

B U T L E R
P A R T N E R S

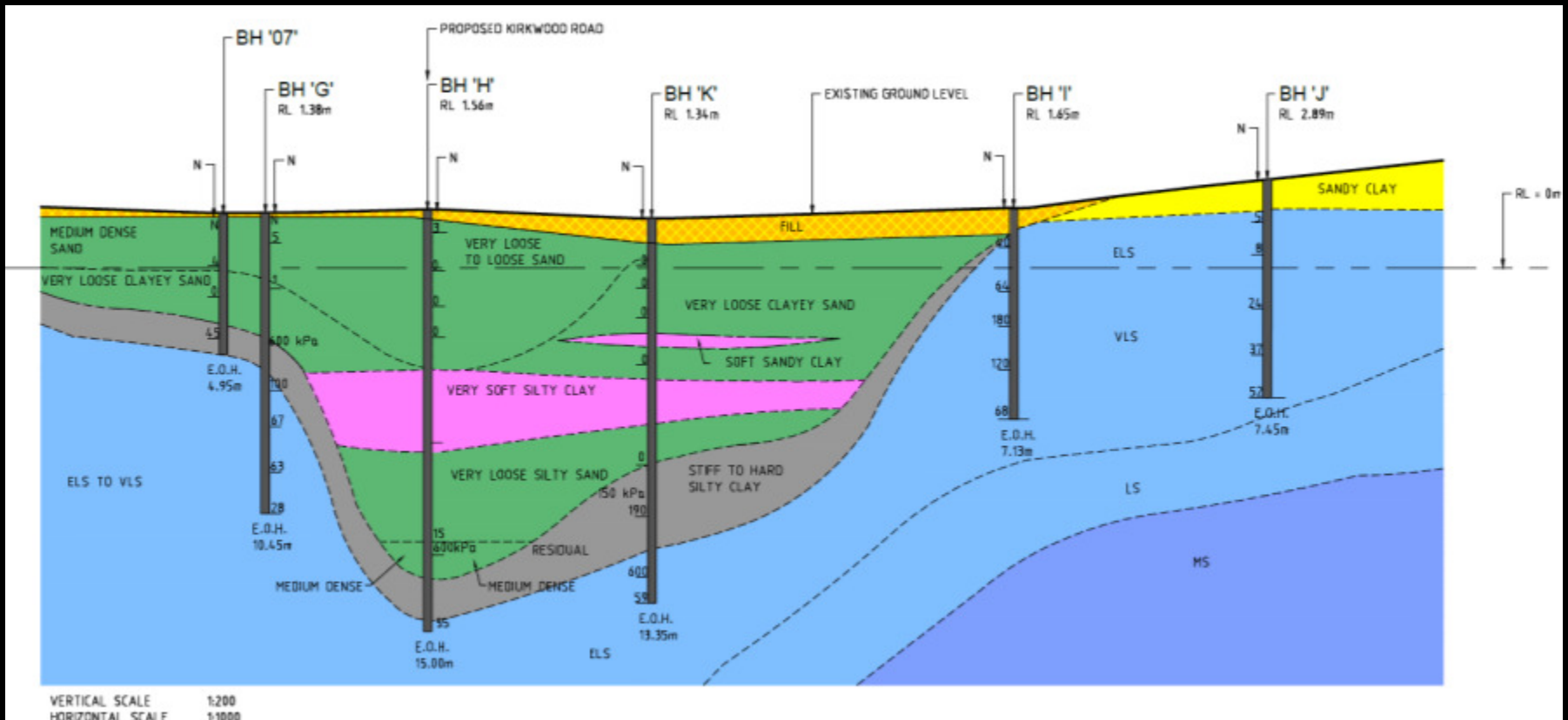
geotechnical • geo-environmental • groundwater

Site Plan



B

Cross Section





գործընկերներ - չնձռնելու համար - ցածր գներով

Project Scope

Our involvement began by assisting with improving the embankment design and speed the rate of consolidation

Achieved by:

- **Ground Improvement techniques**
- **Collecting in situ field data**
- **Using field data used to improve settlement calculation accuracy**

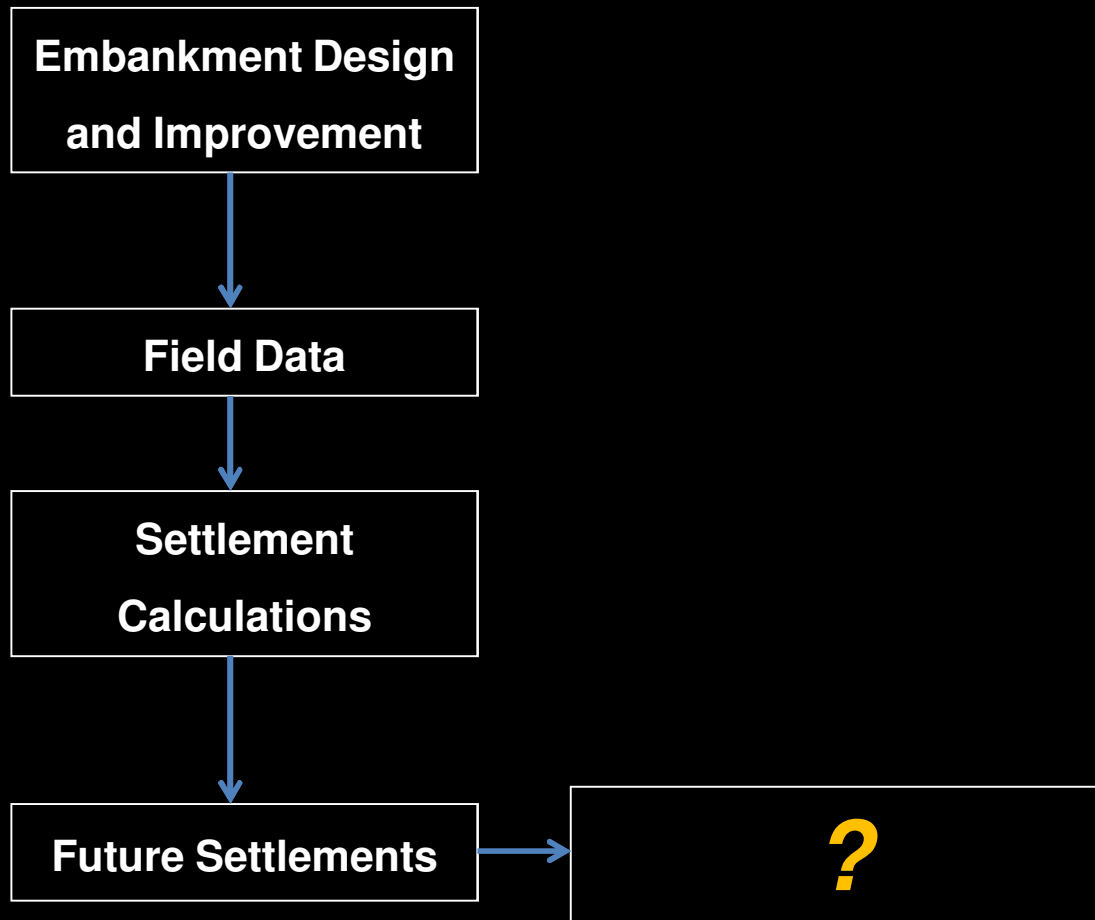
Embankment Improvement

Future Settlements



Project Scope

Project Stage

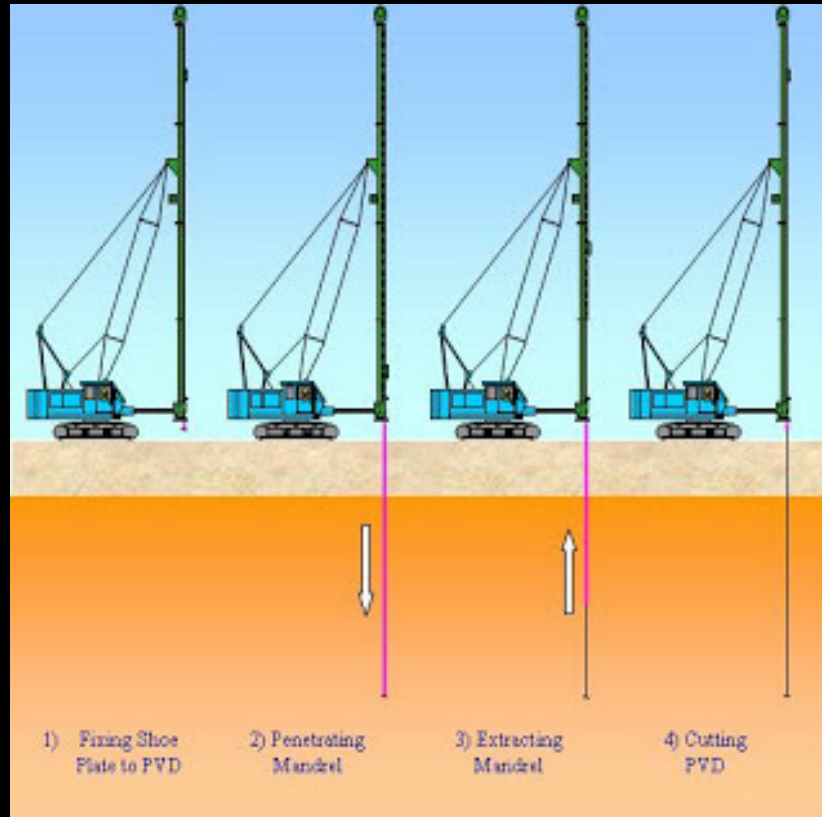




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Embankment Design and Improvement

Wick Drains



Wick Drain Installation Process

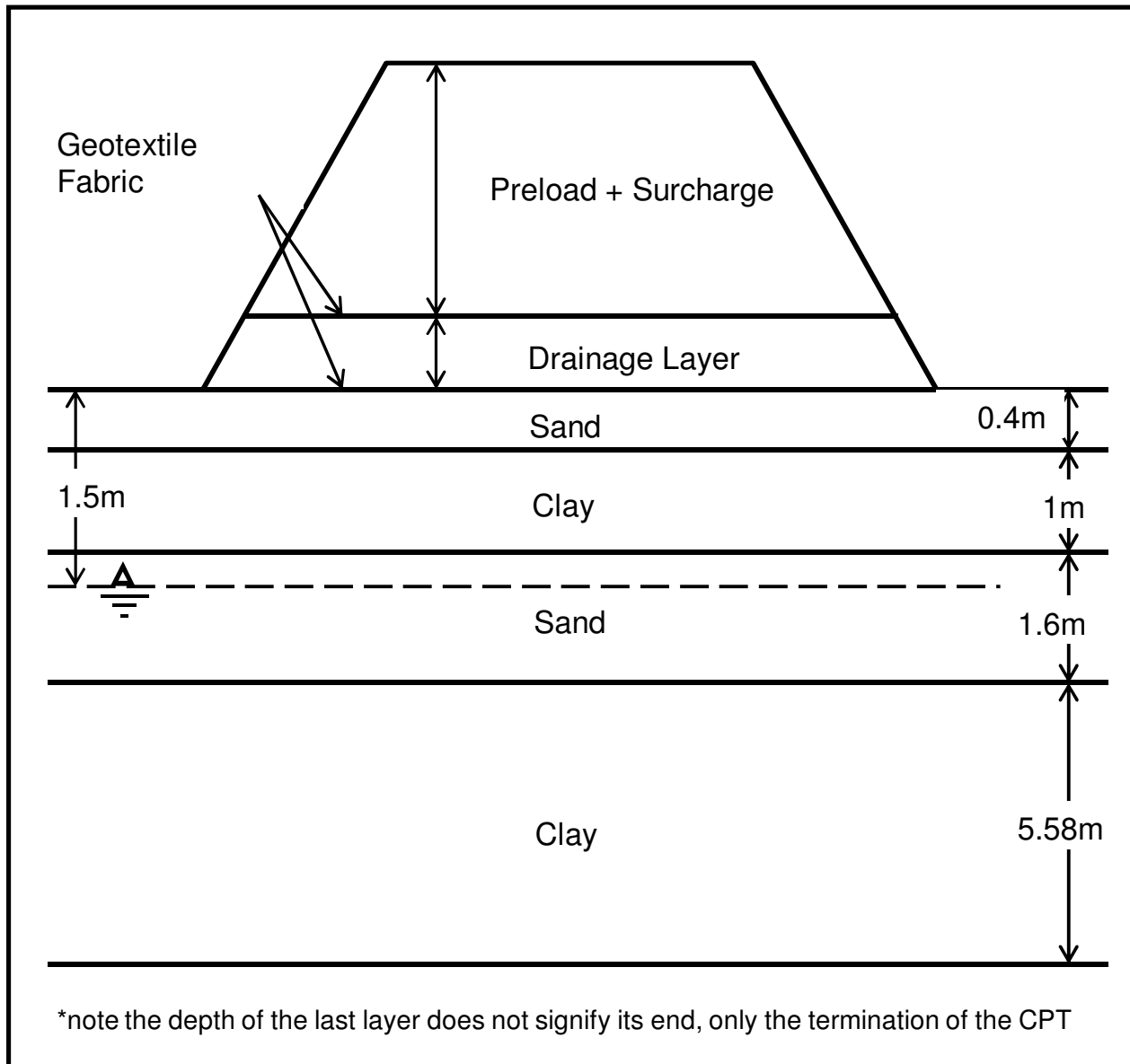
Prefabricated Vertical Drains (PVD):

- Reduce settlement of soft clay
- Allow excess pore water pressure to dissipate
- 90% Consolidation during .

Wick Drains



Geofabric



Pre-Construction Estimated Settlements

Based on CPT data:

- **Primary consolidation settlements;**
- **Ongoing, long term, ‘creep’ settlements.**



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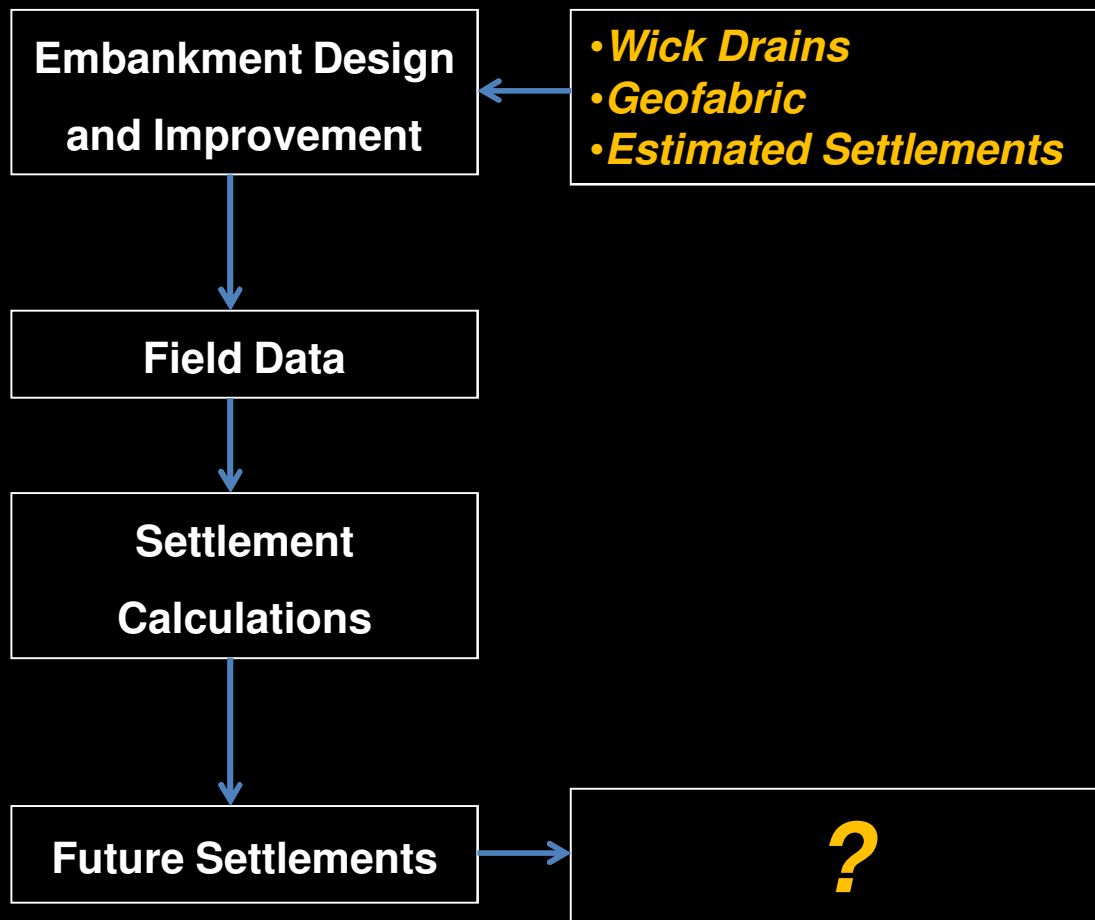
Pre-Construction Estimated Settlements

CPT Location	Applied Load (kPa)	Estimated Primary Consolidation (mm)	Estimated Creep Settlement (o 10 years) (mm)	Estimated Total Settlement (o 10 years) (mm)
BP1-1	230	240 – 770	80 - 285	320 - 1055
BP1-2	230	270 – 1000	40 - 140	310 – 1140
BP1-3	180	190 – 635	50 - 190	240 – 825
BP1-4	180	175 – 630	45 - 160	220 – 790
BP1-5	40	20 - 70	30 - 75	50 – 145
BP1-6	230	10 – 30	negligible	10 - 30
BP1-7	140	10 – 40	negligible	10 - 40
BP1-8	130	120 – 500	20 - 70	140 – 570
BP1-9	160	450 – 1710	50 - 175	500 – 1885
BP1-10	130	390 – 1230	50 - 185	440 – 1415
BP1-11	110	150 – 530	30 - 100	180 – 630
BP1-12	70	10 – 35	negligible	10 – 35
BP1-13	65	10 – 20	negligible	10 – 20
BP1-14	100	55 – 180	20 - 65	75 – 245
BP1-15	100	90 – 275	35 - 120	125 – 395
BP1-16	40	10 - 25	negligible	10 - 25
BP1-17	55	10 – 20	negligible	10 – 20
BP1-18	55	10 – 20	negligible	10 – 20

Project Scope

Project Stage

Methods

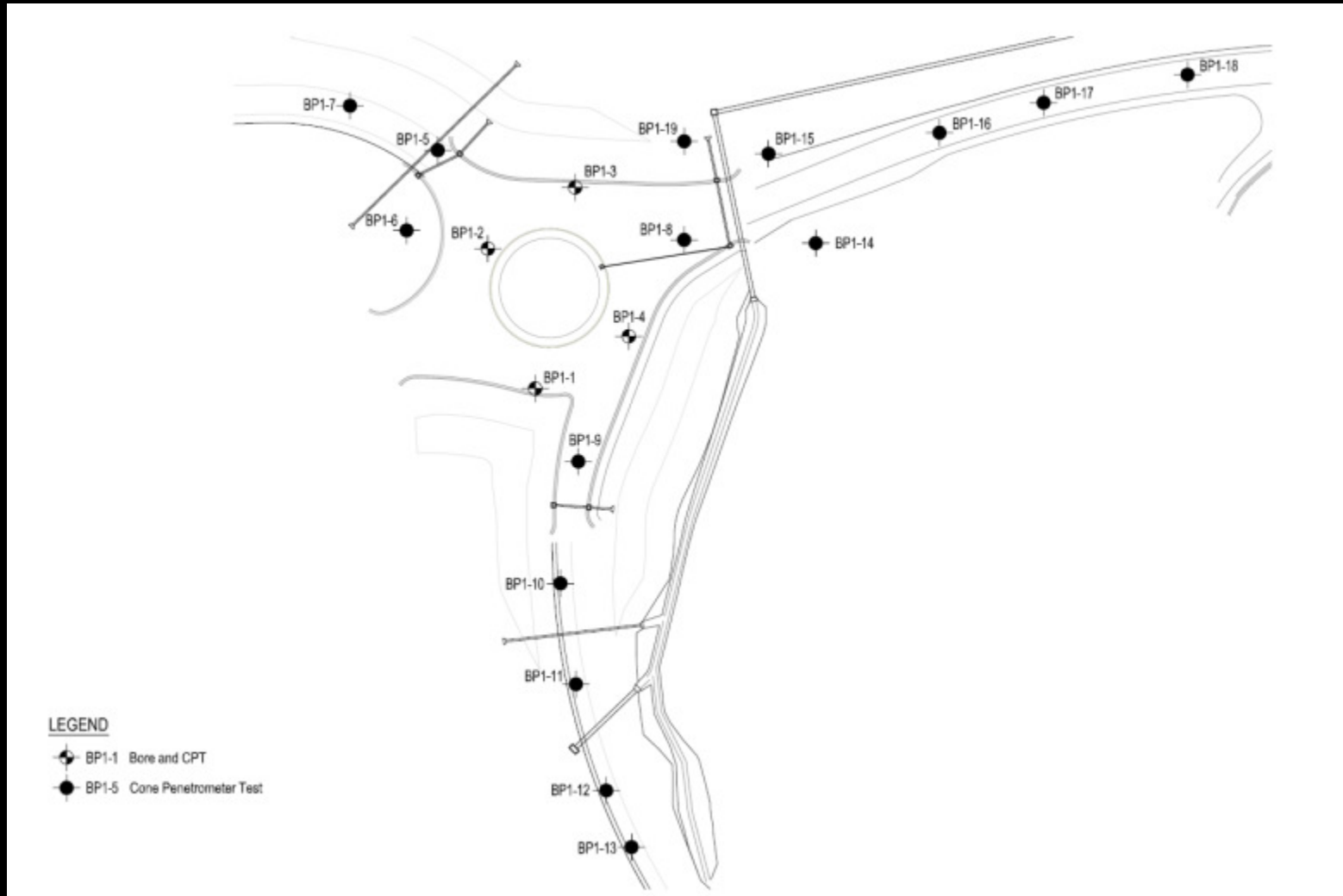




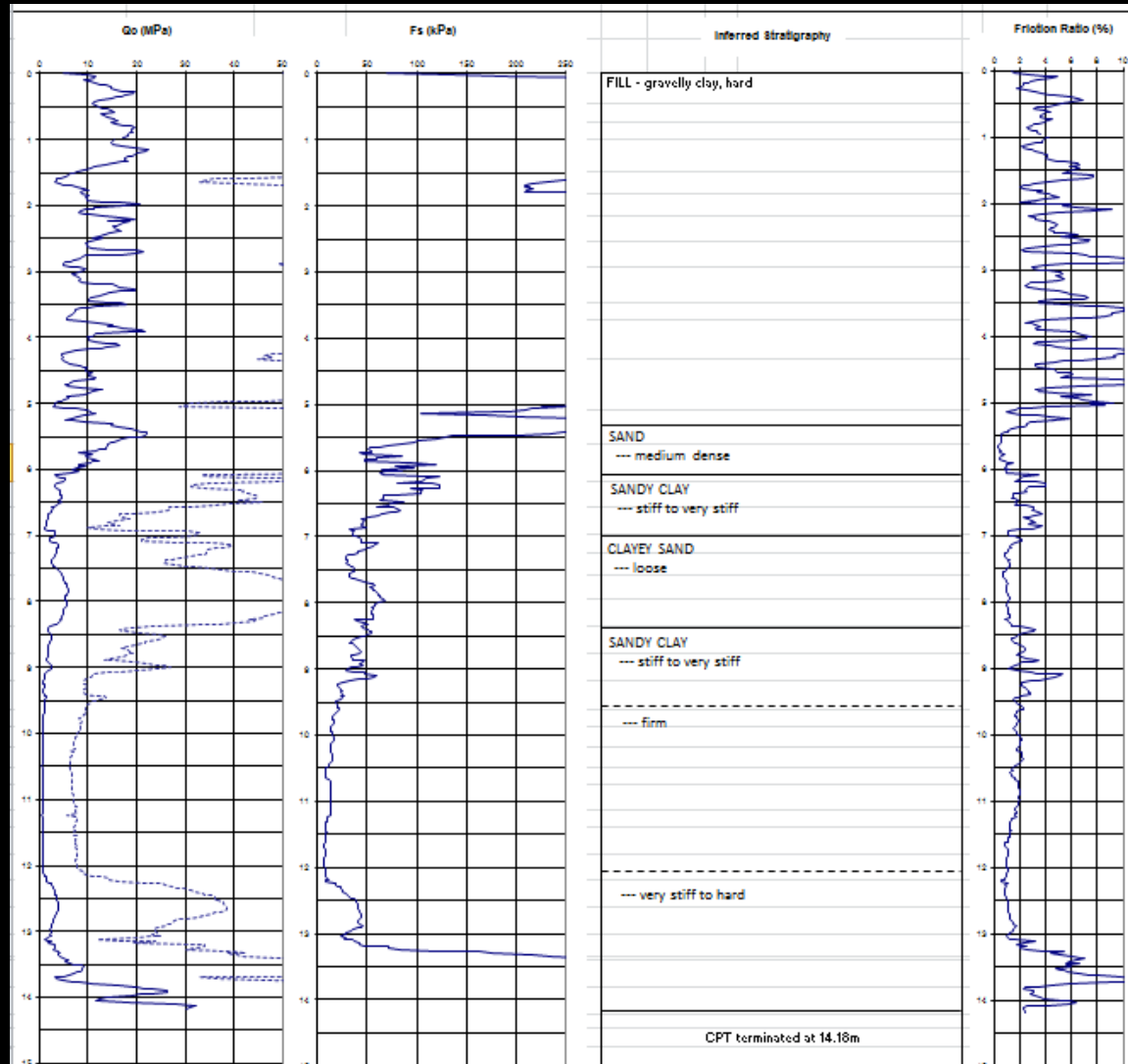
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Field Data

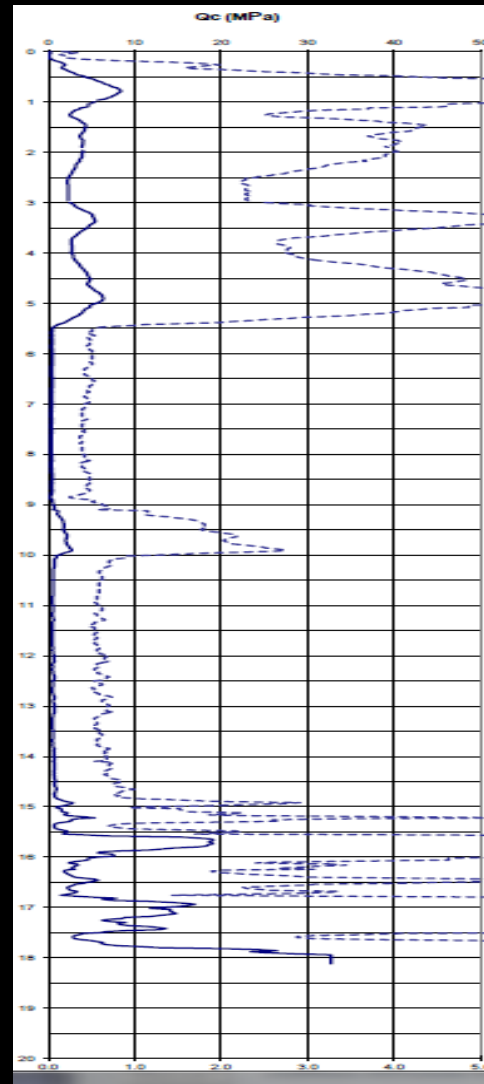
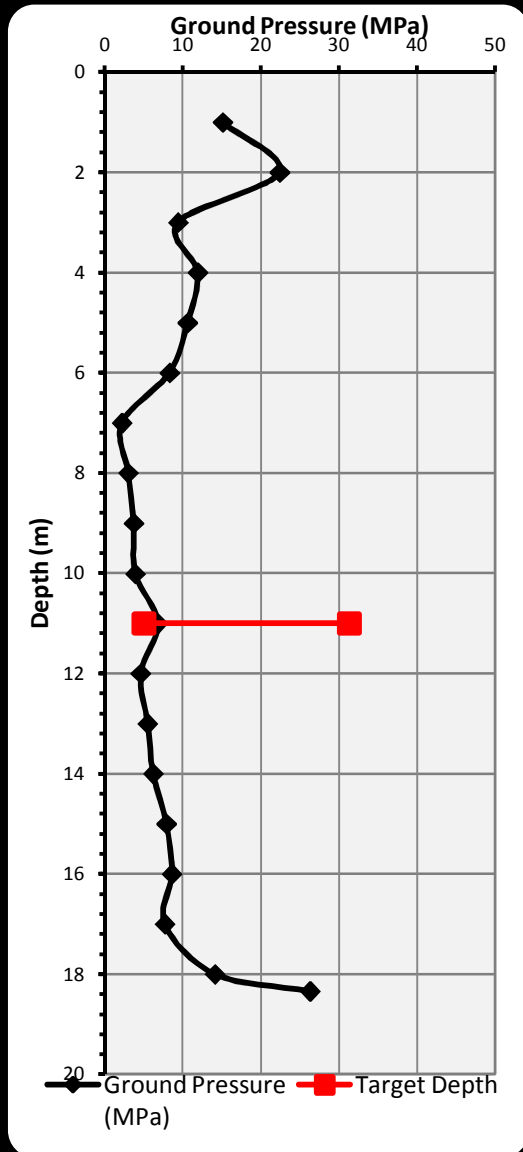
CPT Investigation



CPT Investigation

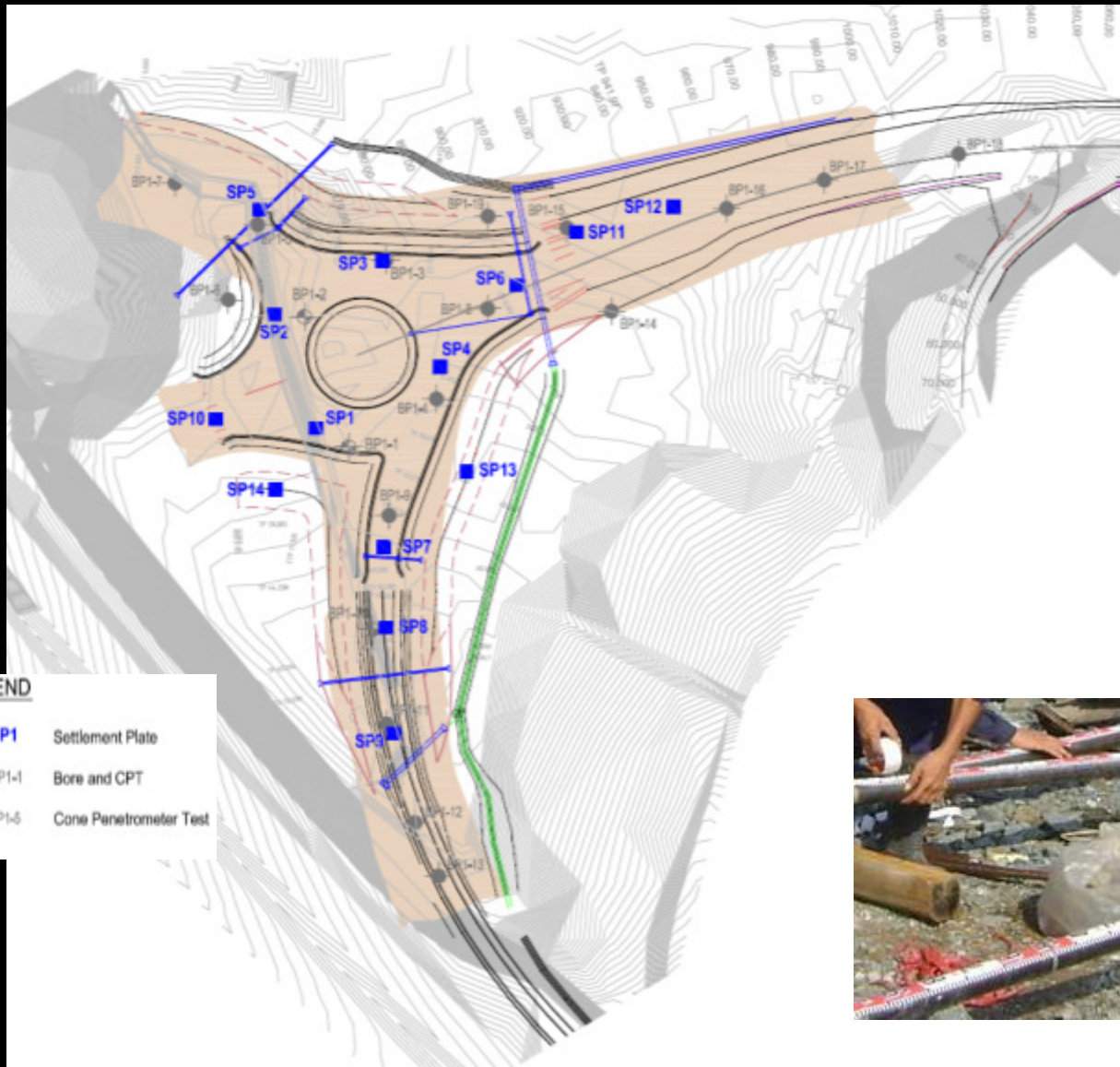


CPT Investigation



- Comparison between Wick Drain and CPT results

Settlement Plates



- 14 Plates
- Periodically Surveyed
- Flood anomaly





գնահատում - ներքին - արտաքին - ցածր-արժեք

Settlement Calculations

Settlement

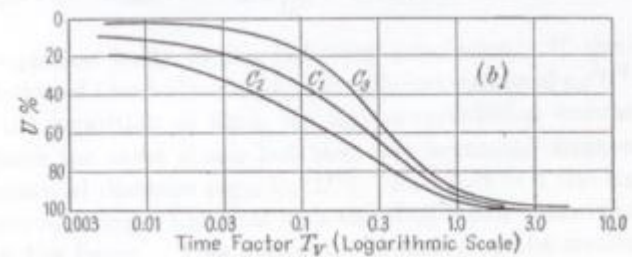
Magnitude

Rate

$$\text{Settlement} = H \cdot m_v \cdot p_1$$

Degree of Consolidation – U

$$T_v = \frac{c_v}{H^2} \cdot t$$

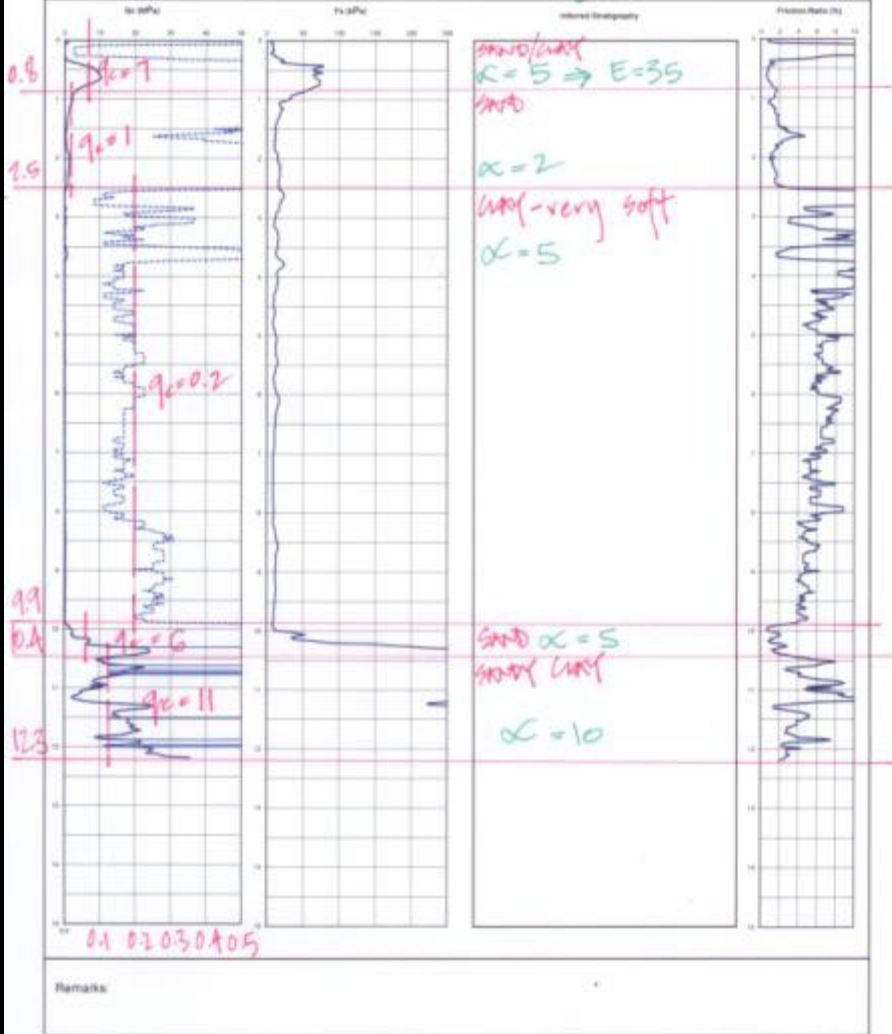


CONE PENETROMETER TEST REPORT

CPT: BP 1-9

$E = \alpha q_c$

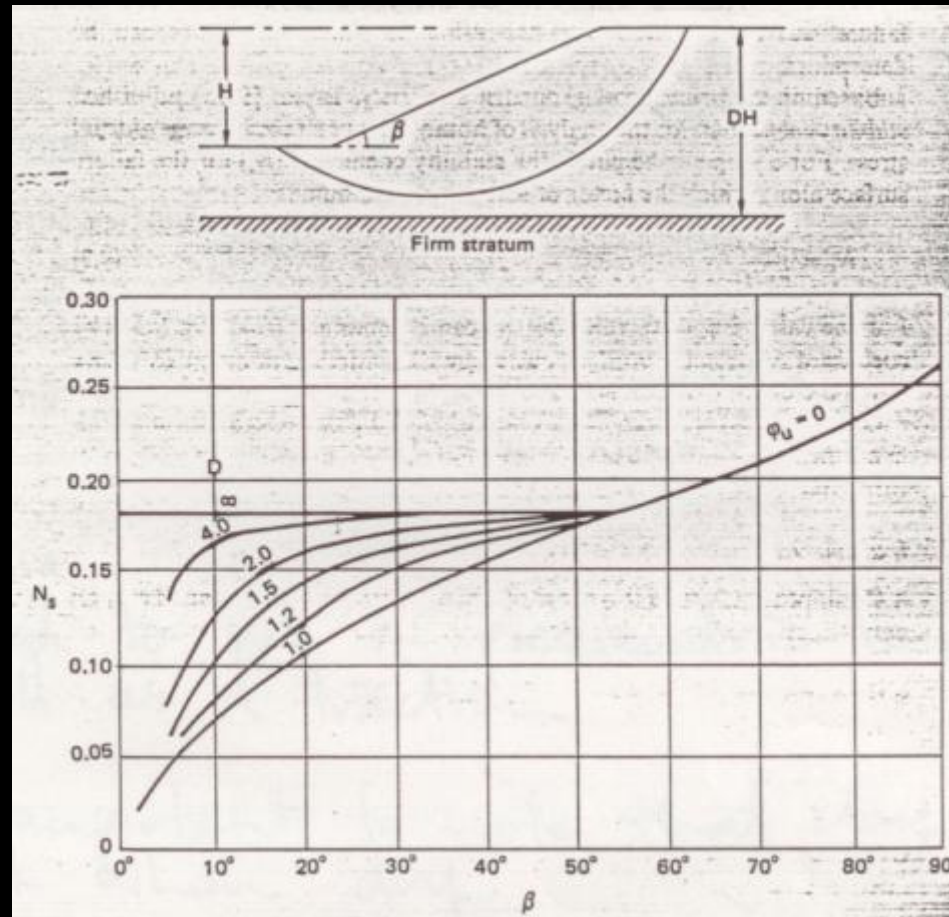
$M_v = \frac{0.75}{E}$



$Settlement = H \cdot m_v \cdot p_1$

$H =$ layer thickness

$p_1 = 144 \text{ kPa approx}$



Stability number – N

$$N = \frac{c_u}{\gamma H}$$





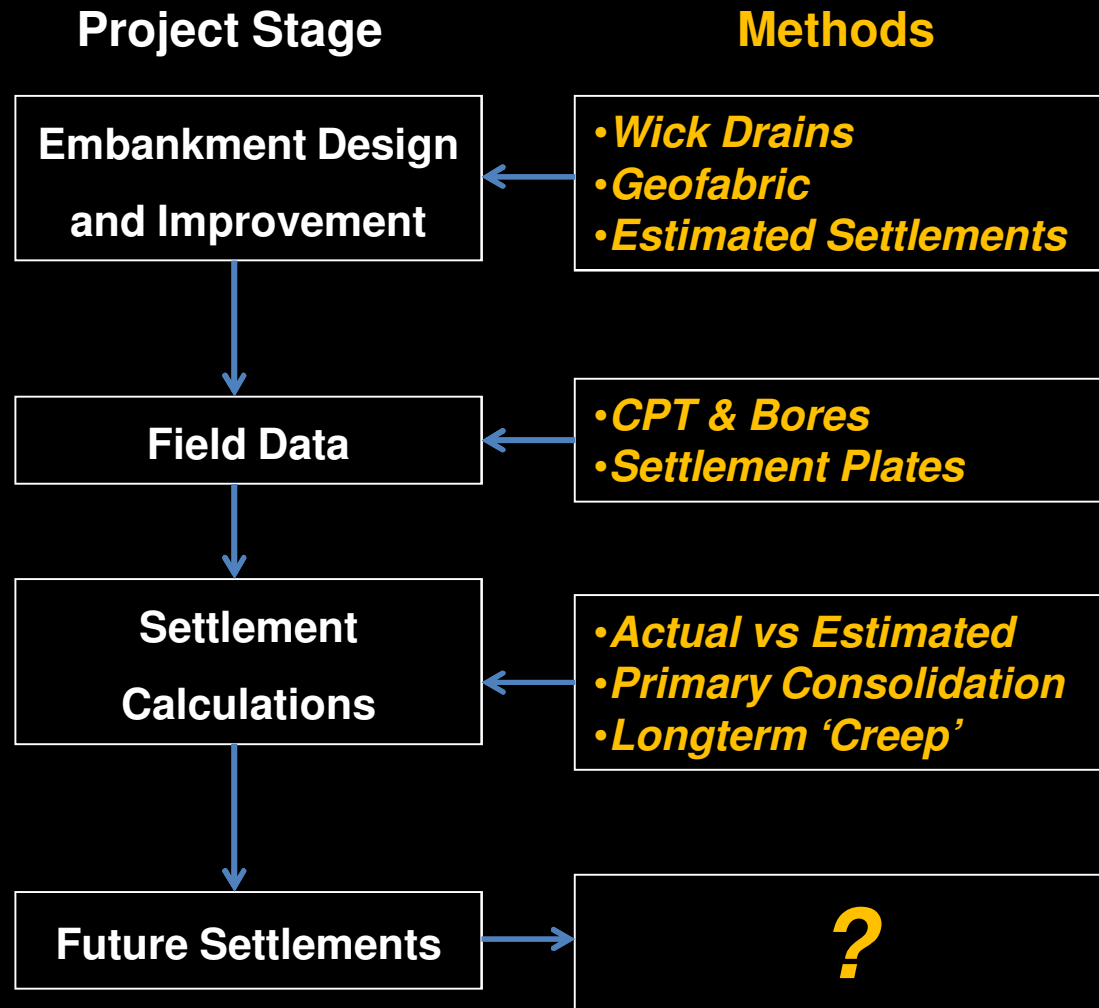
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Settlement Estimated and Measured

Settlement Plate	Original Pre-Construction Estimates			Measured Settlement (mm)	Comments
	Nearest Original CPT	Estimated Primary Consolidation (mm)	Estimated Total Settlement (over 10 years) (mm)		
SP1	BP1-1	240 – 770	320 - 1055	895	Settlement within estimated range, near upper end
SP2	BP1-2	270 – 1000	310 – 1140	336	Settlement near low end of range, but some separation between original CPT and plate location in an area (near the edge of the paleo-basin) where compressible clay thickness varies over short horizontal distances.
SP3	BP1-3	190 – 635	240 – 825	739	Settlement within estimated range, near upper end
SP4	BP1-4	175 – 630	220 – 790	699	Settlement within estimated range, near upper end
SP5	BP1-5	20 - 70	50 – 145	161	Settlement slightly above the upper end of range, but some (relatively minor) separation between original CPT and plate location in an area (near the edge of the paleo-basin) where compressible clay thickness varies over very short horizontal distances.
SP6	BP1-8	120 – 500	140 – 570	163	Settlement near low end of range, but some separation between original CPT and plate location in an area (near the edge of the paleo-basin) where compressible clay thickness varies over short horizontal distances.

Settlement within estimated range, near upper

Project Scope





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Questions