PORT OF MIAMI TUNNEL PROJECT

Tulane Engineering Forum

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PROJECT GOALS

- Provide direct access between the Seaport, Airport I-395 and I-95
- Keep the Port of Miami—the community’s second largest economic generator—competitive
- Relieve congested downtown Miami streets of Port passenger and cargo traffic, improving safety
- Facilitate ongoing and future development plans in and around downtown Miami
- Provide additional access between the mainland and the Port

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MAIN OBJECTIVES FOR P3 IMPLEMENTATION

- Tunnel construction and operation atypical for FDOT
  - Need to share risks with contractors experienced in managing tunneling risks; private sector innovation
  - Encouraging lifecycle efficiencies requires long-term contract

- Short-term local funding, long-term work program funds

- Concern for cost overruns
  - Need long-term guaranteed cost structure
  - Limited interest expressed for fixed-price arrangements

- Considered DB, DBOM and DBFOM project delivery
FUNDING THE POMT

- **Cash Flow:**
  - $100 million during construction
  - $350 million upon POMT completion
  - Remaining in annual "availability payments"
    - Covers both remaining capital and annual operations and maintenance costs
    - Maximum Availability Payment (MAP) was $32.5 million at financial close on October 15, 2009
  - Amount will be adjusted based on annual inflation

- Total Design/Construction cost $668 million
- Total Maximum Availability payment $1.4 billion over 35 years
P3 PROJECT PARTNERS

Public Sponsors

- Miami-Dade County
- Department of Transportation, Florida
- City of Miami, Florida

90% Equity Partner

- Meridiam
- Bouygues

10% Equity Partner

- Bouygues Civil Works
- Transfield Services

Contractor

Federal Support

- TIFIA
- U.S. Department of Transportation

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SCOPE OF WORK

16,000 vehicles (nearly 7,000 trucks & buses) travel to and from the port daily. By 2030, estimated truck traffic will nearly double.

- Shifting of EB MacArthur Cswy
- MacArthur Cswy Bridge Widening
- Twin tunnels under Government Cut
- Modification of Dodge Island Roadway System
TUNNEL BORES: THE TASK

- 2 bored tunnels each 4,200 ft. long
- Tunnel bore 42 ft. with 38 ft. ID
- 8 piece rings using 5.6 ft wide by 24 in. thick segments
- 5% maximum grade and a tight horizontal curve $R_{min} = 1,000$ ft.
- Low ground cover: from ABOVE grade to 0.5 to 1.5 Tunnel Diameters
- Tunnel Separation: 1/3 to 1 ⅓ Tunnel Dia. (edge to edge)
TUNNELING PROFILE SECTION & CROSS PASSAGES

- Tunnels are approximately 4200 ft. long
- +40 ft. under the bottom of Government Cut & approximately 120 ft. below the surface at deepest point
- 5% Grade
- 5 cross passages

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CHALLENGING GEOLOGIC CONDITIONS

Owner’s Site Investigation - 87 explorations
Contractor’s Complementary Site Investigation - 152 explorations

Approximately one exploration for every 35 LF of tunnel
FORMATION GROUTING IN THE KEY LARGO FORMATION

- Formation Grouting along the tunnel alignment during 2012
- Grouting ran 24 hrs during non-cruise days (3 or 4 days per week)
- A total of ~64,000 cy of grout was placed, ~27% of the formation volume.
- Grouting for unplanned interventions, muck conditioning, and tail void grout confinement.

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FORMATION GROUTING DESIGN

- Watson Island
- Government Cut Shipping Channel
  3 Days per week round the clock working hours

- Grouting campaign:
  - 1,050 holes (~30,000m of drilling)
  - ~64,000 cy of grout injection

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TUNNELING MODES

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<thead>
<tr>
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<th>EPB</th>
<th>WCP</th>
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<tbody>
<tr>
<td>WESTBOUND</td>
<td>62%</td>
<td>38%</td>
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<tr>
<td>EASTBOUND</td>
<td>60%</td>
<td>20%</td>
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<tr>
<td>TOTAL (EB &amp; WB)</td>
<td>71%</td>
<td>29%</td>
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TUNNEL BORING MACHINE (TBM)

- TBM cutter head with an outside diameter of **42.3 feet** (as high as a 4 story building)
- **361 foot** long trailing support gear made up of 6 gantries
- Total length of the TBM is **428.5 feet** long (more than a football field).

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CONCRETE SEGMENT PRODUCTION

12,400+ concrete segments
9,000-12,000 psi
Design based on Rapid Chloride Migration

Thickness: 2 Feet
Width: 5 Feet - 7 Inches
Length: 14 Feet - 6 Inches
Weight: 13 Tons
150-Year Durability Requirement!

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WATSON ISLAND LAUNCH SHAFT - DEWATERING
Launch shaft was raised for the roadway grades (max depth 40 ft.) resulting in the TBM being 12 ft. above the existing ground. CTB placed to cover the TBM.

- Design Strength 750 psi
- Wall support Geogrid and vertical fiber nails

Overburden – cement treated base with geotextile to provide 3m minimum cover to TBM

12 ft. dia. CSM Shafts and CSM walls 750 psi
EASTBOUND TUNNEL INTERIOR

Rings Installed: 745 Rings
Length of Bored Tunnel: 4,186 LF
TBM BREAKOUT #1: JULY 31, 2012
To avoid the logistical issues (dismantling and transportation) the TBM was turned around and re-launched within the Dodge Island Shaft using a specially designed turntable (complicated by the 5% incline of the TBM at breakout)

The actual sliding and turning of the shield took 9 days.
TBM TURNAROUND

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WESTBOUND TUBE MINING BEGAN 10/29/12
HARRIET COMPLETES MINING
Cross Passage - CSM Treatment
Cross Passage - Formation Grouting & Ground Freezing Treatment
Intervention Plug – CSM Treatment

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FIVE (5) CROSS PASSAGES

- Required to provide emergency egress between tunnels. Spaced every 656ft
- Constructed after the two bored tunnels are completed.

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Five cross passages, or emergency exits, are being built between the two tunnels.

Cross passages are spaced at 656 feet.

Cross passages 1, 4 and 5 are not underneath the channel and were pretreated from ground surface using cutter-soil mixing panels that form a grouted block of soil and were excavated.

Cross passages 2 and 3, which go underneath Biscayne Bay, were treated with a brine to freeze the ground and excavated.
GROUND FREEZING – CROSS PASSAGES DESIGN

Ice ring development – schematic ~ 1 week to ~6 weeks

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TUNNEL ROADWAY DEVELOPMENT

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DODGE ISLAND PORTAL CONSTRUCTION
Portals and approaches 6,500 psi Architectural Exposed Concrete