



Folloline Project - Norway

A large Scale Project for the future of Oslo

ISM 14th International Workshop For Micropiles

Norway

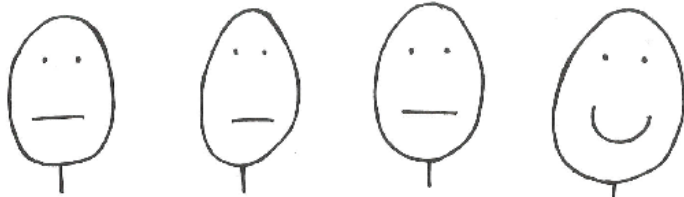
its about people

- its about landscape

The Social Guidebook to Norway

An Illustrated Introduction

Julien S. Bourrelle



HAPPY

SAD

ANGRY

DRUNK

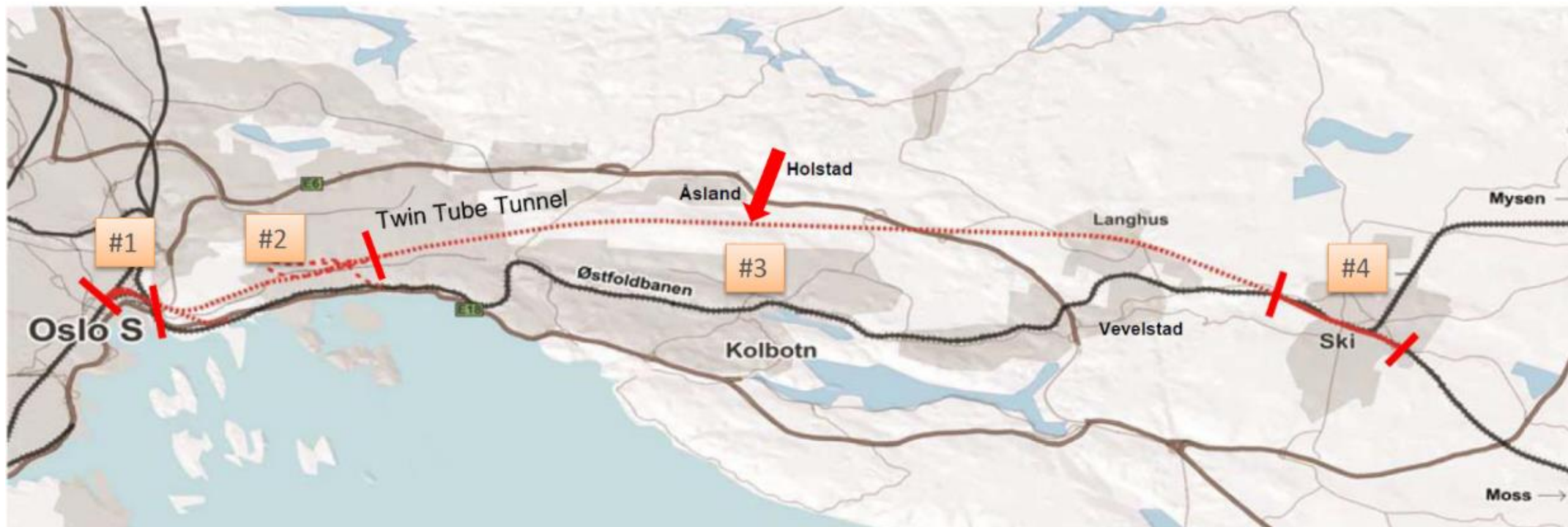
Illustrations by Nicholas Lund



- And of course....
its about micropiles



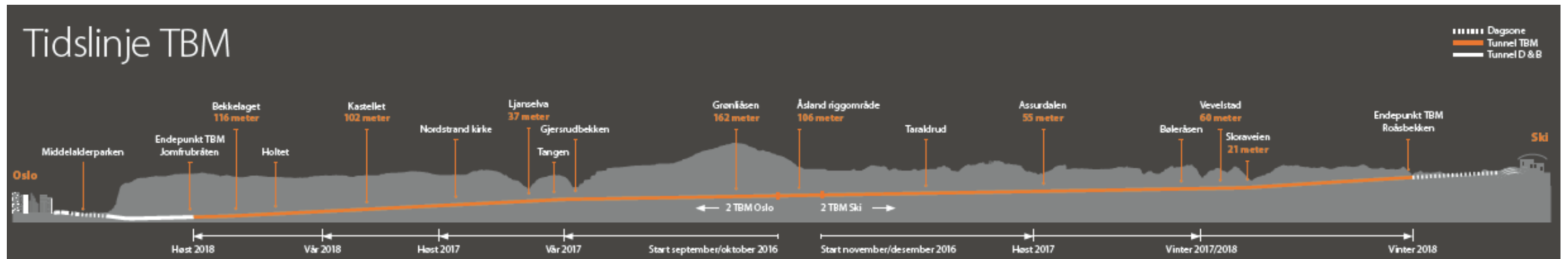
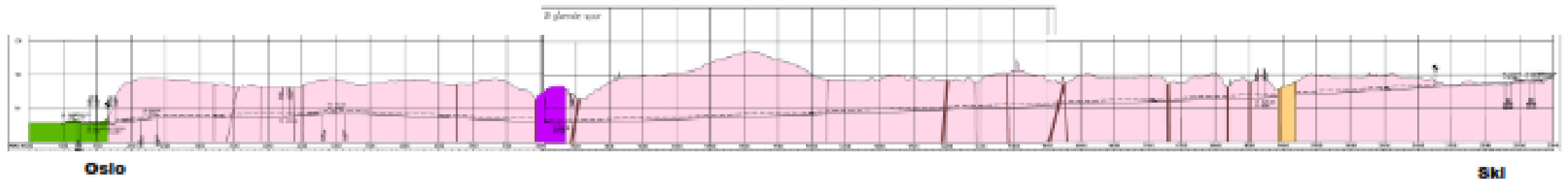
Contracts



The Follo Line Project: Five EPC-contracts

Oslo C	Tunnel		Langhus-Ski
EPC-contract civil	EPC-contract tunnel D&B	EPC-contract tunnel TBM	EPC-contract Ski
EPC-contract Railway systems (Oslo C)	Included railway systems		Included railway systems
Signal (Frame-agreement)			

Geology



Duration 6,3 years

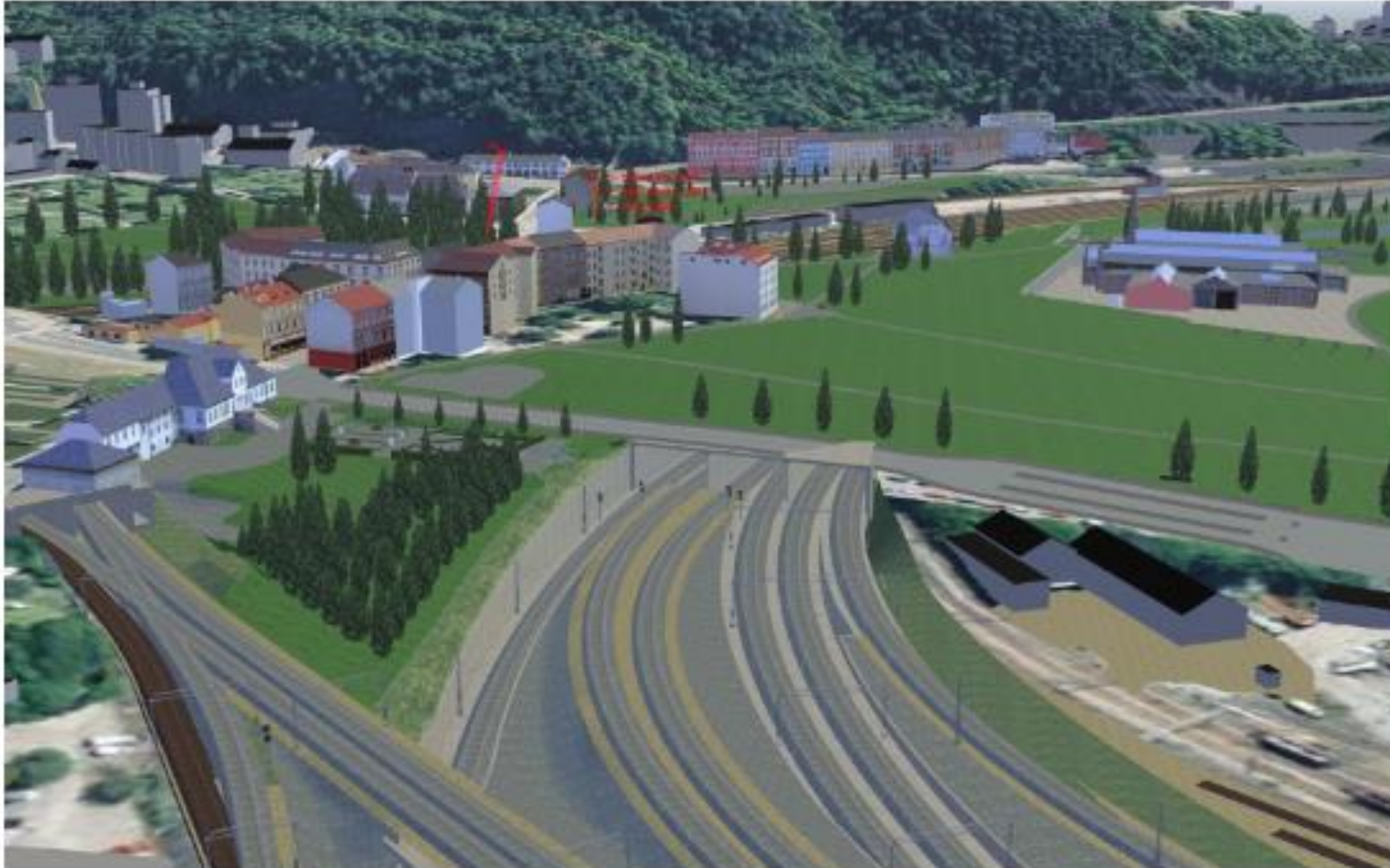
Rock - Clay

- Norwegian rock (250 - 380 MPa)
- Sensitive clay $c_u < 25$ kPa
- Quick clay $c_u < 5$ kPa
($c_{ur} < 0,5$ kPa – liquid)

- Landfill Norway: 2017- 4 people died 280.000m³ landslide
- 4000m³ untreated clay slid at site in Oslo
- 2 tracks closed for 1 week
- JG- works + retaining wall for stabilization executed



Oslo S



Miropiles



8" DTH with casing shoe
273/5mm welded casing
150mm SC with API
Up to 65m pile length
1-8m bed rock length
Follow Norw. Standards



2 - 5 rigs
Grouting with slurry necessary –
ring space

Execution



Drilling in moraine layer

Pressured ground water

Alum shale – bed rock?

Experience of operator

Equipment set up

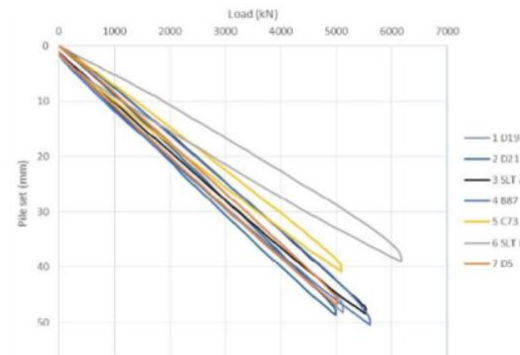
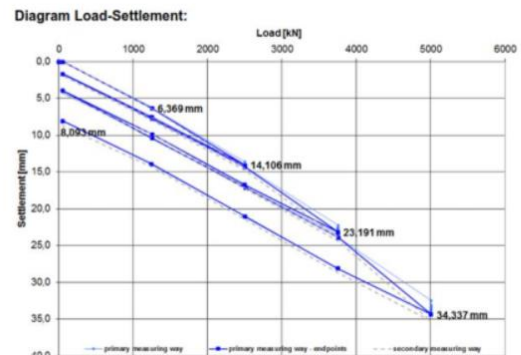
Drilling tools – un/lockable casing shoe

Quality of grouting/spacers

Accuracy: 273mm pile in 400mm wall! [65m - 95m long]

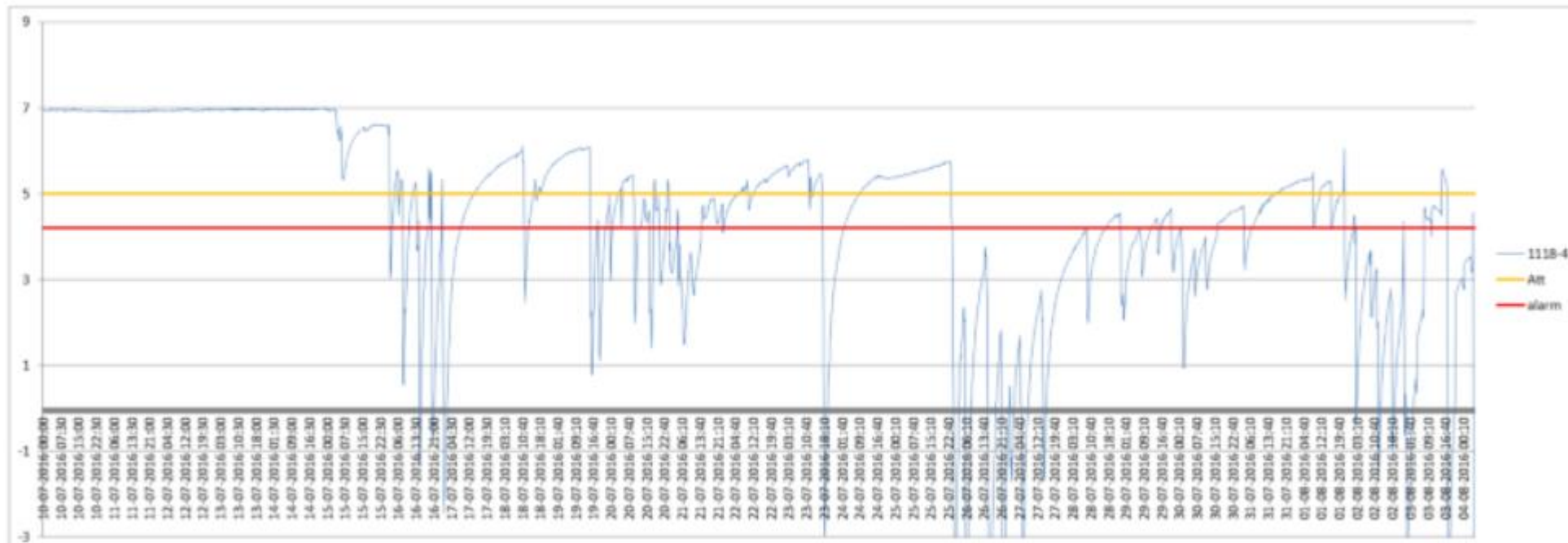
Micropile Testing

- Water testing – pregrouting Y/N
- Drilling in bed rock
- Drop test of Steel Core - redrilling
- Overpressure grouting
- Static + dynamic testing by Keller



Ground Water Level

- Drop in Ground Water can cause large settlements
- Drilling in bed rock – sealed connection of casing to bed rock



KRCRD

Keller Reversed Circulation Drilling

- Drilling in Clay – sensitive and quick clay
- 25m³ air vs. 500l water
- Double head drilling allows controlled flushing of soil inside the casing
- Preventer on double head to analyse the flow input and output



Equipment



down hole hammer

Eccentric bit "Maxbit"

closed



open after turn right



auger bit eccentric



GDU bit



The Water-Propelled Down-The-Hole Hammer WAI 60i

Technical data

- Standard drilling bit \varnothing 165 mm - 203 mm
- Working pressure: 50 - 150 bar (750 - 2200 psi)
- Required amount of water (hammer new): 200 l/min
- Required amount of water (hammer used): 600 l/min
- Impact frequency: up to 2400 impacts/min
- Feed force (formation-related): 15000 - 30000 N
- Rotation speed: 40 - 65 rpm
- Torque (formation-related): 2000 - 4000 Nm

Dimensions

- Length: 1495 mm
- Diameter: 160 mm (6")
- Weight: 145 kg



- Pump type: 2 x PratiSpül 3-plunger pump
- Volumetric flow: up to max. 1 x 720 or 2 x 360l/min by parallel or separate flow feed connection
- Working pressure: up to 190 bar max.
- Weight: 4300kg
- Measurements: 360 x 155 x 210 cm (L x W x H)
- Engine: Iveco C10 Diesel, rated power 310kW, Tier 3



type*	max. flow rate l/min	max. discharge pressure bar	max. suction lift m	power input kW	rotational speed rpm	nominal diameter of force mm	length mm	width mm	height mm	weight kg
SP 350-1	42	3	9	1,5	32	35	242	420	870	65
2	2,142	3	9	1,5/1,9	46/93	35	540	420	870	65
SP 550-1	12	8	9	4	73	50	630	690	1120	160
2	272	8	9	2,744	2673	50	630	690	1120	160
4	48-12	8	9	4	32-73	50	630	690	1120	170
SP 700-1	15	8	9	7,5	67	50	1000	900	1060	490
2	2715	8	9	6,58	2672	50	1050	1000	1100	550
SP 900-1	30	8	9	11	61	70	1250	1300	1450	900
2	1520	8	9	1317	2958	70	1250	1300	1450	995
HC 1024	8	8	11	81	39	70	1850	1300	1450	1100
SP 1100-1	48	8	9	22	37	100	1870	1520	1620	1500
1	48	8	9	15	37	100	1870	1520	1620	1465
2	46	8	9	30	52	100	1870	1520	1620	1570
2	2448	8	9	1821,5	1837	100	1870	1520	1620	1500



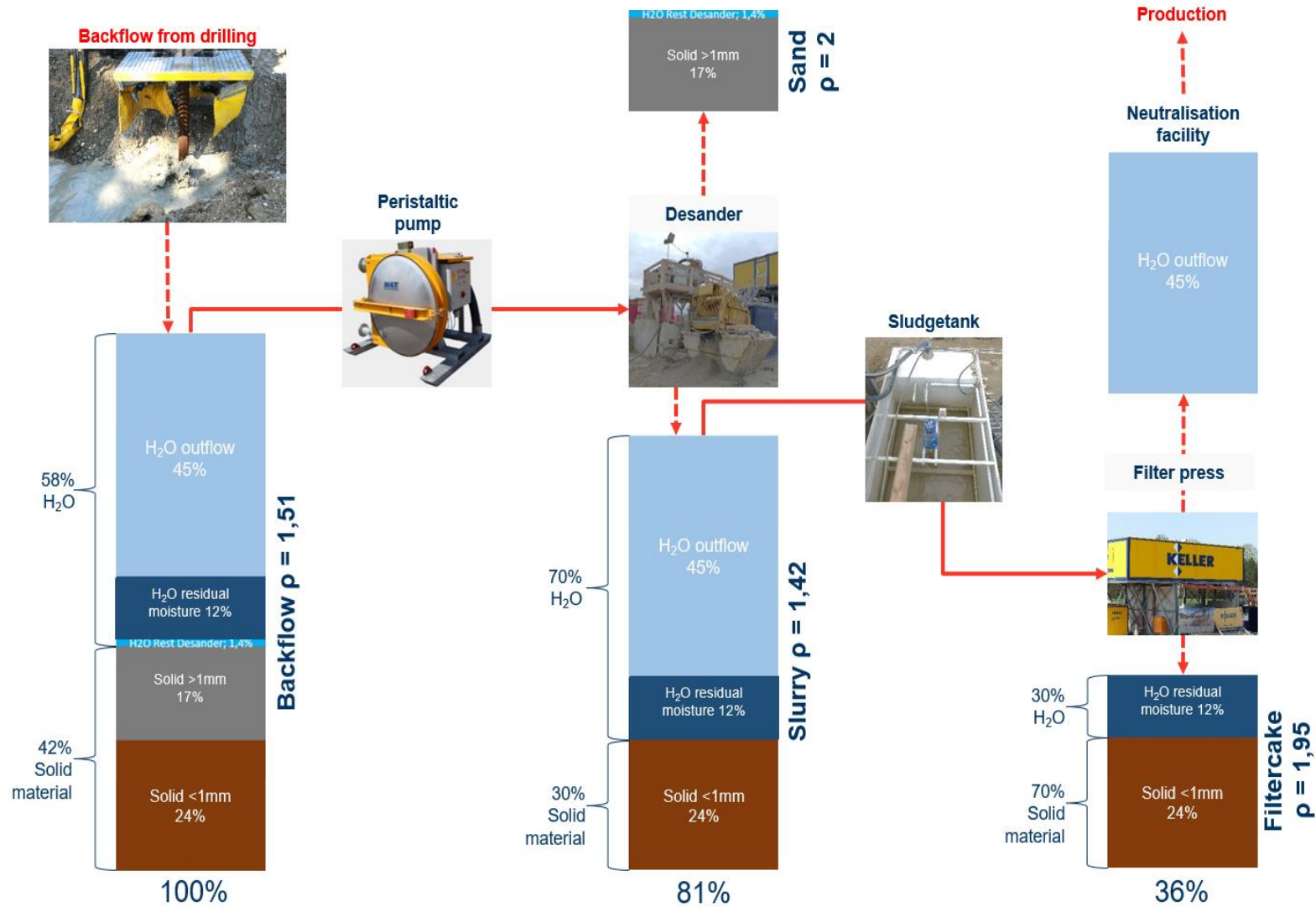
ECO-Graph registration unit for grout pressure and volume (anchor)



Site Setup

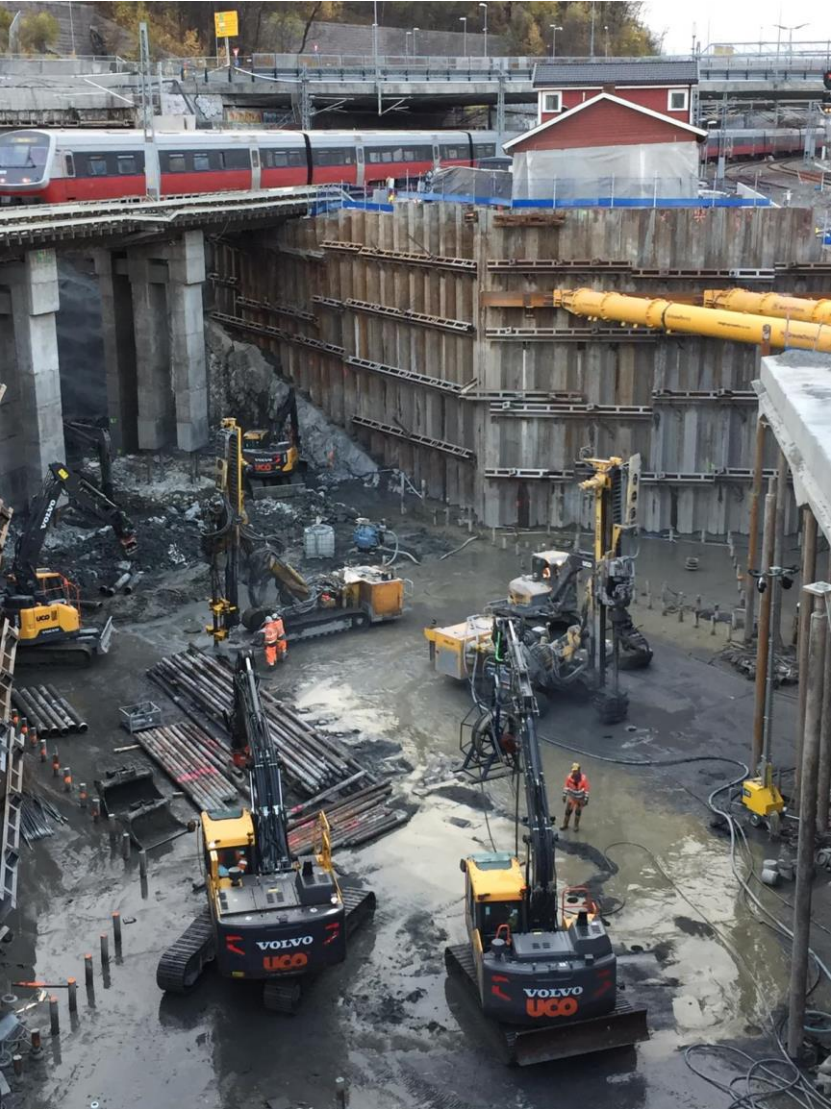


Sludge / Spoil treatment – Volume flowchart





Site Pictures



South Portal

406-609mm cased drilling – granite 280Mpa in sound case



South Portal 406-609mm cased drilling





No light at the end of the tunnel so far



But the equipment to do it!



Folloline Project Oslo

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