Canton Crossing Tower

Baltimore, Maryland

Final Thesis Report

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Construction Management Option
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Canton Crossing Tower
Baltimore, Maryland

HALE PROPERTIES

Gilbane

Project Team

- Owner—Hale Properties
- CM—Gilbane Building Company
- Architects—WBCM, LLC
- Consultants
    - Architectural—Arium, Inc.
    - Engineering—Gipe Associates, Inc.

Project Features

- Duration —12/20/04—5/31/06
- Size - 20 Stories (519,401 sq. ft.)
- Total Cost—$ 51,525,571
- Delivery Method—CM At Risk w/ GMP
- Building Use—Mixed Use Tenants
- Main Tenant—First Mariner Bank
- Utility Distribution—Tower fed by Central Utility Plant located across street

Architectural & Structural

- Foundation —20" Square Precast, Pre-stressed Concrete Piles
- Structure—Composite Steel Framing System with
- Floors—3" Composite Metal Deck with 6-1/4" Lightweight Concrete Slabs
- Exterior Walls—Precast veneered with thin faced brick
- Glazing—Curtain walls & aluminum window glazing systems
- Roof— Hipped Roof (77' Above Last Occ. Flr.)
- Building Use—First Mariner Bank & Mixed Use Tenants

Mechanical, Electrical, Lighting

- Mechanical —Two 8500 cfm AHU's per Floor, Two ERVs on Mech Room Floor
    - 2500 ton Chiller, 3 Boilers, 2 Cooling Towers in Central Plant
- Electrical— 480/277, 3-phase, 4 wire panels
    - 2—13.8 kV Open Loop and 2—4160 V Emergency Feeders from Central Plant
- Lighting—Architectural fluorescents in public areas, tenant areas 277V fluorescents

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CM Option

http://www.arche.psu.edu/thesis/eportfolio/2007/portfolios/TWS148/

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Acknowledgements

Penn State AE Faculty

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Mr. Stephen McLaughlin – Arium Architects

Mr. Mike Prinkey – Penn State University OPP

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Mr. Andrew Rhodes – Mechanical Option

Mr. Chris Ankeny – Electrical Option

Mr. Thaddeus Maugle – Construction Option

Mr. Derek DiPiazza – Construction Option

Most importantly my family and my fiancée Ashleigh Harbaugh for helping me through all of the hard work and trying times!

Executive Summary

The Canton Crossing Tower is the first of 14+ buildings being built in Hale Properties' Planned Unit development of the 65 acre campus in Canton, which is the southeastern portion of Baltimore City. From the architect; "this project is one of the most significant projects to be developed in Baltimore since the Inner Harbor Development created by the Rouse Company and will contain over $150 million in development to the area." (www.wbcm.com)

The attached report is a research report on the Canton Crossing Tower. The report is broken down into six major categories; Project Design Overview, Project Team Overview, Existing Conditions, Research Topic, Technical Analysis 1, and Technical Analysis 2. At the end of the report is an Appendix section which contains documents that parallel the body of the report.

The Research Topic looks at developing a LEED guide for developers who do not presently develop LEED projects. The research analyzed ten projects from four different types of developers; Core and Shell, Own/Occupy, Higher Education, and Build-Lease/Sell. A guide was then developed for each developer. Also, an analysis of how Penn State University compares to the ten other universities researched is illustrated.

The first Technical Analysis was looking at the tower as an independent system, contrary to the initial design which included a Central Plant that housed the mechanical and electrical equipment for the tower. The second Technical Analysis was a redesign of the tower's foundation system from precast concrete piles to cast-in-place concrete caissons.

Project Design Overview

Primary Engineering Systems

Architecture (Design and Functional Components):

The Canton Crossing Tower is the first of many new additions to the 65-acre Canton Crossing campus. The campus is located in the Southeastern portion of Baltimore City just outside of Baltimore's Inner Harbor, known as Canton. Developer, Edwin F. Hale Sr. of Hale Properties, envisions Canton Crossing as "The City within the City". The tower spearheads the construction of the campus that will ultimately consist of more than 1 million square feet of Class-A office space, 250,000 square feet of retail space, 500 condominiums, a 450-unit upscale hotel, and a marina pier. The tower itself has been designed as a 17-story building that will house over 475,000 square feet of commercial space.

Fig 1 – Canton Crossing Master Plan

The octagonal shaped building's exterior architectural features are highlighted by the hipped roof with a metal roofing cap that towers 77' above top floor. The core and shell design provides nearly 30,000 square feet of rentable office space per floor. To maximize the buildings leasable space and accompany the unique hipped roof design, a

2-story Utility Distribution Center (UDC) was built across the street from the tower. The UDC houses the main mechanical and electrical systems that power the building.

With its unique location, the tower provides breathtaking views of Baltimore's Inner Harbor, as well the city's entire skyline. Even as Canton Crossing continues to grow, the Canton Crossing Tower will remain the tallest building throughout the campus. Since it is easily visible from busy locations such as the Inner Harbor, Fort McHenry, and Interstate 95 & 895, the Canton Crossing Tower is sure to put Canton on the map.

Building Envelope:

The building envelope of the tower is quite unique. The tower has an octagonal shaped shell. The four largest sides of the building are comprised of precast concrete panels with thin face brick and 6" deep aluminum window wall systems. The top of these four sides are completed with a triangular peak which is home to the 1st Mariner Bank name and symbol in gold. Two of the smaller sides are the grand entrances, located on either side of the building. These walls are designed with a 7 ½" deep aluminum curtain wall system. The final two sides of the tower are designed the same as the four large ones with the 6" deep aluminum window wall systems. The four smaller sides are all capped off with balconies on the 17th floor.

Fig 2 – Building Rendering

The roof of the Canton Crossing Tower is what makes this high-rise building distinctive. The hipped roof design towers 77' above the top floor. Each of the four hips is covered by a standing seam metal roof. In between the four hips, the core is covered by insulated aluminum panels that then meet the standing seam metal roof cap. The peak of the 17-story building is complimented by a flag pole.

Construction:

Fig 3 – Existing Site Aerial View

The site for Canton Crossing Tower caused dilemmas for the construction team from day one. The site, the former location of an Exxon terminal, was bid as a clean site but was far from it. The soil on the site was classified as contaminated soil and required a Corrective Action Plan (CAP) for the remediation of light non-aqueous phase liquids (LNAPL). The plan included the excavation and transportation of the contaminated soils to an offsite location. Also, before anyone was permitted to work in the contaminated soils they must first complete a 40 hour Hazardous Awareness Training.

Fig 4 – Steel & Precast Erection with a view of fireproofing plastic

Once the project broke ground the concrete piles began to be placed. The steel structure was erected at a very rapid pace. The construction manager followed a demanding schedule of one floor per week. The one floor per week included all of the following; structural steel placed, metal decking placed, and the suspended concrete slab poured. Also, as a safety measure, 75% of the above floor metal decking had to be placed before work began on the floor below. At times the schedule seemed in jeopardy, but by the aggressive management of many individuals the schedule was able to be attained.

The site logistics were in the favor of the construction team for this project. The large site footprint made steel staging a manageable task. Other positive site features were the two surrounding public roadways running on either side of the tower. These, along with the immediate access to Interstate 95, gave some leeway to the delivery methods. Two tower cranes were used for the steel erection and the concrete slabs were placed by pump. The construction team also had two material hoists that ran the length of the 17-story tower during construction. These hoists were crucial to the project because with no elevators, production would have been seriously affected.

As the contract with the owner was for simply the core and shell of the building, the tenant fit-out brought the most challenging aspect of managing the project. Gilbane, the base building CM, was not awarded any of the tenant's CM contracts. Therefore while Gilbane was attempting to complete the base building, tenant hired CM's were beginning their work on the rented floors. Intense coordination and good cooperation had to be implemented for the parties to work side by side.

Electrical:

The tower's electric systems begin at the Central Plant building where the power is housed. In the electrical room of the plant is the Main Service Switchgear (13.2 kV) and the substation with two 3,500 kVA transformers. The power is transferred to the power through 2 – 9-way ductbanks, one for normal power and one for emergency power. The 15 kV switchgear located in the Ground Floor Electrical Room of the tower is where the 13.8 kV normal open loop feeders enter from the Central Plant Ductbanks. The power runs vertically through the entire building through 7 main busways, with one more optional plug-in busway. The busways run through electrical rooms that are located on each side of the tower's core. The one room houses a lighting busway (600A, 480/277V, 3θ, 4W), computer busway (1600A, 480V, 3θ, 3W), emergency life safety busway (600A, 480/277V, 3θ, 4W), and an emergency standby busway (600A, 480/277V, 3θ, 4W). The opposite electrical room houses the HVAC busway (2000A, 480/277V, 3θ, 4W), computer busway (1600A, 480V, 3θ, 3W), lighting busway (1600A, 480/277V, 3θ, 4W), and the optional standby busway (800A, 480V, 3θ, 4W). Each electrical room is also equipped with 3 transformers and six electrical panels. On the 18th floor, the electrical systems floor, the busways come to six ATS's, two main substations, and an emergency substation.

Fig 5 – Typical Floor Electrical Rm showing bust ducts and a transformer

Lighting:

The tower's interior lighting fixture schedule is mostly comprised of 277 V recess mounted fluorescent lamps. The lighting of the building is served via 480/277, 3-phase, 4 wire panels. On the ground floor, the lighting was designed with more of an architectural purpose. This floor's lighting ranges from polished brass wall mounted fixtures to ceiling recessed compact fluorescent downlights. The typical floors contain 2'x2' parabolic fluorescent fixtures in the core areas and 4' heavy duty industrial fluorescents in the tenant shell areas. On the exterior hardscape of the tower, pole mounted light fixtures, in-grade up lights, and bollard lights combine to beautify the surrounding area.

Fig 6 – Architectural Lighting in main lobby

Mechanical:

The mechanical design in the tower is based on two air handling units located on each floor. The units are constant volume vertical air units (8500 cfm), each consisting of a mixing box, chilled water cooling coil and fan. The feeds from these units are predominantly routed down each corridor in the ceiling space of the tower's core. The ducts from the corridor also branch out to the shell area.

The shell is equipped with 8 different VAV boxes. Due to the tower being a tenant fit out building, the ducts are run to the shell and then capped off. This allows tenants to design and construct the mechanical system for their unique spaces. The mechanical room floor, located on the 19th floor, is where the two Energy Recovery Ventilators (ERVs) are positioned. The two ERV units are fed from the ventilation air supply and return ducts that run vertically up the building through the designed duct shafts located beside the mechanical rooms. The Central Plant designed to power the building will house the 2500 ton chiller, three hot water boilers, and two cooling towers. The plant has been designed for future expansion of the Canton campus as well, for example, locations for 3 additional 2500 ton chillers and 3 more hot water boilers.

Fig 7 – Mechanical Room showing Air Handling Unit

Structural:

The structural system in the Canton Crossing Tower starts with a foundation comprised of precast, prestressed concrete piles. The 20" square piles, which use 7000 psi concrete, are situated underneath pile caps. These pile caps are located on the column grid and each covers roughly 4-10 piles.

Fig 8 – Aerial view showing poured pile caps and beginning of column erection

The structure of the tower is made up of a composite steel framing system. Each floor has 3" composite metal decking with a 6-1/4" thick lightweight concrete (3500 psi). The reinforcing used is the new high strength billet steel. A typical bay in the tenant shell space, sized at 37' x 43'3", is laid out with beams at W18x35 and girders ranging from W24x62 to W33x118. In the core area, beams are typically W16x26 and W16x31 while the girders range from W14x22 to W40x249. With floor heights at 13'4", the columns are all designed as W14's. The weights of the columns vary from

Fig 9 – Steel Column Erection view from Gilbane's field trailer

82 lb/ft to 605 lb/ft. The columns ultimately rest on top of the pile caps at the foundation level.

The primary lateral system in the building are braced frames, both concentrically braced and eccentrically braced. Moment frames are also used as a lateral system around the perimeter of the building. The lower level of the hipped roof system has a typical beam size of W16x26 and a typical girder size of W24x76. The upper level of the roof use W12x26 beams and W33x118 girders.

The steel of the building was placed using two tower cranes positioned on the North and South ends of the towers exterior perimeter. The height of the tower cranes were 340 ft & 380 ft respectively. They have a concrete foundation with eight precast piles under each. The pieces of the cranes, known as "towers", were each approximately 20' tall. To remain structurally safe, the maximum free standing towers are nine or 180'. Once the cranes were above the 180' height limit, they had to be tied into the building structure.

Fig 10 – Tower cranes from afar

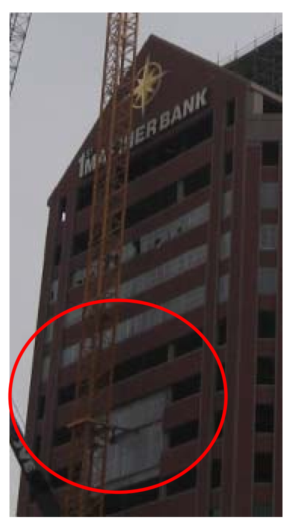


Fig 11 – Tower crane connection to building

Additional Engineering and Engineering Support Systems

Fire Protection:

Fig 12 – Fire Command Center

The tower was designed as a wet sprinkler system except in the loading dock area where a dry system was installed. The fire pump was reduced in size through value engineering to a 750 gpm pump. Each 20-story stairwell contains a 6" standpipe. A jockey pump is used to maintain the pressure in the building at 175 psi. The Fire Command Center is located on the Ground Floor near the West Entrance and houses the Fire Alarm Panel, Fireman's Override Panel, Fire Annunciator Panel, etc. Each typical floor, including core and shell, is equipped with manual pull stations, fire alarm strobes, ceiling mounted smoke detectors, and ceiling mounted fire alarm speakers.

Fig 13 – Fire Pump Room

Transportation:

The building consists of 8 traction elevators, four on each side of the lobby. One of the eight elevators will be used as a service elevator with a capacity of 4,500 lbs and speed of 700 f.p.m. The service elevator will stop on all floors up to the 19th floor. The other 7 elevators are strictly passenger elevators with a capacity of 3,500 lbs and a speed of 700 f.p.m. These elevators will stop on all floors up to the 17th floor. The elevator pits are approximately 8'4" deep with a sump pump in each pit. The 20th floor of the tower houses the elevator machine room.

Fig 14 – Elevator Machine Room

Telecommunications:

Due to the 17-story office tower being designed as a tenant fit-out, the telecommunications aspect of the base building is somewhat minute. The Main Telecommunications Room on the ground floor is where the 12-way incoming ductbank enters from the Central Plant. Each of the typical floors is equipped with two Tele/Data Rooms. Under base building contract, these rooms are built so that each tenant may come in and fit-out their own telecommunications system.

The security system of the building is important because the main tenant of the tower is 1st Mariner Bank. The owner opted to hold the contract with the security subcontractor as opposed to Gilbane holding that contract. The tower is inaccessible to the public after hours, with a 24-hour security crew on board. The exterior entrances are equipped with a telecom system for entry during non-working hours. Each interior floor has been set up with four security cameras that monitor the entire core area.

Demolition Required

No demolition was required for the Canton Crossing Tower.

Cast in Place Concrete

The cast in place concrete for the composite floor slabs is lightweight with a minimum compressive strength of 3500 psi. The 3" metal decking will act as the horizontal formwork for the concrete, while the steel toe plate around the perimeter will act as the vertical formwork. The concrete is to be poured in strips perpendicular to the steel girders. The cast in place concrete is placed by the pump method.

Fig 15 – Concrete Pump during foundation pours

Precast Concrete

The architectural precast panels that were designed for the tower were constructed by The Shockey Precast Group at their plant in Winchester, Virginia. The panels were then transferred by tractor and trailer to the construction site as needed for erection. The two tower cranes were used for the erection of the precast panels.

Precast connections were detailed by Shockey. The connections were a combination of L-shaped steel angles for lateral support, with bearing connection plates embedded in the concrete. The angles were attached to the structure columns and welded to embedded plates in the precast.

Fig 16 – Precast connections to steel columns

Masonry

The masonry used in the tower was very minimal. At locations where masonry was used, it was non-load bearing.

Support of Excavation

The building required a minimal amount of excavation, therefore the only excavation support system needed was around the elevator pits where sheeting and shoring was used. There was no dewatering system used on the project due to the minor excavation.

Fig 17 – Shoring for elevator pits

Client Information

The owner of the Canton Crossing Tower, Hale Properties, built the tower as the first building in their Planned Unit Development (PUD). The company, founded by Edwin F. Hale, Sr. in 1978, is a developer, owner and manager of east coast real estate. Hale Properties' vision is to completely change the existing industrial area of Canton, into a thriving area where individuals can "live, work, and play." The team's PUD had to gain approval from the city of Baltimore before the development of Canton Crossing could occur.

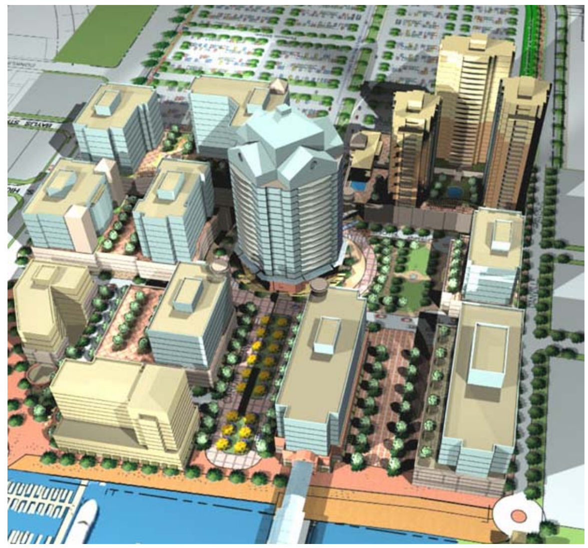


Fig 5– 3D aerial of the Planned Unit Development (PUD)

The cost of the project was set between the Owner (Hale Properties) and the General Contractor (Gilbane) as a Guaranteed Maximum Price of nearly $52 million. The existing offices of Hale Properties are located directly adjacent to the new construction lot of the tower. This made it very easy for both parties, the Owner and the GC, to control quality issues. Both teams embraced the convenient location and used it to their advantage throughout construction. Issues such as first delivery inspections, mock-ups, color schemes for finishes, etc. could be discussed by both teams and decisions were made in a more timely fashion. The schedule of construction was critical to the owner's interests for the major factor of tenant fit-outs. The sooner the

GC could complete the core and shell of the tower, the sooner the new tenants could begin their fit outs. Hale Properties watched the schedule rather closely because of the amount of money that could potentially be lost due to late tenant move-in. Rather than this issue becoming a problem, both teams worked vigorously together as one to assure a beneficial occupancy date as close to the original as possible. The building requiring over 20 stories of steel erection caused safety to be a pivotal factor in the successful completion of the tower. From the very start, Hale Properties did everything possible to help Gilbane implement their Project Safety Plan. At no point did the schedule, cost, and/or quality of the building take precedence over safety.

Fig 6– Project Safety Day presented by Gilbane

The sequencing of construction of this project is of utmost interest to the owner because of tenant fit-outs. The first step in the process is the completion of the core and shell of the building. To speed up the tenant move in dates, the Owner decided to allow the tenant space GC's to begin working simultaneously with Gilbane. Most importantly, the core and shell GC (Gilbane) must have their Certificate of Occupancy from the Baltimore City Fire Marshall before the tenants could apply for their own. The Certificate of Occupancy was the key factor to completing the tower on schedule and to the owner's satisfaction. This was made possible through exceptional communication lines being drawn between Hale Properties, Gilbane, and tenant fit out GC's. Also, the tremendous cooperation from the Baltimore City Fire Marshall was imperative.

Project Delivery System

The construction of the Canton Crossing tower is being delivered as a Construction Management at Risk with a Guaranteed Maximum Price contract with the owner. The CM at Risk delivery method was chosen to help alleviate some of the duties, such as managing the subcontractors, from the Hale Properties staff team. The GMP contract is typical for Gilbane and was what their team proposed.

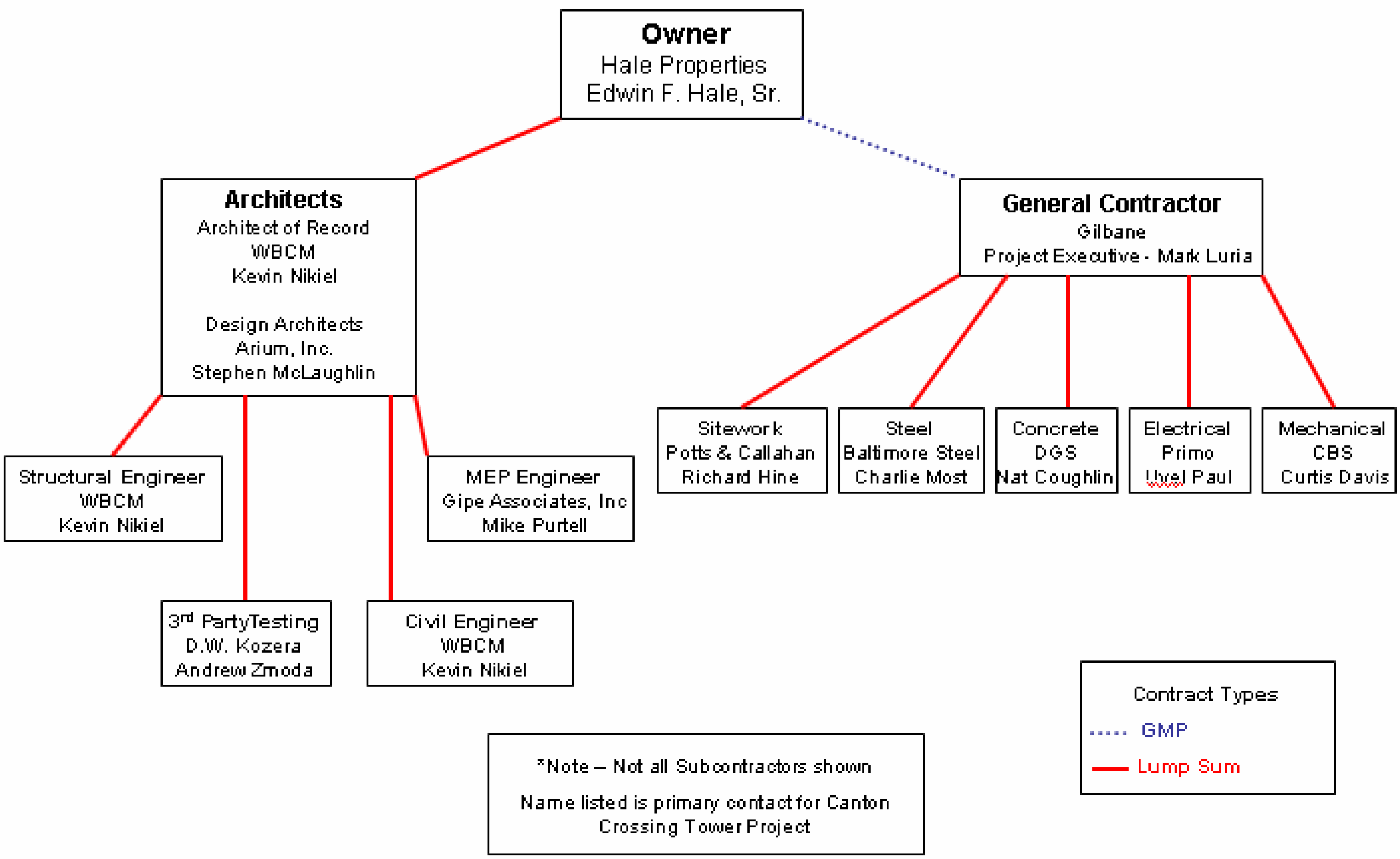
The contract between Hale Properties and Gilbane was a GMP of nearly $52 million and schedule duration of 18 months. The lump sum contracts that Gilbane holds with the subcontractors specify all of the following; list of contract documents, scope of work (inclusions and exclusions), bid breakdown, unit rates, construction milestones, termination conditions, change order process, bonds and insurance, paid when paid conditions, etc.

The Owner-CM contract was based on a prior relationship between Gilbane's Regional Manager and Hale Properties Owner Mr. Hale. Gilbane did not bid the project with the other GC's; instead they negotiated with the owner through the design phases (SD, DD, & CD) by providing estimates and value engineering ideas. At the completion of the Construction Documents, Gilbane then submitted a GMP to be reviewed and approved by the owner. The subcontractor's were selected through a process that reviewed several of the low bids. The process consisted of scope review meetings and review of bond qualifications. Through all of these parameters a subcontractor was chosen, meaning the low bidder was not always chosen.

The owner held the builder's risk insurance for the project, which almost immediately was put into effect. After a barge of precast piles tipped over, the insurance teams were called into action, specifically the builder's risk. The cost of the materials was paid in full by the insurance group. Gilbane carried general liability, automobile, comprehensive, and worker's compensation insurance, but was not required to be bonded. Instead the executives, through a solid relationship with the owner, guaranteed the work on the job. Gilbane requires each subcontractor to have a performance and payment bond, and on this project those bonds accounted for the majority of the contract. This allowed Mr. Hale to save some expenses and not require Gilbane to be bonded. Each subcontractor also had to provide general liability insurance, excess liability insurance, automobile insurance, and worker's compensation insurance. The subcontractors also held Hale Properties and Gilbane as additional insurers in their umbrella.

The CM at Risk delivery method used for the tower was appropriate because Gilbane needed control over the subcontractors to complete the intense 18 month schedule. However, since Gilbane was involved in the design phase, there is a possibility that a Design-Build delivery could have been beneficial to them. Typically design-build gives the owner less control of the design issues, which Hale Properties was not interested in. Also, a Design-Build-Finance approach was mentioned during negotiation but decided against by the team. Overall, the CM at Risk with a GMP contract seemed to be successful.

Canton Crossing Tower Organizational Chart



Detailed Project Schedule

The Canton Crossing Tower detailed schedule that is shown in the Appendix section on pages 3-7 consists of 200 items. The schedule is broken into categories by trade, making it easier to follow through chronological order. The tower had a demanding schedule of 18-months, with on-site construction beginning on February 7th, 2005 and project completion on July 27th, 2006. The schedule is currently showing exactly one day of total float for the project. The steel and concrete contractors each had one week to complete a typical floor. Each trade was followed closely by the next trade in line, leaving no room for delays. All trades had input and agreed upon this schedule at an initial project schedule meeting. The superintendent's two-week look-ahead meetings, held weekly, were important to the success of the on time completion.

Site Plan of Existing Conditions

Vicinity Maps

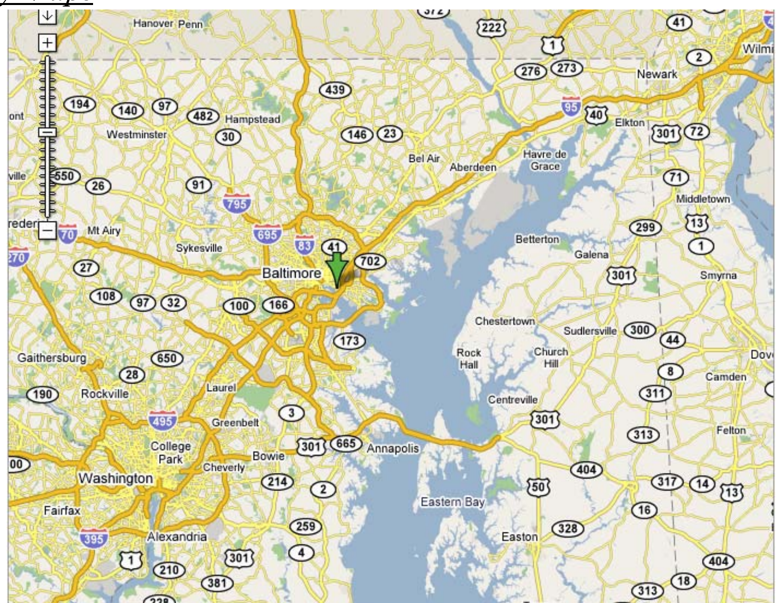


Fig 1 – Project vicinity map (Greater Baltimore and DC areas)

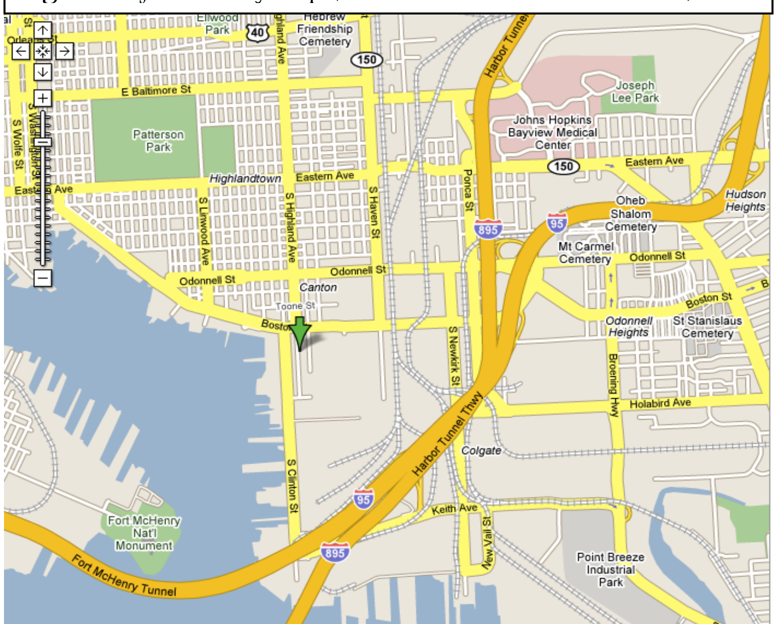


Fig 2– Project vicinity map (Canton and surrounding areas)

** Site Logistics Plan shown on Page 2 of the Appendix Section

Local Conditions

The site of construction for the Canton Crossing Tower is located in the Southeastern part of Baltimore City, otherwise known as Canton. The existing site and adjacent site locations of the Canton Crossing Tower were classified as an industrial area and were previously vacant. In order for the rezoning from industrial to commercial to occur, Hale Properties had to submit a Planned Unit Development (PUD) to Baltimore City. Once approved by the city, the rezoning occurred and construction development began. The tower building was the first of 14+ buildings being built in the 65 acre campus. The methods of construction, as well as the architectural style, used on the tower building will be the beginning of the new style of the Canton Crossing Campus.

The site logistics plan for construction of the tower was favorable to the General Contractor. There is no demolition required onsite before construction, and the existing active utilities are water main and overhead electric. The lot the building sits on is roughly 1.23 acres. Directly adjacent to this lot is a 1.47 acre lot that is available for trailers, steel staging and laydown areas, and dumpsters. Across the street from these lots is a 3+ acre empty lot that can easily hold more trailers, as well as the construction parking for the project. On the opposite side of the street, an existing 2

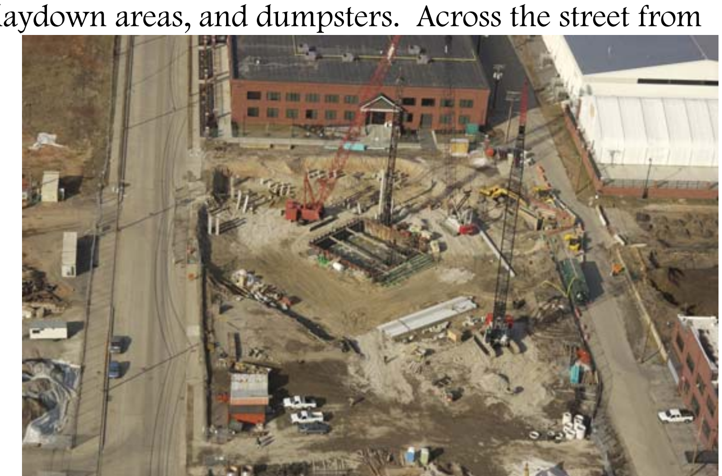


Fig 4– Aerial view of existing site conditions

story warehouse building (also owned by Hale Properties), is the location of the General Contractor's office.

The existing soil conditions became a major issue for the whole construction team in the construction of the tower. A large portion of the Canton Crossing Campus was previously the site of an Exxon Terminal that handled heavy-weight fuel oils. Due to impacts from the terminal, all of the soils on the site have been classified as contaminated. Therefore a Corrective Action Plan (CAP) had to be implemented for the excavation and off-site transportation of the petroleum saturated soils.

The Geotechnical Engineering Study by D.W. Kozera indicates site soils are underlain by a layer of man-made fill, which is then underlain by recent alluvial deposits. Also, since the site is part of the Atlantic Coastal Plain Physiographic Province, the site soils are also underlain by the Potomac Group deposits of the Cretaceous age. These deposits lie above the bedrock that is approximately 200' below ground. The water table is high on the project, sitting just 8' below finished grade.

Research Topic

LEED® Guide for Developers

Problem

Despite the ever-growing participation of development teams to the LEED® classification system, these individuals are not equipped with a user friendly guide for the successful implementation of LEED® points on their building(s). Making this type of guide or tutorial available to both inexperience and experienced development teams would not only gain interest into LEED®, but also set the team up for success in the LEED® system.

Goal

The goal is to provide a developer a guide that, if used from the start of design, can help them to understand the LEED® classification system and to develop buildings and areas that excel under LEED® criterion. I gained an interest in this because of my direct involvement with Hale Properties, who is the developer for Canton Crossing, which is the 60+ acre area in which the Canton Crossing Tower was built. Hale Properties just built the first building of 14+ from the Planned Unit Development (PUD) of Canton Crossing. If the LEED® system could have been introduced to them at the design phase, they could have implemented it into their entire PUD. By analyzing previous development projects and how they scored on the LEED® system, I will be able to educate future LEED® developers on ways to succeed. The guide I am developing will be a user friendly way for developers to be educated about the LEED® system and how to use it on their projects.

Research Techniques

1. Before I can develop a guide to educate individuals on the LEED® system, I must first gain an in-depth knowledge of the subject matter. Therefore, time must first be spent learning the system thoroughly, and its application to development specifically.
2. Identify four business models of developers and begin to research them and their LEED® success.
3. Research ten projects of each model, being sure there vary in location and certification level to keep the research unbiased.
4. After analyzing ten projects of each business model, begin to determine what LEED® categories are most important to each model.
5. Compare the four types of developers directly against one another to look for any obvious similarities or differences.
6. For my interest, I then will examine how Penn State's Office of Physical Plant's (OPP) LEED® point checklist compares to ten other universities throughout the country.
7. Finally I will compile all my results and create a LEED® point checklist for each of the different types of developers.

Tools

1. U.S. Green Building Council (USGBC) website (www.usgbc.org)
2. U.S. Department of Energy Federal Energy Management Program website (www.eere.energy.gov/)
3. LEED® Green Building Rating System for New Construction and Major
4. Renovations (LEED®-NC) Version 2.1
5. LEED® Green Building Rating System for Core and Shell Developement (LEED®-CS) Version 2.0
6. PSU LEED® Requirements – Distributed by Mike Prinkey – PSU OPP
7. Microsoft Excel

Types of Developers

To narrow my research topic I decided to choose four different types of developers. Upon choosing my developers I wanted to be sure the four I chose would make an interesting comparison of LEED® scores from their own unique developing styles. The first developers I chose are those who develop with the intent on owning and occupy the building once it is built. Next are developers who plan on leasing or selling their building at its completion. The third developer is strictly core and shell development with tenant fit-out construction of the building. This is the type of construction that the Canton Crossing Tower was based upon. Finally, I thought it would be beneficial to analyze higher education developers. Not only did I compare

their values to the three developers mentioned above, but also with Penn State OPP's LEED® point checklist to see where Penn State stands among the other ten universities.

An important thing to note is the core and shell developers will be investigated using the LEED®-CS Version 2.0. The LEED®-CS program was created for developers of core and shell and deals specifically with what the developer has direct control over. In addition to LEED®-CS, USGC has created LEED®-CI (Commercial Interiors) to work in unison with LEED®-CS. For this research, LEED®-CI will not be analyzed. The rest of the developers were researched using LEED®-NC Version 2.1. The way the research was conducted this will not effect the outcomes, but to be truthful it should be noted.

Project Selection

The project selection portion of my research was the most important. I wanted to look at an ample amount of projects to really make these findings an accurate display of LEED® scores. As I mentioned previously, I chose ten separate projects for each type of development. The most important things when choosing the projects were LEED® score and location. I wanted the four groups to all have a similar average LEED® score between the ten of them. This goal was achieved rather precisely with the core and shell (avg. 35), own and occupy (avg. 38.5), and build-sell/lease (avg. 35.3), and higher education (avg. 34.3). The four group's averages put them all at the Silver LEED® rating. As for location, I tried to vary it all through the nation with no major tendencies or similarities. I felt these two topics were the best way to keep any bias out of the research. Show below in *Table R1.1* is the project directory by developers.

Table R1.1

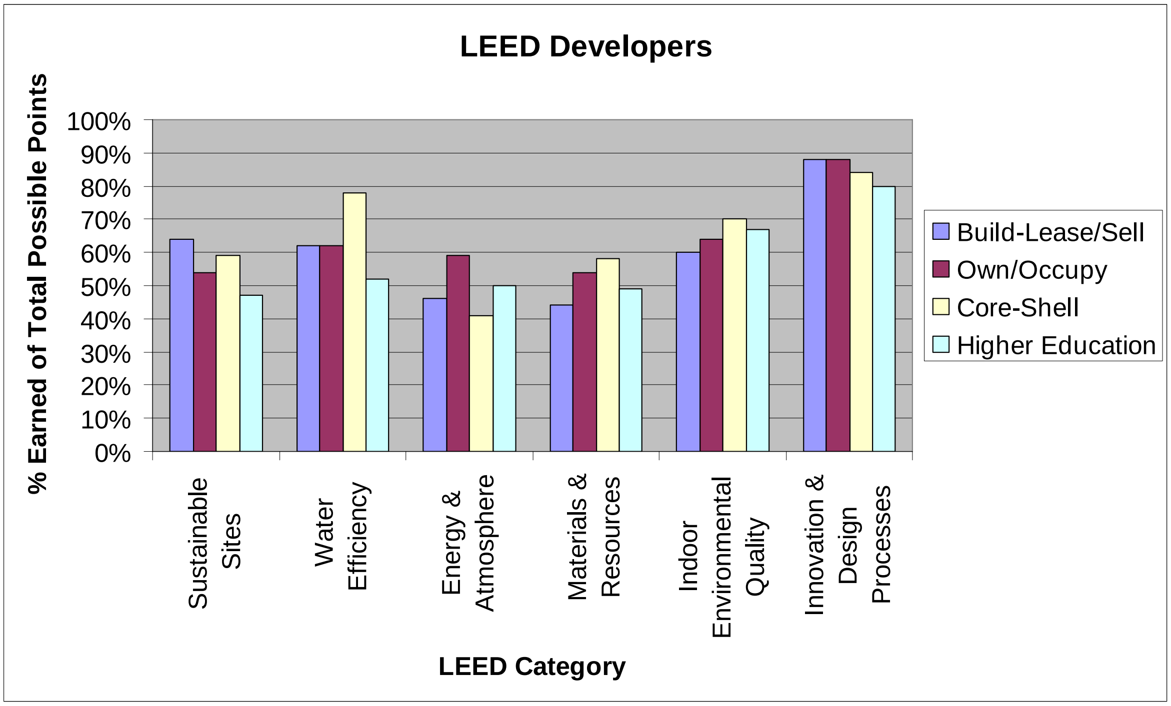
Core-Shell Projects			
Project	**LEED Rating**	**Points Earned (Avg. = 35)**	**Project Location**
Harborside Office Center	Silver	32	Port Huron, MI
Waterfront Technology Center at Camden	Gold	36	Camden, NJ
420 Delaware Drive	Silver	28	Ft Washington, PA
Abercorn Common	Silver	31	Savannah, GA
111 South Wacker Drive	Gold	36	Chicago, IL
Banner Bank Building	Platinum	36	Boise, ID
1 Crescent Drive	Platinum	46	Philadelphia, PA
Collaborative Innovation Center	Gold	40	Pittsburgh, PA
East Hills Center	Gold	35	Grand Rapids, MI
Main Street @ NorthField Stapleton	Silver	30	Denver, CO
Own/Occupy Projects			
Project	**LEED Rating**	**Points Earned (Avg. = 38.5)**	**Project Location**
Yukon Base Facility	Silver	35	Hawthorne, CA
Wind NRG Partners, LLC	Gold	44	Hinesburg, VT
Blue Cross Blue Shield of MA	Certified	31	Grand Rapids, MI
Pfizer Clinical Research Unit	Silver	33	New Haven, CT
Alberici Corporate Headquarters	Platinum	60	St.Louis, MO
Institute of EcoTourism	Gold	39	Sedona, AZ
Ampere Annex	Silver	36	Vancouver, WA
Stantec Centre Atrium Tower	Silver	38	Edmonton, AB
Sprint Building 14	Certified	26	Overland Park, KS
Winrock International New Office Building	Gold	43	Little Rock, AR
Build-Sell/Lease			
Project	**LEED Rating**	**Points Earned (Avg. = 35.3)**	**Project Location**
Public Health Sciences Building	Certified	26	Seattle, WA
Tumwater Office Building	Gold	41	Tumwater, WA
BCBSM/Steketees Building	Certified	27	Grand Rapids, MI
Michigan Alternative Renewal Energy Center	Gold	46	Muskegon, MI
ORNL E. Campus Private Dev.	Certified	27	Oak Ridge, TN
Town Center East Building II	Certified	28	Tumwater, WA
Two Potomac Yard	Gold	42	Arlington, VA
NAR DC Headquarters Building	Silver	33	Washington, DC
Carl T. Curtis Midwest Regional Headquarters	Gold	40	Omaha, NE
One Potomac Yard	Gold	43	Arlington, VA

Higher Education Projects			
Project	LEED Rating	Points Earned (Avg. = 34.3)	University
Center for Interdisciplinary Engineering	Silver	33	Duke University
Orr Admission and College Relations Bldg	Gold	39	Warren Wilson College
Skenandoa House	Silver	33	Hamilton College
Interdisciplinary Science & Technology I	Silver	35	University of Washington
Clemson University's Advanced Material	Silver	33	Clemson University
Central College Housing Phase 2	Gold	39	Central College
Innovation Center	Certified	31	University of Arkansas
Redmond Campus Facility	Silver	35	Lake Washington Tech College
Coffin Street Dormatories	Silver	36	Bowdoin College
John Mitchell Center at USM	Certified	29	University of Southern Maine

Developer Research Findings

The most efficient way I have found to analyze all of my results is by breaking them up into the separate LEED® point categories. I tallied up all of the points that the projects of each developer received in each category and then divided that number by the total possible points in that category. For example, the core and shell projects had 94 total points achieved in the Sustainable Sites category out of the total possible 160 points they could have received. Meaning between the ten projects researched, there were 94 LEED® points achieved between those ten projects in this category. The total possible points are the amount of LEED® points in a category multiplied by ten for the amount of projects there were. The percentage that group received in that category is then 59%. All of these percentages were then placed into a bar graph, which is shown below in *Graph R1.1*. In the Appendix section on pages 9-16 the charts are shown for each of the four groups to show how they performed individually.

Graph R1.1



As for the interpretations of the results, once again it is easiest to break it into the separate categories, starting with Sustainable Sites. The rankings came in the following order; build-lease/sell, core and shell, own/occupy, and then higher education. I feel the biggest surprise out of this list is that higher education is the lowest. I would have assumed that they would be higher due to universities already having restrictions about their land that would be parallel with LEED® development.

The next category researched was Water Efficiency. The results were as follows; core and shell, a tie between build-lease/sell and own/occupy, and finally higher education. This outcome is not what I expected. The own/occupy developers are undoubtedly going to pay their water bill, so I would assume they would pay closer attention to that function than those developers who will have help with the bills from tenants or buyers. This outcome would be expected if these developments were triple net, meaning the developer themselves pay the water bill. Then they would pay close attention to water usage.

The Energy & Atmosphere category results were own/occupy, higher education, build-lease/sell, and core and shell. I had a lot of the same assumptions for this category as I did the Water Efficiency and this time my theories held true. The own/occupy group won this category by a large margin. The results make sense, understanding this group has to pay the usage bills themselves.

The next category, Materials & Resources, is one that I did not have a valid assumption for in the beginning. This category, unlike the majority of the categories, does not directly affect the building's performance. The results were core and shell, own/occupy, higher education, and build-lease/sell. Although unpredictable, these results are interesting to see who is taking the initiative of building green.

The Indoor Environmental Quality was the most anticipated of the results of this research. At the start, I assumed that own/occupy would win this category outright because their workers are going to be the occupants of the building. Results have shown workers' sick days decrease, their production increases, and students learn better in green buildings. These facts have become the trademark positives to building green. The results of my research were core and shell, higher education, own/occupy, and build-lease/sell. I was surprised that core and shell won this category, but I am not surprised that higher education came in a close second. The one thing that was as expected, this category had the highest average percentages over all of the groups.

Finally the Innovation & Design Processes category was even throughout the groups. The only revelation in this category was that higher education came in the lowest. As for the other three, each were only separated by 4%.

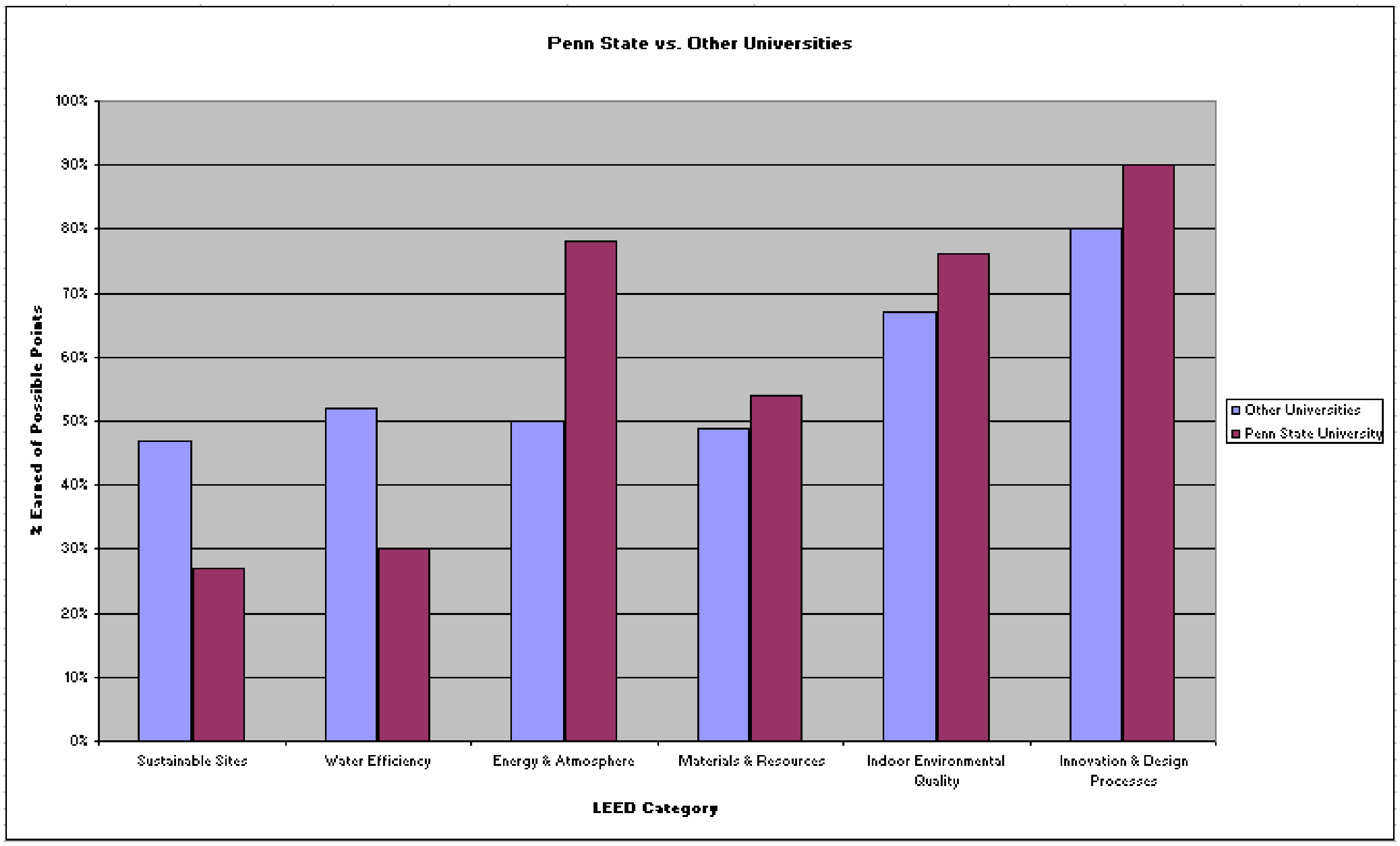
University Comparisons

I compared the ten higher education projects to the PSU LEED® Requirements checklist distributed to me by Mike Prinkey of PSU OPP. Penn State has created a checklist of that lists out each LEED® point and describes their effort of achieving it. They use three categories of effort, mandatory, significant effort, and minimal effort. From that they know where to focus their efforts for the design of new buildings on campus.

To be able to directly relate this checklist to my research outcomes of the other universities I set a number scale to Penn State's list. Mandatory effort was a two, significant effort was a one, and minimal effort was a zero. So on the LEED® point checklist, anywhere Penn State describes it as mandatory effort, I gave them two points. From there I added up their total points in each category, just as I did for the other universities. I then divided their total from the twos, ones, and zeros and divided that number by the total possible. The total possible was set by giving every single point in that category a "two". The interpretation of this assumption is that if Penn State would assign mandatory effort to every LEED® point on the list, then I can assume they would receive recognition of it every project. If they assign significant effort, then I am assuming they would get it half of the time. Finally, the minimal effort points are going to be received none of the time. The new percentage number I calculated gave me a way to accurately compare the other universities against Penn State. In the Appendix section on pages 17-18 a table is shown where you can see the calculations and the direct comparisons.

As you can see in *Graph R1.2*, Penn State is trailing the other universities in the first two categories, Sustainable Sites and Water Efficiency. After compiling research with Penn State, I found the reason behind this is that the site selection and landscape issues are all a portion of Penn State's Master Plan and are not negotiable at a project based level. From there you can see that Penn State begins to pull ahead of the other universities in the remaining categories. It is interesting to note the Energy & Atmosphere category where Penn State scored nearly 30% better than the competition. As the percentages for each category were looked at as a total LEED® score for both competitors, both schools scored Silver with Penn State coming in four points higher scoring a 46 (Silver) and the rest of the universities scored a 42 (Silver).

Graph R1.2


Penn State vs. Other Universities
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Earned of Possible Points
Sustainable Sites
Water Efficiency
Energy & Atmosphere
Materials & Resources
Indoor Environmental Quality
Innovation & Design Processes
LEED Category
Other Universities
Penn State University

Developer Guides

I have created a simple guide that shows the points in which developers, of each type researched, should focus their attention on. After reviewing Penn States LEED® points checklist I have decided to use a similar rating system they have used. I feel it keeps the guide simple and easy to understand yet just as effective. The guide lists the effort that should be exerted to achieve that point in one of four ways; mandatory compliance, significant effort, adequate effort or minimal effort. The effort level that each point is assigned was based on the results from analyzing the ten projects. Any point that had 75% or more of the projects complying is mandatory compliance. After that level any point between 50-74% is significant effort, 25-49% adequate effort, and 0-24% is minimal effort. As I stated before, I purposely kept the guides rather simple and easy to use. In their current form they will be able to assist the intended audience, a developer who is not LEED® experienced. The LEED® guides for each developer are located in the Appendix section on pages 19-30.

Conclusion

I feel that informing and educating developers about the LEED® rating system is crucial for the success of LEED®. A large majority of buildings being built in some way have a tie to a developer. I chose four business models of developers to research, but there are still quite a few more models out there. The guides I developed are one of the first stepping stones to educating developers of the LEED® system. I am confident that these guides would be useful for developers at the early stages of a project, just as Penn

State OPP uses their similar LEED® guide. As for the Penn State portion of my research I feel that Penn State stood up against their competitors rather impressively. Excluding the categories in which a land grant university has no control over, they were superior in every category.

The LEED® system is beginning to take hold, but it will take individuals and companies like researched in this project to get LEED® everywhere. With the USGBC creating new categories like the Core and Shell scoring category, each and every construction project nationwide can be implementing LEED®. I also think as leaders in the research field, universities can help other developers gain confidence in the LEED® system.

Technical Analysis #1

Canton Crossing Tower as an Independent System with the Equipment Rooms Located in Basement Addition

Problem

The Canton Crossing Central Plant currently houses the mechanical and electrical equipment for the tower. The Central Plant is an $8.9 million one story concrete building that is located across South Clinton Street from the tower. The technical analysis will look into eliminating the Central Plant and making the tower an independent, stand alone system. The cost of the building itself, along with financing issues that arose with the tower due to the Central Plant made the thought of eliminating it arise. As the design was originally, the tower can not function without the Central Plant. Therefore the schedule issues that arose during the Central Plant's construction, the tower's opening was delayed. Also, the Central Plant was originally designed with the thought of two more high-rise buildings being built immediately following the tower. If this was the case, then the upfront costs of the plant would be justifiable. As it stands now the following two buildings are going to be delayed and the large upfront cost of the plant is going unused.

Not only will the cost impact of the new design proposal be looked at, but also the tower's capacity for the change. For example, where the equipment will be housed and whether or not the structural integrity of the tower will be in jeopardy by the addition of all the equipment are items that will need to be checked before the cost impact of implementation can be checked

Goal

The goal of the analysis is to illustrate to the audience that the tower could effectively operate as a stand alone system. The $8.9 million contract that was used on the Central Plant could be eliminated. Obviously a certain amount of that cost will still be needed for the tower, i.e. equipment costs, etc. but a cost savings will be made by making the tower an independent system. Also, the new location of the mechanical rooms will be a benefit to all of the tenant subcontractors in the tower in material and construction costs.

Due to the complexity of this technical analysis, it will act as a breadth topic in the mechanical, electrical, and structural areas.

Analysis Techniques

1. A list of all the equipment placed in the tower will need to be compiled, including the sizes, weights, assembly details, etc.
2. The new equipment floors will need to be selected, taking into account the existing structural steel design.
3. A construction plan will be created paying attention to all of the possible issues that will now arise from the new equipment, i.e. equipment placement techniques, etc.
4. The new structural loads resulting from all of the added equipment will then be calculated and analyzed for structural integrity.

5. An estimated schedule and budget will need to be created for the new construction plan, with help from the superintendent and project manager of the project team.
6. The results of the new plan's calculations will then be shown along with the existing system's numbers to show the advantages and disadvantages.

Tools

1. Architectural Engineering Faculty (Parfitt, Schneider, Hanagan)
2. Gilbane Building Company Canton Crossing Tower/Central Plant Construction Team
3. Microsoft Excel
4. EnerCalc
5. Ms. Nicole Hazy, Michael Baker Corporation
6. Soil Safe, Inc. , Maryland

Outcomes

Structural

The mechanical and electrical equipment that are going to be removed from the Central Plant have to be housed in the tower itself. Instead of jeopardizing the amount of income a floor makes the owner on a monthly lease agreement, I have decided to add a basement to the tower. The basement will house all of the mechanical and electrical equipment that was originally designed for the Central Plant. The square footage of the Central Plant and the footprint of the tower are similar, within 1000 square feet so the equipment will fit in the space with no trouble.

The structure of the basement will be the same as the above floors with the columns extending down through to the previously redesigned caissons. The concrete exterior walls designed will act as retaining walls. The floor will be an 8" concrete slab-on-grade with #6 @ 12", due to the heavier types of loads that could be encountered (i.e. equipment rollers, etc.). The loads that the equipment will introduce were taking into account by adding 190 psf dead load and 100 psf live load to the structural calculations for the caissons.

The walls of the basement are designed as 20" cast-in-place concrete walls with reinforcing. The footer is designed as 6' wide by 16" thick. The wall was design as a retaining wall because of the columns and the caissons carrying the loads of the buildings. A surcharge of 50 psf was added in the case of other buildings or roadways being added in the future. To verify my calculations I used the program EnerCalc to design a "Restrained Retaining Wall", with the wall being "at-rest" by being restrained at the top and bottom. The calculations, sections, and print outs from EnerCalc can all be found in the Appendix section on pages 32-36 .

Also, an areaway must be considered for access to the equipment once it is installed. The areaway will be installed on the Northeast portion of the tower, an area secluded from the majority of the vehicular and pedestrian traffic.

The excavation of the project will require the contaminated soils to be removed from site. The footprint of the building at 30,000 ft^2 and the basement at a depth of 20' will require approximately 36,000 tons of contaminated soil to be removed from site. At $30.00/ton, quoted from Soil Safe, Inc., to transport and disposal this will cost an extra $1,080,000.

Mechanical

The first task that I completed was the mechanical portion of the redesign. By moving the mechanical equipment into the tower, I will be eliminating the heat exchanger system which was major component of the original design. Also, the pump system will go from a primary secondary to strictly a primary for inside the tower. As I began to research the equipment in the Central Plant, I realized it was oversized. There are a couple of reasons for this but the main reason being that the equipment was purchased with the idea that future buildings would be joining into the system. Also, the fact that the equipment was originally sized as a part of the district system including a heat exchanger system made it much larger than necessary for a stand alone tower system.

In all, it was required that I resize the chillers, boilers, heating and chilled water pumps, condenser water pumps. The resizing calculations were made based on the data given on the drawings for the tower. For the chillers, the components to the load were Air Handlers, Fan Coils, and Heat Recovery Air Handlers. The tons needed for the tower came to a total of 700. For redundancy options, I have chosen to use (3) 350 ton capable chillers for the tower. The boiler calculations were comprised of Air Handlers, VAV Fan Powered Terminal Units, Fan Coils, Unit Heaters, Heat Recovery Air Handlers, and Cabinet Unit Heaters. In all, the boiler is required to support a 497 ton load, or 5,964 MBH. Once again for redundancy purposes I have chosen (3) 3,000 MBH, 100 HP boilers. The next redesign was the pump system. The chilled water pumps need to support a load of 920 GPM, therefore I have chosen (3) 460 GPM pumps. The heated water pumps are required to produce 600 GPM so the new design is (3) 300 GPM pumps. The condenser pumps are required to produce 1,100 GPM, the new design will be (3) 550 GPM.

The other major component of the mechanical system is the cooling tower. Currently the cooling towers are located on the site that is between the tower and the Central Plant. The original design has the condenser supply and return coming from the Central Plant. With the new design, these condenser lines will be run from the tower to the cooling towers. Additional equipment that will need to be place in the tower is expansion tanks, air separators, a chemical feed for the heated water, and a make-up water system.

Electrical

The electrical components for the tower than were originally housed in the Central Plant were not oversized like the mechanical equipment. Currently there are two generators, main service switchgear, main distribution switchgear, two service transformers, and emergency switchgear. All of this equipment will be transferred over to the tower for the new design.

Comparisons

Schedule

The schedule comparisons between the old design and the proposed design are not going to be significant. The newly proposed basement structure is cast-in-place concrete just as the Central Plant walls are. The square footage of the basement and the

Central Plant are within roughly 1,500 sq. ft. of one another. With the location being similar for delivery purposes, the size being nearly identical, and the construction methods being used are identical I cannot see the schedule being affected.

The only schedule concern I had at the beginning of this analysis was the idea of the Central Plant's completion to be delaying the opening of the tower. With the proposed solution, the tower will be ready to open when its construction is complete with no outside factors affecting it.

Cost

Shown below in *Table TA1.1* are the pieces of equipment that were removed and the newly designed equipment with their respective costs. Also shown below is *Table TA1.2* which shows the overall cost comparison of the new system, including excavation, structure, mechanical, and electrical.

Table TA1.1

Equipment Cost Comparisons of Stand Alone System			
Equipment Added	**Quantity**	**Unit Cost**	**Cost**
Boiler - 3000 MBH, 100 HP	3	36,000	108,000
Chiller - 350 Ton, Centrifigal	3	140,000	420,000
Chilled Water Pumps - 460 GPM	3	3,200	9,600
Heated Water Pumps - 300 GPM	3	2,500	7,500
Condesner Water Pumps - 550 GPM	3	4,350	13,050
TOTAL ADDED COST			***$558,150***
Equipment Eliminated	**Quantity**	**Unit Cost**	**Cost**
Boiler - 15,000 MBH, 475 HP	1	100,000	100,000
Chiller - 2500 Ton, Centrifial	1	700,000	700,000
Chilled Water Pumps - 3500 GPM	3	4,200	12,600
Heated Water Pumps - 1030 GPM	3	10,000	30,000
Condesner Water Pumps - 4160 GPM	3	11,500	34,500
TOTAL ELIMINATED COST			***$877,100***
	TOTAL SAVINGS		***$318,950***

Table TA1.2

Overall Cost Comparison for Tower as a Stand Alone System		
Added Costs		
Category	**Description**	**Cost**
Excavation/Remediation of Soils	36,000 tons @ $30/ton	$1,080,000
Structure of Basement	30000 s.f. @ $92/s.f.	$2,750,000
Mechanical - New Chiller	(3) 350 Ton Centrifigal Chillers	$420,000
Mechanical - New Boiler	(3) 3000 MBH, 100 HP Boilers	$108,000
Mechanical - New Pumps	Heated, Chilled, & Condeser Water Pumps	$30,150
Additional Mechanical Contract from CP	Add'l Equipment & Contract from CP	$400,000
Electrical from CP Contract	Value from Equipment @ CP	$350,000
	TOTALS	***$5,138,150***
Subtracted Costs		
Category	**Description**	**Cost**
CP Contract minus the Equipment Removed	CP contract minus $877,100 for equipment	$8,022,900
	TOTALS	***$8,022,900***
	Total Savings for Stand Alone System	***$2,884,750***

Conclusion

Upon completion of my analysis I feel that the owner would have been better off designing the Canton Crossing Tower as a stand-alone system. The schedule and cost comparisons illustrated and discussed above speak for themselves. I do understand the thought process of the design team and the owner with the 14+ buildings going up in the future at Canton Crossing, but the outside factors such as financing became larger than anyone expected. With the new proposal, nearly 3 million dollars could have been saved with a few simple changes. As it is now, the Central Plant is largely oversized and will no be needed in its full capacity for at least 2-3 more years.

In my opinion, it would have been advisable to eliminate the Central Plant and all of its issues, financing, schedule issues, etc. This advice is based on the speed that the entire campus is being built. Each building built on the campus in the future could have been designed as stand-alone systems as well. This would relieve some of the pressure and up-front costs that the owner is dealing with and will inevitably have to deal with during the entire development project at Canton Crossing.

Technical Analysis #2

Cast-in-place caissons vs. Pre-cast concrete piles

Problem

The tower had a difficult schedule to adhere to from the start of the project. The foundation system used did not get the project started on a positive note. The pre-cast piles used brought about multiple issues throughout the foundation construction that could have been avoided. Issues ranging from barge deliveries to driving to engineered depth not only frustrated the team, but also put them behind schedule from the beginning. The Central Plant located across the street used a cast-in-place caisson foundation system. The construction process of this foundation went smooth, with only minor issues arising. Furthermore, the Central Plant's soil conditions, site logistics, construction crew, etc. are all identical to that of the tower. With these details known, the foundation system used on the Central Plant, at least initially, seems as though it would have been a better choice for that of the tower.

Goal

The goal of this technical analysis is to evaluate using the cast-in-place caissons as the tower's foundation system; the team would have saved not only time but money as well. The research will primarily be focused on the schedule impact the alternate system will have, but the cost issue will also be addressed. The added costs that occurred from unforeseen developments during the pre-cast pile construction will also be factored into the research.

Analysis Techniques

1. Determine all of the loads from the building that are acting at the base of each column. Loads values used are given by the designers on the drawings.
2. Once load calculations are completed caisson sizes and quantities can be determined.
3. All relevant information from the tower's foundation construction, original budget, actual cost, actual schedule dates, etc will be compiled and reviewed.
4. The actual construction details were retrieved from the Central Plant team. This information, such as caissons/day, cost/caisson, etc. allowed for a very accurate estimate for the tower. Also, a RS Means estimate comparison was shown for clarification.
5. Analyze any structural issues that will change due to the analysis.
6. Create a schedule and budget for the alternate system on the tower.
7. Compare the actual costs and duration dates of the existing schedule to the results from the alternate system.

Tools

1. Architectural Engineering Faculty (Parfitt, Schneider, Hanagan)
2. Gilbane Building Company Canton Crossing Tower/Central Plant Construction Team
3. Microsoft Excel
4. Soil Safe, Inc. , Maryland

Column Load Determinations

The start of the redesign process was calculating the tributary area for each of the columns. From there each of the twenty floors was added onto that value. The design value for dead loads was 57 psf and live loads 100 psf. The next step was to incorporate the roof loads and wind loads, which were also given by the designer. An estimated value for each column load was giving in the geotechnical report, but for accuracy reasons the loads were calculated by hand and then compared to the estimates. Shown below are sample calculations for final loads on columns A-2 and B-3 to illustrate the formulas used for wind loaded and non-wind loaded columns.

Sample Load Calculations

A-2 (Non-wind loaded column)

1.2(D) + 1.6(L)

1.2(298,576) + 1.6(521,600) = ***1,193 kips***

B-3(Wind loaded column)

1.6(W) + 1.2(D) + 1.0(L)

1.6(600) + 1.2(957,992) + 1.0(1,663,280) = ***2,814 kips***

In the Appendix section on pages 38-39 a table is provided showing all of the calculations used for each of the 49 caissons.

Caison Design Calculations

The previously calculated loads at the column bases were then used to design each of the 49 caissons needed in the structural system. Various critical numbers came from the geotechnical report for the foundation. *Table TA2.1* below shows of all of these values is shown below.

Table TA2.1

Stratum	Top of Stratum Elevation	Ultimate Skin Friction	Factor of Safety / New Ultimate	Ultimate End Bearing	Factor of Safety / New Ultimate
Recent Alluvial	EL 0	1.0 ksf	FS= 2.5 *0.4 ksf*	N/A	FS= 2.0 ~~
Upper Potomac	EL -25	3.0 ksf	FS= 2.5 *1.2 ksf*	20 ksf	FS= 2.0 *10 ksf*
Lower Potomac	**EL -50**	**4.0 ksf**	**FS= 2.5** ***1.6 ksf***	**60 ksf**	**FS= 2.0** ***30 ksf***

To begin the design I decided to use the Lower Potomac soil level values because I was estimating a depth of 70'-80' from historical data. The next step was to calculate how much load caissons of varying diameters would hold at various depths. The compression loads were all calculated with the factor of safety of 2.0. I then added on the value of skin friction for each of the caissons, while also checking the uplift loads. This calculation was simply the surface area of the caisson times the ultimate skin friction value shown in the table above. The final value calculated was the weight of the shaft using the effective weight of concrete as 85 pcf, this value was then subtracted from uplift load. The final check was to be sure the new value of skin friction minus the self-weight was greater than the target value of 1900 kips given in the geotechnical report. The extra values in skin friction and self-weight exceeding the 1900 kips of uplift were then added to the final load calculation.

Once each diameter of caisson at all five trial depths had a final load capacity value, the column loads were analyzed to decide what size caissons at which depth would be most efficient. The tables for the load capacities are shown in the Appendix at the end of the report. The two depths that I decided for were 70' and 80', and after a comparison of the excavated materials between the two I chose 80'. The comparison is shown below in *Table TA2.3* For construction simplicity I chose to use only six different size caissons and to keep all of the depths consistent at 80'.

In the Appendix section pages 40-41, tables are shown for every depth that was considered for caissons (50'-90'). Once again, it should be noted that 80' was chosen for the depth of all 49 caissons.

Table TA2.3

Excavation Comparison for 70' & 80' Depths						
Excavation Details for 70' Depth				Excavation Details for 80' Depth		
Volume (cy)	# of Ciassons	CY of Caissons		Volume (cy)	# of Ciassons	CY of Caissons
20.94				20.94		
28.51				28.51		
37.23				37.23		
47.12				47.12		
58.18				58.18	8	465.42
70.40	8	563.16		70.40	10	703.95
83.78	10	837.76		83.78		
98.32				98.32		
114.03				114.03	7	798.20
130.90	7	916.30		130.90	15	1,963.50
148.94	15	2,234.03		148.94	2	297.87
168.13	2	336.27		168.13		
188.50				188.50		
210.02				210.02	6	1,260.13
232.71	6	1,396.27		232.71		
256.56				256.56		
281.58				281.58		
307.76				307.76		
335.10				335.10		
363.61				363.61		
393.28				393.28		
424.12				424.12		
	TOTAL CY	**6,283.78**			**TOTAL CY**	**5,489.07**

Shown below are the caisson sizing calculations for a caisson with a 96" diameter at 80' depth. On the following page *Table TA2.4* shows all of the calculations for the 80' deep caissons. It is important to note that the actual elevation of the caissons are EL = -95' due to the basement that was added in the other Technical Analysis.

Sample Caisson Sizing Calculations (96"diamter @ 80' depth)

L_{eb} = Ultimate End Bearing * π r^2

L_{eb} = 30 ksf * π (4 ft)^2

L_{eb} = *1,508 kips*

L_{sf} = Ultimate Skin Friction * SA

$L_{sf} = 1.6 \text{ ksf} * [(2\pi)(4 \text{ ft})^2 + (2\pi)(4 \text{ ft})(80 \text{ ft})]$

L_{sf} = *3,378 kips – 1900 kips = 1478 kips added to load*

Self-Wt = πr^2 * depth * 85 pcf

$SW = \pi (4 \text{ ft})^2 * 80 \text{ ft} * 85 \text{ pcf}$

SW = 342 kips

Final Load Calculation = $L_{eb} + (L_{sf} - \text{Uplift}) + SW$

FL = 1,508 + (3,378-1900) + 342

FL = ***3328 kips***

Table TA2.4

Sizing Index @ 80' Depth								
Diameter (in)	Diameter (ft)	Kips	S A @ 80'	Skin Friction	Added KIPS	Total w/ SF	SW	**Final Kips**
36	3	212	768	1229	-671	-459	48	**-411**
42	3.5	289	899	1438	-462	-173	65	**-108**
48	4	377	1030	1649	-251	126	85	**211**
54	4.5	477	1163	1860	-40	438	108	**546**
60	5	589	1296	2073	173	763	134	**896**
66	5.5	713	1430	2288	388	1100	162	**1262**
72	6	848	1565	2503	603	1451	192	**1644**
78	6.5	995	1700	2720	820	1815	226	**2041**
84	7	1155	1836	2938	1038	2193	262	**2454**
90	7.5	1325	1973	3157	1257	2583	300	**2883**
96	8	1508	2111	3378	1478	2986	342	**3328**
102	8.5	1702	2250	3600	1700	3402	386	**3788**
108	9	1909	2389	3823	1923	3831	433	**4264**
114	9.5	2126	2529	4047	2147	4273	482	**4755**
120	10	2356	2670	4273	2373	4729	534	**5263**
126	10.5	2598	2812	4499	2599	5197	589	**5786**
132	11	2851	2955	4727	2827	5678	646	**6325**
138	11.5	3116	3098	4957	3057	6173	706	**6879**
144	12	3393	3242	5187	3287	6680	769	**7449**
150	12.5	3682	3387	5419	3519	7201	834	**8035**
156	13	3982	3533	5652	3752	7734	903	**8637**
162	13.5	4294	3679	5887	3987	8281	973	**9254**

Caisson Reinforcement Sizing

The reinforcing for the caissons was designed assuming that the area of the steel would be 1% of the gross cross-sectional area of the caisson, as shown below in *Table TA2.5*. The size of the reinforcing rebar was simplified for construction to two different sizes for the whole building, #11's & #14's. The rebar cages are to extend to at least EL = -50 due to soil conditions through the top layers. Additionally, ties will be used at 18" o.c.

Table TA 2.5

Sizing Reinforcement as As=1% of Total Area				
Diameter (in)	Area (sq in)	As (sq in)	Bar Size	Total Area
36	1,018	10.18		
42	1,385	13.85		
48	1,810	18.10		
54	2,290	22.90		
60	2,827	28.27	20 - #11	31.20
66	3,421	34.21	24 - #11	37.44
72	4,072	40.72		
78	4,778	47.78		
84	5,542	55.42	36 #11	56.16
90	6,362	63.62	42 #11	65.52
96	7,238	72.38	32 #14	72.00
102	8,171	81.71		
108	9,161	91.61		
114	10,207	102.07	46 #14	103.50

Comparisons

The schedule breakdowns were calculated using actual data from the Central Plant contract and the subcontractors used on that job as well as the actual construction schedule from the tower. The caisson data will be more accurate this way than if collected from another source, for instance R.S. Means, because it takes into account location, soil conditions, subcontractors, etc. The tower's pile data is actual information since at the time of this report the construction had been completed. As shown below the caissons had a much shorter duration that the piles. Rounding off to account for any unforeseen issues with the caisson construction, they still are completed roughly a month before the piles. This month's worth of time will show up in the cost comparison shown in the next section of the report. A month's worth of time in a tenant fit-out building means extra income to the owner from leases.

Table TA2.6

Schedule Breakdowns		
Description	**Piles**	**Caissons**
Actual Rates	4/day	153.5 CY/day
# of Units	314	5489.07
Actual Duration	78.5 days	35.75 days

The cost comparison also used historical data from the contracts of the Central Plant and the tower for the most accurate reporting possible. The piles cost approximately $68/LF while the caissons were $443/CY. The differences between the two began with the pile caps. The original design required pile caps where as the redesign of caissons eliminated that, removing $122,705 from the contract. The caissons on the other hand required that nearly 2,225 tons of contaminated soils be removed from site and disposed of properly. This value came from the assumption in the geotechnical report that the soil was contaminated to EL = -20'. This value is accounted for in the previous Technical Analysis where the basement level was added to the tower. That excavation, if combined with this redesign, will already account for all of the contaminated soils. The big cost savings comes with the month that is saved from the shorter construction duration of the caissons. At $24 rent/sq ft a year (quoted from Gilbane Building Company's Project Executive, Mark Luria) the savings calculates to $1,000,000 for this 500,000 sq ft of commercial leasing space.

Table TA 2.7

Cost Breakdowns		
Description	Piles [=] LF	Caissons [=] CY
# of Piles/Caissons	314	49
Cost per Pile/Caisson	$5,941	$37,566
Unit Cost [=] LF/CY	$67.90	$442.98
# of Units	27,777 LF	5,489.07 CY
Pile Caps	$122,705	0
Removal of Contaminated Soils		$66,825[a]
1 Month Early Completion		($1,000,000)
Totals (basement added from Analysis #1)	***$2,008,762.13***	***$1,431,548.23***
Totals (no basement)		***$1,498,373.23***

[a] Value accounted for in Technical Analysis #1 for the basement addition.

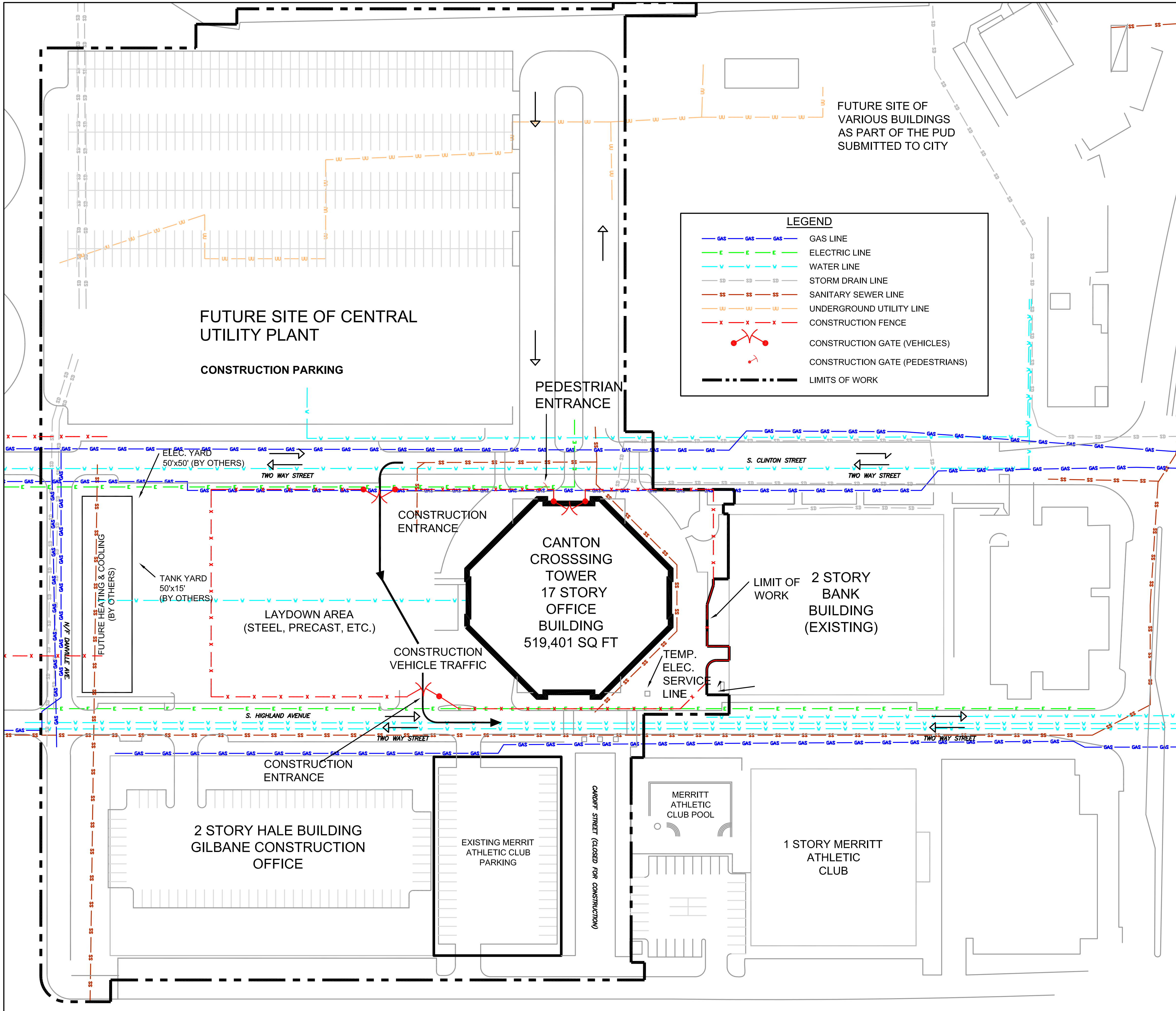
Conclusion

After completing this analysis I conclude that the decision to use cast-in-place caissons is superior to that of precast, prestressed driven piles. The idea for the analysis came after issues arose during the construction of the piles, but the implementation of caissons was discussed during early design. The design team decided against the caissons, but as this analysis shows in hind sight the caissons were the better choice. The most important discovery during this analysis was the speed of the caissons duration compared to the piles. Any owner, especially a tenant fit-out owner, is going to want to reduce their schedule by a month if the situation arises. Not only did the caissons save nearly $1.5 million, but it allows the project's schedule to be on track from the start. Another notable advantage of the caissons is the delivery method that was used for the precast piles. The piles had to be barged in through the harbor for delivery. With the site located along the water this should not be an issue, but during construction one of the delivery barges tipped over losing roughly $150,000 worth of piles. This is an extreme occurrence that is out of the normal, but should be noted for comparison.

APPENDIX ~ PROJECT LOGISTICS

SITE LOGISTICS PLAN

DETAILED PROJECT SCHEDULE



CANTON CROSSING TOWER
1501 S. CLINTON ST
BALTIMORE, MD 21224

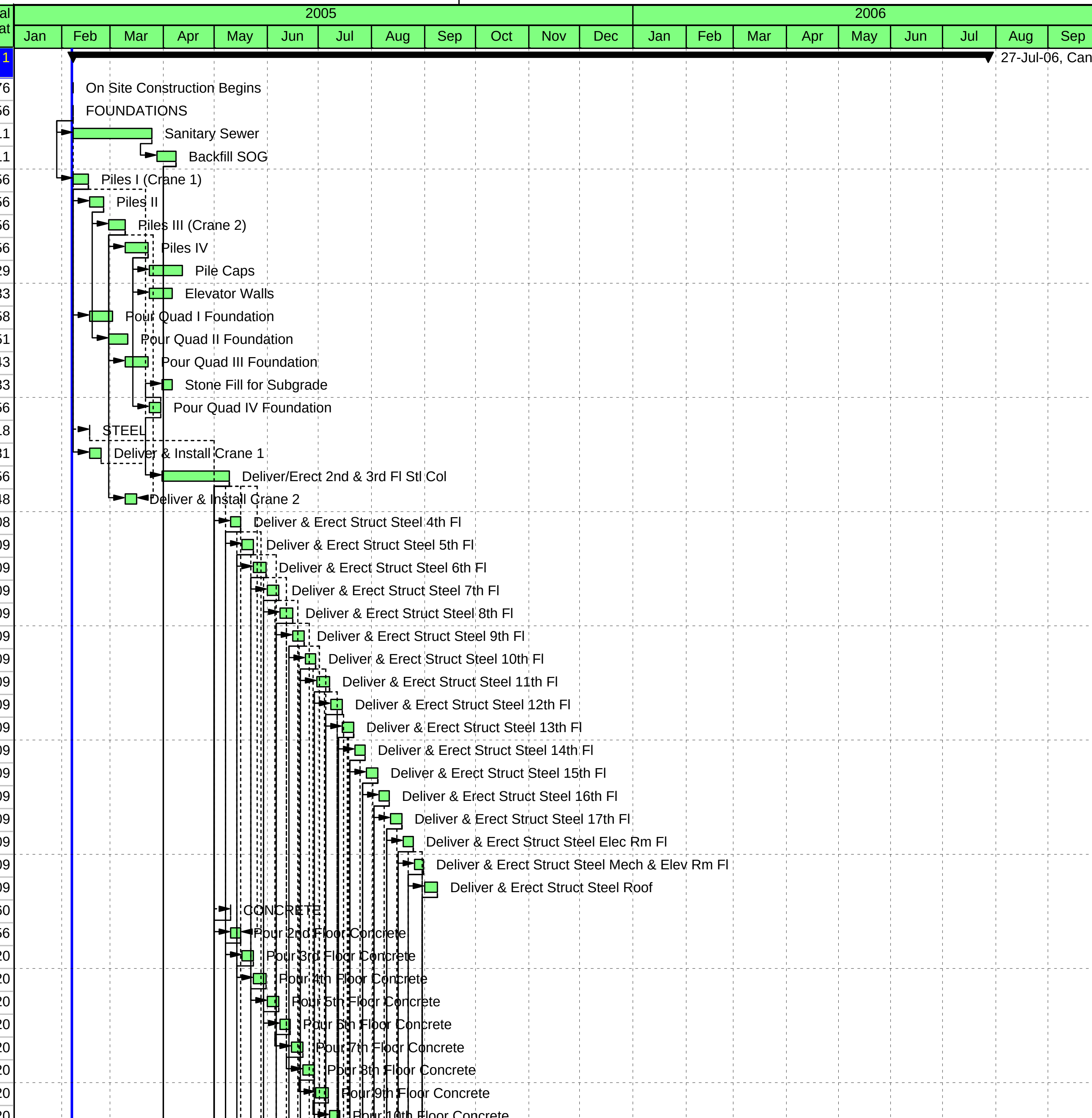
SITE PLAN OF EXISTING CONDITIONS

TECH ASSG #1 R - 11/6/06

TYLER SWARTZWELDER
CM OPTION - DR. MESSNER

DWG - 1.0 R

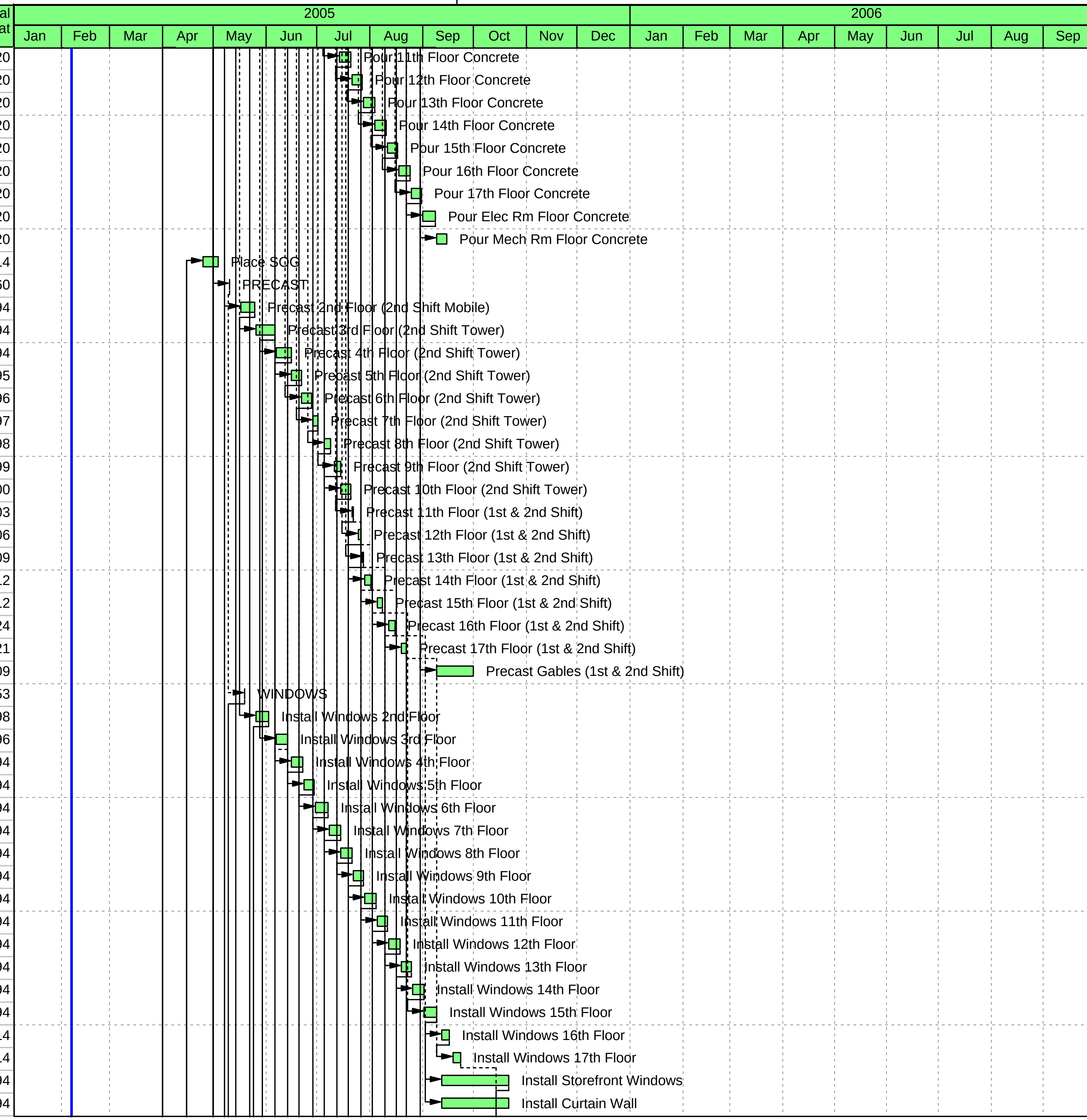
Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Start	Finish	Total Float
Canton Crossing Tower 2		375	375	0%	07-Feb-05	27-Jul-06	1
A1001	On Site Construction Begins	0	0	0%	07-Feb-05	07-Feb-05	376
A1002	FOUNDATIONS	0	0	0%	07-Feb-05	07-Feb-05	56
A1010	Sanitary Sewer	35	35	0%	07-Feb-05	25-Mar-05	311
A1020	Backfill SOG	10	10	0%	28-Mar-05	08-Apr-05	311
A1030	Piles I (Crane 1)	8	8	0%	07-Feb-05	16-Feb-05	56
A1040	Piles II	7	7	0%	17-Feb-05	25-Feb-05	56
A1050	Piles III (Crane 2)	8	8	0%	28-Feb-05	09-Mar-05	56
A1060	Piles IV	10	10	0%	10-Mar-05	23-Mar-05	56
A1070	Pile Caps	14	14	0%	24-Mar-05	12-Apr-05	329
A1080	Elevator Walls	10	10	0%	24-Mar-05	06-Apr-05	333
A1090	Pour Quad I Foundation	10	10	0%	17-Feb-05	02-Mar-05	358
A1100	Pour Quad II Foundation	10	10	0%	28-Feb-05	11-Mar-05	351
A1110	Pour Quad III Foundation	10	10	0%	10-Mar-05	23-Mar-05	343
A1120	Stone Fill for Subgrade	5	5	0%	31-Mar-05	06-Apr-05	333
A1130	Pour Quad IV Foundation	5	5	0%	24-Mar-05	30-Mar-05	56
A1131	STEEL	0	0	0%	17-Feb-05*	17-Feb-05	218
A1132	Deliver & Install Crane 1	5	5	0%	17-Feb-05	23-Feb-05	81
A1133	Deliver/Erect 2nd & 3rd Fl Stl Col	28	28	0%	31-Mar-05	09-May-05	56
A1134	Deliver & Install Crane 2	5	5	0%	10-Mar-05	16-Mar-05	348
A1135	Deliver & Erect Struct Steel 4th Fl	5	5	0%	10-May-05	16-May-05	208
A1136	Deliver & Erect Struct Steel 5th Fl	5	5	0%	17-May-05	23-May-05	209
A1137	Deliver & Erect Struct Steel 6th Fl	5	5	0%	24-May-05	31-May-05	209
A1138	Deliver & Erect Struct Steel 7th Fl	5	5	0%	01-Jun-05	07-Jun-05	209
A1139	Deliver & Erect Struct Steel 8th Fl	6	6	0%	08-Jun-05	15-Jun-05	209
A1140	Deliver & Erect Struct Steel 9th Fl	5	5	0%	16-Jun-05	22-Jun-05	209
A1141	Deliver & Erect Struct Steel 10th Fl	5	5	0%	23-Jun-05	29-Jun-05	209
A1142	Deliver & Erect Struct Steel 11th Fl	5	5	0%	30-Jun-05	07-Jul-05	209
A1143	Deliver & Erect Struct Steel 12th Fl	5	5	0%	08-Jul-05	14-Jul-05	209
A1144	Deliver & Erect Struct Steel 13th Fl	5	5	0%	15-Jul-05	21-Jul-05	209
A1145	Deliver & Erect Struct Steel 14th Fl	5	5	0%	22-Jul-05	28-Jul-05	209
A1146	Deliver & Erect Struct Steel 15th Fl	5	5	0%	29-Jul-05	04-Aug-05	209
A1147	Deliver & Erect Struct Steel 16th Fl	5	5	0%	05-Aug-05	11-Aug-05	209
A1148	Deliver & Erect Struct Steel 17th Fl	5	5	0%	12-Aug-05	18-Aug-05	209
A1149	Deliver & Erect Struct Steel Elec Rm Fl	5	5	0%	19-Aug-05	25-Aug-05	209
A1150	Deliver & Erect Struct Steel Mech & Ele...	4	4	0%	26-Aug-05	31-Aug-05	209
A1151	Deliver & Erect Struct Steel Roof	5	5	0%	01-Sep-05	08-Sep-05	209
A1157	CONCRETE	0	0	0%	10-May-05*	10-May-05	160
A1158	Pour 2nd Floor Concrete	5	5	0%	10-May-05	16-May-05	56
A1159	Pour 3rd Floor Concrete	5	5	0%	17-May-05	23-May-05	220
A1160	Pour 4th Floor Concrete	5	5	0%	24-May-05	31-May-05	220
A1170	Pour 5th Floor Concrete	5	5	0%	01-Jun-05	07-Jun-05	220
A1180	Pour 6th Floor Concrete	5	5	0%	08-Jun-05	14-Jun-05	220
A1190	Pour 7th Floor Concrete	5	5	0%	15-Jun-05	21-Jun-05	220
A1200	Pour 8th Floor Concrete	5	5	0%	22-Jun-05	28-Jun-05	220
A1210	Pour 9th Floor Concrete	5	5	0%	29-Jun-05	06-Jul-05	220
A1220	Pour 10th Floor Concrete	5	5	0%	07-Jul-05	13-Jul-05	220



Actual Work | Critical Remaining Work | Summary | Remaining Work | Milestone

TASK filter: All Activities

Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Start	Finish	Total Float
A1230	Pour 11th Floor Concrete	5	5	0%	14-Jul-05	20-Jul-05	220
A1240	Pour 12th Floor Concrete	5	5	0%	21-Jul-05	27-Jul-05	220
A1250	Pour 13th Floor Concrete	5	5	0%	28-Jul-05	03-Aug-05	220
A1260	Pour 14th Floor Concrete	5	5	0%	04-Aug-05	10-Aug-05	220
A1270	Pour 15th Floor Concrete	5	5	0%	11-Aug-05	17-Aug-05	220
A1280	Pour 16th Floor Concrete	5	5	0%	18-Aug-05	24-Aug-05	220
A1290	Pour 17th Floor Concrete	5	5	0%	25-Aug-05	31-Aug-05	220
A1300	Pour Elec Rm Floor Concrete	5	5	0%	01-Sep-05	08-Sep-05	220
A1310	Pour Mech Rm Floor Concrete	5	5	0%	09-Sep-05	15-Sep-05	220
A1320	Place SOG	7	7	0%	25-Apr-05	03-May-05	314
A1321	PRECAST	0	0	0%	10-May-05*	10-May-05	160
A1530	Precast 2nd Floor (2nd Shift Mobile)	7	7	0%	17-May-05	25-May-05	194
A1540	Precast 3rd Floor (2nd Shift Tower)	7	7	0%	26-May-05	06-Jun-05	194
A1545	Precast 4th Floor (2nd Shift Tower)	7	7	0%	07-Jun-05	15-Jun-05	194
A1550	Precast 5th Floor (2nd Shift Tower)	4	4	0%	16-Jun-05	21-Jun-05	195
A1560	Precast 6th Floor (2nd Shift Tower)	4	4	0%	22-Jun-05	27-Jun-05	196
A1570	Precast 7th Floor (2nd Shift Tower)	4	4	0%	28-Jun-05	01-Jul-05	197
A1580	Precast 8th Floor (2nd Shift Tower)	4	4	0%	05-Jul-05	08-Jul-05	198
A1590	Precast 9th Floor (2nd Shift Tower)	4	4	0%	11-Jul-05	14-Jul-05	199
A1600	Precast 10th Floor (2nd Shift Tower)	4	4	0%	15-Jul-05	20-Jul-05	200
A1610	Precast 11th Floor (1st & 2nd Shift)	2	2	0%	21-Jul-05	22-Jul-05	203
A1620	Precast 12th Floor (1st & 2nd Shift)	2	2	0%	25-Jul-05	26-Jul-05	206
A1630	Precast 13th Floor (1st & 2nd Shift)	2	2	0%	27-Jul-05	28-Jul-05	209
A1640	Precast 14th Floor (1st & 2nd Shift)	2	2	0%	29-Jul-05	01-Aug-05	212
A1650	Precast 15th Floor (1st & 2nd Shift)	2	2	0%	05-Aug-05	08-Aug-05	212
A1660	Precast 16th Floor (1st & 2nd Shift)	2	2	0%	12-Aug-05	15-Aug-05	224
A1670	Precast 17th Floor (1st & 2nd Shift)	2	2	0%	19-Aug-05	22-Aug-05	221
A1680	Precast Gables (1st & 2nd Shift)	16	16	0%	09-Sep-05	30-Sep-05	209
A1681	WINDOWS	0	0	0%	19-May-05*	19-May-05	153
A1700	Install Windows 2nd Floor	5	5	0%	26-May-05	02-Jun-05	198
A1710	Install Windows 3rd Floor	5	5	0%	07-Jun-05	13-Jun-05	196
A1720	Install Windows 4th Floor	5	5	0%	16-Jun-05	22-Jun-05	194
A1730	Install Windows 5th Floor	5	5	0%	23-Jun-05	29-Jun-05	194
A1740	Install Windows 6th Floor	5	5	0%	30-Jun-05	07-Jul-05	194
A1750	Install Windows 7th Floor	5	5	0%	08-Jul-05	14-Jul-05	194
A1760	Install Windows 8th Floor	5	5	0%	15-Jul-05	21-Jul-05	194
A1770	Install Windows 9th Floor	5	5	0%	22-Jul-05	28-Jul-05	194
A1780	Install Windows 10th Floor	5	5	0%	29-Jul-05	04-Aug-05	194
A1790	Install Windows 11th Floor	5	5	0%	05-Aug-05	11-Aug-05	194
A1800	Install Windows 12th Floor	5	5	0%	12-Aug-05	18-Aug-05	194
A1810	Install Windows 13th Floor	5	5	0%	19-Aug-05	25-Aug-05	194
A1820	Install Windows 14th Floor	5	5	0%	26-Aug-05	01-Sep-05	194
A1830	Install Windows 15th Floor	5	5	0%	02-Sep-05	09-Sep-05	194
A1840	Install Windows 16th Floor	5	5	0%	12-Sep-05	16-Sep-05	214
A1850	Install Windows 17th Floor	5	5	0%	19-Sep-05	23-Sep-05	214
A1860	Install Storefront Windows	30	30	0%	12-Sep-05	21-Oct-05	194
A1870	Install Curtain Wall	30	30	0%	12-Sep-05	21-Oct-05	194



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

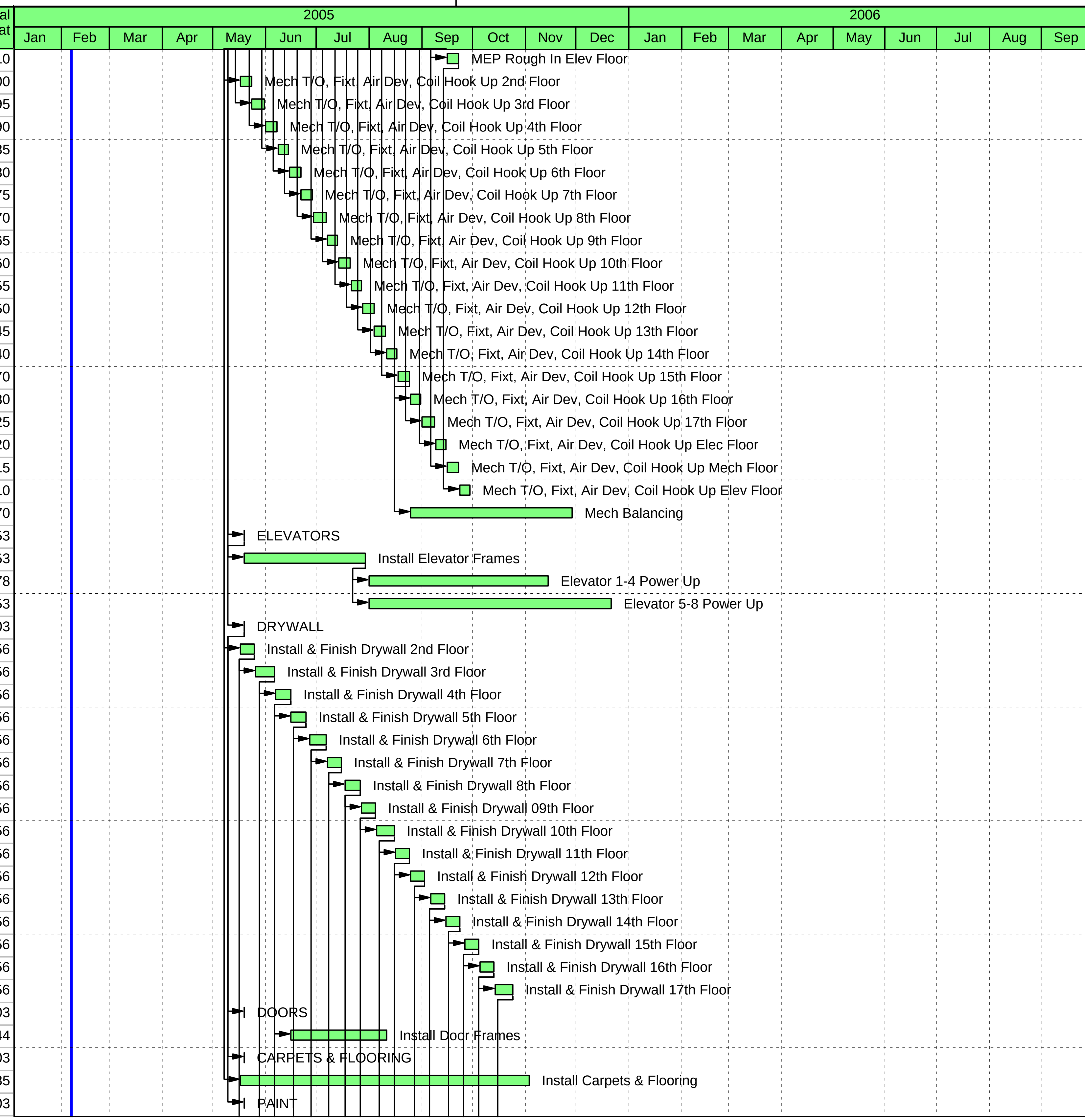
TASK filter: All Activities

Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Start	Finish	Total Float
A1871	Building Enclosure	0	0	0%	24-Oct-05		194
A1872	FIREPROOFING	0	0	0%	19-May-05	19-May-05	153
A1880	Deliver & Install Fireproofing Ground Flr	5	5	0%	03-Jun-05	09-Jun-05	288
A1890	Deliver & Install Fireproofing 2nd Flr	5	5	0%	10-May-05	16-May-05	305
A1900	Deliver & Install Fireproofing 3rd Flr	5	5	0%	10-May-05	16-May-05	305
A1910	Deliver & Install Fireproofing 4th Flr	5	5	0%	17-May-05	23-May-05	300
A1920	Deliver & Install Fireproofing 5th Flr	5	5	0%	24-May-05	31-May-05	295
A1930	Deliver & Install Fireproofing 6th Flr	5	5	0%	01-Jun-05	07-Jun-05	290
A1940	Deliver & Install Fireproofing 7th Flr	5	5	0%	08-Jun-05	14-Jun-05	285
A1950	Deliver & Install Fireproofing 8th Flr	6	6	0%	16-Jun-05	23-Jun-05	278
A1960	Deliver & Install Fireproofing 9th Flr	6	6	0%	23-Jun-05	30-Jun-05	273
A1970	Deliver & Install Fireproofing 10th Flr	5	5	0%	30-Jun-05	07-Jul-05	269
A1980	Deliver & Install Fireproofing 11th Flr	5	5	0%	08-Jul-05	14-Jul-05	264
A1990	Deliver & Install Fireproofing 12th Flr	5	5	0%	15-Jul-05	21-Jul-05	259
A2000	Deliver & Install Fireproofing 13th Flr	5	5	0%	22-Jul-05	28-Jul-05	254
A2010	Deliver & Install Fireproofing 14th Flr	5	5	0%	29-Jul-05	04-Aug-05	249
A2020	Deliver & Install Fireproofing 15th Flr	5	5	0%	05-Aug-05	11-Aug-05	244
A2030	Deliver & Install Fireproofing 16th Flr	5	5	0%	12-Aug-05	18-Aug-05	239
A2040	Deliver & Install Fireproofing 17th Flr	5	5	0%	19-Aug-05	25-Aug-05	234
A2050	Deliver & Install Fireproofing Elec Rm Flr	5	5	0%	26-Aug-05	01-Sep-05	229
A2060	Deliver & Install Fireproofing Mech Rm Flr	5	5	0%	01-Sep-05	08-Sep-05	225
A2070	Deliver & Install Fireproofing Elev Flr/Roof	5	5	0%	09-Sep-05	15-Sep-05	220
A2071	MECHANICAL/ELECTRICAL/PLUMBING	0	0	0%	19-May-05	19-May-05	153
A2080	SOG Underground Electric	20	20	0%	11-Apr-05	06-May-05	311
A2090	Underground Sanitary Plumbing	10	10	0%	11-Apr-05	22-Apr-05	314
A2100	Underground Storm Plumbing	10	10	0%	11-Apr-05	22-Apr-05	314
A2110	Underground Domestic Water (Plumbing)	2	2	0%	11-Apr-05	12-Apr-05	322
A2120	Underground Gas Vent (Plumbing)	8	8	0%	11-Apr-05	20-Apr-05	316
A2130	MEP Rough In 2nd Floor	5	5	0%	10-May-05	16-May-05	170
A2140	MEP Rough In 1st Floor	15	15	0%	10-May-05	31-May-05	295
A2150	MEP Rough In 3rd Floor	5	5	0%	17-May-05	23-May-05	170
A2160	MEP Rough In 4th Floor	5	5	0%	24-May-05	31-May-05	170
A2170	MEP Rough In 5th Floor	5	5	0%	01-Jun-05	07-Jun-05	170
A2180	MEP Rough In 6th Floor	5	5	0%	08-Jun-05	14-Jun-05	170
A2190	MEP Rough In 7th Floor	5	5	0%	15-Jun-05	21-Jun-05	170
A2200	MEP Rough In 8th Floor	5	5	0%	22-Jun-05	28-Jun-05	170
A2210	MEP Rough In 9th Floor	5	5	0%	29-Jun-05	06-Jul-05	170
A2220	MEP Rough In 10th Floor	5	5	0%	07-Jul-05	13-Jul-05	170
A2230	MEP Rough In 11th Floor	5	5	0%	14-Jul-05	20-Jul-05	170
A2240	MEP Rough In 12th Floor	5	5	0%	21-Jul-05	27-Jul-05	170
A2250	MEP Rough In 13th Floor	5	5	0%	28-Jul-05	03-Aug-05	170
A2260	MEP Rough In 14th Floor	5	5	0%	04-Aug-05	10-Aug-05	170
A2270	MEP Rough In 15th Floor	5	5	0%	11-Aug-05	17-Aug-05	170
A2280	MEP Rough In 16th Floor	5	5	0%	18-Aug-05	24-Aug-05	210
A2290	MEP Rough In 17th Floor	5	5	0%	25-Aug-05	31-Aug-05	210
A2300	MEP Rough In Elect Rm Floor	5	5	0%	01-Sep-05	08-Sep-05	210
A2310	MEP Rough In Mech Rm Floor	5	5	0%	09-Sep-05	15-Sep-05	210

Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

TASK filter: All Activities

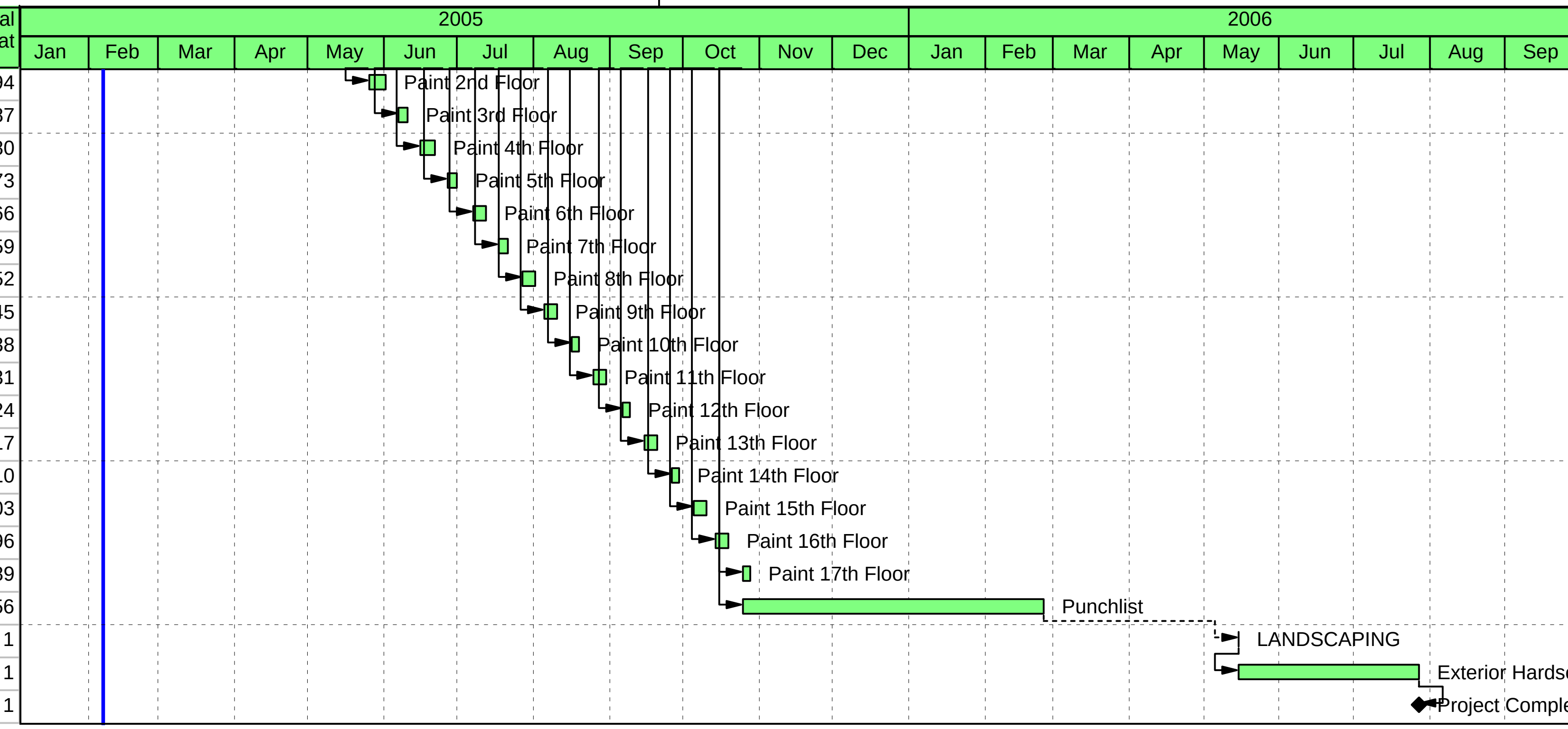
Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Start	Finish	Total Float
A2320	MEP Rough In Elev Floor	5	5	0%	16-Sep-05	22-Sep-05	210
A2340	Mech T/O, Fixt, Air Dev, Coil Hook Up 2...	5	5	0%	17-May-05	23-May-05	300
A2350	Mech T/O, Fixt, Air Dev, Coil Hook Up 3...	5	5	0%	24-May-05	31-May-05	295
A2360	Mech T/O, Fixt, Air Dev, Coil Hook Up 4...	5	5	0%	01-Jun-05	07-Jun-05	290
A2370	Mech T/O, Fixt, Air Dev, Coil Hook Up 5...	5	5	0%	08-Jun-05	14-Jun-05	285
A2380	Mech T/O, Fixt, Air Dev, Coil Hook Up 6...	5	5	0%	15-Jun-05	21-Jun-05	280
A2390	Mech T/O, Fixt, Air Dev, Coil Hook Up 7...	5	5	0%	22-Jun-05	28-Jun-05	275
A2400	Mech T/O, Fixt, Air Dev, Coil Hook Up 8...	5	5	0%	29-Jun-05	06-Jul-05	270
A2410	Mech T/O, Fixt, Air Dev, Coil Hook Up 9...	5	5	0%	07-Jul-05	13-Jul-05	265
A2420	Mech T/O, Fixt, Air Dev, Coil Hook Up 1...	5	5	0%	14-Jul-05	20-Jul-05	260
A2430	Mech T/O, Fixt, Air Dev, Coil Hook Up 1...	5	5	0%	21-Jul-05	27-Jul-05	255
A2440	Mech T/O, Fixt, Air Dev, Coil Hook Up 1...	5	5	0%	28-Jul-05	03-Aug-05	250
A2450	Mech T/O, Fixt, Air Dev, Coil Hook Up 1...	5	5	0%	04-Aug-05	10-Aug-05	245
A2460	Mech T/O, Fixt, Air Dev, Coil Hook Up 1...	5	5	0%	11-Aug-05	17-Aug-05	240
A2470	Mech T/O, Fixt, Air Dev, Coil Hook Up 1...	5	5	0%	18-Aug-05	24-Aug-05	170
A2480	Mech T/O, Fixt, Air Dev, Coil Hook Up 1...	5	5	0%	25-Aug-05	31-Aug-05	230
A2490	Mech T/O, Fixt, Air Dev, Coil Hook Up 1...	5	5	0%	01-Sep-05	08-Sep-05	225
A2500	Mech T/O, Fixt, Air Dev, Coil Hook Up ...	5	5	0%	09-Sep-05	15-Sep-05	220
A2510	Mech T/O, Fixt, Air Dev, Coil Hook Up ...	5	5	0%	16-Sep-05	22-Sep-05	215
A2520	Mech T/O, Fixt, Air Dev, Coil Hook Up ...	5	5	0%	23-Sep-05	29-Sep-05	210
A2530	Mech Balancing	65	65	0%	25-Aug-05	28-Nov-05	170
A2531	ELEVATORS	0	0	0%	19-May-05	19-May-05	153
A2540	Install Elevator Frames	50	50	0%	19-May-05	29-Jul-05	153
A2550	Elevator 1-4 Power Up	75	75	0%	01-Aug-05	14-Nov-05	178
A2560	Elevator 5-8 Power Up	100	100	0%	01-Aug-05	21-Dec-05	153
A2561	DRYWALL	0	0	0%	19-May-05	19-May-05	303
A2570	Install & Finish Drywall 2nd Floor	7	7	0%	17-May-05	25-May-05	56
A2580	Install & Finish Drywall 3rd Floor	7	7	0%	26-May-05	06-Jun-05	56
A2590	Install & Finish Drywall 4th Floor	7	7	0%	07-Jun-05	15-Jun-05	56
A2600	Install & Finish Drywall 5th Floor	7	7	0%	16-Jun-05	24-Jun-05	56
A2610	Install & Finish Drywall 6th Floor	7	7	0%	27-Jun-05	06-Jul-05	56
A2620	Install & Finish Drywall 7th Floor	7	7	0%	07-Jul-05	15-Jul-05	56
A2630	Install & Finish Drywall 8th Floor	7	7	0%	18-Jul-05	26-Jul-05	56
A2640	Install & Finish Drywall 09th Floor	7	7	0%	27-Jul-05	04-Aug-05	56
A2650	Install & Finish Drywall 10th Floor	7	7	0%	05-Aug-05	15-Aug-05	56
A2660	Install & Finish Drywall 11th Floor	7	7	0%	16-Aug-05	24-Aug-05	56
A2670	Install & Finish Drywall 12th Floor	7	7	0%	25-Aug-05	02-Sep-05	56
A2680	Install & Finish Drywall 13th Floor	7	7	0%	06-Sep-05	14-Sep-05	56
A2690	Install & Finish Drywall 14th Floor	7	7	0%	15-Sep-05	23-Sep-05	56
A2700	Install & Finish Drywall 15th Floor	7	7	0%	26-Sep-05	04-Oct-05	56
A2710	Install & Finish Drywall 16th Floor	7	7	0%	05-Oct-05	13-Oct-05	56
A2720	Install & Finish Drywall 17th Floor	7	7	0%	14-Oct-05	24-Oct-05	56
A2721	DOORS	0	0	0%	19-May-05	19-May-05	303
A2730	Install Door Frames	40	40	0%	16-Jun-05	11-Aug-05	244
A2731	CARPETS & FLOORING	0	0	0%	19-May-05	19-May-05	303
A2740	Install Carpets & Flooring	120	120	0%	17-May-05	03-Nov-05	185
A2741	PAINT	0	0	0%	19-May-05	19-May-05	303



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

TASK filter: All Activities

Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Start	Finish	Total Float
A2750	Paint 2nd Floor	4	4	0%	26-May-05	01-Jun-05	294
A2760	Paint 3rd Floor	4	4	0%	07-Jun-05	10-Jun-05	287
A2770	Paint 4th Floor	4	4	0%	16-Jun-05	21-Jun-05	280
A2780	Paint 5th Floor	4	4	0%	27-Jun-05	30-Jun-05	273
A2790	Paint 6th Floor	4	4	0%	07-Jul-05	12-Jul-05	266
A2800	Paint 7th Floor	4	4	0%	18-Jul-05	21-Jul-05	259
A2810	Paint 8th Floor	4	4	0%	27-Jul-05	01-Aug-05	252
A2820	Paint 9th Floor	4	4	0%	05-Aug-05	10-Aug-05	245
A2830	Paint 10th Floor	4	4	0%	16-Aug-05	19-Aug-05	238
A2840	Paint 11th Floor	4	4	0%	25-Aug-05	30-Aug-05	231
A2850	Paint 12th Floor	4	4	0%	06-Sep-05	09-Sep-05	224
A2860	Paint 13th Floor	4	4	0%	15-Sep-05	20-Sep-05	217
A2870	Paint 14th Floor	4	4	0%	26-Sep-05	29-Sep-05	210
A2880	Paint 15th Floor	4	4	0%	05-Oct-05	10-Oct-05	203
A2890	Paint 16th Floor	4	4	0%	14-Oct-05	19-Oct-05	196
A2900	Paint 17th Floor	4	4	0%	25-Oct-05	28-Oct-05	189
A2910	Punchlist	85	85	0%	25-Oct-05	24-Feb-06	56
A2911	LANDSCAPING	0	0	0%	15-May-06*	15-May-06	1
A2920	Exterior Hardscape	52	52	0%	15-May-06	27-Jul-06	1
A2930	Project Complete	0	0	0%		27-Jul-06	1



Actual Work | Critical Remaining Work | Summary
Remaining Work ◆ | ◆ Milestone

TASK filter: All Activities

APPENDIX – RESEARCH TOPIC

INDIVIDUAL LEED CHECKLIST SPREADSHEETS

PENN STATE VS. OTHER UNIVERSITIES

DEVELOPER GUIDES

		Core & Shell Projects											
	LEED-CS V1.0(Pilot)/2.0 Points	Harbor Side Office Center	Waterfront Technology Center @ Camden	420 Deleware Drive	Abercorn Common	111 South Wacker Drive	Banner Bank Building	1 Crescent Drive	Collaborative Innovation Center	East Hills Center	Main Street @ NorthField Stapleton	Totals	
		Silver	Gold	Silver	Silver	Gold	Platinum	Platinum	Gold	Gold	Silver		
	Sustainable Sites											160	
Prereq 1	**Construction Activity Pollution Prevention**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1	**Site Selection**	X	X		X	X	X	X	X	X	X	9	90%
Credit 2	**Development Density & Community Connectivity**		X			X	X	X	X			5	50%
Credit 3	**Brownfield Redevelopement**	X	X				X	X		X	X	6	60%
Credit 4.1	**Alternative Transportation: Public Transportation Access**	X	X		X	X	X	X	X	X		8	80%
Credit 4.2	**Alternative Transportation:** Bicycle Storage & Changing Rooms			X	X	X	X	X	X			6	60%
Credit 4.3	**Alternative Transportation:** Low-Emitting & Fuel-Efficient Vehicles		X	X	X	X	X	X		X		7	70%
Credit 4.4	**Alternative Transportation:** Parking Capacity	X	X		X	X	X		X	X		7	70%
Credit 5.1	**Site Development:** Protect of Restore Habitat					X						1	10%
Credit 5.2	**Site Development:** Maximize Open Space					X		X				2	20%
Credit 6.1	**Stormwater Design:** Quantity Control	X			X	X	X	X	X	X	X	8	80%
Credit 6.2	**Stormwater Design:** Quality Control	X			X		X	X		X	X	6	60%
Credit 7.1	**Construction Activity Pollution Prevention**	X				X	X	X	X		X	6	60%
Credit 7.2	**Heat Island Effect,** Roof	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 8	**Light Pollution Reduction**			X			X	X		X		4	40%
Credit 9	**Tenant Design & Construction Guidelines**	X	X	X	X		X	X	X	X	X	9	90%
												94	59%
	Water Efficiency											50	
Credit 1.1	**Water Efficient Landscaping:** Reduce by 50%	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 1.2	**Water Efficient Landscaping:** No Potable Use or No Irrigation		X	X	X	X	X	X	X	X		8	80%
Credit 2	**Innovative Wastewater Technologies**						X		X			2	20%
Credit 3.1	**Water Use Reduction:** 20% Reduction	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 3.2	**Water Use Reduction:** 30% Reduction	X		X	X	X	X	X	X	X	X	9	90%
												39	78%
	Energy & Atmosphere											170	
Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	X	X	X	X	X	X	X	X	X	X	10	
Prereq 2	**Minimum Energy Performance**	X	X	X	X	X	X	X	X	X	X	10	
Prereq 3	**Fundamental Refrigerant Management**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1	**Optimize Energy Performance**	XXX	XX	X	XXXX			XXXXX	XXX	XXXXX		23	230%
	10.5% New Buildings or 3.5% Existing Building Renovations												
	14% New Buildings or 7% Existing Building Renovations												
	17.5% New Buildings or 10.5% Existing Building Renovations												
	21% New Buildings or 14% Existing Building Renovations												
	24.5% New Buildings or 17.5% Existing Building Renovations												
	28% New Buildings or 21% Existing Building Renovations												
	31.5% New Buildings or 24.5% Existing Building Renovations												
	35% New Buildings or 28% Existing Building Renovations												
Credit 2	**On-Site Renewable Energy**												
Credit 3	**Enhanced Commissioning**		X	X								2	20%
Credit 4	**Enhanced Refrigerant Management**	X				X	X			X	X	5	50%
Credit 5.1	**Measurement & Verification** - Base Building		X					XX	X		XX	6	60%
Credit 5.2	**Measurement & Verification** - Tenant Sub-metering							X		X	X	3	30%
Credit 6	**Green Power**												0%
												69	41%

	Materials & Resources											120	
Prereq 1	**Storage & Collection of Recyclables**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1.1	**Building Reuse:** Maintain 25% of Existing Walls, Floors & Roof					X	X					2	20%
Credit 1.2	**Building Reuse:** Maintain 50% of Existing Walls, Floors & Roof					X	X					2	20%
Credit 1.3	**Building Reuse:** Maintain 75% of Interior Non-Structural Elements	X	X	X	X			X	X	X		7	70%
Credit 2.1	**Construction Waste Management:** Divert 50% from Disposal	X	X	X	X			X	X	X		7	70%
Credit 2.2	**Construction Waste Management:** Divert 75% from Disposal		X								X	2	20%
Credit 3	**Materials Reuse:** 1%	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 4.1	**Recycled Content:** 10% (post-consumer + ½ pre-consumer)	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 4.2	**Recycled Content:** 20% (post-consumer + ½ pre-consumer)	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 5.1	**Regional Materials:** 10% Extracted, Processed & Manufactured Reg	X	X	X	X			X	X	X	X	8	80%
Credit 5.2	**Regional Materials:** 20% Extracted, Processed & Manufactured Reg											0	0%
Credit 6	**Certified Wood**		X	X								2	20%
												70	58%
	Indoor Environmental Quality											160	
Prereq 1	**Minimum IAQ Performance**	X	X	X	X	X	X	X	X	X	X	10	
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1	**Outdoor Air Delivery Monitoring**	X	X	X		X	X	X	X			7	70%
Credit 2	**Increased Ventilation**			X	X	X	X		X			5	50%
Credit 3	**Construction IAQ Management Plan:** During Construction	X	X		X			X	X	X	X	7	70%
Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	X	X	X	X	**0.6**	**0.6**	X	X	X		**9**	90%
Credit 4.2	**Low-Emitting Materials:** Paints & Coatings	X	X	X	X	**0.6**	**0.6**	X	X		X	**9**	90%
Credit 4.3	**Low-Emitting Materials:** Carpet Systems	X	X	X				X	X		X	7	70%
Credit 4.4	**Low-Emitting Materials:** Composite Wood & Agrifiber Products			X		X	X	X				4	40%
Credit 5	**Indoor Chemical & Pollutant Source Control**	X	X	X		X	X	X				6	60%
Credit 6.1	**Controllability of Systems:** Perimeter					X	X		X			3	30%
Credit 6.2	**Controllability of Systems:** Non-Perimeter					X	X		X			3	30%
Credit 7.1	**Thermal Comfort:** Comply with ASHRAE 55-1992	X	X		X	X	X	X	X		X	8	80%
Credit 7.2	**Thermal Comfort:** Permanent Monitoring System	X	X			X	X	X	X		X	7	70%
Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	X	X			X	X	X	X	X	X	8	80%
Credit 8.2	**Daylight & Views:** Views for 90% of Spaces	X	X	X		X	X	X	X	X	X	9	90%
												112	70%
	Innovation & Design Process											50	
Credit 1.1	**Innovation in Design**: Provide Specific Title		X	X		X	X	X	X	X	X	8	80%
Credit 1.2	**Innovation in Design**: Provide Specific Title		X		X	X	X	X	X	X	X	8	80%
Credit 1.3	**Innovation in Design**: Provide Specific Title		X	X	X	X	X	X	X	X	X	9	90%
Credit 1.4	**Innovation in Design**: Provide Specific Title				X	X	X	X	X	X	X	7	70%
Credit 2	**LEED® Accredited Professional**	X	X	X	X	X	X	X	X	X	X	10	100%
												42	84%
	Totals (pre-certification estimates)	**32**	**36**	**28**	**31**	**36**	**36**	**46**	**40**	**35**	**30**	**350**	**35**

		Higher Education Projects											
	LEED-NC V2.1 Points (Higher Education)	Center for Inter. Engineering	Orr Admission & College Relations Bldg	Skenandoa House	Inter. Science & Tech. I	Clemson University's Advanced Material	Central College Housing Phase 2	Innovation Center	Redmond Campus Facility	Coffin Street Dormatories	John Mitchell Center at USM	Totals	
		Silver	Gold	Silver	Silver	Silver	Gold	Certified	Silver	Silver	Certified		
	Sustainable Sites											150	
Prereq 1	**Erosion & Sedimentation Control**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1	**Site Selection**	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 2	**Development Density**				X							1	10%
Credit 3	**Brownfield Redevelopment**				X							1	10%
Credit 4.1	**Alternative Transportation**, Public Transportation Access	X	X	X	X	X		X				6	60%
Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	X		X	X	X	X		X	X	X	8	80%
Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles		X				X					2	20%
Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling					X			X			2	20%
Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	X				X						2	20%
Credit 5.2	**Reduced Site Disturbance**, Development Footprint		X	X		X	X	X	X	X	X	9	90%
Credit 6.1	**Stormwater Management**, Rate and Quantity	X	X			X	X		X	X		6	60%
Credit 6.2	**Stormwater Management**, Treatment		X		X					X		3	30%
Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	X	X				X		X			4	40%
Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	X			X			X		X		4	40%
Credit 8	**Light Pollution Reduction**		X		X			X				3	30%
												71	47%
	Water Efficiency											50	
Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	X	X	X		X	X	X		X	X	8	80%
Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	X	X	X		X	X			X	X	7	70%
Credit 2	**Innovative Wastewater Technologies**									X		1	10%
Credit 3.1	**Water Use Reduction**, 20% Reduction	X			X	X	X	X			X	6	60%
Credit 3.2	**Water Use Reduction**, 30% Reduction	X				X	X	X				4	40%
												26	52%
	Energy & Atmosphere											200	
Prereq 1	**Fundamental Building Systems Commissioning**	X	X	X	X	X	X	X	X	X	X	10	
Prereq 2	**Minimum Energy Performance**	X	X	X	X	X	X	X	X	X	X	10	
Prereq 3	**CFC Reduction in HVAC&R Equipment**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1	**Optimize Energy Performance**		XXXXXX	XXXXXX	XXXX	XXXX	XXXXX	XXXXXXX	XXXXX	XXXXXXX	XXXX	53	530%
	15% New Buildings or 5% Existing Building Renovations												
	20% New Buildings or 10% Existing Building Renovations												
	25% New Buildings or 15% Existing Building Renovations												
	30% New Buildings or 20% Existing Building Renovations												
	35% New Buildings or 25% Existing Building Renovations												
	40% New Buildings or 30% Existing Building Renovations												
	45% New Buildings or 35% Existing Building Renovations												
	50% New Buildings or 40% Existing Building Renovations												
	55% New Buildings or 45% Existing Building Renovations												
	60% New Buildings or 50% Existing Building Renovations												
Credit 2.1	**Renewable Energy**, 5%												
Credit 2.2	**Renewable Energy**, 10%												
Credit 2.3	**Renewable Energy**, 20%												
Credit 3	**Additional Commissioning**	X	X		X		X		X			5	50%
Credit 4	**Ozone Depletion**					X	X		X		X	4	40%
Credit 5	**Measurement & Verification**		X				X					2	20%
Credit 6	**Green Power**	X	X	X			X				X	5	50%
												99	50%

	Materials & Resources											140	
Prereq 1	**Storage & Collection of Recyclables**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell			X	X							2	20%
Credit 1.2	**Building Reuse**, Maintain 100% of Shell			X								1	10%
Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell			X								1	10%
Credit 2.1	**Construction Waste Management**, Divert 50%	X	X	X	X	X		X	X	X	X	9	90%
Credit 2.2	**Construction Waste Management**, Divert 75%	X	X	X	X	X			X	X	X	8	80%
Credit 3.1	**Resource Reuse**, Specify 5%		X		X							2	20%
Credit 3.2	**Resource Reuse**, Specify 10%				X							1	10%
Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	X		X	X	X	X	X	X	X	X	9	90%
Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	X			X			X	X	X	X	6	60%
Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	X	X	X	X			X	X	X		7	70%
Credit 6	**Rapidly Renewable Materials**												0%
Credit 7	**Certified Wood**							X	X		X	3	30%
												69	49%
	Indoor Environmental Quality											170	
Prereq 1	**Minimum IAQ Performance**	X	X	X	X	X	X	X	X	X	X	10	100%
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	X	X		X		X	X	X		X	7	70%
Credit 2	**Ventilation Effectiveness**				X	X						2	20%
Credit 3.1	**Construction IAQ Management Plan**, During Construction	X	X		X	X	X		X	X		7	70%
Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	X				X	X	X	X			5	50%
Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	X		X		X	X	X	X	X	X	8	80%
Credit 4.2	**Low-Emitting Materials**, Paints	X	X	X	X		X	X	X	X	X	9	90%
Credit 4.3	**Low-Emitting Materials**, Carpet	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber						X	X	X		X	4	40%
Credit 5	**Indoor Chemical & Pollutant Source Control**	X	X	X	X	X	X		X	X	X	9	90%
Credit 6.1	**Controllability of Systems**, Perimeter		X	X			X			X		4	40%
Credit 6.2	**Controllability of Systems**, Non-Perimeter			X		X	X			X		4	40%
Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	X	X	X	X	X	X		X	X	X	9	90%
Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	X	X			X	X		X		X	6	60%
Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces		X	X					X	X		4	40%
Credit 8.2	**Daylight & Views**, Views for 90% of Spaces		X	X		X	X		X	X		6	60%
												114	67%
	Innovation & Design Process											50	
Credit 1.1	**Innovation in Design**: Provide Specific Title	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 1.2	**Innovation in Design**: Provide Specific Title	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 1.3	**Innovation in Design**: Provide Specific Title	X	X		X		X	X		X		6	60%
Credit 1.4	**Innovation in Design**: Provide Specific Title	X	X		X		X					4	40%
Credit 2	**LEED™ Accredited Professional**	X	X	X	X	X	X	X	X	X	X	10	100%
												40	80%
Totals (pre-certification estimates)		**33**	**39**	**33**	**35**	**33**	**39**	**31**	**35**	**36**	**29**	**343**	**34.3**

		Own/Occupy Projects											
	LEED-NC V2.1 Points (Owner Build/Occupy)	Yukon Base Facility	Wind NRG Partners, LLC	BCBS of MA	Pfizer Research Unit	Alberici Corporate Headqtrs	Institute of EcoTourism	Ampere Annex	Stantec Centre	Sprint Bldg 14	Winrock Intl Office	Totals	
		Silver	Gold	Certified	Silver	Platinum	Gold	Silver	Silver	Certified	Gold		
	Sustainable Sites											150	
Prereq 1	**Erosion & Sedimentation Control**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1	**Site Selection**	X			X	X		X	X			5	
Credit 2	**Development Density**								X			1	10%
Credit 3	**Brownfield Redevelopment**				X	X						2	20%
Credit 4.1	**Alternative Transportation**, Public Transportation Access	X		X	X	X	X	X	X	X	X	9	90%
Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	X	X	X	X	X		X	X	X	X	9	90%
Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	X					X					2	20%
Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling		X		X	X	X	X	X	X	X	8	80%
Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space					X	X				X	3	30%
Credit 5.2	**Reduced Site Disturbance**, Development Footprint		X			X	X	X		X		5	50%
Credit 6.1	**Stormwater Management**, Rate and Quantity					X			X	X		3	30%
Credit 6.2	**Stormwater Management**, Treatment			X		X		X		X		4	40%
Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**,N-Roof			X	X	X	X	X	X	X	X	8	80%
Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	X	X	X	X	X		X	X		X	8	80%
Credit 8	**Light Pollution Reduction**		X			X	X	X				4	40%
												81	54%
	Water Efficiency											50	
Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	X	X	X	X	X		X	X		X	8	80%
Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation		X		X	X		X	X		X	6	60%
Credit 2	**Innovative Wastewater Technologies**					X						1	10%
Credit 3.1	**Water Use Reduction**, 20% Reduction	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 3.2	**Water Use Reduction**, 30% Reduction	X	X			X		X	X		X	6	60%
												31	62%
	Energy & Atmosphere											200	
Prereq 1	**Fundamental Building Systems Commissioning**	X	X	X	X	X	X	X	X	X	X	10	
Prereq 2	**Minimum Energy Performance**	X	X	X	X	X	X	X	X	X	X	10	
Prereq 3	**CFC Reduction in HVAC&R Equipment**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1	**Optimize Energy Performance**	XXXXXXXX	XXXXXXXXXX	XXXX	XXXXX	XXXXXXXXXX	XXXXXXX	XXXX	XXXX	XXXX	XXXXXX	62	620%
	15% New Buildings or 5% Existing Building Renovations												
	20% New Buildings or 10% Existing Building Renovations												
	25% New Buildings or 15% Existing Building Renovations												
	30% New Buildings or 20% Existing Building Renovations												
	35% New Buildings or 25% Existing Building Renovations												
	40% New Buildings or 30% Existing Building Renovations												
	45% New Buildings or 35% Existing Building Renovations												
	50% New Buildings or 40% Existing Building Renovations												
	55% New Buildings or 45% Existing Building Renovations												
	60% New Buildings or 50% Existing Building Renovations												
Credit 2.1	**Renewable Energy**, 5%	X	X			X						3	30%
Credit 2.2	**Renewable Energy**, 10%	X	X			X						3	30%
Credit 2.3	**Renewable Energy**, 20%	X	X			X						3	30%
Credit 3	**Additional Commissioning**			X	X	X			X		X	5	50%
Credit 4	**Ozone Depletion**					X	X	X	X	X	X	6	60%
Credit 5	**Measurement & Verification**					X							
Credit 6	**Green Power**	X					X		X	X	X	5	50%
												117	59%

	Materials & Resources											140	
Prereq 1	**Storage & Collection of Recyclables**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell						X	X				2	20%
Credit 1.2	**Building Reuse**, Maintain 100% of Shell						X					1	10%
Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell												0%
Credit 2.1	**Construction Waste Management**, Divert 50%	X	X	X	X	X	X	X	X		X	9	90%
Credit 2.2	**Construction Waste Management**, Divert 75%	X	X	X	X	X	X	X	X		X	9	90%
Credit 3.1	**Resource Reuse**, Specify 5%					X	X					2	20%
Credit 3.2	**Resource Reuse**, Specify 10%						X					1	10%
Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	X	X	X	X	X		X	X	X	X	9	90%
Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	X	X	X		X		X	X	X	X	8	80%
Credit 6	**Rapidly Renewable Materials**					X						1	10%
Credit 7	**Certified Wood**		X		X	X						3	30%
												75	54%
	Indoor Environmental Quality											170	
Prereq 1	**Minimum IAQ Performance**	X	X	X	X	X	X	X	X	X	X	10	100%
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	X			X	X	X		X	X	X	7	70%
Credit 2	**Ventilation Effectiveness**					X				X	X	3	30%
Credit 3.1	**Construction IAQ Management Plan**, During Construction			X	X	X	X				X	5	50%
Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	X		X	X	X					X	5	50%
Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	X	X	X	X	X	X		X	X	X	9	90%
Credit 4.2	**Low-Emitting Materials**, Paints	X	X	X	X	X	X	X	X		X	9	90%
Credit 4.3	**Low-Emitting Materials**, Carpet	X	X	X		X	X	X	X	X	X	9	90%
Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber		X	X	X		X	X				5	50%
Credit 5	**Indoor Chemical & Pollutant Source Control**			X	X	X	X		X		X	6	60%
Credit 6.1	**Controllability of Systems**, Perimeter		X			X		X				3	30%
Credit 6.2	**Controllability of Systems**, Non-Perimeter		X	X		X					X	4	40%
Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992		X		X	X	X	X	X		X	7	70%
Credit 7.2	**Thermal Comfort**, Permanent Monitoring System		X		X	X	X		X		X	6	60%
Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces		X					X			X	3	30%
Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	X	X			X	X	X	X		X	7	70%
												108	64%
	Innovation & Design Process											50	
Credit 1.1	**Innovation in Design**: Provide Specific Title	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 1.2	**Innovation in Design**: Provide Specific Title	X	X	X		X	X	X	X	X	X	9	90%
Credit 1.3	**Innovation in Design**: Provide Specific Title		X	X		X	X	X	X	X	X	8	80%
Credit 1.4	**Innovation in Design**: Provide Specific Title		X	X		X			X		X	5	50%
Credit 2	**LEED™ Accredited Professional**	X	X	X	X	X	X	X	X	X	X	10	100%
												42	84%
	Totals (pre-certification estimates)	**35**	**44**	**31**	**33**	**60**	**39**	**36**	**38**	**26**	**43**	**385**	**38.5**

		Build-Lease/Sell Projects											
	LEED-NC V2.1 Points (Build/Sell/Lease)	Public Health Sciences	Tumwater Office	BCBSM/ Steketees Building	Michigan Renewal Energy	ORNL E. Campus	Town Center E Bldg II	Two Pot. Yard	NAR DC Bldg	Carl T. Curtis MW Reg	One Pot. Yard	Totals	
		Certified	Gold	Certified	Gold	Certified	Certified	Gold	Silver	Gold	Gold		
	Sustainable Sites											150	
Prereq 1	**Erosion & Sedimentation Control**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1	**Site Selection**	X	X	X			X	X	X	X	X	8	80%
Credit 2	**Development Density**	X		X				X	X		X	5	50%
Credit 3	**Brownfield Redevelopment**	X		X	X			X	X	X	X	6	60%
Credit 4.1	**Alternative Transportation**, Public Transportation Access	X	X	X	X			X	X		X	7	70%
Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	X	X		X	X	X	X	X	X	X	9	90%
Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles				X			X	X		X	4	40%
Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling		X		X	X	X	X		X	X	7	70%
Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space		X		X	X		X				4	40%
Credit 5.2	**Reduced Site Disturbance**, Development Footprint				X					X		2	20%
Credit 6.1	**Stormwater Management**, Rate and Quantity		X		X		X				X	4	40%
Credit 6.2	**Stormwater Management**, Treatment	X	X				X	X		X	X	6	60%
Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**,N-Roof	X			X	X		X	X	X	X	7	70%
Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof		X		X	X	X	X	X	X		7	70%
Credit 8	**Light Pollution Reduction**			X	X	X			X			4	40%
												90	60%
	Water Efficiency											50	
Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	X	X		X	X	X	X	X	X	X	9	90%
Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	X	X		X	X		X	X	X	X	8	80%
Credit 2	**Innovative Wastewater Technologies**												0%
Credit 3.1	**Water Use Reduction**, 20% Reduction		X	X	X		X	X	X	X	X	8	80%
Credit 3.2	**Water Use Reduction**, 30% Reduction		X		X			X	X	X	X	6	60%
												31	62%
	Energy & Atmosphere											200	
Prereq 1	**Fundamental Building Systems Commissioning**	X	X	X	X	X	X	X	X	X	X	10	
Prereq 2	**Minimum Energy Performance**	X	X	X	X	X	X	X	X	X	X	10	
Prereq 3	**CFC Reduction in HVAC&R Equipment**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1	**Optimize Energy Performance**		XXXXXX	XXXXX	XXXXXXX	XXX	XXXXXX	XX	XXXX	XXX	XXX	39	390%
	15% New Buildings or 5% Existing Building Renovations												
	20% New Buildings or 10% Existing Building Renovations												
	25% New Buildings or 15% Existing Building Renovations												
	30% New Buildings or 20% Existing Building Renovations												
	35% New Buildings or 25% Existing Building Renovations												
	40% New Buildings or 30% Existing Building Renovations												
	45% New Buildings or 35% Existing Building Renovations												
	50% New Buildings or 40% Existing Building Renovations												
	55% New Buildings or 45% Existing Building Renovations												
	60% New Buildings or 50% Existing Building Renovations												
Credit 2.1	**Renewable Energy**, 5%				X							1	
Credit 2.2	**Renewable Energy**, 10%				X							1	
Credit 2.3	**Renewable Energy**, 20%				X							1	
Credit 3	**Additional Commissioning**		X			X		X		X	X	5	50%
Credit 4	**Ozone Depletion**		X		X	X	X	X			X	6	60%
Credit 5	**Measurement & Verification**					X				X	X	3	30%
Credit 6	**Green Power**	X			X			X	X	X	X	6	60%
												92	46%

	Materials & Resources											140	
Prereq 1	**Storage & Collection of Recyclables**	X	X	X	X	X	X	X	X	X	X	10	
Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell			X								1	10%
Credit 1.2	**Building Reuse**, Maintain 100% of Shell			X								1	10%
Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell												0%
Credit 2.1	**Construction Waste Management**, Divert 50%	X	X		X	X	X	X		X	X	8	80%
Credit 2.2	**Construction Waste Management**, Divert 75%	X	X		X		X					4	40%
Credit 3.1	**Resource Reuse**, Specify 5%												0%
Credit 3.2	**Resource Reuse**, Specify 10%												0%
Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	X	X		X	X	X	X		X	X	8	80%
Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	X	X	X	X		X	X	X	X	X	9	90%
Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	X	X				X	X	X	X	X	7	70%
Credit 6	**Rapidly Renewable Materials**												0%
Credit 7	**Certified Wood**			X				X		X	X	4	40%
												62	44%
	Indoor Environmental Quality											170	
Prereq 1	**Minimum IAQ Performance**	X	X	X	X	X	X	X	X	X	X	10	100%
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**		X	X	X	X		X	X	X	X	8	80%
Credit 2	**Ventilation Effectiveness**				X					X		2	20%
Credit 3.1	**Construction IAQ Management Plan**, During Construction	X	X		X	X		X		X	X	7	70%
Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	X	X		X	X		X			X	6	60%
Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	X	X	X	X	X		X		X	X	8	80%
Credit 4.2	**Low-Emitting Materials**, Paints		X	X	X	X	X	X	X	X	X	9	90%
Credit 4.3	**Low-Emitting Materials**, Carpet	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber			X			X	X			X	4	40%
Credit 5	**Indoor Chemical & Pollutant Source Control**	X	X	X	X			X	X	X	X	8	80%
Credit 6.1	**Controllability of Systems**, Perimeter												0%
Credit 6.2	**Controllability of Systems**, Non-Perimeter												0%
Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992		X	X				X	X	X	X	6	60%
Credit 7.2	**Thermal Comfort**, Permanent Monitoring System		X	X				X		X	X	5	50%
Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces								X	X		2	20%
Credit 8.2	**Daylight & Views**, Views for 90% of Spaces		X	X	X		X	X	X	X	X	7	70%
												102	60%
	Innovation & Design Process											50	
Credit 1.1	**Innovation in Design**: Provide Specific Title	X	X		X	X		X	X	X	X	8	80%
Credit 1.2	**Innovation in Design**: Provide Specific Title	X	X	X	X	X	X	X	X	X	X	10	100%
Credit 1.3	**Innovation in Design**: Provide Specific Title	X	X		X	X		X	X	X	X	8	80%
Credit 1.4	**Innovation in Design**: Provide Specific Title	X	X		X		X	X	X	X	X	8	80%
Credit 2	**LEED™ Accredited Professional**	X	X	X	X	X	X	X	X	X	X	10	100%
												44	88%
	Totals (pre-certification estimates)	**26**	**41**	**27**	**46**	**27**	**28**	**42**	**33**	**40**	**43**	**353**	**35.3**

PENN STATE UNIVERSITY VS. OTHER RESEARCH UNIVERSITIES LEED POINT ANALYSIS					
	LEED-NC V2.1 Points (Higher Education)	PENN STATE UNIVERSITY		OTHER RESEARCH UNIVERSITIES	
	Sustainable Sites	Total Possible Points = 30		Total Possible Points = 150	
Prereq 1	**Erosion & Sedimentation Control**	2		10	
Credit 1	**Site Selection**	0		10	100%
Credit 2	**Development Density**	0		1	10%
Credit 3	**Brownfield Redevelopment**	0		1	10%
Credit 4.1	**Alternative Transportation**, Public Transportation Access	0		6	60%
Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1		8	80%
Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	0		2	20%
Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	0		2	20%
Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	0		2	20%
Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1		9	90%
Credit 6.1	**Stormwater Management**, Rate and Quantity	2		6	60%
Credit 6.2	**Stormwater Management**, Treatment	1		3	30%
Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	0		4	40%
Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1		4	40%
Credit 8	**Light Pollution Reduction**	0		3	30%
		8	27%	71	47%
	Water Efficiency	Total Possible Points = 10		Total Possible Points = 50	
Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	0		8	80%
Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	0		7	70%
Credit 2	**Innovative Wastewater Technologies**	0		1	10%
Credit 3.1	**Water Use Reduction**, 20% Reduction	2		6	60%
Credit 3.2	**Water Use Reduction**, 30% Reduction	1		4	40%
		3	30%	26	52%
	Energy & Atmosphere	Total Possible Points = 40		Total Possible Points = 200	
Prereq 1	**Fundamental Building Systems Commissioning**	2		10	
Prereq 2	**Minimum Energy Performance**	2		10	
Prereq 3	**CFC Reduction in HVAC&R Equipment**	2		10	
Credit 1	**Optimize Energy Performance**			53	530%
	15% New Buildings or 5% Existing Building Renovations	2			
	20% New Buildings or 10% Existing Building Renovations	2			
	25% New Buildings or 15% Existing Building Renovations	2			
	30% New Buildings or 20% Existing Building Renovations	2			
	35% New Buildings or 25% Existing Building Renovations	2			
	40% New Buildings or 30% Existing Building Renovations	2			
	45% New Buildings or 35% Existing Building Renovations	1			
	50% New Buildings or 40% Existing Building Renovations	1			
	55% New Buildings or 45% Existing Building Renovations	1			
	60% New Buildings or 50% Existing Building Renovations	1			
Credit 2.1	**Renewable Energy**, 5%	1			
Credit 2.2	**Renewable Energy**, 10%	0			
Credit 2.3	**Renewable Energy**, 20%	2			
Credit 3	**Additional Commissioning**	2		5	50%
Credit 4	**Ozone Depletion**	2		4	40%
Credit 5	**Measurement & Verification**	0		2	20%
Credit 6	**Green Power**	2		5	50%
		31	78%	99	50%
	Materials & Resources	Total Possible Points = 28		Total Possible Points = 140	
Prereq 1	**Storage & Collection of Recyclables**	2		10	
Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	0		2	20%
Credit 1.2	**Building Reuse**, Maintain 100% of Shell	0		1	10%
Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	0		1	10%
Credit 2.1	**Construction Waste Management**, Divert 50%	2		9	90%
Credit 2.2	**Construction Waste Management**, Divert 75%	2		8	80%
Credit 3.1	**Resource Reuse**, Specify 5%	0		2	20%
Credit 3.2	**Resource Reuse**, Specify 10%	0		1	10%

Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	2		9	90%
Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	1		6	60%
Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	2		10	100%
Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	2		7	70%
Credit 6	**Rapidly Renewable Materials**	0			0%
Credit 7	**Certified Wood**	2		3	30%
		15	54%	69	49%
	Indoor Environmental Quality	**Total Possible Points = 34**		**Total Possible Points = 170**	
Prereq 1	**Minimum IAQ Performance**	2		10	100%
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	2		10	100%
Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	2		7	70%
Credit 2	**Ventilation Effectiveness**	0		2	20%
Credit 3.1	**Construction IAQ Management Plan**, During Construction	2		7	70%
Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	2		5	50%
Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	2		8	80%
Credit 4.2	**Low-Emitting Materials**, Paints	2		9	90%
Credit 4.3	**Low-Emitting Materials**, Carpet	2		10	100%
Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	2		4	40%
Credit 5	**Indoor Chemical & Pollutant Source Control**	2		9	90%
Credit 6.1	**Controllability of Systems**, Perimeter	2		4	40%
Credit 6.2	**Controllability of Systems**, Non-Perimeter	1		4	40%
Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	0		9	90%
Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	2		6	60%
Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1		4	40%
Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	0		6	60%
		26	76%	114	67%
	Innovation & Design Process	**Total Possible Points = 10**		**Total Possible Points = 50**	
Credit 1.1	**Innovation in Design**: Provide Specific Title	2		10	100%
Credit 1.2	**Innovation in Design**: Provide Specific Title	2		10	100%
Credit 1.3	**Innovation in Design**: Provide Specific Title	1		6	60%
Credit 1.4	**Innovation in Design**: Provide Specific Title	2		4	40%
Credit 2	**LEED™ Accredited Professional**	2		10	100%
		9	90%	40	80%
		AVG LEED SCORE = 46 - GOLD		**AVG LEED SCORE = 42 - GOLD**	

LEED Guide for Core and Shell Developers			
	LEED-CS V1.0(Pilot)/2.0 Points	**Guide Data**	
		% of Research Projects	**Compliance Effort**
	Sustainable Sites		
Prereq 1	**Construction Activity Pollution Prevention**	100%	Mandatory Compliance
Credit 1	**Site Selection**	90%	Mandatory Compliance
Credit 2	**Development Density & Community Connectivity**	50%	Significant Effort
Credit 3	**Brownfield Redevelopement**	60%	Significant Effort
Credit 4.1	**Alternative Transportation: Public Transportation Access**	80%	Mandatory Compliance
Credit 4.2	**Alternative Transportation:** Bicycle Storage & Changing Rooms	60%	Significant Effort
Credit 4.3	**Alternative Transportation:** Low-Emitting and Fuel-Efficient Vehicles	70%	Significant Effort
Credit 4.4	**Alternative Transportation:** Parking Capacity	70%	Significant Effort
Credit 5.1	**Site Development:** Protect of Restore Habitat	10%	Minimal Effort
Credit 5.2	**Site Development:** Maximize Open Space	20%	Minimal Effort
Credit 6.1	**Stormwater Design:** Quantity Control	80%	Mandatory Compliance
Credit 6.2	**Stormwater Design:** Quality Control	60%	Significant Effort
Credit 7.1	**Construction Activity Pollution Prevention**	60%	Significant Effort
Credit 7.2	**Heat Island Effect,** Roof	100%	Mandatory Compliance
Credit 8	**Light Pollution Reduction**	40%	Adequate Effort
Credit 9	**Tenant Design & Construction Guidelines**	90%	Mandatory Compliance
	Water Efficiency		
Credit 1.1	**Water Efficient Landscaping:** Reduce by 50%	100%	Mandatory Compliance
Credit 1.2	**Water Efficient Landscaping:** No Potable Use or No Irrigation	80%	Mandatory Compliance
Credit 2	**Innovative Wastewater Technologies**	20%	Minimal Effort
Credit 3.1	**Water Use Reduction:** 20% Reduction	100%	Mandatory Compliance
Credit 3.2	**Water Use Reduction:** 30% Reduction	90%	Mandatory Compliance

	Energy & Atmosphere		
Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	100%	Mandatory Compliance
Prereq 2	**Minimum Energy Performance**	100%	Mandatory Compliance
Prereq 3	**Fundamental Refrigerant Management**	100%	Mandatory Compliance
Credit 1	**Optimize Energy Performance**	29% of Credit 1	Adequate Effort
	10.5% New Buildings or 3.5% Existing Building Renovations		
	14% New Buildings or 7% Existing Building Renovations		
	17.5% New Buildings or 10.5% Existing Building Renovations		
	21% New Buildings or 14% Existing Building Renovations		
	24.5% New Buildings or 17.5% Existing Building Renovations		
	28% New Buildings or 21% Existing Building Renovations		
	31.5% New Buildings or 24.5% Existing Building Renovations		
	35% New Buildings or 28% Existing Building Renovations		
Credit 2	**On-Site Renewable Energy**	0%	Minimal Effort
Credit 3	**Enhanced Commissioning**	20%	Minimal Effort
Credit 4	**Enhanced Refrigerant Management**	50%	Significant Effort
Credit 5.1	**Measurement & Verification** - Base Building	60%	Significant Effort
Credit 5.2	**Measurement & Verification -** Tenant Sub-metering	30%	Adequate Effort
Credit 6	**Green Power**	0%	Minimal Effort
	Materials & Resources		
Prereq 1	**Storage & Collection of Recyclables**	100%	Mandatory Compliance
Credit 1.1	**Building Reuse:** Maintain 25% of Existing Walls, Floors & Roof	20%	Minimal Effort
Credit 1.2	**Building Reuse:** Maintain 50% of Existing Walls, Floors & Roof	20%	Minimal Effort
Credit 1.3	**Building Reuse:** Maintain 75% of Interior Non-Structural Elements	70%	Significant Effort
Credit 2.1	**Construction Waste Management:** Divert 50% from Disposal	70%	Significant Effort
Credit 2.2	**Construction Waste Management:** Divert 75% from Disposal	20%	Minimal Effort
Credit 3	**Materials Reuse:** 1%	100%	Mandatory Compliance
Credit 4.1	**Recycled Content:** 10% (post-consumer + ½ pre-consumer)	100%	Mandatory Compliance
Credit 4.2	**Recycled Content:** 20% (post-consumer + ½ pre-consumer)	100%	Mandatory Compliance
Credit 5.1	**Regional Materials:** 10% Extracted, Processed & Manufactured Reg.	80%	Mandatory Compliance
Credit 5.2	**Regional Materials:** 20% Extracted, Processed & Manufactured Reg.	0%	Minimal Effort
Credit 6	**Certified Wood**	20%	Minimal Effort

	Indoor Environmental Quality		
Prereq 1	**Minimum IAQ Performance**	100%	Mandatory Compliance
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	100%	Mandatory Compliance
Credit 1	**Outdoor Air Delivery Monitoring**	70%	Significant Effort
Credit 2	**Increased Ventilation**	50%	Significant Effort
Credit 3	**Construction IAQ Management Plan:** During Construction	70%	Significant Effort
Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	90%	Mandatory Compliance
Credit 4.2	**Low-Emitting Materials:** Paints & Coatings	90%	Mandatory Compliance
Credit 4.3	**Low-Emitting Materials:** Carpet Systems	70%	Significant Effort
Credit 4.4	**Low-Emitting Materials:** Composite Wood & Agrifiber Products	40%	Adequate Effort
Credit 5	**Indoor Chemical & Pollutant Source Control**	60%	Significant Effort
Credit 6.1	**Controllability of Systems:** Perimeter	30%	Adequate Effort
Credit 6.2	**Controllability of Systems:** Non-Perimeter	30%	Adequate Effort
Credit 7.1	**Thermal Comfort:** Comply with ASHRAE 55-1992	80%	Mandatory Compliance
Credit 7.2	**Thermal Comfort:** Permanent Monitoring System	70%	Significant Effort
Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	80%	Mandatory Compliance
Credit 8.2	**Daylight & Views:** Views for 90% of Spaces	90%	Mandatory Compliance
	Innovation & Design Process		
Credit 1.1	**Innovation in Design**: Provide Specific Title	80%	Mandatory Compliance
Credit 1.2	**Innovation in Design**: Provide Specific Title	80%	Mandatory Compliance
Credit 1.3	**Innovation in Design**: Provide Specific Title	90%	Mandatory Compliance
Credit 1.4	**Innovation in Design**: Provide Specific Title	70%	Significant Effort
Credit 2	**LEED® Accredited Professional**	100%	Mandatory Compliance

LEED Guide for Higher Education Developers			
	LEED-NC V2.1 Points (Higher Education)	Guide Data	
		% of Research Projects	**Compliance Effort**
	Sustainable Sites		
Prereq 1	**Erosion & Sedimentation Control**	100%	Mandatory Compliance
Credit 1	**Site Selection**	100%	Mandatory Compliance
Credit 2	**Development Density**	10%	Minimal Effort
Credit 3	**Brownfield Redevelopment**	10%	Minimal Effort
Credit 4.1	**Alternative Transportation**, Public Transportation Access	60%	Significant Effort
Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	80%	Mandatory Compliance
Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	20%	Minimal Effort
Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	20%	Minimal Effort
Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	20%	Minimal Effort
Credit 5.2	**Reduced Site Disturbance**, Development Footprint	90%	Mandatory Compliance
Credit 6.1	**Stormwater Management**, Rate and Quantity	60%	Significant Effort
Credit 6.2	**Stormwater Management**, Treatment	40%	Adequate Effort
Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	40%	Adequate Effort
Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	40%	Adequate Effort
Credit 8	**Light Pollution Reduction**	30%	Adequate Effort
	Water Efficiency		
Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	80%	Mandatory Compliance
Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	70%	Significant Effort
Credit 2	**Innovative Wastewater Technologies**	10%	Minimal Effort
Credit 3.1	**Water Use Reduction**, 20% Reduction	60%	Significant Effort
Credit 3.2	**Water Use Reduction**, 30% Reduction	40%	Adequate Effort

	Energy & Atmosphere		
Prereq 1	**Fundamental Building Systems Commissioning**	100%	Mandatory Compliance
Prereq 2	**Minimum Energy Performance**	100%	Mandatory Compliance
Prereq 3	**CFC Reduction in HVAC&R Equipment**	100%	Mandatory Compliance
Credit 1	**Optimize Energy Performance**	53% of Credit 1	Significant Effort
	15% New Buildings or 5% Existing Building Renovations		
	20% New Buildings or 10% Existing Building Renovations		
	25% New Buildings or 15% Existing Building Renovations		
	30% New Buildings or 20% Existing Building Renovations		
	35% New Buildings or 25% Existing Building Renovations		
	40% New Buildings or 30% Existing Building Renovations		
	45% New Buildings or 35% Existing Building Renovations		
	50% New Buildings or 40% Existing Building Renovations		
	55% New Buildings or 45% Existing Building Renovations		
	60% New Buildings or 50% Existing Building Renovations		
Credit 2.1	**Renewable Energy**, 5%	0%	Minimal Effort
Credit 2.2	**Renewable Energy**, 10%	0%	Minimal Effort
Credit 2.3	**Renewable Energy**, 20%	0%	Minimal Effort
Credit 3	**Additional Commissioning**	50%	Significant Effort
Credit 4	**Ozone Depletion**	40%	Adequate Effort
Credit 5	**Measurement & Verification**	20%	Minimal Effort
Credit 6	**Green Power**	50%	Significant Effort
	Materials & Resources		
Prereq 1	**Storage & Collection of Recyclables**	100%	Mandatory Comliance
Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	20%	Minimal Effort
Credit 1.2	**Building Reuse**, Maintain 100% of Shell	10%	Minimal Effort
Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	10%	Minimal Effort
Credit 2.1	**Construction Waste Management**, Divert 50%	90%	Mandatory Comliance
Credit 2.2	**Construction Waste Management**, Divert 75%	80%	Mandatory Comliance
Credit 3.1	**Resource Reuse**, Specify 5%	20%	Minimal Effort
Credit 3.2	**Resource Reuse**, Specify 10%	10%	Minimal Effort
Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	90%	Mandatory Comliance
Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	60%	Significant Effort
Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	100%	Mandatory Comliance
Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	70%	Significant Effort
Credit 6	**Rapidly Renewable Materials**	0%	Minimal Effort
Credit 7	**Certified Wood**	30%	Adequate Effort

	Indoor Environmental Quality		
Prereq 1	**Minimum IAQ Performance**	100%	Mandatory Comliance
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	100%	Mandatory Comliance
Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	70%	Significant Effort
Credit 2	**Ventilation Effectiveness**	20%	Minimal Effort
Credit 3.1	**Construction IAQ Management Plan**, During Construction	70%	Significant Effort
Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	50%	Significant Effort
Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	80%	Mandatory Comliance
Credit 4.2	**Low-Emitting Materials**, Paints	90%	Mandatory Comliance
Credit 4.3	**Low-Emitting Materials**, Carpet	100%	Mandatory Comliance
Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	40%	Adequate Effort
Credit 5	**Indoor Chemical & Pollutant Source Control**	90%	Mandatory Comliance
Credit 6.1	**Controllability of Systems**, Perimeter	40%	Adequate Effort
Credit 6.2	**Controllability of Systems**, Non-Perimeter	40%	Adequate Effort
Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	90%	Mandatory Comliance
Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	60%	Significant Effort
Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	40%	Adequate Effort
Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	60%	Significant Effort
	Innovation & Design Process		
Credit 1.1	**Innovation in Design**: Provide Specific Title	100%	Mandatory Comliance
Credit 1.2	**Innovation in Design**: Provide Specific Title	100%	Mandatory Comliance
Credit 1.3	**Innovation in Design**: Provide Specific Title	60%	Significant Effort
Credit 1.4	**Innovation in Design**: Provide Specific Title	40%	Adequate Effort
Credit 2	**LEED™ Accredited Professional**	100%	Mandatory Comliance

LEED Guide for Own/Occupy Developers			
	LEED-NC V2.1 Points (Higher Education)	**Guide Data**	
		% of Research Projects	**Compliance Effort**
	Sustainable Sites		
Prereq 1	**Erosion & Sedimentation Control**	100%	Mandatory Compliance
Credit 1	**Site Selection**	50%	Significant Effort
Credit 2	**Development Density**	10%	Minimal Effort
Credit 3	**Brownfield Redevelopment**	20%	Minimal Effort
Credit 4.1	**Alternative Transportation**, Public Transportation Access	90%	Mandatory Compliance
Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	90%	Mandatory Compliance
Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	20%	Minimal Effort
Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	80%	Mandatory Compliance
Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	30%	Adequate Effort
Credit 5.2	**Reduced Site Disturbance**, Development Footprint	50%	Significant Effort
Credit 6.1	**Stormwater Management**, Rate and Quantity	30%	Adequate Effort
Credit 6.2	**Stormwater Management**, Treatment	40%	Adequate Effort
Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	80%	Mandatory Compliance
Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	80%	Mandatory Compliance
Credit 8	**Light Pollution Reduction**	40%	Adequate Effort
	Water Efficiency		
Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	80%	Mandatory Compliance
Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	60%	Significant Effort
Credit 2	**Innovative Wastewater Technologies**	10%	Minimal Effort
Credit 3.1	**Water Use Reduction**, 20% Reduction	100%	Mandatory Compliance
Credit 3.2	**Water Use Reduction**, 30% Reduction	60%	Significant Effort

	Energy & Atmosphere		
Prereq 1	**Fundamental Building Systems Commissioning**	100%	Mandatory Compliance
Prereq 2	**Minimum Energy Performance**	100%	Mandatory Compliance
Prereq 3	**CFC Reduction in HVAC&R Equipment**	100%	Mandatory Compliance
Credit 1	**Optimize Energy Performance**	62% of Credit 1	Significant Effort
	15% New Buildings or 5% Existing Building Renovations		
	20% New Buildings or 10% Existing Building Renovations		
	25% New Buildings or 15% Existing Building Renovations		
	30% New Buildings or 20% Existing Building Renovations		
	35% New Buildings or 25% Existing Building Renovations		
	40% New Buildings or 30% Existing Building Renovations		
	45% New Buildings or 35% Existing Building Renovations		
	50% New Buildings or 40% Existing Building Renovations		
	55% New Buildings or 45% Existing Building Renovations		
	60% New Buildings or 50% Existing Building Renovations		
Credit 2.1	**Renewable Energy**, 5%	30%	Adequate Effort
Credit 2.2	**Renewable Energy**, 10%	30%	Adequate Effort
Credit 2.3	**Renewable Energy**, 20%	30%	Adequate Effort
Credit 3	**Additional Commissioning**	50%	Significant Effort
Credit 4	**Ozone Depletion**	60%	Significant Effort
Credit 5	**Measurement & Verification**	0%	Minimal Effort
Credit 6	**Green Power**	5%	Minimal Effort
	Materials & Resources		
Prereq 1	**Storage & Collection of Recyclables**	100%	Mandatory Comliance
Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	20%	Minimal Effort
Credit 1.2	**Building Reuse**, Maintain 100% of Shell	10%	Minimal Effort
Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	0%	Minimal Effort
Credit 2.1	**Construction Waste Management**, Divert 50%	90%	Mandatory Comliance
Credit 2.2	**Construction Waste Management**, Divert 75%	90%	Mandatory Comliance
Credit 3.1	**Resource Reuse**, Specify 5%	20%	Minimal Effort
Credit 3.2	**Resource Reuse**, Specify 10%	10%	Minimal Effort
Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	10%	Minimal Effort
Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	10%	Minimal Effort
Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	90%	Mandatory Comliance
Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	80%	Mandatory Comliance
Credit 6	**Rapidly Renewable Materials**	10%	Minimal Effort
Credit 7	**Certified Wood**	30%	Adequate Effort

	Indoor Environmental Quality		
Prereq 1	**Minimum IAQ Performance**	100%	Mandatory Comliance
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	100%	Mandatory Comliance
Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	70%	Significant Effort
Credit 2	**Ventilation Effectiveness**	30%	Adequate Effort
Credit 3.1	**Construction IAQ Management Plan**, During Construction	50%	Significant Effort
Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	50%	Significant Effort
Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	90%	Mandatory Comliance
Credit 4.2	**Low-Emitting Materials**, Paints	90%	Mandatory Comliance
Credit 4.3	**Low-Emitting Materials**, Carpet	90%	Mandatory Comliance
Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	50%	Significant Effort
Credit 5	**Indoor Chemical & Pollutant Source Control**	60%	Significant Effort
Credit 6.1	**Controllability of Systems**, Perimeter	30%	Adequate Effort
Credit 6.2	**Controllability of Systems**, Non-Perimeter	40%	Adequate Effort
Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	70%	Significant Effort
Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	60%	Significant Effort
Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	30%	Adequate Effort
Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	70%	Significant Effort
	Innovation & Design Process		
Credit 1.1	**Innovation in Design**: Provide Specific Title	100%	Mandatory Comliance
Credit 1.2	**Innovation in Design**: Provide Specific Title	90%	Mandatory Comliance
Credit 1.3	**Innovation in Design**: Provide Specific Title	80%	Mandatory Comliance
Credit 1.4	**Innovation in Design**: Provide Specific Title	50%	Significant Effort
Credit 2	**LEED™ Accredited Professional**	100%	Mandatory Comliance

LEED Guide for Build-Lease/Sell Developers			
	LEED-NC V2.1 Points (Higher Education)	Guide Data	
		% of Research Projects	**Compliance Effort**
	Sustainable Sites		
Prereq 1	**Erosion & Sedimentation Control**	100%	Mandatory Compliance
Credit 1	**Site Selection**	80%	Mandatory Compliance
Credit 2	**Development Density**	50%	Significant Effort
Credit 3	**Brownfield Redevelopment**	60%	Significant Effort
Credit 4.1	**Alternative Transportation**, Public Transportation Access	70%	Significant Effort
Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	90%	Mandatory Compliance
Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	40%	Adequate Effort
Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	70%	Significant Effort
Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	40%	Adequate Effort
Credit 5.2	**Reduced Site Disturbance**, Development Footprint	20%	Minimal Effort
Credit 6.1	**Stormwater Management**, Rate and Quantity	40%	Adequate Effort
Credit 6.2	**Stormwater Management**, Treatment	60%	Significant Effort
Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	70%	Significant Effort
Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	70%	Significant Effort
Credit 8	**Light Pollution Reduction**	40%	Adequate Effort
	Water Efficiency		
Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	90%	Mandatory Compliance
Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	80%	Mandatory Compliance
Credit 2	**Innovative Wastewater Technologies**	0%	Minimal Effort
Credit 3.1	**Water Use Reduction**, 20% Reduction	80%	Mandatory Compliance
Credit 3.2	**Water Use Reduction**, 30% Reduction	60%	Significant Effort

	Energy & Atmosphere		
Prereq 1	**Fundamental Building Systems Commissioning**	100%	Mandatory Compliance
Prereq 2	**Minimum Energy Performance**	100%	Mandatory Compliance
Prereq 3	**CFC Reduction in HVAC&R Equipment**	100%	Mandatory Compliance
Credit 1	**Optimize Energy Performance**	39% of Credit 1	Adequate Effort
	15% New Buildings or 5% Existing Building Renovations		
	20% New Buildings or 10% Existing Building Renovations		
	25% New Buildings or 15% Existing Building Renovations		
	30% New Buildings or 20% Existing Building Renovations		
	35% New Buildings or 25% Existing Building Renovations		
	40% New Buildings or 30% Existing Building Renovations		
	45% New Buildings or 35% Existing Building Renovations		
	50% New Buildings or 40% Existing Building Renovations		
	55% New Buildings or 45% Existing Building Renovations		
	60% New Buildings or 50% Existing Building Renovations		
Credit 2.1	**Renewable Energy**, 5%	10%	Minimal Effort
Credit 2.2	**Renewable Energy**, 10%	10%	Minimal Effort
Credit 2.3	**Renewable Energy**, 20%	10%	Minimal Effort
Credit 3	**Additional Commissioning**	50%	Significant Effort
Credit 4	**Ozone Depletion**	60%	Significant Effort
Credit 5	**Measurement & Verification**	30%	Adequate Effort
Credit 6	**Green Power**	60%	Significant Effort
	Materials & Resources		
Prereq 1	**Storage & Collection of Recyclables**	100%	Mandatory Comliance
Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	10%	Minimal Effort
Credit 1.2	**Building Reuse**, Maintain 100% of Shell	10%	Minimal Effort
Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	0%	Minimal Effort
Credit 2.1	**Construction Waste Management**, Divert 50%	80%	Mandatory Comliance
Credit 2.2	**Construction Waste Management**, Divert 75%	40%	Adequate Effort
Credit 3.1	**Resource Reuse**, Specify 5%	0%	Minimal Effort
Credit 3.2	**Resource Reuse**, Specify 10%	0%	Minimal Effort
Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	100%	Mandatory Comliance
Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	80%	Mandatory Comliance
Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	90%	Mandatory Comliance
Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	70%	Significant Effort
Credit 6	**Rapidly Renewable Materials**	0%	Minimal Effort
Credit 7	**Certified Wood**	40%	Adequate Effort

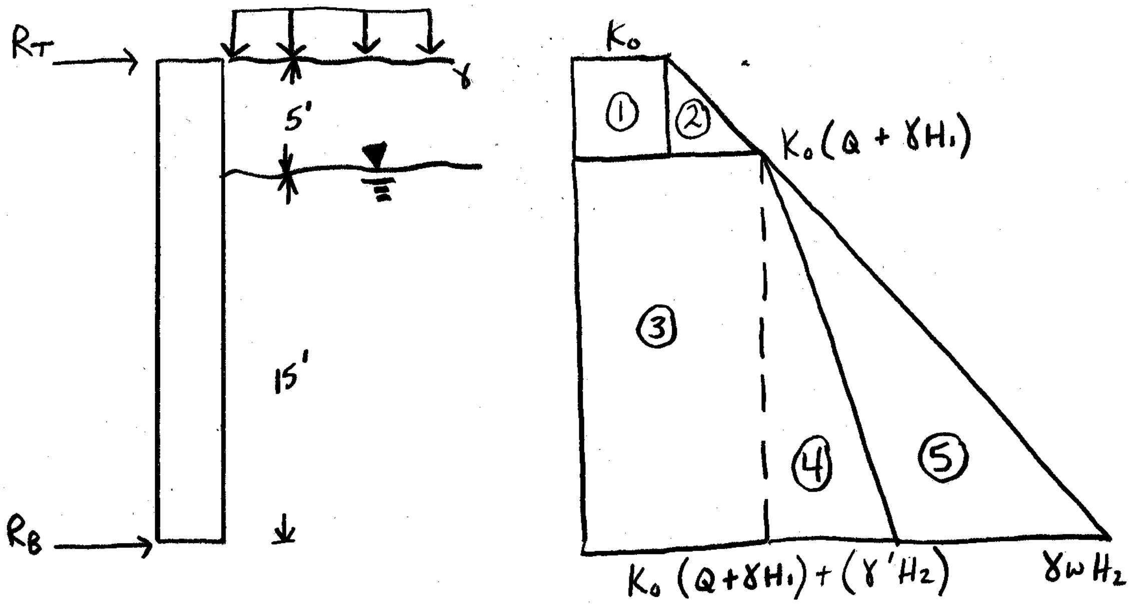
	Indoor Environmental Quality		
Prereq 1	**Minimum IAQ Performance**	100%	Mandatory Comliance
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	100%	Mandatory Comliance
Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	70%	Significant Effort
Credit 2	**Ventilation Effectiveness**	20%	Minimal Effort
Credit 3.1	**Construction IAQ Management Plan**, During Construction	70%	Significant Effort
Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	60%	Significant Effort
Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	80%	Mandatory Comliance
Credit 4.2	**Low-Emitting Materials**, Paints	90%	Mandatory Comliance
Credit 4.3	**Low-Emitting Materials**, Carpet	100%	Mandatory Comliance
Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	40%	Adequate Effort
Credit 5	**Indoor Chemical & Pollutant Source Control**	80%	Significant Effort
Credit 6.1	**Controllability of Systems**, Perimeter	0%	Minimal Effort
Credit 6.2	**Controllability of Systems**, Non-Perimeter	0%	Minimal Effort
Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	60%	Significant Effort
Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	50%	Significant Effort
Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	20%	Minimal Effort
Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	70%	Significant Effort
	Innovation & Design Process		
Credit 1.1	**Innovation in Design**: Provide Specific Title	80%	Mandatory Comliance
Credit 1.2	**Innovation in Design**: Provide Specific Title	100%	Mandatory Comliance
Credit 1.3	**Innovation in Design**: Provide Specific Title	80%	Mandatory Comliance
Credit 1.4	**Innovation in Design**: Provide Specific Title	80%	Mandatory Comliance
Credit 2	**LEED™ Accredited Professional**	100%	Mandatory Comliance

APPENDIX – TECHNICAL ANALYSIS 1

TOWER AS AN INDEPENDENT SYSTEM

BASEMENT WALL CALCULATIONS, SECTIONS, & ENERCALC PRINTOUTS

WALL LOADS



$K_A = 0.333$
$K_P = 3$
$K_o = 0.5$
$Q = 50$ PSF
$\gamma = 120$ PCF
$\gamma_{SAT} = 150$ PCF

$\gamma' = \gamma_{SAT} - \gamma_w$
$= 150 \text{ PCF} - 62.4 \text{ PCF}$
$= 87.6 \text{ PCF}$

$$P_0 = K_o Q H_1 + \tfrac{1}{2} K_o \gamma H_1^2 + K_o(Q + \gamma H_1) H_2 + \tfrac{1}{2} K_o \gamma' H_2^2 + \tfrac{1}{2}\gamma_w H_2^2$$
$$= 0.5(50 \text{ PSF})5' + \tfrac{1}{2}(0.5)\,120 \text{ PCF}\,(5')^2 + 0.5\,(50 \text{ PSF} + 120 \text{ PCF}(8'))\,15' + \tfrac{1}{2}(0.5)\,87.6 \text{ PCF}\,(15')^2 + \tfrac{1}{2}(62.4 \text{ PCF})(15')^2$$

$$= 125 + 750 + 4875 + 4927.5 + 7020$$

$$= 17697.5 \text{ LB}$$

$$\Sigma M_B = P_o \bar{z} = P_1(17.5') + P_2(16.67') + P_3(7.5') + 5'(P_4 + P_5) = 110990'\text{LB}$$

$$\bar{z} = \frac{M_B}{P_o} = \frac{110990 \text{ FT LB}}{17697.5 \text{ LB}} = 6.27 \text{ FT}$$

$R_T = 5549.5$ LB
$R_B = 12148$ LB

WALL DESIGN

* ACI → WALL >10"
MAT REQ'D @
EACH EDGE

TRY 20" TK WALL:

$$R_u = \frac{M_u}{\phi b d^2} = \frac{110990 \text{ FT LB}}{0.9(10")^2(12")} = 1233.2 \text{ IN}\cdot\text{LB}$$

$$\rho = \frac{0.85 f'_c}{F_y}\left(1 - \sqrt{1 - \frac{2R_u}{0.85 f'_c}}\right)$$

$$= \frac{0.85(4000 \text{ PSI})}{60000 \text{ PSI}}\left(1 - \sqrt{1 - \frac{2(1233.2 \text{ IN LB})}{0.85(4000 \text{ PSI})}}\right)$$

$$\rho_{MIN} = \frac{200}{F_y} = \frac{200}{60000 \text{ PSI}} = 0.0033$$

$$A_s = \rho b d = 0.02697(12")(10") = 3.24 \text{ in}^2$$

* USE 2 ROWS OF #9 @ 6" O.C. HORIZ

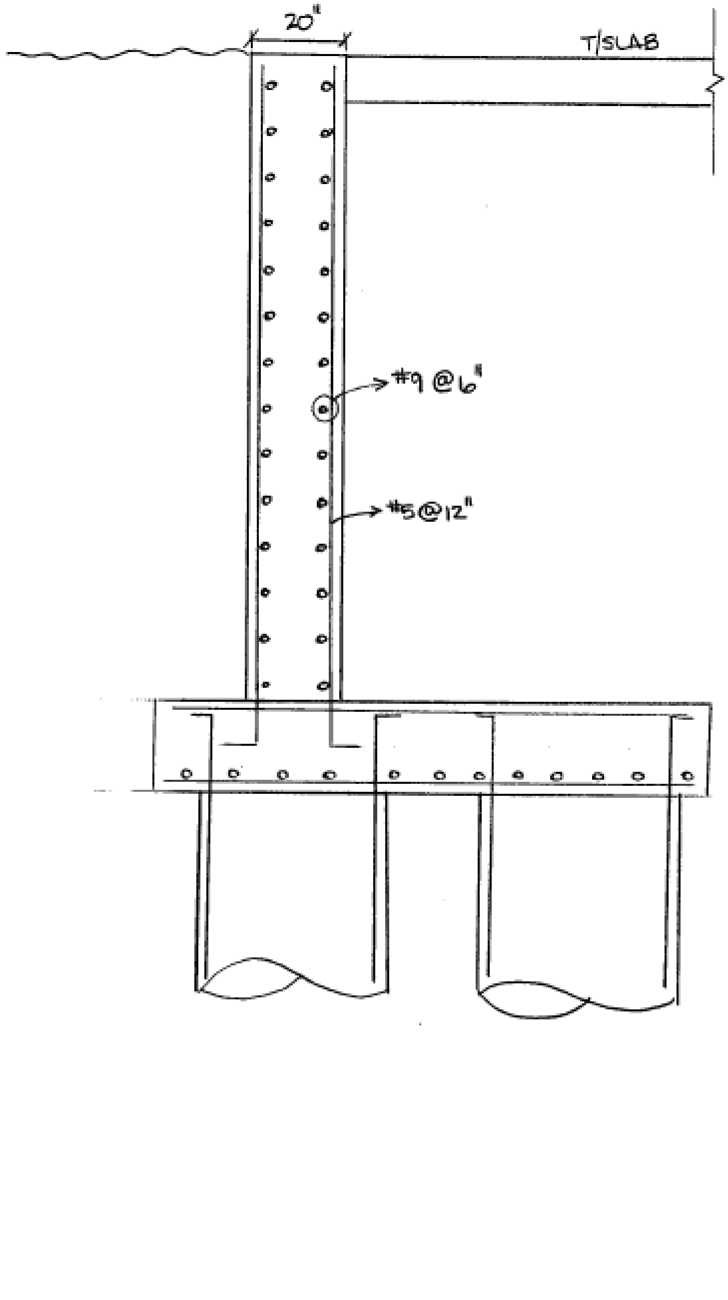
CK CONC @ BASE →

$$V_c = 2\sqrt{f'_c}\, bd = 2\sqrt{4000 \text{ PSI}}\,(12")(17") = 21503.5 \text{ LB}$$

$$V_u/\phi = 12148 \text{ LB}/0.75 = 16197.3 \text{ LB} \leq 21503.5 \text{ LB} \therefore \text{OK}$$

$$A_v = \frac{V_u}{\phi F_y \mu} = \frac{16197.3 \text{ LB}}{60000 \text{ PSI}(0.6)} = 0.45 \text{ in}^2$$

USE #5 @ 12" (BOTH EDGES) VERT


20"
T/SLAB
#9 @6"
#5@12"

Restrained Retaining Wall Design

Description Thesis

Criteria

Retained Height	=	20.00 ft
Wall height above soil	=	0.00 ft
Total Wall Height	=	20.00 ft
Top Support Height	=	20.00 ft
Slope Behind Wall	=	0.00 : 1
Height of Soil over Toe	=	0.00 in
Soil Density	=	150.00 pcf
Wind on Stem	=	0.0 psf

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Heel Active Pressure	=	25.0
Toe Active Pressure	=	0.0
Passive Pressure	=	225.0
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in

Footing Strengths & Dimensions

f'c = 4,000 psi	Fy =	60,000 psi
Min. As %	=	0.0018
Toe Width	=	2.17 ft
Heel Width	=	3.83
Total Footing Width	=	6.00
Footing Thickness	=	16.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft
Cover @ Top = 3.00 in	@ Btm.=	3.00 in

Surcharge Loads

Surcharge Over Heel = 50.0 psf
>>>NOT Used To Resist Sliding & Overturn
Surcharge Over Toe = 0.0 psf
NOT Used for Sliding & Overturning

Uniform Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line
Base Above/Below Soil at Back of Wall	=	0.0 ft

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Design Summary

Total Bearing Load	=	12,493 lbs	
...resultant ecc.	=	1.24 in	
Soil Pressure @ Toe	=	2,298 psf	OK
Soil Pressure @ Heel	=	1,867 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	3,217 psf	
ACI Factored @ Heel	=	2,614 psf	
Footing Shear @ Toe	=	40.8 psi	OK
Footing Shear @ Heel	=	65.9 psi	OK
Allowable	=	107.5 psi	
Reaction at Top	=	1,062.5 lbs	
Reaction at Bottom	=	4,804.2 lbs	

Sliding Calcs Slab Resists All Sliding !
Lateral Sliding Force = 4,804.2 lbs

Concrete Stem Construction

Thickness = 20.00 in Fy = 60,000 psi
Wall Weight = 241.7 pcf f'c = 4,000 psi
Stem is FIXED to top of footing

		@ Top Support	Mmax Between Top & Base	@ Base of Wall
		Stem OK	Stem OK	Stem OK
Design height	=	20.00 ft	11.08 ft	0.00 ft
Rebar Size	=	# 5	# 9	# 9
Rebar Spacing	=	12.00 in	6.00 in	6.00 in
Rebar Placed at	=	Edge	Edge	Edge
Rebar Depth 'd'	=	16.50 in	16.50 in	16.50 in
Design Data				
fb/FB + fa/Fa	=	0.000	0.078	0.173
Mu....Actual	=	0.0 ft-#	10,521.0 ft-#	23,375.5 ft-#
Mn * Phi.....Allowable	=	22,698.6 ft-#	135225.0 ft-#	135225.0 ft-#
Shear Force @ this height	=	1,806.2 lbs		6,977.1 lbs
Shear.....Actual	=	9.12 psi		35.24 psi
Shear.....Allowable	=	107.52 psi		107.52 psi
Rebar Lap Required	=	18.50 in	41.62 in	
Rebar embedment into footing	=			9.00 in

Other Acceptable Sizes & Spacings:

Toe: # 5 @ 12.00 in -or- #4@ 9.00 in, #5@ 14.00 in, #6@ 19.75 in, #7@ 26.:
Heel:# 5 @ 12.00 in -or- #4@ 9.00 in, #5@ 14.00 in, #6@ 19.75 in, #7@ 26.:
Key: No key defined -or- No key defined

Footing Design Results

		Toe	Heel	
Factored Pressure	=	3,217	2,614	psf
Mu' : Upward	=	7,380	0	ft-#
Mu' : Downward	=	657	10,680	ft-#
Mu: Design	=	6,722	10,680	ft-#
Actual 1-Way Shear	=	40.84	65.94	psi
Allow 1-Way Shear	=	107.52	107.52	psi

Restrained Retaining Wall Design

Description Thesis

Summary of Forces on Footing : Slab RESISTS sliding, stem is FIXED at footing

Forces acting on footing for soil pressure

>>> Sliding Forces are restrained by the adjacent slab

Load & Moment Summary For Footing : For Soil Pressure Calcs

Moment @ Top of Footing Applied from Stem			=	-13,750.3 ft-#
Surcharge Over Heel	=	lbs	ft	ft-#
Axial Dead Load on Stem	=	lbs	ft	ft-#
Soil Over Toe	=	lbs	ft	ft-#
Surcharge Over Toe	=	lbs	ft	ft-#
Stem Weight	=	4,833.3 lbs	3.00 ft	14,500.0 ft-#
Soil Over Heel	=	6,500.0 lbs	4.92 ft	31,958.3 ft-#
Footing Weight	=	1,160.0 lbs	3.00 ft	3,480.0 ft-#
Total Vertical Force	=	12,493.3 lbs	Base Moment =	36,188.1 ft-#

Soil Pressure Resulting Moment = 1,291.9ft-#

APPENDIX – TECHNICAL ANALYSIS 2

CAST-IN-PLACE CAISSON VS. PRECAST PILES

CAISSON LOAD DETERMINATIONS

CAISSON LOAD ANALYSIS

Caisson Redesign Calculations															
Column	**Floor (ft^2)**	**Roof (ft^2)**	**DL-bsmt (psf)**	**DL-floor (psf)**	**DL-roof (psf)**	**Total Dead (lbs)**	**LL-bsmt (psf)**	**LL-floor (psf)**	**LL-roof (psf)**	**Total Live (lbs)**	**WL (psf)**	**WL (lbs)**	**Non-WL (lbs)**	**Final Load (kips)**	**Caisson Size (Colors from Depth Charts)**
A-2	5,168	160	190	57	25	356,336	100	100	30	552,000			1,310,803	**1,311**	**D = 66"**
A-3	11,560	480	190	57	25	800,120	100	100	30	1,238,400			2,941,584	**2,942**	**D = 90"**
A-4	11,560	480	190	57	25	800,120	100	100	30	1,238,400			2,941,584	**2,942**	**D = 90"**
A-5	6,800	160	190	57	25	467,600	100	100	30	724,800			1,720,800	**1,721**	**D = 84"**
A.2-1.8	5,032		190	57	25	343,064	100	100	30	532,800			1,264,157	**1,264**	**D = 66"**
A.8-1.2	5,032		190	57	25	343,064	100	100	30	532,800			1,264,157	**1,264**	**D = 66"**
E.2-5.8	5,032		190	57	25	343,064	100	100	30	532,800			1,264,157	**1,264**	**D = 66"**
E.8-5.2	5,032		190	57	25	343,064	100	100	30	532,800			1,264,157	**1,264**	**D = 66"**
A.2-5.2	2,788		190	57	25	190,076	100	100	30	295,200			700,411	**700**	**D = 60"**
A.8-5.8	2,176		190	57	25	148,352	100	100	30	230,400			546,662	**547**	**D = 60"**
E.2-1.2	2,176		190	57	25	148,352	100	100	30	230,400			546,662	**547**	**D = 60"**
E.8-1.8	2,788		190	57	25	190,076	100	100	30	295,200			700,411	**700**	**D = 60"**
B-1	5,168	160	190	57	25	356,336	100	100	30	552,000			1,310,803	**1,311**	**D = 66"**
B-2	18,476	588	190	57	25	1,274,328	100	100	30	1,973,922			4,687,470	**4,687**	**D = 114"**
B-3	16,256	1,256	190	57	25	1,139,677	100	100	30	1,758,904	600	3,127,476		**3,127**	**D = 90"**
B-4	18,324	1,256	190	57	25	1,280,666	100	100	30	1,977,868	600	3,515,627		**3,516**	**D = 96"**
B-5	18,840	588	190	57	25	1,299,145	100	100	30	2,012,464			4,778,915	**4,779**	**D = 114"**
B-6	7,072	160	190	57	25	486,144	100	100	30	753,600			1,789,133	**1,789**	**D = 84"**
B.3-3.5	4,644	512	190	57	25	329,412	100	100	30	507,078	3,500	907,971		**908**	**D = 60"**
B.3-4.6	2,892		190	57	25	197,166	100	100	30	306,212	3,500	548,411		**548**	**D = 60"**
C-1	11,560	432	190	57	25	798,920	100	100	30	1,236,960			2,937,840	**2,938**	**D = 90"**
C-2	22,344	1,192	190	57	25	1,553,135	100	100	30	2,401,595	600	4,266,317		**4,266**	**D = 114"**
C-3	15,360	832	190	57	25	1,067,991	100	100	30	1,651,313	3,500	2,938,502		**2,939**	**D = 90"**
C-3.5	13,356		190	57	25	910,565	100	100	30	1,414,165	3,500	2,512,443		**2,512**	**D = 84"**
C-4	11,504	832	190	57	25	805,102	100	100	30	1,243,031	3,500	2,214,753		**2,215**	**D = 84"**
C-4.6	7,376		190	57	25	502,870	100	100	30	780,988	3,500	1,390,032		**1,390**	**D = 66"**
C-5	15,532	1,192	190	57	25	1,088,717	100	100	30	1,680,325	600	2,987,745		**2,988**	**D = 90"**

Caisson Redesign Calculations (cont'd)															
Column	Floor (ft^2)	Roof (ft^2)	DL-bsmt (psf)	DL-floor (psf)	DL-roof (psf)	Total Dead (lbs)	LL-bsmt (psf)	LL-floor (psf)	LL-roof (psf)	Total Live (lbs)	WL (psf)	WL (lbs)	Non-WL (lbs)	Final Load (kips)	Caisson Size (Colors from Depth Charts)
C-6	11,560	480	190	57	25	800,120	100	100	30	1,238,400			2,941,584	**2,942**	**D = 90"**
D-1	11,560	480	190	57	25	800,120	100	100	30	1,238,400			2,941,584	**2,942**	**D = 90"**
D-2	15,532	1,192	190	57	25	1,088,717	100	100	30	1,680,325	600	2,987,745		**2,988**	**D = 90"**
D-2.3	7,376		190	57	25	502,870	100	100	30	780,988	3,500	1,390,032		**1,390**	**D = 66"**
D-3	11,504	832	190	57	25	805,102	100	100	30	1,243,031	3,500	2,214,753		**2,215**	**D = 84"**
D-3.5	13,356	512	190	57	25	923,365	100	100	30	1,429,525	3,500	2,543,163		**2,543**	**D = 90"**
D-4	15,360	832	190	57	25	1,067,991	100	100	30	1,651,313	3,500	2,938,502		**2,939**	**D = 90"**
D-5	22,344	1,192	190	57	25	1,553,135	100	100	30	2,401,595	600	4,266,317		**4,266**	**D = 114"**
D-6	11,560	432	190	57	25	798,920	100	100	30	1,236,960			2,937,840	**2,938**	**D = 90"**
D.7-2.3	2,892		190	57	25	197,166	100	100	30	306,212	3,500	548,411		**548**	**D = 60"**
D.7-3.5	4,644		190	57	25	316,612	100	100	30	491,718	3,500	877,251		**877**	**D = 60"**
E-1	7,072	160	190	57	25	486,144	100	100	30	753,600			1,789,133	**1,789**	**D = 84"**
E-2	18,840	588	190	57	25	1,299,145	100	100	30	2,012,464			4,778,915	**4,779**	**D = 114"**
E-3	18,324	1,256	190	57	25	1,280,666	100	100	30	1,977,868	600	3,515,627		**3,516**	**D = 114"**
E-4	16,256	1,256	190	57	25	1,139,677	100	100	30	1,758,904	600	3,127,476		**3,127**	**D = 90"**
E-5	18,476	588	190	57	25	1,274,328	100	100	30	1,973,922			4,687,470	**4,687**	**D = 114"**
E-6	5,168	160	190	57	25	356,336	100	100	30	552,000			1,310,803	**1,311**	**D = 66"**
F-2	6,800	160	190	57	25	467,600	100	100	30	724,800			1,720,800	**1,721**	**D = 84"**
F-3	11,560	480	190	57	25	800,120	100	100	30	1,238,400			2,941,584	**2,942**	**D = 90"**
F-4	11,560	480	190	57	25	800,120	100	100	30	1,238,400			2,941,584	**2,942**	**D = 90"**
F-5	5,168	160	190	57	25	356,336	100	100	30	552,000			1,310,803	**1,311**	**D = 66"**

Sizing Index @ 50' Depth								
Diameter (in)	Diameter (ft)	Kips	S A @ 50'	Skin Friction	Added KIPS	Total w/ SF	SW	**Capacity (kips)**
36	3	212	485	777	-1123	-911	30	**-881**
42	3.5	289	569	910	-990	-701	41	**-660**
48	4	377	653	1046	-854	-477	53	**-424**
54	4.5	477	739	1182	-718	-241	68	**-173**
60	5	589	825	1319	-581	9	83	**92**
66	5.5	713	911	1458	-442	271	101	**372**
72	6	848	999	1598	-302	547	120	**667**
78	6.5	995	1087	1740	-160	835	141	**976**
84	7	1155	1177	1882	-18	1137	164	**1301**
90	7.5	1325	1266	2026	126	1452	188	**1639**
96	8	1508	1357	2171	271	1779	214	**1993**
102	8.5	1702	1449	2318	418	2120	241	**2361**
108	9	1909	1541	2466	566	2474	270	**2744**
114	9.5	2126	1634	2614	714	2841	301	**3142**
120	10	2356	1728	2765	865	3221	334	**3555**
126	10.5	2598	1823	2916	1016	3614	368	**3982**
132	11	2851	1918	3069	1169	4020	404	**4424**
138	11.5	3116	2014	3223	1323	4439	441	**4880**
Sizing Index @ 60' Depth								
Diameter (in)	Diameter (ft)	Kips	S A @ 60'	Skin Friction	Added KIPS	Total w/ SF	SW	**Capacity (kips)**
36	3	212	580	927	-973	-761	36	**-724**
42	3.5	289	679	1086	-814	-525	49	**-476**
48	4	377	779	1247	-653	-276	64	**-212**
54	4.5	477	880	1408	-492	-15	81	**66**
60	5	589	982	1571	-329	260	100	**360**
66	5.5	713	1084	1735	-165	548	121	**669**
72	6	848	1188	1900	0	848	144	**992**
78	6.5	995	1292	2067	167	1162	169	**1331**
84	7	1155	1396	2234	334	1489	196	**1685**
90	7.5	1325	1502	2403	503	1829	225	**2054**
96	8	1508	1608	2574	674	2182	256	**2438**
102	8.5	1702	1716	2745	845	2547	289	**2837**
108	9	1909	1824	2918	1018	2926	324	**3251**
114	9.5	2126	1932	3092	1192	3318	361	**3680**
120	10	2356	2042	3267	1367	3723	401	**4124**
126	10.5	2598	2152	3444	1544	4142	442	**4583**
132	11	2851	2264	3622	1722	4573	485	**5057**
138	11.5	3116	2375	3801	1901	5017	530	**5547**
Sizing Index @ 70' Depth								
Diameter (in)	Diameter (ft)	Kips	S A @ 70'	Skin Friction	Added KIPS	Total w/ SF	SW	**Capacity (kips)**
36	3	212	674	1078	-822	-610	42	**-568**
42	3.5	289	789	1262	-638	-349	57	**-292**
48	4	377	905	1448	-452	-75	75	**-1**
54	4.5	477	1021	1634	-266	211	95	**306**
60	5	589	1139	1822	-78	511	117	**628**
66	5.5	713	1257	2011	111	824	141	**965**
72	6	848	1376	2202	302	1150	168	**1318**
78	6.5	995	1496	2393	493	1489	197	**1686**
84	7	1155	1616	2586	686	1841	229	**2070**
90	7.5	1325	1738	2780	880	2206	263	**2469**
96	8	1508	1860	2976	1076	2584	299	**2883**
102	8.5	1702	1983	3172	1272	2975	338	**3312**
108	9	1909	2106	3370	1470	3379	379	**3757**
114	9.5	2126	2231	3569	1669	3796	422	**4218**
120	10	2356	2356	3770	1870	4226	467	**4693**
126	10.5	2598	2482	3972	2072	4669	515	**5185**
132	11	2851	2609	4175	2275	5126	565	**5691**
138	11.5	3116	2737	4379	2479	5595	618	**6213**

Sizing Index @ 80' Depth								
Diameter (in)	Diameter (ft)	Kips	S A @ 80'	Skin Friction	Added KIPS	Total w/ SF	SW	**Capacity (kips)**
36	3	212	768	1229	-671	-459	48	**-411**
42	3.5	289	899	1438	-462	-173	65	**-108**
48	4	377	1030	1649	-251	126	85	**211**
54	4.5	477	1163	1860	-40	438	108	**546**
60	5	589	1296	2073	173	763	134	**896**
66	5.5	713	1430	2288	388	1100	162	**1262**
72	6	848	1565	2503	603	1451	192	**1644**
78	6.5	995	1700	2720	820	1815	226	**2041**
84	7	1155	1836	2938	1038	2193	262	**2454**
90	7.5	1325	1973	3157	1257	2583	300	**2883**
96	8	1508	2111	3378	1478	2986	342	**3328**
102	8.5	1702	2250	3600	1700	3402	386	**3788**
108	9	1909	2389	3823	1923	3831	433	**4264**
114	9.5	2126	2529	4047	2147	4273	482	**4755**
120	10	2356	2670	4273	2373	4729	534	**5263**
126	10.5	2598	2812	4499	2599	5197	589	**5786**
132	11	2851	2955	4727	2827	5678	646	**6325**
138	11.5	3116	3098	4957	3057	6173	706	**6879**
Sizing Index @ 90' Depth								
Diameter (in)	Diameter (ft)	Kips	S A @ 90'	Skin Friction	Added KIPS	Total w/ SF	SW	**Capacity (kips)**
36	3	212	862	1380	-520	-308	54	**-254**
42	3.5	289	1009	1614	-286	3	74	**76**
48	4	377	1156	1850	-50	327	96	**423**
54	4.5	477	1304	2087	187	664	122	**785**
60	5	589	1453	2325	425	1014	150	**1164**
66	5.5	713	1603	2564	664	1377	182	**1559**
72	6	848	1753	2805	905	1753	216	**1969**
78	6.5	995	1904	3047	1147	2142	254	**2396**
84	7	1155	2056	3290	1390	2544	294	**2839**
90	7.5	1325	2209	3534	1634	2960	338	**3298**
96	8	1508	2362	3780	1880	3388	385	**3772**
102	8.5	1702	2517	4027	2127	3829	434	**4263**
108	9	1909	2672	4275	2375	4284	487	**4770**
114	9.5	2126	2828	4525	2625	4751	542	**5293**
120	10	2356	2985	4775	2875	5231	601	**5832**
126	10.5	2598	3142	5027	3127	5725	662	**6387**
132	11	2851	3300	5280	3380	6231	727	**6958**
138	11.5	3116	3459	5535	3635	6751	795	**7546**