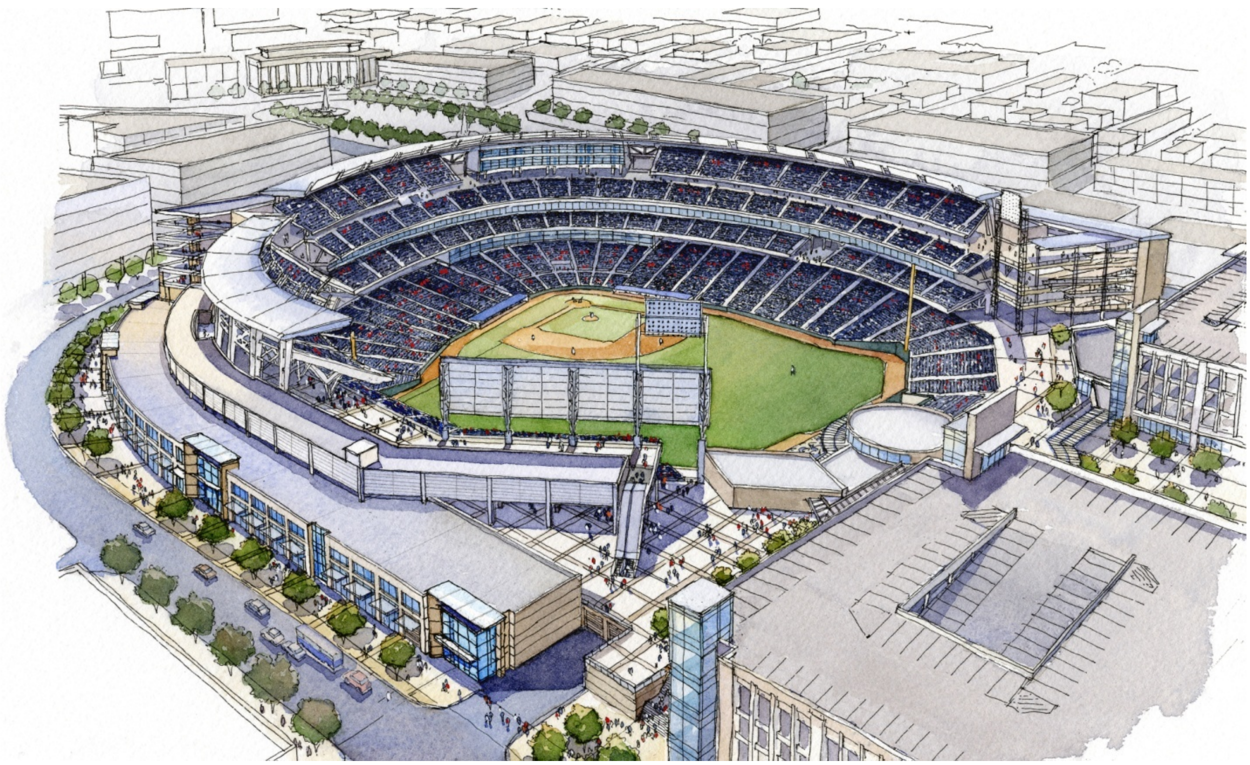
# Nationals Park

24 Potomac Ave SE, Washington DC 2003

Architectural Engineering Senior Thesis



**Matthew T. Moore**

Construction Management

Spring 2008

# WASHINGTON NATIONALS BALLPARK

## 24 POTOMAC AVE SE, WASHINGTON DC 20003

### Project Overview

- Function – A Major League Baseball Ballpark
- Occupancy Team – MLB's The Washington Nationals
- Total project cost – $611 million
- Size – 1.2 million square feet
- Stadium Seating – 41,000 fans
- Dates of construction – June 2006 through April 2008
- Project delivery method – Fast-tracked design-build

### Project Team

- Owner – DC Sports Commission
- General Contractor – Clark/Hunt/Smoot
- Architects:
  - Exterior – HOK / D & P Architects
  - Interior – Bowie Gridley
  - Landscape – Peter Liu Associates, Inc
- Structural Engineers – Restl/Thronton-Tomasetti
- Mechanical Engineers – ME Engineers
- Electrical Engineers – JVP
- Plumbing Engineers – SIM-G
- Civil Engineers – Delon Hampton & Associates
- Food Service – S3 Consultants
- Code Consultants – Howie Engineers

### Structural System

- Multiple independent systems to shorten construction time
- Concrete Framing - Foundations, Main Concourse, part of the Club Level
- Steel Framing - Club Level and above
- Deep foundation system - 14" Steel H-piles
- Building Envelope - Pre-cast concrete with masonry back-up curtain wall and storefront glazing systems as well as metal panels with masonry back-up
- Roofing systems - Combination of many types including a parapeted built-up roof with scupper and leader drainage, and sheet metal decking with scupper and leader

### Architecture

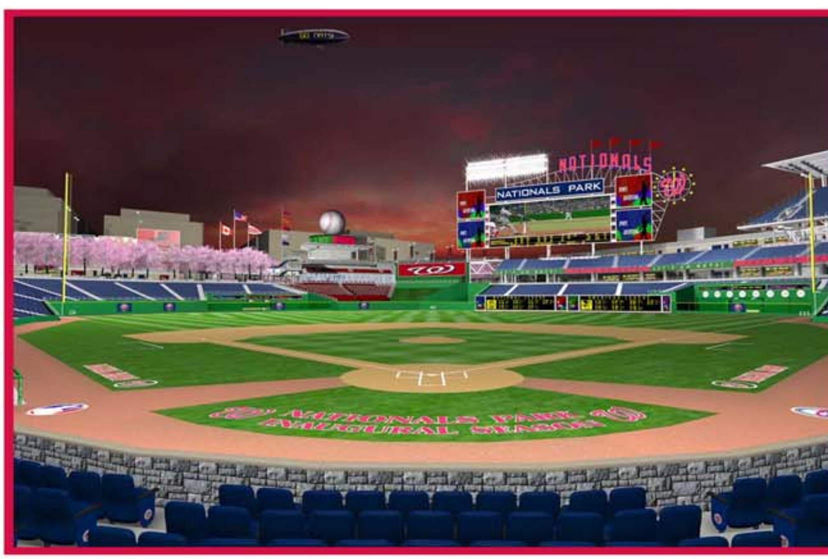
- The ballpark is an open concourse baseball stadium with conditioned premium spaces.
- Major national model codes - International Building Code 2003 (incl. ANSI) supplemented by ADAAG
- LEED Certified

### Mechanical System

- Peak Cooling Load - 2,000 tons
- Peak Loads - (2) 800 ton water cooled chillers
- Off peak loads - (1) 400 ton water cooled chiller
- Air conditioned spaces will have Variable Air Volume Air Handling Units with VAV Boxes

### Electrical System

- 13.2kV conduits feeding transformers
- Step down transformers to 4160 volt
- Unit substations - Dry type transformers rated for 2500/3330kVa, 4, 160 volt. 3-phase delta primary and a 480/277 volt wye secondary
- Transformers feed a 400 amp switchboard rated - 277/480 volt, 3 phase, 4-wire




## MATTHEW T. MOORE | CONSTRUCTION MANAGEMENT

CPEP: www.engr.psu.edu/ae/thesis/portfolio/2008/mtm213

# Architectural Engineer Senior Thesis
# Construction Management
# Spring 2008

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## Acknowledgements

I would like to thank all of my family and friends who supported me in this year long endeavor.

I would like to thank ISEC, Inc for all of their help and support.

I would like to thank the project team from Clark, Hunt, and Smoot.

I would also like to thank all of the Architectural Engineering Faculty.

## Executive Summary

Nationals Park is home to the Major League Baseball Team, The Washington Nationals. The ballpark is a fast-tracked design build project located in the SE of Washington, DC. The ballpark was completed by opening day for on March 30th, 2008. There are three major general contractors that formed “A Joint Venture” and became Clark / Hunt / Smoot, to oversee the ballparks construction. The ballpark was designed by another joint venture, HOK Sport and Devrouax and Purnell. They were the architects that came together to create the beautiful, and unique ballpark. The project has the largest construction cost ever to date for a Major League Baseball stadium with an overall project cost of $611 million.

The research that was done for this thesis is on Short Interval Production Scheduling, (SIPS). Within this document you will find background on SIPS and well as the methodology about how to develop a successful schedule. It describes that step by step process which will guide you to developing a SIPS:

1. Break the operation into specific activities
2. Assign production rates to each activity
3. Calculate extensions and set goals
4. Develop a time-scaled, resource loaded bar chart

The first breadth area is on structural column redesign and how it can affect the project schedule and the project budget. It shows how much a little change in the structural redesign can change the project cost and project schedule.

The second breadth area is a lighting redesign of the indoor batting cages. It demonstrates how by changing the lighting design you can save the owner building operation costs and make the building more environmentally friendly.

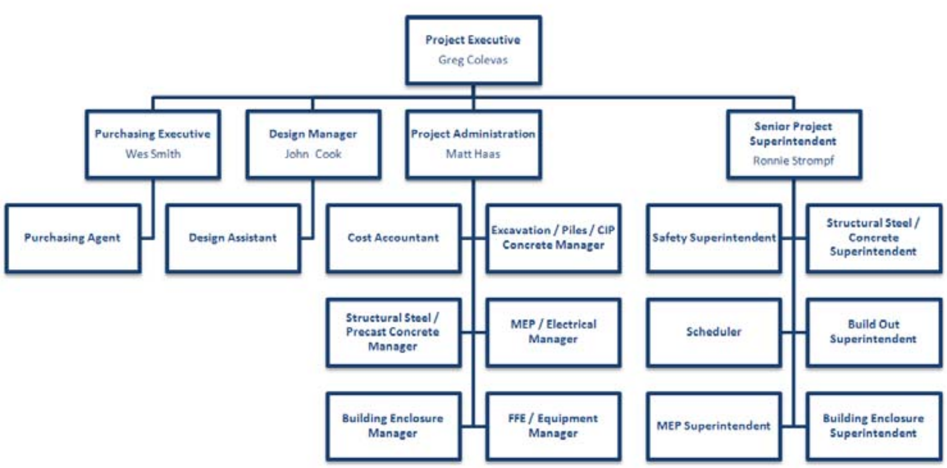
## Project Overview

The Washington Nationals Ballpark is a fast-tracked design build baseball ballpark located in the SE of Washington, DC. The ballpark is set to be completed by opening day for Major League Baseballs Washington Nationals in April of 2008. Three major general contractors in the DC area formed "A Joint Venture" to become Clark / Hunt / Smoot, to oversee the ballparks erection. The ballpark is the creation of another joint venture in HOK Sport and Devrouax and Purnell, the architects who came together to create the beautiful, and unique ballpark. The project has the largest construction cost ever to date for a Major League Baseball stadium with an overall project cost of $611 million.

## Project Team

The staffing is unique to this project since it is multiple companies, Clark, Hunt, and Smoot that are coming together to form “A Joint Venture.”

The Project Executive is responsible for overseeing the entire project and making sure that the ballpark is being constructed to the owner’s specifications. The Project Administrator is responsible for overseeing the work of the individual trade Project Managers. The individual trade Project Managers are responsible for managing the subcontractors that were hired to perform work on the ballpark. For example the Structural Steel / Precast Concrete Manager is responsible for all of the subcontractors that are performing the steel and concrete work. They are responsible for the coordination of the shop drawings and well as making sure that the subcontractors are able to perform the work that they have contractually agreed to complete. The Senior Project Superintendent is responsible for all of the work that is being performed on site. He is responsible for managing all of the individual Superintendents and he is also responsible for making sure that the project is being constructed properly. The individual Superintendents are responsible for the onsite work, within their trade, that is being constructed on a daily basis.



## Client Information

The owner of the ballpark is the DC Sports and Entertainment Commission. They are independent agency of the District of Columbia government. The DCSEC is active in the planning and revitalization of the Anacostia water front. They are building the new ballpark to help redevelop the area as well as to provide a new home for the Washington Nationals, A Major League Baseball team. They will be responsible for the management and operation of the new home to the Washington Nationals. The DCSEC wanted to provide a spectacular venue for the Washington Nationals that will combine the best parts of other MLB ballparks and well as provide its own unique style. As owners of the RFK stadium, where the Nationals currently play, the DCSEC wanted to make sure that they created a new ballpark that was above and beyond the old stadium, which can be seen below in the stadium comparisons. They wanted the design of the playing field to have an asymmetrical outfield to create exciting plays. They also wanted the make sure it had great views from any seat in the house. One concern was how many seats it will hold which it will have 41,222 outside seats and 76 suites, which includes 8 founder's suites, 1 team owner double suite, 1 DCSEC double suite, 8 party double suites, and 58 regular suites. The owner's major concern with the project is that will it be ready for the start of the 2008 baseball season, with the first pitch thrown on Sunday, March 30, 2008.

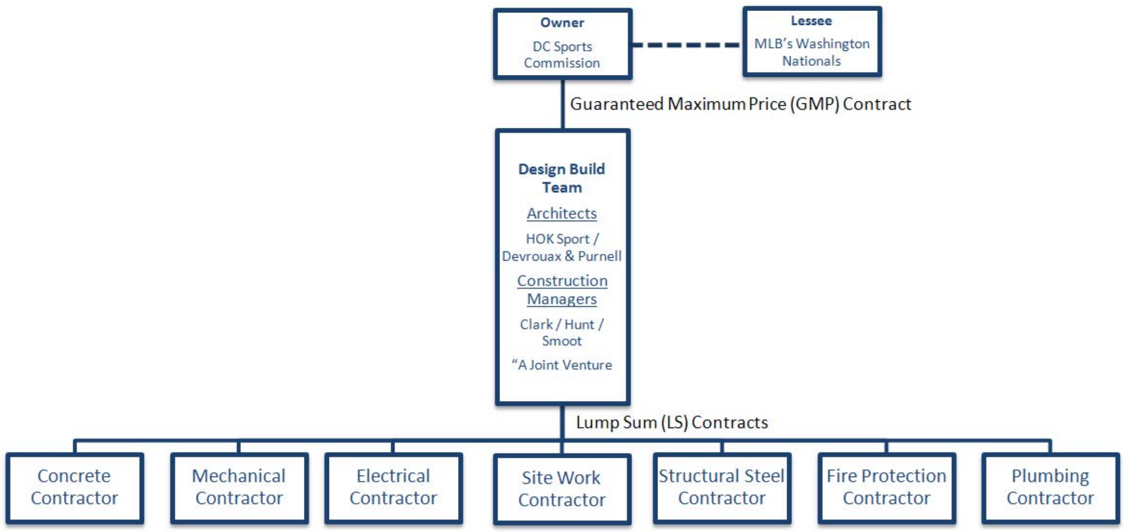
Comparison of the New Ballpark vs. RFK Stadium (The Nationals Old Home):

| | Nationals Park | vs. | RFK Stadium | |
|---|---|---|---|---|
| | | **Total Capacity** | | |
| | 41,222 | | 46,000 | |
| | | **Field Dimensions** | | |
| Left Field | 336 ft | | Left Field | 335 ft |
| Left Center | 377 ft | | Left Center | 380 ft |
| Center Field | 403 ft | | Center Field | 410 ft |
| Right Center | 370 ft | | Right Center | 380 ft |
| Right Field | 335 ft | | Right Field | 335 ft |
| | | **Average Concourse Width** | | |
| Main Level | 40 ft | | Main Level | 19 ft |
| Club Level | 26 ft | | Mezzanine Level | 20 ft |
| Upper Level | 30 ft | | Upper Level | 15 ft |
| | | **Concessions – point of sale** | | |
| | 181 | | 102 | |
| | | **Restaurants (square footage)** | | |
| 4 Clubs | 64,200 sf | | Diamond Club | 8,900 sf |

| Nationals Park | vs. | RFK Stadium |
|---|---|---|
| | **Cupholders** | |
| 41,222 | | 0 |
| | **Legroom between rows** | |
| 33" to 42" | | 26" |
| | **Disabled Seats** | |
| 853 | | 448 |
| | **Vertical Transportation** | |
| Escalators 8 | | Escalators 0 |
| Elevators 7 | | Elevators 1 |
| | **Permanent Ticket Windows** | |
| 33 | | 10 |
| | **Team Stores** | |
| 3 stores | | 1 store |
| | **Scoreboard Dimensions** | |
| 4,532 sf | | 1,376 sf |

## Project Delivery System

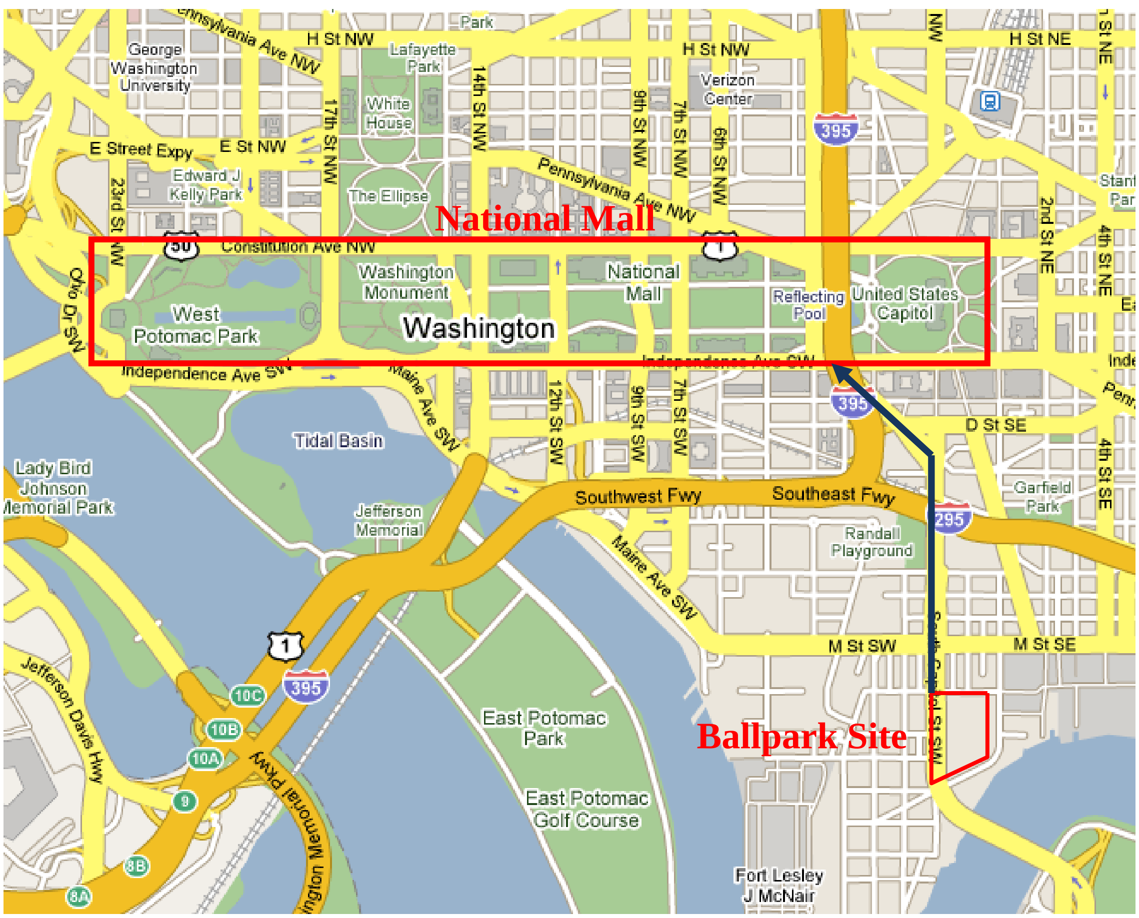
The ballpark is an extremely unique project that has many different companies coming together to form a joint venture to make the ballpark come to life. The project is a combination of multiple companies coming together to deliver the fast-tracked design-build project. The design team of HOK Sport, and Devrouax and Purnell, formed a joint venture to act as the architects of the project. When they were 50% complete with the design process, the Guaranteed Maximum Price (GMP) contract was accepted by the District of Columbia. After the GMP contract was accepted, major local general contractors, Clark, Hunt, and Smoot formed a joint venture to work together as one construction company and perform the work as the construction managers on the ballpark. They assumed the design team contract with the owner creating a large design build firm. The major benefits of the design-build construction method are that it allows for great coordination between the designers and the contractors. Coordination is a major concern for making sure that project is completed on time for the 2008 baseball season. Clark, Hunt, and Smoot, are in charge of holding the contracts between the GC and the subcontractors.



## Site Plan

The site is located in the middle of the revitalization of the "New Ballpark District." The ballpark is facing north and is on a direct line with The United States Capital. The ballpark will have 2 parking garages and metro stop at the Navy Yard green line that is one block from the ballpark. Below is a map of Washington, DC showing the close proximity of the ballpark to the National Mall.

Map of Washington, DC:



The ballpark has a very unique site layout due to the constraints on being located in the heart of the "New Ballpark District" in Washington, D.C. The site layout which is located in Appendix A is for the initial stage of steel erection before the construction of the 2 parking garages, which will be located on the site right next to the ballpark. The position of parking garages were initially used for material lay down, until their construction is to commence. The center of the playing field was the location for all of the steel lay down area. The steel will need to be fully erected before the construction of the playing field's surface can begin. A major concern with the site plan is that once the stadium is fully erected there will be very few spaces that can be used as material lay down areas. With the limited space that will be created, it will in then in turn create major scheduling issues that dictate when materials can be delivered. It will only allow the material that is absolutely necessary for that weeks work to be able to be delivered to the site so it can be installed right away and not take up any room on the already congested site. There are also 3 cranes operating at the same time to help shorten the time for the building superstructure to go up.

## Local Conditions

### Waste Removal

The overall goal of the waste removal program is that by the end of the project there will be a minimum of 75% salvage and recycling ratio vs. the total wasted generated by the work. There will be separate containers for recyclable materials and every worker is required to be trained on proper waste management.

### Site Conditions - Geotechnical Report

The proposed ballpark structure will have concrete framing which will then support a steel frame. The design loads are from approximately 200 kips to 3600 kips. There were 19 test boring taken in 2 different phases. In phase 1, 6 test borings were initially taken and then in Phase 2, 13 test borings were taken. The site is underlain with loose/soft fill consisting of silt, fat clay and silty sand, with asphalt, concrete and brick fragments down to 25 feet below the surface. The next level of soils consist of alluvium and terrace deposits containing inter-bedded deposits of medium stiff to hard fat clay, very soft to hard lean clay and sandy silt, and dense to very dense clayey sand to poorly graded gravel down to 72 feet. They are then followed by stiff to hard sandy lean clay to fat clay and dense to very dense poorly graded sand with clay to clayey sand down to 100 feet. The allowable bearing capacity of 3000 psf is to be located on natural soils and on the sand filters they can carry a capacity up to 2000 psf. The recommendation for the foundations is that it is to be a deep foundation system with the use of 14 inch steel H-piles. The backfill is to consist of SM, SP, SW, GM, GC, GP or GW soils per ASTM D-2487 with a liquid limit of 45 and plasticity index of 15. The fill that is placed behind a retaining wall should be compacted to 95% of the max dry density as per ASTM D-698.

## Building Systems Summary

| Work Scope | Yes | No |
|---|---|---|
| Demolition Required | X | |
| Support of Excavation | X | |
| Structural Steel Frame | X | |
| Cast in Place Concrete | X | |
| Precast Concrete | X | |
| Masonry and Curtain Wall | X | |
| Mechanical System | X | |
| Electrical System | X | |

### Demolition

It was necessary for the demolition of buildings located on site before the construction could begin. The ballpark is located in the South East of Washington, DC, where they are trying to revitalize the area around the ballpark. The entire surrounding areas are all going to be demolished and rebuilt in hopes that it will renew the area. It is effectively named "The Ballpark District" which is going to be a mixed use community that features shops, restaurants, entertainment venues, offices, hotels, and apartments.

### Support of Excavation

A free draining sheeting systems, which consists of H Beams, wood lagging and bracing, was used for excavation support. All excavations were within code from the Occupational Safety and Health Administration (OSHA) and in accordance with the District of Columbia and Federals regulations for supporting the excavation.

**Structural Steel Framing**

The structural steel is unique because it is only located in the structures above the Club Level as well as in the scoreboard in the right field. All of the rolled shapes excluding angles and channels shall conform to ASTM A992 or A572, Grade 50 steel. The connection materials are conformed to ASTM A36 steel. The metal decking is composed of 3” 18 gage type VL.

**Cast in Place Concrete**

Cast in place concrete is used for the foundation and SOG. The SOG is 6” thick with reinforced WWF which is on top of a drainage layer made of washed gravel and crushed stone. There are also foundation walls on the services level that are cast in place concrete, which are to be 18” thick min. The retaining walls on the service level are 24” min to support the backfill pressure. They are all vertically formed by formwork and are required to have a design strength of 5000 psi after 28 days.

**Precast Concrete**

Precast concrete is mainly used for the seating bowl of the stadium. They are precast, pre-stressed with 6” thick risers and 4” thick treads that are formed offsite. The precast seating will have an average thickness of 5.5” and are reinforced to 1.5 psf.

**Masonry and Curtain Wall**

The ballpark consists of pre-cast concrete with masonry back-up curtain wall and storefront glazing systems, as well as metal panels with masonry back-up. There are single wythe running bond CMU with rebar that are filled cell for support. The roofing systems are made up of a combination of many types including a parapeted built-up roof with scupper and leader drainage, and some sheet metal decking with scupper and leader drainage.

**Mechanical System**

The mechanical system is designed for a peak cooling load of 2000 tons. It has (2) 800 ton water cooled chillers for the on peak loads and (1) 400 ton water cooled chiller for the off peak loads. The cooling loads were designed with an outside temperature of 95$^{o}$ F dB and 76$^{o}$ F Wb, and with an inside temperature of 72$^{o}$ F +/- 3$^{o}$ F. Humidity will not be added to any of the enclosed spaces and it will be kept under 60% at all times. The premium spaces will have variable air volume air handling units with VAV Boxes for control. For the heating loads there will be (2) 12500 AMBH output, natural gas fired, forced draft hot water boilers.

**Electrical System**

The electrical system has (3) 13.2 kV circuit feeders that are provided from the Potomac Electric Power Company (PEPCO) that will supply the ballpark. The main switchgear feeds the step-down transformers that support a 4160 volt network bus switchgear that are distributed throughout the ballpark. There are unit substations have dry type transformers rated for 28500/3330 kVA, 4, 160 volt, 3-phase delta primary and a 480/277 volt wye secondary. The transformers feed a 400 amp switch board rated for 277/480 volt, 3 phase, 4-wire. There is also an emergency power system that has generators that will provide 1000 kW and 1250kW in the case of a power failure. The generators will provide back up for the building egress lighting, seating bowl emergency lighting, fire alarm systems, security systems, fire department communication, emergency sound system and fire pump systems.

## Project Schedule

The detailed project schedule that highlights the major phases of construction, with an emphasis on the foundation and structure for the ballpark can be found in Appendix B.

The ballpark is being created with the most intensive schedule ever created for a Major League Ballpark. It is schedule to only take 2 years to complete, which has never been done before. Because of the hard deadline of opening day the schedule for the ballpark schedule was developed with very little margin for error in construction.

There is a fee of $1,000,000 per day in liquated damages if the ballpark is not completed by opening day for The Washington Nationals.

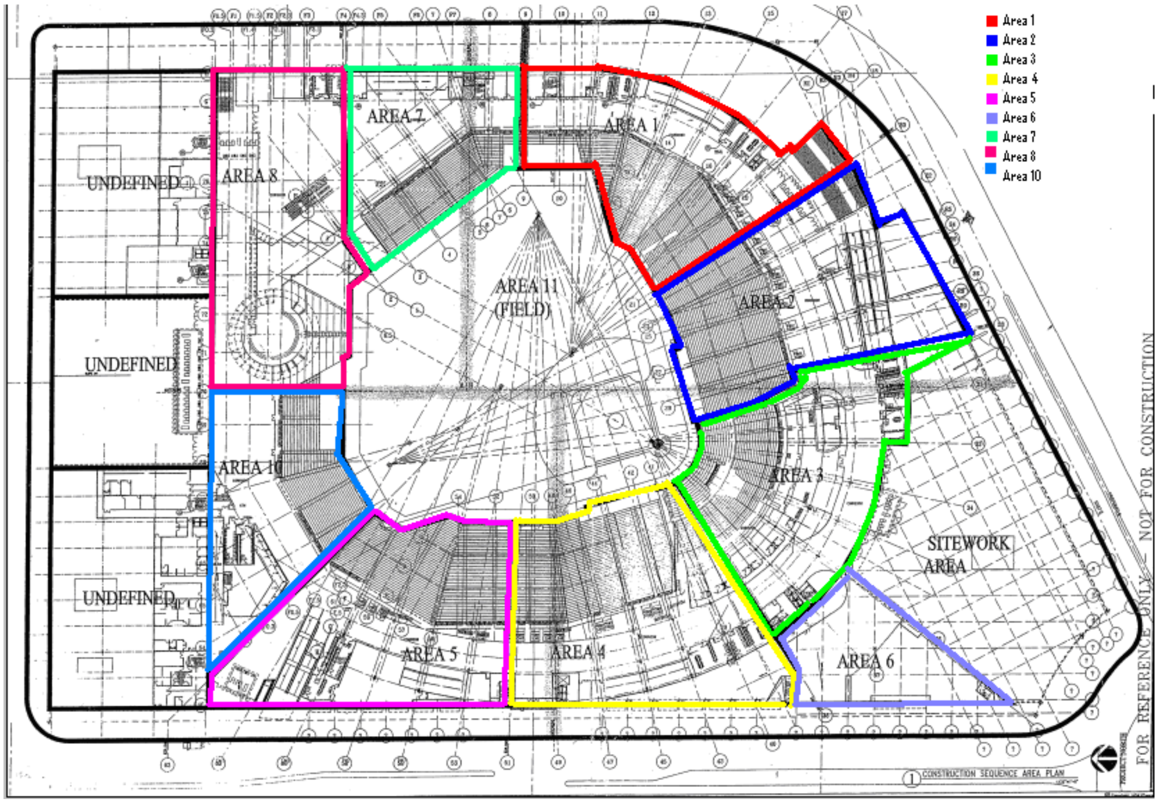
### Key Project Dates

- Schematic Design Begins — September 6, 2005
- Notice to Proceed — March 22, 2006
- Foundations Started — May 22, 2006
- CIP Concrete Begins — June 14, 2006
- Structural Steel Started — October 5, 2006
- Topping Out — July 11, 2007
- Playing Field Begins — October 1, 2007
- Substantial Completion — March 21, 2008
- First Pitch — March 30, 2008

**Foundation Sequence**

The ballpark consists of a deep foundation system. They are using 14” concrete H-piles which were driven down 45 feet to gain the allowable bearing capacity of 100 tons per pile. They were left 2’6” above the slab-on-grade so that the structure can tie into the foundation system. The foundation system was selected due to the site containing very hard clays and silty sands, which is typical since it is located right along the Anacostia River. The foundation was sequenced by breaking the ballpark into 10 different areas, which can be seen in the plan below. There were 3 different rigs which drilled an average of 12 piles per day. The first rig started in Area 1 and continued to Area 2. (See Construction Area Breakdown to note the location of the different areas) The second rig started in Area 4 and moved to Area 3 and then Area 5. The third rig was started in Area 7 and moved to Area 8 and then to Area 10. This was sequenced by making sure the main concourse area was completed first because that is where the majority of the ballparks structure is. The rigs worked their way around to meet in between Area 2 and Area 3, which is the center of the main concourse area.

Construction Area Breakdown:




## Structural Sequence

The structural sequence is unique because half way through construction it was changed from a concrete structural system to a steel structural system, due to fact that steel was a long lead time item and concrete would allow them to fast-track the project and begin while the steel was being fabricated. The concrete framed areas, the 1st and 2nd level, are cast in place beams and girders. The 3rd level and above will be steel construction. The structural steel is sequenced the same way that the foundation was. They first starting erecting in Area 1 and continued to Area 2. They then started in Area 4 which was followed by Area 3 and then Area 5. They then erected the steel in Area 7, and then Area 8.

**Finishing Sequence**

The finishing work that must be completed is located inside premium spaces in the ballpark, which includes rooms like the Players Locker Rooms, the Founders Bar and the many Suites. The interior build out sequence is broken down by:

- GWB Framing
- Tie-in Conduit/Pull Wire
- Hang GWB Walls
- Paint Walls
- Acoustic Ceiling Grid
- GWB Ceiling Framing
- GWB Ceilings
- Light Fixtures and MEP Drops
- Millwork
- Plumbing Fixtures
- Flooring
- Doors and Architectural Trim
- Toilet Accessories
- Finish Painting and Wall Covering
- Ceiling Pads
- MEP Devices
- FF & E

## Project Cost Evaluation

### Overall Project Costs

The overall project cost for the ballpark is $611 million.

The cost per square foot (611 million / 1.2 million square feet) is $509.16 per square foot.

### D4Cost

D4Cost was used to try to create a schematic estimate of the ballpark. D4Cost uses actual cost data from existing building projects to help develop a schematic estimate of a new construction project. Unfortunately there is only 1 related project which the ballpark can be compared to, the Southwestern Bell Bricktown Ballpark, a minor league (AAA) stadium with an overall project cost of $21,835,787. With the location modifier of Washington, DC and an updated time modifier, D4Cost came up with an overall construction cost of $177,191,520. It is well below the ballparks overall project cost.

### R.S. Means

There is no way to estimate a baseball stadium by a square foot estimate in R.S. Means. Historical data on ballpark construction costs were compared instead.

### Historical Data Comparison

Typically ballpark estimates are based off of cost per seat, therefore project cost and seating capacity was collected from the 10 the most recent major league ballparks that have been constructed.

Cost Comparisons of Recent Ballpark Construction:

| Team | Ballpark Name | Year | Project Cost (millions) | Capacity | Cost / Seat |
|---|---|---|---|---|---|
| Washington Nationals | Washington National Ballpark | 2008 | $611 | 41222 | $14,822.18 |
| St. Louis Cardinals | Busch Stadium | 2006 | $346 | 43975 | $7,868.11 |
| Philadelphia Phillies | Citizens Bank Park | 2004 | $346 | 43647 | $7,927.23 |
| San Diego Padres | PETCO Park | 2004 | $411 | 42445 | $9,683.12 |
| Cincinnati Reds | Great American Ballpark | 2003 | $297 | 42059 | $7,061.51 |
| Milwaukee Brewers | Miller Park | 2001 | $322 | 42200 | $7,630.33 |
| Pittsburgh Pirates | PNC Park | 2001 | $230 | 38496 | $5,974.65 |
| Detroit Tigers | Comerica Park | 2000 | $300 | 41070 | $7,304.60 |
| Houston Astros | Minute Maid Park | 2000 | $266 | 40950 | $6,495.73 |
| San Francisco Giants | AT&T Park | 2000 | $306 | 41503 | $7,372.96 |
| Seattle Mariners | Safeco Field | 1999 | $517 | 47116 | $10,972.92 |

**Compare Estimates**

The Washington National Ballpark has the largest project cost in the history of construction of Major League Baseball stadiums. This can be contributed to the excessive amount of luxury boxes, 78 in total, as well as the fast-tracked schedule. The ballpark is trying to become the first LEED rated stadium. There are also major cost impacts from the extreme fast paced schedule that they needed to create to make sure the ballpark opened on time. It is also extremely expensive in trying to achieve the LEED rating. The D4Cost estimate can not even compare to the overall budget of the project because it is based off of historical data from a Minor League ballpark which will not have any of the same amenities that a Major League ballpark has.

## Short Interval Production Schedule – Research

### Background

Nationals Park has multiple highly repeatable tasks that can be scheduled as efficiently as possible by the development of a Short Interval Production Schedule (SIPS). SIPS is a highly detailed way to schedule a repetitive construction project. Many construction projects go over budget and over schedule due to poor detailed scheduling and with the use of a SIPS it can make sure the project gets completed on time and on budget.

A SIPS is developed to detail the necessary day-to-day production or task-to-task production during any repeatable construction project. It details scheduling at the crew level and must rely on exact information that is vital to the successful completion of any construction task. The most usefully cases where a SIPS can be beneficial is for a project that has many highly repeatable activities, such as apartments, hotels, office buildings and even schools. Typically, these projects will have a standardized interior floor or wing layout that makes the use of a SIPS desirable. The ballpark has just that with 58 of the same exact luxury suite. The interior build out of the suites will gain a great deal of scheduling time if SIPS was used to construct the luxury suites.

There are 3 main ideas that differentiate SIPS from any other standard scheduling methods:

- Only one major specific operation is detailed
- A higher level of detail is developed then typically seen
- There must be personnel involvement and commitment from everyone contributing to the operation

There are 5 steps that need to be taken to develop a SIPS:

1. Break the operation into specific activities
2. Assign production rates to each activity
3. Calculate extensions and set goals
4. Develop a time-scaled, resource loaded bar chart

The major benefits that will be seen throughout the project will only be achieved if every participant involved had at least a general understanding of the SIPS that will be utilized. The superintendents and the subcontractors must have firsthand knowledge of the minor details that will go into the construction of the building. The crew members must be given a very detailed schedule of the general building sequencing and time period the tasks needs to be completed before the job can even begin.

Burkhart, A. (1989). "The use of SIPS as a productivity improvement tool." Construction Congress 1989, Concrete Construction Publications, Inc. 381-386.

**Problem Statement**

Due to the repeatability of the 58 luxury suites, how can the use of a Short Interval Production Schedule benefit the completion of the ballpark?

**Proposal**

The development of a SIPS will have major time implications if it is properly designed and executed for the interior build out for the 58 luxury suites.

**Methodology**

There are 5 steps that need to be taken to develop a SIPS (Burkhart):

1. Break the operation into specific activities
2. Assign production rates to each activity

3. Calculate extensions and set goals
4. Develop a time-scaled, resource loaded bar chart

**Step 1 – Break the operation into specific activities**

The first step is to break the selected tasks into a list of activities that will be necessary to complete all of the work at hand. One great way to come up with activities is by sitting down with the all of the supervisors and have a brainstorming session about the order of tasks. This is the finishing sequence of the 58 luxury suites that was developed.

- Subroof
- GWB Framing
- Tie-in Conduit/Pull Wire
- Hang GWB Walls
- Paint Walls
- Acoustic Ceiling Grid
- GWB Ceiling Framing
- GWB Ceilings
- Light Fixtures and MEP Drops
- Millwork
- Plumbing Fixtures
- Flooring
- Doors and Architectural Trim
- Toilet Accessories
- Finish Painting and Wall Covering
- Ceiling Pads
- MEP Devices
- FF & E

**Step 2 – Assign production rates to each activity**

Assigning the right production rate to each activity is the most important and difficult step to complete properly. As seen on the this page, each task is broken into manageable groups and each production rate is assigned to each individual activity. Grouping of the activities was necessary to make sure each task would fit well into allotted time constraint of a 2 day activity group.

| Production Rates | | | | |
|---|---|---|---|---|
| ID | Interior Buildout | # days to complete 10 Suites | # of days to complete 1 suite | # of suites completed per day |
| 1 | Subroof | 5 | 0.5 | 2 |
| | GWB Framing | 15 | 1.5 | 0.666667 |
| 2 | Suite Exterior Slider System | 15 | 1.5 | 0.666667 |
| | Tie-in Conduit/Pull Wire | 5 | 0.5 | 2 |
| 3 | Hang GWB Walls | 10 | 1 | 1 |
| | Paint Walls | 5 | 0.5 | 2 |
| | Acoustic Ceiling Grid | 5 | 0.5 | 2 |
| 4 | GWB Ceiling Framing | 5 | 0.5 | 2 |
| | GWB Ceilings | 5 | 0.5 | 2 |
| | Light Fixtures and MEP Drops | 10 | 1 | 1 |
| 5 | Millwork | 15 | 1.5 | 0.666667 |
| | Plumbing Fixtures | 5 | 0.5 | 2 |
| 6 | Flooring | 10 | 1 | 1 |
| | Doors and Architectural Trim | 5 | 0.5 | 2 |
| | Toilet Accessories | 5 | 0.5 | 2 |
| 7 | Finish Painting and Wall Covering | 5 | 0.5 | 2 |
| | Ceiling Pads | 5 | 0.5 | 2 |
| | MEP Devices | 5 | 0.5 | 2 |
| | FF & E | 5 | 0.5 | 2 |

**Step 3 – Calculate extensions and set goals**

This is the step were you try to figure out any setbacks that might occur throughout the construction of the suites. Because this is being done in the beginning of the suites scheduling process there are no unforeseen setbacks currently. It is important however to brainstorm any unanticipated incidents because it can help serve as a guideline giving you ideas about what to look out for during the installation process.

**Step 5 – Develop a time-scaled, resource loaded bar chart**

This is the last step in the development of a SIPS. This is where you take all of the information that you have gathered in the previous steps and combine it to create your Short Interval Production Schedule. Below is a sample of the SIPS that was developed for the interior suites build out. The more detail and complete schedule can be found in appendix C.

| Level | Zone | Area | Room Number | Room Name | Month 1 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Week 1 | | | | | Week 2 | | | | | Week 3 | | | | | Week 4 | | | | |
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 3 | B | 2 | 3.22.04 | Suite 1 | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | | | | | | |
| 3 | B | 2 | 3.24.01 | Suite 2 | | | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | | | | |
| 3 | B | 2 | 3.24.04 | Suite 3 | | | | | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | | |
| 3 | B | 2 | 3.26.01 | Suite 4 | | | | | | | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | |
| 3 | B | 2 | 3.26.04 | Suite 5 | | | | | | | | | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| 3 | B | 3 | 3.28.01 | Suite 6 | | | | | | | | | | | 1 | | 2 | | 3 | | 4 | | 5 | |
| 3 | C | 3 | 3.31.02 | Suite 7 | | | | | | | | | | | | | 1 | | 2 | | 3 | | 4 | |
| 3 | C | 3 | 3.33.01 | Suite 8 | | | | | | | | | | | | | | | 1 | | 2 | | 3 | |
| 3 | C | 3 | 3.33.04 | Suite 9 | | | | | | | | | | | | | | | | | 1 | | 2 | |
| 3 | C | 3 | 3.34.01 | Suite 10 | | | | | | | | | | | | | | | | | | | 1 | |
| 3 | C | 3 | 3.35.01 | Suite 11 | | | | | | | | | | | | | | | | | | | | |
| 3 | C | 3 | 3.36.01 | Suite 12 | | | | | | | | | | | | | | | | | | | | |
| 3 | C | 3 | 3.36.04 | Suite 13 | | | | | | | | | | | | | | | | | | | | |

**Conclusion and Recommendation**

After the development of the SIPS for the interior suites it was discovered that it will only take the suites a total of 123 days to complete the interior build out. The project schedule gave the suites 157 days to complete the entire suites. That is a saving of 34 important days that can be saved due to the repeatability of the suites as well as the very detailed scheduling that occurred. Since many construction projects go over budget and over schedule due to poor detailed scheduling and SIPS will not only help keep it on schedule it can also help reduce the overall time that a activity can take due to the high level of detail and repetition that can occur.

## Structural Column Alternate Selection – Breadth Topic

**Background**

The ballpark is a combination of steel and cast in place concrete. The structural steel is unique because it is only located in the structures above the Club Level as well as in the scoreboard in the right field. Cast in place concrete was used for the load bearing columns for the Service Level ($1^{st}$ level only). Washington DC is known for there CIP concrete structural systems but steel is starting to take over.

**Problem Statement**

A cast-in-place (CIP) concrete structural system takes much more construction time to erect then a steel structural system. Would it save valuable schedule time and be more cost effective if the ballpark was designed using only one type of structural system, specifically an all steel system?

**Proposal**

Changing all of the structural CIP concrete columns to steel equivalent would help save valuable construction time and help shorten the overall project schedule. The goal is to get the ballpark built as quickly as possible without any extreme added cost. This will look at the benefits and trade offs that will deal with the use of all one structural system. It will specifically look at the cost impact and the project schedule impact that the one structural system will effect.

**Applicable Design Codes**

All structural elements shall be designed in accordance with the requirements of the International Building Code 2000, as amended by the District of Columbia Register, 2003

**Structural Steel Design Codes**

All structural steel shall be designed in accordance with the IBC 2000. In general, details and design of structural steel shall be in accordance with the American Institute of Steel Construction, "Manual of Steel Construction, Load and Resistance Factor Design", 3rd edition.

**Concrete Design Codes**

All concrete structures shall be designed in accordance with the IBC 2000. Ultimate strength design shall be used in accordance with ACI-318-02, "American Concrete Institute, Building Code for Structural Concrete." In general, details shall be in accordance with ACI 315, "Manual of Standard Practice for Detailing Reinforced Concrete Structures," latest edition.

**Structural Steel Materials**

- All rolled shapes excluding angles and channels shall conform of ASTM A992 or A572, Grade 50
- All connection material and base plates shall conform to ASTM A36
- All angles and channels shall conform to ASTM A36
- All anchor bolts shall conform to ASTM F1554, unless otherwise noted on drawings
- All bolts other than anchor bolts shall conform to A325 or A490

**Concrete Materials**

- All concrete shall have the indicated design strength after 28 days
    - Footings and Slab On Grade 4000 psi N.W.
    - Foundation 4000 psi N.W.

- Slab on Metal Deck — 4000 psi N.W.
- Cast In Place Reinforced Slabs — 5000 psi N.W.
- Cast In Place Reinforced Columns — 5000 psi N.W. min
- Topping slabs — 3000 psi N.W.

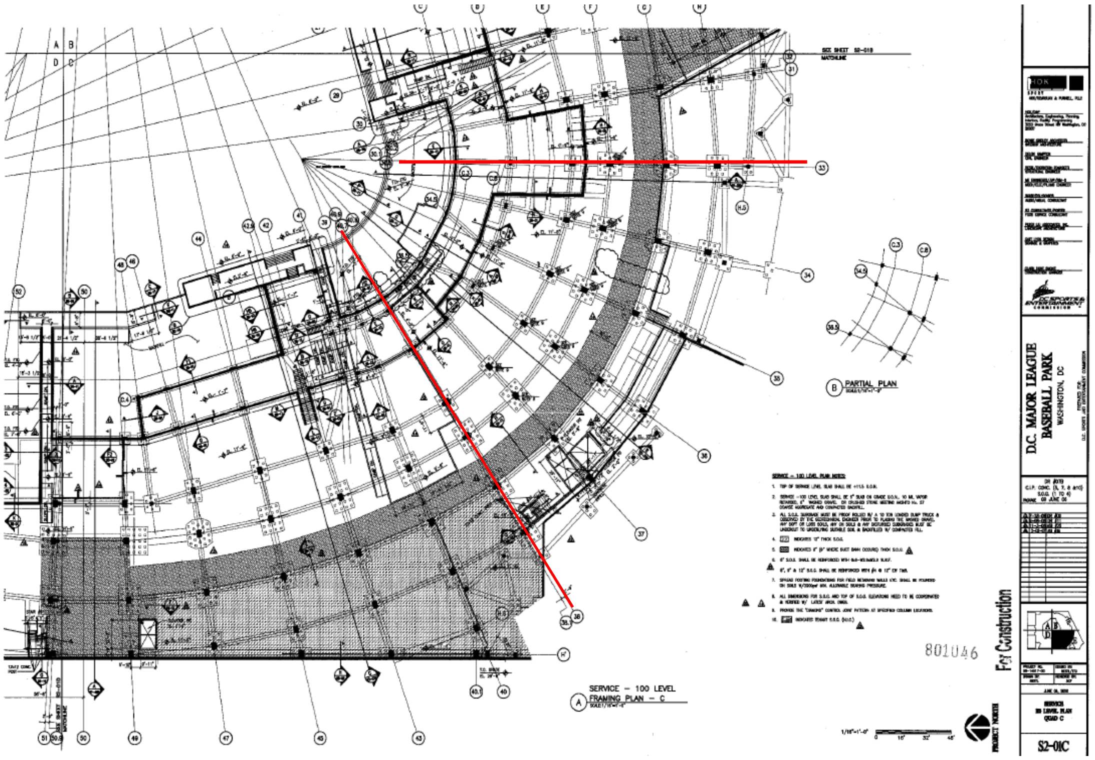
- All reinforcing bars shall be ASTM A615, Grade 60 deformed bars
  - Yield strength may not exceed 78 ksi
  - Ratio of actual ultimate tensile strength to the actual tensile yield strength may not be less than 1.25
- All stirrups and column ties shall be deformed bars with 60,000 psi minimum yield strength, ASTM A615, Grade 60
- All reinforcing to be welded shall be ASTM A706, Grade 60

**Methodology**

The existing structural system was reviewed and it was discovered that only the 1st level was selected to be cast-in-place concrete. This was found to be unusual because everything else was designed using an all steel framing system.

A typical bay was selected for the redesign of the structural columns and it was located between the column line 33 and the column line 38, which can be seen on the next page. There are 5 other similar typical bays that were extrapolated to get the overall steel cost.

Service Area structural floor plan from column line 33 to 38 highlighted in red:




**Concrete to Steel Column Redesign**

The goal is to determine the least weight column that can handle the already factored load. The design is done by using LRFD.

The typical column that was selected is on line 36 and is a 36” x 48” concrete column, 12#11 rebar with an effective height of 20 ft. The applied load is 1000 kips and is already factored (done by structural designer). The cost for that concrete column is $6,422.22

The effective length for each axis was assumed to be the same in both directions

$KL_y = 20$ ft

$KL_x = 20$ ft

Since the column has the same effective length about the *x*-axes and *y*-axes it was concluded that KL=20 ft.

The Steel Construction Manual was used to find the least weight W member that can carry the applied already factor load of 1000 kips.

The member that can carry the applied load is a W12 x 120 which can carry a applied load of 1030 kips.
The cost was then analyzed and it was found that the cost of the new steel column is $4,560.00 which is based off the member size and weight.

**Cost Analysis**
The cost data was taken from RS Means Building Construction Cost Data 2008 and it included all material and labor for the steel and for the concrete estimate the rebar was included, as well. A more detailed breakdown of the individual estimates can be found in Appendix D.

The comparison of overall cost differences can be found on the next page in the Concrete vs. Steel Column Summary table. The overall cost of using all steel structural columns instead of a combined system showed an increase in the construction cost of over $1,659,392.64. That is a major increase in the overall project cost just by selecting the alternate columns.

| CONCRETE vs. STEEL COLUMNS SUMMARY | |
|---|---|
| **SUBTOTAL STEEL TYPICAL SECTION ESTIMATE:** | **$532,976.60** |
| **LOCATION MULTIPLIER 99% FOR DC:** | $527,646.83 |
| **TOTAL STEEL TYPICAL SECTION COST:** | **$527,646.83** |
| | |
| **SUBTOTAL CONCRETE TYPICAL SECTION ESTIMATE:** | **$253,617.57** |
| **LOCATION MULTIPLIER 99% FOR DC:** | $251,081.39 |
| **TOTAL CONCRETE TYPICAL SECTION COST:** | **$251,081.39** |
| | |
| **INCREASE IN COST DUE TO ALL STEEL TYPICAL SECTION:** | **$276,565.44** |
| | |
| **SUBTOTAL COMPLETE STEEL ESTIMATE:** | **$3,197,859.60** |
| **LOCATION MULTIPLIER 99% FOR DC:** | $3,165,881.00 |
| **TOTAL STEEL COST:** | **$3,165,881.00** |
| | |
| **SUBTOTAL CONCRETE ESTIMATE:** | **$1,521,705.42** |
| **LOCATION MULTIPLIER 99% FOR DC:** | $1,506,488.36 |
| **TOTAL CONCRETE COST:** | **$1,506,488.36** |
| | |
| **INCREASE IN COST DUE TO ALL STEEL:** | **$1,659,392.64** |

**Schedule Analysis**

The new construction schedule for the column redesign can be found in Appendix E. In the dual system that the design team selected it was expected to take 140 days to construct the 1$^{st}$ level concrete columns. It was found that it would only take 60 days to construct the same amount of columns for the structural steel system. By switching the concrete columns to steel columns it would save the construction team almost 80 days as long as there are no major setbacks.

**Conclusion and Recommendation**

Overall there are two major conclusions that can be made from this analysis of an alternate column system. The 1st conclusion to be made is that it is not beneficial to the overall project budget if it was designed using only steel columns. An increase in over $1 million can not be an acceptable outcome to the owner of the building. The 2nd conclusion is that it does help shorten project schedule time and could very well impact the overall project schedule. It could help the project team gain 80 days as long as there are no major setbacks.

It comes down to what is driving the project more, cost or schedule. Since schedule is the most important factor in driving the ballpark project it is acceptable to use an all steel structural system. With $1 million per day in liquated damages for every day that The Washington Nationals can't occupy the ballpark it would make it seem like the schedule is what is driving this project.

## Lighting Design for Indoor Batting Cage - Breadth

### Background

The current lighting design for indoor batting cage located within the ballpark is currently based off of gym criteria. The room is expected to have an illumance of 50 fc. which can be done with a multiple of different options for lamp types, like metal halide lamps and fluorescent lamps.  Lighting designers are still using Metal Halide lamps in there lighting design even when there are better products out there. Metal halide lamps have to warm up before they light up and other options such as a 4100K fluorescent lamps light up instantly when the light switch is flipped.

### Problem Statement

Is there an alternative lighting solution that can activate instantly without have to warm up and help reduce the electricity cost?

### Proposal

By selecting an alternate lighting system for the indoor batting cage there will be a way to reduce the overall power use and help reduce the total building electricity load.

### Goal

The goal is to find a better choice for a lighting system that will not only provide adequate lighting conditions but will also help reduce the load on the power system.

### Old Lighting Fixture

The old lighting fixture was a TX A26: Premium Enclosed Aluminum Optical made by Lithuania. The lamp is a 400-Watt Clear BT-37 Metal Halide.

**Technical Information**

Intended Use

- Areas that require good vertical illumination
- Excellent glare control at low mounting heights
- Ideal for general open areas, retail spaces, aisles and manufacturing areas

Ballast

- High power factor ballast with a minimum of class H insulation.

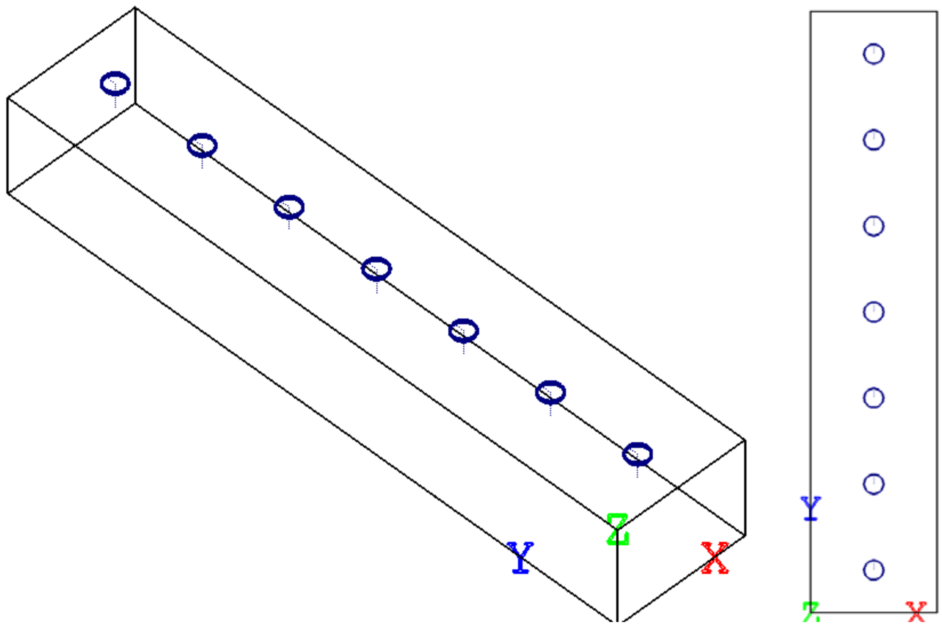
Optics

- Injection-molded virgin acrylic lens, fully fluted anodized aluminum reflector
- Hinge and lens retainer latches facilitate tool-less removal for maintenance and cleaning
- Totally enclosed, gasketed refractor and reflector inhibit the entrance of ambient contaminants.

Socket

- Glazed porcelain, vertically oriented, mogul-base socket with copper alloy, nickel-plated screw shell and center contact
- UL Listed 1500W, 600V
- 4KV pulse-rated

**Current Lighting Design Images**




**New Lighting Fixture**

The new lighting fixture that was selected for the indoor batting cages is a Schelde Sports Light 54 with 4 high output T5 4100K fluorescent lamps.

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**Technical Information**

SportLight 54

IFT5 Four-Lamp

Product Features

- Ideal solution for high mounting applications
- Excellent alternative to costly HID fixtures
- T5 high output 4100K fluorescent lamps
- Energy efficient high power factor electronic ballasts
- Reduced energy cost by 50%
- 96% specular reflector
- Proprietary modular reflector
- Lightweight corrosion resistant aluminum alloy housing

- Shipped fully assembled
- Easy to install

Electrical Information

- Thermally protected, Class "P", HPF, sound rated, electronic ballast
  Rotary lock lampholders
- Total system wattage 246
- Universal voltage for 120V through 480V UL/CUL listed

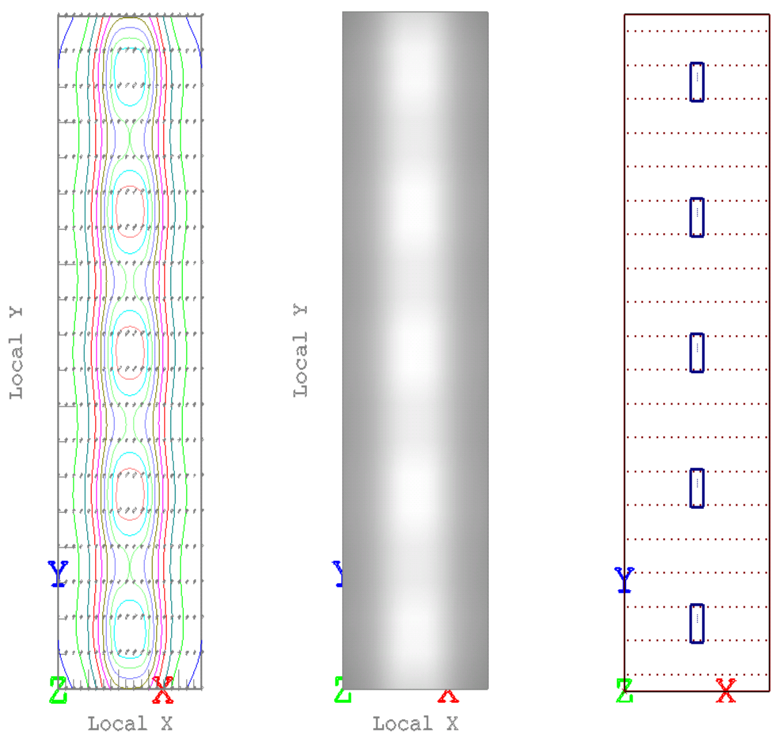
Lamp

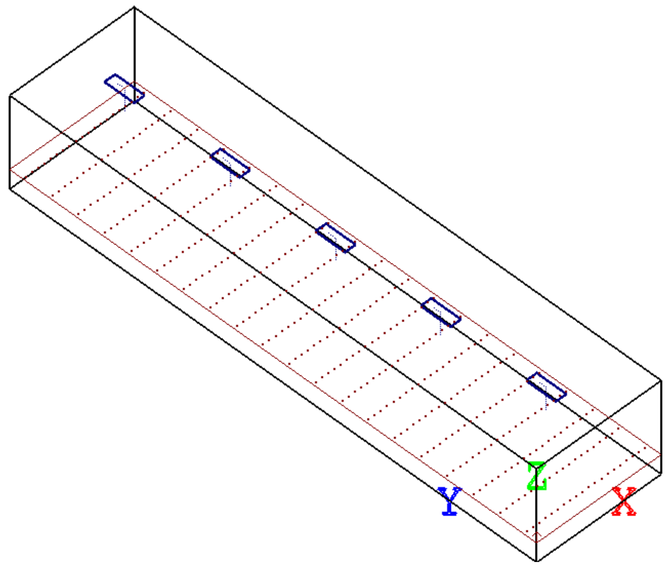
- Four high output T5 4100K fluorescent lamps
- Color rendering index 85
- Mean lumen output (fixture) 16,734
- Lamp lumen maintenance up to 94%

Construction

- .040" aluminum die formed housing and end plates
- End plates are fastened to frame with screws
- Quick release access covers allow accessibility to ballast while fixture is still hanging
- Fixture weight 10 pounds

**New Lighting Design Images**






**Cost Analysis**

The SportLight 54's T5 4100K fluorescent lamps cost half as much as the Metal Halide Lamp. Overall the owner, The DCSEC could save up to $1,458.72 per year in operational costs.

## Lighting Comparison

| 400/U Metal Halide vs. SportLight 54 | | | | | |
|---|---|---|---|---|---|
| Lighting Type | Initial Lumens | Mean Lumens | Lamp Life (Hours) | Total Wattage/ Fixture | Enegry Cost / Fixture / Year @ $0.11/KWH |
| 400/U Metal Halide | **36,000** | **23,500** | 20,000 | 458 | $440.12 |
| SportLight 54 | 17,800 | 16,734 | **24,000** | **246** | **$236.40** |

| | |
|---|---|
| (6) Metal Halide Yearly Cost | $2,640.72 |
| (5) SportLight 54 | $1,182.00 |

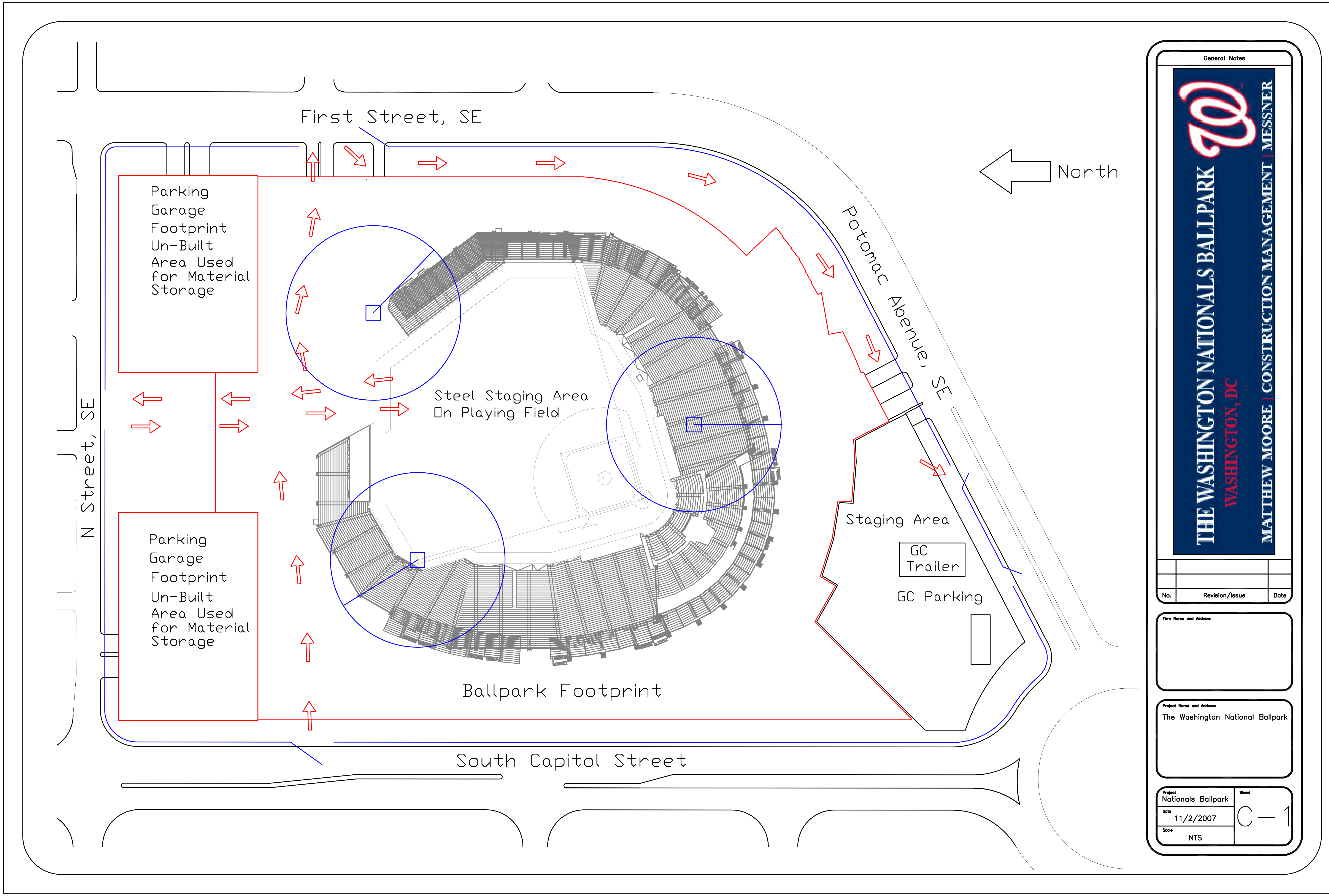
| | |
|---|---|
| Savings by using SportLight 54 | $1,458.72 |

**Conclusion and Recommendation**

There are many benefits from the redesign of the indoor batting cage lighting system. By switching to a florescent lamp from a metal halide lamp you not only saved the owner, The DCSEC up to $1,458.72 per year in operational cost, it improved the overall lighting situation for the Nationals. The will not have to wait for the lights to warm up and have a slow start up. They will also benefit from the better lighting conditions while taking batting practice. It was demonstrated that by changing the lighting design you can save the owner building operation costs and make the building more environmentally friendly.

# Appendix A

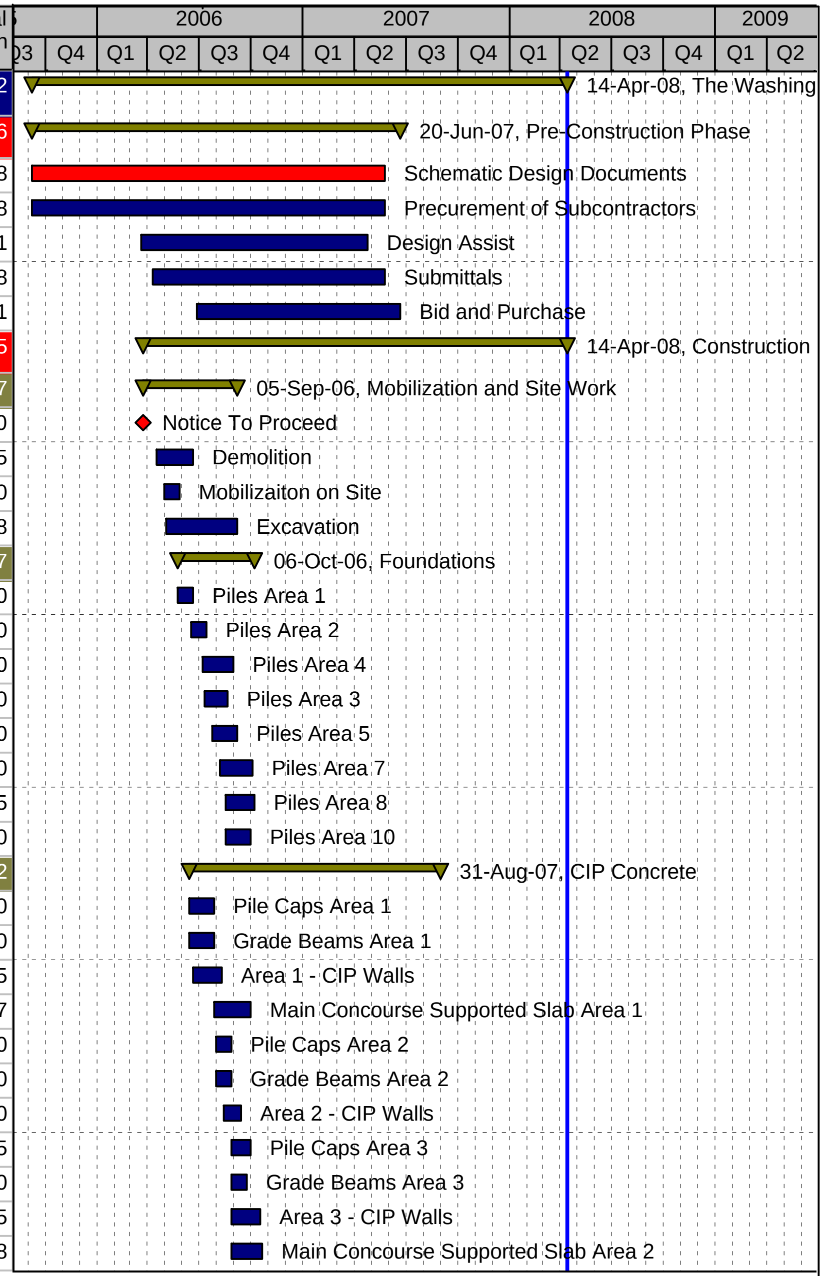
**Site Plan**


First Street, SE
North
Potomac Avenue, SE
N Street, SE
South Capitol Street
Parking Garage Footprint Un-Built Area Used for Material Storage
Parking Garage Footprint Un-Built Area Used for Material Storage
Steel Staging Area On Playing Field
Ballpark Footprint
Staging Area
GC Trailer
GC Parking
General Notes
THE WASHINGTON NATIONALS BALLPARK
WASHINGTON, DC
MATTHEW MOORE | CONSTRUCTION MANAGEMENT | MESSNER
No.
Revision/Issue
Date
Firm Name and Address
Project Name and Address
The Washington National Ballpark
Project
Nationals Ballpark
Date
11/2/2007
Scale
NTS
Sheet
C—1

# Appendix B

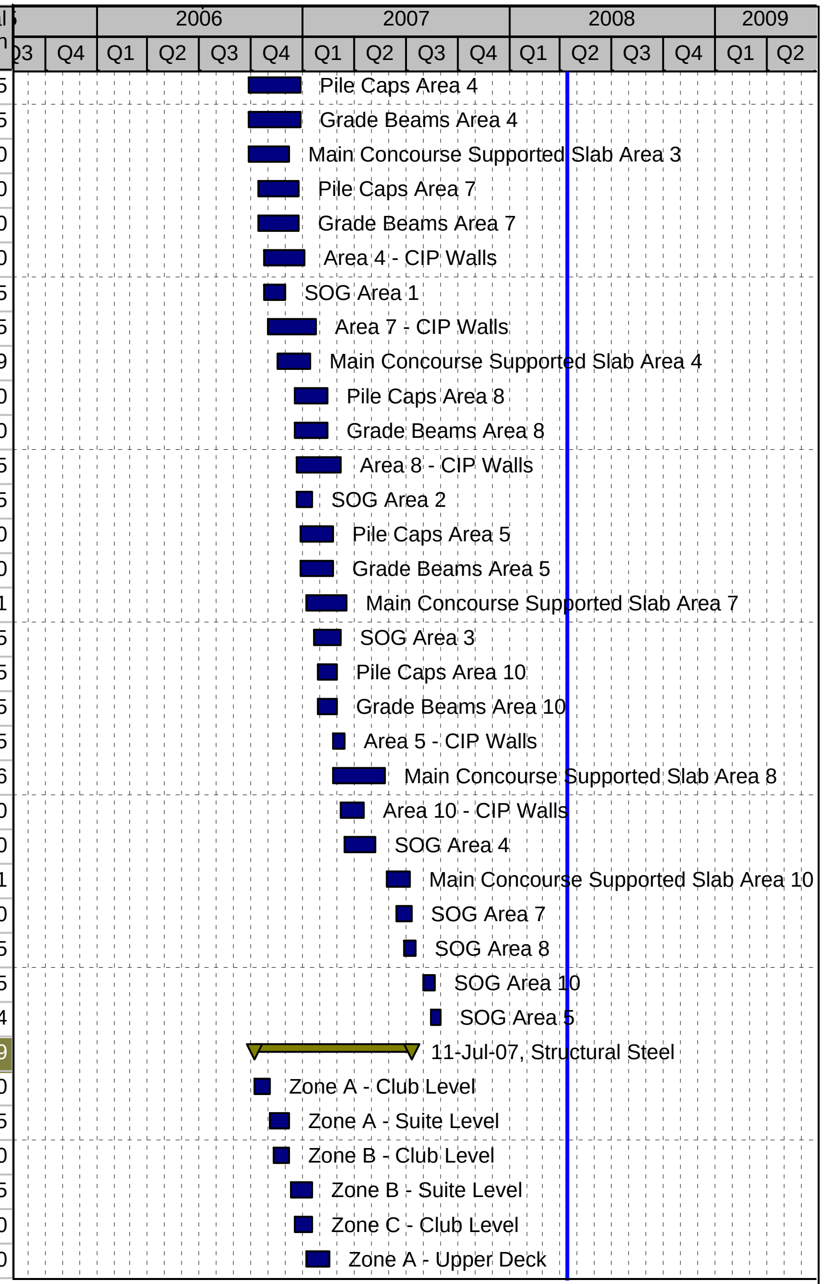
**Project Schedule**

| Activity ID | Activity Name | Start | Finish | Original Duration |
|---|---|---|---|---|
| **The Washington Nationals Ballpark** | | 06-Sep-05 A | 14-Apr-08 | 672 |
| **Pre-Construction Phase** | | 06-Sep-05 | 20-Jun-07 | 456 |
| A1000 | Schematic Design Documents | 06-Sep-05 | 25-May-07 | 438 |
| A1010 | Precurement of Subcontractors | 06-Sep-05 | 25-May-07 | 438 |
| A1020 | Design Assist | 20-Mar-06 | 25-Apr-07 | 281 |
| A1280 | Submittals | 10-Apr-06 | 25-May-07 | 288 |
| A1290 | Bid and Purchase | 27-Jun-06 | 20-Jun-07 | 251 |
| **Construction Phase** | | 22-Mar-06 A | 14-Apr-08 | 535 |
| **Mobilization and Site Work** | | 22-Mar-06 | 05-Sep-06 | 117 |
| A1030 | Notice To Proceed | 22-Mar-06 | | 0 |
| A1040 | Demolition | 17-Apr-06 | 19-Jun-06 | 45 |
| A1050 | Mobilizaiton on Site | 01-May-06 | 26-May-06 | 20 |
| A1060 | Excavation | 02-May-06 | 05-Sep-06 | 88 |
| **Foundations** | | 22-May-06 | 06-Oct-06 | 97 |
| A1380 | Piles Area 1 | 22-May-06 | 19-Jun-06 | 20 |
| A1390 | Piles Area 2 | 16-Jun-06 | 14-Jul-06 | 20 |
| A1400 | Piles Area 4 | 05-Jul-06 | 29-Aug-06 | 40 |
| A1410 | Piles Area 3 | 10-Jul-06 | 18-Aug-06 | 30 |
| A1420 | Piles Area 5 | 25-Jul-06 | 05-Sep-06 | 30 |
| A1430 | Piles Area 7 | 07-Aug-06 | 02-Oct-06 | 40 |
| A1440 | Piles Area 8 | 18-Aug-06 | 06-Oct-06 | 35 |
| A1450 | Piles Area 10 | 18-Aug-06 | 29-Sep-06 | 30 |
| **CIP Concrete** | | 14-Jun-06 | 31-Aug-07 | 312 |
| A1080 | Pile Caps Area 1 | 14-Jun-06 | 26-Jul-06 | 30 |
| A1320 | Grade Beams Area 1 | 14-Jun-06 | 26-Jul-06 | 30 |
| A1530 | Area 1 - CIP Walls | 21-Jun-06 | 09-Aug-06 | 35 |
| A1750 | Main Concourse Supported Slab Area 1 | 26-Jul-06 | 29-Sep-06 | 47 |
| A1460 | Pile Caps Area 2 | 31-Jul-06 | 25-Aug-06 | 20 |
| A1680 | Grade Beams Area 2 | 31-Jul-06 | 25-Aug-06 | 20 |
| A1540 | Area 2 - CIP Walls | 14-Aug-06 | 11-Sep-06 | 20 |
| A1470 | Pile Caps Area 3 | 25-Aug-06 | 29-Sep-06 | 25 |
| A1690 | Grade Beams Area 3 | 25-Aug-06 | 22-Sep-06 | 20 |
| A1550 | Area 3 - CIP Walls | 28-Aug-06 | 16-Oct-06 | 35 |
| A1760 | Main Concourse Supported Slab Area 2 | 28-Aug-06 | 19-Oct-06 | 38 |



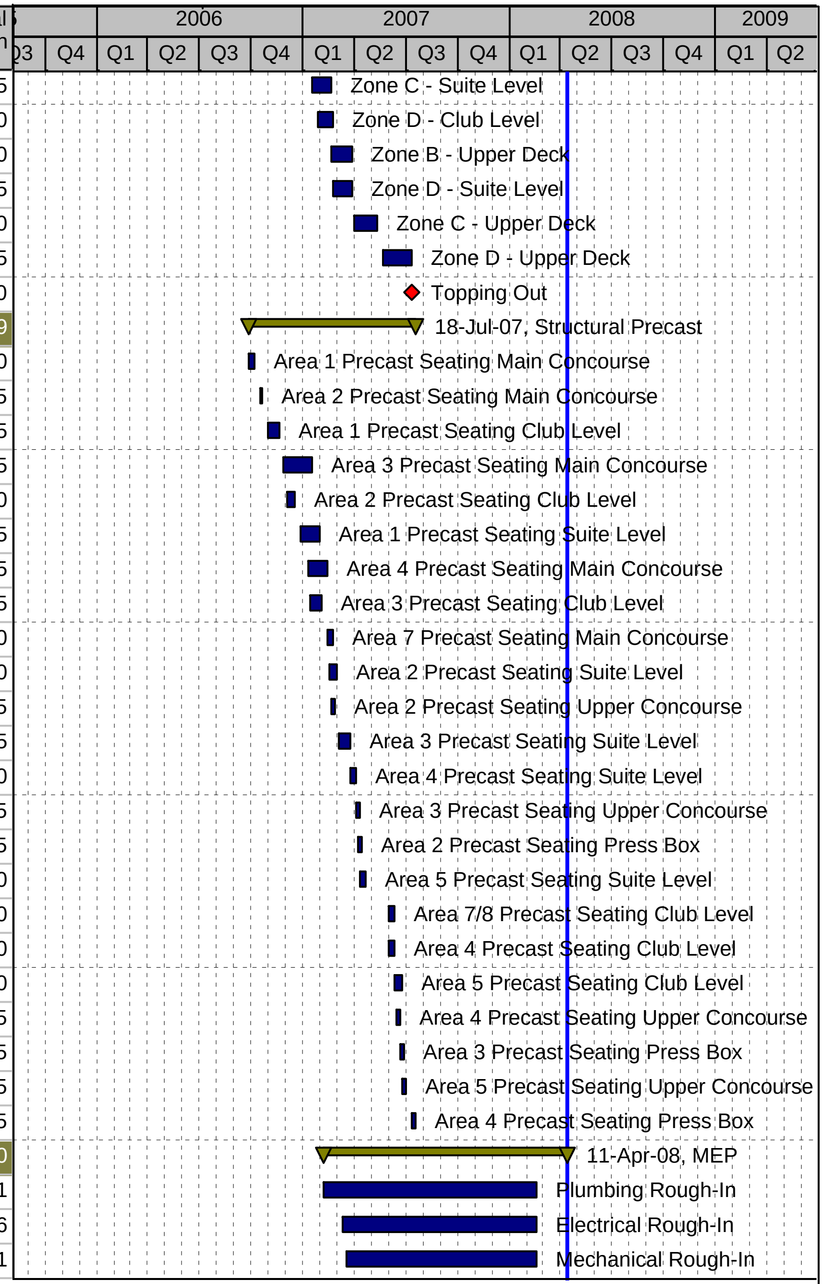

Actual Work — Critical Remaining Work — Summary
Remaining Work — Milestone

| Activity ID | Activity Name | Start | Finish | Original Duration |
|---|---|---|---|---|
| A1480 | Pile Caps Area 4 | 25-Sep-06 | 27-Dec-06 | 65 |
| A1700 | Grade Beams Area 4 | 25-Sep-06 | 27-Dec-06 | 65 |
| A1770 | Main Concourse Supported Slab Area 3 | 27-Sep-06 | 07-Dec-06 | 50 |
| A1490 | Pile Caps Area 7 | 12-Oct-06 | 22-Dec-06 | 50 |
| A1710 | Grade Beams Area 7 | 12-Oct-06 | 22-Dec-06 | 50 |
| A1560 | Area 4 - CIP Walls | 23-Oct-06 | 04-Jan-07 | 50 |
| A1610 | SOG Area 1 | 24-Oct-06 | 29-Nov-06 | 25 |
| A1570 | Area 7 - CIP Walls | 01-Nov-06 | 22-Jan-07 | 55 |
| A1780 | Main Concourse Supported Slab Area 4 | 15-Nov-06 | 12-Jan-07 | 39 |
| A1500 | Pile Caps Area 8 | 18-Dec-06 | 13-Feb-07 | 40 |
| A1720 | Grade Beams Area 8 | 18-Dec-06 | 13-Feb-07 | 40 |
| A1580 | Area 8 - CIP Walls | 20-Dec-06 | 08-Mar-07 | 55 |
| A1620 | SOG Area 2 | 22-Dec-06 | 15-Jan-07 | 15 |
| A1510 | Pile Caps Area 5 | 28-Dec-06 | 22-Feb-07 | 40 |
| A1730 | Grade Beams Area 5 | 28-Dec-06 | 22-Feb-07 | 40 |
| A1790 | Main Concourse Supported Slab Area 7 | 08-Jan-07 | 19-Mar-07 | 51 |
| A1630 | SOG Area 3 | 19-Jan-07 | 08-Mar-07 | 35 |
| A1520 | Pile Caps Area 10 | 26-Jan-07 | 01-Mar-07 | 25 |
| A1740 | Grade Beams Area 10 | 26-Jan-07 | 01-Mar-07 | 25 |
| A1590 | Area 5 - CIP Walls | 22-Feb-07 | 14-Mar-07 | 15 |
| A1800 | Main Concourse Supported Slab Area 8 | 23-Feb-07 | 25-May-07 | 66 |
| A1600 | Area 10 - CIP Walls | 07-Mar-07 | 17-Apr-07 | 30 |
| A1640 | SOG Area 4 | 14-Mar-07 | 08-May-07 | 40 |
| A1810 | Main Concourse Supported Slab Area 10 | 29-May-07 | 10-Jul-07 | 31 |
| A1650 | SOG Area 7 | 14-Jun-07 | 11-Jul-07 | 20 |
| A1660 | SOG Area 8 | 28-Jun-07 | 18-Jul-07 | 15 |
| A1670 | SOG Area 10 | 01-Aug-07 | 21-Aug-07 | 15 |
| A1820 | SOG Area 5 | 14-Aug-07 | 31-Aug-07 | 14 |
| **Structural Steel** | | 05-Oct-06 A | 11-Jul-07 | 269 |
| A1830 | Zone A - Club Level | 05-Oct-06 | 01-Nov-06 | 20 |
| A1870 | Zone A - Suite Level | 02-Nov-06 | 08-Dec-06 | 25 |
| A1840 | Zone B - Club Level | 09-Nov-06 | 08-Dec-06 | 20 |
| A1880 | Zone B - Suite Level | 11-Dec-06 | 16-Jan-07 | 25 |
| A1860 | Zone C - Club Level | 18-Dec-06 | 16-Jan-07 | 20 |
| A2690 | Zone A - Upper Deck | 08-Jan-07 | 16-Feb-07 | 30 |




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

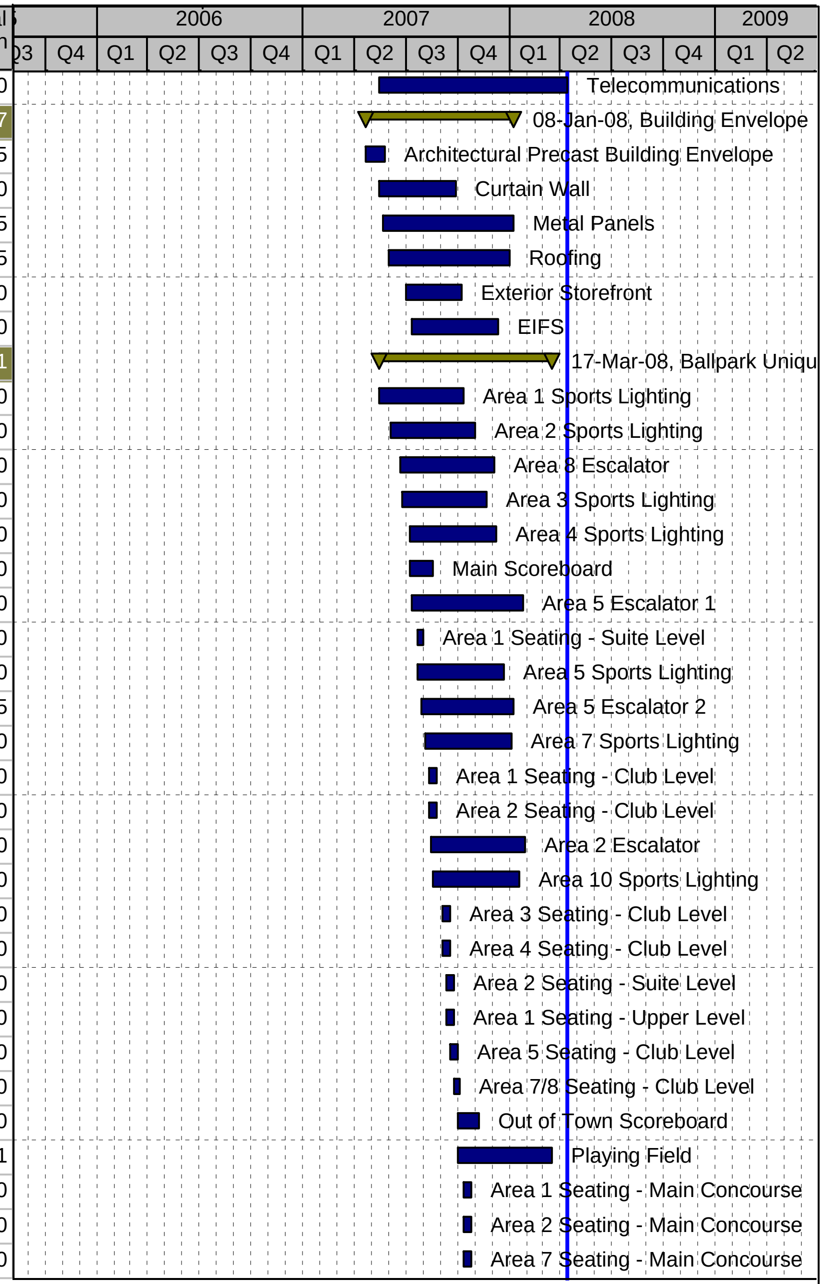
| Activity ID | Activity Name | Start | Finish | Original Duration |
| --- | --- | --- | --- | --- |
| A1890 | Zone C - Suite Level | 17-Jan-07 | 20-Feb-07 | 25 |
| A1850 | Zone D - Club Level | 26-Jan-07 | 22-Feb-07 | 20 |
| A2700 | Zone B - Upper Deck | 19-Feb-07 | 30-Mar-07 | 30 |
| A1900 | Zone D - Suite Level | 23-Feb-07 | 29-Mar-07 | 25 |
| A2710 | Zone C - Upper Deck | 02-Apr-07 | 11-May-07 | 30 |
| A2720 | Zone D - Upper Deck | 24-May-07 | 11-Jul-07 | 35 |
| A1110 | Topping Out | 11-Jul-07 A | | 0 |
| **Structural Precast** | | 25-Sep-06 | 18-Jul-07 | 209 |
| A1910 | Area 1 Precast Seating Main Concourse | 25-Sep-06 | 06-Oct-06 | 10 |
| A1920 | Area 2 Precast Seating Main Concourse | 16-Oct-06 | 20-Oct-06 | 5 |
| A1960 | Area 1 Precast Seating Club Level | 31-Oct-06 | 20-Nov-06 | 15 |
| A1930 | Area 3 Precast Seating Main Concourse | 27-Nov-06 | 16-Jan-07 | 35 |
| A1970 | Area 2 Precast Seating Club Level | 04-Dec-06 | 15-Dec-06 | 10 |
| A2020 | Area 1 Precast Seating Suite Level | 26-Dec-06 | 30-Jan-07 | 25 |
| A1940 | Area 4 Precast Seating Main Concourse | 09-Jan-07 | 12-Feb-07 | 25 |
| A1980 | Area 3 Precast Seating Club Level | 12-Jan-07 | 01-Feb-07 | 15 |
| A1950 | Area 7 Precast Seating Main Concourse | 12-Feb-07 | 23-Feb-07 | 10 |
| A2030 | Area 2 Precast Seating Suite Level | 15-Feb-07 | 28-Feb-07 | 10 |
| A2070 | Area 2 Precast Seating Upper Concourse | 20-Feb-07 | 26-Feb-07 | 5 |
| A2040 | Area 3 Precast Seating Suite Level | 06-Mar-07 | 26-Mar-07 | 15 |
| A2050 | Area 4 Precast Seating Suite Level | 26-Mar-07 | 06-Apr-07 | 10 |
| A2080 | Area 3 Precast Seating Upper Concourse | 05-Apr-07 | 11-Apr-07 | 5 |
| A2110 | Area 2 Precast Seating Press Box | 09-Apr-07 | 13-Apr-07 | 5 |
| A2060 | Area 5 Precast Seating Suite Level | 10-Apr-07 | 23-Apr-07 | 10 |
| A1990 | Area 7/8 Precast Seating Club Level | 31-May-07 | 13-Jun-07 | 10 |
| A2000 | Area 4 Precast Seating Club Level | 31-May-07 | 13-Jun-07 | 10 |
| A2010 | Area 5 Precast Seating Club Level | 13-Jun-07 | 26-Jun-07 | 10 |
| A2090 | Area 4 Precast Seating Upper Concourse | 14-Jun-07 | 20-Jun-07 | 5 |
| A2120 | Area 3 Precast Seating Press Box | 21-Jun-07 | 27-Jun-07 | 5 |
| A2100 | Area 5 Precast Seating Upper Concourse | 27-Jun-07 | 03-Jul-07 | 5 |
| A2130 | Area 4 Precast Seating Press Box | 12-Jul-07 | 18-Jul-07 | 5 |
| **MEP** | | 05-Feb-07 | 11-Apr-08 | 310 |
| A2830 | Plumbing Rough-In | 05-Feb-07 | 18-Feb-08 | 271 |
| A2820 | Electrical Rough-In | 12-Mar-07 | 18-Feb-08 | 246 |
| A2520 | Mechanical Rough-In | 19-Mar-07 | 18-Feb-08 | 241 |




Actual Work — Critical Remaining Work — Summary

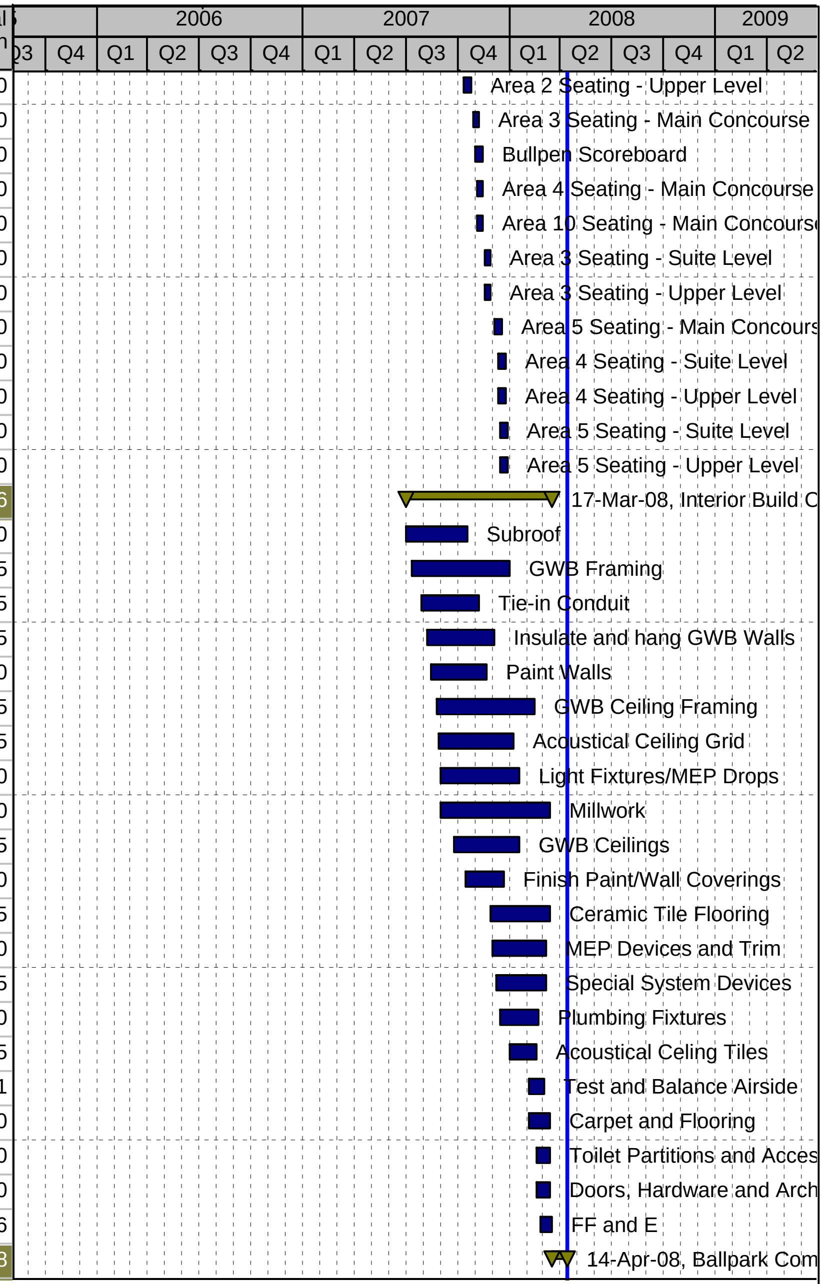
Remaining Work — Milestone

| Activity ID | Activity Name | Start | Finish | Original Duration |
|---|---|---|---|---|
| A2850 | Telecommunications | 14-May-07 | 11-Apr-08 | 240 |
| **Building Envelope** | | 23-Apr-07 | 08-Jan-08 | 187 |
| A2140 | Architectural Precast Building Envelope | 23-Apr-07 | 25-May-07 | 25 |
| A2150 | Curtain Wall | 14-May-07 | 28-Sep-07 | 100 |
| A2170 | Metal Panels | 23-May-07 | 08-Jan-08 | 165 |
| A2190 | Roofing | 31-May-07 | 02-Jan-08 | 155 |
| A2160 | Exterior Storefront | 03-Jul-07 | 08-Oct-07 | 70 |
| A2180 | EIFS | 13-Jul-07 | 13-Dec-07 | 110 |
| **Ballpark Unique Features** | | 14-May-07 | 17-Mar-08 | 221 |
| A1300 | Area 1 Sports Lighting | 14-May-07 | 12-Oct-07 | 110 |
| A2730 | Area 2 Sports Lighting | 04-Jun-07 | 02-Nov-07 | 110 |
| A2410 | Area 8 Escalator | 21-Jun-07 | 05-Dec-07 | 120 |
| A2740 | Area 3 Sports Lighting | 25-Jun-07 | 23-Nov-07 | 110 |
| A2750 | Area 4 Sports Lighting | 09-Jul-07 | 07-Dec-07 | 110 |
| A2790 | Main Scoreboard | 09-Jul-07 | 17-Aug-07 | 30 |
| A2420 | Area 5 Escalator 1 | 13-Jul-07 | 24-Jan-08 | 140 |
| A2590 | Area 1 Seating - Suite Level | 23-Jul-07 | 03-Aug-07 | 10 |
| A2760 | Area 5 Sports Lighting | 23-Jul-07 | 21-Dec-07 | 110 |
| A2430 | Area 5 Escalator 2 | 31-Jul-07 | 07-Jan-08 | 115 |
| A2770 | Area 7 Sports Lighting | 06-Aug-07 | 04-Jan-08 | 110 |
| A2530 | Area 1 Seating - Club Level | 13-Aug-07 | 24-Aug-07 | 10 |
| A2540 | Area 2 Seating - Club Level | 13-Aug-07 | 24-Aug-07 | 10 |
| A2440 | Area 2 Escalator | 16-Aug-07 | 30-Jan-08 | 120 |
| A2780 | Area 10 Sports Lighting | 20-Aug-07 | 18-Jan-08 | 110 |
| A2550 | Area 3 Seating - Club Level | 04-Sep-07 | 17-Sep-07 | 10 |
| A2560 | Area 4 Seating - Club Level | 04-Sep-07 | 17-Sep-07 | 10 |
| A2600 | Area 2 Seating - Suite Level | 11-Sep-07 | 24-Sep-07 | 10 |
| A2640 | Area 1 Seating - Upper Level | 13-Sep-07 | 26-Sep-07 | 10 |
| A2570 | Area 5 Seating - Club Level | 18-Sep-07 | 01-Oct-07 | 10 |
| A2580 | Area 7/8 Seating - Club Level | 24-Sep-07 | 05-Oct-07 | 10 |
| A2800 | Out of Town Scoreboard | 01-Oct-07 | 09-Nov-07 | 30 |
| A2840 | Playing Field | 01-Oct-07 | 17-Mar-08 | 121 |
| A2450 | Area 1 Seating - Main Concourse | 11-Oct-07 | 24-Oct-07 | 10 |
| A2460 | Area 2 Seating - Main Concourse | 11-Oct-07 | 24-Oct-07 | 10 |
| A2500 | Area 7 Seating - Main Concourse | 11-Oct-07 | 24-Oct-07 | 10 |



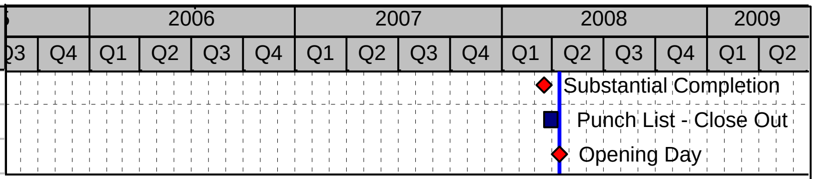

Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

| Activity ID | Activity Name | Start | Finish | Original Duration |
|---|---|---|---|---|
| A2650 | Area 2 Seating - Upper Level | 11-Oct-07 | 24-Oct-07 | 10 |
| A2470 | Area 3 Seating - Main Concourse | 29-Oct-07 | 09-Nov-07 | 10 |
| A2810 | Bullpen Scoreboard | 01-Nov-07 | 14-Nov-07 | 10 |
| A2480 | Area 4 Seating - Main Concourse | 05-Nov-07 | 16-Nov-07 | 10 |
| A2510 | Area 10 Seating - Main Concourse | 05-Nov-07 | 16-Nov-07 | 10 |
| A2610 | Area 3 Seating - Suite Level | 19-Nov-07 | 30-Nov-07 | 10 |
| A2660 | Area 3 Seating - Upper Level | 19-Nov-07 | 30-Nov-07 | 10 |
| A2490 | Area 5 Seating - Main Concourse | 05-Dec-07 | 18-Dec-07 | 10 |
| A2620 | Area 4 Seating - Suite Level | 12-Dec-07 | 25-Dec-07 | 10 |
| A2670 | Area 4 Seating - Upper Level | 12-Dec-07 | 25-Dec-07 | 10 |
| A2630 | Area 5 Seating - Suite Level | 17-Dec-07 | 28-Dec-07 | 10 |
| A2680 | Area 5 Seating - Upper Level | 17-Dec-07 | 28-Dec-07 | 10 |
| **Interior Build Out** | | 02-Jul-07 | 17-Mar-08 | 186 |
| A2200 | Subroof | 02-Jul-07 | 19-Oct-07 | 80 |
| A2210 | GWB Framing | 11-Jul-07 | 01-Jan-08 | 125 |
| A2220 | Tie-in Conduit | 30-Jul-07 | 09-Nov-07 | 75 |
| A2230 | Insulate and hang GWB Walls | 10-Aug-07 | 06-Dec-07 | 85 |
| A2240 | Paint Walls | 15-Aug-07 | 20-Nov-07 | 70 |
| A2250 | GWB Ceiling Framing | 27-Aug-07 | 15-Feb-08 | 125 |
| A2260 | Acoustical Ceiling Grid | 30-Aug-07 | 09-Jan-08 | 95 |
| A2270 | Light Fixtures/MEP Drops | 03-Sep-07 | 18-Jan-08 | 100 |
| A2280 | Millwork | 03-Sep-07 | 14-Mar-08 | 140 |
| A2290 | GWB Ceilings | 24-Sep-07 | 18-Jan-08 | 85 |
| A2300 | Finish Paint/Wall Coverings | 15-Oct-07 | 21-Dec-07 | 50 |
| A2310 | Ceramic Tile Flooring | 30-Nov-07 | 13-Mar-08 | 75 |
| A2320 | MEP Devices and Trim | 03-Dec-07 | 07-Mar-08 | 70 |
| A2330 | Special System Devices | 10-Dec-07 | 07-Mar-08 | 65 |
| A2340 | Plumbing Fixtures | 17-Dec-07 | 22-Feb-08 | 50 |
| A2350 | Acoustical Celing Tiles | 02-Jan-08 | 19-Feb-08 | 35 |
| A2360 | Test and Balance Airside | 04-Feb-08 | 03-Mar-08 | 21 |
| A2370 | Carpet and Flooring | 04-Feb-08 | 14-Mar-08 | 30 |
| A2380 | Toilet Partitions and Accessories | 18-Feb-08 | 14-Mar-08 | 20 |
| A2390 | Doors, Hardware and Architectural Trim | 18-Feb-08 | 14-Mar-08 | 20 |
| A2400 | FF and E | 25-Feb-08 | 17-Mar-08 | 16 |
| **Ballpark Completion** | | 17-Mar-08 A | 14-Apr-08 | 128 |




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

| Activity ID | Activity Name | Start | Finish | Original Duration |
| --- | --- | --- | --- | --- |
| A1260 | Substantial Completion | 17-Mar-08 A | | 0 |
| A1250 | Punch List - Close Out | 18-Mar-08 A | 11-Apr-08 A | 23 |
| A1270 | Opening Day | 14-Apr-08 | | 0 |




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

# Appendix C

## Detailed Short Interval Production Schedule

<table>
<tr><th rowspan="3">Level</th><th rowspan="3">Zone</th><th rowspan="3">Area</th><th rowspan="3">Room Number</th><th rowspan="3">Room Name</th><th colspan="20">Month 1</th><th colspan="20">Month 2</th><th colspan="20">Month 3</th><th colspan="20">Month 4</th><th colspan="20">Month 5</th><th colspan="20">Month 6</th><th colspan="10">Month 7</th></tr>
<tr><th colspan="5">Week 1</th><th colspan="5">Week 2</th><th colspan="5">Week 3</th><th colspan="5">Week 4</th><th colspan="5">Week 5</th><th colspan="5">Week 6</th><th colspan="5">Week 7</th><th colspan="5">Week 8</th><th colspan="5">Week 9</th><th colspan="5">Week 10</th><th colspan="5">Week 11</th><th colspan="5">Week 12</th><th colspan="5">Week 13</th><th colspan="5">Week 14</th><th colspan="5">Week 15</th><th colspan="5">Week 16</th><th colspan="5">Week 17</th><th colspan="5">Week 18</th><th colspan="5">Week 19</th><th colspan="5">Week 20</th><th colspan="5">Week 21</th><th colspan="5">Week 22</th><th colspan="5">Week 23</th><th colspan="5">Week 24</th><th colspan="5">Week 25</th><th colspan="5">Week 26</th></tr>
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<tr><td>3</td><td>B</td><td>3</td><td>3.28.01</td><td>Suite 6</td><td colspan="10"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="106"></td></tr>
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<tr><td>4</td><td>C</td><td>3</td><td>4.31.01</td><td>Suite 35</td><td colspan="68"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="48"></td></tr>
<tr><td>4</td><td>C</td><td>3</td><td>4.31.03</td><td>Suite 36</td><td colspan="70"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="46"></td></tr>
<tr><td>4</td><td>C</td><td>3</td><td>4.31.05</td><td>Suite 37</td><td colspan="72"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="44"></td></tr>
<tr><td>4</td><td>C</td><td>3</td><td>4.33.01</td><td>Suite 38</td><td colspan="74"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="42"></td></tr>
<tr><td>4</td><td>C</td><td>3</td><td>4.33.03</td><td>Suite 39</td><td colspan="76"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="40"></td></tr>
<tr><td>4</td><td>C</td><td>3</td><td>4.34.01</td><td>Suite 40</td><td colspan="78"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="38"></td></tr>
<tr><td>4</td><td>C</td><td>3</td><td>4.34.03</td><td>Suite 41</td><td colspan="80"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="36"></td></tr>
<tr><td>4</td><td>C</td><td>3</td><td>4.36.01</td><td>Suite 42</td><td colspan="82"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="34"></td></tr>
<tr><td>4</td><td>C</td><td>3</td><td>4.36.03</td><td>Suite 43</td><td colspan="84"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="32"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.38.01</td><td>Suite 44</td><td colspan="86"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="30"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.38.03</td><td>Suite 45</td><td colspan="88"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="28"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.38.05</td><td>Suite 46</td><td colspan="90"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="26"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.40.01</td><td>Suite 47</td><td colspan="92"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="24"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.40.03</td><td>Suite 48</td><td colspan="94"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="22"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.40.05</td><td>Suite 49</td><td colspan="96"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="20"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.43.01</td><td>Suite 50</td><td colspan="98"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="18"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.43.03</td><td>Suite 51</td><td colspan="100"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="16"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.43.05</td><td>Suite 52</td><td colspan="102"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="14"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.45.01</td><td>Suite 53</td><td colspan="104"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="12"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.45.03</td><td>Suite 54</td><td colspan="106"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="10"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.45.05</td><td>Suite 55</td><td colspan="108"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="8"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.47.01</td><td>Suite 56</td><td colspan="110"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="6"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.47.03</td><td>Suite 57</td><td colspan="112"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="4"></td></tr>
<tr><td>4</td><td>C</td><td>4</td><td>4.47.05</td><td>Suite 58</td><td colspan="114"></td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td colspan="2">6</td><td colspan="2">7</td><td colspan="2"></td></tr>
</table>

# Appendix D

## Concrete vs. Steel Cost Data

# Concrete vs. Steel Columns Estimate Typical Section

**CONCRETE vs. STEEL COLUMNS**

| Line | Pile | Concrete Column | Rebar | Height | Factored Load (k) | Steel Column | Column Load (k) | Column Load > Factored Load | Concrete Cost | Steel Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 33 | P-2 | 24x18 | 8#11 | 5 | 200 | W8x31 | 374 | acceptable | $401.39 | $294.50 |
| 33 | P-4 | 36x24 | 20#11 | 10 | 400 | W12x45 | 448 | acceptable | $1,605.56 | $855.00 |
| 33 | P-7 | 36x48 | 16#11 | 20 | 1000 | W12x120 | 1030 | acceptable | $6,422.22 | $5,836.80 |
| 33 | P-6 | 36x48 | 22#11 | 32 | 400 | W12x96 | 412 | acceptable | $10,275.56 | $4,560.00 |
| 33 | P-14 | 36x48 | 12#11 | 32 | 2100 | W14x311 | 2230 | acceptable | $10,275.56 | $18,908.80 |
| 33 | P-15 | 36x48 | 12#11 | 32 | 2800 | W14x398 | 2950 | acceptable | $10,275.56 | $24,198.40 |
| 33 | P-17 | 36x48 | 24#11 | 32 | 3600 | W14x500 | 3820 | acceptable | $10,275.56 | $30,400.00 |
| 34 | P-2 | 24x18 | 10#11 | 5 | 200 | W8x31 | 374 | acceptable | $401.39 | $294.50 |
| 34 | P-4 | 36x18 | 16#11 | 10 | 300 | W8x31 | 374 | acceptable | $1,204.17 | $589.00 |
| 34 | P-7 | 36x48 | 12#11 | 20 | 1000 | W12x120 | 1030 | acceptable | $6,422.22 | $4,560.00 |
| 34 | P-14 | 36x48 | 12#11 | 32 | 2100 | W14x311 | 2230 | acceptable | $10,275.56 | $18,908.80 |
| 34 | P-15 | 36x48 | 12#11 | 32 | 2900 | W14x398 | 2950 | acceptable | $10,275.56 | $24,198.40 |
| 34 | P-17 | 36x48 | 24#11 | 32 | 3700 | W14x500 | 3820 | acceptable | $10,275.56 | $30,400.00 |
| 35 | P-2 | 24x18 | 8#11 | 5 | 200 | W8x31 | 374 | acceptable | $401.39 | $294.50 |
| 35 | P-2 | 24x18 | 8#11 | 10 | 200 | W8x31 | 374 | acceptable | $802.78 | $589.00 |
| 35 | P-4 | 36x18 | 16#11 | 20 | 300 | W8x67 | 347 | acceptable | $2,408.33 | $2,546.00 |
| 35 | P-8 | 36x48 | 12#11 | 32 | 1000 | W14x159 | 1070 | acceptable | $10,275.56 | $9,667.20 |
| 35 | P-14 | 36x48 | 12#11 | 32 | 2300 | W14x342 | 2500 | acceptable | $10,275.56 | $20,793.60 |
| 35 | P-15 | 36x48 | 12#11 | 32 | 2900 | W14x398 | 2950 | acceptable | $10,275.56 | $24,198.40 |
| 35 | P-17 | 36x48 | 28#11 | 32 | 4000 | W14x550 | 4270 | acceptable | $10,275.56 | $33,440.00 |
| 36 | P-2 | 24x18 | 8#11 | 5 | 200 | W8x31 | 374 | acceptable | $401.39 | $294.50 |
| 36 | P-4 | 36x18 | 16#11 | 10 | 400 | W12x45 | 448 | acceptable | $1,204.17 | $3,952.00 |
| 36 | P-8 | 36x48 | 12#11 | 20 | 1000 | W12x120 | 1030 | acceptable | $6,422.22 | $855.00 |
| 36 | P-2 | 24x18 | 8#11 | 32 | 200 | W12x65 | 362 | acceptable | $2,568.89 | $4,560.00 |
| 36 | P-17 | 36x48 | 20#11 | 32 | 2800 | W14x398 | 2950 | acceptable | $10,275.56 | $24,198.40 |
| 36 | P-17 | 36x48 | 16#11 | 32 | 3200 | W14x455 | 3440 | acceptable | $10,275.56 | $27,664.00 |
| 36 | P-17 | 36x48 | 28#11 | 32 | 4000 | W14x550 | 4270 | acceptable | $10,275.56 | $33,440.00 |
| 37 | P-1 | 24x18 | 8#11 | 5 | 200 | W8x31 | 374 | acceptable | $401.39 | $471.20 |
| 37 | P-2 | 24x18 | 8#11 | 8 | 200 | W8x31 | 374 | acceptable | $642.22 | $294.50 |
| 37 | P-4 | 36x18 | 16#11 | 10 | 400 | W12x45 | 448 | acceptable | $1,204.17 | $855.00 |
| 37 | P-8 | 36x48 | 12#11 | 20 | 1000 | W12x120 | 1030 | acceptable | $6,422.22 | $4,560.00 |
| 37 | P-20 | 36x48 | 28#11 | 32 | 3500 | W14x500 | 3820 | acceptable | $10,275.56 | $30,400.00 |
| 37 | P-18 | 36x48 | 32#11 | 32 | 4100 | W14x550 | 4270 | acceptable | $10,275.56 | $33,440.00 |
| 37 | P-18 | 36x48 | 32#11 | 32 | 4100 | W14x550 | 4270 | acceptable | $10,275.56 | $33,440.00 |
| 38 | P-2 | 30x18 | 8#11 | 5 | 200 | W8x31 | 374 | acceptable | $501.74 | $471.20 |
| 38 | P-2 | 24x18 | 8#11 | 8 | 200 | W8x31 | 374 | acceptable | $642.22 | $294.50 |
| 38 | P-4 | 36x18 | 16#11 | 10 | 300 | W8x31 | 374 | acceptable | $1,204.17 | $589.00 |
| 38 | P-10 | 36x48 | 12#11 | 20 | 700 | W12x87 | 736 | acceptable | $6,422.22 | $3,306.00 |
| 38 | P-20 | 36x48 | 40#11 | 32 | 2500 | W14x342 | 2500 | acceptable | $10,275.56 | $20,793.60 |
| 38 | P-20 | 36x48 | 20#11 | 32 | 3000 | W14x426 | 3170 | acceptable | $10,275.56 | $25,900.80 |
| 38 | P-20 | 36x48 | 20#11 | 32 | 3400 | W14x455 | 3440 | acceptable | $10,275.56 | $27,664.00 |
| | | | | | | | | **Totals:** | **$253,617.57** | **$532,976.60** |

# Steel Estimate

## STEEL COLUMNS

**Steel Columns**

| Line | Beam Type | | | | Beam Length (ft) | Beam Weight (Tons) | Cost per Ton | Individual Cost |
|---|---|---|---|---|---|---|---|---|
| 33 | W | 14 | x | 311 | 56 | 8.708 | $3,800.00 | $33,090.40 |
| 33 | W | 36 | x | 170 | 8 | 0.68 | $3,800.00 | $2,584.00 |
| 33 | W | 33 | x | 330 | 46 | 7.59 | $3,800.00 | $28,842.00 |
| 33 | W | 36 | x | 43 | 26 | 0.559 | $3,800.00 | $2,124.20 |
| 33 | W | 36 | x | 395 | 56 | 11.06 | $3,800.00 | $42,028.00 |
| 34 | W | 14 | x | 68 | 16 | 0.544 | $3,800.00 | $2,067.20 |
| 34 | W | 14 | x | 311 | 56 | 8.708 | $3,800.00 | $33,090.40 |
| 34 | W | 14 | x | 109 | 28 | 1.526 | $3,800.00 | $5,798.80 |
| 34 | W | 14 | x | 109 | 48 | 2.616 | $3,800.00 | $9,940.80 |
| 34 | W | 36 | x | 361 | 56 | 10.108 | $3,800.00 | $38,410.40 |
| 34 | W | 36 | x | 247 | 40 | 4.94 | $3,800.00 | $18,772.00 |
| 34 | W | 36 | x | 330 | 56 | 9.24 | $3,800.00 | $35,112.00 |
| 35 | W | 14 | x | 68 | 16 | 0.544 | $3,800.00 | $2,067.20 |
| 35 | W | 14 | x | 311 | 56 | 8.708 | $3,800.00 | $33,090.40 |
| 35 | W | 14 | x | 109 | 28 | 1.526 | $3,800.00 | $5,798.80 |
| 35 | W | 14 | x | 109 | 48 | 2.616 | $3,800.00 | $9,940.80 |
| 35 | W | 36 | x | 361 | 56 | 10.108 | $3,800.00 | $38,410.40 |
| 35 | W | 36 | x | 247 | 40 | 4.94 | $3,800.00 | $18,772.00 |
| 35 | W | 36 | x | 330 | 56 | 9.24 | $3,800.00 | $35,112.00 |
| 36 | W | 14 | x | 68 | 16 | 0.544 | $3,800.00 | $2,067.20 |
| 36 | W | 14 | x | 311 | 56 | 8.708 | $3,800.00 | $33,090.40 |
| 36 | W | 14 | x | 109 | 28 | 1.526 | $3,800.00 | $5,798.80 |
| 36 | W | 14 | x | 109 | 48 | 2.616 | $3,800.00 | $9,940.80 |
| 36 | W | 36 | x | 361 | 56 | 10.108 | $3,800.00 | $38,410.40 |
| 36 | W | 36 | x | 247 | 40 | 4.94 | $3,800.00 | $18,772.00 |
| 36 | W | 36 | x | 330 | 56 | 9.24 | $3,800.00 | $35,112.00 |
| 37 | W | 14 | x | 68 | 16 | 0.544 | $3,800.00 | $2,067.20 |
| 37 | W | 14 | x | 311 | 56 | 8.708 | $3,800.00 | $33,090.40 |
| 37 | W | 14 | x | 109 | 28 | 1.526 | $3,800.00 | $5,798.80 |
| 37 | W | 14 | x | 109 | 48 | 2.616 | $3,800.00 | $9,940.80 |
| 37 | W | 36 | x | 361 | 56 | 10.108 | $3,800.00 | $38,410.40 |
| 37 | W | 36 | x | 247 | 40 | 4.94 | $3,800.00 | $18,772.00 |
| 37 | W | 36 | x | 330 | 56 | 9.24 | $3,800.00 | $35,112.00 |
| 38 | W | 14 | x | 311 | 56 | 8.708 | $3,800.00 | $33,090.40 |
| 38 | W | 36 | x | 170 | 8 | 0.68 | $3,800.00 | $2,584.00 |
| 38 | W | 33 | x | 330 | 46 | 7.59 | $3,800.00 | $28,842.00 |
| 38 | W | 36 | x | 43 | 26 | 0.559 | $3,800.00 | $2,124.20 |
| 38 | W | 36 | x | 395 | 56 | 11.06 | $3,800.00 | $42,028.00 |
| | | | | | | | **Total:** | **$790,103.60** |

| New Steel Columns from Concrete Comparison | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Line | Beam Type | | | | Beam Length (ft) | Beam Weight (Tons) | Cost per Ton | Individual Cost |
| 33 | W | 8 | x | 31 | 5 | 0.0775 | $3,800.00 | $294.50 |
| 33 | W | 12 | x | 45 | 10 | 0.225 | $3,800.00 | $855.00 |
| 33 | W | 12 | x | 96 | 32 | 1.536 | $3,800.00 | $5,836.80 |
| 33 | W | 12 | x | 120 | 20 | 1.2 | $3,800.00 | $4,560.00 |
| 33 | W | 14 | x | 311 | 32 | 4.976 | $3,800.00 | $18,908.80 |
| 33 | W | 14 | x | 398 | 32 | 6.368 | $3,800.00 | $24,198.40 |
| 33 | W | 14 | x | 500 | 32 | 8 | $3,800.00 | $30,400.00 |
| 34 | W | 8 | x | 31 | 5 | 0.0775 | $3,800.00 | $294.50 |
| 34 | W | 8 | x | 31 | 10 | 0.155 | $3,800.00 | $589.00 |
| 34 | W | 12 | x | 120 | 20 | 1.2 | $3,800.00 | $4,560.00 |
| 34 | W | 14 | x | 311 | 32 | 4.976 | $3,800.00 | $18,908.80 |
| 34 | W | 14 | x | 398 | 32 | 6.368 | $3,800.00 | $24,198.40 |
| 34 | W | 14 | x | 500 | 32 | 8 | $3,800.00 | $30,400.00 |
| 35 | W | 8 | x | 31 | 5 | 0.0775 | $3,800.00 | $294.50 |
| 35 | W | 8 | x | 31 | 10 | 0.155 | $3,800.00 | $589.00 |
| 35 | W | 8 | x | 67 | 20 | 0.67 | $3,800.00 | $2,546.00 |
| 35 | W | 14 | x | 159 | 32 | 2.544 | $3,800.00 | $9,667.20 |
| 35 | W | 14 | x | 342 | 32 | 5.472 | $3,800.00 | $20,793.60 |
| 35 | W | 14 | x | 398 | 32 | 6.368 | $3,800.00 | $24,198.40 |
| 35 | W | 14 | x | 550 | 32 | 8.8 | $3,800.00 | $33,440.00 |
| 36 | W | 8 | x | 31 | 5 | 0.0775 | $3,800.00 | $294.50 |
| 36 | W | 12 | x | 65 | 32 | 1.04 | $3,800.00 | $3,952.00 |
| 36 | W | 12 | x | 45 | 10 | 0.225 | $3,800.00 | $855.00 |
| 36 | W | 12 | x | 120 | 20 | 1.2 | $3,800.00 | $4,560.00 |
| 36 | W | 14 | x | 398 | 32 | 6.368 | $3,800.00 | $24,198.40 |
| 36 | W | 14 | x | 455 | 32 | 7.28 | $3,800.00 | $27,664.00 |
| 36 | W | 14 | x | 550 | 32 | 8.8 | $3,800.00 | $33,440.00 |
| 37 | W | 8 | x | 31 | 8 | 0.124 | $3,800.00 | $471.20 |
| 37 | W | 8 | x | 31 | 5 | 0.0775 | $3,800.00 | $294.50 |
| 37 | W | 12 | x | 45 | 10 | 0.225 | $3,800.00 | $855.00 |
| 37 | W | 12 | x | 120 | 20 | 1.2 | $3,800.00 | $4,560.00 |
| 37 | W | 14 | x | 500 | 32 | 8 | $3,800.00 | $30,400.00 |
| 37 | W | 14 | x | 550 | 32 | 8.8 | $3,800.00 | $33,440.00 |
| 37 | W | 14 | x | 550 | 32 | 8.8 | $3,800.00 | $33,440.00 |
| 38 | W | 8 | x | 31 | 8 | 0.124 | $3,800.00 | $471.20 |
| 38 | W | 8 | x | 31 | 5 | 0.0775 | $3,800.00 | $294.50 |
| 38 | W | 8 | x | 31 | 10 | 0.155 | $3,800.00 | $589.00 |
| 38 | W | 12 | x | 87 | 20 | 0.87 | $3,800.00 | $3,306.00 |
| 38 | W | 14 | x | 342 | 32 | 5.472 | $3,800.00 | $20,793.60 |
| 38 | W | 14 | x | 426 | 32 | 6.816 | $3,800.00 | $25,900.80 |
| 38 | W | 14 | x | 455 | 32 | 7.28 | $3,800.00 | $27,664.00 |
| | | | | | | | **Total:** | **$532,976.60** |

**STEEL SUMMARY**

| | |
|---|---|
| **SUBTOTAL STEEL ESTIMATE:** | **$1,323,080.20** |
| LOCATION MULTIPLIER 99% FOR DC: | $1,309,849.40 |
| **TOTAL STEEL COST:** | **$1,309,849.40** |

# Concrete Estimate

## CONCRETE COLUMNS

**100 Level**

Line 33

| Column On Pile | Rebar | Factored Load | Pile | Length | Width | Height | CY of Concrete Column | Cost per CY | Individual Cost |
|---|---|---|---|---|---|---|---|---|---|
| 24x18 | 8#11 | 200 | P-2 | 24 | 18 | 5 | 0.56 | $722.50 | $401.39 |
| 36x24 | 20#11 | 400 | P-4 | 36 | 24 | 10 | 2.22 | $722.50 | $1,605.56 |
| 36x48 | 16#11 | 1000 | P-7 | 36 | 48 | 20 | 8.89 | $722.50 | $6,422.22 |
| 36x48 | 24#11 | 3600 | P-17 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 12#11 | 2800 | P-15 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 12#11 | 2100 | P-14 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 22#11 | 400 | P-6 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| | | | | | | | | **Total:** | **$49,531.39** |

Line 34

| Column On Pile | Rebar | Factored Load | Piles | Length | Width | Height | CY of Concrete Column | Cost per CY | Individual Cost |
|---|---|---|---|---|---|---|---|---|---|
| 24x18 | 10#11 | 200 | P-2 | 24 | 18 | 5 | 0.56 | $722.50 | $401.39 |
| 36x18 | 16#11 | 300 | P-4 | 36 | 18 | 10 | 1.67 | $722.50 | $1,204.17 |
| 36x48 | 12#11 | 1000 | P-7 | 36 | 48 | 20 | 8.89 | $722.50 | $6,422.22 |
| 36x48 | 24#11 | 3700 | P-17 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 12#11 | 2900 | P-15 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 12#11 | 2100 | P-14 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| | | | | | | | | **Total:** | **$38,854.44** |

Line 35

| Column On Pile | Rebar | Factored Load | Piles | Length | Width | Height | CY of Concrete Column | Cost per CY | Individual Cost |
|---|---|---|---|---|---|---|---|---|---|
| 24x18 | 8#11 | 200 | P-2 | 24 | 18 | 5 | 0.56 | $722.50 | $401.39 |
| 24x18 | 8#11 | 200 | P-2 | 24 | 18 | 10 | 1.11 | $722.50 | $802.78 |
| 36x18 | 16#11 | 300 | P-4 | 36 | 18 | 20 | 3.33 | $722.50 | $2,408.33 |
| 36x48 | 12#11 | 1000 | P-8 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 28#11 | 4000 | P-17 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 12#11 | 2900 | P-15 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 12#11 | 2300 | P-14 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| | | | | | | | | **Total:** | **$44,714.72** |

Line 36

| Column On Pile | Rebar | Factored Load | Piles | Length | Width | Height | CY of Concrete Column | Cost per CY | Individual Cost |
|---|---|---|---|---|---|---|---|---|---|
| 24x18 | 8#11 | 200 | P-2 | 24 | 18 | 5 | 0.56 | $722.50 | $401.39 |
| 36x18 | 16#11 | 400 | P-4 | 36 | 18 | 10 | 1.67 | $722.50 | $1,204.17 |
| 36x48 | 12#11 | 1000 | P-8 | 36 | 48 | 20 | 8.89 | $722.50 | $6,422.22 |
| 36x48 | 28#11 | 4000 | P-17 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 16#11 | 3200 | P-17 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 20#11 | 2800 | P-17 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 24x18 | 8#11 | 200 | P-2 | 24 | 18 | 32 | 3.56 | $722.50 | $2,568.89 |
| | | | | | | | | **Total:** | **$41,423.33** |

| Line 37 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Column On Pile | Rebar | Factored Load | Piles | Length | Width | Height | CY of Concrete Column | Cost per CY | Individual Cost |
| 24x18 | 8#11 | 100 | P-1 | 24 | 18 | 5 | 0.56 | $722.50 | $401.39 |
| 24x18 | 8#11 | 200 | P-2 | 24 | 18 | 8 | 0.89 | $722.50 | $642.22 |
| 36x18 | 16#11 | 400 | P-4 | 36 | 18 | 10 | 1.67 | $722.50 | $1,204.17 |
| 36x48 | 12#11 | 1000 | P-8 | 36 | 48 | 20 | 8.89 | $722.50 | $6,422.22 |
| 36x48 | 32#11 | 4100 | P-18 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 32#11 | 4100 | P-18 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 28#11 | 3500 | P-20 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| | | | | | | | | **Total:** | **$39,496.67** |

| Line 38 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Column On Pile | Rebar | Factored Load | Piles | Length | Width | Height | CY of Concrete Column | Cost per CY | Individual Cost |
| 30x18 | 8#11 | 100 | P-2 | 30 | 18 | 5 | 0.69 | $722.50 | $501.74 |
| 24x18 | 8#11 | 200 | P-2 | 24 | 18 | 8 | 0.89 | $722.50 | $642.22 |
| 36x18 | 16#11 | 300 | P-4 | 36 | 18 | 10 | 1.67 | $722.50 | $1,204.17 |
| 36x48 | 12#11 | 700 | P-10 | 36 | 48 | 20 | 8.89 | $722.50 | $6,422.22 |
| 36x48 | 20#11 | 3400 | P-20 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 20#11 | 3000 | P-20 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| 36x48 | 40#11 | 2500 | P-20 | 36 | 48 | 32 | 14.22 | $722.50 | $10,275.56 |
| | | | | | | | | **Total:** | **$39,597.01** |

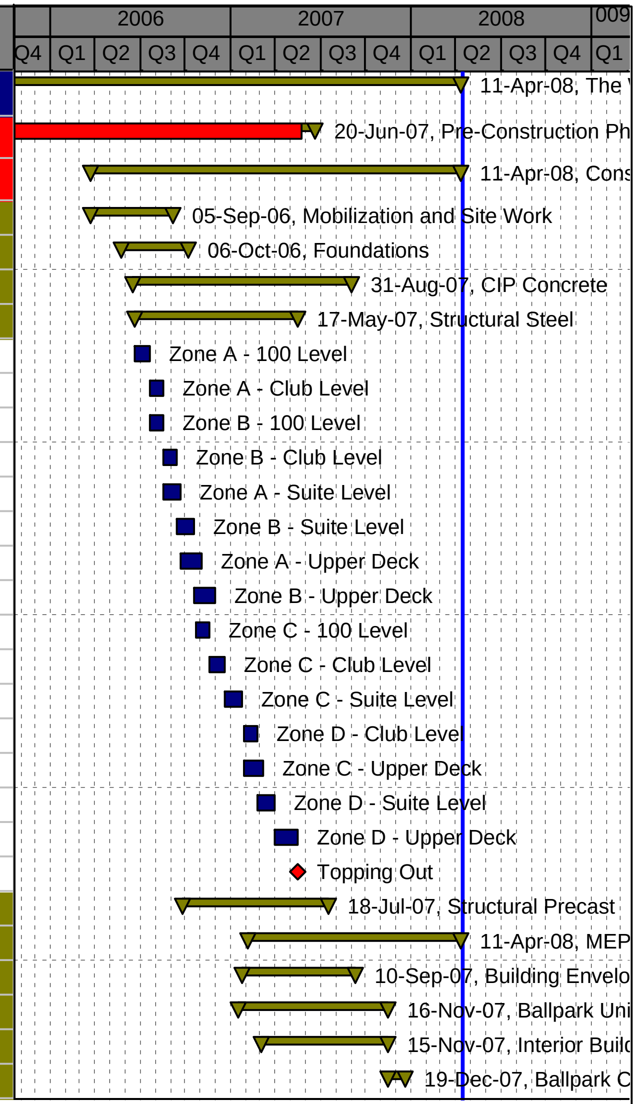
## CONCRETE ESTIMATE SUMMARY

| | |
|---|---|
| **SUBTOTAL CONCRETE COLUMN ESTIMATE:** | **$253,617.57** |
| LOCATION MULTIPLIER 99% FOR DC: | $251,081.39 |
| **TOTAL CONCRETE COLUMN COST:** | **$251,081.39** |

## Appendix E

**All Steel Structural Construction Schedule**

| Activity ID | Activity Name | Original Duration | Remaining Duration | Schedule % Complete | Start | Finish |
|---|---|---|---|---|---|---|
| **The Washington Nationals Ballpark** | | 668 | 668 | 0% | 06-Sep-05 A | 11-Apr-08 |
| **Pre-Construction Phase** | | 456 | 456 | 0% | 06-Sep-05 | 20-Jun-07 |
| **Construction Phase** | | 531 | 531 | 0% | 22-Mar-06 A | 11-Apr-08 |
| **Mobilization and Site Work** | | 117 | 117 | 0% | 22-Mar-06 | 05-Sep-06 |
| **Foundations** | | 97 | 97 | 0% | 22-May-06 | 06-Oct-06 |
| **CIP Concrete** | | 312 | 312 | 0% | 14-Jun-06 | 31-Aug-07 |
| **Structural Steel** | | 343 | 231 | 0% | 21-Jun-06 A | 17-May-07 |
| A2860 | Zone A - 100 Level | 20 | 20 | 100% | 21-Jun-06 | 19-Jul-06 |
| A1830 | Zone A - Club Level | 20 | 20 | 100% | 20-Jul-06 | 16-Aug-06 |
| A2870 | Zone B - 100 Level | 20 | 20 | 100% | 20-Jul-06 | 16-Aug-06 |
| A1840 | Zone B - Club Level | 20 | 20 | 100% | 16-Aug-06 | 13-Sep-06 |
| A1870 | Zone A - Suite Level | 25 | 25 | 100% | 17-Aug-06 | 21-Sep-06 |
| A1880 | Zone B - Suite Level | 25 | 25 | 100% | 14-Sep-06 | 18-Oct-06 |
| A2690 | Zone A - Upper Deck | 30 | 30 | 100% | 22-Sep-06 | 02-Nov-06 |
| A2700 | Zone B - Upper Deck | 30 | 30 | 100% | 19-Oct-06 | 01-Dec-06 |
| A2880 | Zone C - 100 Level | 20 | 20 | 100% | 23-Oct-06 | 17-Nov-06 |
| A1860 | Zone C - Club Level | 20 | 20 | 100% | 20-Nov-06 | 19-Dec-06 |
| A1890 | Zone C - Suite Level | 25 | 25 | 100% | 20-Dec-06 | 25-Jan-07 |
| A1850 | Zone D - Club Level | 20 | 20 | 100% | 26-Jan-07 | 22-Feb-07 |
| A2710 | Zone C - Upper Deck | 30 | 30 | 100% | 26-Jan-07 | 08-Mar-07 |
| A1900 | Zone D - Suite Level | 25 | 25 | 100% | 23-Feb-07 | 29-Mar-07 |
| A2720 | Zone D - Upper Deck | 35 | 35 | 100% | 30-Mar-07 | 17-May-07 |
| A1110 | Topping Out | 0 | 0 | 100% | 17-May-07 A | |
| **Structural Precast** | | 209 | 209 | 0% | 25-Sep-06 | 18-Jul-07 |
| **MEP** | | 310 | 310 | 0% | 05-Feb-07 | 11-Apr-08 |
| **Building Envelope** | | 165 | 165 | 0% | 23-Jan-07 | 10-Sep-07 |
| **Ballpark Unique Features** | | 220 | 220 | 0% | 15-Jan-07 | 16-Nov-07 |
| **Interior Build Out** | | 185 | 185 | 0% | 02-Mar-07 | 15-Nov-07 |
| **Ballpark Completion** | | 42 | 23 | 0% | 17-Nov-07 A | 19-Dec-07 |




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



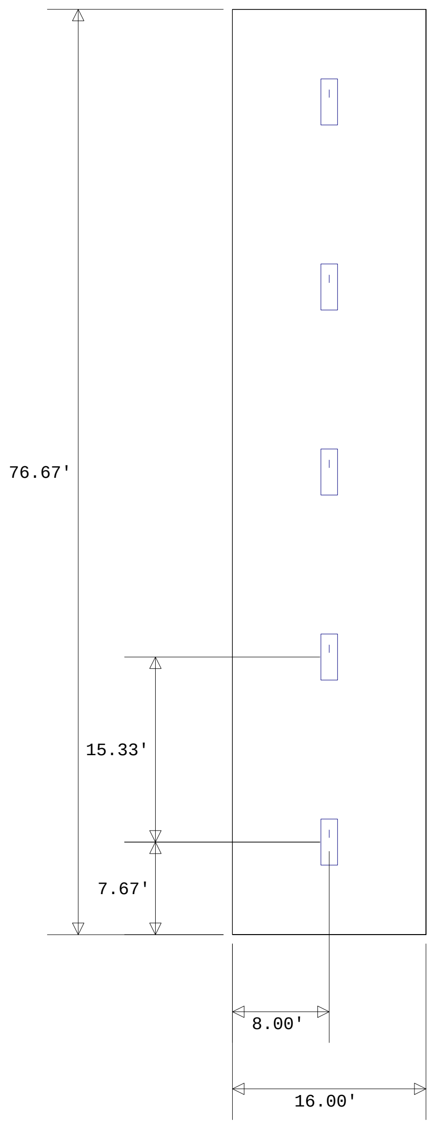
TASK filter: All Activities

## Appendix F – Lighting Design Sheets

## Results (Layout 1)

| | | | |
|---|---|---|---|
| Average Illuminance Obtained: | 44.39 fc(avg) | # of Rows: | 5 |
| Unit Power Density (UPD): | 0.96 W/sq. ft. | Row Spacing: | 15.33 |
| Spacing Criteria: | Exceeded | # of Cols: | 1 |
| | | Col. Spacing | 0.00 |

*5 luminaires provide 44.39 fc (avg). 0.96 W/sq. ft. meets target UPD of 1.2 W/sq. ft.*




## Room Characteristics

| | | | | | | |
|---|---|---|---|---|---|---|
| Dimensions: | X: 16.00 ft | Reflectances: | Ceiling: | 0.8 | Work Plane Height: | 2.50 ft |
| | Y: 76.67 ft | | Walls: | 0.5 | Target UPD: | 0.96 W/sq. ft. |
| | Z: 12.00 ft | | Floor: | 0.2 | Target Illuminance: | 0.00 fc(avg) |

## Luminaire Characteristics

Luminaire Description: T:\final\lighting\battingtunnels\mydesign\okHighBayT5_4L_IES_Report.IES

Suspension Length 0.00 ft CU: 0.68

Light Loss Factor: 0.80

Lamp Description

Lamps/Luminaire 4 Lamp Lumens: 5000 lms

Lamp Life: 0

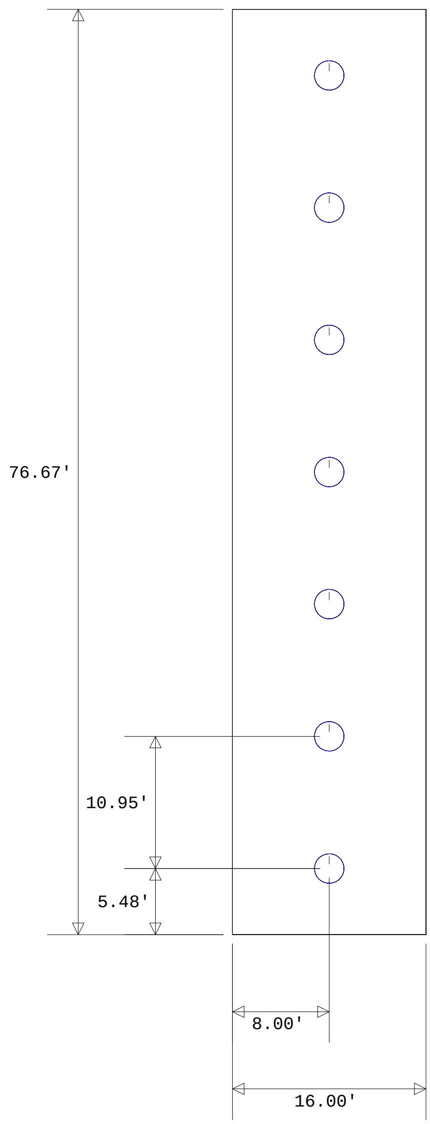
Ballast:

Ballast Factor: 1

## Results (Layout 1)

| | | | |
|---|---|---|---|
| Average Illuminance Obtained: | 94.83 fc(avg) | # of Rows: | 7 |
| Unit Power Density (UPD): | 2.61 W/sq. ft. | Row Spacing: | 10.95 |
| Spacing Criteria: | Acceptable | # of Cols: | 1 |
| | | Col. Spacing | 0.00 |

*7 luminaires provide 94.83 fc (avg). 2.61 W/sq. ft. exceeds target UPD of 1.2 W/sq. ft.*




## Room Characteristics

| | | | | | | |
|---|---|---|---|---|---|---|
| Dimensions: | X: 16.00 ft | Reflectances: | Ceiling: | 0.8 | Work Plane Height: | 2.50 ft |
| | Y: 76.67 ft | | Walls: | 0.5 | Target UPD: | 2.61 W/sq. ft. |
| | Z: 12.00 ft | | Floor: | 0.2 | Target Illuminance: | 100.00 fc(avg) |

## Luminaire Characteristics

Luminaire Description: TX 400M A30

Suspension Length 0.00 ft CU: 0.58

Light Loss Factor: 0.80

Lamp Description ONE 400-WATT CLEAR BT-37 METAL HALIDE VERTICAL BASE-UP POSITION.

Lamps/Luminaire 1 Lamp Lumens: 36000 lms

Lamp Life: 0

Ballast:

Ballast Factor: 1