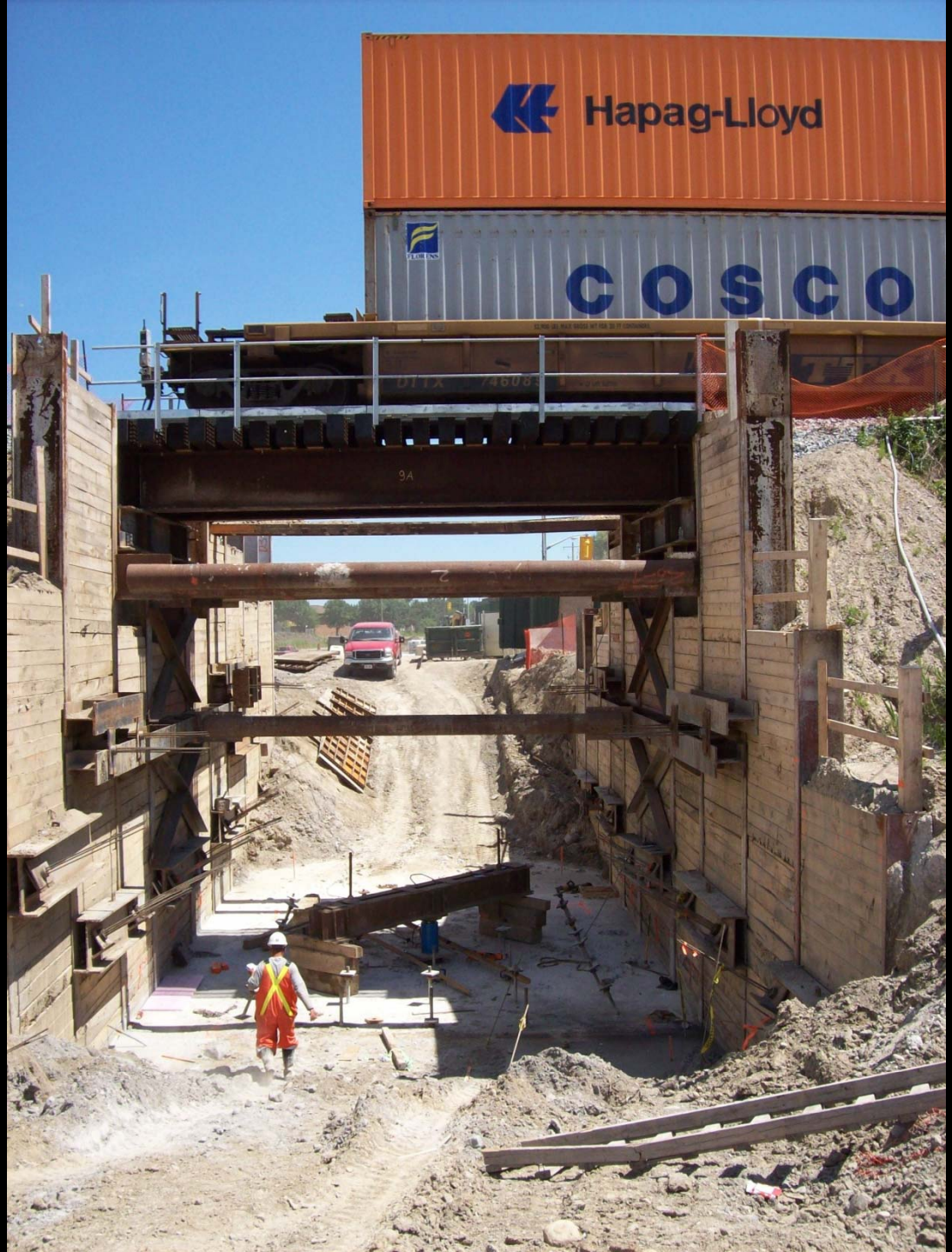
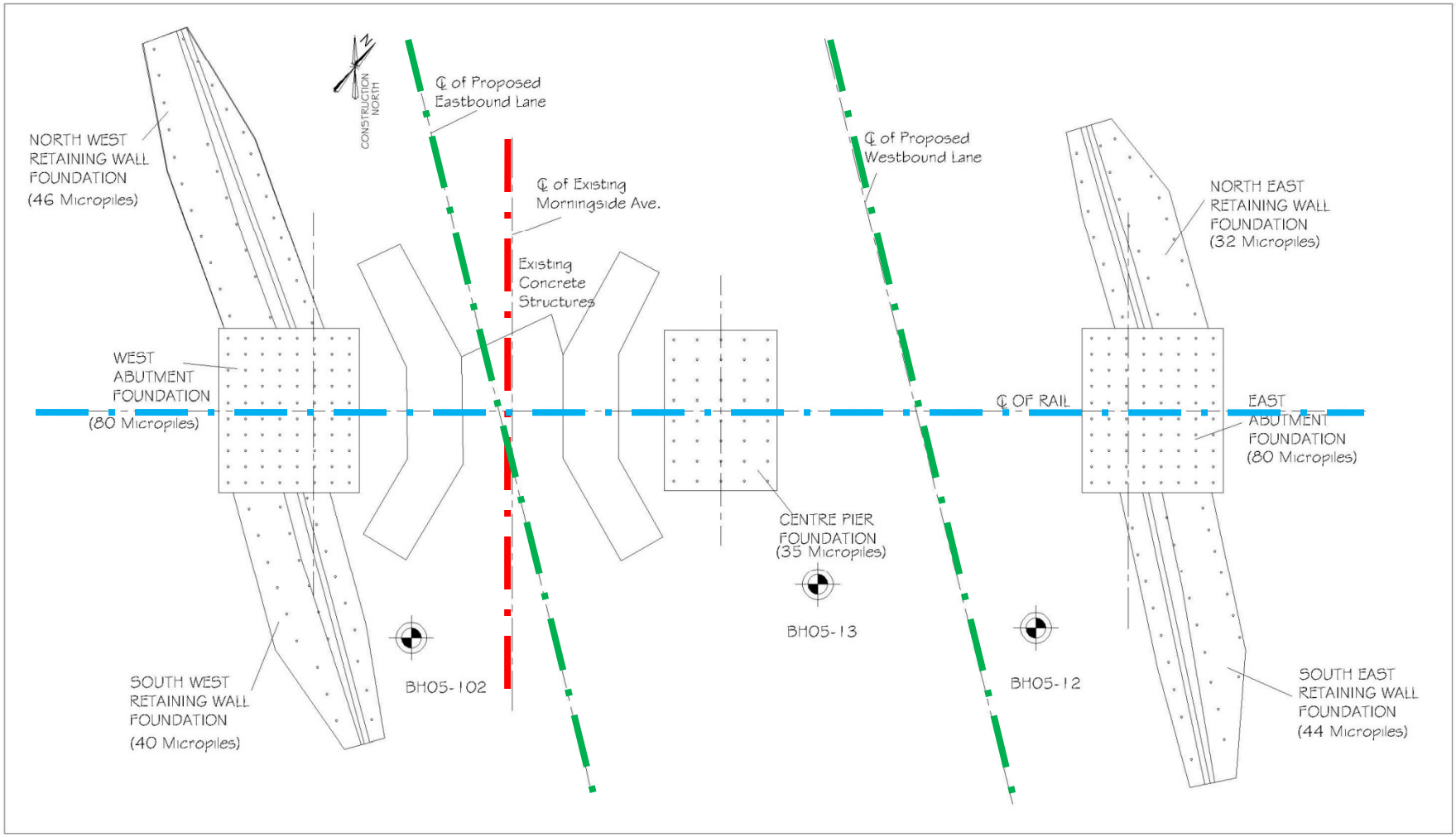
GEO-FOUNDATIONS
Contractors Inc.

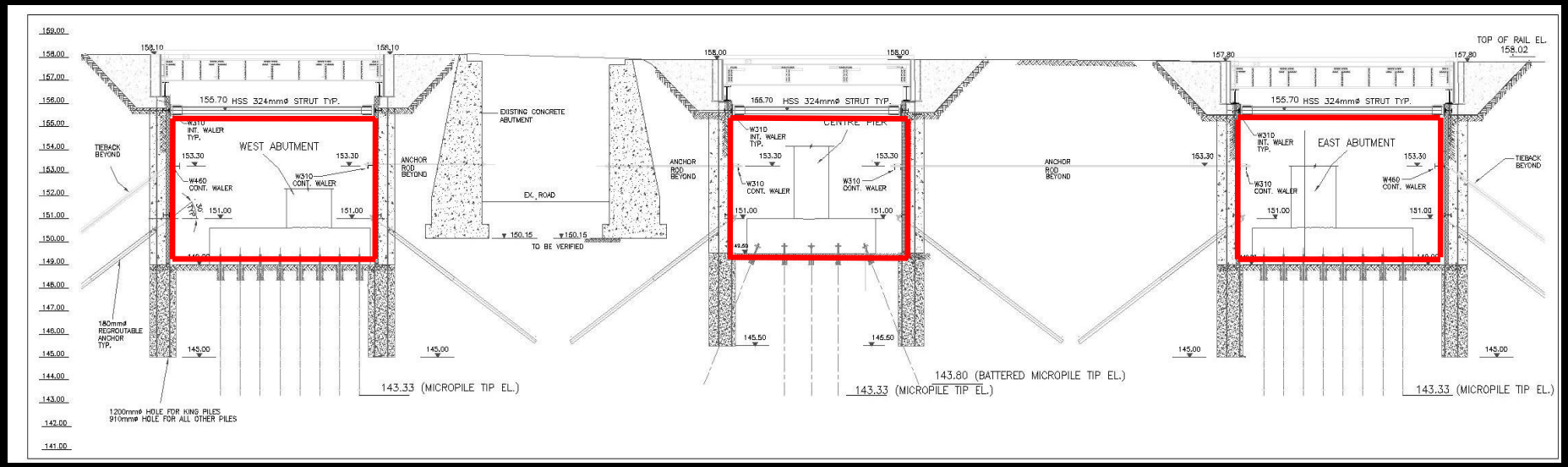
CPR Morningside Grade Separation

ISM London 2009

Presented by Jim Bruce, P. Eng.

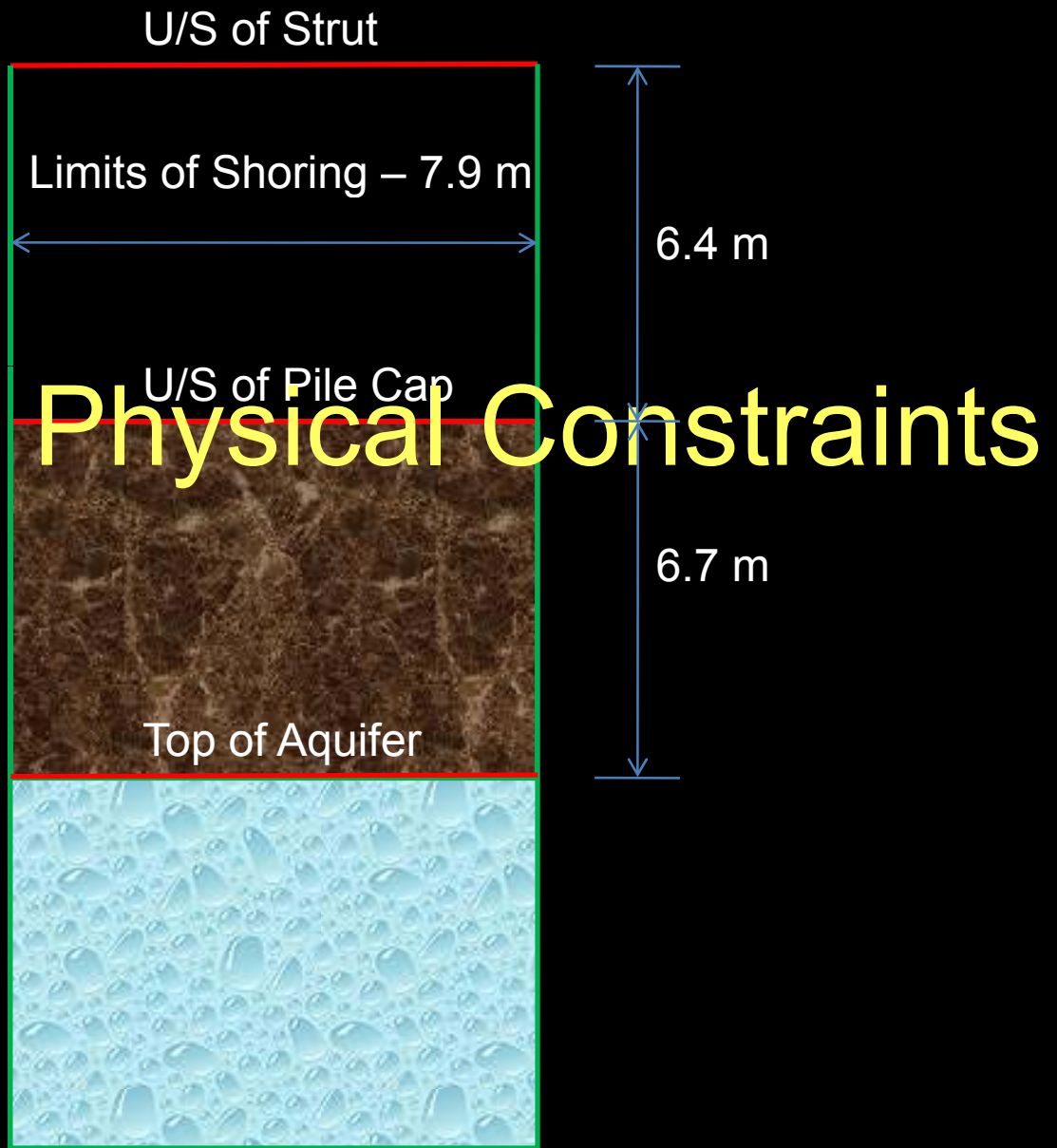

Hapag-Lloyd
COSCO


CONSTRUCTION NORTH
℄ of Proposed Eastbound Lane
℄ of Existing Morningside Ave.
Existing Concrete Structures
℄ of Proposed Westbound Lane
NORTH WEST RETAINING WALL FOUNDATION (46 Micropiles)
NORTH EAST RETAINING WALL FOUNDATION (32 Micropiles)
WEST ABUTMENT FOUNDATION (80 Micropiles)
℄ OF RAIL
EAST ABUTMENT FOUNDATION (80 Micropiles)
CENTRE PIER FOUNDATION (35 Micropiles)
BH05-13
BH05-102
BH05-12
SOUTH WEST RETAINING WALL FOUNDATION (40 Micropiles)
SOUTH EAST RETAINING WALL FOUNDATION (44 Micropiles)


TOP OF RAIL EL. 158.02
158.10
158.10
155.70 HSS 324mmø STRUT TYP.
W310 INT. WALER TYP.
WEST ABUTMENT
153.30
153.30
W310 CONT. WALER
W460 CONT. WALER
151.00
151.00
TIEBACK BEYOND
ANCHOR ROD BEYOND
EXISTING CONCRETE ABUTMENT
EX. ROAD
150.15
150.15
TO BE VERIFIED
180mmø REGROUTABLE ANCHOR TYP.
145.00
145.00
143.33 (MICROPILE TIP EL.)
1200mmø HOLE FOR KING PILES
910mmø HOLE FOR ALL OTHER PILES
158.00
158.00
155.70 HSS 324mmø STRUT TYP.
CENTRE PIER
W310 INT. WALER TYP.
153.30
153.30
W310 CONT. WALER
W310 CONT. WALER
151.00
151.00
ANCHOR ROD BEYOND
ANCHOR ROD BEYOND
145.50
145.50
143.80 (BATTERED MICROPILE TIP EL.)
143.33 (MICROPILE TIP EL.)
157.80
157.80
155.70 HSS 324mmø STRUT TYP.
W310 INT. WALER TYP.
EAST ABUTMENT
153.30
153.30
W310 CONT. WALER
W460 CONT. WALER
151.00
151.00
TIEBACK BEYOND
145.00
145.00
143.33 (MICROPILE TIP EL.)
169.00
158.00
157.00
156.00
155.00
154.00
153.00
152.00
151.00
150.00
149.00
148.00
147.00
146.00
145.00
144.00
143.00
142.00
141.00


3.7m

Physical Constraints



Owner’s Specified Scheme:

324 Ø driven, closed-ended tube piles x 4m embedment

223 no. Driven Piles @ 535 kN SLS

Micropile Scheme:

52 Ø hollow bar micropiles x 5.7m embedment, installed using continuous grout flush

357 no. micropiles @ 365 kN SLS

The Pitch:

Micropile materials in stock and ready for shipment to site

Contractor to perform 5 load tests, including 2 pre-production

Measurement for payment by lump sum, on a performance basis

Design Approach:

Reduced individual pile loading

Willingness to go closer to aquifer

Load transfer into soil over entire embedment length

CONTINUOUS GROUT FLUSH

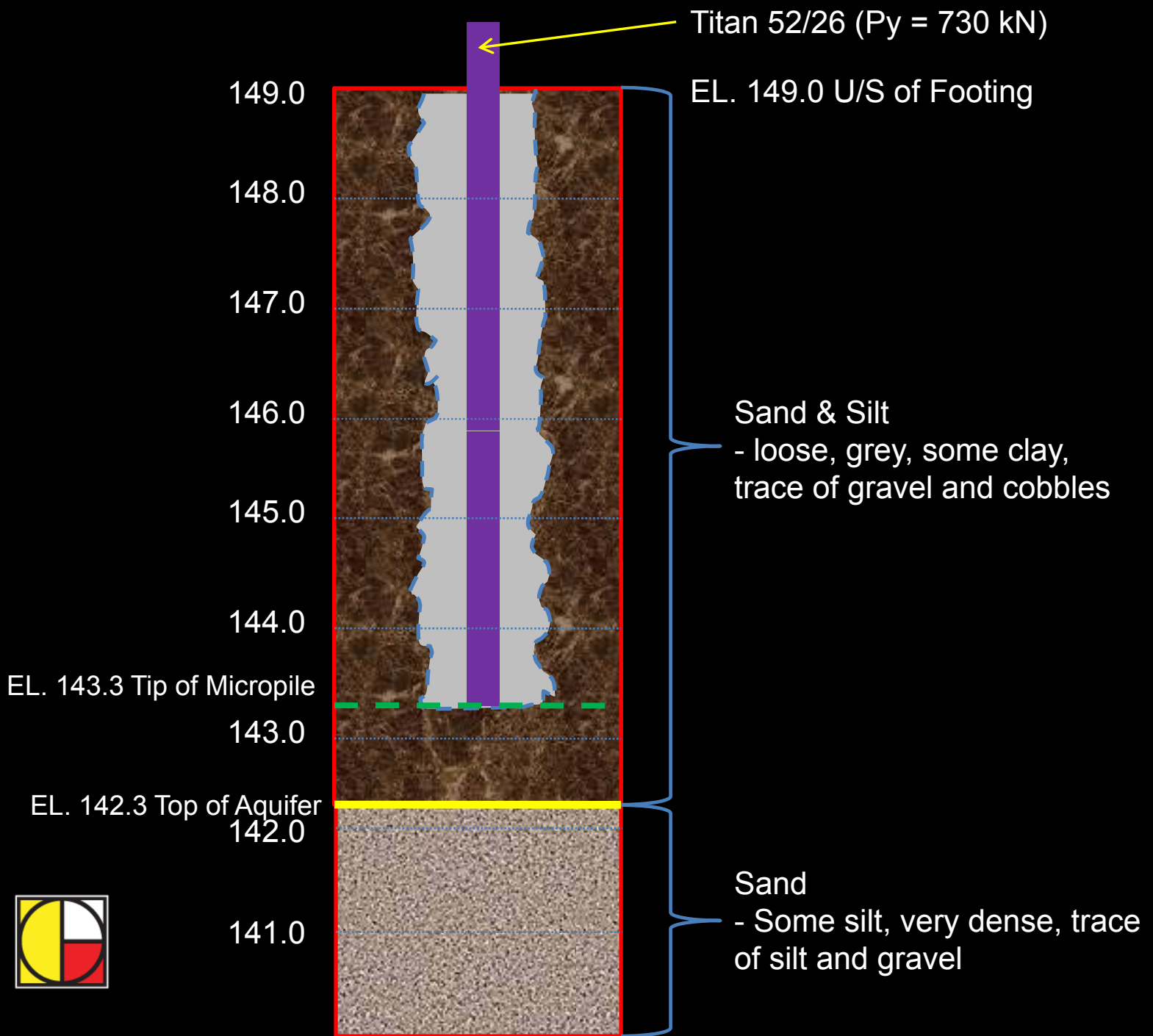
Resulting Design:

5.7 m embedment (commercially driven)

65 kN/m adhesion (carefully calculated risk taken by micropile contractor)

365 kN axial service compression per pile

Titan 52 hollow bar with 115 Ø drill bit; black, uncased


Titan 52/26 (Py = 730 kN)
149.0
EL. 149.0 U/S of Footing
148.0
147.0
146.0
Sand & Silt
- loose, grey, some clay,
trace of gravel and cobbles
145.0
144.0
EL. 143.3 Tip of Micropile
143.0
EL. 142.3 Top of Aquifer
142.0
Sand
- Some silt, very dense, trace
of silt and gravel
141.0

Load Testing:

- Total of 5 load tests – 2 at each abutment, 1 at centre pier

- Typical movements under static compressive loading to 100% : < 3mm

- Pre-production tension test performed to validate results of static compressive test


DeWALT

Benefits of using micropiles at this site:

- Reduced risk to aquifer
- Small equipment able to work comfortably in constricted space
- Off the shelf materials readily available
- Cost certainty from transferring measurement for payment from unit rate to lump sum
- Transfer of risk from owner to contractor via change to performance micropile contract from prescriptive driven pile design

Conclusions:

- Micropiles were a better foundation design for this project than driven piles

- The switch to micropiles resulted in lower total foundation cost, but only because the micropile contractor was the micropile designer ….

Hypothesis:

Although the use of micropiles at CPR Morningside was of immeasurable benefit to the owner, this project would be tendered no differently today

223 no. Driven Tube Piles @ 535 kN SLS

↓

5.7 m max. embedment @ 65 kN/m

↓

365 kN SLS ….. 357 no. micropiles

5.7 m max. embedment

↓

max. 40 kN/m …. max. 230 kN per pile

↓

> 500 no. Prescriptive designed piles

Hypothesis Confirmed:

Considering the absence of rock and the strict restriction on embedment depth, the owner could not possibly have gone to tender on micropiles because:

- Few to no local consulting engineers are able or willing to design it,
- Not more than one or two local micropile contractors are able to construct it, and …
- Procurement via prescriptive design would have diverted the design away from micropiles due to high cost

Thank you