Project Overview

Phase 1

- Project Owner: Metropolitan Washington Airports Authority (MWAA)
- Dulles Transit Partners
  - A team of Bechtel and URS
  - Design-Build (D-B) Contractor
- Eventually will be turned over to WMATA
Project Overview

Phase 1 Scope of Work

- 11.7 miles - West Falls Church to Wiehle Avenue
- 5 stations, 2 vent buildings
- 5 bridges and 3 aerial viaduct structures, 3.2 miles in length
- 8+ miles of retaining walls
- Extensive Utility Works
- Systems tie-ins at existing Orange Line & operations facilities
Final Tunnel Alignment - Adjacent Structures

- Courtyard by Marriott
- Tunnel Alignment
- Route 123 Overpass
- Route 123
- International Drive
Alignment Features
Alignment Features – Tysons 123 East
Cap of Ancient Coastal Plain Sediments
- Bands of clay with silty sands, gravels, and cobbles
- Residual soils and soil-like decomposed rock
  - Fine sandy silts, clays, and silty fine sands
- Decomposed Rock
  - Soil-like with higher strength
- Groundwater
  - Invert level at portal locations
  - Tunnel spring line at mid-point of tunnel alignment
Site Conditions

- Unconsolidated Ancient Coastal Plain Sediments
- Piedmont Residual Soil
  - Fine sandy silts, clays, and silty fine sands
  - Relict Joint Structures
  - Quartz Veins
Risks Identified for Tysons Corner Tunnels
- Shallow cover to major road infrastructure
- High concentration of utilities
- Close Proximity to Marriott Hotel underground parking garage and Route 123 Overpass bridge piers
- Excessive ground surface settlement
- Tunnel wall and crown instability due to unforeseen ground conditions
- Influence of groundwater on face stability

Risk Management by Detailed Design
- Design Details / Prescriptive
- Specifications
- Skill Set – Experienced Execution
Excavation and Support

- Use of Steel grouted pipe arch canopy pre-support due to soft ground and shallow overburden
  - Gradual increase in tunnel size to allow for subsequent pipe drilling resulted in a saw tooth effect
- Excavation: Typical Conventional method sequence with two 3 foot top heading rounds, followed by a single 6 foot bench/invert round
Pipe arch canopies selected to:
- Assist with face stability
- Minimize ground deformations due to tunnel excavation
- Mitigate Risk

Pre-Support consisted of:
- 114 mm diameter, 18 meter long grouted pipes
- Radial spacing of 300 mm
- Create an arching effect around the tunnel opening
- Grouted to fill annular void
- Prepared Initially for Double Packer use

Two types of canopy systems used:
- Double Row (57 pipes): First 100 m from East Portal
- Single Row (27 pipes): Remaining length of tunnels
Very Shallow Tunnel vs. Utilities & Roadway

- Shortening of IB saw tooth length due to very shallow overburden at International Drive and high density of utilities
  - Six saw teeth reduced from 13 m to 7 m
  - One saw tooth reduced from 13 m to 11 m
- Utilities abandoned prior to excavation including gas lines, communication ducts, and electrical lines
- Majority of utilities remained active during excavation
Tunnel Design Considerations

- WMATA Design Standards and Specifications
- Meet NFPA 130 2003 Ed. Requirements
- Waterproofing and Compartmentalization
- Stripping Strength Adjustments vs. Standard WMATA Specifications
Final Concrete Lining Stripping Strength

- WMATA requires concrete achieve 35% of specified design strength (4000 psi) prior to stripping formwork
- DTP proposed stripping at 500 psi and then 750 psi
  - Based on case histories and standards for Austria, Germany, and Japan
- WMATA/DTP Compromise
  - Strip arch formwork after reaching strength of 900 psi after minimum of 12 hrs
Final Concrete Lining Stripping Strength

- For $f'_c = 750$ psi, $E = 1360$ ksi [9.37 GPa]
- For $f'_c = 1400$ psi, $E = 1840$ ksi [12.68 GPa]

- Elastic modulus data calculated using a power regression of field data provided by Froehling & Robertson, Inc.

- Maximum displacement for 750 psi concrete lining is 0.17 mm.

- Maximum displacement for 1400 psi concrete lining is 0.13 mm

- Each gridline spacing equals 0.5 mm of deflection.

Red: Deflected Nodes, ($f'_c = 1400$ psi, Scale = 1000)
Green: Deflected Nodes, ($f'_c = 750$ psi, Scale = 1000)
Excavation Phase
Pipe Arch Canopy Installation for Pre-support
Instrumentation and Monitoring

- Intensified Monitoring Zone (IMZ)
- Request of Virginia Department of Transportation (VDOT): “MANDATORY”
- “Real Time” Monitoring
As-built Surface Settlements

- No surface settlements surpassed maximum threshold values
  - Maximum value realized 1 ¼” vs. 1 ½” allowed
- Maximum observed slope of 1/300
- All settlement data jointly evaluated by construction, engineering, and owner’s representatives at daily RESS meeting
Smoothing Layer
Arch Waterproofing and Reinforcement
Acknowledgements

MWAA (Client)
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