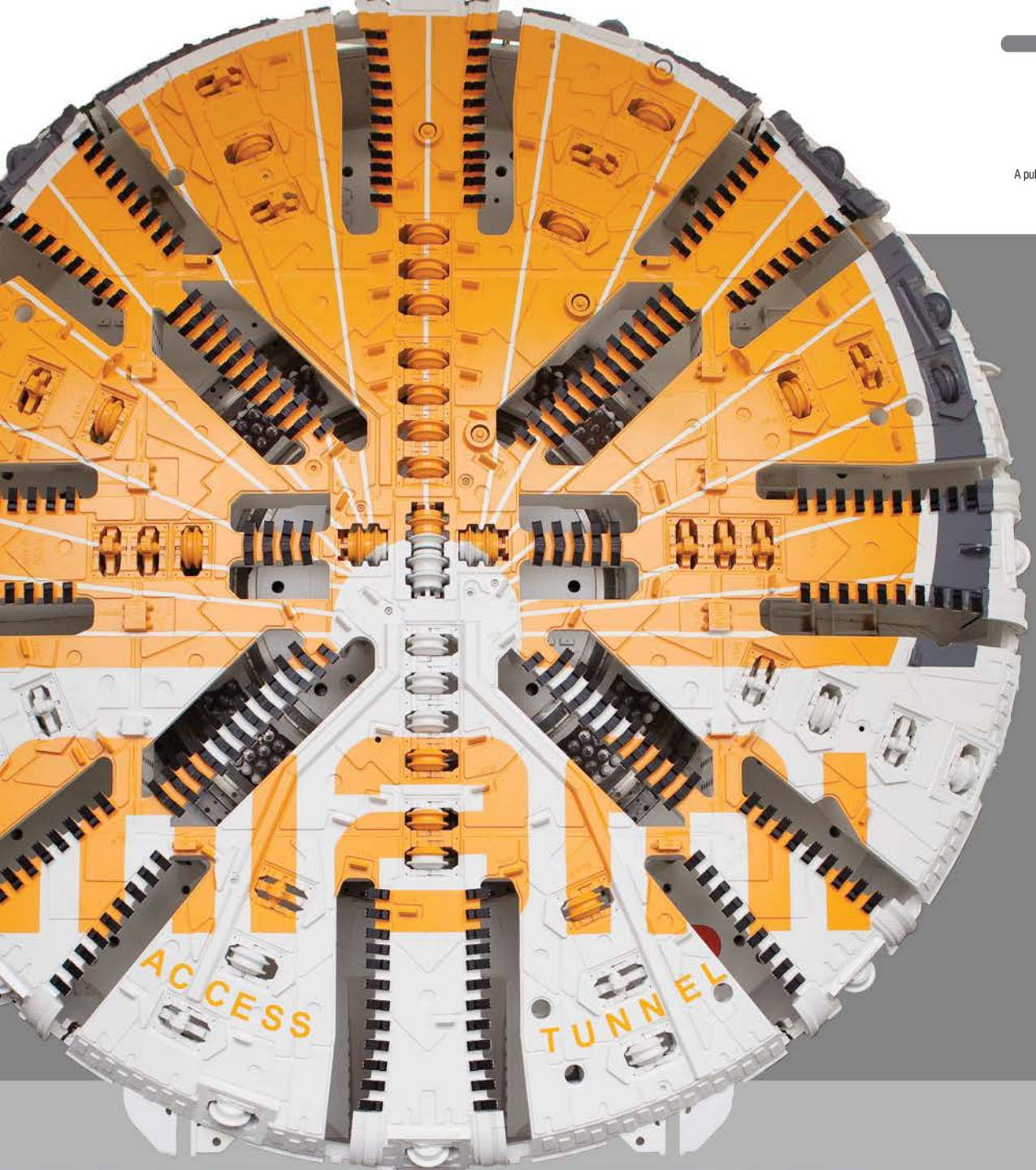


PORTMIAMI Tunnel

A public-private partnership project by FDOT MIAMI-DADE COUNTY

PORT OF MIAMI TUNNEL PROJECT

National Concrete Consortium

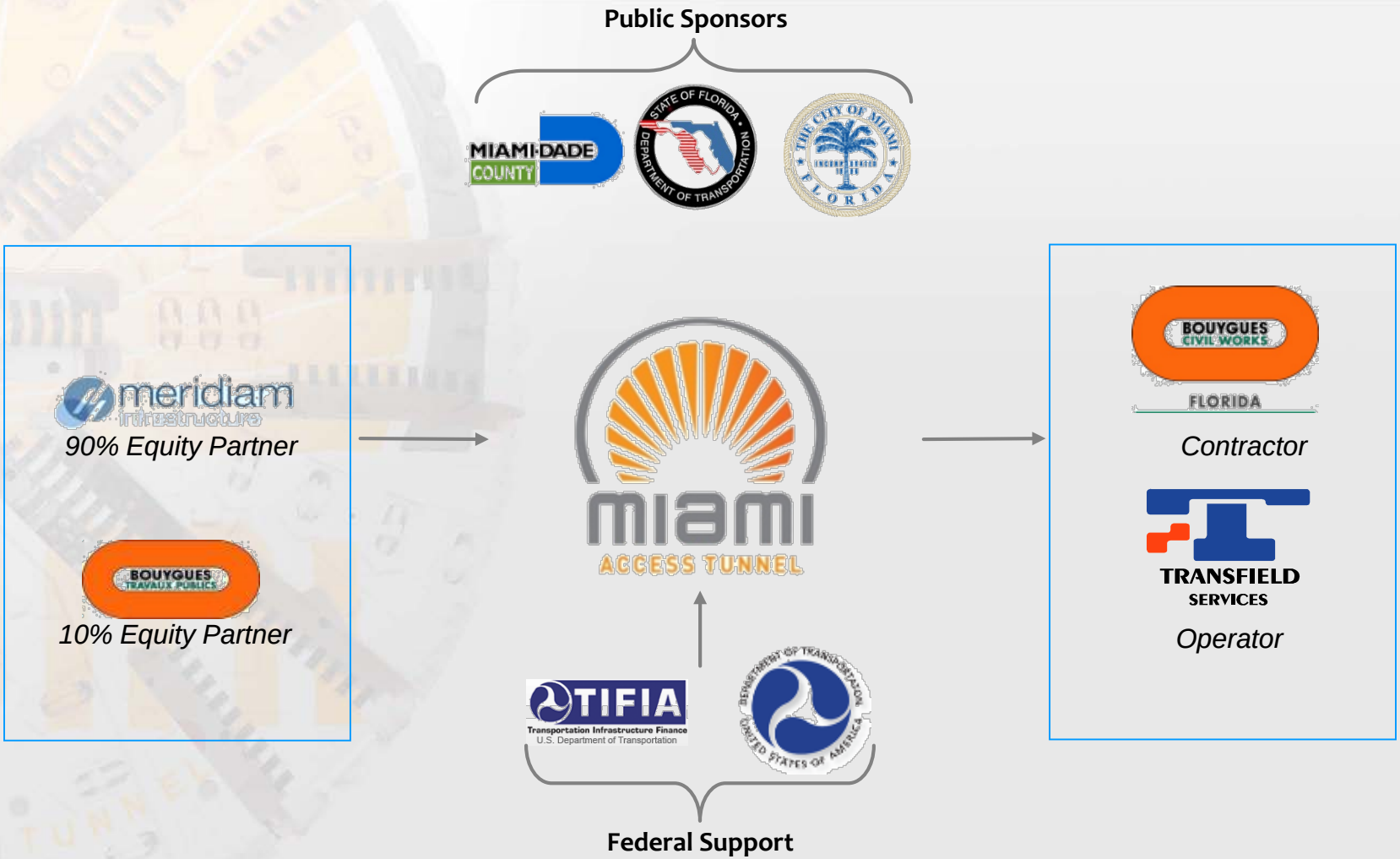
April 24, 2014

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.

P3 PROJECT PARTNERS

Overall Project Cost $1.2B
Design & Construction Cost $668M



PROJECT SCHEDULE

2003 – FDOT Site Investigations Begin

2006 – Conceptual Design is Completed

2007- Contract is Advertised

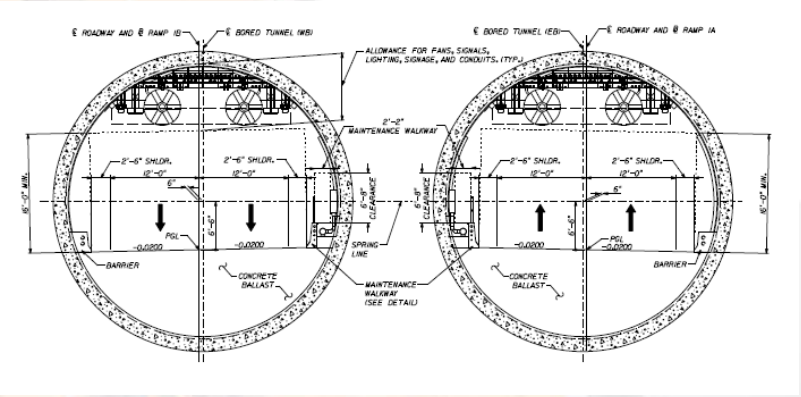
2009 – Contract is Awarded to Miami Access Tunnel LLC.

May 10, 2010 – Final Design and Construction Begins

May 19, 2014 – Planned Substantial Completion - Port of Miami Tunnel opens to traffic, O&M Period begins

A TRUE ENGINEERING FEAT

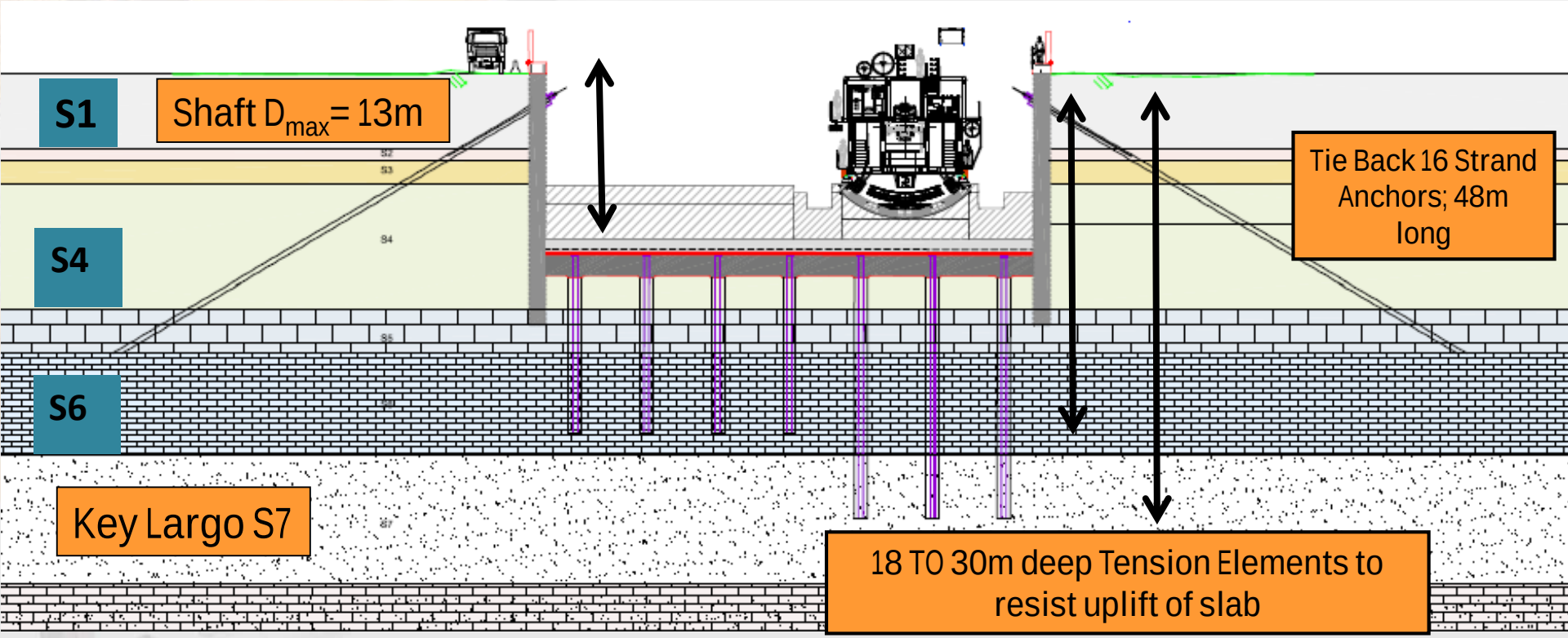
TUNNEL BORES: THE TASK



- **2 bored tunnels each 4,200 ft. long**
- **Tunnel bore 42 ft. with 37ft. ID**
- **8 piece rings using 5.6ft wide by 24 in. thick segments**
- **5% maximum grade and a tight horizontal curve Rmin= 1,000 ft.**
- **Low ground cover : from ABOVE grade to 0.5 to 1.5 Tunnel Diameters**
- **Tunnel Separation: 1/3 to 1 ¼ Tunnel Dia. (edge to edge)**

WATSON ISLAND LAUNCH SHAFT

- Cutter Soil (cement) Mix Walls with Steel Soldier piles and tiebacks and an unreinforced tremie concrete bottom with tie-downs;

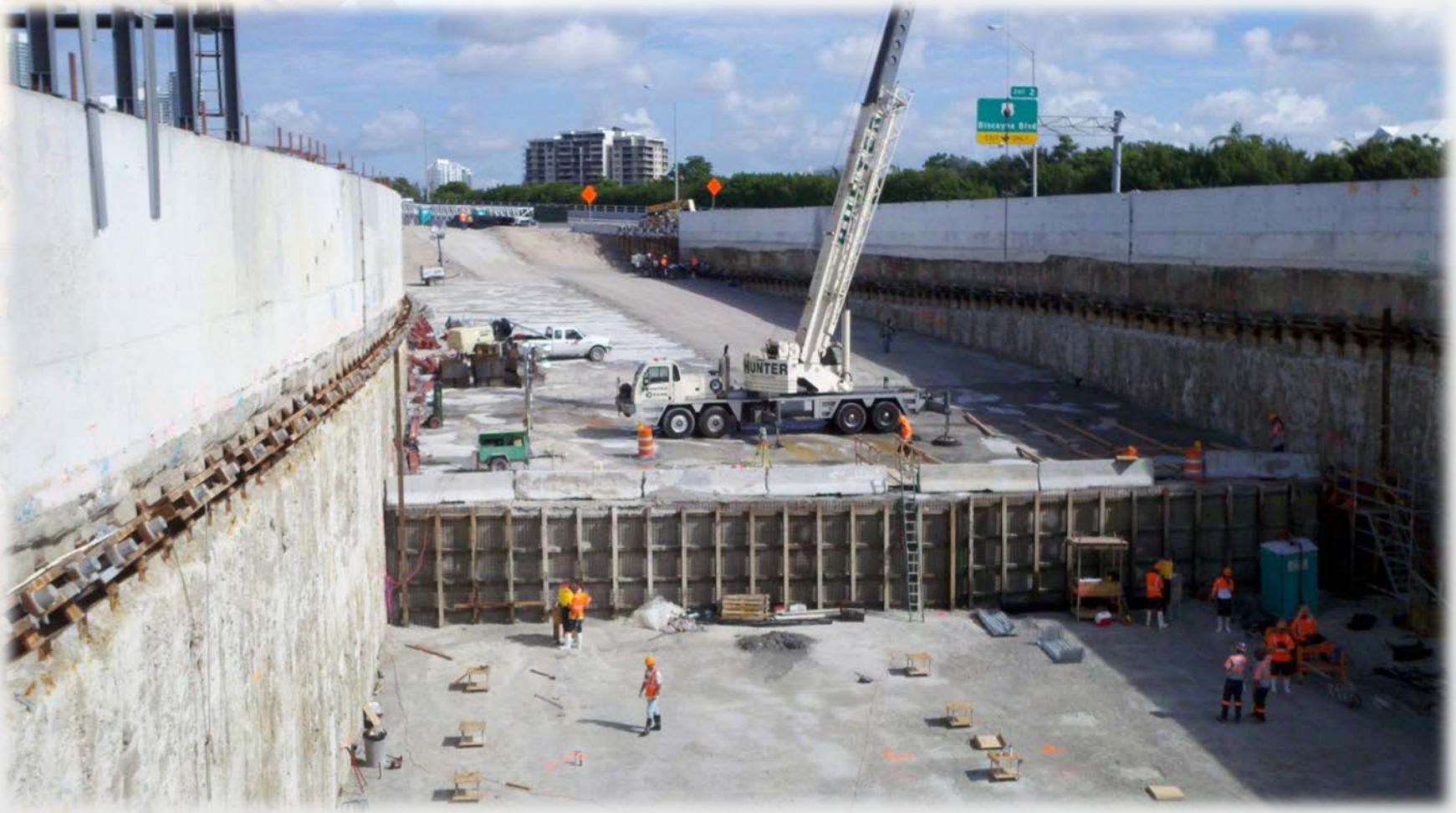


EXCAVATION OF LAUNCH SHAFT

Tremie Concrete Pour

3200 CY concrete placement – Up to 9 feet thick
3500 psi mix design

WATSON ISLAND LAUNCH SHAFT - DEWATERING



CONCRETE QUANTITIES

- 176,400 Cubic Yards of Concrete

- ~53,000 Short Tons of Cement
- ~18,000 Short Tons of Reinforcing Steel

- Approximately 350,000 Tons of aggregate

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!

150 Yr. Concrete Design.

- Concrete was designed using the DuraCrete Model and optimized by the and DARTS (Durable and Reliable Tunnel Structures) Reliability based Model (chloride and carbonation penetration model) and evaluated against compared to Life 365 and other Empirical models.
- Initial Target $2.8x10^{-12}m^2/s$ @ 56 days for a 93% probability of initiation of corrosion at 150 yrs.
- Mix Design 306 lb. Type II, 409 lb. Slag, and 79 lb Class F Flyash, 0.32 w/c ratio.

150 Yr. Concrete Design.

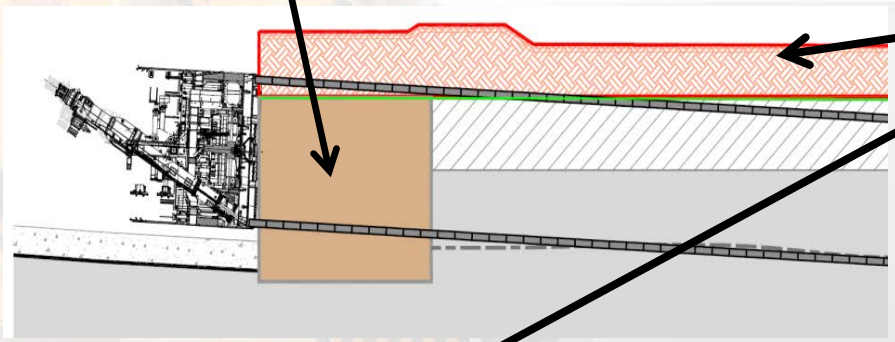
- The Contractor initially requested an 18 hour cure time v. the mandated 72 hours.
- However the testing and modeling indicated a significant sensitivity to initial curing.
- Decreasing curing time from 72 hours to 18 hours increased the 150 yr. predicted carbonation penetration from 24 mm to 36 mm (total cover is 76.2 mm (3”))

150 Yr. Concrete Design.

- Experimental and Production RCM tests confirmed the predicted results. Average ~600 coulombs passed v. 400 coulombs (18 hr. v. 72 hr. cure). Chloride Pen. 5.9 mm v. 1.4 mm
- Air permeability tests measured 0.06 v. 0.013 ($10^{-16}m^2$)
- Production controlled with RCM testing and monitored with Surface Resistivity for changes Actual RCM results $2.5x10^{-12}m^2/s$ @ 28 days

OVERBURDEN

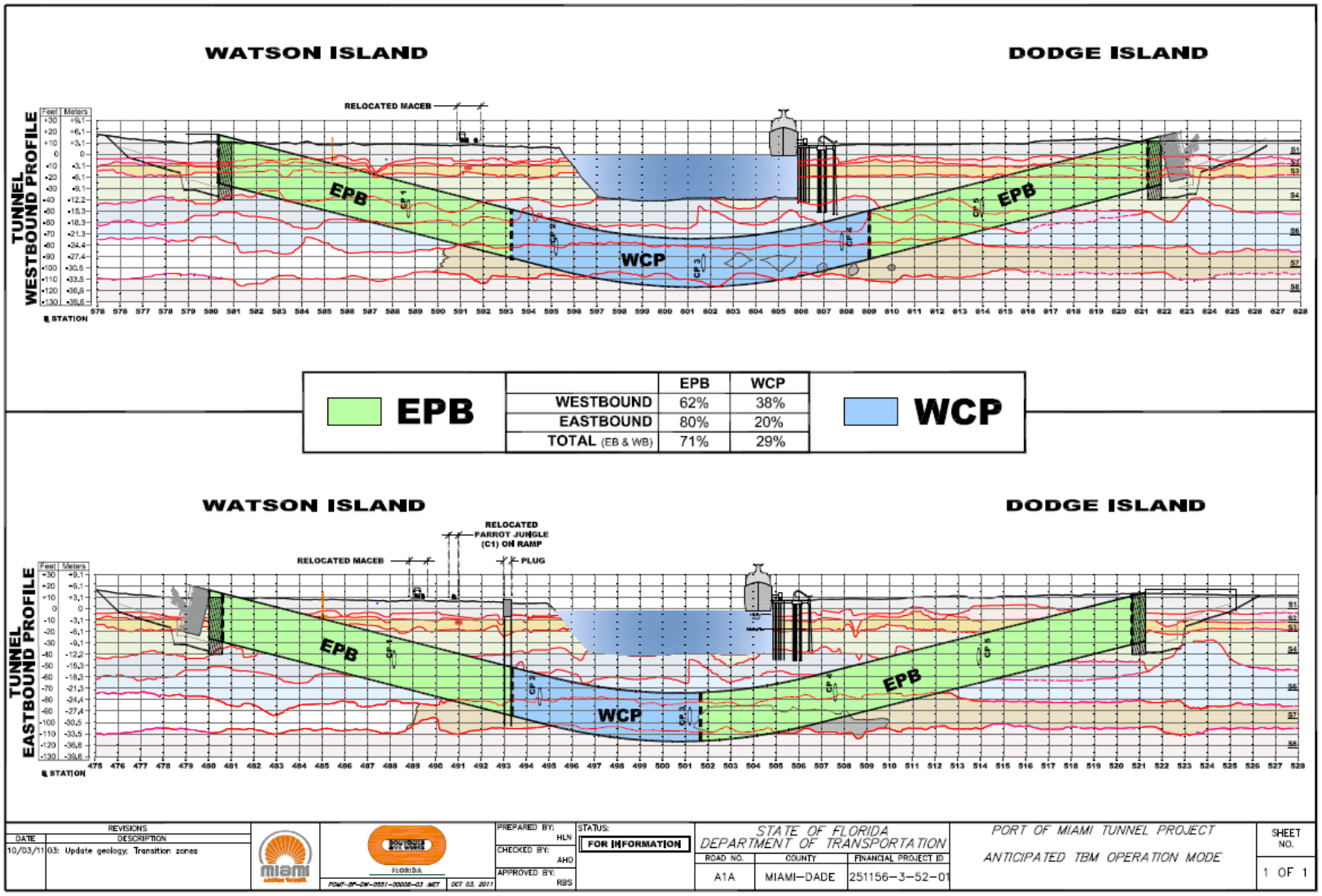
12 ft. dia. CSM Shafts and CSM walls 750 psi



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

- ✓ **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**

TUNNELING MODES



	EPB	WCP
WESTBOUND	62%	38%
EASTBOUND	80%	20%
TOTAL (EB & WB)	71%	29%

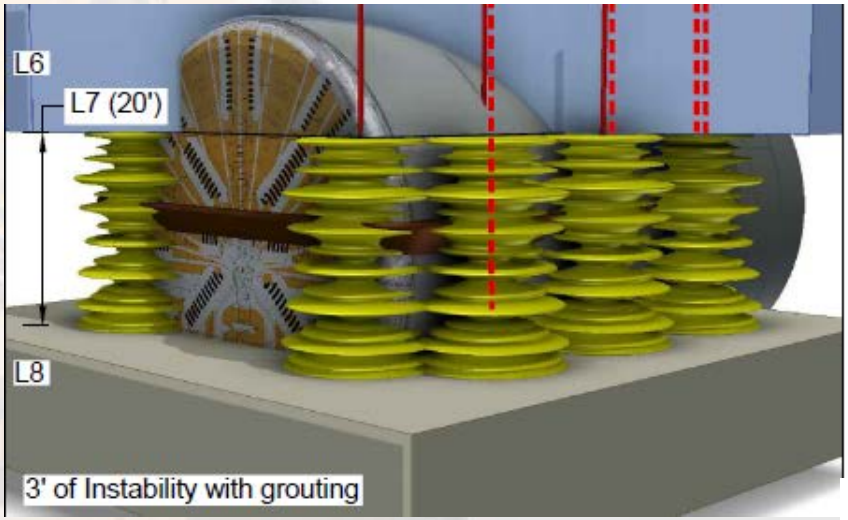
GROUT TESTING PROGRAM: MIX DESIGN

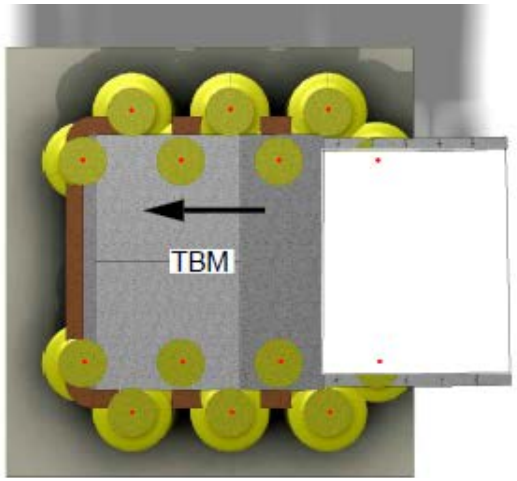
- **A pumpable, stable mix with low strength, high penetrability but high thixotropy, and excellent filtrate resistance (very difficult combination to achieve)**

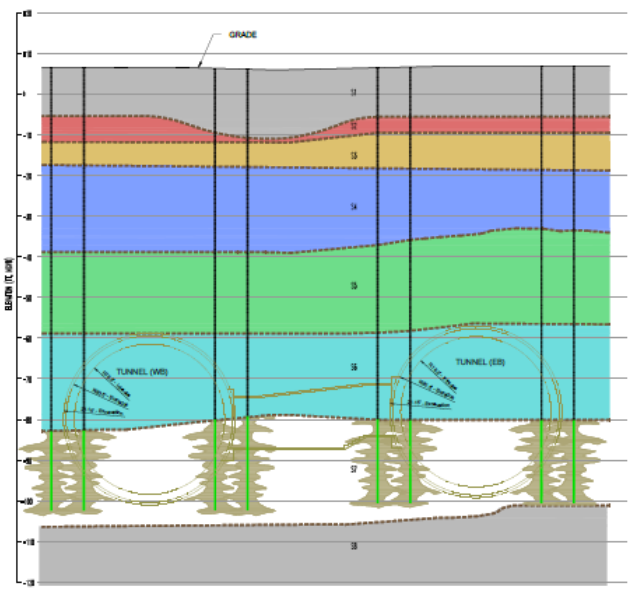
- **A most unusual mix design which satisfies all criteria and has clearly performed well.**

i.	Bentonite	77.9 kg
ii.	Cemex "Lake Fill"	1295.0 kg
iii.	Water*	449.4 kg
iv.	Cement	145.4 kg
v.	Filtrate reducer	8.4 kg

FORMATION GROUTING – SCHEMATIC OF TREATMENT





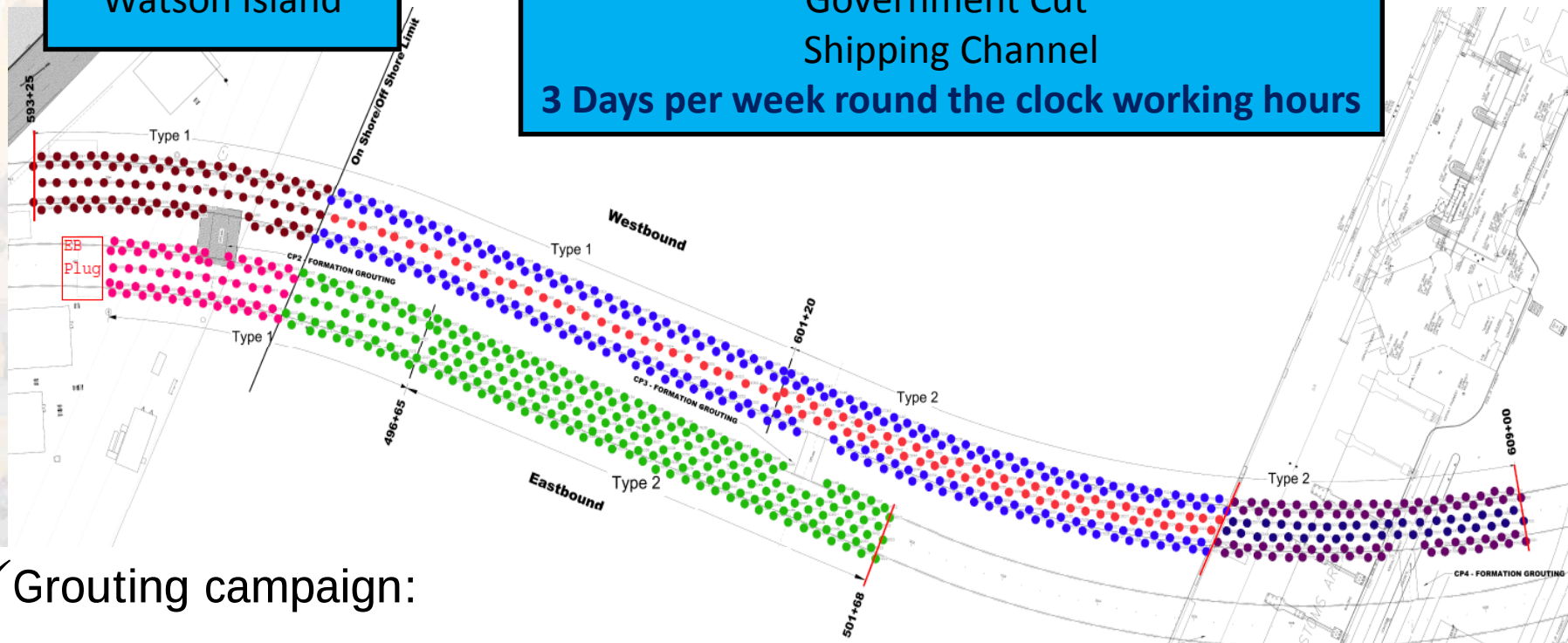


- **Formation Grouting Treatment for the Key Largo Layer 64,000 CY**
- **TBM Liner Back Grouting - cement/flyash/bentonite grout ~29,000 CY**

FORMATION GROUTING DESIGN

Watson Island

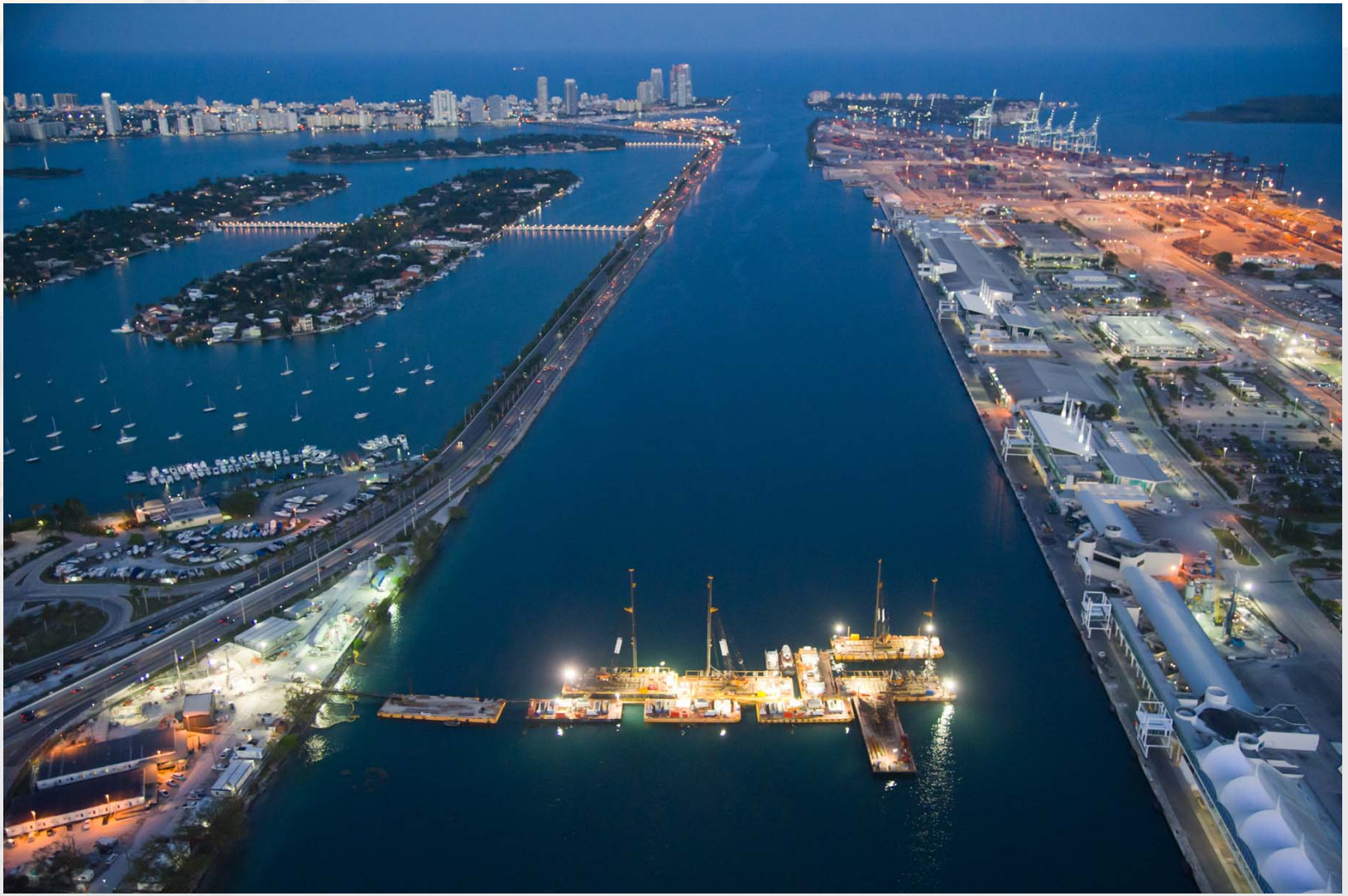
Government Cut
Shipping Channel
3 Days per week round the clock working hours



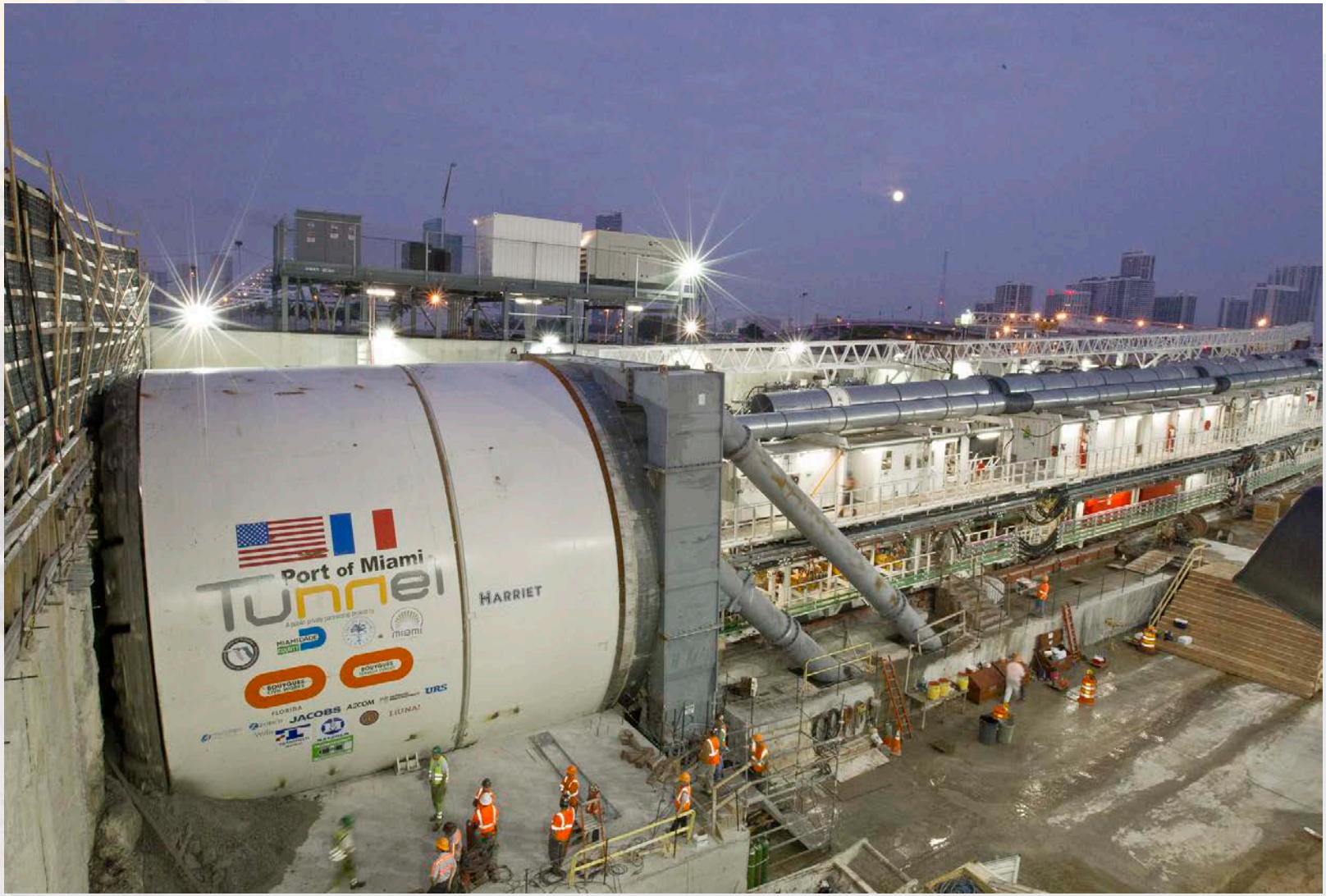
- ✓Grouting campaign:
  - ✓1,050 holes (~30,000m of drilling)
  - ✓~64,000 cy of grout injection

Dodge Island

FORMATION GROUTING



TBM BREAK-IN: NOVEMBER 11, 2011

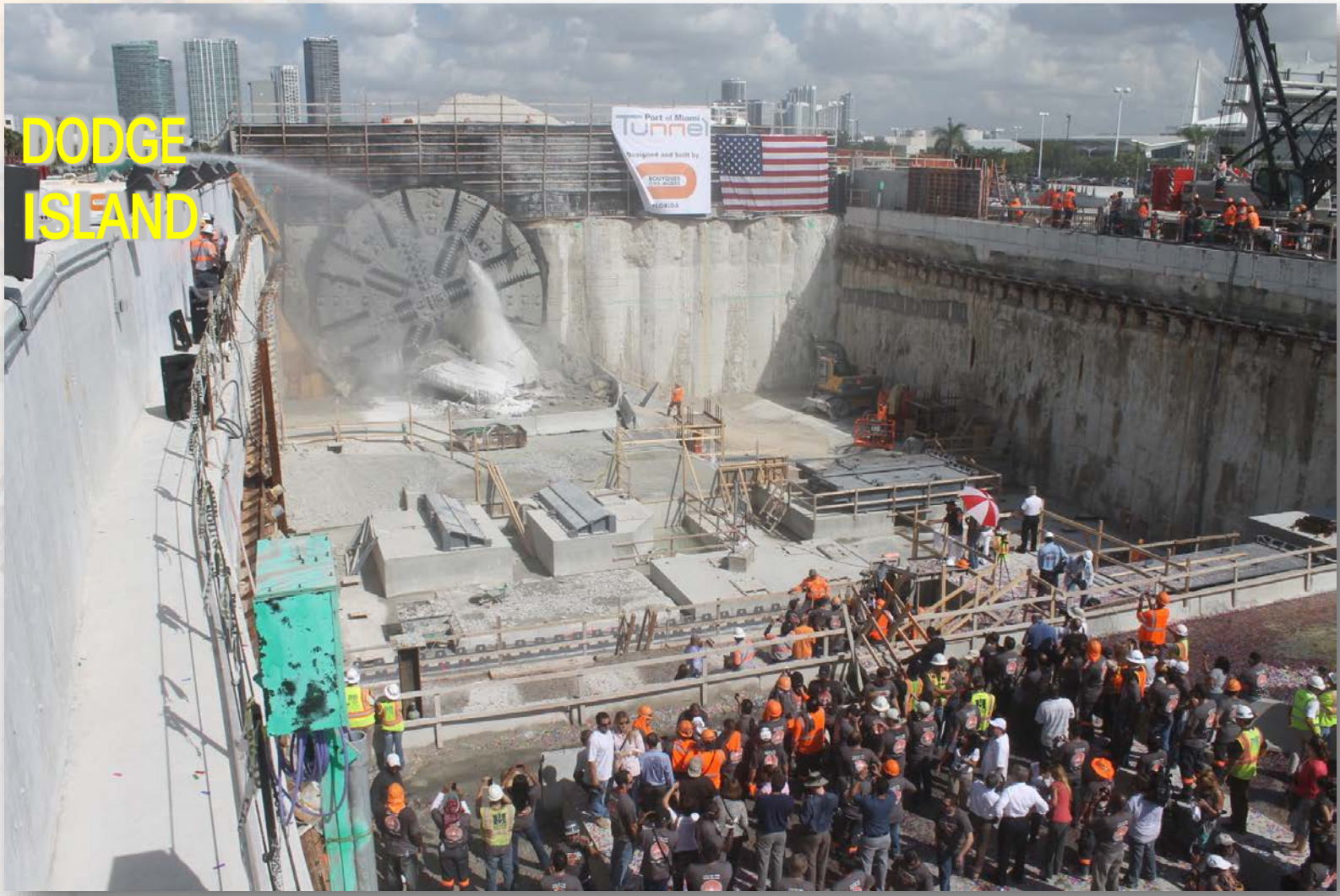



Port of Miami
Tunnel
A public-private partnership project by
THE CITY OF MIAMI FLORIDA
miami
ACCESS TUNNEL
MIAMI-DADE
COUNTY
BOUYGUES
TRAVAUX PUBLICS
BOUYGUES
CIVIL WORKS
FLORIDA
AECOM
PB PARSONS BRINCKERHOFF
URS
meridiam
infrastructure
ZURICH
JACOBS
Willis
LiUNA!


Port of Miami
Tunnel
HARRIET
JACOBS
AECOM
URS

WATSON ISLAND

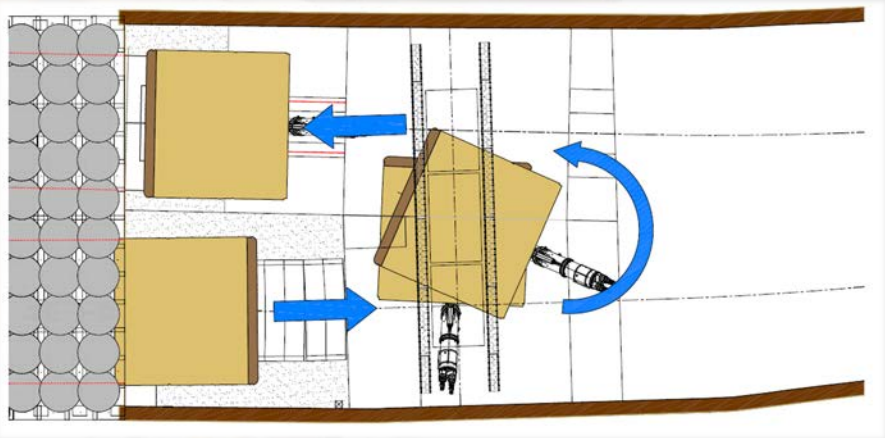
TBM BREAKOUT #1: JULY 31, 2012

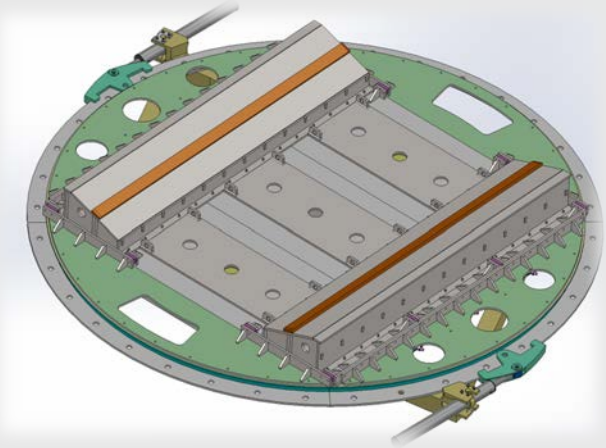


MINING COMPLETED ON EASTBOUND TUNNEL

TBM TURNAROUND TABLE

- **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 – TURNING 1,500 TONS

TBM TURNAROUND

TBM TURNAROUND

TBM TURNAROUND

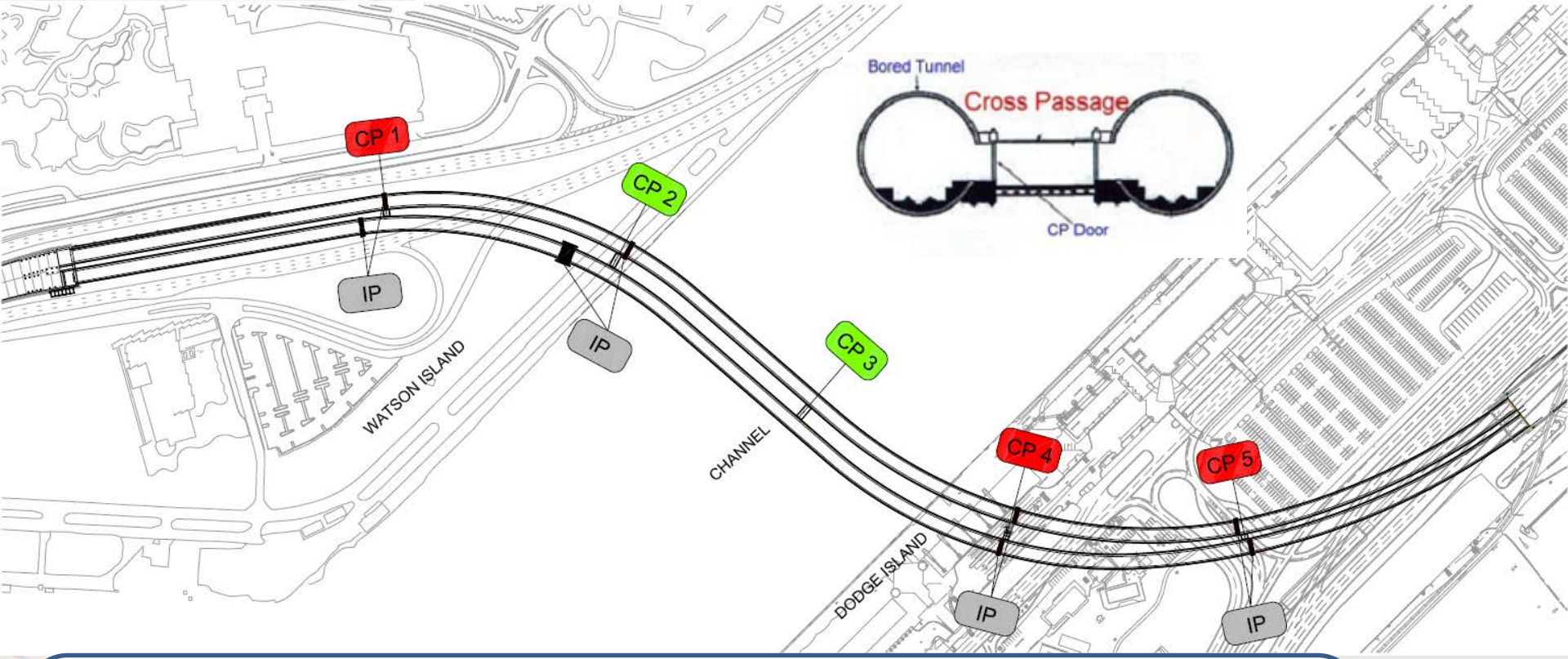
TBM TURNAROUND

WESTBOUND TUBE MINING BEGAN 10/29/12

HARRIET COMPLETES MINING

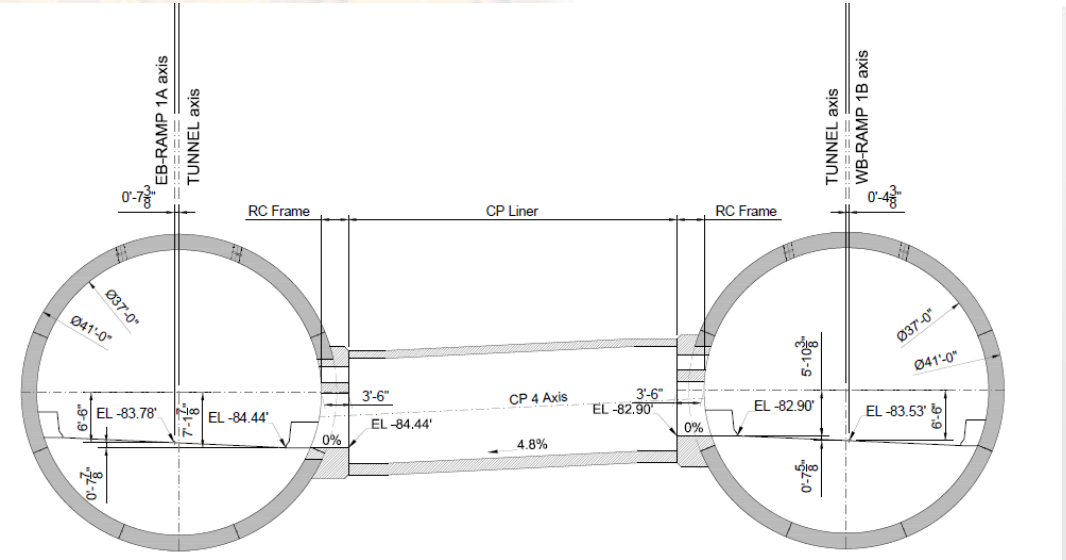
5 CROSS PASSAGES

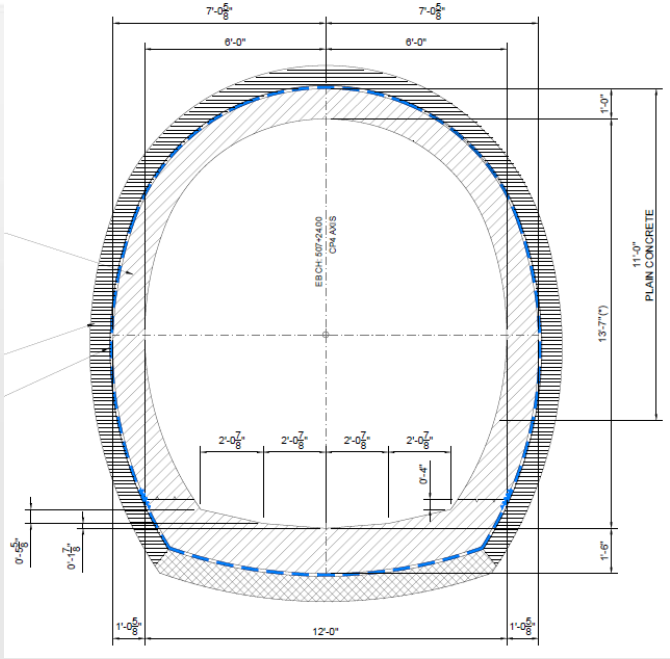
CROSS PASSAGES



- Cross Passage - CSM Treatment
- Cross Passage - Formation Grouting & Ground Freezing Treatment
- Intervention Plug – CSM Treatment

FIVE (5) CROSS PASSAGES

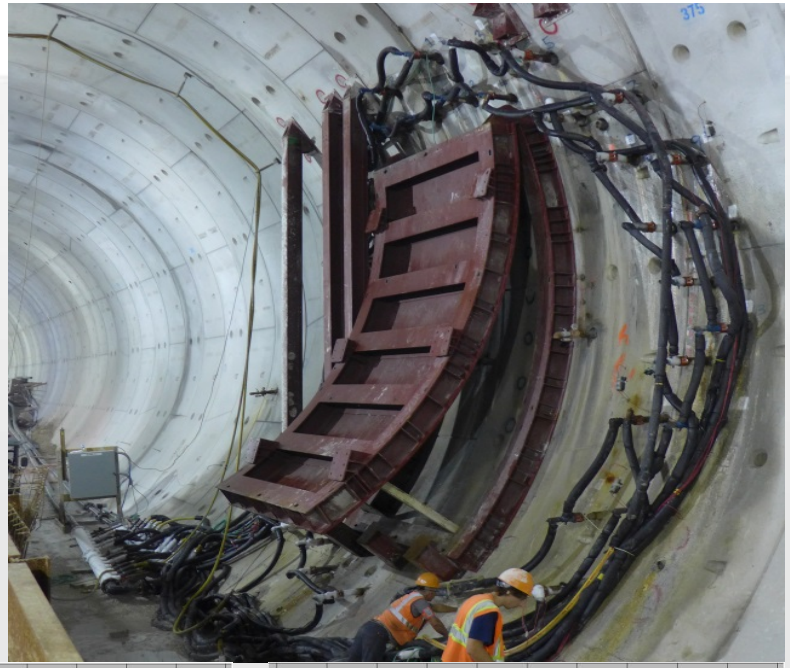


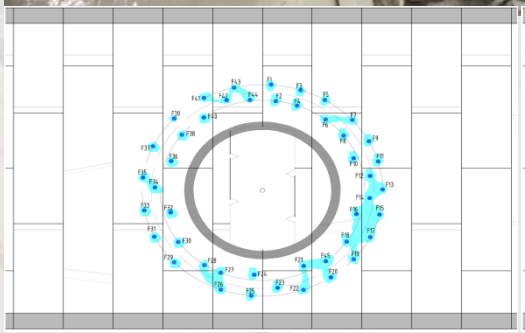


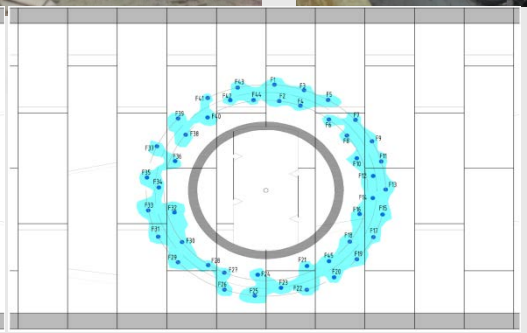
- **Required to provide emergency egress between tunnels. Spaced every 656ft**
- **Constructed after the two bored tunnels are completed.**

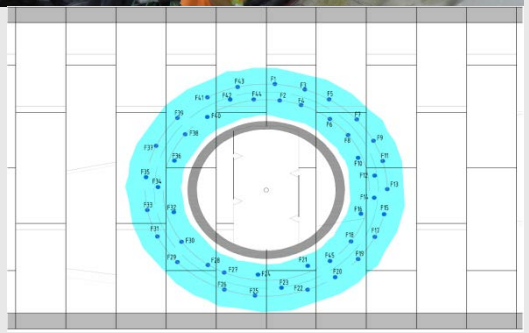
CROSS PASSAGES 1, 4 & 5 IN CSM

GROUND FREEZING – CROSS PASSAGES DESIGN









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

CROSS PASSAGE LINING

Temporary Support provided by Steel Ribs and Shotcrete

A 12-Inch thick Reinforced Permanent Lining was installed.

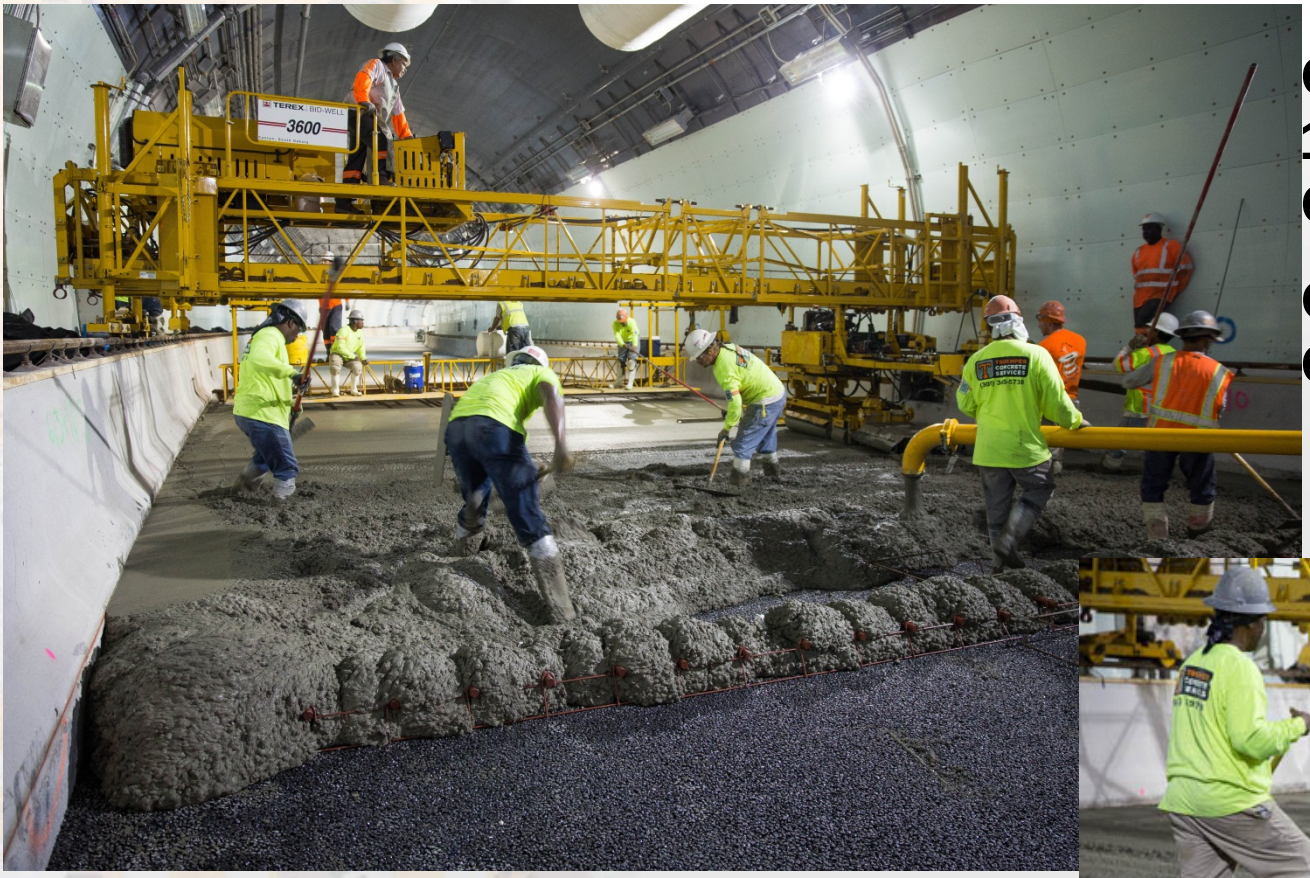
Cutting Tool after use.

MACARTHUR CAUSEWAY BRIDGE WIDENING

MacArthur Causeway Bridge Widening to carry additional traffic lanes to/from the new tunnel.

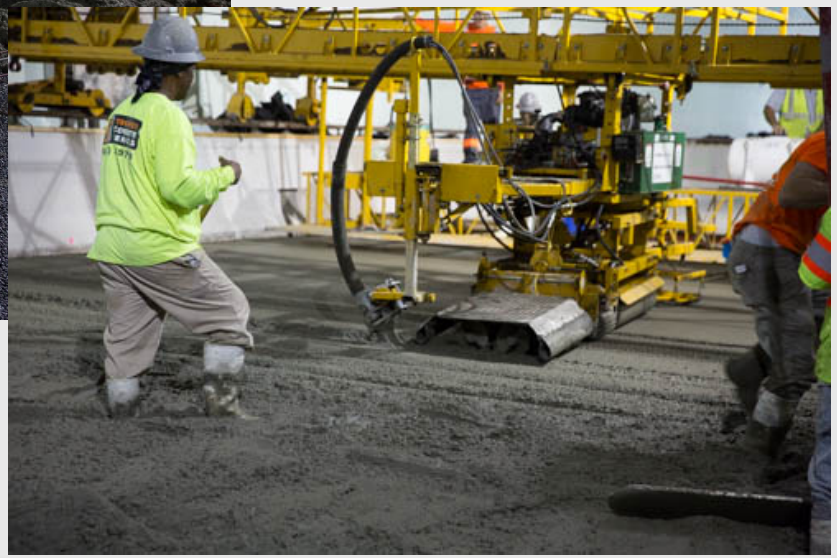
TUNNEL ROADWAY DEVELOPMENT

TUNNEL ROADWAY DEVELOPMENT



Concrete Pavement
10,000 cy of 3,000 psi Concrete

Over 14 ft. depth of Cement Treated Base

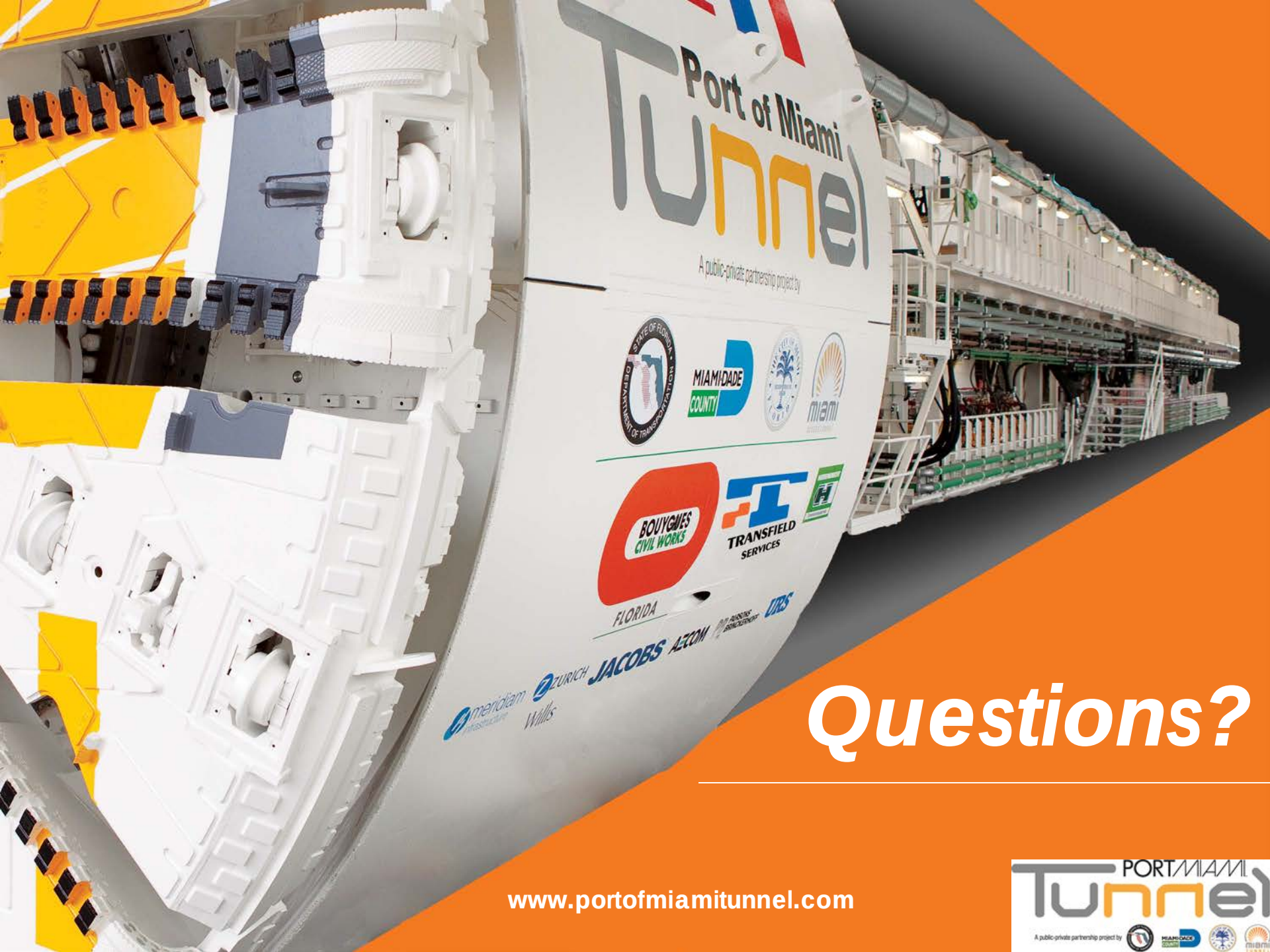


TUNNEL FINAL PAVEMENT

DODGE ISLAND PORTAL CONSTRUCTION

Portals and approaches 6,500 psi Architectural Exposed Concrete

WATSON ISLAND TUNNEL PORTALS



Questions?

www.portofmiamitunnel.com

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