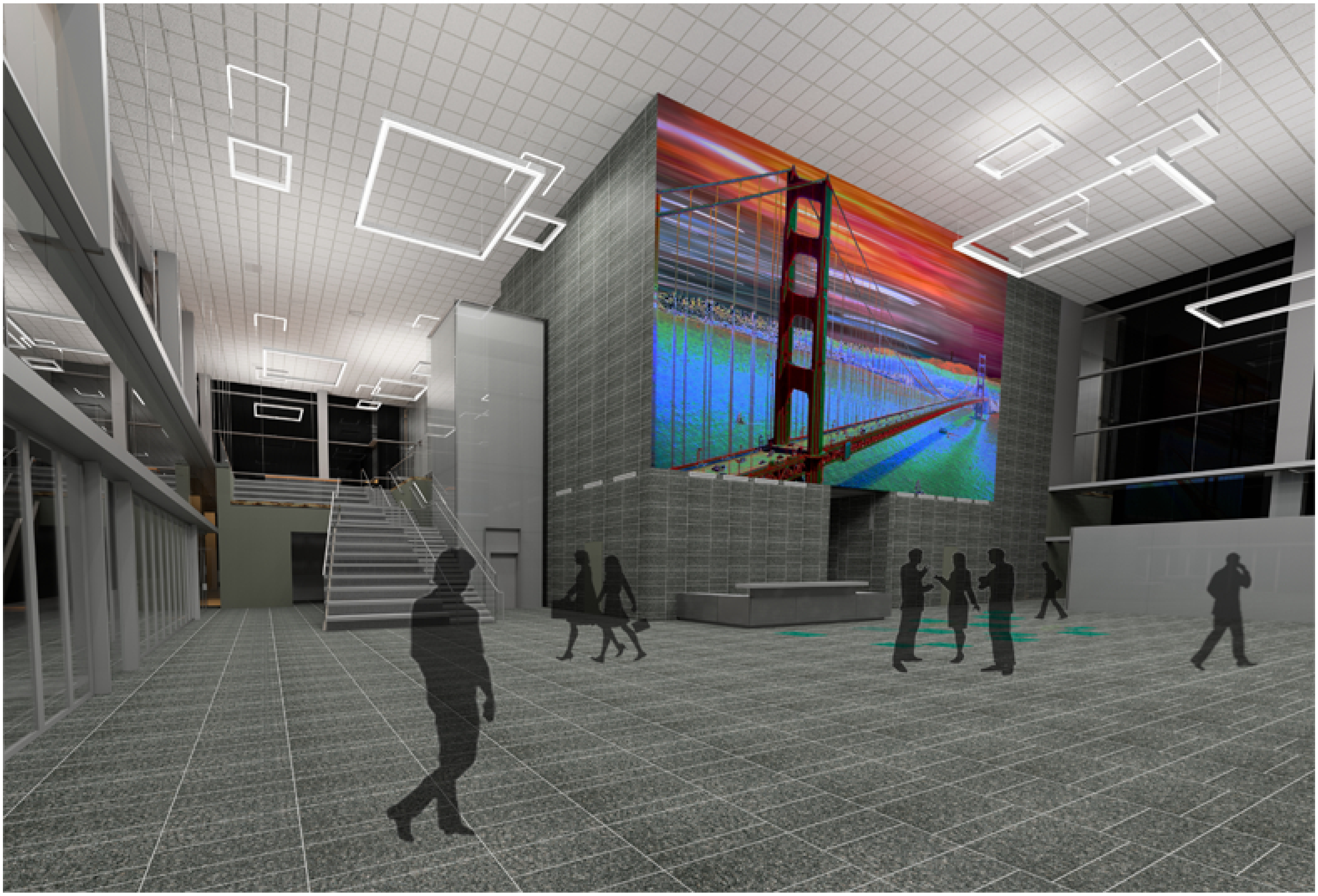
AEVITAS

UNENDING COMMITMENT TO INTEGRATED DESIGN



Taking an *integrated approach*, **AEVITAS** strives to *minimize environmental influences* by *engaging our community* with *sustainable* practices in energy conservation & emission reduction.

[ZERO**impact**]

ASCE Charles Pankow Foundation Annual Architectural Engineering Student Competition

Team Registration Number **03-2014**

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CONSTRUCTION

Table of Contents

Construction Narrative

Supporting Documents

Drawings

EXECUTIVE SUMMARY

The following report details the construction engineering and management techniques for the **AEVITAS** design of 350 Mission Street in San Francisco, California.

With the end goal of designing a net-zero high-rise building in the heart of San Francisco, **AEVITAS** developed the overarching attitude of [ZERO**impact**], encompassing four design goals of [ZERO**interruption**], [ZERO**energy**], [ZERO**waste**], and [ZERO**emissions**]. Through integrated design analysis, **AEVITAS** achieves these goals through effective and efficient collaboration. **AEVITAS** is an integrated design team, composed of representatives from the construction, structural, electrical, and mechanical disciplines. Through a unified effort, 350 Mission's environmental impact has subsided. Information about the design of 350 Mission can be found in **AEVITAS**' reports as detailed in Table 1.

TABLE 1: SYSTEM OVERVIEW BREAKDOWN

ARCHITECTURAL	Floor Plan Changes, Vestibule Addition, Integrated Public Art Piece
FAÇADE	Natural Ventilation Louvers, Seismic Connections, Electrochromic Glazing
MECHANICAL	Radiant Floor System, Natural Ventilation Louvers, Dedicated Outdoor Air System
LIGHTING	LED Lighting, DALI Controls Responsive to Daylighting and Occupancy, Task Lighting
ENERGY GENERATION	Onsite Solar Array, Offsite Solar Array, Human Waste to Power Converter
ELECTRICAL	AC and DC Distribution, Natural Gas-Powered Fuel Cells, Dual Electrical Risers
STRUCTURAL	Steel Superstructure, Braced Frame Core, Composite Beams and Deck, Outrigger System, Concrete Substructure
CONSTRUCTION	Production Planning, Matrix Scheduling, Waste Management, BIM Execution Planning, Site Planning

350 Mission is located in the South of Market (SoMa) district of downtown San Francisco, a diverse neighborhood housing several prominent high rise buildings. The area is consistently congested with an extremely small site area providing little to no laydown area outside of the building footprint.

With the early development of a Building Information Management and Modeling Execution plan, preparation was in place to manage and maintain efficiency. Coordination measures were taken to ensure integration throughout all aspects of planning, design, construction, and operation of 350 Mission. Through the building model components given, **AEVITAS** has presented a project delivery method of Bridging Design-Build with a five year 'maintain' addition to the contract. This method will allow for specialty contractors to act as multiple primes and have greater influence in construction to aid in deriving a net-zero design.

Facilities Integration Management Modeling is a practice **AEVITAS** developed to continue operating the building at maximum productivity after construction. Through methods of Building Information Modeling, data about all building systems is tied into a central core of information to aid in maintenance and education for all users at 350 Mission.

Because a net-zero approaches will typically cost more than traditional construction methods, **AEVITAS** endeavored to reduce cost through time savings. Waste management is employed to ensure a [ZERO**impact**] attitude throughout design, construction, and operation. A variety of scheduling techniques were used throughout the different areas of the project to increase efficiency. Matrix scheduling, phase planning, and short interval production scheduling methods were utilized to achieve an overall building schedule of 25 months and a cost of $158,951,700.

TEAM DIRECTION: GOALS AND ATTITUDE

350 Mission is above all else, a collaboration. Through a joint effort, the concept of 'net-zero building' has grown to fully encompass the idea of green living and **AEVITAS** is on the forefront of this movement. In order to reach the infinite goals that are stemming from such sustainable building ideas, **AEVITAS** set out to define the way the team would approach 350 Mission. Provided with an established architectural design but a different set of owner goals, the team has been dedicated to making design decisions that reflect the new goals of the owner, as well as the community and future tenants. **AEVITAS** is a talented team comprised of eight individuals with varying educations and diverse experience including backgrounds in structural design, MEP systems design, and construction engineering and management.

For the *2014 ASCE Charles Pankow Foundation Annual Architectural Engineering Student Competition*, teams are challenged to embrace the "development and integration of innovative and original solutions to the design challenge." With an emphasis placed on "integration of the engineered systems and construction management plan for a high performance building."

When coming together as a unified design force, the team as a whole was adamant early on about developing something more than a set of goals, something that would enable our interconnected thought process throughout design – our over-arching attitude. This attitude would encompass all team-driven specifications, with the owner profile and competition goals providing direction. From these motives, [ZERO**impact**] was born. [ZERO**impact**] is the way the project team defines the sustainable practices that are driving design decisions and owner goal integration. Within this all-encompassing team attitude and a strong mission statement, there are four focus areas that the goals are derived from, as shown below in Figure 1.

Taking an *integrated approach*, **AEVITAS** strives to *minimize environmental influences* by *engaging our community* with *sustainable* practices in energy conservation and emission reduction.

[ZERO**impact**]

[ZERO**energy**]

With a constant drive toward source net-zero energy consumption, **AEVITAS** defines the above as replacing any and all power pulled from the grid within a one year time span.

[ZERO**interruption**]

Through developed techniques, **AEVITAS** designs the solutions to have no impact on the daily operations of all project stakeholders in any seismic event.

[ZERO**waste**]

In aiming to be as efficient as possible, **AEVITAS** strives to eliminate all wasteful methods of design, both physical and abstract, with innovative construction processes.

[ZERO**emissions**]

Taking a holistic approach to preserving the environment, **AEVITAS** works to eliminate the production of all harmful emissions through strict material and process decisions.

FIGURE 1: AEVITAS ATTITUDE WITH GOAL BREAKOUT

In the following report, **AEVITAS** has responded to the owner's goals to establish a building that is as close to having zero impact on all project stakeholders when possible. The symbols of the goals appear throughout the report to show the actions **AEVITAS** took to achieve these goals. As one cohesive team – with the project requirements established, the opinion of net-zero defined, mission statement created, and the attitude of [ZERO**impact**] applied – **AEVITAS** created the systems and solutions found in this report to achieve all goals of 350 Mission. Throughout all design and project decision making, application of the [ZERO**impact**] attitude was the ultimate driving force.

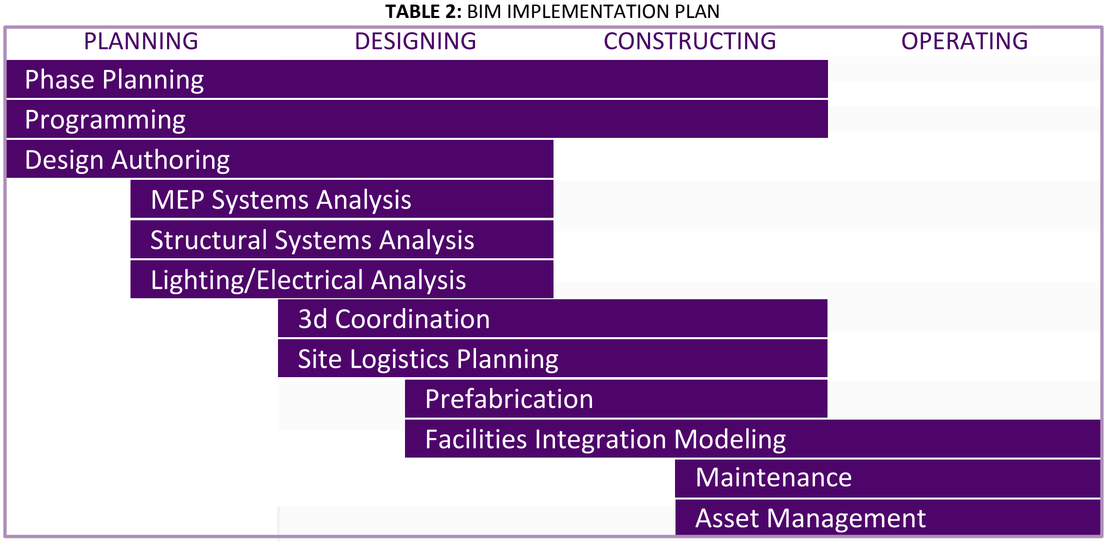
BUILDING INFORMATION MANAGEMENT EXECUTION PLANNING

As the first major step in our team process, AEVITAS came together as a project team to develop a Building Information Management Project Execution Plan. In accordance with a main goal and focus area, [ZERO**interruption**], the creation of this plan and utilization of the methods we created at the start of the process allowed for no interruptions to the design process and construction planning. More information on the BIM Ex Plan can be found in Supporting Documentation page #.

BIM Execution Uses

To maintain efficiency and goal oriented decision making, AE**VITAS** implemented a BIM Execution Plan. With the aim of being as industry realistic as possible, it was important to have coordination meetings early on with all options and disciplines present to develop the plan moving throughout all phases of the project. The purpose of a typical Building Information Modeling Execution Plan in industry is to lead a team through the planning process for BIM by adapting the planning principle that every project implementing BIM in some way should "begin with the end in mind." This process helps to incorporate all stakeholders in the project (Architectural, Engineering, Construction, and Operations) to incorporate and communicate their goals for executing BIM in the future of the project and its' lifecycle. There are a variety of uses for a BIM Execution plan and it is important to pinpoint the uses that are specific to a project early on. Developing the goals within the planning, design, constructing, and operating stages before any of these stages begin will be beneficial in being efficient and effective long term. For 350 Mission Street, the AE**VITAS** implementation plan can be seen in Table 2.

TABLE 2: BIM IMPLEMENTATION PLAN



After discussing the basic phases that AE**VITAS** planned to use BIM, it was important to integrate more information. Critical points of integration involved stating up front which disciplines would need to have active involvement in which stages, the information or training they would need to do so, and the experience, resources, and competency in which they had to proceed forward. A matrix of BIM uses can be found on page SD5 of the Supporting Documentation.

EXISTING CONDITIONS

The 350 Mission jobsite is bordered by two streets to its southern and western sides, which can be seen in Figure 2 on the next page. Mission Street, to the south, offers many challenges with regards to access to the site as it has two-way traffic and is a main route for the MUNI (San Francisco MUNIcipal Railway Company) system, San Francisco's public transportation system. Along Mission Street there are overhead electrical lines, utility

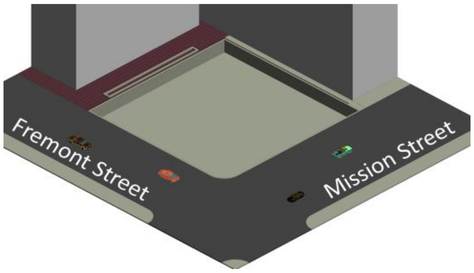


FIGURE 2: SITE LOCATION ORIENTATION AND EXISTING CONDITIONS

poles, fire hydrants, street lights, and a traffic signal; all of which will have to be protected during construction of the new building. On the building corner of Mission Street and Fremont, there are a variety of guy wires that will be rerouted. Fremont Street, to the west of the site, is a one-way street that is also a route for the MUNI system but the bus lane is located on the opposite side of the street from the project. Currently, the site has an existing building that is to be entirely demolished for the construction of 350 Mission. This existing structure bears on a wooden pile foundation system that will be excavated and removed. The building's basement expands out and under the sidewalks along Fremont and Mission Street. Most of the site utilities enter the building in the existing basement which contains two utility-owned high voltage switchgears; these switchgears are located below the sidewalks. The vault on Fremont Street will be protected during the new construction, and the other located on Mission Street will be removed and reconstructed for the new building.

Sub Grade Conditions

With job proximity close to the San Francisco bay, the water table is an issue that **AEVITAS** took into consideration for the logistics and planning of 350 Mission. The geotechnical report reveals that the water table ranges from 3 to 12 feet below grade with bedrock appearing at around 250 feet below grade. This first layer of soil that is feasible for bearing significant loads is a dense sand layer located at about 50 feet below grade. At this level, **AEVITAS** expects that during the excavation the wooden piles, concrete pile caps, and concrete underpinning of the previously discussed building will be encountered and **AEVITAS** is prepared to recycle these materials as much as possible. The Waste Management and Recycling log can be found in the Supporting Documentation page #.

AEVITAS' 350 MISSION BUILDING FEATURES

With the new defined set of owner and team goals determined, the design of the **AEVITAS** 350 Mission Street began to take shape. Coming together, the project team was able to design a building that refocused the project on the [ZERO**impact**] attitude; driving us toward a net-zero building. To ensure an integrated approach, the building was approached in sections. In the next few pages, the design of the substructure, superstructure and core, building envelope, lobby, and typical office floors are shown.

Substructure

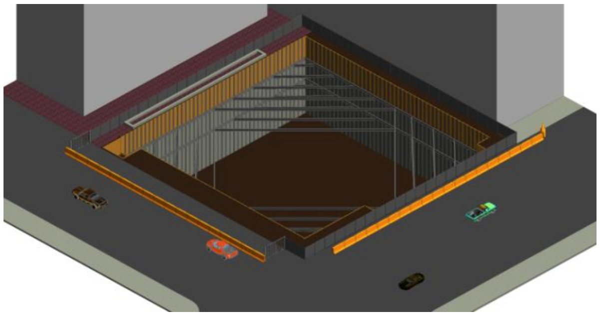


FIGURE 3: SLURRY WALL DETAIL WITH DIAGONAL BRACED

AEVITAS has developed a foundation system for 350 Mission Street that will include a concrete mat foundation and a layered foundation wall system comprised of a slurry wall, concrete piers, and a central concrete core. The layered foundation wall system was developed utilizing an exterior composite slurry wall, an interior waterproofing layer, interior drainage board for water draining, and a more aesthetically pleasing interior reinforced concrete wall. The exterior composite slurry wall system is a combination of reinforced concrete and steel I-beams; there is a diagonal braced frame system to support the structure during installation. A detail of this system can be seen in Figure 3. This foundation system was developed using information that **AEVITAS** gathered from the results of the geotechnical report, past successful projects in the area, and practices that are commonly successful in bay area soils.

Constructability

The slurry wall installation will begin with drilling holes around the perimeter of the site at 6 feet on center. In these holes, steel I-beams will be set into place and surrounded with a slurry mix to prevent any caving of the soil. After a guide wall is installed, the area in between these I-beams will be excavated with slurry being pumped in to prevent caving. The concrete will then be tremied into the excavation to finish the panels. When the diaphragm is complete, the cofferdam will be excavated and diagonally braced shoring will be installed for support. After the excavation is complete, waterproofing will be installed over the naturally compacted sand and also lining the surface of the slurry wall. A mud slab of lean concrete will then be placed over the waterproofing membrane on the ground to protect the membrane. Once completed, the mat slab will then be reinforced and poured. The construction of the core, concrete piers, foundation walls, and floors can then begin. As the floors are built, the diagonal bracing can be removed because the floors will now support the lateral load.

Quality

The composite slurry wall will assist in the prevention of ground water migrating into the cofferdam during the excavation. This will contain the need for dewatering to only the water that will seep through the floor of the excavation. The steel beams integrated into the slurry wall will also provide a more rigid diaphragm for the wall. This diaphragm will reduce the levels of interior diagonal bracing needed during construction. The waterproofing and foundation wall added to the interior of the slurry wall will also provide a higher quality both aesthetically as well as for water penetration. For these reasons, the slurry wall was not used as the final foundation wall.

Superstructure and Building Core

Relating directly back to the main focus area of [ZERO**emissions**], **AEVITAS** made the major decision to change the main structural system to steel with a concrete substructure and concrete decks. With the research performed, less long term emissions will be emitted with the material change. Figure 4 is a graphical representation of the emission reduction research that **AEVITAS** performed. Steel emits approximately 1,100 less tons of CO_2 per year than concrete. The structural frame of the building, including the building core, will be steel with the exception of the composite slabs for each floor. By reducing the amount of the concrete in the building to the minimal amounts needed for substructure and decks, the emissions impact was able to be decreased.

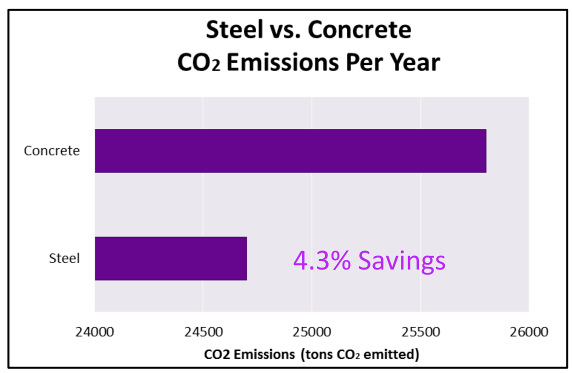


FIGURE 4: EMISSIONS EVALUATION PER YEAR STEEL VS. CONCRETE

Constructability

The vertical steel members in the core splice at the same level as the rest of the building frame, which means they will dictate the sequence of the steel work. The location at which the columns are spliced controls the number of floors that can be constructed before the next set of columns is raised. With this information and the Occupational Health and Safety Association (OSHA) regulation that requires a maximum fall to only be 2 stories, the columns will follow the steel splicing schedule and move on a two story cycle. The beams for two stories above are in place before the metal decking can begin installation on the floor two below. Sequencing is discussed in further detail in the 'Site Utilization and Phasing' section of this report along with a graphical representation of the work sequencing in Figure 5 on the next page.

Schedule

While looking more closely at the focus areas for the project, **AEVITAS** found that by using different scheduling techniques with the steel material choice, time and money could be saved with a shortened schedule. A steel structure is traditionally faster moving than a concrete structure when equipped with a strong ironworkers' work force such as the one that **AEVITAS** has hired to complete the structure at 350 Mission. Also, with an all steel structure, the core of the building can be erected at the same time as the rest of the building frame; the core sequencing is shown in sequence with the rest of the structure in the above graphic, Figure 5. In a concrete core, there are elements that are typically constructed ahead of time, causing a scheduling delay. An important detail in maintaining the time savings that steel can provide is placing the steel mill order with enough time for fabrication, delivery, and quality control checks. In order to maintain an accurate, efficient, and effective process, **AEVITAS** developed a process to control and track all parts of the steel transportation. This process can be seen in the form of a flow chart on Supporting Documentation page D1. By tracking this process through the Building Information Model, all members of the process will always be up to date on processes, quality checks, and delivery statuses. With these proper measures taken, the steel will lend larger time savings. **AEVITAS** has also made an effort to designing the structural connections to reduce waste in the form of materials, time, and money. There are many bolted connections in the structure that will reduce the extremely timely process of onsite welding and thus significantly reduce the schedule. The time achieved by **AEVITAS** for the erection of the steel is 5 months. With this reduction, the faster construction of floors and decking will allow for a quicker installation of concrete floor slab and hydronic piping for the radiant system on typical office floors.

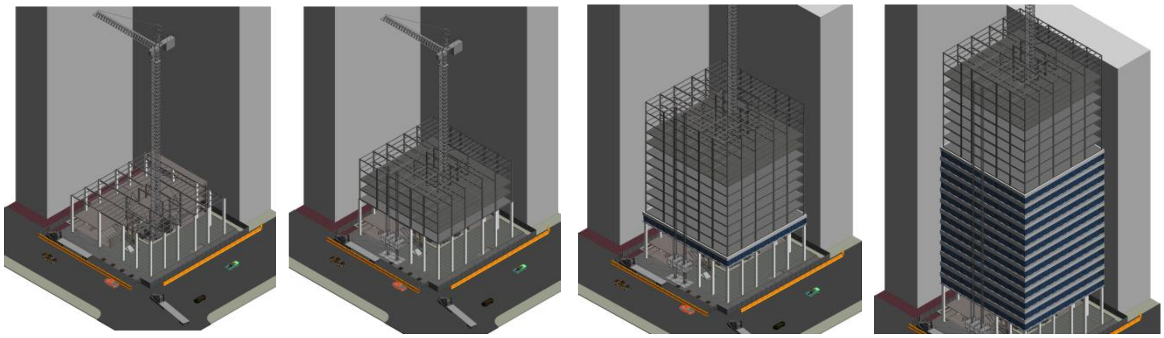


FIGURE 5: 350 MISSION PHASING

Coordination

The core of the building will be the central distribution hub, supplying services to each floor in high-rise buildings. The use of steel for this element of the building has the advantage of increased flexibility in the distribution of the systems to each floor. This is allowed due to the large openings created by the skeletal nature of steel structures. This is an improvement for our goal set to decrease coordination and quality control efforts that would otherwise be required for a concrete core. When it comes time for the trades to begin installation of their work, the process will happen more rapidly having the removal of a solid wall with formed openings that could be placed incorrectly to a more open steel structure.

Building Envelope

From the new owner's goal set along with the [ZERO**impact**] attitude that **AEVITAS** has developed, the new façade design utilizes a prefabricated panelized curtain wall system that consists of a double paned glass with an alternating saw-tooth, woven design and an innovative louver system at the finished floor level to allow for natural ventilation into the building. The system is a variation on the original architectural design provided by the owner's architectural design team but restructured to fit the new goals of the owner and **AEVITAS**. The contractual structure of the **AEVITAS** 350 Mission Street project is explained in further detail on page 14 under Project Delivery.

Constructability

Prefabrication of the façade panels is the key to the success of the design and installation. A single subcontractor will be responsible for the façade construction and installation. Typically, a variety of contractors would be involved on such a complicated design but **AEVITAS** has found a contractor that is willing to work the project through start to finish, saving time and money throughout the process. This will aid in organization of the entire façade process as well as overall project schedule, providing a higher quality product for 350 Mission. The façade subcontractor will be brought on the project as a design-build subcontractor at the beginning of the project to coordinate with the subcontractor in charge of controls for the operable louvers and the owners architectural design team to ensure the new design is acceptable as a substitute for the original system. The façade system will be prefabricated into three main parts providing an easier installation on site. The steel mullions will be prefabricated with the steel angle connections to the building structure as well as the glass panel. The natural ventilation louver will then be slid into place and fastened. The last piece to the façade system is the aluminum paneling that will be placed around the above ceiling plenum space for aesthetic appeal.

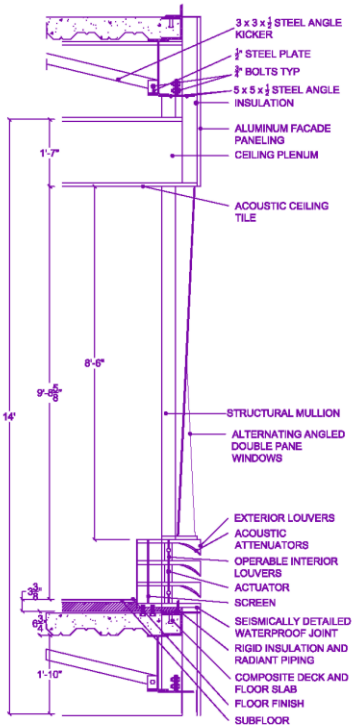


FIGURE 7: FAÇADE DETAIL

Quality

With prefabrication, there is traditionally a higher risk of tolerance issues as well as a higher possibility of leaks in the building skin. To prevent any tolerance issues, after the enclosure is designed, a physical mockup will be constructed to discuss and analyze tolerance constraints the panels must be built to. The panels will be constructed at a testing facility where the physical mockup will be tested for leaks to confirm that the system will be successful in stopping air, water, and moisture leaks. The workers that assemble and test this mockup in the facility will be the ones constructing the system on site making it an experiment as well as a learning tool to hopefully expedite the installation on site. Not only will **AEVITAS** build a physical sample of the prefabricated panel to test, but also a virtual mockup. By building and coordinating a virtual mockup of the panel before it is prefabricated, the organization of the process with run much more smoothly; a sample of a virtural mockup **AEVITAS** created is shown in Figure 11. Specific areas of coordination for the panel include the structural connections on the top and bottom details of the panel. These connection details are also shown in Figure 7; see **AEVITAS** Structural Report for more details on these components of the pre-fabrication process.

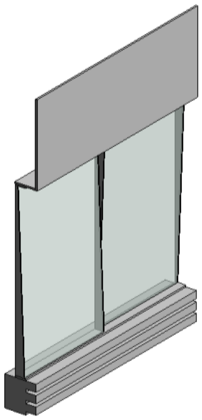


FIGURE 8: VIRTUAL MOCKUP

Schedule

The prefabrication of these panels will be the biggest benefit to the project schedule because it will allow for faster installation of the building enclosure and free up the interior trades that will follow. After the façade system goes through the testing and is proven successful the pieces of the façade will be shipped directly to the site on a weekly basis. It is expected that the façade will take five days per floor for the first few floors and will shorten to four days per floor once the workforce learns the most efficient method of installation. The façade panels will have to be left out at the location of the material and man hoists until the first elevator bank is energized and the hoists can be removed, once this is complete the remaining panels will be installed. With this assumption, the time achieved in the schedule for façade installation is about 5.5 months and as the building is closed in on each floor it will open up the floor for rough-in operations. This can be seen in Figure 5, the 350 Mission Phasing diagram.

Lobby

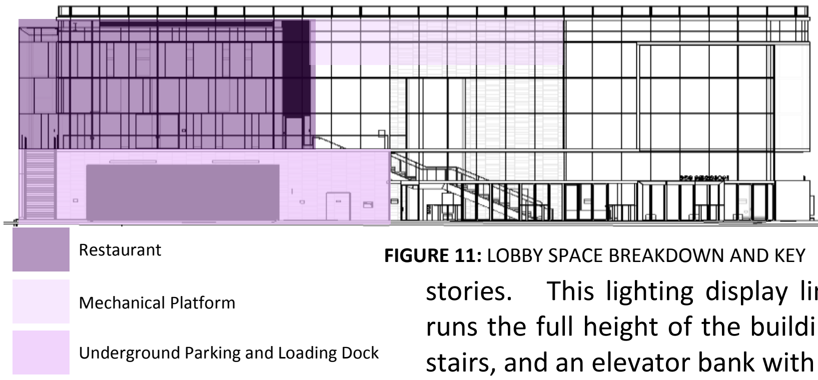


FIGURE 11: LOBBY SPACE BREAKDOWN AND KEY

The four story lobby is a block of space within 350 Mission building that is shared by a multitude of atypical spaces, all holding different purposes. In the section that opens to Mission Street, a four story tall space is equipped with public seating, a retail venue, and a large interactive lighting display encompassing the full four stories. This lighting display lines the exterior of the buildings core which runs the full height of the building and contains all system risers, emergency stairs, and an elevator bank with seven elevators. On the side which opens to Fremont Street, this four story section is split into different levels, each with a different purpose. The ground floor is an entrance to the underground parking garage and a loading dock area that doubles as a trash disposal room. Above this space on the second floor is a restaurant with a two story dining room and a one story kitchen space. Beyond the kitchen space is a one story mechanical platform for the HVAC equipment. The breakdown of this space looking from Mission Street can be seen in Figure 12. More on space allocation can be found on drawing page D3.

Delivery

Due to the separation of this space from the office floors located in the stories above this space, **AEVITAS** has devised a solution to provide this space to the owner earlier than the completion of the full building. By turning this space over before the actual finish date, we will allow for the owner to open the space to the public and begin branding and revenue of the retail and restaurant spaces. A marketing tool that the owner can use to attract future and current tenants, this feature will be something that enhances the buildings applicability. Publicity will be gained from this early move-in date, allowing the public to experience **AEVITAS**'s 350 Mission while still in construction. If the owner has not reached full occupancy by the time of the first lobby turnover, they could use this as a time to attract future tenants into the space.

Typical Office Floor

Radiant Heating

The heating system designed for the 350 Mission building includes radiant flooring in the typical office floors of the building. Though efficient in their heat distribution, the radiant heating produces many constructability concerns. The first concern is the possibility of leaks in the hydronic piping; to ensure a quality installation it is important that each radiant loop is tested for any leakage before the carpet pad and carpet tile are installed over it. Typically carpet is a concern for the performance of radiant heating, however using panelized insulation systems such as Warmboard in combination with a low R-Value carpet pad the efficiency losses are minimal. The Warmboard system will be installed on top of the concrete slab before the radiant tubing, the system contains grooves that the tubing is laid into providing an easy definable layout. The system also provides flexibility for future renovations as the panels can be adjusted to accommodate the zoning the owner is looking for.

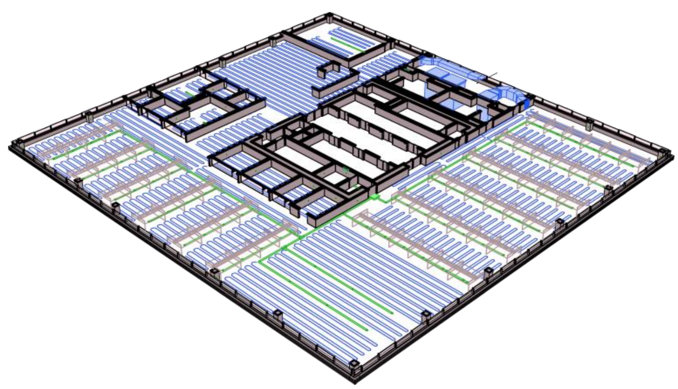


FIGURE 13: TYPICAL OFFICE LAYOUT: RADIANT VS CONDUIT

Prefabricated Plumbing Assemblies

Another feature used in the construction at 350 Mission is pre-fabricated plumbing assemblies. Because the building has an identical layout on each of the office floors, there is the possibility to achieve schedule savings by moving the work for the plumbing assemblies to an off-site warehouse that is and will be leased for the duration of the project. This means that the work for the plumbing will begin significantly well before the work on site would allow. Once the floors get to the stage where the plumbing would have to be installed, the assemblies can be transported to the site and simply attached to the plumbing risers.

PLANNING AND LOGISTICS

Geographical Considerations

San Francisco is built on a peninsula, where it is only connected to land on the south side, making planning and logistics a challenge. The main concern is access to the city itself. There are multiple access routes from the south with the collection of Route 1, Route 101, and I-280; however, aside from these there are only two access points from any other direction, I-80 from the East, and Route 101 from the North. Due to the limited space in San Francisco, it is assumed that most of the sub-contractors and suppliers will be outside of the city and will rely on these access points to get to 350 Mission. Labor personnel will have more access to the city by utilizing the public transportation systems such as the Bay Area Rapid Transit (BART) system and ferries crossing the San Francisco bay.

Permitting and Regulations

Due to the limited space available on the 350 Mission site it is necessary to use the adjacent sidewalks and parking lanes on Fremont Street and Mission Street for construction operations. Any work that blocks public right-of-ways including roadways, plazas, bike lanes, and sidewalks for an extended period of time requires a Special Traffic Permit issued through the San Francisco's Municipal Transportation Authority (SFMTA). This type of permit must be renewed by the contractor every 30 calendar days. The SFMTA also regulates a Holiday Moratorium where any work blocking public rights-of-way on city blocks with at least 50% of business frontage is forbidden during daytime hours from the day after Thanksgiving to New Year's Day. To determine if the block is included a Moratorium Survey must be filled out by the contractor and submitted to the SFMTA. If the block falls under the Moratorium then the only hours available for work are from 10:00PM to 7:00AM, in which a Night Noise Permit may be required.

Labor Force & Material Considerations

Currently there is a large volume of construction taking place in San Francisco, especially in the financial district of the city where the 350 Mission site is located. The most notable of the projects is the new Transbay terminal and tower that is located adjacent to the 350 mission site. Because this project is so large and so close to the 350 Mission site, it may result in competition for labor and material. The implications of this can include a lower quality workforce, scheduling conflicts, longer material lead times, lower availability of material, and reduced sub-contractor and supplier cooperation. **AEVITAS** plans to mitigate these future issues by advanced scheduling techniques that allow the project team to be aware of milestones in advance to plan for the lead times that not just pieces of steel or machinery yield but also the needed work force and material deliveries. Because **AEVITAS** has chosen to use the best labor available, the labor force in San Francisco will involve a strong union presence and the extra cost of this improved performance is factored into the building plan and estimate.

Delivery Planning

Due to site constraints and the use of aggressive scheduling techniques, Just-In-Time delivery planning will be utilized for the project. An offsite warehouse will be leased for the duration of the project to be used as material storage and staging area; the location of the warehouse can be seen in Figure 14. This warehouse will receive the bulk deliveries of the materials to be sent to the site. At the warehouse the materials will be accounted for, checked for quality, and organized for delivery to the site; an example flowchart of the steel delivery is available in drawing D1 along with other considerations for the Warehouse and Delivery Logistics. To transport all material to the site without extralegal permits, trucks must not exceed certain dimensions according to the California Vehicle Code (CVC). Trucks are allowed to be a max of 14' tall, 8' 6" wide, 65' long and as a general rule of thumb have no more than 20,000 lbs on a single axle. Also, on both Fremont Street and Mission Street there are overhead electrical wires located directly above the street right of way with 17.6 feet of clearance above the street. These lines are owned by the SFMTA for the city's public transportation system, called the MUNI system. These wires must remain in use during construction and must be taken into account when planning deliveries to ensure none of the deliveries will interfere with their use or location.

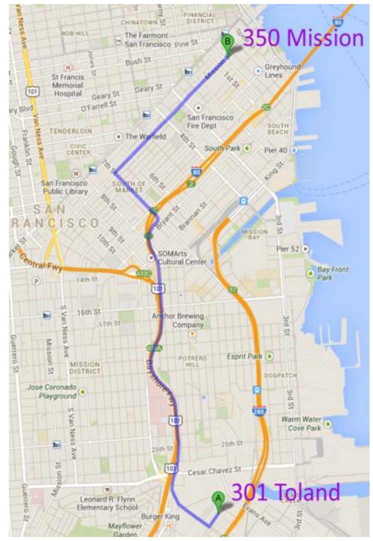


FIGURE 14: WAREHOUSE LOCATION

SITE UTILIZATION AND PHASING

With the existing conditions outlined earlier, **AEVITAS** determined that the optimal location to access the site would be on Fremont Street as it has fewer obstacles to deal with and provides a better opportunity for lane closures during daily site operations. The parking lane and bike lane adjacent to the site on Fremont will be closed off and designated as the delivery lane for the site. Temporary pavement markings will be put in place to direct cars turning off Mission Street onto Fremont Street. To minimize the impact of the construction on pedestrian traffic around the block a barricade will be set up in the parking lane of Mission Street to provide a temporary sidewalk, the sidewalk on Fremont however will inevitably be closed forcing pedestrians to use the sidewalk across Fremont. The courtyard on the site's north side located between 45 Fremont and the project site was looked at as a possibility for increased site space, however was determined unusable as it is owned by the 45 Fremont property owners according to the San Francisco property map.

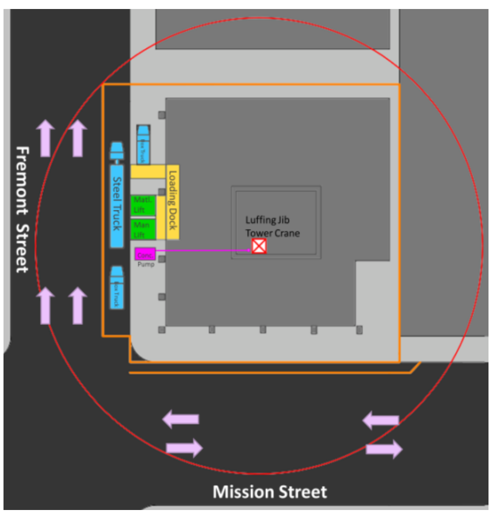


FIGURE 6: SITE LOGISTICS AND UTILIZATION

Demolition

Before any demolition work starts, utility companies such as PG&E (Pacific Gas and Electric) and the San Francisco Public Utilities Commission (SFPUC) will have to be contacted to coordinate utility shut-offs into the building. Because the basement of the existing building extends under the sidewalks on both adjacent streets, there will be temporary shoring set up to drive any heavy equipment over this area for demolition purposes. Temporary protection will have to be set up on the sides of the site facing the brick courtyard towards 45 Fremont and the 50 Beale Street building to prevent any damage resulting from the demolition of the existing building. The waste management plan will be most important in this part of the project as there will be large quantities of recyclable material trucked off site. The concrete will be processed on site some of which will be recycled for use on the site and the rest will be available to other construction sites in the bay area.

Excavation

As mentioned in the Building Features section earlier in this report, a composite slurry wall will be used as part of the foundation system for the 350 Mission building. This system will be more costly and time consuming to install but will be more effective in dewatering efforts in the cofferdam and will provide a more rigid diaphragm assisting in the bracing of the cofferdam. The slurry wall installation can be referenced in the constructability section of the substructure section earlier in the report. The slurry wall system will require an on-site slurry mixing plant to generate the product for the wall excavation. A crawler crane and clamshell bucket will be brought on site for the trench excavation; an example of this can be seen in Figure 7. After the slurry wall is installed, the excavation of the cofferdam can begin. In the beginning, a ramp will be built in the building footprint to allow equipment access to the cofferdam. When a depth of around 20 feet below street level is achieved, this ramp will be too steep for mobility; at this point a mobile crane will be brought in to haul the excavated soil out of the cofferdam so it can be trucked off site. As the excavation gets deeper internal diagonal braced diaphragms will be installed as support for the cofferdam. A crane will be onsite to install the interior shoring system consisting of ring beams and diagonal bracing. The excavation will stop at a depth of 55 feet below street level allowing the work for the substructure to begin. Water pumps will also be needed on site at this time due to the high water table at the site.

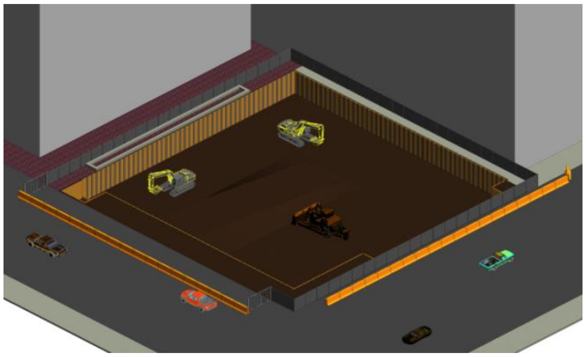


FIGURE 7: EXCAVATION PHASE

Substructure

The substructure phase begins with the construction of a mud slab to bring the elevation of the excavation up to 52 feet below street level. On top of this slab, a layer of waterproofing will be installed before the reinforcing for the mat foundation is constructed. Within the building core, a luffing jib tower crane will be constructed in the place of the buildings elevator shafts. The crane will assist with the reinforcement construction during this phase. At the bottom of the core, there will be an extra crane pad to support the heavy weight of the crane during the construction. This pad will stay after construction is complete and throughout the future life of the building. The substructure core will be the first component of the substructure to be built and will be constructed two floors ahead of the subgrade foundation walls columns, and floors. A layer of waterproofing will be installed between the slurry wall and the interior foundation wall as the substructure is built up. As the floors of the substructure are built, they will assume the lateral loads and the internal diagonal bracing of the shoring system, shown earlier on page 3.

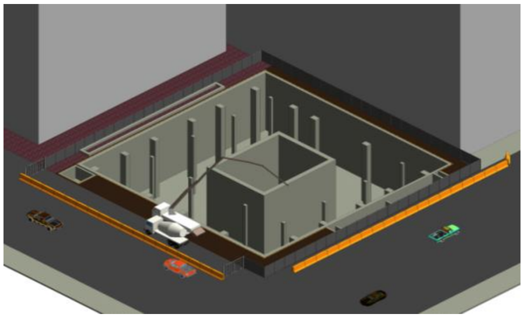


FIGURE 8: SUBSTRUCTURE PHASE

Superstructure

The first activity to occur with the construction of the superstructure will be the steel frame erection. Since the first set of steel columns rise the first five floors, the entire structure of those floors will be constructed before any following work will begin. Because the columns that are ranging the five stories will be so large, a splice will occur at the middle of this column to ensure easier transport and erection. After this steel is in place the space will be open and ready steel decking crew to install the deck and shear studs on 2nd floor and the Equipment Platform level. After the steel is past the 5th floor, the columns shorten to span 2 floors. This will create a two floor cycle where the steel frame will be erected two floors which will then be followed by the decking crew installing the metal deck and studs for these two floors. After the steel reaches the 9th floor, crews from the electrical and concrete trades will come in to place the wire mesh and rough-in the in slab conduit, test the radiant tubing for leaks, and finally pour the concrete slab. After steel is erected to the 18th floor and the slab operations have been done up to the 12th floor, the installation of the curtain wall panels will start on the 5th floor. This installation starts on the 5th floor because there will still be equipment accessing the inside of the lobby and it is likely that any panels installed in the first five floors would face a higher risk of damage. Panels will have to be left out on the Fremont side of the building where the material and personnel lifts are located. These panels will be filled in once the service elevator is energized. The interior core rough-in will start after the curtain wall operation has reached the 16th floor, the location of the crane in the core will not interfere with any of the systems risers since it is located in the elevator shaft. After the risers are installed, the horizontal rough-in and interiors work can take over as the risers reach the 7th floor. After the equipment is lifted into the building and the steel is topped out, the crane will have to be deconstructed. To deconstruct, a derrick crane will have to be installed on the roof to disassemble the crane and lower it to the ground. See drawing D2 for a 3D representation of this.

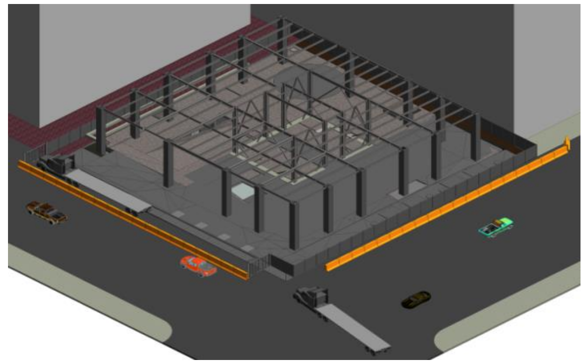


FIGURE 9: SUPERSTRUCTURE PHASE

TABLE 3: MATERIAL BREAKDOWN

Material Type	Quantity	
Concrete (Structure)	3181	CuYd
Columns	109	CuYd
Slabs	3072	CuYd
Wood (Piles)	756	Each
Glass (Windows)	5616	SF
Carpet	56718	SF

WASTE MANAGEMENT

FIGURE 10: GREEN FACTS EXAMPLE

Given the strong initiative for sustainability set by the goals for 350 Mission and the push by **AEVITAS** for [ZERO**impact**], it defeat the concept net-zero building if all the waste from the construction process went into landfills; this introduces an even greater need – a waste management plan. The plan will require multiple dumpsters and sorting techniques to be used on site at the multiple phases of construction. The demolition phase will be the most important phase of the construction to focus on because of the amount of materials that would otherwise be trucked to landfills. Table 3 shows an approximation of the materials that might be able to be recycled or even reused in the construction of the new project. Greater waste management planning can be found in Supporting Documentation # along with a sample Waste Management Tracking Log developed by **AEVITAS.** Though waste management planning is ethical and environmental, it is often an under-acknowledged effort by the contractor and owner that costs money and has minimal return. To add value to the waste management efforts used on site, everything that is reused or recycled in the construction of the new building will be tracked. The company Waste Management has released a new program called the Diversion and Recycling Tracking tool (DART). The tool tracks the quantity of materials hauled off the jobsite, in coordination with the weekly Waste Management Tracking Log found in Supporting Documentation #, that are diverted from landfills to reuse and recycle. The program then has the ability to create what is referred to as 'Green Facts' that show the significance of the recycling efforts in easily understood facts about the environmental impact; an example of the 'Green Facts' that could be produced is found in Figure 10. Throughout the construction process, these facts and figures will be available to all onsite workers, motivating all members of the project to follow the methods outlined in the waste management plan to make a difference on the amount of waste produced. By bringing this process on site during the actual construction of the building, the [ZERO**impact**] attitude will be carried through not just the lifecycle of the building but also throughout the construction. This entire process will add value to the project for the owner because the owner will be able to use these "green facts" as marketing to possible tenants of the building and to support the [ZERO**impact**] attitude.

PRODUCTION PLANNING

The nature of a high rise office building is to have typical floors where the layout for multiple floors is the same. Repeatability in design provides a constructor the opportunity to develop 'lessons learned' with each successive floor and establish the most efficient process for constructing the floor. Again, AE**VITAS** looked back to the main attitude and focus areas to determine the best way to move forward. With waste being one of the main niches, we decided to find the best type of scheduling system to reduce time on the 350 Mission project. The result is Matrix Scheduling which will yield a reduction in schedule and wasted time while maintaining quality and adding value to the project.

Matrix Scheduling

Matrix scheduling will be implemented for the rough-in and interior work as means to reduce wasted time in the schedule. Each trade will follow a Short Interval Production Schedule (SIPS) in which the tasks for that trade will be broken down to identify the amount of time in minutes the task will take to complete. Assuming each trade is allotted a week to get one floor done, the production rates for that trade will be established and the coordination of how the trades follow each other will be decided upon before construction begins and written into each subcontractor's contract. This type of schedule also requires a lot of involvement from the subcontractor foremen because they must 'buy into' the schedule and give feedback as to whether the amount of work they have in a week is feasible. If all trades 'buy into' the SIPS method, efficiency and effectiveness can be greatly improved. Each trade will have a designated time to be in an allotted space and during that time, they will be the only trade there. This eliminates the common issues in field of trades running into each other trying to perform work within the same space to stay on schedule. In SIPS, this confusion is eliminated and all areas are secured for certain trades ahead of time. The 350 Mission matrix schedule developed by AE**VITAS** can be seen on drawing D8 of Supporting Documentation.

PROJECT SCHEDULES

The 350 Mission project is slated to start in April 2014 with a notice to proceed date of 4/7/2014 and projected duration of 25 months. Post-demolition, the building is expected to spend 22 months total under construction, using the techniques outlined throughout this report. The excavation for the project is projected to take just under five months to reach the elevation for the bottom of the mat foundation, the length of the excavation is a bit longer than typical because of the composite slurry wall mention earlier. The building is then expected to rise back out of the ground by March of 2015 with the first piece of structural steel being raised on March 30th. The schedule will then follow the sequencing mentioned in the superstructure section above. A more detailed version of the schedule can be seen in drawing D4 in the drawings section of this report. Some of the long lead items are included in table 4.

TABLE 4: LONG LEAD ITEMS

Long Lead Items	Lead Times
Loading Dock Turntable	12 Weeks
Fuel Cell	30 Weeks
Switchgears	6 Weeks
Uniterruptable Power Supply	8 Weeks
Solar Panels	6 Weeks
Cooling Tower	24 Weeks
Generator	16 Weeks
Façade Panels	12 Weeks
Heat Pumps	8 Weeks
Chillers	6 Weeks
Boilers	6 Weeks
Steel	40 Weeks
Air Handling Units	12 Weeks

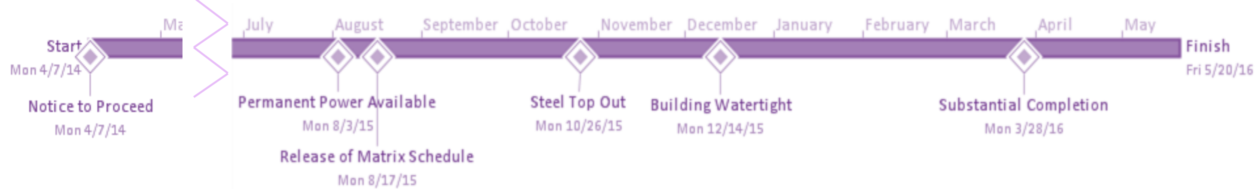


FIGURE 11: SCHEDULE TIMELINE

PROJECT DELIVERY

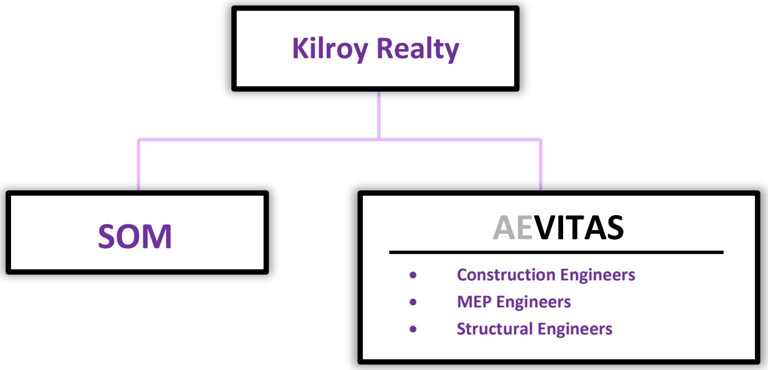


FIGURE 12: AEVITAS PROJECT DELIVERY METHOD

350 Mission will be delivered to Kilroy Realty using a bridging design-build delivery method. Bridging design-build is a hybrid between the traditional design-bid-build and the design-build methods in terms of structure. The owner hired their architect to produce the initial design documents then hired **AEVITAS** as the design builder to finish the design and construct the project. Specific to 350 Mission, Kilroy Realty hired Skidmore, Owings, and Merrill (SOM) as their design consultant for the initial architectural design of the building. After the initial architectural design documents are handed over, **AEVITAS** will be responsible for the completion of the design and the construction for the building. The completion of the design includes the design of the MEP systems, structural system, and any minor changes necessary in the architectural design concept to accommodate these systems.

Project Delivery Reasoning

The bridging design build delivery method is typically more expensive than standard design build due to the fact that the owner will have to pay a fee to both SOM and **AEVITAS**. However, the advantage of bridging design build to the owner is that the owner will be allowed more input into the design concept of the building. In this case the owner will be able to achieve the look they want for the building but can leave the schematic and detailed design as well as the construction of the functional systems in the building to **AEVITAS**. Internally, the **AEVITAS** team will be led by a construction management team that will team up with design build specialty contractors for the design and construction of the MEP systems, structural system, and building enclosure for the 350 Mission building. There will also be a number of consultants that join the AEVITAS team throughout the design and construction process due to the complexities of the specialty equipment in the building such as the fuel cells and DC electrical systems. This will be in the best interest of the owner because the team that designs the systems will also be constructing the systems. With each party the field personnel will be located on site each day and project managers and designers will have offices at the offsite warehouse, reporting to site only on an as needed basis. The meetings between all personnel will be held in a conference room located at the warehouse in which the team can discuss look-ahead items, coordinate any issues, exchange important information or documents, and discuss delivery plans. This increased coordination will greatly reduce any time and money lost to change orders typically encountered in other types of delivery methods.

During the preconstruction period, construction personnel will run team coordination meetings where they provide feedback on constructability, cost, schedule, and model/system coordination to the design team. They will also be responsible to track these meetings, create any preparation documents for the meetings, and track the progress of the entire team. To track all of this data and share information a document sharing medium will be set up so that all members of the team have access to the documentation being done by the other team members. Group text messaging will be used by the team so all parties are involved on questions asked and answered. Independently, construction specialists will be responsible for preliminary estimates and schedules, constructability analyses, site logistics planning, long lead item procurement, off-site storage/staging area planning, delivery planning, utility hook-ups, geotechnical report review, document control, permit procurement, and waste management planning.

FACILITIES MANAGEMENT PLANNING

In a net-zero building it is common to have state of the art equipment and systems, however whether the building is operating at a net-zero capacity or not is contingent on how efficiently the equipment is operating. The equipment and systems cannot be expected to run perfectly throughout the building lifetime by themselves so it is important to have a management plan for the facility to minimize the cost of inefficiency.

Contractual Recommendations

AEVITAS is recommending the owner enter into a service contract and purchase an extended five year warranty up front from the MEP contractors responsible for building each system and perhaps some of the specialists on the fuel cells to be included in the building. The benefit provided by this will be that the contractors who built the system will help to maintain the systems so they are operating at maximum efficiency and train the facilities maintenance staff that will be hired for the building. Each agreement will require an estimated $800,000 up front cost but will be well worth the money to save efficiency of the equipment. These contracts will be separate from the original bridging design-build contract.

Facilities Integration Model

During the design and construction of the 350 Mission building, a facilities integration model was created as a means to assist in the operations and maintenance contracts. This model was built to be utilized following the completion of the construction throughout the full lifecycle of the building. The model contains cut sheets for the equipment in the building and cost information for commonly replaced materials in the building, making itself a valuable asset in any future updates to the building. Refer to Drawings # and # for more information on the FIM at 350 Mission.

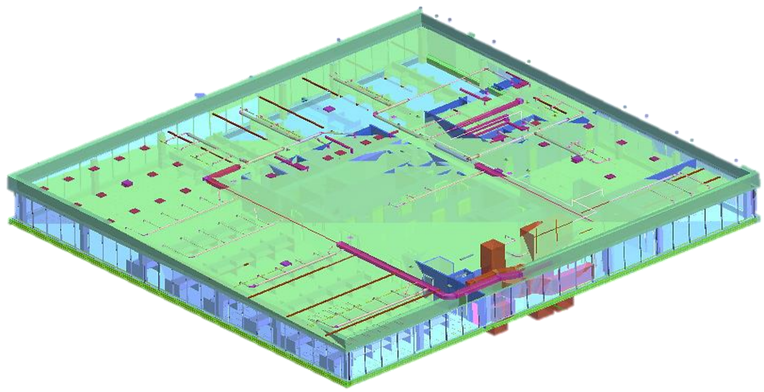


FIGURE 13: FACILITIES INTEGRATION MODEL FOR FACILITIES MAINTENANCE

Building Lifecycle

The high performance equipment used in the design of the 350 Mission building is aimed at minimizing these operating costs through efficiency and the used of alternate energy sources. In addition, the maintenance costs of the building over its lifetime can contribute to a large portion of lifecycle costs in a building as well. Therefore considering the life of the equipment, how the equipment can be moved in and out of the building, and even the finish materials used can help minimize maintenance cost without reducing the value of the building. Refer to Supporting Documentation pages SD15 and SD16 for information on building and equipment lifecycle costs.

ESTIMATES

The initial cost of the 350 Mission building was estimated to be $158,951,700.00 which equates out to be $370.00/sqft. The general conditions associated with the project are projected to be about 6.56% of the overall building cost. The buildings high performance HVAC and electrical systems attribute to a majority of the building cost as they hold 26.63% of the

CSI DIVISION	TOTALS
Division 2 - Existing Conditions	$531,320
Division 3 - Concrete	$11,416,200
Division 4 - Masonry	$186,680
Division 5 - Metals	$16,230,585
Division 6 - Wood, Plastics, Comp	$258,480
Division 7 - Thermal and Moisture Prot	$1,335,480
Division 8 - Openings	$21,942,080
Division 9 - Finishes	$6,232,240
Division 10 - Specialties	$1,579,600
Division 11 - Equipment	$1,134,440
Division 12 - Furnishings	$258,480
Division 14 - Conveying Equipment	$6,734,840
Division 21 - Fire Suppression	$2,053,480
Division 22 - Plumbing	$4,552,120
Division 23 - HVAC	$18,452,600
Division 26 - Electrical	$19,788,080
Division 27 - Communications	$3,001,240
Division 31 - Earthwork	$13,254,280
Division 32 - Exterior Improvements	$430,800
Division 33 - Utilities	$502,600
Direct Costs	$143,600,000
General Conditions	$9,419,000
Fee	$4,308,000
Total Building Cost	**$157,327,000**

building cost together. A large component of this is the fuel cells that are to be encompassed in the electrical scope of work. The building façade is another large portion of the building cost as the monochromic glass and natural ventilation louvers drive the cost of the enclosure up however with the monochromic glass comes savings in the specialties division for shades. Also the costs of prefabrication and testing for the panels proves to be expensive at first but the savings in the schedule is perhaps the largest benefit. Lastly the values for the earthwork and concrete are also large portions of the project due to the logistics of the site, the foundation system, and the composite slurry wall system that is to be used for the excavation support. See SD11

CONCLUSION

AEVITAS strives to achieve the desires of the owner to have a net zero building while still considering the needs of Kilroy Reality as a developer to have the building delivered in the most efficient way possible. Using techniques such as the matrix scheduling where manpower and work activities were broken down into such specific elements to analyze the most efficient construction sequencing and phasing the team believes that it has trimmed wasted time out of the construction schedule for the typical office floors. The team has provided Kilroy Reality with the proper equipment and methods to achieve a net zero building but has then taken it a step further by providing suggestions for how to properly maintain the building after building turnover to ensure proper performance and life-long source net zero energy use. The building has a high initial cost as a penalty for such innovative technology but AEVITAS has provided a maximum 10.6 year payback period for the cost.

AEVITAS developed a way to measure the lessening impact on the energy we used in Figure 19. In order to show a normalized graphical representation some of the values we have been tracking throughout the design and construction process, all numbers started out with a baseline value of the starting number, the worst that the value would be. Then **AEVITAS** worked to decrease these values throughout design decision, goal focusing, and waste management.

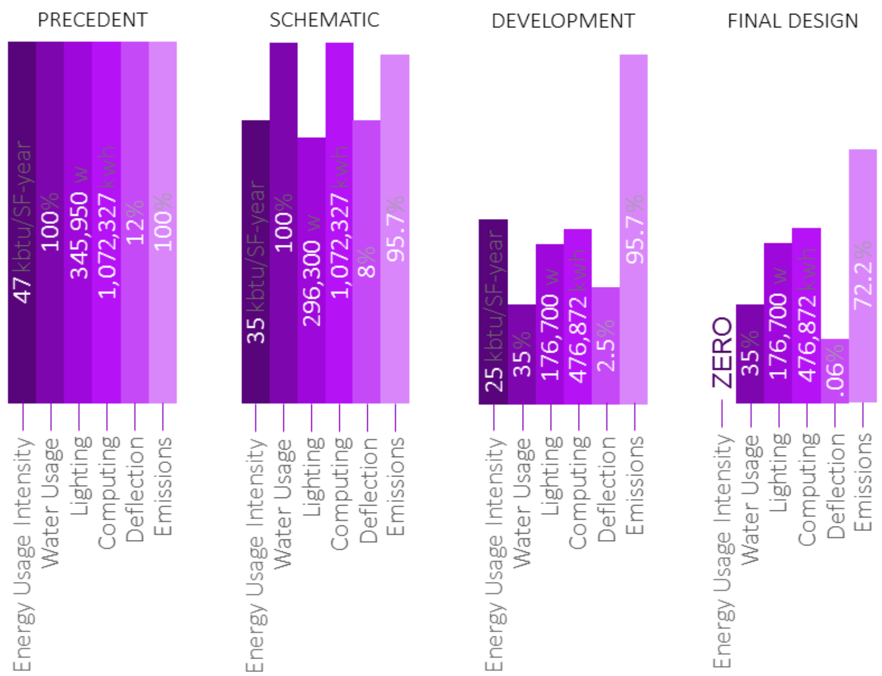


FIGURE 19: MEASURES OF SUCCESS

The analyses show a design that adequately addresses the attitude of [ZERO**impact**], without losing sight of the bottom line. In attrition to being net-zero, the design also offers a competitive life-cycle-cost of 10.6 years when compared to the baseline building. **AEVITAS** strongly believes 350 Mission is a constructible, innovative, high-performance and realistic design for a net-zero building.

REFERENCES

People

Jim Faust – Federal Reserve Bank
Andrew Paxton – Southland Industries
Andrew Rhodes – Southland Industries
Lance English – Southland Industries
Mark Collins – Southland Industries
Victor Sanvido – Southland Industries
Emily O'Connor – Pankow Construction
John Thomson – Carousel-USA
Craig Dubler – Penn State Office of Physical Plant
Rob Leicht – Penn State Professor of Architectural Engineering
John Messner – Penn State Professor of Architectural Engineering

Books

[1] Xanthakos, Petros P. *Slurry walls as structural systems*. 2nd ed. New York: McGraw-Hill, 1994.

[2] Puller, Malcolm. *Deep excavations: A practical manual*. London: T. Telford ;, 1996.

Papers

[3] "An Owners Guide to Project Delivery Methods." CMAA 1 (2012): 24.

[4] Tommelein, Iris D., David R. Riley, and Greg A. Howell. "Parade Game: Impact Of Work Flow Variability On Trade Performance." Journal of Construction Engineering and Management 125, no. 5 (1999): 304.

Websites

[5] "Warmboard, Inc. |." Warmboard, Inc.. http://www.warmboard.com/ (accessed February 10, 2014).

[6] "The Gateway to Up-To-Date Information on Integrated 'Whole Building' Design Techniques and Technologies." WBDG. http://www.wbdg.org (accessed February 10, 2014).

[7] "Version 5.0.3." RSMeansOnline: Construction cost estimates made easy. http://rsmeansonline.com/ (accessed February 9, 2014).

[8] "Search Commercial Real Estate." Commercial Real Estate. http://www.cityfeet.com/ (accessed February 10, 2014).

[9] "INTRODUCTION." BIM Planning. http://bim.psu.edu (accessed February 10, 2014).

[10] "SFMTA Municipal Transportation Agency." SFMTA. http://www.sfmta.com/ (accessed February 10, 2014).

[11] "Department of Building Inspection : Home." Department of Building Inspection : Home. http://www.sfdbi.org (accessed February 10, 2014).

[12] "Select an Area.." Diversion & Recycling Tracking Tool for Enterprise. http://www.wm.com/enterprise/construction/Diversion-and-Recycling-Tracking-Tool.jsp (accessed February 10, 2014).

DECISION POINT SYSTEM

Construction Management

	SYSTEM DESCRIPTION	ZERO IMPACT GOALS				OWNER DRIVEN EVALUATION CRITERIA														RECOMMENDED?
		ENERGY	INTERRUPTION	WASTE	EMISSIONS	ENERGY QUANTITY	COST	SUSTAINABILITY	PHASEABILITY	INNOVATION	COMPLEXITY	SPACE NEEDED	MAINTENANCE	INTEGRATION	SITE ISSUES	TEACHING	PRACTICALITY	LIFECYCLE	EFFECTIVENESS	
Production Tracking	SIPS Scheduling	0	0	+	0	0	+	0	++	+	-	+	+	++	++	+	++	0	++	Y
	Last Planner	0	0	+	0	0	++	0	++	+	-	0	-	++	+	+	+	0	+	M
	CPM Schedule	0	0	+	0	0	-	0	+	-	++	0	-	0	0	0	+	0	-	N
Reduce Reuse Recycle	WM Bagster	0	0	+	0	0	-	+	+	+	+	+	+	0	-	0	--	--	--	N
	WM DART	0	0	++	++	0	-	+	0	+	-	0	-	0	-	+	+	+	+	Y
	Recycled Matl.	0	0	++	++	0	-	++	0	+	+	0	0	0	0	0	+	0	+	Y
Prefabrication	Toilet Racks	0	0	+	0	0	+	0	+	++	+	+	0	+	+	0	++	0	++	Y
	Façade Panels	0	+	+	0	0	+	0	+	-	-	-	0	+	-	0	+	0	++	M
	Overhead Racks	0	0	+	0	0	-	0	+	+	--	--	0	+	--	0	-	0	-	N
Virtual Construction	Augmented Reality	0	0	-	0	0	--	0	0	+	--	0	--	+	+	+	-	+	-	N
	FIM	++	0	++	+	0	-	++	0	++	--	0	--	++	+	++	++	+	+	Y
	Virtual Mockups	0	0	+	0	0	+	0	0	+	+	0	0	+	0	+	+	0	+	M
	4D Model	0	0	+	0	0	-	0	++	+	+	0	+	+	++	++	++	0	++	Y
Project Delivery	Bridging D-B-O-M	++	0	+	+	0	--	0	0	++	-	0	0	++	0	0	++	++	++	Y
	IPD	0	0	+	0	0	-	0	0	++	--	0	0	++	0	0	-	0	+	N
	CM Agency	0	0	+	0	0	+	0	0	+	+	0	0	+	0	0	+	0	+	N

Explanation of Decisions

Production Tracking

System	Reasoning for *Accepting* or Rejecting	Details
SIPS Scheduling/Matrix Schedule	*Detail, Minimal Waste, Repetitive*	*Minimizes wasted time in the schedule, determines a detailed breakdown of the sequence of work, excels in repetitive spaces*
Last Planner System	Doesn't effectively allow a set duration for repetitive work	The Last Planner system was identified as a feasible option for minimizing wasted time, however due to the repetitive nature of the design of office buildings it was not the optimal choice to maximize the efficiency of the typical office floor construction.
CPM Scheduling	Not Applicable, Waste	CPM scheduling is not a valid application for high rises due to the nature of how they are sequenced. Since the building grows vertically different tasks are accomplished on different floors.

Waste Management

System	Reasoning for *Accepting* or Rejecting	Details
WM DART	*Workforce Involvement, Client Marketing*	*The use of Waste Management's newest tool the Diversion and Recycling Tracking Tool will allow the tracking of the waste being hauled offsite and location to where it is going. The "green facts" that the tool generates create a relatable statistic that when presented will draw in more participation.*
WM Bagster	Not Feasible for the Project, OSHA Concerns	The "Bagster" is another solution that Waste Management offers, it is a flexible dumpster that would be useful for separating waste on the separate floors of the building, and this would allow reuse of any scraps collected on that floor.
Recycled Materials	*Achieve LEED points, contribute to Future Recycling*	The use of recycled material for the finishes in the building is an absolute must in regards to getting LEED points. Aside from that it is important include materials that can be recycled in future renovations.

Virtual Construction

System	Reasoning for *Accepting* or Rejecting	Details
Facilities Integrated Model (FIM)	*Maintenance, Sustainability, Lifecycle*	*With the high performance equipment included in the design of the 350 Mission project and the desire of the building owners to have a net zero building, a FIM seems absolutely necessary in the lifecycle maintenance of the building*
Virtual Mockups	*Visual Representation, Constructability*	*Virtual mockups will provide a visual representation of the prefabricated façade panels, assisting in their prefabrication*
4D Model	*Visual Representation of Sequencing conflicts*	*A 4D model linking the schedule to the site logistics and building model allow the identification of space conflicts and sequencing issues in the construction process. This is crucial to the success of the 350 Mission site due to the tight constraints for the buildings construction.*
Augmented Reality	Cost, Ineffective	Augmented Reality was determined to be too expensive and timely to justify using the tool. It was determined that this tool would not show anything more than the renderings would

Prefabrication

System	Reasoning for *Accepting* or Rejecting	Details
Toilet Racks	*Cost Effectivenes, Time Savings*	*The typical office floors in the building have the exact same bathroom layout on each floor, this provides the opportunity to prefabricate the plumbing racks that feed the toilets and thus save time during the installation on site.*
Façade Panels	*Cost Savings, Schedule Savings*	The façade system designed for the 350 Mission building is rather complicated and it integrates the operable louvers used for natural ventilation into the building enclosure. Panelizing and prefabricating the systems will provide installation time savings and allow the panels to be constructed and tested offsite.
Overhead Racks	Not feasible	With the duct layout in the buildings office floors and the minimal duct on the floors, prefabricating overhead racks for the office floors in not a feasible option in the buildings construction.

Project Delivery

System	Reasoning for *Accepting* or Rejecting	Details
Bridging Design-Build w/ Operate and Maintain	*Facilities Maintenance, Group effort*	*Since SOM has provided the architectural design for the building this is the most feasible option for the delivery of the 350 Mission building. This delivery allows the owner more control on the architectural look of the building but still allows collaboration between the design teams.*
IPD	Complicated to pull off, Costly	IPD would be a very good solution as the delivery method for the 350 Mission project. The downsides however, are that it requires all parties being involved for the start, since SOM was not part of the AEVITAS team it is not applicable.
CM Agency	Less Collaboration	With CM agency there is still a separation of interest between the parties, each entity is still in it to make their own money rather than come together as a group to determine design and construction fees

BUILDING INFORMATION MODELING USES

BIM USE	PROJECT VALUE	RESPONSIBLE PARTY	VALUE TO RESPONSIBLE PARTY	CAPABILITY RATING Scale 1-3 (1 = Low)			ADDITIONAL RESOURCES	NOTES	PROCEED?
	HIGH/MED/LOW		HIGH/MED/LOW	Resources	Competency	Experience			YES / NO / MAYBE
Detailed Estimation	MED	Construction Managers	HIGH	3	3	3	Past project data, detailed and accurate structural model	Good comunication of changes throughout the process is crucial	**YES**
		Structural Engineers	LOW	1	1	3			
4D Modeling	HIGH	Construction Managers	HIGH	3	3	3	Accurate and detailed schedule	Full participation from all parties	**YES**
		Structural Engineers	LOW	1	1	2	Accurate and complete BIMs		
		Mechanical Engineers	LOW	1	1	2			
		Lighting/Electrical Engineers	LOW	1	1	2			
Clash Detection	HIGH	Construction Managers	HIGH	3	3	3	Latest Navisworks software, using Manage 2014 on 350 Mission. Accurate and complete BIMs	High value to all parties due to preventative measures in saving both time and money for all parties	**YES**
		Structural Engineers	HIGH	3	3	3			
		Mechanical Engineers	MED	2	3	3			
		Lighting/Electrical Engineers	MED	1	3	3			
3D Coordination	HIGH	Construction Managers	HIGH	3	3	3	Full party participation for accurate Building Information Modeling	Modeling learning curve possible	**YES**
		Structural Engineers	HIGH	3	3	3			
		Mechanical Engineers	MED	3	3	3			
		Lighting/Electrical Engineers	MED	2	2	2			
		Owner	HIGH	1	1	1			
		Architects	MED	2	2	2			
Engineering Analyses	MED	Structural Engineers	HIGH	3	3	3	Must have access to all updated technologies and programs		**YES**
		Mechanical Engineers	HIGH	3	3	3			
		Lighting/Electrical Engineers	HIGH	3	3	3			
Facilities Integration Modeling	MED	Construction Managers	MED	2	2	1	Cost Data integrated with building elements, must have accurate and updated information in BIM for all systems	High value to owner, can save a lot of time and money for all. This process will be necessary to continuation of the netzero process and AEVITAS' ZEROimpact goalset	**MAYBE**
		Structural Engineers	LOW	1	1	1			
		Mechanical Engineers	HIGH	3	3	3			
		Lighting/Electrical Engineers	MED	2	2	2			
		Owner	HIGH	3	1	1	Must be onboard with decisions		
		Building Manager	HIGH	3	3	3	Must receive training		
Site Logistics	LOW	Construction Managers	HIGH	3	3	2	Updated location information	CM to coordinate input from all	**YES**
Design Authoring	HIGH	Structural Engineers	MED	3	3	3	Collaborative Design Cooperation		**YES**
		Mechanical Engineers	MED	3	3	3			
		Lighting/Electrical Engineers	MED	3	3	3			
		Owner	MED	1	1	1			
		Architects	HIGH	3	3	3			

WASTE MANAGEMENT TRACKING LOG

1) AEVITAS strives to divert a minimum of 80% by weight of waste during construction of the 350 Mission building from landfills. As a collective team all parties involved with the construction of the 350 Mission building will contribute to the waste management effort and use the same waste management entity for consistent waste diversion tracking. The Waste Management for the project will utilize the Diversion and Recycling Tracking Tool (DART) created by Waste Management Company, or equivalent tool by another waste management entity.
2) The targeted materials to be recycled include the following:
   - Scrap Metals
   - Concrete
   - Masonry
   - Gypsum Board
   - Carpet
   - Material Packaging
   - Wood
3) The aforementioned materials will be recycled in a Co-Mingled manner, meaning that all materials will be disposed of in the same dumpster and sorted at the waste management subcontractor's facility. The following table is a sample of how the material will be tracked. An AEVITAS superintendent will be responsible for this tracking log and coordinating with the waste management subcontractor for dumpster delivery and pick-up.

Date	Destination	Destination Ticket No.	Trash	Concrete	Metal	Wood	Plastics	Cardboard	Drywall	Other	Total Weight
			Unrecycled Weight	Recycled Weight							
5/1/2014											
5/2/2014											
5/3/2014											
5/4/2014											
5/5/2014											
5/6/2014											
5/7/2014											
MONTH TOTALS											

4) The implementation of this plan will require multiple preconstruction meetings with the specialty contractors that are contracted to be part of the AEVITAS team. In the meetings the procedures to be followed for the duration of the project will be discussed and the specialty contractors will be able to provide feedback to establish the most efficient processes for the waste management efforts. The specialty contractors will also be able to provide feedback on any additional materials that are eligible to be recycled.
5) During construction the results of the tracking efforts will be posted around the construction site and in the new structure to remind workers of the significance of the plan and encourage increased participation in the recycling efforts. The "green facts" generated by the DART tool mentioned earlier will be a good representation of the efforts as they provide easily understood representations of the results. Upon completion a project summary will be created and turned over to the owner for their own marketing purposes.

MEETING AGENDA EXAMPLE

AEVITAS | Meeting Agenda | 1/13/14

OPENING ITEMS

- Meeting Minutes taken by: ____________________
  - Reference in the AEVITAS Google Drive Under: Integration – Meeting Minutes – 1/13/14
- Timeline: 2 Weeks – Next Deadline, 4 Weeks – Final Submission

MEETING SPECIFIC TOPICS

- Discuss Individual Advisor Meeting notes
- Ideas for the Integration Presentation, who will be assuming lead role?
- BIM's for presentations/reports and who will be responsible for them
- Revit Model Discussion (How will the Lobby be modeling individually?)
  - Facade modeling – when will this be complete?
- Supporting Documentation sharing between disciplines – who needs what?
- Discussion of verb tense consistency in reports
- Integration Report responsibilities
- Page limit discussion
- 5^{th} Façade face analysis results – green roof or PV array?
- References discussion
- Update Information Exchange document continuously
- When can we start clash detection?
- PDF document linking?

GENERAL

- Design Decisions to make?
- What inter-discipline meetings need to be scheduled?
- Feedback on this meeting?
- Opinions on how to be more efficient?
- Opinions on how we are operating?

Coordination Meeting | 1

MEETING MINUTES EXAMPLE

Meeting Minutes taken by: ____________________
Timeline: 2 Weeks – Next Deadline, 4 Weeks – Final Submission

MEETING SPECIFIC TOPICS

- Individual Advisor Meeting Notes
  - Mechanical: Net-zero energy consumption finally achieved through PV array offsite
  - Structural: Continue modeling outriggers
  - Construction: Phasing plan complete
  - Lighting/Electrical: PV array on roof is a go
- BIM's progress
  - Integration of models is proceeding on Navisworks, Construction to take lead
- Revit Model Discussion
  - Facade modeling – completed
  - Lobby – completed and ready to run individual analyses
- Supporting Documentation sharing between disciplines
  - Structural to develop software exchanges timeline
- Integration Report responsibilities
  - Substructure, FIM/Building Management: Construction
  - Building Envelope: Lighting/Electrical
  - Typical Office Floor: Mechanical
  - Superstructure: Structural
- Page limit discussion
  - Title Page, Executive Summary, and Table of Contents not included in 15 page limit
- 5th Façade face analysis results
  - Proceeding with PV array
- When can we start clash detection
  - Starting 1/16/14

Conclusion: Continue to update Information Exchanges Document!

LEED CHECKLIST

Under the LEED 2009 for New Construction and Major Renovations Checklist, 350 Mission can achieve LEED Platinum Accreditation, accumulating 93 points out of a possible 110 points.

Sustainable Sites (21/26 Points)

Prereq 1	Construction Activity Pollution Prevention	
Credit 1	Site Selection	1 Point
Credit 2	Development Density and Community Connectivity	5 Points
Credit 4.1	Alternative Transportation – Public Transportation Access	6 Points
Credit 4.2	Alternative Transportation – Bicycle Storage and Changing Rooms	1 Point
Credit 4.3	Alternative Transportation – Low-Emitting and Fuel-Efficient Vehicles	3 Points
Credit 4.4	Alternative Transportation – Parking Capacity	2 Points
Credit 6.1	Stormwater Design – Quantity Control	1 Point
Credit 7.1	Heat Island Effect – Non-roof	1 Point
Credit 8	Light Pollution Reduction	1 Point

Water Efficiency (10/10 Points)

Prereq 1	Water Use Reduction – 20% Reduction	
Credit 1	Water Efficient Landscaping | No Potable Water Use or Irrigation	4 Points
Credit 2	Innovative Wastewater Technologies	2 Points
Credit 3	Water Use Reduction | Reduce by 40%	4 Points

Energy and Atmosphere (31/35 Points)

Prereq 1	Fundamental Commissioning of Building Energy Systems	
Prereq 2	Minimum Energy Performance	
Prereq 3	Fundamental Refrigerant Management	
Credit 1	Optimize Energy Performance| Improve by 48%+ for New Buildings	19 Points
Credit 2	On-Site Renewable Energy | 72% Renewable Energy	7 Points
Credit 3	Enhanced Commissioning	2 Points
Credit 5	Measurement and Verification	3 Points

Materials and Resources (9/14 Points)

Prereq 1	Storage and Collection of Recyclables	
Credit 2	Construction Waste Management | 75% Recycled or Salvaged	2 Points
Credit 3	Materials Reuse | Reuse 10%	2 Points
Credit 4	Recycled Content | 20% of Materials	2 Points
Credit 5	Regional Materials	2 Points
Credit 7	Certified Wood	1 Point

Indoor Environmental Quality (14/15 Points)

Prereq 1	Minimum Indoor Air Quality Performance	1 Point
Prereq 2	Environmental Tobacco Smoke (ETS) Control	1 Point
Credit 1	Outdoor Air Delivery Monitoring	1 Point
Credit 2	Increased Ventilation	1 Point
Credit 3.1	Construction IAQ Management Plan – During Construction	1 Point
Credit 3.2	Construction IAQ Management Plan – Before Occupancy	1 Point
Credit 4.1	Low-Emitting Materials – Adhesives and Sealants	1 Point
Credit 4.2	Low-Emitting Materials – Paints and Coatings	1 Point
Credit 4.3	Low-Emitting Materials – Flooring Systems	1 Point
Credit 4.4	Low-Emitting Materials – Composite Wood and Agrifiber Products	1 Point
Credit 5	Indoor Chemical and Pollutant Source Control	1 Point
Credit 6.1	Controllability of Systems – Lighting	1 Point
Credit 6.2	Controllability of Systems – Thermal Comfort	1 Point
Credit 7.1	Thermal Comfort – Design	1 Point
Credit 7.2	Thermal Comfort – Verification	1 Point
Credit 8.2	Daylight and Views - Views	1 Point

Innovation and Design Process (4/6 Points)

Credit 1.1	Innovation in Design: Acoustics Pilot Credit	1 Point
Credit 1.2	Innovation in Design: Interior Lighting – Quality Pilot Credit	1 Point
Credit 1.3	Innovation in Design: Sustainable Wastewater Management Pilot Credit	1 Point
Credit 2	LEED Accredited Professional	1 Point

Regional Priority Credits (4/4 Points)

Credit 1.1	Regional Priority: On-site Renewable Energy	1 Point
Credit 1.2	Regional Priority: Daylight & Views - Daylight	1 Point
Credit 1.3	Regional Priority: Innovative wastewater technologies	1 Point
Credit 1.4	Regional Priority: Water use reduction	1 Point

Total LEED Points 93/110

FULL ESTIMATE BY CSI DIVISION

CSI DIVISION		TOTALS	$/SF	% OF TOTAL
Division 2 - Existing Conditions		**$531,320**	**$1.25**	**0.37%**
02 40 00	Demolition/Remediation	$531,320	$1.25	0.37%
Division 3 - Concrete		**$11,416,200**	**$26.86**	**7.95%**
03 10 00	Concrete Forming	$1,694,480	$3.99	1.18%
03 20 00	Concrete Reinforcing	$2,469,920	$5.81	1.72%
03 30 00	Cast In Place Concrete	$7,251,800	$17.06	5.05%
Division 4 - Masonry		**$186,680**	**$0.44**	**0.13%**
04 00 00	Masonry	$186,680	$0.44	0.13%
Division 5 - Metals		**$16,230,585**	**$38.19**	**11.30%**
05 10 00	Structural Steel	$12,525,705	$29.47	8.72%
05 30 00	Metal Decking	$1,694,480	$3.99	1.18%
05 50 00	Miscellaneous Metals	$2,010,400	$4.73	1.40%
Division 6 - Wood, Plastics, Comp		**$258,480**	**$0.61**	**0.18%**
06 20 00	Millwork	$258,480	$0.61	0.18%
Division 7 - Thermal and Moisture Prot		**$1,335,480**	**$3.14**	**0.93%**
07 10 00	Water Proofing	$904,680	$2.13	0.63%
07 50 00	Membrane Roofing	$430,800	$1.01	0.30%
Division 8 - Openings		**$21,942,080**	**$51.63**	**15.28%**
08 10 00	Doors and Frames	$560,040	$1.32	0.39%
08 30 00	Overhead Doors	$100,520	$0.24	0.07%
08 80 00	Glazing/Curtain Walls	$19,457,800	$45.78	13.55%
08 90 00	Louvers and Vents	$1,823,720	$4.29	1.27%
Division 9 - Finishes		**$6,232,240**	**$14.66**	**4.34%**
09 20 00	Drywall/Partitions	$2,125,280	$5.00	1.48%
09 30 00	Tiling	$229,760	$0.54	0.16%
09 50 00	Ceilings	$2,584,800	$6.08	1.80%
09 60 00	Carpet Tile	$718,000	$1.69	0.50%
09 90 00	Painting	$574,400	$1.35	0.40%
Division 10 - Specialties		**$1,579,600**	**$3.72**	**1.10%**
10 00 00	Specialties/Signage	$1,579,600	$3.72	1.10%
Division 11 - Equipment		**$1,134,440**	**$2.67**	**0.79%**
11 00 00	Equipment	$1,134,440	$2.67	0.79%
Division 12 - Furnishings		**$258,480**	**$0.61**	**0.18%**
12 40 00	Furnishings and Accessories	$258,480	$0.61	0.18%
Division 14 - Conveying Equipment		**$6,734,840**	**$15.85**	**4.69%**
14 20 00	Elevators	$6,734,840	$15.85	4.69%
Division 21 - Fire Suppression		**$2,053,480**	**$4.83**	**1.43%**
21 00 00	Fire Suppression	$2,053,480	$4.83	1.43%
Division 22 - Plumbing		**$4,552,120**	**$10.71**	**3.17%**
22 00 00	Plumbing	$4,552,120	$10.71	3.17%
Division 23 - HVAC		**$18,452,600**	**$43.42**	**12.85%**
23 00 00	HVAC	$18,452,600	$43.42	12.85%
Division 26 - Electrical		**$19,788,080**	**$46.56**	**13.78%**
26 00 00	Electrical	$19,788,080	$46.56	13.78%
Division 27 - Communications		**$3,001,240**	**$7.06**	**2.09%**
27 00 00	Communications	$3,001,240	$7.06	2.09%
Division 31 - Earthwork		**$13,254,280**	**$31.19**	**9.23%**
31 00 00	Earthwork	$11,172,080	$26.29	7.78%
31 40 00	Shoring and Underpinning	$574,400	$1.35	0.40%
31 50 00	Excavation Support and Prot	$1,507,800	$3.55	1.05%
Division 32 - Exterior Improvements		**$430,800**	**$1.01**	**0.30%**
32 00 00	Hardscaping/Site Work	$430,800	$1.01	0.30%
Division 33 - Utilities		**$502,600**	**$1.18**	**0.35%**
33 00 00	Utilities	$502,600	$1.18	0.35%
Direct Costs		$143,600,000	$337.88	90.44%
General Conditions		$9,419,000	$22.16	6.56%
Fee		$4,308,000	$10.14	3.00%
Total Building Cost		**$157,327,000**	**$370.18**	**100.00%**

GENERAL CONDITIONS ESTIMATE

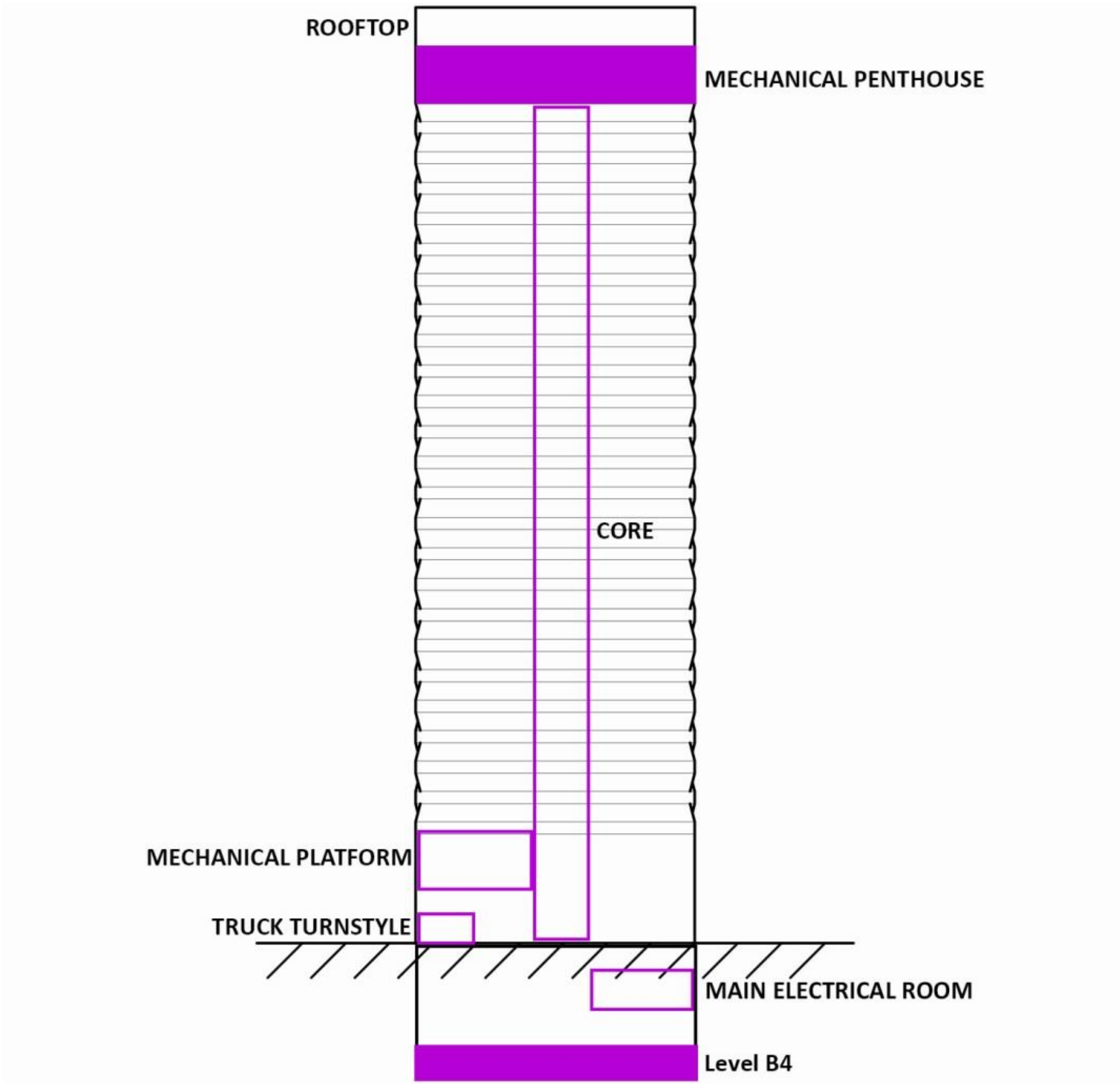
CSI CODE	TITLE	QUANTITY	UNITS	$/UNIT	TOTALS
01 30 00	**Administrative Reqs**				
	Project Staff				
	Project Executive	65	Weeks	$10,000	$650,000
	Senior Project Manager	85	Weeks	$5,000	$425,000
	Project Manager	100	Weeks	$4,000	$400,000
	Assistant Project Manager	100	Weeks	$3,000	$300,000
	Project Engineer	100	Weeks	$2,250	$225,000
	Project Engineer	92	Weeks	$2,250	$207,000
	Project Engineer	88	Weeks	$2,250	$198,000
	Senior Superintendent	85	Weeks	$4,200	$357,000
	Superintendent	100	Weeks	$3,000	$300,000
	Superintendent	85	Weeks	$3,000	$255,000
	Assistant Superintendent	100	Weeks	$2,500	$250,000
	Assistant Superintendent	88	Weeks	$2,500	$220,000
	Assistant Superintendent	75	Weeks	$2,500	$187,500
	Assistant Superintendent	75	Weeks	$2,500	$187,500
	Quality Control Manager	85	Weeks	$2,050	$174,250
	Safety Manager	85	Weeks	$2,050	$174,250
	Project Management/Coordination				
	Office Supplies/Equip/Furniture	1	LS	$100,000	$100,000
	Computers/Fax/Printers/Software	1	LS	$100,000	$100,000
	Printing Charges	1	LS	$50,000	$50,000
	Safety Equipment	1	LS	$125,000	$125,000
	Postage/Packaging	1	LS	$12,000	$12,000
	Permitting	1	LS	$250,000	$250,000
	Progress Photos	1	LS	$12,000	$12,000
01 40 00	**Quality Requirements**				
	Quality Control	1	LS	$20,000	$20,000
	Testing and Inspection	1	LS	$300,000	$300,000
	Testing Laboratory Services	1	LS	$25,000	$25,000
01 50 00	**Temporary Facilities and Controls**				
	Temporary Utilities Consumption				
	Temporary Utilities	1	LS	$100,000	$100,000
	Waste Management				
	Waste Management Fees	1	LS	$500,000	$500,000
	Construction Facilities				
	Job Office Trailer	1	LS	$8,000	$8,000
	Job Warehouse	25	Months	$7,100	$177,500
	Warehouse Set Up	1	LS	$5,000	$5,000
	Drinking Water/Ice	1	LS	$12,000	$12,000
	Radios/Phones	1	LS	$15,000	$15,000
	Construction Aids				
	Personal Protection Equipment (PPE)	1	LS	$15,000	$15,000
	Temporary Hoists	1	LS	$300,000	$300,000
	Temporary Cranes	9	Months	$75,000	$675,000
	Crane Set Up & Demobilization	1	LS	$600,000	$600,000
	Temporary Scaffolding and Platforms	1	LS	$100,000	$100,000
	Temporary Shoring and Bracing	1	LS	$400,000	$400,000
	Temporary Dewatering Pumps	1	LS	$200,000	$200,000
	Temporary Barriers and Enclosures				
	Temporary Fencing (Plastic Jersey Barriers)	1	LS	$10,000	$10,000
	Temporary Protection of Adjacent Structures	1	LS	$10,000	$10,000
01 70 00	**Execution and Closeout Requirements**				
	Execution				
	Signage	1	LS	$12,000	$12,000
	Topping Out	1	LS	$50,000	$50,000
	Business Promotions	1	LS	$15,000	$15,000
	Vehicle Mileage	1	LS	$25,000	$25,000
	Auto Allowances	1	LS	$100,000	$100,000
	Job Site Travel	1	LS	$100,000	$100,000
	Cleaning and Waste Management				
	Progress Cleaning	1	LS	$80,000	$80,000
	Final Cleaning	1	LS	$405,000	$405,000
	TOTAL AMOUNT				**$9,419,000**

DETAILED STEEL TAKEOFF

Horizontal Steel Members												
Takeoff Totals			Unit Pricing					Total Prices				
Item	Quantity	Tonnage	Material	Labor	Equipment	Total	Total O&P	Material	Labor	Equipment	Total	Total O&P
Beams and Girders												
W 8 X 10	3481.32 LF	17.5325	$14.30	$4.58	$2.54	$21.42	$26.50	$49,782.88	$15,944.45	$8,842.55	$74,569.87	$92,254.98
W 10 X 12	4171.96 LF	25.1275	$17.15	$4.58	$2.54	$24.27	$29.50	$71,549.11	$19,107.58	$10,596.78	$101,253.47	$123,072.82
W 12 X 14	7051.72 LF	49.9105	$20.00	$3.12	$1.73	$24.85	$29.00	$141,034.40	$22,001.37	$12,199.48	$175,235.24	$204,494.27
W 12 X 16	9946.02 LF	79.703	$23.00	$3.12	$1.73	$27.85	$32.50	$228,758.46	$31,031.58	$17,206.61	$276,996.66	$323,245.65
W 12 X 19	9355.50 LF	88.6595	$27.25	$3.12	$1.73	$32.10	$37.46	$254,937.38	$29,189.16	$16,185.02	$300,311.55	$350,454.57
W 14 X 22	15103.56 LF	166.7735	$31.50	$2.77	$1.54	$35.81	$41.79	$475,762.14	$41,836.86	$23,259.48	$540,858.48	$631,165.62
W 16 X 26	9670.12 LF	126.356	$37.00	$2.75	$1.52	$41.27	$47.50	$357,794.44	$26,592.83	$14,698.58	$399,085.85	$459,330.70
W 16 X 31`	1469.96 LF	22.834	$44.50	$3.05	$1.69	$49.24	$56.00	$65,413.22	$4,483.38	$2,484.23	$72,380.83	$82,317.76
W 18 X 35	2854.14 LF	50.017	$50.00	$4.13	$1.74	$55.87	$64.00	$142,707.00	$11,787.60	$4,966.20	$159,460.80	$182,664.96
W 18 X 40	38.00 LF	0.763	$57.00	$4.13	$1.74	$62.87	$72.00	$2,166.00	$156.94	$66.12	$2,389.06	$2,736.00
W 18 X 175	2401.30 LF	209.5885	$250.25	$4.40	$1.85	$256.50	$299.33	$600,925.33	$10,565.72	$4,442.41	$615,933.45	$718,775.86
W 18 X 192	2357.64 LF	226.235	$274.56	$4.40	$1.85	$280.81	$327.70	$647,313.64	$10,373.62	$4,361.63	$662,048.89	$772,591.19
W 18 X 234	87.32 LF	10.2215	$325.73	$4.40	$1.85	$331.98	$387.41	$28,442.74	$384.21	$161.54	$28,988.49	$33,828.70
W 18 X 258	2357.64 LF	304.455	$374.69	$4.40	$1.85	$380.94	$444.55	$883,384.13	$10,373.62	$4,361.63	$898,119.38	$1,048,078.37
W 21 X 44	1471.48 LF	32.5465	$63.00	$3.73	$1.57	$68.30	$77.00	$92,703.24	$5,488.62	$2,310.22	$100,502.08	$113,303.96
W 21 X 48	38.00 LF	0.9115	$69.25	$3.73	$1.57	$74.55	$87.00	$2,631.50	$141.74	$59.66	$2,832.90	$3,305.91
W 21 X 55	76.00 LF	2.095	$77.38	$3.73	$1.57	$82.68	$99.22	$5,880.88	$283.48	$119.32	$6,283.68	$7,540.42
W 21 X 57	2052.00 LF	58.304	$82.50	$3.73	$1.57	$87.80	$105.36	$169,290.00	$7,653.96	$3,221.64	$180,165.60	$216,198.72
W 21 X 73	38.00 LF	1.39	$94.76	$3.83	$1.61	$100.20	$120.24	$3,600.88	$145.54	$61.18	$3,807.60	$4,569.12
W 21 X 93	38.00 LF	1.765	$133.00	$3.96	$1.67	$138.63	$140.00	$5,054.00	$150.48	$63.46	$5,267.94	$5,320.00
W 21 X 101	3230.82 LF	163.807	$144.00	$3.96	$1.67	$149.63	$168.00	$465,238.08	$12,794.05	$5,395.47	$483,427.60	$542,777.76
W 21 X 111	174.64 LF	9.716	$159.00	$3.96	$1.67	$164.63	$189.28	$27,767.76	$691.57	$291.65	$28,750.98	$33,055.01
W 21 X 122	1260.48 LF	76.99	$174.00	$3.96	$1.67	$179.63	$201.00	$219,323.52	$4,991.50	$2,105.00	$226,420.02	$253,356.48
W 21 X 132	3667.44 LF	242.102	$189.00	$3.96	$1.67	$194.63	$227.13	$693,146.16	$14,523.06	$6,124.62	$713,793.85	$832,976.01
W 24 X 55	38.00 LF	1.0475	$78.50	$3.57	$1.50	$83.57	$94.50	$2,983.00	$135.66	$57.00	$3,175.66	$3,591.00
W 24 X 62	130.98 LF	4.056	$88.50	$3.57	$1.50	$93.57	$105.00	$11,591.73	$467.60	$196.47	$12,255.80	$13,752.90
W 24 X 68	125.32 LF	4.2855	$97.00	$3.57	$1.50	$102.07	$115.00	$12,156.04	$447.39	$187.98	$12,791.41	$14,411.80
W 24 X 76	174.64 LF	6.6555	$109.00	$3.57	$1.50	$114.07	$128.00	$19,035.76	$623.46	$261.96	$19,921.18	$22,353.92
W 27 X 84	43.66 LF	1.842	$120.00	$3.33	$1.40	$124.73	$139.00	$5,239.20	$145.39	$61.12	$5,445.71	$6,068.74
W 30 X 90	43.66 LF	1.961	$129.00	$3.30	$1.39	$133.69	$153.70	$5,632.14	$144.08	$60.69	$5,836.91	$6,710.69
Total Horizontal Members		1987.651						$5,634,606.88	$280,692.90	$143,584.50	$6,058,884.29	$7,104,303.89
Vertical Steel Members												
Takeoff Totals			Unit Pricing					Total Prices				
Item	Quantity	Tonnage	Material	Labor	Equipment	Total	Total O&P	Material	Labor	Equipment	Total	Total O&P
W 14 X 43	1068	22.8955	$61.49	$2.64	$1.43	$65.56	$75.50	$65,671.32	$2,819.52	$1,527.24	$70,018.08	$80,634.00
W 14 X 48	168	4.0305	$68.50	$2.64	$1.43	$72.57	$83.43	$11,508.00	$443.52	$240.24	$12,191.76	$14,016.87
W 14 X 53	224	5.9455	$75.79	$2.64	$1.43	$79.86	$91.50	$16,976.96	$591.36	$320.32	$17,888.64	$20,496.00
W 14 X 61	557	16.9635	$83.25	$2.64	$1.43	$87.32	$100.39	$46,370.25	$1,470.48	$796.51	$48,637.24	$55,918.23
W 14 X 68	336	11.4335	$94.36	$2.79	$1.55	$98.70	$113.48	$31,704.96	$937.44	$520.80	$33,163.20	$38,127.73
W 14 X 74	671	7.2695	$106.00	$2.79	$1.55	$110.34	$122.00	$71,126.00	$1,872.09	$1,040.05	$74,038.14	$81,862.00
W 14 X 82	308	12.5765	$117.50	$2.79	$1.55	$121.84	$140.08	$36,190.00	$859.32	$477.40	$37,526.72	$43,144.47
W 14 X 90	868	39.1355	$129.00	$2.79	$1.55	$133.34	$151.00	$111,972.00	$2,421.72	$1,345.40	$115,739.12	$131,068.00
W 14 X 99	392	19.408	$141.25	$2.86	$1.67	$145.78	$167.60	$55,370.00	$1,121.12	$654.64	$57,145.76	$65,700.48
W 14 X 109	308	16.769	$157.75	$2.86	$1.67	$162.28	$186.57	$48,587.00	$880.88	$514.36	$49,982.24	$57,464.58
W 14 X 120	532	31.9515	$172.00	$2.86	$1.67	$176.53	$196.00	$91,504.00	$1,521.52	$888.44	$93,913.96	$104,272.00
W 14 X 132	308	20.3325	$192.00	$2.86	$1.67	$196.53	$225.95	$59,136.00	$880.88	$514.36	$60,531.24	$69,592.77
W 14 X 145	560	40.6835	$207.35	$2.86	$1.67	$211.88	$243.60	$116,116.00	$1,601.60	$935.20	$118,652.80	$136,415.12
W 14 X 159	364	28.9215	$227.37	$2.86	$1.67	$231.90	$266.62	$82,762.68	$1,041.04	$607.88	$84,411.60	$97,048.02
W 14 X 176	560	49.354	$252.00	$2.86	$1.67	$256.53	$284.00	$141,120.00	$1,601.60	$935.20	$143,656.80	$159,040.00
W 14 X 193	532	51.412	$275.99	$2.86	$1.67	$280.52	$322.51	$146,826.68	$1,521.52	$888.44	$149,236.64	$171,577.37
W 14 X 211	392	41.3505	$301.73	$3.07	$1.78	$306.58	$352.48	$118,278.16	$1,203.44	$697.76	$120,179.36	$138,170.21
W 14 X 233	448	52.212	$333.19	$3.07	$1.78	$338.04	$388.64	$149,269.12	$1,375.36	$797.44	$151,441.92	$174,112.78
W 14 X 257	532	68.4285	$367.51	$3.07	$1.78	$372.36	$428.10	$195,515.32	$1,633.24	$946.96	$198,095.52	$227,750.42
W 14 X 283	308	43.6515	$404.69	$3.07	$1.78	$409.54	$470.85	$124,644.52	$945.56	$548.24	$126,138.32	$145,021.23
W 14 X 311	448	69.667	$444.73	$3.14	$1.91	$449.78	$517.11	$199,239.04	$1,406.72	$855.68	$201,501.44	$231,666.21
W 14 X 342	446	76.641	$489.06	$3.14	$1.91	$494.11	$568.08	$218,120.76	$1,400.44	$851.86	$220,373.06	$253,362.91
W 14 X 370	250	46.363	$529.10	$3.14	$1.91	$534.15	$614.11	$132,275.00	$785.00	$477.50	$133,537.50	$153,528.06
W 14 X 398	222	44.192	$569.14	$3.14	$1.91	$574.19	$660.15	$126,349.08	$697.08	$424.02	$127,470.18	$146,552.47
W 14 X 426	140	29.7745	$609.18	$3.29	$2.02	$614.49	$706.48	$85,285.20	$460.60	$282.80	$86,028.60	$98,907.08
W 14 X 455	220	50.157	$650.65	$3.29	$2.02	$655.96	$754.16	$143,143.00	$723.80	$444.40	$144,311.20	$165,914.59
W 14 X 500	112	28.0115	$715.00	$3.40	$2.13	$720.53	$828.39	$80,080.00	$380.80	$238.56	$80,699.36	$92,780.05
W 14 X 550	56	15.435	$786.50	$3.40	$2.13	$792.03	$910.60	$44,044.00	$190.40	$119.28	$44,353.68	$50,993.43
W 14 X 605	164	49.667	$865.15	$3.72	$2.25	$871.12	$1,001.53	$141,884.60	$610.08	$369.00	$142,863.68	$164,250.37
W 14 X 665	272	90.7045	$950.95	$3.72	$2.25	$956.92	$1,100.17	$258,658.40	$1,011.84	$612.00	$260,282.24	$299,246.49
W 14 X 730	1030	376.7725	$1,043.90	$3.72	$2.25	$1,049.87	$1,207.04	$1,075,217.00	$3,831.60	$2,317.50	$1,081,366.10	$1,243,246.61
Total Vertical Members		1462.1095						$4,224,945.05	$38,241.57	$22,189.48	$4,285,376.10	$4,911,880.53
Diagonal Bracing Steel Members												
Takeoff Totals			Unit Pricing					Total Prices				
Item	Quantity	Tonnage	Material	Labor	Equipment	Total	Total O&P	Material	Labor	Equipment	Total	Total O&P
HSS 10 X 10 X 5/8"	750.58 LF	30.92	$1.30	$0.24	$0.14	$1.68	$2.00	$80,392.00	$14,841.60	$8,657.60	$103,891.20	$123,680.00
HSS 8 X 8 X 1/2"	165.17 LF	3.44	$1.30	$0.24	$0.14	$1.68	$2.00	$8,944.00	$1,651.20	$963.20	$11,558.40	$13,760.00
HSS 4 X 4 X 1/4"	5220.67 LF	27.15	$1.30	$0.24	$0.14	$1.68	$2.00	$70,590.00	$13,032.00	$7,602.00	$91,224.00	$108,600.00
HSS 6 X 4 X 1/4"	157.33 LF	1.04	$1.30	$0.24	$0.14	$1.68	$2.00	$2,704.00	$499.20	$291.20	$3,494.40	$4,160.00
HSS 5 X 5 X 5/16"	4255.42 LF	34.55	$1.30	$0.24	$0.14	$1.68	$2.00	$89,830.00	$16,584.00	$9,674.00	$116,088.00	$138,200.00
HSS 7 X 5 X 5/16"	752.83 LF	7.48	$1.30	$0.24	$0.14	$1.68	$2.00	$19,448.00	$3,590.40	$2,094.40	$25,132.80	$29,920.00
HSS 10 X 6 X3/8"	171.5 LF	2.59	$1.30	$0.24	$0.14	$1.68	$2.00	$6,734.00	$1,243.20	$725.20	$8,702.40	$10,360.00
HSS 8 X 6 X 3/8"	180.41 LF	2.5	$1.30	$0.24	$0.14	$1.68	$2.00	$6,500.00	$1,200.00	$700.00	$8,400.00	$10,000.00
HSS 12 X 6 X 3/8"	28.33 LF	0.52	$1.30	$0.24	$0.14	$1.68	$2.00	$1,352.00	$249.60	$145.60	$1,747.20	$2,080.00
HSS 14 X 6 X 3/8"	28.33 LF	0.58	$1.30	$0.24	$0.14	$1.68	$2.00	$1,508.00	$278.40	$162.40	$1,948.80	$2,320.00
HSS 6 X 6 X 3/8"	635 LF	7.44	$1.30	$0.24	$0.14	$1.68	$2.00	$19,344.00	$3,571.20	$2,083.20	$24,998.40	$29,760.00
HSS 3 X 3 X 3/16"	288.75 LF	0.84	$1.30	$0.24	$0.14	$1.68	$2.00	$2,184.00	$403.20	$235.20	$2,822.40	$3,360.00
HSS 4 X 3 X 3/16"	109.33 LF	0.38	$1.30	$0.24	$0.14	$1.68	$2.00	$988.00	$182.40	$106.40	$1,276.80	$1,520.00
HSS 7 X 3 X 3/16"	861 LF	4.36	$1.30	$0.24	$0.14	$1.68	$2.00	$11,336.00	$2,092.80	$1,220.80	$14,649.60	$17,440.00
HSS 6 X 3 X 3/16"	671.5 LF	3.04	$1.30	$0.24	$0.14	$1.68	$2.00	$7,904.00	$1,459.20	$851.20	$10,214.40	$12,160.00
HSS 8 X 4 X 1/4"	144.17 LF	0.55	$1.30	$0.24	$0.14	$1.68	$2.00	$1,430.00	$264.00	$154.00	$1,848.00	$2,200.00
Total Diagonal Bracing		127.38						$331,188.00	$61,142.40	$35,666.40	$427,996.80	$509,520.00
Total Steel								**$10,190,739.93**	**$380,076.87**	**$201,440.38**	**$10,772,257.19**	**$12,525,704.42**

EQUIPMENT SCHEDULE AND LOCATION KEY

OPTION	EQUIPMENT	QUANTITY	DIMENSIONS (LWH)	LOCATION	CUT SHEET AND SPECIFICATION INFO
MECHANICAL	Boiler	3	5'2" - 3'1" - 6'3"	Penthouse	Boiler
	Chiller	3	14'2" - 6'6" - 7'5"	Penthouse	Chiller
	DOAS Fans	2	5' - 5' - 7'	Rooftop	DOAS Fans
	DOAS 1 AHU	1	11'7" - 4'5" - 9'5"	Penthouse	DOAS 1 AHU
	DOAS 2 AHU	1	11'7" - 4'5" - 9'5"	Mech. Platform M206	DOAS 2 AHU
	Smoke Exhaust Fan	1	6' - 6' - 7'	Rooftop	Smoke Exhaust Fan
	Kitchen Exhaust Fan	1	4' - 4' -6'	Mech. Platform M206	Kitchen Exhaust Fan
	Bathroom Fan + VFD 1	1	4' - 4' -6'	Rooftop	Bathroom Fan + VFD 1
	Bathroom Fan + VFD 2	1	4' - 4' -6'	Mech. Platform M206	Bathroom Fan + VFD 2
	Garage Exhaust Fan	1	5' - 5' - 7'	Near truck turnstyle	Garage Exhaust Fan
	HVAC Primary Pumps + VFD	6	1' - 1' - 1'6"	Penthouse	HVAC Primary Pumps + VFD
	HVAC Secondary Pumps + VFD	2	1' - 1' - 1'6"	Penthouse	HVAC Secondary Pumps + VFD
	Tertiary Pumps + VFD	26 (1 per fl.)	1' - 1' - 1'6"	Mech. Space per floor	Tertiary Pumps + VFD
	Dom. Water Booster Pumps + VFD	2	1' - 1' - 1'6"	Pump RM (Level B4)	Dom. Water Booster Pumps + VFD
	Fire Pump + VFD	1	1' - 1' - 1'6"	Fire Pump RM (Level B4)	Fire Pump + VFD
	Cooling Tower	1	13'11" - 22'5" - 22'7"	Penthouse	Cooling Tower
	Greywater Storage Tank	1	See room size	RM B422B (Level B4)	Greywater Storage Tank
	Robust Potable Storage Tank	1	12'D - 10'H	Penthouse	Robust Potable Storage Tank
	Fire Suppression Tank	1	See room size	RM B422A (Level B4)	Fire Suppression Tank
LIGHTING/ELECTRICAL	Fuel Cell	3	27'4" - 8'4" - 10'	Penthouse Electrical Room (2) and Main Electrical Room (1)	Fuel Cell
	Human Waste to Energy	1		Storage B420 (Level B4)	Human Waste to Energy
	Onsite Solar	200 kW	15,000 ft.^{2}	Rooftop	Onsite Solar
	Paralleling Switchgear	2	24' - 3'6" - 8'	Penthouse Electrical Room (1) and Main Electrical Room (1)	Paralleling Switchgear
	Battery Pack	2		Penthouse Electrical Room, Server Room	Battery Pack
	Rectifier	1		Penthouse Electrical Room	Rectifier
	Inverter	1		Penthouse Electrical Room	Inverter
	Primary Transformers	2	Provided by Utility	Service Entrance (PG&E vault)	Primary Transformers
	Secondary Transformers	27		Electrical Room every floor	Secondary Transformers
	Rack Servers	50		Server Room	Rack Servers
	Equipment Distribution Panelboards	4		Penthouse Electrical Room (2) and Main Electrical Room (2)	Equipment Distribution Panelboards
	Branch Panelboards	75		Electrical Room per floor	Branch Panelboards
	Primary ATS	1		Penthouse Electrical Room	Primary ATS
	Secondary ATS	26 (1 per fl.)		Electrical Room per floor	Secondary ATS



LIFECYCLE COST ANALYSIS

Life Cycle Cost Analysis	Project Information	
Options Comparison	Building	350 Mission St.
Input Table	Project Name	AEVITAS Thesis
Date January 15, 2014	Project Type (lighting, heating, etc)	HVAC system

Costs

	BASELINE		Proposed	
Initial Costs				
Total Cost	$ 10,989,149	Total Cost	$ 26,779,952
Incentives	$ -	Incentives	$ 7,642,500
Net Costs	**$ 10,989,149**	**Net Costs**	**$ 19,137,452**
Replacement Costs				
Expected Life (Years)	20	Expected Life (Years)	20
Replacement Cost	$ 10,989,149	Replacement Cost	$ 26,779,952

One Time Operating Costs

		Materials	Labor	Total		Materials	Labor	Total
FY14	Year 1	$ 178,400	$ 250,000	$ 428,400	Year 1	$ -	$ 400,000	$ 400,000
FY15	Year 2	$ 178,400	$ 250,000	$ 428,400	Year 2	$ -	$ 400,000	$ 400,000
FY16	Year 3	$ 178,400	$ 250,000	$ 428,400	Year 3	$ -	$ 400,000	$ 400,000
FY17	Year 4	$ 178,400	$ 250,000	$ 428,400	Year 4	$ -	$ 400,000	$ 400,000
FY18	Year 5	$ 178,400	$ 250,000	$ 428,400	Year 5	$ -	$ 400,000	$ 400,000
FY19	Year 6	$ 178,400	$ 250,000	$ 428,400	Year 6	$ 294,400	$ 400,000	$ 694,400
FY20	Year 7	$ 178,400	$ 250,000	$ 428,400	Year 7	$ 294,400	$ 400,000	$ 694,400
FY21	Year 8	$ 178,400	$ 250,000	$ 428,400	Year 8	$ 294,400	$ 400,000	$ 694,400
FY22	Year 9	$ 178,400	$ 250,000	$ 428,400	Year 9	$ 294,400	$ 400,000	$ 694,400
FY23	Year 10	$ 178,400	$ 250,000	$ 428,400	Year 10	$ 480,820	$ 400,000	$ 880,820
FY24	Year 11	$ 178,400	$ 250,000	$ 428,400	Year 11	$ 294,400	$ 400,000	$ 694,400
FY25	Year 12	$ 178,400	$ 250,000	$ 428,400	Year 12	$ 294,400	$ 400,000	$ 694,400
FY26	Year 13	$ 178,400	$ 250,000	$ 428,400	Year 13	$ 294,400	$ 400,000	$ 694,400
FY27	Year 14	$ 178,400	$ 250,000	$ 428,400	Year 14	$ 294,400	$ 400,000	$ 694,400
FY28	Year 15	$ 178,400	$ 250,000	$ 428,400	Year 15	$ 294,400	$ 400,000	$ 694,400
FY29	Year 16	$ 178,400	$ 250,000	$ 428,400	Year 16	$ 294,400	$ 400,000	$ 694,400
FY30	Year 17	$ 178,400	$ 250,000	$ 428,400	Year 17	$ 294,400	$ 400,000	$ 694,400
FY31	Year 18	$ 178,400	$ 250,000	$ 428,400	Year 18	$ 294,400	$ 400,000	$ 694,400
FY32	Year 19	$ 178,400	$ 250,000	$ 428,400	Year 19	$ 294,400	$ 400,000	$ 694,400
FY33	Year 20	$ 178,400	$ 250,000	$ 428,400	Year 20	$ 480,820	$ 400,000	$ 880,820
	Totals	**$ 3,568,000**	**$ 5,000,000**	**$ 8,568,000**	**Totals**	**$ 4,788,840**	**$ 8,000,000**	**$ 12,788,840**
	Yr 20 Remaining Equip. Value			**$ -**	**Yr 20 Remaining Equip. Value**			**$ -**

Annual Consumption

	BASELINE Annual Consumption	Cost ($)		Proposed Annual Consumption	Cost ($)	
Electricity	3,504,241	$ 588,390		-5,543,956	$ (582,614.34)	
Natural Gas	83,432	$ 79,260.57		168,952	$ 146,297.23	
	TOTALS	**$ 667,651**		**TOTALS**	**$ (436,317)**	

Assumptions

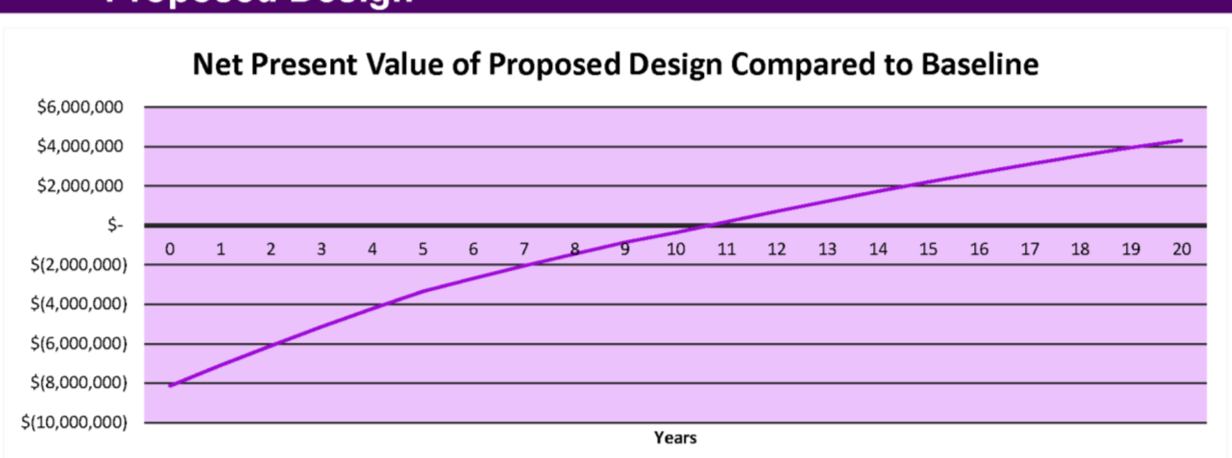
Discount Rate	Escalation Rates: Electricity	Natural Gas	Materials	Maint. and Labor	Study Period
8.00%	3.75%	5.00%	**1.73%**	**1.73%**	**20**

Life Cycle Cost Analysis	Project Information	
Options Comparison	**Building**	350 Mission St.
Results Table	**Project Name**	AEVITAS Thesis
Date January 15, 2014	**Project Type (lighting, heating, etc)**	HVAC system

Baseline 20 Year Total Cost of Ownership (TCO)	Cost to Own
	$ 24,350,582

Proposed Design

	Cost/Savings Variable Cost Only
20 Yr Total Cost of Ownership	**$ 20,040,069**
20 Yr Net Present Value (NPV)	**$ 4,310,513**
Simple Payback Analysis	
	Cost/Savings Variable Cost Only
First Year Utility Savings (FY14 rates)	$1,103,968
Simple Payback Period (Years)	7.38
First Year Return on Investment	13.5%
Life Cycle Cost Metrics	
	Cost/Savings Variable Cost Only
20 Year Savings to Investment Ratio	1.52
Discounted Payback Period (Years)	See Graph
Adjusted Internal Rate of Return	14.0%



FUEL CELL

Fuel Cell	Max Output		Output Voltage		Electrical Efficiency	Natural Gas Consumption		Heat for Recovery			CO_2 Emissions			Space Required (Dimen. & Area)
ClearEdge Model 400 PureCell	400	kW	480	VAC	42%	3,630,000	Btu/h	1,550,000	Btu/h	at 140°F	1059	lb/MWh	no recovery	27'4" x 8'4" x 10'
			380	VDC	47%						497	lb/MWh	w/ recovery	

Expected AC Energy	800,000	kwh	Annually
Expected DC Energy	1,000,000	kwh	Annually

Natural Gas Fuel Usage

Fuel Cell	Electrical Energy Use		Hours of Use		Total Energy Consumption [using electrical efficiency]		Cas Consumption in kBtu		Gas Consumption in Therms		Monthly Therms	
ClearEdge AC	800000	kwh	2000	hr	1904762	kwh	6499048	kBtu	64990	therms	5416	therms
ClearEdge DC1	500000	kwh	1250	hr	1063830	kwh	3629787	kBtu	36298	therms	3025	therms
ClearEdge DC2	500000	kwh	1250	hr	1063830	kwh	3629787	kBtu	36298	therms	3025	therms
Total	1800000	kwh	4500	hr	4032421	kwh	13,758,622	kBtu	137586	therms	11466	therms

Heat for Recovery

	Heat Recovery from Fuel Cell		Actual Heat to Mechanical Equ.		Annual Energy Used in Recovery Heat	
ClearEdge Model 400	6975000	kBtu	4185000	kBtu	1226553	kwh

Carbon Footprint (CO_2)

ClearEdge Model 400	1906200	lb	864637	kg	Annually, no recovery
	894600	lb	405783	kg	Annually, with recovery

Cost Analysis

Summer $/Month	Winter $/Month	Flat $	Total $	
Cost using natural gas				
$9,239.83	$9,815.10	$1,808.64	$116,138.22	Annually
Cost using grid electricity				
$35,259.50	$22,458.50	-	$346,308.00	Annually
Monetary Savings from using Fuel Cells			$230,169.78	Annually

Primary Fuel Comparison

Energy Source	Annual Primary Fuel Energy Consumption		Assumptions
Grid Natural Gas with Fuel Cells	4,688,862	kwh	Natural gas tranmission results in 14% losses from source to site
Grid Electric	5,806,452	kwh	Electric grid is 33% efficient from source to site after generation and tranmission
Savings	1,117,589	kwh	

Primary Fuel Utilization Comparison

Energy Source	Energy Use	Energy Consumption	
Fuel Cell	Total Required	4,688,862	kwh
	Electricity	1,800,000	kwh
	Recovery Heat	343,563	kwh
	Percent of total	46%	kwh
Electric Grid	Total Required	5,806,452	kwh
	Electricity	1,800,000	kwh
	Percent of Total	31%	kwh

Characteristic	*Units*	*Maximum Power Mode**	*Baseload Power Mode**
Electric Power	kW/kVA	440/440	400/471
Electrical Efficiency	%, LHV	41%	42%
Peak Overall Efficiency	%, LHV	90%	90%
Gas Consumption	MMBtu/h, HHV	4.11	3.63
High-Grade Heat Output @ up to 250ºF	MMBtu/h	0.78	0.65
Low-Grade Heat Output @ up to 140ºF	MMBtu/h	1.04	0.90

From a maintenance standpoint, the fuel cell stacks will require replacement after 10 years of use.

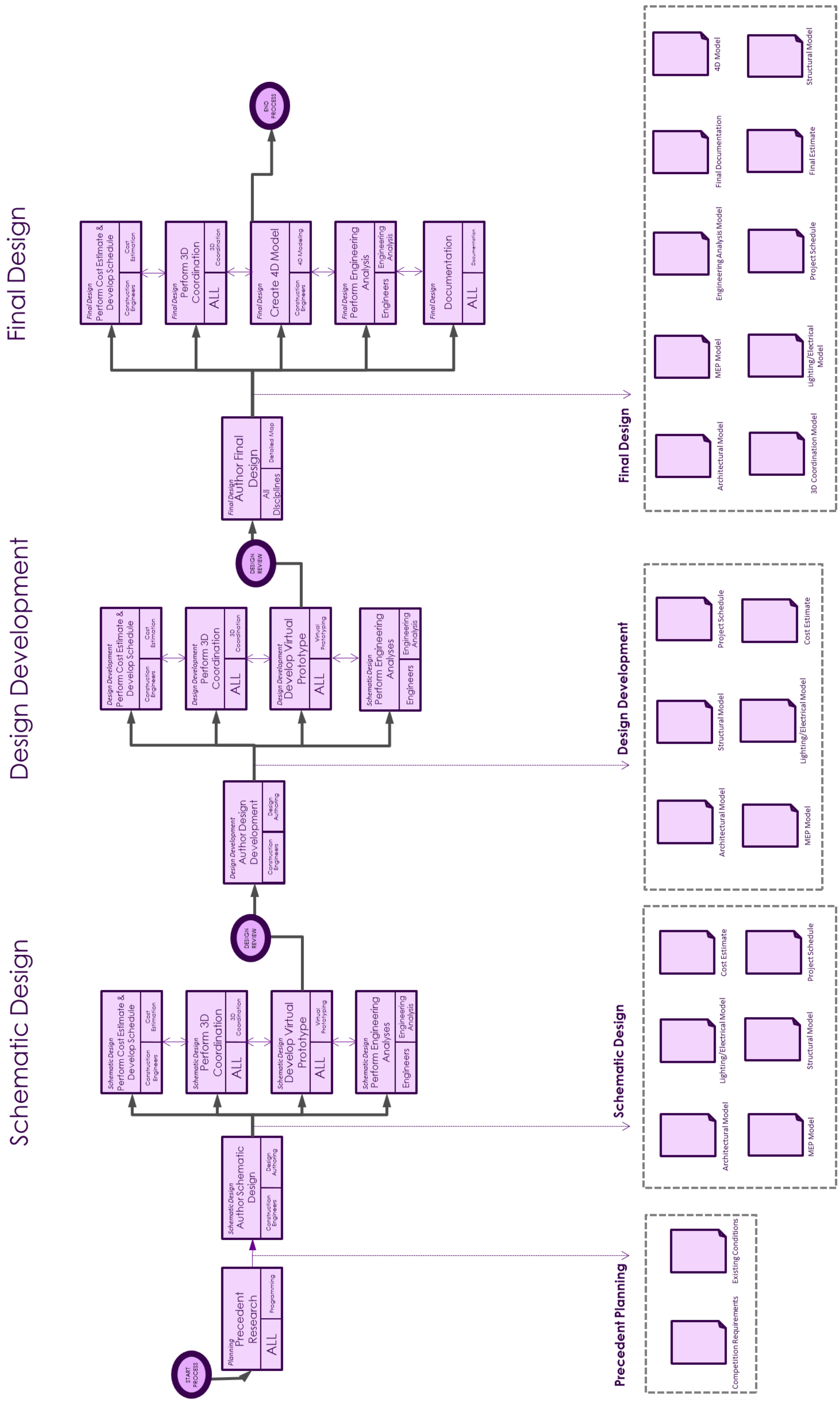
Due to the low price of PG&E's natural gas compared to its electric grid, which continues to increase rates, using the fuel cells to supply the building's electrical loads will save approximately $230,000 annually. The capital cost of the fuel cells is also low, as the self-generation incentives shown in Figures _ and _ provide over 80% of the initial cost. Most importantly, as 350 Mission aims to be net-zero, the comparison of primary fuel usage between onsite generation with the fuel cells and the electric grid is shown in the red box in Table ___. The natural gas fuel cells save over 100,000 kWh annually and lead to a 15% efficiency increase.

Self-Generation Incentive Program (SGIP)

The 2014 incentive levels are as follows:

$33.4 million per year in available incentives	75 percent renewable and emerging/25 percent nonrenewable	
Incentive levels	**Technology**	**Incentive ($/watt)**
Renewable, waste heat capture technologies	Wind turbines	$1.13/W
	Waste heat to power	$1.13/W
	Pressure reduction turbine	$1.13/W
	Renewable microturbine (on-site or directed biogas)	$2.08/W*
	Renewable internal combustion engine (on-site or directed biogas)	$2.08/W*
	Renewable gas turbine (on-site or directed biogas)	$2.08/W*
	Renewable fuel cells (on-site or directed biogas)	$3.45/W*
Emerging technologies	Advanced Energy Storage (AES)	$1.62/W
	Fuel cells: combined heat and power (CHP) or electric	$1.83/W

PROCESS FLOW DIAGRAM



MANPOWER CALCULATIONS

Mechanical			Mechanical								
Takeoff Totals			Productivity						Labor Durations		
Item	Quantity		Crew	Men/ Crew	# Crews	# Men	Crew Output	Total Output	Hours	Days	Weeks
Radiant Heat			Radiant Heat								
12 Circuit Manifold	1	Ea	Q5	2.0	2.0	4.0	10.0	20.0	0.4	0.1	0.0
12 Circuit Manifold Header	1	Ea	Q5	2.0	2.0	4.0	3.1	6.2	1.3	0.2	0.0
Zone Valve Actuator	12	Ea	Q5	2.0	2.0	4.0	40.0	80.0	1.2	0.2	0.0
Motorized Zone Valve	12	Ea	Q5	2.0	2.0	4.0	35.0	70.0	1.4	0.2	0.0
Zone Control Panel	1	Ea	Q5	2.0	2.0	4.0	20.0	40.0	0.2	0.0	0.0
Radiant Pump	1	Ea	Q1	2.0	2.0	4.0	6.0	12.0	0.7	0.1	0.0
Ductwork			Ductwork								
4" Dia.	241	LF	Q9	3.0	4.0	12.0	360.0	1440.0	1.3	0.2	0.0
6" Dia.	65.5	LF	Q9	3.0	4.0	12.0	280.0	1120.0	0.5	0.1	0.0
9" Dia.	50	LF	Q9	3.0	4.0	12.0	180.0	720.0	0.6	0.1	0.0
10" Dia.	245	LF	Q9	3.0	4.0	12.0	160.0	640.0	3.1	0.4	0.1
12" Dia.	70.5	LF	Q9	3.0	4.0	12.0	120.0	480.0	1.2	0.1	0.0
14" Dia.	14.5	LF	Q9	3.0	4.0	12.0	80.0	320.0	0.4	0.0	0.0
6" X 6"	113	LB	Q10	3.0	4.0	12.0	275.0	1100.0	0.8	0.1	0.0
12" X 12"	276	LB	Q10	3.0	4.0	12.0	275.0	1100.0	2.0	0.3	0.1
12" X 16"	353	LB	Q10	3.0	4.0	12.0	275.0	1100.0	2.6	0.3	0.1
12" X 18"	195	LB	Q10	3.0	4.0	12.0	275.0	1100.0	1.4	0.2	0.0
12" X 20"	571	LB	Q10	3.0	4.0	12.0	275.0	1100.0	4.2	0.5	0.1
12" X 60"	154	LB	Q10	3.0	4.0	12.0	275.0	1100.0	1.1	0.1	0.0
14" X 20"	479	LB	Q10	3.0	4.0	12.0	275.0	1100.0	3.5	0.4	0.1
20" X 24"	57	LB	Q10	3.0	4.0	12.0	275.0	1100.0	0.4	0.1	0.0
25" X 50"	903	LB	Q10	3.0	4.0	12.0	275.0	1100.0	6.6	0.8	0.2
Dampers			Dampers								
4" Dia.	47	EA	1 Shee	1.0	4.0	4.0	24.0	96.0	3.9	0.5	0.1
6" Dia.	7	EA	1 Shee	1.0	4.0	4.0	24.0	96.0	0.6	0.1	0.0
9" Dia.	4	EA	1 Shee	1.0	4.0	4.0	22.0	88.0	0.4	0.0	0.0
10" Dia.	3	EA	1 Shee	1.0	4.0	4.0	21.0	84.0	0.3	0.0	0.0
12" Dia.	3	EA	1 Shee	1.0	4.0	4.0	21.0	84.0	0.3	0.0	0.0
12" X 20"	2	EA	1 Shee	1.0	4.0	4.0	16.0	64.0	0.3	0.0	0.0
14" X 20"	4	EA	1 Shee	1.0	4.0	4.0	15.0	60.0	0.5	0.1	0.0
20" X 24"	1	EA	1 Shee	1.0	4.0	4.0	8.0	32.0	0.3	0.0	0.0
Diffusers			Diffusers								
4' Linear Diffusers	49	EA	1 Shee	1.0	2.0	2.0	26.0	52.0	7.5	0.9	0.2
6" Dia. Diffusers	7	EA	1 Shee	1.0	2.0	2.0	18.0	36.0	1.6	0.2	0.0
12" Dia.	2	EA	1 Shee	1.0	2.0	2.0	12.0	24.0	0.7	0.1	0.0
6" X 6"	7	EA	1 Shee	1.0	2.0	2.0	16.0	32.0	1.8	0.2	0.0
12" X 12"	3	EA	1 Shee	1.0	2.0	2.0	12.0	24.0	1.0	0.1	0.0
14" X 20"	2	EA	1 Shee	1.0	2.0	2.0	22.0	44.0	0.4	0.0	0.0
25" X 50"	2	EA	1 Shee	1.0	2.0	2.0	10.0	20.0	0.8	0.1	0.0

Plumbing			Plumbing								
Takeoff Totals			Productivity						Labor Durations		
Item	Quantity		Crew	Men/ Crew	# Crews	# Men	Daily Output	Total Output	Hours	Days	Weeks
Sprinkler			Sprinklers								
Cast Iron Pipe (3")	500	LF	Q1	2.0	3.0	6.0	60.0	180.0	22.2	2.8	0.6
Cast Iron Pipe (2")	300	LF	Q1	2.0	3.0	6.0	63.0	189.0	12.7	1.6	0.3
Sprinkler Heads	36	Ea	1 Spr	1.0	2.0	2.0	16.0	32.0	9.0	1.1	0.2
Water Motor	1	Ea	1 Spr	1.0	2.0	2.0	4.0	8.0	1.0	0.1	0.0
Domestic Water			Domestic Water								
Copper Pipe (1.5")	100	LF	1 Plum	1.0	2.0	2.0	50.0	100.0	8.0	1.0	0.2
90 Elbows (1.5")	10	Ea	Q1	2.0	2.0	4.0	13.0	26.0	3.1	0.4	0.1
Tee (1.5")	6	Ea	1 Plum	1.0	2.0	2.0	8.0	16.0	3.0	0.4	0.1
Sanitary			Sanitary								
Cast Iron Pipe (4")	30	LF	Q1	2.0	3.0	6.0	55.0	165.0	1.5	0.2	0.0
Cast Iron Pipe (2")	80	LF	Q1	2.0	3.0	6.0	63.0	189.0	3.4	0.4	0.1
Wye (4")	10	Ea	Q1	2.0	3.0	6.0	4.0	12.0	6.7	0.8	0.2
Wye (2")	8	Ea	Q1	2.0	3.0	6.0	11.0	33.0	1.9	0.2	0.0
45 Elbows (4")	8	Ea	Q1	2.0	3.0	6.0	6.0	18.0	3.6	0.4	0.1
45 Elbows (2")	18	Ea	Q1	2.0	3.0	6.0	18.0	54.0	2.7	0.3	0.1
90 Elbows (4")	2	Ea	Q1	2.0	3.0	6.0	6.0	18.0	0.9	0.1	0.0
90 Elbows (2")	8	Ea	Q1	2.0	3.0	6.0	18.0	54.0	1.2	0.1	0.0
P Traps (2")	4	Ea	Q1	2.0	3.0	6.0	13.0	39.0	0.8	0.1	0.0
Fixtures			Fixtures								
Toilet Carrier System	6	Ea	Q1	2.0	2.0	4.0	2.1	4.3	11.2	1.4	0.3
Water Closet	6	Ea	Q1	2.0	2.0	4.0	2.6	5.1	9.4	1.2	0.2
Waterless Urinals	2	Ea	Q1	2.0	2.0	4.0	21.3	42.6	0.4	0.0	0.0
Sinks	4	Ea	Q1	2.0	2.0	4.0	6.4	12.8	2.5	0.3	0.1

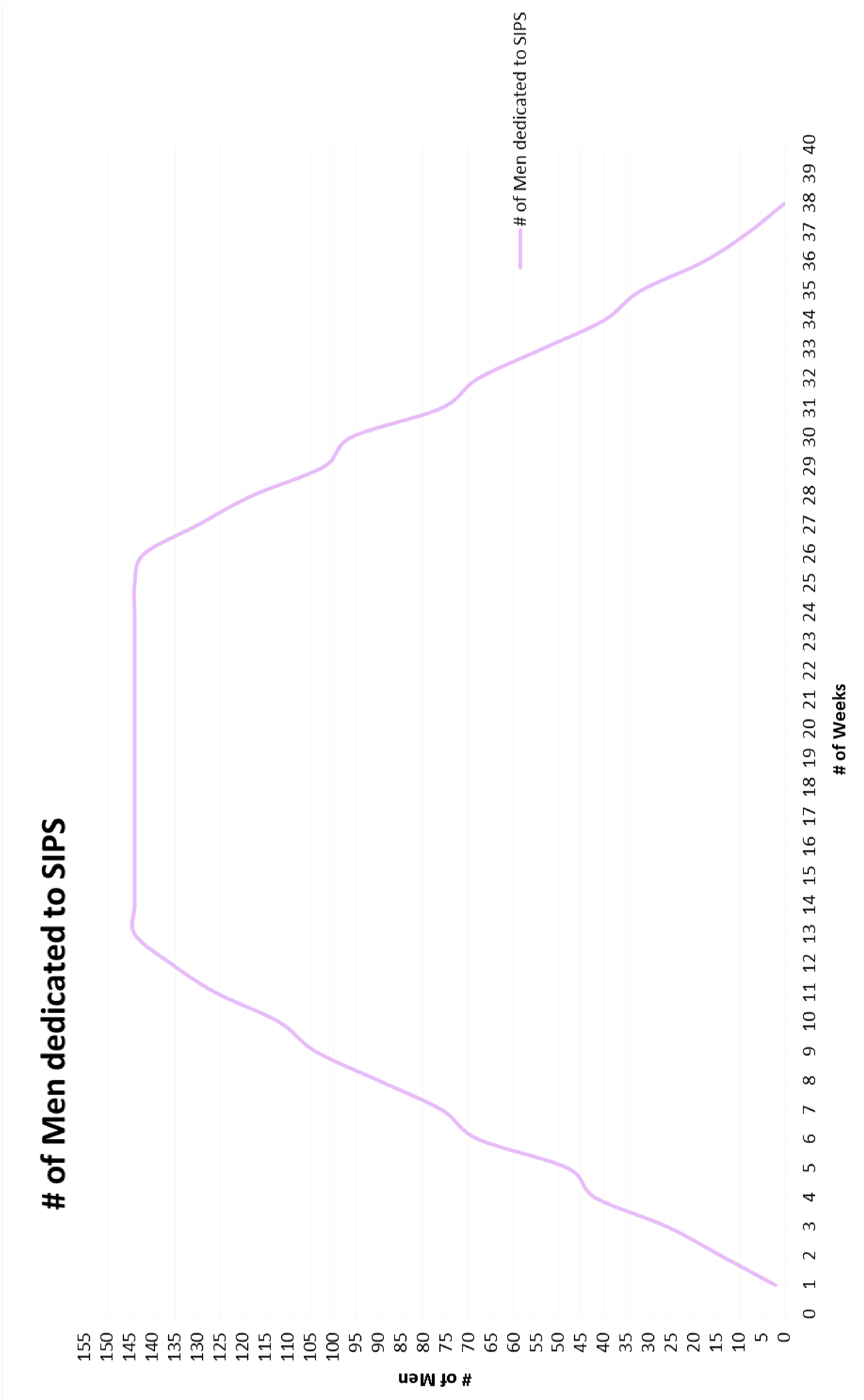
Electrical/Communications			Electrical								
Takeoff Totals			Productivity						Labor Durations		
Item	Quantity		Crew	Men/ Crew	# Crews	# Men	Daily Output	Total Output	Hours	Days	Weeks
Branch Circuits			Branch Circuits								
EMT Conduit (3/4")	3000	LF	1 Elec	1.0	8.0	8.0	253.0	2024.0	11.9	1.5	0.3
#12 Wire	120	CLF	1 Elec	1.0	8.0	8.0	11.0	88.0	10.9	1.4	0.3
#12 Wire Terminations	300	Ea	1 Elec	1.0	8.0	8.0	50.0	400.0	6.0	0.8	0.2
#10 Wire	40	CLF	1 Elec	1.0	8.0	8.0	10.0	80.0	4.0	0.5	0.1
#10 Wire Terminations	150	Ea	1 Elec	1.0	8.0	8.0	45.0	360.0	3.3	0.4	0.1
Armored Cable (3) #12	7.5	CLF	1 Elec	1.0	8.0	8.0	2.0	16.0	3.8	0.5	0.1
Junction Boxes	80	Ea	1 Elec	1.0	8.0	8.0	8.0	64.0	10.0	1.3	0.3
Outlet Boxes	156	Ea	1 Elec	1.0	8.0	8.0	20.0	160.0	7.8	1.0	0.2
Receptacles	156	Ea	1 Elec	1.0	8.0	8.0	32.0	256.0	4.9	0.6	0.1
Fixtures			Fixtures								
4' Linear Recessed	118	Ea	1 Elec	1.0	10.0	10.0	8.0	80.0	11.8	1.5	0.3
2X2 Troffer	34	Ea	1 Elec	1.0	10.0	10.0	5.7	57.0	4.8	0.6	0.1
Down Light	47	Ea	1 Elec	1.0	10.0	10.0	8.0	80.0	4.7	0.6	0.1
Linear Fluorescent Fixt	14	Ea	1 Elec	1.0	10.0	10.0	8.0	80.0	1.4	0.2	0.0
Task Lighting	120	Ea	1 Elec	1.0	10.0	10.0	10.0	100.0	9.6	1.2	0.2
Emergency Lighting	12	Ea	1 Elec	1.0	10.0	10.0	4.0	40.0	2.4	0.3	0.1
Exit Signs	6	Ea	1 Elec	1.0	10.0	10.0	4.0	40.0	1.2	0.2	0.0
Equipment			Equipment								
DC Conversion Module	5	Ea	1 Elec	1.0	10.0	10.0	5.0	50.0	0.8	0.1	0.0
Grounding Rod	1	Ea	1 Elec	1.0	10.0	10.0	5.3	53.0	0.2	0.0	0.0
Occupancy Sensors	6	Ea	1 Elec	1.0	10.0	10.0	6.5	65.0	0.7	0.1	0.0
Daylighting Sensors	4	Ea	1 Elec	1.0	10.0	10.0	6.5	65.0	0.5	0.1	0.0
Life Safety			Life Safety								
Fiber Optic Cable	10	CLF	1 Elec	1.0	4.0	4.0	6.7	26.7	3.0	0.4	0.1
Heat Detectors	4	Ea	1 Elec	1.0	10.0	10.0	8.0	80.0	0.4	0.1	0.0
Smoke Detectors	6	Ea	1 Elec	1.0	10.0	10.0	6.0	60.0	0.8	0.1	0.0
Carbon Monoxide Detect	2	Ea	1 Elec	1.0	10.0	10.0	8.0	80.0	0.2	0.0	0.0
Visual Alarms	6	Ea	1 Elec	1.0	10.0	10.0	5.3	53.0	0.9	0.1	0.0
Audible Alarms	2	Ea	1 Elec	1.0	10.0	10.0	6.7	67.0	0.2	0.0	0.0
Data			Data								
24 Port Patch Panel	1	Ea	2 Elec	2.0	1.0	2.0	6.0	6.0	1.3	0.2	0.0
Cat 6 Cable	25	CLF	1 Elec	1.0	4.0	4.0	7.0	28.0	7.1	0.9	0.2
Network Hub Router	6	Ea	3 Elec	3.0	2.0	6.0	1.5	3.0	16.0	2.0	0.4

Interiors			Interiors								
Takeoff Totals			Productivity						Labor Durations		
Item	Quantity		Crew	Men/ Crew	# Crews	# Men	Daily Output	Total Output	Hours	Days	Weeks
Walls			Walls								
Metal Studs	1100	LF	2 Carp	2.0	3.0	6.0	120.0	360.0	24.4	3.1	0.6
1/2" GWB	19500	SF	2 Carp	2.0	4.0	8.0	1000.0	4000.0	39.0	4.9	1.0
Firestopping	27	EA	1 Carp	1.0	2.0	2.0	14.0	28.0	7.7	1.0	0.2
Glass	1000	SF	2 Glaz	2.0	4.0	8.0	100.0	400.0	20.0	2.5	0.5
Painting	10000	SF	1 Pntr	1.0	4.0	4.0	1700.0	6800.0	11.8	1.5	0.3
Acoustical Insulation	5000	SF	1 Carp	1.0	4.0	4.0	910.0	3640.0	11.0	1.4	0.3
Flooring			Flooring								
Ceramic Tile	450	SF	D7	2.0	2.0	4.0	290.0	580.0	6.2	0.8	0.2
Carpet Tile	1416.67	SY	1 Tilf	1.0	6.0	6.0	80.0	480.0	23.6	3.0	0.6
Resilient Base	1400	LF	1 Tilf	1.0	6.0	6.0	315.0	1890.0	5.9	0.7	0.1
Doors			Doors								
Metal Fire Doors	16	Ea	2 Carp	2.0	2.0	4.0	15.0	30.0	4.3	0.5	0.1
Door Frames	16	Ea	2 Carp	2.0	2.0	4.0	16.0	32.0	4.0	0.5	0.1
Glass Doors	10	Ea	1 Glaz	1.0	1.0	1.0	10.0	10.0	8.0	1.0	0.2
Access Doors	6	Ea	1 Carp	1.0	1.0	1.0	9.0	9.0	5.3	0.7	0.1
Ceilings			Ceilings								
Acoustical Celing Panels	12930	SF	1 Carp	1.0	6.0	6.0	600.0	3600.0	28.7	3.6	0.7
Acoustical Ceiling Grid	12930	SF	1 Carp	1.0	16.0	16.0	650.0	10400.0	9.9	1.2	0.2
Seismic Clips	500	Ea	1 Carp	1.0	16.0	16.0	60.0	960.0	4.2	0.5	0.1

MATRIX MANPOWER BREAKDOWN

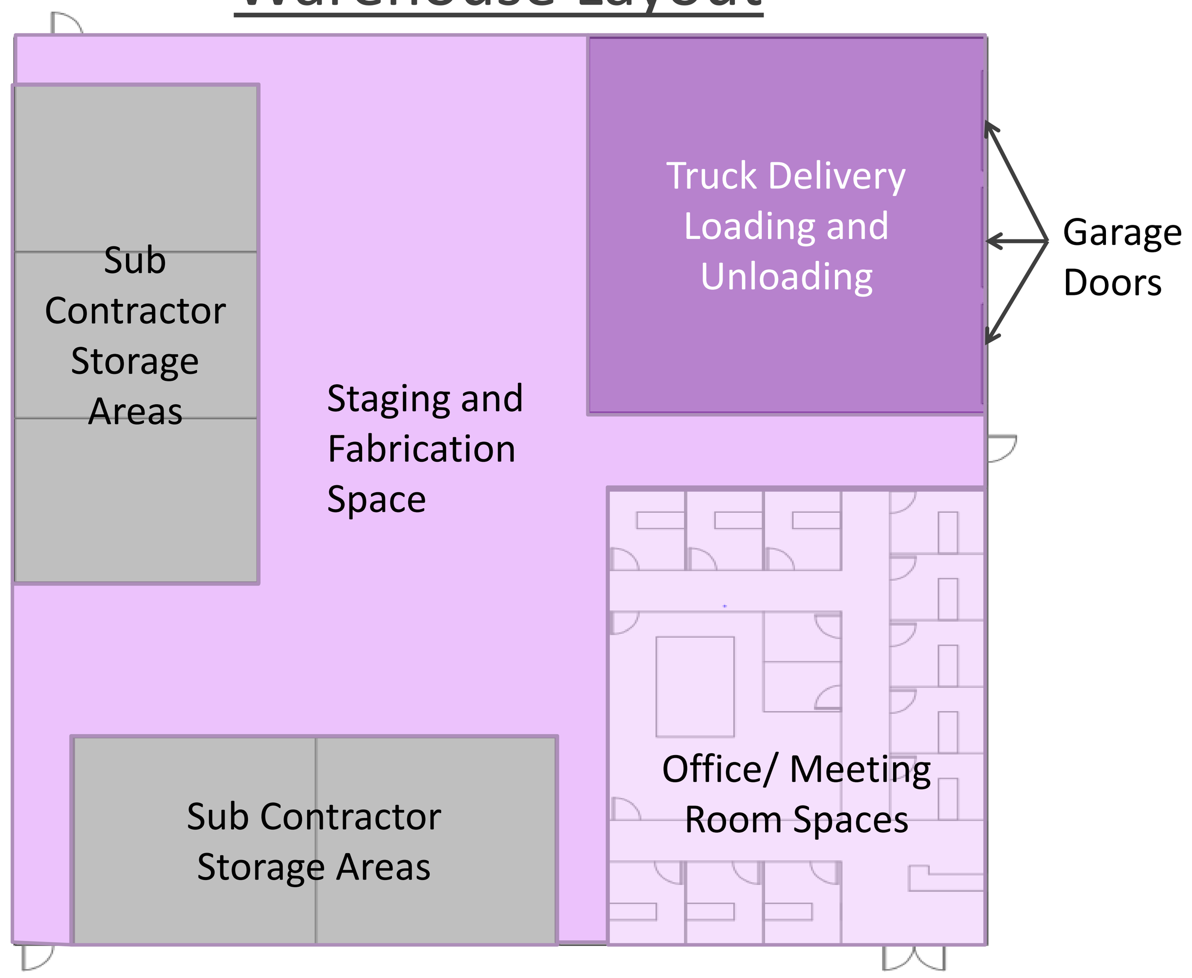
Seq #	Task	Desired Duration	Trade	# Men Req'd To Meet Desired Duration	Total # of Men
1	Layout Install Top Track Layout Duct Openings in Wall Metal Stud Wall/Openings	5	Interiors	2	**2**
2	HVAC Duct Mains/Dampers HVAC Duct Branches Install Duct Insulation Radiant Slab Tie In	5	Mech	12	**12**
3	Domestic Water Branches Sanitary/Prefab Toilet Rack Install Pipe Testing Pipe Insulation Sprinkler Mains Sprinkler Branches	5	Plum FP	6 6	**12**
4	Install Large Conduit Firestop and Caulk Penetrations Install Interior Partitions One Side Drywall	5	Elec All Interiors	6 2 8	**16**
5	In-Wall Electrical/Comm In Wall Controls In Wall Testing/QC	5	Elec	6	**6**
6	Close In Inspection Finish Drywall Install Door Frames Frame and Install Ceiling Grid	5	All Interiors	4 16	**20**
7	Pull Electrical Wire Pull Data Cable Pull Fire Alarm Cable	5	Elec	8	**8**
8	Prime and Paint Walls Install Carpet Tile/Ceramic Tile	5	Painter Flooring	4 10	**14**
9	Install Electrical Trim/Wall Controls Install Light Fixtures Set and Hookup Plumbing Fixtures Caulk Plumbing Fixtures	5	Elec Plum	10 4	**14**
10	Install Sprinkler Drops Sprinkler Hydrotest Install Bathroom Trim/Partitions Install Doors/Locks/Closers	5	FP Interiors	4 4	**8**
11	Overhead Close In Inspection Install Ceiling Tile HVAC Ceiling Trim Electrical Ceiling Trim Sprinkler Ceiling Trim Misc Ceiling Trim	5	All Interiors Mech Elec FP Interiors	4 6 1 1 1 1	**14**
12	Final Paint Final Clean Air and Water Balancing Fire Alarm Testing	5	Painter AEVITAS Plum/Mech Elec/Comm	4 2 2 2	**10**
13	Performance Tests - TAB Performance Tests - Controls Performance Tests - Lighting Performance Tests - Radiant	5	Mech/Plum Elec/Controls Elec Mech/Plum	2 2 2 2	**8**
14	Final Inspection/Punchout Punchout and Signoff Final Acceptance/Floor Completion	5	AEVITAS/KR	-- -- --	**0**

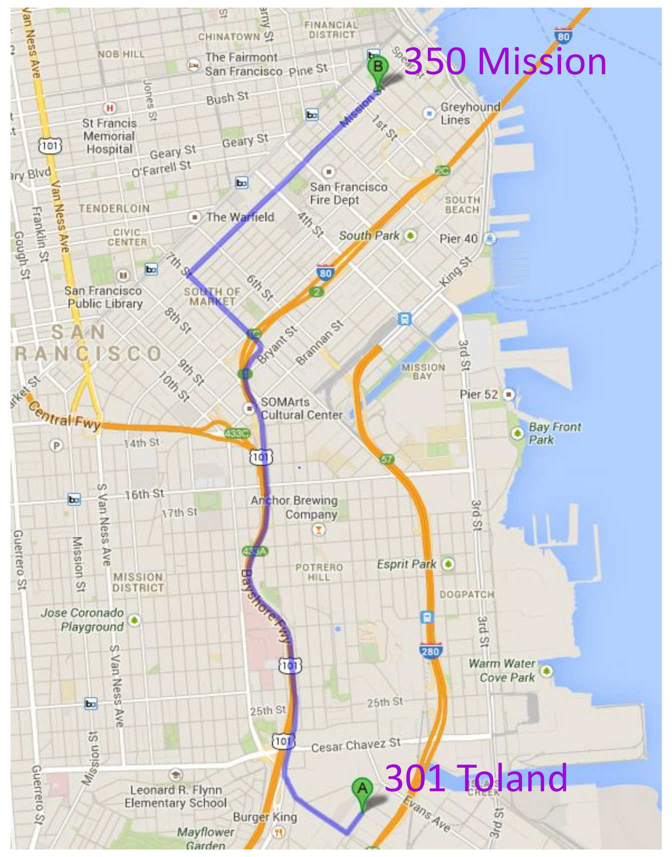
RESOURCE ALLOCATION CHART



AEVITAS | Warehouse and Delivery Logistics

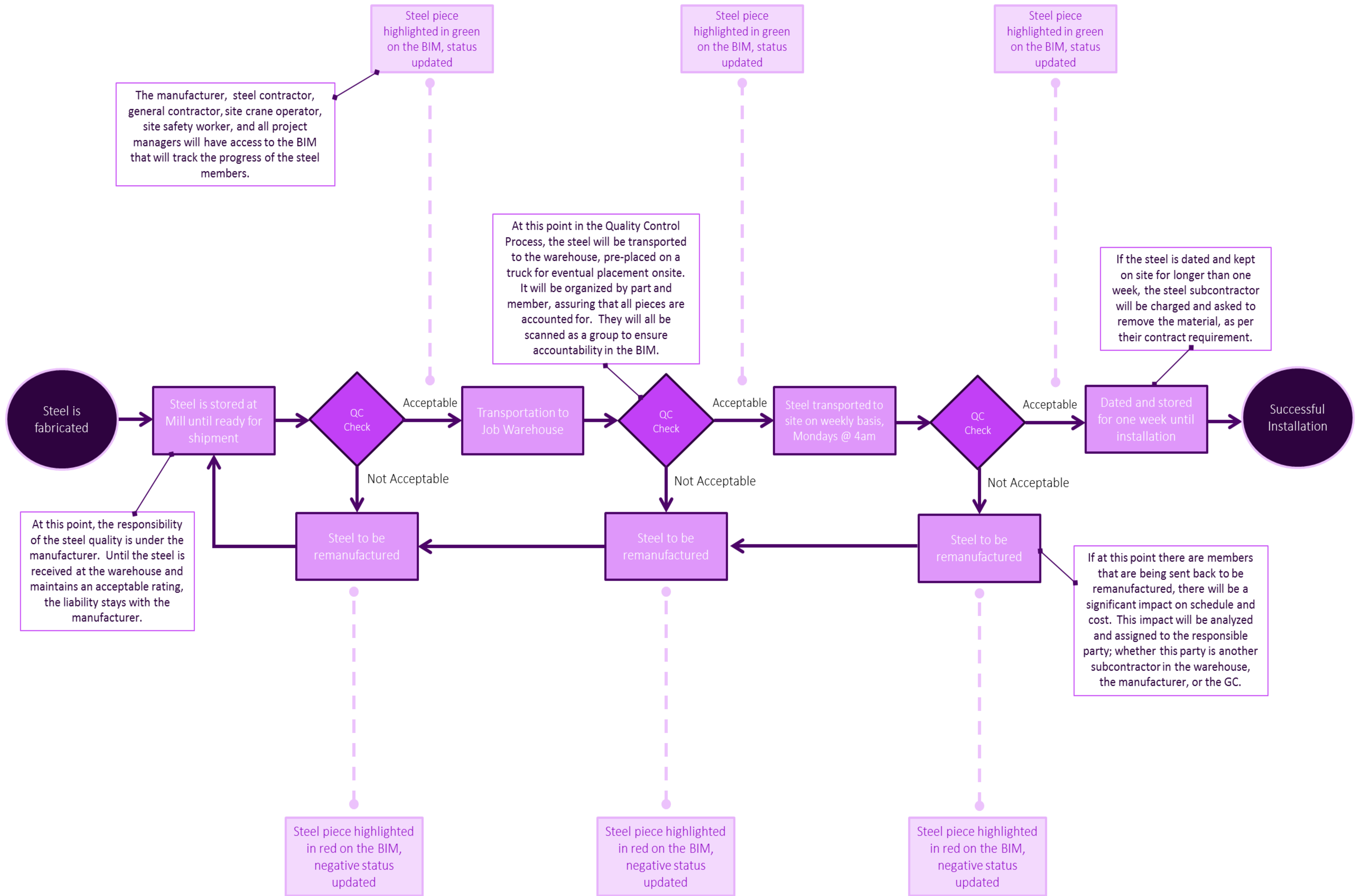
Warehouse Layout

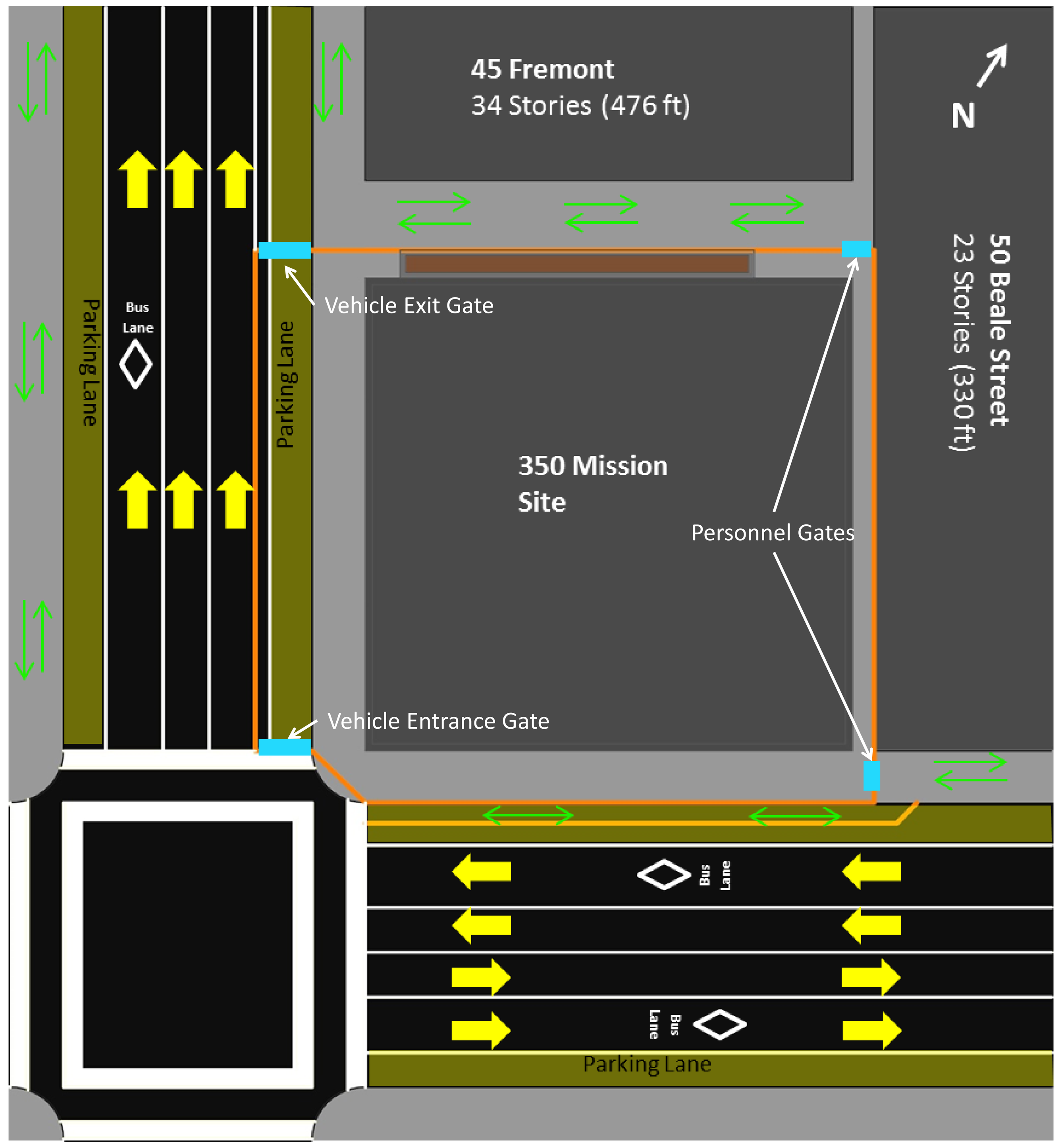




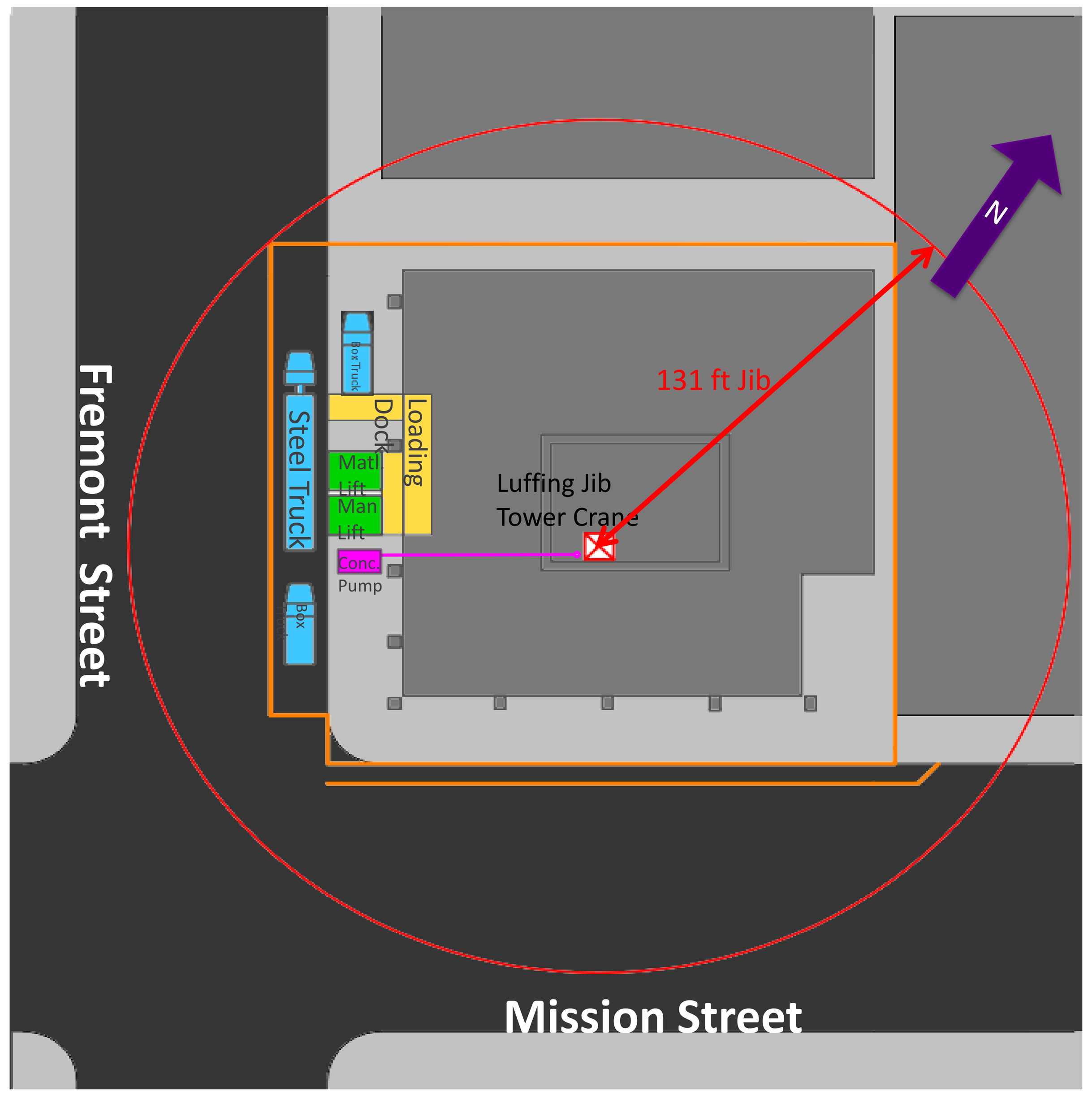
The Figures above represent the warehouse AEVITAS plans to lease for a large majority of the project. The idea behind this is to have a space solely focused around the 350 Mission project. The map represents a possible location for the warehouse , ideally located just 10 minutes away form the site. A warehouse in Oakland would have most likely been cheaper than the one AEVITAS used as an example, the problem with this is that it would force any of the specialty contractors located outside of Oakland to go through San Francisco and cross the San Francisco-Oakland bay bridge. The warehouse space is crucial in both the design and construction of the building as AEVITAS would like to create an integrated atmosphere for the project as a whole. This may be somewhat of a bold idea because it would force our design build specialty contractors to staff the warehouse space with designers, project managers, and fabricators alike but it would also allow for more face to face communication leading to quicker decision making and greater collaboration. The space is allocated to allow for staging and fabrication space off site due to the tight constraints of the 350 Mission Site.

Quality Check Flow Chart – Steel Example





Superstructure Phase Delivery Plan

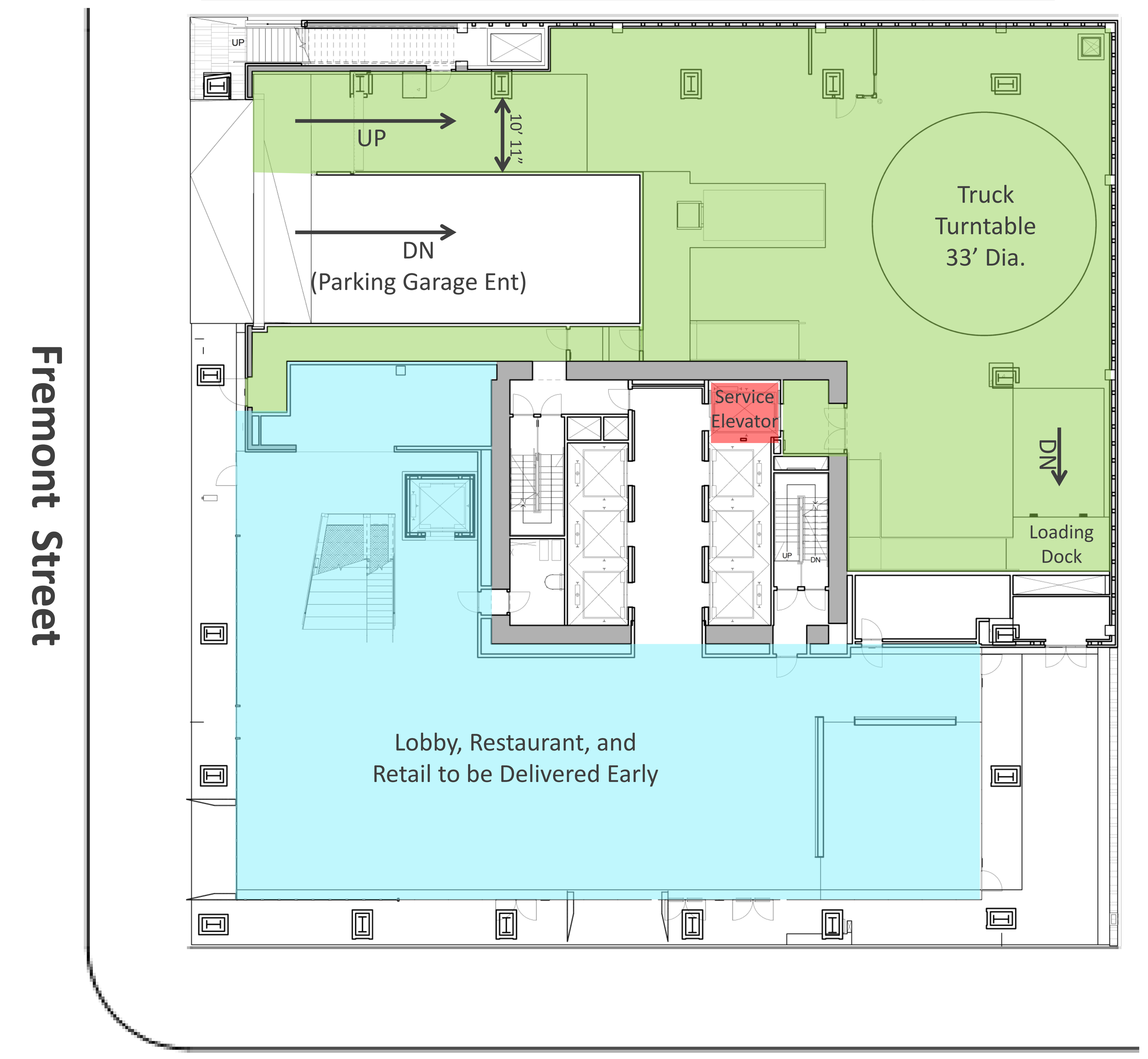


Once the building structure starts rising a material and man hoist will be needed to provide vertical transportation for both the workers and any material that will not be hoisted by the crane. To unload this material a loading dock shown in the delivery plan above will be constructed so material can be off loaded with ease.

Site Logistics

The plan to the left indicates the proposed construction site boundary outlined in orange. The main delivery lane for the site will be located along Fremont Street causing the least amount of impact to the area. The parking lane and bike lane on Fremont will be occupied as a result of this delivery lane but it is a necessary measure to create room for the construction. A pedestrian walkway will be created in the parking lane on Mission street to allow for foot traffic walking past the site, indicated by the green arrows seen in the plan to the left. Throughout the duration of the project it is imperative that the public transportation system is not affected by the project. To accomplish this the intended site boundary does not infringe on any of the bus lanes adjacent to the site. On the buildings northeast and northwest are two existing buildings in close proximity to the site. These buildings are occupied and will remain fully functional throughout the construction, temporary protection will have to be put up to protect these buildings during the construction of 350 Mission. On the side of the site facing the 45 Fremont building there is an existing planter that must be protected throughout the duration of the project.

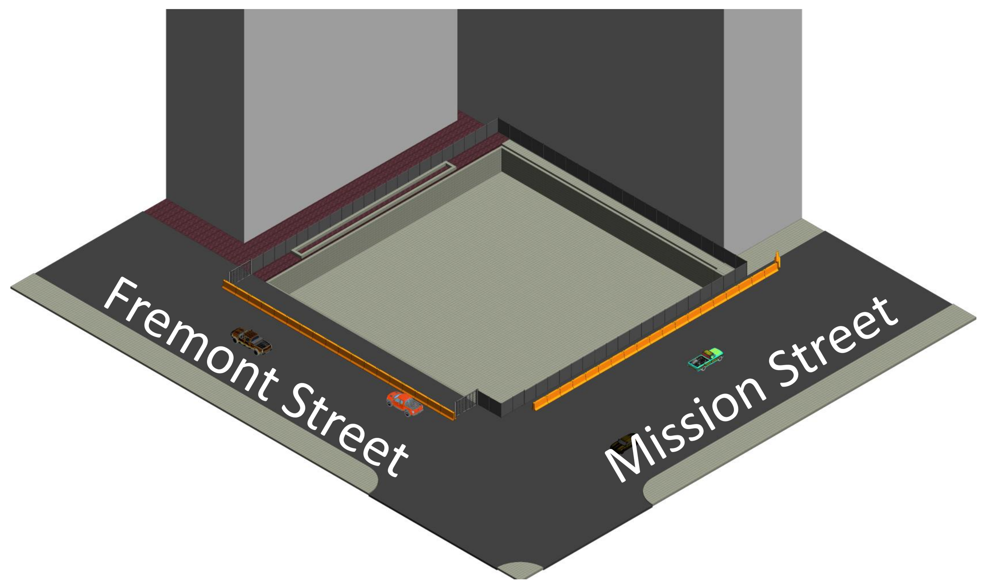
Interior Finishes Phase Delivery Plan



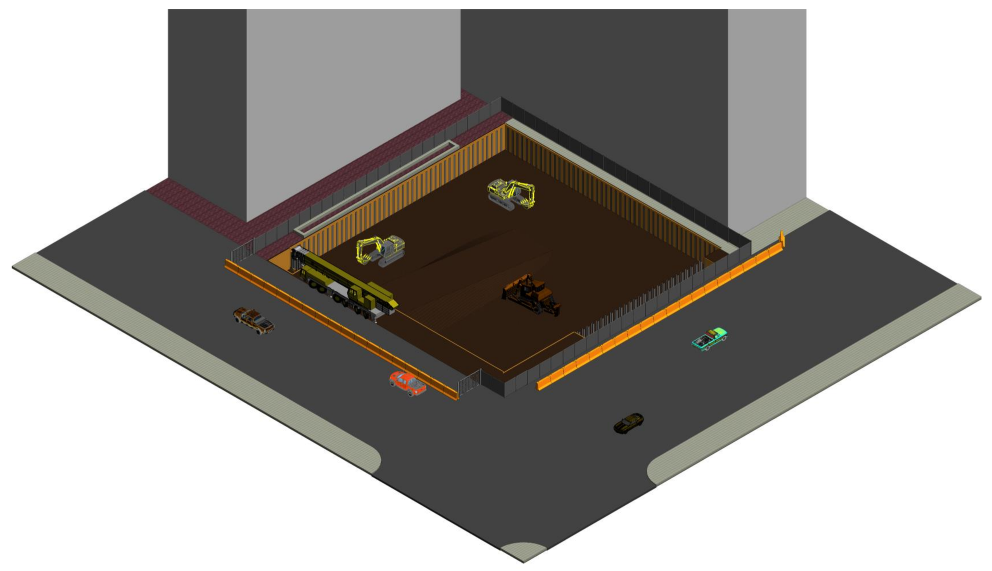
At the time the elevators are energized, the hoists located on the edge of the building will be removed, and the curtain wall panels will be finished where they were left out for the hoists. All major items will have been moved into the building by this point but the service elevator will move most of the MEP and Interiors material up the building to the floor it will be installed on. The material will be delivered to the building via the loading dock located on the first floor of the building. The turntable intended for this space will be installed by this point and available for use. The advantage to having this loading dock space is that it is completely isolated from the other spaces in the buildings first four stories such as the lobby, the restaurant, and the retail space allowing tenant work in this space to begin before the office space is completed.

AEVITAS | 4D Phasing Model

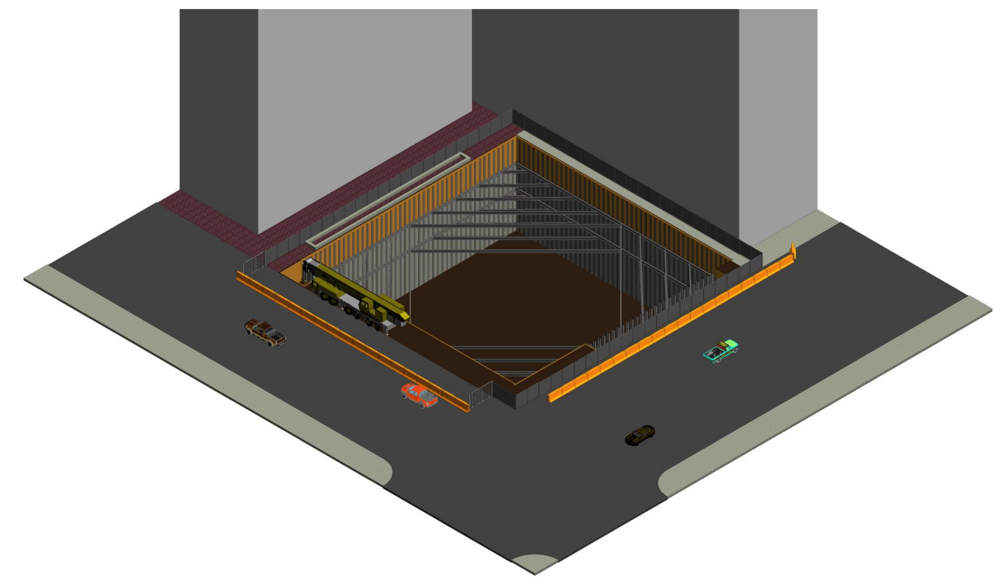
Post Demolition – 7/7/2014



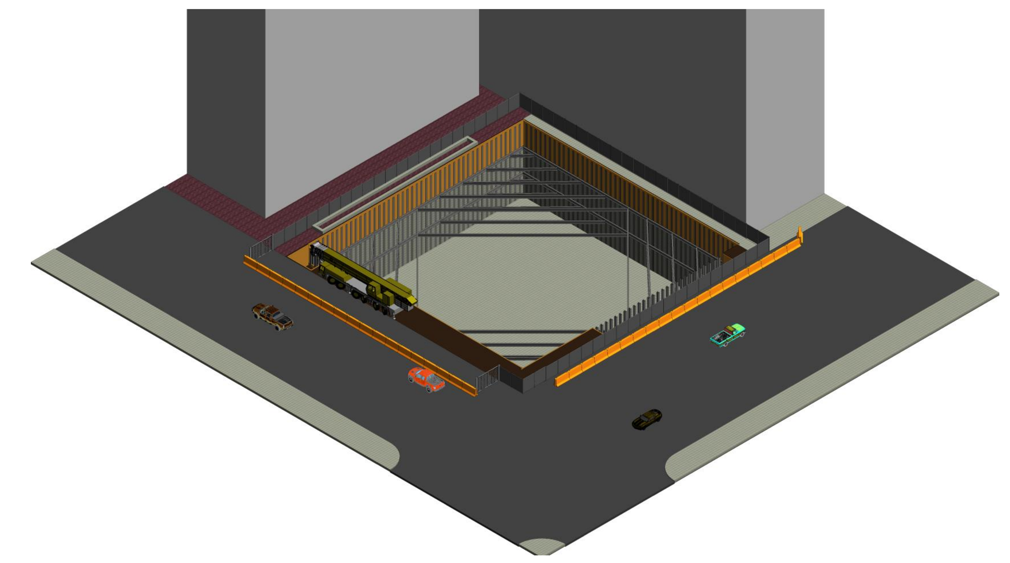
Excavation Begins – 7/21/2014



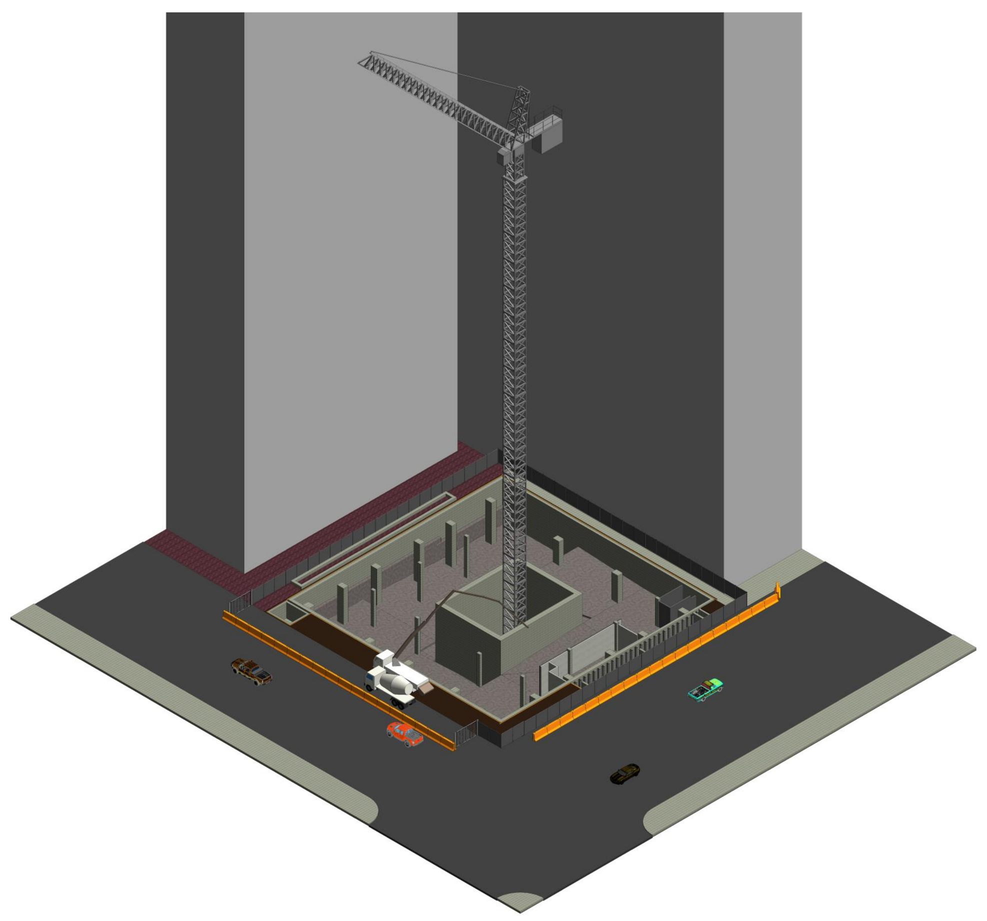
Excavation Complete – 11/21/2014



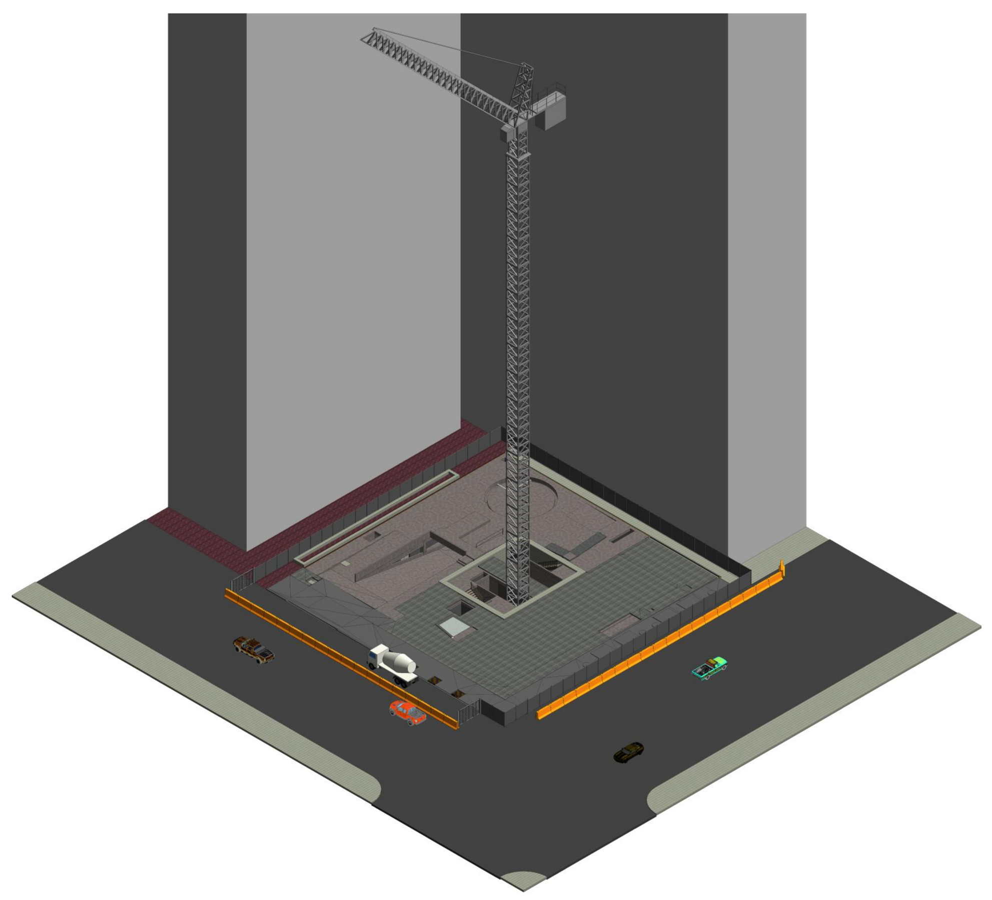
Foundations Complete – 12/19/2014



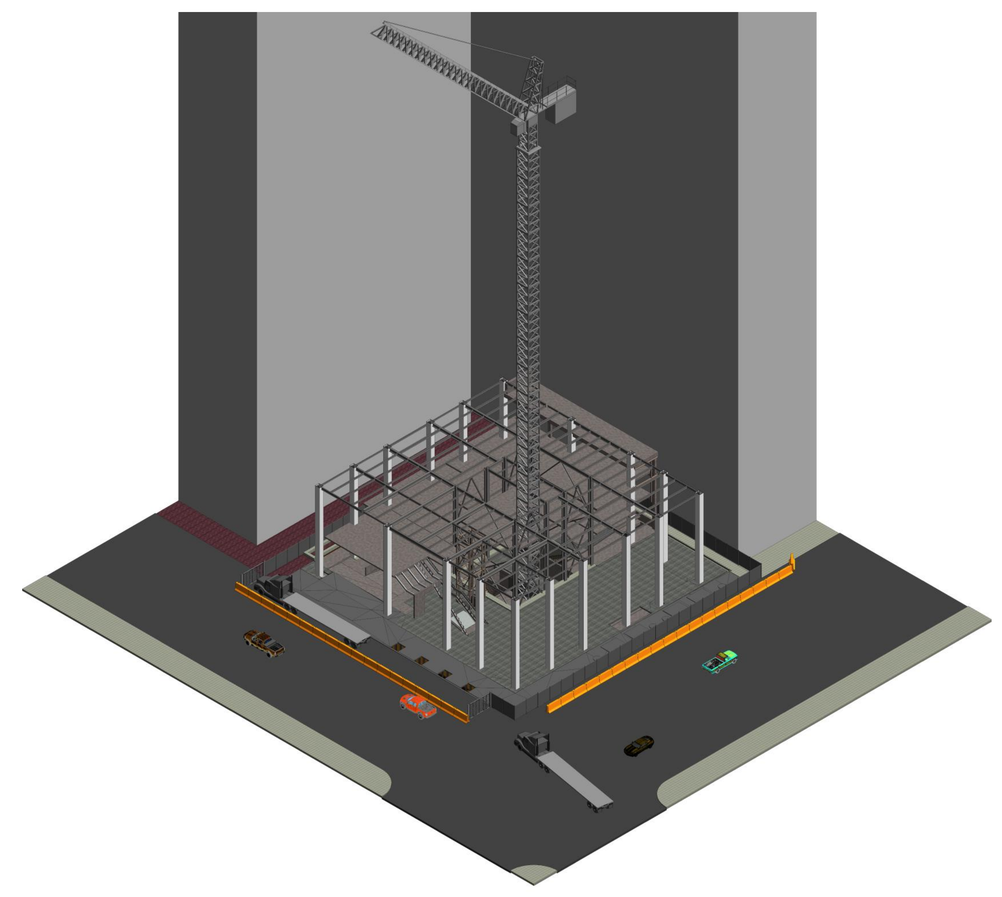
Substructure – 2/23/2015



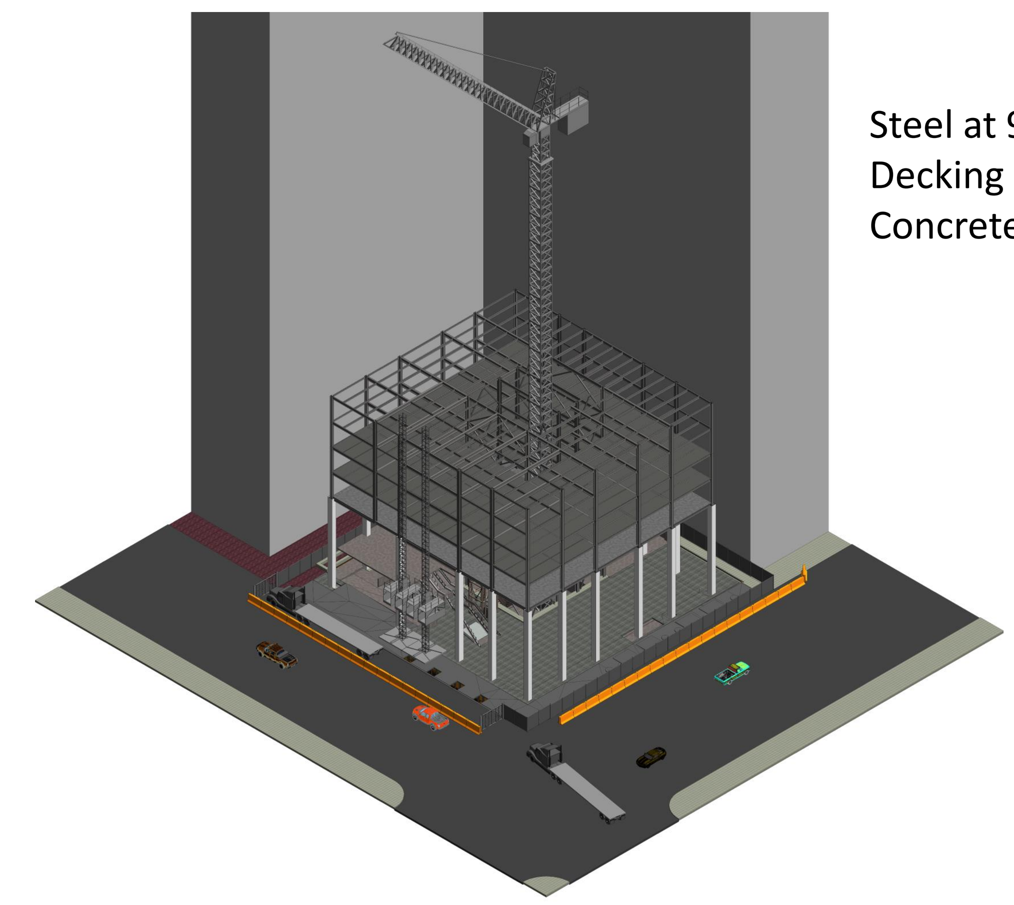
Substructure Complete – 3/27/2015



Superstructure Starts - 3/30/2015

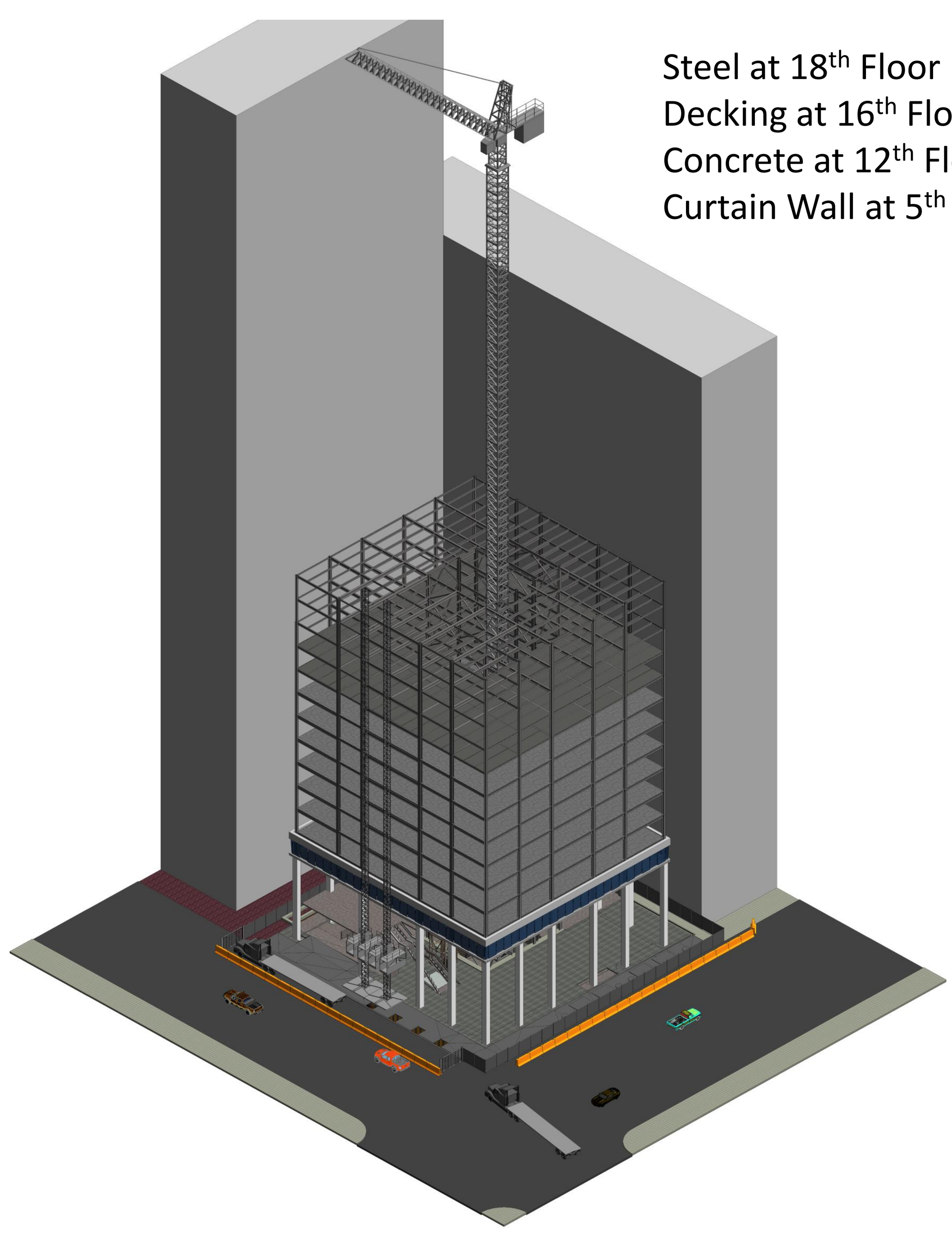


Composite Slabs Begin – 5/25/2015



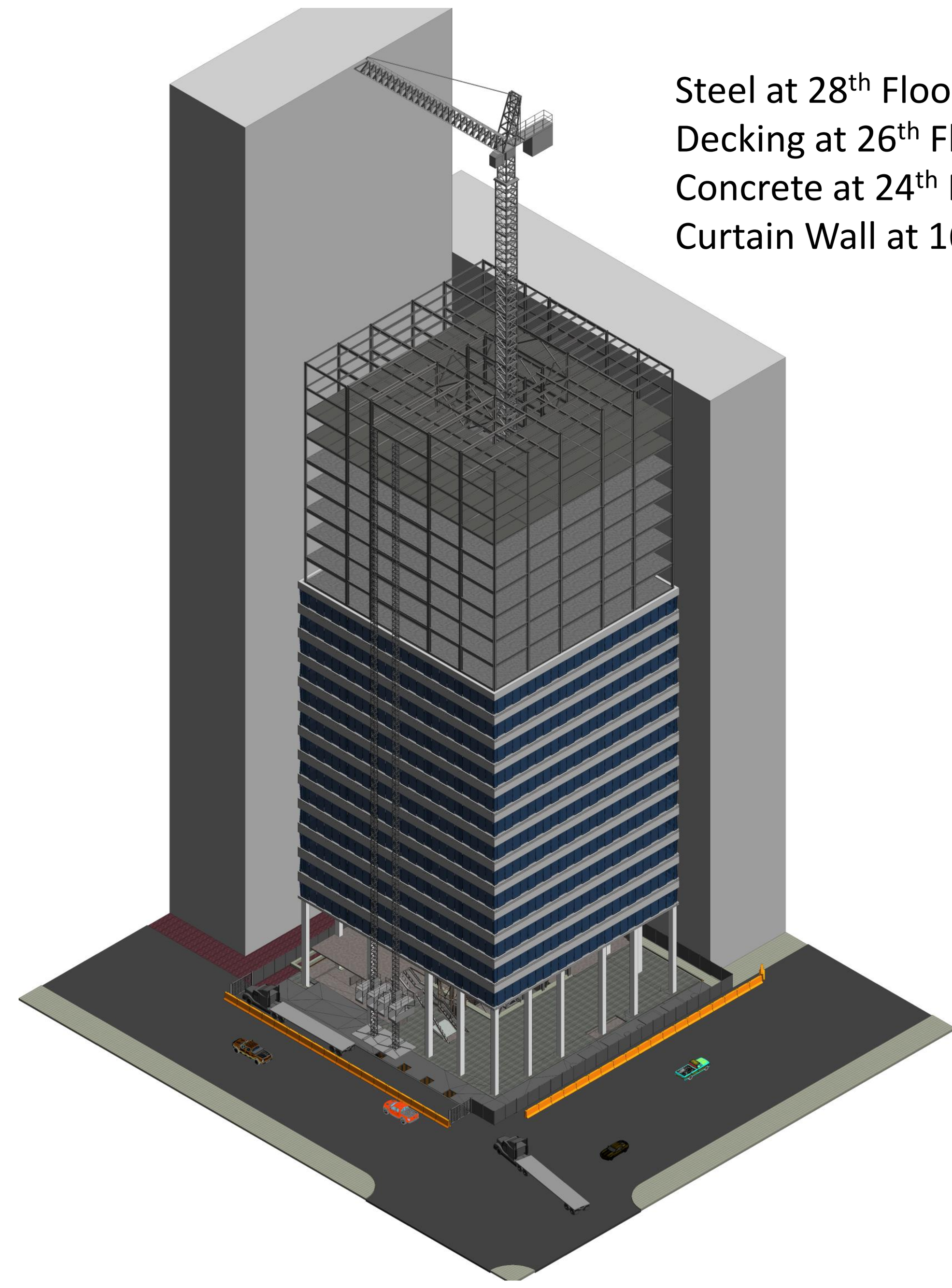
Steel at 9th Floor
Decking at 7th Floor
Concrete at 5th Floor

Building Enclosure Begins – 6/29/2015



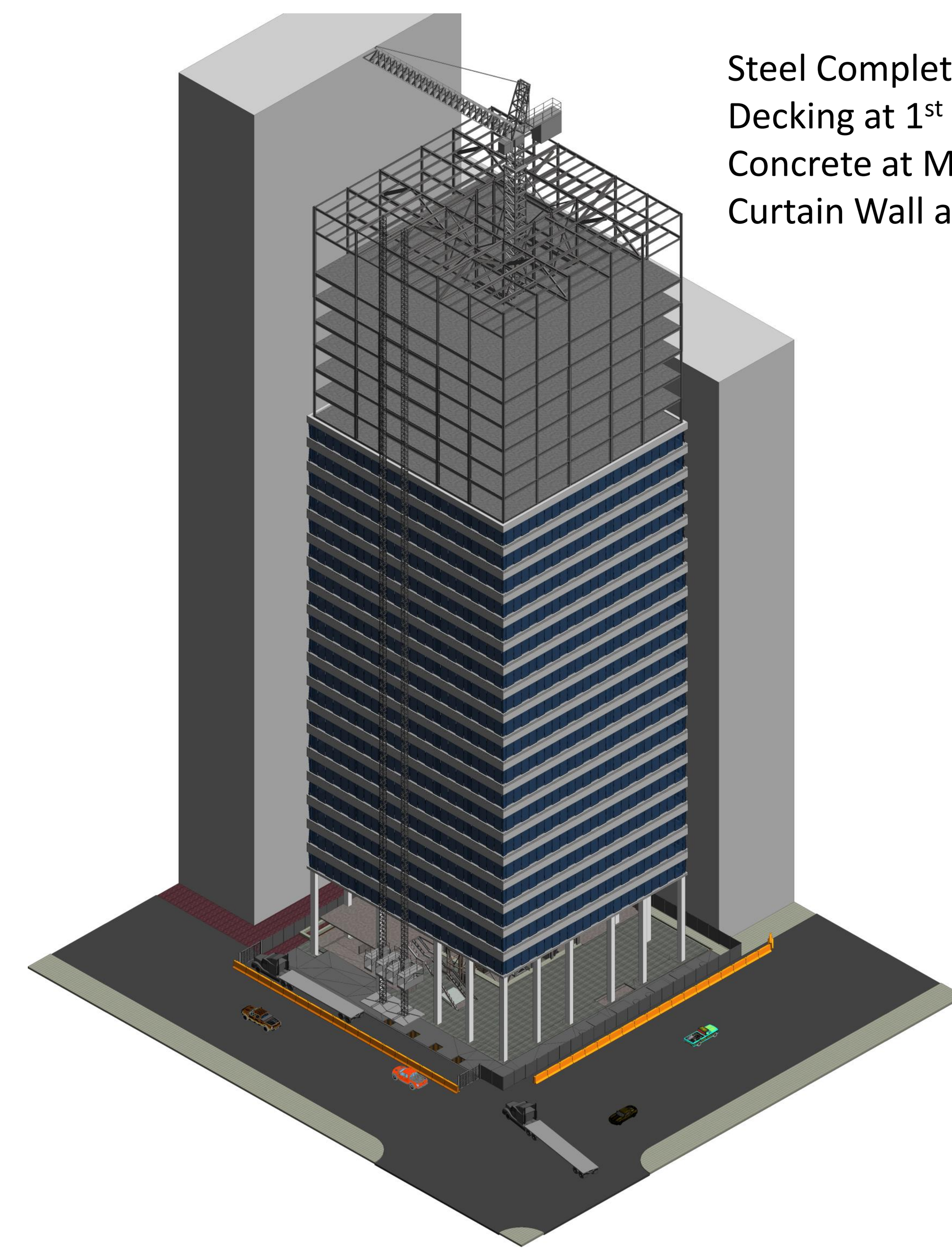
Steel at 18th Floor
Decking at 16th Floor
Concrete at 12th Floor
Curtain Wall at 5th Floor

Interior Core/Typ Floors Start – 8/10/2015



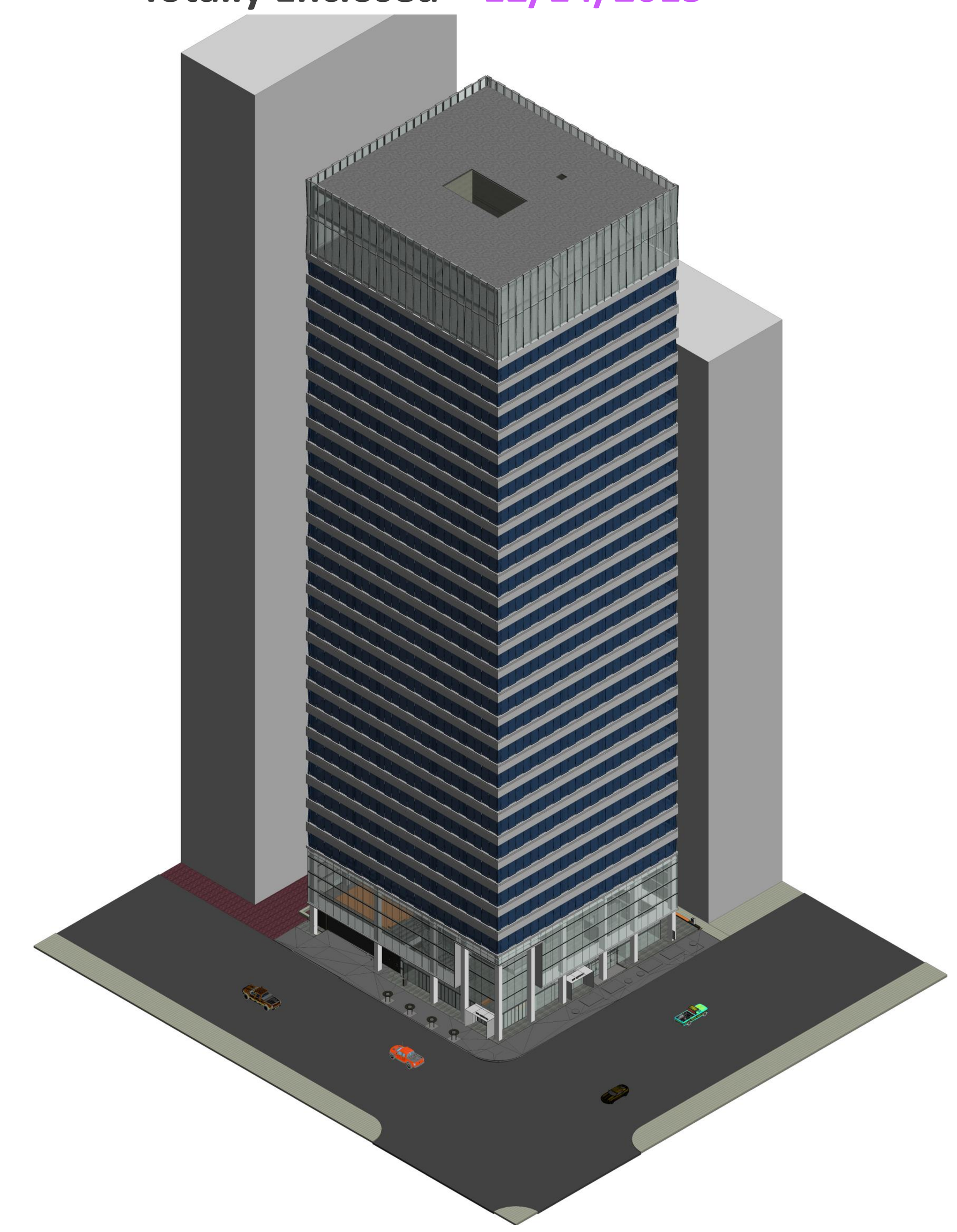
Steel at 28th Floor
Decking at 26th Floor
Concrete at 24th Floor
Curtain Wall at 16th Floor

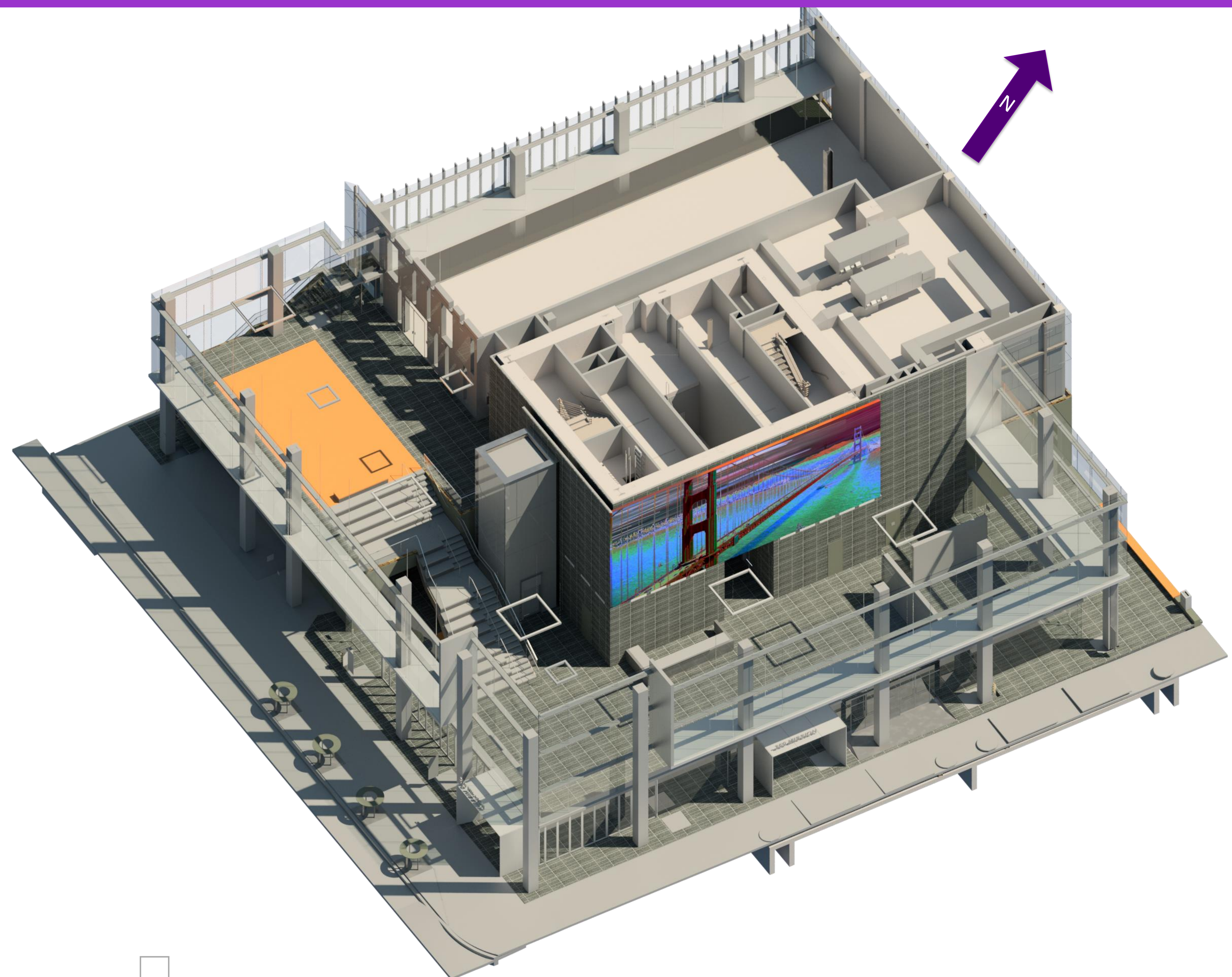
Steel Top Out – 10/26/2015



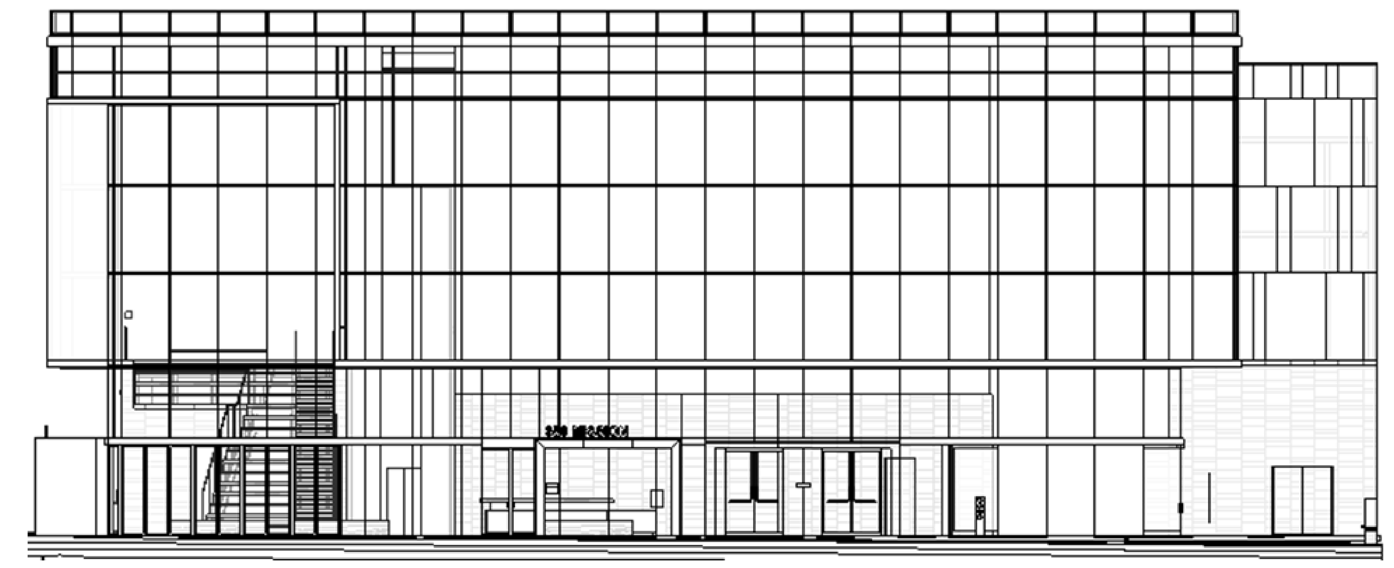
Steel Complete
Decking at 1st Outrigger Level
Concrete at Mech. Floor
Curtain Wall at 24th Floor

Totally Enclosed – 12/14/2015

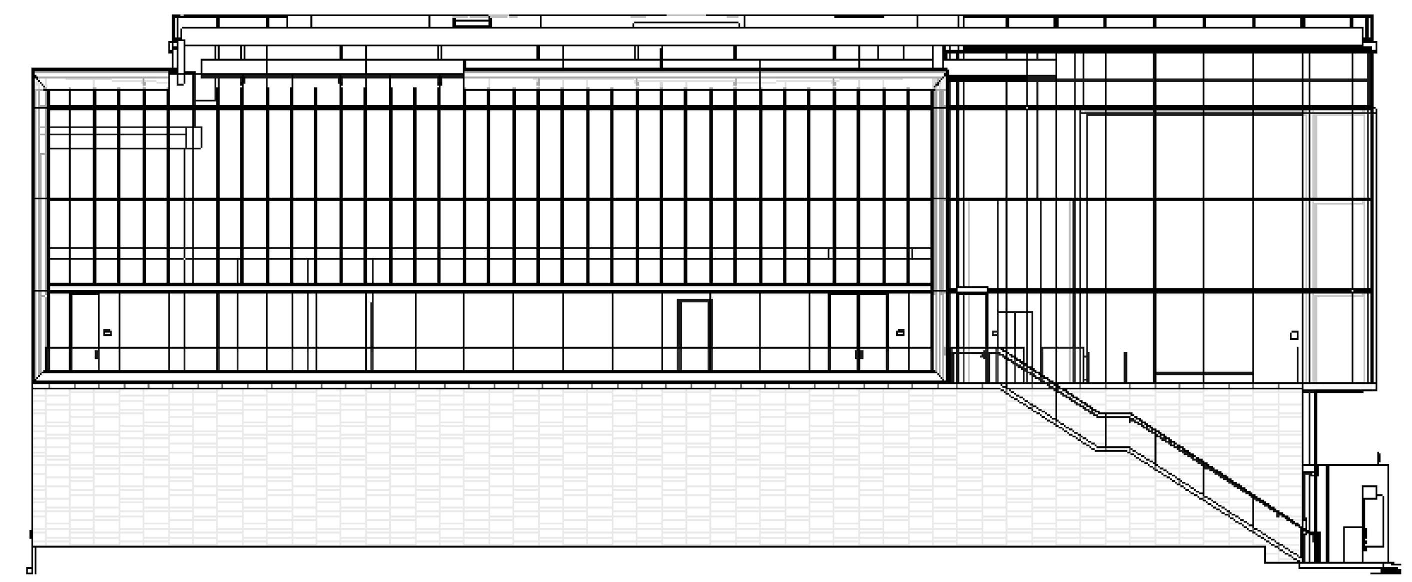




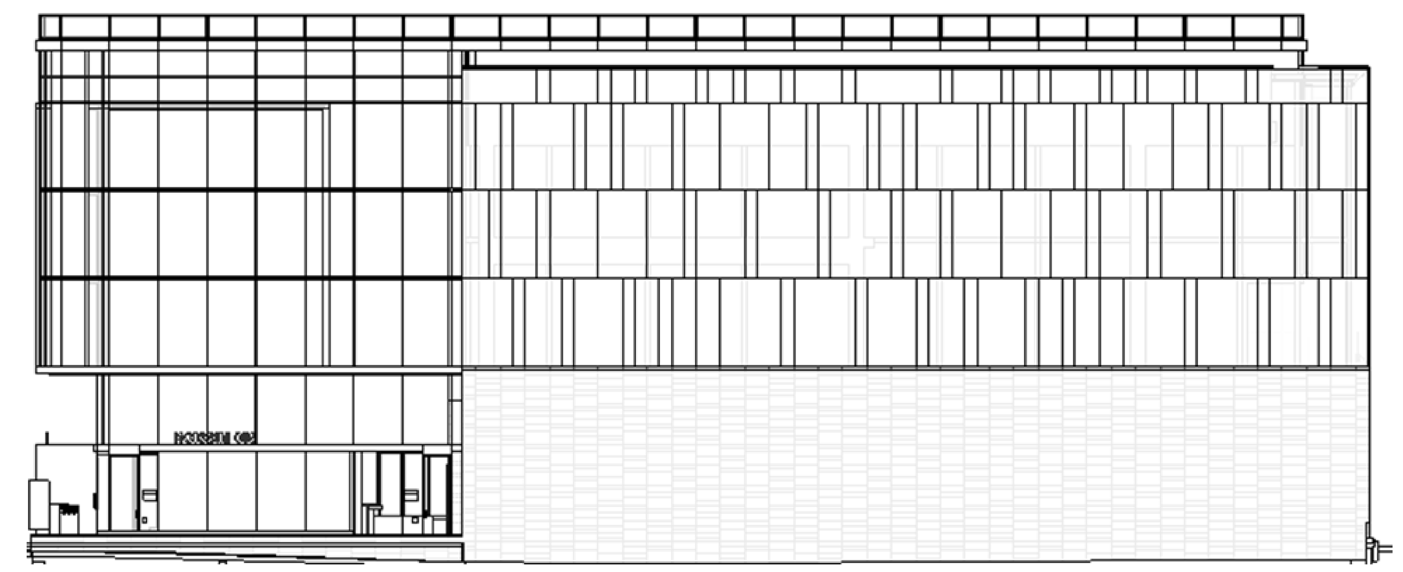
Southwest Elevation



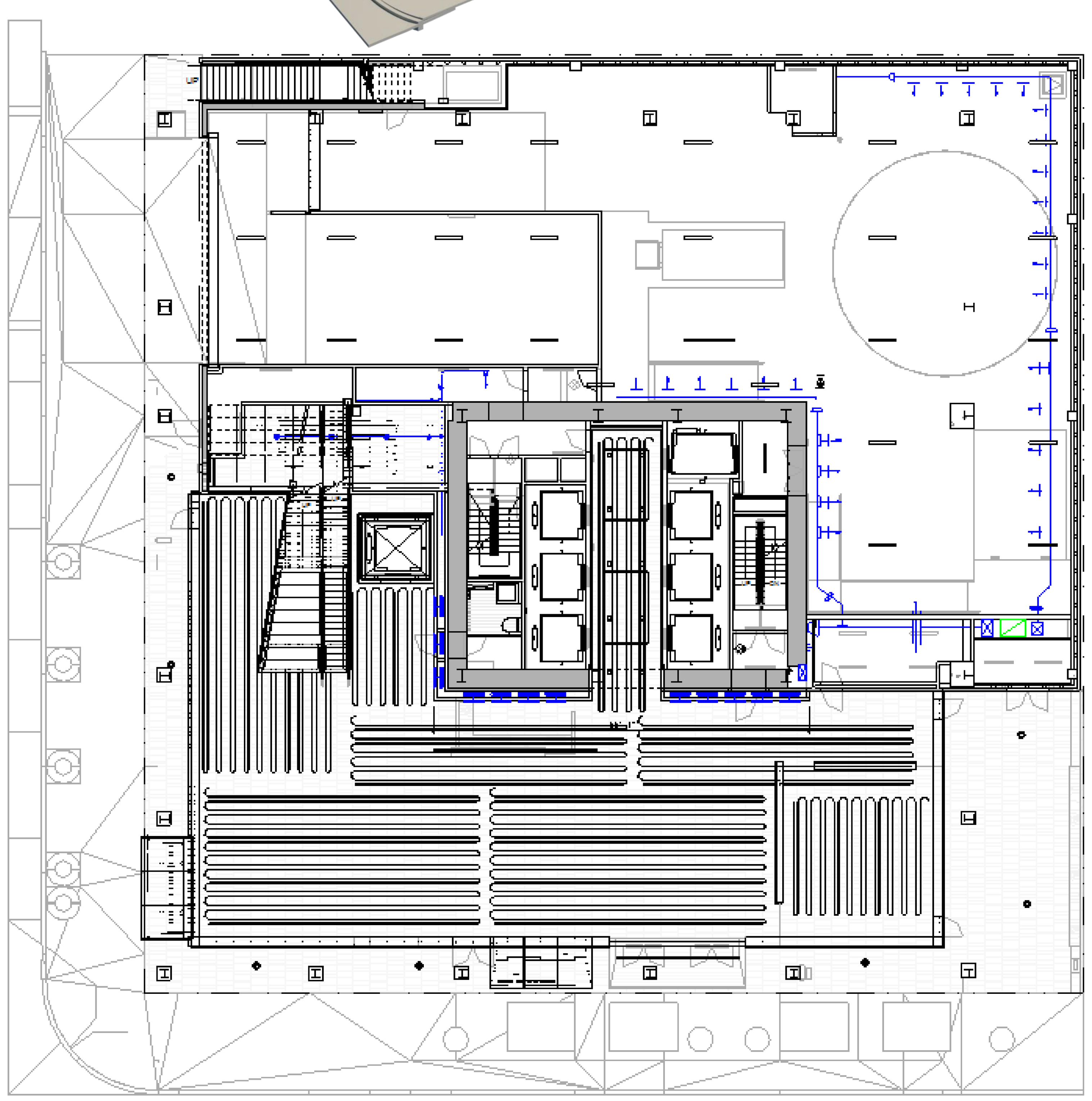
Southeast Elevation

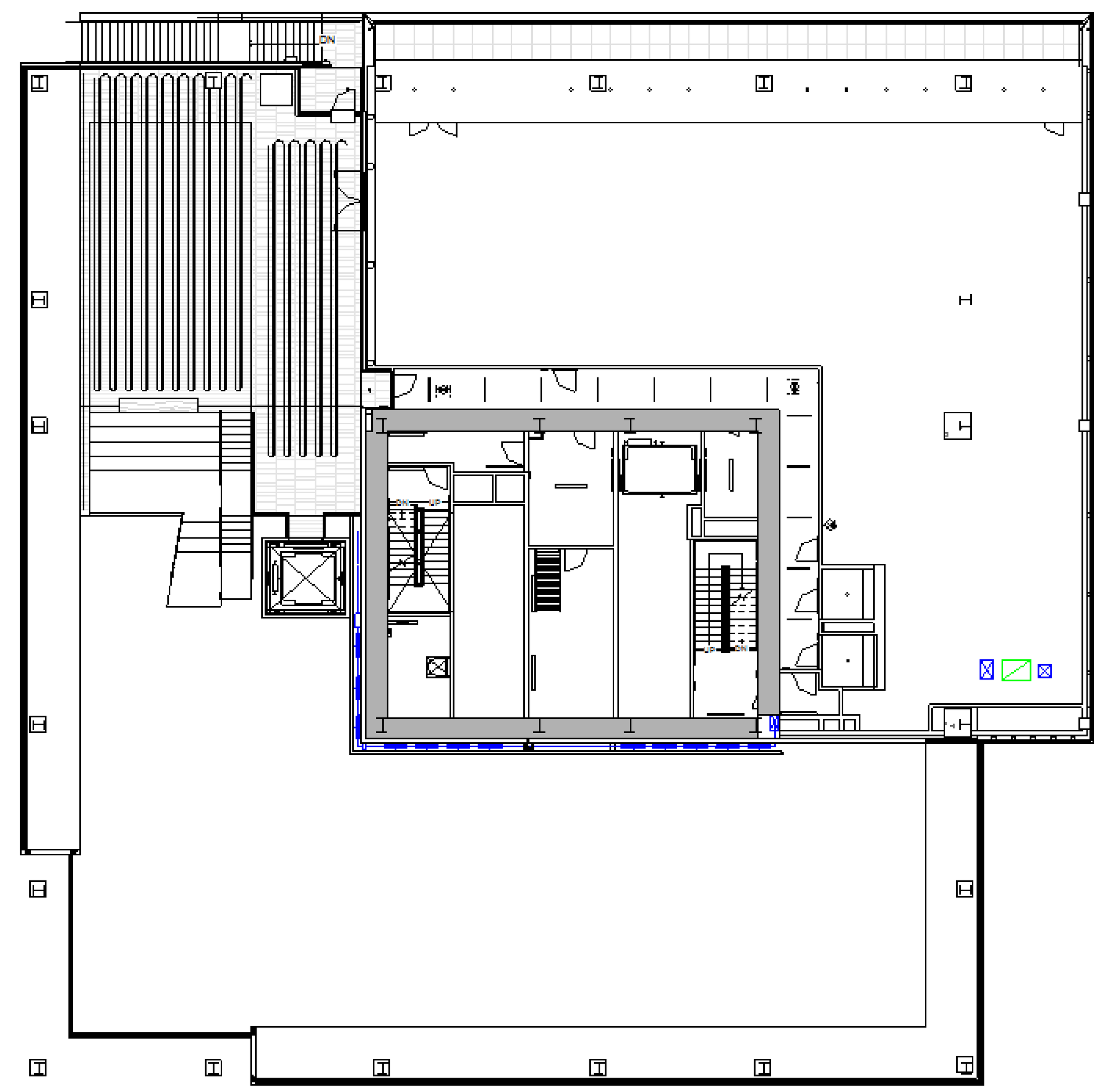


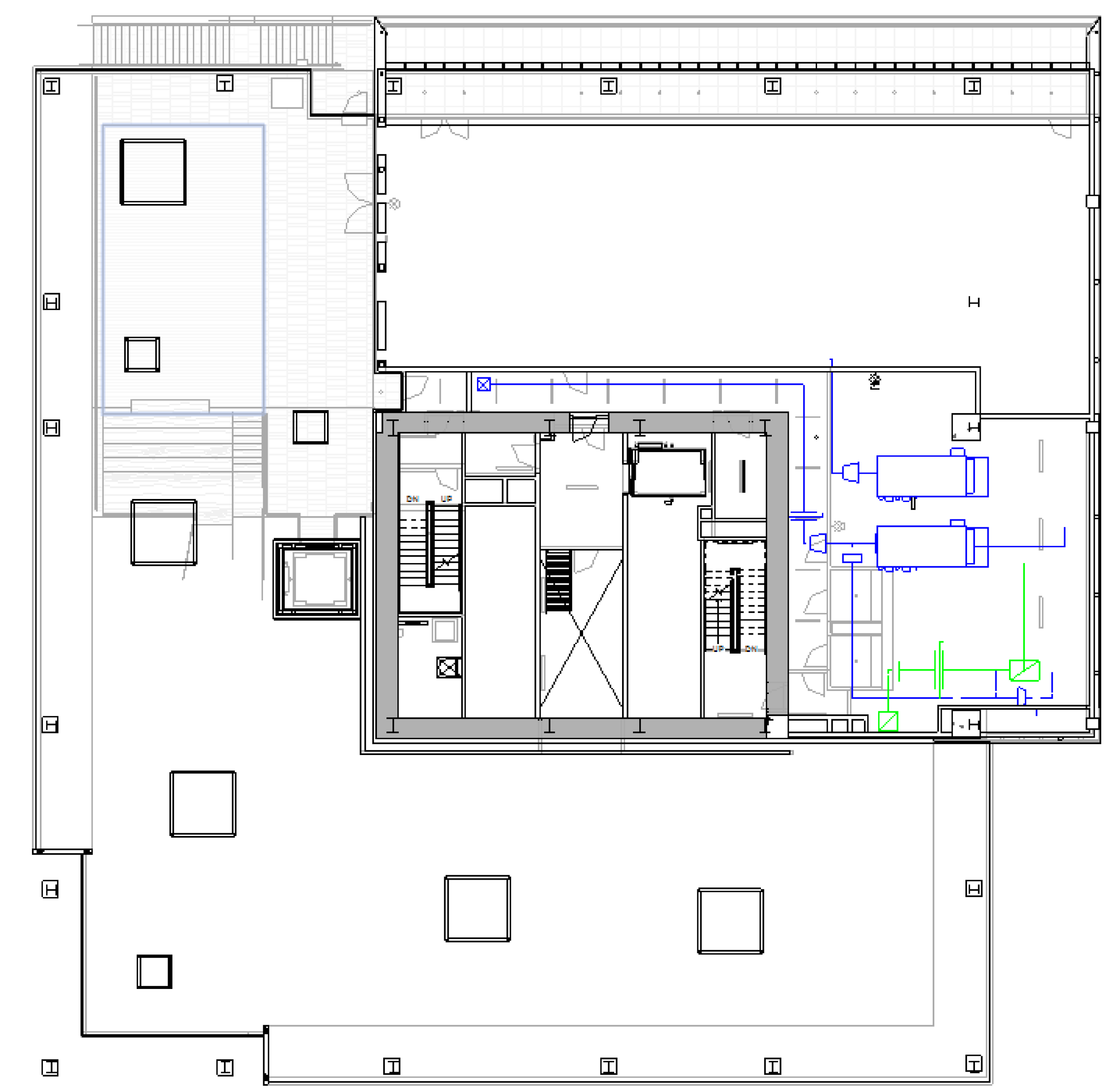
Northwest Elevation



Northeast Elevation

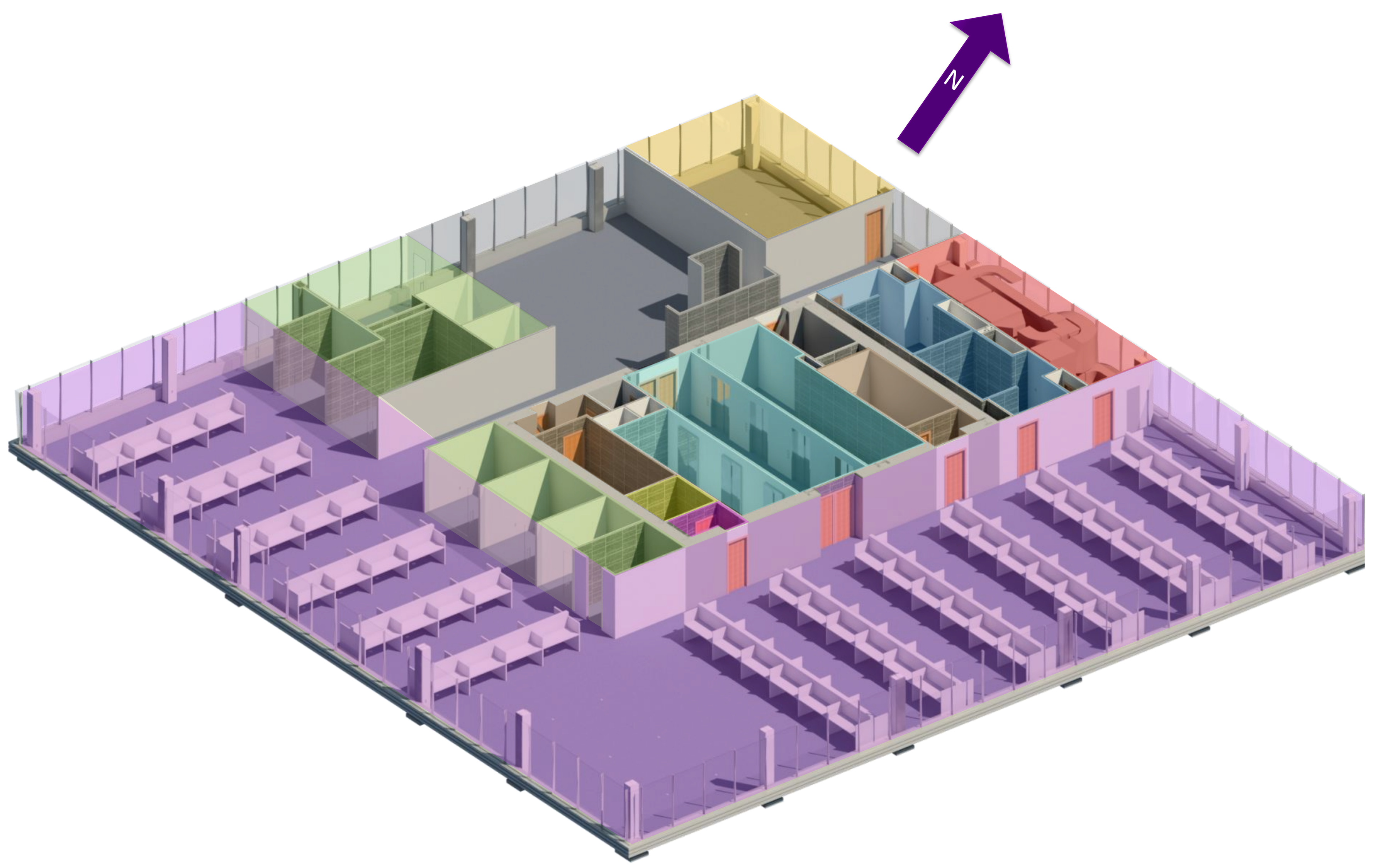




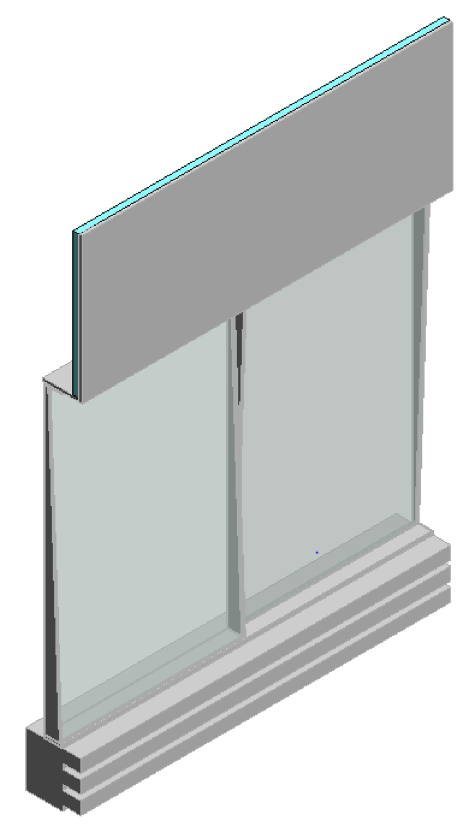


Disclaimer: Architecture and Layout Courtesy of Skidmore, Owings, and Merrill

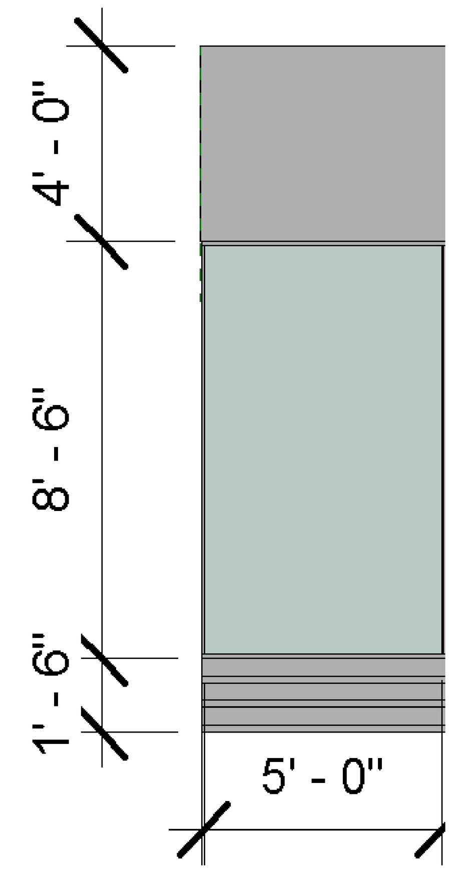
AEVITAS | Typical Office Floor



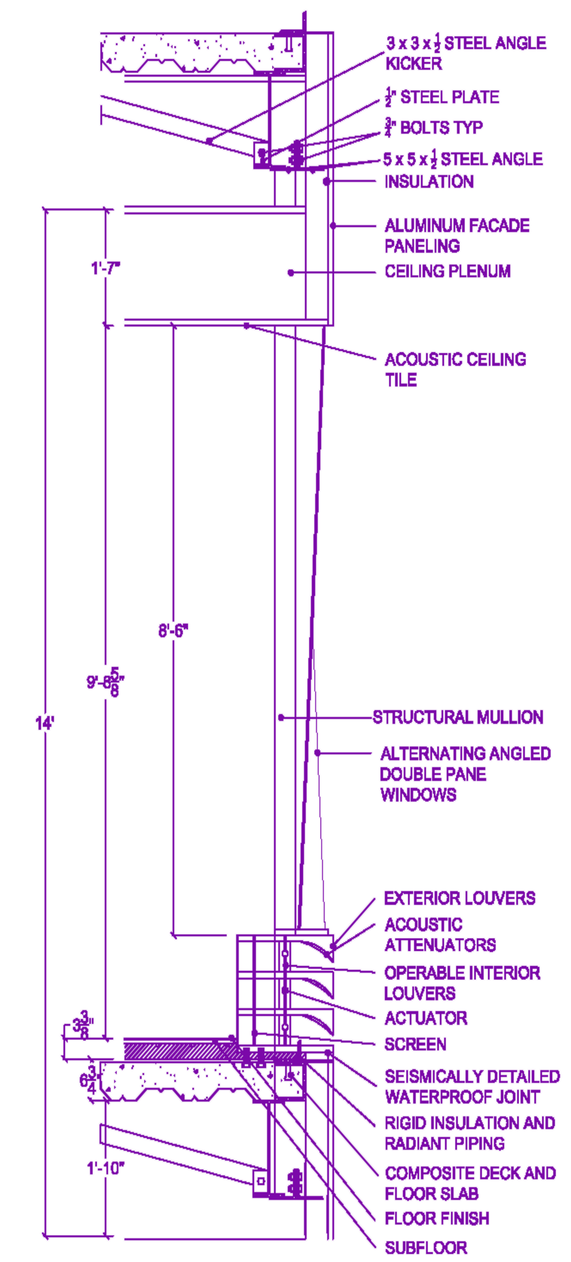
Virtual Mockup



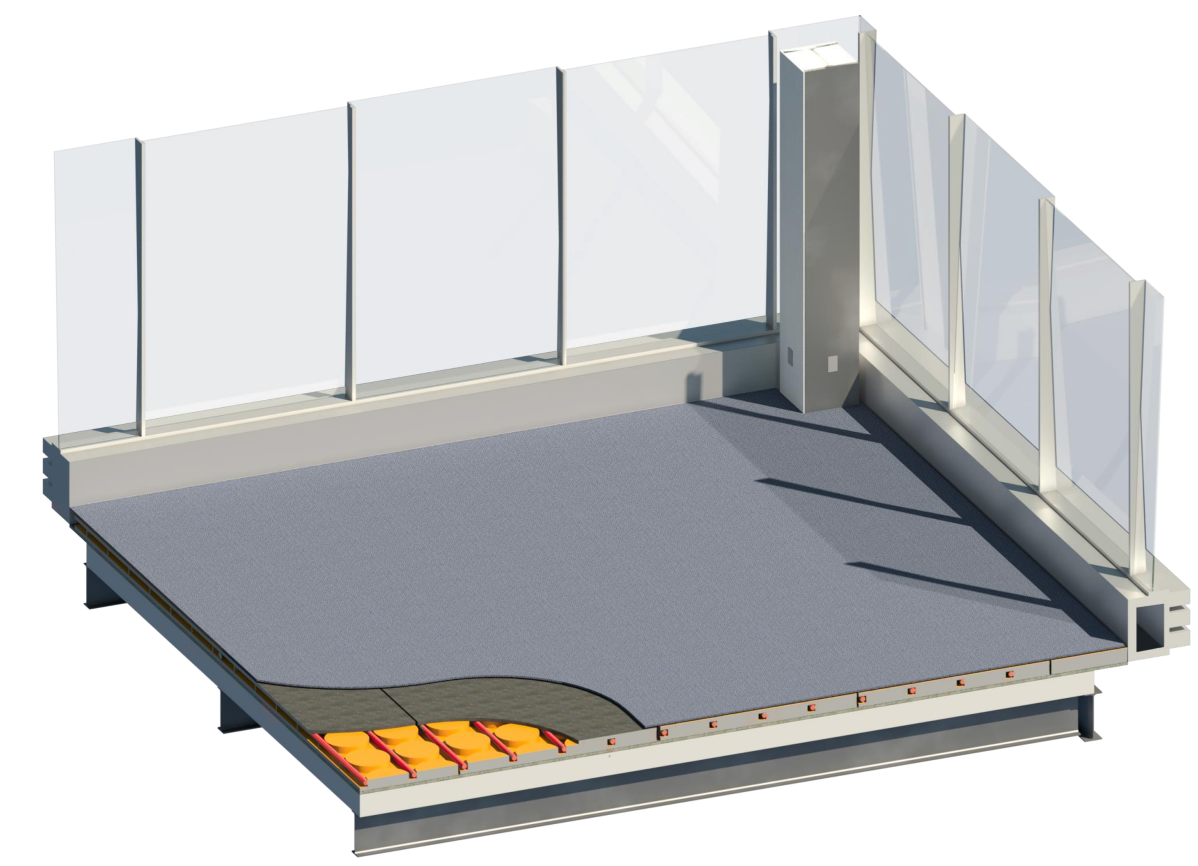
Prefabricated Façade Panel (Exterior)



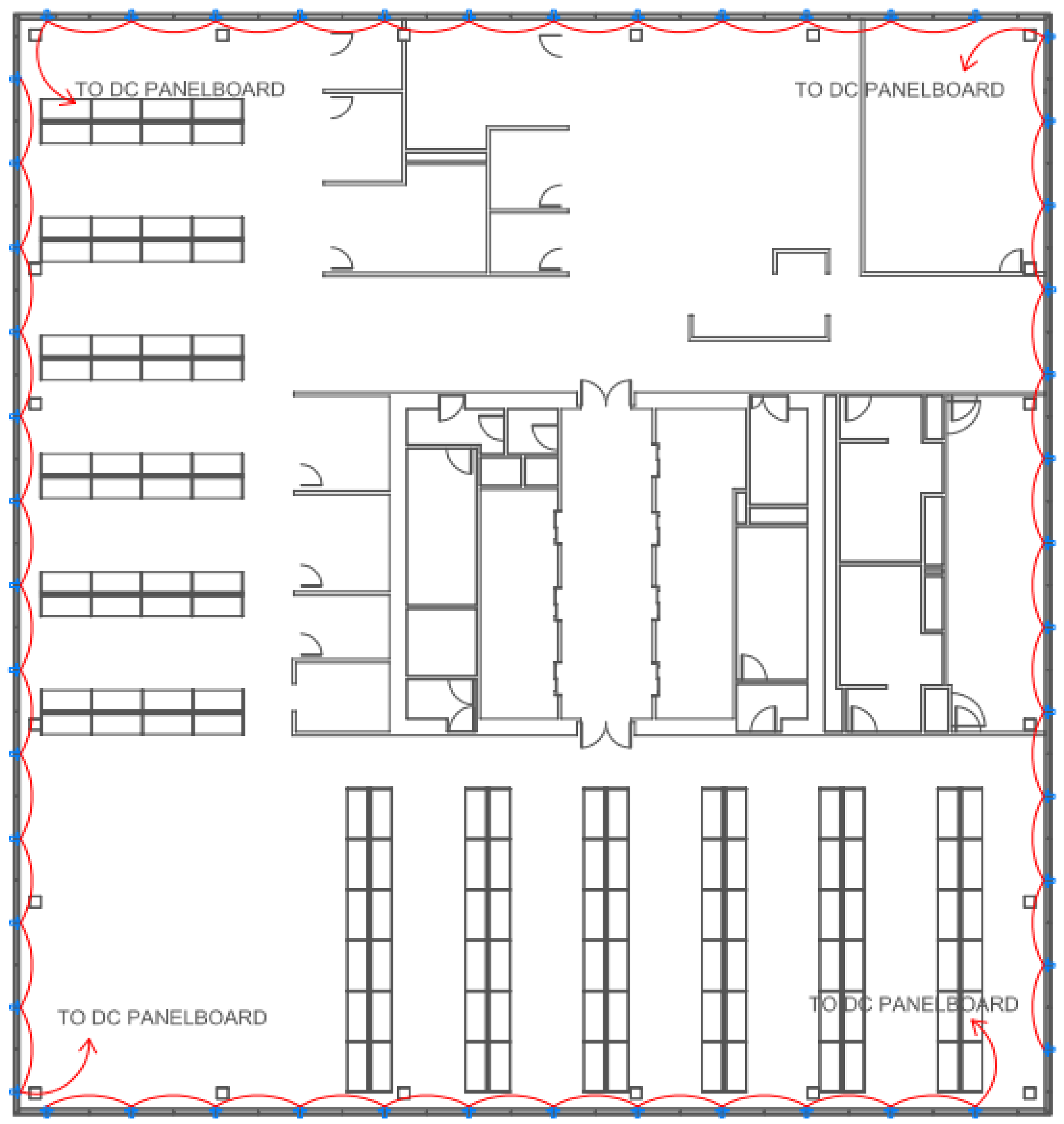
Façade/Radiant Detail



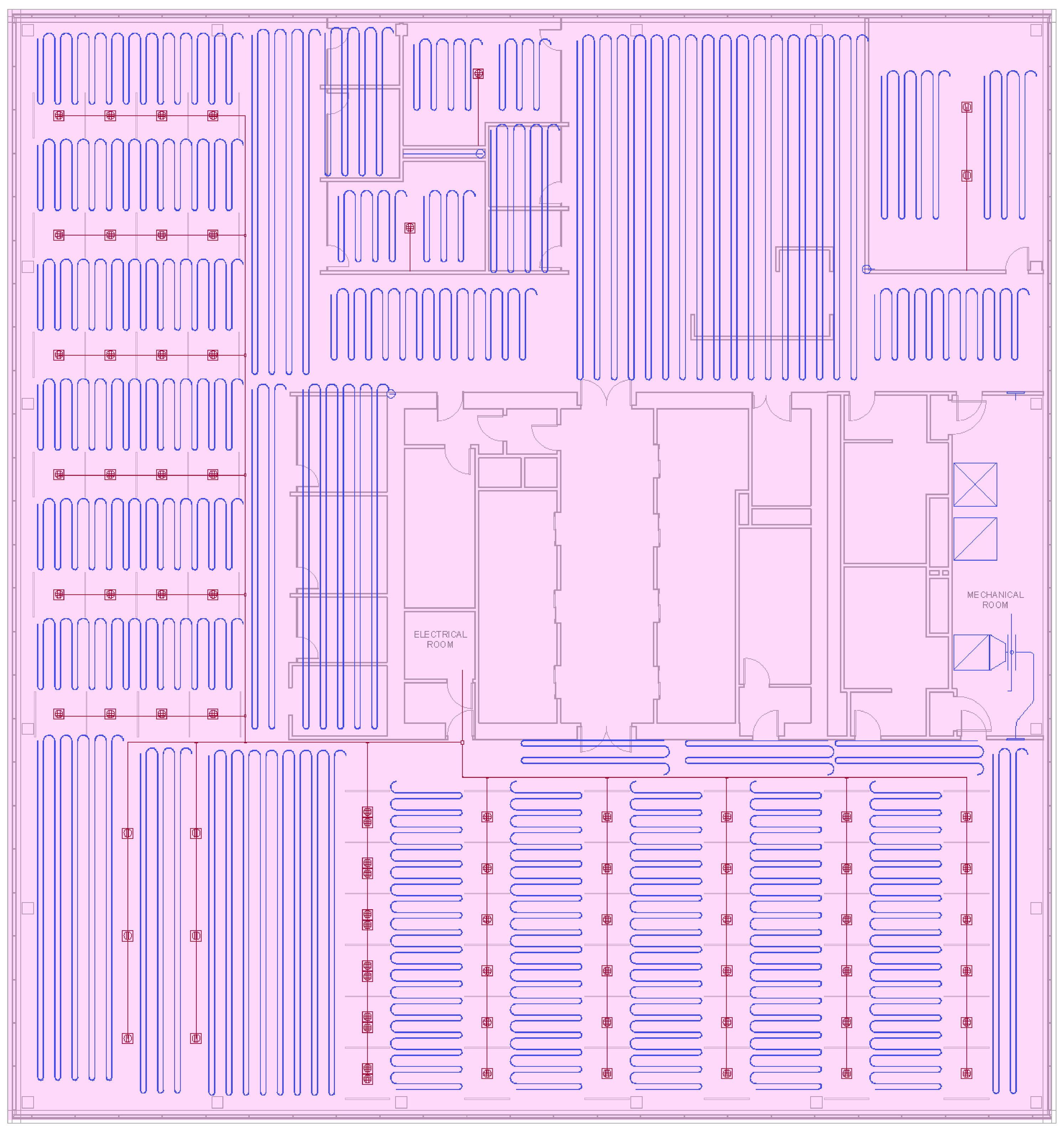
3D Radiant Flooring Detail



Typical Floor Façade Panels w/ Actuators for Operable Louvers

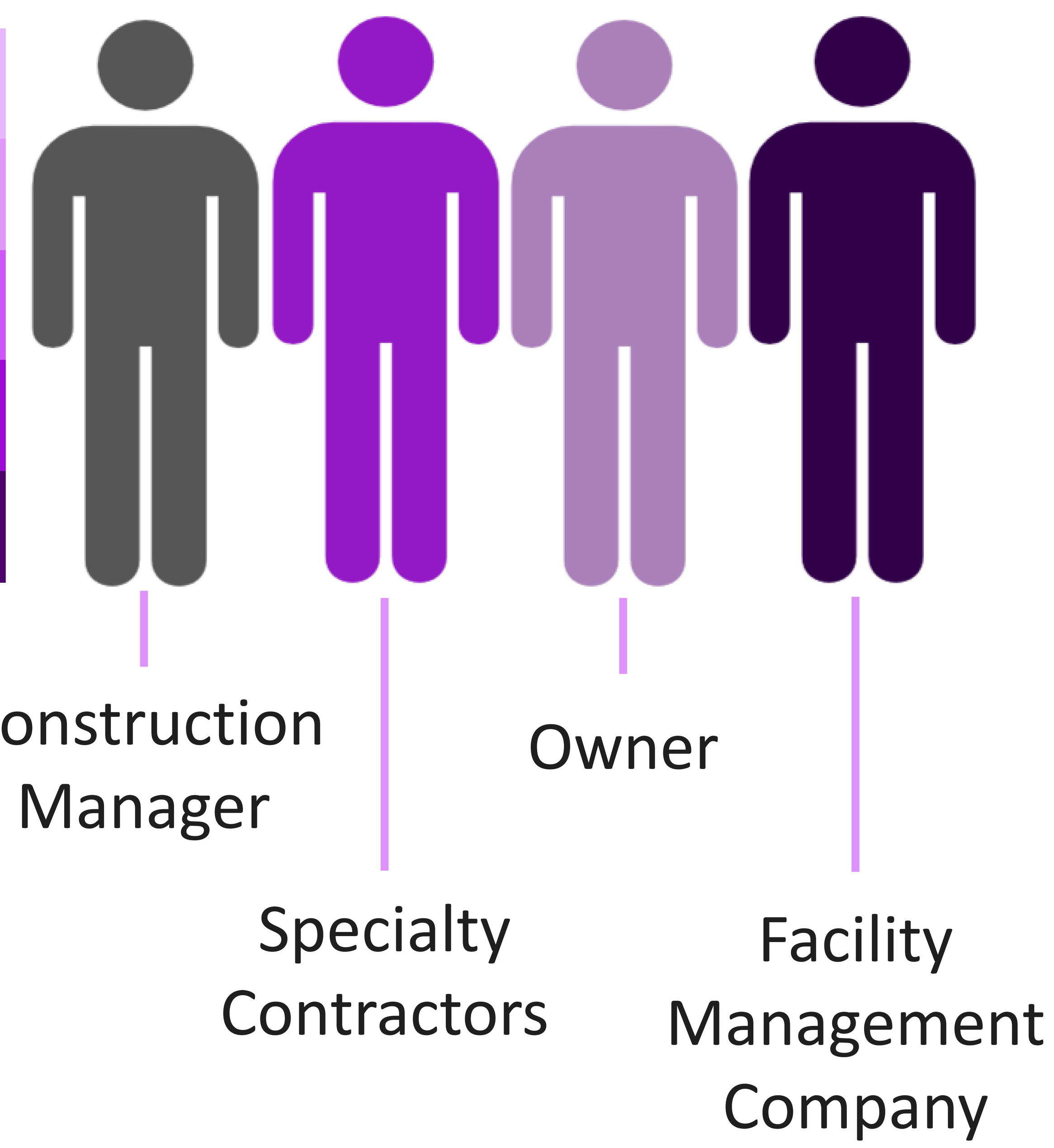


Typical Floor Radiant vs Electrical Coordination



FACILITY DATA

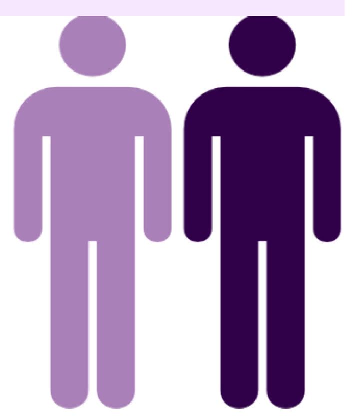
- SPACE DATA
- UTILITIES DATA
- AS-BUILTS
- WORK ORDERS
- EQUIPMENT LIST

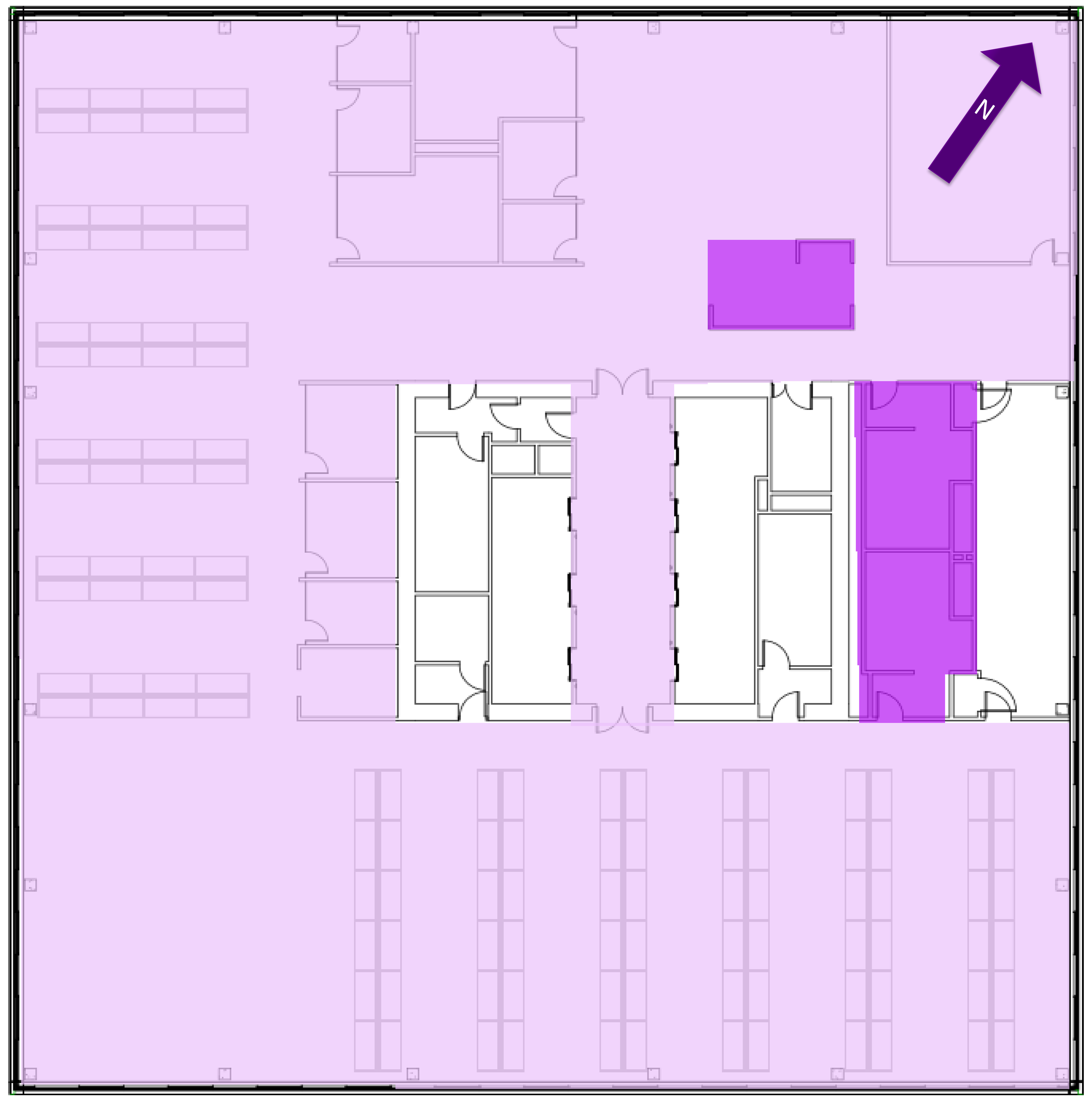


*Facilities Maintenance is a large part of AEVITAS's plan in helping 350 Mission to succeed in being [zero**impact**] by reaching net-zero energy consumption. In order for the building to perform so effectively, it will be critical that all pieces of equipment are functioning at maximum efficiency. The facility data includes space data, utilities information, as-built drawings, work orders, and equipment lists. Through these sources of information, a BIM was developed to keep all information in one place. The human figure graphics represent those who have an impact on the facilities integration modeling throughout the entire process.*

SPACE DATA

The Owner and the Facility Management Company have an impact on the space data and how it will change from tenant to tenant. These individuals are responsible for maintaining accurate space data after construction ends. During the operate phase and the lifecycle of the building, maintaining this section of the model will ensure proper zoning controls for all MEP systems which will improve the operations of all machinery. This type of information within the Building Information Model made for Facilities Integration and Maintenance can also be used to determine quantities of material for replacement in the future.

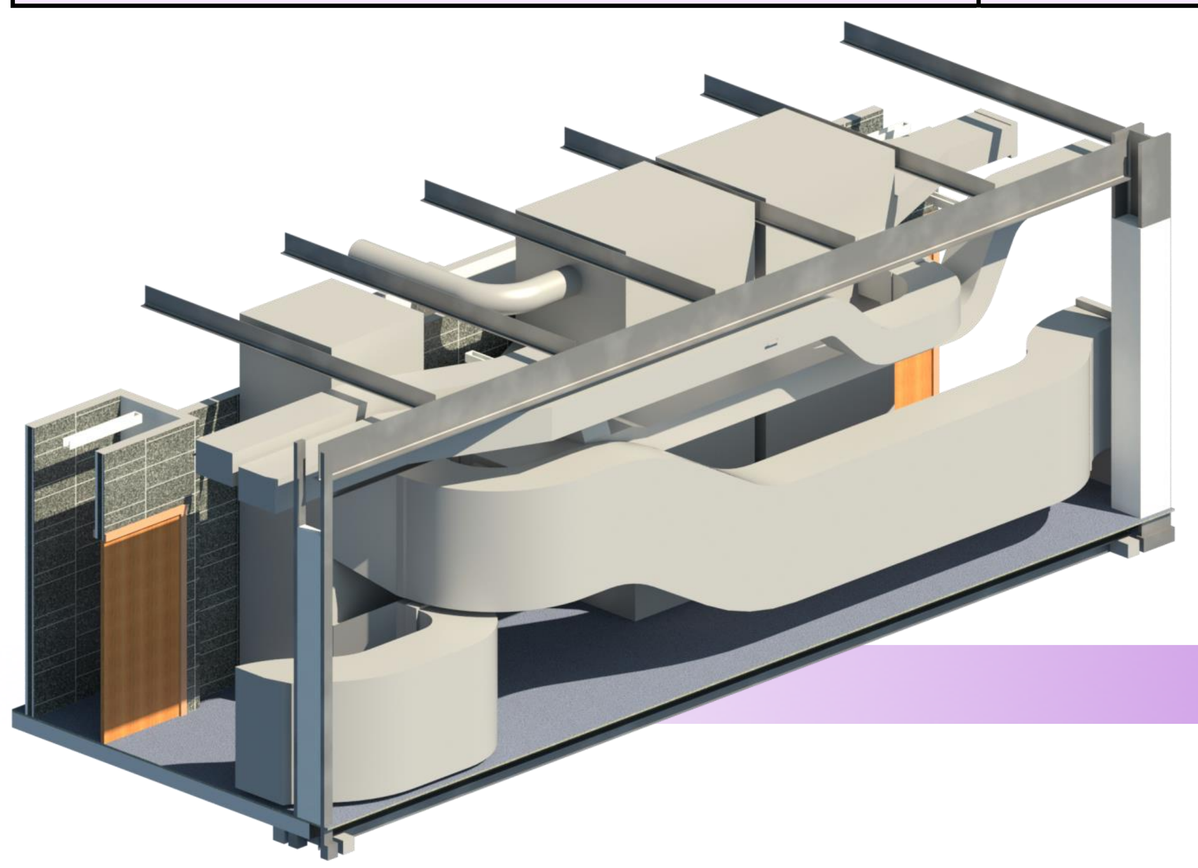




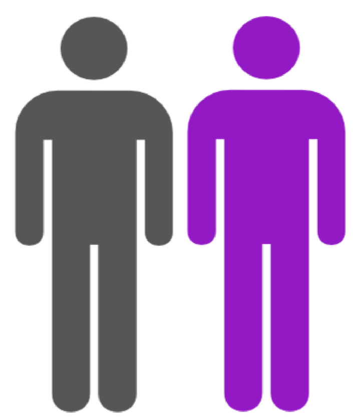
Flooring	New Group Description		
Flooring.New Item	Carpet	12,376.675	ft²
Flooring.New Item_2	Tile	715.049	ft²

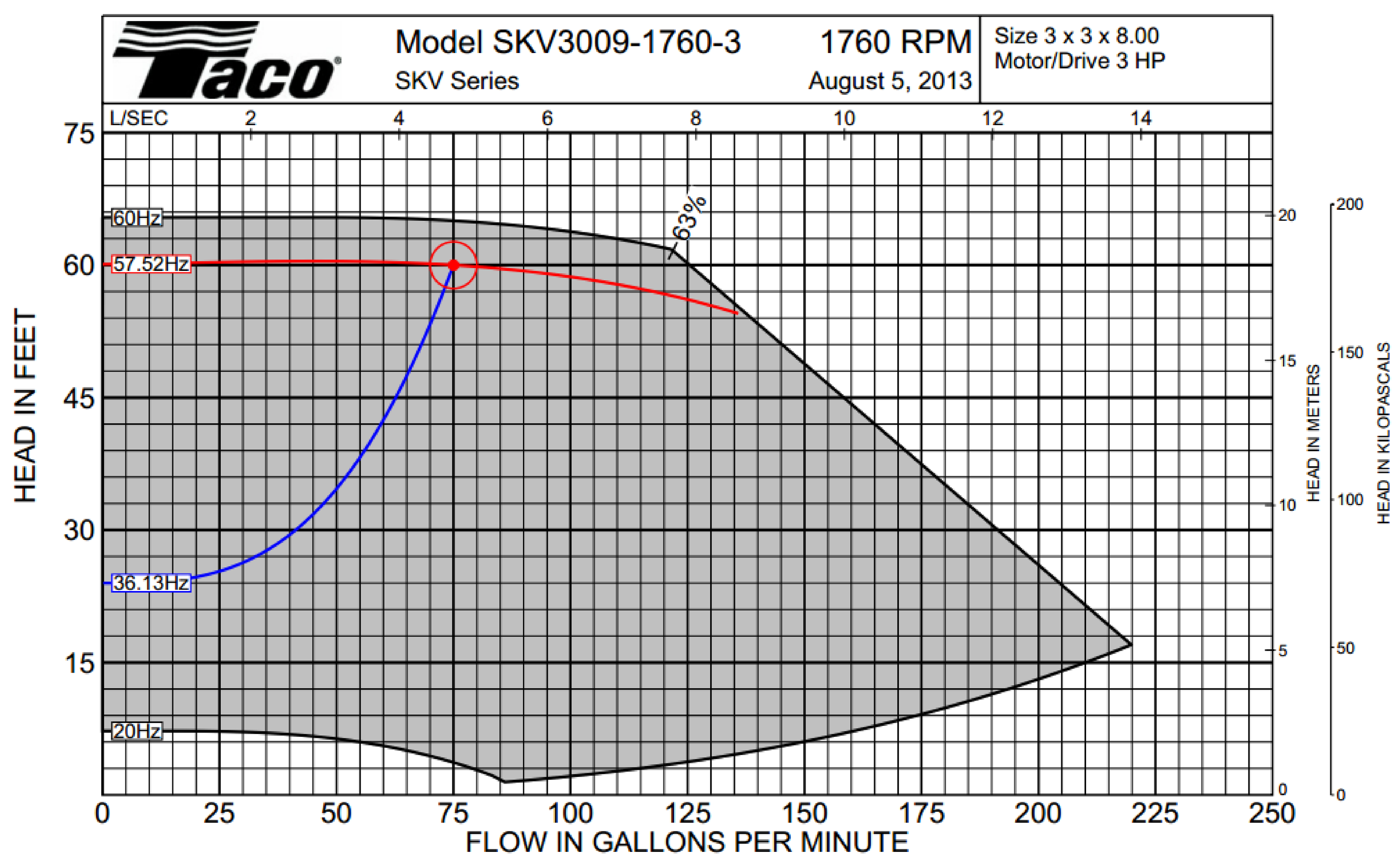
EQUIPMENT LIST WITH CUT SHEET AND COST DATA

EQUIPMENT	QUANTITY	DIMENSIONS (LWH)	LOCATION	CUT SHEET AND SPECIFICATION INFO
Tertiary Pumps + VFD	26 (1 per fl.)	1' - 1' - 1'6"	Mech. Space per floor	Tertiary Pumps + VFD
Secondary Transformers	27		Electrical Room every floor	Secondary Transformers
Branch Panelboards	75		Electrical Room per floor	Branch Panelboards
Secondary ATS	26 (1 per fl.)		Electrical Room per floor	Secondary ATS

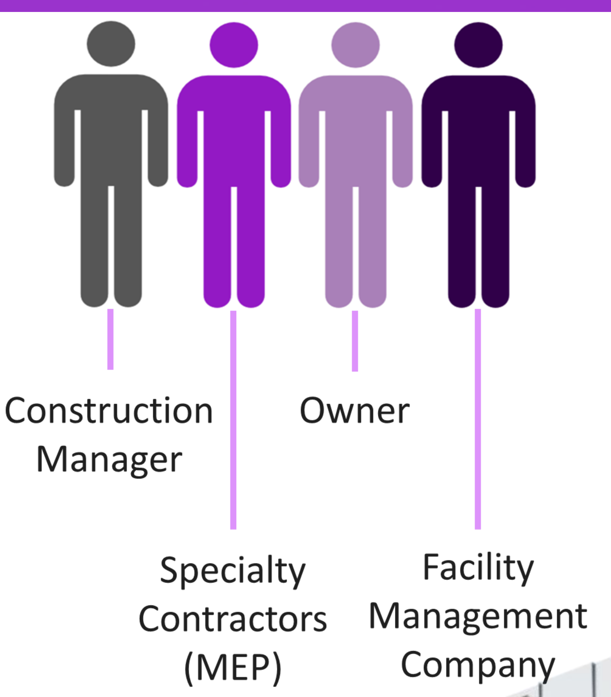


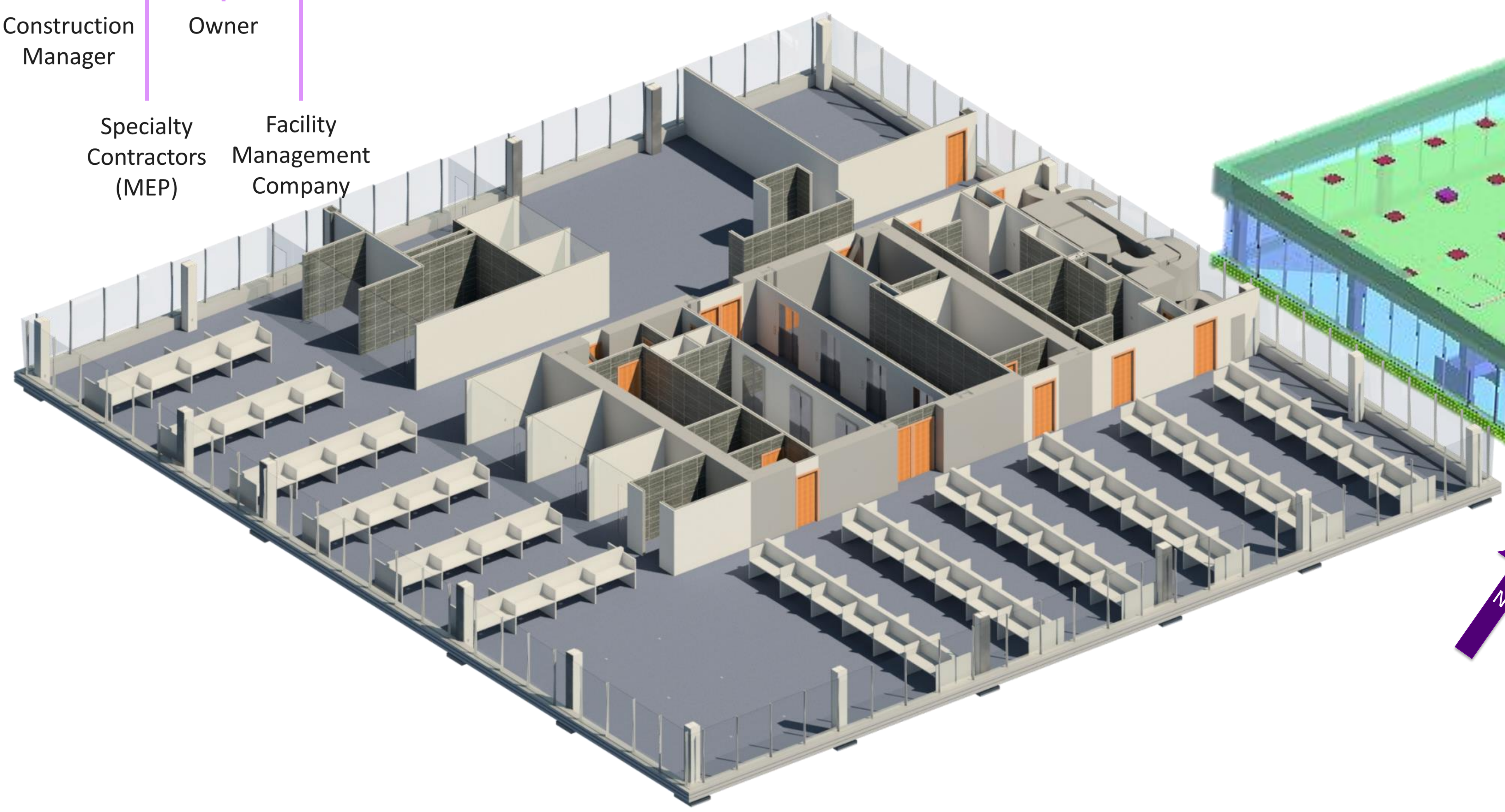
Throughout the BIM, each individual piece of equipment is connected to the equipment list, the cut sheet for the machine, as well as cost replacement and maintenance information. The specialty contractors will turn this over to the facility managers during the five year contract time span. All BIMs are linked together to provide ultimate visibility of all working parts and pieces of the MEP equipment. The architectural model is also linked to provide information on items such as filter changes for the natural ventilation louvers.



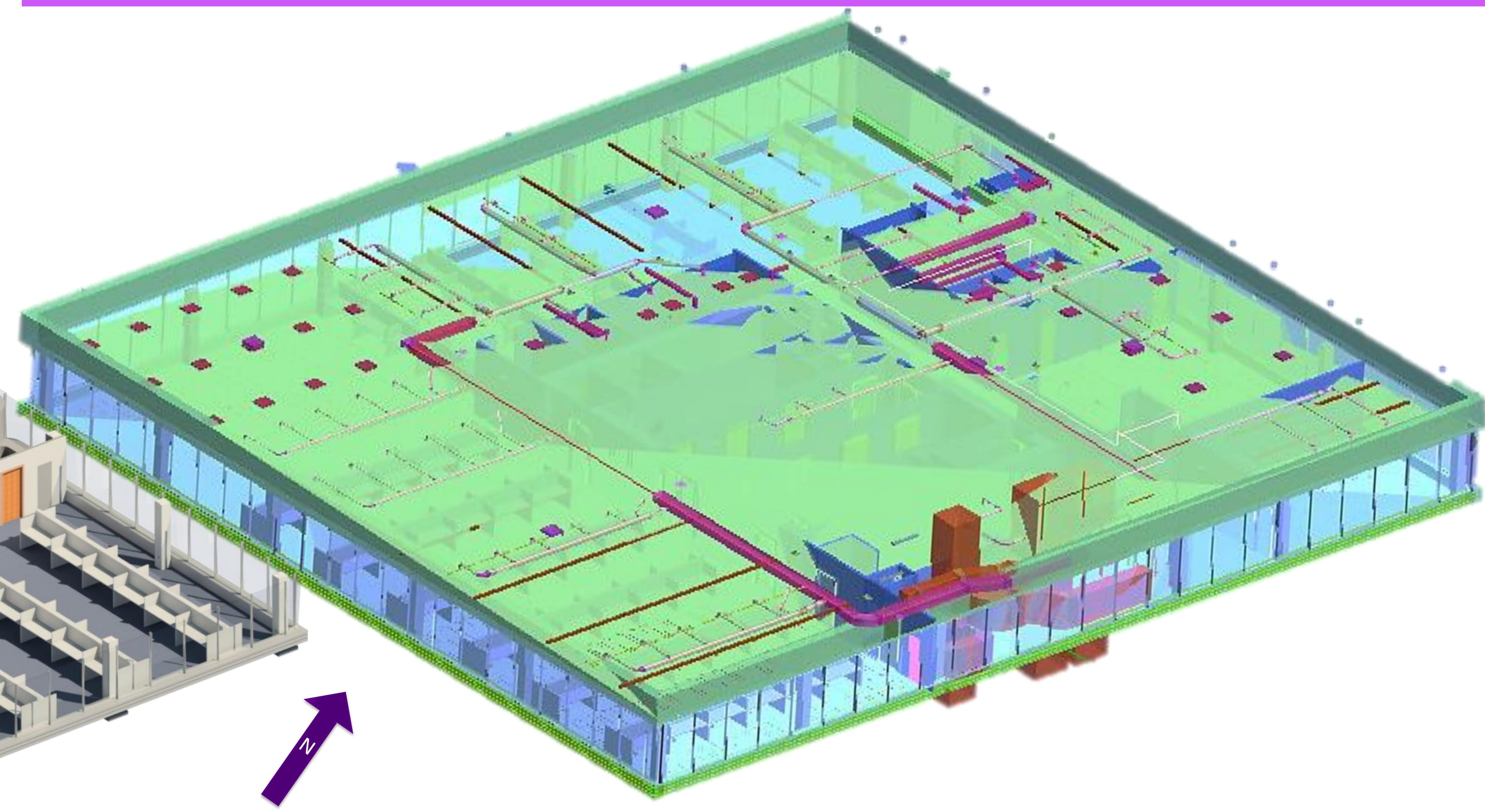


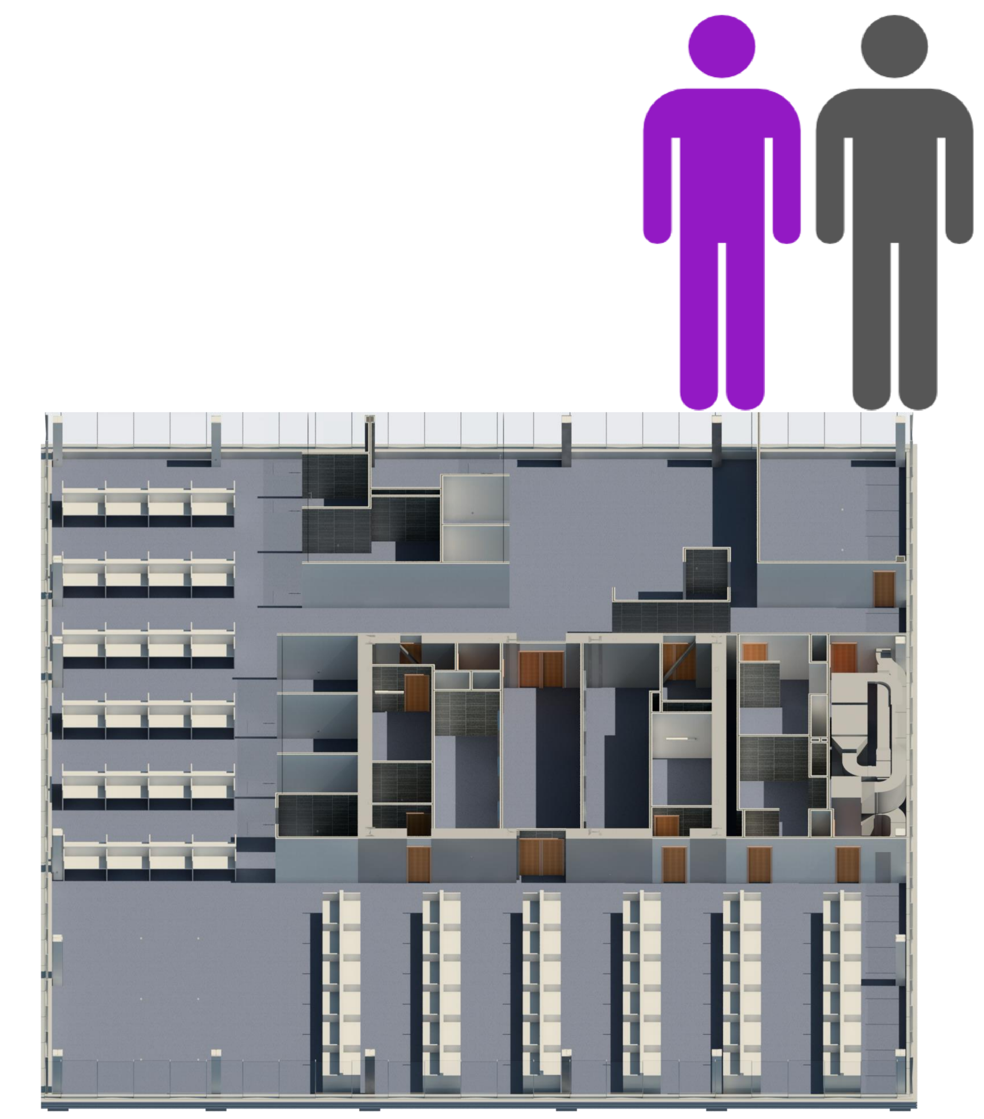
AEVITAS | Facilities Integration Modeling – Typical Office Floor Example Continued





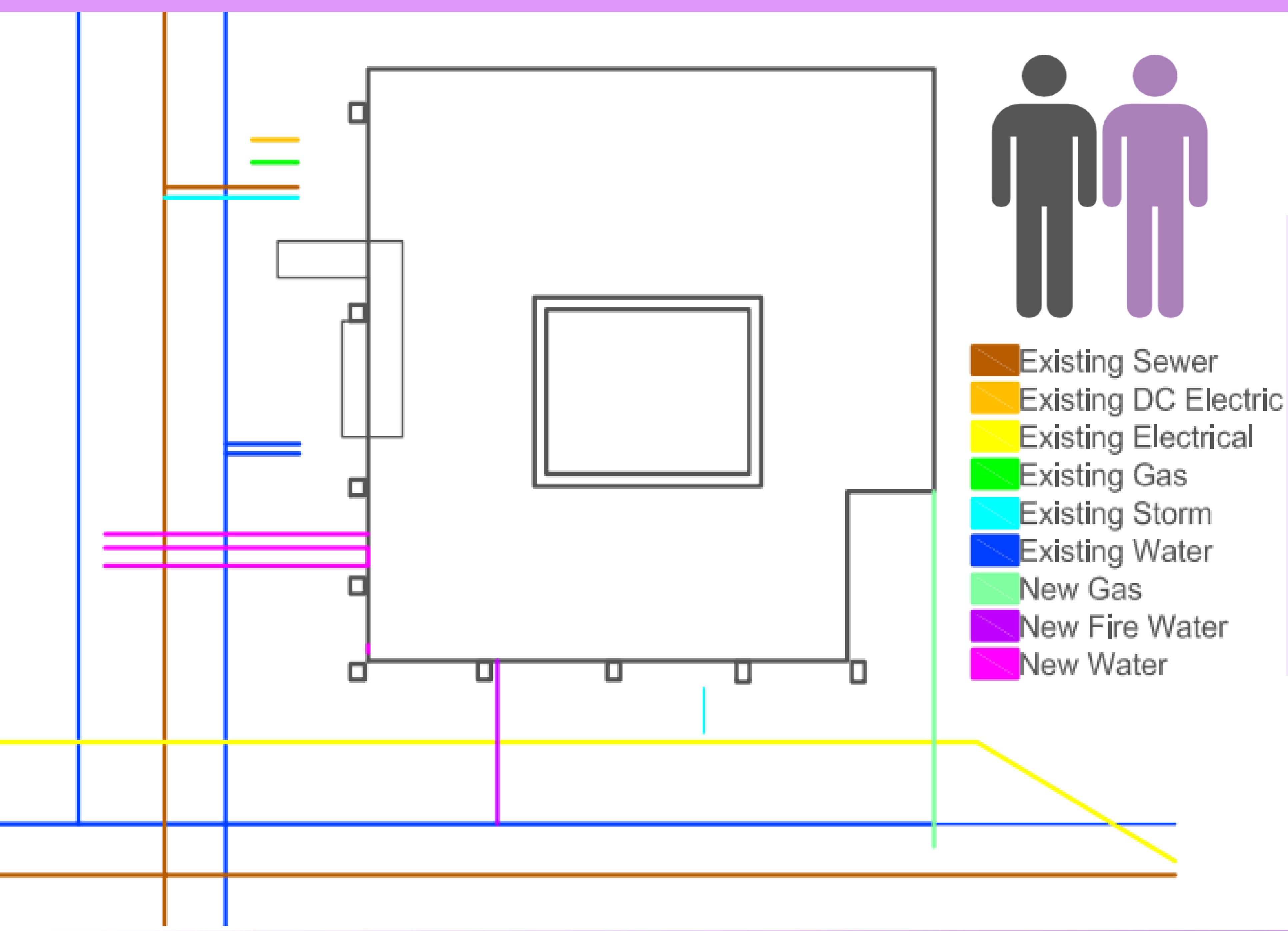
AS-BUILTS





The models shown above represent the as-builts in model form. Through this virtual look into each space of the building, the facility manager or owner will be able to view the space in a more concise and readable way. By clicking on items throughout these models, data can be retrieved involving cost, maintenance, or specifications. These models are linked to all utilities data, work orders, space planning, and equipment lists.

UTILIES DATA



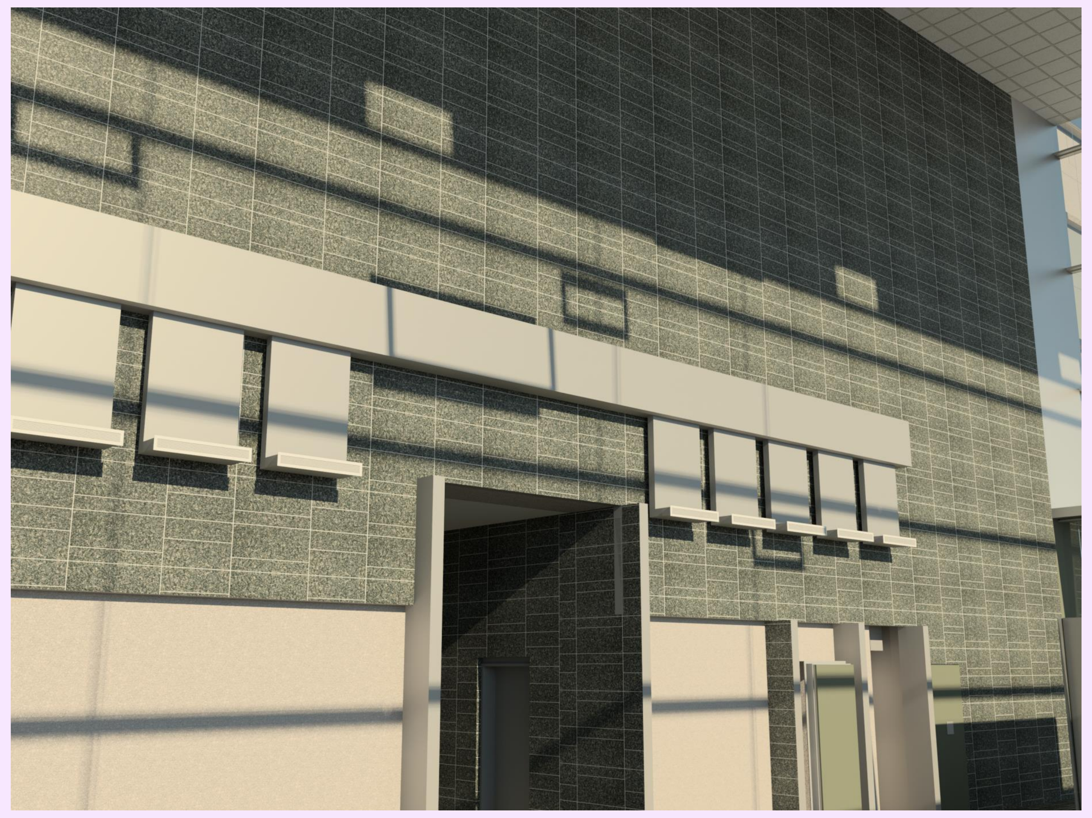
The area to the left represents Utilities Data that is stored within the Building Information Models. This data will be used to identify changing utility rates of cost data as well as locations throughout the building that access the public utility. This information is used in emergency planning as well as day to day operations.

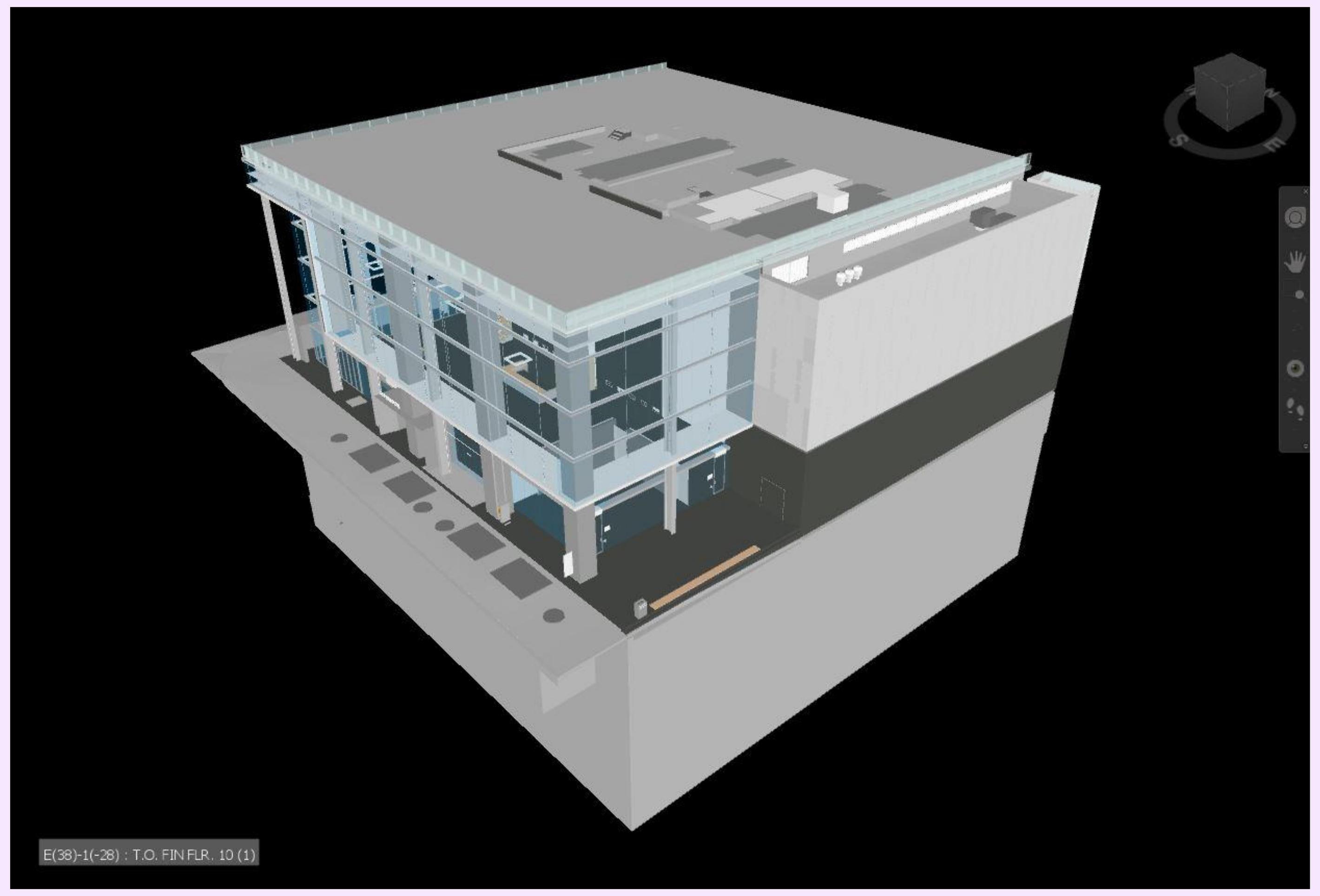
WORK ORDERS

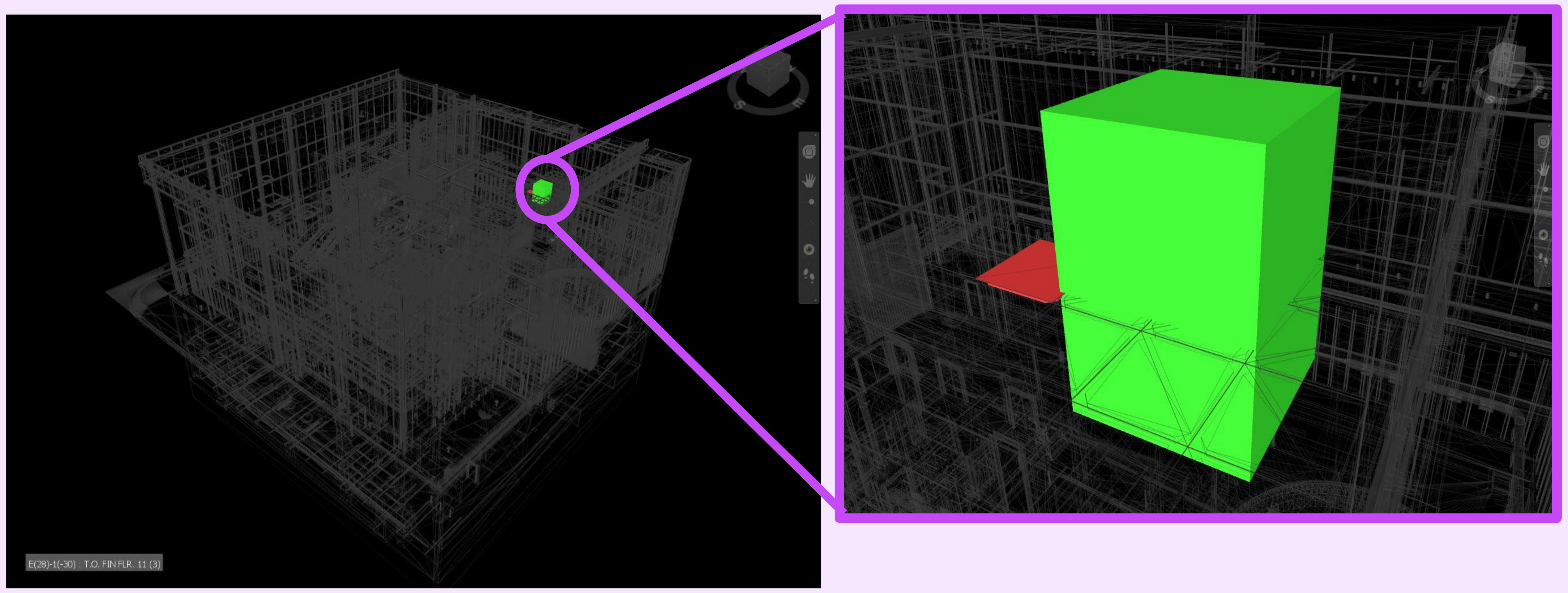
Lighting/Electrical	OfficeFloorLE			
Lighting/Electrical.Communication	Communication Devices			
Lighting/Electrical.Communicati...	Communication Device - Wall - Copy			
Lighting/Electrical.Communicati...	Voice-Data Outlet	7.000	ea	
Lighting/Electrical.Communicati...	Communication Device - Wall			
Lighting/Electrical.Communicati...	Voice-Data Outlet	127.000	ea	
Lighting/Electrical.Communicati...	Data Outlet	3.000	ea	
Lighting/Electrical.Communicati...	Speaker	3.000	ea	
Lighting/Electrical.Communicati...	TV Outlet	9.000	ea	
Lighting/Electrical.Conduit	Conduits			
Lighting/Electrical.Conduit Fittings	Conduit Fittings			
Lighting/Electrical.Data	Data Devices			
Lighting/Electrical.Electrical Eq...	Electrical Equipment			
Lighting/Electrical.Electrical Fixt...	Electrical Fixtures			
Lighting/Electrical.Fire Alarm	Fire Alarm Devices			
Lighting/Electrical.Lighting Fixtu...	Lighting Fixtures			
Lighting/Electrical.Lighting Fixtu...	INDUSTRIAL SURFACE			
Lighting/Electrical.Lighting Fixtu...	AXIS 2X2			
Lighting/Electrical.Lighting Fixtu...	Day 2x2 4400lm	23.000	ea	Lamps rated for 50,000h use, maintenance check on drivers every 5 years.
Lighting/Electrical.Lighting Fixtu...	Day 2x2 2500lm	13.000	ea	Lamps rated for 50,000h use, maintenance check on drivers every 5 years.

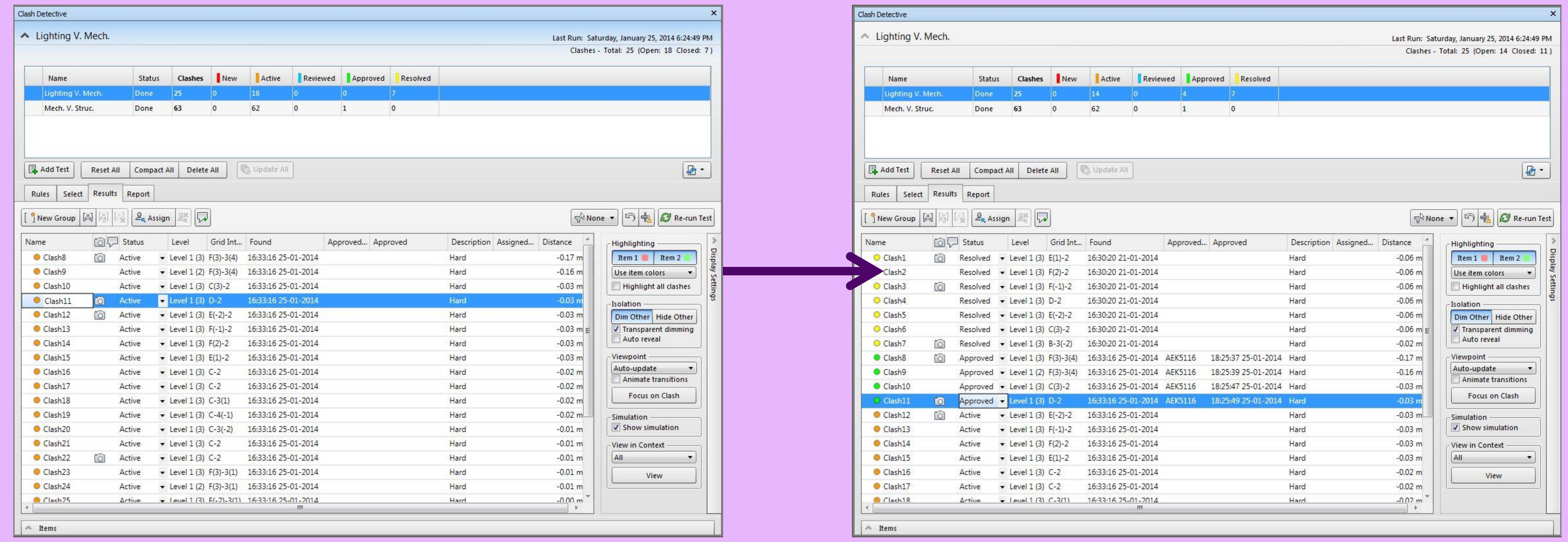
The information to the left is developed from Quantity Takeoff. Here, the lighting and electrical takeoff for the typical office floor is shown . For example, if the owner wanted to update all speakers on a floor, they would have 3 to locate and change. Work orders can also be entered through this system to allow for routine maintenance throughout the building or to alert facility managers of issues at any given time.

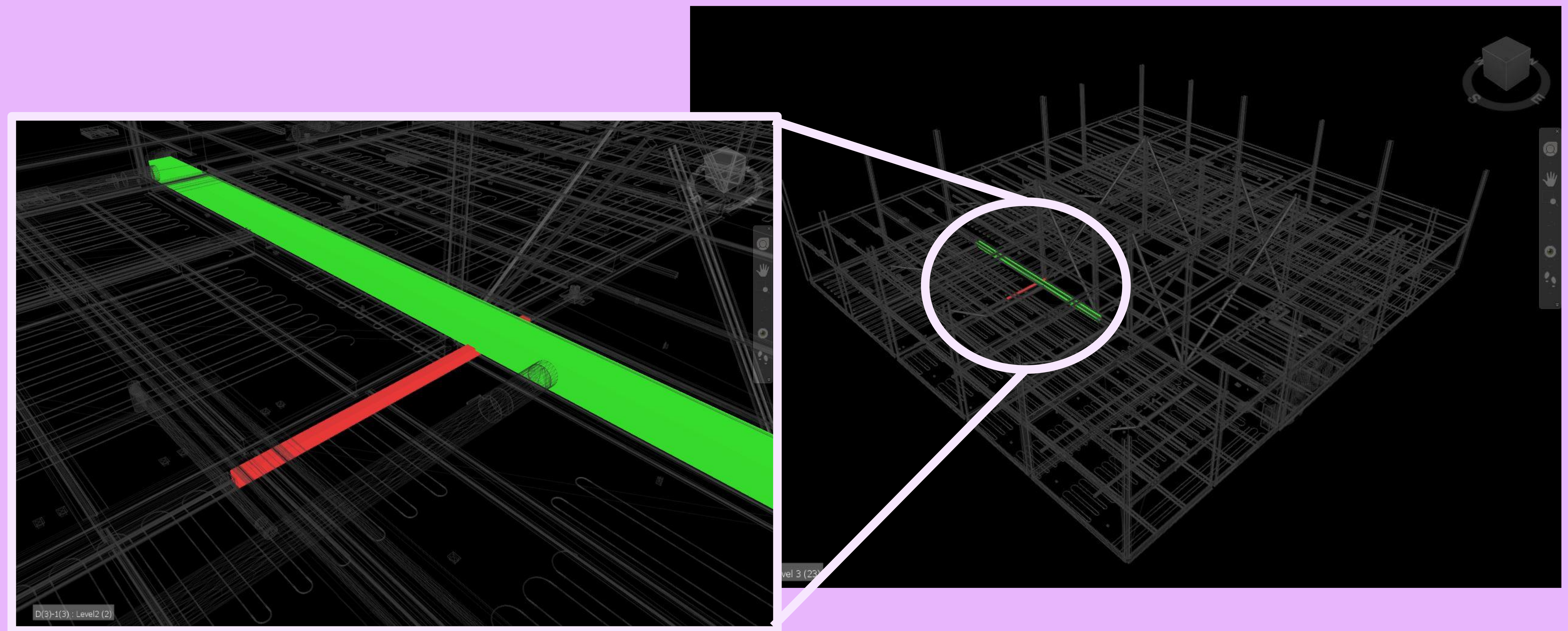
LOBBY

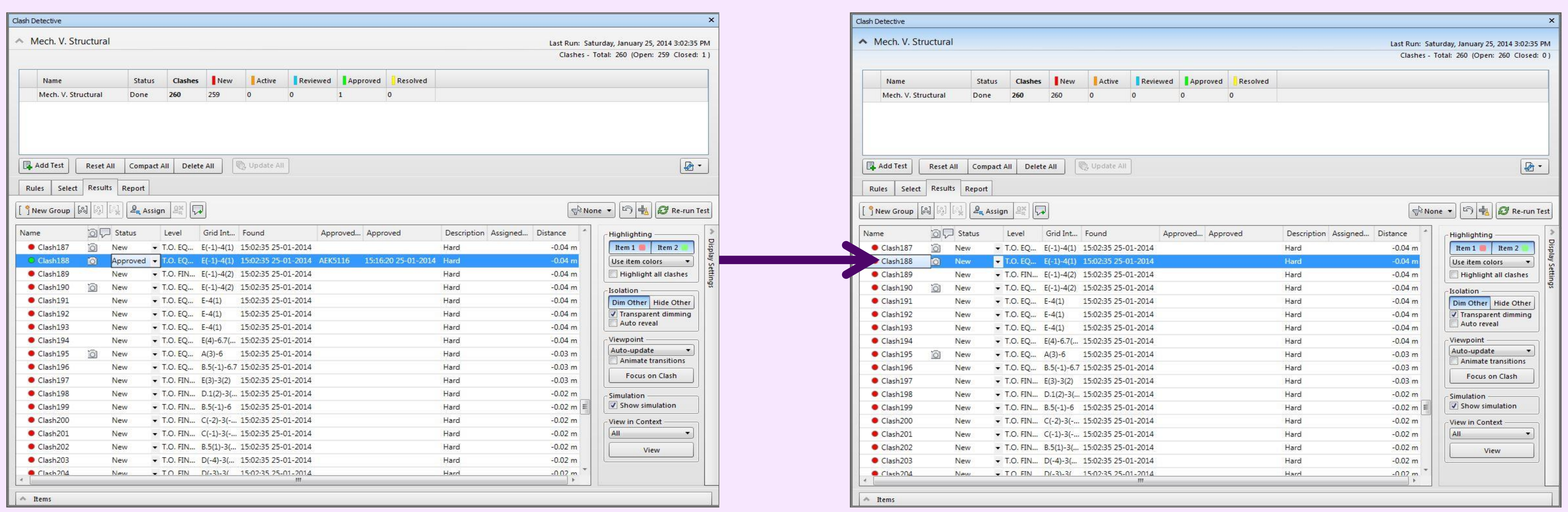


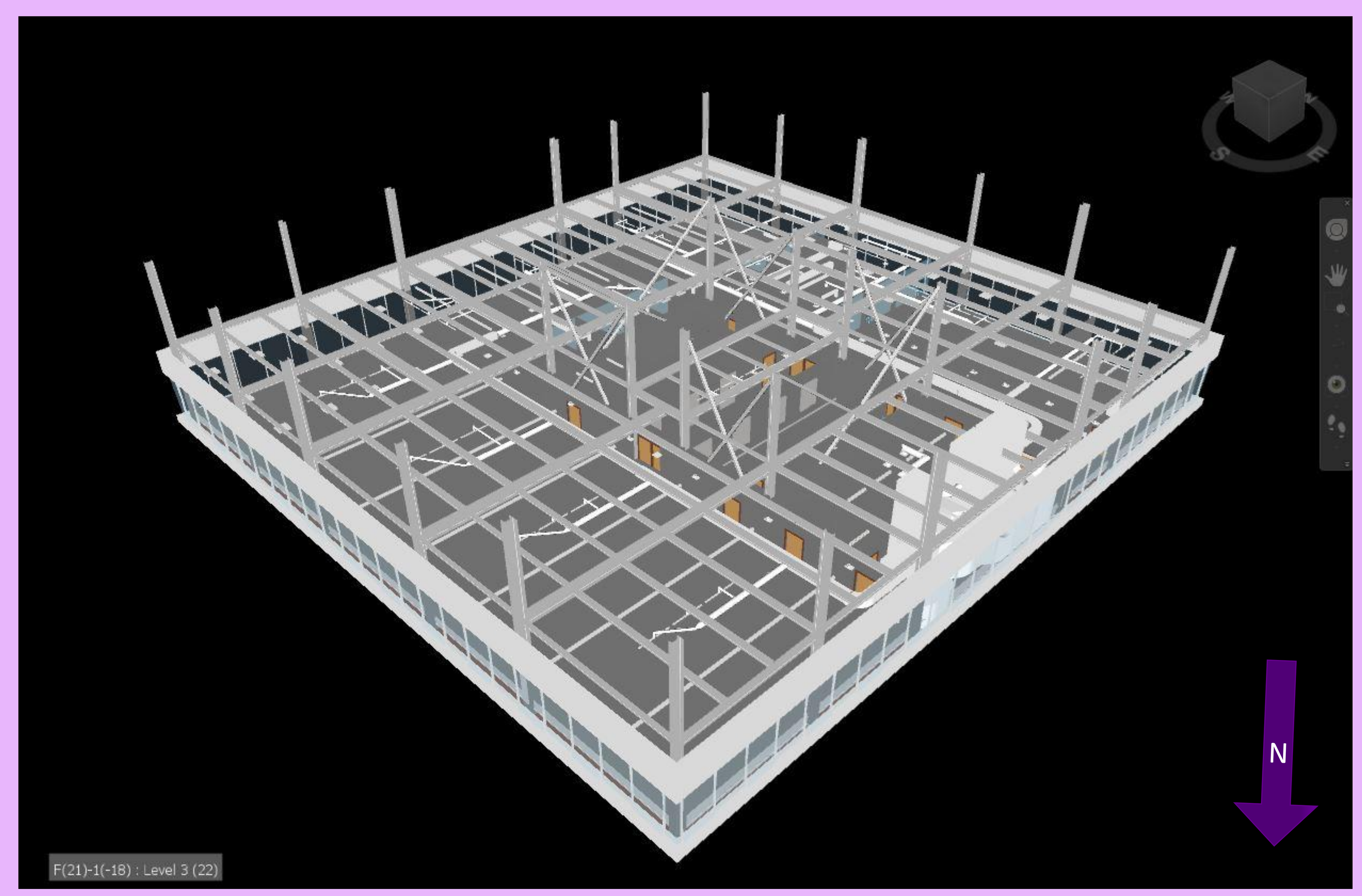












Clash Detection was performed on the main coordination areas of AEVITAS's 350 Mission. In order to facilitate as integration an approach as possible, all disciplines were present during clash detection meetings. This drawing is an example of some major clashes within the typical office floor as well as the lobby. In the final designs, all clashes were resolved.

OFFICE FLOOR

AEVITAS (Typical Office Floor)

	Sep-15				Oct-15				Nov-15					Dec-15			
Floor	7	14	21	28	5	12	19	26	2	9	16	23	30	7	14	21	28
5	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
6		1	2	3	4	5	6	7	8	9	10	11	12	13	14		
7			1	2	3	4	5	6	7	8	9	10	11	12	13	14	
8				1	2	3	4	5	6	7	8	9	10	11	12	13	14
9					1	2	3	4	5	6	7	8	9	10	11	12	13
10						1	2	3	4	5	6	7	8	9	10	11	12
11							1	2	3	4	5	6	7	8	9	10	11
12								1	2	3	4	5	6	7	8	9	10
14									1	2	3	4	5	6	7	8	9
15										1	2	3	4	5	6	7	8
16											1	2	3	4	5	6	7
17												1	2	3	4	5	6
18													1	2	3	4	5
19														1	2	3	4
20															1	2	3
21																1	2
22																	1
23																	
24																	
25																	
26																	
27																	
28																	
29																	
30																	

	Jan-16				Feb-16					Mar-16				Apr-16				May-16			
Floor	4	11	18	25	1	8	15	22	29	7	14	21	28	4	11	18	25	2	9	16	23
5																					
6																					
7																					
8																					
9	14																				
10	13	14																			
11	12	13	14																		
12	11	12	13	14																	
14	10	11	12	13	14																
15	9	10	11	12	13	14															
16	8	9	10	11	12	13	14														
17	7	8	9	10	11	12	13	14													
18	6	7	8	9	10	11	12	13	14												
19	5	6	7	8	9	10	11	12	13	14											
20	4	5	6	7	8	9	10	11	12	13	14										
21	3	4	5	6	7	8	9	10	11	12	13	14									
22	2	3	4	5	6	7	8	9	10	11	12	13	14								
23	1	2	3	4	5	6	7	8	9	10	11	12	13	14							
24		1	2	3	4	5	6	7	8	9	10	11	12	13	14						
25			1	2	3	4	5	6	7	8	9	10	11	12	13	14					
26				1	2	3	4	5	6	7	8	9	10	11	12	13	14				
27					1	2	3	4	5	6	7	8	9	10	11	12	13	14			
28						1	2	3	4	5	6	7	8	9	10	11	12	13	14		
29							1	2	3	4	5	6	7	8	9	10	11	12	13	14	
30								1	2	3	4	5	6	7	8	9	10	11	12	13	14

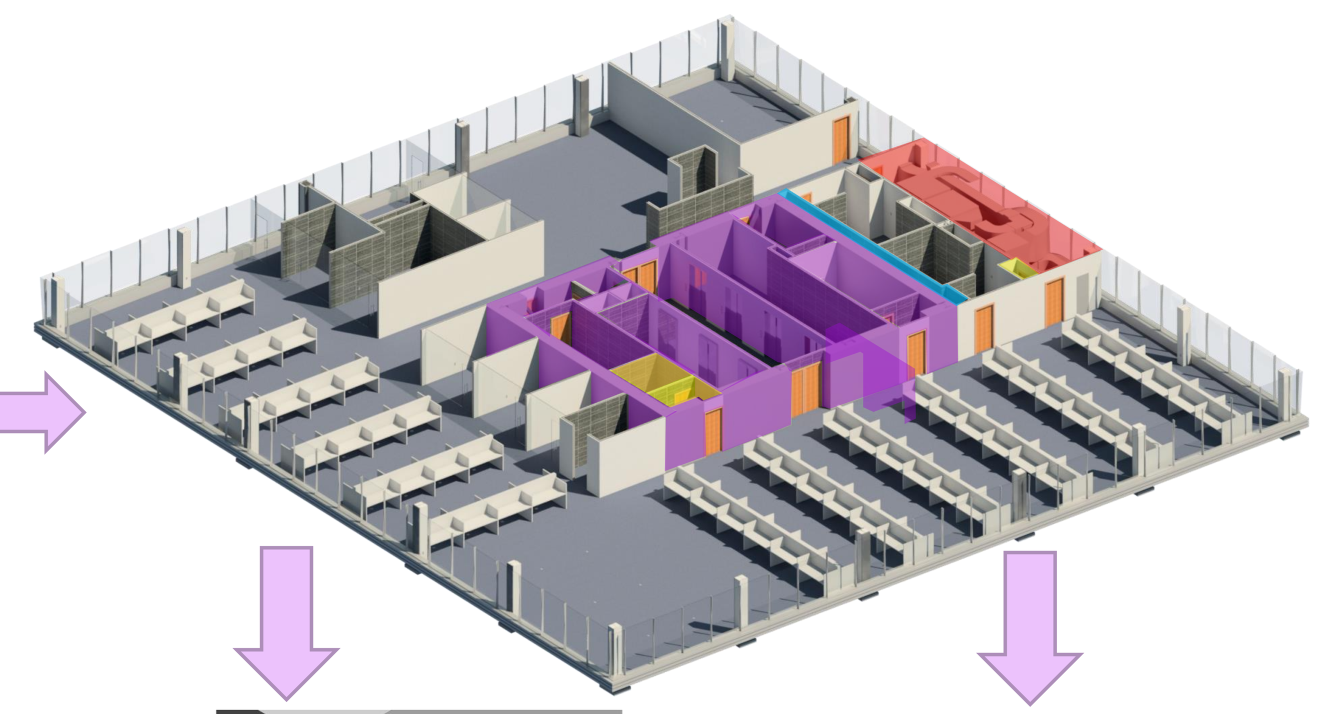
Seq #	Activity	Trade
1	Layout Floor Install Top Track	Interiors
	Install Raised Floor Warmboard System	Interiors
	Layout/Install Radiant Tubing	Mech
	Layout Duct Openings in Int. Walls	Mech
	Metal Stud Walls/Openings	Interiors
2	HVAC Duct Mains/Dampers	Mech
	HVAC Duct Branches	Mech
	Install Duct Insulation	Mech
	Radiant Slab Tie In	Mech
3	Domestic Water Branches	Plum
	Sanitary/Prefab Toilet Rack Install	Plum
	Pipe Testing	Plum
	Pipe Insulation	Plum
	Sprinkler Mains	FP
	Sprinkler Branches	FP
4	Install Large Conduit	Elec
	Firestop and Caulk Penetrations	All
	Install Interior Partitions	Interiors
	One Side Drywall	Interiors
5	In Wall Electrical/Comm	Elec/Comm
	In Wall Controls	Controls
	In Wall Electrical Testing/QC	Mech/Plum
6	Close In Inspection	All
	Finish Drywall	Interiors
	Install Door Frames	Interiors
	Install Interior Glass Partitions	Glazer
	Frame/Install Ceiling Grid	Interiors
7	Pull Electrical Wire	Elec
	Pull Data Cable	Elec/Comm
	Pull Fire Alarm Cable	Elec/Comm

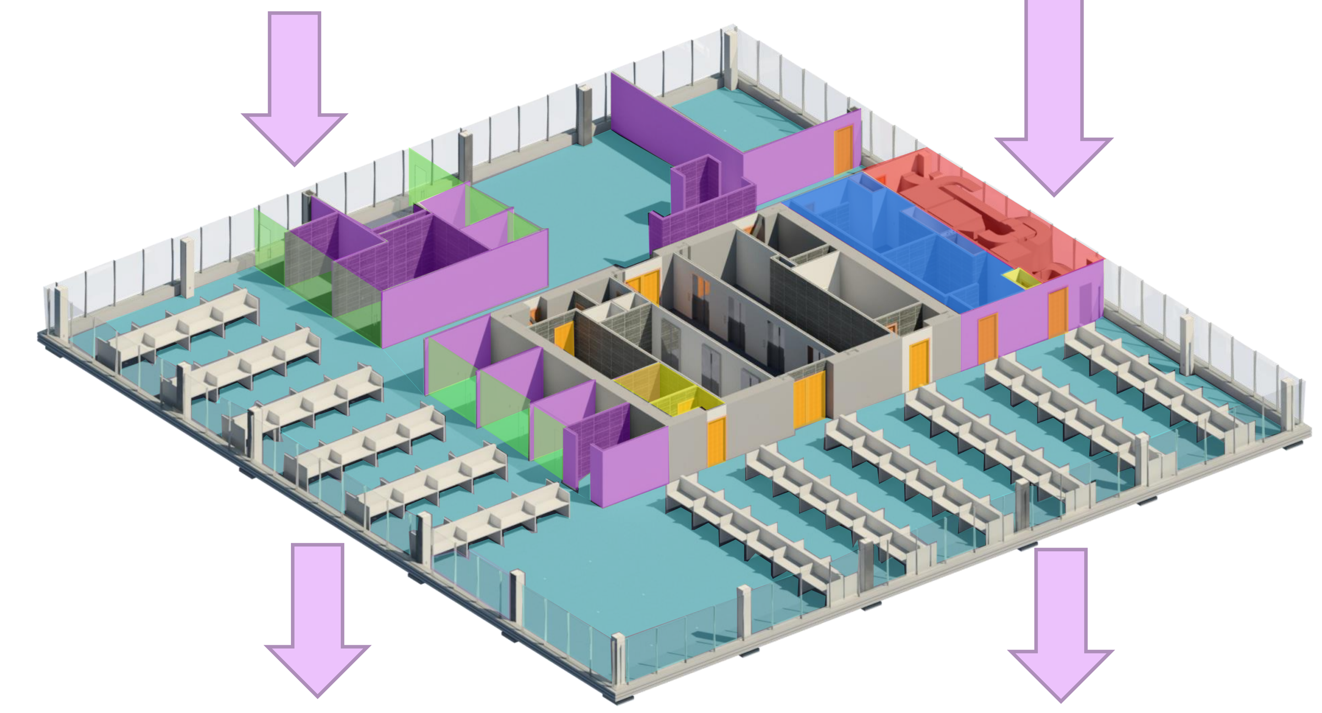
Seq #	Activity	Trade
8	Prime and Paint Walls	Painter
	Install Carpet Tile/Ceramic Tile	Flooring
9	Install Electrical Trim/Wall Controls	Elec
	Install Light Fixtures	Elec
	Set and Hookup Plumbing Fixtures	Mech/Plum
	Caulk Plumbing Fixtures	Mech/Plum
10	Install Sprinkler Drops	FP
	Sprinkler Hydrotest	FP
	Install Bathroom Trim and Partitions	Interiors
	Install Doors/Locks/Closers	Interiors
11	Overhead Close In Inspection	All
	Install Ceiling Tile	Interiors
	HVAC Ceiling Trim	Mech/Plum
	Electrical Ceiling Trim	Elec
	Sprinkler Ceiling Trim	FP
	Misc Trim	Interiors
12	Final Paint	Painter
	Final Clean	AEVITAS
	Air and Water Balancing	Mech/Plum
	Fire Alarm Testing	Elec/Comm
13	Performance Tests - TAB	Mech/Plum
	Performance Tests - Controls	Elec/Controls
	Performance Tests - Lighting	Elec
	Performance Tests - Radiant	Mech/Plum
14	Final Inspection/Punchout	AEVITAS/KR
	Punchout and Signoff	AEVITAS/KR
	Final Acceptance/Floor Completion	AEVITAS/KR

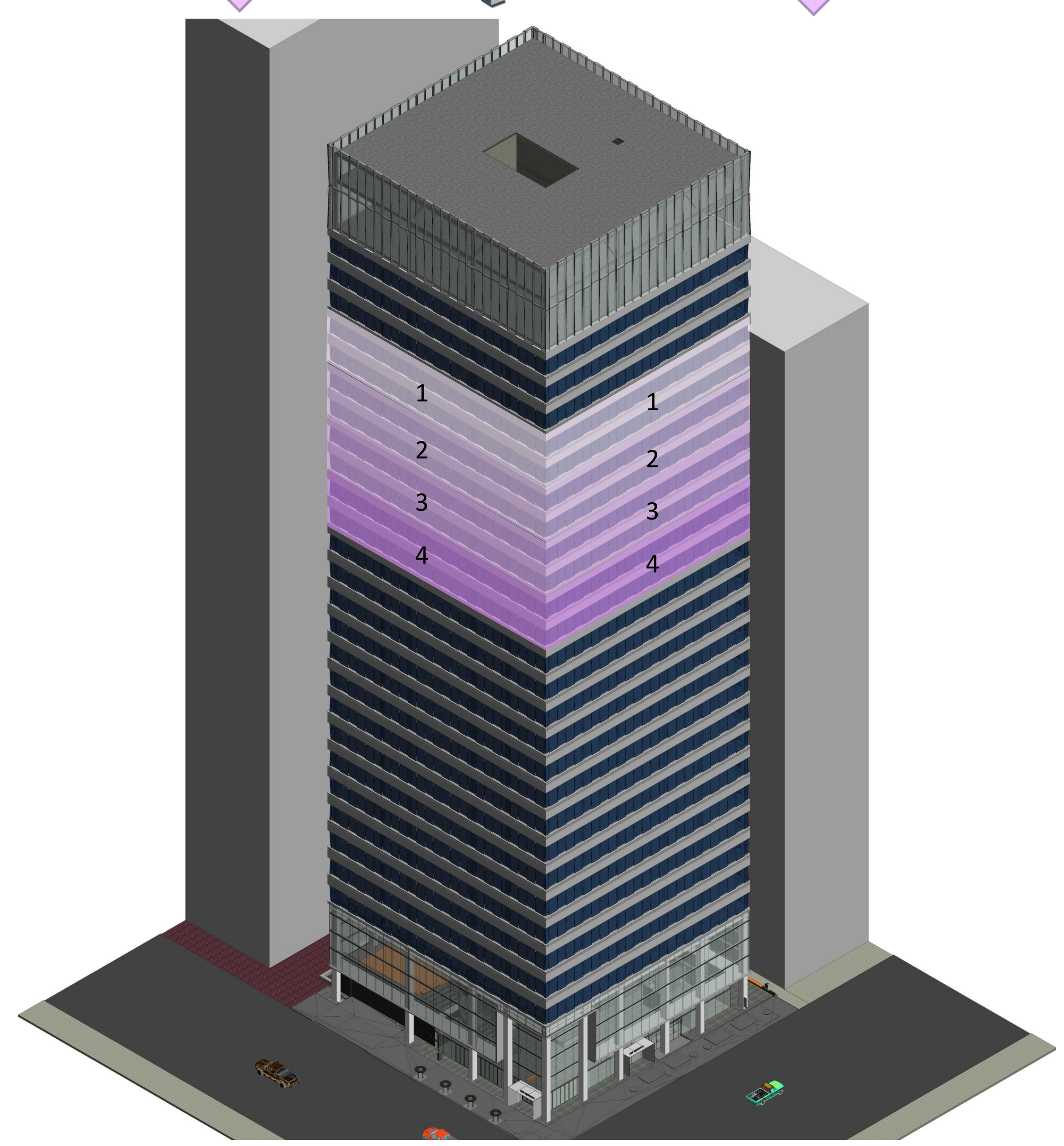
AEVITAS (Building Core/Risers)

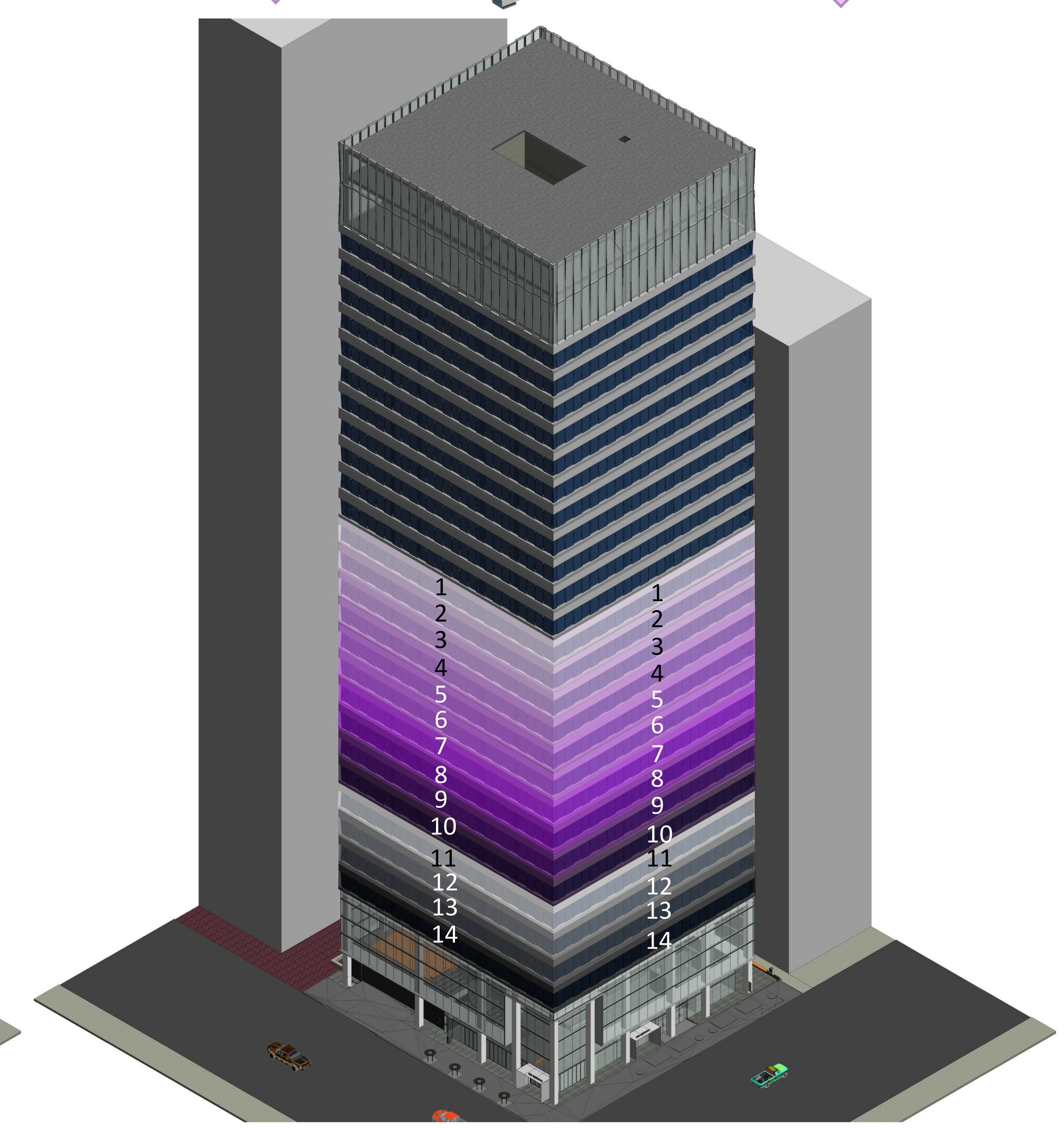
	Aug-15				Sept-15				Oct-15				Nov-15			
Floor	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23
5	1	2	3	4												
6																
7		1	2	3	4											
8																
9			1	2	3	4										
10																
11				1	2	3	4									
12																
14					1	2	3	4								
15																
16						1	2	3	4							
17																
18							1	2	3	4						
19																
20								1	2	3	4					
21																
22									1	2	3	4				
23																
24										1	2	3	4			
25																
26											1	2	3	4		
27																
28												1	2	3	4	
29																
30													1	2	3	4

Seq #	Activity	Trade
1	Fall Protection at Core	Interiors
	Install Top Track Around Shaft	Interiors
	Install Duct Risers	Mech
	Install Fire Damper in Duct Risers	Mech
2	Install HVAC Piping Risers	Mech/Plum
	Install Plumbing Risers	Plum
	Install Elec/Comm Risers	Elec/Comm
3	Test HVAC Piping Risers	Mech/Plum
	Test Plumbing Risers	Plum
	Insulate HVAC Piping Risers	Mech/Plum
	Insulate HVAC Duct Risers	Mech
4	Close In Inspection	All
	Install Fire Rated Shaft Walls	Interiors







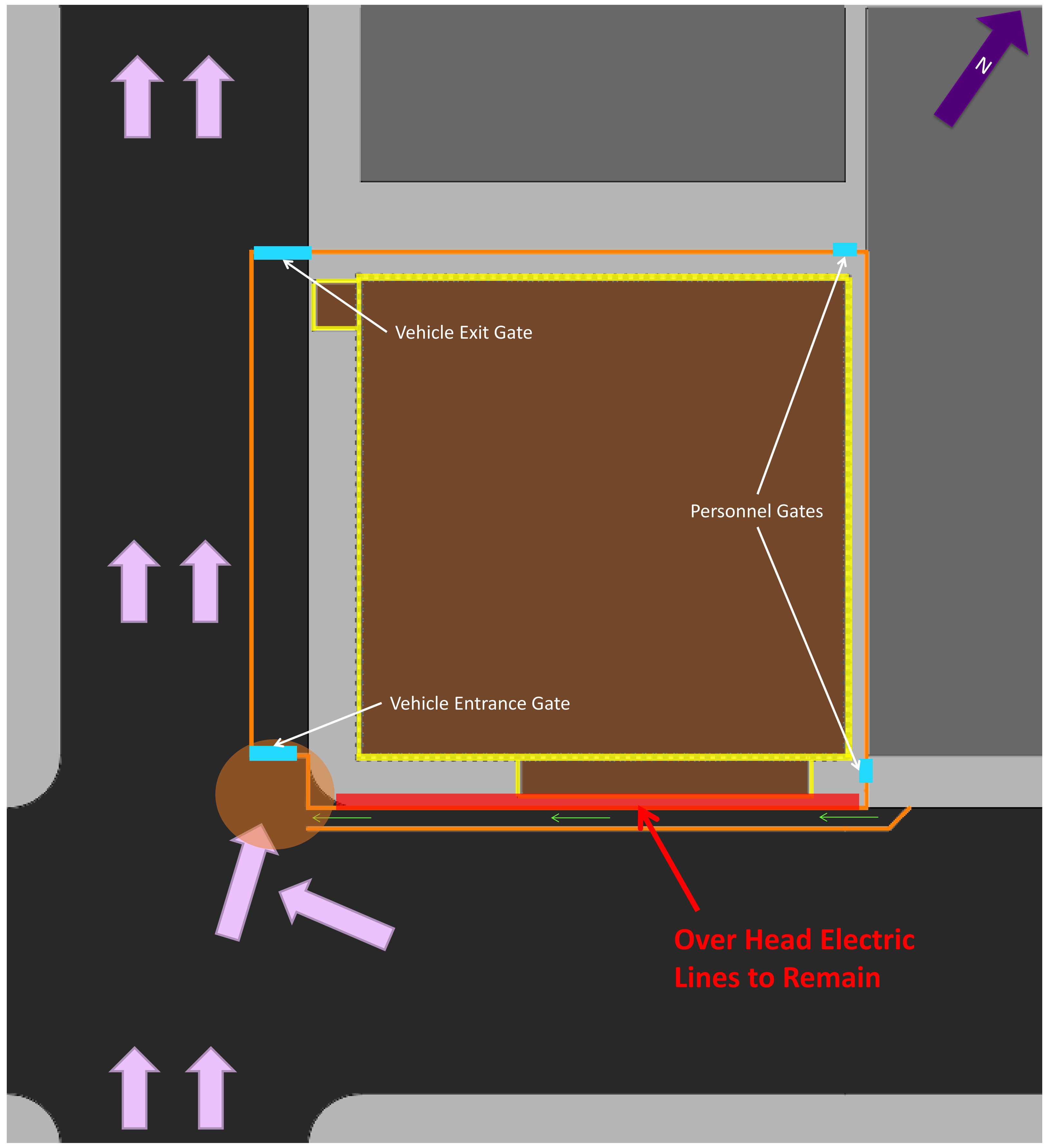


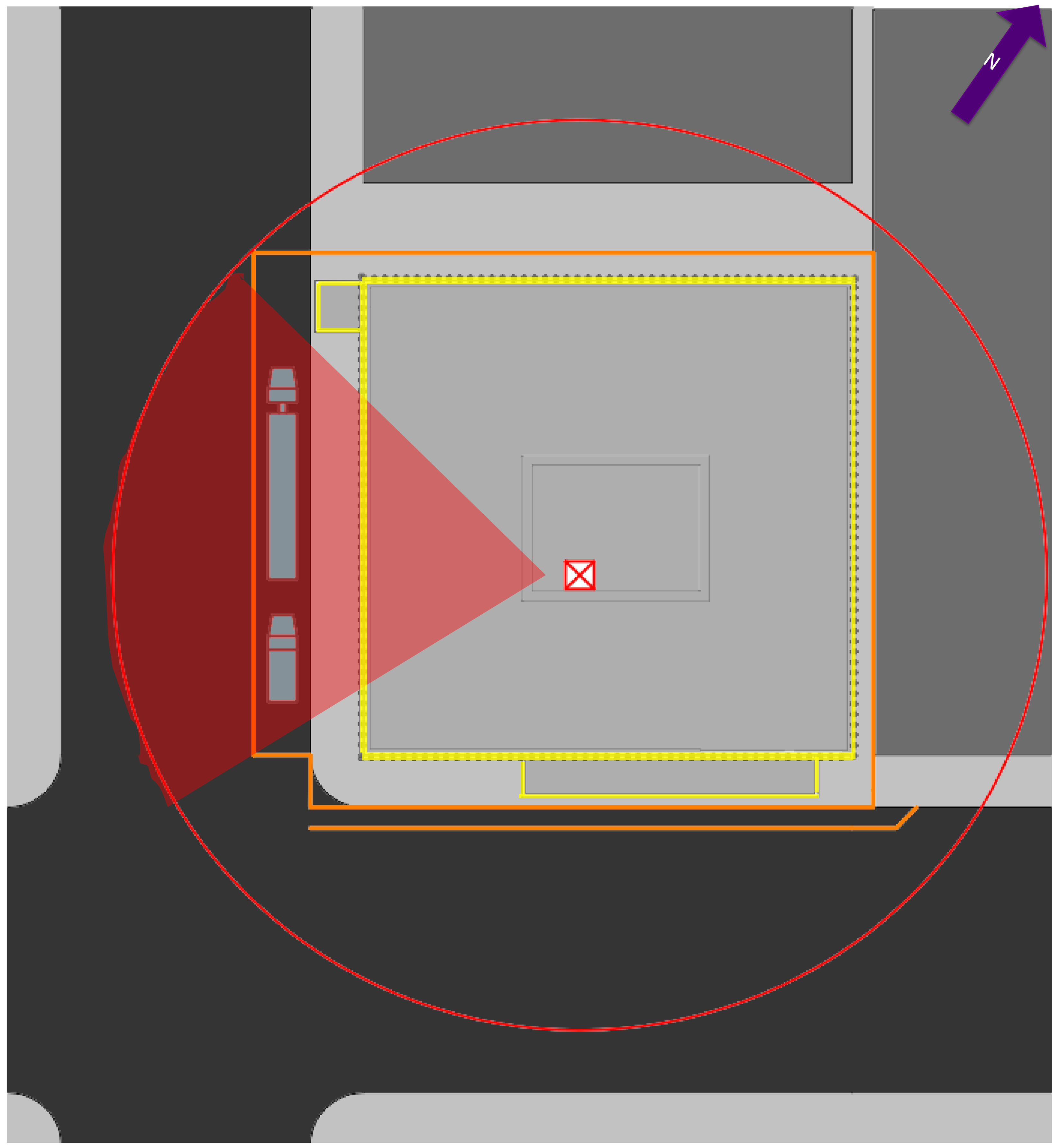
The matrix schedules shown here represent the production flow of the interior work to be completed on each typical office floor. The vertical axis represents the area that will be worked in, in this case the floor the work will be occurring on. The horizontal axis is then the week that the work will take place and the number/color where the two axis meet then represent the same number/color found on the adjacent tables that outline the scope of work associated with the unit. This scope of work is then visually represented by the typical floor plan models shown. The sequence in which these scopes of work occur in the building are then represented on the full building models. The matrix schedule for the core indicated that two floors will be completed in a five day period while the remainder of the work on each floor will take five days per floor. This will serve as the baseline schedule for the work but it is possible that the schedule will become more efficient as the processes for installation are developed during construction. More detail about manpower allocated for this work can be seen on pages SD18-20 of the supporting documents.

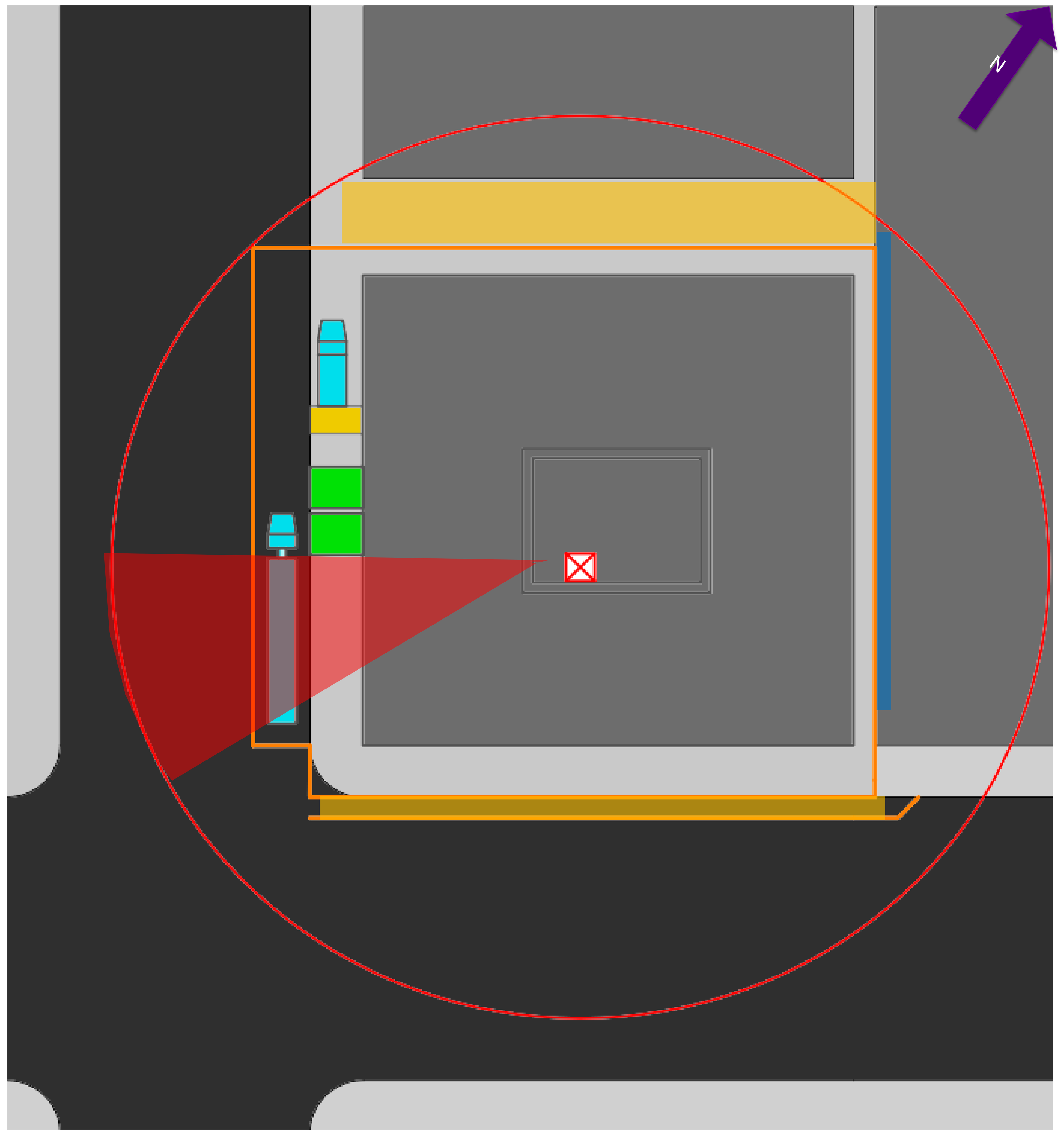
AEVITAS |Gantt Chart Schedule – Full Building

	Task Name	Duration	Start	Finish	Free Slack	Total Slack
1	Notice to Proceed	0 days	Mon 4/7/14	Mon 4/7/14	0 days	145 days
2	Existing Building Demo	65 days	Mon 4/7/14	Fri 7/4/14	0 days	145 days
3	Mobilization	10 days	Mon 7/7/14	Fri 7/18/14	0 days	145 days
4	Slurry Wall Excavation and Installation	30 days	Mon 7/21/14	Fri 8/29/14	0 days	145 days
5	Bulk Excavation	55 days	Mon 9/1/14	Fri 11/14/14	0 days	145 days
6	Diagonal Cross Lot Shoring	30 days	Mon 9/29/14	Fri 11/7/14	0 days	145 days
7	Mat Foundation Excavation	10 days	Mon 11/10/14	Fri 11/21/14	0 days	145 days
8	Foundation Waterproofing	60 days	Mon 11/24/14	Fri 2/13/15	0 days	145 days
9	FRP Mat Foundation Footing	15 days	Mon 12/1/14	Fri 12/19/14	0 days	330 days
10	FRP Foundation Core	40 days	Mon 12/22/14	Fri 2/13/15	0 days	330 days
11	FRP Substructure Floors, Columns, Walls	55 days	Mon 1/12/15	Fri 3/27/15	0 days	115 days
12	Set Structural steel to 5th floor	20 days	Mon 3/30/15	Fri 4/24/15	0 days	115 days
13	Set Structural steel to Mech 1	80 days	Mon 4/27/15	Fri 8/14/15	0 days	135 days
14	Lift Major Equipment within building	10 days	Mon 8/17/15	Fri 8/28/15	20 days	135 days
15	Pour Concrete floors to Equip Plat	10 days	Mon 5/11/15	Fri 5/22/15	0 days	115 days
16	Place Concrete Slabs to Mech 1	80 days	Mon 5/25/15	Fri 9/11/15	0 days	115 days
17	Lift and Set rooftop equipment	10 days	Mon 9/14/15	Fri 9/25/15	0 days	115 days
18	Set Structural Steel to Parapet	20 days	Mon 9/28/15	Fri 10/23/15	0 days	115 days
19	Steel Top Out	0 days	Mon 10/26/15	Mon 10/26/15	10 days	125 days
20	Permanent Roof	25 days	Mon 11/9/15	Fri 12/11/15	0 days	115 days
21	Building Watertight	0 days	Mon 12/14/15	Mon 12/14/15	115 days	115 days
22	Start Curtain Wall at 5th floor	10 days	Mon 6/15/15	Fri 6/26/15	0 days	115 days
23	Curtain wall to Parapet floor	100 days	Mon 6/29/15	Fri 11/13/15	0 days	115 days
24	Curtain wall G to 5th Floor	35 days	Mon 10/26/15	Fri 12/11/15	0 days	115 days
25	Set basement Equipment	10 days	Mon 5/11/15	Fri 5/22/15	0 days	160 days
26	Permanent Power Startup	10 days	Mon 7/20/15	Fri 7/31/15	0 days	205 days
27	Permanent Power Available	0 days	Mon 8/3/15	Mon 8/3/15	50 days	205 days
28	Substructure Rough In	40 days	Mon 5/25/15	Fri 7/17/15	0 days	220 days
29	Substructure Interiors	40 days	Mon 6/8/15	Fri 7/31/15	45 days	70 days
30	Elevator shaft work	80 days	Mon 6/22/15	Fri 10/9/15	0 days	155 days
31	Energize elev machines	5 days	Mon 10/12/15	Fri 10/16/15	115 days	155 days
32	Building Core Riser Rough In (Matrix Sched)	80 days	Mon 8/10/15	Fri 11/27/15	0 days	125 days
33	Lobby work	100 days	Mon 8/24/15	Fri 1/8/16	0 days	25 days
34	Sitework/Hardscaping	30 days	Mon 12/28/15	Fri 2/5/16	35 days	75 days
35	Release of Matrix Schedule	0 days	Mon 8/17/15	Mon 8/17/15	15 days	15 days
36	Typ Floor Construction (Matrix Schedule)	185 days	Mon 9/7/15	Fri 5/20/16	0 days	0 days
37	Commissioning & Start ups	60 days	Mon 2/29/16	Fri 5/20/16	0 days	0 days
38	Substantial Completion	0 days	Mon 3/28/16	Mon 3/28/16	0 days	40 days
39	Allow Tenant work to begin	0 days	Tue 3/29/16	Tue 3/29/16	39 days	39 days

April 2014 – May 2016 = 25 Months







The delivery lane on Fremont street and the temporary walkway along Mission street create a safety concern at the southern corner of the site. The pedestrian flow is indicated by the green arrows and traffic by the purple arrows. The red circle is the area of concern where pedestrians on foot are vulnerable to being struck by vehicular traffic either turning right off of Mission Street or turning into the site off of Fremont Street. To mitigate the problem all deliveries will be thoroughly planned out to the time at which materials will arrive on site, at this time a flagger will be present to direct the delivery onto the site. This will be an issue to consider throughout the construction of the high rise and thus is not reiterated on further safety plans. In an attempt to prevent any problems with public vehicular traffic in this area there will be signage and pavement markings to direct the cars to avoid the pedestrians. There is also a great risk of falls in the excavation and foundation plans as there will be a large open excavation in which workers will be prone to falls. Therefore fall protection will be installed in the form of wood railings around the border of the excavation.

In the foundations and substructure phase falls will still be an issue as there will still be a large pit in the ground so the wood railings will still surround the site. Now that the crane is installed the area between the delivery lane and the actual working site will be a high caution area where workers will be urged not to stand under the crane picks. With the trucks coming on site in frequency it is important to heighten the awareness of the workers on site to pay attention to their surroundings especially when in the delivery lane area.

In the superstructure phase there will be materials lifted and work taking place in the air space above the streets of San Francisco, this will require overhead protection for pedestrian walkways adjacent to the site, indicated by the orange boxes in the drawing above. There will also be a need for protection of the adjacent to the site to protect them from damage, this is indicated by the blue. The superstructure phase also includes exterior man and material hoists, indicated by the green boxes. that will limit the crane pick radius in most cases so it is not lifting material over these hoists. To prevent falls there will be netting installed around the perimeter of the building on the working floors, this will also prevent any debris from blowing off of the building floors onto the street below.