2013 ASCE

Microtunneling in Difficult Ground

Craig Camp

July 31, 2013

Hatch Mott MacDonald
www.hatchmott.com

Agenda

- Introduction
- Difficult Ground

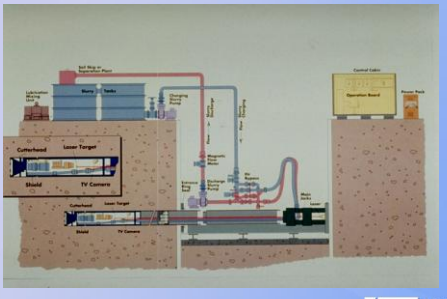
Hatch Mott MacDonald
www.hatchmott.com

Microtunneling Characteristics (NASTT)

- Earth pressure balancing
- Hydrostatic pressure balancing
- Guided and steered to line and grade
- Remote controlled
- Non-man-entry
- Installs continuous string of pipe by pipe jacking (pipe jacking method)

Hatch Mott MacDonald
www.hatchmott.com

Microtunneling System – 1979 Iseki



First Microtunneling Manufacturer

Hatch Mott MacDonald
www.hatchmott.com

1984 Highway Crossing Miami, Florida

First Microtunneling Project in NA

Hatch Mott MacDonald
www.hatchmott.com

Akkerman MTBM Introduced 1995

First Manufacturer in NA

Hatch Mott MacDonald
www.hatchmott.com

Difficult Ground

- Difficult – Conditions which cannot typically be excavate without causing settlement or heave or failure to complete the drive.
- Ground – Native matrix into which the pipe is excavated and jacked into place.

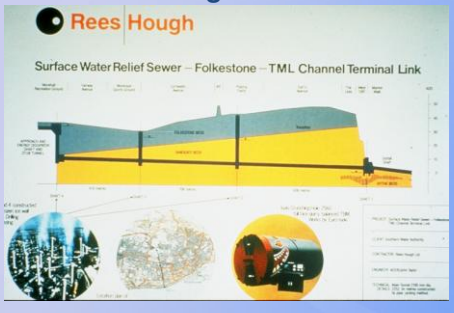
Agenda

- Introduction
- Difficult Ground

Difficult Soils

- Squeezing Ground
- Steep Slope
- Low Blow Count Soils
- Mixed Face
- Mixed Ground
- Mixed Drive
- Rock
- Curves

1990 MTBM with Segments



Storm Water Drain for English Chunnel

Pipe Jack Converted to Concrete Segments

Segment Erector

Difficult Soils

- Squeezing Ground
- Steep Slope
- Low Blow Count Soils
- Mixed Face
- Mixed Ground
- Mixed Drive
- Rock
- Curves

Hatch Mott MacDonald

1991 Salmon River HDD Crossing

Electrical Conduit

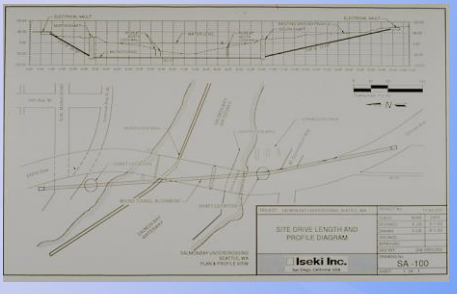
Hatch Mott MacDonald

US Army Corps of Engineers

Shipping Channel

Hatch Mott MacDonald

Microtunneling Replaces HDD



38° uphill drive

Hatch Mott MacDonald

Modified Cutter Face

38-inch OD MTBM Completed 38° Uphill Drive

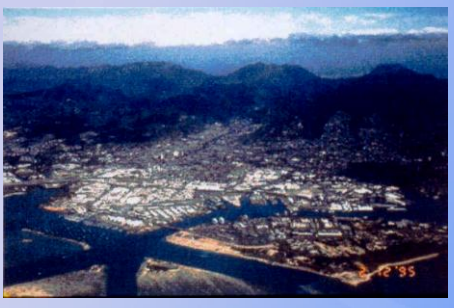
Hatch Mott MacDonald

Difficult Soils

- Squeezing Ground
- Steep Slope
- Low Blow Count Soils
- Mixed Face
- Mixed Ground
- Mixed Drive
- Rock
- Curves

Hatch Mott MacDonald

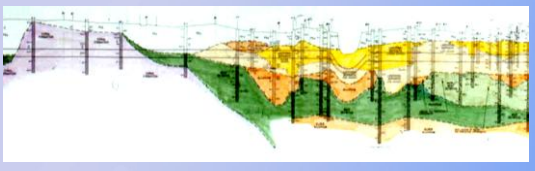
1993 Nimitz Highway, Honolulu



Project Setting

Hatch Mott MacDonald
www.hatchmott.com

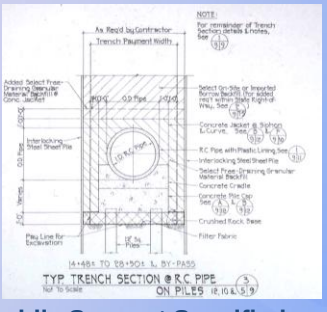
1993 Nimitz Highway, Honolulu



Anticipated Soil Conditions:
Highly Saturated Fill and
Lagoonal Deposits Over Coral

Hatch Mott MacDonald
www.hatchmott.com

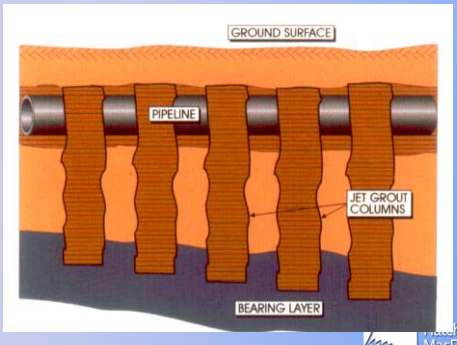
Open Cut Converted to Microtunnel



Pile and Saddle Support Specified

Hatch Mott MacDonald
www.hatchmott.com

Conceptualized Jet Grout Columns



Hatch Mott MacDonald
www.hatchmott.com

1994 First Avenue, Seattle

Frozen Ground Shaft

Hatch Mott MacDonald
www.hatchmott.com

Very Soft Ground EPB Machine

N=0 to 10, Saturated Silts and Sands

Hatch Mott MacDonald
www.hatchmott.com

Very Soft Ground MTBM

Light Machine Weight
Active Face

120- inch ID RCP

138- inch OD RCP

Difficult Soils

- Squeezing Ground
- Steep Slope
- Low Blow Count Soils
- Mixed Face
- Mixed Ground
- Mixed Drive
- Rock
- Curves

Mixed Face

An interface within the excavated tunnel zone between two geological units with different engineering properties. e.g., rock overlain by soft ground or very soft, low strength soil overlain or underlain by a very stiff, high strength soil.

Issue

- MTBM will tend to deflect
  - When entering, along the harder material
  - When exiting, out of harder material
- MTBM must be Capable of Both Materials

Difficult Soils

- Squeezing Ground
- Steep Slope
- Low Blow Count Soils
- Mixed Face
- Mixed Ground
- Mixed Drive
- Rock
- Curves

Mixed Ground

The excavated tunnel zone without a defined interface that contains soil and coarse fractions of gravels, cobbles, and boulders, i.e., silt with boulders.

This term is not currently defined by ASTM or USCS.

Issue

- MTBM will tend to Deflect
- MTBM may “See” Full Face Rock
- MTBM must be Capable of Both Materials

Difficult Soils

- Squeezing Ground
- Steep Slope
- Low Blow Count Soils
- Mixed Face
- Mixed Ground
- Mixed Drive
- Rock
- Curves

Mixed Drive

A drive that progresses between two geological units with different engineering properties. e.g., rock into soft ground or very soft, low strength soil into a very stiff, high strength soil.

This term is not currently defined by ASTM or USCS.

Issue

- MTBM may encounter a Mixed Face
- MTBM must be Capable of Both Materials

Difficult Soils

- Squeezing Ground
- Steep Slope
- Low Blow Count Soils
- Mixed Face
- Mixed Ground
- Mixed Drive
- Rock
- Curves

Rock is a Different Beast

- High thrust load improves cutter performance
- Rock does not tend to heave/subside
- Removing cut material improves cutter performance
- Pipe jacking is not required for ground support
- Machine can jack from side wall
- Access to face is preferred to change cutters
- Energy consumed is a function of spoils surface area created

Rock Microtunneling

Old Technology & Poor Face Cleaning

Single Disk Cutter – New Technology

Volcanic Tuff

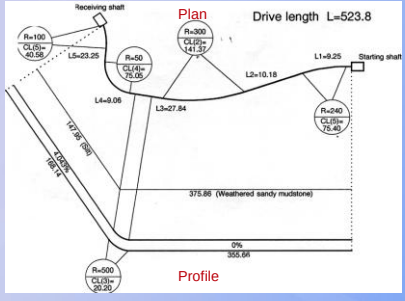
Unproven MTBM Technology

Abrasion

Difficult Soils

- Squeezing Ground
- Steep Slope
- Low Blow Count Soils
- Mixed Face
- Mixed Ground
- Mixed Drive
- Rock
- Curves

1997 Curved Microtunneling Design



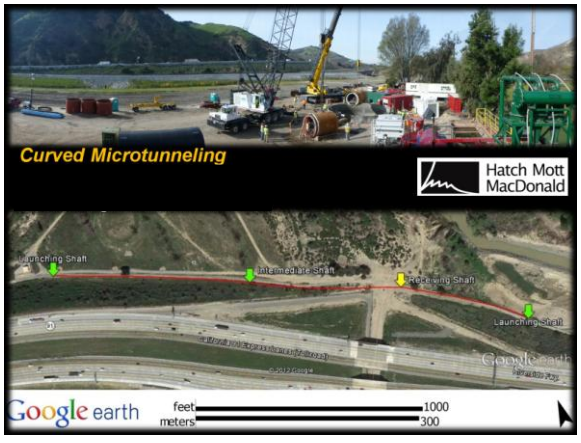
Special Planning and Execution

Double Articulated MTBM

Special Machine for 50-M Radius

2012 SARI

- First “S” curve
- First use of hydraulic packer
- Use of curved guidance system
- Contractor Value Engineering proposal



Consider

- Outside Diameter
- MTBM and Pipe Length
- IJS Length
- Jacking Loads
- Pipe Joint
- MTBM Overcut
- Curve Placement in Drive
- Lost Productivity (Total Cost)
- Guidance and Surveying

Questions?

Craig Camp

Hatch Mott MacDonald
401 B St.
Suite 1520
San Diego, CA 92108
(Office) 619.881.0407
Craig.Camp@HatchMott.com
(Cell) 619.410.6328
www.HatchMott.com