Residence Inn By Marriott

2345 Mill Rd, Alexandria, VA

Julia E. Phillips

Construction Management

Senior Thesis Final Report

Spring 2008

Residence Inn by Marriott

2345 Mill Rd., Alexandria, VA 22314

Project Overview

- *Owner: Miller Global Properties*
- *Occupant: Marriott Hotels*
- *CM: Balfour Beatty Construction*
- *Civil: Christopher Consultants*
- *Function Type: 181 room Hotel*
- *Size:169,206 sf, w/ underground parking*
  125,548 sf, residential hotel rooms
- *Total Levels: 15 stories above grade, with 3 below grade of underground parking*
- *Project Delivery Method: Design-Bid-Build for Architecture / Structural, Civil*
  Design-Build for MEP systems.
- *Project Cost: $33.5 Million*

Architecture – Davis, Carter, Scott Design

- *Exercise room and spa on the second floor.*
- *The exterior of the building was designed to emphasize horizontal lines with an off-set top edge with "punch-out" windows.*
- *The curtain wall system spans the total height on the southeast corner over the lobby.*
- *Entrance is designed to add aesthetic appeal while mimicking the building across the street to create a "column of light" when the afternoon sun hits both buildings.*
- *20 LEED points required by City of Alexandria, and emphasizing the top, middle, and bottom of the façade.*

Structural – SKA & Associates

- *3ft. reinforced Mat slab with a "false slab" underneath to aid in water proofing.*
- *7.5 inch Post-tensioned Concrete floors*
- *Façade is brick panels with precast concrete panels and CMU back-up*
- *Typical Column Size: Cast in place concrete 18x30 moving to 14x30, spaced at 19ft N-S and approx. 15ft E-W with 12x18 concrete beams.*
- *9" thick window with STC of 59 due to Metro noise.*

Lighting / Electrical – Dynalectric

- *3000 a. at 480/277 v. 3ø. 4W. switchboard*
- *A typical guest room with all equipment on draws 58 amps.*
- *Transformers: 1 - 750 kva feeds the bus-duct riser, which provides 120/208 v power to all of the guest room panels.*
- *7 other transformers provide step down voltage from 480 to 120/208 volt power for various areas such as the back of house outlets, low voltage kitchen equipment, corridor lighting and power, and miscellaneous garage power.*
- *400 kw, 480 v back-up generator would provide power to all emergency lighting, fire alarm, stair pressure fans, smoke removal fans, fire pump, emergency for elevators, selected circuits for security.*

Mechanical – Southland Industries

- *1 Air cooled chiller located on the roof with nominal capacity of 155 tons.*
- *2 natural gas fired boilers with a capacity of 1,800,000 btu input and 1,530,000 btu output, used for domestic and air handling unit needs.*
- *Chilled water fan coil unit system with electric heating coils in the fan coil units for heat for each guestroom.*
- *Variable Air Volume units with electric hear coils for the lobby, offices, and other spaces on the first and second floor.*
- *Two shell and tube heat exchanges used to generate the domestic hot water with a capacity of 1,424,000 btu each.*

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http://www.engr.psu.edu/ae/thesis/portfolios/2008/jep249/

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Executive Summary

Three technical issues and one critical industry research area will be explored for possible improvements. Throughout these analysis and research areas I hope to add value to the building by implementing more green technologies and materials, as well as reducing the schedule and cost, and improving the constructability of the project.

The underground structural system provides an area for improvement because the underground garage is made entirely of cast in place concrete. The project is already behind schedule due to unexpected water issues, if the garage was made of pre-cast Filigree panels there is a possibility for schedule acceleration without taxing the ability of the tradesmen. Based on the analysis of structural design, cost, schedule, and constructability the Filigree slab and beam system is the recommended system. It exceeds the original design and the flat plate re-designed system in every aspect. It is quicker, saves the owner money, and helps them bring in more revenue.

The fan coil units in each guestroom are set to run 24 hours a day. This is due the high sound levels produced by the nearby metro tracks. This provides an area of research in finding better controls and sound attenuation system in the façade to reduce the amount of energy consumed. Based on the analysis, the Delta Controls system using the DNT – T103 is the recommended system. It produces a superior system to the original but is not as expensive as the INNCOM system. Its performance results are nearly equivalent to the INNCOM. This system provides the guests with an acceptable environment thermally and acoustically as well as providing savings to the owner.

Hotels produce a large amount of greywater everyday; this provides another area of research to institute a greywater system into this hotel. This should not add a great deal of design and construction coordination because the building already has separate supply risers to the water closets and shower as well as having the water closets in an easily separated location on the sanitary riser. Based upon this analysis the constructed wetland greywater treatment system has both positive aspects and negative aspects associated with it. These aspects should be considered when deciding to install a constructed wetland system. Considering these factors, the owner of the project would play the deciding role. The system would be recommended if the owner is focused on helping the environment and aesthetic appeal of the building. However, the system would not be recommended if the owner is only concerned with the bottom line, saving money.

There an unfortunate misconception in this industry that adding green value or achieving LEED points simply costs too much no matter what the benefits could be. The goal of this research is to investigate the sustainability or “Greening” of hotels by incorporating green design into the project and analyzing the corresponding cost. This research will compare typical building materials and systems to their green alternative. The analysis includes comparing upfront cost, installation cost, and life cost to determine which is most economical.

Introduction & Project Background

The Residence Inn by Marriott is located at 2345 Mill Rd. Alexandria, VA. It is conveniently located near many government buildings allowing for long term guests on business to be close to work. The site is very constricted and is defined by the two streets that border the site as well as two metro tracks that cut through the Southwest side of the site. The Marriott is owned by Miller Global Properties and operated by Marriott staff. It is a 181 room, 15 story Hotel, post tensioned concrete structure, with 3 levels of underground parking on site.

In Alexandria, Virginia, every new building that is designed and built must go through a rigorous approval process. The city must approve the building use, design, façade, exterior penetrations, colors, and each building must have at least 20 LEED points. After this approval takes place the façade cannot change without re-doing the same process to evaluate the changes. The building must have minimum exterior penetrations, and they must be visually appealing or disguised in some way to hide them from the public view. The exterior colors also must consist of the very top of the building being a light beige color, with a pink / mauve brick façade in the middle, and a red brick on the base. As well as each portion of the building being distinct and identifiable as a top, middle, and bottom. The city also requires an appealing exterior walk with shade trees and wide walkways to blend each new building with the existing buildings.

This building consists of four different types of wall sections. The three walls bordering the two metro tracks consist of face brick with concrete masonry block back up and pre-cast exterior panels with thick batting insulation and drywall interior. The fourth wall on the opposite side of the metro tracks is partly made of face brick and pre-cast panels as well as some metal cladding with rigid and batting insulation back up, as well as the corner of the curtain wall system. On roof and penthouse area has an EFIS system with a pre-cast concrete back up, and rigid insulation. The roofing system is made of parapet walls with a roofing membrane, protection board, and tapered rigid insulation over a post-tensioned concrete slab.

Client Information

Miller Global Properties, LLC is a partnership between Miller Properties Group and Global Holdings. Miller Global Properties, LLC is a private equity fund corporation which develops, acquires and temporarily owns the projects they build, once stable the buildings are sold to make a profit; the operation of the building is usually contracted to the tenant. Miller Global started by leasing and selling office buildings Denver, CO but now lease and sell many types of buildings including high rises, like the 40 story Nakatomi Plaza featured in the movie Die Hard, and hotels around the world in cities like Amsterdam and London. Mickey Miller and Jim Miller are the current owners and operate the day – to – day activities. Miller Global currently has projects in progress in Alexandria, VA, Orlando, FL, Seattle, WA, San Antonio, TX, and soon to be in San Diego, CA, Hawaii and Dubai.

Miller Global has strong commitment to making the guest experience the best it can be. They do this by having high design and construction standards for all projects. Miller Global aims to out do the neighboring buildings by having more efficient installation of windows and equipment, minimizing façade penetrations, and sometimes paying an extra expense to have the latest greatest technologies and construction methods. They showed this commitment while building the Marriott Hotel on Duke St also in Alexandria, VA, by installing the most efficient mechanical system and upgrading the telecom system from the standard CAT 5 cable to fiber optics knowing that fiber optics is the best choice and will soon replace the Cat 5 cable. In Seattle, they upgraded the mechanical system from the common V-Tack system to a more efficient 2 pipe system. In the Residence Inn Marriott they are currently building they have chosen to install a more expensive but very efficient 4 pipe mechanical system that is longer lasting and more functional, and use fiber optics with CAT 5 cables for the Voice Over IP phone system and television instead of the common CAT 3 analog phone system.

Miller Global chose to build this Residence Inn Marriott in Alexandria because they have already built a Marriott on Duke St in Alexandria and have had great success with it. They know what to expect from the city requirements; they also know that they will have good returns and a constant guest flow due to being located very near the Pentagon. They also chose to take on this project after a one year delay. Marriott almost abandoned the project due to high cost and approval issues. However because of the good experience with the Duke St Marriott, Miller Global knew that this would be a successful project once approved by the city.

The key sequencing issues Miller Global is concerned with are the same for all of their projects: finishing on schedule and on budget, and maximizing the guest experience. If those key things are achieved they have built a successful project. Once Miller Global has owned the building for about 5 to 10 years they will most likely sell the building to a real-estate investment company because they have contracted the operations and maintenance to Marriott and want to sell the property to a long term owner.

Project Delivery System

A detailed hierarchy of the project team can be seen on page 8.

The delivery method for the Residence Inn Marriott was partly design-bid-build and partly design-build. The mechanical, electrical, and plumbing trades are design-build and everything else is design-bid-build. The reason for this is because Southland Industries, the mechanical and plumbing design contractor, has a very good relationship with the owner, Miller Global Properties, and after discussing the project Miller Global agreed to a design-build contract. Southland has done projects with Miller Global in the past and from their excellent reputation and design work, Miller Global knows the head engineers at Southland and felt comfortable enough to do this design-build and to also speed up the construction process. Southland holds a GMP contract with Balfour Beatty Construction with a shared savings clause that gives incentive

to bring the project in under budget and the savings would go to the owner providing that the scope does not change. Miller Global also selected Dynalectric Company for the electrical design-build for the same reasoning.

Balfour Beatty Construction was selected by Miller Global for this project also because they have a good rapport with the owner and was able to easily negotiate a GMP. The civil engineer, Christopher Consultants, was also selected by Miller Global and has a phased lump sum contract directly with them due to the many stages of work that is required for the civil work. Davis, Carter, Scott Design was selected for this project because they have done work in Alexandria, VA before and has experience with the approval board there; and through them SKA Associates was selected as the structural engineer.

During the preconstruction phase, as Balfour Beatty Construction was putting together their GMP estimate, they "bid" out all the subs including the design-build companies to get a handle on the cost of the project. During this phase all subs were required to include a bond in their estimate. From the tabulation of those numbers Balfour Beatty took out a bond that covers all of their subs. Balfour Beatty also required certificates of insurance for their subs; all other companies must present one to Miller Global.

Due to the nature of the project, and the delay in the middle of design, Davis, Carter, Scott Design holds a Cost + Fee contract directly with Miller Global. This is enables them to charge the owner with change orders because of changing the design from having a spa to have an exercise room instead. Under Davis, Carter, Scott, SKA holds a Lump Sum contract with them for the structural work. Miller Global also holds a contract directly with Riegel Consulting, they are an agent to the owner to help coordinate design and construction and are present if the owner cannot be; they act as the owner representative to help orchestrate the project.

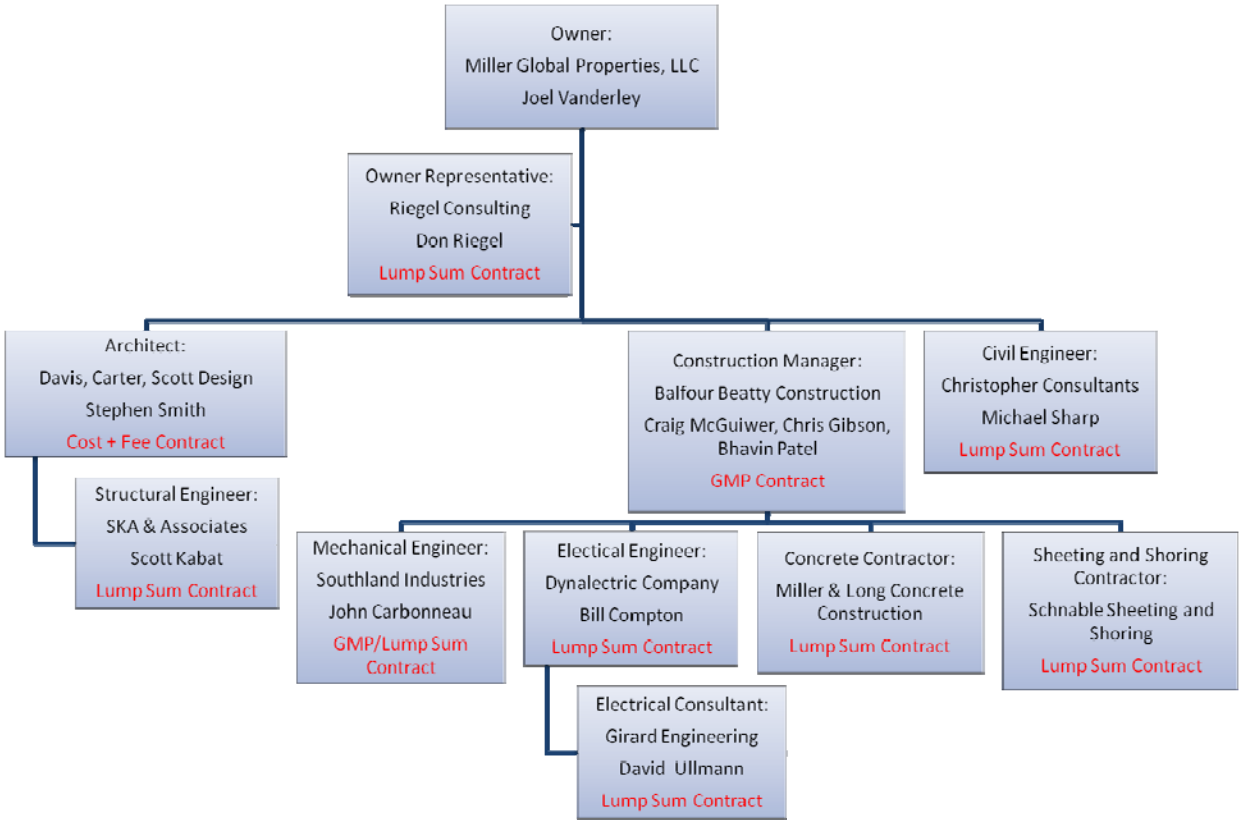

Figure 1: Project Heirearchy

Staffing Plan

Balfour Beatty Constructions Division VP and Purchasing Manager; Matt Dye and Ken Lyons are located in the Fairfax, VA office. They ensure the project was acquired correctly and helped in the pre-construction activities of negotiating the GMP contract. All other staff is located on site in the trailer. Craig McGwier coordinates the meetings for the MEP trades while Chris Gibson and Bhavin Patel organize all RFI's and weekly trade meetings on site with the superintendent Bill Carroll. The accountant Maria Serrano is also on site to help ensure that money is being spent correctly and paying the subcontractors. Chief Field Engineer, Brian Fox helps Bill Carroll handle the day to day activities of the trades on site. They make sure each trade submits daily progress reports to Balfour Beatty Construction so productivity can be tracked accurately. The hierarchy can be seen below.

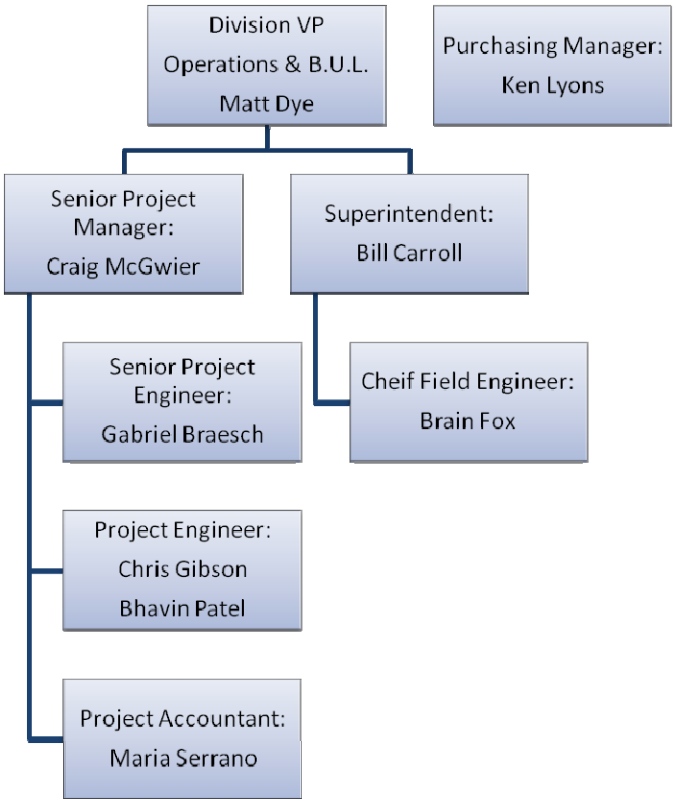

Figure 2: Balfour Beatty Project Staff

Site Plan of Existing Conditions

The site is in "Old Town" Alexandria, VA. It is neighbored by the city courthouse and other apartment buildings; it is also very close to the Pentagon. It is located just off Capital Beltway I-495 E at 2345 Mill Rd. This location enables long term guests on business for the government, and is convenient for their commute. The site is extremely restricted; it is bordered by two metro tracks and two roads. The delivery trucks must use I-495 to Telegraph Rd North, then onto Mill Rd to gain site access. All other roads in Alexandria are too constricted to use for site deliveries. There is virtually no space on site for long term storage or lay down. Mill road to the south of the site has been instituted for construction deliveries by blocking one of the two lanes available and using flaggers to direct traffic.

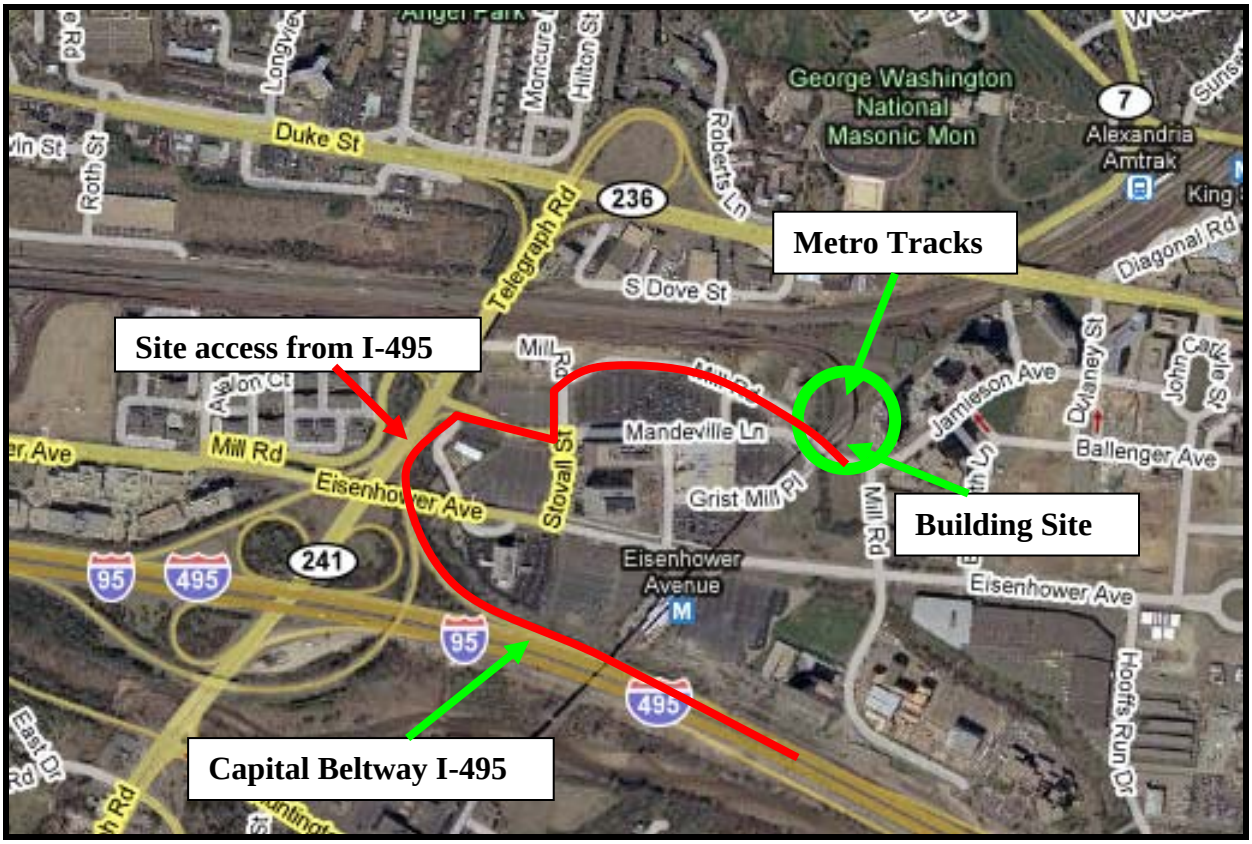

Figure 3: Road Map of Jobsite Access
Courtesy of Google Maps

Local Conditions

There are not many predetermined construction methods used in Alexandria, however concrete, pre-cast, cast in place, and post tensioned, are very common. This building uses all three types of concrete and it is possible to hire skilled workers that are comfortable working with these types of concrete, this is in part because Alexandria relies heavily on union workers. There is no on-site parking due to a constricted site; workers are expected to park in public hourly garages. The cost of parking in the nearby garages is reimbursed by Balfour Beatty for all trades, and has been accounted for in the budget. When interior construction starts there will be dumpsters on site placed under the metro track with the trailers for recycling for LEED points. The soil found on site is mostly yellow / brown fat clay in the sub-grade and silty clay with gravel near the surface. They were not expecting to encounter water problems based on the geo-tech report, but that is not the case. The excavation required is below the water table and there has been a lot of de-watering needed before pouring the mat slab foundation, as well as placing a working slab underneath the mat slab to aid in water proofing the site.

Architecture & Building Systems Summary

YES	NO	WORK SCOPE
	X	Demolition Required?
X		Architecture Features
	X	Structural Steel Frame
X		Cast in Place Concrete
X		Pre-cast Concrete
X		Mechanical System
X		Electrical System
X		Masonry
X		Curtain Wall
X		Acoustics
X		Support of Excavation
X		Transportation

❖ *Architecture*

The building consists of three levels of underground parking and 15 levels above ground. The main lobby is located on the first floor at ground level, with an exercise room and spa on the second floor. All levels above grade are post-tensioned concrete chosen to maximize the floor to floor height and enabled the design to add floors for little cost. The exterior of the building was designed to emphasize horizontal lines through the building and an offset top edge with

"punch-out" windows throughout the building. The curtain wall system spans the total height on the southeast corner of the building over the lobby entrance. It is designed to add aesthetic appeal while mimicking the glass curtain wall of the building across the street to create a "column of light" effect on either side of the street when the afternoon sun hits both buildings.

❖ *Cast in Place Concrete*

The mat slab foundation, the three underground parking levels, and the post tensioned floor decks are made of cast in place concrete. The mat slab thickness ranges from 30, 36, to 48 inches thick is 5000psi normal weight reinforced concrete and has a minimum 4" working slab of 2000psi concrete underneath it to aid in stopping water penetration. The drainage and sump pump pits were formed in the ground during pouring. The walls and columns of the parking levels are minimum 18' spans with average 10' by 10' drop panels and formed with vertical reusable formwork with 5000 psi normal weight concrete. The parking level floors are 8" thick and made of 5000 psi cast in place normal weight concrete. The typical post tensioned floors above grade are 5000psi normal weight concrete, once the strength reaches 3000 psi tensioning of the cables can occur. All exterior and exposed cast in place concrete is air entrained 3000psi concrete.

❖ *Pre-Cast Concrete*

The façade of the building above grade is comprised of pre-cast concrete with a rigid insulation and CMU backup system. The pre-cast concrete is prefabricated in panels to look like red brick to help it blend with the other buildings in Alexandria. The precast panels will be connected vertically with tee connections, and horizontally with ties imbedded in the mortar joints of the CMU block backup system.

❖ *Mechanical System*

The system is primarily a chilled fan coil unit system with electric heating coils in the fan coil units for heat. There is one air cooled chiller located on the roof that has a nominal capacity of 155 tons which pumps chilled water to the coils inside the fan coil units in each guest room. The variable air volume air handling unit located on the second floor that provides air for the lobby, offices and all other spaces on the second floor. The variable air volume boxes in the ceiling also have electric heat coils to provide heat to the spaces. There are two natural gas fired boilers that have a capacity of 1,800,000 btu input and 1,530,000 btu output. The boilers are used for domestic hot water needs and for heat inside the second floor air handling unit needs. The system also has two shell and tube heat exchanges used to generate the domestic hot water which have a capacity of 1,424,000 btu each.

The fire protection system in the building is rather complex and some aspects are added as a "code plus" to make the system more advanced. The roof top makeup air unit provides ventilation for the corridors, bathroom exhaust, and smoke ventilation. The unit normally operates at a low flow but increases once smoke has been detected by a smoke detector located in every room in the building. The smoke exhaust system is designed to provide about 12 air changes per hour, 67% of the volume on the fire floor, and pressurize the stairwells and hoistways. This is done to control the migration of smoke throughout the building, mainly focusing on the means of egress into and out of the building. While the system is in fire mode, no service will be provided through the small VAV boxes. When the smoke detectors are tripped fire dampers will open fully enabling the pressurization of the stairwells and hoistways, which means they will remain operable during a fire emergency.

❖ *Electrical System*

The switchboard is rated at 3000 amps with 480/277 volts, 3 phase, 4 wire system. A typical guest room with all equipment on draws 58 amps. Most lighting fixtures are fluorescent to add efficiency to the design and to attain the appropriate LEED points. The following transformers service the building: one 750 kva feeds the bus-duct riser, which provides 120/208 volts power to all of the guest room panels; seven other transformers provide step down voltage from 480 volts to 120/208 volt power for various areas such as the back of house outlets, low voltage kitchen equipment, corridor lighting and power, and miscellaneous garage power. The backup generator is sized at 400 kw and 480 volt would provide power to all emergency lighting, fire alarm, stair pressure fans, smoke removal fans, fire pump, emergency for elevators, selected circuits for security if the power should ever go out. The telecom load is very small and is accommodated by miscellaneous 20 amp circuits in the telecom closets to run the servers and routers. In the workout room there are 20 amp circuits for each major piece of equipment, like treadmills and plasma screen televisions.

❖ *Masonry & Curtain Wall*

There is very little masonry throughout the building; it is only in the CMU back-up wall system and on the face brick façade. The CMU is located behind the per-cast concrete panels with a full bond mortar joint and is designed to help sound attenuation and thermal insulation with the rigid insulation. There is also masonry in the brick paving on the sidewalks, but this is only for aesthetic appeal. The curtain wall system spans the total height on the southeast corner of the building over the lobby entrance is designed to add aesthetic appeal while mimicking the glass curtain wall of the building across the street to create a "column of light" effect on either side of the street when the afternoon sun hits both buildings. The curtain wall is also designed to hide the fact that there is no atrium; the lobby is only one floor in height.

❖ *Acoustics*

Shen, Milsom & Wilke performed an extensive acoustical noise study on site before construction began. This was done to learn as much as possible about the sound levels of the metro Yellow Line that runs very frequently at night, about every 5 to 10 minutes. A 24-hour measurement was conducted from 26-27 July 2005. Site measurements were also conducted on 26, 27 & 29 July 2005. Measurements were taken at the grade level and at the elevation of the raised Metro track. Metro trains traveling on the elevated track reached levels of 100 and 102 dBA. Metro trains in service traveling on the grade level tracks reached levels between 85 and 99 dBA depending on whether the operator used the horn when entering or exiting the tunnel. This research in very important to Miller Global because their main focus for every building is the guest experience. Since the World Health Organization (WHO) requires a 30 dBA level sound for good sleep the metro noise could be a large potential problem since most of the metro activity occurs at night.

Once field measurements were taken SM&W performed tests with mock up window assemblies of different STC / OITC ratings that are acceptable to the WHO. Five assemblies were tested all of which outperformed the national regulations. The third assembly proved to be the most cost effective (approximately $200 / SF) which is:

1 ¼" IGU consisting of ¼" Annealed
+ ¾" Air Space
+ ¼" Annealed with
5 3/8” air space and
3/8” laminated

This equals a total frame depth of 9”. The configuration provides an increase in performance of 3 dB at 630 Hz and 6 dB at 4000 Hz, the most critical frequency bands.
Based on this research they concluded that the appropriate window required a Sound Transmission Class (STC) of 59 and Outdoor-Indoor Transmission Class (OITC) of 46. This assembly out performs the WHO and Department of Housing and Urban Development (HUB) requirements of STC 56 and OITC 43 even without the sound barrier that will be installed. Heavy drapes will also be hung on the interior side of the windows to further help sound attenuation and increase the guest experience.

❖ *Support of Excavation*

The excavation needed support on all sides and is clear of all permanent construction work. However, due to the restrictions working around the metro tracks tie-backs were not allowed in fear of disrupting or moving the column foundations that support the metro, instead large rakers had to be installed across the site. On the other three sides that did not border the metro a regular

tie-back and lagging system was used. There were some issues during excavation with failing tie-backs; in those areas rakers were installed to support the walls. Also one raker had to be moved since it was placed on a future column line. This was done because the sheeting and shoring is to remain in place during construction.

❖ *Transportation*

There are three elevators located in one elevator bank in the southwest corner of the building. These elevators run from the lowest P-1 parking level to the highest space on the 15th floor. There are three stairwells labeled A, B, and C. Stair A is located adjacent to the elevator bank in the southwest corner and also runs from P-1 parking to the 15th floor. Stair B is located opposite Stair A in the northeast corner, and only services the underground parking levels to street level. Stair C is located adjacent to Stair B in the northeast corner, and services the first through the 15th floor.

Project Schedule Summary

Please see Appendix A for the Project Schedule Summary and Detailed Project Schedule.

Notice to Proceed was given on Friday June 9, 2006 afterward design went on as planned. However, once design just finished the 100% Design Documents there were cost and ownership issues and the project was put on hold for about nine months. After which Miller Global Properties took over the project early in 2007.

Since then, excavation has taken place from March to June 2007 and the mat slab and parking levels have been poured. During this process the concrete was poured in three phases working from North to South through the building footprint, each phase is about a third of the building footprint. There have also been some delays during excavation; the water table was much higher than expected and a great deal of de-watering had to take place. The schedule since then has been accelerated to make up for the lost time. Once the upper more typical floors are in construction the schedule will be able to catch up and make up for the time.

One of the most crucial parts of the schedule is the parking level concrete. This will determine the length of time left to complete the project. The post tensioned concrete floors above also rely on this being completed on time since they must cure to the proper strength before the cables can be tightened. Once the floors are tensioned the shoring can be removed the exterior brick and CMU backup can be installed followed by the parapet EFIS system.

After the tower is built the interior work will also be able to move quickly. This is possible because most of the guestrooms are very similar and have many typical finishes. After the

interior work is complete all that remains is testing and balancing and turning the project over to the owner.

The schedule has been accelerated more than previously to try to make up for lost time from delays while pouring the lower level parking areas. Fortunately due to a repetitive floor plan the other trades will be able to keep up with the reworked durations during the interior construction. The Residence Inn is being constructed like many other high rise repetitive buildings have been done. The excavation was first, to install the mat slab foundation and water proofing. Then the below grade concrete levels and columns were constructed followed by accelerating the upper floors easily because of a repetitive floor layout and penetrations. The tower crane is placed in an area that can be finished quickly at the end of the project (crane placement can be seen in the Detailed Site Plan Appendix C).

The interior floor construction is understood easiest by floor; however each floor is also organized logically by trade. Once interior construction starts it progresses through each floor in approximately 150 days while leaving time at the end of the schedule to close up the room that had the tower crane. The progress through each floor consists of the following sequence:

Interior Construction Sequence: 3rd Floor

Task	Duration	Start	Finish
Layout Floor	5 days	11/2/2007	11/8/2007
3rd Floor Interior Construction	153 days	11/2/2007	6/10/2008
HVAC Risers and Wall/Clg.Rough In	7 days	11/9/2007	11/19/2007
Fire Protection Rough In	3 days	11/20/2007	11/26/2007
Frame Walls, Core, Set Door Frames	5 days	11/27/2007	12/3/2007
Set Tubs, Strap Waste and Risers	4 days	12/4/2007	12/7/2007
Exterior Studs - East Side	4 days	12/7/2007	12/12/2007
CMU Exterior South	2 days	12/14/2007	12/17/2007
CMU West	2 days	1/8/2008	1/9/2008
Frame Exterior Walls	4 days	1/8/2008	1/11/2008
CMU North	2 days	1/10/2008	1/11/2008
Electrical Wall/Clg Rough In	4 days	1/10/2008	1/15/2008
Inspections, MEP, Elec, Wall Close In	5 days	1/16/2008	1/22/2008
Install Windows 3rd Floor	5 days	1/16/2008	1/22/2008
Hang Shafts (str., elev, 3 side MEP) Purple	3 days	1/23/2008	1/25/2008
Temp Dry in up to 6th Flr.	5 days	2/13/2008	2/19/2008
Hang Dry Wall & Tape except at FCU's	8 days	2/20/2008	2/29/2008

Set and Hook Up FCU / Inspect for Close In	5 days	3/3/2008	3/7/2008
Hang Drywall and Tape at FCU's	4 days	3/10/2008	3/13/2008
Temporary Conditioning	1 day	3/28/2008	3/28/2008
Install Wood Trim	4 days	3/31/2008	4/3/2008
Prime Paint and Texture Clgs	3 days	4/4/2008	4/8/2008
Point up, Reprime	3 days	4/9/2008	4/11/2008
Wall Covering and Paint, Tile	5 days	4/14/2008	4/18/2008
Install Kicthen and Bath Casework	7 days	4/21/2008	4/29/2008
Install Kitchen Sinks, and Electrical Trim	4 days	4/28/2008	5/1/2008
Final Coat Paint	3 days	5/2/2008	5/6/2008
Install Carpet	5 days	5/7/2008	5/13/2008
Start up FCU, Test MEP	5 days	5/14/2008	5/20/2008
Punch Floor	5 days	5/21/2008	5/27/2008
Complete Punch	5 days	5/28/2008	6/3/2008
Owner FFE Items	5 days	6/4/2008	6/10/2008
5 Day Stagger	5 days	6/11/2008	6/17/2008
Complete Walls and Finishes at Hoist Room	10 days	8/8/2008	8/21/2008
Owner FFE at Hoist Room	2 days	8/22/2008	8/25/2008

Figure 4: Interior Construction Schedule
Courtesy of Balfour Beatty Construction

The HVAC rough-in occurs very early in the process followed by the Fire Protection, and shortly after that the Electrical rough-in. After the rough-ins occur the systems are inspected and the rest of the interior construction can flow smoothly. As the rough-ins are taking place the masonry is being installed to help close in the building as quickly as possible. The close in of each floor occurs about half way through the interior construction of that floor. This helps the finish trades progress quickly since the environment inside the building will be more controlled for dry wall, painting, and wood trim activities. Each floor is punched when construction is completed with the exception of the hoist room, this will help when closing out the project. There will be a minimum amount of punchlist items left once the interior construction is complete and help finish on time. This also allows for the time needed at the end of the schedule to remove the tower crane and close up the room on each floor that had not been completed. Since the hoist room has its own punch and turnover process it can go very quickly because there will need to be only one room per floor punched rather than the entire floor. This enables other punchlist problems to be addressed before the hoist room is completed and possibly causing the project completion to be delayed.

Project Cost Evaluation

Total Square Footage, including underground parking: 169,205 SF

Construction Cost:	Actual: $28,587,075.00 Per SF: $168.90 / SF
Total Project Cost:	Actual: $33,500,000.00 Per SF: $197.98 / SF
Major Building Systems:	
Mechanical & Plumbing	Actual: $6,171,501.00 Per SF: $36.47 / SF
Electrical	Actual: $3,440,000.00 Per SF: $20.33 / SF
Sprinklers	Actual: $505,980.00 Per SF: $2.99 / SF
Structural	Actual: $5,628,925.00 Per SF: $33.27 / SF
Architecture / Building Skin	Actual: $3,486,828.00 Per SF: $20.61 / SF
Interior Finishes	Actual: $2,061,826.00 Per SF: $12.19 / SF
Sound Barrier	Actual: $67,080.00 Length: 325 ft. Per LF: $206.40 / LF *Exterior of Building Footprint on Metro

R.S. Means Square Foot Data: *Square Foot Cost 2007*

Please see Appendix B for reference sheets with calculations.

Total Square Footage, including underground parking: 169,205 SF
Total Building Perimeter: 451.4 LF

M.360 Hotel, 8 – 24 Story
$132.71 / SF
Location Modifier: Commercial Alexandria, VA 0.94

R.S. Means SF Estimate: $124.75 / SF

This does not include additions for the elevators with additional stops (more than 10), fire alarms and smoke detectors, plasma televisions, and washers and dryers.

***D4Cost 2002 Estimate**: a detailed print out can be found in Appendix B.*

This estimate is an average of three similar projects chosen from the available resources in D4Cost 2002.

Code	Division Name	%	Sq. Cost	Projected
00	Bidding Requirements	5.37	$9.36	$1,774,918.00
01	General Requirements	6.55	$11.42	$2,166,291.00
02	Site Work	1.55	$2.70	$511,104.00
03	Concrete	11.49	$20.03	$3,797,518.00
04	Masonry	1.87	$3.27	$619,272.00
05	Metals	2.76	$4.81	$912,652.00
06	Wood & Plastics	2.36	$4.11	$778,903.00
07	Thermal & Moisture Protection	5.32	$9.28	$1,759,242.00
08	Doors & Windows	4.94	$8.61	$1,632,106.00
09	Finishes	6.65	$11.59	$2,198,274.00
10	Specialties	0.43	$0.75	$142,659.00
11	Equipment	0.45	$0.79	$149,073.00
12	Furnishings	0.38	$0.67	$126,306.00
13	Special Construction	0.33	$0.58	$110,743.00
14	Conveying Systems	2.40	$4.19	$794,765.00
15	Mechanical	11.10	$19.35	$3,668,401.00
16	Electrical	6.09	$10.62	$2,014,298.00
21	Fire Suppression	1.65	$2.87	$544,188.00
22	Plumbing	8.53	$14.87	$2,819,289.00
23	HVAC	9.12	$15.91	$3,015,984.00
26	Electrical	9.52	$16.60	$3,147,114.00
31	Earthwork	0.87	$1.52	$288,485.00
32	Exterior Improvements	0.28	$0.48	$91,791.00
	Total Building Costs	**100.00**	**$174.37**	**$33,063,375.00**

Figure 5: Detailed Cost Breakdown from D4Cost 2002

Cost Comparison

The differences in the calculated square foot cost versus the R.S. Means square foot cost can be attributed to the fact that R.S. Means does not include additions for the elevators with additional stops (more than 10), fire alarms and smoke detectors, plasma televisions, and washers and dryers. These additions would increase the cost per square foot to $130.51 / SF with the location modification of 0.94. This is still too low, compared to the calculated $197.98 / SF because there are some project specific costs involved with the site and permitting and the nine month delay in the middle of the project that contributed to the cost increase. The R.S. Means value of $130.51 / SF is closer to the actual construction cost per square foot than the D4Cost estimate but is still too low because of the extra measures taken during excavation and foundation de-watering problems. R.S. Means also does not account for post tensioned concrete which can increase the cost as well as a very expensive window system to block out the metro noise at night.

On the other hand the D4 estimate is only off by about $450,000.00 which considering some of the complexities of the project is rather impressive. Also the three buildings chosen to average were all shorter and had larger footprints than the Residence Inn Marriott. The square foot cost is also more accurate at $174.37 / SF but still cannot account for the very constricted site and extra precautions taken to protect the metro track and sound attenuation.

Research Introduction

Three technical issues and one critical industry research area will be explored for possible improvements. Throughout these analysis and research areas I hope to add value to the building by implementing more green technologies and materials, as well as reducing the schedule and cost, and improving the constructability of the project.

Since this project has many unique aspects there are a number of areas that can be analyzed to add improvements to the building. The fan coil units in each guestroom are set to run 24 hours a day. This is due the high sound levels produced by the nearby metro tracks. This provides an area of research in finding better controls and sound attenuation system in the façade to reduce the amount of energy the fan coil units consume and increase the acoustical properties of the façade. While analyzing these areas, LEED rated and recycled materials will be investigated to add more value to the building.

Hotels produce a large amount of greywater everyday; this provides another area of research to institute a greywater system into this hotel. This should not add a great deal of design and construction coordination because the building already has separate supply risers to the water closets and shower as well as having the water closets in an easily separated location on the sanitary riser.

The underground structural system also provides an area for improvement because the underground garage is made entirely of cast in place concrete. The project is already behind schedule due to unexpected water issues, if the garage was made of pre-cast Filigree panels there is a possibility for schedule acceleration without taxing the ability of the tradesmen.

Analysis 1: Structural Design of Underground Garage

This analysis focuses on reducing the slab depth, schedule, and cost of constructing the underground garage by instituting the use of the flat plate pre-cast Filigree structural panels. The Filigree system will also be compared to a cast in place flat plate system that eliminates stud rails and drop panels to reduce concrete, steel, and formwork use.

Analysis 2: Mechanical System #1: Controls

This analysis focuses on reducing the energy consumption by the fan coil units in the guestrooms that are designed to run 24 hours a day. This analysis is intended to provide a superior system to save energy for a minimum cost and not increase complexity in construction.

Analysis 3: Mechanical System #2: Greywater

This analysis focuses on implementing a constructed wetlands greywater system in to the building to reduce the water usage and add green value and aesthetic appeal to the building by recycling water.

Critical Industry Research: "Greening" of Hotels

The goal of this research is to investigate the sustainability or "Greening" of hotels by incorporating green design into the project and analyzing the corresponding cost. This research will compare typical building materials and systems to their green alternative. The analysis includes comparing upfront cost, installation cost, and life cost to determine which is most economical.

Weight Matrix

The table below shows a breakdown of how each analysis area will be weighted into the grading system and directly correlates to the efforts put forth while researching these areas for my senior thesis.

Description	***Research: Going "Green"***	***Value Engineering***	***Constructability Review***	***Schedule Reduction***	***Total***
Research	*10%*	*10%*			***20%***
Controls	*5%*	*10%*	*5%*		***20%***
Greywater	*5%*	*5%*	*15%*		***25%***
Structural		*7%*	*10%*	*18%*	***35%***
Total	***20%***	***32%***	***30%***	***18%***	***100%***

Figure 6: Detailed Weight Matrix

Analysis 1: Structural Design of Underground Garage - Breadth

Background

The underground garage is entirely constructed of cast in place concrete with an 8" slab and 5.5" drop panels at the columns totaling a 13.5" slab at the deepest sections. The cast in place floor area was averaged to 14,700 SF per floor. The rebar in the beams was estimated by the specifications in the drawings by using 2/3 the length of the beam for the top rebar and the full length for the bottom rebar. An original floor plan can be found in Appendix D. This system was designed to minimize the floor depth, to be able to help maximize the total number of floors in the building, enabling construction of 15 floors compared to 14 floors. Unexpected water problems associated with excavation pushed the project behind schedule. The added time for curing the cast in place concrete to the full 28 day strength only slowed the project more. The project has a relatively tight schedule of approximately a year and a half, so any time that can be saved once the schedule is behind, needs to be saved or the project will not finish on time.

One possible solution is to switch the cast in place concrete to a Filigree concrete system. Filigree virtually eliminates formwork and is very easy and quick to install. This system uses a small amount of shoring to support the pre-stressed prefabricated Filigree panels. The Filigree panels once supported act as the "formwork" for the topping slab that ties the system together structurally. The Filigree panels come with shear studs imbedded and can be used as a flat plate system or a slab and beam system.

Goal

The goal of the re-design is to decrease the floor depth, materials, and cost while accelerating the construction sequence utilizing the flat plate system of cast in place concrete or the pre-cast Filigree panels of either flat plate or a slab and beam system as seen on the following page. The Filigree panels are thin pre-stressed concrete panels that are prefabricated then tied together by a topping slab that is poured on site. This reduces the amount of poured concrete and the curing time needed before shoring is removed. The topping slab concrete needs to be at 75% of the full strength for the shoring to be removed; compared to the full 28 day strength as originally specified by the structural engineer. There are two systems that can be designed: a flat plate or a slab and beam. The flat plate system, Figure 7 on the following page, has all flat wideslab panels tied and grouted together and composite with the topping slab. The slab and beam system, Figure 8 on the following page, uses a thinner slab system as described earlier, in conjunction with one way beams. The drop down beams are tied to the flat wideslab panels to create the structure.

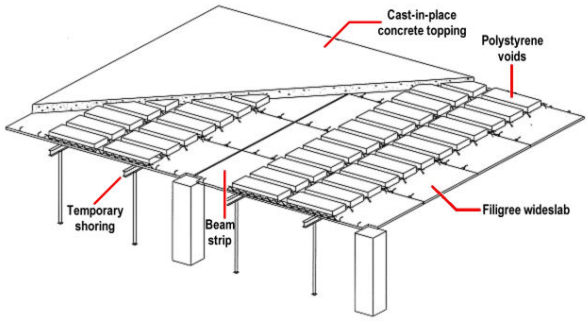

Figure 7: Flat Plate Filigree System

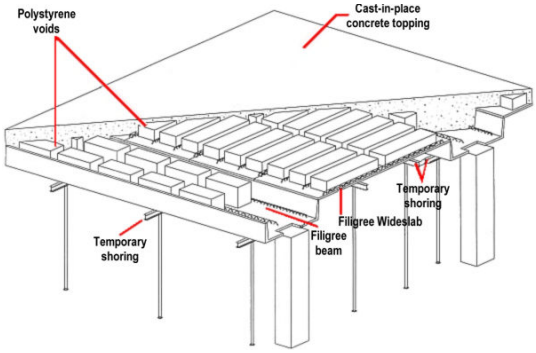

Figure 8: Slab and Beam Filigree System

The design will compare three systems: 1) the original cast in place slab with drop panels and stud rails to 2) a flat plate system with only stud rails and no drop panels to 3) the pre-cast Filigree system (either flat plate or slab and beam). Each design will be compared based on:

- Lbs. / SF of Steel
- Total steel tonnage
- Steel Cost
- CY of Concrete
- Depth of slab, beam, and drop panel
- Concrete Cost
- Total formwork SF
- Formwork Cost
- Total Duration

Resources

- Structural Engineering Faculty – Professor Lepage
- Midstate Filigree Systems website and contact – Gene McDermott
- Healy Long & Jevin, Inc. contact – Mike Jevin
- Balfour Beatty on-site staff
- Textbook: Design of Concrete Structures, 13th ed.

Structural Analysis

Please refer to Appendix D for Structural calculations and comparisons.

❖ *Step 1: Standardizing the Column Grid*

- Parking Level P-1 was chosen for the analysis because the columns run through the lowest parking level and the first floor. This level also has the most common steel characteristics between the first floor and the first parking level; it shows an average of the steel layout per floor of the P-2, P-1 and 1st floor. This level was previously estimated during the detailed structural take off in Technical Report 2 and was deemed accurate to the original with help of the onsite Balfour Beatty staff.
- The column grid was "standardized" to form a typical spacing. The current grid has column lines that are off-set from one another. To perform this breadth study a standardized grid was used for ease of calculations based on the recommendation of Professor Lepage.
- The average bay size was found to be 27' x 17'.

❖ *Step 2: Stud Rail Design*

- As noted in the structural drawings the Live Load used was 40 PSF.
- For this design the columns were not being re-designed and the Dead Load is assumed to be only the weight of the concrete slab of 150 PCF.
- Based on page 436 in the concrete design textbook and lengths of the spans, it was determined that the minimum allowable slab depth could be 9.6", rounded to 10". This means the Dead Load is 125 PSF.
- The Live and Dead loads were then factored by multiplying by 1.6 and 1.2 respectively, according to ASCE 7 – '05, and was found to be 214 PSF.
- Next the distributed load, effective width, and shear were found at the critical distance from the column face. The shear force was determined to be 234.4 kips which is significantly more than the tributary load at the columns and means that stud rails were not needed.
- This analysis was double checked, by recommendation of the structural practitioners, using Decon Studrails. This online calculation verified that stud rails were not necessary. The calculation sheet can be found in Appendix D.

❖ *Step 3: Flat Plate Design*

- As determined in the stud rail design the minimum allowable slab depth of 10" was used as well as a steel depth of 8.5" assuming a 1.5" cover.
- A picture of the averaged column grid and frames analyzed can be seen on the following page.
- All columns were assumed to be 18" x 30" which is the most common column size as well as 10 column lines.
- All frames were analyzed using the direct design method.
- For each frame analyzed the moment at the frame was calculated then the interior/exterior positive and negative moments were calculated.

- With these moments, the column strip and middle strip moments were calculated.
- By using the effective widths and moments of each column strip and middle strip, the nominal moment, R value, ρ, and required steel area and bar number were calculated to determine what rebar is need to satisfy the loading.
- The rebar solution is shown at the bottom of each frame analysis in Appendix D.
- From there the lengths of the rebar were calculated based on design standards in the concrete design textbook, and the lengths were tallied and a cost was calculated using data from R.S. Means 2008.
- The cubic yards of concrete were also tallied and a cost was calculated.
- Calculations include all three levels in the re-design.

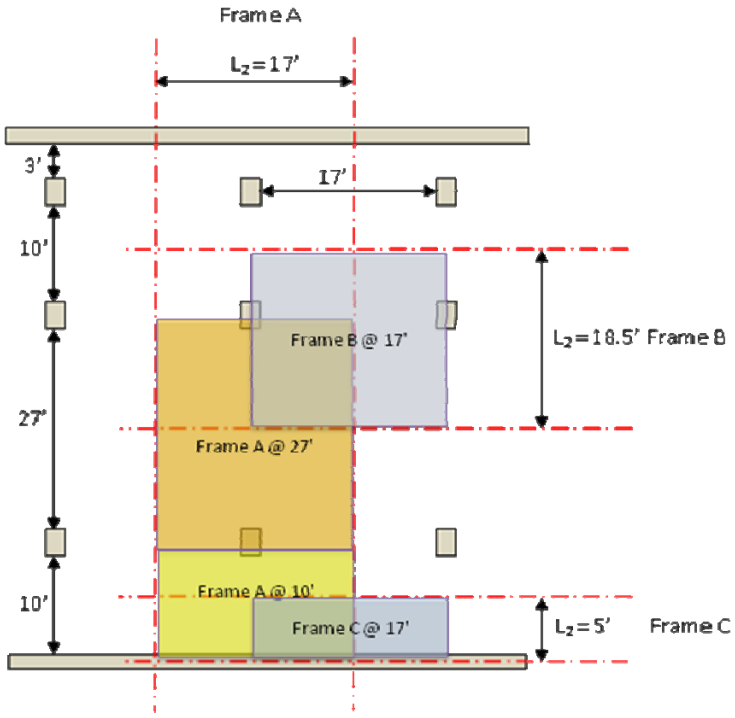

Figure 9: Averaged Column Grid and Frame Locations

❖ *Step 4: Filigree Design*

- Gene McDermott at Midstate Filigree Systems was contacted to aid in the re-design.
- Original drawings and load cases were sent for the analysis.
- A slab and beam system was chosen for the Filigree design because it requires less steel and concrete; it also has a smaller total floor depth.
- Through Gene, Mike Jevin at Healy Long & Jevin, Inc. was contacted for an estimate and schedule data.

- An estimate was performed for the new slab and beam Filigree system and for the original system with drop panels; which was very similar in quantities to the structural take off performed in Technical Report 2 and could be compared to the Filigree system.
    - The estimates performed by Healy Long & Jevin, Inc were averaged from a previous job, Wilmington High-Rises, and then adjusted for this project. This explains why the square footages in their estimate are 36,000 when the actual total is 44,100. Because of this difference, the SF prices from the estimates were applied to the true SF of 44,100.
    - The formwork SF cost, from Healy Long & Jevin, Inc, was taken directly from the Filigree estimate and applied to the total square footage. The Miller & Long formwork SF cost was applied to the calculated total square footage of the original system and the flat plate system. The estimate was done in this manner because of the different types of formwork used in the Filigree system compared to both cast in place systems.
    - Based on the tonnage and cubic yard quantities of steel and concrete, respectively I used RSMeans 2008 to find the total cost including labor and materials for the original system and the flat plate system.

Analysis Results

Please refer to Appendix D for calculations and comparisons.

❖ *Stud Rail Design*

- As described earlier the stud rails were not necessary to accommodate shear forces.
- The total factored load equaled 214 PSF and the total distributed load equaled 3.745 kips.
- Based on the factored load and distributed load the tributary load at the column face was found, the shear equaled 68.35 kips.
- Using the common column size of 18" x 30" the effective width, b_o, was found to be 130 inches.
- From this data the shear strength at critical section d/2 from the column face was found to be 234.41 kips.
- 234.41 kips is significantly greater than 68.35 kip load.
- Stud rails were not required.

❖ *Flat Plate Design*

- Using a 10" slab and the averaged column grid described earlier, four critical frames were analyzed at the column strips and middle strips to determine what rebar was required to satisfy the moments on those frames. The frames analyzed can be seen in Figure 9 on page 28.

- From this detailed analysis the total lengths, pounds, and tonnage of steel were calculated, as well as the total cubic yards of concrete. Then those numbers were multiplied by a unit cost per ton and a labor cost taken from RSMeans 2008.
- The total quantities equal 42.1 tons and 1361.11 cubic yard, and costs equal $59,144.32 and $596,575.00 respectively.
- Formwork cost was calculated based on total square footage multiplied by the square footage cost of $5.50/SF, supplied by Miller & Long, the concrete contractor.
    - This square footage cost was used because of the methods used for typical cast in place concrete; the formwork is usually stick built forms of plywood.
- The total formwork square footage equaled 44,100.00, and cost $242,550.00.
- This system has a duration of 27 days as determined by Healy Long & Jevin, Inc.

❖ *Filigree Design*

- The structural design for the Filigree system was performed by Gene McDermott of Midstate Filigree Systems.
- The slab and beam system was chosen because it was more efficient for the floor plan than a flat plate system; the slab being 6" and the beam being 11.5". A structural plan of the slab and beam Filigree system can be found in Appendix D.
- Based on the design and estimate provided by Healy Long & Jevin, Inc the quantities of steel, concrete and formwork were tallied. The costs of steel and concrete were calculated using RSMeans 2008 to maintain consistency, and were comparable to the actual estimate.
- The formwork cost was taken directly from the estimate because of the scaffolding type of formwork used compared to the stick built plywood system of the cast in place slabs.
- The total quantities of steel, concrete, and formwork equal 48 tons, 816.67 cubic yards, and 44,100 and cost $67,440.00, $357,945.00, and $142,575.30 respectively.
- This system has a duration of 21 days as determined by Healy Long & Jevin, Inc.

System Comparison

A system comparison can be found on the following page and in Appendix D.

Site delivery expenses were not included in this estimate.

As shown on the following page, the 10" cast in place slab system saves $27,952.49 in steel costs, $10,493.74 in formwork costs and 17 schedule days for only the slab work. However, the re-designed cast in place system requires 14.53 more cubic yards of concrete which costs $6,367.53. Despite the greater amount of concrete required the re-designed cast in place system saves a total of $30,153.98 compared to the original system with the adjusted location factor.

The slab and beam Filigree system saves $19,656.81 in steel cost, $232,262.44 in concrete cost, $110,468.44 in formwork cost, and 23 schedule days for only the slab work. This system saves in all categories analyzed totaling a savings of $340,644.45 as compared to the original system with the adjusted location factor. This savings is due to the minimal amounts of steel, concrete, and formwork required in the pre-stressed pre-cast panels that form the structure. These panels are used as formwork in conjunction with the scaffold system.

Structural System Comparison Summary

Analysis Description	Existing CIP Slab with Drop Panels	Re-Designed CIP Slab without Drop Panels	Filigree Slab and Beam System
Steel Cost	$87,096.81	$59,144.32	$67,440.00
Concrete (CY)	1346.58	1361.11	816.67
Concrete Cost	$590,207.48	$596,575.00	$357,945.00
Formwork Cost	$253,043.74	$242,550.00	$142,575.30
Slab Duration (Days)	44	27	21
Adjusted Total Cost	**$874,527.14**	**$844,373.16**	**$533,882.68**
Savings Analysis			
Steel Cost	n/a	**$27,952.49**	**$19,656.81**
Concrete (CY)	n/a	**-14.53**	**303.81**
Concrete Cost	n/a	**-$6,367.53**	**$232,262.48**
Formwork Cost	n/a	**$10,493.74**	**$110,468.44**
Slab Duration (Days)	n/a	**17**	**23**
Adjusted Total Cost Savings	**n/a**	**$30,153.98**	**$340,644.45**

Figure 10: Structural System Comparison Summary

Schedule Reduction Analysis

A detailed structural schedule can be found in Appendix D and on the following page.

The original garage system was scheduled to be completed in three phases of each level working from the mat slab up through the building. The schedule includes pouring the columns, walls, and slabs of each level together before moving to the next level. The schedule also includes the reshore being stripped at the full 28 day strength. The original system was started on 6/20/07 and completed on 11/5/07 taking 98 schedule days (weekends not included).

The re-designed cast in place system utilizing a flat plate 10" slab is also scheduled in a similar fashion. The construction progresses floor by floor, including pouring the columns, walls, and slabs before moving to the next floor. The schedule also includes stripping the reshore at only 75% of the full strength as determined by Healy Long & Jevin, Inc. The flat plate system beginning on the same start date, 6/20/07 would finish on 9/27/07 taking 71 schedule days to complete; saving 27 schedule days.

The Filigree system is scheduled beginning on the same start date due to the same foundation system and crane set date. This system also progresses floor by floor including the columns, walls, and slabs being constructed before moving to the next floor. The Filigree shoring can also be used as the reshore system because it is a scaffolding type system. The shoring does need to be cracked from the concrete at 75% strength to avoid buckling or bending of the system. The Filigree is scheduled to start on 6/20/07 and would finish on 9/19/07 taking 65 schedule days to complete; saving 33 schedule days.

	Task Name	Duration	Start	Finish
1	**ORIGINAL CONCRETE**	**98 days**	**Wed 6/20/07**	**Mon 11/5/07**
2	**P3 to 1st Floor Concrete**	**98 days**	**Wed 6/20/07**	**Mon 11/5/07**
3	P3 Concrete, Mat Slab, Walls, Columns	15 days	Wed 6/20/07	Wed 7/11/07
4	Cure Pad	5 days	Wed 7/25/07	Tue 7/31/07
5	Erect Tower Crane - Connect Power	5 days	Mon 8/6/07	Fri 8/10/07
6	P2 Concrete, Slab, Columns, Walls	15 days	Fri 7/20/07	Thu 8/9/07
7	P1 Concrete, Slab, Columns, Walls	15 days	Fri 8/10/07	Thu 8/30/07
8	1st Flr. - Slab, Columns, Walls	14 days	Tue 9/18/07	Fri 10/5/07
9	Strip Reshore P3	2 days	Fri 10/12/07	Mon 10/15/07
10	Strip Reshore P2	2 days	Fri 10/19/07	Mon 10/22/07
11	Strip Reshore P1	2 days	Fri 10/26/07	Mon 10/29/07
12	Strip Reshore 1st Flr.	2 days	Fri 11/2/07	Mon 11/5/07
13				
14	**RE-DEISGNED CONCRETE**	**71 days**	**Wed 6/20/07**	**Thu 9/27/07**
15	**P3 to 1st Floor Concrete**	**71 days**	**Wed 6/20/07**	**Thu 9/27/07**
16	P3 Concrete, Mat Slab, Walls, Columns	15 days	Wed 6/20/07	Wed 7/11/07
17	Cure Pad	5 days	Wed 7/25/07	Tue 7/31/07
18	Erect Tower Crane - Connect Power	5 days	Mon 8/6/07	Fri 8/10/07
19	P2 Concrete, Slab, Columns, Walls	9 days	Tue 7/31/07	Fri 8/10/07
20	P1 Concrete, Slab, Columns, Walls	9 days	Mon 8/13/07	Thu 8/23/07
21	1st Flr. - Slab, Columns, Walls	9 days	Fri 8/24/07	Wed 9/5/07
22	Strip Reshore P3	2 days	Wed 8/29/07	Thu 8/30/07
23	Strip Reshore P2	2 days	Fri 8/31/07	Mon 9/3/07
24	Strip Reshore P1	2 days	Thu 9/13/07	Fri 9/14/07
25	Strip Reshore 1st Flr.	2 days	Wed 9/26/07	Thu 9/27/07
26				
27	**FILIGREE SYSTEM**	**65 days**	**Wed 6/20/07**	**Wed 9/19/07**
28	**P3 to 1st Floor Concrete**	**65 days**	**Wed 6/20/07**	**Wed 9/19/07**
29	P3 Concrete, Mat Slab, Walls, Columns	15 days	Wed 6/20/07	Wed 7/11/07
30	Cure Pad	5 days	Wed 7/25/07	Tue 7/31/07
31	Erect Tower Crane - Connect Power	5 days	Mon 8/6/07	Fri 8/10/07
32	P2 Concrete, Slab, Columns, Walls	6 days	Fri 8/3/07	Fri 8/10/07
33	P1 Concrete, Slab, Columns, Walls	6 days	Mon 8/13/07	Mon 8/20/07
34	1st Flr. - Slab, Columns, Walls	6 days	Tue 8/21/07	Tue 8/28/07
35	Strip Reshore P3	2 days	Wed 8/29/07	Thu 8/30/07
36	Strip Reshore P2	2 days	Fri 8/31/07	Mon 9/3/07
37	Strip Reshore P1	2 days	Mon 9/10/07	Tue 9/11/07
38	Strip Reshore 1st Flr.	2 days	Tue 9/18/07	Wed 9/19/07

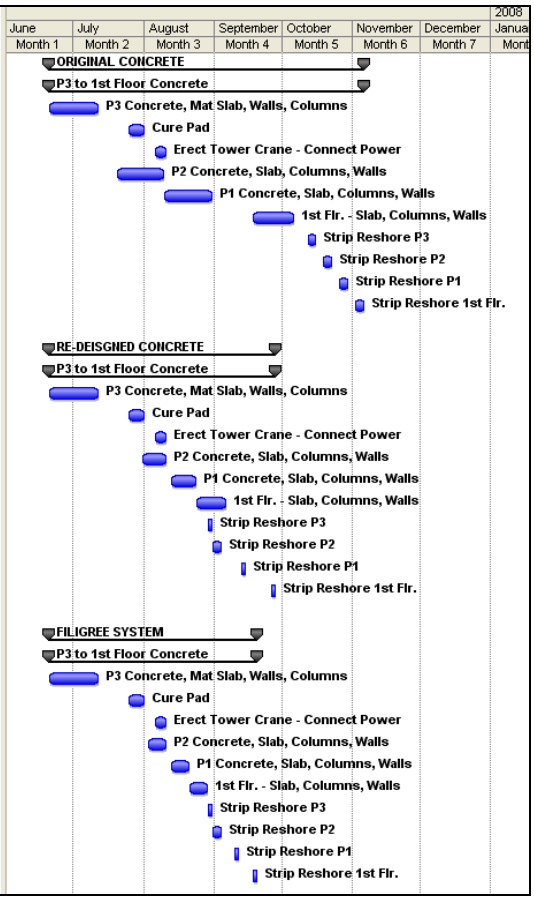

Figure 11: Detailed Structural Schedule, original provided by Balfour Beatty.

Both proposed systems would get the project out of the ground faster than the original which directly leads to an overall shorter project schedule. And in turn the Residence Inn would be able to open sooner than the current scheduled opening date of 9/12/08. The Figure 12 on the next page is an estimate of the revenue that could be made if the hotel was able to open earlier using either the 10" flat plate system or the Filigree system.

- The nights counted include the weekend time during the 27 schedule day improvement for the 10" flat plate system, and the 33 schedule day improvement for the Filigree system.

- The Residence Inn is predicted to bring in approximately $180 per room after three years, as provided by Don Nagl at Marriott.
- This estimate does not include operations costs.

System	Price/Unit	Units	Time	Revenue
10" CIP	$180	147	37 Nights	**$979,020.00**
Filigree	$180	147	45 Nights	**$1,190,700.00**

Figure 12: Revenue Summary

Constructability Review

For all three systems analyzed, the site would still be as constricted as it is currently. The original system and the 10" flat plate system use more concrete pumps than the crane, which can cause site congestion because the pump truck must be close to the footprint onsite. The Filigree system would also utilize pump trucks near the footprint to pour the topping slab. However, the Filigree system would utilize the crane more than the other two cast in place systems. This is because the pre-stressed pre-cast panels are too heavy to be set by hand; they must be set by the crane. Since the tower crane would be in place before the Filigree panels would arrive onsite, there would be no added cost for extra time with the crane.

Overall, all three systems would be constructed very similarly and would not pose anymore site congestion problems than already exist. The biggest advantage would be that the construction would take less schedule time which means less congested time onsite.

Conclusion & Recommendation

The benefits of the Filigree system far outweigh those of the 10" cast in place flat plate system as well as the original system.

- The Filigree system has a smaller overall depth which is key in designing clearance heights and piping and plumbing work.
- The construction is 33 days faster which can enable an early opening.
- This system also saves the owner approximately $362,000.00 in construction cost and can possibly add additional revenue of $1.2 million within the first 45 nights.

Based on this analysis of structural design, cost, schedule, and constructability the Filigree slab and beam system is the recommended system. It exceeds the original design and the flat plate re-designed system in every aspect. It is quicker, saves the owner money, and helps them bring in more revenue.

Analysis 2: Mechanical System #1: Controls - Breath

Background

The fan coil unit (FCU) mechanical system is designed to condition the guest rooms and other spaces in addition to masking the noise from the metro tracks that impede the site. The original mechanical fan coil units were intended to run 24 hours a day to condition the space. The primary purpose was to create a white noise background to prevent guests from being disturbed during their stay at the Residence Inn. The Washington area metro tracks near the building create approximately 102 decibels of noise. Long exposure of this level of noise can cause permanent hearing damage. The building façade blocks out 50 decibels, which means that approximately 52 will transmit through the facade. 52 decibels of noise is acceptable for a room during waking hours. However, to get a good night sleep, the noise level should not be more than 30 decibels; which is why the FCU was meant to be run 24 hours a day 7 days a week.

This is a potentially large problem for guests comfort. There will be guests that want to turn off the unit at night because the units can create bothersome noise. Unfortunately the original units will not be able to be turned off, causing some guests to become upset. If the units are too loud it can cause guests to be unhappy and possibly spread this bad experience to other future guests.

Since the original design, there has been a system overhaul. The new system, called INNCOM, is highly intelligent utilizing door switches temperature and occupancy sensors to increase energy efficiency specifically tailored to hotels. This system is activated when a guest checks in at the front desk, otherwise the systems in unoccupied rooms are off. This system is designed to cycle on and off the way a central air system would in a home. The user is able to control the temperature set point during the day. The INNCOM system is designed to run at a low fan speed throughout the night to mask the metro noise.

A possible solution is to provide an intermediate solution. Investigate the options of control systems for the units to provide user control during the day and an “over-ride” noise control at night. This means that the units can be turned off during the day by the occupant, but there will be certain times of the day or night that the unit will be on in the “over-ride” mode. The “over-ride” mode will be in effect from 10:00pm to 7:00am daily to mask the worst of the metro noise. This more advanced control will also help reduce energy use in the building.

Goal

The overriding goal of this analysis focuses on reducing the energy consumption by the fan coil units in the guestrooms. This analysis is also intended to provide a superior system to the original, to save energy for a minimum cost, and not increase complexity during construction. The goal of this analysis is to re-design the controls for the guestroom mechanical units to be

more user oriented during the day and have an automatic override at night to mask the metro noise.

The re-design of the guestroom mechanical unit controls will include investigating energy efficient controls that are able to be controlled on a network, to help reduce energy consumption. The original system and networked system will be evaluated by comparing:

- Total kWh's used per year
- Total Cost per year

The original system, the INNCOM system, and this re-design will be compared on unit cost, installation cost, and constructability.

The kWh's and cost will be calculated using Virginia Dominion Power company's rates. All systems analyzed assume an 81% hotel occupancy rate, as provided by Don Nagl at Marriott. This equates to 147 rooms of the 181 total rooms being used by guests.

Resources

- Southland Industries – Mike Phillips and Laura Slingerland
- Mechanical option faculty – Professor Moses Ling
- Architectural Engineering 5th year Mechanical option students: Max Chen, Will Tang
- Mechanical Textbook: Mechanical and Electrical Equipment for Buildings. 9th ed.

Energy Analysis

Please reference Appendix E for drawings, cut sheets, calculations, comparisons, and tables.

❖ *Step 1: Find a Networkable Thermostat System*

- An internet search was performed in conjunction with consulting Mike Phillips at Southland Industries.
- The programmable thermostat that was selected for this system can be networked with the other thermostats in the building and controlled by a single computer. This means that the building's fan coil units can be controlled from one place and that the guest can be locked out of the system.
- The thermostat chosen is Delta Controls DNT – T103. The cut sheet can be found in Appendix E.
- This thermostat network has the capabilities of the nightly "over-ride" mode and occupant control during the day.

❖ *Step 2: Heating and Cooling Durations*

- Annual weather data was collected from www.weatherdatadepot.com for Washington D.C. but can also be applied to Alexandria, VA, referencing the year 2007.
- The weather data includes charts for average daily temperature, cumulative heating degree days and cooling degree days, and a comparison with 2006, as well as the degree days broken down for heating and cooling based on a balance point of 65° F.
    - Degree Days are "quantitative indices designed to reflect the demand for energy needed to heat or cool a home or business. These indices are derived from daily temperature observations, and the heating (or cooling) requirements for a given structure at a specific location are considered to be directly proportional to the number of heating degree days at that location."
    - This means that if the outside temperature is 85°F and the inside temperature is set to 65°F a cooling degree day of 20 results.
    - 65°F is a typical reference point or balance point because at this temperature heating or cooling is generally not required.
    - Balance point is defined as "the average daily outside temperature at which a building maintains a comfortable indoor temperature without heating or cooling. At this outside temperature, the indoor heat gains (due to people, lighting, equipment, etc) "balance" with heat loss through windows, walls, roof and ventilation."

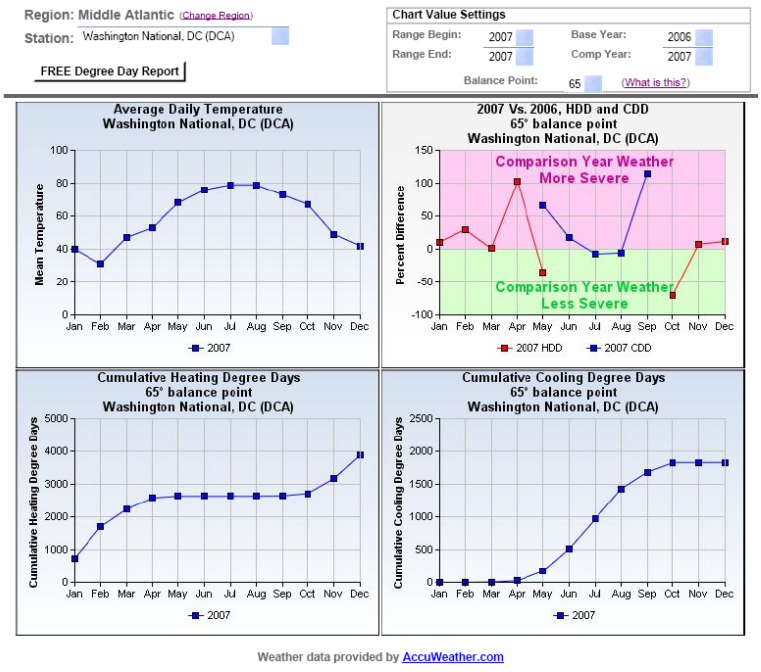

Figure 13: Annual Weather Charts, Washington D.C., courtesy of Weatherdatadepot.com

- Based on the cumulative annual degree days, the percentage of annual heating and cooling was calculated to be 68% and 32% respectively. The detailed degree day chart can be found in Appendix E.
- The daily heating and cooling durations can be seen below.

System	Conditioning	Duration (hrs.)
Original	Heating	16.32
	Cooling	7.68
Networked	Heating*	9.96
	Cooling*	4.69

*Duration includes "Over-ride" and User Controlled modes.

Figure 14: Daily Heating and Cooling Durations

❖ *Step 3: Original Energy Use and Cost*

- As noted in the Electrical drawings on sheet E 3.3 the total kW's for all electric heating units equals 349 kW.
- The building demand equals 656.1 kVA, also on drawing E 3.3.
- The horsepower for the motor of the FCU is 1/15 hp, as seen in the schedule on drawing M-602 in Appendix E. For one motor the horsepower of 1/15 is equivalent to 0.05 kW.
- The total kW of the motors for all 189 FCU's equal 9.45 kW.
- Thus the total heating energy equals 358.45 kW and the total cooling energy equals 9.45 kW. This neglects the energy to for the chiller to cool the water that is used in the FCU during cooling conditions.
- Based on the published billing data from Virginia Dominion Power, the Residence Inn is assumed to be in Schedule GS-4, the Large General Service Primary Voltage category, as confirmed by Southland Industries.
    - The peak energy cost is $0.404 per kWh during 6/1 to 9/30 Monday through Friday from 10:00am to 10:00pm and 10/1 to 5/31 Monday through Friday from 7:00am to 10:00pm
    - The off peak energy cost is $0.272 per kWh during 1/1 to 12/31 Evenings and Weekends.
    - Detailed calculations can be found in Appendix E.
- The total kWh and cost for peak and off-peak time can be seen below.

Total kWh =	**1,765,059.67**
Total Cost =	**$5,764.27**

Figure 15: Original System Total kWh and Cost

❖ *Step 4: Occupancy per Hour*

- The hourly occupancy rates for a typical hotel room were taken from the mechanical software program, Trane Trace. These rates were then adjusted for a business commute.
  - Trace Schedule for Hotel Occupancy Rate:
    12 am - 9 am = 100%
    9 am - 11 am = 20%
    11 am - 5 pm = 0%
    5 pm - 12 am = 100%
- The Residence Inn is slated for mainly long term business people. Average hours of commute are between 7 am and 9 am.
  - Adjusted Schedule for Hotel Occupancy Rate:
    12 am - 9 am = 85% * Assumes leaving at 7:30 am
    9 am - 11 am = 0%
    11 am - 5 pm = 0%
    5 pm - 12 am = 100%
- Based on these occupancy rates, the total hours the room is occupied by a guest was calculated to be 14.56. This includes the "over-ride" time from 10:00pm to 7:00am and from 5:00pm to 10:00pm and 7:00am to 7:30am of user controlled time.
- Of the user controlled time, 3.84 hrs are heating and 1.81 hrs are cooling time.

❖ *Step 5: New Energy Use and Cost*

- Based on the "over-ride" mode and user controlled mode the heating and cooling was calculated. The same 68% and 32% were used for heating and cooling.
- This new Delta system assumes that when the room is occupied the FCU will be on to prevent the air form becoming "stagnant". This also assumes that while the room is unoccupied the FCU is off.
- Schedule GS-4 form Virginia Dominion Power kW rates were applied.
  - The peak energy cost is $0.404 per kWh during 6/1 to 9/30 Monday through Friday from 10:00am to 10:00pm and 10/1 to 5/31 Monday through Friday from 7:00am to 10:00pm
  - The off peak energy cost is $0.272 per kWh during 1/1 to 12/31 Evenings and Weekends.
  - Detailed calculations can be found in Appendix E.
- The total kWh and cost of the new networked system can be seen below. This is a savings of 696,231.65 kWh in energy and $2,312.94 in energy costs.

Total kWh =	**1,068,828.11**
Total Cost =	**$3,451.33**

Figure 16: Networked System Total kWh and Cost

System Comparison

A controls system comparison chart can be seen below.

The original control system utilizes thermostats (t-stat) that cost approximately $30 each, $5,670 for all 189, with very basic in room wiring, no networking, which totals $37,900. This is the total system cost of the controls for the building. There is no networking with this system because the thermostats do not have the capabilities; they are controlled in each room independent of each other.

The new networked Delta system employing the "over-ride" mode and user controlled mode, has thermostats that cost $98 each, $18,522 for all 189 units. This system does have temperature sensors that help control when the system should condition the air based on temperature. These are similar to thermostats and sensors found in a home. These sensors add approximately $19,350 to the total cost. The wiring installation is about $50,000. This cost is much greater than the original because wiring must be run to a central location for the networking of the system. This system costs about $87,872, which equates to $49,972 more than the original system.

The INNCOM system which is currently being employed uses thermostats that cost about $200 each, and $37,800 for all 189. These thermostats also use many sensors for doors, infrared, and occupancy, as well as a specific type of software to run the network. This accounts for $96,550 of the total price. The wiring installation is the same as the re-designed network because the same amount of wiring is required to install a thermostat network. This costs approximately $50,000. The INNCOM system costs about $184,350 total. This is $146,450 more than the original and $96,478 more than the re-designed system in this analysis.

Controls System Comparison

System Type	Original	Networked	INNCOM
Price / Unit	$30.00	$98.00	$200.00
Total T-stat Cost	$5,670.00	$18,522.00	$37,800.00
Installation	$32,230.00	$50,000.00	$50,000.00
Sensors, etc.	n/a	$19,350.00	$96,550.00
Total System Cost	**$37,900.00**	**$87,872.00**	**$184,350.00**

Figure 17: Controls System Comparison

Constructability Review

Please reference the wiring diagram on the following page, and in Appendix E.

The original wiring of the system was very simple. The thermostat was tied directly to the FCU in each room. For the two bedroom units each FCU has its own thermostat. A wiring detail of typical studio rooms can be seen below circled in red, from drawing E 2.1.

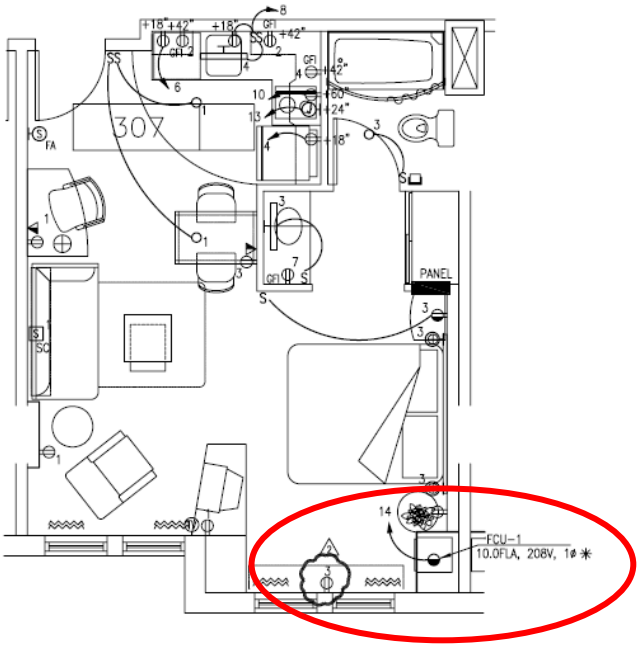

Figure 18: Original Wiring Diagram, Drawing E 2.1

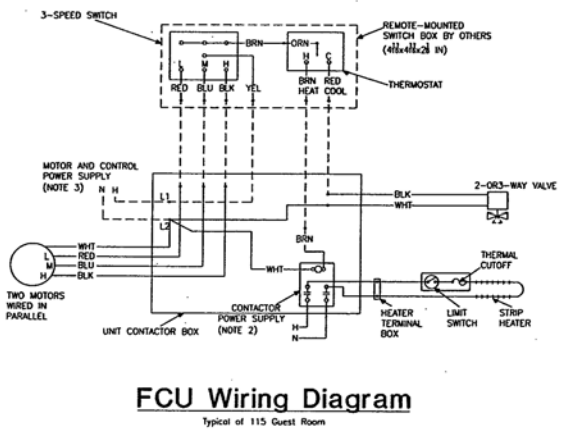

Figure 19: Detailed FCU Wiring Diagram

The re-designed networked Delta system will have more complex construction very similar to the new INNCOM system that will be installed. The re-designed Delta system will have extra wiring to connect all the thermostats to one network. This system will not require as much wiring for the sensors that the INNCOM system has. In addition, The Delta system does not require any specific software installation. On the next page a detail of the network wiring is shown as well as a detailed wiring diagram of a typical studio room. The full detailed INNCOM wiring diagram can be found in Appendix E. This wiring is more complex than the original but not as complex as what the INNCOM drawings show.

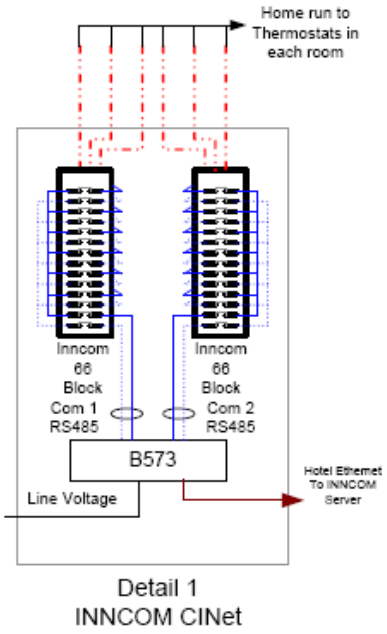

Figure 20: Detailed INNCOM Network Wiring Diagram, provided by Southland Industries

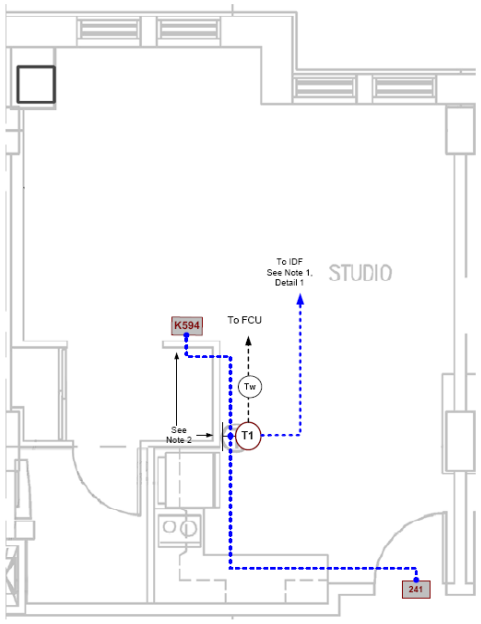

Figure 21: Typical INNCOM Wiring Diagram for a Studio Room, provided by Southland Industries

Conclusion & Recommendation

The benefits of changing the controls system for the FCU's are apparent; a great deal of energy and money can be saved starting the first year. The construction of the system is also within reasonable complexity. The re-designed controls system utilizing the Delta DNT – T103 is an excellent alternative to the original system.

- The Delta system saves 696,231.56 kWh in energy and $2,312.94 in energy costs each year.
- This system costs $49,972 more in construction compared to the original but saves $96,478 compared to the new INNCOM system.
- The construction is comparable to the INNCOM system; neither is too complex to maintain a swift schedule. Networked thermostats are very common in commercial buildings.

Based on this analysis, the Delta Controls system using the DNT – T103 is the recommended system. It produces a superior system to the original but is not as expensive as the INNCOM system. Its performance results are nearly equivalent to the INNCOM. This system provides the guests with an acceptable environment thermally and acoustically as well as providing savings to the owner.

Analysis 3: Mechanical System #2: Greywater - Breadth

Background

Hotels generate a large amount of greywater from showers, sinks, and laundry. Currently this water is being expelled through the storm water and sanitary systems out to the city sewer system; none of it is being recycled. Each guest room has a typical bathroom with a shower, sink, and toilet. Because the Residence Inn Marriott is for long term stay the rooms also have kitchenettes with a sink, which increases the greywater production in each room. However, the Residence Inn does not have on-site laundry facilities like that of a more typical hotel. The only laundry facility present is a small bank of public washers and dryers, about 5 each. The Residence Inn sends their laundry to a third party service for cleaning. This greatly reduces the amount of greywater production.

It is possible to reuse water from showers, sinks, and laundry areas and expel it as blackwater that is not sanitary for reuse. The water being recycled is called greywater. Greywater is "washwater". It is wastewater that contains all the waste from showers, sinks, and laundry areas with the exception of toilet waste and food waste from garbage disposals. There are significant differences between greywater and blackwater from toilets. Greywater can be cleaned either mechanically or biologically and recycled throughout a building or used for irrigation of landscaping and gardens. Blackwater cannot be cleaned or recycled due to fecal and other contaminants in the water. A general diagram of a typical residential greywater application can be seen below. Given enough space, this application is also viable for commercial buildings.

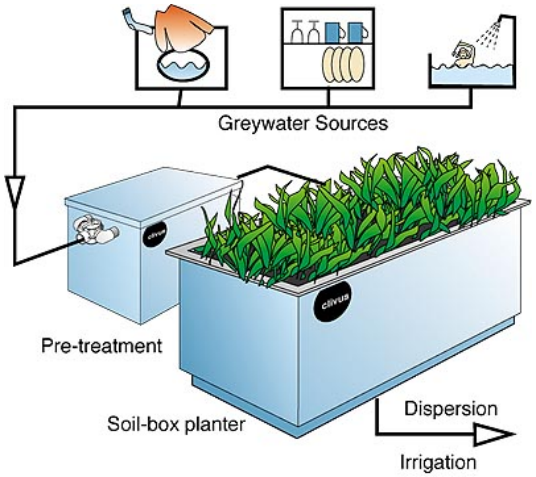

Figure 22: Residential Greywater System
Courtesy of www.greywater.com

The institution of a greywater system into a commercial or residential building can greatly reduce water consumption and help the plants and environment of the surrounding site.

Goal

One possible solution is to use shower water to flush toilets by implementing a constructed wetlands greywater system. Since the linens are sent to a third party service for cleaning, in this case the laundry water will not be used. The shower water will be analyzed for cleaning and recycling to flush toilets.

This breadth focuses on implementing a constructed wetlands greywater system, to reduce the water usage and add value to the building. This will be achieved by reducing the water need while providing a better system at a minimal cost. Constructability will also be analyzed to ensure the system can be built and managed.

Resources

- Southland Industries – Mike Miller
- Mechanical option faculty – Professor Moses Ling
- Agricultural Engineering faculty – Professor Robert Cameron
- Mechanical Textbook: Mechanical and Electrical Equipment for Buildings. 9th ed.

Constructed Wetlands Analysis

Please refer to Appendix F for calculations, diagrams, pictures, and cut sheets.

❖ *Step 1: Defining the Constructed Wetlands Greywater System*

- A constructed wetlands greywater system cleans the greywater biologically. This means the "constructed wetland system (CWS) pre-treats wastewater by filtration, settling, and bacterial decomposition" as defined by the University of Minnesota.
- This system is intended to mimic the system currently in use at Penn State's Center for Sustainability.
  - "[This is a] natural wastewater treatment facility that mimics nature's own processes found in wetlands and marshes to remediate contaminated water. Micro-organisms break down and digest the waste, as they do in our outdoor ecosystems, found in closed aerobic and anaerobic tanks. Inside the biofilter's greenhouse, tropical plants, flowers and a fish flourish in open aerobic tanks, continuing this filtering process. Since the plants are doing most of the work, the Ecological Systems Lab offers a low impact, less costly and less energy intensive alternative to chemical waste water treatment."
  - Please visit: www.engr.psu.edu/cfs/index.aspx?p=1, for more information regarding Penn State's Center for Sustainability.
  - Please refer to Appendix F for site pictures from March 19, 2008.

- The system intended for the Residence Inn will not need the closed aerobic treatment chambers because there will be no solid waste. Those chambers are only used in conjunction with a septic system to filter out and breakdown solid waste products. Shower water does not contain any solid waste and can be fed directly from the building into the "biofilter" tanks.

❖ *Step 2: Defining How the Constructed Wetlands Greywater System Works*

- The constructed wetlands system works by utilizing naturally occurring plants to filter out contaminants. This process typically takes 10 days to ensure the water is contaminant free. These contaminants in our shower water are actually helpful for plants like cattails, papyrus, and elephant ears; commonly used plants in a constructed wetlands system.
    - Commonly found contaminants in shower water are nitrogen, ammonium, phosphorus, and toxic organics such as chemical cleaning products; these materials are readily absorbed and used as nutrients in wetland plants.
    - Shower water usually does not contain pathogens, heavy metals, and dissolved inorganics that can cause harm if ingested.
    - Please visit http://www.epa.gov/nrmrl/pubs/625r00008/html/html/625R00008.htm for more information regarding greywater contaminants.
    - Please refer to Appendix F for select charts from the EPA.

Figure 23: Papyrus and Elephant Ears
Located at Penn State's Center for Sustainability

- The plants are held in a series of three to four "biofilter" tanks. The first three tanks contain the plants that can absorb the highest level of containments. The last tank, called the clarifier tank, contains small plants that usually float on the water and absorb the remaining few contaminants.

Figure 24: Clarifying Tank
Located at Penn State's Center for Sustainability

- From the clarifier tank, the water is funneled to a lined rock bed containing two types of rock, 3" to 5" rock and small pea gravel. These rocks filter more contaminants that the plants cannot absorb.
- After the rock bed filtering process, the water must be sent through a contained sand filter to eliminate any remaining particles or contaminants. Then the water can be sent back to the building.
- Because this system is intended use the water to flush toilets, the water must be potable. If there were to be a serious water crisis and the water supply was shutdown, the water in the tank of the toilet would to be used as the potable water supply. To achieve this, chlorine tablets should be added to the water to ensure there is no bacteria or other contaminants and is safe for ingestion.
- Figure 25 below shows a diagram of the system. The blue lines are the city water supply, the red are greywater, and black is black water. The arrows indicate the direction of the water flow. As seen, the water travels the shower and becomes greywater, then is treated and sent back in to flush toilets and becomes untreatable blackwater.

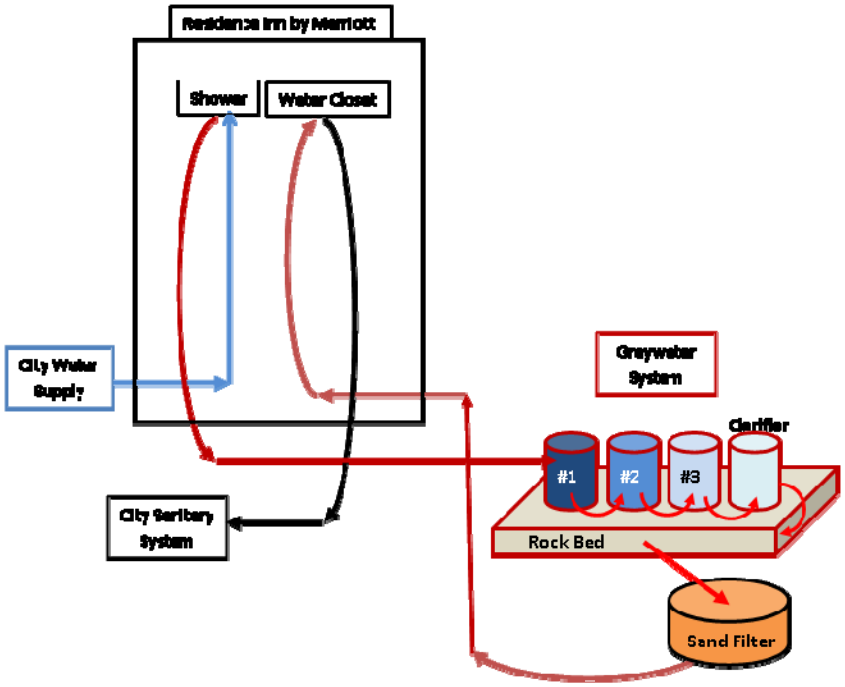

Figure 25: Constructed Wetlands Flow Diagram

❖ *Step 3: Options of the Constructed Wetlands Greywater System*

- Hotels produce approximately 60 gallons per day of greywater for each typical 2 person room. This translates to 30 gallons per person per day.

- The occupancy rate of a Residence Inn averages 81%, which in this case equals 203 people.
- The equipment used in the Residence Inn are low flow fixtures, using 2.5 gpm and 1.6 gal/flush for the shower head and toilet, respectively.
- This equates to 50,750 gallons of greywater production over ten days, but only 9,744 gallons of demand for ten days. There is a surplus of 41,006 gallons per ten days, approximately 4,100 gallons a day.
- There are three possible options to utilize all of the clean water produced:

    - The water can be deposited into the bay area near Alexandria, VA. This requires a National Pollutant Discharge Elimination System permit from the city, and a monitoring system. This option is not feasible for a hotel. The permit is very expensive and to properly monitor the water is unreasonable for a hotel.

    - The water can be supplied to a neighboring building to also flush toilets or clean laundry with. This option also requires extra permitting beyond that of a normal building permit; as well as a greater amount of piping to connect the buildings together. This option also poses coordination issues. It would be very difficult to ensure the system was built correctly. If not built correctly there would be serious health concerns of the occupants possibly ingesting untreated water. Overall, this option is not feasible due to cost and complexity.

    - The water can be used to enhance the aesthetics of the hotel by adding a waterfall, fountain, or greenhouse. This option requires a small amount of additional piping, two extra tanks and pumps to run the system, as well as minimum maintenance. The two extra tanks are required to store the water used in the fountain and for the fountain itself. This does provide more aesthetic appeal which could bring in more guests to the hotel. The waterfall or fountain would need to be fenced in to prevent any children from climbing in to swim or play, or from being harmed. This is the most feasible option.

❖ *Step 4: Implementing the Constructed Wetlands Greywater System*

- A fountain and greenhouse will be implemented into the constructed wetlands system. However, not all of the water will be used. The system will produce approximately double the volume needed for the toilets, enabling the other half will be used for the fountain. This is due to space constraints onsite.
- As noted earlier, the water needed for flushing toilets is 974.4 gallons per day, 9,744 gallons per ten days. Doubling the volume equals 1,950 gallons per day to be able to supply the building and the fountain.

- Based on the occupancy rate of 81%, 83 people produce 2,075 gallons per day which equals 5.5 floors of the hotel.
- The system must be sized to accommodate ten days of water and rock volume.
  - This system must process 20,750 gallons of water every ten days.
  - The water volume equals 2,774.3 CF. This is multiplied by 25% as a safety factor and rock volume, which equals 3,467.8 CF.
  - Half of this volume is stored in the rock bed; 1,734 CF.
  - A typical constructed wetland is 3' deep. By dividing by 3, the required wetland area is 578 SF. This does not include the area of the tanks.
  - The tanks must hold the other half of the water, 1,734 CF equals 12,969.3 gallons.
    - Due to tank restrictions, this system will essentially operate as two cleaning systems. The water will be split into two sets of the cleaning and clarifying tanks, which requires eight tanks. Each tank must hold at least 6,484.7 gallons.
- Each tank is sized at 6,800 gallons, is 10' in diameter and 12' high. The tanks will be buried so that only 3' are above ground level. These tanks add an area of 628.3 SF, making the total area required 1,206 SF. A greenhouse of 25' by 50' will be able to house the tanks and rock bed.

Figure 26: Penn State's Center for Sustainability Greenhouse
Courtesy of Penn State's Center for Sustainability website.

- The sand filter, fountain, and fountain storage tanks are also sized at 6,800 gallons. The sand filter and fountain storage tanks are buried underground, between the greenhouse and the fountain.
- The fountain and storage tank are connected in a loop. The fountain has an overflow near the top that will drain water into the storage tank below ground. In turn that water will then be pumped back into the fountain for reuse. This circular system is ideal, so that all the water is used in the fountain and can be evaporated.
- The constructed wetlands system produces 2,075 gallons per day. Half goes to the fountain and the other half is used for flushing toilets. However, this is 63.1 gallons per day more than the required amount for the building demand of 974.4 gallons. This excess allows for days when the water demand will be higher than designed for. Thus there must be another storage tank in the building. The extra storage tank inside the

building is 500 gallons and is tied into the booster pump system to pump the water to all 15 floors. This tank has an overflow that directs water to the city's sanitary system.

- A system rendering can be seen below. As shown, the fountain is in the foreground with the storage tank underneath it in white. The sand filter is the brown box below ground that feeds into the building. The greenhouse holds the cleaning and clarifying tanks. Flowers and plants can be grown in the rock bed. Flowers are shown inside the greenhouse to increase the aesthetic appeal; this can be seen in Figure 28 on the following page.

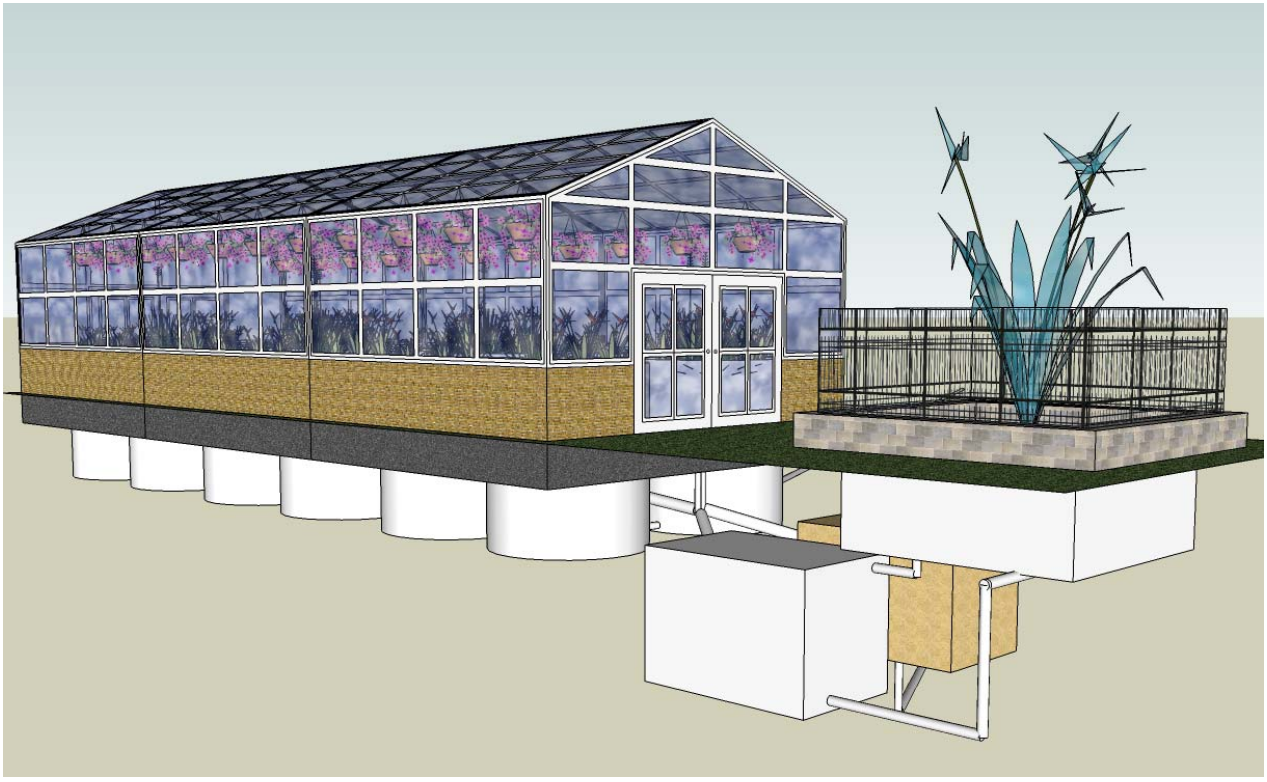

Figure 27: Constructed Wetland Greywater System Rendering
Created in Google SketchUp

Figure 28: Interior View of the Greenhouse
Created in Google SketchUp

Cost Analysis

By instituting a constructed wetlands greywater treatment system, an additional $88,787.52 must be added to the project budget. This is for materials only; additional excavation and crane usage would increase this cost. A typical greywater system is about $150,000.00. This is most likely how much the constructed wetlands would cost after the excavation and crane time were factored in.

However, by installing this system, 757,375 gallons of water would be saved each year. This equates to saving $518.80 per year on water costs according to Virginia American Water Company, who services the Alexandria area. The overall appeal of the system could help bring in more guests generating more revenue.

Constructability Review

The construction of the system is similar to that of any building. Excavation occurs first, then the underground piping and lining are installed. Next the tanks would be set and the stone backfilled in around them. Finally the fountain and greenhouse would be constructed. This process would require more equipment and crane usage, which could make the construction of the building more complex because of site constraints. The extra excavation and construction would add time to the schedule, the piping alone would add 6 days. The excavation and

construction could add a great deal more than that. Construction time was not added into this analysis.

The extra storage tank and booster pump needed inside the building pose another challenge. The original system's booster pump is located on the P-1 Level on the south end of the building. There is no space there to add another pump and tank. The new pump and tank would need to be located at the north end of the building where parking spot 30-C is located. This spot is between a mechanical shaft riser and an electrical room. By blocking this space and adding another booster pump room, there would be ample space to house the system. This can be seen in the figure below, and on Drawing P-103 in Appendix F.

Figure 29: North End of Building Footprint, Drawing P-103

By placing the booster pump room in space 30-C, architectural problems would also arise. There are a certain number of spaces for this building which fulfill a LEED requirement. If the number of spaces drops below the limit, that LEED point will be forfeited.

The metro tracks also pose an obstacle for construction. The additional crane would have to large enough to lift the tanks, the heaviest being about 1,600 lbs, but small enough to fit below the metro tracks. This poses the greatest challenge; the crane and the system must not damage or even touch the metro track, as mandated by the Washington Area Metro Transit Authority. Once the system is built, its footprint is also not permitted to be under the footprint of the metro tracks.

This greatly limits the space available to utilize for the constructed wetlands. Figure 30 and 31 on the next page show a plan view of the layout and a three dimensional view at the metro track. These figures show that the space is extremely limited but the system will fit without disrupting the limitations of the metro tracks.

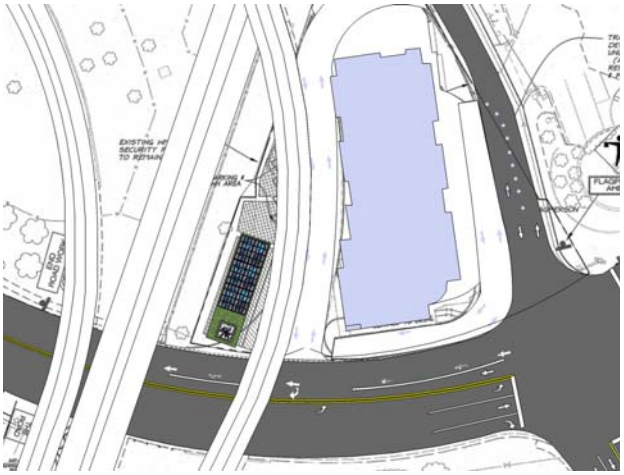

Figure 30: Site Plan with Constructed Wetlands System Created in Google SketchUp

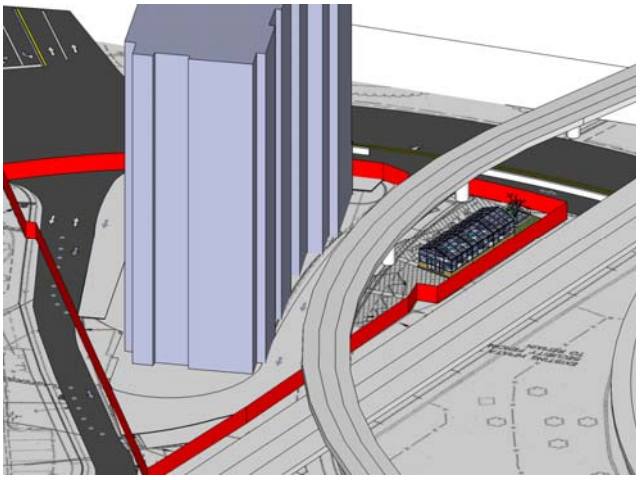

Figure 31: Aerial View from North End Created in Google SketchUp

Conclusion & Recommendation

Based upon this analysis the constructed wetland greywater treatment system has both positive aspects and negative aspects associated with it. These aspects should be considered when deciding to install a constructed wetland system.

- If the system is installed it adds at least $88,787.52 to the total budget, as well as schedule time. But it saves $518.80 and 757,375 gallons of water annually.
- If the system is not installed, time and money are saved, but 757,375 more gallons of water will be used annually. It also saves bringing an additional crane to the site and the site congestion associated with the construction.

Considering these factors, the owner of the project would play the deciding role. The system would be recommended if the owner is focused on helping the environment and aesthetic appeal of the building. However, the system would not be recommended if the owner is only concerned with the bottom line, saving money.

* This system will be addressed again in the Critical Industry Research Conclusion Area where a final conclusion will be made with regards to this project and owner.

Critical Industry Research: "Greening" of Hotels - Depth

Background

There is an unfortunate misconception in this industry that adding green value or achieving LEED points simply costs too much no matter what the benefits could be. The city of Alexandria, VA is trying to help this cause in new construction by requiring all new buildings to have at least 20 LEED points. While budgeting for this project it was initially determined to include what would qualify for only the required 20 points.

Marriott firmly believes in adding green or LEED credits to many of their new hotels and resorts. Marriott shows that they are one of the leaders in green technologies and are willing to try new energy and mechanical systems. Since Marriott is one of the leading hotel chains their ideas and practices will filter to all other hotel chains.

Goal

The goal of this research is to investigate the sustainability or "Greening" of hotels by incorporating green design into the project and analyzing the corresponding cost. This research will compare typical building materials and systems to their green alternative. The analysis includes comparing upfront cost, installation cost, and life cost to determine which is most economical. This research will compare:

- Painted Gypsum Board to Colored Clay Plaster
- Fiberglass Batting Insulation to Blown Cellulose Insulation
- Ceramic Tile Flooring to Polished Concrete
- Continuously powered A/C units to Programmed Networked A/C units
- Typical Sanitary System to Constructed Wetlands Greywater System

The owner's and architect will be surveyed to gain an initial opinion regarding these green technologies. Once the research is complete a concluding survey will be sent with an overview of the results, to determine if the research was effective.

Resources

- Project staff and consultants
- R.S. Means Interior Cost Data, and Square Foot Costs
- Material manufacturer's websites
    - www.greenbuildingpages.com
    - www.buildinggreen.com

Industry Analysis

Please refer to Appendix G for surveys, results, and R.S. Means cut sheets.

❖ *Step 1: Product / System Overview*

- Painted Gypsum Board vs. Colored Clay Plaster
  - Drywall is a very common material used in the Residence Inn Marriott. It is used for wall coverings as well as acoustical use. There are multiple layers of drywall on every wall between each guestroom and the exterior walls on the north, west, and south faces of the building which greatly escalates the material cost. These multiple layers of drywall are intended to help with the sound attenuation from outside the façade and from room to room.
  - Clay plaster is an excellent alternative to drywall. It is a very flexible and workable material that can be stained or painted and can easily be repaired. The plaster has many similar characteristics to drywall; it is fire rated, can be painted, and absorbs sound in the same way. It is also mold, moisture, and pest resistant. Although the plaster can be painted, it is easier to use the color packages and add a stain to it, so once the plaster is installed there is no need to come back and paint. This will reduce the labor cost and eliminate painting. The plaster can also be sprayed on, increasing construction efficiency. The plaster also out performs the drywall in terms of mold and moisture absorption, and is pest resistant. The clay used in the plaster is extracted from soils in the United States; clay is renewable resource which adds green value to the product.

Figure 32: Stained Plaster (Left), Painted Plaster (Right)
Courtesy of American Clay Plaster

- Fiberglass Batting Insulation vs. Blown Cellulose Insulation
  - The current insulation is typical 6" fiberglass batting insulation. It has an R-value of 19 which is most common and sufficient for use in a hotel. The insulation like the drywall is being used in almost every wall throughout the hotel to block sound. The insulation is located on all exterior walls to provide thermal comfort and in each wall separating guestrooms to provide sound attenuation. However, this typical insulation is truly meant for thermal comfort more so than sound attenuation.
  - Blown cementitious foam insulation, called cellulose, is an excellent alternative to the fiberglass batting. The cellulose fills many air gaps that exist with batting, and decreases air infiltration. The cellulose also has a Class A fire rating which aids in the stability of the wall and façade allowing more time for evacuation if the building were to be compromised.
    - More stable R-value throughout the year and no fluffing required.
    - *"All loose-fill insulation settles after installation. Cellulose insulation is always specified and sold at settled density, so compensation for settling is built into the bag count and material weight columns of cellulose coverage charts."*
    - "Research shows cellulose to be up to 40% better than fiber glass at controlling air infiltration. – makes air barriers not necessary"
    - Absorbs moisture that might get into the wall cavity
    - Class A fire rating vs. Noncombustible

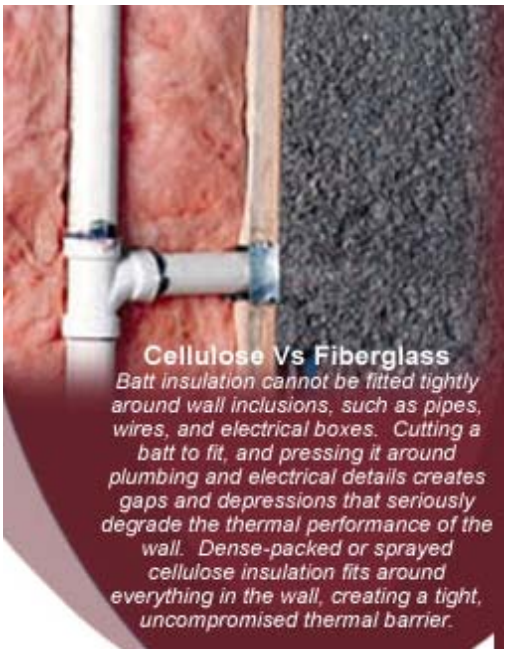

Figure 33: Cellulose Insulation
Courtesy of Cellulose website

- Ceramic Tile Flooring vs. Polished Concrete
  - Ceramic tile is currently being used in the lobby area of the Residence Inn by Marriott. The lobby is a very high traffic area which means an alternative must be very durable.
  - Polished concrete is an excellent alternative to ceramic tile flooring. The structural floor system being used in the hotel currently is a post-tensioned concrete floor system. This alternative is an ideal technology because there is no longer a need to add cost to the project by specifying a material finish and hiring highly skilled labor to install. The polished concrete floor finishing eliminates the extra cost for materials and extra laborers. The finished product looks like a high gloss expensive coating, tile, or linoleum and colors and patterns can be added increase the aesthetics of the flooring.
    - A polished concrete floor will outlast a ceramic tile floor in high traffic areas because the concrete is sealed after be polished to resist fading, staining, and damages. Ceramic tile colors fade and the floor system cannot be sealed as effectively.

Figure 34: Polished Concrete Flooring
Courtesy of Retroplate website

- Continuously Powered A/C Units vs. Programmed Networked A/C Units
  - The fan coil unit (FCU) mechanical system is designed to condition the guest rooms and other spaces in addition to masking the noise from the metro tracks that impede the site. The original mechanical fan coil units were intended to run 24 hours a day to condition the space. The primary purpose was to create a white noise background to prevent guests from being disturbed during their stay at the Residence Inn.
  - The programmable thermostat was selected as an alternative for this system because it can be networked with the other thermostats in the building and controlled by a single computer. This means that the building's fan coil units can be controlled from one place and that the guest can be locked out of the system.

- This thermostat network has the capabilities of the nightly "over-ride" mode and occupant control during the day.

Figure 35: Delta DNT-103 Programmable Thermostat
Courtesy of Delta Controls

- Typical Sanitary System vs. Constructed Wetlands Greywater System
  - Hotels generate a large amount of greywater from showers, sinks, and laundry. Currently this water is being expelled through the storm water and sanitary systems out to the city sewer system; none of it is being recycled.
  - A constructed wetlands greywater system is an excellent alternative to the current system. This system will save water, help the environment, and add aesthetic appeal.
    - A constructed wetlands greywater system cleans the greywater biologically. This means the "constructed wetland system (CWS) pre-treats wastewater by filtration, settling, and bacterial decomposition" as defined by the University of Minnesota.
    - This system is intended to mimic the system currently in use at Penn State's Center for Sustainability. "[This is a] natural wastewater treatment facility that mimics nature's own processes found in wetlands and marshes to remediate contaminated water. Micro-organisms break down and digest the waste, as they do in our outdoor ecosystems, found in closed aerobic and anaerobic tanks. Inside the biofilter's greenhouse, tropical plants, flowers and a fish flourish in open aerobic tanks, continuing this filtering process. Since the plants are doing most of the work, the Ecological Systems Lab offers a low impact, less costly and less energy intensive alternative to chemical waste water treatment."

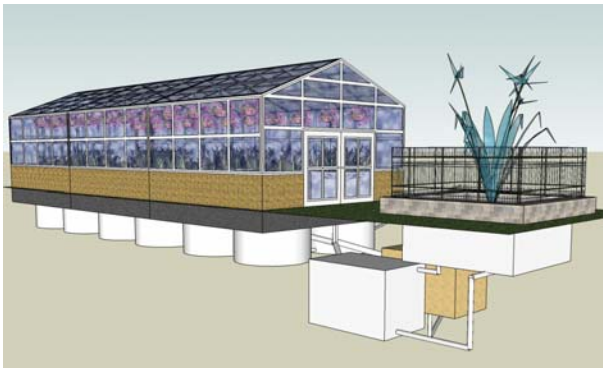

Figure 36: Constructed Wetlands Greywater System Created in Google SketchUp

❖ *Step 2: Initial Survey*

Please refer to Appendix G for surveys.

- The survey was designed to learn the opinions of the owner, owner's representative, two architects, and an estimator regarding green technologies usefulness and cost. These participants were chosen because they have the greatest influence over the design of the project and can decide what technologies should be implemented.
  - Marriott was contacted to participate in the survey, but was unable to do so. Their efforts are clearly in favor of green technologies and are outlined later.
- A series of questions were asked to gain an understanding of the familiarity to LEED and green technologies each person has, as well as their experience with each.
- At the end of the survey was a chart with each set of materials and systems listed. Participants were asked to check which they thought was greater between each set, the upfront cost, payback period, and life cycle cost.
- The survey also asked which they thought was the most cost effective project: a LEED project, a green project, or a project which implements neither.
  - The results show that on average from a scale of 1 to 10 the participants showed a 7.6 familiarity with LEED and 4.6 with green technologies.
  - On average, participants have worked on 1 to 5 projects that implemented LEED, and 5 to 10 projects that implemented green technologies.
  - Each showed an average of 5 to 10% cost increase. Most participants sited "compliance" as the reason the increased cost made the project worthwhile.
  - The results for the chart varied widely. There was no definitive way to tabulate a result. Most participants responded with "it depends" as to whether the upfront cost, payback period, and life cycle cost were greater between the technologies in each set.
  - Almost all participants site that the most cost effective project implements green technologies.

- The results of the initial survey show that overall there is a greater understanding the LEED system than there is of green technologies. This is very interesting because LEED aims to push green technologies in building design.
- The results also show that the cost effectiveness of each green technology and system compared do depend on the application. But there is also no consistency between the participants as to which is better.

❖ *Step 3: Research*

- Contractor quotes and R.S. Means were used to determine the material and labor costs.
- Manufacturer data was used to determine product life.
- For each set of materials the product costs were broken down per square foot. This was then used to derive the life cost; this is not a true life cycle cost. This is the annual cost of the product over the useful life of the product.
- The A/C units were compared by thermostat unit cost, labor, and installed cost. They were not able to be compared for the life cost due to the unknown nature of the thermostat life. Thus, the units were compared by total price per unit.
- The sanitary systems were not able to be compared in this manner. The total average cost of a greywater system was applied, and the water savings was highlighted.

❖ *Step 4: Concluding Survey*

Please refer to Appendix G for surveys.

- The concluding survey was very brief. The participants were presented with a chart of the same sets of materials and technologies, showing the material upfront cost, labor cost, total cost, life cost, and product life. They were asked to choose one from each set that they would use on a project and briefing explain why.
  - All participants chose painted gypsum board over colored clay plaster. Most sited the ease of installation, maintenance and repair as the deciding factors. Some also noted that it is more applicable in buildings that are renovated frequently, such as hotels.
  - There was a tie between the blown cellulose insulation and the fiberglass batting insulation. Some noted that the fiberglass batting is easy to install because it comes in appropriate widths for stud cavities. Others reasoned that since the cellulose has almost the identical life cost per year and higher thermal protection qualities that it should be implemented.
  - Most chose the polished concrete flooring over the ceramic tile. This was interesting because one participant chose it after learning about it through this survey. They found it to have “good savings and a durable solution”. Another noted that it would aid in renovation by eliminating the need for demolition of the existing flooring. However, this product cannot be used in all projects because the architectural design

may not allow for it. This is because a polished concrete flooring system, if not stained, can produce an industrial look with the space.
  - All participants chose the programmed networked A/C units based on the energy and cost savings. They felt the higher upfront cost was justified by the savings produced.
  - Almost all participants chose the greywater system over the typical sanitary system. Most noted that the water savings was the reason to implement this system, but also weighed it with ability to design, install, and maintain it properly. Jurisdictional issues could also cause problems with a greywater system.
- These results were very encouraging. In most cases the green alternative technology was chosen over its more common counterpart. This was intriguing because when asked which technology was more costly, longer payback, or higher life cycle cost, the answers varied widely. This means that most participants did not have a clear understanding of what costs are associated with each product. However, when shown hard numbers and savings data, their choices were clear. The higher upfront cost was justified by the savings and the environmentally friendly technologies.

Marriott's "Green" Efforts

"Marriott International, Inc. is a leading lodging company. Its heritage can be traced to a root beer stand opened in Washington, D.C., in 1927 by J. Willard and Alice S. Marriott. Today, Marriott International has about 3,000 lodging properties located in the United States and 67 other countries and territories."

At the Residence Inn by Marriott the company prides themselves in inviting guests for long term stays in a place that is as close to "home" as you can get. They want to make the guest feel as comfortable as possible. They do this by implementing:

- Residential atmosphere with spacious accommodations
- Complimentary hot breakfast
- Evening hospitality hour
- Swimming pool
- Sport Court®
- Personalized grocery shopping
- Daily housekeeping
- Guest suites with separate living and sleeping areas
- Fully equipped kitchen
- Work space with data ports and voicemail

Marriott also prides itself in the "greening" of their hotels. They have received numerous awards and recognitions for energy conservation, coral reef restorations, recycling construction waste, planting trees, to name only a few. Marriott has a "commitment to sustainable environmental

practices" demonstrated by their sponsorships and corporate programs: Clean Up the World Sponsor and the Environmentally Conscious Hotel Operations (ECHO) program. Pictures of some of their most recognized hotels and efforts can be seen below. For more information please visit www.marriott.com.

Los Suenos Marriott Builds a Home for the Endangered Scarlet Macaw

Miami Hotels Recycle 300 Tons of Materials During Renovation

Grand Cayman Marriott Leads Successful Beach and Reef Restoration Effort

JW Marriott Bangkok Associates Plant 400 Trees, Help Reforest Fragile Coastline

Figure 37: Pictures of Marriott's Green Efforts

A few of their most recent prestigious awards include:

- "It is ranked as the lodging industry's most admired company and one of the best places to work for by FORTUNE®."
- "The company is also a 2006 U.S. Environmental Protection Agency (EPA) ENERGY STAR® Partner."
- "Marriott has been recognized by the U.S. Environmental Protection Agency (EPA) with the 2007 Sustained Excellence Award and Partner of the Year since 2004."

When designing and building a green hotel, there are four key areas that Marriott focuses on.

1. Use of environment-friendly building materials – Materials that are renewable resources are targeted. Wood is certified, and wood stains are water based to minimize VOC emissions. Paints and wallpaper glue are also low VOC materials.

2. Recycling – Materials that contain recycled content are used in construction, as well as recycling construction waste. Energy recovery units are used where applicable.

3. Water Conservation – Low flow fixtures are installed where applicable. Guests are encouraged to reuse bath towels and bed linens rather than having newly washed sets every day.

4. Smoke-Free Environment – All Marriott properties are smoke free spaces.

By focusing on these main areas of conservation, energy is reduced and helps reduce greenhouse gas production. This helps create a healthier living environment for guests. In conjunction with Travelocity a poll was conducted, the survey showed that 38% of the respondents "were interested in taking a vacation where they can give back and make a difference during their stay". From this a grant was formed to give to people who demonstrate a strong commitment to improving the environment. For more information please visit Travelocity's website at www.travelocity.com/travelforgood.

Conclusion & Recommendation

This research shows that green technologies are favored among industry members, and are regarded as cost effective. It is also apparent for green technologies the upfront cost, payback period, and life cycle cost are not widely known in comparison with their common counterparts. Based on these results the constructed wetlands greywater treatment system would be recommended for this project. The project participants showed they feel the upfront cost is worth the green value, aesthetic appeal, and water savings.

From these results it shows this research was effective since the green alternative technology was favored. An initial opinion was attained and in some cases participants were educated about new green technologies. Overall, it shows that when presented with hard numbers in terms of cost and savings, the decision makers chose the environmentally friendly alternative.

Research Conclusion

Based on the analysis of structural design, cost, schedule, and constructability the Filigree slab and beam system is the recommended system. It exceeds the original design and the flat plate re-designed system in every aspect. It is quicker by 23 schedule days, saves the owner money totaling $340,644.45, and helps them bring in more revenue, as much as $1,190,700.00.

The Delta Controls system using the DNT – T103 is the recommended system to reduce energy consumption. It produces a superior system to the original but is not as expensive as the INNCOM system, saving $96,478.00. Its performance results are nearly equivalent to the INNCOM. This system provides the guests with an acceptable environment thermally and acoustically as well as providing savings to the owner.

The constructed wetland greywater treatment system has both positive aspects and negative aspects associated with it. These aspects should be considered when deciding to install a constructed wetland system.

- If the system is installed it adds at least $88,787.52 to the total budget, as well as schedule time. But it saves $518.80 and 757,375 gallons of water annually.
- If the system is not installed, time and money are saved, but 757,375 more gallons of water will be used annually. It also saves bringing an additional crane to the site and the site congestion associated with the construction.

Considering these factors, the owner and tenant of the project would play the deciding role. The constructed wetlands greywater system is recommended because Marriott is extremely focused on helping the environment and increasing aesthetic appeal of the building.

By implementing all recommended systems the owner would be able to save approximately $351,200.00 and gain as much as $1,190,700.00 in revenue. The figure below details the total cost savings with all systems implemented.

System	Cost Savings	Additional Savings
Slab and Beam Filigree Structure	$340,644.45	$1,190,700.00 Added Revenue in 45 Nights
Delta Controls DNT-T103	$98,790.94	696,231.56 kWh of Energy Annually
Constructed Wetlands Greywater	-$88,268.72	757,375.00 Gallons of Water Annually
Grand Total Cost Savings	**$351,166.67**	

Figure 38: Final Cost Savings

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Appendix A: Project Schedule Summary

The Microsoft Project, Project Schedule Summary and Detailed Project Schedule can be found on the following pages.

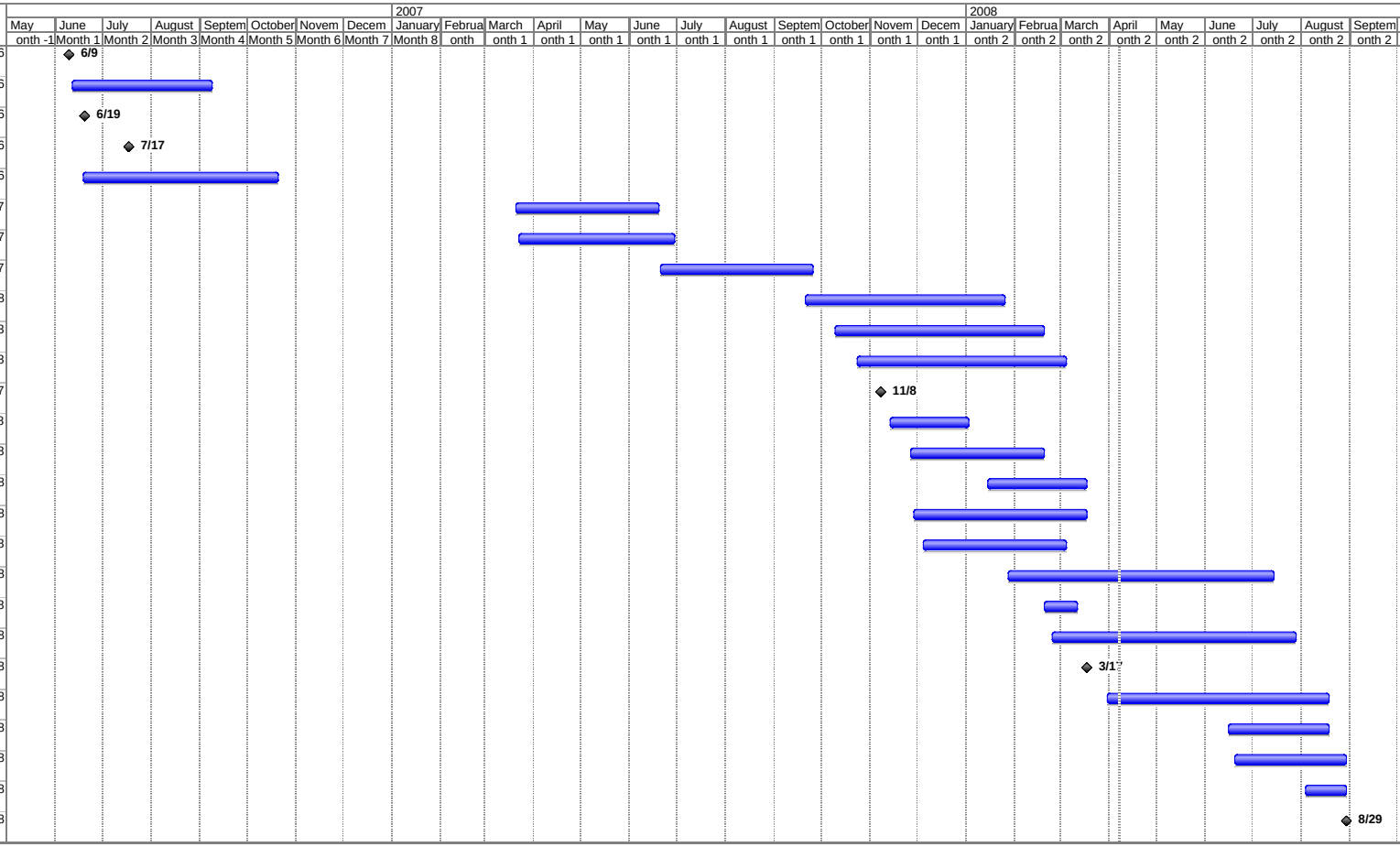
Residence Inn

By Marriott
2345 Mill Rd, Alexandria, VA

Julia E. Phillips
Construction Management

Project Schedule Summary
Appendix A

ID	Task Name	Duration	Start	Finish
1	Notice To Proceed - Civil	0 days	Fri 6/9/06	Fri 6/9/06
2	City of Alexandria Review	65 days	Mon 6/12/06	Fri 9/8/06
3	Notice To Proceed - Arch	0 days	Mon 6/19/06	Mon 6/19/06
4	Design Documents 100% Complete	0 days	Mon 7/17/06	Mon 7/17/06
5	MEP Design Phase	90 days	Mon 6/19/06	Fri 10/20/06
6	Excavate / Lag to Bottom	65 days	Wed 3/21/07	Tue 6/19/07
7	Complete Sheeting and Shoring	71 days	Fri 3/23/07	Fri 6/29/07
8	P3 to 1st Floor Concrete	68 days	Thu 6/21/07	Tue 9/25/07
9	Above Grade Floors 2 - 15	86 days	Fri 9/21/07	Fri 1/25/08
10	Rough-In Overhead	90 days	Wed 10/10/07	Tue 2/19/08
11	Studs / Shafts / Permieter	90 days	Wed 10/24/07	Tue 3/4/08
12	Permanent Power	0 days	Thu 11/8/07	Thu 11/8/07
13	Install Precast 1- 3	32 days	Wed 11/14/07	Wed 1/2/08
14	Block Back-up Flrs 3 - 15	58 days	Tue 11/27/07	Tue 2/19/08
15	Roof	45 days	Tue 1/15/08	Mon 3/17/08
16	Windows / Curtianwall	75 days	Thu 11/29/07	Mon 3/17/08
17	Exterior Brick	62 days	Wed 12/5/07	Tue 3/4/08
18	Elevator	120 days	Mon 1/28/08	Mon 7/14/08
19	Parapet EFIS	15 days	Wed 2/20/08	Tue 3/11/08
20	Drywall	110 days	Mon 2/25/08	Mon 7/28/08
21	Substantially Dry	0 days	Mon 3/17/08	Mon 3/17/08
22	Finishes	100 days	Mon 3/31/08	Mon 8/18/08
23	Testing & Balancing	45 days	Mon 6/16/08	Mon 8/18/08
24	A/E Punchlist by Floor	50 days	Fri 6/20/08	Fri 8/29/08
25	Owner FFE Installtion	20 days	Mon 8/4/08	Fri 8/29/08
26	Substantial Completion	0 days	Fri 8/29/08	Fri 8/29/08



Project: Summary Schedule
Date: Mon 4/7/08

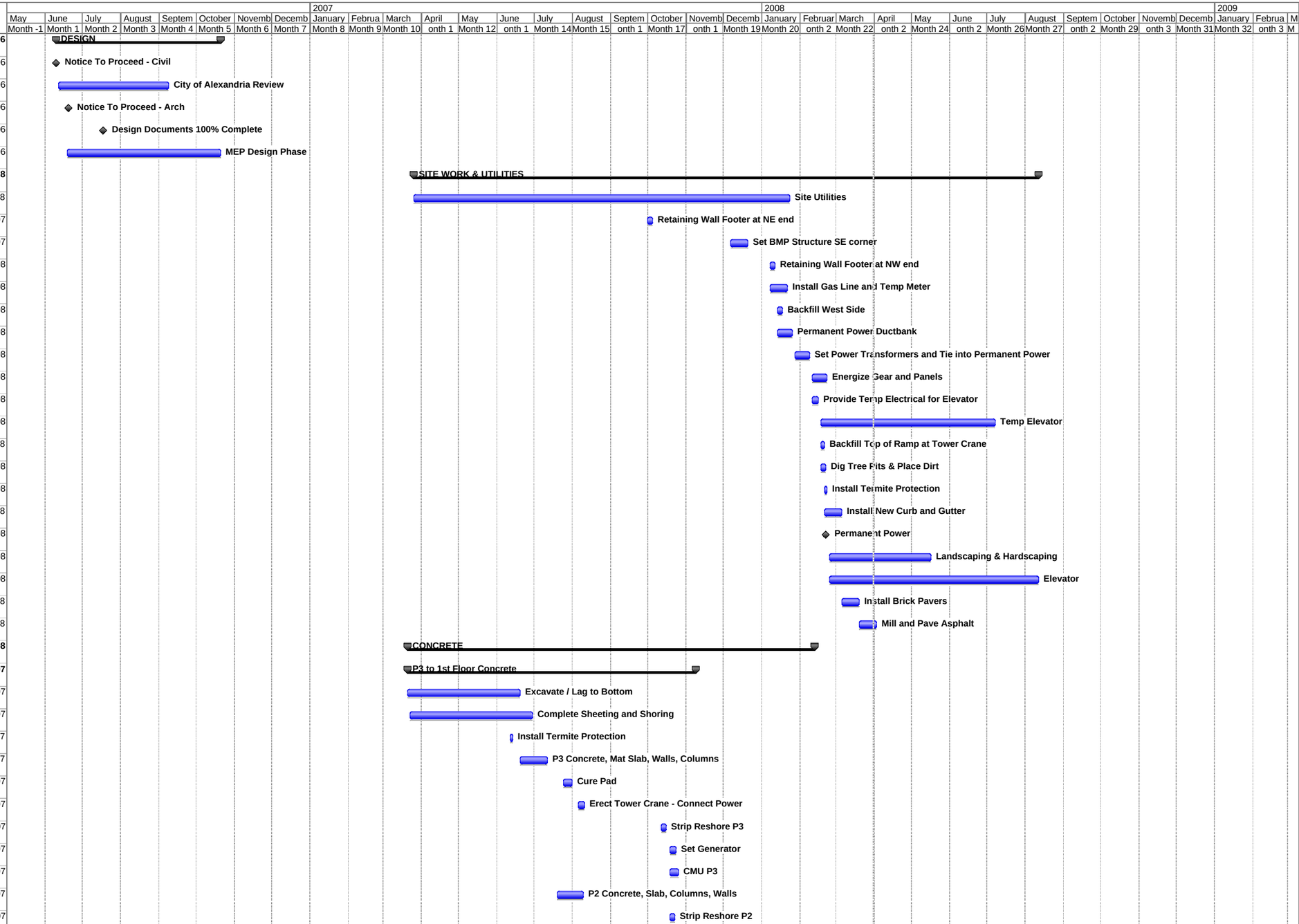
Task — Progress — Summary — External Tasks — Deadline
Split — Milestone — Project Summary — External Milestone

Residence Inn
By Marriott
2345 Mill Rd, Alexandria, VA

Julia E. Phillips
Construction Management

Detailed Project Schedule
Appendix A

ID	Task Name	Duration	Start	Finish
1	**DESIGN**	**95 days**	**Fri 6/9/06**	**Fri 10/20/06**
2	Notice To Proceed - Civil	0 days	Fri 6/9/06	Fri 6/9/06
3	City of Alexandria Review	65 days	Mon 6/12/06	Fri 9/8/06
4	Notice To Proceed - Arch	0 days	Mon 6/19/06	Mon 6/19/06
5	Design Documents 100% Complete	0 days	Mon 7/17/06	Mon 7/17/06
6	MEP Design Phase	90 days	Mon 6/19/06	Fri 10/20/06
7	**SITE WORK & UTILITIES**	**354 days**	**Mon 3/26/07**	**Mon 8/11/08**
8	Site Utilities	212 days	Mon 3/26/07	Wed 1/23/08
9	Retaining Wall Footer at NE end	4 days	Mon 10/1/07	Thu 10/4/07
10	Set BMP Structure SE corner	10 days	Fri 12/7/07	Thu 12/20/07
11	Retaining Wall Footer at NW end	4 days	Tue 1/8/08	Fri 1/11/08
12	Install Gas Line and Temp Meter	10 days	Tue 1/8/08	Mon 1/21/08
13	Backfill West Side	4 days	Mon 1/14/08	Thu 1/17/08
14	Permanent Power Ductbank	10 days	Mon 1/14/08	Fri 1/25/08
15	Set Power Transformers and Tie into Permanent Pow	10 days	Mon 1/28/08	Fri 2/8/08
16	Energize Gear and Panels	10 days	Mon 2/11/08	Fri 2/22/08
17	Provide Temp Electrical for Elevator	5 days	Mon 2/11/08	Fri 2/15/08
18	Temp Elevator	100 days	Mon 2/18/08	Mon 7/7/08
19	Backfill Top of Ramp at Tower Crane	3 days	Mon 2/18/08	Wed 2/20/08
20	Dig Tree Pits & Place Dirt	4 days	Mon 2/18/08	Thu 2/21/08
21	Install Termite Protection	2 days	Thu 2/21/08	Fri 2/22/08
22	Install New Curb and Gutter	10 days	Thu 2/21/08	Wed 3/5/08
23	Permanent Power	0 days	Fri 2/22/08	Fri 2/22/08
24	Landscaping & Hardscaping	60 days	Mon 2/25/08	Fri 5/16/08
25	Elevator	120 days	Mon 2/25/08	Mon 8/11/08
26	Install Brick Pavers	10 days	Thu 3/6/08	Wed 3/19/08
27	Mill and Pave Asphalt	10 days	Thu 3/20/08	Wed 4/2/08
28	**CONCRETE**	**229 days**	**Wed 3/21/07**	**Tue 2/12/08**
29	**P3 to 1st Floor Concrete**	**166 days**	**Wed 3/21/07**	**Thu 11/8/07**
30	Excavate / Lag to Bottom	65 days	Wed 3/21/07	Tue 6/19/07
31	Complete Sheeting and Shoring	71 days	Fri 3/23/07	Fri 6/29/07
32	Install Termite Protection	2 days	Tue 6/12/07	Wed 6/13/07
33	P3 Concrete, Mat Slab, Walls, Columns	15 days	Wed 6/20/07	Wed 7/11/07
34	Cure Pad	5 days	Wed 7/25/07	Tue 7/31/07
35	Erect Tower Crane - Connect Power	5 days	Mon 8/6/07	Fri 8/10/07
36	Strip Reshore P3	2 days	Fri 10/12/07	Mon 10/15/07
37	Set Generator	3 days	Fri 10/19/07	Tue 10/23/07
38	CMU P3	5 days	Fri 10/19/07	Thu 10/25/07
39	P2 Concrete, Slab, Columns, Walls	15 days	Fri 7/20/07	Thu 8/9/07
40	Strip Reshore P2	2 days	Fri 10/19/07	Mon 10/22/07



Project: Detailed Schedule
Date: Mon 3/31/08

Task — Progress — Summary — Rolled Up Critical Task — Rolled Up Progress — External Tasks — Group By Summary
Critical Task — Milestone — Rolled Up Task — Rolled Up Milestone — Split — Project Summary — Deadline

Residence Inn
By Marriott
2345 Mill Rd, Alexandria, VA

Julia E. Phillips
Construction Management

Detailed Project Schedule
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ID	Task Name	Duration	Start	Finish
41	CMU P2	5 days	Fri 10/26/07	Thu 11/1/07
42	P1 Concrete, Slab, Columns, Walls	15 days	Fri 8/10/07	Thu 8/30/07
43	Strip Reshore P1	2 days	Fri 10/26/07	Mon 10/29/07
44	CMU P1	5 days	Fri 11/2/07	Thu 11/8/07
45	1st Flr. Concrete - Slab, Columns, Shear Walls	14 days	Tue 9/18/07	Fri 10/5/07
46	Strip Reshore 1st Flr.	2 days	Fri 11/2/07	Mon 11/5/07
47	**Above Grade Floors 2 - 15**	**95 days**	**Wed 9/26/07**	**Tue 2/12/08**
48	2nd Flr. Concrete - Slab, Columns, Shear Walls	8 days	Wed 9/26/07	Fri 10/5/07
49	Strip Reshore 2nd Flr.	2 days	Fri 11/9/07	Mon 11/12/07
50	3rd Flr. Concrete - Slab, Columns, Shear Walls	5 days	Fri 10/5/07	Thu 10/11/07
51	Strip Reshore 3rdFlr.	2 days	Fri 10/19/07	Mon 10/22/07
52	4th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Fri 10/12/07	Thu 10/18/07
53	Strip Reshore 4th Flr.	2 days	Fri 10/26/07	Mon 10/29/07
54	5th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Fri 10/19/07	Thu 10/25/07
55	Strip Reshore 5th Flr.	2 days	Fri 11/2/07	Mon 11/5/07
56	6th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Fri 10/26/07	Thu 11/1/07
57	Strip Reshore 6th Flr.	2 days	Fri 11/9/07	Mon 11/12/07
58	7th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Fri 11/2/07	Thu 11/8/07
59	Strip Reshore 7th Flr.	2 days	Fri 11/16/07	Mon 11/19/07
60	8th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Fri 11/9/07	Thu 11/15/07
61	Strip Reshore 8th Flr.	2 days	Tue 11/27/07	Wed 11/28/07
62	9th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Fri 11/16/07	Mon 11/26/07
63	Strip Reshore 9th Flr.	2 days	Tue 12/4/07	Wed 12/5/07
64	10th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Tue 11/27/07	Mon 12/3/07
65	Strip Reshore 10th Flr.	2 days	Tue 12/11/07	Wed 12/12/07
66	11th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Tue 12/4/07	Mon 12/10/07
67	Strip Reshore 11th Flr.	2 days	Tue 12/18/07	Wed 12/19/07
68	12th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Tue 12/11/07	Mon 12/17/07
69	Strip Reshore 12th Flr.	2 days	Thu 12/27/07	Fri 12/28/07
70	13th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Tue 12/18/07	Mon 12/24/07
71	Strip Reshore 13th Flr.	2 days	Fri 1/4/08	Mon 1/7/08
72	14th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Wed 12/26/07	Thu 1/3/08
73	Strip Reshore 14th Flr.	2 days	Fri 1/11/08	Mon 1/14/08
74	15th Flr. Concrete - Slab, Columns, Shear Walls	5 days	Fri 1/4/08	Thu 1/10/08
75	Strip Reshore 15th Flr.	2 days	Wed 1/23/08	Thu 1/24/08
76	Roof Concrete	8 days	Fri 1/11/08	Tue 1/22/08
77	Cure Concret, Clean & Prep Roof	15 days	Wed 1/23/08	Tue 2/12/08
78	Strip Reshore Roof	2 days	Thu 2/7/08	Fri 2/8/08
79	Penthouse Concrete	5 days	Wed 1/23/08	Tue 1/29/08
80	Cure and Strip Penthouse Concrete	5 days	Wed 1/30/08	Tue 2/5/08

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Julia E. Phillips
Construction Management

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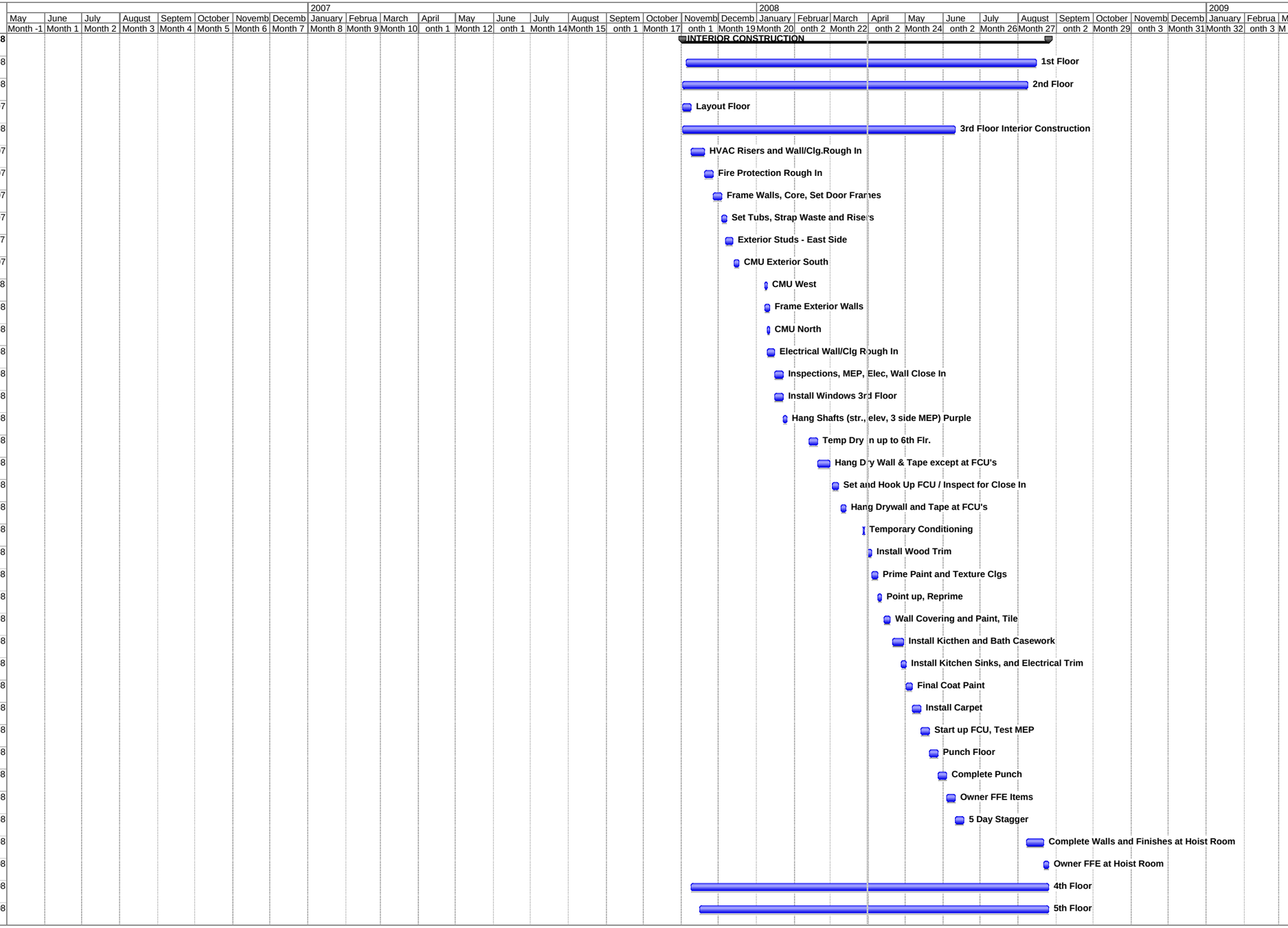
Appendix A

ID	Task Name	Duration	Start	Finish
81	**INTERIOR CONSTRUCTION**	**206 days**	**Fri 11/2/07**	**Mon 8/25/08**
82	1st Floor	199 days	Mon 11/5/07	Fri 8/15/08
83	2nd Floor	195 days	Fri 11/2/07	Fri 8/8/08
84	Layout Floor	5 days	Fri 11/2/07	Thu 11/8/07
85	3rd Floor Interior Construction	153 days	Fri 11/2/07	Tue 6/10/08
86	HVAC Risers and Wall/Clg.Rough In	7 days	Fri 11/9/07	Mon 11/19/07
87	Fire Protection Rough In	3 days	Tue 11/20/07	Mon 11/26/07
88	Frame Walls, Core, Set Door Frames	5 days	Tue 11/27/07	Mon 12/3/07
89	Set Tubs, Strap Waste and Risers	4 days	Tue 12/4/07	Fri 12/7/07
90	Exterior Studs - East Side	4 days	Fri 12/7/07	Wed 12/12/07
91	CMU Exterior South	2 days	Fri 12/14/07	Mon 12/17/07
92	CMU West	2 days	Tue 1/8/08	Wed 1/9/08
93	Frame Exterior Walls	4 days	Tue 1/8/08	Fri 1/11/08
94	CMU North	2 days	Thu 1/10/08	Fri 1/11/08
95	Electrical Wall/Clg Rough In	4 days	Thu 1/10/08	Tue 1/15/08
96	Inspections, MEP, Elec, Wall Close In	5 days	Wed 1/16/08	Tue 1/22/08
97	Install Windows 3rd Floor	5 days	Wed 1/16/08	Tue 1/22/08
98	Hang Shafts (str., elev, 3 side MEP) Purple	3 days	Wed 1/23/08	Fri 1/25/08
99	Temp Dry in up to 6th Flr.	5 days	Wed 2/13/08	Tue 2/19/08
100	Hang Dry Wall & Tape except at FCU's	8 days	Wed 2/20/08	Fri 2/29/08
101	Set and Hook Up FCU / Inspect for Close In	5 days	Mon 3/3/08	Fri 3/7/08
102	Hang Drywall and Tape at FCU's	4 days	Mon 3/10/08	Thu 3/13/08
103	Temporary Conditioning	1 day	Fri 3/28/08	Fri 3/28/08
104	Install Wood Trim	4 days	Mon 3/31/08	Thu 4/3/08
105	Prime Paint and Texture Clgs	3 days	Fri 4/4/08	Tue 4/8/08
106	Point up, Reprime	3 days	Wed 4/9/08	Fri 4/11/08
107	Wall Covering and Paint, Tile	5 days	Mon 4/14/08	Fri 4/18/08
108	Install Kicthen and Bath Casework	7 days	Mon 4/21/08	Tue 4/29/08
109	Install Kitchen Sinks, and Electrical Trim	4 days	Mon 4/28/08	Thu 5/1/08
110	Final Coat Paint	3 days	Fri 5/2/08	Tue 5/6/08
111	Install Carpet	5 days	Wed 5/7/08	Tue 5/13/08
112	Start up FCU, Test MEP	5 days	Wed 5/14/08	Tue 5/20/08
113	Punch Floor	5 days	Wed 5/21/08	Tue 5/27/08
114	Complete Punch	5 days	Wed 5/28/08	Tue 6/3/08
115	Owner FFE Items	5 days	Wed 6/4/08	Tue 6/10/08
116	5 Day Stagger	5 days	Wed 6/11/08	Tue 6/17/08
117	Complete Walls and Finishes at Hoist Room	10 days	Fri 8/8/08	Thu 8/21/08
118	Owner FFE at Hoist Room	2 days	Fri 8/22/08	Mon 8/25/08
119	4th Floor	201 days	Fri 11/9/07	Mon 8/25/08
120	5th Floor	196 days	Fri 11/16/07	Mon 8/25/08



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Construction Management

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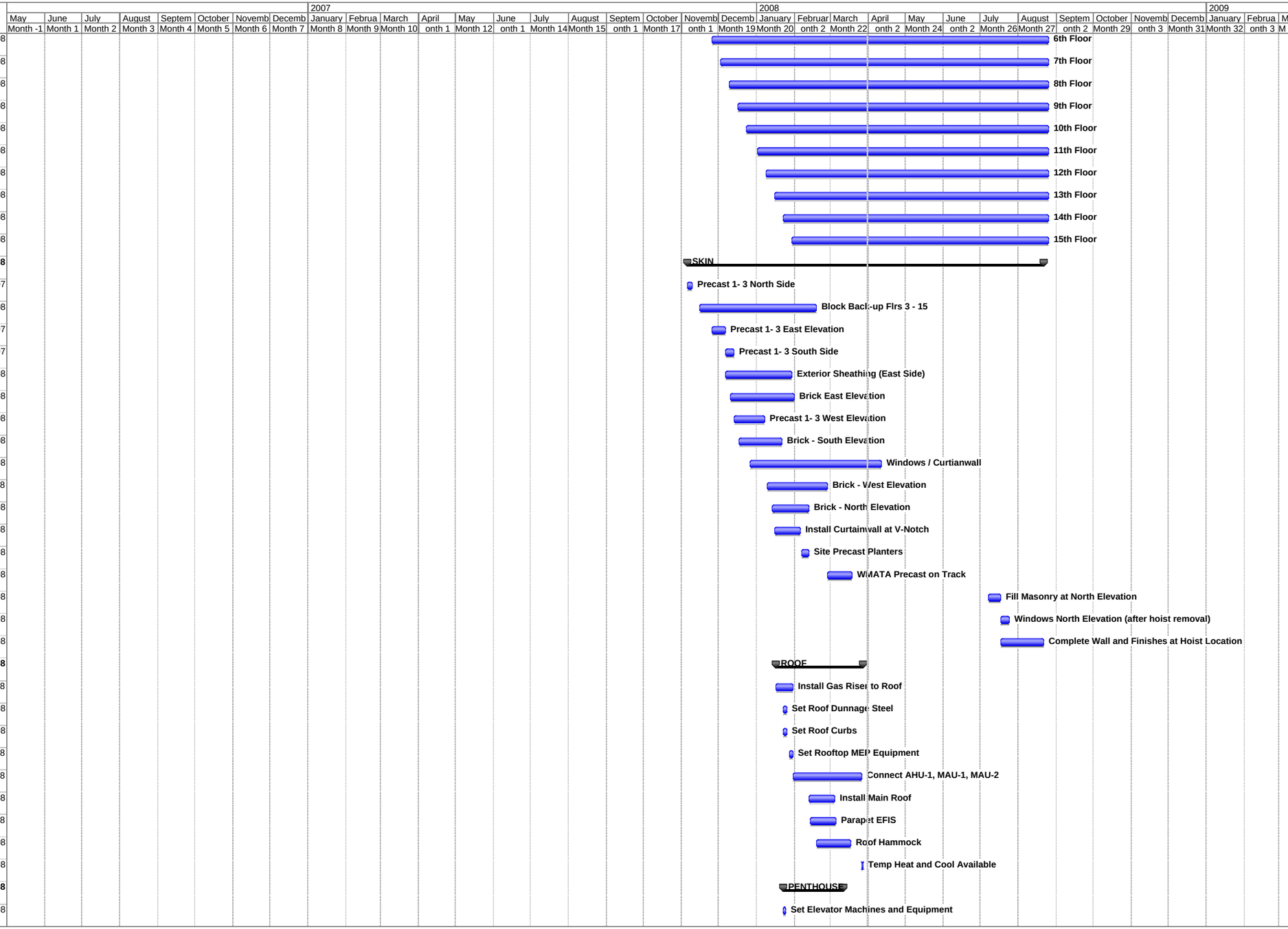
Appendix A

ID	Task Name	Duration	Start	Finish
121	6th Floor	192 days	Mon 11/26/07	Mon 8/25/08
122	7th Floor	187 days	Mon 12/3/07	Mon 8/25/08
123	8th Floor	182 days	Mon 12/10/07	Mon 8/25/08
124	9th Floor	177 days	Mon 12/17/07	Mon 8/25/08
125	10th Floor	172 days	Mon 12/24/07	Mon 8/25/08
126	11th Floor	168 days	Wed 1/2/08	Mon 8/25/08
127	12th Floor	163 days	Wed 1/9/08	Mon 8/25/08
128	13th Floor	158 days	Wed 1/16/08	Mon 8/25/08
129	14th Floor	153 days	Wed 1/23/08	Mon 8/25/08
130	15th Floor	148 days	Wed 1/30/08	Mon 8/25/08
131	**SKIN**	**202 days**	**Tue 11/6/07**	**Thu 8/21/08**
132	Precast 1- 3 North Side	4 days	Tue 11/6/07	Fri 11/9/07
133	Block Back-up Flrs 3 - 15	62 days	Fri 11/16/07	Mon 2/18/08
134	Precast 1- 3 East Elevation	9 days	Mon 11/26/07	Thu 12/6/07
135	Precast 1- 3 South Side	5 days	Fri 12/7/07	Thu 12/13/07
136	Exterior Sheathing (East Side)	35 days	Fri 12/7/07	Tue 1/29/08
137	Brick East Elevation	35 days	Tue 12/11/07	Thu 1/31/08
138	Precast 1- 3 West Elevation	14 days	Fri 12/14/07	Mon 1/7/08
139	Brick - South Elevation	22 days	Tue 12/18/07	Mon 1/21/08
140	Windows / Curtianwall	75 days	Thu 12/27/07	Fri 4/11/08
141	Brick - West Elevation	35 days	Thu 1/10/08	Wed 2/27/08
142	Brick - North Elevation	22 days	Mon 1/14/08	Tue 2/12/08
143	Install Curtainwall at V-Notch	15 days	Wed 1/16/08	Tue 2/5/08
144	Site Precast Planters	4 days	Thu 2/7/08	Tue 2/12/08
145	WMATA Precast on Track	14 days	Thu 2/28/08	Tue 3/18/08
146	Fill Masonry at North Elevation	8 days	Tue 7/8/08	Thu 7/17/08
147	Windows North Elevation (after hoist removal)	5 days	Fri 7/18/08	Thu 7/24/08
148	Complete Wall and Finishes at Hoist Location	25 days	Fri 7/18/08	Thu 8/21/08
149	**ROOF**	**51 days**	**Thu 1/17/08**	**Thu 3/27/08**
150	Install Gas Riser to Roof	10 days	Thu 1/17/08	Wed 1/30/08
151	Set Roof Dunnage Steel	3 days	Wed 1/23/08	Fri 1/25/08
152	Set Roof Curbs	3 days	Wed 1/23/08	Fri 1/25/08
153	Set Rooftop MEP Equipment	3 days	Mon 1/28/08	Wed 1/30/08
154	Connect AHU-1, MAU-1, MAU-2	40 days	Thu 1/31/08	Wed 3/26/08
155	Install Main Roof	15 days	Wed 2/13/08	Tue 3/4/08
156	Parapet EFIS	15 days	Thu 2/14/08	Wed 3/5/08
157	Roof Hammock	20 days	Tue 2/19/08	Mon 3/17/08
158	Temp Heat and Cool Available	1 day	Thu 3/27/08	Thu 3/27/08
159	**PENTHOUSE**	**35 days**	**Wed 1/23/08**	**Tue 3/11/08**
160	Set Elevator Machines and Equipment	2 days	Wed 1/23/08	Thu 1/24/08



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Construction Management

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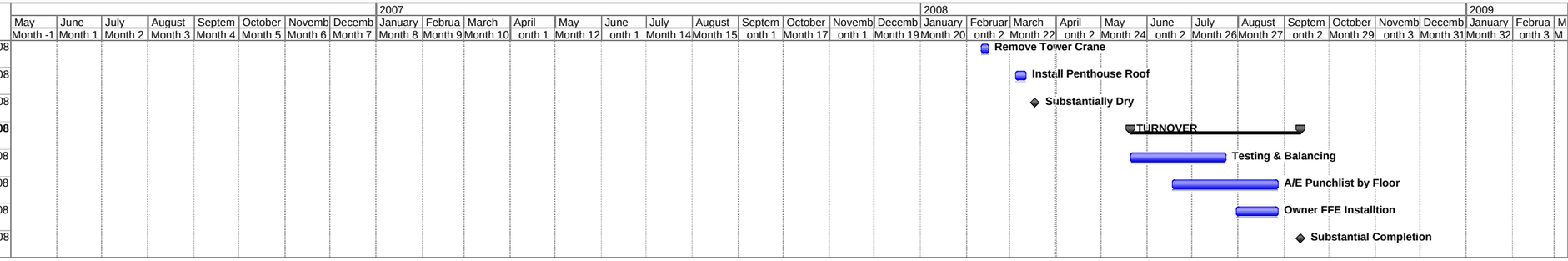
Appendix A

ID	Task Name	Duration	Start	Finish
161	Remove Tower Crane	5 days	Mon 2/11/08	Fri 2/15/08
162	Install Penthouse Roof	5 days	Wed 3/5/08	Tue 3/11/08
163	Substantially Dry	0 days	Mon 3/17/08	Mon 3/17/08
164	**TURNOVER**	**81 days**	**Wed 5/21/08**	**Fri 9/12/08**
165	Testing & Balancing	45 days	Wed 5/21/08	Wed 7/23/08
166	A/E Punchlist by Floor	50 days	Wed 6/18/08	Wed 8/27/08
167	Owner FFE Installtion	20 days	Thu 7/31/08	Wed 8/27/08
168	Substantial Completion	0 days	Fri 9/12/08	Fri 9/12/08



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Appendix B: Project Cost Evaluation

The detailed D4Cost 2002 Estimate and R.S. Means sheets can be found on the following pages.

nesday, October 3, 2007

Estimate of Probable Cost

Residence Inn by Marriott - Mar 2007 - VA - Alexandria

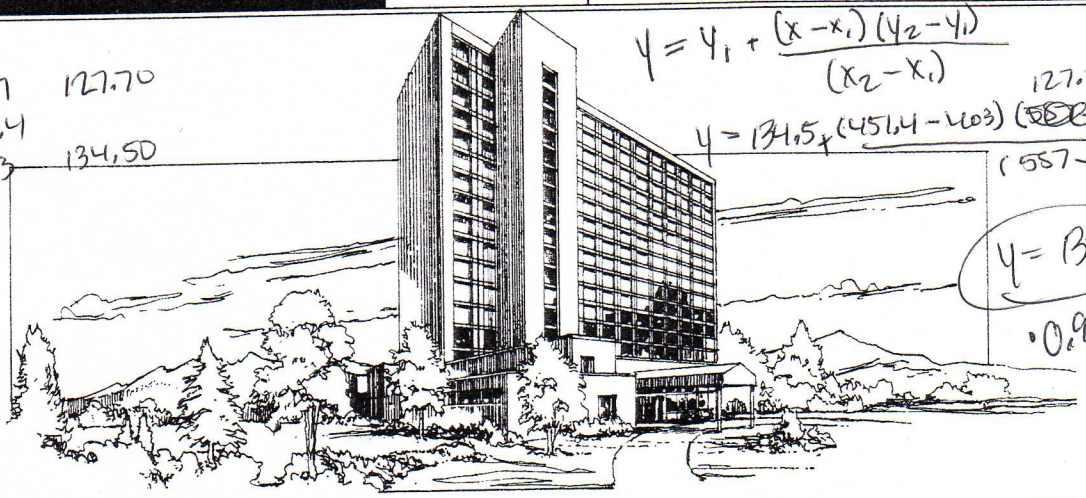
Prepared By:	Julia Phillips Residence Inn by Marriott 2345 Mill Rd. Alexandria, VA Fax:	Prepared For:	Dr. Horman Construction Management Penn State University , Fax:
Building Sq. Size:	189620	Site Sq. Size:	17936
Bid Date:	5/6/2006	Building use:	Hotel/Motel
No. of floors:	15	Foundation:	MAT
No. of buildings:	1	Exterior Walls:	CON
Project Height:	171.5	Interior Walls:	DRY
1st Floor Height:		Roof Type:	BUP
1st Floor Size:	9500	Floor Type:	CON
		Project Type:	NEW

Division		Percent	Sq. Cost	Amount
00	**Bidding Requirements**	**5.37**	**9.36**	**1,774,918**
	Bidding Requirements	5.37	9.36	1,774,918
01	**General Requirements**	**6.55**	**11.42**	**2,166,291**
	General Requirements	6.55	11.42	2,166,291
02	**Site Work**	**1.55**	**2.70**	**511,104**
	Site Work	1.55	2.70	511,104
03	**Concrete**	**11.49**	**20.03**	**3,797,518**
	Concrete	11.49	20.03	3,797,518
04	**Masonry**	**1.87**	**3.27**	**619,272**
	Masonry	1.87	3.27	619,272
05	**Metals**	**2.76**	**4.81**	**912,652**
	Metals	2.76	4.81	912,652
06	**Wood & Plastics**	**2.36**	**4.11**	**778,903**
	Wood & Plastics	2.36	4.11	778,903
07	**Thermal & Moisture Protection**	**5.32**	**9.28**	**1,759,242**
	Thermal & Moisture Protection	5.32	9.28	1,759,242
08	**Doors & Windows**	**4.94**	**8.61**	**1,632,106**
	Doors & Windows	4.94	8.61	1,632,106
09	**Finishes**	**6.65**	**11.59**	**2,198,274**
	Finishes	6.65	11.59	2,198,274
10	**Specialties**	**0.43**	**0.75**	**142,659**
	Specialties	0.43	0.75	142,659
11	**Equipment**	**0.45**	**0.79**	**149,073**
	Equipment	0.45	0.79	149,073
12	**Furnishings**	**0.38**	**0.67**	**126,306**
	Furnishings	0.38	0.67	126,306
13	**Special Construction**	**0.33**	**0.58**	**110,743**
	Special Construction	0.33	0.58	110,743
14	**Conveying Systems**	**2.40**	**4.19**	**794,765**
	Conveying Systems	2.40	4.19	794,765
15	**Mechanical**	**11.10**	**19.35**	**3,668,401**
	Mechanical	11.10	19.35	3,668,401
16	**Electrical**	**6.09**	**10.62**	**2,014,298**
	Electrical	6.09	10.62	2,014,298
21	**Fire Suppression**	**1.65**	**2.87**	**544,188**
	Fire Suppression	1.65	2.87	544,188

Wednesday, October 3, 2007

22	**Plumbing**	**8.53**	**14.87**	**2,819,289**
	Plumbing	8.53	14.87	2,819,289
23	**HVAC**	**9.12**	**15.91**	**3,015,984**
	HVAC	9.12	15.91	3,015,984
26	**Electrical**	**9.52**	**16.60**	**3,147,114**
	Electrical	9.52	16.60	3,147,114
31	**Earthwork**	**0.87**	**1.52**	**288,485**
	Earthwork	0.87	1.52	288,485
32	**Exterior Improvements**	**0.28**	**0.48**	**91,791**
	Exterior Improvements	0.28	0.48	91,791
Total Building Costs		**100.00**	**174.37**	**33,063,375**
Total Non-Building Costs		**100.00**	**0.00**	**0**
Total Project Costs		--	--	**33,063,375**

R.S. MEANS 2007.



243000 587 127.70
169200 451.4
140000 403 134.50

$y = y_1 + \frac{(x - x_1)(y_2 - y_1)}{(x_2 - x_1)}$

$y = 134.5 + (451.4 - 403)\ (127.70 - 134.50)$
$(557 - 403)$

$y = 132.71$
$\cdot 0.94 = 124.75$ FINAL

$434 + 12 + 5 = 451.4$

Costs per square foot of floor area

169200

Exterior Wall	S.F. Area	140000	243000	346000	450000	552000	655000	760000	860000	965000
	L.F. Perimeter	403	587	672	800	936	1073	1213	1195	1312
Face Brick with Concrete Block Back-up	Steel Frame	134.25	127.45	122.80	120.90	119.80	119.15	118.55	116.90	116.60
	R/Conc. Frame	134.50	127.70	123.05	121.10	120.05	119.35	118.75	117.10	116.80
Face Brick Veneer On Steel Studs	Steel Frame	132.00	125.60	121.30	119.50	118.55	117.85	117.30	115.85	115.55
	R/Conc. Frame	132.65	126.25	121.95	120.15	119.20	118.45	117.95	116.45	116.15
Glass and Metal Curtain Walls	Steel Frame	157.90	144.90	138.20	**135.00**	133.15	131.80	130.95	129.30	128.70
	R/Conc. Frame	158.55	145.50	138.90	135.65	133.80	132.50	131.55	129.95	129.35
Perimeter Adj., Add or Deduct	Per 100 L.F.	4.85	2.80	1.95	1.50	1.30	1.00	.90	.85	.70
Story Hgt. Adj., Add or Deduct	Per 1 Ft.	1.85	1.60	1.25	1.10	1.20	1.00	1.10	.90	.85

For Basement, add $29.40 per square foot of basement area

The above costs were calculated using the basic specifications shown on the facing page. These costs should be adjusted where necessary for design alternatives and owner's requirements. Reported completed project costs, for this type of structure, range from $105.85 to $185.10 per S.F.

Common additives

Description	Unit	$ Cost
Bar, Front bar	L.F.	345
Back bar	L.F.	277
Booth, Upholstered, custom, straight	L.F.	182 - 335
"L" or "U" shaped	L.F.	188 - 320
Closed Circuit Surveillance, One station		
Camera and monitor	Each	1675
For additional camera stations, add	Each	910
Directory Boards, Plastic, glass covered		
30" x 20"	Each	570
36" x 48"	Each	1375
Aluminum, 24" x 18"	Each	555
48" x 32"	Each	885
1011 48" x 60"	Each	1850
Elevators, Electric passenger, 10 stops		
3500# capacity 3	Each	270,500
5000# capacity	Each	278,000
Additional stop, add +8	Each	7675
Emergency Lighting, 25 watt, battery operated		
Lead battery	Each	265
Nickel cadmium	Each	770

Description	Unit	$ Cost
Laundry Equipment		
Folders, blankets & sheets, king size	Each	64,000
Ironers, 110" single roll	Each	34,600
Combination washer & extractor 50# (4)	Each	11,900
125#	Each	31,800
Sauna, Prefabricated, complete		
6' x 4'	Each	4950
6' x 6'	Each	5925
6' x 9'	Each	7300
8' x 8'	Each	8600
10' x 12'	Each	11,900
Smoke Detectors		
Ceiling type 200	Each	171
Duct type 48	Each	440
Sound System	Each	
Amplifier, 250 watts	Each	2125
Speaker, ceiling or wall	Each	174
Trumpet	Each	335
TV Antenna, Master system, 12 outlet	Outlet	288
30 outlet	Outlet	185
100 outlet	Outlet	173

Important: See the Reference Section for Location Factors

Model costs calculated for a 15 story building with 10′ story height and 450,000 square feet of floor area

Hotel, 8-24 Story

				Unit	Unit Cost	Cost Per S.F.	% Of Sub-Total
A. SUBSTRUCTURE							
1010	Standard Foundations	Poured concrete; strip and spread footings		S.F. Ground	16.05	1.07	1.5%
1030	Slab on Grade	4" reinforced concrete with vapor barrier and granular base		S.F. Slab	4.45	.30	
2010	Basement Excavation	Site preparation for slab and trench for foundation wall and footing		S.F. Ground	.14	.01	
2020	Basement Walls	4′ foundation wall		L.F. Wall	69	.15	
B. SHELL							
	B10 Superstructure						
1010	Floor Construction	Open web steel joists, slab form, concrete, columns		S.F. Floor	17.63	16.45	16.6%
1020	Roof Construction	Metal deck, open web steel joists, beams, columns		S.F. Roof	7.50	.50	
	B20 Exterior Enclosure						
2010	Exterior Walls	N/A		–	–	–	5.6%
2020	Exterior Windows	Glass and metal curtain walls	100% of wall	Each	20	5.55	
2030	Exterior Doors	Glass and metal doors and entrances		Each	2582	.19	
	B30 Roofing						
3010	Roof Coverings	Built-up tar and gravel with flashing; perlite/EPS composite insulation		S.F. Roof	5.10	.34	0.3%
3020	Roof Openings	N/A		–	–	–	
C. INTERIORS							
1010	Partitions	Gypsum board and sound deadening board, steel studs	9 S.F. Floor/L.F. Partition	S.F. Partition	6.38	5.67	27.8%
1020	Interior Doors	Single leaf hollow metal	90 S.F. Floor/Door	Each	815	9.06	
1030	Fittings	N/A		–	–	–	
2010	Stair Construction	Concrete filled metal pan		Flight	11,550	2.34	
3010	Wall Finishes	20% paint, 75% vinyl cover, 5% ceramic tile		S.F. Surface	1.67	2.96	
3020	Floor Finishes	80% carpet tile, 10% vinyl composition tile, 10% ceramic tile		S.F. Floor	4.75	4.75	
3030	Ceiling Finishes	Gypsum board on resilient channel		S.F. Ceiling	3.54	3.54	
D. SERVICES							
	D10 Conveying						
1010	Elevators & Lifts	One geared freight, six geared passenger elevators		Each	303,750	4.05	4.0%
1020	Escalators & Moving Walks	N/A		–	–	–	
	D20 Plumbing						
2010	Plumbing Fixtures	Kitchen, toilet and service fixtures, supply and drainage	1 Fixture/165 S.F. Floor	Each	2301	13.95	17.8%
2020	Domestic Water Distribution	Electric water heater		S.F. Floor	4.07	4.07	
2040	Rain Water Drainage	Roof drains		S.F. Roof	1.50	.10	
	D30 HVAC						
3010	Energy Supply	Oil fired hot water, wall fin radiation		S.F.Floor	2.00	2.00	11.8%
3020	Heat Generating Systems	N/A		–	–	–	
3030	Cooling Generating Systems	Chilled water, fan coil units		S.F. Floor	10.01	10.01	
3050	Terminal & Package Units	N/A		–	–	–	
3090	Other HVAC Sys. & Equipment	N/A		–	–	–	
	D40 Fire Protection						
4010	Sprinklers	Sprinkler system, light hazard		S.F. Floor	2.89	2.89	3.1%
4020	Standpipes	Standpipes and hose systems		S.F. Floor	.31	.31	
	D50 Electrical						
5010	Electrical Service/Distribution	6000 ampere service, panel board and feeders		S.F. Floor	1.37	1.37	11.4%
5020	Lighting & Branch Wiring	Fluorescent fixtures, receptacles, switches, A.C. and misc. power		S.F. Floor	7.40	7.40	
5030	Communications & Security	Alarm systems, internet wiring, communications systems and emergency lighting		S.F. Floor	2.53	2.53	
5090	Other Electrical Systems	Emergency generator, 500 kW		S.F. Floor	.32	.32	
E. EQUIPMENT & FURNISHINGS							
1010	Commercial Equipment	N/A		–	–	–	0.0%
1020	Institutional Equipment	N/A		–	–	–	
1030	Vehicular Equipment	N/A		–	–	–	
1090	Other Equipment	N/A		–	–	–	
F. SPECIAL CONSTRUCTION							
1020	Integrated Construction	N/A		–	–	–	0.0%
1040	Special Facilities	N/A		–	–	–	
G. BUILDING SITEWORK		**N/A**					
					Sub-Total	101.89	**100%**
	CONTRACTOR FEES (General Requirements: 10%, Overhead: 5%, Profit: 10%)				25%	25.47	
	ARCHITECT FEES				8%	7.64	
					Total Building Cost	**135.00**	

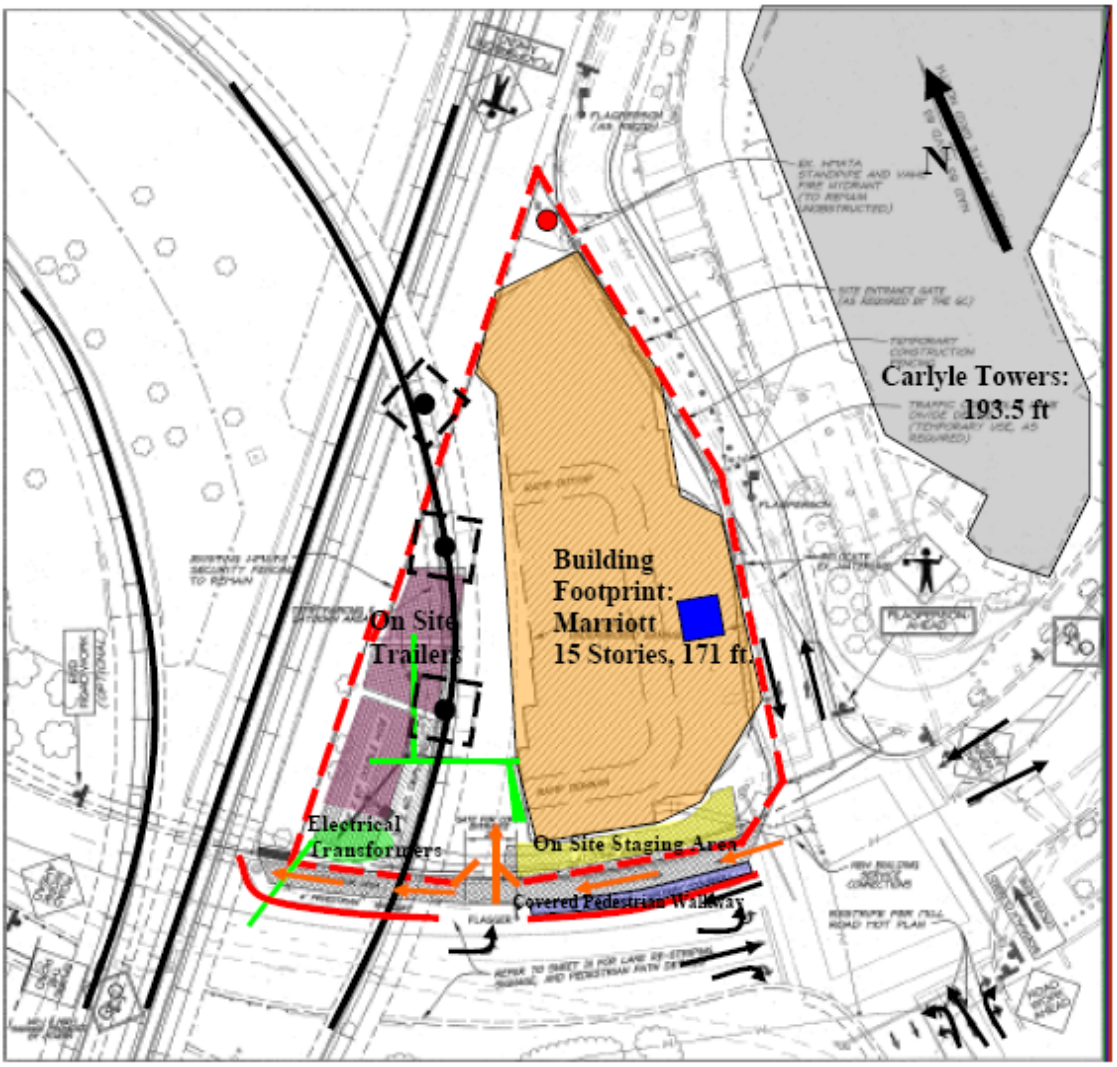
Location Factors

STATE/ZIP	CITY	Residential	Commercial
VIRGINIA			
220-221	Fairfax	1.02	.93
222	Arlington	1.04	.93
223	Alexandria	1.06	.94
224-225	Fredericksburg	.95	.89
226	Winchester	.93	.87
227	Culpeper	1.00	.89
228	Harrisonburg	.90	.86
229	Charlottesville	.92	.87
230-232	Richmond	1.01	.89
233-235	Norfolk	1.02	.88
236	Newport News	1.01	.88
237	Portsmouth	.92	.86
238	Petersburg	.99	.89
239	Farmville	.91	.82
240-241	Roanoke	.99	.87
242	Bristol	.86	.82
243	Pulaski	.84	.81
244	Staunton	.93	.85
245	Lynchburg	.97	.87
246	Grundy	.85	.81
WASHINGTON			
980-981,987	Seattle	1.02	1.04
982	Everett	1.05	1.02
983-984	Tacoma	1.01	1.03
985	Olympia	1.01	1.01
986	Vancouver	.98	1.02
988	Wenatchee	.93	.96
989	Yakima	.97	.98
990-992	Spokane	.99	.95
993	Richland	.97	.97
994	Clarkston	.97	.95
WEST VIRGINIA			
247-248	Bluefield	.88	.89
249	Lewisburg	.89	.92
250-253	Charleston	.97	.95
254	Martinsburg	.86	.90
255-257	Huntington	1.01	.99
258-259	Beckley	.90	.93
260	Wheeling	.93	.97
261	Parkersburg	.92	.96
262	Buckhannon	.92	.96
263-264	Clarksburg	.92	.96
265	Morgantown	.93	.96
266	Gassaway	.92	.95
267	Romney	.88	.93
268	Petersburg	.90	.94
WISCONSIN			
530,532	Milwaukee	1.07	1.02
531	Kenosha	1.04	1.00
534	Racine	1.02	1.00
535	Beloit	1.00	.98
537	Madison	.99	.97
538	Lancaster	.97	.94
539	Portage	.96	.95
540	New Richmond	1.00	.96
541-543	Green Bay	1.01	.97
544	Wausau	.95	.94
545	Rhinelander	.95	.96
546	La Crosse	.94	.95
547	Eau Claire	.98	.97
548	Superior	.99	.98
549	Oshkosh	.95	.94
WYOMING			
820	Cheyenne	.84	.86
821	Yellowstone Nat. Pk.	.75	.82
822	Wheatland	.75	.82
823	Rawlins	.76	.83
824	Worland	.75	.81
825	Riverton	.74	.81
826	Casper	.78	.83
827	Newcastle	.74	.81
828	Sheridan	.80	.84
829-831	Rock Springs	.79	.83

STATE/ZIP	CITY	Residential	Commercial
CANADIAN FACTORS (reflect Canadian currency)			
ALBERTA			
	Calgary	1.14	1.11
	Edmonton	1.13	1.12
	Fort McMurray	1.09	1.06
	Lethbridge	1.10	1.07
	Lloydminster	1.09	1.07
	Medicine Hat	1.10	1.06
	Red Deer	1.10	1.06
BRITISH COLUMBIA			
	Kamloops	1.08	1.09
	Prince George	1.08	1.09
	Vancouver	1.09	1.10
	Victoria	1.03	1.04
MANITOBA			
	Brandon	1.06	1.01
	Portage la Prairie	1.06	1.01
	Winnipeg	1.05	1.03
NEW BRUNSWICK			
	Bathurst	.97	.96
	Dalhousie	.97	.96
	Fredericton	1.05	.99
	Moncton	.98	.97
	Newcastle	.97	.96
	Saint John	1.05	1.00
NEWFOUNDLAND			
	Corner Brook	.99	.99
	St. John's	1.01	1.00
NORTHWEST TERRITORIES			
	Yellowknife	1.10	1.08
NOVA SCOTIA			
	Dartmouth	1.00	1.01
	Halifax	1.02	1.03
	New Glasgow	1.00	1.00
	Sydney	.99	.99
	Yarmouth	1.00	1.00
ONTARIO			
	Barrie	1.17	1.11
	Brantford	1.19	1.12
	Cornwall	1.19	1.11
	Hamilton	1.19	1.14
	Kingston	1.19	1.11
	Kitchener	1.11	1.06
	London	1.17	1.11
	North Bay	1.15	1.10
	Oshawa	1.17	1.11
	Ottawa	1.19	1.11
	Owen Sound	1.15	1.10
	Peterborough	1.16	1.10
	Sarnia	1.19	1.13
	Sudbury	1.09	1.05
	Thunder Bay	1.15	1.06
	Toronto	1.20	1.14
	Windsor	1.14	1.06
PRINCE EDWARD ISLAND			
	Charlottetown	.95	.96
	Summerside	.94	.96
QUEBEC			
	Cap-de-la-Madeleine	1.18	1.06
	Charlesbourg	1.18	1.06
	Chicoutimi	1.20	1.08
	Gatineau	1.16	1.06
	Laval	1.17	1.06
	Montreal	1.21	1.11
	Quebec	1.22	1.11
	Sherbrooke	1.17	1.06
	Trois Rivieres	1.18	1.06
SASKATCHEWAN			
	Moose Jaw	.97	.97
	Prince Albert	.96	.95
	Regina	.99	.98
	Saskatoon	.97	.97
YUKON			
	Whitehorse	.96	.96

Appendix C: Detailed Site Plan

The Detailed Site Plan showing exact locations on the site that were described in the Site Plan of Existing Conditions section can be found on the following page.



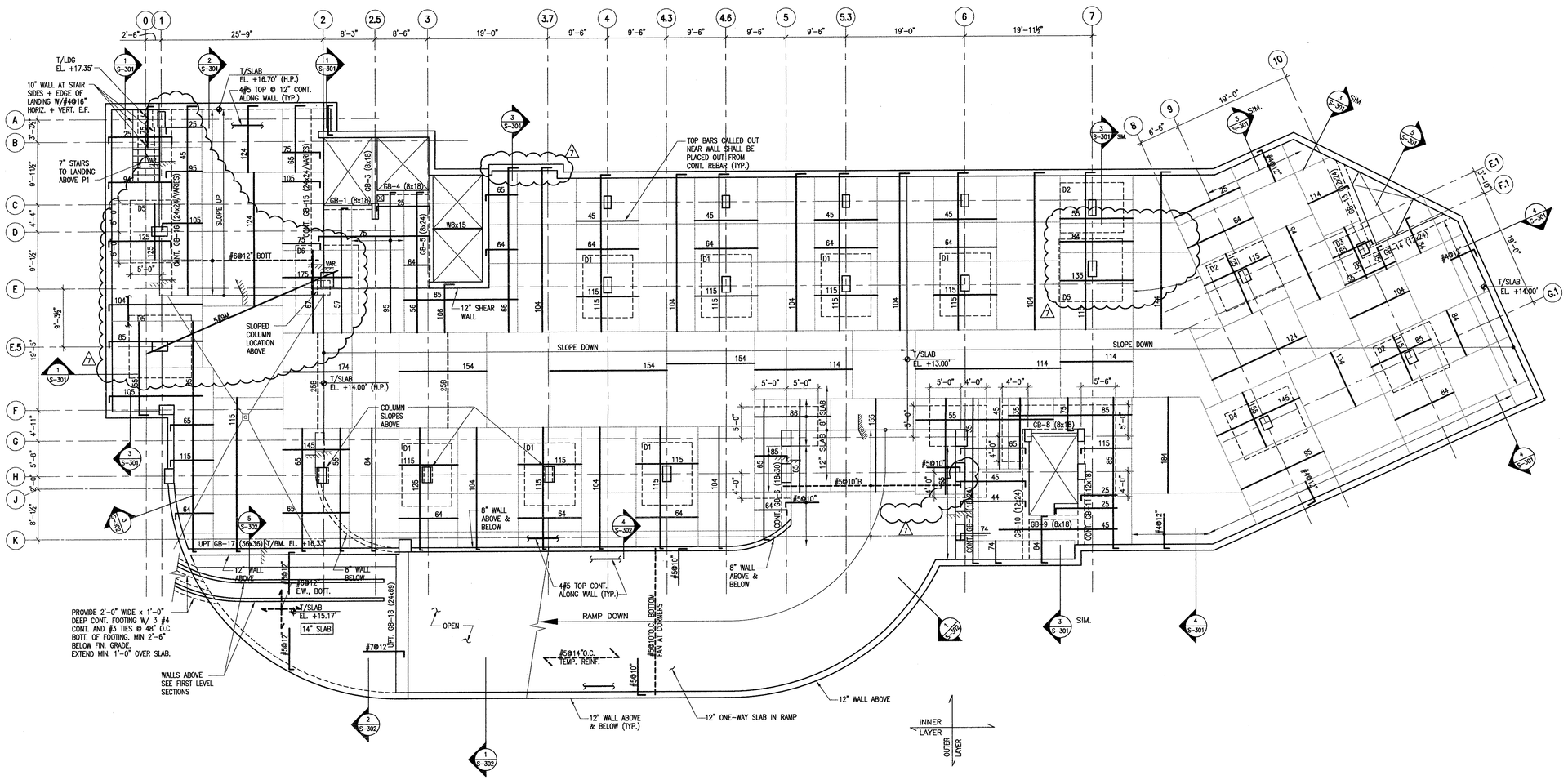
Legend:

- Construction Fencing
- Construction Gate
- Construction Traffic
- Construction Barrier
- Electrical Power & Utilities
- Tower Crane
- Metro Track
- Protected Metro Column
- Protected City Fire Hydrant
- Public Traffic

Appendix D: Structural Calculations and Comparisons

The following can be found in this Structural Appendix:

- *Original Floor Plan of P-1 Level, Drawing S – 103*
- *Stud Rail Calculations*
- *Decon Stud Rail Cut Sheet*
- *Re-Designed Cast In Place Flat Plate Calculations*
- *Filigree Floor Plan*
- *Healy Long & Jevin, Inc. Estimates*
  - *Filigree System*
  - *Original Flat Slab System*
- *Take Off Estimate of Original Flat Slab System*
- *System Comparison Chart*
- *Structural Schedule*

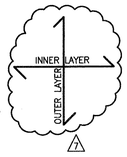


P-1 LEVEL FRAMING PLAN

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

NOTES:

1. TYPICAL SLAB CONSTRUCTION: 8" THICK (UNLESS NOTED OTHERWISE) NORMAL WEIGHT CONCRETE (F'C=5000 PSI) WITH 60,000 PSI REINFORCING STEEL. ALL REINFORCING BARS AND ACCESSORIES SHALL BE EPOXY-COATED PER STRUCTURAL NOTES.
2. BASIC SLAB ELEVATIONS ARE NOTED ON PLAN. SEE ARCHITECTURAL AND MECHANICAL DRAWINGS FOR SLOPES AND FLOOR DRAINS.
3. DROP PANELS ARE 5/8"THICK (1 3/8" TOTAL THICKNESS), AND SIZES ARE PER SCHEDULE, CENTERED ON COLUMN, U.N.O.
4. BOTTOM MAT IS #4@12" O.C. EACH WAY., U.O.N. REINFORCING MARKED THUS 35B ON PLAN ARE 3#5 BOTTOM BARS IN THE DIRECTION SHOWN IN ADDITION TO THE BOTTOM MAT.
5. TOP REINFORCING FOR COLUMN AND MIDDLE STRIPS IS AS SHOWN ON PLAN. REINFORCING MARKED THUS 16S ON PLAN ARE 16#5 TOP BARS.
6. REINFORCING MARKED THUS: 14+7S ON PLAN ARE 14-#5 BARS EVENLY DISTRIBUTED ACROSS THE COLUMN STRIP WITH 7-#5 BARS ADDED ACROSS A SLAB WIDTH EXTENDING ON EITHER SIDE OF THE COLUMN A DISTANCE OF 1.5H (WHERE H = SLAB + DROP PANEL THICKNESS).
7. SEE ARCHITECTURAL AND MEP DRAWINGS FOR SIZE AND LOCATION OF ALL SLAB OPENINGS. PROVIDE REINFORCING PER TYPICAL DETAIL ON S-602. CONTRACTOR SHALL COORDINATE AND SUBMIT SLAB PENETRATION SHOP DRAWINGS PRIOR TO CONCRETE POUR.
8. SEE ARCHITECTURAL DRAWINGS FOR LOCATION OF COLUMNS, EOS, CURBS, CMU WALLS, AND SLOPES FOR DRAINS.



NOTATION	SIZE	NOTES
D1	8'-0"x10'-0"	NOTES 1, 2
D2	10'-0"x8'-0"	NOTES 1, 2
D3	8'-0"x8'-0"	NOTES 1, 2
D4	11'-0"x8'-0"	NOTES 1, 2
D5	10'-0"x10'-0"	NOTES 1, 2
D6	10'-0"x11'-0"	NOTES 1, 2

NOTES:
1. FIRST DIMENSION IS LEFT TO RIGHT ON PLAN.
2. DROP CENTERED OVER COLUMN.

SEE WMATA NOTE ON SHEET A-001.

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REVISIONS

PERMIT SET	OCT. 20, 2006
95% PRICING	DEC. 01, 2006
FINAL CONSTRUCTION SET	FEB. 16, 2007
7 CCB#03-RELOCATED COLUMNS	APRIL 20, 2007

PROJECT TITLE

RESIDENCE INN BY MARRIOTT

2345/2347 MILL ROAD
ALEXANDRIA, VIRGINIA
PROJECT NO. 305412.00

DRAWING TITLE

P-1 LEVEL FRAMING PLAN

Printed On: 4/25/07, 3:41 pm

SCALE AS NOTED
DATE FEBRUARY 16, 2007
DRAWN BY
CHECKED BY

S103.dwg

DRAWING NUMBER

S-103

SK&A PROJECT NUMBER: 05-158
SHEET OF

RESIDENCE INN
BY MARRIOTT
2345 MILL RD, ALEXANDRIA, VA

JULIA E. PHILLIPS
CONSTRUCTION MANAGEMENT

Stud Rail Re-Design of P-1 Garage Level

Typical Bay Size (ft.) = 26.5 x 17.5

Column Size (in.) = 18 x 30

Fy = 60 ksi

No Existing Edge Beams

Exterior Panels (in.) = ln/30 = 17.5'/30 (12") = 7.00 in.

Interior Panels (in.) = ln/33 = 26.5'/33 (12") = 9.64 in.

h = 10 in.

d = 8.50 in.

Factored Load (P)

Live Load = 40 psf

Dead Load = 150 (10/12) = 125.00 psf

P = 1.2D + 1.6L = 214 psf

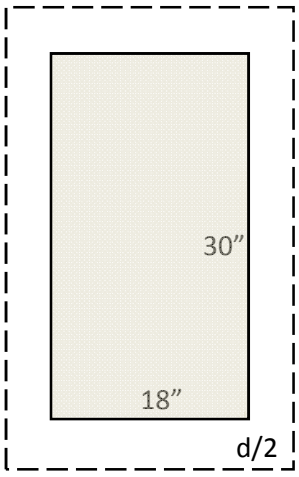
Distributed Load

ω = P * w = 3.745 kips

Tributary Load at Column

V_u = P * w * (1/2d + 1/2l) = 68.35 kips

Effective Width (b_o)



d/2 = 4.25 in.

b_{ol} = 38.50 in.

b_{os} = 26.50 in.

b_o = 130.00 in.

Shear Strength

Φ = 0.75

ΦVc = Φ4 * √f'c * bo * d = 234.41 kips > 68.35 kips

No Shear Stud Rails Required

DECON STUDRAILS

USA: 800-527-RAIL
CAN: 800-36-DECON

PROJECT TITLE: (NONE) (Feb 7,2008)

GENERAL DATA
File Name: C:\...\UNTITLED.INW
Project Title: (NONE)
Design Code: ACI 318-95
System of Units: US (in., lb.)
gamma, 0: 0

STUDRAIL DATA
Stud yield strength (fy): 50000 psi
Stud Diameter: Automatic
Stud Spacing: Automatic

SLAB DATA
Effective depth (d): 8.5 in.
Slab thickness: 10 in.
Top cover: 1 in.
Bottom cover: 1.5 in.
Concrete strength (f'c): 5000 psi
Concrete Density: Normal Weight

DESIGN PARAMETERS AT d/2 FROM COLUMN FACE:
Column centroid: Xo = 0.00 in.
Yo = 0.00 in.
Critical Section Area: Ac = 1105.0 in7^2
Moments of Inertia: Jx = 2.48E+05 in7^4
Jy = 1.41E+05 in7^4
Jxy = 0.00E+00 in7^4
Maximum shear stress: vu = 78 psi at x = 13.25 in.
y = 19.25 in.
Shear resistance: ϕvn = 240 psi

CONNECTION DATA
Connection Name: Column 1
Connection Type: Interior Column
Column size x: 18 in.
Column size y: 30 in.
Overhang (x): 0 in.
Overhang (y): 0 in.
Vu: 68.3 kip
Mox: 20 ft-kip
Moy: 20 ft-kip
Prestress (fpc): 0 psi
Number of Studrails: Automatic

WARNING AND OUTPUT MESSAGES

Design Result: Studrails are not required. The maximum shear stress is 78 psi and the factored resistance is 240 psi.

JULIA E. PHILLIPS
CONSTRUCTION MANAGEMENT

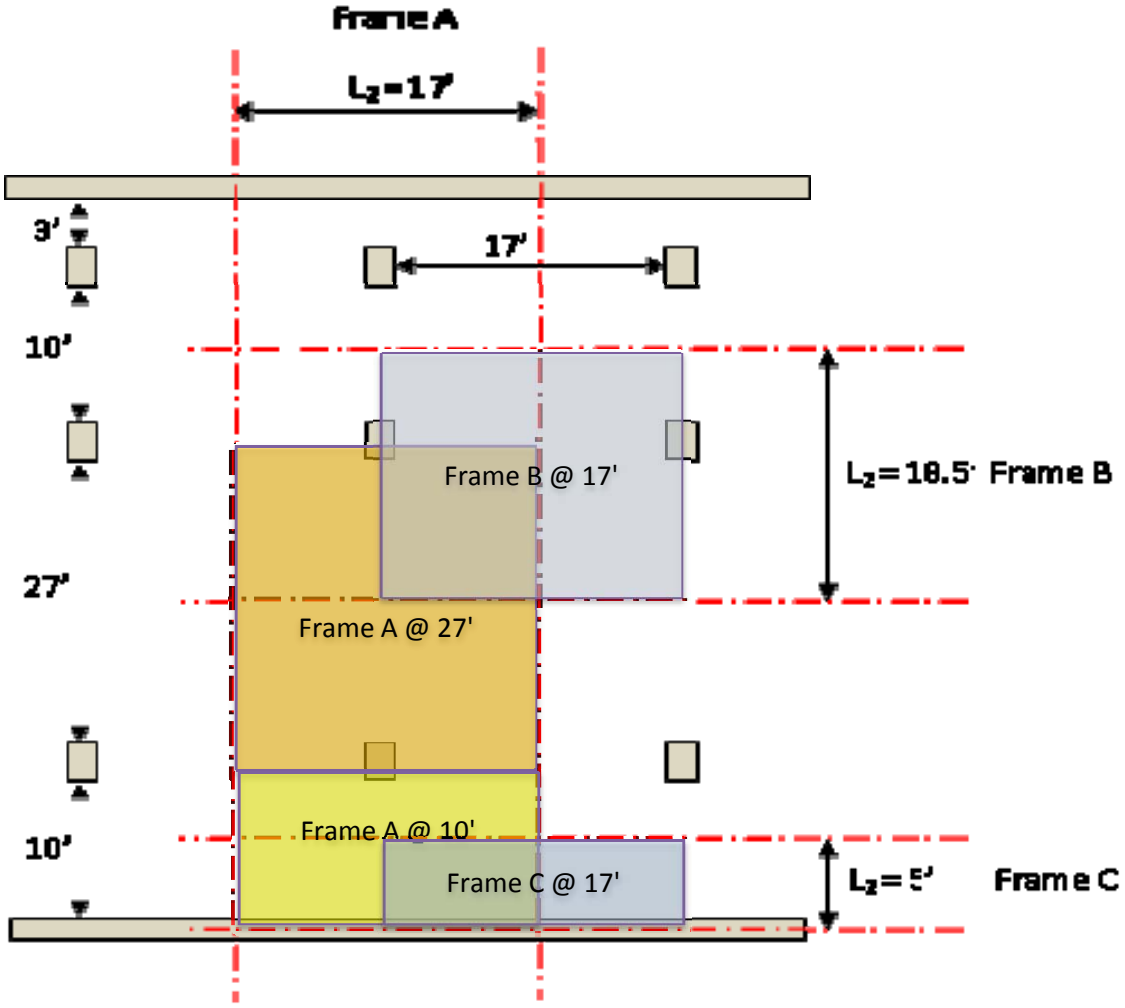
Flat Plate Re-Design of P-1 Garage Level

*** Assume Direct Design Method**
*** Assume Columns are In Line**
*** Assume 10 Column Lines**
*** Assume All Columns are 18" x 30"**
*** Frame C is doubled to account for the 3' span**

Frames Analyzed:
Frame A @ 27'
Frame A @ 10'
Frame B @ 17'
Frame C @ 17'

From Stud Rail Design
t = 10"
d = 8.5"

Averaged Column Grid:



Factored Loads Wu = 1.2D + 1.6L

Wu = 1.2 (125) + 1.6 (40) = 214 psf

JULIA E. PHILLIPS
CONSTRUCTION MANAGEMENT

Frame A @ 27'

$M_O = \frac{W_U * l_2 * l_n^2}{8}$ $M_O =$ 331.51 K-ft

$M_{INT}^+ =$ 0.35 $M_O =$ 116.03 K-ft $\alpha_1 = 0$ (No Beams)

$M_{INT}^- =$ 0.65 $M_O =$ 215.48 K-ft $l_2/l_1 = 17/27 =$ 0.63

Column Strip Moments

$M_{INT}^+ = 0.60\ M_{INT}^+ =$ 69.62 K-ft

$M_{INT}^- = 0.75\ M_{INT}^- =$ 161.61 K-ft

Middle Strip Moments

$M_{INT}^+ = 0.40\ M_{INT}^+ =$ 46.41 K-ft

$M_{INT}^- = 0.25\ M_{INT}^- =$ 53.87 K-ft

Rebar Design for Frame A @ 27'

		Column Strip		Middle Strip	
Item	Description	M_{INT}^+	M_{INT}^-	M_{INT}^+	M_{INT}^-
1	Moment (K-ft)	69.62	161.61	46.41	53.87
2	Width b (in.)	102	102	102	102
3	Effective d (in.)	8.5	8.5	8.5	8.5
4	$M_n = M_O / 0.9$	77.35	179.57	51.57	59.86
5	$R = \frac{M_n (1000)(12)}{b * d^2}$	125.96	292.40	83.97	97.47
6	ρ (Table A.5a)	0.002	0.005	0.0015	0.0015
7	$As = \rho\ b\ d$	1.73	4.34	1.30	1.30
8	$As_{MIN} = 0.0018\ b\ t$	1.84	1.84	1.84	1.84
9	$n = As_{MIN} / A_{BAR}$	4.17	9.85	9.18	9.18
10	$n_{MIN} = b / 2t$	5.1	5.1	5.1	5.1
	Solution	(6) #6	(10) #6	(10) #4	(10) #4

JULIA E. PHILLIPS
CONSTRUCTION MANAGEMENT

Frame A @ 10'

$M_O = \frac{W_U * l_2 * l_n^2}{8}$ $M_O =$ 45.48 K-ft

$M_{EXT}^- =$ 0.26 $M_O =$ 11.82 K-ft

$M_{EXT}^+ =$ 0.52 $M_O =$ 23.65 K-ft

$M_{INT}^- =$ 0.70 $M_O =$ 31.83 K-ft

$\alpha_1 = 0$ (No Beams)

$l_2/l_1 = 17/27 =$ 0.63

Column Strip Moments

$M_{EXT}^- = 1.0\ M_{EXT}^- =$ 11.82 K-ft

$M_{EXT}^+ = 0.60\ M_{EXT}^+ =$ 14.19 K-ft

$M_{INT}^- = 0.75\ M_{INT}^- =$ 23.87 K-ft

Middle Strip Moments

$M_{EXT}^- = (0)\ M_{EXT}^- =$ 0 K-ft

$M_{EXT}^+ = 0.40\ M_{EXT}^+ =$ 9.46 K-ft

$M_{INT}^- = 0.25\ M_{INT}^- =$ 7.96 K-ft

Rebar Design for Frame A @ 10'

		Column Strip			Middle Strip		
Item	Description	M_{EXT}^-	M_{EXT}^+	M_{INT}^-	M_{EXT}^-	M_{EXT}^+	M_{INT}^-
1	Moment (K-ft)	11.82	14.19	23.87	0.00	9.46	7.96
2	Width b (in.)	102	102	102	102	102	102
3	Effective d (in.)	8.5	8.5	8.5	8.5	8.5	8.5
4	$M_n = M_O / 0.9$	13.14	15.76	26.53	0.00	10.51	8.84
5	$R = \frac{M_n (1000)(12)}{b * d^2}$	21.39	25.67	43.19	0.00	17.11	14.40
6	ρ (Table A.5a)	0.0005	0.0005	0.0005	0	0.0005	0.0005
7	$As = \rho\ b\ d$	0.43	0.43	0.43	0.00	0.43	0.43
8	$As_{MIN} = 0.0018\ b\ t$	1.84	1.84	1.84	1.84	1.84	1.84
9	$n = As_{MIN} / A_{BAR}$	4.17	4.17	4.17	5.92	9.18	9.18
10	$n_{MIN} = b / 2t$	5.1	5.1	5.1	5.1	5.1	5.1
	Solution	(6) #6	(6) #6	(6) #6	(6) #5	(10) #4	(10) #4

JULIA E. PHILLIPS
CONSTRUCTION MANAGEMENT

Frame B @ 17'

$M_O = \frac{W_U * l_2 * l_n^2}{8}$ $M_O =$ 143.02 K-ft

$M_{INT}^+ =$ 0.35 $M_O =$ 50.06 K-ft

$M_{INT}^- =$ 0.65 $M_O =$ 92.96 K-ft

$\alpha_1 = 0$ (No Beams)

$l_2/l_1 = 18.5/17 =$ 1.09

Column Strip Moments

$M_{INT}^+ = 0.60\ M_{INT}^+ =$ 30.03 K-ft

$M_{INT}^- = 0.75\ M_{INT}^- =$ 69.72 K-ft

Middle Strip Moments

$M_{INT}^+ = 0.40\ M_{INT}^+ =$ 20.02 K-ft

$M_{INT}^- = 0.25\ M_{INT}^- =$ 23.24 K-ft

Rebar Design for Frame B @ 17'

		Column Strip		Middle Strip	
Item	Description	M_{INT}^+	M_{INT}^-	M_{INT}^+	M_{INT}^-
1	Moment (K-ft)	30.03	69.72	20.02	23.24
2	Width b (in.)	81	81	141	141
3	Effective d (in.)	8.5	8.5	8.5	8.5
4	$M_n = M_O / 0.9$	33.37	77.47	22.25	25.82
5	$R = \frac{M_n (1000)(12)}{b * d^2}$	68.43	158.85	26.21	30.42
6	ρ (Table A.5a)	0.001	0.0025	0.0005	0.0005
7	$As = \rho\ b\ d$	0.69	1.72	0.60	0.60
8	$As_{MIN} = 0.0018\ b\ t$	1.46	1.46	2.54	2.54
9	$n = As_{MIN} / A_{BAR}$	3.31	3.91	12.69	12.69
10	$n_{MIN} = b / 2t$	4.05	4.05	7.05	7.05
	Solution	(5) #6	(5) #6	(13) #4	(13) #4

JULIA E. PHILLIPS
CONSTRUCTION MANAGEMENT

Frame C @ 17'

$M_O = \frac{W_U * l_2 * l_n^2}{8}$ $M_O =$ 38.65 K-ft

$M_{INT}^+ =$ 0.35 $M_O =$ 13.53 K-ft $\alpha_1 = 0$ (No Beams)

$M_{INT}^- =$ 0.65 $M_O =$ 25.12 K-ft $l_2/l_1 = 5/17 =$ 0.29

Column Strip Moments

$M_{INT}^+ = 0.60\ M_{INT}^+ =$ 8.12 K-ft

$M_{INT}^- = 0.75\ M_{INT}^- =$ 18.84 K-ft

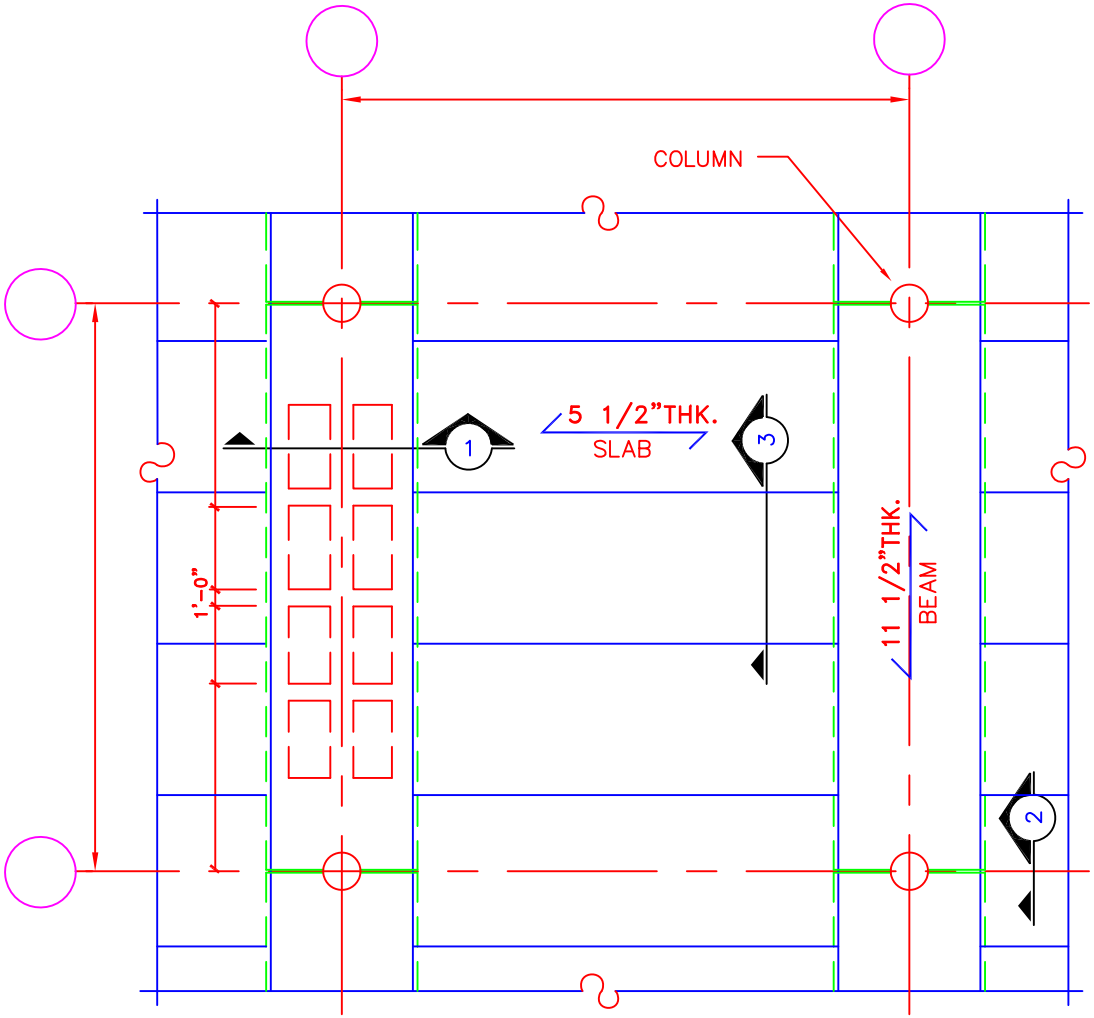
Middle Strip Moments

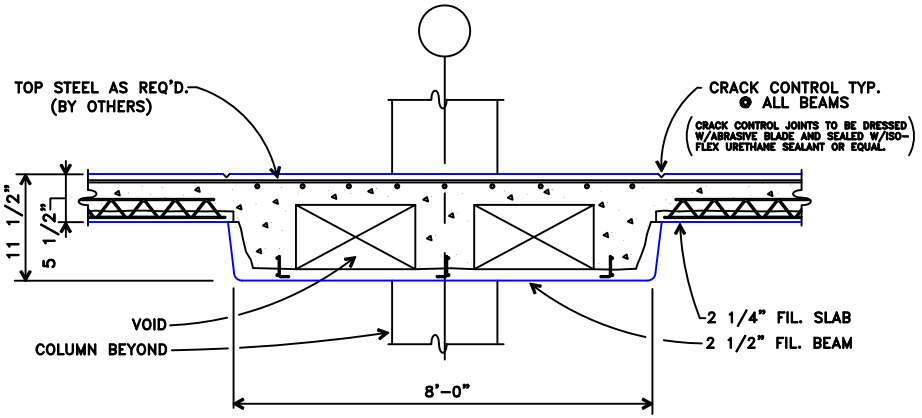
$M_{INT}^+ = 0.40\ M_{INT}^+ =$ 5.41 K-ft

$M_{INT}^- = 0.25\ M_{INT}^- =$ 6.28 K-ft

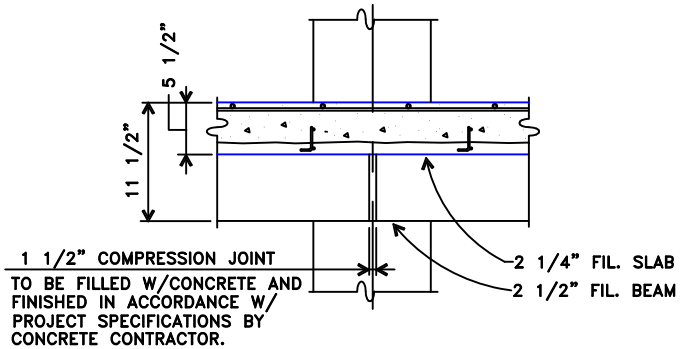
Rebar Design for Frame C @ 17'

		Column Strip		Middle Strip	
Item	Description	M_{INT}^+	M_{INT}^-	M_{INT}^+	M_{INT}^-
1	Moment (K-ft)	8.12	18.84	5.41	6.28
2	Width b (in.)	15	15	45	45
3	Effective d (in.)	8.5	8.5	8.5	8.5
4	$M_n = M_O / 0.9$	9.02	20.94	6.01	6.98
5	$R = \frac{M_n (1000)(12)}{b * d^2}$	99.87	231.83	22.19	25.76
6	ρ (Table A.5a)	0.0015	0.004	0.0005	0.0005
7	$As = \rho\ b\ d$	0.19	0.51	0.19	0.19
8	$As_{MIN} = 0.0018\ b\ t$	0.27	0.27	0.81	0.81
9	$n = As_{MIN} / A_{BAR}$	1.35	2.55	4.05	4.05
10	$n_{MIN} = b / 2t$	0.75	0.75	2.25	2.25
	Solution	(2) #4	(3) #4	(5) #4	(5) #4

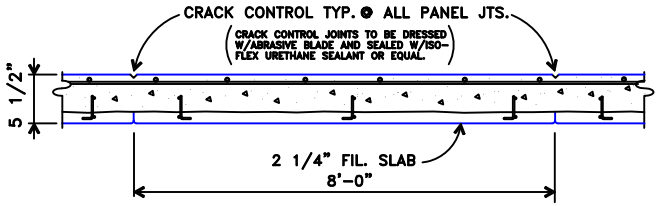




SECTION-1



SECTION-2



SECTION-3

NO.	REVISION	DATE

FILIGREE WIDE SLAB

MID-STATE FILIGREE
CRANBURY, N.J.

RESIDENCE @ MARRIOTT

FILIGREE BEAM AND SLAB FOR PARKING

DWN DJK
CHKD.
SEQ.

JOB NO. PROP-SK1
DATE 2/29/08

Residence Inn
Thesis Project
Filigree System

Project name	22008-999 Thesis Filigree
Estimator	MAJ
Labor rate table	PA
Job size	36000 SF
Bid date	3/21/2008 2:00 PM
Report format	Sorted by 'Group phase/Phase' 'Detail' summary Allocate addons Combine items

Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Unit Cost	Subcontract Amount	Subcontract Name	Total Amount
10.000	***REINFORCING STEEL***										
10.364	**Buy & Place Rebar**										
r	F & I Black Rebar	48.00	ton	-	-	1,083.45 /ton	52,005	831.832 /ton	39,928		91,933
	Buy & Place Rebar						**52,005**		**39,928**		**91,933**
10.416	**Detailing Reinforcing**										
10	Detailing	48.00	ton	-	-	5.74 /ton	275	40.16 /ton	1,928		2,203
	Detailing Reinforcing						**275**		**1,928**		**2,203**
10.418	**Accessories**										
r	Accessories	48.00	ton	-	-	64.52 /ton	3,097	-	-		3,097
	Accessories						**3,097**				**3,097**
	REINFORCING STEEL				***0***		***55,378***		***41,855***		***97,233***
30.000	***MISCELLANEOUS WORK***										
30.100	**General Conditions**										
10	General Conditions	763.12	cuyd			6.884 /cuyd	5,253				5,253
20	Travel	763.12	cuyd			4.59 /cuyd	3,502				3,502
	General Conditions						**8,756**				**8,756**
30.101	**Equipment**										
cy	Pump / Crane	763.12	cuyd					50.484 /cuyd	38,525		38,525
	Equipment								**38,525**		**38,525**
30.102	**Clean-up**										
lab	Clean-up	36,000.00	sqft	0.094 /sqft	3,398	0.012 /sqft	438	-	-		3,836
	Clean-up				**3,398**		**438**				**3,836**
30.103	**Safety**										
carp	Safety	36,000.00	sqft	0.13 /sqft	4,510	0.05 /sqft	1,753	-	-		6,263
	Safety				**4,510**		**1,753**				**6,263**
30.203	**Guaranteed Time**										
$	Guaranteed Time	1.00	L/S	2,058.86 /L/S	2,059	-	-	-	-		2,059
	Guaranteed Time				**2,059**						**2,059**
30.205	**Shop Expense**										
$	Shop Expense	1.00	L/S	7,079.56 /L/S	7,080	-	-	-	-		7,080
	Shop Expense				**7,080**						**7,080**
	MISCELLANEOUS WORK				***17,047***		***10,947***		***38,525***		***66,519***
38.000	***FILIGREE SLAB SYSTEM***										
38.316	**"Tooled" Filigree Joints**										
fin	"Tooled" Joints	5,500.00	lnft	0.784 /lnft	4,310	0.183 /lnft	1,004				5,315
	"Tooled" Filigree Joints				**4,310**		**1,004**				**5,315**
38.327	**Finish & Cure Slab**										
fin	F & C Slab	36,000.00	sqft	0.63 /sqft	22,571	0.024 /sqft	877				23,447
	Finish & Cure Slab				**22,571**		**877**				**23,447**
38.328	**Shore Filigree**										
f 14	Shore - 10' to 14' AFF	36,000.00	sqft	2.193 /sqft	78,932	1.04 /sqft	37,251	-	-		116,183
filC	Buy & Set Filigree - Carpenters	36,000.00	sqft	0.63 /sqft	22,552	8.704 /sqft	313,347	-	-		335,899
	Shore Filigree				**101,484**		**350,598**				**452,082**
38.329	**Prep Filigree**										
f	Prep Filigree Slab	36,000.00	sqft	2.09 /sqft	75,174	0.304 /sqft	10,956	-	-		86,130
	Prep Filigree				**75,174**		**10,956**				**86,130**
38.330	**Pour Concrete**										
c 50	Pour 5000 psi	763.12	cuyd	23.892 /cuyd	18,232	127.822 /cuyd	97,543	-	-		115,775
	Pour Concrete				**18,232**		**97,543**				**115,775**
	FILIGREE SLAB SYSTEM				***221,771***		***460,978***		***0***		***682,749***

Estimate Totals

Description	Amount	Totals	Rate	Cost per Unit
Labor	238,818			6.63 /SF
Material	527,303			14.65 /SF
Subcontract	80,380			2.23 /SF
Equipment				
Other				
	846,501	846,501		23.51 /SF
Total		846,501		23.51 /SF

Residence Inn
Thesis Project
Flat Plate

Project name	22008-999 Thesis FP
Estimator	MAJ
Labor rate table	PA
Job size	36000 SF
Bid date	3/21/2008 2:00 PM
Report format	Sorted by 'Group phase/Phase' 'Detail' summary Allocate addons Combine items

Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Unit Cost	Subcontract Amount	Subcontract Name	Total Amount
10.000	***REINFORCING STEEL***										
10.364	**Buy & Place Rebar**										
r	F & I Black Rebar	81.00	ton	-	-	1,097.691 /ton	88,913	843.44 /ton	68,318		157,231
	Buy & Place Rebar						**88,913**		**68,318**		**157,231**
10.416	**Detailing Reinforcing**										
10	Detailing	81.00	ton	-	-	5.82 /ton	471	40.72 /ton	3,298		3,769
	Detailing Reinforcing						**471**		**3,298**		**3,769**
10.418	**Accessories**										
r	Accessories	81.00	ton	-	-	65.37 /ton	5,295	-	-		5,295
	Accessories						**5,295**				**5,295**
	REINFORCING STEEL				***0***		***94,679***		***71,617***		***166,295***
13.000	***STRUCTURAL SLABS***										
13.327	**Finish & Cure Slab**										
fin	F & C Slab	36,000.00	sqft	0.631 /sqft	22,732	0.03 /sqft	888				23,620
	Finish & Cure Slab				**22,732**		**888**				**23,620**
13.328	**Form/Shore Slab**										
f	Form Structural Slab	36,000.00	sqft	2.104 /sqft	75,750	0.93 /sqft	33,301	-	-		109,051
t 10	Titan Shore - 7'-8" to 11'-8" AFF	36,000.00	sqft	4.734 /sqft	170,437	1.79 /sqft	64,381	-	-		234,818
	Form/Shore Slab				**246,187**		**97,682**				**343,869**
13.329	**Prep Slab**										
f	Prep Structural Slab	36,000.00	sqft	2.104 /sqft	75,750	0.31 /sqft	11,100	-	-		86,850
	Prep Slab				**75,750**		**11,100**				**86,850**
13.330	**Pour Concrete**										
c 50	Pour 5000 psi	916.014	cuyd	24.052 /cuyd	22,032	129.503 /cuyd	118,626	-	-		140,658
	Pour Concrete				**22,032**		**118,626**				**140,658**
13.331	**Reshore**										
f1	Reshore Slab (Titan)	36,000.00	sqft			0.432 /sqft	15,540	-	-		15,540
	Reshore						**15,540**				**15,540**
	STRUCTURAL SLABS				***366,700***		***243,837***		***0***		***610,538***
30.000	***MISCELLANEOUS WORK***										
30.100	**General Conditions**										
10	General Conditions	1,008.67	cuyd			6.98 /cuyd	7,041				7,041
20	Travel	1,008.67	cuyd			4.653 /cuyd	4,694				4,694
	General Conditions						**11,734**				**11,734**
30.101	**Equipment**										
cy	Pump / Crane	1,008.67	cuyd					37.23 /cuyd	37,550		37,550
	Equipment								**37,550**		**37,550**
30.102	**Clean-up**										
lab	Clean-up	36,000.00	sqft	0.10 /sqft	3,421	0.012 /sqft	444	-	-		3,865
	Clean-up				**3,421**		**444**				**3,865**
30.103	**Safety**										
carp	Safety	36,000.00	sqft	0.13 /sqft	4,545	0.05 /sqft	1,776	-	-		6,321
	Safety				**4,545**		**1,776**				**6,321**
30.203	**Guaranteed Time**										
$	Guaranteed Time	1.00	L/S	2,074.86 /L/S	2,075	-	-	-	-		2,075
	Guaranteed Time				**2,075**						**2,075**
30.205	**Shop Expense**										
$	Shop Expense	1.00	L/S	7,127.58 /L/S	7,128	-	-	-	-		7,128
	Shop Expense				**7,128**						**7,128**
30.420	**Rub**										
10	Rub - Slabs, Beams, Columns	36,000.00	sqft	0.564 /sqft	20,296	0.062 /sqft	2,220	-	-		22,516
	Rub				**20,296**		**2,220**				**22,516**
	MISCELLANEOUS WORK				***37,465***		***16,175***		***37,550***		***91,190***
51.000	***COLUMN CAPITALS***										
51.328	**Form Capitals/Dropheads**										
f	Form Drop Edge	1,080.00	sqft	16.833 /sqft	18,180	2.47 /sqft	2,664	-	-		20,844
	Form Capitals/Dropheads				**18,180**		**2,664**				**20,844**
51.330	**Pour Concrete**										
c 50	Pour 5000 psi	92.654	cuyd	24.052 /cuyd	2,228	129.503 /cuyd	11,999	-	-		14,227
	Pour Concrete				**2,228**		**11,999**				**14,227**
	COLUMN CAPITALS				***20,408***		***14,663***		***0***		***35,071***

Estimate Totals

Description	Amount	Totals	Rate	Cost per Unit
Labor	424,574			11.79 /SF
Material	369,354			10.26 /SF
Subcontract	109,167			3.03 /SF
Equipment				
Other				
	903,095	903,095		25.09 /SF
Total		903,095		25.09 /SF

3 Level Existing Cast In Place Slab Concrete Reinforcing

Bar No.	Length (LF)	Steel (LBS)	Steel (TONS)	Unit Cost ($/TON)	Labor Cost	Total Cost
#4	110526	73831.37	36.92	950	455	$51,866.54
#5	35526.6	37054.24	18.53	950	455	$26,030.61
#6	6843	10278.19	5.14	950	455	$7,220.43
#7	555	1134.42	0.57	950	455	$796.93
#9	495	1683.00	0.84	950	455	$1,182.31
Total		**123981.22**	**61.99**			**$87,096.81**

3 Level Existing Cast In Place Slab & Drop Panel Concrete Volume

Panel No.	Depth (IN)	Area (SF)	Concrete (CY)	Unit Cost ($/CY)	Labor Cost	Equipment Cost ($/CY)	Total Cost
	8	40428	998.22	274	150	14.3	$437,520.80
	14	1224	52.89	274	150	14.3	$23,181.20
D 1 (7)	5.5	1680	199.63	274	150	14.3	$87,497.67
D 2 (3)	5.5	720	36.67	274	150	14.3	$16,071.00
D 3 (1)	5.5	192	3.26	274	150	14.3	$1,428.53
D 4 (1)	5.5	264	4.48	274	150	14.3	$1,964.23
D 5 (3)	5.5	900	45.83	274	150	14.3	$20,088.75
D 6 (1)	5.5	330	5.60	274	150	14.3	$2,455.29
Total			**1346.58**				**$590,207.48**

New 3 Level Cast In Place Slab Concrete Reinforcing

Bar No.	Length (LF)	Steel (LBS)	Steel (TONS)	Unit Cost ($/TON)	Labor Cost ($/TON)	Total Cost
#4	60243.6	40242.72	20.12	950	455	$28,270.51
#5	792	826.06	0.41	950	455	$580.30
#6	28710	43122.42	21.56	950	455	$30,293.50
Total		**84191.20**	**42.10**			**$59,144.32**

New 3 Level Cast In Place Slab Concrete Volume

Panel No.	Depth (IN)	Area (SF)	Concrete (CY)	Unit Cost ($/CY)	Labor Cost ($/CY)	Equipment Cost ($/CY)	Total Cost
n/a	10	44100	1361.11	274	150	14.3	$596,575.00
Total			**1361.11**				**$596,575.00**

Julia E. Phillips
Construction Management

Structural System Comparison

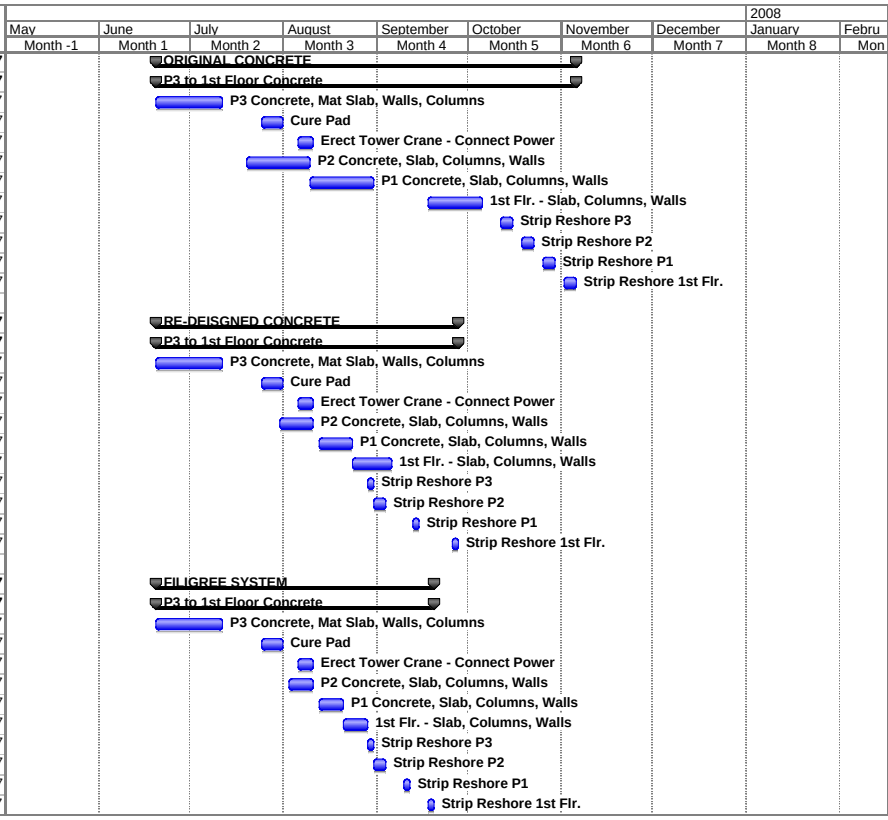
Analysis Description	Existing CIP Slab with Drop Panels	Re-Designed CIP Slab without Drop Panels	Filigree Slab and Beam System
Steel (TONS)	61.99	42.10	48.00
Steel (lbs./SF)	2.81	1.91	2.25
Steel Cost	$87,096.81	$59,144.32	$67,440.00
Concrete (CY)	1346.58	1361.11	816.67
Concrete Drop/Beam (in.)	13.5	0	11.5
Concrete Slab (in.)	8	10	6
Concrete Cost	$590,207.48	$596,575.00	$357,945.00
Formwork (SF)	46007.95	44100.00	44100.00
Formwork Cost	$253,043.74	$242,550.00	$142,575.30
Slab Duration (Days)	44	27	21
Total Cost	**$930,348.02**	**$898,269.32**	**$567,960.30**
Location Factor Adjustment	0.94	0.94	0.94
Adjusted Total Cost	**$874,527.14**	**$844,373.16**	**$533,882.68**
Savings Analysis			
Steel (TONS)	n/a	**19.90**	**13.99**
Steel (lbs./SF)	n/a	**0.90**	**0.56**
Steel Cost	n/a	**$27,952.49**	**$19,656.81**
Concrete (CY)	n/a	**-14.53**	**529.92**
Concrete Cost	n/a	**-$6,367.53**	**$232,262.48**
Formwork (SF)	n/a	**1907.95**	**1907.95**
Formwork Cost	n/a	**$10,493.74**	**$110,468.44**
Slab Duration (Days)	n/a	**17**	**23**
Total Cost Savings	**n/a**	**$32,078.70**	**$362,387.72**
Location Factor Adjustment	0.94	0.94	0.94
Adjusted Total Cost Savings	**n/a**	**$30,153.98**	**$340,644.45**

Residence Inn
By Marriott
2345 Mill Rd, Alexandria, VA

Julia E. Phillips
Construction Management

Detailed Structural Schedule
Appendix D

ID	Task Name	Duration	Start	Finish
1	**ORIGINAL CONCRETE**	**98 days**	**Wed 6/20/07**	**Mon 11/5/07**
2	**P3 to 1st Floor Concrete**	**98 days**	**Wed 6/20/07**	**Mon 11/5/07**
3	P3 Concrete, Mat Slab, Walls, Columns	15 days	Wed 6/20/07	Wed 7/11/07
4	Cure Pad	5 days	Wed 7/25/07	Tue 7/31/07
5	Erect Tower Crane - Connect Power	5 days	Mon 8/6/07	Fri 8/10/07
6	P2 Concrete, Slab, Columns, Walls	15 days	Fri 7/20/07	Thu 8/9/07
7	P1 Concrete, Slab, Columns, Walls	15 days	Fri 8/10/07	Thu 8/30/07
8	1st Flr. - Slab, Columns, Walls	14 days	Tue 9/18/07	Fri 10/5/07
9	Strip Reshore P3	2 days	Fri 10/12/07	Mon 10/15/07
10	Strip Reshore P2	2 days	Fri 10/19/07	Mon 10/22/07
11	Strip Reshore P1	2 days	Fri 10/26/07	Mon 10/29/07
12	Strip Reshore 1st Flr.	2 days	Fri 11/2/07	Mon 11/5/07
13				
14	**RE-DEISGNED CONCRETE**	**71 days**	**Wed 6/20/07**	**Thu 9/27/07**
15	**P3 to 1st Floor Concrete**	**71 days**	**Wed 6/20/07**	**Thu 9/27/07**
16	P3 Concrete, Mat Slab, Walls, Columns	15 days	Wed 6/20/07	Wed 7/11/07
17	Cure Pad	5 days	Wed 7/25/07	Tue 7/31/07
18	Erect Tower Crane - Connect Power	5 days	Mon 8/6/07	Fri 8/10/07
19	P2 Concrete, Slab, Columns, Walls	9 days	Tue 7/31/07	Fri 8/10/07
20	P1 Concrete, Slab, Columns, Walls	9 days	Mon 8/13/07	Thu 8/23/07
21	1st Flr. - Slab, Columns, Walls	9 days	Fri 8/24/07	Wed 9/5/07
22	Strip Reshore P3	2 days	Wed 8/29/07	Thu 8/30/07
23	Strip Reshore P2	2 days	Fri 8/31/07	Mon 9/3/07
24	Strip Reshore P1	2 days	Thu 9/13/07	Fri 9/14/07
25	Strip Reshore 1st Flr.	2 days	Wed 9/26/07	Thu 9/27/07
26				
27	**FILIGREE SYSTEM**	**65 days**	**Wed 6/20/07**	**Wed 9/19/07**
28	**P3 to 1st Floor Concrete**	**65 days**	**Wed 6/20/07**	**Wed 9/19/07**
29	P3 Concrete, Mat Slab, Walls, Columns	15 days	Wed 6/20/07	Wed 7/11/07
30	Cure Pad	5 days	Wed 7/25/07	Tue 7/31/07
31	Erect Tower Crane - Connect Power	5 days	Mon 8/6/07	Fri 8/10/07
32	P2 Concrete, Slab, Columns, Walls	6 days	Fri 8/3/07	Fri 8/10/07
33	P1 Concrete, Slab, Columns, Walls	6 days	Mon 8/13/07	Mon 8/20/07
34	1st Flr. - Slab, Columns, Walls	6 days	Tue 8/21/07	Tue 8/28/07
35	Strip Reshore P3	2 days	Wed 8/29/07	Thu 8/30/07
36	Strip Reshore P2	2 days	Fri 8/31/07	Mon 9/3/07
37	Strip Reshore P1	2 days	Mon 9/10/07	Tue 9/11/07
38	Strip Reshore 1st Flr.	2 days	Tue 9/18/07	Wed 9/19/07



Project: Structural Schedule
Date: Mon 3/31/08

Task
Critical Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Critical Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline

Appendix E: Controls Energy and Unit Calculations

The following can be found in this Controls Appendix:

- *Delta DNT – 103 Specification/Cut Sheet*
- *BACnet Testing Labs – Test Sheet*
- *Weather Data for Alexandria, VA*
- *Drawing E 3.3*
- *Drawing M – 602*
- *Virginia Dominion Power, GS – 4 Schedule*
- *Energy and Cost Calculations*
- *Detail from Drawing E 2.1, Unit C*
- *Original Wiring Diagram*
- *INNCOM Wiring Diagrams*

Network Thermostats

BACstat II: DNT-T103/H103

Description

The DNT-T103 is an intelligent room thermostat with a custom 3-value, 96 segment, LCD display. The DNT-T103 can communicate on Delta's LINKnet network or directly on a BACnet MS/TP network.

The DNT-T103 can display a wide-range of digital or analog values including setpoints, temperature, airflow, heating and cooling status, fan speed, valve and damper position, and more. When connected on a BACnet MS/TP network, the DNT-T103 functions as an independent BACnet thermostat. When connected to a Controller, on a LINKnet network, the DNT-T103 provides a programmable remote sensor and expanded I/O capabilities.

Application

The DNT-T103 is designed to be a low-cost solution for control of unitary equipment. It has built-in, configurable algorithms for VAV, VVT, fan coil/unit ventilator, heat pump, radiation and humidification applications.

The DNT-T103 may also be connected to a LINKnet network to provide programmable remote sensor and expanded I/O capabilities.

Features

—Native BACnet™ firmware

—BACnet MS/TP or LINKnet communications

—Configurable 3-value, 96 segment, LCD display (with optional backlighting)

—4 Configurable push buttons

—Derived Network Addressing (DNA) for simple integration into a standard network architecture

—Field selectable applications

—Service port

Specifications

BACnet Device Profile
BACnet Application Specific Controller (B-ASC)

LCD
3-value and various icons (96 total segments) with optional backlighting

Push Buttons
4 stylized momentary push buttons

Temperature Sensor
Thermistor Input - 10kΩ at 77°F (25°C)

Accuracy +/-0.36°F from 32-158°F (+/- 0.2°C from 0-70°C)

Display resolution of 0.1°

Stability 0.24°F over 5 years (0.13°C)

Humidity Sensor
Accuracy of +/-2% RH from 0-100% RH (25°C, Vsupply = 5Vdc)

Display resolution of 0.1%

Stability of +/- 1% RH (typical at 50% RH over 5 years)

Note: Extended exposure to >90% RH causes a reversible shift of 3% RH

Inputs
1 Universal input - 10 bit (supporting 0-5v, 0-10v, 10kΩ)

Outputs
3 Binary triac outputs (supporting binary, PWM or tri-state)

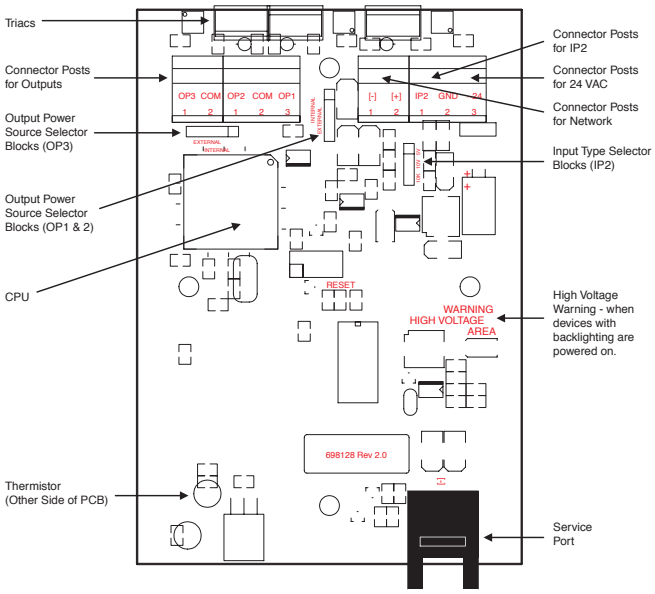
Technology
8-bit processor with internal A/D, Flash and RAM

Document Edition 1.2 August 2004

Do it right. Delta™ CONTROLS

Network Thermostats

BACstat II: DNT-T103/H103 Board Layout Diagram



Accessories

RPT-768—Delta Network Repeater for BACnet MS/TP

TRM-768—Delta Network Terminator for BACnet MS/TP

CON-768—Delta Network Converter

Ordering

Order the DNT-T103/H103 with the desired options, according to the following product numbers:

DNT-T103—Internal Thermistor Input, Additional I/O (1 IP and 3 OP), Backlighting (Option B), External Thermistor Terminator (Option X)

DNT-H103—Internal Thermistor Input, Internal Humidity Input, Additional I/O (1 IP and 3 OP), Backlighting, External Thermistor Terminator

An appended button icon code must be included to specify the desired icons embossed on the buttons. If a button icon code is not specified, the product is shipped with the default button icons.

Default—Bottom 2 buttons are ▼ & ▲ (Setpoint Adjust), top 2 buttons are OFF and ON

INT—Bottom 2 buttons are ▼ & ▲ (Setpoint Adjust), top 2 buttons are O and I (International)

Specifications (Continued)

Device Type
Configured as a LINKnet or subnet device

Device Addressing
Set via keypad

Communications Ports
BACnet MS/TP @ 9600, 19200, 38400 or 76800 bps (maximum of 99 devices per BACnet MS/TP segment)

Delta LINKnet @76800 bps (maximum 12 devices, depending on the controller with no more than 2 DFM/DNT devices per LINKnet segment)

Connectors
Screw-type terminal connectors

Wiring Class
Class 2

Power
24V AC

41 VA (with internally powered outputs)

Ambient
32° to 131°F (0° to 55°C)

10 - 90% RH (non-condensing)

Dimensions
5 x 3.25 x 1 in. (12.7 x 8.3 x 2.5 cm) with housing

0.3 lb. (120 g) with housing

Approvals/Standards
UL 916 Listed

CE

FCC Class B

BTL Listed

BACnet Testing Labs
Product Listing

This product has been tested at the BACnet Testing Labs and found to comply with all the necessary interoperability requirements in place on the published test date. This listing represents the tested capability of the Listed Product. For information on additional functionality that was not covered in the test process, refer to the Manufacturer's PICS statement on the BMA website.

Listing Information

Vendor		Listing Status
Delta Controls 17850 - 56th Ave. Surrey, BC, Canada V3S 1C7		Listed Product
Test Requirements	BACnet Protocol Revision	Date Tested
Requirements as of January 2002	135-1995b	January 2002

Product Name	Model Number	Software Version
BACstat II	DNS-24, DNT-T103, DNT-T221	Release 2

Product Name	Link to PICS on BMA Website
BACstat II	http://www.bacnetassociation.org/delta controls/BACstat II

Device Profiles

Profile	Model Numbers
BACnet Application Specific Controller (B-ASC)	DNS-24, DNT-T103, DNT-T221

BIBBs Supported

Data Sharing	ReadProperty-B	DS-RP-B
	ReadPropertyMultiple-B	DS-RPM-B
	WriteProperty-B	DS-WP-B

Device and Network Management	Dynamic Device Binding-B	DM-DDB-B
	Dynamic Object Binding-B	DM-DOB-B
	DeviceCommunicationControl-B	DM-DCC-B
	ReinitializeDevice-B	DM-RD-B

Object Type Support

Analog Input	Analog Value	Device

Data Link Layer Options

Media	Options
MS/TP master	9600, 19200, 38400, 76800

Device Binding Support

Static Binding is supported.

Character Set Support

ANSI X3.4

weatherdatadepot home faq charts contact

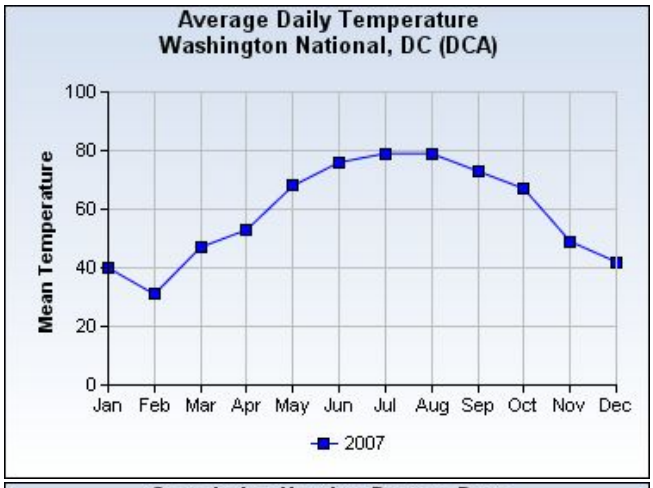
Region: Middle Atlantic (Change Region)

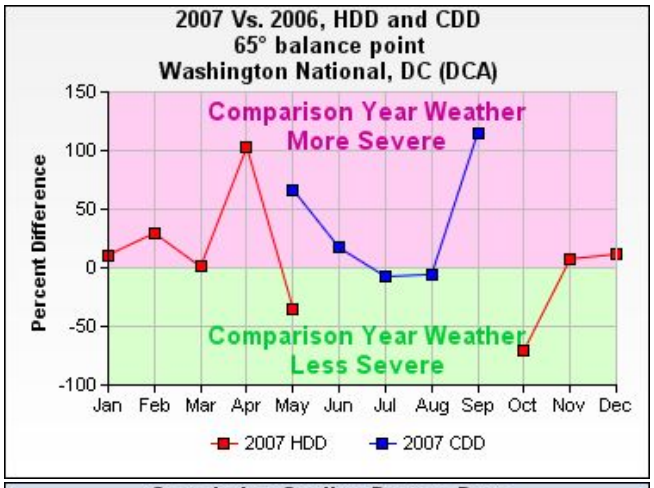
Station: Washington National, DC (DCA)

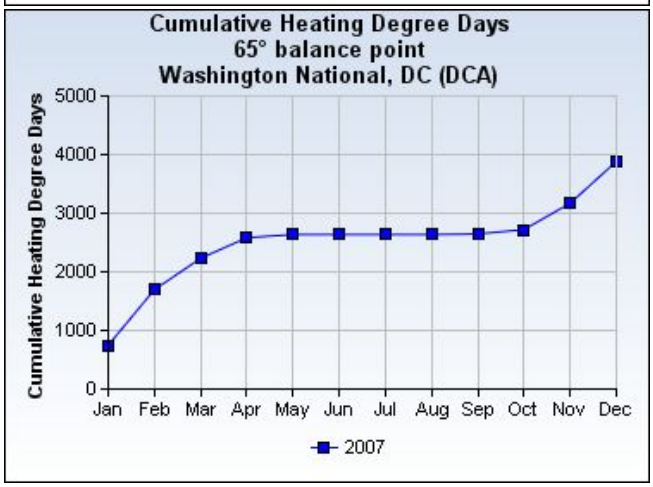
FREE Degree Day Report

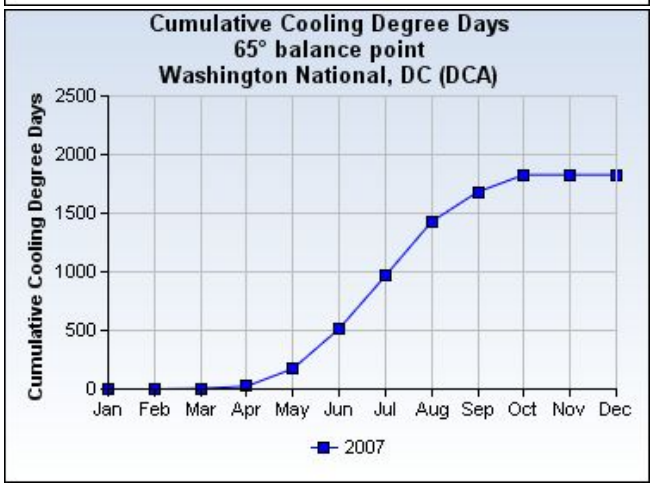
Chart Value Settings

Range Begin:	2007	Base Year:	2006
Range End:	2007	Comp Year:	2007
Balance Point:	65	(What is this?)	









Weather data provided by AccuWeather.com

weatherdatadepot

Degree Day Comparison Report

Provided by
EnergyCAP Energy Efficiency Software
and AccuWeather

Weather Station Code: DCA
Weather Station Location: Washington National, DC
Balance Point Temperature: 65°

Print Friendly Version

	Base Year = 2006			Comparison Year = 2007			Comparison Percentages**		
Month	**Heating**	**Cooling**	**Total**	**Heating**	**Cooling**	**Total**	**Heating**	**Cooling**	**Total**
Jan	672	0	672	746	0	746	11%	N/A	11%
Feb	733	0	733	950	0	950	29.6%	N/A	29.6%
Mar	529	6	535	534	5	539	0.9%	N/A	0.7%
Apr	174	16	190	353	19	372	102.9%	N/A	95.8%
May	81	90	171	53	150	203	-34.6%	66.7%	18.7%
Jun	0	291	291	0	341	341	N/A	17.2%	17.2%
Jul	0	487	487	0	451	451	N/A	-7.4%	-7.4%
Aug	0	490	490	0	462	462	N/A	-5.7%	-5.7%
Sep	22	118	140	10	254	264	N/A	115.3%	88.6%
Oct	250	20	270	74	146	220	-70.4%	N/A	-18.5%
Nov	419	0	419	451	0	451	7.6%	N/A	7.6%
Dec	639	0	639	713	0	713	11.6%	N/A	11.6%
Totals YTD:	3519	1518	5037	3884	1828	5712	10.4%	20.4%	13.4%

**Please note: When the monthly degree days in either the base year or the comparison year are less then 30, a percentage comparison is not calculated. HOWEVER, all total comparison percentages (month and year) do include all heating and cooling degree days. YTD means Year-To-Date.

Degree Day Comparison Report Provided by EnergyCAP and weatherDataDepot
http://www.weatherdatadepot.com

Weather Information Provided by AccuWeather
http://www.accuweather.com

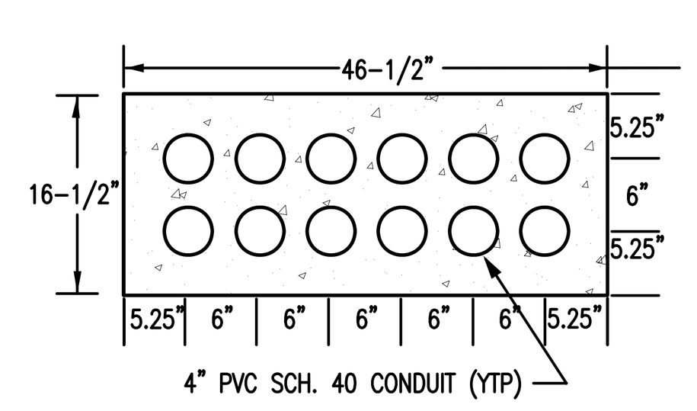
FEEDER SCHEDULE

ALL FEEDERS LISTED ARE BASED ON 75°C COPPER CONDUCTORS PER SET

NO.	NO. SETS	PHASE	NEUTRAL	GROUND	CONDUIT	NO.	NO. SETS	PHASE	NEUTRAL	GROUND	CONDUIT
1	1	1 #12	#12	#12	3/4"	30	1	3 500 kcmil	—	#3	3-1/2"
2	1	3 #12	--	#12	3/4"	31	1	3 500 kcmil	500 kcmil	#3	4"
3	1	3 #12	#12	#12	3/4"	31N	1	3 500 kcmil	2 500 kcmil	#3	4"
4	1	3 #10	--	#10	3/4"	32	2	3 #4/0	—	#2	2-1/2"
5	1	3 #10	#10	#10	3/4"	33	2	3 #4/0	#4/0	#2	2-1/2"
6	1	3 #8	--	#10	1"	34	2	3 250 kcmil	—	#2	2-1/2"
7	1	3 #8	#8	#10	1"	35	2	3 250 kcmil	250 kcmil	#2	3"
8	1	3 #6	--	#10	1"	35N	2	3 250 kcmil	2 250 kcmil	#2	3"
9	1	3 #6	#6	#10	1-1/4"	36	2	3 350 kcmil	—	#1	3"
10	1	3 #4	--	#8	1-1/4"	37	2	3 350 kcmil	350 kcmil	#1	3-1/2"
11	1	3 #4	#4	#8	1-1/4"	38	2	3 400 kcmil	—	#1/0	3"
12	1	3 #3	—	#8	1-1/4"	39	2	3 400 kcmil	400 kcmil	#1/0	3-1/2"
13	1	3 #3	#3	#8	1-1/2"	40	2	3 500 kcmil	—	#1/0	3-1/2"
13N	1	3 #3	2 #3	#8	1-1/2"	41	2	3 500 kcmil	500 kcmil	#1/0	4"
14	1	3 #2	—	#6	1-1/4"	42	3	3 350 kcmil	—	#2/0	3"
15	1	3 #2	#2	#6	1-1/2"	43	3	3 350 kcmil	350 kcmil	#2/0	3-1/2"
16	1	3 #1/0	—	#6	2"	44	3	3 400 kcmil	—	#2/0	3"
17	1	3 #1/0	#1/0	#6	2"	45	3	3 400 kcmil	400 kcmil	#2/0	3-1/2"
17N	1	3 #1/0	2 #1/0	#6	2"	46	3	3 500 kcmil	—	#3/0	3-1/2"
18	1	3 #2/0	—	#6	2"	47	3	3 500 kcmil	500 kcmil	#3/0	4"
19	1	3 #2/0	#2/0	#6	2"	48	4	3 350 kcmil	350 kcmil	#3/0	3-1/2"
20	1	3 #3/0	—	#6	2"	49	5	3 400 kcmil	400 kcmil	#4/0	3-1/2"
21	1	3 #3/0	#3/0	#6	2-1/2"	50	6	3 400 kcmil	400 kcmil	250 kcmil	3-1/2"
21N	1	3 #3/0	2 #3/0	#6	2-1/2"	51	7	3 500 kcmil	500 kcmil	350 kcmil	4"
22	1	3 #4/0	—	#4	2-1/2"	52	8	3 500 kcmil	500 kcmil	400 kcmil	4"
23	1	3 #4/0	#4/0	#4	2-1/2"	53	11	3 500 kcmil	500 kcmil	500 kcmil	4"
23N	1	3 #4/0	2 #4/0	#4	3"	54	9	3 700 kcmil	700 kcmil	#3/0	4"
24	1	3 250 kcmil	--	#4	2-1/2"	55	6	3 600 kcmil	600 kcmil	#3/0	4"
25	1	3 250 kcmil	250 kcmil	#4	3"	56	1	2 #12	#12	#12	3/4"
25N	1	3 250 kcmil	2 250 kcmil	#4	2-1/2"	57	11	3 750 kcmil ALUMINUM	750 kcmil ALUMINUM	800 kcmil ALUMINUM	4"
26	1	3 350 kcmil	--	#4	3"						
27	1	3 350 kcmil	350 kcmil	#4	3-1/2"						
28	1	3 400 kcmil	—	#3	3"						
29	1	3 400 kcmil	400 kcmil	#3	3-1/2"						

EQUIPMENT SCHEDULE

ITEM	DESCRIPTION
1	NOT USED
2	STANDBY DIESEL GENERATOR 450KW, 460/265V, 3ø, 4W, W/ (2) MCB AS INDICATED ON POWER RISER
3	CHILLER @ 313MCA, 460V, 3ø.
4	DRY-TYPE TRANSFORMER 30KVA, 480-208/120V, 3ø
5	DRY-TYPE TRANSFORMER, 45 KVA, 480-208/120V, 3ø
6	AUTOMATIC TRANSFER SWITCH, 200A, 480V, 3ø 0-1 MINUTE TIME DELAY, 65,000 AIC SERIES RATED
7	AUTOMATIC TRANSFER SWITCH, 250A, 480V, 3ø 0-1 MINUTE TIME DELAY, 65,000 AIC SERIES RATED
8	TRANSIENT VOLTAGE SURGE SUPPRESSION UNIT (TVSS) WITH INTERGRAL DISCONNECT, 320KA
9	DRY-TYPE TRANSFORMER, 75 KVA, 480-208/120V, 3ø
10	3/60/50 FUSED SAFETY SWITCH FOR PANELS 'L_'
11	3/400/300 FUSED SAFETY SWITCH FOR PANELS 'SDP-'
12	3/400/400 FUSED SAFETY SWITCH FOR PANEL 'LL'
13	20A, 1P ENCLOSED CIRCUIT BREAKER FOR ELEV. LTG. AND CONTROLS



DUCTBANK SECTION SWITCHBOARD A

SCALE: 3/4" = 1'-0"

SERVICE ENTRANCE DUCTBANK NOTES

1. CONTRACTOR SHALL SECURE APPROVAL FROM VIRGINIA POWER FOR ALL PROPOSED SERVICE ENTRANCE INSTALLATIONS. COORDINATE THE ENTIRE INSTALLATION WITH VIRGINIA POWER.
2. THE INNER SURFACE OF CONDUITS SHALL BE FREE OF OBSTRUCTIONS THAT MAY DAMAGE CABLING DURING INSTALLATION. CONTRACTOR SHALL INSTALL PLUGS OR EQUIVALENT IN ALL CUSTOMER OWNED CONDUIT TO PREVENT DIRT OR DEBRIS FROM ENTERING.
3. CONCRETE SHALL BE VIBRATED TO ELIMINATE VOIDS.
4. CONTRACTOR SHALL WATERSEAL ALL CONDUITS ENTERING THE BUILDING.
5. PROVIDE PULL STRING IN ALL CONDUITS, INCLUDING SPARE CONDUITS.

SWITCHBOARD SCHEDULE

3000 A, 480/277 V, 3ø, 4W 200,000 A.I.C.

CONN. LOAD	NO.	POLE	CIRCUIT BREAKER FRAME	CIRCUIT BREAKER TRIP	SWITCH	FUSE	EQUIPMENT SERVED
	1	3	—	—	—	—	INCOMING SERVICE & VA POWER C/T
	2	3	—	—	—	—	EMERGENCY TAP SECTION
	3	3	—	—	—	—	OWNER METERING
	4	3	—	—	3000	3000	MAIN BPS SWITCH *
65.7	5	3	200	150	—	—	PANEL EH
133.9	6	3	400	225	—	—	PANEL EH1
166.2	7	3	400	250	—	—	PANEL HH
165	8	3	400	250	—	—	PANEL H1
199.3	9	3	400	400	—	—	CHILLER CH-1
203.8	10	3	400	400	—	—	PANEL HP
66	11	3	200	150	—	—	PANEL HM2
	12	3	400	—	—	—	SPACE WITH BUSBAR PROVISIONS
	13	3	400	—	—	—	SPACE WITH BUSBAR PROVISIONS
	14	3	400	—	—	—	SPACE WITH BUSBAR PROVISIONS
656.1	15	3	-	-	1200	1200	TRANSFORMER PRIMARY BPS
	16						
	17						

NEC TOTAL LOAD : 1639.2KW ----1793.9 AMPS

* PROVIDE GROUND FAULT PROTECTION SET AT 600 AMPS.

GROUND CONDUCTOR SCHEDULE

ALL CONDUCTORS ARE COPPER

NO.	DESCRIPTION
G1	#8 INSULATED GROUND CONDUCTOR
G2	#6 INSULATED GROUND CONDUCTOR
G3	#4 INSULATED GROUND CONDUCTOR
G4	#2 INSULATED GROUND CONDUCTOR
G5	#1/0 INSULATED GROUND CONDUCTOR
G6	#2/0 INSULATED GROUND CONDUCTOR
G7	#3/0 INSULATED GROUND CONDUCTOR
G8	#750 MCM INSULATED GROUND CONDUCTOR

EMERGENCY GENERATOR SCHEDULE

450KW, 480/277V, 3ø, 4W DIESEL GENSET
50 GALLON DAY TANK

MAXIMUM SkW REQ. 516 kW
MAXIMUM SkVA REQ. 1896 kVA
MAX. STARTING VOLTAGE DIP 20%

	STEP	LOAD SERVED	HP	KW
	1	BUILDING EMERGENCY LIGHTING		15.0
	1	FIRE ALARM SYSTEM		10.0
	2	FIRE PUMP	125.0	99.3
*	3	STAIRWELL PRESSURIZATION FANS SF1-SF5	5 @ 7.5HP	35.0
*	3	MAU-01 AND -02	2 @ 10HP	21.4
	4	BUILDING ELEVATORS - (1 ELEVATORS)	17.0	13.0
	4	SPARE		40.0
	5	MISCELLANEOUS BUILDING EQUIPMENT		149.6

* PROVIDE RELAY FOR TIME DELAY

TOTAL GENERATOR LOAD SUMMARY 383.3 kW

PLUG-IN BUSWAY CALCS

1	GENERAL LIGHTING (181 UNITS x 497 SF AVERAGE x 3W/SF)	= 269,871 VA
2	TWO SMALL APPLIANCE CIRCUITS (181 UNITS x 3,000W)	= 543,000 VA
3	DISHWASHER (181 UNITS x 1,100W)	= 199,100 VA
4	GARBAGE DISPOSAL (181 UNITS x 800W)	= 144,500 VA
5	MICROWAVE (181 UNITS x 1,100W)	= 199,100 VA
6	ELECTRIC RANGE (181 UNITS x 2,500W)	= 452,500 VA
7	FANS (189 UNITS x 450W)	= 85,050 VA
8	ELECTRIC HEATING COIL (189 UNITS x 2000W)*	= 378,000 VA
	TOTAL	2,271 KVA
	DEMAND FACTOR 23% PER 220.32	
	TOTAL DEMANDED LOAD	522.3 KVA (1,451.2 AMP)
	PANELS L4, L9, L14	= 26.5 KVA
	PANEL LL	= 107.3 KVA
	TOTAL	656.1 KVA (1,823.3 AMP)

ELECTRICAL SERVICE: 2,500 AMPERES 120/208 VOLTS 3 PHASE - 4 WIRE

* AVERAGE ELECTRIC HEATING COIL FOR 140 UNITS @ 1,5KW, 33 @ 3.0KW, AND 8 @ 2,500KW x 2

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DESIGN ACC/AW DRAWN LDN/AW
JOB No. 05055.00 Q.A. DCU

REVISIONS

PERMIT SET OCT. 20, 2006
1 95% PRICING DEC. 01, 2006
2 CITY OF ALEXANDRIA PERMIT COMMENTS DEC. 12, 2006
CITY OF ALEXANDRIA PERMIT COMMENTS #2 JAN. 23. 2007
4 FINAL CONSTRUCTION SET FEB. 16, 2007

PROJECT TITLE

RESIDENCE INN BY MARRIOTT

2345/2347 MILL ROAD ALEXANDRIA, VIRGINIA

PROJECT NO. 30541200

DRAWING TITLE

ELECTRIC EQUIPMENT- MISCELLANEOUS DETAILS

Printed On: 2/20/07, 4:20 pm

SCALE
DATE OCTOBER 20th, 2006
DRAWN BY
CHECKED BY

E 3-3 (EQUIPSCHED).dwg

DRAWING NUMBER

E 3.3

SHEET *OF*

(TYPICAL) VERTICAL FAN COIL UNIT SCHEDULE

SYMBOL	MANUFACTURER MODEL	TYPE	LOCATION	SERVICE	QTY	SUPPLY FAN SUPPLY (CFM)	SUPPLY FAN OSA (CFM)	SUPPLY FAN TSP (IN WC)	SUPPLY FAN ESP (IN WC)	SUPPLY FAN ELEV (FT)	SUPPLY FAN DRIVE TYPE	SUPPLY FAN BHP	SUPPLY FAN HP	CHILLED WATER COOLING COIL TOTAL (MBH)	SENSIBLE (MBH)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	△ PA (IN WC)	FLOW (GPM)	EWT (°F)	LWT (°F)	△ PW (FT WC)	ROWS / FPI	VALVE TYPE	ELECTRIC HEATING COIL CAPACITY (MBH)	CAPACITY KW	EAT (°F)	LAT (°F)	△ PA (IN WC)	ELECTRICAL VOLTAGE	FLA (AMPS)	MCA (AMPS)	FILTERS TYPE	FILTERS SIZE (IN)	VIBRATION ISOLATION	OPER WGT (LBS)	REMARKS
FCU-1 / 2-1	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	2ND FL GUEST ROOM 1-BR ADA M	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	3.4	1	72	79	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-2 / 2-2	WILLIAMS ER-006	VERTICAL FAN COIL UNIT	2ND FL GUEST ROOM STUDIO C1	GUEST ROOM CONDITIONING	1	665	–	–	0	–	DIRECT DRIVE	–	1/6	12.8	11	75	63	59.9	56.7	.22	1.8	44	58	1.2	4 / –	3-WAY MOD	5.1	1.5	72	79	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 2-3	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	2ND FLOOR STUDIO B	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82.4	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 2-4	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	2ND FLOOR STUDIO B	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82.4	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-2 / 2-5	WILLIAMS ER-006	VERTICAL FAN COIL UNIT	2ND FL GUEST ROOM STUDIO A1	GUEST ROOM CONDITIONING	1	665	–	–	0	–	DIRECT DRIVE	–	1/6	12.8	11	75	63	59.9	56.7	.22	1.8	44	58	1.2	4 / –	3-WAY MOD	6.8	2.0	72	81	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-2 / 2-6	WILLIAMS ER-006	VERTICAL FAN COIL UNIT	2ND FL GUEST ROOM STUDIO B1	GUEST ROOM CONDITIONING	1	665	–	–	0	–	DIRECT DRIVE	–	1/6	12.8	11	75	63	59.9	56.7	.22	1.8	44	58	1.2	4 / –	3-WAY MOD	6.8	2.0	72	81	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-3 / 2-7	WILLIAMS ER-008	VERTICAL FAN COIL UNIT	2ND FL GUEST ROOM 1-BR H	GUEST ROOM CONDITIONING	1	860	–	–	0	–	DIRECT DRIVE	–	1/6	19.0	15.8	75	63	58.2	55.7	.18	2.7	44	58	2.5	4 / –	3-WAY MOD	10.2	3.0	72	83	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-1	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS 1-BR J	GUEST ROOM CONDITIONING	12	450	–	–	.3	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	6.8	2.0	72	86	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,7,8
FCU-1 / x-2	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS STUDIO C	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82.4	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-3	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS STUDIO A	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	3.4	1.0	72	82.4	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-4	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS STUDIO A	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	3.4	1.0	72	82.4	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-5	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS STUDIO A1	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	3.4	1.0	72	79	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-6	WILLIAMS ER-006	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS STUDIO B1	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-2 / x-7	WILLIAMS ER-006	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS 1-BR H	GUEST ROOM CONDITIONING	12	665	–	–	.3	–	DIRECT DRIVE	–	1/6	12.8	11	75	63	59.9	56.7	.22	1.8	44	58	1.2	4 / –	3-WAY MOD	8.5	2.5	72	84	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,7,8
FCU-1 / x-8	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 GUEST ROOMS STUDIO G	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	3.4	1	72	79	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-9	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS STUDIO F- ADA	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	6.8	2.0	72	86	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-10	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS STUDIO E	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	6.8	2.0	72	86	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-11	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS STUDIO D	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-12	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS STUDIO D	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-13	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS STUDIO D	GUEST ROOM CONDITIONING	12	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / x-14	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	3-14 FL GUEST ROOMS 1 BR - K	GUEST ROOM CONDITIONING	12	450	–	–	.3	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	6.8	2.0	72	86	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,7,8
FCU-1 / 15-1	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM 1-BR J	GUEST ROOM CONDITIONING	1	450	–	–	.3	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	8.5	2.5	72	89	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,7,8
FCU-1 / 15-2	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM STUDIO C	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82.4	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 15-3	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM STUDIO A	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82.4	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 15-4	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM STUDIO A	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82.4	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 15-5	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM STUDIO A1	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82.4	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 15-6	WILLIAMS ER-006	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM STUDIO B1	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-2 / 15-7	WILLIAMS ER-006	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM 2 - BR L2	GUEST ROOM CONDITIONING	1	665	–	–	.3	–	DIRECT DRIVE	–	1/6	12.8	11	75	63	59.9	56.7	.22	1.8	44	58	1.2	4 / –	3-WAY MOD	8.5	2.5	72	84	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,7,8
FCU-1 / 15-8	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM 2 - BR L2	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	3.4	1	72	79	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 15-9	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM STUDIO F- ADA	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	6.8	2.0	72	86	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 15-10	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM STUDIO E	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	86	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 15-11	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM STUDIO D	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 15-12	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM STUDIO D	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 15-13	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM STUDIO D	GUEST ROOM CONDITIONING	1	450	–	–	0	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	5.1	1.5	72	82	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,6,8
FCU-1 / 15-14	WILLIAMS ER-004	VERTICAL FAN COIL UNIT	15TH FL GUEST ROOM 1 BR - K	GUEST ROOM CONDITIONING	1	450	–	–	.3	–	DIRECT DRIVE	–	1/15	8.4	7.2	75	63	60.4	56.9	.09	1.2	44	58	1.7	3 / –	3-WAY MOD	6.8	2.0	72	86	–	208-1-60	–	–	PLEATED	14"X25"X1"	INTERNAL	300	1,2,3,4,5,7,8

NOTES:
1. 1/2" THICK, 3 POUND DENSITY, NEOPRENE COATED INSULATION
2. WALL MOUNT 24V THERMOSTAT WITH MANUAL CHANGE OVER. FAN SHALL HAVE A MEDIUM/HIGH BUT NO OFF POSITION.
3. 3-WAY ELECTRIC VALVE PACKAGE
4. STAINLESS STEEL DRAIN PAN WITH FORMED P-TRAP CONNECTION
5. TRANSFORMER
6. DOUBLE DEFLECTION ALUMINUM SUPPLY AIR GRILLE
7. DUCTED SUPPLY AIR CONNECTION
8. INTEGRAL ELECTRIC DISCONNECT

TAG KEY

FCU-2 / 15-14
- NOMINAL UNIT SIZE: 1-400 CFM, 2-600 CFM, 3-800 CFM
- FLOOR
- SEQUENTIAL NUMBER PER FLOOR

BUILDING AUTOMATION SYSTEM PANEL SCHEDULE

TAG	LOCATION	ELECTRICAL DATA CONTROL VA	CONVENIENCE OUTLET-AMPS	POWER (VOLTS/PH/HZ)	EMERGENCY POWER
BMS-1	PENTHOUSE	400	10	120-1-60	YES
BMS-2	MER 2003	300	10	120-1-60	YES
BMS-3	1ST FL FIRE CONTROL ROOM 1002	200	–	120-1-60	NO
BMS-4	1ST FL STORAGE 1019	200	10	120-1-60	YES
BMS-5	1ST FL STORAGE 1007A	200	10	120-1-60	YES
BMS-6	P-1 LEVEL	200	10	120-1-60	YES
BMS-7	P-2 LEVEL	200	10	120-1-60	YES
BMS-8	P-3 LEVEL	200	10	120-1-60	YES

SPA DE-HUMIDIFICATION UNIT SCHEDULE

SYMBOL	MANUFACTURER MODEL	TYPE	LOCATION	SERVICE	SUPPLY FAN SUPPLY (CFM)	RETURN (CFM)	MIN OSA (CFM)	TSP (IN WC)	ESP (IN WC)	FAN RPM	ELEV (FT)	FAN TYPE	DRIVE TYPE	BHP	HP	DEHUMIDIFICATION CAPACITY TOTAL (MBH)	SENSIBLE (MBH)	SPACE TEMP (°F) DB	SPACE TEMP RH	SPA TEMP (°F)	MOISTURE REMOVAL (LBS/HR)	ELECTRICAL DATA MCA (AMPS)	MOP (AMPS)	POWER (VOLTS/PH/HZ)	FILTERS	VIBRATION ISOLATION	OPER WGT (LBS)	REMARKS
DHU / 01	POOL-PAK AWV-550	CONSTANT VOLUME VERTICAL PACKAGED INDOOR TYPE	SPA 2ND FLOOR	SPA SPACE CONDITIONING	1,300	1,300	0	–	.5	–	–	CENTRIF. FC	BELT	.4	1/2	23	14	86	60%	104	10	18	25	208-1-60		INTERNAL	450	1,2,3

NOTES:
1. SINGLE SOURCE POWER SUPPLY.
2. MATCH TO AC-1 FOR HEAT REJECTION
3. MATCH TO DH-1 FOR SPACE HEATING

AIR COOLED CONDENSER SCHEDULE

SYMBOL	MANUFACTURER MODEL	LOCATION	SERVICE	CAPACITY AMBIENT (°F)	CAPACITY (MBH)	ELECTRICAL DATA # FANS	FLA (IN WC)	POWER (VOLTS/PH/HZ)	VIBRATION ISOLATION	OPER WGT (LBS)	REMARKS
CU / 2	POOL-PAK PAC-042	– –	SPA SPACE HEAT REJECTION	105	25	1	3	208-1-60	INTERNAL	450	1

NOTES:
1. MATCH TO DHU-1.

ELECTRIC DUCT HEATER SCHEDULE

SYMBOL	MANUFACTURER MODEL	LOCATION	SERVICE	CAPACITY (KW)	(MBH)	AIRFLOW (CFM)	EAT (°F)	LAT (°F)	ELECTRICAL DATA # STGS	–	POWER (VOLTS/PH/HZ)	REMARKS
DH / 01	INDEECO –	– –	SPA SPACE HEATING	10	34	1,300	55	79	3	–	460-3-60	1

NOTES:
1. --

SEE WMATA NOTE ON SHEET A-001.

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REVISIONS
- PERMIT SET OCT. 20, 2006
- 1 95% PRICING DEC. 01, 2006
- 2 CITY OF ALEXANDRIA PERMIT COMMENTS DEC. 12, 2006
- 3 CITY OF ALEXANDRIA PERMIT COMMENTS #2 JAN. 23. 2007
- 4 FINAL CONSTRUCTION SET FEB. 16, 2007

PROJECT TITLE

RESIDENCE INN BY MARRIOTT

2345/2347 MILL ROAD
ALEXANDRIA, VIRGINIA

PROJECT NO. 305412.00

DRAWING TITLE

MECHANICAL SCHEDULES

Printed On: 2/16/07, 10:58 am

SCALE NO SCALE
DATE OCTOBER 20th, 2006
DRAWN BY
CHECKED BY

M-602.dwg

DRAWING NUMBER

M-602

SHEET 0 OF 00

Schedule GS-4
LARGE GENERAL SERVICE
PRIMARY VOLTAGE

I. APPLICABILITY

Except as modified herein, this schedule is applicable only to a non-residential transmission or primary voltage Customer (as defined in Paragraph XI.) who elects to receive Electricity Supply Service and Electric Delivery Service from the Company and whose peak measured demand has reached or exceeded 500 kW during at least three billing months within the current and previous 11 billing months.

For a Customer served under this schedule whose peak measured demand has decreased to less than 500 kW, this schedule shall remain applicable to the Customer and the Customer shall not have the option to purchase electricity under Schedule GS-1, GS-2, or GS-2T until such time as the maximum measured demand has remained at less than 500 kW during all billing months within the current and previous 11 billing months.

At such time the Customer no longer meets the above applicability requirements, the Customer shall remain on this schedule for the period (not exceeding two additional billing months) required to achieve an orderly transfer to the applicable schedule.

For new service, this schedule is applicable when the anticipated kW demand meets the above criteria.

II. 30-DAY RATE

A. Distribution Service Charges

1. Basic Customer Charge
   Basic Customer Charge $127.60 per billing month.

2. Plus Distribution Demand Charge

First 5000 kW of Distribution Demand	@	$1.000 per kW
Additional kW of Distribution Demand	@	$0.755 per kW

3. Plus rkVA Demand Charge @ $0.15 per rkVA

(Continued)

Schedule GS-4
LARGE GENERAL SERVICE
PRIMARY VOLTAGE

II. 30-DAY RATE (Continued)

B. Electricity Supply Service Charges

1. On-Peak Electricity Supply Demand Charge

a. All On-Peak Electricity Supply Demand for Primary Service Voltage @ $ 12.003 per kW

b. All On-Peak Electricity Supply Demand for Transmission Service Voltage @ $ 11.715 per kW

2. Plus Off-Peak Electricity Supply Demand Charge
All Off-Peak kW Demand @ $ 0.632 per kW

3. Plus Electricity Supply Adjustment Demand Charge
First 5000 kW of Demand @ ($ 0.421) per kW
Additional kW of Demand @ ($ 0.318) per kW

4. Plus Electricity Supply kWh Charge
All On-peak kWh @ 0.404¢ per kWh
All Off-Peak kWh @ 0.272¢ per kWh

5. Each Electricity Supply kilowatthour used is subject to Fuel Charge Rider A.

C. The minimum charge shall be as may be contracted for.

(Continued)

Schedule GS-4
LARGE GENERAL SERVICE
PRIMARY VOLTAGE

III. DETERMINATION OF ON-PEAK AND OFF-PEAK HOURS

The following on-peak and off-peak hours are applicable to the billing of all charges stated in this schedule.

A. On-peak hours are as follows:

1. For the period of June 1 through September 30, 10 a.m. to 10 p.m., Mondays through Fridays.

2. For the period of October 1 through May 31, 7 a.m. to 10 p.m., Mondays through Fridays.

B. All hours not specified in III.A. are off-peak.

IV. DETERMINATION OF DISTRIBUTION DEMAND

A. Distribution Demand shall be billed only where the normal service delivery voltage is less than 69 kV.

B. The Distribution Demand billed under Paragraph II.A.2. shall be such as may be contracted for but not less than the highest of:

1. The highest average kW measured at the location during any 30-minute interval of the current and previous 11 billing months.

2. 500 kW.

C. When the Customer's power factor is less than 85 percent, a minimum distribution demand of not less than 85 percent of the Customer's maximum kVA demand may be established.

V. DETERMINATION OF rkVA DEMAND

The rkVA of demand billed shall be the highest average rkVA measured in any 30-minute interval during the current billing month.

(Continued)

Schedule GS-4
LARGE GENERAL SERVICE
PRIMARY VOLTAGE

VI. DETERMINATION OF ON-PEAK ELECTRICITY SUPPLY DEMAND

The kW of demand billed under II.B.1. shall be the highest of:

A. The highest average kW measured in any 30-minute interval of the current billing month during on-peak hours.

B. Seventy-five percent of the highest kW of demand at this location as determined under VI.A., above, during the billing months of June through September of the preceding 11 billing months.

C. 100 kW.

VII. DETERMINATION OF OFF-PEAK ELECTRICITY SUPPLY DEMAND

The kW of demand billed under Paragraph II.B.2. shall be the off-peak demand which is in excess of 90% of the On-Peak Electricity Supply Demand determined under Paragraph VI.

VIII. DETERMINATION OF ELECTRICITY SUPPLY ADJUSTMENT DEMAND

This credit is required in order to achieve customer bill neutrality, arising from changes to the Distribution Demand Charge while maintaining the overall capped rates. The kW of demand billed under Paragraph II.B.3. shall be the Distribution Demand determined under Paragraph IV.

IX. METER READING AND BILLING

When the actual number of days between meter readings is more or less than 30 days, the Basic Customer Charge, the Distribution Demand Charge, the rkVA Demand Charge, the On-Peak Electricity Supply Demand Charge, the Off-peak Electricity Supply Demand Charge, the Electricity Supply Adjustment Demand Charge, and the minimum charge of the 30-day rate will each be multiplied by the actual number of days in the billing period and divided by 30.

(Continued)

Schedule GS-4
LARGE GENERAL SERVICE
PRIMARY VOLTAGE

X. STANDBY, MAINTENANCE OR PARALLEL OPERATION SERVICE

A Customer requiring standby, maintenance or parallel operation service may elect service under this schedule provided the Customer contracts for the maximum kW which the Company is to supply. Standby, maintenance or parallel operation service is subject to the following provisions:

A. Suitable relays and protective apparatus shall be furnished, installed, and maintained at the Customer's expense in accordance with specifications furnished by the Company. The relays and protective equipment shall be subject, at all reasonable times, to inspection by the Company's authorized representative.

B. In case the Distribution Demand determined under Paragraph IV. exceeds the contract demand, the contract demand shall be increased by such excess demand.

C. The demand billed under II.A.2. and II.B.3. shall be the contract demand.

XI. DEFINITION OF TRANSMISSION, PRIMARY AND SECONDARY VOLTAGE CUSTOMER

A. A transmission voltage Customer is any Customer whose delivery voltage is 69 kV or above.

B. A primary voltage Customer is any Customer (a) served from a circuit of 69 kV or more where the delivery voltage is 4,000 volts or more, (b) served from a circuit of less than 69 kV where Company-owned transformation is not required at the Customer's site, (c) where Company-owned transformation has become necessary at the Customer's site because the Company has changed the voltage of the circuit from that originally supplied, or (d) at a location served prior to October 27, 1992 where the Customer's connection to the Company's facilities is made at 2,000 volts or more.

C. A secondary voltage Customer is any Customer not defined in XI.A. or XI.B. as a transmission or primary voltage Customer.

(Continued)

Schedule GS-4
LARGE GENERAL SERVICE
PRIMARY VOLTAGE

(Continued)

XII. TERM OF CONTRACT

The contract shall be open order unless (a) standby, maintenance or parallel operation service is provided, or (b) the Customer or the Company requests a written contract. In such cases, the term of contract for the purchase of electricity under this schedule shall be as mutually agreed upon, but for not less than one year. During the minimum term of applicability, the Customer may be billed under the corresponding Unbundled Rate Schedule GS-4U, if applicable.

RESIDENCE INN
BY MARRIOTT
2345 MILL RD, ALEXANDRIA, VA

JULIA E. PHILLIPS
CONSTRUCTION MANAGEMENT

Current Energy Use Based on 24/7 Run Schedule

Based on Degree Day Weather Data:

Heating = 68% of Total Year
Cooling = 32% of Total Year
*** Assumed Set Point of 65° F**

Average Electric Heating Units (Drawing E 3.3)

140 x	1.50	kW
33 x	3.00	kW
16 x	2.50	kW
189 units	349	kW

Average Horsepower per fan = 0.05kW
Total Electric for Cooling = 189*0.05 = 9.45kW

Building Demand = 656.1 kVA → *** Assume GS - 4 Determined by Virginia Dominion Power**

*** Assume 81% Occupancy** → 147 Rooms Filled of 181

Total Heating Energy Use = (0.81)(358.45 kW) = 290.34 kW
Total Cooling Energy Use = (0.81)(9.45 kW) = 7.65 kW

Total Heating Energy Use per Day = (0.81)(0.68*24 Hrs)(358.45 kW) = 3,939.19 kWh
Total Cooling Energy Use per Day = (0.81)(0.32*24 Hrs)(358.45 kW) = 1,853.74 kWh

Peak Time →
6/1 to 9/30 Monday through Friday from 10:00am to 10:00pm
10/1 to 5/31 Monday through Friday from 7:00am to 10:00pm
$0.404 per kWh
261 Peak Days

Off-Peak Time →
1/1 to 12/31 Evenings and Weekends
$0.272 per kWh
104 Off-Peak Days

<u>Energy Cost Calculations</u>

<u>Peak Time Cost - Heating</u>

$$= (290.34) * \left[\left(\frac{12\ hrs.}{1\ Day}\right)\left(\frac{99\ Days}{1\ Year}\right) + \left(\frac{15\ hrs.}{1\ Day}\right)\left(\frac{179\ Days}{1\ Year}\right)\right] * 0.68$$

= 720,832.48 kWh
= $2,912.16

JULIA E. PHILLIPS
CONSTRUCTION MANAGEMENT

Peak Time Cost - Cooling

$$= (7.65) * \left[\left(\frac{12\ hrs.}{1\ Day}\right)\left(\frac{88\ Days}{1\ Year}\right) + \left(\frac{18\ hrs.}{1\ Day}\right)\left(\frac{178\ Days}{1\ Year}\right)\right] * 0.32$$

= 8942.91 kWh

= $36.13

Off-Peak Time Cost - Heating

$$= (290.34) * \left[\left(\frac{24\ hrs.}{1\ Day}\right)\left(\frac{104\ Days}{1\ Year}\right) + \left(\frac{12\ hrs.}{1\ Day}\right)\left(\frac{88\ Days}{1\ Year}\right) + \left(\frac{18\ hrs.}{1\ Day}\right)\left(\frac{178\ Days}{1\ Year}\right)\right] * 0.66$$

= 1,008,691.63 kWh

= $2,743.64

Off-Peak Time Cost - Cooling

$$= (7.65) * \left[\left(\frac{24\ hrs.}{1\ Day}\right)\left(\frac{104\ Days}{1\ Year}\right) + \left(\frac{12\ hrs.}{1\ Day}\right)\left(\frac{88\ Days}{1\ Year}\right) + \left(\frac{18\ hrs.}{1\ Day}\right)\left(\frac{178\ Days}{1\ Year}\right)\right] * 0.32$$

= 26,592.65 kWh

= $72.33

Total kWh =	**1,765,059.67**
Total Cost =	**$5,764.27**

Residence Inn
By Marriott
2345 Mill Rd, Alexandria, VA

Julia E. Phillips
Construction Management

Energy Calculations
Appendix E

New Energy Use Based on Adjustable Run Schedule

Based on Degree Day Weather Data:

Heating = 68% of Total Year
Cooling = 32% of Total Year
*** Assumed Set Point of 65° F**

Average Electric Heating Units (Drawing E 3.3)

140	x	1.50	kW
33	x	3.00	kW
16	x	2.50	kW
189 units		349	kW

Average Horsepower per fan = 0.05kW
Total Electric for Cooling = 189*0.05 = 9.45kW

Average Horsepower per fan = 0.05kW
Total Electric for Cooling = 189*0.05 = 9.45kW

Building Demand = 656.1 kVA → *** Assume GS - 4 Determined by Virginia Dominion Power**

*** Assume 81% Occupancy** → 147 Rooms Filled of 181

Total Heating Energy Use = (0.81)(358.45 kW) = 290.34 kW
Total Cooling Energy Use = (0.81)(9.45 kW) = 7.65 kW

Total Heating Energy Use per Day = (0.81)(0.68*24 Hrs)(358.45 kW) = 3,939.19 kWh
Total Cooling Energy Use per Day = (0.81)(0.32*24 Hrs)(358.45 kW) = 1,853.74 kWh

Peak Time →
6/1 to 9/30 Monday through Friday from 10:00am to 10:00pm
10/1 to 5/31 Monday through Friday from 7:00am to 10:00pm
$0.404 per kWh
261 Peak Days

Off-Peak Time →
1/1 to 12/31 Evenings and Weekends
$0.272 per kWh
104 Off-Peak Days

Trace Schedule for Hotel Occupancy Rate:

12 am - 9 am =	100%
9 am - 11 am =	20%
11 am - 5 pm =	0%
5 pm - 12 am =	100%

RESIDENCE INN
BY MARRIOTT
2345 MILL RD, ALEXANDRIA, VA

JULIA E. PHILLIPS
CONSTRUCTION MANAGEMENT

ENERGY CALCULATIONS
APPENDIX E

The Residence Inn is slated for mainly long term business people. Average hours of commute are between 7 am and 9 am.

Adjusted Schedule for Hotel Occupancy Rate:

12 am - 9 am =	85%	*** Assumes leaving at 7:30 am**
9 am - 11 am =	0%	
11 am - 5 pm =	0%	
5 pm - 12 am =	100%	

Energy Cost Calculations

"Over-ride" Heating Usage = All Off-Peak Time from 10:00pm to 7:00am

$$= (290.34) * \left[\left(\frac{9\ hrs.}{1\ Day}\right)\left(\frac{368\ Days}{1\ Year}\right)\right] * 0.68$$

= 648,571.54 kWh

= $1,764.11

"Over-ride" Cooling Usage = All Off-Peak Time from 10:00pm to 7:00am

$$= (7.65) * \left[\left(\frac{9\ hrs.}{1\ Day}\right)\left(\frac{368\ Days}{1\ Year}\right)\right] * 0.32$$

= 8,046.41 kWh

= $21.89

User Controlled Heating Usage = All Peak Time = 5.65 hrs total of Day

$$= (290.34) * \left[\left(\frac{368\ hrs.}{1\ Day}\right)\left(\frac{368\ Days}{1\ Year}\right)\right] * 0.68$$

= 407,158.80 kWh

= $1,644.92

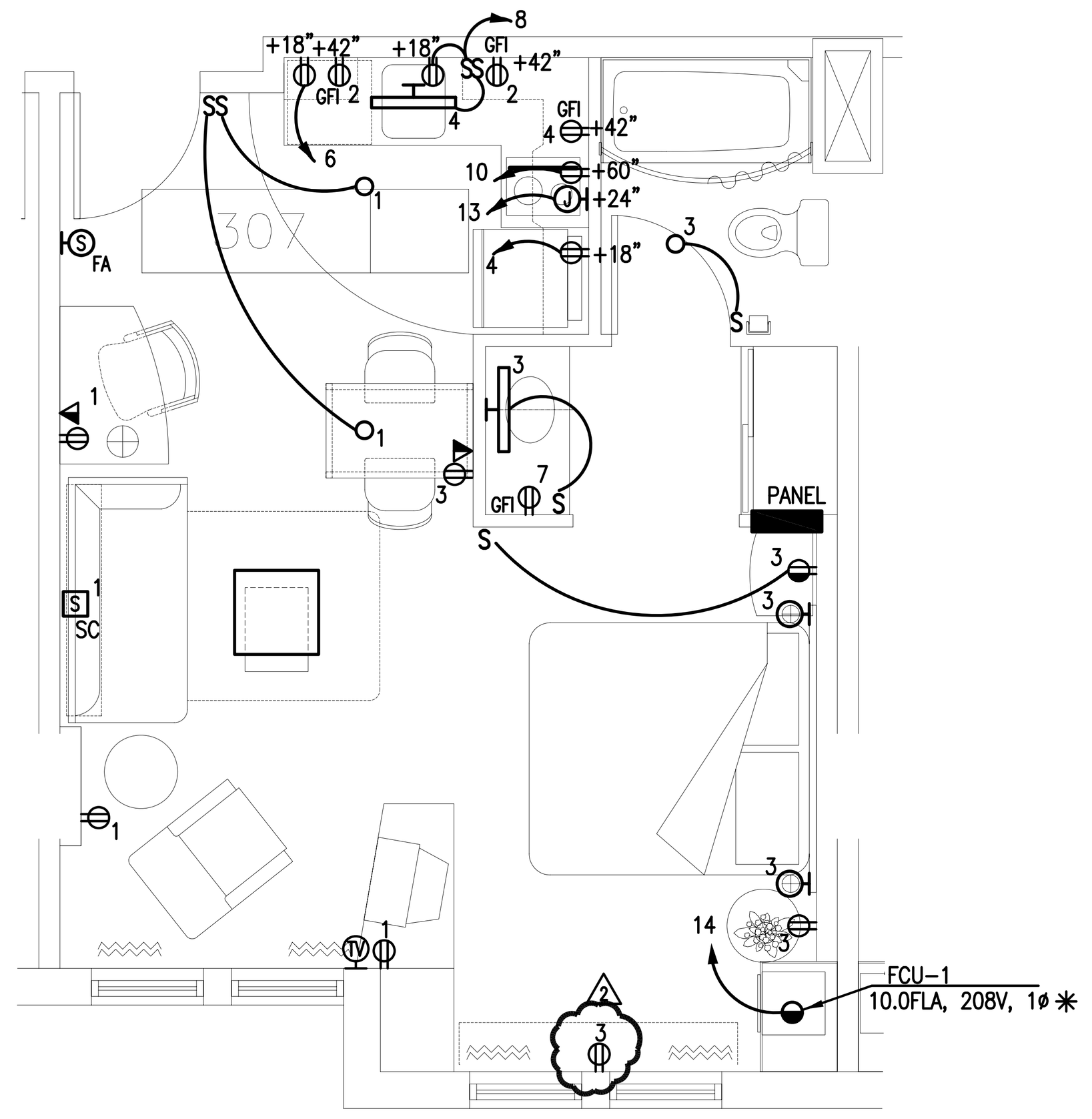
User Controlled Cooling Usage = All Peak Time = 5.65 hrs total of Day

$$= (7.65) * \left[\left(\frac{368\ hrs.}{1\ Day}\right)\left(\frac{368\ Days}{1\ Year}\right)\right] * 0.32$$

= 5,051.36 kWh

= $20.41

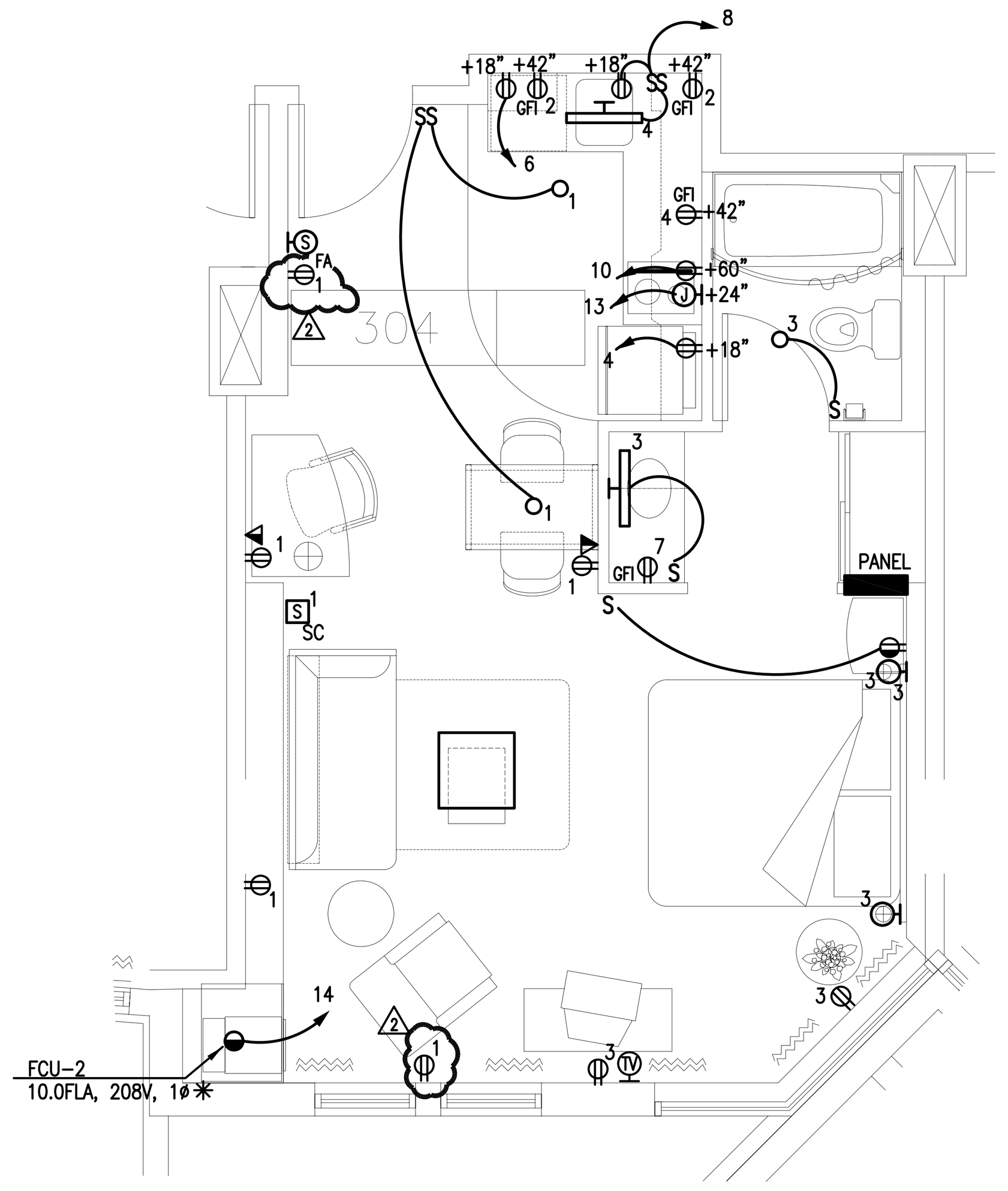
Total kWh =	**1,068,828.11**
Total Cost =	**$3,451.33**



UNIT A, A1, A2, C, D, E

SCALE: 1/4" = 1'-0

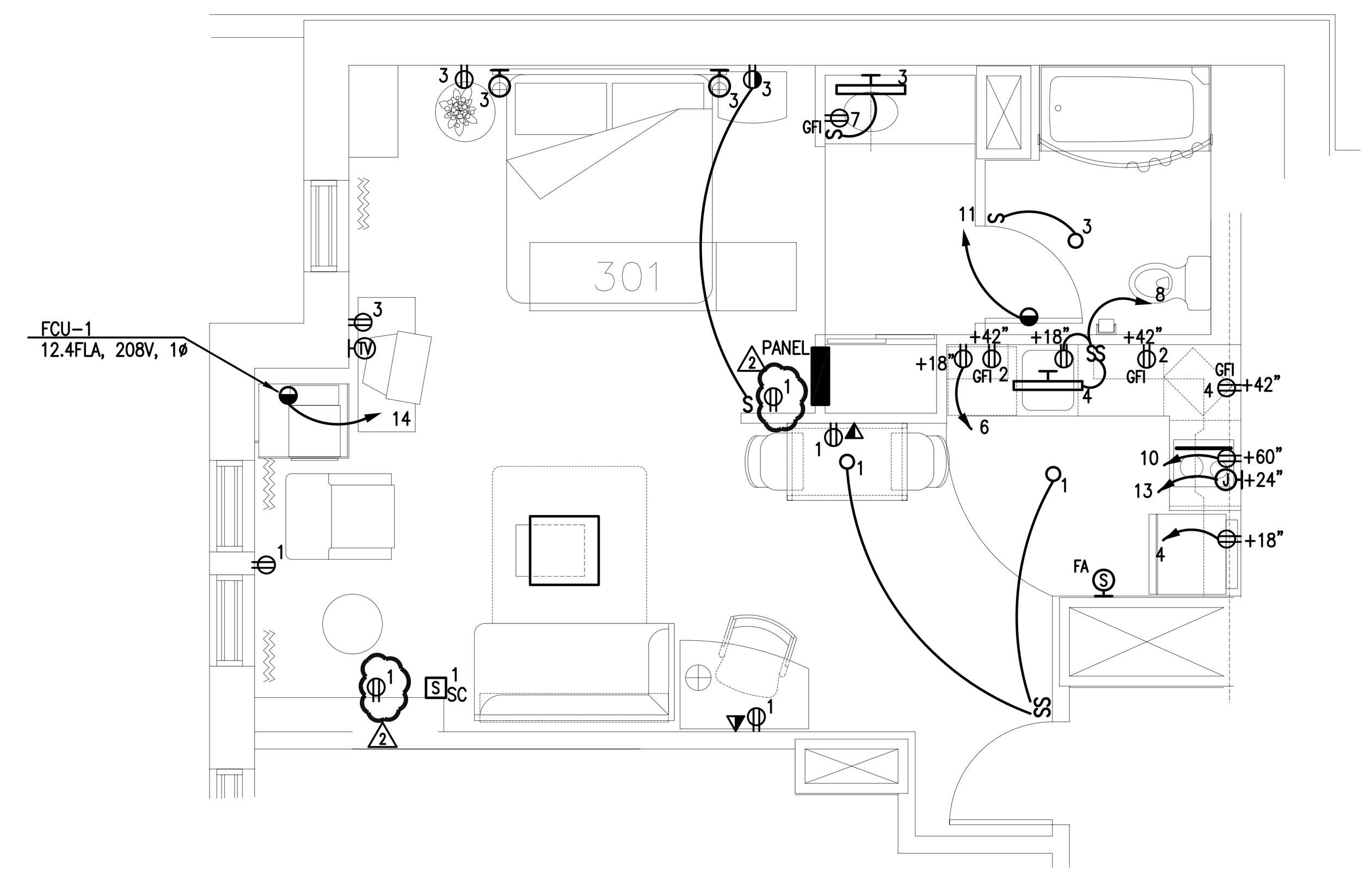
✳ NOTE: UNIT A1 HAS 13.4 FLA (FCU-2, 1/6HP FAN, 2.0KW HEAT)
UNIT A HAS 7.6 FLA (FCU-1, 1/15HP FAN, 1.0KW HEAT)



UNIT B1, B2, B3

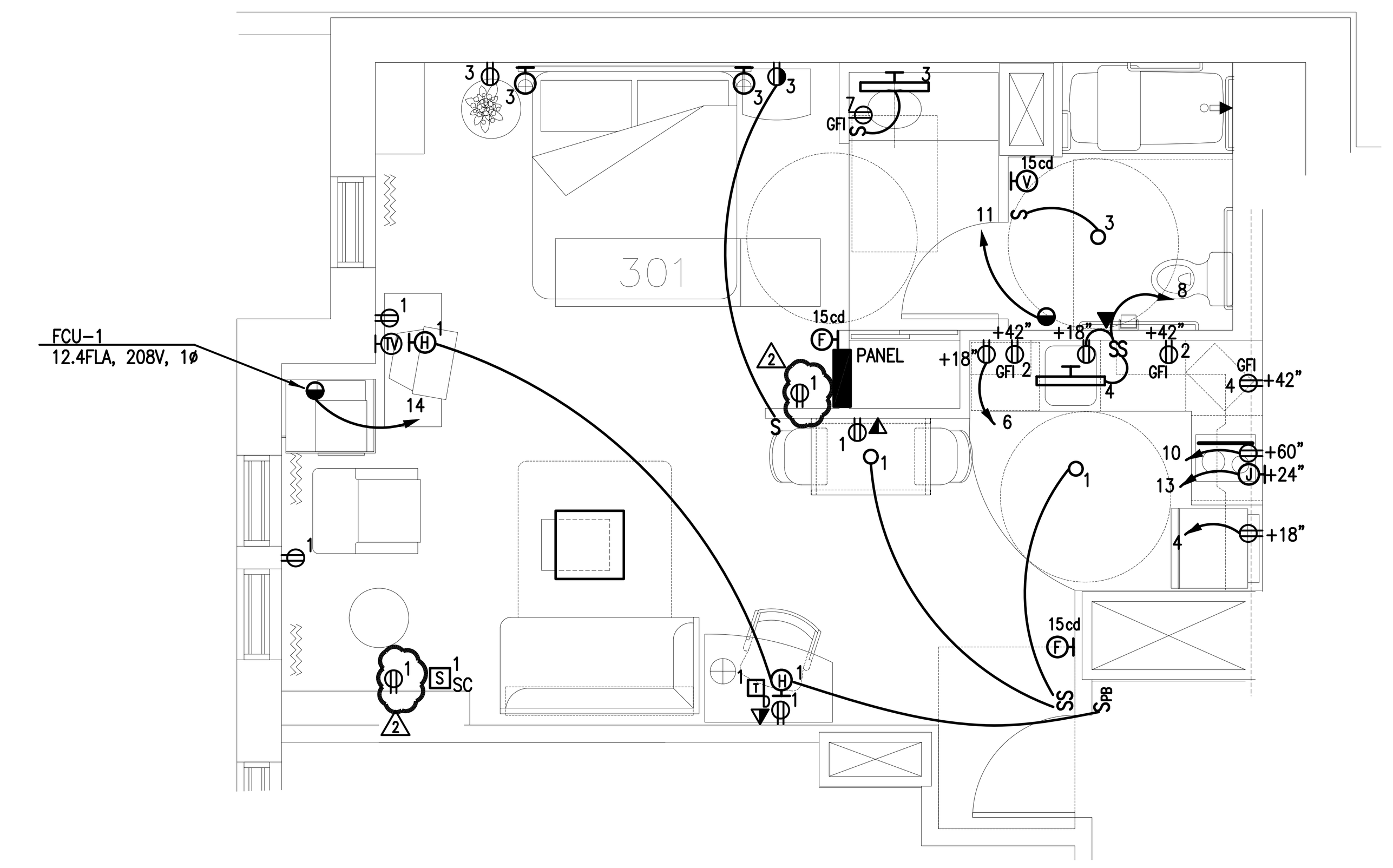
SCALE: 1/4" = 1'-0

✳ NOTE: UNIT B1 FCU IS 13.4 FLA (1/6HP FAN, 2.0KW HEAT)



UNIT F

SCALE: 1/4" = 1'-0



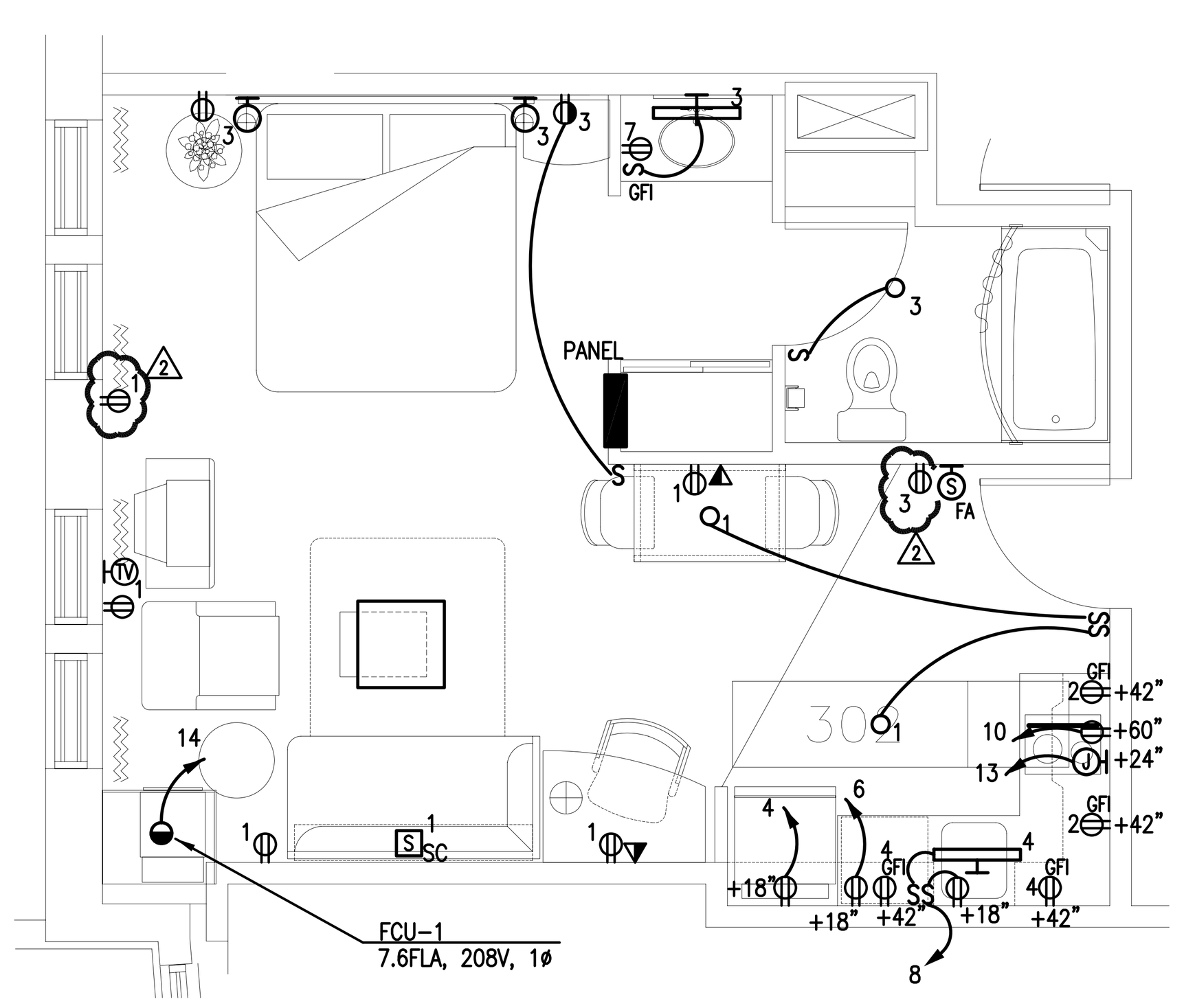
UNIT F ADA

SCALE: 1/4" = 1'-0

✳ SEE ARCHITECTURAL DRAWINGS NOTE: UNIT B1 FCU IS 13.4 FLA (1/6HP FAN, 2.0KW HEAT)

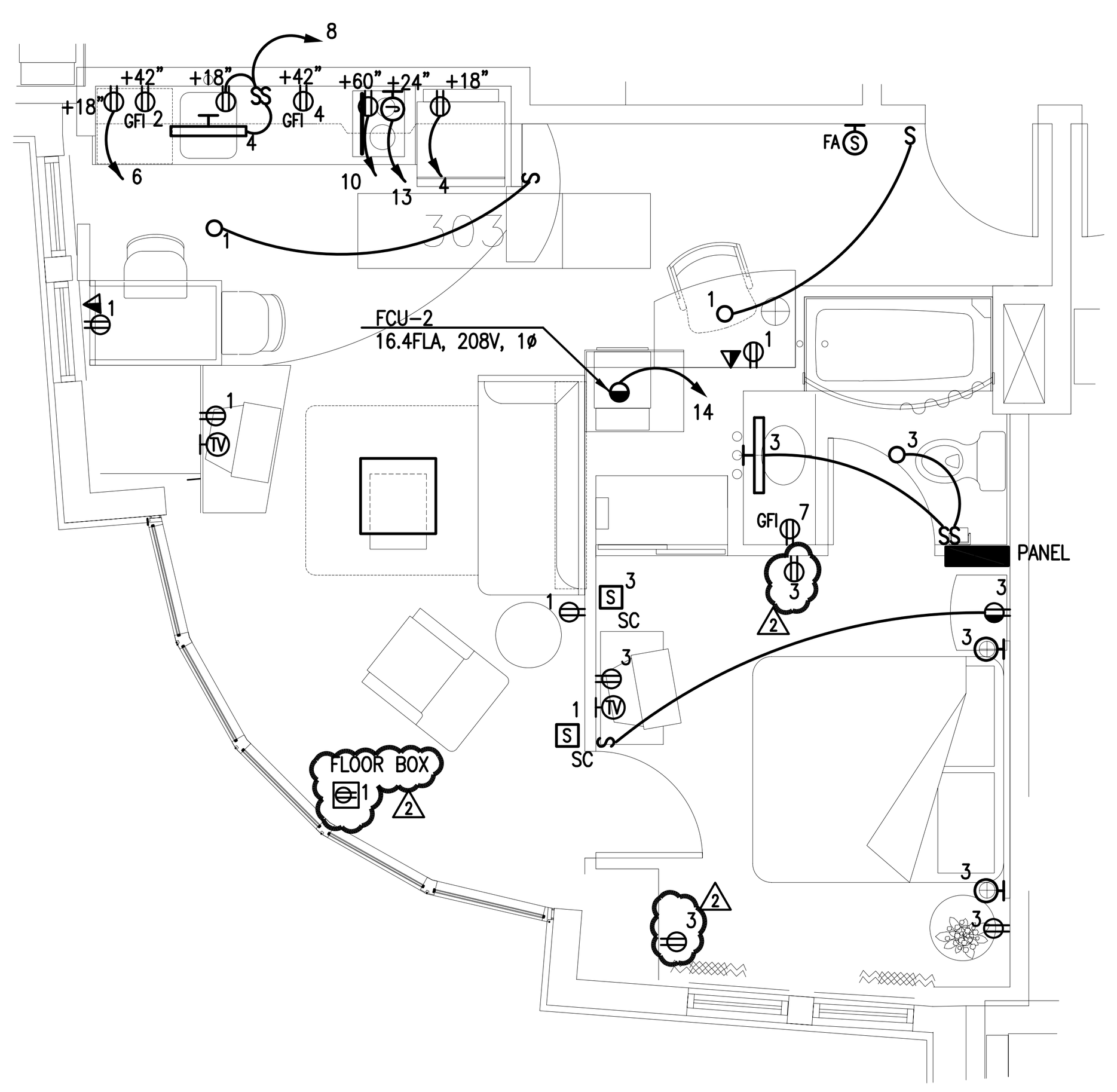
NOTE: 1. INSTALL THE FOLLOWING EQUIPMENT IN HEARING IMPAIRED UNITS: PUSH BUTTON S, COMBINATION MINIHORN-STROBE FOR DOOR SIGNALING, XFMR.
2. HEARING IMPAIRED EQUIPMENT WILL BE INSTALLED ONLY IN UNITS IDENTIFIED BY ARCHITECTURAL DRAWINGS.
3. EXACT LOCATION OF DOOR XFMR SHALL BE FIELD COORDINATED.

SEE DRAWING E 2.2 FOR DRAWING NOTES, DWELLING UNIT NOTES AND MOUNTING HEIGHT INSTALLATION NOTES.
SEE MECHANICAL DRAWING M-602 FOR ADDITIONAL INFORMATION ON FAN COILED UNITS AND ELECTRIC HEATERS.



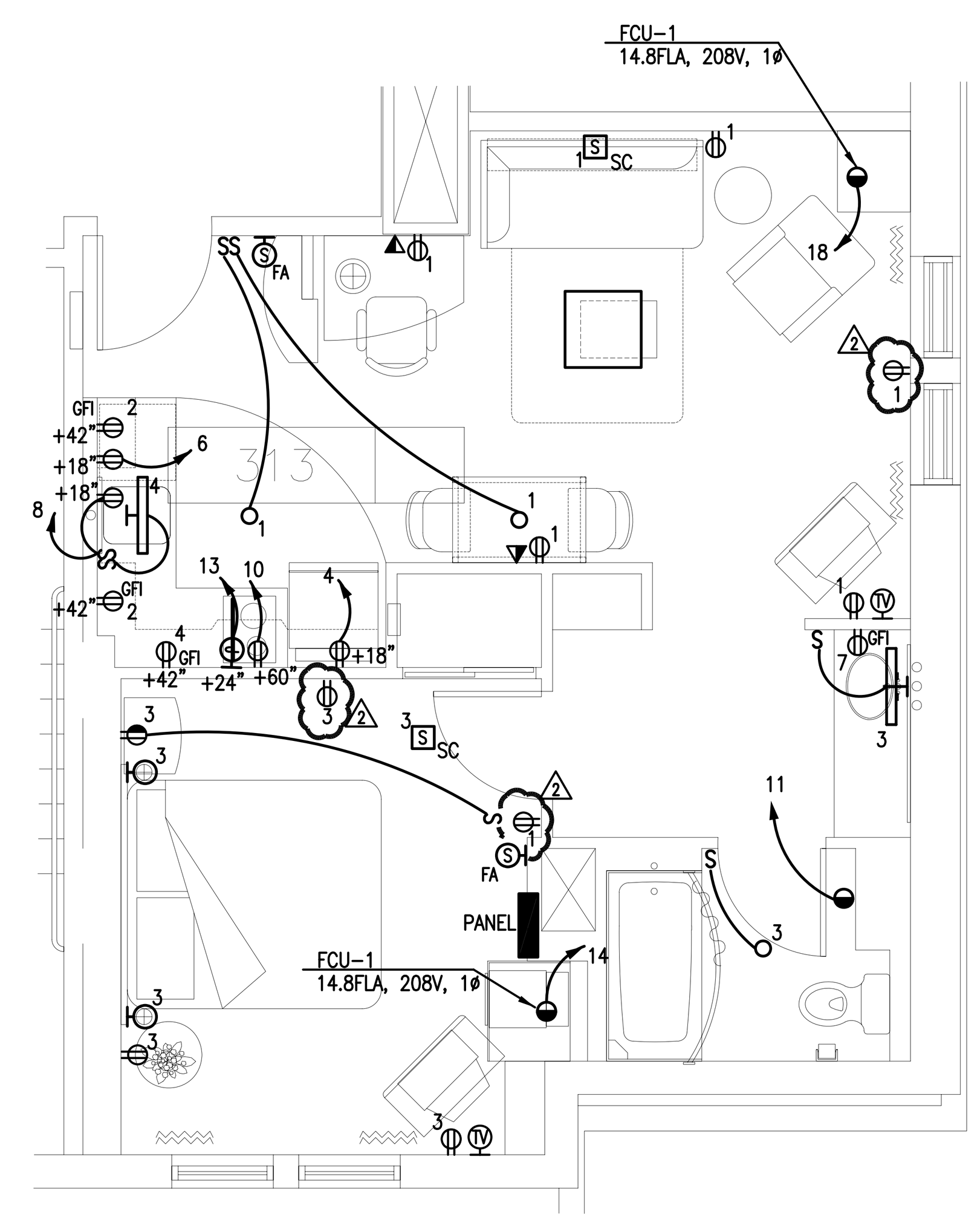
UNIT G

SCALE: 1/4" = 1'-0



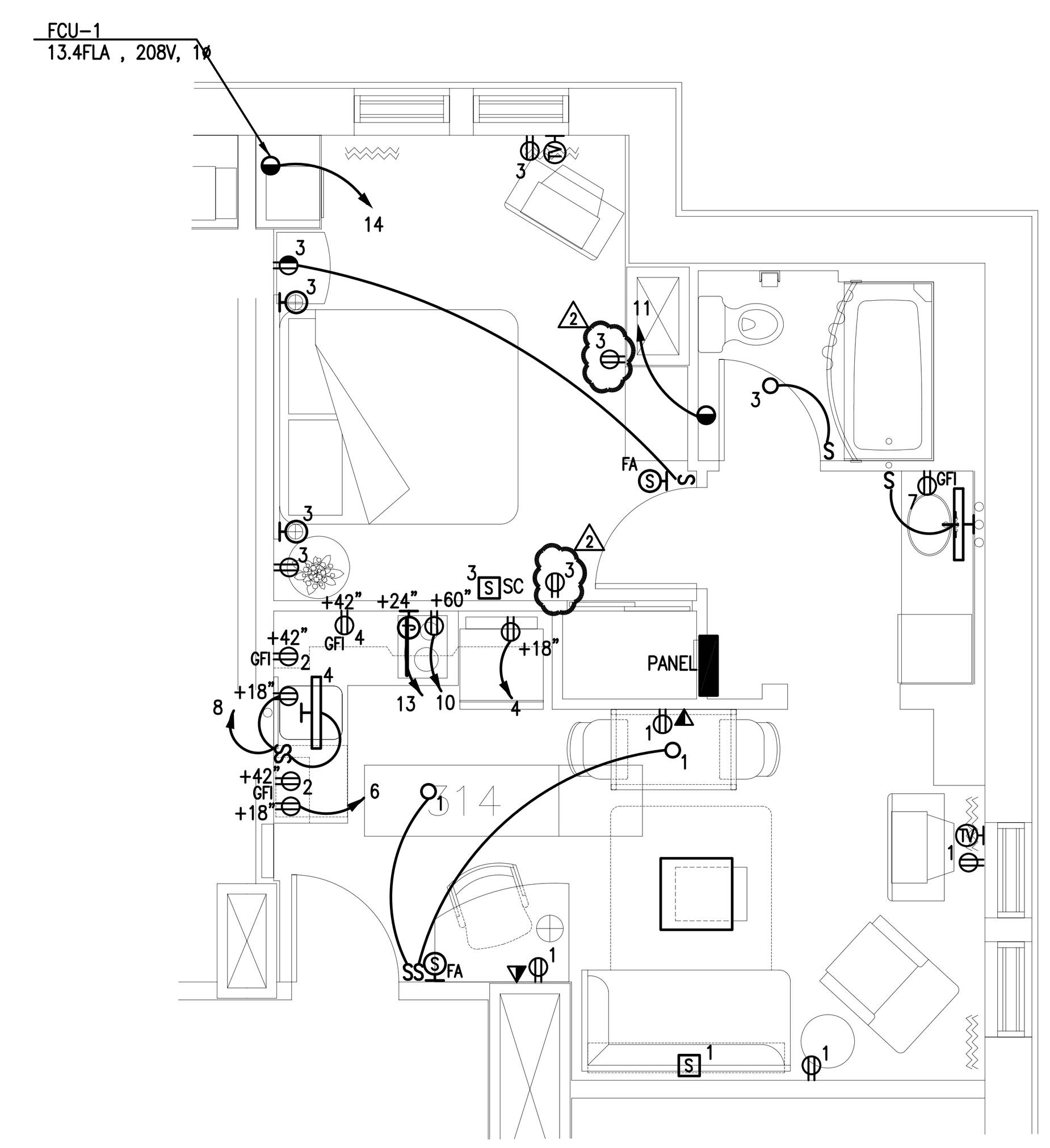
UNIT H

SCALE: 1/4" = 1'-0



UNIT J

SCALE: 1/4" = 1'-0



UNIT K

SCALE: 1/4" = 1'-0

dcs DESIGN
DAVIS CARTER SCOTT Ltd
Architecture
Interior Architecture
Land Planning
1676 International Drive
Suite 500
McLean, Virginia 22102
P 703.556.9275
F 703.821.6976
www.dcsdesign.com

GIRARD
GIRARD ENGINEERING
1355 Beverly Rd.
McLean, Virginia 22101
(703) 442-8787 356-0169 (FAX)

DESIGN ACC/AW DRAWN LDN/AW
JOB No. 05055.00 Q.A. DCU

REVISIONS	
PERMIT SET	OCT. 20, 2006
95% PRICING	DEC. 01, 2006
CITY OF ALEXANDRIA PERMIT COMMENTS	DEC. 12, 2006
CITY OF ALEXANDRIA PERMIT COMMENTS #2	JAN. 23, 2007
FINAL CONSTRUCTION SET	FEB. 16, 2007

PROJECT TITLE
RESIDENCE INN BY MARRIOTT

2345/2347 MILL ROAD
ALEXANDRIA, VIRGINIA
PROJECT NO. 30541200

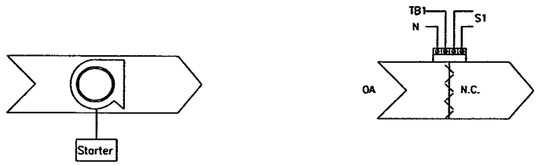
DRAWING TITLE
1/4" SCALE GUEST ROOM LAYOUTS

Printed On: 2/20/07, 4:17 pm

SCALE
DATE OCTOBER 20th, 2006
DRAWN BY
CHECKED BY

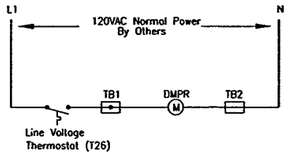
E 2-1(UNITS).dwg

DRAWING NUMBER
E 2.1
SHEET OF



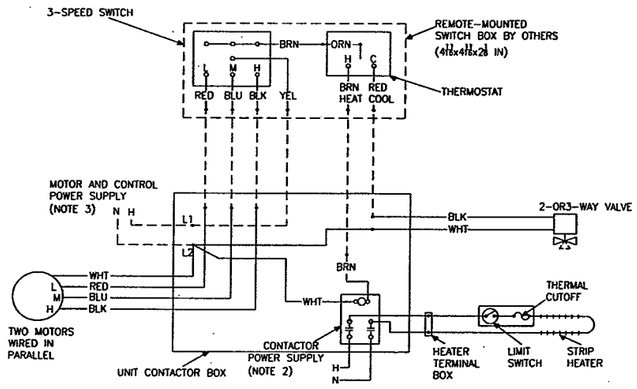
Equipment Room Exhaust Fan/Intake Damper

Typical of 2



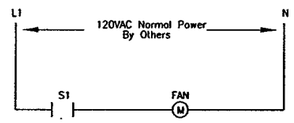
Damper Thermostat Wiring Detail

Typical of 5



FCU Wiring Diagram

Typical of 115 Guest Room



Exhaust Fan Motor Wiring Detail

Typical of 2

Residence Inn By Marriott

2345 / 2347 Mill Road, Alexandria, VA

BUILDING AUTOMATION SYSTEM

MISCELLANEOUS CONTROLS

REV. 1	SUBMITTAL	5-24-2007	JOB NO.: 7116968

Southland Industries
22340 Dresden St. Suite 177
Dulles, VA 20166
(703) 834-5570

ENGINEER: YZ

DRAWN BY: YZ

PRELIMINARY
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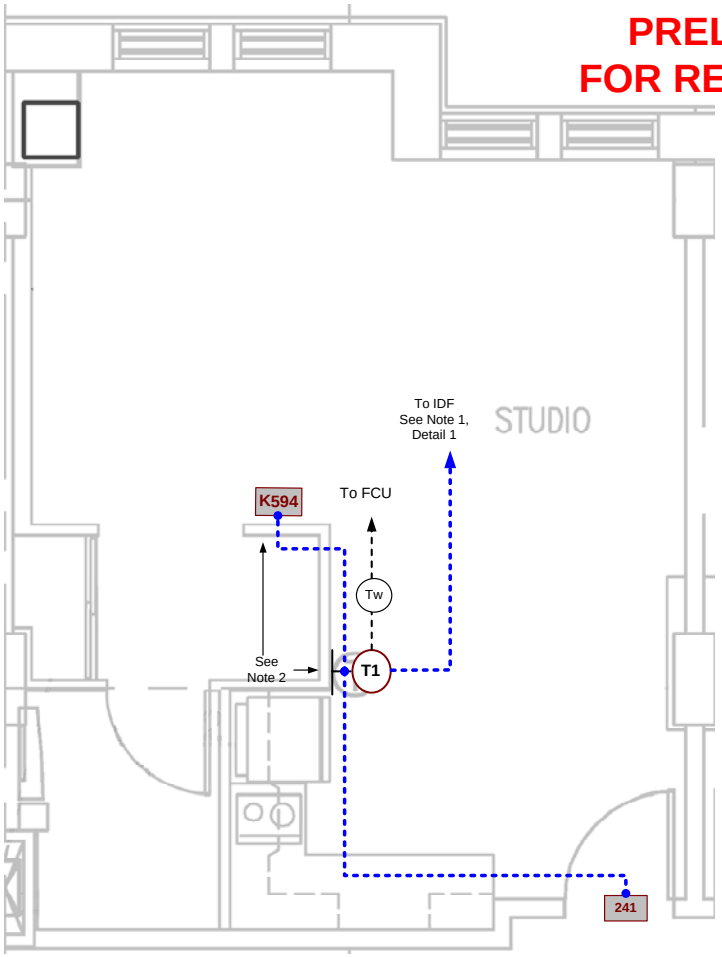
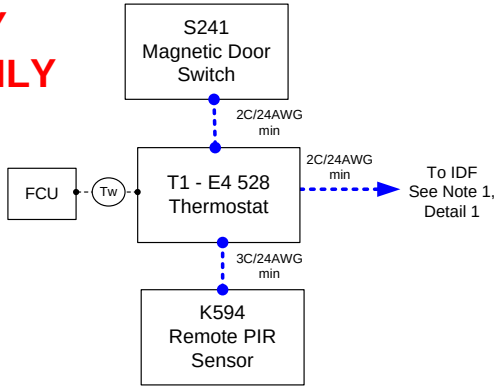
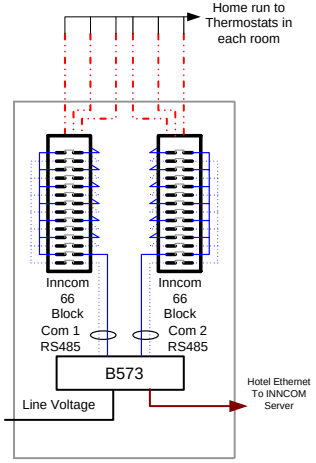






Detail 1
INNCOM CINet

Design Notes
1. A spare pair of conductors from the data jack is not viable. A dedicated CAT5 cable would be required if the data jack is used or a spare phone pair of conductors can be used.
2. The thermostat location shown will not provide acceptable passive infrared room coverage. Note that the thermostat should be relocated, coverage angle is 178°. Alternately, use a remote PIR as shown.
3. Remote Passive IR sensors are added where the thermostat does not provide adequate coverage. Location of remote IR sensor is flexible, however locate to provide maximum room coverage. Coverage angle is 178°
4. A B573 can support up to 80 room gateway devices (40 per Com 1 and 40 per Com 2) and must have an Ethernet connection in the IDF closet, static IP address required for each B573

Residence Inn Alexandria
INNCOM Device Count
Room Types
Wayne Hakenjos
30 Nov 2007

		Device Count Per Room		
Unit Type	**Keys**	**S241**	**E528**	**K594**
Studio	140	1	1	1
1 Bedroom	33	1	1	1
2 Bedroom	8	1	2	1
Total	**181**			

		Total Device Count		
Unit Type		**S241**	**E528**	**K594**
Studio		140	140	140
1 Bedroom		33	33	33
2 Bedroom		8	16	8
Total		**181**	**189**	**181**

INNCOM International Inc
277 W Main St
Niantic, CT
06357
860-739-4468

DEVICE LEGEND

- T1 — E4 (528) Thermostat
- 241 — Magnetic Door Switch
- K594 — Remote PIR Sensor (IINCOM K594)

CABLE LEGEND

- S5 Communication bus — Cat5 preferred, refer to block cabling diagram for specific conductor requirement.
- Line voltage
- Tw — Thermostat Wire, Both low and nominal voltage systems to follow UL and local codes
- Cat5 cable, Non INNCOM S5 Communication bus

Project:
RESIDENCE INN ALEXANDRIA

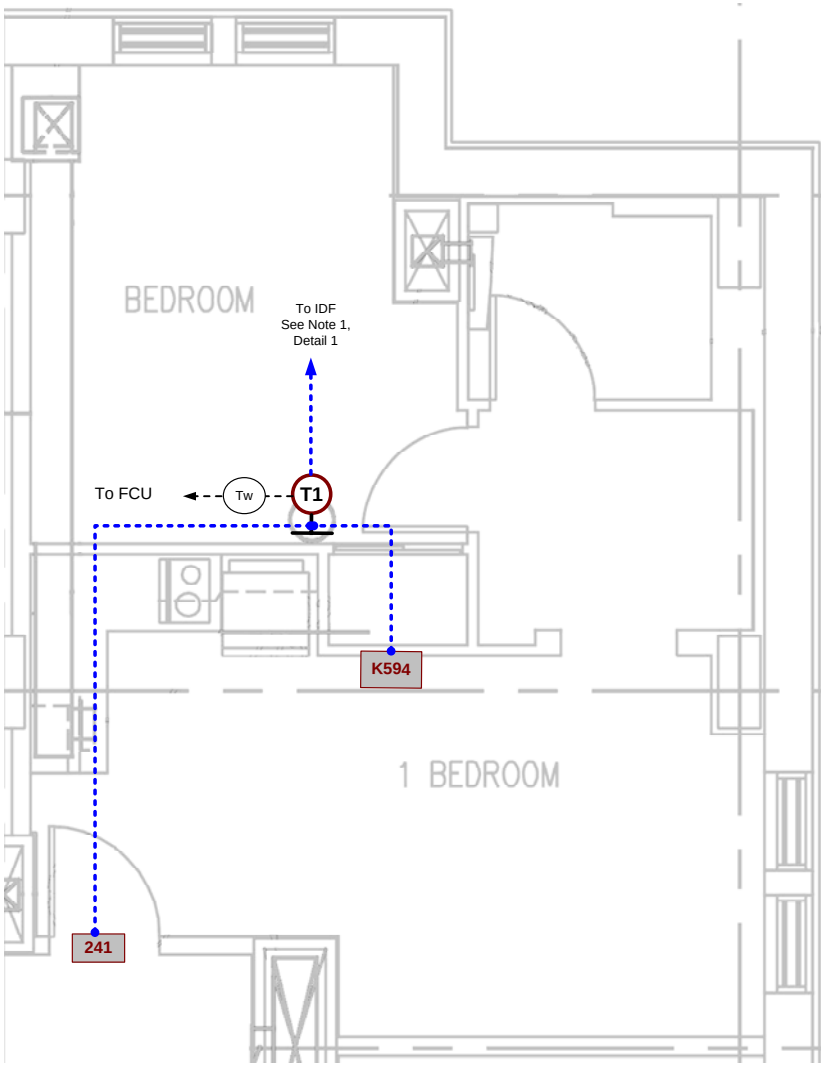
Drawing: Standard Studio Unit INNCOM Cable Diagram — Rev:-

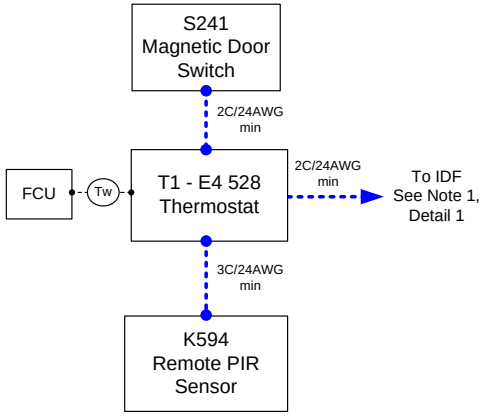
Drawn By: WSH — AE: GS OPS: MF

Date: 30 NOV 2007 — Sheet 1/3

File Name: T:\Customers\R\Residence Inn Alexandria VA\Engineering\Drawings\INNCOM

PRELIMINARY
FOR REVIEW ONLY





Design Notes
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2. The thermostat location shown will provide acceptable passive infrared room coverage. Note that the thermostats can be relocated, however note that coverage angle is about 178°. Thermostat must be positioned to provide IR coverage.
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4. A B573 can support up to 80 room gateway devices (40 per Com 1 and 40 per Com 2) and must have an Ethernet connection in the IDF closet, static IP address required for each B573.

INNCOM
International Inc
277 W Main St
Niantic, CT
06357
860-739-4468

DEVICE LEGEND

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Line voltage

Tw — Thermostat Wire, Both low and nominal voltage systems to follow UL and local codes

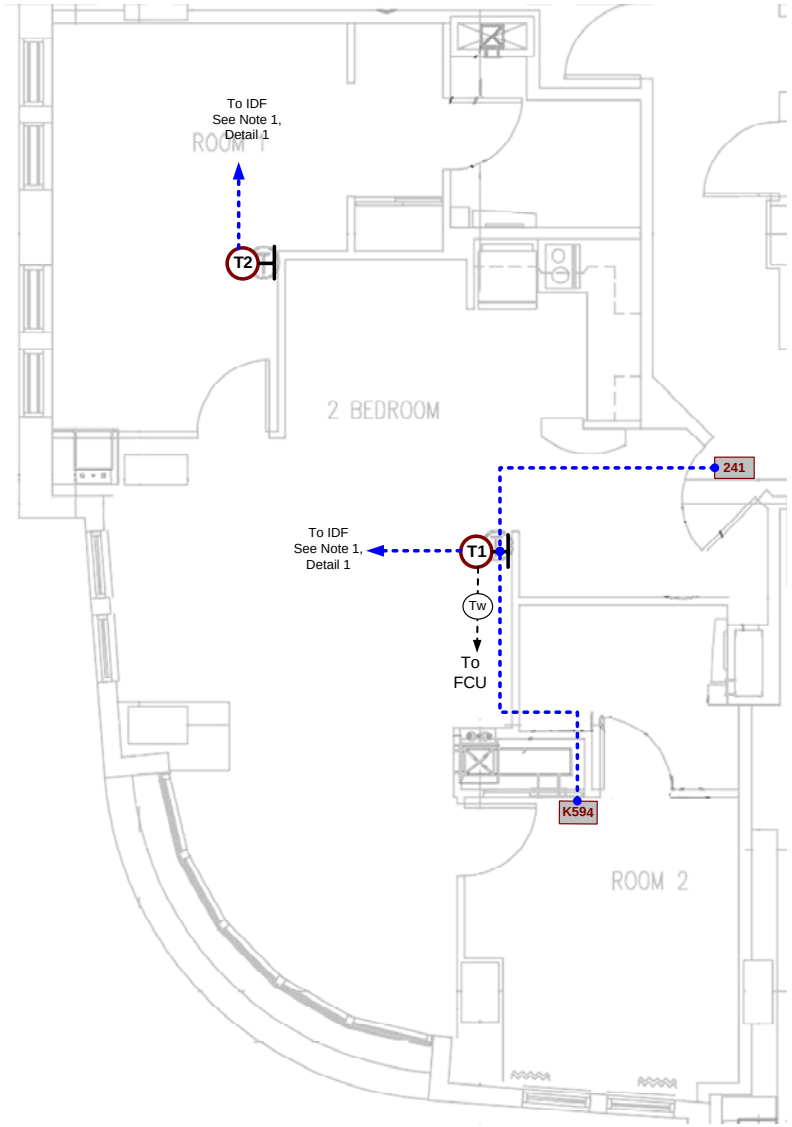
Cat5 cable, Non INNCOM S5 Communication bus

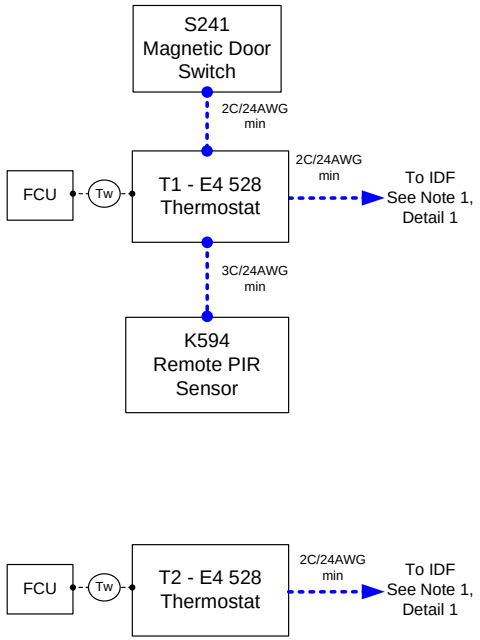
Project:
RESIDENCE INN
ALEXANDRIA

Drawing: Standard 1 Bedroom Unit
INNCOM Cable Diagrams
Rev:-

Drawn By:	WSH	AE: GS OPS: MF	
Date:	30 NOV 2007	Sheet	2/3
File Name:	T:\Customers\R\Residence Inn Alexandria VA\ Engineering\Drawings\INNCOM		

PRELIMINARY
FOR REVIEW ONLY





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INNCOM
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277 W Main St
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DEVICE LEGEND

T1 — E4 (528) Thermostat

241 — Magnetic Door Switch

K594 — Remote PIR Sensor (IINCOM K594)

CABLE LEGEND

S5 Communication bus
Cat5 preferred, refer to block cabling diagram for specific conductor requirement.

Line voltage

Tw — Thermostat Wire, Both low and nominal voltage systems to follow UL and local codes

Cat5 cable, Non INNCOM S5 Communication bus

Project:
RESIDENCE INN
ALEXANDRIA

Drawing: Standard 2 Bedroom Unit INNCOM Cable Diagrams
Rev:-

Drawn By:	WSH	AE: GS OPS: MF
Date:	30 NOV 2007	Sheet 3/3
File Name:	T:\Customers\R\Residence Inn Alexandria VA\ Engineering\Drawings\INNCOM	

Appendix F: Constructed Wetland Greywater System

The following can be found in this Constructed Wetland Greywater System Appendix:

- Center for Sustainability Site Visit Pictures
- Environmental Protection Agency Definitions
- Greywater System Calculations
- Tank and Pump Cut Sheets
- Drawing P-103
- Virginia American Water Rates and Schedules

Center For Sustainability Site Visit – 3/19/2008


Plant Cleaning Tank


Aerobic Airated Tanks


Papyrus and Elephant Ear Plants


Clarifying Tank


Close Up of Liner


Collection Tank – Suitable for sustaining fish


Cleaning and Clarifying Tanks with Plants


Collection Tank


Cleaning tank and Aerobic Tanks

Airation Gauge


Airator Pump


Aerobic Tank Vents


Fluorescent Lighting

Wetland Plants

Softstem bulrush and cattail are emergent aquatic plants. Emergent plants can stabilize the wetland bed surface, provide an attachment surface for microbes, insulate the bed, and assist in decomposition of pollutants. During the active growth period, plants are able to significantly reduce pollutants in the water by providing oxygen to the microbes in the root zone and consuming nutrients to build additional plant biomass. During the senescent phase, plants still contribute to the reduction of pollutants by providing oxygen to the microbes.

Softstem Bulrush was collected approximately one-half a mile from the test site. Bulrush can survive over a wide pH range of 5.4 to 7.5, and their adaptability is high. The Wyoming growth period for bulrush is approximately six months (spring to fall).

Broadleaf Cattail was collected from same site as the bulrush. The cattail growth period extends from April to August. Cattails can tolerate pH levels from 5.5 to 7.5. Studies indicate cattail is a good wetland plant for removing organic pollutants from the water. Cattail oxidizes the soil creating an aerobic environment.

Hydraulic Retention Time (HRT)

The HRT is a measurement of how long on average the water is in contact with the wetland. The HRT is equal to water volume divided by the flow rate. By plotting HRT v. pilot wetland treatment performance data, one can begin to size of a full-size treatment wetland (Table 6 and Figure 10).

Typically, pea gravel has a 30% porosity and hydraulic conductivity between 10^{-1} to 10^{2} cm/sec. With 30% porosity the water is able to flow through the media. Sufficient pore space is available for microbes to attach to the surface area of the gravel and permit plant roots to expand.

The use of the small rock size has a number of advantages. (1) There is more surface area available on the media for treatment as compared to large rock. (2) Small void spaces are compatible with development of the roots and rhizomes of the vegetation. (3) It creates laminar flow conditions (*USAE WES-Constructed Wetlands Design*) (Table 7).

Figure 3-16. Typical wastewater pollutants of concern

Pollutant	Reason for concern
Total suspended solids (TSS) and turbidity (NTU)	In surface waters, suspended solids can result in the development of sludge deposits that smother benthic macroinvertebrates and fish eggs and can contribute to benthic enrichment, toxicity, and sediment oxygen demand. Excessive turbidity (colloidal solids that interfere with light penetration) can block sunlight, harm aquatic life (e.g., by blocking sunlight needed by plants), and lower the ability of aquatic plants to increase dissolved oxygen in the water column. In drinking water, turbidity is aesthetically displeasing and interferes with disinfection.
Biodegradable organics (BOD)	Biological stabilization of organics in the water column can deplete dissolved oxygen in surface waters, creating anoxic conditions harmful to aquatic life. Oxygen-reducing conditions can also result in taste and odor problems in drinking water.
Pathogens	Parasites, bacteria, and viruses can cause communicable diseases through direct/indirect body contact or ingestion of contaminated water or shellfish. A particular threat occurs when partially treated sewage pools on ground surfaces or migrates to recreational waters. Transport distances of some pathogens (e.g., viruses and bacteria) in ground water or surface waters can be significant.
Nitrogen	Nitrogen is an aquatic plant nutrient that can contribute to eutrophication and dissolved oxygen loss in surface waters, especially in lakes, estuaries, and coastal embayments. Algae and aquatic weeds can contribute trihalomethane (THM) precursors to the water column that may generate carcinogenic THMs in chlorinated drinking water. Excesive nitrate-nitrogen in drinking water can cause methemoglobinemia in infants and pregnancy complications for women. Livestock can also suffer health impacts from drinking water high in nitrogen.
Phosphorus	Phosphorus is an aquatic plant nutrient that can contribute to eutrophication of inland and coastal surface waters and reduction of dissolved oxygen.
Toxic organics	Toxic organic compunds present in household chemicals and cleaning agents can interfere with certain biological processes in alternative OWTSs. They can be persistent in ground water and contaminate downgradient sources of drinking water. They can also cause damage to surface water ecosystems and human health through ingestion of contaminated aquatic organisms (e.g., fish, shellfish).
Heavy metals	Heavy metals like lead and mercury in drinking water can cause human health problems. In the aquatic ecosystem, they can also be toxic to aquatic life and accumulate in fish and shellfish that might be consumed by humans.
Dissolved inorganics	Chloride and sulfide can cause taste and odor problems in drinking water. Boron, sodium, chlorides, sulfate, and other solutes may limit treated wastewater reuse options (e.g., irrigation). Sodium and to a lesser extent potassium can be deleterious to soil structure and SWIS performance.
Source: Adapted in part from Tchobanoglous and Burton, 1991.	

Table 3-7. Constituent mass loadings and concentrations in typical residential wastewater[a]

Constituent	Mass loading (grams/person/day)	Concentration[b] (mg/L)
Total solids (TS)	115-200	500-880
Volatile solids	65-85	280-375
Total suspended solids (TSS)	35-75	155-330
Volatile suspended solids	25-60	110-265
5-day blochemical oxygen demand (BOD_5)	35-65	155-286
Chemical oxygen demand (COD)	115-150	500-660
Total nitrogen (TN)	6-17	26-75
Ammonia (NH_4)	1-3	4-13
Nitrites and natrates (NO_2-N; NO_3-N)	<1	<1
Total phosphorus (TP)[c]	1-2	6-12
Fats, oils, and grease	12-18	70-105
Volatile organic compounds (VOC)	0.02-0.07	0.1-0.3
Surfactants	2-4	9-18
Total coliforms (TC)[d]	—	10^8-10^{10}
Fecal coliforms (FC)[d]	—	10^6-10^8

[a]For typical residential dwellings equipped with standard water-using fixtures and appliances.
[b]Milligrams per liter; assumed water use of 60 gallons/person/day (227 liters/person/day).
[c]The detergent industry has lowered the TP concentrations since early literature studies; therefore, Sedlak (1991) was used for TP data.
[d]Concentrations presented in Most Probable Number of organisms per 100 milliliters.

Source: Adapted from Bauer et al., 1979; Bennett and Linstedt, 1975; Laak, 1975, 1986; Sedlak, 1991, Tchobanoglous and Burton, 1991.

Table 3-8. Residential wastewater pollutant contributions by source[a,b]

Parameter		Garbage disposal (gpcd)[c]	Toilet (gpcd)[c]	Bathing, sinks, appliances (gpcd)[c]	Approximate total (gpcd)[c]
BOD_5	mean range % of total	18.0 10.9-30.9 (28%)	16.7 6.9-23.6 (26%)	28.5 24.5-38.8 (45%)	63.2 (100%)
Total suspended solids	mean range % of total	26.5 15.8-43.6 (37%)	27.0 12.5-36.5 (38%)	17.2 10.8-22.6 (24%)	70.7 (100%)
Total nitrogen	mean range % of total	0.6 0.2-0.9 (5%)	8.7 4.1-16.8 (78%)	1.9 1.1-2.0 (17%)	11.2 (100%)
Total phosphorus[d]	mean range % of total	0.1 (4%)	1.6 (59%)	1.0 (37%)	2.7 (100%)

[a]Adapted from USEPA, 1992.
[b]Means and ranges for BOD, TSS, and TN are results reported in Bennett and Linstedt, 1975; Laak, 1975; Ligman et al., 1974; Olsson et al., 1968; and Siegrist et al., 1976.
[c]Grams per capita (person) per day.
[d]The use of low-phosphate detergents in recent years has lowered the TP concentrations since early literature studies; therefore, Sedlak (1991) was used for TP data.

Residence Inn
By Marriott
2345, Mill Rd, Alexandria, VA

Julia E. Phillips
Construction Management

Greywater Production vs. Demand

Hotels produce approximately 60 gallons per day of greywater for each typical 2 person room.
This translates to approximately 30 gallons per day per person.

Occupancy Rates:

*** Assume 1 person in a Studio, 2 people in a 1 Bedroom, 4 people in a 2 Bedroom.**

140	Studio Rooms =	140 People
33,	1 Bedroom =	66 People
8,	2 Bedroom =	32 People
	Total =	238 People

*** Assume 85% Occupancy inculding guests and employee water usage = 203 People**
*** Assume using 5.5 floors of water to recycle to all water closets = 83 people**
*** Assumes each person takes one (1) 10 minute shower per day. (Public and Private Shower)**
*** Assumes 3 flushes per person per day.**

Equipment:

Shower	→	2.5 gpm
Low Flow Water Closet	→	1.6 g/flush

Production Per Person Per Day

10	minute Shower =	25 gpd
3	Flushes per Day =	4.8 gpd
	Total Per Day =	29.8 gpd

Total Greywater Production from Showers =	**2075 gpd**
Total Greywater Consumption from Water Closets =	**974.4 gpd**

Greywater treament system holds water for an average of 10 days.

Total Greywater Production from Showers =	**20750 gal./10 days**
Total Greywater Consumption from Water Closets =	**9744 gal./10 days**

x 0.1337 =	2774.3	CF
x 1.25 =	3467.8	CF
÷ 2 =	1733.9	CF
÷ 3' =	577.97	SF

Julia E. Phillips
Construction Management

Greywater Material Costs

*** Cost calculations only inculde materials**
*** Assume a cost mutiplier of 0.45 on list prices at 10ft. Lengths.**

By adding the Greywater system to the builing, a sanitary riser must be added and the Water Closet Riser must be redirected from the city water supply to the greywater supply system.
11 Sanitary Risers must be added to separate the Shower water and direct it to the greywater system.

Sanitary Riser Length =	46	LF	for 4" pipe	
Total Sanitary Riser Length =	506	LF	for 4" pipe	24LF/man-day
Total Sanitary Riser Cost =	$3,363.13			
Redircted Horizontal Piping =	130.00	LF	for 4" pipe	18LF/man-day
Horizontal Piping Cost =	$864.05			
Constructed Wetlands Piping =	90.00	LF	for 2" pipe	18LF/man-day
Wetlands Piping Cost =	$333.72			
Duplex Booster Pump Cost =	$15,817.00			
6,800 Gallon Open Top Tank =	$3,400.00		8 Tanks needed	
500 Gallon Storage Tank =	$700.00			
Total Open Top Tank Cost =	$27,900.00			
6,800 Gallon Basin =	$5,500.00		2 Basins needed, customized for filters and fountain.	
Total Basin Cost =	$16,500.00			
Pumps and Fountain Head Cost =	$470.00			
3" to 5" VA 1,2,3,4 Stone =	$25.00	per TON	79 Tons needed	
Pea Gravel, Stone #78 =	$30.00	per TON	35.84 Tons needed	
Total Rock Bed Cost =	$3,050.20			

Total Greywater System Cost = $68,298.09

Add 30% for Shipping and Customization of Tanks

Total Greywater System Cost = $88,787.52

Added Piping Installation Duration = 33 Man-Days *Crew Size Dependent - 2 crews of 3 men
Added Piping Installation Duration = 6 Schedule Days

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- RV HOLDING TANKS

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- FULL DRAINING TANKS STEEL CRADLE
- FLAT BOTTOM UTILITY TANKS
- OPEN TOP TANKS
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  - RECTANGLE LIDS
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- LOW PROFILE HAULING TANKS
- CONTAINMENT BASINS
- DOUBLE WALL TANKS
- SPILL CONTAINMENT TRAYS
- DRUM SPILL PALLETS
- PICK UP TRUCK TANKS
- AUTO DETAIL TANKS
- Doorway Tanks (29" wide)
- FULLY DRAINING TANKS
- WASTE OIL TANKS
- STOCK TANKS
- BRINE STORAGE TANKS
- PALLET (forkliftable) TANKS
- PCO STORAGE TANKS
- SPOT SPRAYER TANKS

Below Ground Septic/Cistern Tanks
- PLASTIC CISTERN WATER TANKS

3399.99 (click here for details)

Part Number:	DHOP6800-120
Capacity:	6800 gallon CYLINDRICAL OPEN TOP TANK
Size:	120"dia. x 144"H
USD Price:	3399.99
USD Shipping:	CALL FOR PRICING

** Oversized item. Shipping will be billed separately.
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Tanks are translucent white with gallon markers

wt: 1525 lbs

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Below Ground Septic/Cistern Tanks

- PLASTIC CISTERN WATER TANKS

LIQUID STORAGE & CONTAINMENT => OPEN TOP TANKS => CYLINDRICAL TANKS

699.99

Part Number:	ROTC500
Capacity:	500 Gallon Open Top Cylindrical Poly Tank
Size:	52"dia. x 60"H
USD Price:	699.99
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3/8ths Wall Thickness
LID PRICE 69.99

Tank is 52" bottom dia.
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Total dia. with flange 56"
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Lid fits down over flange of the tank, does not lock in place....

Excellent chemical and impact resistance for long dependable service. Operating temperature up to 140° F. Open Top Tanks allow convenient mixing and filling. Self-supporting. Translucent* for visible content level.

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GENERAL INFORMATION

Bio-Sanitizer Disinfecting Tablets are scientifically formulated to provide efficient and reliable disinfection of wastewater flows. Manufactured from pure calcium hypochlorite, Bio-Sanitizer Disinfecting Tablets dissolve slowly and evenly, providing effective and economical bacteria killing power. Each tablet contains 70% available chlorine to insure maximum effectiveness. Bio-Sanitizer Disinfecting Tablets are a dependable, long term source of chlorine that automatically adjust their application to the rate of flow. Bio-Sanitizer Disinfecting Tablets insure reliable disinfection rates up to intermittent peak flow factors of four and maintain a uniform chlorination rate even when the significant runoff period is six hours. When used as directed in any approved, gravity flow chlorinator, Bio-Sanitizer Disinfecting Tablets provide positive disinfection and inhibit bacteria regrowth.

Bio-Sanitizer Disinfecting Tablets represent a new refinement in dry chlorination technology, providing maximum disinfection without releasing unnecessary quantities of chlorine into the environment. Extensive product research and tablet development have provided a precise chemical formulation uniquely suitable for this application. Registered with the U.S. E.P.A., Bio-Sanitizer Disinfecting Tablets provide reliable, high quality chlorination to assist in the maintenance of environmental standards. Packaged in 25-lb., 45-lb. and 100-lb. DOT approved containers, Bio-Sanitizer Disinfecting Tablets are a preferred, cost effective alternative to dangerous liquid and gas chlorination systems. If a safe and dependable disinfection system is desired, please consider the advantages of Bio-Sanitizer Disinfecting Tablets.

ADVANTAGES

- Environmentally safe when used as directed
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SPECIFICATIONS

Tablet Size	2-5/8" diameter, 13/16" thick
Approx. Tablet Weight	5 oz. (140 grams)
Approx. Tablet Density	125 lbs./ft³
Active Ingredient	Calcium Hypochlorite $Ca(OCl)_2 \cdot H_2O$
Available Chlorine	70%
Inert Ingredients	30%
Appearance and Odor	White tablet with chlorine odor
E.P.A. Registration	63243-1

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Bio-Sanitizer Disinfecting Tablets are a strong oxidizing agent and highly corrosive. Contact with other chlorine products or reducing agents such as Bio-Neutralizer Dechlorination Tablets is extremely dangerous — Fire or explosion could result. Improper use of this product may cause personal injury or property damage. Tablets may be fatal if swallowed and tablet dust is irritating to the eyes, nose and throat. Keep out of the reach of children and do not allow tablets or feed tubes to contact skin, eyes or clothing. Do not handle the tablets or feed tubes without first contacting your local distributor and obtaining specific instructions for usage, handling and storage. Store only in original container and read label carefully prior to use. It is a violation of Federal Law to use Bio-Sanitizer Disinfecting Tablets in a manner inconsistent with its labeling.

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NEW Mag Drive Pumps

These high volume magnetic drive pumps are durable, reliable and energy-efficient. These pump motors are equipped with thermal protection switches that shut the pump off before it can be damaged, should it be clogged or jammed. Comes with five year warranty. Operates in or out of the water. 1 1/2" NPT connectors.

SKU	Description	Price	Order
P3700	Cal 3700gph Mag drive Pump	226.95	Buy Now
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New Mag Drive Waterfall Pump

These magnetic drive waterfall pumps use up to 40-60% less electricity than direct drive pumps. Come with a one year warranty. 1 1/2" intake and output. 20' powercord.

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PWM3900	Cal Magdrive Waterfall Pump 3900gph	162.95	Buy Now
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Magnetic Drive Pumps

The most exciting of the new technologies available for light-duty applications is known as a magnetic drive, or wet-rotor pump. All electrical components in these units are completely sealed in a non-toxic plastic resin. The impeller is mounted on a magnet that is chased around in circles by electrical charge from the sealed motor. It's a safe, efficient product for light-duty freshwater or saltwater applications. Our magnetic drive pumps have pumping capacities of 60 gph up to 1600 gph.

SKU	Description	Price	Order
P80	Cal Pump P80	14.95	Buy Now
P140	Cal Pump P140	19.95	Buy Now
P300	Cal Pump P300	sold out	Buy Now
P600	Cal Pump P600	sold out	Buy Now
P900	Cal Pump P900	sold Out	Buy Now
P1500	Cal Pump P1500	sold out	Buy Now

<<Top of Page>>

Stainless Steel & Bronze Pumps

Cal Pumps longtime customers rely on our stainless steel and bronze pumps, and once you've owned one, you'll know why. Five different models with flow rates from 225 gph to 2700 gph cover a wide variety of uses. All pumps in this series come with a two-year warranty and will provide trouble free use in freshwater, saltwater or chlorinated water (3-5ppm). You can even use it in hot water up to 110°F!

6' or 20' power cords are standard. Stainless steel and bronze pumps are widely used in Koi ponds, water gardening, and applications where dependability and longevity are a must.

SKU	Description	Price	Order
S22520	Cal Pump S225T20	84.95	Buy Now
S32020	Cal Pump S320T20	93.95	Buy Now
S58020	Cal Pump S580T20	129.95	Buy Now
S90020	Cal Pump S900T20	139.95	Buy Now
S120020	Cal Pump S1200T20	149.95	Buy Now
SPB1	Cal Positioning Bracket for S580 S900 S1200	7.95	Buy Now

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SKU	Description	Price	Order
CFS170	Cal Plastic Screen fits 1" FNPT	7.95	Buy Now
CFS155	Cal Plastic Screen fits 1/2" and 3/4" FNPT	7.95	Buy Now
955	Cal Foam Pre-filter for CFS155	13.95	Buy Now

Aluminum Pumps

Cal Pumps durable cast aluminum pumps

have been a best seller at Cal Pump for over 40 years. They are reliable, versatile and can be used submerged or in open air. You can select from three different models ranging from 210 gph to 430 gph and, although the pumps come standard with a 6' or 20' power cord, custom cord lengths are available up to 100'. The motor is permanently sealed in a biodegradable vegetable-based lubricant for long lasting and safe operation.

SKU	Description	Price	Order
A21020	Cal Pump A210 gph	68.95	Buy Now
A28020	Cal Pump A280 gph	69.95	Buy Now
A43020	Cal Pump A420 gph	71.95	Buy Now

<<Top of Page>>

Epoxy encapsulated Pond Pumps

Cal Pumps designed three epoxy pumps with flow rates from 200 gph to 500 gph. You'll find they're perfect for your fountain, pond or nearly any de-watering application. The tough plastic pump and trouble free motor are designed to peacefully co-exist with any water feature. These pumps come with a 6' or 20' power cord standard, or custom cord lengths are available up to 100'. All models of epoxy pumps are standard with .316 stainless steel shaft. Suitable for use in fresh, salt or chlorinated water (3-5 ppm).

SKU	Description	Price	Order
E-200-20	Cal Pump E-200-20		
E-350-20	Cal Pump E-350-20		

Cal Fountain Heads

FT2 3 step Flower

FT4 Water Lily

FT5 Aqua Dome

FT9 Trumpet

FT10 Pattern Set of 4

FT25 1/2" Telescoping Riser

FT30 3/4" Telescoping Riser w/ diverter

for P80/P140 FT724 17" Ring w/22 jets w/diverter

SKU	Description	Price	Order
FT2	Cal FT2 Plastic 3 step Fleur de Lis fountain head	8.95	Buy Now
FT4	Cal FT4 Plastic Water lily fountain head	8.95	Buy Now
FT5	Cal FT5 Plastic Aqua dome fountain head	8.95	Buy Now
FT9	Cal FT9 Plastic Trumpet fountain head	.95	Buy Now
FT10	Cal 4 Pattern Fountain head set for P80/140	13.95	Buy Now
FT724	Cal 17" ring with 22 jets	89.95	Buy Now
FT25	1/2" telescoping riser w/diverter	8.95	Buy Now
FT30	3/4" telescoping riser w/diverter	14.95	Buy Now

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Large Volume submersible Pumps

The sound of a waterfall cascading down rocks into a pond or stream enhances the auditory experience in a way no other water feature can. A waterfall further benefits fish and plant life by oxygenating the water as it returns to its basin.

waterfall pumps are solidly constructed with non-corrosive components, ceramic mechanical seal and brass insert in the 1 1/4" discharge. Their water-cooled design ensures safe and efficient operation without fear of harm to ornamental fish or aquatic plants.

SKU	Description	Price	Order
PW1200	Cal Pump PW1200	100.95	Buy Now
PW2500	Cal Pump PW2500	121.95	Buy Now
PW3500	Cal Pump PW3500	136.95	Buy Now
PW4500	Cal Pump PW4500	162.95	Buy Now
PW5500	Cal Pump PW5500	185.95	Buy Now

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Torpedo Pump

The first pump designed for the pond enthusiast that is lightweight, water cooled, uses no oil and can be used in or out of water. Its high volume water flow and low energy consumption makes it the most unique pond pump available, and it requires no tools for installation.

SKU	Description	Price	Order
T1500	Cal Pump T1500	128.95	Buy Now
T4000	Cal Pump T4000	165.95	Buy Now
T7500	Cal Pump T7500	250.95	Buy Now
T10000	Cal Pump T10000	285.95	Buy Now

PL0150	Plastic Suction Strainer 1.5"	9.95	Buy Now
PL0200	Plastic Suction Strainer 2"	10.95	Buy Now
PL0300	Plastic Suction Strainer 3"	14.95	Buy Now
TF10	Torpedo Screen 1 1/2" thread	10.95	Buy Now

Water Garden Pumps with Venturi

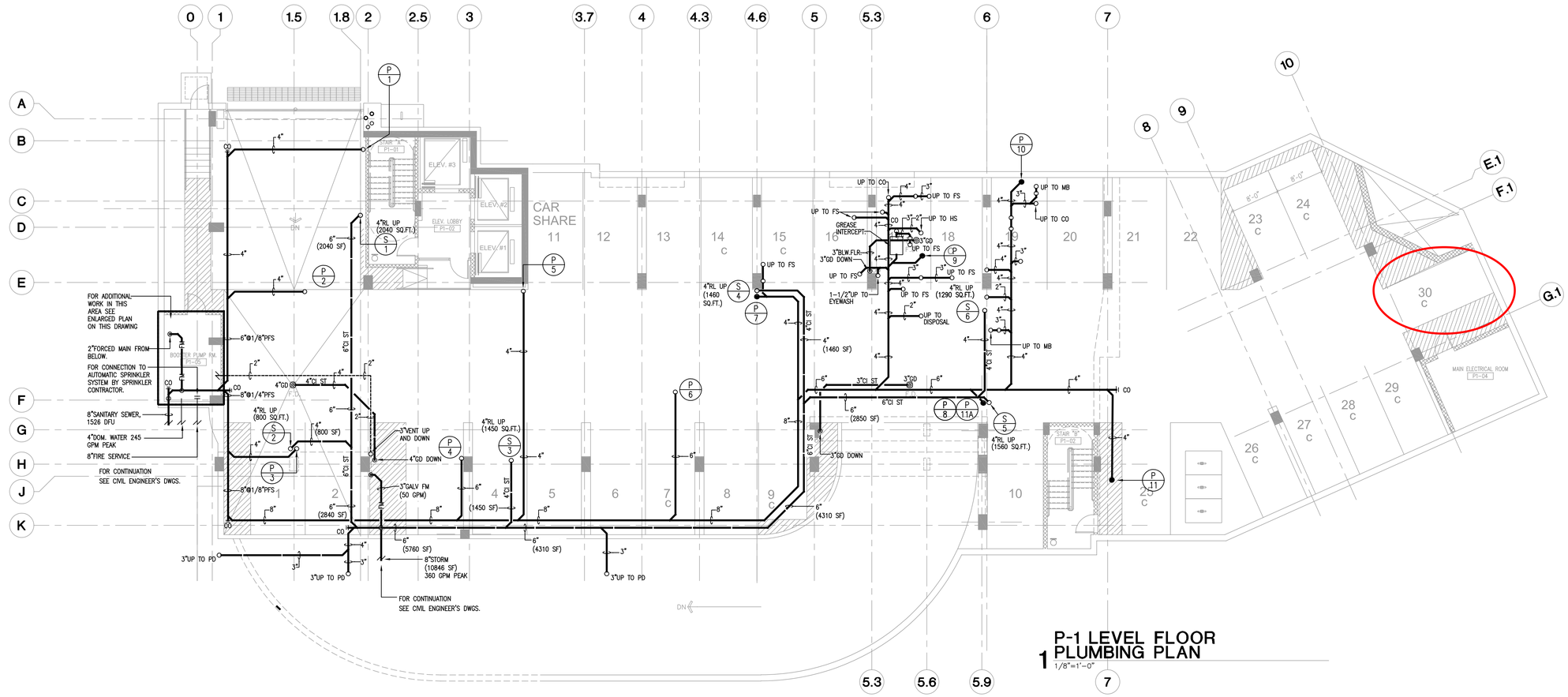
- Thermal protection switch to protect pump from accidental burn out due to clogs or jams
- Complete with a telescoping riser/diverter and two beautiful spray heads
- 3 year limited warranty
- 20 foot cord

SKU	Description	Price	Order
WG660	Water Garden pump w/venturi 660 gph	67.95	Buy Now
WG1000	Water Garden pump w/venturi 1000 gph		Sold Out
WG1500	Water Garden pump w/venturi 1500 gph		Sold Out

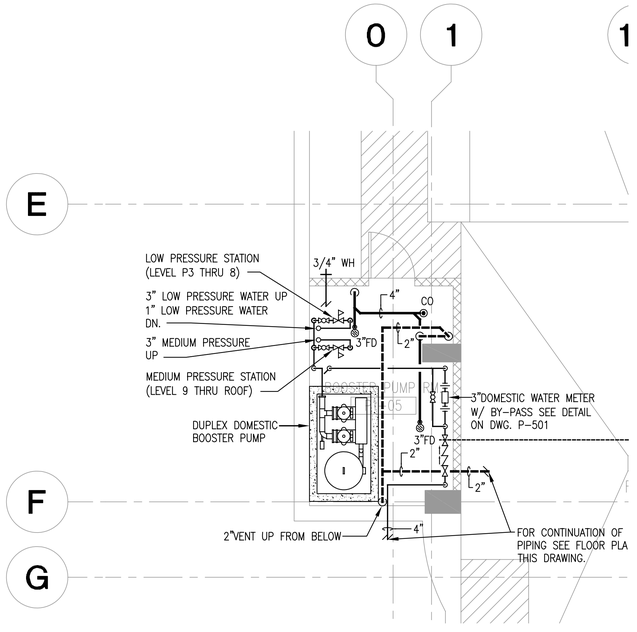
Kits do not include Egglites

SKU	Description	Price	Order
SDS201	Cal Splash Dance Small Single Pump Kit	142.95	Buy Now
SDM203	Cal Splash Dance Small 3 pump kit	272.95	Buy Now
SDS1001	Cal Splash Dance Large Single Pump Kit	215.95	Buy Now
SDM1003	Cal Splash Dance Larsh 3 pump kit	349.95	Buy Now
SDIG	Cal Splash Dance Option in-ground Installation Kit	53.95	Buy Now
LESD3	Cal 3 egglite Kit w/30' cord	64.95	Buy Now
SDRJ	Cal Garden Decor Kit for Splashdance	97.95	Buy Now

View Cart/Check Out Phone: 1-410-803-1688 email



1 P-1 LEVEL FLOOR PLUMBING PLAN
1/8"=1'-0"



2 PARTIAL P-1 LEVEL FLOOR PLUMBING PLAN
1/4"=1'-0"

SEE WMATA NOTE ON SHEET A-001.

dcs DESIGN
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Land Planning
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22340 DRESDEN STREET, SUITE 177
DULLES, VIRGINIA 20166
(703) 834-5570

REVISIONS

PERMIT SET	OCT. 20, 2006
1 95% PRICING	DEC. 01, 2006
2 CITY OF ALEXANDRIA PERMIT COMMENTS	DEC. 12, 2006
3 CITY OF ALEXANDRIA PERMIT COMMENTS #2	JAN. 23, 2007
4 FINAL CONSTRUCTION SET	FEB. 16, 2007

PROJECT TITLE

RESIDENCE INN BY MARRIOTT

2345/2347 MILL ROAD
ALEXANDRIA, VIRGINIA
PROJECT NO. 305412.00

DRAWING TITLE

P-1 LEVEL FLOOR PLAN PLUMBING

Printed On: 2/16/07, 11:00 am

SCALE	1/8"=1'-0"
DATE	OCTOBER 20th, 2006
DRAWN BY	
CHECKED BY	

P-103.dwg

DRAWING NUMBER

P-103

SHEET 0 *OF* 00

VIRGINIA-AMERICAN WATER COMPANY

RATES, RULES AND REGULATIONS

FOR

FURNISHING WATER SERVICE IN THE TERRITORY SUPPLIED BY THE COMPANY IN THE CITY OF ALEXANDRIA, CITY OF HOPEWELL, A PORTION OF PRINCE GEORGE COUNTY AND A PORTION OF PRINCE WILLIAM COUNTY, VIRGINIA.

INDEX

Applicable in all territory served by the Alexandria District.

AVAILABILILTY OF SERVICE:

Available to all metered customers other than public authority customers and customers purchasing water for resale.

RATE:

	Gallons Per Month	Gallons Per Quarter	Rate Per 1,000 Gallons
For the first	2,000	6,000	(minimum charge)
For all over	2,000	6,000	$1.3757

MINIMUM CHARGE:

No bill will be rendered for less than the minimum charges set forth below:

Size of meter	Minimum Charge Per Month	Minimum Charge Per Quarter
5/8 inch	$8.28	$24.84
3/4 inch	12.44	37.32
1 inch	20.71	62.13
1 1/2 inch	41.42	124.26
2 inch	66.26	198.78
3 inch	124.28	372.84
4 inch	207.14	621.42
6 inch	414.29	1,242.87
8 inch	662.85	1,988.55

ACTIVATION CHARGE:

When a customer applies to initiate water service, a charge of twenty-five dollars ($25.00) will be assessed to cover the cost of activating the service.

SERVICE CONNECTION CHARGE:

3/4 inch Service Connection	$900.00
Service Connections over 3/4 inch	Actual cost to Company including overhead

All service connection charges will be gross-up for federal income tax if any should occur.
The customer shall pay to the Company the service connection charge prior to installation.

Turn-on and shut-off charges during normal scheduled working hours associated with new accounts, seasonal customers, as well as non-payment and rules violation situations, will be $25.00. An additional charge of $25.00 will be made for all returned checks tendered.

METER RATES (Continued)

A multiple unit housing development owned by an individual, partnership or corporation other than a governmental authority where each and every unit in the development has at all times the same common owner, is located on a single site composed of one or more contiguous parcels; where the housing development owns, maintains and operates all lines of pipe for the distribution of water within the site; and where the housing development furnishes water to its tenants as part of the considerations for the rent charged and does not install, maintain or operate water meters for the submetering of water service; where the housing development enters into a special contract with the Company, with such guarantee as may be satisfactory to the Company, to pay to the Company, a minimum of $5,000 per month for water service to said premises; at the regularly established rates of the Company.

Meters, except those installed on private fire connections or sewer exempt meters will be furnished, installed and removed by the Company and shall remain its property.

When meters are installed for the purpose of allowing customers to use water and be exempt from sewer charges, the customer shall provide a meter and installation at his expense; however, the meter location and type must be approved by the Water Company.

Turn-on and shut-off charges during normal scheduled working hours will be $ 25.00.

An additional charge of $ 25.00 will be made for all returned checks tendered.

Applicable in all territory served by the Hopewell District.

AVAILABILILTY OF SERVICE:
Available to all metered customers for water treated with fluoride and carbon as required, except for public authority customers and customers purchasing water for resale.

METER QUANTITY CHARGE:
Where water is supplied by meter measurement, each customer shall be required to pay, and the Company shall collect for all water so supplied at the regular published schedule of rates, herein set forth, subject to the meter minimum charges herein stated.

RATE:

	Cubic Feet		Rate Per
	Month	Quarter	100 Cubic Feet
For the first	300	900	(minimum charge)
For the next	1,700	5,100	$3.2320
For the next	298,000	894,000	2.7092
For the next	700,000	2,100,000	1.7782
For the next	5,000,000	15,000,000	.7432
For All Over	6,000,000	18,000,000	1.0068

MINIMUM CHARGE:

No bill will be rendered for less than the minimum charges set forth below:

	Minimum Charge	
Size of meter	Per Month	Per Quarter
5/8 inch	$12.20	$36.60
3/4 inch	18.30	54.90
1 inch	30.40	91.20
1 1/2 inch	60.90	182.70
2 inch	97.50	292.50
3 inch	182.50	547.50
4 inch	304.00	912.00
6 inch	609.00	1,827.00
8 inch	974.00	2,922.00
10 inch	1,319.00	3,957.00
12 inch	2,622.00	7,866.00

ACTIVATION CHARGE:
When a customer applies to initiate water service, a charge of twenty-five dollars ($25.00) will be assessed to cover the cost of activating the service.

SERVICE CONNECTION CHARGE:

3/4 inch Service Connection	$560.00
Service Connections over 3/4 inch	Actual cost to Company including overhead

All service connection charges will be gross-up for federal income tax if any should occur.
The customer shall pay to the Company the service connection charge prior to installation.

Turn-on and shut-off charges during normal scheduled working hours associated with new accounts, seasonal customers, as well as non-payment and rules violation situations, will be $25.00. An additional charge of $25.00 will be made for all returned checks tendered.

Applicable in all territory served by the Hopewell District.

AVAILABILILTY OF SERVICE:

Available to all metered customers that purchase non-potable service and have potable and non-potable annual consumption averages greater than or equal to 3 million gallons per day, except public authority non-potable customers.

METER QUANTITY CHARGE:
Where water is supplied by meter measurement, each customer shall be required to pay, and the Company shall collect for all water so supplied at the regular published schedule of rates, herein set forth, subject to the meter minimum charges herein stated.

RATE:

	Month	Quarter	Rate Per 100 Cubic Feet
For the first	10,000 ccf	30,000 ccf	$1.0068
For the next	290,000 ccf	870,000 ccf	.6747
All over	300,000 ccf	900,000 ccf	.7432

MINIMUM CHARGE:

No bill will be rendered for less than the minimum charges set forth below:

Size of meter	Minimum Charge Per Month	Per Quarter
5/8 inch	$12.20	$36.60
3/4 inch	18.30	54.90
1 inch	30.40	91.20
1 1/2 inch	60.90	182.70
2 inch	97.50	292.50
3 inch	182.50	547.50
4 inch	304.00	912.00
6 inch	609.00	1,827.00
8 inch	974.00	2,922.00
10 inch	1,319.00	3,957.00
12 inch	2,622.00	7,866.00

VIRGINIA-AMERICAN WATER COMPANY

Applicable in all territory served by the Hopewell District.

AVAILABILILTY OF SERVICE:

Available to all metered customers that purchase non-potable service and have potable and non-potable annual consumption averages less than 3 million gallons per day, except public authority non-potable customers.

METER QUANTITY CHARGE:
Where water is supplied by meter measurement, each customer shall be required to pay, and the Company shall collect for all water so supplied at the regular published schedule of rates, herein set forth, subject to the meter minimum charges herein stated.

RATE:

	Month	Quarter	Rate Per 100 Cubic Feet
First	10,000 ccf	30,000 ccf	$1.4180
Next	20,000 ccf	60,000 ccf	1.2145
All over	30,000 ccf	90,000 ccf	.6747

MINIMUM CHARGE:

No bill will be rendered for less than the minimum charges set forth below:

Size of meter	Minimum Charge Per Month	Per Quarter
5/8 inch	$12.20	$36.60
3/4 inch	18.30	54.90
1 inch	30.40	91.20
1 1/2 inch	60.90	182.70
2 inch	97.50	292.50
3 inch	182.50	547.50
4 inch	304.00	912.00
6 inch	609.00	1,827.00
8 inch	974.00	2,922.00
10 inch	1,319.00	3,957.00
12 inch	2,622.00	7,866.00

Applicable in all territory served by the Prince William District.

AVAILABILILTY OF SERVICE:

Available to all metered customers other than public authority customers and customers purchasing water for resale.

RATE:

	Gallons Per Month	Gallons Per Quarter	Rate Per 1,000 Gallons
For the first	2,000	6,000	(minimum charge)
For all over	2,000	6,000	$3.2332

MINIMUM CHARGE:

No bill will be rendered for less than the minimum charges set forth below:

Size of meter	Minimum Charge Per Month	Minimum Charge Per Quarter
5/8 inch	$7.58	$22.74
3/4 inch	11.37	34.11
1 inch	18.95	56.85
1 1/2 inch	37.89	113.67
2 inch	60.63	181.89
3 inch	113.67	341.01
4 inch	189.46	568.38
6 inch	378.91	1,136.73
8 inch	606.26	1,818.78

ACTIVATION CHARGE:

When a customer applies to initiate water service, a charge of twenty-five dollars ($25.00) will be assessed to cover the cost of activating the service.

SERVICE CONNECTION CHARGE:

3/4 inch Service Connection	$675.00
Service Connections over 3/4 inch	Actual cost to Company including overhead

All service connection charges will be gross-up for federal income tax if any should occur.
The customer shall pay to the Company the service connection charge prior to installation.

Turn-on and shut-off charges during normal scheduled working hours associated with new accounts, seasonal customers, as well as non-payment and rules violation situations, will be $25.00. An additional charge of $25.00 will be made for all returned checks tendered.

RIDER A

Purchased Water Surcharge

The rates charged for water in the Alexandria and Prince William Districts are subject to fluctuation in accordance with the following formula:

1. On December 1 of each year (and during the month in which this adjustment becomes effective), the Company shall compute a Purchased Water Surcharge in the following manner:

   P1 = The Cost of water to be paid by the Company to Fairfax County Water Authority on estimated purchases during the succeeding year, taking into account all proposed charges.

   P2 = The number of gallons used in the computation made pursuant to P1 above priced at 43.2¢ per 1,000 gallons in the case of the Alexandria District and 32¢ per 1,000 gallons in the case of the Prince William District.

   S = Estimated sales in 1,000 gallons during such succeeding year (or remainder of the first year.)

   T = The sum of the state and local gross receipts tax rates (expressed as a percentage) to be effective during the next succeeding year (or remainder of the first year).

   The surcharge per 1,000 gallons is computed as follows:

$$\frac{(P1 - P2)}{(S)} * \frac{(1)}{(1 - T)} = \text{Purchases Water Surcharge}$$

   The surcharge shall be computed separately for the Alexandria and Prince William Districts.

The computation shall be submitted to the Commission and, unless disapproved because of incorrect calculations, shall be applied to all bills rendered after January 1 of the succeeding year.

2. On or before June 1 of each year beginning in 1990, the Company shall submit to the Commission a Purchased Water Adjustment Factor as follows:

A = The amount charged or credited to the Company by Fairfax County Water Authority because the actual amount of charges was greater or less than the estimated amount used in the computation of bills rendered during the preceding calendar year.

B = The amount over or under collected in the previous years Purchased Water Adjustment Factor, excluding gross receipts taxes (True-up Mechanism).

C = The estimated number of gallons expressed in 1,000 gallon terms to be sold by the Company from June 1 through December 31 of the current year.

T = The sum of the state and local gross receipt tax rates (expressed as a percentage) to be effective during the current year.

The additional surcharge or credit (Purchased Water Adjustment Factor) is computed as follows:

$$\frac{(A + B) * \frac{1}{(1 - T)}}{C} = \text{Purchased Water Adjustment Factor}$$

This computation shall be made separately for the Alexandria and Prince William Districts.

This computation shall be submitted to the Commission and, unless it is disapproved because of incorrect calculations, the additional surcharge shall be charged or the special credit shall be credited on bills rendered for all water sales between June 1 and December 31.

RIDER A
ALEXANDRIA DISTRICT
Computation of the Purchased Water Adjustment Rate
In Accordance with Rider A Original Sheet No. 18 S.C.C. VA. No. 11.

P1 = Total estimated dollars to be paid to Fairfax County Water Authority :

Basic monthly charge ($ 25,253.13 x 12)	=	$303,038
Supplemental monthly charge ($ 5,698 x 1) + (($ 750 + $ 9,554) x 12)	=	129,346
O & M Expense (6,108,332 (000 gal) x .82)	=	5,008,832
Extraordinary major repair, replacement or improvement (6,108,332 (000 gal) x .18) (New five year rate Established 01/01/07)	=	1,099,500
Improvement Fund Expenditures 2002 - 2006 ($22,706 x 12)		272,472
FCWA Occoquan Plant Replacement monthly amount ($ 135,349.14 x 1) + (141,047.14*11)	=	1,686,868
Total amount to be paid to F.C.W.A.	=	8,500,056

P2 = Total gallons sold x $ .432
5,561,636 (000 gal) x $ .432 = 2,402,627

S = Estimated sales - 1,000 gallons = 5,561,636

T = Effect of gross receipts taxes

$$\frac{(P1 + P2)}{S} \times \frac{1}{(1 - T)}$$

$$\frac{\$\ 8,500,056 - \$\ 2,402,627}{5,561,636} \times \frac{1}{1 - .0260}$$

$$\frac{6,097,429}{5,561,636} \times \frac{1}{0.9740}$$

1.09634 x 1.02669 = 1.12560

Rate used
Surcharge effective 01/01/08 : $ 1.126

Effective : January 1, 2008

RIDER A
PRINCE WILLIAM DISTRICT
Computation of the Purchased Water Adjustment Rate
In Accordance with Rider A Original Sheet No. 18 S.C.C. VA. No. 11.

P1 = Total estimated dollars to be paid to Fairfax County Water Authority :

Basic monthly charge ($ 19,015.41 x 12)	=	$228,185
Supplemental monthly charge ($ 1,258 x 1) + (($ 424 + $ 2,397) x 12)	=	35,110
O & M Expense (1,889,947 (000 gal) x .82)	=	1,549,757
Supplemental monthly charge No. 2 Transmission Main ($ 9,964 x 12)	=	119,568
Supplemental monthly charge No. 3 Additional capacity ($ 68,491 x 12)	=	821,892
Extraordinary major repair, replacement or improvement (1,889,947 (000 gal) x .18) (New five year rate Established 01/01/07)	=	340,190
Improvement Fund Expenditures 2002 - 2006 ($13,078 x 12)		156,936
FCWA Occoquan Plant Replacement monthly amount ($ 23,185.88 x 1) + ($ 24,443.88 x 11)	=	292,069
Total amount to be paid to F.C.W.A.	=	3,543,707

P2 = Total gallons sold x $ .32
1,719,868 (000 gal) x $ .32 = 550,358

S = Estimated sales - 1,000 gallons = 1,719,868

T = Effect of gross receipts taxes

$$\frac{(P1 + P2)}{S} \times \frac{1}{(1 - T)}$$

$$\frac{\$\ 3,543,707 - \$\ 550,358}{1,719,868} \times \frac{1}{1 - .0239}$$

$$\frac{2,993,349}{1,719,868} \times \frac{1}{0.9761}$$

1.74045 x 1.02449 = 1.78307

Rate used
Surcharge effective 01/01/08 : $ 1.783

Effective : January 1, 2008

RIDER B
ALEXANDRIA DISTRICT
Computation of the Sales & Use Tax Surcharge Rate
In Accordance with Va Code & 58.1-603 and 58.1-604

A = Amount charged to Company by Vendors for sales tax to tangible personal property

B = Amount (over) or under collected in the previous year's sales tax.

C = Estimated sales from September 1 through August 31 (1,000 gallons).

T = Sum of state and local gross receipts tax rates.

$$\frac{(A + B)}{C} \times \frac{1}{(1 - T)}$$

$$\frac{155{,}060}{6{,}132{,}944} \times \frac{1}{(1 - .0270)}$$

$$\frac{155{,}060}{6{,}132{,}944} \times 1.027749$$

$$\frac{159{,}363}{6{,}132{,}944} = 0.0260$$

Rate used		
Surcharge effective 09/01/04 :	0.026	
September 1, 2004 Surcharge Rate	$0.026	
September 1, 2005 Adjustment	(0.052)	
September 1, 2006 Adjustment	0.026	
Net Surcharge	($0.000)	per 1,000 gallons

Effective : September 1, 2006

RIDER B
PRINCE WILLIAM DISTRICT
Computation of the Sales & Use Tax Surcharge Rate
In Accordance with Va Code & 58.1-603 and 58.1-604

A = Amount charged to Company by Vendors for sales tax to tangible personal property

B = Amount (over) or under collected in the previous year's sales tax.

C = Estimated sales from September 1 through August 31 (1,000 gallons).

T = Sum of state and local gross receipts tax rates.

$$\frac{(A + B)}{C} \times \frac{1}{(1 - T)}$$

$$\frac{62{,}627}{2{,}169{,}669} \times \frac{1}{(1 - .0249)}$$

$$\frac{62{,}627}{2{,}169{,}669} \times 1.025536$$

$$\frac{64{,}226}{2{,}169{,}669} = 0.0296$$

Rate used		
Surcharge effective 09/01/04 :	0.030	
September 1, 2004 Surcharge Rate	$0.030	
September 1, 2005 Adjustment	(0.060)	
September 1, 2006 Adjustment	0.030	
Net Surcharge	($0.000)	per 1,000 gallons

Effective : September 1, 2006

RIDER B
HOPEWELL DISTRICT
Computation of the Sales & Use Tax Surcharge Rate
In Accordance with Va Code & 58.1-603 and 58.1-604

A = Amount charged to Company by Vendors for sales tax to tangible personal property

B = Amount (over) or under collected in the previous year's sales tax.

C = Estimated sales from September 1 through August 31 (CCF).

T = Sum of state and local gross receipts tax rates.

$$\frac{(A + B)}{C} \times \frac{1}{(1 - T)}$$

$$\frac{69{,}735}{9{,}950{,}231} \times \frac{1}{(1 - .0270)}$$

$$\frac{69{,}735}{9{,}950{,}231} \times 1.027749$$

$$\frac{71{,}670}{9{,}950{,}231} = 0.00720$$

Rate used Surcharge effective 09/01/04 :	0.00720
September 1, 2004 Surcharge Rate	$0.0072
September 1, 2005 Adjustment	(0.0144)
September 1, 2006 Adjustment	0.0072
Net Surcharge	($0.0000)

Effective : September 1, 2006

RULES AND REGULATIONS

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RULES AND REGULATIONS

The Rules and Regulations, as herein set forth, or as they may hereafter be altered or amended in a regular or legal manner, shall govern the rendering of water service, including the extension of mains and the making of connections thereto, and every customer, upon signing an application for any service rendered by the Company, or upon the taking of water service, shall be bound thereby.

RULE NO. 1 - DEFINITIONS:

(a) A "service connection" is a pipe used to supply a single premise only, and no premises shall be supplied by more than one service connection unless agreed upon between the owners and the Company.

(b) "Premises" as used herein shall mean:

1. A building under one roof, owned or leased by one party and occupied as one business or residence; or

2. A combination of buildings, owned or leased by one party in one common enclosure, occupied by one family or business, exclusive of apartment houses; or

3. The one side of a double house, having a solid vertical partition wall; or

4. A building owned or leased by one party, of more than one apartment, and using in common one hall and one entrance; or

5. A building owned or leased by one party, having a number of apartments or offices, and using in common one hall and one or more means of entrance; or

6. A building owned or leased by one party having a number of apartments, offices or lofts which are rented to tenants; or

7. A combination of contiguous apartment buildings owned or leased by one party having a number of apartments which are rented to tenants; or

8. Each local housing authority created pursuant to State law operating without profit a low rent housing and slum clearance project which is located on a single site, provided that such site may be composed of one or more contiguous parcels and provided further that roadways through the site shall not be considered as dividing or separating the same into more than one site. Each such project will be billed for the consumption of the project as totalized whether or not one or more meters are used; or

RULES AND REGULATIONS

RULE NO. 1 - DEFINITIONS: (CONTINUED)

(b) 9. A public building such as a town hall, school house, fire engine house, etc.; or

10. A single lot or park or playground; or

11. Each house or building in a row having common walls.

(c) A "customer" is any party contracting for and receiving water service through a meter connection.

(d) "Company" as used herein is Virginia-American Water Company.

RULE NO. 2 - SERVICE CONNECTIONS:

(a) Before a service connection is provided, the owner of the premises to be supplied, or his duly authorized representative, shall make application for water service upon forms prescribed by the Company, and pay to the Company the service connection charges as herein provided on the appropriate District Tariff sheet. Upon approval of the application, the Company shall install the service connection from the main in the street to the outlet side of the curb stop when the meter is installed inside the property line of the premises or to the meter box when the meter is installed at the curb or property line.

(b) The Company will maintain and replace when necessary all service connections from the main to the curb box or outside meter setting.

(c) The Company will make all connections to its mains and will specify the size, kind and quality of all materials entering into the service connection.

(d) The corporation cock, curb cock, curb box and service pipe from the street main to the curb box laid at right angles to the main will be furnished and installed by and shall remain the property of the Company and under its sole control and jurisdiction.

(e) The service connection from the main to and including the curb box, or outside meter setting will be maintained by the Company at its expense.

(f) These rules and regulations shall not apply to special connections for fire service, or to service of a temporary nature. Such special connections for fire service and services of a temporary nature shall be installed, maintained, replaced and removed at the expense of the owner, but such installation shall be subject to approval by the Company.

RULE NO. 3 - CUSTOMER'S SERVICE PIPES:

(a) The Company will specify the size, kind and quality of the materials which shall be laid between the property line and the structures on the premises to be supplied.

(b) The service pipe from the property line to the place of consumption, not less than 3/4 inch diameter, shall be furnished and installed by the customer at his expense and risk.

RULE NO. 3 - CUSTOMER'S SERVICE PIPES: (CONTINUED)

(c) The customer's service pipe and all connections and fixtures attached thereto shall be subject to the inspection and approval of the Company before the water will be turned on.

(d) The customer's service pipe shall be laid at all points at least three feet (3') below the surface of the ground and shall be installed in a trench at least ten feet (10') in a horizontal direction from any sewer trench and two feet (2') from any other trench unless otherwise specifically authorized or approved by the Company. In backfilling the trench, rock or ashes shall not be permitted within one foot (1') of the service pipe and clean soil shall be filled into a depth of at least one foot (1') over the service pipe. All installation shall conform to Commonwealth of Virginia Waterworks Regulations.

(e) The customer shall install a stop and waste cock of a type approved by the Company on the service pipe immediately inside the foundation wall of the building supplied, or immediately outside of the foundation in a suitable tile or vault, and so located as to be easily accessible to the occupants and to provide proper drainage for all of the pipe line in the building and the meter if installed in the building.

(f) No fixture shall be attached to or any branch made in the service pipe between the meter and the street main.

(g) Any repairs, maintenance, replacement or relocation necessary on the customer's service pipe or fixtures in or upon the customer's premises shall be performed by the customer at his expense and risk.

RULE NO. 4 - CROSS CONNECTIONS AND BACK SIPHONAGE:

(a) No pipe or fixtures connected with the mains of the Company shall also be connected with pipes or fixtures supplied with water from any other source.

(b) Piping systems supplying swimming pools or tanks shall be so arranged as to prevent water from re-entering the water distribution system by siphonage or other means. An independent supply pipe shall be provided in such a way that its discharge end is at least eight inches (8") above the highest possible water level in such a swimming pool or tank. These installations shall, in each case, be approved by the Company.

(c) The plumbing on all premises supplied from the Company's water system shall conform to the Commonwealth of Virginia Waterworks Regulations, and any local codes which may be applicable.

RULE NO. 5 - METERS AND METER INSTALLATIONS:

(a) The Company shall determine the type and size of meter to be installed.

(b) Meters, except those installed on private fire connections or for sewer exemption purposes, will be furnished, installed and removed by the Company and shall remain its property.

(c) Where meters are installed within the building, the customer shall provide at his expense, a readily accessible and protected location for the installation of the meter at such a point as will control the entire supply to the premises, which location must be acceptable to the Company as most convenient for its service.

(d) Each premises shall be supplied through a separate meter, or, if necessary and at the option of the Company, through a separate battery of meters. Where a battery of meters is installed, the registrations of such meters shall be combined for billing purposes and shall be subject to a Minimum Charge equal to the combined Minimum Charges for the meters comprising the battery setting. Where, however, a premises is supplied through more than one service, unless otherwise provided in contracts entered into for service to premises, the registration of the meter installed on each such service shall be billed separately subject to the Minimum Charge for each meter.

(e) Meters will be maintained by the Company at its expense insofar as ordinary wear is concerned, but damage to any meter due to hot water, freezing, or other external causes arising out of or caused by the customer's negligence or carelessness shall be paid for by the customer.

(f) The customer shall promptly notify the Company of any defect in or damage to the meter or its connection.

RULE NO. 6 - METER TESTS AND TEST FEES:

(a) All meters are accurately tested before installation. Meters are also periodically tested in accordance with State Corporation Commission's Regulations. The Company may, at any time, remove any meter for routine tests, repairs, or replacement.

RULE NO. 6 - METER TESTS AND TEST FEES: (CONTINUTED)

(b) The Company shall, upon request of a customer, and if he so desires in his presence or that of his authorized representative, make without charge, a test of the accuracy of the meter in use at his premises, provided that the meter has not been tested by the Company or by the State Corporation Commission within the period of one year previous to such request, and that the customer will agree to abide by the results of such test in the adjustment of disputed charges. A written report of the results of the test shall be furnished the customer.

(c) Whenever a test of a meter reveals it to have an average error or more than two percent (2%), the Company shall bill or refund to the customer, as the case may be, such percentage of the amount of bills, covering the consumption indicated by the meter for the previous six (6) months, as the meter was found to be in error at the time of test.

RULE NO. 7 - PRIVATE FIRE SERVICE CONNECTIONS:

(a) All applications for private fire service connections and private fire hydrants shall be made in writing on application forms provided by the Company.

(b) The size of the private fire service connection shall be determined by the Company.

(c) The entire private fire service system shall be subject to the inspection test and approval of the Company before the service is made effective. The Company shall have the right to enter the premises at any reasonable time for the purpose of making an inspection of the entire private fire service system. Any irregularities disclosed shall be cause for discontinuing service unless corrected by the customer within ten (10) days after written notice is given by the Company.

(d) No water shall be taken or used through a private fire service connection for any purpose other than for extinguishing fires, except for the purpose of testing fire fighting equipment. Such test as mentioned above may be made only under special permit from the Company, and the Company may require that its representative be present at such test.

(e) Hydrants and other fixtures connected with a private fire service connection may be sealed by the Company and such seals shall be broken only in case of fire or as specially permitted by the Company, and the customer must immediately notify the Company of the breaking of any such seal.

RULE NO. 7 - PRIVATE FIRE SERVICE CONNECTIONS: (CONTINUED)

(f) The Company shall not, in any way or under any circumstances, be held liable or responsible to any party for any losses or damage resulting from fire or water or other agency which may occur due to the installation of presence of a private fire service connection, or any pipe or fixture connected therewith; or for any losses or damage resulting from any leakage or other flow of water from said private fire service connection or any of the pipes or fixtures connected therewith; or for any losses or damage resulting from any excess or deficiency in pressure or supply of water due to any cause whatsoever.

(g) The Company requires an approved fire line meter or a detector check valve with by-pass, including meter installed in such by-pass, to be furnished and installed by the customer just inside the building wall or other convenient location on the customer's premises.

(h) The entire cost and expense of installing and maintaining a private fire service connection or a private fire hydrant shall be paid for by the customer, and any work done by the Company in connection therewith shall be at the expense and risk of the customer. The customer shall deposit with the Company, in advance, a sum estimated by the Company to cover the cost and expense of any labor or materials it may furnish. The deposit shall be adjusted upon completion of the work to agree with the actual cost and expense to the Company. The Company shall, at the expense of the customer, make the tap in the main.

RULE NO. 8 - CUSTOMER DEPOSITS:

(a) The Company may require of any customer a cash deposit or other suitable guarantee to secure the performance by the customer of the terms and conditions of the Company under which water service is supplied. The amount of the deposit shall be determined in the following manner.

An amount equal to the estimated bill for two months service.

(b) The deposit will be refunded after final settlement of the customer's account and interest on the deposit will be paid as determined by the Commission annually from the date of the deposit receipt to the date the customer discontinues the use of water service.

(c) Whenever the Company has determined that a customer's credit has been satisfactorily established for a one-year period, it shall apply the deposit to the customer's account with interest.

(d) If the customer fails to maintain satisfactory credit with the Company, it may require a deposit from the customer which will be held until the customer has established satisfactory credit for a period of not less than one year.

RULE NO.9 - DISCONTINUANCE OF WATER SERVICE:

(a) Service rendered may be discontinued by the Water Company after ten (10) days written or printed notice for any of the following reasons:

(1) For willful or indifferent waste of water due to any cause.

(2) For failure to protect and maintain the service pipe or fixtures on the property of the customer in a condition satisfactory to the Company.

(3) For molesting or tampering by the customer, or others with the knowledge of the customer, with any meters, connection, service pipe, curb cock, seal or any other appearance of the Company controlling or regulating the customer's water supply.

(4) For failure to provide the Company's employees free and reasonable access to the premises supplied, or for obstructing the way of ingress to the meter or other appliances controlling or regulating the customer's water supply.

(5) For nonpayment of any account ten (10) days past due for water supplied, for any fee or charge accruing under these Rules and Regulations and the effective Schedule of Rates. In no case shall payment for current service be considered past due if received by the Company within twenty (20) days from the mailing date or date of hand delivery.

(6) For violation of any rule or regulation of the Company.

(7) Upon the request of public authorities for nonpayment of sewer bills in accordance with Section 5.1-321 of the Code of Virginia.

(b) Service may be disconnected after five (5) day written or printed notice if an insufficient funds check was utilized to make payment and the account is at least ten (10) days past the original due date.

(c) Discontinuing the supply of water to a premises for any reason shall not prevent the Company from pursuing any lawful remedy by action at law or otherwise for the collection of moneys due from the customer.

(d) When water service to a customer has been terminated for any above stated reasons, it will be renewed only after the conditions, circumstances or practices which caused the water service to be discontinued are corrected to the satisfaction of the Company, upon payment of all charges due and payable by the customer in accordance with these Rules and Regulations and the effective Schedule of Rates.

RULE NO.10- TURN-ON OR OFF CHARGES:

(a) When water service to any premises has been discontinued because of nonpayment of a bill or other violation of the rules and regulations, the charge stated in the schedule of rates will be required during normal scheduled working hours; and this charge, together with all other amounts which may be due to Company by the customer, must be paid before the water is restored.

(b) If, at the time of such discontinuance of service for nonpayment of bill, the customer does not have a deposit with the Company, the Company may require a deposit as a guarantee of the payment of future bills, as set forth in Rule. No. 8, before the water will be turned on.

(c) For turn-ons and turn-offs requested by the customer, the charge stated in the schedule of rates will be required during normal working hours.

(d) Turn-ons, turnoffs requested by the customer for reasons other than nonpayment of a bill during nonscheduled working hours will be paid by the customer at a cost of $80.

RULE NO.11- BAD CHECK CHARGE:

Whenever a check tendered by a customer in payment of his bill is returned by the bank on which it is drawn unpaid, for any reason, the additional charge stated in the schedule of rates shall be added to the customer's bill.

RULE NO. 12- BILLS FOR WATER SERVICE:

(a) Customers are responsible for furnishing the Company with their correct address. Failure to receive bills will not be considered an excuse for nonpayment nor permit an extension of the date when the account will be considered delinquent.

(b) If bills are to be sent to an address other than the premises served, the Company should be notified in writing by the customer of any change of address.

(c) If requested in writing by the customer, the Company will send bills to and will receive payments from agents of tenants, However, this accommodation will in no way relieve the customer of the liability for all water charges, and the Company shall not be obligated to notify the customer of the nonpayment of water bills by such agents or tenants.

(d) Payment shall be made at the office of the Company or at such places conveniently located as may be designated by the Company.

RULE NO.12- BILLS FOR WATER SERVICE:(CONTINUED)

(e) The Company reserves the right to correct any bills rendered in error as to service supplied.

(f) Each "Premises" as described in Rule No. 1 shall be billed separately for service.

(g) If the meter should fail to register for any reason, or if the meter reader should be unable to read the meter at the time the meter is to be read, an estimated bill will be submitted.

(h) Bills for metered water service shall be rendered monthly or quarterly in arrears depending upon the class and quantity of service rendered.

(i) Water for building purposes will be furnished by meter measurements only, and all water for building purposes must pass through one and the same meter. A suitable deposit, the amount to be determined by the Company, may be required.

RULE NO. 13 - TERM OF PAYMENT:

(a) Bills for water service shall be due and payable twenty (20) days from the mailing date or date of hand delivery.

(b) If a bill is not paid within ten (10) days after a written or printed notice properly given by the Company to the customer of record, the account will be delinquent, service may be discontinued and the meter removed by the Company, and the deposit, if any may be applied against such bill and any other arrears due by the customer.

RULES NO. 14 - CUSTOMER'S LIABILITY FOR CHARGES:

A customer who has made applications for or received water service at a premises shall be held liable for all water service to such premises until such time as the customer properly notifies the Company to discontinue the service for his account.

RULE NO. 15 - ABATEMENTS AND REFUNDS:

There shall be no abatement of the minimum water rates, in whole or in part, by reason of the extended absence of the customer, unless the customer has requested that such service be discontinued. No abatement shall be made for leaks or for water wasted by improper or damaged service pipes or fixtures belonging to the customer; except in the following cases:

(1) In the residential and commercial classifications, a one time, adjustment will be considered for an underground leak. This adjustment will be based upon fifty percent (50%) of the excess in billed amounts as calculated from the previous three (3) consecutive billing periods. Adjustments will not be considered for new construction, where the permanent resident has occupied the property for less than one (1) year.

RULE NO. 15 - ABATEMENTS AND REFUNDS:(CONTINUED)

(2) In the residential classification, a one time per five (5) year period, adjustment will be considered for a leaking toilet fixture. This adjustment will be based upon fifty percent (50%) of the excess in billed amounts as calculated from the previous three (3) consecutive billing periods. Adjustments will not be considered for new construction, where the permanent resident has occupied the property for less than one (1) year.

In each case where an adjustment is considered, satisfactory proof of repairs must be provided by the customer prior to processing of such adjustment

RULE NO.16- PRESSURE AND CONTINUITY OF SUPPLY:

(a) The Company does not guarantee a sufficient or uniform pressure, or uninterrupted supply of water, and customers are cautioned to provide sufficient storage of water where an absolutely uninterrupted supply must be assured, such as for steam boilers, hot water systems, gas engines, etc.

(b) In high level sections where pressure is low, the customer shall, if he desires a higher pressure than furnished at the mains of the Company, install at his own expense a tank and/or booster pump, of a type and installation approved by the Company.

(c) Where the pressure to a customer's premises is greater than he wishes, it shall be his responsibility to install the proper regulating device to reduce the pressure to the extent desired.

(d) The Company will supply at a minimum pressure of 20 psi., under normal operating conditions.

RULE NO.17- INTERCEPTING TANK REQUIRED FOR LARGE CUSTOMERS:

Service pipes for railroad locomotive supply or character of uses requiring a large quantity of water within a short period will not be permitted except through intercepting or intermediate storage tanks. The connection for such tanks shall be made in such a manner as may be approved by the Company.

RULE NO. -18 INTERRUPTIONS IN WATER SUPPLY:

(a) The Company may, at any time, shut off the water in the mains in case of accident, or for the purpose of making connections, alterations, repairs changes or for public fire service or other emergencies whenever the public welfare may require it.

(b) While it is the intention of the Company to give notice in advance of any work, which must be done, that will necessitate any interruption of the supply, such notice is to be considered a courtesy, and not a requirement on the part of the Company. Property owners must so regulate their installations connected with the water supply system that damage will not occur if water is shut off without notice.

RULE NO. -18 INTERRUPTIONS IN WATER SUPPLY:(CONTINUED)

(c) The Company will undertake to use reasonable care and diligence in order to prevent and avoid interruptions and fluctuations in the service, but it cannot and does not guarantee that such will not occur

RULE NO.19 - GENERAL:

(a) The service pipes, meter and fixtures on the customer's premises shall be accessible to the Company for observation or inspection at reasonable hours.

(b) No one person shall turn the water on or off at any street valve, corporation cock, curb cock or other street connection or disconnect or remove any meter without the consent of the Company. Penalties provided by law for any such unauthorized action will be rigidly enforced.

(c) Employees or agents of the Company are expressly forbidden to demand or accept any compensation for any service rendered to its customer except as covered by its Rules and Regulations and effective Schedule of Rates.

(d) No employee or agent of the Company shall have the right or authority to bind it by any promise, agreement or representation contrary to the letter or intent of these Rules and Regulations.

(e) Any complaint against the service or employees of the Company should be made at the office of the Company and preferably in writing.

RULE NO. 20 - PUBLIC FIRE HYDRANTS:

General - The following provisions shall apply to all fire hydrants:

(a) The use of public fire hydrants will be restricted to the taking of water for the extinguishments of fire and water shall not be taken form any public fire hydrants for construction purposes, sprinkling streets, flushing sewer or gutter, or for any other use, unless specially permitted by the Company for the particular time and occasion.

(b) The Company shall not be considered in any manner as insurer of persons or property, or to have undertaken to extinguish fires, or to protect any persons or property against loss or damage by fire or otherwise, and shall not be responsible to any person or persons for any loss, damage or injury by reason of fire, water, failure to supply water or pressure, or for any other cause whatsoever.

(1) Alexandria District - The installation of fire hydrants in the Alexandria District shall be installed in accordance with existing franchise agreements.

(2) Hopewell District - The installation of fire hydrants in the Hopewell District shall be installed in accordance with existing franchise agreements.

RULE NO. 20 - PUBLIC FIRE HYDRANTS: (CONTINUED)

(3) The installation of public fire services in the Hopewell District, outside the City of Hopewell shall be installed as follows:

Any government unit located in the Utility's service area by ordinance of its Council or by resolution of its Board of County Commissioners shall have the right to order the installation of additional fire hydrants on existing utility owned mains having an internal diameter of six (6) inches or larger and the utility will install such hydrants at its own cost and expense; provided, however, the estimated gross receipts from hydrant rentals shall equal or exceed twenty-four (24) percent annually of the cost of said installations.

(4) Prince William District- Public fire hydrants will be installed in public streets and roads at the expense of the developer of the property. Such hydrants are to be attached to mains six (6) inches or larger in diameter. The cost of the hydrant installation shall include the connection at the main, the lateral piping and the valve, as well as the hydrant, together with the cost of installing same. All public hydrants shall be installed in accordance with applicable regulations of the appropriate governmental unit.

Public fire hydrants shall be the property of Water Company and will be maintained by the Water Company.

RULES NO.21- EXTENSION OF MAINS:

The Company will extend its distribution system to supply consumers where application of service has been made, under the following terms and conditions:

(a) Where the cost of the extension does not exceed three and one half- times annual revenue from bona fide applicants whose pipe will be directly connected to the extension and from whom the Company has received applications for service upon forms provided by the Company for this purpose, the Company will install, at its own cost and expense, the necessary extension.

(b) When the estimated cost of the extension exceeds three and one-half times the estimated normal annual revenue from bona fida applicants whose service pipes will be directly connected to the extension and from whom the Company has received applications for service upon forms provided by the Company for this purpose, the person seeking the extension will deposit with the Company the difference between the cost estimated by the Company of the construction of the extension including Federal income taxes imposed with respect thereto and three and one-half times the estimated normal annual revenue of the person seeking the extension. Upon completion of the cost of the extension, the computation shall be made to determine the actual cost of the extension (including Federal income taxes). If the deposit differs from the actual cost of the extension, less three and one-half times the estimated normal annual revenue of the depositor, the epositor will deposit any additional amounts shown to be due or the Company will refund to the depositor any excess amount shown to have been deposited. It is the intent that the deposit required should be based on actual installation cost including Federal income taxes.

(c) Any deposit so made shall remain without interest, in the possession of the Company, subject to refunds as follows:

(d) When and as additional bona fida consumers are secured whose service lines are directly connected to such extension, the Company will refund to the original depositor or depositors an amount equal to three and one -half times the estimated annual normal revenue from such additional consumers. Refunds will be made for a period of ten years only from date original deposit, and the total of such refunds will in no event exceed the amount of the original deposit. All or any part of the deposit not refunded within said ten year period shall remain the property of the Company.

(e) The ownership of the extension installed under this rule shall at all times be in the Company, its successors and assigns.

RULE NO. 21 - EXTENSION OF MAINS: (CONTINUED)

(f) Where the main or extension is to be installed in a private street the owner thereof shall provide, free of cost to the Company, an easement and a free, unobstructed and uninterrupted right of way for the installation, maintenance and extension of the main in such private street, and shall, if requested by the Company, place on public record a facsimile plat showing the location of such street.

(g) The Company reserves the right to determine the size of the pipe necessary in making such extension, but in no case shall pipe smaller than six (6) inches in diameter be laid except where public fire protection service is not involved.

(h) Estimated normal annual revenue as used in Rule 21 (a), (b) and (d) and as applying to residential customers, shall be determined each year by computing the average residential revenue of all residential customers for the previous year.

Appendix G: "Greening" of Hotels Research

The Initial Survey, Concluding Survey, all results, and the R.S. Means cut sheets can be found on the following pages.

Name: _____ **Company:** _____

Rate the following on a Scale of 1 to 10 based on level of FAMILARITY
(10 being Extremely Familiar; 1 being Not at All Familiar)

Leadership in Energy and Environmental Design (LEED) Rating System

1 2 3 4 5 6 7 8 9 10

Environmentally Friendly (GREEN) Building Technologies

1 2 3 4 5 6 7 8 9 10

How many projects have you been associated with that have employed GREEN Technologies?

☐ 1 to 5 ☐ 5 to 10 ☐ 10 or more

Do you feel that by implementing GREEN Technologies the total cost of the project was increased?

☐ Yes ☐ No

If yes, how much of the total cost?

☐ 1 - 5%
☐ 5 - 10%
☐ 10% or more

Was the extra cost worth it? Why?

☐ Yes
☐ No

How many projects have you been associated with that have employed LEED?

☐ 1 to 5 ☐ 5 to 10 ☐ 10 or more

Do you feel that by implementing LEED the total cost of the project was increased?

*Disregard any cost associated with documentation, focus only on building cost.

☐ Yes ☐ No

If yes, how much of the total cost?

☐ 1 - 5%
☐ 5 - 10%
☐ 10% or more

Was the extra cost worth it? Why?

☐ Yes
☐ No

Based on your experience with GREEN Technologies, check which cost is greater/longer between each set:

	Up Front Cost	**Payback Period**	**Life Cycle Cost**
Colored Clay Plaster	☐	☐	☐
Painted Gypsum Board	☐	☐	☐
Blown Cellulose Insulation	☐	☐	☐
Fiberglass Batting Insulation	☐	☐	☐
Polished Concrete Floor	☐	☐	☐
Ceramic Tile Floor	☐	☐	☐
Pre-Prgrammed A/C Units	☐	☐	☐
Continuously Powered A/C Units	☐	☐	☐
Greywater System	☐	☐	☐
Normal Sanitary System	☐	☐	☐

The most cost effective project implements:

☐ LEED
☐ GREEN Technologies
☐ Neither

Name: JOEL VANDERLEY **Company:** MILLER GLOBAL

Rate the following on a Scale of 1 to 10 based on level of FAMILARITY
(10 being Extremely Familiar; 1 being Not at All Familiar)

Leadership in Energy and Environmental Design (LEED) Rating System

1 2 3 4 (5) 6 7 8 9 10

Environmentally Friendly (GREEN) Building Technologies

1 2 3 4 (5) 6 7 8 9 10

How many projects have you been associated with that have employed GREEN Technologies?

[X] 1 to 5 [ ] 5 to 10 [ ] 10 or more

Do you feel that by implementing GREEN Technologies the total cost of the project was increased?

[X] Yes [ ] No

If yes, how much of the total cost?

[X] 1 - 5%
[ ] 5 - 10%
[ ] 10% or more

Was the extra cost worth it? Why?

[X] Yes ① PAYBACK
[ ] No ② COMPLIANCE

How many projects have you been associated with that have employed LEED?

[X] 1 to 5 [ ] 5 to 10 [ ] 10 or more

Do you feel that by implementing LEED the total cost of the project was increased?

*Disregard any cost associated with documentation, focus only on building cost.

[X] Yes [ ] No

If yes, how much of the total cost?

[X] 1 - 5%
[ ] 5 - 10%
[ ] 10% or more

Was the extra cost worth it? Why?

[X] Yes COMPLIANCE
[ ] No

Based on your experience with GREEN Technologies, check which cost is greater/longer between each set:

	Up Front Cost	Payback Period	Life Cycle Cost
Colored Clay Plaster	X		
Painted Gypsum Board		X	X
Blown Cellulose Insulation DIFF IN COST IS NEGLIGABLE			
Fiberglass Batting Insulation			
Polished Concrete Floor	X		X
Ceramic Tile Floor		X	
Pre-Prgrammed A/C Units	X	X	X
Continuously Powered A/C Units			
Greywater System	X		
Normal Sanitary System		X	X

The most cost effective project implements:

[ ] LEED
[X] GREEN Technologies
[ ] Neither

3/18/08 PHONE INTERVIEW

Name: DON RIEGEL **Company:** RIEGEL CONSULTING

Rate the following on a Scale of 1 to 10 based on level of FAMILARITY
(10 being Extremely Familiar; 1 being Not at All Familiar)

Leadership in Energy and Environmental Design (LEED) Rating System

1 2 3 4 5 6 7 **(8)** 9 10

Environmentally Friendly (GREEN) Building Technologies

1 2 3 **(4)** 5 6 7 8 9 10

How many projects have you been associated with that have employed GREEN Technologies?

[✓] 1 to 5 [ ] 5 to 10 [ ] 10 or more

Do you feel that by implementing GREEN Technologies the total cost of the project was increased?

[X] Yes [ ] No

If yes, how much of the total cost?

[ ] 1 - 5%
[ ] 5 - 10%
[X] 10% or more

Was the extra cost worth it? Why?

[ ] Yes
[X] No - GOV'T OFFICE BLDGS.
- COMPLIANCE.
- LONG PAYBACK (MORE THAN 2YRS.)
- MAIN INTEREST FOR ECONOMIC SENSE.

How many projects have you been associated with that have employed LEED?

[ ] 1 to 5 [X] 5 to 10 [ ] 10 or more

Do you feel that by implementing LEED the total cost of the project was increased?

*Disregard any cost associated with documentation, focus only on building cost.

[X] Yes [ ] No

If yes, how much of the total cost?

[ ] 1 - 5%
[ ] 5 - 10%
[X] 10% or more

Was the extra cost worth it? Why?

[X] Yes → OWNER OCCUPIED.
-GOVT MANDATED.
[X] No → SPEC OFFICES
-SHORT OWNERSHIP.

Based on your experience with GREEN Technologies, check which is greater:

	Up Front Cost	Payback Period	Life Cycle Cost
Colored Clay Plaster / Painted Gypsum Board N/A	[ ] / [ ]	[ ] / [ ]	[ ] / [ ]
Blown Cellulose Insulation / Fiberglass Batting Insulation	[ ] / [X]	[ ] / [X]	[X] / [ ] BETTER.
Polished Concrete Floor / Ceramic Tile Floor	[ ] / [X]	[ ] / [X]	[ ] / [X]
Pre-Prgrammed A/C Units / Continuously Powered A/C Units	[ ] / [ ] SAME	[ ] / [X]	[ ] / [X]
Greywater System / Normal Sanitary System	[X] / [ ]	[X] / [ ]	[ ] / [ ] LOWER.

The most cost effective project implements:

[X] LEED → MUST HAVE ENERGY CONSERVATION - BEAT ASHRAE 90.1
[ ] GREEN Technologies
[ ] Neither

Name: Stephen Smith Company: DavisCarterScott

Rate the following on a Scale of 1 to 10 based on level of FAMILARITY
(10 being Extremely Familiar; 1 being Not at All Familiar)

Leadership in Energy and Environmental Design (LEED) Rating System

1 2 3 4 5 6 **7** 8 9 10

Environmentally Friendly (GREEN) Building Technologies

1 2 3 4 **5** 6 7 8 9 10

How many projects have you been associated with that have employed GREEN Technologies?

☑ 1 to 5 (1) ☐ 5 to 10 ☐ 10 or more

Do you feel that by implementing GREEN Technologies the total cost of the project was increased?

☑ Yes (2) ☐ No

If yes, how much of the total cost?

☑ 1 - 5%
☑ 5 - 10%
☑ 10% or more

Was the extra cost worth it? Why? (3)

☐ Yes
☐ No

How many projects have you been associated with that have employed LEED?

☐ 1 to 5 ☑ 5 to 10 (1) ☐ 10 or more

Do you feel that by implementing LEED the total cost of the project was increased?

*Disregard any cost associated with documentation, focus only on building cost.

☑ Yes (2) ☐ No

If yes, how much of the total cost?

☑ 1 - 5% CERTIFIED
☑ 5 - 10% SILVER - GOLD
☑ 10% or more GOLD - PLATINUM

Was the extra cost worth it? Why? (3)

☐ Yes
☐ No

Based on your experience with GREEN Technologies, check which cost is greater/longer between each set:

	Up Front Cost	Payback Period	Life Cycle Cost
Colored Clay Plaster — NO EXPERIENCE Painted Gypsum Board	☐ ☑	☐ ☑	☐ ☑ DEPENDS ON USE OF THE SPACE
Blown Cellulose Insulation Fiberglass Batting Insulation	☐ ☑	☐ ☑	☐ ☒ NA
Polished Concrete Floor Ceramic Tile Floor	☑ ☐	☑ ☐	☒ ☐ Depends on space/client requirements
Pre-Prgrammed A/C Units (4) Continuously Powered A/C Units	☐ ☐	☐ ☐	☐ ☐
Greywater System Normal Sanitary System (5)	☑ ☐	☑ ☐	☐ ☐

The most cost effective project implements:

☐ LEED
☐ GREEN Technologies
☐ Neither

Name: Kathy Lawson **Company:** Davis Carter Scott Ltd

Rate the following on a Scale of 1 to 10 based on level of FAMILARITY
(10 being Extremely Familiar; 1 being Not at All Familiar)

Leadership in Energy and Environmental Design (LEED) Rating System

1 2 3 4 5 6 7 8 9 (10)

Environmentally Friendly (GREEN) Building Technologies

1 2 3 4 5 6 7 8 (9) 10

How many projects have you been associated with that have employed GREEN Technologies?

[ ] 1 to 5 [x] 5 to 10 [ ] 10 or more

Do you feel that by implementing GREEN Technologies the total cost of the project was increased?

[ ] Yes [ ] No [x] Sometimes

If yes, how much of the total cost?

[x] 1 - 5%
[ ] 5 - 10%
[ ] 10% or more

Was the extra cost worth it? Why?

[x] Yes
[ ] No

How many projects have you been associated with that have employed LEED?

[x] 1 to 5 [ ] 5 to 10 [ ] 10 or more

Do you feel that by implementing LEED the total cost of the project was increased?

*Disregard any cost associated with documentation, focus only on building cost.

[ ] Yes [ ] No [x] Sometimes

If yes, how much of the total cost?

[x] 1 - 5%
[ ] 5 - 10%
[ ] 10% or more

Was the extra cost worth it? Why?

[x] Yes
[ ] No

Based on your experience with GREEN Technologies, check which cost is greater/longer between each set:

	Up Front Cost	Payback Period	Life Cycle Cost
Colored Clay Plaster	x	x	x
Painted Gypsum Board			
Blown Cellulose Insulation	x	x	
Fiberglass Batting Insulation			x
Polished Concrete Floor			
Ceramic Tile Floor	x	x	x
Pre-Prgrammed A/C Units	x	x	
Continuously Powered A/C Units			x
Greywater System	x	x	
Normal Sanitary System			x

The most cost effective project implements:

[ ] LEED
[x] GREEN Technologies
[ ] Neither

Name: Genelle McDonald **Company:** Balfour Beatty Construction

Rate the following on a Scale of 1 to 10 based on level of FAMILIARITY
(10 being Extremely Familiar; 1 being Not at All Familiar)

Leadership in Energy and Environmental Design (LEED) Rating System

1 2 3 4 5 6 7 (8) 9 10

Environmentally Friendly (GREEN) Building Technologies

1 2 3 4 5 6 7 8 9 10

How many projects have you been associated with that have employed GREEN Technologies?

☑ 1 to 5 ☐ 5 to 10 ☐ 10 or more

Do you feel that by implementing GREEN Technologies the total cost of the project was increased?

☐ Yes ☑ No

If yes, how much of the total cost?

☐ 1 - 5%
☐ 5 - 10%
☐ 10% or more

Was the extra cost worth it? Why?

☐ Yes
☐ No

How many projects have you been associated with that have employed LEED?

☐ 1 to 5 ☑ 5 to 10 ☐ 10 or more

Do you feel that by implementing LEED the total cost of the project was increased?

*Disregard any cost associated with documentation, focus only on building cost.

☑ Yes ☐ No

If yes, how much of the total cost?

☑ 1 - 5%
☐ 5 - 10%
☐ 10% or more

Was the extra cost worth it? Why?

☐ Yes
☐ No

Based on your experience with GREEN Technologies, check which cost is greater/longer between each set:

	Up Front Cost	Payback Period	Life Cycle Cost
Colored Clay Plaster	☑	☐	☐
Painted Gypsum Board	☐	☐	☐
Blown Cellulose Insulation	☑	☐	☐
Fiberglass Batting Insulation	☐	☐	☐
Polished Concrete Floor	☐	☐	☐
Ceramic Tile Floor	☑	☐	☐
Pre-Prgrammed A/C Units	☐	☐	☐
Continuously Powered A/C Units	☐	☐	☐
Greywater System	☑	☐	☐
Normal Sanitary System	☐	☐	☐

The most cost effective project implements:

☐ LEED
☐ GREEN Technologies
☐ Neither

Technology	Material Up Front Cost	Installed Cost (labor)	Total Cost	Life Cost	Product Life (Yrs.)	Choose One
Colored Clay Plaster	0.21 $/SF	7.8 $/SF	8.01 $/SF	0.11 $/SF/Yr	75	
Painted Gypsum Board	0.35 $/SF	3 $/SF	3.35 $/SF	0.13 $/SF/Yr	25	
Blown Cellulose Insulation	1.45 $/CF	1.52 $/CF	2.97 $/CF	0.10 $/CF/Yr	30	
Fiberglass Batting Insulation	0.7 $/SF	0.27 $/SF	0.97 $/SF	0.06 $/SF/Yr	15	
Polished Concrete Floor	1.75 $/SF	7.25 $/SF	9 $/SF	0.09 $/SF/Yr	Building Life	
Ceramic Tile Floor	8.44 $/SF	3.26 $/SF	11.7 $/SF	0.23 $/SF/Yr	50	
Pre-Prgrammed A/C Units*	98 $/Unit	$50,000.00	$68,522.00	362.55 $/Unit	n/a	
Continuously Powered A/C Units	30 $/Unit	$32,230.00	$37,900.00	200.53 $/Unit	n/a	
Greywater System*	n/a	n/a	Add $150,000	n/a	Building Life	
Normal Sanitary System	n/a	n/a	n/a	n/a	Building Life	

Building Life is assumed to be 100 years.

Pre-Prgrammed A/C Units*	Saves 696,241.5 kWh/Year = $2,312.94 /Year
Greywater System*	Saves 355,656 Gallons of Water/Year = $487.25 /Year

Technology	Material Up Front Cost	Installed Cost (labor)	Total Cost	Life Cost	Product Life (Yrs.)	Choose One
Colored Clay Plaster	0.21 $/SF	7.8 $/SF	8.01 $/SF	0.11 $/SF/Yr	75	
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Blown Cellulose Insulation	1.45 $/CF	1.52 $/CF	2.97 $/CF	0.10 $/CF/Yr	30	
Fiberglass Batting Insulation	0.7 $/SF	0.27 $/SF	0.97 $/SF	0.06 $/SF/Yr	15	
Polished Concrete Floor	1.75 $/SF	7.25 $/SF	9 $/SF	0.09 $/SF/Yr	Building Life	
Ceramic Tile Floor	8.44 $/SF	3.26 $/SF	11.7 $/SF	0.23 $/SF/Yr	50	
Pre-Prgrammed A/C Units*	98 $/Unit	$50,000.00	$68,522.00	362.55 $/Unit	n/a	✓ JV
Continuously Powered A/C Units	30 $/Unit	$32,230.00	$37,900.00	200.53 $/Unit	n/a	
Greywater System*	n/a	n/a	Add $150,000	n/a	Building Life	
Normal Sanitary System	n/a	n/a	n/a	n/a	Building Life	

Building Life is assumed to be 100 years.

Pre-Prgrammed A/C Units*	Saves 75,810,749.85 kWh/Year = $252,782.63 /Year
Greywater System*	Saves 355,656 Gallons of Water/Year = $244,691.33 /Year
	First year net savings = $94,637.98

Technology	Material Up Front Cost	Installed Cost (labor)	Total Cost	Life Cost	Product Life (Yrs.)	Choose One
Colored Clay Plaster	0.21 $/SF	7.8 $/SF	8.01 $/SF	0.11 $/SF/Yr	75	
Painted Gypsum Board	0.35 $/SF	3 $/SF	3.35 $/SF	0.13 $/SF/Yr	25	*
Blown Cellulose Insulation	1.45 $/CF	1.52 $/CF	2.97 $/CF	0.10 $/CF/Yr	30	
Fiberglass Batting Insulation	0.7 $/SF	0.27 $/SF	0.97 $/SF	0.06 $/SF/Yr	15	*
Polished Concrete Floor	1.75 $/SF	7.25 $/SF	9 $/SF	0.09 $/SF/Yr	Building Life	*
Ceramic Tile Floor	8.44 $/SF	3.26 $/SF	11.7 $/SF	0.23 $/SF/Yr	50	
Pre-Prgrammed A/C Units*	98 $/Unit	$50,000.00	$68,522.00	362.55 $/Unit	n/a	*
Continuously Powered A/C Units	30 $/Unit	$32,230.00	$37,900.00	200.53 $/Unit	n/a	
Greywater System*	n/a	n/a	Add $150,000	n/a	Building Life	
Normal Sanitary System	n/a	n/a	n/a	n/a	Building Life	*

Building Life is assumed to be 100 years.

Pre-Prgrammed A/C Units*	Saves 696,241.5 kWh/Year = $2,312.94 /Year
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	Painted Gypsum Board	0.35 $/SF	3 $/SF	3.35 $/SF	0.13 $/SF/Yr	25	X
2)	Blown Cellulose Insulation	1.45 $/CF	1.52 $/CF	2.97 $/CF	0.10 $/CF/Yr	30	
	Fiberglass Batting Insulation	0.7 $/SF	0.27 $/SF	0.97 $/SF	0.06 $/SF/Yr	15	X
3)	Polished Concrete Floor	1.75 $/SF	7.25 $/SF	9 $/SF	0.09 $/SF/Yr	Building Life	X
	Ceramic Tile Floor	8.44 $/SF	3.26 $/SF	11.7 $/SF	0.23 $/SF/Yr	50	X
4)	Pre-Prgrammed A/C Units*	98 $/Unit	$50,000.00	$68,522.00	362.55 $/Unit	n/a	X
	Continuously Powered A/C Units	30 $/Unit	$32,230.00	$37,900.00	200.53 $/Unit	n/a	
5)	Greywater System*	n/a	n/a	Add $150,000	n/a	Building Life	X
	Normal Sanitary System	n/a	n/a	n/a	n/a	Building Life	

> DEPENDS ON APPLICATION

Building Life is assumed to be 100 years.

Pre-Prgrammed A/C Units*	Saves 75,810,749.85 kWh/Year = $252,782.63 /Year
Greywater System*	Saves 355,656 Gallons of Water/Year = $244,691.33 /Year
	First year net savings = $94,637.98

1) PAINTED GYP. BOARD - LOWER INITIAL COST, EASY MAINTENANCE.

2) FIBERGLASS BATT. - CELLULOSE IS BETTER PRODUCT FOR ENERGY EFFICIENCY, BUT IT IS VERY DIFFICULT TO JUSTIFY THE SIGNIFICANT COST INCREASE TO THE DEVELOPER.

3) POLISHED CONCRETE OR TILE - I LIKE BOTH FINISHES HOWEVER POLISHED CONCRETE ~~IS NOT~~ HAS LIMITED APPLICATION BECAUSE IT DOES NOT FIT W/ ALL ARCHITECTURAL STYLES.

4) PRE-PROGRAMMED - IF WE CAN CONVINCE THE CLIENT TO PAY THE UPFRONT COST, I PREFER PRE-PROGRAM B/C OF THE ENERGY SAVINGS.

5) GREYWATER SYSTEM - OFFERS SIGNIFICANT WATER SAVINGS, BUT TYPICALLY NOT USED BECAUSE OF UPFRONT COST.

Technology	Material Up Front Cost	Installed Cost (labor)	Total Cost	Life Cost	Product Life (Yrs.)	Choose One
Colored Clay Plaster	0.21 $/SF	7.8 $/SF	8.01 $/SF	0.11 $/SF/Yr	75	
Painted Gypsum Board	0.35 $/SF	3 $/SF	3.35 $/SF	0.13 $/SF/Yr	25	X
Blown Cellulose Insulation	1.45 $/CF	1.52 $/CF	2.97 $/CF	0.10 $/CF/Yr	30	X
Fiberglass Batting Insulation	0.7 $/SF	0.27 $/SF	0.97 $/SF	0.06 $/SF/Yr	15	
Polished Concrete Floor	1.75 $/SF	7.25 $/SF	9 $/SF	0.09 $/SF/Yr	Building Life	X
Ceramic Tile Floor	8.44 $/SF	3.26 $/SF	11.7 $/SF	0.23 $/SF/Yr	50	
Pre-Prgrammed A/C Units*	98 $/Unit	$50,000.00	$68,522.00	362.55 $/Unit	n/a	X
Continuously Powered A/C Units	30 $/Unit	$32,230.00	$37,900.00	200.53 $/Unit	n/a	
Greywater System*	n/a	n/a	Add $150,000	n/a	Building Life	X
Normal Sanitary System	n/a	n/a	n/a	n/a	Building Life	

Building Life is assumed to be 100 years.

Pre-Prgrammed A/C Units*	Saves 75,810,749.85 kWh/Year = $252,782.63 /Year
Greywater System*	Saves 355,656 Gallons of Water/Year = $244,691.33 /Year
	First year net savings = $94,637.98

1. I chose gyp board over plater due to up front costs. For commercial use, most people anticipate renovating their spaces every so often, so the long product expectancy is of little benefit.

2. I chose blown cellulose insulation because the per square foot costs for cellulose vs. fiberglass are about the same. In other words, there is no reason not to use it.

3. I chose polished concrete over tile for the lower up front cost as well as the ease of maintenance. Plus, it is easier to renovate space with polished concrete vs. tile - no demolition required.

4. I chose the pre-programmed A/C units and greywater system due to the energy savings, which provide sufficient savings to offset the up front costs in a short time.

Initial Survey Comments:

Architect:
I think that some of the items on the questionnaire, will not relate a true answer, so here are a few of my comments too. Please note that these are my personal opinions, and do not convey an official DCS company opinion or policy.
1. How many projects... I have always tried to initiate responsible design into my projects, long before "LEED " or "Green" became household names. So, in all my projects, about 200 over the last 26 years, I have implemented many of the same principals as what is required by LEED or Green today.
2. Cost.... On the Mill Road Marriott project, we are providing the city with documentation of twenty LEED points, BBC has told us this is at no premium cost. However, on other projects I know that the owner has certainly paid significant premiums to achieve the silver, gold or platinum levels.
3. Worth it?.... In monetary pay back, perhaps not.
In environmental impact most likely yes.
In employee satisfaction, probably but maybe not.
4. What is a continuously powered AC unit? All HVAC units are thermostatically controlled - on when needed to be on, off when not needed.
5. Greywater systems are very expensive to build. And again it depends on the use of the building. I am currently working on a school where we are looking into using a greywater system. We have looked at both building greywater, and also saving storm water runoff. The cost of providing what essentially amounts to two sets of sanitary piping systems in the building is huge and not advantageous to the client. Since this is a high school, with exterior athletic playing fields, they cannot generate enough water to make much of a difference. They would have to hope for extraordinary rainfall. the Mill Road Marriott is the opposite. They have such a small amount of planting to be watered, the greywater system would require more cost in system maintenance than what would be saved instead of using city water.

Concluding Survey Comments:

Architect:
1. Plaster- Gypsum Board: Most buildings don't really last much more than 20 to 25 years. The IRS has an owner depreciate them over time, and by the time you get to 30 years, the owner is ready to tear it down and build anew. Now many businesses plan on staying in one location for more than 20 years. If they do, then the usually want to do a building make over and change colors. With this in mind, there is not much savings to go with colored clay plaster.
2. Insulation - I see no reason to go with blown cellulose instead of fiberglass insulation. The wall cavities are a given thickness (4" studs, 6" studs, etc) and batt insulation is manufactured in the appropriate thicknesses to suit the stud space. There is a new sprayed on expanding foam insulation, that has a lot of promise. As a sprayed on product, it seals around all holes and gaps and provides better insulation per inch than the fiberglass.
3. Floor - I am intrigued with the polished concrete floor, but have not been able to use this yet. This appears to be a good saving and a durable solution. Unfortunately this gives your building an industrial look that many clients don't want.
4. A/C units. I am not sure what you mean by continuously powered. I am not sure we ever do this in any of our projects. All of the buildings I have done in the last 10 years have had thermostatically controlled operation that has a night setback.
5. A greywater system has a lot of costs associated with it. I am no sure how you got the number $150,000. These usually also have a pump and filter system that requires maintenance.

I am now working on a 60,000 sf addition to an elementary school. They want the project to be LEED certified. We looked at a greywater system, and determined it to have a cost of close to $500,000 to

connect all toilets and roof drains and store the water in an underground storage tank. If this was a developer, he would have had to borrow money to pay for this which would have resulted in a cost of $1,500,000 over thirty years, negating any savings. The good news is that we have about 40 possible points and need only 29 for a school to be certified.

Owner:
First, my selection is Pre-programmed A/C units. We have already implemented this for Mill Rd.

Second, my choice is based primarily on short term payback and lower operating costs

Third, my second choice would be a Greywater system. I question the payback you've calculated as I believe the original cost would be much higher but that's just my gut feel. Additionally, jurisdictional approval would be problematic.

Plaster is a wonderful product but is nearly impossible to patch correctly. Over the years, renovations, installation of new technology, etc. would make everything look like a patchwork quilt. Add to that the fact that you can't find any tradesmen it is not realistic.

Insulation changes don't really have a payback.

Concrete polished floors are great but elevation changes between rooms of different flooring types would create havoc during construction and in 7 years you renovate and add tile anyway. The payback isn't there and the headaches aren't worth it.

09 30 13.10 Ceramic Tile

		Crew	Daily Output	Labor-Hours	Unit	2008 Bare Costs Material	Labor	Equipment	Total	Total Incl O&P
0010	**CERAMIC TILE**									
0050	Base, using 1' x 4" high pc. with 1" x 1" tiles, mud set	D-7	82	.195	L.F.	4.48	6.45		10.93	14.40
0100	Thin set	"	128	.125		4.26	4.14		8.40	10.75
0300	For 6" high base, 1" x 1" tile face, add					.70			.70	.77
0400	For 2" x 2" tile face, add to above					.37			.37	.41
0600	Cove base, 4-1/4" x 4-1/4" high, mud set	D-7	91	.176		3.54	5.80		9.34	12.45
0700	Thin set		128	.125		3.56	4.14		7.70	9.95
0900	6" x 4-1/4" high, mud set		100	.160		3.23	5.30		8.53	11.30
1000	Thin set		137	.117		3.23	3.86		7.09	9.20
1200	Sanitary cove base, 6" x 4-1/4" high, mud set		93	.172		3.61	5.70		9.31	12.30
1300	Thin set		124	.129		4.11	4.27		8.38	10.75
1500	6" x 6" high, mud set		84	.190		4.47	6.30		10.77	14.15
1600	Thin set		117	.137		4.47	4.52		8.99	11.55
1800	Bathroom accessories, average		82	.195	Ea.	10.35	6.45		16.80	21
1900	Bathtub, 5', rec. 4-1/4" x 4-1/4" tile wainscot, adhesive set 6' high		2.90	5.517		156	183		339	440
2100	7' high wainscot		2.50	6.400		179	212		391	505
2200	8' high wainscot		2.20	7.273		190	241		431	565
2400	Bullnose trim, 4-1/4" x 4-1/4", mud set		82	.195	L.F.	3.35	6.45		9.80	13.15
2500	Thin set		128	.125		3.12	4.14		7.26	9.50
2700	6" x 4-1/4" bullnose trim, mud set		84	.190		2.54	6.30		8.84	12.05
2800	Thin set		124	.129		2.54	4.27		6.81	9.05
3255	Floors, glazed, thin set, 6" x 6", color group 1		200	.080	S.F.	3.36	2.65		6.01	7.60
3260	8" x 8" tile		250	.064		3.36	2.12		5.48	6.80
3270	12" x 12" tile		325	.049		4.22	1.63		5.85	7.05
3280	16" x 16" tile		550	.029		6.05	.96		7.01	8.05
3285	Border, 6" x 12" tile		275	.058		11.10	1.92		13.02	15
3290	3" x 12" tile		200	.080		32.50	2.65		35.15	40
3300	Porcelain type, 1 color, color group 2, 1" x 1"		183	.087		4.57	2.89		7.46	9.30
3310	2" x 2" or 2" x 1", thin set		190	.084		5.05	2.79		7.84	9.65
3350	For random blend, 2 colors, add					.85			.85	.94
3360	4 colors, add					1.20			1.20	1.32
3370	For color group 3, add					.49			.49	.54
3380	For abrasive non-slip tile, add					.48			.48	.53
4300	Specialty tile, 4-1/4" x 4-1/4" x 1/2", decorator finish	D-7	183	.087		10	2.89		12.89	15.25
4500	Add for epoxy grout, 1/16" joint, 1" x 1" tile		800	.020		.60	.66		1.26	1.63
4600	2" x 2" tile		820	.020		.54	.65		1.19	1.54
4800	Pregrouted sheets, walls, 4-1/4" x 4-1/4", 6" x 4-1/4"									
4810	and 8-1/2" x 4-1/4", 4 S.F. sheets, silicone grout	D-7	240	.067	S.F.	4.59	2.21		6.80	8.30
5100	Floors, unglazed, 2 S.F. sheets,									
5110	Urethane adhesive	D-7	180	.089	S.F.	4.57	2.94		7.51	9.35
5400	Walls, interior, thin set, 4-1/4" x 4-1/4" tile		190	.084		2.22	2.79		5.01	6.55
5500	6" x 4-1/4" tile		190	.084		2.51	2.79		5.30	6.85
5700	8-1/2" x 4-1/4" tile		190	.084		3.55	2.79		6.34	8
5800	6" x 6" tile		200	.080		3.03	2.65		5.68	7.20
5810	8" x 8" tile		225	.071		4.04	2.35		6.39	7.90
5820	12" x 12" tile		300	.053		3.25	1.76		5.01	6.15
5830	16" x 16" tile		500	.032		3.52	1.06		4.58	5.40
5900	Decorated wall tile, 4-1/4" x 4-1/4", minimum		270	.059		3.34	1.96		5.30	6.55
6000	Maximum		180	.089		42.50	2.94		45.44	51
6100	Exterior walls, frostproof, mud set, 4-1/4" x 4-1/4"		102	.157		6	5.20		11.20	14.20
6200	1-3/8" x 1-3/8"		93	.172		4.13	5.70		9.83	12.90
6300	Crystalline glazed, 4-1/4" x 4-1/4", mud set, plain		100	.160		3.66	5.30		8.96	11.80
6500	4-1/4" x 4-1/4", scored tile		100	.160		4.42	5.30		9.72	12.60

Hotel, 8-24 Story

Model costs calculated for a 15 story building with 10′ story height and 450,000 square feet of floor area

				Unit	Unit Cost	Cost Per S.F.	% Of Sub-Total
A. SUBSTRUCTURE							
1010	Standard Foundations	CIP concrete pile caps		S.F. Ground	5.25	.35	6.6%
1020	Special Foundations	Steel H-piles, concrete grade beams		S.F. Ground	95	6.30	
1030	Slab on Grade	4″ reinforced concrete with vapor barrier and granular base		S.F. Slab	4.45	.30	
2010	Basement Excavation	Site preparation for slab, piles and grade beams		S.F. Ground	.14	.01	
2020	Basement Walls	4′ foundation wall		L.F. Wall	69	.15	
B. SHELL							
	B10 Superstructure						
1010	Floor Construction	Open web steel joists, slab form, concrete, columns		S.F. Floor	17.63	16.45	15.8%
1020	Roof Construction	Metal deck, open web steel joists, beams, columns		S.F. Roof	7.50	.50	
	B20 Exterior Enclosure						
2010	Exterior Walls	N/A		—	—	—	5.3 %
2020	Exterior Windows	Glass and metal curtain walls	*100% of wall*	Each	20.80	5.55	
2030	Exterior Doors	Glass and metal doors and entrances		Each	2582	.19	
	B30 Roofing						
3010	Roof Coverings	Built-up tar and gravel with flashing; perlite/EPS composite insulation		S.F. Roof	5.10	.34	0.3%
3020	Roof Openings	N/A		—	—	—	
C. INTERIORS							
1010	Partitions	Gypsum board and sound deadening board, steel studs	*9 S.F. Floor/L.F. Partition*	S.F. Partition	6.38	5.67	26.4%
1020	Interior Doors	Single leaf hollow metal	*90 S.F. Floor/Door*	Each	815	9.06	
1030	Fittings	N/A		—	—	—	
2010	Stair Construction	Concrete filled metal pan		Flight	11,550	2.34	
3010	Wall Finishes	20% paint, 75% vinyl cover, 5% ceramic tile		S.F. Surface	1.67	2.96	
3020	Floor Finishes	80% carpet tile, 10% vinyl composition tile, 10% ceramic tile		S.F. Floor	4.75	4.75	
3030	Ceiling Finishes	Gypsum board on resilient channel		S.F. Ceiling	3.54	3.54	
D. SERVICES							
	D10 Conveying						
1010	Elevators & Lifts	One geared freight, six geared passenger elevators		Each	303,750	4.05	3.8%
1020	Escalators & Moving Walks	N/A		—	—	—	
	D20 Plumbing						
2010	Plumbing Fixtures	Kitchen, toilet and service fixtures, supply and drainage	*1 Fixture/165 S.F. Floor*	Each	2302	13.95	16.9%
2020	Domestic Water Distribution	Electric water heater		S.F. Floor	4.07	4.07	
2040	Rain Water Drainage	Roof drains		S.F. Roof	1.50	.10	
	D30 HVAC						
3010	Energy Supply	Oil fired hot water, wall fin radiation		S.F.Floor	2	2	11.2%
3020	Heat Generating Systems	N/A		—	—	—	
3030	Cooling Generating Systems	Chilled water, fan coil units		S.F. Floor	10.01	10.01	
3050	Terminal & Package Units	N/A		—	—	—	
3090	Other HVAC Sys. & Equipment	N/A		—	—	—	
	D40 Fire Protection						
4010	Sprinklers	Sprinkler system, light hazard		S.F. Floor	2.89	2.89	3.0%
4020	Standpipes	Standpipes and hose systems		S.F. Floor	.31	.31	
	D50 Electrical						
5010	Electrical Service/Distribution	6000 ampere service, panel board and feeders		S.F. Floor	1.37	1.37	10.8%
5020	Lighting & Branch Wiring	Fluorescent fixtures, receptacles, switches, A.C. and misc. power		S.F. Floor	7.40	7.40	
5030	Communications & Security	Alarm systems, internet wiring, communications systems and emergency lighting		S.F. Floor	2.53	2.53	
5090	Other Electrical Systems	Emergency generator, 500 kW		S.F. Floor	.32	.32	
E. EQUIPMENT & FURNISHINGS							
1010	Commercial Equipment	N/A		—	—	—	0.0 %
1020	Institutional Equipment	N/A		—	—	—	
1030	Vehicular Equipment	N/A		—	—	—	
1090	Other Equipment	N/A		—	—	—	
F. SPECIAL CONSTRUCTION							
1020	Integrated Construction	N/A		—	—	—	0.0 %
1040	Special Facilities	N/A		—	—	—	
G. BUILDING SITEWORK		**N/A**					
					Sub-Total	107.47	**100%**
	CONTRACTOR FEES (General Requirements: 10%, Overhead: 5%, Profit: 10%)				25%	26.87	
	ARCHITECT FEES				6%	8.06	
					Total Building Cost	**142.40**	

07 21 Thermal Insulation

07 21 16 – Blanket Insulation

	07 21 16.20 Blanket Insulation for Walls	Crew	Daily Output	Labor-Hours	Unit	2008 Bare Costs Material	Labor	Equipment	Total	Total Incl O&P
0484	15" wide	1 Carp	1350	.006	S.F.	.57	.23		.80	.98
0486	23" wide		1600	.005		.57	.19		.76	.93
0488	9" thick, R-30, 11" wide		985	.008		.84	.31		1.15	1.40
0500	9" thick, R30, 15" wide		1150	.007		.84	.27		1.11	1.33
0550	23" wide		1350	.006		.84	.23		1.07	1.27
0560	12" thick, R-38, 11" wide		985	.008		.84	.31		1.15	1.40
0570	15" wide		1150	.007		.84	.27		1.11	1.33
0580	23" wide		1350	.006		.84	.23		1.07	1.27
0620	Unfaced fiberglass, 3-1/2" thick, R-13, 11" wide		1150	.007		.36	.27		.63	.81
0820	15" wide		1350	.006		.36	.23		.59	.75
0830	23" wide		1600	.005		.36	.19		.55	.70
0832	R15, 11" wide		1150	.007		.32	.27		.59	.76
0836	23" wide		1600	.005		.32	.19		.51	.65
0838	6" thick, R19, 11" wide		1150	.007		.58	.27		.85	1.05
0860	15" wide		1150	.007		.58	.27		.85	1.05
0880	23" wide		1350	.006		.58	.23		.81	.99
0882	R-21, 11" wide		1150	.007		.67	.27		.94	1.15
0886	15" wide		1350	.006		.67	.23		.90	1.09
0888	23" wide		1600	.005		.67	.19		.86	1.04
0890	9" thick, R30, 11" wide		985	.008		.84	.31		1.15	1.40
0900	15" wide		1150	.007		.84	.27		1.11	1.33
0920	23" wide		1350	.006		.84	.23		1.07	1.27
0930	12" thick, R38, 11" wide		985	.008		.90	.31		1.21	1.47
0940	15" wide		1000	.008		.90	.30		1.20	1.46
0960	23" wide		1150	.007		.90	.27		1.17	1.40
1300	Mineral fiber batts, kraft faced									
1320	3-1/2" thick, R12	1 Carp	1600	.005	S.F.	.38	.19		.57	.72
1340	6" thick, R19		1600	.005		.51	.19		.70	.86
1380	10" thick, R30		1350	.006		.75	.23		.98	1.18
1850	Friction fit wire insulation supports, 16" O.C.		960	.008	Ea.	.08	.32		.40	.58

07 21 23 – Loose-Fill Insulation

07 21 23.10 Poured Loose-Fill Insulation

0010	**POURED LOOSE-FILL INSULATION**									
0020	Cellulose fiber, R3.8 per inch	1 Carp	200	.040	C.F.	.64	1.52		2.16	3.07
0040	Ceramic type (perlite), R3.2 per inch		200	.040		1.72	1.52		3.24	4.26
0080	Fiberglass wool, R4 per inch		200	.040		.51	1.52		2.03	2.93
0100	Mineral wool, R3 per inch		200	.040		.39	1.52		1.91	2.80
0300	Polystyrene, R4 per inch		200	.040		3.09	1.52		4.61	5.75
0400	Vermiculite or perlite, R2.7 per inch		200	.040		1.72	1.52		3.24	4.26
0700	Wood fiber, R3.85 per inch		200	.040		.70	1.52		2.22	3.14

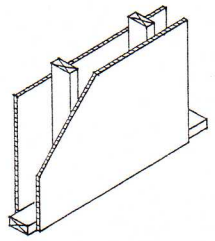
07 21 23.20 Masonry Loose-Fill Insulation

0010	**MASONRY LOOSE-FILL INSULATION**, vermiculite or perlite									
0100	In cores of concrete block, 4" thick wall, .115 CF/SF	D-1	4800	.003	S.F.	.20	.12		.32	.40
0200	6" thick wall, .175 CF/SF		3000	.005		.30	.19		.49	.61
0300	8" thick wall, .258 CF/SF		2400	.007		.44	.23		.67	.84
0400	10" thick wall, .340 CF/SF		1850	.009		.58	.30		.88	1.10
0500	12" thick wall, .422 CF/SF		1200	.013		.73	.47		1.20	1.51
0550	For sand fill, deduct from above					70%				
0600	Poured cavity wall, vermiculite or perlite, water repellant	D-1	250	.064	C.F.	1.72	2.23		3.95	5.30
0700	Foamed in place, urethane in 2-5/8" cavity	G-2A	1035	.023	S.F.	.41	.68	.58	1.67	2.21
0800	For each 1" added thickness, add	"	2372	.010	"	.12	.30	.25	.67	.90

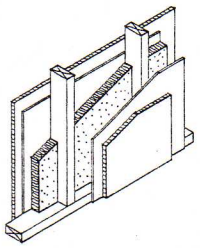
	09 91 23.72 Walls and Ceilings, Interior	Crew	Daily Output	Labor-Hours	Unit	2008 Bare Costs Material	Labor	Equipment	Total	Total Incl O&P
0400	Paint 1 coat, smooth finish, brushwork	1 Pord	1200	.007	S.F.	.06	.23		.29	.41
0440	Roller		1300	.006		.06	.21		.27	.38
0480	Spray		2275	.004		.05	.12		.17	.24
0500	Sand finish, brushwork		1050	.008		.06	.26		.32	.46
0540	Roller		1600	.005		.06	.17		.23	.32
0580	Spray		2100	.004		.05	.13		.18	.25
0800	Paint 2 coats, smooth finish, brushwork		680	.012		.12	.40		.52	.74
0840	Roller		800	.010		.13	.34		.47	.65
0880	Spray		1625	.005		.11	.17		.28	.37
0900	Sand finish, brushwork		605	.013		.12	.45		.57	.80
0940	Roller		1020	.008		.13	.26		.39	.54
0980	Spray		1700	.005		.11	.16		.27	.36
1200	Paint 3 coats, smooth finish, brushwork		510	.016		.18	.53		.71	1
1240	Roller		650	.012		.19	.42		.61	.83
1280	Spray		1625	.005		.16	.17		.33	.43
1300	Sand finish, brushwork		454	.018		.18	.59		.77	1.09
1340	Roller		680	.012		.19	.40		.59	.81
1380	Spray		1133	.007		.16	.24		.40	.54
1600	Glaze coating, 2 coats, spray, clear		1200	.007		.42	.23		.65	.80
1640	Multicolor		1200	.007		.87	.23		1.10	1.29
1700	For latex paint, deduct					10%				
1800	For ceiling installations, add						25%			
2000	Masonry or concrete block, oil base, primer or sealer coat									
2100	Smooth finish, brushwork	1 Pord	1224	.007	S.F.	.05	.22		.27	.39
2180	Spray		2400	.003		.08	.11		.19	.26
2200	Sand finish, brushwork		1089	.007		.09	.25		.34	.47
2280	Spray		2400	.003		.08	.11		.19	.26
2400	Paint 1 coat, smooth finish, brushwork		1100	.007		.09	.25		.34	.47
2480	Spray		2400	.003		.08	.11		.19	.26
2500	Sand finish, brushwork		979	.008		.09	.28		.37	.51
2580	Spray		2400	.003		.08	.11		.19	.26
2800	Paint 2 coats, smooth finish, brushwork		756	.011		.18	.36		.54	.73
2880	Spray		1360	.006		.16	.20		.36	.48
2900	Sand finish, brushwork		672	.012		.18	.40		.58	.79
2980	Spray		1360	.006		.16	.20		.36	.48
3200	Paint 3 coats, smooth finish, brushwork		560	.014		.26	.48		.74	1.01
3280	Spray		1088	.007		.24	.25		.49	.64
3300	Sand finish, brushwork		498	.016		.26	.54		.80	1.10
3380	Spray		1088	.007		.24	.25		.49	.64
3600	Glaze coating, 3 coats, spray, clear		900	.009		.60	.30		.90	1.11
3620	Multicolor		900	.009		1	.30		1.30	1.55
4000	Block filler, 1 coat, brushwork		425	.019		.12	.64		.76	1.08
4100	Silicone, water repellent, 2 coats, spray		2000	.004		.27	.14		.41	.49
4120	For latex paint, deduct					10%				
8200	For work 8 - 15' H, add						10%			
8300	For work over 15' H, add						20%			

	09 91 23.75 Dry Fall Painting									
0010	**DRY FALL PAINTING**	R099100-10								
0100	Walls									
0200	Wallboard and smooth plaster, one coat, brush	R099100-20	1 Pord	910	.009	S.F.	.04	.30	.34	.50
0210	Roll			1560	.005		.04	.17	.21	.31
0220	Spray			2600	.003		.04	.10	.14	.21

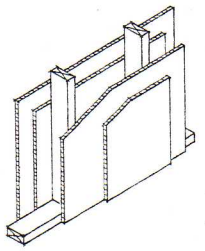
C1010 Partitions



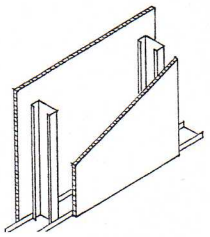
Gypsum board, single layer each side on wood studs.



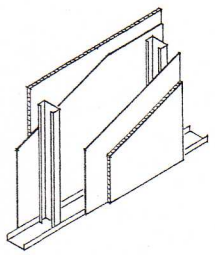
Gypsum board, sound deadening board each side, with 1-1/2" insulation on wood studs.



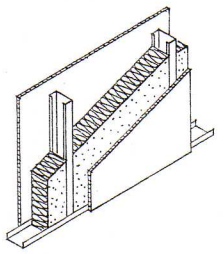
Gypsum board, two layers each side on wood studs.



Gypsum board, single layer each side on metal studs.



Gypsum board, sound deadening board each side on metal studs.

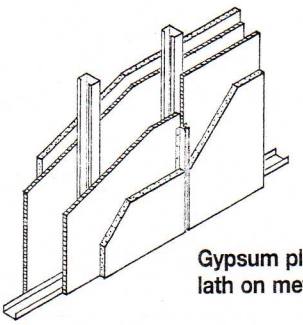


Gypsum board two layers one side, single layer opposite side, with 3-1/2" insulation on metal studs.

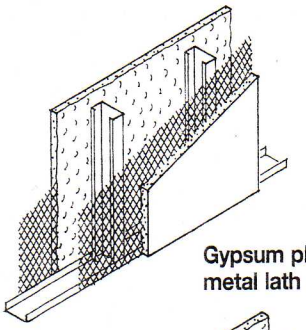
C1010 124 Drywall Partitions/Wood Stud Framing

	FACE LAYER	BASE LAYER	FRAMING	OPPOSITE FACE	INSULATION	COST PER S.F.		
						MAT.	INST.	TOTAL
1200	5/8" FR drywall	none	2 x 4, @ 16" O.C.	same	0	1.17	2.83	4
1250				5/8" reg. drywall	0	1.15	2.83	3.98
1300				nothing	0	.79	1.89	2.68
1400		1/4" SD gypsum	2 x 4 @ 16" O.C.	same	1-1/2" fiberglass	2.45	4.36	6.81
1450				5/8" FR drywall	1-1/2" fiberglass	2.16	3.83	5.99
1500				nothing	1-1/2" fiberglass	1.78	2.89	4.67
1600		resil. channels	2 x 4 @ 16", O.C.	same	1-1/2" fiberglass	2.18	5.55	7.73
1650				5/8" FR drywall	1-1/2" fiberglass	2.03	4.42	6.45
1700				nothing	1-1/2" fiberglass	1.65	3.48	5.13
1800		5/8" FR drywall	2 x 4 @ 24" O.C.	same	0	1.73	3.58	5.31
1850				5/8" FR drywall	0	1.40	3.11	4.51
1900				nothing	0	1.02	2.17	3.19
2200		5/8" FR drywall	2 rows-2 x 4 16"O.C.	same	2" fiberglass	2.99	5.20	8.19
2250				5/8" FR drywall	2" fiberglass	2.66	4.72	7.38
2300				nothing	2" fiberglass	2.28	3.78	6.06
2400	5/8" WR drywall	none	2 x 4, @ 16" O.C.	same	0	1.25	2.83	4.08
2450				5/8" FR drywall	0	1.21	2.83	4.04
2500				nothing	0	.83	1.89	2.72
2600		5/8" FR drywall	2 x 4, @ 24" O.C.	same	0	1.81	3.58	5.39
2650				5/8" FR drywall	0	1.44	3.11	4.55
2700				nothing	0	1.06	2.17	3.23
2800	5/8 VF drywall	none	2 x 4, @ 16" O.C.	same	0	2.13	3.05	5.18
2850				5/8" FR drywall	0	1.65	2.94	4.59
2900				nothing	0	1.27	2	3.27

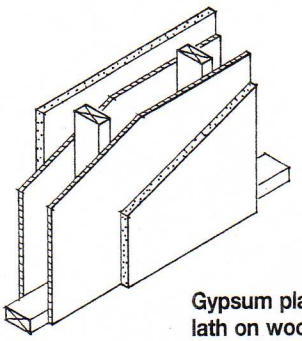
C1010 Partitions



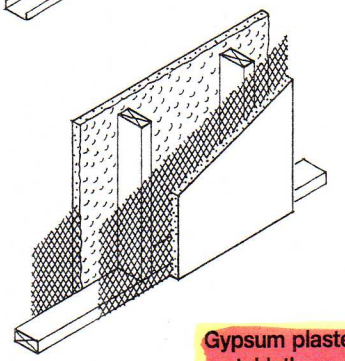
Gypsum plaster and gypsum lath on metal studs.



Gypsum plaster and diamond metal lath on metal studs.



Gypsum plaster and gypsum lath on wood studs.



Gypsum plaster and diamond metal lath on wood studs.

C1010 140 Plaster Partitions/Metal Stud Framing

	TYPE	FRAMING	LATH	OPPOSITE FACE		COST PER S.F. MAT.	INST.	TOTAL
1000	2 coat gypsum	2-1/2" @ 16"O.C.	3/8" gypsum	same		2.67	6.90	9.57
1010				nothing		1.56	4.01	5.57
1100		3-1/4" @ 24"O.C.	1/2" gypsum	same		2.77	6.70	9.47
1110				nothing		1.58	3.72	5.30
1500	2 coat vermiculite	2-1/2" @ 16"O.C.	3/8" gypsum	same		2.54	7.50	10.04
1510				nothing		1.49	4.33	5.82
1600		3-1/4" @ 24"O.C.	1/2" gypsum	same		2.64	7.30	9.94
1610				nothing		1.51	4.04	5.55
2000	3 coat gypsum	2-1/2" @ 16"O.C.	3/8" gypsum	same		2.56	7.90	10.46
2010				nothing		1.50	4.51	6.01
2020			3.4lb. diamond	same		2.29	7.90	10.19
2030				nothing		1.37	4.51	5.88
2040			2.75lb. ribbed	same		2.09	7.90	9.99
2050				nothing		1.27	4.51	5.78
2100		3-1/4" @ 24"O.C.	1/2" gypsum	same		2.66	7.65	10.31
2110				nothing		1.52	4.22	5.74
2120			3.4lb. ribbed	same		2.42	7.65	10.07
2130				nothing		1.41	4.22	5.63
3500	3 coat gypsum	2-1/2" @ 16"O.C.	3/8" gypsum	same		3.16	10.15	13.31
3510	W/med. Keenes			nothing		1.80	5.65	7.45
3520			3.4lb. diamond	same		2.89	10.15	13.04
3530				nothing		1.67	5.65	7.32
3540			2.75lb. ribbed	same		2.69	10.15	12.84
3550				nothing		1.57	5.65	7.22
3600		3-1/4" @ 24"O.C.	1/2" gypsum	same		3.26	9.90	13.16
3610				nothing		1.82	5.35	7.17
3620			3.4lb. ribbed	same		3.02	9.90	12.92
3630				nothing		1.71	5.35	7.06

C1010 Partitions

C1010 140 Plaster Partitions/Metal Stud Framing

	TYPE	FRAMING	LATH	OPPOSITE FACE		COST PER S.F. MAT.	INST.	TOTAL
4000	3 coat gypsum W/hard Keenes	2-1/2" @ 16"O.C.	3/8" gypsum	same		3.17	11.25	14.42
4010				nothing		1.80	6.15	7.95
4022		2-1/2" @ 16"O.C.	3.4 lb. diamond	same		2.90	11.25	14.15
4032				nothing		1.67	6.15	7.82
4040			2.75lb. ribbed	same		2.70	11.25	13.95
4050				nothing		1.57	6.15	7.72
4100		3-1/4" @ 24"O.C.	1/2" gypsum	same		3.27	11	14.27
4110				nothing		1.82	5.85	7.67
4120			3.4lb. ribbed	same		3.03	11	14.03
4130				nothing		1.71	5.85	7.56

C1010 142 Plaster Partitions/Wood Stud Framing

	TYPE	FRAMING	LATH	OPPOSITE FACE		COST PER S.F. MAT.	INST.	TOTAL
5000	2 coat gypsum	2"x4" @ 16"O.C.	3/8" gypsum	same		2.73	6.75	9.48
5010				nothing		1.62	3.92	5.54
5100		2"x4" @ 24"O.C.	1/2" gypsum	same		2.79	6.65	9.44
5110				nothing		1.60	3.76	5.36
5500	2 coat vermiculite	2"x4" @ 16"O.C.	3/8" gypsum	same		2.60	7.35	9.95
5510				nothing		1.55	4.24	5.79
5600		2"x4" @ 24"O.C.	1/2" gypsum	same		2.66	7.25	9.91
5610				nothing		1.53	4.08	5.61
6000	3 coat gypsum	2"x4" @ 16"O.C.	3/8" gypsum	same		2.62	7.75	10.37
6010				nothing		1.56	4.42	5.98
6020			3.4lb. diamond	same		2.35	7.80	10.15
6030				nothing		1.43	4.45	5.88
6040			2.75lb. ribbed	same		2.12	7.85	9.97
6050				nothing		1.32	4.47	5.79
6100		2"x4" @ 24"O.C.	1/2" gypsum	same		2.68	7.60	10.28
6110				nothing		1.54	4.26	5.80
6120			3.4lb. ribbed	same		2.05	7.70	9.75
6130				nothing		1.23	4.30	5.53
7500	3 coat gypsum W/med Keenes	2"x4" @ 16"O.C.	3/8" gypsum	same		3.22	10	13.22
7510				nothing		1.86	5.55	7.41
7520			3.4lb. diamond	same		2.95	10.05	13
7530				nothing		1.73	5.55	7.28
7540			2.75lb. ribbed	same		2.72	10.10	12.82
7550				nothing		1.62	5.60	7.22
7600		2"x4" @ 24"O.C.	1/2" gypsum	same		3.28	9.85	13.13
7610				nothing		1.84	5.40	7.24
7620			3.4lb. ribbed	same		3.04	10.05	13.09
7630				nothing		1.73	5.45	7.18
8000	3 coat gypsum W/hard Keenes	2"x4" @ 16"O.C.	3/8" gypsum	same		3.23	11.05	14.28
8010				nothing		1.86	6.05	7.91
8020			3.4lb. diamond	same		2.96	11.15	14.11
8030				nothing		1.73	6.10	7.83
8040			2.75lb. ribbed	same		2.73	11.15	13.88
8050				nothing		1.62	6.10	7.72
8100		2"x4" @ 24"O.C.	1/2" gypsum	same		3.29	10.95	14.24
8110				nothing		1.84	5.90	7.74
8120			3.4lb. ribbed	same		3.05	11.10	14.15
8130				nothing		1.73	6	7.73