




### PRESENTATION OUTLINE

- **Project Overview**
- Chilled Beams & Commissioning
  - Mechanical Breadth
- Parking Garage Waffle Slab
  - Structural Breadth
- Curtain Wall Installation
  - MAE Graduate Level Component
- Summary
- Questions and Acknowledgements

NATALIE BRYNER  
CONSTRUCTION MANAGEMENT OPTION
CONSTITUTION CENTER  
400 7TH STREET SE, WASHINGTON, DC 20004

### HISTORY

- Renovation of an existing building
- Originally constructed in 1976
- Formerly occupied by the Department of Transportation
- Operated and leased by David Nassif Associates




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### LOCATION

- Located a few blocks south of the National Mall and the United State Capital
- Between 6<sup>th</sup> and 7<sup>th</sup> Street and D and E Street in SW DC



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### PROJECT OVERVIEW

- **Size:** 1,500,000SF base building and 6,000SF parking garage
- **Number of Stories:** Three-level underground parking garage, 10 stories, plus a Pent House
- **Cost:** \$246 Million GMP
- **Construction Dates:** July 2007 – November 2009
- **Security Rating:** Level IV
- **LEED Rating:** Gold Project

### PROJECT TEAM

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graph TD
    Owner[Owner: David Nassif Associates]
    Arch[Architect/MEP Engineer: SmithGroup, Inc.]
    OwnersRep[Owners Representative: Kramer Consulting]
    GC[General Contractor: James G. Davis Construction Corp.]
    CivilEng[Civil Engineer: Wiles Mensch Corp.]
    StructEng[Structural Engineer: SK&A]
    Abat[Abatement Subcontractor: Accepco, Inc.]
    Sub[Subcontractors Not Listed]

    Owner --- Arch
    Owner --- OwnersRep
    Owner --- GC
    Arch --- CivilEng
    OwnersRep --- StructEng
    GC --- Abat
    GC --- Sub

    Arch -.->|Lump Sum| CivilEng
    OwnersRep -.->|Lump Sum| StructEng
    GC -.->|GMP| Abat
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### ARCHITECTURE OVERVIEW

- 4 separate, but integrated quadrants
  - Elevator
  - Stairways
  - Restrooms
  - Electrical and Communication Closets
- One acre courtyard that is a private, secure green space
  - Fountain, seating areas, sculpture, and 32 Honey Locust Shad Trees that are 11'-5" tall
- Built-up roofing system and metal panels used to conceal the MEP equipment on the Pent House level

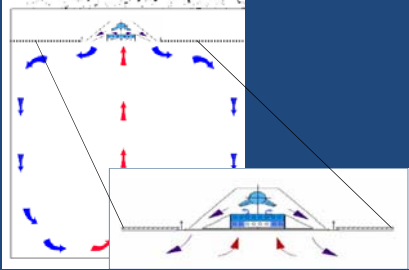
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### CHILLED BEAMS

- Finned chilled water heat exchanger utilizing cooling coils
- Active chilled beams
  - About 7,000 units



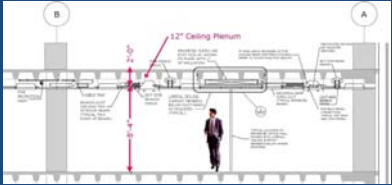
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### CHILLED BEAMS

- Limited ceiling plenum
- Goal:
  - 8'-4" ceiling height
  - Leaves 2'-0" to work with, including 1'-0" waffle slab
- TROX customized systems to only be 7.5" high and 2' wide by 8' long.



### PRESENTATION OUTLINE

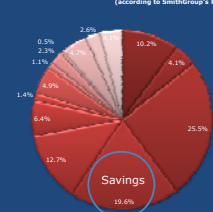
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### ENERGY USAGE

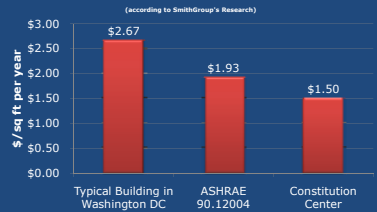
(according to SmithGroup's Research)



|                          |       |
|--------------------------|-------|
| Lighting - Conditioned   | 10.2% |
| Lighting - Unconditioned | 4.1%  |
| Space Heating            | 25.5% |
| Savings                  | 19.6% |
| Space Cooling            | 12.7% |
| Pumps                    | 6.4%  |
| Cooling Tower            | 1.4%  |
| Service Water Heating    | 0.5%  |
| Fans - Misc.             | 1.5%  |
| Fans - Parking Garage    | 2.3%  |
| Service Water Heating    | 0.5%  |
| Office Equipment         | 4.7%  |
| Elevator & Escalators    | 2.6%  |
| Misc. Equipment          | 4.1%  |
| Misc.                    | 1.5%  |
| Parking Garage           | 2.3%  |
| Service Water Heating    | 0.5%  |
| Cooling Tower            | 1.4%  |
| Fans - Misc.             | 1.5%  |
| Fans - AHU               | 4.5%  |
| Pumps                    | 6.4%  |

### ENERGY COST COMPARISON

(according to SmithGroup's Research)



| Building Type                         | Cost (\$/sq ft per year) |
|---------------------------------------|--------------------------|
| Typical Building in Washington DC     | \$2.67                   |
| ASHRAE 90.12004 Baseline              | \$1.93                   |
| Constitution Center (1,504,000 sq ft) | \$1.50                   |

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### MULTI-SERVICE BEAMS

- Services built into them for "just-in-time" arrival
  - Lighting fixtures and control circuits
    - Direct and/or indirect
  - Public address speakers
  - Occupancy sensors
  - Fire and smoke sensors and alarms
  - Passive infra-red detectors
  - Acoustic insulation
  - Sprinklers
  - Fresh air supply
  - Cooling and heating



|   |  |  |
|---|--|--|
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|---|--|--|

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| <h3>PRESENTATION OUTLINE</h3> <ul style="list-style-type: none"> <li>• Project Overview</li> <li>• Chilled Beams &amp; Commissioning             <ul style="list-style-type: none"> <li>– Mechanical Breadth</li> </ul> </li> <li>• Parking Garage Waffle Slab             <ul style="list-style-type: none"> <li>– Structural Breadth</li> </ul> </li> <li>• Curtain Wall Installation             <ul style="list-style-type: none"> <li>– MAE Graduate Level Component</li> </ul> </li> <li>• Summary</li> <li>• Questions and Acknowledgements</li> </ul> <p><small>NATALIE BRYNER<br/>CONSTRUCTION MANAGEMENT OPTION</small>      <small>CONSTITUTION CENTER<br/>400 7TH STREET SE, WASHINGTON, DC 20004</small></p> | <h3>COST COMPARISON</h3> <ul style="list-style-type: none"> <li>• Active Chilled Beams             <ul style="list-style-type: none"> <li>– \$150/LF to \$200/LF</li> </ul> </li> <li>• Multi-Service Chilled Beams             <ul style="list-style-type: none"> <li>– \$350/LF to \$500/LF</li> </ul> </li> </ul> | <h3>SCHEDULE COMPARISON</h3> <ul style="list-style-type: none"> <li>• Active Chilled Beams             <ul style="list-style-type: none"> <li>– About 20 minutes to install one unit</li> </ul> </li> <li>• Multi-Service Chilled Beams             <ul style="list-style-type: none"> <li>– About 25 minutes to install one unit</li> </ul> </li> </ul> |
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### COMMISSIONING

- LEED Gold rating
  - Energy & Atmosphere LEED points
- Four phases:
  - Phase 1 - Hot Water System
  - Phase 2 - CHW/CW & North AHU system
  - Phase 3 - SW AHU System, Fuel Oil System, Emergency Power System, and Power Monitoring System
  - Phase 4 - SE AHU System, FA System, BMS System, and conclude with Endurance Period

### COMMISSIONING

- ComIT
- Program used to track deficiency items, post information such as schedules, submittals, and start-up forms



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### COMMISSIONING

- Interview of several industry members:
  - “Identify the commissioning needs and program requirements early in the design stage so all team members can understand and set their strategies to meet the project goals”
  - “Make sure all parties know what is required for commissioning as soon in the project as possible (Communications is key)”

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|---|---|--|

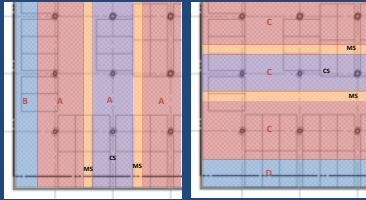


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## TWO-WAY REINFORCED CONCRETE SLABS



| Given Information           |       |                               |      |
|-----------------------------|-------|-------------------------------|------|
| $l_1$ (ft)                  | 30    | $w_{slab}$ (psf)              | 15   |
| $l_2$ (ft)                  | 30    | $w_{slab}$ (psf)              | 150  |
| $f_{slab}$ (in)             | 12    | $w_{slab}$ (psf)              | 50   |
| $y_c$ (pcf)                 | 150   | $w_{slab}$ (psf)              | 278  |
| $f_c$ (psi)                 | 4000  | $\Phi_{slab}$ (in)            | 1    |
|                             | 60000 | $A_{slab}$ (in <sup>2</sup> ) | 0.79 |
| Column Size (in) $l_c, l_s$ | 26    | $w_{slab}$ (psf)              | 15   |
|                             | 26    | $w_{slab}$ (psf)              | 150  |

| Frame | Total Width (ft) | CS (ft) | HS (ft) | Total Moment | CS (+M) | HS (-M) | Total Moment | CS (+M) | HS (-M) |
|-------|------------------|---------|---------|--------------|---------|---------|--------------|---------|---------|
| A     | 30               | 15      | 15      | -565.33      | -424.00 | -141.33 | 419.96       | 251.98  | 167.98  |
| B     | 15               | 7.5     | 7.5     | -104.99      | -104.99 | 0.00    | 209.98       | 125.99  | 83.99   |
| C     | 30               | 15      | 15      | -565.33      | -424.00 | -141.33 | 419.96       | 251.98  | 167.98  |
| D     | 15               | 7.5     | 7.5     | -104.99      | -104.99 | 0.00    | 209.98       | 125.99  | 83.99   |

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| Design Reinforcement for CS |     | Design Reinforcement for HS |    |
|-----------------------------|-----|-----------------------------|----|
| Frame A                     | #1  | Frame A                     | #8 |
| Frame B                     | #   | Frame B                     | #  |
| Frame C                     | #14 | Frame C                     | #  |
| Frame D                     | #   | Frame D                     | #  |

| For Frame B & D Design Reinforcement For CS (Will Use #8 Bars) |   |         |        |
|--|---|---------|--------|
| Item   | Description                                 | M       | M'     |
| 1  | $M_x$ (ft-Kip)                              | -104.99 | 125.99 |
| 2  | $b$ (in)                                    | 154.00  | 154.00 |
| 3  | $d$ (in)                                    | 9.50    | 9.50   |
| 4  | $M_u = M_x/0.9$ (ft-Kip)                    | -116.66 | 139.99 |
| 5  | $R = M_u/bd^2$                              | 100.72  | 120.87 |
| 6  | $\rho$ [Table A.5a]                         | 0.00    | 0.00   |
| 7  | $A_{st} = \rho bd$ (in <sup>2</sup> )       | 2.49    | 3.00   |
| 8  | $A_{s,prov} = 0.002bt$                      | 3.70    | 3.70   |
| 9  | $N = \#7$ or $\#8$ (Greater/ $A_{s,prov}$ ) | 3.70    | 3.70   |
| 10   | $N_{min} = width_{slab}/2t$                 | 3.75    | 3.75   |

| For Frame A Design Reinforcement For CS (Will Use #8 Bars) |   |         |        |
|--|---|---------|--------|
| Item   | Description                                 | M       | M'     |
| 1  | $M_x$ (ft-Kip)                              | -424.00 | 251.98 |
| 2  | $b$ (in)                                    | 154.00  | 154.00 |
| 3  | $d$ (in)                                    | 11.50   | 11.50  |
| 4  | $M_u = M_x/0.9$ (ft-Kip)                    | -471.11 | 279.57 |
| 5  | $R = M_u/bd^2$                              | 277.58  | 164.96 |
| 6  | $\rho$ [Table A.5a]                         | 0.00    | 0.00   |
| 7  | $A_{st} = \rho bd$ (in <sup>2</sup> )       | 8.43    | 4.96   |
| 8  | $A_{s,prov} = 0.002bt$                      | 3.70    | 3.70   |
| 9  | $N = \#7$ or $\#8$ (Greater/ $A_{s,prov}$ ) | 8.43    | 6.28   |
| 10   | $N_{min} = width_{slab}/2t$                 | 7.50    | 7.50   |

| For Frame C Design Reinforcement For CS (Will Use #8 Bars) |   |         |        |
|--|---|---------|--------|
| Item   | Description                                 | M       | M'     |
| 1  | $M_x$ (ft-Kip)                              | -424.00 | 251.98 |
| 2  | $b$ (in)                                    | 154.00  | 154.00 |
| 3  | $d$ (in)                                    | 9.50    | 9.50   |
| 4  | $M_u = M_x/0.9$ (ft-Kip)                    | -471.11 | 279.57 |
| 5  | $R = M_u/bd^2$                              | 406.76  | 241.73 |
| 6  | $\rho$ [Table A.5a]                         | 0.01    | 0.00   |
| 7  | $A_{st} = \rho bd$ (in <sup>2</sup> )       | 10.60   | 6.11   |
| 8  | $A_{s,prov} = 0.002bt$                      | 3.70    | 3.70   |
| 9  | $N = \#7$ or $\#8$ (Greater/ $A_{s,prov}$ ) | 13.42   | 7.73   |
| 10   | $N_{min} = width_{slab}/2t$                 | 7.50    | 7.50   |

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|   | Quantity | Unit | Extended Total        | Extended Total<br>@ 8 P |
|---|----------|------|-----------------------|-------------------------|
| Structural Concrete, Ready Mix, Normal Weight, 4,000psi | 22,500   | CY   | \$1,040,875           | \$3,356,500             |
| Reinforcing steel, in place, elevated slab, #8          | 74       | Ton  | \$107,418.4           | \$136,207.36            |
| Reinforcing steel, in place, Slab on Grade, #8          | 37       | Ton  | \$54,063.29           | \$70,008.44             |
| <b>Total</b>  |          |      | <b>\$3,202,356.69</b> | <b>\$3,562,765.80</b>   |

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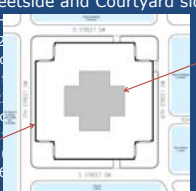
### CURRENT SCHEDULE

| Quadrant  | Time Frame                    |
|-----------|-------------------------------|
| Northeast | November 2007 – February 2008 |
| Southeast | February 2008 – May 2008      |
| Southwest | May 2008 – August 2008        |
| Northwest | August 2008 – November 2008   |

### TWO-WAY SLAB SCHEDULE

|  | Quantity | Unit | Daily Output | Total (Days) |
|--|----------|------|--------------|--------------|
| Structural Concrete, Ready Mix, Normal Weight, 4,000psi, elevated slab, pumped | 15,000   | CY   | 180          | 84           |
| Structural Concrete, Ready Mix, Normal Weight, 4,000psi, slab on grade, pumped | 7,500    | CY   | 185          | 41           |
| Reinforcing steel, in place, elevated slab, #8                                 | 74       | Ton  | 2.30         | 33           |
| Reinforcing steel, in place, Slab on Grade, #8                                 | 37       | Ton  | 2.90         | 13           |
| <b>Total</b>   |          |      |              | <b>171</b>   |

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|---|--|

|   |   |                            |                 |                           |                   |                 |                |                   |                 |                              |                    |   |
|---|---|----------------------------|-----------------|---------------------------|-------------------|-----------------|----------------|-------------------|-----------------|------------------------------|--------------------|---|
| <h3 style="text-align: center;">PRESENTATION OUTLINE</h3> <ul style="list-style-type: none"> <li>• Project Overview</li> <li>• Chilled Beams &amp; Commissioning             <ul style="list-style-type: none"> <li>– Mechanical Breadth</li> </ul> </li> <li>• Parking Garage Waffle Slab             <ul style="list-style-type: none"> <li>– Structural Breadth</li> </ul> </li> <li>• Curtain Wall Installation             <ul style="list-style-type: none"> <li>– MAE Graduate Level Component</li> </ul> </li> <li>• Summary</li> <li>• Questions and Acknowledgements</li> </ul> <p style="font-size: small; margin-top: 20px;">                 NATALIE BRYNER<br/>                 CONSTRUCTION MANAGEMENT OPTION<br/>                 CONSTITUTION CENTER<br/>                 400 7TH STREET SE, WASHINGTON, DC 20004             </p> | <h3 style="text-align: center;">OVERVIEW OF CURTAIN WALL</h3> <table style="width: 100%; font-size: x-small; border-collapse: collapse;"> <tr> <td>1. Precast Concrete Panels</td> <td>6. Vision Glass</td> </tr> <tr> <td>2. Metal Panels &amp; Louvers</td> <td>7. Spandrel Glass</td> </tr> <tr> <td>3. Vision Glass</td> <td>8. Metal Panel</td> </tr> <tr> <td>4. Spandrel Glass</td> <td>9. Vision Glass</td> </tr> <tr> <td>5. Vertical Aluminum Mullion</td> <td>10. Spandrel Glass</td> </tr> </table>  | 1. Precast Concrete Panels | 6. Vision Glass | 2. Metal Panels & Louvers | 7. Spandrel Glass | 3. Vision Glass | 8. Metal Panel | 4. Spandrel Glass | 9. Vision Glass | 5. Vertical Aluminum Mullion | 10. Spandrel Glass | <h3 style="text-align: center;">OVERVIEW OF CURTAIN WALL</h3> <ul style="list-style-type: none"> <li>• Nearly 5,000 curtain wall panels</li> <li>• Both Streetside and Courtyard sides</li> <li>• Storefront             <ul style="list-style-type: none"> <li>– 5' by 12'</li> <li>– 1,100 total</li> </ul> </li> <li>• Levels 2-4             <ul style="list-style-type: none"> <li>– 5' by 2'</li> <li>– 2,300 total</li> </ul> </li> <li>• Levels 8-9             <ul style="list-style-type: none"> <li>– 5' by 12'</li> <li>– 500 to 600 total</li> </ul> </li> </ul>  |
| 1. Precast Concrete Panels  | 6. Vision Glass   |                            |                 |                           |                   |                 |                |                   |                 |                              |                    |   |
| 2. Metal Panels & Louvers   | 7. Spandrel Glass   |                            |                 |                           |                   |                 |                |                   |                 |                              |                    |   |
| 3. Vision Glass   | 8. Metal Panel  |                            |                 |                           |                   |                 |                |                   |                 |                              |                    |   |
| 4. Spandrel Glass   | 9. Vision Glass   |                            |                 |                           |                   |                 |                |                   |                 |                              |                    |   |
| 5. Vertical Aluminum Mullion  | 10. Spandrel Glass  |                            |                 |                           |                   |                 |                |                   |                 |                              |                    |   |

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### EQUIPMENT USED

- Streetside Panels
  - Crane for Levels 2 to 8
- Courtyard Panels
  - Monorail system



### ESTIMATED CREW SIZES

| Location   | Level  | Crew Size | Equipment      |
|------------|--------|-----------|----------------|
| Streetside | 2 - 8  | 6         | Crane          |
| Streetside | 9 - 10 | 4         | Crane          |
| Courtyard  | 2 - 10 | 6*        | Monorail       |
| Storefront | 1      | 4 - 6     | Multiple Types |

\* 4 people used for the monorail installation, and two would follow behind for the sealants and/or boot

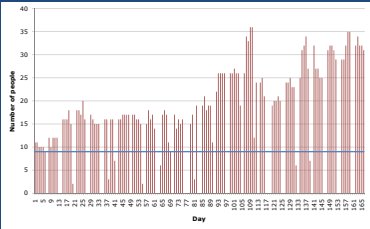
| Location   | Level  | Span | Deliveries | Crew Size |
|------------|--------|------|------------|-----------|
| Streetside | 2 - 8  | 2    | 12         | 4         |
| Courtyard  | 2 - 10 | 1    | 18-24      | 4         |

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### ACTUAL TOTAL CREW SIZE



### PRESENTATION OUTLINE

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### ESTIMATED INSTALLATION

- Streetside Panels
  - Between 20 to 30
- Courtyard Panels
  - Between 35 to 40

### ACTUAL INSTALLATION

Legend: Courtyard (blue), Streetside (red), Storefront (green), Estimated (black line)

### PRESENTATION OUTLINE

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### PRODUCTIVITY

Legend: Actual Daily Productivity (blue), Estimated Daily Productivity (red)

### PRESENTATION OUTLINE

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### ESTIMATED SCHEDULE

| Task                                       | Duration   | Start             | Finish            |
|--|------------|-------------------|-------------------|
| <b>Exterior Façade</b>                     | <b>366</b> | <b>10/1/2007</b>  | <b>12/21/2008</b> |
| North                                      | 328        | 10/1/2007         | 12/21/2008        |
| Fabrications for Slab Extensions           | 32         | 10/1/2007         | 11/13/2007        |
| Demol & Shoring 2nd Floor at Blast Beams   | 18         | 11/15/2007        | 11/18/2007        |
| Slab Extensions                            | 1          | 12/17/2007        | 12/17/2007        |
| Erect Parallel Columns at Blast Beams      | 1          | 12/1/2007         | 12/1/2007         |
| F.R.R.P Blast Beams                        | 1          | 1/18/2008         | 1/18/2008         |
| Fit Anchors & Plates for Curtain wall      | 1          | 1/21/2008         | 1/21/2008         |
| Install Anchors & Plates for Curtain wall  | 1          | 1/12/2008         | 1/12/2008         |
| Erect Curtain wall                         | 91         | 2/22/2008         | 6/22/2008         |
| Erect Metal Panels                         | 29         | 7/26/2008         | 8/29/2008         |
| Erect Exterior Stonefront                  | 17         | 11/12/2008        | 12/4/2008         |
| Erect Exterior Stone                       | 17         | 12/6/2008         | 12/31/2008        |
| East                                       | 311        | 10/1/2007         | 12/18/2008        |
| West                                       | 266        | 12/21/2008        | 12/21/2009        |
| South                                      | 272        | 2/8/2008          | 2/23/2009         |
| <b>Courtyard Façade</b>                    | <b>232</b> | <b>12/22/2008</b> | <b>4/29/2009</b>  |
| North                                      | 232        | 1/22/2008         | 12/10/2008        |
| Fit Anchors & Plates for Eyed Curtain wall | 28         | 1/22/2008         | 2/22/2008         |
| Install Anchors & Plates for Curtain wall  | 21         | 4/11/2008         | 5/9/2008          |
| Erect Structural Steel & Deck              | 16         | 5/12/2008         | 6/2/2008          |
| Erect Curtain wall                         | 26         | 8/26/2008         | 9/26/2008         |
| Erect Metal Panels                         | 1          | 10/13/2008        | 10/13/2008        |
| Erect Stonefront                           | 12         | 11/22/2008        | 12/10/2008        |
| East                                       | 207        | 2/8/2008          | 11/24/2008        |
| West                                       | 163        | 5/21/2008         | 12/24/2008        |
| South                                      | 247        | 5/26/2008         | 4/29/2009         |

### ACTUAL SCHEDULE

| Task                    | Start             | Finish     |
|-------------------------|-------------------|------------|
| <b>Exterior Façade</b>  | <b>8/29/2008</b>  |            |
| South                   | 8/29/2008         | 10/6/2008  |
| East                    | 4/14/2008         | 12/2/2008  |
| West                    | 8/12/2008         | 12/3/2008  |
| South                   | 1/28/2008         | 2/6/2009   |
| Stonefront North        | 12/2/2008         | 1/2/2009   |
| Stonefront East         | 1/5/2009          | 1/14/2009  |
| Stonefront West         | 2/9/2009          | 1/14/2009  |
| Stonefront South        | 1/14/2009         |            |
| <b>Courtyard Façade</b> | <b>12/22/2008</b> |            |
| North                   | 12/22/2008        | 1/3/2009   |
| East                    | 5/26/2008         | 8/29/2008  |
| West                    | 8/22/2008         | 11/2/2008  |
| South                   | 10/13/2008        | 12/12/2008 |
| Courtyard North         | 12/2/2008         | 3/13/2009  |
| Courtyard East          | 2/18/2009         | 2/23/2009  |
| Courtyard West          | 1/23/2009         | 2/18/2009  |
| Courtyard South         | 2/16/2009         |            |

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### FACTORS FOR DELAYS

- Weather
- Trade Coordination
- Deficient Frames

#### Daily High and Low Temperatures

#### Daily Wind Speed

### PRESENTATION OUTLINE

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### FACTORS FOR DELAYS

- Weather
- Trade Coordination
- Deficient Frames

#### Precipitation

|  |  |
|--|--|
| <h3>PRESENTATION OUTLINE</h3> <ul style="list-style-type: none"> <li>• Project Overview</li> <li>• Chilled Beams &amp; Commissioning             <ul style="list-style-type: none"> <li>– Mechanical Breadth</li> </ul> </li> <li>• Parking Garage Waffle Slab             <ul style="list-style-type: none"> <li>– Structural Breadth</li> </ul> </li> <li>• <b>Curtain Wall Installation</b> <ul style="list-style-type: none"> <li>– MAE Graduate Level Component</li> </ul> </li> <li>• Summary</li> <li>• Questions and Acknowledgements</li> </ul> <p><small>NATALIE BRYNER<br/>CONSTRUCTION MANAGEMENT OPTION</small></p> <p><small>CONSTITUTION CENTER<br/>400 7TH STREET SE, WASHINGTON, DC 20004</small></p> | <h3>OUTCOME</h3> <ul style="list-style-type: none"> <li>• Curtain wall productivity was slightly under the estimated productivity</li> </ul> |
|--|--|

|  |   |
|--|---|
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|--|---|


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## QUESTIONS



## ACKNOWLEDGEMENTS


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