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Scott Hall Vivarium Study

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A. Executive Summary

The existing vivarium located in the basement of Scott Hall is operational but due to the age of the facility, it does not meet current standards for Vivarium design, controllability of systems, redundancy and other aspects of daily operations. It is desired to upgrade the facility to meet current standards including but not limited to cage washing, ventilated cage racks and dedicated cage changing stations. The purpose of this study is to identify options for renovation and construction implementation along with the associated costs. This results in the development of four progressive plan options:

1. Existing Plan: Upgrade HVAC and electrical systems, the plan remains "as-is".
2. Minimal Alteration: Upgrade Systems for Performance, Reconfigure the Cage Wash and Minor Alteration of the Vivarium Layout.
3. Moderate Alteration: Upgrade Systems with Reconfiguration of the Cage Wash and Vivarium Layout.
4. Intensive Alteration: Upgrade Systems and Major Reconfiguration of the Cage wash and Vivarium Layout.

When comparing the options, a cost differential is identified between the existing plan and the alteration plans. Although keeping the existing layout is an option, it is not recommended as it does not address desired daily operational improvements.

There are minimal cost differences when comparing the three alteration plans. There is approximately a 4% difference between the minimal and intensive options. This is due to the MEP systems, which form the majority of the cost, remains changed between options. The plan that best meets the operational and animal population goals for the vivarium is recommended.

The greatest cost and time differential occurs when comparing a single construction phase to a 2-phase construction. The 2-phase concept is the result of developing a scenario in which the vivarium is required to remain partially operational. The single phase is recommended in lieu of 2-phase concept. The 2-phase approach results in extended construction noise, which will likely create sustained stress on the animals, as well as is a significant increase in cost and schedule.

B. Introduction

The goal of this project is to make recommendations for renovation of the existing animal holding facility in the basement of the WSU School of Medicine's Scott Hall. The facility is one of the first to be AAALAC certified and has continuously maintained certification since the Scott Hall facility was constructed in 1971.

Animal types housed in the vivarium include mice, rats and rabbits. This mix of species is not likely to change in the foreseeable future. In recent years, the university has gradually shifted away from static to individually ventilated cages. This type of housing can improves animal health, reduces animal stress, increases population density and offers opportunities for energy conservation. Approximately 2/3 of the animals are housed in individually ventilated cages.

The use of water bottles has been reduced in favor of an automated watering system and this trend will continue. It is anticipated that use of water bottles will eventually be limited to only those animals that, for experimental reasons, might require the use of water bottles.

Methods of animal care have changed greatly since the vivarium was last renovated in 1985 and 1997. One of the major advancements has been the use of cage changing stations that minimize staff exposure to bedding dust and animal allergens during the cage changing process. New animal holding facilities are designed to accommodate this equipment within the confines of the animal holding room. It would be desirable to enlarge animal holding rooms in the Scott Hall facility to allow placement of a dedicated cage changing station in each animal holding room.

Some of the immunocompromised experimental animals housed in Scott hall require a bioexclusion housing approach. This is achieved using micro isolator caging with racks that allow positive air pressure inside animal cages relative to the surrounding room air. In other instances, where animals are infected with zoonotic agents, a biocontainment strategy involving negative cage pressurization is used. In both cases, personal protective equipment (PPE) is worn and procedures involving the animals are carried out in Class II biosafety cabinets that protect both animal and the researcher from infection.

Based upon discussions with WSU personnel, it is our understanding that an animal biosafety level (ABSL) somewhere between ABSL-2 and ABSL-3 will be required. Given that direction, various animal holding / procedure suites that offer varying levels of isolation from the remainder of the vivarium are proposed. Optional separation of these suites via an ante-room for donning and doffing of PPE will also be considered.

The study is limited to the considerations internal to the existing suite and does not address larger building circulation, animal receiving, animal transportation, vivarium access and security.

C. Existing Conditions Systems Description

The existing vivarium was constructed in two phases and result in two areas with different organizational strategies and efficiencies. The original portion, organized linearly along a single corridor 0400, was constructed in 1971 and the cage wash area was renovated with new equipment in 1997. A second animal holding area, was constructed in 1985 in space formerly occupied by non-animal-related research facilities. It is organized around a looped, also known as a racetrack, style corridor 0200.

Because of the phasing of construction, the connection between the common cage washing area and the newer corridor 0200 holding suite is awkward. There is no direct connection between the clean side of the cage wash room and corridor 0200. It would be more in alignment with standards of good practice and more efficient if both clean and dirty sides of the cage wash area could be accessed directly by both suite 0400 and suite 0200 animal holding areas. The most recent improvements to the cage wash area occurred in 1997 and these included installation of a new rack washer bottle washer and autoclave.

Existing lighting, heating, ventilation and air conditioning systems cannot be reliably controlled or monitored at the individual room level. The facility currently employs approximately 60% ventilated racks with the remaining 40% of racks being static. The preferred vendors for ventilated rack systems are Tecniplast and Allentown. It is anticipated that the utilization of ventilated racks will continue to increase over time.

The existing cage wash system, although appropriately sized for current and projected weekly throughputs, is at the end of its useful life and is becoming unreliable. There is no pre-wash bay on the dirty side of the rack washer. However, there is a large floor-mounted drainage grate on the clean size of the rack washer that is not needed. It would be more useful to have this drainage grate located on the dirty side of the rack washer. The installed grate is also very heavy and it is difficult to remove it for cleaning. Movement away from bottle watering has rendered high-capacity bottle washing equipment obsolete. The WSU vivarium staff prefer the configuration as represented in the recently renovated "I-Bio" animal holding facility on the WSU campus. It has both a rack washer and a cabinet washer in the cage washing area. The cabinet washer serves as an emergency backup to the rack washer but is also capable of washing small batches of water bottles and other items that cannot be economically washed in the large rack washer.

Existing animal holding rooms in the Scott Hall facility, which were originally designed for open caging are very small by current standards. Their small size will not accommodate the use of a modern cage change station within the room and many rooms can only comfortably accommodate a single rack of ventilated cages. The result is that much of the square footage currently dedicated to animal holding is underutilized and does not realize the higher population density possible with holding proportioned for ventilated cage racks. In the case of the 0200 suite, much of the square footage is currently dedicated to the corridor. It can be reconfigured as a single corridor system which would increase the area dedicated to animal holding, which will provide additional space for ventilated cage racks and the cage changing station.

Throughout the facility, animal holding room and cage wash room doors are of inadequate width to allow easy movement of racks, changing stations and other equipment in and out of these spaces. Dedicated storage space appears to be inadequate and this has resulted in a number of animal holding rooms being used as storage space. Storage and other support spaces such as feed and bedding storage are not centrally located in close proximity to the cage wash area resulting in operational inefficiencies. In addition, existing feed storage and procedure spaces are currently comingled with staff office locker and break areas, which it is good practice to have a clear separation between staff spaces and the vivarium.

D. Needed Improvements to Meet Current Design Standards and Best Practices

- Upgrade HVAC controls and air handling to allow control of temperature and humidity at the room level and can accommodate the range of environmental and humidity requirements for mice, rats and rabbits.
- Upgrade lighting controls to allow control of light levels and timed light cycle switching at the individual room level. Upgrade lighting to incorporate new LED technologies that conserve energy and provide red or white light without the use of filters.
- Increase holding/population capacity by increasing the animal holding room size and door widths to accommodate larger numbers of ventilated racks and cage changing stations.
- Animal Holding / Procedure suites to meet ABSL-2-plus standard (between ABSL-2 and -3). Autoclaves will not be provided, but individual benchtop models can be added by individual researchers as needed.
- Provide a direct connection between the clean side of the cage wash and the 0200 corridor animal holding suite.

- Provide dedicated storage areas and reprogram the space to logically separate staff spaces from other support functions.
- Remove bottle washing equipment and replace with a cabinet washer.
- Replace rack washer. Provide a pre-wash bay on the cage wash dirty side for rinsing of racks prior to their placement in the rack washer.
- Provide either a pass-through autoclave or separate autoclaves on the clean and dirty sides of the cage wash so that biohazardous waste will not be brought into the cage wash clean side for autoclaving.


Example of a Cabinet & Rack Washer


Example of a Pass-thru Autoclave

E. Options (Refer to Floor Plans – Appendix A) This study includes considerations for four levels of upgrades:

1. Existing Plan: Upgrade HVAC and electrical systems, the plan remains "as-is".
2. Minimal Alteration: Upgrade Systems for Performance, Reconfigure the Cage Wash and Minor Alteration of the Vivarium Layout.
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F. Reference Guides:

The vivarium, is a specially designed facility type, which accommodates tightly controlled environments to avoid the introduction of contaminants or pathogens, and prevent the transmission of infectious agents, and avoid the migration of odors. The facilities are complex, expensive, but they are vital to the support of a proper, safe, and humane research effort. The following are the guidelines that establish the standards of good practice for the care and maintenance of research animals:

- Association for Accreditation and Assessment of Laboratory Animal Care International (AAALAC).
- Design Requirements Manual for Biomedical Laboratories and Animal Research Facilities (DRM), 2016 edition by the U.S. National Institute of Health.
- Biosafety in Microbiological and Biomedical Laboratories (BMBL) 5th Edition by U.S. Department of Health and Human Services, Centers for Disease Control and Prevention and National Institutes of Health.
- Guide for the Care and Use of Laboratory Animals by the Institute of Laboratory Animal Resources, Commission on Life Sciences, National Research Council.

G. Vivarium – Typical Space Types

The minimum "ideal" module for a flexible multi-species holding room is 16'x24'. (This module is also suitable for converting a holding room to a procedure room.) This provides enough space for (4) double sided cage racks and (1) cage changing station for rodents or (5) cage racks for rabbits.

Holding Room Basic Requirements:

- BSC/Cage Changing Station. (Except for Rabbit Holding Rooms.)
- Handwash Sink.
- Hose Bib.
- Floor Drain (capable of being capped).
- Doors with a Vision Window with a Red Filter and/or Shade Device
- Multi-level and Red Filtered Lighting with a Diurnal Cycle control and an Animal Care Staff override.
- Environmental Controls & Monitoring with Single Centralized Control and Holding Room Display.
- Negative pressure room. (Except for transgenic and immune-compromised animals, which will require positive pressure.)
- Auto-watering service with cage rack connections.
- Ventilated cage rack air supply and exhaust connections.
- Power provided by retractable cord reels mounted to the ceiling.

Typical Holding Room for Mice with Single & Double Sided Ventilated Cage Racks

Typical Ventilated Cage Rack for Rabbits

Capacity: For purposes of comparison, the following assumptions are applied to the plans options:

- A ventilated cage rack that is 70" wide x 30" deep.
- 3-ft clearance from the face of each cage provided.
- Each cage rack for mice can hold 160 cages with 3 mice per cage for a total population of 480 each rack.
- Each cage rack for rats can hold 70 cages with 2 rats per cage for a total population of 140 each rack.
- Each cage rack for rabbits can hold 8 rabbits per rack with 1 rabbit per cage.
- A Cage Changing Station is 60" wide x 30" deep.
- One change changing station per holding room. (Except for holding rooms that are too small to fit both a cage rack and a cage changing station.)
- Existing plan assumes full potential capacity, not current actual capacity.
- The maximum capacity calculations (no plan options were developed in conjunction with the committee) are based removing most all of the holding room dividing walls to create 2 large and 1 medium sized holding room with the following dimensions: 22-ft x 70-ft, 20.5-ft x 53-ft and 21-ft x 22-ft.

Environmental Requirements: The following outline the temperature and humidity ranges as recommended by the National Institute of Health for the Design of Animal Research Facilities for Biomedical Research and the Guide for the Care and Use of Laboratory Animals by the National Research Council.

Species	Dry-Bulb Temperature Range deg. C	Dry-Bulb Temperature Range deg. F	Humidity Range
Mouse	18-26	64-79	30-70%
Rat	18-26	64-79	30-70%
Rabbit	16-22	61-72	30-70%

Procedure Room Basic Requirements:

- Proximate to animal holding rooms.
- Biological Safety Cabinet.
- Handwash sink.
- Emergency eyewash.
- Benchtop autoclave as required by research and agent.

Barrier Basic Requirements: Facilities for working with immuno-compromised species. (Containment facilities are similar with all of the same requirements except negative pressure and different protocols for material and waste flows.)

- Airlocks
- Isolators.
- Autoclaves.
- Positive pressure.
- Special operational protocols.
- Control and monitoring systems and equipment to maintain the required pressures and flows.

Cagewash Basic Requirements:

- The space for all cleaning, sanitizing, and husbandry activities.
- The major equipment items include pass-through rackwashers, cabinet washers, pass-through autoclaves, bedding dispensers and dump stations.

Storage Requirements:

- Cage storage and repair.
- Feed, bedding, and equipment.
- Refrigerated storage.

Quarantine Basic Requirements:

- A dedicated animal holding room for incoming animals to verify their health and prevent the introduction of disease.

Necropsy/Perfusion Basic Requirements:

- A space for post mortem procedures on sacrificed animals, which should not be near or adjacent to "clean" areas.

Veterinary Care Basic Requirements;

- Lab and care functions, e.g. surgery, clinical chemistry, and histology.
- In-suite office spaces for veterinary care staff.

Staff Support Areas Basic Rudiments:

- Break area.

- Workstation.
- Lockers and Shower.
- Toilet-room facilities.

H. Architectural Requirements

Flooring: Epoxy terrazzo or resinous floor coatings are recommended.

Interior Walls and Partitions: Walls in animal holding areas are to be stable and capable of withstanding abuse and wash-down. Concrete masonry units are preferred substrate because of their strength and stability. The wall coating to include a block filler for a smooth surface, and epoxy based under-coatings, and are top coats. Steel studs and gypsum board are suitable in personnel spaces. Walls should have an impervious, easily cleanable finish, either an epoxy or latex based paint.

Doors: Are be a minimum of 42" wide and 90" high or more to accommodate the free movement of racks with integrated blowers. The opening size depends on the cage and rack system in use. Doors need to be properly protected, particularly latches, locks, and other hardware. Continuous hinges are preferred.

Ceilings: Ceilings in animal holding areas are to be moisture-resistant gypsum board with an epoxy based coating and sealant at intersections with walls and openings to ensure air and water tightness. Moisture resistant and washable ceiling tiles may be used in corridors and regular lay-in acoustic tile can be used in staff areas.

I. Mechanical – Existing Conditions Systems Description

The existing vivarium space is in the eastern part of the basement of Scott Hall. The vivarium space was originally served by one air handling unit (AC-2), but it is currently served by two air handling units – AC-1 and AC-2 – because of the vivarium expanding during both the 1985 and 1997 renovations. (Refer to Appendix B for a diagram showing the areas served by each of the two air handling units.)

AC-1 is a large unit (approx. 40,590 CFM), and it serves portions of the vivarium (approx. 10,440 CFM) as well as areas outside of the vivarium space. AC-2 is a small unit (approx. 7,860 CFM) that only serves the vivarium space. Both AC-1 and AC-2 are installed in Mechanical Equipment Room G-85.

AC-1 consists of an outdoor air damper, face-and-bypass damper, steam heating coil, supply fan, humidifier manifold, cooling coil, and access doors. AC-1 is original to the Building, and the casing is in poor condition. Ductwork extends from AC-1 to terminal units (TU), and ductwork extends from each TU to the zone in which it serves. The TUs modulate the airflow to the zone as well as the temperature of air delivered to each zone to maintain space conditions. The TUs associated with the vivarium are located both in the vivarium's main corridor as well as in Mechanical Equipment Room G-85.

AC-2 consists of an outdoor air damper, steam heating coil, supply fan, humidifier manifold, cooling coil, and access doors. AC-2 is original to the Building, and the casing is in poor condition. Ductwork extends from AC-2 to duct-mounted heating coils, and ductwork extends from the duct-mounted heating coils to the zone in which it serves. The duct-mounted heating coil modulates the temperature of the air being delivered to the space to maintain space conditions, but the airflow remains constant.

J. Mechanical – Existing Issues and Recommended Solutions

The following lists some of the main mechanical issues that exist along with the recommended solution:

1. **Issue**: The existing air handling units (AC-1 and AC-2) are original to the building and are beyond the end of their useful life. The vivarium suite is currently served by both air handlers. The University has expressed a desire to serve the vivarium suit from a dedicated air handler, and the design team agrees with this approach.

    a. **Recommended Solution**: The design team proposes that a new custom air handler be provided. The new recommended air handler would be a 100% outdoor air unit and would contain filters, an energy recovery coil, heating coil, humidification manifold, cooling coil, and a supply fan array. The energy recovery coil would be part of a run-around loop consisting of a coil in the air handler and a coil in the exhaust air stream. A glycol solution would be pumped between these two coils to transfer energy between the exhaust air and outside air streams to reduce the overall heating and cooling demand.

       It is important that the Vivarium systems remain operational and are not impacted by maintenance activities or equipment failures. A conceptual way to address this need at the air handler level is to provide the new air handling unit with two separate air tunnels. The air handler would be one large unit with an interior wall down the middle that creates two tunnels. Each tunnel would contain the components listed above (fans, coils, filters, etc.), and each tunnel would be capable of being isolated from the system. In normal operation, the air handler would utilize both tunnels where both air tunnels would be seeing 50% of the airflow. The design of the air handler would keep the velocity through the components (coils and filters) around 300 – 350 fpm during normal operation. The air handler would have the ability to go into emergency mode where one of the tunnels is isolated. The active tunnel would be designed to provide 100% of the airflow. The velocity through the components would be higher than normal mode, but the design of the fans would account for this higher velocity. This approach will provide N+1 redundancy for all fans, coils, filters, dampers, and the associated controls.

A potential location for the new air handling unit is the area directly to the west of AC-1. This area currently is caged off, and it appears to be storage for mechanical and electrical equipment. If this location were pursued, then the items being stored would need to be relocated and the cage would need to be removed. An existing pump that appears to be no longer in service located north of the cage would also need to be removed.

2. **Issue**: There are several issues/comments related to maintaining proper conditions within the vivarium. The following is a list of issues that IMEG is currently aware:

    a. Insufficient Cooling Capacity

    b. Different animals require different room conditions. For example, spaces containing rabbits should be around 65°F whereas spaces with rodents are typically between 72°F and 78°F.

    c. The researchers have requested the ability to have any animal storage space capable of controlling the room temperature anywhere between 65°F and 78°F.

    d. The rooms are to be controlled to ±0.5°F off the setpoint.

    e. **Recommended Solution**: The recommended new air handler described above would be sized to accommodate the cooling load of the vivarium using the building's chilled water system. The design team will calculate the cooling load using all the pertinent information (e.g. occupant load, lighting load, animal load, equipment load, etc.). These calculations will ensure that the new air handler has adequate capacity to satisfy the cooling load.

It is our understanding that the University disables the chilled water system from late fall through early spring. If the outdoor air temperature gets too warm during the time when there is not chilled water, the system may have difficulty accommodating the cooling load. This is something that will need to be addressed during the design phase. The design team proposes providing two dedicated air-cooled chillers that would be sized for the Vivarium's peak cooling load. This approach would mean that the Vivarium would be completely removed from the Building's main chilled water plant. Each chiller would be sized for 100% of the load providing N+1 redundancy. Each chiller will be designed to have multi circuits so losing a compressor doesn't disable the entire chiller.

Each space will be provided with a new pressure independent airflow control device for both supply and exhaust air – VAV box for non-lab spaces and an air valve for lab spaces – that will control the airflow to the space it serves. Each of the supply airflow control devices will have an associated hot water reheat coil. The airflow and the air temperature will modulate to maintain the desired space temperature within ±2°F while also maintaining the required air changes per hour. The space temperature will be fully adjustable through a room mounted temperature sensor, which will provide the user the temperature flexibility they've requested.

3. **Issue**: The hot water heat exchangers are sized for the heating load of the entire building. In the summer, the heat exchangers are only used for the reheat load of the vivarium. This results in control issues because the heat exchangers are oversized for the summer use.

    a. **Recommended Solution**: The design team recommends that new heat exchangers be provided that are dedicated to the vivarium loads. The new heat exchangers would be sized to accommodate the heating load of the new air handling unit as well as all the new reheat coils mentioned above. The design team recommends that two heat exchangers be installed providing N+1 redundancy. Providing heat exchangers dedicated to the vivarium space will solve the issue described above.

4. **Issue**: The University has requested that the vivarium maintain 50% relative humidity (RH) ±10%.

    a. **Recommended Solution**: The new air handling unit is proposed to have a humidification manifold. Building steam will be supplied to the manifold, and the steam flow will be controlled to maintain the humidification setpoint. Electronic humidification is acceptable by the University.

5. **Issue**: Valve bodies and actuators need to be replaced as well as providing new piping for the air compressors which is stressed and failing. The University prefers standard pneumatic actuators to be provided for large valves due to cost and ease of repair, while electric is preferred for other control valves.

    a. **Recommended Solution**: The existing control system is Honeywell's ComfortPoint Open control system. This is a direct digital control (DDC) system. All new equipment will be tied into this existing control system, and all new actuators will be electric actuators. All of the new equipment will be imported into the existing Siemens Desigo front end.

    b. The control system and air flow will be designed such that the animal holding rooms are provided with even low velocity airflow to provide a reasonably stable temperature throughout the strata of the room and minimize air currents and turbulence. The temperature sensor in animal holding rooms will have the dual purpose of environmental system control and research monitoring and recording. Sensor location is ideally placed at the location where the temperature is required. The design will give consideration for location and height of the sensor and ensure that it is not obstructed or blocked in any way.

6. **Issue**: The exhaust fans are beyond their useful life.

    a. **Recommended Solution**: The design team recommends that new exhaust fans be installed on the roof that are dedicated to the vivarium suite. It is recommended that two fans be installed to provide N+1 redundancy.

K. Electrical – Existing Conditions Systems Description

Scott Hall is fed from a 13.2kV primary switchgear with a relay-controlled main-tie-main circuit breaker configuration. The relays monitor incoming voltage on the two utility feeders, and can automatically close the tie breaker upon loss of voltage on one of the utility feeders. The building is backed by (2) 2000kW 13.2kV standby generators via (2) closed transition automatic transfer switches. The generators and transfer switches were part of a 2005 upgrade and are in good condition.

The vivarium space is served by distribution fed from Substations #3 and #4 in the east mechanical room of the ground floor. The distribution equipment serving the vivarium space is vintage to the building, and is obsolete. Mechanical equipment is served by an

MCC in the mechanical room and is also obsolete. The 200-suite and 400-suite are fed by local lighting and receptacle panelboards.

Lighting in the vivarium is fluorescent type. While it has been upgraded since Scott Hall opened, it does not allow the flexibility needed for animal husbandry. Lighting control for the animal holding areas rely on mechanical timers, and dark cycle service requires tube sleeves or lens films to produce red light. Monitoring of light levels in the room is problematic, and deviations from levels required by studies may not be detected.

L. Electrical – Existing Issues and Recommended Solutions

The following lists some of the main electrical issues that exist along with the recommended solution:

1. **Issue**: The existing distribution systems and wiring devices are antiquated and cannot be easily upgraded.

   Recommended Solution: No changes for the incoming service or generator systems are recommended as part of this project. While closed transition transfer switches provide a seamless power transfer, it is recommended that any potentially sensitive equipment be provided with a local UPS.

   Existing branch circuit lighting and power panels and associated transformers serving the vivarium will be removed. The existing feeders will be removed back to the source. New lighting loads will be served from a new 100 amp, 480/277 volt, 3 phase, 4 wire branch circuit panel. New branch receptacle loads will be served from (2) new 225 amp, 208/120 volt, 3 phase, 4 wire branch circuit panel. This panel will be connected to a new 75kVA transformer fed from the existing bus-duct system. Air handling units will be fed from a new 600A power distribution panel in the mechanical room. A new 100 amp 480V, 3 phase, 4 wire panelboard will be provided as required for new cage wash equipment.

   Distribution equipment will be provided with copper bussing, and sized with a minimum of 15% spare circuits. The transformer will be K-4 or K-13 rated, with copper windings, 150°C temperature rise. All wire will be copper, and feeder sizes will be increased as required to limit voltage drop from the service entrance to the branch circuit panel to not more than 2%. Dedicated neutral conductors and ground conductors will be provided with each branch circuit.

   New specification-grade receptacles will be provided in staff areas. GFCI receptacles will be provided in locations within 6’-0” of all sinks, and at water coolers. In animal holding areas, GFCI receptacles with weatherproof, heavy duty covers will be provided to protect against moisture. Fifty percent (50%) of receptacles in open and private offices will be connected to vacancy sensors serving the lighting. These devices will be labeled to indicate switched control.

Motors 3/4 horsepower and larger will be served at 480 or 208 volt, 3 phase, 3 wire by VFDs. Motors less than 3/4 horsepower will be served at 120 volt service, 1 phase, 2 wire as applicable. HVAC and other mechanical loads will generally be served at 480 volt, 3 phase, 3 wire.

2. **Issue**: The existing lighting fixtures lack the controllability and flexibility required by animal husbandry best practices.

    a. **Recommended Solution**: All new lights will be LED's. LED luminaires with dimmable drivers will be used for general lighting. Luminaires in the animal holding areas will be weatherproof and fully gasketed, with switchable red and white LEDs. Luminaires will have a Correlated Color Temperature (CCT) of 4000°K in the staff areas and 5000°K in the animal holding areas, with a minimum Color Rendering Index (CRI) of 80. Lighting design for this project will meet current Illuminating Engineering Society recommended illuminance targets. The average maintained illuminance levels are indicated in the table below.

3. **Issue**: The existing lighting controls are obsolete, inflexible, and do not offer monitoring capabilities.

    a. **Recommended Solution**: New lighting controls will be required to comply with the 2015 Michigan Energy Code and with best practices for vivariums. Automatic shutoff will be achieved using a combination of relays via the networked monitoring and control station, vacancy sensors, and occupancy sensors. Lighting controls will be installed in areas listed in the table below. Required manual override switches will be installed in each individual room. Momentary contact switches will be provided to interface with the vacancy sensors in most rooms. Refer to the table below for areas requiring dimming. Devices in animal holding areas will be waterproof. A central monitoring and control station for Animal Holding Areas will be capable of the following:

        i. Cycle Controls: Individual room light/dark cycles will be controlled via a simple user interface to allow programming of diurnal cycles and any override durations.

ii. Monitoring: A photocell will be located in each individual room to allow monitoring of light levels in the room for reporting and alarm purposes.

iii. Overrides: A local switch at each individual room will be able to override the lighting in the room. Duration of overrides is programmable. During low and high light cycles, the switch will turn lighting off. During dark cycles, the override switch will turn the red LEDs on.

iv. Alarming: When light levels are outside of programmed conditions, an alarm will provide notification at the control station and text alert to Public Safety through the RENO system.

The lighting control system will be non-proprietary based to avoid obsolescence (Honeywell based or equal).

Area Description	Luminaires	Controls	Illuminance Levels
		Typical Room Spaces	
Toilet Room	Recessed perimeter cove light on wet wall and vanity luminaire	Wall switch type vacancy sensor	15 to 25 foot-candles
Storage Rooms	Sealed and gasketed luminaires	Wall switch type vacancy sensor	10 foot-candles
Electrical Closet	4' suspended industrial luminaires	Wall switch	25 to 30 foot-candles
Office	2'x4' or 2'x2' dimmable volumetric type luminaires	Manual dimmers with ceiling-mounted vacancy sensors	30 to 50 foot-candles
Animal Holding Rooms	Sealed and gasketed dimmable luminaires with independent red and white LEDs	Controlled by a programmable monitoring and control station with local overrides	Off/Dark Cycle: 0 foot-candles Override (Red LEDs): 10 to 15 foot-candles Low/Animal Housing Cycle: 25 to 35 foot-candles High/Procedure/ Sanitation Cycle: 75 to 100 foot-candles
Procedure Rooms	Sealed and gasketed dimmable luminaires	Manual dimmers with ceiling-mounted vacancy sensors	75 to 100 foot-candles

Area Description	Luminaires	Controls	Illuminance Levels
Corridors	Dimmable volumetric type 2'x4' luminaires in staff area Sealed and gasketed dimmable luminaires with independent red and white LEDs in animal holding areas	Manual switches with ceiling-mounted occupancy sensors Manual dimmers with ceiling-mounted occupancy sensors in animal holding areas	10 foot-candles
Staff Break Rooms, Locker Rooms	2'x4' or 2'x2' volumetric type luminaires	Manual dimmers with ceiling-mounted vacancy sensors	30 foot-candles
Laundry Room	Acrylic lens luminaires	Manual dimmers with ceiling-mounted vacancy sensors	15 to 25 foot-candles
Cage Wash Rooms	Sealed and gasketed luminaires	Manual controls with ceiling-mounted vacancy sensors	50 foot-candles

4. **Issue**: The existing fire alarm and technology systems will need to be modified for any renovations.

   a. **Recommended Solution**: The existing fire alarm system will be modified as required to serve the renovated areas. System notification will consist of ADA- and NFPA-compliant audio (voice), visual, and combination audio/visual devices, and reduced audio output devices will be used in animal holding areas. Duct-type smoke detectors to close smoke dampers and shut down air distribution systems will be provided. Pressure differential in a state of emergency, when the supply air is shut down and exhaust remains operational, will be given consideration during design process to ensure that door operation and egress is not impeded. Heat detectors will be provided in electrical rooms. Pull stations will be located within exit stairwells. Any door unlocking and hold-open devices will be provided for corridor doors per the life safety plans and applicable codes. All devices in animal holding areas will be waterproof.

      Horizontal telecommunications cabling and outlets will be provided to the office, animal holding rooms, procedure rooms, etc. as required. The existing Access Control System, Video Surveillance System, and Intrusion Detection System will be modified to provide secure entrances to animal holding areas.

M. Recommendations

The cost to renovate Vivariums as well as operational costs are very high as compared to other space types and uses. This s primarily due to the need for the controllability, stability and redundancy of building systems serving the suite.

When comparing the cost difference between the 4 floor plan options developed, there is little difference in cost. The bulk of the project cost will be in the mechanical, plumbing and electrical requirements which effectively remain unchanged between the 4 floor plans.

		Plan Option 1 (Existing Plan)		Plan Options 2 (Minimal Plan)		Plan Option 3 (Moderate Plan)		Plan Option 4 (Intensive Plan Option)		Duration in months est.
Single Construction Phase		$3,022,393		$3,798,455		$3,948,455		$3,948,455		6-9 mo.
WSU Soft Cost range		$800,000	$1,250,000	$800,000	$1,250,000	$800,000	$1,250,000	$800,000	$1,250,000	1 mo. Ti move
Total Est. Cost Range		**$3,822,393**	**$4,272,393**	**$4,598,455**	**$5,048,455**	**$4,748,455**	**$5,198,455**	**$4,748,455**	**$5,198,455**	**7 to 10 mo.Total**
with Inflation 2020	**2.32%**	$3,911,073	$4,371,513	$4,705,139	$5,165,579	$4,858,619	$5,319,059	$4,858,619	$5,319,059	
with Inflation 2021	**2.18%**	$3,996,334	$4,466,811	$4,807,711	$5,278,189	$4,964,537	$5,435,015	$4,964,537	$5,435,015	
with Inflation 2022	**2.27%**	$4,087,051	$4,568,208	$4,916,846	$5,398,004	$5,077,232	$5,558,389	$5,077,232	$5,558,389	

* As per projections by https://www.statista.com/statistics/244983/projected-inflation-rate-in-the-united-states/

Option 1 keeps the existing floor plan in its current configuration and it remains basically "as-is" with improvements only provided to the Mechanical, Electrical and Plumbing systems and associated ceiling replacements.

Option 3 and Option 4 are nearly identical in plan and are therefore the same in cost. The only difference between the two plan options is the proportioning of space assigned to the cage wash, a holding room and storage program elements.

There is a small cost difference between Option 2 and Options 3 & 4. It is approximately $150,000 in architectural changes, or in other words only 4% of the total project cost. To summarize, the cost differences between the 4 floor plan options does not appear to be a major driver in in differentiating between the plan options. Option 4, the vivarium staff preferred option, is recommended as it achieves the greatest benefit with nominal increase in project cost.

Construction Phasing

Single Phase Option: The factor that resulted in the greatest difference in cost is phasing consideration for construction. With cost control in mind, the best strategy is a single phase requiring the current vivarium functions to be temporarily relocated off-site, decommission so that the entire suite can be renovated in a single phase. This approach is the most cost efficient relative to construction costs as well as offers the most compact construction schedule. A single phase renovation will likely have a 6-9 month construction schedule. (Refer to Appendix D – Estimate of Probable Cost for the Phasing Options as applied to Option 4)

Phase 1 & 2 Option: The Vivarium staff and committee members for this study communicated a requirement to remain operational during the renovations. To meet this requirement, the project would have to be broken into 2 phases: (Refer to Appendix C – Phasing Option).

		Plan Option 1 (Existing Plan)		Plan Options 2 (Minimal Plan)		Plan Option 3 (Moderate Plan)		Plan Option 4 (Intensive Plan Option)		Duration in months est.
Construction Phase 1		$2,604,346		$3,214,789		$3,341,776		$3,341,776		6-9 mo.
Construction Phase 2		$651,086		$803,697		$835,444		$835,444		6-9 mo.
Total Construction		$3,255,432		$4,018,486		$4,177,220		$4,177,220		12 to 18 mo.
WSU Soft Cost range		$800,000	$1,250,000	$800,000	$1,250,000	$800,000	$1,250,000	$800,000	$1,250,000	2 mo. to move
Total Est. Cost Range		**$4,055,432**	**$4,505,432**	**$4,818,486**	**$5,268,486**	**$4,977,220**	**$5,427,220**	**$4,977,220**	**$5,427,220**	**14 to 20 mo. Total**
with Inflation 2020	**2.32%**	$4,149,518	$4,609,958	$4,930,275	$5,390,715	$5,092,692	$5,553,132	$5,092,692	$5,553,132	
with Inflation 2021	**2.18%**	$4,239,978	$4,710,455	$5,037,754	$5,508,232	$5,203,712	$5,674,190	$5,203,712	$5,674,190	
with Inflation 2022	**2.27%**	$4,336,225	$4,817,382	$5,152,112	$5,633,269	$5,321,836	$5,802,994	$5,321,836	$5,802,994	

* As per projections by https://www.statista.com/statistics/244983/projected-inflation-rate-in-the-united-states/

Phase 1 Description:

It is recommended that the first phase of the renovation be limited to the animal holding and cage wash portion of the Corridor 0400 area, as indicated in the diagram. The existing animals will need to be consolidated in the corridor 0200 suite holding rooms for the duration of this first phase. The balance of the facility can continue to operate on the existing systems, as the phase one area will include the installation of the first new air handling unit.

This first phase will also take both the clean and dirty cage washing support areas off-line. The caging will either need to be collected and cleaned at a remote facility or disposable cages will need to be employed.

Phase 2 Description:

The second phase will require a transfer period of time to move the animals from the holding rooms in the corridor 0200 suite to the phase 1 area off corridor 0400. The second phase of renovation will include the animal holding suite as well as the reconfiguration of the staff areas including the break area, work area, laundry, locker and toilet facilities.

It should also be noted that supplemental HVAC support may also be required to keep the facility operational. This would be confirmed during the design stage of the project. If it is determined that it is required, then a temporary HVAC unit will need to be rented by the contractor. It can be located at grade at the floor above on the North side of Scott Hall, between the building and the dock access road. The North-east stairwell will need to be secured, the glass panel removed and temporary construction provided to run the HVAC support down through the stairwell to the vivarium below. When the support is no longer needed, the temporary construction can be removed and the glass replaced.

The Phase 1 & 2 approach does increase the cost of construction, because it is effectively becomes two separate projects requiring construction staff to be committed over a longer period of time and will require a greater sensitivity to operational conditions.

In summary, the primary concern is the impact of the construction noise on the animals. To address this a temporary wall can be constructed to separate the phase 1 area from the balance of the facility. The diagram indicates the boundary with the smallest common wall separating the two areas. This temporary wall will need to be constructed first and will either remain in place or at the end of the project. It will be designed to provide acoustic separation with a low sound transmission through the assembly and treated with acoustic sealant. This method will manage the migration of ambient construction noise, but there is no effective means for managing the vibrational noise or that may be transmitted through the existing building structure. Isolation of this form of vibrational disturbance is not manageable or preventable in this existing building context. It cannot be guaranteed that the research animals will not be impacted by or stressed from construction activities. Consideration by the University should be given to comparing the limited transportation and acclimation stress of moving the animals to another facility versus the several months' long stress associated with a two-phase construction process that will likely require 12 to 18 months to complete.

Reversed Phases

A phasing sequence where the 0200 suite is implemented first followed by the 0400 area was considered. This option is not viable as the HVAC units and associated available space and location does not support this sequence necessary for renovation. It was determined to not be feasible.

Appendix A

Vivarium Floor Plans

Description:

The following four graphic plans document the layout of the existing vivarium with its current configuration followed by three proposed layout options that represent a minimum, a moderate and an intensive level of changes and improvements.

ESTIMATED ANIMAL CAPACITY:

MICE:
33 RACKS 5280 CAGES 15840 ANIMALS

RATS:
33 RACKS 2310 CAGES 4620 ANIMALS

RABBITS:
33 RACKS 264 CAGES 264 ANIMALS

ASSUMPTIONS:

160 MOUSE CAGES PER RACK WITH THREE MICE PER CAGE
70 RAT CAGES PER RACK WITH TWO RATS PER CAGE
8 RABBIT CAGES PER RACK WITH 1 RABBIT PER CAGE

NUMBERS IN PARENTHESES DENOTE ASSUMED RACK CAPACITY FOR EACH ANIMAL HOLDING ROOM.

EXISTING SPACE ALLOCATION:

DEDICATEDANIMAL HOLDING	3351 SQ. FT.
DED. PROCEDURE/LAB SPACE	417 SQ. FT.
FLEX. ANIM. HOLD. OR PROC.	0 SQ. FT.
DED. STORAGE	506 SQ. FT.
STAFF/SUPPORT	698 SQ. FT.
CAGE WASH	1184 SQ. FT.
CORRIDOR	2359 SQ. FT.
NET USABLE TOTAL SQUARE FEET:	8515 SQ. FT.

SCOTT HALL BASEMENT VIVARIUM EXISTING FLOOR PLAN

SCALE: 1/16" = 1'-0"

WAYNE STATE UNIVERSITY

LOCATION:
DETROIT, MICHIGAN

CONTACT:
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issue:	date:
PROGRESS	11-17-17
ENGINEERING USE	01-15-18

PRELIMINARY NOT FOR CONSTRUCTION

designed by:	J. FLIGGER
drawn by:	J. FLIGGER
coordination checked:	J. FLIGGER
checked:	
approved:	

project:
SCOTT HALL VIVARIUM STUDY

sheet title:
EXISTING PLAN

project number: 1156-10
sheet number: 1

ESTIMATED ANIMAL CAPACITY:

MICE:		
30 RACKS	4800 CAGES	14400 ANIMALS
RATS:		
30 RACKS	2100 CAGES	4200 ANIMALS
RABBITS:		
30 RACKS	240 CAGES	240 ANIMALS

ASSUMPTIONS:

160 MOUSE CAGES PER RACK WITH THREE MICE PER CAGE
70 RAT CAGES PER RACK WITH TWO RATS PER CAGE
8 RABBIT CAGES PER RACK WITH 1 RABBIT PER CAGE

NUMBERS IN PARENTHESES DENOTE ASSUMED RACK CAPACITY FOR EACH ANIMAL HOLDING ROOM.

PROPOSED SPACE ALLOCATION:

DEDICATEDANIMAL HOLDING	2616 SQ. FT.
DED. PROCEDURE/LAB SPACE	499 SQ. FT.
FLEX. ANIM. HOLD. OR PROC.	532 SQ. FT.
DED. STORAGE	1523 SQ. FT.
STAFF/SUPPORT	713 SQ. FT.
CAGE WASH	1148 SQ. FT.
CORRIDOR	2150 SQ. FT.
NET USABLE TOTAL SQUARE FEET:	9181 SQ. FT.

SCOTT HALL BASEMENT VIVARIUM MINIMAL ALTERATION OPTION

SCALE: 1/16" = 1'-0"

WAYNE STATE

WAYNE STATE UNIVERSITY

LOCATION:
DETROIT, MICHIGAN

CONTACT:
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ENGINEERING USE	01-15-18
REVISION	02-20-18

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checked:	
approved:	

project:
SCOTT HALL
VIVARIUM STUDY

sheet title:
MINIMAL ALTERATION
OPTION

project number: 1156-10

sheet number: 2

ESTIMATED ANIMAL CAPACITY:

MICE:
29 RACKS 4640 CAGES 13920 ANIMALS

RATS:
29 RACKS 2030 CAGES 4060 ANIMALS

RABBITS:
29 RACKS 232 CAGES 232 ANIMALS

ASSUMPTIONS:

160 MOUSE CAGES PER RACK WITH THREE MICE PER CAGE
70 RAT CAGES PER RACK WITH TWO RATS PER CAGE
8 RABBIT CAGES PER RACK WITH 1 RABBIT PER CAGE

NUMBERS IN PARENTHESES DENOTE ASSUMED RACK CAPACITY FOR EACH ANIMAL HOLDING ROOM.

PROPOSED SPACE ALLOCATION:

	DEDICATEDANIMAL HOLDING	2903 SQ. FT.
	DED. PROCEDURE/LAB SPACE	881 SQ. FT.
	FLEX. ANIM. HOLD. OR PROC.	0 SQ. FT.
	DED. STORAGE	1324 SQ. FT.
	STAFF/SUPPORT	713 SQ. FT.
	CAGE WASH	1258 SQ. FT.
	CORRIDOR	2098 SQ. FT.
NET USABLE TOTAL SQUARE FEET:		9177 SQ. FT.

SCOTT HALL BASEMENT VIVARIUM
MODERATE ALTERATION OPTION

SCALE: 1/16" = 1'-0"

WAYNE STATE

WAYNE STATE UNIVERSITY

LOCATION:
DETROIT, MICHIGAN

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ENGINEERING USE	01-15-18
OWNER REVIEW	02-20-18

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checked:	
approved:	

project:
SCOTT HALL
VIVARIUM STUDY

sheet title:
MODERATE ALTERATION
OPTION

project number:	sheet number:
1156-10	3

ESTIMATED ANIMAL CAPACITY:

MICE:			
28 RACKS	4480 CAGES	13440 ANIMALS	
RATS:			
28 RACKS	1960 CAGES	3920 ANIMALS	
RABBITS:			
28 RACKS	224 CAGES	224 ANIMALS	

ASSUMPTIONS:

160 MOUSE CAGES PER RACK WITH THREE MICE PER CAGE
70 RAT CAGES PER RACK WITH TWO RATS PER CAGE
8 RABBIT CAGES PER RACK WITH 1 RABBIT PER CAGE

NUMBERS IN PARENTHESES DENOTE ASSUMED RACK CAPACITY FOR EACH ANIMAL HOLDING ROOM.

PROPOSED SPACE ALLOCATION:

DEDICATEDANIMAL HOLDING	2850 SQ. FT.
DED. PROCEDURE/LAB SPACE	881 SQ. FT.
FLEX. ANIM. HOLD. OR PROC.	0 SQ. FT.
DED. STORAGE	849 SQ. FT.
STAFF/SUPPORT	713 SQ. FT.
CAGE WASH	1704 SQ. FT.
CORRIDOR	2185 SQ. FT.
NET USABLE TOTAL SQUARE FEET:	9182 SQ. FT.

SCOTT HALL BASEMENT VIVARIUM
INTENSIVE ALTERATION OPTION

SCALE: 1/16" = 1'-0"

WAYNE STATE

WAYNE STATE UNIVERSITY

LOCATION:
DETROIT, MICHIGAN

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ENGINEERING USE	01-15-18
REVISION	02-20-18

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coordination checked:	J. FLIGGER
checked:	
approved:	

project:
SCOTT HALL
VIVARIUM STUDY

sheet title:
INTENSIVE ALTERATION OPTION

project number:	sheet number:
1156-10	4

Appendix B

Areas Served by Existing Air Supply Systems

Description:

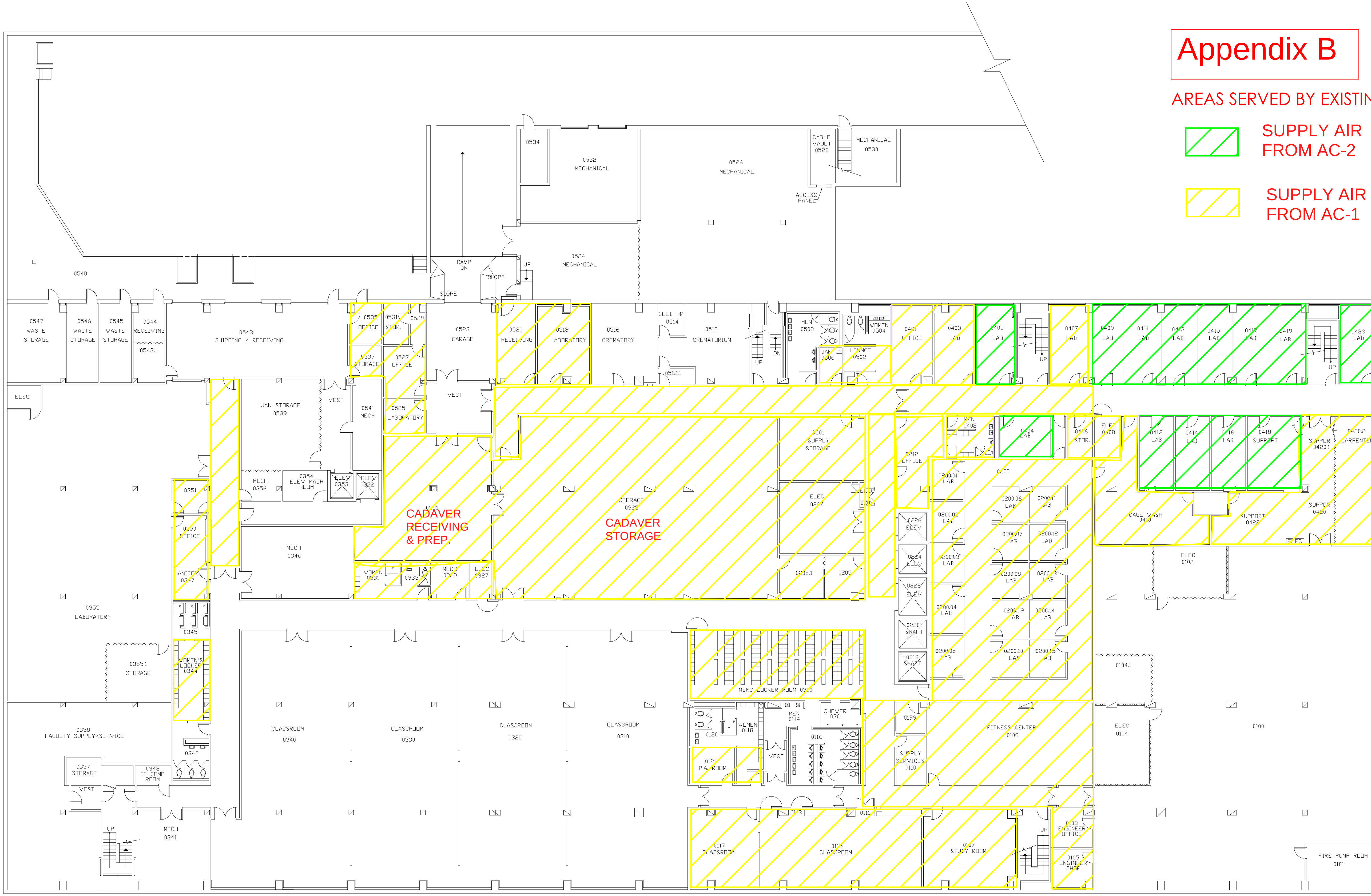
Appendix B identifies the areas that are served by each of the two existing air handling units (AC-1 and AC-2). AC-1 is the larger of the two units, and serves the majority of the Basement Floor. All spaces served by AC-1 are identified with a yellow hatch pattern. AC-2 is the smaller of the two units, and it serves only spaces within the existing vivarium. All spaces served by AC-2 are identified with a green hatch pattern.

Appendix B

AREAS SERVED BY EXISTING UNITS

SUPPLY AIR FROM AC-2

SUPPLY AIR FROM AC-1



SCOTT HALL
BUILDING #612
BASEMENT FLOOR

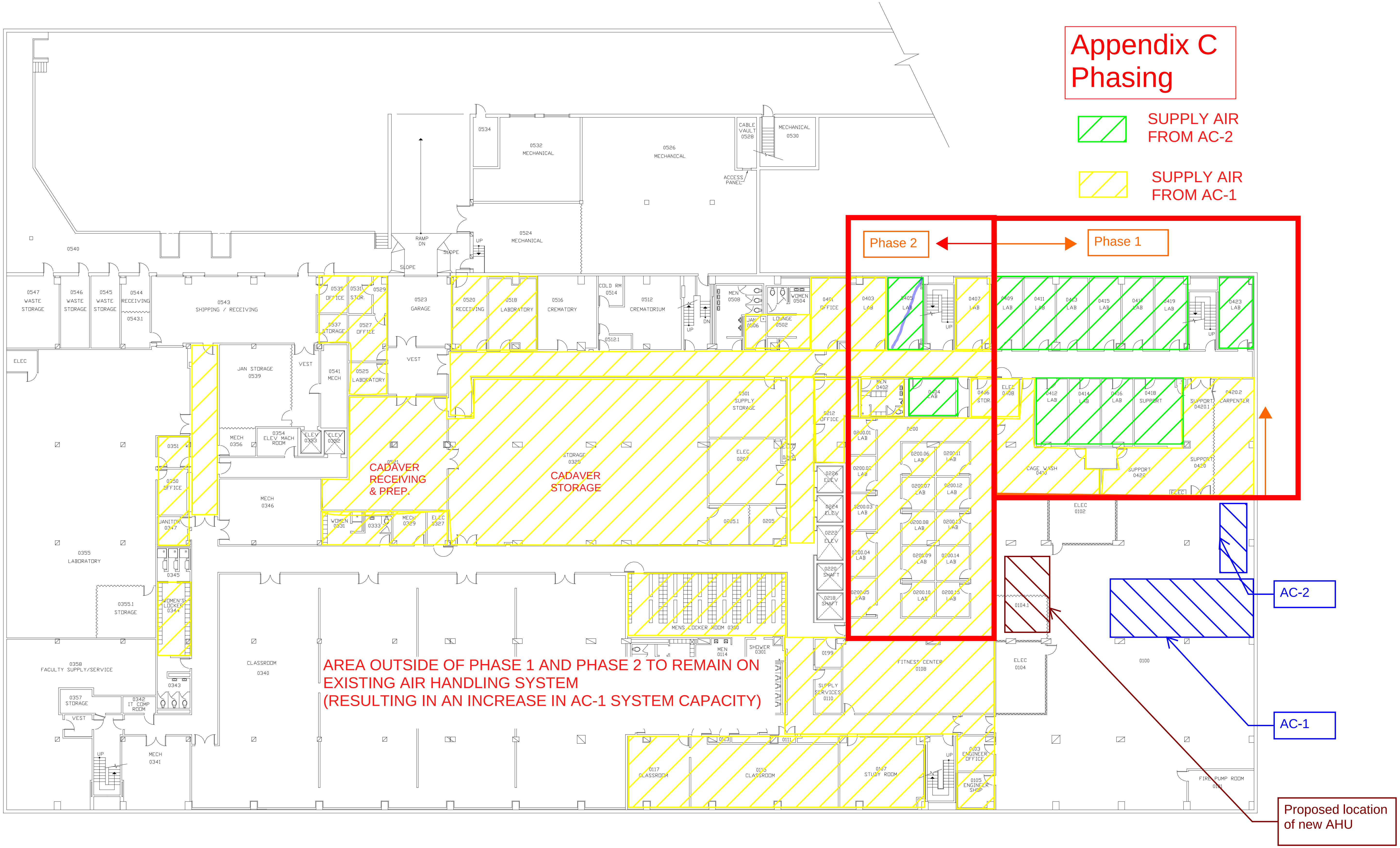
Appendix C

Phasing Plan

Description:

Appendix C graphically represents how the design team envisioned a two-phase project could be phased. This also reflects how the pricing was structured. Phase 1 is the northeast corner of the vivarium suite. This was chosen because it essentially encompasses everything currently served by AC-2. Putting these spaces in phase 1 will allow us to demolish AC-2 as part of phase 1, which opens up mechanical room floor space for new equipment.

Appendix C Phasing



SCOTT HALL
BUILDING #612
BASEMENT FLOOR

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Appendix D

Estimate of Probable Cost

Description:

Appendix D is an estimate of probable cost. It forms the detail and basis for the estimate of probable cost referenced in "Section M. Recommendations" of this report. The other estimates were arrived at by modifying quantities and scope within the framework of this cost model.

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ESTIMATE OF PROBABLE COST'
Project: **Scott Hall Vivarium Study**
Project No.: **612-302440**
Date: **3/26/2018**

Vivarium GSF 10,400 not including Mechnical Area

				Two Phase Renovation		
		ESTIMATE SUMMARY	**Single Phase**	**Phase 1**	**Phase 2**	**NOTES**
01	GENERAL REQUIREMENTS					
		Dumpsters and Trucking	2,000.00	1,000.00	1,000.00	
		HVAC System Support	0.00	10,000.00	0.00	rental to keep half operational
		Temporary Construction	0.00	3,800.00	0.00	Stairwell | Stairwell and Ph 1 Barrier Wall
		TOTAL-GENERAL REQUIREMENTS	2,000.00	14,800.00	1,000.00	
02	EXISTING CONDITIONS					
		Demolition	46,614.67	23,307.34	27,968.80	Pit for Cage & Rack Washer
		TOTAL-SITE WORK	46,614.67	23,307.34	27,968.80	
03	CONCRETE					
		Misc. Concrete	2,350.00	1,880.00	705.00	HVAC Pads, Floor Patching, Leveling
		TOTAL-CONCRETE	2,350.00	1,880.00	705.00	
04	MASONRY					
		Misc. CMU (New and Alteration)	35,950.00	14,380.00	21,570.00	
		TOTAL-MASONRY	35,950.00	14,380.00	21,570.00	
05	METALS					
		Misc. Metals	19,740.24	7,896.10	11,844.14	Supports, Drainage Grate
		TOTAL-METALS	19,740.24	7,896.10	11,844.14	
06	WOOD & PLASTICS					
		Misc Carpentry	7,000.00	5,000.00	2,000.00	
		Millwork & Countertops	4,875.00	0.00	4,875.00	
		TOTAL-WOOD & PLASTICS	11,875.00	5,000.00	6,875.00	
07	THERMO & MOISTURE PROTECTION					
		Moisture Protectioon	10,000.00	4,000.00	6,000.00	
		Adhesives and Sealants	10,000.00	4,000.00	6,000.00	
		TOTAL-THERMO & MOISTURE PROTECTION	20,000.00	8,000.00	12,000.00	
08	DOORS & WINDOWS					
		Hollow Metal Doors and Frames	20,790.88	8,316.35	12,474.53	
		Hardware	27,500.00	11,000.00	16,500.00	
		TOTAL-THERMO & DOORS & WINDOWS	48,290.88	19,316.35	28,974.53	
09	FINISHES					
		Lay-in Washable Ceiling Tile	15,000.00	10,500.00	4,500.00	
		Lay-in Ceiling Tile	2,930.00	0.00	2,930.00	
		Gyp Bd Ceiling	17,955.00	4,488.75	13,466.25	
		Epoxy	67,575.00	33,787.50	33,787.50	
		Ceramic Tile	2,379.00	0.00	2,379.00	
		Ceramic Tile Wainscot	4,512.00	0.00	4,512.00	
		Gyp. BD. Partition Walls	5,175.00	0.00	5,175.00	
		Epoxy Painting	52,416.00	20,966.40	31,449.60	
		Paint Doors and Frames	4,210.80	1,684.32	2,526.48	
		TOTAL-FINISHES	172,152.80	71,426.97	100,725.83	
10	SPECIALTIES					
		Signage	2,237.20	1,342.32	25.57	
		Lockers	568.84	0.00	568.84	
		Bench	167.10	0.00	167.10	
		Grab Bars	124.80	0.00	124.80	
		Coat Racks	300.00	0.00	300.00	
		Mirrors	93.60	0.00	93.60	
		Toilet Accessories	84.14	0.00	84.14	
		TOTAL-SPECIALTIES	3,575.68	1,342.32	1,364.05	
11	EQUIPMENT					
		Heavy Duty Shelving	9,500.00	0.00	9,500.00	
		New Sinks	4,150.00	1,245.00	2,905.00	
		Sink Fixtures	3,300.00	990.00	2,310.00	
		Hose Reels	1,159.92	347.98	811.94	
		EM Eyewash	3,060.00	765.00	2,295.00	
		Shower	1,750.00	0.00	1,750.00	
		Stainless Vivarium Equipment - Cage Wash Area	2,400.00	2,400.00	0.00	
		Washer	900.00	0.00	900.00	
		Dryer	900.00	0.00	900.00	
		Sterilizer (Autoclave)	40,000.00	40,000.00	0.00	
		Cabinet Washer	26,000.00	26,000.00	0.00	
		Rack Washer	55,000.00	55,000.00	0.00	
		Biological Safety Cabinet	84,000.00	25,200.00	58,800.00	procedure rooms
		Cage Changing Station	72,000.00	23,976.00	47,952.00	enlarged rooms
		Ventilated Cage Rack	184,000.00	88,000.00	96,000.00	enlarged rooms
		TOTAL-EQUIPMENT	488,119.92	263,923.98	224,123.94	
12	FURNISHINGS					
		Base Cabinets and Benchtops	19,320.00	5,796.00	13,524.00	
		Wall Cabinets	3,600.00	1,080.00	2,520.00	
		Tall Cabinets	4,000.00	0.00	4,000.00	
		TOTAL-FURNISHINGS	26,920.00	6,876.00	20,044.00	

15	MECHANICAL					
		HVAC	1,210,000.00	960,000.00	320,000.00	
		Plumbing	190,000.00	100,000.00	100,000.00	
		Fire Protection	40,000.00	20,000.00	20,000.00	
		TOTAL-MECHANICAL	1,440,000.00	1,080,000.00	440,000.00	
16	ELECTRICAL					
		Electrical	490,000.00	280,000.00	240,000.00	
		Structured Cabling	30,000.00	15,000.00	15,000.00	
		TOTAL-ELECTRICAL	520,000.00	295,000.00	255,000.00	
		PROJECT SUB-TOTAL	**2,837,589.19**	**1,813,149.05**	**1,152,195.30**	
	DESIGN CONTINGENCY AND ESCALATION					
		Design Fee	286,596.51	183,128.05	116,371.73	
		Design Contingency	141,879.46	90,657.45	57,609.76	
		Escalation	85,127.68	54,394.47	34,565.86	
		TOTAL-CONTINGENCIES	513,603.64	328,179.98	208,547.35	
	CONSTRUCTION					
		Contigency	141,879.46	90,657.45	57,609.76	
		Staffing	200,000.00	140,000.00	120,000.00	
		General Conditons	170,255.35	108,788.94	69,131.72	inc after hours work and shut downs
		Construction Fee	85,127.68	54,394.47	34,565.86	
		TOTAL AE FIXED LIMIT OF CONSTRUCTION	597,262.49	393,840.87	281,307.34	
	TOTAL COST SINGLE PHASE		**3,948,455.32**	2,535,169.90	1,642,049.99	$372.09/SF
	TOTAL COST TWO PHASES				**4,177,219.88**	$393.61/SF