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Oskarshamn site investigation

Slug tests in groundwater monitoring wells in soil in the Laxemar area

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October 2004

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Keywords: Laxemar, Soil, Quaternary deposits, Slug test, Hydraulic parameters, Soil tubes.

Abstract

The methodology, analyses and results of slug tests performed in 14 groundwater-monitoring wells in the Laxemar area during September 2004 are presented in this report. The specific objective of the performed slug tests is to obtain the hydrogeological and hydrogeochemical characteristics of the soils and describe and relate these to the corresponding characteristics of the bedrock and the groundwater. The data from the tests were evaluated using three similar methods: the Hvorslev method, the Bouwer & Rice method and the Cooper-Bredehoeft-Papadopulos method.

The principle of slug tests is to initiate an instantaneous displacement of the water level in a groundwater-monitoring well, and to observe the following recovery of the water level in the well as a function of time. A slug test can be performed by causing a sudden rise of the water level (referred to as a falling-head test), or a sudden fall of the water level (referred to as a rising-head test). In all the wells both falling-head tests and rising-head tests were performed.

The Hvorslev and the Bouwer & Rice methods are both designed to estimate the hydraulic conductivity of an aquifer. The methods assume a fully or partially penetrating well in a confined or unconfined aquifer. In the computer program, a straight-line plot of the logarithm of the ratio h/h_0 versus time is automatically fitted to the measured data. If the semi-logarithmic plot of the measured data gives a concave-upward curve, automatic fitting is inappropriate, and manual curve fitting is recommended. The manual curve fitting method has been used for all analyses in this report.

Sources of unreliability are: difficulty in predicting the thickness of the aquifer, difficulty in determining whether confined or unconfined conditions prevail, the heterogeneity of the soil etc.

The values of the transmissivity obtained from the analyses with the Hvorslev, the Bouwer & Rice and the Cooper-Bredehoeft-Papadopulos methods varied between 9.9×10^{-7} m^2/s and 6.3×10^{-4} m^2/s.

The values of the hydraulic conductivity obtained from the analyses with the Hvorslev, the Bouwer & Rice and the Cooper-Bredehoeft-Papadopulos methods varied between 9.9×10^{-7} m/s and 6.3×10^{-4} m/s.

Sammanfattning

Metodik, analys och resultat från de slugtester som utfördes i 14 grundvattenrör i Laxemarområdet under september 2004 redovisas i rapporten. Målet med slugtesterna är att erhålla jordens hydrogeologiska och hydrogeokemiska egenskaper och beskriva och relatera dessa till bergets och grundvattnets egenskaper. Data från testerna utvärderades med tre liknande metoder: Hvorslev, Bouwer & Rice och Cooper-Bredehoeft-Papadopulos.

Principen för slugtesterna är att starta en ögonblicklig förändring av vattenytan i grundvattenröret och samtidigt mäta trycket till dess att vattenytan har återställts till ursprunglig nivå. Slugtesterna kan utföras genom en snabb höjning av vattenytan (s k falling-head test) eller genom en snabb sänkning av vattenytan (s k rising-head test). I alla grundvattenrör utfördes båda dessa tester.

Både Hvorslev-metoden och Bouwer & Rice-metoden är avsedda att uppskatta den hydrauliska konduktiviteten hos en akvifer. Metoderna förutsätter ett fullständig eller delvis genomträngande rör i en öppen eller sluten akvifer. I dataprogrammet ritas automatiskt en rak linje upp mot de uppmätta värdena i diagrammet (logaritmen av h/h_0 – tidsdiagrammet). Om en konkav kurva erhålls vid uppritandet av de uppmätta värdena, är det olämpligt att använda sig av den automatiskt uppritade linjen, och istället använder man manuell passning av linjen. I den här rapporten användes manuell passning i alla analyser.

Orsaker till att resultaten är osäkra kan vara: akviferens mäktighet är svår att fastställa, om slutna eller öppna förhållanden råder, jordens heterogenitet mm.

Värdena på transmissiviteten som erhölls från analyserna med Hvorslev-metoden, Bouwer & Rice-metoden och Cooper-Bredehoeft-Papadopulos-metoden varierade mellan $9{,}9\times10^{-7}$ m^2/s och $6{,}3\times10^{-4}$ m^2/s.

Värdena på den hydrauliska konduktiviteten som erhölls från analyserna med Hvorslev-metoden, Bouwer & Rice-metoden och Cooper-Bredehoeft-Papadopulos-metoden varierade mellan $9{,}9\times10^{-7}$ m/s och $6{,}3\times10^{-4}$ m/s.

Contents

1 Introduction

A general programme for site investigations presenting survey methods has been prepared (SKB 2001a /1/), as well as a site-specific programme for the investigations in the Simpevarp area (SKB 2001b /2/). The hydrogeological characterization of the Quaternary deposits by means of slug-tests form part of the site characterization programme under item 1.1.8.1 soil drilling in the work breakdown structure of the execution programme, SKB 2002 /3/.

The hydraulic tests were carried out during September 2004 following the methodologies described in SKB MD 325.001,and in the activity plan AP PS 400-04-019 (SKB internal controlling documents). Data and results were entered into the SKB site characterization database SICADA.

This report presents the methodology, analyses and results of slug tests performed in the Laxemar sub-area at the Oskarshamn site. The tests have been performed according to the Activity Plan AP PS 400-04-019 and to SKB's method description for slug tests in groundwater monitoring wells. A total of 14 observation wells were tested. The locations of the tested groundwater monitoring wells are shown in Figure 1-1.

Most of the tested wells are placed in till, in the contact zone between soil and bedrock. The composition of the till varies from gravely sandy till to clayey till. At many locations the till is overlain by peat, clay and/or gyttja which implies semi-confined to confined conditions. At a few locations the till extends to the soil surface or is overlain by sand deposits, which implies unconfined conditions. For information on soil profiles at the location of the groundwater monitoring wells, see /4/.

For information about the site investigation in the Simpevarp area which were performed in 2004 by WSP Group, see /5/ and /6/.

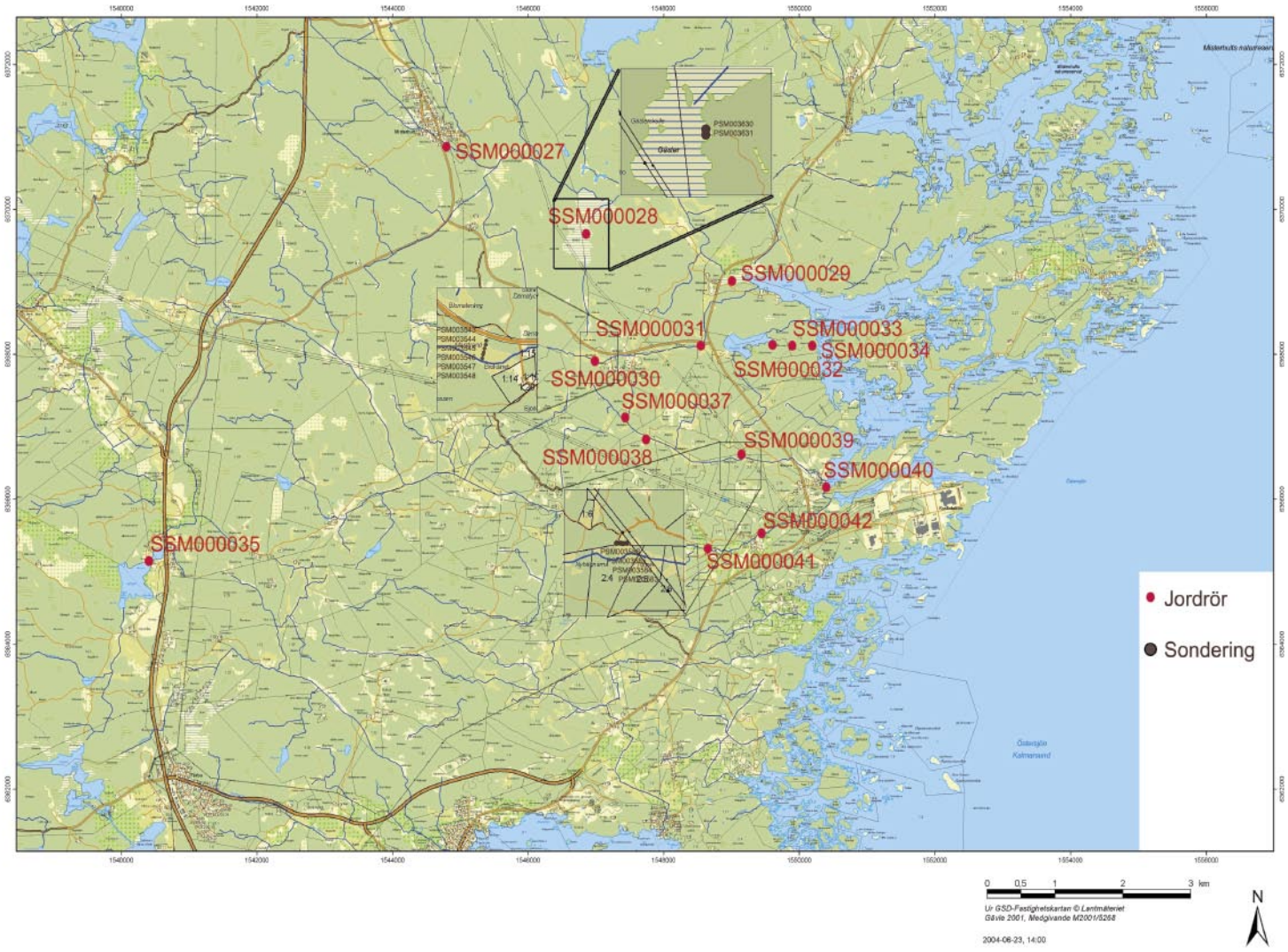

Figure 1-1. *Groundwater monitoring soil tubes in the Laxemar area in which slug tests have been performed.*

2 Objective

The specific objectives of the performed slug tests are to obtain the hydrogeological and hydrogeochemical characteristics of the soils, and to describe and relate these to the corresponding characteristics of the bedrock and the groundwater.

3 Scope

3.1 Boreholes tested

Basic technical data of the groundwater monitoring wells in which the slug tests were performed are shown in Table 3-1. The groundwater monitoring wells consist of a standpipe and a screen made of PEH.

Table 3-1. Technical data of the groundwater monitoring wells.

Groundwater monitoring wells		Standpipe		Screen		
Borehole ID	Borehole diameter (mm)	Inner diameter (mm)	Inclination from vertical plane (°)	Depth to upper screen level1 (m)	Depth to lower screen level1 (m)	Screen length (m)
SSM000027	120	50	0	3.0	5.0	2.0
SSM000028	82	50	0	2.0	3.0	1.0
SSM000029	82	50	0	5.0	7.0	2.0
SSM000030	120	50	0	4.0	5.0	1.0
SSM000031	120	50	0	3.0	4.0	1.0
SSM000032	82	50	0	3.0	4.0	1.0
SSM000033	82	50	0	1.0	2.0	1.0
SSM000034	82	50	0	3.0	4.0	1.0
SSM000035	120	50	0	3.0	4.0	1.0
SSM000037	120	50	0	3.0	4.0	1.0
SSM000039	120	50	0	3.0	5.0	2.0
SSM000040	82	50	0	2.0	3.0	1.0
SSM000041	120	50	0	2.0	4.0	2.0
SSM000042	120	50	0	3.0	5.0	2.0

[1]Depth is measured from the top of the standpipe.

3.2 Equipment check

Prior to each slug test, the equipment which was used for logging the water pressure heads during the tests (Van Essen Instrument Diver®) was exposed to air pressure and undisturbed water pressure.

3.3 Tests

The performed slug tests are summarized in Table 3-2.

Table 3-2. Slug test performed in the groundwater monitoring wells SSM000027 – SSM000042.

Groundwater monitoring well	Test start (YYYY-MM-DD hh:mm)	Time of falling-head test (s)	Depth to water level in well prior to slug test[1] (m)	Diver® depth during slug test[1] (m)	Slug length (m)
SSM000027	2004-09-30 14:03	115	1.65	3.80	1.0
SSM000028	2004-09-27 15:55	4,860	1.05	2.80	1.0
SSM000029	2004-09-27 14:43	460	0.76	2.80	1.0
SSM000030	2004-09-28 14:28	280	1.63	3.80	1.0
SSM000031	2004-09-27 13:43	88	1.14	3.80	1.0
SSM000032	2004-09-30 09:00	7,680	3.00	3.80	0.5
SSM000033	2004-09-30 11:44	1,080	–[2]	1.90	0.5
SSM000034	2004-09-29 15:51	570	1.25	3.20	0.5
SSM000035	2004-09-30 15:19	1,370	1.65	3.80	1.0
SSM000037	2004-09-28 13:19	360	1.52	3.80	1.0
SSM000039	2004-09-28 11:48	20	3.70	4.90	0.5
SSM000040	2004-09-29 11:39	4,140	0.81	2.80	1.0
SSM000041	2004-09-28 08:47	284	1.98	3.80	1.0
SSM000042	2004-09-28 10:03	880	2.40	4.80	1.0

[1] The depth is measured from the top of the standpipe.
[2] No water present in well prior to the test.

4 Equipment

4.1 Description of equipment

For the slug tests, the following equipment was used:

- Van Essen Instrument Diver® with built-in pressure transducer and connecting cable.
- Portable PC.
- Slug and wire.
- Wire stopper.
- Light and sound indicator.

4.2 Sensors and slug

General sensor data on the Diver® and data on the slug used for the test:

Diver®:

- Material: stainless steel
- Material pressure sensor: ceramic.
- Diameter: 22 mm.
- Length: 230 mm.
- Measurement range: 0–500 centimetre water column.
- Resolution: 0.2 cm.
- Accuracy: ±0.1 % of measurement range.
- Wire ∅: 1 mm.

Slug and wire:

- Slug ∅: 40 mm.
- Slug length: 0.5 or 1.0.
- Slug wire ∅: 6 mm.

Table 4-1. The position of the pressure transducer in the Diver®, the wire length[2] and the slug length for each test.

Monitoring well	Diver® depth[1] (m)	Wire length[2] (m)	Slug length (m)
SSM000027	3.80	0.55	1.00
SSM000028	2.80	0.45	1.00
SSM000029	2.80	0.74	1.00
SSM000030	3.80	0.57	1.00
SSM000031	3.80	0.46	1.00
SSM000032	3.80	0.10	0.50
SSM000033	1.90	–	0.50
SSM000034	3.20	0.75	0.50
SSM000035	3.80	0.55	1.00
SSM000037	3.80	0.48	1.00
SSM000039	4.90	0.50	0.50
SSM000040	2.80	0.69	1.00
SSM000041	3.80	0.52	1.00
SSM000042	4.80	1.10	1.00

[1] The depth is measured from the top of the standpipe.
[2] The length of wire in contact with the water.

5 Execution

5.1 Preparations

During a different field test, the water level changes measured by the Divers® were compared to the water level changes measured by a handheld water-level meter. The Divers® measurements were similar to those measured by the handheld water-level meter.

Equipment checks were also performed in connection with each slug test (see Chapter 3.2).

Prior to each slug test, the pipes were examined to ensure that no sediment remained at the bottom of the pipe. If any sediment was found, it was removed with a suction pipe.

5.2 Test principle

The principle of slug tests is to initiate an instantaneous displacement of the water level in a groundwater-monitoring well, and to observe the following recovery of the water level in the well as a function of time. A slug test can be performed by causing a sudden rise of the water level (referred to as a falling-head test), or a sudden fall of the water level (referred to as a rising-head test). In all the wells both falling-head tests and rising-head tests were performed. The sampling interval of the pressure measurements during the tests was 1 second for wells SSM000027 and SSM000035; 2 seconds for wells SSM000028–31, SSM000037, SSM000039 and SSM000041–42; 30 seconds for wells SSM000032–34 and SSM000040.

Falling-head test

The Diver® is lowered into the well. The Diver® causes a small displacement of the groundwater level, so the test begins after the water level has recovered. The light and sound indicator is used to check that the water level is fully recovered. The slug is then rapidly lowered into the well causing a sudden rise of the water level. As the water level recovers, the Diver® measures the pressure every second. When the water level is fully recovered the rising-head test commences. For wells with a very quick recovery (less than 5 minutes), another two tests are performed.

Rising-head test

The rising-head test follows the same principle as the falling-head test but in this case the slug is rapidly withdrawn from the well causing a sudden drop of the water level. As the water level recovers, the Diver® measures the pressure every second until the water level is fully recovered. For wells with a very quick recovery (less than 5 minutes), another two tests are performed.

Table 6-2 shows the hydraulic conductivity and transmissivity results from the slug tests.

5.2.1 Test procedure

The test procedure is briefly described below:

1. Cleaning of equipment that is lowered into the well.
2. Measurement of the depth from the top of the standpipe to the bottom of the well.
3. Determination of the slug and wire length. The objective is to cause as much initial displacement of the water level as possible. In the majority of the performed tests, a shallow undisturbed water level meant that the slug length had to be restricted to 0.50 m or 1.00 m, in order to prevent water from rising over the top of the rising pipe in the falling-head tests.
4. Logging the pressure in air, and thereafter the undisturbed water level in the well, with the Diver®.
5. Performance of falling-head test: Rapid lowering of the slug into the well (fixed with a wire stop). Sampling frequency of the Diver®: 1 measurement per second. Measurement of the recovery of the water level in the well with a water-level meter.
6. Performance of rising-head test: Withdrawal of the slug from the well when the water level has recovered after the falling-head test. Sampling frequency of the Diver®: 1 measurement per second.
7. Termination of slug tests approximately 1 h after start of the rising-head test.

5.3 Data handling

Raw data from the Diver® (internal *.mon format) was saved on a portable PC, using the computer program EnviroMon Version 1.45. After each test, the saved *.mon files were exported from EnviroMon to *.csv (comma-separated format).

Prior to the data evaluation for the generation of primary data files, all files in *.csv format were imported to MS Excel and saved in *.xls format. The data was processed in MS Excel, in order to produce data files for the estimation of transmissivity and hydraulic conductivity (see Sections 5.4 and 6). The data processing in MS Excel involved (1) correction of the pressure data for the barometric pressure (obtained by keeping the Diver® in the open air prior to each slug test), and (2) identification of the exact starting time of the test for the analysis (removal of the initial oscillation effects, which usually lasted on the order of 1–10 seconds after lowering the slug into the well).

A list of all the generated raw and primary data files is given in Appendix 1. The raw data files (*.mon) were imported in digital format to the Activity Leader, as were the results of the evaluation (HY670 – PLU Slug test_lax1.xls) for quality control and storage in the SICADA database.

5.4 Analyses and interpretation

The following section gives an overview of the methods used for analysis and interpretation of the slug test data.

The computer program Aquifer Test Version 3.5 was used for all the slug test analyses; see /7/. The program allows for both automatic and manual fitting of a straight-line plot to the measured data. In the evaluation the aquifer thickness refers to the smaller of the two values: screen length and the distance between groundwater level and bedrock in the unconfined case, and screen length and the distance between bottom of the clay layer and bedrock in the confined case.

5.4.1 The Hvorslev and the Bouwer & Rice methods

The Hvorslev method and the Bouwer & Rice method are both designed to estimate the hydraulic conductivity of an aquifer. The methods assume a fully or partially penetrating well in a confined or unconfined aquifer. A straight-line plot of the logarithm of the ratio h/h_0 versus time is automatically fitted to the measured data. If the semi-logarithmic plot of the measured data gives a concave-upward curve, automatic fitting is inappropriate, and manual curve fitting is recommended. The manual curve fitting method has been used for all analyses in this report. The theory of the Hvorslev method and the Bouwer & Rice method and practical recommendations for their applications are given in /8/.

The analyses in this report have been made with the Hvorslev method for confined conditions and the Bouwer & Rice method for unconfined conditions.

5.4.2 The Cooper-Bredehoeft-Papadopulos method

The Cooper-Bredehoeft-Papadopulos method is designed to estimate the hydraulic conductivity of an aquifer. The method is usually used for wells with large diameters and when confined conditions prevail /7/ and /8/. The method gives a semi-logarithmic plot of the measured data. The program automatically draws a number of curves with different α-values. The data is then manually fitted to the α-curve which best corresponds to the measured data.

The Cooper-Bredehoeft-Papadopulos method was used for estimating the hydraulic conductivity in seven wells.

6 Results

6.1 Nomenclature and symbols

The nomenclature and symbols used for the results presented in the following sections are as follows:

h_0 (m): Water pressure head at measuring point prior to the slug test.
dh_0* (m): Expected initial displacement.
dh_0_p (m): Initial displacement for falling-head test.
dh_0*/dh_0_p: Ratio between expected and actual displacement.
hp (m): Water pressure head at the measuring point at the end of a falling-head test.

6.2 Slug test results

The results of the performed slug tests are summarized in Table 6-1. below.

Table 6-1. Summary of the results of the slug tests.

Well ID	h_0 (m)	dh_0* (m)	dh_0_p (m)	dh_0*/dh_0_p	hp (m)
SSM000027	3.13	0.65	0.85	0.76	3.13
SSM000028	–	0.65	–	–	–
SSM000029	2.82	0.65	0.76	0.86	2.82
SSM000030	2.98	0.65	0.27	2.41	2.98
SSM000031	3.41	0.65	0.83	0.78	3.41
SSM000032	–	0.32	–	–	–
SSM000033	1.70	0.76	0.76	1.00	1.70
SSM000034	2.95	0.32	0.25	1.28	2.98
SSM000035	3.10	0.65	0.60	1.08	3.09
SSM000037	3.08	0.65	1.10	0.59	3.08
SSM000039	2.02	0.33	0.13	2.54	2.02
SSM000040	2.88	0.65	0.30	2.17	2.90
SSM000041	2.64	0.65	0.84	0.77	2.65
SSM000042	3.23	0.66	0.81	0.81	3.24

For some wells the initial displacement is greater than the expected displacement. The reason for this is unclear, but the initial displacement has been ignored in the analyses. The first seconds after the slug has been lowered or withdrawn from the well the water level fluctuates and therefore these first seconds are not used in the analyses.

6.3 Evaluation results

Table 6-2 (below) presents the results of the slug test analyses according to the Hvorslev, the Bouwer & Rice and the Cooper-Bredehoeft-Papadopulos methods. The results show the hydraulic conductivity (K), aquifer thickness (b^1) and transmissivity (T) for each monitoring well.

Table 6-2. Results evaluated with the Hvorslev, the Bouwer & Rice and the Cooper-Bredehoeft-Papadopulos methods.

Groundwater monitoring well	Hydraulic conductivity K (m/s)	Aquifer thickness B[1] (m)	Transmissivity T (m^2/s)	Method of analysis
SSM000027	3.6E–05	2	7.1E–05	Bouwer & Rice
SSM000027	1.2E–04	2	2.5E–04	Cooper-Bredehoeft-Papadopulos
SSM000028	–	1	–	–
SSM000029	2.1E–05	2	4.1E–05	Hvorslev
SSM000029	3.2E–05	2	6.4E–05	Cooper-Bredehoeft-Papadopulos
SSM000030	2.7E–05	0.8	2.2E–05	Hvorslev
SSM000031	1.2E–04	1	1.2E–04	Bouwer & Rice
SSM000031	6.3E–04	1	6.3E–04	Cooper-Bredehoeft-Papadopulos
SSM000032	–	1	–	–
SSM000033	7.0E–06	0.8	5.6E–06	Bouwer & Rice
SSM000033	2.1E–05	0.8	1.7E–05	Cooper-Bredehoeft-Papadopulos
SSM000034	5.8E–06	1	5.8E–06	Hvorslev
SSM000034	1.6E–05	1	1.6E–05	Cooper-Bredehoeft-Papadopulos
SSM000035	2.6E–06	1	2.6E–06	Bouwer & Rice
SSM000037	2.0E–05	1	2.0E–05	Bouwer & Rice
SSM000039	6.1E–05	1.3	7.9E–05	Bouwer & Rice
SSM000040	9.9E–07	1	9.9E–07	Bouwer & Rice
SSM000041	6.4E–06	2	1.3E–05	Bouwer & Rice
SSM000041	1.4E–05	2	2.7E–05	Cooper-Bredehoeft-Papadopulos
SSM000042	3.8E–06	2	7.6E–06	Bouwer & Rice
SSM000042	4.6E–06	2	9.2E–06	Cooper-Bredehoeft-Papadopulos

[1]The B-value is the smaller of the two values: aquifer thickness and screen length.

7 Summary and discussions

The groundwater monitoring wells were evaluated according to the Hvorslev, the Bouwer & Rice and the Cooper-Bredehoeft-Papadopulos methods. The computer program Aquifer Test Version 3.5 was used for the analyses.

Results of the hydraulic conductivity and transmissivity were not possible to evaluate in well SSM000028 and SSM000032. After the slug was lowered into the well the water level did not recover. One possible reason is that the screen was located in the layer of gyttja.

Sources of unreliability are: difficulty in predicting the thickness of the aquifer, difficulty in determining whether confined or unconfined conditions prevailed, the heterogeneity of the soil etc.

The values of the transmissivity obtained from the analysis according to the Hvorslev, the Bouwer & Rice and the Cooper-Bredehoeft-Papadopulos methods varied between 9.9×10^{-7} m^2/s and 6.3×10^{-4} m^2/s.

The values of the hydraulic conductivity obtained from the analysis according to the Hvorslev, the Bouwer & Rice and the Cooper-Bredehoeft-Papadopulos methods varied between 9.9×10^{-7} m/s and 6.3×10^{-4} m/s.

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Appendix 1

List of generated raw data files and primary data files

Table A1-1. List of generated raw data files and primary data files.

Obs well	Raw data files: *.mon	Data processing files: *.xls	Primary data files: *.mdb
SSM000027	SSM 000027	Sammanställning_slug_test	Laxemar_redovisning
SSM000028	SSM 000028	Sammanställning_slug_test	Laxemar_redovisning
SSM000029	SSM 000029	Sammanställning_slug_test	Laxemar_redovisning
SSM000030	SSM 000030	Sammanställning_slug_test	Laxemar_redovisning
SSM000031	SSM 000031	Sammanställning_slug_test	Laxemar_redovisning
SSM000032	SSM 000032	Sammanställning_slug_test	Laxemar_redovisning
SSM000033	SSM 000033	Sammanställning_slug_test	Laxemar_redovisning
SSM000034	SSM 000034	Sammanställning_slug_test	Laxemar_redovisning
SSM000035	SSM 000035	Sammanställning_slug_test	Laxemar_redovisning
SSM000037	SSM 000037	Sammanställning_slug_test	Laxemar_redovisning
SSM000039	SSM 000039	Sammanställning_slug_test	Laxemar_redovisning
SSM000040	SSM 000040	Sammanställning_slug_test	Laxemar_redovisning
SSM000041	SSM 000041	Sammanställning_slug_test	Laxemar_redovisning
SSM000042	SSM 000042	Sammanställning_slug_test	Laxemar_redovisning

Table A1-2. Evaluated parameters.

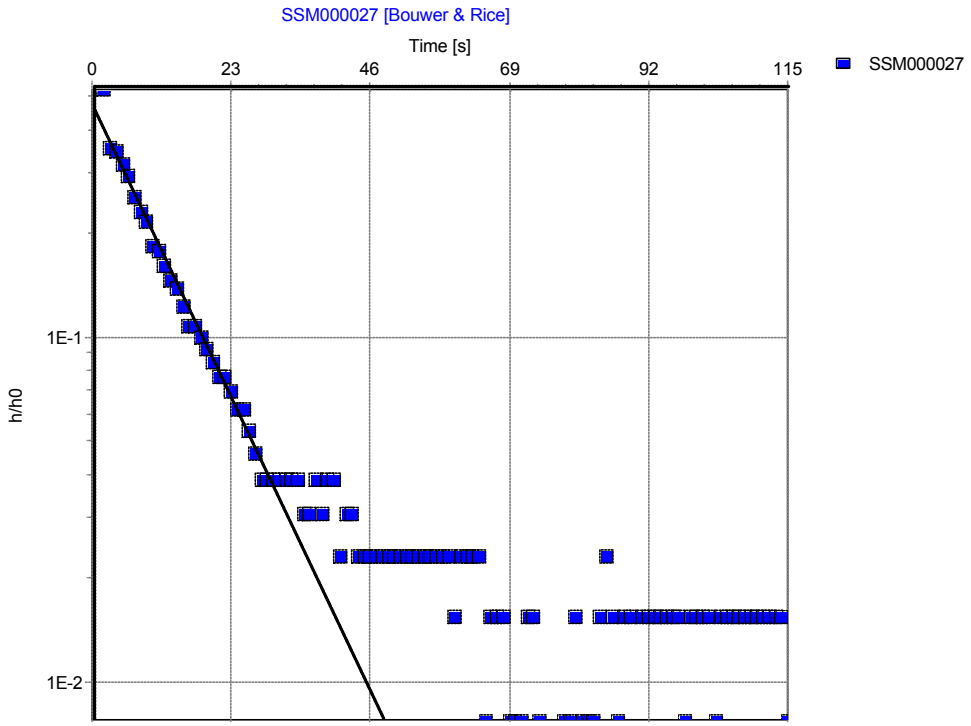
Borehole	Borehole secup[1] (m)	Borehole seclow[1] (m)	Test type (1-6)	Date for test, start YY-MM-DD	Start test hh:mm	tp (s)	h_0 (m)	dh_0* (m)	hp (m)	b (m)	T_s (m^2/s)	Ts2 (m^2/s)
SSM000027	3.0	5.0	4	2004-09-30	14:03	115	3.13	0.65	3.13	2.00	7.1E–05	2.5E–04
SSM000028	2.0	3.0	4	2004-09-27	15:55	4,860	–	0.65	–	1.00	–	–
SSM000029	5.0	7.0	4	2004-09-27	14:43	460	2.82	0.65	2.82	2.00	4.1E–05	6.4E–05
SSM000030	4.0	5.0	4	2004-09-28	14:28	280	2.98	0.65	2.98	0.80	2.2E–05	
SSM000031	3.0	4.0	4	2004-09-27	13:43	88	3.41	0.65	3.41	1.00	1.2E–04	6.3E–04
SSM000032	3.0	4.0	4	2004-09-30	09:00	7,680	–	0.32	–	1.00	–	–
SSM000033	1.0	2.0	4	2004-09-30	11:44	10,80	1.70	0.76	1.70	0.80	5.6E–06	1.7E–05
SSM000034	3.0	4.0	4	2004-09-29	15:51	570	2.95	0.32	2.98	1.00	5.8E–06	1.6E–05
SSM000035	3.0	4.0	4	2004-09-30	15:19	1,370	3.10	0.65	3.09	1.00	2.6E–06	–
SSM000037	3.0	4.0	4	2004-09-28	13:19	360	3.08	0.65	3.08	1.00	2.0E–05	–
SSM000039	3.0	5.0	4	2004-09-28	11:48	20	2.02	0.33	2.02	1.30	7.9E–05	–
SSM000040	2.0	3.0	4	2004-09-29	11:39	4,140	2.88	0.65	2.90	1.00	9.9E–07	–
SSM000041	2.0	4.0	4	2004-09-28	08:47	284	2.64	0.65	2.65	2.00	1.3E–05	2.7E–05
SSM000042	3.0	5.0	4	2004-09-28	10:03	880	3.23	0.66	3.24	2.00	7.6E–06	9.2E–06

[1] The length is measured from the top of the standpipe.
[2] Evaluated with Cooper Bredehoeft Papadopulos method.

Appendix 2

Slug test analysis report

WSP Environmental	Slug Test Analysis Report
Slagthuset	Project: Laxemar
211 20 Malmö	Number: 1005 0829
Tel. 040 - 699 62 00	Client: SKB



Slug Test: **SSM000027**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 3.57E-5 [m/s]

Test parameters:

Test Well:	SSM000027	Aquifer Thickness:	2 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	2 [m]		
Boring radius:	0.06 [m]		
r(eff):	0.037 [m]		

Comments: The analysis is performed with Bouwer and Rice method as the aquifer is considered to be unconfined. The aquifer thickness refers to the soil layers.

Evaluated by: ÅH

Evaluation Date: 11/10/2004

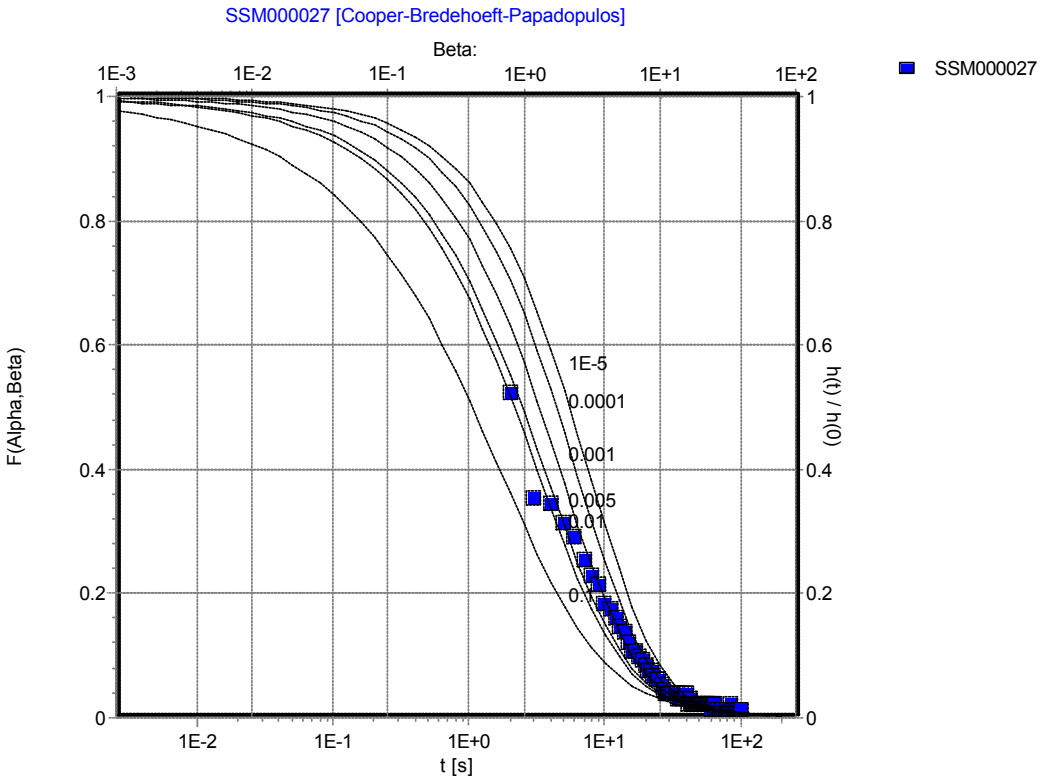
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000027**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	2.46E-4 [m²/s]	Conductivity:	1.23E-4 [m/s]
	Storativity:	5.00E-7		
Test parameters:	Test Well:	SSM000027	Aquifer Thickness:	2 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	2 [m]		
	Boring radius:	0.06 [m]		
	r(c):	2.5 [m]		

Comments:

Evaluated by: ÅH

Evaluation Date: 12/10/2004

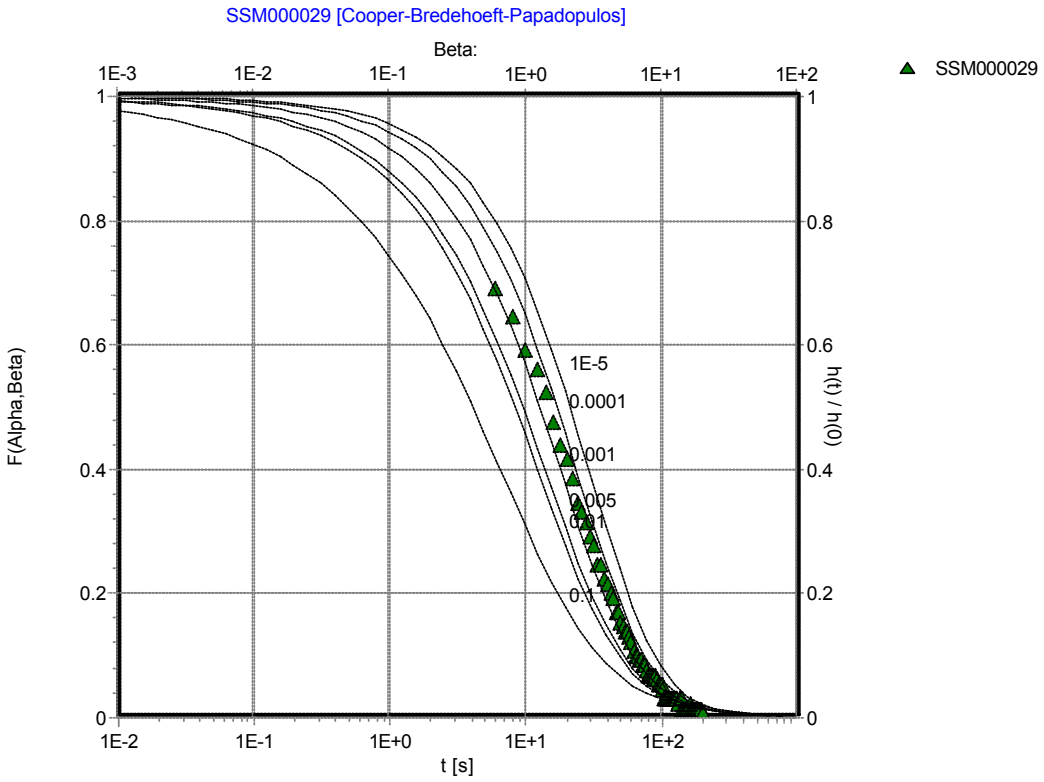
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000029**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	6.40E-5 [m²/s]	Conductivity:	3.20E-5 [m/s]
	Storativity:	5.00E-7		
Test parameters:	Test Well:	SSM000029	Aquifer Thickness:	2 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	2 [m]		
	Boring radius:	0.041 [m]		
	r(c):	2.5 [m]		

Comments:

Evaluated by: ÅH

Evaluation Date: 11/10/2004

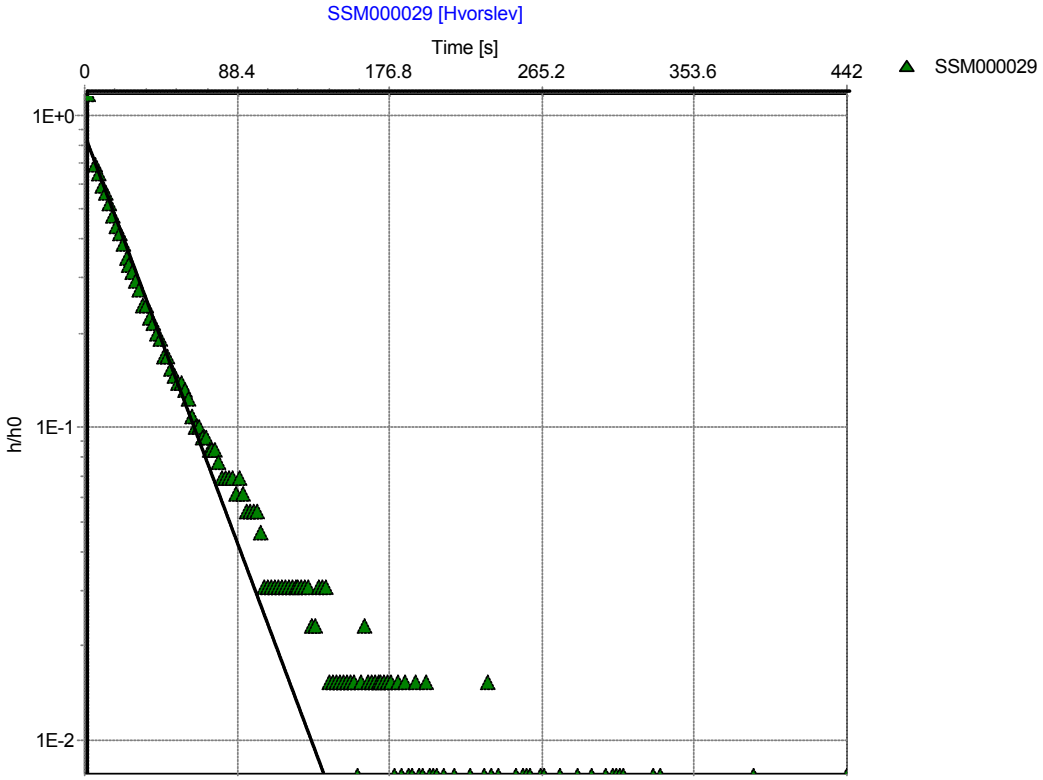
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000029**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 2.07E-5 [m/s]

Test parameters:

Test Well:	SSM000029	Aquifer Thickness:	2 [m]
Casing radius:	0.025 [m]		
Screen length:	2 [m]		
Boring radius:	0.041 [m]		

Comments: The analysis is performed with the Hvorslev method as the aquifer is considered to be confined. The aquifer thickness refers to the soil layers.

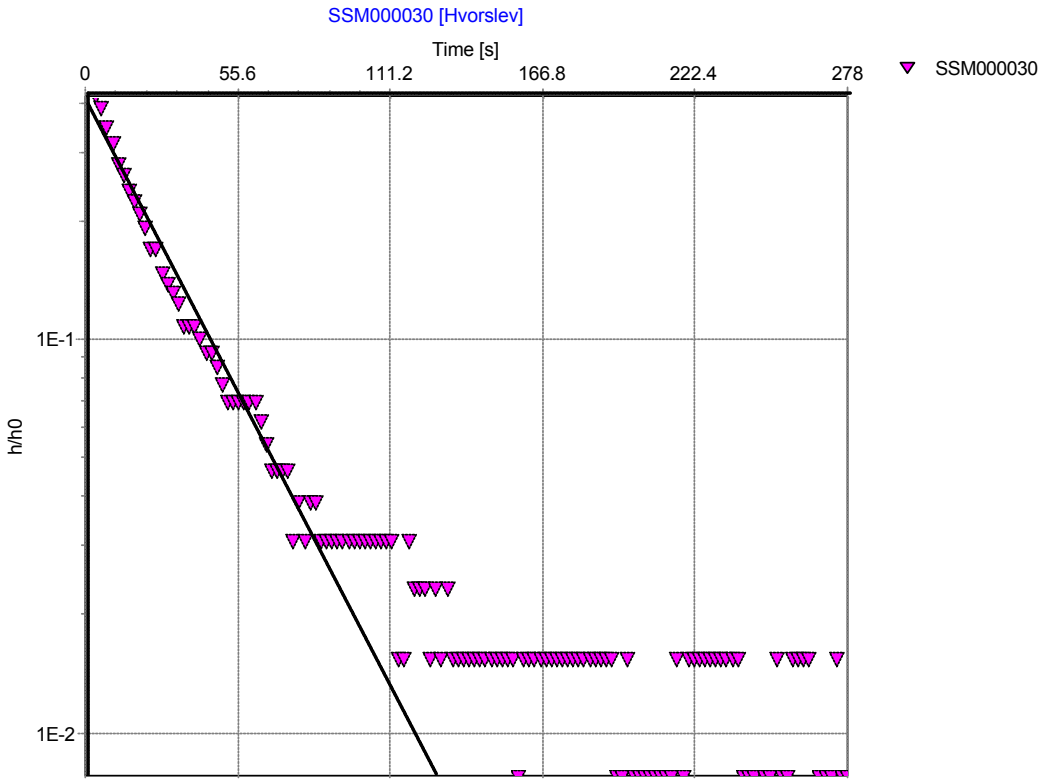
Evaluated by: ÅH

Evaluation Date: 11/10/2004

WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar
Number: 1005 0829
Client: SKB



Slug Test: **SSM000030**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 2.74E-5 [m/s]

Test parameters:

Test Well:	SSM000030	Aquifer Thickness:	0.8 [m]
Casing radius:	0.025 [m]		
Screen length:	1 [m]		
Boring radius:	0.06 [m]		

Comments: The analysis is performed with the Hvorslev method as the aquifer is considered to be confined. The aquifer thickness refers to the soil layers.

Evaluated by: ÅH

Evaluation Date: 11/10/2004

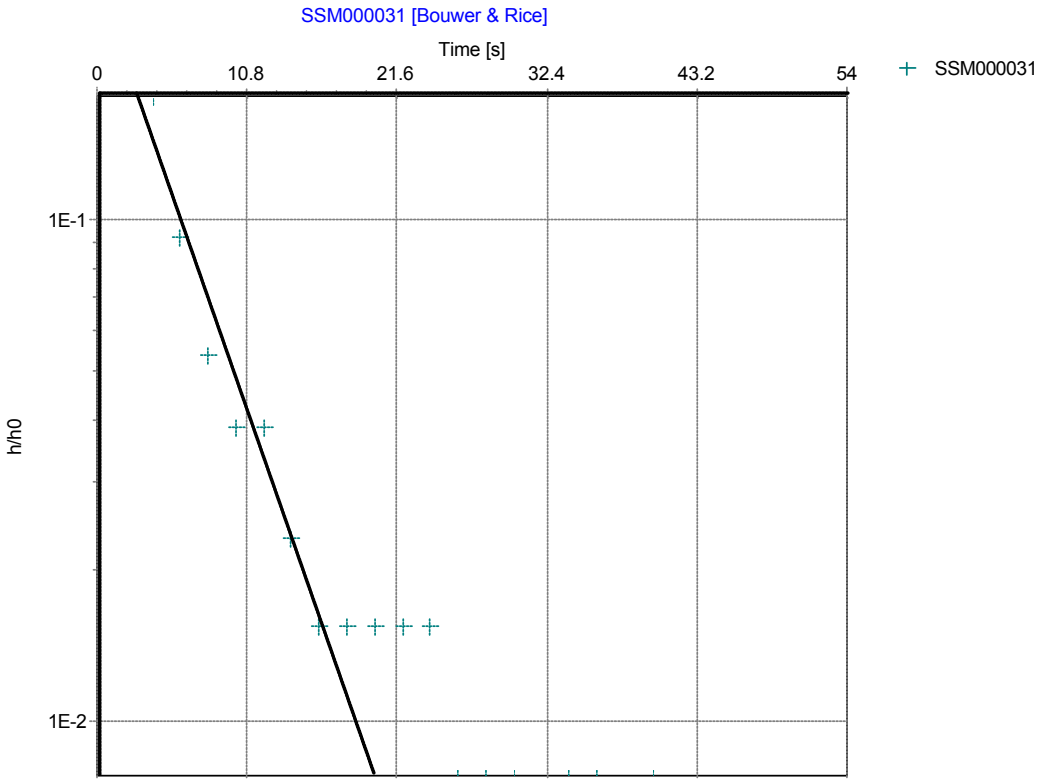
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000031**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 1.21E-4 [m/s]

Test parameters:

Test Well:	SSM000031	Aquifer Thickness:	1 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	1 [m]		
Boring radius:	0.06 [m]		
r(eff):	0.037 [m]		

Comments: The analysis is performed with the Bouwer and Rice method as the aquifer is considered to be unconfined. The aquifer thickness refers to the soil layers.

Evaluated by: ÅH

Evaluation Date: 11/10/2004

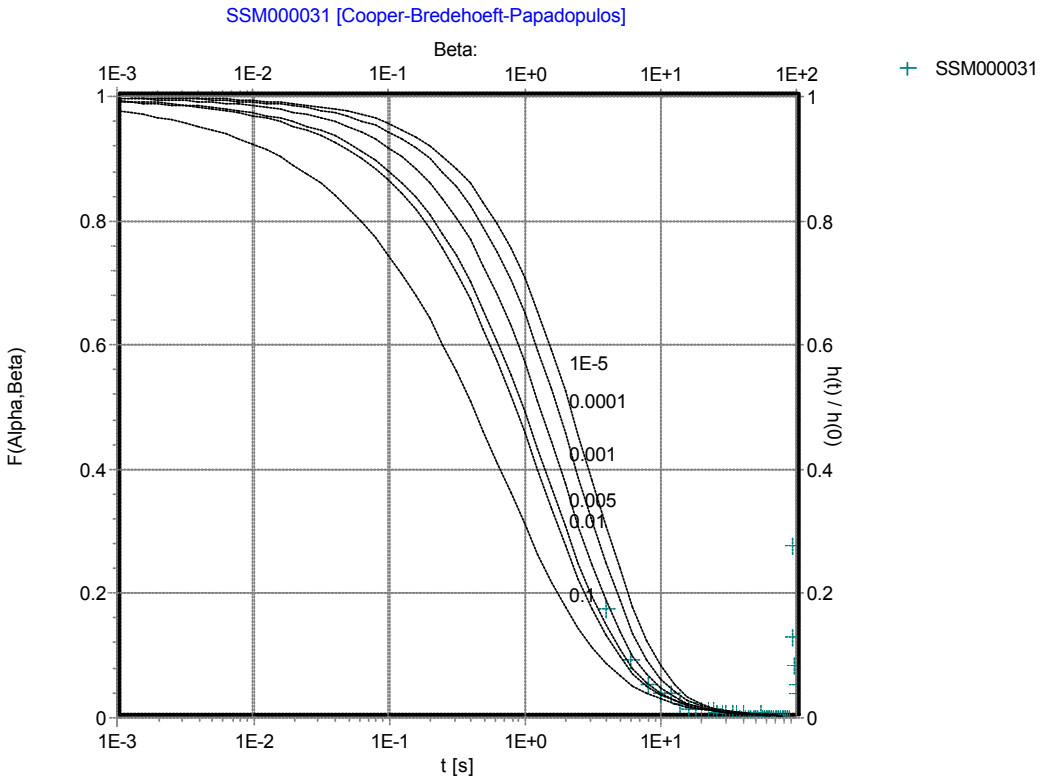
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000031**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	6.32E-4 [m²/s]	Conductivity:	6.32E-4 [m/s]
	Storativity:	5.00E-7		
Test parameters:	Test Well:	SSM000031	Aquifer Thickness:	1 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	1 [m]		
	Boring radius:	0.06 [m]		
	r(c):	2.5 [m]		

Comments:

Evaluated by: ÅH

Evaluation Date: 12/10/2004

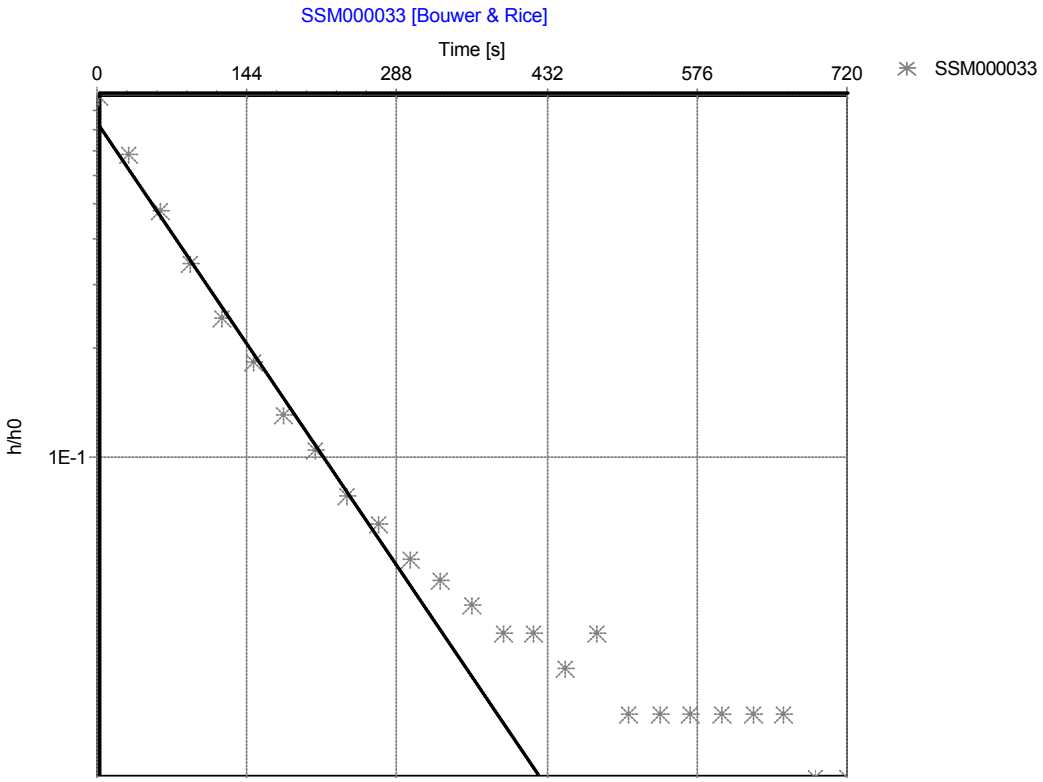
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000033**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 6.98E-6 [m/s]

Test parameters:

Test Well:	SSM000033	Aquifer Thickness:	0.8 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	1 [m]		
Boring radius:	0.041 [m]		
r(eff):	0.030 [m]		

Comments: The analysis is performed with the Bouwer and Rice method as the aquifer is considered to unconfined. The aquifer thickness refers to the soil layers.

Evaluated by: ÅH

Evaluation Date: 12/10/2004

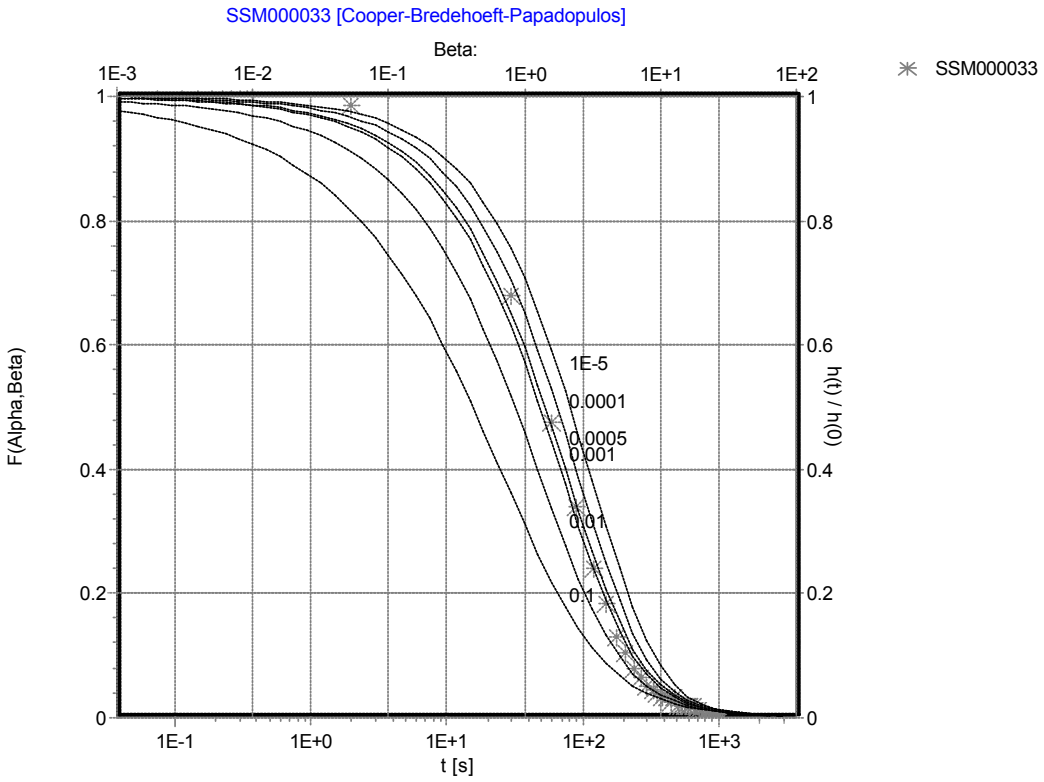
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000033**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	1.67E-5 [m²/s]	Conductivity:	2.09E-5 [m/s]
	Storativity:	5.00E-4		
Test parameters:	Test Well:	SSM000033	Aquifer Thickness:	0.8 [m]
	Casing radius:	0.025 [m]	Alpha:	0.0005
	Screen length:	1 [m]		
	Boring radius:	0.041 [m]		
	r(c):	0.025 [m]		

Comments:

Evaluated by: ÅH

Evaluation Date: 12/10/2004

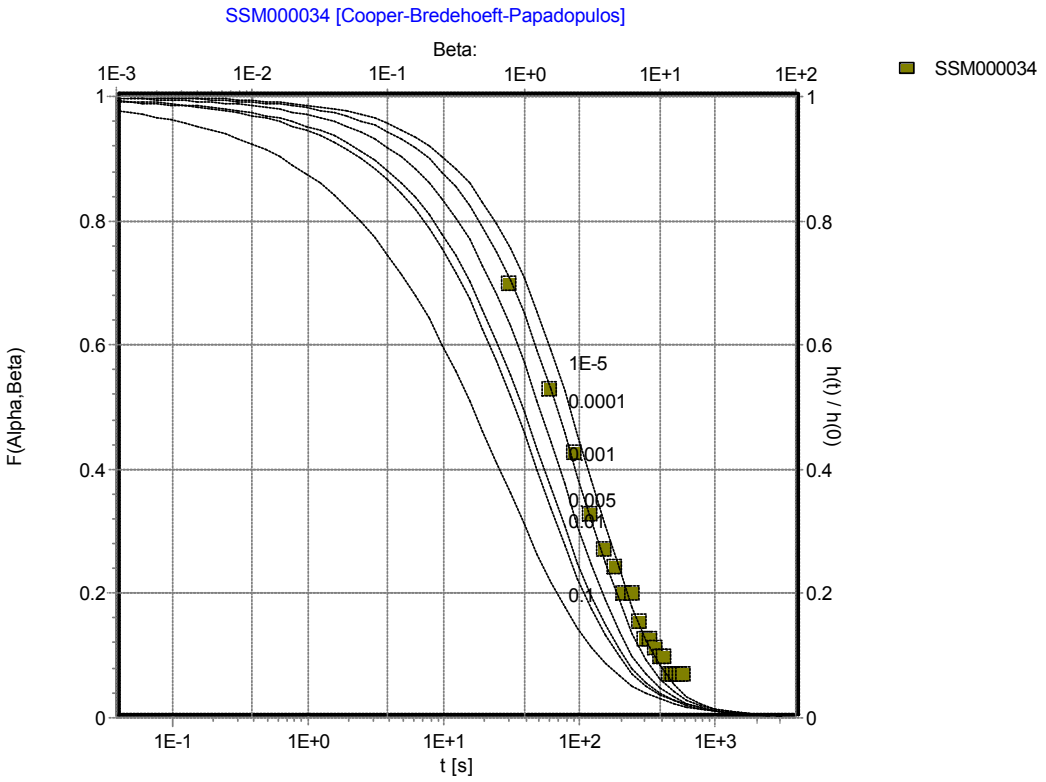
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000034**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	1.61E-5 [m²/s]	Conductivity:	1.61E-5 [m/s]
	Storativity:	5.00E-7		
Test parameters:	Test Well:	SSM000034	Aquifer Thickness:	1 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	1 [m]		
	Boring radius:	0.041 [m]		
	r(c):	2.5 [m]		

Comments:

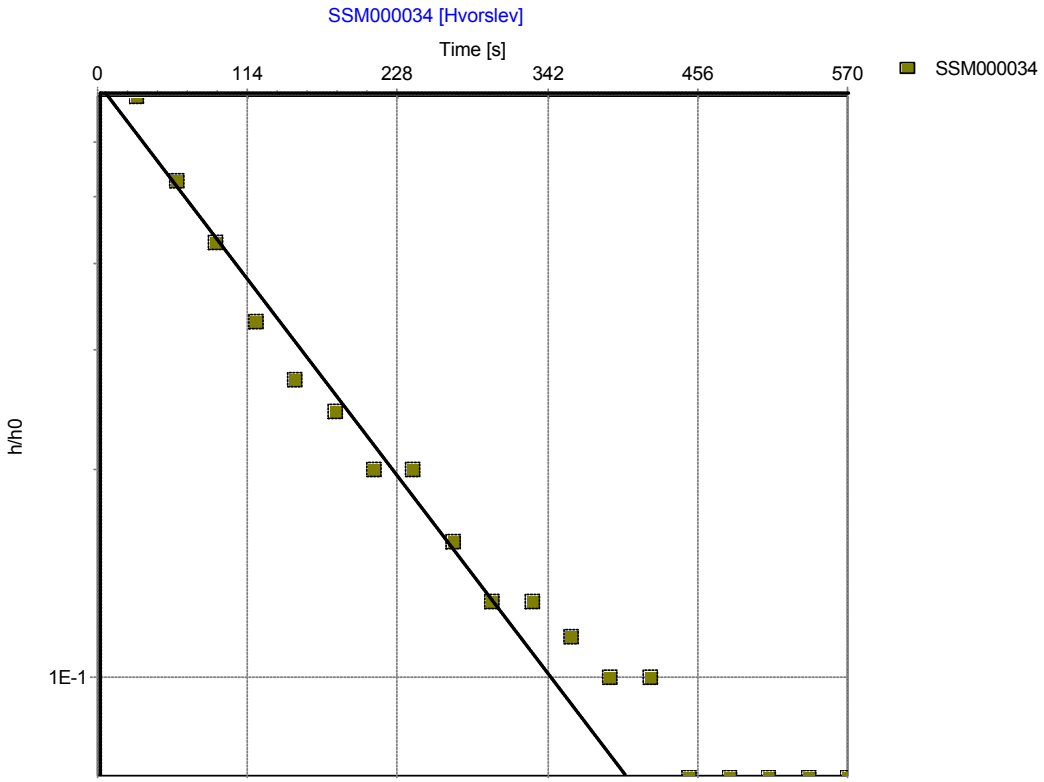
Evaluated by: ÅH

Evaluation Date: 12/10/2004

WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar
Number: 1005 0829
Client: SKB



Slug Test: **SSM000034**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 5.79E-6 [m/s]

Test parameters:

Test Well:	SSM000034	Aquifer Thickness:	1 [m]
Casing radius:	0.025 [m]		
Screen length:	1 [m]		
Boring radius:	0.041 [m]		

Comments: The analysis is performed with the Hvorslev method as the aquifer is considered to be confined. The aquifer thickness refers to the soil layers.

Evaluated by: ÅH

Evaluation Date: 12/10/2004

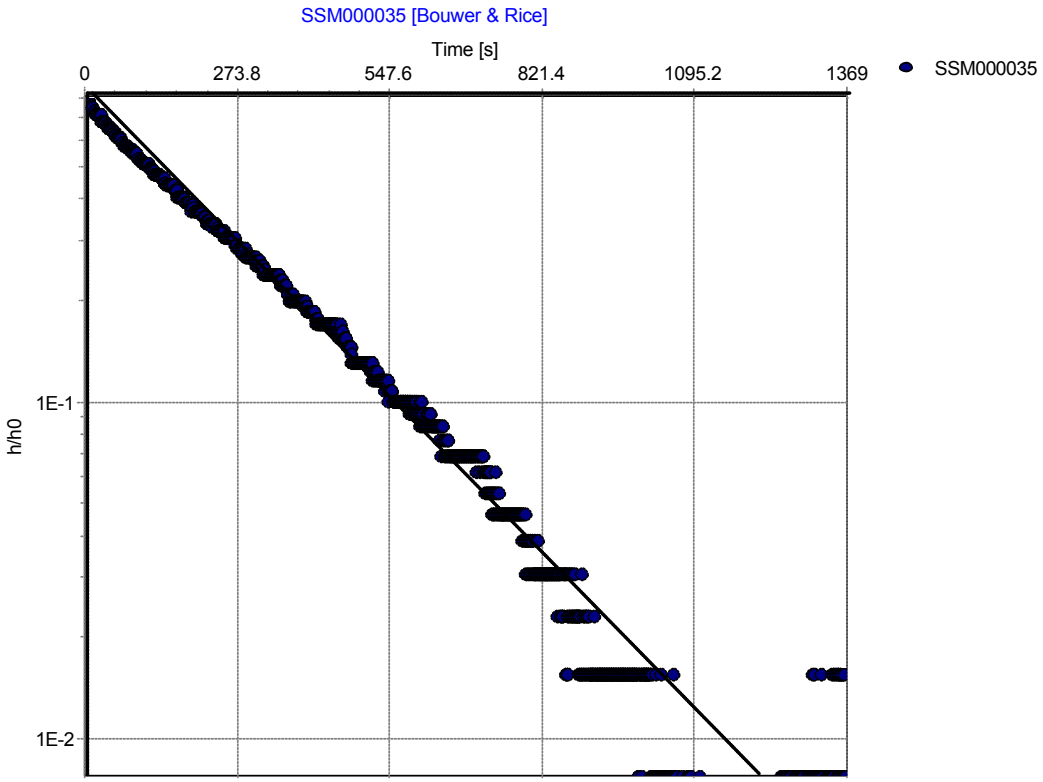
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000035**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 2.57E-6 [m/s]

Test parameters:

Test Well:	SSM000035	Aquifer Thickness:	1 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	1 [m]		
Boring radius:	0.06 [m]		
r(eff):	0.037 [m]		

Comments: The analysis is performed with the Bouwer and Rice method as the aquifer is considered to be unconfined. The aquifer thickness refers to the soil layers.

Evaluated by: ÅH

Evaluation Date: 12/10/2004

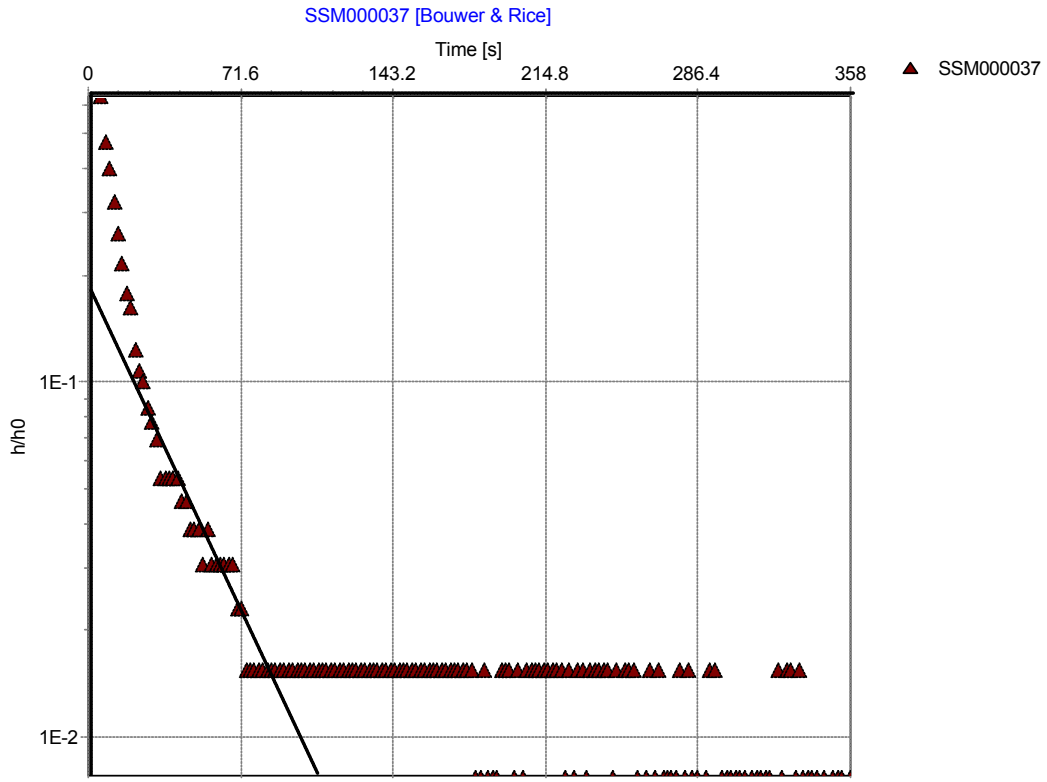
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000037**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 1.96E-5 [m/s]

Test parameters:				
	Test Well:	SSM000037	Aquifer Thickness:	1 [m]
	Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
	Screen length:	1 [m]		
	Boring radius:	0.06 [m]		
	r(eff):	0.037 [m]		

Comments: The analysis is performed with the bouwer and Rice methid as the aquifer is considered to be unconfined. The aquifer thickness refers to the soil layers.

Evaluated by: ÅH

Evaluation Date: 12/10/2004

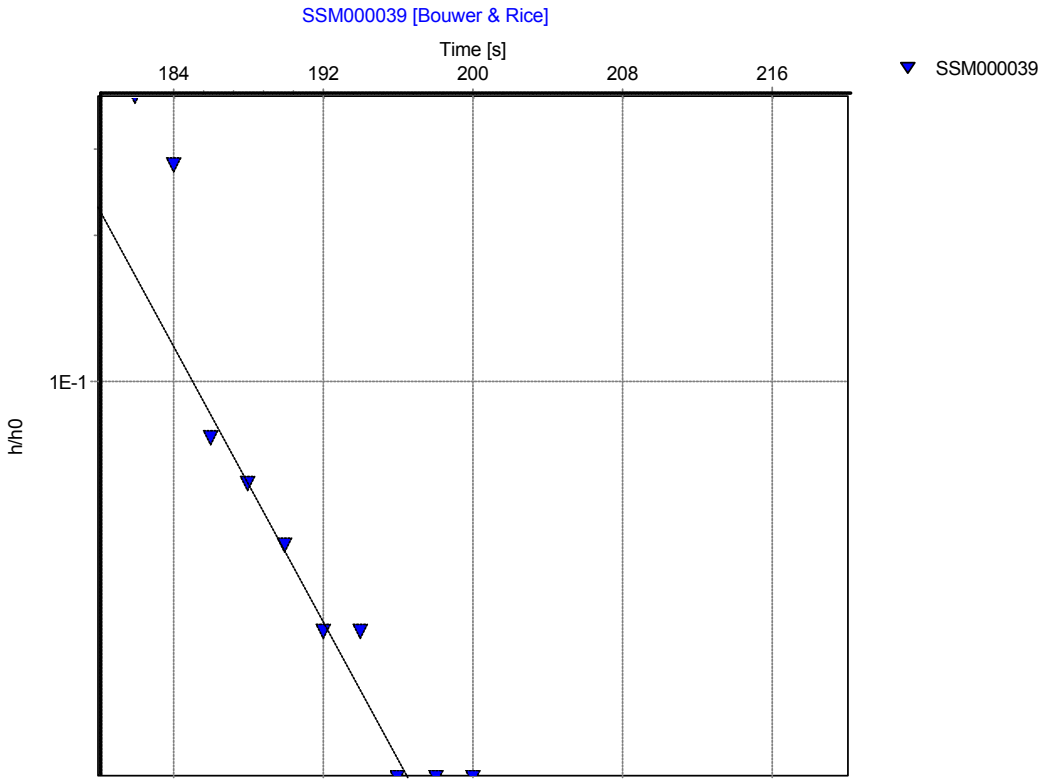
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000039**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 6.11E-5 [m/s]

Test parameters:

Test Well:	SSM000039	Aquifer Thickness:	1.3 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	2 [m]		
Boring radius:	0.06 [m]		
r(eff):	0.037 [m]		

Comments: The analysis is performed with the Bouwer and Rice method as the aquifer is considered to be unconfined. The aquifer thickness refers to the soil layers.

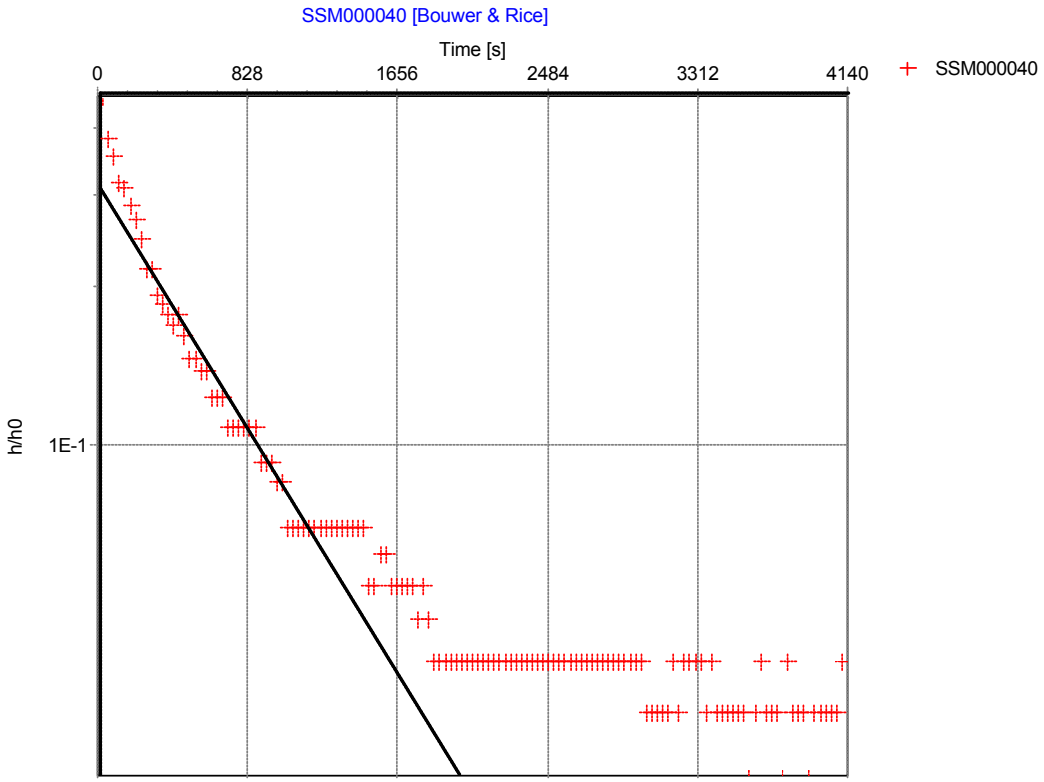
Evaluated by: ÅH

Evaluation Date: 12/10/2004

WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar
Number: 1005 0829
Client: SKB



Slug Test: **SSM000040**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 9.86E-7 [m/s]

Test parameters:				
	Test Well:	SSM000040	Aquifer Thickness:	1 [m]
	Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
	Screen length:	1 [m]		
	Boring radius:	0.041 [m]		
	r(eff):	0.030 [m]		

Comments: The analysis is performed with the Bouwer and Rice method as the aquifer is considered to be uncinfined. The aquifer thickness refers to the soil layers.

Evaluated by: ÅH

Evaluation Date: 12/10/2004

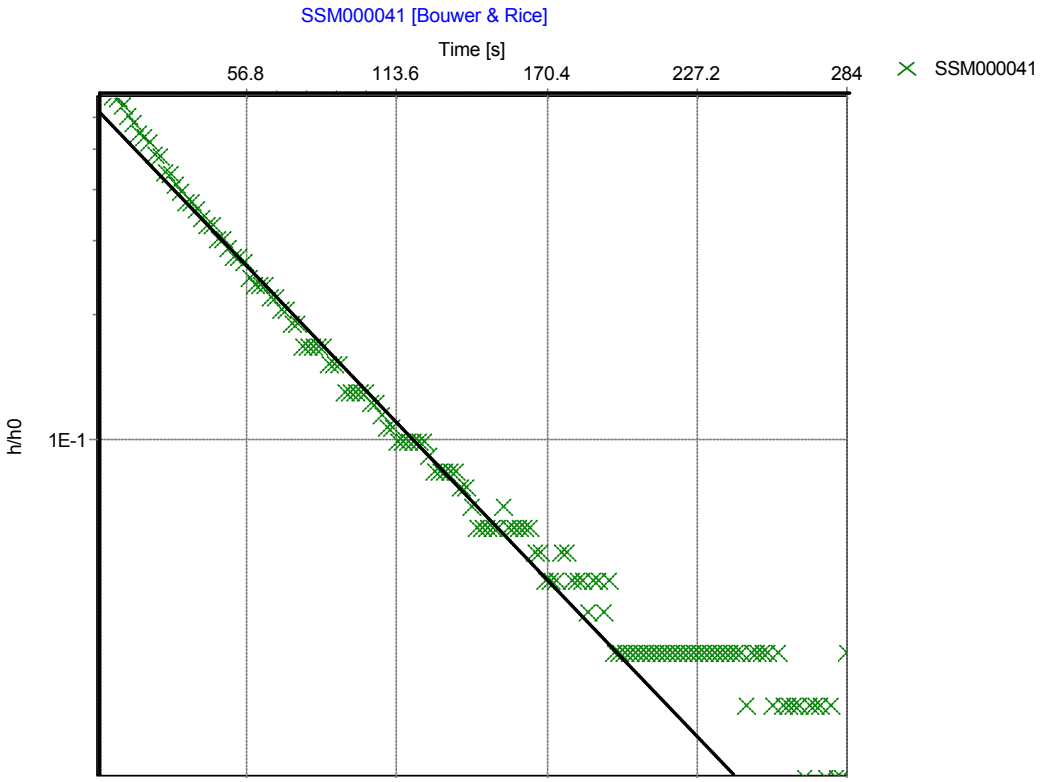
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000041**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 6.43E-6 [m/s]

Test parameters:				
	Test Well:	SSM000041	Aquifer Thickness:	2 [m]
	Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
	Screen length:	2 [m]		
	Boring radius:	0.06 [m]		
	r(eff):	0.037 [m]		

Comments: The analysis is performed with Bouwer and Rice method as the aquifer is considered to be unconfined. The aquifer thickness refers to the soil layers.

Evaluated by: ÅH

Evaluation Date: 12/10/2004

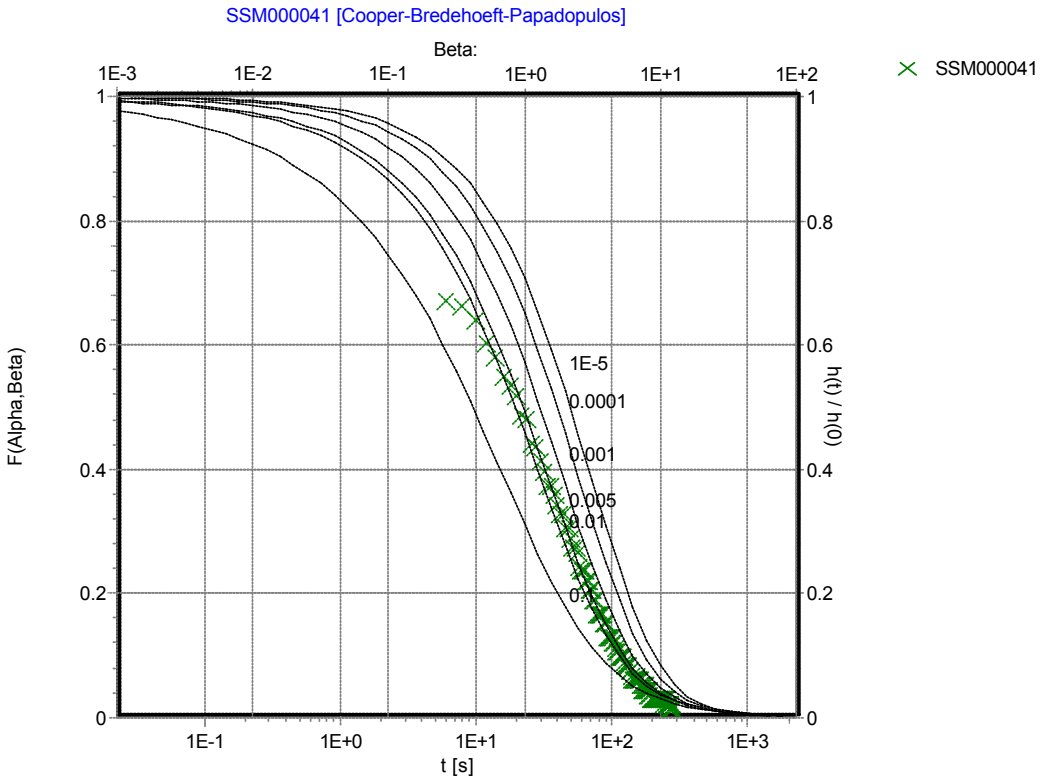
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000041**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	2.74E-5 [m²/s]	Conductivity:	1.37E-5 [m/s]
	Storativity:	5.00E-7		
Test parameters:	Test Well:	SSM000041	Aquifer Thickness:	2 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	2 [m]		
	Boring radius:	0.06 [m]		
	r(c):	2.5 [m]		

Comments:

Evaluated by: ÅH

Evaluation Date: 12/10/2004

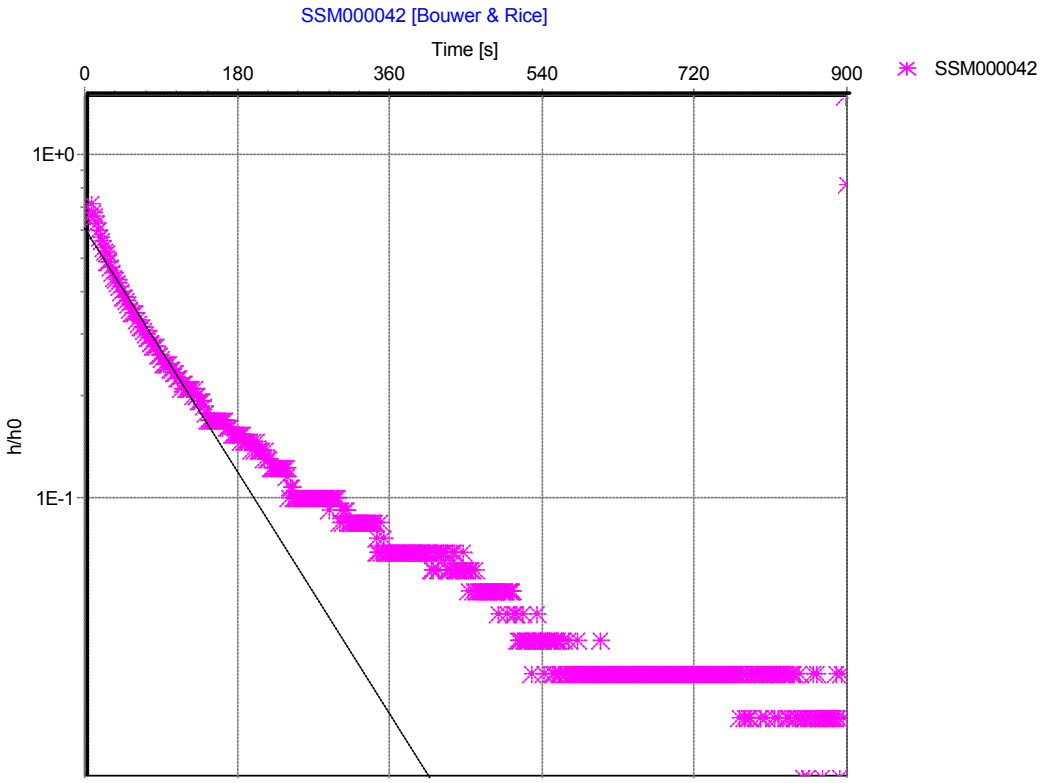
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000042**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 3.78E-6 [m/s]

Test parameters:

Test Well:	SSM000042	Aquifer Thickness:	2 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	2 [m]		
Boring radius:	0.06 [m]		
r(eff):	0.037 [m]		

Comments: The analysis is performed with Bouwer and Rice method as the aquifer is considered to be unconfined. The aquifer thickness refers to the soil layers.

Evaluated by: ÅH

Evaluation Date: 12/10/2004

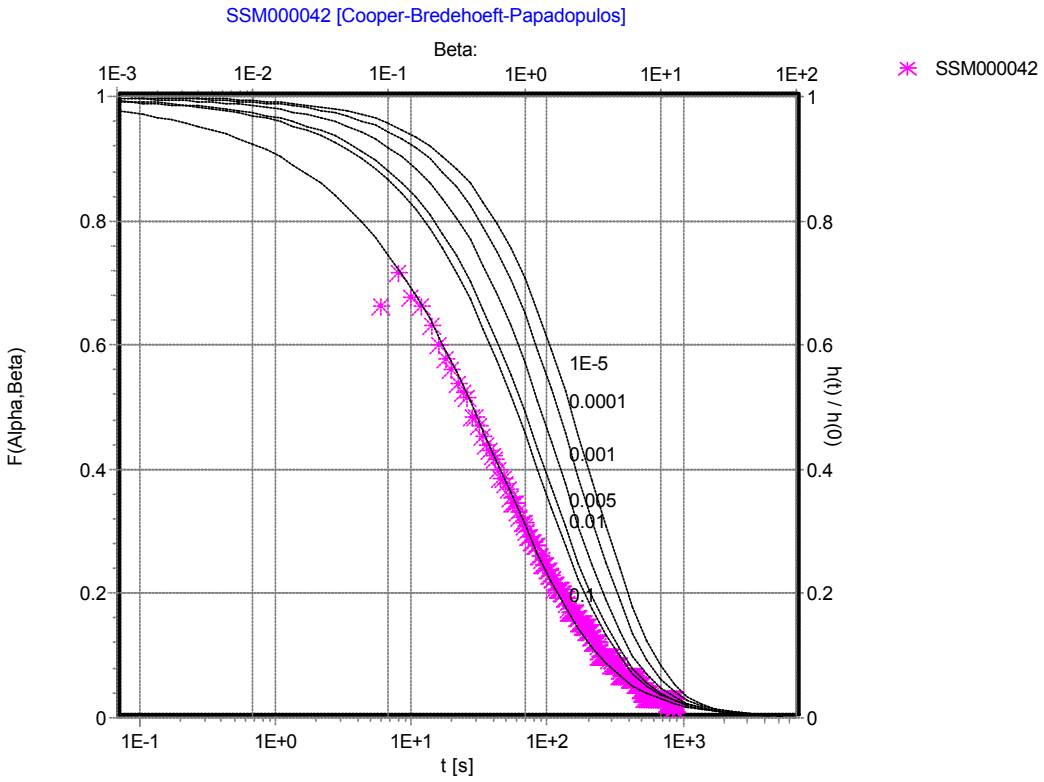
WSP Environmental
Slagthuset
211 20 Malmö
Tel. 040 - 699 62 00

Slug Test Analysis Report

Project: Laxemar

Number: 1005 0829

Client: SKB



Slug Test: **SSM000042**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	9.17E-6 [m²/s]	Conductivity:	4.58E-6 [m/s]
	Storativity:	5.00E-7		
Test parameters:	Test Well:	SSM000042	Aquifer Thickness:	2 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	2 [m]		
	Boring radius:	0.06 [m]		
	r(c):	2.5 [m]		

Comments:

Evaluated by: ÅH

Evaluation Date: 12/10/2004

Soil tubes

WSP

LAXEMAR BOREHOLE SSM000027

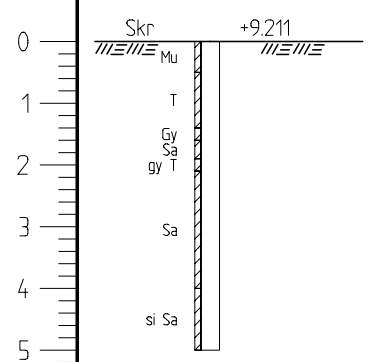
Company rep.
Lennart Adestam and Torbjörn Johansson

Client: Svensk Kärnbränslehantering AB

Northing :6370908.457
Easting :1544779.145

Coordinate system : RT90-RHB70

Top of stand pipe :0,2 m.a.g.l.
Total pipe length :5,10 m
Groundwater level :1,4 m.b.g.l.
Date of completion :2004-06-28



Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 3,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 1,40 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 3,70 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,5m Topsoil
0,5-1,4m peat
1,4-1,6m gyttja
1,6-1,9m sand
1,9-2,1m gyttja-bearing peat
2,1-4,0m sand
4,0-5,0m silty sand

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000028

Company rep.
Lennart Adestam and Torbjörn Johansson

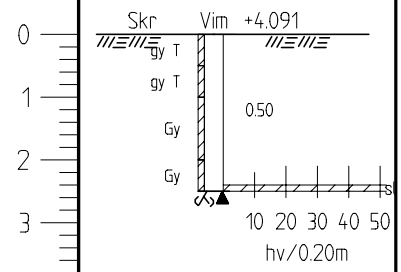
Client: Svensk Kärnbränslehantering AB

Northing :6369642.670
Easting :1546933.108

Coordinate system : RT90-RHB70

Top of stand pipe : 0,55 m.a.g.l.
Total pipe length : 3,10 m
Groundwater level : 0,1 m.b.g.l.
Date of completion : 2004-06-09

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information



Drilling method : Auger
Borehole diameter : 82 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 0,95 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 1,80 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-1,0m Gyttja-bearing Peat
1,0-2,5m Gyttja

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000029

Company rep.
Lennart Adestam and Torbjörn Johansson

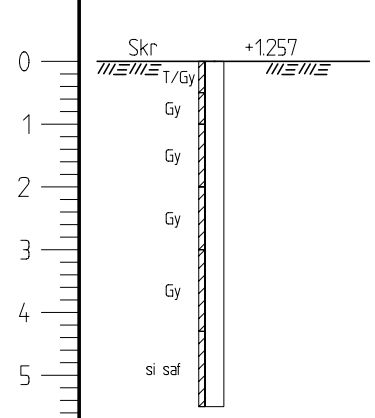
Client: Svensk Kärnbränslehantering AB

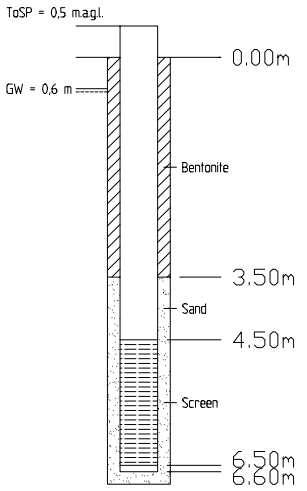
Northing :6368975.702
Easting :1548879.095

Coordinate system : RT90-RHB70

Top of stand pipe : 0,5 m.a.g.l.
Total pipe length : 7,10 m
Groundwater level : 0,5 m.b.g.l.
Date of completion : 2004-06-08

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information





Drilling method : Auger
Borehole diameter : 82 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 5,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 3,50 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 3,30 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,5m Peat and gyttja
0,5-4,3m gyttja
4,3-5,5m silty fine sand

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000030

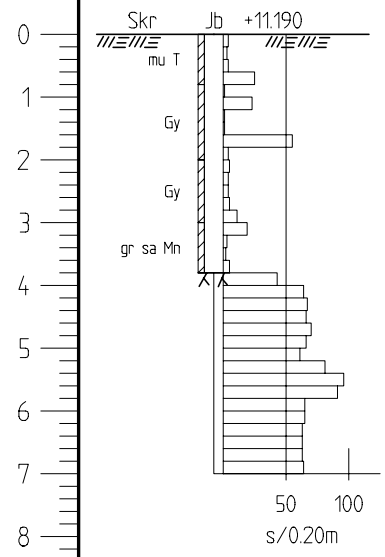
Company rep.
Lennart Adestam and Torbjörn Johansson

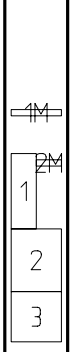
Client: Svensk Kärnbränslehantering AB

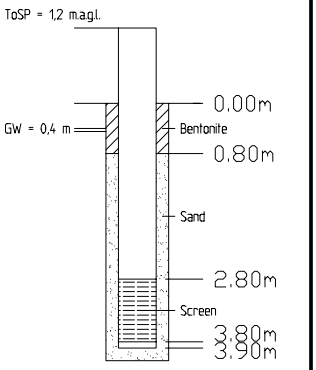
Northing : 6367907.748
Easting : 1546986.153

Coordinate system : RT90-RHB70

Top of stand pipe : 1,2 m.a.g.l.
Total pipe length : 5,10 m
Groundwater level : 0,4 m.b.g.l.
Date of completion : 2004-09-10







Borehole Construction Information

Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 4,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 0,80 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 2,30 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,8m Humus-bearing peat
0,8-3,0m gyttja
3,0-3,8m gravelly sandy till

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000031

Company rep.
Lennart Adestam and Torbjörn Johansson

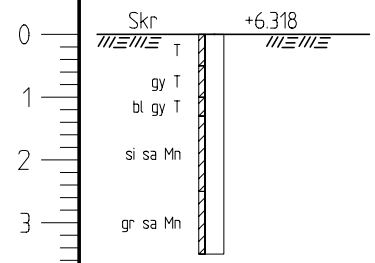
Client: Svensk Kärnbränslehantering AB

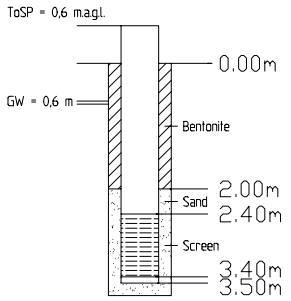
Northing :6368132.651
Easting :1548562.650

Coordinate system : RT90-RHB70

Top of stand pipe : 0,6 m.a.g.l.
Total pipe length : 4,10 m
Groundwater level : 0,6 m.b.g.l.
Date of completion : 2004-06-10

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information





Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 3,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 2,0 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 1,70 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,5m Peat
0,5-1,0m gyttja-bearing peat
1,0-1,3m boulder and gyttja-bearing peat
1,3-2,5m silty sandy till
2,5-3,5m gravelly sandy till

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000032

Company rep.
Lennart Adestam and Torbjörn Johansson

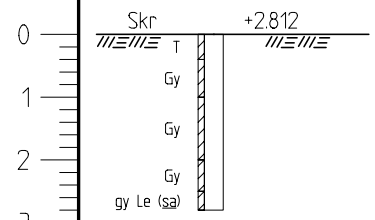
Client: Svensk Kärnbränslehantering AB

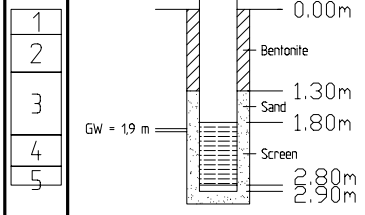
Northing : 6367970.561
Easting : 1549397.481

Coordinate system : RT90-RHB70

Top of stand pipe : 1,2 m.a.g.l.
Total pipe length : 4,10 m
Groundwater level : 1,9 m.b.g.l.
Date of completion : 2004-06-15

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information





Drilling method : Auger
Borehole diameter : 82 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 3,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 1,30 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 1,80 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,4m Peat
0,4-2,5m gyttja
2,5-2,8m gyttja-bearing clay with sand layer

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000033

Company rep.
Lennart Adestam and Torbjörn Johansson

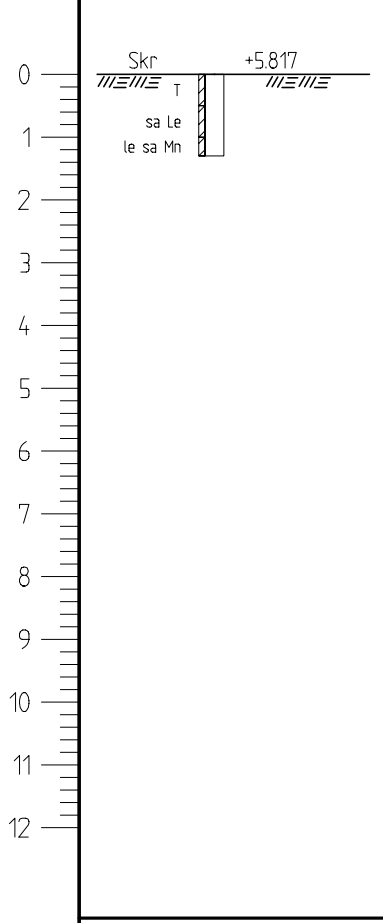
Client: Svensk Kärnbränslehantering AB

Northing :6368095.404
Easting :1549884.138

Coordinate system : RT90-RHB70

Top of stand pipe : 0,7 m.a.g.l.
Total pipe length : 2,10 m
Groundwater level : 0,20 m.b.g.l.
Date of completion : 2004-06-15

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information



Drilling method : Auger
Borehole diameter : 82 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 0,10 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 1,50 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,5m Peat
0,5-1,0m sandy clay
1,0-1,3m clayey sandy till

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000034

Company rep.
Lennart Adestam and Torbjörn Johansson

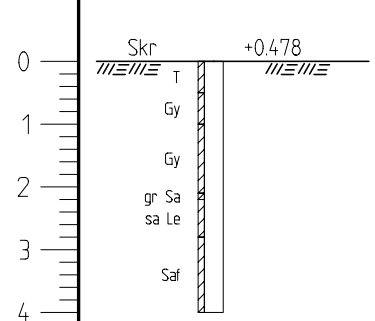
Client: Svensk Kärnbränslehantering AB

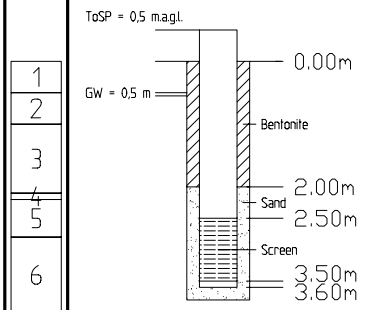
Northing :6368089.977
Easting :1550122.872

Coordinate system : RT90-RHB70

Top of stand pipe : 0,5 m.a.g.l.
Total pipe length : 4,10 m
Groundwater level : 0,5 m.b.g.l.
Date of completion : 2004-06-16

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information





Drilling method : Auger
Borehole diameter : 82 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 3,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 2,00 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 1.80 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,5m Peat
0,5-2,1m gyttja
2,1-2,2m gravelly sand
2,2-2,8m sandy clay
2,8-4,0m fine sand

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000035

Company rep.
Lennart Adestam and Torbjörn Johansson

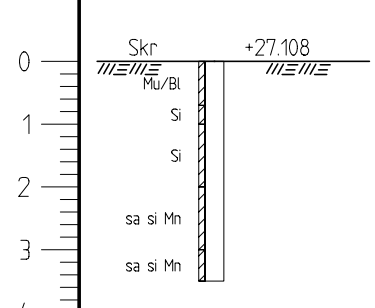
Client: Svensk Kärnbränslehantering AB

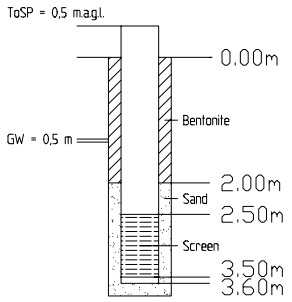
Northing :6365137.081
Easting :1540387.450

Coordinate system : RT90-RHB70

Top of stand pipe : 0,5 m.a.g.l.
Total pipe length : 4,10 m
Groundwater level : 1,3 m.b.g.l.
Date of completion : 2004-06-09

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information





Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 3,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 2,00 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 1,80 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,7m Topsoil and boulders
0,7-2,0m Silt
2,0-3,5m Sandy silty till

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000037

Company rep.
Lennart Adestam and Torbjörn Johansson

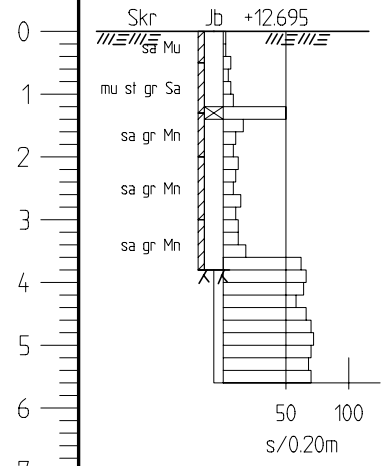
Client: Svensk Kärnbränslehantering AB

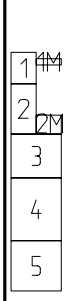
Northing :6367185.645
Easting :1547490.006

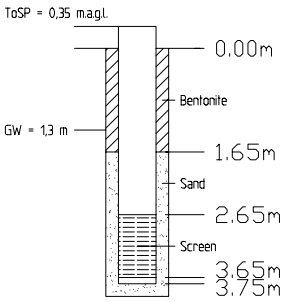
Coordinate system : RT90-RHB70

Top of stand pipe : 0,35 m.a.g.l.
Total pipe length : 4,10 m
Groundwater level : 1,3 m.b.g.l.
Date of completion : 2004-06-22

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information







Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 3,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 1,65 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 2,30 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,5m Sandy topsoil
0,5-1,3m humus- and cobble-bearing gravelly sand
1,3-3,8m sandy gravelly till
3,8m rock surface

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000039

Company rep.
Lennart Adestam and Torbjörn Johansson

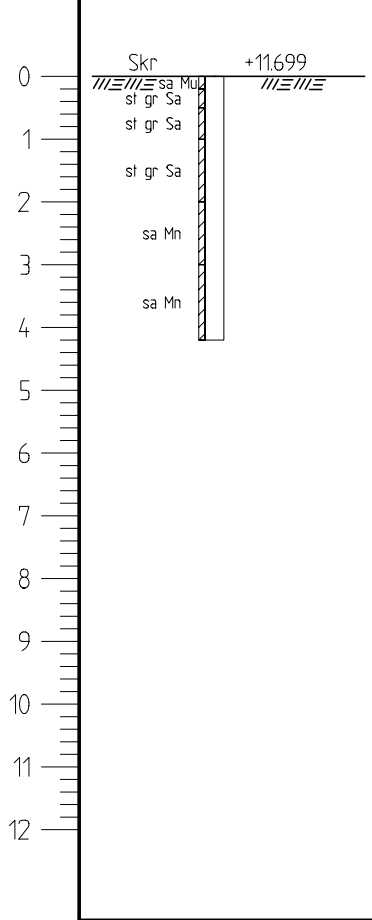
Client: Svensk Kärnbränslehantering AB

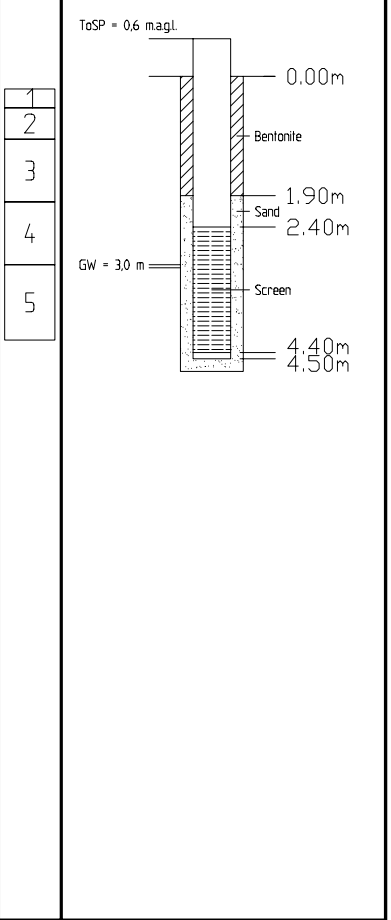
Northing :6366619.896
Easting :1549136.075

Coordinate system : RT90-RHB70

Top of stand pipe : 0,6 m.a.g.l.
Total pipe length : 5,10 m
Groundwater level : 3,0 m.b.g.l.
Date of completion : 2004-06-21

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information





Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 3,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 1,90 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 2,80 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,2m Sandy topsoil
0,2-2,0m cobble-bearing gravelly sand
2,0-4,2m sandy till

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000040

Company rep.
Lennart Adestam and Torbjörn Johansson

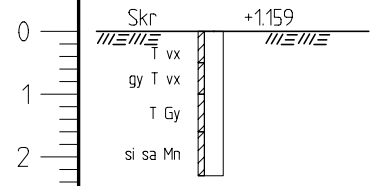
Client: Svensk Kärnbränslehantering AB

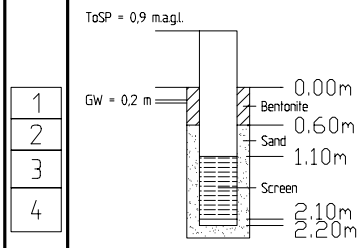
Northing : 6366207.045
Easting : 1550351.240

Coordinate system : RT90-RHB70

Top of stand pipe : 0,9 m.a.g.l.
Total pipe length : 3,10 m
Groundwater level : 0,2 m.b.g.l.
Date of completion : 2004-06-14

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information





Drilling method : Auger
Borehole diameter : 82 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 0,60 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 1,80 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,5m Peat containing plant remains
0,5-1,0m gyttja-bearing peat containing plant remains
1,0-1,6m peat
1,6-2,3m silty sandy till

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000041

Company rep.
Lennart Adestam and Torbjörn Johansson

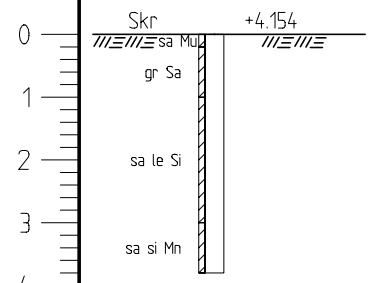
Client: Svensk Kärnbränslehantering AB

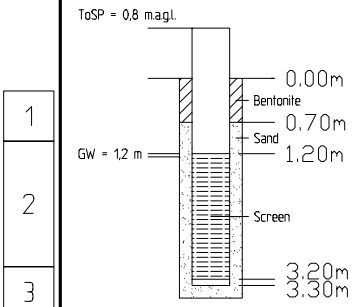
Northing :6365332.746
Easting :1548655.277

Coordinate system : RT90-RHB70

Top of stand pipe : 0,8 m.a.g.l.
Total pipe length : 4,10 m
Groundwater level : 1,2 m.b.g.l.
Date of completion : 2004-07-07

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information





Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 0,70 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 2,30 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,2m Sandy topsoil
0,2-1,0m gravelly sand
1,0-3,0m sandy clayey silt
3,0-3,8m sandy silty till

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000042

Company rep.
Lennart Adestam and Torbjörn Johansson

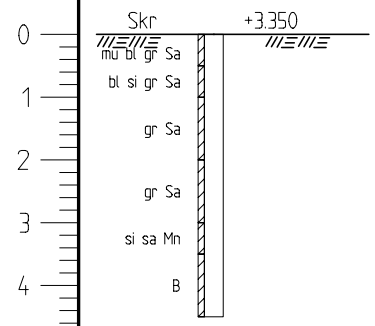
Client: Svensk Kärnbränslehantering AB

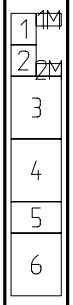
Northing : 6365540.811
Easting : 1549487.958

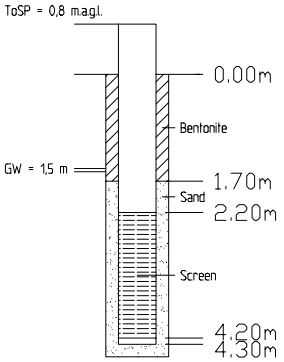
Coordinate system : RT90-RHB70

Top of stand pipe : 0,8 m.a.g.l.
Total pipe length : 5,10 m
Groundwater level : 1,5 m.b.g.l.
Date of completion : 2004-06-17

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information







Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 3,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 1,70 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 2,80 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG

0-0,5m	Humus- and boulder-bearing gravelly sand
0,5-1,0m	boulder-bearing silty gravelly sand
1,0-3,0m	gravelly sand
3,0-3,5m	silty sandy till
3,5-4,5m	rock or boulders

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000209

Company rep.
Lennart Adestam and Torbjörn Johansson

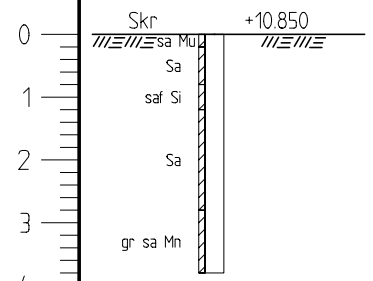
Client: Svensk Kärnbränslehantering AB

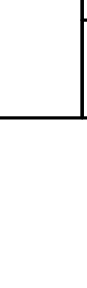
Northing :6367980.830
Easting :1548118.377

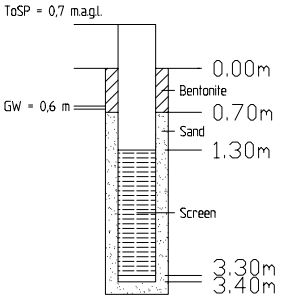
Coordinate system : RT90-RHB70

Top of stand pipe : 0,7 m.a.g.l.
Total pipe length : 4,10 m
Groundwater level : 0,6 m.b.g.l.
Date of completion : 2004-06-29

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information







Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 0,70 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 2,90 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,2m Sandy topsoil
0,2-0,8m sand
0,8-1,2m fine sandy silt
1,2-2,8m sand
2,8-3,8m gravelly sandy till

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000210

Company rep.
Lennart Adestam and Torbjörn Johansson

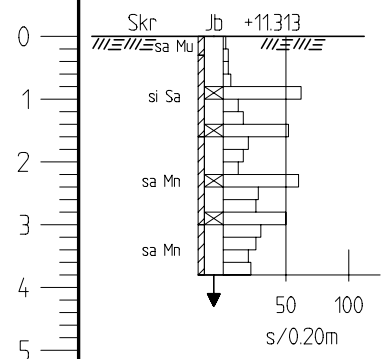
Client: Svensk Kärnbränslehantering AB

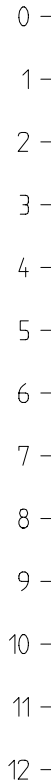
Northing :6367877.080
Easting :1548567.865

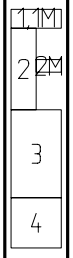
Coordinate system : RT90-RHB70

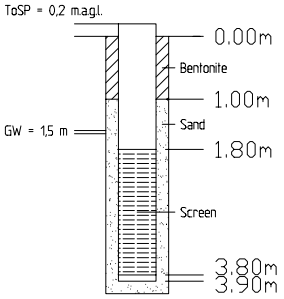
Top of stand pipe : 0,2 m.a.g.l.
Total pipe length : 4,10 m
Groundwater level : 1,5 m.b.g.l.
Date of completion : 2004-06-29

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information









Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 1,00 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 3,10 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,3m Sandy topsoil
0,3-1,6m silty sand
1,6-3,8m sandy till

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000211

Company rep.
Lennart Adestam and Torbjörn Johansson

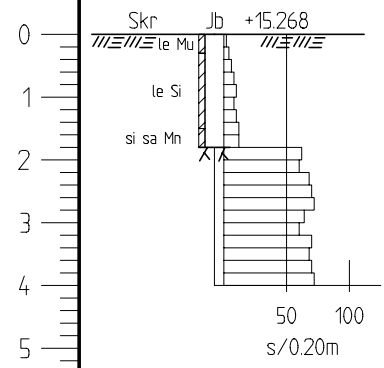
Client: Svensk Kärnbränslehantering AB

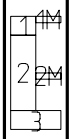
Northing :6367353.169
Easting :1548533.850

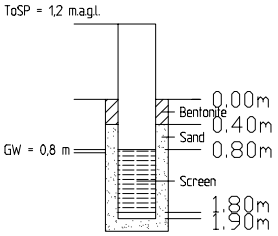
Coordinate system : RT90-RHB70

Top of stand pipe : 1,2 m.a.g.l.
Total pipe length : 3,10 m
Groundwater level : 0,8 m.b.g.l.
Date of completion : 2004-06-30

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information







Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 2,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 0,40 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 1,70 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,3m Clayey topsoil
0,3-1,5m clayey silt
1,5-1,8m silty sandy till
1.8m rock surface

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000212

Company rep.
Lennart Adestam and Torbjörn Johansson

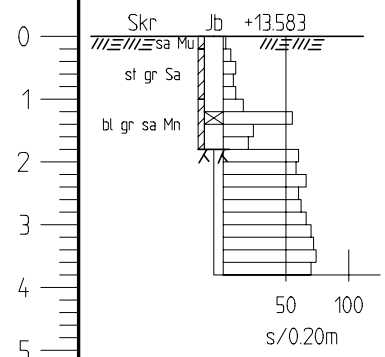
Client: Svensk Kärnbränslehantering AB

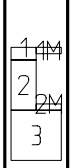
Northing :6365673.710
Easting :1548869.822

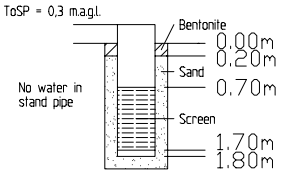
Coordinate system : RT90-RHB70

Top of stand pipe :0,3 m.a.g.l.
Total pipe length :2,10 m
Groundwater level :-
Date of completion :2004-07-05

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information







Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 0,20 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 1,80 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,2m Sandy topsoil
0,2-1,0m cobble-bearing gravelly sand
1,0-1,8m boulder-bearing gravelly sandy till
1,8m rock surface

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level

LAXEMAR BOREHOLE SSM000213

Company rep.
Lennart Adestam and Torbjörn Johansson

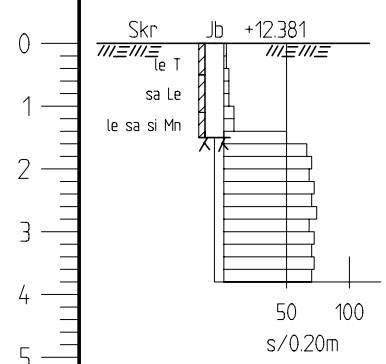
Client: Svensk Kärnbränslehantering AB

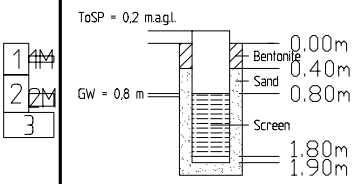
Northing :6365702.618
Easting :1548881.451

Coordinate system : RT90-RHB70

Top of stand pipe : 0,2 m.a.g.l.
Total pipe length : 2,10 m
Groundwater level : 0,8 m.b.g.l.
Date of completion : 2004-07-06

Depth (m)	Description	Samples	Groundwater monitoring well description	Borehole Construction Information





Drilling method : NOEK
Borehole diameter : 120 mm
sampling method : Auger

CASING
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m

SCREEN
Material : PEH
Outer diameter : 63 mm
Inner diameter : 50 mm
Total length : 1,00 m
Slot : 0,3 mm

ANNULUS SEAL
Material : Bentonite clay
Total length : 0,40 m

SAND PACK
Grain size : 0,4-0,8 mm
Total length : 1,70 m

DRILLING EQUIPMENT
Drilling rig : Geotech 604
Drill hammer : Furukawa HB2G
Drill rod : Geostång Φ44
Drill bit : Stift Φ54

GEOLOGICAL LOG
0-0,5m Clayey peat
0,5-1,1m sandy clay
1,1-1,5m clayey sandy silty till
1,5m rock surface

ToSP : Top of Stand Pipe
m.a.g.l. : meters above ground level
m.b.g.l. : meters below ground level