



Metropolitan Water Tunnel Program

Tunnel Program Update

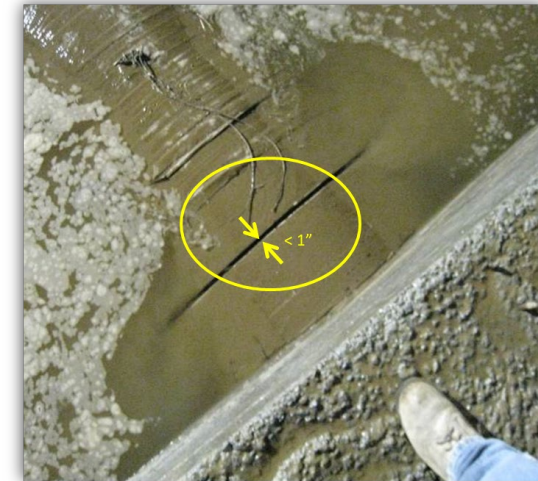
Presented to MWRA Advisory Board

April 18, 2024



Metropolitan Water Tunnel Program Purpose

- Our current Metropolitan Tunnel System, servicing the Boston area, is in need of repair
- The tunnels, valves, chambers & pipelines are between 50 – 80 years old



- Currently we cannot maintain our tunnel system east of Shaft 5 in Weston because a shutdown of the entire Metropolitan Tunnel System would be required
- The **Metropolitan Water Tunnel Program** will solve that problem by creating a redundant water tunnel system allowing the old system to be completely taken offline for inspection, maintenance, and repair
- In the mean time, a series of interim improvement projects are underway to reduce the risk of failure of surface components of the existing Metropolitan Tunnel System



Metropolitan Redundancy Interim Improvement Projects

- Commonwealth Ave Pumping Station Improvements – completed in 2021, \$8.0M
- Tunnel-Shaft Pipeline Improvements
 - Shafts 6, 8, and 9A, completed in 2020, \$2.2M
 - Shaft 5, awarded in Feb 2024, \$5.4M
 - Shaft 7, 7B, 7D, and 7D, ~2026, est. \$8.6M
 - Shaft 5 building, ~2026, \$3.3M
 - Shaft 9, ~2028, \$13.6M
- WASM 3 Rehabilitation
 - 2.5 miles completed in May 2023, \$20.5M
 - 0.6 miles in design, NTP May 2025, ~\$13.8M
 - 6.5 miles (future), NTP Jul 2030, ~\$80M
- Low Service Pressure Reducing Valve Improvements, \$12.2M
- Section 101 Waltham Pipeline Extension, ~40% complete, \$32.7M



WASM 3 – pipe replacement



New Pumps at Commonwealth Avenue



36" pipe & thrust block @ Lexington St & Totten Pond Rd



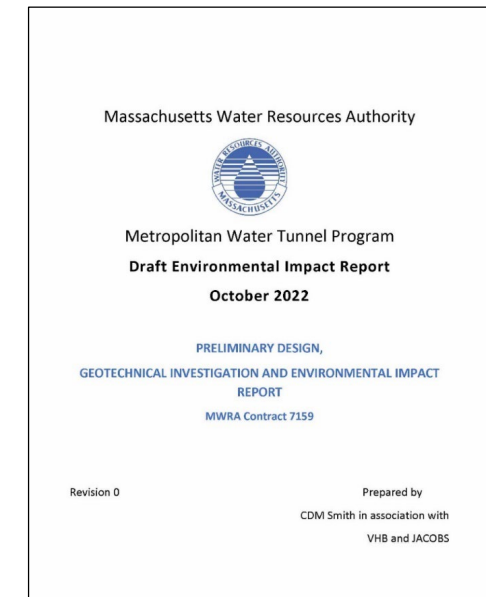
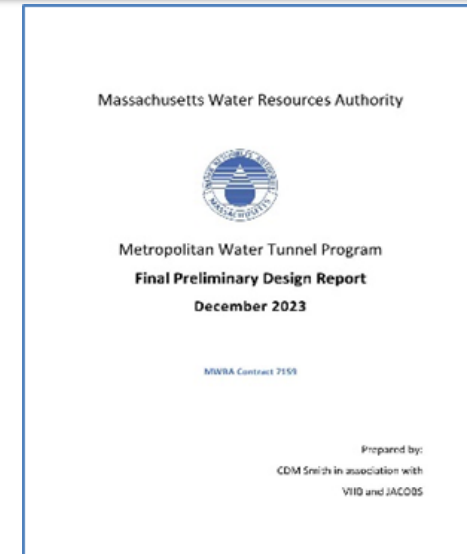
Metropolitan Water Tunnel Program

Preliminary Design and Environmental Impact Report



Preliminary Design and Environmental Impact Report

- Preliminary Design Report
 - 15 miles of deep rock tunnel
 - 100 Year Service Design Life
 - Preliminary tunnel alignment and profile, valve chambers and surface pipeline connections
 - Construction contract packaging and sequence approach
 - Updated construction cost estimate and construction schedule
- MEPA filings and Environmental Impact Reports
 - Environmental Notification Form
 - Draft Environmental Impact Report
 - Supplemental Draft Environmental Impact Report
 - Final Environmental Impact Report
 - FEIR submitted to EEA February 2024





Preliminary Design & EIR – Performed in Parallel

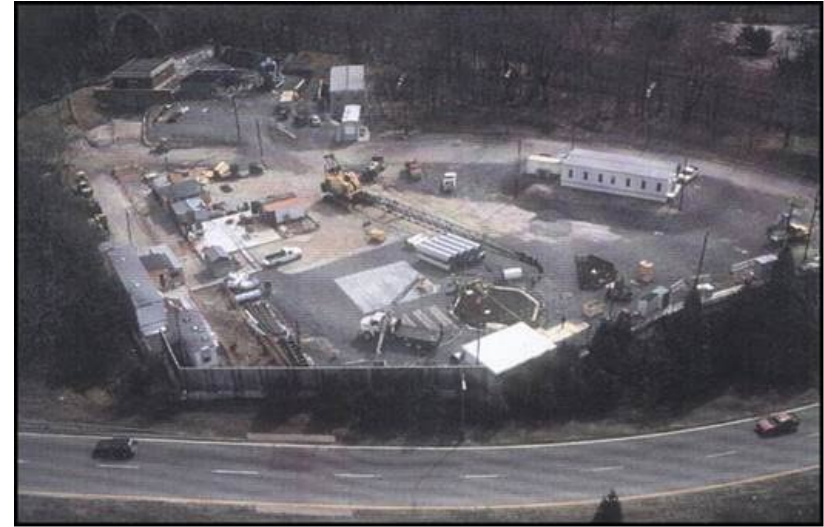
Key Objectives:

- Shaft site selection
 - Meet system hydraulic requirements, provide full redundancy
 - Provide sufficient space for temporary construction staging and permanent infrastructure
- Establish tunnel alignment (both horizontal and vertical)
 - Minimize overall tunnel length
 - Avoid geo-hazards when possible
 - Maximize length of unreinforced concrete liner
 - Establish readily constructible tunnel segment lengths
- Avoid, minimize, and mitigate impacts to the environmental and communities to the maximum extent practicable
- Establish construction sequence and packaging
 - Promote good competition by qualified bidders
 - Balance risks



Shaft Site Selection Objectives

- During Construction
 - Sufficient size for construction
 - Locate away from sensitive receptors and abutters
 - Close to major highway
 - Near receiving water
- After Construction
 - Landscaped and secured
 - Periodic site visits and maintenance
 - Good neighbor



Shaft Site During Construction



Shaft Site After Construction



Shaft Sites

Construction Shaft Sites

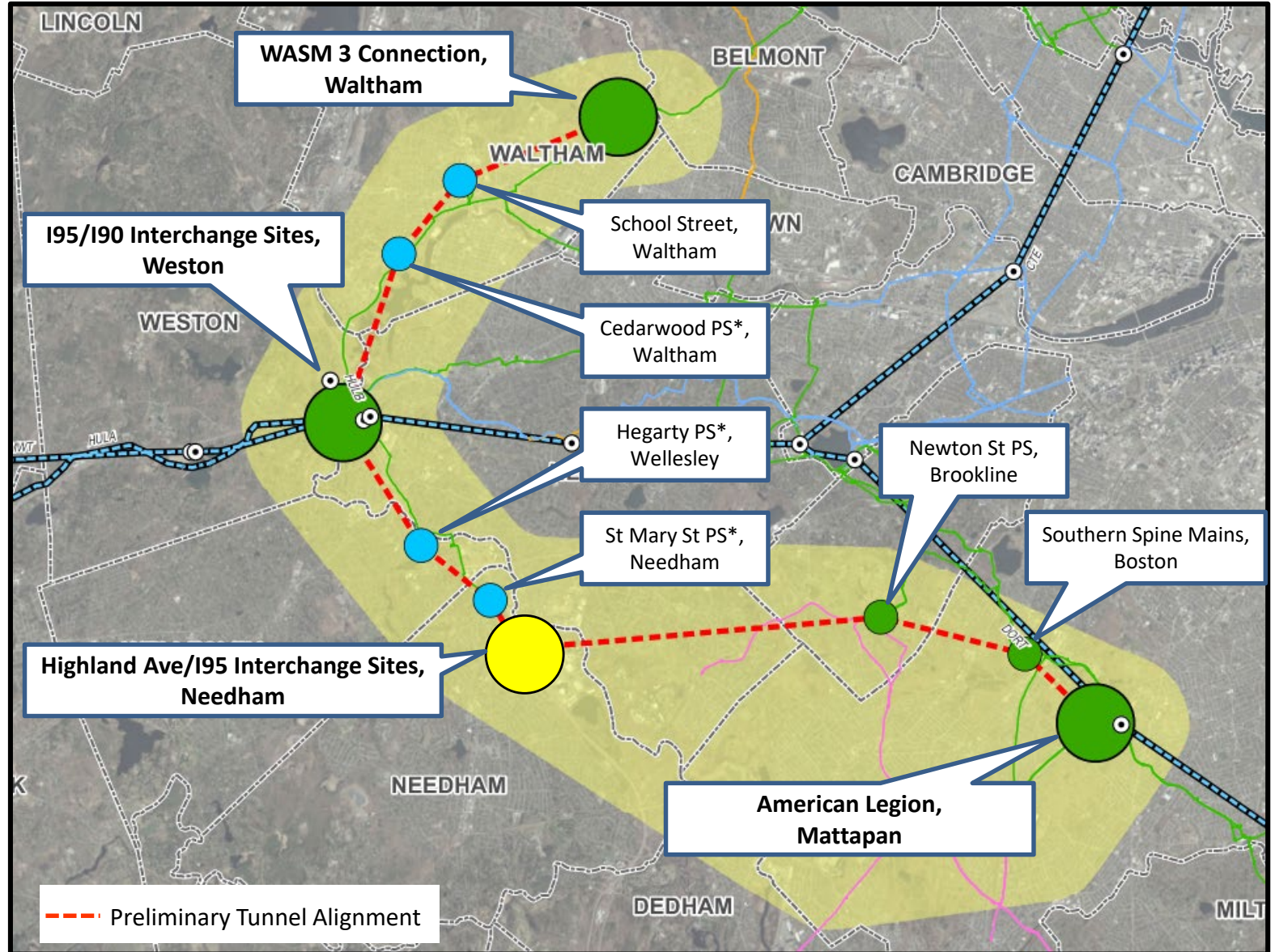
- WASM 3 Connection, Waltham
- I90/I95 Interchange, Weston
- Highland Ave/I95 Interchange, Needham
- American Legion, Mattapan

Connection Shaft Sites

- Lexington St Pump Station, Waltham
- Cedarwood Pump Station, Waltham
- Hegarty Pump Station, Wellesley
- St. Mary Street Pump Station, Needham
- Newton Street Pump Station, Brookline
- Southern Spine Mains, Boston

Final shaft locations subject to permits and real estate acquisition

* Non MWRA Pump Station



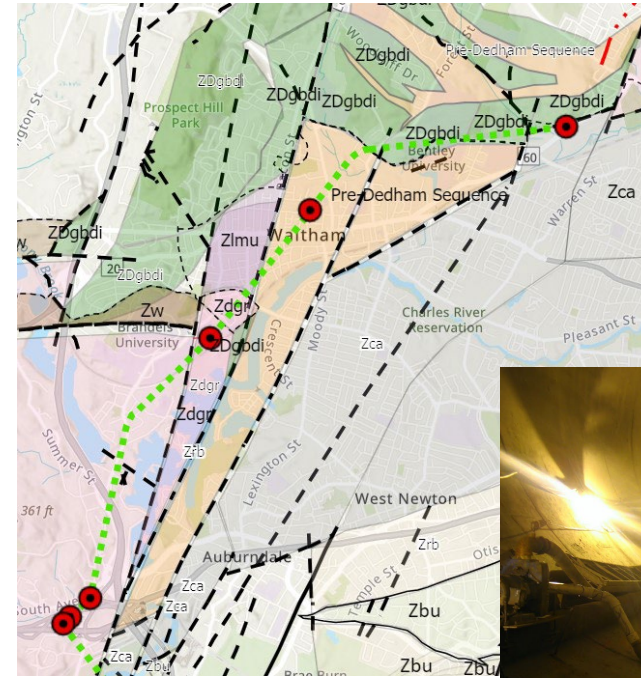
- Required Connection (required for system redundancy)
- Secondary Connection (provides local benefit)
- Construction Shaft (South Tunnel Isolation)



Tunnel Alignment & Segments

Objective:

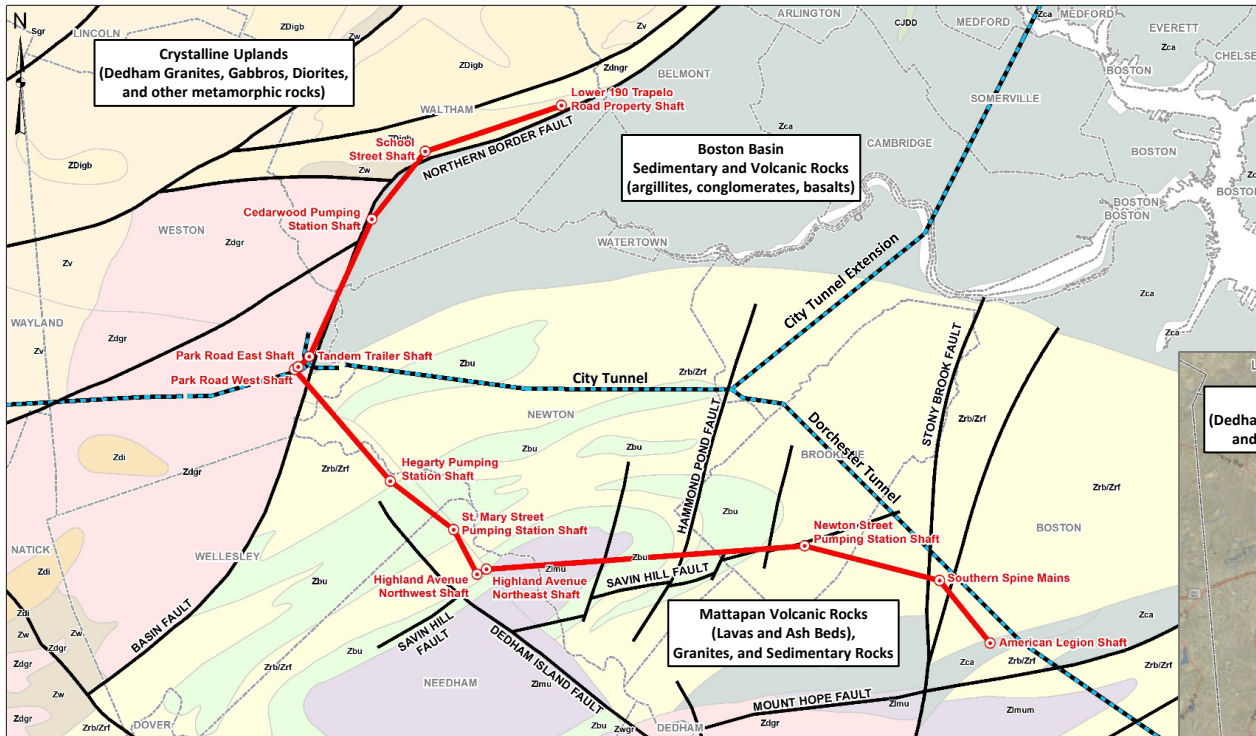
- Establish tunnel alignment (both horizontal and vertical) to minimize overall length and maximize unreinforced concrete permanent liner system
- Avoid/minimize mining through difficult ground conditions where possible
- Select segment lengths to shorten overall construction duration and provide added operational flexibility
- Control construction costs by combining tunnel segments into contract packages that minimize contract interfaces and encourage construction flexibility





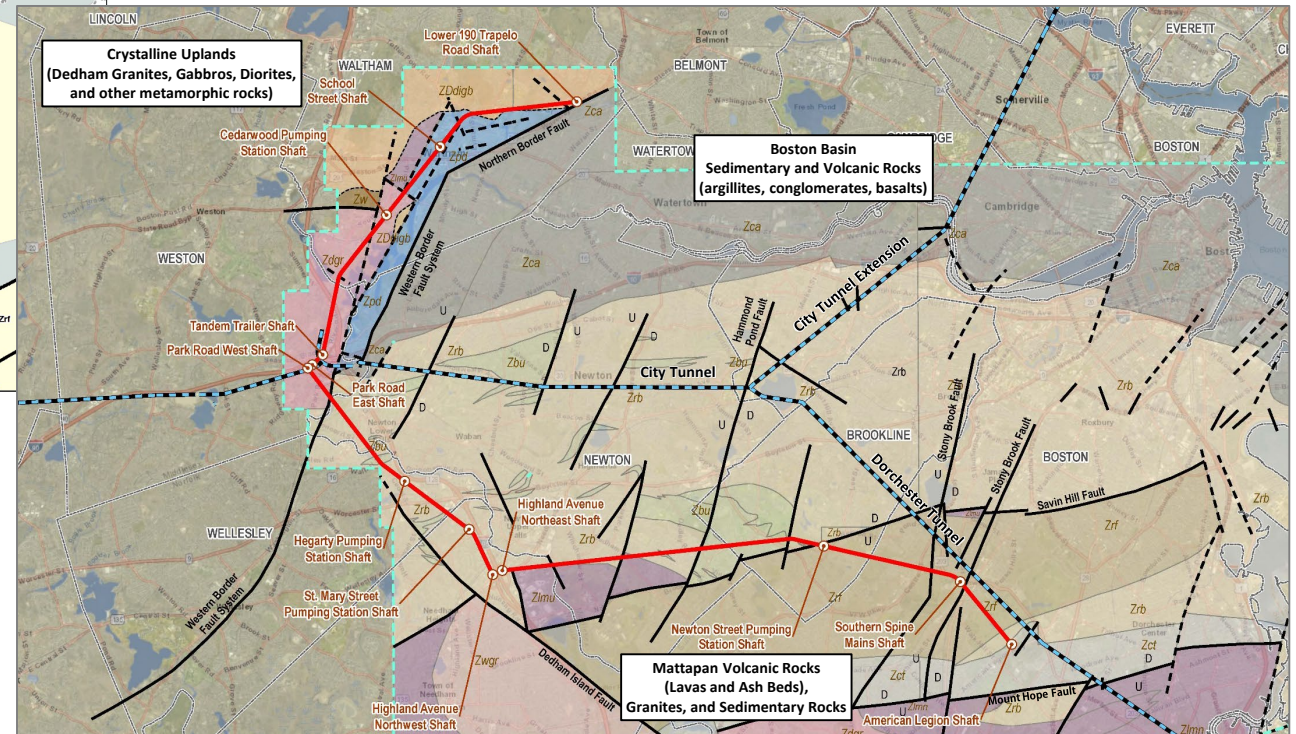
Geologic Conditions Influence Tunnel Alignment and Construction

Beginning of Preliminary Design



Final Design Stage geotechnical investigations will add to our understanding of geologic conditions and will be used to refine tunnel alignment, construction methods, schedule and costs

End of Preliminary Design

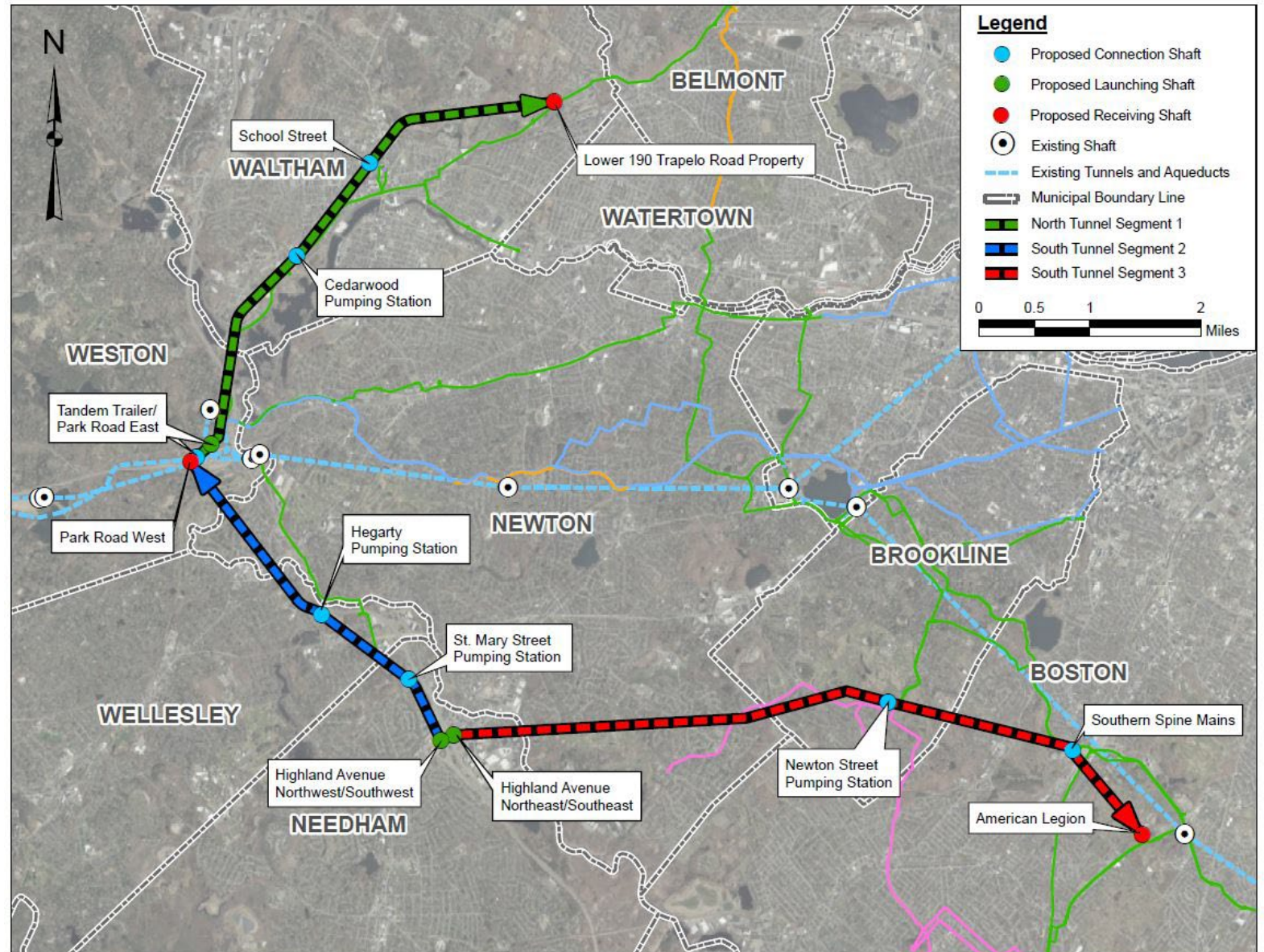


- Crossing 4 major fault systems
- Poor quality rock w/ thick overburden found in Waltham
- Adjusted tunnel alignment to avoid geo-hazards
- Adjusted estimated tunnel mining production rate to reflect conditions



Tunnel Alignment, Segments, and Contract Packaging

- 15 miles of deep, hard rock, pressure tunnel, 250 to 500 feet deep
- Three launching and three receiving shafts
- Three tunnel segments (4.8, 3.4 and 6.8 miles long)
- Six intermediate connection shafts
- Alignment has been adjusted to avoid known geo-hazards
- Two tunnel construction packages
 - North Tunnel (Segment 1)
 - South Tunnel (Segments 2 & 3)
- Contract package sizes should promote good competition

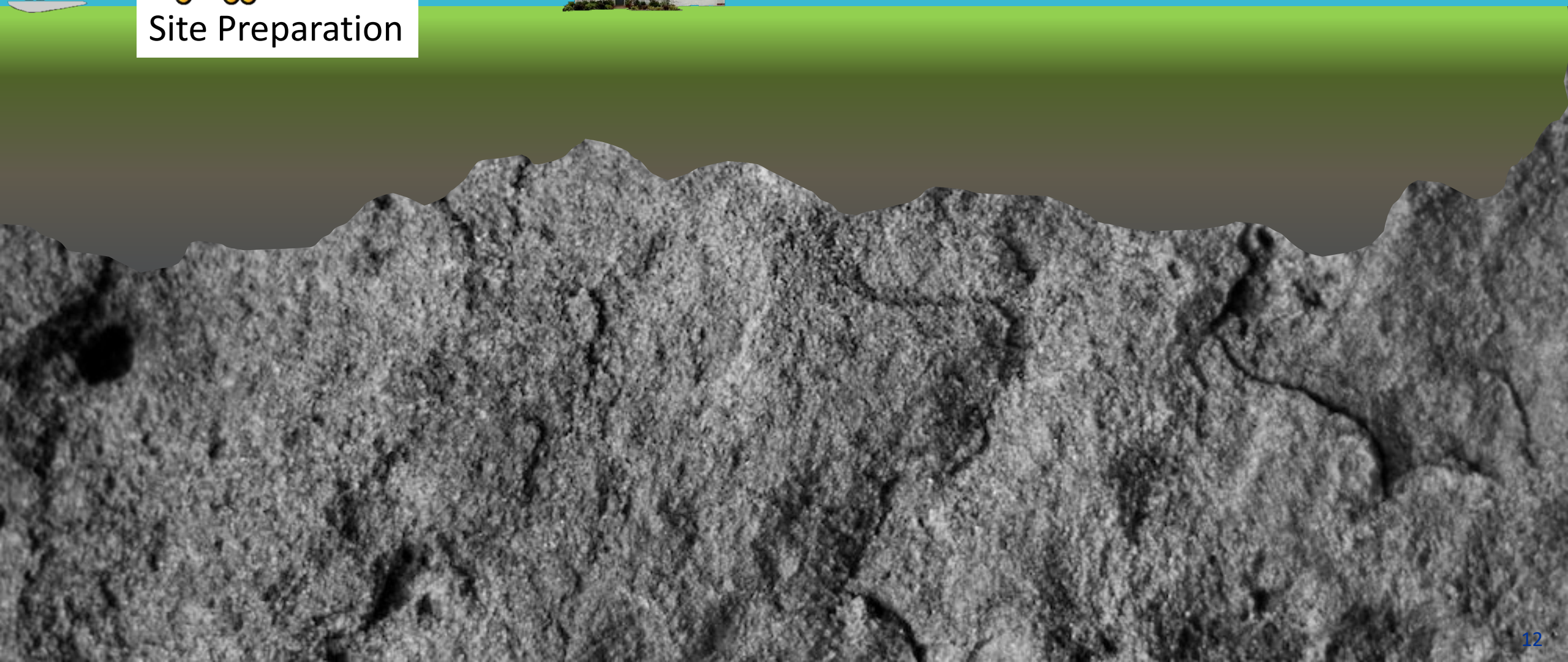




Tunnel Construction

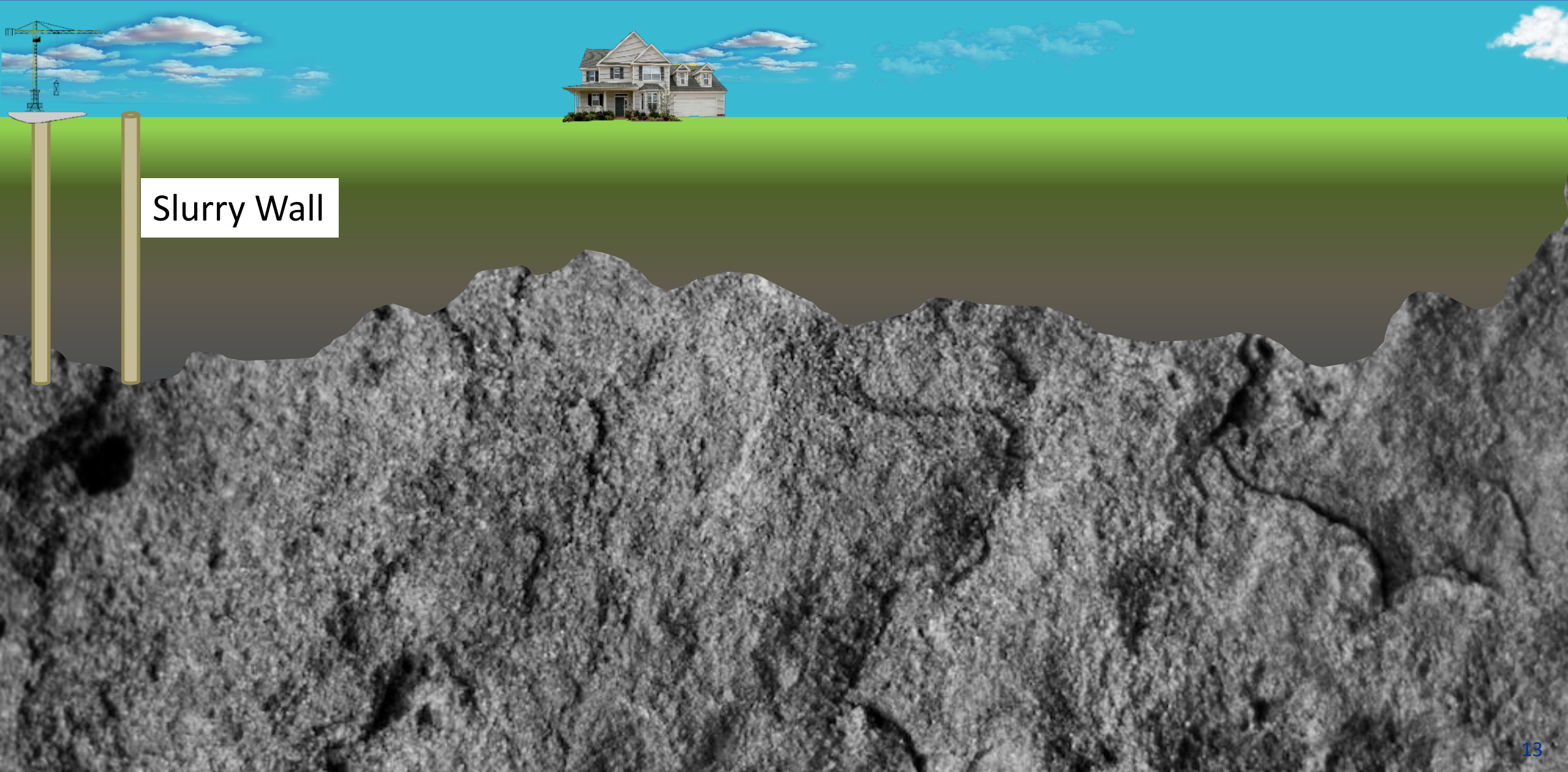


Site Preparation





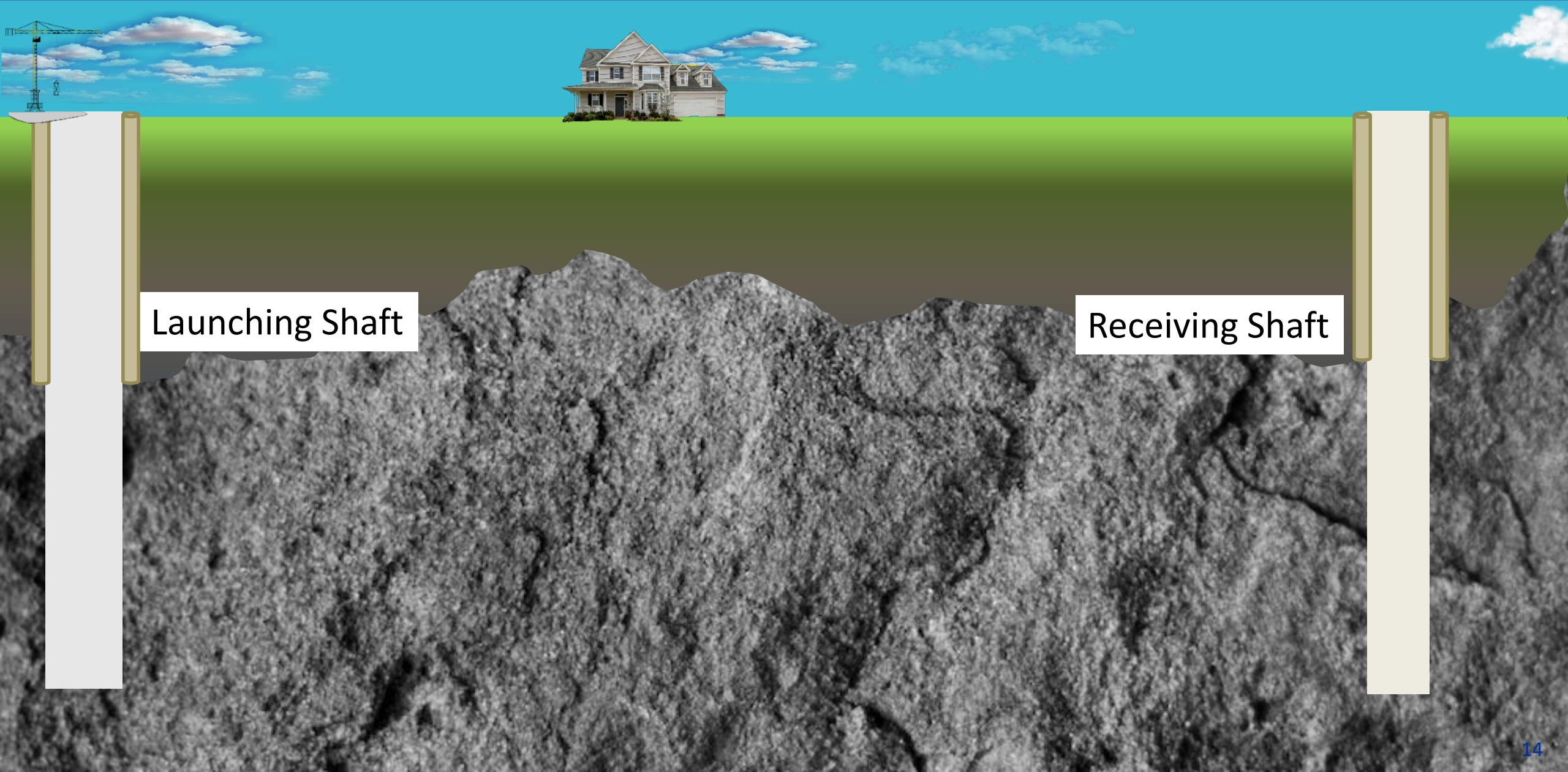
Tunnel Construction



Slurry Wall



Tunnel Construction

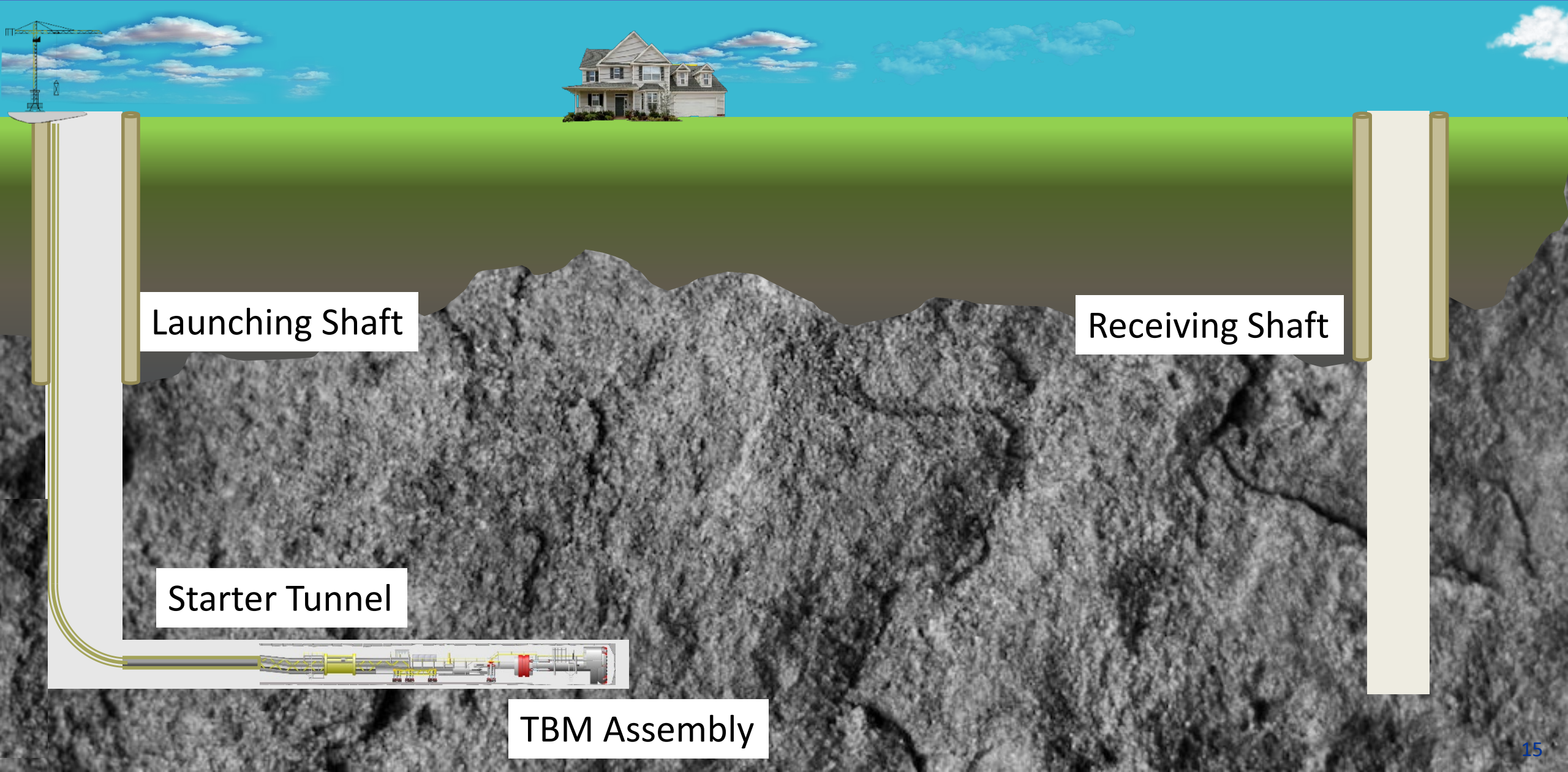


Launching Shaft

Receiving Shaft



Tunnel Construction



Launching Shaft

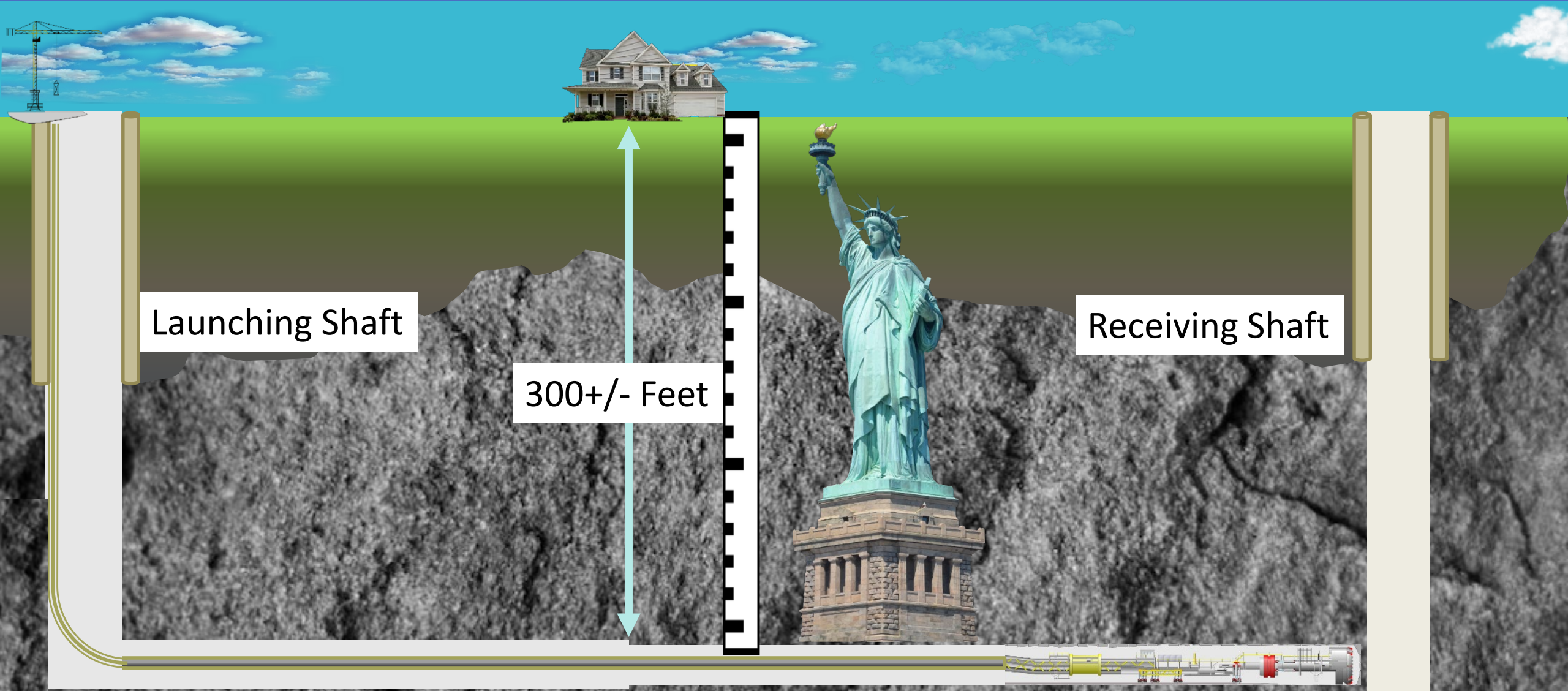
Receiving Shaft

Starter Tunnel

TBM Assembly

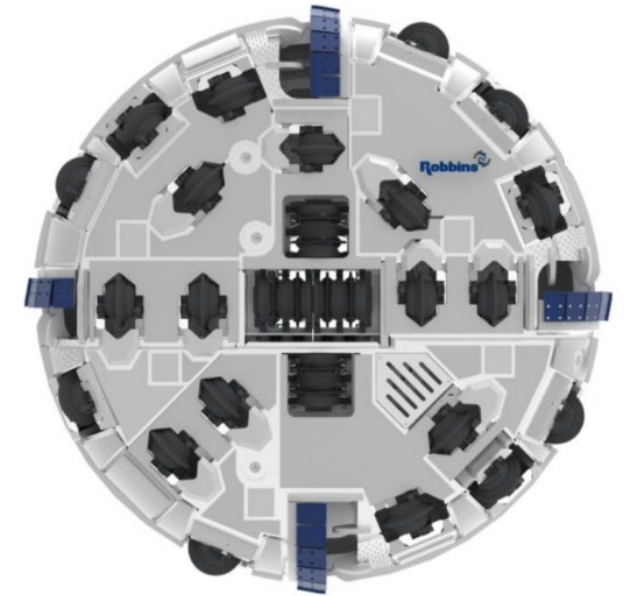
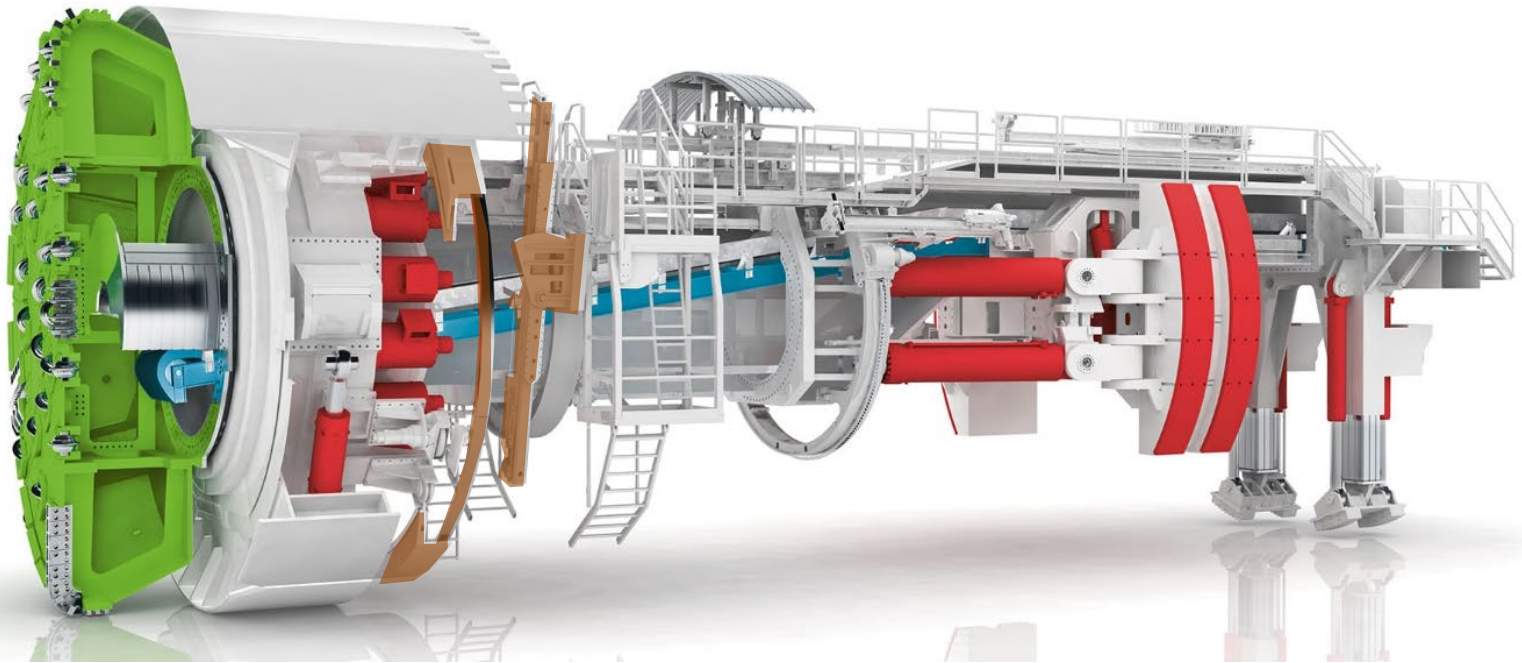


Tunnel Construction





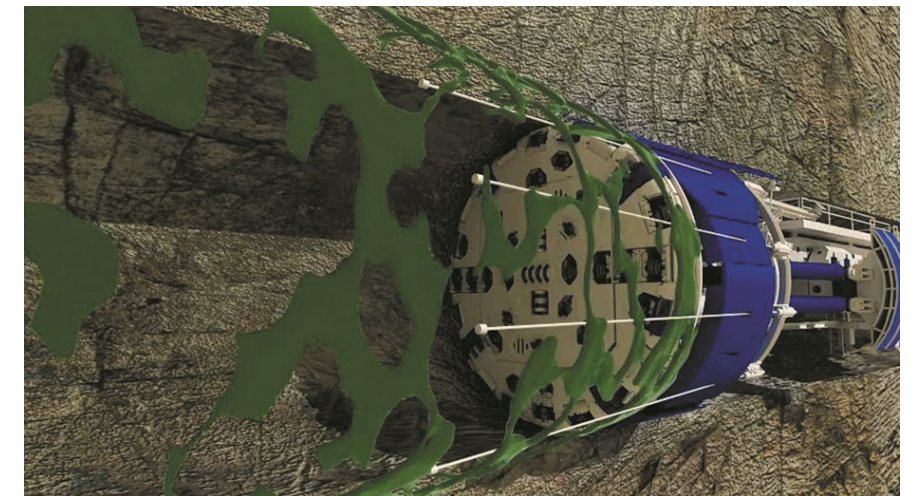
Tunnel Boring Machine



Source: www.robbins.com

Source: www.herrenknecht.com

- **Cutterhead** grinds the bedrock into small pieces
- **Conveyors** move the broken rock to the back of the TBM
- **Self propelled** grippers push to side of tunnel, jacks propel forward
- Bedrock is self supporting or supported with rib (**rib erector**), rock bolts (**rock drill**), and shotcrete
- Probing and **grouting** is used to control groundwater

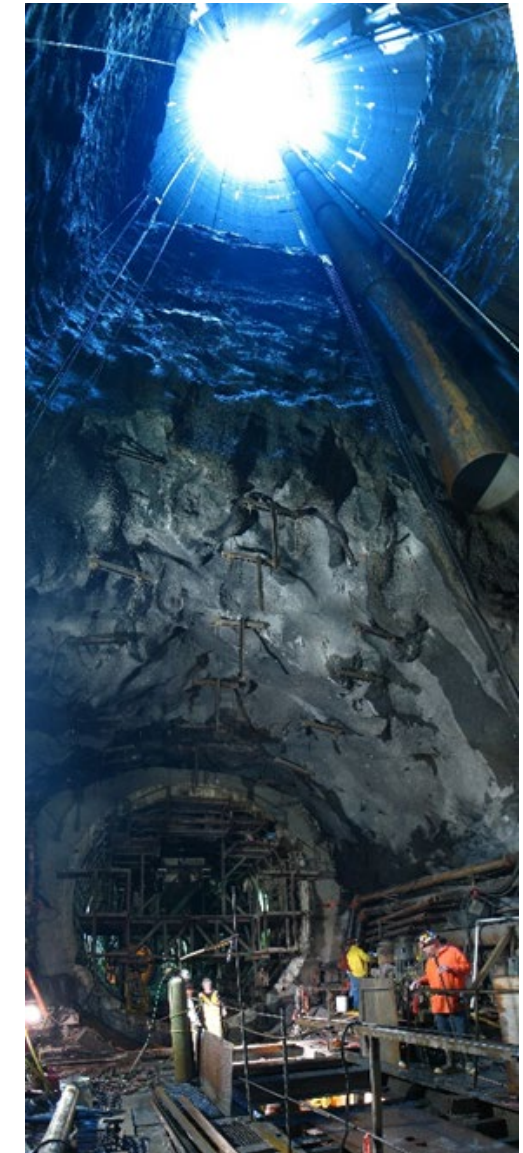
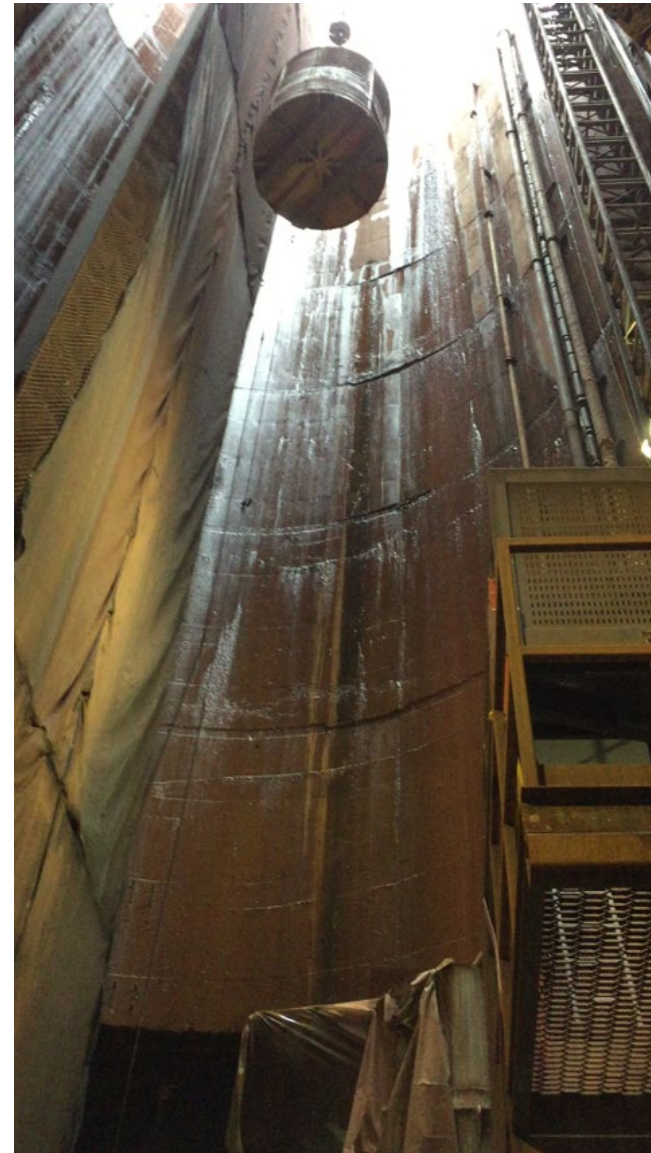




Launching / Receiving Shaft Construction



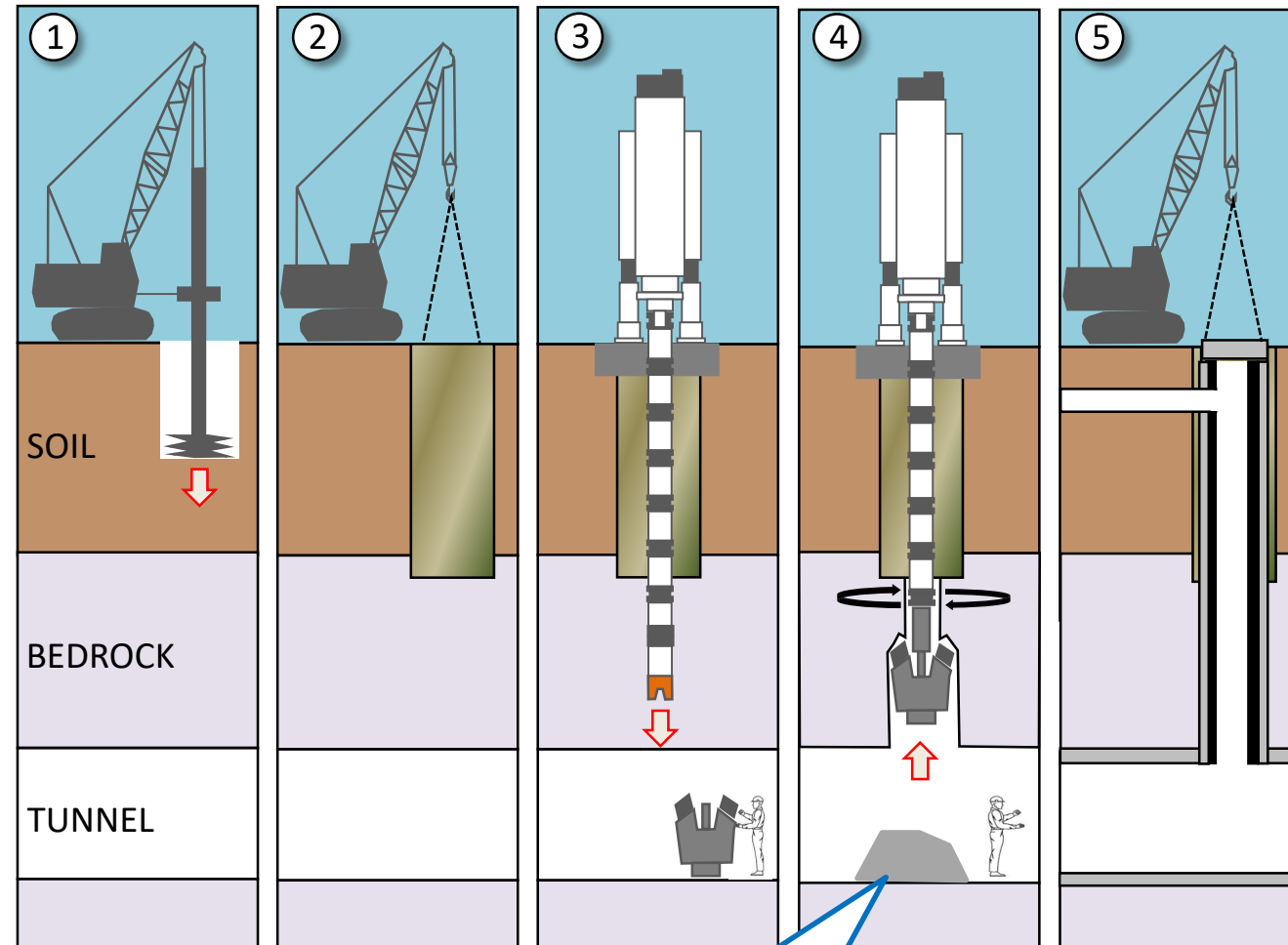
- ~25' – 40' diameter, ~250' – 400' deep
- Launching shaft is the only access to the tunnel until breakthrough into the receiving shaft
- Constructed by drill and blast methods
- “Cavern” at the bottom of launching shaft is where TBM will be assembled





Intermediate Shaft Construction

- Intermediate connection shafts are smaller diameter
- Use raised bore shaft construction method where possible
- Sequence of Construction (after tunnel has passed below):
 - (1) Auger drill through soil
 - (2) Install steel casing through soil
 - (3) Drill pilot hole in rock
 - (4) Ream larger hole in rock – **spoil drops into and is removed from the tunnel**
 - (5) Install shaft lining
- Benefits of Raised Bore Shaft Method:
 - Smallest footprint at the surface
 - Most excavate is removed from inside the tunnel which limits hauling from the site
 - No blasting
 - Not 24/7



Excavated rock drops into tunnel and is transported to and removed from the launching shaft



Potential Permits and Approvals

Federal

- National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP)
- NPDES Dewatering and Remediation General Permit (DRGP), if needed
- Section 404 Department of the Army Permit (General and Preconstruction Notice)

Commonwealth of Massachusetts

- Massachusetts Environmental Policy Act (MEPA) Review
- Massachusetts Historical Commission (Massachusetts General Law Ch. 9, Section 26-27C)
- Highway Access/Construction Access Permits
- MBTA Right of Way Access License Agreement
- Natural Heritage Endangered Species Program
- Water Management Act Permit
- Chapter 91 Licenses
- Superseding Order of Conditions, upon appeal
- Section 401 Water Quality Certificate
- Distribution System Modification
- Land disposition/easements
- Article 97 Land Disposition Legislation

Municipal

- Wetlands Protection Act Order of Conditions
- Roadway Access Permits/Street Opening Permit
- Hydrant Permit
- Drainage Discharge Permit





Environmental and Community Impacts

Avoid, minimize, and mitigate impacts to the environmental and communities to the maximum extent practicable:

- Shaft site selection considered land use, traffic, noise, hauling routes, proximity to sensitive receptors, EJ communities, etc.
- Prioritized public land (MWRA, DCR, MassDOT) and communities that directly benefit from the Tunnel Program
- Construction methods selected to minimize impacts where possible (e.g., TBM, raise bore shaft construction method)
- Solicited stakeholder input throughout the process to help understand impacts and inform decisions
- Locating launching shaft sites along major highways and near receiving water was key to minimizing impacts
- Shaft sites selected should avoid the need for costly mitigations

Construction impacts are temporary

Redundant water supply is a long-term benefit



Community & Stakeholder Outreach

- Met with 10 communities in the study area
- Established a Working Group with representative from each community
- Numerous meetings with the 7 communities in which the tunnel will be constructed:
 - Town Management, Public Works, Public Safety/Fire, Conservation Commission, etc.
- Multiple meetings with key stakeholders and permit agencies:
 - EEA, DEP, MassDOT, DCR, DPH, DYS, UMass and DCAMM
- Met with numerous organizations, businesses & private property owners to coordinate field work
- Met with community interest groups
 - WLT, CRWA, neighborhood groups and others
- Established a Website <https://www.mwra.com/mwtp.html> and email address (for questions) Tunnels.info@mwra.com
- Created multiple Fact Sheets – available in 4 languages
- Outreach will continue throughout design and construction



Metropolitan Water Tunnel Program How Were Shaft Sites Selected?

Through the Metropolitan Water Tunnel Program, the Massachusetts Water Resources Authority (MWRA) will construct two new water supply tunnels that will allow our aging existing water tunnel system to be rehabilitated without interrupting service. Implementing the Program will require construction of deep shafts, rock tunnels, and near surface valve vaults, and pipeline connection facilities.

Most of the construction will take place deep below the surface, as the tunnel boring machine (TBM) excavates through rock up to 400 feet underground. However, several shafts will connect the tunnel to the surface to allow the TBM to enter and exit the tunnel, while connection shafts provide new tunnels to our existing water transmission system and to the local First Street distribution system. This fact sheet describes these shafts and how the sites were selected.



Shafts to be constructed at 175 feet up to 300 feet deep and 600 feet for tunnel and shafts may be required. The amount of land around the shafts will vary. TBM assembly, tunnel setting, water handling, and extraction approximately 1.5 permanent top of shaft surface pipelines that will tie into our existing water distribution system.

Shafts 25 feet in diameter by up to 300 feet deep and are located at the end of the tunnel to remove the TBM from the ground once it has completed mining and existing water distribution system. Two or three receiving shafts may be required at the surface of receiving shafts during construction to support the permanent top of shaft.

Shafts 5 to 10 feet in diameter by up to 300 feet deep shafts along the tunnel connections between the tunnel and existing water distribution system stations. Approximately 40 connections that are planned, each requiring 400 sq ft of construction, depending on the construction method. After construction, 100 sq ft of permanent top of shaft will be required.

Shafts, the ideal site needs to be large enough to support planned construction, close to a body of water for discharge of treated water, near MWRA's transmission assets, and, as far as possible from environmental, historic, or other sensitive resources. Shaft sites require less land and construction activities are less, the existing water infrastructure (pipelines or pump stations) as well as locating environmental, historic, or cultural resources.



About MWRA's Metropolitan Water Tunnel Program

Although best known for the successful storage of Boston Harbor, the Massachusetts Water Resources Authority (MWRA) also provides safe drinking water to over three million residents and 140,000 businesses in Massachusetts. Our water supply system dates back to the early 1900s and has been continually upgraded and improved upon for over 100 years. Our main water source – the Quabbin and Westwater Reservoirs – are natural sources of water in some of the most protected watersheds in Massachusetts. In 2015, our water was voted the best in the world for the first time since 2011.

What if we started in 1964, MWRA inherited one of the country's great water systems, however, it had been neglected for decades. We have since invested heavily to modernize the water system, constructing a 17.6 mile water tunnel, a state-of-the-art water treatment plant and seven new water storage facilities. We have also replaced or repaired over 100 miles of water pipelines. In recent years, our focus has been ensuring a capability to maintain or to create water during maintenance outages or in the event of a break so that service is not interrupted. This work included the long overdue repair of the Hudson Aqueduct, two pipelines in parts of the service area that had single point-of-failure and a new emergency pumping station in Middleborough. Also, we have begun the initial design phase for two new water supply tunnels that will allow us to make repairs to our existing water tunnel system.

ABOUT THE METROPOLITAN WATER TUNNEL PROGRAM

Through the Metropolitan Water Tunnel Program, MWRA will construct two new water supply tunnels that will allow our aging existing water tunnel system to be rehabilitated without interrupting service. The Program will provide complete redundancy for the existing Metropolitan Water Tunnel System, which includes the City Tunnel (2003), City Tunnel Extension (2015) and Westwater Tunnel (2015). These new water supply tunnels will be constructed from the Quabbin Reservoir through a series of tunnels and aqueducts to our state-of-the-art water treatment plant at Middleborough and seven new water storage facilities in various Massachusetts communities. These two new water supply tunnels – one to the North and one to the South of the Metropolitan Boston service area – will also provide complete redundancy for the existing Metropolitan Tunnel System in those of its lines, tunnels and aqueducts.

WHY IS THIS PROGRAM NECESSARY?

The existing Metropolitan Tunnel System has been in constant use for over 50 years. Today the tunnels and the related water pumping and valves operate the water intake, all the time, inspection or repairs require their use critical for water transmission to homes and businesses, construction, and because these lines are redundant systems on back lines up. Without redundancy with the addition of our new transmission system, a failure could result in the interruption of service, significantly reduced water delivery capacity or even the interruption of service, which requires a complete. The economic impact of a major failure of the MWRA's existing Metropolitan Tunnel System is estimated at over \$100 million per day. The potential public health, safety and economic impacts of a prolonged water outage for Greater Massachusetts are unacceptable.

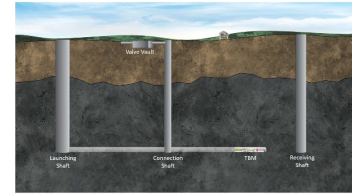


Metropolitan Water Tunnel Program How Is A Tunnel Constructed?

Through the Metropolitan Water Tunnel Program, the MWRA will construct two new water supply tunnels that will allow our aging existing water tunnel system to be rehabilitated without interrupting service. Implementing the Program will require construction of deep shafts, tunnels, and near surface valve vaults, and pipeline connection facilities. This fact sheet provides a description of these elements and some typical construction methods that will be used to complete the Program.

Types of Tunnel Shafts

Construction will start at the surface with shaft construction. Shafts provide the vertical connections from the surface to the depth of the tunnel. Three types of shafts will be constructed, each with a different function during construction, operation, receiving shafts, connection shafts, and receiving shafts. When the tunnel is in operation, these shafts will provide the connections from the new tunnels to our existing water transmission system and to the local distribution system that we serve.



Launching shafts are the largest diameter shafts to be constructed for the Program and will provide the primary staging for tunnel construction. A launching shaft will be approximately 40 feet in diameter. Two to three of these types of shafts may be required. A minimum of approximately 10 acres of land surrounding the shafts are required at the surface of each launching shaft site to support tunnel boring machine (TBM) assembly, tunnel excavation, tunnel rock handling, water handling, and tunnel line installation. A smaller footprint of approximately 1.5 to 2 acres may be needed for the permanent top of the shaft structure, valve vaults, and near surface pipelines which will provide connections to our existing water distribution system.



MWRA's Metropolitan Water Tunnel Program Potential Traffic Impacts Fact Sheet

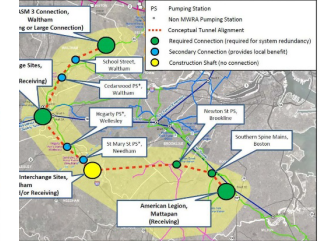
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Most of the construction will take place below the surface, as the tunnel boring machine (TBM) excavates through rock up to 400 feet underground. However, several shafts will connect the tunnel to the surface. Near these shaft sites, you may notice an increase in truck traffic. Truck routes have been identified and evaluated through the Environmental Impact Review (EIR) process, which included a Traffic Impact Analysis of potential impacts and strategies to avoid, minimize, and mitigate impacts. This fact sheet describes the potential traffic impacts during construction of the Program.

direction take place?

Water supply tunnels will be mostly constructed several hundred feet below ground, surface-level "place" primarily around up to seven launching/receiving shaft sites and six connection shaft sites. Shaft sites are selected to avoid and minimize construction truck traffic in addition to considerations of cost, and community impacts.

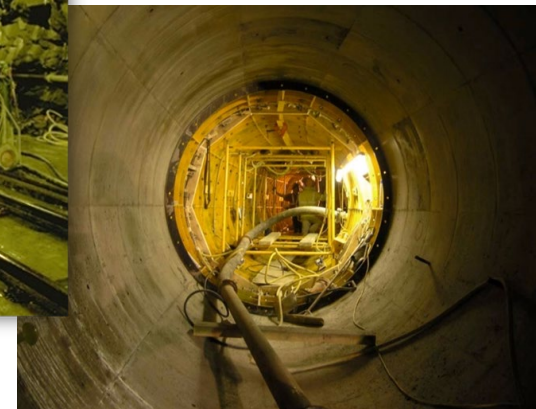
If alignment is shown below:





Key Characteristics of the 2017 Two-Tunnel Concept Maintained

- Hard rock pressure tunnels
- Two separate tunnels:
 - One begins in Weston and ends in Waltham (North Tunnel)
 - One begins in Weston and ends in Mattapan (South Tunnel)
- TBM excavation with two pass construction method
- Set horizontal and vertical alignment to maximum unreinforced concrete liner, limit steel liner
- Probing and grouting to control ground water
- Buried top of shaft structures and valve vaults
- Meets goal of full redundancy





Key Changes Since 2017 Concept

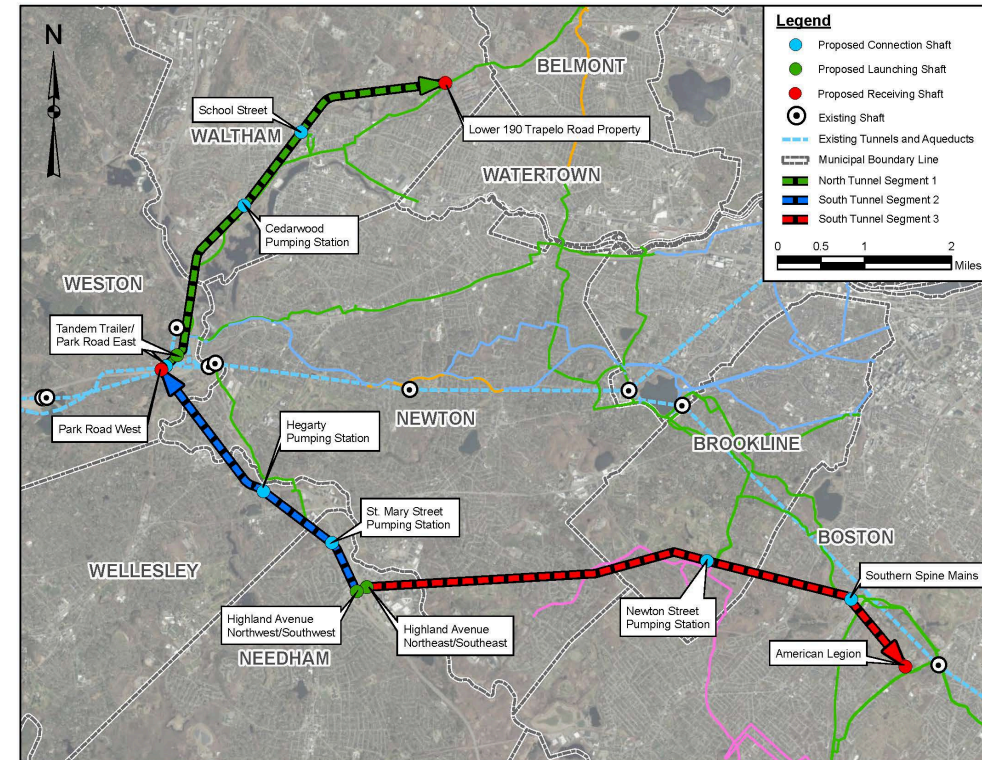


2017 (Two-Tunnel Concept):

- 14 miles, 2 segments, 2 TBM's
- Four intermediate shaft
- One double launching shaft site at I90/I95
- Two receiving shafts (Waltham & Mattapan)

2023 (Preliminary Design / FEIR):

- Accounts for land availability and environmental impacts
- Accounts for geologic conditions
- 15 miles, 3 segments, 2 or 3 TBM's
- Six intermediate shafts, 1 large connection shaft, 2 connector tunnels
- Two launching shaft sites at Highland Ave, one at I90/I95
- Three receiving shafts (Waltham, I90/I95, Mattapan)





2017 Two-Tunnel Concept vs. 2023 Preliminary Design/FEIR

- Benefits of 2023 Configuration:
 - Improves construction packaging
 - Reduces construction schedule
 - Reduces construction contract interfaces
 - Reduces risks
 - Improves community supply resilience
 - Provides added long-term operations capability
- Accounts for land availability
- Accounts for geologic conditions
- Avoids/minimizes/mitigates environmental and community impacts, to the extent practical
- Prioritizes construction sequence to match largest need for redundancy (South Tunnel first)
- Establishes construction contract packaging that should promote good competition
- Constructible tunnel system that will meet redundancy goals



Metropolitan Water Tunnel Program

Tunnel Program Look Ahead



Critical Path Tasks

- Geotechnical Investigations
- Land Acquisitions
- Community/Stakeholder Agreements (MOU's)
- TBM Power Supply



- Tunnel Construction



Geotechnical Explorations

Understanding geologic conditions are essential to a successful rock tunnel:

- More than ½ the Tunnel Program cost is associated with making a hole through the ground
- Crossing at least 4 major fault zones
- No previous deep borings along portions of both tunnel alignments
- TBM's will be built for the specific ground conditions
- Takes ~8 weeks to fully drill & test a deep rock boring
- Test boring locations will be increasingly difficult to access as design progresses
- Currently ~40% complete with planned deep test boring program
- Have encountered a few unexpected conditions:
 - Poor quality rock with thick overburden through portions of Waltham / North Tunnel
 - Small amount of naturally occurring asbestos has been found in 3 rock formations along South Tunnel
- Core Storage Facility in Needham allows for accelerated processing of data



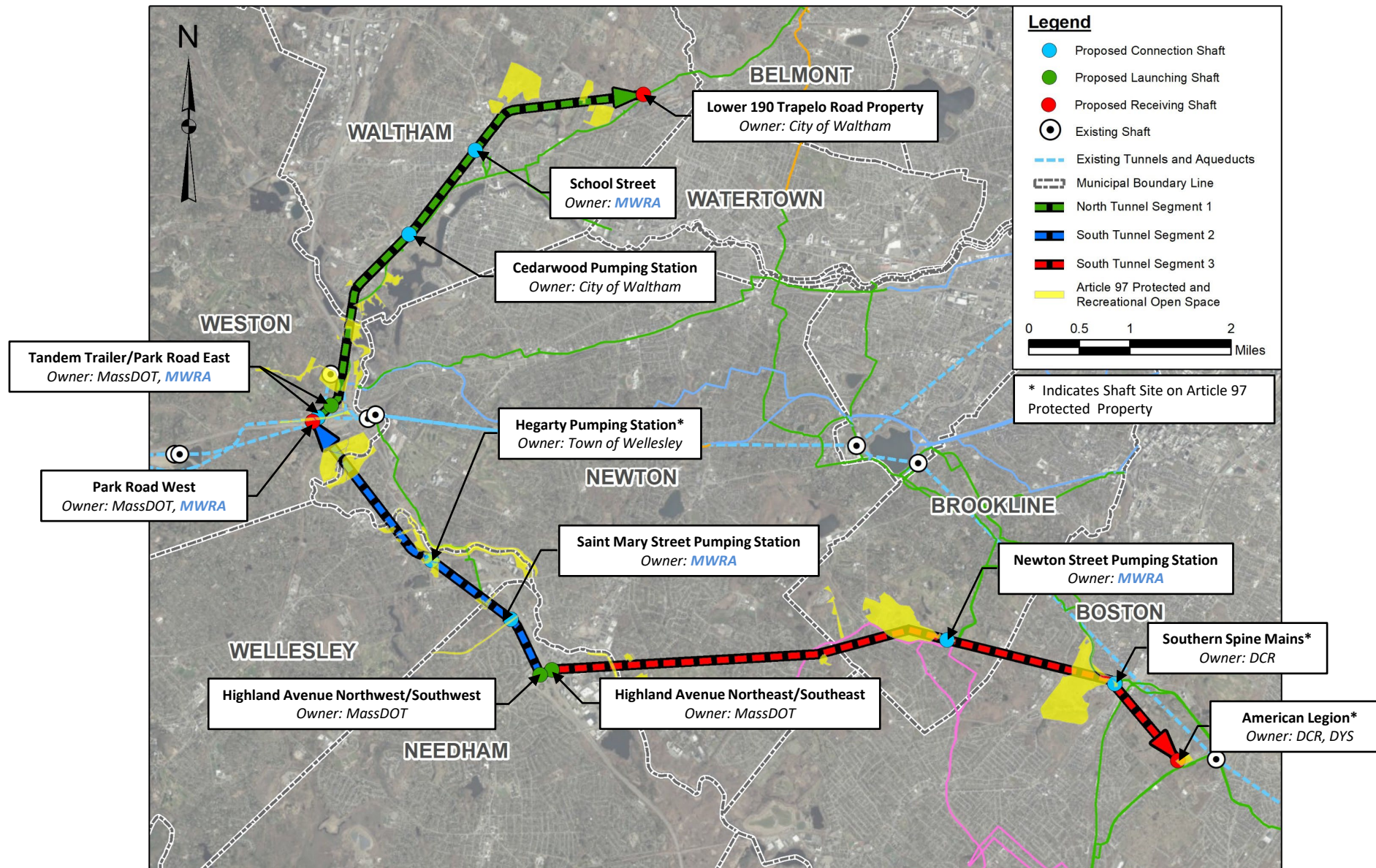


Land Acquisitions

- 13 shaft sites -
 - Larger temporary staging area and smaller permanent facility footprint
 - MWRA owns 3 shaft sites & has partial control of 2 shaft sites already
- Pipeline easements - ~6,000 ft
- Permanent surface access easements - ~9 sites
- Subterranean easements - ~600 individual properties
- ~3.8 acres of land for permanent facilities will require Article 97 legislation
- Land purchases/easements will be based on appraised value and negotiations
- Own in fee (most sites) or permanent easement (MassDOT)
- Land acquisitions will require Board approval



Land Acquisitions & Article 97 Properties



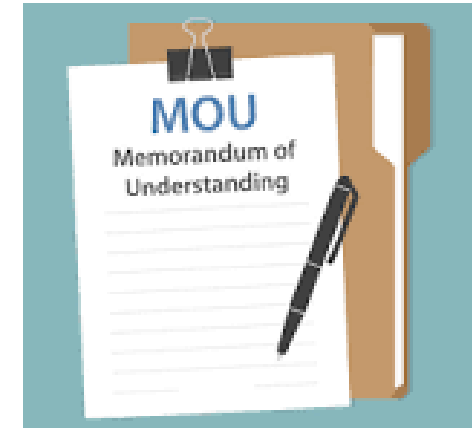


Community/Stakeholder Agreements (MOU's)

Topics may include:

- Land acquisitions
- Permitting and local regulations
- Public safety and emergency response
- Water supply contingency
- Work hours, hauling hours and routes, traffic management
- Dust and noise control, blasting and vibration control
- Connections to community water systems
- Mitigations and final site conditions (fencing, lighting, landscaping, etc.)

- Expect to execute MOU's with 7 communities (Waltham, Weston, Wellesley, Needham, Newton, Brookline & Boston)
- Expect to have agreements/MOU's (or similar) with DCR, MassDOT, and DYS related to land acquisitions
- All MOU's will be presented to the Board for approval





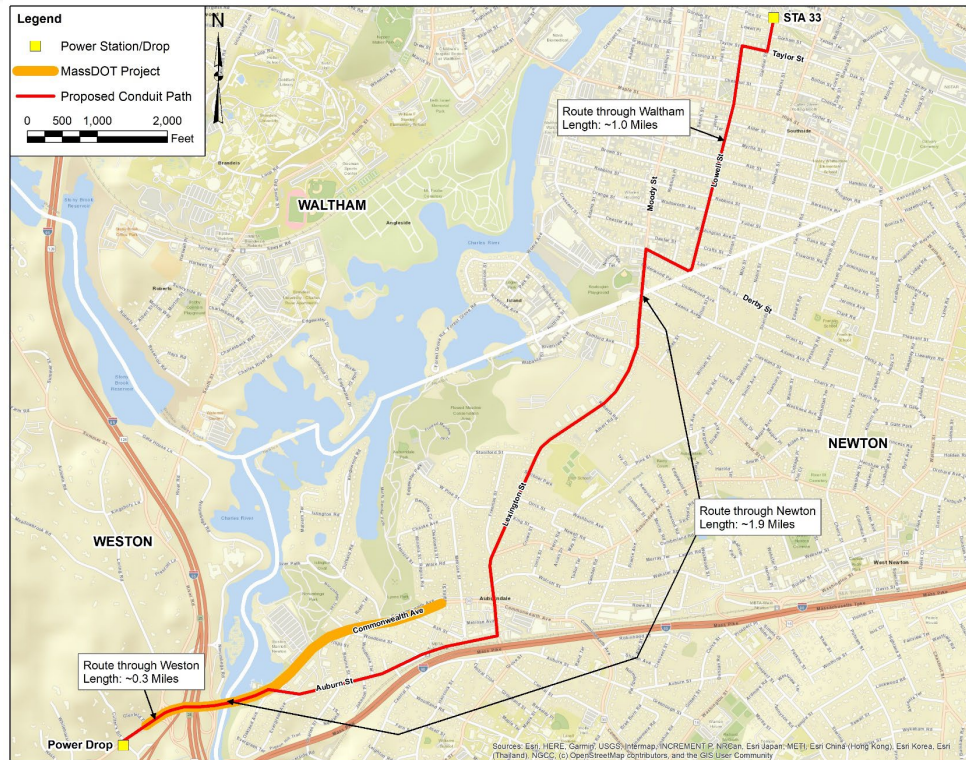
Emergency Response

- Shafts in six (6) communities, tunnel alignment beneath seven (7) communities
- Advance coordination to ensure coordinated emergency response during construction
- Staff have had three (3) meetings with community Emergency Responders:
 - Uniqueness of the underground construction environment and its hazards
 - Anticipated role and responsibilities of the MWRA tunnel contractors and community Emergency Responders
 - Tunnel Contractors to provide all OSHA required tunnel rescue resources (2 teams)
 - Community Emergency Responders assume incident command on the surface and, if needed, support underground for extrication and medical care
 - Training and equipment needed by the community Emergency Responders throughout tunnel construction
- Emergency response coordination needs to be tailored to the supporting communities' capabilities and size
- MWRA resources will be needed to ready the community Emergency Responders
- MOU's between MWRA and each community will include emergency response support





TBM Power Supply



190/I95 – Tandem Trailer Launching Shaft Site:

- ~3.2 miles of new duct bank & cable
- Coordinating with ongoing MassDOT project along Route 30
- Through Waltham, Newton & Weston

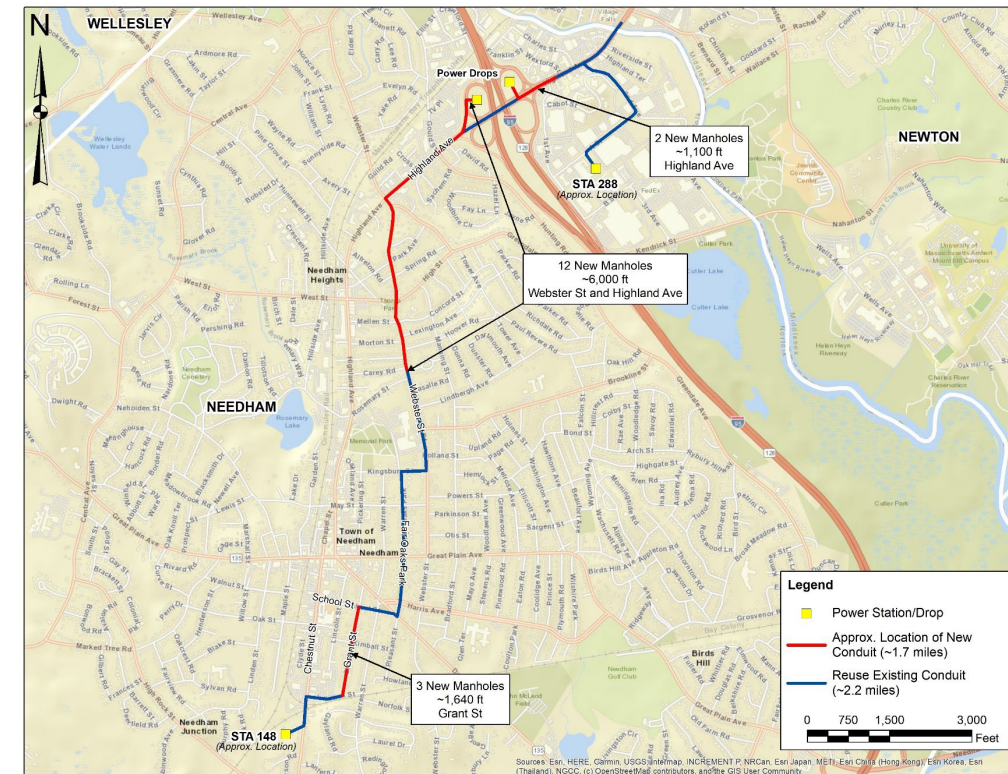
Eversource will design and install all new duct bank & cable

MWRA and Eversource will enter into an agreement addressing completion schedule and compensation, subject to Board approval

Power supply will remain and provide added resilience to the power grid

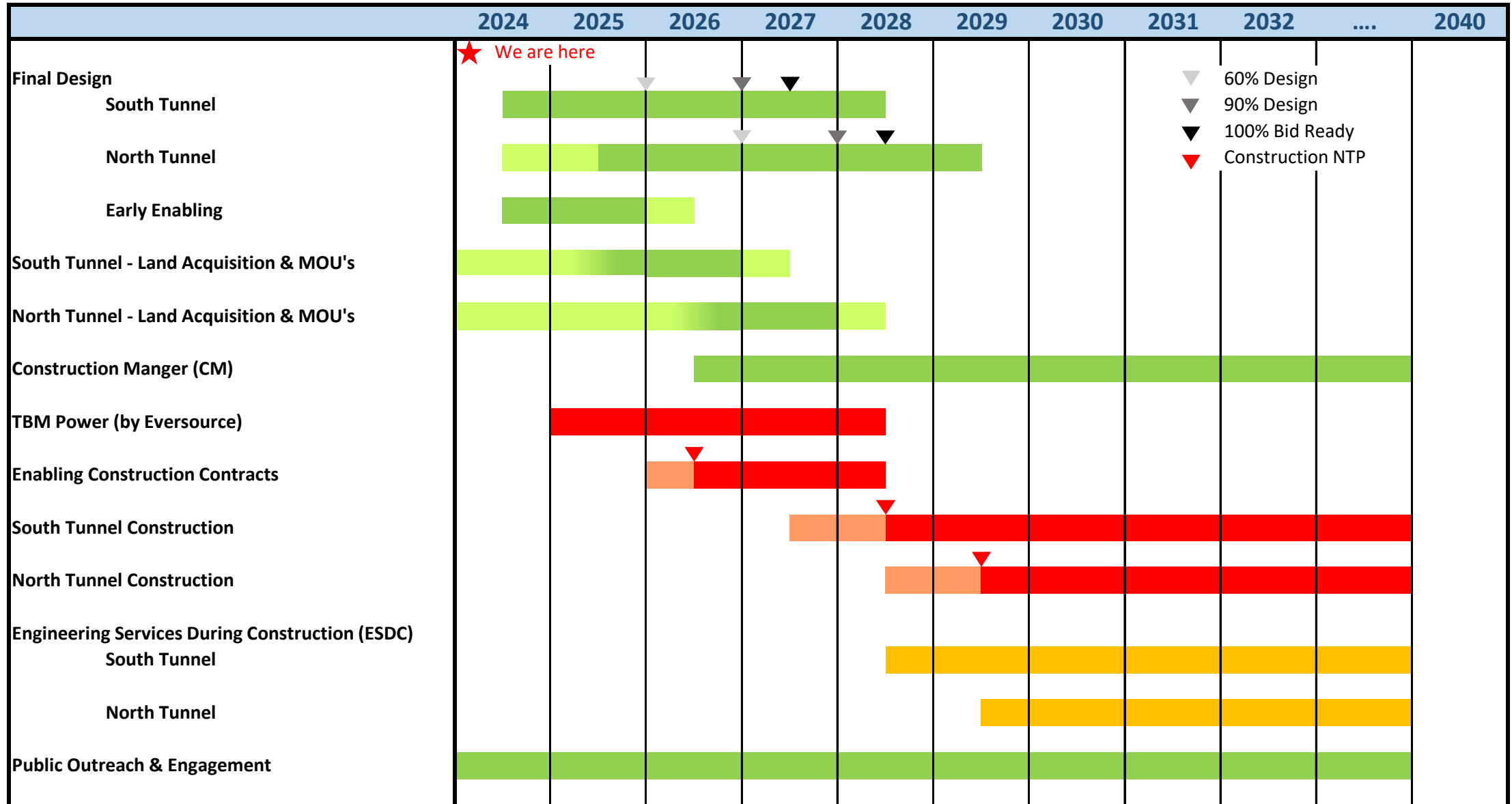
Highland Ave Launching Shaft Sites:

- ~1.7 miles of new duct bank & cable
- ~2.2 miles of reused duct bank & cable
- All within Needham



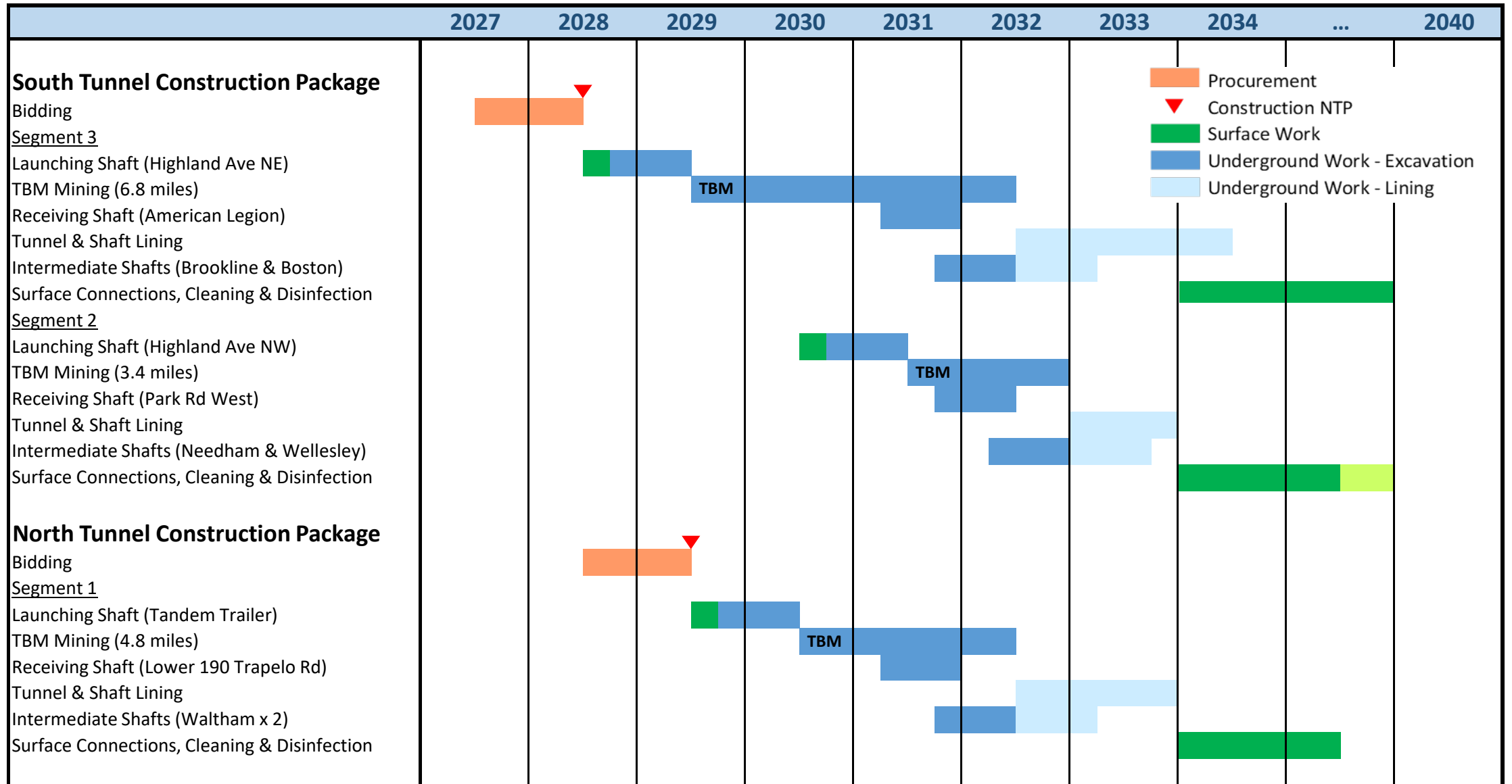


Tunnel Program - Critical Path Schedule





Tunnel System – Construction Schedule Look Ahead





Metropolitan Water Tunnel Program



Thank You!