 9 percent. Below table 30 and graphs 15 and 17 give detailed monthly energy consumption for the building using both the original system and the alternate Aircuity Optinet demand controlled ventilation system. The system uses consistently less electricity per month shown in graph 15 and savings on heating are saved primarily during the summer months as shown in graph 17.

Table 30: Original System vs. DCV Energy Usage

|                     |                       | Original System VAV Reheat |                   | Alternate DCV    |                |
|---------------------|-----------------------|----------------------------|-------------------|------------------|----------------|
|                     |                       | Electric KWH               | Gas Therms        | Electric KWH     | Gas Therms     |
| <b>Energy Usage</b> | <b>Jan</b>            | 721,666                    | 17,302            | 630,014          | 18,918         |
|                     | <b>Feb</b>            | 654,882                    | 16,453            | 571,874          | 18,323         |
|                     | <b>Mar</b>            | 791,432                    | 10,610            | 694,572          | 10,289         |
|                     | <b>Apr</b>            | 746,783                    | 6,680             | 659,139          | 4,954          |
|                     | <b>May</b>            | 894,909                    | 6,230             | 811,156          | 4,473          |
|                     | <b>June</b>           | 978,922                    | 4,318             | 923,273          | 3,839          |
|                     | <b>July</b>           | 962,894                    | 1,243             | 947,253          | 3,007          |
|                     | <b>Aug</b>            | 1,040,655                  | 3,556             | 987,417          | 3,922          |
|                     | <b>Sept</b>           | 847,768                    | 6,004             | 766,895          | 4,229          |
|                     | <b>Oct</b>            | 895,855                    | 7,054             | 800,672          | 4,943          |
|                     | <b>Nov</b>            | 771,446                    | 8,173             | 664,497          | 6,118          |
|                     | <b>Dec</b>            | 678,311                    | 19,423            | 602,751          | 22,206         |
|                     | <b>Total</b>          | <b>9,985,524</b>           | <b>107,047</b>    | <b>9,059,513</b> | <b>105,222</b> |
| <b>Difference</b>   |                       |                            |                   |                  |                |
|                     | <b>Electrical KWH</b> |                            | <b>Gas Therms</b> |                  |                |
|                     | <b>-926,011</b>       |                            | <b>-1,825</b>     |                  |                |

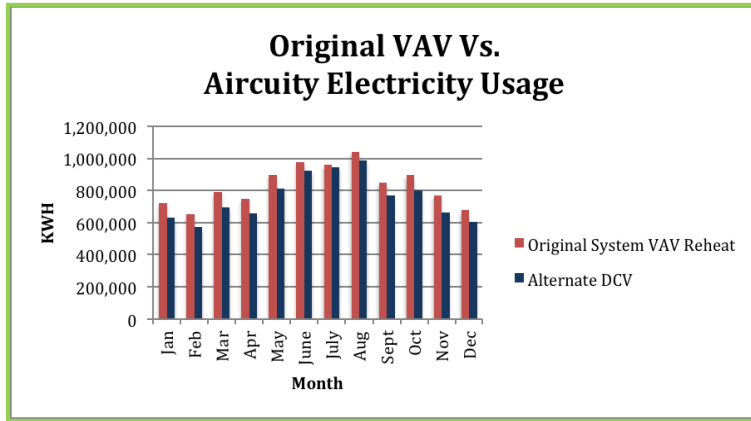


Figure 17: VAV vs. Aircuity DCV Electricity Usage

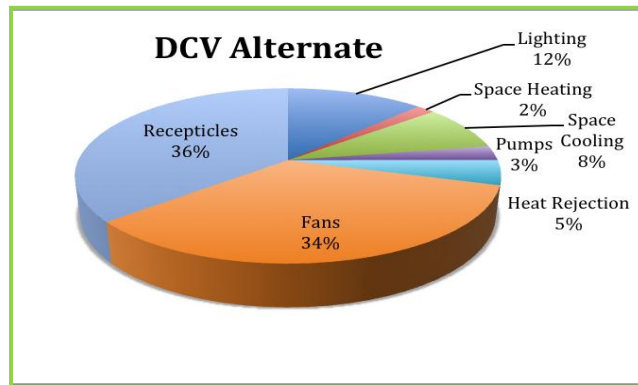


Figure 18: Aircuity Optinet DCV Electrical Breakdown

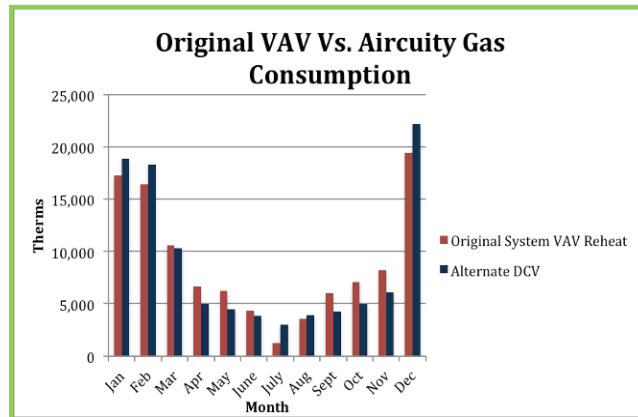


Figure 19: VAV vs. Aircuity Optinet DCV Gas consumption comparison

## Operating Costs

The upfront costs for 75 Ames was \$5000 per sensed room and a \$20963 optional yearly maintenance fee, which is waived the first year. As seen in the table below the Aircurity system is able to pay for itself within .85 years, even with the yearly maintenance, by saving \$ 189,042.74 annually. The addition of this system would mean the saving of over \$1,000,000 within 10 years.

Table 31: 10 Year Life Cycle Cost Compared To VAV

| 10 Year Life Cycle Cost Analysis |                            |                           |                                  |
|----------------------------------|----------------------------|---------------------------|----------------------------------|
| YEAR                             | Original System VAV Reheat | DCV - Aircurity Alternate | With Maintenance First Year Free |
| 0                                | \$0                        | \$160,000.00              | \$160,000.00                     |
| 1                                | \$2,178,044.38             | \$2,149,001.65            | \$2,149,001.65                   |
| 2                                | \$4,356,088.77             | \$4,138,003.29            | \$4,158,966.29                   |
| 3                                | \$6,534,133.15             | \$6,127,004.94            | \$6,168,930.94                   |
| 4                                | \$8,712,177.53             | \$8,116,006.59            | \$8,178,895.59                   |
| 5                                | \$10,890,221.92            | \$10,105,008.24           | \$10,188,860.24                  |
| 6                                | \$13,068,266.30            | \$12,094,009.88           | \$12,198,824.88                  |
| 7                                | \$15,246,310.68            | \$14,083,011.53           | \$14,208,789.53                  |
| 8                                | \$17,424,355.06            | \$16,072,013.18           | \$16,218,754.18                  |
| 9                                | \$19,602,399.45            | \$18,061,014.82           | \$18,228,718.82                  |
| 10                               | \$21,780,443.83            | \$20,050,016.47           | \$20,238,683.47                  |

## Emissions Estimate

Through the use of Trace 700's Environmental Impact Analysis the change in pollutant output from the original system can be studied. The three main pollutants are CO2, SO2, and NOX. By reducing the amount of electricity used compared to the original design the environmental impact will be changed. In the table below it can be seen that each pollutant has been decreased by 9.27% compared to the original system.

Table 32: Aircurity Optinet DCV Environmental Impact Compared to Original

| ENVIRONMENTAL IMPACT |        |                            |                           |          |            |
|----------------------|--------|----------------------------|---------------------------|----------|------------|
|                      | Unit   | Original System VAV Reheat | DCV - Aircurity Alternate | % Change | Difference |
| CO2                  | lbm/yr | 876,396,480                | 795,123,520               | -9.27%   | 81,272,960 |
| SO2                  | gm/yr  | 2,742,078                  | 2,487,791                 | -9.27%   | 254,287    |
| NOX                  | gm/yr  | 742,165                    | 673,340                   | -9.27%   | 68,825     |

## Summary

For only a small upfront investment (\$160,000) an Aircuity system is able to be installed into 75 Ames Street and be paid off within under a year. Not only does this system end up saving The Broad Institute (75 Ames Street Owners) over \$1 million in 10 years but also reduces 3 of the main environmental contaminants by 9 % and taking 81,272,960 lbm/yr of carbon dioxide out of the air. This system would be a great addition for 75 Ames Street and would not be too much of an economic concern.

## Depth II: Chilled Beams

### Objectives

Chilled beams are most successful in rooms with high sensible loads, like offices and some labs. By alternating the mechanical system of 75 Ames from a variable air volume system to a chilled beam system, the hope is to reduce life cycle costs by significant savings in fan energy and reheat energy. In a typical variable air volume system large amounts of air are supplied to a space to cool or heat the room. Using chilled beams allows the system to supply less air and switches the task of cooling the room to the chilled beams.

### Design Considerations

#### Active vs. Passive

There are two types of chilled beams to consider in designing a system, active and passive beams. A passive beam relies solely on free convection to cool or heat a room. Passive beams have lower cooling capacities compared to active beams and require another source to supply the supply air to the room so they are best implemented in retrofits.

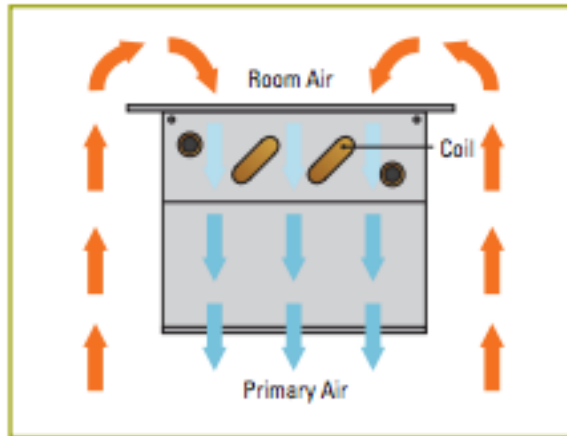


Figure 20: Passive Chilled Beam Schematic Courtesy of PRICE

Active beams are more complex than the passive. Active beams have a higher capacity than the passive beams that depends on the supply water temperature, room temperature, and the primary airflow. Active beams have primarily been selected for the 75 Ames project to provide the most effective and efficient cooling.

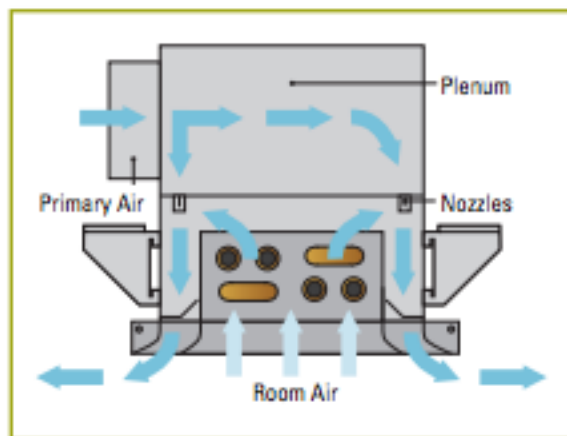


Figure 21: Active Chilled Beam Schematic Courtesy of PRICE

## Pipe Arrangement

Another important part of a chilled beams system to look at is how the system shall be heated. Chilled beams allow for two different configurations a 2-pipe (cooling only) system, and a 4-pipe (cooling and heating). The Two different configurations are shown in the figure 22 below. The two pipe configurations are more desirable in that it is cheaper and more efficient. But the 4-pipe offers the ability of heating a space with one system rather than needing some other system to heat the space.

For 75 Ames Street perimeter rooms utilized the 2-pipe system with radiant baseboard heating on the exterior walls. For the interior spaces the 4-pipe system shall be utilized to meet the heating and cooling needs.

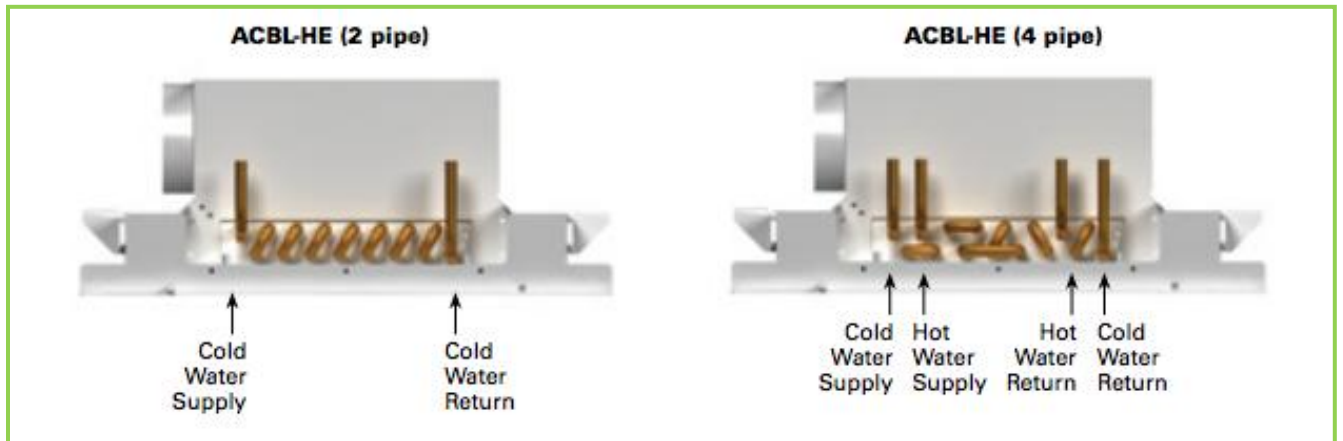


Figure 22: 2-Pipe vs. 4-Pipe Arrangement Courtesy of PRICE

## Sizing and Selection

Below is a detailed example of how the chilled beams were chosen for each room. Room 6012, a typical office space seen below in figure 23 was used.

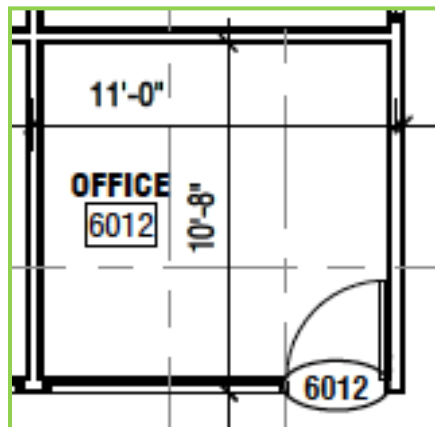


Figure 23: Typical Office Room

### 1) Determine the Sensible and Latent Loads of the Space

To determine the sensible and latent loads in a space the loads supplied from the occupants, lighting and equipment must be analyzed. This can be done by hand or with the help of Trane TRACE 700. Using the TRACE model it is possible to calculate the sensible and latent loads to each space much faster than by hand and the values from below were taken from this model.

$$Q_{\text{sensible}}=1332 \text{ BTU/ hr}$$

$$Q_{\text{latent}}=152.5 \text{ BTU/hr}$$

## 2) Determine the Fresh Air Flow Rate

Ventilation rates were taken from ASHRAE Standard 62.1-2010. Using these ventilation rates per person and per area, and knowing the area and number of people in the room the Fresh airflow rate can be found. Values of 5 cfm/person and 0.06cfm/ft<sup>2</sup> for an office were found and used for this space.

$$V_{\text{bz}}=R_p \cdot P_z + R_a \cdot A_z$$

$$V_{\text{bz}}=5 \cdot 1 + 0.06 \cdot 109 = 11.54 \text{ cfm}$$

## 3) Determine The Cooling Capacity of The Air

The supply air humidity ratio is found to be  $w_{\text{supply}}=0.007997 \text{ lb}_w/\text{lbDA}$  and for the room  $w_{\text{room}}=0.009233 \text{ lb}_w/\text{lbDA}$

$$Q_{\text{latent}} = 4840 V_{\text{bz}} (w_{\text{room}} - w_{\text{supply}})$$

$$Q_{\text{latent}} = 4840 (11.54)(0.009233 - 0.007997)$$

$$Q_{\text{latent}} = 69 \text{ BTU/hr}$$

$$Q_{\text{sensible}} = 1.08 V_{\text{bz}} (T_{\text{room}} - T_{\text{supply}})$$

$$Q_{\text{sensible}} = 1.08 (11.54) (75 - 55)$$

$$Q_{\text{sensible}} = 249.264$$

#### 4) Determine Required Supply Air Volume To Remove Latent Load

For the chilled beams to work effectively the latent load must be removed from the room before the sensible load can be handled. For this room since the room latent load of 152.5 BTU/hr is greater than 69 BTU/hr, the supply air must be increased. To determine how much the supply air must now be we use the equation below.

$$Q_{\text{latent}} = 4840 V_{\text{bz}} (w_{\text{room}} - w_{\text{supply}})$$

$$152.5 = 4840 V (0.009233 - 0.007997)$$

$$V = 25.41 \text{ CFM}$$

This gives a new sensible capacity of

$$Q_{\text{sensible}} = 1.08 V_{\text{bz}} (T_{\text{room}} - T_{\text{supply}})$$

$$Q_{\text{sensible}} = 1.08 (25.41) (75 - 55)$$

$$Q_{\text{sensible}} = 548.856 \text{ BTU/hr}$$

#### 5) Determine the Sensible Load Radiant Requirements

$$Q_{\text{sensible, radiant}} = 1332 - 548.856 = 783.144$$

#### 6) Determine the Chilled Beam Size and Quantity

The Beam is sized based on the CFM requirements as well as the sensible cooling load and the number of beams. For this selection a chilled beam sized at 4 feet by 1 foot to fit in the 2x2 ACT and take up a smaller amount of ceiling space from the room. Using the performance data provided by PRICE in Table 33 below a 2 Way, 4-pipe active chilled beam with 24 cfm primary air was chosen and found to have a capacity of 1618 btu/hr total.



Table 33: 12" 2 Way 4 Pipe Active Chilled Beams Performance Data Courtesy Of PRICE HVAC

| <b>Performance Data - (4 Pipe) Cooling</b>     |            |             |                              |                            |          |                   |                               |             |                               |                 |          |
|--|------------|-------------|------------------------------|----------------------------|----------|-------------------|-------------------------------|-------------|-------------------------------|-----------------|----------|
| <b>ACBL, 2 way, 12 inch - (4 pipe) Cooling</b> |            |             |                              |                            |          |                   |                               |             |                               |                 |          |
| Unit Length ft                                 | Inlet Size | Nozzle Size | Air Flow cfm Total (Primary) | Plenum Static Pressure in. | Sound NC | Capacity - 4 Pipe |                               |             |                               | Induction Ratio | Throw ft |
|  |            |             |                              |                            |          | Cooling           |                               |             |                               |                 |          |
|  |            |             |                              |                            |          | Coil Btu/h        | Transfer Efficiency Btu/h cfm | Total Btu/h | Head Loss ft H <sub>2</sub> O |                 |          |
| 4 ft   | 5          | 20          | 9                            | 0.21                       | --       | 645               | 72                            | 820         | 1.16                          | 3.60            | 0-1-2    |
|  | 5          |             | 14                           | 0.49                       | --       | 926               | 66                            | 1198        |                               | 3.60            | 1-1-5    |
|  | 5          |             | 19                           | 0.82                       | --       | 1159              | 63                            | 1519        |                               | 3.60            | 1-2-8    |
|  | 5          | 30          | 15                           | 0.20                       | --       | 846               | 56                            | 1138        |                               | 2.90            | 0-1-4    |
|  | 5          |             | 24                           | 0.49                       | --       | 1151              | 48                            | 1618        |                               | 2.90            | 1-3-9    |
|  | 5          |             | 31                           | 0.79                       | 16       | 1357              | 44                            | 1961        |                               | 2.90            | 2-4-12   |
|  | 5          | 40          | 21                           | 0.20                       | --       | 949               | 45                            | 1358        |                               | 2.60            | 1-2-7    |
|  | 5          |             | 34                           | 0.49                       | --       | 1300              | 39                            | 1962        |                               | 2.60            | 2-4-12   |
|  | 5          |             | 44                           | 0.79                       | 20       | 1534              | 35                            | 2391        |                               | 2.60            | 3-8-14   |
|  | 5          | 50          | 26                           | 0.20                       | --       | 939               | 36                            | 1445        |                               | 2.20            | 1-2-8    |
|  | 5          |             | 43                           | 0.50                       | 16       | 1297              | 30                            | 2134        |                               | 2.20            | 3-6-13   |
|  | 5          |             | 55                           | 0.79                       | 23       | 1514              | 28                            | 2585        |                               | 2.20            | 4-9-15   |
|  | 5          | 60          | 39                           | 0.20                       | --       | 1186              | 30                            | 1945        |                               | 2.10            | 2-4-12   |
|  | 5          |             | 64                           | 0.51                       | 23       | 1587              | 25                            | 2833        |                               | 2.10            | 5-10-16  |
|  | 5          |             | 82                           | 0.80                       | 29       | 1831              | 22                            | 3428        |                               | 2.10            | 8-12-18  |
|  | 5          | 70          | 58                           | 0.20                       | --       | 1343              | 23                            | 2472        |                               | 1.50            | 3-6-13   |
|  | 5          |             | 94                           | 0.50                       | 27       | 1739              | 18                            | 3569        |                               | 1.50            | 7-12-17  |
|  | 5          |             | 121                          | 0.80                       | 34       | 1985              | 16                            | 4341        |                               | 1.50            | 10-14-19 |
|  | 5          | 80          | 80                           | 0.20                       | 20       | 1321              | 17                            | 2879        |                               | 1.20            | 4-9-15   |
|  | 5          |             | 131                          | 0.50                       | 33       | 1779              | 14                            | 4330        |                               | 1.20            | 9-13-19  |
| 4x10   | 169        |             | 0.80                         | 35                         | 2067     | 12                | 5358                          | 1.20        | 12-15-21                      |                 |          |

This process was done for each room in 75 Ames Street in an Excel document. This schedule can be found in Appendix H.

### Airside Summary

A primary savings is found in the supply air volume for 75 Ames Street. The air-handling units supply 55 F air, which is used to cool or heat a space. By choosing chilled beams over a conventional variable air volume system the primary cooling is supplied by the chilled beams within the space. Fresh air is only supplied in a chilled beam system to eliminate the latent load, which is usually much less than the sensible load, or to meet ventilation requirements. Using TRANE TRACE 700 software the conventional VAV system was modeled against the Active chilled beams.

Table 34: Supply Air Comparison for Original System and Chilled Beams

| UNIT            | SYSTEM               | 100 %OA Cooling CFM | Heating CFM |
|-----------------|----------------------|---------------------|-------------|
| <b>EXISTING</b> |                      |                     |             |
| AHU-1-2         | VAV                  | 77,274              | 26,333      |
| AHU-3-4         | VAV                  | 223,882             | 121,876     |
| <b>REDESIGN</b> |                      |                     |             |
| AHU-1-2         | VAV                  | 77,274              | 26,333      |
| <b>% CHANGE</b> |                      | 0%                  | 0%          |
| AHU-3-4         | ACTIVE CHILLED BEAMS | 82,552              | 82,552      |
| <b>% CHANGE</b> |                      | -63%                | -32%        |

Because of this vast reduction in supply air by the addition of chilled beams to many spaces there are some savings available in the elimination of one of the four 28,750 CFM air handlers supplying the building. This elimination keeps the other three remaining air handlers at roughly the same CFM as they were in the original. This also means the downsizing of the exhaust air-handling units. The results can be seen in the table below.

Table 35: Air Handling Units Redesigned Supply For Chilled Beams System

| <b>AHU Redesign</b> |               |        |          |                   |
|---------------------|---------------|--------|----------|-------------------|
| Unit                | Fan Type      | # Fans | Original | Redesign          |
| AHU1                | <i>plenum</i> | 4      | 28750    | 30516             |
| AHU2                | <i>plenum</i> | 4      | 28750    | 30516             |
| AHU3                | <i>plenum</i> | 4      | 28750    | 30516             |
| AHU4                | <i>plenum</i> | 4      | 28750    | <b>ELIMINATED</b> |
| AHU5                | <i>plenum</i> | 4      | 15000    | 15000             |
| EAHU1               | <i>Cent.</i>  | 5      | 57,500   | 45,774            |
| EAHU2               | <i>Cent.</i>  | 5      | 57,500   | 45,774            |
| EAHU3               | <i>Cent.</i>  | 3      | 30000    | 30000             |

This new demand for supply air means the supply and exhaust fans can be downsized to meet the new requirements. The CFM calculated from TRACE above was used to calculate these new fan sizes. These calculations were performed using the fan affinity laws under the assumption that there is a constant pressure drop of 0.08" WG per 100' and the ductwork distribution is similar to the existing design.

Table 36: New Fan Sizing

| Fan Sizing      |               |          |        |        |       |      |
|-----------------|---------------|----------|--------|--------|-------|------|
| Unit            | Type          | Quantity | CFM    | Min SP | HP    | RPM  |
| <b>EXISTING</b> |               |          |        |        |       |      |
| AHU1            | <i>plenum</i> | 4        | 28750  | 7.5    | 75    | 1750 |
| AHU2            | <i>plenum</i> | 4        | 28750  | 7.5    | 75    | 1750 |
| AHU3            | <i>plenum</i> | 4        | 28750  | 7.5    | 75    | 1750 |
| AHU4            | <i>plenum</i> | 4        | 28750  | 7.5    | 75    | 1750 |
| AHU5            | <i>plenum</i> | 4        | 15000  | 7.5    | 50    | 1750 |
| EAHU1           | <i>Cent.</i>  | 5        | 57,500 | 5.3    | 100   | 770  |
| EAHU2           | <i>Cent.</i>  | 5        | 57,500 | 5.3    | 100   | 770  |
| EAHU3           | <i>Cent.</i>  | 3        | 30000  | 4.5    | 50    | 1132 |
| <b>REDESIGN</b> |               |          |        |        |       |      |
| Unit            | Type          | Quantity | CFM    | Min SP | HP    | RPM  |
| AHU1            | <i>plenum</i> | 4        | 30516  | 7.5    | 89.76 | 1858 |
| AHU2            | <i>plenum</i> | 4        | 30516  | 7.5    | 89.76 | 1858 |
| AHU3            | <i>plenum</i> | 4        | 30516  | 7.5    | 89.76 | 1858 |
| AHU5            | <i>plenum</i> | 4        | 15000  | 7.5    | 50    | 1750 |
| EAHU1           | <i>Cent.</i>  | 5        | 45,774 | 5.3    | 50.46 | 613  |
| EAHU2           | <i>Cent.</i>  | 5        | 45,774 | 5.3    | 50.46 | 613  |
| EAHU3           | <i>Cent.</i>  | 3        | 30000  | 4.5    | 50    | 1132 |

## Waterside Summary

### Chilled Water System

Separate chiller plants can be used in the design of chilled beams; this allows the chillers to operate at a higher coefficient of performance due to the higher supply water temperature to the beams, to avoid condensation. This is not the typical choice in design due to a higher installed cost.

A more common plant configuration for chilled beams is to use one set of chillers to make cold water at one temperature for the entire building. Some of this water will be sent to the primary cooling coils in the air-handling units and the rest is to be mixed with warm water, which is returning from the chilled beams. This design shall be utilized for the redesign of 75 Ames Street.

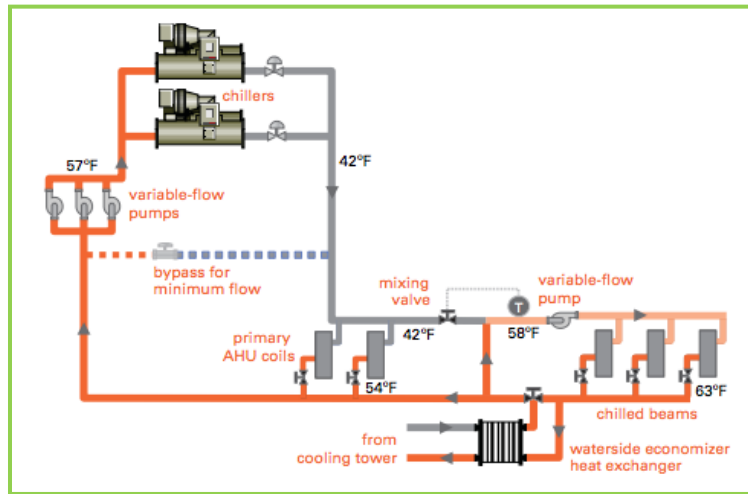


Figure 24: Chilled Water Supply Schematic

### Chilled Water Pump Sizing

To size the chilled beam variable flow pump the total BTU/HR of 4582210.148 was determined for each space using the excel spreadsheet sizing each chilled beam. Sizing the pump GPM can be done using the equation below.

$$Q=500 \times \text{GPM} \times \text{DT}$$

Where...

$$\text{DT}=5$$

$$Q= 4582210 \text{ BTU/HR}$$

$$\text{GPM}= (4582210 \text{ BTU/HR}) / (5 \times 500) = 1832.884 \text{ GPM}$$

Now that the flow has been determined the pressure drop can be calculated to correctly size the pump. Due to similar designs for each floor the flow to each floor was determined by a floor area to service area ratio. Next a piping layout was determined for the 6th floor to determine the piping length and fittings that will add to the pressure drop. Pipes were sized based on a 4 ft per 100 ft maximum pressure drop for pipes larger than 2" and a max velocity of 4 fps for pipes 2" or smaller. The total head loss was determined to be 59 ft H<sub>2</sub>O for level 6. Further detail can be found in APPENDIX I

Table 37: Chilled Water Piping For Chilled Beams GPM, Size and Head.

| CHILLED BEAM AREA PER FLOOR |                   |                    |               |                |                    |
|-----------------------------|-------------------|--------------------|---------------|----------------|--------------------|
| Floor Number                | AREA [FT^2]       | PERCENT TOTAL AREA | GPM PER FLOOR | Pipe Size [IN] | Head [FT H2O]      |
| 2                           | 4807              | 4%                 | 78            | 3              | 23.3               |
| 3                           | 7013              | 6%                 | 114           | 3              | 34.0               |
| 4                           | 6611.1            | 6%                 | 108           | 3              | 32.0               |
| 5                           | 6624.06           | 6%                 | 108           | 3              | 32.1               |
| 6                           | 14575.124         | 13%                | 237           | 4              | 70.6               |
| 7                           | 16807.1           | 15%                | 273           | 5              | 81.4               |
| 8                           | 15341.99          | 14%                | 250           | 4              | 74.3               |
| 9                           | 14467.989         | 13%                | 235           | 4              | 70.1               |
| 10                          | 14180             | 13%                | 231           | 4              | 68.7               |
| 11                          | 12250             | 11%                | 199           | 4              | 59.3               |
| <b>TOTAL</b>                | <b>112677.617</b> | <b>100%</b>        | <b>1833</b>   |                | <b>545.7956831</b> |

Using the max head loss of 81.4 FT H2O a pump was able to be selected from Bell & Gossett 1510 series catalog for centrifugal pumps. The pump was selected using the pump curve below, with roughly 1500 GPM and 70 ft head in feet. The result was a 40 HP pump on a variable frequency drive to meet the system curve.

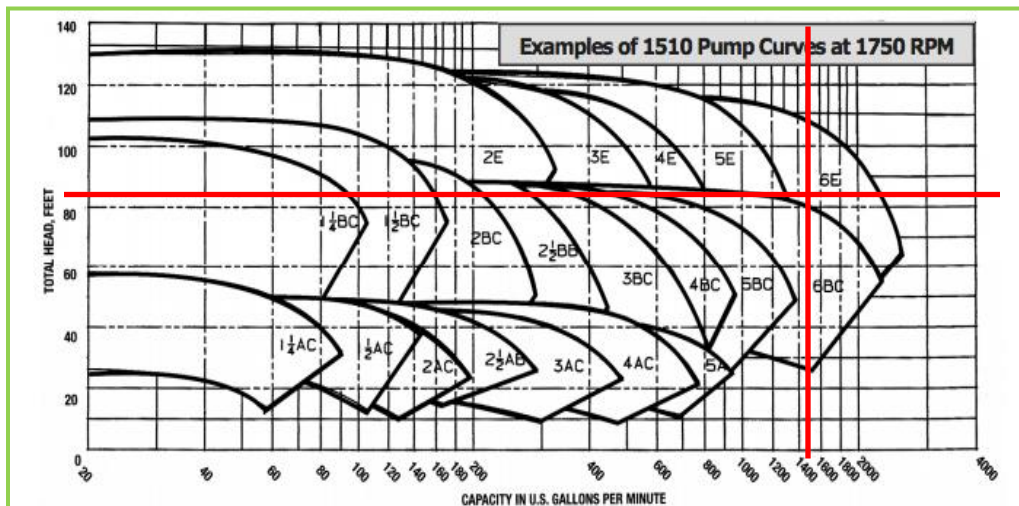


Figure 25: Bell and Gossett Pump Selection Graph

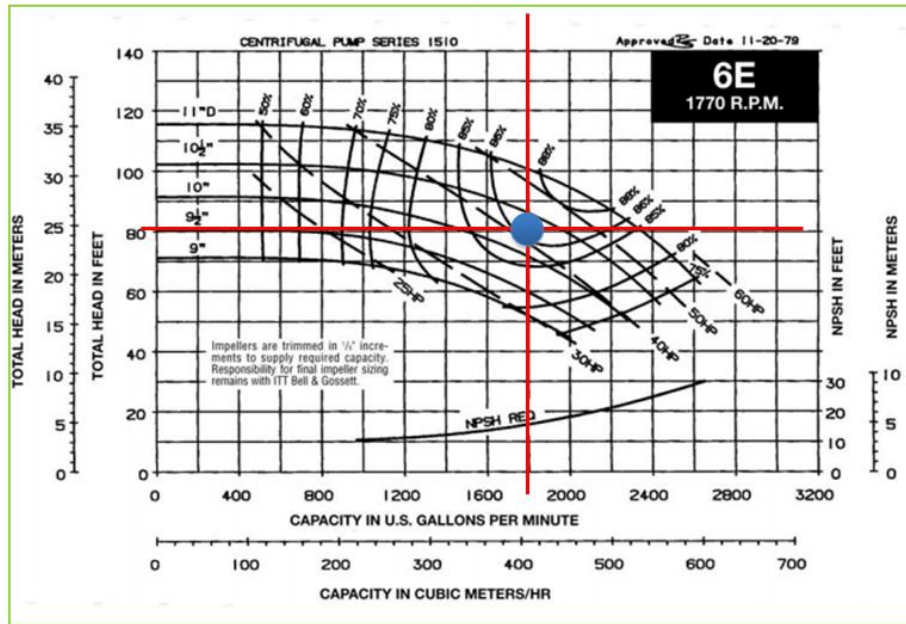


Figure 26: Chilled Water Pump Curve

### System Controls

Typically chilled beams are constant volume systems. But on occasion chilled beams used in line with a VAV box enabling an even less use of supply air. This can have troubles with controls and it must always be assured that each room maintains acceptable rates to deal with the latent loads and contain the room dew point.

Varying the water flow rate or supply temperature to the beam using a zone level thermostat is done to control the room temperature. Modulating the flow rate can typically produce a 7 or 8 degree Fahrenheit change in the supplied temperature. This small change reduces the beams sensible cooling rate by as much as 60%. Care must be taken to maintain a reasonable space dew point temperature and a chilled water supply temperature well above this value. Dew point sensors should be used to ensure proper levels are maintained. A dew point sensor would reset water temperature higher thus increasing the surface temperatures and not allowing condensate to form. A dew point sensor could also shut supply to the beam off and let the primary airflow bring the dew point back to the proper level. The beam supply is varied using a floating-point 2-way valve actuators providing on/off control. The zone thermostat controls the valves. Isolation Valves are used to isolate the chilled beams from the overall system if beams need maintenance or replacing.

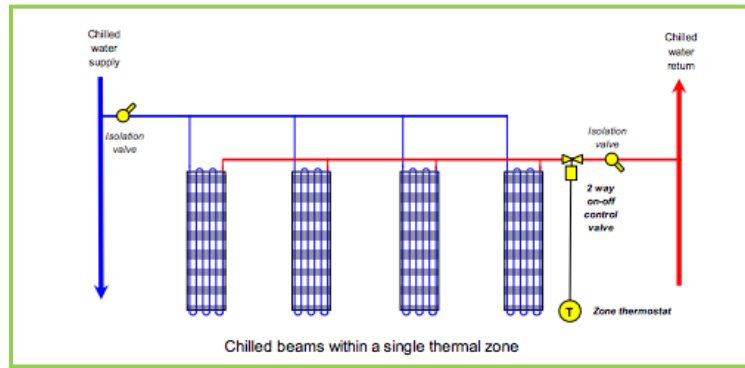


Figure 27: Chilled Beams Chilled Water Piping Controls

Not only can sensors in the rooms be used to monitor comfort and the chilled beams performance, but moisture monitors on the pipes themselves can be installed on the coldest pipe locating in a room. When moisture is detected the water flow is shut down and will not restore until the moisture has been evaporated.

Labs tend to need to be more control strategies than normal office spaces. Along with the typical chilled beam controls a general exhaust is required for pressurization and fume hood turndown.

## Energy Model

Trane Trace 700 was used to calculate the energy usage from a chilled beam. The Trace inputs are shown below.

Table 38: Trace Inputs for Chilled Beams

| TRANE TRACE 700 : 75 Ames Inputs |   |                     |                      |
|----------------------------------|---|---------------------|----------------------|
| Location/Weather                 | Boston, Massachusetts                           |                     |                      |
| System                           | VAV System with reheat (30% Min Flow)           |                     |                      |
|                                  | Active Chilled Beams (48 BTU/ (CFM Primary Air) |                     |                      |
| Room Set Points                  |   | Winter (°F)         | Summer (°F)          |
|                                  | Temperature                                     | 72                  | 75                   |
|                                  | Humidity  | 25% (±5)            | 50% (±5)             |
| Internal Loads                   |   | Lighting (Watts/SF) | Equipment (Watts/SF) |
|                                  | Office  | 1.2                 | 2                    |
|                                  | Labs  | 2                   | 10                   |
|                                  | Tissue Culture:                                 | 2                   | 20                   |
| Airside Components               | 100% Outside Air System                         |                     |                      |
|                                  | Duct Supply air Temp Max (°F)                   | 55                  |                      |

|                      |   |                   |          |         |
|----------------------|---|-------------------|----------|---------|
|                      | Duct Supply air Min (°F)  | 52                |          |         |
|                      | Humidity ratio difference (gr/lb.)  | 0.0012            |          |         |
| Waterside Components |   | EWT (°F)          | LWT (°F) | ΔT (°F) |
|                      | Chiller   | 56                | 42       | 14      |
|                      | Evaporator  | 95                | 85       | 10      |
| Schedules            | <i>During unoccupied times ventilation rates are lowered<br/>See Appendix G</i> |                   |          |         |
| Ventilation Rates    | Labs  | 6 to 12 ACH       |          |         |
|                      | Office  | 20 CFM Per Person |          |         |

## Energy Analysis

Running the Trace model under the conditions noted in Table 38 there were very high-energy savings compared to the original system. The greatest energy savings comes from the electricity cost per year. The change to the chilled beams yields a saving of \$435,796.82 annually from electricity costs, and \$96,420.47 annually for natural gas costs. The total savings is \$532,217.29 per year. A detailed breakdown is shown below in tables 39 and 40.

Table 39: Utility Costs

| Utility     | Unit     | Cost  |
|-------------|----------|-------|
| Electricity | \$/KWH   | 0.201 |
| Natural Gas | \$/Therm | 1.597 |

Table 40: Chilled Beams Energy Cost Analysis

|                 | Electricity (kWh) | Natural Gas (Therms) | Electricity Cost Per year | Natural Gas Cost per year | Total Cost Per Year |
|-----------------|-------------------|----------------------|---------------------------|---------------------------|---------------------|
| Original System | 9,985,524.00      | 107,047.00           | \$2,007,090.32            | \$170,954.06              | \$2,178,044.38      |
| Chilled Beams   | 7,817,379.00      | 46,671.00            | \$1,571,293.18            | \$74,533.59               | \$1,645,826.77      |
|                 |                   |                      |                           | <b>% Change</b>           | <b>-24%</b>         |

The graph below (figures 28--29) shows a more detailed breakdown of energy usage by month and equipment. In figure 28 it can be seen the greatest savings are accumulated in the summer months due to the lowering of fan power needed to supply and cool a space.



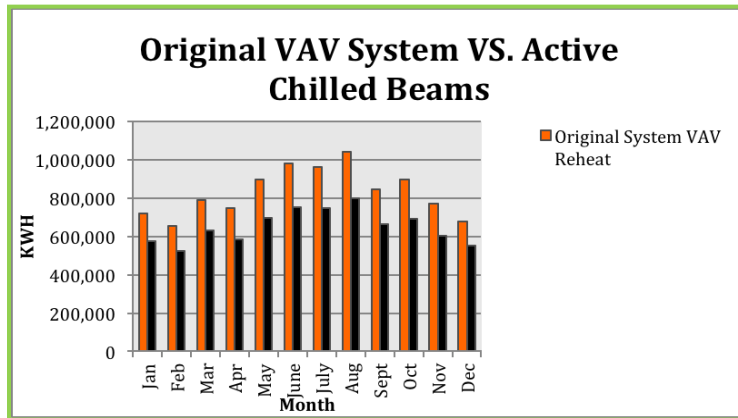


Figure 28: Original Vs. Chilled Beams Electricity usage

Great savings are also seen in the heating during the winter months in figure 29. This is due to the fact that the air does not have to be reheated to get back up to acceptable temperatures such as what happens in traditional VAV systems.

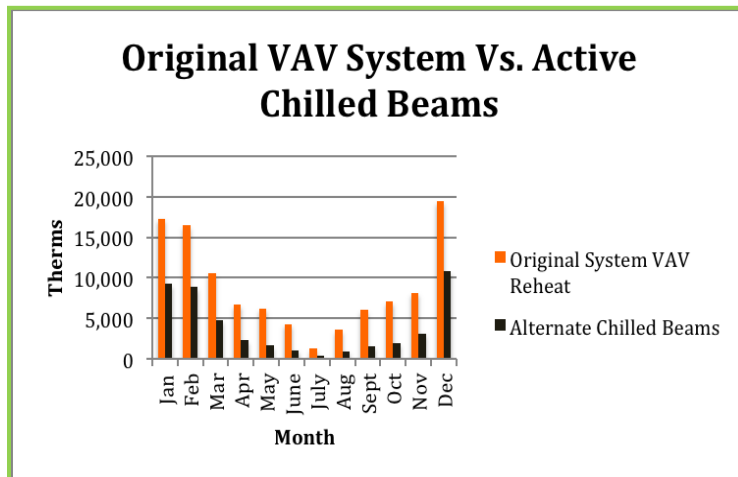


Figure 29: Original Vs. Chilled beams Gas Usage

Figure 30 yields the electricity usage breakdown by equipment. Since this building is part load and part office there are high receptacle loads compromising most of the cost. The next highest usage of electricity is the fans, which shows why it is so effective in terms of energy usage to improve the fan efficiency and lower the power needed to supply the fans.

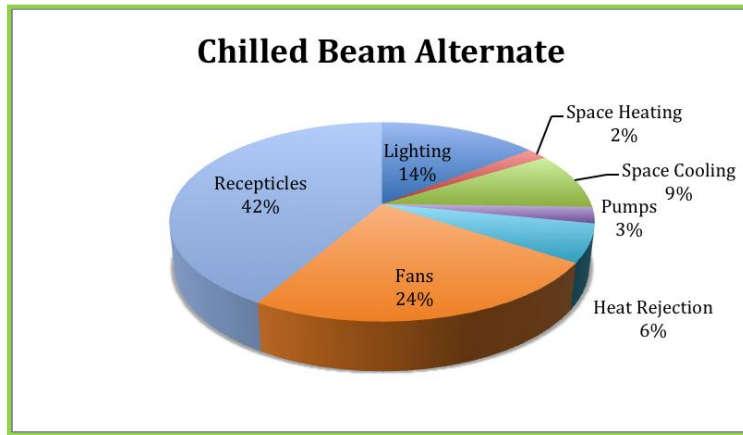


Figure 30: Chilled Beams Electricity Usage Breakdown

## Cost Analysis

A study was conducted on the cost of the first cost of the chilled beams, the payback period, and the lifecycle cost for the installation of the chilled beams system, and can be found below.

### First Cost

Using the chilled beam schedule in Appendix H the total cost of the chilled beams could be calculated. The total linear feet of the beams added was multiplied by 130\$/LF for chilled beams. Next the cost of the VAV boxes and diffusers were calculated. Next the VAV boxes were resized based on the new supply air CFM.

For piping a general layout was prepared for the 6<sup>th</sup> floor and then extrapolated for each other floor due to similar floor layouts. Lastly the downsizing of the exhaust air handling units by adding up all the chilled beams, piping, AHU removal, and VAV resizing the total chilled beams cost was found. This was then subtracted by the original VAV box cost and diffuser cost to find the cost difference between the two systems. This equated out to an additional cost of \$743167.79 for the chilled beams system. A breakdown of the cost can be found in table 41. A more detailed breakdown may be found in APPENDIX H.

Table 41: Chilled Beam Cost Analysis

| Unit   | Cost                  |
|--|-----------------------|
| <b>Chilled Beams &amp; Resized VAV Box's Total</b> | <b>\$962,824.69</b>   |
| <b>VAV BOX &amp; Diffusers</b>                     | <b>\$(417,784.28)</b> |
| <b>Piping</b>                                      | <b>\$822,942.38</b>   |
| <b>AHU Removal</b>                                 | <b>\$(640,815.00)</b> |
| <b>CHW PUMP</b>                                    | <b>\$16,000.00</b>    |
| <b>Total Cost</b>                                  | <b>\$743,167.79</b>   |

## Life Cycle Cost

Using the additional chilled beam cost found above payback period compared to at VAV reheat system could be found. With the total savings of \$532,217.29 per year the payback period took just over a year (1.4 year payback). A breakdown of this can be found in table 42. Table 42 also shows the savings compared to the original VAV system after 10 years and the additional savings after 10 years can be found to be \$4,579,008.38.

Table 42: Chilled Beams 10 Year Cost Analysis

| 10 Year Life Cycle Cost Analysis |                            |                         |
|----------------------------------|----------------------------|-------------------------|
| YEAR                             | Original System VAV Reheat | Chilled Beams Alternate |
| 0                                | \$0                        | \$743,167.79            |
| 1                                | \$2,178,044.38             | \$2,388,994.56          |
| 2                                | \$4,356,088.77             | \$4,034,821.32          |
| 3                                | \$6,534,133.15             | \$5,680,648.09          |
| 4                                | \$8,712,177.53             | \$7,326,474.86          |
| 5                                | \$10,890,221.92            | \$8,972,301.62          |
| 6                                | \$13,068,266.30            | \$10,618,128.39         |
| 7                                | \$15,246,310.68            | \$12,263,955.15         |
| 8                                | \$17,424,355.06            | \$13,909,781.92         |
| 9                                | \$19,602,399.45            | \$15,555,608.69         |
| 10                               | \$21,780,443.83            | \$17,201,435.45         |

## Emissions Reduction

Due to the reduction in energy usage the negative effects from the production of that energy will be reduced as well. Using Trane Trace 700 the environmental impact of three main pollutants was studied. The three pollutants studied were CO<sub>2</sub>, SO<sub>2</sub>, and NO<sub>x</sub>. As seen in Table 43, the impact on the environment from adding the chilled beams was greatly reduced. It should be noted that this study does not take into account the impact of creating the equipment for the new systems. The building emissions for all three pollutants were reduced by 22%. CO<sub>2</sub> output was most drastically changed by 191,112,128 lbm/yr.

Table 43: Environmental Impact of Chilled Beams

| ENVIRONMENTAL IMPACT |        |                            |                         |          |             |
|----------------------|--------|----------------------------|-------------------------|----------|-------------|
| Pollutant            | Unit   | Original System VAV Reheat | Chilled Beams Alternate | % Change | Difference  |
| CO <sub>2</sub>      | lbm/yr | 876,396,480                | 685,284,352             | -21.81%  | 191,112,128 |
| SO <sub>2</sub>      | gm/yr  | 2,742,078                  | 2,144,125               | -21.81%  | 597,953     |
| NO <sub>x</sub>      | gm/yr  | 742,165                    | 580,324                 | -21.81%  | 161,841     |

## Summary

75 Ames Street is a perfect candidate for a chilled beams system for day 1 use. Chilled beams can be used in labs and offices to lower the airflow needed to cool or heat a space. In 75 Ames case there is great savings involved and a very acceptable payback period. Not only are the economics favorable but there is also the large incentive to install this system because of the large environmental impact savings.

## Depth III: Chilled Beams & Arcuity's Demand Controlled Ventilation

### Objectives

By combining the chilled beam system with the Arcuity Optinet system even lower energy rates may be obtained. Chilled beams in the labs must still supply enough air for ventilation for the space. This leaves the system with even more room to turn down the airflow rates by using a demand controlled ventilation system.

### Design Considerations

The design considerations are the same for both the chilled beams from Depth II and the Aircuity Optinet demand controlled ventilation system in Depth I. By following the designs outlined in each depth an analysis can be performed on the two systems working together. The table below shows the inputs put into TRANE TRACE 700 to calculate the Energy usage of this new design.

Table 44: Trace 700 Inputs DCV & Aircuity

| TRANE TRACE 700 : 75 Ames Inputs |   |                     |                      |         |
|----------------------------------|---|---------------------|----------------------|---------|
| Location/Weather                 | Boston, Massachusetts   |                     |                      |         |
| System                           | VAV System with reheat (30% Min Flow)                                   |                     |                      |         |
|                                  | Active Chilled Beams (48 BTU/ (CFM Primary Air)                         |                     |                      |         |
| Room Set Points                  |   | Winter (°F)         | Summer (°F)          |         |
|                                  | Temperature   | 72                  | 75                   |         |
|                                  | Humidity  | 25% (±5)            | 50% (±5)             |         |
| Internal Loads                   |   | Lighting (Watts/SF) | Equipment (Watts/SF) |         |
|                                  | Office  | 1.2                 | 2                    |         |
|                                  | Labs  | 2                   | 10                   |         |
|                                  | Tissue Culture:   | 2                   | 20                   |         |
| Airside Components               | 100% Outside Air System   |                     |                      |         |
|                                  | Duct Supply air Temp Max (°F)   | 55                  |                      |         |
|                                  | Duct Supply air Min (°F)  | 52                  |                      |         |
|                                  | Humidity ratio difference (gr/lb.)                                      | 0.0012              |                      |         |
| Waterside Components             |   | EWT (°F)            | LWT (°F)             | ΔT (°F) |
|                                  | Chiller   | 56                  | 42                   | 14      |
|                                  | Evaporator  | 95                  | 85                   | 10      |
| Schedules                        | During unoccupied times ventilation rates are lowered<br>See Appendix G |                     |                      |         |
| Ventilation Rates                | Labs  | 6 to 12 ACH         |                      |         |
|                                  | Labs DCV  | 2 to 4 ACH          |                      |         |
|                                  | Office  | 20 CFM Per Person   |                      |         |

## Energy Usage Estimates

Using Trane Trace 700 and the variables described above the following energy consumption was found.

Table 45: DCV & Chilled Beams Energy Usage

|                            | Electricity (kWh) | Natural Gas (Therms) | Electricity Cost Per year | Natural Gas Cost per year | Total Cost Per Year |
|----------------------------|-------------------|----------------------|---------------------------|---------------------------|---------------------|
| <b>Original System</b>     | 9,985,524.00      | 107,047.00           | \$2,007,090.32            | \$170,954.06              | \$2,178,044.38      |
| <b>Chilled Beams + DCV</b> | 7,493,006.00      | 42,136.00            | \$1,506,094.21            | \$67,291.19               | \$1,573,385.40      |
| <b>Difference</b>          | 2,492,518.00      | 64,911.00            | \$500,996.12              | \$103,662.87              | \$604,658.99        |
|                            |                   |                      |                           | <b>% change</b>           | <b>-28%</b>         |

Table 45 shows the increase percent change of the total energy cost per year of the combinations of the two systems vs. the original VAV reheat system. The chilled beams, which changed the energy use by 24 % and the Aircuity system that changed it by 9 %, were able to decrease the total energy by 28 % when combined. This means that annually \$604,658.99 is saved.

### First Cost

The first cost of this system is just the sum of the first costs from Depth 1 and Depth 2. There is no other equipment necessary to make this work. The equipment cannot be downsized further than it was in the chilled beams because the Aircuity system must be able to meet the system purge conditions where labs may need high air change rates to get rid of chemical contaminants in a room.

### Lifecycle

Below table 46 shows the 10 year savings and a payback of 1.5 years. The first cost is \$743,167.79 for the chilled beams and \$160,000.00 for the Aircuity system, totaling \$903,167.79. Since the system saves \$604,658.99 a year compared to the original system it does not take long to pay itself off. The Aircuity system also has the option of yearly maintenance for \$20963, which is waived the first year. For just the Aircuity system with no maintenance the total savings after 10 years is \$5,143,421.23. If the maintenance is chosen the 10-year savings is \$4,954,754.23.

Table 46: DCV & Chilled Beams 10 Year Lifecycle & Payback

| 10 Year Life Cycle Cost Analysis |                            |                               |                                  |
|----------------------------------|----------------------------|-------------------------------|----------------------------------|
| YEAR                             | Original System VAV Reheat | DCV + Chilled Beams Alternate | With Maintenance First Year Free |
|                                  |                            |                               |                                  |

|    |                 |                 |                 |
|----|-----------------|-----------------|-----------------|
| 0  | \$0             | \$903,167.79    | \$903,167.79    |
| 1  | \$2,178,044.38  | \$2,476,553.19  | \$2,476,553.19  |
| 2  | \$4,356,088.77  | \$4,049,938.59  | \$4,070,901.59  |
| 3  | \$6,534,133.15  | \$5,623,323.98  | \$5,665,249.98  |
| 4  | \$8,712,177.53  | \$7,196,709.38  | \$7,259,598.38  |
| 5  | \$10,890,221.92 | \$8,770,094.78  | \$8,853,946.78  |
| 6  | \$13,068,266.30 | \$10,343,480.18 | \$10,448,295.18 |
| 7  | \$15,246,310.68 | \$11,916,865.58 | \$12,042,643.58 |
| 8  | \$17,424,355.06 | \$13,490,250.97 | \$13,636,991.97 |
| 9  | \$19,602,399.45 | \$15,063,636.37 | \$15,231,340.37 |
| 10 | \$21,780,443.83 | \$16,637,021.77 | \$16,825,688.77 |

## Emissions

By placing the two systems together 75 Ames Street was able to gain even greater energy savings, up to a 25% change in emissions. 218,760,064. That is equivalent to the emissions of 19,200 cars per year. The entire emissions breakdown can be found in table 47 below.

Table 47: DCV & Chilled Beams Environmental Impact

| ENVIRONMENTAL IMPACT |        |                            |                               |          |             |
|----------------------|--------|----------------------------|-------------------------------|----------|-------------|
| Pollutant            | Unit   | Original System VAV Reheat | DCV & Chilled Beams Alternate | % Change | Difference  |
| CO2                  | lbm/yr | 876,396,480                | 657,636,416                   | -24.96%  | 218,760,064 |
| SO2                  | gm/yr  | 2,742,078                  | 2,057,619                     | -24.96%  | 684,459     |
| NOX                  | gm/yr  | 742,165                    | 556,911                       | -24.96%  | 185,254     |

## Summary

Combining both systems amounts to the greatest savings. These two systems tend to complement each other, the chilled beams act to remove a bulk of the fan power needed in labs and offices, then the Aircurity lets the labs supply air be turned down even lower. Using this system with the yearly maintenance would be the best choice of the three depths discussed. The maintenance is import to ensure the system is reading properly and monitoring the rooms to ensure safety to the occupants.

## Breadth I: Electrical/ Lighting

### Introduction

75 Ames's transition from a VAV system to a chilled beam system resulted in changes to equipment sizing. This size change will result in changes to the power distribution, which will be discussed below. There was also a change to the room layout due to chilled beams being longer than just a normal diffuser. The changes to the ceiling plan and effect on lighting for the offices shall also be analyzed.

## Design: Electrical

Using fan affinity laws the new fan horse power could be found. Using Table 430.250 *Full Load Current Three-Phase Alternating-Current Motors* from the NEC 2011 for the fans and pumps the full load current was found. From this it was possible to calculate the volt-amps for each motor using the following formula...

$$FLA = KVA / (Voltage \sqrt{3}) \rightarrow KVA = (Voltage)(\sqrt{3})(FLA)$$

Using the full load amps with a 1.25 multiplier for continuous loads the wire is able to be sized using Table 310.15(B)(16) from the NEC 2011 for a THWN type wire rated for 75°C. The next step is to size the short circuit protection. From Table 430.52 in the NEC 2011 and using a 2.5 multiplier on the FLC the circuit breaker amps are found. In this assessment the next lowest breaker size was chosen. For example if the amps are found to be 160 a 150-amp circuit breaker would be chosen. Now that both the circuit breaker and wires are chosen a ground wire needs to be sized based on the circuit breaker size using table 250.122 from the NEC 2011. The conduit size is chosen by using Table C.1 in the NEC 2011 for electromagnetic tubing (EMT). Lastly the starter size and local disconnect must be sized. The starter is based off of a chart of NEMA Starter Sizes and local disconnects come in standard sizes of 30, 60, 100, and 200 amps so the next higher disconnect is chosen based on the FLC.

Below Table 48 shows the sizes selected for the new and old equipment installed in 75 Ames Street.



| Existing |        |      |       |        |     |     |          |           |         |             |          |         |          |         |             |
|----------|--------|------|-------|--------|-----|-----|----------|-----------|---------|-------------|----------|---------|----------|---------|-------------|
| UNIT     | UNIT # | Volt | Phase | Fan HP | FLA | kVA | Wire     | Wire amps | Conduit | Starter     | Load Amp | CB Size | Gnd Size | Disc. A | Panel Board |
| AHU1     | SF1    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | E4M31       |
|          | SF2    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | E4M32       |
|          | SF3    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | DP4M21      |
|          | SF4    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | DP4M21      |
| AHU2     | SF1    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | E4M32       |
|          | SF2    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | E4M32       |
|          | SF3    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | DP4M31      |
|          | SF4    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | DP4M31      |
| AHU3     | SF1    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | E4M32       |
|          | SF2    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | E4M31       |
|          | SF3    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | SWB-4M2     |
|          | SF4    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | SWB-4M2     |
| AHU4     | SF1    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | E4M32       |
|          | SF2    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | E4M32       |
|          | SF3    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | SWB-4M3     |
|          | SF4    | 480  | 3     | 75     | 96  | 80  | 4 - #1   | 120       | 1-1/4"  | NEMA SIZE 4 | 240      | 225     | 4        | 100     | SWB-4M3     |
| AHU5     | SF1    | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | EDP4M31     |
|          | SF2    | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | EDP4M31     |
|          | SF3    | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | EDP4M31     |
|          | SF4    | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | EDP4M31     |
| EAHU1    | EF1    | 480  | 3     | 100    | 124 | 103 | 4 - #2/0 | 155       | 2"      | NEMA SIZE 4 | 310      | 300     | 3        | 200     | E4M32       |
|          | EF2    | 480  | 3     | 100    | 124 | 103 | 4 - #2/0 | 155       | 2"      | NEMA SIZE 4 | 310      | 300     | 3        | 200     | E4M31       |
|          | EF3    | 480  | 3     | 100    | 124 | 103 | 4 - #2/0 | 155       | 2"      | NEMA SIZE 4 | 310      | 300     | 3        | 200     | SWB-4M3     |
|          | EF4    | 480  | 3     | 100    | 124 | 103 | 4 - #2/0 | 155       | 2"      | NEMA SIZE 4 | 310      | 300     | 3        | 200     | SWB-4M3     |
|          | EF5    | 480  | 3     | 100    | 124 | 103 | 4 - #2/0 | 155       | 2"      | NEMA SIZE 4 | 310      | 300     | 3        | 200     | SWB-4M3     |
| EAHU2    | EF1    | 480  | 3     | 100    | 124 | 103 | 4 - #2/0 | 155       | 2"      | NEMA SIZE 4 | 310      | 300     | 3        | 200     | E4M32       |
|          | EF2    | 480  | 3     | 100    | 124 | 103 | 4 - #2/0 | 155       | 2"      | NEMA SIZE 4 | 310      | 300     | 3        | 200     | E4M32       |
|          | EF3    | 480  | 3     | 100    | 124 | 103 | 4 - #2/0 | 155       | 2"      | NEMA SIZE 4 | 310      | 300     | 3        | 200     | SWB-4M2     |
|          | EF4    | 480  | 3     | 100    | 124 | 103 | 4 - #2/0 | 155       | 2"      | NEMA SIZE 4 | 310      | 300     | 3        | 200     | SWB-4M2     |
|          | EF5    | 480  | 3     | 100    | 124 | 103 | 4 - #2/0 | 155       | 2"      | NEMA SIZE 4 | 310      | 300     | 3        | 200     | SWB-4M2     |
| EAHU3    | EF1    | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | E4M33       |
|          | EF2    | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | E4M33       |
|          | EF3    | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | E4M33       |

| Redesign |               |      |       |        |     |     |          |           |         |             |          |         |          |         |             |
|----------|---------------|------|-------|--------|-----|-----|----------|-----------|---------|-------------|----------|---------|----------|---------|-------------|
| UNIT     | UNIT #        | Volt | Phase | Fan HP | FLA | kVA | Wire     | Wire amps | Conduit | Starter     | Load Amp | CB Size | Gnd Size | Disc. A | Panel Board |
| AHU1     | SF1           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | E4M31       |
|          | SF2           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | E4M32       |
|          | SF3           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | DP4M21      |
|          | SF4           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | DP4M21      |
| AHU2     | SF1           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | E4M32       |
|          | SF2           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | E4M32       |
|          | SF3           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | DP4M31      |
|          | SF4           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | DP4M31      |
| AHU3     | SF1           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | E4M32       |
|          | SF2           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | E4M31       |
|          | SF3           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | SWB-4M2     |
|          | SF4           | 480  | 3     | 90     | 113 | 94  | 4 - #1/0 | 141.25    | 1-1/2"  | NEMA SIZE 4 | 282.5    | 250     | 4        | 200     | SWB-4M2     |
| AHU5     | SF1           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | EDP4M31     |
|          | SF2           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | EDP4M31     |
|          | SF3           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | EDP4M31     |
|          | SF4           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | EDP4M31     |
| EAHU1    | EF1           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | E4M32       |
|          | EF2           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | E4M31       |
|          | EF3           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | SWB-4M3     |
|          | EF4           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | SWB-4M3     |
|          | EF5           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | SWB-4M3     |
| EAHU2    | EF1           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | E4M32       |
|          | EF2           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | E4M32       |
|          | EF3           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | SWB-4M2     |
|          | EF4           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | SWB-4M2     |
|          | EF5           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | SWB-4M2     |
| EAHU3    | EF1           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | E4M33       |
|          | EF2           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | E4M33       |
|          | EF3           | 480  | 3     | 50     | 65  | 54  | 4 - #4   | 81.25     | 1"      | NEMA SIZE 3 | 162.5    | 150     | 6        | 100     | E4M33       |
| CHWP     | CHILLED BEAMS | 480  | 3     | 40     | 52  | 43  | 4 - #6   | 65        | 3/4"    | NEMA SIZE 3 | 130      | 110     | 6        | 100     | EDP4M21     |

Table 48: New Motor Wiring, Circuit Breaker, Starter and Disconnect Schedule

## Design: Lighting

Due to the length of chilled beams the ceiling layout will be affected and a main component may need to be moved for effective placement of the chilled beams. The typical lighting for offices is volumetric series fluorescent lighting from Lithonia Lighting. Using AGI 32 lighting analysis software the movement of the lights for a typical office space was analyzed. A 2 T8 lamp 32watt 2x4 was analyzed against the placement of 2 2x2 24watt LED lights and 2 2x2 T5 14 watt lights in volumetric troffers. Typically offices are best when lit to be between 40-50 foot-candles by an overhead light. For any job that may require more task lighting on the desks can be utilized.

The room was designed using the following assumption for reflectance

Table 49: Surface Reflectance's

| Surface | Reflect |
|---------|---------|
| Floor   | 0.65    |
| Wall    | 0.70    |
| Ceiling | 0.75    |

Below is a breakdown of each lighting type and their room layouts.

### Option 1

This first lighting breakdown is the typical for the office room type. As one can see in the following figures 31 & 32 lighting is reaching acceptable regions. The Problem with this layout is the chilled Beam will be placed in the center of the room for the best occupancy comfort due to symmetric throw patters, disrupting the lighting layout. Below there are 3 alternates studied to find the best new layout.

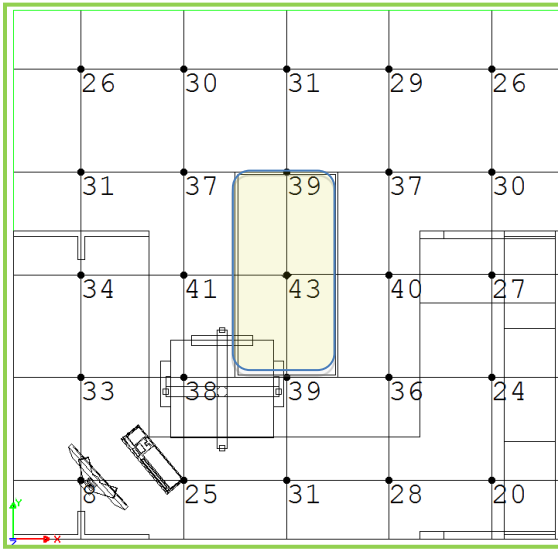


Figure 31: Original Lighting Layout



Figure 32: Rendered Original Lighting Layout

At first the original luminaire was rotated horizontally and moved closer towards the desk wall. This ensured higher illuminance. This can be seen in figure 33 & 34. One notable feature of this though is a very uneven distribution of light throughout the room. The areas around the wall opposite the desk fall to as low as 19 foot candles. A well-designed room should have a relatively uniform lighting so this layout is undesirable. Another option with the original light was just to move it to the left by one 2x4 unit. This leads to a semi un-uniform layout, but the lighting concentration is on the area where the worker will primarily be. This layout can be seen in figure 35. If the original light is to be used this would be the best position for the light to be placed. And according to drillspot.com this light would only cost \$195.06/ EA-Each, so only \$195.06per office.

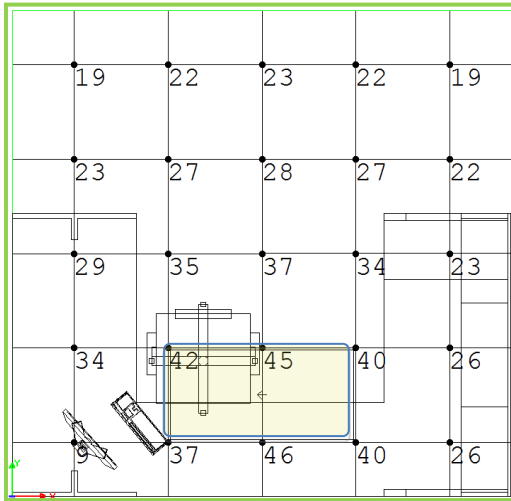


Figure 33: Lighting Layout Option 1

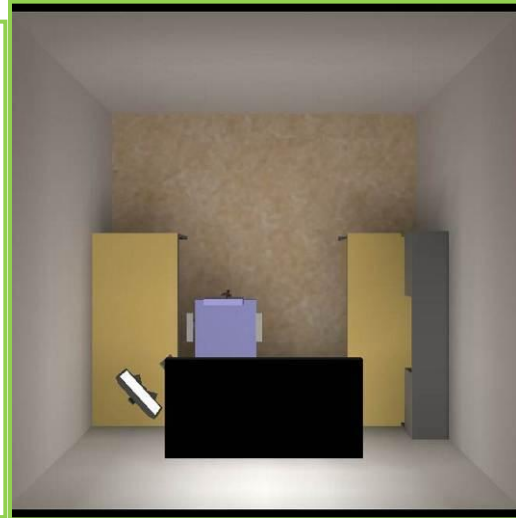


Figure 34: Rendered Lighting Layout 1

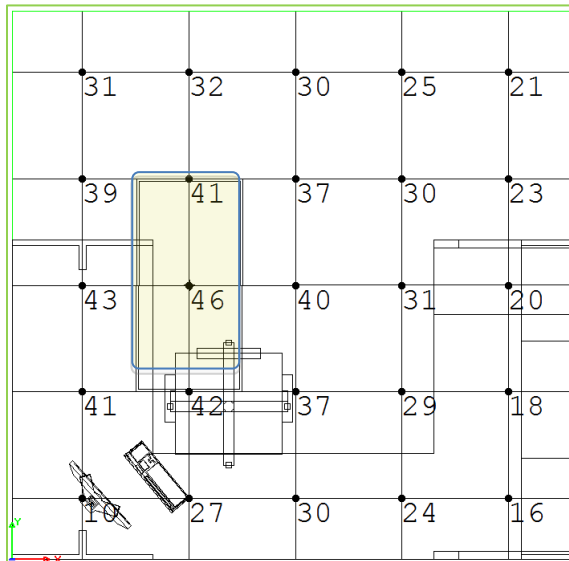
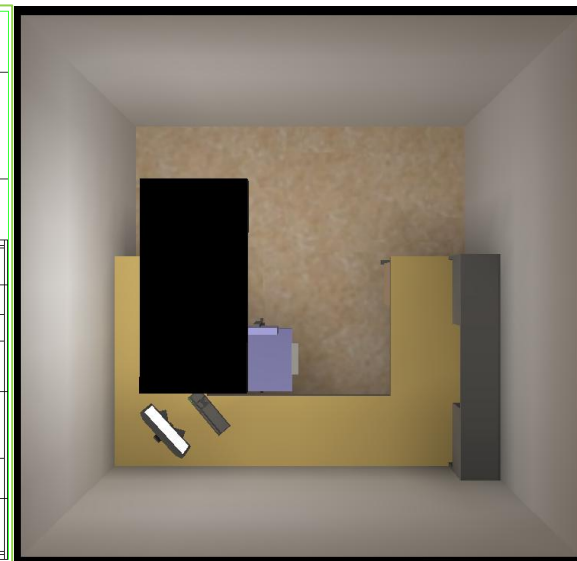


Figure 35: Rendered Lighting Layout Original Option 2



## Option 2

The second option analyzed was the use of two 2x2 volumetric troffers with 3 T5 lamps in each at 14watts. Placement of these opens up an area in the center of the room for proper placement of the chilled beams. This layout also gave a good distribution of lighting throughout the entire office with very acceptable levels of illuminance as seen below in figure 36. One complaint of this set up could be the high light density of the walls closest to the lights as seen in figure 37, but this should not be too much of a disturbance for the occupants. This

lights cost \$213.25 according to drillspot.com so each office would cost \$426.50 for the new lights.

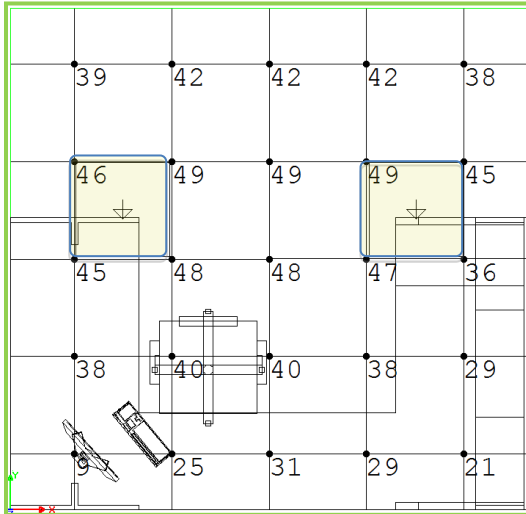


Figure 36: Option 2 Lighting Layout



Figure 37: Option 2 Lighting Elevation Rendering

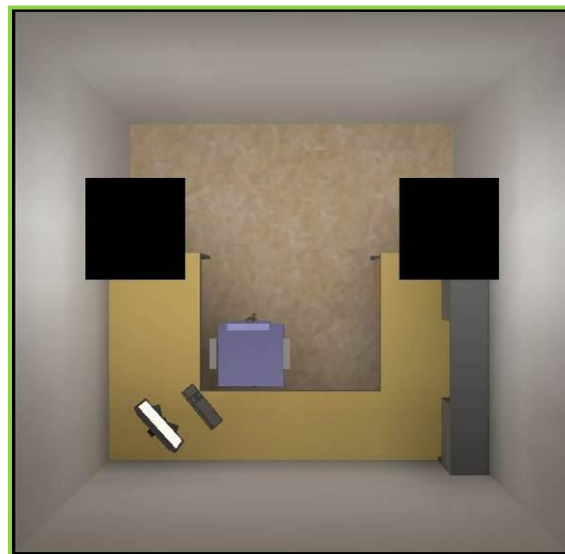


Figure 38: Option 2 Lighting Plan Rendering

### Option 3

The third option looked into was using LED lights in a similar pattern to the T5 lamps. LED lamps have benefit over incandescent and fluorescent because of long life. Beams do not have to be replaced as often so there is a potential for savings. There is also potential for energy savings in using LED lamps. LED's can potentially be 80% efficient at

converting energy to light. Below figures 39, 40 & 41 show the illumination of the office room with very reasonable results. The desk has lighting levels of 23 to 43 which falls in an acceptable range. The only down side seen with they lay out is the same seen in the T5 layout. There is a high lighting density on the walls nearest the lights, but again this should not be too much of a problem. The LED lights do come at a greater cost; according to drillspot.com one unit is \$408.79. This means that by room the lighting fixture will cost \$817.58.

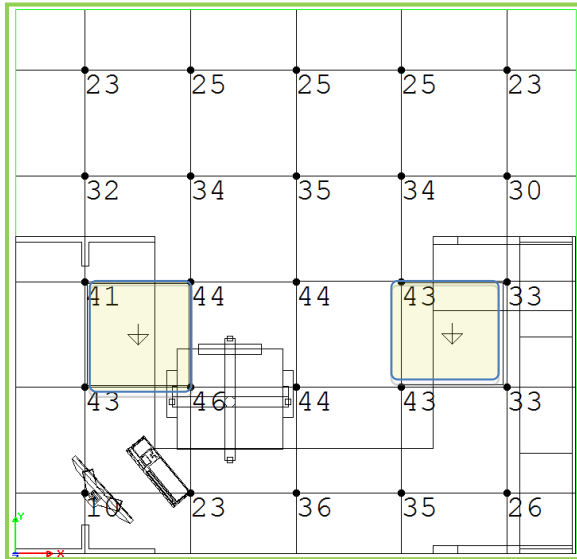


Figure 39: Option 3 Lighting Layout

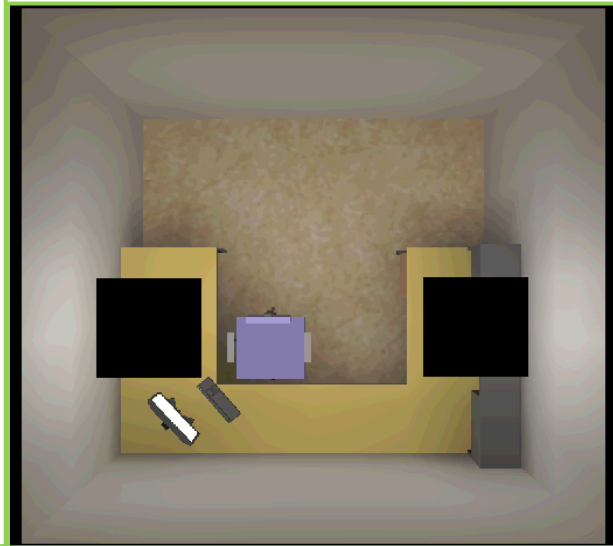


Figure 40: Option 3 Lighting Plan Rendering



Figure 41: Option 3 Lighting Elevation Rendering

## Summary

This lighting study analyzed three different lighting techniques for a typical office room. The most economical choice is to go with the original unit and move it to the left. The next is two 2x2 T5 volumetric troffers, then the LED volumetric troffers. The LEDs have the potential to save money in less purchasing and replacing of bulbs. There is also the potential in cost savings from the energy that could be saved by using the LED lamps.

## Breadth II: Structural

### Introduction

The removal of the air-handling unit on the first floor calls for an investigation into any possible changes to the structural design. Using the structural framing plans and the load assumptions for each room the beams, girders, and the columns were able to be designed. Below is the process to designing the beams, girder and columns.

### Design

The first step in the design process is to find to loads the floor will carry, both dead and live loads. Below are the different loads that will be used in calculating the beam, girder and column sizes.

#### *Uniformly distributed Floor live loads*

- Basement, M1, M2, & M3.....150 psf
- Roof Loads.....125 psf

#### *Floor:*

- 3" x 18 ga. Composite Metal Deck (galvanized) with 4-1/2" normal weight concrete cover. Total thickness = 7-1/2". Reinforce slab with #4 @ 12" EA. Way TOP. = 75 psf (from Vulcraft Catalog)

#### *Other:*

- 5 psf Allowance for beam self-weight
- 2 psf allowance for girder weight
- Un-shored Construction

## Design Calculations

In this section the design calculations of the beams, girders and columns will be reviewed. To get a better understanding of the layout of the system being analyzed figure 42 has been provided. This figure highlights the area to be examined ( AHU1) and shows the current layout of the structural system. Figure 43 gives a even closer look to the exact area.

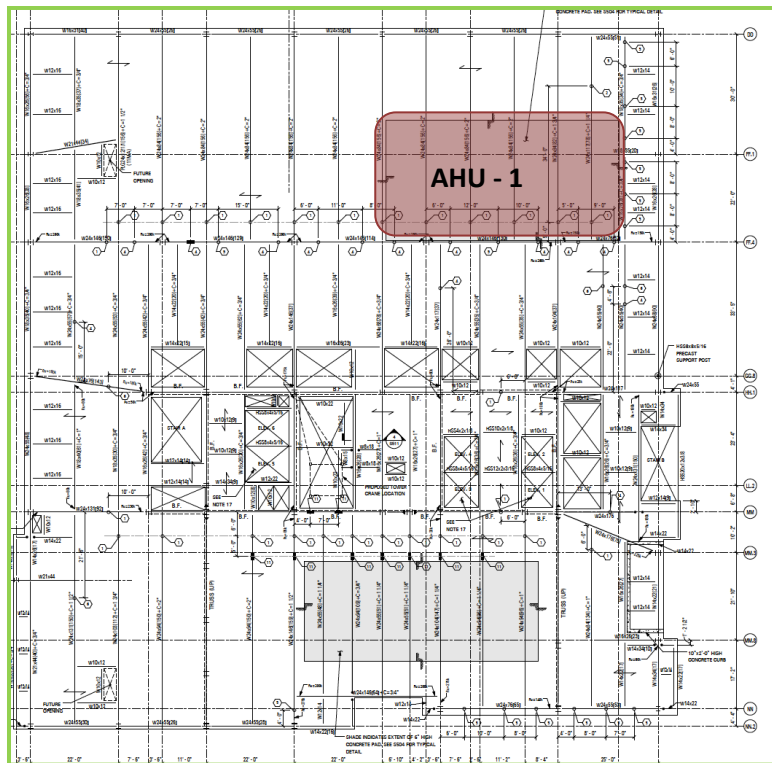


Figure 42: LEVEL M1 Structural Floor Plan



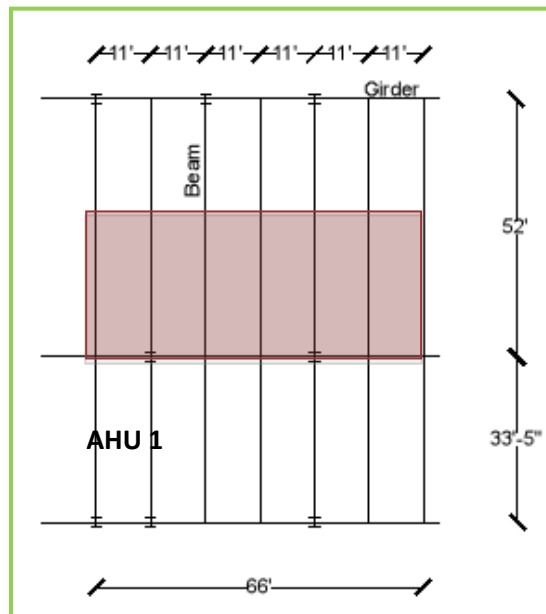


Figure 43: M1 Beam layout for AHU1

## Beam Design:

### Design load:

The dead load is comprised of the 75 psf vulcraft composite deck and a 5 psf allowance for the beams self-weight shown below...

$$\text{Dead load} = 75 \text{ psf} + 5 = 80 \text{ psf}$$

The live load was found in the structural design conditions and is shown below.

$$\text{Live Load} = 150 \text{ psf}$$

The Next step is to see if the live load is allowed to be reduced using the equation below. The only condition to using this equation is that the influence area must be greater than 400ft. The influence area is the live load element factor ( $K_{LL}$ ) times the tributary area ( $A_T$ )

$$\text{LL Reduction} = L = L_o (0.25 + 15/\sqrt{K_{LL}A_T})$$

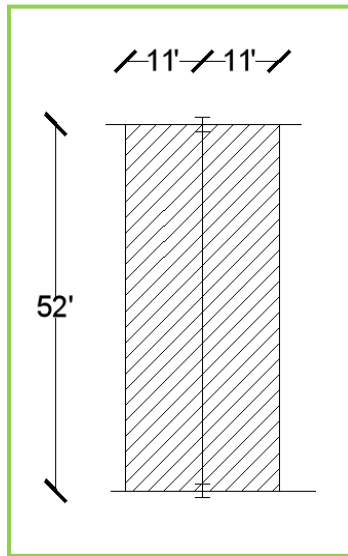


Figure 44: Beam Schematic

The area of the beam is shown in figure 44. The load element factor is found to be 2 from ASCE 7-05. Using these two variables  $K_{LL}A_T$  is found to be greater than 400 and thus reducible..

$$A_t = 572 \text{ ft}^2$$

$$K_{ll} = 2$$

$$K_{ll}A_t = 1144 > 400 \rightarrow \text{The live load is reducible}$$

$$LL_{\text{reduced}} = 150(0.25 + (15/\sqrt{1144})) = 104.023 \text{ psf}$$

Now that the Using this new live load the combined factored loads can be calculated using the formula  $(1.2 \times D \times \text{width} + 1.6 \times 104.023 \times \text{width})/1000$ . The number calculated is the distributed load along the beat per foot

$$W_u = (1.2(80)(11) + 1.6(104.023)(11))/ (1000) = 2.89 \text{ KLF}$$

The beam shear and moment is able to be calculated using the formula found in table 3-23 of the AISC for beam formulas. Using these values the beam was able to be designed using the AISC Steel Construction Manual Table 3-2. Figures 45, 46, 47, were supplied to visualize the loads on the beam.

$$\text{SHEAR: } V_u = ((2.89)(52))/2 = 75 \text{ Kips}$$

$$\text{MOMENT: } M_u = ((2.89)(52^2))/8 = 976.82 \text{ Ft Kips}$$

From the AISC Steel Construction Manual Table 3-2

USE W 30 x 90

$$\Phi Mn = 1060 > 977.82$$

$$\Phi Vn = 374 > 75$$

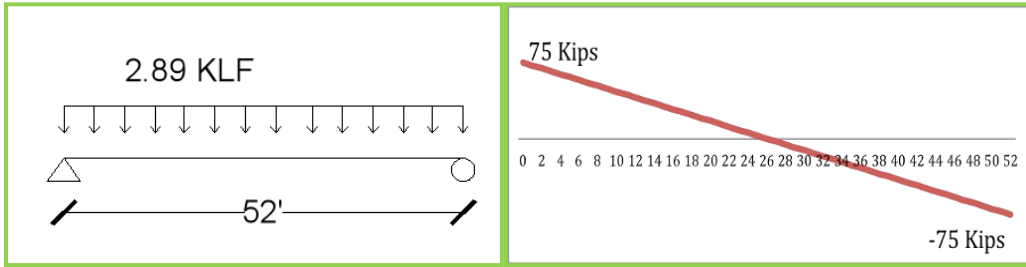


Figure 45: Beam Load Diagram

Figure 46: Beam Shear Diagram

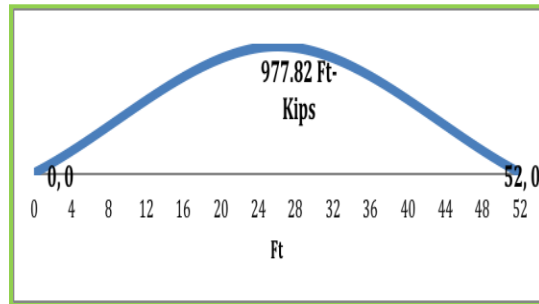


Figure 47: Beam Moment Diagram

## Girder Design:

Next the Girder was designed for the floor area. Figure 48 shows the girder to be analyzed.

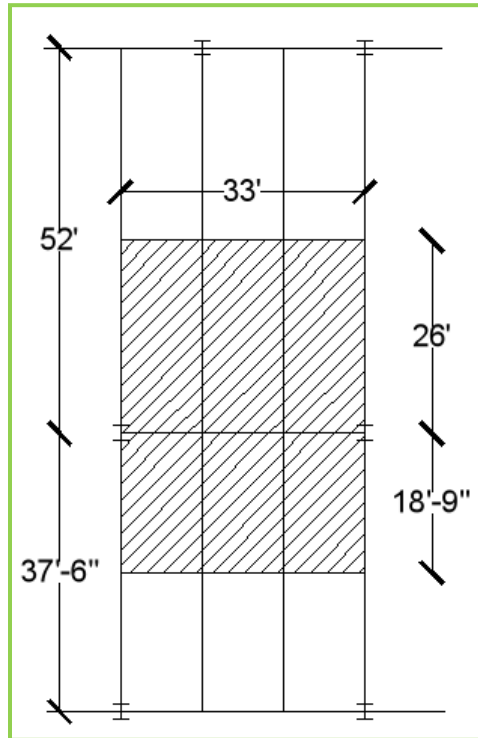


Figure 48: Girder Schematic

The loads for the floor area can be found below accounting for the 75 psf floor, 5 psf beam allowance and 2 psf girder allowances. The live load was found in the structural design conditions.

Loads:

$$DL = 75 + 5 + 2 = 82 \text{ psf}$$

$$LL = 150 \text{ psf}$$

Again the area was looked at to see if live load reduction could be used.

$$A_t = 33 \times (26 + 18.75) = 1476.75 > 400 \rightarrow \text{Reducible}$$

$$K_{II} = 2$$

$$A_t K_{II} = (2 \times 1476.75) = 2953.5$$

$$LL_{\text{reduction}} = 150 (.25 + (15 / \sqrt{2953.5})) = 78.9 \text{ psf}$$

Using the new live load of 78.9psf and the same formula from the beam design a new combined factored load can be found for the girder.

$$W_u = \frac{1.2 \times 82 \text{ psf} \times 11' + 1.6 \times 78.9 \times 11'}{1000} = 2.47 \text{ KLF}$$

To now find the shear in the girder this load must be multiplied by the width of the tributary area which is 18.75+26 = 44.75 '. The moment is then found by multiplying the shear by 11'. These formulas can be found in the AISC Table 3-23 figure 9 – Simple Beam – two equal concentrated loads symmetrically placed.

$$V_u = 2.247 \times 26 + 2.247 \times 18.75 = 110.58$$

$$M_u = 110.58 \times 11 = 1216.37 \text{ ft kips}$$

**CHOOSE: W30 x 108**

Below figures 49, 50 and 51 show the loading diagram and shear and moment diagrams for the girder.

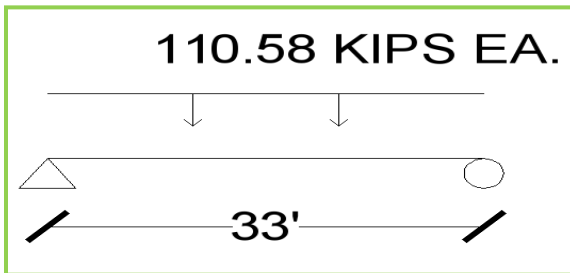


Figure 49: Girder Load Diagram

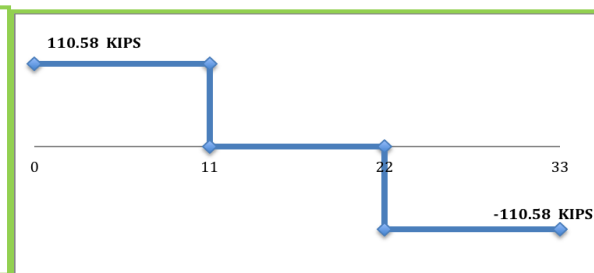


Figure 50: Girder Shear Diagram

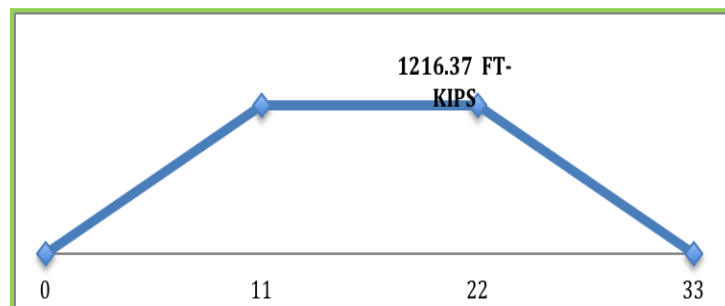


Figure 51: Girder Moment Diagram

## Column Design

Lastly the column supporting this floor and the levels above must be designed. Figure 52 shows the column and tributary area. Columns are easiest to be analyzed using a table so table 50 was used in sizing the beam.

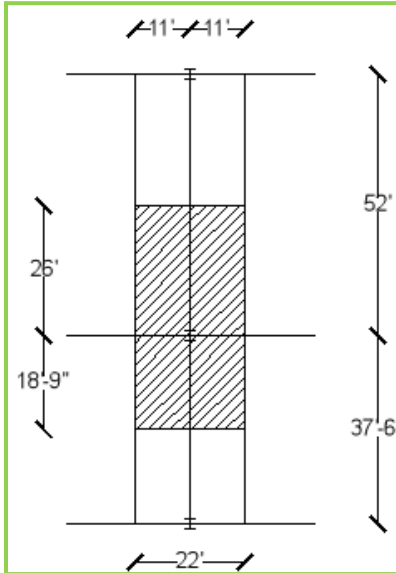


Figure 52: Column Design Schematic

The following equations find the tributary area and influence area of the column.

$$A_t = (22 \times (26 + 18.75)) = 984.5$$

$$K_{ij} = 4$$

$$K_{kk}A_t = 4 \times 984.5 = 1969'$$

As said earlier it is easier to analyze columns using a table so the provided table below (Table 50) was used. The column must hold the floor weight of level M1, L-12 M2, M3 and the roof. In the Table the live load reduction was performed using the LL given in the design conditions and the equation below.

$$LL_{\text{reduction}} = LL (.25 + (15 / (\sqrt{\# \text{floors above}(K_{LL}A_t)})))$$

The minimum value for  $(.25 + (15 / (\sqrt{\# \text{floors above}(K_{LL}A_t)})))$  is 0.4

Next the axial load on the column is found using 1.2 times the tributary area and the dead load. A 1.6 multiplier is used upon the live load time the tributary area, and then the loads from the floors above are accumulated into the axial load of the column. Next the column is chosen assuming a splice at every floor (every

15 feet). The columns are chosen using Table 4-1 from AISC Construction Manual. The total weight is then calculated

Table 50: Column Loading Schedule

| Floor | Column | # Floors Above | LL (PSF) | LL Reduction (PSF) | Pu (KIPS) | KI (FT) | Column Size | Length (FT) | Weight (PLF) | Total Weight (LBS.) |
|-------|--------|----------------|----------|--------------------|-----------|---------|-------------|-------------|--------------|---------------------|
| M1    | 12     | 4              | 150      | 75                 | 1052.51   | 15      | W10x112     | 15          | 112          | 1680                |
| L-12  | 13     | 3              | 125      | 63                 | 827.93    | 15      | W10X88      | 15          | 88           | 1320                |
| M2    | 14     | 2              | 150      | 63                 | 623.05    | 15      | W10x68      | 15          | 68           | 1020                |
| M3    | 15     | 1              | 150      | 73                 | 417.61    | 15      | W10X49      | 15          | 49           | 735                 |
| ROOF  | 16     | 0              | 125      | 61                 | 195.63    | 15      | W10X33      | 15          | 33           | 495                 |

### Summary

The beams are girders and columns were all designed for 75 Ames building. Due to the large design loads there was not much of an effect on the structural design. That being said, figure 53 shows the layout of the newly designed structural system under the removed air handling unit on floor M1 using the methods from above.

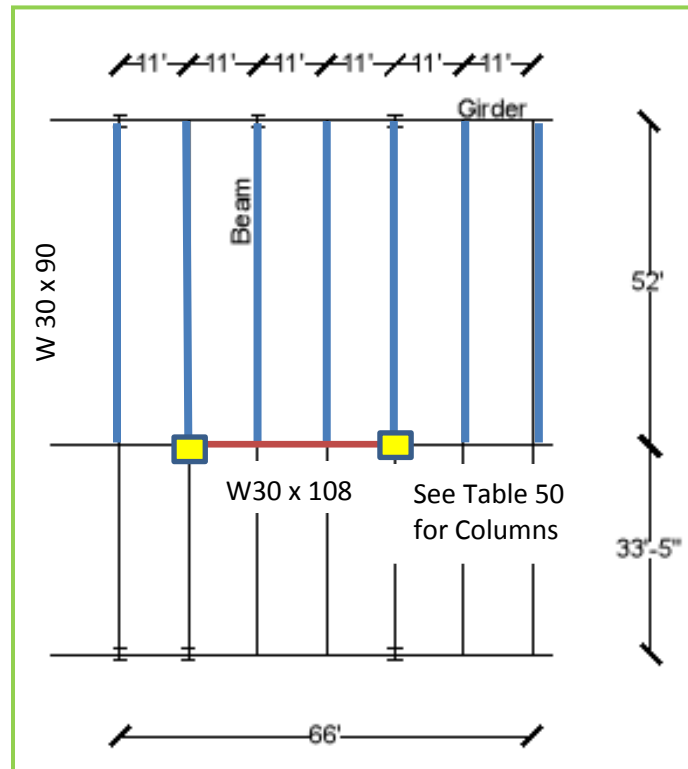


Figure 53: New Columns Layout

## Conclusion:

Chilled beams can be a very effective way of saving energy and reducing emissions and coupling this with demand controlled ventilation is able to bring even greater savings. The calculated savings for this location was \$604,658.99. Even though the upfront cost for the chilled beams may seem expensive at first because of the savings in supply air, fans and air handlers may be downsized, VAV boxes may be downsized or eliminated and ducts sizes may be decreased as well. This allowed for a very quick payback period and great savings in the long run,

Changing to a chilled beam may also have savings by lowering the wire and conduit sizes needed to supply all the downsized equipment. And although the larger chilled beams may have a larger footprint than a normal VAV diffuser lighting may not be too poorly effected if the right lights are chosen.

The Aircuity Optinet system along with energy and emissions savings can also be used to make sure employees are using proper lab safety techniques. By monitoring the total volume of contaminants per room and keeping a backup of the levels one can see rooms with continuously high levels of contaminants and talk to the occupants about why there may be such a problem occurring. So not only does a Aircuity system help the owner save money but it helps the occupants stay safe as well. Overall the change of the system is for the better both economically and environmentally

(Bell & Gossett Centrifugal Pumps & Accessories )



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# Appendix A: ASHRAE 62.1 Ventilation Compliance Spreadsheet

## AHU'S 1-4 %OA ANALYSIS

|   |  |  |              |   |                  |                             |
|---|--|--|--------------|---|------------------|-----------------------------|
| <b>Building:</b>  |  | <b>Delete Zone</b>   |              | 75 AMES St.                                       |                  |                             |
| <b>System Tag/Name:</b>   |  | <b>Add Zone</b>  |              | AHU-1-2-3-4                                       |                  |                             |
| <b>Operating Condition Description:</b>   |  |  |              | Occupied Operation                                |                  |                             |
| <b>Units (select from pull-down list)</b>   |  |  |              | IP  |                  |                             |
| <b>Inputs for System</b>  |  | <b>Name</b>  | <b>Units</b> | <b>w/o diversity System</b>                       | <b>Diversity</b> | <b>w / diversity System</b> |
| Floor area served by system   |  | As   | sf           | 176713.6994                                       |                  |                             |
| Population of area served by system   |  | Ps   | P            | 2,185   | D 100%           | 2,185                       |
| Design primary supply fan airflow rate  |  | Vpsd   | cfm          | 321,250   | D 100%           | 321,250                     |
| OA req'd per unit area for system (Weighted average)                                |  | Ras  | cfm/sf       | 0.09  |                  |                             |
| OA req'd per person for system area (Weighted average)                              |  | Rps  | cfm/p        | 6.7   |                  |                             |
| Does system have Outdoor Air Economizer   |  |  |              |   |                  | No                          |
| <b>Outdoor air intake provided for system</b>                                       |  | OA   | cfm          | 460,000   |                  |                             |
| <b>Inputs for Potentially Critical zones</b>  |  | <b>Show Values per Zone</b>                                |              |   |                  |                             |
| Zone Name   |  |  |              |   |                  |                             |
| Zone Tag  |  | <i>Zone title turns purple italic for critical zone(s)</i> |              |   |                  |                             |
| Occupancy Category  |  | Select from pull-down list:                                |              |   |                  |                             |
| Floor Area of zone  |  | Az   | sf           |   |                  |                             |
| Design population of zone   |  | Pz   | P            | (default value listed; may be overridden)         |                  |                             |
| Design total supply to zone (primary plus local recirculated)                       |  | Vdzd   | cfm          |   |                  |                             |
| Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?                        |  |  |              | Select from pull-down list or leave blank if N/A: |                  |                             |
| Fraction of zone supply air that is representative of system RA                     |  | Er   |              |   |                  |                             |
| <b>Inputs for Operating Condition Analyzed</b>                                      |  |  |              |   |                  | 57%                         |
| Percent of total design airflow rate at conditioned analyzed                        |  | Ds   | %            |   |                  |                             |
| Air distribution type at conditioned analyzed                                       |  |  |              | Select from pull-down list:                       |                  |                             |
| Zone air distribution effectiveness at conditioned analyzed                         |  | Ez   |              | <b>Show codes for Ez</b>                          |                  |                             |
| Primary air fraction of supply air at conditioned analyzed                          |  | Ep   |              |   |                  |                             |
| <b>Inputs for Systems with Outdoor Air Economizers</b>                              |  |  |              |   |                  |                             |
| Outdoor air Temperature   |  | Toa  | Deg F        |   |                  |                             |
| Supply Air Temperature  |  | Tp   | Deg F        |   |                  |                             |
| Return Air Temperature  |  | Tr   | Deg F        |   |                  |                             |
| Supply Fan Heat Gain  |  | dTsf   | Deg F        |   |                  |                             |
| Return Fan Heat Gain  |  | dTrf   | Deg F        |   |                  |                             |
| <b>Results of Minimum ASHRAE 62.1 Ventilation Rate Procedure (EQp1)</b>             |  |  |              |   |                  |                             |
| System Ventilation Efficiency   |  | Ev   |              |   |                  | 0.41                        |
| Outdoor air intake required for system (EQp1)                                       |  | Vot  | cfm          |   |                  | 74,213                      |
| Outdoor air per unit floor area   |  | Vot/As   | cfm/sf       |   |                  | 0.42                        |
| Outdoor air per person served by system (including diversity)                       |  | Vot/Ps   | cfm/p        |   |                  | 34.0                        |
| Outdoor air as a % of design primary supply air                                     |  | Ypd  | %            |   |                  | 23%                         |
| <b>Results of 30% Increase beyond ASHRAE 62.1 Ventilation Rate Procedure (EQc2)</b> |  |  |              |   |                  |                             |
| System Ventilation Efficiency with 30% increase (EQc2)                              |  | Evz30  |              |   |                  | 0.23                        |
| Outdoor air intake required for system with 30% increase (EQc2)                     |  | Vot30  | cfm          |   |                  | 169,091                     |
| Outdoor air per unit floor area for system with 30% increase (EQc2)                 |  | Vot30/As   | cfm/sf       |   |                  | 0.96                        |
| Outdoor air per person served by system (including diversity) (EQc2)                |  | Vot30/Ps   | cfm/p        |   |                  | 77.4                        |
| Outdoor air as a % of design primary supply air (EQc2)                              |  | Ypd30  | %            |   |                  | 53%                         |
| <b>Detailed Calculations</b>  |  |  |              |   |                  |                             |
| <b>Initial Calculations for the System as a whole</b>                               |  |  |              |   |                  |                             |
| System primary supply air flow at conditioned analyzed                              |  | Vps  | cfm          | = Vpsd Ds   | =                | 182815                      |
| Uncorrected OA intake flow req'd for system   |  | Vou  | cfm          | = Rps Ps + Ras As                                 | =                | 30522                       |
| 30% increase Uncorrected OA intake flow req'd for system (EAc2)                     |  | Vou30  | cfm          | = (Rps Ps + Ras As)*1.3                           | =                | 39678                       |
| Uncorrected OA req'd as a fraction of primary SA                                    |  | Xs   |              | = Vou / Vps                                       | =                | 0.17                        |
| 30% increase Uncorrected OA req'd as a fraction of primary SA                       |  | Xs30   |              | = Vou30 / Vps                                     | =                | 0.22                        |
| <b>Initial Calculations for individual zones</b>                                    |  |  |              |   |                  |                             |
| Area outdoor air rate   |  | Ra   | cfm/sf       |   |                  |                             |
| People outdoor air rate   |  | Rp   | cfm/p        |   |                  |                             |
| Total supply air to zone (at condition being analyzed)                              |  | Vdz  | cfm          | = Vdzd Ds   | =                |                             |
| Primary airflow to zone (at condition being analyzed)                               |  | Vpz  | cfm          | = Vdz Ep  | =                |                             |
| Breathing zone outdoor airflow  |  | Vbz  | cfm          | = Rp Pz + Ra Az                                   | =                |                             |
| Breathing zone outdoor airflow with 30% increase (EAc2)                             |  | Vbz30  | cfm          | = (Rp Pz + Ra Az)*1.3                             | =                |                             |
| Zone outdoor airflow  |  | Voz  | cfm          | = Vbz / Ez  | =                |                             |
| Zone outdoor airflow with 30% increase (EAc2)                                       |  | Voz30  | cfm          | = Vbz30/Ez  | =                |                             |
| Fraction of zone supply not directly recirc. from zone                              |  | Fa   |              | = Ep + (1-Ep) Er                                  | =                |                             |
| Fraction of zone supply from fully mixed primary air                                |  | Fb   |              | = Ep  | =                |                             |
| Fraction of zone OA not directly recirc. from zone                                  |  | Fc   |              | = 1-(1-Ez)(1-Ep)(1-Er)                            | =                |                             |
| OA fraction required in the supply air to the zone                                  |  | Zd   |              | = Voz / Vdz                                       | =                |                             |
| OA fraction required in the primary air to the zone                                 |  | Zpz  |              | = Voz / Vpz                                       | =                |                             |
| OA fraction required in the supply air to the zone for EAc2                         |  | Zd30   |              | = Voz30 / Vdz                                     | =                |                             |
| OA fraction required in the primary air to the zone for EAc2                        |  | Zpz30  |              | = Voz30/ Vpz                                      | =                |                             |
| <b>System Ventilation Efficiency</b>  |  |  |              |   |                  |                             |
| Zone Ventilation Efficiency (App A Method)  |  | Evz  |              | = (Fa+FbXs-FcZpzEp)/Fa                            | =                |                             |
| Zone Ventilation Efficiency with 30% increase (EAc2) (App A)                        |  | Evz30  |              | = (Fa+FbXs30-FcZpz30Ep)/Fa                        | =                |                             |
| System Ventilation Efficiency (App A Method)  |  | Ev   |              | = min (Evz)                                       | =                | 0.41                        |
| System Ventilation Efficiency (Table 6.3 Method)                                    |  | Ev   |              | = Value from Table 6.3                            | =                | n/a                         |
| System Ventilation Efficiency w/ 30% increase (EAc2) (App A)                        |  | Ev30   |              | = min (Evz30)                                     | =                | 0.23                        |
| System Ventilation Efficiency w/ 30% increase (EAc2) (Table 6.3)                    |  | Ev30   |              | = Value from Table 6.3                            | =                | n/a                         |
| <b>Minimum outdoor air intake airflow (EQp1)</b>                                    |  |  |              |   |                  |                             |
| Outdoor Air Intake Flow required to System  |  | Vot  | cfm          | = Vou / Ev  | =                | 74213                       |
| OA intake req'd as a fraction of primary SA   |  | Y  |              | = Vot / Vps                                       | =                | 0.41                        |
| Outdoor Air Intake Flow required to System (Table 6.3 Method)                       |  | Vot  | cfm          | = Vou / Ev  | =                | n/a                         |
| OA intake req'd as a fraction of primary SA (Table 6.3 Method)                      |  | Y  |              | = Vot / Vps                                       | =                | n/a                         |
| <b>Time-averaging</b>   |  |  |              |   |                  |                             |
| Time period with high occupancy   |  | Th   | min          |   |                  |                             |
| Room height   |  | h  | ft           | =   | 3 v / Vbz        | =                           |
| Time period over which averaging can take place                                     |  | T  | min          | =   |                  |                             |
| Error - sum of all values above will show error                                     |  |  |              |   |                  |                             |
| Error flag  |  | FALSE  |              |   |                  |                             |
| <b>30% increase beyond Minimum Outdoor air intake airflow (EQc2)</b>                |  |  |              |   |                  |                             |
| Outdoor Air Intake Flow required to System  |  | Vot30  | cfm          | = Vou / Ev  | =                | 169091                      |
| OA intake req'd as a fraction of primary SA   |  | Y30  |              | = Vot / Vps                                       | =                | 0.92                        |
| Outdoor Air Intake Flow required to System (Table 6.3 Method)                       |  | Vot30  | cfm          | = Vou / Ev  | =                | n/a                         |
| OA intake req'd as a fraction of primary SA (Table 6.3 Method)                      |  | Y30  |              | = Vot / Vps                                       | =                | n/a                         |
| <b>OA Temp at which Min. OA provides all cooling</b>                                |  |  |              |   |                  |                             |
| OAT below which OA Intake flow is @ minimum   |  |  | Deg F        | = ((Tp-dTsf)-(1-Y))*(Tr+dTrf)/Y                   | =                | 30                          |

| B0018 - EHS STORAGE | B0013 - FUEL OIL STORAGE | B0011 - MECH/PLUMBING     | B0012 - HOLDING | B0010 - FIRE PUMP         | B000LA - FIRE SERVICE ACCESS LOBBY | B0001 - FACILITIES | B0005 - MICROBULK NIT4 CO2 | B0003 - BIO WASTE | VESIBULE  | 1000CB - PASSAGE |
|---------------------|--------------------------|---------------------------|-----------------|---------------------------|------------------------------------|--------------------|----------------------------|-------------------|-----------|------------------|
| 0-1                 | 0-3                      | 0-5A, 0-5B                | 0-7             | 0-9                       | 0-11                               | 0-13               | 0-15                       | 0-17              | 0-19      | 1-1              |
| Storage rooms       | Storage rooms            | Elec/mech equipment rooms | Storage rooms   | Elec/mech equipment rooms | Corridors                          | Storage rooms      | Unocc / Not Used           | Storage rooms     | Corridors | Corridors        |
| 101                 | 690                      | 2,647                     | 320             | 501                       | 211                                | 75                 | 203                        | 195               | 86        | 82               |
| 0                   | 0                        | 0                         | 0               | 0                         | 0                                  | 0                  | 0                          | 0                 | 0         | 0                |
| 300                 | 1,950                    | 2,600                     | 325             | 525                       | 300                                | 200                | 200                        | 750               | 200       | 200              |
|                     |                          |                           |                 |                           |                                    |                    |                            |                   |           |                  |
| 50%                 | 100%                     | 56%                       | 46%             | 48%                       | 50%                                | 50%                | 50%                        | 50%               | 100%      | 100%             |
| CSCRW               | CSCRW                    | CSCRW                     | CSCRW           | CSCRW                     | CSCRW                              | CSCRW              | CSCRW                      | CSCRW             | CSCRW     | CSCRW            |
| 1.00                | 1.00                     | 1.00                      | 1.00            | 1.00                      | 1.00                               | 1.00               | 1.00                       | 1.00              | 1.00      | 1.00             |
| 1.00                | 1.00                     | 1.00                      | 1.00            | 1.00                      | 1.00                               | 1.00               | 1.00                       | 1.00              | 1.00      | 1.00             |
| 1.00                | 1.00                     | 1.00                      | 1.00            | 1.00                      | 1.00                               | 1.00               | 1.00                       | 1.00              | 1.00      | 1.00             |

|      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.06 | 0.06 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 150  | 1950 | 1450 | 150  | 250  | 150  | 100  | 100  | 375  | 200  | 200  |
| 150  | 1950 | 1450 | 150  | 250  | 150  | 100  | 100  | 375  | 200  | 200  |
| 0    | 0    | 0    | 0    | 0    | 13   | 0    | 0    | 0    | 5    | 5    |
| 0    | 0    | 0    | 0    | 0    | 16   | 0    | 0    | 0    | 7    | 6    |
| 0    | 0    | 0    | 0    | 0    | 13   | 0    | 0    | 0    | 5    | 5    |
| 0    | 0    | 0    | 0    | 0    | 16   | 0    | 0    | 0    | 7    | 6    |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.03 | 0.03 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.03 | 0.03 |
| 1.17 | 1.17 | 1.17 | 1.17 | 1.17 | 1.08 | 1.17 | 1.17 | 1.17 | 1.14 | 1.14 |
| 1.22 | 1.22 | 1.22 | 1.22 | 1.22 | 1.11 | 1.22 | 1.22 | 1.22 | 1.18 | 1.19 |

9  
27270000  
27272320  
FALSE

| 1015 - FCC       | 1011 - LOBBY       | 1007 - MANAGER | 1003 - LOADING DOCK | 1000LV - VIVARIUM ELEV LOBBY | 1000LA - SERVICE ELEV LOBBY | 1012 - PH NEUT   | 1000LB - ELEVATOR LOBBY | 1010 - SECURITY   | 1008 - VIRGIN CHEM STORAGE (H-2) | 1006 - WASTE CHEM STORAGE (H-2) | 2000CA - BREAKOUT CONNECTOR | 2001 - MULTIPURPOSE CONFERENCE | 2001 - MULTIPURPOSE CONFERENCE |
|------------------|--------------------|----------------|---------------------|------------------------------|-----------------------------|------------------|-------------------------|-------------------|----------------------------------|---------------------------------|-----------------------------|--------------------------------|--------------------------------|
| 1-3              | 1-5                | 1-9            | 1-11, 1-13          | 1-15                         | 1-17                        | 1-19             | 1-21                    | 1-23              | 1-25                             | 1-27                            | 2-1, 2-3                    | 2-5                            | 2-7                            |
| Unocc / Not Used | Main entry lobbies | Office space   | Unocc / Not Used    | Corridors                    | Corridors                   | Unocc / Not Used | Corridors               | Telephone closets | Storage rooms                    | Storage rooms                   | Corridors                   | Conference/meeting             | Conference/meeting             |
| 186              | 876                | 84             | 1,966               | 82                           | 131                         | 135              | 163                     | 94                | 116                              | 173                             | 2,100                       | 788                            | 788                            |
| 0                | 8.76               | 0.42           | 0                   | 0                            | 0                           | 0                | 0                       | 0                 | 0                                | 0                               | 0                           | 39.375                         | 39.375                         |
| 300              | 1,200              | 200            | 2,200               | 400                          | 400                         | 1,300            | 400                     | 850               | 650                              | 600                             | 2,100                       | 1,500                          | 1,500                          |
| 50%              | 100%               | 100%           | 100%                | 100%                         | 100%                        | 100%             | 100%                    | 41%               | 50%                              | 50%                             | 50%                         | 50%                            | 50%                            |
| CSCRW            | CSCRW              | CSCRW          | CSCRW               | CSCRW                        | CSCRW                       | CSCRW            | CSCRW                   | CSCRW             | CSCRW                            | CSCRW                           | CSCRW                       | CSCRW                          | CSCRW                          |
| 1.00             | 1.00               | 1.00           | 1.00                | 1.00                         | 1.00                        | 1.00             | 1.00                    | 1.00              | 1.00                             | 1.00                            | 1.00                        | 1.00                           | 1.00                           |
| 1.00             | 1.00               | 1.00           | 1.00                | 1.00                         | 1.00                        | 1.00             | 1.00                    | 1.00              | 1.00                             | 1.00                            | 1.00                        | 1.00                           | 1.00                           |
| 0.00             | 0.06               | 0.06           | 0.00                | 0.06                         | 0.06                        | 0.00             | 0.06                    | 0.00              | 0.00                             | 0.00                            | 0.06                        | 0.06                           | 0.06                           |
| 0.00             | 5.00               | 5.00           | 0.00                | 0.00                         | 0.00                        | 0.00             | 0.00                    | 0.00              | 0.00                             | 0.00                            | 0.00                        | 5.00                           | 5.00                           |
| 150              | 1200               | 200            | 2200                | 400                          | 400                         | 1300             | 400                     | 350               | 325                              | 300                             | 1050                        | 750                            | 750                            |
| 150              | 1200               | 200            | 2200                | 400                          | 400                         | 1300             | 400                     | 350               | 325                              | 300                             | 1050                        | 750                            | 750                            |
| 0                | 96                 | 7              | 0                   | 5                            | 8                           | 0                | 10                      | 0                 | 0                                | 0                               | 126                         | 244                            | 244                            |
| 0                | 125                | 9              | 0                   | 6                            | 10                          | 0                | 13                      | 0                 | 0                                | 0                               | 164                         | 317                            | 317                            |
| 0                | 96                 | 7              | 0                   | 5                            | 8                           | 0                | 10                      | 0                 | 0                                | 0                               | 126                         | 244                            | 244                            |
| 0                | 125                | 9              | 0                   | 6                            | 10                          | 0                | 13                      | 0                 | 0                                | 0                               | 164                         | 317                            | 317                            |
| 1.00             | 1.00               | 1.00           | 1.00                | 1.00                         | 1.00                        | 1.00             | 1.00                    | 1.00              | 1.00                             | 1.00                            | 1.00                        | 1.00                           | 1.00                           |
| 1.00             | 1.00               | 1.00           | 1.00                | 1.00                         | 1.00                        | 1.00             | 1.00                    | 1.00              | 1.00                             | 1.00                            | 1.00                        | 1.00                           | 1.00                           |
| 1.00             | 1.00               | 1.00           | 1.00                | 1.00                         | 1.00                        | 1.00             | 1.00                    | 1.00              | 1.00                             | 1.00                            | 1.00                        | 1.00                           | 1.00                           |
| 0.00             | 0.08               | 0.04           | 0.00                | 0.01                         | 0.02                        | 0.00             | 0.02                    | 0.00              | 0.00                             | 0.00                            | 0.12                        | 0.33                           | 0.33                           |
| 0.00             | 0.08               | 0.04           | 0.00                | 0.01                         | 0.02                        | 0.00             | 0.02                    | 0.00              | 0.00                             | 0.00                            | 0.12                        | 0.33                           | 0.33                           |
| 0.00             | 0.10               | 0.05           | 0.00                | 0.02                         | 0.03                        | 0.00             | 0.03                    | 0.00              | 0.00                             | 0.00                            | 0.16                        | 0.42                           | 0.42                           |
| 0.00             | 0.10               | 0.05           | 0.00                | 0.02                         | 0.03                        | 0.00             | 0.03                    | 0.00              | 0.00                             | 0.00                            | 0.16                        | 0.42                           | 0.42                           |
| 1.17             | 1.09               | 1.13           | 1.17                | 1.15                         | 1.15                        | 1.17             | 1.14                    | 1.17              | 1.17                             | 1.17                            | 1.05                        | 0.84                           | 0.84                           |
| 1.22             | 1.11               | 1.17           | 1.22                | 1.20                         | 1.19                        | 1.22             | 1.19                    | 1.22              | 1.22                             | 1.22                            | 1.06                        | 0.79                           | 0.79                           |

| 2007 - FREEZER ROOM | 2011 - PRE PCR       | 2006 - WARM ROOM | 2008 - COLD ROOM | 2005 - RNAI LAB      | 2015 - RNAI LAB      | 2035 - DNA CLEAN LAB | 2025 - CLONE PRODUCTION CLEAN LAB | 2053 - OFFICE | 2051 - LAB DESKS | 2058E - ELEC              | 2000LB - ELEVATOR LOBBY |
|---------------------|----------------------|------------------|------------------|----------------------|----------------------|----------------------|-----------------------------------|---------------|------------------|---------------------------|-------------------------|
| 2-9                 | 2-11                 | 2-13             | 2-13             | 2-15A, 2-15B         | 2-17A, 2-17B         | 2-19                 | 2-21                              | 2-23          | 2-25             | 2-27                      | 2-29                    |
| Storage rooms       | Science laboratories | Storage rooms    | Storage rooms    | Science laboratories | Science laboratories | Science laboratories | Science laboratories              | Office space  | Office space     | Elec/mech equipment rooms | Corridors               |
| 998                 | 186                  | 112              | 151              | 1,345                | 1,374                | 237                  | 273                               | 159           | 448              | 236                       | 379                     |
| 0                   | 3                    | 0                | 0                | 24                   | 19                   | 5                    | 6                                 | 1             | 2,2382           | 0                         | 0                       |
| 925                 | 400                  | 25               | 50               | 3,600                | 3,600                | 600                  | 750                               | 250           | 1,100            | 850                       | 400                     |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
| 51%                 | 63%                  | 100%             | 100%             | 35%                  | 35%                  | 100%                 | 100%                              | 50%           | 50%              | 41%                       | 100%                    |
| CSCRW               | CSCRW                | CSCRW            | CSCRW            | CSCRW                | CSCRW                | CSCRW                | CSCRW                             | CSCRW         | CSCRW            | CSCRW                     | CSCRW                   |
| 1.00                | 1.00                 | 1.00             | 1.00             | 1.00                 | 1.00                 | 1.00                 | 1.00                              | 1.00          | 1.00             | 1.00                      | 1.00                    |
| 1.00                | 1.00                 | 1.00             | 1.00             | 1.00                 | 1.00                 | 1.00                 | 1.00                              | 1.00          | 1.00             | 1.00                      | 1.00                    |
| 1.00                | 1.00                 | 1.00             | 1.00             | 1.00                 | 1.00                 | 1.00                 | 1.00                              | 1.00          | 1.00             | 1.00                      | 1.00                    |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
|                     |                      |                  |                  |                      |                      |                      |                                   |               |                  |                           |                         |
| 0.00                | 0.18                 | 0.00             | 0.00             | 0.18                 | 0.18                 | 0.18                 | 0.18                              | 0.06          | 0.06             | 0.00                      | 0.06                    |
| 0.00                | 10.00                | 0.00             | 0.00             | 10.00                | 10.00                | 10.00                | 10.00                             | 5.00          | 5.00             | 0.00                      | 0.00                    |
| 475                 | 250                  | 25               | 50               | 1250                 | 1250                 | 600                  | 750                               | 125           | 550              | 350                       | 400                     |
| 475                 | 250                  | 25               | 50               | 1250                 | 1250                 | 600                  | 750                               | 125           | 550              | 350                       | 400                     |
| 0                   | 63                   | 0                | 0                | 482                  | 437                  | 93                   | 109                               | 15            | 38               | 0                         | 23                      |
| 0                   | 82                   | 0                | 0                | 627                  | 568                  | 121                  | 142                               | 19            | 49               | 0                         | 30                      |
| 0                   | 63                   | 0                | 0                | 482                  | 437                  | 93                   | 109                               | 15            | 38               | 0                         | 23                      |
| 0                   | 82                   | 0                | 0                | 627                  | 568                  | 121                  | 142                               | 19            | 49               | 0                         | 30                      |
| 1.00                | 1.00                 | 1.00             | 1.00             | 1.00                 | 1.00                 | 1.00                 | 1.00                              | 1.00          | 1.00             | 1.00                      | 1.00                    |
| 1.00                | 1.00                 | 1.00             | 1.00             | 1.00                 | 1.00                 | 1.00                 | 1.00                              | 1.00          | 1.00             | 1.00                      | 1.00                    |
| 1.00                | 1.00                 | 1.00             | 1.00             | 1.00                 | 1.00                 | 1.00                 | 1.00                              | 1.00          | 1.00             | 1.00                      | 1.00                    |
| 0.00                | 0.25                 | 0.00             | 0.00             | 0.39                 | 0.35                 | 0.15                 | 0.15                              | 0.12          | 0.07             | 0.00                      | 0.06                    |
| 0.00                | 0.25                 | 0.00             | 0.00             | 0.39                 | 0.35                 | 0.15                 | 0.15                              | 0.12          | 0.07             | 0.00                      | 0.06                    |
| 0.00                | 0.33                 | 0.00             | 0.00             | 0.50                 | 0.45                 | 0.20                 | 0.19                              | 0.15          | 0.09             | 0.00                      | 0.07                    |
| 0.00                | 0.33                 | 0.00             | 0.00             | 0.50                 | 0.45                 | 0.20                 | 0.19                              | 0.15          | 0.09             | 0.00                      | 0.07                    |
| 1.17                | 0.91                 | 1.17             | 1.17             | 0.78                 | 0.82                 | 1.01                 | 1.02                              | 1.05          | 1.10             | 1.17                      | 1.11                    |
| 1.22                | 0.89                 | 1.22             | 1.22             | 0.72                 | 0.76                 | 1.02                 | 1.03                              | 1.07          | 1.13             | 1.22                      | 1.14                    |

| 2040 - MEN, 2044 - WOMEN, 2000CB - CORRIDOR, 2000LA - FIRE SERVICE ACCESS LOBBY | 3000CA - BREAKOUT/CONNECTOR | 3001 - LARGE CONFERENCE | 3005 - COPY | 3007 - OFFICE, 3011 - OFFICE, 3009 - OFFICE | 3013 - OFFICE | 3000CC - CORRIDOR | 3008 - OFFICE, 3022 - OFFICE | 3010 - OFFICE, 3020 - OFFICE | 3015 - OFFICE, 3017 - OFFICE, 3019 - OFFICE | 3026 - LAB SUPPORT | 3029 - TISSUE CULTURE ROOM | 3035 - NOVEL THERAPEUTIC/ CHEM BIO              | 3053 - LAB DESKS |
|---|-----------------------------|-------------------------|-------------|---|---------------|-------------------|------------------------------|------------------------------|---|--------------------|----------------------------|---|------------------|
| 2-31, 2-33  | 3-1, 3-3                    | 3-5                     | 3-7         | 3-9   | 3-11          | 3-13              | 3-15                         | 3-17                         | 3-19  | 3-21               | 3-25                       | 3-27A, 3-27B, 3-27C, 3-27D, 3-27E, 3-27F, 3-27G | 3-27H            |
| Corridors   | Corridors                   | Conference/meeting      | Corridors   | Office space                                | Office space  | Corridors         | Office space                 | Office space                 | Office space                                | Storage rooms      | Science laboratories       | Science laboratories                            | Office space     |
| 1,460   | 1,352                       | 626                     | 167         | 449   | 268           | 234               | 419                          | 274                          | 254   | 148                | 314                        | 3,163   | 782              |
| 0   | 0                           | 31,2855                 | 0           | 9   | 1             | 0                 | 8                            | 6                            | 5   | 0                  | 4                          | 27  | 3,91             |
| 1,600   | 2,400                       | 1,280                   | 150         | 525   | 300           | 125               | 400                          | 350                          | 525   | 500                | 1,500                      | 21,000  | 1,650            |
| 100%  | 50%                         | 50%                     | 100%        | 48%   | 50%           | 100%              | 50%                          | 50%                          | 48%   | 50%                | 100%                       | 17%   | 11%              |
| CSCRW   | CSCRW                       | CSCRW                   | CSCRW       | CSCRW                                       | CSCRW         | CSCRW             | CSCRW                        | CSCRW                        | CSCRW                                       | CSCRW              | CSCRW                      | CSCRW   | CSCRW            |
| 1.00  | 1.00                        | 1.00                    | 1.00        | 1.00  | 1.00          | 1.00              | 1.00                         | 1.00                         | 1.00  | 1.00               | 1.00                       | 1.00  | 1.00             |
| 1.00  | 1.00                        | 1.00                    | 1.00        | 1.00  | 1.00          | 1.00              | 1.00                         | 1.00                         | 1.00  | 1.00               | 1.00                       | 1.00  | 1.00             |
| 1.00  | 1.00                        | 1.00                    | 1.00        | 1.00  | 1.00          | 1.00              | 1.00                         | 1.00                         | 1.00  | 1.00               | 1.00                       | 1.00  | 1.00             |

|      |      |      |      |      |      |      |      |      |      |      |       |       |      |
|------|------|------|------|------|------|------|------|------|------|------|-------|-------|------|
| 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.00 | 0.18  | 0.18  | 0.06 |
| 0.00 | 0.00 | 5.00 | 0.00 | 5.00 | 5.00 | 0.00 | 5.00 | 5.00 | 5.00 | 0.00 | 10.00 | 10.00 | 5.00 |
| 1600 | 1200 | 640  | 150  | 250  | 150  | 125  | 200  | 175  | 250  | 250  | 1500  | 3500  | 180  |
| 1600 | 1200 | 640  | 150  | 250  | 150  | 125  | 200  | 175  | 250  | 250  | 1500  | 3500  | 180  |
| 88   | 81   | 194  | 10   | 72   | 21   | 14   | 65   | 46   | 40   | 0    | 97    | 839   | 66   |
| 114  | 105  | 252  | 13   | 94   | 27   | 18   | 85   | 60   | 52   | 0    | 125   | 1091  | 86   |
| 88   | 81   | 194  | 10   | 72   | 21   | 14   | 65   | 46   | 40   | 0    | 97    | 839   | 66   |
| 114  | 105  | 252  | 13   | 94   | 27   | 18   | 85   | 60   | 52   | 0    | 125   | 1091  | 86   |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00  | 1.00  | 1.00 |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00  | 1.00  | 1.00 |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00  | 1.00  | 1.00 |
| 0.05 | 0.07 | 0.30 | 0.07 | 0.29 | 0.14 | 0.11 | 0.33 | 0.27 | 0.16 | 0.00 | 0.06  | 0.24  | 0.37 |
| 0.05 | 0.07 | 0.30 | 0.07 | 0.29 | 0.14 | 0.11 | 0.33 | 0.27 | 0.16 | 0.00 | 0.06  | 0.24  | 0.37 |
| 0.07 | 0.09 | 0.39 | 0.09 | 0.37 | 0.18 | 0.15 | 0.42 | 0.34 | 0.21 | 0.00 | 0.08  | 0.31  | 0.48 |
| 0.07 | 0.09 | 0.39 | 0.09 | 0.37 | 0.18 | 0.15 | 0.42 | 0.34 | 0.21 | 0.00 | 0.08  | 0.31  | 0.48 |
| 1.11 | 1.10 | 0.86 | 1.10 | 0.88 | 1.03 | 1.05 | 0.84 | 0.90 | 1.01 | 1.17 | 1.10  | 0.93  | 0.80 |
| 1.15 | 1.13 | 0.82 | 1.13 | 0.84 | 1.03 | 1.07 | 0.79 | 0.87 | 1.01 | 1.22 | 1.13  | 0.91  | 0.74 |

| 3000LB - ELEVATOR LOBBY | 3058E - ELEC              | 3044 - WOMEN, 3040 - MEN, 3000CE - CORRIDOR, 3000LA - FIRE SERVICE ACCESS LOBBY | 4007 - OFFICE, 4009 - OFFICE, 4011 - OFFICE | 4013 - OFFICE | 4015 - OFFICE | 4017 - OFFICE | 4010 - OFFICE, 4012 - OFFICE | 4008 - OFFICE, 4016 - OFFICE | 4023 - OFFICE, 4021 - OFFICE, 4019 - OFFICE | 4020 - OFFICE, 4024 - OFFICE, 4022 - OFFICE | 4018 - OFFICE, 4034 - OFFICE, 4014 - OFFICE | 4032 - OFFICE | 4031 - MEDIUM CONFERENCE ROOM | 4036 - OFFICE | 4047 - LAB SUPPORT |
|-------------------------|---------------------------|---|---|---------------|---------------|---------------|------------------------------|------------------------------|---|---|---|---------------|-------------------------------|---------------|--------------------|
| 3-33                    | 3-35                      | 3-37, 3-39  | 4-1   | 4-3           | 4-5           | 4-7           | 4-9                          | 4-11                         | 4-13  | 4-15  | 4-17  | 4-19          | 4-21                          | 4-23          | 4-25               |
| Corridors               | Elec/mech equipment rooms | Corridors   | Office space                                | Office space  | Office space  | Office space  | Office space                 | Office space                 | Office space                                | Office space                                | Office space                                | Office space  | Conference/meeting            | Office space  | Storage rooms      |
| 360                     | 249                       | 1,347   | 392   | 275           | 170           | 135           | 260                          | 320                          | 485   | 390   | 475   | 156           | 251                           | 154           | 281                |
| 0                       | 0                         | 0   | 8   | 1             | 3             | 3             | 6                            | 8                            | 6   | 9   | 12  | 4             | 12.55                         | 4             | 0                  |
| 400                     | 850                       | 1,600   | 525   | 300           | 400           | 400           | 400                          | 400                          | 800   | 525   | 600   | 200           | 525                           | 200           | 600                |
| 100%                    | 41%                       | 100%  | 48%   | 50%           | 50%           | 100%          | 50%                          | 50%                          | 50%   | 48%   | 50%   | 50%           | 48%                           | 50%           | 50%                |
| CSCRW                   | CSCRW                     | CSCRW   | CSCRW                                       | CSCRW         | CSCRW         | CSCRW         | CSCRW                        | CSCRW                        | CSCRW                                       | CSCRW                                       | CSCRW                                       | CSCRW         | CSCRW                         | CSCRW         | CSCRW              |
| 1.00                    | 1.00                      | 1.00  | 1.00  | 1.00          | 1.00          | 1.00          | 1.00                         | 1.00                         | 1.00  | 1.00  | 1.00  | 1.00          | 1.00                          | 1.00          | 1.00               |
| 1.00                    | 1.00                      | 1.00  | 1.00  | 1.00          | 1.00          | 1.00          | 1.00                         | 1.00                         | 1.00  | 1.00  | 1.00  | 1.00          | 1.00                          | 1.00          | 1.00               |
| 1.00                    | 1.00                      | 1.00  | 1.00  | 1.00          | 1.00          | 1.00          | 1.00                         | 1.00                         | 1.00  | 1.00  | 1.00  | 1.00          | 1.00                          | 1.00          | 1.00               |
| 0.06                    | 0.00                      | 0.06  | 0.06  | 0.06          | 0.06          | 0.06          | 0.06                         | 0.06                         | 0.06  | 0.06  | 0.06  | 0.06          | 0.06                          | 0.06          | 0.06               |
| 0.00                    | 0.00                      | 0.00  | 5.00  | 5.00          | 5.00          | 5.00          | 5.00                         | 5.00                         | 5.00  | 5.00  | 5.00  | 5.00          | 5.00                          | 5.00          | 5.00               |
| 400                     | 350                       | 1600  | 250   | 150           | 200           | 400           | 200                          | 200                          | 400   | 250   | 300   | 100           | 250                           | 100           | 300                |
| 400                     | 350                       | 1600  | 250   | 150           | 200           | 400           | 200                          | 200                          | 400   | 250   | 300   | 100           | 250                           | 100           | 300                |
| 22                      | 0                         | 81  | 64  | 22            | 25            | 23            | 46                           | 59                           | 58  | 68  | 89  | 29            | 78                            | 29            | 0                  |
| 28                      | 0                         | 105   | 83  | 28            | 33            | 30            | 59                           | 77                           | 75  | 89  | 115   | 38            | 101                           | 38            | 0                  |
| 22                      | 0                         | 81  | 64  | 22            | 25            | 23            | 46                           | 59                           | 58  | 68  | 89  | 29            | 78                            | 29            | 0                  |
| 28                      | 0                         | 105   | 83  | 28            | 33            | 30            | 59                           | 77                           | 75  | 89  | 115   | 38            | 101                           | 38            | 0                  |
| 1.00                    | 1.00                      | 1.00  | 1.00  | 1.00          | 1.00          | 1.00          | 1.00                         | 1.00                         | 1.00  | 1.00  | 1.00  | 1.00          | 1.00                          | 1.00          | 1.00               |
| 1.00                    | 1.00                      | 1.00  | 1.00  | 1.00          | 1.00          | 1.00          | 1.00                         | 1.00                         | 1.00  | 1.00  | 1.00  | 1.00          | 1.00                          | 1.00          | 1.00               |
| 1.00                    | 1.00                      | 1.00  | 1.00  | 1.00          | 1.00          | 1.00          | 1.00                         | 1.00                         | 1.00  | 1.00  | 1.00  | 1.00          | 1.00                          | 1.00          | 1.00               |
| 0.05                    | 0.00                      | 0.05  | 0.25  | 0.14          | 0.13          | 0.06          | 0.23                         | 0.30                         | 0.14  | 0.27  | 0.30  | 0.29          | 0.31                          | 0.29          | 0.00               |
| 0.05                    | 0.00                      | 0.05  | 0.25  | 0.14          | 0.13          | 0.06          | 0.23                         | 0.30                         | 0.14  | 0.27  | 0.30  | 0.29          | 0.31                          | 0.29          | 0.00               |
| 0.07                    | 0.00                      | 0.07  | 0.33  | 0.19          | 0.16          | 0.08          | 0.30                         | 0.38                         | 0.19  | 0.36  | 0.38  | 0.38          | 0.40                          | 0.38          | 0.00               |
| 0.07                    | 0.00                      | 0.07  | 0.33  | 0.19          | 0.16          | 0.08          | 0.30                         | 0.38                         | 0.19  | 0.36  | 0.38  | 0.38          | 0.40                          | 0.38          | 0.00               |
| 1.11                    | 1.17                      | 1.12  | 0.91  | 1.02          | 1.04          | 1.11          | 0.94                         | 0.87                         | 1.02  | 0.89  | 0.87  | 0.87          | 0.86                          | 0.87          | 1.17               |
| 1.15                    | 1.22                      | 1.15  | 0.89  | 1.03          | 1.05          | 1.14          | 0.92                         | 0.83                         | 1.03  | 0.86  | 0.83  | 0.84          | 0.81                          | 0.84          | 1.22               |



| 4038 - PRE PCR LAB   | 4045 - POST PCR LAB BL2 | 4053 - LAB DESKS | 4058E - ELEC              | 4000LB - ELEVATOR LOBBY | 4040 - MEN, 4044 - WOMEN, 4000CE - CORRIDOR, 4000LA - FIRE SERVICE ACCESS LOBBY | 4000CA - BREAKOUT/CONNECTOR | 4005 - COPY | 4001 - LARGE CONFERENCE |
|----------------------|-------------------------|------------------|---------------------------|-------------------------|---|-----------------------------|-------------|-------------------------|
| 4-27                 | 4-29A, 4-29B            | 4-31             | 4-33                      | 4-35                    | 4-37, 4-39  | 4-41, 4-43                  | 4-45        | 4-47                    |
| Science laboratories | Science laboratories    | Office space     | Elec/mech equipment rooms | Corridors               | Corridors   | Corridors                   | Corridors   | Conference/meeting      |
| 283                  | 1,366                   | 630              | 248                       | 522                     | 1,413   | 1,226                       | 147         | 622                     |
| 6                    | 23                      | 3.15             | 0                         | 0                       | 0   | 0                           | 0           | 31.1                    |
| 800                  | 2,800                   | 1,500            | 850                       | 400                     | 1,600   | 2,400                       | 150         | 1280                    |
|                      |                         |                  |                           |                         |   |                             |             |                         |
| 50% CSCRW            | 45% CSCRW               | 50% CSCRW        | 41% CSCRW                 | 100% CSCRW              | 100% CSCRW  | 88% CSCRW                   | 100% CSCRW  | 50% CSCRW               |
| 1.00                 | 1.00                    | 1.00             | 1.00                      | 1.00                    | 1.00  | 1.00                        | 1.00        | 1.00                    |
| 1.00                 | 1.00                    | 1.00             | 1.00                      | 1.00                    | 1.00  | 1.00                        | 1.00        | 1.00                    |
| 1.00                 | 1.00                    | 1.00             | 1.00                      | 1.00                    | 1.00  | 1.00                        | 1.00        | 1.00                    |
|                      |                         |                  |                           |                         |   |                             |             |                         |
|                      |                         |                  |                           |                         |   |                             |             |                         |
|                      |                         |                  |                           |                         |   |                             |             |                         |
|                      |                         |                  |                           |                         |   |                             |             |                         |
|                      |                         |                  |                           |                         |   |                             |             |                         |
|                      |                         |                  |                           |                         |   |                             |             |                         |
|                      |                         |                  |                           |                         |   |                             |             |                         |
|                      |                         |                  |                           |                         |   |                             |             |                         |
|                      |                         |                  |                           |                         |   |                             |             |                         |
| 0.18                 | 0.18                    | 0.06             | 0.00                      | 0.06                    | 0.06  | 0.06                        | 0.06        | 0.06                    |
| 10.00                | 10.00                   | 5.00             | 0.00                      | 0.00                    | 0.00  | 0.00                        | 0.00        | 5.00                    |
| 400                  | 1250                    | 750              | 350                       | 400                     | 1600  | 2100                        | 150         | 640                     |
| 400                  | 1250                    | 750              | 350                       | 400                     | 1600  | 2100                        | 150         | 640                     |
| 111                  | 476                     | 54               | 0                         | 31                      | 85  | 74                          | 9           | 193                     |
| 144                  | 619                     | 70               | 0                         | 41                      | 110   | 96                          | 11          | 251                     |
| 111                  | 476                     | 54               | 0                         | 31                      | 85  | 74                          | 9           | 193                     |
| 144                  | 619                     | 70               | 0                         | 41                      | 110   | 96                          | 11          | 251                     |
| 1.00                 | 1.00                    | 1.00             | 1.00                      | 1.00                    | 1.00  | 1.00                        | 1.00        | 1.00                    |
| 1.00                 | 1.00                    | 1.00             | 1.00                      | 1.00                    | 1.00  | 1.00                        | 1.00        | 1.00                    |
| 1.00                 | 1.00                    | 1.00             | 1.00                      | 1.00                    | 1.00  | 1.00                        | 1.00        | 1.00                    |
| 0.28                 | 0.38                    | 0.07             | 0.00                      | 0.08                    | 0.05  | 0.04                        | 0.06        | 0.30                    |
| 0.28                 | 0.38                    | 0.07             | 0.00                      | 0.08                    | 0.05  | 0.04                        | 0.06        | 0.30                    |
| 0.36                 | 0.49                    | 0.09             | 0.00                      | 0.10                    | 0.07  | 0.05                        | 0.08        | 0.39                    |
| 0.36                 | 0.49                    | 0.09             | 0.00                      | 0.10                    | 0.07  | 0.05                        | 0.08        | 0.39                    |
| 0.89                 | 0.79                    | 1.10             | 1.17                      | 1.09                    | 1.11  | 1.13                        | 1.11        | 0.87                    |
| 0.86                 | 0.72                    | 1.12             | 1.22                      | 1.12                    | 1.15  | 1.17                        | 1.14        | 0.83                    |

| 4001 - LARGE CONFERENCE | 5007 - OFFICE, 5009 - OFFICE, 5011 - OFFICE | 5013 - OFFICE | 5008 - WORKSTATIONS | 5012 - WORKSTATIONS | 5000CC - CORRIDOR | 5019 - OFFICE, 5017 - OFFICE, 5015 - OFFICE | 5021 - MEDIUM CONFERENCE | 5022 - LAB DESKS, 5030 LAB DESKS, 5028 - LAB DESKS | 5036 - COLD ROOM | 5038 - FREEZER ROOM | 5045 - RNAI BL2+ LAB | 5035 - RNAI BL2+ LAB       | 5058E - ELEC              | 5000LB - ELEVATOR LOBBY | 5000CE - CORRIDOR, 5000LA - FIRE SERVICE ACCESS LOBBY, 5040 MEN, 5044 - WOMEN |
|-------------------------|---|---------------|---------------------|---------------------|-------------------|---|--------------------------|--|------------------|---------------------|----------------------|----------------------------|---------------------------|-------------------------|---|
| 4-47                    | 5-1   | 5-3           | 5-5                 | 5-7                 | 5-9               | 5-11  | 5-13                     | 5-15   | 5-17             | 5-19                | 5-23A, 5-23B, 5-25   | 5-27A, 5-27B, 5-27C, 5-27D | 5-39                      | 5-41                    | 5-43  |
| Conference/meeting      | Office space                                | Office space  | Office space        | Office space        | Corridors         | Office space                                | Conference/meeting       | Office space                                       | Storage rooms    | Storage rooms       | Science laboratories | Science laboratories       | Elec/mech equipment rooms | Corridors               | Corridors   |
| 622                     | 429   | 179           | 276                 | 457                 | 276               | 338   | 252                      | 466  | 107              | 255                 | 1,508                | 2,077                      | 247                       | 348                     | 1,456   |
| 31.1                    | 6   | 1             | 4                   | 8                   | 0                 | 5   | 12.6                     | 18   | 0                | 0                   | 12                   | 12                         | 0                         | 0                       | 0   |
| 1280                    | 525   | 300           | 400                 | 1,000               | 300               | 475   | 400                      | 450  | 35               | 800                 | 3,850                | 5,250                      | 850                       | 400                     | 1,700   |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
| 50%                     | 48%   | 50%           | 50%                 | 50%                 | 100%              | 53%   | 50%                      | 50%  | 100%             | 100%                | 90%                  | 100%                       | 100%                      | 100%                    | 100%  |
| CSCRW                   | CSCRW                                       | CSCRW         | CSCRW               | CSCRW               | CSCRW             | CSCRW                                       | CSCRW                    | CSCRW  | CSCRW            | CSCRW               | CSCRW                | CSCRW                      | CSCRW                     | CSCRW                   | CSCRW   |
| 1.00                    | 1.00  | 1.00          | 1.00                | 1.00                | 1.00              | 1.00  | 1.00                     | 1.00   | 1.00             | 1.00                | 1.00                 | 1.00                       | 1.00                      | 1.00                    | 1.00  |
| 1.00                    | 1.00  | 1.00          | 1.00                | 1.00                | 1.00              | 1.00  | 1.00                     | 1.00   | 1.00             | 1.00                | 1.00                 | 1.00                       | 1.00                      | 1.00                    | 1.00  |
| 1.00                    | 1.00  | 1.00          | 1.00                | 1.00                | 1.00              | 1.00  | 1.00                     | 1.00   | 1.00             | 1.00                | 1.00                 | 1.00                       | 1.00                      | 1.00                    | 1.00  |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
|                         |   |               |                     |                     |                   |   |                          |  |                  |                     |                      |                            |                           |                         |   |
| 0.06                    | 0.06  | 0.06          | 0.06                | 0.06                | 0.06              | 0.06  | 0.06                     | 0.06   | 0.00             | 0.00                | 0.18                 | 0.18                       | 0.00                      | 0.06                    | 0.06  |
| 5.00                    | 5.00  | 5.00          | 5.00                | 5.00                | 0.00              | 5.00  | 5.00                     | 5.00   | 0.00             | 0.00                | 10.00                | 10.00                      | 0.00                      | 0.00                    | 0.00  |
| 640                     | 250   | 150           | 200                 | 500                 | 300               | 250   | 200                      | 225  | 35               | 800                 | 3450                 | 5250                       | 850                       | 400                     | 1700  |
| 640                     | 250   | 150           | 200                 | 500                 | 300               | 250   | 200                      | 225  | 35               | 800                 | 3450                 | 5250                       | 850                       | 400                     | 1700  |
| 193                     | 56  | 16            | 37                  | 67                  | 17                | 45  | 78                       | 118  | 0                | 0                   | 392                  | 494                        | 0                         | 21                      | 87  |
| 251                     | 72  | 20            | 48                  | 88                  | 22                | 59  | 102                      | 153  | 0                | 0                   | 509                  | 642                        | 0                         | 27                      | 114   |
| 193                     | 56  | 16            | 37                  | 67                  | 17                | 45  | 78                       | 118  | 0                | 0                   | 392                  | 494                        | 0                         | 21                      | 87  |
| 251                     | 72  | 20            | 48                  | 88                  | 22                | 59  | 102                      | 153  | 0                | 0                   | 509                  | 642                        | 0                         | 27                      | 114   |
| 1.00                    | 1.00  | 1.00          | 1.00                | 1.00                | 1.00              | 1.00  | 1.00                     | 1.00   | 1.00             | 1.00                | 1.00                 | 1.00                       | 1.00                      | 1.00                    | 1.00  |
| 1.00                    | 1.00  | 1.00          | 1.00                | 1.00                | 1.00              | 1.00  | 1.00                     | 1.00   | 1.00             | 1.00                | 1.00                 | 1.00                       | 1.00                      | 1.00                    | 1.00  |
| 1.00                    | 1.00  | 1.00          | 1.00                | 1.00                | 1.00              | 1.00  | 1.00                     | 1.00   | 1.00             | 1.00                | 1.00                 | 1.00                       | 1.00                      | 1.00                    | 1.00  |
| 0.30                    | 0.22  | 0.10          | 0.18                | 0.13                | 0.06              | 0.18  | 0.39                     | 0.52   | 0.00             | 0.00                | 0.11                 | 0.09                       | 0.00                      | 0.05                    | 0.05  |
| 0.30                    | 0.22  | 0.10          | 0.18                | 0.13                | 0.06              | 0.18  | 0.39                     | 0.52   | 0.00             | 0.00                | 0.11                 | 0.09                       | 0.00                      | 0.05                    | 0.05  |
| 0.39                    | 0.29  | 0.14          | 0.24                | 0.18                | 0.07              | 0.24  | 0.51                     | 0.68   | 0.00             | 0.00                | 0.15                 | 0.12                       | 0.00                      | 0.07                    | 0.07  |
| 0.39                    | 0.29  | 0.14          | 0.24                | 0.18                | 0.07              | 0.24  | 0.51                     | 0.68   | 0.00             | 0.00                | 0.15                 | 0.12                       | 0.00                      | 0.07                    | 0.07  |
| 0.87                    | 0.94  | 1.06          | 0.98                | 1.03                | 1.11              | 0.99  | 0.78                     | 0.64   | 1.17             | 1.17                | 1.05                 | 1.07                       | 1.17                      | 1.11                    | 1.12  |
| 0.83                    | 0.93  | 1.08          | 0.98                | 1.04                | 1.15              | 0.98  | 0.71                     | 0.54   | 1.22             | 1.22                | 1.07                 | 1.09                       | 1.22                      | 1.15                    | 1.15  |

| 5000CA - BREAKOUT/CONNECTOR | 5001 - LARGE CONFERENCE | 5005 - COPY | 6007 - OFFICE, 6009 - OFFICE, 6011 - OFFICE, 6013 - OFFICE | 6013 - OFFICE | 6008 - OFFICE, 6020 - OFFICE | 6010 - OFFICE, 6012 - OFFICE | 6015 - OFFICE, 6017 - OFFICE | 6019 - OFFICE, 6021 - OFFICE | 6014 - OFFICE, 6016 - OFFICE, 6028 - OFFICE | 6018 - OFFICE, 6024 - WORKSTATIONS | 6023 - OFFICE, 6029 - OFFICE | 6026 - OFFICE, 6030 - OFFICE | 6040 - MEN, 6044 - WOMEN, 6000CA - CORRIDOR, 6000LB - ELEVATOR LOBBY, 6000LA - FIRE SERVICE ACCESS LOBBY | 6031 - LARGE CONFERENCE |
|-----------------------------|-------------------------|-------------|--|---------------|------------------------------|------------------------------|------------------------------|------------------------------|---|------------------------------------|------------------------------|------------------------------|--|-------------------------|
| 5-45, 5-47                  | 5-49                    | 5-51        | 6-1  | 6-3           | 6-7                          | 6-9                          | 6-11                         | 6-13                         | 6-15  | 6-17                               | 6-23                         | 6-25                         | 6-27, 6-43   | 6-29                    |
| Corridors                   | Conference/meeting      | Corridors   | Office space   | Office space  | Office space                 | Office space                 | Office space                 | Office space                 | Office space                                | Office space                       | Office space                 | Office space                 | Corridors  | Conference/meeting      |
| 1,365                       | 635                     | 151         | 649  | 266           | 358                          | 218                          | 249                          | 250                          | 348   | 474                                | 403                          | 316                          | 1,889  | 419                     |
| 0                           | 31.75                   | 0           | 8  | 1             | 4                            | 1                            | 5                            | 4                            | 5   | 7                                  | 4                            | 6                            | 0  | 20.95                   |
| 2,400                       | 1,250                   | 200         | 525  | 300           | 400                          | 400                          | 375                          | 400                          | 525   | 600                                | 400                          | 400                          | 1,600  | 900                     |
| 50%                         | 50%                     | 100%        | 52%  | 50%           | 50%                          | 50%                          | 53%                          | 50%                          | 48%   | 50%                                | 50%                          | 50%                          | 100%   | 50%                     |
| CSCRW                       | CSCRW                   | CSCRW       | CSCRW  | CSCRW         | CSCRW                        | CSCRW                        | CSCRW                        | CSCRW                        | CSCRW                                       | CSCRW                              | CSCRW                        | CSCRW                        | CSCRW  | CSCRW                   |
| 1.00                        | 1.00                    | 1.00        | 1.00   | 1.00          | 1.00                         | 1.00                         | 1.00                         | 1.00                         | 1.00  | 1.00                               | 1.00                         | 1.00                         | 1.00   | 1.00                    |
| 1.00                        | 1.00                    | 1.00        | 1.00   | 1.00          | 1.00                         | 1.00                         | 1.00                         | 1.00                         | 1.00  | 1.00                               | 1.00                         | 1.00                         | 1.00   | 1.00                    |
| 1.00                        | 1.00                    | 1.00        | 1.00   | 1.00          | 1.00                         | 1.00                         | 1.00                         | 1.00                         | 1.00  | 1.00                               | 1.00                         | 1.00                         | 1.00   | 1.00                    |
| 0.06                        | 0.06                    | 0.06        | 0.06   | 0.06          | 0.06                         | 0.06                         | 0.06                         | 0.06                         | 0.06  | 0.06                               | 0.06                         | 0.06                         | 0.06   | 0.06                    |
| 0.00                        | 5.00                    | 0.00        | 5.00   | 5.00          | 5.00                         | 5.00                         | 5.00                         | 5.00                         | 5.00  | 5.00                               | 5.00                         | 5.00                         | 5.00   | 5.00                    |
| 1200                        | 625                     | 200         | 275  | 150           | 200                          | 200                          | 200                          | 200                          | 250   | 300                                | 200                          | 200                          | 1600   | 450                     |
| 1200                        | 625                     | 200         | 275  | 150           | 200                          | 200                          | 200                          | 200                          | 250   | 300                                | 200                          | 200                          | 1600   | 450                     |
| 82                          | 197                     | 9           | 79   | 21            | 41                           | 18                           | 40                           | 35                           | 46  | 63                                 | 44                           | 49                           | 113  | 130                     |
| 106                         | 256                     | 12          | 103  | 27            | 54                           | 24                           | 52                           | 46                           | 60  | 82                                 | 57                           | 64                           | 147  | 169                     |
| 82                          | 197                     | 9           | 79   | 21            | 41                           | 18                           | 40                           | 35                           | 46  | 63                                 | 44                           | 49                           | 113  | 130                     |
| 106                         | 256                     | 12          | 103  | 27            | 54                           | 24                           | 52                           | 46                           | 60  | 82                                 | 57                           | 64                           | 147  | 169                     |
| 1.00                        | 1.00                    | 1.00        | 1.00   | 1.00          | 1.00                         | 1.00                         | 1.00                         | 1.00                         | 1.00  | 1.00                               | 1.00                         | 1.00                         | 1.00   | 1.00                    |
| 1.00                        | 1.00                    | 1.00        | 1.00   | 1.00          | 1.00                         | 1.00                         | 1.00                         | 1.00                         | 1.00  | 1.00                               | 1.00                         | 1.00                         | 1.00   | 1.00                    |
| 1.00                        | 1.00                    | 1.00        | 1.00   | 1.00          | 1.00                         | 1.00                         | 1.00                         | 1.00                         | 1.00  | 1.00                               | 1.00                         | 1.00                         | 1.00   | 1.00                    |
| 0.07                        | 0.31                    | 0.05        | 0.29   | 0.14          | 0.21                         | 0.09                         | 0.20                         | 0.18                         | 0.18  | 0.21                               | 0.22                         | 0.24                         | 0.07   | 0.29                    |
| 0.07                        | 0.31                    | 0.05        | 0.29   | 0.14          | 0.21                         | 0.09                         | 0.20                         | 0.18                         | 0.18  | 0.21                               | 0.22                         | 0.24                         | 0.07   | 0.29                    |
| 0.09                        | 0.41                    | 0.06        | 0.37   | 0.18          | 0.27                         | 0.12                         | 0.26                         | 0.23                         | 0.24  | 0.27                               | 0.29                         | 0.32                         | 0.09   | 0.38                    |
| 0.09                        | 0.41                    | 0.06        | 0.37   | 0.18          | 0.27                         | 0.12                         | 0.26                         | 0.23                         | 0.24  | 0.27                               | 0.29                         | 0.32                         | 0.09   | 0.38                    |
| 1.10                        | 0.85                    | 1.12        | 0.88   | 1.03          | 0.96                         | 1.08                         | 0.97                         | 0.99                         | 0.98  | 0.96                               | 0.95                         | 0.92                         | 1.10   | 0.88                    |
| 1.13                        | 0.81                    | 1.16        | 0.84   | 1.04          | 0.95                         | 1.10                         | 0.96                         | 0.99                         | 0.98  | 0.94                               | 0.93                         | 0.90                         | 1.12   | 0.84                    |

| 6032 - SCIENTIFIC LIVING ROOM | 6048 - OFFICE, 6050 - OFFICE | 6055 - OFFICE, 6057 - OFFICE, 6053 - OFFICE | 6053 - OFFICE | 6047 - OFFICE, 6049 - OFFICE | 6091 - OFFICE | 6095 - OFFICE, 6093 - OFFICE | 6099 - OFFICE, 6101 - OFFICE, 6097 - OFFICE | 6103 - OFFICE | 6109 - OFFICE, 6107 - OFFICE, 6105 - OFFICE | 6111 - OFFICE, 6113 - OFFICE | 6106 - OFFICE, 6108 - OFFICE | 6080 - OFFICE, 6082 - OFFICE, 6084 - OFFICE | 6092 - OFFICE, 6094 - OFFICE | 6060E1 - ELEC, 6058E2 - ELEC |
|-------------------------------|------------------------------|---|---------------|------------------------------|---------------|------------------------------|---|---------------|---|------------------------------|------------------------------|---|------------------------------|------------------------------|
| 6-31                          | 6-33                         | 6-35  | 6-37          | 6-39                         | 6-47          | 6-49                         | 6-51  | 6-53          | 6-55  | 6-57                         | 6-59                         | 6-61  | 6-63                         | 6-65                         |
| Break rooms                   | Office space                 | Office space                                | Office space  | Office space                 | Office space  | Office space                 | Office space                                | Office space  | Office space                                | Office space                 | Office space                 | Office space                                | Office space                 | Elec/mech equipment rooms    |
| 323                           | 262                          | 518   | 254           | 261                          | 235           | 255                          | 384   | 264           | 421   | 274                          | 397                          | 397   | 394                          | 227                          |
| 6                             | 6                            | 3   | 2             | 5                            | 4             | 6                            | 9   | 1             | 8   | 2                            | 9                            | 9   | 8                            | 0                            |
| 1,000                         | 350                          | 375   | 400           | 350                          | 350           | 350                          | 575   | 275           | 625   | 400                          | 525                          | 525   | 350                          | 1,350                        |
| 50%                           | 50%                          | 47%   | 50%           | 50%                          | 50%           | 50%                          | 52%   | 55%           | 48%   | 50%                          | 52%                          | 52%   | 50%                          | 26%                          |
| CSCRW                         | CSCRW                        | CSCRW                                       | CSCRW         | CSCRW                        | CSCRW         | CSCRW                        | CSCRW                                       | CSCRW         | CSCRW                                       | CSCRW                        | CSCRW                        | CSCRW                                       | CSCRW                        | CSCRW                        |
| 1.00                          | 1.00                         | 1.00  | 1.00          | 1.00                         | 1.00          | 1.00                         | 1.00  | 1.00          | 1.00  | 1.00                         | 1.00                         | 1.00  | 1.00                         | 1.00                         |
| 1.00                          | 1.00                         | 1.00  | 1.00          | 1.00                         | 1.00          | 1.00                         | 1.00  | 1.00          | 1.00  | 1.00                         | 1.00                         | 1.00  | 1.00                         | 1.00                         |
| 1.00                          | 1.00                         | 1.00  | 1.00          | 1.00                         | 1.00          | 1.00                         | 1.00  | 1.00          | 1.00  | 1.00                         | 1.00                         | 1.00  | 1.00                         | 1.00                         |
| 0.06                          | 0.06                         | 0.06  | 0.06          | 0.06                         | 0.06          | 0.06                         | 0.06  | 0.06          | 0.06  | 0.06                         | 0.06                         | 0.06  | 0.06                         | 0.00                         |
| 5.00                          | 5.00                         | 5.00  | 5.00          | 5.00                         | 5.00          | 5.00                         | 5.00  | 5.00          | 5.00  | 5.00                         | 5.00                         | 5.00  | 5.00                         | 0.00                         |
| 500                           | 175                          | 175   | 200           | 175                          | 175           | 175                          | 300   | 150           | 300   | 200                          | 275                          | 275   | 175                          | 350                          |
| 500                           | 175                          | 175   | 200           | 175                          | 175           | 175                          | 300   | 150           | 300   | 200                          | 275                          | 275   | 175                          | 350                          |
| 49                            | 46                           | 46  | 25            | 41                           | 34            | 45                           | 68  | 21            | 65  | 26                           | 69                           | 69  | 64                           | 0                            |
| 64                            | 59                           | 60  | 33            | 53                           | 44            | 59                           | 88  | 27            | 85  | 34                           | 89                           | 89  | 83                           | 0                            |
| 49                            | 46                           | 46  | 25            | 41                           | 34            | 45                           | 68  | 21            | 65  | 26                           | 69                           | 69  | 64                           | 0                            |
| 64                            | 59                           | 60  | 33            | 53                           | 44            | 59                           | 88  | 27            | 85  | 34                           | 89                           | 89  | 83                           | 0                            |
| 1.00                          | 1.00                         | 1.00  | 1.00          | 1.00                         | 1.00          | 1.00                         | 1.00  | 1.00          | 1.00  | 1.00                         | 1.00                         | 1.00  | 1.00                         | 1.00                         |
| 1.00                          | 1.00                         | 1.00  | 1.00          | 1.00                         | 1.00          | 1.00                         | 1.00  | 1.00          | 1.00  | 1.00                         | 1.00                         | 1.00  | 1.00                         | 1.00                         |
| 1.00                          | 1.00                         | 1.00  | 1.00          | 1.00                         | 1.00          | 1.00                         | 1.00  | 1.00          | 1.00  | 1.00                         | 1.00                         | 1.00  | 1.00                         | 1.00                         |
| 0.10                          | 0.26                         | 0.26  | 0.13          | 0.23                         | 0.19          | 0.26                         | 0.23  | 0.14          | 0.22  | 0.13                         | 0.25                         | 0.25  | 0.36                         | 0.00                         |
| 0.10                          | 0.26                         | 0.26  | 0.13          | 0.23                         | 0.19          | 0.26                         | 0.23  | 0.14          | 0.22  | 0.13                         | 0.25                         | 0.25  | 0.36                         | 0.00                         |
| 0.13                          | 0.34                         | 0.34  | 0.16          | 0.30                         | 0.25          | 0.34                         | 0.29  | 0.18          | 0.28  | 0.17                         | 0.33                         | 0.33  | 0.47                         | 0.00                         |
| 0.13                          | 0.34                         | 0.34  | 0.16          | 0.30                         | 0.25          | 0.34                         | 0.29  | 0.18          | 0.28  | 0.17                         | 0.33                         | 0.33  | 0.47                         | 0.00                         |
| 1.07                          | 0.91                         | 0.90  | 1.04          | 0.93                         | 0.97          | 0.91                         | 0.94  | 1.03          | 0.95  | 1.03                         | 0.92                         | 0.92  | 0.80                         | 1.17                         |
| 1.09                          | 0.88                         | 0.87  | 1.05          | 0.91                         | 0.96          | 0.88                         | 0.92  | 1.04          | 0.93  | 1.05                         | 0.89                         | 0.89  | 0.74                         | 1.22                         |

| 6074 - OFFICE, 6078 - OFFICE | 6062 - OFFICE, 6064 - OFFICE | 6068 - OFFICE, 6070 - OFFICE, 6072 - OFFICE | 6116 - SMALL CONFERENCE | 6000CP - CORRIDOR | 6112 - OFFICE, 6114 - OFFICE | 6115 - GSAP LAB           | 6130 - COLD ROOM | 6133 - LAB DESKS | 6135 - LAB DESKS, 6137 - LAB DESKS | 6139 - LAB DESKS | 6141 - MEETING     | 6128 - TISSUE CULTURE | 6132 - CLEAN ROOM |
|------------------------------|------------------------------|---|-------------------------|-------------------|------------------------------|---------------------------|------------------|------------------|------------------------------------|------------------|--------------------|-----------------------|-------------------|
| 6-67                         | 6-69                         | 6-73  | 6-75                    | 6-79              | 6-77                         | 6-83A, 6-83B, 6-85, 6-87A | 6-89             | 6-91             | 6-93                               | 6-95             | 6-95               | 6-99                  | 6-101             |
| Office space                 | Office space                 | Office space                                | Conference/meeting      | Corridors         | Office space                 | Science laboratories      | Storage rooms    | Office space     | Office space                       | Office space     | Conference/meeting | Science laboratories  | Storage rooms     |
| 245                          | 270                          | 383   | 148                     | 546               | 239                          | 3,375                     | 134              | 112              | 277                                | 141              | 131                | 211                   | 152               |
| 5                            | 4                            | 9   | 7.4                     | 0                 | 4                            | 60                        | 0                | 3                | 10                                 | 5                | 4                  | 2                     | 0                 |
| 350                          | 350                          | 525   | 350                     | 400               | 350                          | 7,500                     | 35               | 200              | 400                                | 200              | 200                | 1,200                 | 300               |
| 50%                          | 50%                          | 52%   | 50%                     | 100%              | 50%                          | 49%                       | 100%             | 50%              | 75%                                | 75%              | 75%                | 100%                  | 67%               |
| CSCRW                        | CSCRW                        | CSCRW                                       | CSCRW                   | CSCRW             | CSCRW                        | CSCRW                     | CSCRW            | CSCRW            | CSCRW                              | CSCRW            | CSCRW              | CSCRW                 | CSCRW             |
| 1.00                         | 1.00                         | 1.00  | 1.00                    | 1.00              | 1.00                         | 1.00                      | 1.00             | 1.00             | 1.00                               | 1.00             | 1.00               | 1.00                  | 1.00              |
| 1.00                         | 1.00                         | 1.00  | 1.00                    | 1.00              | 1.00                         | 1.00                      | 1.00             | 1.00             | 1.00                               | 1.00             | 1.00               | 1.00                  | 1.00              |
| 1.00                         | 1.00                         | 1.00  | 1.00                    | 1.00              | 1.00                         | 1.00                      | 1.00             | 1.00             | 1.00                               | 1.00             | 1.00               | 1.00                  | 1.00              |

|      |      |      |      |      |      |       |      |      |      |      |      |       |      |
|------|------|------|------|------|------|-------|------|------|------|------|------|-------|------|
| 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.18  | 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.18  | 0.00 |
| 5.00 | 5.00 | 5.00 | 5.00 | 0.00 | 5.00 | 10.00 | 0.00 | 5.00 | 5.00 | 5.00 | 5.00 | 10.00 | 0.00 |
| 175  | 175  | 275  | 175  | 400  | 175  | 3700  | 35   | 100  | 300  | 150  | 150  | 1200  | 200  |
| 175  | 175  | 275  | 175  | 400  | 175  | 3700  | 35   | 100  | 300  | 150  | 150  | 1200  | 200  |
| 40   | 36   | 68   | 46   | 33   | 34   | 1208  | 0    | 22   | 67   | 33   | 28   | 58    | 0    |
| 52   | 47   | 88   | 60   | 43   | 45   | 1570  | 0    | 28   | 87   | 43   | 36   | 75    | 0    |
| 40   | 36   | 68   | 46   | 33   | 34   | 1208  | 0    | 22   | 67   | 33   | 28   | 58    | 0    |
| 52   | 47   | 88   | 60   | 43   | 45   | 1570  | 0    | 28   | 87   | 43   | 36   | 75    | 0    |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00  | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00  | 1.00 |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00  | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00  | 1.00 |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00  | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00  | 1.00 |
| 0.23 | 0.21 | 0.25 | 0.26 | 0.08 | 0.20 | 0.33  | 0.00 | 0.22 | 0.22 | 0.22 | 0.19 | 0.05  | 0.00 |
| 0.23 | 0.21 | 0.25 | 0.26 | 0.08 | 0.20 | 0.33  | 0.00 | 0.22 | 0.22 | 0.22 | 0.19 | 0.05  | 0.00 |
| 0.29 | 0.27 | 0.32 | 0.34 | 0.11 | 0.26 | 0.42  | 0.00 | 0.28 | 0.29 | 0.29 | 0.24 | 0.06  | 0.00 |
| 0.29 | 0.27 | 0.32 | 0.34 | 0.11 | 0.26 | 0.42  | 0.00 | 0.28 | 0.29 | 0.29 | 0.24 | 0.06  | 0.00 |
| 0.94 | 0.96 | 0.92 | 0.90 | 1.09 | 0.97 | 0.84  | 1.17 | 0.95 | 0.94 | 0.94 | 0.98 | 1.12  | 1.17 |
| 0.92 | 0.95 | 0.90 | 0.88 | 1.11 | 0.96 | 0.79  | 1.22 | 0.93 | 0.93 | 0.93 | 0.98 | 1.15  | 1.22 |

| 6122 - FREEZER ROOM | 6124 - BL2+ VIRAL PREP | 6000CR - CORRIDOR | 6120 - PRE PCR       | 6118 - GEL ROOM      | 6143 - MEDIUM CONFERENCE | 6145 - BREAK AREA, UNAMED SPACE NEXT TO 6145 | 6000 - ATRIUM         | 7001 - BREAK AREA | 7011 - MEDIUM CONFERENCE | 7015 - OFFICE, 7017 - OFFICE, 7019 - OFFICE | 7025 - OFFICE, 7027 - OFFICE | 7003 - OPEN OFFICE    |
|---------------------|------------------------|-------------------|----------------------|----------------------|--------------------------|--|-----------------------|-------------------|--------------------------|---|------------------------------|-----------------------|
| 6-107               | 6-103                  | 6-105             | 6-109                | 6-111                | 6-113                    | 6-115  | 6-117A, 6-117B, 6-121 | 7-1               | 7-3                      | 7-5   | 7-7                          | 7-9, 7-11, 7-15, 7-19 |
| Storage rooms       | Science laboratories   | Corridors         | Science laboratories | Science laboratories | Conference/meeting       | Break rooms                                  | Multi-use assembly    | Break rooms       | Conference/meeting       | Office space                                | Office space                 | Office space          |
| 483                 | 225                    | 325               | 173                  | 155                  | 183                      | 301  | 1,347                 | 574               | 368                      | 383   | 255                          | 3,776                 |
| 0                   | 2                      | 0                 | 3                    | 3                    | 9.15                     | 10   | 125                   | 14.35             | 18.4                     | 1,915                                       | 1,275                        | 18.88                 |
| 200                 | 1,200                  | 250               | 375                  | 375                  | 400                      | 600  | 3,300                 | 750               | 500                      | 525   | 350                          | 4,725                 |
|                     |                        |                   |                      |                      |                          |  |                       |                   |                          |   |                              |                       |
| 100%                | 100%                   | 60%               | 53%                  | 53%                  | 50%                      | 50%  | 45%                   | 50%               | 50%                      | 52%   | 50%                          | 50%                   |
| CSCRW               | CSCRW                  | CSCRW             | CSCRW                | CSCRW                | CSCRW                    | CSCRW  | CSCRW                 | CSCRW             | CSCRW                    | CSCRW                                       | CSCRW                        | CSCRW                 |
| 1.00                | 1.00                   | 1.00              | 1.00                 | 1.00                 | 1.00                     | 1.00   | 1.00                  | 1.00              | 1.00                     | 1.00  | 1.00                         | 1.00                  |
| 1.00                | 1.00                   | 1.00              | 1.00                 | 1.00                 | 1.00                     | 1.00   | 1.00                  | 1.00              | 1.00                     | 1.00  | 1.00                         | 1.00                  |
|                     |                        |                   |                      |                      |                          |  |                       |                   |                          |   |                              |                       |
|                     |                        |                   |                      |                      |                          |  |                       |                   |                          |   |                              |                       |
|                     |                        |                   |                      |                      |                          |  |                       |                   |                          |   |                              |                       |
|                     |                        |                   |                      |                      |                          |  |                       |                   |                          |   |                              |                       |
|                     |                        |                   |                      |                      |                          |  |                       |                   |                          |   |                              |                       |
|                     |                        |                   |                      |                      |                          |  |                       |                   |                          |   |                              |                       |
| 0.00                | 0.18                   | 0.06              | 0.18                 | 0.18                 | 0.06                     | 0.06   | 0.06                  | 0.06              | 0.06                     | 0.06  | 0.06                         | 0.06                  |
| 0.00                | 10.00                  | 0.00              | 10.00                | 10.00                | 5.00                     | 5.00   | 7.50                  | 5.00              | 5.00                     | 5.00  | 5.00                         | 5.00                  |
| 200                 | 1200                   | 150               | 200                  | 200                  | 200                      | 300  | 1475                  | 375               | 250                      | 275   | 175                          | 2375                  |
| 200                 | 1200                   | 150               | 200                  | 200                  | 200                      | 300  | 1475                  | 375               | 250                      | 275   | 175                          | 2375                  |
| 0                   | 61                     | 20                | 61                   | 58                   | 57                       | 68   | 1018                  | 106               | 114                      | 33  | 22                           | 321                   |
| 0                   | 79                     | 25                | 79                   | 75                   | 74                       | 88   | 1324                  | 138               | 148                      | 42  | 28                           | 417                   |
| 0                   | 61                     | 20                | 61                   | 58                   | 57                       | 68   | 1018                  | 106               | 114                      | 33  | 22                           | 321                   |
| 0                   | 79                     | 25                | 79                   | 75                   | 74                       | 88   | 1324                  | 138               | 148                      | 42  | 28                           | 417                   |
| 1.00                | 1.00                   | 1.00              | 1.00                 | 1.00                 | 1.00                     | 1.00   | 1.00                  | 1.00              | 1.00                     | 1.00  | 1.00                         | 1.00                  |
| 1.00                | 1.00                   | 1.00              | 1.00                 | 1.00                 | 1.00                     | 1.00   | 1.00                  | 1.00              | 1.00                     | 1.00  | 1.00                         | 1.00                  |
| 1.00                | 1.00                   | 1.00              | 1.00                 | 1.00                 | 1.00                     | 1.00   | 1.00                  | 1.00              | 1.00                     | 1.00  | 1.00                         | 1.00                  |
| 0.00                | 0.05                   | 0.13              | 0.31                 | 0.29                 | 0.28                     | 0.23   | 0.69                  | 0.28              | 0.46                     | 0.12  | 0.12                         | 0.14                  |
| 0.00                | 0.05                   | 0.13              | 0.31                 | 0.29                 | 0.28                     | 0.23   | 0.69                  | 0.28              | 0.46                     | 0.12  | 0.12                         | 0.14                  |
| 0.00                | 0.07                   | 0.17              | 0.40                 | 0.38                 | 0.37                     | 0.29   | 0.90                  | 0.37              | 0.59                     | 0.15  | 0.16                         | 0.18                  |
| 0.00                | 0.07                   | 0.17              | 0.40                 | 0.38                 | 0.37                     | 0.29   | 0.90                  | 0.37              | 0.59                     | 0.15  | 0.16                         | 0.18                  |
| 1.17                | 1.12                   | 1.04              | 0.86                 | 0.88                 | 0.88                     | 0.94   | 0.48                  | 0.88              | 0.71                     | 1.05  | 1.04                         | 1.03                  |
| 1.22                | 1.15                   | 1.05              | 0.82                 | 0.84                 | 0.85                     | 0.92   | 0.32                  | 0.85              | 0.62                     | 1.06  | 1.06                         | 1.04                  |

| 7031 - SMALL CONFERENCE | 7000CC - CORRIDOR, 7000LB - ELEVATOR LOBBY | 7045 - R&D           | 7000LA - FIRE SERVICE ACCESS LOBBY | 706000 - ELEC, 70580 - ELEC | 7076 - REAGENT PREP                        | 7055 - ION DETECTION | 7065 - ILLUMINA      | 7075 - SAMPLE PREP                                     | 7057 - BREAKING RM   | 7059 - GOWNING RM |
|-------------------------|--|----------------------|------------------------------------|-----------------------------|--|----------------------|----------------------|--|----------------------|-------------------|
| 7-13                    | 7-17                                       | 7-21A, 7-21B         | 7-23                               | 7-25                        | 7-27                                       | 7-29                 | 7-31                 | 7-33A, 7-33B, 7-33C, 7-33D, 7-35A, 7-35B, 7-35C, 7-35D | 7-37                 | 7-39              |
| Conference/meeting      | Corridors                                  | Science laboratories | Corridors                          | Elec/mech equipment rooms   | Occupiable storage rooms for dry materials | Science laboratories | Science laboratories | Science laboratories                                   | Science laboratories | Corridors         |
| 181                     | 1,150                                      | 1,510                | 237                                | 300                         | 129  | 1,132                | 1,831                | 3,326  | 248                  | 218               |
| 9.05                    | 0  | 20                   | 0                                  | 0                           | 0.258                                      | 20                   | 4                    | 26   | 4                    | 0                 |
| 225                     | 750  | 2,950                | 400                                | 1,350                       | 1,000                                      | 1,025                | 1,650                | 7,800  | 1,900                | 800               |
| 67%                     | 100%                                       | 54%                  | 100%                               | 26%                         | 100%                                       | 100%                 | 100%                 | 38%  | 100%                 | 25%               |
| CSCRW                   | CSCRW                                      | CSCRW                | CSCRW                              | CSCRW                       | CSCRW                                      | CSCRW                | CSCRW                | CSCRW  | CSCRW                | CSCRW             |
| 1.00                    | 1.00                                       | 1.00                 | 1.00                               | 1.00                        | 1.00                                       | 1.00                 | 1.00                 | 1.00   | 1.00                 | 1.00              |
| 1.00                    | 1.00                                       | 1.00                 | 1.00                               | 1.00                        | 1.00                                       | 1.00                 | 1.00                 | 1.00   | 1.00                 | 1.00              |
| 1.00                    | 1.00                                       | 1.00                 | 1.00                               | 1.00                        | 1.00                                       | 1.00                 | 1.00                 | 1.00   | 1.00                 | 1.00              |
| 0.06                    | 0.06                                       | 0.18                 | 0.06                               | 0.00                        | 0.06                                       | 0.18                 | 0.18                 | 0.18   | 0.18                 | 0.06              |
| 5.00                    | 0.00                                       | 10.00                | 0.00                               | 0.00                        | 5.00                                       | 10.00                | 10.00                | 10.00  | 10.00                | 0.00              |
| 150                     | 750  | 1600                 | 400                                | 350                         | 1000                                       | 1025                 | 1650                 | 3000   | 1900                 | 200               |
| 150                     | 750  | 1600                 | 400                                | 350                         | 1000                                       | 1025                 | 1650                 | 3000   | 1900                 | 200               |
| 56                      | 69   | 472                  | 14                                 | 0                           | 9  | 404                  | 370                  | 859  | 85                   | 13                |
| 73                      | 90   | 613                  | 18                                 | 0                           | 12   | 525                  | 480                  | 1116   | 110                  | 17                |
| 56                      | 69   | 472                  | 14                                 | 0                           | 9  | 404                  | 370                  | 859  | 85                   | 13                |
| 73                      | 90   | 613                  | 18                                 | 0                           | 12   | 525                  | 480                  | 1116   | 110                  | 17                |
| 1.00                    | 1.00                                       | 1.00                 | 1.00                               | 1.00                        | 1.00                                       | 1.00                 | 1.00                 | 1.00   | 1.00                 | 1.00              |
| 1.00                    | 1.00                                       | 1.00                 | 1.00                               | 1.00                        | 1.00                                       | 1.00                 | 1.00                 | 1.00   | 1.00                 | 1.00              |
| 1.00                    | 1.00                                       | 1.00                 | 1.00                               | 1.00                        | 1.00                                       | 1.00                 | 1.00                 | 1.00   | 1.00                 | 1.00              |
| 0.37                    | 0.09                                       | 0.29                 | 0.04                               | 0.00                        | 0.01                                       | 0.39                 | 0.22                 | 0.29   | 0.04                 | 0.07              |
| 0.37                    | 0.09                                       | 0.29                 | 0.04                               | 0.00                        | 0.01                                       | 0.39                 | 0.22                 | 0.29   | 0.04                 | 0.07              |
| 0.49                    | 0.12                                       | 0.38                 | 0.05                               | 0.00                        | 0.01                                       | 0.51                 | 0.29                 | 0.37   | 0.06                 | 0.09              |
| 0.49                    | 0.12                                       | 0.38                 | 0.05                               | 0.00                        | 0.01                                       | 0.51                 | 0.29                 | 0.37   | 0.06                 | 0.09              |
| 0.79                    | 1.07                                       | 0.87                 | 1.13                               | 1.17                        | 1.16                                       | 0.77                 | 0.94                 | 0.88   | 1.12                 | 1.10              |
| 0.73                    | 1.10                                       | 0.83                 | 1.17                               | 1.22                        | 1.21                                       | 0.70                 | 0.93                 | 0.84   | 1.16                 | 1.13              |

| 7085 - CLEAN SAMPLE 2 | 7000CF - CORRIDOR | 7000CG - CORRIDOR | 7095 - CLEAN SAMPLE 1  | 7105 - SINGLE CELL PCR | 7115 - BL2           | 7119 - GOWNING RM | 7116 - ANTEROOM | 7084 - RODI/GAS MANIFOLD RM | 7000CB - PASSAGE | 7121 - SMALL CONFERENCE | 7000CJ - CORRIDOR  | 8009 - OFFICE, 8007 - OFFICE, 8011 - OFFICE | 8013 - OFFICE |
|-----------------------|-------------------|-------------------|------------------------|------------------------|----------------------|-------------------|-----------------|-----------------------------|------------------|-------------------------|--------------------|---|---------------|
| 7-43, 7-49            | 7-45              | 7-51              | 7-55, 7-59, 7-61, 7-63 | 7-67                   | 7-69                 | 7-71              | 7-73            | 7-75                        | 7-75             | 7-77                    | 7-79, 7-81A, 7-81B | 8-1   | 8-3           |
| Science laboratories  | Corridors         | Corridors         | Science laboratories   | Science laboratories   | Science laboratories | Corridors         | Corridors       | Storage rooms               | Corridors        | Conference/meeting      | Corridors          | Office space                                | Office space  |
| 914                   | 363               | 569               | 1,373                  | 494                    | 240                  | 242               | 75              | 93                          | 63               | 188                     | 649                | 490   | 209           |
| 13                    | 0                 | 0                 | 20                     | 10                     | 5                    | 0                 | 0               | 0                           | 0                | 9.4                     | 0                  | 8   | 1             |
| 2,600                 | 400               | 400               | 3,300                  | 800                    | 900                  | 800               | 200             | 100                         | 300              | 300                     | 5,000              | 525   | 200           |
|                       |                   |                   |                        |                        |                      |                   |                 |                             |                  |                         |                    |   |               |
| 42%                   | 50%               | 50%               | 20%                    | 31%                    | 25%                  | 28%               | 100%            | 100%                        | 100%             | 50%                     | 50%                | 52%   | 50%           |
| CSCRW                 | CSCRW             | CSCRW             | CSCRW                  | CSCRW                  | CSCRW                | CSCRW             | CSCRW           | CSCRW                       | CSCRW            | CSCRW                   | CSCRW              | CSCRW                                       | CSCRW         |
| 1.00                  | 1.00              | 1.00              | 1.00                   | 1.00                   | 1.00                 | 1.00              | 1.00            | 1.00                        | 1.00             | 1.00                    | 1.00               | 1.00  | 1.00          |
| 1.00                  | 1.00              | 1.00              | 1.00                   | 1.00                   | 1.00                 | 1.00              | 1.00            | 1.00                        | 1.00             | 1.00                    | 1.00               | 1.00  | 1.00          |
| 1.00                  | 1.00              | 1.00              | 1.00                   | 1.00                   | 1.00                 | 1.00              | 1.00            | 1.00                        | 1.00             | 1.00                    | 1.00               | 1.00  | 1.00          |

|       |      |      |       |       |       |      |      |      |      |      |      |      |      |
|-------|------|------|-------|-------|-------|------|------|------|------|------|------|------|------|
| 0.18  | 0.06 | 0.06 | 0.18  | 0.18  | 0.18  | 0.06 | 0.06 | 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| 10.00 | 0.00 | 0.00 | 10.00 | 10.00 | 10.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.00 | 0.00 | 5.00 | 5.00 |
| 1100  | 200  | 200  | 650   | 250   | 225   | 225  | 200  | 100  | 300  | 150  | 2500 | 275  | 100  |
| 1100  | 200  | 200  | 650   | 250   | 225   | 225  | 200  | 100  | 300  | 150  | 2500 | 275  | 100  |
| 295   | 22   | 34   | 447   | 189   | 93    | 15   | 5    | 0    | 4    | 58   | 39   | 69   | 18   |
| 383   | 28   | 44   | 581   | 246   | 121   | 19   | 6    | 0    | 5    | 76   | 51   | 90   | 23   |
| 295   | 22   | 34   | 447   | 189   | 93    | 15   | 5    | 0    | 4    | 58   | 39   | 69   | 18   |
| 383   | 28   | 44   | 581   | 246   | 121   | 19   | 6    | 0    | 5    | 76   | 51   | 90   | 23   |
| 1.00  | 1.00 | 1.00 | 1.00  | 1.00  | 1.00  | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.00  | 1.00 | 1.00 | 1.00  | 1.00  | 1.00  | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.00  | 1.00 | 1.00 | 1.00  | 1.00  | 1.00  | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 0.27  | 0.11 | 0.17 | 0.69  | 0.76  | 0.41  | 0.06 | 0.02 | 0.00 | 0.01 | 0.39 | 0.02 | 0.25 | 0.18 |
| 0.27  | 0.11 | 0.17 | 0.69  | 0.76  | 0.41  | 0.06 | 0.02 | 0.00 | 0.01 | 0.39 | 0.02 | 0.25 | 0.18 |
| 0.35  | 0.14 | 0.22 | 0.89  | 0.98  | 0.54  | 0.08 | 0.03 | 0.00 | 0.02 | 0.51 | 0.02 | 0.33 | 0.23 |
| 0.35  | 0.14 | 0.22 | 0.89  | 0.98  | 0.54  | 0.08 | 0.03 | 0.00 | 0.02 | 0.51 | 0.02 | 0.33 | 0.23 |
| 0.90  | 1.06 | 1.00 | 0.48  | 0.41  | 0.75  | 1.10 | 1.14 | 1.17 | 1.15 | 0.78 | 1.15 | 0.91 | 0.99 |
| 0.87  | 1.08 | 1.00 | 0.32  | 0.23  | 0.68  | 1.13 | 1.19 | 1.22 | 1.20 | 0.71 | 1.20 | 0.89 | 0.99 |



| 8015 - SMALL CONFERENCE | 8008 - OFFICE, 8010 - OFFICE, 8012 - OFFICE | 8029 - BSP POST PCR  | 8014 - TISSUE CULTURE ROOM | 8016 - COLD ROOM, 8018 - FREEZER | 8028 - RTS ROOM      | 8026 - LAB DESKS | 8025 - BSP PRE LAB   | 8039 - LAB DESKS | 8037 - LAB DESKS | 8035 - LAB DESKS | 8033 - LAB DESKS |
|-------------------------|---|----------------------|----------------------------|----------------------------------|----------------------|------------------|----------------------|------------------|------------------|------------------|------------------|
| 8-5                     | 8-7   | 8-9                  | 8-11                       | 8-13                             | 8-15                 | 8-17             | 8-17A, 8-17B, 8-19A  | 8-21A            | 8-21B            | 8-21C            | 8-21D            |
| Conference/meeting      | Office space                                | Science laboratories | Science laboratories       | Storage rooms                    | Science laboratories | Office space     | Science laboratories | Office space     | Office space     | Office space     | Office space     |
| 223                     | 394   | 350                  | 252                        | 181                              | 489                  | 232              | 3,160                | 210              | 209              | 186              | 174              |
| 11.15                   | 9   | 8                    | 3                          | 0                                | 5                    | 6                | 48                   | 4                | 8                | 6                | 6                |
| 350                     | 525   | 750                  | 1,200                      | 60                               | 350                  | 400              | 6,250                | 250              | 250              | 250              | 250              |
|                         |   |                      |                            |                                  |                      |                  |                      |                  |                  |                  |                  |
| 50%                     | 52%   | 50%                  | 100%                       | 100%                             | 79%                  | 50%              | 51%                  | 60%              | 60%              | 60%              | 60%              |
| CSCRW                   | CSCRW                                       | CSCRW                | CSCRW                      | CSCRW                            | CSCRW                | CSCRW            | CSCRW                | CSCRW            | CSCRW            | CSCRW            | CSCRW            |
| 1.00                    | 1.00  | 1.00                 | 1.00                       | 1.00                             | 1.00                 | 1.00             | 1.00                 | 1.00             | 1.00             | 1.00             | 1.00             |
| 1.00                    | 1.00  | 1.00                 | 1.00                       | 1.00                             | 1.00                 | 1.00             | 1.00                 | 1.00             | 1.00             | 1.00             | 1.00             |
| 1.00                    | 1.00  | 1.00                 | 1.00                       | 1.00                             | 1.00                 | 1.00             | 1.00                 | 1.00             | 1.00             | 1.00             | 1.00             |

|      |      |       |       |      |       |      |       |      |      |      |      |
|------|------|-------|-------|------|-------|------|-------|------|------|------|------|
| 0.06 | 0.06 | 0.18  | 0.18  | 0.00 | 0.18  | 0.06 | 0.18  | 0.06 | 0.06 | 0.06 | 0.06 |
| 5.00 | 5.00 | 10.00 | 10.00 | 0.00 | 10.00 | 5.00 | 10.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| 175  | 275  | 375   | 1200  | 60   | 275   | 200  | 3200  | 150  | 150  | 150  | 150  |
| 175  | 275  | 375   | 1200  | 60   | 275   | 200  | 3200  | 150  | 150  | 150  | 150  |
| 69   | 69   | 143   | 75    | 0    | 138   | 44   | 1049  | 33   | 53   | 41   | 40   |
| 90   | 89   | 186   | 98    | 0    | 179   | 57   | 1363  | 42   | 68   | 54   | 53   |
| 69   | 69   | 143   | 75    | 0    | 138   | 44   | 1049  | 33   | 53   | 41   | 40   |
| 90   | 89   | 186   | 98    | 0    | 179   | 57   | 1363  | 42   | 68   | 54   | 53   |
| 1.00 | 1.00 | 1.00  | 1.00  | 1.00 | 1.00  | 1.00 | 1.00  | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.00 | 1.00 | 1.00  | 1.00  | 1.00 | 1.00  | 1.00 | 1.00  | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.00 | 1.00 | 1.00  | 1.00  | 1.00 | 1.00  | 1.00 | 1.00  | 1.00 | 1.00 | 1.00 | 1.00 |
| 0.40 | 0.25 | 0.38  | 0.06  | 0.00 | 0.50  | 0.22 | 0.33  | 0.22 | 0.35 | 0.27 | 0.27 |
| 0.40 | 0.25 | 0.38  | 0.06  | 0.00 | 0.50  | 0.22 | 0.33  | 0.22 | 0.35 | 0.27 | 0.27 |
| 0.51 | 0.32 | 0.50  | 0.08  | 0.00 | 0.65  | 0.29 | 0.43  | 0.28 | 0.46 | 0.36 | 0.35 |
| 0.51 | 0.32 | 0.50  | 0.08  | 0.00 | 0.65  | 0.29 | 0.43  | 0.28 | 0.46 | 0.36 | 0.35 |
| 0.77 | 0.92 | 0.79  | 1.10  | 1.17 | 0.67  | 0.95 | 0.84  | 0.95 | 0.82 | 0.89 | 0.90 |
| 0.70 | 0.89 | 0.72  | 1.14  | 1.22 | 0.56  | 0.93 | 0.79  | 0.93 | 0.76 | 0.86 | 0.87 |

| 8040 - MEN, 8044 - WOMEN, 8000LB - ELEVATOR LOBBY, 8000CC - CORRIDOR, 8000LA - FIRE SERVICE ACCESS LOBBY | 8061 - PROJECT MANAGERS OFFICE | 8059 - LAB MANAGERS | 8063 - LAB DESKS | 8065 - POST PCR GAP LAB                  | 8058E2 - ELEC, 8060 - ELEC | 8062 - SMALL CONFERENCE | 8064 - STORAGE | 8070, 8066 COLD ROOM, 8068, 8072 FREEZER | 8075 - PRE PCR WHOLE GENOME | 8085 - PRE PCR EXPRESSION | 8095 - PRE PCR LOWPLEX | 8097 - OFFICE | 8099 - OFFICE, 8103 - OFFICE | 8111 - MEETING     | 8086 - LAB SUPPORT | 8102 - COPY |
|--|--------------------------------|---------------------|------------------|--|----------------------------|-------------------------|----------------|--|-----------------------------|---------------------------|------------------------|---------------|------------------------------|--------------------|--------------------|-------------|
| 8-23, 8-61   | 8-25                           | 8-27                | 8-29A, 8-29B     | 8-31A, 8-31B, 8-31C, 8-31D, 8-33B, 8-33C | 8-35                       | 8-37                    | 8-39           | 8-41                                     | 8-43A, 8-43B                | 8-45                      | 8-47A, 8-47B           | 8-49          | 8-51                         | 8-51               | 8-53               | 8-55        |
| Corridors  | Office space                   | Office space        | Office space     | Science laboratories                     | Elec/mech equipment rooms  | Conference/meeting      | Storage rooms  | Storage rooms                            | Science laboratories        | Science laboratories      | Science laboratories   | Office space  | Office space                 | Conference/meeting | Storage rooms      | Corridors   |
| 1,768  | 242                            | 389                 | 738              | 4,451                                    | 286                        | 229                     | 162            | 492                                      | 746                         | 312                       | 957                    | 195           | 260                          | 122                | 133                | 120         |
| 0  | 3                              | 6                   | 5                | 51                                       | 0                          | 11.45                   | 0              | 0  | 12                          | 4                         | 18                     | 4             | 6                            | 6.1                | 0                  | 0           |
| 1,600  | 300                            | 550                 | 1,000            | 9,325                                    | 1,350                      | 400                     | 300            | 120                                      | 1,600                       | 850                       | 1,950                  | 300           | 400                          | 200                | 250                | 250         |
| 100%   | 50%                            | 50%                 | 50%              | 43%                                      | 26%                        | 50%                     | 50%            | 100%                                     | 42%                         | 47%                       | 45%                    | 50%           | 50%                          | 50%                | 50%                | 60%         |
| CSCRW  | CSCRW                          | CSCRW               | CSCRW            | CSCRW                                    | CSCRW                      | CSCRW                   | CSCRW          | CSCRW                                    | CSCRW                       | CSCRW                     | CSCRW                  | CSCRW         | CSCRW                        | CSCRW              | CSCRW              | CSCRW       |
| 1.00   | 1.00                           | 1.00                | 1.00             | 1.00                                     | 1.00                       | 1.00                    | 1.00           | 1.00                                     | 1.00                        | 1.00                      | 1.00                   | 1.00          | 1.00                         | 1.00               | 1.00               | 1.00        |
| 1.00   | 1.00                           | 1.00                | 1.00             | 1.00                                     | 1.00                       | 1.00                    | 1.00           | 1.00                                     | 1.00                        | 1.00                      | 1.00                   | 1.00          | 1.00                         | 1.00               | 1.00               | 1.00        |
| 1.00   | 1.00                           | 1.00                | 1.00             | 1.00                                     | 1.00                       | 1.00                    | 1.00           | 1.00                                     | 1.00                        | 1.00                      | 1.00                   | 1.00          | 1.00                         | 1.00               | 1.00               | 1.00        |
| 0.06   | 0.06                           | 0.06                | 0.06             | 0.18                                     | 0.00                       | 0.06                    | 0.00           | 0.00                                     | 0.18                        | 0.18                      | 0.18                   | 0.06          | 0.06                         | 0.06               | 0.00               | 0.06        |
| 0.00   | 5.00                           | 5.00                | 5.00             | 10.00                                    | 0.00                       | 5.00                    | 0.00           | 0.00                                     | 10.00                       | 10.00                     | 10.00                  | 5.00          | 5.00                         | 5.00               | 0.00               | 0.00        |
| 1600   | 150                            | 275                 | 500              | 4050                                     | 350                        | 200                     | 150            | 120                                      | 675                         | 400                       | 875                    | 150           | 200                          | 100                | 125                | 150         |
| 1600   | 150                            | 275                 | 500              | 4050                                     | 350                        | 200                     | 150            | 120                                      | 675                         | 400                       | 875                    | 150           | 200                          | 100                | 125                | 150         |
| 106  | 30                             | 53                  | 69               | 1311                                     | 0                          | 71                      | 0              | 0  | 254                         | 96                        | 352                    | 32            | 46                           | 38                 | 0                  | 7           |
| 138  | 38                             | 69                  | 90               | 1705                                     | 0                          | 92                      | 0              | 0  | 331                         | 125                       | 458                    | 41            | 59                           | 49                 | 0                  | 9           |
| 106  | 30                             | 53                  | 69               | 1311                                     | 0                          | 71                      | 0              | 0  | 254                         | 96                        | 352                    | 32            | 46                           | 38                 | 0                  | 7           |
| 138  | 38                             | 69                  | 90               | 1705                                     | 0                          | 92                      | 0              | 0  | 331                         | 125                       | 458                    | 41            | 59                           | 49                 | 0                  | 9           |
| 1.00   | 1.00                           | 1.00                | 1.00             | 1.00                                     | 1.00                       | 1.00                    | 1.00           | 1.00                                     | 1.00                        | 1.00                      | 1.00                   | 1.00          | 1.00                         | 1.00               | 1.00               | 1.00        |
| 1.00   | 1.00                           | 1.00                | 1.00             | 1.00                                     | 1.00                       | 1.00                    | 1.00           | 1.00                                     | 1.00                        | 1.00                      | 1.00                   | 1.00          | 1.00                         | 1.00               | 1.00               | 1.00        |
| 1.00   | 1.00                           | 1.00                | 1.00             | 1.00                                     | 1.00                       | 1.00                    | 1.00           | 1.00                                     | 1.00                        | 1.00                      | 1.00                   | 1.00          | 1.00                         | 1.00               | 1.00               | 1.00        |
| 0.07   | 0.20                           | 0.19                | 0.14             | 0.32                                     | 0.00                       | 0.35                    | 0.00           | 0.00                                     | 0.38                        | 0.24                      | 0.40                   | 0.21          | 0.23                         | 0.38               | 0.00               | 0.05        |
| 0.07   | 0.20                           | 0.19                | 0.14             | 0.32                                     | 0.00                       | 0.35                    | 0.00           | 0.00                                     | 0.38                        | 0.24                      | 0.40                   | 0.21          | 0.23                         | 0.38               | 0.00               | 0.05        |
| 0.09   | 0.26                           | 0.25                | 0.18             | 0.42                                     | 0.00                       | 0.46                    | 0.00           | 0.00                                     | 0.49                        | 0.31                      | 0.52                   | 0.27          | 0.30                         | 0.49               | 0.00               | 0.06        |
| 0.09   | 0.26                           | 0.25                | 0.18             | 0.42                                     | 0.00                       | 0.46                    | 0.00           | 0.00                                     | 0.49                        | 0.31                      | 0.52                   | 0.27          | 0.30                         | 0.49               | 0.00               | 0.06        |
| 1.10   | 0.97                           | 0.97                | 1.03             | 0.84                                     | 1.17                       | 0.81                    | 1.17           | 1.17                                     | 0.79                        | 0.93                      | 0.76                   | 0.96          | 0.94                         | 0.79               | 1.17               | 1.12        |
| 1.13   | 0.96                           | 0.96                | 1.04             | 0.80                                     | 1.22                       | 0.76                    | 1.22           | 1.22                                     | 0.73                        | 0.90                      | 0.69                   | 0.94          | 0.92                         | 0.73               | 1.22               | 1.15        |

|   |                   |   |               |                              |               |                 |                              |                              |   |   |  |
|---|-------------------|---|---------------|------------------------------|---------------|-----------------|------------------------------|------------------------------|---|---|--|
| 8084 - THERMO CYCLER, 8082 - CRYOGEN MANIFOLD, 8080 - -80 FREEZER, 8078 - -80 FREEZER | 8001 - BREAK AREA | 9009 - OFFICE, 9007 - OFFICE, 9011 - OFFICE | 9013 - OFFICE | 9017 - OFFICE, 9015 - OFFICE | 9010 - OFFICE | 9012 - BREAKOUT | 9022 - OFFICE, 9008 - OFFICE | 9021 - OFFICE, 9019 - OFFICE | 9014 - OFFICE, 9016 - OFFICE, 9018 - OFFICE | 9026 - OFFICE, 9024 - OFFICE, 9020 - OFFICE | 9040 - MEN, 9044 - WOMEN, 9000LB - ELEVATOR LOBBY, 9000CA - CORRIDOR, 9000LA - FIRE SERVICE ACCESS LOBBY |
| 8-57  | 8-59              | 9-1   | 9-3           | 9-5                          | 9-7           | 9-9             | 9-11                         | 9-13                         | 9-15  | 9-17  | 9-19, 9-97   |
| Storage rooms   | Break rooms       | Office space                                | Office space  | Office space                 | Office space  | Corridors       | Office space                 | Office space                 | Office space                                | Office space                                | Corridors  |
| 1,251   | 910               | 390   | 276           | 308                          | 109           | 138             | 336                          | 260                          | 327   | 540   | 1,754  |
| 0   | 22.75             | 7   | 1             | 6                            | 1             | 0               | 7                            | 5                            | 3   | 12  | 0  |
| 800   | 1,400             | 525   | 300           | 400                          | 200           | 200             | 450                          | 350                          | 450   | 675   | 1,600  |
| 600.00  | 800.00            | 600.00                                      | 800.00        | 600.00                       | 800.00        | 600.00          | 800.00                       | 600.00                       | 800.00                                      | 600.00                                      | 800.00   |
| 100%  | 50%               | 48%   | 50%           | 50%                          | 50%           | 50%             | 50%                          | 50%                          | 50%   | 48%   | 100%   |
| CSCRW   | CSCRW             | CSCRW                                       | CSCRW         | CSCRW                        | CSCRW         | CSCRW           | CSCRW                        | CSCRW                        | CSCRW                                       | CSCRW                                       | CSCRW  |
| 1.00  | 1.00              | 1.00  | 1.00          | 1.00                         | 1.00          | 1.00            | 1.00                         | 1.00                         | 1.00  | 1.00  | 1.00   |
| 1.00  | 1.00              | 1.00  | 1.00          | 1.00                         | 1.00          | 1.00            | 1.00                         | 1.00                         | 1.00  | 1.00  | 1.00   |
| 1.00  | 1.00              | 1.00  | 1.00          | 1.00                         | 1.00          | 1.00            | 1.00                         | 1.00                         | 1.00  | 1.00  | 1.00   |

|      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| 0.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 0.00 | 5.00 | 5.00 | 5.00 | 0.00 |
| 800  | 700  | 250  | 150  | 200  | 100  | 100  | 225  | 175  | 225  | 325  | 1600 |
| 800  | 700  | 250  | 150  | 200  | 100  | 100  | 225  | 175  | 225  | 325  | 1600 |
| 0    | 168  | 58   | 22   | 48   | 12   | 8    | 55   | 41   | 35   | 92   | 105  |
| 0    | 219  | 76   | 28   | 63   | 15   | 11   | 72   | 53   | 45   | 120  | 137  |
| 0    | 168  | 58   | 22   | 48   | 12   | 8    | 55   | 41   | 35   | 92   | 105  |
| 0    | 219  | 76   | 28   | 63   | 15   | 11   | 72   | 53   | 45   | 120  | 137  |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 0.00 | 0.24 | 0.23 | 0.14 | 0.24 | 0.12 | 0.08 | 0.25 | 0.23 | 0.15 | 0.28 | 0.07 |
| 0.00 | 0.24 | 0.23 | 0.14 | 0.24 | 0.12 | 0.08 | 0.25 | 0.23 | 0.15 | 0.28 | 0.07 |
| 0.00 | 0.31 | 0.30 | 0.19 | 0.32 | 0.15 | 0.11 | 0.32 | 0.30 | 0.20 | 0.37 | 0.09 |
| 0.00 | 0.31 | 0.30 | 0.19 | 0.32 | 0.15 | 0.11 | 0.32 | 0.30 | 0.20 | 0.37 | 0.09 |
| 1.17 | 0.93 | 0.93 | 1.02 | 0.92 | 1.05 | 1.08 | 0.92 | 0.93 | 1.01 | 0.88 | 1.10 |
| 1.22 | 0.90 | 0.91 | 1.03 | 0.90 | 1.07 | 1.11 | 0.90 | 0.92 | 1.02 | 0.85 | 1.13 |

| 9023 - OFFICE, 9029 - OFFICE | 9028 - OFFICE, 9030 - OFFICE | 9031 - LARGE CONFERENCE | 9032 - SCIENTIFIC LIVING ROOM | 9057 - OFFICE, 9055 - OFFICE | 9053 - OFFICE | 9047 - OFFICE, 9049 - OFFICE | 9048 - OFFICE, 9050 - OFFICE | 9077 - TISSUE CULTURE ROOM | 9066 - MICROSCOPY IMAGING |
|------------------------------|------------------------------|-------------------------|-------------------------------|------------------------------|---------------|------------------------------|------------------------------|----------------------------|---------------------------|
| 9-21                         | 9-23                         | 9-25                    | 9-27                          | 9-29                         | 9-31          | 9-33                         | 9-35                         | 9-37                       | 9-41                      |
| Office space                 | Office space                 | Conference/meeting      | Break rooms                   | Office space                 | Office space  | Office space                 | Office space                 | Science laboratories       | Office space              |
| 355                          | 316                          | 433                     | 322                           | 273                          | 255           | 270                          | 260                          | 484                        | 188                       |
| 6                            | 6                            | 21.65                   | 6                             | 2                            | 1             | 6                            | 6                            | 5                          | 0.94                      |
| 450                          | 400                          | 1,300                   | 1,200                         | 350                          | 350           | 400                          | 350                          | 2,500                      | 450                       |
| 50%<br>CSCRW                 | 50%<br>CSCRW                 | 50%<br>CSCRW            | 50%<br>CSCRW                  | 50%<br>CSCRW                 | 50%<br>CSCRW  | 50%<br>CSCRW                 | 50%<br>CSCRW                 | 100%<br>CSCRW              | 50%<br>CSCRW              |
| 1.00                         | 1.00                         | 1.00                    | 1.00                          | 1.00                         | 1.00          | 1.00                         | 1.00                         | 1.00                       | 1.00                      |
| 1.00                         | 1.00                         | 1.00                    | 1.00                          | 1.00                         | 1.00          | 1.00                         | 1.00                         | 1.00                       | 1.00                      |
| 0.06                         | 0.06                         | 0.06                    | 0.06                          | 0.06                         | 0.06          | 0.06                         | 0.06                         | 0.18                       | 0.06                      |
| 5.00                         | 5.00                         | 5.00                    | 5.00                          | 5.00                         | 5.00          | 5.00                         | 5.00                         | 10.00                      | 5.00                      |
| 225                          | 200                          | 650                     | 600                           | 175                          | 175           | 200                          | 175                          | 2500                       | 225                       |
| 225                          | 200                          | 650                     | 600                           | 175                          | 175           | 200                          | 175                          | 2500                       | 225                       |
| 51                           | 49                           | 134                     | 49                            | 26                           | 20            | 46                           | 46                           | 137                        | 16                        |
| 67                           | 64                           | 174                     | 64                            | 34                           | 26            | 60                           | 59                           | 178                        | 21                        |
| 51                           | 49                           | 134                     | 49                            | 26                           | 20            | 46                           | 46                           | 137                        | 16                        |
| 67                           | 64                           | 174                     | 64                            | 34                           | 26            | 60                           | 59                           | 178                        | 21                        |
| 1.00                         | 1.00                         | 1.00                    | 1.00                          | 1.00                         | 1.00          | 1.00                         | 1.00                         | 1.00                       | 1.00                      |
| 1.00                         | 1.00                         | 1.00                    | 1.00                          | 1.00                         | 1.00          | 1.00                         | 1.00                         | 1.00                       | 1.00                      |
| 1.00                         | 1.00                         | 1.00                    | 1.00                          | 1.00                         | 1.00          | 1.00                         | 1.00                         | 1.00                       | 1.00                      |
| 0.23                         | 0.24                         | 0.21                    | 0.08                          | 0.15                         | 0.12          | 0.23                         | 0.26                         | 0.05                       | 0.07                      |
| 0.23                         | 0.24                         | 0.21                    | 0.08                          | 0.15                         | 0.12          | 0.23                         | 0.26                         | 0.05                       | 0.07                      |
| 0.30                         | 0.32                         | 0.27                    | 0.11                          | 0.20                         | 0.15          | 0.30                         | 0.34                         | 0.07                       | 0.09                      |
| 0.30                         | 0.32                         | 0.27                    | 0.11                          | 0.20                         | 0.15          | 0.30                         | 0.34                         | 0.07                       | 0.09                      |
| 0.94                         | 0.92                         | 0.96                    | 1.08                          | 1.02                         | 1.05          | 0.94                         | 0.91                         | 1.11                       | 1.10                      |
| 0.92                         | 0.90                         | 0.95                    | 1.11                          | 1.02                         | 1.07          | 0.92                         | 0.88                         | 1.15                       | 1.12                      |

| 9062 - EPHYS ROOM | 9000CJ - CORRIDOR | 9060E2 - ELEC, 90580 - ELEC | 9070 - BL2 + TISSUE CULTURE ROOM | 9064 - H-2 STORAGE | 9068 - COLD ROOM | 9083 - LAB DESKS, 9081 - LAB DESKS, 9079 - LAB DESKS | 9087 - LAB DESKS, 9085 - LAB DESKS | 9089 - LAB DESKS | 9075 - LAB  | 9000CL - CORRIDOR | 9093 - OFFICE | 9099 - OFFICE, 9095 - OFFICE, 9097 - OFFICE |
|-------------------|-------------------|-----------------------------|----------------------------------|--------------------|------------------|--|------------------------------------|------------------|---|-------------------|---------------|---|
| 9-43              | 9-45              | 9-47                        | 9-49                             | 9-51               | 9-53             | 9-55   | 9-57A                              | 9-57B            | 9-59A, 9-59B, 9-59C, 9-61A, 9-61B, 9-61C, 9-63A, 9-63B, 9-63C | 9-65              | 9-67          | 9-69  |
| Corridors         | Corridors         | Elec/mech equipment rooms   | Science laboratories             | Storage rooms      | Storage rooms    | Office space   | Office space                       | Office space     | Science laboratories  | Corridors         | Office space  | Office space                                |
| 180               | 197               | 281                         | 421                              | 88                 | 118              | 460  | 432                                | 432              | 6,295   | 508               | 208           | 399   |
| 0                 | 0                 | 0                           | 4                                | 0                  | 0                | 15   | 10                                 | 3                | 110   | 0                 | 1             | 7   |
| 600               | 100               | 1,350                       | 2,600                            | 250                | 35               | 600  | 400                                | 200              | 12,700  | 250               | 250           | 550   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
| 50%               | 100%              | 26%                         | 100%                             | 60%                | 100%             | 75%  | 75%                                | 75%              | 44%   | 100%              | 50%           | 50%   |
| CSCRW             | CSCRW             | CSCRW                       | CSCRW                            | CSCRW              | CSCRW            | CSCRW  | CSCRW                              | CSCRW            | CSCRW   | CSCRW             | CSCRW         | CSCRW                                       |
| 1.00              | 1.00              | 1.00                        | 1.00                             | 1.00               | 1.00             | 1.00   | 1.00                               | 1.00             | 1.00  | 1.00              | 1.00          | 1.00  |
| 1.00              | 1.00              | 1.00                        | 1.00                             | 1.00               | 1.00             | 1.00   | 1.00                               | 1.00             | 1.00  | 1.00              | 1.00          | 1.00  |
| 1.00              | 1.00              | 1.00                        | 1.00                             | 1.00               | 1.00             | 1.00   | 1.00                               | 1.00             | 1.00  | 1.00              | 1.00          | 1.00  |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
|                   |                   |                             |                                  |                    |                  |  |                                    |                  |   |                   |               |   |
| 0.06              | 0.06              | 0.00                        | 0.18                             | 0.00               | 0.00             | 0.06   | 0.06                               | 0.06             | 0.18  | 0.06              | 0.06          | 0.06  |
| 0.00              | 0.00              | 0.00                        | 10.00                            | 0.00               | 0.00             | 5.00   | 5.00                               | 5.00             | 10.00   | 0.00              | 5.00          | 5.00  |
| 300               | 100               | 350                         | 2600                             | 150                | 35               | 450  | 300                                | 150              | 5625  | 250               | 125           | 275   |
| 300               | 100               | 350                         | 2600                             | 150                | 35               | 450  | 300                                | 150              | 5625  | 250               | 125           | 275   |
| 11                | 12                | 0                           | 116                              | 0                  | 0                | 103  | 76                                 | 41               | 2233  | 30                | 17            | 59  |
| 14                | 15                | 0                           | 151                              | 0                  | 0                | 133  | 99                                 | 53               | 2903  | 40                | 23            | 77  |
| 11                | 12                | 0                           | 116                              | 0                  | 0                | 103  | 76                                 | 41               | 2233  | 30                | 17            | 59  |
| 14                | 15                | 0                           | 151                              | 0                  | 0                | 133  | 99                                 | 53               | 2903  | 40                | 23            | 77  |
| 1.00              | 1.00              | 1.00                        | 1.00                             | 1.00               | 1.00             | 1.00   | 1.00                               | 1.00             | 1.00  | 1.00              | 1.00          | 1.00  |
| 1.00              | 1.00              | 1.00                        | 1.00                             | 1.00               | 1.00             | 1.00   | 1.00                               | 1.00             | 1.00  | 1.00              | 1.00          | 1.00  |
| 1.00              | 1.00              | 1.00                        | 1.00                             | 1.00               | 1.00             | 1.00   | 1.00                               | 1.00             | 1.00  | 1.00              | 1.00          | 1.00  |
| 0.04              | 0.12              | 0.00                        | 0.04                             | 0.00               | 0.00             | 0.23   | 0.25                               | 0.27             | 0.40  | 0.12              | 0.14          | 0.21  |
| 0.04              | 0.12              | 0.00                        | 0.04                             | 0.00               | 0.00             | 0.23   | 0.25                               | 0.27             | 0.40  | 0.12              | 0.14          | 0.21  |
| 0.05              | 0.15              | 0.00                        | 0.06                             | 0.00               | 0.00             | 0.30   | 0.33                               | 0.35             | 0.52  | 0.16              | 0.18          | 0.28  |
| 0.05              | 0.15              | 0.00                        | 0.06                             | 0.00               | 0.00             | 0.30   | 0.33                               | 0.35             | 0.52  | 0.16              | 0.18          | 0.28  |
| 1.13              | 1.05              | 1.17                        | 1.12                             | 1.17               | 1.17             | 0.94   | 0.91                               | 0.89             | 0.77  | 1.05              | 1.03          | 0.95  |
| 1.17              | 1.06              | 1.22                        | 1.16                             | 1.22               | 1.22             | 0.92   | 0.89                               | 0.86             | 0.70  | 1.06              | 1.04          | 0.94  |

| 9101 - BREAK | 9105 - OFFICE | 9090 - FREEZER ROOM | 9086 - RADIO ISOTOPE RM | 9084 - DARK ROOM     | 9080 - STORAGE | 9088 - LAB MECH RM | 9000CK - CORRIDOR | 9082 - HOLDING | 9078 - PROCEDURE ROOM |
|--------------|---------------|---------------------|-------------------------|----------------------|----------------|--------------------|-------------------|----------------|-----------------------|
| 9-71         | 9-73          | 9-75                | 9-77                    | 9-79                 | 9-79           | 9-81               | 9-83              | 9-85           | 9-87                  |
| Break rooms  | Office space  | Storage rooms       | Science laboratories    | Science laboratories | Storage rooms  | Storage rooms      | Corridors         | Storage rooms  | Medical Procedure     |
| 270          | 148           | 291                 | 121                     | 110                  | 92             | 92                 | 326               | 86             | 224                   |
| 6.75         | 1             | 0                   | 2                       | 1                    | 0              | 0                  | 0                 | 0              | 4.48                  |
| 350          | 200           | 150                 | 650                     | 175                  | 100            | 775                | 300               | 250            | 500                   |
| 50%<br>CSCRW | 50%<br>CSCRW  | 100%<br>CSCRW       | 100%<br>CSCRW           | 100%<br>CSCRW        | 100%<br>CSCRW  | 13%<br>CSCRW       | 100%<br>CSCRW     | 100%<br>CSCRW  | 80%<br>CSCRW          |
| 1.00         | 1.00          | 1.00                | 1.00                    | 1.00                 | 1.00           | 1.00               | 1.00              | 1.00           | 1.00                  |
| 1.00         | 1.00          | 1.00                | 1.00                    | 1.00                 | 1.00           | 1.00               | 1.00              | 1.00           | 1.00                  |
| 0.06         | 0.06          | 0.00                | 0.18                    | 0.18                 | 0.00           | 0.00               | 0.06              | 0.00           | 0.00                  |
| 5.00         | 5.00          | 0.00                | 10.00                   | 10.00                | 0.00           | 0.00               | 0.00              | 0.00           | 15.00                 |
| 175          | 100           | 150                 | 650                     | 175                  | 100            | 100                | 300               | 250            | 400                   |
| 175          | 100           | 150                 | 650                     | 175                  | 100            | 100                | 300               | 250            | 400                   |
| 50           | 14            | 0                   | 42                      | 30                   | 0              | 0                  | 20                | 0              | 67                    |
| 65           | 18            | 0                   | 54                      | 39                   | 0              | 0                  | 25                | 0              | 87                    |
| 50           | 14            | 0                   | 42                      | 30                   | 0              | 0                  | 20                | 0              | 67                    |
| 65           | 18            | 0                   | 54                      | 39                   | 0              | 0                  | 25                | 0              | 87                    |
| 1.00         | 1.00          | 1.00                | 1.00                    | 1.00                 | 1.00           | 1.00               | 1.00              | 1.00           | 1.00                  |
| 1.00         | 1.00          | 1.00                | 1.00                    | 1.00                 | 1.00           | 1.00               | 1.00              | 1.00           | 1.00                  |
| 1.00         | 1.00          | 1.00                | 1.00                    | 1.00                 | 1.00           | 1.00               | 1.00              | 1.00           | 1.00                  |
| 0.29         | 0.14          | 0.00                | 0.06                    | 0.17                 | 0.00           | 0.00               | 0.07              | 0.00           | 0.17                  |
| 0.29         | 0.14          | 0.00                | 0.06                    | 0.17                 | 0.00           | 0.00               | 0.07              | 0.00           | 0.17                  |
| 0.37         | 0.18          | 0.00                | 0.08                    | 0.22                 | 0.00           | 0.00               | 0.08              | 0.00           | 0.22                  |
| 0.37         | 0.18          | 0.00                | 0.08                    | 0.22                 | 0.00           | 0.00               | 0.08              | 0.00           | 0.22                  |
| 0.88         | 1.03          | 1.17                | 1.10                    | 1.00                 | 1.17           | 1.17               | 1.10              | 1.17           | 1.00                  |
| 0.85         | 1.04          | 1.22                | 1.13                    | 1.00                 | 1.22           | 1.22               | 1.13              | 1.22           | 1.00                  |

| 9076 - TISSUE CULTURE ROOM | 9108 - COPY | 9107 - SMALL CONFERENCE | 9001 - BREAK AREA | 10011 - OFFICE, 10009 - OFFICE, 10007 - OFFICE | 10013 - OFFICE | 10017 - OFFICE, 10015 - OFFICE | 10010 - OFFICE | 10012 - BREAKOUT | 10022 - OFFICE, 10008 - OFFICE | 10021 - OFFICE, 10019 - OFFICE | 10014 - OFFICE, 10016 - OFFICE, 10018 - OFFICE | 10026 - OFFICE, 10024 - OFFICE, 10020 - OFFICE | 10023 - OFFICE, 10029 - OFFICE |
|----------------------------|-------------|-------------------------|-------------------|--|----------------|--------------------------------|----------------|------------------|--------------------------------|--------------------------------|--|--|--------------------------------|
| 9-89                       | 9-91        | 9-93                    | 9-95              | 10-1   | 10-3           | 10-5                           | 10-7           | 10-7             | 10-9                           | 10-11                          | 10-13  | 10-15  | 10-17                          |
| Science laboratories       | Corridors   | Conference/meeting      | Break rooms       | Office space                                   | Office space   | Office space                   | Office space   | Break rooms      | Office space                   | Office space                   | Office space                                   | Office space                                   | Office space                   |
| 280                        | 102         | 219                     | 1,028             | 387  | 257            | 297                            | 128            | 138              | 313                            | 262                            | 390  | 477  | 353                            |
| 3                          | 0           | 10.95                   | 25.7              | 8  | 1              | 6                              | 3              | 3                | 6                              | 5                              | 9  | 9  | 4                              |
| 1,700                      | 175         | 300                     | 1,200             | 525  | 300            | 350                            | 175            | 200              | 400                            | 350                            | 525  | 600  | 500                            |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
| 100%                       | 100%        | 50%                     | 50%               | 48%  | 50%            | 50%                            | 57%            | 50%              | 50%                            | 50%                            | 48%  | 50%  | 50%                            |
| CSCRW                      | CSCRW       | CSCRW                   | CSCRW             | CSCRW  | CSCRW          | CSCRW                          | CSCRW          | CSCRW            | CSCRW                          | CSCRW                          | CSCRW  | CSCRW  | CSCRW                          |
| 1.00                       | 1.00        | 1.00                    | 1.00              | 1.00   | 1.00           | 1.00                           | 1.00           | 1.00             | 1.00                           | 1.00                           | 1.00   | 1.00   | 1.00                           |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
| 1.00                       | 1.00        | 1.00                    | 1.00              | 1.00   | 1.00           | 1.00                           | 1.00           | 1.00             | 1.00                           | 1.00                           | 1.00   | 1.00   | 1.00                           |
| 1.00                       | 1.00        | 1.00                    | 1.00              | 1.00   | 1.00           | 1.00                           | 1.00           | 1.00             | 1.00                           | 1.00                           | 1.00   | 1.00   | 1.00                           |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
| 0.18                       | 0.06        | 0.06                    | 0.06              | 0.06   | 0.06           | 0.06                           | 0.06           | 0.06             | 0.06                           | 0.06                           | 0.06   | 0.06   | 0.06                           |
| 10.00                      | 0.00        | 5.00                    | 5.00              | 5.00   | 5.00           | 5.00                           | 5.00           | 5.00             | 5.00                           | 5.00                           | 5.00   | 5.00   | 5.00                           |
| 1700                       | 175         | 150                     | 600               | 250  | 150            | 175                            | 100            | 100              | 200                            | 175                            | 250  | 300  | 250                            |
| 1700                       | 175         | 150                     | 600               | 250  | 150            | 175                            | 100            | 100              | 200                            | 175                            | 250  | 300  | 250                            |
| 80                         | 6           | 68                      | 190               | 63   | 20             | 48                             | 23             | 23               | 49                             | 41                             | 68   | 74   | 41                             |
| 105                        | 8           | 88                      | 247               | 82   | 27             | 62                             | 29             | 30               | 63                             | 53                             | 89   | 96   | 54                             |
| 80                         | 6           | 68                      | 190               | 63   | 20             | 48                             | 23             | 23               | 49                             | 41                             | 68   | 74   | 41                             |
| 105                        | 8           | 88                      | 247               | 82   | 27             | 62                             | 29             | 30               | 63                             | 53                             | 89   | 96   | 54                             |
| 1.00                       | 1.00        | 1.00                    | 1.00              | 1.00   | 1.00           | 1.00                           | 1.00           | 1.00             | 1.00                           | 1.00                           | 1.00   | 1.00   | 1.00                           |
| 1.00                       | 1.00        | 1.00                    | 1.00              | 1.00   | 1.00           | 1.00                           | 1.00           | 1.00             | 1.00                           | 1.00                           | 1.00   | 1.00   | 1.00                           |
| 1.00                       | 1.00        | 1.00                    | 1.00              | 1.00   | 1.00           | 1.00                           | 1.00           | 1.00             | 1.00                           | 1.00                           | 1.00   | 1.00   | 1.00                           |
| 1.00                       | 1.00        | 1.00                    | 1.00              | 1.00   | 1.00           | 1.00                           | 1.00           | 1.00             | 1.00                           | 1.00                           | 1.00   | 1.00   | 1.00                           |
| 0.05                       | 0.03        | 0.45                    | 0.32              | 0.25   | 0.14           | 0.27                           | 0.23           | 0.23             | 0.24                           | 0.23                           | 0.27   | 0.25   | 0.16                           |
| 0.05                       | 0.03        | 0.45                    | 0.32              | 0.25   | 0.14           | 0.27                           | 0.23           | 0.23             | 0.24                           | 0.23                           | 0.27   | 0.25   | 0.16                           |
| 0.06                       | 0.05        | 0.59                    | 0.41              | 0.33   | 0.18           | 0.36                           | 0.29           | 0.30             | 0.32                           | 0.30                           | 0.36   | 0.32   | 0.21                           |
| 0.06                       | 0.05        | 0.59                    | 0.41              | 0.33   | 0.18           | 0.36                           | 0.29           | 0.30             | 0.32                           | 0.30                           | 0.36   | 0.32   | 0.21                           |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
| 1.12                       | 1.13        | 0.71                    | 0.85              | 0.91   | 1.03           | 0.89                           | 0.94           | 0.93             | 0.92                           | 0.93                           | 0.89   | 0.92   | 1.00                           |
| 1.16                       | 1.17        | 0.63                    | 0.80              | 0.89   | 1.04           | 0.86                           | 0.92           | 0.91             | 0.90                           | 0.91                           | 0.86   | 0.90   | 1.00                           |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |
|                            |             |                         |                   |  |                |                                |                |                  |                                |                                |  |  |                                |

| 10028 - OFFICE, 10030 - OFFICE | 10040 - MEN, 10044 - WOMEN, 10000LB - ELEVATOR LOBBY, 10000CA - CORRIDOR, 10000LA - FIRE SERVICE ACCESS LOBBY | 10031 - LARGE CONFERENCE | 10032 - SCIENTIFIC LIVING ROOM | 10057 - OFFICE, 10055 - OFFICE | 10053 - OFFICE | 10047 - OFFICE, 10049 - OFFICE | 10048 - OFFICE, 10050 - OFFICE | 10077 - -80 FREEZER ROOM | 10079 - TISSUE CULTURE | 10066 - COLD ROOM | 10062 - H-2 STORAGE | 10000CJ - CORRIDOR | 10064 - EPHYS ROOM | 10068 - MICROSCOPY/IMAGING |              |
|--------------------------------|---|--------------------------|--------------------------------|--------------------------------|----------------|--------------------------------|--------------------------------|--------------------------|------------------------|-------------------|---------------------|--------------------|--------------------|----------------------------|--------------|
| 10-19                          | 10-21, 10-73  | 10-23                    | 10-25                          | 10-27                          | 10-29          | 10-31                          | 10-33                          | 10-35                    | 10-37                  | 10-39             | 10-41               | 10-43              | 10-45              | 10-47                      |              |
| Office space                   | Corridors   | Conference/ meeting      | Break rooms                    | Office space                   | Office space   | Office space                   | Office space                   | Storage rooms            | Science laboratories   | Storage rooms     | Storage rooms       | Corridors          | Corridors          | Office space               |              |
| 314                            | 2,250   | 433                      | 323                            | 271                            | 247            | 269                            | 260                            | 464                      | 207                    | 100               | 92                  | 197                | 188                | 184                        |              |
| 6                              | 0   | 21.65                    | 6                              | 3                              | 1              | 5                              | 6                              | 0                        | 2                      | 0                 | 0                   | 0                  | 0                  | 0.92                       |              |
| 400                            | 1,600   | 1,200                    | 1,200                          | 350                            | 350            | 400                            | 350                            | 450                      | 950                    | 35                | 150                 | 100                | 400                | 350                        |              |
| 50%<br>CSCRW                   | 100%<br>CSCRW   | 50%<br>CSCRW             | 50%<br>CSCRW                   | 50%<br>CSCRW                   | 50%<br>CSCRW   | 50%<br>CSCRW                   | 50%<br>CSCRW                   | 50%<br>CSCRW             | 100%<br>CSCRW          | 100%<br>CSCRW     | 100%<br>CSCRW       | 100%<br>CSCRW      | 100%<br>CSCRW      | 50%<br>CSCRW               | 50%<br>CSCRW |
| 1.00                           | 1.00  | 1.00                     | 1.00                           | 1.00                           | 1.00           | 1.00                           | 1.00                           | 1.00                     | 1.00                   | 1.00              | 1.00                | 1.00               | 1.00               | 1.00                       | 1.00         |
| 1.00                           | 1.00  | 1.00                     | 1.00                           | 1.00                           | 1.00           | 1.00                           | 1.00                           | 1.00                     | 1.00                   | 1.00              | 1.00                | 1.00               | 1.00               | 1.00                       | 1.00         |
| 0.06                           | 0.06  | 0.06                     | 0.06                           | 0.06                           | 0.06           | 0.06                           | 0.06                           | 0.00                     | 0.18                   | 0.00              | 0.00                | 0.06               | 0.06               | 0.06                       |              |
| 5.00                           | 0.00  | 5.00                     | 5.00                           | 5.00                           | 5.00           | 5.00                           | 5.00                           | 0.00                     | 10.00                  | 0.00              | 0.00                | 0.00               | 0.00               | 5.00                       |              |
| 200                            | 1600  | 600                      | 600                            | 175                            | 175            | 200                            | 175                            | 450                      | 950                    | 35                | 150                 | 100                | 200                | 175                        |              |
| 200                            | 1600  | 600                      | 600                            | 175                            | 175            | 200                            | 175                            | 450                      | 950                    | 35                | 150                 | 100                | 200                | 175                        |              |
| 49                             | 135   | 134                      | 49                             | 31                             | 20             | 41                             | 46                             | 0                        | 57                     | 0                 | 0                   | 12                 | 11                 | 16                         |              |
| 63                             | 176   | 174                      | 64                             | 41                             | 26             | 53                             | 59                             | 0                        | 74                     | 0                 | 0                   | 15                 | 15                 | 20                         |              |
| 49                             | 135   | 134                      | 49                             | 31                             | 20             | 41                             | 46                             | 0                        | 57                     | 0                 | 0                   | 12                 | 11                 | 16                         |              |
| 63                             | 176   | 174                      | 64                             | 41                             | 26             | 53                             | 59                             | 0                        | 74                     | 0                 | 0                   | 15                 | 15                 | 20                         |              |
| 1.00                           | 1.00  | 1.00                     | 1.00                           | 1.00                           | 1.00           | 1.00                           | 1.00                           | 1.00                     | 1.00                   | 1.00              | 1.00                | 1.00               | 1.00               | 1.00                       | 1.00         |
| 1.00                           | 1.00  | 1.00                     | 1.00                           | 1.00                           | 1.00           | 1.00                           | 1.00                           | 1.00                     | 1.00                   | 1.00              | 1.00                | 1.00               | 1.00               | 1.00                       | 1.00         |
| 0.24                           | 0.08  | 0.22                     | 0.08                           | 0.18                           | 0.11           | 0.21                           | 0.26                           | 0.00                     | 0.06                   | 0.00              | 0.00                | 0.12               | 0.06               | 0.09                       |              |
| 0.24                           | 0.08  | 0.22                     | 0.08                           | 0.18                           | 0.11           | 0.21                           | 0.26                           | 0.00                     | 0.06                   | 0.00              | 0.00                | 0.12               | 0.06               | 0.09                       |              |
| 0.32                           | 0.11  | 0.29                     | 0.11                           | 0.23                           | 0.15           | 0.27                           | 0.34                           | 0.00                     | 0.08                   | 0.00              | 0.00                | 0.15               | 0.07               | 0.12                       |              |
| 0.32                           | 0.11  | 0.29                     | 0.11                           | 0.23                           | 0.15           | 0.27                           | 0.34                           | 0.00                     | 0.08                   | 0.00              | 0.00                | 0.15               | 0.07               | 0.12                       |              |
| 0.92                           | 1.08  | 0.94                     | 1.08                           | 0.99                           | 1.05           | 0.96                           | 0.91                           | 1.17                     | 1.11                   | 1.17              | 1.17                | 1.05               | 1.11               | 1.08                       |              |
| 0.90                           | 1.11  | 0.93                     | 1.11                           | 0.98                           | 1.07           | 0.95                           | 0.88                           | 1.22                     | 1.14                   | 1.22              | 1.22                | 1.06               | 1.14               | 1.10                       |              |



| 10068 - MICROSCOPY IMAGING | 10058E1 - ELEC, 10060E2 - ELEC | 10070 - MACHINE SHOP/ELECTRONICS | 10083 - LAB DESKS, 10081 - LAB DESKS | 10087 - LAB DESKS, 10085 - LAB DESKS, 10089 - LAB DESKS | 10075 - LAB  | 10093 - LAB DESKS, 10095 - LAB DESKS, 10097 - LAB DESKS | 10099 - LAB DESKS, 10101 - LAB DESKS, 10103 - LAB DESKS | 10105 - OFFICE | 10107 - SMALL CONFERENCE | 10090 - MICROSCOPY IMAGING | 10000CK - CORRIDOR | 10086 - CELL SORTER  | 10084 - HOLDING | 10082 - PROCEDURE ROOM |
|----------------------------|--------------------------------|----------------------------------|--------------------------------------|---|--|---|---|----------------|--------------------------|----------------------------|--------------------|----------------------|-----------------|------------------------|
| 10-47                      | 10-49                          | 10-51                            | 10-55                                | 10-57A, 10-57B  | 10-59A, 10-59B, 10-59C, 10-61A, 10-61B, 10-61C, 10-61D, 10-63A, 10-63B, 10-63C | 10-65A, 10-65B  | 10-67   | 10-69A         | 10-69B                   | 10-79                      | 10-83              | 10-85                | 10-87           | 10-89                  |
| Office space               | Elec/mech equipment rooms      | Storage rooms                    | Office space                         | Office space  | Science laboratories   | Office space  | Office space  | Office space   | Conference/meeting       | Office space               | Corridors          | Science laboratories | Storage rooms   | Medical Procedure      |
| 184                        | 286                            | 115                              | 307                                  | 432   | 6,705  | 391   | 415   | 140            | 205                      | 120                        | 319                | 113                  | 86              | 140                    |
| 0.92                       | 0                              | 0                                | 10                                   | 13  | 42   | 13  | 15  | 3              | 10.25                    | 0.6                        | 0                  | 1                    | 0               | 2.8                    |
| 350                        | 1,350                          | 300                              | 400                                  | 600   | 14,400   | 600   | 600   | 200            | 275                      | 250                        | 175                | 300                  | 300             | 950                    |
| 50%                        | 26%                            | 50%                              | 75%                                  | 75%   | 42%  | 75%   | 75%   | 75%            | 55%                      | 50%                        | 100%               | 50%                  | 50%             | 50%                    |
| CSCRW                      | CSCRW                          | CSCRW                            | CSCRW                                | CSCRW   | CSCRW  | CSCRW   | CSCRW   | CSCRW          | CSCRW                    | CSCRW                      | CSCRW              | CSCRW                | CSCRW           | CSCRW                  |
| 1.00                       | 1.00                           | 1.00                             | 1.00                                 | 1.00  | 1.00   | 1.00  | 1.00  | 1.00           | 1.00                     | 1.00                       | 1.00               | 1.00                 | 1.00            | 1.00                   |
| 1.00                       | 1.00                           | 1.00                             | 1.00                                 | 1.00  | 1.00   | 1.00  | 1.00  | 1.00           | 1.00                     | 1.00                       | 1.00               | 1.00                 | 1.00            | 1.00                   |
| 1.00                       | 1.00                           | 1.00                             | 1.00                                 | 1.00  | 1.00   | 1.00  | 1.00  | 1.00           | 1.00                     | 1.00                       | 1.00               | 1.00                 | 1.00            | 1.00                   |
| 0.06                       | 0.00                           | 0.00                             | 0.06                                 | 0.06  | 0.18   | 0.06  | 0.06  | 0.06           | 0.06                     | 0.06                       | 0.06               | 0.18                 | 0.00            | 0.00                   |
| 5.00                       | 0.00                           | 0.00                             | 5.00                                 | 5.00  | 10.00  | 5.00  | 5.00  | 5.00           | 5.00                     | 5.00                       | 5.00               | 10.00                | 0.00            | 15.00                  |
| 175                        | 350                            | 150                              | 300                                  | 450   | 6100   | 450   | 450   | 150            | 150                      | 125                        | 175                | 150                  | 150             | 475                    |
| 175                        | 350                            | 150                              | 300                                  | 450   | 6100   | 450   | 450   | 150            | 150                      | 125                        | 175                | 150                  | 150             | 475                    |
| 16                         | 0                              | 0                                | 68                                   | 91  | 1627   | 88  | 100   | 23             | 64                       | 10                         | 19                 | 30                   | 0               | 42                     |
| 20                         | 0                              | 0                                | 89                                   | 118   | 2115   | 115   | 130   | 30             | 83                       | 13                         | 25                 | 39                   | 0               | 55                     |
| 16                         | 0                              | 0                                | 68                                   | 91  | 1627   | 88  | 100   | 23             | 64                       | 10                         | 19                 | 30                   | 0               | 42                     |
| 20                         | 0                              | 0                                | 89                                   | 118   | 2115   | 115   | 130   | 30             | 83                       | 13                         | 25                 | 39                   | 0               | 55                     |
| 1.00                       | 1.00                           | 1.00                             | 1.00                                 | 1.00  | 1.00   | 1.00  | 1.00  | 1.00           | 1.00                     | 1.00                       | 1.00               | 1.00                 | 1.00            | 1.00                   |
| 1.00                       | 1.00                           | 1.00                             | 1.00                                 | 1.00  | 1.00   | 1.00  | 1.00  | 1.00           | 1.00                     | 1.00                       | 1.00               | 1.00                 | 1.00            | 1.00                   |
| 1.00                       | 1.00                           | 1.00                             | 1.00                                 | 1.00  | 1.00   | 1.00  | 1.00  | 1.00           | 1.00                     | 1.00                       | 1.00               | 1.00                 | 1.00            | 1.00                   |
| 0.09                       | 0.00                           | 0.00                             | 0.23                                 | 0.20  | 0.27   | 0.20  | 0.22  | 0.16           | 0.42                     | 0.08                       | 0.11               | 0.20                 | 0.00            | 0.09                   |
| 0.09                       | 0.00                           | 0.00                             | 0.23                                 | 0.20  | 0.27   | 0.20  | 0.22  | 0.16           | 0.42                     | 0.08                       | 0.11               | 0.20                 | 0.00            | 0.09                   |
| 0.12                       | 0.00                           | 0.00                             | 0.30                                 | 0.26  | 0.35   | 0.26  | 0.29  | 0.20           | 0.55                     | 0.11                       | 0.14               | 0.26                 | 0.00            | 0.11                   |
| 0.12                       | 0.00                           | 0.00                             | 0.30                                 | 0.26  | 0.35   | 0.26  | 0.29  | 0.20           | 0.55                     | 0.11                       | 0.14               | 0.26                 | 0.00            | 0.11                   |
| 1.08                       | 1.17                           | 1.17                             | 0.94                                 | 0.96  | 0.90   | 0.97  | 0.94  | 1.01           | 0.74                     | 1.09                       | 1.06               | 0.96                 | 1.17            | 1.08                   |
| 1.10                       | 1.22                           | 1.22                             | 0.92                                 | 0.95  | 0.87   | 0.96  | 0.93  | 1.01           | 0.67                     | 1.11                       | 1.07               | 0.95                 | 1.22            | 1.10                   |

| 10108 - COPY | 10001 - BREAK AREA | 11007 - OFFICE, 11009 - OFFICE, 11011 - OFFICE | 11000CB - CORRIDOR | 11008 - OFFICE, 11010 - OFFICE, 11012 - OFFICE | 11013 - OFFICE | 11017 - OFFICE, 11019 - OFFICE, 11021 - OFFICE, 11023 - OFFICE | 11014 - OFFICE, 11022 - OFFICE | 11027 - OFFICE, 11029 - OFFICE | 11000CE - CORRIDOR | 11024 - OFFICE, 11026 - OFFICE, 11028 - OFFICE, 11030 - OFFICE | 11031 - LARGE CONFERENCE | 11032 - SCIENTIFIC LIVING ROOM | 11048 - OFFICE, 11050 - OFFICE | 11055 - OFFICE, 11057 - OFFICE |
|--------------|--------------------|--|--------------------|--|----------------|--|--------------------------------|--------------------------------|--------------------|--|--------------------------|--------------------------------|--------------------------------|--------------------------------|
| 10-101       | 10-105             | 11-1   | 11-3               | 11-5   | 11-7           | 11-9   | 11-11                          | 11-13                          | 11-15              | 11-17  | 11-19                    | 11-21                          | 11-23                          | 11-25                          |
| Corridors    | Break rooms        | Office space                                   | Corridors          | Office space                                   | Office space   | Office space   | Office space                   | Office space                   | Corridors          | Office space   | Conference/ meeting      | Break rooms                    | Office space                   | Office space                   |
| 120          | 872                | 426  | 171                | 327  | 172            | 508  | 333                            | 359                            | 171                | 652  | 433                      | 361                            | 260                            | 277                            |
| 0            | 21.8               | 8  | 0                  | 5  | 1              | 10   | 7                              | 2                              | 0                  | 11   | 21.65                    | 6                              | 6                              | 3                              |
| 175          | 1,200              | 550  | 300                | 425  | 225            | 675  | 425                            | 450                            | 300                | 700  | 450                      | 450                            | 300                            | 325                            |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
| 100%         | 50%                | 41%  | 100%               | 47%  | 44%            | 44%  | 47%                            | 50%                            | 100%               | 50%  | 50%                      | 50%                            | 50%                            | 46%                            |
| CSCRW        | CSCRW              | CSCRW  | CSCRW              | CSCRW  | CSCRW          | CSCRW  | CSCRW                          | CSCRW                          | CSCRW              | CSCRW  | CSCRW                    | CSCRW                          | CSCRW                          | CSCRW                          |
| 1.00         | 1.00               | 1.00   | 1.00               | 1.00   | 1.00           | 1.00   | 1.00                           | 1.00                           | 1.00               | 1.00   | 1.00                     | 1.00                           | 1.00                           | 1.00                           |
| 1.00         | 1.00               | 1.00   | 1.00               | 1.00   | 1.00           | 1.00   | 1.00                           | 1.00                           | 1.00               | 1.00   | 1.00                     | 1.00                           | 1.00                           | 1.00                           |
| 1.00         | 1.00               | 1.00   | 1.00               | 1.00   | 1.00           | 1.00   | 1.00                           | 1.00                           | 1.00               | 1.00   | 1.00                     | 1.00                           | 1.00                           | 1.00                           |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
|              |                    |  |                    |  |                |  |                                |                                |                    |  |                          |                                |                                |                                |
| 0.06         | 0.06               | 0.06   | 0.06               | 0.06   | 0.06           | 0.06   | 0.06                           | 0.06                           | 0.06               | 0.06   | 0.06                     | 0.06                           | 0.06                           | 0.06                           |
| 0.00         | 5.00               | 5.00   | 0.00               | 5.00   | 5.00           | 5.00   | 5.00                           | 5.00                           | 5.00               | 5.00   | 5.00                     | 5.00                           | 5.00                           | 5.00                           |
| 175          | 600                | 225  | 300                | 200  | 100            | 300  | 200                            | 225                            | 300                | 350  | 225                      | 225                            | 150                            | 150                            |
| 175          | 600                | 225  | 300                | 200  | 100            | 300  | 200                            | 225                            | 300                | 350  | 225                      | 225                            | 150                            | 150                            |
| 7            | 161                | 66   | 10                 | 45   | 15             | 80   | 55                             | 32                             | 10                 | 94   | 134                      | 52                             | 46                             | 32                             |
| 9            | 210                | 85   | 13                 | 58   | 20             | 105  | 71                             | 41                             | 13                 | 122  | 174                      | 67                             | 59                             | 41                             |
| 7            | 161                | 66   | 10                 | 45   | 15             | 80   | 55                             | 32                             | 10                 | 94   | 134                      | 52                             | 46                             | 32                             |
| 9            | 210                | 85   | 13                 | 58   | 20             | 105  | 71                             | 41                             | 13                 | 122  | 174                      | 67                             | 59                             | 41                             |
| 1.00         | 1.00               | 1.00   | 1.00               | 1.00   | 1.00           | 1.00   | 1.00                           | 1.00                           | 1.00               | 1.00   | 1.00                     | 1.00                           | 1.00                           | 1.00                           |
| 1.00         | 1.00               | 1.00   | 1.00               | 1.00   | 1.00           | 1.00   | 1.00                           | 1.00                           | 1.00               | 1.00   | 1.00                     | 1.00                           | 1.00                           | 1.00                           |
| 1.00         | 1.00               | 1.00   | 1.00               | 1.00   | 1.00           | 1.00   | 1.00                           | 1.00                           | 1.00               | 1.00   | 1.00                     | 1.00                           | 1.00                           | 1.00                           |
| 0.04         | 0.27               | 0.29   | 0.03               | 0.22   | 0.15           | 0.27   | 0.27                           | 0.14                           | 0.03               | 0.27   | 0.60                     | 0.23                           | 0.30                           | 0.21                           |
| 0.04         | 0.27               | 0.29   | 0.03               | 0.22   | 0.15           | 0.27   | 0.27                           | 0.14                           | 0.03               | 0.27   | 0.60                     | 0.23                           | 0.30                           | 0.21                           |
| 0.05         | 0.35               | 0.38   | 0.04               | 0.29   | 0.20           | 0.35   | 0.36                           | 0.18                           | 0.04               | 0.35   | 0.78                     | 0.30                           | 0.40                           | 0.27                           |
| 0.05         | 0.35               | 0.38   | 0.04               | 0.29   | 0.20           | 0.35   | 0.36                           | 0.18                           | 0.04               | 0.35   | 0.78                     | 0.30                           | 0.40                           | 0.27                           |
| 1.13         | 0.90               | 0.88   | 1.13               | 0.94   | 1.01           | 0.90   | 0.89                           | 1.03                           | 1.13               | 0.90   | 0.57                     | 0.94                           | 0.86                           | 0.96                           |
| 1.16         | 0.87               | 0.84   | 1.17               | 0.93   | 1.02           | 0.87   | 0.86                           | 1.03                           | 1.17               | 0.87   | 0.44                     | 0.92                           | 0.82                           | 0.94                           |

| 11053 - OFFICE | 11047 - OFFICE, 11049 - OFFICE | 11000CA - CORRIDOR, 11000LB - ELEVATOR LOBBY, 11040 - MEN, 11044 - WOMEN, 11000LA - FIRE SERVICE ACCESS LOBBY | 11081 - MEDIUM CONFERENCE | 11083 - OFFICE, 11085 - OFFICE | 11074 - OFFICE, 11078 - OFFICE, 11084 - OFFICE | 11062 - MEETING    | 11064 - OFFICE, 11082 - OFFICE | 110580 - ELEC, 1106000 - ELEC | 11087 - OFFICE, 11089 - OFFICE, 11091 - OFFICE | 11093 - OFFICE | 11090 - OFFICE, 11098 - OFFICE, 11102 - OFFICE | 11000CN - CORRIDOR | 11066 - FILES | 11068 - OFFICE, 11070 - OFFICE, 11072 - OFFICE |
|----------------|--------------------------------|---|---------------------------|--------------------------------|--|--------------------|--------------------------------|-------------------------------|--|----------------|--|--------------------|---------------|--|
| 11-27          | 11-29                          | 11-31, 11-81  | 11-33                     | 11-35                          | 11-37  | 11-39              | 11-39                          | 11-41                         | 11-43  | 11-45          | 11-47  | 11-49              | 11-57         | 11-57  |
| Office space   | Office space                   | Corridors   | Conference/meeting        | Office space                   | Office space                                   | Conference/meeting | Office space                   | Elec/mech equipment rooms     | Office space                                   | Office space   | Office space                                   | Corridors          | Storage rooms | Office space                                   |
| 262            | 262                            | 2,202   | 250                       | 274                            | 361  | 126                | 259                            | 283                           | 414  | 180            | 391  | 861                | 130           | 380  |
| 1              | 2                              | 0   | 12.5                      | 5                              | 6  | 6.3                | 6                              | 0                             | 8  | 1              | 9  | 0                  | 0             | 8  |
| 325            | 350                            | 1,600   | 500                       | 350                            | 450  | 150                | 300                            | 1,350                         | 525  | 225            | 450  | 400                | 150           | 450  |
| 46%            | 43%                            | 100%  | 50%                       | 43%                            | 50%  | 50%                | 50%                            | 26%                           | 48%  | 44%            | 50%  | 100%               | 50%           | 50%  |
| CSCRW          | CSCRW                          | CSCRW   | CSCRW                     | CSCRW                          | CSCRW  | CSCRW              | CSCRW                          | CSCRW                         | CSCRW  | CSCRW          | CSCRW  | CSCRW              | CSCRW         | CSCRW  |
| 1.00           | 1.00                           | 1.00  | 1.00                      | 1.00                           | 1.00   | 1.00               | 1.00                           | 1.00                          | 1.00   | 1.00           | 1.00   | 1.00               | 1.00          | 1.00   |
| 1.00           | 1.00                           | 1.00  | 1.00                      | 1.00                           | 1.00   | 1.00               | 1.00                           | 1.00                          | 1.00   | 1.00           | 1.00   | 1.00               | 1.00          | 1.00   |
| 1.00           | 1.00                           | 1.00  | 1.00                      | 1.00                           | 1.00   | 1.00               | 1.00                           | 1.00                          | 1.00   | 1.00           | 1.00   | 1.00               | 1.00          | 1.00   |
| 0.06           | 0.06                           | 0.06  | 0.06                      | 0.06                           | 0.06   | 0.06               | 0.06                           | 0.00                          | 0.06   | 0.06           | 0.06   | 0.06               | 0.00          | 0.06   |
| 5.00           | 5.00                           | 0.00  | 5.00                      | 5.00                           | 5.00   | 5.00               | 5.00                           | 0.00                          | 5.00   | 5.00           | 5.00   | 5.00               | 0.00          | 5.00   |
| 150            | 150                            | 1600  | 250                       | 150                            | 225  | 75                 | 150                            | 350                           | 250  | 100            | 225  | 400                | 75            | 225  |
| 150            | 150                            | 1600  | 250                       | 150                            | 225  | 75                 | 150                            | 350                           | 250  | 100            | 225  | 400                | 75            | 225  |
| 21             | 26                             | 132   | 78                        | 41                             | 52   | 39                 | 46                             | 0                             | 65   | 16             | 68   | 52                 | 0             | 63   |
| 27             | 33                             | 172   | 101                       | 54                             | 67   | 51                 | 59                             | 0                             | 84   | 21             | 89   | 67                 | 0             | 82   |
| 21             | 26                             | 132   | 78                        | 41                             | 52   | 39                 | 46                             | 0                             | 65   | 16             | 68   | 52                 | 0             | 63   |
| 27             | 33                             | 172   | 101                       | 54                             | 67   | 51                 | 59                             | 0                             | 84   | 21             | 89   | 67                 | 0             | 82   |
| 1.00           | 1.00                           | 1.00  | 1.00                      | 1.00                           | 1.00   | 1.00               | 1.00                           | 1.00                          | 1.00   | 1.00           | 1.00   | 1.00               | 1.00          | 1.00   |
| 1.00           | 1.00                           | 1.00  | 1.00                      | 1.00                           | 1.00   | 1.00               | 1.00                           | 1.00                          | 1.00   | 1.00           | 1.00   | 1.00               | 1.00          | 1.00   |
| 1.00           | 1.00                           | 1.00  | 1.00                      | 1.00                           | 1.00   | 1.00               | 1.00                           | 1.00                          | 1.00   | 1.00           | 1.00   | 1.00               | 1.00          | 1.00   |
| 0.14           | 0.17                           | 0.08  | 0.31                      | 0.28                           | 0.23   | 0.52               | 0.30                           | 0.00                          | 0.26   | 0.16           | 0.30   | 0.13               | 0.00          | 0.28   |
| 0.14           | 0.17                           | 0.08  | 0.31                      | 0.28                           | 0.23   | 0.52               | 0.30                           | 0.00                          | 0.26   | 0.16           | 0.30   | 0.13               | 0.00          | 0.28   |
| 0.18           | 0.22                           | 0.11  | 0.40                      | 0.36                           | 0.30   | 0.68               | 0.39                           | 0.00                          | 0.34   | 0.21           | 0.40   | 0.17               | 0.00          | 0.36   |
| 0.18           | 0.22                           | 0.11  | 0.40                      | 0.36                           | 0.30   | 0.68               | 0.39                           | 0.00                          | 0.34   | 0.21           | 0.40   | 0.17               | 0.00          | 0.36   |
| 1.03           | 1.00                           | 1.08  | 0.86                      | 0.89                           | 0.94   | 0.65               | 0.86                           | 1.17                          | 0.91   | 1.01           | 0.86   | 1.04               | 1.17          | 0.89   |
| 1.04           | 0.99                           | 1.11  | 0.81                      | 0.86                           | 0.92   | 0.54               | 0.82                           | 1.22                          | 0.88   | 1.01           | 0.82   | 1.05               | 1.22          | 0.85   |



| M1000LA - FIRE SERVICE ACCESS LOBBY, M1000LB - ELEVATOR LOBBY | new zone                  | M1007 - MECHANICAL        | M2000LA - FIRE SERVICE ACCESS LOBBY | M3000LA - FIRE SERVICE ACCESS LOBBY | Totals/averages    |                |                 |
|---|---------------------------|---------------------------|-------------------------------------|-------------------------------------|--------------------|----------------|-----------------|
| M1-1  | M1-2                      | M1-3, M1-4                | M2-1                                | M3-1                                |                    |                |                 |
| Corridors   | Elec/mech equipment rooms | Elec/mech equipment rooms | Corridors                           | Corridors                           |                    |                |                 |
| 590   | 553                       | 1,012                     | 230                                 | 223                                 | 176,714            | total sf       |                 |
| 0   | 0                         | 0                         | 0                                   | 0                                   | 2184.582           | total P        |                 |
| 800   | 500                       | 2,000                     | 400                                 | 400                                 | 321,250            | total cfm      |                 |
|   |                           |                           |                                     |                                     | 1.00               | average        |                 |
| 100%  | 100%                      | 100%                      | 100%                                | 100%                                | 63%                | average        |                 |
| CSCRW   | CSCRW                     | CSCRW                     | CSCRW                               | CSCRW                               | 1.00               | average        | Primary airflow |
| 1.00  | 1.00                      | 1.00                      | 1.00                                | 1.00                                | 1.00               | average        | 182815          |
| 1.00  | 1.00                      | 1.00                      | 1.00                                | 1.00                                | Er for ITU/TF      |                | 57%             |
| 1.00  | 1.00                      | 1.00                      | 1.00                                | 1.00                                | Ep for ITU/DFDD/TF |                |                 |
| 0.06  | 0.00                      | 0.00                      | 0.06                                | 0.06                                |                    |                |                 |
| 0.00  | 0.00                      | 0.00                      | 0.00                                | 0.00                                |                    |                |                 |
| 800   | 500                       | 2000                      | 400                                 | 400                                 | 183455             |                |                 |
| 800   | 500                       | 2000                      | 400                                 | 400                                 | 183455             |                |                 |
| 35  | 0                         | 0                         | 14                                  | 13                                  | 30522              |                |                 |
| 46  | 0                         | 0                         | 18                                  | 17                                  | 39678              |                |                 |
| 35  | 0                         | 0                         | 14                                  | 13                                  | 30522              |                |                 |
| 46  | 0                         | 0                         | 18                                  | 17                                  | 39678              |                |                 |
| 1.00  | 1.00                      | 1.00                      | 1.00                                | 1.00                                |                    |                |                 |
| 1.00  | 1.00                      | 1.00                      | 1.00                                | 1.00                                |                    |                |                 |
| 1.00  | 1.00                      | 1.00                      | 1.00                                | 1.00                                |                    |                |                 |
| 0.04  | 0.00                      | 0.00                      | 0.03                                | 0.03                                | 0.76               | Maximum Zd     |                 |
| 0.04  | 0.00                      | 0.00                      | 0.03                                | 0.03                                | 0.76               | Maximum Zpz    |                 |
| 0.06  | 0.00                      | 0.00                      | 0.04                                | 0.04                                | 0.98               | Maximum Zd30   |                 |
| 0.06  | 0.00                      | 0.00                      | 0.04                                | 0.04                                | 0.98               | Maximum Zpz 30 |                 |
| 1.12  | 1.17                      | 1.17                      | 1.13                                | 1.13                                |                    |                |                 |
| 1.16  | 1.22                      | 1.22                      | 1.17                                | 1.17                                |                    |                |                 |

# AHU-5 OA% ANALYSIS

|  |  |                      |  |   |  |  |  |
|--|--|----------------------|--|---|--|--|--|
| Building:  |  | Delete Zone          |  | 75 Ames AHU-5   |  |  |  |
| System Tag/Name:   |  | Add Zone             |  | *****IMPORTANT NOTES***** Enable Macros               |  |  |  |
| Operating Condition Description:   |  |                      |  | Macro - Security Warning -> Options -> Enable Content |  |  |  |
| Units (select from pull-down list)   |  |                      |  | IP  |  |  |  |
| Inputs for System  |  | Name                 |  | w/o diversity   |  | w/ diversity                           |  |
| Floor area served by system  |  | As                   |  | System  |  | System                                 |  |
| Population of area served by system  |  | Ps                   |  | 20007.01  |  |  |  |
| Design primary supply fan airflow rate                                       |  | Vpsd                 |  | 81  |  | 81                                     |  |
| OA req'd per unit area for system (Weighted average)                         |  | Ras                  |  | 53,910  |  | 53,910                                 |  |
| OA req'd per person for system area (Weighted average)                       |  | Rps                  |  | 0.09  |  |  |  |
| Does system have Outdoor Air Economizer                                      |  |                      |  | 9.8   |  |  |  |
| Outdoor air intake provided for system                                       |  | OA                   |  | 60,000  |  | No                                     |  |
| Inputs for Potentially Critical zones  |  | Show Values per Zone |  |   |  |  |  |
| Zone Name  |  |                      |  |   |  |  |  |
| Zone Tag   |  |                      |  |   |  |  |  |
| Occupancy Category   |  |                      |  |   |  |  |  |
| Floor Area of zone   |  | Az                   |  | Select from pull-down list:                           |  |  |  |
| Design population of zone  |  | Pz                   |  | P (default value listed; may be overridden)           |  |  |  |
| Design total supply to zone (primary plus local recirculated)                |  | Vdzd                 |  | cfm   |  |  |  |
| Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?                 |  |                      |  | Select from pull-down list or leave blank if N/A:     |  |  |  |
| Frac. of local recirc. air that is representative of system RA               |  | Er                   |  |   |  |  |  |
| Inputs for Operating Condition Analyzed                                      |  | Ds                   |  | %   |  | 80%                                    |  |
| Percent of total design airflow rate at conditioned analyzed                 |  |                      |  | Select from pull-down list:                           |  | Show codes for Ez                      |  |
| Air distribution type at conditioned analyzed                                |  | Ez                   |  |   |  |  |  |
| Zone air distribution effectiveness at conditioned analyzed                  |  | Ep                   |  |   |  |  |  |
| Primary air fraction of supply air at conditioned analyzed                   |  |                      |  |   |  |  |  |
| Inputs for Systems with Outdoor Air Economizers                              |  | Toa                  |  | Deg F   |  |  |  |
| Outdoor air Temperature  |  | Tp                   |  | Deg F   |  |  |  |
| Supply Air Temperature   |  | Tr                   |  | Deg F   |  |  |  |
| Return Air Temperature   |  | dTsf                 |  | Deg F   |  |  |  |
| Supply Fan Heat Gain   |  | dTrf                 |  | Deg F   |  |  |  |
| Return Fan Heat Gain   |  |                      |  |   |  |  |  |
| Results of Minimum ASHRAE 62.1 Ventilation Rate Procedure (EQp1)             |  | Ev                   |  |   |  | 0.83                                   |  |
| System Ventilation Efficiency  |  | Vot                  |  | cfm   |  | 3,191                                  |  |
| Outdoor air intake required for system (EQp1)                                |  | Vot/As               |  | cfm/sf  |  | 0.16                                   |  |
| Outdoor air per unit floor area  |  | Vot/Ps               |  | cfm/p   |  | 39.5                                   |  |
| Outdoor air per person served by system (including diversity)                |  | Ypd                  |  | %   |  | 6%                                     |  |
| Outdoor air as a % of design primary supply air                              |  |                      |  |   |  |  |  |
| Results of 30% Increase beyond ASHRAE 62.1 Ventilation Rate Procedure (EQc2) |  | Evz30                |  |   |  | 0.78                                   |  |
| System Ventilation Efficiency with 30% increase (EQc2)                       |  | Vot30                |  | cfm   |  | 4,421                                  |  |
| Outdoor air intake required for system with 30% increase (EQc2)              |  | Vot30/As             |  | cfm/sf  |  | 0.22                                   |  |
| Outdoor air per unit floor area for system with 30% increase (EQc2)          |  | Vot30/Ps             |  | cfm/p   |  | 54.7                                   |  |
| Outdoor air per person served by system (including diversity) (EQc2)         |  | Ypd30                |  | %   |  | 8%                                     |  |
| Outdoor air as a % of design primary supply air (EQc2)                       |  |                      |  |   |  |  |  |
| Detailed Calculations  |  |                      |  |   |  |  |  |
| Initial Calculations for the System as a whole                               |  |                      |  |   |  |  |  |
| System primary supply air flow at conditioned analyzed                       |  | Vps                  |  | cfm   |  | = Vpsd Ds = 43210                      |  |
| Uncorrected OA intake flow req'd for system                                  |  | Vou                  |  | cfm   |  | = Rps Ps + Ras As = 2648               |  |
| 30% increase Uncorrected OA intake flow req'd for system (EAc2)              |  | Vou30                |  | cfm   |  | = (Rps Ps + Ras As)*1.3 = 3442         |  |
| Uncorrected OA req'd as a fraction of primary SA                             |  | Xs                   |  |   |  | = Vou / Vps = 0.06                     |  |
| 30% increase Uncorrected OA req'd as a fraction of primary SA                |  | Xs30                 |  |   |  | = Vou30 / Vps = 0.08                   |  |
| Initial Calculations for individual zones                                    |  |                      |  |   |  |  |  |
| Area outdoor air rate  |  | Ra                   |  | cfm/sf  |  |  |  |
| People outdoor air rate  |  | Rp                   |  | cfm/p   |  |  |  |
| Total supply air to zone (at condition being analyzed)                       |  | Vdz                  |  | cfm   |  | = Vdzd Ds                              |  |
| Primary airflow to zone (at condition being analyzed)                        |  | Vpz                  |  | cfm   |  | = Vdz Ep                               |  |
| Breathing zone outdoor airflow   |  | Vbz                  |  | cfm   |  | = Rp Pz + Ra Az                        |  |
| Breathing zone outdoor airflow with 30% increase (EAc2)                      |  | Vbz30                |  | cfm   |  | = (Rp Pz + Ra Az)*1.3                  |  |
| Zone outdoor airflow   |  | Voz                  |  | cfm   |  | = Vbz / Ez                             |  |
| Zone outdoor airflow with 30% increase (EAc2)                                |  | Voz30                |  | cfm   |  | = Vbz30/Ez                             |  |
| Fraction of zone supply not directly recirc. from zone                       |  | Fa                   |  |   |  | = Ep + (1-Ep) Er                       |  |
| Fraction of zone supply from fully mixed primary air                         |  | Fb                   |  |   |  | = Ep                                   |  |
| Fraction of zone OA not directly recirc. from zone                           |  | Fc                   |  |   |  | = 1-(1-Ez)(1-Ep)(1-Er)                 |  |
| OA fraction required in the supply air to the zone                           |  | Zd                   |  |   |  | = Voz / Vdz                            |  |
| OA fraction required in the primary air to the zone                          |  | Zpz                  |  |   |  | = Voz / Vpz                            |  |
| OA fraction required in the supply air to the zone for EAc2                  |  | Zd30                 |  |   |  | = Voz30 / Vdz                          |  |
| OA fraction required in the primary air to the zone for EAc2                 |  | Zpz30                |  |   |  | = Voz30/ Vpz                           |  |
| System Ventilation Efficiency  |  |                      |  |   |  |  |  |
| Zone Ventilation Efficiency (App A Method)                                   |  | Evz                  |  |   |  | = (Fa+FbXs-FcZpzEp)/Fa =               |  |
| Zone Ventilation Efficiency with 30% increase (EAc2) (App A)                 |  | Evz30                |  |   |  | = (Fa+FbXs-FcZpz30Ep)/Fa =             |  |
| System Ventilation Efficiency (App A Method)                                 |  | Ev                   |  |   |  | = min (Evz) = 0.83                     |  |
| System Ventilation Efficiency (Table 6.3 Method)                             |  | Ev                   |  |   |  | = Value from Table 6.3 = 0.92          |  |
| System Ventilation Efficiency w/ 30% increase (EAc2) (App A)                 |  | Ev30                 |  |   |  | = min (Evz30) = 0.78                   |  |
| System Ventilation Efficiency w/ 30% increase (EAc2) (Table 6.3)             |  | Ev30                 |  |   |  | = Value from Table 6.3 = 0.85          |  |
| Minimum outdoor air intake airflow (EQp1)                                    |  |                      |  |   |  |  |  |
| Outdoor Air Intake Flow required to System                                   |  | Vot                  |  | cfm   |  | = Vou / Ev = 3191                      |  |
| OA intake req'd as a fraction of primary SA                                  |  | Y                    |  |   |  | = Vot / Vps = 0.07                     |  |
| Outdoor Air Intake Flow required to System (Table 6.3 Method)                |  | Vot                  |  | cfm   |  | = Vou / Ev = 2883                      |  |
| OA intake req'd as a fraction of primary SA (Table 6.3 Method)               |  | Y                    |  |   |  | = Vot / Vps = 0.07                     |  |
| Time-averaging   |  |                      |  |   |  |  |  |
| Time period with high occupancy  |  | Th                   |  | min   |  |  |  |
| Room height  |  | h                    |  | ft  |  |  |  |
| Time period over which averaging can take place                              |  | T                    |  | min   |  | = 3 v / Vbz =                          |  |
| Error - sum of all values above will show error                              |  |                      |  |   |  |  |  |
| Error flag   |  |                      |  |   |  | FALSE                                  |  |
| 30% increase beyond Minimum Outdoor air intake airflow (EQc2)                |  |                      |  |   |  |  |  |
| Outdoor Air Intake Flow required to System                                   |  | Vot30                |  | cfm   |  | = Vou / Ev = 4421                      |  |
| OA intake req'd as a fraction of primary SA                                  |  | Y30                  |  |   |  | = Vot / Vps = 0.10                     |  |
| Outdoor Air Intake Flow required to System (Table 6.3 Method)                |  | Vot30                |  | cfm   |  | = Vou / Ev = 4054                      |  |
| OA intake req'd as a fraction of primary SA (Table 6.3 Method)               |  | Y30                  |  |   |  | = Vot / Vps = 0.09                     |  |
| OA Temp at which Min OA provides all cooling                                 |  |                      |  |   |  |  |  |
| OAT below which OA Intake flow is @ minimum                                  |  |                      |  | Deg F   |  | = {(Tp-dTsf)-(1-Y)*(Tr+dTrf)}/Y = -158 |  |

| 12000CD - CLEAN CORRIDOR | 12000CC - VESTIBULE | 12005 - ANIMAL HOLDING | 12007 - ANIMAL HOLDING | 12009 - ANIMAL HOLDING | 12011 - ANIMAL HOLDING | 12013 - ANIMAL HOLDING | 12015 - ANIMAL HOLDING | 12122 - LOCKERS/BR EAK | 12017 - ANIMAL HOLDING | 12019 - ANIMAL HOLDING |
|--------------------------|---------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| 12-1                     | 12-1                | 12-3                   | 12-5                   | 12-7                   | 12-9                   | 12-11                  | 12-13                  | 12-93                  | 12-15                  | 12-17                  |
| Corridors                | Corridors           | Science laboratories   | Science laboratories   | Science laboratories   | Science laboratories   | Science laboratories   | Science laboratories   | Break rooms            | Science laboratories   | Science laboratories   |
| 1,117                    | 193                 | 381                    | 382                    | 382                    | 383                    | 305                    | 304                    | 300                    | 304                    | 303                    |
| 0                        | 0                   | 2                      | 2                      | 2                      | 2                      | 2                      | 2                      | 7.5                    | 2                      | 2                      |
| 1,200                    | 50                  | 1,000                  | 1,000                  | 1,000                  | 1,000                  | 750                    | 750                    | 750                    | 750                    | 750                    |
| 100%                     | 100%                | 75%                    | 75%                    | 75%                    | 75%                    | 73%                    | 73%                    | 67%                    | 73%                    | 73%                    |
| CSCRW                    | CSCRW               | CSCRW                  | CSCRW                  | CSCRW                  | CSCRW                  | CSCRW                  | CSCRW                  | CSCRW                  | CSCRW                  | CSCRW                  |
| 1.00                     | 1.00                | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   |
| 1.00                     | 1.00                | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   |
| 1.00                     | 1.00                | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   | 1.00                   |

|        |      |       |       |       |       |       |       |      |       |       |
|--------|------|-------|-------|-------|-------|-------|-------|------|-------|-------|
| 0.06   | 0.06 | 0.18  | 0.18  | 0.18  | 0.18  | 0.18  | 0.18  | 0.06 | 0.18  | 0.18  |
| 0.00   | 0.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 5.00 | 10.00 | 10.00 |
| 1200   | 50   | 750   | 750   | 750   | 750   | 550   | 550   | 500  | 550   | 550   |
| 1200   | 50   | 750   | 750   | 750   | 750   | 550   | 550   | 500  | 550   | 550   |
| 67     | 12   | 89    | 89    | 89    | 89    | 75    | 75    | 56   | 75    | 75    |
| 87     | 15   | 115   | 115   | 115   | 116   | 97    | 97    | 72   | 97    | 97    |
| 67     | 12   | 89    | 89    | 89    | 89    | 75    | 75    | 56   | 75    | 75    |
| 87     | 15   | 115   | 115   | 115   | 116   | 97    | 97    | 72   | 97    | 97    |
| 1.00   | 1.00 | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00 | 1.00  | 1.00  |
| 1.00   | 1.00 | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00 | 1.00  | 1.00  |
| 1.00   | 1.00 | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00 | 1.00  | 1.00  |
| 0.06   | 0.23 | 0.12  | 0.12  | 0.12  | 0.12  | 0.14  | 0.14  | 0.11 | 0.14  | 0.14  |
| 0.06   | 0.23 | 0.12  | 0.12  | 0.12  | 0.12  | 0.14  | 0.14  | 0.11 | 0.14  | 0.14  |
| 0.07   | 0.30 | 0.15  | 0.15  | 0.15  | 0.15  | 0.18  | 0.18  | 0.14 | 0.18  | 0.18  |
| 0.07   | 0.30 | 0.15  | 0.15  | 0.15  | 0.15  | 0.18  | 0.18  | 0.14 | 0.18  | 0.18  |
| 1.01   | 0.83 | 0.94  | 0.94  | 0.94  | 0.94  | 0.93  | 0.93  | 0.95 | 0.93  | 0.93  |
| 1.01   | 0.78 | 0.93  | 0.93  | 0.93  | 0.93  | 0.90  | 0.90  | 0.94 | 0.90  | 0.90  |
| 308.30 |      |       |       |       |       |       |       |      |       |       |
| 0.10   |      |       |       |       |       |       |       |      |       |       |
| 9      |      |       |       |       |       |       |       |      |       |       |
| 450    |      |       |       |       |       |       |       |      |       |       |
| 7403   |      |       |       |       |       |       |       |      |       |       |
| FALSE  |      |       |       |       |       |       |       |      |       |       |
| 366.32 |      |       |       |       |       |       |       |      |       |       |
| 0.08   |      |       |       |       |       |       |       |      |       |       |


| 12021 - ANIMAL HOLDING | 12023 - ANIMAL HOLDING | 12025 - ANIMAL HOLDING | 12000CE - CLEAN CORRIDOR | 12027 - PROCEDURE ROOM | 12029 - PROCEDURE ROOM | 12031 - PROCEDURE ROOM | 12033 - NECROPSY     | 12035 - NARCOTICS | 12037 - BREAK RM | 12039 - OFFICE | 12048, 12052, 12056 - TESTING |
|------------------------|------------------------|------------------------|--------------------------|------------------------|------------------------|------------------------|----------------------|-------------------|------------------|----------------|-------------------------------|
| 12-19                  | 12-21                  | 12-23                  | 12-25, 12-35             | 12-27                  | 12-29                  | 12-31                  | 12-33                | 12-37             | 12-39            | 12-41          | 12-43                         |
| Science laboratories   | Science laboratories   | Science laboratories   | Corridors                | Medical Procedure      | Medical Procedure      | Medical Procedure      | Science laboratories | Storage rooms     | Break rooms      | Office space   | Science laboratories          |
| 349                    | 345                    | 282                    | 958                      | 103                    | 109                    | 84                     | 94                   | 49                | 193              | 67             | 98                            |
| 2                      | 2                      | 2                      | 0                        | 2.06                   | 2.18                   | 1.68                   | 2                    | 0                 | 4.825            | 0.335          | 2                             |
| 1,000                  | 1,000                  | 750                    | 1,800                    | 300                    | 300                    | 300                    | 1,350                | 200               | 400              | 220            | 825                           |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
| 75%                    | 75%                    | 73%                    | 100%                     | 100%                   | 100%                   | 100%                   | 100%                 | 100%              | 63%              | 100%           | 55%                           |
| CSCRW                  | CSCRW                  | CSCRW                  | CSCRW                    | CSCRW                  | CSCRW                  | CSCRW                  | CSCRW                | CSCRW             | CSCRW            | CSCRW          | CSCRW                         |
| 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                   | 1.00                   | 1.00                 | 1.00              | 1.00             | 1.00           | 1.00                          |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
| 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                   | 1.00                   | 1.00                 | 1.00              | 1.00             | 1.00           | 1.00                          |
| 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                   | 1.00                   | 1.00                 | 1.00              | 1.00             | 1.00           | 1.00                          |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
| 0.18                   | 0.18                   | 0.18                   | 0.06                     | 0.00                   | 0.00                   | 0.00                   | 0.18                 | 0.00              | 0.06             | 0.06           | 0.18                          |
| 10.00                  | 10.00                  | 10.00                  | 0.00                     | 15.00                  | 15.00                  | 15.00                  | 10.00                | 0.00              | 5.00             | 5.00           | 10.00                         |
| 750                    | 750                    | 550                    | 1800                     | 300                    | 300                    | 300                    | 1350                 | 200               | 250              | 220            | 450                           |
| 750                    | 750                    | 550                    | 1800                     | 300                    | 300                    | 300                    | 1350                 | 200               | 250              | 220            | 450                           |
| 83                     | 82                     | 71                     | 57                       | 31                     | 33                     | 25                     | 37                   | 0                 | 36               | 6              | 38                            |
| 108                    | 107                    | 92                     | 75                       | 40                     | 43                     | 33                     | 48                   | 0                 | 46               | 7              | 49                            |
| 83                     | 82                     | 71                     | 57                       | 31                     | 33                     | 25                     | 37                   | 0                 | 36               | 6              | 38                            |
| 108                    | 107                    | 92                     | 75                       | 40                     | 43                     | 33                     | 48                   | 0                 | 46               | 7              | 49                            |
| 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                   | 1.00                   | 1.00                 | 1.00              | 1.00             | 1.00           | 1.00                          |
| 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                   | 1.00                   | 1.00                 | 1.00              | 1.00             | 1.00           | 1.00                          |
| 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                   | 1.00                   | 1.00                 | 1.00              | 1.00             | 1.00           | 1.00                          |
| 0.11                   | 0.11                   | 0.13                   | 0.03                     | 0.10                   | 0.11                   | 0.08                   | 0.03                 | 0.00              | 0.14             | 0.03           | 0.08                          |
| 0.11                   | 0.11                   | 0.13                   | 0.03                     | 0.10                   | 0.11                   | 0.08                   | 0.03                 | 0.00              | 0.14             | 0.03           | 0.08                          |
| 0.14                   | 0.14                   | 0.17                   | 0.04                     | 0.13                   | 0.14                   | 0.11                   | 0.04                 | 0.00              | 0.19             | 0.03           | 0.11                          |
| 0.14                   | 0.14                   | 0.17                   | 0.04                     | 0.13                   | 0.14                   | 0.11                   | 0.04                 | 0.00              | 0.19             | 0.03           | 0.11                          |
|                        |                        |                        |                          |                        |                        |                        |                      |                   |                  |                |                               |
| 0.95                   | 0.95                   | 0.93                   | 1.03                     | 0.96                   | 0.95                   | 0.98                   | 1.03                 | 1.06              | 0.92             | 1.04           | 0.98                          |
| 0.94                   | 0.94                   | 0.91                   | 1.04                     | 0.95                   | 0.94                   | 0.97                   | 1.04                 | 1.08              | 0.89             | 1.05           | 0.97                          |



| 12050, 12054, 12062 - TESTING | 12041 - PROCEDURE ROOM | 12043 - PROCEDURE ROOM | 12045 - PROCEDURE ROOM | 12000CG - CLEAN CORRIDOR | 12047 - PROCEDURE ROOM | 12000CH - BEHAVIORAL TESTING CORRIDOR | 12000CH - BEHAVIORAL TESTING CORRIDOR | 12049 - CONTROL AREA | 120681 12072, 12076 - TESTING | 12061, 12063, 12065 - IC | 12067 - CONTROL AREA | 12066, 12070, 12074 - TESTING | 12000CJ - SOILED CORRIDOR | 12077 - VESTIBULE | 12079 - ANIMAL HOLDING |
|-------------------------------|------------------------|------------------------|------------------------|--------------------------|------------------------|---------------------------------------|---------------------------------------|----------------------|-------------------------------|--------------------------|----------------------|-------------------------------|---------------------------|-------------------|------------------------|
| 12-45                         | 12-47                  | 12-49                  | 12-51                  | 12-53                    | 12-55                  | 12-57                                 | 12-63                                 | 12-57                | 12-59                         | 12-61                    | 12-63                | 12-65                         | 12-67                     | 12-67             | 12-69                  |
| Science laboratories          | Medical Procedure      | Medical Procedure      | Medical Procedure      | Corridors                | Medical Procedure      | Corridors                             | Corridors                             | Corridors            | Science laboratories          | Science laboratories     | Corridors            | Science laboratories          | Corridors                 | Unocc / Not Used  | Science laboratories   |
| 121                           | 107                    | 99                     | 104                    | 228                      | 96                     | 360                                   | 360                                   | 443                  | 99                            | 37                       | 446                  | 118                           | 356                       | 74                | 370                    |
| 2                             | 2.14                   | 1.98                   | 2.08                   | 0                        | 1.92                   | 0                                     | 0                                     | 0                    | 2                             | 0                        | 0                    | 0                             | 0                         | 0                 | 2                      |
| 825                           | 300                    | 450                    | 300                    | 650                      | 300                    | 275                                   | 275                                   | 900                  | 825                           | 150                      | 900                  | 825                           | 200                       | 50                | 1,000                  |
| 55%                           | 100%                   | 100%                   | 100%                   | 100%                     | 100%                   | 100%                                  | 100%                                  | 100%                 | 55%                           | 100%                     | 100%                 | 55%                           | 100%                      | 100%              | 75%                    |
| CSCRW                         | CSCRW                  | CSCRW                  | CSCRW                  | CSCRW                    | CSCRW                  | CSCRW                                 | CSCRW                                 | CSCRW                | CSCRW                         | CSCRW                    | CSCRW                | CSCRW                         | CSCRW                     | CSCRW             | CSCRW                  |
| 1.00                          | 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                                  | 1.00                                  | 1.00                 | 1.00                          | 1.00                     | 1.00                 | 1.00                          | 1.00                      | 1.00              | 1.00                   |
| 1.00                          | 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                                  | 1.00                                  | 1.00                 | 1.00                          | 1.00                     | 1.00                 | 1.00                          | 1.00                      | 1.00              | 1.00                   |
| 1.00                          | 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                                  | 1.00                                  | 1.00                 | 1.00                          | 1.00                     | 1.00                 | 1.00                          | 1.00                      | 1.00              | 1.00                   |
| 0.18                          | 0.00                   | 0.00                   | 0.00                   | 0.06                     | 0.00                   | 0.06                                  | 0.06                                  | 0.06                 | 0.18                          | 0.18                     | 0.06                 | 0.18                          | 0.06                      | 0.00              | 0.18                   |
| 10.00                         | 15.00                  | 15.00                  | 15.00                  | 0.00                     | 15.00                  | 0.00                                  | 0.00                                  | 0.00                 | 10.00                         | 10.00                    | 0.00                 | 10.00                         | 0.00                      | 0.00              | 10.00                  |
| 450                           | 300                    | 450                    | 300                    | 650                      | 300                    | 275                                   | 275                                   | 900                  | 450                           | 150                      | 900                  | 450                           | 200                       | 50                | 750                    |
| 450                           | 300                    | 450                    | 300                    | 650                      | 300                    | 275                                   | 275                                   | 900                  | 450                           | 150                      | 900                  | 450                           | 200                       | 50                | 750                    |
| 42                            | 32                     | 30                     | 31                     | 14                       | 29                     | 22                                    | 22                                    | 27                   | 38                            | 7                        | 27                   | 21                            | 21                        | 0                 | 87                     |
| 54                            | 42                     | 39                     | 41                     | 18                       | 37                     | 28                                    | 28                                    | 35                   | 49                            | 9                        | 35                   | 28                            | 28                        | 0                 | 113                    |
| 42                            | 32                     | 30                     | 31                     | 14                       | 29                     | 22                                    | 22                                    | 27                   | 38                            | 7                        | 27                   | 21                            | 21                        | 0                 | 87                     |
| 54                            | 42                     | 39                     | 41                     | 18                       | 37                     | 28                                    | 28                                    | 35                   | 49                            | 9                        | 35                   | 28                            | 28                        | 0                 | 113                    |
| 1.00                          | 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                                  | 1.00                                  | 1.00                 | 1.00                          | 1.00                     | 1.00                 | 1.00                          | 1.00                      | 1.00              | 1.00                   |
| 1.00                          | 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                                  | 1.00                                  | 1.00                 | 1.00                          | 1.00                     | 1.00                 | 1.00                          | 1.00                      | 1.00              | 1.00                   |
| 1.00                          | 1.00                   | 1.00                   | 1.00                   | 1.00                     | 1.00                   | 1.00                                  | 1.00                                  | 1.00                 | 1.00                          | 1.00                     | 1.00                 | 1.00                          | 1.00                      | 1.00              | 1.00                   |
| 0.09                          | 0.11                   | 0.07                   | 0.10                   | 0.02                     | 0.10                   | 0.08                                  | 0.08                                  | 0.03                 | 0.08                          | 0.04                     | 0.03                 | 0.05                          | 0.11                      | 0.00              | 0.12                   |
| 0.09                          | 0.11                   | 0.07                   | 0.10                   | 0.02                     | 0.10                   | 0.08                                  | 0.08                                  | 0.03                 | 0.08                          | 0.04                     | 0.03                 | 0.05                          | 0.11                      | 0.00              | 0.12                   |
| 0.12                          | 0.14                   | 0.09                   | 0.14                   | 0.03                     | 0.12                   | 0.10                                  | 0.10                                  | 0.04                 | 0.11                          | 0.06                     | 0.04                 | 0.06                          | 0.14                      | 0.00              | 0.15                   |
| 0.12                          | 0.14                   | 0.09                   | 0.14                   | 0.03                     | 0.12                   | 0.10                                  | 0.10                                  | 0.04                 | 0.11                          | 0.06                     | 0.04                 | 0.06                          | 0.14                      | 0.00              | 0.15                   |
| 0.97                          | 0.95                   | 1.00                   | 0.96                   | 1.04                     | 0.97                   | 0.98                                  | 0.98                                  | 1.03                 | 0.98                          | 1.02                     | 1.03                 | 1.01                          | 0.95                      | 1.06              | 0.95                   |
| 0.96                          | 0.94                   | 0.99                   | 0.94                   | 1.05                     | 0.95                   | 0.98                                  | 0.98                                  | 1.04                 | 0.97                          | 1.02                     | 1.04                 | 1.02                          | 0.94                      | 1.08              | 0.93                   |



## Appendix B: LEED 2009 Checklist Construction and Major Renovations

|  <b>LEED 2009 for New Construction and Major Renovations</b><br>Project Checklist |           |           |   | Project Name   |
|--|-----------|-----------|---|--|
|  |           |           |   | Date   |
| <b>22</b>  | <b>1</b>  | <b>3</b>  | <b>Sustainable Sites</b>  | Possible Points: <b>26</b>   |
| Y ? N  |           |           |   |  |
| Y  |           |           | Prereq 1 Construction Activity Pollution Prevention                       |  |
| 1  |           |           | Credit 1 Site Selection   | 1  |
| 5  |           |           | Credit 2 Development Density and Community Connectivity                   | 5  |
| 1  |           |           | Credit 3 Brownfield Redevelopment   | 1  |
| 6  |           |           | Credit 4.1 Alternative Transportation—Public Transportation Access        | 6  |
| 1  |           |           | Credit 4.2 Alternative Transportation—Bicycle Storage and Changing Room   | 1  |
| 3  |           |           | Credit 4.3 Alternative Transportation—Low-Emitting and Fuel-Efficient Ve  | 3  |
| 2  |           |           | Credit 4.4 Alternative Transportation—Parking Capacity                    | 2  |
| 1  |           |           | Credit 5.1 Site Development—Protect or Restore Habitat                    | 1  |
| 1  |           |           | Credit 5.2 Site Development—Maximize Open Space                           | 1  |
| 1  |           |           | Credit 6.1 Stormwater Design—Quantity Control                             | 1  |
| 1  |           |           | Credit 6.2 Stormwater Design—Quality Control                              | 1  |
| 1  |           |           | Credit 7.1 Heat Island Effect—Non-roof                                    | 1  |
| 1  |           |           | Credit 7.2 Heat Island Effect—Roof  | 1  |
| 1  |           |           | Credit 8 Light Pollution Reduction  | 1  |
| <b>2</b>   | <b>3</b>  | <b>3</b>  | <b>Water Efficiency</b>   | Possible Points: <b>10</b>   |
| Y  |           |           | Prereq 1 Water Use Reduction—20% Reduction                                |  |
| 2  |           |           | Credit 1 Water Efficient Landscaping                                      | 2 to 4   |
| 2  |           |           | Credit 2 Innovative Wastewater Technologies                               | 2  |
| 2  | 1         | 1         | Credit 3 Water Use Reduction  | 2 to 4   |
| <b>10</b>  | <b>5</b>  | <b>20</b> | <b>Energy and Atmosphere</b>  | Possible Points: <b>35</b>   |
| Y  |           |           | Prereq 1 Fundamental Commissioning of Building Energy Systems             |  |
| Y  |           |           | Prereq 2 Minimum Energy Performance                                       |  |
| Y  |           |           | Prereq 3 Fundamental Refrigerant Management                               |  |
| 5  | 3         | 11        | Credit 1 Optimize Energy Performance                                      | 1 to 19  |
| 7  |           |           | Credit 2 On-Site Renewable Energy   | 1 to 7   |
| 2  |           |           | Credit 3 Enhanced Commissioning   | 2  |
| 2  |           |           | Credit 4 Enhanced Refrigerant Management                                  | 2  |
| 1  |           | 2         | Credit 5 Measurement and Verification                                     | 3  |
| 2  |           |           | Credit 6 Green Power  | 2  |
| <b>4</b>   | <b>3</b>  | <b>7</b>  | <b>Materials and Resources</b>  | Possible Points: <b>14</b>   |
| Y  |           |           | Prereq 1 Storage and Collection of Recyclables                            |  |
| 3  |           |           | Credit 1.1 Building Reuse—Maintain Existing Walls, Floors, and Roof       | 1 to 3   |
| 1  |           |           | Credit 1.2 Building Reuse—Maintain 50% of Interior Non-Structural Element | 1  |
| 2  |           |           | Credit 2 Construction Waste Management                                    | 1 to 2   |
| 2  |           |           | Credit 3 Materials Reuse  | 1 to 2   |
| <b>10</b>  | <b>1</b>  | <b>4</b>  | <b>Indoor Environmental Quality</b>                                       | Possible Points: <b>15</b>   |
| Y  |           |           | Prereq 1 Minimum Indoor Air Quality Performance                           |  |
| Y  |           |           | Prereq 2 Environmental Tobacco Smoke (ETS) Control                        |  |
| 1  |           |           | Credit 1 Outdoor Air Delivery Monitoring                                  | 1  |
| 1  |           |           | Credit 2 Increased Ventilation  | 1  |
| 1  |           |           | Credit 3.1 Construction IAQ Management Plan—During Construction           | 1  |
| 1  |           |           | Credit 3.2 Construction IAQ Management Plan—Before Occupancy              | 1  |
| 1  |           |           | Credit 4.1 Low-Emitting Materials—Adhesives and Sealants                  | 1  |
| 1  |           |           | Credit 4.2 Low-Emitting Materials—Paints and Coatings                     | 1  |
| 1  |           |           | Credit 4.3 Low-Emitting Materials—Flooring Systems                        | 1  |
| 1  |           |           | Credit 4.4 Low-Emitting Materials—Composite Wood and Agrifiber Product    | 1  |
| 1  |           |           | Credit 5 Indoor Chemical and Pollutant Source Control                     | 1  |
| 1  |           |           | Credit 6.1 Controllability of Systems—Lighting                            | 1  |
| 1  |           |           | Credit 6.2 Controllability of Systems—Thermal Comfort                     | 1  |
| 1  |           |           | Credit 7.1 Thermal Comfort—Design   | 1  |
| 1  |           |           | Credit 7.2 Thermal Comfort—Verification                                   | 1  |
| 1  |           |           | Credit 8.1 Daylight and Views—Daylight                                    | 1  |
| 1  |           |           | Credit 8.2 Daylight and Views—Views                                       | 1  |
| <b>4</b>   | <b>2</b>  |           | <b>Innovation and Design Process</b>                                      | Possible Points: <b>6</b>  |
| 1  |           |           | Credit 1.1 Innovation in Design: Specific Title                           | 1  |
| 1  |           |           | Credit 1.2 Innovation in Design: Specific Title                           | 1  |
| 1  |           |           | Credit 1.3 Innovation in Design: Specific Title                           | 1  |
| 1  |           |           | Credit 1.4 Innovation in Design: Specific Title                           | 1  |
| 1  |           |           | Credit 1.5 Innovation in Design: Specific Title                           | 1  |
| 1  |           |           | Credit 2 LEED Accredited Professional                                     | 1  |
| <b>4</b>   |           |           | <b>Regional Priority Credits</b>  | Possible Points: <b>4</b>  |
| 1  |           |           | Credit 1.1 Regional Priority: Specific Credit                             | 1  |
| 1  |           |           | Credit 1.2 Regional Priority: Specific Credit                             | 1  |
| 1  |           |           | Credit 1.3 Regional Priority: Specific Credit                             | 1  |
| 1  |           |           | Credit 1.4 Regional Priority: Specific Credit                             | 1  |
| <b>56</b>  | <b>15</b> | <b>37</b> | <b>Total</b>  | Possible Points: <b>110</b>  |
|  |           |           |   | Certified 40 to 43 points Silver 50 to 53 points Gold 60 to 73 points Platinum 80 to 110 |

## Appendix C: EAc4 Enhanced Refrigerant Management

### 75 AMES

#### EAc4 Enhanced Refrigerant Management

LEED NC v3

| Equipment Type      | Manufacturer | Model             | N | Q (tons) | Refrig. | GWP <sub>r</sub> | ODP <sub>r</sub> | Rc (lb/ton) | Life (yrs) | Lr (%) | Mr (%) | LCGWP | LCODP<br>x10 <sup>4</sup> 5 | Refrigerant<br>Impact per ton | Refrigerant<br>Impact Total |
|---------------------|--------------|-------------------|---|----------|---------|------------------|------------------|-------------|------------|--------|--------|-------|-----------------------------|-------------------------------|-----------------------------|
| Centrifugal Chiller | CARRIER      | 19XR/5659374F-H64 | 2 | 450      | R-134A  | 1320             | 0                | 3,566,667   | 25         | 2%     | 10%    | 113.0 | 0.0                         | 113.0                         | 101,693                     |
| Centrifugal Chiller | CARRIER      | 19XR/76755EMDH64  | 3 | 1000     | R-134A  | 1320             | 0                | 2,697       | 25         | 2%     | 10%    | 85.4  | 0.0                         | 85.4                          | 256,323                     |

**3900 TOTAL TONS**

**TOTAL 91.8 358,016 PASSES**

**Legend:**

- N Number of pieces of equipment (multiplier).
- Q (tons) Cooling capacity/in tons.
- Refrig. Refrigerant type.
- Rc (lb/ton) Refrigerant charge in lbs/ton. Provide from manufacturer documentation. Adjust for length of refrigerant lines, if applicable.
- Lr (%) Annual leakage rate, in % of total charge. Use default, unless supported by manufacturer documentation.
- Mr (%) End of equipment life refrigerant loss, in % of total refrigerant charge. Use default.

Table was created using equation

$$LCGWP + LCODP \times 105 \leq 100$$

Where

| Calculation definitions for LCGWP + LCODP x 105 ≤ 100 (IP units)                                      |
|---|
| LCODP = [ODPr x (Lr x Life +Mr) x Rc]/Life  |
| LCGWP = [GWPr x (Lr x Life +Mr) x Rc]/Life  |
| LCODP: Lifecycle Ozone Depletion Potential<br>(lb CFC 11/Ton-Year)                                    |
| LCGWP: Lifecycle Direct Global Warming Potential<br>(lb CO2/Ton-Year)                                 |
| GWPr: Global Warming Potential of Refrigerant<br>(0 to 12,000 lb CO2/lbr)                             |
| ODPr: Ozone Depletion Potential of Refrigerant<br>(0 to 0.2 lb CFC 11/lbr)                            |
| Lr: Refrigerant Leakage Rate<br>(0.5% to 2.0%; default of 2% unless otherwise demonstrated)           |
| Mr: End-of-life Refrigerant Loss<br>(2% to 10%; default of 10% unless otherwise demonstrated)         |
| Rc: Refrigerant Charge<br>(0.5 to 5.0 lbs of refrigerant per ton of gross ARI rated cooling capacity) |
| Life: Equipment Life<br>(10 years; default based on equipment type, unless otherwise demonstrated)    |

Appendix D: IEQc5 Indoor Chemical & Pollutant Source Control

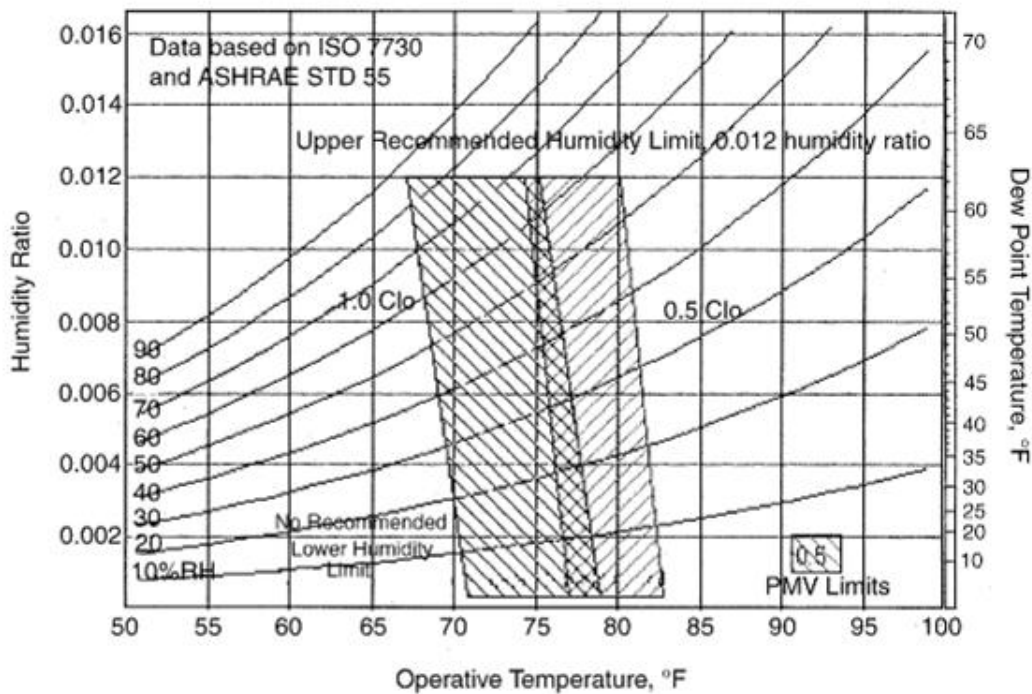
75 AMES  
IEQc5 Indoor Chemical & Pollutant Source Control

BR+A

| Room #     | Room Name                 | Door Name | Room Area (sq) | Exhaust Rate (cm) | Door Pressurization (+/- cm) | NUMBER OF DOORS | Door Width (m) | Door Height (m) | Door? Double | Exhaust (cm/m <sup>2</sup> ) | Door Crack Area (m <sup>2</sup> ) | Door Pressurization (Pa) | Door Pressurization (Pa) | Room Separation   |
|------------|---------------------------|-----------|----------------|-------------------|------------------------------|-----------------|----------------|-----------------|--------------|------------------------------|-----------------------------------|--------------------------|--------------------------|---|
| 8002       | BIO WASTE                 | B002      | 194            | 740               | 0.00                         | 1               | 4.0            | 8.0             | Y            | 3.92                         | 0.497                             | 0.090                    | 22.96                    |   |
| 8005       | MICROBIAL NITE C02        | B005      | 203            | 150               | 0.00                         | 1               | 6.0            | 8.0             | Y            | 0.74                         | 0.198                             | 0.071                    | 17.98                    |   |
| 8020       | RAO WASTE                 | B020      | 160            | 450               | 0.00                         | 1               | 6.0            | 8.0             | Y            | 2.81                         | 0.188                             | 0.040                    | 9.84                     |   |
| 1006       | WASTE CHEM STORAGE (H-5)  | 1006      | 183            | 200               | 0.00                         | 1               | 4.0            | 8.0             | Y            | 1.09                         | 0.167                             | 0.050                    | 12.57                    |   |
| 1008       | VIRGIN CHEM STORAGE (H-2) | 1008      | 124            | 400               | 0.00                         | 1               | 4.0            | 8.0             | Y            | 3.23                         | 0.167                             | 0.050                    | 12.57                    |   |
| 2005       | RNA LAB                   | 2005      | 1345           | 3000              | 0.00                         | 2               | 4.0            | 8.0             | Y            | 2.23                         | 0.375                             | 0.090                    | 22.96                    |   |
| 2015       | RNA LAB                   | 2015      | 1374           | 3000              | 0.00                         | 1               | 3.6            | 8.0             | Y            | 2.18                         | 0.198                             | 0.080                    | 23.92                    | NO DOOR PRESSURIZATION, BUT ASSUMING IT SHOULD BE -300  |
| 3020       | TISSUE CULTURE ROOM       | 3020      | 313            | 1360              | 0.00                         | 2               | 3.6            | 8.0             | N            | 4.31                         | 0.242                             | 0.024                    | 5.99                     |   |
| 3028       | NOVEL THERAPEUTICS CHEM10 | 3028      | 3163           | 5035              | 0.00                         | 3               | 3.6            | 8.0             | Y            | 1.80                         | 0.375                             | 0.160                    | 38.74                    | DOOR LEADS TO 3035  |
| 4045       | POST-PCR LAB BL-2         |           | 1364           | 3100              | 0.00                         | 1               | 6.0            | 8.0             | N            | 2.27                         | 0.198                             | 0.160                    | 39.74                    |   |
| 5025       | RNA BL-2 LAB              | 5025      | 1929           | 4400              | 0.00                         | 1               | 3.0            | 8.0             | N            | 2.82                         | 0.115                             | 0.107                    | 26.80                    |   |
| 5045       | RNA BL-2 LAB              | 5045      | 2077           | 4900              | 0.00                         | 1               | 6.0            | 8.0             | Y            | 2.36                         | 0.188                             | 0.160                    | 39.74                    | INCLUDING CORRIDOR 6000R  |
| 6115       | SSM LAB                   | 6115      | 3790           | 5750              | 0.00                         | 2               | 4.0            | 8.0             | Y            | 0.392                        | 0.160                             | 0.160                    | 39.74                    | DOOR LEADS TO SSAM LAB (6115)   |
| 6118       | SEL ROOM                  | 6118      | 155            | 100               | 0.00                         | 1               | 3.6            | 8.0             | N            | 0.66                         | 0.121                             | 0.043                    | 10.63                    | DOOR LEADS TO CORRIDOR 6000COR  |
| 6124       | BLA VIRAL PREP            | 6124      | 225            | 1100              | 100                          | 1               | 3.6            | 8.0             | N            | 4.89                         | 0.121                             | 0.043                    | 10.63                    |   |
| 7075       | SAMPLE PREP               |           | 3876           | 10200             | 1500                         | 5               | 6.0            | 9.0             | Y            | 2.83                         | 1.016                             | 0.136                    | 33.86                    |   |
| 8025       | BSP PREP LAB              | 8025      | 3160           | 3100              | 0.00                         | 2               | 7.0            | 8.0             | Y            | 0.98                         | 0.396                             | 0.143                    | 10.63                    |   |
| 8066       | POST PCR GMP LAB          |           | 966            | 7460              | 0.00                         | 5               | 6.0            | 8.9             | N            | 0.76                         | 0.029                             | 0.029                    | 6.44                     |   |
| 9064       | H2 STORAGE                | 9064      | 88             | 300               | 0.00                         | 2               | 3.0            | 8.0             | Y            | 7.74                         | 0.121                             | 0.045                    | 13.14                    |   |
| 9070       | BL-2 TISSUE CULTURE ROOM  | 9070      | 408            | 2700              | 0.00                         | 1               | 3.6            | 8.0             | N            | 6.92                         | 0.121                             | 0.088                    | 23.92                    |   |
| 9075       | LAB                       |           | 7349           | 4950              | 0.00                         | 8               | 3.0            | 8.0             | N            | 0.65                         | 0.617                             | 0.060                    | 14.96                    | INCLUDING EPHYS ROOM (9072) MICROSCOPY (IMAGING) (9069), DARK ROOM (9064), CORRIDOR (9000CL), CORRIDOR (9000CI)   |
| 9076       | TISSUE CULTURE ROOM       |           | 275            | 1800              | 0.00                         | 2               | 5.5            | 8.0             | Y            | 0.719                        | 0.35                              | 0.098                    | 24.34                    |   |
| 9077       | TISSUE CULTURE ROOM       | 9077      | 508            | 2200              | 0.00                         | 1               | 6.0            | 8.0             | N            | 0.371                        | 0.194                             | 0.148                    | 40.50                    |   |
| 9079       | PROCEDURE ROOM            | 9079      | 229            | 600               | 0.00                         | 1               | 3.6            | 8.0             | N            | 6.65                         | 0.121                             | 0.043                    | 10.63                    |   |
| 9082       | HOLDING                   | 9082      | 86             | 400               | 0.00                         | 1               | 3.6            | 8.0             | N            | 5.81                         | 0.121                             | 0.043                    | 10.63                    |   |
| 9086       | RADIO ISOTOPE             | 9086      | 122            | 1425              | 0.00                         | 1               | 3.6            | 8.0             | N            | 4.85                         | 0.121                             | 0.096                    | 23.92                    |   |
| 9088       | LAB MECH ROOM             | 9088      | 92             | 925               | 0.00                         | 1               | 3.6            | 8.0             | N            | 10.05                        | 0.121                             | 0.096                    | 23.92                    |   |
| 10082      | H2 STORAGE                |           | 92             | 175               | 0.00                         | 1               | 3.6            | 8.0             | N            | 1.90                         | 0.121                             | 0.096                    | 23.92                    |   |
| 10075      | LAB                       |           | 6361           | 6000              | 1500                         | 14              | 3.6            | 8.0             | N            | 0.72                         | 1.692                             | 0.049                    | 12.21                    | INCLUDING CELLUSOSTERIL (0080) MICROSCOPY (0080) ATLAS (0080) EIGHT SPEECH (0080) ACTUAL (0080) MICROSCOPY (0080) EPHYS ROOM (0099) MACHINE SHOP/ELECTRONICS (0099) CORRIDOR (0000CL), (0000CI) |
| 2000CL COR | SOILED CORRIDOR           |           | 2101           | 3350              | 0.00                         | 21              | 6.0            | 8.0             | Y            | 0.198                        | 0.143                             | 0.160                    | 36.67                    |   |
| 12005      | ANNUAL HOLDING            | 12005     | 382            | 750               | 0.00                         | 1               | 3.6            | 8.0             | N            | 1.99                         | 2.838                             | 0.096                    | 23.92                    |   |
| 12007      | ANNUAL HOLDING            | 12007     | 392            | 750               | 0.00                         | 1               | 3.6            | 8.0             | N            | 1.97                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12010      | ANNUAL HOLDING            | 12010     | 392            | 750               | 0.00                         | 1               | 3.6            | 8.0             | N            | 1.86                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12011      | ANNUAL HOLDING            | 12011     | 392            | 750               | 0.00                         | 1               | 3.6            | 8.0             | N            | 1.40                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12013      | ANNUAL HOLDING            | 12013     | 305            | 550               | 0.00                         | 1               | 3.6            | 8.0             | N            | 1.80                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12015      | ANNUAL HOLDING            | 12015     | 304            | 550               | 0.00                         | 1               | 3.6            | 8.0             | N            | 1.81                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12017      | ANNUAL HOLDING            | 12017     | 304            | 550               | 0.00                         | 1               | 3.6            | 8.0             | N            | 1.81                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12019      | ANNUAL HOLDING            | 12019     | 303            | 550               | 0.00                         | 1               | 3.6            | 8.0             | N            | 1.82                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12021      | ANNUAL HOLDING            | 12021     | 349            | 750               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.15                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12023      | ANNUAL HOLDING            | 12023     | 345            | 750               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.17                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12025      | ANNUAL HOLDING            | 12025     | 292            | 440               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.92                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12028      | PROCEDURE ROOM            | 12028     | 109            | 450               | 0.00                         | 1               | 3.6            | 8.0             | N            | 4.73                         | 0.121                             | 0.088                    | 23.92                    |   |
| 12029      | PROCEDURE ROOM            | 12029     | 84             | 450               | 0.00                         | 1               | 3.6            | 8.0             | N            | 5.36                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12031      | PROCEDURE ROOM            | 12031     | 84             | 450               | 0.00                         | 1               | 3.6            | 8.0             | N            | 5.36                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12033      | PROCEDURE ROOM            | 12033     | 94             | 200               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.19                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12035      | NARCOTICS                 | 12035     | 62             | 350               | 0.00                         | 1               | 3.6            | 8.0             | N            | 5.65                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12043      | PROCEDURE ROOM            | 12043     | 107            | 500               | 0.00                         | 1               | 3.6            | 8.0             | N            | 4.67                         | 0.121                             | 0.171                    | 42.53                    |   |
| 12045      | PROCEDURE ROOM            | 12045     | 104            | 650               | 0.00                         | 1               | 3.6            | 8.0             | N            | 4.91                         | 0.121                             | 0.171                    | 42.53                    |   |
| 12046      | PROCEDURE ROOM            | 12046     | 104            | 650               | 0.00                         | 1               | 3.6            | 8.0             | N            | 4.91                         | 0.121                             | 0.171                    | 42.53                    |   |
| 12047      | PROCEDURE ROOM            | 12047     | 104            | 650               | 0.00                         | 1               | 3.6            | 8.0             | N            | 4.91                         | 0.121                             | 0.171                    | 42.53                    |   |
| 12048      | TESTING                   | 12048     | 121            | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.48                         | 0.121                             | 0.088                    | 23.92                    |   |
| 12052      | TESTING                   | 12052     | 97             | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 3.99                         | 0.121                             | 0.088                    | 23.92                    |   |
| 12054      | TESTING                   | 12054     | 120            | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.90                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12056      | TESTING                   | 12056     | 96             | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 3.06                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12062      | TESTING                   | 12062     | 120            | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.90                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12066      | TESTING                   | 12066     | 118            | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.94                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12068      | TESTING                   | 12068     | 120            | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.94                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12070      | TESTING                   | 12070     | 99             | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 3.05                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12072      | TESTING                   | 12072     | 98             | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.90                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12074      | TESTING                   | 12074     | 98             | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.90                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12076      | TESTING                   | 12076     | 99             | 300               | 0.00                         | 1               | 3.6            | 8.0             | N            | 3.09                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12079      | ANNUAL HOLDING            | 12079     | 970            | 750               | 0.00                         | 1               | 3.6            | 8.0             | N            | 0.77                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12081      | ANNUAL HOLDING            | 12081     | 970            | 750               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.03                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12083      | ANNUAL HOLDING            | 12083     | 970            | 750               | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.03                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12085      | ANNUAL HOLDING            | 12085     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12086      | ANNUAL HOLDING            | 12086     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12087      | ANNUAL HOLDING            | 12087     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12088      | ANNUAL HOLDING            | 12088     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12089      | ANNUAL HOLDING            | 12089     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12090      | ANNUAL HOLDING            | 12090     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12091      | ANNUAL HOLDING            | 12091     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12092      | ANNUAL HOLDING            | 12092     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12093      | ANNUAL HOLDING            | 12093     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12094      | ANNUAL HOLDING            | 12094     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12095      | ANNUAL HOLDING            | 12095     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12096      | ANNUAL HOLDING            | 12096     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12097      | ANNUAL HOLDING            | 12097     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12098      | ANNUAL HOLDING            | 12098     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12099      | ANNUAL HOLDING            | 12099     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12100      | ANNUAL HOLDING            | 12100     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12101      | ANNUAL HOLDING            | 12101     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12102      | ANNUAL HOLDING            | 12102     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12103      | ANNUAL HOLDING            | 12103     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12104      | ANNUAL HOLDING            | 12104     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12105      | ANNUAL HOLDING            | 12105     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12106      | ANNUAL HOLDING            | 12106     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12107      | ANNUAL HOLDING            | 12107     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12108      | ANNUAL HOLDING            | 12108     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12109      | ANNUAL HOLDING            | 12109     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12110      | ANNUAL HOLDING            | 12110     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.096                    | 23.92                    |   |
| 12111      | ANNUAL HOLDING            | 12111     | 986            | 1900              | 0.00                         | 1               | 3.6            | 8.0             | N            | 2.91                         | 0.121                             | 0.09                     |                          |   |

## Appendix E: EQc7.1 01 Detailed Narrative from BR+A

1. It is expected that the occupants will, for the most part, dress seasonally. Since the building occupancy includes areas that require special clothing to fulfill the space function, such as lab coats for the lab areas, these areas were designed to have a consistent clothing level year round. Clothing insulation is considered in design only as it relates to the seasonal requirements for the space temperature and humidity setpoints, when the clothing levels are expected to be remarkably different throughout the year (short sleeves in summer, wool sweaters in winter) requiring different seasonal setpoints. Each unique category of space design setpoints is outlined on the LEED-Online Form.



The space setpoint for typical spaces on the project was designed based on 74°F and 50% RH in cooling mode and 68 °F in heating mode. These setpoints are also outlined in the uploaded HVAC BOD.

In all spaces that comprise this project, the space activity level was taken into account when calculating the cooling load and sizing the HVAC equipment serving the spaces. ASHRAE Fundamentals has several categories of occupant activity that designers use when calculating cooling loads, ranging from seated at theater (sitting for long periods of time), office work (standing and sitting), walking standing (moving about a lot between workstations) to higher level activities like factory work, bowling, and athletics, where the people would be contributing a much higher heat gain to the spaces. Since the spaces have primarily office, meeting space and lab occupancy, they were designed to the standing and sitting activity level.

Radiant temperatures are a concern in this building mainly at the perimeter glazed areas. Design measures to mitigate excess solar gain include active chilled beams, interior adjustable blinds, and daylighting control of the Eastern exposure light fixtures. Design measures to mitigate asymmetric radiant winter conditions near windows include excellent thermal-performing windows, radiant floor heating at the perimeter, and local perimeter thermal control zones.

The air speed is a consideration in the design of the air outlets in regards to placement and outlet

velocity of the air distribution systems. The supply air diffusers were selected and placed to prevent any air “dumping” on the occupants, where the cold air hits an obstruction and crashes down on the occupants at low discharge air temperatures, or high discharge air velocities preventing the cold discharge air from mixing at the ceiling level before reaching the occupied zone. As such, the diffusers were placed away from any obstructions such as columns and were selected so that their 50 fpm throw (distance from the diffuser at which the air is at 50 fpm) was low enough to prevent the air streams from adjacent diffusers from crashing, which would have the same effect. The diffusers are all a high-induction type to allow for proper air mixing with the ambient air prior to reaching the occupants at a lower velocity (less than 40 fpm), eliminating both drafts and cold spots over a variable volume operating range.

2. The unit capacities to serve the space conditions are as indicated in the uploaded AHU schedule and psychrometric charts. It is expected that the space comfort levels will be maintained year round with the VAV systems as designed and controlled. Refer to the attached Sequences of Operation for the designed response of the systems to varying loads and conditions.
3. The systems have been designed to maintain comfort levels within the building year round and under all occupancy levels. The systems were designed at outside air conditions (summer and winter) that exceed ASHRAE’s 1% weather conditions, making weather related comfort issues such as extended heat waves or cold snaps less likely, though not impossible. The only other factors that would negatively impact space comfort, besides problems with the installation or operation of the systems, would be if space occupancies changed dramatically post-installation, making the as-designed HVAC systems over- or under-sized for the new usage. The diversity built into the systems should allow for the zone level HVAC to be modified or replaced in these cases without impacting the central system capacities.
4. Please refer to uploaded ductwork and piping plans for the space layouts served by the HVAC systems. Individual zones are identified by the terminal devices (VAV/CV boxes, chilled beams, radiant heating). All terminal devices, as well as registers and outlets, are labeled and scheduled in the uploaded documentation.
5. It is not expected that any structural or decorative items will negatively impact comfort levels within the spaces. All outlets have been selected and located to prevent any drafts or cold spots. The control sensors have been located within the room to be away from heat sources, including windows and equipment layouts as designed; the occupants will be oriented to the need to not obstruct the sensors by the building operators once the building is occupied and as new employees are brought on board as part of their thermal comfort response to EQc7.2.
6. It is not anticipated that any zone will have areas outside the comfort control areas that will preclude any occupants from being permanently located.
7. Please refer to uploaded piping plans for locations of thermal controls and the Instrumentation Terminal Devices and Direct Digital/Automatic Temperature Controls documents for control descriptions. The temperature sensors to be installed on this project provide some manual adjustment of the local setpoint for each zone ( $\pm 4$  °F) but the overall control of the facility will be automatically controlled by the BMS.
8. The control functionality that must be met on this project is outlined in the Direct Digital/Automatic Temperature Controls and Sequences of Operation documents, which have been uploaded. The final control sequences and diagrams will be produced by the installing contractor and provided to the building Owner as part of the project closeout documents.
9. The operation and maintenance documentation, including the building controls, will be provided to the building Owner as part of the project closeout documents.



10. The operation and maintenance requirements of the building controls will be provided to the building Owner as part of the project closeout documents. All zone and central controls will be automatic and monitored and supervised by the BMS.
11. The capacity of the unit serving the project was based on the calculated peak loads. These were based on the outside air conditions and interior cooling loads for the project, as listed in the uploaded HVAC BOD and the envelope criteria as listed below. The outside air loads were based on the conditions outlined in the uploaded HVAC BOD and psychometric charts and the air volumes listed in the uploaded AHU schedules.

The building envelope information was based on the actual architectural design as follows:

*Wall:* Assembly U-value: 0.043 Btu/h-ft<sup>2</sup>-F; corrugated metal panel, 2 1/2" R.I, air barrier, 5/8" sheathing, 3 1/2" cavity insulation, 1/2" GWB.

*Roof:* Assembly U-value: 0.036 Btu/h-ft<sup>2</sup>-F; 2" conc pavers, 4" R.I, 1/8" asphalt board, waterproof membrane, 4 1/2" normal weight concrete slab, 3" vented roof deck

*Floor:* 6" conc slab, w/continuous vapor barrier & 2" continuous insulation under the slab.

*Glazing:* 1" clear heat strengthened radiant low-e insulating glass. Whole curtain wall U-value: 0.3, SHGC: 0.41

Since all the installed systems are variable volume, they are fully capable of meeting the expected diversity in the cooling and heating loads throughout the year.

## Appendix F: Labs To Aircuity Optinet System

| Areas to Aircuity                   |                  |            |
|-------------------------------------|------------------|------------|
| Space                               | SpaceType        | Area (SF)  |
| 2005 - RNAi LAB                     | Aircuity         | 1344.68994 |
| 2015 - RNAi LAB                     | Aircuity         | 1373.68994 |
| 3029 - TISSUE CULTURE ROOM          | Aircuity- Tissue | 314        |
| 3035 - NOVEL THERAPEUTICS/ CHEM BIO | Aircuity         | 3163       |
| 4045 - POST PCR LAB BL2             | Aircuity         | 1366       |
| 5045 - RNAi BL2+ LAB                | Aircuity         | 1509       |
| 5035 - RNAi BL2+ LAB                | Aircuity         | 2077       |
| 6115 - GSAP LAB                     | Aircuity         | 3375       |
| 6128 - TISSUE CULTURE               | Aircuity- Tissue | 211        |
| 7045 - R&D                          | Aircuity         | 1510       |
| 7055 - ION DETECTION                | Aircuity         | 1132       |
| 7065 - ILLUMINA                     | Aircuity         | 1831       |
| 7075 - SAMPLE PREP                  | Aircuity         | 3326       |
| 7085 - CLEAN SAMPLE 2               | Aircuity         | 914        |
| 7095 - CLEAN SAMPLE 1               | Aircuity         | 1373       |
| 8014 - TISSUE CULTURE ROOM          | Aircuity- Tissue | 252        |
| 8065 - POST PCR GAP LAB             | Aircuity         | 4451       |
| 8075 - PRE PCR WHOLE GENOME         | Aircuity         | 746        |
| 8095 - PRE PCR LOWPLEX              | Aircuity         | 957        |
| 9070 - BL2 + TISSUE CULTURE ROOM    | Aircuity- Tissue | 421        |
| 9075 - LAB                          | Aircuity         | 6295       |
| 9086 - RADIO ISOTOPE RM             | Aircuity         | 121        |
| 9076 - TISSUE CULTURE ROOM          | Aircuity- Tissue | 280        |
| 10079 - TISSUE CULTURE              | Aircuity- Tissue | 207        |
| 10090 - MICROSCOPY/ IMAGING         | Animal Imaging   | 120        |
| 10082 - PROCEDURE ROOM              | Aircuity         | 140        |
| 10076 - BACTERIAL ROOM              | Aircuity         | 90         |
| 10068 - MICROSCOPY/ IMAGING         | Animal Imaging   | 184        |
| 10075 - LAB                         | Aircuity         | 6705       |
| 9077 - TISSUE CULTURE ROOM          | Aircuity- Tissue | 484        |
| 10092 - BL2+ TISSUE CULTURE ROOM    | Aircuity- Tissue | 537        |
| 10078 - TISSUE CULTURE ROOM         | Aircuity- Tissue | 476        |
| 10078 - TISSUE CULTURE ROOM         | Aircuity- Tissue | 476        |

## Appendix G: Schedules

Schedule type: Utilization

Description: Vent - LABS

Simulation type:  Reduced year  
 Full year (day types only)

Comments:

|                    |   |
|--------------------|---|
| January - December | Cooling design to Saturday Heating design |
| January - December | Cooling design to Weekday                 |
| January - December | Cooling design to Sunday                  |

Del Definition

Schedule Definition

Start: January, End: December

Day type: Cooling design, Weekday

| Start time | End time | Percentage |
|------------|----------|------------|
| Midnight   | 6 a.m.   | 50         |
| 6 a.m.     | Noon     | 81         |
| Noon       | 6 p.m.   | 74         |
| 6 p.m.     | Midnight | 50         |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |

Reset and lockout table

| % | Sensor type | Op | Reset | Offset | And |
|---|-------------|----|-------|--------|-----|
|   |             |    |       |        |     |
|   |             |    |       |        |     |

NOTE: The reset and lockouts are available for the following: Design phase infiltration, ventilation, reheat minimum, and all system

Schedule type: Utilization

Description: Vent - LABS

Simulation type:  Reduced year  
 Full year (day types only)

Comments:

|                    |   |
|--------------------|---|
| January - December | Cooling design to Saturday Heating design |
| January - December | Cooling design to Weekday                 |
| January - December | Cooling design to Sunday                  |

Del Definition

Schedule Definition

Start: January, End: December

Day type: Cooling design, Saturday

| Start time | End time | Percentage |
|------------|----------|------------|
| Midnight   | 8 a.m.   | 50         |
| 8 a.m.     | Noon     | 55         |
| Noon       | 1 p.m.   | 65         |
| 1 p.m.     | 6 p.m.   | 55         |
| 6 p.m.     | Midnight | 50         |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |

Reset and lockout table

| % | Sensor type | Op | Reset | Offset | And |
|---|-------------|----|-------|--------|-----|
|   |             |    |       |        |     |
|   |             |    |       |        |     |

NOTE: The reset and lockouts are available for the following: Design phase infiltration, ventilation, reheat minimum, and all system

Schedule type: Utilization

Description: Vent - LABS

Simulation type:  Reduced year  
 Full year (day types only)

Comments:

|                    |  |
|--------------------|--|
| January - December | Cooling design to Saturday<br>Heating design |
| January - December | Cooling design to Weekday                    |
| January - December | Cooling design to Sunday                     |

Def Definition

Schedule Definition

Start: January, End: December

Day type: Cooling design, Sunday

| Start time | End time | Percentage |
|------------|----------|------------|
| Midnight   | Midnight | 50         |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |

Reset and lockout table

| % | Sensor type | Op | Reset | Offset | And |
|---|-------------|----|-------|--------|-----|
|   |             |    |       |        |     |
|   |             |    |       |        |     |

NOTE: The reset and lockouts are available for the following: Design phase infiltration, ventilation, reheal minimum, and all system

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Schedule type: Utilization

Description: Vent - Office

Simulation type:  Reduced year  
 Full year (day types only)

Comments:

|                    |                           |
|--------------------|---------------------------|
| January - December | Cooling design to Weekday |
|                    |                           |
| January - December | Heating design            |
| January - December | Saturday to Sunday        |

Def Definition

Schedule Definition

Start: January, End: December

Day type: Cooling design, Weekday

| Start time | End time | Percentage |
|------------|----------|------------|
| Midnight   | 7 a.m.   | 0          |
| 7 a.m.     | 6 p.m.   | 100        |
| 6 p.m.     | Midnight | 0          |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |

Reset and lockout table

| % | Sensor type | Op | Reset | Offset | And |
|---|-------------|----|-------|--------|-----|
|   |             |    |       |        |     |
|   |             |    |       |        |     |

NOTE: The reset and lockouts are available for the following: Design phase infiltration, ventilation, reheal minimum, and all system

Schedule type: Utilization  
 Description: Vent - Office  
 Simulation type:  Reduced year  
 Full year (day types only)

Comments:

January - December Cooling design to Weekday Heating design  
 January - December Saturday to Sunday

Def Definition

Schedule Definition

Start: Month: January, Day type: Saturday  
 End: Month: December, Day type: Sunday

| Start time | End time | Percentage |
|------------|----------|------------|
| Midnight   | Midnight | 0          |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |
|            |          |            |

Reset and lockout table

| % | Sensor type | Op | Reset | Offset | And |
|---|-------------|----|-------|--------|-----|
|   |             |    |       |        |     |
|   |             |    |       |        |     |

NOTE: The reset and lockouts are available for the following: Design phase infiltration, ventilation, reheat minimum, and all system

## Appendix H: Chilled Beam Selections

| Space   | People | Floor Area # | Space Air Flow CFM | Space Sensible Load Btu/h | Space Latent Load Btu/h | primary cooling Noz Sensible CFM | primary cooling Latent Btu/h | Cooling Ventilation Dripen Per Liter | Ventilation to cover latent CFM | New Ventilation Sensible Btu/h | Chilled Beam Type | Quantity # | Total Length ft. | Total Inlet Size in. | Nozzle Size in. | Airflow per Unit CFM | Total Airflow CFM | New Room Sens due to CFM | Cooling Unit Btu/h | Total Coiling Btu/h | Head Loss Ratio | Induction Ratio | Original W/W Cost \$ | Diffuser Existing \$ | Total Existing \$ | Resized W/W \$ | Chilled Beams \$ | Difference Original - New \$ |
|---|--------|--------------|--------------------|---------------------------|-------------------------|----------------------------------|------------------------------|--------------------------------------|---------------------------------|--------------------------------|-------------------|------------|------------------|----------------------|-----------------|----------------------|-------------------|--------------------------|--------------------|---------------------|-----------------|-----------------|----------------------|----------------------|-------------------|----------------|------------------|------------------------------|
|   |        |              |                    |                           |                         |                                  |                              |                                      |                                 |                                |                   |            |                  |                      |                 |                      |                   |                          |                    |                     |                 |                 |                      |                      |                   |                |                  |                              |
| 8111- Meeting                                     | 6      | 122          | 543                | 12103                     | 946                     | 38                               | 817                          | 226                                  | 159                             | 3413                           | AC24-HE           | 1          | 8                | 4.67                 | 60              | 173                  | 173               | 8386                     | 6838               | 8828                | 4.46            | 3.3             | 1,507.40             | 1,841.55             | 1,068.73          | 1,200.00       | 1,200.00         | (428.18)                     |
| 1001- OFFICE, 1009- OFFICE, 1007- OFFICE          | 3      | 387          | 1,554              | 34,637                    | 433                     | 38                               | 826                          | 229                                  | 72                              | 1555                           | AC24-HE           | 3          | 8                | 4.410                | 40              | 548                  | 548               | 2778                     | 10616              | 31988               | 5.37            | 4.5             | 2,286.07             | 2,620.22             | 1,507.40          | 3,600.00       | 3,600.00         | (2,467.18)                   |
| 1005- OFFICE                                      | 2      | 257          | 1,881              | 41,940                    | 359                     | 25                               | 549                          | 152                                  | 61                              | 1296                           | AC24-HE           | 2          | 8                | 4.410                | 80              | 363                  | 726               | 2629                     | 13989              | 27818               | 4.46            | 2               | 2,286.07             | 2,620.22             | 1,507.40          | 2,400.00       | 2,400.00         | (1,267.19)                   |
| 1004- OFFICE, 1006- OFFICE, 1008- OFFICE          | 3      | 390          | 214                | 4,765                     | 545                     | 38                               | 829                          | 230                                  | 91                              | 1986                           | AC24-HE           | 3          | 4                | 5                    | 40              | 32                   | 96                | 2932                     | 2594               | 7792                | 2.5             | 4.5             | 1,312.43             | 205.33               | 1,517.75          | 1,800.00       | 1,800.00         | (1,351.98)                   |
| 1007- OFFICE, 1005- OFFICE                        | 2      | 297          | 1,888              | 40,299                    | 415                     | 28                               | 601                          | 166                                  | 69                              | 1450                           | AC24-HE           | 2          | 8                | 4.410                | 80              | 363                  | 726               | 2487                     | 13989              | 27818               | 4.46            | 2               | 2,286.07             | 2,620.22             | 1,507.40          | 2,400.00       | 2,400.00         | (1,267.19)                   |
| 1002- OFFICE, 1009- OFFICE                        | 2      | 262          | 816                | 18,185                    | 366                     | 28                               | 556                          | 154                                  | 61                              | 1318                           | AC24-HE           | 2          | 8                | 4.410                | 40              | 147                  | 294               | 1165                     | 8881               | 17982               | 4.46            | 3.6             | 1,759.89             | 334.15               | 2,084.13          | 2,400.00       | 2,400.00         | (1,618.30)                   |
| 1002- OFFICE, 1008- OFFICE                        | 2      | 313          | 172                | 3,825                     | 438                     | 29                               | 622                          | 172                                  | 73                              | 1577                           | AC24-HE           | 2          | 4                | 8                    | 5               | 37                   | 74                | 2226                     | 3437               | 8874                | 2.5             | 5.7             | 1,068.73             | 205.33               | 1,275.06          | 1,200.00       | 1,200.00         | (684.68)                     |
| 1002- OFFICE, 1009- OFFICE                        | 2      | 353          | 1,697              | 35,626                    | 494                     | 31                               | 673                          | 187                                  | 83                              | 1793                           | AC24-HE           | 2          | 8                | 4.410                | 80              | 363                  | 726               | 2044                     | 13989              | 27818               | 4.46            | 2               | 2,286.07             | 2,620.22             | 1,507.40          | 2,400.00       | 2,400.00         | (1,267.19)                   |
| 1002- OFFICE, 1004- OFFICE, 1002- OFFICE          | 3      | 477          | 261                | 5,828                     | 667                     | 44                               | 942                          | 261                                  | 112                             | 2419                           | AC24-HE           | 3          | 4                | 5                    | 50              | 38                   | 114               | 3386                     | 2705               | 8115                | 2.5             | 3.6             | 1,312.43             | 205.33               | 1,517.75          | 1,800.00       | 1,800.00         | (1,351.98)                   |
| 1002- OFFICE, 1009- OFFICE                        | 2      | 314          | 172                | 3,857                     | 439                     | 29                               | 623                          | 173                                  | 73                              | 1577                           | AC24-HE           | 2          | 4                | 8                    | 5               | 37                   | 74                | 2228                     | 3437               | 8874                | 2.5             | 5.7             | 1,068.73             | 205.33               | 1,275.06          | 1,200.00       | 1,200.00         | (684.68)                     |
| 1001- LARGE CONFERENCE                            | 22     | 433          | 2,475              | 55,184                    | 3,356                   | 134                              | 2889                         | 803                                  | 501                             | 12118                          | AC24-HE           | 4          | 6                | 5                    | 60              | 157                  | 628               | 4459                     | 12772              | 46888               | 3.51            | 3.3             | 2,592.25             | 334.15               | 2,826.40          | 3,600.00       | 3,600.00         | (2,271.10)                   |
| 1004- OFFICE, 1008- OFFICE                        | 2      | 289          | 229                | 5,111                     | 376                     | 26                               | 565                          | 156                                  | 63                              | 1381                           | AC24-HE           | 2          | 4                | 8                    | 5               | 112                  | 224               | 273                      | 5814               | 11628               | 2.5             | 3.3             | 1,312.43             | 205.33               | 1,517.75          | 1,200.00       | 1,200.00         | (684.68)                     |
| 1008- OFFICE, 1009- OFFICE                        | 2      | 260          | 142                | 3,177                     | 364                     | 26                               | 553                          | 153                                  | 61                              | 1318                           | AC24-HE           | 2          | 4                | 8                    | 5               | 0                    | 0                 | 3177                     | 2138               | 4276                | 2.8             | -               | 1,068.73             | 205.33               | 1,275.06          | 1,200.00       | 1,200.00         | (684.68)                     |
| 1003- OFFICE                                      | 2      | 247          | 1,390              | 30,996                    | 104                     | 25                               | 536                          | 146                                  | 25                              | 538                            | AC24-HE           | 2          | 10               | 20                   | 4410            | 322                  | 644               | 17066                    | 14887              | 28774               | 5.37            | 2               | 2,064.71             | 334.15               | 2,398.86          | 3,000.00       | 3,000.00         | (2,168.54)                   |
| 1007- OFFICE, 1005- OFFICE                        | 2      | 271          | 1,567              | 34,881                    | 379                     | 26                               | 567                          | 157                                  | 63                              | 1381                           | AC24-HE           | 2          | 6                | 12                   | 5               | 103                  | 206               | 30481                    | 10860              | 21820               | 3.51            | 3.6             | 2,286.07             | 334.15               | 2,620.22          | 1,800.00       | 1,800.00         | (682.27)                     |
| 1007- TISSUE CULTURE ROOM                         | 14     | 476          | 1,638              | 36,528                    | 2,859                   | 87                               | 18507                        | 5126                                 | 901                             | 19440                          | AC24-HE           | 1          | 10               | 10                   | 4410            | 80                   | 465               | 28484                    | 17192              | 17192               | 5.37            | 2               | 2,286.07             | 334.15               | 2,620.22          | 1,500.00       | 1,500.00         | (687.19)                     |
| 1007- TISSUE CULTURE                              | 6      | 207          | 790                | 17,889                    | 1,243                   | 373                              | 8146                         | 2229                                 | 373                             | 8146                           | AC24-HE           | 1          | 10               | 10                   | 4410            | 80                   | 210               | 13073                    | 44033              | 14609               | 5.37            | 2               | 1,507.40             | 334.15               | 1,841.55          | 1,500.00       | 1,500.00         | (601.88)                     |
| 1008- LAB DESKS, 1008- LAB DESKS                  | 6      | 307          | 383                | 8,328                     | 1,228                   | 49                               | 1061                         | 294                                  | 206                             | 4428                           | AC24-HE           | 2          | 4                | 8                    | 5               | 105                  | 250               | 3128                     | 5967               | 11934               | 2.5             | 2.7             | 1,312.43             | 334.15               | 1,646.58          | 1,200.00       | 1,200.00         | (686.68)                     |
| 1007- LAB DESKS, 1008- LAB DESKS, 1008- LAB DESKS | 9      | 432          | 951                | 21,295                    | 1,728                   | 68                               | 1463                         | 413                                  | 288                             | 6242                           | AC24-HE           | 3          | 4                | 12                   | 5               | 112                  | 338               | 13847                    | 5814               | 17442               | 2.5             | 3.3             | 1,759.89             | 334.15               | 2,084.13          | 1,800.00       | 1,800.00         | (1,018.30)                   |
| 1009- BL2- TISSUE CULTURE ROOM                    | 16     | 537          | 1,079              | 24,851                    | 4,032                   | 97                               | 20879                        | 5792                                 | 907                             | 20879                          | AC24-HE           | 1          | 4                | 4                    | 5               | 40                   | 71                | 22517                    | 4769               | 4769                | 2.5             | 4.5             | 2,064.71             | 334.15               | 2,398.86          | 600.00         | 600.00           | (729.13)                     |
| 1003- LAB DESKS, 1005- LAB DESKS, 1007- LAB DESKS | 8      | 391          | 1,329              | 29,624                    | 1,564                   | 63                               | 1351                         | 374                                  | 261                             | 5838                           | AC24-HE           | 3          | 6                | 18                   | 5               | 134                  | 402               | 28940                    | 7323               | 23769               | 4.46            | 3.6             | 2,064.71             | 334.15               | 2,398.86          | 2,700.00       | 2,700.00         | (1,808.54)                   |
| 1009- LAB DESKS, 1010- LAB DESKS, 1010- LAB DESKS | 8      | 415          | 1,423              | 31,717                    | 1,660                   | 66                               | 1434                         | 397                                  | 277                             | 5963                           | AC24-HE           | 3          | 8                | 24                   | 4410            | 147                  | 441               | 22181                    | 8881               | 28873               | 4.46            | 3.6             | 2,064.71             | 334.15               | 2,398.86          | 3,000.00       | 3,000.00         | (2,168.54)                   |

|  |    |     |       |        |       |     |      |     |               |     |       |      |         |   |    |      |      |     |     |       |       |       |       |      |             |             |             |             |             |               |             |
|--|----|-----|-------|--------|-------|-----|------|-----|---------------|-----|-------|------|---------|---|----|------|------|-----|-----|-------|-------|-------|-------|------|-------------|-------------|-------------|-------------|-------------|---------------|-------------|
| 1085-OFFICE  | 1  | 140 | 471   | 10,481 | 157   | 13  | 287  | 80  | Coating/Diven | 26  | 562   | 950  | ACB-LHE | 1 | 10 | 467  | 50   | 170 | 170 | 819   | 9704  | 9704  | 5.37  | 4.5  | \$ 1,507.40 | \$ 334.15   | \$ 1,841.55 | \$ 1,067.73 | \$ 1,500.00 | \$ (728.16)   |             |
| 1087-SMALL CONFERENCE                                  | 10 | 205 | 842   | 18,776 | 1,589 | 64  | 1373 | 390 | Coating/Diven | 265 | 5746  | 1030 | ACB-LHE | 1 | 10 | 4610 | 60   | 283 | 283 | 1265  | 12859 | 12859 | 5.37  | 3.3  | \$ 1,759.98 | \$ 334.15   | \$ 2,094.13 | \$ 1,372.43 | \$ 1,500.00 | \$ (718.30)   |             |
| 11007-OFFICE, 11008-OFFICE, 11011-OFFICE               | 3  | 436 | 1,573 | 35,862 | 596   | 40  | 674  | 242 | Coating/Diven | 100 | 2180  | 3202 | ACB-LHE | 3 | 8  | 4610 | 40   | 147 | 441 | 25556 | 8891  | 28973 | 4.46  | 4.5  | \$ 2,286.07 | \$ 334.15   | \$ 2,620.22 | \$ 1,507.40 | \$ 3,000.00 | \$ (2,487.18) |             |
| 11008-OFFICE, 11010-OFFICE, 11022-OFFICE               | 3  | 327 | 179   | 3,396  | 457   | 35  | 748  | 207 | Coating/Diven | 76  | 1642  | 2364 | ACB-LHE | 3 | 4  | 12   | 5    | 40  | 37  | 111   | 3437  | 10311 | 2.5   | 5.7  | \$ 1,068.73 | \$ 205.33   | \$ 1,273.06 | \$ 1,068.73 | \$ 1,800.00 | \$ (1,594.68) |             |
| 11093-OFFICE   | 1  | 172 | 2,104 | 46,888 | 96    | 16  | 333  | 98  | Medium Diven  | 16  | 363   | 4654 | ACB-LHE | 1 | 10 | 4610 | 80   | 465 | 465 | 38854 | 17192 | 17192 | 2.37  | 2    | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 1,507.40 | \$ 1,500.00 | \$ (171.00)   |             |
| 11094-OFFICE, 11022-OFFICE                             | 2  | 333 | 183   | 4,069  | 466   | 32  | 683  | 188 | Coating/Diven | 78  | 1685  | 2394 | ACB-LHE | 2 | 4  | 8    | 5    | 40  | 37  | 74    | 3437  | 8874  | 2.5   | 5.7  | \$ 1,068.73 | \$ 205.33   | \$ 1,273.06 | \$ 1,068.73 | \$ 1,200.00 | \$ (944.68)   |             |
| 11096-FILES  | 1  | 158 | 87    | 1,931  | 221   | 15  | 324  | 90  | Coating/Diven | 37  | 799   | 1131 | ACB-LHE | 1 | 4  | 4    | 5    | 40  | 37  | 37    | 3437  | 3437  | 2.5   | 5.7  | \$ 1,068.73 | \$ 205.33   | \$ 1,273.06 | \$ 1,068.73 | \$ 600.00   | \$ (944.68)   |             |
| 11097-OFFICE, 11095-OFFICE, 11021-OFFICE, 11023-OFFICE | 4  | 508 | 2,370 | 52,849 | 710   | 48  | 1042 | 288 | Coating/Diven | 119 | 2570  | 3279 | ACB-LHE | 4 | 8  | 32   | 4610 | 70  | 205 | 830   | 9563  | 38252 | 4.46  | 2.7  | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 1,759.98 | \$ 4,800.00 | \$ (3,723.58) |             |
| 11094-OFFICE, 11024-OFFICE, 11028-OFFICE, 11030-OFFICE | 5  | 682 | 337   | 7,867  | 912   | 62  | 1337 | 370 | Coating/Diven | 152 | 3283  | 4894 | ACB-LHE | 4 | 4  | 16   | 5    | 50  | 38  | 152   | 2705  | 10820 | 2.5   | 3.6  | \$ 1,312.43 | \$ 334.15   | \$ 1,646.58 | \$ 1,068.73 | \$ 2,400.00 | \$ (1,623.16) |             |
| 11097-OFFICE, 11025-OFFICE                             | 3  | 339 | 1,594 | 34,872 | 502   | 34  | 726  | 204 | Coating/Diven | 84  | 1814  | 3357 | ACB-LHE | 2 | 10 | 20   | 4610 | 70  | 270 | 590   | 11802 | 22804 | 4.46  | 2.7  | \$ 2,286.07 | \$ 334.15   | \$ 2,620.22 | \$ 1,507.40 | \$ 3,000.00 | \$ (1,587.18) |             |
| 11091-LARGE CONFERENCE                                 | 22 | 433 | 2,400 | 55,351 | 3,356 | 134 | 2889 | 803 | Coating/Diven | 551 | 12719 | 4224 | ACB-LHE | 4 | 8  | 32   | 4610 | 70  | 205 | 620   | 9563  | 38252 | 4.46  | 2.7  | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 1,759.98 | \$ 4,800.00 | \$ (3,723.58) |             |
| 11097-OFFICE, 11045-OFFICE                             | 2  | 282 | 226   | 5,028  | 366   | 25  | 537  | 149 | Coating/Diven | 61  | 1318  | 3711 | ACB-LHE | 2 | 4  | 8    | 5    | 40  | 37  | 74    | 3437  | 8874  | 2.5   | 5.7  | \$ 1,312.43 | \$ 205.33   | \$ 1,517.75 | \$ 1,068.73 | \$ 1,200.00 | \$ (751.58)   |             |
| 11098-OFFICE, 11065-OFFICE                             | 2  | 280 | 142   | 3,177  | 364   | 25  | 533  | 148 | Coating/Diven | 61  | 1318  | 1889 | ACB-LHE | 2 | 4  | 8    | 5    | 40  | 37  | 74    | 1579  | 3437  | 2.5   | 5.7  | \$ 1,068.73 | \$ 205.33   | \$ 1,273.06 | \$ 1,068.73 | \$ 1,200.00 | \$ (844.68)   |             |
| 11063-OFFICE   | 2  | 282 | 1,457 | 32,488 | 110   | 25  | 537  | 149 | Medium Diven  | 25  | 537   | 3190 | ACB-LHE | 1 | 10 | 10   | 4610 | 80  | 465 | 465   | 22444 | 17192 | 17192 | 2.37 | 2           | \$ 2,094.71 | \$ 334.15   | \$ 2,388.86 | \$ 1,507.40 | \$ 1,500.00   | \$ (808.54) |
| 11065-OFFICE, 11067-OFFICE                             | 2  | 277 | 1,570 | 34,997 | 387   | 26  | 558  | 157 | Coating/Diven | 65  | 1404  | 3363 | ACB-LHE | 2 | 10 | 20   | 4610 | 70  | 270 | 540   | 11802 | 22804 | 4.46  | 2.7  | \$ 2,286.07 | \$ 334.15   | \$ 2,620.22 | \$ 1,507.40 | \$ 3,000.00 | \$ (1,587.18) |             |
| 11064-OFFICE, 11082-OFFICE                             | 2  | 259 | 142   | 3,165  | 362   | 25  | 531  | 147 | Coating/Diven | 61  | 1318  | 1847 | ACB-LHE | 2 | 4  | 8    | 5    | 40  | 37  | 74    | 1566  | 3437  | 2.5   | 5.7  | \$ 1,068.73 | \$ 205.33   | \$ 1,273.06 | \$ 1,068.73 | \$ 1,200.00 | \$ (844.68)   |             |
| 11088-OFFICE, 11074-OFFICE, 11072-OFFICE               | 3  | 380 | 208   | 4,843  | 531   | 38  | 779  | 216 | Coating/Diven | 89  | 1922  | 2721 | ACB-LHE | 3 | 4  | 12   | 5    | 40  | 37  | 111   | 3437  | 10311 | 2.5   | 5.7  | \$ 1,312.43 | \$ 205.33   | \$ 1,517.75 | \$ 1,068.73 | \$ 1,800.00 | \$ (1,351.98) |             |
| 11074-OFFICE, 11075-OFFICE, 11084-OFFICE               | 3  | 361 | 198   | 4,411  | 505   | 34  | 740  | 205 | Coating/Diven | 84  | 1814  | 2597 | ACB-LHE | 3 | 4  | 12   | 5    | 40  | 37  | 111   | 2013  | 3437  | 2.5   | 5.7  | \$ 1,068.73 | \$ 205.33   | \$ 1,273.06 | \$ 1,068.73 | \$ 1,800.00 | \$ (1,594.68) |             |
| 11076-OFFICE, 11086-OFFICE, 11088-OFFICE               | 3  | 391 | 214   | 4,778  | 547   | 37  | 802  | 222 | Coating/Diven | 91  | 1966  | 2812 | ACB-LHE | 3 | 4  | 12   | 5    | 40  | 37  | 111   | 2280  | 3437  | 2.5   | 5.7  | \$ 1,312.43 | \$ 205.33   | \$ 1,517.75 | \$ 1,068.73 | \$ 1,800.00 | \$ (1,351.98) |             |
| 11081-MEDIUM CONFERENCE                                | 19 | 290 | 483   | 10,328 | 1,938 | 78  | 1674 | 464 | Coating/Diven | 324 | 6888  | 3330 | ACB-LHE | 3 | 4  | 12   | 5    | 40  | 37  | 111   | 7951  | 3437  | 2.5   | 5.7  | \$ 1,507.40 | \$ 334.15   | \$ 1,841.55 | \$ 1,068.73 | \$ 1,800.00 | \$ (1,028.16) |             |
| 11083-OFFICE, 11085-OFFICE                             | 2  | 274 | 340   | 7,641  | 383   | 26  | 562  | 156 | Coating/Diven | 64  | 1382  | 6259 | ACB-LHE | 2 | 4  | 8    | 5    | 20  | 37  | 74    | 6043  | 3437  | 2.5   | 5.7  | \$ 1,312.43 | \$ 334.15   | \$ 1,646.58 | \$ 1,068.73 | \$ 1,200.00 | \$ (823.16)   |             |
| 11087-OFFICE, 11089-OFFICE, 11091-OFFICE               | 3  | 414 | 515   | 11,888 | 579   | 38  | 840  | 235 | Coating/Diven | 97  | 2085  | 3302 | ACB-LHE | 3 | 4  | 12   | 5    | 40  | 37  | 111   | 9900  | 3437  | 2.5   | 5.7  | \$ 1,507.40 | \$ 334.15   | \$ 1,841.55 | \$ 1,068.73 | \$ 1,800.00 | \$ (1,028.16) |             |

|   |    |       |       |         |        |      |        |       |                 |      |        |       |        |   |    |    |      |    |     |       |        |        |        |      |     |             |           |             |          |             |               |
|---|----|-------|-------|---------|--------|------|--------|-------|-----------------|------|--------|-------|--------|---|----|----|------|----|-----|-------|--------|--------|--------|------|-----|-------------|-----------|-------------|----------|-------------|---------------|
| 11089 - OFFICE, 1108 - OFFICE, 1102 - OFFICE                | 3  | 381   | 214   | 4,778   | 547    | 37   | 802    | 222   | Cooling Duen    | 91   | 1986   | 2612  | AC/LHE | 3 | 4  | 12 | 5    | 40 | 37  | 111   | 2380   | 3407   | 10311  | 2.5  | 5.7 | \$ 1,312.40 | \$ 263.33 | \$ 1,577.75 | 1,087.73 | \$ 1,800.00 | \$ (1,361.98) |
| 11093 - OFFICE  | 1  | 180   | 671   | 14,987  | 76     | 17   | 369    | 102   | Validation Duen | 17   | 369    | 1,627 | AC/LHE | 1 | 8  | 8  | 4x10 | 60 | 226 | 226   | 1,0065 | 1,0718 | 10,718 | 4.48 | 3.3 | \$ 1,507.40 | \$ 324.15 | \$ 1,841.55 | 1,312.43 | \$ 1,200.00 | \$ 670.89     |
| 11095 - OFFICE, 1109 - OFFICE, 1103 - OFFICE                | 3  | 418   | 1,425 | 31,786  | 175    | 40   | 857    | 237   | Validation Duen | 40   | 857    | 3,009 | AC/LHE | 3 | 8  | 24 | 5    | 50 | 134 | 402   | 2,383  | 7923   | 23,789 | 4.48 | 3.6 | \$ 2,064.71 | \$ 324.15 | \$ 2,388.86 | 1,507.40 | \$ 3,600.00 | \$ (2,765.54) |
| 11104 - OFFICE, 1110 - OFFICE, 1108 - OFFICE, 1110 - OFFICE | 4  | 520   | 265   | 6,384   | 727    | 49   | 1,097  | 295   | Cooling Duen    | 122  | 2635   | 3,719 | AC/LHE | 4 | 4  | 16 | 5    | 50 | 38  | 152   | 3,071  | 2,705  | 10,820 | 2.5  | 3.6 | \$ 1,312.40 | \$ 263.33 | \$ 1,577.75 | 1,087.73 | \$ 2,400.00 | \$ (1,961.98) |
| 11105 - OFFICE, 1110 - OFFICE, 1109 - OFFICE, 1111 - OFFICE | 4  | 576   | 1,680 | 41,247  | 242    | 55   | 1,182  | 327   | Validation Duen | 55   | 1,182  | 4,095 | AC/LHE | 4 | 8  | 32 | 4x10 | 70 | 205 | 820   | 2,383  | 8,923  | 38,923 | 4.48 | 2.7 | \$ 2,286.07 | \$ 324.15 | \$ 2,610.22 | 1,799.88 | \$ 4,800.00 | \$ (3,837.76) |
| 11112 - NETWORK OPERATIONS CENTER                           | 2  | 389   | 189   | 3,776   | 432    | 29   | 634    | 176   | Cooling Duen    | 72   | 1,555  | 2,220 | AC/LHE | 1 | 4  | 4  | 5    | 70 | 125 | 125   | 1,076  | 5,987  | 5,987  | 2.5  | 2.7 | \$ 1,087.73 | \$ 263.33 | \$ 1,275.06 | 1,087.73 | \$ 600.00   | \$ (394.68)   |
| 11115 - OFFICE, 1112 - OFFICE                               | 2  | 286   | 162   | 3,817   | 444    | 28   | 607    | 168   | Cooling Duen    | 69   | 1,430  | 2,126 | AC/LHE | 2 | 4  | 8  | 5    | 40 | 37  | 74    | 2,018  | 3,407  | 6,874  | 2.5  | 5.7 | \$ 1,087.73 | \$ 263.33 | \$ 1,275.06 | 1,087.73 | \$ 1,200.00 | \$ 894.68     |
| 11122 - IT WORKROOM   | 2  | 271   | 149   | 3,311   | 379    | 26   | 556    | 154   | Cooling Duen    | 63   | 1,361  | 1,981 | AC/LHE | 1 | 4  | 4  | 5    | 70 | 125 | 125   | 611    | 5,987  | 5,987  | 2.5  | 2.7 | \$ 1,087.73 | \$ 263.33 | \$ 1,275.06 | 1,087.73 | \$ 600.00   | \$ (394.68)   |
| 11125 - OFFICE, 1117 - OFFICE, 1112 - OFFICE                | 3  | 388   | 1,236 | 27,553  | 183    | 37   | 738    | 221   | Validation Duen | 37   | 738    | 2,676 | AC/LHE | 3 | 6  | 18 | 5    | 50 | 135 | 405   | 1,885  | 7,748  | 23,144 | 1.51 | 3.6 | \$ 2,064.71 | \$ 324.15 | \$ 2,388.86 | 1,507.40 | \$ 2,700.00 | \$ (1,808.54) |
| 11133 - OFFICE  | 1  | 180   | 388   | 13,100  | 282    | 17   | 369    | 102   | Cooling Duen    | 42   | 907    | 1,223 | AC/LHE | 1 | 6  | 6  | 4x10 | 50 | 177 | 177   | 9307   | 9,964  | 9,964  | 4.48 | 3.6 | \$ 1,507.40 | \$ 324.15 | \$ 1,841.55 | 1,087.73 | \$ 900.00   | \$ (1,281.8)  |
| 11135 - OFFICE, 1117 - OFFICE, 1113 - OFFICE                | 3  | 412   | 1,371 | 30,570  | 576    | 38   | 845    | 234   | Cooling Duen    | 96   | 2,074  | 2,946 | AC/LHE | 3 | 6  | 18 | 5    | 50 | 135 | 405   | 2,162  | 7,748  | 23,144 | 1.51 | 3.6 | \$ 2,064.71 | \$ 324.15 | \$ 2,388.86 | 1,507.40 | \$ 2,700.00 | \$ (1,808.54) |
| 11141 - OFFICE, 1114 - OFFICE, 1145 - OFFICE, 1114 - OFFICE | 4  | 553   | 1,830 | 40,880  | 773    | 53   | 1,134  | 314   | Cooling Duen    | 129  | 2,786  | 3,814 | AC/LHE | 4 | 8  | 32 | 4x10 | 70 | 205 | 820   | 2,388  | 8,923  | 38,923 | 4.48 | 2.7 | \$ 2,286.07 | \$ 324.15 | \$ 2,610.22 | 1,799.88 | \$ 4,800.00 | \$ (3,837.76) |
| 11142 - OFFICE, 1114 - OFFICE                               | 2  | 260   | 142   | 3,177   | 364    | 25   | 533    | 148   | Cooling Duen    | 61   | 1,318  | 1,859 | AC/LHE | 2 | 4  | 8  | 5    | 40 | 37  | 74    | 1,579  | 3,407  | 6,874  | 2.5  | 5.7 | \$ 1,087.73 | \$ 263.33 | \$ 1,275.06 | 1,087.73 | \$ 1,200.00 | \$ (894.68)   |
| 2001 - MULTIPURPOSE CONFERENCE                              | 39 | 788   | 1,119 | 24,948  | 6,103  | 244  | 5,273  | 1,460 | Cooling Duen    | 1020 | 2,302  | 2,916 | PCBL   | 1 | 6  | 6  | -    | -  | 0   | 0     | 2,916  | 3,207  | 3,207  | 2.8  | -   | \$ 2,064.71 | \$ 324.15 | \$ 2,388.86 | 2,064.71 | \$ 900.00   | \$ 566.65     |
| 2005 - RNA LAB  | 41 | 1,345 | 3,525 | 78,888  | 10,065 | 240  | 5,282  | 1,440 | Validation Duen | 240  | 5,282  | 2,637 | AC/LHE | 4 | 8  | 32 | 4x10 | 50 | 30  | 372   | 7,663  | 7,180  | 28,940 | 4.48 | 3.6 | \$ 2,502.25 | \$ 324.15 | \$ 2,826.40 | 1,312.43 | \$ 4,800.00 | \$ (3,276.03) |
| 2011 - PRE PCR  | 6  | 166   | 1,046 | 13,325  | 1,115  | 600  | 1,280  | 3,589 | Validation Duen | 600  | 1,280  | 1,065 | AC/LHE | 2 | 8  | 16 | 5    | 40 | 66  | 132   | 2,464  | 9,128  | 10,288 | 4.48 | 4.5 | \$ 2,064.71 | \$ 324.15 | \$ 2,388.86 | 1,087.73 | \$ 2,400.00 | \$ (1,070.07) |
| 2015 - RNA LAB  | 42 | 1,374 | 4,971 | 110,819 | 10,313 | 2473 | 5,3493 | 14732 | Validation Duen | 2473 | 5,3493 | 5,741 | AC/LHE | 5 | 10 | 50 | 4x10 | 80 | 465 | 0     | 1,0819 | 17,162 | 0      | 5.37 | 2   | \$ 2,502.25 | \$ 324.15 | \$ 2,826.40 | 1,087.73 | \$ 7,500.00 | \$ (5,733.33) |
| 2025 - CLONE PRODUCTION CLEAN LAB                           | 8  | 273   | 547   | 12,295  | 461    | 491  | 1,059  | 235   | Validation Duen | 491  | 1,059  | 1,610 | PCBL   | 1 | 4  | 4  | -    | -  | 0   | 0     | 1,610  | 2,138  | 2,138  | 2.8  | -   | \$ 1,507.40 | \$ 324.15 | \$ 1,841.55 | 1,507.40 | \$ 600.00   | \$ 265.65     |
| 2035 - DNA CLEAN LAB  | 7  | 227   | 1,146 | 25,547  | 1,782  | 115  | 2,477  | 686   | Cooling Duen    | 19   | 410    | 2,537 | AC/LHE | 3 | 8  | 24 | 4x17 | 40 | 112 | 336   | 1,820  | 7,456  | 22,388 | 4.48 | 4.5 | \$ 2,064.71 | \$ 324.15 | \$ 2,388.86 | 1,312.43 | \$ 3,800.00 | \$ (2,613.57) |
| 2051 - LAB DESKS  | 9  | 448   | 537   | 11,981  | 1,791  | 72   | 1,547  | 428   | Cooling Duen    | 289  | 6438   | 5523  | AC/LHE | 3 | 4  | 12 | 5    | 70 | 125 | 375   | 3,881  | 5,987  | 17,981 | 2.5  | 2.7 | \$ 1,507.40 | \$ 324.15 | \$ 1,841.55 | 1,312.43 | \$ 1,800.00 | \$ (1,270.88) |
| 2053 - OFFICE   | 1  | 159   | 1,384 | 31,087  | 222    | 15   | 326    | 90    | Cooling Duen    | 37   | 789    | 3,028 | AC/LHE | 1 | 10 | 10 | 4x10 | 80 | 465 | 465   | 2,145  | 17,192 | 17,192 | 2.37 | 2   | \$ 2,064.71 | \$ 324.15 | \$ 2,388.86 | 1,507.40 | \$ 1,500.00 | \$ 608.54     |
| 3001 - LARGE CONFERENCE                                     | 31 | 628   | 3,242 | 72,271  | 4,849  | 194  | 4,190  | 1,190 | Cooling Duen    | 811  | 1,7518 | 5,453 | AC/LHE | 4 | 10 | 40 | 4x10 | 60 | 283 | 1,132 | 4,750  | 12,859 | 51,438 | 5.37 | 3.3 | \$ 2,502.25 | \$ 324.15 | \$ 2,826.40 | 2,064.71 | \$ 6,000.00 | \$ (5,283.31) |
| 3007 - OFFICE, 3011 - OFFICE, 3009 - OFFICE                 | 3  | 449   | 1,392 | 31,029  | 628    | 43   | 921    | 255   | Cooling Duen    | 105  | 2,288  | 2,976 | AC/LHE | 3 | 6  | 18 | 5    | 50 | 135 | 405   | 2,281  | 7,748  | 23,144 | 1.51 | 3.6 | \$ 2,064.71 | \$ 324.15 | \$ 2,388.86 | 1,507.40 | \$ 2,700.00 | \$ (1,808.54) |
| 3008 - OFFICE, 3022 - OFFICE                                | 3  | 419   | 220   | 5,120   | 586    | 40   | 859    | 238   | Cooling Duen    | 88   | 2,117  | 3,003 | AC/LHE | 2 | 4  | 8  | 5    | 60 | 50  | 100   | 2,840  | 3,342  | 6,684  | 2.5  | 3.3 | \$ 1,312.40 | \$ 263.33 | \$ 1,577.75 | 1,087.73 | \$ 1,200.00 | \$ (761.98)   |



|   |    |       |        |         |        |       |        |        |                 |      |       |       |        |    |    |     |    |    |     |      |       |       |       |     |     |                         |                         |          |              |             |
|---|----|-------|--------|---------|--------|-------|--------|--------|-----------------|------|-------|-------|--------|----|----|-----|----|----|-----|------|-------|-------|-------|-----|-----|-------------------------|-------------------------|----------|--------------|-------------|
| 3015 - OFFICE, 3020 - OFFICE                | 2  | 274   | 159    | 3,348   | 380    | 26    | 592    | 156    | Coating Dهن     | 64   | 1382  | 1865  | ACBLHE | 2  | 4  | 6   | 5  | 40 | 37  | 74   | 1750  | 3407  | 8874  | 25  | 5.7 | \$ 1,083.73 \$ 2,063.53 | \$ 1,275.06 \$ 1,200.00 | 1,083.73 | \$ 1,200.00  | (94.68)     |
| 3015 - OFFICE                               | 2  | 288   | 1,078  | 24,043  | 300    | 25    | 550    | 152    | Coating Dهن     | 50   | 1080  | 2263  | ACBLHE | 2  | 4  | 8   | 5  | 40 | 37  | 74   | 2245  | 3407  | 8874  | 25  | 5.7 | \$ 2,064.71 \$ 3,344.15 | \$ 2,388.86 \$ 2,388.86 | 1,083.73 | \$ 1,200.00  | 128.13      |
| 3015 - OFFICE, 3017 - OFFICE, 3019 - OFFICE | 2  | 254   | 385    | 8,884   | 355    | 24    | 521    | 144    | Coating Dهن     | 59   | 1274  | 7309  | ACBLHE | 3  | 4  | 12  | 5  | 50 | 38  | 114  | 6121  | 2705  | 8115  | 25  | 3.6 | \$ 1,312.43 \$ 3,344.15 | \$ 1,646.59 \$ 1,800.00 | 1,083.73 | \$ 1,800.00  | (1,233.16)  |
| 3025 - LAB SUPPORT                          | 4  | 148   | 297    | 6,829   | 1,111  | 31    | 676    | 187    | Coating Dهن     | 186  | 4018  | 2611  | PCBL   | 1  | 6  | 6   | -  | -  | 0   | 0    | 2611  | 3207  | 3207  | 23  | -   | \$ 1,312.43 \$ 2,063.53 | \$ 1,517.75 \$ 900.00   | 1,083.73 | \$ 900.00    | (461.98)    |
| 3025 - TISSUE CULTURE ROOM                  | 10 | 314   | 1,196  | 26,441  | 1,886  | 565   | 12,208 | 3381   | Ventilation Dهن | 555  | 12208 | 4223  | ACBLHE | 2  | 8  | 16  | 44 | 80 | 343 | 726  | 10780 | 13909 | 27818 | 446 | 2   | \$ 2,064.71 \$ 3,344.15 | \$ 2,388.86 \$ 2,388.86 | 1,507.40 | \$ 2,400.00  | (1,638.54)  |
| 3035 - NOVEL THERAPEUTICS CHEM BIO          | 96 | 3,163 | 10,323 | 220,155 | 23,746 | 5683  | 12,277 | 34659  | Ventilation Dهن | 5533 | 12297 | 10717 | ACBLHE | 20 | 6  | 120 | 44 | 50 | 80  | 1680 | 19559 | 5455  | 18070 | -   | -   | \$ 2,502.25 \$ 3,344.15 | \$ 2,826.40 \$ 2,826.40 | 2,286.07 | \$ 18,000.00 | (17,449.07) |
| 3055 - LAB DESKS                            | 16 | 782   | 2,476  | 55,998  | 3,128  | 125   | 2703   | 748    | Coating Dهن     | 523  | 11297 | 4901  | ACBLHE | 4  | 10 | 40  | 44 | 80 | 283 | 1132 | 3047  | 12859 | 51458 | 537 | 3.3 | \$ 2,502.25 \$ 3,344.15 | \$ 2,826.40 \$ 2,826.40 | 2,064.71 | \$ 6,000.00  | (5,228.31)  |
| 4010 - LARGE CONFERENCE                     | 31 | 622   | 3,327  | 72,469  | 4,821  | 193   | 4165   | 1153   | Coating Dهن     | 805  | 17410 | 5070  | ACBLHE | 4  | 10 | 40  | 44 | 80 | 233 | 1132 | 4718  | 12859 | 51458 | 537 | 3.3 | \$ 2,502.25 \$ 3,344.15 | \$ 2,826.40 \$ 2,826.40 | 2,064.71 | \$ 6,000.00  | (5,228.31)  |
| 4017 - OFFICE, 4019 - OFFICE, 4011 - OFFICE | 3  | 392   | 1,391  | 30,346  | 546    | 37    | 804    | 223    | Coating Dهن     | 92   | 1897  | 2859  | ACBLHE | 3  | 8  | 24  | 5  | 50 | 147 | 441  | 20821 | 8881  | 28973 | 446 | 3.6 | \$ 2,064.71 \$ 3,344.15 | \$ 2,388.86 \$ 2,388.86 | 1,507.40 | \$ 3,000.00  | (2,708.54)  |
| 4015 - OFFICE                               | 2  | 320   | 175    | 3,910   | 448    | 30    | 656    | 182    | Coating Dهن     | 75   | 1620  | 2290  | ACBLHE | 2  | 4  | 8   | 5  | 40 | 37  | 74   | 2312  | 3407  | 8874  | 25  | 5.7 | \$ 1,083.73 \$ 2,063.53 | \$ 1,275.06 \$ 1,200.00 | 1,083.73 | \$ 1,200.00  | (94.68)     |
| 4016 - OFFICE, 4012 - OFFICE                | 2  | 260   | 142    | 3,177   | 364    | 25    | 533    | 148    | Coating Dهن     | 61   | 1318  | 1850  | ACBLHE | 2  | 4  | 8   | 5  | 40 | 37  | 74   | 1579  | 3407  | 8874  | 25  | 5.7 | \$ 1,083.73 \$ 2,063.53 | \$ 1,275.06 \$ 1,200.00 | 1,083.73 | \$ 1,200.00  | (94.68)     |
| 4013 - OFFICE                               | 2  | 275   | 1,082  | 24,427  | 308    | 26    | 554    | 156    | Coating Dهن     | 51   | 1102  | 2305  | ACBLHE | 2  | 6  | 12  | 44 | 80 | 202 | 494  | 15480 | 8668  | 17188 | 351 | 2   | \$ 2,064.71 \$ 3,344.15 | \$ 2,388.86 \$ 2,388.86 | 1,507.40 | \$ 1,800.00  | (908.54)    |
| 4015 - OFFICE                               | 1  | 170   | 1,022  | 22,282  | 228    | 16    | 349    | 97     | Coating Dهن     | 40   | 864   | 2181  | ACBLHE | 1  | 10 | 10  | 44 | 80 | 465 | 465  | 12739 | 17192 | 17192 | 537 | 2   | \$ 2,064.71 \$ 3,344.15 | \$ 2,388.86 \$ 2,388.86 | 1,507.40 | \$ 1,500.00  | (808.54)    |
| 4017 - OFFICE                               | 1  | 135   | 783    | 17,006  | 188    | 13    | 277    | 77     | Coating Dهن     | 32   | 681   | 1635  | ACBLHE | 1  | 8  | 8   | 44 | 80 | 275 | 275  | 11886 | 11280 | 11280 | 446 | 2   | \$ 1,507.40 \$ 3,344.15 | \$ 1,841.55 \$ 1,841.55 | 1,312.43 | \$ 1,200.00  | (670.88)    |
| 4018 - OFFICE, 4034 - OFFICE, 4014 - OFFICE | 3  | 475   | 280    | 5,804   | 664    | 45    | 974    | 270    | Coating Dهن     | 111  | 2388  | 3406  | ACBLHE | 3  | 4  | 12  | 5  | 50 | 38  | 114  | 3342  | 2705  | 8115  | 25  | 3.6 | \$ 1,312.43 \$ 2,063.53 | \$ 1,517.75 \$ 1,517.75 | 1,083.73 | \$ 1,800.00  | (1,361.98)  |
| 4020 - OFFICE, 4024 - OFFICE, 4022 - OFFICE | 3  | 390   | 214    | 4,765   | 545    | 37    | 800    | 222    | Coating Dهن     | 91   | 1866  | 2800  | ACBLHE | 3  | 4  | 12  | 5  | 40 | 37  | 111  | 2288  | 3407  | 10311 | 25  | 5.7 | \$ 1,312.43 \$ 2,063.53 | \$ 1,517.75 \$ 1,517.75 | 1,083.73 | \$ 1,800.00  | (1,361.98)  |
| 4023 - OFFICE, 4021 - OFFICE, 4019 - OFFICE | 3  | 465   | 1,780  | 39,676  | 690    | 44    | 954    | 284    | Coating Dهن     | 109  | 2354  | 3222  | ACBLHE | 3  | 8  | 24  | 44 | 70 | 205 | 615  | 28392 | 9563  | 28988 | 446 | 2.7 | \$ 2,286.07 \$ 3,344.15 | \$ 2,620.22 \$ 2,620.22 | 1,507.40 | \$ 3,000.00  | (2,467.78)  |
| 4031 - MEDIUM CONFERENCE ROOM               | 13 | 251   | 1,273  | 28,381  | 1,945  | 78    | 1881   | 465    | Coating Dهن     | 325  | 7020  | 21971 | ACBLHE | 2  | 8  | 16  | 44 | 70 | 270 | 540  | 16727 | 11802 | 23284 | 446 | 2.7 | \$ 2,064.71 \$ 3,344.15 | \$ 2,388.86 \$ 2,388.86 | 1,507.40 | \$ 2,400.00  | (1,108.54)  |
| 4035 - OFFICE                               | 1  | 156   | 85     | 1,306   | 216    | 15    | 320    | 89     | Coating Dهن     | 36   | 778   | 1129  | ACBLHE | 1  | 4  | 4   | 5  | 40 | 37  | 37   | 1107  | 3407  | 3407  | 25  | 5.7 | \$ 1,083.73 \$ 2,063.53 | \$ 1,275.06 \$ 600.00   | 1,083.73 | \$ 600.00    | (394.68)    |
| 4035 - OFFICE                               | 1  | 154   | 84     | 1,882   | 215    | 15    | 316    | 87     | Coating Dهن     | 36   | 778   | 1104  | ACBLHE | 1  | 4  | 4   | 5  | 40 | 37  | 37   | 1083  | 3407  | 3407  | 25  | 5.7 | \$ 1,083.73 \$ 2,063.53 | \$ 1,275.06 \$ 600.00   | 1,083.73 | \$ 600.00    | (394.68)    |
| 4038 - PREPCR LAB                           | 9  | 283   | 598    | 12,675  | 2,125  | 509   | 11,003 | 3047   | Ventilation Dهن | 509  | 11003 | 1072  | PCBL   | 1  | 4  | 4   | -  | -  | 0   | 0    | 1672  | 2138  | 2138  | 23  | -   | \$ 1,507.40 \$ 3,344.15 | \$ 1,841.55 \$ 1,841.55 | 1,507.40 | \$ 600.00    | (265.95)    |
| 4045 - POST PCR LAB B/L2                    | 41 | 1,386 | 4,889  | 104,335 | 10,255 | 2,469 | 53,110 | 14,079 | Ventilation Dهن | 2459 | 53110 | 51425 | ACBLHE | 5  | 8  | 40  | 44 | 80 | 345 | 1815 | 65331 | 13909 | 69545 | 446 | 2   | \$ 2,502.25 \$ 3,344.15 | \$ 2,826.40 \$ 2,826.40 | 2,286.07 | \$ 6,000.00  | (5,449.07)  |
| 4047 - LAB SUPPORT                          | 9  | 281   | 1,212  | 27,020  | 2,110  | 136   | 2932   | 812    | Coating Dهن     | 353  | 7825  | 19365 | ACBLHE | 2  | 8  | 16  | 44 | 70 | 205 | 410  | 18164 | 9563  | 19128 | 446 | 2.7 | \$ 2,064.71 \$ 3,344.15 | \$ 2,388.86 \$ 2,388.86 | 1,507.40 | \$ 2,400.00  | (1,638.54)  |
| 4053 - LAB DESKS                            | 13 | 630   | 2,295  | 49,157  | 2,520  | 101   | 2177   | 603    | Coating Dهن     | 421  | 9684  | 4084  | ACBLHE | 4  | 8  | 32  | 44 | 70 | 205 | 820  | 32466 | 9563  | 35632 | 446 | 2.7 | \$ 2,502.25 \$ 3,344.15 | \$ 2,826.40 \$ 2,826.40 | 1,799.88 | \$ 4,800.00  | (3,723.59)  |

|  |    |      |       |         |        |      |       |       |                  |      |       |       |         |   |    |    |      |     |      |      |       |       |        |      |             |             |             |             |             |               |               |
|--|----|------|-------|---------|--------|------|-------|-------|------------------|------|-------|-------|---------|---|----|----|------|-----|------|------|-------|-------|--------|------|-------------|-------------|-------------|-------------|-------------|---------------|---------------|
| 801 - LARGE CONFERENCE                                     | 32 | 635  | 3,253 | 72,825  | 4,821  | 197  | 422   | 1178  | Coating/Drum     | 823  | 1777  | 5446  | ACB/LHE | 4 | 10 | 40 | 40   | 283 | 1132 | 4874 | 12859 | 51458 | 5.37   | 3.3  | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 2,064.71 | \$ 6,000.00 | \$ (6,228.31) |               |
| 801 - OFFICE, 8005 - OFFICE, 8011 - OFFICE                 | 3  | 429  | 1,380 | 30,771  | 600    | 41   | 830   | 244   | Coating/Drum     | 100  | 2180  | 28011 | ACB/LHE | 3 | 6  | 18 | 5    | 50  | 115  | 465  | 22023 | 7748  | 23246  | 3.51 | 3.6         | \$ 2,064.71 | \$ 334.15   | \$ 2,398.86 | \$ 1,597.40 | \$ 2,700.00   | \$ (1,888.54) |
| 8008 - WORKSTATIONS  | 6  | 276  | 2,898 | 46,851  | 1,194  | 44   | 954   | 284   | Coating/Drum     | 195  | 3696  | 42555 | ACB/LHE | 4 | 8  | 32 | 4x10 | 70  | 205  | 820  | 32666 | 9563  | 30622  | 4.48 | 2.7         | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 1,759.98 | \$ 4,800.00   | \$ (3,723.59) |
| 8014 - OFFICE  | 1  | 179  | 877   | 19,546  | 100    | 17   | 367   | 102   | Ventilation/Drum | 17   | 367   | 19719 | ACB/LHE | 2 | 6  | 12 | 4x10 | 80  | 202  | 404  | 10820 | 8568  | 17136  | 3.51 | 2           | \$ 1,759.98 | \$ 334.15   | \$ 2,094.13 | \$ 1,597.40 | \$ 1,800.00   | \$ (1,243.27) |
| 8015 - OFFICE, 8017 - OFFICE, 8015 - OFFICE                | 2  | 339  | 2,821 | 45,866  | 474    | 32   | 635   | 193   | Coating/Drum     | 79   | 1706  | 42551 | ACB/LHE | 3 | 8  | 32 | 4x10 | 70  | 205  | 820  | 32666 | 9563  | 30622  | 4.48 | 2.7         | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 1,759.98 | \$ 4,800.00   | \$ (3,723.59) |
| 8021 - MEDIUM CONFERENCE                                   | 13 | 252  | 1,363 | 30,384  | 1,933  | 78   | 1827  | 467   | Coating/Drum     | 326  | 7042  | 23262 | ACB/LHE | 2 | 8  | 32 | 4x10 | 70  | 205  | 820  | 32666 | 9563  | 30622  | 4.48 | 2.7         | \$ 2,064.71 | \$ 334.15   | \$ 2,398.86 | \$ 1,759.98 | \$ 4,800.00   | \$ (4,161.12) |
| 8033 - RNA BL2A-LAB  | 63 | 2077 | 6,173 | 137,634 | 15,293 | 378  | 80754 | 22365 | Ventilation/Drum | 3739 | 80754 | 59881 | ACB/LHE | 6 | 10 | 60 | 4x10 | 80  | 465  | 2790 | 77270 | 17192 | 100152 | 5.37 | 2           | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 2,502.25 | \$ 9,000.00   | \$ (8,665.65) |
| 8041 - RNA BL2A-LAB  | 46 | 1509 | 6,467 | 144,178 | 11,329 | 2716 | 59870 | 16289 | Ventilation/Drum | 2716 | 59870 | 86590 | ACB/LHE | 6 | 10 | 60 | 4x10 | 80  | 465  | 2790 | 83914 | 17192 | 100152 | 5.37 | 2           | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 2,502.25 | \$ 9,000.00   | \$ (8,665.65) |
| 8007 - OFFICE, 8009 - OFFICE, 8011 - OFFICE, 8013 - OFFICE | 5  | 646  | 2,251 | 50,078  | 786    | 62   | 1331  | 389   | Coating/Drum     | 121  | 2614  | 47365 | ACB/LHE | 4 | 8  | 32 | 4x10 | 70  | 205  | 820  | 32666 | 9563  | 30622  | 4.48 | 2.7         | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 1,759.98 | \$ 4,800.00   | \$ (3,723.59) |
| 8008 - OFFICE, 8020 - OFFICE                               | 3  | 338  | 186   | 4,374   | 501    | 34   | 734   | 203   | Coating/Drum     | 84   | 1814  | 2501  | ACB/LHE | 2 | 4  | 8  | 5    | 50  | 100  | 214  | 3242  | 6484  | 25     | 3.3  | \$ 1,069.73 | \$ 205.33   | \$ 1,275.06 | \$ 1,069.73 | \$ 1,200.00 | \$ (944.68)   |               |
| 8014 - OFFICE, 8012 - OFFICE                               | 2  | 218  | 119   | 2,664   | 305    | 21   | 447   | 124   | Coating/Drum     | 51   | 1102  | 1592  | ACB/LHE | 2 | 4  | 8  | 5    | 10  | 29   | 58   | 1411  | 3014  | 6028   | 0.84 | 6.2         | \$ 1,069.73 | \$ 205.33   | \$ 1,275.06 | \$ 1,069.73 | \$ 1,200.00   | \$ (944.68)   |
| 8014 - OFFICE, 8016 - OFFICE, 8020 - OFFICE                | 2  | 346  | 191   | 4,252   | 467    | 33   | 714   | 198   | Coating/Drum     | 81   | 1750  | 2503  | ACB/LHE | 3 | 4  | 4  | 5    | 40  | 37   | 37   | 1107  | 3427  | 3427   | 2.5  | 5.7         | \$ 1,069.73 | \$ 205.33   | \$ 1,275.06 | \$ 1,069.73 | \$ 600.00     | \$ (944.68)   |
| 8015 - OFFICE, 8017 - OFFICE                               | 2  | 248  | 1,556 | 34,888  | 348    | 24   | 511   | 141   | Coating/Drum     | 58   | 1253  | 3365  | ACB/LHE | 2 | 10 | 20 | 4x10 | 70  | 270  | 540  | 2284  | 11922 | 23284  | 4.48 | 2.7         | \$ 2,286.07 | \$ 334.15   | \$ 2,620.22 | \$ 1,597.40 | \$ 3,000.00   | \$ (1,887.18) |
| 8019 - OFFICE, 8024 - OFFICE                               | 2  | 250  | 1,203 | 26,810  | 300    | 24   | 513   | 142   | Coating/Drum     | 58   | 1253  | 25977 | ACB/LHE | 2 | 8  | 16 | 4x10 | 70  | 205  | 410  | 17974 | 9563  | 19128  | 4.48 | 2.7         | \$ 2,064.71 | \$ 334.15   | \$ 2,398.86 | \$ 1,597.40 | \$ 2,400.00   | \$ (1,508.54) |
| 8023 - OFFICE, 8029 - OFFICE                               | 3  | 403  | 1,889 | 40,316  | 564    | 38   | 827   | 229   | Coating/Drum     | 94   | 2030  | 30306 | ACB/LHE | 2 | 8  | 16 | 4x10 | 70  | 313  | 726  | 24654 | 13929 | 27818  | 4.48 | 2.7         | \$ 2,286.07 | \$ 334.15   | \$ 2,620.22 | \$ 1,597.40 | \$ 2,400.00   | \$ (1,287.18) |
| 8025 - OFFICE, 8030 - OFFICE                               | 2  | 316  | 173   | 3,861   | 442    | 30   | 648   | 180   | Coating/Drum     | 74   | 1586  | 2263  | ACB/LHE | 2 | 4  | 8  | 5    | 40  | 37   | 74   | 2263  | 3427  | 8874   | 2.5  | 5.7         | \$ 1,069.73 | \$ 205.33   | \$ 1,275.06 | \$ 1,069.73 | \$ 1,200.00   | \$ (944.68)   |
| 8031 - LARGE CONFERENCE                                    | 21 | 419  | 2,454 | 54,713  | 3,347  | 130  | 2836  | 777   | Coating/Drum     | 543  | 11729 | 42865 | ACB/LHE | 4 | 10 | 40 | 4x10 | 80  | 233  | 1132 | 32682 | 12859 | 51458  | 5.37 | 3.3         | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 2,064.71 | \$ 6,000.00   | \$ (6,228.31) |
| 8047 - OFFICE, 8049 - OFFICE                               | 2  | 261  | 225   | 5,016   | 365    | 25   | 535   | 148   | Coating/Drum     | 61   | 1318  | 3893  | ACB/LHE | 2 | 4  | 8  | 5    | 40  | 37   | 74   | 3418  | 3427  | 8874   | 2.5  | 5.7         | \$ 1,312.43 | \$ 205.33   | \$ 1,517.75 | \$ 1,069.73 | \$ 1,200.00   | \$ (751.96)   |
| 8048 - OFFICE, 8050 - OFFICE                               | 2  | 262  | 144   | 3,201   | 366    | 25   | 537   | 149   | Coating/Drum     | 61   | 1318  | 1984  | ACB/LHE | 2 | 4  | 8  | 5    | 40  | 37   | 74   | 1983  | 3427  | 8874   | 2.5  | 5.7         | \$ 1,069.73 | \$ 205.33   | \$ 1,275.06 | \$ 1,069.73 | \$ 1,200.00   | \$ (944.68)   |
| 8055 - OFFICE, 8057 - OFFICE, 8063 - OFFICE                | 4  | 516  | 2,916 | 65,810  | 724    | 49   | 1063  | 294   | Coating/Drum     | 121  | 2614  | 62386 | ACB/LHE | 3 | 8  | 32 | 4x10 | 70  | 205  | 820  | 32666 | 9563  | 30622  | 4.48 | 2.7         | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 1,759.98 | \$ 4,800.00   | \$ (3,723.59) |
| 8062 - OFFICE, 8064 - OFFICE                               | 2  | 270  | 148   | 3,299   | 378    | 26   | 554   | 153   | Coating/Drum     | 63   | 1361  | 1933  | ACB/LHE | 2 | 4  | 8  | 5    | 40  | 37   | 74   | 1701  | 3427  | 8874   | 2.5  | 5.7         | \$ 1,069.73 | \$ 205.33   | \$ 1,275.06 | \$ 1,069.73 | \$ 1,200.00   | \$ (944.68)   |
| 8066 - OFFICE, 8070 - OFFICE, 8072 - OFFICE                | 3  | 383  | 210   | 4,880   | 536    | 36   | 736   | 218   | Coating/Drum     | 90   | 1944  | 2736  | ACB/LHE | 3 | 4  | 12 | 5    | 40  | 37   | 111  | 2282  | 3427  | 10311  | 2.5  | 5.7         | \$ 1,312.43 | \$ 205.33   | \$ 1,517.75 | \$ 1,069.73 | \$ 1,800.00   | \$ (1,351.96) |
| 8074 - OFFICE, 8078 - OFFICE                               | 2  | 245  | 154   | 2,894   | 340    | 23   | 510   | 139   | Coating/Drum     | 57   | 1231  | 1762  | ACB/LHE | 2 | 4  | 8  | 5    | 40  | 37   | 74   | 1395  | 3427  | 8874   | 2.5  | 5.7         | \$ 1,069.73 | \$ 205.33   | \$ 1,275.06 | \$ 1,069.73 | \$ 1,200.00   | \$ (944.68)   |
| 8080 - OFFICE, 8082 - OFFICE, 8084 - OFFICE                | 3  | 397  | 218   | 4,881   | 555    | 38   | 814   | 226   | Coating/Drum     | 93   | 2039  | 2842  | ACB/LHE | 2 | 4  | 8  | 5    | 60  | 50   | 100  | 2691  | 3342  | 6484   | 2.5  | 3.3         | \$ 1,312.43 | \$ 205.33   | \$ 1,517.75 | \$ 1,069.73 | \$ 1,200.00   | \$ (751.96)   |

|  |     |       |       |         |        |      |        |        |                   |      |        |       |          |    |    |     |   |    |     |       |       |        |      |     |    |          |    |        |    |          |    |          |    |           |    |             |
|--|-----|-------|-------|---------|--------|------|--------|--------|-------------------|------|--------|-------|----------|----|----|-----|---|----|-----|-------|-------|--------|------|-----|----|----------|----|--------|----|----------|----|----------|----|-----------|----|-------------|
| 8091 - OFFICE                                | 2   | 25    | 167   | 3,724   | 329    | 22   | 62     | 134    | Coating Drien     | 55   | 188    | 2546  | P-ZBL    | 1  | 6  | 6   | - | 0  | 0   | 2546  | 3207  | 3207   | 2.8  | -   | \$ | 1,089.73 | \$ | 265.53 | \$ | 1,275.06 | \$ | 1,089.73 | \$ | 900.00    | \$ | (894.08)    |
| 8092 - OFFICE, 8094 - OFFICE                 | 3   | 384   | 216   | 4,814   | 551    | 37   | 838    | 224    | Coating Drien     | 92   | 1897   | 2827  | ACB, LHE | 2  | 4  | 8   | 5 | 60 | 50  | 2854  | 3242  | 6484   | 2.5  | 3.3 | \$ | 1,312.43 | \$ | 325.33 | \$ | 1,517.75 | \$ | 1,089.73 | \$ | 1,200.00  | \$ | (751.98)    |
| 8095 - OFFICE, 8093 - OFFICE                 | 2   | 255   | 338   | 7,466   | 357    | 24   | 623    | 145    | Coating Drien     | 60   | 1236   | 6130  | ACB, LHE | 2  | 4  | 8   | 5 | 20 | 37  | 5988  | 3407  | 6814   | 2.5  | 5.7 | \$ | 1,312.43 | \$ | 334.15 | \$ | 1,646.58 | \$ | 1,089.73 | \$ | 1,200.00  | \$ | (623.16)    |
| 8096 - OFFICE, 8101 - OFFICE, 8097 - OFFICE  | 3   | 384   | 594   | 11,241  | 537    | 36   | 789    | 218    | Coating Drien     | 90   | 1944   | 9257  | ACB, LHE | 3  | 4  | 12  | 5 | 40 | 37  | 8843  | 3427  | 10311  | 2.5  | 5.7 | \$ | 1,507.40 | \$ | 334.15 | \$ | 1,841.55 | \$ | 1,089.73 | \$ | 1,800.00  | \$ | (1,028.18)  |
| 8103 - OFFICE                                | 2   | 284   | 887   | 19,773  | 111    | 25   | 542    | 150    | Ventilation Drien | 25   | 542    | 19231 | ACB, LHE | 1  | 10 | 10  | 4 | 10 | 465 | 9729  | 17192 | 17192  | 5.37 | 2   | \$ | 1,759.98 | \$ | 334.15 | \$ | 2,094.13 | \$ | 1,507.40 | \$ | 1,500.00  | \$ | (912.27)    |
| 8106 - OFFICE, 8108 - OFFICE                 | 3   | 307   | 218   | 4,851   | 555    | 38   | 814    | 226    | Coating Drien     | 93   | 2039   | 2842  | ACB, LHE | 2  | 4  | 8   | 5 | 60 | 50  | 2691  | 3242  | 6484   | 2.5  | 3.3 | \$ | 1,312.43 | \$ | 265.33 | \$ | 1,517.75 | \$ | 1,089.73 | \$ | 1,200.00  | \$ | (751.98)    |
| 8109 - OFFICE, 8107 - OFFICE, 8105 - OFFICE  | 3   | 421   | 1,426 | 31,789  | 177    | 40   | 884    | 239    | Ventilation Drien | 40   | 884    | 30226 | ACB, LHE | 3  | 8  | 24  | 4 | 70 | 205 | 18305 | 9583  | 26989  | 4.46 | 2.7 | \$ | 2,084.71 | \$ | 334.15 | \$ | 2,398.86 | \$ | 1,507.40 | \$ | 3,000.00  | \$ | (2,708.54)  |
| 8111 - OFFICE, 8113 - OFFICE                 | 2   | 274   | 831   | 18,228  | 115    | 26   | 592    | 156    | Ventilation Drien | 26   | 592    | 17985 | ACB, LHE | 2  | 10 | 20  | 4 | 50 | 170 | 11184 | 9704  | 19498  | 5.37 | 4.5 | \$ | 1,759.98 | \$ | 334.15 | \$ | 2,094.13 | \$ | 1,312.43 | \$ | 3,000.00  | \$ | (2,218.30)  |
| 8112 - OFFICE, 8114 - OFFICE                 | 2   | 228   | 131   | 2,820   | 334    | 23   | 490    | 136    | Coating Drien     | 56   | 1210   | 1711  | ACB, LHE | 2  | 4  | 8   | 5 | 50 | 38  | 1279  | 2705  | 5410   | 2.5  | 3.6 | \$ | 1,089.73 | \$ | 265.33 | \$ | 1,275.06 | \$ | 1,089.73 | \$ | 1,200.00  | \$ | (894.08)    |
| 8115 - GSAP LAB                              | 102 | 3,375 | 8,890 | 198,195 | 24,338 | 6075 | 13,220 | 36,342 | Ventilation Drien | 6075 | 13,220 | 66975 | ACB, LHE | 17 | 10 | 170 | 4 | 10 | 465 | 27447 | 17192 | 202264 | 5.37 | 2   | \$ | 2,502.25 | \$ | 334.15 | \$ | 2,836.40 | \$ | 2,502.25 | \$ | 25,500.00 | \$ | (25,165.95) |
| 8120 - PRE PCR                               | 5   | 173   | 348   | 7,748   | 1,289  | 311  | 676    | 1863   | Ventilation Drien | 311  | 676    | 1022  | P-ZBL    | 1  | 4  | 4   | - | 0  | 0   | 1022  | 2138  | 2138   | 2.8  | -   | \$ | 1,312.43 | \$ | 334.15 | \$ | 1,646.58 | \$ | 1,312.43 | \$ | 600.00    | \$ | (265.55)    |
| 8124 - BL2+VIRAL PREP                        | 7   | 225   | 452   | 10,077  | 1,689  | 405  | 846    | 2423   | Ventilation Drien | 405  | 846    | 1329  | P-ZBL    | 1  | 4  | 4   | - | 0  | 0   | 1329  | 2138  | 2138   | 2.8  | -   | \$ | 1,507.40 | \$ | 334.15 | \$ | 1,841.55 | \$ | 1,507.40 | \$ | 600.00    | \$ | (265.55)    |
| 8128 - TISSUE CULTURE                        | 6   | 211   | 726   | 16,192  | 1,267  | 380  | 824    | 2272   | Ventilation Drien | 380  | 824    | 7988  | ACB, LHE | 1  | 8  | 8   | 4 | 70 | 205 | 11764 | 9583  | 9583   | 4.46 | 2.7 | \$ | 1,507.40 | \$ | 334.15 | \$ | 1,841.55 | \$ | 1,312.43 | \$ | 1,200.00  | \$ | (670.86)    |
| 8132 - LAB DESKS                             | 2   | 112   | 429   | 9,558   | 134    | 18   | 387    | 107    | Coating Drien     | 22   | 475    | 933   | ACB, LHE | 1  | 10 | 10  | 4 | 50 | 170 | 5986  | 9704  | 9704   | 5.37 | 4.5 | \$ | 1,507.40 | \$ | 334.15 | \$ | 1,841.55 | \$ | 1,089.73 | \$ | 1,500.00  | \$ | (728.16)    |
| 8135 - LAB DESKS, 8137 - LAB DESKS           | 6   | 277   | 510   | 11,373  | 332    | 44   | 957    | 265    | Coating Drien     | 56   | 1210   | 10764 | ACB, LHE | 2  | 6  | 12  | 4 | 50 | 80  | 7917  | 5435  | 10870  | -    | -   | \$ | 1,507.40 | \$ | 334.15 | \$ | 1,841.55 | \$ | 1,089.73 | \$ | 1,800.00  | \$ | (1,028.18)  |
| 8139 - LAB DESKS                             | 3   | 141   | 475   | 10,809  | 564    | 23   | 497    | 135    | Coating Drien     | 94   | 2030   | 6578  | ACB, LHE | 1  | 10 | 10  | 4 | 50 | 170 | 6987  | 9704  | 9704   | 5.37 | 4.5 | \$ | 1,507.40 | \$ | 334.15 | \$ | 1,841.55 | \$ | 1,089.73 | \$ | 1,500.00  | \$ | (728.16)    |
| 8141 - MEETING                               | 7   | 131   | 556   | 12,404  | 812    | 41   | 877    | 243    | Coating Drien     | 136  | 2938   | 9466  | ACB, LHE | 1  | 10 | 10  | 4 | 50 | 170 | 8722  | 9704  | 9704   | 5.37 | 4.5 | \$ | 1,507.40 | \$ | 334.15 | \$ | 1,841.55 | \$ | 1,089.73 | \$ | 1,500.00  | \$ | (728.16)    |
| 8143 - MEDIUM CONFERENCE                     | 9   | 183   | 620   | 13,824  | 1,418  | 57   | 1225   | 339    | Coating Drien     | 237  | 5119   | 8704  | ACB, LHE | 1  | 10 | 10  | 4 | 60 | 283 | 7711  | 12859 | 12859  | 5.37 | 3.3 | \$ | 1,507.40 | \$ | 334.15 | \$ | 1,841.55 | \$ | 1,312.43 | \$ | 1,500.00  | \$ | (970.86)    |
| 8146 - BREAK AREA, UNMID SPACEX NEXT TO 8145 | 15  | 301   | 1,065 | 23,704  | 3,763  | 93   | 2015   | 563    | Coating Drien     | 629  | 13596  | 10118 | ACB, LHE | 2  | 10 | 20  | 4 | 50 | 340 | 16380 | 9704  | 19498  | 5.37 | 4.5 | \$ | 2,084.71 | \$ | 334.15 | \$ | 2,398.86 | \$ | 1,312.43 | \$ | 3,000.00  | \$ | (1,913.57)  |
| 7001 - BREAK AREA                            | 29  | 574   | 1,307 | 28,142  | 7,175  | 178  | 3844   | 1064   | Coating Drien     | 1199 | 25886  | 3243  | P-ZBL    | 1  | 6  | 6   | - | 0  | 0   | 3243  | 3207  | 3207   | 2.8  | -   | \$ | 2,084.71 | \$ | 334.15 | \$ | 2,398.86 | \$ | 2,084.71 | \$ | 900.00    | \$ | (565.85)    |
| 7003 - OPEN OFFICE                           | 76  | 3,776 | 5,023 | 111,983 | 15,104 | 604  | 13,300 | 3614   | Coating Drien     | 2525 | 54540  | 57443 | ACB, LHE | 5  | 10 | 50  | 5 | 70 | 465 | 61763 | 17192 | 85560  | 2.5  | 2.7 | \$ | 2,502.25 | \$ | 334.15 | \$ | 2,836.40 | \$ | 2,502.25 | \$ | 7,500.00  | \$ | (7,165.95)  |
| 7011 - MEDIUM CONFERENCE                     | 18  | 368   | 1,391 | 35,253  | 2,242  | 114  | 2464   | 682    | Coating Drien     | 381  | 8220   | 27624 | ACB, LHE | 2  | 10 | 20  | 4 | 80 | 465 | 15165 | 17192 | 34384  | 5.37 | 2   | \$ | 2,286.07 | \$ | 334.15 | \$ | 2,620.22 | \$ | 1,759.98 | \$ | 3,000.00  | \$ | (2,139.76)  |
| 7015 - OFFICE, 7017 - OFFICE, 7019 - OFFICE  | 3   | 383   | 1,219 | 27,173  | 536    | 36   | 786    | 218    | Coating Drien     | 91   | 1944   | 25229 | ACB, LHE | 3  | 6  | 18  | 5 | 50 | 155 | 19425 | 7748  | 23244  | 3.51 | 3.6 | \$ | 2,084.71 | \$ | 334.15 | \$ | 2,398.86 | \$ | 1,507.40 | \$ | 2,700.00  | \$ | (1,888.54)  |
| 7025 - OFFICE, 7027 - OFFICE                 | 2   | 265   | 812   | 18,112  | 397    | 24   | 523    | 145    | Coating Drien     | 60   | 1236   | 18916 | ACB, LHE | 2  | 8  | 16  | 4 | 10 | 147 | 11761 | 8911  | 17982  | 4.46 | 3.6 | \$ | 1,759.98 | \$ | 334.15 | \$ | 2,094.13 | \$ | 1,312.43 | \$ | 2,400.00  | \$ | (1,618.30)  |

|  |     |       |        |         |        |      |        |        |                  |      |        |        |        |    |    |     |      |    |     |      |       |       |        |      |     |             |           |             |             |              |                |
|--|-----|-------|--------|---------|--------|------|--------|--------|------------------|------|--------|--------|--------|----|----|-----|------|----|-----|------|-------|-------|--------|------|-----|-------------|-----------|-------------|-------------|--------------|----------------|
| 7001- SMALL CONFERENCE                 | 9   | 181   | 710    | 15,827  | 1,122  | 56   | 122    | 336    | Coing/Dien       | 186  | 461    | 1766   | A02LHE | 1  | 8  | 8   | 4x10 | 80 | 275 | 275  | 987   | 11284 | 11284  | 4.86 | 2   | \$ 1,507.40 | \$ 394.15 | \$ 1,841.55 | \$ 1,372.45 | \$ 1,200.00  | \$ (670.08)    |
| 7045- R4D                              | 46  | 1,510 | 5,659  | 128,185 | 11,338 | 2718 | 53709  | 162610 | Ventilation/Dien | 2718 | 53709  | 67459  | A02LHE | 6  | 10 | 60  | 4x10 | 80 | 465 | 2700 | 63001 | 17192 | 103192 | 5.37 | 2   | \$ 2,502.25 | \$ 394.15 | \$ 2,838.40 | \$ 2,502.25 | \$ 9,000.00  | \$ (8,665.65)  |
| 7065- ION DETECTION                    | 34  | 1,132 | 2,466  | 55,655  | 8,488  | 2038 | 44072  | 12189  | Ventilation/Dien | 2038 | 44072  | 1162   | A02LHE | 5  | 10 | 50  | 4x10 | 80 | 465 | 2205 | 5435  | 17192 | 86960  | 5.37 | 2   | \$ 2,502.25 | \$ 394.15 | \$ 2,838.40 | \$ 2,502.25 | \$ 7,500.00  | \$ (7,165.65)  |
| 7067- BREAKING RM                      | 8   | 248   | 853    | 19,072  | 1,862  | 446  | 9642   | 2670   | Ventilation/Dien | 446  | 9642   | 970    | A02LHE | 2  | 10 | 20  | 4x7  | 50 | 170 | 340  | 1168  | 9704  | 19408  | 5.37 | 4.5 | \$ 1,750.08 | \$ 394.15 | \$ 2,044.13 | \$ 1,972.45 | \$ 3,000.00  | \$ (2,218.50)  |
| 7069- GOWNING RM                       | 7   | 218   | 793    | 17,671  | 1,837  | 392  | 8476   | 2547   | Ventilation/Dien | 392  | 8476   | 916    | A02LHE | 1  | 10 | 170 | 4x10 | 80 | 465 | 465  | 7637  | 17192 | 17192  | 5.37 | 2   | \$ 1,507.40 | \$ 394.15 | \$ 1,841.55 | \$ 1,507.40 | \$ 2,500.00  | \$ (25,165.65) |
| 7065- ILLUMINA                         | 55  | 1,831 | 5,223  | 116,435 | 13,746 | 3266 | 71188  | 19716  | Ventilation/Dien | 3266 | 71188  | 4294   | A02LHE | 8  | 10 | 170 | 4x10 | 80 | 465 | 3720 | 36083 | 17192 | 107336 | 5.37 | 2   | \$ 2,502.25 | \$ 394.15 | \$ 2,838.40 | \$ 2,502.25 | \$ 2,500.00  | \$ (25,165.65) |
| 7075- SAMPLE PREP                      | 101 | 3,326 | 6,822  | 146,953 | 24,970 | 5987 | 129315 | 38914  | Ventilation/Dien | 5987 | 129315 | 1849   | A02LHE | 22 | 10 | 220 | 4x10 | 60 | 283 | 6226 | 14481 | 12859 | 282898 | 5.37 | 3.3 | \$ 2,502.25 | \$ 394.15 | \$ 2,838.40 | \$ 2,502.25 | \$ 33,000.00 | \$ (32,665.65) |
| 7085- CLEAN SAMPLE 2                   | 28  | 914   | 3,254  | 72,556  | 6,862  | 3200 | 69120  | 19143  | Ventilation/Dien | 3200 | 69120  | 3461   | A02LHE | 3  | 10 | 170 | 4x10 | 80 | 465 | 1395 | 4264  | 17192 | 91576  | 5.37 | 2   | \$ 2,502.25 | \$ 394.15 | \$ 2,838.40 | \$ 2,084.71 | \$ 2,500.00  | \$ (24,238.01) |
| 7085- CLEAN SAMPLE 1                   | 42  | 1,373 | 4,525  | 109,793 | 10,388 | 4000 | 86400  | 28292  | Ventilation/Dien | 4000 | 86400  | 2333   | A02LHE | 5  | 10 | 170 | 4x10 | 80 | 465 | 2205 | 55573 | 17192 | 86960  | 5.37 | 2   | \$ 2,502.25 | \$ 394.15 | \$ 2,838.40 | \$ 2,502.25 | \$ 2,500.00  | \$ (25,165.65) |
| 7105- SINGLE CELL PCR                  | 15  | 494   | 1,622  | 37,052  | 3,709  | 889  | 19307  | 5318   | Ventilation/Dien | 889  | 19307  | 1765   | A02LHE | 2  | 10 | 20  | 4x10 | 80 | 465 | 930  | 1694  | 17192 | 34384  | 5.37 | 2   | \$ 2,286.07 | \$ 394.15 | \$ 2,620.22 | \$ 1,799.88 | \$ 3,000.00  | \$ (2,139.76)  |
| 7115- B12                              | 7   | 240   | 812    | 18,114  | 1,802  | 632  | 9301   | 2564   | Ventilation/Dien | 632  | 9301   | 873    | A02LHE | 2  | 10 | 20  | 4x10 | 60 | 283 | 566  | 3688  | 12859 | 25716  | 5.37 | 3.3 | \$ 1,750.08 | \$ 394.15 | \$ 2,044.13 | \$ 1,507.40 | \$ 3,000.00  | \$ (2,413.27)  |
| 7119- GOWNING RM                       | 7   | 242   | 816    | 18,202  | 1,817  | 636  | 9408   | 2606   | Ventilation/Dien | 636  | 9408   | 873    | A02LHE | 2  | 10 | 20  | 4x10 | 60 | 283 | 566  | 3678  | 12859 | 25718  | 5.37 | 3.3 | \$ 1,750.08 | \$ 394.15 | \$ 2,044.13 | \$ 1,507.40 | \$ 3,000.00  | \$ (2,413.27)  |
| 7121- SMALL CONFERENCE                 | 9   | 188   | 599    | 13,390  | 1,457  | 59   | 1269   | 349    | Coing/Dien       | 244  | 570    | 879    | A02LHE | 1  | 10 | 10  | 4x10 | 60 | 283 | 283  | 7237  | 12859 | 10959  | 5.37 | 3.3 | \$ 1,507.40 | \$ 394.15 | \$ 1,841.55 | \$ 1,372.45 | \$ 1,500.00  | \$ (970.88)    |
| 8008- OFFICE 8000- OFFICE 8002- OFFICE | 3   | 394   | 216    | 4,814   | 551    | 37   | 886    | 224    | Coing/Dien       | 92   | 1987   | 2627   | A02LHE | 3  | 4  | 12  | 5    | 48 | 37  | 111  | 2417  | 3497  | 10111  | 2.5  | 5.7 | \$ 1,372.45 | \$ 205.33 | \$ 1,577.75 | \$ 1,089.73 | \$ 1,800.00  | \$ (1,351.98)  |
| 8009- OFFICE 8007- OFFICE 8011- OFFICE | 3   | 400   | 1,411  | 31,451  | 685    | 47   | 1005   | 278    | Coing/Dien       | 115  | 2484   | 2687   | A02LHE | 3  | 10 | 30  | 4x7  | 50 | 170 | 510  | 20453 | 9704  | 28112  | 5.37 | 4.5 | \$ 2,084.71 | \$ 394.15 | \$ 2,398.86 | \$ 1,507.40 | \$ 4,500.00  | \$ (3,688.94)  |
| 8013- OFFICE                           | 2   | 209   | 916    | 20,415  | 117    | 23   | 487    | 135    | Ventilation/Dien | 23   | 487    | 1929   | A02LHE | 2  | 6  | 12  | 4x10 | 80 | 202 | 404  | 1168  | 8588  | 17196  | 3.51 | 2   | \$ 1,750.08 | \$ 394.15 | \$ 2,044.13 | \$ 1,507.40 | \$ 1,800.00  | \$ (1,213.27)  |
| 8014- TISSUE CULTURE ROOM              | 8   | 252   | 887    | 19,338  | 1,514  | 464  | 9798   | 2714   | Ventilation/Dien | 464  | 9798   | 954    | A02LHE | 1  | 10 | 10  | 4x10 | 80 | 465 | 465  | 9294  | 17192 | 17192  | 5.37 | 2   | \$ 1,750.08 | \$ 394.15 | \$ 2,044.13 | \$ 1,507.40 | \$ 1,500.00  | \$ (913.27)    |
| 8015- SMALL CONFERENCE                 | 11  | 223   | 974    | 21,704  | 1,728  | 69   | 1483   | 414    | Coing/Dien       | 289  | 6242   | 1642   | A02LHE | 2  | 8  | 16  | 4x10 | 40 | 147 | 294  | 15354 | 8891  | 17982  | 4.46 | 3.6 | \$ 1,750.08 | \$ 394.15 | \$ 2,044.13 | \$ 1,372.45 | \$ 2,400.00  | \$ (1,618.30)  |
| 8025- BSP PRE LAB                      | 96  | 3,160 | 10,317 | 230,025 | 23,724 | 5698 | 122861 | 34027  | Ventilation/Dien | 5698 | 122861 | 107164 | A02LHE | 20 | 10 | 200 | 4x10 | 80 | 465 | 9300 | 29145 | 17192 | 343840 | 5.37 | 2   | \$ 2,502.25 | \$ 394.15 | \$ 2,838.40 | \$ 2,502.25 | \$ 30,000.00 | \$ (29,665.65) |
| 8028- RT'S ROOM                        | 15  | 489   | 982    | 21,901  | 3,671  | 226  | 5102   | 1413   | Coing/Dien       | 614  | 13802  | 863    | A02LHE | 2  | 10 | 20  | 4x10 | 80 | 465 | 930  | 1613  | 17192 | 34384  | 5.37 | 2   | \$ 1,750.08 | \$ 394.15 | \$ 2,044.13 | \$ 1,799.88 | \$ 3,000.00  | \$ (2,665.65)  |
| 8029- BSP POST PCR                     | 11  | 380   | 1,598  | 35,398  | 2,638  | 900  | 19440  | 5364   | Ventilation/Dien | 900  | 19440  | 1656   | A02LHE | 2  | 10 | 20  | 4x10 | 80 | 465 | 930  | 15308 | 17192 | 34384  | 5.37 | 2   | \$ 2,286.07 | \$ 394.15 | \$ 2,620.22 | \$ 1,799.88 | \$ 3,000.00  | \$ (2,139.76)  |
| 8033- LAB DESKS                        | 3   | 174   | 198    | 3,512   | 696    | 28   | 601    | 167    | Coing/Dien       | 116  | 2566   | 1005   | A02LHE | 1  | 4  | 4   | 5    | 70 | 125 | 125  | 812   | 5967  | 5967   | 2.5  | 2.7 | \$ 1,089.73 | \$ 205.33 | \$ 1,275.06 | \$ 1,089.73 | \$ 600.00    | \$ (394.68)    |
| 8035- LAB DESKS                        | 4   | 196   | 166    | 3,693   | 595    | 30   | 643    | 178    | Coing/Dien       | 99   | 2138   | 154    | A02LHE | 1  | 4  | 4   | 5    | 70 | 125 | 125  | 983   | 5967  | 5967   | 2.5  | 2.7 | \$ 1,089.73 | \$ 205.33 | \$ 1,275.06 | \$ 1,089.73 | \$ 600.00    | \$ (394.68)    |
| 8037- LAB DESKS                        | 4   | 209   | 311    | 6,833   | 251    | 33   | 722    | 200    | Coing/Dien       | 42   | 907    | 606    | A02LHE | 2  | 4  | 8   | 5    | 20 | 37  | 74   | 5335  | 3497  | 6874   | 2.5  | 5.7 | \$ 1,372.45 | \$ 394.15 | \$ 1,841.55 | \$ 1,089.73 | \$ 1,200.00  | \$ (822.16)    |

|  |     |       |        |         |        |      |        |       |                   |      |        |        |        |    |    |     |      |    |     |      |        |       |       |     |     |             |             |             |             |             |               |                |
|--|-----|-------|--------|---------|--------|------|--------|-------|-------------------|------|--------|--------|--------|----|----|-----|------|----|-----|------|--------|-------|-------|-----|-----|-------------|-------------|-------------|-------------|-------------|---------------|----------------|
| 805- LAB DESKS                         | 4   | 210   | 1,662  | 37,194  | 940    | 34   | 726    | 201   | Coring Drien      | 140  | 3204   | 39470  | ACB,HE | 2  | 8  | 16  | 4x10 | 80 | 393 | 726  | 21613  | 13909 | 27918 | 446 | 2   | \$ 2,286.07 | \$ 334.15   | \$ 2,620.22 | \$ 1,507.40 | \$ 2,400.00 | \$ (1,287.16) |                |
| 805- LAB MANAGERS                      | 3   | 388   | 282    | 6,584   | 435    | 37   | 798    | 221   | Coring Drien      | 73   | 1577   | 4927   | ACB,HE | 3  | 4  | 12  | 5    | 50 | 38  | 114  | 4842   | 2705  | 8115  | 253 | 3.6 | \$          | \$ 1,912.45 | \$ 265.53   | \$ 1,517.75 | \$ 1,089.73 | \$ 1,800.00   | \$ (1,351.98)  |
| 805- PROJECT MANAGERS OFFICE           | 2   | 242   | 214    | 4,774   | 338    | 23   | 485    | 137   | Coring Drien      | 57   | 1231   | 3543   | P,CSL  | 1  | 6  | 6   | -    | -  | 0   | 0    | 3543   | 3307  | 3037  | 283 | -   | \$          | \$ 1,912.45 | \$ 265.53   | \$ 1,517.75 | \$ 1,089.73 | \$ 900.00     | \$ (461.98)    |
| 805- POST PCR CAP LAB                  | 135 | 4,451 | 12,701 | 283,155 | 3,3416 | 8012 | 179355 | 47929 | Ventilation Drien | 8012 | 179355 | 110100 | ACB,HE | 11 | 10 | 110 | 4x10 | 80 | 465 | 5115 | 172671 | 17192 | 18812 | 537 | 2   | \$          | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 2,502.25 | \$ 16,200.00  | \$ (16,165.66) |
| 805- PRE PCR WHOLE GENOME              | 23  | 746   | 2,205  | 48,160  | 5,601  | 1343 | 23004  | 8033  | Ventilation Drien | 1343 | 29004  | 20555  | ACB,HE | 4  | 8  | 32  | 4x10 | 40 | 147 | 588  | 36459  | 8991  | 35964 | 448 | 3.6 | \$          | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 1,507.40 | \$ 4,800.00   | \$ (3,471.00)  |
| 805- PRE PCR EXPRESSION                | 9   | 312   | 891    | 21,861  | 2,342  | 582  | 12131  | 3380  | Ventilation Drien | 582  | 12131  | 9731   | ACB,HE | 2  | 8  | 16  | 4x10 | 80 | 393 | 726  | 6180   | 13909 | 27918 | 446 | 2   | \$          | \$ 1,793.98 | \$ 334.15   | \$ 2,094.13 | \$ 1,507.40 | \$ 2,400.00   | \$ (1,613.27)  |
| 805- LAB SUPPORT                       | 3   | 133   | 267    | 5,957   | 998    | 21   | 460    | 127   | Coring Drien      | 167  | 3607   | 2350   | P,CSL  | 1  | 6  | 6   | -    | -  | 0   | 0    | 2350   | 3307  | 3037  | 283 | -   | \$          | \$ 1,912.45 | \$ 265.53   | \$ 1,517.75 | \$ 1,089.73 | \$ 900.00     | \$ (461.98)    |
| 805- PRE PCR COMPLEX                   | 29  | 957   | 3,356  | 74,426  | 7,105  | 1723 | 37228  | 10305 | Ventilation Drien | 1723 | 37228  | 37618  | ACB,HE | 4  | 10 | 40  | 4x10 | 80 | 465 | 1880 | 34650  | 17192 | 89768 | 537 | 2   | \$          | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 2,286.07 | \$ 6,000.00   | \$ (5,449.07)  |
| 807- OFFICE                            | 1   | 185   | 688    | 15,163  | 273    | 19   | 400    | 111   | Coring Drien      | 46   | 994    | 14169  | ACB,HE | 1  | 8  | 8   | 4x10 | 80 | 226 | 226  | 10281  | 10718 | 10718 | 446 | 3.3 | \$          | \$ 1,507.40 | \$ 334.15   | \$ 1,941.55 | \$ 1,912.45 | \$ 1,200.00   | \$ (670.08)    |
| 808- OFFICE 8105- OFFICE               | 2   | 260   | 907    | 20,216  | 364    | 25   | 533    | 148   | Coring Drien      | 61   | 1318   | 18888  | ACB,HE | 2  | 6  | 12  | 5    | 50 | 155 | 270  | 14384  | 7748  | 15498 | 351 | 3.6 | \$          | \$ 1,793.98 | \$ 334.15   | \$ 2,094.13 | \$ 1,912.45 | \$ 1,800.00   | \$ (1,018.30)  |
| 900- OFFICE 9007- OFFICE, 9011- OFFICE | 3   | 300   | 1,361  | 30,335  | 545    | 37   | 800    | 222   | Coring Drien      | 91   | 1966   | 28970  | ACB,HE | 3  | 8  | 24  | 4x10 | 50 | 177 | 531  | 18866  | 9664  | 26992 | 446 | 3.6 | \$          | \$ 2,084.71 | \$ 334.15   | \$ 2,398.86 | \$ 1,507.40 | \$ 3,000.00   | \$ (2,718.94)  |
| 901- OFFICE                            | 2   | 276   | 1,033  | 23,040  | 309    | 26   | 556    | 157   | Coring Drien      | 52   | 1123   | 21917  | ACB,HE | 2  | 6  | 12  | 4x10 | 80 | 202 | 404  | 14314  | 8588  | 17138 | 351 | 2   | \$          | \$ 2,084.71 | \$ 334.15   | \$ 2,398.86 | \$ 1,507.40 | \$ 1,800.00   | \$ (908.54)    |
| 901- OFFICE 9016- OFFICE, 9018- OFFICE | 2   | 327   | 179    | 3,996   | 457    | 31   | 671    | 186   | Coring Drien      | 76   | 1642   | 2354   | ACB,HE | 3  | 4  | 12  | 5    | 40 | 37  | 111  | 1598   | 3437  | 10311 | 253 | 5.7 | \$          | \$ 1,089.73 | \$ 265.53   | \$ 1,275.06 | \$ 1,089.73 | \$ 1,800.00   | \$ (1,584.68)  |
| 901- OFFICE 9015- OFFICE               | 2   | 306   | 1,011  | 22,529  | 451    | 29   | 632    | 175   | Coring Drien      | 72   | 1555   | 20974  | ACB,HE | 2  | 8  | 16  | 4x7  | 60 | 173 | 346  | 15056  | 8928  | 17896 | 446 | 3.3 | \$          | \$ 2,084.71 | \$ 334.15   | \$ 2,398.86 | \$ 1,912.45 | \$ 2,400.00   | \$ (1,313.57)  |
| 902- OFFICE 9016- OFFICE               | 2   | 260   | 815    | 18,165  | 364    | 25   | 533    | 148   | Coring Drien      | 61   | 1318   | 18948  | ACB,HE | 2  | 8  | 16  | 4x10 | 40 | 147 | 284  | 11615  | 8991  | 17962 | 446 | 3.6 | \$          | \$ 1,793.98 | \$ 334.15   | \$ 2,094.13 | \$ 1,912.45 | \$ 2,400.00   | \$ (1,618.30)  |
| 902- OFFICE 9005- OFFICE               | 2   | 336   | 184    | 4,106   | 470    | 32   | 689    | 191   | Coring Drien      | 79   | 1706   | 2389   | ACB,HE | 2  | 4  | 8   | 5    | 50 | 38  | 76   | 2464   | 2705  | 8410  | 253 | 3.6 | \$          | \$ 1,089.73 | \$ 265.53   | \$ 1,275.06 | \$ 1,089.73 | \$ 1,200.00   | \$ (984.68)    |
| 902- OFFICE 9029- OFFICE               | 2   | 355   | 1,628  | 36,398  | 497    | 34   | 728    | 202   | Coring Drien      | 728  | 15882  | 20917  | ACB,HE | 2  | 8  | 16  | 4x10 | 80 | 393 | 726  | 20617  | 13909 | 27918 | 446 | 2   | \$          | \$ 2,286.07 | \$ 334.15   | \$ 2,620.22 | \$ 1,507.40 | \$ 2,400.00   | \$ (1,287.16)  |
| 905- OFFICE 9024- OFFICE, 9028- OFFICE | 4   | 540   | 256    | 6,598   | 755    | 51   | 1108   | 307   | Coring Drien      | 126  | 2722   | 3977   | P,CSL  | 3  | 4  | 12  | -    | -  | 0   | 0    | 3977   | 2138  | 6414  | 283 | -   | \$          | \$ 1,912.45 | \$ 265.53   | \$ 1,517.75 | \$ 1,089.73 | \$ 1,800.00   | \$ (1,351.98)  |
| 902- OFFICE 9003- OFFICE               | 2   | 316   | 173    | 3,861   | 442    | 30   | 646    | 180   | Coring Drien      | 74   | 1598   | 2363   | ACB,HE | 2  | 4  | 8   | 5    | 20 | 37  | 74   | 2263   | 3437  | 8974  | 253 | 5.7 | \$          | \$ 1,089.73 | \$ 265.53   | \$ 1,275.06 | \$ 1,089.73 | \$ 1,200.00   | \$ (984.68)    |
| 901- LARGE CONFERENCE                  | 22  | 433   | 2,419  | 53,337  | 3,336  | 134  | 2889   | 803   | Coring Drien      | 561  | 12118  | 41919  | ACB,HE | 4  | 8  | 32  | 4x10 | 70 | 265 | 820  | 36225  | 9563  | 38322 | 446 | 2.7 | \$          | \$ 2,502.25 | \$ 334.15   | \$ 2,836.40 | \$ 1,799.98 | \$ 4,800.00   | \$ (3,723.98)  |
| 901- OFFICE 9044- OFFICE               | 2   | 270   | 220    | 5,124   | 376    | 26   | 594    | 153   | Coring Drien      | 63   | 1361   | 3763   | ACB,HE | 2  | 4  | 8   | 5    | 20 | 37  | 74   | 3526   | 3437  | 8974  | 253 | 5.7 | \$          | \$ 1,912.45 | \$ 265.53   | \$ 1,517.75 | \$ 1,089.73 | \$ 1,200.00   | \$ (751.98)    |
| 904- OFFICE 9055- OFFICE               | 2   | 260   | 142    | 3,177   | 364    | 25   | 533    | 148   | Coring Drien      | 61   | 1318   | 1899   | ACB,HE | 2  | 4  | 8   | 5    | 20 | 37  | 74   | 1579   | 3437  | 8974  | 253 | 5.7 | \$          | \$ 1,089.73 | \$ 265.53   | \$ 1,275.06 | \$ 1,089.73 | \$ 1,200.00   | \$ (984.68)    |
| 905- OFFICE                            | 2   | 255   | 1,443  | 32,163  | 107    | 24   | 523    | 145   | Ventilation Drien | 24   | 523    | 31640  | ACB,HE | 2  | 6  | 12  | 4x10 | 80 | 266 | 532  | 20672  | 10997 | 21194 | 237 | 2   | \$          | \$ 2,084.71 | \$ 334.15   | \$ 2,398.86 | \$ 1,507.40 | \$ 1,800.00   | \$ (908.54)    |
| 907- OFFICE 9055- OFFICE               | 2   | 273   | 1,584  | 35,316  | 382    | 26   | 590    | 155   | Coring Drien      | 64   | 1382   | 33933  | ACB,HE | 2  | 4  | 8   | 5    | 20 | 37  | 74   | 33717  | 3437  | 8974  | 253 | 5.7 | \$          | \$ 2,286.07 | \$ 334.15   | \$ 2,620.22 | \$ 1,089.73 | \$ 1,200.00   | \$ 350.49      |

|  |     |         |         |           |         |       |       |        |                  |        |        |        |         |   |    |    |      |    |     |       |       |       |      |     |             |           |             |             |             |                   |
|--|-----|---------|---------|-----------|---------|-------|-------|--------|------------------|--------|--------|--------|---------|---|----|----|------|----|-----|-------|-------|-------|------|-----|-------------|-----------|-------------|-------------|-------------|-------------------|
| 982- ERHYS ROOM                                | 5   | 180     | 382     | 8,062     | 1,351   | 324   | 688   | 1,038  | Ventilation Duct | 24     | 688    | 103    | PCBL    | 1 | 4  | 4  | -    | 0  | 0   | 183   | 218   | 218   | 23   | -   | \$ 1,372.45 | \$ 384.15 | \$ 1,666.58 | \$ 1,372.45 | \$ 800.00   | \$ (265.95)       |
| 986- MICROSCOPY IMAGING                        | 6   | 188     | 378     | 8,420     | 1,411   | 333   | 709   | 2,024  | Ventilation Duct | 33     | 709    | 111    | PCBL    | 1 | 4  | 4  | -    | 0  | 0   | 1111  | 218   | 218   | 23   | -   | \$ 1,372.45 | \$ 384.15 | \$ 1,666.58 | \$ 1,372.45 | \$ 800.00   | \$ (265.95)       |
| 987- BL2 + TISSUE CULTURE ROOM                 | 13  | 421     | 846     | 18,886    | 3,161   | 759   | 1638  | 4,533  | Ventilation Duct | 79     | 1638   | 247    | PCBL    | 1 | 6  | 6  | -    | 0  | 0   | 2,487 | 3207  | 3207  | 2,08 | -   | \$ 1,759.98 | \$ 384.15 | \$ 2,084.13 | \$ 1,507.40 | \$ 900.00   | \$ (912.27)       |
| 987- TISSUE CULTURE ROOM                       | 8   | 280     | 564     | 21,487    | 1,882   | 514   | 1086  | 3,015  | Ventilation Duct | 514    | 1086   | 1801   | AC2H-HE | 1 | 10 | 10 | 4x10 | 80 | 355 | 13819 | 14887 | 14887 | 5,37 | 2   | \$ 1,759.98 | \$ 384.15 | \$ 2,084.13 | \$ 1,372.45 | \$ 1,500.00 | \$ (718.20)       |
| 987- TISSUE CULTURE ROOM                       | 15  | 484     | 1,819   | 48,547    | 2,987   | 871   | 1888  | 5,212  | Ventilation Duct | 871    | 1888   | 2729   | AC2H-HE | 2 | 8  | 16 | 4x10 | 80 | 353 | 2686  | 13880 | 2788  | 4,6  | 2   | \$ 2,286.07 | \$ 384.15 | \$ 2,620.22 | \$ 1,507.40 | \$ 2,400.00 | \$ (1,287.18)     |
| 987- PROCEDURE ROOM                            | 7   | 224     | 450     | 10,022    | 1,882   | 403   | 879   | 2,412  | Ventilation Duct | 403    | 879    | 123    | PCBL    | 1 | 4  | 4  | -    | 0  | 0   | 1,323 | 218   | 218   | 23   | -   | \$ 1,507.40 | \$ 384.15 | \$ 1,841.55 | \$ 1,507.40 | \$ 800.00   | \$ (265.95)       |
| 988- LAB DESKS, 981- LAB DESKS, 982- LAB DESKS | 9   | 480     | 574     | 12,786    | 1,840   | 74    | 653   | 440    | Coring Duct      | 338    | 653    | 614    | PCBL    | 2 | 6  | 12 | -    | 0  | 0   | 614   | 3207  | 844   | 23   | -   | \$ 1,507.40 | \$ 384.15 | \$ 1,841.55 | \$ 1,372.45 | \$ 1,800.00 | \$ (1,270.88)     |
| 987- LAB DESKS, 985- LAB DESKS                 | 9   | 422     | 454     | 10,122    | 1,728   | 69    | 622   | 413    | Coring Duct      | 289    | 622    | 380    | PCBL    | 2 | 4  | 8  | -    | 0  | 0   | 380   | 218   | 4276  | 23   | -   | \$ 1,507.40 | \$ 384.15 | \$ 1,841.55 | \$ 1,372.45 | \$ 1,200.00 | \$ (670.88)       |
| 988- LAB DESKS                                 | 9   | 422     | 467     | 15,337    | 1,728   | 69    | 622   | 413    | Coring Duct      | 289    | 622    | 1304   | AC2H-HE | 2 | 8  | 16 | 4x10 | 40 | 147 | 1,286 | 8891  | 1782  | 4,6  | 3,6 | \$ 1,759.98 | \$ 384.15 | \$ 2,084.13 | \$ 1,372.45 | \$ 2,400.00 | \$ (1,618.20)     |
| 989- OFFICE                                    | 1   | 288     | 889     | 18,086    | 87      | 20    | 427   | 118    | Ventilation Duct | 21     | 427    | 1705   | AC2H-HE | 1 | 10 | 10 | 4x10 | 80 | 283 | 1923  | 12859 | 1889  | 5,37 | 3,3 | \$ 1,759.98 | \$ 384.15 | \$ 2,084.13 | \$ 1,372.45 | \$ 1,500.00 | \$ (718.20)       |
| 989- OFFICE, 985- OFFICE, 987- OFFICE          | 3   | 389     | 1,365   | 30,425    | 588     | 33    | 208   | 227    | Coring Duct      | 83     | 208    | 2816   | AC2H-HE | 3 | 6  | 18 | 5    | 50 | 465 | 2,077 | 7748  | 2244  | 3,51 | 3,6 | \$ 2,064.71 | \$ 384.15 | \$ 2,388.86 | \$ 1,507.40 | \$ 2,700.00 | \$ (1,888.54)     |
| 981- BREAK                                     | 14  | 270     | 1,842   | 21,226    | 2,700   | 84    | 972   | 511    | Coring Duct      | 451    | 972    | 1544   | AC2H-HE | 1 | 10 | 10 | 4x10 | 80 | 465 | 1519  | 17192 | 17192 | 2,27 | 2   | \$ 2,064.71 | \$ 384.15 | \$ 2,388.86 | \$ 1,507.40 | \$ 1,500.00 | \$ (688.54)       |
| 985- OFFICE                                    | 1   | 148     | 462     | 10,389    | 287     | 14    | 34    | 84     | Coring Duct      | 35     | 76     | 953    | AC2H-HE | 1 | 6  | 6  | 5    | 50 | 135 | 733   | 7748  | 7748  | 3,51 | 4,5 | \$ 1,507.40 | \$ 384.15 | \$ 1,841.55 | \$ 1,082.73 | \$ 900.00   | \$ (28.18)        |
| 987- SMALL CONFERENCE                          | 11  | 219     | 880     | 19,171    | 1,887   | 68    | 614   | 405    | Coring Duct      | 284    | 614    | 1307   | AC2H-HE | 1 | 10 | 10 | 4x10 | 80 | 465 | 917   | 17192 | 17192 | 2,27 | 2   | \$ 1,759.98 | \$ 384.15 | \$ 2,084.13 | \$ 1,507.40 | \$ 1,500.00 | \$ (912.27)       |
| AU   | 234 | 114,489 | 382,285 | 6,738,559 | 665,242 | 17537 | 37880 | 10,811 | Coring Duct      | 101192 | 216521 | 453207 |         |   |    |    |      |    |     |       |       |       |      |     |             |           |             |             |             | \$ (5,651,040.41) |

## Performance Data - (2 Pipe) Cooling

ACBL-HE, 2 way, 24 inch - (2 pipe) Cooling

| Unit Length ft | Inlet Size | Nozzle Size | Air Flow cfm Total (Primary) | Plenum Static Pressure in. | Sound NC | Capacity - 2 Pipe |                               |             |                               | Induction Ratio | Throw ft |
|----------------|------------|-------------|------------------------------|----------------------------|----------|-------------------|-------------------------------|-------------|-------------------------------|-----------------|----------|
|                |            |             |                              |                            |          | Cooling           |                               |             | Head Loss ft H <sub>2</sub> O |                 |          |
|                |            |             |                              |                            |          | Coil Btu/h        | Transfer Efficiency Btu/h cfm | Total Btu/h |                               |                 |          |
| 4 ft           | 5          | 10          | 13                           | 0.20                       | --       | 1541              | 119                           | 1794        | 2.50                          | 6.2             | 0-1-4    |
|                | 5          |             | 22                           | 0.50                       | --       | 2084              | 95                            | 2512        |                               | 6.2             | 1-3-8    |
|                | 5          |             | 29                           | 0.80                       | --       | 2423              | 84                            | 2983        |                               | 6.2             | 2-4-11   |
|                | 5          | 20          | 17                           | 0.20                       | --       | 1567              | 94                            | 1891        |                               | 5.7             | 1-1-5    |
|                | 5          |             | 28                           | 0.50                       | --       | 2269              | 81                            | 2814        |                               | 5.7             | 2-4-10   |
|                | 5          |             | 37                           | 0.80                       | 18       | 2724              | 74                            | 3437        |                               | 5.7             | 3-6-13   |
|                | 5          | 30          | 20                           | 0.20                       | --       | 1523              | 76                            | 1914        |                               | 5.3             | 1-2-6    |
|                | 5          |             | 35                           | 0.50                       | --       | 2363              | 68                            | 3035        |                               | 5.3             | 2-5-11   |
|                | 5          |             | 45                           | 0.80                       | 21       | 2927              | 64                            | 3811        |                               | 5.3             | 4-7-14   |
|                | 5          | 40          | 32                           | 0.20                       | --       | 1971              | 62                            | 2594        |                               | 4.5             | 1-3-9    |
|                | 5          |             | 54                           | 0.50                       | 22       | 2822              | 52                            | 3874        |                               | 4.5             | 4-8-14   |
|                | 5          |             | 71                           | 0.80                       | 28       | 3378              | 48                            | 4760        |                               | 4.5             | 7-10-16  |
|                | 5          | 50          | 38                           | 0.20                       | --       | 1965              | 52                            | 2705        |                               | 3.6             | 1-3-9    |
|                | 5          |             | 65                           | 0.50                       | 23       | 2863              | 44                            | 4134        |                               | 3.6             | 4-8-14   |
|                | 5          |             | 86                           | 0.80                       | 29       | 3439              | 40                            | 5113        |                               | 3.6             | 7-10-17  |
|                | 5          | 60          | 50                           | 0.20                       | --       | 2268              | 45                            | 3242        |                               | 3.3             | 2-5-11   |
|                | 5          |             | 85                           | 0.50                       | 27       | 3106              | 37                            | 4761        |                               | 3.3             | 6-10-16  |
|                | 5          |             | 112                          | 0.80                       | 33       | 3633              | 32                            | 5814        |                               | 3.3             | 8-13-18  |
|                | 5          | 70          | 57                           | 0.20                       | 15       | 2161              | 38                            | 3270        |                               | 2.7             | 2-4-11   |
|                | 5          |             | 98                           | 0.50                       | 27       | 2984              | 30                            | 4892        |                               | 2.7             | 6-9-16   |
| 5              | 128        |             | 0.80                         | 33                         | 3475     | 27                | 5967                          | 2.7         | 8-12-18                       |                 |          |
| 5              | 80         | 80          | 0.20                         | 19                         | 2354     | 29                | 3912                          | 2           | 3-6-13                        |                 |          |
| 5              |            | 135         | 0.50                         | 30                         | 3309     | 25                | 5937                          | 2           | 7-11-17                       |                 |          |
| 4x10           |            | 178         | 0.80                         | 34                         | 3928     | 22                | 7393                          | 2           | 9-14-19                       |                 |          |
| 6 ft           | 5          | 10          | 20                           | 0.20                       | --       | 2375              | 119                           | 2764        | 3.51                          | 6.2             | 0-1-4    |
|                | 5          |             | 34                           | 0.50                       | --       | 3172              | 93                            | 3836        |                               | 6.2             | 1-3-11   |
|                | 5          |             | 45                           | 0.80                       | 20       | 3665              | 81                            | 4542        |                               | 6.2             | 2-5-14   |
|                | 5          | 20          | 26                           | 0.20                       | --       | 2498              | 96                            | 3005        |                               | 5.7             | 1-2-6    |
|                | 5          |             | 44                           | 0.50                       | 18       | 3557              | 80                            | 4419        |                               | 5.7             | 2-4-13   |
|                | 5          |             | 58                           | 0.80                       | 25       | 4231              | 72                            | 5368        |                               | 5.7             | 3-8-17   |
|                | 5          | 30          | 31                           | 0.20                       | --       | 2312              | 75                            | 2916        |                               | 5.3             | 1-2-8    |
|                | 5          |             | 53                           | 0.50                       | 21       | 3492              | 66                            | 4524        |                               | 5.3             | 2-6-14   |
|                | 5          |             | 69                           | 0.80                       | 27       | 4230              | 61                            | 5575        |                               | 5.3             | 4-9-17   |
|                | 5          | 40          | 48                           | 0.20                       | 15       | 2884              | 60                            | 3819        |                               | 4.5             | 2-3-11   |
|                | 5          |             | 82                           | 0.50                       | 27       | 4069              | 50                            | 5665        |                               | 4.5             | 4-10-18  |
|                | 4x10       |             | 108                          | 0.80                       | 30       | 4804              | 44                            | 6906        |                               | 4.5             | 8-13-20  |
|                | 5          | 50          | 60                           | 0.20                       | 17       | 3067              | 51                            | 4235        |                               | 3.6             | 2-4-12   |
|                | 5          |             | 103                          | 0.50                       | 29       | 4347              | 42                            | 6352        |                               | 3.6             | 5-10-18  |
|                | 5          |             | 135                          | 0.80                       | 35       | 5120              | 38                            | 7748        |                               | 3.6             | 8-13-21  |
|                | 5          | 60          | 70                           | 0.20                       | 19       | 2957              | 42                            | 4320        |                               | 3.3             | 2-4-13   |
|                | 5          |             | 120                          | 0.50                       | 31       | 4009              | 33                            | 6345        |                               | 3.3             | 6-11-19  |
|                | 4x7        |             | 157                          | 0.80                       | 36       | 4629              | 29                            | 7686        |                               | 3.3             | 10-15-22 |
|                | 5          | 70          | 93                           | 0.20                       | 22       | 3448              | 37                            | 5259        |                               | 2.7             | 3-6-15   |
|                | 5          |             | 157                          | 0.50                       | 34       | 4581              | 29                            | 7638        |                               | 2.7             | 7-13-20  |
| 4x10           | 206        |             | 0.80                         | 37                         | 5261     | 26                | 9272                          | 2.7         | 11-16-23                      |                 |          |
| 5              | 80         | 120         | 0.20                         | 25                         | 3380     | 28                | 5717                          | 2           | 3-6-16                        |                 |          |
| 4x10           |            | 202         | 0.50                         | 32                         | 4635     | 23                | 8568                          | 2           | 8-13-21                       |                 |          |
| 4x10           |            | 266         | 0.80                         | 39                         | 5418     | 20                | 10597                         | 2           | 12-17-24                      |                 |          |

## Performance Data - (2 Pipe) Cooling

### ACBL-HE, 2 way, 24 inch - (2 pipe) Cooling

| Unit Length ft | Inlet Size | Nozzle Size | Air Flow cfm Total (Primary) | Plenum Static Pressure in. | Sound NC | Capacity - 2 Pipe |                               |             |                               | Induction Ratio | Throw ft |
|----------------|------------|-------------|------------------------------|----------------------------|----------|-------------------|-------------------------------|-------------|-------------------------------|-----------------|----------|
|                |            |             |                              |                            |          | Cooling           |                               |             | Head Loss ft H <sub>2</sub> O |                 |          |
|                |            |             |                              |                            |          | Coil Btu/h        | Transfer Efficiency Btu/h cfm | Total Btu/h |                               |                 |          |
| 8 ft           | 5          | 10          | 27                           | 0.20                       | --       | 3136              | 116                           | 3662        | 4.46                          | 6.2             | 0-1-4    |
|                | 5          |             | 46                           | 0.50                       | 19       | 4134              | 89                            | 5034        |                               | 6.2             | 1-3-13   |
|                | 5          |             | 61                           | 0.80                       | 25       | 4735              | 78                            | 5922        |                               | 6.2             | 2-6-17   |
|                | 5          | 20          | 36                           | 0.20                       | --       | 3379              | 94                            | 4080        |                               | 5.7             | 1-2-7    |
|                | 5          |             | 61                           | 0.50                       | 23       | 4692              | 77                            | 5880        |                               | 5.7             | 2-5-16   |
|                | 5          |             | 80                           | 0.80                       | 29       | 5491              | 69                            | 7048        |                               | 5.7             | 4-8-19   |
|                | 5          | 30          | 41                           | 0.20                       | --       | 2986              | 73                            | 3784        |                               | 5.3             | 1-2-8    |
|                | 5          |             | 71                           | 0.50                       | 25       | 4459              | 63                            | 5842        |                               | 5.3             | 3-6-17   |
|                | 5          |             | 93                           | 0.80                       | 31       | 5349              | 58                            | 7160        |                               | 5.3             | 4-10-20  |
|                | 5          | 40          | 66                           | 0.20                       | 19       | 3844              | 58                            | 5129        |                               | 4.5             | 2-4-14   |
|                | 4x7        |             | 112                          | 0.50                       | 30       | 5276              | 47                            | 7456        |                               | 4.5             | 5-11-21  |
|                | 4x10       |             | 147                          | 0.80                       | 35       | 6129              | 42                            | 8991        |                               | 4.5             | 8-15-24  |
|                | 5          | 50          | 80                           | 0.20                       | 20       | 3877              | 48                            | 5435        |                               | 3.6             | 2-4-14   |
|                | 5          |             | 134                          | 0.50                       | 32       | 5314              | 40                            | 7923        |                               | 3.6             | 5-11-21  |
|                | 4x10       |             | 177                          | 0.80                       | 36       | 6218              | 35                            | 9664        |                               | 3.6             | 8-16-24  |
|                | 5          | 60          | 100                          | 0.20                       | 24       | 4190              | 42                            | 6137        |                               | 3.3             | 2-5-16   |
|                | 4x7        |             | 173                          | 0.50                       | 35       | 5560              | 32                            | 8928        |                               | 3.3             | 7-14-23  |
|                | 4x10       |             | 226                          | 0.80                       | 39       | 6318              | 28                            | 10718       |                               | 3.3             | 12-18-26 |
|                | 5          | 70          | 122                          | 0.20                       | 27       | 4277              | 35                            | 6652        |                               | 2.7             | 3-6-17   |
|                | 4x10       |             | 205                          | 0.50                       | 34       | 5572              | 27                            | 9563        |                               | 2.7             | 7-14-23  |
|                | 4x10       |             | 270                          | 0.80                       | 40       | 6345              | 24                            | 11602       |                               | 2.7             | 13-19-26 |
|                | 5          | 80          | 163                          | 0.20                       | 34       | 4420              | 27                            | 7594        |                               | 2               | 3-7-18   |
|                | 4x10       |             | 275                          | 0.50                       | 37       | 5931              | 22                            | 11284       |                               | 2               | 9-16-24  |
|                | 4x10       |             | 363                          | 0.80                       | 43       | 6842              | 19                            | 13909       |                               | 2               | 14-19-28 |
| 10 ft          | 5          | 10          | 34                           | 0.20                       | --       | 3832              | 113                           | 4494        | 5.37                          | 6.2             | 0-1-4    |
|                | 5          |             | 58                           | 0.50                       | 22       | 4986              | 86                            | 6119        |                               | 6.2             | 1-3-13   |
|                | 5          |             | 77                           | 0.80                       | 28       | 5669              | 74                            | 7169        |                               | 6.2             | 2-6-19   |
|                | 5          | 20          | 44                           | 0.20                       | --       | 3993              | 91                            | 4849        |                               | 5.7             | 1-2-6    |
|                | 5          |             | 75                           | 0.50                       | 25       | 5486              | 73                            | 6949        |                               | 5.7             | 2-5-17   |
|                | 5          |             | 99                           | 0.80                       | 32       | 6380              | 64                            | 8307        |                               | 5.7             | 4-8-21   |
|                | 5          | 30          | 53                           | 0.20                       | 16       | 3767              | 71                            | 4799        |                               | 5.3             | 1-2-8    |
|                | 5          |             | 90                           | 0.50                       | 28       | 5427              | 60                            | 7179        |                               | 5.3             | 3-6-20   |
|                | 5          |             | 118                          | 0.80                       | 34       | 6430              | 54                            | 8728        |                               | 5.3             | 4-10-23  |
|                | 5          | 40          | 81                           | 0.20                       | 22       | 4541              | 56                            | 6118        |                               | 4.5             | 2-4-14   |
|                | 4x10       |             | 140                          | 0.50                       | 31       | 6190              | 44                            | 8916        |                               | 4.5             | 5-11-23  |
|                | 4x10       |             | 183                          | 0.80                       | 37       | 7103              | 39                            | 10666       |                               | 4.5             | 8-17-26  |
|                | 5          | 50          | 100                          | 0.20                       | 24       | 4716              | 47                            | 6663        |                               | 3.6             | 2-4-15   |
|                | 4x7        |             | 170                          | 0.50                       | 34       | 6395              | 38                            | 9704        |                               | 3.6             | 5-11-23  |
|                | 4x10       |             | 225                          | 0.80                       | 39       | 7399              | 33                            | 11779       |                               | 3.6             | 9-18-27  |
|                | 5          | 60          | 125                          | 0.20                       | 28       | 4999              | 40                            | 7433        |                               | 3.3             | 2-5-19   |
|                | 4x10       |             | 215                          | 0.50                       | 36       | 6505              | 30                            | 10691       |                               | 3.3             | 7-15-25  |
|                | 4x10       |             | 283                          | 0.80                       | 42       | 7349              | 26                            | 12859       |                               | 3.3             | 12-21-29 |
|                | 5          | 70          | 151                          | 0.20                       | 33       | 5112              | 34                            | 8051        |                               | 2.7             | 3-6-19   |
|                | 4x10       |             | 260                          | 0.50                       | 37       | 6619              | 25                            | 11681       |                               | 2.7             | 7-17-26  |
|                | 4x10       |             | 342                          | 0.80                       | 43       | 7454              | 22                            | 14112       |                               | 2.7             | 13-21-30 |
|                | 5          | 80          | 210                          | 0.20                       | 29       | 5467              | 26                            | 9555        |                               | 2               | 3-7-21   |
|                | 4x10       |             | 355                          | 0.50                       | 41       | 7176              | 20                            | 14087       |                               | 2               | 9-18-27  |
|                | 4x10       |             | 465                          | 0.80                       | 47       | 8139              | 18                            | 17192       |                               | 2               | 16-22-31 |



## Performance Data - (4 Pipe) Cooling

### ACBL-HE, 2 way, 24 inch - (4 pipe) Cooling

| Unit Length ft | Inlet Size | Nozzle Size | Air Flow cfm Total (Primary) | Plenum Static Pressure in. | Sound NC | Capacity - 4 Pipe |                               |             |                               | Induction Ratio | Throw ft |
|----------------|------------|-------------|------------------------------|----------------------------|----------|-------------------|-------------------------------|-------------|-------------------------------|-----------------|----------|
|                |            |             |                              |                            |          | Cooling           |                               |             | Head Loss ft H <sub>2</sub> O |                 |          |
|                |            |             |                              |                            |          | Coil Btu/h        | Transfer Efficiency Btu/h cfm | Total Btu/h |                               |                 |          |
| 4 ft           | 5          | 10          | 13                           | 0.20                       | --       | 1401              | 108                           | 1654        | 2.00                          | 6.2             | 0-1-4    |
|                |            |             | 22                           | 0.50                       | --       | 1895              | 86                            | 2323        |                               | 6.2             | 1-3-8    |
|                |            |             | 29                           | 0.80                       | --       | 2202              | 76                            | 2763        |                               | 6.2             | 2-4-11   |
|                | 5          | 20          | 17                           | 0.20                       | --       | 1425              | 86                            | 1748        |                               | 5.7             | 1-1-5    |
|                |            |             | 28                           | 0.50                       | --       | 2062              | 74                            | 2607        |                               | 5.7             | 2-4-10   |
|                |            |             | 37                           | 0.80                       | 18       | 2477              | 68                            | 3189        |                               | 5.7             | 3-6-13   |
|                | 5          | 30          | 20                           | 0.20                       | --       | 1384              | 69                            | 1776        |                               | 5.3             | 1-2-6    |
|                |            |             | 35                           | 0.50                       | --       | 2148              | 62                            | 2820        |                               | 5.3             | 2-5-11   |
|                |            |             | 45                           | 0.80                       | 21       | 2661              | 59                            | 3545        |                               | 5.3             | 4-7-14   |
|                | 5          | 40          | 32                           | 0.20                       | --       | 1792              | 56                            | 2415        |                               | 4.5             | 1-3-9    |
|                |            |             | 54                           | 0.50                       | 22       | 2566              | 48                            | 3617        |                               | 4.5             | 4-8-14   |
|                |            |             | 71                           | 0.80                       | 28       | 3071              | 43                            | 4453        |                               | 4.5             | 7-10-16  |
|                | 5          | 50          | 38                           | 0.20                       | --       | 1787              | 47                            | 2526        |                               | 3.6             | 1-3-9    |
|                |            |             | 65                           | 0.50                       | 23       | 2603              | 40                            | 3874        |                               | 3.6             | 4-8-14   |
|                |            |             | 86                           | 0.80                       | 29       | 3127              | 36                            | 4801        |                               | 3.6             | 7-10-17  |
|                | 5          | 60          | 50                           | 0.20                       | --       | 2062              | 41                            | 3036        |                               | 3.3             | 2-5-11   |
|                |            |             | 85                           | 0.50                       | 27       | 2824              | 33                            | 4479        |                               | 3.3             | 6-10-16  |
|                |            |             | 112                          | 0.80                       | 33       | 3303              | 29                            | 5484        |                               | 3.3             | 8-13-18  |
|                | 5          | 70          | 57                           | 0.20                       | 15       | 1964              | 34                            | 3074        |                               | 2.7             | 2-4-11   |
|                |            |             | 98                           | 0.50                       | 27       | 2712              | 28                            | 4620        |                               | 2.7             | 6-9-16   |
| 128            |            |             | 0.80                         | 33                         | 3159     | 25                | 5651                          | 2.7         | 8-12-18                       |                 |          |
| 5              | 80         | 80          | 0.20                         | 19                         | 2140     | 27                | 3698                          | 2           | 3-6-13                        |                 |          |
|                |            | 135         | 0.50                         | 30                         | 3008     | 22                | 5636                          | 2           | 7-11-17                       |                 |          |
|                |            | 178         | 0.80                         | 34                         | 3571     | 20                | 7036                          | 2           | 9-14-19                       |                 |          |
| 6 ft           | 5          | 10          | 20                           | 0.20                       | --       | 2159              | 108                           | 2548        | 2.80                          | 6.2             | 0-1-4    |
|                |            |             | 34                           | 0.50                       | --       | 2884              | 85                            | 3548        |                               | 6.2             | 1-3-11   |
|                |            |             | 45                           | 0.80                       | 20       | 3332              | 74                            | 4208        |                               | 6.2             | 2-5-14   |
|                | 5          | 20          | 26                           | 0.20                       | --       | 2271              | 87                            | 2777        |                               | 5.7             | 1-2-6    |
|                |            |             | 44                           | 0.50                       | 18       | 3234              | 73                            | 4096        |                               | 5.7             | 2-4-13   |
|                |            |             | 58                           | 0.80                       | 25       | 3846              | 66                            | 4983        |                               | 5.7             | 3-8-17   |
|                | 5          | 30          | 31                           | 0.20                       | --       | 2102              | 68                            | 2705        |                               | 5.3             | 1-2-8    |
|                |            |             | 53                           | 0.50                       | 21       | 3174              | 60                            | 4206        |                               | 5.3             | 2-6-14   |
|                |            |             | 69                           | 0.80                       | 27       | 3845              | 56                            | 5191        |                               | 5.3             | 4-9-17   |
|                | 5          | 40          | 48                           | 0.20                       | 15       | 2622              | 55                            | 3557        |                               | 4.5             | 2-3-11   |
|                |            |             | 82                           | 0.50                       | 27       | 3699              | 45                            | 5295        |                               | 4.5             | 4-10-18  |
|                |            |             | 108                          | 0.80                       | 30       | 4367              | 40                            | 6470        |                               | 4.5             | 8-13-20  |
|                | 5          | 50          | 60                           | 0.20                       | 17       | 2788              | 46                            | 3956        |                               | 3.6             | 2-4-12   |
|                |            |             | 103                          | 0.50                       | 29       | 3951              | 38                            | 5957        |                               | 3.6             | 5-10-18  |
|                |            |             | 135                          | 0.80                       | 35       | 4654              | 34                            | 7282        |                               | 3.6             | 8-13-21  |
|                | 5          | 60          | 70                           | 0.20                       | 19       | 2688              | 38                            | 4051        |                               | 3.3             | 2-4-13   |
|                |            |             | 120                          | 0.50                       | 31       | 3644              | 30                            | 5981        |                               | 3.3             | 6-11-19  |
|                |            |             | 157                          | 0.80                       | 36       | 4208              | 27                            | 7265        |                               | 3.3             | 10-15-22 |
|                | 5          | 70          | 93                           | 0.20                       | 22       | 3134              | 34                            | 4945        |                               | 2.7             | 3-6-15   |
|                |            |             | 157                          | 0.50                       | 34       | 4165              | 27                            | 7222        |                               | 2.7             | 7-13-20  |
| 206            |            |             | 0.80                         | 37                         | 4783     | 23                | 8793                          | 2.7         | 11-16-23                      |                 |          |
| 5              | 80         | 120         | 0.20                         | 25                         | 3073     | 26                | 5409                          | 2           | 3-6-16                        |                 |          |
|                |            | 202         | 0.50                         | 32                         | 4214     | 21                | 8146                          | 2           | 8-13-21                       |                 |          |
|                |            | 266         | 0.80                         | 39                         | 4925     | 19                | 10104                         | 2           | 12-17-24                      |                 |          |

## Performance Data - (4 Pipe) Cooling

### ACBL-HE, 2 way, 24 inch - (4 pipe) Cooling

| Unit Length ft | Inlet Size | Nozzle Size | Air Flow cfm Total (Primary) | Plenum Static Pressure in. | Sound NC | Capacity - 4 Pipe |                               |             |                               | Induction Ratio | Throw ft |     |        |
|----------------|------------|-------------|------------------------------|----------------------------|----------|-------------------|-------------------------------|-------------|-------------------------------|-----------------|----------|-----|--------|
|                |            |             |                              |                            |          | Cooling           |                               |             | Head Loss ft H <sub>2</sub> O |                 |          |     |        |
|                |            |             |                              |                            |          | Coil Btu/h        | Transfer Efficiency Btu/h cfm | Total Btu/h |                               |                 |          |     |        |
| 8 ft           | 5          | 10          | 27                           | 0.20                       | --       | 2851              | 106                           | 3376        | 3.56                          | 6.2             | 0-1-4    |     |        |
|                | 5          |             | 46                           | 0.50                       | 19       | 3758              | 81                            | 4658        |                               | 6.2             | 1-3-13   |     |        |
|                | 5          |             | 61                           | 0.80                       | 25       | 4304              | 71                            | 5492        |                               | 6.2             | 2-6-17   |     |        |
|                | 5          | 20          | 36                           | 0.20                       | --       | 3072              | 85                            | 3773        |                               | 5.7             | 1-2-7    |     |        |
|                | 5          |             | 61                           | 0.50                       | 23       | 4266              | 70                            | 5453        |                               | 5.7             | 2-5-16   |     |        |
|                | 5          |             | 80                           | 0.80                       | 29       | 4992              | 62                            | 6549        |                               | 5.7             | 4-8-19   |     |        |
|                | 5          | 30          | 41                           | 0.20                       | --       | 2714              | 66                            | 3513        |                               | 5.3             | 1-2-8    |     |        |
|                | 5          |             | 71                           | 0.50                       | 25       | 4054              | 57                            | 5436        |                               | 5.3             | 3-6-17   |     |        |
|                | 5          |             | 93                           | 0.80                       | 31       | 4863              | 52                            | 6673        |                               | 5.3             | 4-10-20  |     |        |
|                | 5          | 40          | 66                           | 0.20                       | 19       | 3495              | 53                            | 4780        |                               | 4.5             | 2-4-14   |     |        |
|                | 4x7        |             | 112                          | 0.50                       | 30       | 4796              | 43                            | 6977        |                               | 4.5             | 5-11-21  |     |        |
|                | 4x10       |             | 147                          | 0.80                       | 35       | 5572              | 38                            | 8434        |                               | 4.5             | 8-15-24  |     |        |
|                | 5          | 50          | 80                           | 0.20                       | 20       | 3525              | 44                            | 5082        |                               | 3.6             | 2-4-14   |     |        |
|                | 5          |             | 134                          | 0.50                       | 32       | 4831              | 36                            | 7440        |                               | 3.6             | 5-11-21  |     |        |
|                | 4x10       |             | 177                          | 0.80                       | 36       | 5653              | 32                            | 9099        |                               | 3.6             | 8-16-24  |     |        |
|                | 5          | 60          | 100                          | 0.20                       | 24       | 3809              | 38                            | 5756        |                               | 3.3             | 2-5-16   |     |        |
|                | 4x7        |             | 173                          | 0.50                       | 35       | 5055              | 29                            | 8423        |                               | 3.3             | 7-14-23  |     |        |
|                | 4x10       |             | 226                          | 0.80                       | 39       | 5744              | 25                            | 10144       |                               | 3.3             | 12-18-26 |     |        |
|                | 5          | 70          | 122                          | 0.20                       | 27       | 3888              | 32                            | 6263        |                               | 2.7             | 3-6-17   |     |        |
|                | 4x10       |             | 205                          | 0.50                       | 34       | 5066              | 25                            | 9057        |                               | 2.7             | 7-14-23  |     |        |
|                | 4x10       |             | 270                          | 0.80                       | 40       | 5769              | 21                            | 11025       |                               | 2.7             | 13-19-26 |     |        |
|                | 5          | 80          | 163                          | 0.20                       | 34       | 4018              | 25                            | 7192        |                               | 2               | 3-7-18   |     |        |
|                | 4x10       |             | 275                          | 0.50                       | 37       | 5391              | 20                            | 10745       |                               | 2               | 9-16-24  |     |        |
|                | 4x10       |             | 363                          | 0.80                       | 43       | 6220              | 17                            | 13287       |                               | 2               | 14-19-28 |     |        |
|                | 10 ft      | 5           | 10                           | 34                         | 0.20     | --                | 3484                          | 102         |                               | 4146            | 4.29     | 6.2 | 0-1-4  |
|                |            | 5           |                              | 58                         | 0.50     | 22                | 4532                          | 78          |                               | 5665            |          | 6.2 | 1-3-13 |
|                |            | 5           |                              | 77                         | 0.80     | 28                | 5154                          | 67          |                               | 6653            |          | 6.2 | 2-6-19 |
|                |            | 5           | 20                           | 44                         | 0.20     | --                | 3630                          | 82          |                               | 4486            |          | 5.7 | 1-2-6  |
| 5              |            | 75          |                              | 0.50                       | 25       | 4988              | 66                            | 6450        | 5.7                           | 2-5-17          |          |     |        |
| 5              |            | 99          |                              | 0.80                       | 32       | 5800              | 59                            | 7727        | 5.7                           | 4-8-21          |          |     |        |
| 5              |            | 30          | 53                           | 0.20                       | 16       | 3424              | 65                            | 4456        | 5.3                           | 1-2-8           |          |     |        |
| 5              |            |             | 90                           | 0.50                       | 28       | 4934              | 55                            | 6686        | 5.3                           | 3-6-20          |          |     |        |
| 5              |            |             | 118                          | 0.80                       | 34       | 5846              | 50                            | 8143        | 5.3                           | 4-10-23         |          |     |        |
| 5              |            | 40          | 81                           | 0.20                       | 22       | 4129              | 51                            | 5706        | 4.5                           | 2-4-14          |          |     |        |
| 4x10           |            |             | 140                          | 0.50                       | 31       | 5627              | 40                            | 8353        | 4.5                           | 5-11-23         |          |     |        |
| 4x10           |            |             | 183                          | 0.80                       | 37       | 6457              | 35                            | 10020       | 4.5                           | 8-17-26         |          |     |        |
| 5              |            | 50          | 100                          | 0.20                       | 24       | 4287              | 43                            | 6234        | 3.6                           | 2-4-15          |          |     |        |
| 4x7            |            |             | 170                          | 0.50                       | 34       | 5813              | 34                            | 9123        | 3.6                           | 5-11-23         |          |     |        |
| 4x10           |            |             | 225                          | 0.80                       | 39       | 6726              | 30                            | 11107       | 3.6                           | 9-18-27         |          |     |        |
| 5              |            | 60          | 125                          | 0.20                       | 28       | 4545              | 36                            | 6979        | 3.3                           | 2-5-19          |          |     |        |
| 4x10           |            |             | 215                          | 0.50                       | 36       | 5914              | 28                            | 10100       | 3.3                           | 7-15-25         |          |     |        |
| 4x10           |            |             | 283                          | 0.80                       | 42       | 6681              | 24                            | 12191       | 3.3                           | 12-21-29        |          |     |        |
| 5              |            | 70          | 151                          | 0.20                       | 33       | 4647              | 31                            | 7587        | 2.7                           | 3-6-19          |          |     |        |
| 4x10           |            |             | 260                          | 0.50                       | 37       | 6018              | 23                            | 11080       | 2.7                           | 7-17-26         |          |     |        |
| 4x10           |            |             | 342                          | 0.80                       | 43       | 6776              | 20                            | 13435       | 2.7                           | 13-21-30        |          |     |        |
| 5              |            | 80          | 210                          | 0.20                       | 29       | 4970              | 24                            | 9058        | 2                             | 3-7-21          |          |     |        |
| 4x10           |            |             | 355                          | 0.50                       | 41       | 6524              | 18                            | 13435       | 2                             | 9-18-27         |          |     |        |
| 4x10           |            |             | 465                          | 0.80                       | 47       | 7399              | 16                            | 16452       | 2                             | 16-22-31        |          |     |        |

