2012

Senior Thesis Final Report

VIDA Fitness Center, Washington D.C.

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Construction Option
Faculty Advisor: Dr. Leicht
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VIDA FITNESS

VIDA Fitness Center

Washington D.C.

All renderings courtesy of SvS Architects

[Project Overview]

Owner: Urban Adventures

General Contractor: Forrester Construction

Interiors Architect: Stoneking von Storch

Base Building Architect: Core Architects

Project Delivery Method: Design-Bid-Build

Contract Type: Negotiated

Construction Dates: 09/2010 - 09/2011

Size : Addition - 10,920SF

Renovation - 49,450SF

Levels: Four + Penthouse

Actual Cost: $14 M

[Architecture]

For the VIDA Fitness Center addition and renovation on U Street, each floor was designed so as to promote a differing function or workout focus. As the fifth VIDA, this location will not only be the largest with over 51,000SF dedicated to fitness and cardio, but will also become the flagship location for the chain of VIDA Fitness Centers.

[Structural System]

The existing building structure consists of concrete columns, beams, and two-way slabs with a façade of load bearing masonry walls. The three floor new addition was constructed of concrete columns and beams with post-tensioned slabs. This system rests on a foundation of grade beams, pile caps, and finally micro piles. The addition has a masonry façade tied to CMU to match the existing building. Both roofs are accessible, and have pavers or turf grass elevated on pedestals above the rubberized asphalt monolithic roof membrane that rests on corrugated metal decking.

[Mechanical System]

The primary mechanical system is a Variable Air Volume (VAV) system. Air is preconditioned in the heat recovery makeup air unit before being distributed to and conditioned in one of the 18 Air Handling Units. A 310 GPM chiller affords the AC system with chilled water. An 850 MBH gas-fired hot water boiler supplies the hot water for the system. Because the structure is exposed and there is no plenum space to utilize for return air, the system utilizes both supply and return ducts.

[Electrical System]

The electrical system ties into the grid from the existing connection, a 208/120, 3-phase, 4 wire, 1600 amp feed supplied by Pepco. The majority of the lighting in the fitness center consists of HID downlights, with specialty LED lighting in certain areas for accenting.

[http://www.engr.psu.edu/ae/thesis/portfolios/2012/CKW5012/index.html]

EXECUTIVE SUMMARY:

The following comprehensive report details the four technical analyses performed on the VIDA Fitness Center. Owned by David von Storch of Urban Adventures, this VIDA is now the largest of his fitness centers and will serve as the new flagship location in Washington, D.C. This building will also eventually include a new high end restaurant, the Aura Spa, the Bang Salon, and a new office space for his company, Urban Adventures. The 60,370 square foot project includes a 10,920 square foot, three-story addition and the renovation of an existing 49,450 square foot building.

Technical Analysis 1: Application of ReRev Energy Harvesting System

The first technical analysis in this report includes an electrical breadth and introduces a ReRev energy harvesting system that captures the DC energy generated from cardio equipment and converts it to AC power. Applying this system with the cardio equipment would provide renewable energy and long-term cost savings for VIDA, along with a "green" feature that promotes a positive, sustainable image to the public which, in turn, increases the market value for the Owner. Including the incentives for renewable energy, the payback period would be only five years for the installed ReRev equipment at VIDA and has an estimated accrued savings of $2,085,000 after forty years.

Technical Analysis 2: Study of Scheduled Overtime Effects on Worker Productivity

The second technical analysis investigates the effects of scheduled overtime use during the construction of VIDA. Investigations were conducted and the point was determined at which the overtime costs, decreased quality, and efficiency losses of overtime outweighed the costs of the traditional, 40-hour week. A new work schedule comprised of four 9-hour (4-9s) days and one eight-hour (1-8) day was selected that decreased both the weekly work hours and the number of days worked per week. Utilization of this alternative schedule could have saved subcontractors a total of over $1.3 million in lost labor costs and decreased the schedule hours by approximately 2%.

Technical Analysis 3: Implementation of Job Order Contracting

The third analysis discusses Job Order Contracting (JOC) and how it can be applied in a unique manner to the VIDA project. This was done by studying the benefits associated with Forrester Construction holding a Job Order Contract with a steel subcontractor for the construction of four VIDA fitness centers. Implementing JOC could also have potentially saved the steel subcontractor approximately $465,000 and Forrester Construction approximately $9.9 million from the four fitness centers combined. JOC could also have decreased the procurement and preconstruction durations and allowed for the steel construction to commence 6-8 weeks sooner than scheduled.

Technical Analysis 4: Mechanical System Layout Constructability and Value Examination

The fourth and final analysis, which includes a mechanical breadth, proposes relocating the two exterior duct lines into the interior of the building and redesigning the ductwork on each floor for a more efficient layout. A metrics measuring chart was developed for each ductwork redesign and used to choose Layout 2 as the best solution. Though this layout costs approximately $85,300 more than the existing layout, it is more aesthetically pleasing, more easily constructible, and adds additional lines to areas of the building that were not conditioned properly.

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Casey Mowery – Forrester Construction Assistant Project Manager

Emory Land – VIDA Fitness Senior General Manager

Britnei Godusky – MAE Student Graduate

Tom Horensky – MAE Student Graduate

Kathy Watson – Loving Mother and Proofreader

PACE Industry Members

Family and Friends

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PROJECT DESCRIPTION:

Owner David von Storch is launching his new flagship building at 1612 U Street which will include the largest of his VIDA Fitness Centers, along with a new high end restaurant, the Aura Spa, the Bang Salon, and new office space for his company, Urban Adventures. The 60,370 square foot project includes a 10,920 square foot, three-story addition and the renovation of an existing 49,450 square foot building.

Figure 1: Cardio Area, Photo Courtesy of VIDA Fitness

Originally a parking garage, the architect utilized the building's existing structure as architecture, allowing for exposed concrete columns, ductwork, beams, and exiting brick walls (see Figure 1). The monumental stairwell in the center of the gym is a signature statement to all VIDA Fitness Centers: an exposed steel stairwell that disconnects at every floor and raises five floors to the roof penthouse. This industrial feeling, coupled with over 15,000 square feet of glazing, promotes a bright, exposed, and spacious area in which to work out.

Figure 2: Cardio Area, Photo Courtesy of VIDA Fitness

Each floor of the Fitness Center was designed so as to promote a differing function or workout focus. The first floor will eventually house the future restaurant and spa, both of which are planned for completion in summer 2012. It also houses the gym's main entrance, along with a Fuel Bar and salon. The second floor houses the main cardio workout area (shown in Figure 2), along with sales offices, endless pools (swimmers' treadmills), saunas, tanning facilities, a steam room, and luxurious locker room facilities. The third floor of the facility encompasses the equipment area, personal training desks, and the Group Fitness studio, where many fitness classes are held. The fourth floor of the facility holds the Inner Fitness studio and Pilates studio, but is most notable for its access onto the lower roof, which will house a sun deck and bar area. The main roof of the building is accessed through the fifth floor penthouse and contains a pool, bar, fire pits, and cabanas for all guests (see Figure 3).

Figure 3: Roof Bar, Rendering Courtesy of SvS

Located in the center of D.C., the constraints of a restricted site and tight schedule coupled with unforeseen hurdles that come with renovating a 100+ year old building created a unique and challenging project for Forrester Construction. This gym is located on the U Street Corridor, an area that not only houses many residential row houses, but also various nightclubs, restaurants, bars, shops, galleries, and music venues. Because the majority of the area was developed between 1862 and 1900 and most of the architecture is considered Victorian, it has been designated as part of the historic district (Ault). It is for this reason that the project architect had strict guidelines both for designing the exterior façade of the new building addition and for renovating the existing building façade. The original existing building is shown in Figure 4 below.

Figure 4: Original Existing Building, Photo Taken by Luis Ortiz

In addition, the expansion began construction while the building was still occupied, as the existing Results Gym remained open and still had an active lease. When the gym closed and construction consumed the entire facility, parts of the building opened in phases. Bang Salon was first to open, followed by two separate phases of the VIDA Fitness Center, with plans for the restaurant and spa to open in May 2012.

PROJECT LOCATION:

Overview

Even through the downturn of the economy, Washington D.C. remains one of the main construction hubs in the country. Reinforced concrete remains the preferred structural building material in the area, mainly due to the strict height restrictions set by Congress in the Heights of Buildings Act (Grunwald). Other construction challenges include high population density, generally constricted sites, heavy traffic, historical preservation guidelines, building codes, a high water table, and zoning specifications.

Building History

Located on 1612 U Street NW in Washington D.C. (shown in Figure 5) on a 14,485 square foot site, the VIDA Fitness project is a renovation and addition to an existing building that housed a Results Gym, Café 1612, Bulldog Productions, and a Bang Salon.

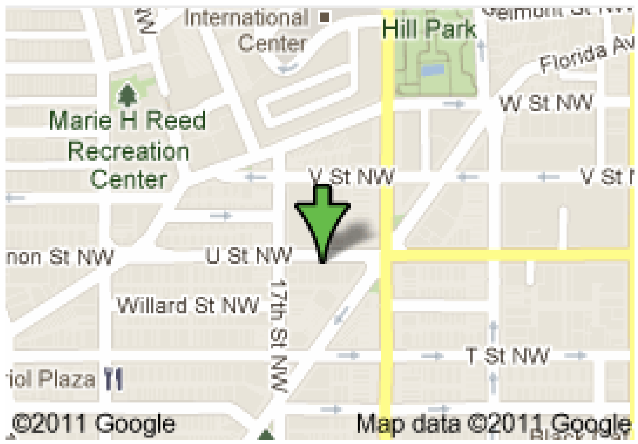


Figure 5: VIDA Fitness Location, Courtesy of Google

This complex is located on the U Street Corridor, an area that not only houses many residential row houses, but also various nightclubs, restaurants, bars, shops, galleries, and music venues. Because the majority of the area was developed between 1862 and 1900 and most of the architecture is considered Victorian, it has been designated as part of the historic district (Ault). It is for this reason that the project architect had strict guidelines both for designing the exterior façade of the new building addition and for renovating the existing building façade (Greater U Street). Approved by the Historic Preservation Review Board, the addition is said to "complement and preserve the historic architecture of the existing circa 1921 building" (Hays).

Client Information:

Owner Background

David von Storch is the president and founder of Urban Adventures Companies, Inc., a company founded in 1986 that acts as the corporate heading for VIDA Fitness, Bang Salon, Capitol City Brewing Company, Aura Spa, and two new restaurants (one at 1612 U Street and one at 901 Ninth Street). Dubbed "Rich and Ripped" by The Washington Post, von Storch hit the number 16 spot on the Men's Health list of The World's Richest and Fittest Guys (Leitko). He moved to Washington D.C. after earning his MBA at Harvard Business School and it was there that he began construction of his empire. Atop all of the successful businesses, this empire includes nearly 1,500 employees coupled with a seven figure income, and is spread out over 200,000 square feet of Washington (Zak).

1612 U Street

Though the first VIDA Fitness was opened in 2006, there are currently five open at varying locations with another one on the way, ensuring von Storch is well on his way to achieving his goal of eight by 2015 (David Von Storch). One of the new fitness centers under active development is slated to be the flagship location; this 1612 U Street location is dubbed "the culmination of everything" by von Storch and will house a new high-end restaurant, Aura Spa, Bang Salon, and of course, VIDA Fitness (Zak).

Originally a parking garage, 1612 U Street was converted into E.B. Adams Co., a restaurant supply storage facility. Von Storch co-signed an agreement to own the four-story building in 1995, and began plans designing a gym with his architect brother, Stephen von Storch. Von Storch decided to put the gym on hold, preferring instead to focus on the expansion of Capitol City Brewing. He elected Doug Jefferies, owner of Results Gym, to rent the space as a gym. It was not until 2005 that von Storch bought the building for $5.8 million and began planning the addition and transformation of the U Street building (Samuelson).

VIDA Fitness Expansion

It is clear that growth of VIDA Fitness plays a key role in the new 50,000 square foot fitness center. Not only is its size impressive, but the new rooftop will include a 60-foot pool, bar, outdoor cabanas, and a communal fire pit, living up to von Storch's affirmation to "try to do something better with each new VIDA Fitness". Compared to the 3,000 member existing Results Gym, von Storch hopes to have approximately 10,000 members by the time the building is fully open, 20 percent of which will be members of the rooftop pool club (Frederick). The entirely renovated existing four story building coupled with the new 10,000 square foot, three floor expansion will eventually house the largest VIDA Fitness, which includes over 50,000 square feet of cardio and fitness area (shown in Figure 6 on the next page). This VIDA will house six fitness studios, including Group Fitness, Inner Fitness, Yoga, Pilates, TRX, and GTS.

Figure 6: VIDA Fitness Center, Photo Taken by Clara Watson

Critical Project Factors

For an experienced client like David von Storch who has already built several fitness centers and restaurants, there are several significant expectations that must be met to ensure owner satisfaction. Chief expectations for this particular owner include project schedule, cost, quality, project phasing, sequencing, and safety.

Schedule is an extremely critical factor on this project because it was von Storch's personal goal for groundbreaking in August of 2010, followed by the opening of the entirely renovated gym along with the three story addition in March, 2011. Though construction on the new addition began according to schedule and continued while the existing Results Gym remained open, the renovation of the entire existing 50,000 square foot building (and accessible roof) was left to be completed, along with the finish work of the new addition, in a mere three months. For every week that VIDA Fitness did not open on time, the company lost approximately $100,000, a fact that made it critical for the fitness center to open on time and according to the project's tight schedule.

Because detailed and accurate scheduling was acute to project success, the schedule was discussed weekly at both the Owner's meetings and the Foreman's meetings to ensure that all subcontractors knew what was to be completed when; sequencing also played an imperative role in the assurance of maintaining the project schedule. An overall VIDA Fitness project timeline is shown in Figure 7 below.

Figure 7: VIDA Fitness Center, Photo Taken by Clara Watson

Cost is another key aspect affecting the construction of the fitness center. Von Storch asserts that Urban Adventures Companies has a "low-risk profile", and claims that in terms of leverage, Bang Salon, Vida Fitness, and Capital City Brewing have virtually no bank debt. To fund this project, von Storch took out a $10 million loan against the building, and plans to invest the rest (approximately $5 million) in cash from his businesses (Heath). As unforeseen conditions caused the project contingency to be exhausted during the beginning phases of the project, a detailed project budget became even more critical to von Storch and the Forrester Construction Project Team. Because of this, budget was discussed weekly at the Owner meetings.

As von Storch spent a great deal of money on high-end finishes for his building, the **quality** of the finished product was of great importance to him; he worked closely with Wade Hallock of Hallock Design Group to ensure every detail was up to his standards. Von Storch expects excellence in both materials and workmanship. It was for this reason that quality was monitored closely throughout the project, and when it did not meet the standards of the project team, subcontractors were required to either repair their work or redo it entirely.

The Timeline above in Figure 10 shows that construction was still ongoing when the fitness center opened for business. Bang Salon also opened while the building was under construction, creating even more public foot traffic through the construction area. For this reason **project phasing** and **sequencing** coupled with occupant **safety** became important integral daily site activities. It remained a priority for Forrester Construction to protect not only the public, but also all of the Owner's employees. Temporary construction walls separated construction areas from public areas and construction signage labeled all necessary areas and egress paths. In addition to these safety precautions, all workers or personnel entering construction areas were required to read and sign the Forrester Construction Safety Plan and abide by its contents. Safety glasses, hardhats, safety vests, long pants, and work boots were required in construction areas at all times and all codes and regulations were followed to ensure a secure and safe project.

PROJECT DELIVERY SYSTEM:

Forrester Construction was selected for this project because of their relationship with the Owner, Urban Adventures, and because they had done several past projects for David von Storch. Both the addition and renovation on the new VIDA Fitness Center at 1612 U Street were completed using a Design-Bid-Build with Design Assist project delivery system. Though project documents and drawings are usually 100% complete in traditional Design-Bid-Build delivery systems, because of Forrester's standing relationship with the Owner and because it was a negotiated contract, this was not the case for this project; the drawings for this project continued to progress throughout the beginning of the job. Forrester Construction also aided in the bidding process and provided some of their own insight that had been gained from building two previous VIDA's for von Storch.

Typical for this type of delivery system, the contract between Forrester Construction and the Owner was a lump sum contract, and Forrester agreed in the contract to do the specified project for a fixed price. Forrester carried alternates and allowances that could not be executed without von Storch's permission. Any money not spent from these allowances will be returned to the Owner at the end of the project. Though not characteristic of a lump sum contract, alternates and allowances were used for this project because of the relationship between Forrester Construction and the Owner. Allowances in this case gave von Storch the latitude to change his mind as on design issues while still protecting Forrester from scope busts.

The initial contract signed between Forrester Construction and Urban Adventures for general contractor services was only for the construction of Bang Salon, Urban Adventures offices, and VIDA Fitness. The restaurant and Aura Spa that will also be housed in the building are a separate contract that has yet to be awarded. These spaces are planned for opening in May 2012.

All of the subcontracts held with Forrester Construction were lump sum contracts that were awarded to the lowest qualified bidder. The type of bonding required by Forrester for their subcontractors is dependent on the size of their contract, their experience with Forrester, and their current backlog. Performance and payment bonds are required by Forrester for subcontracts that exceed a certain amount.

Insurance requirements generally include Commercial General Liability Insurance, Commercial Automobile Liability Insurance, Workers' Compensation and Employers' Liability Insurance, and Excess Umbrella Liability Insurance.

Forrester is carrying All-Risk Builders Risk Insurance for this project. If a subcontractor fails to hold any of the four types of insurances listed above, Forrester reserves the right to procure and maintain those services, while the subcontractor will remain responsible for paying for the services.

The Project Organization Chart can be seen below Figure 8. Lump sum contracts are depicted with **blue** lines, and communication lines are shown in **green**.

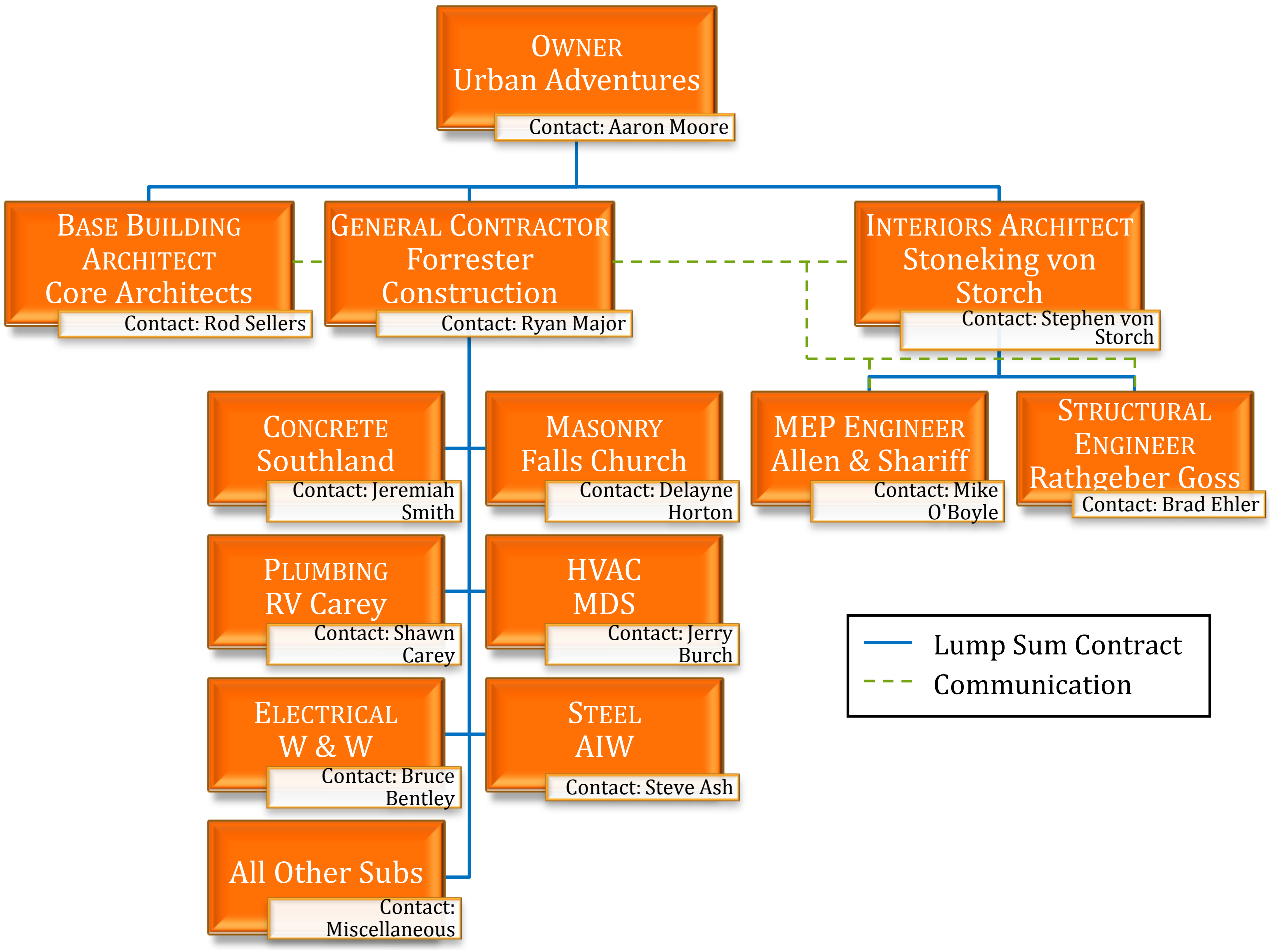


Figure 8: Project Delivery Chart

Overall, both the contract types and project delivery method chosen for this project are appropriate selections. Because of Forrester's history with the Owner and experience building past VIDA's, a modified Design-Bid-Build with Design Assist delivery system coupled with a lump sum contract provided both Forrester and Urban Adventures with a unique agreement for construction.

PROJECT TEAM STAFFING PLAN:

The Project Team Staffing Plan shown in Figure 9 below is a typical layout for a Forrester Construction project. Forrester organizes their project teams based on project size and complexity. The Project Executive oversees several projects and visits each only once every couple of weeks. The Project Manager is located in the office and visits the job site for Owner's meetings or other important meetings. Both Superintendents were located full time on site, as was the Project Intern. The Assistant Project Managers split time between both the site and the office.

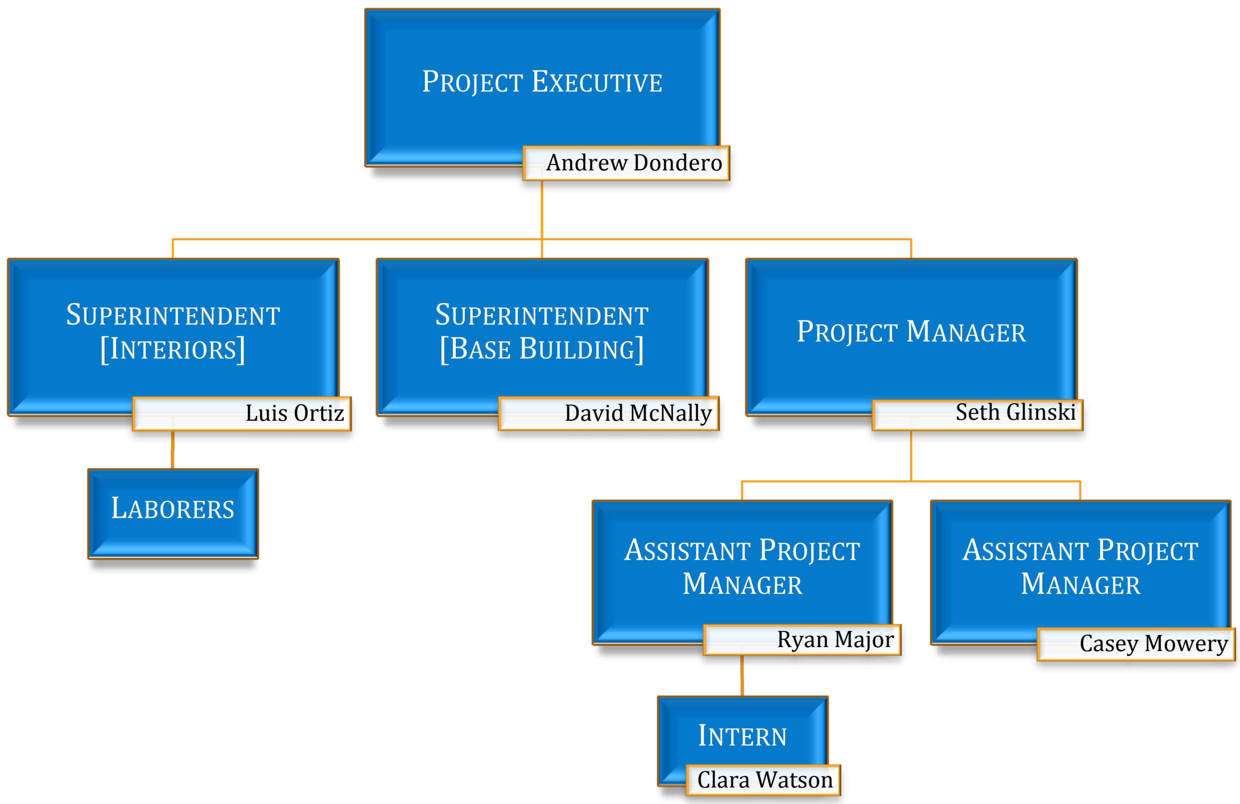


Figure 9: Project Staffing Plan

BUILDING SYSTEMS SUMMARY:

The Building Systems Checklist shown below summarizes the crucial building systems for both the existing building and new addition for VIDA Fitness. The building system summaries that follow detail the key design and construction facets of the project.

BUILDING SYSTEMS CHECKLIST				
Work Scope	Existing Building		New Addition	
	Yes	No	Yes	No
Demolition Required	X		X	
Structural Steel Frame	X			X
Cast in Place Concrete	X		X	
Precast Concrete		X		X
Mechanical System	X		X	
Electrical System	X		X	
Masonry	X		X	
Curtain Wall		X	X	
Support of Excavation		X		X

Demolition

Approximately 3,640 square feet of an existing concrete slab on grade that served as surface parking was demolished for the new three-story addition located in the alley on the East side of the existing building. Selective demolition also took place throughout the existing building, and included the demolition of existing CMU and metal stud walls, floor finishes, and concrete stairwells.

Finally, approximately 360 square feet of concrete floor slab were demolished per floor to allow for the construction of a new monumental steel stairwell that would rise through all four floors and culminate in the new roof penthouse. The existing 700 square foot penthouse also had to be demolished before construction could begin on the new roof or new penthouse. This structure was load bearing masonry walls.

No lead paint or asbestos was found during the demolition on this project.

Figure 10: Tower Crane, Picture Courtesy of Luis Ortiz

Structural Steel Frame

Though neither the existing structure nor the structure for the new addition is steel, new structural steel was added on every floor to support the new monumental stairwell described above, which was also fabricated out of structural steel. The opening for the stairwell is supported with W18's, while the stairwell itself is constructed of varying sizes of HSS. Additional W12's and W14's were used to reinforce the two existing stairwells in order to support the increased dead load on the roof due to the addition of the pool on the roof.

To ensure the addition of the pool did not infringe too heavily on the floor-to-floor height below it, a new roof was constructed approximately two feet above the existing roof on the existing building only. This new roof of structural steel framing consists of W12's, W14's, and W18's, which were embedded into the existing load bearing parapet masonry walls and rest on steel embedded bearing plates.

Figure 11: Existing Stripped Column, Courtesy of Luis Ortiz

Two cranes were used at differing times on the project to fly steel to the respective floors. The first was a 17.5-ton tower crane and the second was a 35-ton city truck crane. To see the location of these cranes, refer to Construction Site Plan Phase 2: Superstructure and Existing Roof in Appendix A. The tower crane can be seen in Figure 10 on the previous page.

Cast in Place Concrete

The existing building structure consists of concrete columns, beams, and two-way slabs. This structure received some upgrades due to the additional dead load of a pool on the roof of the building. Several of the existing concrete columns were stripped down to their outer surface of spiral ties and rewrapped with carbon fiber or concrete after additional reinforcing had been added. A stripped column can be seen in Figure 11. In addition to these upgrades, all of the existing footings were enlarged to increase their load-bearing capacity to the new weight.

The three floor new addition was constructed of concrete columns and beams with post-tensioned slabs. This system rests on a foundation of grade beams, pile caps, and finally piles.

All of the cast in place concrete was placed directly from the concrete truck or pumped to the desired location. The cast in place columns were formed with spiral tubing, whereas the concrete beams and slabs were formed with plywood. The footers, grade beams, and pile caps did not require any formwork.

Mechanical System

There are two larger mechanical rooms accompanied by eight smaller rooms, all located in the existing building. One of the larger main rooms is located on the ground floor, and the other is located on the fourth. Of the remaining eight rooms, four are located on the second floor and four are located on the third floor.

The primary mechanical system is a mixed water and glycol Variable Air Volume (VAV) system. Ventilation air comes from the heat recovery makeup air unit located in the fourth floor mechanical room. Air is preconditioned within this unit with the enthalpy wheel before being distributed to and conditioned in one of the 18 Air Handling Units (AHUs) in the four-pipe system located throughout the building. These small AHU's are essentially fan coil units. A 310 GPM chiller is located in the fourth floor mechanical room and affords the AC system with chilled water. An 850 MBH gas-fired hot water boiler supplies the hot water for the system. Because the structure is exposed and there is no plenum space to utilize for return air, the system utilizes both supply and return ducts.

Both the new addition and the existing building received a new wet pipe sprinkler system due to its reliability and simplicity.

Electrical System

The electrical system ties into the grid from the existing connection, a 208/120, 3-phase, 4 wire, 1600 amp feed supplied by Pepco. Because a back-up generator was not included for this particular project, emergency fire alarms were specified to have battery back-ups.

The majority of the lighting in the fitness center consists of HID downlights, with specialty LED lighting in certain areas for accenting.

Masonry

Typical for buildings built in this area in the late 1800s, the existing building at 1612 U Street had exterior load-bearing masonry walls (approximately 1.5 feet thick), though most of the load is still carried by the structural concrete columns.

Figure 12: New Addition Curtain Wall, Photo Taken by Clara Watson

The masonry walls on the addition are comprised of standard brick veneer with an air cavity, rigid polystyrene insulation, and an air/vapor barrier. These are attached to 8" x 8" x 16" CMU blocks that tie into the precast floor slabs. These 8" CMU walls are reinforced every 24" o.c. and fully grouted. The brick veneer is tied into the masonry with steel lintels at all interfaces.

Free standing scaffolding was used on the East and South sides of the building for masonry construction. The location of this scaffolding can be seen in the Construction Site Plan Phase 3: Finishes and Existing Roof in Appendix A.

Curtain Wall

Because the existing building's exterior walls were constructed of load-bearing masonry, the only curtain wall on the project was located on the North and South façades of the new addition. These elevations are almost entirely glass storefront with aluminum framing (shown in Figure 12 on the previous page), with HSS to support the curtain wall itself. A glass folding Nana wall is located on the front of the new addition on the ground floor level, and will eventually be able to be opened for the new restaurant.

After the steel contractor installed the HSS, these storefront windows were installed by a glass subcontractor on a boom lift and were designed by the structural engineer for the project, Rathgeber Goss Associates.

PROJECT COST EVALUATION:

The RS Means Square Foot Cost Estimate and the RS Means Assembly Cost Estimate can be found in Appendix B and Appendix C, respectfully.

Project Parameters

PROJECT PARAMETERS			
Parameter	Existing Building	New Addition	Total
Square Footage	49450	10920	60370
Number of Floors	4 + Penthouse	3	5
Footprint (SF)	9890	3640	13530

Construction Costs vs. Total Project Costs

The cost information shown below is based upon a cost estimate afforded by Forrester Construction and does not represent actual project bid costs. The Construction Costs (CC) shown in the table below exclude site work, land costs, contingency, permitting, and contractor fees. To calculate the cost per square foot, the total square footage was taken from the Project Parameters table above.

ACTUAL PROJECT COSTS	
Parameter	Existing Building
Construction Costs (CC)	$ 8,891,768.00
CC/SF	$ 147.29
Total Project Costs (TC)	$ 12,355,031.00
TC/SF	$ 204.66

Building System Costs

The following is a summary of the construction costs of the major building systems.

ACTUAL MAJOR BUILDING SYSTEMS COSTS		
System	CC	CC/SF
Plumbing	$ 726,895.00	$ 12.04
Fire Protection	$ 119,350.00	$ 1.98
Mechanical	$ 2,217,219.00	$ 36.73
Electrical	$ 1,135,570.00	$ 18.81
Structural Concrete	$ 135,046.00	$ 2.24
Structural Steel	$ 280,327.00	$ 4.64

Cost Comparison

In order to provide an accurate comparison of the three estimations, the construction costs must be compared rather than the total costs because RS Means excludes site work, design fees, contingencies, etc. The table below compares the actual total construction costs with the construction costs of the RS Means Square Foot Estimate. The square foot estimate is a little over $2M lower than that of the actual construction cost. This could be due to a number of reasons, but is most likely attributed to the fact that the gymnasium square foot cost data provided by RS Means does not include the high-end finishes that the VIDA Fitness Center has (not to mention it excludes the saunas and spa).

Actual Construction		RS Means SF	
Total Cost	CC/SF	Total Cost	CC/SF
$ 12,355,031.00	$ 204.66	$ 10,695,000.00	$ 177.16

The table below summarizes the total construction costs for the mechanical, electrical, plumbing, and fire protection systems. (Full break-downs of the RS Means estimates can be seen in Appendix B and Appendix C, respectively.) As shown, the Square Foot Estimate is the lowest of the three. This is likely due to the generalization of the estimate. Because of the Owner's high standards on this project and because it is a fitness center, a higher-end mechanical system was installed. Though the Assembly Estimate accounts for more of the mechanical system specifics than the Square Foot Estimate, the actual construction cost is still higher than both estimates. Once again, this is likely due to the fact that high-end systems were installed, along with high-end fixtures.

Actual Construction		RS Means SF		RS Means Assembly	
Total Cost	CC/SF	Total Cost	CC/SF	Total Cost	CC/SF
$ 4,614,407.00	$ 76.44	$ 2,307,000.00	$ 38.21	$ 3,396,938.71	$ 56.27

Notes

RS Means CostWorks software was utilized for both the Square Foot Estimate and the Assembly Estimate.

For any items or parameters that were not listed in RS Means that were specified for use on the project, the closest possible match was chosen for use in the estimates.

GENERAL CONDITIONS ESTIMATE:

The General Conditions Estimate can be found in Appendix D.

The General Conditions Estimate for the VIDA Fitness Project can be broken down into three main areas: Project Team & Personnel, Site Expenses, and Miscellaneous Costs. The Project Team & Personnel section of the General Conditions Estimate includes all of the management and support staff on the VIDA project. The Site Expenses section consists of costs relating to the site office, Owner sales trailer, and other various site construction costs. Last, the Miscellaneous Costs are made up of insurance, bonds, contingency, and permit costs. A summary of the General Conditions Estimate can be seen below in the table below. A more detailed breakdown of each General Conditions line item is shown in Appendix D.

General Conditions Summary				
LINE ITEM	QUANTITY	UNIT	RATE	TOTAL COST
Project Team & Personnel	52.00	WKS	$ 10,996.92	$ 571,840.00
Site Expenses	52.00	WKS	$ 2,486.48	$ 129,296.97
Miscellaneous Costs	52.00	WKS	$ 19,313.94	$ 1,004,324.85
Total General Conditions Cost			**$32,797**	**$ 1,705,461.82**

The $1,705,462 General Conditions Estimate was developed using both RS Means and MC² Estimating rates. For items where exact project rates were known, the actual rates were used instead of the estimated rates. Note that the total estimated cost in the table above includes Miscellaneous Costs. This number compares with the actual General Conditions Estimate provided by Forrester of $1,071,889 which also includes Miscellaneous Costs. As seen in Figure 13, the Miscellaneous Costs make up approximately 59% of the General Conditions Costs. If these costs are removed, the estimated General Conditions Costs total $701,137, which compares with Forrester's estimate of $779,183.

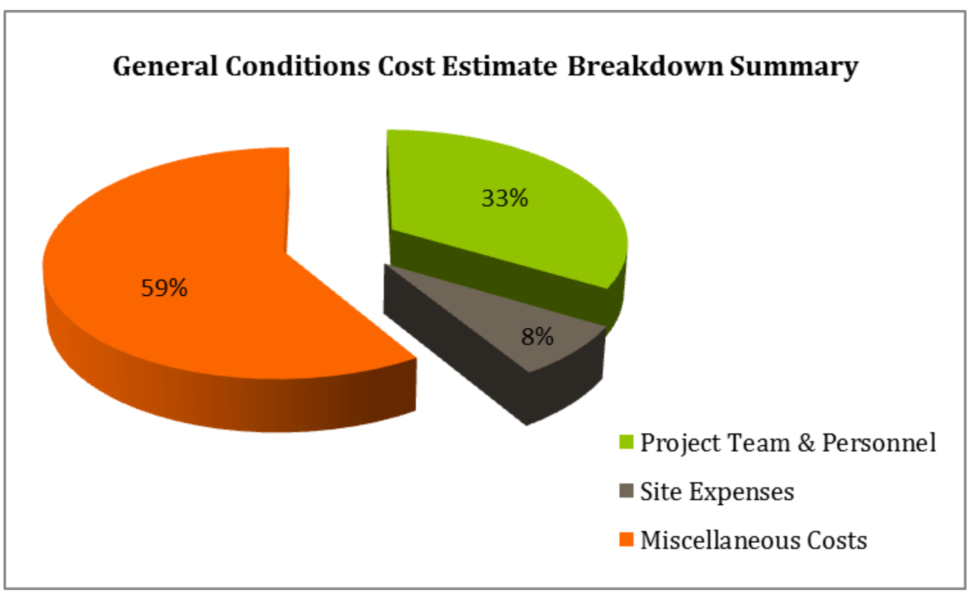


Figure 13: General Conditions Cost Estimate Breakdown

The $701,137 General Conditions Estimate is in comparison with an original contract value of $11,093,165 (excluding all change orders). The cost difference between the General Conditions Estimate detailed in Appendix D and Forrester's actual General Conditions Estimate is likely due to the percentage costs of insurance, bonds, contingency, and permits. These items are estimated by a percentage of the entire project cost; RS Means provides broad ranges for these percentages, which could cause the General Conditions Costs to vary greatly.

Due to the Owner's personal preference, several items that would normally be included in General Conditions Costs were instead bid out to subcontractors in Division 2 of the CSI MasterFormat. These costs included such items as construction fencing and site utilities and totaled an estimated $176,551. For a full line item breakout of these costs not included in the General Conditions Estimate, see Appendix D.

The $1,705,462 General Conditions amount accounts for approximately 15% of the project cost. This is high when compared to many projects, mainly because it is a renovation and because of the relationship between von Storch and the project team. This is the fourth VIDA constructed by Forrester, meaning that the project team knew what items would be needed in the General Conditions section and added them accordingly. The fact that this project is mainly a renovation rather than new construction would also increase the percentage of General Conditions Costs when compared to the Overall Project Cost. This is due to the fact that the structure of the building remained, meaning minimal project costs were associated with the structure, which is often an expensive component of a project. If the Overall Project Cost largely negates structural costs, the Overall Project Cost will be smaller in comparison to the General Conditions Costs, which will result in the increased percentage of General Conditions Costs.

Overall, General Conditions Costs account for approximately $32,797 a week (if Miscellaneous Costs are included) or $13,483 a week (if Miscellaneous Costs are not included). It is evident that monitoring the project schedule is critical for maintaining the project budget and not incurring any additional General Conditions Costs.

EXISTING CONDITIONS SITE PLAN SUMMARY:

The Existing Conditions Site Plan can be seen in Appendix E.

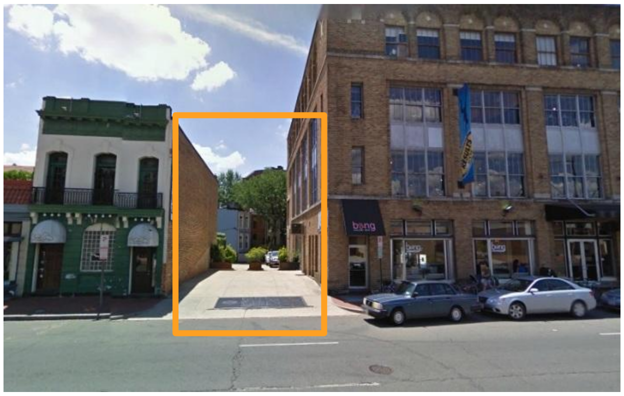


Figure 14: Alley Alongside Existing Building, Courtesy of Google Earth

The existing building on 1612 U Street is located between two existing structures, a Chi-Cha Lounge and Stetson's Famous Bar and Grill. The Chi-Cha Lounge is directly adjacent to the existing fitness center, but there was an alley between Stetson's and the existing gym.

As seen in **orange** in Figure 14, the existing building had an alley running along its East side. VIDA Fitness was expanded into this alley up to the adjacent neighboring building (Stetson's). This area was previously used for alley access and parking, which was rerouted during construction. The new 45 foot addition was Phase 1 of construction and began while the existing building was still occupied by its previous tenants.

Figure 15: VIDA Fitness Rendering, Courtesy of SvS

The addition of a new Penthouse on the main existing roof of the building will bring the total height of the health club to 66FT. At this height, VIDA will be taller than both neighboring buildings to the East and West, as both of these buildings are two stories and three stories, respectively (shown in Figure 15 on the previous page). The two neighboring buildings are shown in **red**. For a full Existing Conditions Site Plan, which includes utilities, building footprints and heights, property lines, and traffic flows, see Appendix E.

SITE LAYOUT PLANNING:

The Phased Construction Site Plans for the three main phases of construction can be seen in Appendix A.

Due to the limited space on site, each phase of construction was planned so as to maximize efficiency and minimize any time wasted due to site congestion. The construction site can be seen in the aerial photo shown below in Figure 16. The overall site is outlined in **red** and the existing building is highlighted in **blue**.

Figure 16: Aerial View of Site, Courtesy of Google Earth

The following is a detailed description of the three construction site plans created for each main phase of construction. These plans can be found in Appendix A.

Phase 1: Foundation for New Addition

The demolition and excavation phase of the project began on the new addition while the existing building was still occupied. This phase of work included demolition of the existing concrete pad, excavation for pile caps, pile installation, and pouring the pile caps. The excavator and Bobcat shown in this plan move throughout the construction area (shown in yellow) during this phase. The concrete truck shown was used for the placement of the pile caps and slab on grade, and accessed the construction area through the alley on the south side of the site. The two construction fences shown in red could be moved at any time to allow for construction vehicle access and were placed merely for security purposes.

All demolished concrete and excavated soil was removed out of the South side of the construction area and loaded onto a live-load dumpster. Any construction vehicles that needed to be in the alley had to be manned at all times, and all dumpsters had to be live-load only. This ensured that the alley could be cleared quickly for any residential neighbors needing to access the area. Temporary road blocks were also placed at the three alley entrances and two laborers were stationed full-time to monitor the alley and ensure only permitted vehicles (and local residential traffic) were allowed to access the area.

The Owner placed a trailer at the front of the building to begin selling gym memberships to VIDA Fitness throughout the course of construction. This trailer was used only for the Owner and no other trailer was used throughout construction. The construction management team set up an office on the third floor of the existing building and moved the office throughout the course of construction to ensure it did not hinder the project schedule.

Considering the challenges posed with a tight site and expedited schedule, this site layout functioned well at this stage of the project. Pedestrian traffic was not hindered and the flow of construction vehicles was as logical as it could be given the space. The project management team worked with the neighbors to ensure that local residents and business owners were not impeded by the construction.

Phase 2: Superstructure and Existing Roof

The construction of the superstructure of the new addition began while part of the existing building was still occupied. Concrete trucks used the back alley for access to pour the three floor addition with an entirely cast in place post-tensioned concrete structure. A new roof over the existing building also began construction in this phase. A 90-ton hydraulic truck crane was used to erect and disassemble the 17.5-ton tower crane. The tower crane was then used to move structural steel to the roof, where a new roof was erected two feet above the existing roof (to allow more depth and structural stability for the new pool).

Once the existing building was vacated, workers began saw-cutting an opening in the concrete slab on every floor for the addition of a steel monumental staircase. This is shown in **green** on the Phase 2 Site Plan. The tower crane was also used at this time to remove pieces of demolished slab cut concrete from the existing building. Once the slab was demolished, the monumental stairwell previously mentioned was lowered through the hole in pieces. There were two prefabricated stair runs for each floor, meaning that a total of ten stair runs were lowered through the opening and held in place with the crane while the steel crew welded them in place.

Though more congested than the previous plan, this plan is also logical considering the provided parameters. Alley access was again monitored by two full-time laborers and all material deliveries were made between the hours of 7AM and 7PM in the two construction lanes at the front of the building. All materials were immediately off-loaded and stored in pre-approved storage areas throughout the building. Subcontractors coordinated the location of their material storage with

Forrester Construction's on-site Superintendent. There are no substantial changes that could be made to this site plan to improve it or the construction flow.

Phase 3: Finishes and Existing Roof

As high-end finishes began going into the interiors of both the existing building and new addition, steel erection on the existing roof began for the fifth floor penthouse and bar area. The installation of metal decking also began over the new steel installed for the new roof on the existing building.

Material deliveries were again made on the North side of the building and either carried to a storage area inside the building or lifted with one of the two boom lifts. The exception to this was the storefront glass, which was kept outside of the building (shown in **pink** on the site plan) and installed in the new addition using one of the lifts. The 35-ton city truck crane was on site only when needed, and was used mainly for lifting coping stone and materials to one of the two roofs.

The scaffolding along the East and South sides of the building was used to install the 45" brick wall around the perimeter of the new addition's accessible roof. This posed the only problem with this site plan, as the scaffolding on the East side of the building was suspended over Stetson's roof and mortar was dropped onto the neighbor's roof. To remedy this, the masons covered Stetson's roof with plastic and removed it after they had finished with their masonry work. Though the location of the scaffolding angered the owner of Stetson's, there was no other feasible way to install the brick wall on the East side of the addition.

Overall, the three site plans for the main phases of construction, though cluttered, were logically thought through and laid out, presenting realistic representations of the construction process and flow of both vehicles and materials on the construction site.

Local Conditions:

Overview

Even through the downturn of the economy, Washington D.C. remains one of the main construction hubs in the country. Reinforced concrete remains the preferred structural building material in the area, mainly due to the strict height restrictions set by Congress in the Heights of Buildings Act (Grunwald). Other construction challenges include high population density, generally constricted sites, heavy traffic, historical preservation guidelines, building codes, a high water table, and zoning specifications.

History

Located on 1612 U Street NW in Washington D.C. (shown in Figure 17) on a 14,485 square foot site, the VIDA Fitness project is a renovation and addition to an existing building that housed a Results Gym, Café 1612, Bulldog Productions, and a Bang Salon.

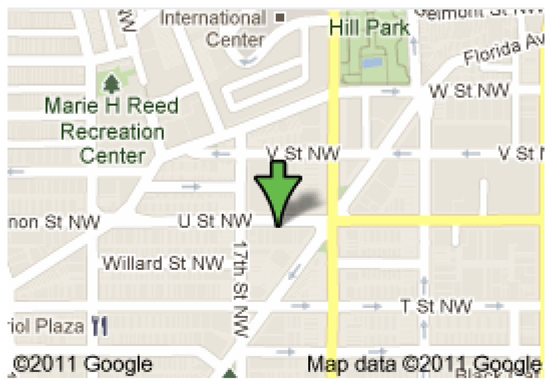


Figure 17: VIDA Fitness Location, Courtesy of Google

This complex is located on the U Street Corridor, an area that not only houses many residential row houses, but also various nightclubs, restaurants, bars, shops, galleries, and music venues. Because the majority of the area was developed between 1862 and 1900 and most of the architecture is considered Victorian, it has been designated as part of the historic district (Ault). It is for this reason that the project architect had strict guidelines both for designing the exterior façade of the new building addition and for renovating the existing building façade (Greater U Street). Approved by the Historic Preservation Review Board, the addition is said to "complement and preserve the historic architecture of the existing circa 1921 building" (Hays).

Soil and Subsurface Water Conditions

The geotechnical report revealed topsoil to be existent at depths from 2-4 inches on this site, along with a water table 12 feet below ground surface (BGS). Because of this, a sump pump was utilized during excavation for pile caps and grade beams.

Waste Removal

Due to the tight site conditions, only one dumpster at a time could fit in front of the building. These were typical dumpsters for miscellaneous site materials and waste with a cost of $500 per trade-out; Forrester Construction allotted for thirty dumpsters throughout the course of the project. Occasionally, waste would need to be removed in large quantities from the back of the site via the alley. In these instances, the dumpster would be live-loaded while still on the truck, in case any local residents needed alley access. None of the construction waste materials was recycled on this project site.

Site Parking

On-site parking was extremely limited for both construction vehicles and building occupants because of the downtown site location. Only six parking meters existed in front of the building, and due to the residential area behind the building, any construction vehicle needed in that area had to be manned at all times to ensure easy alley access for locals. As seen in Figure 18 below, during construction hours of 7AM-7PM, Forrester Construction had permits for the parking lane and the first lane of traffic in front of the site. These spots were reserved for deliveries, lifts, cranes, and Superintendent, Project Manager, and Assistant Project Manager parking. All other construction workers were required to find parking either on neighboring streets (limited to two hours) or in the parking garage up the street (aproximately 0.5 miles away from the jobsite) that cost $11/day.

Figure 18: VIDA Site Parking; Picture Taken by Clara Watson

Local Bylaws and Permitting

Washington D.C. adopts the international codes that are published by the International Code Council (ICC). The Department of Consumer and Regulatory Affairs issues permits in D.C. and requires building permits for construction of the following:

- New construction and foundations
- Additions, alterations, or repair to existing buildings
- Demolition
- Signs or awnings erection
- Razes
- Fence, retaining wall, shed, vault, or garage construction
- Interior layout changes in an existing commercial building

A public space permit was also required for this project because a trailer and dumpster were kept in the front of the building for part of the construction process. The location of these can be seen on the construction site plans located in Appendix A. The use and occupancy of public spaces and public space permitting is overseen by the District Department of Transportation (DDOT).

Typical to most large cities, the permits become invalid and expire if construction has not begun within one year after the permit has been issued. Permits can take up to 30 days to acquire and fines are afforded to those who break the terms of the permit or do not follow its specific scope of work (which includes the project documents and plans). Any modifications made to the plans after approval or the permit scope must be reapproved.

One of the challenges with acquiring a building permit on this project was that the building is in the historic district, meaning that any proposed changes to the building must preserve the historical characteristics. The histroic preservation design review process is typically part of the building permit process in this area and takes place for the addition or alteration of a building façade. The Historic Preservation Office (HPO) and Historic Preservation Review Board (HPRB) both review any proposed changes before approving the project documents and plans for construction.

DETAILED PROJECT SCHEDULE:

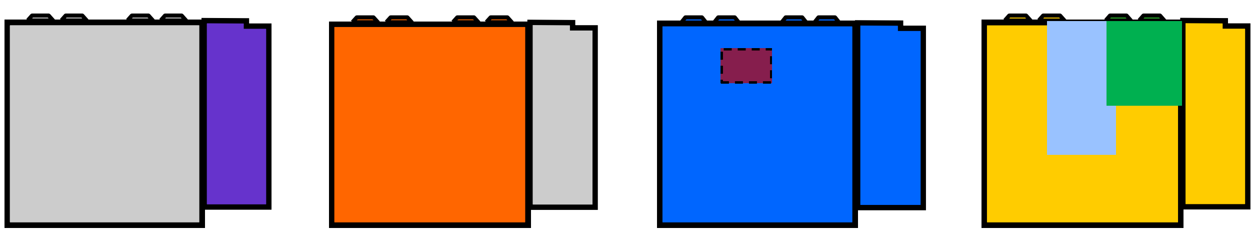
The Detailed Project Schedule can be found in Appendix F.

Overview

The project schedule was one of the main driving factors for this project, due to the fact that the Owner lost approximately $100,000 for every week that the Fitness Center did not open. The extremely tight project schedule was made even more stressful when unforeseen structural conditions delayed the project. The Detailed Project Schedule shown in Appendix F is a relatively thorough and sequential summary of the key activities throughout the project. This schedule does not reflect any delays during construction, but rather depicts the original projected project schedule.

Sequencing

This Detailed Project Schedule abridges the main areas for construction on the project. Phase 1 consists of procurement, preconstruction, and the base building of the new addition. Phase 2 consists of the renovation of the existing building, all interior work, and all roof work. The zones detailed on the project schedule are depicted in Figure 19 below and represent the differing construction areas.



These construction areas are ordered on the Detailed Project Schedule by start date; an overview of these zones with their construction dates can be seen in the table on the next page.

While these individual areas were relatively independent of each other, the tasks in these phases are almost all in sequential order. The delay of one task would push all those in that sequence back, delaying the project schedule. Overlapping shown between tasks was critical to the project being completed successfully on time. The building also opened to the public in varying stages, so delays in of one of the construction areas could potentially have delayed the opening of a portion of the building.

NEW ADDITION
MAIN ROOF
SECOND, THIRD, AND FOURTH FLOORS
MONUMENTAL STAIR / ELEVATOR
FIRST FLOOR OFFICES / ENTRY
FIRST FLOOR BANG SALON
FIRST FLOOR FUTURE SPA / RESTAURANT

Figure 19: Construction Areas for the Detailed Project Schedule

Task Name	Duration	Start	Finish
PHASE 1: New Addition Construction	**305 days**	**Wed 2/3/10**	**Tue 4/5/11**
Procurement / Preconstruction	305 days	Wed 2/3/10	Tue 4/5/11
New Addition Construction	116 days	Mon 10/18/10	Mon 3/28/11
PHASE 2: Renovation & Interiors	**197 days**	**Thu 12/16/10**	**Sat 9/17/11**
Roof	156 days	Thu 12/16/10	Fri 7/22/11
Fourth Floor	107 days	Tue 2/1/11	Thu 6/30/11
Monumental Stairs & Elevator	59 days	Tue 2/8/11	Fri 4/29/11
Second Floor	50 days	Mon 2/28/11	Fri 5/6/11
Third Floor	45 days	Mon 2/28/11	Fri 4/29/11
First Floor - Offices / Entry	59 days	Tue 2/22/11	Fri 5/13/11
First Floor - Future Spa / Restaurant	65 days	Tue 3/1/11	Mon 5/30/11
First Floor - Bang Salon	43 days	Tue 3/1/11	Fri 4/29/11
Project Close-Out	101 days	Fri 4/29/11	Sat 9/17/11

TECHNICAL ANALYSIS 1: APPLICATION OF REREV ENERGY HARVESTING SYSTEM

The electrical breadth summary can be seen in Appendix BB.

Problem Identification

No specific sustainable practices or technologies were incorporated into the VIDA Project, due mainly to the fact that it was not a priority of the Owner. However, with the large consumption of electricity from the building, great potential exists to incorporate sustainability to decrease monthly utility bills. Over 100 pieces of cardio fitness equipment and two endless pools (swimmers' treadmills) contribute to the massive electricity use at the VIDA Fitness Center. With this immense amount of energy use, introducing a sustainability feature that could potentially result in a net decrease in electricity usage could provide substantial long-term cost benefits to an Owner with intentions of remaining in the downtown U Street location indefinitely.

Research Objectives

This analysis was chosen as the critical industry issue analysis because sustainability plays such a key role in today's AEC industry and because of the strong personal interest in the topic as a whole. Various ways exist in which green practices can be integrated into a project this size, many of which would not only decrease electricity usages but could also aid in promoting a positive public image of the Fitness Center as an environmentally friendly building. A ReRev energy harvesting system captures the DC kinetic energy generated from cardio equipment and converts it to AC power. This system is specified for fitness centers alone and affords a unique and trendy approach to commercial sustainability application. Implementing this system with the cardio equipment could provide potential energy and long-term cost savings for VIDA, along with a "green" feature that would promote a positive, sustainable image to the public.

In order to properly analyze the employment of a ReRev system at VIDA, several key aspects must be thoroughly researched and considered. The initial equipment and installation cost must be measured against the payback period in a lifecycle cost analysis to evaluate the feasibility of installation. The VIDA General Manager can be interviewed not only to receive feedback on his opinion of implementing an energy harvesting system, but also to obtain information on the electricity usage and costs for VIDA.

Case studies for other similar fitness centers will be studied for feedback on the ReRev system along with the general public opinion before and after ReRev integration. The installation process for the ReRev system will be examined in conjunction with how best to incorporate the system to maximize its use; this evaluation will introduce an electrical breadth that will be needed for a partial system redesign with integration of the ReRev system.

Application Methodology

To properly analyze the employment of a ReRev energy harvesting system, the following steps will be taken:

- Additional research on ReRev systems and application with similar projects will be performed.
- The VIDA Fitness General Manager will be interviewed to provide further feedback on public opinions, feasibility, and related electricity use and cost information.
- The ReRev manufacturing company will be contacted to access detailed cost and energy generation numbers associated with the system.
- The ReRev system will be designed according to the project size and energy consumption.
- An electrical breadth analysis will be performed for a partial electrical system redesign due to the addition of the ReRev system (see Appendix BB).
- A project implementation strategy will be researched to identify areas both before and after construction that will be affected by the addition of the ReRev system; once these areas are determined, the most beneficial approach for applying ReRev will be selected and explored.
- Varying project impacts due to the introduction of the ReRev system will be investigated.
- An overall return on investment and lifecycle cost analysis will be performed through the utilization of data collected from previous steps.
- Lastly, an overall feasibility analysis will be developed considering the lifecycle cost, return on investment, and electricity generation of the ReRev system against the Owner's likes and opinions.

Preliminary Analysis

Because of the initial expense of the ReRev system and challenges associated with other unknown variables, a cursory study on the feasibility of this technical analysis was performed. According to a USA Today article written on the ReRev system, the average cost to introduce ReRev per piece of cardio equipment is approximately $1,000 (Kioh). With roughly 100 pieces of cardio equipment, the overall cost of the system should be around $100,000.

The ReRev manufacturers claim a thirty minute workout can generate approximately 50 watts of power (ReRev). If each piece of cardio equipment were used for approximately 10 hours a day, nearly one kilowatt of electricity per machine would be generated. According to ReRev manufacturers, this could provide a potential payback period of 15 years (Parks). Though these numbers are estimates, they ensure at least partial feasibility for the employment of ReRev and lay the groundwork for a more detailed and technical study.

System Overview

Hudson Harr graduated four years ago with dual degrees in mechanical and electrical engineering and set forth to develop a way to capture the kinetic energy created with cardio exercise and turn it into electrical power. Harr's patent-pending Renewable Energy Revolution, or "ReRev" system, began in his mother's house but has now blossomed into a multi-million dollar company of which he is president. This energy harvesting system captures the DC energy generated from cardio equipment and converts it to AC power and is 98 percent efficient. To do this, gym equipment is retrofitted by removing the internal resistance present in cardio equipment and instead applying an external resistance load consisting of a small generator and central processing unit (CPU). This reroutes the heat energy emitted, converting it into utility grade electricity while removing some of the heat load on the mechanical system. Each of these units is fed into an inverter, which is tapped into the AC mains panel and can handle approximately 20-25 cardio machines (Parks). Figure 20 shows the overall conversion of heat energy into utility grade electricity.

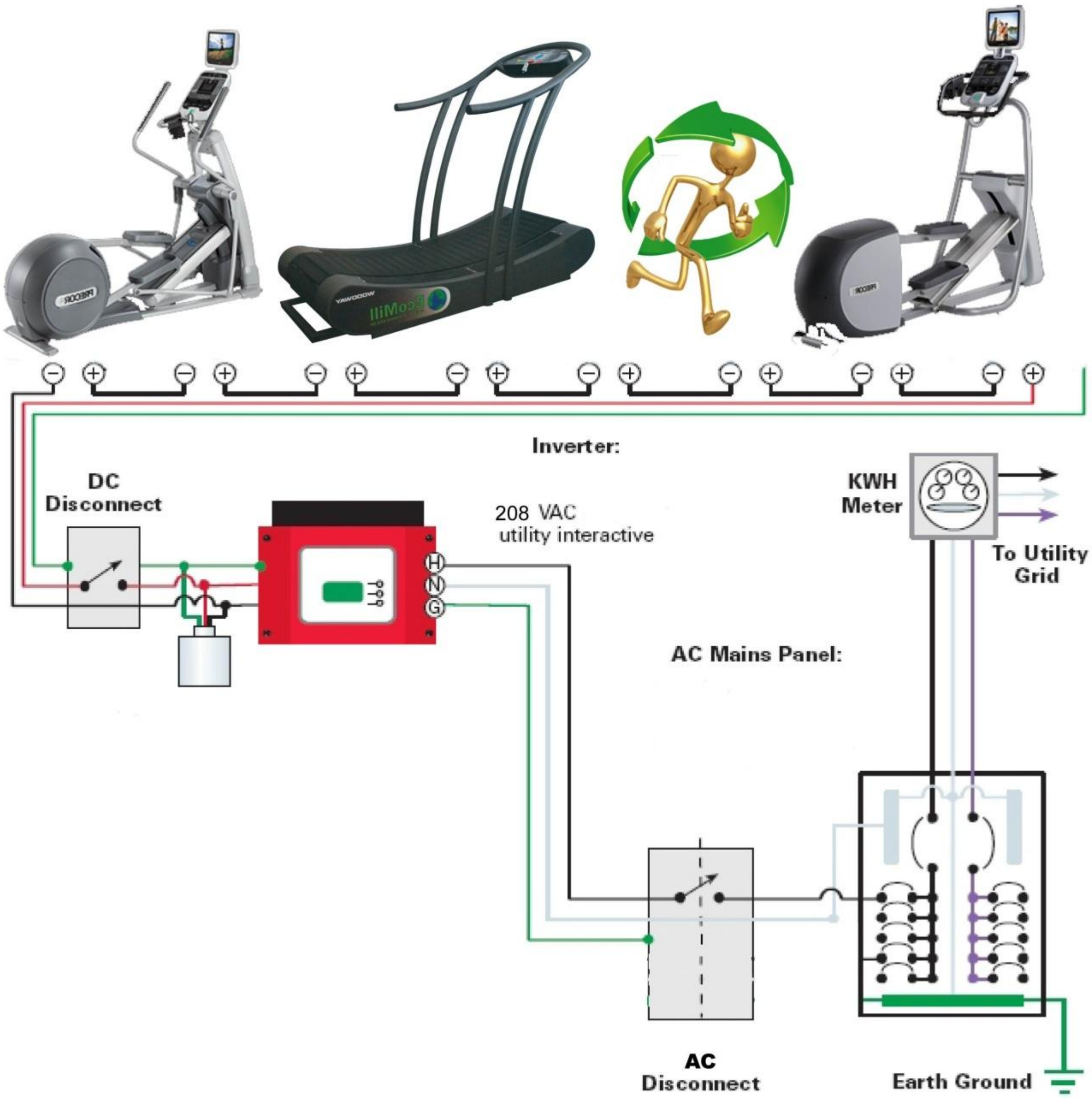


Figure 20: ReRev Schematic (ReRev)

Though many people are often skeptical that ReRev will generate enough power to make any substantial difference in energy savings, Harr's business ideas were developed for health clubs where machines are almost constantly in use. Because most are used for more than 10 hours a day, it can be considered "crowd farming, a term to describe the collective impact of small contributions from a mass of people" (Parks). According to the manufacturer, an average 30-minute cardio workout can generate approximately 50 watt-hours of electricity. This, in turn, is enough to power a compact fluorescent light bulb (CFL) for 2.5 hours, charge a cell phone 6 times, or power a laptop for an hour. The ReRev Company provides a turnkey system that includes system design, equipment supply and installation, and maintenance training (ReRev).

Energy Generation and Total Output

To calculate the annual kilowatt savings, several variables had to first be determined, including the types of equipment and number of each type. This information for VIDA is summarized in the table to the right and was provided by the VIDA General Manager. It was also necessary to determine the average number of hours per day each piece of equipment is used; this proved to be more difficult, as some types of equipment are used more than others and some days of the week are busier than others.

VIDA Cardio Equipment	
Type	**Number**
Treadmill	36
Elliptical	25
Stairmaster	4
Upright Bike	6
Recumbent	6
X-Trainer	8
Arc Trainer	5
Spin	30
Total	120

With this information provided by the General Manager, the Cardio Equipment Usage Summary tables in Appendix G were created for each day of the week. These tables have an hourly breakdown and depict which pieces of equipment are in use on certain hours of the day. The Cardio Equipment Usage Summary per Equipment Type chart shown below compiles the results of these daily tables and provides averages in hours for daily usage and equipment usage.

Cardio Equipment Usage Summary Per Equipment Type						
Day	**Treadmills**	**Ellipticals**	**StairMasters**	**Upright Bikes**	**Recumbent Bikes**	**Daily Average**
Sundays	14.00	13.00	12.00	10.00	10.00	11.80
Mondays	18.00	18.00	18.00	18.00	18.00	18.00
Tuesdays	18.00	18.00	18.00	17.00	17.00	17.60
Wednesdays	18.00	18.00	17.00	17.00	16.00	17.20
Thursdays	18.00	18.00	18.00	16.00	16.00	17.20
Fridays	18.00	18.00	17.00	16.00	16.00	17.00
Saturdays	14.00	14.00	14.00	14.00	14.00	14.00
Average	16.86	16.71	16.29	15.43	15.29	16.11

As seen above, the overall average for both days of the week and equipment type was found to be 16.11 hours per day. Multiplying this number by the total number of cardio machines (120), the total hours of use per day can be determined for all of the cardio equipment that could be integrated with the ReRev System. This equation is shown below:

$$(\boldsymbol{Average\ Hourly\ Use}) \times (\boldsymbol{Number\ of\ Cardio\ Machines}) = \boldsymbol{Total\ Hours\ of\ Use\ Per\ Day}$$

The total hours of use per day can then be multiplied by the average amount of watts generated hourly by one machine, typically 100 watts/hour, which determines the watts per day generated (Odato). Multiplying the watts per day generated by the number of days per year VIDA is open to the public provides the total number of watts generated per year. Both of these equations are shown below.

$$(\textbf{Hours of Use Per Day}) \times (\textbf{Watts Per Hour Generated}) = \textbf{Watts Per Day Generated}$$

$$(\textbf{Watts Per Day Generated}) \times (\textbf{Days Per Year}) = \textbf{Watts Per Year Generated}$$

The average hourly equipment use was also used in conjunction with these equations to calculate the average number of watts produced per day of the week. These calculations are shown in the table below.

Average Watts Produced Per Day of the Week				
Weekday	Daily Hours of Use	Watts Produced Per Hour	Number of Machines	Watts Produced Per Day
Sunday	11.80	100.00	120.00	141600.00
Monday	18.00	100.00	120.00	216000.00
Tuesday	17.60	100.00	120.00	211200.00
Wednesday	17.20	100.00	120.00	206400.00
Thursday	17.20	100.00	120.00	206400.00
Friday	17.00	100.00	120.00	204000.00
Saturday	14.00	100.00	120.00	168000.00
Average	16.11			193371.43

These results are visualized in Figure 21 below and reflect the busiest days (or days open longer) as producing the most watts.

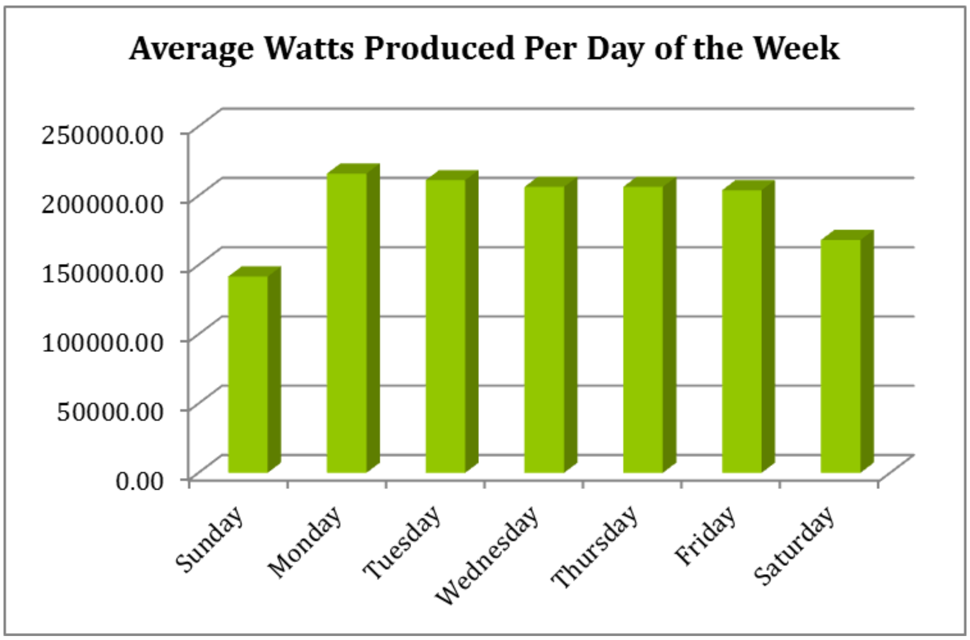


Figure 21: Average Watts Produced Per Day of the Week

Comprehensive Cost Analysis

Two main types of savings are accrued from implementing ReRev, cost savings associated with kilowatt savings and cost savings associated with decreased cooling loads. The US Bureau of Labor

Statistics publishes average energy prices for the Washington-Baltimore area and provided the average cost per kilowatt ($0.129) for the past year. This cost was multiplied by the kilowatts per year to determine the kilowatt savings for the first year the system was in use. These equations are shown below.

$$(\boldsymbol{Average\ Cost\ Per\ kW}) \times \frac{\boldsymbol{Watts\ Per\ Year\ Generated}}{\boldsymbol{1000\ Watts}} = \boldsymbol{Kilowatt\ Savings\ for\ Year\ One}$$

The equation to calculate the kilowatt savings had to be adjusted for each year succeeding the first due to the yearly increases in energy costs. Using an estimated 5% energy rise (provided by the ReRev manufacturer), the following equation was used.

$$(\boldsymbol{kW\ Savings\ From\ Previous\ Year}) \times (\boldsymbol{1} + \boldsymbol{Percent\ Energy\ Rise}) = \boldsymbol{Yearly\ kW\ Savings}$$

Because of the process of converting heat energy, the use of a ReRev system decreases the amount of heat generated by each piece of equipment. In order to calculate the annual air conditioning (AC) and AC power savings associated with this heat loss, the number of months of AC use had to first be determined. According to the VIDA General Manager, the Locker Rooms and Yoga studios were conditioned eight months out of the year and all other spaces (including the cardio and equipment areas) were conditioned year round. The following equation was developed to determine the average number of months that air conditioning is running at VIDA.

$$\frac{\boldsymbol{1}}{\boldsymbol{Total\ VIDA\ SF}} \left(\frac{\boldsymbol{SF\ of\ Locker\ Rooms/Yoga}}{\boldsymbol{8\ Months}} + \frac{\boldsymbol{SF\ of\ Cardio/Equipment}}{\boldsymbol{12\ Months}} \right) = \boldsymbol{AC\ Months}$$

Once solved, this equation provided the average number of air conditioning months per year to be 11.43 months. This number was divided by the total number of months per year and then by both the percent of annual AC savings and the annual kilowatt savings. The equation used below solves for the total annual AC savings. Thirty percent was provided by the ReRev manufacturer for the percent of AC savings and was used in the following equation.

$$(\boldsymbol{Yearly\ kW\ Savings}) \times (\%\ \boldsymbol{of\ AC\ Savings}) \times \frac{\boldsymbol{Months\ of\ AC\ Use}}{\boldsymbol{12\ Months\ Per\ Year}} = \boldsymbol{Annual\ AC\ Savings}$$

To calculate the total yearly savings from implementing the ReRev system, the kW and AC cost savings were summed with the following equation.

$$(\boldsymbol{Annual\ kW\ Savings}) + (\boldsymbol{Annual\ AC\ Savings}) = \boldsymbol{Total\ Annual\ Cost\ Savings}$$

A summary of these results and associated cost savings over a 40-year period can be seen in Appendix H.

System Proposal and Payback Period

Though the estimated cost for a ReRev system is approximately $1,000 per machine, it was necessary to get a detailed estimate provided by the manufacturer in order to calculate the system payback period (ReRev). The ReRev manufacturer was contacted and the proper facility assessment paperwork was completed and sent. This included the type of equipment, number of each type, and model number. A cardio equipment layout was also required for the system estimate. A layout for both the second and third floor was created and can be seen in Appendix I.

The resulting ReRev System Proposal provided by the company can be seen in Appendix J and dictates the total system cost to be $148,000. Using the cost analysis developed in the previous section with total calculated savings shown in Appendix H, the simple payback period for this equipment is 11 years. A summary of this is seen in the table below.

ReRev System Annual Savings Calculations					
Year	Annual KW Savings	Annual A/C Savings	Total Savings	Potential Profit	Simple Payback
1	$ 9,080.67	$ 2,594.80	$ 11,675.47	$ (136,324.53)	
2	$ 9,534.70	$ 2,724.54	$ 23,934.71	$ (124,065.29)	
3	$ 10,011.43	$ 2,860.77	$ 36,806.91	$ (111,193.09)	
4	$ 10,512.01	$ 3,003.81	$ 50,322.72	$ (97,677.28)	
5	$ 11,037.61	$ 3,154.00	$ 64,514.32	$ (83,485.68)	
6	$ 11,589.49	$ 3,311.70	$ 79,415.50	$ (68,584.50)	
7	$ 12,168.96	$ 3,477.28	$ 95,061.74	$ (52,938.26)	
8	$ 12,777.41	$ 3,651.14	$ 111,490.30	$ (36,509.70)	
9	$ 13,416.28	$ 3,833.70	$ 128,740.28	$ (19,259.72)	
10	$ 14,087.09	$ 4,025.39	$ 146,852.76	$ (1,147.24)	
11	$ 14,791.45	$ 4,226.66	$ 165,870.86	$ 17,870.86	$ 148,000.00

With this in mind, all cost savings accrued after the eleventh year of operation would be seen as potential profit. The life expectancy of the ReRev equipment is 25 years if the equipment is located outside; because this equipment is located inside, it can be expected to last longer. (The price calculations provided by the ReRev manufacturer were for a 40-year duration). Even if the cardio equipment must be replaced, the ReRev equipment can be used for the extent of its life. The total potential profit per year can be seen in Appendix H on the Annual Savings Calculations table.

Energy Impact

Because the construction on VIDA was completed only recently, their monthly electrical bills are still estimated and exact power usage could not be provided. To calculate an estimated power use, a case study on The California State University of San Bernardino was compared. The 38,000 square foot fitness facility on campus had 20 machines retrofitted with ReRev back in 2009. This fitness center uses approximately 2,100 kilowatt hours of electricity per day (Santschi, 4). Dividing this number by the total square footage of the facility provides an estimated kilowatt hours per square foot used for one day and was found to be approximately 0.055 kWh/SF. This number was then multiplied by the total square footage of VIDA to calculate the estimated kilowatt hours used per day at VIDA. These equations are shown below.

$$\frac{\textit{Kilowatt Hours Used Per Day}}{\textit{Total Square Feet}} = \textit{Kilowatt Hours Used Per SF of a Fitness Center}$$

$$(\textit{Kilowatt Hours Used Per SF}) \times (\textit{VIDA SF}) = \textit{Kilowatt Hours Used Per Day at VIDA}$$

These equations conclude that the kilowatt hours used daily at VIDA comes to approximately 3336.24 kWh/day or 1,217,726.45 kWh/year. For comparison, the following equation was used to calculate the percentage of the total energy generated annually with the ReRev system.

$$\frac{\textbf{Kilowatt Hours Generated Per Day}}{\textbf{Kilowatt Hours Used Per Day}} = \textbf{Percent of Total Energy Generated}$$

This percentage was found to be 5.76 percent of the total energy generated, a small yet significant number.

Social Impact

The common assumption is that it is too expensive to build a sustainable or green building for smaller commercial projects. Even if this were true, the money saved over the life of the building through reduced energy costs in the form of lower utility bills would far outweigh any additional cost of construction (Green Buildings). What are generally overlooked are the long-term maintenance costs that come with buildings that are not designed to be sustainable. When a sustainable building is designed and built, the efficiency with which the building and its site use and harvest energy, water, and materials is increased. Building impacts on human health and the environment are reduced through better design, construction, operation, and maintenance (Green Buildings). Going "green" through energy-efficient construction results in lower energy consumption, decreased utility bills, elevated inhabitant productivity, and healthier indoor air quality.

The United States Green Building Council (USGBC) developed the LEED (Leadership in Energy and Environmental Design) rating system to certify buildings according to points earned for implementing sustainable practices and materials on a building or project. The levels of certification vary according to the amount of points earned (USGBC). Though LEED certification was not attempted on the VIDA project, there are and were many areas where materials or practices could have been adjusted to earn LEED points without significantly changing the project schedule or cost.

In addition to providing energy and long-term cost savings for VIDA, implementation of the ReRev system also introduces a "green" feature that promotes a positive, sustainable image to the general public. Being "green" is popular right now for a variety of reasons, making terms such as "LEED" or "sustainability" buzzwords commonplace. With the introduction of on-site renewable energy, VIDA is given a potential to earn an additional three LEED points (because the ReRev system generates over five percent renewable energy). These additional three points increase VIDA's overall score to 60 points, a LEED Gold Rating. Not only is this a very high rating, but the addition of these three points raises the rating level from Silver to Gold. (For a full LEED Evaluation and the LEED Scorecard, see Appendices K and L respectively).

As the VIDA Fitness Centers' focus is on improving health and well-being, the attainment of LEED certification and a display of the certification to customers would be an additional selling point for membership.

Not only does the installation of the ReRev system generate energy that can be used throughout the building, but it also promotes environmental and sustainable public awareness. When the installation process takes place, the owner has the opportunity to provide a display on each cardio machine highlighting the amount of power generated by the user as he or she works out. Because setting achievable goals increases the rate of an individual's success, the idea of generating energy while working out offers added incentive and interest to many people.

To analyze this hypothesis, a three-question survey was created and sent to 250 people of varying ages and geographical locations. The survey, shown in Appendix M, closed after the first 100 responses were recorded. The results show that 86 percent of responders selected that it was "very likely" they would be willing to use cardio equipment that generated electricity from the ReRev system. With this in mind, 67 percent of responders declared that they would consider using a fitness center that offered energy-generating cardio equipment over a fitness center with typical cardio equipment. The response results from this question can be seen in Figure 22 below.

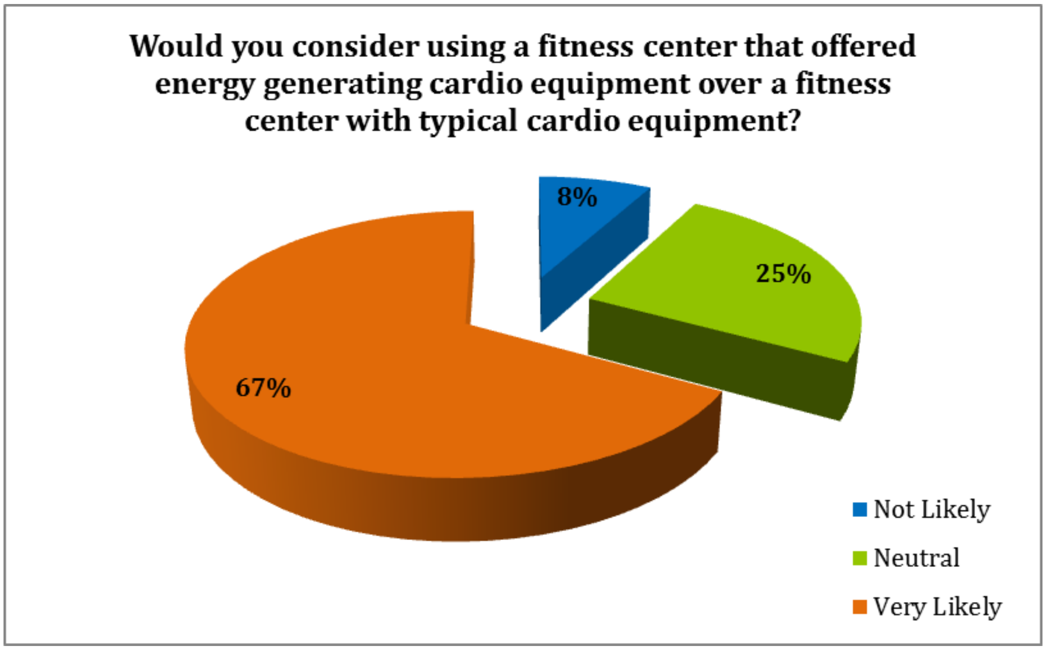


Figure 22: Survey Question 3 Results

It is clear from these results that implementing a ReRev system at VIDA would not only save electricity, but would also increase interest in the gym as a whole.

Not only is the reduced electricity usage tied to cost savings, but it also promotes positive environmental effects. An average of 0.5416 kg of carbon dioxide (CO_2) is produced per kilowatt-hour; using the Simple Carbon Calculator provided by the National Energy Foundation, the kilograms of CO_2 saved by implementing ReRev total 41,648 kg per year (National Energy Foundation). With a display on each cardio machine showing the amount of energy saved (along with the typical calories burned, distance traveled, etc.), users can not only have the satisfaction of feeling healthier with each workout, but they can also feel satisfaction with the understanding that they are saving electricity and helping the environment (Barois, 11).

According to a study performed by the US Environmental Protection Agency on the educational benefits associated with energy-generating exercise equipment in a gym, the presence of such equipment not only significantly improved user's "understanding of renewable energy sources, but also increased the amount of participants that engaged in positive environmental behavior" (The Effectiveness of Energy). These results explain that not only does a gym with energy-generating equipment promote the conservation of energy, but it also reinforces the benefits associated with sustainability and its practices. Instead of energy existing as an immeasurable quantity that people find difficult to understand or relate to, ReRev allows for energy to become a quantifiable and understandable value tied to many activities and decisions in everyday life.

Potential Funding and Renewable Energy Incentives

Several possible programs exist, including rebates, incentives, and tax credits that can aid in recovering the initial ReRev system cost. Local power companies can provide additional assistance, as many provide incentives for the use of a renewable resource (ReRev). Pepco, the electric provider for VIDA, offers an incentive of up to $250,000 for their C&I Energy Savings Program under special projects. To be eligible, the project must be new commercial construction or a major renovation, be at least 50,000 square feet, and must incorporate energy saving practices. Pre-approval is required prior to the purchase and installation of the equipment. A possible $1,000 is provided for the project for the brainstorming of renewable energy generating opportunities. An additional $5,000 for the first 50,000 square feet is provided for a simulation analysis on the renewable energy project; another $0.03 is available for each additional square foot over the initial 50,000. (For VIDA, this accumulates to only $311.10.) During the construction phase of the project, incorporating the designed energy efficient measures or renewable energy ideas can generate $8,000 in incentives (Pepco). This totals a possible $14,311.10 in incentives provided by Pepco. Any additional incentives provided by Pepco would be project-specific.

The District of Columbia also offers incentives with their Renewable Energy Incentive Program for businesses (REIP). With this program, the incentives are based upon the amount of kilowatt output produced by a renewable energy source. For each of the first 3,000 installed watts of capacity, $1.50 is given, and an additional $1.00 is given for the next 7,000 installed watts of capacity. Lastly, $0.50 is provided for each of the next 10,000 installed watts of capacity. The total incentive cost is capped at 20 kilowatts, or $16,500 per year (Renewable Energy Incentive). With 70,175.16 watts generated per year by the ReRev machines at VIDA, this qualifies for the maximum rebate of $16,500 every year.

Using the Pepco incentives provided the first year of the project and the REIP incentives provided annually, the project payback period drops to 5 years from the initial 11 year period.

The savings calculations for the first 5 years can be seen in the table below.

ReRev System Annual Savings Calculations Including Incentives							
Year	Annual KW Savings	Annual A/C Savings	Potential Pepco Incentive	Potential REIP Incentive	Total Savings	Potential Profit	Simple Payback
1	$ 9,080.67	$ 2,594.80	$ 14,311.10	$ 16,500.00	$ 42,486.57	$ (105,513.43)	
2	$ 9,534.70	$ 2,724.54	$ -	$ 16,500.00	$ 71,245.81	$ (76,754.19)	
3	$ 10,011.43	$ 2,860.77	$ -	$ 16,500.00	$ 100,618.01	$ (47,381.99)	
4	$ 10,512.01	$ 3,003.81	$ -	$ 16,500.00	$ 130,633.82	$ (17,366.18)	
5	$ 11,037.61	$ 3,154.00	$ -	$ 16,500.00	$ 161,325.42	$ 13,325.42	**5**

For the total savings over a 40 year period taking incentives into account, reference Appendix N.

New and Existing Warranties

ReRev provides its own 5-year warranty following the initial date of installation, which can be seen in Appendix O. ReRev has also contracted with several cardio equipment companies to ensure that retrofitting the machines will not void their individual warranties (Epstein, 8).

Electrical Breadth: System Impacts and Electrical Tie-in

The VIDA electrical system ties into the grid from the existing connection, a 208/120, 3-phase, 4 wire, 1600 amp feed supplied by Pepco. Each of the 120 cardio units is fed into an inverter, which is tapped into the AC main panel and can handle approximately 20-25 cardio machines (Parks). According to the facility proposal provided by ReRev specifically for VIDA, six 3,600 watt grid-tied inverters will be required for this facility. A cut sheet for an inverter chosen for this application can be seen in Appendix P.

In order to properly size the breakers and wires, it was necessary to work backwards from the information provided by ReRev in their System Proposal. ReRev provided a wire size of #14 AWG from the control board (located inside each piece of cardio equipment) and the junction box. A #8 AWG wire size was also provided between the DC Disconnect and the Inverter. Assuming a Power Factor of one, the following equation was used to determine the ampacity of the wires between the Inverter and AC Disconnect.

$$\frac{\boldsymbol{Watts}}{\boldsymbol{Volts}} = \boldsymbol{Amps} \times \boldsymbol{Power\ Factor}$$

$$\frac{\mathbf{3600}\ \boldsymbol{Watts}}{\mathbf{208}\ \boldsymbol{Volts}} = \mathbf{17.3}\ \boldsymbol{Amps}$$

Once calculated, this number was used in conjunction with the National Electric Code (NEC) to determine a wire size of #12 AWG which has a maximum ampacity of 25 amps. This is greater than the required 17.3 amps, so this size wire is suitable.

The schematic shown in Figure 23 below was developed to delineate the changing wire sizes.

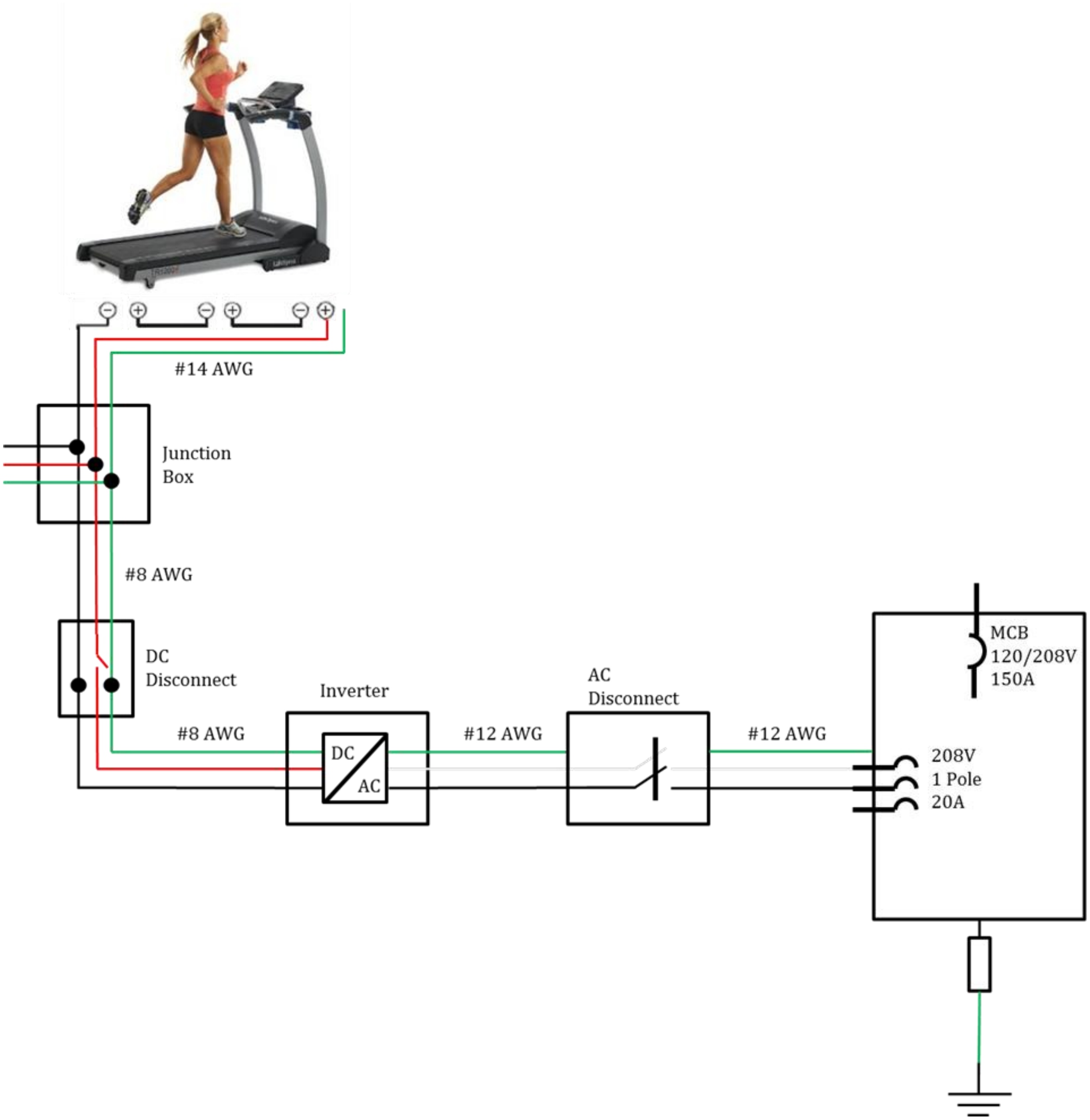


Figure 23: ReRev Electrical Schematic

Due to the lack of space in the existing panels, it was necessary to add an additional panel. The breakers were also sized with the NEC, and were found to be 20 amp breakers. This number is greater than the wire ampacity but less than the maximum load ampacity, so it is appropriate in this instance.

The panel schedule shown below was created to relay this information.

PANEL SCHEDULE			Amps = 150			AIC = 10,000		
Volts = 208/120			Mounting = Surface			Type = MCB		
Phase / Wire = 3Φ 4W			Fed From = DPB			Spaces = 12		
REV 1								
CKT NO	NO	LOAD	TRIP	POLE	VOLT	kVA	WIRE	COND
1	1 - ReRev Inverter		20	1	208	3.6	3 #12 + 1#12g	3/4" EMT
2	2 - ReRev Inverter		20	1	208	3.6	3 #12 + 1#12g	3/4" EMT
3	3 - ReRev Inverter		20	1	208	3.6	3 #12 + 1#12g	3/4" EMT
4	4 - ReRev Inverter		20	1	208	3.6	3 #12 + 1#12g	3/4" EMT
5	5 - ReRev Inverter		20	1	208	3.6	3 #12 + 1#12g	3/4" EMT
6	6 - ReRev Inverter		20	1	208	3.6	3 #12 + 1#12g	3/4" EMT

Once this was determined, the main circuit breaker (MCB) was sized with the equations below.

$$(\boldsymbol{Number\ of\ Breakers}) \times (\boldsymbol{Ampacity\ of\ Wires}) = \boldsymbol{Ampacity\ of\ Main\ Circuit\ Breaker}$$

$$(\mathbf{6}) \times (\mathbf{17.3}\ \boldsymbol{Amps}) = \mathbf{103.8}\ \boldsymbol{Amps}$$

$$(\boldsymbol{Ampacity\ of\ MCB}) \times (\%\ \boldsymbol{Spare}) = \boldsymbol{Adjusted\ Ampacity\ of\ Main\ Circuit\ Breaker}$$

$$(\mathbf{103.8}) \times (\mathbf{25}\%) = \mathbf{129.8}\ \boldsymbol{Amps}$$

Using the NEC, the main circuit breaker was sized for a 150 amp capacity, greater than the 129.8 ampacity required. The wire sized for the MSB to the service is 1/O and has a 150 amp capacity. The panel schedule shown below reflects this information.

PANEL SCHEDULE			Amps = 800			AIC = Existing		
Volts = 208/120			Mounting = Surface			Type = 800A Main		
Phase / Wire = 3Φ 4W			Fed From = MDB			Spaces = SWBD		
DPB								
CKT NO	NO	LOAD	TRIP	POLE	VOLT	kVA	WIRE	COND
1	1 - Panel 1A		200	3	208	30	3 #12 + 1#12g	3/4" EMT
2	2 - Panel 2A		200	3	208	23	3 #12 + 1#12g	3/4" EMT
3	3 - Panel 3A		200	3	208	13	3 #12 + 1#12g	3/4" EMT
4	4 - Panel REV1		150	3	208	22	3 #12 + 1#12g	3/4" EMT
5	5 - Panel 5A		200	3	208	20	3 #12 + 1#12g	3/4" EMT
						108 = Total kVA Connected		

Conclusions and Recommendations

Not only does the installation of a ReRev system at VIDA promote the generation of clean, carbon-free electricity, but it also exemplifies a unique and trendy approach to commercial sustainability application. With the incentives for renewable energy, the payback period is only five years for the installed ReRev equipment and predicts an accrued savings of $730,371.52 after 20 years and $2,084,704.75 after 40 years. Even if the incentives could not be obtained, the payback period is still only 11 years. Because of these results, it would be theoretically recommended that a ReRev system be implemented at VIDA.

TECHNICAL ANALYSIS 2: STUDY OF SCHEDULED OVERTIME EFFECTS ON WORKER PRODUCTIVITY AND QUALITY

Problem Identification

Schedule was an extremely critical factor on this project because it was the Owner's personal goal for groundbreaking on the new addition in August, 2010, followed by the opening of the entirely renovated gym along with the three-story addition in March, 2011. Though construction on the new addition began according to schedule and continued while the existing Results Gym remained open, the renovation of the entire existing 50,000 square foot building (and accessible roof) was left to be completed, along with the finish work of the new addition, in a mere three months. For every week that VIDA Fitness did not open on time, the company lost approximately $100,000, a fact that made it critical for the fitness center to open on time and according to the project's schedule. The extremely tight project schedule was made even more stressful when unforeseen structural conditions delayed the project. Keeping on schedule was further hindered when the installation of the monumental stairwell took more than twice as long as originally scheduled.

Due to the fact that the initially tight schedule was delayed early in the construction process, subcontractors began to work six-day work weeks of 12-hour days. The crew productivity levels of trades working these extreme hours began to drastically decrease towards the end of the summer. The general opinion was that of frustration, exhaustion, and burn-out from working such long hours on the same project. It became difficult to motivate workers and keep them on schedule late in the project.

Research Objectives

Morale can often be key to a project's success, which is why this negative attitude towards the project from overworking most likely had an adverse effect on productivity and workmanship quality levels. It is possible that there was a point in the VIDA project where the additional overtime labor costs coupled with quality and productivity losses became more expensive than working a typical, 40-hour work week.

Scheduled overtime is traditionally utilized in construction to accelerate the project schedule, either to make up lost time on a delayed project or simply to ensure a project with an extremely constricted timeframe does not fall behind schedule. In the case of the VIDA project, scheduled overtime was used to combat both of these reasons. Research has proven that this extended use of overtime can negatively affect worker productivity on a project. Investigations on this topic will be conducted in order to properly analyze whether it is possible that the overtime costs and efficiency losses associated with working overtime at VIDA outweighed the costs of working a traditional, 40-hour week.

These issues are extremely difficult to research, as it is challenging to gauge productivity levels and how they are adversely linked to overtime on a project. Dr. Randolph Thomas, a Penn State researcher, thoroughly investigated this idea with the aid of numerous performed case studies. His research and publications provide data to consider and adjust for applicability on the VIDA Fitness project. Information including average worker wages, overtime hours worked per subcontractor, and crew sizes can all be obtained through interviews with each of the major trade foremen on the project or from quantities found in daily reports. Differences in initial and actual schedules can be determined by comparing the original project schedule to the actual construction schedule, provided by Forrester Construction.

Application Methodology

To properly investigate the effects of scheduled overtime work on the VIDA project, the following steps will be taken:

- Additional research on overtime effects will be conducted, with specific focus on Dr. Thomas' research.
- Trade foremen will be interviewed and asked to provide average worker wages, overtime hours worked, and average crew sizes for the project.
- The applicability of the gathered research for the VIDA project will then be examined, along with the project specific impacts associated with the overtime work.
- A cost analysis will be performed to compare the costs of overtime labor and loss of efficiency with the existing 72-hour work week.
- The project work schedule will then be analyzed to determine any duration changes.
- Lastly, an overall feasibility analysis will be developed evaluating the cost analysis and revised work schedule with the positive and negative implementation effects of each.

Preliminary Analysis

Because the calculations associated with this technical analysis require significant time and research, a preliminary analysis was performed by researching common effects of scheduled overtime and identifying which effects could be considered specifically for the VIDA project. A Penn State AE Construction Management alum, Thomas Horensky, was also interviewed because of his experience with this topic on his own thesis project. He encouraged the idea by providing research guidance and stating how diminishing marginal returns on working continuous overtime is one of the most overlooked issues within schedule acceleration.

Background Information

The US Bureau of Labor Statistics (BLS) produced a detailed study in the 1940s that has become a standard for labor productivity analyses through the decades. This study concluded that "the average productivity for 50-hour, 60-hour, and 70-hour work weeks were 92%, 84%, and 78% respectively" (Bureau of Labor). With this in mind, it was logical that the schedule overtime of 12-hour work days for six days a week at VIDA would have greatly decreased worker efficiency. In this case, as is standard in the construction industry, scheduled overtime is defined by working more than 40-hour weeks (Brunies, 2).

Though the BLS report evaluated many case studies to produce these results, the study was not focused on the construction industry alone. There have been several studies completed since the

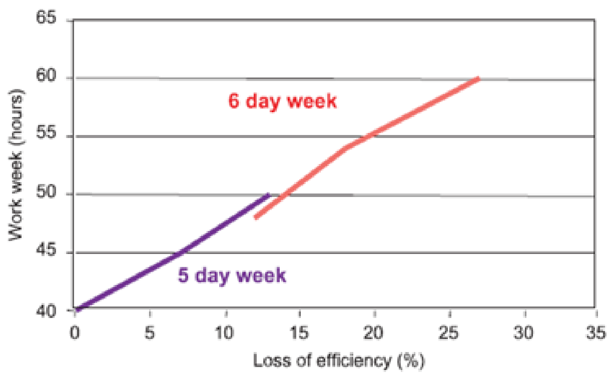


Figure 24: Loss of Efficiency vs. Work Week (Brunies)

release of this publication, most of which reflect the results of the BLS study, and several of which have been focused on the construction industry. Foster Wheeler Corporation focused their research to construction scheduling and produced results very similar to that of the BLS study. This study compared the negative effects of working a six-day work week in place of a five-day work week.

As seen by the graph in Figure 24, losses in efficiency from working six days a week could potentially near 30% (Brunies, 2).

Building on this study, the Business Roundtable (BRT) published a report in 1980 that narrowed the analysis to "Scheduled Overtime Effects on Construction Projects". The data that was utilized to compile results for this report was, for the first time, taken from several construction jobs over a 10-year period. It also began to focus on *why* productivity decreases with overtime, showing the disruption frequency and its relationship to the number of hours worked. These "disruptions" are generally defined as anything that could adversely affect labor efficiency, and were categorized into three groups by Dr. Randolph Thomas and Dr. Karl Raynar in "Scheduled Overtime and Labor Productivity: Quantitative Analysis". The three groups are Resources, Rework and Management. Using these three groups, Figure 25 lists various disruptions that impeded the efficiency on the VIDA project (Raynar, 13).

Figure 25: Disruptions at VIDA

Productivity Loss Calculations

After isolating the disruptions, it was important to understand how they had an adverse effect on the productivity level at VIDA. Dr. Thomas and Dr. Raynar proved that increased overtime increased the number of disruptions, so it can therefore be concluded that overtime indirectly causes disruptions. "Scheduled Overtime and Labor Productivity" explains that overtime itself does not cause decreases in productivity, but rather causes additional variables to cause issues (Raynar, 3). The Differences in Work Week Hours chart below compares the average number of hours worked per day at VIDA compared to a typical work week.

Differences in Work Week Hours		
Days	**Typical Work Week**	**VIDA Work Week**
Sunday	0	0
Monday	8	12
Tuesday	8	12
Wednesday	8	12
Thursday	8	12
Friday	8	12
Saturday	0	12
Total	40	72

The total 72-hour work week is 32 hours longer than a traditional week; this 32 hours accounts for an 80% increase in the amount of labor hours when compared to a typical week. Though this is a drastic increase in work hours, it did not allow for the work to be completed 80% faster. For this to happen, all aspects associated with the construction process would have had to occur 80% faster; this means the project team would have to answer 80% more questions, process 80% more paperwork, and ensure materials, equipment, and tools were available 80% more quickly. This is where the link is drawn explaining why it is disruptions during overtime that actually account for the majority of the productivity loss (Raynar, 3).

After this relationship was determined, it became necessary to calculate the exact productivity losses associated with the scheduled overtime on the VIDA project. The graph shown in Figure 26 on the next page summarizes the data for productivity levels associated with progressive overtime work (Brunies, 6). This graph combines both efficiency decreases from number of work days and efficiency decreases from the number of work hours per day.

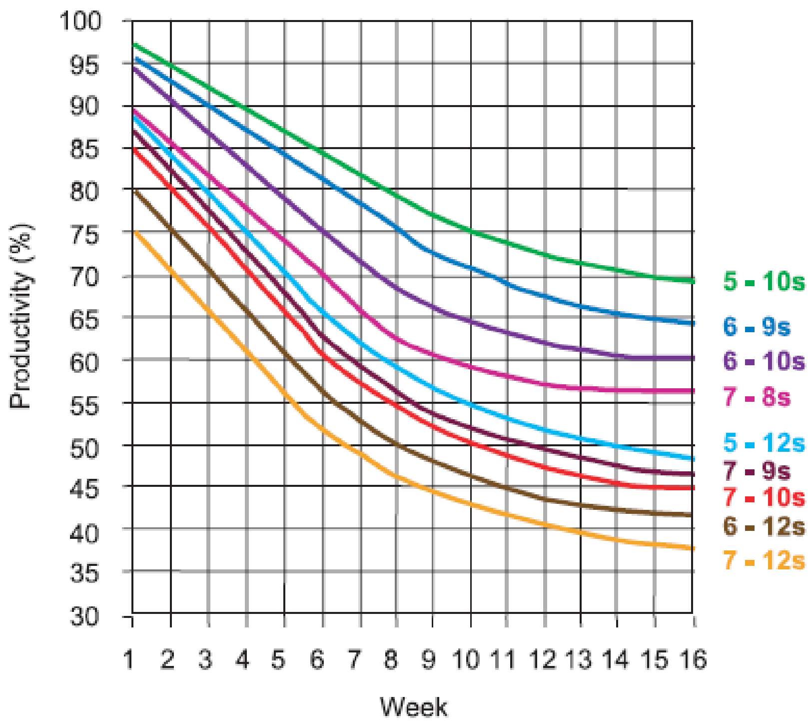


Figure 26: Productivity Levels vs. Number of Work Weeks (Brunies)

To properly compare this data with VIDA overtime hours, six subcontractors were observed for a total of 20 weeks. The steel, masonry, electrical, plumbing, drywall, and mechanical subcontractors were the six chosen, as they had the majority of the work and were on-site most regularly. The 20-week period was chosen because it focused on the months where the majority of the work took place on the project. Of these 20 weeks, 16 were taken to use in the productivity calculations. These sixteen weeks varied per subcontractor, ensuring that during the sixteen weeks chosen the specified subcontractor (sub) was working every week. The charts depicting which subcontractors were on site which weeks can be seen in Appendix Q.

Wage Loss Calculations

After selecting 16 weeks for which each of the six subcontractors was consecutively on-site, the data was used from Figure 26 to compute the actual effective work hours per week. As evidenced by the chart, productivity steadily declined as the weeks progressed. For example, after 16 weeks of working six, 12-hour days, the worker productivity level decreased to 41% as opposed to 75% during the fourth week. This is a total of 72 hours worked per week, 40 of which are considered regular work hours and 32 of which are considered overtime hours. Calculating 41% of each of these numbers produces 16.4 regular effective hours and 13.1 overtime effective hours respectively. This equation is shown below:

$$(\boldsymbol{Work\ Hours}) \times (\boldsymbol{Productivity\ Percentage}) = \boldsymbol{Effective\ Work\ Hours}$$

Subtracting these numbers from the regular work hours (40) and overtime work hours (32) demonstrates the regular and overtime hours lost per week. This equation is shown below:

$$(\boldsymbol{Work\ Hours}) - (\boldsymbol{Effective\ Work\ Hours}) = \boldsymbol{Hours\ Lost\ Per\ Week}$$

Finally, the total lost wages per subcontractor were calculated by multiplying the hours lost by the average laborer salary from each subcontractor and then again by the average number of laborers per week. These equations are shown below:

$$(\boldsymbol{Hours\ Lost\ Per\ Week}) \times (\boldsymbol{Average\ Laborer\ Salary}) = \boldsymbol{Lost\ Wages\ Per\ Laborer}$$

$$(\boldsymbol{Lost\ Wages\ Per\ Laborer}) \times (\boldsymbol{Average\ Number\ of\ Laborers}) = \boldsymbol{Total\ Lost\ Wages}$$

An example for these calculations is shown for the steel subcontractor in the table below:

Steel Subcontractor Lost Wages (6-12s)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
3	40	32	0.80	32.0	25.6	8.0	6.4	$42.13	$63.20	$ 741.49	4	$ 2,965.95
4	40	32	0.75	30.0	24.0	10.0	8.0	$42.13	$63.20	$ 926.86	7	$ 6,488.02
5	40	32	0.71	28.4	22.7	11.6	9.3	$42.13	$63.20	$ 1,075.16	8	$ 8,601.26
6	40	32	0.65	26.0	20.8	14.0	11.2	$42.13	$63.20	$ 1,297.60	7	$ 9,083.23
7	40	32	0.61	24.4	19.5	15.6	12.5	$42.13	$63.20	$ 1,445.90	7	$ 10,121.31
8	40	32	0.57	22.8	18.2	17.2	13.8	$42.13	$63.20	$ 1,594.20	7	$ 11,159.39
9	40	32	0.54	21.6	17.3	18.4	14.7	$42.13	$63.20	$ 1,705.42	9	$ 15,348.80
10	40	32	0.50	20.0	16.0	20.0	16.0	$42.13	$63.20	$ 1,853.72	9	$ 16,683.48
11	40	32	0.48	19.2	15.4	20.8	16.6	$42.13	$63.20	$ 1,927.87	10	$ 19,278.69
12	40	32	0.46	18.4	14.7	21.6	17.3	$42.13	$63.20	$ 2,002.02	11	$ 22,022.19
13	40	32	0.45	18.0	14.4	22.0	17.6	$42.13	$63.20	$ 2,039.09	11	$ 22,430.01
14	40	32	0.44	17.6	14.1	22.4	17.9	$42.13	$63.20	$ 2,076.17	9	$ 18,685.50
15	40	32	0.43	17.2	13.8	22.8	18.2	$42.13	$63.20	$ 2,113.24	8	$ 16,905.93
16	40	32	0.42	16.8	13.4	23.2	18.6	$42.13	$63.20	$ 2,150.32	4	$ 8,601.26
17	40	32	0.41	16.4	13.1	23.6	18.9	$42.13	$63.20	$ 2,187.39	4	$ 8,749.56
18	40	32	0.41	16.4	13.1	23.6	18.9	$42.13	$63.20	$ 2,187.39	4	$ 8,749.56
Totals				345.2	276.2	294.8	235.8			$ 27,323.83		$205,874.14

Because some of the subcontractors were unwilling to release this salary information, the average laborer salaries per hour were taken from R.S. Means for Washington D.C. The overtime hourly wages were assumed to be 1.5 times that of the regular hourly rate. The total lost wages calculations for each subcontractor can be seen in Appendix R. A summary of the totals can be seen in the chart below:

Total Lost Wages per Subcontractor (6-12s)						
Steel Sub	Masonry Sub	Electrical Sub	Plumbing Sub	Drywall Sub	Mechanical Sub	Total
$ 205,874.14	$ 151,021.89	$ 329,616.98	$ 299,003.37	$ 224,169.08	$ 329,796.02	$ 1,539,481.48

These totals show that approximately $1.5 million was wasted because it was spent on ineffective labor. Figure 27 below summarizes this data and shows a percentage breakdown for each of the major six subcontractors:

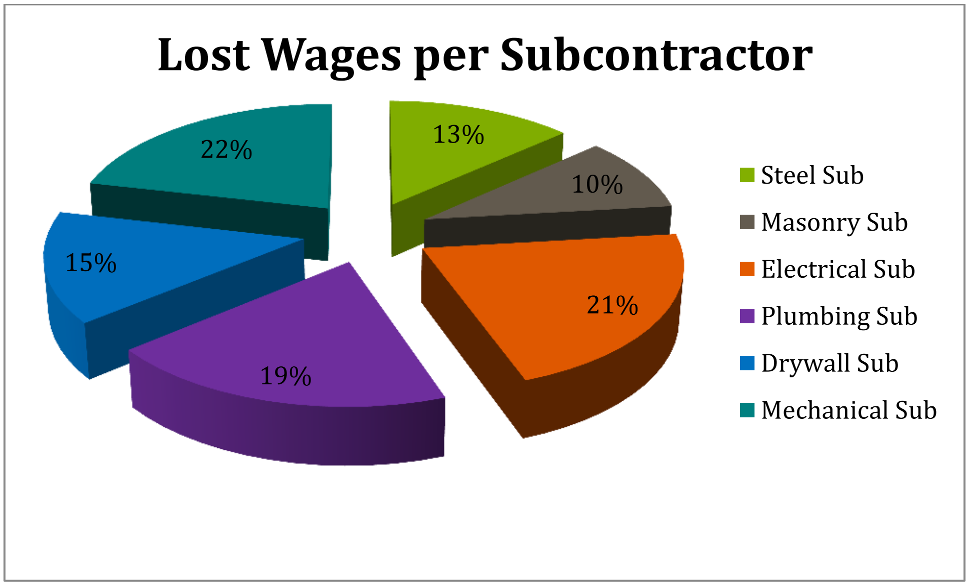


Figure 27: Lost Wages Per Subcontractor

Though only the six most active subcontractors on the project were analyzed, several other subcontractors worked overtime hours, though it was more sporadic and the results would be significantly more difficult to predict and analyze. It is still, however, likely that they too would contribute to lost wages because of productivity losses.

Comparing Scheduled Overtime Alternatives

The two most common ways of completing work more rapidly on a construction project are to either increase the amount of workers, or increase the number of hours worked. Due to the tight schedule and complications associated with a zero lot line project, the site was extremely congested and increasing the labor force was not an applicable solution. It was for this reason scheduled overtime was initially implemented with six, 12-hour work days. Because scheduled overtime was necessary to complete the project on time, it would have not been possible to employ a typical 40-hour construction work week on the VIDA project and still meet the scheduled deadlines. For this analysis to be plausible, other overtime alternatives had to be considered to ensure the schedule deadlines were not negatively affected.

As previously discussed, efficiency loss is directly related to the length of the workday and number of hours worked per week. However, “Effects of Scheduled Overtime on Labor Productivity” discusses the possibility that though increased total work hours per week decreases productivity, efficiency loss may not be directly related to the number of hours worked per day.

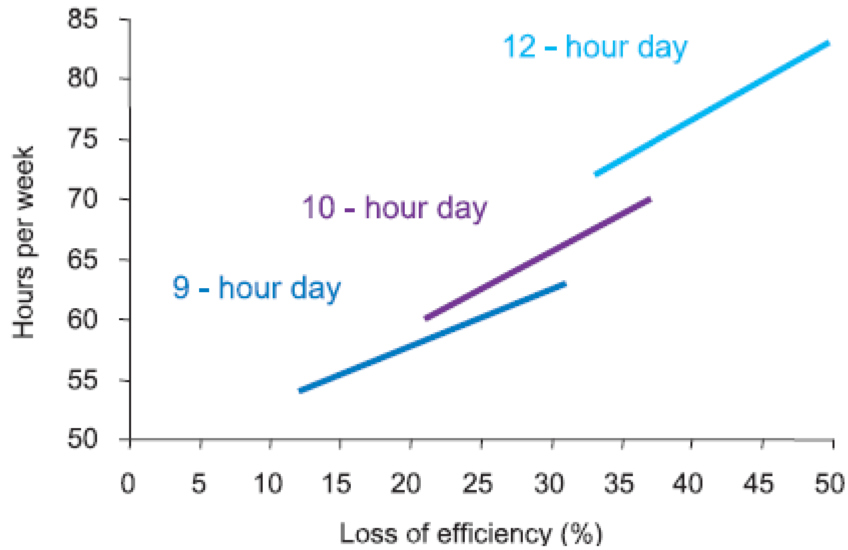


Figure 28: Efficiency Loss Compared to Length of Work Day (Brunies, 6)

The results shown above in Figure 28 reflect efficiency loss as a function of the hours worked per week and the length of the work day; this in fact proves that a longer work day can actually be more efficient when the total hours per week are within a reasonable range. This can be attributed mainly to inefficiencies of "starting up and winding down" (Thomas, 18).

The number of days worked per week is the other variable associated with overtime. One of the best studies done on this topic was published by the Construction Industry Institute (CII) in 1988 and is a compilation of data taken from seven large industrial construction projects (Brunies, 4). This study calculated a Weekly Performance Factor for each job so as to better evaluate the results when compared with days worked per week. To calculate this factor, expected baseline productivity (work hours per quantity) was divided by the actual weekly productivity. This equation is shown below:

$$\frac{\textbf{Work Hours}}{\textbf{Weekly Productivity}} = \textbf{Weekly Performance Factor}$$

A number less than one would signify that the performance that week was less than expected. The CII then compared these calculated Weekly Performance Factors with the number of days that were worked per week on each construction job (Raynar, 9).

The results from this comparison are visualized in Figure 29 and show that working four days per week is clearly more effective than any other option, as the Weekly Performance Factor was at one, or 100%.

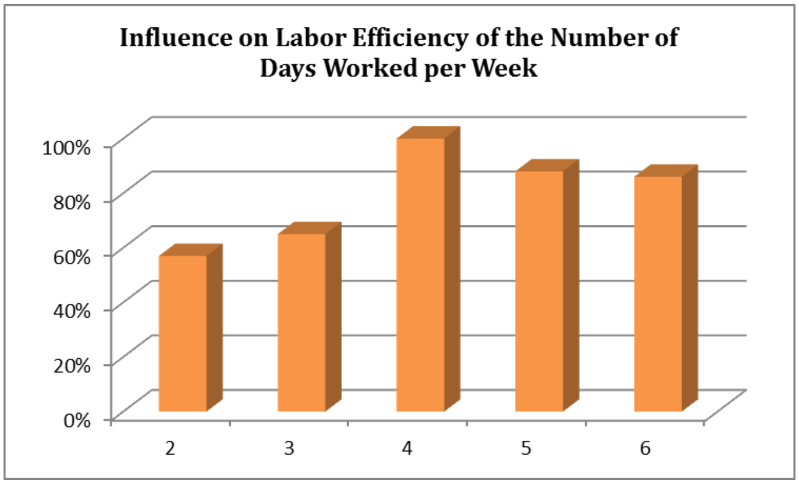


Figure 29: Efficiency Compared With Work Days Per Week (Brunies, 4)

Building on this idea, the U.S. Army Corps of Engineers worked on plotting data where efficiency was a function of both the number of days worked per week and the number of hours worked per day (Brunies, 7). These results focused on finding a balance of the two variables and allowed for the best possible work schedule to be examined (shown in Figure 30).

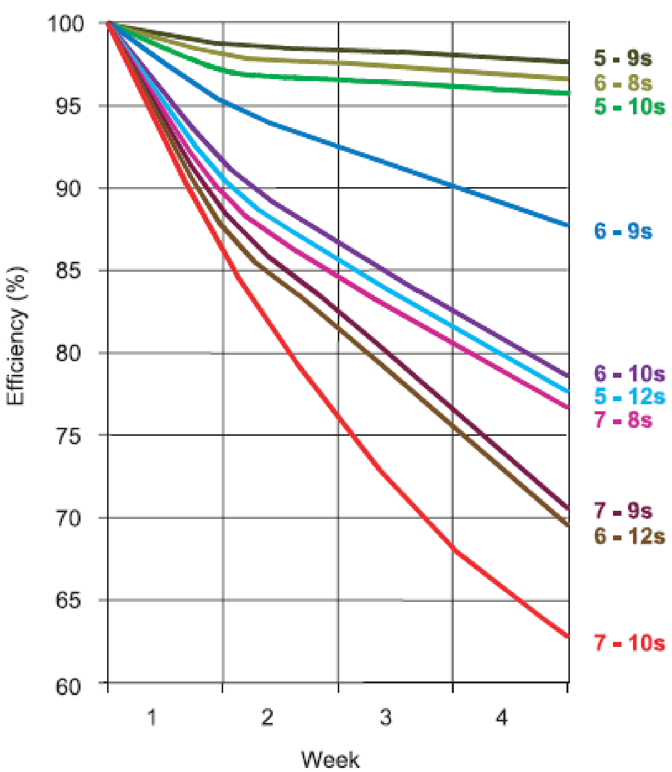


Figure 30: Work Schedule Effects on Efficiency (Brunies, 7)

These results were utilized for calculating possible alternative work schedules that could be implemented on the VIDA project. To devise the best possible option, the actual effective work hours per subcontractor were first calculated (see Appendix S). The total number of effective work hours for the six-day, 12-hour (6-12s) schedule used on VIDA (taken over a 16-week period) is shown on the Actual Effective Work Hours per Worker Table to be 621.4 hours per laborer. It can then be assumed that the amount of work to be completed on the project over a 16-week period is 621.4 hours per laborer. With this in mind, it is then possible to analyze other possible work schedules and their total effective hours over a 16-week period.

Actual Effective Work Hours Per Worker			
Week	Effective Regular Hrs	Effective OT Hrs	Total Effective Hrs
1	32.0	25.6	57.6
2	30.0	24.0	54.0
3	28.4	22.7	51.1
4	26.0	20.8	46.8
5	24.4	19.5	43.9
6	22.8	18.2	41.0
7	21.6	17.3	38.9
8	20.0	16.0	36.0
9	19.2	15.4	34.6
10	18.4	14.7	33.1
11	18.0	14.4	32.4
12	17.6	14.1	31.7
13	17.2	13.8	31.0
14	16.8	13.4	30.2
15	16.4	13.1	29.5
16	16.4	13.1	29.5
Totals	345.2	276.2	621.4

The following alternative work schedules were analyzed: 4-10s, 4-9s & 1-8, 5-8s, 5-10s, 6-9s, 6-10s, 7-8s, 5-12s, 7-9s, 7-10s, 6-12s, and 7-12s. The productivity levels for these prospective work schedules were taken from "The Measurement and Analysis of Construction Labor Productivity"(Talhouni), "Effects of Scheduled Overtime on Labor Productivity" (Thomas) and "Calculating Loss of Productivity Due to Overtime Using Published Charts – Fact or Fiction" (Brunies) and the results are presented in Appendix T. These results examine the weekly hours worked for each alternative schedule and how their corresponding productivity levels affect the effective hours worked over a 16-week period. A summary of total effective hours for each schedule alternative is depicted in the table below.

Alt. Schedule	Effective Hrs
4-10s	605.2
4-9s & 1-8	627.9
5-8s	570
5-10s	643.5
6-9s	662.6
6-10s	690
7-8s	597.5
5-12s	599.4
7-9s	605.4
7-10s	651.7
6-12s	621.4
7-12s	672

As previously discussed, productivity levels decrease when the number of days per week worked and/or the number of hours per week worked increase. The existing baseline schedule (6-12s) is outlined in **blue** and depicts the schedule and effective hours actually implemented on the VIDA project. The alterative theoretical schedule (4-9s & 1-8) outlined in **red** is the most appropriate schedule chosen for use on VIDA. This schedule consists of four 9-hour work days and one 8-hour work day per week and was chosen because it is the alterative schedule with the least amount of work days and work hours that still produces more than the required 621.4 effective work hours.

As it was for the existing schedule, the theoretical effective work hours per subcontractor were calculated with the productivity levels for the 4-9s & 1-8 schedule. This too can be seen in Appendix S and shows a significant increase in the number of effective work hours over the 16-week period.

Feasibility Analysis

The Actual and Theoretical Schedule Comparison table below displays the deteriorating productivity over the 16-week period for both of these schedules. The total weekly hours worked for each are also depicted, showing that the theoretical schedule decreases the weekly work hours by 28 hours.

Actual and Theoretical Schedule Comparison						
	6-12s			4-9s & 1-8		
Week	Weekly Hrs	Produc-tivity	Effective Hrs	Weekly Hrs	Produc-tivity	Effective Hrs
1	72	0.80	57.6	44	1.00	44.0
2	72	0.75	54.0	44	0.99	43.6
3	72	0.71	51.1	44	0.99	43.6
4	72	0.65	46.8	44	0.99	43.6
5	72	0.61	43.9	44	0.98	43.1
6	72	0.57	41.0	44	0.97	42.7
7	72	0.54	38.9	44	0.94	41.4
8	72	0.50	36.0	44	0.92	40.5
9	72	0.48	34.6	44	0.88	38.7
10	72	0.46	33.1	44	0.85	37.4
11	72	0.45	32.4	44	0.82	36.1
12	72	0.44	31.7	44	0.78	34.3
13	72	0.43	31.0	44	0.79	34.8
14	72	0.42	30.2	44	0.79	34.8
15	72	0.41	29.5	44	0.79	34.8
16	72	0.41	29.5	44	0.79	34.8
Totals			621.4			627.9

This reduction in scheduled labor hours can significantly decrease the labor costs associated with paying the labor force for each subcontractor. Using the same method as that which was previously discussed, the lost wages due to productivity loss were calculated for each subcontractor using the new theoretical schedule (4-9s and 1-8). These tables can be seen in Appendix U. The total lost wages for each subcontractor along with the % savings can be seen in the Comparison of Lost Wages between Actual and Proposed Work Schedules table on the next page. This table shows that implementing the 4-9s and 1-8 schedule over the 6-12s schedule produces over $1.3 million dollars in savings, or an 87% total savings.

Comparison of Lost Wages Between Actual and Proposed Work Schedules							
Schedule	Steel Sub	Masonry Sub	Electrical Sub	Plumbing Sub	Drywall Sub	Mechanical Sub	Total
6-12s	$ 205,874.14	$ 151,021.89	$ 329,616.98	$ 299,003.37	$ 224,169.08	$ 329,796.02	$ 1,539,481.48
4-9s & 1-8	$ 24,883.66	$ 18,826.21	$ 43,147.08	$ 38,423.87	$ 24,601.18	$ 42,908.11	$ 192,790.11
Savings	**$180,990.48**	**$132,195.68**	**$286,469.90**	**$260,579.50**	**$199,567.90**	**$286,887.91**	**$1,346,691.37**
% Savings	**88%**	**88%**	**87%**	**87%**	**89%**	**87%**	**87%**

Though this savings is distributed throughout the subcontractors (because they pay their own laborers), this still provides each subcontractor with at least 87% savings in wasted labor costs. It also provides each subcontractor with the opportunity to complete the work slightly faster than the existing 6-12s schedule. This is based on the Effective Work Hour calculations that were computed for each subcontractor using the theoretical 4-9s and 1-8 schedule. The Comparison of Total Effective Work Hours table shown below summarizes the differences between the existing and theoretical work schedules and depicts the percentage at which the 4-9s and 1-8 schedule would be completed slightly faster.

Comparison of Total Effective Work Hours									
	Per Worker			Total Effective Work Hours Per Subcontractor					
Schedule	Effective Regular Hrs	Effective OT Hrs	Total Effective Hrs	Steel Sub	Masonry Sub	Electrical Sub	Plumbing Sub	Drywall Sub	Mechanical Sub
6-12s	345.2	276.2	621.4	4569.8	4299.1	6146.6	5048.6	6636.2	6151.7
4-9s & 1-8	570.8	57.4	627.9	4673.1	4381.7	6320.0	5240.8	6764.3	6458.1
% Faster Completion				2.2%	1.9%	2.7%	3.7%	1.9%	4.7%

Conclusions and Recommendations

It is apparent from the above analysis that scheduled overtime negatively affects productivity levels and that the proper selection of a work schedule should be thoroughly considered before implementing one on a construction project. Productivity levels decrease with increases in the number of work hours per week and/or the number of work days per week; this is due mainly to the increase in disruptions, which includes the inability to afford materials, tools, or other resources at an enhanced rate (Raynar). Taking these actualities into account, not only is it possible to select an appropriate work schedule for a project before construction commences, but it is also feasible to predict the costs associated with accelerating an ongoing schedule. This can be advantageous to numerous parties, including the project team, contractors, and the owner. It also affords an owner the opportunity to come to an agreement with a contractor to be paid for a predetermined productivity loss throughout the construction of the project. This agreement can eliminate excessive efficiency losses, especially when workers pace themselves for longer work days.

Based on this information and the productivity levels from "The Measurement and Analysis of Construction Labor Productivity"(Talhouni), “Effects of Scheduled Overtime on Labor Productivity” (Thomas), and "Calculating Loss of Productivity Due to Overtime Using Published Charts – Fact or Fiction" (Brunies), the Work Schedule Alternatives table (Appendix T) was developed to select the most appropriate work schedule for VIDA. The Work Schedule Alternatives table analyzed the days per week, hours per week, and productivity losses for each work schedule prospect. Comparing the results allowed for the 4-9s and 1-8 work schedule to be selected as a superior schedule for implementation on the VIDA construction project.

Though it was only the second most productive schedule, this alternative schedule was selected because it had more than the required 621.4 effective work hours (which was taken from the existing 6-12s schedule and assumed to be the number of hours required to complete the allotted work in a 16-week period). The theoretical 4-9s and 1-8 work schedule also decreased both the weekly work hours and the number of days worked per week, which saved subcontractors a total of over $1.3 million in wasted labor costs and decreased the schedule by approximately 2%. Though the schedule reduction is negligible, the cost savings is significant and would save both the subcontractors and, subsequently, the Owner, a substantial amount on labor costs. It is for this reason the theoretical 4-9s and 1-8 work schedule would be recommended over the existing 6-12s work schedule on the VIDA project.

TECHNICAL ANALYSIS 3: IMPLEMENTATION OF JOB ORDER CONTRACTING

The MAE breadth summary associated with this technical analysis can be found in Appendix CC.

Problem Identification

The monumental stairwell in the center of the gym is a signature statement of all VIDA Fitness Centers: an exposed steel stairwell that disconnects at every floor and raises five floors to the roof penthouse. The uniqueness associated with a custom designed stairwell with no standard sections created several challenges associated with constructability and schedule.

Because the stairwell differed in both shape and access points at each floor, the sizes and shapes of the slab cuts needed for its installation varied per floor. Saw cutting these openings for the stairwell took two and a half times longer than what was originally estimated by the subcontractor. Prefabricating the stairwell in sections saved installation time, but though the schedule was well planned and the process was thoroughly sequenced, this too took more than twice as long as originally estimated by the steel subcontractor. This subcontractor guaranteed finish dates that were never met and made little effort to gain back any lost time on the project schedule. The opening of the first phase of VIDA depended upon the completion of this stairwell, which made it a critical challenge throughout the first phase of the project.

Research Objectives

Instead of the traditional Design-Bid-Build process, Job Order Contracting (JOC) could be developed with a pre-qualified steel subcontractor to prevent the selection of inadequate subcontractors for VIDA projects. JOC is typically employed on smaller projects and permits an owner to achieve multiple smaller contracts under the umbrella of one large, competitively bid contract (Pulaski). Though this umbrella contract is typically held between the owner and contractor, a unique analysis could be performed to examine the benefits of Forrester Construction holding a Job Order Contract with a subcontractor on the VIDA project. This could be especially beneficial due to the fact that David von Storch, the Owner of VIDA, consistently uses Forrester for construction of all of his VIDA Fitness Centers, all of which possess the signature monumental stairwell and combine similar features and finishes. It would also allow for the subcontractor to be pre-qualified, a step that could later improve the quality and timeliness of the constructed stairwells.

Though JOC with any of the trades usually employed on VIDA projects could prove advantageous, it would be most valuable to focus on the steel subcontractor, as the monumental steel stairwell is typically a critical schedule issue and proved to be such a challenge for this particular VIDA project. With this idea in mind, procurement and delivery times could be decreased, substantial cost savings could be reaped for both the steel subcontractor and Forrester, and quality could be increased, all of which support improved efficiency and value.

Incorporating JOC in this unique manner will involve a process of gathering information and applying it in a specific way. After substantial research has been done on the topic, interviews will be conducted with the Project Superintendent and Project Manager to discuss the variables in preconstruction that would affect JOC use.

Application Methodology

To properly explore the effects of implementing JOC, the following steps will be taken:

- Research will be collected on implementation strategies along with positive and negative attributes associated with JOC.
- Additional research on other projects with this Owner will be compiled and considered.
- The Superintendent and Project Manager will be interviewed to provide insight on the variables that would need to be examined with JOC employment.
- The application strategies for the VIDA project (and other projects with this Owner) will then be examined, along with the project specific impacts.
- A cost analysis will be performed to determine savings in the preconstruction and construction project phases.
- The project schedule will be analyzed to determine any changed durations.
- Lastly, an overall feasibility analysis will be developed evaluating all results.

Preliminary Analysis

Because there were no simple methods to determining the preliminary feasibility of this analysis (especially with this unique application), the idea was thoroughly discussed in-depth with Dr. Robert Leicht, Assistant Professor in Penn State's Architectural Engineering Department, who encouraged the idea because of the learning opportunities associated with the analysis.

Developing the Job Order Contract

In order to fully understand the proper application of JOC on VIDA, it is first necessary to develop an implementation plan. In the typical JOC contract, an owner contracts with a subcontractor which will perform many jobs based on the original pre-established price. Work is then completed by a series of separate work orders to the chosen contractor (Best Practices Guide, 3). The proposed application for JOC on the VIDA project poses a unique alteration to this typical usage: the project's general contractor, Forrester Construction, would hold the umbrella Job Order Contract and would be subcontracting out to the steel subcontractor. This dictates that Forrester would be the assumed "owner" in a typical JOC contract.

Five VIDA Fitness Centers are currently open, four of which have their own steel monumental stairwell. Three more VIDA's are planned for opening before 2015, all of which will possess a monumental stairwell. The Job Order Contracting analysis was performed on the first four constructed VIDA's to determine the effects associated with implementing a JOC contract between Forrester and a steel subcontractor for these four jobs.

The first step of the process would be for Forrester to issue an RFQ, or Request for Qualifications. This RFQ would include a Construction Task Catalog, Technical Specifications, General Conditions, and the overall Contract. The Construction Task Catalog or unit price book should include the construction task descriptions that will be required by the contract coupled with both a unit of measurement and a unit of price. These costs will be developed based upon local prices for direct labor, equipment usage, and material costs (Job Order Contracting). Examples of existing Construction Task Catalogs include the RS Means Building Construction Cost Data book and the Gordian Group's Construction Task Catalog and cost approximately $180 (RSMeans). The first 15 pages of an example Construction Task Catalog for CSI MasterFormat Division 5 – Metals can be seen in Appendix V. This Task Catalog was developed by The Gordian Group for Purdue University (The Gordian Group).

Next, the Technical Specifications should be developed for each construction task and integrate the facility owner's personal standard. In this particular case, the facility owner would be David von Storch, the owner of the VIDA Fitness line. These specs will be similar to those used on every construction job, but will be generalized so that all four of the VIDA's in the contract will be covered. Because the finishes and processes are typical at all of the VIDA's, this will allow for the specs to be tailored to a VIDA job.

Lastly, both the Contract and General Conditions should be designed specifically for this particular JOC scenario. Several companies exist to generate these contracts, the most common of which is The Gordian Group, a company that first introduced the JOC idea to the U.S. in 1985 (Pulaski). The actual contract is considered an indefinite delivery-indefinite quantity (IDIQ) contract, and is usually terminated after a certain time period or after a certain dollar amount has been reached. It details the minimum and maximum amounts of work that will be awarded for each location. A JOC contract developed for VIDA would include the minimum and maximum amount of work for a bidding steel contractor that would be allocated for each new VIDA job. This contract must not only include an overview of work to be done, but also the location of the work (Center for JOC Excellence). In this particular situation, all of the VIDA Fitness Centers are located in Washington D.C.

Implementing the JOC Delivery Process

Once the RFQ has been issued, several pre-bid meetings are held with the intent of educating bidding contractors (or other involved parties) on the JOC process as a whole (Best Practices Guide). Contractors are then requested to submit a multiplier to act as their own coefficient for the general conditions. This adjustment factor compensates for insurance and bonds, overhead and profit fees, and other indirect costs associated with the JOC project. Bidding contractors will usually submit two coefficients: one for overtime work and one for typical, straight time work. Once these numbers have been submitted by all of the bidding contractors, the factors will be utilized to aid the owner in selecting the appropriate contractor (Pulaski).

The easiest way for an owner to review the proposed adjustment factors is by analyzing a recently completed non-JOC project similar to the type anticipated under the contract. This example job can be separated into the line items listed in the Construction Task Catalog. Prices for these line items can then be summed and divided into the project cost of the example project. This number portrays what the adjustment coefficient would have been had JOC been implemented on the example project.

The equation for this process can be seen below:

$$\frac{\textbf{\textit{Total Project Cost}}}{\textbf{\textit{Sum of Line Items}}} = \textbf{\textit{Estimated Adjustment Factor}}$$

The determined estimated adjustment factor can then be used as a guideline coefficient and compared against actual contractor- submitted adjustment factors. It is usually reasonable that the submitted adjustment factors can be negotiated lower than the estimated example factor; this is due to the decreased contractor start-up costs that are lessened by the anticipation of having multiple jobs covered under one contract (Center for JOC Excellence).

Other relevant criteria, including past job performance, financial status, references, qualifications, Experience Modification Ratio (EMR) and safety history, and a quality assurance plan, will also be considered during the contractor selection process. All of these conditions are weighted based on the owner's preference and then used to select the most appropriate contractor for the JOC project. Once a contractor has been chosen, a work order is given to the contracted company and the owner assigns the first project selected for construction (Center for JOC Excellence).

This arrangement allows for the JOC contractor to earn more than the minimum amount of contracted work by impressing the owner. High levels of quality, professionalism, work, and service can dictate a strong contractor performance to obtain additional projects up to the maximum quantified amount specified in the contract; the awarding of additional projects is also dependent on the owner's need for additional construction services. After the initial project is determined, both the owner and the contractor create a scope of work comprised of tasks listed in the Construction Task Catalog. These Catalog numbers can be multiplied with prices from the Construction Task Catalog to ultimately determine the cost estimate price for the first project under the contract (Pulaski).

Once the cost estimate is submitted to the owner it must be evaluated and prices must be confirmed by the owner. If a task was overlooked, omitted from the scope, or if there is a discrepancy between the owner's and contractor's price, then these items will be negotiated until an agreement can be reached. Construction can begin once both parties agree upon the JOC contract and associated documents (Center for JOC Excellence). An overview of the entire JOC process is depicted in Figure 31.

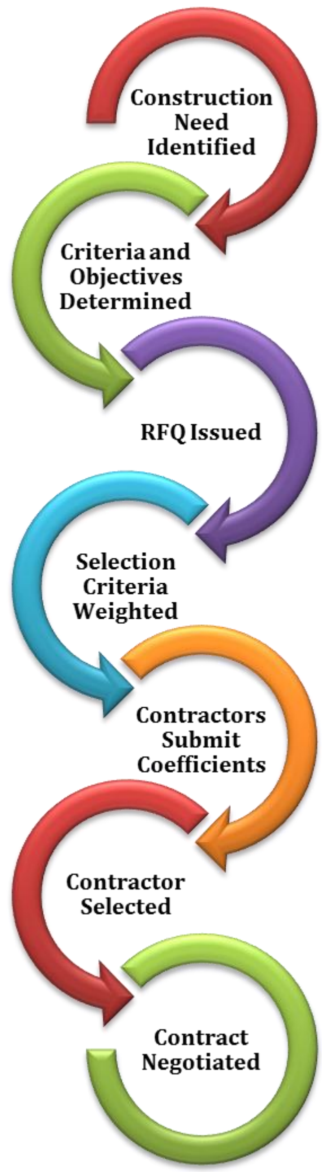


Figure 31: Overall JOC Process

Comprehensive Cost Analysis

One of the main benefits associated with Job Order Contracting is the cost savings accrued from increased efficiency in the procurement, design, and construction processes. Design costs are ultimately decreased because JOC eliminates the necessity of assembling a bid package for each project, which traditionally runs from 6- 8% of the cost of construction. This accounts for a savings of 3-5% in design costs alone. A total of 1-2% of procurement and overhead costs can be saved because the contracted JOC contractor is no longer required to waste time and money on preparing a bid it may not win (Job Order Contracting).

There is also a 3-6% cost savings associated with the direct costs of construction, caused by decreased contingencies and volume cost discounts. Decreased contingencies are directly related to the risk reduction because of the contractor's active participation in writing the scope of work. Because of the nature of JOC (combining several smaller projects under one master contract), many contractors will lower their overhead and profit margins or offer a volume discount because they know that they are bidding on a large volume contract where profits will be greater than that of a smaller project (Job Order Contracting).

Lastly, a reduction in award claims after construction completion can accrue a cost savings of 1-2%. This savings can be credited to the fact that the contractor participates in writing the work scope and holds the responsibility for any omissions or errors in the Proposal. Creating a non-adversarial relationship is in the contractor's best interest, as JOC is a series of multiple job orders the contractor is not guaranteed to win. Overall, savings in these four categories because of employing JOC can attribute to approximately 8-15% of total cost savings for the contractor (Job Order Contracting). Though the cost savings discussed above directly affects the contractor, cost savings are also indirectly passed onto the owner, or contract holder (in this case, Forrester Construction). This savings can be anywhere from 9 -21% (Pulaski, 2).

Applying these researched cost savings to VIDA was done in several steps. Because the cost information for the steel contracts on the other VIDA jobs was not accessible, the steel cost per square foot ($13.07) on the U Street VIDA was used as an estimate and multiplied with the square footages of the other three VIDAs. This provided a total estimated steel contract cost for each of the four VIDAs. This equation is shown below:

$$(\textbf{\textit{Square Footage}}) \times (\textbf{\textit{Steel Cost Per SF}}) = \textbf{\textit{Total Steel Contract Cost}}$$

After these contract costs were determined, the minimum, maximum, and average savings were determined using the 8-15 percentage range for cost savings discussed above. These equations are shown below:

$$(\textbf{\textit{Total Steel Contract Cost}}) \times (\mathbf{8}\%) = \textbf{\textit{Minimum Cost Savings for Steel Subcontractor}}$$

$$(\textbf{\textit{Total Steel Contract Cost}}) \times (\mathbf{15}\%) = \textbf{\textit{Maximum Cost Savings for Steel Subcontractor}}$$

$$(\textbf{\textit{Total Steel Contract Cost}}) \times (\mathbf{11.5}\%) = \textbf{\textit{Average Cost Savings for Steel Subcontractor}}$$

The table below details these calculations and provides an average total cost savings of approximately $356,000 and a maximum cost savings of $465,000 for the steel subcontractor if JOC was employed on the four VIDA projects.

Steel Subcontractor Cost Savings from Employing JOC						
VIDA Name	**Square Footage**	**Steel Cost/SF**	**Total Cost**	**Min Savings (8%)**	**Max Savings (15%)**	**Avg Savings (11.5%)**
U Street	80,000	$ 13.07	$ 1,045,600.00	$ 83,648.00	$ 156,840.00	$ 120,244.00
Metropole	65,000	$ 13.07	$ 849,550.00	$ 67,964.00	$ 127,432.50	$ 97,698.25
Verizon Center	60,000	$ 13.07	$ 784,200.00	$ 62,736.00	$ 117,630.00	$ 90,183.00
Renaissance Hotel	32,000	$ 13.07	$ 418,240.00	$ 33,459.20	$ 62,736.00	$ 48,097.60
TOTAL			$ 3,097,590.00	$ 247,807.20	$ 464,638.50	$ 356,222.85

The cost savings for Forrester Construction were calculated in much the same way, except that the percentage range for cost savings was 9-21%. Using Forrester's total contracted price for the U Street VIDA, the $199.91/SF cost was used as a baseline for the other three VIDA gyms. The calculations can be seen in the table below:

Forrester Construction Cost Savings from Employing JOC						
VIDA Name	**Square Footage**	**Cost/SF**	**Total Cost**	**Min Savings (9%)**	**Max Savings (21%)**	**Avg Savings (15%)**
U Street	80,000	$ 199.91	$15,992,800.00	$ 1,439,352.00	$ 3,358,488.00	$ 2,398,920.00
Metropole	65,000	$ 199.91	$12,994,150.00	$ 1,169,473.50	$ 2,728,771.50	$ 1,949,122.50
Verizon Center	60,000	$ 199.91	$11,994,600.00	$ 1,079,514.00	$ 2,518,866.00	$ 1,799,190.00
Renaissance Hotel	32,000	$ 199.91	$ 6,397,120.00	$ 575,740.80	$ 1,343,395.20	$ 959,568.00
TOTAL			$47,378,670.00	$ 4,264,080.30	$ 9,949,520.70	$ 7,106,800.50

As seen by this table, these calculations would have accrued Forrester an average cost savings of $7.1 million and a maximum cost savings of $9.9 million combined between the four fitness centers. It is clear from the aforementioned savings calculated for both the steel subcontractor and Forrester Construction that a JOC is more than cost effective when compared with the almost negligible costs associated with its implementation.

Decreased Procurement and Preconstruction Durations

Another advantage linked to the use of Job Order Contracting is the decrease in procurement and construction times over traditional contracting approaches. Because the subcontractor is already under contract and ready to work, the procurement time associated with traditional contracts is significantly diminished; in fact, work can start anywhere from 75-85% more quickly with the use of JOC (Job Order Contracting).

Applying these percent time savings to the task durations from the U Street VIDA project schedule provides new durations that can then be input into the overall procurement schedule. These equations are shown below:

$$(\textbf{\textit{Task Duration in Days}}) \times (\mathbf{75\%}) = \textbf{\textit{Minimum Time Savings for Steel Subcontractor}}$$

$$(\textbf{\textit{Task Duration in Days}}) \times (\mathbf{85\%}) = \textbf{\textit{Maximum Time Savings for Steel Subcontractor}}$$

$$(\textbf{\textit{Task Duration in Days}}) \times (\mathbf{80\%}) = \textbf{\textit{Average Time Savings for Steel Subcontractor}}$$

The calculated average time savings were the durations that were used to compute the new task durations. This equation is shown below:

$$(\boldsymbol{Original\ Task\ Duration}) - (\boldsymbol{Avg\ Time\ Savings}) = \boldsymbol{New\ Task\ Duration\ in\ Days}$$

The total calculated procurement and preconstruction task duration savings can be seen in the table below:

Procurement and Preconstruction Task Duration Savings from Employing JOC					
Task Name	**Days**	**Min Savings (75%)**	**Max Savings (85%)**	**Avg Savings (80%)**	**New Durations**
Structural Steel Shop Drawings	10	7.5	8.5	8	2
Review Structural Steel Shop Drawings	10	7.5	8.5	8	2
Monumental Stair Submittals	10	7.5	8.5	8	2
Fabricate Structural Steel	20	15	17	16	4
Monumental Stair Submittal Review	10	7.5	8.5	8	2
Fabricate Monumental Stair	25	18.75	21.25	20	5
TOTAL	85	63.75	72.25	68	17

Though these duration changes had no impact on the overall 305 day Procurement and Preconstruction Schedule, they did impact the completion of steel and monumental stair fabrication dates. Originally scheduled for completion on Monday 1/3/2011, the revised schedule would have allowed the Fabricated Structural Steel to be completed on Thursday, 11/18/2010, an almost six week time savings. Similarly, the Fabricated Monumental Stair was scheduled to be completed on Tuesday, 1/25/2011, but the schedule was adjusted for completion on Tuesday, 11/30/2010, an eight week time savings. These time savings in the fabrication mean that the steel construction could start substantially sooner if JOC was used. Because the construction of the monumental stairwell (and thus the steel subcontractor) was what delayed the project, beginning construction 6-8 weeks sooner could have drastically affected the steel construction and the delayed turnover dates. This could even eliminate costs associated with the long overtime hours due to the delayed schedule.

Once the theoretical new durations were calculated for the U Street VIDA, an equation was developed to determine the steel task durations for procurement for each of the other three VIDAs. Because the schedules could not be obtained for these three VIDAs, the U Street VIDA was used as a base constant. To solve for their estimated task durations, the task duration for the U Street (base) VIDA was divided by the square footage of the base VIDA. This number was then multiplied by the square footage of the VIDA that was being solved, the “unknown” VIDA.

This equation, used for the Metropole, Verizon Center, and Renaissance Hotel VIDAs, can be seen below:

$$\frac{\boldsymbol{Base\ VIDA\ Task\ Duration}}{\boldsymbol{Base\ VIDA\ Square\ Feet}} \times (\boldsymbol{Unknown\ VIDA\ Square\ Feet}) = \boldsymbol{Unknown\ VIDA\ Duration}$$

The results from the above equation are detailed in the Task Durations per VIDA Gym table shown below:

Task Durations Per VIDA Gym (Days)					
Task Name	**Days**	**U Street (80,000SF)**	**Metropole (65,000SF)**	**Verizon Center (60,000SF)**	**Renaissance Hotel (32,000SF)**
Structural Steel Shop Drawings	10.00	10.00	8.13	7.50	4.00
Review Structural Steel Shop Drawings	10.00	10.00	8.13	7.50	4.00
Monumental Stair Submittals	10.00	10.00	8.13	7.50	4.00
Fabricate Structural Steel	20.00	20.00	16.25	15.00	8.00
Monumental Stair Submittal Review	10.00	10.00	8.13	7.50	4.00
Fabricate Monumental Stair	25.00	25.00	20.31	18.75	10.00
TOTAL	85.00	85.00	69.06	63.75	34.00

After the estimated task durations for each of the VIDAs were calculated, the minimum, maximum, and average time savings along with the new task duration were calculated using the same method as that shown above for the U Street VIDA. These numbers are displayed in the Task Durations per VIDA Gym tables listed in Appendix W. A summary including the Actual and New durations for each VIDA gym are shown in the table that follows:

Task Durations Savings Summary Per VIDA Gym								
Task Name	**U Street Durations**		**Metropole Durations**		**Verizon Center Durations**		**Renaissance Durations**	
	Actual	**New**	**Actual**	**New**	**Actual**	**New**	**Actual**	**New**
Structural Steel Shop Drawings	10.00	2.00	8.13	1.63	7.50	1.50	4.00	0.80
Review Structural Steel Shop Drawings	10.00	2.00	8.13	1.63	7.50	1.50	4.00	0.80
Monumental Stair Submittals	10.00	2.00	8.13	1.63	7.50	1.50	4.00	0.80
Fabricate Structural Steel	20.00	4.00	8.13	3.25	15.00	3.00	8.00	1.60
Monumental Stair Submittal Review	10.00	2.00	16.25	1.63	7.50	1.50	4.00	0.80
Fabricate Monumental Stair	25.00	5.00	8.13	4.06	18.75	3.75	10.00	2.00
TOTAL	85.00	17.00	56.88	13.83	63.75	12.75	34.00	6.80

As previously discussed, decreasing the procurement and preconstruction durations can allow for the steel construction to commence sooner than scheduled. The effects associated with implementing JOC on the four VIDA jobs are significant, and would have benefited the steel subcontractor, Forrester Construction, and the Owner.

Increased Construction Quality and Service

Another advantage associated with JOC is the increase in construction quality that is regularly reported by project owners. Because of the cost incentives provided to the contractor, they strive to increase the construction quality so as to win another individual Job Order. If the contractor does not meet the owner's quality and service standards, the owner may decide to hire a different contractor for future jobs under the JOC (Pulaski, 3).

Unlike a traditional Design-Bid-Build contractual system where a contractor would be awarded a single lump sum contract, JOC provides opportunities for increased quality in construction. A DBB contract encourages the contractor maximize profit on that single project; this is characteristically achieved by cutting corners on quality or exploiting costs associated with project change orders. This contractor mannerism is eliminated with a JOC contract due to the contractor's motivation to win future projects under the JOC (Job Order Contracting).

Because quality cannot be measured, it was not assessed for the VIDA projects. It should be noted, however, that quality was an issue associated with the monumental stairwell installation on the U Street VIDA. The steel subcontractor was required to refinish several sections of railing because they did not meet the Owner's quality standards. This problem could potentially have been eliminated had a JOC contract been implemented with this VIDA and the other three under analysis.

Feasibility Analysis

The associated cost savings, decreased procurement and preconstruction durations, and increased construction quality are all significant benefits detailed above that would have come with using a JOC on the four VIDA projects. Though these three benefits promote the usage of JOC, there are also negatives associated with its implementation that must also be considered. One of the main limitations is the fact that it is challenging for an owner to anticipate all of the tasks that may be essential in the Construction Task Catalog or required over the life of the JOC contract. This may lessen with more experienced owners, but it is still a challenge associated with JOC (Best Practices Guide, 4).

The second drawback of JOC is the preliminary investment the owner must make in either buying or developing a Construction Task Catalog. As previously discussed, the RS Means version is approximately $180, though custom versions from varying companies can cost more (Best Practices Guide, 4).

MAE Requirements: JOC Implementation

The integrated BAE/MAE requirements for this senior thesis research were fulfilled on this technical analysis, Implementation of Job Order Contracting. JOC was introduced and discussed by Dr. Robert Leicht in AE570: Production Management in Construction. The knowledge gained from this class was incorporated into this analysis in the determination of how JOC could be used to decrease the length of procurement and preconstruction, increase overall quality, and provide a substantial cost savings for both Forrester and the Owner.

Conclusions and Recommendations

In place of the traditional Design-Bid-Build process, the above analysis proves that JOC could be implemented with Forrester Construction holding a JOC contract with a subcontractor on four VIDA projects. This pre-qualified steel subcontractor could prevent the selection of inadequate subcontractors for VIDA projects which could, in turn, increase service and quality levels. Implementing JOC could also potentially save the steel subcontractor approximately $465,000 and Forrester Construction approximately $9.9 million combined between the four fitness centers. As previously discussed, JOC could also decrease the procurement and preconstruction durations and allow for the steel construction to commence 6-8 weeks sooner than scheduled. This could eliminate potential delays that were caused on the U Street VIDA by the steel subcontractor taking longer than originally expected.

It is clear from these results and the above detailed analysis that employing JOC on four VIDA projects would have been extremely beneficial to Forrester Construction, the steel subcontractor, and the Owner. Because of this, if the fitness centers were not yet built, it would be theoretically recommended that JOC be implemented for the four VIDA Fitness construction projects.

TECHNICAL ANALYSIS 4: MECHANICAL SYSTEM LAYOUT CONSTRUCTABILITY AND VALUE EXAMINATION

The mechanical and MAE breadth summaries associated with this technical analysis can be found in Appendix BB and Appendix CC respectively.

Problem Identification

The process of getting the HVAC and mechanical system functional to allow the gym to open in the hot summer months also proved to be a problem on the VIDA project. The extremely congested site caused many trades to work in close quarters, a situation made more difficult by the confusing and congested duct layouts that caused the mechanical subcontractors to constantly move from one location to another.

To compound this, the main supply and exhaust ducts were run up the back exterior of the building. This was done to save floor space inside the gym, but merely created an eyesore and a schedule delay due to the large penetrations that had to be made through the exterior brick wall and the fact that the alley was constantly blocked by a lift required to complete the ductwork installation.

Research Objectives

Redesigning the ductwork on each floor and/or moving the exterior supply and exhaust ducts could potentially introduce several benefits. If the two exterior ducts were moved to an area inside the building, not only would this eliminate the issues associated with them being outside but it would also provide an opportunity to redesign the interior ductwork, which could open potentials for increasing constructability and decreasing material and labor costs. Moving the exterior ductwork would also eliminate the need for penetrations to be cut through the brick façade.

Moving the two exterior ducts and redesigning two layouts could potentially serve as a mechanical breadth, with the constructability, schedule, and cost analyses associated with this redesign acting as the depth analysis. Because of the Owner's strict aesthetic requirements and because of the other variables associated with a layout change, a metrics measuring chart will be developed for each ductwork redesign. This chart will include categories such as aesthetics, layout, material use, schedule, cost, and constructability and will be used to evaluate each layout (including the existing one) on a 0-5 scale. The charts can then be compared to determine the best possible ductwork layout that will provide the best value to the Owner.

Application Methodology

To ensure each redesign is thoroughly evaluated, the following steps will be taken:

- Research and interviews will first take place on the variables associated with ductwork installation and constructability.
- The mechanical breadth analysis of moving the exterior duct lines and redesigning the interior layout will be developed (Appendix BB).
- The cost and schedule changes will then be determined for each layout redesign.

- Metric Measuring Charts will be created for each system and the redesign with the highest Chart rankings will be chosen.
- Lastly, a feasibility analysis will be performed on the chosen layout redesign.

Preliminary Analysis

Because there are no simple methods to determining the preliminary feasibility of this analysis, the idea was thoroughly discussed with Dr. Robert Leicht, Assistant Professor in Penn State's Architectural Engineering Department, who encouraged the idea because of the learning opportunities associated with the breakdown.

Redesign of Optional Layout 1

The first redesigned layout option relocates the exterior supply and exhaust ducts to the interior, southwestern corner of the building (shown in Figure 32 below). They are depicted as **red** and **blue** boxes and shown on each floor of the plans in Appendix X.

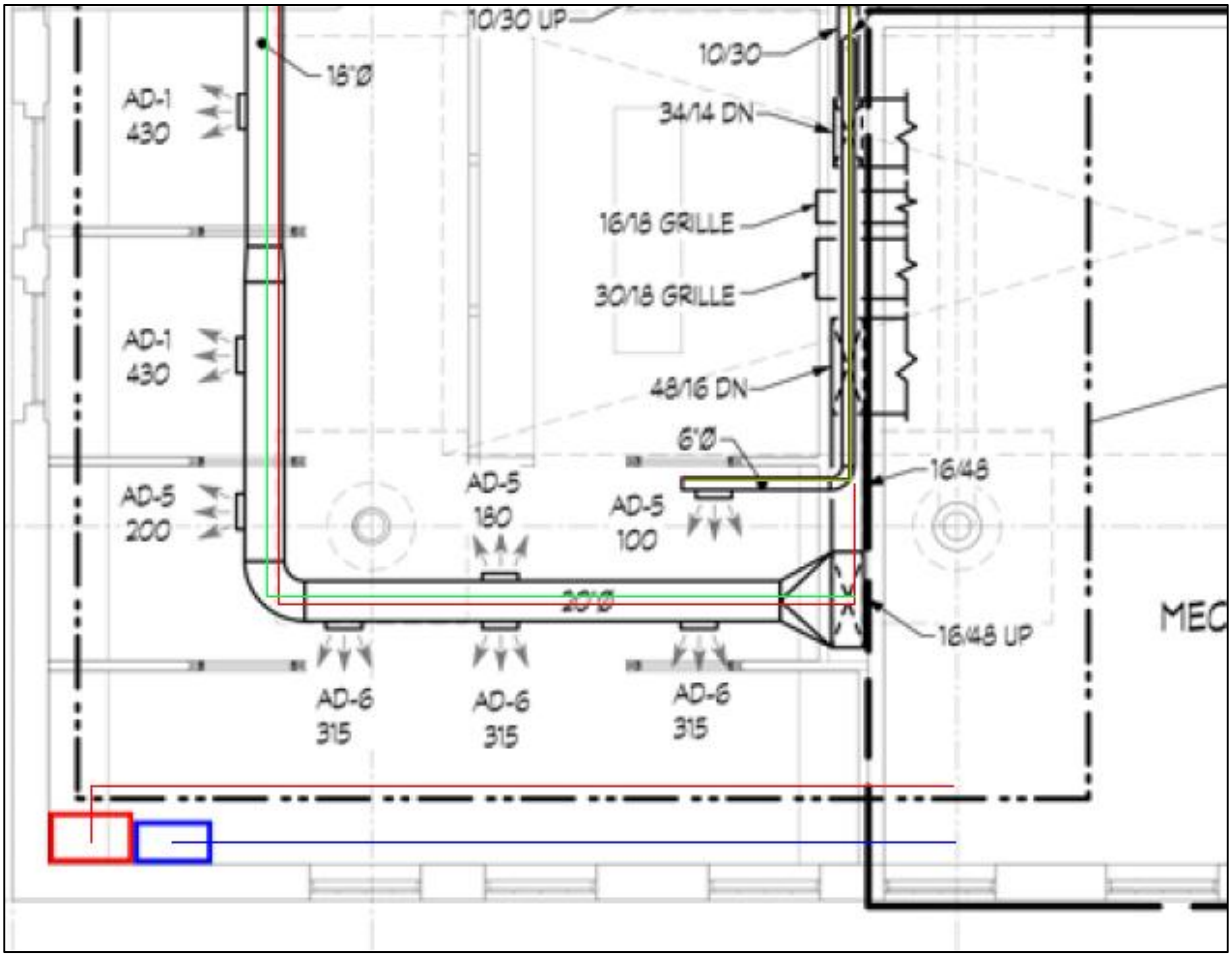


Figure 32: Proposed Supply and Exhaust Duct Location

These **red** and **blue** boxes represent the supply and exhaust ducts, respectively, and have corresponding colored lines that dictate the newly proposed duct lines. The existing supply and exhaust (return) duct lines are also shown on the plans in Appendix X and noted as green (existing supply) and **orange** (existing exhaust/return) lines.

Because most of the first floor was not in the mechanical contract, the redesigned ductwork layout on the first floor was similar to that of the original layout, the only minor change being the relocation and connection of the two exterior duct lines. The second floor is not as easy, as moving the two lines to the SW corner causes a bathroom stall to be removed in the men's locker room restroom. To calculate the correct number of required water closet fixtures, the local codes and SvS Architectural drawings were used.

The required number of fixtures compared with the actual provided number of fixtures can be seen in the table below:

Total Number of Water Closet Fixtures							
		Total Occupants		Men		Women	
Area Description	Square Feet	Rate	Count	Rate	Required	Rate	Required
VIDA	4326.00	1 per 50	87.00	1 per 125	0.30	1 per 65	0.70
Bang Salon	2078.00	1 per 60	35.00	1 per 500	0.00	1 per 500	0.00
Fourth Floor Roof Terrace	1680.00	1 per 50	34.00	1 per 125	0.10	1 per 65	0.30
Roof Pool Deck	7379.00	1 per 50	148.00	1 per 125	0.60	1 per 65	1.10
Roof Bar	2024.00	1 per 15	159.00	1 per 40	2.00	1 per 40	2.00
UA Offices	3168.00	1 per 100	32.00	1 per 25	0.60	1 per 25	0.60
Total Required					3.60		4.70
Total Provided					8.00		11.00

This table demonstrates that because there are only 0.3 fixtures required for men in the VIDA area, eliminating one of those originally provided will still keep to the code. The rest of the second floor layout remains similar to the original design, with the connection of the supply and exhaust lines running through the locker rooms and the addition of three branch lines in the cardio areas.

The third floor relocation of the exterior ducts would place them in an undisturbed corner of the Group Fitness room. They would then be connected to the main branches through this room. This layout also proposes two new branch lines in the equipment area. Lastly, the fourth floor remains almost identical to the original layout, with the exception of the relocation of the two exterior ducts, which would eliminate approximately 2.5 square feet from the corner UA Office. These ducts would then be connected to the mechanical room through the UA Offices area.

Redesign of Optional Layout 2

Similar to the redesign of the first layout, the second focuses mainly on the relocation of the two exterior supply and exhaust ducts. In this case, they were relocated to a location inside the building behind the elevator, which is shown below in Figure 33:

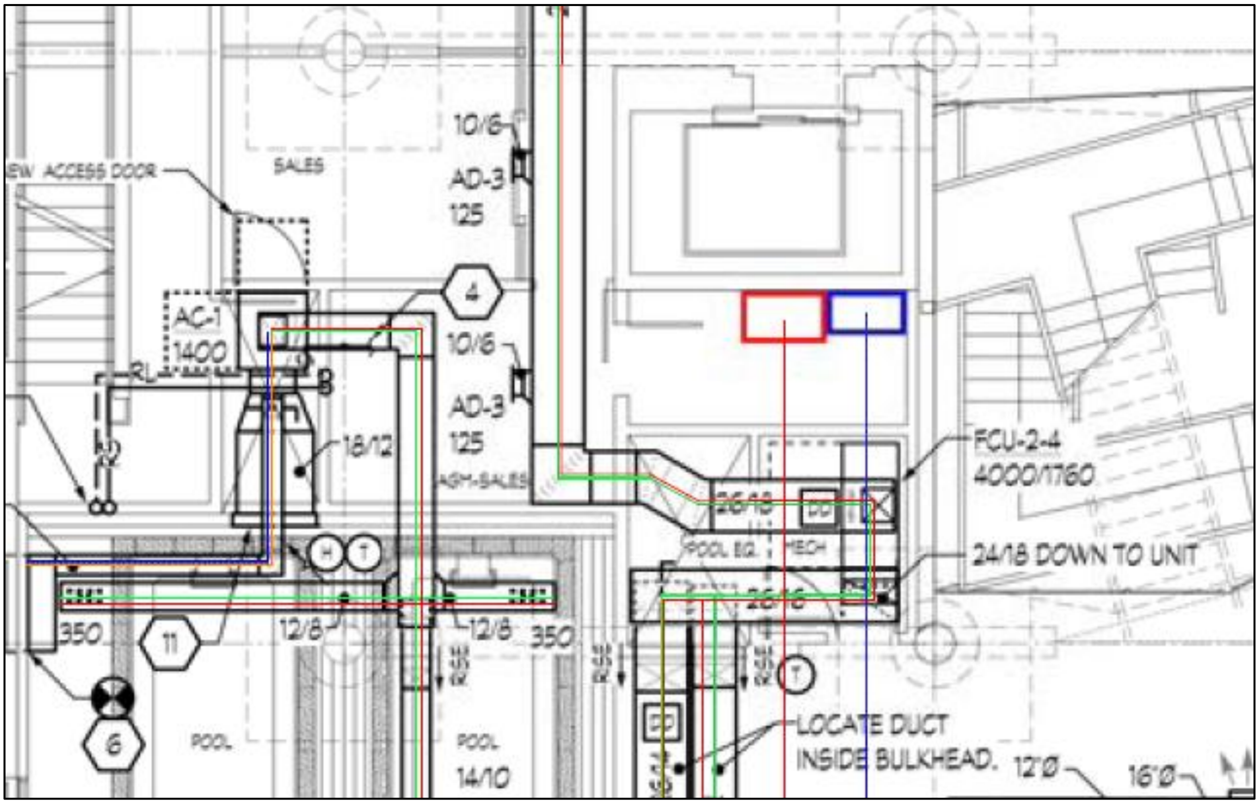


Figure 33: Proposed Supply and Exhaust Duct Location

The full plans can be seen in Appendix Y and, like the Layout 1, the green represents the existing supply and the **orange** represents the existing exhaust/return lines. The proposed duct supply and exhaust lines are again **red** and **blue**, respectively. This area is open on the first floor and allows for these lines to be easily connected to the rest of the originally-designed ductwork.

The second floor redesign mirrors the existing layout for the Endless Pool and Locker Room areas, but proposes slight changes for the cardio equipment areas. These changes include the addition of three branch lines that will aid in cooling the cardio areas, all of which had air conditioning that was far from satisfactory. The third floor layout also proposes two new branch lines in the equipment area and a slight move in the supply line around the General Manager's office. This move would prevent the line from penetrating the glass façade of the Manager's office and would greatly increase the aesthetics of the office. Due to its complexity, the mechanical room and most of the fourth floor ductwork layout was left as originally designed, with the exception of relocation of the two exterior lines to behind the elevator. These lines were then connected to the West side of the mechanical room for entry into their respective plenum boxes.

Initial Cost Analysis

Using AutoCAD Quantity Takeoff, the linear footage of each ductwork layout was calculated for both the existing and proposed options. To calculate the average cost saved for each initial layout option, the total cost of the mechanical contract ($1,186,476) was divided by the total linear feet of the existing ductwork. This equation shown below determines the average mechanical cost per linear foot of ductwork.

$$\frac{\textbf{Total Cost of Mechanical Contract}}{\textbf{Total Linear Feet of Existing Ductwork}} = \textbf{Average Cost per Linear Foot of Ductwork}$$

This method calculates the cost per LF of duct to be $768.03, which not only includes the mechanical subcontractor's applied overhead and profit, but assumedly averages the ductwork sizes and gauges to determine an average price. Once the average cost per linear foot is determined, it can be multiplied with the supply and exhaust linear feet for each layout.

These equations shown below determine the supply and existing ductwork cost for each layout.

$$(\textbf{Average Cost per LF}) \times (\textbf{Supply LF}) = \textbf{Estimated Cost of Supply Ductwork}$$

$$(\textbf{Average Cost per LF}) \times (\textbf{Exhaust LF}) = \textbf{Estimated Cost of Exhaust Ductwork}$$

Once the Ductwork Cost was determined for each layout, the difference in cost was calculated between the proposed layouts and the existing layouts. The percent difference was then produced from these calculations. These equations are shown below:

$$\textbf{Proposed Layout Supply Cost} - \textbf{Existing Layout Supply Cost} = \textbf{Cost Difference}$$

$$\textbf{Proposed Layout Exhaust Cost} - \textbf{Existing Layout Exhaust Cost} = \textbf{Cost Difference}$$

$$\frac{\textbf{Supply Cost Difference}}{\textbf{Existing Layout Supply Cost}} \times (\textbf{100}) = \textbf{Percent Difference in Cost}$$

$$\frac{\textbf{Exhaust Cost Difference}}{\textbf{Existing Layout Exhaust Cost}} \times (\textbf{100}) = \textbf{Percent Difference in Cost}$$

From these numbers, the total cost for each proposed layout was calculated along with the cost difference between the proposed layout and the originally designed existing layout. The percent difference between the proposed layouts and the existing layout was calculated from these determined numbers. These equations are shown below:

$$\textbf{Supply Duct Cost} + \textbf{Exhaust Duct Cost} = \textbf{Total Layout Cost}$$

$$\textbf{Proposed Layout Total Cost} - \textbf{Existing Layout Total Cost} = \textbf{Total Cost Difference}$$

$$\frac{\textbf{Cost Difference}}{\textbf{Existing Layout Cost}} \times (\textbf{100}) = \textbf{Percent Difference in Cost}$$

The summary for the existing layout and each proposed layout can be seen in the table below:

Average Cost Per LF of Ductwork									
Duct	Layout	Linear Feet	Avg $/LF	Duct Cost	Difference	% Difference	Layout Cost	Difference	% Difference
Supply	Exst	1106.35	$768.03	$ 849,709.99	$ -	0.00%	$ 1,186,475.78	$ -	0.00%
Exhaust	Exst	438.48	$768.03	$ 336,765.79	$ -	0.00%			
Supply	1	1926.49	$768.03	$ 1,479,602.11	$629,892.12	74.13%	$ 2,066,522.96	$880,047.18	74.17%
Exhaust	1	764.19	$768.03	$ 586,920.85	$250,155.05	74.28%			
Supply	2	1217.53	$768.03	$ 935,099.57	$ 85,389.58	10.05%	$ 1,277,182.43	$ 90,706.65	7.65%
Exhaust	2	445.40	$768.03	$ 342,082.87	$ 5,317.07	1.58%			

This summarizes the linear footage and ductwork cost for both supply and exhaust/return lines for each layout. It is clear from these numbers that the original existing layout is the least expensive option of the three layouts, though the proposed Layout 2 is only a 7.65% increase in price and could, potentially, cool areas more effectively.

Initial Schedule Analysis

The initial schedule analysis was performed in much the same way as the initial cost analysis. Because the linear footage for each layout was already calculated, these numbers were used to determine the total duration in days for each layout option. The total linear footage of the existing ductwork was divided by the total number of work days for ductwork installation (153 days) to compute the average linear footage of ductwork that was installed per day. (Reference the Detailed Project Schedule in Appendix F for schedule durations.) This equation is shown below:

$$\frac{\textbf{Total Linear Feet of Existing Ductwork}}{\textbf{Total Work Days}} = \textbf{Average Linear Feet of Duct Per Day}$$

Once the installation rate of linear footage per day was determined to be 10.09 LF/Day, the duration in days for both supply and exhaust was calculated for each layout using the equations below:

$$(\textbf{Average LF Per Day}) \times (\textbf{Supply LF}) = \textbf{Estimated Duration of Supply Ductwork}$$

$$(\textbf{Average LF Per Day}) \times (\textbf{Exhaust LF}\ ) = \textbf{Estimated Duration of Exhaust Ductwork}$$

From these numbers, the difference, percent difference, and total were calculated in the same manner as the as the average cost per linear foot discussed above. A summary of the duration results are in the table below:

Average Duration Per LF of Ductwork									
Duct	Layout	Linear Feet	Avg LF/Day	Duration (Days)	Difference	% Difference	Total Duration (Days)	Difference	% Difference
Supply	Exst	1106.35	10.09	109.65	0.00	0.00%	153.11	0.00	0.00%
Exhaust	Exst	438.48	10.09	43.46	0.00	0.00%			
Supply	1	1926.49	10.09	190.93	81.28	74.13%	266.67	113.56	74.17%
Exhaust	1	764.19	10.09	75.74	32.28	74.28%			
Supply	2	1217.53	10.09	120.67	11.02	10.05%	164.81	11.70	7.65%
Exhaust	2	445.40	10.09	44.14	0.69	1.58%			

Though the existing layout has the shortest duration, Layout 2 is less than 12 work days longer but could provide increased cooling efficiency to the areas where new ductwork was added.

Mechanical Ductwork Design Process and Design Criteria

Though the mechanical trade is usually the first trade for coordination (due to the large size of ductwork), its design process involves several factors. A Mechanical Ductwork Design Process Map (located in Appendix Z) was developed to outline the process, factors, and information associated with a ductwork design. This process map connects any referenced information to the process stages along with any information that may be exchanged between design or construction parties.

There are several variables and criteria that play into the design of a ductwork layout and are considered by various parties including the mechanical designer, architect, contractor, and owner. The first of these criteria is the air friction loss that is affected by the duct shape, size, material, and connections. For example, round ductwork, which was utilized in several instances throughout VIDA, is the most efficient duct for fan horsepower and installation labor and has the lowest friction loss per linear foot. The quality of the fittings, number of turns, and size reductions also affect the air pressure drop. Minimizing these can reduce the turbulence and friction losses (Carrier, 3).

Heatflow and airflow leakage is also considered by the mechanical designer in the layout and design of ductwork. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) publishes energy codes that require types of ductwork insulation and joint seals.

An example of duct seal level requirements is shown in Figure 34 below from ASHRAE 90.1.

Minimum Duct Seal Level

ASHRAE 90.1 Table 6.2.4.3A

Duct Location	Duct Type			
	Supply		Exhaust	Return
	≤ 2 in. w.c.	> 2 in. w.c.		
Outdoors	A	A	C	A
Unconditioned Spaces	B	A	C	B
Conditioned Spaces * *	C	B	B	C

Duct Seal Levels

ASHRAE 90.1 Table 6.2.4.3B

Seal Level	Sealing Requirements *
A	All transverse joints and longitudinal seams, and duct wall penetrations. Pressure-sensitive tape shall not be used as the primary sealant.
B	All transverse joints and longitudinal seams. Pressure-sensitive tape shall not be used as the primary sealant.
C	Transverse joints only

Figure 34: Duct Seal Levels Taken From ASHRAE 90.1

Improperly insulated or sealed ductwork can decrease the effectiveness of the heating or cooling equipment which could, in turn, waste significant amounts of energy, create occupant discomfort, and/or increase system operating costs (Carrier, 4).

Noisy ductwork was a concern in the design of the VIDA duct system because there is no plenum space and the ductwork is exposed throughout the building. If a system is designed improperly and undersized, it can increase the air velocity in the ductwork and create noise. Any turbulence created from fittings or joints can cause additional ductwork noise (Carrier, 5). Figure 35 below provides several options for eliminating noise in ductwork.

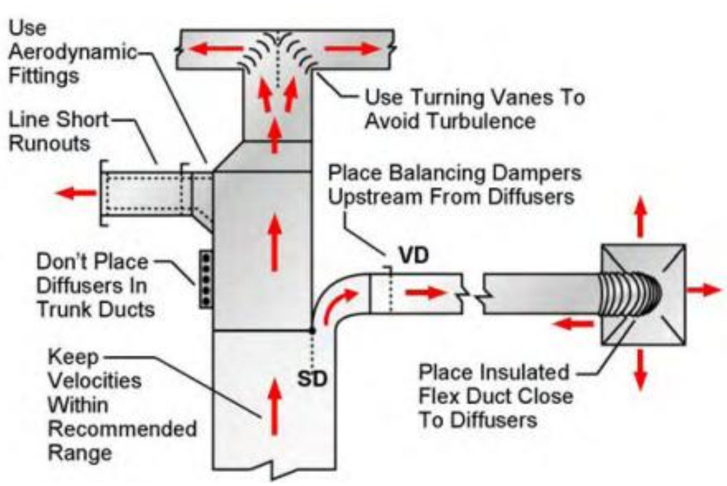


Figure 35: Options for Decreasing Noise in Ductwork, Carrier

Space availability and aesthetics are also concerns associated with the ductwork design of a project. On many projects, ceiling plenum space is a limiting factor on the size of duct that can be used and installed. This could account for an incorrectly sized duct being designed, which may not work effectively (Carrier, 2). Because there was no ceiling (and thus no plenum space) on the VIDA project, the ductwork was exposed and sizing was not an issue. Though this exposed ductwork created the industrial look the Owner desired, aesthetic problems arose because the new ductwork had to be run through an existing building.

Assuming the contractor is on board early in the preconstruction process, the ductwork design will also be analyzed for installation logistics and constructability. Every project is unique, meaning the contractor may provide project specific insight on something that was originally overlooked. Once the logistics and constructability have been considered, the contractor will evaluate the installation costs associated with the ductwork design. The mechanical designer may also have insight in this area. Overall cost can be affected by the labor, materials, size, type, and joint fittings used on a project. Because the costs of ductwork systems are approximately 85% labor costs, creating a labor-saving design can greatly decrease costs associated with the system. A contractor's field expertise can be beneficial here to generate more economical design ideas (Carrier, 2).

Ductwork Layout Metrics and Examination

The design variables previously outlined contributed to the creation of the Ductwork System Layout Metrics Measuring Chart which was made for evaluating each layout (including the existing one) on a 0-5 scale for each variable. This chart was then used to compare the layouts and ultimately to choose the best option. Due to the fact that round duct was used wherever possible in the original design, it will be assumed that the two proposed layouts do this as well. This will ensure that the material use, friction loss, heat and air flow, noise, and space availability are comparable among all three layouts and need not be considered in the Metrics Measuring Chart. With this in mind, the factors included in the Metrics Measuring Chart were aesthetics, schedule, cost, and constructability. Each of these was rated for all three layouts using the scale from 0 to 5 shown below:

Very Poor		Poor		Weak		Neutral		Good		Excellent
0	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**

The aesthetics variable was the first to be evaluated with this scale. The ductwork for the existing layout received a 0.5 out of 5 for aesthetics. One point was deducted for each of the exterior supply and exhaust ducts that run up the back of the building and penetrate the façade to enter the mechanical room (shown in Figure 36 on the next page).

Figure 36: Mechanical Ductwork on Exterior Facade, Picture Taken by Clara Watson

Also shown in the picture is the exhaust duct penetrating the façade from the fourth floor mechanical room, which subtracts another 0.5 point from the aesthetics total.

There are four locations on the third floor where the duct line penetrates an architectural glass curtain wall, all of which occur in the General Manager's office. Two of these penetrations are from a round, 24" diameter supply duct that enters and exits the office. The second two penetrations are caused by a Y branch duct off of the main supply. Each of these instances (shown in Figure 37 on the next page) subtracts another 0.5 point from the aesthetics total. This brings the aesthetics total to 0.5 out of 5.

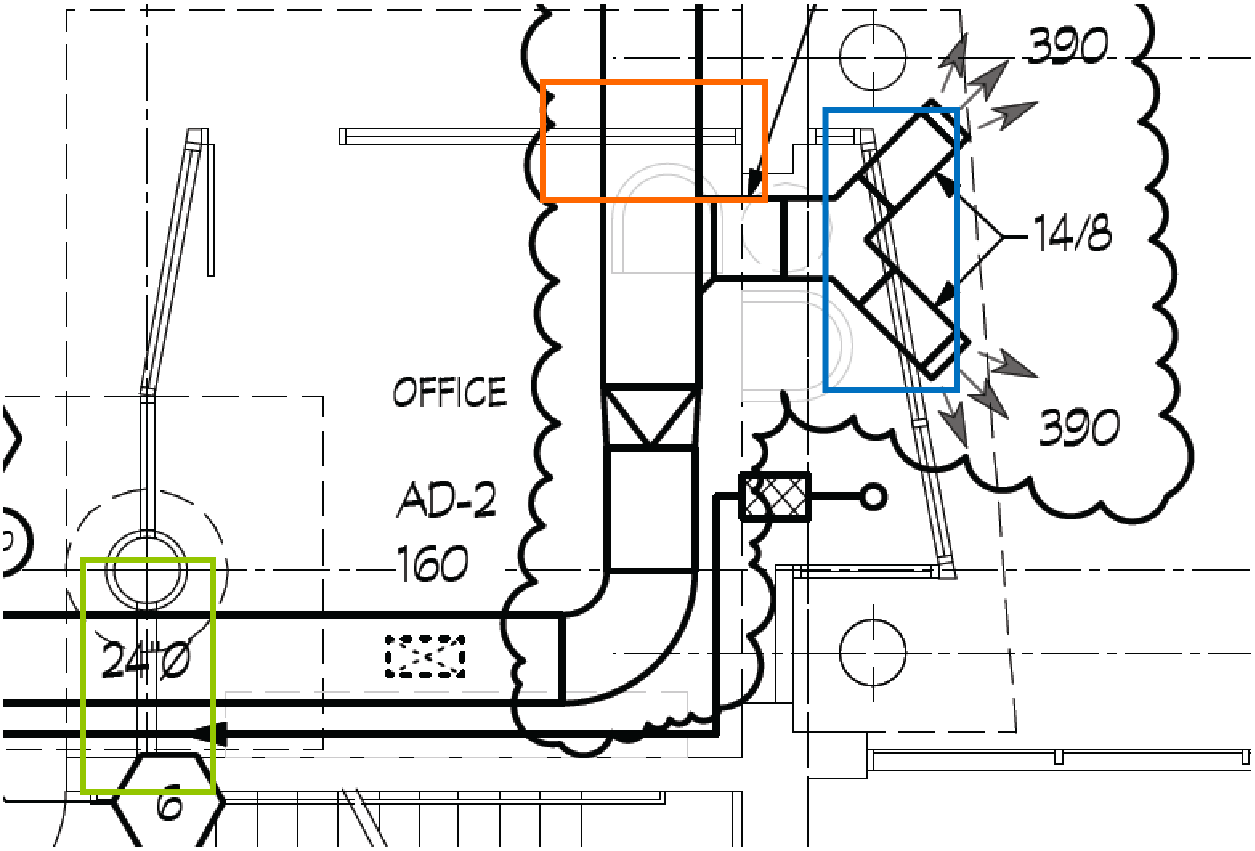


Figure 37: Duct Penetrations through Glass Curtain wall, SvS Architectural Drawings

The proposed Layout 1 was next to be evaluated for aesthetics, and received a 3.5 out of 5. The exterior ducts were relocated with this layout, leaving only the exterior exhaust duct to subtract 0.5 points from the aesthetics total. The branch Y duct in the GM's office was eliminated, but the 24" round supply duct still penetrated the office in two places (shown in **green** and **orange** in Figure 37), which deducted another 0.5 points for each location. The final aesthetics total for Layout 1 came to 3.5 points.

Layout 2 also eliminated the exterior ductwork, but still possessed the exterior exhaust duct that subtracted 0.5 points from its aesthetics total. This layout also eliminated the branch Y duct and rerouted the 24" round supply duct penetrating the GM's office. Because of this, the aesthetics points for Layout 2 totaled 4.5 out of 5.

Both the cost and schedule variables were calculated for each layout from the Preliminary Cost and Preliminary Schedule analyses previously discussed. The existing layout was used as the baseline and received a 5 in both categories because the ductwork installation was on budget and on schedule. The total percent difference from the Preliminary Cost and Preliminary Schedule analyses was then used to determine the points awarded for the other two layouts in these categories. The percent variation in relation to points awarded is shown below:

91-100%	81-90%	71-80%	61-70%	51-60%	41-50%	31-40%	21-30%	11-20%	1-10%	0%
0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5

Percent Difference Compared to Existing Layout	
Layout	Percent Difference
Existing	0.00%
1	74.17%
2	7.65%

Because the calculated linear footage of duct was the same for each analysis, the percent difference is constant for the Preliminary Cost and Schedule analyses. The percent difference for each layout when compared with the existing layout can be seen in the table to the left. Using the variation and points scale shown above, Layout 1 received a 1.5 out of 5 for both the Cost and Schedule metrics and Layout 2 received 4.5 out of 5 for both metrics.

The last metric used for analyzing the three layouts is constructability. The existing layout received a 2 for this category, as one point was deducted for each of the three ductwork penetrations through the exterior of the building. With this method, Layout's 1 and 2 both receive 4 out of 5 for their one penetration for the exhaust vent.

After all of the metrics were measured for each layout, they were tallied in the table below and totaled to define the best optional layout.

Ductwork Layout Metrics Measuring Chart					
Layout	Aesthetics	Cost	Schedule	Constructability	Total
Existing	0.5	5	5	2	12.5
Layout 1	3.5	1.5	1.5	4	10.5
Layout 2	4.5	4.5	4.5	4	17.5

From these results, it is clear that Layout 2 is the best option for the ductwork layout at VIDA.

Mechanical Breadth: CPM Calculations and Duct Sizing

Once Layout 2 was chosen, it was necessary to calculate the Cubic Feet per Minute (CFM) of Outside Air (OA) required for each space. This number is based on the size of the space, the use of the space, and the number of occupants in the space. Once determined, it can be used to size the required ductwork that distributes the outside air.

The square footage for each area was taken from the project's architectural drawings. All occupant and outside air requirements are standards determined by The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). For each space, the CFM provided is determined by summing the area's square footage multiplied by the OA requirements per square foot and the number of occupants multiplied by the OA requirements per occupant. The following two equations were used to calculate the number of occupants per space and CFM provided to each space.

$$\boldsymbol{Area} \times \frac{\boldsymbol{Occupant\ Density}}{\boldsymbol{1000\ SF}} = \boldsymbol{Number\ of\ Occupants}$$

$$(\boldsymbol{Area} \times \boldsymbol{OA\ CFM\ Per\ SF}) + (\#\ \boldsymbol{of\ Occupants} \times \boldsymbol{OA\ CFM\ Per\ Occupant}) = \boldsymbol{CFM\ Provided}$$

The CFM requirements were then summarized in the table below.

CFM Requirements Per Space							
Space Name	Floor	Area (SF)	Occupant Density (#/1000SF)	Occupants (#)	OA Per Occupant (CFM)	OA Per SF (CFM)	OA Provided (CFM)
Bang Salon	1	1500	25.00	37.50	7.50	0.06	371.25
Lobby	1	1800	10.00	18.00	5.00	0.06	198.00
Break Room	1	505	5.00	2.53	15.00	0.06	68.18
Office	1	50	5.00	0.25	5.00	0.06	4.25
Women's Lockers	2	2400	10.00	24.00	30.00	0.12	1008.00
Men's Lockers	2	2400	10.00	24.00	30.00	0.12	1008.00
Sales Rm 1	2	120	15.00	1.80	7.50	0.12	27.90
Sales Rm 2	2	120	15.00	1.80	7.50	0.12	27.90
Cardio Area	2	4525	10.00	45.25	20.00	0.06	1176.50
Group Fitness	3	2040	40.00	81.60	20.00	0.06	1754.40
Equipment Area	3	7350	10.00	73.50	20.00	0.06	1911.00
Office	3	190	5.00	0.95	5.00	0.06	16.15
Spin Class	3	605	40.00	24.20	20.00	0.06	520.30
GTS	4	375	40.00	15.00	20.00	0.06	322.50
Pilates	4	400	40.00	16.00	20.00	0.06	344.00
Inner Fitness	4	1100	40.00	44.00	20.00	0.06	946.00
Open Fitness	4	1850	40.00	74.00	20.00	0.06	1591.00
Laundry	4	250	10.00	2.50	35.00	0.12	117.50

These CFM requirements for each space were used in conjunction with a Ductulator Duct Designer to determine the ductwork size for each area. A friction loss of 0.1 inches of water per 100 feet of duct was the assumed friction loss factor. The Layout 2 completed and redesigned ductwork layouts for each floor (including duct size labels) can be seen in Appendix AA.

MAE Requirements: Mechanical Ductwork Design Process Map

The integrated BAE/MAE requirements for this senior thesis research were also fulfilled on this technical analysis. Dr. Leicht taught AE572: Project Development and Delivery Planning, which was incorporated into this analysis with the creation of the Mechanical Ductwork Design Process Map used for decision making on mechanical system designs and layouts. This process map was developed to outline the process, factors, and information associated with a ductwork design and connects any referenced information to the process stages along with any information that may be exchanged between design or construction parties.

Conclusions and Recommendations

As previously discussed, the Ductwork Layout Metrics Measuring Chart analyzes the aesthetics, cost, schedule, and constructability of Layout 2 compared with the existing layout. As shown in the revised chart below, Layout 2 was superior to the existing layout in the aesthetics and constructability categories.

Ductwork Layout Metrics Measuring Chart					
Layout	Aesthetics	Cost	Schedule	Constructability	Total
Existing	0.5	5	5	2	12.5
Layout 2	4.5	4.5	4.5	4	17.5

Though the initial cost analysis determined that Layout 2 cost approximately $90,706,65 more than the existing layout, this was a generalized cost estimate and did not take into account reductions in cost for the second layout because of the elimination of the two exterior ducts. It took two masons two full days to cut the two exterior duct penetrations. It also took two of the insulators seven work days to insulate the two exterior duct lines. Assuming 12-hour work days and using RS Means for standard worker wages, the following table was created to reflect the additional costs associated with the two exterior ductwork lines.

Existing Layout Additional Costs							
Subcontractor	No. of Workers	Avg Laborer $/Hr	OT Laborer $/Hr	Total No. of Work Days	No. of Regular Hrs	No. of OT Hours	Total Cost
Masonry	2	$ 32.82	$ 49.23	2	16	8	$ 918.96
Mechanical	2	$ 45.95	$ 68.93	7	56	28	$ 4,503.10
Total							$ 5,422.06

Subtracting these costs from the $90,706.65 additional costs for Layout 2, the second layout estimated additional costs total $85,284.59. Even with these additional costs, it is still recommended that Layout 2 be theoretically used in place of the existing layout. Not only is the second layout more aesthetically pleasing and more easily constructible, but it adds additional lines to areas of the building that had variances in temperature and were not conditioned properly.

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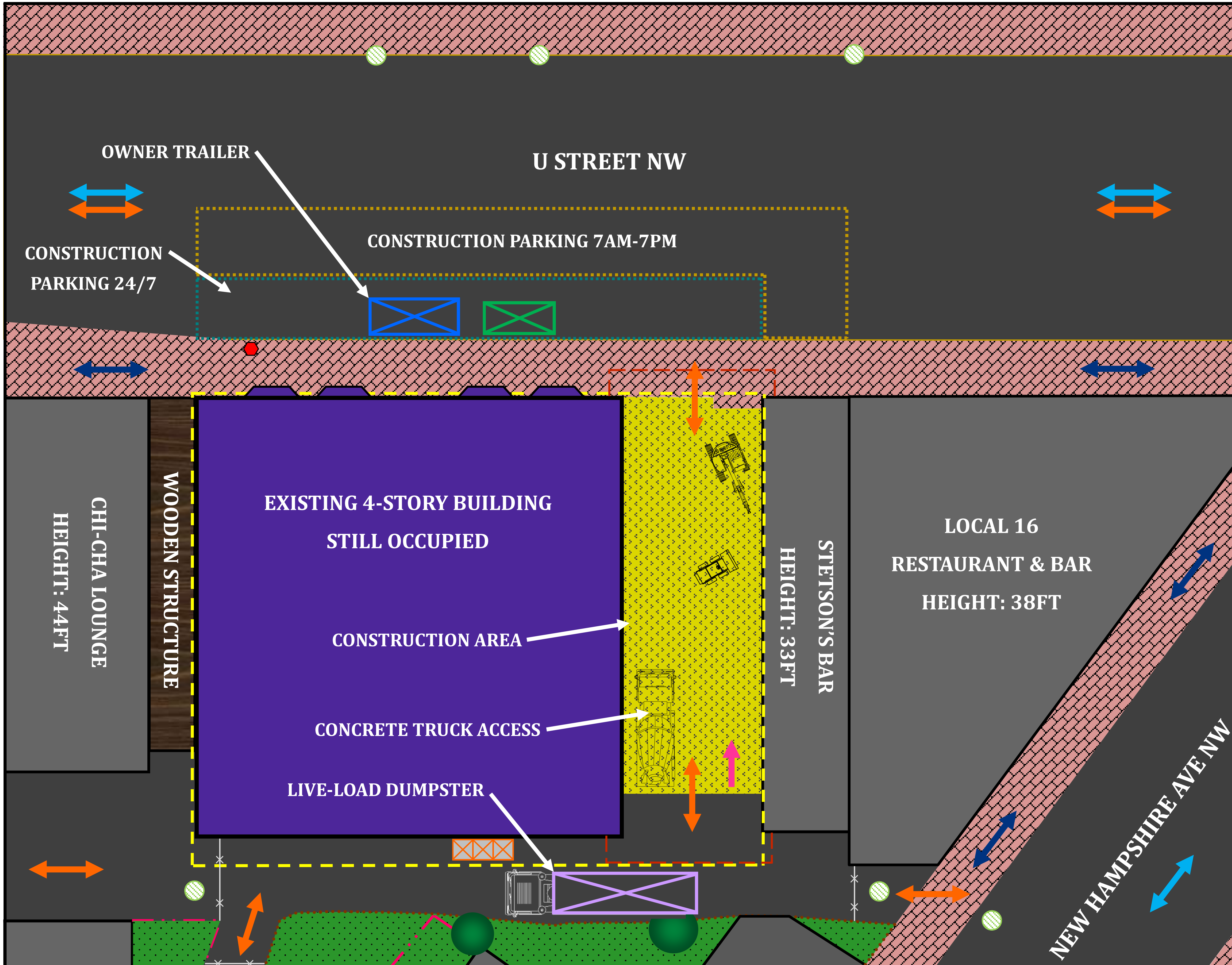
Appendix A

Phased Construction Site Plans



LEGEND

SYMBOLS

- PROPERTY LINE
- BRICK WALL
- WOODEN FENCE
- CONSTRUCTION FENCE
- TEMPORARY ROAD BLOCK
- PORTABLE TOILET
- MANHOLE COVER
- EXISTING TREE
- CONSTRUCTION TRAFFIC
- PEDESTRIAN TRAFFIC
- VEHICULAR TRAFFIC
- WORK FLOW
- FIRE HYDRANT
- WASTE DUMPSTER

PROJECT: VIDA FITNESS CENTER

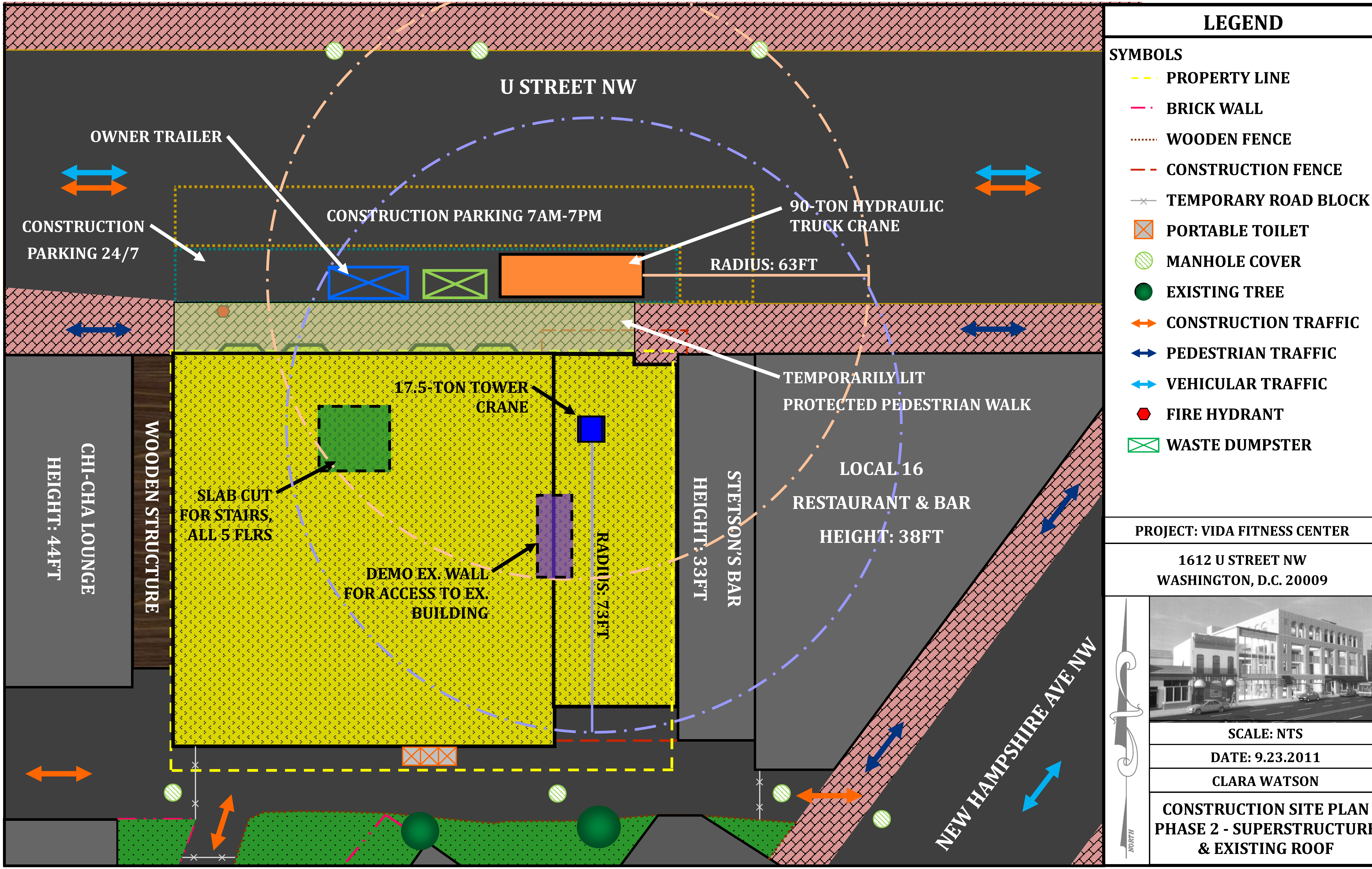
1612 U STREET NW
WASHINGTON, D.C. 20009

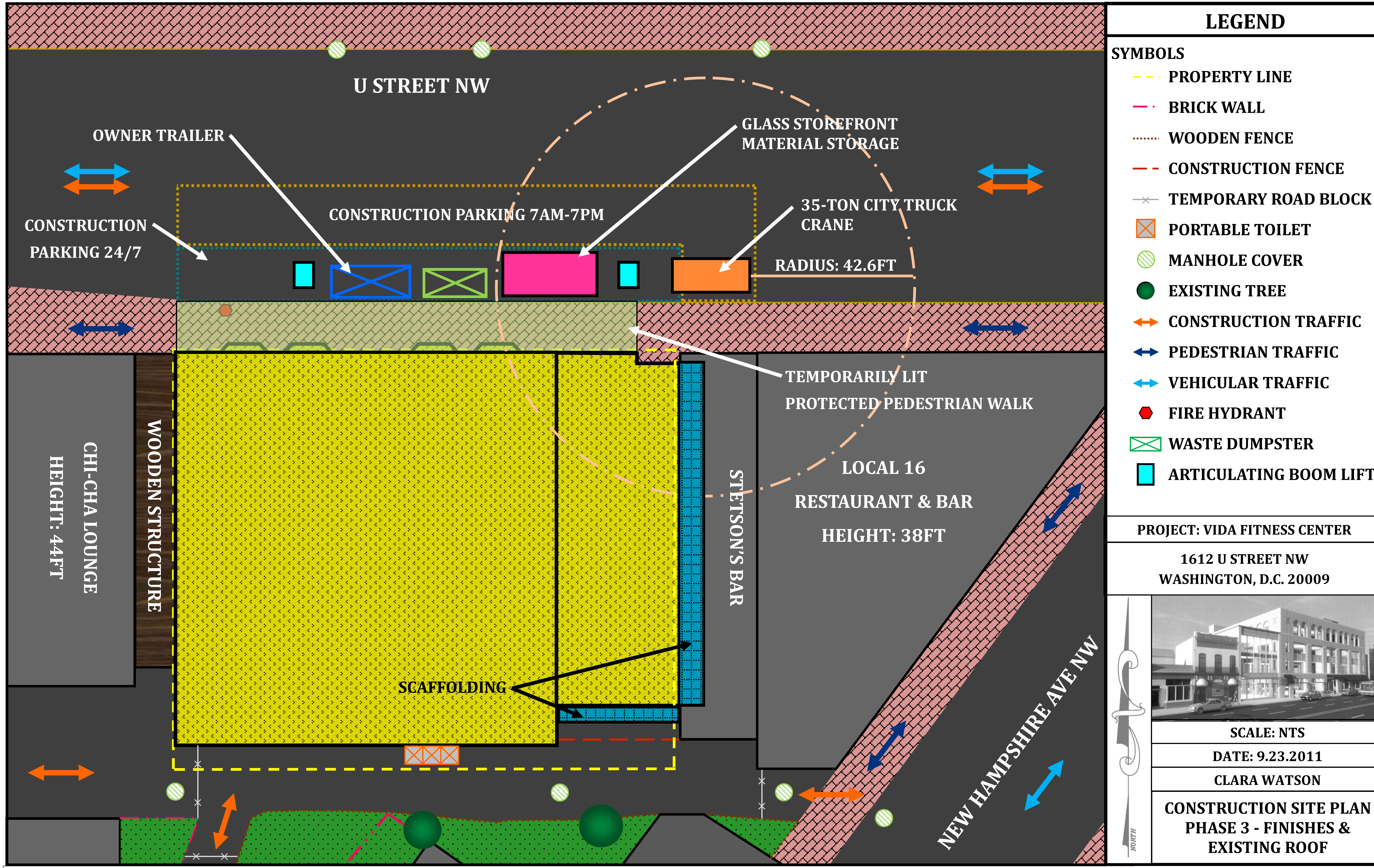
SCALE: NTS

DATE: 9.23.2011

CLARA WATSON

CONSTRUCTION SITE PLAN
PHASE 1 - FOUNDATION FOR
NEW ADDITION


U STREET NW
OWNER TRAILER
CONSTRUCTION PARKING 24/7
CONSTRUCTION PARKING 7AM-7PM
90-TON HYDRAULIC TRUCK CRANE
RADIUS: 63FT
TEMPORARILY LIT PROTECTED PEDESTRIAN WALK
17.5-TON TOWER CRANE
SLAB CUT FOR STAIRS, ALL 5 FLRS
DEMO EX. WALL FOR ACCESS TO EX. BUILDING
RADIUS: 73FT
CHI-CHA LOUNGE
HEIGHT: 44FT
WOODEN STRUCTURE
STETSON'S BAR
HEIGHT: 33FT
LOCAL 16
RESTAURANT & BAR
HEIGHT: 38FT
NEW HAMPSHIRE AVE NW
LEGEND
SYMBOLS
PROPERTY LINE
BRICK WALL
WOODEN FENCE
CONSTRUCTION FENCE
TEMPORARY ROAD BLOCK
PORTABLE TOILET
MANHOLE COVER
EXISTING TREE
CONSTRUCTION TRAFFIC
PEDESTRIAN TRAFFIC
VEHICULAR TRAFFIC
FIRE HYDRANT
WASTE DUMPSTER
PROJECT: VIDA FITNESS CENTER
1612 U STREET NW
WASHINGTON, D.C. 20009
SCALE: NTS
DATE: 9.23.2011
CLARA WATSON
CONSTRUCTION SITE PLAN
PHASE 2 - SUPERSTRUCTURE
& EXISTING ROOF


U STREET NW
OWNER TRAILER
GLASS STOREFRONT MATERIAL STORAGE
CONSTRUCTION PARKING 7AM-7PM
CONSTRUCTION PARKING 24/7
35-TON CITY TRUCK CRANE
RADIUS: 42.6FT
TEMPORARILY LIT PROTECTED PEDESTRIAN WALK
LOCAL 16 RESTAURANT & BAR HEIGHT: 38FT
STETSON'S BAR
CHI-CHA LOUNGE HEIGHT: 44FT
WOODEN STRUCTURE
SCAFFOLDING
NEW HAMPSHIRE AVE NW
LEGEND
SYMBOLS
PROPERTY LINE
BRICK WALL
WOODEN FENCE
CONSTRUCTION FENCE
TEMPORARY ROAD BLOCK
PORTABLE TOILET
MANHOLE COVER
EXISTING TREE
CONSTRUCTION TRAFFIC
PEDESTRIAN TRAFFIC
VEHICULAR TRAFFIC
FIRE HYDRANT
WASTE DUMPSTER
ARTICULATING BOOM LIFT
PROJECT: VIDA FITNESS CENTER
1612 U STREET NW
WASHINGTON, D.C. 20009
SCALE: NTS
DATE: 9.23.2011
CLARA WATSON
CONSTRUCTION SITE PLAN
PHASE 3 - FINISHES & EXISTING ROOF

Appendix B

RS Means Square Foot Cost Estimates

Square Foot Cost Estimate Report

Estimate Name:	**New Addition**
Building Type:	**Gymnasium with Face Brick with Concrete Block Back-up / Reinforced Concrete**
Location:	**WASHINGTON, DC**
Story Count:	**3**
Story Height (L.F.):	**13.2**
Floor Area (S.F.):	**10920**
Labor Type:	**Union**
Basement Included:	**No**
Data Release:	**Year 2011**
Cost Per Square Foot:	**$194.73**
Building Cost:	**$2,126,500**

Costs are derived from a building model with basic components.

Scope differences and market conditions can cause costs to vary significantly.

Parameters are not within the ranges recommended by RSMeans.

		% of Total	Cost Per S.F.	Cost
A Substructure		**4.70%**	**$6.82**	**$74,500**
A1010	**Standard Foundations**		**$2.11**	**$23,000**
	Strip footing, concrete, reinforced, load 11.1 KLF, soil bearing capacity 6 KSF, 12" deep x 24" wide			
	spread footings, 3000 PSI concrete, load 50K, soil bearing capacity 6 KSF, 3' - 0" square x 12" deep			
A1030	**Slab on Grade**		**$1.65**	**$18,000**
	Slab on grade, 4" thick, non industrial, reinforced			
A2010	**Basement Excavation**		**$0.05**	**$500**
	Excavate and fill, 30,000 SF, 4' deep, sand, gravel, or common earth, on site storage			
A2020	**Basement Walls**		**$3.02**	**$33,000**
	Foundation wall, CIP, 4' wall height, direct chute, .099 CY/LF, 4.8 PLF, 8" thick			
B Shell		**47.30%**	**$68.82**	**$751,500**
B1020	**Roof Construction**		**$12.87**	**$140,500**
	Steel deck, 3" deep, 16 ga, single 20' span, 6.0 PSF, 40 PSF superimposed load			
B2010	**Exterior Walls**		**$45.83**	**$500,500**
	Brick wall, composite double wythe, standard face/CMU back-up, 8" thick, perlite core fill			
B2020	**Exterior Windows**		**$7.97**	**$87,000**
	Windows, aluminum, awning, standard glass, 3'-1" x 3'-2"			
B2030	**Exterior Doors**		**$0.60**	**$6,500**
	Door, aluminum & glass, sliding patio, tempered glass, economy, 6'-0" x 7'-0" opening			
	Door, wood, overhead, panels, heavy duty, manual operation, 10'-0" x 10'-0" opening			
	Door, steel 24 gauge, overhead, sectional, manual operation, 10'-0" x 10'-0" opening			

B3010	**Roof Coverings**		**$1.56**	**$17,000**
	Drip edge, aluminum .016" thick, 5" girth, mill finish			
	Roofing, single ply membrane, EPDM, 60 mils, fully adhered			
	Insulation, rigid, roof deck, polyisocyanurate, 2#/CF, 3.5" thick			
C Interiors		**16.40%**	**$23.81**	**$260,000**
C1010	**Partitions**		**$1.60**	**$17,500**
	Concrere block (CMU) partition, light weight, hollow, 6" thick, no finish			
C1020	**Interior Doors**		**$2.15**	**$23,500**
	Door, single leaf, kd steel frame, hollow metal, commercial quality, flush, 3'-0" x 7'-0" x 1-3/8"			
C1030	**Fittings**		**$0.41**	**$4,500**
	Toilet partitions, cubicles, ceiling hung, stainless steel			
C3010	**Wall Finishes**		**$5.27**	**$57,500**
	2 coats paint on masonry with block filler			
	Painting, masonry or concrete, latex, brushwork, primer & 2 coats			
	Ceramic tile, thin set, 4-1/4" x 4-1/4"			
C3020	**Floor Finishes**		**$13.46**	**$147,000**
	Tile, ceramic natural clay			
	Maple strip, sanded and finished, maximum			
	Add for sleepers on concrete, treated, 24" OC, 1"x2"			
C3030	**Ceiling Finishes**		**$0.92**	**$10,000**
	Acoustic ceilings, 3/4"mineral fiber, 12" x 12" tile, concealed 2" bar & channel grid, suspended support			
D Services		**27.60%**	**$40.11**	**$438,000**
D2010	**Plumbing Fixtures**		**$7.55**	**$82,500**
	Water closet, vitreous china, bowl only with flush valve, wall hung			
	Urinal, vitreous china, wall hung			
	Lavatory w/trim, wall hung, PE on CI, 19" x 17"			
	Kitchen sink w/trim, countertop, stainless steel, 33" x 22" double bowl			
	Service sink w/trim, PE on CI,wall hung w/rim guard, 24" x 20"			
	Shower, stall, baked enamel, terrazzo receptor, 36" square			
	Water cooler, electric, wall hung, dual height, 14.3 GPH			
D2020	**Domestic Water Distribution**		**$3.89**	**$42,500**
	Gas fired water heater, commercial, 100< F rise, 600 MBH input, 576 GPH			
D3050	**Terminal & Package Units**		**$10.35**	**$113,000**
	Rooftop, single zone, air conditioner, banks or libraries, 10,000 SF, 41.67 ton			
D4010	**Sprinklers**		**$3.30**	**$36,000**
	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 10,000 SF			

D4020	**Standpipes**		**$0.82**	**$9,000**
	Wet standpipe risers, class III, steel, black, sch 40, 6" diam pipe, 1 floor			
	Wet standpipe risers, class III, steel, black, sch 40, 6" diam pipe, additional floors			
D5010	**Electrical Service/Distribution**		**$1.88**	**$20,500**
	Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 400 A			
	Feeder installation 600 V, including RGS conduit and XHHW wire, 400 A			
	Switchgear installation, incl switchboard, panels & circuit breaker, 400 A			
D5020	**Lighting and Branch Wiring**		**$8.88**	**$97,000**
	Receptacles incl plate, box, conduit, wire, 8 per 1000 SF, .9 watts per SF			
	Wall switches, 1.0 per 1000 SF			
	Miscellaneous power, 1 watt			
	Central air conditioning power, 4 watts			
	Fluorescent fixtures recess mounted in ceiling, 1.6 watt per SF, 40 FC, 10 fixtures @32watt per 1000 SF			
D5030	**Communications and Security**		**$3.25**	**$35,500**
	Communication and alarm systems, includes outlets, boxes, conduit and wire, sound systems, 12 outlets			
	Communication and alarm systems, fire detection, addressable, 25 detectors, includes outlets, boxes, conduit and wire			
	Fire alarm command center, addressable with voice, excl. wire & conduit			
D5090	**Other Electrical Systems**		**$0.18**	**$2,000**
	Generator sets, w/battery, charger, muffler and transfer switch, gas/gasoline operated, 3 phase, 4 wire, 277/480 V, 7.5 kW			
E Equipment & Furnishings		**4.20%**	**$6.04**	**$66,000**
E1090	**Other Equipment**		**$6.04**	**$66,000**
	Architectural equipment, school equipment, weight lifting gym, universal, deluxe			
	Architectural equipment, sauna, prefabricated, including heater and controls, 7' high, 6' x 4'			
F Special Construction		**0.00%**	**$0.00**	**$0**
G Building Sitework		**0.00%**	**$0.00**	**$0**
SubTotal		**100%**	**$145.60**	**$1,590,000**
Contractor Fees (General Conditions,Overhead,Profit)		**25.00%**	**$36.40**	**$397,500**
Architectural Fees		**7.00%**	**$12.73**	**$139,000**
User Fees		**0.00%**	**$0.00**	**$0**
Total Building Cost			**$194.73**	**$2,126,500**

Square Foot Cost Estimate Report

Estimate Name:	**Renovation of Existing Building**
Building Type:	**Gymnasium with Face Brick with Concrete Block Back-up / Reinforced Concrete**
Location:	**WASHINGTON, DC**
Story Count:	**5**
Story Height (L.F.):	**13.2**
Floor Area (S.F.):	**49450**
Labor Type:	**Union**
Basement Included:	**No**
Data Release:	**Year 2011**
Cost Per Square Foot:	**$173.28**
Building Cost:	**$8,568,500**

Costs are derived from a building model with basic components.

Scope differences and market conditions can cause costs to vary significantly.

Parameters are not within the ranges recommended by RSMeans.

		% of Total	Cost Per S.F.	Cost
A Substructure		**2.90%**	**$3.71**	**$183,500**
A1010	**Standard Foundations**		**$1.20**	**$59,500**
	Strip footing, concrete, reinforced, load 11.1 KLF, soil bearing capacity 6 KSF, 12" deep x 24" wide			
	spread footings, 3000 PSI concrete, load 50K, soil bearing capacity 6 KSF, 3' - 0" square x 12" deep			
A1030	**Slab on Grade**		**$0.99**	**$49,000**
	Slab on grade, 4" thick, non industrial, reinforced			
A2010	**Basement Excavation**		**$0.03**	**$1,500**
	Excavate and fill, 30,000 SF, 4' deep, sand, gravel, or common earth, on site storage			
A2020	**Basement Walls**		**$1.49**	**$73,500**
	Foundation wall, CIP, 4' wall height, direct chute, .099 CY/LF, 4.8 PLF, 8" thick			
B Shell		**44.40%**	**$57.51**	**$2,844,000**
B1020	**Roof Construction**		**$11.91**	**$589,000**
	Steel deck, 3" deep, 16 ga, single 20' span, 6.0 PSF, 40 PSF superimposed load			
B2010	**Exterior Walls**		**$37.53**	**$1,856,000**
	Brick wall, composite double wythe, standard face/CMU back-up, 8" thick, perlite core fill			
B2020	**Exterior Windows**		**$6.54**	**$323,500**
	Windows, aluminum, awning, standard glass, 3'-1" x 3'-2"			
B2030	**Exterior Doors**		**$0.58**	**$28,500**
	Door, aluminum & glass, sliding patio, tempered glass, economy, 6'-0" x 7'-0" opening			
	Door, wood, overhead, panels, heavy duty, manual operation, 10'-0" x 10'-0" opening			
	Door, steel 24 gauge, overhead, sectional, manual operation, 10'-0" x 10'-0" opening			

B3010	**Roof Coverings**		**$0.95**	**$47,000**
	Drip edge, aluminum .016" thick, 5" girth, mill finish			
	Roofing, single ply membrane, EPDM, 60 mils, fully adhered			
	Insulation, rigid, roof deck, polyisocyanurate, 2#/CF, 3.5" thick			
C Interiors		**17.60%**	**$22.81**	**$1,128,000**
C1010	**Partitions**		**$1.61**	**$79,500**
	Concrere block (CMU) partition, light weight, hollow, 6" thick, no finish			
C1020	**Interior Doors**		**$2.14**	**$106,000**
	Door, single leaf, kd steel frame, hollow metal, commercial quality, flush, 3'-0" x 7'-0" x 1-3/8"			
C1030	**Fittings**		**$0.09**	**$4,500**
	Toilet partitions, cubicles, ceiling hung, stainless steel			
C3010	**Wall Finishes**		**$4.59**	**$227,000**
	2 coats paint on masonry with block filler			
	Painting, masonry or concrete, latex, brushwork, primer & 2 coats			
	Ceramic tile, thin set, 4-1/4" x 4-1/4"			
C3020	**Floor Finishes**		**$13.47**	**$666,000**
	Tile, ceramic natural clay			
	Maple strip, sanded and finished, maximum			
	Add for sleepers on concrete, treated, 24" OC, 1"x2"			
C3030	**Ceiling Finishes**		**$0.91**	**$45,000**
	Acoustic ceilings, 3/4"mineral fiber, 12" x 12" tile, concealed 2" bar & channel grid, suspended support			
D Services		**29.20%**	**$37.80**	**$1,869,000**
D2010	**Plumbing Fixtures**		**$7.56**	**$374,000**
	Water closet, vitreous china, bowl only with flush valve, wall hung			
	Urinal, vitreous china, wall hung			
	Lavatory w/trim, wall hung, PE on CI, 19" x 17"			
	Kitchen sink w/trim, countertop, stainless steel, 33" x 22" double bowl			
	Service sink w/trim, PE on CI,wall hung w/rim guard, 24" x 20"			
	Shower, stall, baked enamel, terrazzo receptor, 36" square			
	Water cooler, electric, wall hung, dual height, 14.3 GPH			
D2020	**Domestic Water Distribution**		**$3.88**	**$192,000**
	Gas fired water heater, commercial, 100< F rise, 600 MBH input, 576 GPH			
D3050	**Terminal & Package Units**		**$10.33**	**$511,000**
	Rooftop, single zone, air conditioner, banks or libraries, 10,000 SF, 41.67 ton			
D4010	**Sprinklers**		**$3.29**	**$162,500**
	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 10,000 SF			

D4020	**Standpipes**		**$0.82**	**$40,500**
	Wet standpipe risers, class III, steel, black, sch 40, 6" diam pipe, 1 floor			
	Wet standpipe risers, class III, steel, black, sch 40, 6" diam pipe, additional floors			
D5010	**Electrical Service/Distribution**		**$0.41**	**$20,500**
	Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 400 A			
	Feeder installation 600 V, including RGS conduit and XHHW wire, 400 A			
	Switchgear installation, incl switchboard, panels & circuit breaker, 400 A			
D5020	**Lighting and Branch Wiring**		**$8.89**	**$439,500**
	Receptacles incl plate, box, conduit, wire, 8 per 1000 SF, .9 watts per SF			
	Wall switches, 1.0 per 1000 SF			
	Miscellaneous power, 1 watt			
	Central air conditioning power, 4 watts			
	Fluorescent fixtures recess mounted in ceiling, 1.6 watt per SF, 40 FC, 10 fixtures @32watt per 1000 SF			
D5030	**Communications and Security**		**$2.41**	**$119,000**
	Communication and alarm systems, includes outlets, boxes, conduit and wire, sound systems, 12 outlets			
	Communication and alarm systems, fire detection, addressable, 25 detectors, includes outlets, boxes, conduit and wire			
	Fire alarm command center, addressable with voice, excl. wire & conduit			
D5090	**Other Electrical Systems**		**$0.20**	**$10,000**
	Generator sets, w/battery, charger, muffler and transfer switch, gas/gasoline operated, 3 phase, 4 wire, 277/480 V, 7.5 kW			
E Equipment & Furnishings		**6.00%**	**$7.72**	**$382,000**
E1090	**Other Equipment**		**$7.72**	**$382,000**
	256 - Lockers, steel, baked enamel, single tier, maximum			
	Architectural equipment, school equipment, weight lifting gym, universal, deluxe			
	Architectural equipment, sauna, prefabricated, including heater and controls, 7' high, 6' x 4'			
F Special Construction		**0.00%**	**$0.00**	**$0**
G Building Sitework		**0.00%**	**$0.00**	**$0**
SubTotal		**100%**	**$129.56**	**$6,406,500**
Contractor Fees (General Conditions,Overhead,Profit)		**25.00%**	**$32.39**	**$1,601,500**
Architectural Fees		**7.00%**	**$11.33**	**$560,500**
User Fees		**0.00%**	**$0.00**	**$0**
Total Building Cost			**$173.28**	**$8,568,500**

APPENDIX C

RS MEANS ASSEMBLY COST ESTIMATE

MEP Assemblies Cost Estimate Report									
Quantity	Assembly Number	Description	Unit	Material O&P	Installation O&P	Total O&P	Ext. Material O&P	Ext. Installation O&P	Ext. Total O&P
D2010	**Plumbing Fixtures**								
14	D20101101920	Water closet, vitreous china, tank type, floor mount, 1 piece	Ea.	$ 1,452.90	$ 683.28	$ 2,136.18	$ 20,340.60	$ 9,565.92	$ 29,906.52
5	D20102102000	Urinal, vitreous china, wall hung	Ea.	$ 591.18	$ 725.99	$ 1,317.17	$ 2,955.90	$ 3,629.95	$ 6,585.85
12	D20103101640	Lavatory w/trim, vanity top, PE on CI, 18" round	Ea.	$ 606.21	$ 645.32	$ 1,251.53	$ 7,274.52	$ 7,743.84	$ 15,018.36
5	D20103102040	Lavatory w/trim, wall hung, PE on CI, 18" x 15"	Ea.	$ 871.74	$ 711.75	$ 1,583.49	$ 4,358.70	$ 3,558.75	$ 7,917.45
2	D20104102240	Kitchen sink w/trim, raised deck, PE on CI, 32" x 21", dual level, double bowl	Ea.	$ 811.62	$ 972.73	$ 1,784.35	$ 1,623.24	$ 1,945.46	$ 3,568.70
14	D20107101600	Shower, stall, baked enamel, molded stone receptor, 32" square	Ea.	$ 1,202.40	$ 754.46	$ 1,956.86	$ 16,833.60	$ 10,562.44	$ 27,396.04
2	D20107102100	Shower, ss panels, handicap w/fixed & handheld head, control valves,grab bar & seat	Ea.	$ 5,320.62	$ 3,340.48	$ 8,661.10	$ 10,641.24	$ 6,680.96	$ 17,322.20
3	D20108101920	Drinking fountain, 1 bubbler, wall mounted, non recessed, stainless steel, no back	Ea.	$ 1,277.55	$ 427.05	$ 1,704.60	$ 3,832.65	$ 1,281.15	$ 5,113.80
3	D20108201880	Water cooler, electric, wall hung, dual height, 14.3 GPH	Ea.	$ 1,528.05	$ 564.66	$ 2,092.71	$ 4,584.15	$ 1,693.98	$ 6,278.13
D2020	**Domestic Water Distribution**								
4	D20202502260	Gas fired water heater, commercial, 100< F rise, 600 MBH input, 576 GPH	Ea.	$19,338.60	$ 3,487.58	$ 22,826.18	$ 77,354.40	$ 13,950.32	$ 91,304.72
D2040	**Rain Water Drainage**								
6	D20402101880	Roof drain, DWV PVC, 2" diam, piping, 10' high	Ea.	$ 286.57	$ 607.36	$ 893.93	$ 1,719.42	$ 3,644.16	$ 5,363.58
D3010	**Energy Supply**								
60000	D30105301960	Commercial building heating systems, terminal unit heaters, forced hot water, 100,000 SF bldg, 1mil CF, total, 3 floors	S.F.	$ 1.72	$ 2.01	$ 3.73	$ 103,200.00	$ 120,600.00	$ 223,800.00
D3020	**Heat Generating Systems**								
2	D30201061080	Boiler, gas, cast iron, hot water, 1,088 MBH	Ea.	$14,228.40	$ 5,836.35	$ 20,064.75	$ 28,456.80	$ 11,672.70	$ 40,129.50
D3030	**Cooling Generating Systems**								
60000	D30301154280	Packaged chiller, water cooled, with fan coil unit, restaurants, 40,000 SF, 200.00 ton	S.F.	$ 7.82	$ 5.86	$ 13.68	$ 469,200.00	$ 351,600.00	$ 820,800.00
3	D30301401010	Chiller, centrifugal, water cooled, packaged hermetic, standard controls, 200 ton	Ea.	$97,695.00	$29,396.20	$ 127,091.20	$ 293,085.00	$ 88,188.60	$ 381,273.60

D3040	**Distribution Systems**								
3	D30401281010	Fan coil A/C system, horizontal with cabinet, controls, 4 pipe, 1/2 ton	Ea.	$ 2,855.70	$ 3,202.88	$ 6,058.58	$ 8,567.10	$ 9,608.64	$ 18,175.74
15	D30401221010	Fan coil A/C system, cabinet mounted, controls, 4 pipe, 1/2 ton	Ea.	$ 1,953.90	$ 2,206.43	$ 4,160.33	$ 29,308.50	$ 33,096.45	$ 62,404.95
2	D30401341040	VAV terminal, cooling, hot water reheat, with actuator / controls, 800 CFM	Ea.	$ 2,379.75	$ 4,412.85	$ 6,792.60	$ 4,759.50	$ 8,825.70	$ 13,585.20
6	D30401341070	VAV terminal, cooling, hot water reheat, with actuator / controls, 1500 CFM	Ea.	$ 3,256.50	$ 7,212.40	$ 10,468.90	$ 19,539.00	$ 43,274.40	$ 62,813.40
2	D30401341080	VAV terminal, cooling, hot water reheat, with actuator / controls, 2000 CFM	Ea.	$ 3,882.75	$ 9,774.70	$ 13,657.45	$ 7,765.50	$ 19,549.40	$ 27,314.90
1	D30401341010	VAV terminal, cooling, hot water reheat, with actuator/controls, 200 CFM	Ea.	$ 1,842.77	$ 2,030.89	$ 3,873.66	$ 1,842.77	$ 2,030.89	$ 3,873.66
1	D30401341020	VAV terminal, cooling, hot water reheat, with actuator / controls, 400 CFM	Ea.	$ 2,029.05	$ 2,752.10	$ 4,781.15	$ 2,029.05	$ 2,752.10	$ 4,781.15
2	D30401341030	VAV terminal, cooling, hot water reheat, with actuator / controls, 600 CFM	Ea.	$ 2,279.55	$ 3,772.28	$ 6,051.83	$ 4,559.10	$ 7,544.56	$ 12,103.66
1	D30406101010	Plate heat exchanger, 400 GPM	Ea.	$49,198.20	$13,944.50	$ 63,142.70	$ 49,198.20	$ 13,944.50	$ 63,142.70
D3050	**Terminal & Package Units**								
1	D30502011010	A/C packaged, DX, air cooled, electric heat, constant volume, 5 ton	Ea.	$ 8,391.75	$ 3,748.55	$ 12,140.30	$ 8,391.75	$ 3,748.55	$ 12,140.30
D4010	**Sprinklers**								
10000	D40104101080	Wet pipe sprinkler systems, steel, ordinary hazard, 1 floor, 10,000 SF	S.F.	$ 1.92	$ 2.27	$ 4.19	$ 19,200.00	$ 22,700.00	$ 41,900.00
50000	D40104101220	Wet pipe sprinkler systems, steel, ordinary hazard, each additional floor, 10,000 SF	S.F.	$ 1.31	$ 2.12	$ 3.43	$ 65,500.00	$ 106,000.00	$ 171,500.00
D4020	**Standpipes**								
1	D40203100600	Wet standpipe risers, class I, steel, black, sch 40, 6" diam pipe, 1 floor	Floor	$ 6,487.95	$ 5,271.73	$ 11,759.68	$ 6,487.95	$ 5,271.73	$ 11,759.68
4	D40203100620	Wet standpipe risers, class I, steel, black, sch 40, 6" diam pipe, additional floors	Floor	$ 1,553.10	$ 1,461.53	$ 3,014.63	$ 6,212.40	$ 5,846.12	$ 12,058.52
D5010	**Electrical Service/Distribution**								
1	D50101200520	Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 1600 A	Ea.	$28,189.20	$ 8,617.20	$ 36,806.40	$ 28,189.20	$ 8,617.20	$ 36,806.40
D5020	**Lighting and Branch Wiring**								
30000	D50201150760	Receptacle systems, conduit system with floor boxes, high density	S.F.	$ 2.27	$ 2.02	$ 4.29	$ 68,100.00	$ 60,600.00	$ 128,700.00
30000	D50201300240	Wall switches, 1.2 per 1000 SF	S.F.	$ 0.06	$ 0.25	$ 0.31	$ 1,800.00	$ 7,500.00	$ 9,300.00
30000	D50202140400	Incandescent fixtures recess mounted, 100 FC, type A, 34 fixtures per 400 SF	S.F.	$ 13.99	$ 18.89	$ 32.88	$ 419,700.00	$ 566,700.00	$ 986,400.00
D5030	**Communications and Security**								
20000	D50303100520	Telephone systems, telepoles, low density	S.F.	$ 1.18	$ 0.64	$ 1.82	$ 23,600.00	$ 12,800.00	$ 36,400.00
Total Building Cost									**$3,396,938.71**

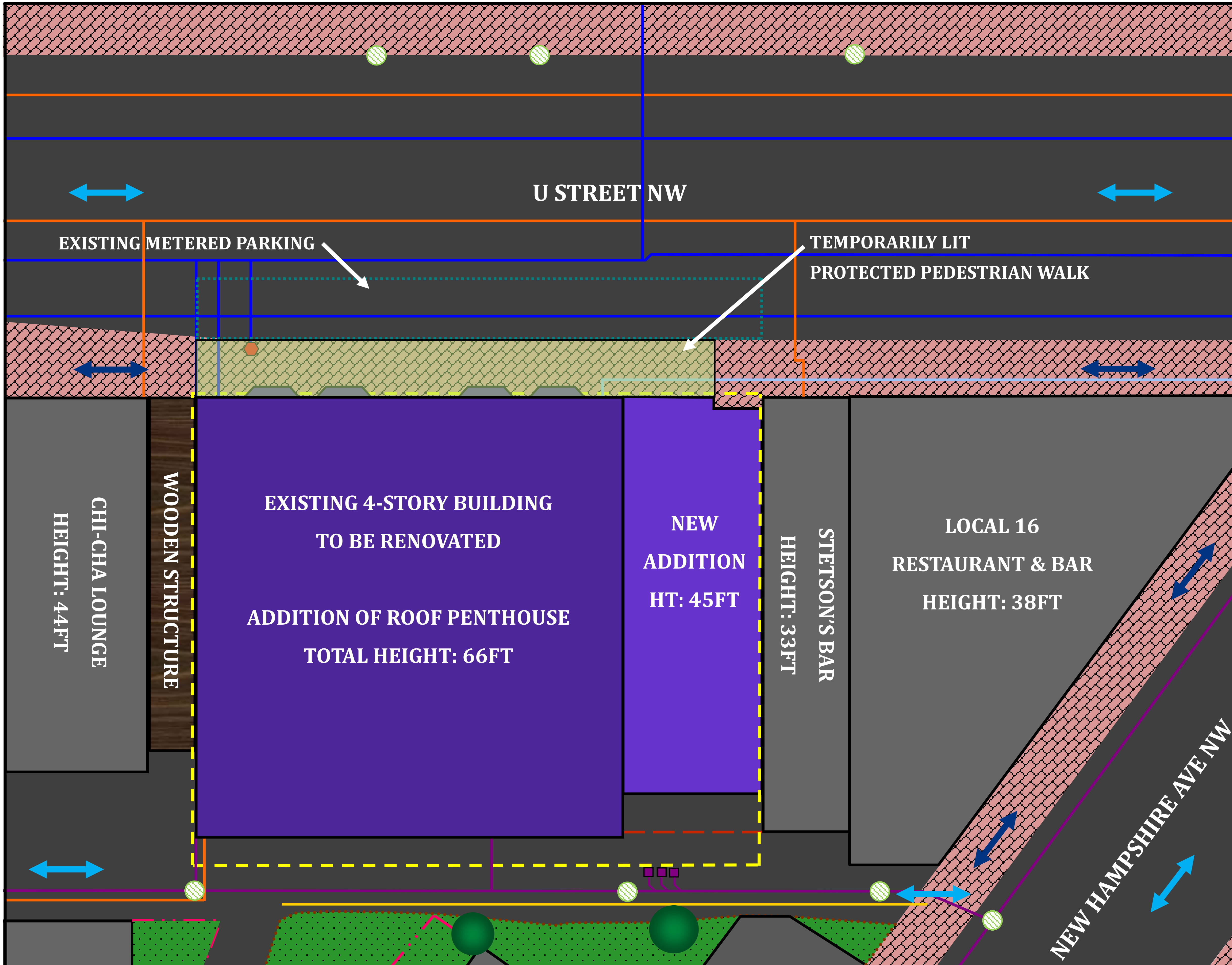
Appendix D

General Conditions Estimate

LINE ITEM	QUANTITY	UNIT	RATE	TOTAL COST
Project Team & Personnel				
Project Manager	26.00	WKS	$ 3,175.00	$ 82,550.00
Assistant Project Manager	52.00	WKS	$ 2,750.00	$ 143,000.00
Intern	12.00	WKS	$ 640.00	$ 7,680.00
Lead Superintendent	52.00	WKS	$ 3,375.00	$ 175,500.00
Ass't Superintendent	8.00	WKS	$ 2,675.00	$ 21,400.00
Vice President	0.50	WKS	$ 8,004.00	$ 4,002.00
Project Executive	1.00	WKS	$ 6,546.00	$ 6,546.00
Administrative Assistant	20.00	WKS	$ 1,400.00	$ 28,000.00
Carpenter	12.00	WKS	$ 1,600.00	$ 19,200.00
Laborer	12.00	WKS	$ 2,075.00	$ 24,900.00
Cost Engineer	2.00	WKS	$ 1,988.00	$ 4,000.00
Purchasing Project Manager	2.00	WKS	$ 3,557.00	$ 7,114.00
Project Accountant	20.00	WKS	$ 2,312.00	$ 46,240.00
Safety Inspections	7.00	EA	$ 244.00	$ 1,708.00
Site Expenses				
Computers (Two)	52.00	WKS	$ 33.14	$ 1,723.28
Site Company Truck & Expenditures	52.00	WKS	$ 244.64	$ 12,721.28
Drawings & Specifications	1.00	LS	$ 5,000.00	$ 5,000.00
Tests & Inspections	1.00	LS	$ 33,861.00	$ 33,861.00
Postage & Shipping	32.00	WKS	$ 75.00	$ 2,400.00
Project Signs	1.00	EA	$ 1,200.00	$ 1,200.00
CPM Schedule	1.00	EA	$ 4,852.00	$ 4,852.00
Trailer rental	52.00	WKS	$ 157.53	$ 8,191.56
Site Office Equipment	32.00	WKS	$ 84.11	$ 2,691.52
Cell Phones	52.00	WKS	$ 22.64	$ 1,177.28
Site Telephone	7.00	MOS	$ 48.95	$ 342.65
Sanitary Facilities	7.00	MOS	$ 135.00	$ 945.00
Dumpsters	32.00	EA	$ 600.00	$ 19,200.00
Daily Clean-Up	52.00	WKS	$ 234.45	$ 12,191.40
Final Clean-Up	60,000.00	SF	$ 0.38	$ 22,800.00
Miscellaneous Costs				
Builder's Risk Insurance	0.25	%	$ 11,159,165.00	$ 27,897.91
General Liability Insurance	0.75	%	$ 11,159,165.00	$ 83,693.74
Subcontractor Default Insurance	1.25	%	$ 11,159,165.00	$ 139,489.56
Payment & Performance Bonds	1.00	%	$ 11,159,165.00	$ 111,591.65
Contingency	5.00	%	$ 11,159,165.00	$ 557,958.25
Permits	0.75	%	$ 11,159,165.00	$ 83,693.74
Total General Conditions Cost				**$ 1,705,461.82**

APPENDIX E

EXISTING CONDITIONS SITE PLAN



LEGEND

EXISTINT UTILITIES

- GAS LINE
- ABANDONED GAS LINE
- SEWER LINE
- WATER LINE

SYMBOLS

- PROPERTY LINE
- BRICK WALL
- WOODEN FENCE
- CONSTRUCTION FENCE
- MANHOLE COVER
- EXISTING TREE
- CLEAN OUT
- PEDESTRIAN TRAFFIC
- VEHICULAR TRAFFIC
- FIRE HYDRANT

PROJECT: VIDA FITNESS CENTER

1612 U STREET NW
WASHINGTON, D.C. 20009

NORTH

SCALE: NTS

DATE: 9.23.2011

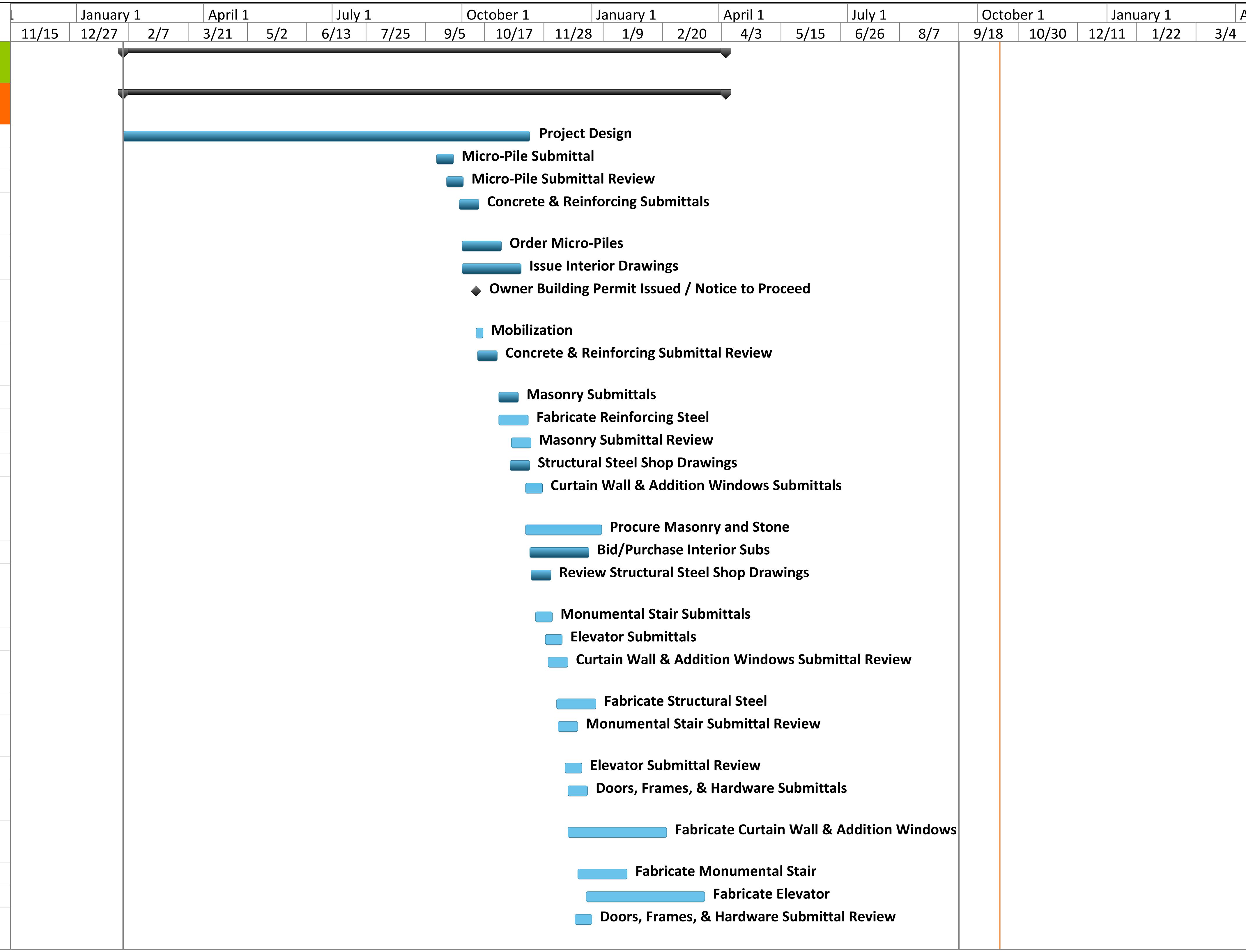
CLARA WATSON

EXISTING CONDITIONS PLAN

APPENDIX F

DETAILED PROJECT SCHEDULE

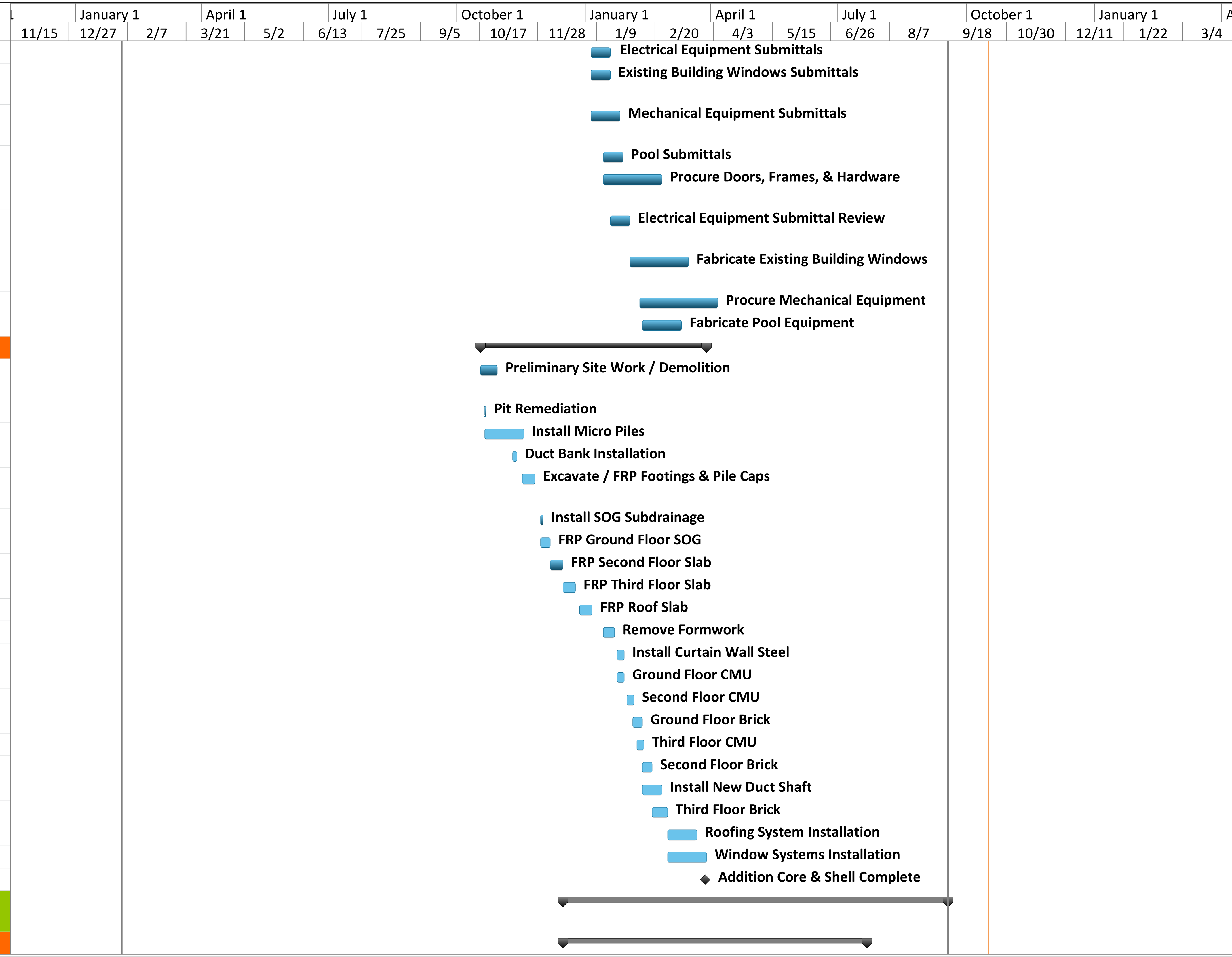
ID	Task Name	Duration	Start
1	**PHASE 1: New Addition Construction**	**305 days**	**Wed 2/3/10**
2	**Procurement / Preconstruction**	**305 days**	**Wed 2/3/10**
3	Project Design	206 days	Wed 2/3/10
4	Micro-Pile Submittal	10 days	Mon 9/13/10
5	Micro-Pile Submittal Review	10 days	Mon 9/20/10
6	Concrete & Reinforcing Submittals	10 days	Wed 9/29/10
7	Order Micro-Piles	20 days	Fri 10/1/10
8	Issue Interior Drawings	30 days	Fri 10/1/10
9	Owner Building Permit Issued / Notice to Proceed	0 days	Mon 10/11/10
10	Mobilization	5 days	Mon 10/11/10
11	Concrete & Reinforcing Submittal Review	10 days	Tue 10/12/10
12	Masonry Submittals	10 days	Wed 10/27/10
13	Fabricate Reinforcing Steel	15 days	Wed 10/27/10
14	Masonry Submittal Review	10 days	Fri 11/5/10
15	Structural Steel Shop Drawings	10 days	Thu 11/4/10
16	Curtain Wall & Addition Windows Submittals	10 days	Mon 11/15/10
17	Procure Masonry and Stone	40 days	Mon 11/15/10
18	Bid/Purchase Interior Subs	30 days	Thu 11/18/10
19	Review Structural Steel Shop Drawings	10 days	Fri 11/19/10
20	Monumental Stair Submittals	10 days	Mon 11/22/10
21	Elevator Submittals	10 days	Mon 11/29/10
22	Curtain Wall & Addition Windows Submittal Review	10 days	Wed 12/1/10
23	Fabricate Structural Steel	20 days	Tue 12/7/10
24	Monumental Stair Submittal Review	10 days	Wed 12/8/10
25	Elevator Submittal Review	10 days	Mon 12/13/10
26	Doors, Frames, & Hardware Submittals	10 days	Wed 12/15/10
27	Fabricate Curtain Wall & Addition Windows	50 days	Wed 12/15/10
28	Fabricate Monumental Stair	25 days	Wed 12/22/10
29	Fabricate Elevator	60 days	Tue 12/28/10
30	Doors, Frames, & Hardware Submittal Review	10 days	Mon 12/20/10



Project: VIDA Project Schedule
Date: Mon 10/17/11

Task; Split; Milestone; Summary; Project Summary; External Tasks; External Milestone; Inactive Task; Inactive Milestone; Inactive Summary; Manual Task; Duration-only; Manual Summary Rollup; Manual Summary; Start-only; Finish-only; Deadline; Progress

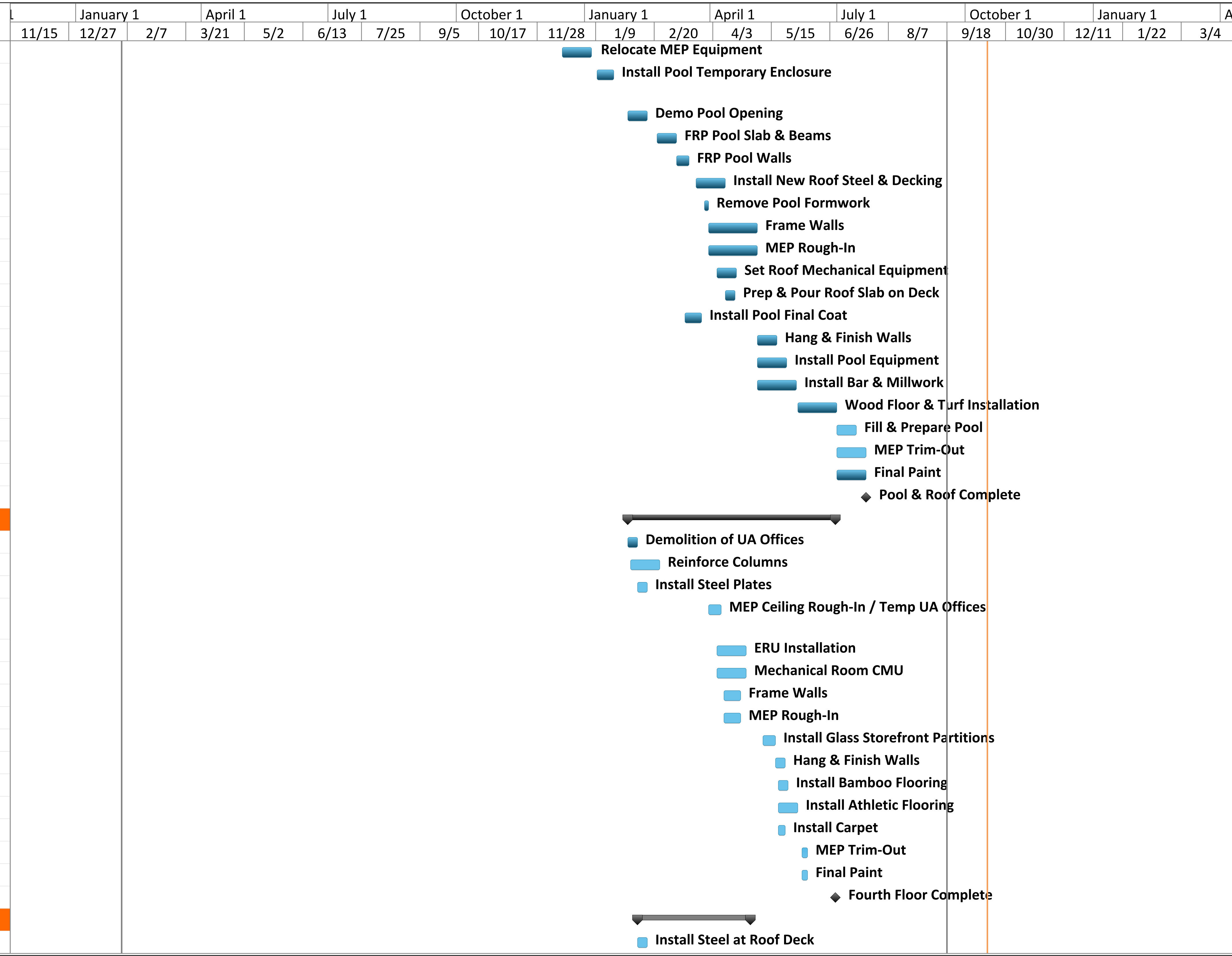
ID	Task Name	Duration	Start
31	Electrical Equipment Submittals	10 days	Wed 1/5/11
32	Existing Building Windows Submittals	10 days	Wed 1/5/11
33	Mechanical Equipment Submittals	15 days	Wed 1/5/11
34	Pool Submittals	10 days	Fri 1/14/11
35	Procure Doors, Frames, & Hardware	30 days	Fri 1/14/11
36	Electrical Equipment Submittal Review	10 days	Wed 1/19/11
37	Fabricate Existing Building Windows	30 days	Wed 2/2/11
38	Procure Mechanical Equipment	40 days	Wed 2/9/11
39	Fabricate Pool Equipment	20 days	Fri 2/11/11
40	**New Addition Construction**	**116 days**	**Mon 10/18/10**
41	Preliminary Site Work / Demolition	10 days	Mon 10/18/10
42	Pit Remediation	1 day	Thu 10/21/10
43	Install Micro Piles	20 days	Thu 10/21/10
44	Duct Bank Installation	3 days	Wed 11/10/10
45	Excavate / FRP Footings & Pile Caps	7 days	Wed 11/17/10
46	Install SOG Subdrainage	2 days	Tue 11/30/10
47	FRP Ground Floor SOG	5 days	Tue 11/30/10
48	FRP Second Floor Slab	7 days	Tue 12/7/10
49	FRP Third Floor Slab	7 days	Thu 12/16/10
50	FRP Roof Slab	7 days	Tue 12/28/10
51	Remove Formwork	6 days	Fri 1/14/11
52	Install Curtain Wall Steel	5 days	Mon 1/24/11
53	Ground Floor CMU	5 days	Mon 1/24/11
54	Second Floor CMU	5 days	Mon 1/31/11
55	Ground Floor Brick	5 days	Fri 2/4/11
56	Third Floor CMU	5 days	Mon 2/7/11
57	Second Floor Brick	5 days	Fri 2/11/11
58	Install New Duct Shaft	10 days	Fri 2/11/11
59	Third Floor Brick	7 days	Fri 2/18/11
60	Roofing System Installation	15 days	Tue 3/1/11
61	Window Systems Installation	20 days	Tue 3/1/11
62	Addition Core & Shell Complete	0 days	Mon 3/28/11
63	**PHASE 2: Renovation & Interiors**	**197 days**	**Thu 12/16/10**
64	**Roof**	**156 days**	**Thu 12/16/10**



Project: VIDA Project Schedule
Date: Mon 10/17/11

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

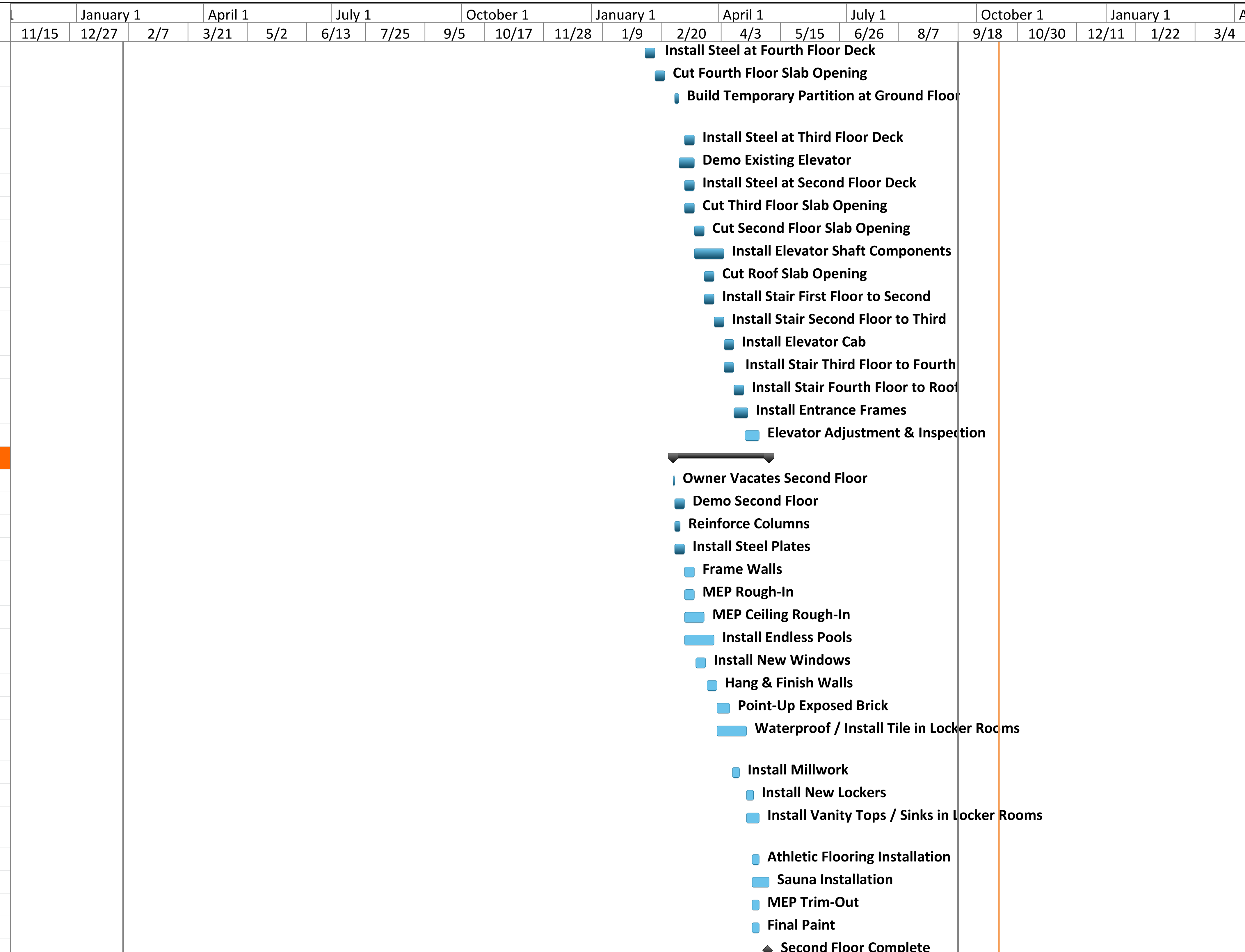
ID	Task Name	Duration	Start
65	Relocate MEP Equipment	15 days	Thu 12/16/10
66	Install Pool Temporary Enclosure	10 days	Mon 1/10/11
67	Demo Pool Opening	10 days	Tue 2/1/11
68	FRP Pool Slab & Beams	10 days	Tue 2/22/11
69	FRP Pool Walls	7 days	Tue 3/8/11
70	Install New Roof Steel & Decking	15 days	Tue 3/22/11
71	Remove Pool Formwork	3 days	Mon 3/28/11
72	Frame Walls	25 days	Thu 3/31/11
73	MEP Rough-In	25 days	Thu 3/31/11
74	Set Roof Mechanical Equipment	10 days	Wed 4/6/11
75	Prep & Pour Roof Slab on Deck	5 days	Tue 4/12/11
76	Install Pool Final Coat	10 days	Mon 3/14/11
77	Hang & Finish Walls	10 days	Thu 5/5/11
78	Install Pool Equipment	15 days	Thu 5/5/11
79	Install Bar & Millwork	20 days	Thu 5/5/11
80	Wood Floor & Turf Installation	20 days	Fri 6/3/11
81	Fill & Prepare Pool	10 days	Fri 7/1/11
82	MEP Trim-Out	15 days	Fri 7/1/11
83	Final Paint	15 days	Fri 7/1/11
84	Pool & Roof Complete	0 days	Fri 7/22/11
85	**Fourth Floor**	**107 days**	**Tue 2/1/11**
86	Demolition of UA Offices	5 days	Tue 2/1/11
87	Reinforce Columns	15 days	Thu 2/3/11
88	Install Steel Plates	5 days	Tue 2/8/11
89	MEP Ceiling Rough-In / Temp UA Offices	7 days	Thu 3/31/11
90	ERU Installation	15 days	Wed 4/6/11
91	Mechanical Room CMU	15 days	Wed 4/6/11
92	Frame Walls	10 days	Mon 4/11/11
93	MEP Rough-In	10 days	Mon 4/11/11
94	Install Glass Storefront Partitions	7 days	Mon 5/9/11
95	Hang & Finish Walls	5 days	Wed 5/18/11
96	Install Bamboo Flooring	5 days	Fri 5/20/11
97	Install Athletic Flooring	10 days	Fri 5/20/11
98	Install Carpet	3 days	Fri 5/20/11
99	MEP Trim-Out	4 days	Mon 6/6/11
100	Final Paint	4 days	Mon 6/6/11
101	Fourth Floor Complete	0 days	Thu 6/30/11
102	**Monumental Stairs & Elevator**	**59 days**	**Tue 2/8/11**
103	Install Steel at Roof Deck	5 days	Tue 2/8/11



Project: VIDA Project Schedule
Date: Mon 10/17/11

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

ID	Task Name	Duration	Start
104	Install Steel at Fourth Floor Deck	5 days	Tue 2/8/11
105	Cut Fourth Floor Slab Opening	5 days	Tue 2/15/11
106	Build Temporary Partition at Ground Floor	3 days	Tue 3/1/11
107	Install Steel at Third Floor Deck	5 days	Tue 3/8/11
108	Demo Existing Elevator	7 days	Fri 3/4/11
109	Install Steel at Second Floor Deck	5 days	Tue 3/8/11
110	Cut Third Floor Slab Opening	5 days	Tue 3/8/11
111	Cut Second Floor Slab Opening	5 days	Tue 3/15/11
112	Install Elevator Shaft Component	15 days	Tue 3/15/11
113	Cut Roof Slab Opening	5 days	Tue 3/22/11
114	Install Stair First Floor to Second	5 days	Tue 3/22/11
115	Install Stair Second Floor to Thir	5 days	Tue 3/29/11
116	Install Elevator Cab	5 days	Tue 4/5/11
117	Install Stair Third Floor to Fourt	5 days	Tue 4/5/11
118	Install Stair Fourth Floor to Roof	5 days	Tue 4/12/11
119	Install Entrance Frames	8 days	Tue 4/12/11
120	Elevator Adjustment & Inspectio	8 days	Wed 4/20/11
121	**Second Floor**	**50 days**	**Mon 2/28/11**
122	Owner Vacates Second Floor	1 day	Mon 2/28/11
123	Demo Second Floor	5 days	Tue 3/1/11
124	Reinforce Columns	4 days	Tue 3/1/11
125	Install Steel Plates	5 days	Tue 3/1/11
126	Frame Walls	5 days	Tue 3/8/11
127	MEP Rough-In	5 days	Tue 3/8/11
128	MEP Ceiling Rough-In	10 days	Tue 3/8/11
129	Install Endless Pools	15 days	Tue 3/8/11
130	Install New Windows	5 days	Wed 3/16/11
131	Hang & Finish Walls	5 days	Thu 3/24/11
132	Point-Up Exposed Brick	7 days	Thu 3/31/11
133	Waterproof / Install Tile in Locker Rooms	15 days	Thu 3/31/11
134	Install Millwork	5 days	Mon 4/11/11
135	Install New Lockers	3 days	Thu 4/21/11
136	Install Vanity Tops / Sinks in Locker Rooms	7 days	Thu 4/21/11
137	Athletic Flooring Installation	5 days	Mon 4/25/11
138	Sauna Installation	10 days	Mon 4/25/11
139	MEP Trim-Out	5 days	Mon 4/25/11
140	Final Paint	5 days	Mon 4/25/11
141	Second Floor Complete	0 days	Fri 5/6/11



Project: VIDA Project Schedule
Date: Mon 10/17/11

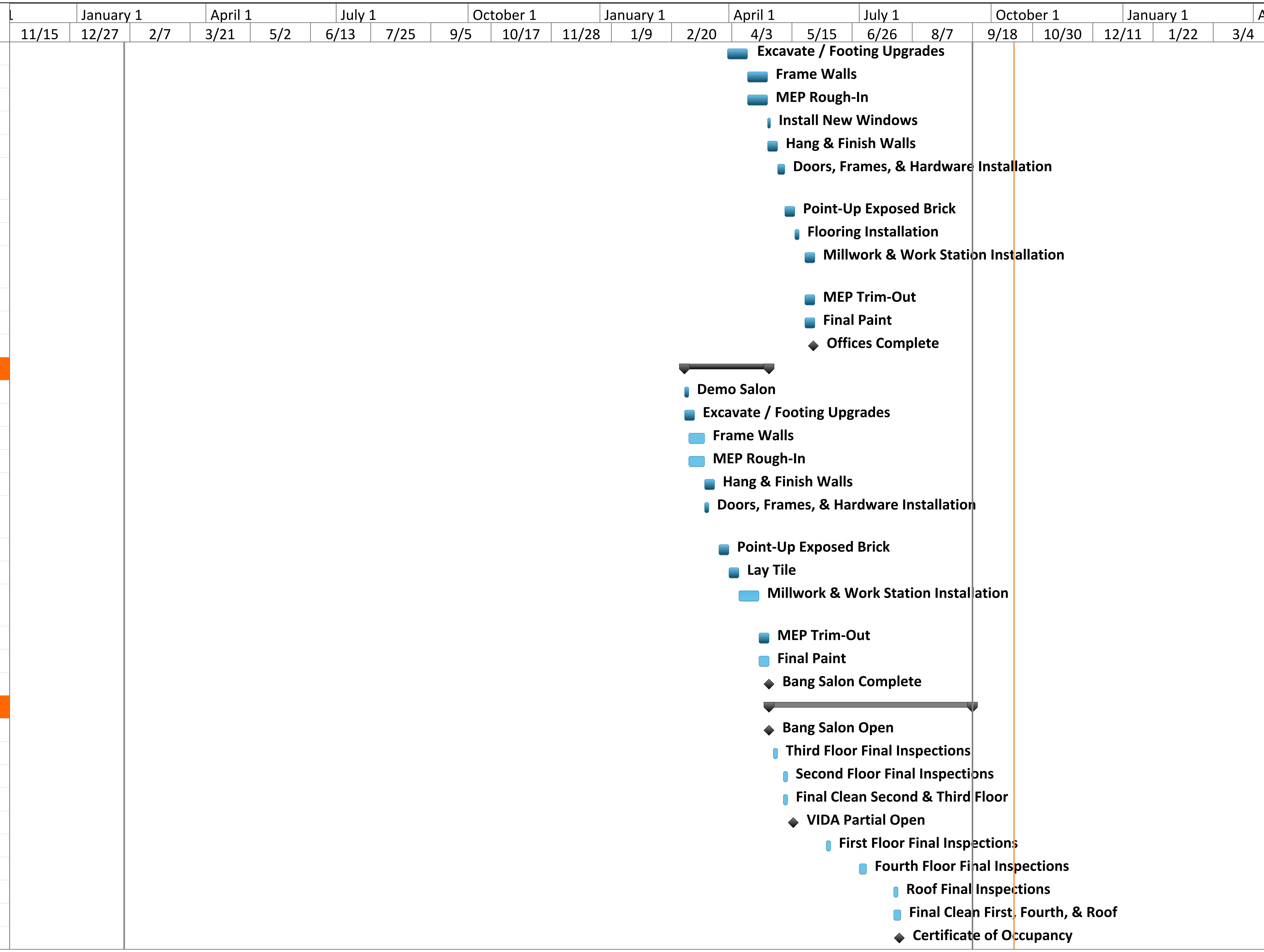
Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

ID	Task Name	Duration	Start
142	**Third Floor**	**45 days**	**Mon 2/28/11**
143	Owner Vacates Third Floor	1 day	Mon 2/28/11
144	Demo Third Floor	3 days	Tue 3/1/11
145	Reinforce Columns	15 days	Tue 3/1/11
146	Install Steel Plates	5 days	Fri 3/4/11
147	Frame Walls	5 days	Fri 3/11/11
148	MEP Rough-In	5 days	Fri 3/11/11
149	MEP Ceiling Rough-In	10 days	Fri 3/11/11
150	Install New Windows	5 days	Fri 3/18/11
151	Hang & Finish Walls	5 days	Fri 3/18/11
152	Point-Up Exposed Brick	7 days	Fri 3/25/11
153	Install Millwork / Fitness Desk	6 days	Tue 4/5/11
154	Athletic Flooring Installation	7 days	Thu 4/7/11
155	Bamboo Flooring Installation	5 days	Mon 4/18/11
156	MEP Trim-Out	5 days	Mon 4/25/11
157	Final Paint	5 days	Mon 4/25/11
158	Third Floor Complete	0 days	Fri 4/29/11
159	**First Floor - Offices / Entry**	**59 days**	**Tue 2/22/11**
160	Deliver Modular Sales Office	1 day	Tue 2/22/11
161	Set-Up Modular Sales Office	2 days	Wed 2/23/11
162	Relocate Sales Office	2 days	Fri 2/25/11
163	Demo Office / Restaurant	7 days	Tue 3/1/11
164	Excavate / Footing Upgrades	7 days	Thu 3/3/11
165	MEP Ceiling Rough-In	7 days	Thu 3/10/11
166	Frame Walls	10 days	Mon 3/21/11
167	MEP Rough-In	10 days	Mon 3/21/11
168	Install New Windows	2 days	Mon 4/4/11
169	Hang & Finish Walls	5 days	Mon 4/4/11
170	Doors, Frames, & Hardware Installation	3 days	Mon 4/11/11
171	Point-Up Exposed Brick	5 days	Thu 4/14/11
172	Install Millwork / Fitness Desk	6 days	Tue 4/5/11
173	Lay Tile	5 days	Thu 4/21/11
174	Millwork & Work Station Installation	7 days	Thu 4/28/11
175	MEP Trim-Out	5 days	Mon 5/9/11
176	Final Paint	5 days	Mon 5/9/11
177	Offices Complete	0 days	Fri 5/13/11
178	**First Floor - Future Sauna / Restaurant**	**65 days**	**Tue 3/1/11**
179	Demo First Floor	3 days	Tue 3/1/11

Project: VIDA Project Schedule
Date: Mon 10/17/11

Task, Split, Milestone, Summary, Project Summary, External Tasks, External Milestone, Inactive Task, Inactive Milestone, Inactive Summary, Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only, Finish-only, Deadline, Progress

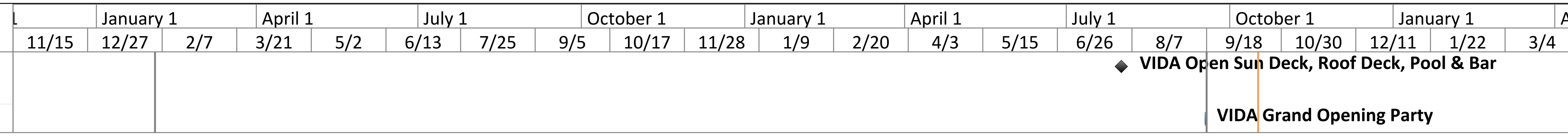
ID	Task Name	Duration	Start
180	Excavate / Footing Upgrades	10 days	Thu 3/31/11
181	Frame Walls	10 days	Thu 4/14/11
182	MEP Rough-In	10 days	Thu 4/14/11
183	Install New Windows	2 days	Thu 4/28/11
184	Hang & Finish Walls	5 days	Thu 4/28/11
185	Doors, Frames, & Hardware Installation	3 days	Thu 5/5/11
186	Point-Up Exposed Brick	5 days	Tue 5/10/11
187	Flooring Installation	3 days	Tue 5/17/11
188	Millwork & Work Station Installation	5 days	Tue 5/24/11
189	MEP Trim-Out	5 days	Tue 5/24/11
190	Final Paint	5 days	Tue 5/24/11
191	Offices Complete	0 days	Mon 5/30/11
192	**First Floor - Bang Salon**	**43 days**	**Tue 3/1/11**
193	Demo Salon	3 days	Tue 3/1/11
194	Excavate / Footing Upgrades	5 days	Tue 3/1/11
195	Frame Walls	7 days	Fri 3/4/11
196	MEP Rough-In	7 days	Fri 3/4/11
197	Hang & Finish Walls	5 days	Tue 3/15/11
198	Doors, Frames, & Hardware Installation	3 days	Tue 3/15/11
199	Point-Up Exposed Brick	5 days	Fri 3/25/11
200	Lay Tile	5 days	Fri 4/1/11
201	Millwork & Work Station Installation	10 days	Fri 4/8/11
202	MEP Trim-Out	5 days	Fri 4/22/11
203	Final Paint	5 days	Fri 4/22/11
204	Bang Salon Complete	0 days	Fri 4/29/11
205	**Project Close-Out**	**101 days**	**Fri 4/29/11**
206	Bang Salon Open	0 days	Fri 4/29/11
207	Third Floor Final Inspections	3 days	Mon 5/2/11
208	Second Floor Final Inspections	3 days	Mon 5/9/11
209	Final Clean Second & Third Floor	3 days	Mon 5/9/11
210	VIDA Partial Open	0 days	Mon 5/16/11
211	First Floor Final Inspections	3 days	Wed 6/8/11
212	Fourth Floor Final Inspections	3 days	Fri 7/1/11
213	Roof Final Inspections	3 days	Mon 7/25/11
214	Final Clean First, Fourth, & Roof	5 days	Mon 7/25/11
215	Certificate of Occupancy	0 days	Fri 7/29/11



Project: VIDA Project Schedule
Date: Mon 10/17/11

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

ID	Task Name	Duration	Start
216	VIDA Open Sun Deck, Roof Deck, Pool & Bar	0 days	Mon 8/1/11
217	VIDA Grand Opening Party	1 day	Sat 9/17/11



Project: VIDA Project Schedule
Date: Mon 10/17/11

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

APPENDIX G

CARDIO EQUIPMENT USAGE SUMMARY

Cardio Equipment Usage Summary - Sundays					
Time	Treadmills	Ellipticals	StairMasters	Upright Bikes	Recumbent Bikes
7:00 AM	In Use				
8:00 AM	In Use	In Use	In Use		
9:00 AM	In Use	In Use	In Use		
10:00 AM	In Use	In Use	In Use	In Use	In Use
11:00 AM	In Use	In Use	In Use	In Use	In Use
12:00 PM	In Use	In Use	In Use	In Use	In Use
1:00 PM	In Use	In Use	In Use	In Use	In Use
2:00 PM	In Use	In Use	In Use	In Use	In Use
3:00 PM	In Use	In Use	In Use	In Use	In Use
4:00 PM	In Use	In Use	In Use	In Use	In Use
5:00 PM	In Use	In Use	In Use	In Use	In Use
6:00 PM	In Use	In Use	In Use	In Use	In Use
7:00 PM	In Use	In Use	In Use	In Use	In Use
8:00 PM	In Use	In Use			
Total Hours	14	13	12	10	10

Cardio Equipment Usage Summary - Mondays					
Time	Treadmills	Ellipticals	StairMasters	Upright Bikes	Recumbent Bikes
5:00 AM	In Use	In Use	In Use	In Use	In Use
6:00 AM	In Use	In Use	In Use	In Use	In Use
7:00 AM	In Use	In Use	In Use	In Use	In Use
8:00 AM	In Use	In Use	In Use	In Use	In Use
9:00 AM	In Use	In Use	In Use	In Use	In Use
10:00 AM	In Use	In Use	In Use	In Use	In Use
11:00 AM	In Use	In Use	In Use	In Use	In Use
12:00 PM	In Use	In Use	In Use	In Use	In Use
1:00 PM	In Use	In Use	In Use	In Use	In Use
2:00 PM	In Use	In Use	In Use	In Use	In Use
3:00 PM	In Use	In Use	In Use	In Use	In Use
4:00 PM	In Use	In Use	In Use	In Use	In Use
5:00 PM	In Use	In Use	In Use	In Use	In Use
6:00 PM	In Use	In Use	In Use	In Use	In Use
7:00 PM	In Use	In Use	In Use	In Use	In Use
8:00 PM	In Use	In Use	In Use	In Use	In Use
9:00 PM	In Use	In Use	In Use	In Use	In Use
10:00 PM	In Use	In Use	In Use	In Use	In Use
Total Hours	18	18	18	18	18

Cardio Equipment Usage Summary - Tuesdays					
Time	Treadmills	Ellipticals	StairMasters	Upright Bikes	Recumbent Bikes
5:00 AM	In Use	In Use	In Use		
6:00 AM	In Use	In Use	In Use	In Use	In Use
7:00 AM	In Use	In Use	In Use	In Use	In Use
8:00 AM	In Use	In Use	In Use	In Use	In Use
9:00 AM	In Use	In Use	In Use	In Use	In Use
10:00 AM	In Use	In Use	In Use	In Use	In Use
11:00 AM	In Use	In Use	In Use	In Use	In Use
12:00 PM	In Use	In Use	In Use	In Use	In Use
1:00 PM	In Use	In Use	In Use	In Use	In Use
2:00 PM	In Use	In Use	In Use	In Use	In Use
3:00 PM	In Use	In Use	In Use	In Use	In Use
4:00 PM	In Use	In Use	In Use	In Use	In Use
5:00 PM	In Use	In Use	In Use	In Use	In Use
6:00 PM	In Use	In Use	In Use	In Use	In Use
7:00 PM	In Use	In Use	In Use	In Use	In Use
8:00 PM	In Use	In Use	In Use	In Use	In Use
9:00 PM	In Use	In Use	In Use	In Use	In Use
10:00 PM	In Use	In Use	In Use	In Use	In Use
Total Hours	18	18	18	17	17

Cardio Equipment Usage Summary - Wednesdays					
Time	Treadmills	Ellipticals	StairMasters	Upright Bikes	Recumbent Bikes
5:00 AM	In Use	In Use			
6:00 AM	In Use	In Use	In Use	In Use	In Use
7:00 AM	In Use	In Use	In Use	In Use	In Use
8:00 AM	In Use	In Use	In Use	In Use	In Use
9:00 AM	In Use	In Use	In Use	In Use	In Use
10:00 AM	In Use	In Use	In Use	In Use	In Use
11:00 AM	In Use	In Use	In Use	In Use	In Use
12:00 PM	In Use	In Use	In Use	In Use	In Use
1:00 PM	In Use	In Use	In Use	In Use	In Use
2:00 PM	In Use	In Use	In Use	In Use	In Use
3:00 PM	In Use	In Use	In Use	In Use	In Use
4:00 PM	In Use	In Use	In Use	In Use	In Use
5:00 PM	In Use	In Use	In Use	In Use	In Use
6:00 PM	In Use	In Use	In Use	In Use	In Use
7:00 PM	In Use	In Use	In Use	In Use	In Use
8:00 PM	In Use	In Use	In Use	In Use	In Use
9:00 PM	In Use	In Use	In Use	In Use	In Use
10:00 PM	In Use	In Use	In Use	In Use	
Total Hours	18	18	17	17	16

Cardio Equipment Usage Summary - Thursdays					
Time	Treadmills	Ellipticals	StairMasters	Upright Bikes	Recumbent Bikes
5:00 AM	In Use	In Use	In Use		
6:00 AM	In Use	In Use	In Use	In Use	In Use
7:00 AM	In Use	In Use	In Use	In Use	In Use
8:00 AM	In Use	In Use	In Use	In Use	In Use
9:00 AM	In Use	In Use	In Use	In Use	In Use
10:00 AM	In Use	In Use	In Use	In Use	In Use
11:00 AM	In Use	In Use	In Use	In Use	In Use
12:00 PM	In Use	In Use	In Use	In Use	In Use
1:00 PM	In Use	In Use	In Use	In Use	In Use
2:00 PM	In Use	In Use	In Use	In Use	In Use
3:00 PM	In Use	In Use	In Use	In Use	In Use
4:00 PM	In Use	In Use	In Use	In Use	In Use
5:00 PM	In Use	In Use	In Use	In Use	In Use
6:00 PM	In Use	In Use	In Use	In Use	In Use
7:00 PM	In Use	In Use	In Use	In Use	In Use
8:00 PM	In Use	In Use	In Use	In Use	In Use
9:00 PM	In Use	In Use	In Use	In Use	In Use
10:00 PM	In Use	In Use	In Use		
Total Hours	18	18	18	16	16

Cardio Equipment Usage Summary - Fridays					
Time	Treadmills	Ellipticals	StairMasters	Upright Bikes	Recumbent Bikes
5:00 AM	In Use	In Use			
6:00 AM	In Use	In Use	In Use		
7:00 AM	In Use	In Use	In Use	In Use	In Use
8:00 AM	In Use	In Use	In Use	In Use	In Use
9:00 AM	In Use	In Use	In Use	In Use	In Use
10:00 AM	In Use	In Use	In Use	In Use	In Use
11:00 AM	In Use	In Use	In Use	In Use	In Use
12:00 PM	In Use	In Use	In Use	In Use	In Use
1:00 PM	In Use	In Use	In Use	In Use	In Use
2:00 PM	In Use	In Use	In Use	In Use	In Use
3:00 PM	In Use	In Use	In Use	In Use	In Use
4:00 PM	In Use	In Use	In Use	In Use	In Use
5:00 PM	In Use	In Use	In Use	In Use	In Use
6:00 PM	In Use	In Use	In Use	In Use	In Use
7:00 PM	In Use	In Use	In Use	In Use	In Use
8:00 PM	In Use	In Use	In Use	In Use	In Use
9:00 PM	In Use	In Use	In Use	In Use	In Use
10:00 PM	In Use	In Use	In Use	In Use	In Use
Total Hours	18	18	17	16	16

Cardio Equipment Usage Summary - Saturdays					
Time	Treadmills	Ellipticals	StairMasters	Upright Bikes	Recumbent Bikes
7:00 AM	In Use	In Use	In Use	In Use	In Use
8:00 AM	In Use	In Use	In Use	In Use	In Use
9:00 AM	In Use	In Use	In Use	In Use	In Use
10:00 AM	In Use	In Use	In Use	In Use	In Use
11:00 AM	In Use	In Use	In Use	In Use	In Use
12:00 PM	In Use	In Use	In Use	In Use	In Use
1:00 PM	In Use	In Use	In Use	In Use	In Use
2:00 PM	In Use	In Use	In Use	In Use	In Use
3:00 PM	In Use	In Use	In Use	In Use	In Use
4:00 PM	In Use	In Use	In Use	In Use	In Use
5:00 PM	In Use	In Use	In Use	In Use	In Use
6:00 PM	In Use	In Use	In Use	In Use	In Use
7:00 PM	In Use	In Use	In Use	In Use	In Use
8:00 PM	In Use	In Use	In Use	In Use	In Use
Total Hours	14	14	14	14	14

Cardio Equipment Usage Summary Per Equipment Type						
Day	Treadmills	Ellipticals	StairMasters	Upright Bikes	Recumbent Bikes	Daily Average
Sundays	14.00	13.00	12.00	10.00	10.00	11.80
Mondays	18.00	18.00	18.00	18.00	18.00	18.00
Tuesdays	18.00	18.00	18.00	17.00	17.00	17.60
Wednesdays	18.00	18.00	17.00	17.00	16.00	17.20
Thursdays	18.00	18.00	18.00	16.00	16.00	17.20
Fridays	18.00	18.00	17.00	16.00	16.00	17.00
Saturdays	14.00	14.00	14.00	14.00	14.00	14.00
Average	16.86	16.71	16.29	15.43	15.29	16.11

Average Watts Produced Per Day of the Week				
Day	Daily Hours of Use	Watts Produced Per Hour	Number of Machines	Watts Produced Per Day
Sundays	11.80	100.00	120.00	141600.00
Mondays	18.00	100.00	120.00	216000.00
Tuesdays	17.60	100.00	120.00	211200.00
Wednesdays	17.20	100.00	120.00	206400.00
Thursdays	17.20	100.00	120.00	206400.00
Fridays	17.00	100.00	120.00	204000.00
Saturdays	14.00	100.00	120.00	168000.00
Average	16.11			193371.43

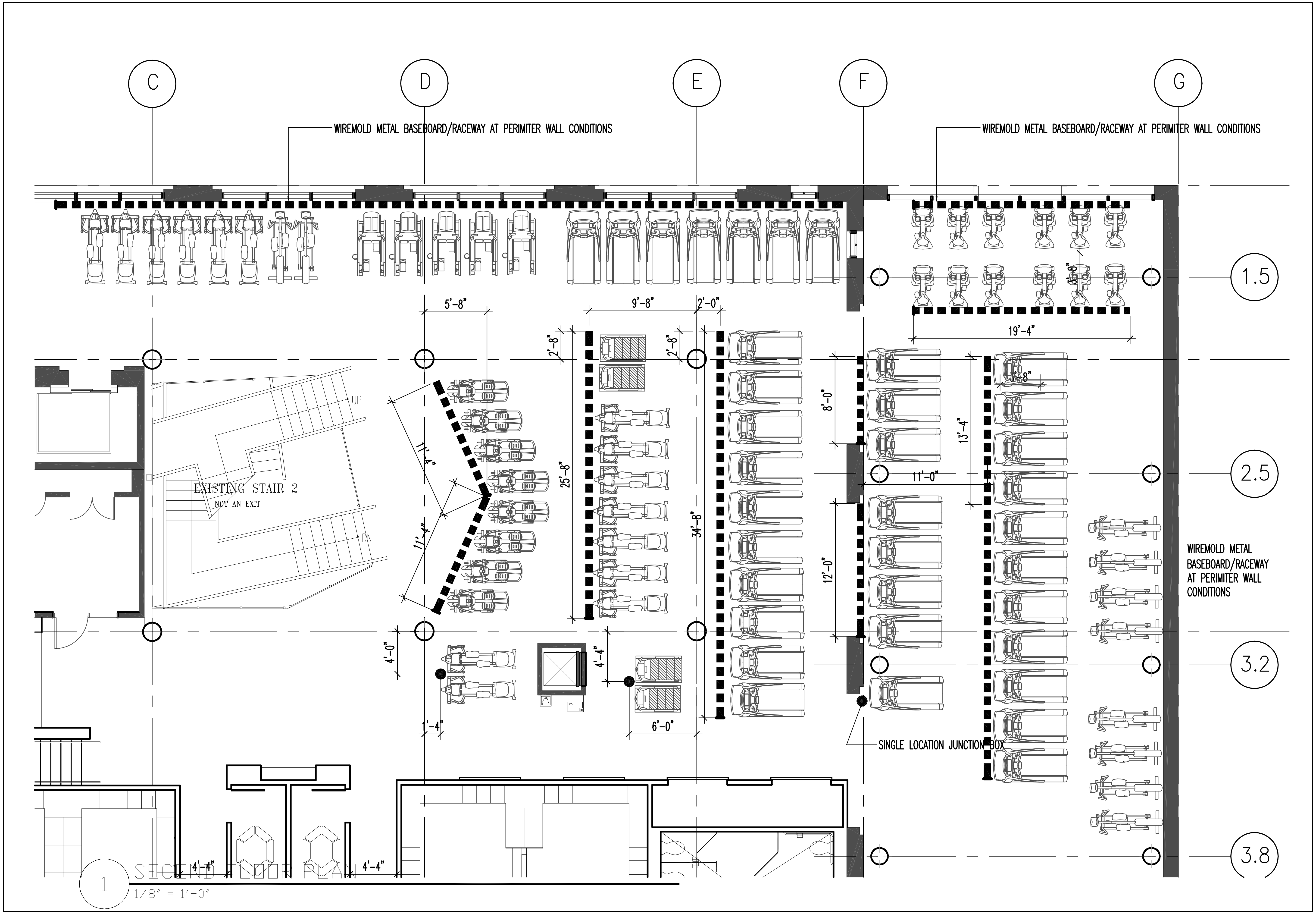
APPENDIX H

REREV ANNUAL SAVINGS CALCULATIONS

ReRev System Annual Savings Calculations					
Year	Annual KW Savings	Annual A/C Savings	Total Savings	Potential Profit	Simple Payback
1	$ 9,080.67	$ 2,594.80	$ 11,675.47	$ (136,324.53)	
2	$ 9,534.70	$ 2,724.54	$ 23,934.71	$ (124,065.29)	
3	$ 10,011.43	$ 2,860.77	$ 36,806.91	$ (111,193.09)	
4	$ 10,512.01	$ 3,003.81	$ 50,322.72	$ (97,677.28)	
5	$ 11,037.61	$ 3,154.00	$ 64,514.32	$ (83,485.68)	
6	$ 11,589.49	$ 3,311.70	$ 79,415.50	$ (68,584.50)	
7	$ 12,168.96	$ 3,477.28	$ 95,061.74	$ (52,938.26)	
8	$ 12,777.41	$ 3,651.14	$ 111,490.30	$ (36,509.70)	
9	$ 13,416.28	$ 3,833.70	$ 128,740.28	$ (19,259.72)	
10	$ 14,087.09	$ 4,025.39	$ 146,852.76	$ (1,147.24)	
11	$ 14,791.45	$ 4,226.66	$ 165,870.86	$ 17,870.86	**11**
12	$ 15,531.02	$ 4,437.99	$ 185,839.87	$ 37,839.87	
13	$ 16,307.57	$ 4,659.89	$ 206,807.33	$ 58,807.33	
14	$ 17,122.95	$ 4,892.88	$ 228,823.16	$ 80,823.16	
15	$ 17,979.10	$ 5,137.53	$ 251,939.78	$ 103,939.78	
16	$ 18,878.05	$ 5,394.40	$ 276,212.24	$ 128,212.24	
17	$ 19,821.95	$ 5,664.12	$ 301,698.32	$ 153,698.32	
18	$ 20,813.05	$ 5,947.33	$ 328,458.70	$ 180,458.70	
19	$ 21,853.70	$ 6,244.70	$ 356,557.10	$ 208,557.10	
20	$ 22,946.39	$ 6,556.93	$ 386,060.42	$ 238,060.42	
21	$ 24,093.71	$ 6,884.78	$ 417,038.91	$ 269,038.91	
22	$ 25,298.39	$ 7,229.02	$ 449,566.32	$ 301,566.32	
23	$ 26,563.31	$ 7,590.47	$ 483,720.10	$ 335,720.10	
24	$ 27,891.48	$ 7,969.99	$ 519,581.57	$ 371,581.57	
25	$ 29,286.05	$ 8,368.49	$ 557,236.12	$ 409,236.12	
26	$ 30,750.36	$ 8,786.91	$ 596,773.39	$ 448,773.39	
27	$ 32,287.88	$ 9,226.26	$ 638,287.52	$ 490,287.52	
28	$ 33,902.27	$ 9,687.57	$ 681,877.37	$ 533,877.37	
29	$ 35,597.38	$ 10,171.95	$ 727,646.70	$ 579,646.70	
30	$ 37,377.25	$ 10,680.55	$ 775,704.50	$ 627,704.50	
31	$ 39,246.11	$ 11,214.58	$ 826,165.19	$ 678,165.19	
32	$ 41,208.42	$ 11,775.31	$ 879,148.92	$ 731,148.92	
33	$ 43,268.84	$ 12,364.07	$ 934,781.83	$ 786,781.83	
34	$ 45,432.28	$ 12,982.27	$ 993,196.39	$ 845,196.39	
35	$ 47,703.90	$ 13,631.39	$ 1,054,531.67	$ 906,531.67	
36	$ 50,089.09	$ 14,312.96	$ 1,118,933.72	$ 970,933.72	
37	$ 52,593.55	$ 15,028.61	$ 1,186,555.87	$ 1,038,555.87	
38	$ 55,223.22	$ 15,780.04	$ 1,257,559.13	$ 1,109,559.13	
39	$ 57,984.38	$ 16,569.04	$ 1,332,112.55	$ 1,184,112.55	
40	$ 60,883.60	$ 17,397.49	$ 1,410,393.65	$ 1,262,393.65	

Appendix I

Cardio Equipment Layouts



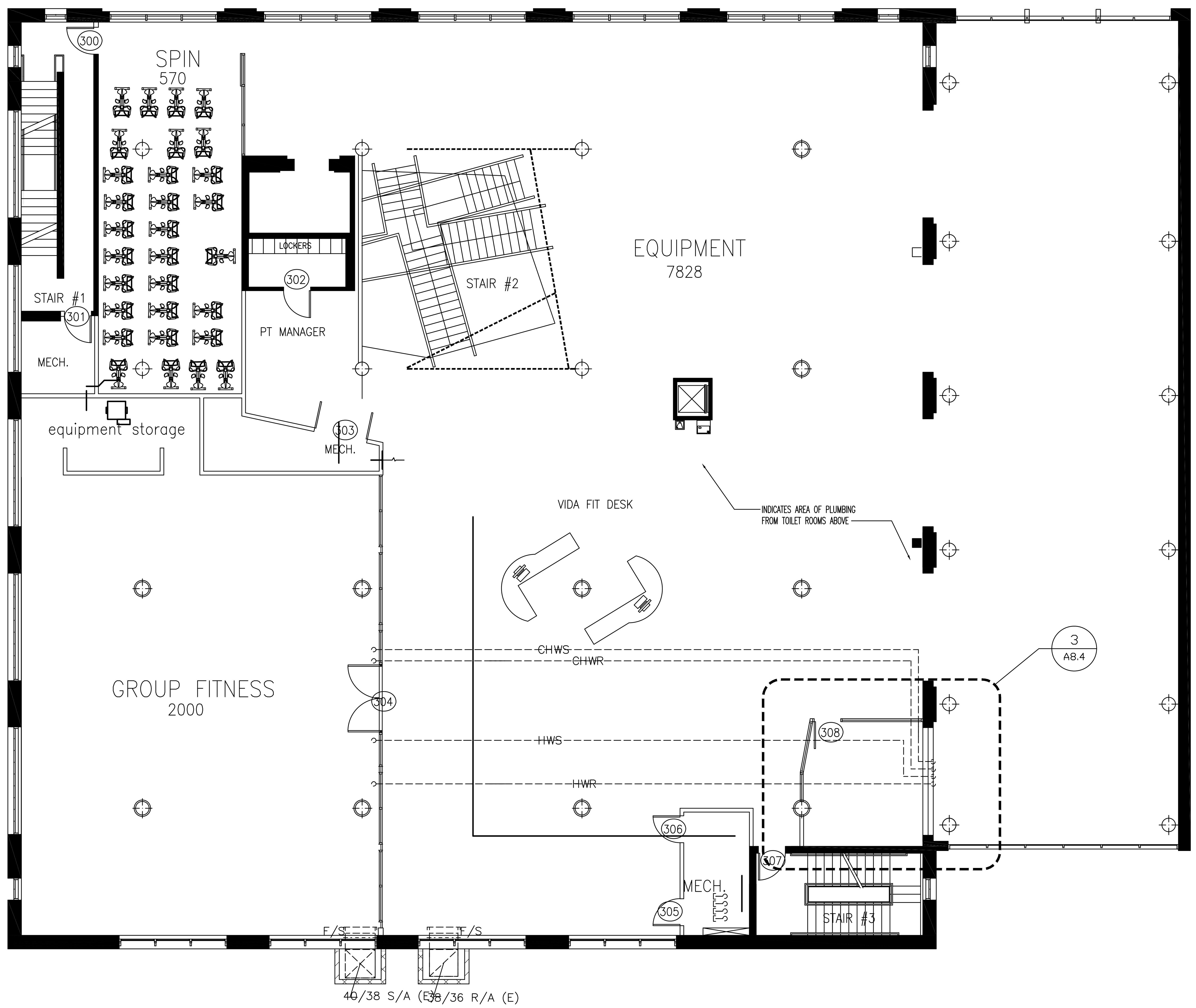
CSK 7

VIDA FITNESS - 1612 U STREET NW
5.5.2011
1/8"=1'-0"

Office Use Only: 5/06/11 - 8:56am
H:\DATA\VIDA\U Street\cd's\Set\Construction\
CSK-7.2 CARDIO LAYOUT.DWG

CARDIO RACEWAY LAYOUT

Stoneking / von Storch Architects
P.O. Box 1332 Charlottesville, VA 22902



1 THIRD FLOOR PLAN
1/8" = 1'-0"

STONEKING VON STORCH
ARCHITECTS

P.O. BOX 1332 CHARLOTTESVILLE, VIRGINIA 22902
Voice 434.295.4204 Fax 434.295.6954 www.s-vs.com

VIDA FITNESS AT 1612 U STREET

DATE	CONSTRUCTION
APRIL 5, 2011	FINAL 2
APRIL 1, 2011	FINAL LAYOUT

DATE	PRE-CONSTRUCTION
12-23-2010	BID SET
10-21-10	PERMIT REVISIONS
8-15-10	PERMIT SET

SHEET TITLE
THIRD FLOOR PLAN

JOB NO. –

Office Use Only 2/16/12 – 1:05pm
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Third Flr Equipment.dwg

SHEET NO. A3.2

Appendix J

ReRev System Proposal

Proposal to Capture Gym Energy

Submitted by ReRev.com LLC

For:
Clara Watson
VIDA Fitness Center

ReRev.com LLC

Renewable Energy Revolution "ReRev"
Nicki Odato
One Progress Plaza – Suite 810
St. Petersburg, FL 33701

Direct: 727-465-4884
Office: 727-556-0804
Fax: 727-556-0360

nicki@rerev.com

ReRev™
www.ReRev.com
A Renewable Energy Revolution

Overview

ReRev™ is a patent pending technology, which converts an otherwise counter-productive heat into a usable form of renewable electricity. ReRev retrofits gym equipment to make alternative energy in a safe, fun, carbon neutral and healthy manner. In an efficient and cost effective way, the kinetic motion of aerobic exercise is captured and converted into renewable energy that feeds back into the local utility's power grid.

VIDA Fitness Center's goals of awareness and fitness align well with this technology's human element. By placing users directly in the renewable energy process new ideas begin to take shape. VIDA presents ideal conditions for the ReRev system given the number of machines and user base. The center's workout volume combined with the amount of equipment will produce significant amounts of utility grade electricity, placing people in the renewable energy production chain.

We have observed very positive feedback from gym patrons and unexpected participation & excitement. People are instantly receptive to decreasing their carbon footprints and creating renewable energy while engaging in a process that demonstrates the relationship between kinetics and electricity.

The ReRev System for your facility consists of the following components:

- (6) 3,600 Watt Synchronous Grid Tied Inverters
- Copper cable wires with connectors for Inverter and Ellipticals
- Installation (Labor and Wiring)
- Controllers and Interface Boards.
- Bi-Directional Meter
- Rectifier Bridge and DC Disconnect
- A 2x3 ft poster and Informational Decals

Description of Project

VIDA Fitness Center has the following machines, which can be connected to ReRev to produce 100% renewable electricity:

36 Treadmills
25 Ellipticals
4 Stairmasters
6 Upright Bikes
6 Recumbent Bikes
8 Cross Trainers
5 Arc Trainers
30 Spin Bikes

Scope of Work

Machine Connection. Each machine will be wired into an array, which feeds the centralized inverter. 14 gauge wires coming from the control boards to the main lines, which will be 8 gauge. All wiring will be insulated with heat shrink and conduit.

Control Boards. All control boards will be mounted inside the machines, out of sight and harm. All connections will be made so the machines maintain their original functionality and can be converted back to their original state at anytime.

Grid Connection. An AC disconnect box will be used to interface the inverter and the utility side power. The inverter stays synchronized with the grid at all times feeding back any available power. A dedicated 208Volt drop is necessary where the inverters are located, preferably central to the machines for efficiency.

Wiring Layout. The wiring layout can conform to any equipment configuration and is suited to any flooring.

Facility Layout

ReRev engineers have based our total system cost on the approximate dimensions of the space provided. A site inspection assessment will be needed to determine the closest mechanical closet and breaker panel. The purchaser agrees to provide a layout of the facility prior to final quote.

Electrical. The purchaser is responsible for providing the 208Volt drop over the inverter.

Safety

A. **Voltage** - The ReRev system integrates with the buildings existing 120-volt wire pathways but maintains a sub 48-volt limit, which is the protocol for phone lines.

B. **Machine Isolation** - Each unit has its own isolating circuit separating it from other machines in the array. It accomplishes this through our regulators and control boards utilizing 600-volt threshold diodes in series, which restrict the reverse flow of current. This ensures that even though the whole array runs at low voltages each machine is also isolated from outside current.

C. **Integration** - Every precaution is taken to ensure the user has no potential to come in contact with any parts of our system minus the desired output data. Machines are generally arranged in a linear fashion facing some form of entertainment (TVs for example). We use existing pathways in front of the machines to encase our lines making a seamless floor.

D. **Zone Control** - The array is broken into individual zones to limit line current to the inverter. No more than twenty machines are in one zone and each zone has an instantaneous circuit breaker to protect the inverter from excess current.

Schedule and Time Frame

After project approval, site inspection, equipment delivery the system can be installed within three weeks.

Publicity

ReRev will provide assistance with logos, marketing and publicizing your facility's installation and participation as requested. VIDA Fitness Center agrees that all publicity, news releases, or other verbal or written communication to the media will be approved in advance by ReRev.

Investment

ReRev has priced this project very close to the actual cost specifically for VIDA Fitness Center. The incremental cost to connect additional machines in the event of a facility expansion is minimal. ReRev will provide necessary wiring for equipment that is being refreshed for new units within six months of the initial installation.

Total System Investment: $ 148,000

Warranty/Upgrades

The system coverage is warranted on the inverter and components we install for a full five-year period. All ReRev systems will be updated as necessary as we progress in the research and development upgrades become available. After the first year, the facility will cover ReRev technician travel expense at the best coach fare. The user may need to adjust the preset manufactures resistance level 0-7, increasing resistance levels and make a more significant energy production.

Rebates, Tax Credits, and Incentives

Many potential cost recovery programs exist for Renewable Energy at the state and federal level. Additionally, your local power company may provide incentives as credits for participation in this renewable resource.

Sales Agreement

In witness whereof, the parties hereto have execute this agreement as of the first date written above.

VENDOR: **ReRev.com, LLC**

By: ______________________________

Name: Nicki Odato

Title: Business Development

Date: March 22, 2012

BUYER: VIDA Fitness Center

By: ______________________________

Name: ______________________________

Title: ______________________________

APPENDIX K

LEED EVALUATION

LEED EVALUATION:

The LEED Scorecard can be seen in Appendix L.

The common assumption is that it is too expensive to build a sustainable or green building for smaller commercial projects. Even if this were true, the money saved over the life of the building through reduced energy costs in the form of lower utility bills would far outweigh any additional cost of construction (Green Buildings). What are generally overlooked are the long-term maintenance costs that come with buildings that are not designed to be sustainable. When a sustainable building is designed and built, the efficiency with which the building and its site use and harvest energy, water, and materials is increased. Building impacts on human health and the environment are reduced through better design, construction, operation, and maintenance (Green Buildings). Going "green" through energy-efficient construction results in lower energy consumption, decreased utility bills, elevated inhabitant productivity, and healthier indoor air quality.

The United States Green Building Council (USGBC) developed the LEED (Leadership in Energy and Environmental Design) rating system to certify buildings according to points earned for implementing sustainable practices and materials on a building or project. The levels of certification vary according to the amount of points earned (USGBC).

Though LEED certification was not attempted on this project, there are and were many areas where materials or practices could have been adjusted to earn LEED points without significantly changing the project schedule or cost. These areas are discussed below, and refer to the completed LEED Checklist in Appendix L.

Sustainable Sites

The main purpose of the Sustainable Sites section of the LEED scorecard is to minimize pollution caused by construction by regulating erosion, sedimentation, and dust. The prerequisite for this subdivision includes creating an erosion and sediment control plan for the project before commencement of construction. Possible earned points in this category are from a variety of items, including community connectivity. VIDA could have received five points in this category because it is located on a previously developed site, is within ½ mile of a residential area and at least ten services, and has pedestrian access from the building to the services.

One of the ways the USGBC works to reduced automobile pollution is to offer points for the project's proximity to either bus stops (less than ¼ mile) or rail stations (less than ½ mile). The VIDA project fulfills both of these requirements. Along this same general line of thinking, additional points are offered for providing bicycle rack storage coupled with shower and changing facilities in the building. Both of these are offered at VIDA, which could provide the project with another potential LEED point. Though no preferred parking could be provided, no new parking was added on the project, which could have also provided one additional LEED point (and possibly a second).

One LEED point is offered for the reduction of light pollution emanating from a building. VIDA could have achieved this point simply by ensuring all non-emergency lights are switched off between the hours of 11:00PM and 5:00AM when the fitness club is closed to the general public.

Water Efficiency

The water efficiency section of the LEED checklist is designed to lessen the loads on wastewater systems and municipal water supply systems by decreasing the individual building's water usage. The prerequisite for the Water Efficiency subdivision is to decrease the total water usage by 20%.

Water saving fixtures could have easily been installed to reduce water usage by 30-40%, earning an additional two to four LEED points. These fixtures could also earn an additional two points by reducing the wastewater by 50%.

Energy and Atmosphere

The Energy and Atmosphere section of the LEED checklist requires that the energy systems used in the building first be commissioned before any of the points in this section can be earned. The intent of this requirement is to ensure that all of the building's energy systems are working properly and according to their design standards. Not only could commissioning energy systems reduce energy usage and operating costs, but it could also decrease contractor call-backs for maintenance or repair and increase occupant productivity. The second prerequisite for the Energy and Atmosphere subdivision is to demonstrate a 5% improvement in the building's performance rating after the completed renovation. The final prerequisite for this section is zero use of chlorofluorocarbon in any new HVAC of refrigeration systems.

Though a 5% improvement in the building's performance rating is required before any points can be earned in this section, increasing the performance rating by more than 5% can earn up to 19 additional points, depending on the percentage of improvement. Another two points could be earned for doing commissioning design and submittal reviews. Because an all-water VAV system was utilized at VIDA, two more points could have been earned as there were no refrigerants used in the mechanical system.

With the introduction of on-site renewable energy, VIDA is also given a potential to earn an additional 3 points (because the ReRev system generates over 5% renewable energy).

Materials and Resources

Recycling for the entire building is already present at VIDA, which is the prerequisite for the Materials and Resources section of the LEED checklist. The main idea of this subdivision is to aid in diminishing the amount of solid waste that is disposed of in landfills. One of the possible areas to earn points for renovations in this section is to maintain the existing building structure or envelope. Up to three points can be earned, depending on the percentage of the existing building that is reused.

Recycling construction waste is a relatively easy way to earn up to two points, depending upon the percentage of waste that is recycled or salvaged. Using recycled new materials can also earn up to two points. This can be easily achieved by simply installing recycled carpet, windows, or other materials. Implementing materials that are manufactured locally (within 500 miles) can also provide an additional two LEED points for a project. Lastly, expending rapidly renewable materials for 2.5% of the building materials can provide another point. This would be easy for the VIDA project, as bamboo is a certified wood, qualifies for this category, and was used in many areas throughout VIDA.

Indoor Environmental Quality

There are two prerequisites for the Indoor Environmental Quality section of the LEED checklist. The first of these prerequisites is for mechanically ventilated buildings, which must be designed to local applicable codes. The second prerequisite is to prohibit smoking except in designated areas outside the building. The overall intent of the Indoor Environmental Quality section is to increase occupant health and comfort by increasing the building's indoor air quality (IAQ). Points can be earned in this area by monitoring CO_2 levels in occupied spaces or by increasing the ventilation to occupied spaces by 30% above the minimum required rates. Development of an IAQ management plan that must be implemented while the building is still under construction and/or pre-occupancy is another way to earn two points.

If low volatile organic compound (VOC) materials are chosen during the design of the building, other LEED points can be earned for the project. This is a relatively easy way to earn points, as most low VOC materials are readily available and do not have escalated prices. Low VOC materials that could easily be used include adhesives, paints, woods, and floorings. A total of four LEED points can be earned if low VOC materials are used for each of these categories.

If the building HVAC system is in compliance with ASHRAE's (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) Thermal Comfort Conditions for Human Occupancy, then a LEED point can be earned for thermal comfort design.

Another LEED point can be netted if the natural daylight levels are monitored and recorded for the main occupied spaces of the building and more than 25 foot-candles of light are achieved. Additionally, one point can be gained for providing a direct line of sight outdoors for 90% of the regularly occupied areas in the building. Natural daylighting should also be optimized to reduce the need for artificial lighting that, in turn, saves energy and money on utility bills. This has already been achieved due to the large windows and storefront glass in VIDA's fitness areas.

Innovation in Design

The Innovation in Design section of the LEED scorecard allows design teams to earn points based upon their own innovation. A point in this category could be earned for VIDA because at least one member of the project team is a LEED accredited professional.

Regional Priority Credits

Regional Priority Credits encourage earning credits with emphasis on geographically specific environmental concerns. They are existing LEED credits labeled particularly significant for their areas by USGBC regional councils. Under the assumption that all of the previously proposed credits were earned, the VIDA project is eligible for one Regional Credit, MRc1.1: Building Reuse.

Critical Evaluation

Overall, the utilization of sustainable technology to achieve LEED certification takes a more environmentally-friendly approach in the way people choose to live. Sustainable buildings help to benefit occupants socially, economically, and environmentally and are an exceptional benefit to society. In the case of the VIDA project, there were several instances where LEED points could have been achieved with minimal effort by the project team. As seen in the LEED Project Checklist in Appendix L, approximately 60 points could have been earned to achieve a Gold level certification. The breakdown of possible points earned by category is shown below in Figure 38.

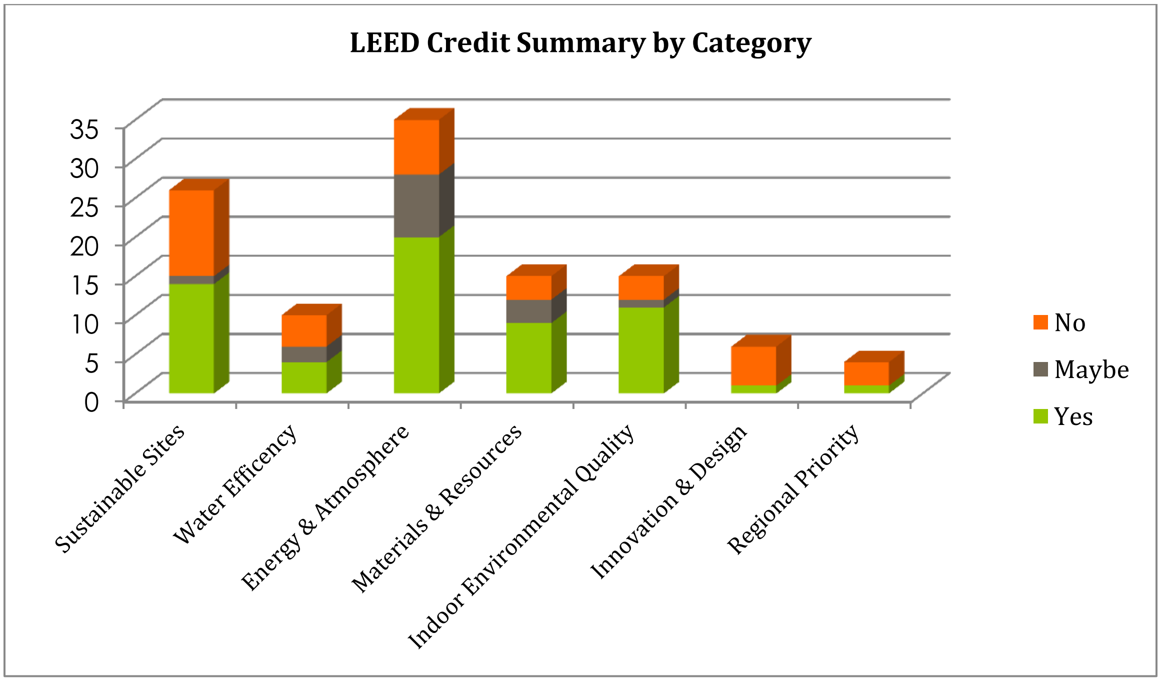


Figure 38: LEED Credit Summary by Category

Designing green buildings can maximize environmental and economic performance and can lower energy usage and cost. Any type of green building will lower energy consumption and utility bills while producing higher inhabitant productivity and enhanced indoor air quality. As the VIDA Fitness Centers' focus is on improving health and well-being, the attainment of LEED certification and a display of the certification to customers would be an additional selling point for membership. It is for these reasons that it is recommended that the VIDA Fitness Owner and project team aim for LEED certification on their next VIDA Fitness project.

Note: All processes and methods discussed above for earning LEED points to achieve certification were taken from the USGBC website.

APPENDIX L

LEED SCORECARD

LEED 2009 for New Construction and Major Renovations

VIDA Fitness Project Checklist

Y	?	N				
14	**1**	**11**	**Sustainable Sites**		Possible Points:	**26**
Y	?	N				
Y			Prereq 1		Construction Activity Pollution Prevention	
		1	Credit 1		Site Selection	1
5			Credit 2		Development Density and Community Connectivity	5
		1	Credit 3		Brownfield Redevelopment	1
6			Credit 4.1		Alternative Transportation—Public Transportation Access	6
1			Credit 4.2		Alternative Transportation—Bicycle Storage and Changing Rooms	1
		3	Credit 4.3		Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
1	**1**		Credit 4.4		Alternative Transportation—Parking Capacity	2
		1	Credit 5.1		Site Development—Protect or Restore Habitat	1
		1	Credit 5.2		Site Development—Maximize Open Space	1
		1	Credit 6.1		Stormwater Design—Quantity Control	1
		1	Credit 6.2		Stormwater Design—Quality Control	1
		1	Credit 7.1		Heat Island Effect—Non-roof	1
		1	Credit 7.2		Heat Island Effect—Roof	1
1			Credit 8		Light Pollution Reduction	1
4	**2**	**4**	**Water Efficiency**		Possible Points:	**10**
Y	?	N				
Y			Prereq 1		Water Use Reduction—20% Reduction	
		4	Credit 1		Water Efficient Landscaping	2 to 4
					Reduce by 50%	2
					No Potable Water Use or Irrigation	4
2			Credit 2		Innovative Wastewater Technologies	2
2	**2**		Credit 3		Water Use Reduction	2 to 4
				2	Reduce by 30%	2
					Reduce by 35%	3
					Reduce by 40%	4

20	8	7	Energy and Atmosphere			Possible Points: 35
Y	?	N				
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems		
Y			Prereq 2	Minimum Energy Performance		
Y			Prereq 3	Fundamental Refrigerant Management		
11	8		Credit 1	Optimize Energy Performance		1 to 19
					Improve by 12% for New Buildings or 8% for Existing Building Renovations	1
					Improve by 14% for New Buildings or 10% for Existing Building Renovations	2
					Improve by 16% for New Buildings or 12% for Existing Building Renovations	3
					Improve by 18% for New Buildings or 14% for Existing Building Renovations	4
					Improve by 20% for New Buildings or 16% for Existing Building Renovations	5
					Improve by 22% for New Buildings or 18% for Existing Building Renovations	6
					Improve by 24% for New Buildings or 20% for Existing Building Renovations	7
					Improve by 26% for New Buildings or 22% for Existing Building Renovations	8
					Improve by 28% for New Buildings or 24% for Existing Building Renovations	9
					Improve by 30% for New Buildings or 26% for Existing Building Renovations	10
				11	Improve by 32% for New Buildings or 28% for Existing Building Renovations	11
					Improve by 34% for New Buildings or 30% for Existing Building Renovations	12
					Improve by 36% for New Buildings or 32% for Existing Building Renovations	13
					Improve by 38% for New Buildings or 34% for Existing Building Renovations	14
					Improve by 40% for New Buildings or 36% for Existing Building Renovations	15
					Improve by 42% for New Buildings or 38% for Existing Building Renovations	16
					Improve by 44% for New Buildings or 40% for Existing Building Renovations	17
					Improve by 46% for New Buildings or 42% for Existing Building Renovations	18
					Improve by 48%+ for New Buildings or 44%+ for Existing Building Renovations	19
3		4	Credit 2	On-Site Renewable Energy		1 to 7
					1% Renewable Energy	1
					3% Renewable Energy	2
				3	5% Renewable Energy	3
					7% Renewable Energy	4
					9% Renewable Energy	5
					11% Renewable Energy	6
					13% Renewable Energy	7
2			Credit 3	Enhanced Commissioning		2
2			Credit 4	Enhanced Refrigerant Management		2
		3	Credit 5	Measurement and Verification		3
2			Credit 6	Green Power		2

9	3	3	**Materials and Resources**			Possible Points: **14**
Y	?	N				
Y			Prereq 1	Storage and Collection of Recyclables		
3			Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof		1 to 3
					Reuse 55%	1
					Reuse 75%	2
				3	Reuse 95%	3
		1	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements		1
1	**1**		Credit 2	Construction Waste Management		1 to 2
				1	50% Recycled or Salvaged	1
					75% Recycled or Salvaged	2
		2	Credit 3	Materials Reuse		1 to 2
					Reuse 5%	1
					Reuse 10%	2
1	**1**		Credit 4	Recycled Content		1 to 2
					10% of Content	1
					20% of Content	2
1	**1**		Credit 5	Regional Materials		1 to 2
					10% of Materials	1
					20% of Materials	2
2			Credit 6	Rapidly Renewable Materials		1
1			Credit 7	Certified Wood		1

11	1	3	**Indoor Environmental Quality**	Possible Points: **15**
Y	?	N		
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
1			Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
		1	Credit 5	Indoor Chemical and Pollutant Source Control	1
		1	Credit 6.1	Controllability of Systems—Lighting	1
		1	Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
	1		Credit 7.2	Thermal Comfort—Verification	1
1			Credit 8.1	Daylight and Views—Daylight	1
1			Credit 8.2	Daylight and Views—Views	1

Y	?	N			
1	**0**	**5**	**Innovation and Design Process**		Possible Points: **6**
Y	?	N			
		1	Credit 1.1	Innovation in Design: Specific Title	1
		1	Credit 1.2	Innovation in Design: Specific Title	1
		1	Credit 1.3	Innovation in Design: Specific Title	1
		1	Credit 1.4	Innovation in Design: Specific Title	1
		1	Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1
1	**0**	**3**	**Regional Priority Credits**		Possible Points: **4**
Y	?	N			
1			Credit 1.1	Regional Priority: MRc1.1	1
		1	Credit 1.2	Regional Priority: EAc1	1
		1	Credit 1.3	Regional Priority: EAc2	1
		1	Credit 1.4	Regional Priority: WEc3	1
60	15	36	**Total**		Possible Points: **110**
			Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110		

APPENDIX M

REREV SYSTEM SURVEY

Response Summary

Total Started Survey: 100
Total Completed Survey: 100 (100%)

PAGE: 1

1. Do you exercise on a regular basis? Create Chart Download

	Response Percent	Response Count
Yes	90.0%	90
No	10.0%	10
answered question		100
skipped question		0

2. Would you be willing to use cardio equipment that generated electricity from your movement? (This process would have no effect on your workout.) Create Chart Download

	Not Likely	Neutral	Very Likely	Rating Average	Response Count
Select One:	0.0% (0)	14.0% (14)	86.0% (86)	2.86	100
answered question					100
skipped question					0

3. Would you consider choosing a fitness center that offered energy generating cardio equipment over typical cardio equipment? Create Chart Download

	Not Likely	Neutral	Very Likely	Rating Average	Response Count
Select One:	8.0% (8)	25.0% (25)	67.0% (67)	2.59	100
answered question					100
skipped question					0

Appendix N

ReRev Annual Savings Calculations With Incentives

ReRev System Annual Savings Calculations With Incentives							
Year	Annual KW Savings	Annual A/C Savings	Potential Pepco Incentive	Potential REIP Incentive	Total Savings	Potential Profit	Simple Payback
1	$ 9,080.67	$ 2,594.80	$ 14,311.10	$ 16,500.00	$ 42,486.57	$ (105,513.43)	
2	$ 9,534.70	$ 2,724.54	$ -	$ 16,500.00	$ 71,245.81	$ (76,754.19)	
3	$ 10,011.43	$ 2,860.77	$ -	$ 16,500.00	$ 100,618.01	$ (47,381.99)	
4	$ 10,512.01	$ 3,003.81	$ -	$ 16,500.00	$ 130,633.82	$ (17,366.18)	
5	$ 11,037.61	$ 3,154.00	$ -	$ 16,500.00	$ 161,325.42	$ 13,325.42	**5**
6	$ 11,589.49	$ 3,311.70	$ -	$ 16,500.00	$ 192,726.60	$ 44,726.60	
7	$ 12,168.96	$ 3,477.28	$ -	$ 16,500.00	$ 224,872.84	$ 76,872.84	
8	$ 12,777.41	$ 3,651.14	$ -	$ 16,500.00	$ 257,801.40	$ 109,801.40	
9	$ 13,416.28	$ 3,833.70	$ -	$ 16,500.00	$ 291,551.38	$ 143,551.38	
10	$ 14,087.09	$ 4,025.39	$ -	$ 16,500.00	$ 326,163.86	$ 178,163.86	
11	$ 14,791.45	$ 4,226.66	$ -	$ 16,500.00	$ 361,681.96	$ 213,681.96	
12	$ 15,531.02	$ 4,437.99	$ -	$ 16,500.00	$ 398,150.97	$ 250,150.97	
13	$ 16,307.57	$ 4,659.89	$ -	$ 16,500.00	$ 435,618.43	$ 287,618.43	
14	$ 17,122.95	$ 4,892.88	$ -	$ 16,500.00	$ 474,134.26	$ 326,134.26	
15	$ 17,979.10	$ 5,137.53	$ -	$ 16,500.00	$ 513,750.88	$ 365,750.88	
16	$ 18,878.05	$ 5,394.40	$ -	$ 16,500.00	$ 554,523.34	$ 406,523.34	
17	$ 19,821.95	$ 5,664.12	$ -	$ 16,500.00	$ 596,509.42	$ 448,509.42	
18	$ 20,813.05	$ 5,947.33	$ -	$ 16,500.00	$ 639,769.80	$ 491,769.80	
19	$ 21,853.70	$ 6,244.70	$ -	$ 16,500.00	$ 684,368.20	$ 536,368.20	
20	$ 22,946.39	$ 6,556.93	$ -	$ 16,500.00	$ 730,371.52	$ 582,371.52	
21	$ 24,093.71	$ 6,884.78	$ -	$ 16,500.00	$ 777,850.01	$ 629,850.01	
22	$ 25,298.39	$ 7,229.02	$ -	$ 16,500.00	$ 826,877.42	$ 678,877.42	
23	$ 26,563.31	$ 7,590.47	$ -	$ 16,500.00	$ 877,531.20	$ 729,531.20	
24	$ 27,891.48	$ 7,969.99	$ -	$ 16,500.00	$ 929,892.67	$ 781,892.67	
25	$ 29,286.05	$ 8,368.49	$ -	$ 16,500.00	$ 984,047.22	$ 836,047.22	
26	$ 30,750.36	$ 8,786.91	$ -	$ 16,500.00	$ 1,040,084.49	$ 892,084.49	
27	$ 32,287.88	$ 9,226.26	$ -	$ 16,500.00	$ 1,098,098.62	$ 950,098.62	
28	$ 33,902.27	$ 9,687.57	$ -	$ 16,500.00	$ 1,158,188.47	$ 1,010,188.47	
29	$ 35,597.38	$ 10,171.95	$ -	$ 16,500.00	$ 1,220,457.80	$ 1,072,457.80	
30	$ 37,377.25	$ 10,680.55	$ -	$ 16,500.00	$ 1,285,015.60	$ 1,137,015.60	
31	$ 39,246.11	$ 11,214.58	$ -	$ 16,500.00	$ 1,351,976.29	$ 1,203,976.29	
32	$ 41,208.42	$ 11,775.31	$ -	$ 16,500.00	$ 1,421,460.02	$ 1,273,460.02	
33	$ 43,268.84	$ 12,364.07	$ -	$ 16,500.00	$ 1,493,592.93	$ 1,345,592.93	
34	$ 45,432.28	$ 12,982.27	$ -	$ 16,500.00	$ 1,568,507.49	$ 1,420,507.49	
35	$ 47,703.90	$ 13,631.39	$ -	$ 16,500.00	$ 1,646,342.77	$ 1,498,342.77	
36	$ 50,089.09	$ 14,312.96	$ -	$ 16,500.00	$ 1,727,244.82	$ 1,579,244.82	
37	$ 52,593.55	$ 15,028.61	$ -	$ 16,500.00	$ 1,811,366.97	$ 1,663,366.97	
38	$ 55,223.22	$ 15,780.04	$ -	$ 16,500.00	$ 1,898,870.23	$ 1,750,870.23	
39	$ 57,984.38	$ 16,569.04	$ -	$ 16,500.00	$ 1,989,923.65	$ 1,841,923.65	
40	$ 60,883.60	$ 17,397.49	$ -	$ 16,500.00	$ 2,084,704.75	$ 1,936,704.75	

APPENDIX O

REREV SYSTEM WARRANTY

WARRANTY COVERAGE

The ReRev™ system including inverter(s) and components is warranted for a full five (5) year period following date of installation. Updates in software will be provided continuously as changes occur.

During the first year following installation, ReRev™ will cover all system components and travel, if necessary. After the first year, travel to and from the job site will be billed at prevailing economy airfare.

IMPORTANT: Improper use or failing to disconnect the machines prior to maintenance can cause damage and void this warranty. All users should be off the equipment before any maintenance is preformed.

For questions regarding this warranty, please contact:

ReRev™

One Progress Plaza – Suite 810

St. Petersburg, FL 33701

P: 727.556.0804

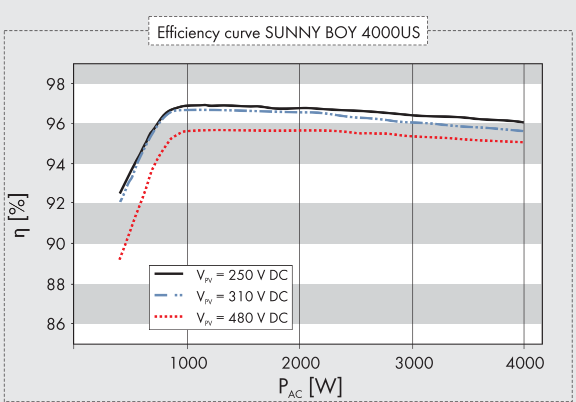
F: 727.556.0360

www.ReRev.com

APPENDIX P

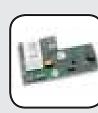
REREV INVERTER CUT SHEET

Technical data	Sunny Boy 3000-US		Sunny Boy 3800-US	Sunny Boy 4000-US	
	208 V AC	240 V AC	240 V AC	208 V AC	240 V AC
Input (DC)					
Max. recommended PV power (@ module STC)	3750 W		4750 W	4375 W	5000 W
Max. DC power (@ cos φ = 1)	3200 W		4200 W	4200 W	
Max. DC voltage	500 V		600 V	600 V	
DC nominal voltage	250 V		310 V	310 V	
MPP voltage range	175 – 400 V	200 – 400 V	250 – 480 V	220 – 480 V	250 – 480 V
Min. DC voltage / start voltage	175 / 228 V	200 / 228 V	250 / 285 V	220 / 285 V	250 / 285 V
Max. input current / per string (at DC disconnect)	17 A / 17 A 36 A @ combined terminal		18 A / 18 A 36 A @ combined terminal	18 A / 18 A 36 A @ combined terminal	
Number of MPP trackers / fused strings per MPP tracker	1 / 4 (DC disconnect)				
Output (AC)					
AC nominal power	3000 W		3800 W	3500 W	4000 W
Max. AC apparent power	3000 VA		3800 VA	3500 VA	4000 VA
Nominal AC voltage / adjustable	208 V / ●	240 V / ●	240 V / –	208 V / ●	240 V / ●
AC voltage range	183 – 229 V	211 – 264 V	211 – 264 V	183 – 229 V	211 – 264 V
AC grid frequency; range	60 Hz; 59.3 – 60.5 Hz		60 Hz; 59.3 – 60.5 Hz	60 Hz; 59.3 – 60.5 Hz	
Max. output current	15 A	13 A	16 A	17 A	
Power factor (cos φ)	1		1	1	
Phase conductors / connection phases	1 / 2		1 / 2	1 / 2	
Harmonics	< 4%		< 4%	< 4%	
Efficiency					
Max. efficiency	96.0%	96.5%	96.8%	96.5%	96.8%
CEC efficiency	95.0%	95.5%	96.0%	95.5%	96.0%
Protection devices					
DC reverse-polarity protection	●		●	●	
AC short circuit protection	●		●	●	
Galvanically isolated / all-pole sensitive monitoring unit	●/–		●/–	●/–	
Protection class / overvoltage category	I / III		I / III	I / III	
General data					
Dimensions (W / H / D) in mm (in)	450 / 350 / 235 (18 / 14 / 9)				
DC Disconnect dimensions (W / H / D) in mm (in)	187 / 297 / 190 (7 / 12 / 7.5)				
Packing dimensions (W / H / D) in mm (in)	390 / 580 / 470 (15 / 23 / 18.5)				
DC Disconnect packing dimensions (W / H / D) in mm (in)	370 / 240 / 280 (15 / 9 / 11)				
Weight / DC Disconnect weight	38 kg (84 lb) / 3.5 kg (8 lb)				
Packing weight / DC Disconnect packing weight	44 kg (97 lb) / 4 kg (9 lb)				
Operating temperature range (full power)	–25 °C ... +45 °C (–13 °F ... +113 °F)				
Noise emission (typical)	40 dB(A)		www.SMA-Solar.com	37 dB(A)	
Internal consumption at night	0.1 W		0.1 W	0.1 W	
Topology	LF transformer		LF transformer	LF transformer	
Cooling concept	OptiCool		OptiCool	OptiCool	
Electronics protection rating / connection area	NEMA 3R / NEMA 3R		NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R	
Features					
Display: text line / graphic	●/–		●/–	●/–	
Interfaces: RS485 / *Bluetooth*	○/○		○/○	○/○	
Warranty: 10 / 15 / 20 years	●/○/○		●/○/○	●/○/○	
Certificates and permits (more available on request)	UL1741, UL1998, IEEE 1547, FCC Part 15 (Class A & B), CSA C22.2 No. 107.1-2001				
NOTE: US inverters ship with gray lids.					
Data at nominal conditions					
● Standard features ○ Optional features – Not available					
Type designation	SB 3000US		SB 3800-US-10	SB 4000US	



Accessories

RS485 interface
485USPB-NR



Bluetooth® Piggy Back
BTPBINV-NR

Combi-Switch
DC disconnect and PV array combiner box
COMBO-SWITCH

Combiner Box
Simplify wiring for added convenience and safety
SBCB-6-3R or SBCB-6-4

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SMA America, LLC

Appendix Q

Subcontractors Present on Site

Subcontractors Present on Site							
	Date	Steel Sub	Masonry Sub	Electrical Sub	Plumbing Sub	Drywall Sub	Mechanical Sub
WEEK 1	3/28/2011		X	X	X		X
	3/29/2011		X	X	X		X
	3/30/2011		X	X	X	X	X
	3/31/2011		X	X	X	X	X
	4/1/2011		X	X	X	X	X
	4/2/2011		X	X	X	X	X
WEEK 2	4/4/2011		X	X	X		
	4/5/2011	X	X	X	X	X	
	4/6/2011	X	X	X	X	X	
	4/7/2011	X	X	X	X	X	
	4/8/2011	X	X	X	X	X	X
	4/9/2011			X	X		X
WEEK 3	4/11/2011	X	X	X	X		X
	4/12/2011	X	X	X	X	X	X
	4/13/2011	X	X	X	X	X	X
	4/14/2011	X	X	X	X	X	X
	4/15/2011	X	X	X	X	X	X
	4/16/2011	X	X	X	X	X	X
WEEK 4	4/18/2011	X	X	X	X	X	X
	4/19/2011	X	X	X	X	X	X
	4/20/2011	X	X	X	X	X	X
	4/21/2011	X	X	X	X	X	X
	4/22/2011	X	X	X	X	X	X
	4/23/2011	X	X	X	X		X
WEEK 5	4/25/2011		X	X	X	X	X
	4/26/2011	X	X	X	X	X	X
	4/27/2011	X	X	X	X	X	X
	4/28/2011	X	X	X	X	X	X
	4/29/2011	X	X	X	X	X	
	4/30/2011	X	X		X	X	X

Subcontractors Present on Site							
	Date	Steel Sub	Masonry Sub	Electrical Sub	Plumbing Sub	Drywall Sub	Mechanical Sub
WEEK 6	5/2/2011	X	X	X	X	X	X
	5/3/2011	X	X	X	X	X	X
	5/4/2011	X	X	X	X	X	X
	5/5/2011	X	X	X	X	X	X
	5/6/2011	X	X	X	X	X	X
	5/7/2011	X	X	X	X	X	X
WEEK 7	5/9/2011	X	X	X	X	X	X
	5/10/2011	X	X	X	X	X	X
	5/11/2011	X	X	X	X	X	X
	5/12/2011	X	X	X	X	X	X
	5/13/2011	X	X	X	X	X	X
	5/14/2011		X	X		X	X
WEEK 8	5/16/2011	X	X	X	X	X	X
	5/17/2011	X	X	X	X	X	X
	5/18/2011	X	X	X	X	X	X
	5/19/2011	X	X	X	X	X	X
	5/20/2011	X	X	X	X	X	X
	5/21/2011		X	X	X	X	X
WEEK 9	5/23/2011	X	X	X	X	X	X
	5/24/2011	X	X	X	X	X	X
	5/25/2011	X	X	X	X	X	X
	5/26/2011	X	X	X	X	X	X
	5/27/2011	X	X	X	X	X	X
	5/28/2011	X	X		X	X	X
WEEK 10	5/30/2011	X	X	X	X	X	X
	5/31/2011	X	X	X	X	X	X
	6/1/2011	X	X	X	X	X	X
	6/2/2011	X	X	X	X	X	X
	6/3/2011	X	X	X	X	X	X
	6/4/2011	X	X	X	X	X	X

Subcontractors Present on Site

	Date	Steel Sub	Masonry Sub	Electrical Sub	Plumbing Sub	Drywall Sub	Mechanical Sub
WEEK 11	6/6/2011	X	X	X	X	X	X
	6/7/2011	X	X	X	X	X	X
	6/8/2011	X	X	X	X	X	X
	6/9/2011	X	X	X	X	X	X
	6/10/2011	X	X	X	X	X	X
	6/11/2011	X	X		X	X	X
WEEK 12	6/13/2011	X	X	X	X	X	X
	6/14/2011	X	X	X	X	X	X
	6/15/2011	X	X	X	X	X	X
	6/16/2011	X	X	X	X	X	X
	6/17/2011	X	X	X	X	X	X
	6/18/2011	X		X		X	X
WEEK 13	6/20/2011	X	X	X	X	X	X
	6/21/2011	X	X	X	X	X	X
	6/22/2011	X	X	X	X	X	X
	6/23/2011	X	X	X	X	X	X
	6/24/2011	X	X	X	X	X	X
	6/25/2011	X	X			X	X
WEEK 14	6/27/2011	X	X	X	X	X	X
	6/28/2011	X	X	X	X	X	X
	6/29/2011	X	X	X	X	X	X
	6/30/2011	X	X	X	X	X	X
	7/1/2011	X	X	X	X	X	X
	7/2/2011			X	X	X	X
WEEK 15	7/4/2011						
	7/5/2011	X	X	X	X	X	X
	7/6/2011	X	X	X	X	X	X
	7/7/2011	X	X	X	X	X	X
	7/8/2011	X	X	X	X	X	X
	7/9/2011			X	X	X	

Subcontractors Present on Site

	Date	Steel Sub	Masonry Sub	Electrical Sub	Plumbing Sub	Drywall Sub	Mechanical Sub
WEEK 16	7/11/2011	X		X	X	X	X
	7/12/2011	X	X	X	X	X	X
	7/13/2011	X	X	X	X	X	X
	7/14/2011	X	X	X	X	X	X
	7/15/2011	X	X	X	X	X	X
	7/16/2011					X	X
WEEK 17	7/18/2011	X		X	X		X
	7/19/2011	X		X	X	X	X
	7/20/2011	X		X	X	X	X
	7/21/2011	X		X	X	X	X
	7/22/2011	X		X	X		X
	7/23/2011	X		X			X
WEEK 18	7/25/2011	X	X	X	X	X	
	7/26/2011	X	X	X	X	X	X
	7/27/2011	X	X	X	X	X	X
	7/28/2011	X	X	X	X	X	X
	7/29/2011		X	X	X	X	X
	7/30/2011	X	X			X	X
WEEK 19	8/1/2011	X		X	X	X	X
	8/2/2011	X		X	X	X	X
	8/3/2011	X		X	X	X	X
	8/4/2011	X		X	X	X	X
	8/5/2011	X		X	X	X	X
	8/6/2011				X		X
WEEK 20	8/8/2011	X		X	X	X	X
	8/9/2011	X		X	X	X	X
	8/10/2011	X		X	X	X	X
	8/11/2011	X		X	X	X	X
	8/12/2011	X		X	X	X	X
	8/13/2011			X	X	X	X

Appendix R

Lost Wages Calculations for a 6-12s Schedule

Steel Subcontractor Lost Wages (6-12s)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
3	40	32	0.80	32.0	25.6	8.0	6.4	$42.13	$63.20	$ 741.49	4	$ 2,965.95
4	40	32	0.75	30.0	24.0	10.0	8.0	$42.13	$63.20	$ 926.86	7	$ 6,488.02
5	40	32	0.71	28.4	22.7	11.6	9.3	$42.13	$63.20	$ 1,075.16	8	$ 8,601.26
6	40	32	0.65	26.0	20.8	14.0	11.2	$42.13	$63.20	$ 1,297.60	7	$ 9,083.23
7	40	32	0.61	24.4	19.5	15.6	12.5	$42.13	$63.20	$ 1,445.90	7	$ 10,121.31
8	40	32	0.57	22.8	18.2	17.2	13.8	$42.13	$63.20	$ 1,594.20	7	$ 11,159.39
9	40	32	0.54	21.6	17.3	18.4	14.7	$42.13	$63.20	$ 1,705.42	9	$ 15,348.80
10	40	32	0.50	20.0	16.0	20.0	16.0	$42.13	$63.20	$ 1,853.72	9	$ 16,683.48
11	40	32	0.48	19.2	15.4	20.8	16.6	$42.13	$63.20	$ 1,927.87	10	$ 19,278.69
12	40	32	0.46	18.4	14.7	21.6	17.3	$42.13	$63.20	$ 2,002.02	11	$ 22,022.19
13	40	32	0.45	18.0	14.4	22.0	17.6	$42.13	$63.20	$ 2,039.09	11	$ 22,430.01
14	40	32	0.44	17.6	14.1	22.4	17.9	$42.13	$63.20	$ 2,076.17	9	$ 18,685.50
15	40	32	0.43	17.2	13.8	22.8	18.2	$42.13	$63.20	$ 2,113.24	8	$ 16,905.93
16	40	32	0.42	16.8	13.4	23.2	18.6	$42.13	$63.20	$ 2,150.32	4	$ 8,601.26
17	40	32	0.41	16.4	13.1	23.6	18.9	$42.13	$63.20	$ 2,187.39	4	$ 8,749.56
18	40	32	0.41	16.4	13.1	23.6	18.9	$42.13	$63.20	$ 2,187.39	4	$ 8,749.56
Totals				345.2	276.2	294.8	235.8			$ 27,323.83		$205,874.14

Masonry Subcontractor Lost Wages (6-12s)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
3	40	32	0.80	32.0	25.6	8.0	6.4	$32.82	$49.23	$ 577.63	5	$ 2,888.16
4	40	32	0.75	30.0	24.0	10.0	8.0	$32.82	$49.23	$ 722.04	7	$ 5,054.28
5	40	32	0.71	28.4	22.7	11.6	9.3	$32.82	$49.23	$ 837.57	8	$ 6,700.53
6	40	32	0.65	26.0	20.8	14.0	11.2	$32.82	$49.23	$ 1,010.86	7	$ 7,075.99
7	40	32	0.61	24.4	19.5	15.6	12.5	$32.82	$49.23	$ 1,126.38	5	$ 5,631.91
8	40	32	0.57	22.8	18.2	17.2	13.8	$32.82	$49.23	$ 1,241.91	8	$ 9,935.27
9	40	32	0.54	21.6	17.3	18.4	14.7	$32.82	$49.23	$ 1,328.55	7	$ 9,299.88
10	40	32	0.50	20.0	16.0	20.0	16.0	$32.82	$49.23	$ 1,444.08	7	$ 10,108.56
11	40	32	0.48	19.2	15.4	20.8	16.6	$32.82	$49.23	$ 1,501.84	7	$ 10,512.90
12	40	32	0.46	18.4	14.7	21.6	17.3	$32.82	$49.23	$ 1,559.61	8	$ 12,476.85
13	40	32	0.45	18.0	14.4	22.0	17.6	$32.82	$49.23	$ 1,588.49	7	$ 11,119.42
14	40	32	0.44	17.6	14.1	22.4	17.9	$32.82	$49.23	$ 1,617.37	7	$ 11,321.59
15	40	32	0.43	17.2	13.8	22.8	18.2	$32.82	$49.23	$ 1,646.25	5	$ 8,231.26
16	40	32	0.42	16.8	13.4	23.2	18.6	$32.82	$49.23	$ 1,675.13	8	$ 13,401.06
17	40	32	0.41	16.4	13.1	23.6	18.9	$32.82	$49.23	$ 1,704.01	8	$ 13,632.12
18	40	32	0.41	16.4	13.1	23.6	18.9	$32.82	$49.23	$ 1,704.01	8	$ 13,632.12
Totals				345.2	276.2	294.8	235.8			$ 21,285.74		$151,021.89

Electrical Subcontractor Lost Wages (6-12s)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
1	40	32	0.80	32.0	25.6	8.0	6.4	$48.25	$72.38	$ 849.20	6	$ 5,095.20
2	40	32	0.75	30.0	24.0	10.0	8.0	$48.25	$72.38	$ 1,061.50	9	$ 9,553.50
3	40	32	0.71	28.4	22.7	11.6	9.3	$48.25	$72.38	$ 1,231.34	9	$ 11,082.06
4	40	32	0.65	26.0	20.8	14.0	11.2	$48.25	$72.38	$ 1,486.10	11	$ 16,347.10
5	40	32	0.61	24.4	19.5	15.6	12.5	$48.25	$72.38	$ 1,655.94	11	$ 18,215.34
6	40	32	0.57	22.8	18.2	17.2	13.8	$48.25	$72.38	$ 1,825.78	9	$ 16,432.02
7	40	32	0.54	21.6	17.3	18.4	14.7	$48.25	$72.38	$ 1,953.16	8	$ 15,625.28
8	40	32	0.50	20.0	16.0	20.0	16.0	$48.25	$72.38	$ 2,123.00	9	$ 19,107.00
9	40	32	0.48	19.2	15.4	20.8	16.6	$48.25	$72.38	$ 2,207.92	10	$ 22,079.20
10	40	32	0.46	18.4	14.7	21.6	17.3	$48.25	$72.38	$ 2,292.84	10	$ 22,928.40
11	40	32	0.45	18.0	14.4	22.0	17.6	$48.25	$72.38	$ 2,335.30	9	$ 21,017.70
12	40	32	0.44	17.6	14.1	22.4	17.9	$48.25	$72.38	$ 2,377.76	12	$ 28,533.12
13	40	32	0.43	17.2	13.8	22.8	18.2	$48.25	$72.38	$ 2,420.22	12	$ 29,042.64
14	40	32	0.42	16.8	13.4	23.2	18.6	$48.25	$72.38	$ 2,462.68	15	$ 36,940.20
15	40	32	0.41	16.4	13.1	23.6	18.9	$48.25	$72.38	$ 2,505.14	12	$ 30,061.68
16	40	32	0.41	16.4	13.1	23.6	18.9	$48.25	$72.38	$ 2,505.14	11	$ 27,556.54
Totals				345.2	276.2	294.8	235.8			$ 31,293.02		$329,616.98

Plumbing Subcontractor Lost Wages (6-12s)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
1	40	32	0.80	32.0	25.6	8.0	6.4	$52.37	$78.56	$ 921.71	4	$ 3,686.85
2	40	32	0.75	30.0	24.0	10.0	8.0	$52.37	$78.56	$ 1,152.14	6	$ 6,912.84
3	40	32	0.71	28.4	22.7	11.6	9.3	$52.37	$78.56	$ 1,336.48	6	$ 8,018.89
4	40	32	0.65	26.0	20.8	14.0	11.2	$52.37	$78.56	$ 1,613.00	8	$ 12,903.97
5	40	32	0.61	24.4	19.5	15.6	12.5	$52.37	$78.56	$ 1,797.34	10	$ 17,973.38
6	40	32	0.57	22.8	18.2	17.2	13.8	$52.37	$78.56	$ 1,981.68	10	$ 19,816.81
7	40	32	0.54	21.6	17.3	18.4	14.7	$52.37	$78.56	$ 2,119.94	8	$ 16,959.50
8	40	32	0.50	20.0	16.0	20.0	16.0	$52.37	$78.56	$ 2,304.28	9	$ 20,738.52
9	40	32	0.48	19.2	15.4	20.8	16.6	$52.37	$78.56	$ 2,396.45	10	$ 23,964.51
10	40	32	0.46	18.4	14.7	21.6	17.3	$52.37	$78.56	$ 2,488.62	7	$ 17,420.36
11	40	32	0.45	18.0	14.4	22.0	17.6	$52.37	$78.56	$ 2,534.71	9	$ 22,812.37
12	40	32	0.44	17.6	14.1	22.4	17.9	$52.37	$78.56	$ 2,580.79	10	$ 25,807.94
13	40	32	0.43	17.2	13.8	22.8	18.2	$52.37	$78.56	$ 2,626.88	10	$ 26,268.79
14	40	32	0.42	16.8	13.4	23.2	18.6	$52.37	$78.56	$ 2,672.96	9	$ 24,056.68
15	40	32	0.41	16.4	13.1	23.6	18.9	$52.37	$78.56	$ 2,719.05	10	$ 27,190.50
16	40	32	0.41	16.4	13.1	23.6	18.9	$52.37	$78.56	$ 2,719.05	9	$ 24,471.45
Totals				345.2	276.2	294.8	235.8			$ 33,965.09		$299,003.37

Drywall Subcontractor Lost Wages (6-12s)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
3	40	32	0.80	32.0	25.6	8.0	6.4	$32.73	$49.10	$ 576.05	3	$ 1,728.14
4	40	32	0.75	30.0	24.0	10.0	8.0	$32.73	$49.10	$ 720.06	5	$ 3,600.30
5	40	32	0.71	28.4	22.7	11.6	9.3	$32.73	$49.10	$ 835.27	12	$ 10,023.24
6	40	32	0.65	26.0	20.8	14.0	11.2	$32.73	$49.10	$ 1,008.08	20	$ 20,161.68
7	40	32	0.61	24.4	19.5	15.6	12.5	$32.73	$49.10	$ 1,123.29	18	$ 20,219.28
8	40	32	0.57	22.8	18.2	17.2	13.8	$32.73	$49.10	$ 1,238.50	18	$ 22,293.06
9	40	32	0.54	21.6	17.3	18.4	14.7	$32.73	$49.10	$ 1,324.91	12	$ 15,898.92
10	40	32	0.50	20.0	16.0	20.0	16.0	$32.73	$49.10	$ 1,440.12	12	$ 17,281.44
11	40	32	0.48	19.2	15.4	20.8	16.6	$32.73	$49.10	$ 1,497.72	7	$ 10,484.07
12	40	32	0.46	18.4	14.7	21.6	17.3	$32.73	$49.10	$ 1,555.33	6	$ 9,331.98
13	40	32	0.45	18.0	14.4	22.0	17.6	$32.73	$49.10	$ 1,584.13	15	$ 23,761.98
14	40	32	0.44	17.6	14.1	22.4	17.9	$32.73	$49.10	$ 1,612.93	13	$ 20,968.15
15	40	32	0.43	17.2	13.8	22.8	18.2	$32.73	$49.10	$ 1,641.74	12	$ 19,700.84
16	40	32	0.42	16.8	13.4	23.2	18.6	$32.73	$49.10	$ 1,670.54	6	$ 10,023.24
17	40	32	0.41	16.4	13.1	23.6	18.9	$32.73	$49.10	$ 1,699.34	5	$ 8,496.71
18	40	32	0.41	16.4	13.1	23.6	18.9	$32.73	$49.10	$ 1,699.34	6	$ 10,196.05
Totals				345.2	276.2	294.8	235.8			$ 21,227.37		$224,169.08

Mechanical Subcontractor Lost Wages (6-12s)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
3	40	32	0.80	32.0	25.6	8.0	6.4	$45.95	$68.93	$ 808.72	3	$ 2,426.16
4	40	32	0.75	30.0	24.0	10.0	8.0	$45.95	$68.93	$ 1,010.90	8	$ 8,087.20
5	40	32	0.71	28.4	22.7	11.6	9.3	$45.95	$68.93	$ 1,172.64	4	$ 4,690.58
6	40	32	0.65	26.0	20.8	14.0	11.2	$45.95	$68.93	$ 1,415.26	10	$ 14,152.60
7	40	32	0.61	24.4	19.5	15.6	12.5	$45.95	$68.93	$ 1,577.00	11	$ 17,347.04
8	40	32	0.57	22.8	18.2	17.2	13.8	$45.95	$68.93	$ 1,738.75	13	$ 22,603.72
9	40	32	0.54	21.6	17.3	18.4	14.7	$45.95	$68.93	$ 1,860.06	12	$ 22,320.67
10	40	32	0.50	20.0	16.0	20.0	16.0	$45.95	$68.93	$ 2,021.80	12	$ 24,261.60
11	40	32	0.48	19.2	15.4	20.8	16.6	$45.95	$68.93	$ 2,102.67	11	$ 23,129.39
12	40	32	0.46	18.4	14.7	21.6	17.3	$45.95	$68.93	$ 2,183.54	12	$ 26,202.53
13	40	32	0.45	18.0	14.4	22.0	17.6	$45.95	$68.93	$ 2,223.98	12	$ 26,687.76
14	40	32	0.44	17.6	14.1	22.4	17.9	$45.95	$68.93	$ 2,264.42	12	$ 27,172.99
15	40	32	0.43	17.2	13.8	22.8	18.2	$45.95	$68.93	$ 2,304.85	12	$ 27,658.22
16	40	32	0.42	16.8	13.4	23.2	18.6	$45.95	$68.93	$ 2,345.29	11	$ 25,798.17
17	40	32	0.41	16.4	13.1	23.6	18.9	$45.95	$68.93	$ 2,385.72	12	$ 28,628.69
18	40	32	0.41	16.4	13.1	23.6	18.9	$45.95	$68.93	$ 2,385.72	12	$ 28,628.69
Totals				345.2	276.2	294.8	235.8			$ 29,801.33		$329,796.02

Total Lost Wages per Subcontractor (6-12s)						
Steel Sub	Masonry Sub	Electrical Sub	Plumbing Sub	Drywall Sub	Mechanical Sub	Total
$ 205,874.14	$ 151,021.89	$ 329,616.98	$ 299,003.37	$ 224,169.08	$ 329,796.02	$ 1,539,481.48

Appendix S

Effective Work Hours Per Subcontractor

Actual Effective Work Hours Per Subcontractor (6-12s)															
	Per Worker			Steel Sub		Masonry Sub		Electrical Sub		Plumbing Sub		Drywall Sub		Mechanical Sub	
Week	Effective Regular Hrs	Effective OT Hrs	Total Effective Hrs	Avg Labor Per Wk	Total Effective Work Hrs	Avg Labor Per Wk	Total Effective Work Hrs	Avg Labor Per Wk	Total Effective Work Hrs	Avg Labor Per Wk	Total Effective Work Hrs	Avg Labor Per Wk	Total Effective Work Hrs	Avg Labor Per Wk	Total Effective Work Hrs
1	32.0	25.6	57.6	4	230.4	5	288.0	6	345.6	4	230.4	3	172.8	3	172.8
2	30.0	24.0	54.0	7	378.0	7	378.0	9	486.0	6	324.0	5	270.0	8	432.0
3	28.4	22.7	51.1	8	409.0	8	409.0	9	460.1	6	306.7	12	613.4	4	204.5
4	26.0	20.8	46.8	7	327.6	7	327.6	11	514.8	8	374.4	20	936.0	10	468.0
5	24.4	19.5	43.9	7	307.4	5	219.6	11	483.1	10	439.2	18	790.6	11	483.1
6	22.8	18.2	41.0	7	287.3	8	328.3	9	369.4	10	410.4	18	738.7	13	533.5
7	21.6	17.3	38.9	9	349.9	7	272.2	8	311.0	8	311.0	12	466.6	12	466.6
8	20.0	16.0	36.0	9	324.0	7	252.0	9	324.0	9	324.0	12	432.0	12	432.0
9	19.2	15.4	34.6	10	345.6	7	241.9	10	345.6	10	345.6	7	241.9	11	380.2
10	18.4	14.7	33.1	11	364.3	8	265.0	10	331.2	7	231.8	6	198.7	12	397.4
11	18.0	14.4	32.4	11	356.4	7	226.8	9	291.6	9	291.6	15	486.0	12	388.8
12	17.6	14.1	31.7	9	285.1	7	221.8	12	380.2	10	316.8	13	411.8	12	380.2
13	17.2	13.8	31.0	8	247.7	5	154.8	12	371.5	10	309.6	12	371.5	12	371.5
14	16.8	13.4	30.2	4	121.0	8	241.9	15	453.6	9	272.2	6	181.4	11	332.6
15	16.4	13.1	29.5	4	118.1	8	236.2	12	354.2	10	295.2	5	147.6	12	354.2
16	16.4	13.1	29.5	4	118.1	8	236.2	11	324.7	9	265.7	6	177.1	12	354.2
Totals	345.2	276.2	621.4		4569.8		4299.1		6146.6		5048.6		6636.2		6151.7

Theoretical Effective Work Hours Per Subcontractor (4-9s & 1-8)															
	Per Worker			Steel Sub		Masonry Sub		Electrical Sub		Plumbing Sub		Drywall Sub		Mechanical Sub	
Week	Effective Regular Hrs	Effective OT Hrs	Total Effective Hrs	Avg Labor Per Wk	Total Effective Work Hrs	Avg Labor Per Wk	Total Effective Work Hrs	Avg Labor Per Wk	Total Effective Work Hrs	Avg Labor Per Wk	Total Effective Work Hrs	Avg Labor Per Wk	Total Effective Work Hrs	Avg Labor Per Wk	Total Effective Work Hrs
1	40.0	4.0	44.0	4	176.0	5	220.0	6	264.0	4	176.0	3	132.0	3	132.0
2	39.6	4.0	43.6	7	305.2	7	305.2	9	392.4	6	261.6	5	218.0	8	348.8
3	39.6	4.0	43.6	8	348.8	8	348.8	9	392.4	6	261.6	12	523.2	4	174.4
4	39.6	4.0	43.6	7	305.2	7	305.2	11	479.6	8	348.8	20	872.0	10	436.0
5	39.2	3.9	43.1	7	301.7	5	215.5	11	474.1	10	431.0	18	775.8	11	474.1
6	38.8	3.9	42.7	7	298.9	8	341.6	9	384.3	10	427.0	18	768.6	13	555.1
7	37.6	3.8	41.4	9	372.6	7	289.8	8	331.2	8	331.2	12	496.8	12	496.8
8	36.8	3.7	40.5	9	364.5	7	283.5	9	364.5	9	364.5	12	486.0	12	486.0
9	35.2	3.5	38.7	10	387.0	7	270.9	10	387.0	10	387.0	7	270.9	11	425.7
10	34.0	3.4	37.4	11	411.4	8	299.2	10	374.0	7	261.8	6	224.4	12	448.8
11	32.8	3.3	36.1	11	397.1	7	252.7	9	324.9	9	324.9	15	541.5	12	433.2
12	31.2	3.1	34.3	9	308.7	7	240.1	12	411.6	10	343.0	13	445.9	12	411.6
13	31.6	3.2	34.8	8	278.4	5	174.0	12	417.6	10	348.0	12	417.6	12	417.6
14	31.6	3.2	34.8	4	139.2	8	278.4	15	522.0	9	313.2	6	208.8	11	382.8
15	31.6	3.2	34.8	4	139.2	8	278.4	12	417.6	10	348.0	5	174.0	12	417.6
16	31.6	3.2	34.8	4	139.2	8	278.4	11	382.8	9	313.2	6	208.8	12	417.6
Totals	570.8	57.4	627.9		4673.1		4381.7		6320.0		5240.8		6764.3		6458.1

Appendix T

Alternative Work Schedules

Work Schedule Alternatives - Part 1												
	4-10s			4-9s & 1-8			5-8s			5-10s		
Week	Weekly Hrs	Produc-tivity	Effective Hrs	Weekly Hrs	Produc-tivity	Effective Hrs	Weekly Hrs	Produc-tivity	Effective Hrs	Weekly Hrs	Produc-tivity	Effective Hrs
1	40	1.00	40.0	44	1.00	44.0	40	0.99	39.6	50	0.97	48.5
2	40	0.99	39.6	44	0.99	43.6	40	0.98	39.2	50	0.95	47.5
3	40	0.99	39.6	44	0.99	43.6	40	0.97	38.8	50	0.93	46.5
4	40	0.98	39.2	44	0.99	43.6	40	0.96	38.4	50	0.89	44.5
5	40	0.98	39.2	44	0.98	43.1	40	0.95	38.0	50	0.87	43.5
6	40	0.97	38.8	44	0.97	42.7	40	0.93	37.2	50	0.84	42.0
7	40	0.97	38.8	44	0.94	41.4	40	0.91	36.4	50	0.82	41.0
8	40	0.96	38.4	44	0.92	40.5	40	0.89	35.6	50	0.79	39.5
9	40	0.95	38.0	44	0.88	38.7	40	0.87	34.8	50	0.77	38.5
10	40	0.94	37.6	44	0.85	37.4	40	0.86	34.4	50	0.75	37.5
11	40	0.93	37.2	44	0.82	36.1	40	0.85	34.0	50	0.74	37.0
12	40	0.92	36.8	44	0.78	34.3	40	0.84	33.6	50	0.73	36.5
13	40	0.91	36.4	44	0.79	34.8	40	0.83	33.2	50	0.72	36.0
14	40	0.89	35.6	44	0.79	34.8	40	0.81	32.4	50	0.71	35.5
15	40	0.88	35.2	44	0.79	34.8	40	0.81	32.4	50	0.70	35.0
16	40	0.87	34.8	44	0.79	34.8	40	0.80	32.0	50	0.69	34.5
Totals			605.2			627.9			570.0			643.5

Work Schedule Alternatives - Part 2												
	6-9s			6-10s			7-8s			5-12s		
Week	Weekly Hrs	Produc-tivity	Effective Hrs	Weekly Hrs	Produc-tivity	Effective Hrs	Weekly Hrs	Produc-tivity	Effective Hrs	Weekly Hrs	Produc-tivity	Effective Hrs
1	54	0.96	51.8	60	0.94	56.4	56	0.89	49.8	60	0.88	52.8
2	54	0.93	50.2	60	0.91	54.6	56	0.86	48.2	60	0.84	50.4
3	54	0.90	48.6	60	0.87	52.2	56	0.83	46.5	60	0.80	48.0
4	54	0.87	47.0	60	0.83	49.8	56	0.78	43.7	60	0.75	45.0
5	54	0.84	45.4	60	0.79	47.4	56	0.74	41.4	60	0.70	42.0
6	54	0.81	43.7	60	0.75	45.0	56	0.7	39.2	60	0.65	39.0
7	54	0.78	42.1	60	0.72	43.2	56	0.66	37.0	60	0.63	37.8
8	54	0.75	40.5	60	0.68	40.8	56	0.63	35.3	60	0.59	35.4
9	54	0.73	39.4	60	0.66	39.6	56	0.6	33.6	60	0.57	34.2
10	54	0.71	38.3	60	0.65	39.0	56	0.59	33.0	60	0.55	33.0
11	54	0.69	37.3	60	0.64	38.4	56	0.58	32.5	60	0.53	31.8
12	54	0.68	36.7	60	0.63	37.8	56	0.57	31.9	60	0.52	31.2
13	54	0.67	36.2	60	0.62	37.2	56	0.56	31.4	60	0.51	30.6
14	54	0.66	35.6	60	0.61	36.6	56	0.56	31.4	60	0.50	30.0
15	54	0.65	35.1	60	0.60	36.0	56	0.56	31.4	60	0.49	29.4
16	54	0.64	34.6	60	0.60	36.0	56	0.56	31.4	60	0.48	28.8
Totals			662.6			690.0			597.5			599.4

Work Schedule Alternatives - Part 3												
	7-9s			7-10s			6-12s			7-12s		
Week	Weekly Hrs	Produc-tivity	Effective Hrs	Weekly Hrs	Produc-tivity	Effective Hrs	Weekly Hrs	Produc-tivity	Effective Hrs	Weekly Hrs	Produc-tivity	Effective Hrs
1	63	0.87	54.8	70	0.85	59.5	72	0.80	57.6	84	0.75	63.0
2	63	0.83	52.3	70	0.80	56.0	72	0.75	54.0	84	0.71	59.6
3	63	0.77	48.5	70	0.75	52.5	72	0.71	51.1	84	0.66	55.4
4	63	0.73	46.0	70	0.70	49.0	72	0.65	46.8	84	0.61	51.2
5	63	0.68	42.8	70	0.65	45.5	72	0.61	43.9	84	0.56	47.0
6	63	0.63	39.7	70	0.60	42.0	72	0.57	41.0	84	0.52	43.7
7	63	0.59	37.2	70	0.58	40.6	72	0.54	38.9	84	0.49	41.2
8	63	0.56	35.3	70	0.55	38.5	72	0.50	36.0	84	0.46	38.6
9	63	0.54	34.0	70	0.53	37.1	72	0.48	34.6	84	0.44	37.0
10	63	0.53	33.4	70	0.50	35.0	72	0.46	33.1	84	0.43	36.1
11	63	0.51	32.1	70	0.49	34.3	72	0.45	32.4	84	0.42	35.3
12	63	0.50	31.5	70	0.48	33.6	72	0.44	31.7	84	0.41	34.4
13	63	0.48	30.2	70	0.47	32.9	72	0.43	31.0	84	0.4	33.6
14	63	0.47	29.6	70	0.46	32.2	72	0.42	30.2	84	0.39	32.8
15	63	0.46	29.0	70	0.45	31.5	72	0.41	29.5	84	0.38	31.9
16	63	0.46	29.0	70	0.45	31.5	72	0.41	29.5	84	0.37	31.1
Totals			605.4			651.7			621.4			672.0

Appendix U

Lost Wages Calculations for a 4-9s and 1-8 Schedule

Steel Subcontractor Lost Wages (4-9s & 1-8)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
3	40	4	1.00	40.0	4.0	0.0	0.0	$42.13	$63.20	$ -	4	$ -
4	40	4	0.99	39.6	4.0	0.4	0.0	$42.13	$63.20	$ 19.38	7	$ 135.66
5	40	4	0.99	39.6	4.0	0.4	0.0	$42.13	$63.20	$ 19.38	8	$ 155.04
6	40	4	0.99	39.6	4.0	0.4	0.0	$42.13	$63.20	$ 19.38	7	$ 135.66
7	40	4	0.98	39.2	3.9	0.8	0.1	$42.13	$63.20	$ 38.76	7	$ 271.32
8	40	4	0.97	38.8	3.9	1.2	0.1	$42.13	$63.20	$ 58.14	7	$ 406.98
9	40	4	0.94	37.6	3.8	2.4	0.2	$42.13	$63.20	$ 116.28	9	$ 1,046.51
10	40	4	0.92	36.8	3.7	3.2	0.3	$42.13	$63.20	$ 155.04	9	$ 1,395.35
11	40	4	0.88	35.2	3.5	4.8	0.5	$42.13	$63.20	$ 232.56	10	$ 2,325.58
12	40	4	0.85	34.0	3.4	6.0	0.6	$42.13	$63.20	$ 290.70	11	$ 3,197.67
13	40	4	0.82	32.8	3.3	7.2	0.7	$42.13	$63.20	$ 348.84	11	$ 3,837.20
14	40	4	0.78	31.2	3.1	8.8	0.9	$42.13	$63.20	$ 426.36	9	$ 3,837.20
15	40	4	0.79	31.6	3.2	8.4	0.8	$42.13	$63.20	$ 406.98	8	$ 3,255.81
16	40	4	0.79	31.6	3.2	8.4	0.8	$42.13	$63.20	$ 406.98	4	$ 1,627.90
17	40	4	0.79	31.6	3.2	8.4	0.8	$42.13	$63.20	$ 406.98	4	$ 1,627.90
18	40	4	0.79	31.6	3.2	8.4	0.8	$42.13	$63.20	$ 406.98	4	$ 1,627.90
Totals				570.8	57.1	69.2	6.9			$ 3,352.71		$ 24,883.66

Masonry Subcontractor Lost Wages (4-9s & 1-8)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
3	40	4	1.00	40.0	4.0	0.0	0.0	$32.82	$49.23	$ -	5	$ -
4	40	4	0.99	39.6	4.0	0.4	0.0	$32.82	$49.23	$ 15.10	7	$ 105.68
5	40	4	0.99	39.6	4.0	0.4	0.0	$32.82	$49.23	$ 15.10	8	$ 120.78
6	40	4	0.99	39.6	4.0	0.4	0.0	$32.82	$49.23	$ 15.10	7	$ 105.68
7	40	4	0.98	39.2	3.9	0.8	0.1	$32.82	$49.23	$ 30.19	5	$ 150.97
8	40	4	0.97	38.8	3.9	1.2	0.1	$32.82	$49.23	$ 45.29	8	$ 362.33
9	40	4	0.94	37.6	3.8	2.4	0.2	$32.82	$49.23	$ 90.58	7	$ 634.08
10	40	4	0.92	36.8	3.7	3.2	0.3	$32.82	$49.23	$ 120.78	7	$ 845.44
11	40	4	0.88	35.2	3.5	4.8	0.5	$32.82	$49.23	$ 181.17	7	$ 1,268.16
12	40	4	0.85	34.0	3.4	6.0	0.6	$32.82	$49.23	$ 226.46	8	$ 1,811.66
13	40	4	0.82	32.8	3.3	7.2	0.7	$32.82	$49.23	$ 271.75	7	$ 1,902.25
14	40	4	0.78	31.2	3.1	8.8	0.9	$32.82	$49.23	$ 332.14	7	$ 2,324.97
15	40	4	0.79	31.6	3.2	8.4	0.8	$32.82	$49.23	$ 317.04	5	$ 1,585.21
16	40	4	0.79	31.6	3.2	8.4	0.8	$32.82	$49.23	$ 317.04	8	$ 2,536.33
17	40	4	0.79	31.6	3.2	8.4	0.8	$32.82	$49.23	$ 317.04	8	$ 2,536.33
18	40	4	0.79	31.6	3.2	8.4	0.8	$32.82	$49.23	$ 317.04	8	$ 2,536.33
Totals				570.8	57.1	69.2	6.9			$ 2,611.82		$ 18,826.21

Electrical Subcontractor Lost Wages (4-9s & 1-8)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
1	40	4	1.00	40.0	4.0	0.0	0.0	$48.25	$72.38	$ -	6	$ -
2	40	4	0.99	39.6	4.0	0.4	0.0	$48.25	$72.38	$ 22.19	9	$ 199.75
3	40	4	0.99	39.6	4.0	0.4	0.0	$48.25	$72.38	$ 22.19	9	$ 199.75
4	40	4	0.99	39.6	4.0	0.4	0.0	$48.25	$72.38	$ 22.19	11	$ 244.14
5	40	4	0.98	39.2	3.9	0.8	0.1	$48.25	$72.38	$ 44.39	11	$ 488.29
6	40	4	0.97	38.8	3.9	1.2	0.1	$48.25	$72.38	$ 66.59	9	$ 599.27
7	40	4	0.94	37.6	3.8	2.4	0.2	$48.25	$72.38	$ 133.17	8	$ 1,065.36
8	40	4	0.92	36.8	3.7	3.2	0.3	$48.25	$72.38	$ 177.56	9	$ 1,598.04
9	40	4	0.88	35.2	3.5	4.8	0.5	$48.25	$72.38	$ 266.34	10	$ 2,663.40
10	40	4	0.85	34.0	3.4	6.0	0.6	$48.25	$72.38	$ 332.93	10	$ 3,329.25
11	40	4	0.82	32.8	3.3	7.2	0.7	$48.25	$72.38	$ 399.51	9	$ 3,595.59
12	40	4	0.78	31.2	3.1	8.8	0.9	$48.25	$72.38	$ 488.29	12	$ 5,859.48
13	40	4	0.79	31.6	3.2	8.4	0.8	$48.25	$72.38	$ 466.10	12	$ 5,593.14
14	40	4	0.79	31.6	3.2	8.4	0.8	$48.25	$72.38	$ 466.10	15	$ 6,991.43
15	40	4	0.79	31.6	3.2	8.4	0.8	$48.25	$72.38	$ 466.10	12	$ 5,593.14
16	40	4	0.79	31.6	3.2	8.4	0.8	$48.25	$72.38	$ 466.10	11	$ 5,127.05
Totals				570.8	57.1	69.2	6.9			$ 3,839.74		$ 43,147.08

Plumbing Subcontractor Lost Wages (4-9s & 1-8)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
1	40	4	1.00	40.0	4.0	0.0	0.0	$52.37	$78.56	$ -	4	$ -
2	40	4	0.99	39.6	4.0	0.4	0.0	$52.37	$78.56	$ 24.09	6	$ 144.54
3	40	4	0.99	39.6	4.0	0.4	0.0	$52.37	$78.56	$ 24.09	6	$ 144.54
4	40	4	0.99	39.6	4.0	0.4	0.0	$52.37	$78.56	$ 24.09	8	$ 192.72
5	40	4	0.98	39.2	3.9	0.8	0.1	$52.37	$78.56	$ 48.18	10	$ 481.80
6	40	4	0.97	38.8	3.9	1.2	0.1	$52.37	$78.56	$ 72.27	10	$ 722.71
7	40	4	0.94	37.6	3.8	2.4	0.2	$52.37	$78.56	$ 144.54	8	$ 1,156.33
8	40	4	0.92	36.8	3.7	3.2	0.3	$52.37	$78.56	$ 192.72	9	$ 1,734.49
9	40	4	0.88	35.2	3.5	4.8	0.5	$52.37	$78.56	$ 289.08	10	$ 2,890.82
10	40	4	0.85	34.0	3.4	6.0	0.6	$52.37	$78.56	$ 361.35	7	$ 2,529.47
11	40	4	0.82	32.8	3.3	7.2	0.7	$52.37	$78.56	$ 433.62	9	$ 3,902.61
12	40	4	0.78	31.2	3.1	8.8	0.9	$52.37	$78.56	$ 529.98	10	$ 5,299.84
13	40	4	0.79	31.6	3.2	8.4	0.8	$52.37	$78.56	$ 505.89	10	$ 5,058.94
14	40	4	0.79	31.6	3.2	8.4	0.8	$52.37	$78.56	$ 505.89	9	$ 4,553.05
15	40	4	0.79	31.6	3.2	8.4	0.8	$52.37	$78.56	$ 505.89	10	$ 5,058.94
16	40	4	0.79	31.6	3.2	8.4	0.8	$52.37	$78.56	$ 505.89	9	$ 4,553.05
Totals				570.8	57.1	69.2	6.9			$ 4,167.60		$ 38,423.87

Drywall Subcontractor Lost Wages (4-9s & 1-8)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
3	40	4	1.00	40.0	4.0	0.0	0.0	$32.73	$49.10	$ -	3	$ -
4	40	4	0.99	39.6	4.0	0.4	0.0	$32.73	$49.10	$ 15.06	5	$ 75.28
5	40	4	0.99	39.6	4.0	0.4	0.0	$32.73	$49.10	$ 15.06	12	$ 180.67
6	40	4	0.99	39.6	4.0	0.4	0.0	$32.73	$49.10	$ 15.06	20	$ 301.12
7	40	4	0.98	39.2	3.9	0.8	0.1	$32.73	$49.10	$ 30.11	18	$ 542.01
8	40	4	0.97	38.8	3.9	1.2	0.1	$32.73	$49.10	$ 45.17	18	$ 813.01
9	40	4	0.94	37.6	3.8	2.4	0.2	$32.73	$49.10	$ 90.33	12	$ 1,084.02
10	40	4	0.92	36.8	3.7	3.2	0.3	$32.73	$49.10	$ 120.45	12	$ 1,445.36
11	40	4	0.88	35.2	3.5	4.8	0.5	$32.73	$49.10	$ 180.67	7	$ 1,264.69
12	40	4	0.85	34.0	3.4	6.0	0.6	$32.73	$49.10	$ 225.84	6	$ 1,355.02
13	40	4	0.82	32.8	3.3	7.2	0.7	$32.73	$49.10	$ 271.00	15	$ 4,065.07
14	40	4	0.78	31.2	3.1	8.8	0.9	$32.73	$49.10	$ 331.23	13	$ 4,305.96
15	40	4	0.79	31.6	3.2	8.4	0.8	$32.73	$49.10	$ 316.17	12	$ 3,794.06
16	40	4	0.79	31.6	3.2	8.4	0.8	$32.73	$49.10	$ 316.17	6	$ 1,897.03
17	40	4	0.79	31.6	3.2	8.4	0.8	$32.73	$49.10	$ 316.17	5	$ 1,580.86
18	40	4	0.79	31.6	3.2	8.4	0.8	$32.73	$49.10	$ 316.17	6	$ 1,897.03
Totals				570.8	57.1	69.2	6.9			$ 2,604.65		$ 24,601.18

Mechanical Subcontractor Lost Wages (4-9s & 1-8)												
Chosen Week	Regular Hrs/Wk	OT Hrs/Wk	Produc-tivity	Effective Regular Hrs	Effective OT Hrs	Regular Hrs Lost	OT Hrs Lost	Avg Laborer $/Hr	OT Laborer $/Hr	Lost $ Per Laborer	Avg Labor Per Wk	Total Lost Wages
3	40	4	1.00	40.0	4.0	0.0	0.0	$45.95	$68.93	$ -	3	$ -
4	40	4	0.99	39.6	4.0	0.4	0.0	$45.95	$68.93	$ 21.14	8	$ 169.10
5	40	4	0.99	39.6	4.0	0.4	0.0	$45.95	$68.93	$ 21.14	4	$ 84.55
6	40	4	0.99	39.6	4.0	0.4	0.0	$45.95	$68.93	$ 21.14	10	$ 211.37
7	40	4	0.98	39.2	3.9	0.8	0.1	$45.95	$68.93	$ 42.27	11	$ 465.01
8	40	4	0.97	38.8	3.9	1.2	0.1	$45.95	$68.93	$ 63.41	13	$ 824.34
9	40	4	0.94	37.6	3.8	2.4	0.2	$45.95	$68.93	$ 126.82	12	$ 1,521.86
10	40	4	0.92	36.8	3.7	3.2	0.3	$45.95	$68.93	$ 169.10	12	$ 2,029.15
11	40	4	0.88	35.2	3.5	4.8	0.5	$45.95	$68.93	$ 253.64	11	$ 2,790.08
12	40	4	0.85	34.0	3.4	6.0	0.6	$45.95	$68.93	$ 317.06	12	$ 3,804.66
13	40	4	0.82	32.8	3.3	7.2	0.7	$45.95	$68.93	$ 380.47	12	$ 4,565.59
14	40	4	0.78	31.2	3.1	8.8	0.9	$45.95	$68.93	$ 465.01	12	$ 5,580.17
15	40	4	0.79	31.6	3.2	8.4	0.8	$45.95	$68.93	$ 443.88	12	$ 5,326.52
16	40	4	0.79	31.6	3.2	8.4	0.8	$45.95	$68.93	$ 443.88	11	$ 4,882.65
17	40	4	0.79	31.6	3.2	8.4	0.8	$45.95	$68.93	$ 443.88	12	$ 5,326.52
18	40	4	0.79	31.6	3.2	8.4	0.8	$45.95	$68.93	$ 443.88	12	$ 5,326.52
Totals				570.8	57.1	69.2	6.9			$ 3,656.70		$ 42,908.11

Theoretical Lost Wages per Subcontractor (4-9s & 1-8)						
Steel Sub	Masonry Sub	Electrical Sub	Plumbing Sub	Drywall Sub	Mechanical Sub	Total
$ 24,883.66	$ 18,826.21	$ 43,147.08	$ 38,423.87	$ 24,601.18	$ 42,908.11	$ 192,790.11

APPENDIX V

EXAMPLE CONSTRUCTION TASK CATALOG

CONTRACT DOCUMENTS

for

JOB ORDER CONTRACT – 2008

PURDUE UNIVERSITY

VOLUME III

CONSTRUCTION TASK CATALOG

Purdue University
West Lafayette, Indiana

February 7, 2008

CTC Information:

1. This catalog was created specifically for **Purdue University**, and published in February 2008 by The Gordian Group Inc.

The Unit Prices Include:

LABOR COSTS:

1. Labor costs include direct labor through the working foreperson level at straight-time prevailing wage rates including published fringe benefits and an allowance for Social Security and Medicare taxes, worker's compensation, unemployment insurance and employee benefits.
2. Labor costs are based on workers familiar with and skilled in the performance of the task following OSHA requirements.
3. Labor costs include time lost for normal work breaks, layout, measuring and cutting to fit, clean-up of regular construction debris, inspection, permit compliance, job meetings and start-up.

EQUIPMENT COSTS:

1. Equipment costs include all equipment required to accomplish the work task. Allowance for the mobilization for large equipment (e.g. cranes, pile drivers, bulldozers, excavators, backhoes, bobcats etc.) is provided for under a separate work task.
2. Equipment costs are based on ownership rates. The rate difference between the Contractor owned equipment costs and the rental equipment costs are part of the adjustment factor.
3. Equipment costs include all operating expenses such as fuel, electricity, lubricants, etc. including the operator unless specifically excluded.

MATERIAL COSTS:

1. Material costs include the cost of the material being installed and all incidentals and accessories integral to the installation.
2. Material costs include manufacturer's and/or fabricator's shop drawings.
3. Material costs include an allowance for waste for such materials that are typically provided in standard widths, lengths, weights and units such as roofing, drywall, VCT, carpet, wall covering, ceiling tile, pipe, conduit, lumber and concrete. This list is not intended to be all inclusive, but descriptive of the types of construction materials that are typically sold in standard lengths, sizes and weights.

Complete and In-Place Construction:

1. Unit prices are for complete and in-place construction and include all labor, equipment and material required to complete the task as described in the CTC.
2. Unit Prices include delivery, unloading and storing materials, tools and equipment on site; moving, materials, tools and equipment from storage area or truck up to 2 ½ stories (2 stories with an attic) and within 125' to reach the site.
3. Unit prices exclude moving material and equipment greater than 2 ½ stories and handling material and equipment more than 125' (See 01661900).
4. Unit prices for imported materials (aggregate, sand, soil, etc.) include delivery up to 15 miles from the closest approved source.
5. Unit prices include all fasteners such as anchor bolts, lag bolts, screws, adhesive, wedge anchors, expansion bolts, roofing clips (excluding hurricane clips) that are required. Fasteners listed separately in the CTC are for use with Owner furnished material and equipment or relocating or reinstalling existing material and equipment.

6. Unit prices exclude more substantial mounting material such as threaded rod or angle iron unless the task description states otherwise.
7. Unit prices for doors and windows, duct work, plumbing fixtures, seamless floors, countertops, flashing, pitch pockets, skylights, curbs, roofing, include sealant and caulking.
8. Unit prices include testing, calibration, balancing and the like required to ensure proper installation, construction and performance (e.g. compaction test for backfill, balancing of heating ventilation and air conditioning, pneumatic or hydrostatic testing, soaping of joints, others as required). Use of owner supplied materials, equipment or tying into existing equipment/piping may justify testing, balancing, etc.

Demolition:

1. Unit prices for demolition include all labor, equipment and material required for the complete removal of the required items; clean-up of the area; and transferring down 2 ½ stories and within 125' of the site into a truck or dumpster for debris or to a designated area for owner requested items.
2. Unit prices for demolition exclude costs for hauling (See 01741900), dump fees (See 01741900), dumpsters (See 01741900), trash chutes (See 01741900), and handling materials more than 2 ½ stories or more than 125’ from the site (See 01661900), unless the task description states otherwise.
3. If the item being demolished is attached to another item being removed and can be removed as one item, then that item shall not be priced as a separate demolition task, unless the component alone must be demolished to accomplish the task (e.g. demolition of pipe includes pipe fittings unless the fitting must be demolished separately to accomplish the task; demolition of a wood door includes hinges, hardware, closures, kick plates, etc.).
4. The description "replace" includes the demolition of the existing item and the installation of the new item.
5. The descriptions "remove and relocate" or "remove and reinstall" includes the removal, cleaning of item and installation of the existing item in either the same location or another location.
6. The description "reinstall" includes the cleaning and installation of the existing item.
7. Salvageable materials remain the property of the Owner and shall be turned over as directed unless otherwise provided for in the Job Order.

The Adjustment Factors Include:

Business Costs:

1. Overhead costs, including but not limited to;
   - home office overhead
   - insurance, bonds, and indemnification
   - project meetings, training, management and supervision
   - mobilization and close-out for the contract and each Job Order
   - project office staff and equipment.
2. Profit.
3. Subcontractor's overhead and profit.
4. All taxes for which a waiver is not available including material sales tax and equipment rental.
5. Employee or Subcontractor’s wage rates that exceed the prevailing wage rates.
6. Fringe benefits, payroll taxes, worker’s compensation, insurance costs and any other payment mandated by law in connection with labor that exceeds the labor rate allowances.
7. Cost of financing the work.
8. Business risks such as the risk of a lower than expected volume of work, smaller than anticipated

Job Orders, poor Subcontractor performance, and inflation or material cost increases.

CONSTRUCTION RELATED COSTS:

1. Services required to obtain filings, building permits, street closure permits, and all other permits or licenses.
2. Costs incurred to investigate work sites necessary to prepare proposals and the preparation and modification of proposals, sketches, incidental drawings such as irrigation layout drawings, drawings detailing the connections and other layout drawings, submittals, as-built drawings, CADD drawings, microfilm, digital photographs and other project records.
3. Costs incurred to define and modify scopes as required to support a work order. The Contractor will be reimbursed for Professional Architectural and Engineering drawings that are required to be stamped by a licensed Architect or Engineer.
4. Office trailer and portable toilets for Contractor's use.
5. Construction vehicles such as pick-up trucks, utility trucks, vans, service trucks, flat bed trucks, tractors, trailers, etc.
6. Storage devices or items such as gang boxes and storage containers for Contractor's tools, equipment and materials.
7. Personnel safety equipment (hard hats, ropes, harness, etc.) and basic safety signage, railings, tape, roping, cable, markings, cones, etc.
8. All traffic barricades, except for those tasks listed in Section 01552600: Traffic Protection – Rental
9. Flagmen, groundmen and/or spotters required for traffic control and required to control the safety of the work site, workmen and pedestrians.
10. Meeting Owner security requirements.
11. Excess waste including roofing, drywall, VCT, carpet, wall covering, ceiling tile, pipe, conduit, siding, concrete, etc. This list is not intended to be all inclusive, but descriptive of the types of construction materials that are typically sold in standard lengths, sizes and weights.
12. Removing and returning Owner's furniture and furnishings (chairs, tables, pictures, etc. but excluding modular furniture, wall or ceiling attached or fastened devices or furnishings, safes or other furniture requiring disassembly).
13. Protection of all surfaces including those not in the scope of work from construction dust, debris or damage during construction up until final acceptance. The methods of protection including plastic, paper, temporary masonite and plywood (except for temporary walls), sealing doors or windows, etc. are the Contractor's responsibility
14. Daily clean-up.
15. Final professional project clean-up.
16. Costs resulting from inadequate supply of building materials, fuel, electricity, or skilled labor.
17. Costs resulting from productivity loss.
18. Working in extreme temperatures (below or above normal) or adverse conditions such as excessive rain, wind, sleet or snow.
19. Differences in project size; complexity and location.
20. All costs for other than discreet items of work specifically required to complete a particular Job Order.
21. Costs associated with Underground Utility location and identification.

PRICE VARIATIONS:

1. Contractors may find differences in labor, equipment and material costs due to certain economic factors. Variations in labor cost can also result from labor efficiency, labor restrictions, working conditions and local work rules. Variations in material costs can also result from the quantity of material purchased, the existing relationship with suppliers, and because the materials have been discontinued or have become obsolete.
2. While diligent effort is made to provide accurate and reliable up-to-date pricing, it is the responsibility of the Contractor to verify the unit prices and to modify their Adjustment Factors accordingly.

GENERAL COSTS:

1. This list is not exhaustive and is intended to provide general examples of costs to be included in the Contractor's Adjustment Factor as defined in the Contract.
2. The only compensation to be paid to a Contractor for the work tasks will be:

Published Unit Price	X	Installation (or Demolition) Quantity	X	Appropriate Adjustment Factor

3. No additional payments of any kind whatsoever will be made. All costs not included in the unit prices must be part of the Adjustment Factors.

General Interpretations:

WORKING HEIGHT:

1. Typical working height for work other than masonry is up to 14' above the finished floor or stationary working surface. The Contractor will not be paid for scaffolding, or similar equipment for work below 14'.
2. Typical working height for masonry work is up to 4' above the finished floor or stationary working surface. The Contractor will not be paid for scaffolding and similar equipment for masonry work below 4'.

FIELD ENGINEERING:

1. Surveying tasks shall be used only when the Owner requests the Contractor to perform topographic surveys or property line surveys or to establish horizontal and vertical controls. If the Owner provides horizontal and vertical control points within or adjacent to the site, any other surveying required to complete the work is considered construction staking or layout and the cost thereof is included in the appropriate task.

ASSEMBLIES:

1. Assembly unit prices take precedence over individual component pricing.

TESTING:

1. Contractor will be paid for testing existing material, as required by the technical specifications and as directed by the Owner (record tests) at the unit price for the appropriate task. The cost of process quality control testing routinely performed by the Contractor is included in the unit prices for the individual tasks.

MISCELLANEOUS:

1. For the purpose of quantity discounts, quantities are calculated on a per project basis. The quantity discount applies to the total quantity so determined.
2. Whenever there are alternative tasks that may be selected to complete work the Contractor shall select the most practical and economical tasks available (e.g. rental of equipment by weeks or months rather than days or painting by roller or spray rather than brush).
3. Restricted Working Space is defined as any area with less than 3' vertical or horizontal clearance and includes areas such as crawl spaces, ceiling plenums where the grid is not removed, narrow piping tunnels, and equipment rooms where the space to install the new work is congested as a result of equipment and piping placement that meet these dimensional restrictions. A Restricted Working Space modifier is available for certain mechanical piping and piping accessories tasks and for certain electrical conduit and conduit accessories tasks. Only those tasks with a modifier for Restricted Working Space are eligible for a price adjustment, and then only if the modifier applies to the contemplated tasks. A non pre-priced task will not be allowed because of Restricted Working Space for any CTC task.
4. Confined Working Space is defined according to the OSHA definition 29 CFR 1926.21(b)(6)(i): "Any space having limited means of egress, which is

subject to accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere, including, but not limited to, storage tanks, process vessels, bins, boilers, ventilation and exhaust duct, sewers, underground vaults, tunnels, pipelines and open top spaces more than 4 feet in depth such as pits and tubs." The Contractor shall conform to all OSHA and Owner requirements for working in Confined Working Spaces. Required ventilation and air monitoring equipment tasks shall be priced from the CTC and the Contractor is entitled to the cost of decreased labor productivity which shall be an increase of 15% of the Labor portion of the CTC tasks being accomplished.

5. Whenever a material, article or piece of equipment is identified in the CTC or in the specifications by reference to manufacturers' or vendors' names, trade names, catalogue numbers, or make, the identification is intended to establish a standard. Any material, article or equipment of another manufacturer or vendor which performs satisfactorily the duties imposed by the general design may be considered equally acceptable provided that, in the opinion of the Owner, the material, article or equipment so proposed is of equal quality, substance and function. The Contractor shall not provide, furnish or install any proposed material, article or equipment without the prior written approval of the Owner. The burden of proof and all costs related thereto concerning the "or equal" nature of the substitute item, whether approved or disapproved, shall be borne by the Contractor.

SPECIFICATIONS:

1. Specifications for tasks shall be interpreted as follows: All labor, material, equipment, spare parts, services, and work required by a specification shall be considered part of the unit price, unless the task description or technical specifications state otherwise.

Useful Information:

UNIT OF MEASURE DEFINITIONS:

ACR – Acre, **BAG** – Bag, **BBL** – Barrel, **BCY** - Bank (In-place) Cubic Yards, **BF** - Board Foot, **BOX** - Box (each), **BTU** - British Thermal Unit, **C** - One Hundred, **CCF** - One Hundred Cubic Feet, **CCY** - Compacted Cubic Yards, **CF** - Cubic Foot, **CFM** - Cubic Feet Per Minute, **CI** – Cubic Inch, **CLF** - One Hundred Linear Feet, **CSF** - One Hundred Square Feet, **CSY** - Hundred Square Yards, **CWT** - Carton Weight, **CY** - Cubic Yard, **CYM** - Cubic Yard Mile, **DAY** – Day, **DRM** - Drum (each), **EA** – Each, **FLR** - Floor (Per Floor), **FT** – Foot, **GAL** – Gallon, **GSF** - Ground Square Foot, **HR** – Hour, **HWT** - Hundred Carton Weight, **HYR** – Half Year, **IN** – Inch, **JOB** – Job, **LAN** – Lane, **LB** – Pound, **LCY** - Loose (Excavated) Cubic Yards, **LF** - Linear Foot, **LFD** - Linear Feet Per Day, **LIT** – Liter, **LOT** – Lot, **MBF** - One Thousand Board Feet, **MBH** - One Thousand British Thermal Units, **MCF** – One Thousand Cubic Feet, **MF3** - One Thousand Cubic Feet Per Minute, **MGL** – One Thousand Gallons, **MI** – Mile, **MLF** - One Thousand Linear Feet, **MO** – Month, **MSF** - One Thousand Square Feet, **MSY** - One Thousand Square Yards, **MT** – Metric Ton, **MTK** – Metric Ton Kilometer, **M2** – Square Meter, **M3K** – Cubic Meter Kilometer, **NPP** – Non Pre-Priced, **NTE** – Note, **OPN** – Opening, **OUT** - Outlet or Output (each), **OZ** – Ounce, **PKG** – Package, **PNT** – Point, **PR** – Pair, **QT** – Quart, **ROL** - Roll (each), **ROM** – Room, **ROW** – Row, **RSR** - Riser (Per Rise), **SEA** – Seat, **SET** – Set, **SF** - Square Foot, **SHT** – Sheet, **SI** - Square Inch, **STP** - Stop (each), **SQ** - Square or One Hundred Square Feet, **SY** - Square Yard, **SYI** – Inches per Square Yard, **TNM** - Tons per Mile, **TON** – Ton, **TRK** – Truck Load, **UI** - United Inch, **UNT** – Unit, **VLF** - Vertical Linear Foot, **WK** – Week, **YD** – Yard, **YR** – Year

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0181	EA	1/4" Diameter x 2-3/8" Long Concrete Strike Anchor	5.36	
		For Galvanized, Add	*0.35*	
		For Stainless Steel, Add	*2.45*	
		For Drilling In Wall, Add	*0.58*	
		For Drilling Overhead, Add	*1.40*	
		For Quantities > 10 To 50, Deduct	*-0.23*	
		For Quantities > 50 To 100, Deduct	*-0.48*	
		For Quantities > 100, Deduct	*-0.97*	
05 05 23 00-0182	EA	5/16" Diameter x 2-3/4" Long Concrete Strike Anchor	5.64	
		For Galvanized, Add	*0.38*	
		For Stainless Steel, Add	*2.63*	
		For Drilling In Wall, Add	*0.61*	
		For Drilling Overhead, Add	*1.47*	
		For Quantities > 10 To 50, Deduct	*-0.24*	
		For Quantities > 50 To 100, Deduct	*-0.51*	
		For Quantities > 100, Deduct	*-1.02*	
05 05 23 00-0183	EA	5/16" Diameter x 4" Long Concrete Strike Anchor	6.22	
		For Galvanized, Add	*0.67*	
		For Stainless Steel, Add	*4.66*	
		For Drilling In Wall, Add	*0.61*	
		For Drilling Overhead, Add	*1.47*	
		For Quantities > 10 To 50, Deduct	*-0.24*	
		For Quantities > 50 To 100, Deduct	*-0.52*	
		For Quantities > 100, Deduct	*-1.04*	
05 05 23 00-0184	EA	3/8" Diameter x 2-3/8" Long Concrete Strike Anchor	6.36	
		For Galvanized, Add	*0.41*	
		For Stainless Steel, Add	*2.87*	
		For Drilling In Wall, Add	*0.69*	
		For Drilling Overhead, Add	*1.66*	
		For Quantities > 10 To 50, Deduct	*-0.28*	
		For Quantities > 50 To 100, Deduct	*-0.57*	
		For Quantities > 100, Deduct	*-1.15*	
05 05 23 00-0185	EA	3/8" Diameter x 3-1/2" Long Concrete Strike Anchor	6.70	
		For Galvanized, Add	*0.58*	
		For Stainless Steel, Add	*4.06*	
		For Drilling In Wall, Add	*0.69*	
		For Drilling Overhead, Add	*1.66*	
		For Quantities > 10 To 50, Deduct	*-0.28*	
		For Quantities > 50 To 100, Deduct	*-0.58*	
		For Quantities > 100, Deduct	*-1.17*	
05 05 23 00-0186	EA	3/8" Diameter x 5" Long Concrete Strike Anchor	8.08	
		For Galvanized, Add	*1.27*	
		For Stainless Steel, Add	*8.89*	
		For Drilling In Wall, Add	*0.69*	
		For Drilling Overhead, Add	*1.66*	
		For Quantities > 10 To 50, Deduct	*-0.28*	
		For Quantities > 50 To 100, Deduct	*-0.62*	
		For Quantities > 100, Deduct	*-1.23*	
05 05 23 00-0187	EA	1/2" Diameter x 2-3/4" Long Concrete Strike Anchor	9.86	
		For Galvanized, Add	*1.00*	
		For Stainless Steel, Add	*6.97*	
		For Drilling In Wall, Add	*0.98*	
		For Drilling Overhead, Add	*2.36*	
		For Quantities > 10 To 50, Deduct	*-0.39*	
		For Quantities > 50 To 100, Deduct	*-0.84*	
		For Quantities > 100, Deduct	*-1.67*	
05 05 23 00-0188	EA	1/2" Diameter x 3-1/2" Long Concrete Strike Anchor	9.97	
		For Galvanized, Add	*1.05*	
		For Stainless Steel, Add	*7.35*	
		For Drilling In Wall, Add	*0.98*	
		For Drilling Overhead, Add	*2.36*	
		For Quantities > 10 To 50, Deduct	*-0.39*	
		For Quantities > 50 To 100, Deduct	*-0.84*	
		For Quantities > 100, Deduct	*-1.68*	
05 05 23 00-0189	EA	1/2" Diameter x 4-3/4" Long Concrete Strike Anchor	10.48	
		For Galvanized, Add	*1.31*	
		For Stainless Steel, Add	*9.14*	
		For Drilling In Wall, Add	*0.98*	
		For Drilling Overhead, Add	*2.36*	
		For Quantities > 10 To 50, Deduct	*-0.39*	
		For Quantities > 50 To 100, Deduct	*-0.85*	
		For Quantities > 100, Deduct	*-1.70*	
05 05 23 00-0190	EA	1/2" Diameter x 6" Long Concrete Strike Anchor	11.03	
		For Galvanized, Add	*1.58*	
		For Stainless Steel, Add	*11.06*	
		For Drilling In Wall, Add	*0.98*	
		For Drilling Overhead, Add	*2.36*	
		For Quantities > 10 To 50, Deduct	*-0.39*	
		For Quantities > 50 To 100, Deduct	*-0.87*	
		For Quantities > 100, Deduct	*-1.73*	
05 05 23 00-0191	EA	5/8" Diameter x 4" Long Concrete Strike Anchor	12.99	
		For Galvanized, Add	*1.64*	
		For Stainless Steel, Add	*11.45*	
		For Drilling In Wall, Add	*1.22*	
		For Drilling Overhead, Add	*2.92*	
		For Quantities > 10 To 50, Deduct	*-0.49*	
		For Quantities > 50 To 100, Deduct	*-1.05*	
		For Quantities > 100, Deduct	*-2.11*	

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0192	EA	5/8" Diameter x 4-3/4" Long Concrete Strike Anchor	13.82	
		For Galvanized, Add	*2.05*	
		For Stainless Steel, Add	*14.35*	
		For Drilling In Wall, Add	*1.22*	
		For Drilling Overhead, Add	*2.92*	
		For Quantities > 10 To 50, Deduct	*-0.49*	
		For Quantities > 50 To 100, Deduct	*-1.07*	
		For Quantities > 100, Deduct	*-2.15*	
05 05 23 00-0193	EA	5/8" Diameter x 6" Long Concrete Strike Anchor	15.29	
		For Galvanized, Add	*2.79*	
		For Stainless Steel, Add	*19.50*	
		For Drilling In Wall, Add	*1.22*	
		For Drilling Overhead, Add	*2.92*	
		For Quantities > 10 To 50, Deduct	*-0.49*	
		For Quantities > 50 To 100, Deduct	*-1.11*	
		For Quantities > 100, Deduct	*-2.22*	
05 05 23 00-0194	EA	3/4" Diameter x 5" Long Concrete Strike Anchor	16.84	
		For Galvanized, Add	*2.64*	
		For Stainless Steel, Add	*18.45*	
		For Drilling In Wall, Add	*1.45*	
		For Drilling Overhead, Add	*3.47*	
		For Quantities > 10 To 50, Deduct	*-0.58*	
		For Quantities > 50 To 100, Deduct	*-1.29*	
		For Quantities > 100, Deduct	*-2.58*	
05 05 23 00-0195	EA	3/4" Diameter x 6" Long Concrete Strike Anchor	18.89	
		For Galvanized, Add	*3.66*	
		For Stainless Steel, Add	*25.62*	
		For Drilling In Wall, Add	*1.45*	
		For Drilling Overhead, Add	*3.47*	
		For Quantities > 10 To 50, Deduct	*-0.58*	
		For Quantities > 50 To 100, Deduct	*-1.34*	
		For Quantities > 100, Deduct	*-2.68*	

05 05 23 00-0196 Concrete Expansion Anchor *(05 05 23 00-0157)*

Note: Includes drilling. Excludes bolt, nut and washer.

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0197	EA	1/4" Concrete Expansion Anchor	5.09	
		For Drilling In Wall, Add	*0.58*	
		For Drilling Overhead, Add	*1.40*	
		For Quantities > 10 To 50, Deduct	*-0.23*	
		For Quantities > 50 To 100, Deduct	*-0.48*	
		For Quantities > 100, Deduct	*-0.95*	
05 05 23 00-0198	EA	5/16" Concrete Expansion Anchor	5.48	
		For Drilling In Wall, Add	*0.61*	
		For Drilling Overhead, Add	*1.47*	
		For Quantities > 10 To 50, Deduct	*-0.24*	
		For Quantities > 50 To 100, Deduct	*-0.50*	
		For Quantities > 100, Deduct	*-1.01*	
05 05 23 00-0199	EA	3/8" Concrete Expansion Anchor	6.24	
		For Drilling In Wall, Add	*0.69*	
		For Drilling Overhead, Add	*1.66*	
		For Quantities > 10 To 50, Deduct	*-0.28*	
		For Quantities > 50 To 100, Deduct	*-0.57*	
		For Quantities > 100, Deduct	*-1.14*	
05 05 23 00-0200	EA	1/2" Concrete Expansion Anchor	9.06	
		For Drilling In Wall, Add	*0.98*	
		For Drilling Overhead, Add	*2.36*	
		For Quantities > 10 To 50, Deduct	*-0.39*	
		For Quantities > 50 To 100, Deduct	*-0.82*	
		For Quantities > 100, Deduct	*-1.63*	
05 05 23 00-0201	EA	5/8" Concrete Expansion Anchor	11.73	
		For Drilling In Wall, Add	*1.22*	
		For Drilling Overhead, Add	*2.92*	
		For Quantities > 10 To 50, Deduct	*-0.49*	
		For Quantities > 50 To 100, Deduct	*-1.02*	
		For Quantities > 100, Deduct	*-2.05*	
05 05 23 00-0202	EA	3/4" Concrete Expansion Anchor	16.13	
		For Drilling In Wall, Add	*1.45*	
		For Drilling Overhead, Add	*3.47*	
		For Quantities > 10 To 50, Deduct	*-0.58*	
		For Quantities > 50 To 100, Deduct	*-1.27*	
		For Quantities > 100, Deduct	*-2.54*	

05 05 23 00-0203 Concrete Lag Shield Anchor *(05 05 23 00-0157)*

Note: Includes drilling. Excludes lag bolt and washer.

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0204	EA	1/4" Concrete Lag Shield Anchor	5.10	
		For Drilling In Wall, Add	*0.58*	
		For Drilling Overhead, Add	*1.40*	
		For Quantities > 10 To 50, Deduct	*-0.23*	
		For Quantities > 50 To 100, Deduct	*-0.48*	
		For Quantities > 100, Deduct	*-0.95*	
05 05 23 00-0205	EA	5/16" Concrete Lag Shield Anchor	6.09	
		For Drilling In Wall, Add	*0.69*	
		For Drilling Overhead, Add	*1.66*	
		For Quantities > 10 To 50, Deduct	*-0.28*	
		For Quantities > 50 To 100, Deduct	*-0.57*	
		For Quantities > 100, Deduct	*-1.13*	

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0206	EA	3/8" Concrete Lag Shield Anchor	6.44	
		For Drilling In Wall, Add	*0.69*	
		For Drilling Overhead, Add	*1.66*	
		For Quantities > 10 To 50, Deduct	*-0.28*	
		For Quantities > 50 To 100, Deduct	*-0.58*	
		For Quantities > 100, Deduct	*-1.15*	
05 05 23 00-0207	EA	1/2" Concrete Lag Shield Anchor	9.14	
		For Drilling In Wall, Add	*0.98*	
		For Drilling Overhead, Add	*2.36*	
		For Quantities > 10 To 50, Deduct	*-0.39*	
		For Quantities > 50 To 100, Deduct	*-0.82*	
		For Quantities > 100, Deduct	*-1.64*	
05 05 23 00-0208	EA	5/8" Concrete Lag Shield Anchor	12.32	
		For Drilling In Wall, Add	*1.22*	
		For Drilling Overhead, Add	*2.92*	
		For Quantities > 10 To 50, Deduct	*-0.49*	
		For Quantities > 50 To 100, Deduct	*-1.04*	
		For Quantities > 100, Deduct	*-2.07*	
05 05 23 00-0209	EA	3/4" Concrete Lag Shield Anchor	14.29	
		For Drilling In Wall, Add	*1.45*	
		For Drilling Overhead, Add	*3.47*	
		For Quantities > 10 To 50, Deduct	*-0.58*	
		For Quantities > 50 To 100, Deduct	*-1.23*	
		For Quantities > 100, Deduct	*-2.45*	

05 05 23 00-0210 Chemical And Adhesive Anchors *(05 05 23 00-0041)*

05 05 23 00-0211 Chemical Adhesives for Bolts Or Threaded Rods *(05 05 23 00-0210)*

Note: Injected or drop in cartridge. Sizes listed are for the diameter of the bolt or rod to be anchored.

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0212	EA	1/4" Chemical Adhesive For Bolt Or Threaded Rod	5.62	
		For Quantities > 10 To 50, Deduct	*-0.26*	
		For Quantities > 50 To 100, Deduct	*-0.52*	
		For Quantities > 100, Deduct	*-1.05*	
05 05 23 00-0213	EA	5/16" Chemical Adhesive For Bolt Or Threaded Rod	6.69	
		For Quantities > 10 To 50, Deduct	*-0.28*	
		For Quantities > 50 To 100, Deduct	*-0.59*	
		For Quantities > 100, Deduct	*-1.17*	
05 05 23 00-0214	EA	3/8" Chemical Adhesive For Bolt Or Threaded Rod	9.64	
		For Quantities > 10 To 50, Deduct	*-0.35*	
		For Quantities > 50 To 100, Deduct	*-0.76*	
		For Quantities > 100, Deduct	*-1.53*	
05 05 23 00-0215	EA	1/2" Chemical Adhesive For Bolt Or Threaded Rod	11.79	
		For Quantities > 10 To 50, Deduct	*-0.39*	
		For Quantities > 50 To 100, Deduct	*-0.88*	
		For Quantities > 100, Deduct	*-1.77*	
05 05 23 00-0216	EA	5/8" Chemical Adhesive For Bolt Or Threaded Rod	14.63	
		For Quantities > 10 To 50, Deduct	*-0.49*	
		For Quantities > 50 To 100, Deduct	*-1.10*	
		For Quantities > 100, Deduct	*-2.19*	
05 05 23 00-0217	EA	3/4" Chemical Adhesive For Bolt Or Threaded Rod	17.90	
		For Quantities > 10 To 50, Deduct	*-0.58*	
		For Quantities > 50 To 100, Deduct	*-1.32*	
		For Quantities > 100, Deduct	*-2.63*	
05 05 23 00-0218	EA	7/8" Chemical Adhesive For Bolt Or Threaded Rod	19.67	
		For Quantities > 10 To 50, Deduct	*-0.63*	
		For Quantities > 50 To 100, Deduct	*-1.43*	
		For Quantities > 100, Deduct	*-2.86*	
05 05 23 00-0219	EA	1" Chemical Adhesive For Bolt Or Threaded Rod	25.84	
		For Quantities > 10 To 50, Deduct	*-0.81*	
		For Quantities > 50 To 100, Deduct	*-1.86*	
		For Quantities > 100, Deduct	*-3.73*	
05 05 23 00-0220	EA	1-1/4" Chemical Adhesive For Bolt Or Threaded Rod	30.85	
		For Quantities > 10 To 50, Deduct	*-1.02*	
		For Quantities > 50 To 100, Deduct	*-2.31*	
		For Quantities > 100, Deduct	*-4.62*	
05 05 23 00-0221	EA	1-1/2" Chemical Adhesive For Bolt Or Threaded Rod	33.85	
		For Quantities > 10 To 50, Deduct	*-1.12*	
		For Quantities > 50 To 100, Deduct	*-2.52*	
		For Quantities > 100, Deduct	*-5.05*	
05 05 23 00-0222	EA	1-3/4" Chemical Adhesive For Bolt Or Threaded Rod	37.01	
		For Quantities > 10 To 50, Deduct	*-1.21*	
		For Quantities > 50 To 100, Deduct	*-2.74*	
		For Quantities > 100, Deduct	*-5.48*	
05 05 23 00-0223	EA	2" Chemical Adhesive For Bolt Or Threaded Rod	39.25	
		For Quantities > 10 To 50, Deduct	*-1.26*	
		For Quantities > 50 To 100, Deduct	*-2.87*	
		For Quantities > 100, Deduct	*-5.73*	

05 05 23 00-0224 Chemically Adhered Anchor Rod *(05 05 23 00-0041)*

Note: Includes drilling hole, injected adhesive or pre-placed adhesive cartridge, nut and washer.

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0225	EA	1/4" x 1-9/16" Long Chemically Adhered Anchor Rod	6.21	
		For Galvanized Bolts, Add	*0.56*	
		For Stainless Steel Bolts, Add	*4.69*	
		For Drilling In Wall, Add	*0.61*	
		For Drilling Overhead, Add	*1.46*	
		For Quantities > 10 To 50, Deduct	*-0.24*	
		For Quantities > 50 To 100, Deduct	*-0.52*	
		For Quantities > 100, Deduct	*-1.04*	

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0226	EA	5/16" x 2-3/8" Long Chemically Adhered Anchor Rod	6.36	
		For Galvanized Bolts, Add	*0.63*	
		For Stainless Steel Bolts, Add	*5.22*	
		For Drilling In Wall, Add	*0.61*	
		For Drilling Overhead, Add	*1.46*	
		For Quantities > 10 To 50, Deduct	*-0.24*	
		For Quantities > 50 To 100, Deduct	*-0.52*	
		For Quantities > 100, Deduct	*-1.05*	
05 05 23 00-0227	EA	3/8" x 2-3/4" Long Chemically Adhered Anchor Rod	6.66	
		For Galvanized Bolts, Add	*0.75*	
		For Stainless Steel Bolts, Add	*6.27*	
		For Drilling In Wall, Add	*0.61*	
		For Drilling Overhead, Add	*1.46*	
		For Quantities > 10 To 50, Deduct	*-0.24*	
		For Quantities > 50 To 100, Deduct	*-0.53*	
		For Quantities > 100, Deduct	*-1.06*	
05 05 23 00-0228	EA	1/2" x 3-11/16" Long Chemically Adhered Anchor Rod	8.74	
		For Galvanized Bolts, Add	*1.57*	
		For Stainless Steel Bolts, Add	*13.09*	
		For Drilling In Wall, Add	*0.63*	
		For Drilling Overhead, Add	*1.50*	
		For Quantities > 10 To 50, Deduct	*-0.25*	
		For Quantities > 50 To 100, Deduct	*-0.59*	
		For Quantities > 100, Deduct	*-1.19*	
05 05 23 00-0229	EA	1/2" x 5-1/2" Long Chemically Adhered Anchor Rod	9.89	
		For Galvanized Bolts, Add	*1.97*	
		For Stainless Steel Bolts, Add	*16.43*	
		For Drilling In Wall, Add	*0.65*	
		For Drilling Overhead, Add	*1.56*	
		For Quantities > 10 To 50, Deduct	*-0.26*	
		For Quantities > 50 To 100, Deduct	*-0.64*	
		For Quantities > 100, Deduct	*-1.27*	
05 05 23 00-0230	EA	5/8" x 7" Long Chemically Adhered Anchor Rod	10.99	
		For Galvanized Bolts, Add	*2.26*	
		For Stainless Steel Bolts, Add	*18.81*	
		For Drilling In Wall, Add	*0.70*	
		For Drilling Overhead, Add	*1.68*	
		For Quantities > 10 To 50, Deduct	*-0.28*	
		For Quantities > 50 To 100, Deduct	*-0.70*	
		For Quantities > 100, Deduct	*-1.39*	
05 05 23 00-0231	EA	3/4" x 9-1/2" Long Chemically Adhered Anchor Rod	11.35	
		For Galvanized Bolts, Add	*2.17*	
		For Stainless Steel Bolts, Add	*18.06*	
		For Drilling In Wall, Add	*0.77*	
		For Drilling Overhead, Add	*1.86*	
		For Quantities > 10 To 50, Deduct	*-0.31*	
		For Quantities > 50 To 100, Deduct	*-0.75*	
		For Quantities > 100, Deduct	*-1.50*	
05 05 23 00-0232	EA	7/8" x 10" Long Chemically Adhered Anchor Rod	14.58	
		For Galvanized Bolts, Add	*3.35*	
		For Stainless Steel Bolts, Add	*27.92*	
		For Drilling In Wall, Add	*0.83*	
		For Drilling Overhead, Add	*1.98*	
		For Quantities > 10 To 50, Deduct	*-0.33*	
		For Quantities > 50 To 100, Deduct	*-0.86*	
		For Quantities > 100, Deduct	*-1.72*	
05 05 23 00-0233	EA	1" x 11-3/4" Long Chemically Adhered Anchor Rod	16.31	
		For Galvanized Bolts, Add	*3.88*	
		For Stainless Steel Bolts, Add	*32.34*	
		For Drilling In Wall, Add	*0.88*	
		For Drilling Overhead, Add	*2.12*	
		For Quantities > 10 To 50, Deduct	*-0.35*	
		For Quantities > 50 To 100, Deduct	*-0.94*	
		For Quantities > 100, Deduct	*-1.88*	
05 05 23 00-0234	EA	1-1/4" x 14" Long Chemically Adhered Anchor Rod	21.20	
		For Galvanized Bolts, Add	*5.44*	
		For Stainless Steel Bolts, Add	*45.33*	
		For Drilling In Wall, Add	*1.03*	
		For Drilling Overhead, Add	*2.48*	
		For Quantities > 10 To 50, Deduct	*-0.41*	
		For Quantities > 50 To 100, Deduct	*-1.15*	
		For Quantities > 100, Deduct	*-2.30*	

05 05 23 00-0235 Grout Concrete Anchor Bolt or Threaded Rod *(05 05 23 00-0041)*

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0236	EA	Grout Concrete Anchor Bolt or Threaded Rod	2.13	
		For Quantities > 10 To 50, Deduct	*-0.10*	
		For Quantities > 50 To 100, Deduct	*-0.21*	
		For Quantities > 100, Deduct	*-0.41*	

05 05 23 00-0237 Other Concrete and Masonry Anchors *(05 05 23 00-0041)*

05 05 23 00-0238 Pin Bolt Drive Zinc Plated *(05 05 23 00-0237)*

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0239	EA	1/4" x 1" Pin Bolt Drive	3.00	
		For Drilling In Wall, Add	*0.35*	
		For Drilling Overhead, Add	*0.84*	
		For Quantities > 10 To 50, Deduct	*-0.14*	
		For Quantities > 50 To 100, Deduct	*-0.28*	
		For Quantities > 100, Deduct	*-0.57*	

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0240	EA	1/4" x 1-1/4" Pin Bolt Drive	3.01	
		For Drilling In Wall, Add	*0.35*	
		For Drilling Overhead, Add	*0.84*	
		For Quantities > 10 To 50, Deduct	*-0.14*	
		For Quantities > 50 To 100, Deduct	*-0.28*	
		For Quantities > 100, Deduct	*-0.57*	
05 05 23 00-0241	EA	1/4" x1-1/2" Pin Bolt Drive	3.03	
		For Drilling In Wall, Add	*0.35*	
		For Drilling Overhead, Add	*0.84*	
		For Quantities > 10 To 50, Deduct	*-0.14*	
		For Quantities > 50 To 100, Deduct	*-0.29*	
		For Quantities > 100, Deduct	*-0.57*	
05 05 23 00-0242	EA	1/4" x 2" Pin Bolt Drive	3.11	
		For Drilling In Wall, Add	*0.35*	
		For Drilling Overhead, Add	*0.84*	
		For Quantities > 10 To 50, Deduct	*-0.14*	
		For Quantities > 50 To 100, Deduct	*-0.29*	
		For Quantities > 100, Deduct	*-0.57*	

05 05 23 00-0243 Tapcon Masonry Fastener *(05 05 23 00-0041)*

Note: Available in countersunk or hex head.

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0244	EA	3/16" x 1-1/4" Tapcon Masonry Screw	4.80	
		For Drilling In Wall, Add	*0.58*	
		For Drilling Overhead, Add	*1.40*	
		For Quantities > 10 To 50, Deduct	*-0.23*	
		For Quantities > 50 To 100, Deduct	*-0.47*	
		For Quantities > 100, Deduct	*-0.94*	
05 05 23 00-0245	EA	3/16" x 2-1/4" Tapcon Masonry Screw	4.84	
		For Drilling In Wall, Add	*0.58*	
		For Drilling Overhead, Add	*1.40*	
		For Quantities > 10 To 50, Deduct	*-0.23*	
		For Quantities > 50 To 100, Deduct	*-0.47*	
		For Quantities > 100, Deduct	*-0.94*	
05 05 23 00-0246	EA	3/16" x 3-1/4" Tapcon Masonry Screw	4.92	
		For Drilling In Wall, Add	*0.58*	
		For Drilling Overhead, Add	*1.40*	
		For Quantities > 10 To 50, Deduct	*-0.23*	
		For Quantities > 50 To 100, Deduct	*-0.47*	
		For Quantities > 100, Deduct	*-0.94*	
05 05 23 00-0247	EA	1/4" x 1-1/4" Tapcon Masonry Screw	4.84	
		For Drilling In Wall, Add	*0.58*	
		For Drilling Overhead, Add	*1.40*	
		For Quantities > 10 To 50, Deduct	*-0.23*	
		For Quantities > 50 To 100, Deduct	*-0.47*	
		For Quantities > 100, Deduct	*-0.94*	
05 05 23 00-0248	EA	1/4" x 2-1/4" Tapcon Masonry Screw	4.89	
		For Drilling In Wall, Add	*0.58*	
		For Drilling Overhead, Add	*1.40*	
		For Quantities > 10 To 50, Deduct	*-0.23*	
		For Quantities > 50 To 100, Deduct	*-0.47*	
		For Quantities > 100, Deduct	*-0.94*	
05 05 23 00-0249	EA	1/4" x 3-1/4" Tapcon Masonry Screw	4.98	
		For Drilling In Wall, Add	*0.58*	
		For Drilling Overhead, Add	*1.40*	
		For Quantities > 10 To 50, Deduct	*-0.23*	
		For Quantities > 50 To 100, Deduct	*-0.47*	
		For Quantities > 100, Deduct	*-0.95*	

05 05 23 00-0250 Hex Bolts *(05 05 23)*

Note: For owner furnished materials or where requested by the owner.

05 05 23 00-0251 A325 High Strength Structural Bolts *(05 05 23 00-0250)*

Note: Includes A325 heavy hex nut and structural washer.

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0252	EA	1/2" Diameter x 1-1/2" Long A325 Hex Bolt	6.43	0.55
		For Galvanized, Add	*0.31*	
		For Quantities > 10 To 50, Deduct	*-0.29*	
		For Quantities > 50 To 100, Deduct	*-0.60*	
		For Quantities > 100, Deduct	*-1.19*	
05 05 23 00-0253	EA	1/2" Diameter x 3" Long A325 Hex Bolt	6.66	0.55
		For Galvanized, Add	*0.43*	
		For Quantities > 10 To 50, Deduct	*-0.29*	
		For Quantities > 50 To 100, Deduct	*-0.60*	
		For Quantities > 100, Deduct	*-1.20*	
05 05 23 00-0254	EA	5/8" Diameter x 2" Long A325 Hex Bolt	6.91	0.55
		For Galvanized, Add	*0.55*	
		For Quantities > 10 To 50, Deduct	*-0.29*	
		For Quantities > 50 To 100, Deduct	*-0.61*	
		For Quantities > 100, Deduct	*-1.22*	
05 05 23 00-0255	EA	5/8" Diameter x 4" Long A325 Hex Bolt	8.26	0.55
		For Galvanized, Add	*0.82*	
		For Quantities > 10 To 50, Deduct	*-0.33*	
		For Quantities > 50 To 100, Deduct	*-0.70*	
		For Quantities > 100, Deduct	*-1.41*	
05 05 23 00-0256	EA	5/8" Diameter x 6" Long A325 Hex Bolt	8.98	0.83
		For Galvanized, Add	*1.22*	
		For Quantities > 10 To 50, Deduct	*-0.33*	
		For Quantities > 50 To 100, Deduct	*-0.72*	
		For Quantities > 100, Deduct	*-1.43*	

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0257	EA	3/4" Diameter x 2" Long A325 Hex Bolt	7.14	0.55
		For Galvanized, Add	*0.67*	
		For Quantities > 10 To 50, Deduct	*-0.29*	
		For Quantities > 50 To 100, Deduct	*-0.61*	
		For Quantities > 100, Deduct	*-1.23*	
05 05 23 00-0258	EA	3/4" Diameter x 4" Long A325 Hex Bolt	9.70	0.83
		For Galvanized, Add	*1.07*	
		For Quantities > 10 To 50, Deduct	*-0.38*	
		For Quantities > 50 To 100, Deduct	*-0.81*	
		For Quantities > 100, Deduct	*-1.62*	
05 05 23 00-0259	EA	3/4" Diameter x 6" Long A325 Hex Bolt	12.74	0.83
		For Galvanized, Add	*1.46*	
		For Quantities > 10 To 50, Deduct	*-0.49*	
		For Quantities > 50 To 100, Deduct	*-1.06*	
		For Quantities > 100, Deduct	*-2.11*	
05 05 23 00-0260	EA	3/4" Diameter x 8" Long A325 Hex Bolt	11.51	1.11
		For Galvanized, Add	*2.11*	
		For Quantities > 10 To 50, Deduct	*-0.36*	
		For Quantities > 50 To 100, Deduct	*-0.83*	
		For Quantities > 100, Deduct	*-1.67*	
05 05 23 00-0261	EA	7/8" Diameter x 2" Long A325 Hex Bolt	8.33	0.83
		For Galvanized, Add	*1.02*	
		For Quantities > 10 To 50, Deduct	*-0.32*	
		For Quantities > 50 To 100, Deduct	*-0.68*	
		For Quantities > 100, Deduct	*-1.36*	
05 05 23 00-0262	EA	7/8" Diameter x 4" Long A325 Hex Bolt	9.84	0.83
		For Galvanized, Add	*1.46*	
		For Quantities > 10 To 50, Deduct	*-0.35*	
		For Quantities > 50 To 100, Deduct	*-0.76*	
		For Quantities > 100, Deduct	*-1.53*	
05 05 23 00-0263	EA	7/8" Diameter x 6" Long A325 Hex Bolt	11.40	1.11
		For Galvanized, Add	*2.06*	
		For Quantities > 10 To 50, Deduct	*-0.36*	
		For Quantities > 50 To 100, Deduct	*-0.83*	
		For Quantities > 100, Deduct	*-1.66*	
05 05 23 00-0264	EA	7/8" Diameter x 8" Long A325 Hex Bolt	13.08	1.11
		For Galvanized, Add	*2.71*	
		For Quantities > 10 To 50, Deduct	*-0.38*	
		For Quantities > 50 To 100, Deduct	*-0.90*	
		For Quantities > 100, Deduct	*-1.80*	
05 05 23 00-0265	EA	1" Diameter x 2" Long A325 Hex Bolt	9.08	1.11
		For Galvanized, Add	*1.27*	
		For Quantities > 10 To 50, Deduct	*-0.33*	
		For Quantities > 50 To 100, Deduct	*-0.72*	
		For Quantities > 100, Deduct	*-1.44*	
05 05 23 00-0266	EA	1" Diameter x 4" Long A325 Hex Bolt	10.88	0.83
		For Galvanized, Add	*1.80*	
		For Quantities > 10 To 50, Deduct	*-0.36*	
		For Quantities > 50 To 100, Deduct	*-0.82*	
		For Quantities > 100, Deduct	*-1.64*	
05 05 23 00-0267	EA	1" Diameter x 6" Long A325 Hex Bolt	12.42	0.83
		For Galvanized, Add	*2.38*	
		For Quantities > 10 To 50, Deduct	*-0.38*	
		For Quantities > 50 To 100, Deduct	*-0.88*	
		For Quantities > 100, Deduct	*-1.77*	
05 05 23 00-0268	EA	1" Diameter x 8" Long A325 Hex Bolt	16.01	0.83
		For Galvanized, Add	*3.93*	
		For Quantities > 10 To 50, Deduct	*-0.41*	
		For Quantities > 50 To 100, Deduct	*-1.01*	
		For Quantities > 100, Deduct	*-2.02*	
05 05 23 00-0269	EA	1-1/4" Diameter x 3" Long A325 Hex Bolt	14.46	0.83
		For Galvanized, Add	*3.16*	
		For Quantities > 10 To 50, Deduct	*-0.41*	
		For Quantities > 50 To 100, Deduct	*-0.97*	
		For Quantities > 100, Deduct	*-1.95*	
05 05 23 00-0270	EA	1-1/4" Diameter x 4" Long A325 Hex Bolt	16.62	0.83
		For Galvanized, Add	*3.99*	
		For Quantities > 10 To 50, Deduct	*-0.43*	
		For Quantities > 50 To 100, Deduct	*-1.06*	
		For Quantities > 100, Deduct	*-2.13*	
05 05 23 00-0271	EA	1-1/4" Diameter x 6" Long A325 Hex Bolt	19.46	0.83
		For Galvanized, Add	*5.10*	
		For Quantities > 10 To 50, Deduct	*-0.46*	
		For Quantities > 50 To 100, Deduct	*-1.18*	
		For Quantities > 100, Deduct	*-2.36*	
05 05 23 00-0272	EA	1-1/4" Diameter x 8" Long A325 Hex Bolt	22.78	1.11
		For Galvanized, Add	*6.45*	
		For Quantities > 10 To 50, Deduct	*-0.49*	
		For Quantities > 50 To 100, Deduct	*-1.31*	
		For Quantities > 100, Deduct	*-2.62*	

05 05 23 00-0273 Threaded Rods Includes Nuts And Washers *(05 05 23)*

See CSI section 05 05 23 00-0210 for anchoring adhesive., 05 05 23 00-0356 for nuts and washers.

05 05 23 00-0274 Carbon Steel, Zinc Plated *(05 05 23 00-0273)*

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0275	LF	1/4" Diameter Continuous Threaded Rod	1.13	0.28
		For Galvanized, Add	*0.23*	
		For Left Hand Threaded Rod, Add	*0.06*	

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0276	LF	5/16" Diameter Continuous Threaded Rod	1.49	0.30
		For Galvanized, Add	*0.35*	
		For Left Hand Threaded Rod, Add	*0.09*	
05 05 23 00-0277	LF	3/8" Diameter Continuous Threaded Rod	1.63	0.35
		For Galvanized, Add	*0.37*	
		For Left Hand Threaded Rod, Add	*0.09*	
05 05 23 00-0278	LF	7/16" Diameter Continuous Threaded Rod	2.05	0.36
		For Galvanized, Add	*0.53*	
		For Left Hand Threaded Rod, Add	*0.13*	
05 05 23 00-0279	LF	1/2" Diameter Continuous Threaded Rod	2.17	0.37
		For Galvanized, Add	*0.57*	
		For Left Hand Threaded Rod, Add	*0.14*	
05 05 23 00-0280	LF	9/16" Diameter Continuous Threaded Rod	2.88	0.38
		For Galvanized, Add	*0.85*	
		For Left Hand Threaded Rod, Add	*0.21*	
05 05 23 00-0281	LF	5/8" Diameter Continuous Threaded Rod	3.08	0.38
		For Galvanized, Add	*0.92*	
		For Left Hand Threaded Rod, Add	*0.23*	
05 05 23 00-0282	LF	3/4" Diameter Continuous Threaded Rod	3.94	0.39
		For Galvanized, Add	*1.26*	
		For Left Hand Threaded Rod, Add	*0.32*	
05 05 23 00-0283	LF	7/8" Diameter Continuous Threaded Rod	6.12	0.41
		For Galvanized, Add	*2.12*	
		For Left Hand Threaded Rod, Add	*0.53*	
05 05 23 00-0284	LF	1" Diameter Continuous Threaded Rod	7.02	0.46
		For Galvanized, Add	*2.44*	
		For Left Hand Threaded Rod, Add	*0.61*	
05 05 23 00-0285	LF	1-1/8" Diameter Continuous Threaded Rod	8.84	0.51
		For Galvanized, Add	*3.13*	
		For Left Hand Threaded Rod, Add	*0.78*	
05 05 23 00-0286	LF	1-1/4" Diameter Continuous Threaded Rod	10.91	0.55
		For Galvanized, Add	*3.90*	
		For Left Hand Threaded Rod, Add	*0.98*	
05 05 23 00-0287	LF	1-3/8" Diameter Continuous Threaded Rod	11.53	0.60
		For Galvanized, Add	*4.13*	
		For Left Hand Threaded Rod, Add	*1.03*	
05 05 23 00-0288	LF	1-1/2" Diameter Continuous Threaded Rod	14.89	0.63
		For Galvanized, Add	*5.45*	
		For Left Hand Threaded Rod, Add	*1.36*	
05 05 23 00-0289	LF	1-3/4" Diameter Continuous Threaded Rod	17.81	0.66
		For Galvanized, Add	*6.60*	
		For Left Hand Threaded Rod, Add	*1.65*	
05 05 23 00-0290	LF	2" Diameter Continuous Threaded Rod	24.90	0.69
		For Galvanized, Add	*9.41*	
		For Left Hand Threaded Rod, Add	*2.35*	

05 05 23 00-0291 Stainless Steel, 304 Grade *(05 05 23 00-0273)*

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0292	LF	1/4" Diameter Threaded Rod	1.61	0.28
		For 316 Stainless Steel, Add	*1.06*	
		For Left Hand Threaded Rod, Add	*0.11*	
05 05 23 00-0293	LF	5/16" Diameter Threaded Rod	2.24	0.30
		For 316 Stainless Steel, Add	*1.63*	
		For Left Hand Threaded Rod, Add	*0.16*	
05 05 23 00-0294	LF	3/8" Diameter Threaded Rod	3.08	0.35
		For 316 Stainless Steel, Add	*2.39*	
		For Left Hand Threaded Rod, Add	*0.24*	
05 05 23 00-0295	LF	7/16" Diameter Threaded Rod	4.05	0.36
		For 316 Stainless Steel, Add	*3.33*	
		For Left Hand Threaded Rod, Add	*0.33*	
05 05 23 00-0296	LF	1/2" Diameter Threaded Rod	5.06	0.37
		For 316 Stainless Steel, Add	*4.32*	
		For Left Hand Threaded Rod, Add	*0.43*	
05 05 23 00-0297	LF	9/16" Diameter Threaded Rod	8.04	0.38
		For 316 Stainless Steel, Add	*7.29*	
		For Left Hand Threaded Rod, Add	*0.73*	
05 05 23 00-0298	LF	5/8" Diameter Threaded Rod	8.85	0.38
		For 316 Stainless Steel, Add	*8.08*	
		For Left Hand Threaded Rod, Add	*0.81*	
05 05 23 00-0299	LF	3/4" Diameter Threaded Rod	10.90	0.39
		For 316 Stainless Steel, Add	*10.11*	
		For Left Hand Threaded Rod, Add	*1.01*	
05 05 23 00-0300	LF	7/8" Diameter Threaded Rod	14.78	0.41
		For 316 Stainless Steel, Add	*13.97*	
		For Left Hand Threaded Rod, Add	*1.40*	
05 05 23 00-0301	LF	1" Diameter Threaded Rod	19.29	0.46
		For 316 Stainless Steel, Add	*18.37*	
		For Left Hand Threaded Rod, Add	*1.84*	
05 05 23 00-0302	LF	1-1/4" Diameter Threaded Rod	35.75	0.55
		For 316 Stainless Steel, Add	*34.60*	
		For Left Hand Threaded Rod, Add	*3.46*	
05 05 23 00-0303	LF	1-1/2" Diameter Threaded Rod	52.41	0.63
		For 316 Stainless Steel, Add	*51.15*	
		For Left Hand Threaded Rod, Add	*5.12*	
05 05 23 00-0304	LF	1-3/4" Diameter Threaded Rod	67.33	0.66
		For 316 Stainless Steel, Add	*66.01*	
		For Left Hand Threaded Rod, Add	*6.60*	
05 05 23 00-0305	LF	2" Diameter Threaded Rod	75.57	0.69
		For 316 Stainless Steel, Add	*74.18*	
		For Left Hand Threaded Rod, Add	*7.42*	

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0306		**B-7 Alloy Steel, Plain** *(05 05 23 00-0273)*		
05 05 23 00-0307	LF	1/4" Diameter Continuous Threaded Rod	2.35	0.28
		For Zinc Plating, Add	*0.90*	
05 05 23 00-0308	LF	5/16" Diameter Continuous Threaded Rod	2.73	0.30
		For Zinc Plating, Add	*1.06*	
05 05 23 00-0309	LF	3/8" Diameter Continuous Threaded Rod	2.94	0.35
		For Zinc Plating, Add	*1.13*	
05 05 23 00-0310	LF	7/16" Diameter Continuous Threaded Rod	3.23	0.36
		For Zinc Plating, Add	*1.26*	
05 05 23 00-0311	LF	1/2" Diameter Continuous Threaded Rod	3.56	0.37
		For Zinc Plating, Add	*1.41*	
05 05 23 00-0312	LF	9/16" Diameter Continuous Threaded Rod	3.95	0.38
		For Zinc Plating, Add	*1.60*	
05 05 23 00-0313	LF	5/8" Diameter Continuous Threaded Rod	4.49	0.38
		For Zinc Plating, Add	*1.86*	
05 05 23 00-0314	LF	3/4" Diameter Continuous Threaded Rod	5.41	0.39
		For Zinc Plating, Add	*2.31*	
05 05 23 00-0315	LF	7/8" Diameter Continuous Threaded Rod	6.98	0.41
		For Zinc Plating, Add	*3.08*	
05 05 23 00-0316	LF	1" Diameter Continuous Threaded Rod	8.50	0.46
		For Zinc Plating, Add	*3.79*	
05 05 23 00-0317	LF	1-1/8" Diameter Continuous Threaded Rod	11.04	0.51
		For Zinc Plating, Add	*5.01*	
05 05 23 00-0318	LF	1-1/4" Diameter Continuous Threaded Rod	12.20	0.55
		For Zinc Plating, Add	*5.52*	
05 05 23 00-0319	LF	1-3/8" Diameter Continuous Threaded Rod	15.33	0.60
		For Zinc Plating, Add	*7.06*	
05 05 23 00-0320	LF	1-1/2" Diameter Continuous Threaded Rod	16.67	0.63
		For Zinc Plating, Add	*7.71*	
05 05 23 00-0321	LF	1-3/4" Diameter Continuous Threaded Rod	19.30	0.66
		For Zinc Plating, Add	*8.99*	
05 05 23 00-0322	LF	2" Diameter Continuous Threaded Rod	30.15	0.69
		For Zinc Plating, Add	*14.38*	
05 05 23 00-0323		**Unistrut** *(05 05 23)* Note: Installation includes all necessary cutting. Excludes threaded rod or wall fasteners. For fastening to masonry/concrete/CMU wall, add appropriate anchor bolts.		
05 05 23 00-0324		**Unistrut Channel 1-5/8"** *(05 05 23 00-0323)*		
05 05 23 00-0325	LF	Unistrut Channel 1-5/8" Wide x 1-5/8" High, 12 Gauge	6.83	1.25
		For Galvanizing, Add	*0.74*	
		For Stainless Steel, Add	*9.53*	
		For Powder Coating, Add	*0.65*	
05 05 23 00-0326	LF	Unistrut Channel 1-5/8" Wide x 1-5/8" High, 14 Gauge	6.34	1.25
		For Galvanizing, Add	*0.65*	
		For Stainless Steel, Add	*8.45*	
		For Powder Coating, Add	*0.58*	
05 05 23 00-0327	LF	Unistrut Channel 1-5/8" Wide x 1-5/8" High, 16 Gauge	6.02	1.25
		For Galvanizing, Add	*0.60*	
		For Stainless Steel, Add	*7.74*	
		For Powder Coating, Add	*0.53*	
05 05 23 00-0328	LF	Unistrut Channel 1-5/8" Wide x 13/16" High, 16 Gauge	4.58	0.89
		For Galvanizing, Add	*0.48*	
		For Stainless Steel, Add	*6.15*	
		For Powder Coating, Add	*0.42*	
05 05 23 00-0329	LF	Unistrut Channel 1-5/8" Wide x 13/16" High, 16 Gauge, P4000HS	5.18	0.89
		For Galvanizing, Add	*0.58*	
		For Stainless Steel, Add	*7.47*	
		For Powder Coating, Add	*0.51*	
05 05 23 00-0330		**Unistrut With Closure Strips** *(05 05 23 00-0323)*		
05 05 23 00-0331	LF	Unistrut With Closure Strips, P1184	2.30	0.28
05 05 23 00-0332	LF	Unistrut With Closure Strips, P3184	2.68	0.28
05 05 23 00-0333		**Unistrut Nuts With Springs** *(05 05 23 00-0323)*		
05 05 23 00-0334	EA	Unistrut Nut With Spring, 1-5/8" Channel 1/4"	1.24	
05 05 23 00-0335	EA	Unistrut Nut With Spring, 1-5/8" Channel 3/8"	1.34	
05 05 23 00-0336	EA	Unistrut Nut With Spring, 1-5/8" Channel 1/2"	1.46	
05 05 23 00-0337	EA	Unistrut Nut With Spring, 13/16" Channel 1/4"	1.15	
05 05 23 00-0338	EA	Unistrut Nut With Spring, 13/16" Channel 3/8"	1.24	
05 05 23 00-0339	EA	Unistrut Nut With Spring, 13/16" Channel 1/2"	1.34	
05 05 23 00-0340		**Unistrut Nuts Without Springs** *(05 05 23 00-0323)*		
05 05 23 00-0341	EA	Unistrut Nut Without Spring, 1-5/8" Channel 1/4"	0.98	
05 05 23 00-0342	EA	Unistrut Nut Without Spring, 1-5/8" Channel 3/8"	1.08	
05 05 23 00-0343	EA	Unistrut Nut Without Spring, 1-5/8" Channel 1/2"	1.20	
05 05 23 00-0344	EA	Unistrut Nut Without Spring, 13/16" Channel 1/4"	0.98	
05 05 23 00-0345	EA	Unistrut Nut Without Spring, 13/16" Channel 3/8"	1.08	
05 05 23 00-0346	EA	Unistrut Nut Without Spring, 13/16" Channel 1/2"	1.20	

05 05 23 00-0347 Unistrut Beam Clamps *(05 05 23 00-0323)*

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0348	EA	Unistrut Beam Clamp, 1-5/8" Channel P2675	11.03	4.16
05 05 23 00-0349	EA	Unistrut Beam Clamp, 1-5/8" Channel P2676	13.55	4.16
05 05 23 00-0350	EA	Add For Unistrut Swivel Nut, P2676	1.37	

05 05 23 00-0351 Unistrut Clevis Hangers *(05 05 23 00-0323)*

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0352	EA	Unistrut Clevis Hanger, 1-5/8" Channel P2674	11.90	4.16
05 05 23 00-0353	EA	Unistrut Clevis Hanger, 1-5/8" Channel P2677	13.91	4.16
05 05 23 00-0354	EA	Add For Unistrut Swivel Nut	1.37	
05 05 23 00-0355	EA	Unistrut Bracket For Shelves	33.01	5.54

05 05 23 00-0356 Nuts And Washers *(05 05 23)*

05 05 23 00-0357 Hex Nuts *(05 05 23 00-0356)*

05 05 23 00-0358 Carbon Steel Hex Nuts, Grade 2, Zinc Plated *(05 05 23 00-0357)*

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0359	EA	Hex Nut, 1/4" - 20	0.29	0.14
05 05 23 00-0360	EA	Hex Nut, 5/16"-18	0.33	0.14
05 05 23 00-0361	EA	Hex Nut, 3/8"-16	0.35	0.14
05 05 23 00-0362	EA	Hex Nut, 7/16" - 14	0.40	0.14
05 05 23 00-0363	EA	Hex Nut, 1/2" - 13	0.44	0.14
05 05 23 00-0364	EA	Hex Nut, 9/16" - 12	0.51	0.14
05 05 23 00-0365	EA	Hex Nut, 5/8" - 11	0.60	0.14
05 05 23 00-0366	EA	Hex Nut, 3/4" - 10	0.62	0.28
05 05 23 00-0367	EA	Hex Nut, 7/8" - 9	0.91	0.28
05 05 23 00-0368	EA	Hex Nut, 1" - 8	1.30	0.28
05 05 23 00-0369	EA	Hex Nut, 1-1/8" - 7	1.46	0.28
05 05 23 00-0370	EA	Hex Nut, 1-1/4" - 7	1.74	0.28
05 05 23 00-0371	EA	Hex Nut, 1-3/8" - 6	2.81	0.28
05 05 23 00-0372	EA	Hex Nut, 1-1/2" - 6	4.10	0.42
05 05 23 00-0373	EA	Hex Nut, 1-3/4" - 5	5.76	0.42
05 05 23 00-0374	EA	Hex Nut, 2" - 4 1/2	9.97	0.42

05 05 23 00-0375 304 Stainless Steel Hex Nuts *(05 05 23 00-0357)*

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0376	EA	Hex Nut, 1/4" - 20	0.35	0.14
		For 316 Stainless Steel, Add	*0.02*	
05 05 23 00-0377	EA	Hex Nut, 5/16" - 18	0.41	0.14
		For 316 Stainless Steel, Add	*0.03*	
05 05 23 00-0378	EA	Hex Nut, 3/8" - 16	0.46	0.14
		For 316 Stainless Steel, Add	*0.05*	
05 05 23 00-0379	EA	Hex Nut, 7/16" - 14	0.60	0.14
		For 316 Stainless Steel, Add	*0.09*	
05 05 23 00-0380	EA	Hex Nut, 1/2" - 13	0.68	0.14
		For 316 Stainless Steel, Add	*0.11*	
05 05 23 00-0381	EA	Hex Nut, 9/16" - 12	0.99	0.14
		For 316 Stainless Steel, Add	*0.20*	
05 05 23 00-0382	EA	Hex Nut, 5/8" - 11	1.01	0.14
		For 316 Stainless Steel, Add	*0.21*	
05 05 23 00-0383	EA	Hex Nut, 3/4" - 10	1.44	0.28
		For 316 Stainless Steel, Add	*0.34*	
05 05 23 00-0384	EA	Hex Nut, 7/8" - 9	2.40	0.28
		For 316 Stainless Steel, Add	*0.64*	
05 05 23 00-0385	EA	Hex Nut, 1" - 8	3.27	0.28
		For 316 Stainless Steel, Add	*0.90*	
05 05 23 00-0386	EA	Hex Nut, 1 1/4" - 7	6.89	0.28
		For 316 Stainless Steel, Add	*2.03*	
05 05 23 00-0387	EA	Hex Nut, 1 1/2" - 6	11.96	0.42
		For 316 Stainless Steel, Add	*3.64*	
05 05 23 00-0388	EA	Hex Nut, 1 3/4" - 5	20.05	0.42
		For 316 Stainless Steel, Add	*6.22*	
05 05 23 00-0389	EA	Hex Nut, 2" - 4 1/2	24.31	0.42
		For 316 Stainless Steel, Add	*7.58*	

05 05 23 00-0390 Round, Flat Washers *(05 05 23 00-0356)*

05 05 23 00-0391 Zinc-Plated Steel, Flat Washers *(05 05 23 00-0390)*

MINOR CSI	UOM	DESCRIPTION	TOTAL DIRECT UNIT COST	DEMOLITION UNIT COST
05 05 23 00-0392	EA	Flat Washer, 1/4"	0.30	0.14
05 05 23 00-0393	EA	Flat Washer, 5/16"	0.33	0.14
05 05 23 00-0394	EA	Flat Washer, 3/8"	0.37	0.14
05 05 23 00-0395	EA	Flat Washer, 7/16"	0.40	0.14
05 05 23 00-0396	EA	Flat Washer, 1/2"	0.45	0.14
05 05 23 00-0397	EA	Flat Washer, 9/16"	0.48	0.14
05 05 23 00-0398	EA	Flat Washer, 5/8"	0.57	0.14
05 05 23 00-0399	EA	Flat Washer, 3/4"	0.71	0.28
05 05 23 00-0400	EA	Flat Washer, 7/8"	0.82	0.28
05 05 23 00-0401	EA	Flat Washer, 1"	0.97	0.28
05 05 23 00-0402	EA	Flat Washer, 1 1/8"	1.14	0.28
05 05 23 00-0403	EA	Flat Washer, 1 1/4"	1.30	0.28
05 05 23 00-0404	EA	Flat Washer, 1 3/8"	1.57	0.28
05 05 23 00-0405	EA	Flat Washer, 1 1/2"	1.74	0.42
05 05 23 00-0406	EA	Flat Washer, 1 3/4"	2.06	0.42
05 05 23 00-0407	EA	Flat Washer, 2"	2.45	0.42

APPENDIX W

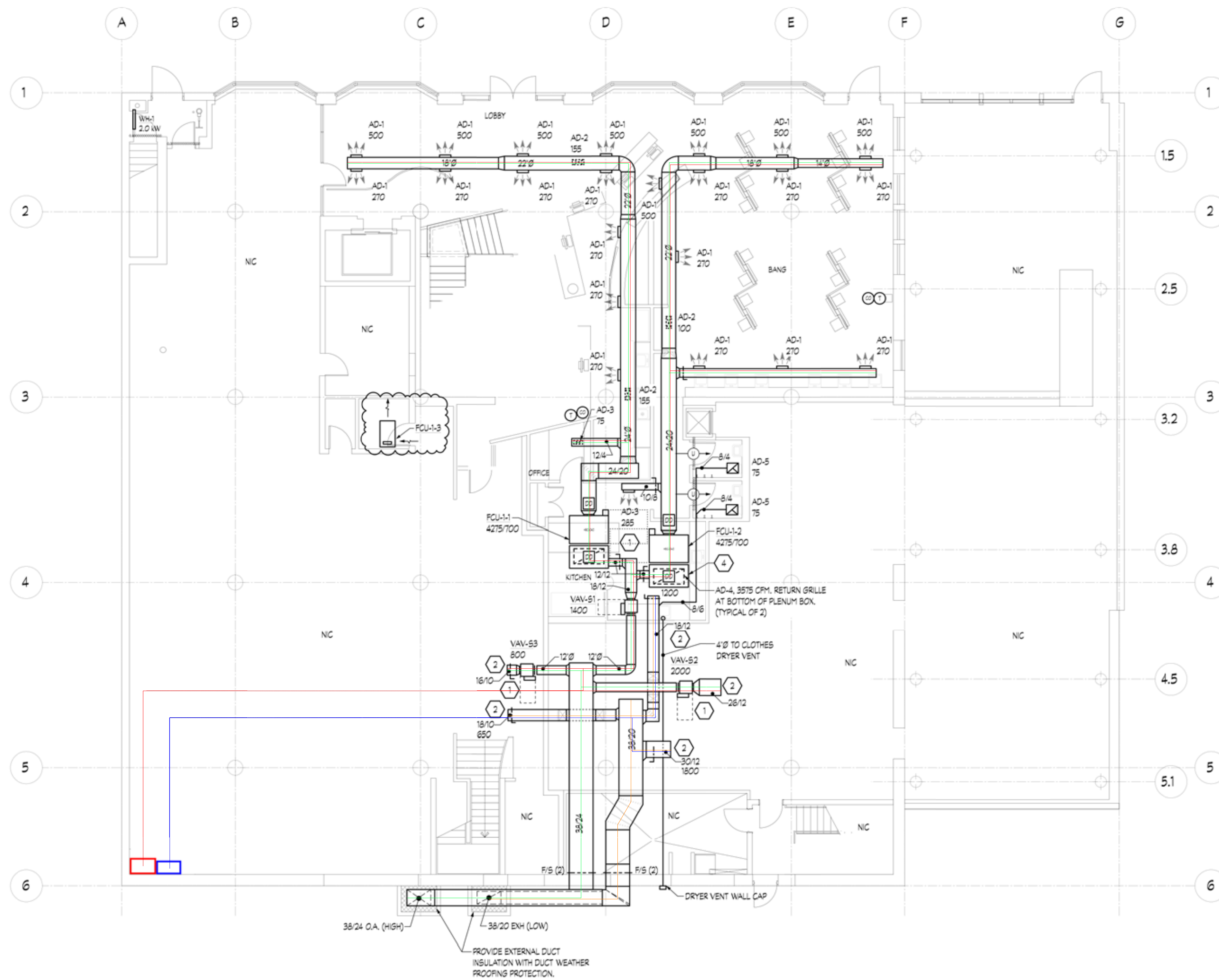
TASK DURATIONS PER VIDA

Task Durations Savings Per VIDA Gym - Part 1										
Task Name	U Street Durations (Days)					Metropole Durations (Days)				
	Actual	Savings			New	Actual	Savings			New
		Min (75%)	Max (85%)	Avg (80%)			Min (75%)	Max (85%)	Avg (80%)	
Structural Steel Shop Drawings	10.00	7.50	8.50	8.00	2.00	8.13	6.09	6.91	6.50	1.63
Review Structural Steel Shop	10.00	7.50	8.50	8.00	2.00	8.13	6.09	6.91	6.50	1.63
Monumental Stair Submittals	10.00	7.50	8.50	8.00	2.00	8.13	6.09	6.91	6.50	1.63
Fabricate Structural Steel	20.00	15.00	17.00	16.00	4.00	16.25	12.19	13.81	13.00	3.25
Monumental Stair Submittal Review	10.00	7.50	8.50	8.00	2.00	8.13	6.09	6.91	6.50	1.63
Fabricate Monumental Stair	25.00	18.75	21.25	20.00	5.00	20.31	15.23	17.27	16.25	4.06
TOTAL	85.00	63.75	72.25	68.00	17.00	69.06	51.80	58.70	55.25	13.81

Task Durations Savings Per VIDA Gym - Part 2										
Task Name	Verizon Center Durations (Days)					Renaissance Hotel Durations (Days)				
	Actual	Savings			New	Actual	Savings			New
		Min (75%)	Max (85%)	Avg (80%)			Min (75%)	Max (85%)	Avg (80%)	
Structural Steel Shop Drawings	7.50	5.63	6.38	6.00	1.50	4.00	3.00	3.40	3.20	0.80
Review Structural Steel Shop	7.50	5.63	6.38	6.00	1.50	4.00	3.00	3.40	3.20	0.80
Monumental Stair Submittals	7.50	5.63	6.38	6.00	1.50	4.00	3.00	3.40	3.20	0.80
Fabricate Structural Steel	15.00	11.25	12.75	12.00	3.00	8.00	6.00	6.80	6.40	1.60
Monumental Stair Submittal Review	7.50	5.63	6.38	6.00	1.50	4.00	3.00	3.40	3.20	0.80
Fabricate Monumental Stair	18.75	14.06	15.94	15.00	3.75	10.00	7.50	8.50	8.00	2.00
TOTAL	63.75	47.81	54.19	51.00	12.75	34.00	25.50	28.90	27.20	6.80

Appendix X

Ductwork Layout Redesign 1



1
M1.01
GROUND FLOOR PLAN - DUCTWORK
SCALE: 1/8" = 1'-0"

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE EQUIPMENT WITH REQUIRED CLEARANCES PER APPLICABLE CODE AND/OR MANUFACTURER'S RECOMMENDATION WHICHEVER IS GREATER.

PLAN NOTES:

1. DASH LINE SHOWS REQUIRED EQUIPMENT CLEARANCE. (TYPICAL)

2. OPEN ENDED DUCT WITH WITH WIRE MESH SCREEN AND FILTER. PROVIDE WITH MANUAL VOLUME DAMPER AND BALANCE TO SHOWN CFM FOR FUTURE TENANT.

3. CONNECT TO EXISTING BASE BUILDING MEDIUM PRESSURE DUCT.

4. PROVIDE WITH PLENUM BOX WITH FULL SIZE EQUAL TO UNIT INLET. FIELD COORDINATE PLENUM BOX DEPTH TO FIT RETURN AND OUTSIDE AIR DUCTWORK. (TYPICAL)

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ARCHITECTS

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VIDA FITNESS AT 1612 U STREET

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DATE	CONSTRUCTION
5-3-11	TELECOM/AIR BALANCE

DATE	PRE-CONSTRUCTION
12-13-10	100% SUBMISSION
11-01-10	BID SET
08-15-10	PERMIT SET
12-16-09	CLIENT REVIEW

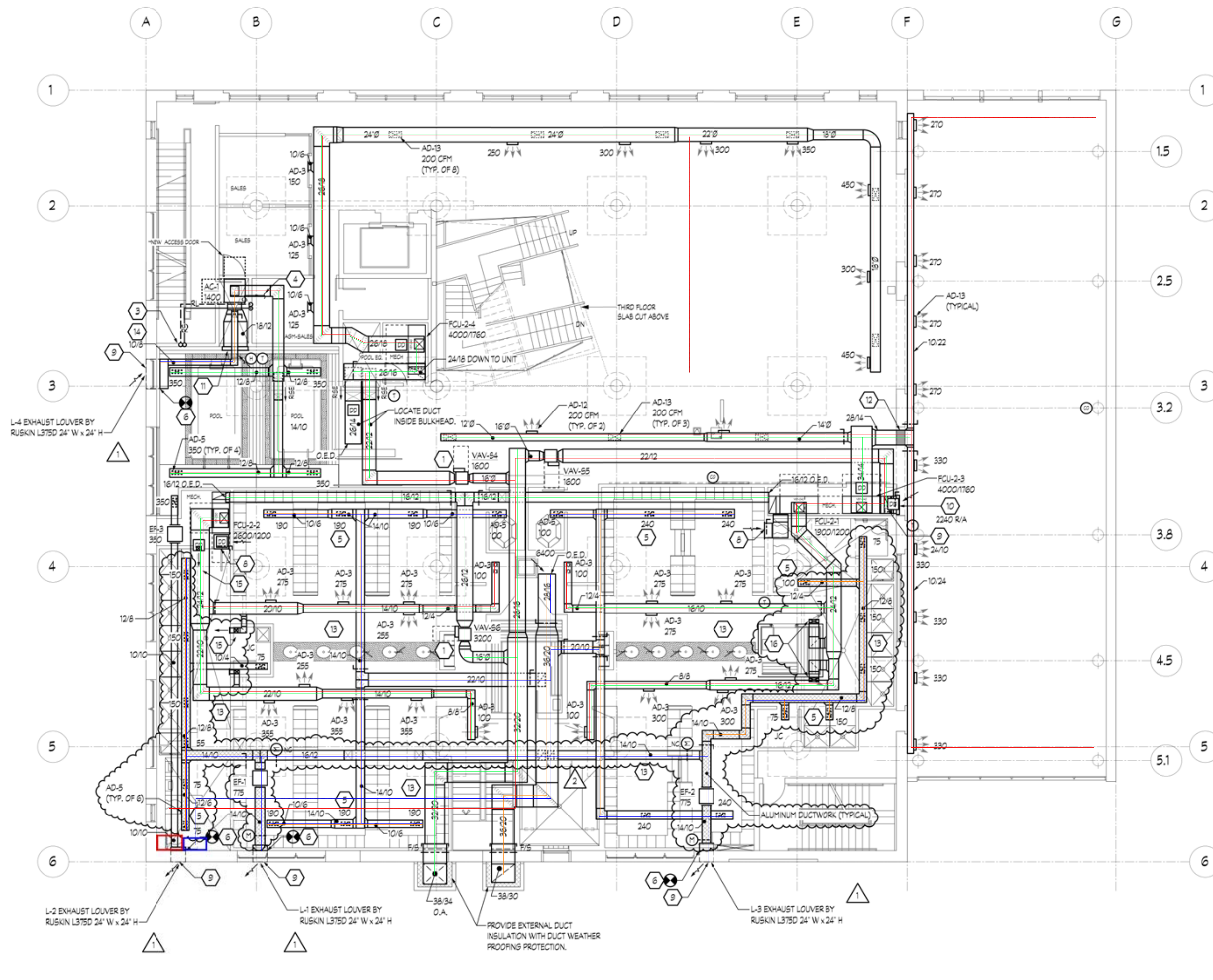
SHEET TITLE
Ground Floor Plan
Mechanical - Ductwork

JOB NO. -

N

SHEET NO.
M1.01

ASE JOB #0911187



1 SECOND FLOOR PLAN - DUCTWORK
M1.02 SCALE: 1/8" = 1'-0"

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE EQUIPMENT WITH REQUIRED CLEARANCES PER APPLICABLE CODE AND/OR MANUFACTURER'S RECOMMENDATION WHICHEVER IS GREATER.

2. PROVIDE LOUVERS WITH INSULATED 8" DEEP PLENUM DUCT WITH FACE SIZE EQUAL TO LOUVER.

PLAN NOTES:

1. LOCATE VAV BOX AND EXHAUST FAN TIGHT AGAINST STRUCTURE ABOVE WHEREVER PRACTICAL. (TYPICAL)

2. NOT USED

3. ROUTE REFRIGERANT PIPING UP TO ROOF MOUNTED CONDENSING UNIT CU-1.

4. ROUTE 1" CONDENSATE DRAIN TO NEAREST FLOOR DRAIN. SEE PLUMBING PLAN FOR LOCATION. (TYPICAL)

5. ALL RETURN AND EXHAUST AIR DEVICES IN MEN'S AND WOMEN'S LOCKER ROOMS ARE AD-5, U.N.O.

6. CONNECT TO EXISTING LOUVER. COORDINATE EXACT LOCATION OF LOUVERS WITH BASE BUILDING.

7. 16/12 OPEN ENDED DUCT (O.E.D.).

8. TRANSFER GRILLE AD-7 WITH 24/12 O.E.D. LOCATE GRILLE ABOVE LOCKERS. (2)

9. PROVIDE INSULATED FULL SIZE PLENUM BEHIND LOUVER. (1)

10. WALL MOUNTED RETURN GRILLE WITH FILTER AD-8. LOCATE GRILLE MINIMUM 6" ABOVE FINISH FLOOR.

11. WALL MOUNTED RETURN GRILLE AD-9. LOCATE GRILLE MINIMUM 3'-0" ABOVE FINISH FLOOR. FIELD COORDINATE EXACT GRILLE ELEVATION WITH AC-1 RETURN OPENING.

12. PROVIDE FLEXIBLE DUCT CONNECTION WHERE DUCT CROSSES NEW BUILDING STRUCTURE EXPANSION JOINT. (TYPICAL)

13. ALL AIR DEVICES WITHIN THE LOCKER ROOMS SHALL BE ALUMINUM IN CONSTRUCTION.

14. INSULATE OUTDOOR AIR INTAKE DUCT.

15. 8/6 DUCT DN. STOP DUCTWORK 6" A.F.F. PROVIDE 8/6 S.A. REGISTER TITUS MODEL 300 FS W/ SINGLE DEFLECTION OPPOSED BLADE DAMPER. SET AIR THROW @ 45°.

16. 16/6 DUCT DN. STOP DUCTWORK 6" A.F.F. PROVIDE 16/6 S.A. REGISTER TITUS MODEL 300 FS W/ SINGLE DEFLECTION OPPOSED BLADE DAMPER. SET AIR THROW @ 45°. (2)

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DATE		CONSTRUCTION
(2) 04-25-11		LOCKER RM REVISION
03-22-11		OWNER'S FIELD REVISION
(1) 1-10-11		POOL PERMIT
DATE		**PRE-CONSTRUCTION**
12-13-10		100% SUBMISSION
11-01-10		BID SET
08-15-10		PERMIT SET
12-16-09		CLIENT REVIEW

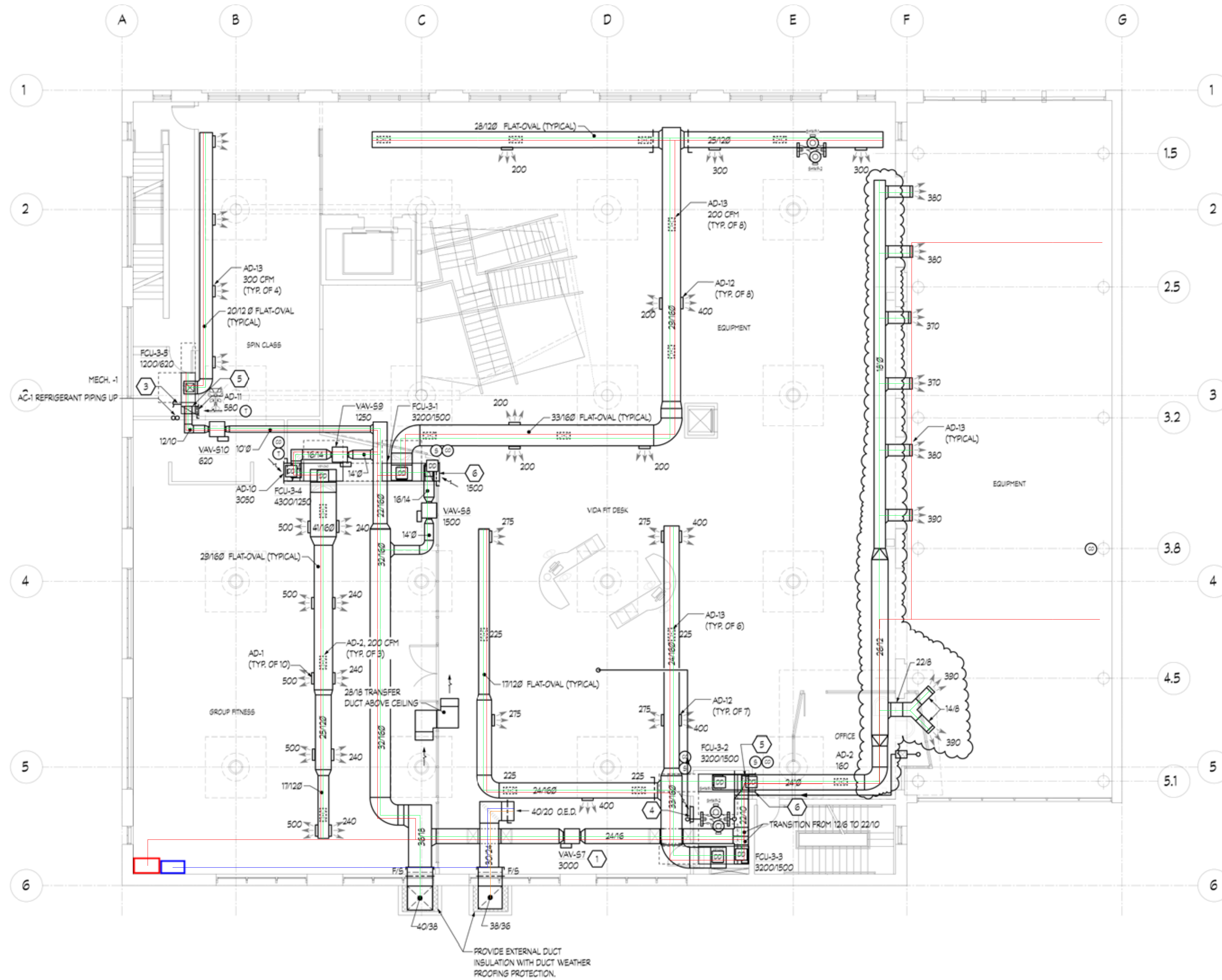
SHEET TITLE
Second Floor Plan
Mechanical - Ductwork

JOB NO. -

N

SHEET NO.
M1.02

ASE JOB #0911187



THIRD FLOOR PLAN - DUCTWORK
SCALE: 1/8" = 1'-0"

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE EQUIPMENT WITH REQUIRED CLEARANCES PER APPLICABLE CODE AND/OR MANUFACTURER'S RECOMMENDATION WHICHEVER IS GREATER.

PLAN NOTES:

1. LOCATE VAV BOX TIGHT AGAINST STRUCTURE ABOVE WHEREVER PRACTICAL. (TYPICAL)

2. NOT USED

3. ROUTE 1" CONDENSATE DRAIN TO NEAREST FLOOR DRAIN. SEE PLUMBING PLAN FOR LOCATION. (TYPICAL)

4. TRANSFER GRILLE AD-7 WITH 24/12 O.E.D. SLEEVE. LOCATE GRILLE HIGH ABOVE WALL.

5. OUTSIDE AIR DUCT DOWN TO PLENUM BOX.

6. WALL MOUNTED RETURN GRILLE WITH FILTER AD-8. LOCATE GRILLE MINIMUM 6" ABOVE FINISH FLOOR.

7. PROVIDE FLEXIBLE DUCT CONNECTION WHERE DUCT CROSSES TO NEW BUILDING STRUCTURE EXPANSION JOINT.

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AT
1612 U STREET

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Columbia, MD 21045
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DATE		CONSTRUCTION
05-05-11		DUCT REVISION
03-22-11		OWNER'S FIELD REVISION

DATE		PRE-CONSTRUCTION
12-13-10		100% SUBMISSION
11-01-10		BID SET
08-15-10		PERMIT SET
12-16-09		CLIENT REVIEW

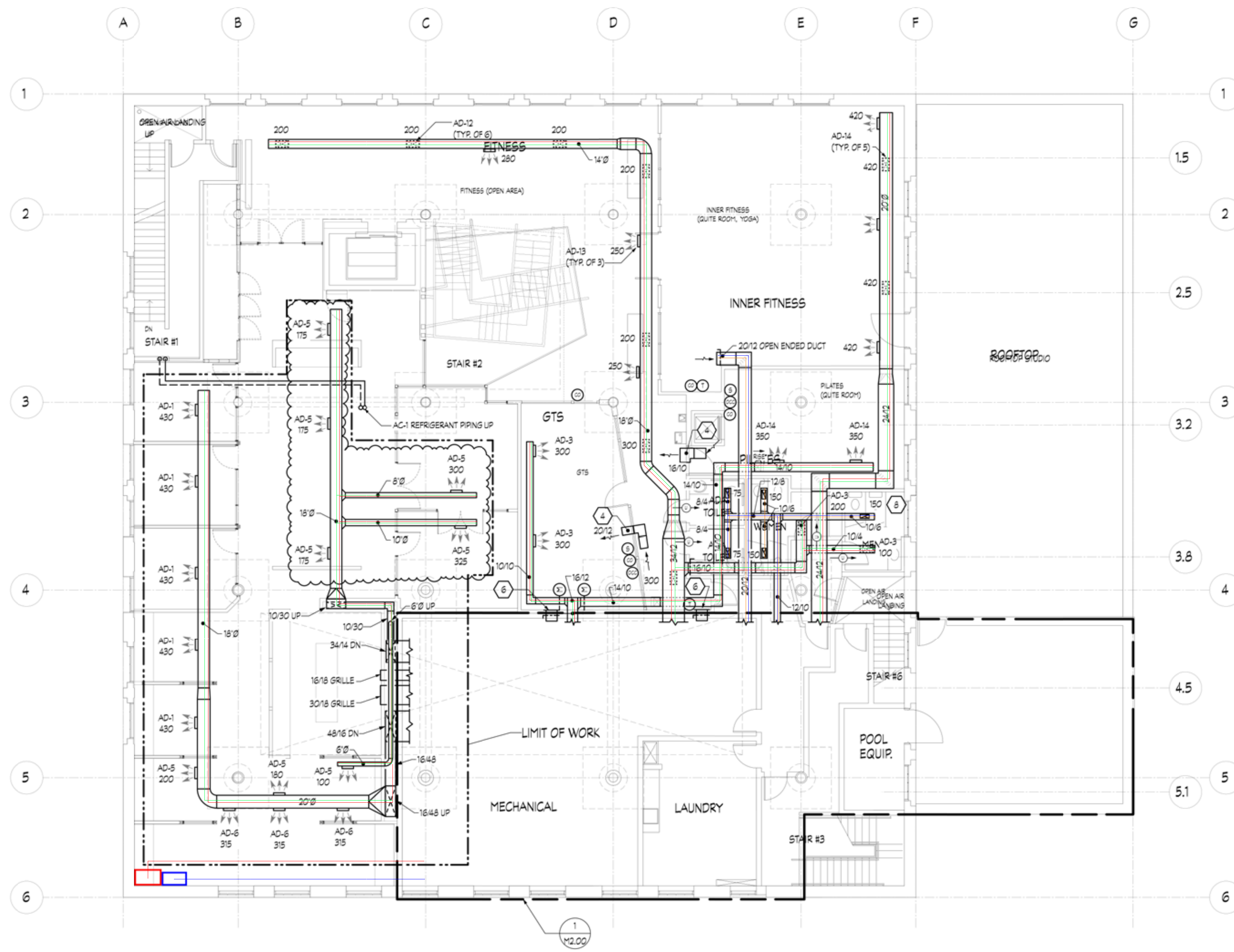
SHEET TITLE
Third Floor Plan
Mechanical - Ductwork

JOB NO. -

N

SHEET NO.
M1.03

ASE JOB #0911187



FOURTH FLOOR PLAN - DUCTWORK
SCALE: 1/8" = 1'-0"

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE EQUIPMENT WITH REQUIRED CLEARANCES PER APPLICABLE CODE AND/OR MANUFACTURER'S RECOMMENDATION WHICHEVER IS GREATER.

PLAN NOTES: ⟨#⟩

1. LOCATE VAV BOX TIGHT AGAINST STRUCTURE ABOVE WHEREVER PRACTICAL. (TYPICAL)
2. EXISTING BASE BUILDING TEMPERED OUTSIDE AIR DUCT.
3. ROUTE 1" CONDENSATE DRAIN TO NEAREST FLOOR DRAIN. SEE PLUMBING PLAN FOR LOCATION. (TYPICAL)
4. TRANSFER DUCT LOCATE HIGH ABOVE WALL.
5. OUTSIDE AIR DUCT DOWN TO PLENUM BOX.
6. WALL MOUNTED RETURN GRILLE WITH FILTER AD-8. LOCATE GRILLE MINIMUM 6" ABOVE FINISH FLOOR.
7. WALL MOUNTED RETURN GRILLE WITH FILTER AD-11. LOCATE GRILLE MINIMUM 6" ABOVE FINISH FLOOR.
8. ALL EXHAUST GRILLES IN TOILET ROOM WILL BE AD-5. U.N.O.
9. CONNECT DRYER EXHAUST TO EXISTING PLENUM. FIELD COORDINATE EXACT LOCATION OF DRYER WITH OWNER.
10. 16/10 DUCT WITH HEATING COIL.
11. CAP DUCT FOR FUTURE.

STONEKING VON STORCH
ARCHITECTS

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DATE	CONSTRUCTION
5-3-11	TELECOM/AIR BALANCE
4-13-11	OFFICE REVISION

DATE	PRE-CONSTRUCTION
08-15-10	PERMIT SET
12-16-09	CLIENT REVIEW

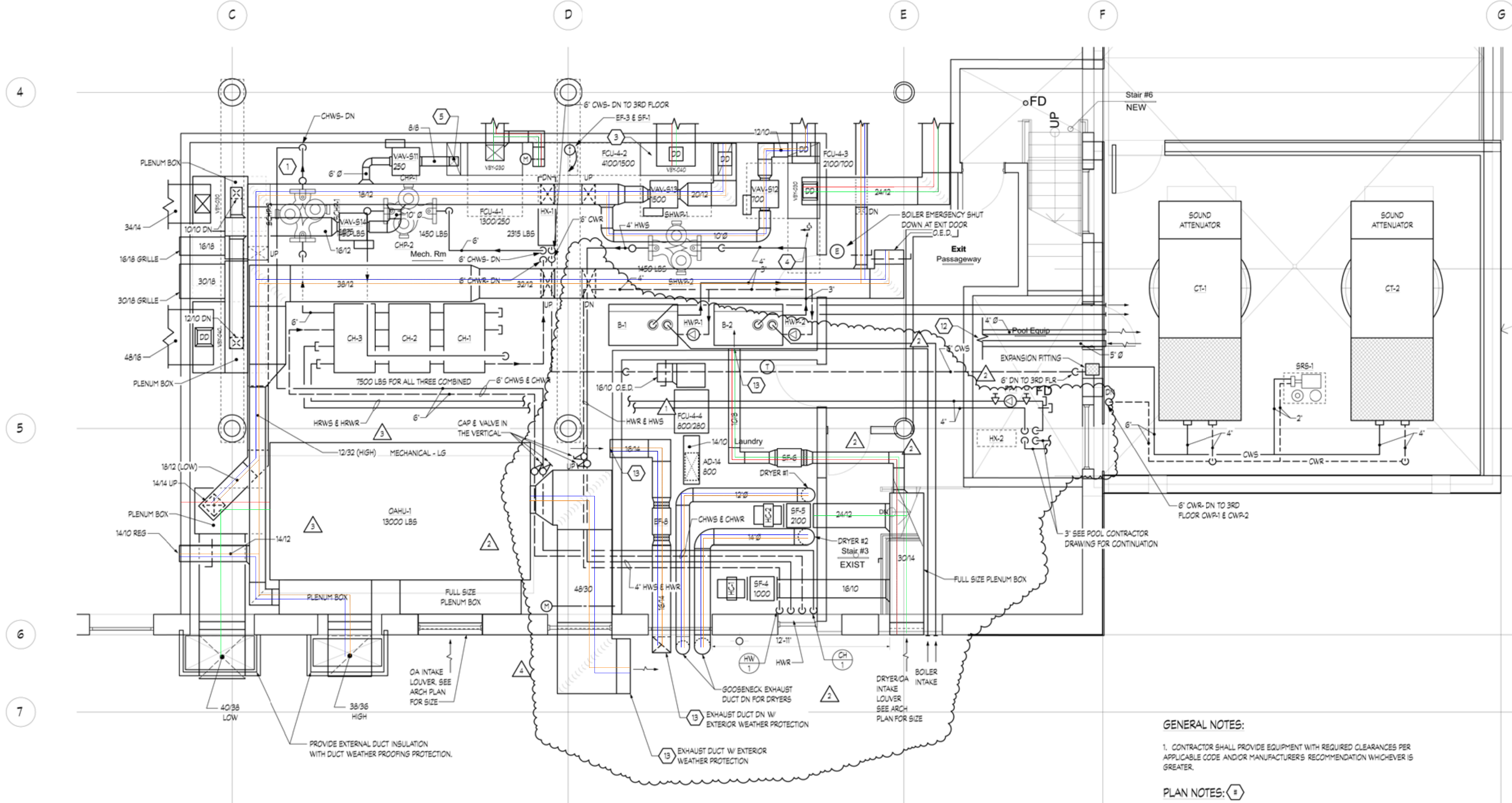
SHEET TITLE
Fourth Floor Plan
Mechanical - Ductwork

JOB NO. -

N

SHEET NO.
M1.04

ASE JOB #0911187



1 M2.00 PART PLAN PROPOSED FOURTH FLOOR
SCALE: 1/4" = 1'-0"

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE EQUIPMENT WITH REQUIRED CLEARANCES PER APPLICABLE CODE AND/OR MANUFACTURER'S RECOMMENDATION WHICHEVER IS GREATER.

PLAN NOTES: (#)

1. LOCATE VAV BOX TIGHT AGAINST STRUCTURE ABOVE WHEREVER PRACTICAL. (TYPICAL)
2. NOT USED
3. ROUTE 1" CONDENSATE DRAIN TO NEAREST FLOOR DRAIN. SEE PLUMBING PLAN FOR LOCATION. (TYPICAL)
4. TRANSFER DUCT LOCATE HIGH ABOVE WALL.
5. OUTSIDE AIR DUCT DOWN TO PLENUM BOX.
6. WALL MOUNTED RETURN GRILLE WITH FILTER AD-8. LOCATE GRILLE MINIMUM 6' ABOVE FINISH FLOOR.
7. WALL MOUNTED RETURN GRILLE WITH FILTER AD-11. LOCATE GRILLE MINIMUM 6' ABOVE FINISH FLOOR.
8. ALL EXHAUST GRILLES IN TOILET ROOM WILL BE AD-5. U.N.O.
9. CONNECT DRYER EXHAUST TO EXISTING PLENUM. FIELD COORDINATE EXACT LOCATION OF DRYER WITH OWNER.
10. 16/10 DUCT WITH HEATING COIL.
11. CAP DUCT FOR FUTURE.
12. INSTALL SIDEWALL VENTING. PROVIDE SINGLE WALL AIR INLET, 5" PIPE AND AL29-4C STAINLESS STEEL FLUE EXHAUST & VENT TERMINATIONS. MAXIMUM VENT LENGTH IS 20 FEET.
13. COVER END OF DUCT WITH SCREEN.

GRAPHIC SCALE 1/8" = 1'-0"

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DATE	CONSTRUCTION
01-10-11	POOL PERMIT

DATE	PRE-CONSTRUCTION
06-07-11	LAUNDRY REVISION
04-13-11	OFFICE REVISION
04-14-11	LAUNDRY REVISION
12-13-10	100% SUBMISSION
11-01-10	BID SET
08-15-10	PERMIT SET
12-16-09	CLIENT REVIEW

SHEET TITLE
Part Plan

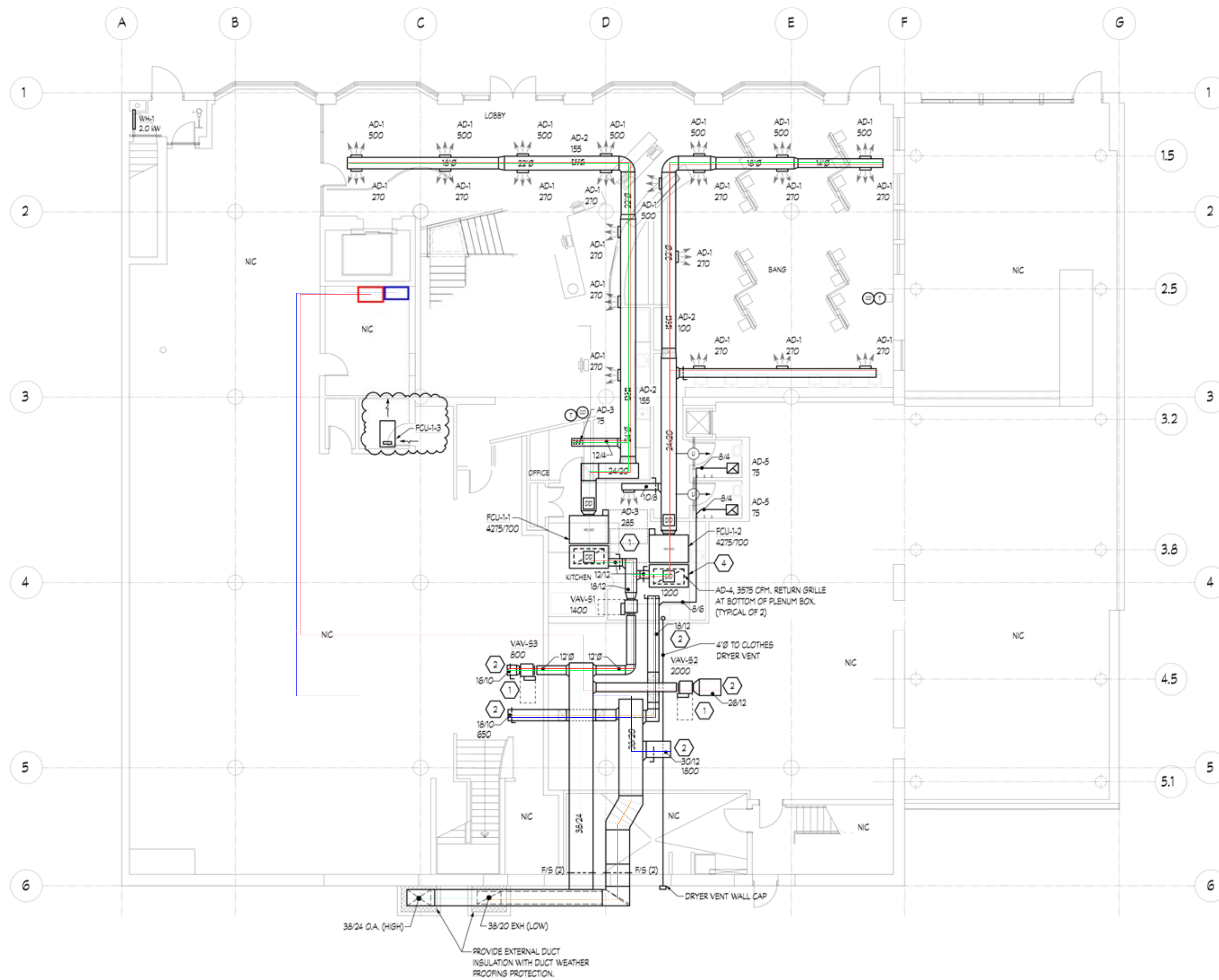
JOB NO. -

SHEET NO.
M2.00

ASE JOB #0911187

APPENDIX Y

DUCTWORK LAYOUT REDESIGN 2



GROUND FLOOR PLAN - DUCTWORK
SCALE: 1/8" = 1'-0"

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE EQUIPMENT WITH REQUIRED CLEARANCES PER APPLICABLE CODE AND/OR MANUFACTURER'S RECOMMENDATION WHICHEVER IS GREATER.

PLAN NOTES:

1. DASH LINE SHOWS REQUIRED EQUIPMENT CLEARANCE. (TYPICAL)
2. OPEN ENDED DUCT WITH WITH WIRE MESH SCREEN AND FILTER. PROVIDE WITH MANUAL VOLUME DAMPER AND BALANCE TO SHOWN CFM FOR FUTURE TENANT.
3. CONNECT TO EXISTING BASE BUILDING MEDIUM PRESSURE DUCT.
4. PROVIDE WITH PLENUM BOX WITH FULL SIZE EQUAL TO UNIT INLET. FIELD COORDINATE PLENUM BOX DEPTH TO FIT RETURN AND OUTSIDE AIR DUCTWORK. (TYPICAL)

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DATE	CONSTRUCTION
5-3-11	TELECOM/AIR BALANCE

DATE	PRE-CONSTRUCTION
12-13-10	100% SUBMISSION
11-01-10	BID SET
08-15-10	PERMIT SET
12-16-09	CLIENT REVIEW

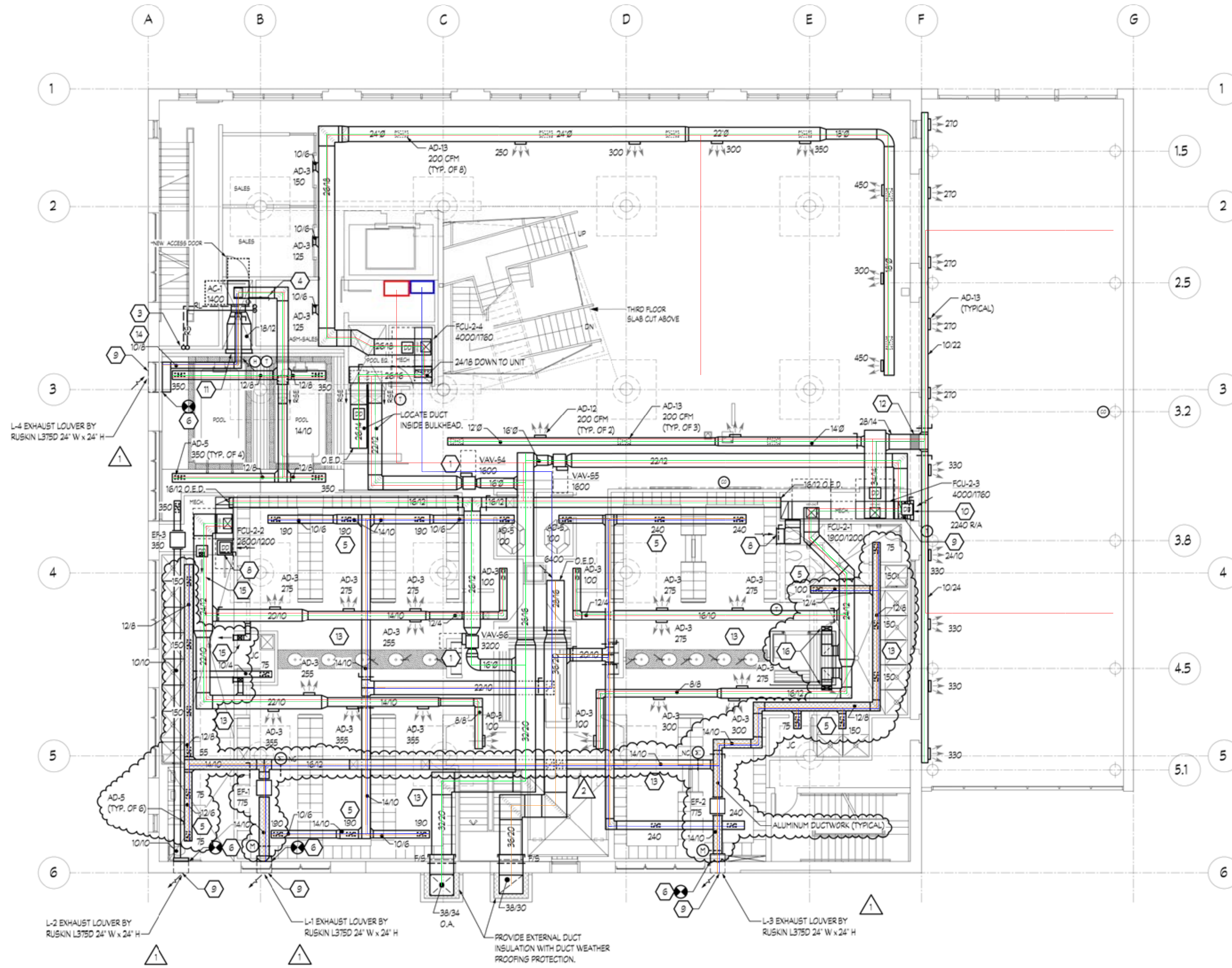
SHEET TITLE
Ground Floor Plan
Mechanical - Ductwork

JOB NO. -

N

SHEET NO.
M1.01

ASE JOB #0911187



1 M1.02 SECOND FLOOR PLAN - DUCTWORK
SCALE: 1/8" = 1'-0"

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE EQUIPMENT WITH REQUIRED CLEARANCES PER APPLICABLE CODE AND/OR MANUFACTURER'S RECOMMENDATION WHICHEVER IS GREATER.

2. PROVIDE LOUVERS WITH INSULATED 8" DEEP PLENUM DUCT WITH FACE SIZE EQUAL TO LOUVER.

PLAN NOTES:

1. LOCATE VAV BOX AND EXHAUST FAN TIGHT AGAINST STRUCTURE ABOVE WHEREVER PRACTICAL. (TYPICAL)

2. NOT USED

3. ROUTE REFRIGERANT PIPING UP TO ROOF MOUNTED CONDENSING UNIT CU-1.

4. ROUTE 1" CONDENSATE DRAIN TO NEAREST FLOOR DRAIN. SEE PLUMBING PLAN FOR LOCATION. (TYPICAL)

5. ALL RETURN AND EXHAUST AIR DEVICES IN MEN'S AND WOMEN'S LOCKER ROOMS ARE AD-5. U.N.O.

6. CONNECT TO EXISTING LOUVER. COORDINATE EXACT LOCATION OF LOUVERS WITH BASE BUILDING.

7. 16/12 OPEN ENDED DUCT (O.E.D.).

8. TRANSFER GRILLE AD-7 WITH 24/12 O.E.D. LOCATE GRILLE ABOVE LOCKERS. (2) (1)

9. PROVIDE INSULATED FULL SIZE PLENUM BEHIND LOUVER.

10. WALL MOUNTED RETURN GRILLE WITH FILTER AD-8. LOCATE GRILLE MINIMUM 6" ABOVE FINISH FLOOR.

11. WALL MOUNTED RETURN GRILLE AD-9. LOCATE GRILLE MINIMUM 3'-0" ABOVE FINISH FLOOR. FIELD COORDINATE EXACT GRILLE ELEVATION WITH AC-1 RETURN OPENING.

12. PROVIDE FLEXIBLE DUCT CONNECTION WHERE DUCT CROSSES NEW BUILDING STRUCTURE EXPANSION JOINT. (TYPICAL)

13. ALL AIR DEVICES WITHIN THE LOCKER ROOMS SHALL BE ALUMINUM IN CONSTRUCTION.

14. INSULATE OUTDOOR AIR INTAKE DUCT.

15. 8/6 DUCT DN. STOP DUCTWORK 6" A.F.F. PROVIDE 8/6 S.A. REGISTER TITUS MODEL 300 FS W/ SINGLE DEFLECTION OPPOSED BLADE DAMPER. SET AIR THROW @ 45°.

16. 16/6 DUCT DN. STOP DUCTWORK 6" A.F.F. PROVIDE 16/6 S.A. REGISTER TITUS MODEL 300 FS W/ SINGLE DEFLECTION OPPOSED BLADE DAMPER. SET AIR THROW @ 45°. (2)

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DATE		CONSTRUCTION
(2) 04-25-11		LOCKER RM REVISION
03-22-11		OWNER'S FIELD REVISION
(1) 1-10-11		POOL PERMIT

DATE		PRE-CONSTRUCTION
12-13-10		100% SUBMISSION
11-01-10		BID SET
08-15-10		PERMIT SET
12-16-09		CLIENT REVIEW

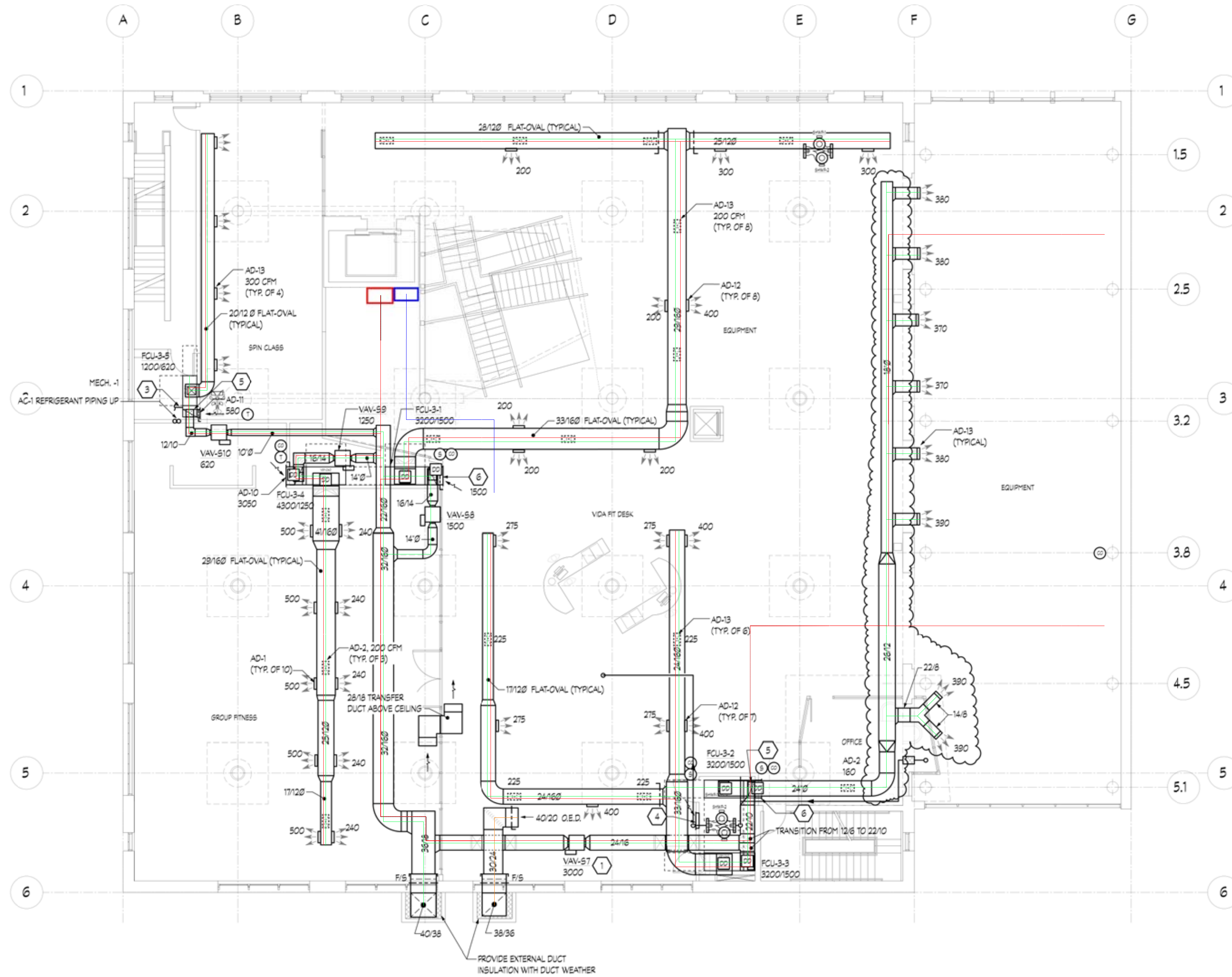
SHEET TITLE
Second Floor Plan
Mechanical - Ductwork

JOB NO. -

N

SHEET NO.
M1.02

ASE JOB #0911187



THIRD FLOOR PLAN - DUCTWORK
SCALE: 1/8" = 1'-0"

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE EQUIPMENT WITH REQUIRED CLEARANCES PER APPLICABLE CODE AND/OR MANUFACTURER'S RECOMMENDATION WHICHEVER IS GREATER.

PLAN NOTES:

1. LOCATE VAV BOX TIGHT AGAINST STRUCTURE ABOVE WHEREVER PRACTICAL. (TYPICAL)

2. NOT USED

3. ROUTE 1" CONDENSATE DRAIN TO NEAREST FLOOR DRAIN. SEE PLUMBING PLAN FOR LOCATION. (TYPICAL)

4. TRANSFER GRILLE AD-7 WITH 24/12 O.E.D. SLEEVE. LOCATE GRILLE HIGH ABOVE WALL.

5. OUTSIDE AIR DUCT DOWN TO PLENUM BOX.

6. WALL MOUNTED RETURN GRILLE WITH FILTER AD-8. LOCATE GRILLE MINIMUM 6" ABOVE FINISH FLOOR.

7. PROVIDE FLEXIBLE DUCT CONNECTION WHERE DUCT CROSSES TO NEW BUILDING STRUCTURE EXPANSION JOINT.

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DATE		CONSTRUCTION
05-05-11		DUCT REVISION
03-22-11		OWNER'S FIELD REVISION

DATE		PRE-CONSTRUCTION
12-13-10		100% SUBMISSION
11-01-10		BID SET
08-15-10		PERMIT SET
12-16-09		CLIENT REVIEW

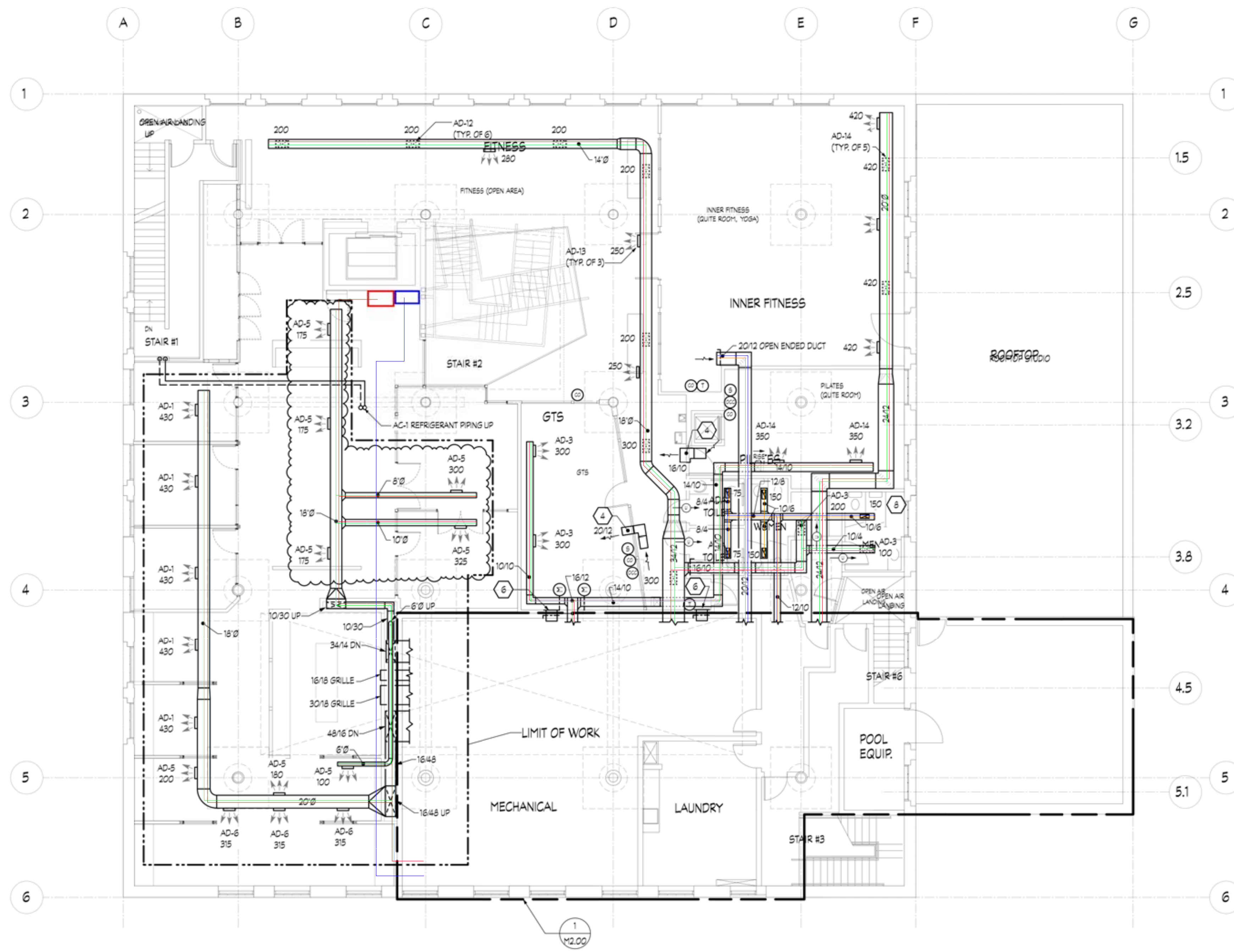
SHEET TITLE
Third Floor Plan
Mechanical - Ductwork

JOB NO. -

N

SHEET NO.
M1.03

ASE JOB #0911187



1 FOURTH FLOOR PLAN - DUCTWORK
M1.04 SCALE: 1/8" = 1'-0"

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE EQUIPMENT WITH REQUIRED CLEARANCES PER APPLICABLE CODE AND/OR MANUFACTURER'S RECOMMENDATION WHICHEVER IS GREATER.

PLAN NOTES: (#)

1. LOCATE VAV BOX TIGHT AGAINST STRUCTURE ABOVE WHEREVER PRACTICAL. (TYPICAL)

2. EXISTING BASE BUILDING TEMPERED OUTSIDE AIR DUCT.

3. ROUTE 1" CONDENSATE DRAIN TO NEAREST FLOOR DRAIN. SEE PLUMBING PLAN FOR LOCATION. (TYPICAL)

4. TRANSFER DUCT LOCATE HIGH ABOVE WALL.

5. OUTSIDE AIR DUCT DOWN TO PLENUM BOX.

6. WALL MOUNTED RETURN GRILLE WITH FILTER AD-8. LOCATE GRILLE MINIMUM 6" ABOVE FINISH FLOOR.

7. WALL MOUNTED RETURN GRILLE WITH FILTER AD-11. LOCATE GRILLE MINIMUM 6" ABOVE FINISH FLOOR.

8. ALL EXHAUST GRILLES IN TOILET ROOM WILL BE AD-5. U.N.O.

9. CONNECT DRYER EXHAUST TO EXISTING PLENUM. FIELD COORDINATE EXACT LOCATION OF DRYER WITH OWNER.

10. 16/10 DUCT WITH HEATING COIL.

11. CAP DUCT FOR FUTURE.

STONEKING VON STORCH
ARCHITECTS

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DATE	CONSTRUCTION
5-3-11	TELECOM/AIR BALANCE
4-13-11	OFFICE REVISION
DATE	PRE-CONSTRUCTION
08-15-10	PERMIT SET
12-16-09	CLIENT REVIEW

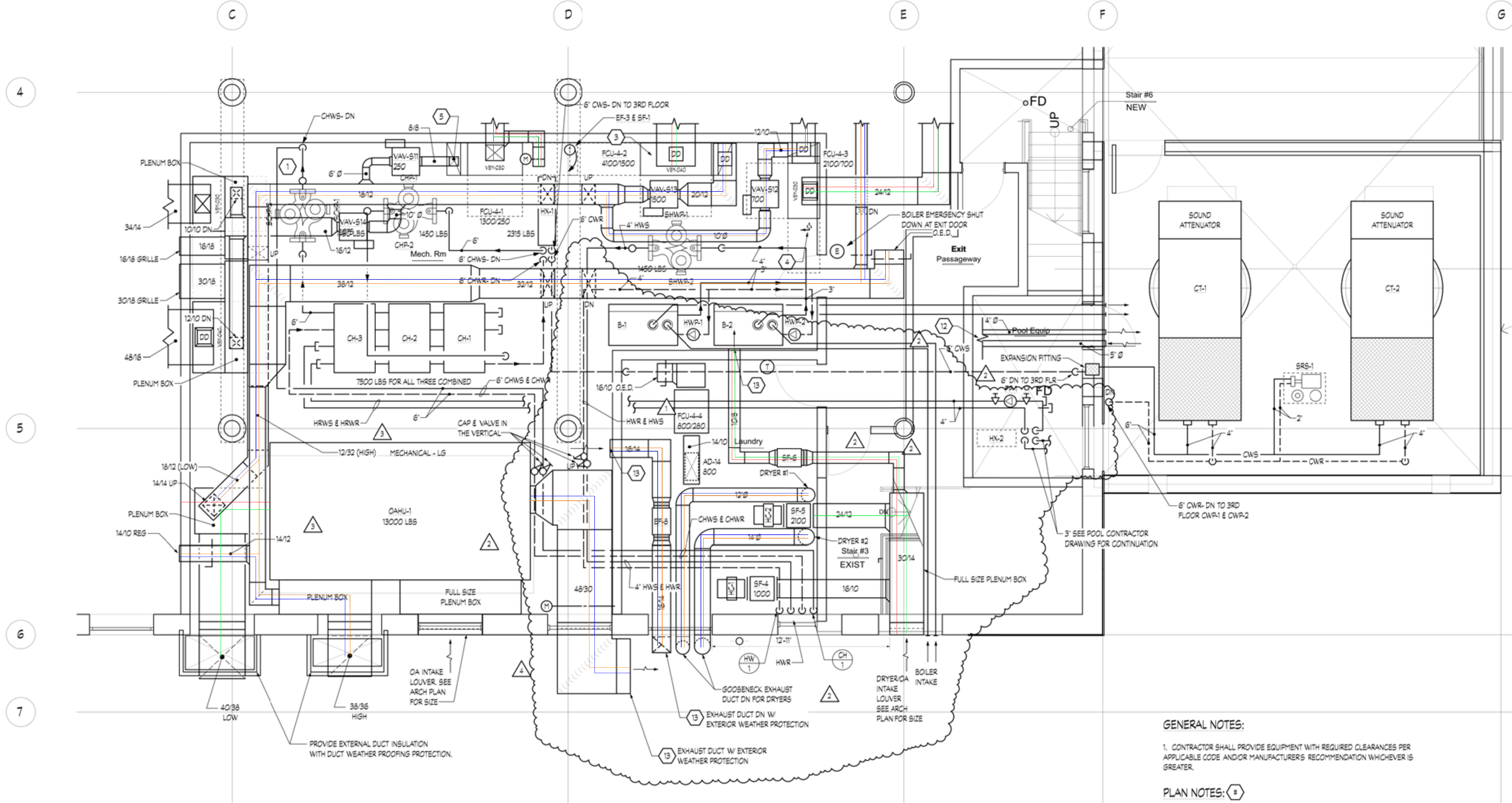
SHEET TITLE
Fourth Floor Plan
Mechanical - Ductwork

JOB NO. -

N

SHEET NO.
M1.04

ASE JOB #0911187



1 M2.00 PART PLAN PROPOSED FOURTH FLOOR
SCALE: 1/4" = 1'-0"

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE EQUIPMENT WITH REQUIRED CLEARANCES PER APPLICABLE CODE AND/OR MANUFACTURER'S RECOMMENDATION WHICHEVER IS GREATER.

PLAN NOTES:

1. LOCATE VAV BOX TIGHT AGAINST STRUCTURE ABOVE WHEREVER PRACTICAL. (TYPICAL)
2. NOT USED
3. ROUTE 1" CONDENSATE DRAIN TO NEAREST FLOOR DRAIN. SEE PLUMBING PLAN FOR LOCATION. (TYPICAL)
4. TRANSFER DUCT LOCATE HIGH ABOVE WALL.
5. OUTSIDE AIR DUCT DOWN TO PLENUM BOX.
6. WALL MOUNTED RETURN GRILLE WITH FILTER AD-8. LOCATE GRILLE MINIMUM 6" ABOVE FINISH FLOOR.
7. WALL MOUNTED RETURN GRILLE WITH FILTER AD-11. LOCATE GRILLE MINIMUM 6" ABOVE FINISH FLOOR.
8. ALL EXHAUST GRILLES IN TOILET ROOM WILL BE AD-5. U.N.O.
9. CONNECT DRYER EXHAUST TO EXISTING PLENUM. FIELD COORDINATE EXACT LOCATION OF DRYER WITH OWNER.
10. 16/10 DUCT WITH HEATING COIL.
11. CAP DUCT FOR FUTURE.
12. (2) INSTALL SIDEWALL VENTING. PROVIDE SINGLE WALL AIR INLET, 5" PIPE AND AL29-4C STAINLESS STEEL FLUE EXHAUST & VENT TERMINATIONS. MAXIMUM VENT LENGTH IS 20 FEET.
13. (4) COVER END OF DUCT WITH SCREEN.

1'0 4' 8' 12' 16'
GRAPHIC SCALE 1/8" = 1'-0"

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ARCHITECTS

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DATE		CONSTRUCTION
(1) 01-10-11		POOL PERMIT

DATE		PRE-CONSTRUCTION
(4) 06-07-11		LAUNDRY REVISION
(3) 04-13-11		OFFICE REVISION
(2) 04-14-11		LAUNDRY REVISION
12-13-10		100% SUBMISSION
11-01-10		BID SET
08-15-10		PERMIT SET
12-16-09		CLIENT REVIEW

SHEET TITLE
Part Plan

JOB NO. -

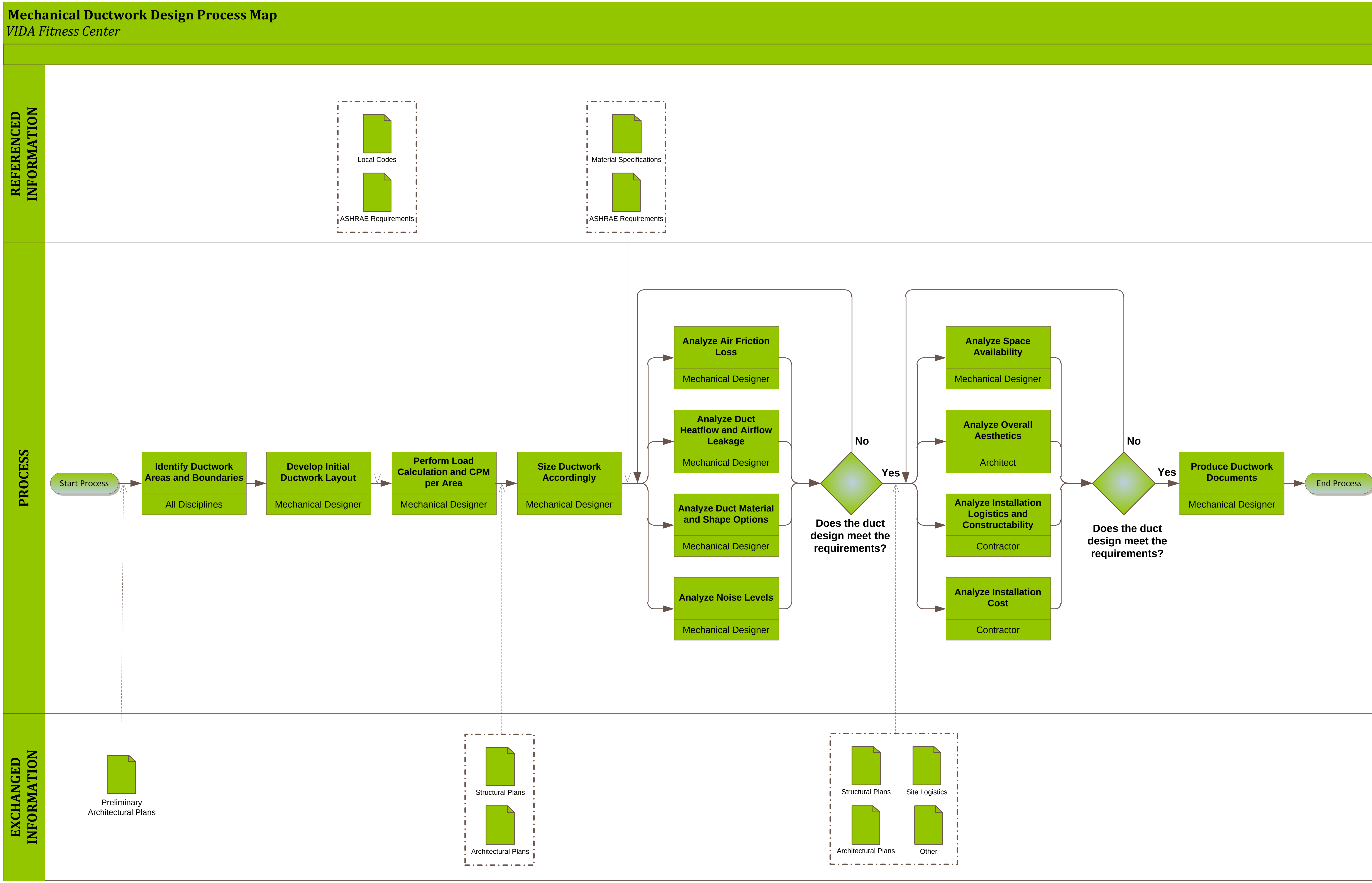
N

SHEET NO.
M2.00

ASE JOB #0911187

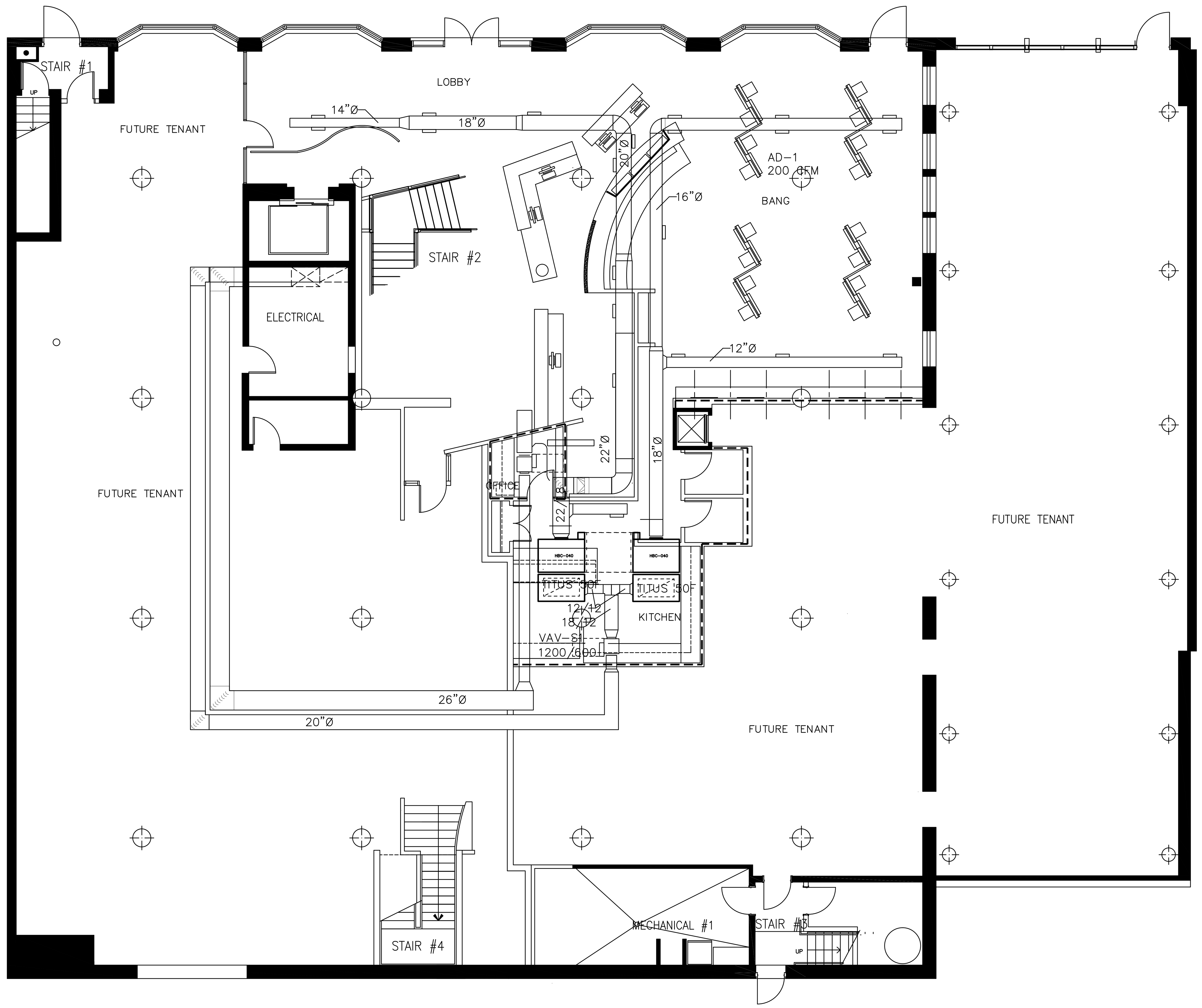
Appendix Z

Mechanical Ductwork Design Process Map


Mechanical Ductwork Design Process Map
VIDA Fitness Center
REFERENCED INFORMATION
Local Codes
ASHRAE Requirements
Material Specifications
ASHRAE Requirements
PROCESS
Start Process
Identify Ductwork Areas and Boundaries
All Disciplines
Develop Initial Ductwork Layout
Mechanical Designer
Perform Load Calculation and CPM per Area
Mechanical Designer
Size Ductwork Accordingly
Mechanical Designer
Analyze Air Friction Loss
Mechanical Designer
Analyze Duct Heatflow and Airflow Leakage
Mechanical Designer
Analyze Duct Material and Shape Options
Mechanical Designer
Analyze Noise Levels
Mechanical Designer
No
Yes
Does the duct design meet the requirements?
Analyze Space Availability
Mechanical Designer
Analyze Overall Aesthetics
Architect
Analyze Installation Logistics and Constructability
Contractor
Analyze Installation Cost
Contractor
No
Yes
Does the duct design meet the requirements?
Produce Ductwork Documents
Mechanical Designer
End Process
EXCHANGED INFORMATION
Preliminary Architectural Plans
Structural Plans
Architectural Plans
Structural Plans
Site Logistics
Architectural Plans
Other

APPENDIX AA

DETAILED LAYOUT 2 REDESIGN



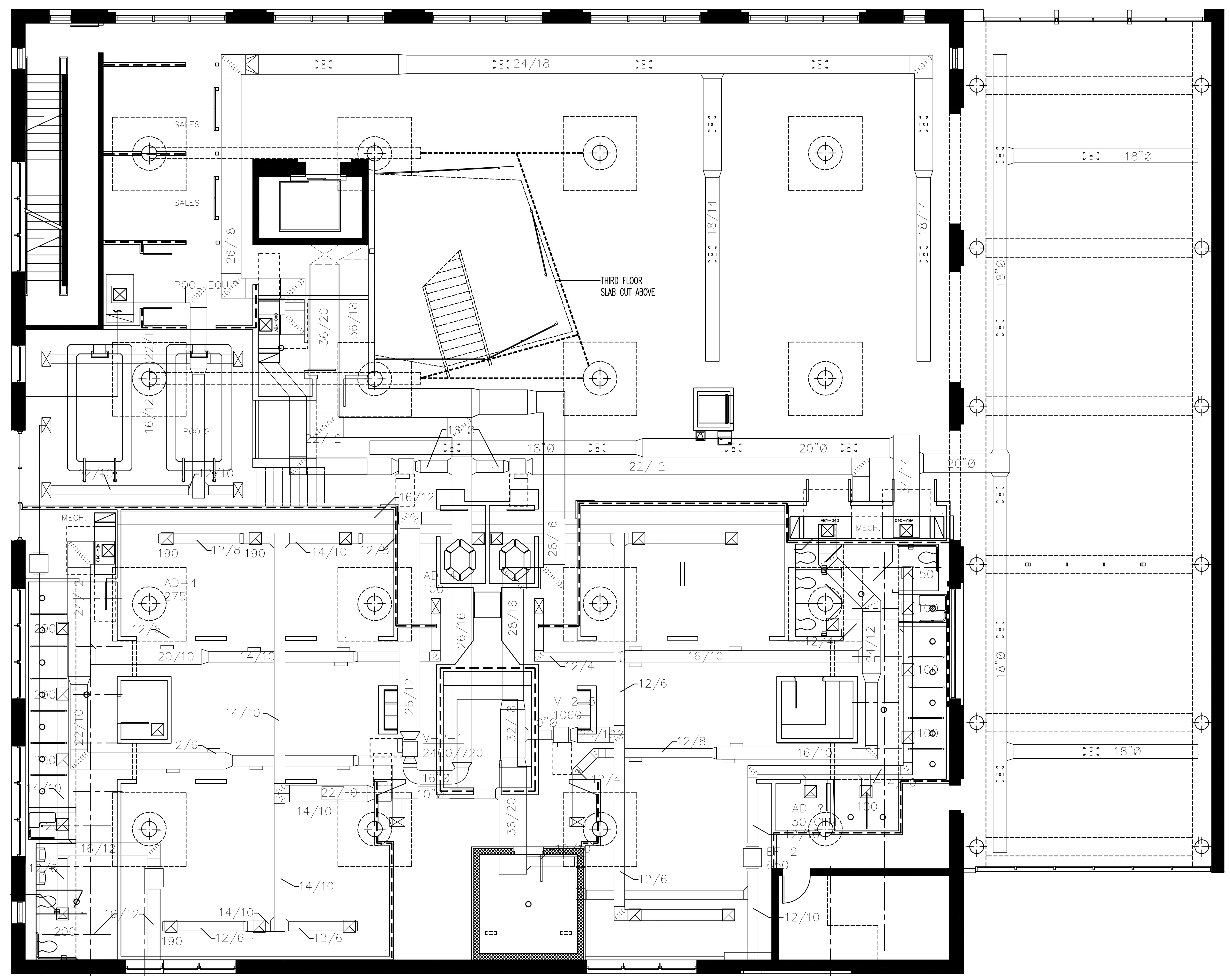
1 GROUND FLOOR PLAN
1/8" = 1'-0"

VIDA Fitness
1612 U St. NW
Washington DC

DATE	CONSTRUCTION
4/4/2012	REDESIGN

SHEET TITLE
Ground Floor Ductwork Redesign

SHEET NO.
M1.01



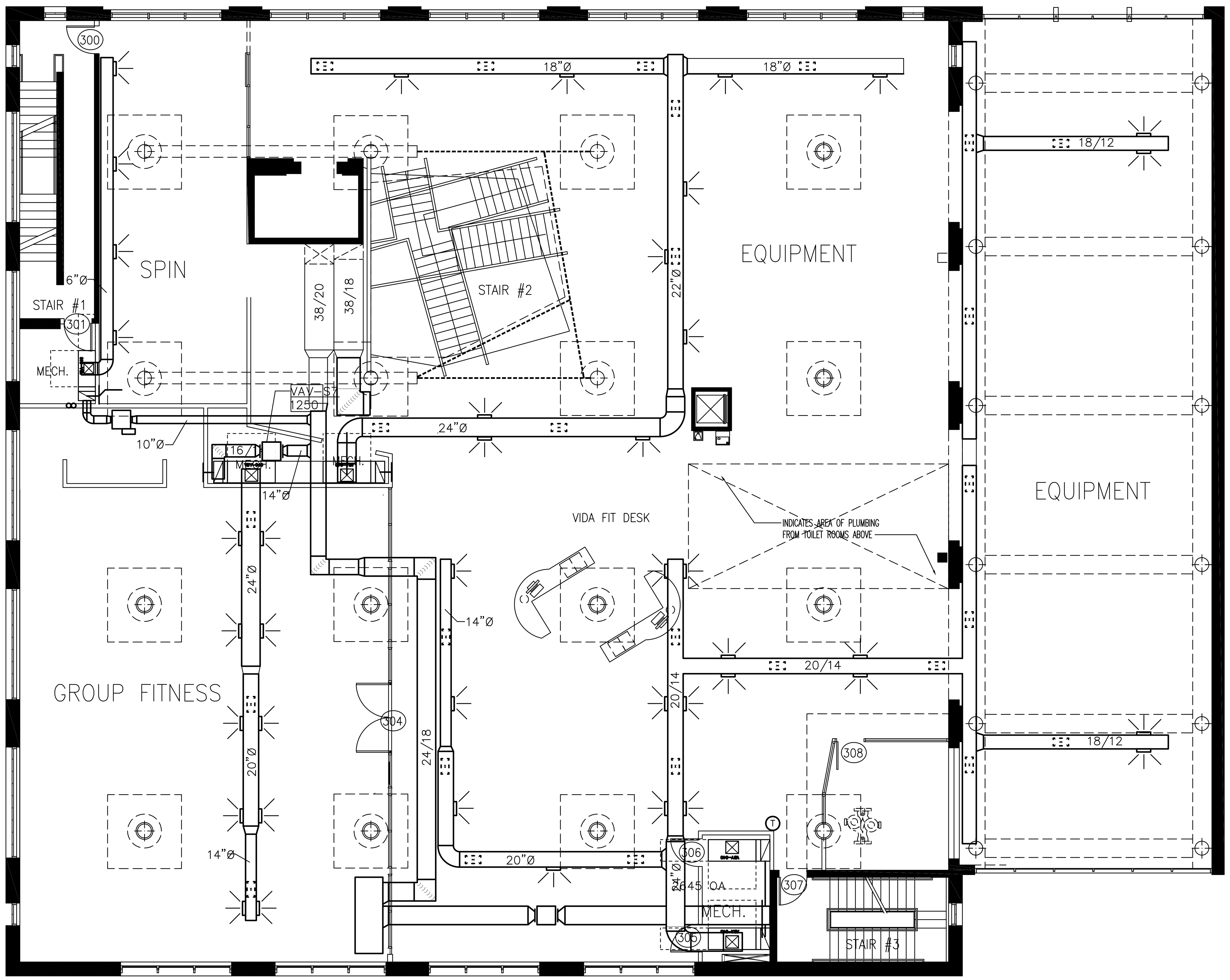
1 SECOND FLOOR PLAN
1/8" = 1'-0"

VIDA Fitness
1612 U St. NW
Washington DC

DATE	CONSTRUCTION
4/4/2012	REDESIGN

SHEET TITLE
Second Floor Ductwork Redesign

SHEET NO.
M1.02



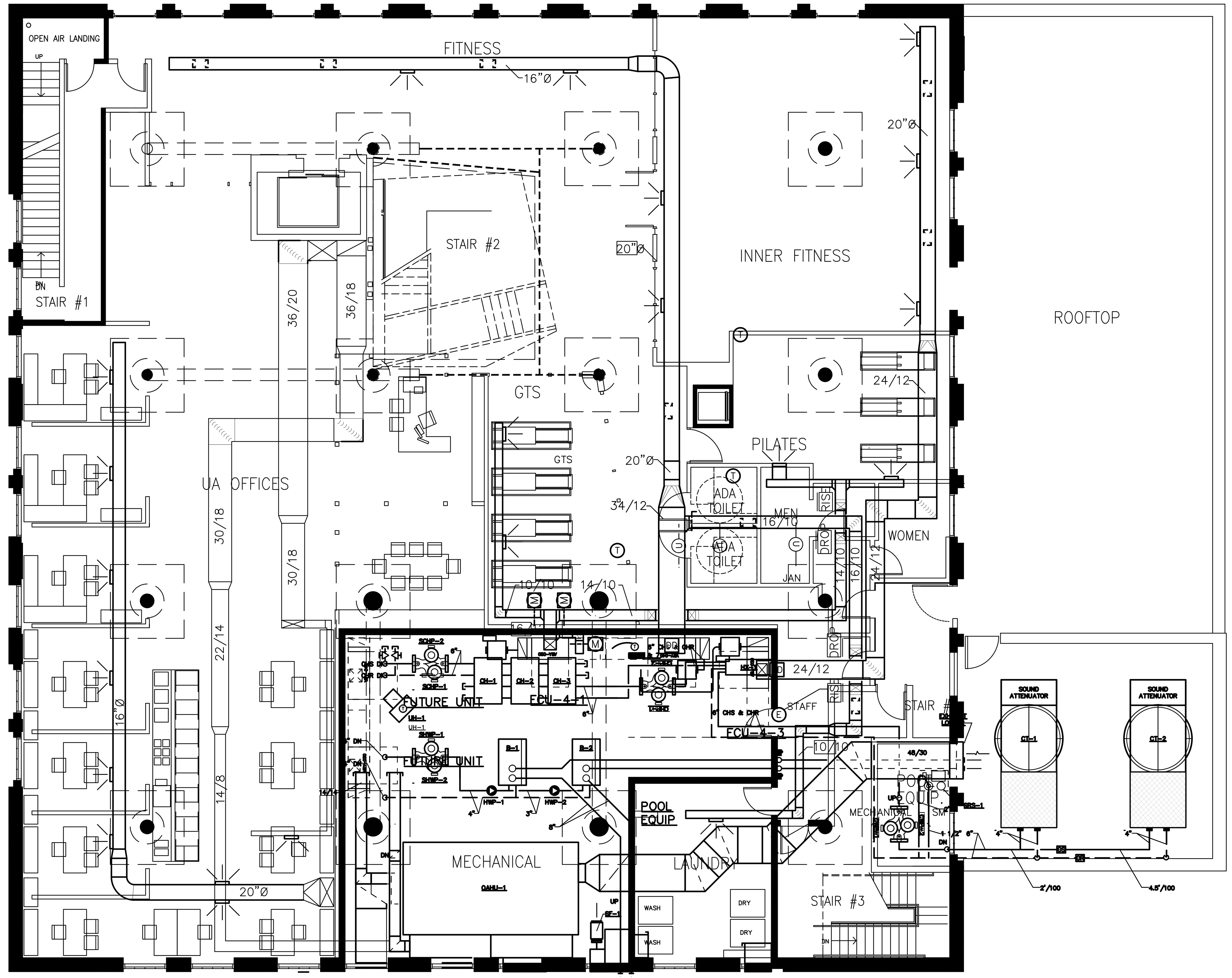
1 THIRD FLOOR PLAN
1/8" = 1'-0"

VIDA Fitness
1612 U St. NW
Washington DC

DATE	CONSTRUCTION
4/4/2012	REDESIGN

SHEET TITLE
Third Floor Ductwork Redesign

SHEET NO.
M1.03



1 FOURTH FLOOR PLAN
1/8" = 1'-0"

VIDA Fitness
1612 U St. NW
Washington DC

DATE	CONSTRUCTION
4/4/2012	REDESIGN

SHEET TITLE
Fourth Floor Ductwork Redesign

SHEET NO.
M1.04

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PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
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APPENDIX BB

ELECTRICAL AND MECHANICAL BREADTH SUMMARIES

ELECTRICAL AND MECHANICAL BREADTH SUMMARIES

Electrical Breadth: System Impacts and Electrical Tie-in

The VIDA electrical system ties into the grid from the existing connection, a 208/120, 3-phase, 4 wire, 1600 amp feed supplied by Pepco. Each of the 120 cardio units is fed into an inverter, which is tapped into the AC main panel and can handle approximately 20-25 cardio machines (Parks). According to the facility proposal provided by ReRev specifically for VIDA, six 3,600 watt grid-tied inverters will be required for this facility.

In order to properly size the breakers and wires, it was necessary to work backwards from the information provided by ReRev in their System Proposal. ReRev provided a wire size of #14 AWG from the control board (located inside each piece of cardio equipment) and the junction box. A #8 AWG wire size was also provided between the DC Disconnect and the Inverter. Assuming a Power Factor of one, the ampacity of the wires between the Inverter and AC Disconnect was determined. Once calculated, this number was used in conjunction with the National Electric Code (NEC) to determine a wire size of #12 AWG which has a maximum ampacity of 25 amps. This is greater than the required 17.3 amps, so this size wire is suitable.

Due to the lack of space in the existing panels, it was necessary to add an additional panel. The breakers were also sized with the NEC, and were found to be 20 amp breakers. This number is greater than the wire ampacity but less than the maximum load ampacity, so it is appropriate in this instance. Using the NEC, the main circuit breaker was sized for a 150 amp capacity, greater than the 129.8 ampacity required. The wire sized for the MSB to the service is 1/O and has a 150 amp capacity. With these numbers two panel schedules were designed.

Mechanical Breadth: CPM Calculations and Duct Sizing

Once Layout 2 was chosen as the best duct design, it was necessary to calculate the Cubic Feet per Minute (CFM) of Outside Air (OA) required for each space. This number is based on the size of the space, the use of the space, and the number of occupants in the space. Once it is determined it can be used to size the required ductwork that distributes the outside air.

The square footage for each area was taken from the project's architectural drawings. All occupant and outside air requirements are standards determined by The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). For each space, the CFM provided is determined by summing the area's square footage multiplied by the OA requirements per square foot and the number of occupants multiplied by the OA requirements per occupant. The number of occupants per space and CFM provided to each space were calculated.

These CFM requirements for each space were used in conjunction with a Ductulator Duct Designer to determine the ductwork size for each area. A friction loss of 0.1 inches of water per 100 feet of duct was the assumed friction loss factor. The Layout 2 completed and redesigned ductwork layouts for each floor (including duct size labels) can be seen in Appendix AA.

APPENDIX CC

MAE REQUIREMENTS

MAE REQUIREMENTS

The integrated BAE/MAE requirements for this senior thesis research were fulfilled on two technical analyses, Analysis 3: Implementation of Job Order Contracting and Analysis 4: Mechanical System Layout Constructability and Value Examination.

Job Order Contracting Implementation

JOC was introduced and discussed by Dr. Robert Leicht in AE570: Production Management in Construction. The idea to implement JOC instead of the traditional Design-Bid-Build process was developed with sources and information learned in this class. The knowledge gained from this class was incorporated into this analysis in the determination of how JOC could be used to decrease the length of procurement and preconstruction, increase overall quality, and provide a substantial cost savings for both Forrester and the Owner.

Mechanical Ductwork Design Process Map

Dr. Leicht taught AE572: Project Development and Delivery Planning, which was incorporated into the fourth analysis with the creation of the Mechanical Ductwork Design Process Map used for decision making on mechanical system designs and layouts. This process map was developed to outline the process, factors, and information associated with a ductwork design and connects any referenced information to the process stages along with any information that may be exchanged between design or construction parties.

Appendix DD

Conclusions and Recommendations

CONCLUSIONS AND RECOMMENDATIONS

Technical Analysis 1: Application of ReRev Energy Harvesting System

Not only does the installation of a ReRev system at VIDA promote the generation of clean, carbon-free electricity, but it also exemplifies a unique and trendy approach to commercial sustainability application. With the incentives for renewable energy, the payback period is only five years for the installed ReRev equipment and predicts an accrued savings of $730,371.52 after 20 years and $2,084,704.75 after 40 years. Even if the incentives could not be obtained, the payback period is still only 11 years. Because of these results, it would be theoretically recommended that a ReRev system be implemented at VIDA.

Technical Analysis 2: Study of Scheduled Overtime Effects on Worker Productivity

It is apparent from this analysis that scheduled overtime negatively affects productivity levels and that the proper selection of a work schedule should be thoroughly considered before implementing one on a construction project. Productivity levels decrease with increases in the number of work hours per week and/or the number of work days per week; this is due mainly to the increase in disruptions, which includes the inability to afford materials, tools, or other resources at an enhanced rate (Raynar). Taking these actualities into account, not only is it possible to select an appropriate work schedule for a project before construction commences, but it is also feasible to predict the costs associated with accelerating an ongoing schedule. This can be advantageous to numerous parties, including the project team, contractors, and the owner. It also affords an owner the opportunity to come to an agreement with a contractor to be paid for a predetermined productivity loss throughout the construction of the project.

The Work Schedule Alternatives table analyzed the days per week, hours per week, and productivity losses for each work schedule prospect. Comparing the results allowed for the 4-9s and 1-8 work schedule to be selected as a superior schedule for implementation on the VIDA construction project. The theoretical 4-9s and 1-8 work schedule decreased both the weekly work hours and the number of days worked per week, which saved subcontractors a total of over $1.3 million in wasted labor costs and decreased the schedule by approximately 2%. Though the schedule reduction is negligible, the cost savings is significant and would save both the subcontractors and, subsequently, the Owner, a substantial amount on labor costs. It is for this reason the theoretical 4-9s and 1-8 work schedule would be recommended over the existing 6-12s work schedule on the VIDA project.

Technical Analysis 3: Implementation of Job Order Contracting

In place of the traditional Design-Bid-Build process, this analysis proves that JOC could be implemented with Forrester Construction holding a JOC contract with a subcontractor on four VIDA projects. This pre-qualified steel subcontractor could prevent the selection of inadequate subcontractors for VIDA projects which could, in turn, increase service and quality levels. Implementing JOC could also potentially save the steel subcontractor approximately $465,000 and Forrester Construction approximately $9.9 million combined between the four fitness centers. As previously discussed, JOC could also decrease the procurement and preconstruction durations and allow for the steel construction to commence 6-8 weeks sooner than scheduled. This could eliminate potential delays that were caused on the U Street VIDA by the steel subcontractor taking longer than originally expected.

It is clear from these results and this detailed analysis that employing JOC on four VIDA projects would have been extremely beneficial to Forrester Construction, the steel subcontractor, and the Owner. Because of this, if the fitness centers were not yet built, it would be theoretically recommended that JOC be implemented for the four VIDA Fitness construction projects.

Technical Analysis 4: Mechanical System Layout Constructability and Value Examination
With this analysis, two new potential ductwork layouts were designed and compared with the existing layout. Though the second layout costs approximately $85,284.59 more than the existing layout, it is more aesthetically pleasing, more easily constructible, and adds additional lines to areas of the building that were not conditioned properly. Even with these additional costs, it is still recommended that Layout 2 be theoretically used in place of the existing layout.