Purdue Geotechnical Society Workshop

Purdue University, West Lafayette, Indiana
May 7, 2007

Instrumentation Results from Construction of a Utility Tunnel for the New Indianapolis International Airport

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Purpose

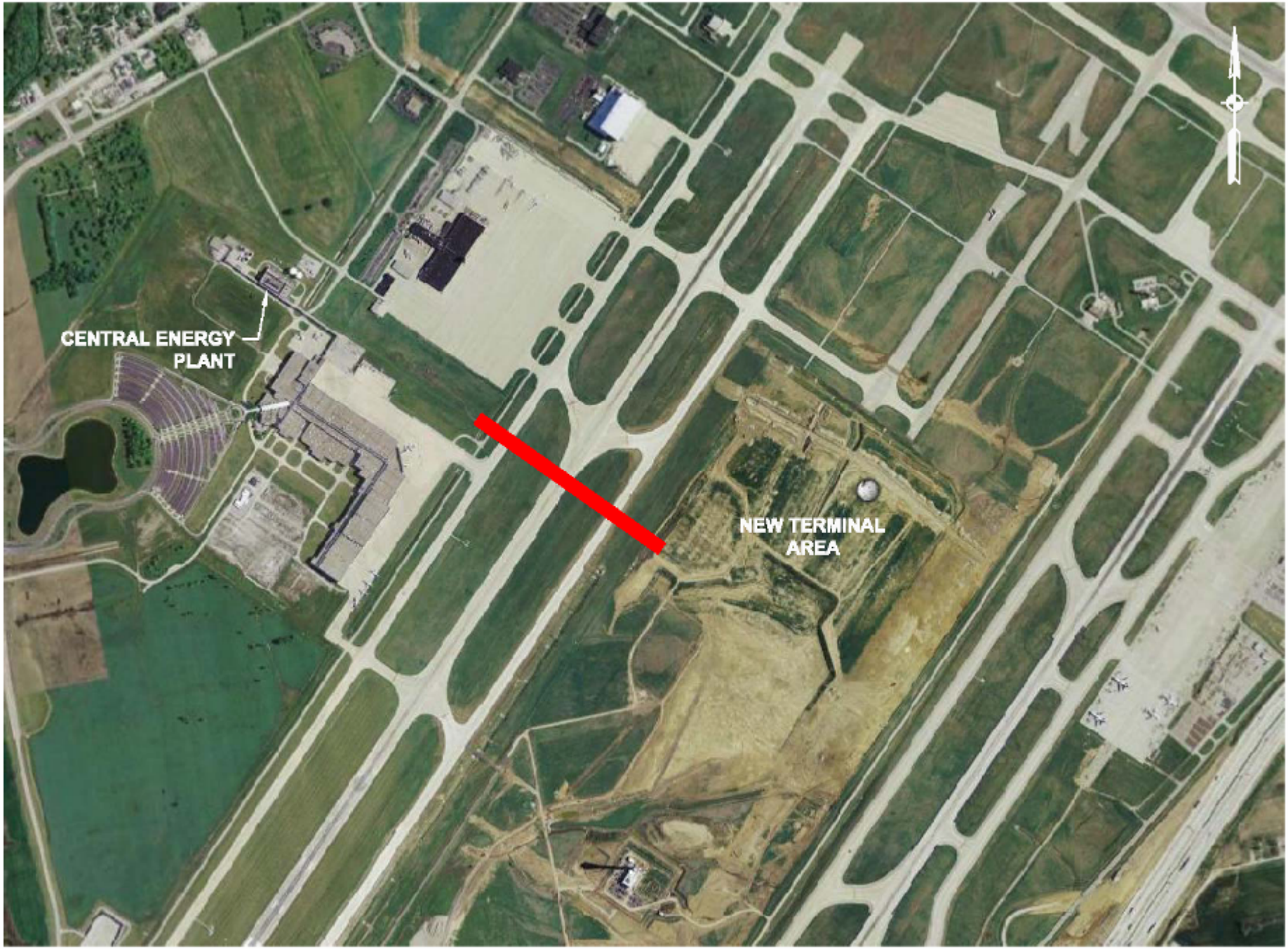
Representatives of the Indianapolis International Airport are currently building a new terminal and infrastructure elements (parking, roadways, etc.)

Need to provide steam and chilled water (among other utilities) to the new terminal area.

Install utilities via cut-and-cover (at least 3 mi.)

OR

Utilize a tunneling technique


CENTRAL ENERGY PLANT
NEW TERMINAL AREA

Quick Stats

Approximate 8-ft diameter tunnel; 2,000 ft long

Earth Pressure Balance (EPB) machine

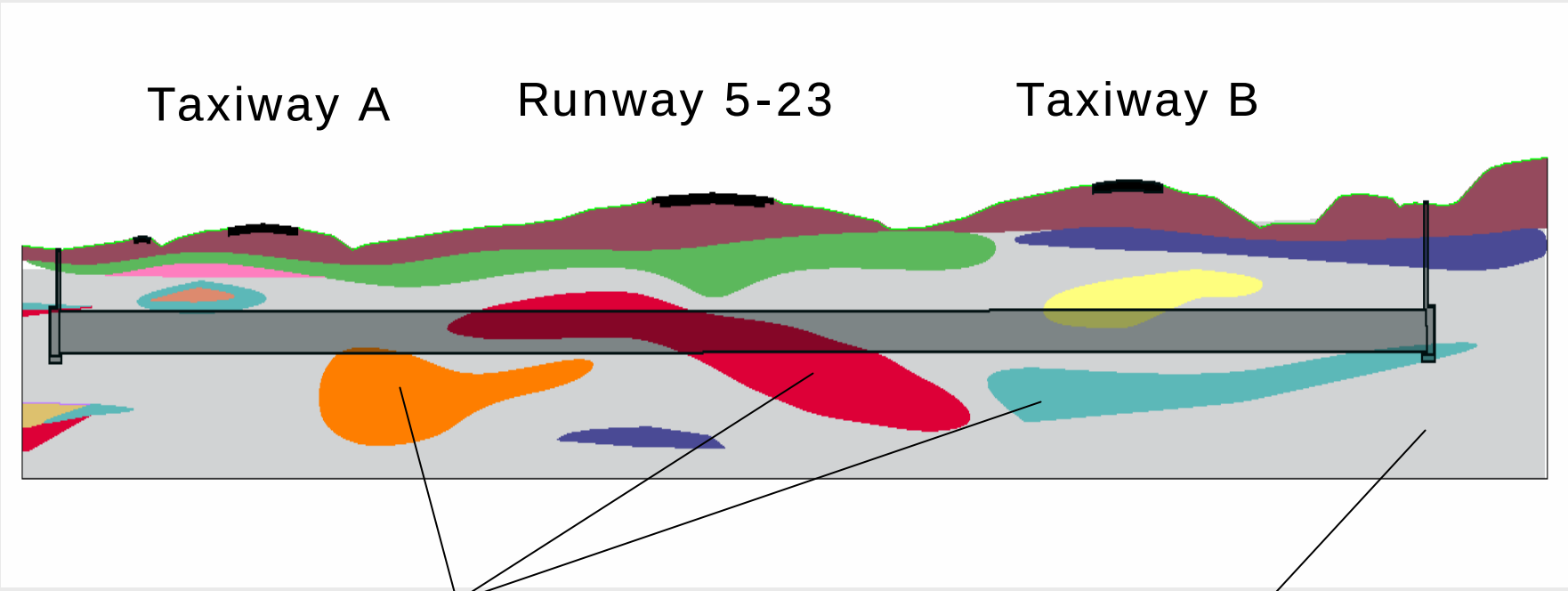
Steel liner plates

Average 15 ft earth cover

Constructed below two active taxiways and one of the primary runways


106 EPBM

Subsurface Profile along Tunnel



Profile provided by Gilco Group, Inc.

Instrumentation

53 surface points on taxiway and runway pavement

48 surface points in non-pavement (grass)

Five single-point borehole extensometers placed to within 3 to 5 ft of crown

Six structure points (placed to observe large culverts)


WARNING!
CALIBRATION
TESTED
GEOKON
Model GK-403
VIBRATING WIRE READOUT
RS232
CHARGER
OFF
ON
MENU/ESCAPE
DISPLAY
MADE IN THE U.S.A

Instrumentation

Surface Points on Pavement:

- Review level ½ in., Alert level 1 in.

Surface Points in Grass:

- Review level ¾ in., Alert level 1½ in.

Structure Points (Culverts)

- Review level ½ in., Alert level ¾ in.

Extensometers

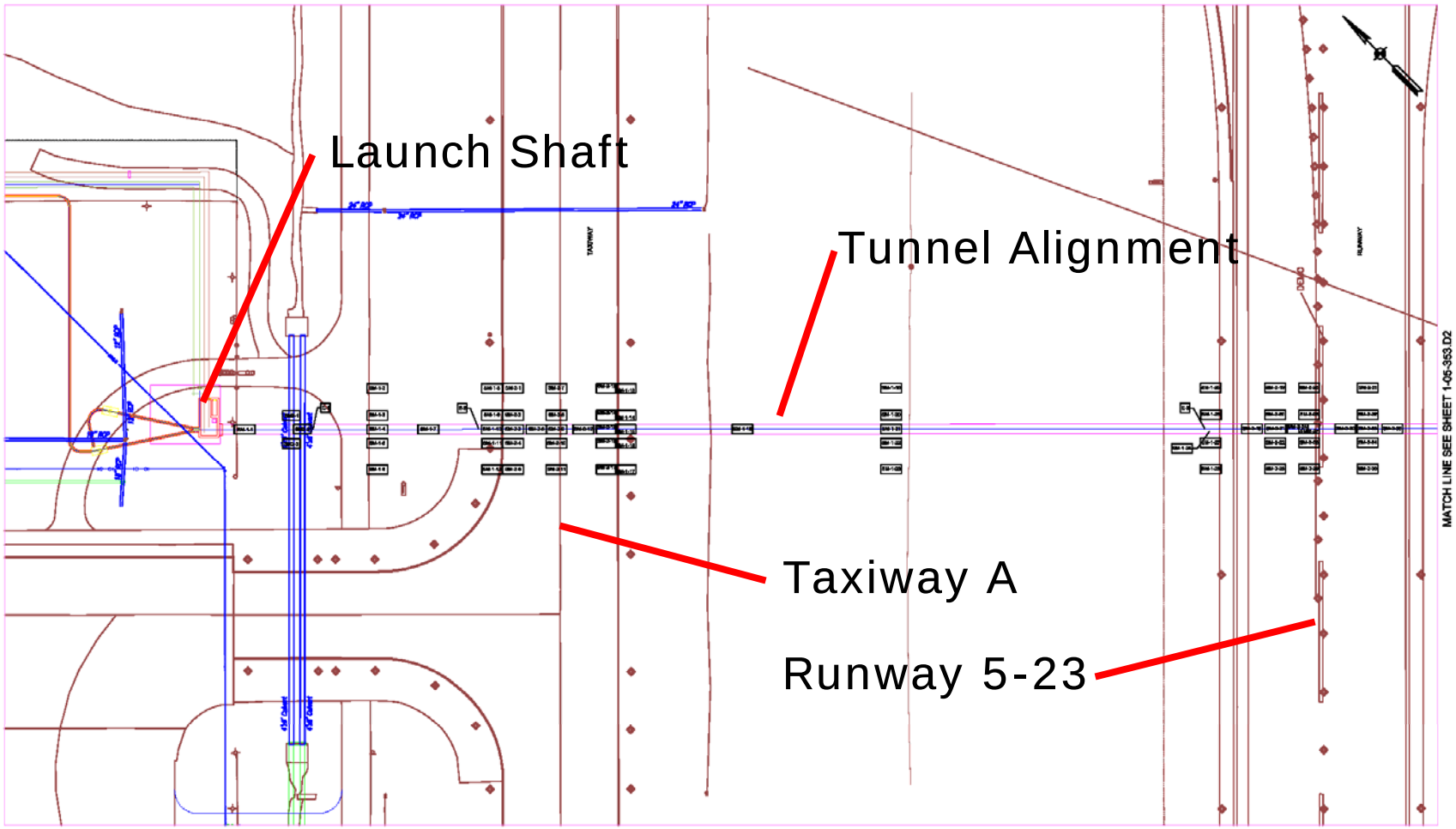
- Review level 1 in., Alert level 1¾ in.

Instrumentation

Monitoring Frequency:

All instruments within 250 ft ahead of and 500 ft behind machine to be monitored on a daily basis.

All instruments to be read bi-monthly regardless of TBM location.



NOTES:
1. Base map developed from an electronic file provided by Parsons Brinckerhoff Quade & Douglas Inc.
2. As-built instrument locations and surface elevations determined by UEI Consultants, Inc.
3. Instruments installed during the period of March 27 through April 5, 2006.
4. See Sheet 1-05-353.D2 for a summary of as-built locations.

SCOTT L. LONDON — No. 910185 — STATE OF INDIANA — REGISTERED PROFESSIONAL ENGINEER

ENGINEER — 5/05/06 DATE

LEGEND
- B-1 BORE HOLE EXTENSOMETER
- SM-1-1 SURFACE MONITORING POINT (UNPAVED)
- SM-2-1 SURFACE MONITORING POINT (PAVEMENT)
- SM-3-1 SURFACE MONITORING POINT (CULVERTS)

PROJECT ENGINEER: MSW
APPROVED BY: S.J.L.
DRAWN: JSF
APPROVED BY: S.J.L.

AS-BUILT GEOTECHNICAL INSTRUMENTATION PLAN

UTILITY CONNECTION TUNNEL
Indianapolis Airport
Indianapolis, Indiana

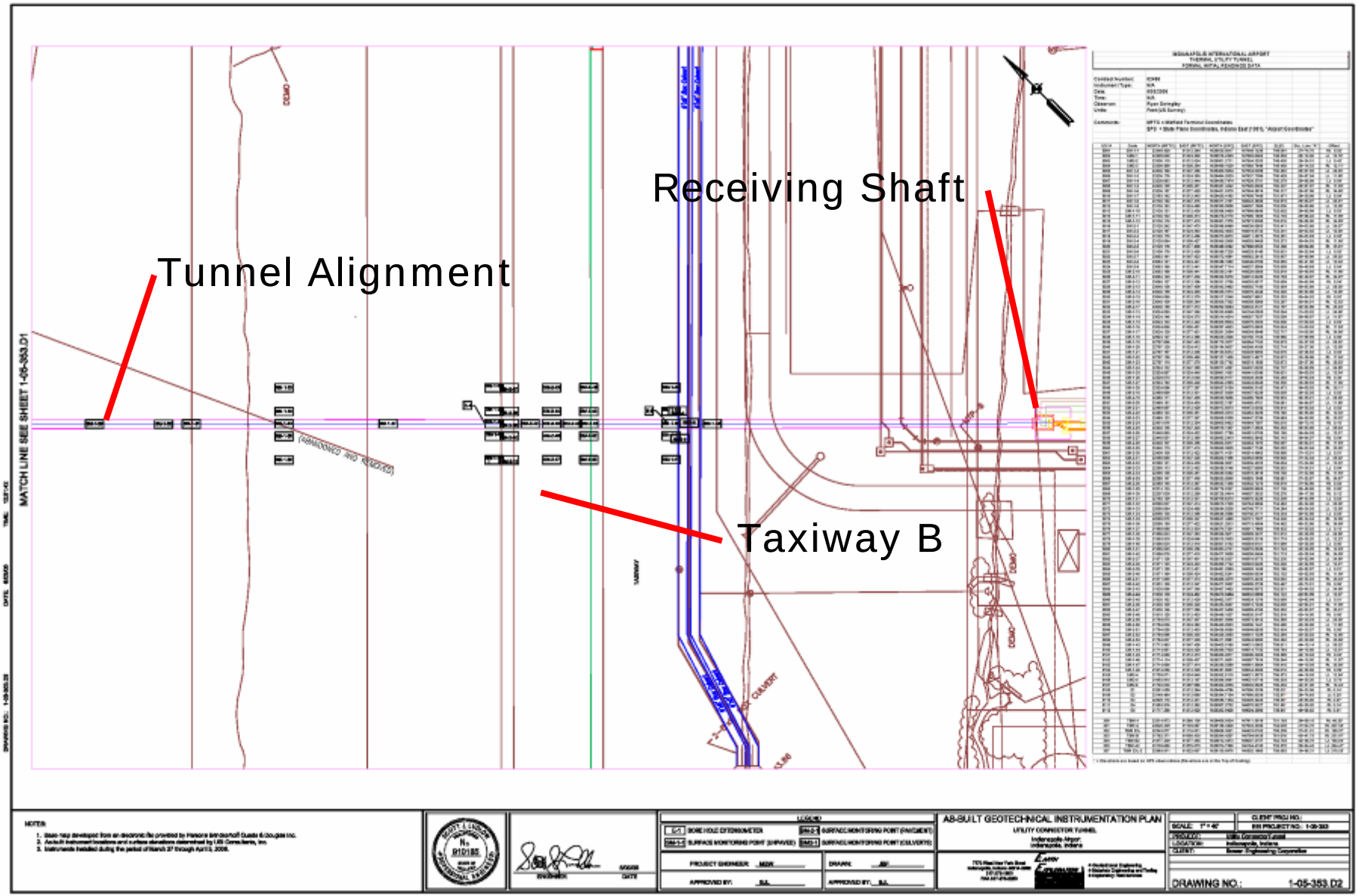
7770 West New York Street
Indianapolis, Indiana 46231-2388
317-273-1000
FAX 317-273-2388

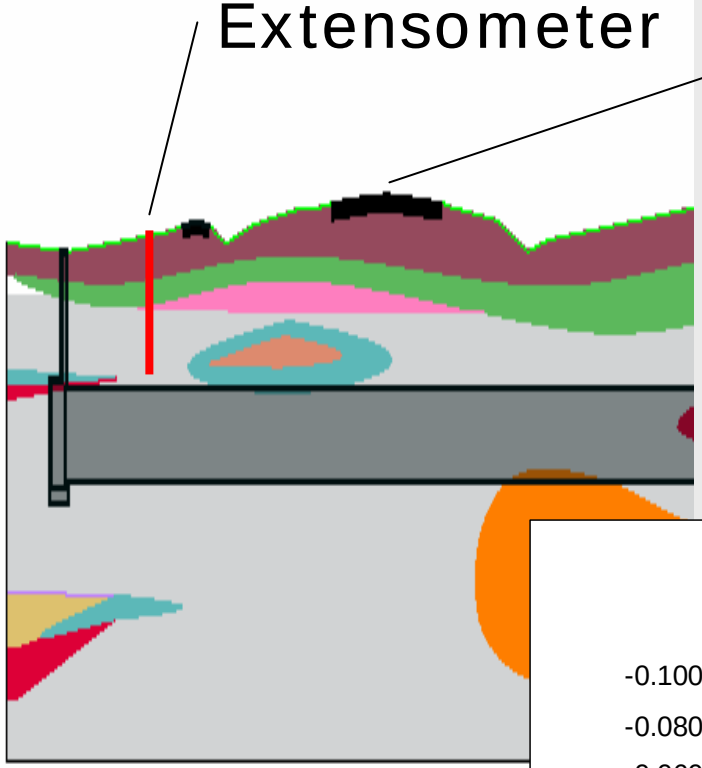
Geotechnical Engineering
Materials Engineering and Testing
Exploratory Field Services

SCALE: 1" = 40'
CLIENT PROJ NO.:
EEI PROJECT NO.: 1-05-353
PROJECT: Utility Connector Tunnel
LOCATION: Indianapolis, Indiana
CLIENT: Bowen Engineering Corporation

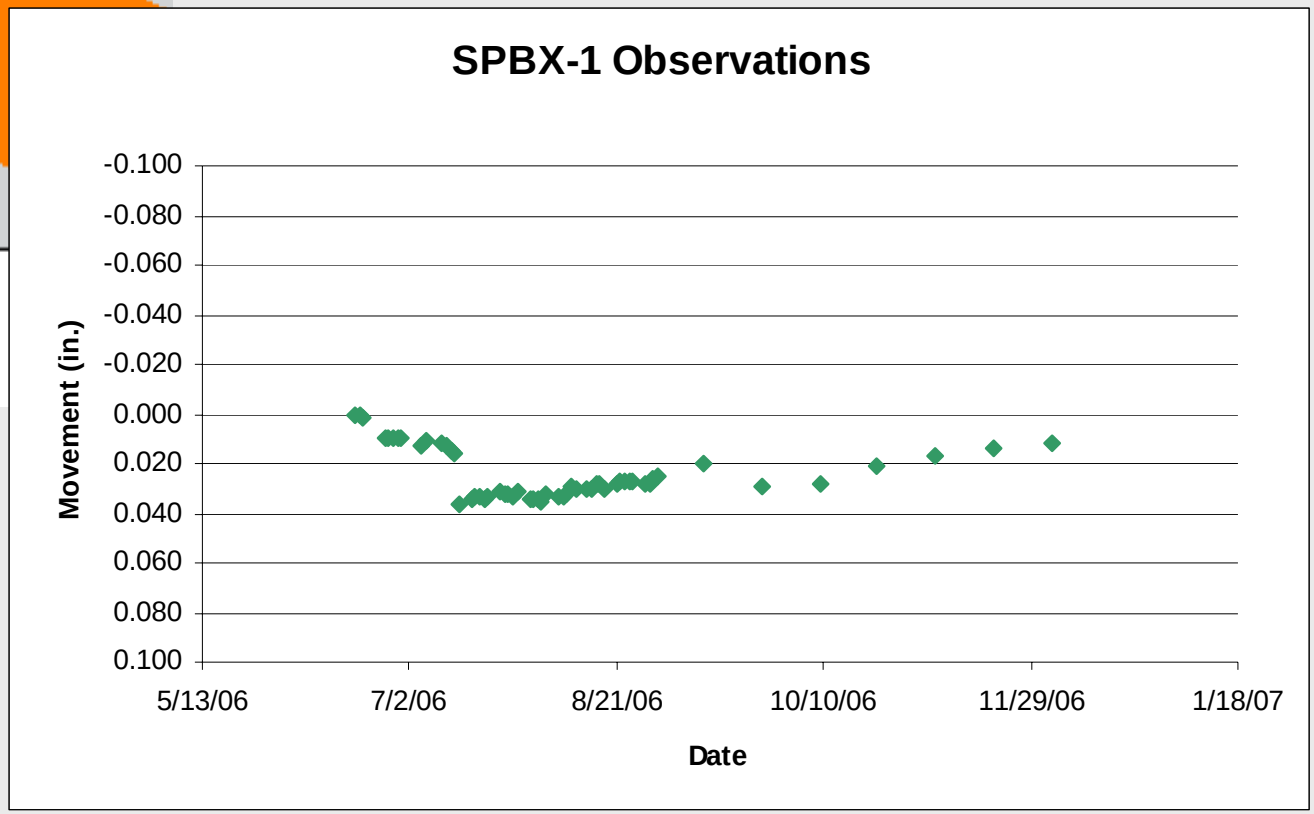
DRAWING NO.: 1-05-353.D1

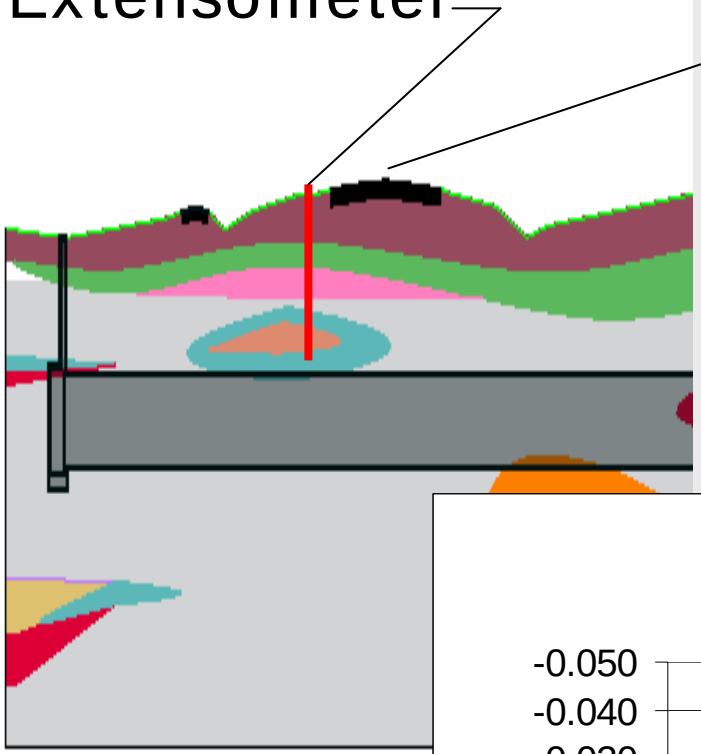
DRAWING NO.: 1-05-353.D1 DATE: 5/05/06 TIME: 12:51:42


Receiving Shaft
Tunnel Alignment
Taxiway B
MATCH LINE SEE SHEET 1-05-353.D1
AS-BUILT GEOTECHNICAL INSTRUMENTATION PLAN
UTILITY CONNECTOR TUNNEL
Indianapolis Airport
Indianapolis, Indiana
DRAWING NO.: 1-05-353.D2

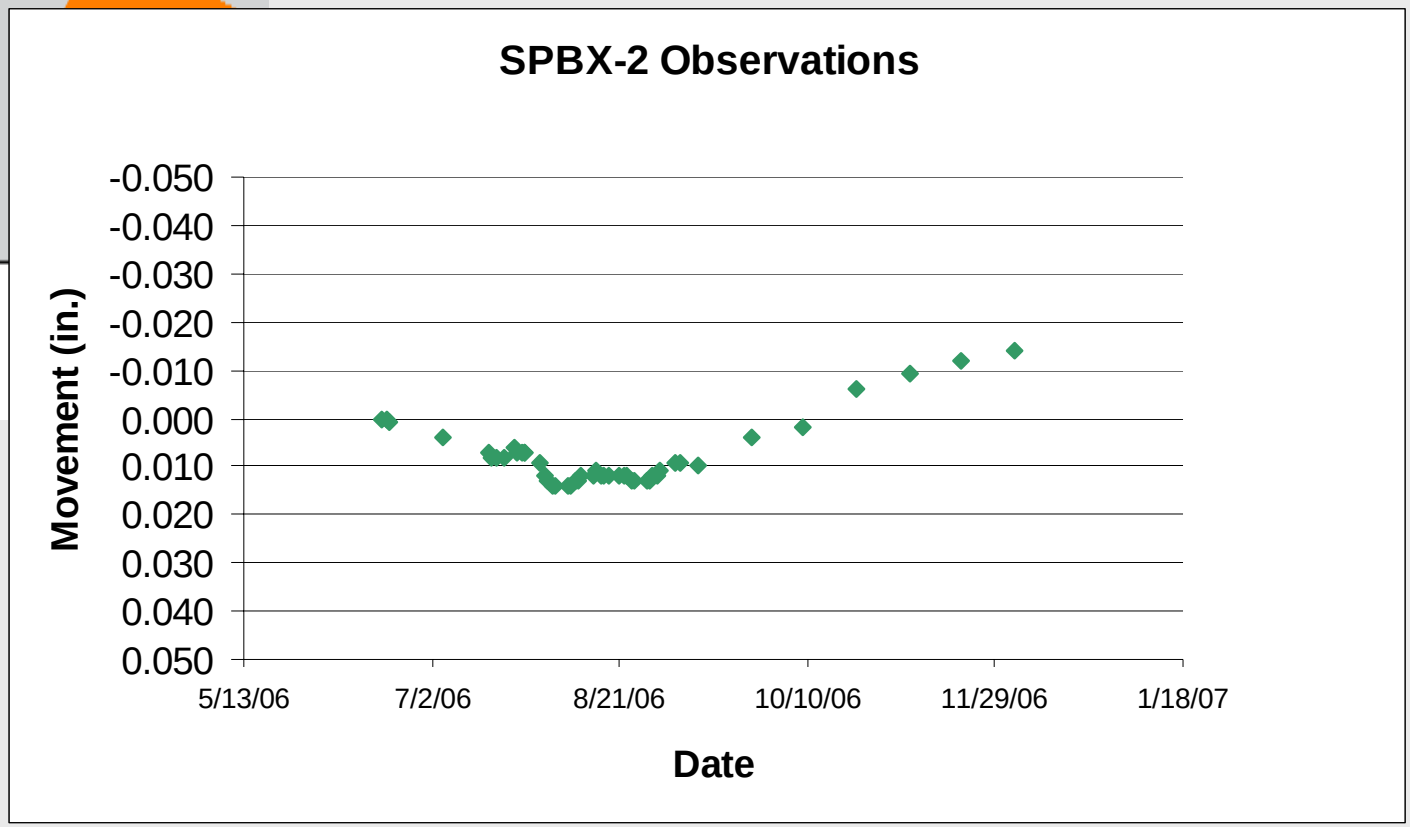


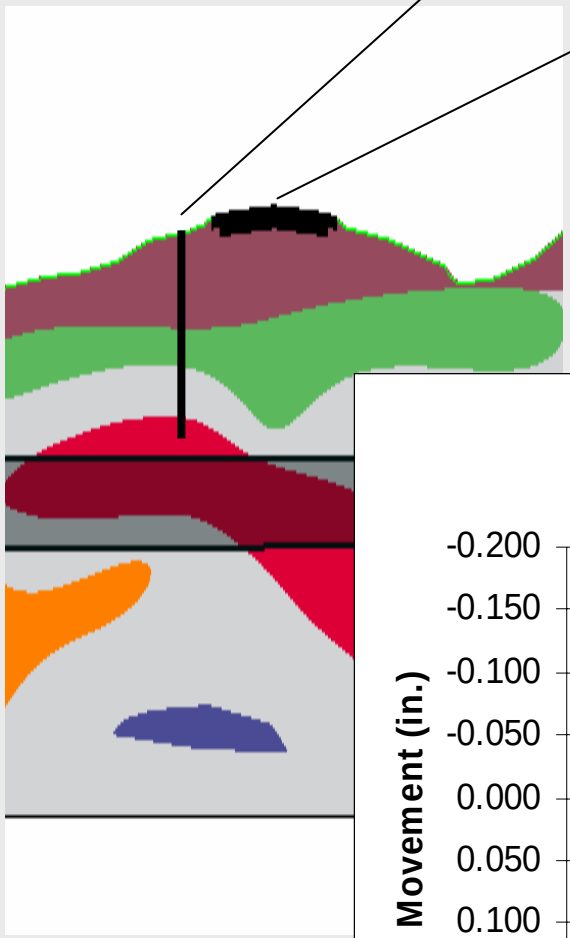
Extensometer Tip and Tunnel Crown in OC Till (CL-ML)





Extensometer Tip and Tunnel Crown near Granular Soils





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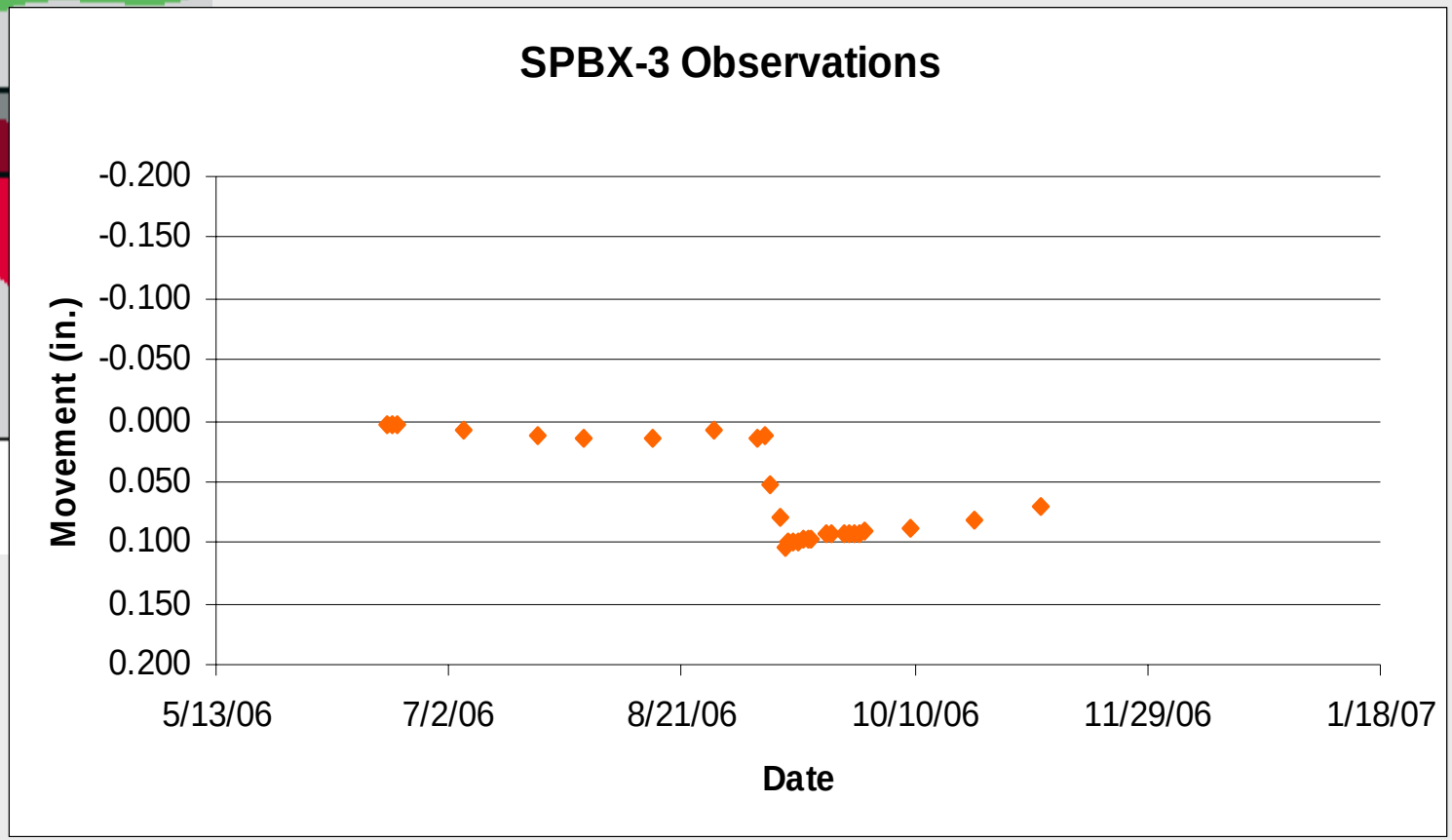

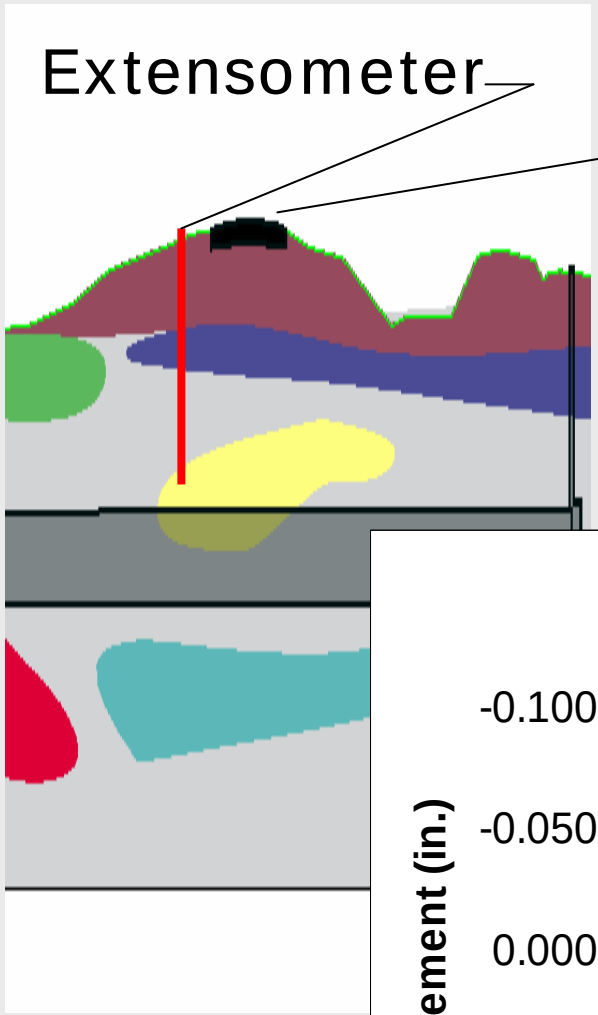

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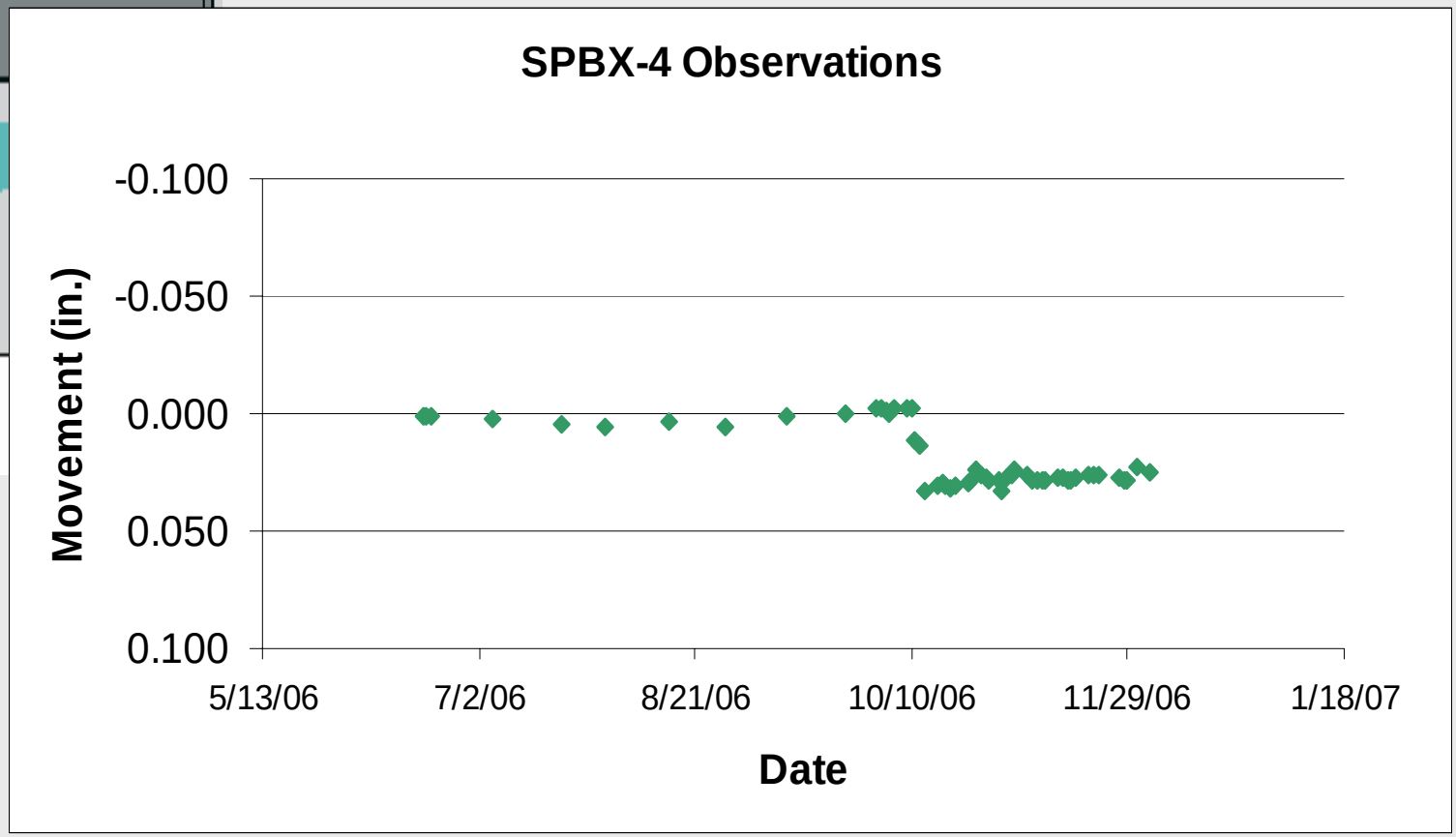
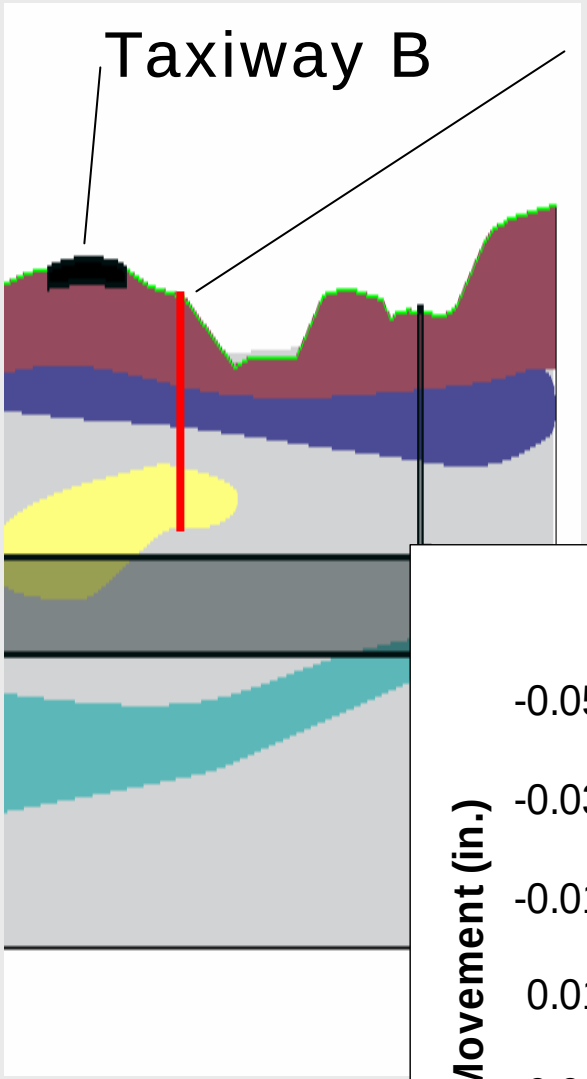
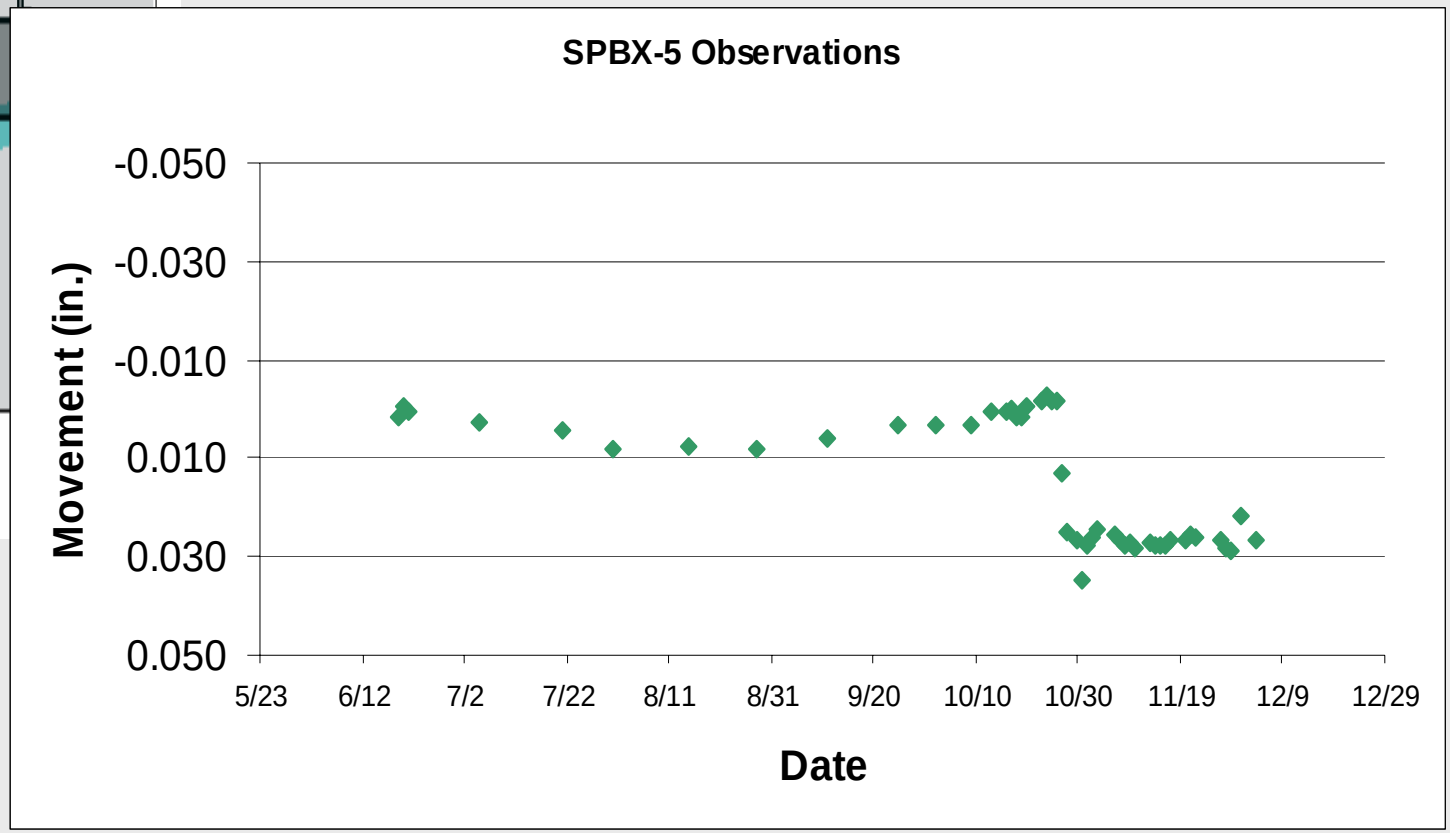




Extensometer Tip and Tunnel Crown in OC Till (CL-ML) near Granular Soils



Surface Settlement Estimate

Mixed Ground Conditions:

Reasonable prediction of volume loss (V_l) in the range of 0.2% to 1% of tunnel volume.

Therefore, volume of surface settlement trough

$$V_s = V_l * (PI * D^2/4)$$

Surface Settlement Estimate

Mixed Ground Conditions:

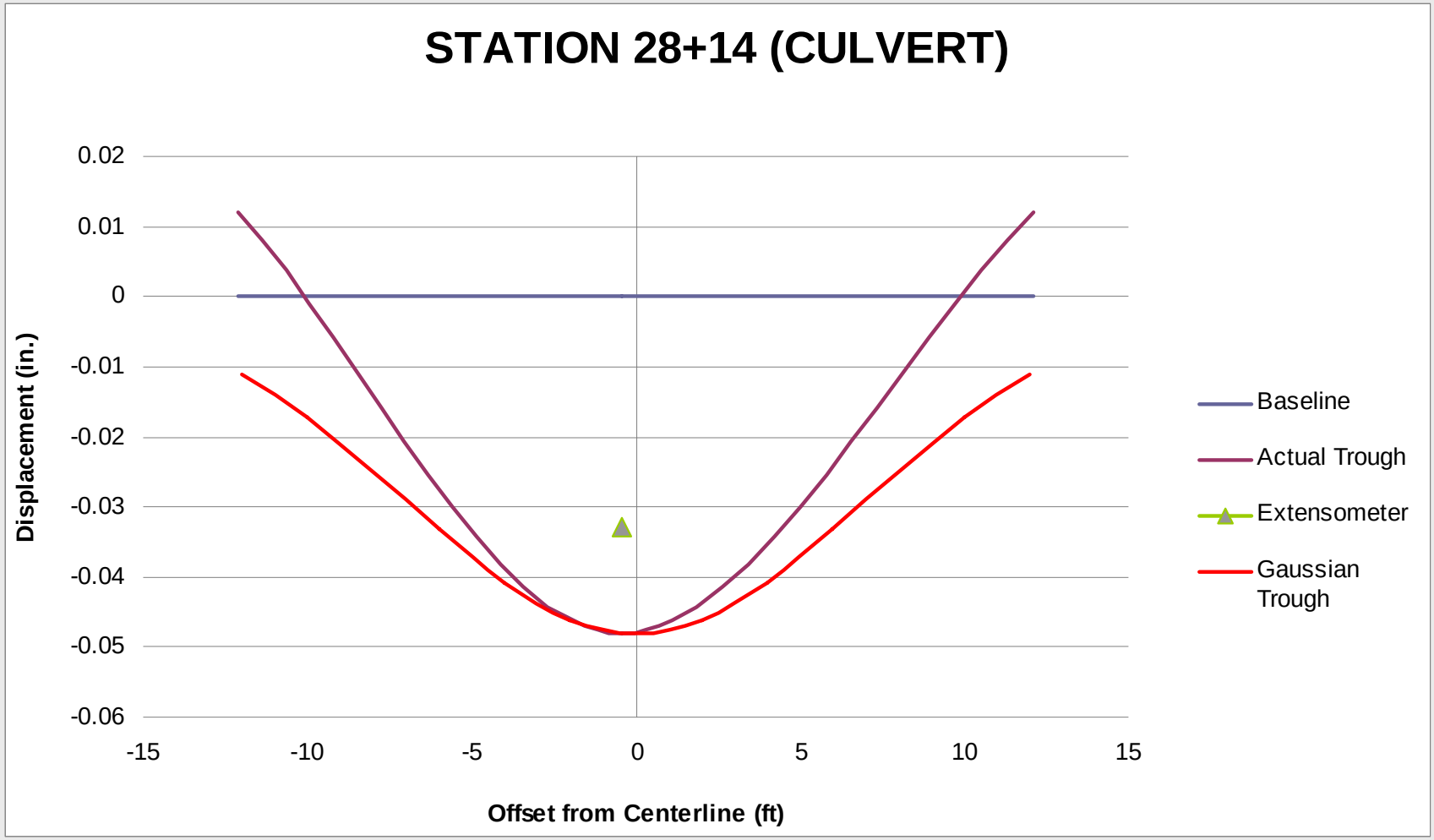
Reasonable prediction of settlement (to assist in establishing review and action levels):

$$S = V_s/[SQRT(2*PI)*i]$$ (Gaussian distribution)

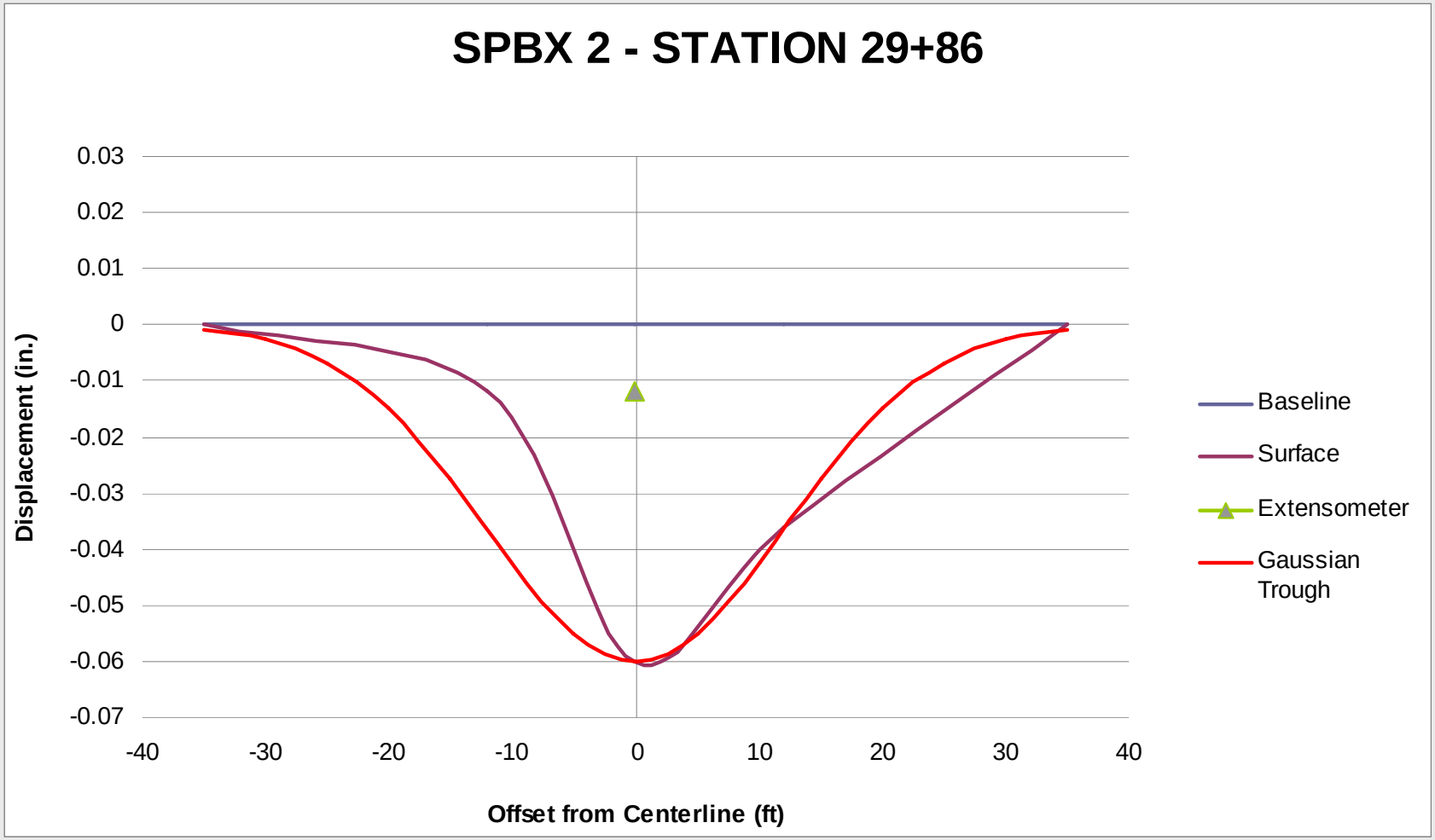
i = function of soil type, depth to crown and tunnel diameter

Predicted settlement in the range of 0.2 to 1 in.

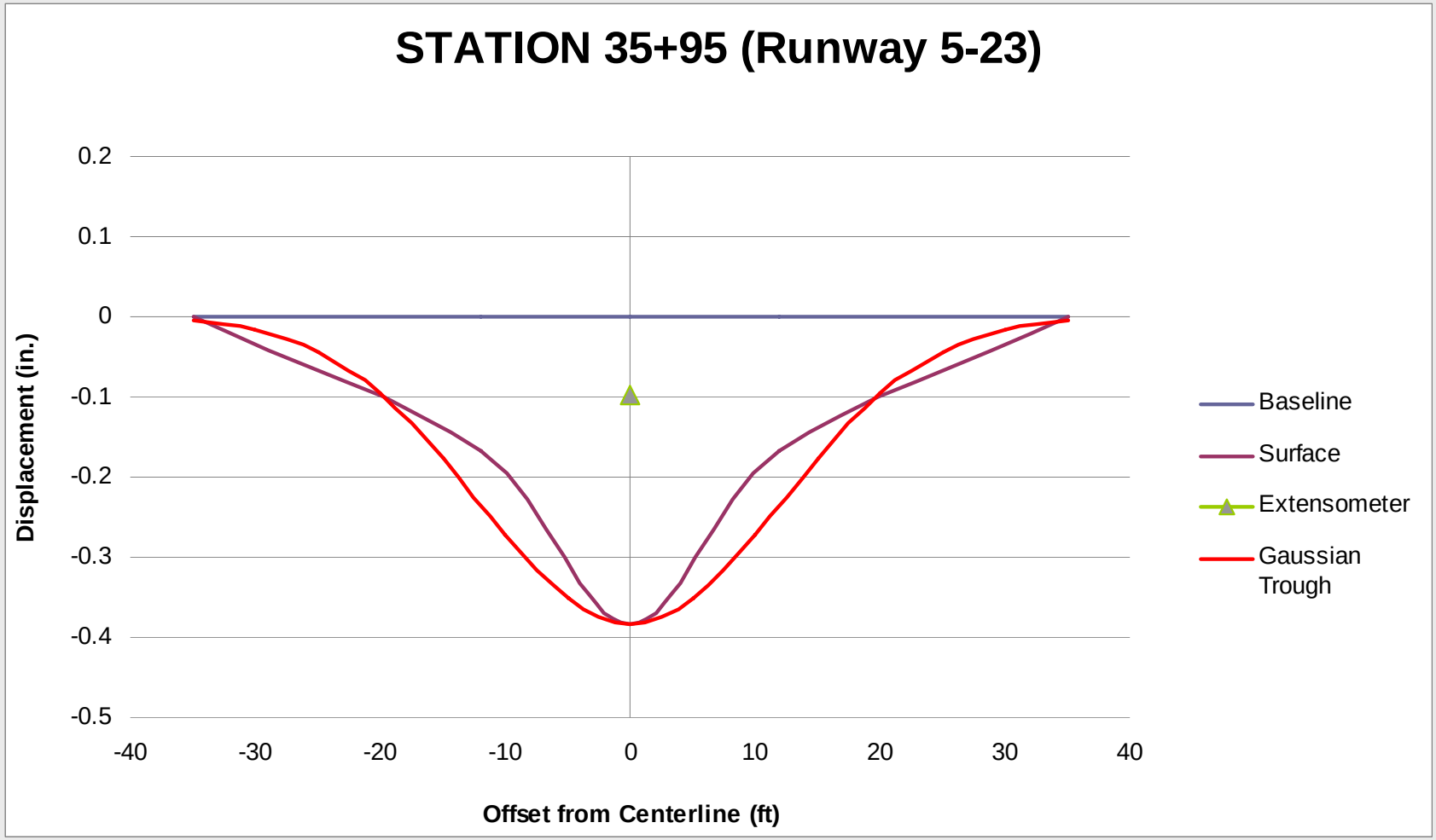
Trough at SPBX-1



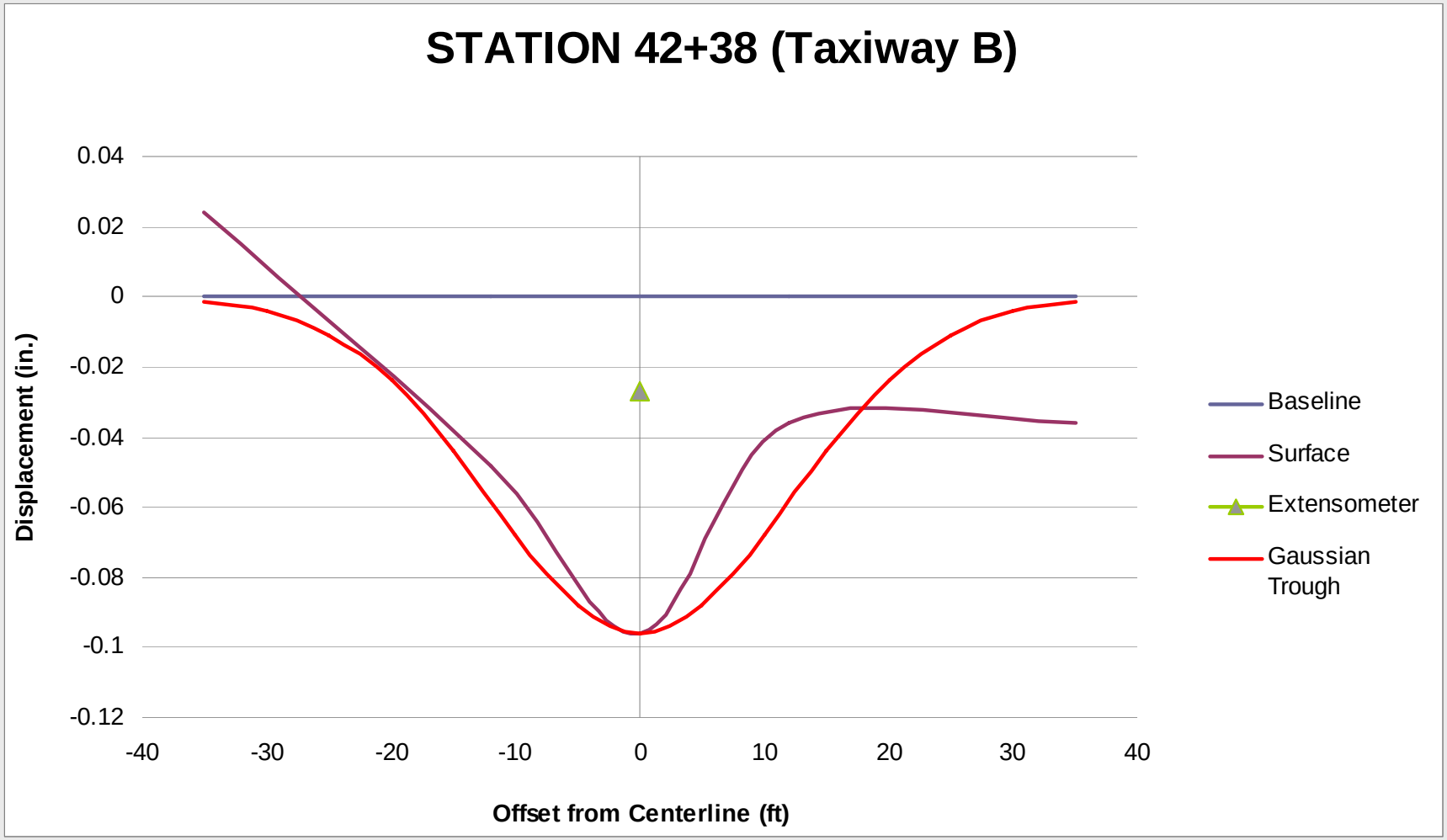
Trough at SPBX-2



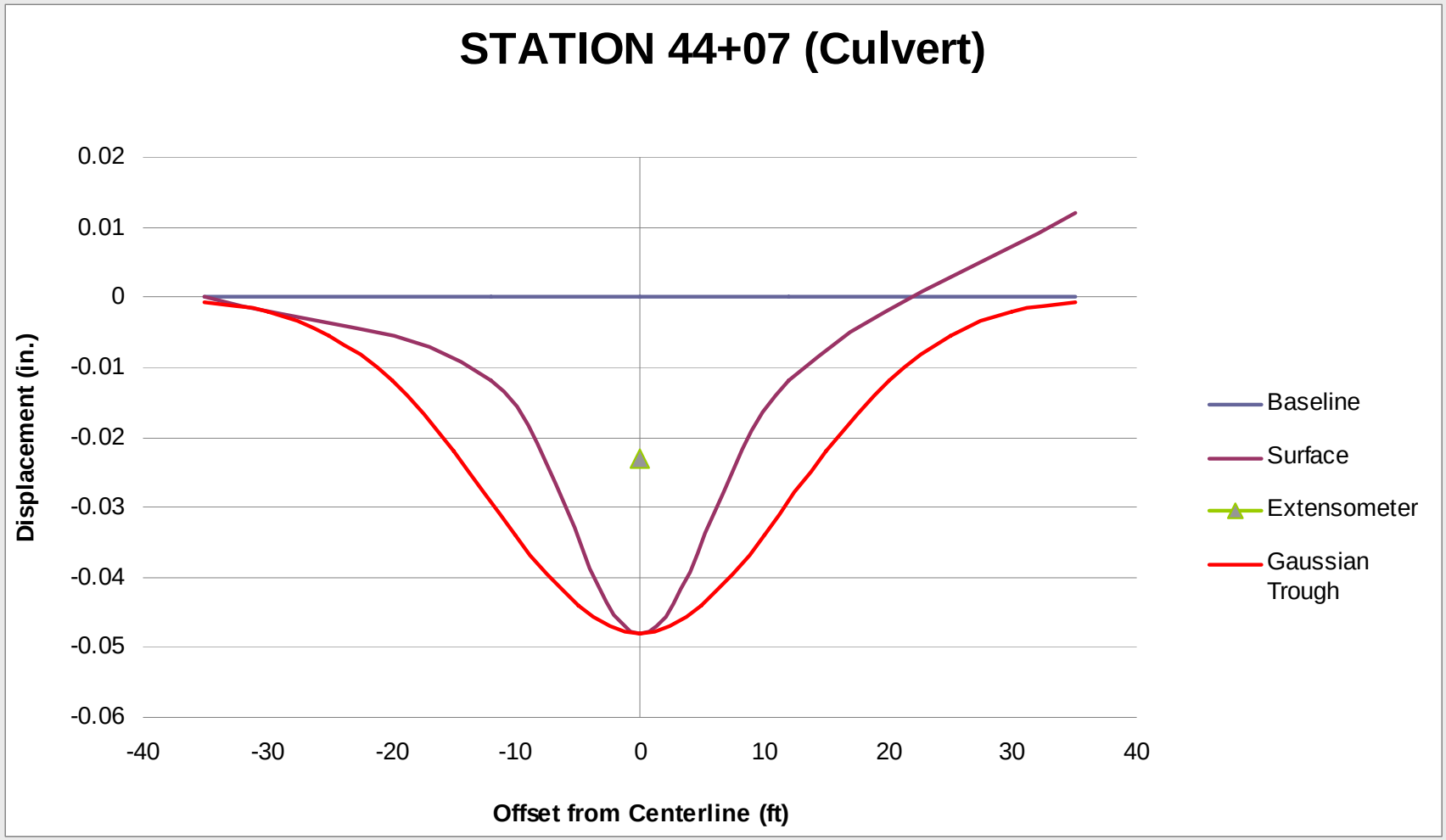
Trough at SPBX-3



Trough at SPBX-4



Trough at SPBX-5



Summary

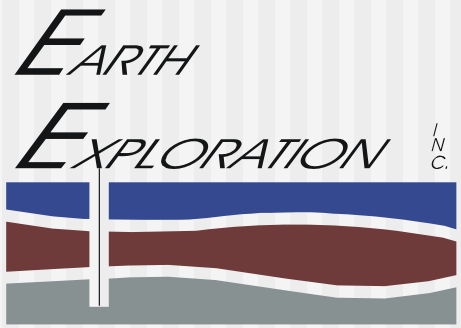
Very little actual settlement likely due to:

- Good control of face pressures and subsequent minimal volume loss.
- Highly over-consolidated and hard nature of the soil which likely led to some arching even with low cover.
- Grouting procedures around liner plates.

Settlement Trough generally followed Gaussian

Thank You

Questions or Comments



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