Mill Creek Deep Tunnel
Geologic Conditions and Potential Impacts on Design/Construction

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Presentation Outline

- Tunnel Alternative Overview.
- Geological Overview of the Valley.
- Bedrock Findings & Impacts.
- Overburden Findings & Impacts.
The Tunnel Alternative
Mill Creek General Reevaluation Report (GRR) Alternatives

- Total Relocation
- Non-Structural
- Non-Structural 2
- Non-Structural 3
- Channel Modification
- Channel Modification 2
- Floodwall & Levee
- Deep Tunnel
- Deep Tunnel 2

Non-Structural

Structural
Mill Creek General Reevaluation Report (GRR) Alternatives

- Total Relocation
- Non-Structural
- **Non-Structural 2**
- Non-Structural 3
- Channel Modification
- **Channel Modification 2**
- Floodwall & Levee
- **Deep Tunnel**
- Deep Tunnel 2
- Proposed Tunnel Aspects -

Approximately 16 miles long

31-foot finished diameter

19 drop shafts, ranging in size from 10-feet to 24-feet in diameter.

4 mining shafts, ranging in size from 30-feet to 60-feet in diameter.

19 access shafts, with 10-foot diameter

Approximately 67 combined sewer (CSO) runs for a total of 12 miles of sewer, ranging from 3.5-feet to 10-feet in diameter
Plunge Shaft

No Scale
Vortex Shaft
Combined Sewer Outflow (CSO) runs going to Drop Shaft

Deep Tunnel
(~300’ below ground surface)
Tunnel Section

Top of ground

Mill Creek

Top of rock
Geologic Overview
Surface Topography of Ohio

Obtained from the Ohio Geological Survey
250,000 YBP

Pre-Illinoian (>150,000 YBP)

**Teays Drainage**

North flowing tributaries to the Teays system in blue. Modern drainage in black. Ohio River nonexistent at that time.

Map of Deep Stage ancestral Ohio shown by arrows.

Cross section of Deep Stage Ohio.

from Durrell, 1977
Illinoian (150,000 YBP)

Advance of Illinoian ice ponding north flowing Licking River with the deposition of lake clay followed by over flow of a divide at Anderson Ferry to create present westward course of the Ohio River, south of Cincinnati.

The further southward advance of the Illinoian ice deposited till over the lake clays and on the uplands.

Wisconsin (20,000 YBP)

Two lobes of Wisconsin ice sheet which fed outwash southward toward the Ohio River. Note braided stream pattern.

Cross section of two terraces in Mill Creek Valley well shown in Spring Grove Cemetery.

from Durrell, 1977
Subsurface Investigations
Bedrock Findings and Impacts on Construction Methods
The Foci of the Investigations

**Historical and Archive Research**: (~1100 historical borings) Included previous borings, research, and investigations by local, state, university, and federal entities.

**Drilling Round 1**: (9 borings) General characterization of the overburden and bedrock formations. Index and physical testing of soils and rock samples.

**Drilling Round 2**: (13 borings) Specific characterization of bedrock, including borehole geophysics, angle borings, joint orientations, etc.

**Drilling Round 3**: (57 borings) Top of rock verification borings to help define the buried valley geometry.

**Consultant Involvement**: Obtained throughout the investigation process to ensure aspects of tunnel investigations were characterized.
Kope formation

Average Compressive Strength: 915 psi
Point Pleasant formation

Avg. Compressive Strength: 3057 psi
Geotechnical and Dam Safety Section
Louisville District

Undifferentiated members

ROCK TYPE: LEXINGTON LIMESTONE

NUMBER OF SAMPLES

OVERALL PERCENTAGE

Avg. Compressive Strength: 9281 psi
Geotechnical and Dam Safety Section

Louisville District

ROCK TYPE: LOGANA

Avg. Compressive Strength: 7821 psi
ROCK TYPE: CURDSVILLE

Avg. Compressive Strength: 12,988 psi
Black River formation

Avg. Compressive Strength: 15,719 psi
Bentonite

Chert

Black River formation
Geotechnical and Dam Safety Section

Louisville District

Kope formation

Point Pleasant formation

Undifferentiated Members

Logana Member

Curdsville Member

Black River formation
Natural gas pocket encountered in southern most boring
Natural gas pocket encountered in one of northern most borings
34-foot excavated diameter tunnel on a 0.075% grade for approximately 16-miles
Tunnel Boring Machines

Photos taken from Robbins
Tunnel Boring Machines

Trailing equipment will consist of rock bolt drill-rigs and possibly instrumentation to sense for high amounts of hydrogen-sulfide and methane, which automatically shuts the TBM down.
Road Headers

Photo taken from Lane Cove Tunnel Project
Drill & Blast

Chattahoochee Tunnel
Rescon Mapei
Potential Ground Improvements

• Pre- or post-grouting to help control water inflow, gas inflow, and help to stabilize loose blocks.

• Rock bolts and straps to minimize rock falls.

• Shotcrete to improve excavation stability.

• Minimize drill & blast operations, which can influence rock stability characteristics outside the lines of the excavation.
Overburden Findings and Impacts on Construction Methods
Tunnel Section

- Top of ground
- Mill Creek
- Top of rock
Overburden Characterization

Generalization of Subsurface Conditions at Drop Shaft Locations for GRR

Geology
- 1) Estimation of Origin

Geography
- 2) Proximity to Valley Wall
- 3) Proximity to Norwood Trough
Geology (Origin)

Man-made
- Artificial fill material (1)

Riverine
- Recent alluviums
  - Wisconsin outwash
  - Illinoian glacial till
- Undifferentiated (2)

Glacial
- Illinoian lacustrine sediments (3)
- Pre-Illinoian Deep Stage sands & gravels (4)
Glacial Deposits located at Caldwell Park (eastern wall of Mill Creek valley)
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Glacial Deposits located at Caldwell Park (eastern wall of Mill Creek valley)
Project Number: LX2002135
Project Name: Mill Creek Deep Tunnel Project
Test ID: FM5M 366
Hole Number: UCL2020
Depth: 35.0′ - 37.0′

Fuller, Mossbarger, Scott and May Engineers, Inc.
Geography

North of the Norwood Trough

Confluence of the Norwood Trough with the Mill Creek Valley (3)

South of the Norwood Trough

Valley Wall (1)
Deep Valley (2)

Valley Wall (4)
Deep Valley (5)
The consistency of the overburden soils was generally stiffer, and the relative density was generally higher, north of the Norwood Trough.

At the confluence of the Norwood Trough with the Mill Creek Valley, deep sand was encountered.

Depth to bedrock decreases near valley walls.
Point-to-Point Profile - Drop Shaft Locations
Deep Valley - South of Norwood Trough

Note: The interface between various strata represents the approximate interface location.
Point-to-Point Profile - Drop Shaft Locations
Valley Wall - South of Norwood Trough

Note: The interface between various strata represents the approximate interface location.
Point-to-Point Profile - Drop Shaft Locations
Deep Valley - North of Norwood Trough

Note: The interface between various strata represents the approximate interface location.
Point-to-Point Profile - Drop Shaft Locations
Valley Wall - North of Norwood Trough

Note: The interface between various strata represents the approximate interface location.
Open Excavations

Chattahoochee River Tunnel Project
Shaft Excavations

Photos from Dawn Underground Engineering Group
Earth Tunnel Excavations
Potential Ground Improvements

- Pre-stabilization of soils to help control water inflow, help to stabilize loose and squeezing soils, and minimize surface settlement.

- Avoid boulder zones if possible.
Mill Creek tunnel stays below the bottom of the buried valley and above bentonite beds.

CSO runs transitioning through different materials to get to drop shafts.
Questions ?