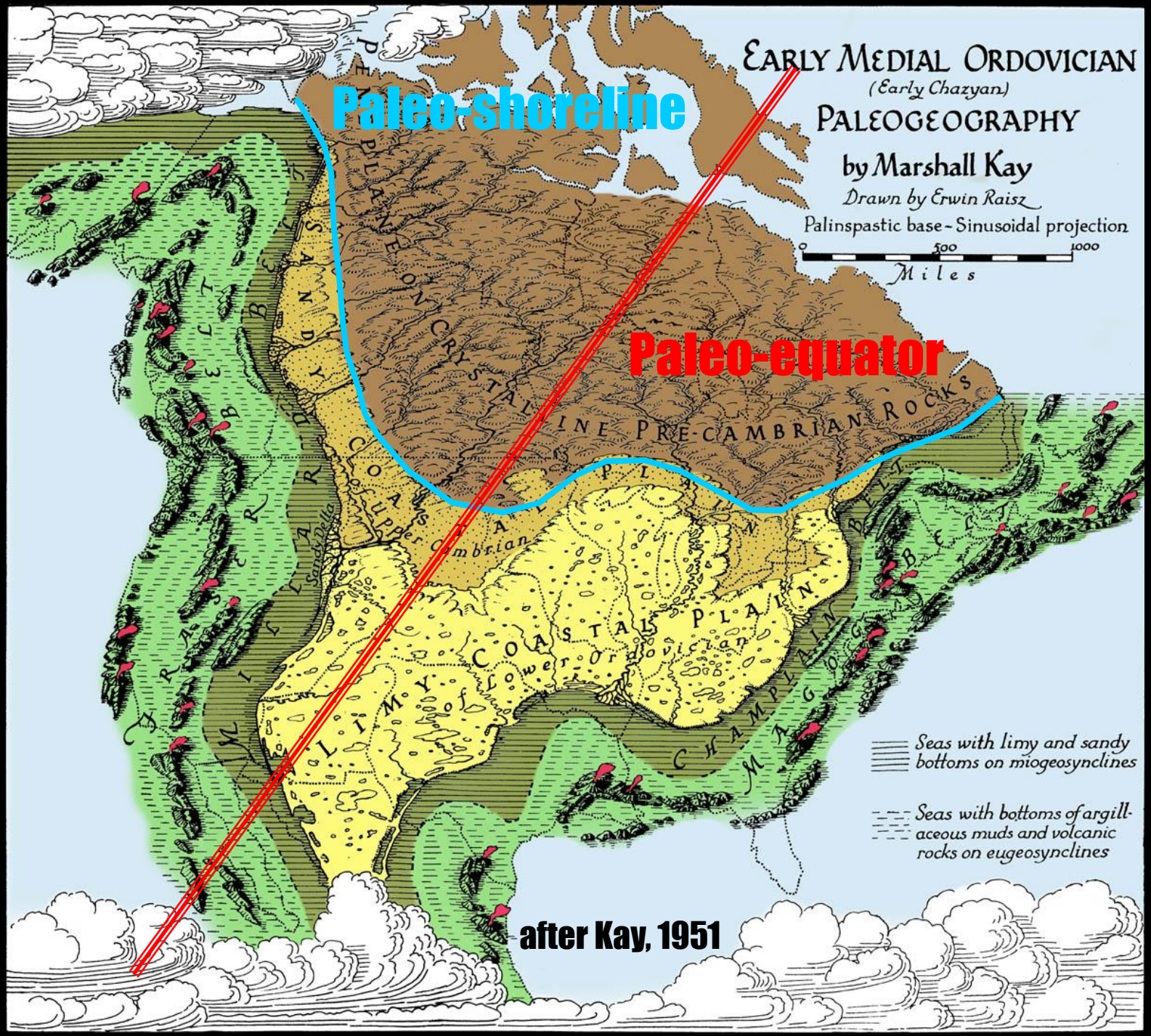
Garvies Point Museum

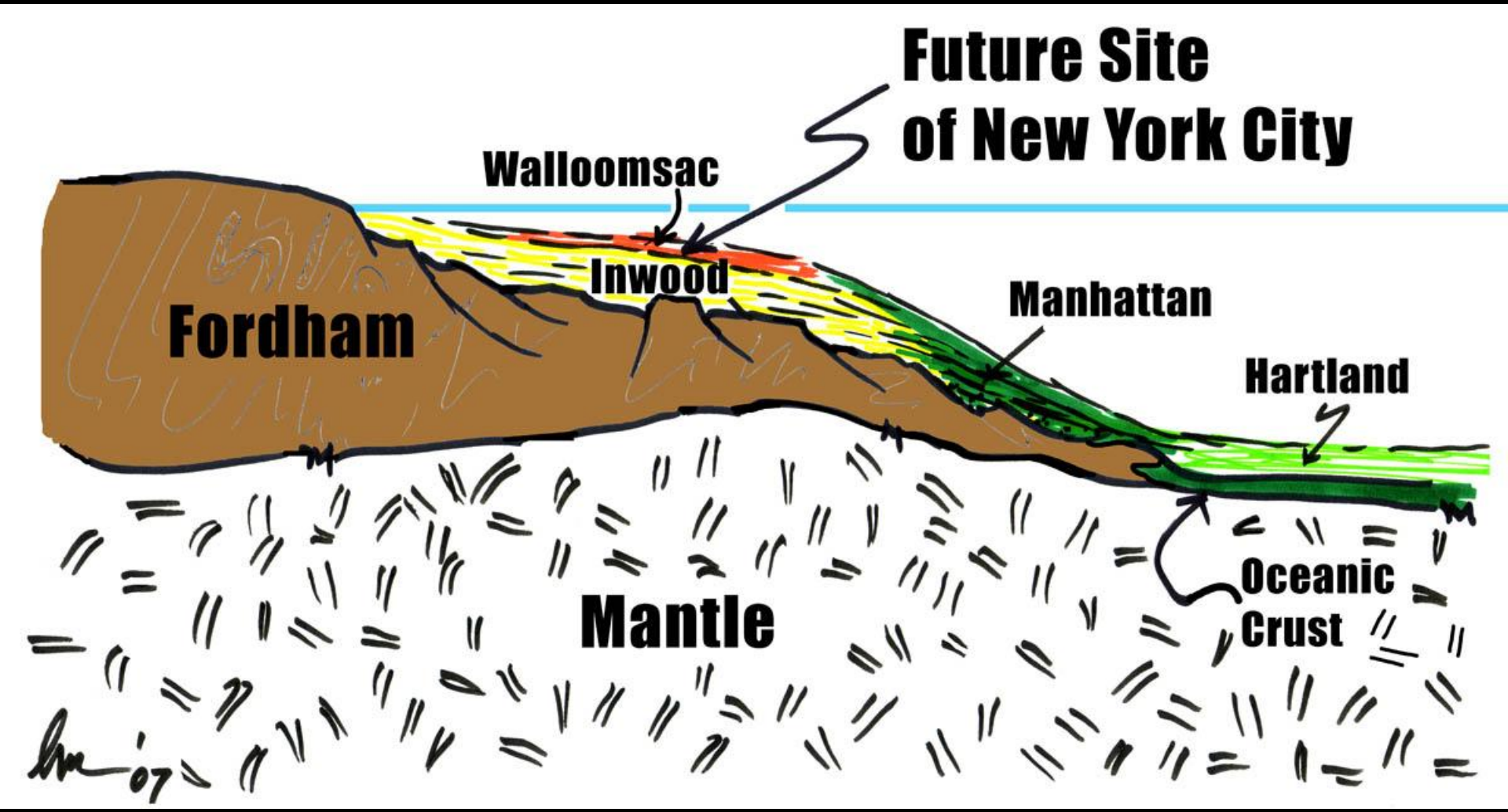
Geology of Subsurface Megaconstruction Projects, New York City, NY

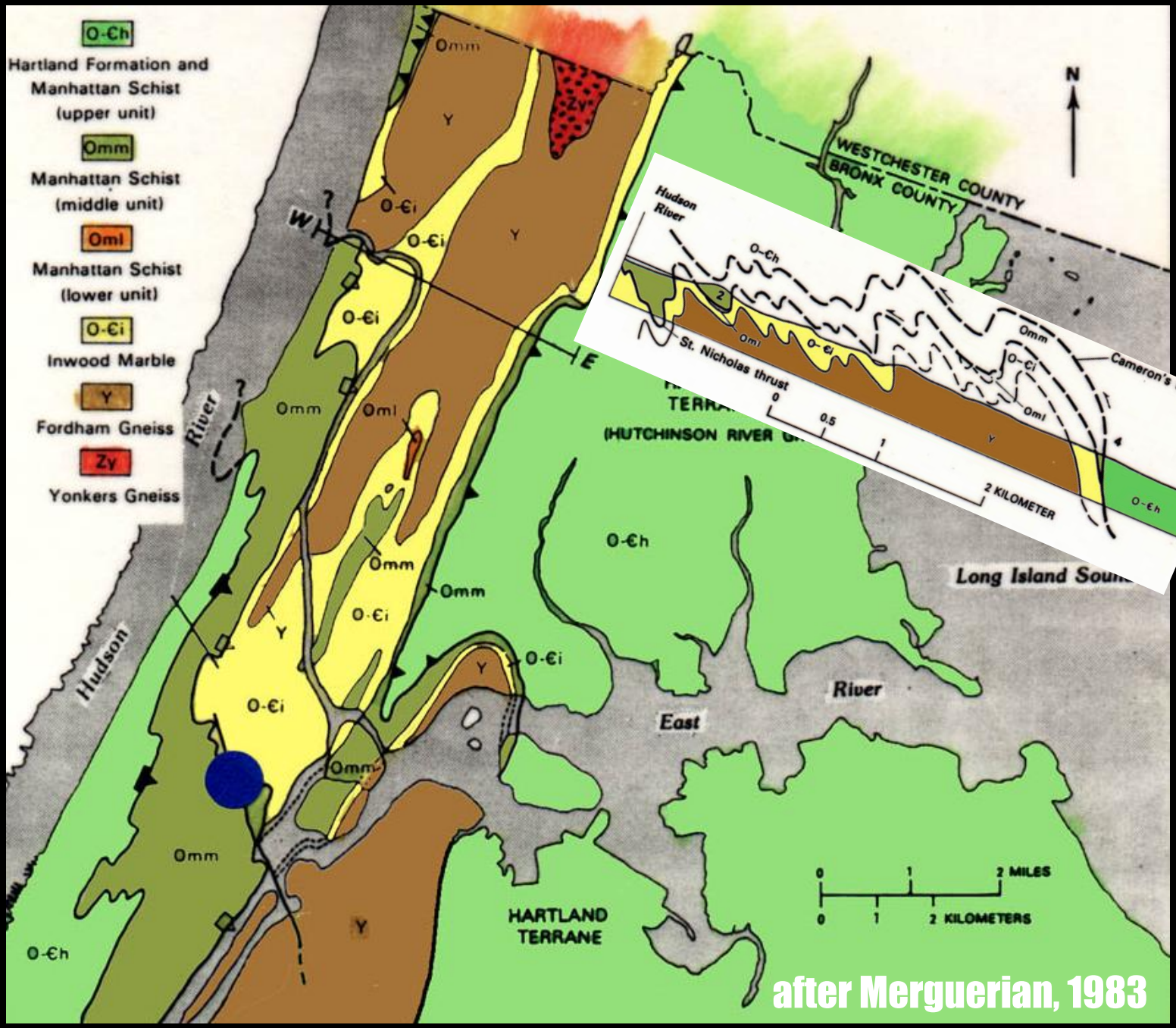
Charles Merguerian

17 April 2010

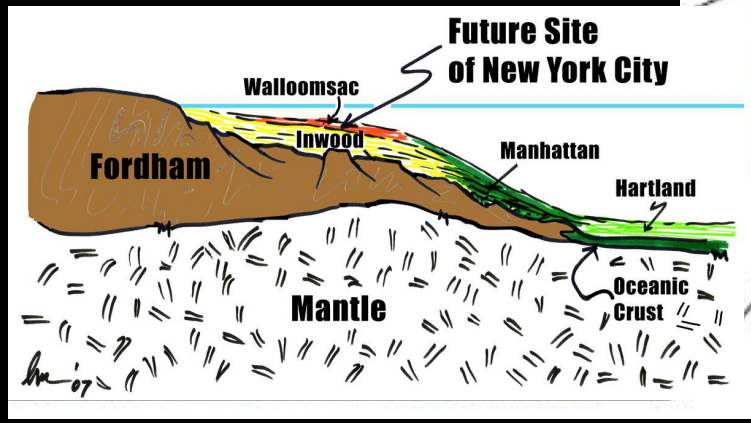
Let's Go Back In Time From Today to the Cambrian!

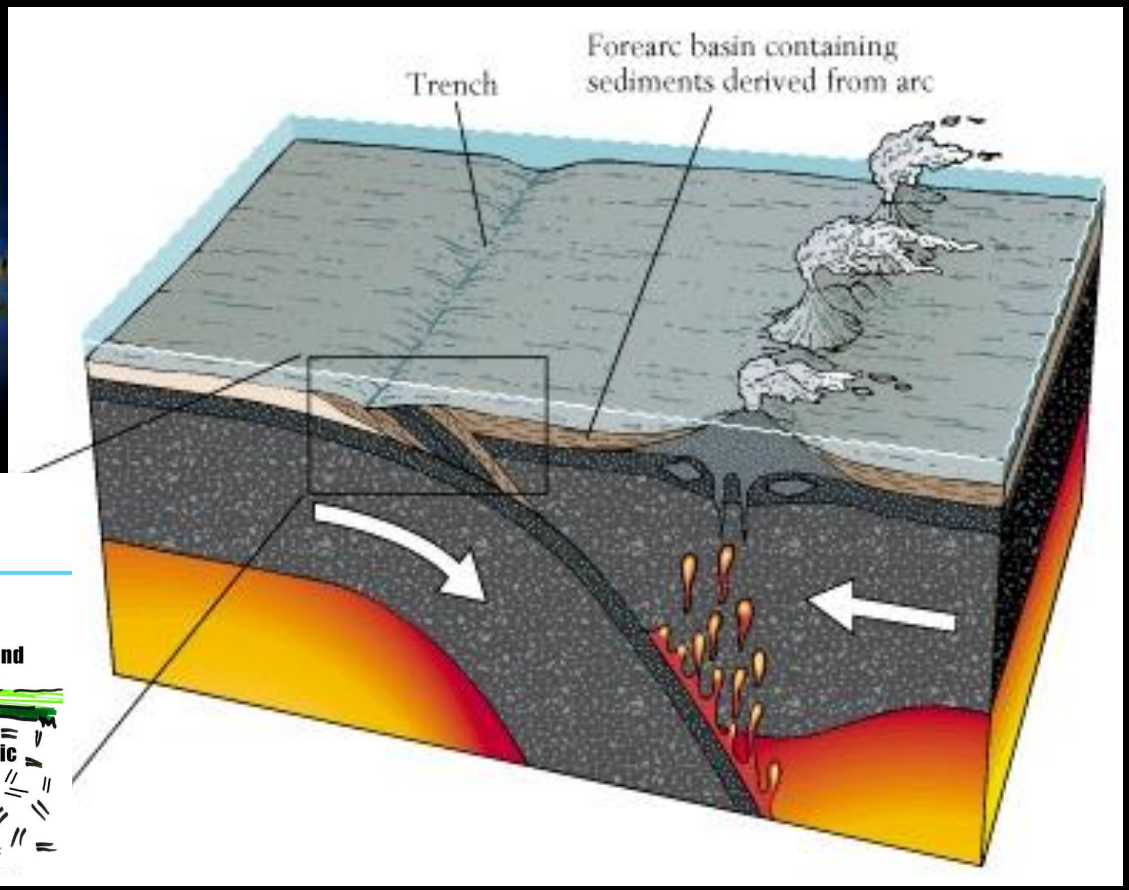

Paleo-shoreline
Paleo-equator
EARLY MEDIAL ORDOVICIAN
(Early Chazyan)
PALEOGEOGRAPHY
by Marshall Kay
Drawn by Erwin Raisz
Palinspastic base - Sinusoidal projection
500
1000
Miles
PEPLANEON CRYSTALLINE PRE-CAMBRIAN ROCKS
SANDY COASTAL PLAIN of Upper Cambrian
LIMY COASTAL PLAIN of Lower Ordovician
CHAMPLAIN MAGEOGEOSYNCLINE
ARAVAIPA BELT
APPALACHIAN BELT
Seas with limy and sandy bottoms on miogeosynclines
Seas with bottoms of argillaceous muds and volcanic rocks on eugeosynclines
after Kay, 1951

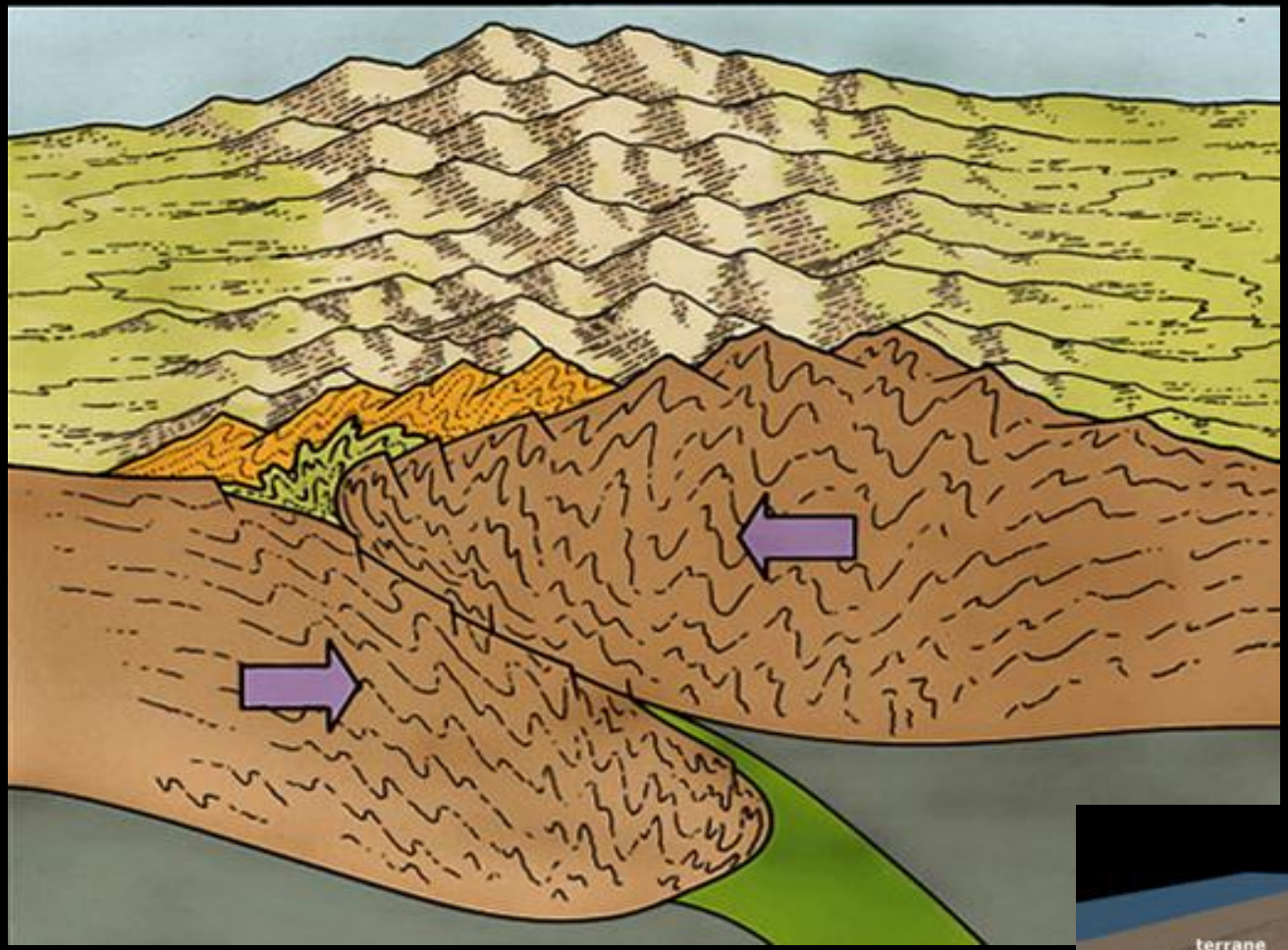

Future Site
of New York City
Walloomsac
Inwood
Fordham
Manhattan
Hartland
Oceanic
Crust
Mantle
'07

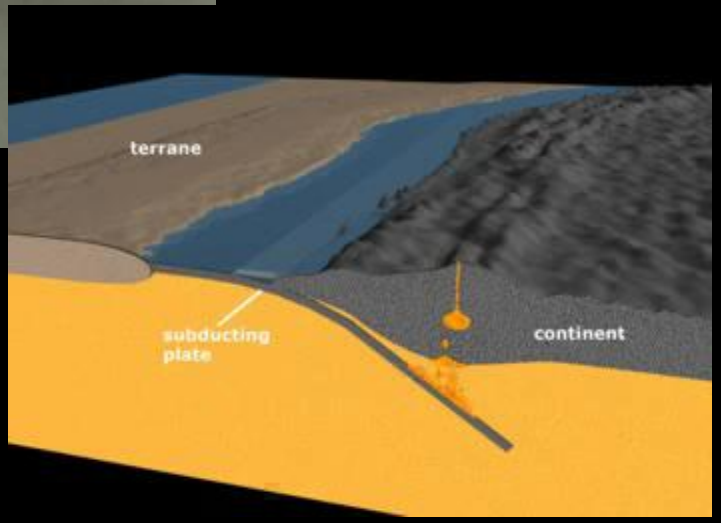

O-Ch
Hartland Formation and Manhattan Schist (upper unit)
Omm
Manhattan Schist (middle unit)
Oml
Manhattan Schist (lower unit)
O-Ci
Inwood Marble
Y
Fordham Gneiss
Zy
Yonkers Gneiss
N
WESTCHESTER COUNTY
BRONX COUNTY
Hudson River
O-Ch
Oml
O-Ci
Omm
Y
St. Nicholas thrust
Cameron's Line
0
0.5
1
2 KILOMETER
O-Ch
TERRANE
(HUTCHINSON RIVER
Long Island Sound
Hudson River
East River
HARTLAND TERRANE
0 1 2 MILES
0 1 2 KILOMETERS
after Merguerian, 1983

~ 450 Ma Taconic Arc – Passive Margin Collision

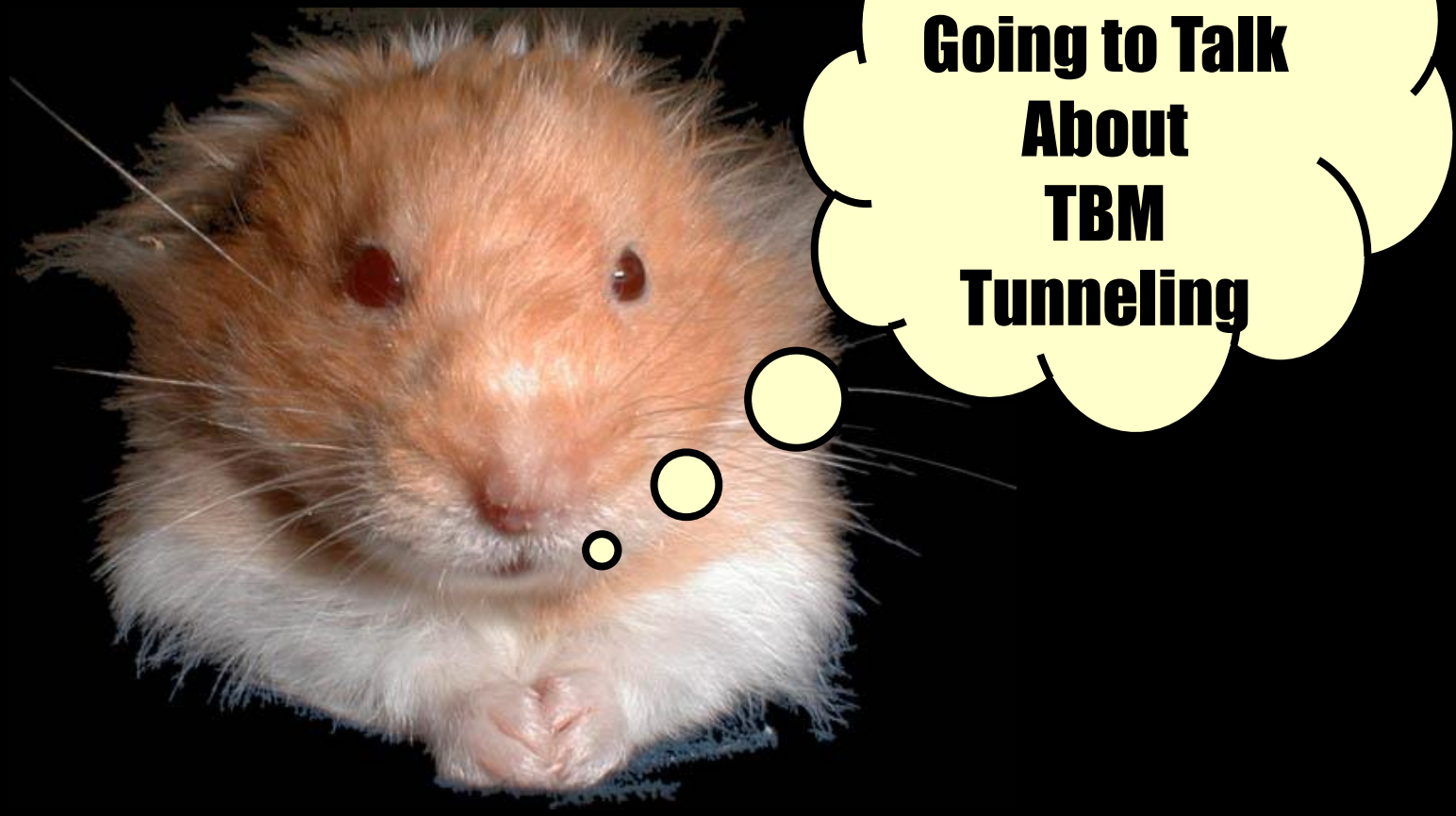






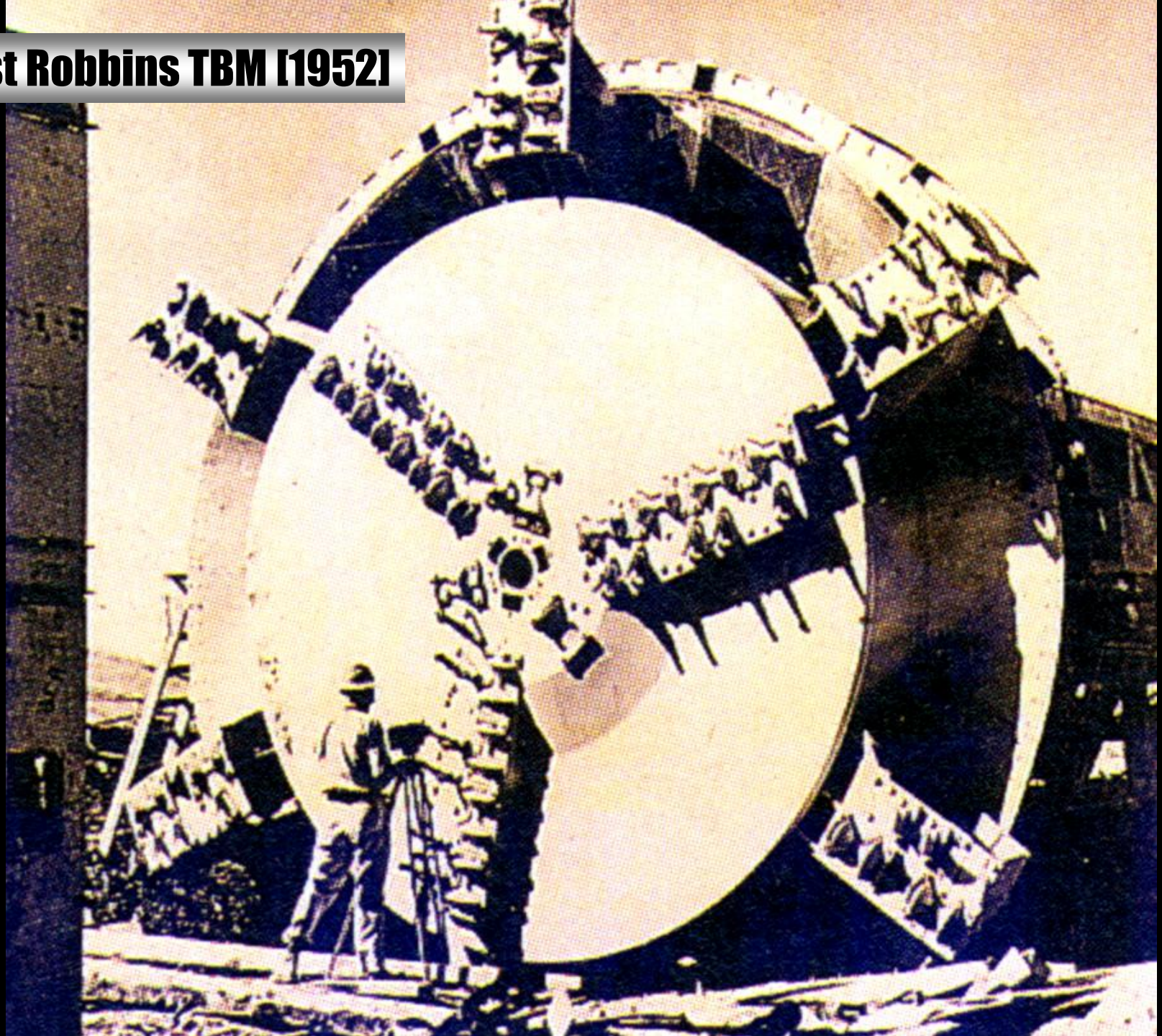


450 Ma to 250 Ma Protracted Plate Collisions Form the Appalachians


Finally, He's
Going to Talk
About
TBM
Tunneling

TBM Tunnelling

First Robbins TBM [1952]



Holing Through North Tunnel, Hudson Tubes, French Line Dock (1904)


Jarva MK 15-52b

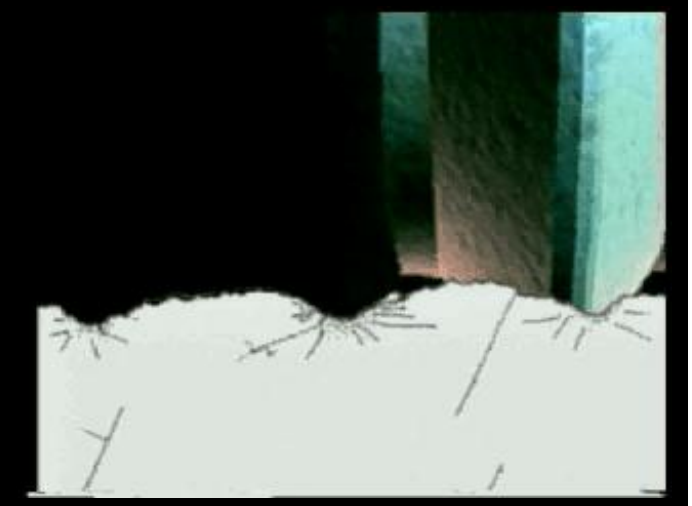
Sorenberg, Switzerland - Herrenknecht TBM

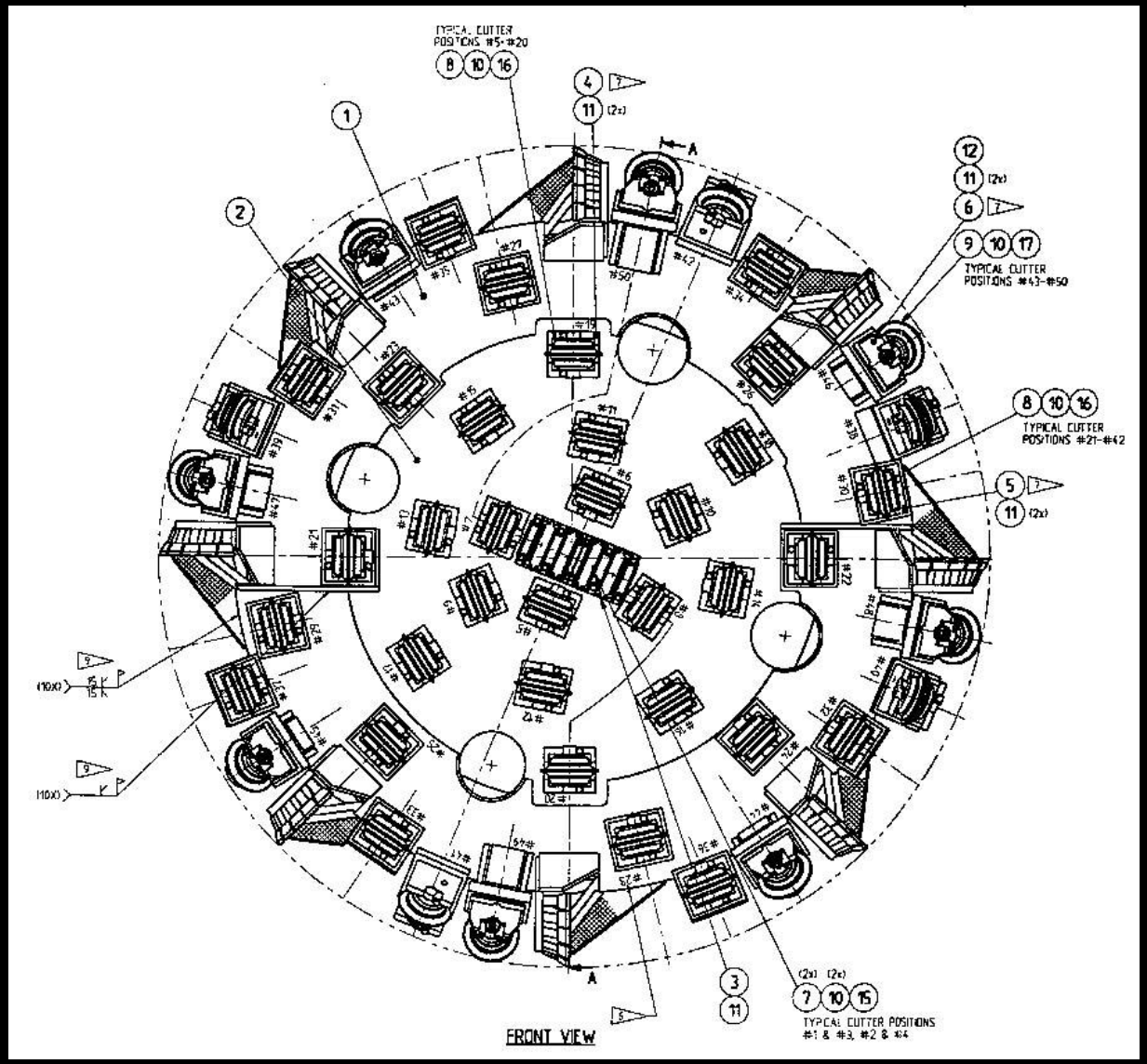
TBM Cutter Head Torque Dynamics

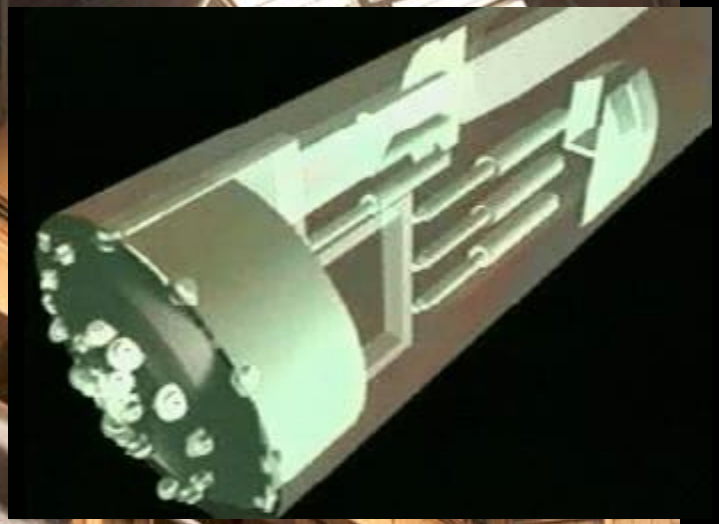
Robbins 235-282 HP Hard Rock Main Beam TBM

Chesterfield, England - 1996

TBM Chip Production







Atlas Copco

Robbins TBM 160-284

MetroWest

In the Belly of the Beast


TBM-Bored Tunnel

What Are the Geological Controls on Effective Hard Rock TBM Tunneling in Crystalline Terrains?

Excessive Fines
Blocky Ground
Unstable Headings and Sidewalls
Low Penetration Rates

Excessive Fines

Blocky Ground

Desirable Kerf Pattern in Hard Rocks


Collapsed Crown and Sidewalls
Short Stand-up Times
Station 153+30

Rainy Conditions

Station 140+60

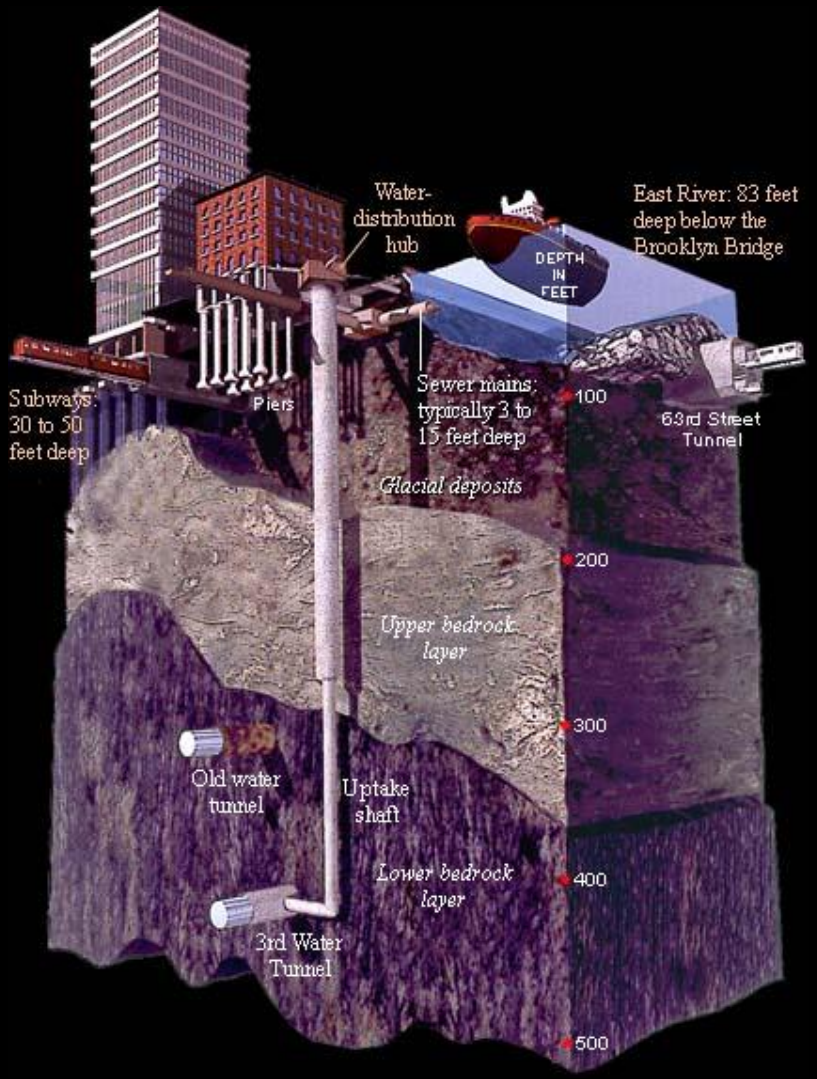
Short Stand-up Times

Unforseen Tunneling Problems

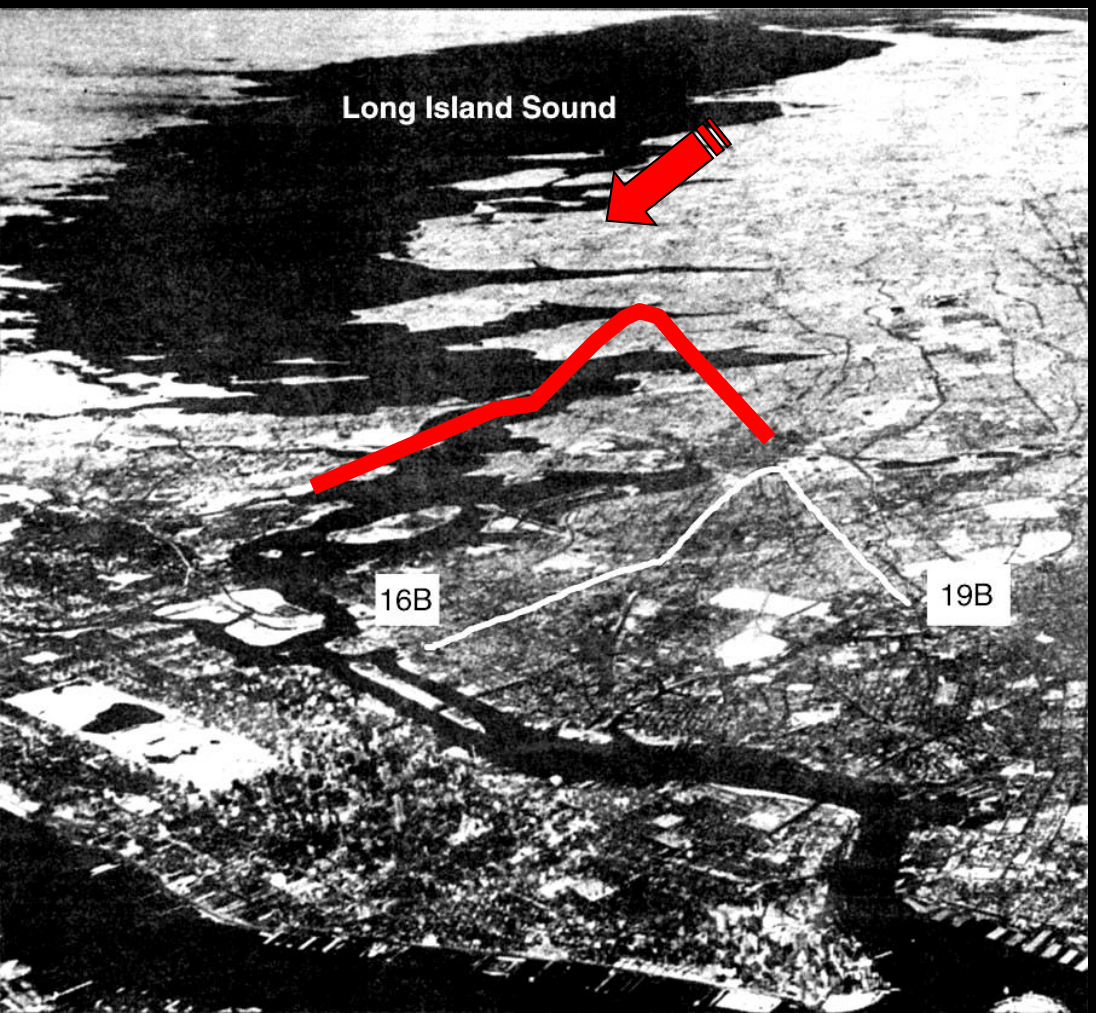

Remember Doc, You're Nothing Without Me!
Finally, He's Going to Talk About Mega-Construction Projects

Mega-Construction Projects

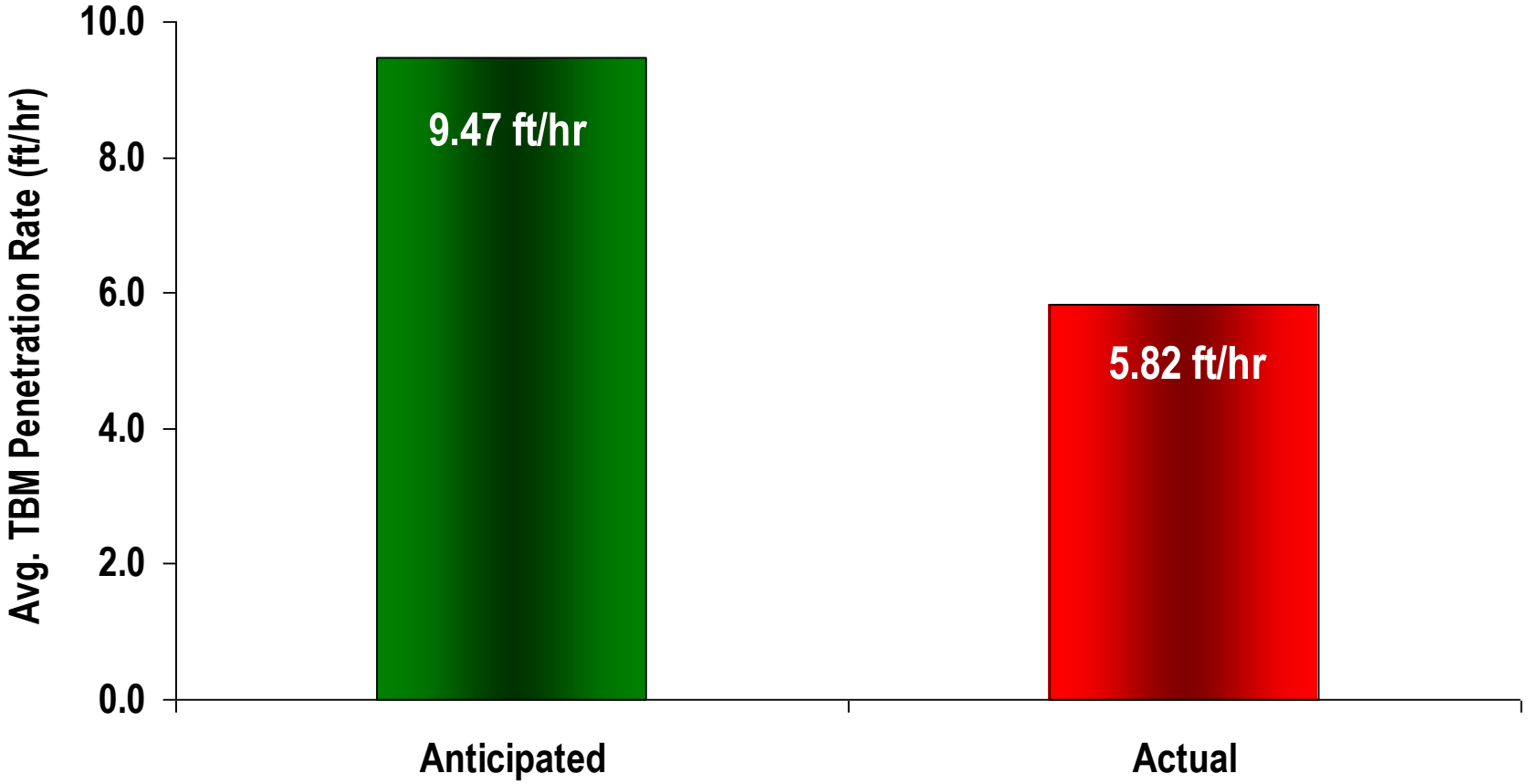
- Queens Water Tunnel
- Con Edison Steam Tunnel
- Manhattan Water Tunnel
- East Side Access Project
- Second Avenue Subway
- IRT #7 Line Extension
- LI Cross Sound Link Tunnel



Construction of the Queens Tunnel
NYC Water Tunnel #3
Oct 1996 – Oct 1999



Anticipated vs. Actual Penetration Rates

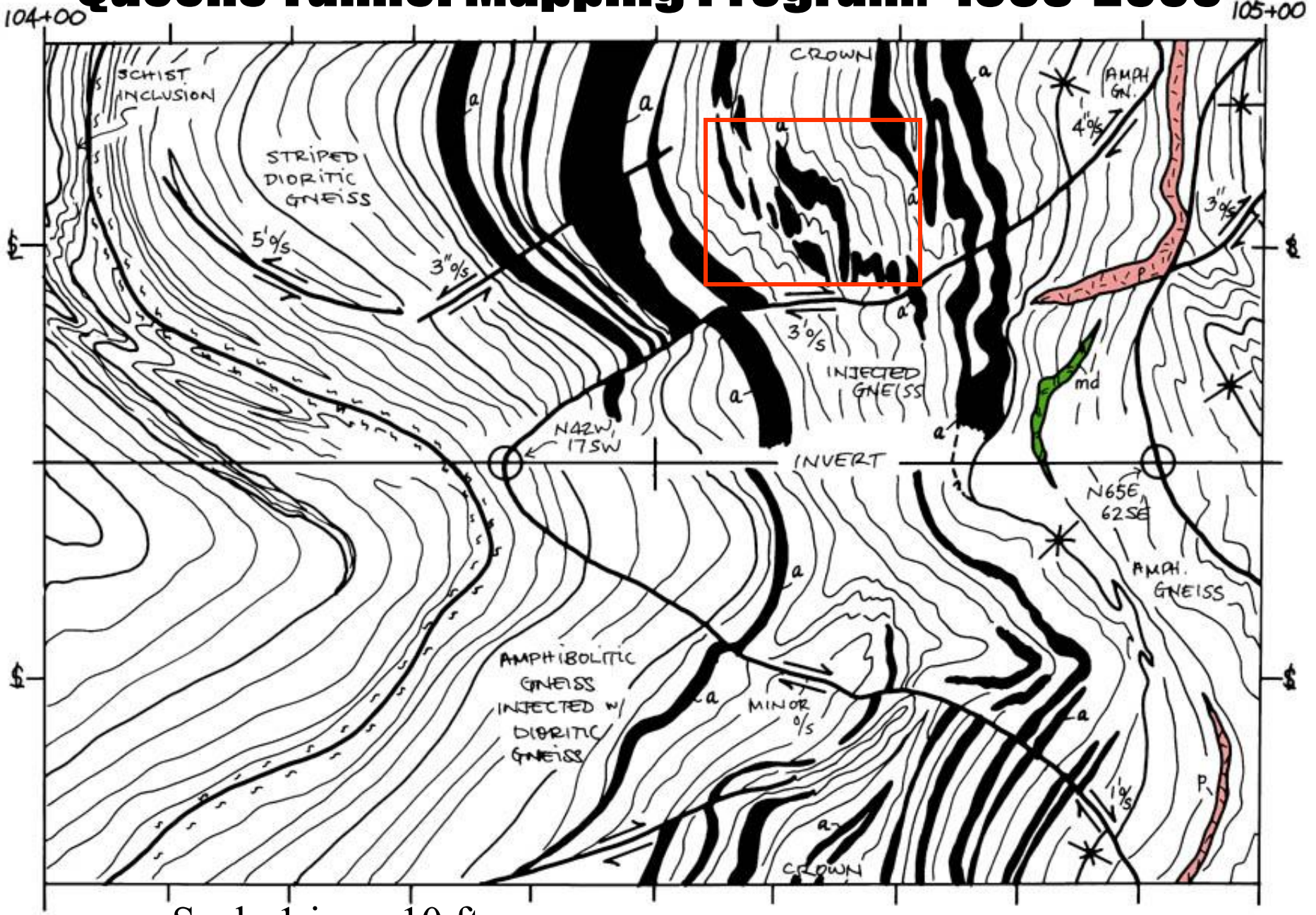


Can Geologic Studies Help Predict TBM Penetration Destiny?

Merguerian's Field Office

Professional, Seasoned, Dukelabs Office Help

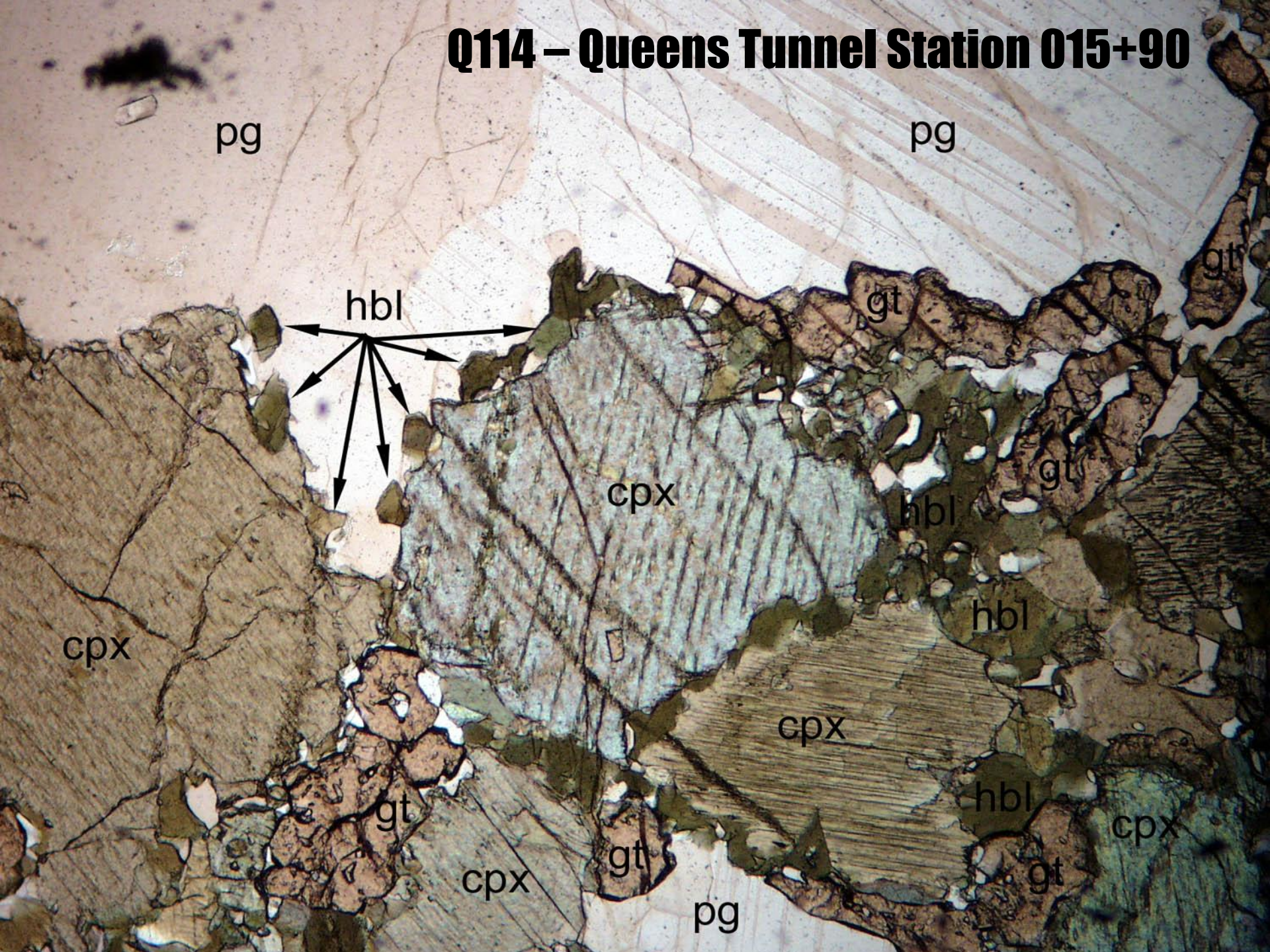
Queens Tunnel Mapping Program: 1998-2000



- Scale 1 in. = 10 ft


104+55
104+60
104+65

Q114 – Queens Tunnel Station 015+90




QUEENSTUNNEL


Con Edison
Utility Tunnel
Pierpont Morgan Library
Chrysler Building
United Nations Headquarters
Stern College
Yeshiva University
American Academy of Dramatic Arts
Little Church around the Corner
Touro College
Madison Square Park
Bellevue Hospital Center
Baruch College
St Francis College
Parsons School of Design
Cabrini Medical Center
Police Academy Museum
Stuyvesant Square
Con Edison Energy Museum
Beth Israel Medical Center
New York University
State Board of Tourism
St Marks Church in the Bowery
Murphy Park
Tompkins Square
The Bowery
Dukelabs © 2003

Con Edison Steam Tunnel TBM

Robbins HP 215-257 Hard Rock Machine
Capable of 5’ stroke

10 Oct 2002


Southern Heading
Shallow NW Dip

TBM Starter Tunnel

CT3, Stage2 Manhattan Water Tunnel

Shaft 26B

10 Oct 2002

South Heading – Manhattan Tunnel

Bottom of Shaft 26B

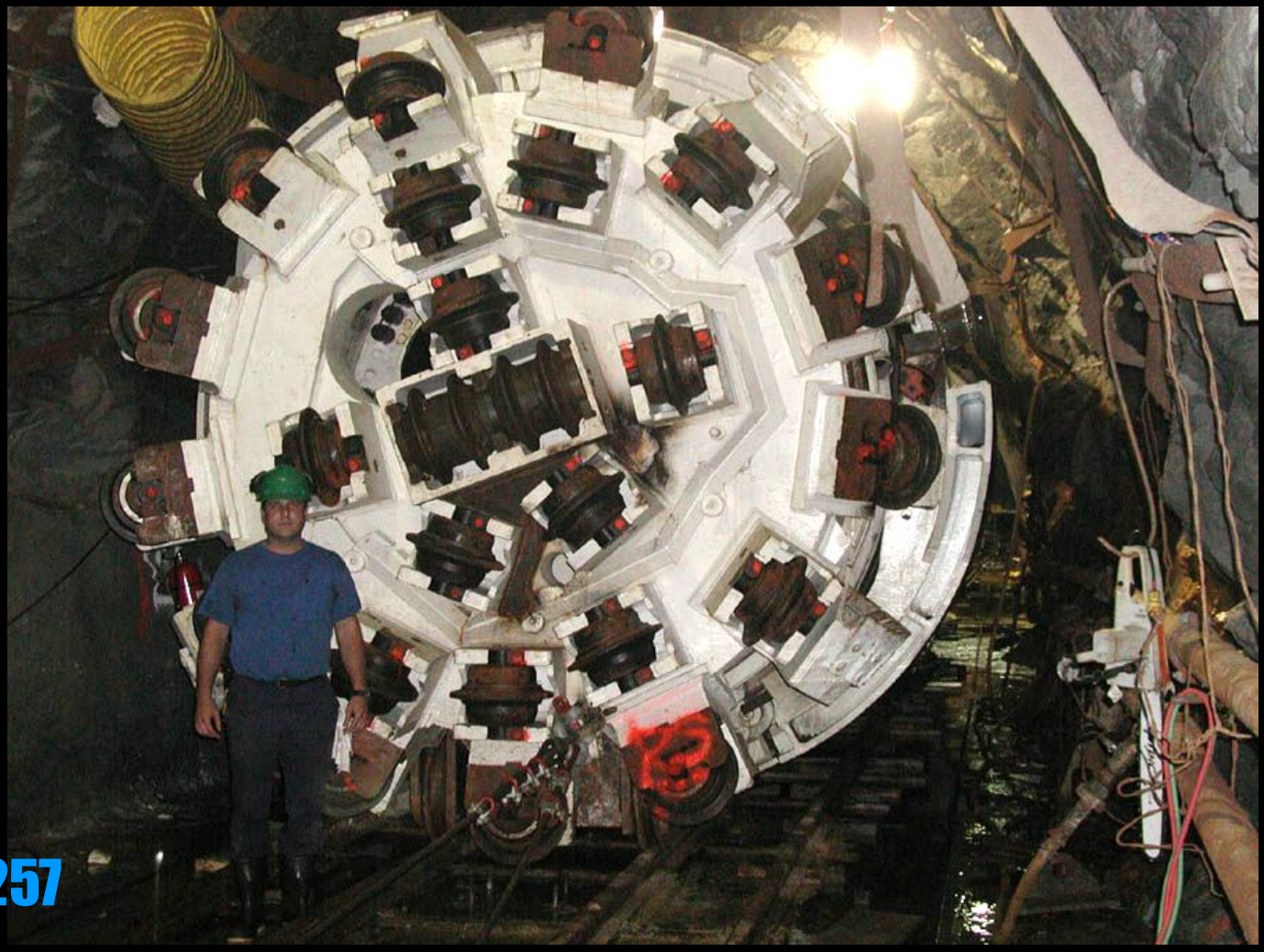
580’ Deep

Manhattan Tunnel


NEW JERSEY
13B
24B
25B
33B
26B
32B
27B
28B
31B
29B
30B
MAIN TUNNEL (Central Park)
MAIN TUNNEL (West Side)
CROSSTOWN TUNNEL (Mid-town)
MAIN TUNNEL (West Side)
MAIN TUNNEL (South Loop)
MANHATTAN
Excavated
To be Excavated
Shafts

Manhattan Tunnel TBM

Rebuilt Robbins HP 215-257 hard rock machine (used first on Con Ed Utility Tunnel on 1st Avenue)

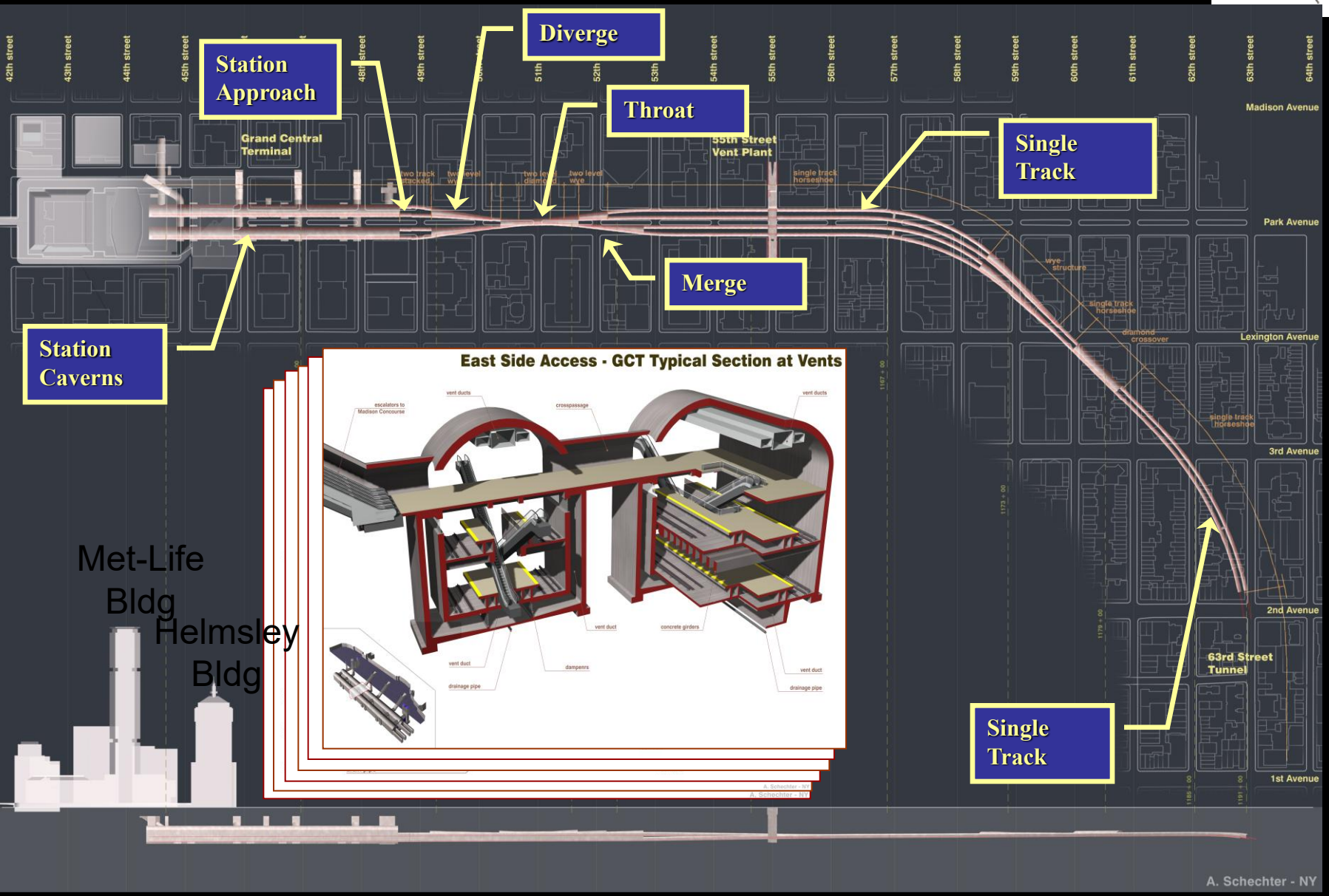


Robbins HP 215-257

East Side Access

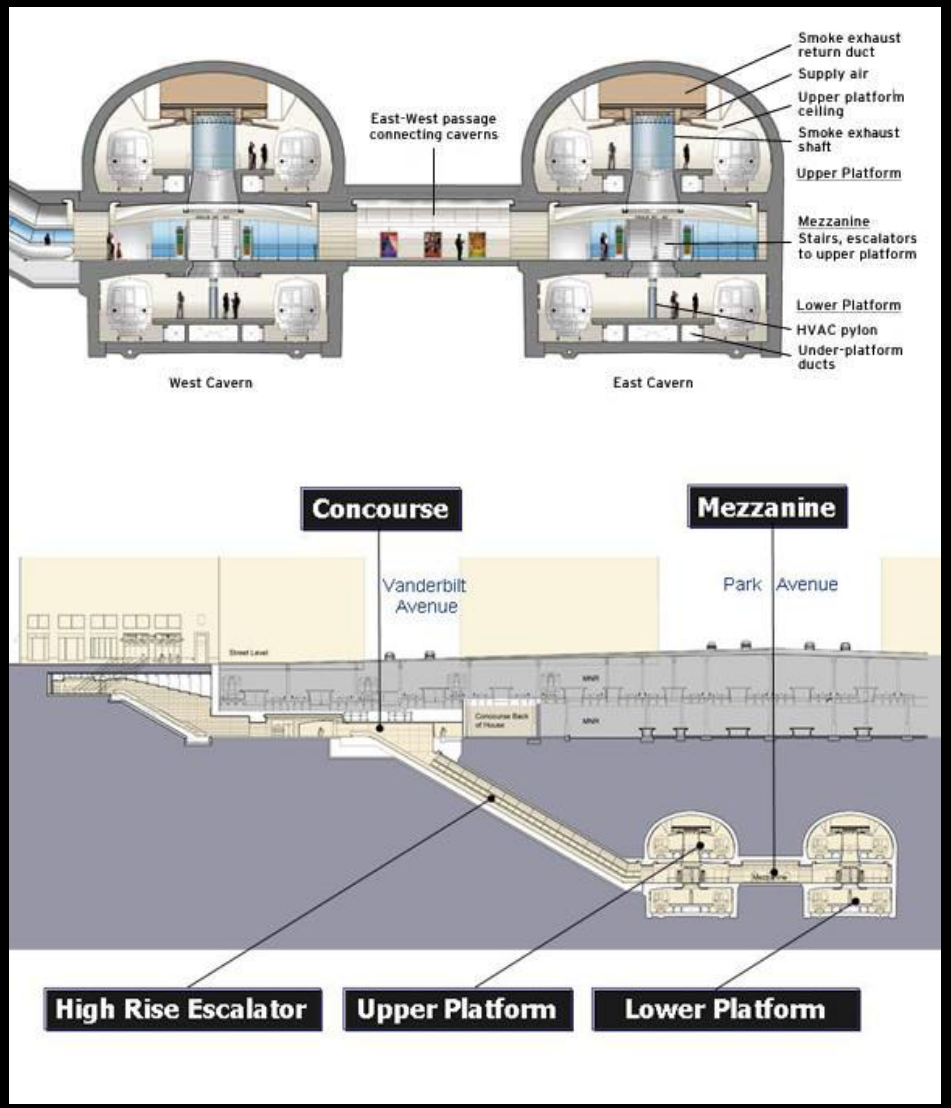
LIRR/MTA


Central Park
Metro-North Railroad
8,600ft
(17,200 Linear Ft.)
63rd Street Tunnel
63rd St
41st Ave
5,500ft
(11,200 Linear Ft.)
Sunnyside Yard
29th Ave
Northern Blvd
AMTRAK
LIRR Port Washington Branch
Queensborough Bridge
Mid-Day Storage Yard
Harold Interlocking
Queens Blvd
QUEENS
Roosevelt Island
Northern Blvd
Sunnyside Station
Arch Street Yard & Shop Facility
7,200ft
(24,000 Linear Ft.)
53rd St
Grand Central Terminal
42nd St
Long Island Expressway
Queens-Midtown Tunnel
LIRR Montauk Branch
EAST RIVER
MANHATTAN
BROOKLYN
Legend
Existing LIRR Tunnel Structure
Tunnel Structure to Be Built


Station Approach
Diverge
Throat
Single Track
Merge
Station Caverns
Single Track
Grand Central Terminal
55th Street Vent Plant
Madison Avenue
Park Avenue
Lexington Avenue
3rd Avenue
2nd Avenue
1st Avenue
63rd Street Tunnel
42th street
43th street
44th street
45th street
48th street
49th street
51th
52th
53th
54th street
55th street
56th street
57th street
58th street
59th street
60th street
61th street
62th street
63th street
64th street
East Side Access - GCT Typical Section at Vents
Met-Life Bldg
Helmsley Bldg
A. Schechter - NY

Construction Will Take Place Under Existing GCT

Using Two TBMs!!




13 Aug 2007

East Side Access – GCT Tunnels

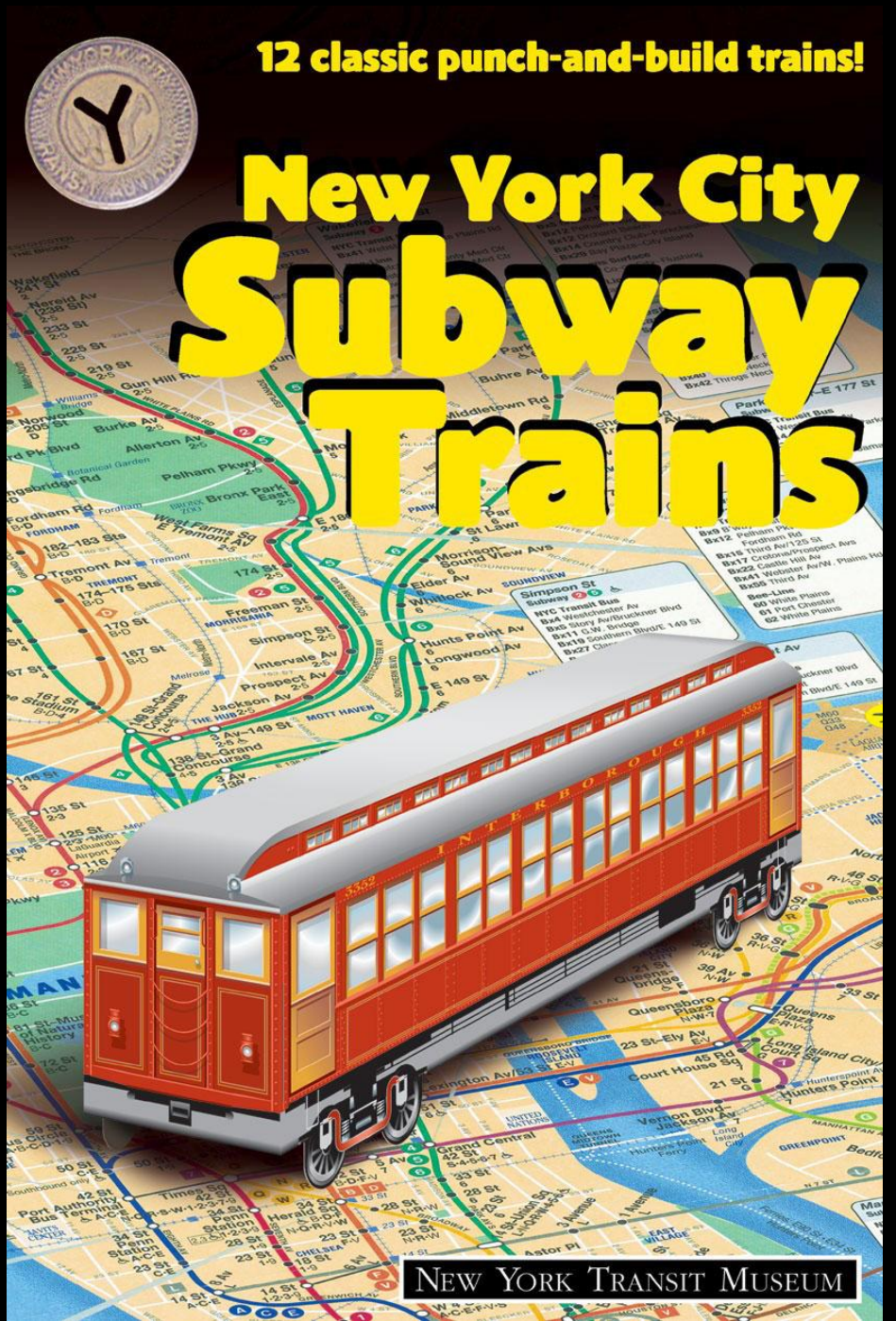

East Side Access – GCT Tunnels

East Side Access – GCT Tunnels

East Side Access – GCT Tunnels

IRT #7 Line Extension

Second Avenue Subway



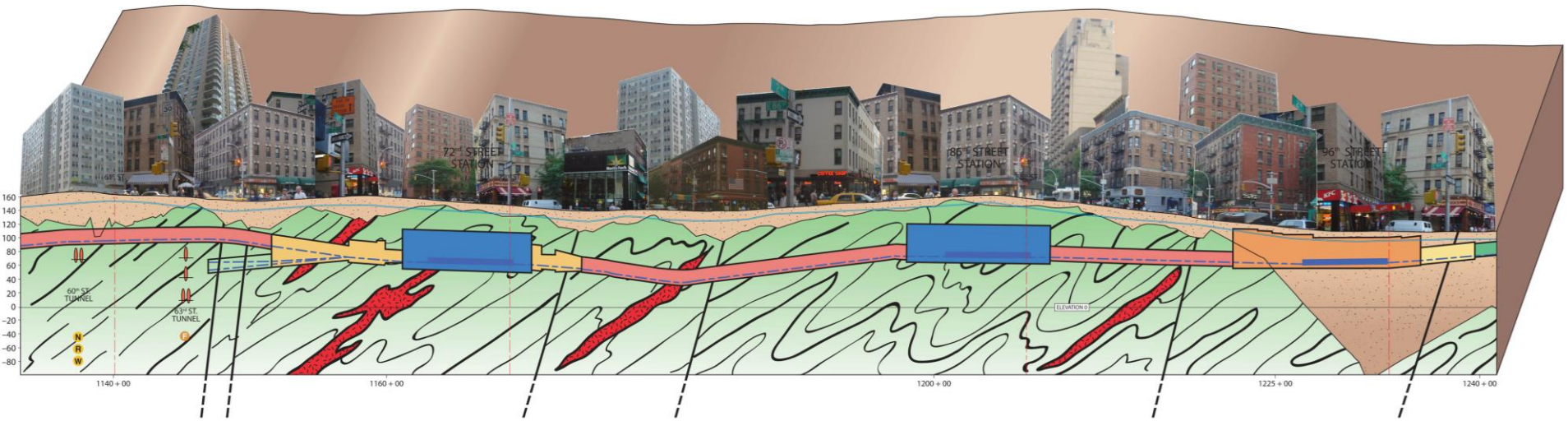
Second Avenue El

1929 – NYC BOT Proposes Second Avenue Subway

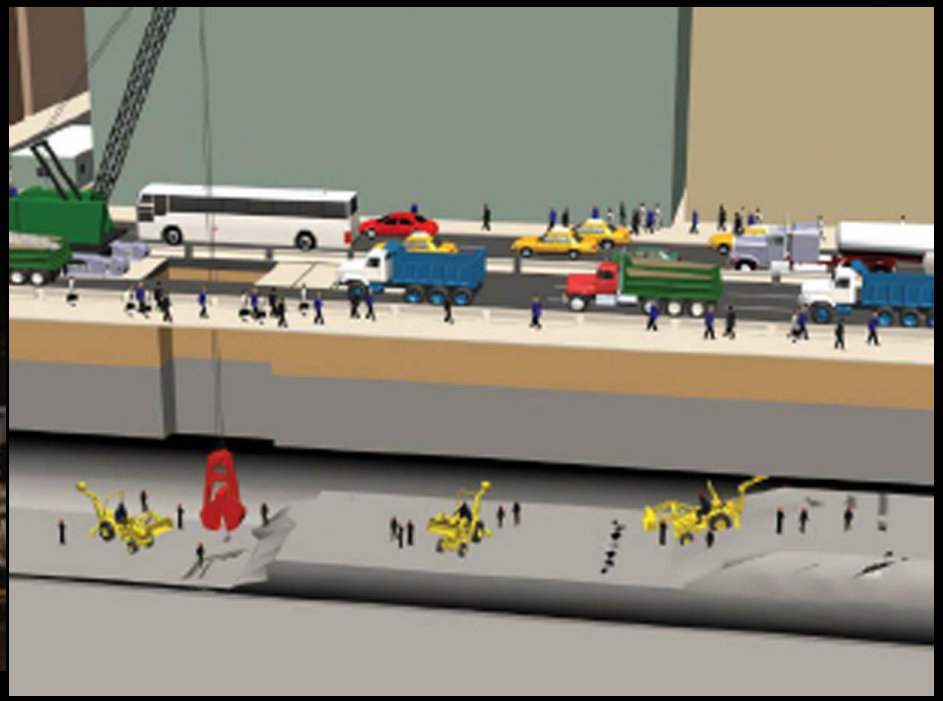
1931 – Plans Postponed Depression Era

$86M → $249M → $500M

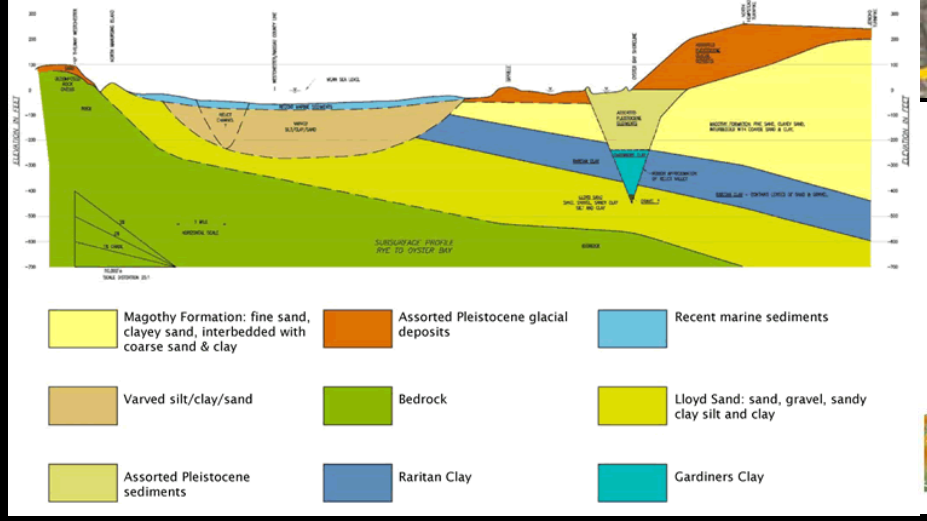
By 1948 – (Abandonment]

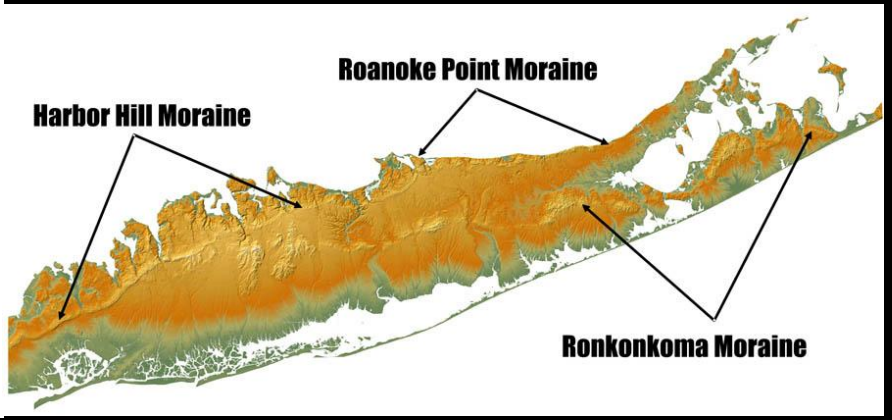


Second Avenue Subway

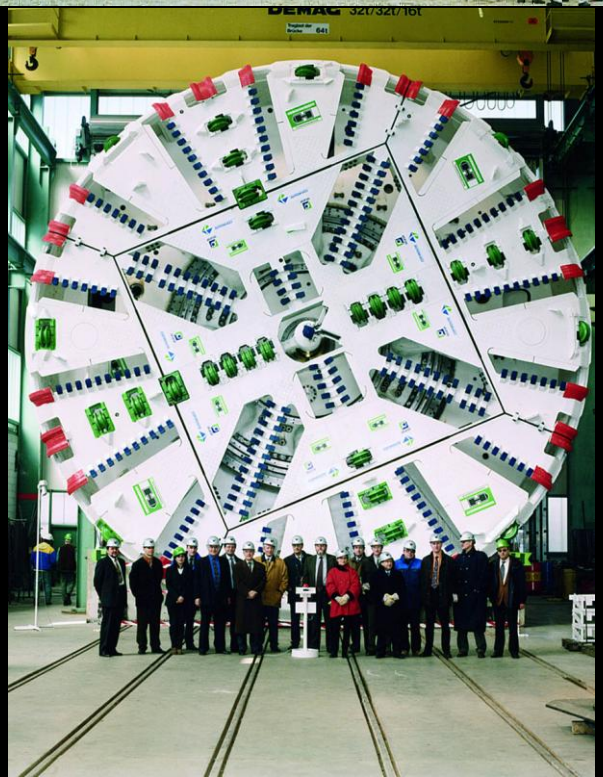


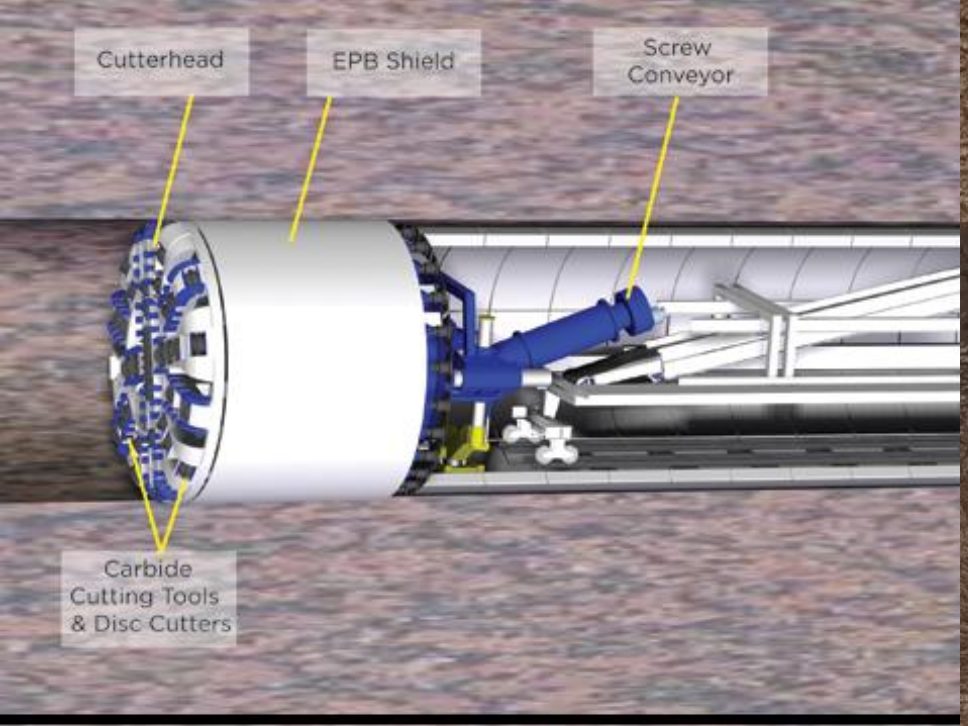
Cross Sound Link Project

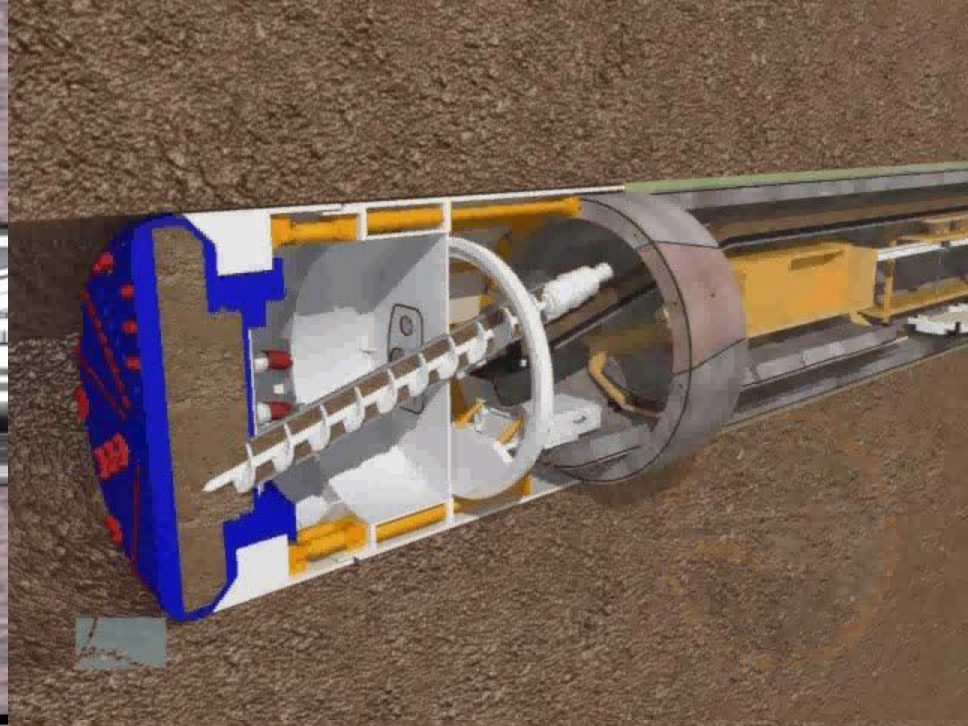


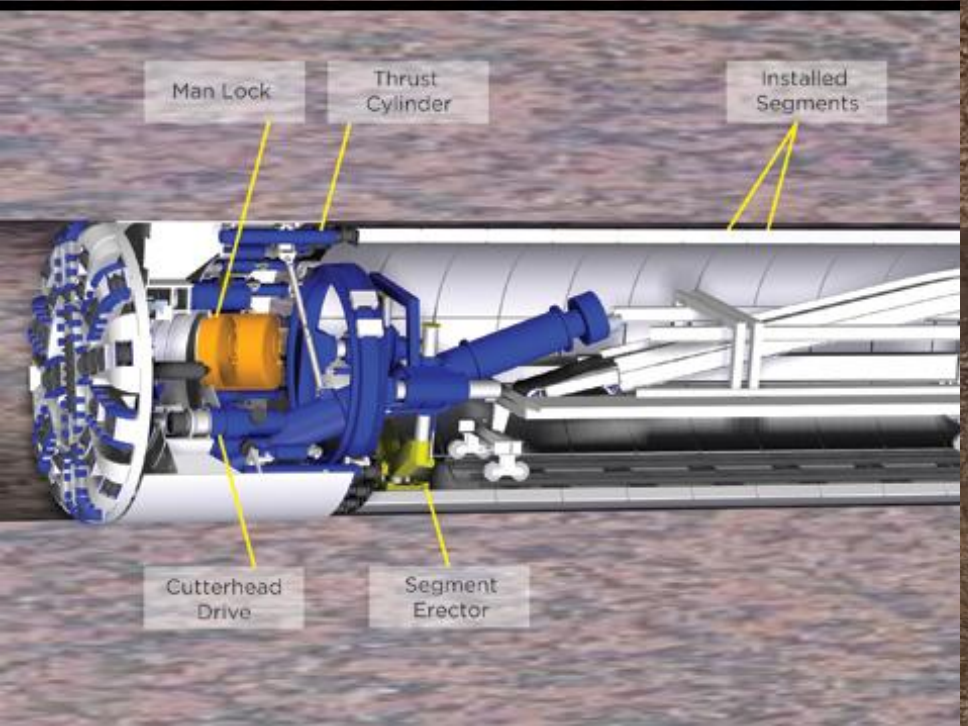


Soft Ground TBMs




Cutterhead
EPB Shield
Screw Conveyor
Carbide Cutting Tools & Disc Cutters




Man Lock
Thrust Cylinder
Installed Segments
Cutterhead Drive
Segment Erector


OK, That's It! I've Heard Enough!

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