



# ANNUAL MEETING PRESENTATION

State Project No. 167-108

## Heroes' Tunnel

Route 15 Wilbur Cross Parkway

Through West Rock Ridge

Hamden, Woodbridge, New Haven

April 21, 2017

# Agenda

- History of Heroes' Tunnel Construction
- Recent Inspection
- Current Project Underway
- Next Steps

## **Presenters:**

David A. Cutler, PE  
Supervising Engineer  
CTDOT  
Bridge Consultant Design

Joseph C. Balskus, PE, PTOE  
Principal  
CDM Smith



# U.S. Route 1

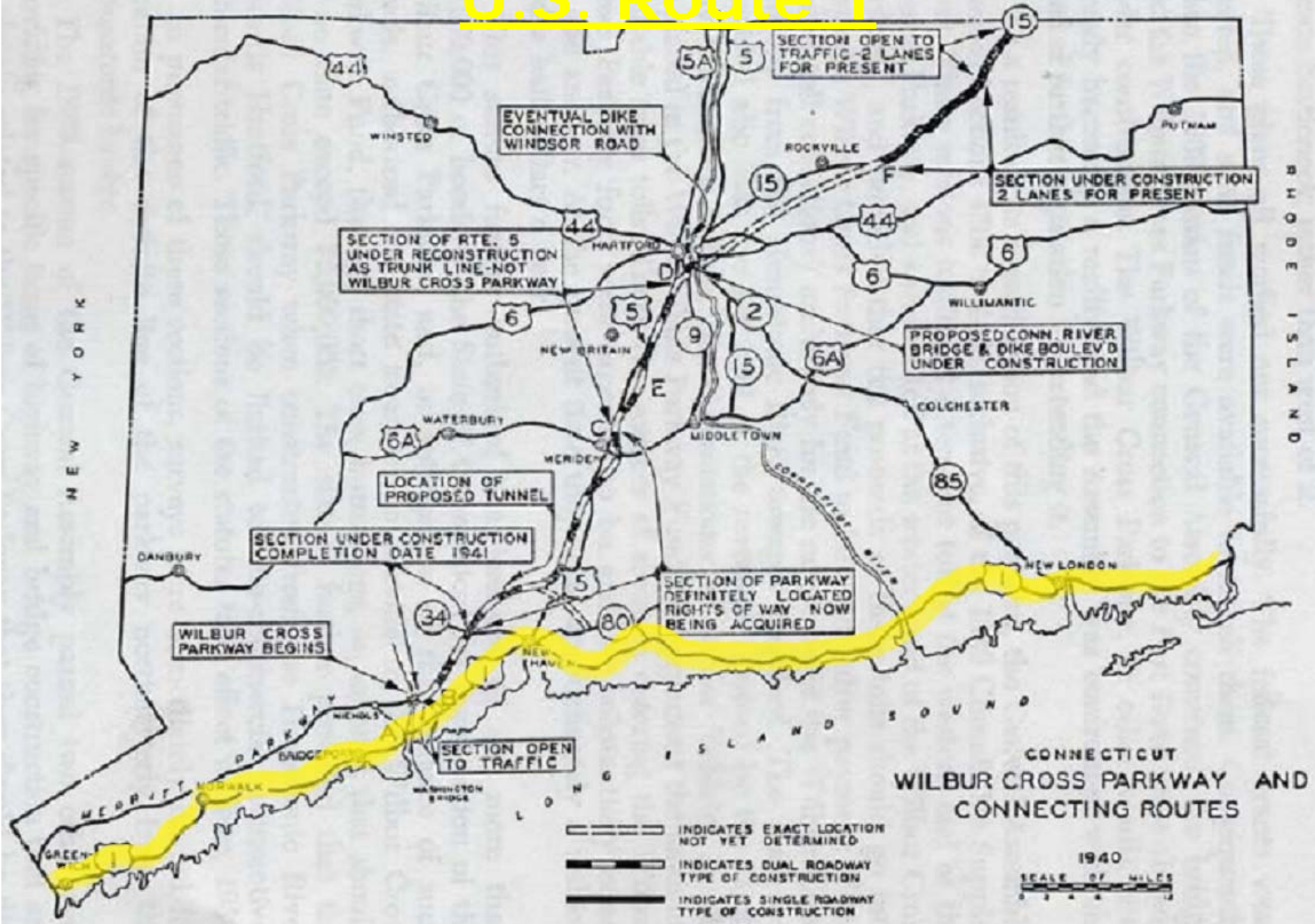


FIG. 32

# Merritt Parkway

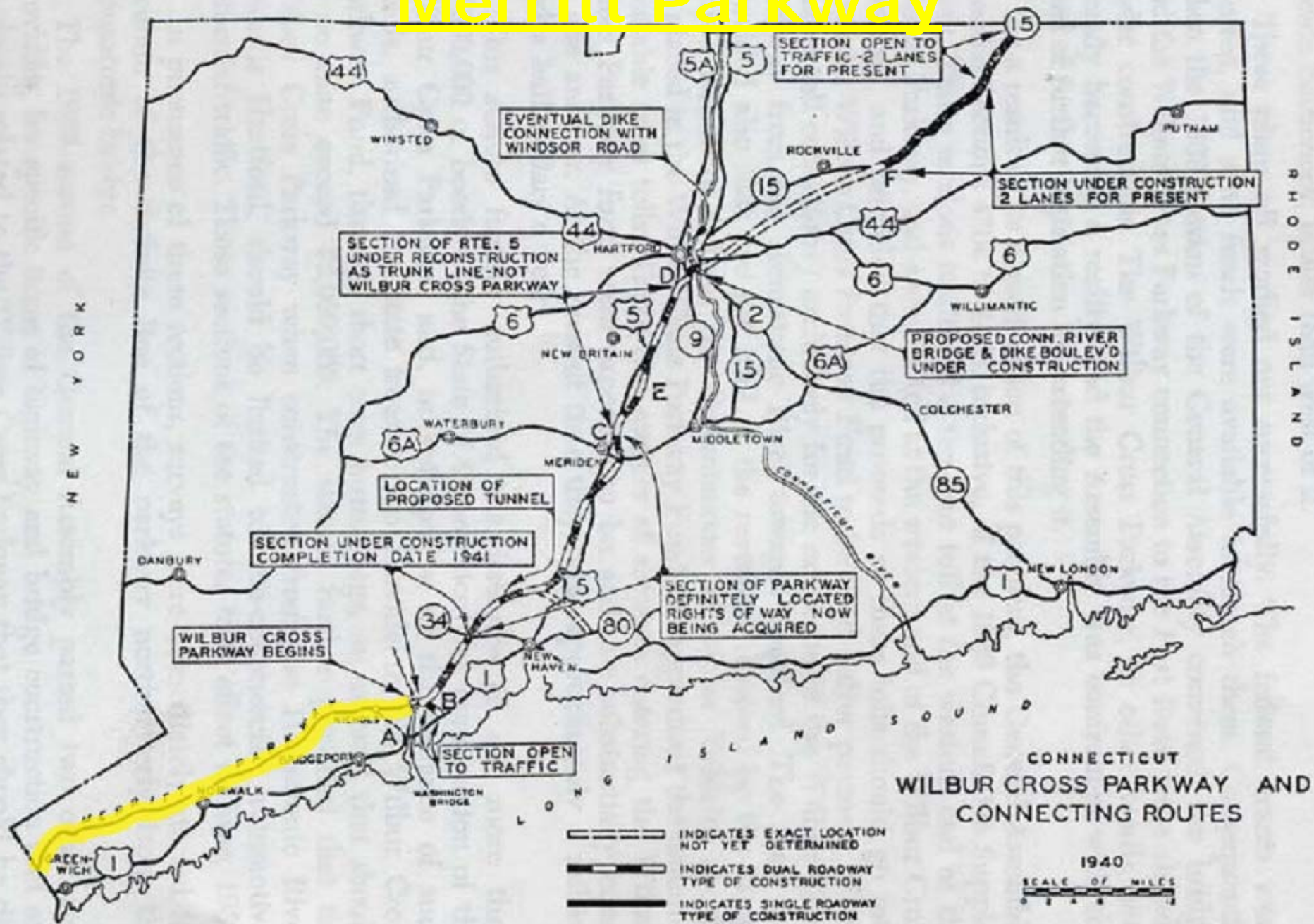


FIG. 32

# Wilbur Cross Parkway

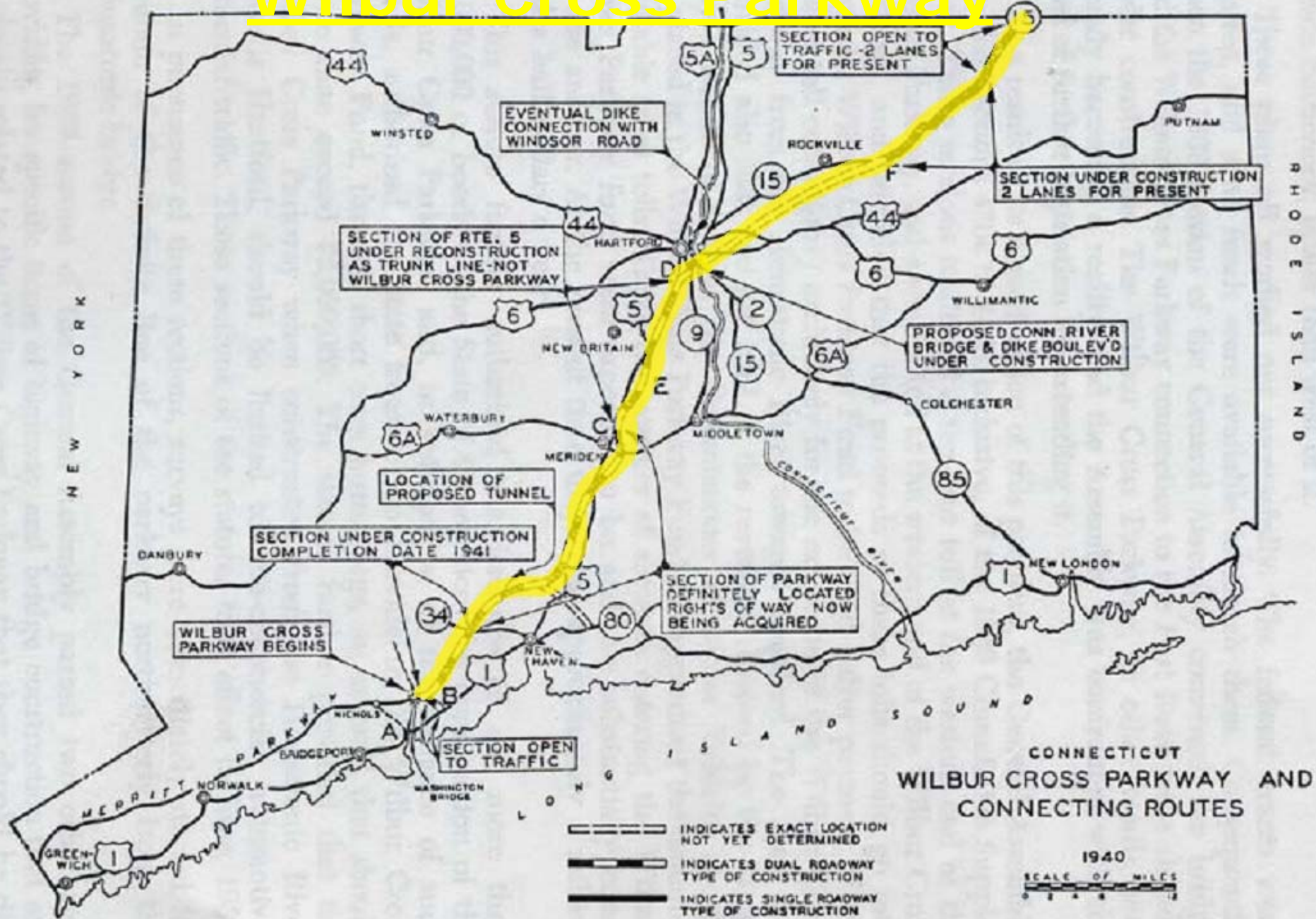


FIG. 32

# Wilbur Cross Parkway (Route 15) New Haven Area



## Original Tunnel Alternatives

- Single Bore – 26'-6" wide
- Single Bore – 52'—6" wide
  
- Twin Bores – each 26'-6" wide  
(selected as the most cost effective alternative)



# Project Inactive During WWII



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## Post War - Tunnel Design

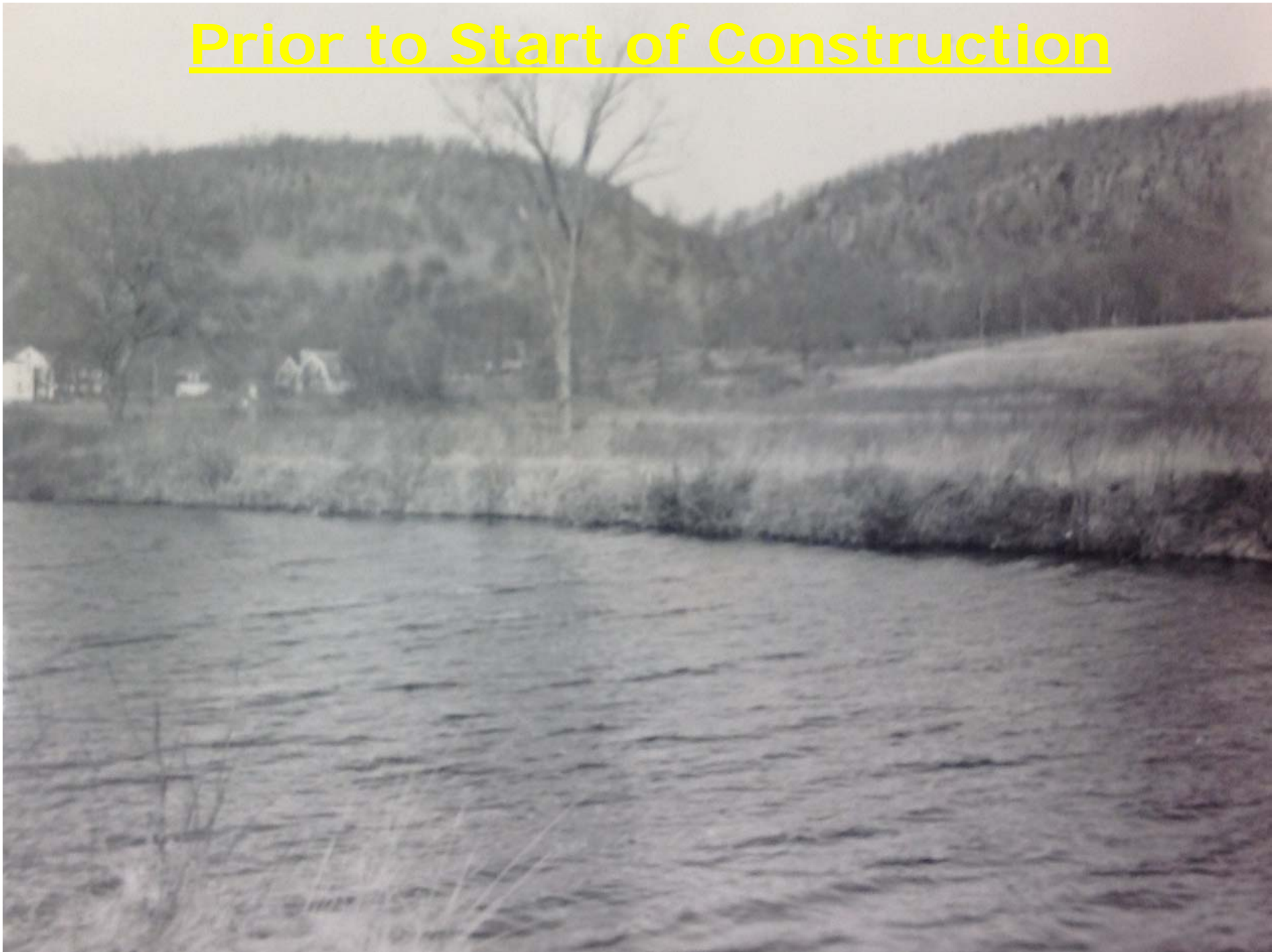
- Parsons, Brinkerhoff, Hogan, and MacDonald prepared design plans
- 1200' long
- Twin Bores – each with 23' roadway and 2'-6" curbs
- Traffic estimate 13,000 (1950)
- Adv. December 1947, Award Jan 1948
- Contractors L.G. Defelice & Gull Contracting
- Construction March 1948 – November 1949
- Cost approximately \$2.0 Million



# Original Construction Photos



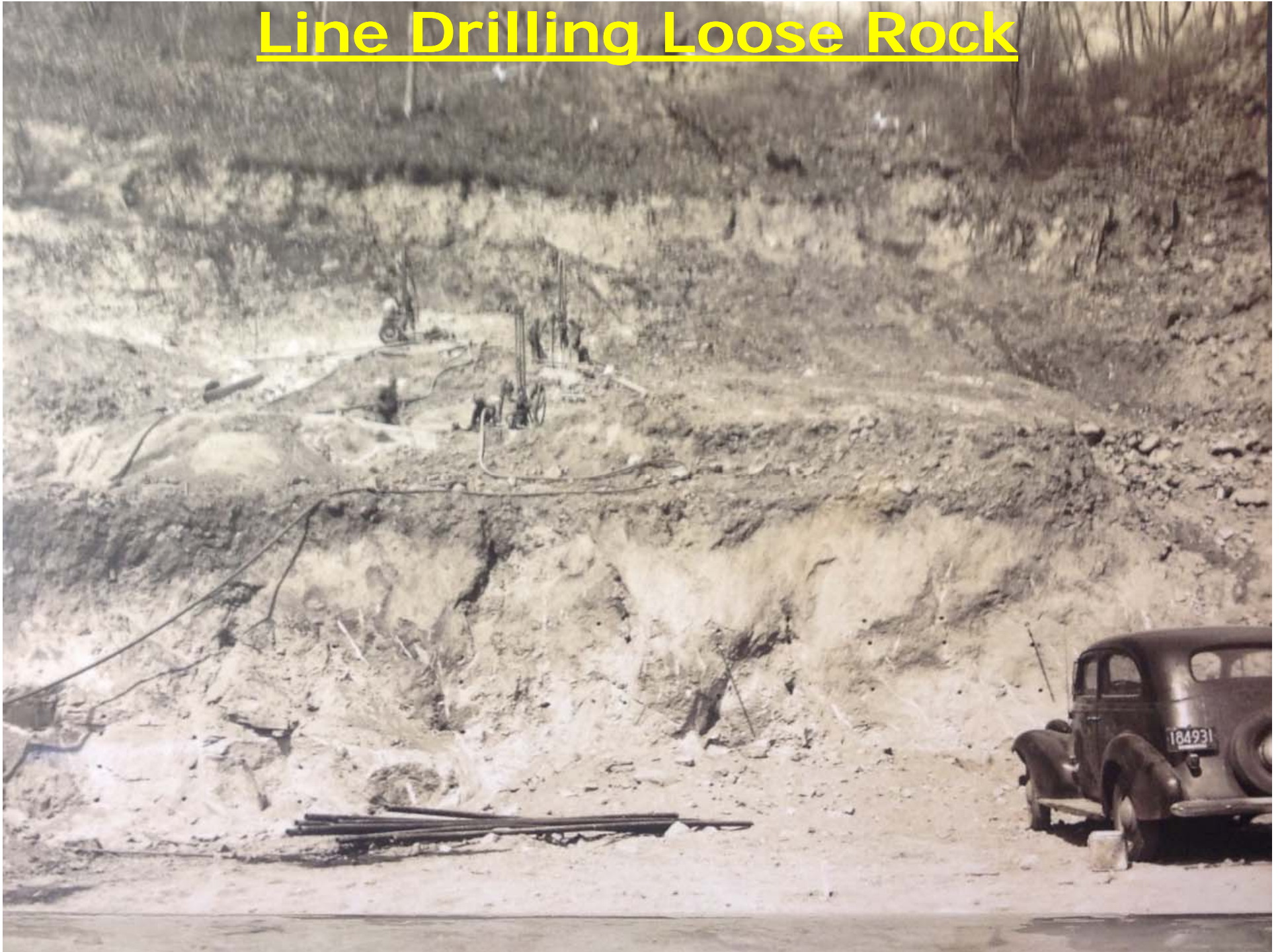
## Prior to Start of Construction





Start of Construction at West Portals

# Line Drilling Loose Rock





Drill Jumbos



Aftermath of First Blast



Rubble Removal

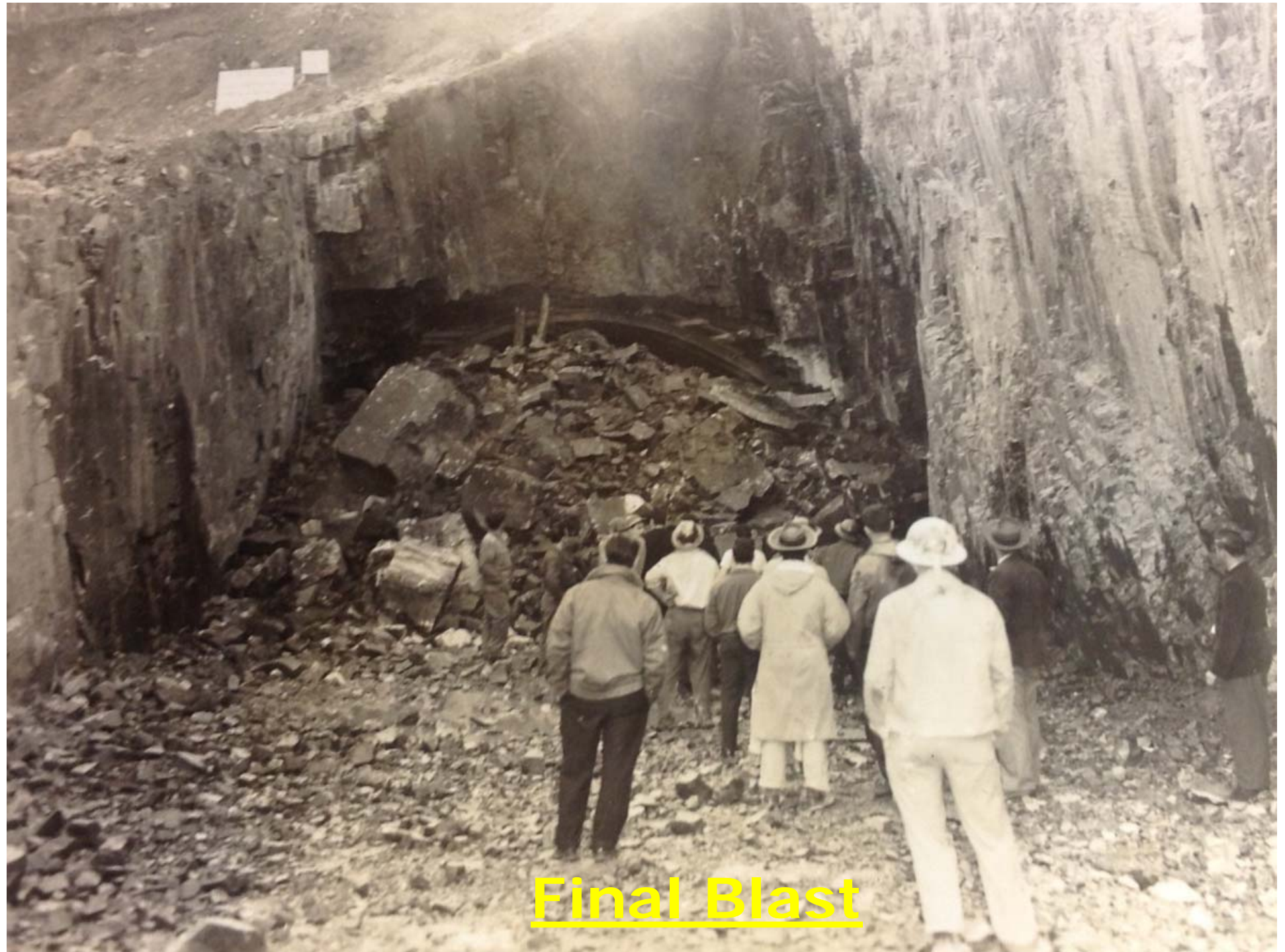




Permanent Steel Support Ribs



Steel Arch Ribs



Final Blast



Final Blast November 8, 1948



Commissioner Hill

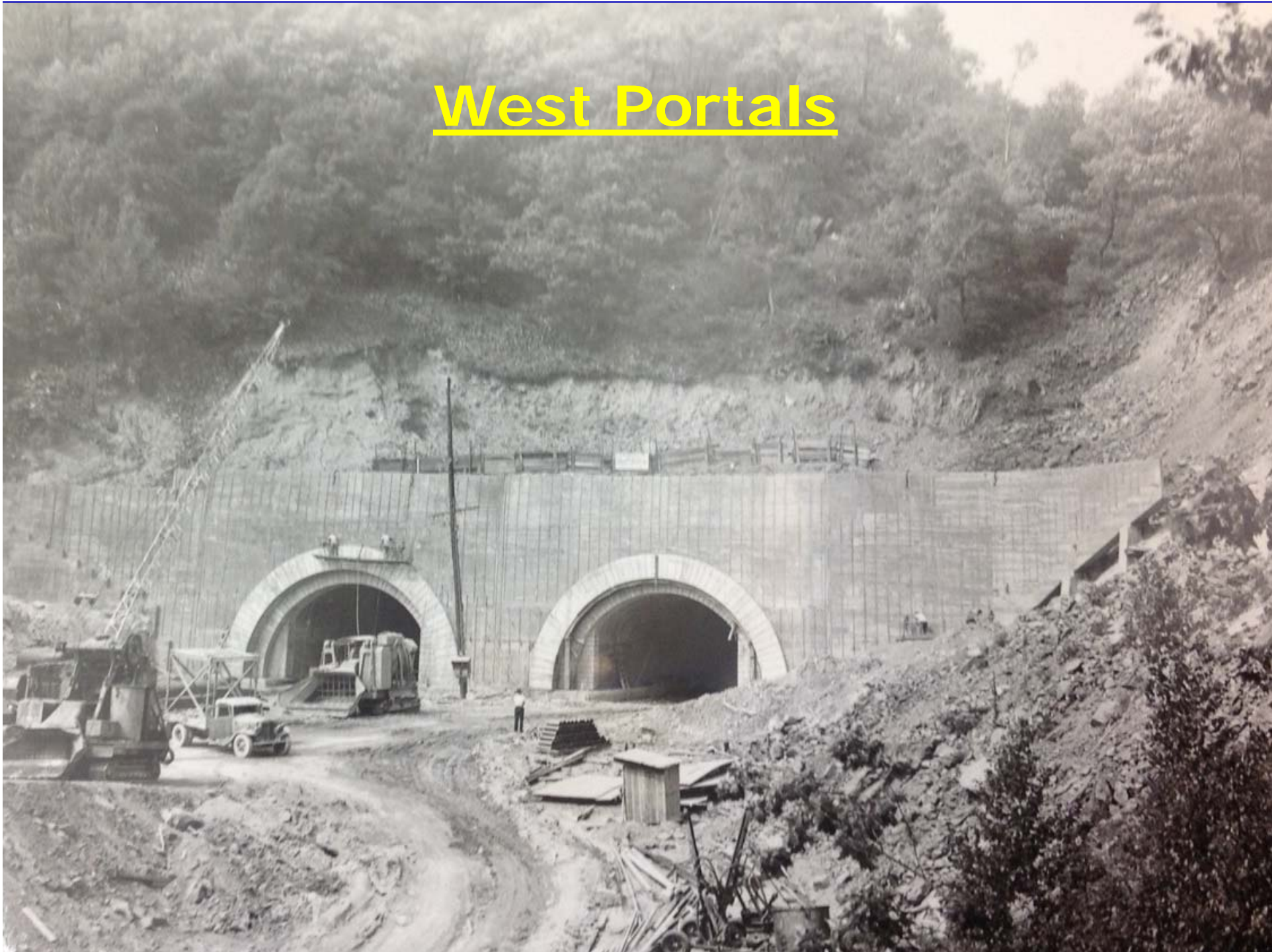
# East Portals May 1949





Placing Reinforcing

# West Portals





# Counterfort Retaining Wall



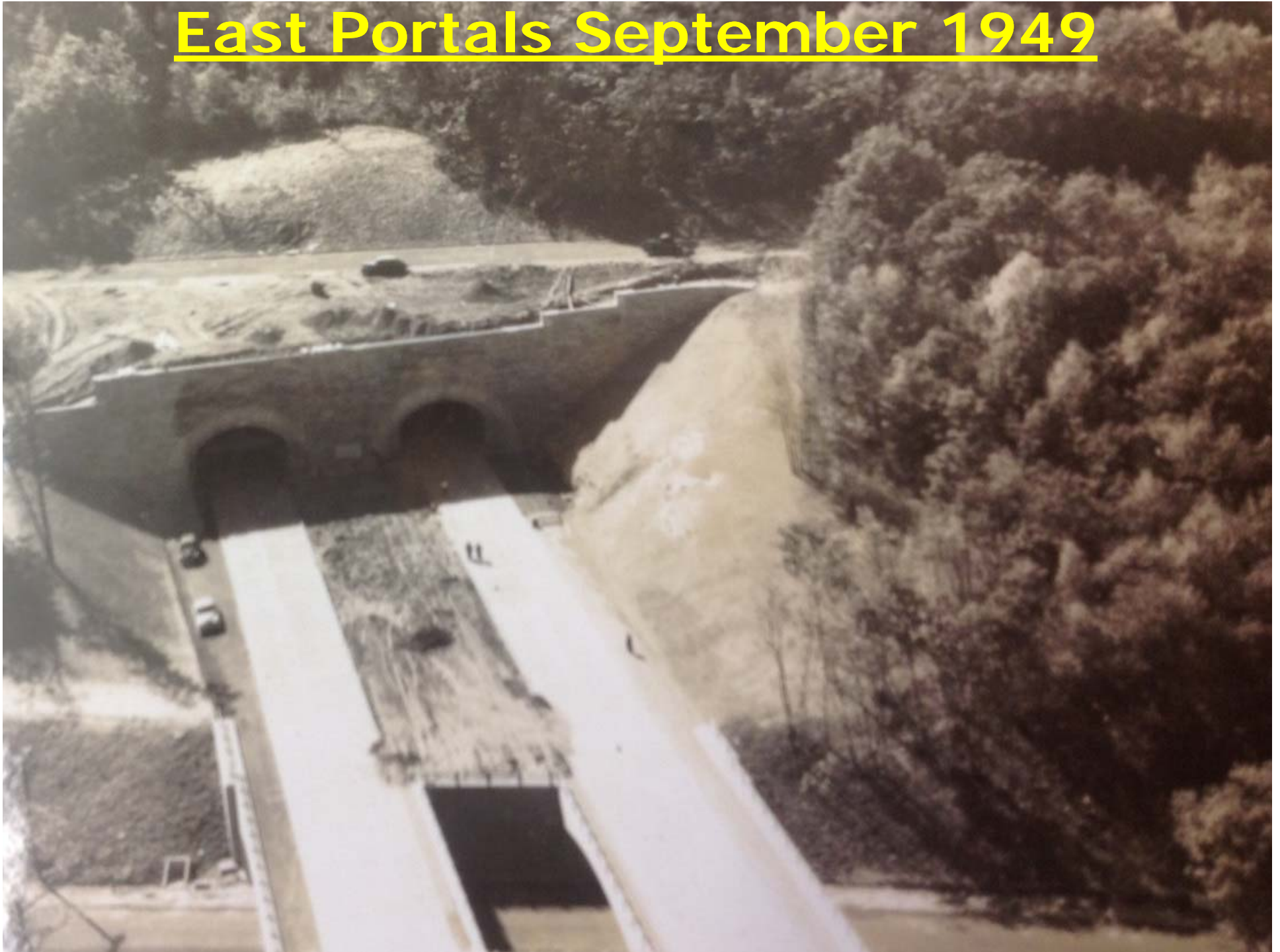
## Cut and Cover Drainage



# West Portals September 1949



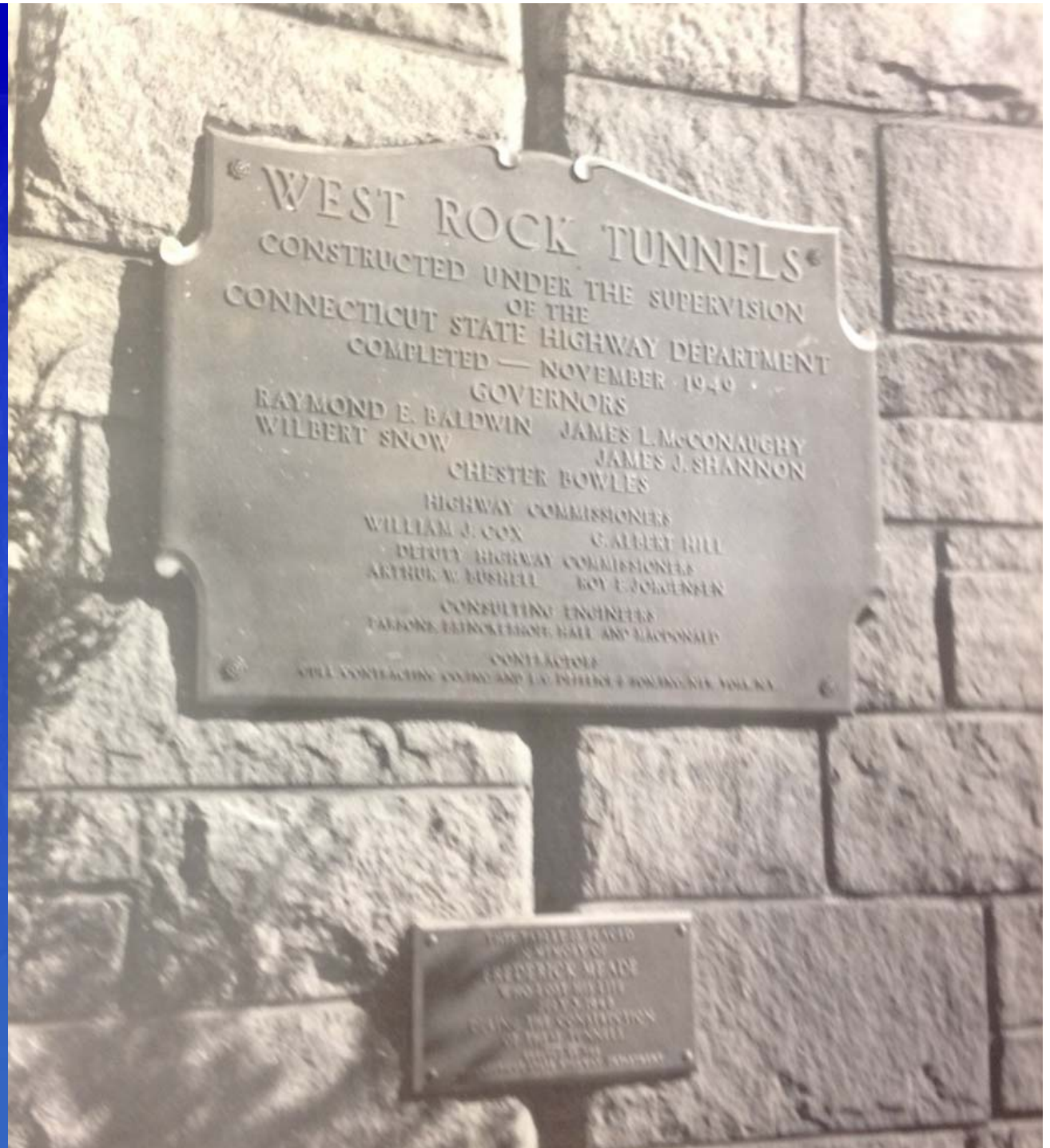
# East Portals September 1949



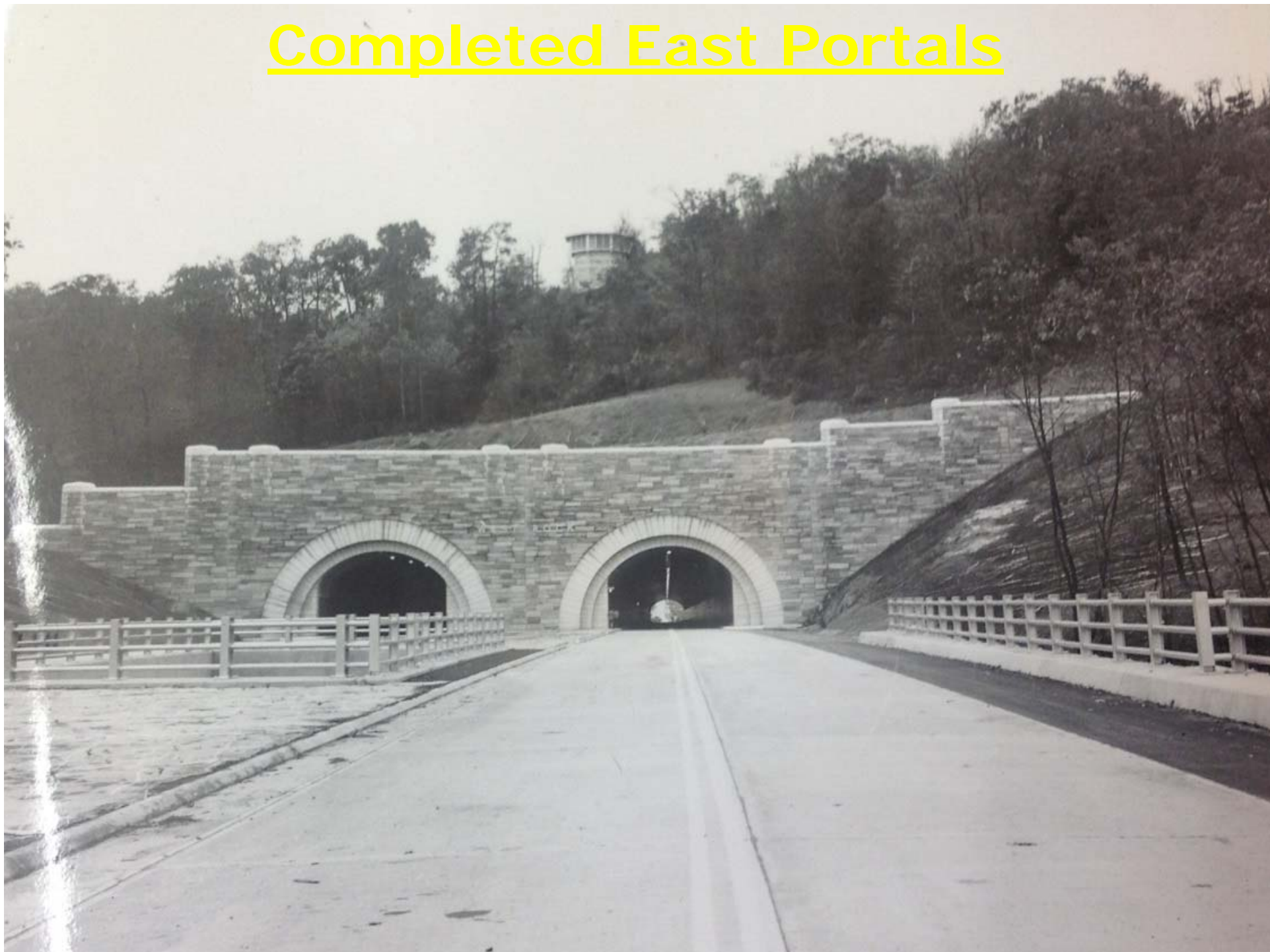


Opening Day November 1, 1949

# Bronze Plaque



# Completed East Portals





East Portals October 2014

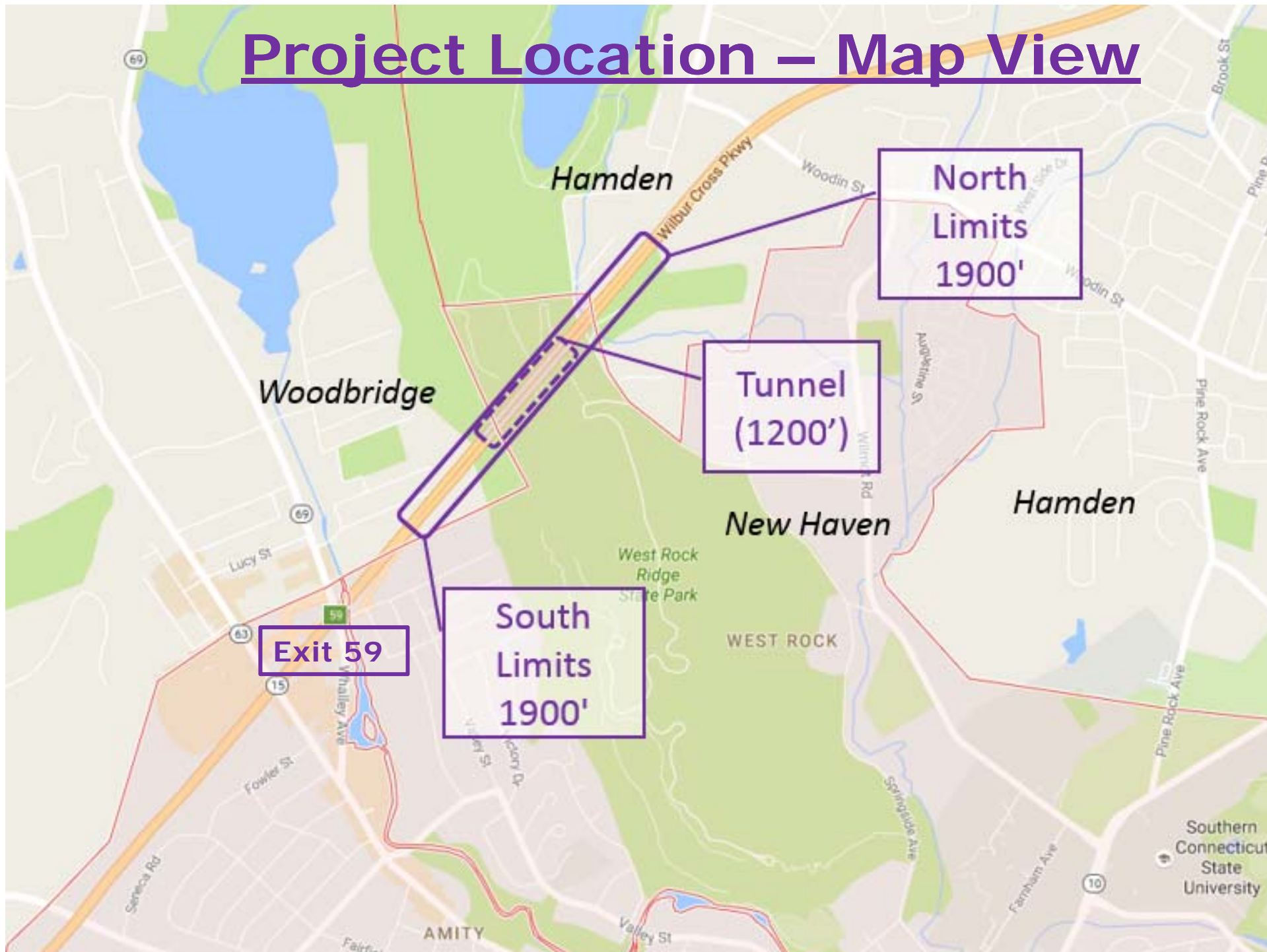


## PE Study – Project No. 167-103

- CDM Smith retained in 2007 to perform inspection and develop rehabilitation alternatives for structural and drainage deficiencies.
- Initial report detailed methods and cost to replace tunnel lining and waterproofing, elec./mech. systems
- Subsequent iterations of the report detailed construction alternatives and associated traffic implications



# Project Location – Map View



# Project Location – Aerial View

Existing Tunnel



# Existing Conditions

- **Significant Deterioration**
  - Prior Biennial Reports
  - CDM Smith Inspection/Study
- **Peak Hour Congestion**
  - Recurring Bottlenecks
- **Emergency Response Constraints**
- **Fire Safety System - None**



# Tunnels

- **Ground Water Infiltration**
  - Walls/Ceiling - Stalagmites
  - Freeze/Thaw Conditions
  - Falling Icicles
- **Cross Section Deficient**
  - 26' Existing Width
  - 50' Required (2 Lanes)
- **Frequent Maintenance Requires Tunnel Closures – Shifting Traffic**



# Traffic

- **Tunnel Cross Sections Cause Traffic Slowdown**
- **Driver Perceptions**
- **Peripheral Vision Changes Abruptly**
- **Paved Shoulders – Non-Existent**
- **Northbound Uphill Flow Impacted Most**



# Tunnel Walls



# Tunnel Walls





# Tunnel Ceiling





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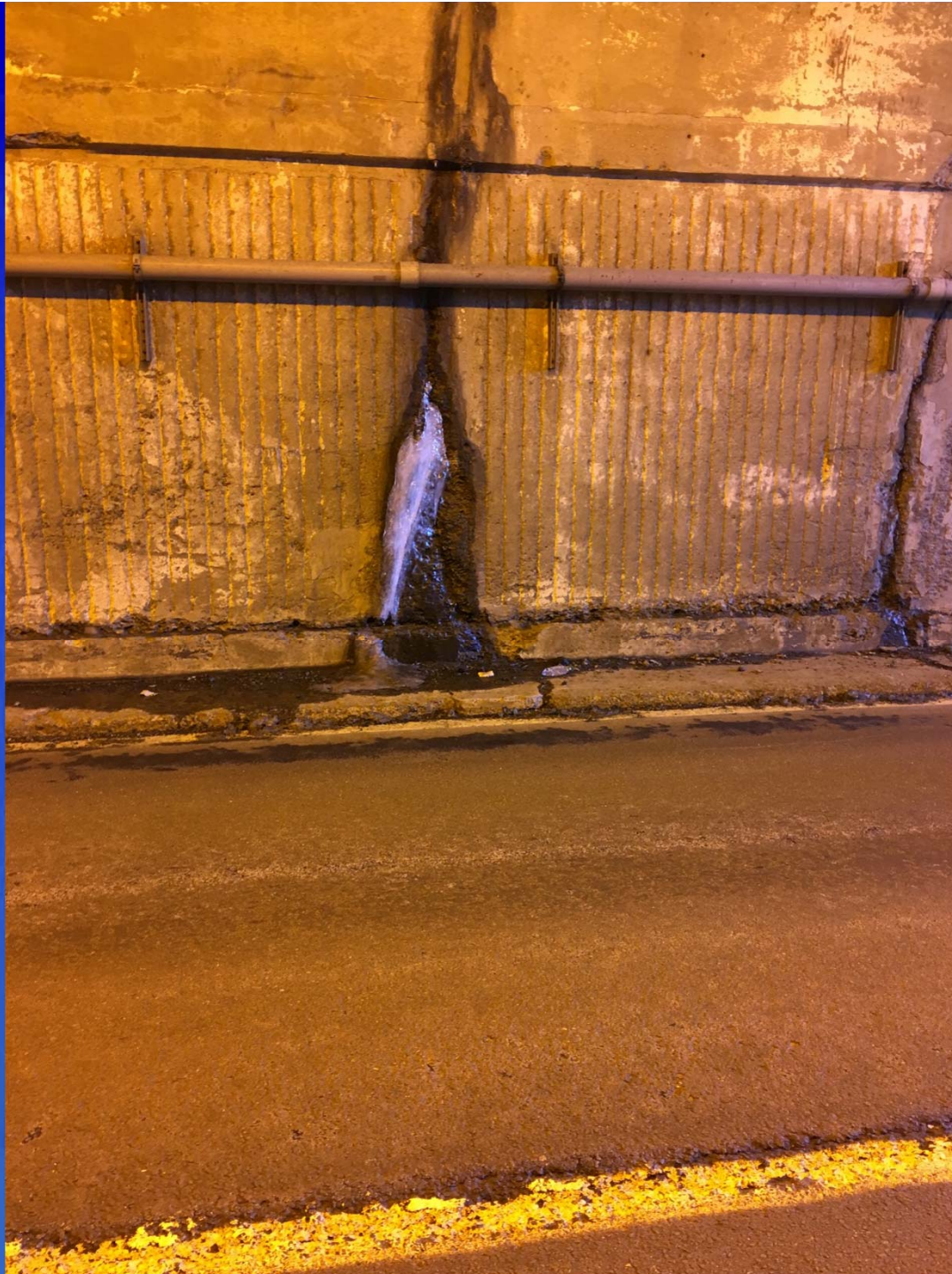


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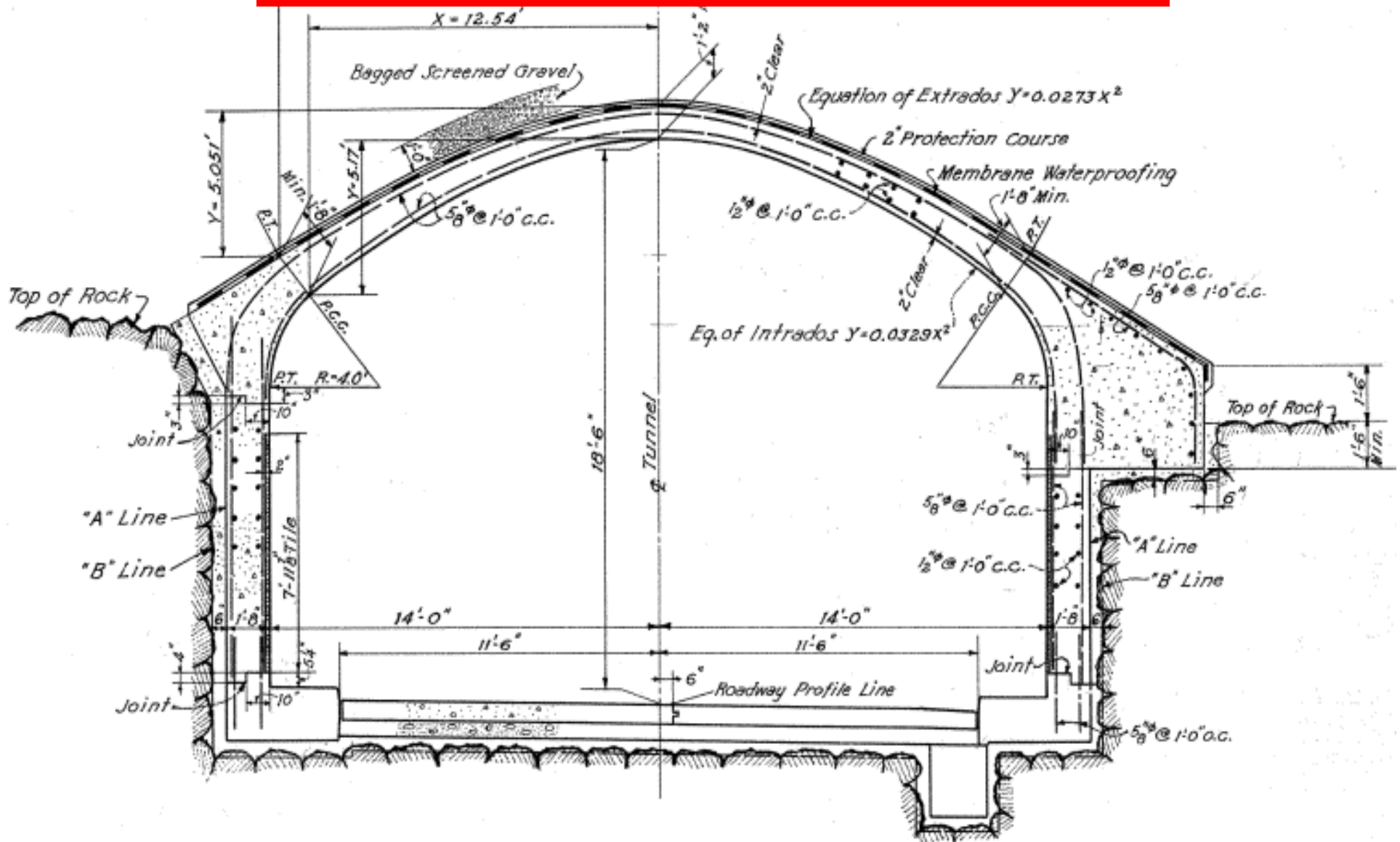


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# Tunnel Built Cross Section



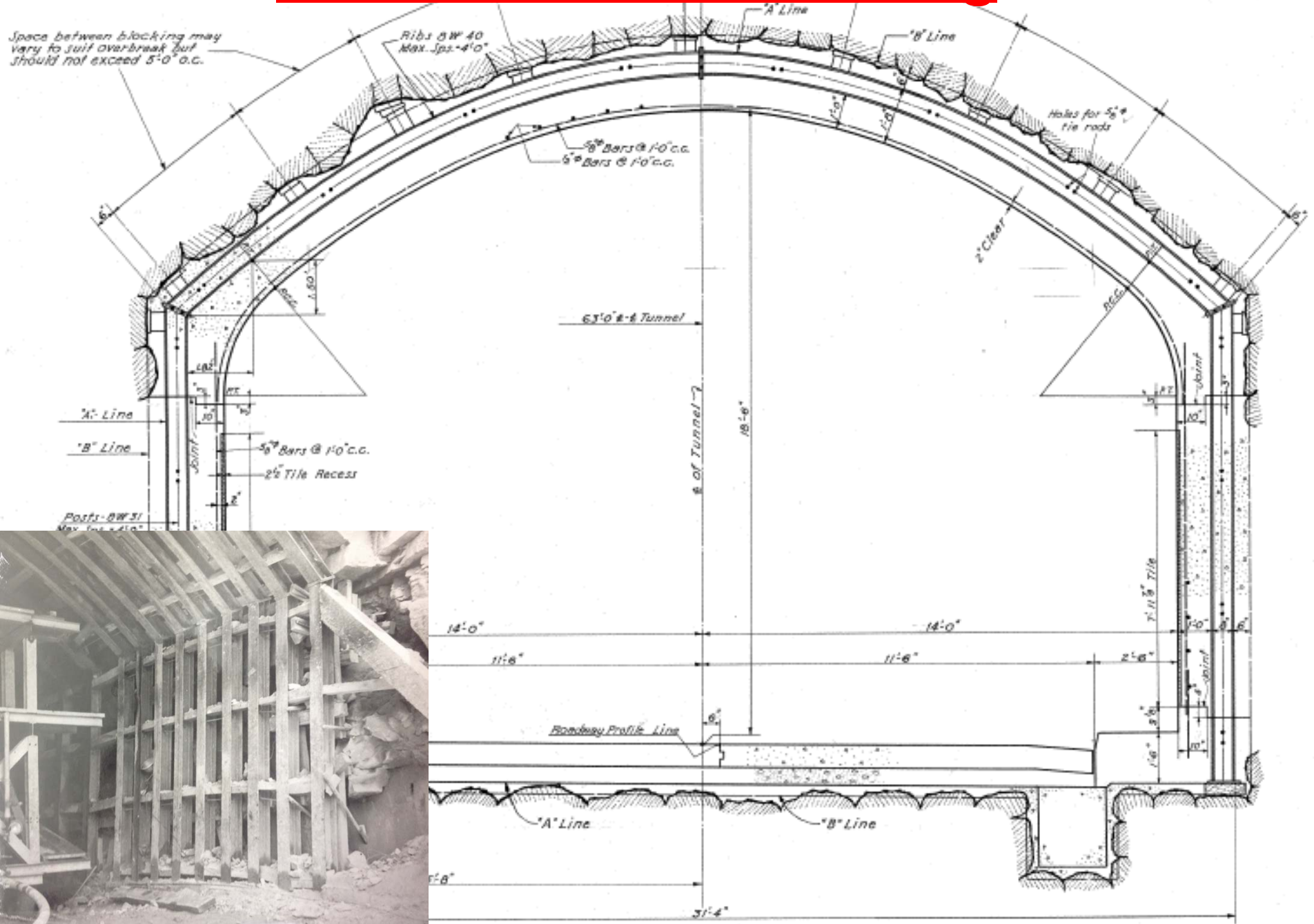
## TYPICAL CROSS SECTION TYPE III

WHERE TOP OF ROCK IS BELOW SPRING LINE OF ARCH AND FOR CUT AND COVER SECTION.

- Scale 1/4" = 1'-0"

# Section w/Steel Framing

Space between blocking may vary to suit overbreak but should not exceed 5'-0" o.c.



# Tunnel Cross Section



# Video



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# Rehabilitation or Reconstruction

- **Rehabilitation of Tunnel Evaluated in 2014 Report**
  - **Significant Traffic Impacts During Lane Closures**
  - **Geometrics Not Correctable Within Existing Tunnel Widths**
    - **Vehicle Speeds Through Tunnel Impacted**
    - **Narrowness of Tunnel Causes Reduced Speeds**
  - **Structural Integrity of Tunnels – Ground Water Infiltration**



# Rehabilitation or Reconstruction

- **Rehabilitation Limits Benefits of Tunnels**
  - Future Service Life
  - Future Traffic Flow Capacity
- **Reconstruction Options Considered**



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# Rehabilitation or Reconstruction

- Traffic Impacts with Rehabilitation
- Closure of One Barrel – Miles of Delays

Performance Measure	Unit	Existing Conditions Value	2019 Future Conditions Without Construction Value	2019 Future Conditions During Construction Value
Throughput Volume	ea	80,619	82,169	75,495
Average Delay Time Per Vehicle	sec	44.1	49.4	121.3
Average Speed	mph	55.4	54.3	42.7
Total Distance Traveled	mi	335,332	341,526	312,305
Number of Stops	ea	109,123	126,357	275,233
Total Stopped Delay	h	125.8	155.9	292.9
Total Travel Time	h	6,048.40	6,286.10	7,313.25
Total Annual Hours	h	2496	2496	2496
Total Period Delay	h	987.6	1,127.5	2543.8
Average Hourly Delay	h	141.9	162.0	365.5
Total Annual Delay	h	354,167.6	404,359.6	912,245.7
Increase in Annual Delay	h	--	50,192.0	507,886.1



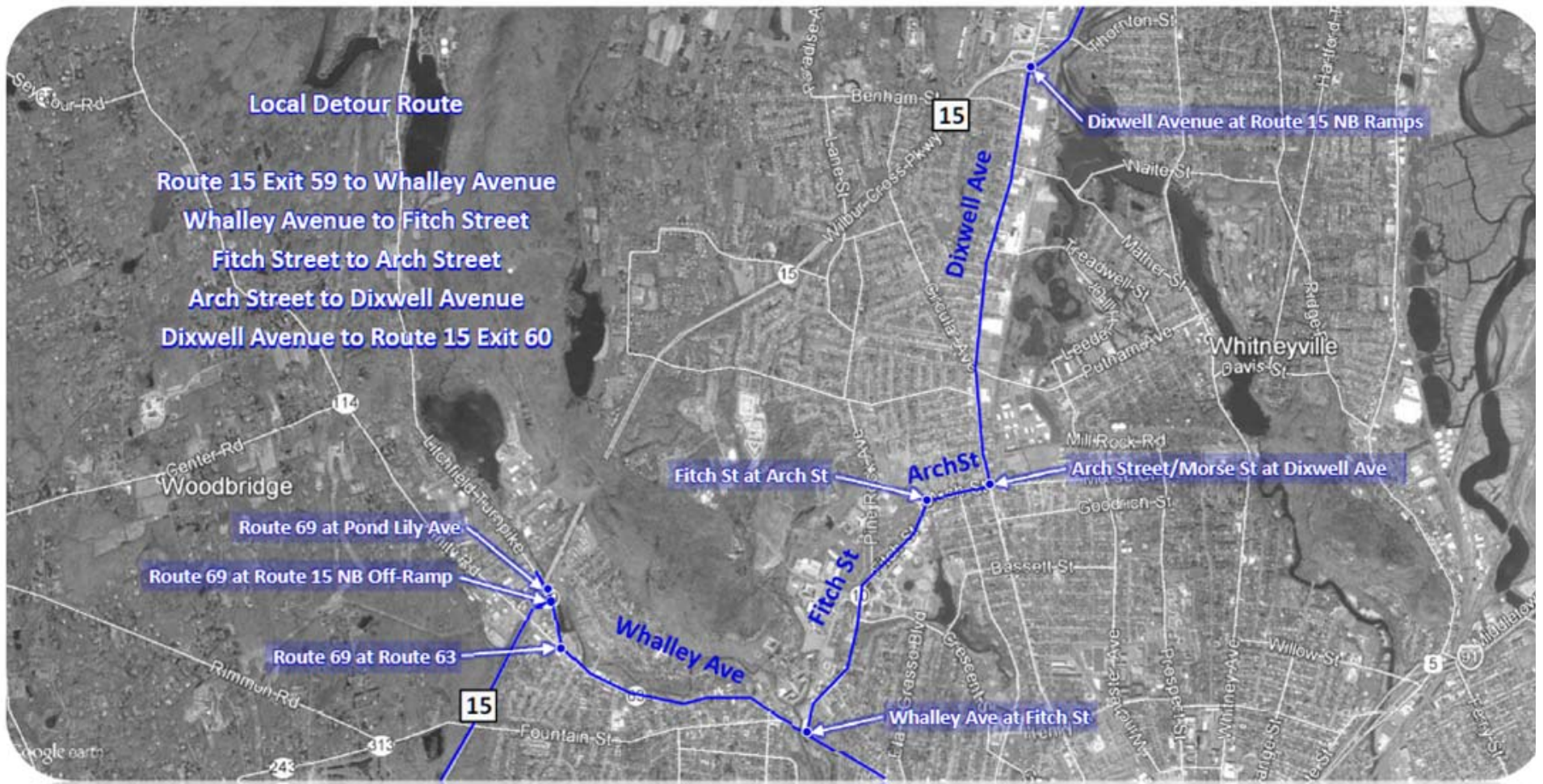
# Rehabilitation or Reconstruction

- DOT Analysis
  - Traffic Calculations indicate 28 mile backup with travel delay at 252 minutes.
  - With 30% volume reductions:
  - Traffic calculations show 5.4 mile PM peak queues at 47.4 minute delay.



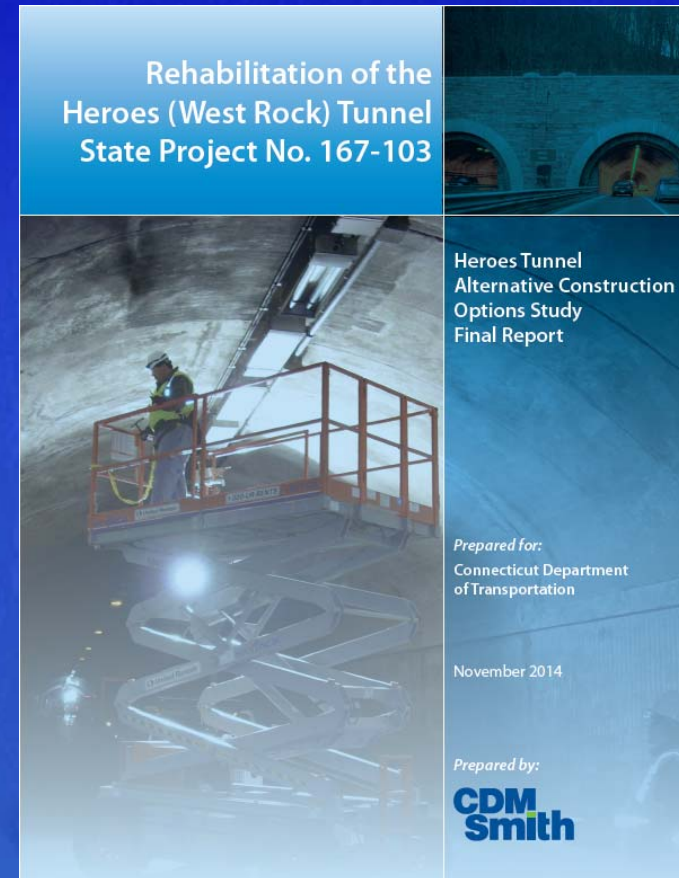
# Rehabilitation or Reconstruction

- Detour Routing



# Rehabilitation Reports Summary

- November 2014 Alternative Construction Options Study
- September 2016 Supplement
- Studied Several Options
  - New One-Lane Tunnel
  - New Two-Lane Tunnel
  - Widen Existing Tunnel
  - Close One Existing Tunnel/Detour
  - Close One Lane in Existing Tunnel
  - Construction Bypass Tunnel (short)
  - Construction Bypass Tunnel (long)
- Additional Options to be Explored
- No Build (Do Nothing)



# November 2014 Report

- ❖ CDM Smith Evaluated the five tunnel rehabilitation and construction options
- ❖ Estimated Anticipated Useful Life
- ❖ Recommended Construction Options:
- ❖ BUILD NEW NB TWO LANE TUNNEL
- ❖ WIDEN EXISTING SB TUNNEL
- ❖ MAINTAIN EXISTING NB TUNNEL – STORAGE/MAINTENANCE



# PE Study Alternative Matrix

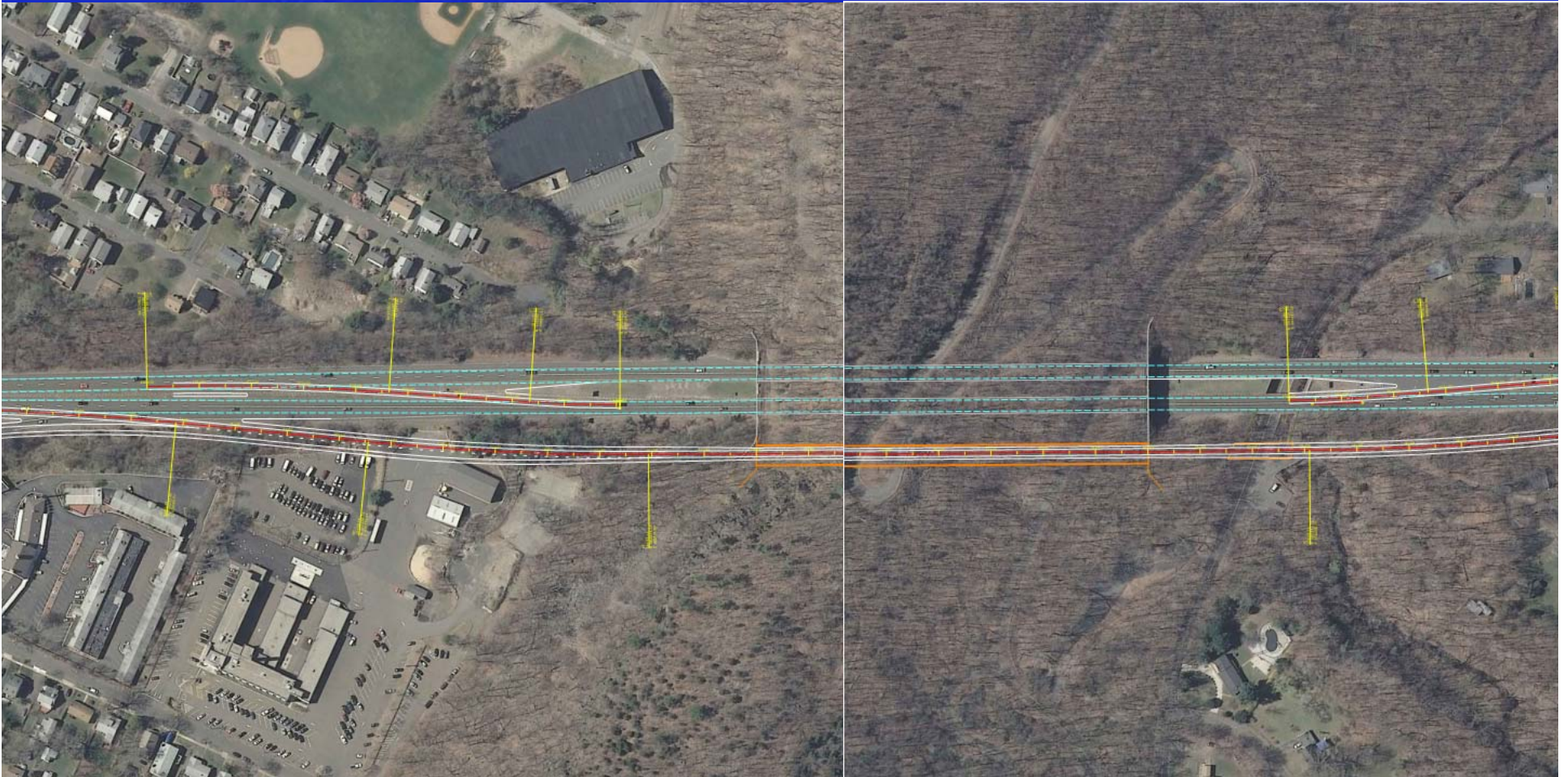
MILES TUNNEL CONSTRUCTION SCENARIOS																		
MASTER SCENARIO DESCRIPTION AND CONCEPTUAL COST ESTIMATE																		
Construction Scenario	Description	New Tunnel Construction Method	Existing Tunnel Rehabilitation Method	Construction Duration (Months)	Estimated Costs (in \$MM)												Engineering	Project Total
					New 1 Lane Tunnel	New 2 Lane Tunnel	New 3 Lane Tunnel	Enlarged 2 Lane Tunnel	Enlarged 3 Lane Tunnel	Rehabilitate 1 Tunnel	Rehabilitate 2 Tunnels	Maintenance & Protection of Traffic Delay	Highway Modifications Construction	ROW	Construction Total			
A	Construct a new single lane tunnel (Option 1) and subsequently rehabilitate both existing barrels in a staggered approach (minimal traffic impact). This results in 5 lanes in the future.	Drill and Blast	Install new drainage system, waterproofing membrane, and protective lining.	37	55.2	--	--	--	--	--	25.3	--	22.9	2.5	96.0	10	106.0	
B1	Construct a new double lane single barrel tunnel (Option 2) and subsequently rehabilitate one of the two existing barrels (minimal traffic impact); abandon non-rehabilitated barrel. This results in 4 lanes in the future plus a non-rehabilitated 2-lane tunnel that would potentially be used for storage by installing bulkheads at each portal to prevent access of pedestrians and traffic through the tunnel.	Drill and Blast	Install new drainage system, waterproofing membrane, and protective lining.	28	--	65.5	--	--	--	12.4	--	--	17.1	2.5	97.5	10	107.5	
B2	Construct a new double lane single barrel tunnel (Option 2) and subsequently rehabilitate both of the two existing barrels (minimal traffic impact). This results in 6 lanes in the future.	Drill and Blast	Install new drainage system, waterproofing membrane, and protective lining.	40	--	65.5	--	--	--	--	25.9	--	17.1	2.5	110.4	10	120.4	
C	Enlarge one barrel of the existing tunnel (Option 3) and subsequently rehabilitate the other existing barrel (minimal traffic impact). This results in 5 lanes in the future.	--	Rehabilitated Barrel: Install new drainage system, waterproofing membrane, and protective lining.	65	--	--	--	--	67.5	12.4	--	--	2.0	--	81.9	8	89.9	
D	Rehabilitate both of the existing barrels with a complete shutdown of one barrel, followed by a complete shutdown of the other barrel (Option 4). This results in 4 lanes in the future.	--	Rehabilitated Barrel: Install new drainage system, waterproofing membrane, and protective lining.	24	--	--	--	--	--	--	24.4	2.8	--	--	26.6	3	29.6	
E	Rehabilitate both of the existing barrels with a partial shutdown of one barrel, followed by a partial shutdown of the other barrel (Option 5). This results in 4 lanes in the future.	--	Rehabilitated Barrel: Install new drainage system, waterproofing membrane, and protective lining.	20	--	--	--	--	--	--	28.5	--	--	--	28.5	3	31.5	
CTDP ALTERNATIVE #1	Construct new 2 lane northbound barrel. Enlarge the southbound barrel to a 2 lane configuration with additional roadway clearance. Rehabilitate the existing northbound barrel for use as a service tunnel.	Drill and Blast	Drill and Blast with Protective Shield: Rehabilitated Barrel: Install new drainage system, waterproofing membrane, and protective lining.	60	--	65.5	--	47.9	--	12.4	--	--	17.1	2.5	145.4	14	159.4	
CTDP ALTERNATIVE #2	Construct new 3 lane northbound barrel. Enlarge the southbound barrel to a 3 lane configuration. Rehabilitate the existing northbound barrel for use as a service tunnel.	Drill and Blast	Drill and Blast with Protective Shield: Rehabilitated Barrel: Install new drainage system, waterproofing membrane, and protective lining.	65	--	65.5	--	67.0	12.4	--	--	--	17.1	2.5	164.5	16	180.5	
CTDP ALTERNATIVE #3	Construct new 3 lane northbound barrel. Enlarge the southbound barrel to a 2 lane configuration with additional roadway clearance. Rehabilitate the existing northbound barrel for use as a service tunnel.	Drill and Blast	Drill and Blast with Protective Shield: Rehabilitated Barrel: Install new drainage system, waterproofing membrane, and protective lining.	60	--	--	93.8	47.9	--	12.4	--	--	24.0	3.5	181.6	18	199.6	
CTDP ALTERNATIVE #4	Construct new 3 lane northbound barrel. Enlarge the southbound barrel to a 3 lane configuration. Rehabilitate the existing northbound barrel for use as a service tunnel.	Drill and Blast	Drill and Blast with Protective Shield: Rehabilitated Barrel: Install new drainage system, waterproofing membrane, and protective lining.	65	--	--	93.8	--	67.0	12.4	--	--	24.0	3.5	200.7	20	220.7	

Notes: Construction Costs include 15% Construction Incentives and 30% Contingencies.  
Engineering Costs are estimated at approximately 10%.  
All costs exclude delay costs associated with construction.  
1 Construction Total Cost includes construction and ROW costs.  
2 Project Total Cost includes construction, ROW, and engineering costs.





# New tunnel

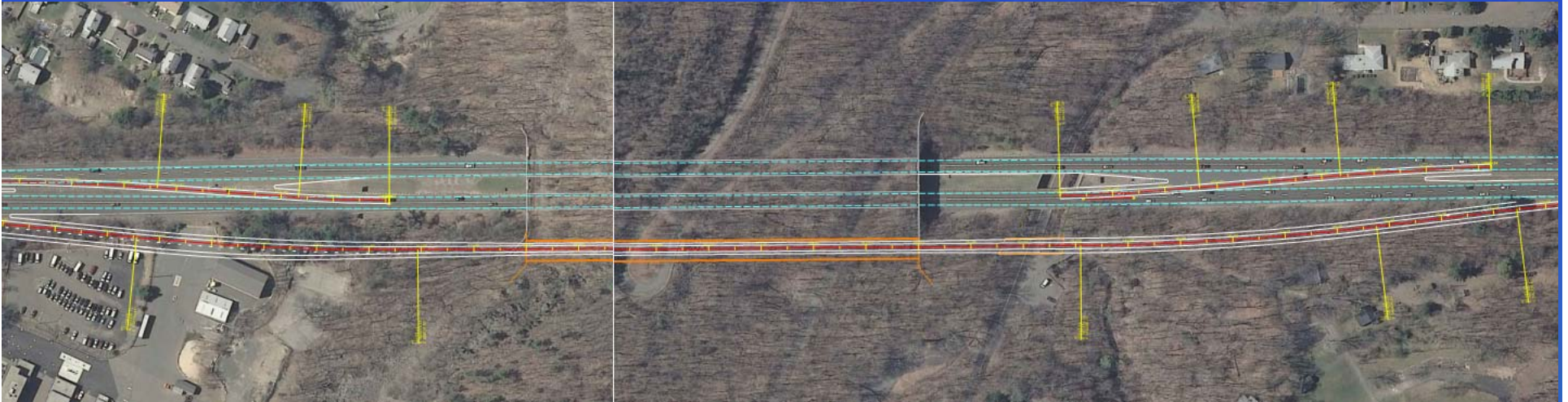


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# Additional Option

- ❖ Supplement to November 2014 Study
- ❖ Evaluate Potential Construction Bypass Tunnel options
  - ✓ Alignment/Geometry
  - ✓ Avoid District III
  - ✓ Avoid Nature Center
  - ✓ Construction cost
  - ✓ Construction duration and sequencing

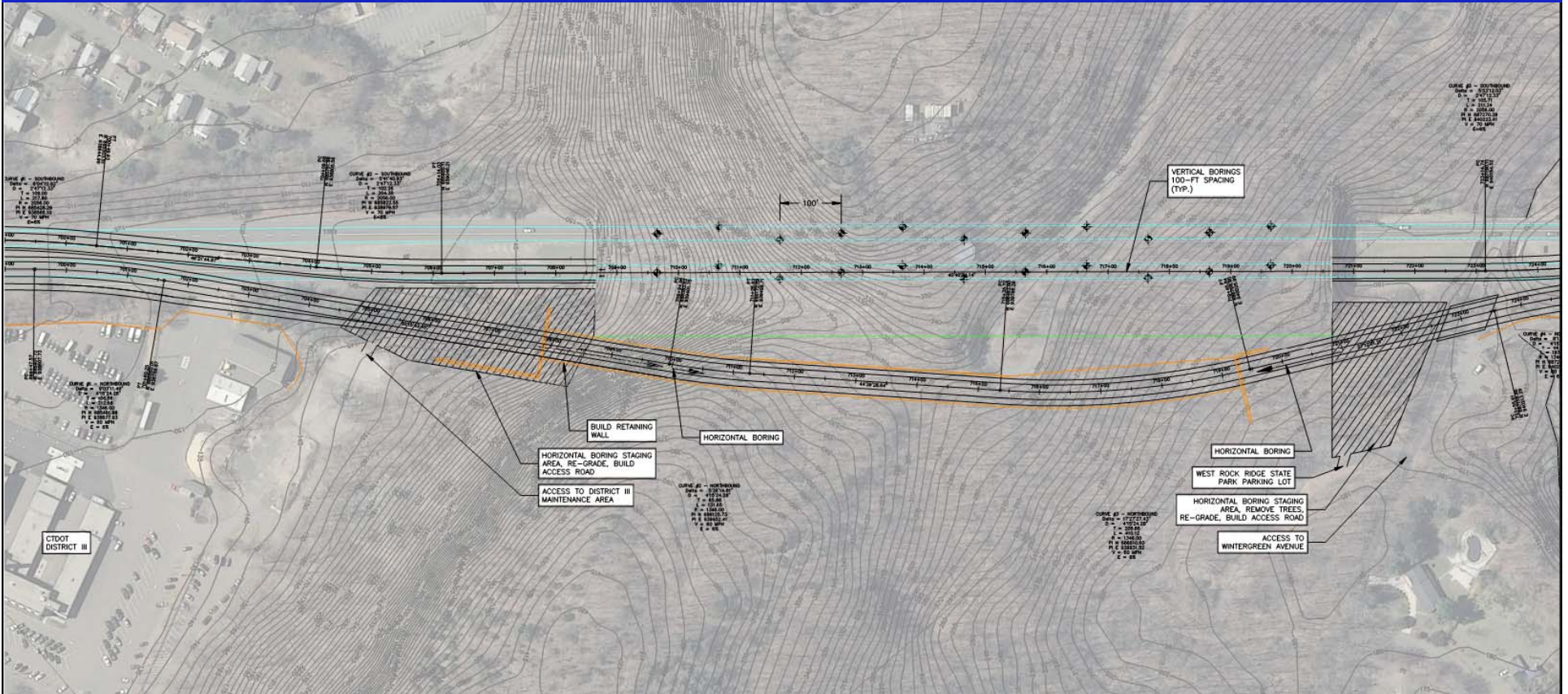


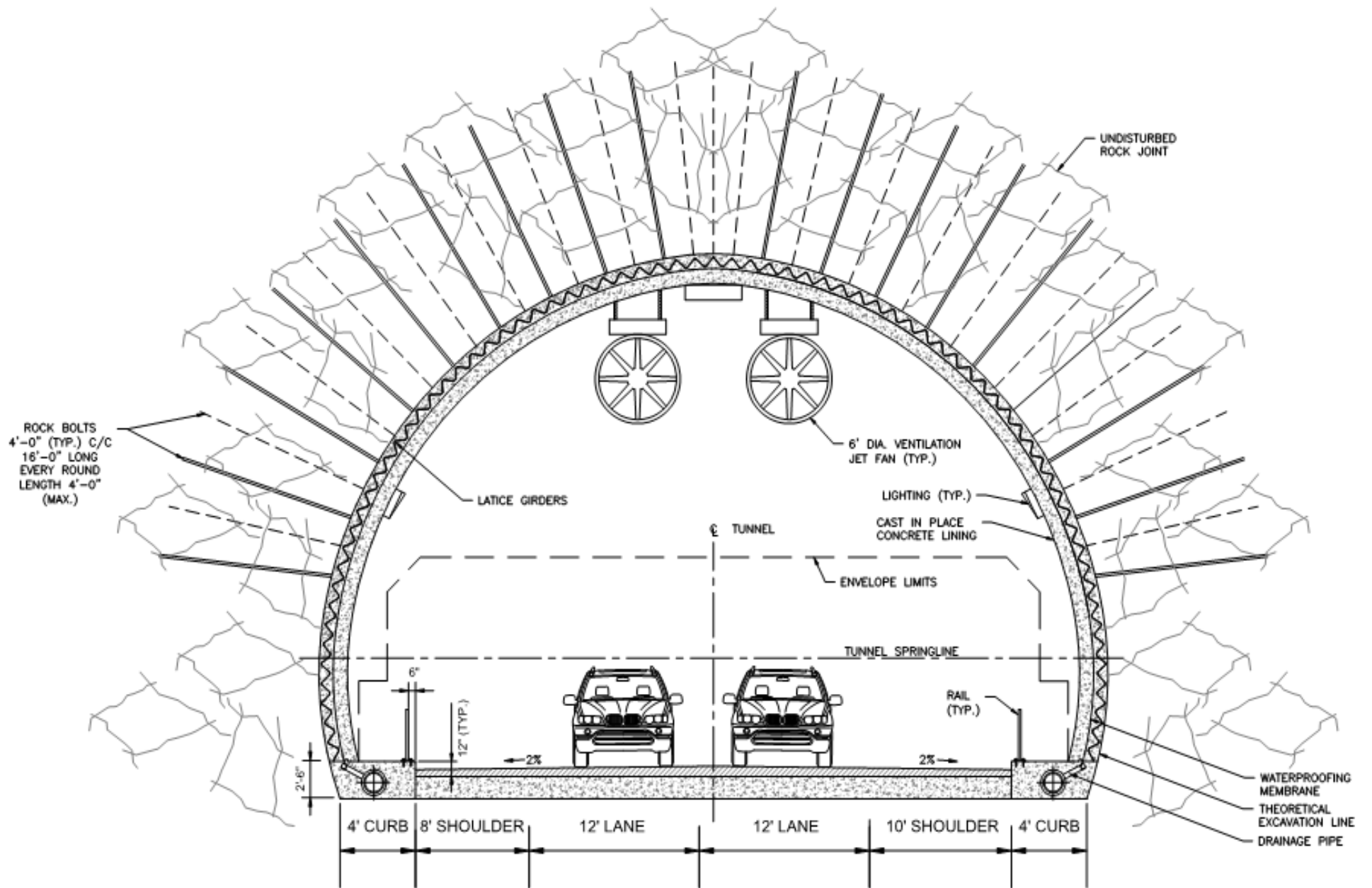
# September 2016 Report

- ❖ Construction Bypass Tunnel Alternative
- ❖ Estimated Anticipated Useful Life
- ❖ Nothing Temporary Allowed Per Standards
- ❖ Revised Geometry – Minimizes Impacts
- ❖ Shorter Tunnel, Potential Steeper Grade



# CBT Alternative





**TWO LANE CONFIGURATION**

Figure 1 Cross Section of New temporary Two lane Tunnel

# Tunnel Boring Machine

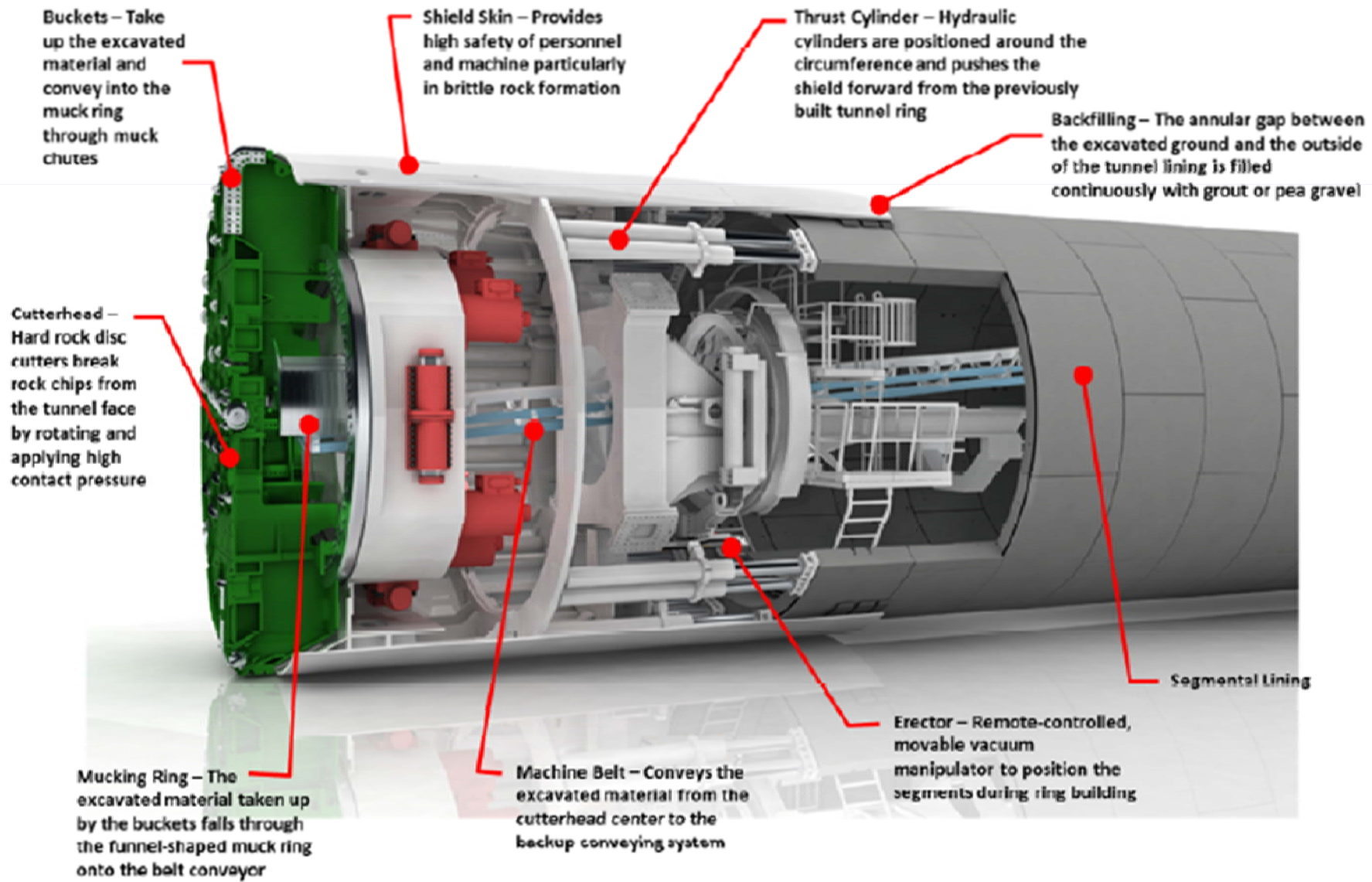


Figure 2. A Typical Single Shield Segmental Lining Machine Manufactured by Herrenknecht (diameter 29.5 feet) (Source <http://www.herrenknecht.com/en/products/core-products/tunnelling-pipelines/single-shield-tbm.html>)

# Road Header Machine



# Enlarge Existing Tunnel

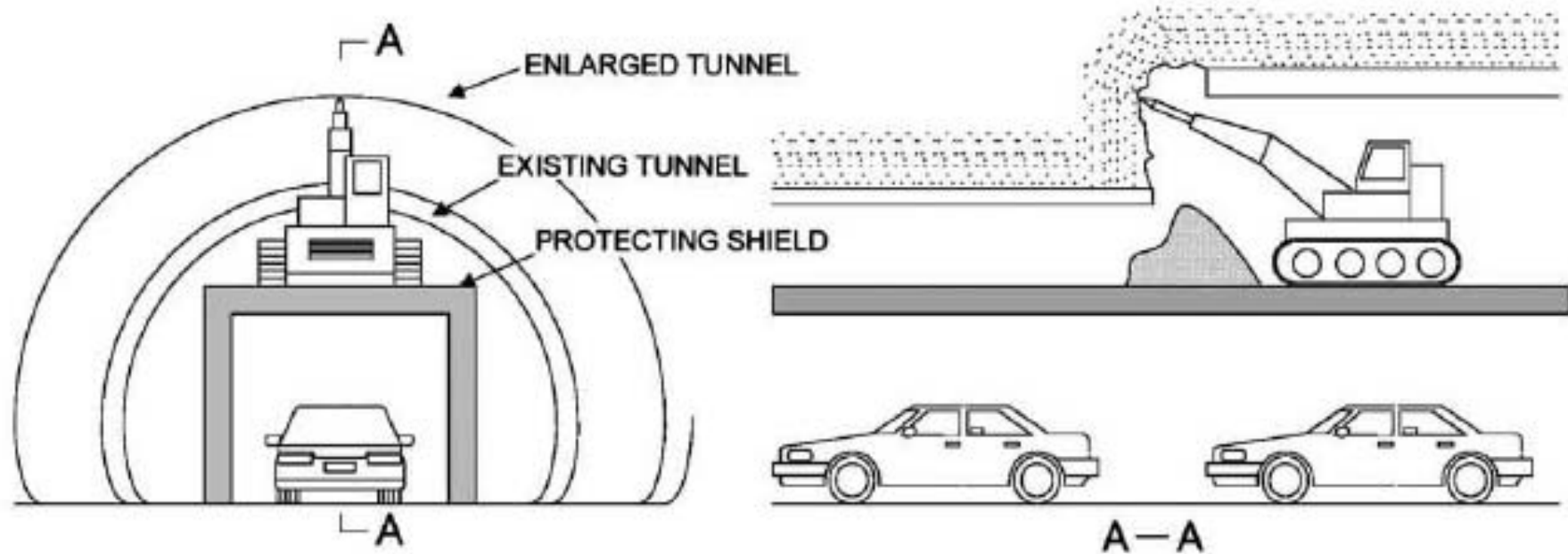


Figure 3.1: Typical Tunnel Enlargement Layout (Tonon 2010)



# Tunnel Rehabilitation Issues

- Tunnel Rehab/Replace Constraints
  - District III Salt Shed
  - New Haven Nature Center
  - West Rock Ridge State Park
- Detouring Traffic!
- Crossover To Adjacent Tunnel – Single Lane
  - Only At Night
  - Otherwise, Traffic Backups for Miles



## Purpose Of Current Project

- To correct current overall rating of “Poor” determined by periodic inspections
- Tunnel is currently inspected on a yearly basis (biennial and special inspections)
- Current “Poor” rating not an indication of an imminent safety issue, but rather identifies the need for action before a more serious condition develops
- Project scope is anticipated to include rehabilitation and/or reconstruction to address structural and geometric deficiencies.



## Current Project No. 167-108

- Independent Utility from Exit 59
- Prepare Additional Studies for Alternative Analyses
- Screen Alternatives
- NEPA, Preliminary Design
- Early Work – Geotech/Surveys

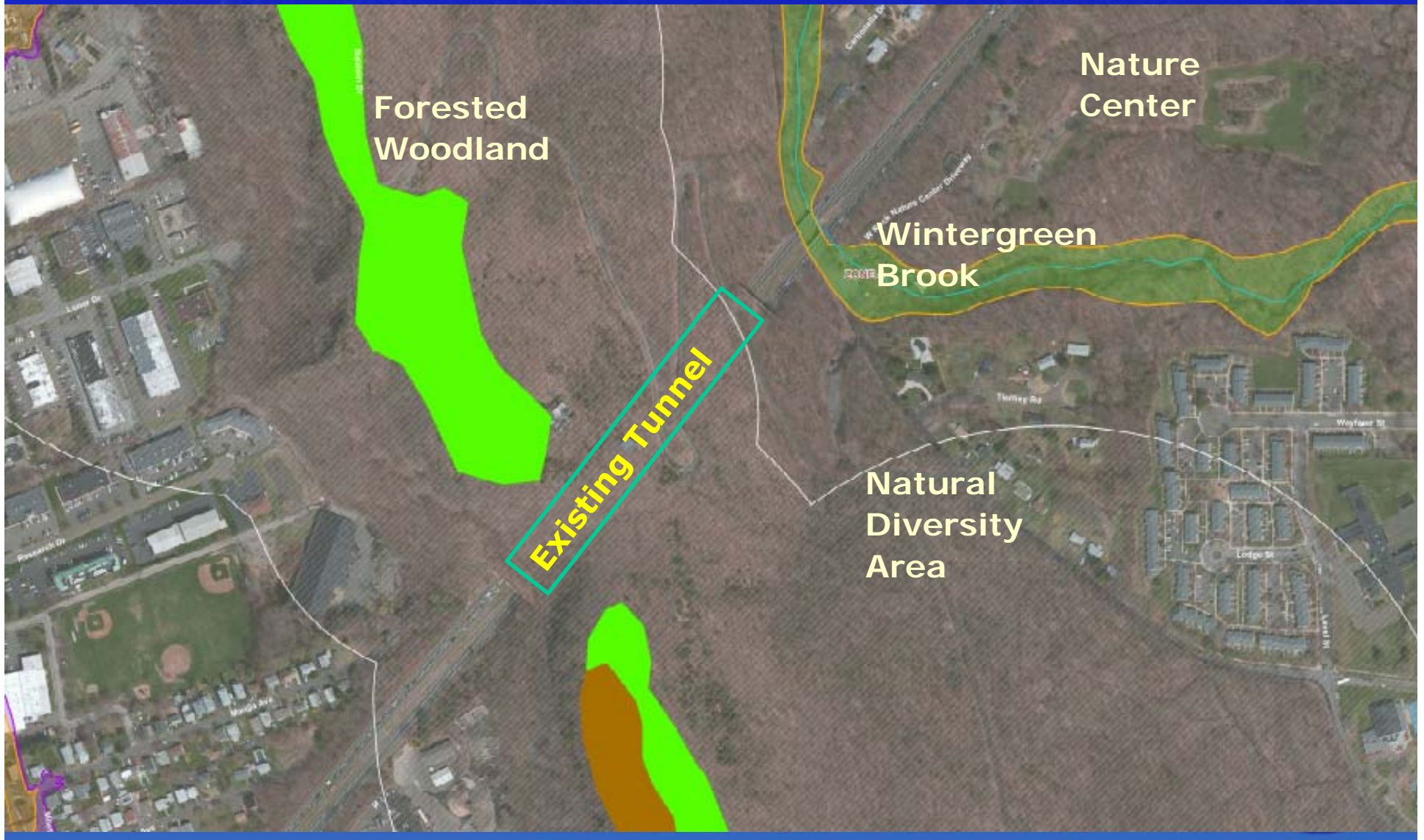


# Environmental Document/Process

- **Prepare Environmental Document**
  - Alternative Analysis Including No Build
  - NEPA/CEPA Processes
  - Potential Environmental Impacts of All Alternatives
  - West Rock Nature Center/West Rock Ridge State Park
  - Public Outreach
  
- **Preliminary Design**
  - Preferred Alternative
  - Construction Staging
  - Impacts



# Existing Environmental Resources



# Public Involvement – Support Process

Includes:

- Community Advisory Committee
- Identification and Engagement of Stakeholders
- Project Website and Social Media
- Email Bulletins to Interested Citizens and Community Groups



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