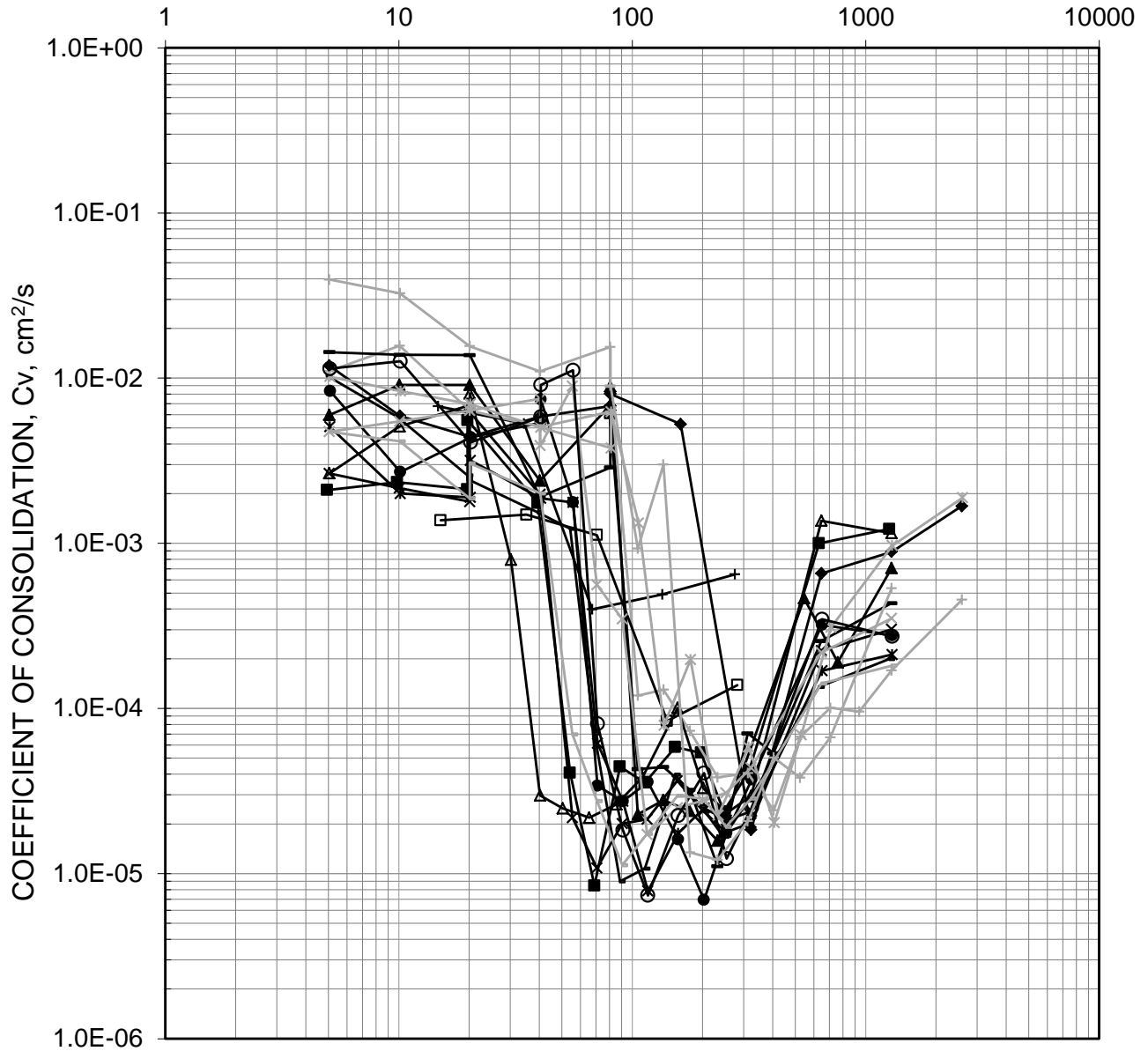




# APPENDIX G


## Summary of Measured/Interpreted Coefficients of Vertical and Horizontal Consolidation

PRESSURE (kilopascals)

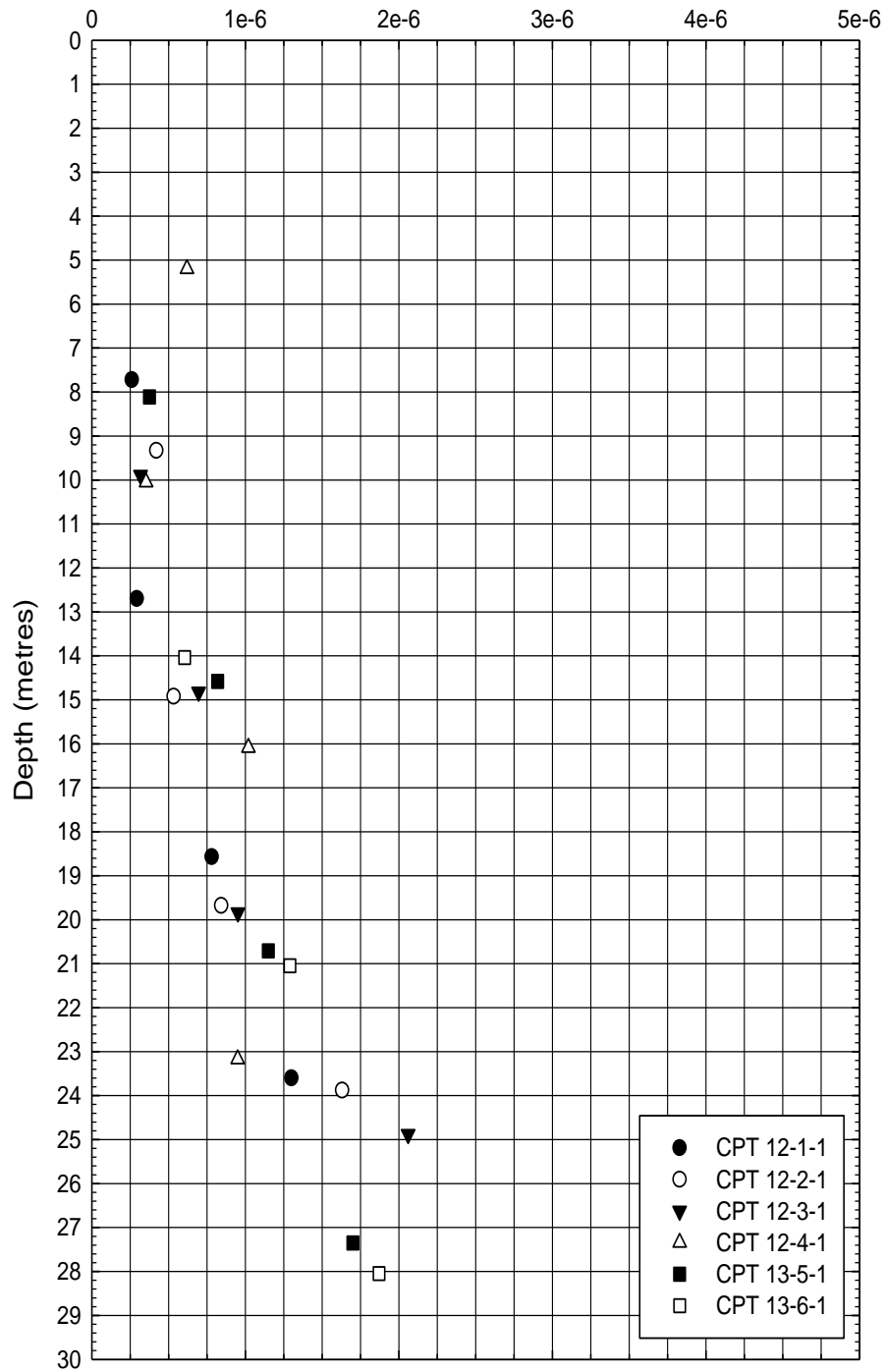


■ 12-1-3 SA 1	+ 12-1-3 SA 2 LT	● 12-1-3 SA 4
▲ 12-1-3 SA 5	× 12-2-3 SA 1	* 12-2-3 SA 2
+ 12-2-3 SA 6	— 12-3-5 SA 1	□ 12-3-5 SA 1 LT
— 12-3-5 SA 2	◆ 12-3-3 SA 6	△ 12-4-3 SA 1
× 12-4-3 SA 3	* 12-4-3 SA 6	○ 13-6-3 SA 3
+ 13-6-3 SA 4	— 13-6-5 SA 1	

Note : LIR not = 1, use Cv's with caution

	SCALE	AS SHOWN	TITLE <b>SUMMARY OF VERTICAL COEFFICIENTS OF CONSOLIDATION</b>
	DATE	11/28/13	
	CADD	N/A	
	DESIGN	CW	
FILE No.	Consolidation summary	CHECK	SAT
PROJECT No.	12-1125-0045	REV.	0
		REVIEW	MIC
			FIGURE <b>G1</b>

### Horizontal Coefficient of Consolidation (m<sup>2</sup>/s)



SCALE	AS SHOWN
DATE	11/28/13
CADD	N/A
DESIGN	MIC

TITLE	<b>SUMMARY OF HORIZONTAL COEFFICIENTS OF CONSOLIDATION</b>	
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FILE No.	Consolidation summary		CHECK	SAT
PROJECT No.	12-1125-0045	REV.	0	REVIEW

FIGURE	<b>G2</b>
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## Dissipation Tests Results

### Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for  $t_{50}$ , which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction  $c_h$  was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

- T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position
- r: piezocone radius
- $I_r$ : stiffness index, equal to shear modulus G divided by the undrained strength of clay ( $S_u$ ).
- $t_{50}$ : time corresponding to 50% consolidation

### Permeability estimates based on dissipation test

The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction ( $c_h$ ) which is influenced by a combination of the soil permeability ( $k_h$ ) and compressibility (M), as defined by the following:

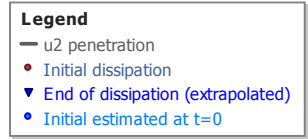
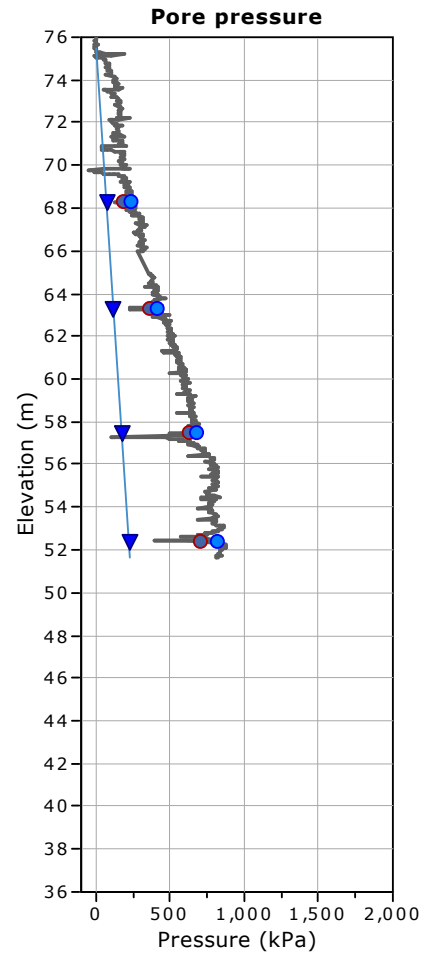
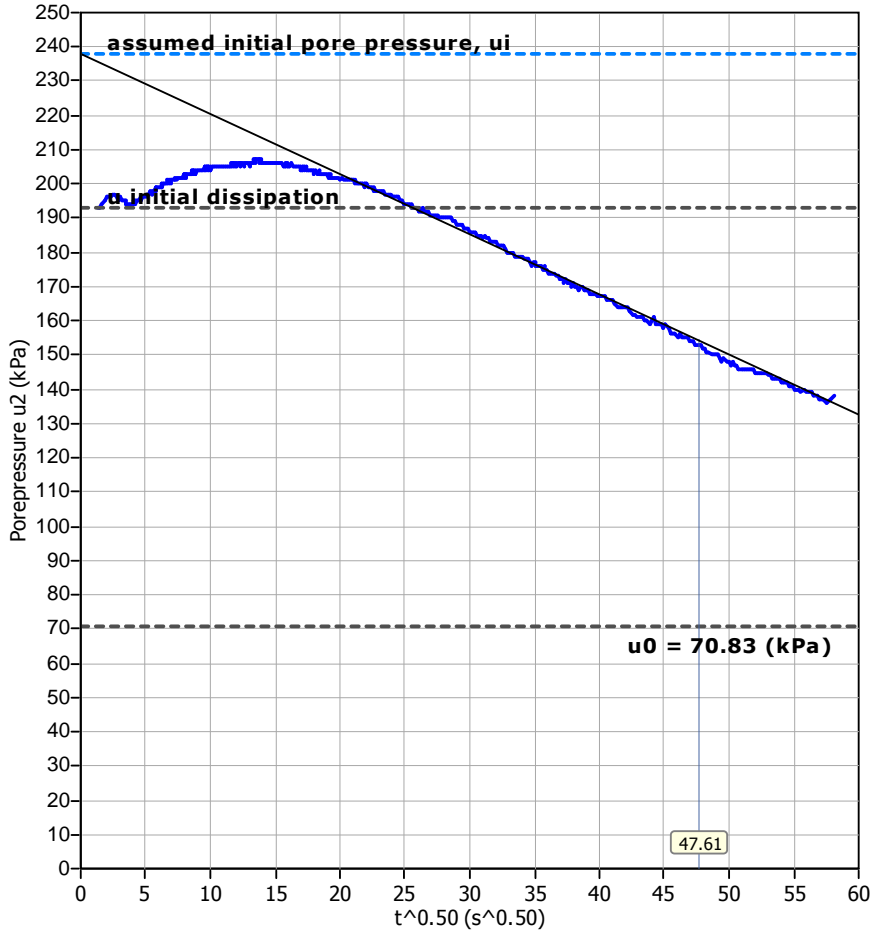
$$k_h = c_h \times \gamma_w / M$$

where: M is the 1-D constrained modulus and  $\gamma_w$  is the unit weight of water, in compatible units.

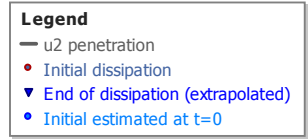
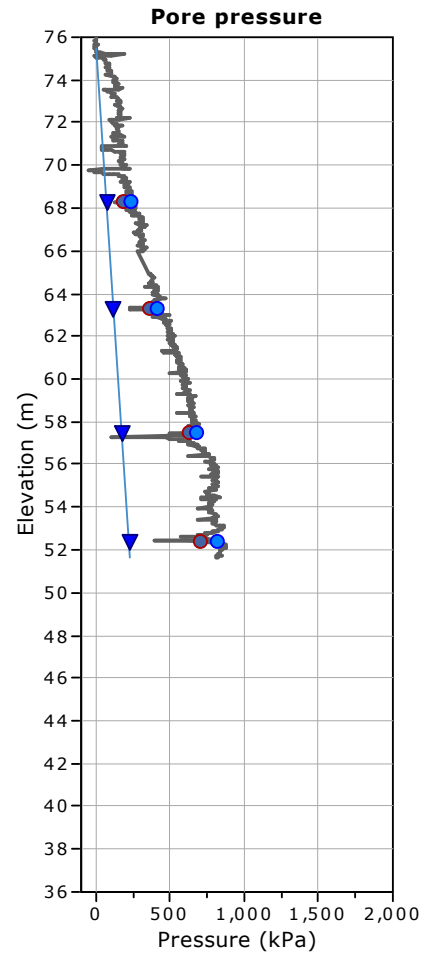
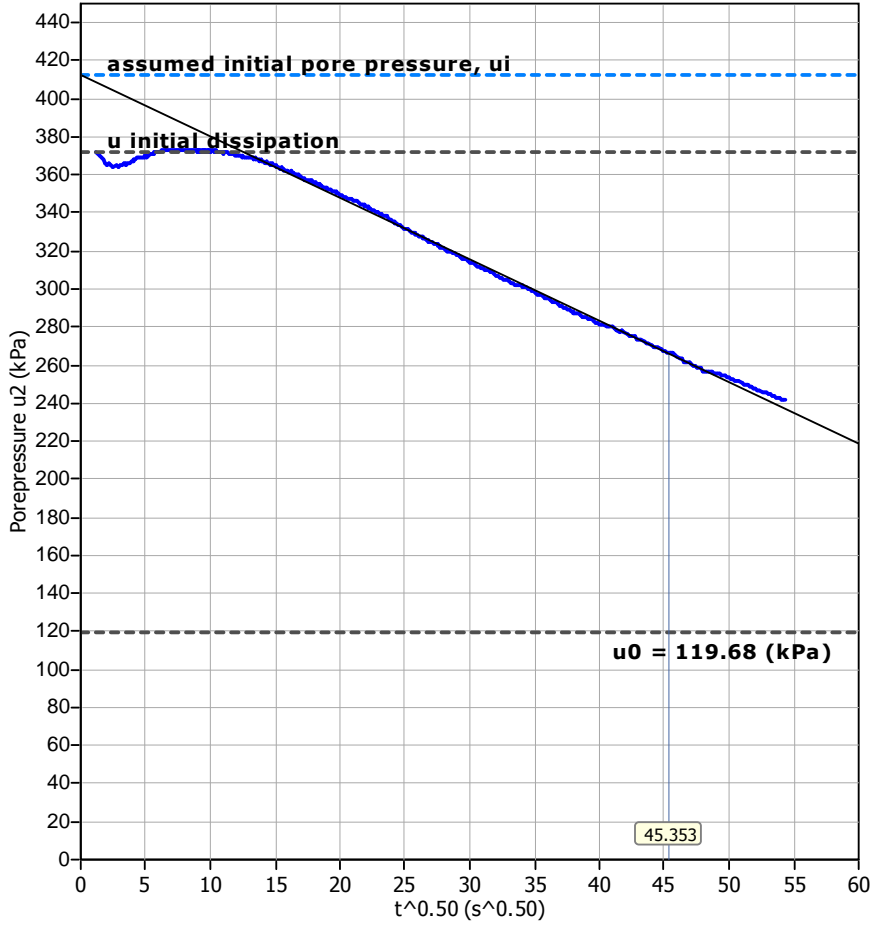
### Tabular results

CPTU Borehole	Depth (m)	$(t_{50})^{0.50}$	$t_{50}$ (s)	$t_{50}$ (years)	G/ $S_u$	$c_h$ ( $m^2/s$ )	$c_h$ ( $m^2/year$ )	M (MPa)	$k_h$ (m/s)
12-1-1 Rev 1	7.72	47.6	2267	7.19E-005	57.00	2.61E-007	8	0.88	2.91E-009
12-1-1 Rev 1	12.70	45.4	2057	6.52E-005	59.00	2.93E-007	9	2.32	1.24E-009
12-1-1 Rev 1	18.57	25.7	659	2.09E-005	43.00	7.81E-007	25	3.71	2.06E-009
12-1-1 Rev 1	23.60	21.8	474	1.50E-005	62.00	1.30E-006	41	3.64	3.51E-009

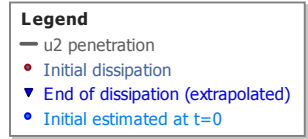
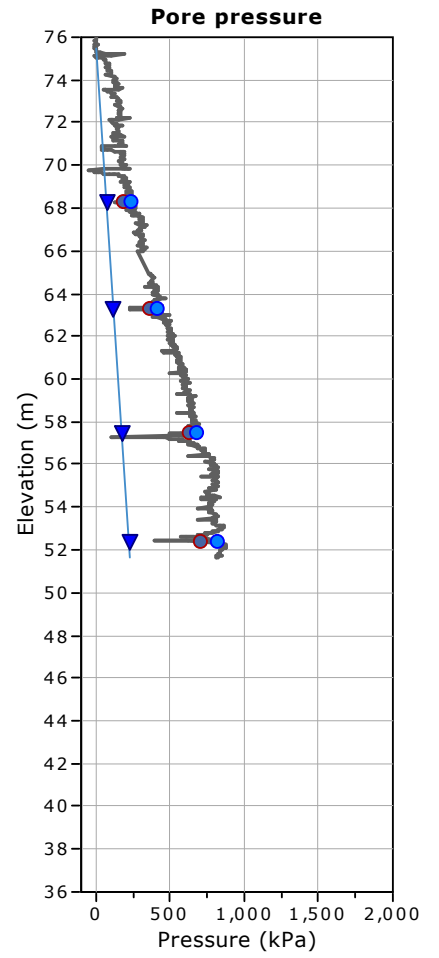
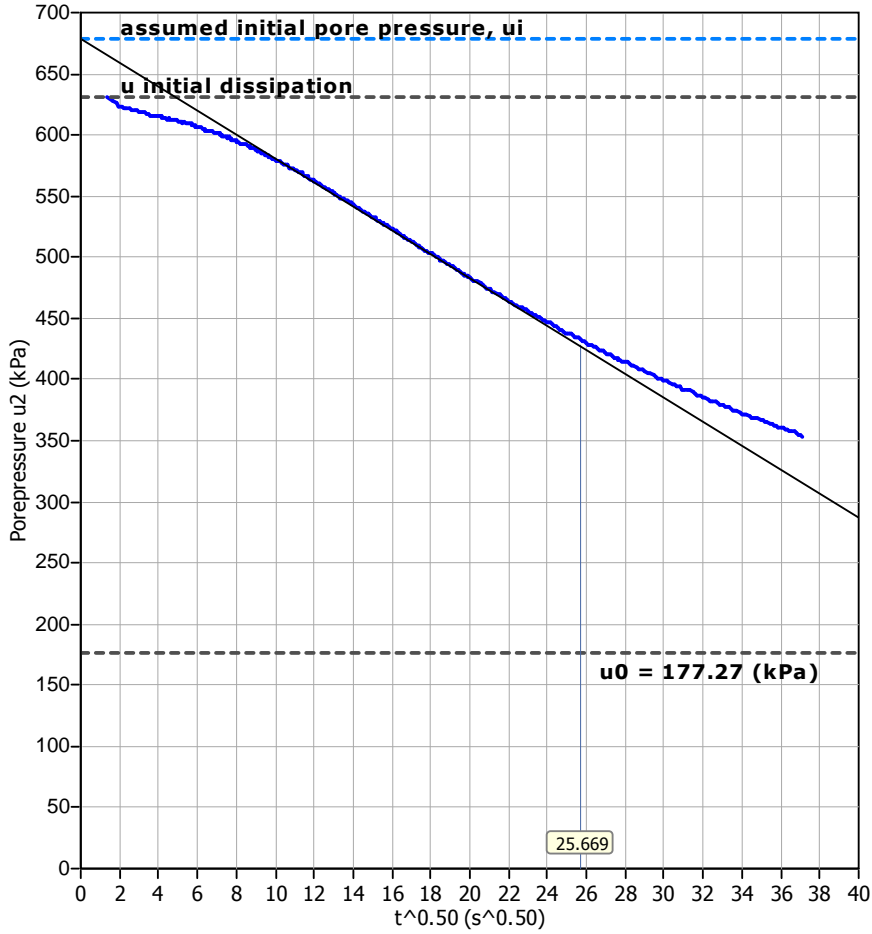
**Piezocene Dissipation Test: 12-1-1 Rev 1**  
**Depth: 7.72 (m)**



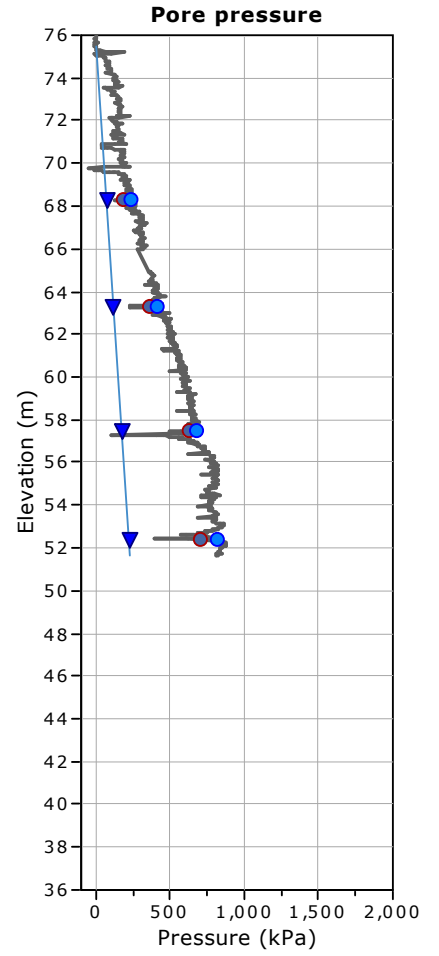
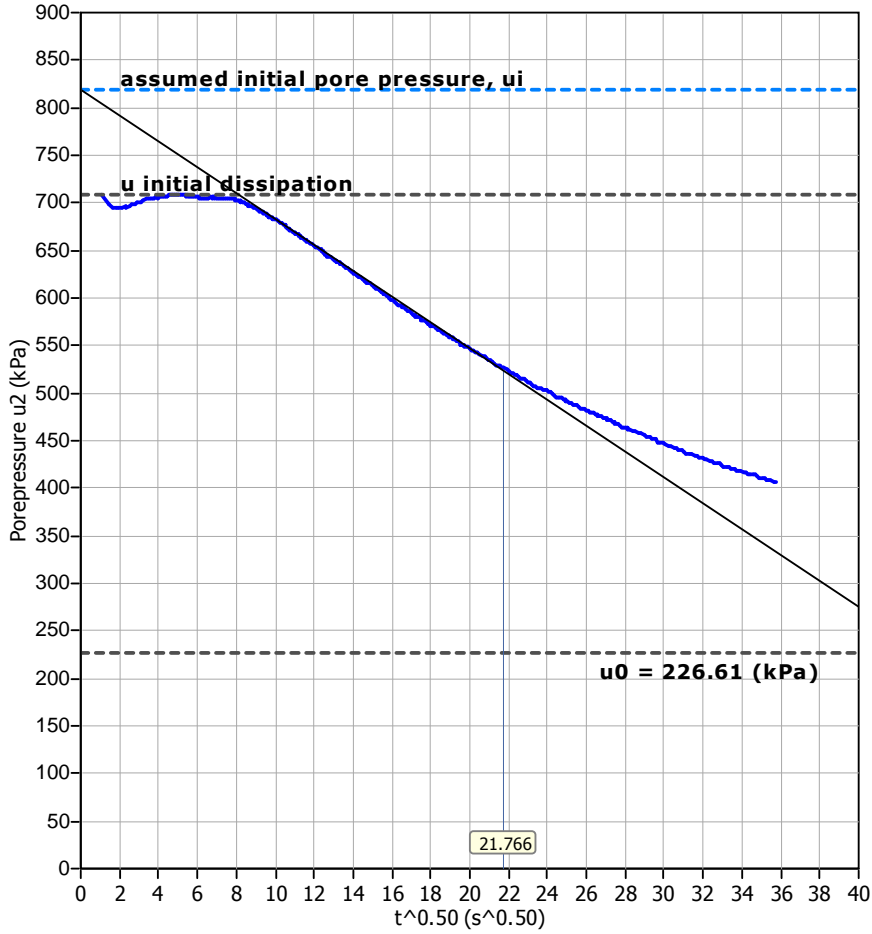
**Piezocone Dissipation Test: 12-1-1 Rev 1**  
**Depth: 12.70 (m)**



**Piezocone Dissipation Test: 12-1-1 Rev 1**  
**Depth: 18.57 (m)**



**Piezocene Dissipation Test: 12-1-1 Rev 1**  
**Depth: 23.60 (m)**



**Legend**

- $u_2$  penetration
- Initial dissipation
- ▼ End of dissipation (extrapolated)
- Initial estimated at t=0





## Dissipation Tests Results

### Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for  $t_{50}$ , which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction  $c_h$  was then calculated by Hously and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

- T: time factor given by Hously and Teh's (1988) theory corresponding to the porepressure position
- r: piezocone radius
- $I_r$ : stiffness index, equal to shear modulus G divided by the undrained strength of clay ( $S_u$ ).
- $t_{50}$ : time corresponding to 50% consolidation

### Permeability estimates based on dissipation test

The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction ( $c_h$ ) which is influenced by a combination of the soil permeability ( $k_h$ ) and compressibility (M), as defined by the following:

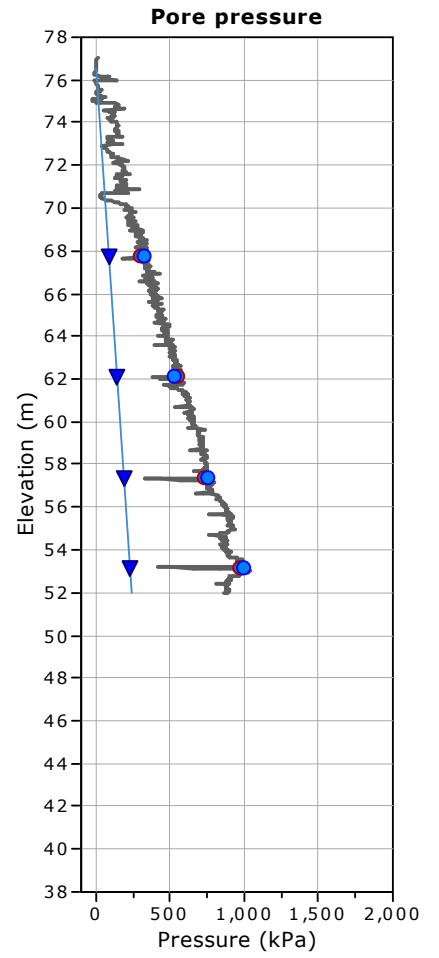
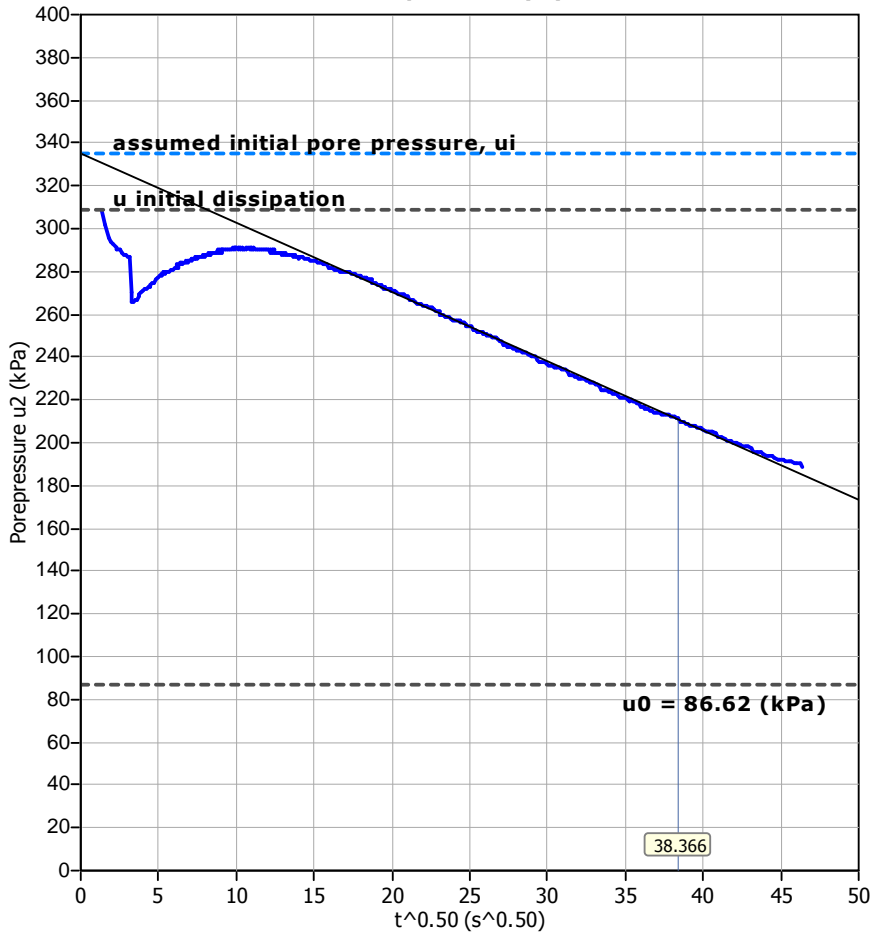
$$k_h = c_h \times \gamma_w / M$$

where: M is the 1-D constrained modulus and  $\gamma_w$  is the unit weight of water, in compatible units.

### Tabular results

CPTU Borehole	Depth (m)	$(t_{50})^{0.50}$	$t_{50}$ (s)	$t_{50}$ (years)	G/ $S_u$	$c_h$ ( $m^2/s$ )	$c_h$ ( $m^2/year$ )	M (MPa)	$k_h$ (m/s)
12-2-1 Rev 1	9.33	38.4	1472	4.67E-005	62.00	4.20E-007	13	1.57	2.62E-009
12-2-1 Rev 1	14.92	34.7	1206	3.82E-005	67.00	5.33E-007	17	2.99	1.75E-009
12-2-1 Rev 1	19.68	24.7	610	1.94E-005	43.00	8.43E-007	27	3.68	2.24E-009
12-2-1 Rev 1	23.88	19.3	371	1.18E-005	59.00	1.63E-006	51	7.50	2.13E-009

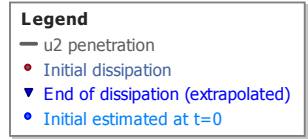
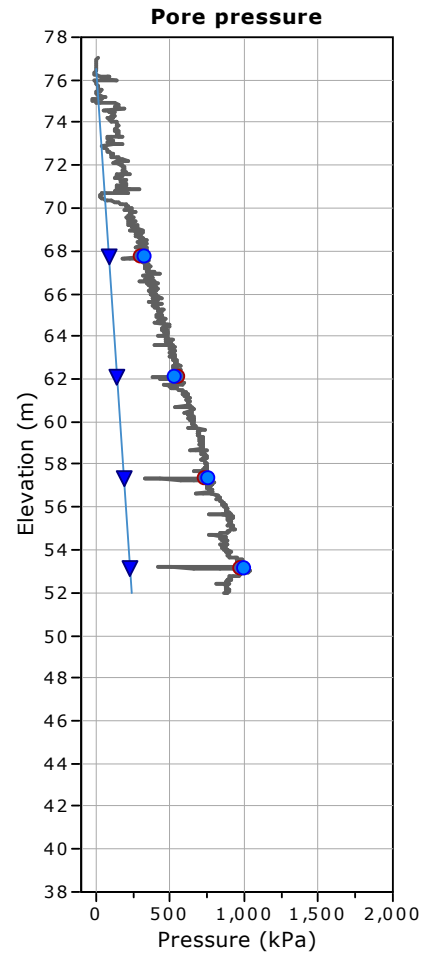
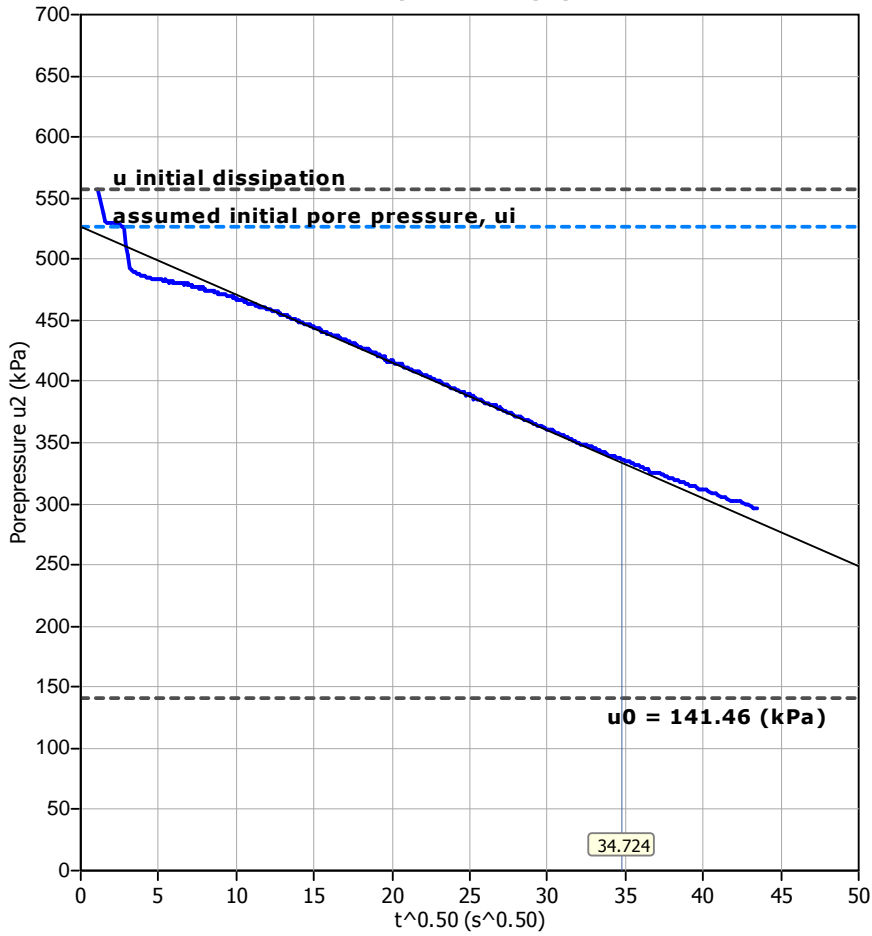
**Piezocene Dissipation Test: 12-2-1 Rev 1**  
**Depth: 9.33 (m)**



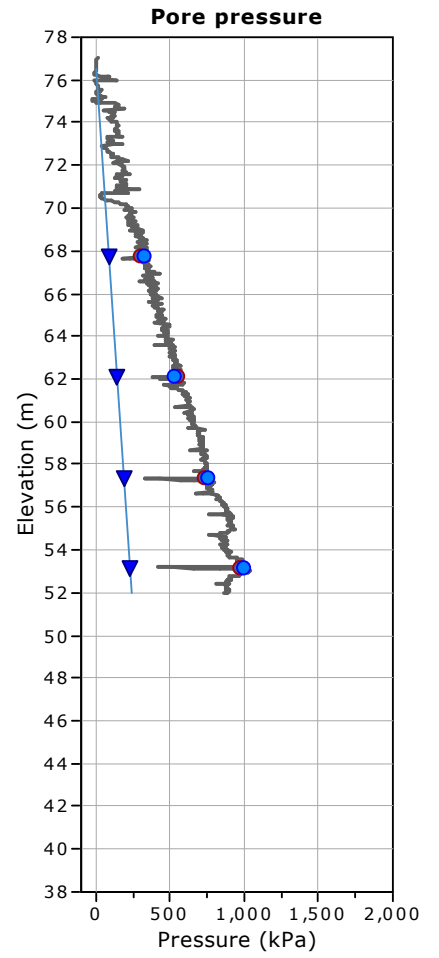
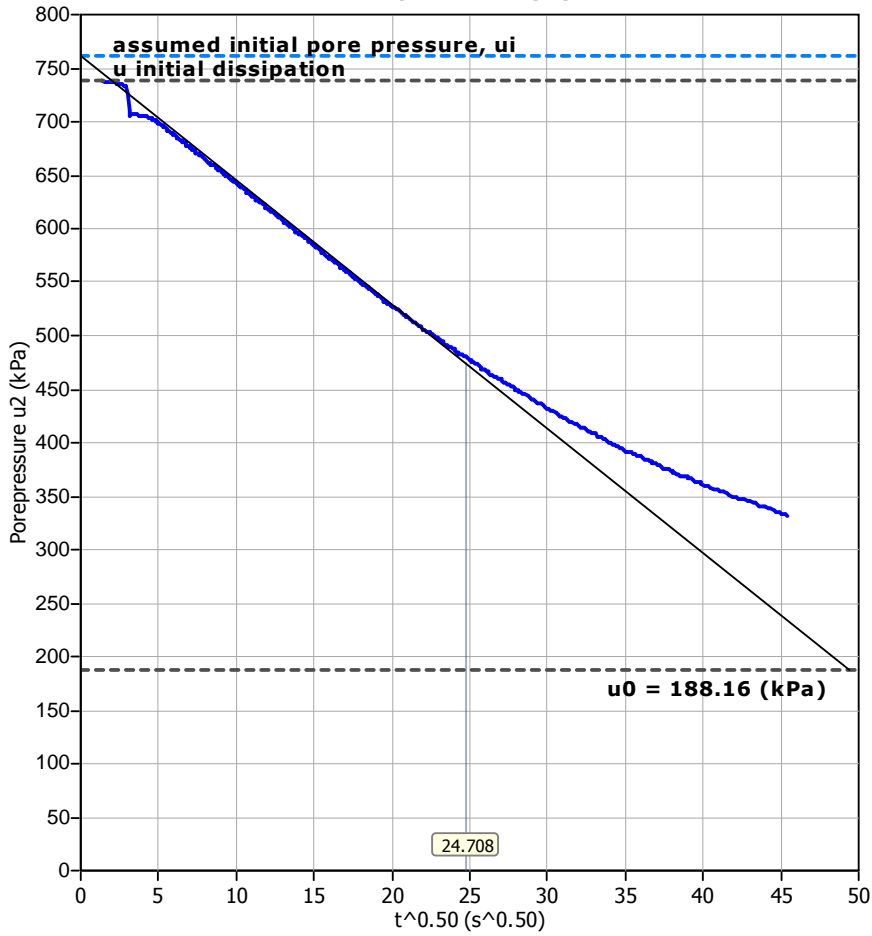
**Legend**

- u2 penetration
- Initial dissipation
- ▼ End of dissipation (extrapolated)
- Initial estimated at t=0

**Piezocene Dissipation Test: 12-2-1 Rev 1**  
**Depth: 14.92 (m)**



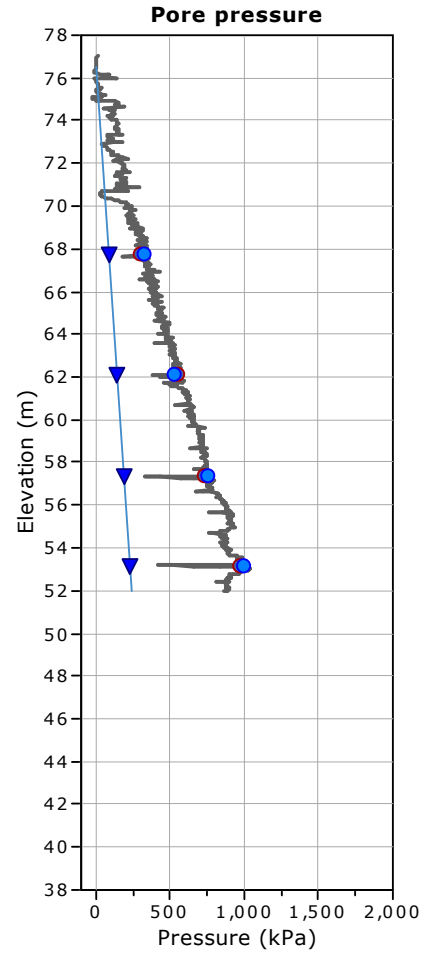
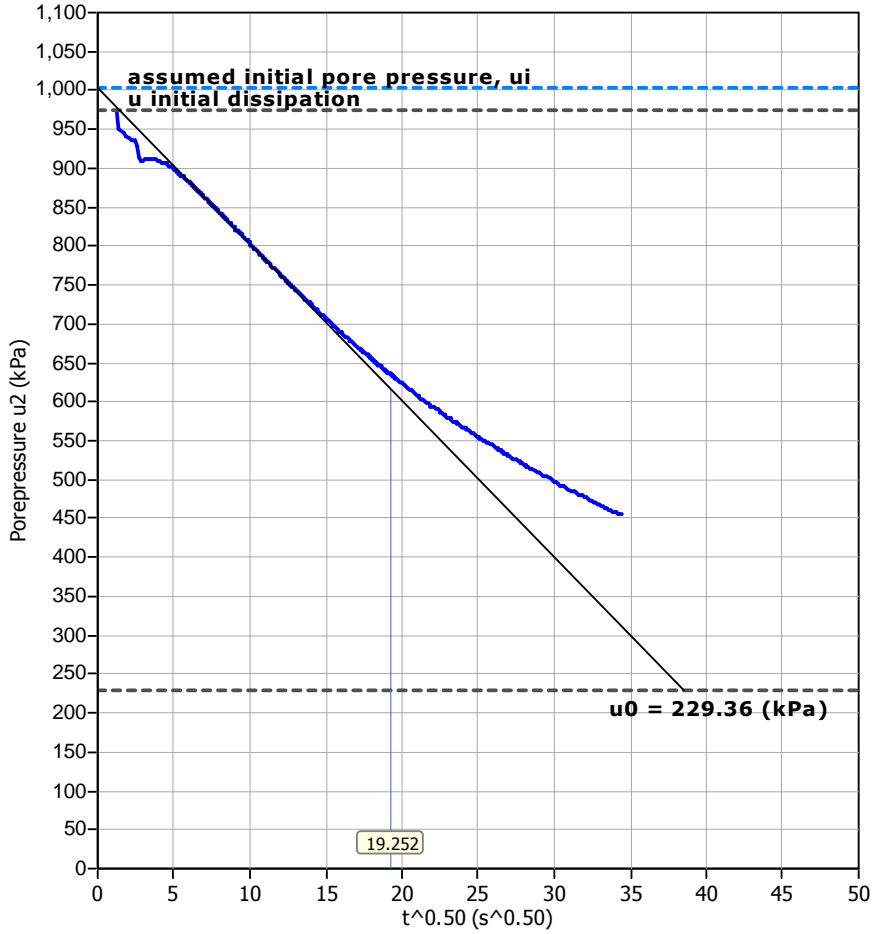
**Piezocene Dissipation Test: 12-2-1 Rev 1**  
**Depth: 19.68 (m)**



**Legend**

- u2 penetration
- Initial dissipation
- ▼ End of dissipation (extrapolated)
- Initial estimated at t=0

**Piezocene Dissipation Test: 12-2-1 Rev 1**  
**Depth: 23.88 (m)**



**Legend**

- u2 penetration
- Initial dissipation
- ▼ End of dissipation (extrapolated)
- Initial estimated at t=0

## Dissipation Tests Results

### Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for  $t_{50}$ , which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction  $c_h$  was then calculated by Hously and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Hously and Teh's (1988) theory corresponding to the porepressure position

r: piezocone radius

$I_r$ : stiffness index, equal to shear modulus G divided by the undrained strength of clay ( $S_u$ ).

$t_{50}$ : time corresponding to 50% consolidation

### Permeability estimates based on dissipation test

The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction ( $c_h$ ) which is influenced by a combination of the soil permeability ( $k_h$ ) and compressibility (M), as defined by the following:

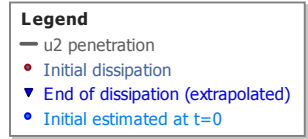
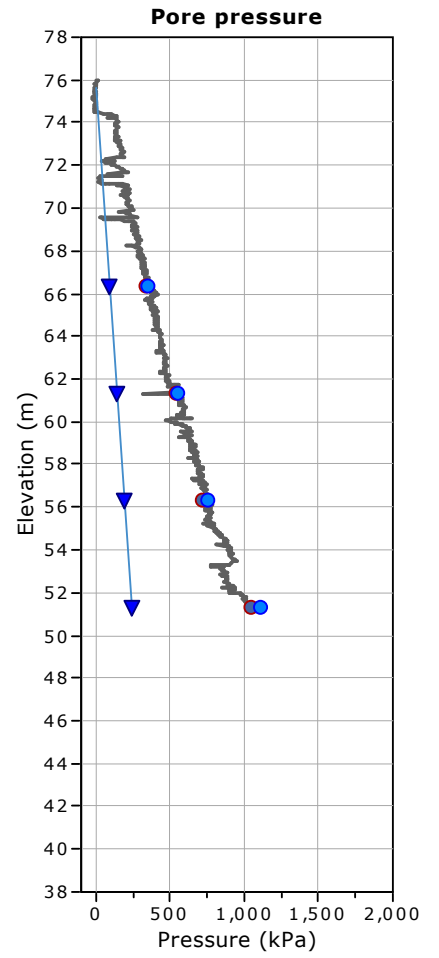
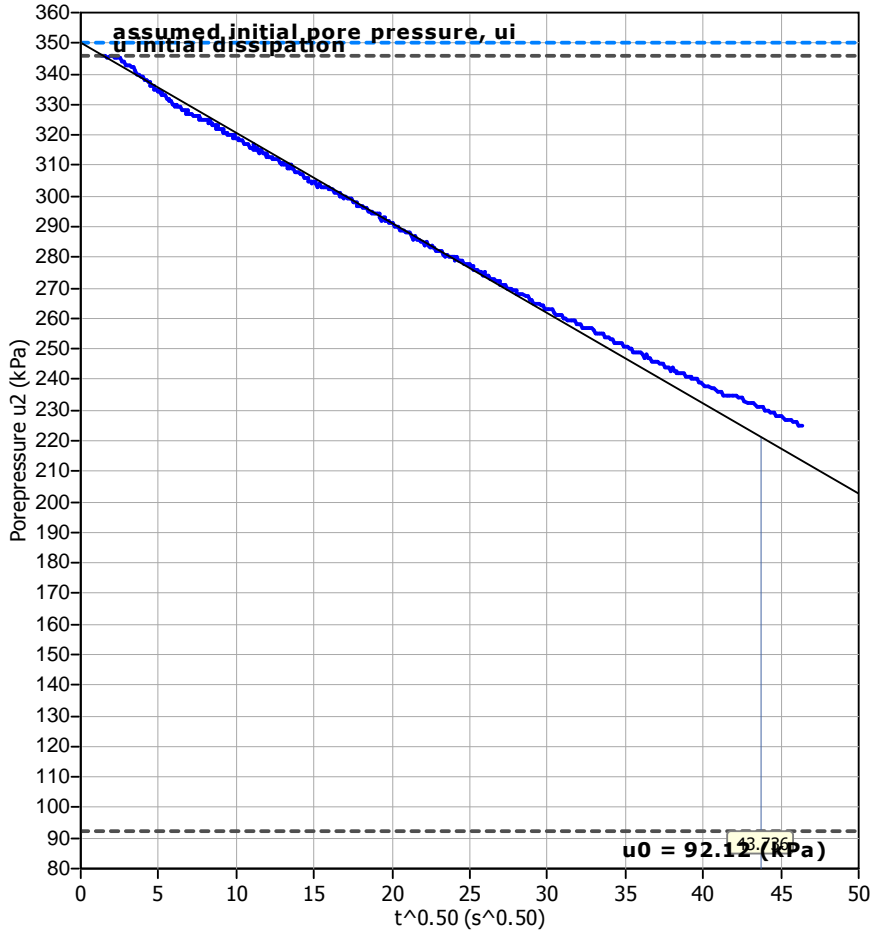
$$k_h = c_h \times \gamma_w / M$$

where: M is the 1-D constrained modulus and  $\gamma_w$  is the unit weight of water, in compatible units.

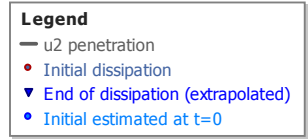
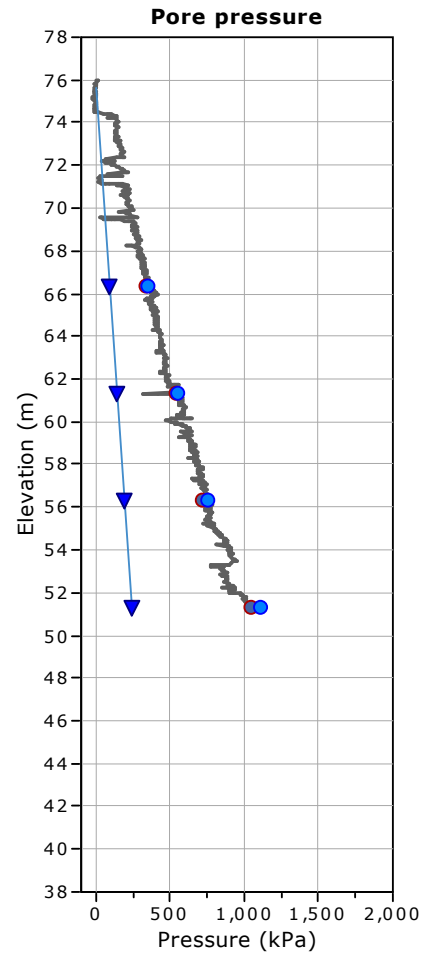
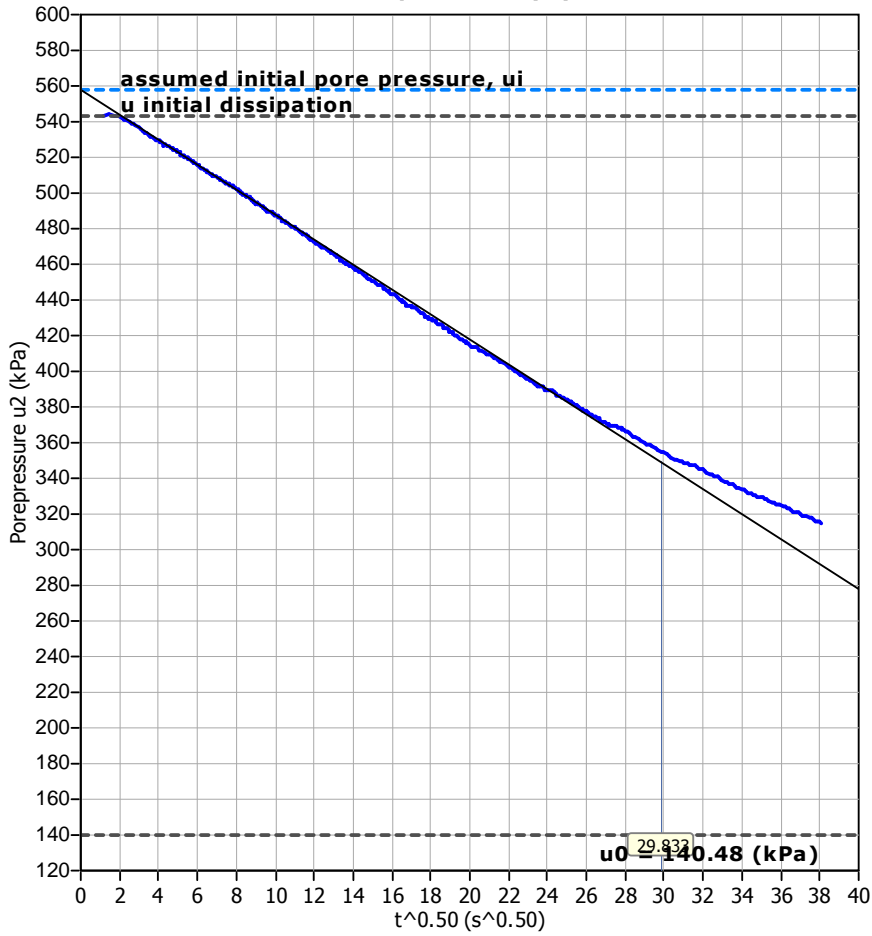
### Tabular results

CPTU Borehole	Depth (m)	$(t_{50})^{0.50}$	$t_{50}$ (s)	$t_{50}$ (years)	G/ $S_u$	$c_h$ ( $m^2/s$ )	$c_h$ ( $m^2/year$ )	M (MPa)	$k_h$ (m/s)
12-3-1 Rev 1	9.89	43.7	1913	6.07E-005	60.00	3.18E-007	10	2.51	1.24E-009
12-3-1 Rev 1	14.82	29.8	890	2.82E-005	62.00	6.95E-007	22	5.09	1.34E-009
12-3-1 Rev 1	19.84	22.8	521	1.65E-005	40.00	9.52E-007	30	6.55	1.43E-009
12-3-1 Rev 1	24.88	16.8	283	8.98E-006	55.00	2.06E-006	65	9.57	2.11E-009

**Piezocene Dissipation Test: 12-3-1 Rev 1**  
**Depth: 9.89 (m)**

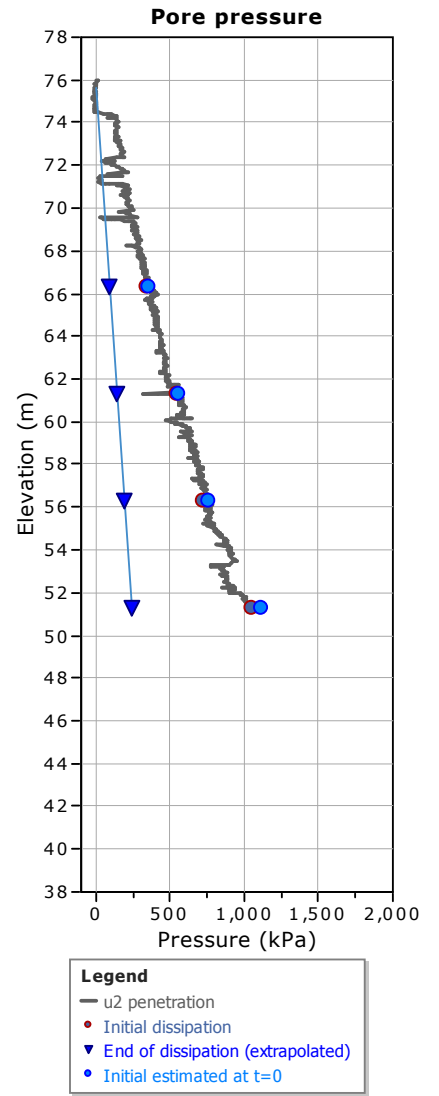
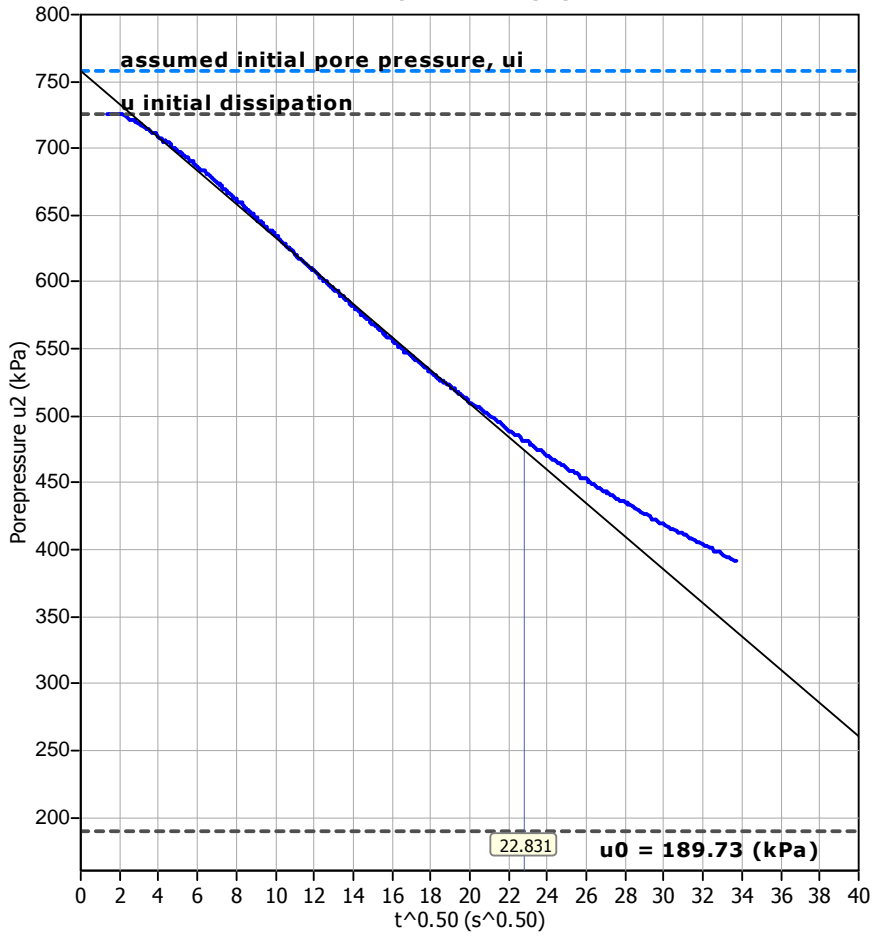


**Piezocone Dissipation Test: 12-3-1 Rev 1**  
**Depth: 14.82 (m)**

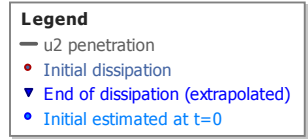
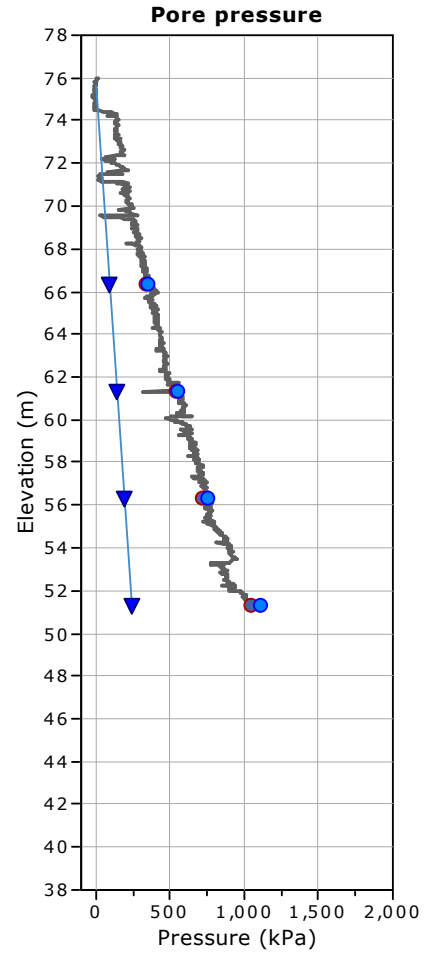
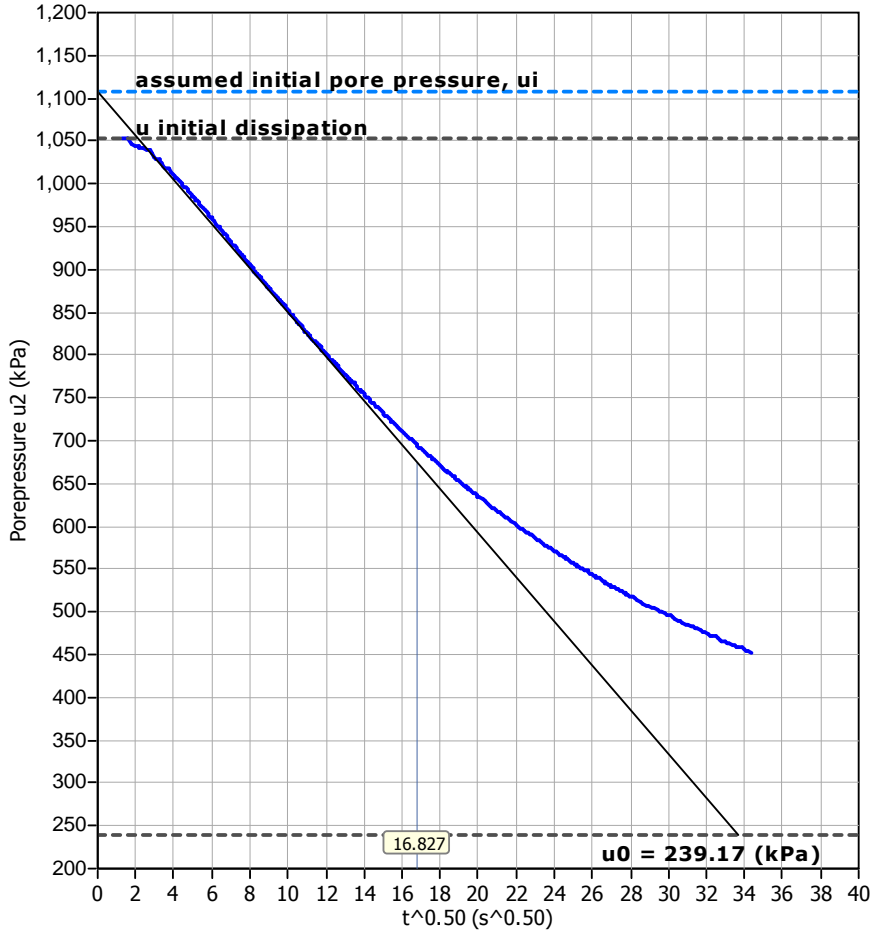




**Piezocene Dissipation Test: 12-3-1 Rev 1**  
**Depth: 19.84 (m)**



**Piezocene Dissipation Test: 12-3-1 Rev 1  
Depth: 24.88 (m)**



## Dissipation Tests Results

### Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for  $t_{50}$ , which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction  $c_h$  was then calculated by Hously and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Hously and Teh's (1988) theory corresponding to the porepressure position

r: piezocone radius

$I_r$ : stiffness index, equal to shear modulus G divided by the undrained strength of clay ( $S_u$ ).

$t_{50}$ : time corresponding to 50% consolidation

### Permeability estimates based on dissipation test

The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction ( $c_h$ ) which is influenced by a combination of the soil permeability ( $k_h$ ) and compressibility (M), as defined by the following:

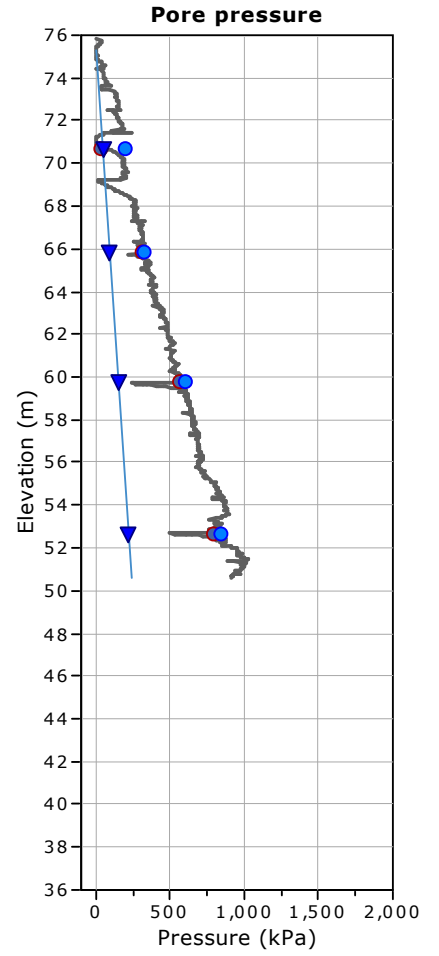
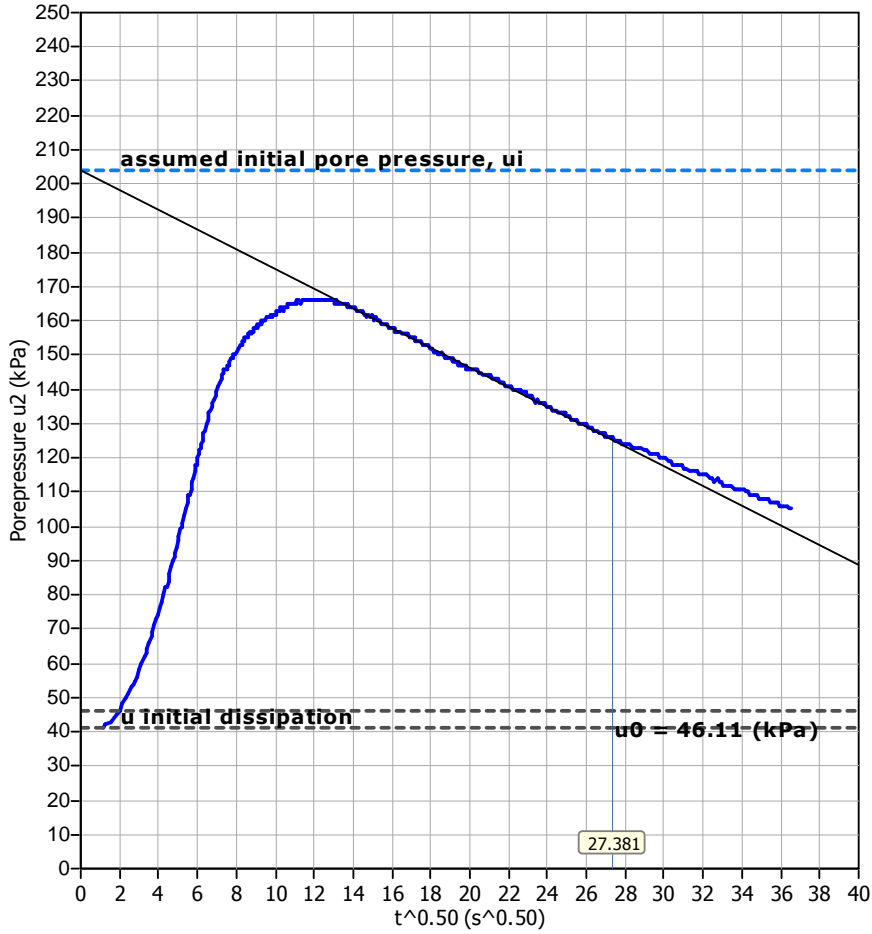
$$k_h = c_h \times \gamma_w / M$$

where: M is the 1-D constrained modulus and  $\gamma_w$  is the unit weight of water, in compatible units.

### Tabular results

CPTU Borehole	Depth (m)	$(t_{50})^{0.50}$	$t_{50}$ (s)	$t_{50}$ (years)	G/ $S_u$	$c_h$ ( $m^2/s$ )	$c_h$ ( $m^2/year$ )	M (MPa)	$k_h$ (m/s)
12-4-1 Rev 1	5.20	27.4	750	2.38E-005	35.00	6.19E-007	20	0.43	1.43E-008
12-4-1 Rev 1	10.05	41.5	1722	5.46E-005	60.00	3.53E-007	11	2.26	1.53E-009
12-4-1 Rev 1	16.09	25.0	626	1.99E-005	66.00	1.02E-006	32	3.27	3.06E-009
12-4-1 Rev 1	23.17	25.3	640	2.03E-005	60.00	9.50E-007	30	4.84	1.93E-009

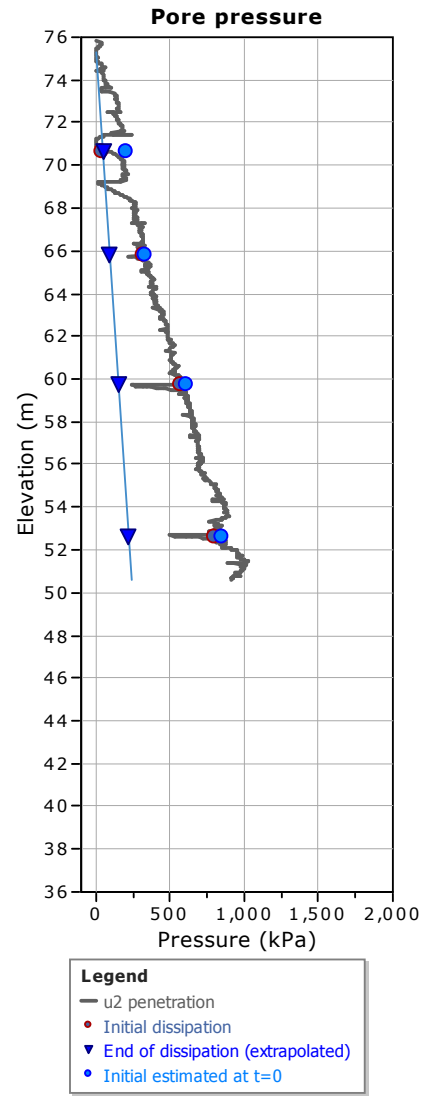
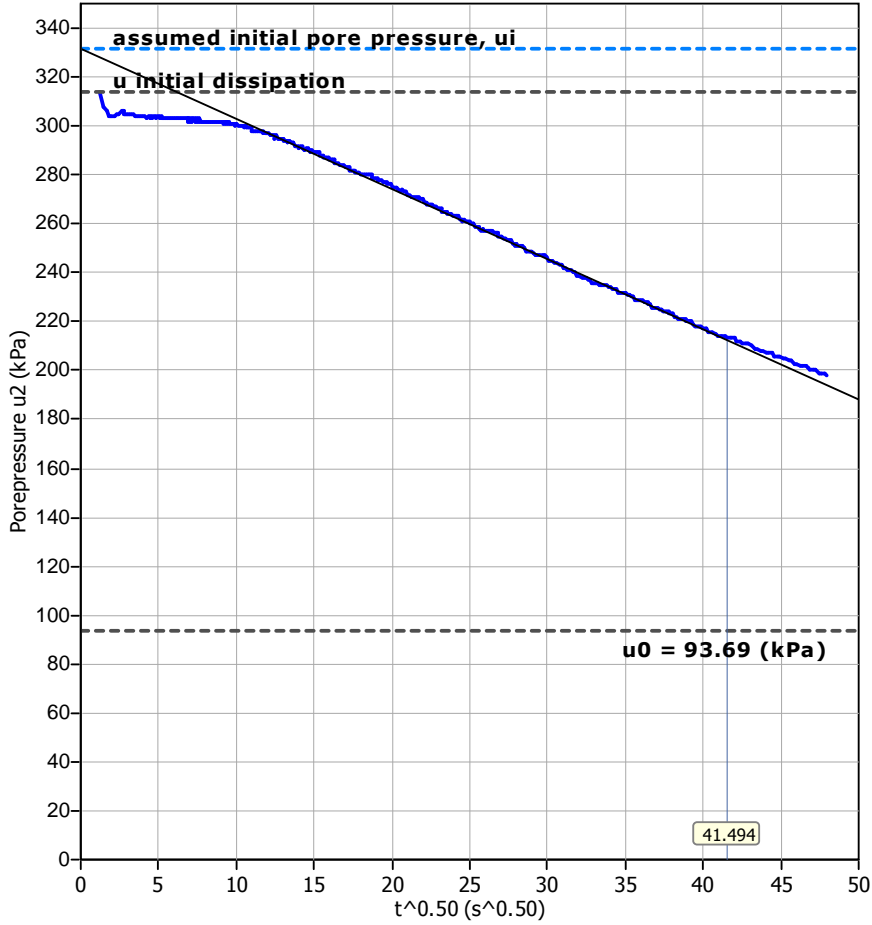
**Piezocone Dissipation Test: 12-4-1 Rev 1**  
**Depth: 5.20 (m)**



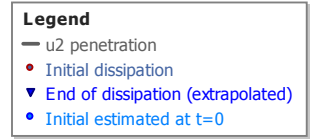
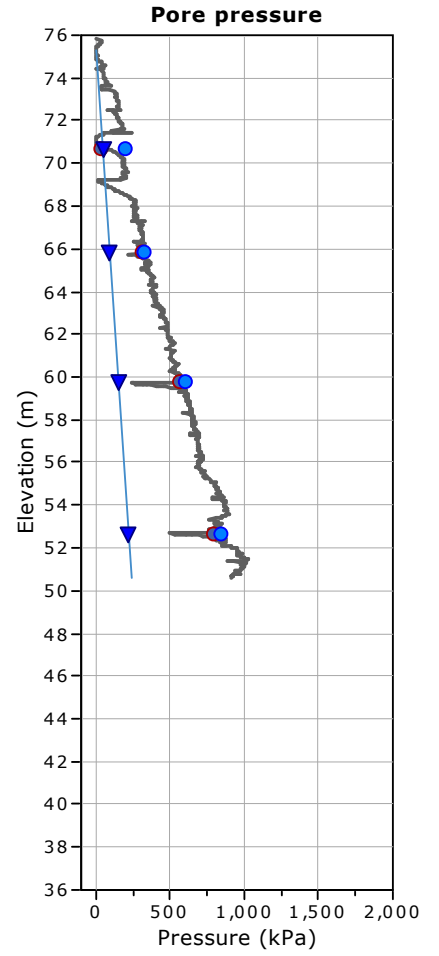
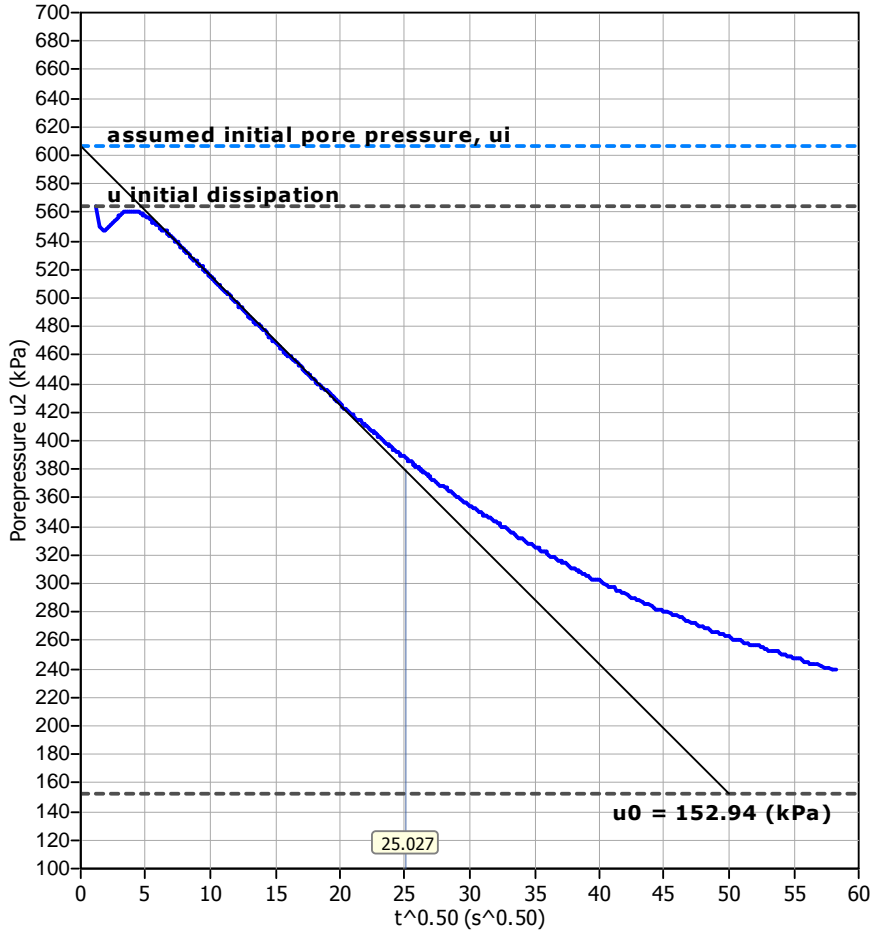
**Legend**

- $u_2$  penetration
- Initial dissipation
- ▼ End of dissipation (extrapolated)
- Initial estimated at  $t=0$

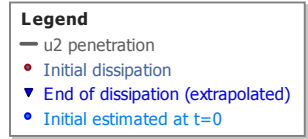
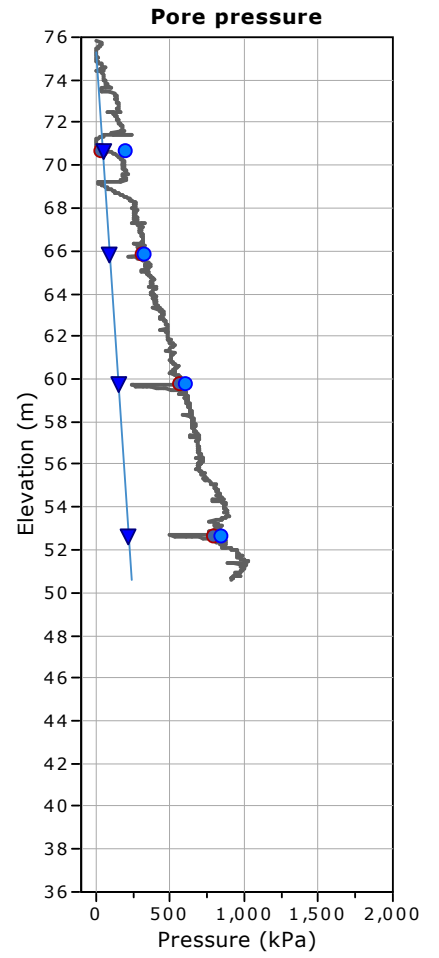
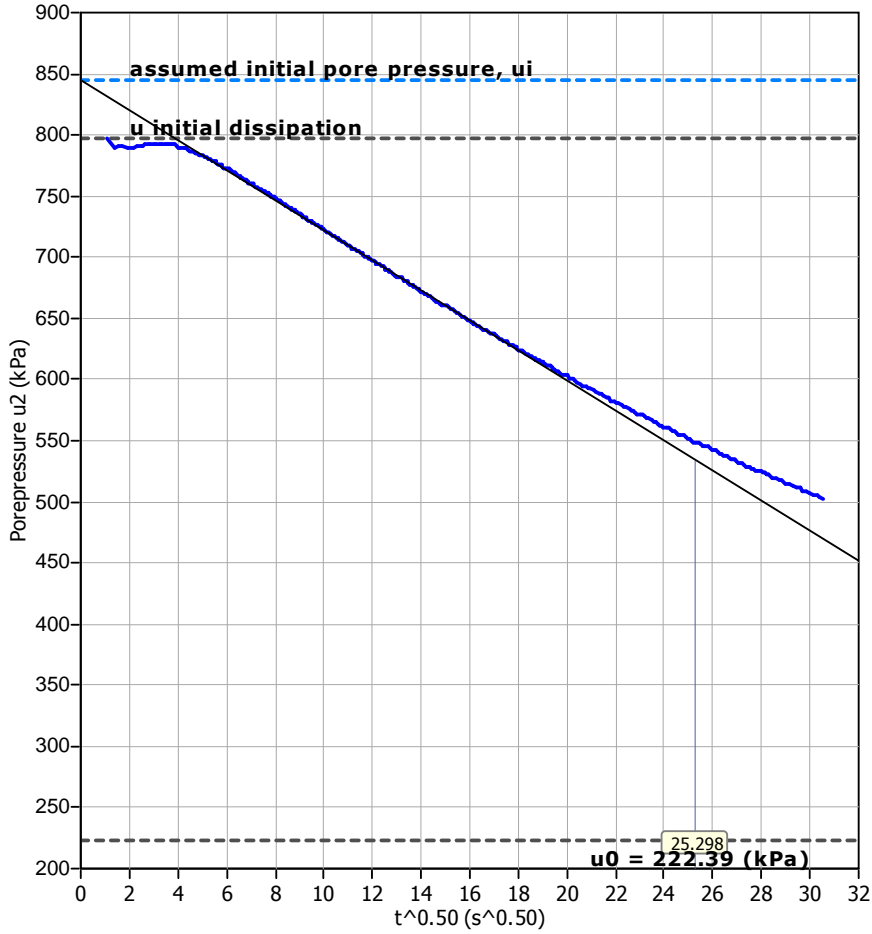
**Piezocene Dissipation Test: 12-4-1 Rev 1**  
**Depth: 10.05 (m)**



**Piezocene Dissipation Test: 12-4-1 Rev 1**  
**Depth: 16.09 (m)**



**Piezocene Dissipation Test: 12-4-1 Rev 1**  
**Depth: 23.17 (m)**



## Dissipation Tests Results

### Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for  $t_{50}$ , which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction  $c_h$  was then calculated by Hously and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Hously and Teh's (1988) theory corresponding to the porepressure position

r: piezocone radius

$I_r$ : stiffness index, equal to shear modulus G divided by the undrained strength of clay ( $S_u$ ).

$t_{50}$ : time corresponding to 50% consolidation

### Permeability estimates based on dissipation test

The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction ( $c_h$ ) which is influenced by a combination of the soil permeability ( $k_h$ ) and compressibility (M), as defined by the following:

$$k_h = c_h \times \gamma_w / M$$

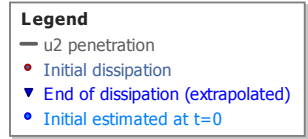
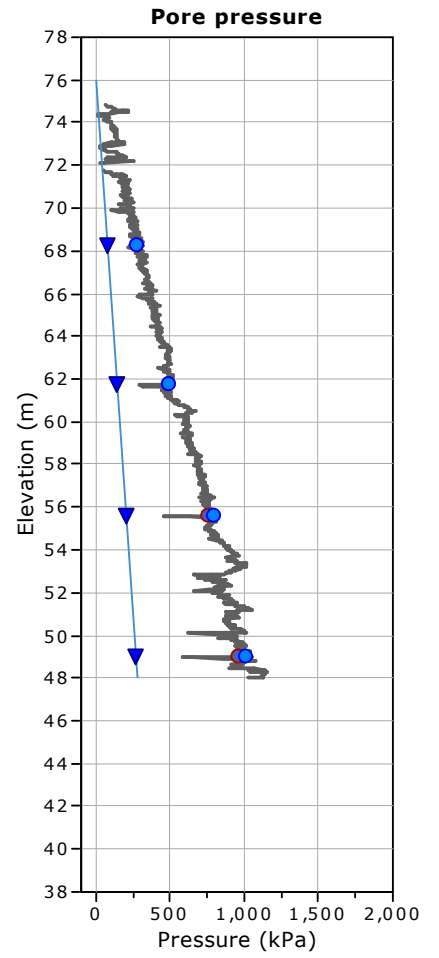
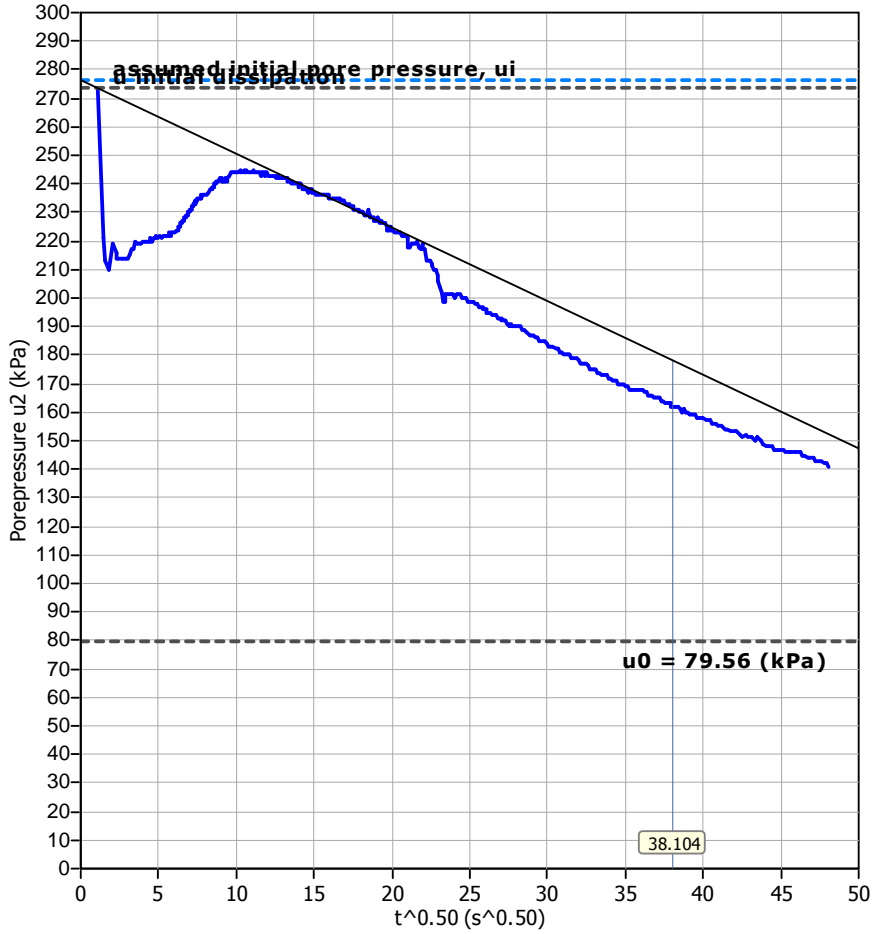
where: M is the 1-D constrained modulus and  $\gamma_w$  is the unit weight of water, in compatible units.

### Tabular results

CPTU Borehole	Depth (m)	$(t_{50})^{0.50}$	$t_{50}$ (s)	$t_{50}$ (years)	G/ $S_u$	$c_h$ ( $m^2/s$ )	$c_h$ ( $m^2/year$ )	M (MPa)	$k_h$ (m/s)
13-5-1 Rev 1	8.11	38.1	1452	4.60E-005	48.00	3.75E-007	12	1.13	3.24E-009
13-5-1 Rev 1	14.58	26.8	718	2.28E-005	56.00	8.19E-007	26	2.46	3.26E-009
13-5-1 Rev 1	20.71	22.0	486	1.54E-005	51.00	1.15E-006	36	3.97	2.85E-009
13-5-1 Rev 1	27.35	21.7	472	1.50E-005	104.00	1.70E-006	53	6.90	2.41E-009

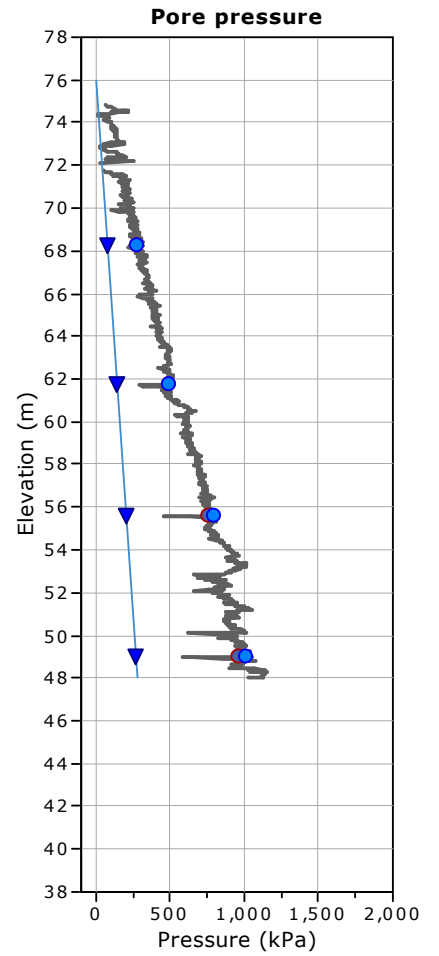
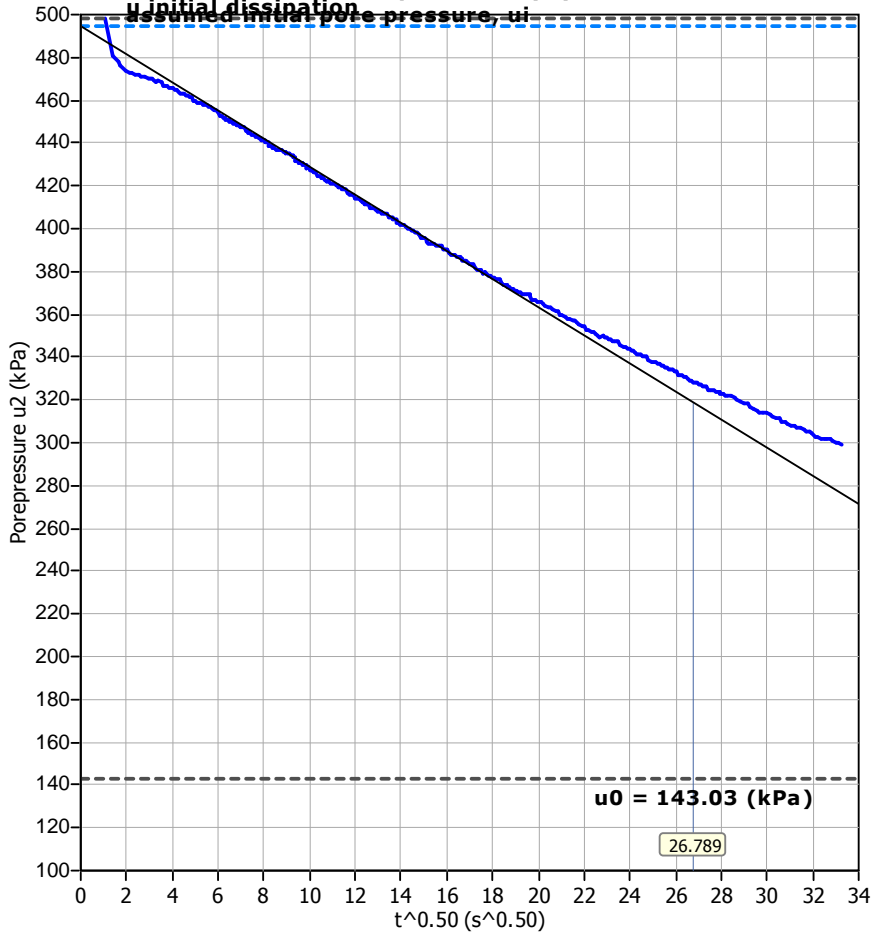


**Piezocene Dissipation Test: 13-5-1 Rev 1**  
**Depth: 8.11 (m)**



**Piezocene Dissipation Test: 13-5-1 Rev 1**

Depth: 14.58 (m)

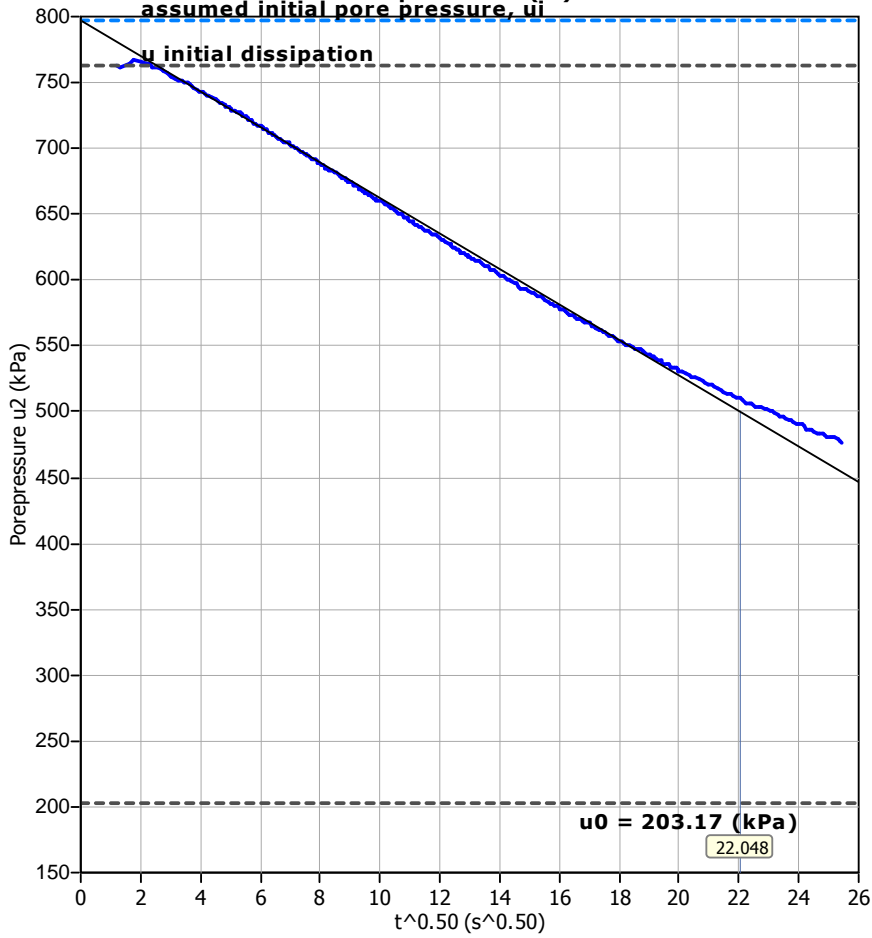


**Legend**

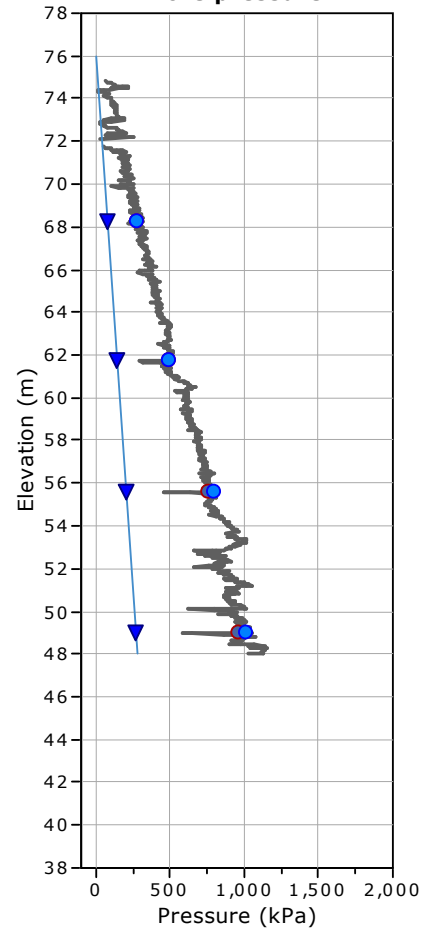
- u2 penetration
- Initial dissipation
- ▼ End of dissipation (extrapolated)
- Initial estimated at t=0

**Piezocene Dissipation Test: 13-5-1 Rev 1**

**Depth: 20.71 (m)**



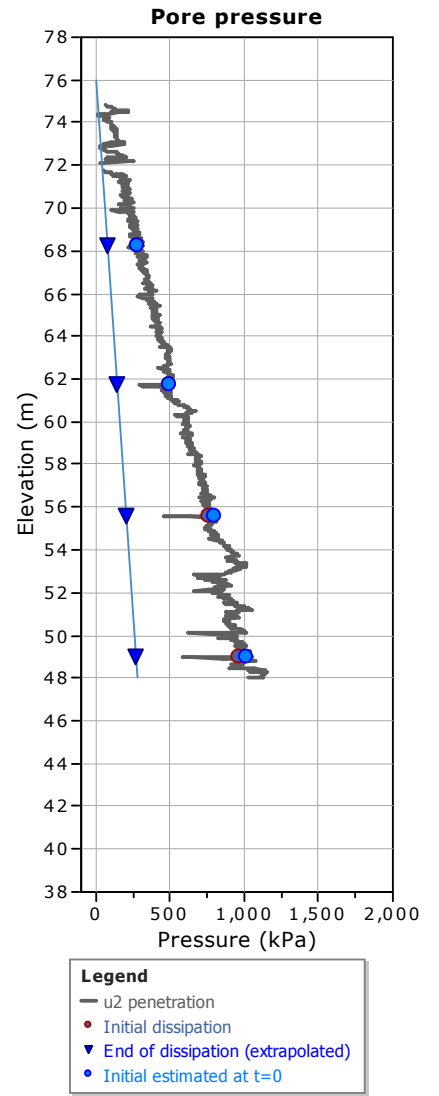
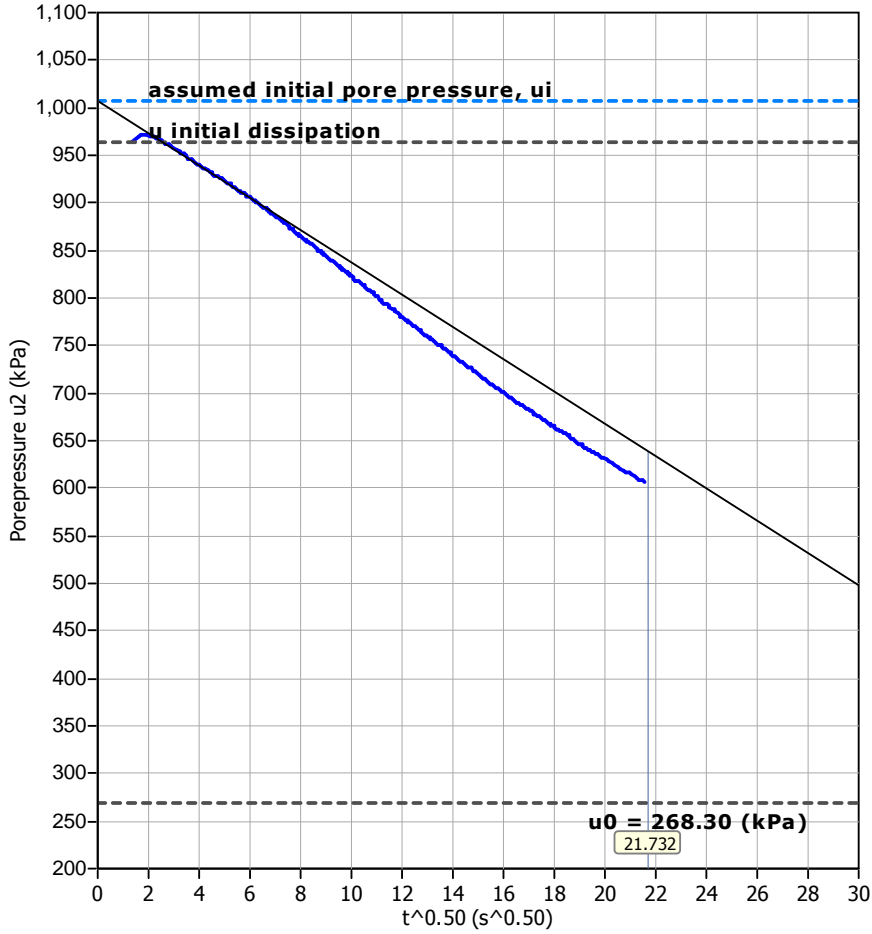
**Pore pressure**



**Legend**

- u2 penetration
- Initial dissipation
- ▼ End of dissipation (extrapolated)
- Initial estimated at t=0

**Piezocene Dissipation Test: 13-5-1 Rev 1**  
**Depth: 27.35 (m)**



## Dissipation Tests Results

### Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for  $t_{50}$ , which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction  $c_h$  was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position

r: piezocone radius

$I_r$ : stiffness index, equal to shear modulus G divided by the undrained strength of clay ( $S_u$ ).

$t_{50}$ : time corresponding to 50% consolidation

### Permeability estimates based on dissipation test

The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction ( $c_h$ ) which is influenced by a combination of the soil permeability ( $k_h$ ) and compressibility (M), as defined by the following:

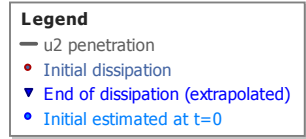
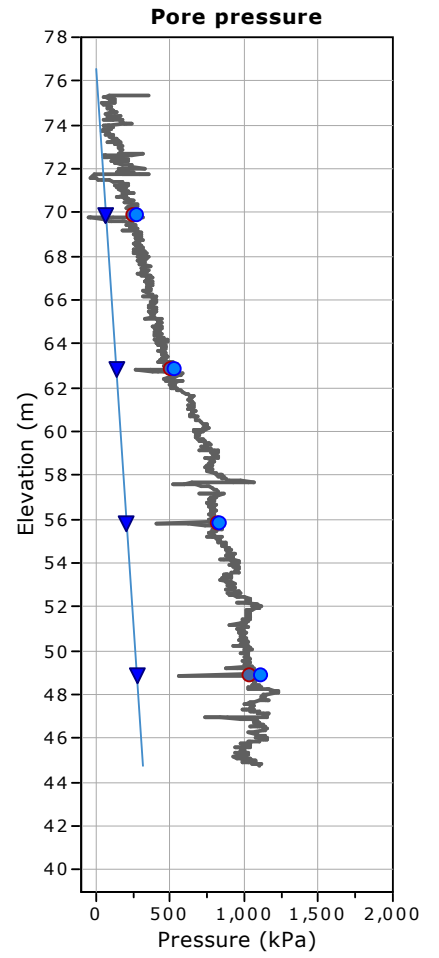
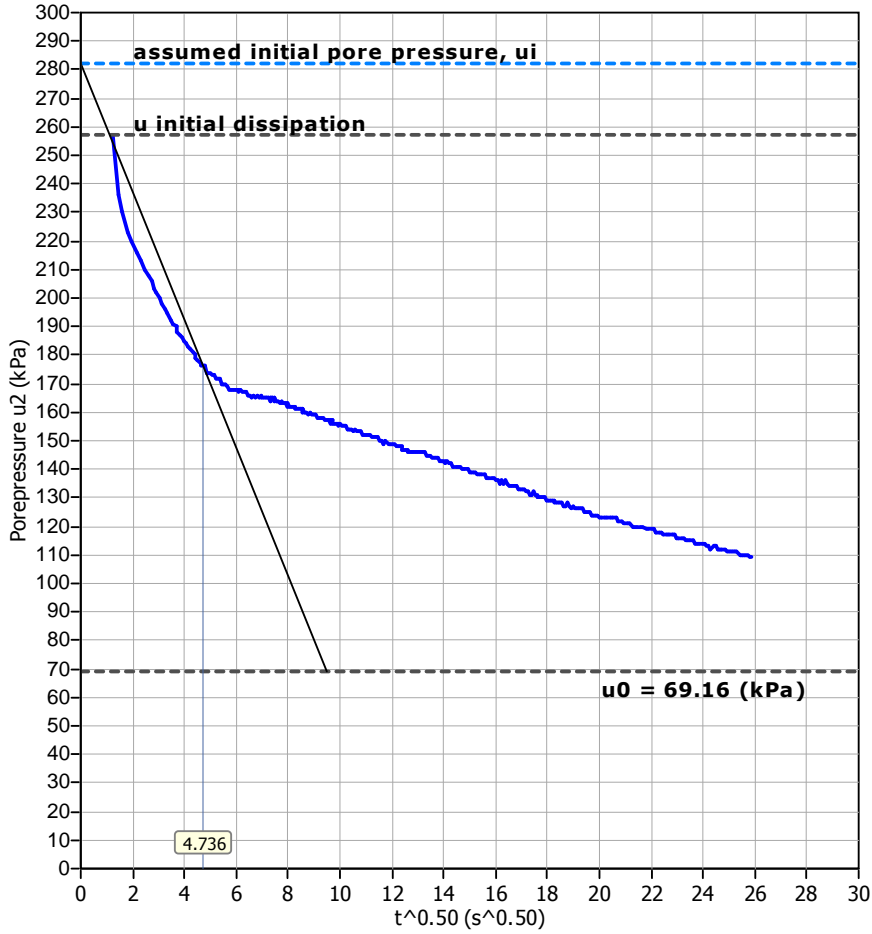
$$k_h = c_h \times \gamma_w / M$$

where: M is the 1-D constrained modulus and  $\gamma_w$  is the unit weight of water, in compatible units.

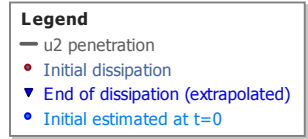
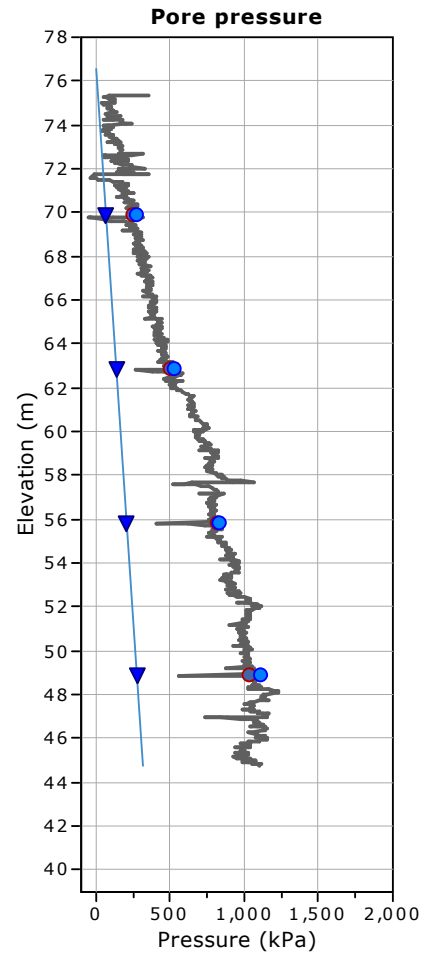
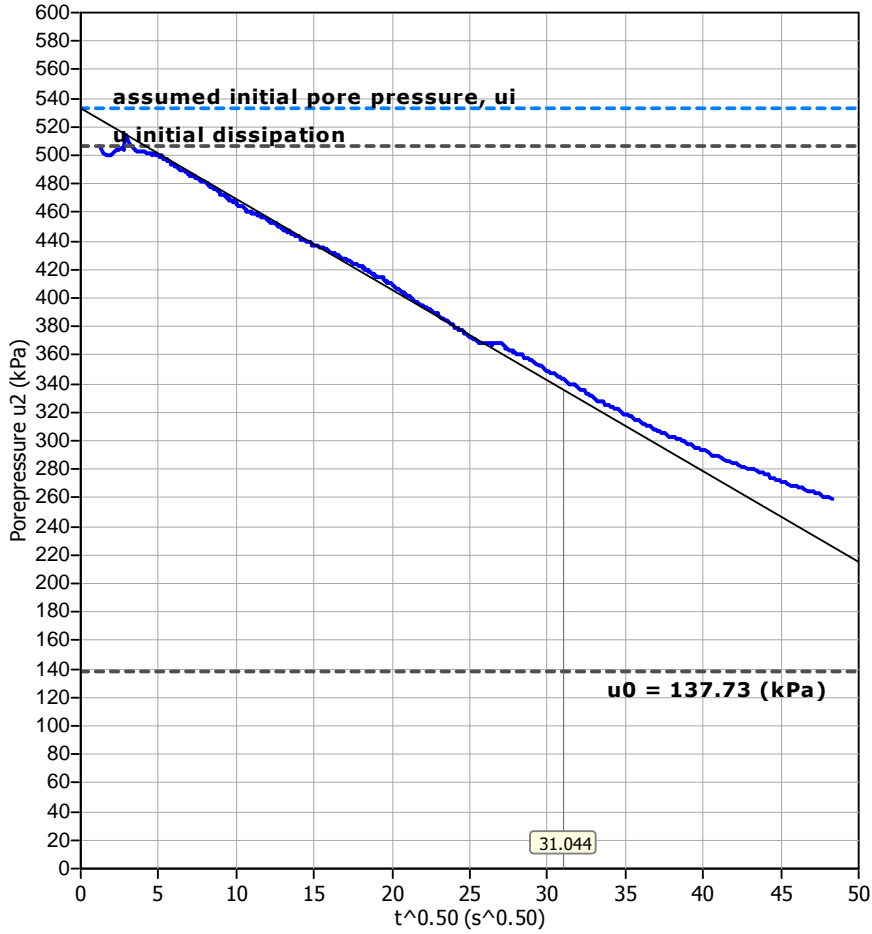
### Tabular results

CPTU Borehole	Depth (m)	$(t_{50})^{0.50}$	$t_{50}$ (s)	$t_{50}$ (years)	G/ $S_u$	$c_h$ ( $m^2/s$ )	$c_h$ ( $m^2/year$ )	M (MPa)	$k_h$ (m/s)
13-6-1 Rev 1	7.05	4.7	22	7.11E-007	72.00	2.97E-005	936	1.61	1.81E-007
13-6-1 Rev 1	14.04	31.0	964	3.06E-005	55.00	6.04E-007	19	3.35	1.77E-009
13-6-1 Rev 1	21.05	21.0	439	1.39E-005	52.00	1.29E-006	41	3.31	3.82E-009
13-6-1 Rev 1	28.05	20.1	402	1.28E-005	92.00	1.87E-006	59	4.97	3.70E-009

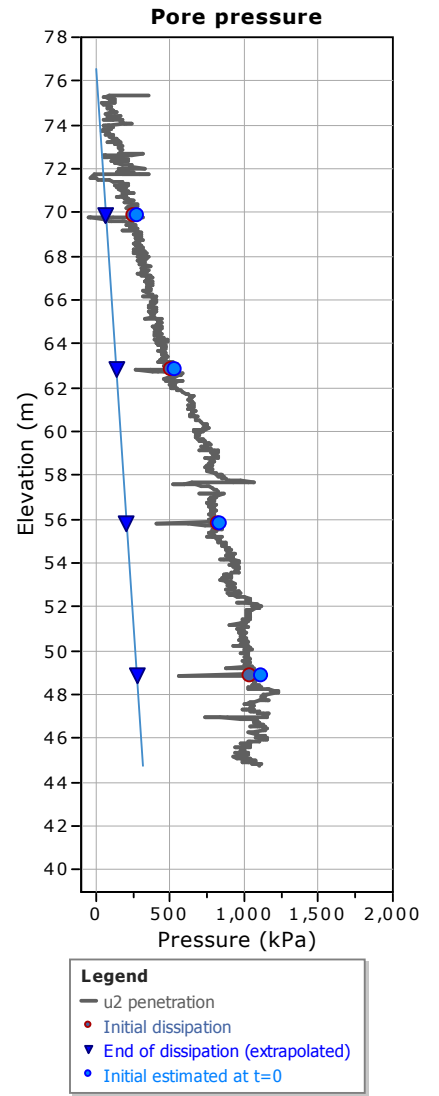
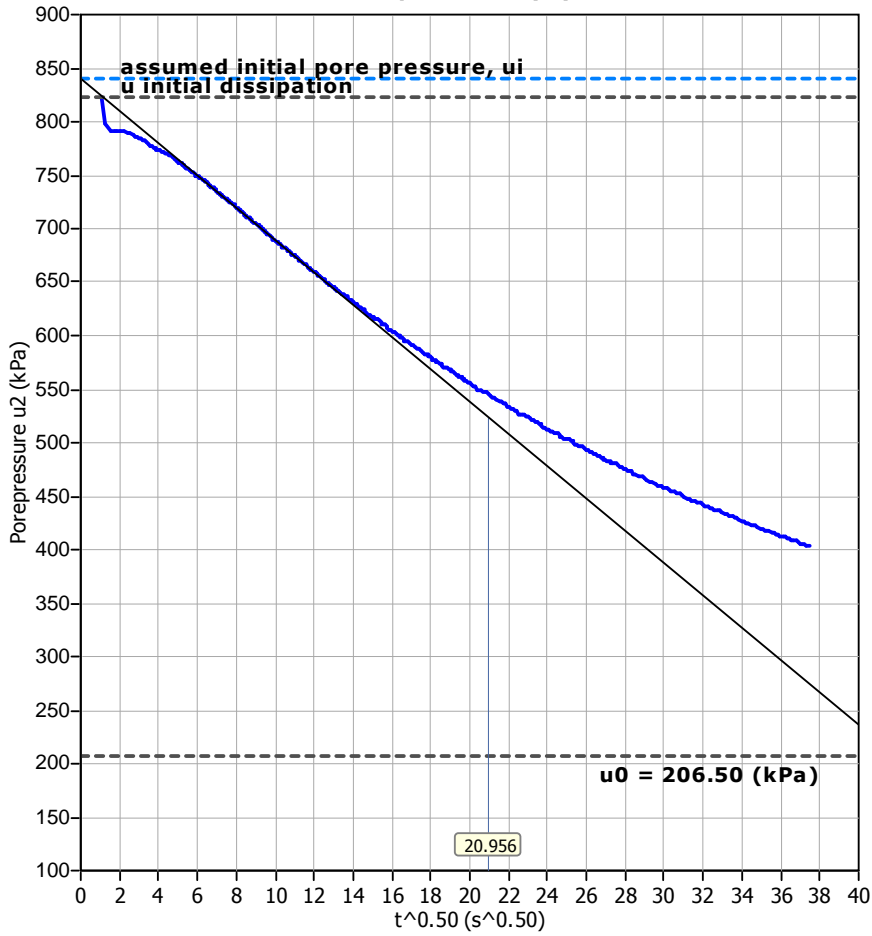
**Piezocene Dissipation Test: 13-6-1 Rev 1**  
**Depth: 7.05 (m)**



**Piezocene Dissipation Test: 13-6-1 Rev 1**  
**Depth: 14.04 (m)**

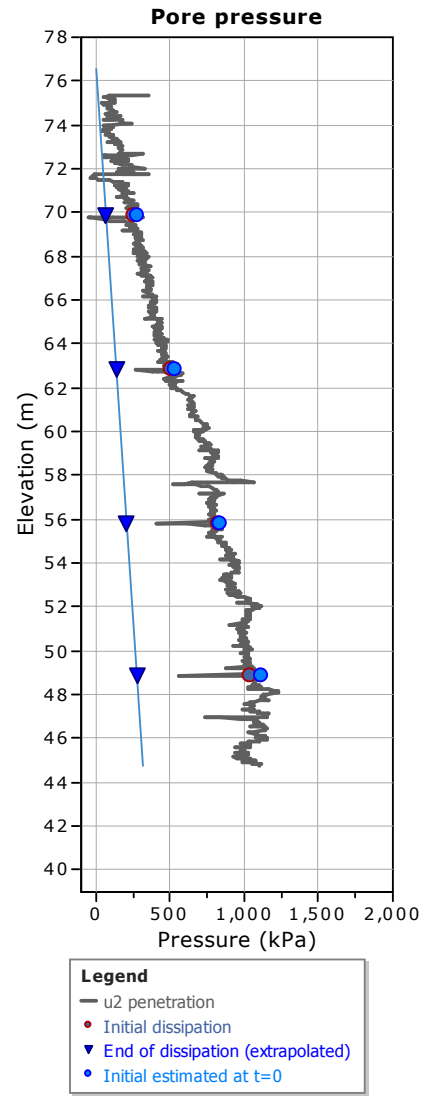
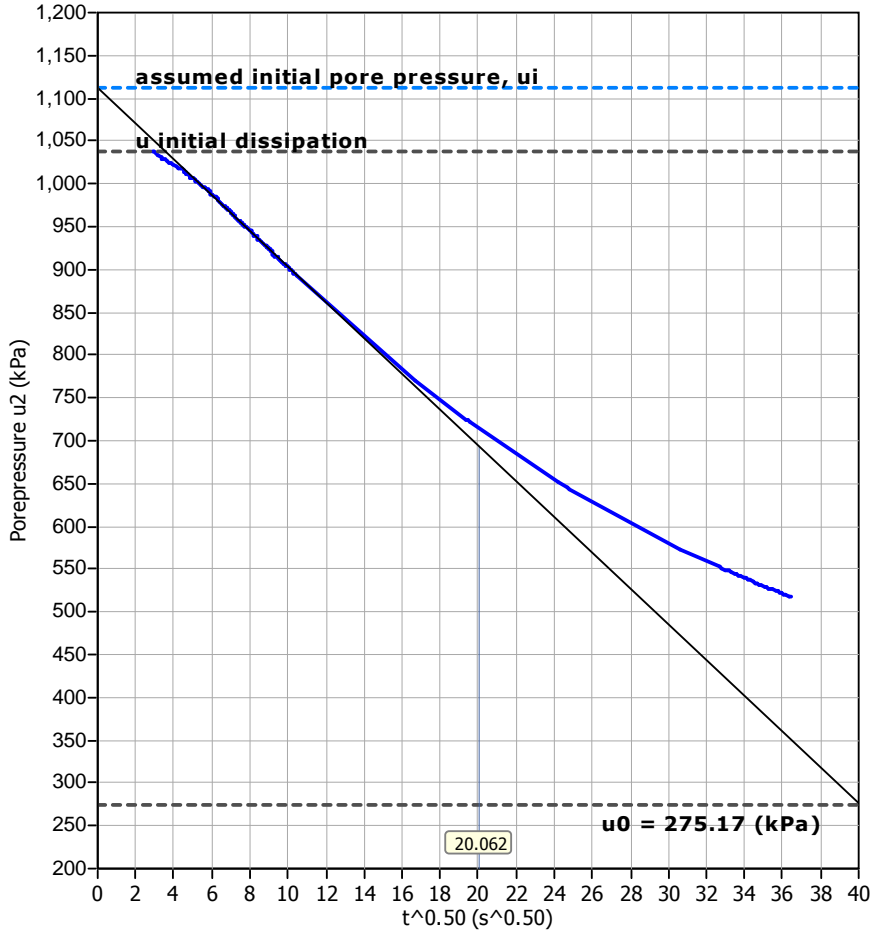


**Piezocene Dissipation Test: 13-6-1 Rev 1**  
**Depth: 21.05 (m)**





**Piezocene Dissipation Test: 13-6-1 Rev 1**  
**Depth: 28.05 (m)**



## Dissipation Tests Results

### Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for  $t_{50}$ , which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction  $c_h$  was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position

r: piezocone radius

$I_r$ : stiffness index, equal to shear modulus G divided by the undrained strength of clay ( $S_u$ ).

$t_{50}$ : time corresponding to 50% consolidation

### Permeability estimates based on dissipation test

The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction ( $c_h$ ) which is influenced by a combination of the soil permeability ( $k_h$ ) and compressibility (M), as defined by the following:

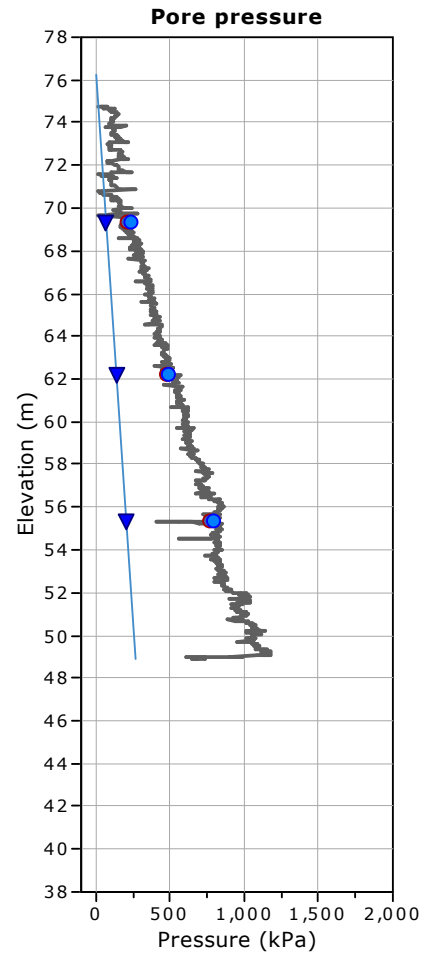
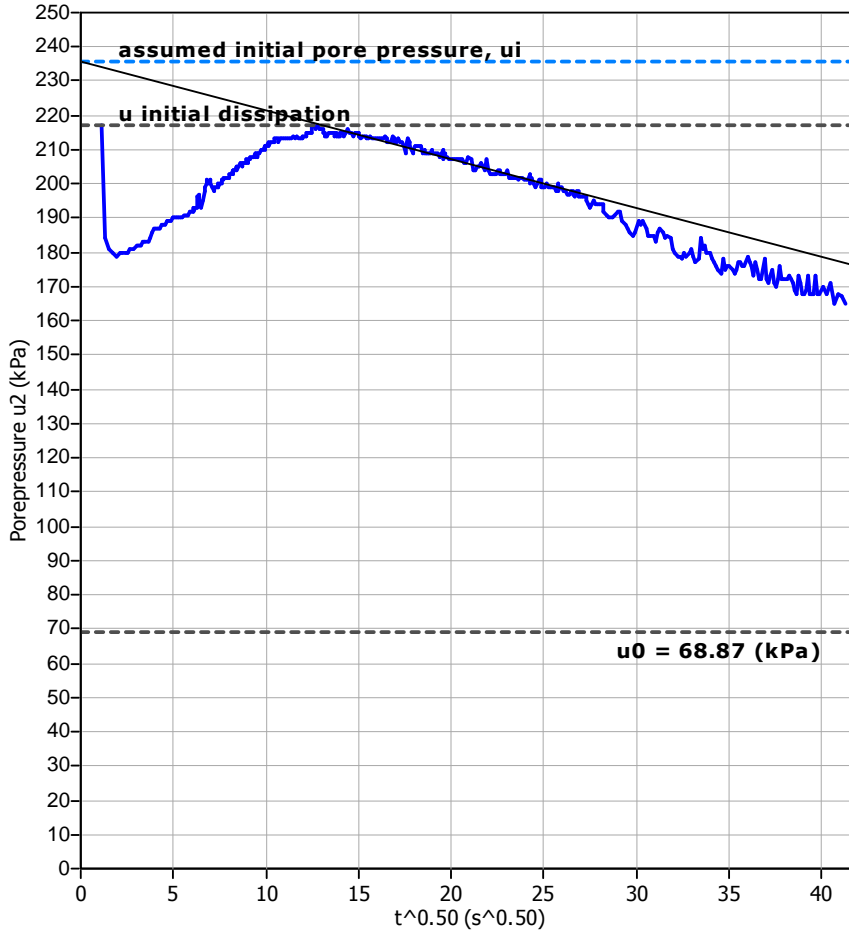
$$k_h = c_h \times \gamma_w / M$$

where: M is the 1-D constrained modulus and  $\gamma_w$  is the unit weight of water, in compatible units.

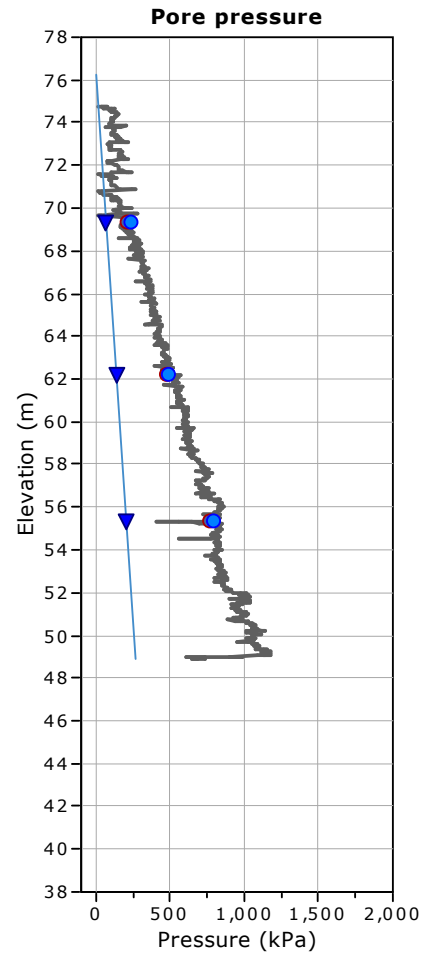
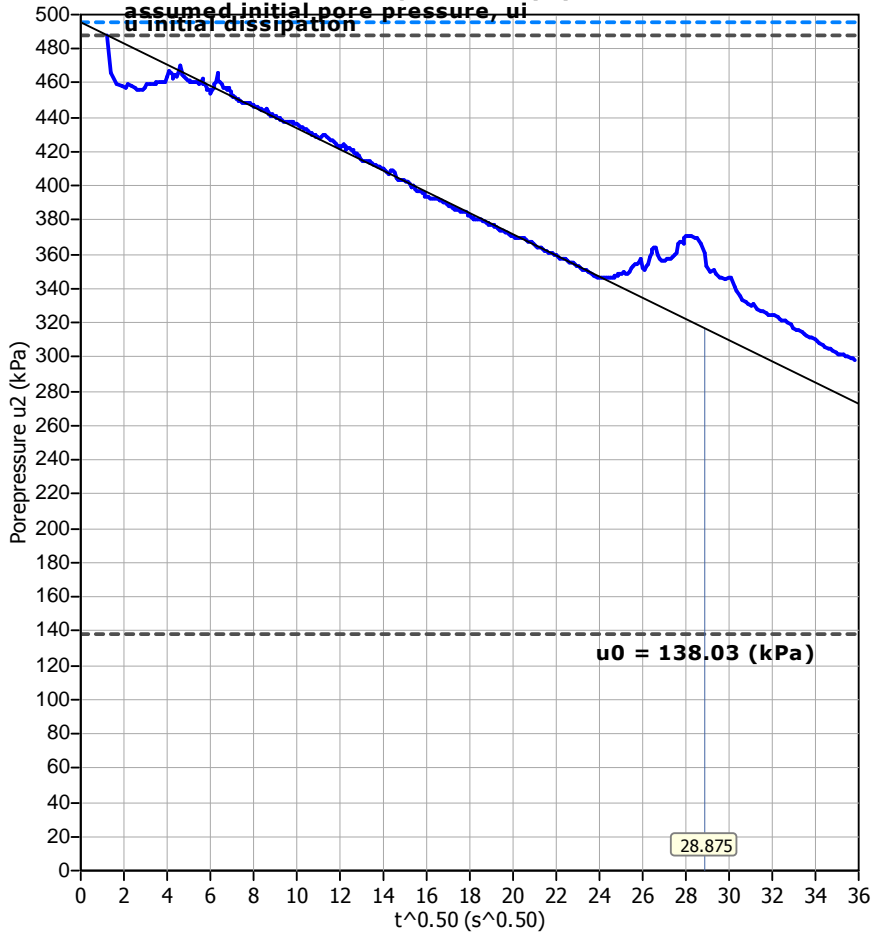
### Tabular results

CPTU Borehole	Depth (m)	$(t_{50})^{0.50}$	$t_{50}$ (s)	$t_{50}$ (years)	G/ $S_u$	$c_h$ ( $m^2/s$ )	$c_h$ ( $m^2/year$ )	M (MPa)	$k_h$ (m/s)
13-7-1 Rev 1	7.02	58.5	3417	1.08E-004	74.00	1.98E-007	6	0.36	5.37E-009
13-7-1 Rev 1	14.07	28.9	834	2.64E-005	57.00	7.11E-007	22	1.45	4.80E-009
13-7-1 Rev 1	20.97	24.4	596	1.89E-005	52.00	9.50E-007	30	3.07	3.03E-009

**Piezocene Dissipation Test: 13-7-1 Rev 1**  
**Depth: 7.02 (m)**



**Piezocone Dissipation Test: 13-7-1 Rev 1**  
**Depth: 14.07 (m)**



- Legend**
- u2 penetration
  - Initial dissipation
  - ▼ End of dissipation (extrapolated)
  - Initial estimated at t=0

**Piezocene Dissipation Test: 13-7-1 Rev 1**  
**Depth: 20.97 (m)**

