Thesis Final Report 2006-2007

# Civista Medical Center

La Plata, MD



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# Civista Medical Center

**— LaPlata, MD —**

## Project Team

- **Owner:** Civista Health, Inc.
- **CM:** Gilbane Building, Co.
- **A/E:** Ellerbe Becket, Inc.

## Mechanical, Lighting / Electrical

- **Mechanical**
    - **Heating System:** (2) 60 psig 200 BoHP Boilers w/ PRV stations.
    - **Cooling System:**(3) 500-667 ton Cooling Towers, (5) 75-450 ton Chillers
- **Electrical**
    - **480/277V:** Lighting, Major Mech. Equip., Building Equip.
    - **208/120V:** Lighting, Small Mech. Equip., Small Building Equip.
    - **Building Service:** 15 kV service
- **Lighting**
    - **Interior:** Fluorescents and HID fixtures throughout @ 277V. Incandescent fixtures @ areas with dimming or decorative applications
    - **Exterior:** Low Wattage HID (metal halide)

## Project Features

- **Scope:** New Addition & Renovations
- **Duration:** 12/1/04—8/1/07
- **Size:** 159,167 SF
- **Total Cost:** $43,941,344
- **Delivery Method:** CM @ Risk w/ GMP
- **Occupancy:** Institutional I-2

## Architectural & Structural

- **Foundation:** Augered CIP Concrete, 5" Slab on Grade
- **Structure:** CIP Concrete
- **Floors:** 10" Two-Way Flat Slab, Columns 24" Square, 8" Drop Panels
- **Exterior Walls:** Precast Stone Masonry Units with Modular Face Brick
- **Building Use:** Medical Care

Gilbane CIVISTA. Health

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**<u>Appendices</u>**

# Acknowledgements

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# Executive Summary

The Civista Medical Center project is a three-phase addition, renovations, and site development project in LaPlata, MD. Its intent is to accommodate the increasing service volumes at the medical center. The recent population growth in the primary service area of the hospital is forecast to continue into the foreseeable future. As a result, the hospital has faced challenges accommodating particular service needs. The new addition comprises of four new floors of patient care and an elevator core on the south side of the existing hospital. New construction coupled with selective renovation should boost Civista back as a viable competitor in the Health Care market.

The Research Topic investigates Infection Control Risk Assessment (ICRA). ICRA a strategic plan intended to identify and alleviate potential risks associated with the air quality environment during the construction phase of a project. Careful coordination and sequencing is essential to properly address and respond to these issues. The research analyzed similar projects to establish a plan unique to Civista.

The first Technical Analysis examines the replacement of the existing Steam Pressure Reducing Valve with a new Non-Condensing Backpressure Steam Turbine. The turbine generates useful electricity from steam flow, ultimately saving Civista money on energy costs.

The Second Technical Analysis looks at the replacement of copper feeders with aluminum alloy (AA-8000 Series) feeders. Recent research indicates that Aluminum can perform just as efficiently as copper at a fraction of the cost. The analysis will discuss its benefits.

# PROJECT DESIGN OVERVIEW

## ***Primary Engineering Systems***

### *Architecture (Design and Functional Components)*

Civista's expansion includes the construction of a new four-story, 120,000 square-foot patient care facility, two new levels of a Cardiac Intensive Care Unit expanded above the existing structure, and miscellaneous renovations throughout the existing facility. Updates and additions to the emergency department, surgery, same-day-surgery, and nursing units are all included in the scope of work.

The materials used to construct the façade will match those of the existing structure to blend the new with the old. Its functional design does present a few new features. A curtain wall atrium at the east service entry reflects Civista's modern and updated look and a new courtyard in the structure's interior acts as retreat for recovering patients and family members. Its new construction will be technologically viable and visually appealing.


**Figure 1: Rendering of Civista's East Service Entry**

### *Building Envelope*

The exterior walls of the Civista Medical Center consist of four different systems; (1) field glazed, prefabricated single and multi-span aluminum curtain and window wall,

(2) modular face, non load-bearing brick, (3) prefabricated calcium silicate masonry, and (4) metal wall panel assembly.

1) Field glazed, prefabricated single and multi-span aluminum curtain and window wall systems consists of windows that are either 1" clear, low E coated insulate glass units or 1" spandrel glass assembly. These systems are located at the east service entrance and all exterior windows (except at the CICU expansion, where there are fixed aluminum window systems).
2) The modular face, non load-bearing brick is designed to match the existing building in terms of size, color, and orientation. This system is constructed over either concrete block backup or over steel stud. The brick over concrete block backup is located along the ground floor masonry screen wall between the courtyard and service area. The brick over steel stud is located elsewhere.
3) The prefabricated calcium silicate masonry units are located at various locations. They are architecturally appealing and measure 11-5/8" wide x 23-5/8" long x 3-5/8" wide. Its assembly is similar to the brick over the steel stud system.
4) The metal wall panel assembly is a system consisting of prefabricated, non-insulated, metal panels applied to the face of the structural steel stud framing and secured to outside face of the floor slab. Metal wall panels are located at various locations.

Finally, the roofing system is comprised of loose laid EPDM membrane with rock and paver ballasts over tapered insulation, all on top of the level concrete deck.

***Demolition***

The demolition required on the Civista project occurs in three phases.  Phase 1 includes 3500SF of the existing asphalt paving along the southwestern entrance, the existing helipad (upon completion of proposed helipad), and an existing police office/shed.  Phase 2 includes approximately 7600SF of asphalt, 440LF of curbing, and 2400SF of parking island removal along the southeastern part of the building in preparation for the construction of the new addition.  Phase 3 of demolition includes the existing La Plata Town Hall and surrounding asphalt.  The Town Hall is approximately 6200SF and the remaining asphalt is another 2460SF.  During all work, contractors have to protect trees, plant growth, and features designated to remain as final landscaping and as required by local regulatory agencies.

***Structural***

The foundation consists of augered cast-in-place pile foundation system.  Cast-in-place pile caps along with grade beams tie the foundation system together.  The slab on grade is typical at a 5” depth, and 6” at the loading dock area.  Two-way concrete slabs account for the majority of the elevated structural system.  Concrete is bucket placed by tower crane at a typical 10” in depth with 6.25” drop panels.  The slabs are supported by 24” square columns.  Concrete slabs require a 4000psi strength and columns require a 5000psi strength.  In total, the foundation requires approximately 2000 Cubic Yards of concrete.  Four floors of elevated slab, along with columns, require 1300 Cubic Yards of concrete.

Steel is the main structural element at the loading dock and access bridge areas only.  They require approximately 45 tons of steel.  Here, it is incorporated as composite floor systems consisting of steel floor decking with nominal column size of 12”. As for the foundation, 32 tons of rebar and 208 SF of weld wire mesh were utilized as reinforcement. The elevated cast-in-place slabs and columns require another 50 tons.

***Electrical***

The electrical service to the new addition will be provided by expanding and reconfiguring the existing 13.8 kV primary switchgear line to a new 15 kV 480/277-Volt switch. The primary distribution will feed lighting and major mechanical equipment loads (including elevators). Dry-type transformers will provide 208/120-Volt power for small mechanical equipment loads and receptacles. The existing outdoor standby diesel generator, located adjacent to the existing building, will provide emergency power to the new addition.

***Mechanical***

*Heating:* The new addition will be service by a 60psig steam supply system from the main plant. It will also be used to generate humidification. Domestic hot water heating is electric-fired (no steam). The heating system includes:

- 60psig steam boilers
- Steam pressure reducing valve stations
- Steam to heating water heat exchangers and pumps (one stand-by)
- Base mounted end-suction or vertical split case hot water circulating pumps (one stand-by)
- Automatic heating water flow control valves and associated accessories

*Cooling:* Civista’s chilled water capacity is generated by two separate plants. The cooling system includes:

- New 500 ton Cooling Tower
    - New 225 ton Chiller

- Existing 667 ton Cooling Tower
    - Existing 450 ton Chiller
    - Existing 400 ton Chiller
- Existing 500 ton Cooling Tower
    - Existing 125 ton Chiller
    - (2) Existing 75 ton Chillers

*Air Handling:* There are five air handling units designated to serve the building.

They are as follows:

- **AHU-1**: 28,100 cfm, (2) supply fans at 50 HP and (2) return fans at 15 HP, variable volume unit with hot water reheat
- **AHU-2**: 26,200 cfm, (2) supply fans at 50 HP and (2) return fans at 15 HP variable volume unit with hot water reheat
- **AHU-3**: 51,000 cfm, (1) supply fan at 100 HP and (1) return fan at 25 HP, variable volume unit with hot water reheat
- **AHU-7**: 10,555 cfm, (1) supply fan at 30 HP and (1) return fan at 15 HP, variable volume unit with hot water reheat
- **AHU-8**: 18,000 cfm, (1) supply fan at 30 HP and (1) return fan at 15 HP, variable volume unit with hot water reheat

### *Fire Protection*

Existing 6” fire service will be removed and rerouted. A new 6” fire loop will be provided around the site and will supply the new addition with a 6” Fire Water (FW) service and 6” Domestic Water service. Both will connect to the existing / rerouted service. The FW will include a double check valve backflow preventer on a new 250 gallons per minute electric pump at 15 HP. The pump will service inside sprinklers and hoses. A combined sprinkler / standpipe system will be provided. The standpipe risers will be located in stairwells. All fire department valves will be located on floor landings. Pre-Action systems will be provided for the elevator machine rooms. Sprinklers in all rooms will be Quick Response. In existing areas undergoing renovations, the existing piping will be modified as required to accommodate the new layouts.

## Project Cost Evaluation

- ***Actual GMP*** (less site work, landscaping, etc.):
  - $29,651,976
  - Unit Price @ 159,167 SF: $186 / SF

- ***Total Project Costs:***
  - $43,941,344
  - Unit Price @ 159,167 SF: $276 / SF

- ***Major Building Systems Costs:***
  - Mechanical: $6,480,995 – $41 / SF
  - Electrical: $3,782,322 – $24 / SF
  - Structural: $5,743,840 – $36 / SF
  - Site work: $2,700,000

- ***Square Foot Estimate from Cost Works 2005***
  - Unit Price of total project costs: median - $181 / SF, ¾ percentile - $275 / SF
  - Mechanical & Electrical: median - $60 / SF

- ***D4 Cost Estimate***
  - Smart averaging of 3 medical facilities ranging from 117,000 SF to 164,000 SF
  - Estimate Cost $32,927,840

## ***Project Summary Schedule***

Civista is organized into three different phases. Phase 1 focuses of site preparation. During this phase, three main activities occur. First, the ambulance route to the emergency room is routed and the old route is reconstructed. Next, preparation can begin for the building pad of the new addition. Finally, the helipad is relocated and parking lots are demoed. Phase 2 focuses on the new addition. During this phase, the foundation and four new levels are constructed as well as an elevator core. Phase 3 focuses on the renovations. Renovations will occur in selected areas and departments of the existing hospital.

***** Please reference Appendix A.***

# PROJECT TEAM OVERVIEW

***Client Information***

The owner of this project is Civista Health, Inc.  Civista Health is a regional, not-for-profit, integrated health system serving Charles County and the surrounding areas of southern Maryland.  Their primary project goal of the addition and renovation is to make Civista Medical Center financially viable in the near future by allowing the hospital to better compete in the current healthcare/health services market.  Improvements to specific facility deficiencies will create a patient oriented environment.

The cost of the project was set between the Owner, Civista Health, and the Construction Manager, Gilbane Building Company, as a Guaranteed Maximum Price of approximately $43 million.  The existing offices of Civista Health, Inc are located in the existing medical center, making for easy communication between parties.  Issues concerning material samples, color samples, and mock-ups result in more timely decisions.

The schedule is vital to the owner's interest due to the well-being of Civista's patients.  They work along side the Construction Manager towards a common goal of proper coordination and sequencing.  The size of the site aided in easy transitions between phases and smooth completion critical tasks.  The helipad changeover is an example.

Civista Health, Inc has made clear the importance of safety and has worked closely with Gilbane to properly promote it.  Appropriate actions are taught and monitored to assure coherence to the Project Safety Plan.

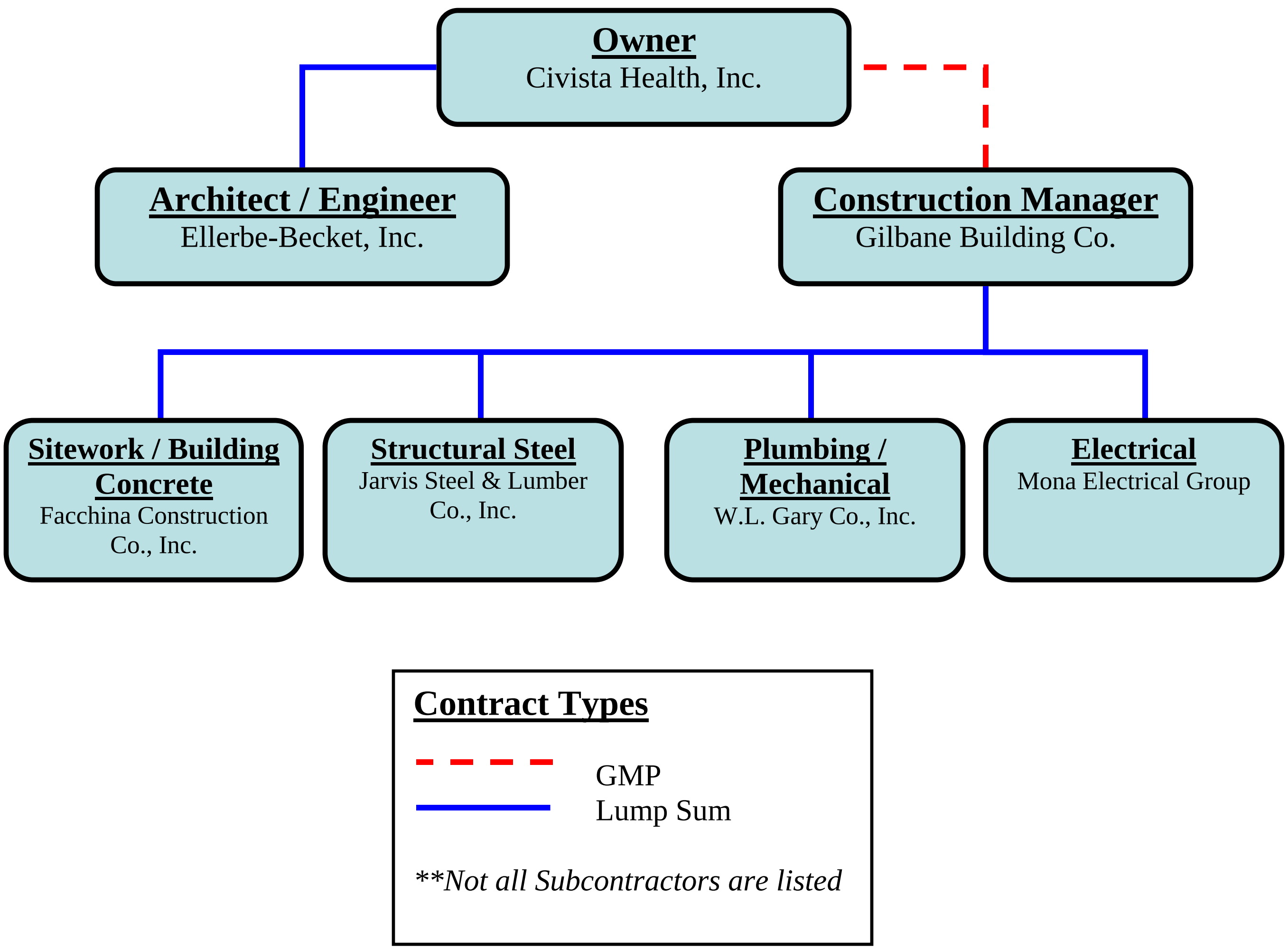
Finally, quality control is a significant aspect during medical facility construction, especially when dealing with Infection Control. It is of the utmost importance to the owner that a safe, clean environment be established and maintained during construction so that proper care can be delived to the hospital's patients. Infection Control Risk Assessment requires the Owner and CM to work together towards formulating and executing a strategic plan intended to identify and alleviate potential risks associated with the air quality environment during the construction phase of a project. It's to be carried through from the initial design stages to the completion and turnover of the project.

## ***Project Delivery System***

The Construction of the Civista Medical Center is delivered as a Construction Management at-Risk with a Guaranteed Maximum Price (GMP) contract with the owner. A CM at-Risk delivery method allows the CM to act as general contractor during construction, assuming the risk of subcontracting the work, and guaranteeing completion of the project. However, the most appealing benefit to a CM at-Risk method is its ability to allow the owner to interview and select a fee-based firm to manage construction before the design is complete. The CM is able to work along side the architects and design engineers to develop and estimate the design in progress. Specific to Civista, this delivery method integrates Gilbane into the design team and allows them to provide value-added expertise where the contractor usually has significant input in the design process.

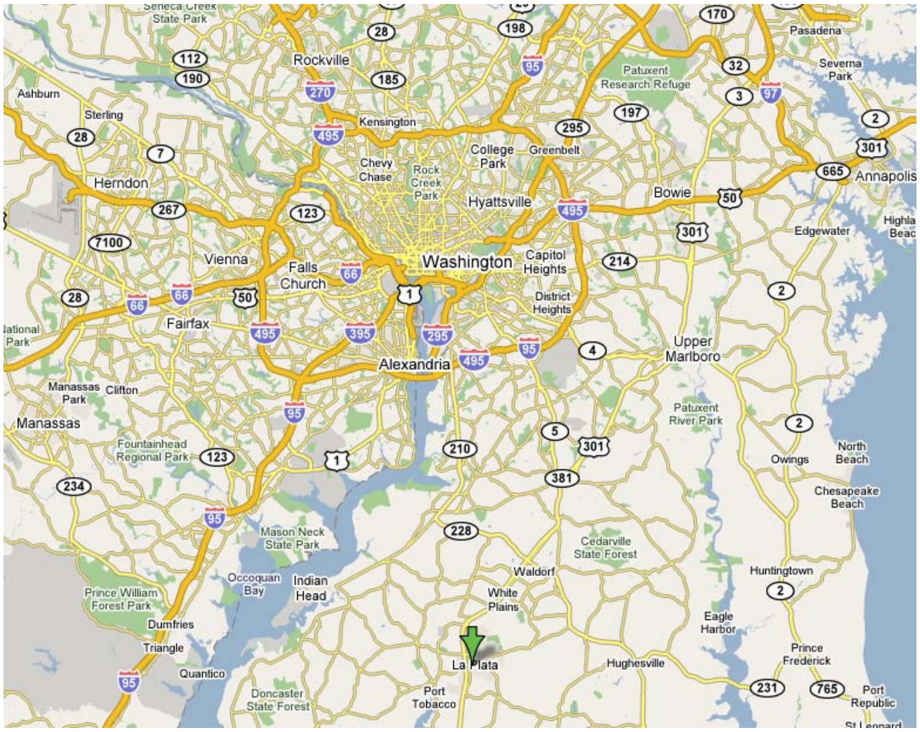
A Guaranteed Maximum Price (GMP) was provided to the owner by Gilbane upon the completion of the construction documents. The GMP includes Gilbane's fee plus the lump sum totals of the subcontractors. The contract between the owner and CM was approved by the Owner at approximately $43 million and is scheduled for 32 months. The Lump Sum contracts that Gilbane holds with the subcontractors (since a CM at-Risk delivery method puts Gilbane as the primary contract holder) includes contract documents, scope of work, bid break downs, unit rates, construction milestones, termination conditions, change order process, bonds and insurance, paid when paid, etc. Subcontractors were appropriately chosen through competitive bids.

# Civista Medical Center Organizational Chart

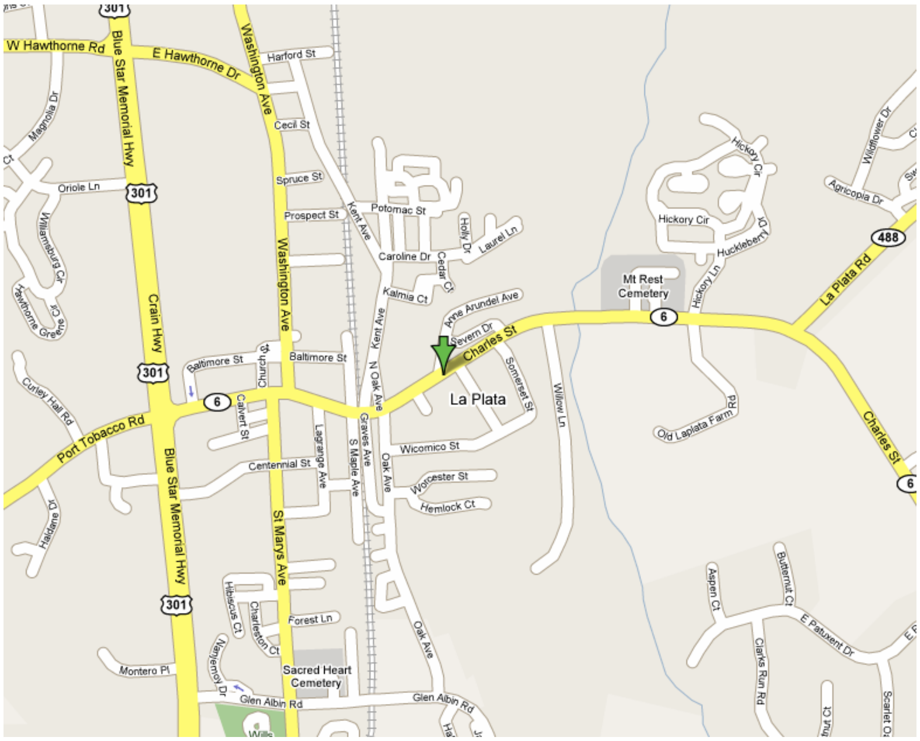


# EXISTING CONDITIONS

## ***Vicinity Maps***




**Project Vicinity Map – La Plata, MD & Its Relation to Washington DC**




**Project Vicinity Map – La Plata, MD**

## ***Local Conditions***

The town of La Plata is a relatively small with a population around 8500 people. It is located in southern Maryland, about 30 miles southeast of Washington DC, 60 miles south of Baltimore, and 45 miles southwest of Annapolis. The existing site is approximately 10 Acres and is zoned as Institutional I-2 to accommodate the original hospital constructed in the late 1960s and additions added in the 1970s and 1980s. The main objective on this project was to combine the existing architectural and structural components with the newly planned components. Given the constraints of a 14’-0” as the typical floor-to-floor height, the structure’s depth, and the existing concrete building to be connected became the critical factors in determining that this facility was to be designed as a concrete structure.

**Figure 2: Arial Picture of the Civista**

The site logistics plan is a challenge due to the task of keeping adequate on-site Civista employee and customer parking available. Parking, factored with the amount of site demolition and construction, requires careful planning and sequencing to avoid setbacks and delays. Local off site parking lots alleviated some of the stress by opening their lots to Civista.

Parking for the construction management staff as well as other members of the project team was not a major concern. By working out of a nearby, single-story house, most of their parking could be accommodated on the house's property. As for trade contractors, parking was a much greater challenge. Due to the limited on site area, typically only foreman were allowed vehicles on site. Off site parking lots were coordinated through the town of La Plata. Buses transport workers from the lots to the site every morning and back to lots every evening. The greatest concern was locating additional patient and customer parking. Much of the existing is phased for demolition. Luckily, the hospital is comparatively small and parking is available on adjacent property.

The Geotechnical Engineering Report, prepared by Schnabel Engineering, concludes excessive settlement due to clay and clay sands. This type of soil has low bearing capacities. To properly accommodate these conditions, the foundation must be properly designed. In this case, the engineer recommends deep foundation systems consisting of augured cast-in-place piles along with imported fill with desired properties.

***Existing Conditions Site Plan***

Please reference Appendix B for a copy of Civista's Existing Conditions Site Plan. Site utilities that required relocation include sanitary sewer, storm sewer, water main, and gas main.

# PROJECT LOGISTICS DETAILS

## ***Detailed Project Schedule***

Please refer to the detailed schedule for Civista in Appendix C. The schedule focuses on the main addition and consists of items 198 line items. It is organized in chronological order by site work, structure, enclosure, interior rough-ins, interior finishes, and clean-up / punchlist / commissioning. Each item is listed with its duration, start and finish dates. The 32 month project begins construction February 2005 and continues through to the completion date in December 2006. All trades provided input towards scheduled activities and later agreed upon the schedule at an initial project schedule meeting. The superintendent's two-week look-ahead meetings, held weekly, were important to the success of the on time completion.

## ***General Conditions Estimate***

Please refer to the general conditions estimate for Civista in Appendix D. It was completed using RS Means Cost Works 2005 and cost data reports obtained from Gilbane. It includes project staffing costs as well as unit and lump sum costs incurred by the construction manager. Gilbane's fee is only 1.5%. This could result from the estimate not including home office overhead and the fact that their on-site office was an existing house, reducing mobilization costs.

# RESEARCH

***Problem***

The construction at Civista Medical Center consists of three phases; a main building addition, a vertical expansion of the existing building, and selective renovations. All three areas must establish a unique Infection Control Risk Assessment or the construction will compromise the existing structure's air quality. Many of the existing building's occupants are in need of sterile environments. An unsanitary environment may jeopardize patients' well-being.

***Goal***

The goal of this research is to illustrate the contents of a tactical plan that will solve the problem of infectious risk for Civista Medical Center throughout the duration and complete of construction.

***Research Techniques***

- Research and study ICRA subject matter to gain an in-depth understanding
- Interview industry members to gather ICRA interests, concerns, and ideas
- Determine a focused assessment to perform
- Determine governing guidelines of ICRA
- Visit Civista for a firsthand evaluation
- Perform Infection Control Risk Assessment
- Publish an ICRA report that will solve the problem of infectious risk at Civista

***Expected Results***

The expected result of this research topic is to provide an Infection Control Risk Assessment of Civista Medical Center. It will indicate areas of concern and propose a tactical solution to the problem (inadequate air quality).

***Background***

The risk of spreading infectious material during construction and renovation is a serious concern in the health care industry. The Centers for Disease Control and Prevention claim that "healthcare-associated infections account for an estimated 2 million infections, 90,000 deaths, and $4.5 billion in excess health care costs annually". Of course, these statistics are not solely attributed to poor construction practices; however, it does demonstrate the need for careful planning to eliminate any danger of introducing bacteria and microorganisms to the surrounding patient occupied facilities. An Infection Control Risk Assessment (ICRA) is a method geared towards suppressing these threats.

Infection Control Risk Assessment (ICRA) is best defined as a strategic plan intended to identify and alleviate potential risks associated with the air quality environment during the construction phase of a project. It's to be carried through from the initial design stages to the completion and turnover of the project. It's unique to the project and is intended to ensure the health safety of its respective occupants. ICRA was first introduced as a requirement for patient areas in health care related projects in the 2001 edition of the *American Institute of Architects (AIA) Guidelines for Design and Construction of Healthcare Facilities*. This requirement was later made mandatory by the *Joint Commission for Accreditation of Health Care Organizations (JCAHO)* and is now implemented on every health care related project in the country. Table 1 presents selective events of nosocomial infection associated with the dispersal of microorganisms during construction per the *Association for Professionals in Infection Control and Epidemiology's* 2000 report on *The Role of Infection Control During Construction in Health Care Facilities*. Once a strategic plan is implemented, Interim Life Safety

Measures (ILSM) are applied. ILSM are a series of actions required to be taken to temporarily compensate for hazards posed by existing *Life Safety Code* deficiencies or construction activities, allowing for safe execution of the ICRA.

**Table 1.** Selected events of nosocomial infection associated with the dispersal of microorganisms during construction

| Year, author | Organism | Population | Epidemiologic factors |
|---|---|---|---|
| Airborne | | | |
| 1976 Aisner et al[1] | Aspergillus spp | Acute leukemia | Fireproofing insulation |
| 1982 Lentino et al[2] | Aspergillus spp | BMT; renal | Road construction; window air conditioners |
| 1985 Krasinski et al[3] | Rhizopus; Aspergillus | Neonatal | False ceiling |
| 1987 Streifel et al[4] | Penicillium spp | BMT | Rotted wood cabinet |
| 1987 Weems et al[5] | Rhizopus; Mucor sp; | Hematologic BMT | Construction activity |
| 1990 Fox et al[6] | Penicillium sp; Cladosporium sp | OR | Ventilation duct fiberglass insulation |
| 1991 Arnow et al[7] | Aspergillus sp | Cancer-melanoma | Tiles; humidified cell incubators; air filters |
| 1993 Flynn et al[8] | Aspergillus terreus | ICU | ICU renovation; elevators |
| 1994 Gerson et al[9] | Aspergillus sp | General | Carpeting |
| 1995 Alvarez et al[10] | Scedosporium prolificans (inflatum) | Neutropenic hematology | Construction, presumed environmental |
| 1996 Pittet et al[11] | Aspergillus sp | COPD | Air filter replacement |
| Waterborne | | | |
| 1976 Haley et al[12] | Legionella spp | Immunosuppressed | Soil; water |
| 1980 Dondero et al[13] | Legionella spp | Adults, employees | Cooling towers |
| 1980 Crane et al[14] | Pseudomonas paucimobilis | ICU | Potable water used to fill flush water bottles |
| 1985 Claesson et al[15] | Group A Streptococcus | Maternity | Shower head |
| 1993 Sniadeck et al[16] | Mycobacterium xenopi | Endoscopy-pseudo | Potable water; scopes |
| 1997 Dearborn et al[17] | Stachybotrys atra | Infants | Water-damaged homes |
| 1997 Fridkin et al[18] | Acremonium kiliense | Ambulatory surgery | Vent system humidifier |

BMT, Bone marrow transplant; OR, operating room; ICU, intensive care unit; COPD, chronic obstructive pulmonary disease.

It is up to the multi-disciplinary professional team to develop infection control strategies, inspect the construction areas during all construction phases, and monitor the air quality to ensure that the plan is properly implemented and carefully executed from the design phase clear through the project completion and turnover.

***Implications of ICRA***

The professional team primarily concerned ICRA is the owner, construction manager, and trade contractors. Each assumes a different responsibility in infection control. The owner is responsible for the ICRA budget and its completion prior to the commencement of work. ICRA precautions may result in costly measures (barriers, negative air pressure, etc.). However, there is no avoiding the required steps. If a project is over budget, cuts have to be made elsewhere. The construction manager will be involved in preconstruction planning and implementation of the infection control measures. Furthermore, they are responsible for the monitoring, documentation, and quality control of the scope of work. It is their responsibility to lead by example and stress the importance of ICRA. Weekly meetings should address the issue and penalize subcontractors responsible for lack in effort. The trade contractors are not specialty contractors and may not always know the proper procedures to comply with ICRA. However, it is required for them to abide by the provided infection control measures. With everyone working together to successfully fulfill their obligations and each others needs, minimal problems should be encountered along the way.

***Infection Control Risk Assessment Analysis of Civista Medical Center***

The following assessment will be conducted for the renovation area only. The new building addition is to be completely sealed off from the existing structure throughout its construction, thus, posing no threat to its occupants. Access to the existing will not be punched out until substantial completion.

**Step One:** *Identify Type of Construction Project Activity (Type A-D)*

| | |
|---|---|
| **Type A** | **Inspection and Non-Invasive Activities.**<br>Includes, but is not limited to:<br>• removal of ceiling tiles for visual inspection limited to 1 tile per 50 square feet<br>• painting (but not sanding)<br>• wall covering, electrical trim work, minor plumbing, and activities which do not generate dust or require cutting of walls or access to ceilings other than for visual inspection. |
| **Type B** | **Small scale, short duration activities which create minimal dust.**<br>**Includes, but is not limited to:**<br>• installation of telephone and computer cabling<br>• access to chase spaces<br>• cutting of walls or ceiling where dust migration can be controlled. |
| **Type C** | **Work that generates a moderate to high level of dust or requires demolition or removal of any fixed building components or assemblies.**<br>Includes, but is not limited to:<br>• sanding of walls for painting or wall covering<br>• removal of floor coverings, ceiling tiles, and casework<br>• new wall construction<br>• minor duct work or electrical work above ceilings<br>• major cabling activities<br>• any activity which cannot be completed within a single work shift. |
| **Type D** | **Major demolition and construction projects.**<br>Includes, but is not limited to:<br>• activities which require consecutive work shifts<br>• requires heavy demolition or removal of a complete cabling system<br>• new construction. |

The construction at Civista is classified as **Type D** construction. The scope of work includes several items from Types A, B, and C; however, the new construction will result in the latter and place Civista in Type D.

**<u>Step 2:</u>** *Identify the Patient Risk Groups*

*** If more than one group is affected, select the group at greater risk.*

| Group 1 Low Risk | Group 2 Medium Risk | Group 3 High Risk | Group 4 Highest Risk |
|---|---|---|---|
| • Office areas | • Cardiology<br>• Echocardiology<br>• Endoscopy<br>• Nuclear Medicine<br>• Physical Therapy<br>• Radiology/MRI<br>• Respiratory Therapy | • Emergency Room<br>• CCU<br>• Labor and Delivery<br>• Outpatient Surgery<br>• Laboratories (specimen)<br>• Newborn Nursery<br>• Pediatrics<br>• Pharmacy<br>• Post Anesthesia Care Unit<br>• Surgical Units | • All OR's<br>• Sterile Processing Areas<br>• Burn Unit<br>• All Cardiac Cath & Angiography Areas<br>• Intensive Care Units<br>• Medical Units<br>• Oncology<br>• Negative Pressure Isolation Rooms<br>• Any area caring for immunocompromised patients. |

Civista is a **<u>Group 4: *Highest Risk*</u>** facility. It falls under this category since a vertical expansion will house the new Intensive Care Unit.

**<u>Step 3:</u>** *Match the*

Patient Risk Group *(Low, Medium, High, Highest)* with the planned…
Construction Project Type *(Type A, B, C, D)* on the following matrix, to find the…
Class of Precautions *(I, II, III, IV)* or level of infection control activities required.

**Class of Precautions: Construction Project by Patient Risk**

| Risk Level | Construction Activity | | | |
|---|---|---|---|---|
| | **Type "A"** | **Type "B"** | **Type "C"** | **Type "D"** |
| Group 1 | I | II | II | III/IV |
| Group 2 | I | II | III | IV |
| Group 3 | I | III | III/IV | IV |
| Group 4 | III | III/IV | III/IV | **IV** |

**Table 2: Class of Precautions**

Civista is a **Type D** project and falls under the category of Highest Risk, **Group 4**. This results in a **Class IV** Classification of Precautions. Consult the required Infection Control precautions listed on the following page. Class IV Classification requires an Infection Control approval prior to turnover.

## Description of Required Infection Control Precautions by Class

| Class | During Construction Project | Upon Completion of Project |
|---|---|---|
| **Class I** | 1. Execute work by methods to minimize raising dust from construction operations.<br>2. Immediately replace ceiling tile if displaced for visual inspection. | |
| **Class II** | 1. Provide active means to prevent airborne dust from dispersing into atmosphere.<br>2. Water mist work surfaces to control dust while cutting.<br>3. Seal unused doors with duct tape.<br>4. Block off and seal air vents.<br>5. Place dust mat at entrance and exit of work area.<br>6. Remove or isolate HVAC system in areas where work is being performed. | 1. Wipe work surfaces with disinfectant.<br>2. Contain construction waste before transport in tightly covered containers<br>3. Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area.<br>4. Remove isolation of HVAC system in areas where work was being performed. |
| **Class III** | 1. Remove or isolate HVAC system in areas where work is being performed to prevent contamination of duct system.<br>2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control tube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins.<br>3. Maintain negative pressure within work site utilizing HEPA equipped air filtration units.<br>4. Contain construction waste before transport in tightly covered containers.<br>5. Cover transport receptacles or carts. Tape covering unless solid. | 1. Do not remover barriers from work area until completed project is inspected by the owner's Safety Department and Infection Control Department and thoroughly cleaned by the owner's Environmental Services Department.<br>2. Remove barrier materials carefully to minimize spread of dirt and debris associated with construction.<br>3. Vacuum work area with HEPA filtered vacuums.<br>4. Wet mop with disinfectant.<br>5. Remove isolation of HVAC system in areas where work was being performed. |
| **Class IV** | 1. Isolate HVAC system in area where work is being done to prevent contamination of duct system.<br>2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control tube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins.<br>3. Maintain negative pressure within work site utilizing HEPA equipped air filtration units.<br>4. Seal holes, pipes, conduits, and punctures appropriately.<br>5. Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site of they can wear cloth or paper coveralls that are removed each time they leave the work site.<br>6. All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worked exits the work area.<br>7. Do not remover barriers from work area until completed project is inspected by the owner's Safety Department and Infection Control Department and thoroughly cleaned by the owner's Environmental Services Department. | 1. Remove barrier materials carefully to minimize spread of dirt and debris associated with construction.<br>2. Contain construction waste before transport in tightly covered containers.<br>3. Cover transport receptacles or carts. Tape covering unless solid lid.<br>4. Vacuum work area with HEPA filtered vacuums.<br>5. Wet mop with disinfectant.<br>6. Remove isolation of HVAC system in areas where work was being performed. |

**<u>Step 4:</u>** **Identify areas surrounding the project area, assessing potential impact.**

| | |
|---|---|
| Unit Below: | High |
| Unit Above: | N/A |
| Lateral: | High |
| Behind: | N/A |
| Front: | High |

**<u>Step 5:</u>** **Identify specific site of activity (e.g. patient rooms, operating rooms, etc.)**

Patient Rooms, Intensive Care, Cardiology, Operating Rooms, Physical Therapy, Offices.

**<u>Step 6:</u>** **Identify issues related to ventilation, plumbing, and electrical in terms of occurrence of probable outages.**

Must submit an outage request for any planned outages.

**<u>Step 7:</u>** **Identify containment measures, using prior assessment. Types of barriers? Will HEPA filtration be required?**

Solid wall barriers between new and existing construction.

Plastic barriers in renovation areas.

HEPA filtration.

**<u>Step 8:</u>** **Consider potential risk of water damage. Is there a risk due to compromising structural integrity?**

No.

**<u>Step 9:</u>** **Work hours: Can or will the work be done during non-patient care hours?**

No.

**<u>Step 10:</u>** **Do plans allow for adequate number of isolation/negative airflow rooms?**

Yes.

**<u>Step 11:</u>** **Do plans allow for the required number and type of hand washing sinks?**

Yes.

**<u>Step 12:</u>** **Does the infection control staff agree with the minimum number of sinks for this project?**

Yes.

**<u>Step 13:</u> Does the infection control staff agree with the plans relative to clean and soiled utility rooms?**

Yes.

**<u>Step 14:</u> Plan to discuss the following containment issues with the project team.**

Traffic Flow / Egress, Debris Removal, Housekeeping, Phasing,
Construct/Deconstruct Trash Chute

***<u>Suggested Infection Control Actions</u>***

Reiterating the fact that the Civista Medical Center Project consists of new construction, renovations, and a vertical expansion, this project falls in line at a Class IV precaution level. The scope of work requires, but is not limited to, additional plumbing and sprinkler piping, HVAC ductwork, as well as electrical and telecomm cable/wiring. MEP expansions/updates require demolition and penetrations through walls, floors, and ceilings. This construction may create a poor, depressurized, air quality; hazardous to surrounding patients if not properly contained.

Considering the previously stated ICRA recommendations and suggestions, precautions taken in preventing infectious risk are as follows:

- A dust proof plastic barrier with a door and framed will be installed to contain demo debris and dust, and protect patients
- The air vents inside the work area will be sealed with plastic sheeting
- Dust mats will be placed at the entrance and exit of work area
- Negative air pressure will be maintained within the work area utilizing HEPA equipped air filtration units
- The construction debris will be transported in tightly covered containers

- Inside work area will be completely cleaned prior to the removal of the plastic barrier
- After removal of the plastic barrier, area will be cleaned again with disinfectant
- All staff in the area is to be briefed prior to the commencement of work

In order to assure the safety of the building occupants, the following Interim Life Safety Measures are to be taken. These steps go hand-in-hand with the ICRA:

- Infection Control Risk Assessment and Interim Life Safety Measures forms submitted and approved.
- All fire door exits will be maintained for clear access at all times.
- The Hospital's existing life safety systems will not be interrupted.
- Additional fire fighting equipment will be available
- All staff in the area is to be briefed prior to the commencement of work
- Install dust proof plastic barriers to contain demo debris and protect occupants
- During demo, ensure that all loads of debris are properly covered
- Clean up interior area, enclosed by barriers
- Remove temporary barriers upon completion
- Clean and disinfect entire area upon removal of temporary barriers

***Additional ICRA Provision Unique to Civista***

The Civista project team follows published guidelines similar to the matrix system above.  Some areas of construction require more stringent provisions than others. The new addition is completely isolated until its substantial completion.  Upon its completion, the team will punch through to the existing building at each corridor.  Any further interior construction of the new addition will require methods of isolation similar to the renovations.  The vertical expansion requires additional plumbing and sprinkler piping to be installed above the ceiling of the existing structure and into the newly expanded levels.  Installing new piping requires demolition and penetrations to the outside environment.  This may create a poor, depressurized, air quality.  It is important that all holes, pipes, conduits, and punctures are sealed appropriately.  As for the renovated areas, the ICRA plan first studies the Decision Tree, Figure 3 on the next page. Individual rooms are sequenced – using only two rooms at a time for more localized construction and better containment.  This sequencing will be examined later.  To avoid the dangers associated with wall penetrations, the constructing team devised a solution. An example of a wall mount configuration used is shown, Figure 3.  It minimizes the number of wall penetrations by running cable and wiring down from the ceilings instead of through the walls.

**Decision Tree for Any**
**Interior Renovation Activity:**

What am I trying to do? Just investigate, or accomplish some invasive work?

*Just Investigating:* **(Write out the plan on ICRA)** *Invasive work:*

Pop one tile at a time, keep the tile above the ceiling, shield patients and visitors, use a disinfectant spray in ceiling.

Lay out the work plan, use containment, shield patients and visitors, use walk off dust Protection, signage as needed and cover trash for removal.

*What type of containment?*

| | |
|---|---|
| < 48 Hours: | Mobile Booth |
| 1-14 Days: | Plastic Wall |
| > 2 Weeks: | Hard Wall |

*Are you doing demolition?*

If taking out an existing smoke or fire wall, part of your plan must address life situation being created.

**(Write out ILSM plan also)**

*Are you affecting existing utilities and/or systems?*

You may need a plan for an outage or work around.

**(Write out an outage Request)**

**Plan the Work &**
**Work the Plan !**

**Figure 1: Decision Tree for Any Interior Renovation Activity**

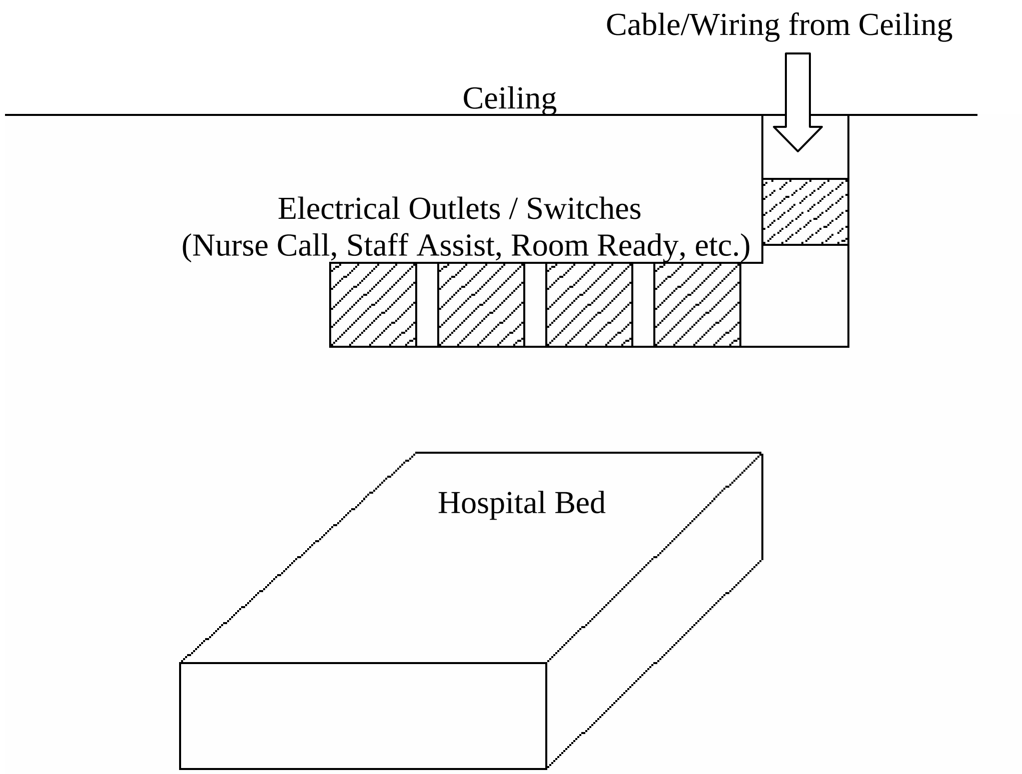



**Figure 2: Wall Mount Configuration**

Since existing utilities and systems will be affected, outage requests must be formulated. For example, the sheaves and belts on Air Handling Unit (AHU) #7 need replaced to upgrade the air flow and the maximum Cubic Feet per Minute (CFM) output. This activity will require a scheduled and approved system outage since it affects the occupied space being renovated. Figure 3, located on the next page, shows an outage request form that must be submitted by the contractor for proper outage coordination. Appropriate management of outages is extremely important. In this case, affected areas are isolated as much as possible since ventilation will be temporarily out of service. Highly sensitive at-risk patients may require the Civista medical staff to temporarily move them to more stable environment.

**OUTAGE REQUEST**

**Submitted By:** Trade Contractor

**Description of Work to be Performed Requiring Outage:**
Contractor requests an outage on AHU #7 Main Building 4th Floor Mechanical Room to replace sheaves and belts in AHU #7 to upgrade the air flow and max CFM for the addition of the ICU.

**Location of Outage:** 4th Floor Mechanical Room

**Duration of Outage:** 2 Hours (12:00 PM to 2:00 PM) 11-21-06

**Affect to Tenants:**
Outage will affect the 2nd floor North and East tenants, also 3rd floor North tenants

**Approved:** ✓ **Rejected:** _____

**CM Signature (dated):** ____________________________________

**Owner Signature (dated):** __________________________________

**Additional Comments on Procedure:**
The Unit will not be shut off until the outside temperature has reached it high for the day, considering the time of year. Furthermore, affected areas are to be isolated as much as possible since ventilation will be temporary out of service.

**Figure 3: Outage Request Form**

## *ICRA – 2nd Floor East Wing Sequencing*

The following is an ICRA plan for work done during the renovation phase. The work is sequenced in such a manner that only two rooms are isolated at any one time. This setup maximizes the amount of occupiable patient care space while safely and efficiently completing the scope of work.

**INFECTION CONTROL RISK ASSESSMENT**
***Civista Medical Center Renovation and Addition Project***

**Date:**

**Location:** 2nd Floor East Wing

**Risk Type:** A B C **[D]**

**Patient Type:** Low Risk Medium Risk
High Risk **[Highest Risk]**

**Duration of Condition:** 110 Calendar Days

**Background Description:**

Additional plumbing and sprinkler piping is required to be installed above the ceilings in the patient rooms of the 2nd Floor East Wing. This piping is required for the addition of the 3rd floor. The work will be accomplished in sequences by only involving two rooms at a time.

**Required Precautions:**

- A dust proof plastic barrier with a door and frame will be installed to contain demo debris and dust and protect patients.
- The air vents inside the work area will be sealed with plastic sheeting.
- Dust mats will be placed at the entrance and exit of work area.
- Negative air pressure will be maintained within the work area utilizing HEPA equipped are filtration units.
- The construction debris will be transported in tightly covered containers.
- Inside work are will be completely cleaned prior to the removal of the plastic barrier.
- After removal of the plastic barrier, area will be cleaned again and tile areas will be wet mopped with disinfectant.
- All staff in area will be notified and briefed on what work will take place.

Submitted By: ____________________________
Approved By: ____________________________

**INTERIM LIFE SAFETY MEASURES**
***Civista Medical Center Renovation and Addition Project***

**Date:**

**Location:** $2^{nd}$ Floor East Wing

**Deficiency:**

The areas included in the construction may involve temporarily blocking fire exits/corridor.

**Background Description:**

Additional plumbing and sprinkler piping is required to be installed above the ceilings in the patient rooms of the $2^{nd}$ Floor East Wing. This piping is required for the addition of the $3^{rd}$ floor. The work will be accomplished in sequences by only involving two rooms at a time.

**Duration of Deficiency:** 110 Calendar Days

**Interim Life Safety Measures Taken:**

- Infection Control Risk Assessment and Interim Life Safety Measures forms submitted and Approved
- All staff in area will be notified and briefed on what work will take place.
- All fire door exits will be maintained for clear access at all times
- Civista's existing life safety systems will not be interrupted.
- Additional fire fighting equipment will be available.
- Install dust proof plastic barrier to contain demo debris and protect patients.
- During removal, ensure all debris is properly covered.
- Clean up interior area.
- Remove temporary barrier upon completion
- Clean entire area. Coordinate with Engineer to replace furniture.

Submitted By: ____________________________
Approved By: ____________________________

Since areas are sequenced by two rooms at a time, there is a total of 8 sequences. Each sequence is to be completed in 10 working days. The following outlines the scope of work.

**Sequence 1, 2, 3, 6, 7, 8**

General Trades

- Remove furniture
- Construct plastic dust barrier
- Install floor protection
- Install HEPA filters in both rooms
- Cut drywall for tie-ins
- Lay out piping on ceilings
- Cut drywall ceiling for piping
- Cut drywall ceiling in toilet room for sprinkler piping and head
- Remove drywall debris

Plumbing Contractor

- Lay out piping on ceilings
- Core drill roof
- Install hangers and piping
- Perform pipe testing

Sprinkler Contractor

- Install hangers and piping
- Install sprinkler heads

General Trades

- Patch drywall walls and ceilings
- Finish paint
- Clean entire rooms
- Remove plastic dust barrier
- Clean area

**Sequence 4 and 5**

*** Can be accomplished after normal working hours without disruption to the hospital staff.*

<u>General Trades</u>

- Remove supplies from the supply room
- Construct plastic dust barrier
- Install floor protection
- Install HEPA filters in both rooms
- Demo drywall ceiling in the supply room
- Remove drywall debris
- Install plastic covering on the walls and floors in rooms to be worked that night
- Remove ceiling tiles as required

<u>Plumbing Contractor</u>

- Lay out piping on ceilings
- Core drill roof
- Install hangers and piping
- Perform pipe testing

<u>Sprinkler Contractor</u>

- Install hangers and piping
- Install sprinkler heads

<u>General Trades</u>

- Patch drywall walls and ceilings
- Finish paint
- Re-install all ceiling tiles
- Remove plastic covering from walls and floors
- Remove plastic dust barrier
- Clean area

***** Refer to Appendix E for Sequencing Drawings***

## ***Conclusion***

Infection control is a vital aspect to all health care construction projects. There are several resources available to aid in the development of a plan that is unique and effective to the project in question. Following an Infection Control Risk Assessment of the renovation phase of Civista, several specific methods for minimizing infection risk were identified. Furthermore, provisions taken that were unique to the project were identified and discussed. Finally, after reviewing several different case studies, a sequencing plan was devised for the $2^{nd}$ Floor East Wing area. This sequencing plan is intended to maximize the amount of occupiable patient care space while safely and efficiently completing the scope of work.

# TECHNICAL ANALYSIS #1

***Problem***

A pressure reducing valve will be replaced with a non-condensing (backpressure) steam turbine. A pressure reducing valve drops the building's steam pressure. In doing so, energy is consumed rather than produced.

***Goal***

Install a non-condensing (backpressure) steam turbine that produces energy while concurrently reducing the steam pressure. The energy produce by the turbine can then be directly connected to an electrical distribution panelboard. This arrangement will ultimately save money and energy.

***Research Techniques***

- Study existing conditions to gauge a firm understanding of the problem
- Interview construction team revision interests, concerns, and ideas
- Visit Civista for a firsthand evaluation
- Determine various solutions and individual benefits
- Determine a focused assessment of a solution to perform
- Perform analysis of proposed solution
- Publish a report of the MEP revision that highlights benefits and advantages to the new system.

***Expected Results***

The expected results of this technical assignment will solve the indicated problem in a manner that proves cost efficient, energy efficient, and beneficial in any way to the problem.

***Background***

The purpose of a steam turbine is pretty simple. It's part of a Combined Heat and Power System that converts otherwise wasted mechanical energy into useful electrical energy. Its main applications are in a Prime Mover and a Thermally Activated Machine. A Prime Mover is operated by steam that has been generated from an on-site boiler and used to produce electricity via an electric generator. A Thermally Activated Machine is operated by steam that has been generated by recycling waste thermal energy or by replacing steam pressure reduction valves. This type is often used in connection with applications where a need for low or medium pressure steam is necessary. Figure 1 shows a schematic of the cycle of a non-condensing backpressure turbine.

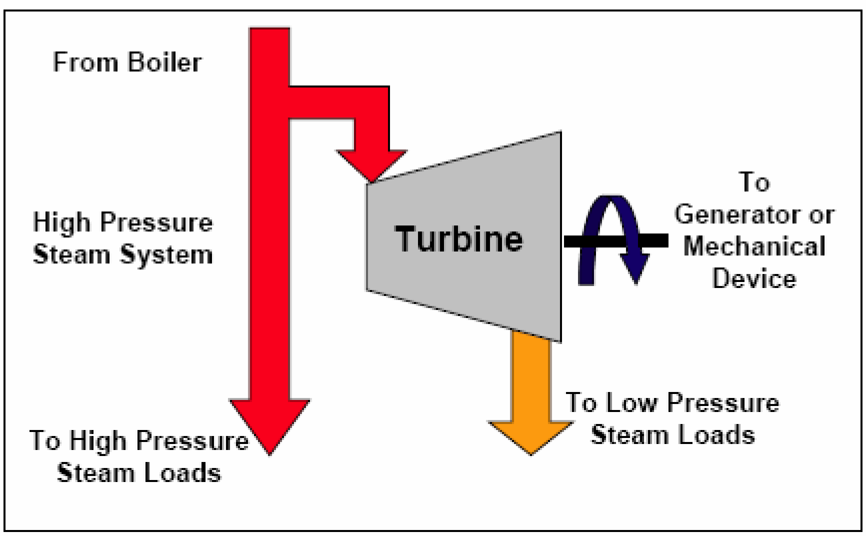



**Figure 1: Steam Turbine Cycle**

High pressure steam flows into the turbine and past its blades. In doing so, the blade shaft begins to spin. The blade shaft is directly connected to an electrical generator where it starts producing electrical power. The power output from the cycle is relative to the drop in steam pressure through the turbine. The larger the pressure drop, the larger the output. This cycle produce no emissions.

There are two different classifications of Combined Heat and Power Steam Turbines; condensing and non-condensing. In a condensing turbine, steam expands below atmospheric pressure (vacuum pressure). When it passes through the condenser (or series of condenses), a maximum pressure drop is experienced. Thus, the maximum amount of energy is extracted from each lbm of steam input. Condensing turbine systems are very efficient, operating at about 30-40% efficiency. However, they are typically more expensive than non-condensing turbines because of the required condenser. Its advantage allows steam pressure regulation, allowing for more steam to be used for thermal applications or for more steam to be used for electrical generation.

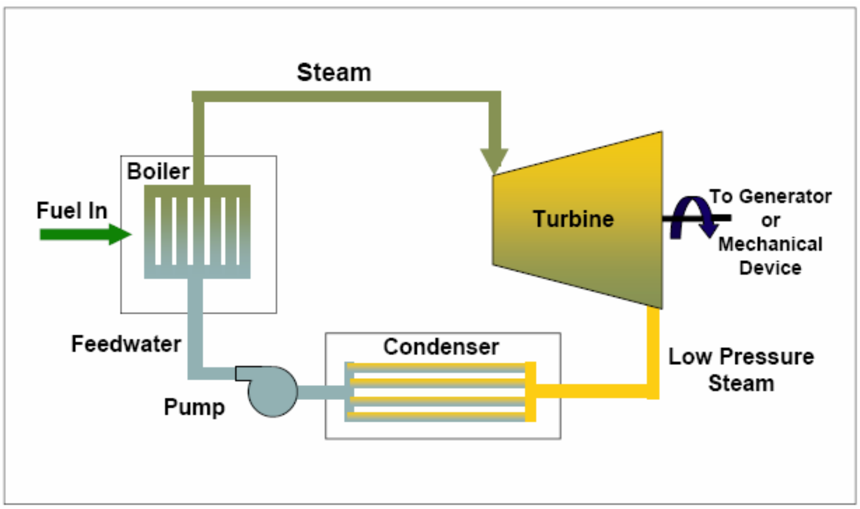



**Figure 2: A Condensing Turbine**

A non-condensing backpressure system is opposite from a condensing system in that it operates above or in excess of atmospheric pressure. It's commonly applied where medium to low pressure steam loads are required. As high pressure steam enters the non-condensing backpressure system, a portion of its thermal energy is converted into mechanical energy. It produces less useful work than that of a condensing turbine, but since unused steam from the turbine continues on to process thermal loads, the lower efficiencies (15-35%) are not of a concern. A non-condensing backpressure system is also usually less expensive.

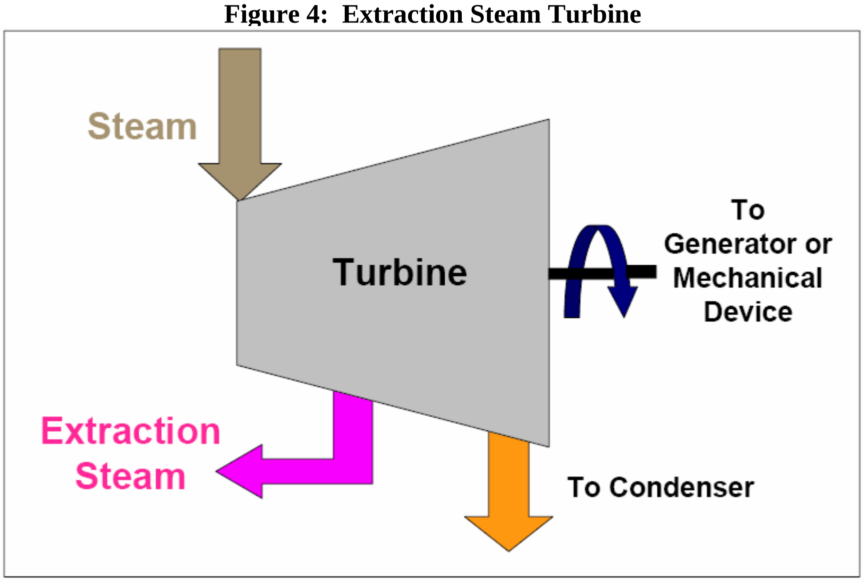
**Steam Turbine Rules-of-Thumb**

| | Backpressure | Condensing |
|---|---|---|
| Power Generation Efficiency, % | 15 - 35 | 30 - 40 |
| Steam Exhaust Pressure | At or above atmospheric | Below atmospheric |
| Steam Required, lb/h per kW | 20 - 100 | 7 - 10 |
| Installed Cost, $/kW | 300 - 400 | 500 - 700 |
| O & M Cost, ¢/kWh | .15 – .35 | .15 - .35 |

**Figure 3 Condensing vs. Non-Condensing Backpressure Turbines**

An extraction steam turbine is a multi-stage piece of equipment designed to withdraw steam from one or more stages, at one or more pressures to allow for intermediate pressure steam process applications. Extraction turbines can be either condensing or non-condensing backpressure. An extraction turbine is also known as a "bleeding" turbine since steam "bleeds" out of if at different locations.

**Figure 4: Extraction Steam Turbine**



***Redesign Steam PRV to Non-Condensing Backpressure Turbine***

Table 1 includes the existing Steam Pressure Reducing Valve present in Civista.

It will be replaced with a Non-Condensing Backpressure Turbine.

**Table 1: Steam Pressure Reducing Valve Schedule**

| Steam Pressure Reducing Valve Schedule | | | | | | |
|---|---|---|---|---|---|---|
| Tag | System | Total Capacity (lb/hr) | Inlet Pressure (psig) | Outlet Pressure (psig) | Body Size (in) | Remarks |
| PRV-1 | Heating | 3590 | 60 | 10 | 3 | |

To size the appropriate turbine, the following calculations were made:

***Given:***

- Temp. of Steam: 300$^{o}$F (est.)
- Inlet Pressure ($P_i$) = 60psig + 14.7 atm pressure = 74.7
- Outlet Pressure ($P_o$) = 10 psig + 14.7 atm pressure = 24.7
- Mass Flow Rate ( $\dot{m}$ ) = 3590 lb/hr (max.)

***Find Enthalpy using Steam Enthalpy Charts***

- $h_i$ = 269.8 BTU/lb
- $h_o$ = 1190 BTU/lb
- $\Delta h = h_o - h_i$ = 920.5 BTU/lb

***Find Power Rate***

- Q = $\dot{m}\ \Delta h$ = (3950 lb/hr) x (920.5 BTU/lb) = 3,635,975 BTU/hr

***Factor in 20% Efficiency*** *(Non-Condensing Backpressure Turbines typically 15-35% efficiency rating)*

- Q = (3,635,975 BTU/hr) x (0.20) = 727,197 BTU/hr

***Convert to kW***

- (727,197 BTU/hr) x [(1 kW) / (3412 BTU)] = 213.13 kW

*** Equipment can now be sized according to kW output.*

It is impractical that a steam turbine would operate at a rate of maximum output. Since 213.13 kW reflects full capacity drive, Table 2 below describes the output as percentage of the maximum value. This chart is most helpful in the presence of steam charts. It aids in the determination of monthly production.

| % of Turbine's Max Capacity | |
|---|---|
| 10% | 21.31 |
| 20% | 42.63 |
| 30% | 63.94 |
| 40% | 85.25 |
| 50% | 106.57 |
| 60% | 127.88 |
| 70% | 149.19 |
| 80% | 170.50 |
| 90% | 191.82 |
| 100% | 213.13 |

**Table 2: % output per Turbine's Max Capacity**

***<u>Cost Analysis</u>***

Since steam charts are not available for Civista Medical Center, a cost analysis will be performed using a percentage of the turbines maximum capacity of 3590 lb/hr. It will be assumed that the steam turbine ran nonstop from the months of July 2006 to March 2007 at 40% maximum capacity during summer months (June-October) and 60% maximum capacity during winter months (November-May). The months represented are those after the new addition began receiving service. With that in mind, Table 3 illustrates Civista's monthly electrical consumption and cost per kWh with existing Steam Pressure Reducing Valve. Table 4 shows Civista's monthly electrical consumption and cost per kWh with a new Non-Condensing Backpressure Turbine.

Again it's assumed to be operating at 40% maximum capacity during summer months and 60% during winter.

| Electric Consumption / Costs | | | |
|---|---|---|---|
| **Month-Year** | **kWh** | **Costs** | **Cost/kWh** |
| **Jul-06** | 535,073 | $52,594.90 | $0.0983 |
| **Aug-06** | 612,040 | $56,174.06 | $0.0918 |
| **Sep-06** | 707,883 | $66,111.23 | $0.0934 |
| **Oct-06** | 693,208 | $67,835.81 | $0.0979 |
| **Nov-06** | 647,974 | $65,677.09 | $0.1014 |
| **Dec-06** | 655,436 | $65,858.73 | $0.1005 |
| **Jan-07** | 700,920 | $69,181.46 | $0.0987 |
| **Feb-07** | 672,387 | $65,779.59 | $0.0978 |
| **Mar-07** | 534,237 | $52,289.27 | $0.0979 |

**Table 3: Electric Consumption and Costs with PRV**

Over the nine months evaluated, the PRV was part of a system that consumed a total of 5,759,158 kWh, costing exactly $508,907.24.

| Electric Consumption / Costs | | | |
|---|---|---|---|
| **Month-Year** | **kWh** | **Costs** | **Cost/kWh** |
| **Jul-06** | 471,646 | $46,362.75 | $0.0983 |
| **Aug-06** | 548,613 | $50,362.63 | $0.0918 |
| **Sep-06** | 646,502 | $60,383.25 | $0.0934 |
| **Oct-06** | 629,781 | $61,655.51 | $0.0979 |
| **Nov-06** | 555,902 | $56,368.45 | $0.1014 |
| **Dec-06** | 560,295 | $56,309.62 | $0.1005 |
| **Jan-07** | 605,779 | $59,790.36 | $0.0987 |
| **Feb-07** | 586,453 | $57,355.10 | $0.0978 |
| **Mar-07** | 439,096 | $42,987.48 | $0.0979 |

**Table 4: Electric Consumption and Costs with Backpressure Turbine operating at 40% capacity during summer months and 60% during winter.**



At a level where the Backpressure Turbine is operating at 40% its maximum load from July 2006 to September 2006 and at 60% its maximum load from October 2006 to March 2007, a noticeable savings can be noticed. A total of 5,044,064 kWh is consumed, 715,094kWh less than that of the Pressure Reducing Valve. This results in a cost savings of $17,332 after only ¾ of the year. Even if the percentage of the maximum load carried by the steam turbine was over estimate, there would still be significant savings.

## Conclusion

The analysis of replacing the Steam Pressure Reducing Valve with a Non-Condensing Backpressure Steam Turbine proved to be a cost effective change. The initial costs incurred would be much higher, however, over an expected life cycle of over 20 years, the steam turbine has potential to save more than $20,000 a year in energy costs, not to mention to good it’s doing for the environment.

# TECHNICAL ANALYSIS #2

***Problem***

Civista is wired using copper conductors only. Copper is an expensive material that is some opinions, offers the same performance from a much cheaper aluminum alloy alternative.

***Goal***

To replace the existing copper feeders with aluminum alloy. An analysis of the new system will compare the alloy's safeness and practicality to that of copper. Finally, a cost analysis will prove the financial benefits associated with the new system.

***Research Techniques***

- Study existing conditions to gauge a firm understanding of the problem
- Interview construction team revision interests, concerns, and ideas
- Visit Civista for a firsthand evaluation
- Determine various solutions and individual benefits
- Determine a focused assessment of a solution to perform
- Perform analysis of proposed solution
- Publish a report of the Electrical revision that highlights benefits and advantages to the new system.

***Expected Results***

The expected results of this technical assignment will solve the indicated problem in a manner that proves safe, cost efficient, time efficient, and beneficial in any way to the problem.



**Background**

Copper was not always the monopoly it is today in electrical conductor types. Aluminum was used as far back as the 1930's and 1940's. But it wasn't until a copper shortage in 1965 forced the building industry towards copper's attractively cheaper alternative, aluminum. At the same time, receptacle brass screws faded from steel screws' newly established spotlight. Problems from all over began to surface. The newly established aluminum to steel connection was far more sensitive than copper to brass. Resulting faulty connections as well as many fires scared people into believing that aluminum as a conductor was just not worth the risk.

The aluminum and other connective devices were to code standards at the times of installation. However, as these problems persisted, the building industry realized that modifications were needed for the improvement of connections and terminations. *The Report of the Commission of Inquiry on Aluminum Building Wire* provided research findings of aluminum building wire systems (specifically branch circuits) in projects constructed between the years of 1941 and 1978. The in-depth evaluation highlighted factors related to the contact resistance of wiring. In total, the study identified 19 different issues impacting contact resistance. Improper installation, thermal expansion, and creep appeared to be the most common flaws.

Improper installation can be avoided through careful attention. This includes neat wiring that is suitably stripped with the appropriate tools, wrapped in a clockwise manner, and then sufficiently tightened. In addition, appropriate materials should be used. The use of appropriate tools decreases the chances of a nicked wire. This ensures a strong wire free from defect. Wrapping the wire in a clockwise direction along the terminal allows the wire to tighten as it is screwed into place. Proper tightening makes certain that there is adequate contact area at the connection. Finally, materials such as "push-in" terminals should be avoided altogether. Items like these are made for copper connections only and create a great hazard when used with aluminum.

The thermal expansion coefficient of aluminum is much greater than that of copper. When aluminum heats up, its diameter expands, and when it cools, it contracts. Previous copper wire classifications such as AA-1350 or EC (Electrical Conductor) aluminum would gradually loosen over each period of a heat and cool cycle from continuous volume differences. These differences then resulted in creep. Creep is the rate of change of a material's permanent dimension deformation over a period of time when exposed to a force at a particular temperature. Today's AA-8000 series aluminum alloys have creep rates very similar to copper building wire, resulting in similar performance. However, if connections are not properly installed (i.e. loose connection point), oxidation occurs and corrodes the contact area. The oxidation will increase the resistance (due to decrease contact area) and temperature. Eventually, the wire will consistently get very hot, melt the insulation or fixture, or may even cause a fire.

**Figure 1: Aluminum Alloy (AA-8176) Conductors**

**NEC (National Electric Code)**

The NEC first recognized aluminum wiring systems in 1901.

***Conductor material*** **—** The NEC specifically requires aluminum conductors of most insulation types for branch-circuit wiring be made of AA-8000 series conductors. 2005 NEC Section 310.14

***Physical characteristics*** **—** The NEC includes aluminum wire dimensions. It also includes some aluminum conductor electrical properties. Consult the conductor manufacturer for more specific properties.

***Conduit fill*** **—** The NEC identifies conduit fill for compact stranded conductors based on the "(A)" tables in Annex C. These tables apply to both aluminum and copper compact stranded wire.

***Terminations*** **—** The NEC requires that terminals used for aluminum be identified. It also requires that aluminum grounding electrode conductors used outdoors shall not be terminated within 18 inches of the earth.

***Installation*** **–** The NEC references the National Electrical Installation Standards (NEIS). NECA/AA 104-2000 defines a minimum baseline of quality and workmanship for installing products and systems.

**ASTM**

AA-8000 series aluminum alloys were developed in the late 1960's. They began manufacturing it in 1972. The building wires are now manufactured according to the American Society for Testing and Materials (ASTM) B-800 and are generally compact stranded according to ASTM B-801.

**UL (Underwriters Laboratories, Inc.)**

In the early 1970's, Underwriters Laboratories removed their section on aluminum conductors for revision to require aluminum alloy conductors. Over the course of this modification, no new aluminum building wire was available for purchase except for what remained. By 1972, the aluminum alloy was being manufactured and sold. UL began listing only series AA-8000 types while at the same time also listing CO/ALR devices compatible with aluminum wire branch circuits. To this day, UL still only list AA-8000 types. These conductors require brass screws.

In 1978, UL issued standard UL486B for connectors for aluminum building wire. It contained more intense testing methods than what was previously required. Today, UL 486B has been combined with UL 486A and the combined standard contains requirements for both copper and aluminum wire connectors.

**NFPA**

All electrical connections should be periodically inspected in accordance with NFPA 70B.7

**Physical Properties**

Pre-1972 aluminum wiring was classified as type AA-1350, also known as EC (Electric Conductor) aluminum. This type of conductor consisted of approximately 99.5% pure aluminum. Copper is a far superior material compared to AA-1350.

| Characteristic Differences Between Copper and Aluminum | | |
|---|---|---|
| **Characteristic** | **Aluminum** | **Copper** |
| Coefficient of Expansion per 1 °C @ 20°C | $23 \times 10^{-6}$ | $16.6 \times 10^{-6}$ |
| Thermal Conductivity (BTU/ft/hr/fft2/°F) @ 20°C | 126 | 222 |
| Electrical Conductivity (%IAS) at 20°C | 61 | 101 |
| Tensile Strength ($lb/in^2$) - (soft) | 12,000 | 32,000 |

**Table 1: Characteristic Differences Between Copper and Aluminum**

However, today's AA-8000 aluminum alloy is much different than that of AA-1350. It contains 0.001 to 0.3% zinc, 0.001 to 0.03% titanium, 0.001 to 0.5% manganese, and 0.03 to 0.4% silicon, depending on product specification. This combination produces excellent strength and resistance to corrosion. Its composition is then made strong and flexible by annealing. Annealing is a process that heats the aluminum and then slowly cools it. By doing so, the material becomes suitable for bending and shaping the material and also prevents breaking and cracking.

AA-8000 has a higher strength-to-weight ratio than an equal ampacity copper wire. AA-8000 series is 0.006 lbs/cmil compared to 0.008 lbs/cmil for copper. It is also about half copper's weight. Since it is lighter, the pulling tension is lower. This is important when considering installation. Lower pulling tension may decrease the chances of damaging the insulated wire in doing so. Its only drawback is that its



diameter is slightly larger (based on compact stranding) for equal an ampacity copper conductor.

## Special Installation Requirements

There are far too many different connection types to explore each individual installation procedure. Instead, the use of oxide inhibitors and wire brushing will be discussed.

Terminating a conductor, both copper and AA-8000, requires similar steps. First, the insulation is stripped. Second, the exposed part of the conductor is wire brushed. Third, an oxide inhibitor is applied. Finally, the connector is tightened to the recommended value.

The exposed part of the conductor should be wire brushed to remove excessive oxide from the wire, pieces of insulation, or other contaminants that may obstruct the connection. Brush only in one direction and not too forceful. Forceful brushing can embed oxides in the wire. Also, be sure to use a brush that has only been used previously on aluminum.

A thin layer of oxide naturally forms on the exterior of aluminum and copper conductors. This layer is broken when the connection screw is physically tightened or the connection is crimped. Wire brushing will remove the oxide and prevent it from being embedded during installation.

An oxide inhibitor should be applied to all exposed parts of a conductor prior to installation. The inhibitor provides a physical barrier at the contact point that protects against moisture and other harmful substances. It’s also an important feature to successfully connecting dissimilar metals. The oxide inhibitor must be compatible with the conductor type. Some compression type connectors may come pre-filled with the appropriate oxide inhibitor. Oxide inhibitor is important to uncoated connections between copper and aluminum. This type of connection is subject to galvanic corrosion.

Always consult the manufacture and product specifications to ensure proper installation. Not all connections may require wire brushing or oxide inhibitors.

| Feeder Schedule | | | | | | |
|---|---|---|---|---|---|---|
| Feeder No. | Circuit Beaker Amp | No. of Sets | Wire Size Per Set | Ground Size Per Set | Conduit Size Per Set | Remarks |
| A | 350 | 1 | 3-1C, #4/0 AWG | 1-#2/0 AWG | 4" | TYPE XLPE/EPR 15kV RATED |
| B | 4000 | 10 | 4-#500 KCM | 1-#500 MCM | 4" | TYPE USE, 600V SERVICE ENTRANCE |
| C | 1800 | 5 | 4-#500 KCM | 1-#4/0 AWG | 4" | THHN/THWN, 600V |
| D | 1200 | 4 | 4-#500 KCM | 1-#3/0 AWG | 4" | THHN/THWN, 600V |
| E | 1000 | 3 | 4-#500 KCM | 1-#2/0 AWG | 4" | THHN/THWN, 600V |
| F | 800 | 2 | 3-#500 KCM | 1-#2/0 AWG | 4" | THHN/THWN, 600V |
| G | 800 | 2 | 4-#500 KCMIL | 1-#1/0 AWG | 4" | THHN/THWN, 600V |
| H | 800 | 2 | 4-#350 KCMIL | 1-#1/0 AWG | 3" | THHN/THWN, 600V |
| I | 500 | 2 | 3-#300 KCMIL | 1-#1/0 AWG | 3" | THHN/THWN, 600V |
| J | 500 | 2 | 4-#300 KCMIL | 1-#1/0 AWG | 3" | THHN/THWN, 600V |
| K | 400 | 1 | 4-#500 KCM | 1-#1/0 AWG | 4" | THHN/THWN, 600V |
| L | 300 | 1 | 4-#350 KCM | 1-#1/0 AWG | 3" | THHN/THWN, 600V |
| M | 250 | 1 | 4-#250 KCMIL | 1-#1 AWG | 2-1/2" | THHN/THWN, 600V |
| N | 225 | 1 | 4-#4/0 AWG | 1-#2 AWG | 2" | THHN/THWN, 600V |
| O | 200 | 1 | 4-#3/0 AWG | 1-#2 AWG | 2" | THHN/THWN, 600V |
| P | 150 | 1 | 4-#1/0 AWG | 1-#4 AWG | 1-1/2" | THHN/THWN, 600V |
| Q | 100 | 1 | 4-#1 AWG | 1-#4 AWG | 1-1/2" | THHN/THWN, 600V |
| R | 450 | 2 | 4-#250 KCMIL | 1-#1 AWG | 1-4" | THHN/THWN, 600V |
| S | 60 | 1 | 4-#4 AWG | 1-#8 AWG | 1-1/4" | THHN/THWN, 600V |
| T | 50 | 1 | 4-#8 KCM | 1-#8 AWG | 1" | THHN/THWN, 600V |
| U | 30 | 1 | 4-#10 AWG | 1-#10 AWG | 3/4" | THHN/THWN, 600V |
| U' | 30 | 1 | 3-#10 AWG | 1-#10 AWG | 3/4" | THHN/THWN, 600V |
| V | 20 | 1 | 4-#12 AWG | 1-#12 AWG | 3/4" | THHN/THWN, 600V |
| W | 60 | 1 | 3-#4 AWG | 1-#6 AWG | 1" | THHN/THWN, 600V |

| Copper Wiring and Conduit Costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **FDR ID** | **OCPD** | **Sets** | **Length (ft)** | **Copper Phase Wires** | **Copper Wire Unit Cost (per LF)** | **Copper Wire Costs** | **Conduit Size Per Set** | **EMT Conduit Unit Cost (per LF)** | **Conduit Costs** | **Total Cost per Feeder** |
| A | 350 | 1 | 50 | 3-1C, #4/0 KCMIL | *** exceeds 600V *** | | | | | |
| B | 4000 | 10 | 120 | 4-#500 KCMIL | $6.95 | $834.00 | 4" | $27.50 | $3,300.00 | $4,134.00 |
| C | 1800 | 5 | 50 | 4-#500 KCMIL | $6.95 | $347.50 | 4" | $27.50 | $1,375.00 | $1,722.50 |
| D | 1200 | 4 | 60 | 4-#500 KCMIL | $6.95 | $417.00 | 4" | $27.50 | $1,650.00 | $2,067.00 |
| E | 1000 | 3 | 40 | 4-#500 KCMIL | $6.95 | $278.00 | 4" | $27.50 | $1,100.00 | $1,378.00 |
| F | 800 | 2 | 80 | 3-#500 KCMIL | $6.95 | $556.00 | 4" | $27.50 | $2,200.00 | $2,756.00 |
| G | 800 | 2 | 130 | 4-#500 KCMIL | $6.95 | $903.50 | 4" | $27.50 | $3,575.00 | $4,478.50 |
| H | 800 | 2 | 110 | 4-#350 KCMIL | $5.45 | $599.50 | 3" | $20.50 | $2,255.00 | $2,854.50 |
| I | 500 | 2 | 100 | 3-#300 KCMIL | $4.90 | $490.00 | 3" | $20.50 | $2,050.00 | $2,540.00 |
| J | 500 | 2 | 100 | 4-#300 KCMIL | $4.90 | $490.00 | 3" | $20.50 | $2,050.00 | $2,540.00 |
| K | 400 | 1 | 400 | 4-#500 KCMIL | $6.95 | $2,780.00 | 4" | $27.50 | $11,000.00 | $13,780.00 |
| L | 300 | 1 | 200 | 4-#350 KCMIL | $5.45 | $1,090.00 | 3" | $20.50 | $4,100.00 | $5,190.00 |
| M | 250 | 1 | 90 | 4-#250 KCMIL | $4.40 | $396.00 | 2-1/2" | $16.10 | $1,449.00 | $1,845.00 |
| N | 225 | 1 | 1500 | 4-#4/0 KCMIL | $3.85 | $5,775.00 | 2" | $10.20 | $15,300.00 | $21,075.00 |
| O | 200 | 1 | 70 | 4-#3/0 KCMIL | $3.25 | $227.50 | 2" | $10.20 | $714.00 | $941.50 |
| P | 150 | 1 | 100 | 4-#1/0 KCMIL | $2.30 | $230.00 | 1-1/2" | $8.65 | $865.00 | $1,095.00 |
| Q | 100 | 1 | 1500 | 4-#1 KCMIL | $1.92 | $2,880.00 | 1-1/2" | $8.65 | $12,975.00 | $15,855.00 |
| R | 450 | 2 | 60 | 4-#250 KCMIL | $4.40 | $264.00 | 2-1/2" | $16.10 | $966.00 | $1,230.00 |
| S | 60 | 1 | 130 | 4-#4 KCMIL | $1.25 | $162.50 | 1-1/4" | $7.35 | $955.50 | $1,118.00 |
| T | 50 | 1 | 80 | 4-#8 KCMIL | $0.72 | $57.60 | 1" | $5.75 | $460.00 | $517.60 |
| U | 30 | 1 | 220 | 4-#10 KCMIL | $0.56 | $123.20 | 3/4" | $4.50 | $990.00 | $1,113.20 |
| U' | 30 | 1 | 160 | 3-#10 KCMIL | $0.56 | $89.60 | 3/4" | $4.50 | $720.00 | $809.60 |
| V | 20 | 1 | 200 | 4-#12 KCMIL | $0.48 | $96.00 | 3/4" | $4.50 | $900.00 | $996.00 |
| W | 60 | 1 | 150 | 3-#4 KCMIL | $1.25 | $187.50 | 1" | $5.75 | $862.50 | $1,050.00 |
| | | | | **TOTAL** | | **$19,274.40** | | | **$71,812.00** | **$91,086.40** |
| | | | | **TOTAL COPPER COSTS** | | | | | | **$91,086.40** |

## Aluminum Wiring and Conduct Costs

| FDR ID | OCPD | Sets | Length (ft) | Aluminum Phase Wires | Aluminum Wire Unit Cost (per LF) | Aluminum Wire Costs | Conduit Size Per Set | EMT Conduit Unit Cost (per LF) | Conduit Costs | Total Cost per Feeder |
|---|---|---|---|---|---|---|---|---|---|---|
| A | 350 | 1 | 50 | 3-1C, #4/0 KCMIL | *** exceeds 600V *** | | | | | |
| B | 4000 | 12 | 120 | 4-#500 KCMIL | $4.45 | $534.00 | 4" | $27.50 | $3,300.00 | $3,834.00 |
| C | 1800 | 5 | 50 | 4-#500 KCMIL | $4.45 | $222.50 | 4" | $27.50 | $1,375.00 | $1,597.50 |
| D | 1200 | 5 | 60 | 4-#400 KCMIL | $3.95 | $237.00 | 3-1/2" | $25.00 | $1,500.00 | $1,737.00 |
| E | 1000 | 4 | 40 | 4-#400 KCMIL | $3.95 | $158.00 | 3-1/2" | $25.00 | $1,000.00 | $1,158.00 |
| F | 800 | 3 | 80 | 3-#400 KCMIL | $3.95 | $316.00 | 3-1/2" | $25.00 | $2,000.00 | $2,316.00 |
| G | 800 | 3 | 130 | 4-#400 KCMIL | $3.95 | $513.50 | 3-1/2" | $25.00 | $3,250.00 | $3,763.50 |
| H | 800 | 3 | 110 | 4-#400 KCMIL | $3.95 | $434.50 | 3-1/2" | $25.00 | $2,750.00 | $3,184.50 |
| I | 500 | 2 | 100 | 3-#400 KCMIL | $3.95 | $395.00 | 3-1/2" | $25.00 | $2,500.00 | $2,895.00 |
| J | 500 | 2 | 100 | 4-#400 KCMIL | $3.95 | $395.00 | 3-1/2" | $25.00 | $2,500.00 | $2,895.00 |
| K | 400 | 2 | 400 | 4-#250 KCMIL | $2.76 | $1,104.00 | 2-1/2" | $16.10 | $6,440.00 | $7,544.00 |
| L | 300 | 1 | 200 | 4-#500 KCMIL | $4.45 | $890.00 | 4" | $27.50 | $5,500.00 | $6,390.00 |
| M | 250 | 1 | 90 | 4-#350 KCMIL | $3.50 | $315.00 | 3" | $10.20 | $918.00 | $1,233.00 |
| N | 225 | 1 | 1500 | 4-#300 KCMIL | $3.35 | $5,025.00 | 3" | $10.20 | $15,300.00 | $20,325.00 |
| O | 200 | 1 | 70 | 4-#3/0 KCMIL | $2.25 | $157.50 | 2" | $10.20 | $714.00 | $871.50 |
| P | 150 | 1 | 100 | 4-#1/0 KCMIL | $1.73 | $173.00 | 1-1/2" | $8.65 | $865.00 | $1,038.00 |
| Q | 100 | 1 | 1500 | 4-#1 KCMIL | $1.51 | $2,265.00 | 1-1/2" | $8.65 | $12,975.00 | $15,240.00 |
| R | 450 | 2 | 60 | 4-#250 KCMIL | $1.76 | $105.60 | 2-1/2" | $16.10 | $966.00 | $1,071.60 |
| S | 60 | 1 | 130 | 4-#4 KCMIL | $0.95 | $123.50 | 1-1/4" | $7.35 | $955.50 | $1,079.00 |
| T | 50 | 1 | 80 | 4-#8 KCMIL | $0.65 | $52.00 | 1" | $5.75 | $460.00 | $512.00 |
| U | 30 | 1 | 220 | 4-#10 KCMIL | $0.50 | $110.00 | 3/4" | $4.50 | $990.00 | $1,100.00 |
| U' | 30 | 1 | 160 | 3-#10 KCMIL | $0.50 | $80.00 | 3/4" | $4.50 | $720.00 | $800.00 |
| V | 20 | 1 | 200 | 3-#12 KCMIL | $0.46 | $92.00 | 3/4" | $4.50 | $900.00 | $992.00 |
| W | 60 | 1 | 150 | 3-#2 KCMIL | $1.20 | $180.00 | 1-1/2" | $8.65 | $1,297.50 | $1,477.50 |
| | | | | **TOTAL** | | **$13,878.10** | | | **$69,176.00** | **$83,054.10** |
| | | | | **TOTAL ALUMINUM COSTS** | | | | | | **$83,054.10** |

| Aluminum vs. Copper - Time Saved | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **FDR ID** | **Cu Sets** | **Al Sets** | **Length (ft)** | **Copper Wire Size** | **Daily Output (CLF)** | **Total Duration (days)** | **Aluminum Wire Size** | **Daily Output (CLF)** | **Total Duration (days)** | **Time Difference (days)** |
| A | 1 | 1 | 50 | 3-1C, #4/0 KCMIL | *** exceeds 600V *** | | | | | |
| B | 10 | 12 | 120 | 4-#500 KCMIL | 4.8 | 2.500 | 4-#500 KCMIL | 6 | 2.000 | 0.500 |
| C | 5 | 5 | 50 | 4-#500 KCMIL | 4.8 | 0.521 | 4-#500 KCMIL | 6 | 0.417 | 0.104 |
| D | 4 | 5 | 60 | 4-#500 KCMIL | 4.8 | 0.500 | 4-#400 KCMIL | 6.9 | 0.348 | 0.152 |
| E | 3 | 4 | 40 | 4-#500 KCMIL | 4.8 | 0.250 | 4-#400 KCMIL | 6.9 | 0.174 | 0.076 |
| F | 2 | 3 | 80 | 3-#500 KCMIL | 4.8 | 0.333 | 3-#400 KCMIL | 6.9 | 0.232 | 0.101 |
| G | 2 | 3 | 130 | 4-#500 KCMIL | 4.8 | 0.542 | 4-#400 KCMIL | 6.9 | 0.377 | 0.165 |
| H | 2 | 3 | 110 | 4-#350 KCMIL | 5.4 | 0.407 | 4-#400 KCMIL | 6.9 | 0.319 | 0.089 |
| I | 2 | 2 | 100 | 3-#300 KCMIL | 5.7 | 0.351 | 3-#400 KCMIL | 6.9 | 0.290 | 0.061 |
| J | 2 | 2 | 100 | 4-#300 KCMIL | 5.7 | 0.351 | 4-#400 KCMIL | 6.9 | 0.290 | 0.061 |
| K | 1 | 2 | 400 | 4-#500 KCMIL | 4.8 | 0.833 | 4-#250 KCMIL | 8.7 | 0.460 | 0.374 |
| L | 1 | 1 | 200 | 4-#350 KCMIL | 5.4 | 0.370 | 4-#500 KCMIL | 6 | 0.333 | 0.037 |
| M | 1 | 1 | 90 | 4-#250 KCMIL | 6 | 0.150 | 4-#350 KCMIL | 7.5 | 0.120 | 0.030 |
| N | 1 | 1 | 1500 | 4-#4/0 KCMIL | 4.4 | 3.409 | 4-#300 KCMIL | 8.1 | 1.852 | 1.557 |
| O | 1 | 1 | 70 | 4-#3/0 KCMIL | 5 | 0.140 | 4-#3/0 KCMIL | 6.6 | 0.106 | 0.034 |
| P | 1 | 1 | 100 | 4-#1/0 KCMIL | 6.6 | 0.152 | 4-#1/0 KCMIL | 8 | 0.125 | 0.027 |
| Q | 1 | 1 | 1500 | 4-#1 KCMIL | 8 | 1.875 | 4-#1 KCMIL | 9 | 1.667 | 0.208 |
| R | 2 | 2 | 60 | 4-#250 KCMIL | 6 | 0.200 | 4-#250 KCMIL | 8.7 | 0.138 | 0.062 |
| S | 1 | 1 | 130 | 4-#4 KCMIL | 10.6 | 0.123 | 4-#4 KCMIL | 13 | 0.100 | 0.023 |
| T | 1 | 1 | 80 | 4-#8 KCMIL | 8 | 0.100 | 4-#8 KCMIL | 9 | 0.089 | 0.011 |
| U | 1 | 1 | 220 | 4-#10 KCMIL | 10 | 0.220 | 4-#10 KCMIL | 11 | 0.200 | 0.020 |
| U' | 1 | 1 | 160 | 3-#10 KCMIL | 10 | 0.160 | 3-#10 KCMIL | 11 | 0.145 | 0.015 |
| V | 1 | 1 | 200 | 4-#12 KCMIL | 11 | 0.182 | 3-#12 KCMIL | 12 | 0.167 | 0.015 |
| W | 1 | 1 | 150 | 3-#4 KCMIL | 10.6 | 0.142 | 3-#2 KCMIL | 10.6 | 0.142 | 0.000 |
| | | | | **TOTAL** | | **13.810** | | | **10.089** | **3.721** |
| | | | | **TOTAL TIME SAVED (Days)** | | | | | | **4** |

## Cost Comparison

Table 1 on the following page is the Feeder Schedule for Civista Medical Center. This schedule is used to compare cost and time savings by redesigning the currently installed copper feeder distribution system to that of aluminum. Following the Feeder Schedule are Table 2 and Table 3. These schedules resize the wires accordingly to over current protection as well as the conduit. Once resized, a cost analysis was preformed.

| | |
|---|---|
| Copper Wiring Costs: | $19,274.40 |
| Copper Conduit Costs: | $71,812.00 |
| Total: | **$91,086.40** |
| | |
| Aluminum Wiring Costs: | $13,878.10 |
| Aluminum Conduit Costs: | $69,176.00 |
| Total: | **$83,054.10** |
| | |
| **Total Cost Savings:** | **$8,032.30** |

Finally, Table 4 displays the total time saved.

| | |
|---|---|
| Copper Installation Duration: | 13.810 days |
| Aluminum Installation Duration: | 10.089 days |
| | |
| **Total Time Savings:** | **4 days** |

## Conclusion

Modern aluminum alloy conductors are at least as safe and reliable as copper. Connections are evaluated and manufactured specifically for aluminum. AA-8000 series conductors have over 30 years of field installation examples proving their reliability and efficiency. They have been recognized in the NEC for more than 20 years as well as the UL.

Utilizing AA-8000 series conductors are also cost effective. On the Civista Medical Center project, the new addition alone saved over $8,000 and four days of installation time. With a project that over and over again proves to be safe, why not consider it as a legitimate option?

# CONCLUSION

Throughout this report, changes were made and fully analyzed. The analysis of replacing the Steam Pressure Reducing Valve with a Non-Condensing Backpressure Steam Turbine proved to be a cost effective change. The initial costs would be much higher, however, over an expected life cycle of over 20 years, the steam turbine has potential to save more than $20,000 a year in energy costs, not to mention to good it's doing for the environment.

The analysis of replacing copper feeder conductors with aluminum alloy AA-8000 series also seemed to be a feasible alternative. It performs as efficiently as copper, yet it is cheaper and faster to install. However, aluminum has received much criticism in the past for failed branch circuit connections. It appears that copper has proven reliable in the industry and no one wants to take the risk of switching to aluminum.

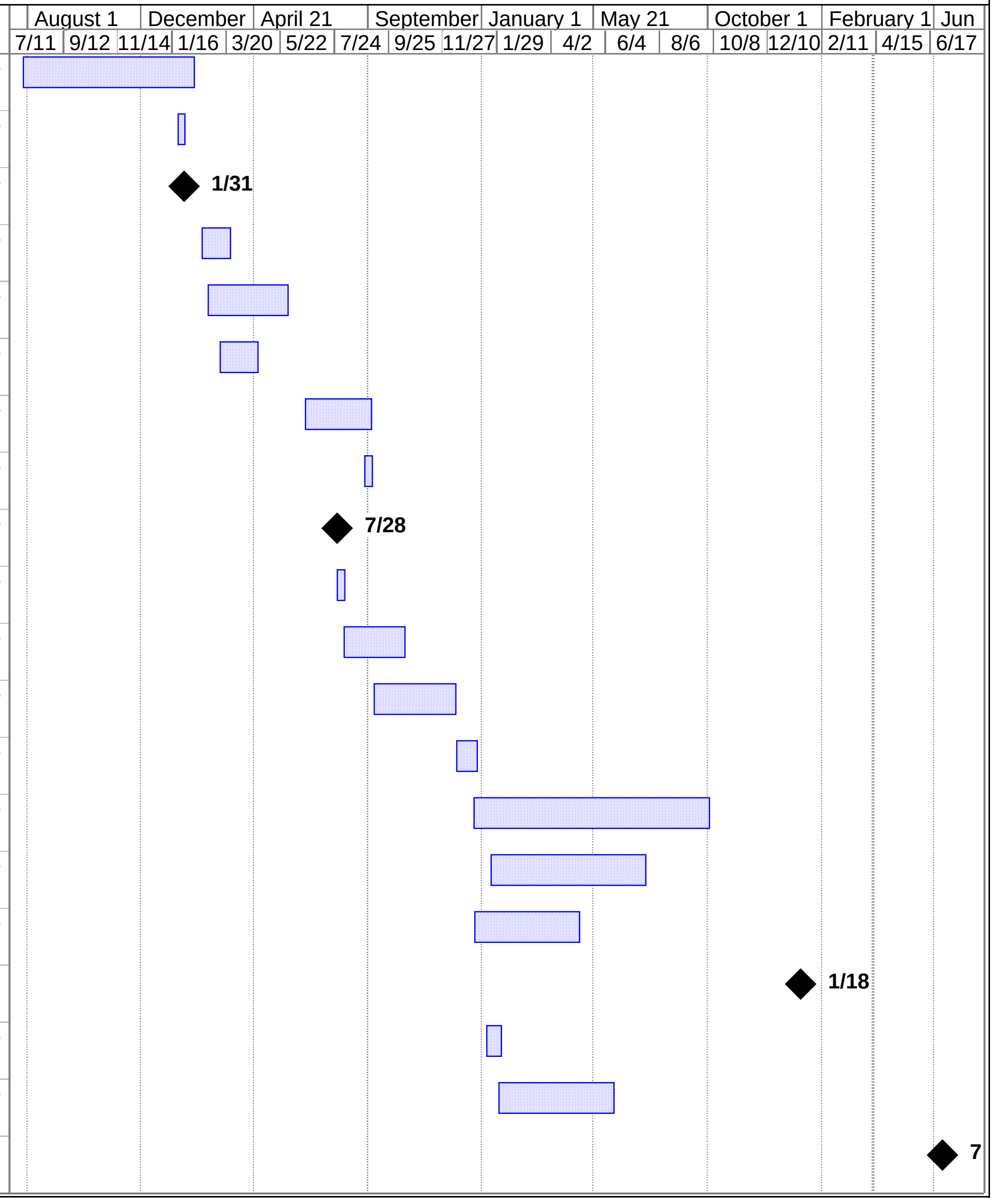
The research component of this report addressed Infection Control Risk Assessment. Information was gathered and studied in order to create a unique ICRA plan for Civista. One completed, it was compared to that of the actually ICRA plan and modifications were made. Finally, a sequencing plan was formulated to maximize the amount of occupiable patient care space while safely and efficiently completing the scope of work.

# APPENDICES

## Appendix A: Project Summary Schedule

Summary Schedule for Civista Medical Center - La Plata, MD

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | Design Phase 1 & 2 | 143 days | Wed 7/28/04 | Fri 2/11/05 |
| 2 | Mobilization | 6 days | Mon 1/24/05 | Mon 1/31/05 |
| 3 | Phase 1 - Site Preparation | 1 day | Mon 1/31/05 | Mon 1/31/05 |
| 4 | Demo | 25 days | Mon 2/21/05 | Fri 3/25/05 |
| 5 | Site Utilities | 67 days | Mon 2/28/05 | Tue 5/31/05 |
| 6 | Construction of Emergency Entry | 32 days | Mon 3/14/05 | Tue 4/26/05 |
| 7 | Relocate Retention Basin | 55 days | Tue 6/21/05 | Mon 9/5/05 |
| 8 | Helipad | 7 days | Mon 8/29/05 | Tue 9/6/05 |
| 9 | Phase 2 - Addition | 1 day | Thu 7/28/05 | Thu 7/28/05 |
| 10 | Demo | 7 days | Thu 7/28/05 | Fri 8/5/05 |
| 11 | Foundation | 51 days | Fri 8/5/05 | Fri 10/14/05 |
| 12 | Structural Decking, CIP Concrete | 67 days | Fri 9/9/05 | Mon 12/12/05 |
| 13 | Roof | 18 days | Wed 12/14/05 | Fri 1/6/06 |
| 14 | Interiors (framing - finisher) | 196 days | Tue 1/3/06 | Tue 10/3/06 |
| 15 | Exteriors | 130 days | Mon 1/23/06 | Fri 7/21/06 |
| 16 | Plan Phase 3: Renovation Phase | 88 days | Wed 1/4/06 | Fri 5/5/06 |
| 17 | Phase 3 - Renovations | 1 day | Thu 1/18/07 | Thu 1/18/07 |
| 18 | Removals | 13 days | Wed 1/18/06 | Fri 2/3/06 |
| 19 | Interiors | 96 days | Wed 2/1/06 | Wed 6/14/06 |
| 20 | Substantial Completion | 1 day | Mon 7/2/07 | Mon 7/2/07 |

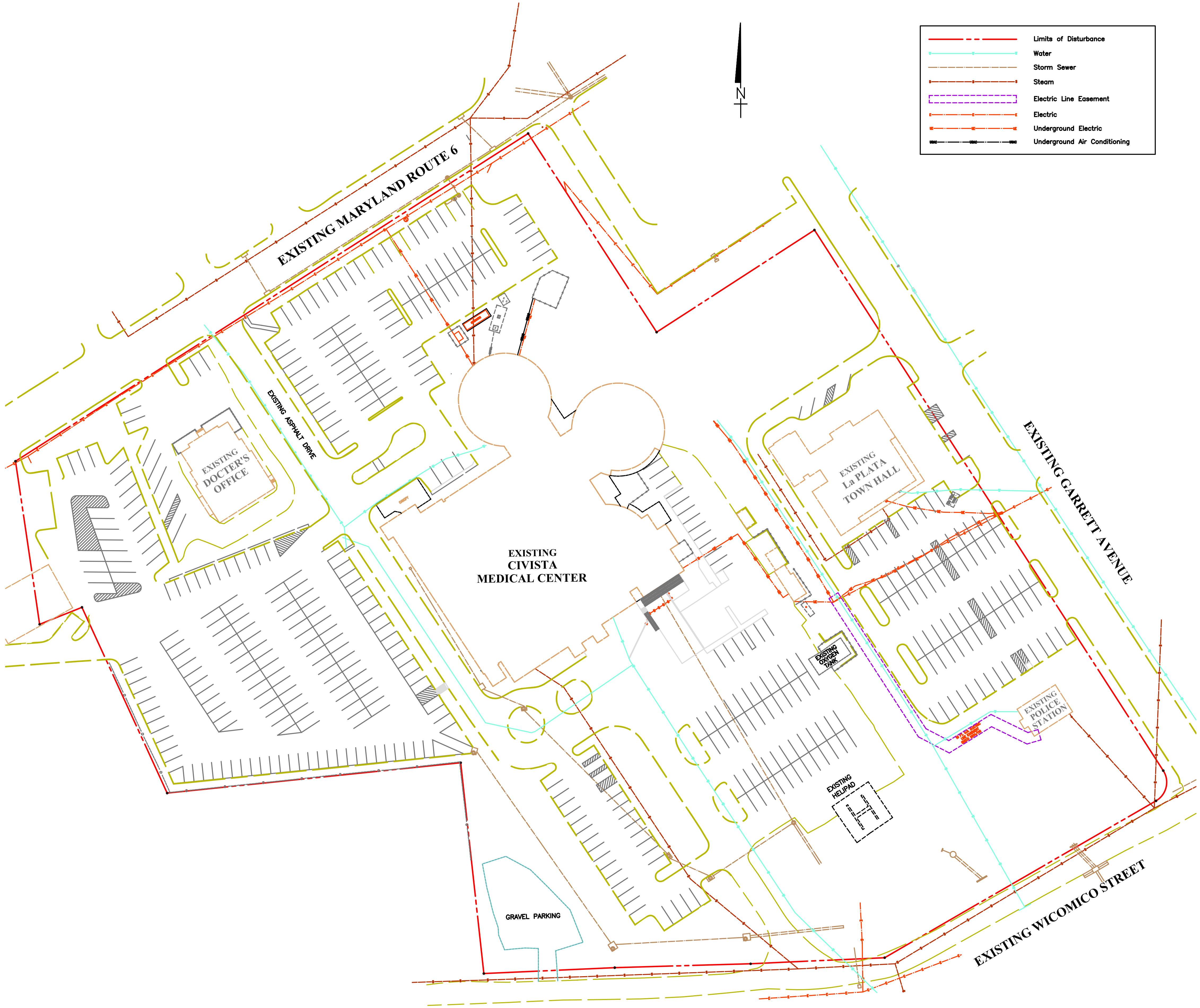



Project: Project1
Date: Wed 4/11/07

| | | | | | |
|---|---|---|---|---|---|
| Task | | Milestone | | External Tasks | |
| Split | | Summary | | External Milestone | |
| Progress | | Project Summary | | Deadline | |



# Appendix B: Existing Conditions Site Plan




CIVISTA Health

Civista Medical Center
La Plata, Maryland

2003–07 Addition & Renovation Project

Thad Maugle
Construction Management
Dr. Horman

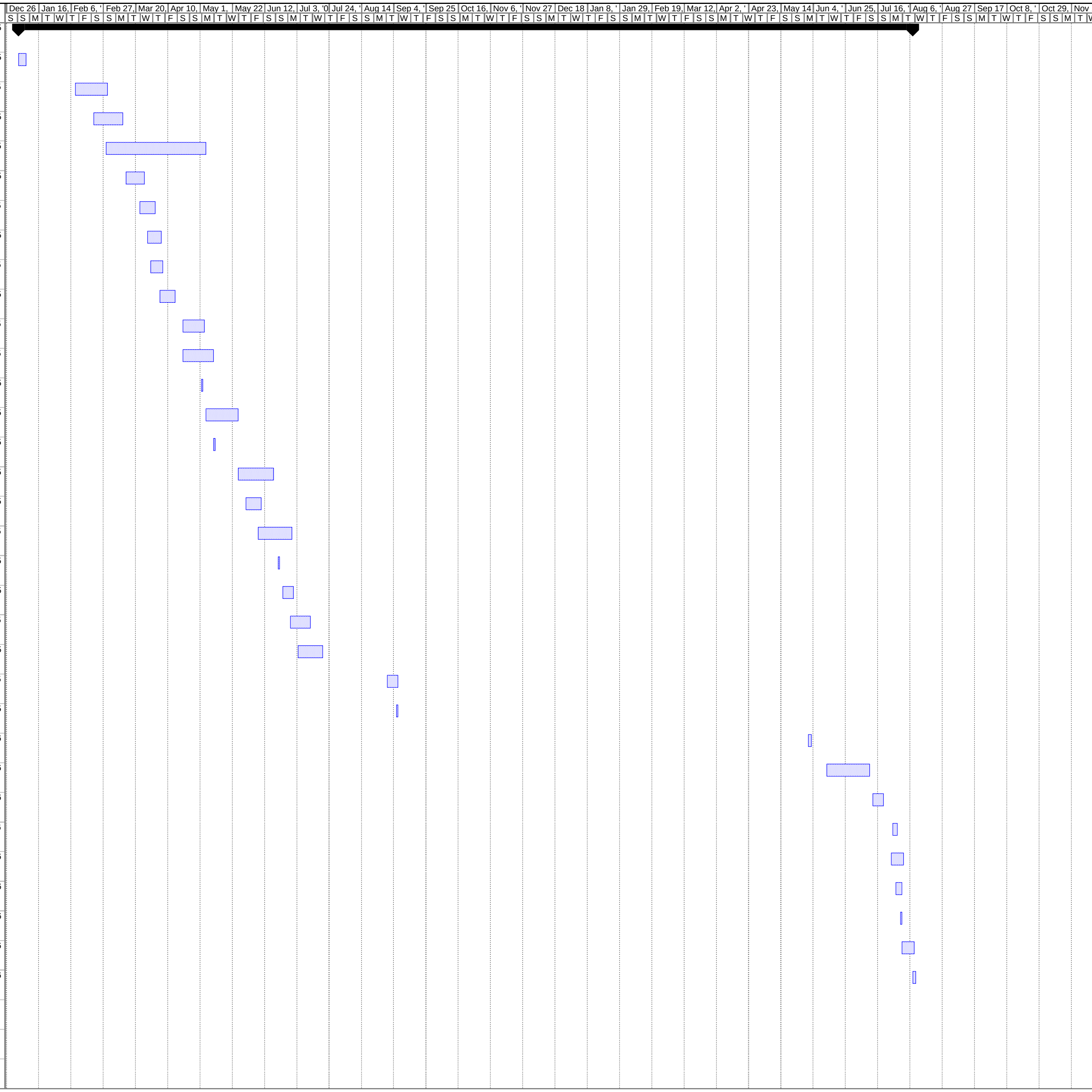
EXISTING CONDITIONS
CIVISTA MEDICAL CENTER
TOWN OF LAPLATA

C101

# Appendix C: Detailed Project Schedule

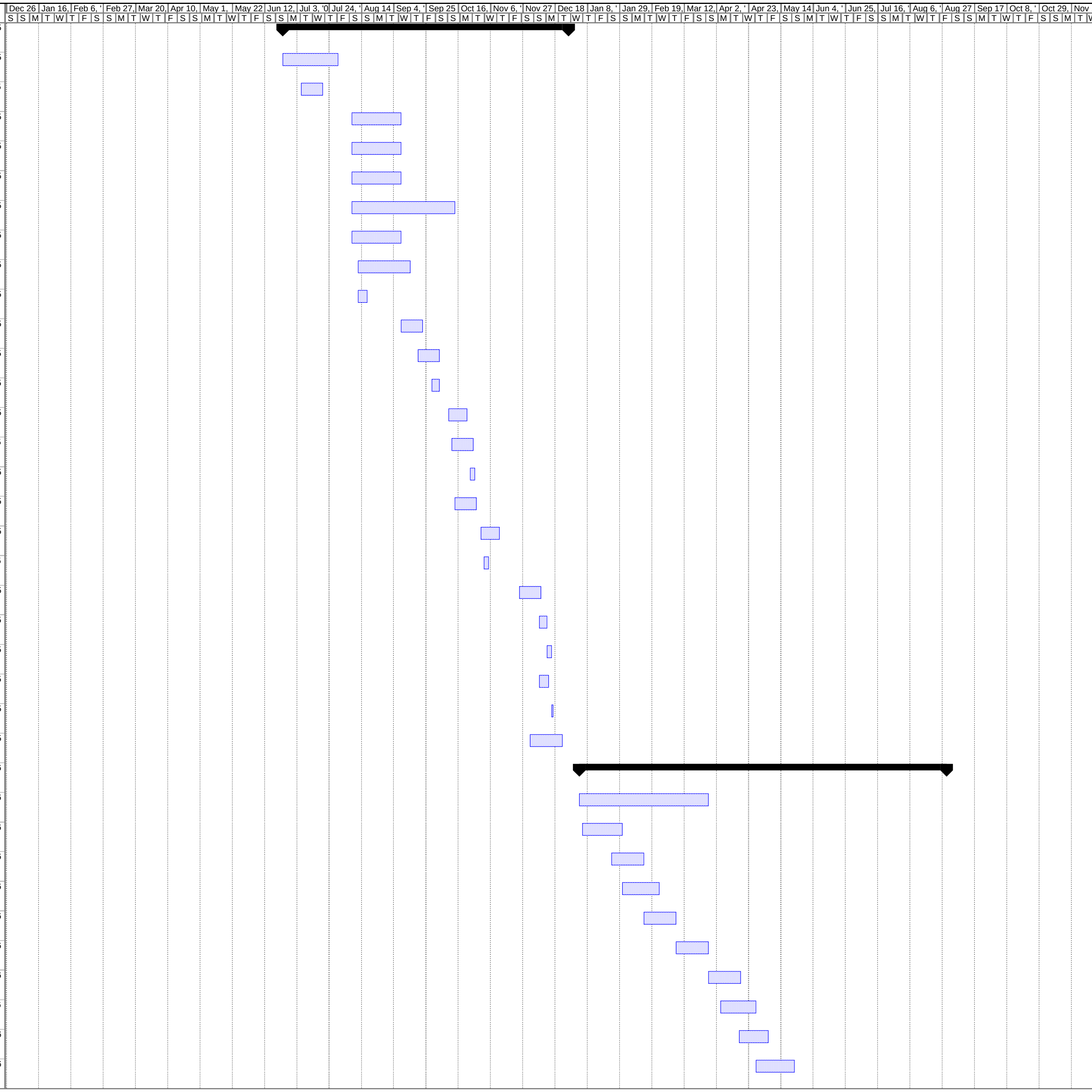
**Civista Medical Center:** Sitework & Main Addition Schedule

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 1 | **Sitework** | 417 days | Mon 1/3/05 |
| 2 | Mobilize Sitework | 5 days | Mon 1/3/05 |
| 3 | Install Barriers & Signage | 15 days | Wed 2/9/05 |
| 4 | Demo Town Hall/Police Shed | 15 days | Mon 2/21/05 |
| 5 | Excavation for SE SWM | 47 days | Tue 3/1/05 |
| 6 | Demo existing West Drive | 10 days | Mon 3/14/05 |
| 7 | Install Water Line at NE Parking | 8 days | Wed 3/23/05 |
| 8 | Install Storm Line at NE Parking | 7 days | Mon 3/28/05 |
| 9 | Install West Drive Waterline | 6 days | Wed 3/30/05 |
| 10 | Install West Drive Storm Line | 8 days | Tue 4/5/05 |
| 11 | Construct West Drive Mod Wall | 10 days | Wed 4/20/05 |
| 12 | Install West Drive Subbase / Curb & Gutter | 14 days | Wed 4/20/05 |
| 13 | Shift Staff Pkg to NE Temp Pkg Lot | 1 day | Mon 5/2/05 |
| 14 | Construct Mod Wall SE SWM | 15 days | Thu 5/5/05 |
| 15 | Pave West Drive | 1 day | Tue 5/10/05 |
| 16 | Construct Temporary ED Entrance | 17 days | Thu 5/26/05 |
| 17 | Form & Place CIP Retaining Wall Ftg | 8 days | Tue 5/31/05 |
| 18 | Form & Place CIP Retaining Wall | 16 days | Wed 6/8/05 |
| 19 | Shift ED Traffic to West Drive | 1 day | Tue 6/21/05 |
| 20 | Misc Demo in South Parking Lot | 5 days | Fri 6/24/05 |
| 21 | Install South Parking Sanitary Line | 9 days | Wed 6/29/05 |
| 22 | Install South Parking Water Line | 12 days | Mon 7/4/05 |
| 23 | Construct New Helipad | 5 days | Wed 8/31/05 |
| 24 | Shift Helipad Use | 1 day | Tue 9/6/05 |
| 25 | Misc Demo for South Parking | 2 days | Thu 6/1/06 |
| 26 | Install Subbase / Curb & Gutter at South Parking | 20 days | Tue 6/13/06 |
| 27 | Pave South Parking (Main Addition) | 5 days | Thu 7/13/06 |
| 28 | Demo SE Parking | 3 days | Wed 7/26/06 |
| 29 | Install Subbase / Curb & Gutter at NE Parking & Entrance | 6 days | Tue 7/25/06 |
| 30 | Pave NE Parking & Entrance | 2 days | Fri 7/28/06 |
| 31 | Shift Pkg to NE Lot | 1 day | Mon 7/31/06 |
| 32 | Install Subbase / Curb & Gutter at SE | 6 days | Tue 8/1/06 |
| 33 | Pave SE Parking | 2 days | Tue 8/8/06 |
| 34 | | | |
| 35 | | | |
| 36 | | | |



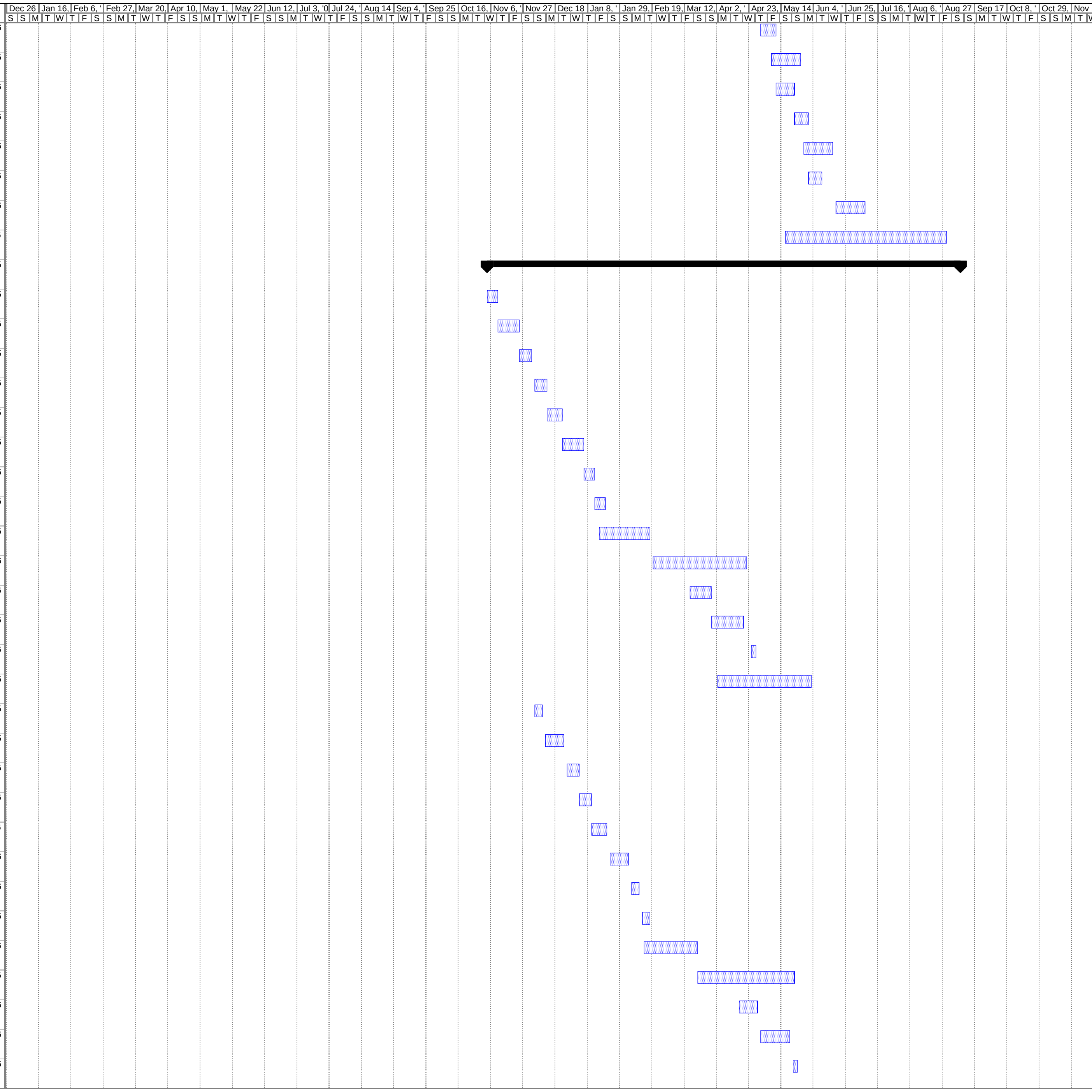
**Civista Medical Center:** Sitework & Main Addition Schedule

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 37 | **Structure** | 133 days | Fri 6/24/05 |
| 38 | Install Piles | 26 days | Fri 6/24/05 |
| 39 | Mob Concrete: Crane & Setup | 10 days | Wed 7/6/05 |
| 40 | Construct CIP (FPS) Pile Caps | 25 days | Mon 8/8/05 |
| 41 | Construct CIP (FPS) Grade Beams | 25 days | Mon 8/8/05 |
| 42 | Construct CIP (FPS) First Column Lift | 25 days | Mon 8/8/05 |
| 43 | Underground Plumbing Work | 50 days | Mon 8/8/05 |
| 44 | Underground Electrical Work | 25 days | Mon 8/8/05 |
| 45 | Construct CIP (FPS) Slab on Grade | 25 days | Fri 8/12/05 |
| 46 | Construct CIP (FPS) Wall at SOG | 5 days | Fri 8/12/05 |
| 47 | Construct CIP (FP) 1st Deck | 10 days | Fri 9/9/05 |
| 48 | Construct CIP (FP) 2nd Column Lift | 10 days | Tue 9/20/05 |
| 49 | Strip / Reshore 1st Deck | 3 days | Thu 9/29/05 |
| 50 | Construct CIP (FP) 2nd Deck | 10 days | Mon 10/10/05 |
| 51 | Construct CIP (FP) 3rd Column Lift | 10 days | Wed 10/12/05 |
| 52 | Strip / Reshore 2nd Deck | 3 days | Mon 10/24/05 |
| 53 | Construct CIP (FP) 3rd Deck | 10 days | Fri 10/14/05 |
| 54 | Construct CIP (FP) 4th Column Lift | 10 days | Mon 10/31/05 |
| 55 | Strip / Reshore 3rd Deck | 3 days | Wed 11/2/05 |
| 56 | Construct CIP (FP) 4th Deck | 10 days | Fri 11/25/05 |
| 57 | Construct CIP (FP) 5th Column Lift | 3 days | Thu 12/8/05 |
| 58 | Strip / Reshore 4th Deck | 3 days | Tue 12/13/05 |
| 59 | Construct CIP (FP) Elev/MR Deck | 4 days | Thu 12/8/05 |
| 60 | Strip / Reshore Elev/MR Deck | 1 day | Fri 12/16/05 |
| 61 | Strip/Remove all Reshores / Demobilize Crane | 15 days | Fri 12/2/05 |
| 62 | **Enclosure** | 171 days | Tue 1/3/06 |
| 63 | Install Steel Framing | 60 days | Tue 1/3/06 |
| 64 | Install Ext. Framing / Sheathing at North Face | 18 days | Thu 1/5/06 |
| 65 | Set Masonry at North Face | 15 days | Tue 1/24/06 |
| 66 | Install Ext. Framing / Sheathing at West Face | 18 days | Tue 1/31/06 |
| 67 | Set Masonry at West Face | 15 days | Tue 2/14/06 |
| 68 | Set Masonry at South Face | 15 days | Tue 3/7/06 |
| 69 | Set Masonry at East Face | 15 days | Tue 3/28/06 |
| 70 | Install Ext. Framing / Sheathing at South Face | 17 days | Wed 4/5/06 |
| 71 | Set Metal Panels/Winds at North Face | 15 days | Mon 4/17/06 |
| 72 | Install Ext. Framing / Sheathing at East Face | 17 days | Fri 4/28/06 |



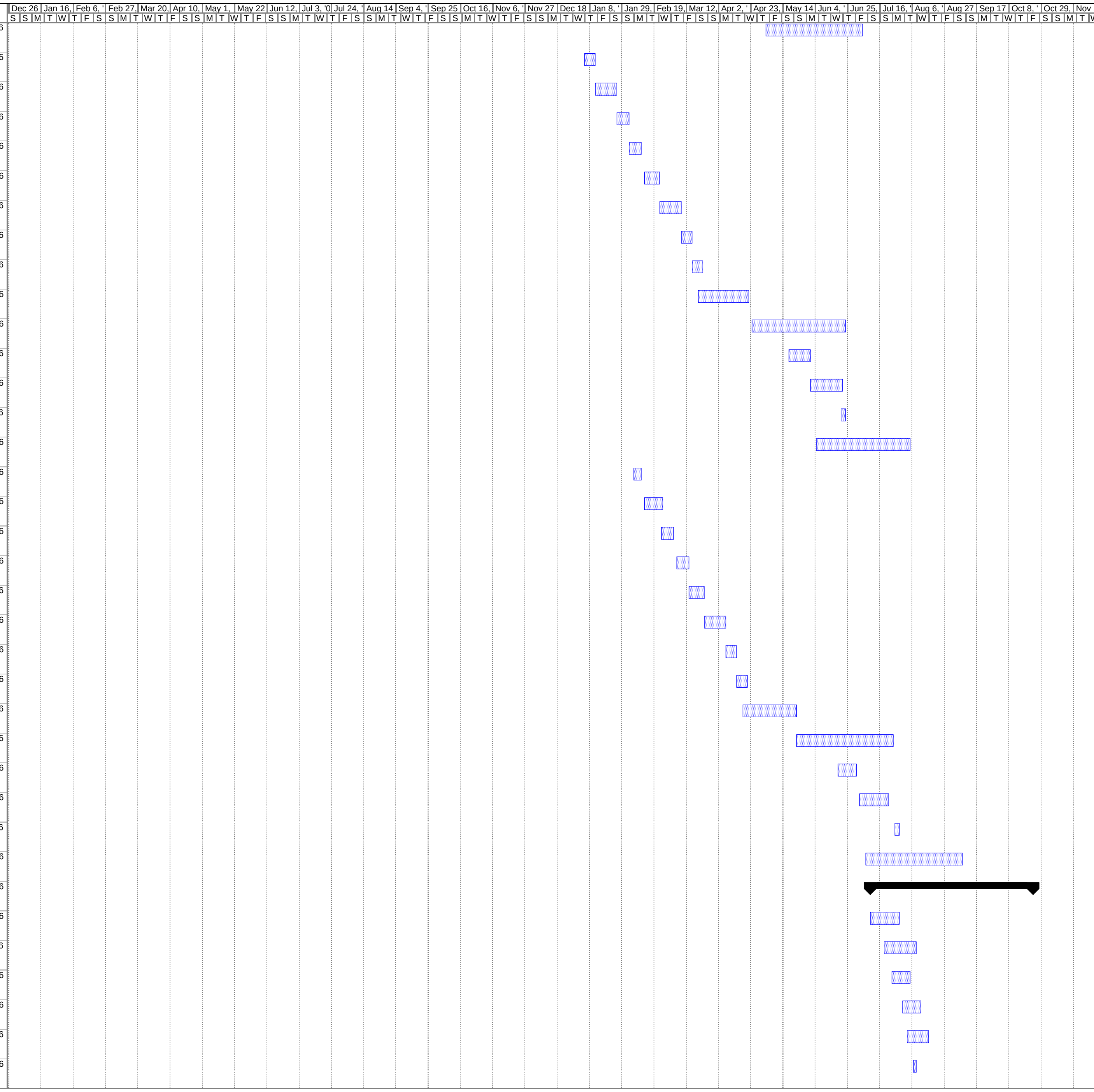
**Civista Medical Center:** Sitework & Main Addition Schedule

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 73 | Install Glazing Windows and Windows at North Face | 8 days | Mon 5/1/06 |
| 74 | Set Metal Panels/Winds at West Face | 15 days | Mon 5/8/06 |
| 75 | Install Glazing Windows and Windows at West Face | 8 days | Thu 5/11/06 |
| 76 | Install Glazing Windows and Windows at South Face | 7 days | Tue 5/23/06 |
| 77 | Set Metal Panels/Winds at South Face | 15 days | Mon 5/29/06 |
| 78 | Install Glazing Windows and Windows at East Face | 7 days | Thu 6/1/06 |
| 79 | Set Metal Panels/Winds at East Face | 15 days | Mon 6/19/06 |
| 80 | Construct Steel Conopies | 75 days | Wed 5/17/06 |
| 81 | **Interior Rough-Ins** | 220 days | Fri 11/4/05 |
| 82 | GR Partition Layout | 5 days | Fri 11/4/05 |
| 83 | GR Above Ceiling Plumbing (Gravity) | 10 days | Fri 11/11/05 |
| 84 | GR Above Ceiling HVAC | 6 days | Fri 11/25/05 |
| 85 | GR Above Ceiling Piping (Pressure) | 6 days | Mon 12/5/05 |
| 86 | GR Above Ceiling Electrical & Pull Wire | 8 days | Tue 12/13/05 |
| 87 | GR Above Ceiling Medical Gas | 10 days | Fri 12/23/05 |
| 88 | GR Fire Protection | 5 days | Fri 1/6/06 |
| 89 | GR Set Door Frames | 5 days | Fri 1/13/06 |
| 90 | GR Partition Framing | 25 days | Mon 1/16/06 |
| 91 | GR In-Wall MEP | 45 days | Mon 2/20/06 |
| 92 | GR Mechanical & Plumbing Insulation | 10 days | Thu 3/16/06 |
| 93 | GR Frame Bulkheads & Drywall Ceilings | 15 days | Thu 3/30/06 |
| 94 | GR Obtain In-Wall Inspection | 3 days | Tue 4/25/06 |
| 95 | GR Hang & Finish Drywall | 45 days | Mon 4/3/06 |
| 96 | f1 Partition Layout | 5 days | Mon 12/5/05 |
| 97 | f1 Above Ceiling Plumbing (Gravity) | 10 days | Mon 12/12/05 |
| 98 | f1 Above Ceiling HVAC | 6 days | Mon 12/26/05 |
| 99 | f1 Above Ceiling Piping (Pressure) | 6 days | Tue 1/3/06 |
| 100 | f1 Above Ceiling Electrical & Pull Wire | 8 days | Wed 1/11/06 |
| 101 | f1 Above Ceiling Medical Gas | 10 days | Mon 1/23/06 |
| 102 | f1 Fire Protection | 5 days | Mon 2/6/06 |
| 103 | f1 Set Door Frames | 5 days | Mon 2/13/06 |
| 104 | f1 Partition Framing | 25 days | Tue 2/14/06 |
| 105 | f1 In-Wall MEP | 45 days | Tue 3/21/06 |
| 106 | f1 Mechanical & Plumbing Insulation | 10 days | Mon 4/17/06 |
| 107 | f1 Frame Bulkheads & Drywall Ceilings | 15 days | Mon 5/1/06 |
| 108 | f1 Obtain In-Wall Inspection | 3 days | Mon 5/22/06 |



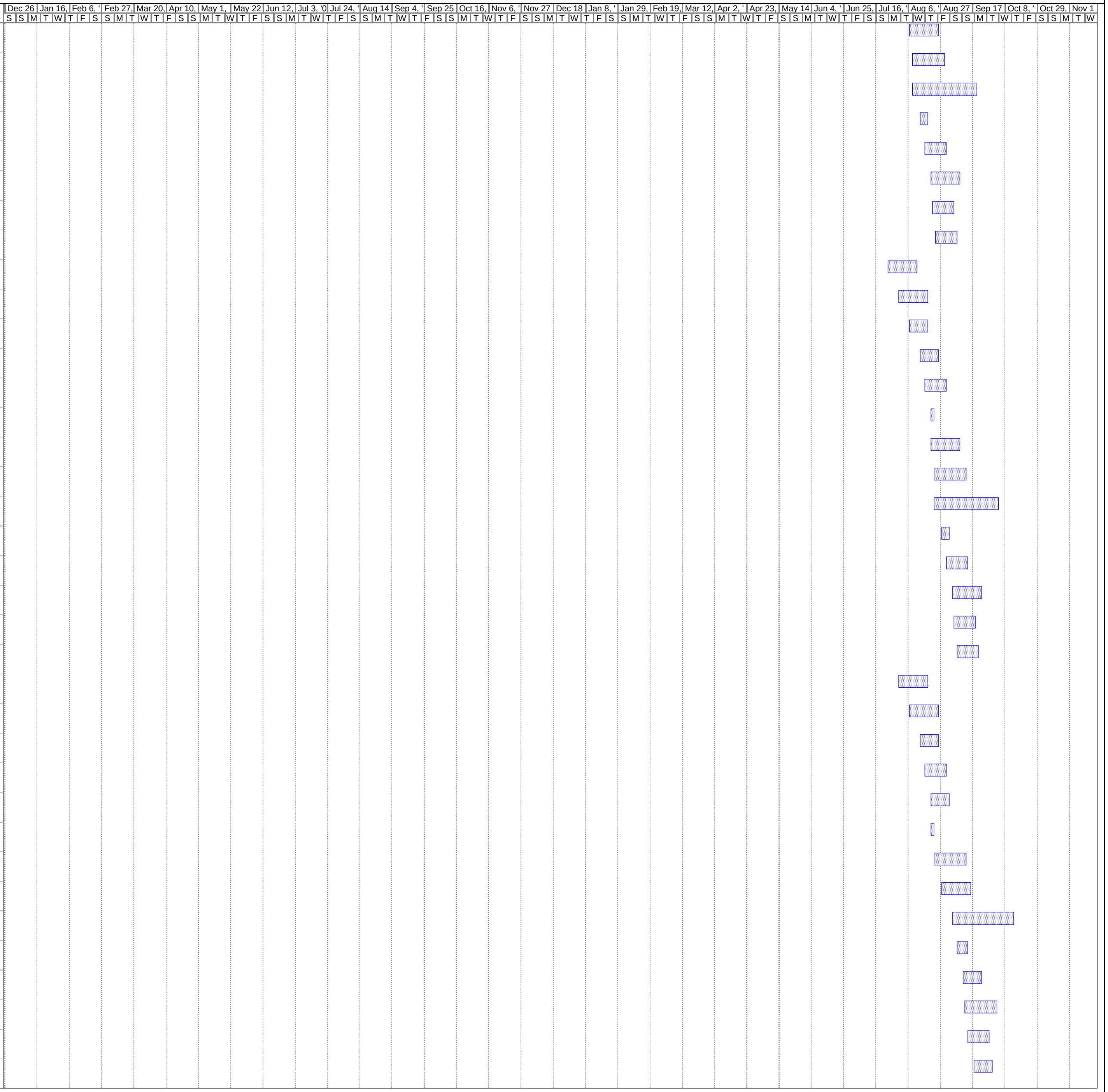
**Civista Medical Center:** Sitework & Main Addition Schedule

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 109 | f1 Hang & Finish Drywall | 45 days | Wed 5/3/06 |
| 110 | f2 Partition Layout | 5 days | Thu 1/5/06 |
| 111 | f2 Above Ceiling Plumbing (Gravity) | 10 days | Thu 1/12/06 |
| 112 | f2 Above Ceiling HVAC | 6 days | Thu 1/26/06 |
| 113 | f2 Above Ceiling Piping (Pressure) | 6 days | Fri 2/3/06 |
| 114 | f2 Above Ceiling Electrical & Pull Wire | 8 days | Mon 2/13/06 |
| 115 | f2 Above Ceiling Medical Gas | 10 days | Thu 2/23/06 |
| 116 | f2 Fire Protection | 5 days | Thu 3/9/06 |
| 117 | f2 Set Door Frames | 5 days | Thu 3/16/06 |
| 118 | f2 Partition Framing | 25 days | Mon 3/20/06 |
| 119 | f2 In-Wall MEP | 45 days | Mon 4/24/06 |
| 120 | f2 Mechanical & Plumbing Insulation | 10 days | Thu 5/18/06 |
| 121 | f2 Frame Bulkheads & Drywall Ceilings | 15 days | Thu 6/1/06 |
| 122 | f2 Obtain In-Wall Inspection | 3 days | Wed 6/21/06 |
| 123 | f2 Hang & Finish Drywall | 45 days | Mon 6/5/06 |
| 124 | f3 Partition Layout | 5 days | Mon 2/6/06 |
| 125 | f3 Above Ceiling Plumbing (Gravity) | 10 days | Mon 2/13/06 |
| 126 | f3 Above Ceiling HVAC | 6 days | Fri 2/24/06 |
| 127 | f3 Above Ceiling Piping (Pressure) | 6 days | Mon 3/6/06 |
| 128 | f3 Above Ceiling Electrical & Pull Wire | 8 days | Tue 3/14/06 |
| 129 | f3 Above Ceiling Medical Gas | 10 days | Fri 3/24/06 |
| 130 | f3 Fire Protection | 5 days | Fri 4/7/06 |
| 131 | f3 Set Door Frames | 5 days | Fri 4/14/06 |
| 132 | f3 Partition Framing | 25 days | Tue 4/18/06 |
| 133 | f3 In-Wall MEP | 45 days | Tue 5/23/06 |
| 134 | f3 Mechanical & Plumbing Insulation | 10 days | Mon 6/19/06 |
| 135 | f3 Frame Bulkheads & Drywall Ceilings | 15 days | Mon 7/3/06 |
| 136 | f3 Obtain In-Wall Inspection | 3 days | Wed 7/26/06 |
| 137 | f3 Hang & Finish Drywall | 45 days | Fri 7/7/06 |
| 138 | **Interior Finishes** | 76 days | Mon 7/10/06 |
| 139 | GR Prime Paint | 15 days | Mon 7/10/06 |
| 140 | GR Ceiling Grid | 15 days | Wed 7/19/06 |
| 141 | GR Light Fixtures | 10 days | Mon 7/24/06 |
| 142 | GR Register, Grilles, & Diffusers | 10 days | Mon 7/31/06 |
| 143 | GR Sprinkle Heads | 10 days | Thu 8/3/06 |
| 144 | GR Obtain Above Ceiling Inspection | 2 days | Mon 8/7/06 |



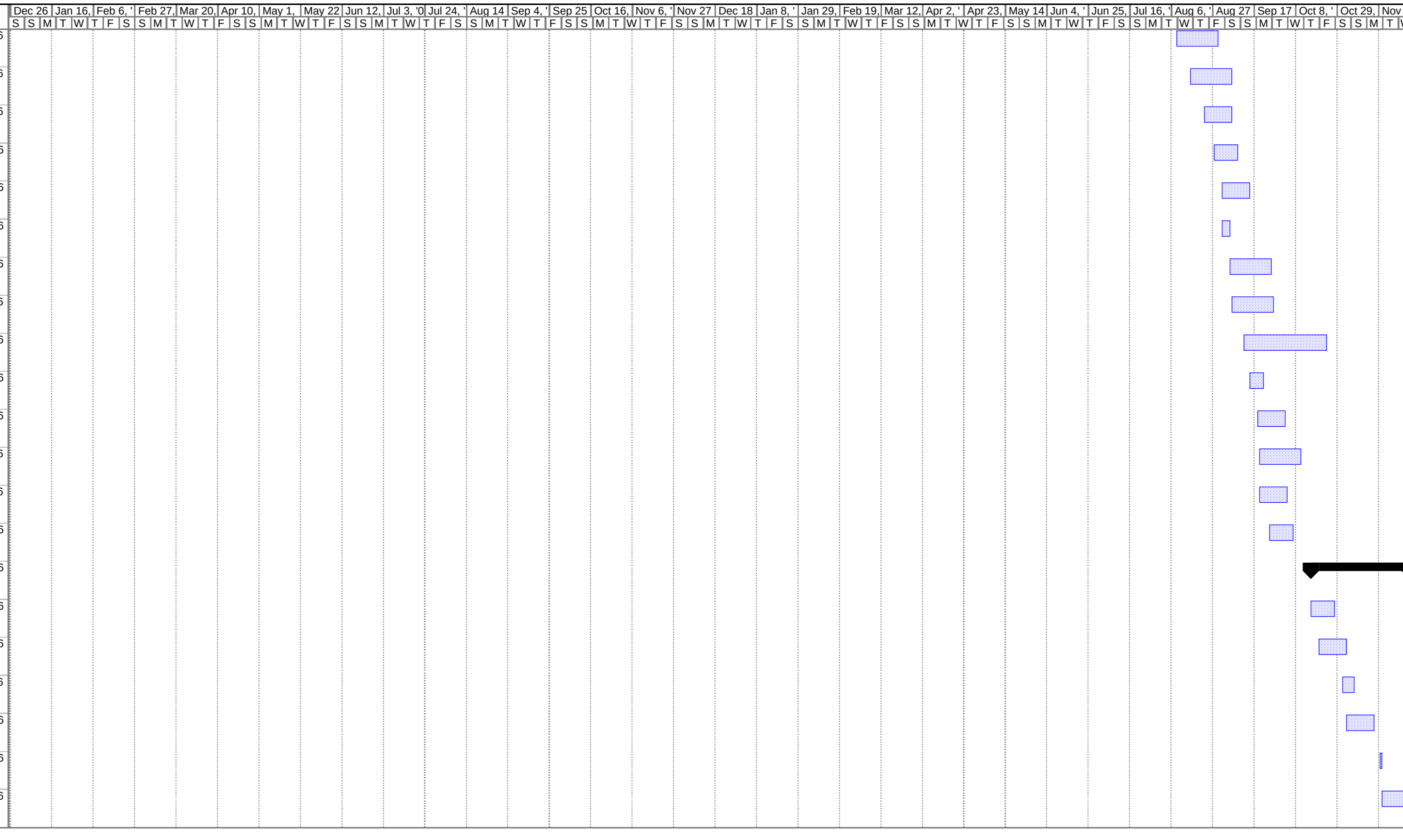
**Civista Medical Center:** Sitework & Main Addition Schedule

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 145 | GR Ceiling Close-In | 15 days | Mon 8/7/06 |
| 146 | GR Flooring | 15 days | Wed 8/9/06 |
| 147 | GR Casework / Specialties | 30 days | Wed 8/9/06 |
| 148 | GR Plumbing Fixtures | 5 days | Mon 8/14/06 |
| 149 | GR Doors & Hardware | 10 days | Thu 8/17/06 |
| 150 | GR Final Paint | 15 days | Mon 8/21/06 |
| 151 | GR Arch Trim | 10 days | Tue 8/22/06 |
| 152 | GR MEP Wall / Ceiling Devices | 10 days | Thu 8/24/06 |
| 153 | f1 Prime Paint | 15 days | Mon 7/24/06 |
| 154 | f1 Ceiling Grid | 15 days | Mon 7/31/06 |
| 155 | f1 Light Fixtures | 10 days | Mon 8/7/06 |
| 156 | f1 Register, Grilles, & Diffusers | 10 days | Mon 8/14/06 |
| 157 | f1 Sprinkle Heads | 10 days | Thu 8/17/06 |
| 158 | f1 Obtain Above Ceiling Inspection | 2 days | Mon 8/21/06 |
| 159 | f1 Ceiling Close-In | 15 days | Mon 8/21/06 |
| 160 | f1 Flooring | 15 days | Wed 8/23/06 |
| 161 | f1 Casework / Specialties | 30 days | Wed 8/23/06 |
| 162 | f1 Plumbing Fixtures | 5 days | Mon 8/28/06 |
| 163 | f1 Doors & Hardware | 10 days | Thu 8/31/06 |
| 164 | f1 Final Paint | 15 days | Mon 9/4/06 |
| 165 | f1 Arch Trim | 10 days | Tue 9/5/06 |
| 166 | f1 MEP Wall / Ceiling Devices | 10 days | Thu 9/7/06 |
| 167 | f2 Prime Paint | 15 days | Mon 7/31/06 |
| 168 | f2 Ceiling Grid | 15 days | Mon 8/7/06 |
| 169 | f2 Light Fixtures | 10 days | Mon 8/14/06 |
| 170 | f2 Register, Grilles, & Diffusers | 10 days | Thu 8/17/06 |
| 171 | f2 Sprinkle Heads | 10 days | Mon 8/21/06 |
| 172 | f2 Obtain Above Ceiling Inspection | 2 days | Mon 8/21/06 |
| 173 | f2 Ceiling Close-In | 15 days | Wed 8/23/06 |
| 174 | f2 Flooring | 15 days | Mon 8/28/06 |
| 175 | f2 Casework / Specialties | 30 days | Mon 9/4/06 |
| 176 | f2 Plumbing Fixtures | 5 days | Thu 9/7/06 |
| 177 | f2 Doors & Hardware | 10 days | Mon 9/11/06 |
| 178 | f2 Final Paint | 15 days | Tue 9/12/06 |
| 179 | f2 Arch Trim | 10 days | Thu 9/14/06 |
| 180 | f2 MEP Wall / Ceiling Devices | 10 days | Mon 9/18/06 |



**Civista Medical Center:** Sitework & Main Addition Schedule

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 181 | f3 Prime Paint | 15 days | Wed 8/9/06 |
| 182 | f3 Ceiling Grid | 15 days | Wed 8/16/06 |
| 183 | f3 Light Fixtures | 10 days | Wed 8/23/06 |
| 184 | f3 Register, Grilles, & Diffusers | 10 days | Mon 8/28/06 |
| 185 | f3 Sprinkle Heads | 10 days | Fri 9/1/06 |
| 186 | f3 Obtain Above Ceiling Inspection | 2 days | Fri 9/1/06 |
| 187 | f3 Ceiling Close-In | 15 days | Tue 9/5/06 |
| 188 | f3 Flooring | 15 days | Wed 9/6/06 |
| 189 | f3 Casework / Specialties | 30 days | Tue 9/12/06 |
| 190 | f3 Plumbing Fixtures | 5 days | Fri 9/15/06 |
| 191 | f3 Doors & Hardware | 10 days | Tue 9/19/06 |
| 192 | f3 Final Paint | 15 days | Wed 9/20/06 |
| 193 | f3 Arch Trim | 10 days | Wed 9/20/06 |
| 194 | f3 MEP Wall / Ceiling Devices | 10 days | Mon 9/25/06 |
| 195 | **<u>Clean-Up / Punchlist / Commissioning</u>** | 36 days | Mon 10/16/06 |
| 196 | MEP System Start / Test / Balance | 10 days | Mon 10/16/06 |
| 197 | Incomplete Work Lists & Repairs | 10 days | Fri 10/20/06 |
| 198 | A/E/O Punchlist | 4 days | Wed 11/1/06 |
| 199 | Punchlist Repairs | 10 days | Fri 11/3/06 |
| 200 | Substantial Completion | 1 day | Mon 11/20/06 |
| 201 | Final Clean-Up | 10 days | Tue 11/21/06 |



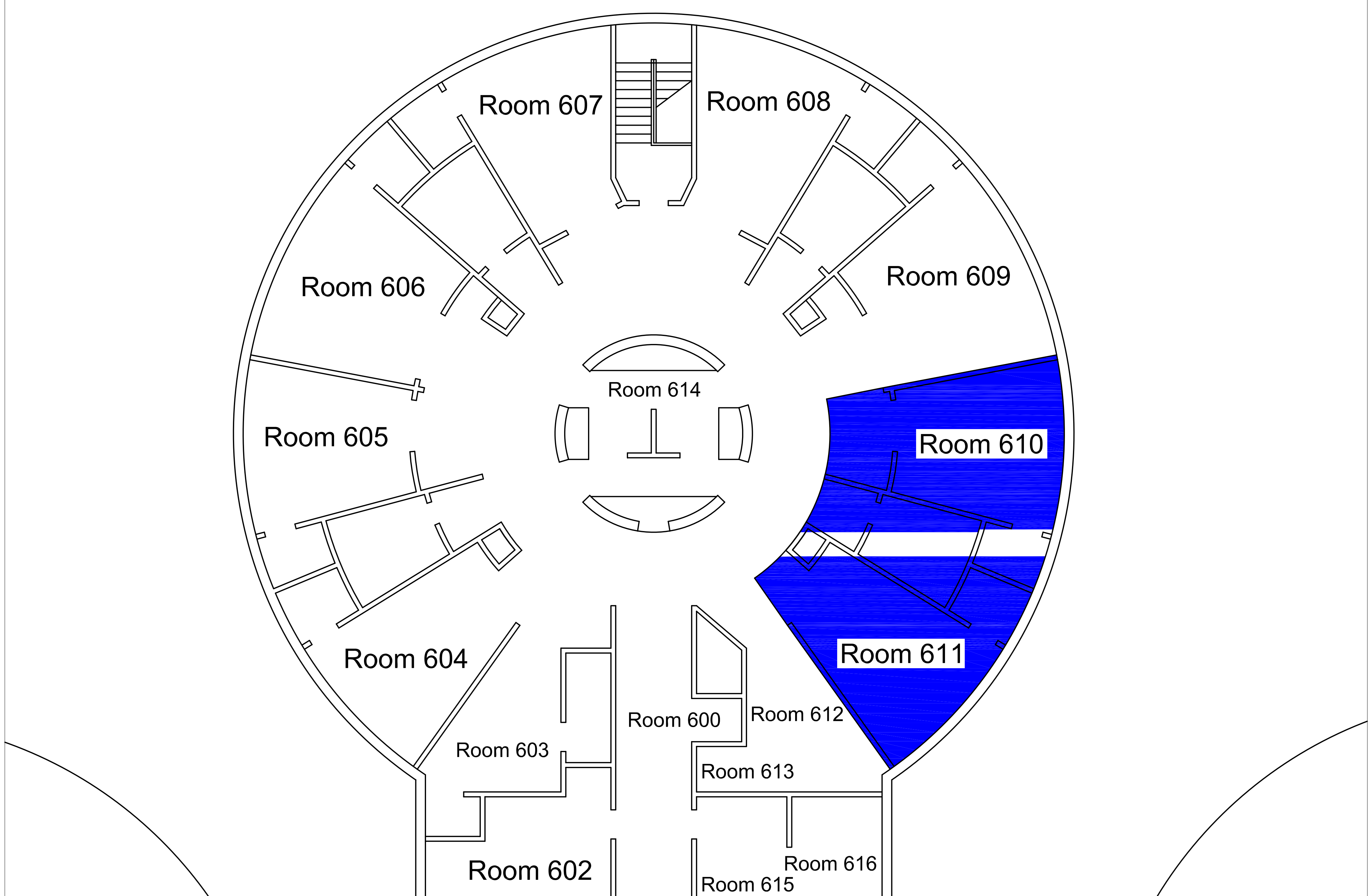
# Appendix D: General Conditions Estimate

## General Conditions Estimate for Construction Phase of Civista Medical Center

| Category | Description | Quantity | Units | Duration | Units | Rate | Total Cost |
|---|---|---|---|---|---|---|---|
| **Field Labor** | Project Manager | 1 | Ea | 32 | Mo | 11,500 | 368,000 |
| | Assistant Project Manager | 1 | Ea | 32 | Mo | 10,100 | 323,200 |
| | Project Engineer | 1 | Ea | 32 | Mo | 7,800 | 249,600 |
| | Office Engineer | 1 | Ea | 26 | Mo | 6,200 | 161,200 |
| | General Superintendant | 1 | Ea | 32 | Mo | 10,700 | 342,400 |
| | MEP Superintendant | 1 | Ea | 22 | Mo | 9,300 | 204,600 |
| | Area Superintendant | 1 | Ea | 32 | Mo | 8,600 | 275,200 |
| | | **Total Field Labor Costs** | | | | | **$1,924,200** |
| | | *** Estimate Values from RS Means Cost Works* | | | | | |
| | | | | | | | |
| **Site Support** | **Field Office** | | | | | | |
| | Trailor Complex | 1 | Ea | 32 | Mo | | |
| | Security System | 1 | LS | | | 2,000 | 2,000 |
| | Maintenance & Repair | | | 32 | Mo | 250 | 8,000 |
| | | | | | | | |
| | **Field Office Equipment** | | | | | | |
| | Copy Machine | | | 32 | Mo | 1,000 | 32,000 |
| | Furniture | 7 | Stat | | | 2,000 | 4,000 |
| | Computer Equipment | | | 32 | Mo | 527 | 60,000 |
| | Telephone System | 7 | Stat | | | 700 | 4,900 |
| | | | | | | | |
| | **Field Office Expense** | | | | | | |
| | Drinking Water | | | 32 | Mo | 80 | 2,560 |
| | Construction Signage | 10 | Est | | | 1,000 | 10,000 |
| | Blueprinting | | | 32 | Mo | 300 | 9,600 |
| | First Aid Supplies | 1 | LS | | | 1,500 | 1,500 |
| | Postage & Shipping | | | 32 | Mo | 400 | 12,800 |
| | Progress Photos | | | 32 | Mo | 200 | 6,400 |
| | Small Tools & Supplies | | | 32 | Mo | 200 | 6,400 |
| | Stationary, Paper & Supplies | | | 32 | Mo | 620 | 19,840 |
| | Nextel Phones, Beepers | | | 32 | Mo | 600 | 19,200 |
| | | | | | | | |
| | **Job Travel Expense** | | | | | | |
| | Staff Travel | | | 32 | Mo | 525 | 16,800 |
| | Job Vehicle / Auto Allowance | | | 41 | Mo | 600 | 24,600 |
| | Temporary Living Expense | | | 18 | Mo | 2,600 | 46,800 |
| | | **Total Site Support Costs** | | | | | **$287,400** |
| | | | | | | | |
| **Site Services** | **Temporary Facilities** | | | | | | |
| | Chemical Toilets | | | 32 | Mo | 115 | 3,680 |
| | Storage Trailors & Tool Rooms | | | 32 | Mo | 300 | 9,600 |
| | | | | | | | |
| | **Layout / Engineering** | | | | | | |
| | Precondition Survey | 1 | LS | | | 30,000 | 30,000 |
| | | | | | | | |
| | **Temporary Construction / Safety** | | | | | | |
| | First Aid Kits | 10 | Ea | | | 120 | 1,200 |
| | Project Fire Extinguishers | 10 | Est | | | 150 | 1,500 |
| | Safety Incentives | 2 | Est | | | 5,000 | 10,000 |
| | Temp Elevator Operator | | | 2 | Mo | 14,000 | 28,000 |
| | Temp Protection of Existing Roofs | 1 | Est | | | 25,000 | 25,000 |
| | Temp Walkways & Guard Rails | 1 | Est | | | 30,000 | 30,000 |
| | Trash Chutes | | | 24 | Mo | 3,000 | 72,000 |
| | | | | | | | |
| | **Project Clean-Up** | | | | | | |
| | Dumpster Services | | | 33 | Mo | 1,400 | 46,200 |
| | Final Clean-Up | 160,000 | SF | | | 0.15 | 24,000 |
| | Clean Exterior Windows | 71,400 | SF | | | 0.35 | 25,000 |
| | | | | | | | |
| | **Temporary Power & Sewer** | | | | | | |
| | Connection - Water & Electric | 1 | Est | | | 10,000 | 10,000 |
| | Water & Sewer Charges | | | 33 | Mo | 450 | 14,850 |
| | Electric Consumption | | | 33 | Mo | 7,000 | 231,000 |
| | Temp. Heat | 1 | Est | | | 38,000 | 38,000 |
| | | | | | | | |
| | **Insurance / Taxes** | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | General & Excess Liability | 1 | Calc | | | 220,000 | 220,000 |
| | | **Total Site Services Costs** | | | | | **$820,030** |
| | | | | | | | |
| **Additional Services** | Temp. Utility Installation | | LS | | | 93,680 | 93,680 |
| | Temp. Roads / Signage | | LS | | | 150,000 | 150,000 |
| | Infection Control / LSM | | LS | | | 220,000 | 220,000 |
| | Hoisting & Scaffolding | | LS | | | 180,000 | 180,000 |
| | | **Total Additional Services Costs** | | | | | **$643,680** |
| | | | | | | | |
| **CM Fee** | Fee @ 1.5% of Project Costs | | | | | | 645,000 |
| | | **Total CM Fee** | | | | | **$645,000** |
| | | | | | | | |
| | | **Total Project General Conditions** | | | | | **$4,320,310** |

# Appendix E: ICRA Sequencing




CIVISTA Health

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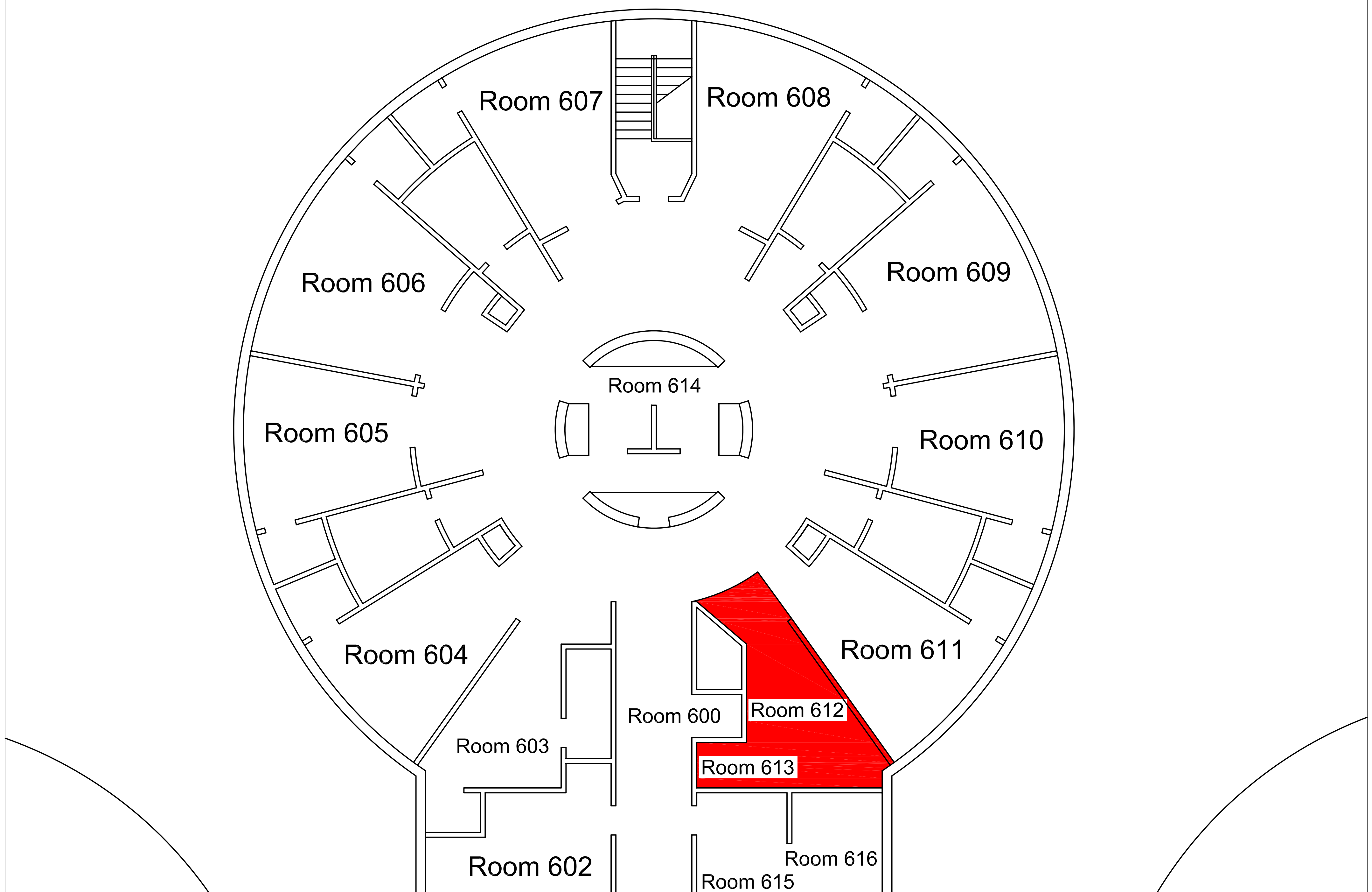
Dr. Horman

ICRA Sequencing
Sequence 1

CIVISTA MEDICAL CENTER
TOWN OF LAPLATA

AP01.1




Civista Health

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La Plata, Maryland

2003–07 Addition & Renovation Project

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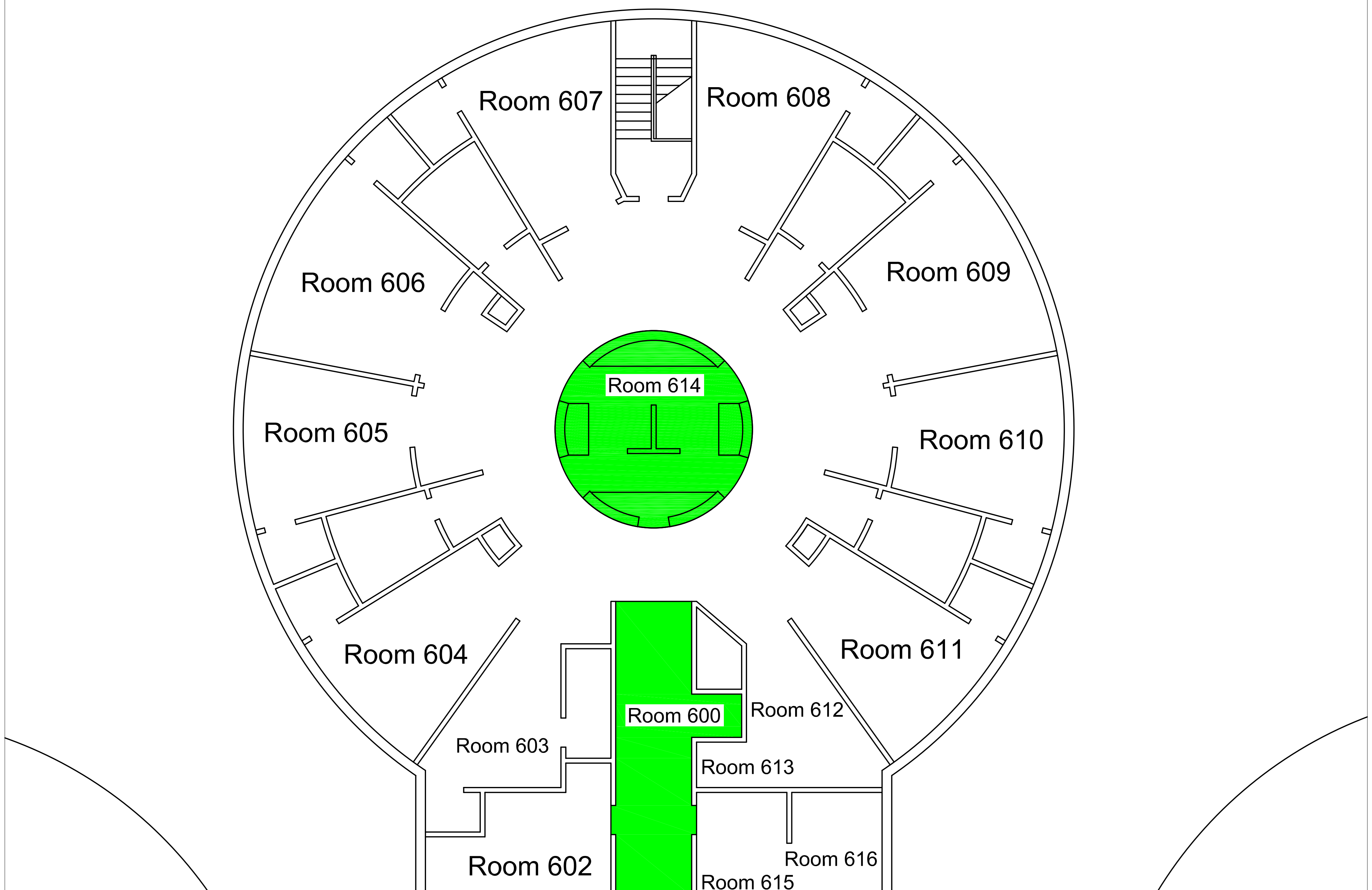
Dr. Horman

ICRA Sequencing
Sequence 2

CIVISTA MEDICAL CENTER
TOWN OF LAPLATA

AP01.2




CIVISTA Health

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La Plata, Maryland

2003–07 Addition & Renovation Project

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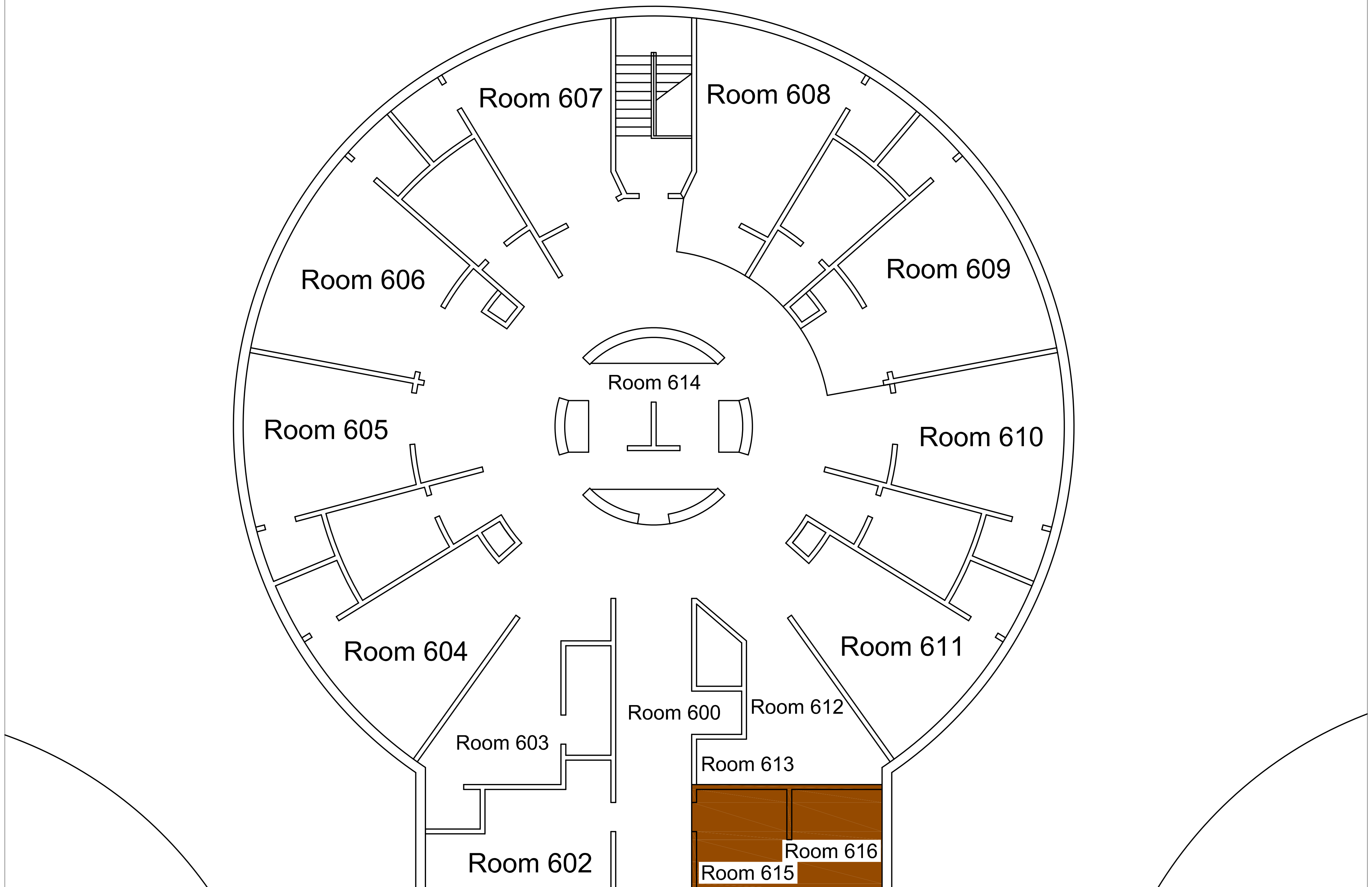
Dr. Horman

ICRA Sequencing
Sequencing 3

CIVISTA MEDICAL CENTER
TOWN OF LAPLATA

AP01.3




Civista Health

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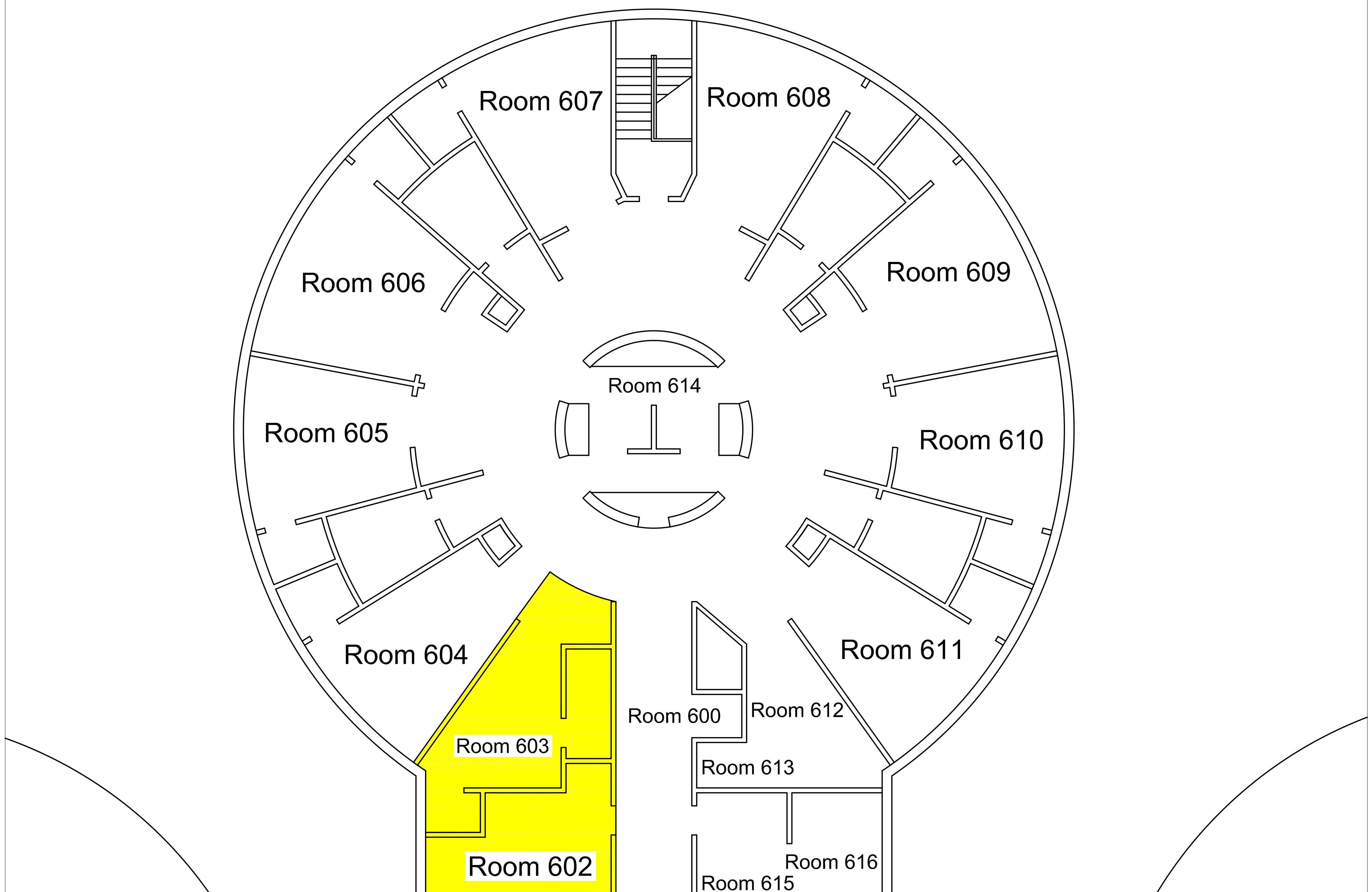
ICRA Sequencing
Sequence 4

CIVISTA MEDICAL CENTER
TOWN OF LAPLATA

AP01.4




CIVISTA Health

Civista Medical Center
La Plata, Maryland

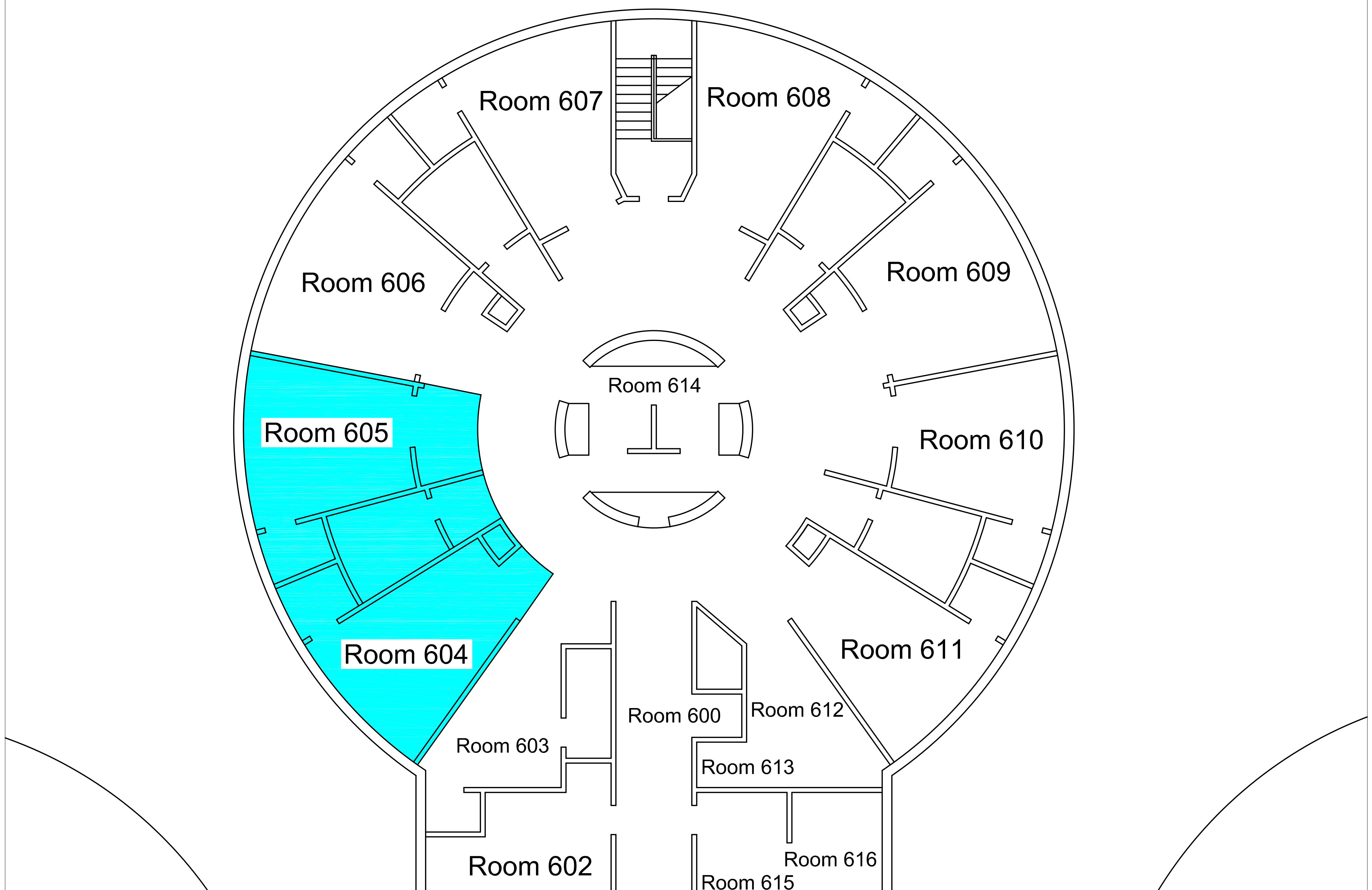
2003–07 Addition & Renovation Project

Thad Maugle
Construction Management
Dr. Horman

ICRA Sequencing
Sequence 5

CIVISTA MEDICAL CENTER
TOWN OF LAPLATA

AP01.5




CIVISTA Health

Civista Medical Center
La Plata, Maryland

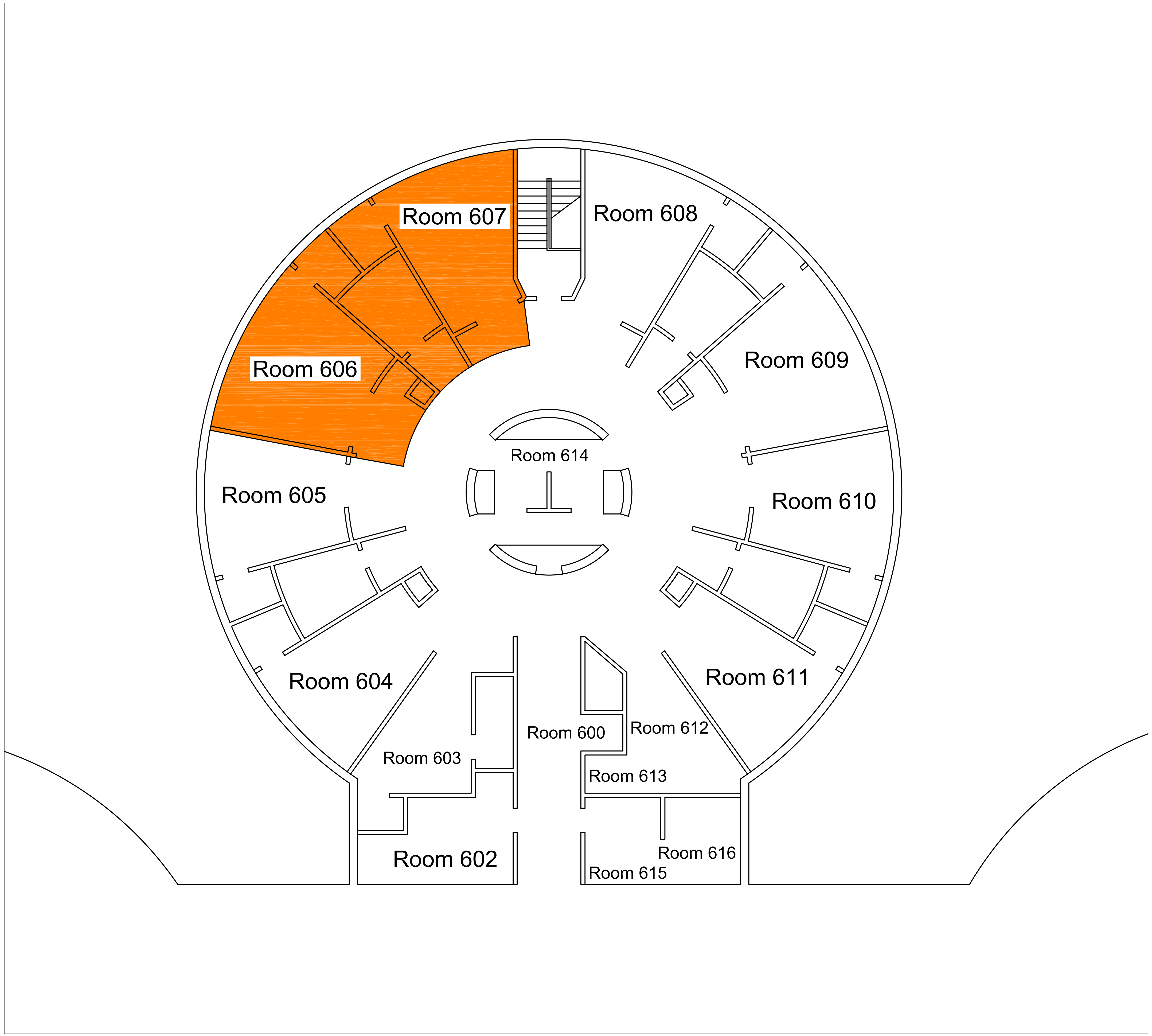
2003–07 Addition & Renovation Project

Thad Maugle
Construction Management
Dr. Horman

ICRA Sequencing
Sequence 6

CIVISTA MEDICAL CENTER
TOWN OF LAPLATA

AP01.6




CIVISTA Health

Civista Medical Center
La Plata, Maryland

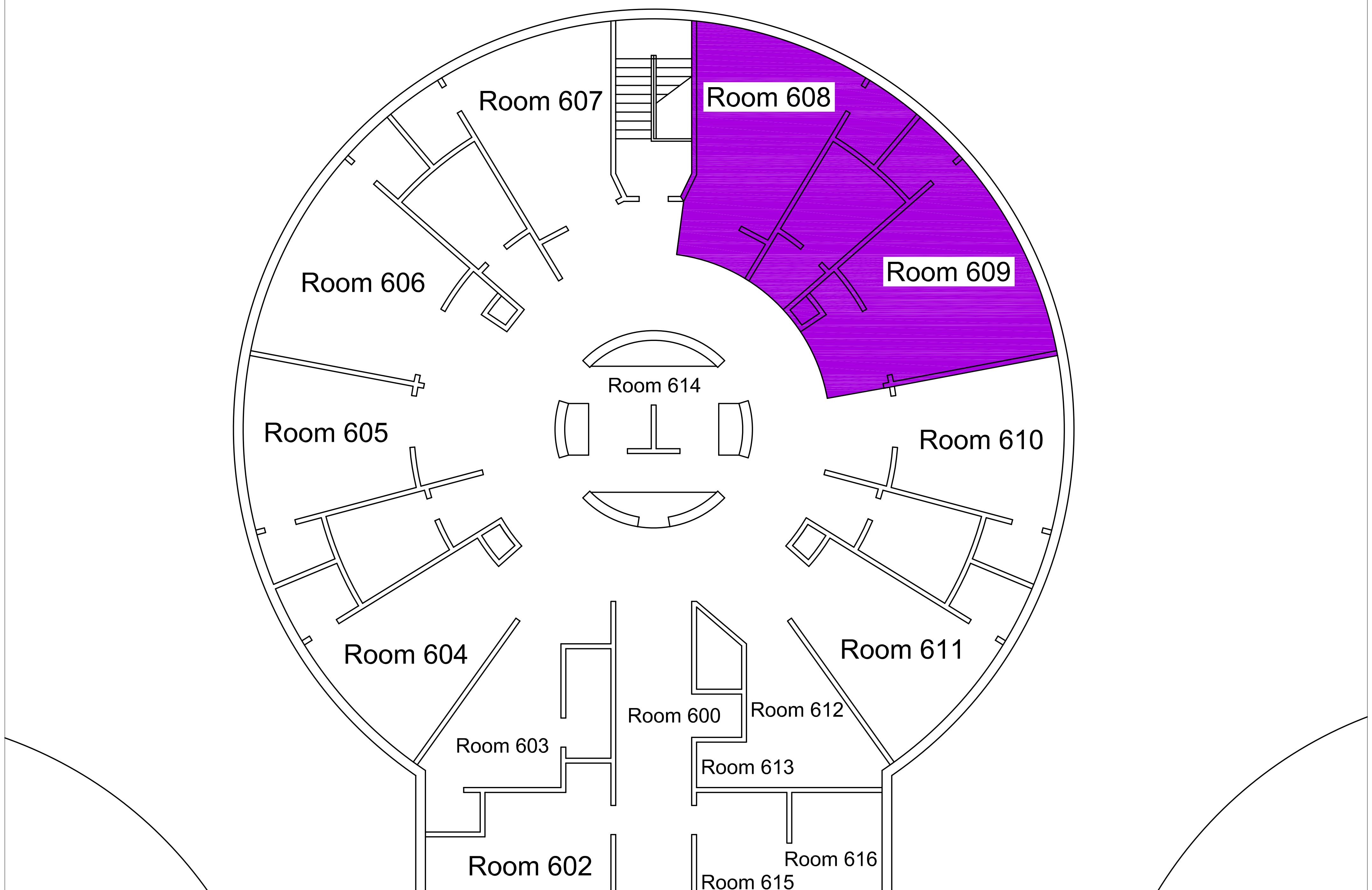
2003–07 Addition & Renovation Project

Thad Maugle
Construction Management
Dr. Horman

ICRA Sequencing
Sequence 7

CIVISTA MEDICAL CENTER
TOWN OF LAPLATA

AP01.7




CIVISTA Health

Civista Medical Center
La Plata, Maryland

2003–07 Addition & Renovation Project

Thad Maugle
Construction Management
Dr. Horman

ICRA Sequencing
Sequence 8

CIVISTA MEDICAL CENTER
TOWN OF LAPLATA

AP01.8