P-04-139

Forsmark site investigation

Supplementary drilling and soil sampling, installation of groundwater monitoring wells, a pumping well and surface water level gauges

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June 2004

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Keywords: Forsmark, AP 400-04-09, AP PF 400-04-15, Field Note Nos. Forsmark 340, 341, Hydrogeology, Soil, Drilling, Sampling, Groundwater monitoring wells, Pumping well, Surface water level gauge.

This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the author and do not necessarily coincide with those of the client.

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Abstract

Supplementary drilling, soil sampling, and installation of groundwater monitoring wells, a pumping well in soil-rock and surface water level gauges were performed in the Forsmark area during the period February to March 2004. In total, 12 groundwater monitoring wells, of which 4 are installed below open water, and one filter well in soil-rock were installed. Surface water level gauges for surface water level measurements were installed at 3 locations.

The objectives of the investigations were, in addition to obtain supplementary information concerning soil depth, soil composition and ground- and surface water levels in the area, to make slug tests and water sampling possible in more near-surface soil layers in connection to previously installed groundwater monitoring wells. These tests may be utilized as a basis for estimation of the vertical variability of the hydraulic conductivity. A further objective is to construct a pumping well in soil-rock to make pumping tests possible.

The drilling on land was performed by use of a track driven GeoMachine 100 GTT drilling rig. Due to weak ice, installation of groundwater monitoring wells below open water and surface water level gauges was executed by use of a hand-held Berema Pionjär hammer drill. Soil sampling on land was performed by auger drilling (Ø: 100 mm) and below open water by means of lake-water flushing. A casing-driver system was used for installation of the groundwater monitoring wells and the pumping well on land.

The groundwater monitoring wells on land were installed inside the drill casing. HDPE screens (Ø: 63/50 mm, length: 0.5-1 m, slot width: 0.3 mm) och HDPE casings (Ø: 63/50 mm) were used for these wells. Filter sand (0.4-0.8 mm) och bentonite (Volclay SG40) were applied outside the well while the drill casing was pulled out. Cover pipes (Ø: 83/80 mm) and caps of stainless steel (SS2333) were installed at the top to protect the HDPE casings.

Steel pipes (SMS 327, Ø: 60.3/51.3 mm) were used for the groundwater monitoring wells below open water. The pipes are perforated by approximately 40-60 holes (Ø: 6 mm) on a length of 0.4-0.6 m at the bottom end. The same type of pipe was used for the surface water level gauges. When possible, the pipes were installed approximately 2 metres down into inorganic sediments or till. The pipes are perforated by approximately 45-60 holes (Ø: 6 mm) at a length of 0.45-0.60 metres just below the surface water level at the time for the installation.

Till is the dominating soil type at the investigated locations. The composition of the till at these locations varies from sandy-silty to clayey. At many locations, the till is overlain by peat, gyttja, and/or clay, which implies that semi-confined to confined groundwater conditions prevail. At other locations, there is till more or less to the ground surface, or the till is overlain by permeable gravel and/or sand, why unconfined conditions prevail.

Sammanfattning

Kompletterande jordborrning, jordprovtagning samt installation av grundvattenrör, en pumpbrunn i jord-berg samt pegelrör utfördes i Forsmarksområdet under perioden februari till mars 2004. Totalt installerades 12 grundvattenrör, varav 4 under öppet vatten, samt en pumpbrunn i jord-berg. Pegelrör för ytvattennivåmätning installerades i 3 punkter.

Målsättningen med undersökningarna var, förutom att erhålla kompletterande information om jorddjup, jordartssammansättning samt grund- och ytvattennivåer inom området, att möjliggöra slugtester och vattenprovtagning i ytligare jordlager i anslutning till tidigare installerade grundvattenrör. Testerna kan nyttjas som underlag för bedömning av den hydrauliska konduktivitetens variation i djupled. Därutöver var målsättningen att utföra en pumpbrunn i jord-berg för att möjliggöra provpumpning.

Borrningarna på land utfördes med en borrbandvagn av typ GeoMachine 100 GTT. På grund av svaga isar genomfördes installationerna av grundvattenrör och pegelrör under öppet vatten med en handhållen Berema Pionjär hammarborr. Jordprovtagningen på land utfördes med skruvborr (Ø: 100 mm) och på öppet vatten genom spolning med sjövatten. Foderrörsborrning användes vid installationen av grundvattenrören och pumpbrunnen på land.

Grundvattenrören på land installerades i borrfoderröret. HDPE-filter (Ø: 63/50 mm, längd: 0,5-1 m, slitsvidd: 0,3 mm) och HDPE-rör (Ø: 63/50 mm) användes för dessa rör. Filtersand (0,4-0,8 mm) och bentonit (Volclay SG40) fylldes utanför grundvattenröret medan borrfoderröret drogs upp. Skyddsrör (Ø: 83/80 mm) och huv av rostfritt stål (SS2333) installerades överst som skydd för HDPE-röret.

För grundvattenrören under öppet vatten användes vanliga stålrör (SMS 327, Ø: 60,3/51,3 mm). Rören är perforerade med ca 40-60 hål (Ø: 6 mm) på en längd av 0,4-0,6 m längst ner. För pegelrören användes samma typ av rör. Om möjligt drevs pegelrören ca 2 m ner i oorganiska sediment eller morän. Pegelrören är perforerade med ca 45-60 hål (Ø: 6 mm) på en längd av 0,45-0,60 m precis under den vattenyta som rådde vid installationen.

Morän är den dominerande jordarten i undersökningspunkterna. Moränens sammansättning i punkterna varierar från sandig-siltig till lerig. I många punkter överlagrades moränen av torv, gyttja och/eller lera vilket betyder att läckande till slutna grundvattenförhållanden råder. I andra punkter fanns morän i stort sett ända upp till markytan, eller så överlagras moränen av genomsläppligt grus och/eller sand och öppna grundvattenförhållanden råder.

Contents

1 Introduction

This report presents the methodology and results of drilling, soil and water sampling, and installation of groundwater monitoring wells, a pumping well in soil-rock, and surface water level gauges in the Forsmark area during the period February 2 to March 30, 2004. The work is part of the activities performed within the site investigation at Forsmark. Previous drilling, soil sampling, and installation of groundwater monitoring wells (some installed in soil below open water) and surface water level gauges were performed during spring 2003 /1/.

The present work has been performed in accordance with activity plan AP PF 400-04-09 for supplementary soil drilling, soil sampling and installation of groundwater monitoring wells and surface water level gauges and AP PF 400-04-15 for supplementary installations of groundwater monitoring wells and a pumping well in soil-rock in Forsmark. The locations of the installed wells and surface water level gauges are shown in Figure 5-1 in Chapter 5. The soil sampling was performed according to AP PF 400-04-12 for observations and analyses of soil types and the results are presented separately in a P-report in progress /2/. The water samples taken were analysed according to AP PF 400-03-33 and the results are presented in a P-report in progress /3/.

In Table 1-1 controlling documents for performing this activity are listed. Both activity plans and method descriptions are SKB's internal controlling documents.

Table 1-1. Controlling documents for the performance of the activity

Activity plans	**Number**	**Version**
Undersökningar i Forsmarksområdet: Kompletterande jordborrning och jordprovtagning samt installation av grundvattenrör och pegelrör	AP PF 400-04-09	1.0
Undersökningar i Forsmarksområdet: Kompletterande installationer av grundvattenrör och en jord-bergbrunn	AP PF 400-04-15	1.0
Observationer och analyser av jordarter	AP PF 400-04-12	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för jordborrning	SKB MD 630.003	1.0
Instruktion för rengöring av borrhålsutrustning och viss markbaserad utrustning	SKB MD 600.004	1.0
Instruktion för användning av kemiska produkter och material vid borrning och undersökningar	SKB MD 600.006	1.0
Inmätning och avvägning av objekt	SKB MD 110.001	1.0

Table 1-2 presents data references to the present activity.

Table 1-2. Data references

Subactivity	Database	Identity number
Drilling, installation of groundwater monitoring wells, a pumping well and surface water level gauges	SICADA	Field Note Nos. Forsmark 340, 341
Surveying	SICADA	Field Note Nos. Forsmark 340, 341
Soil sampling	SICADA	Field Note No. Forsmark 284

2 Objective and scope

The overall objectives of the hydrogeological investigations in the Forsmark area are described in /4/ and /5/. The specific objective of the present work was to obtain supplementary information on soil composition, groundwater and surface water levels and groundwater quality from boreholes distributed within the investigation area. The groundwater monitoring wells shall, beside to enable groundwater level measurements and water sampling, also give possibilities for characterisation of the hydraulic properties of the soil layer by slug tests and for water sampling. Further, the objective was to install a pumping well (in soil-rock) in which pumping tests can be performed.

3 Equipment

3.1 Description of equipment

Most of the drillings and sampling of soil were performed with a track driven drilling rig, GeoMachine GM 100 GTT with an 8-bars Dynaset HKL 4100/8-113 air compressor (Figure 3-1). For installation of SFM0022, SFM0042, and SFM0062-66 (all installed in soil below open water), a hand-held Berema Pionjär hammer drill was used (Figure 3-2).

Figure 3-1. *Installation of groundwater monitoring well SFM0068. A GeoMachine GM 100 GTT drilling rig with a 8-bars Dynaset air compressor was used for installation of all groundwater monitoring wells in soil.*

Figure 3-2. *Installation of groundwater monitoring well SFM0022. A hand-held Berema Pionjär was used for installation of all groundwater monitoring wells below open water and surface water level gauges.*

4 Execution

4.1 General

The work was performed according to the specifications given in SKB´s method description for soil drilling, SKB MD 630.003 (SKB internal controlling document), and according to activity plans AP PF 400-04-09, AP PF 400-02-12, and AP PF 400-04-15. The work included the following: Preparation and mobilisation, drilling and soil sampling, installation of groundwater monitoring wells, a pumping well and surface water level gauges, finishing of work, surveying of boreholes, environmental control programme, and data handling.

4.2 Preparation and mobilisation

In the preparation stage, service and function control of all equipment were conducted. It was checked that the type of fuel, oil and grease was in accordance with SKB´s instruction for chemical products used for drill works, SKB MD 600.006 (SKB internal controlling document). Finally, the equipment was cleaned according to SKB´s instruction for cleaning of borehole equipment, level 1, SKB MD 600.004 (SKB internal controlling document).

The steel pipes and the HDPE (High Density Poly Ethylene) screens and pipes were taken from SKB´s storage at Forsmark or delivered directly from the manufacturer. In both cases they were stored in tight-fitting packages. For pumping well SFM0074, a custom-made drill casing was manufactured at SWECO's engineering workshop in Stockholm and transported in a tight-fitting package to Forsmark. In that well, the drill casing was used as a combined screen and pipe.

Mobilisation onto the site included transport, cleaning of all in-hole equipment, preparation of the first site, lining up the machine and final control of function. It also included transport of pipes, sand, bentonite, sampling pots for soil and cuttings as well as all other necessary equipment.

4.3 Execution of field work

4.3.1 Drilling and sampling in soil

In accordance with activity plan AP PF 400-04-15, soil sampling was performed by auger drilling (Ø: 100 mm) in boreholes SFM0069 and -0072. Soil sampling was performed by flushing (using lake water) in all boreholes drilled below open water. The results of the soil sampling are reported separately /2/.

The boreholes on land were made by air-rotary drilling using a casing driver system, Symmetrix N-82 (borehole diameter 115 mm). Drilling for installation of pumping well SFM0074 was performed using a Symmetrix NO-X 90 (borehole diameter 123 mm).

4.3.2 Installation of groundwater monitoring wells and water sampling

The groundwater monitoring wells on land were installed inside the drill casing. HDPE screens (Ø: 63/50 mm, length: 0.5-1 m, slot: 0.3 mm) and casings (Ø: 63/50 mm) were used for these wells. Filter sand (0.4-0.8 mm) and bentonite clay (Volclay SG40) were filled outside the well while the drill casing was pulled out. Cover pipes (Ø: 83/80 mm) and caps of stainless steel (SS2333) were installed at the top to protect the HDPE casings (Figure 4-1).

For the groundwater monitoring wells below open water, steel pipes (SMS 327, Ø: 60.3/51.3 mm) were installed directly by a hand-held Berema Pionjär hammer drill. The steel pipes were perforated by approximately 40-60 openings (Ø: 6 mm) at a length of 0.4-0.6 m at the bottom (Figure 4-2).

Figure 4-1. *Groundwater monitoring well SFM0067. Cover pipe in stainless steel for protection of the HDPE stand pipe.*

Figure 4-2. *Groundwater monitoring well SFM0065 installed in soil below open water.*

After installation, function tests were performed. The water was pumped out by a submersible pump. No well development was found necessary according to the guidelines in activity plans AP PF 400-04-09 and 400-04-15. After the function tests of the groundwater monitoring wells below open water, pumping was performed in these wells until stable readings of the temperature and the electric conductivity were obtained. Subsequently, water samples were taken.

4.3.3 Installation of pumping well SFM0074

To enable a pumping test in pumping well SFM0074, a custom-made drill casing (outer Ø 103 mm) was installed and used as a combined screen and pipe (Figure 4-3). The filter screen (open area 2.3 dm^2) is perforated by openings (c/c 30 mm, length 40 mm and width 3 mm) at a length of 2.70 m, of which 2.40 m was installed in rock below the soil-rock interface. The open borehole (Ø 57 mm) continues approximately 10 m further down into the rock.

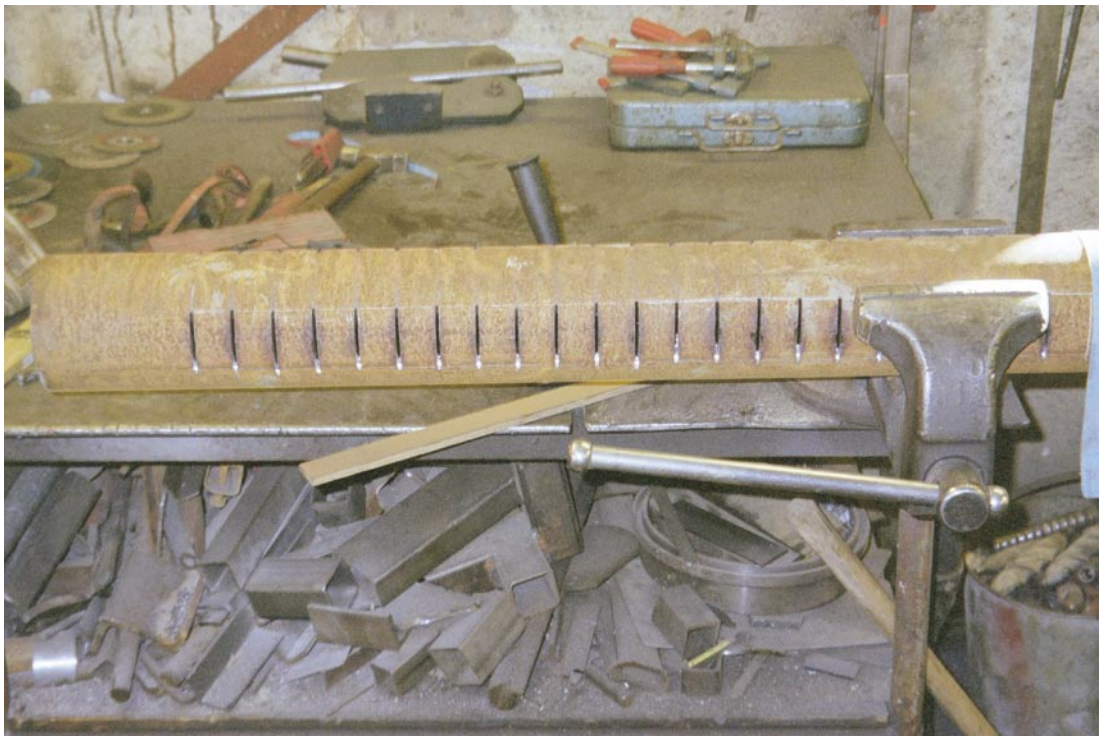


Figure 4-3. *Drill casing used as a combined screen and pipe in pumping well SFM0074 under construction at SWECO's engineering workshop in Stockholm. The custom-made screen is perforated by openings with a length of 40 mm and a width of 3 mm.*

4.3.4 Installation of surface water level gauges

To enable registration of surface water levels, steel pipes (SMS 327, Ø: 60.3/51.3 mm) were driven by a hand-held Pionjär hammer drill. When possible, the pipes were driven to a depth of at least 2 m into inorganic sediments. The steel pipes were perforated by approximately 45 or 60 openings (Ø: 6 mm) at a length of 0.45 or 0.6 m just below the water level at the time for installation.

4.3.5 Finishing of work

The rig was removed, the site was cleaned and an inspection was made by SKB and the consultant together. All sites were documented by photos.

4.3.6 Surveying

After finishing the work, all investigation points were surveyed by a precision GPS, and X-, Y- and Z-coordinates were determined. The surveying is reported separately and stored in SKB:s SICADA database, Field Note Nos. Forsmark 340 and 341.

At the boreholes where no installations of wells were performed, the ground surface was surveyed. Regarding the groundwater monitoring wells on land, the surveyed point was the top of the HDPE standpipe. Finally, at the groundwater monitoring wells below open water and at the surface water level gauges, the top of the stand pipe was surveyed.

4.3.7 Environmental programme

Checklists due to SKB´s routine for the environmental programme were signed by the Activity Leader and are filed in SKB´s archive.

4.4 Data handling/post processing

Minutes for the following items: Activities, Cleaning of equipment, Installation of groundwater monitoring wells and pore pressure devices, and Discrepancy reports have been collected by the Activity Leader for quality control and filing in SKB´s archive.

4.5 Nonconformities

Due to weak ice, a drill rig could neither be used for installation of the groundwater monitoring wells below open water nor the surface water level gauges. Instead, these wells and gauges were installed using a hand-held Berema Pionjär hammer drill.

5 Results

The location of all boreholes is shown in Figure 5-1, and coordinates and borehole type are listed in Table 5-1.

Till is the dominating soil type at the investigated locations. The composition of the till at these locations varies from sandy-silty to clayey. At many locations, the till is overlain by peat, gyttja and/or clay, which implies that semi-confined to confined groundwater conditions prevail. At other locations, there is till more or less to the ground surface, or the till is overlain by permeable gravel and/or sand, why unconfined conditions prevail.

Table 5-2 lists the results of field measurements of water temperature and electrical conductivity. In accordance with activity plan AP PF 400-04-09, electrical conductivity (Ecw) was only measured in the groundwater monitoring wells installed below open water (SFM0022, 0062-63 and 0065).

All results have been delivered to the Activity Leader also in digital form for quality control and storage in SKB´s SICADA data base.

Drawings of all boreholes are presented in Appendix 1, and photos in Appendix 2.

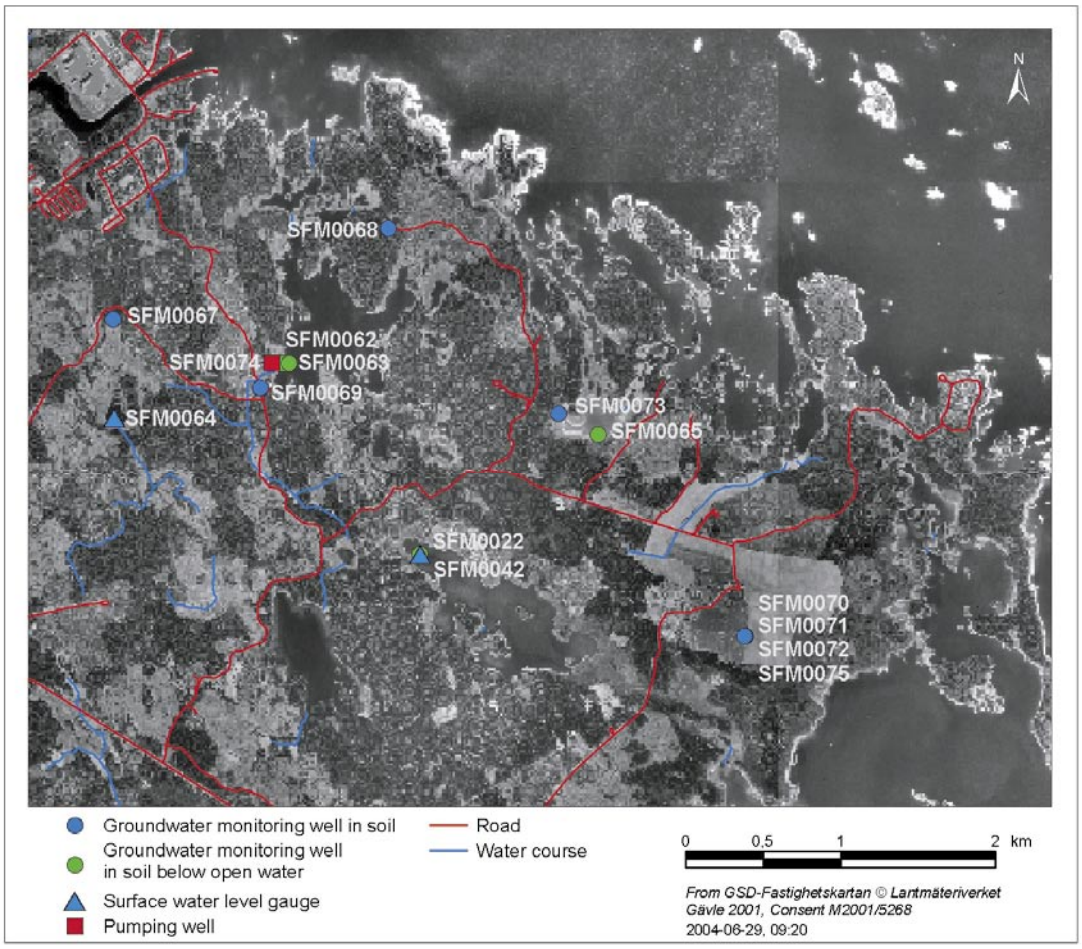


Figure 5-1. *Location of all boreholes, wells and surface water level gauges of the present report.*

Table 5-1. Coordinates (coordinate system RT 90 2.5 gon W 0:-15 for X and Y, and RHB70 for Z) and type for all boreholes

Borehole	X	Y	Z[1]	Type
SFM0022	6697597.55	1632697.18	1.49	Groundwater monitoring well below open water
SFM0042	6697598.02	1632696.42	1.53	Surface water gauge
SFM0062	6698838.72	1631807.99	1.18	Groundwater monitoring well below open water
SFM0063	6698839.05	1631851.41	1.28	Groundwater monitoring well below open water
SFM0064	6698491.57	1630718.38	2.80	Surface water gauge
SFM0065	6698380.94	1633841.58	0.97	Groundwater monitoring well below open water
SFM0066	6698380.47	1633842.38	0.89	Surface water gauge
SFM0067	6699120.60	1630713.36	2.54	Groundwater monitoring well, not at core drill site
SFM0068	6699706.12	1632489.56	2.07	Groundwater monitoring well, not at core drill site
SFM0069	6698680.22	1631662.25	2.50	Groundwater monitoring well, not at core drill site
SFM0070	6697069.55	1634783.49	3.72	Groundwater monitoring well, not at core drill site
SFM0071	6697069.45	1634785.08	3.60	Groundwater monitoring well, not at core drill site
SFM0072	6697069.33	1634789.30	3.69	Groundwater monitoring well, not at core drill site
SFM0073	6698513.24	1633585.10	0.63	Groundwater monitoring well, not at core drill site
SFM0074	6698839.08	1631738.02	0.82	Filter well, not at core drill site
SFM0075	6697069.45	1634786.84	3.78	Groundwater monitoring well, not at core drill site

[1]Top of the stand pipe (m.a.s.l.).

Table 5-2. Field measurements of electric conductivity and temperature in connection to water sampling

Borehole	Date	Electrical conductivity (mS/m)	Temperature (°C)
SFM0022	2004-02-05	35	3.0
SFM0062	2004-02-17	51	4.1
SFM0063	2004-02-18	49	3.1
SFM0065	2004-02-18	22	3.1

References

/1/ **SKB, 2003.** Forsmark site investigation. Drilling and sampling in soil. Installation of groundwater monitoring wells and surface water level gauges. SKB P-03-64.

/2/ **Hedenström A, 2004.** Forsmark site investigation. Stratigraphical and analytical data of Quaternary deposits. SKB P-report in progress.

/3/ **Borgiel M, Nilsson A-C, 2004.** Sampling and analyses of near surface groundwater. Results from shallow monitoring wells in soil, BAT filter tips, springs, and private wells, May 2003 to May 2004. SKB P-report in progress.

/4/ **SKB, 2001.** Platsundersökningar. Undersökningsmetoder och generellt genomförandeprogram. SKB R-01-10 (in Swedish).

/5/ **SKB, 2001.** Program för platsundersökning vid Forsmark. SKB R-01-42 (in Swedish).

Borehole profiles

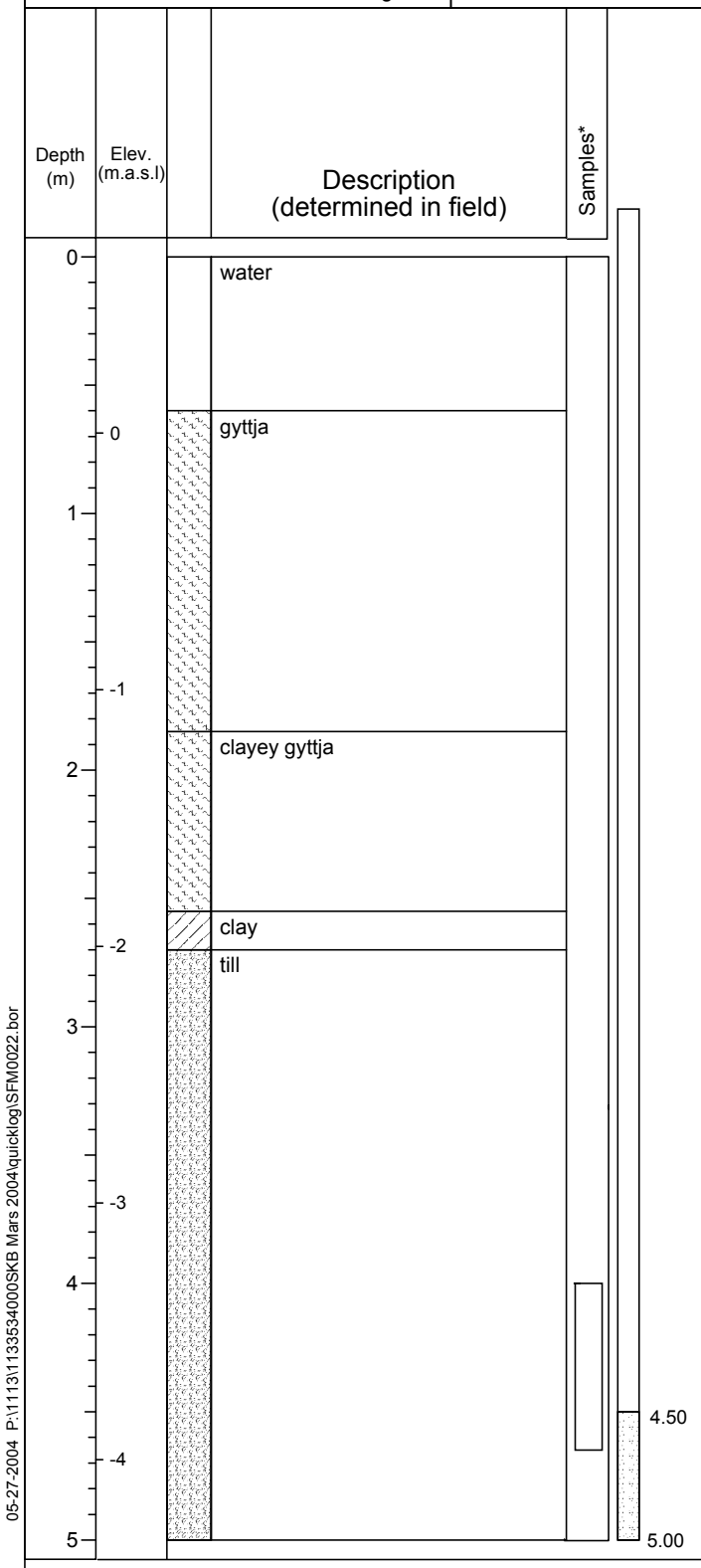
SWECO VIAK	FORSMARK Borehole SFM0022

Company rep.

Leif Lundholm

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 1.487 m.a.s.l
	: RHB 70	Water elevation	: 0.687 m.a.s.l
Northing	: 6697597.549	Total pipe length	: 5.80 m
Easting	: 1632697.179	Groundwater level	: 0.687 m.a.s.l
		Date of completion	: 2004-02-05



Borehole Construction Information

Drilling method	: Hammer
CASING	
Material	: Steel
Inner diameter	: 51.3 mm
Outer diameter	: 60.3 mm
Total length	: 5.30 m
SCREEN	
Material	: Steel
Inner diameter	: 51.3 mm
Outer diameter	: 60.3 mm
Total length	: 0.50 m
Perforated	: 100 openings/ 1m
Opening	: 6 mm

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*SICADA Field note 284

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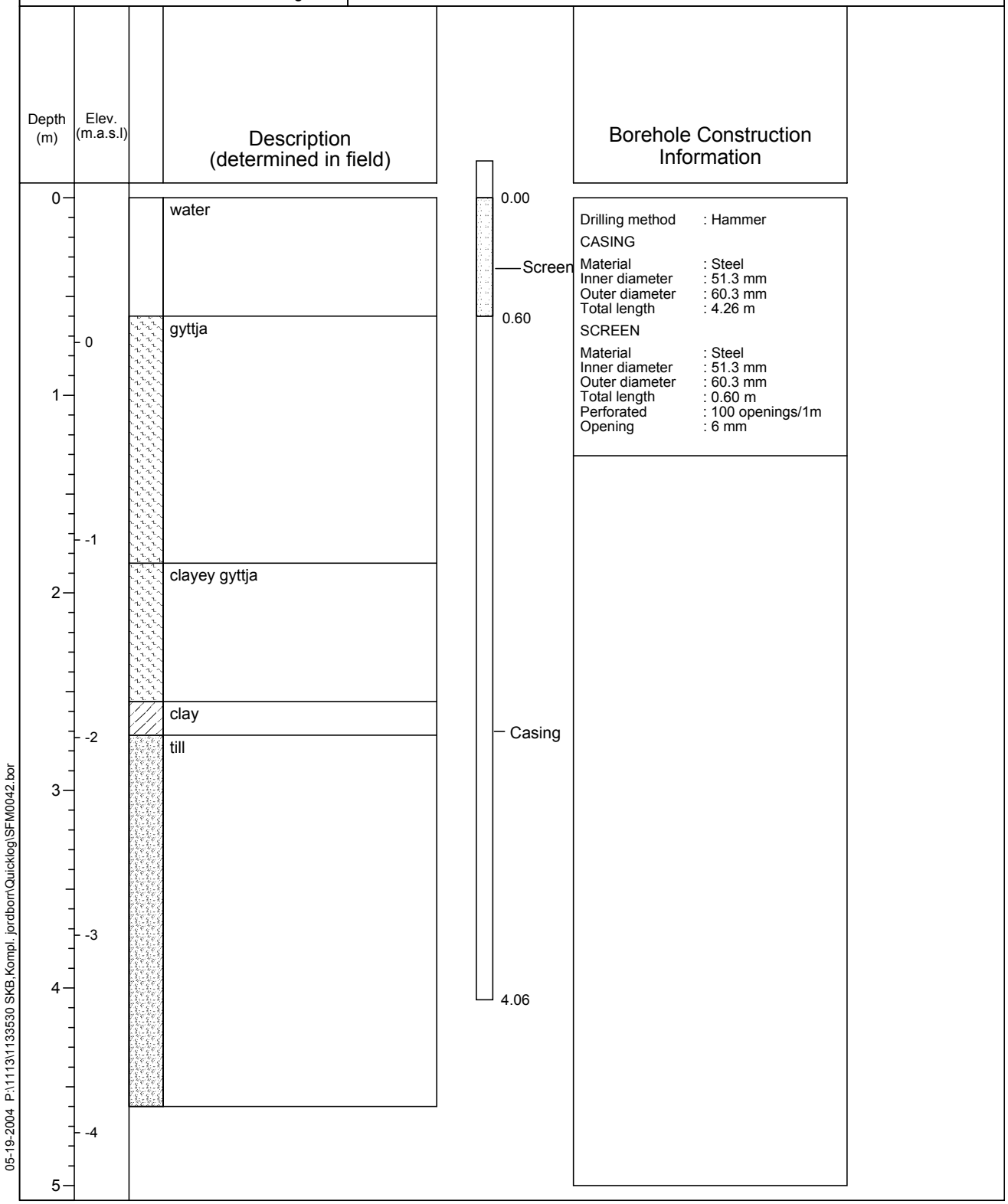
FORSMARK Borehole SFM0042

Company rep.

Leif Lundholm

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 1.532 m.a.s.l
	: RHB 70	Water elevation	: 0.73 m.a.s.l
Northing	: 6697598.017	Total pipe length	: 4.86 m
Easting	: 1632696.420	Groundwater level	: -
		Date of completion	: 2004-02-05



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SWECO VIAK

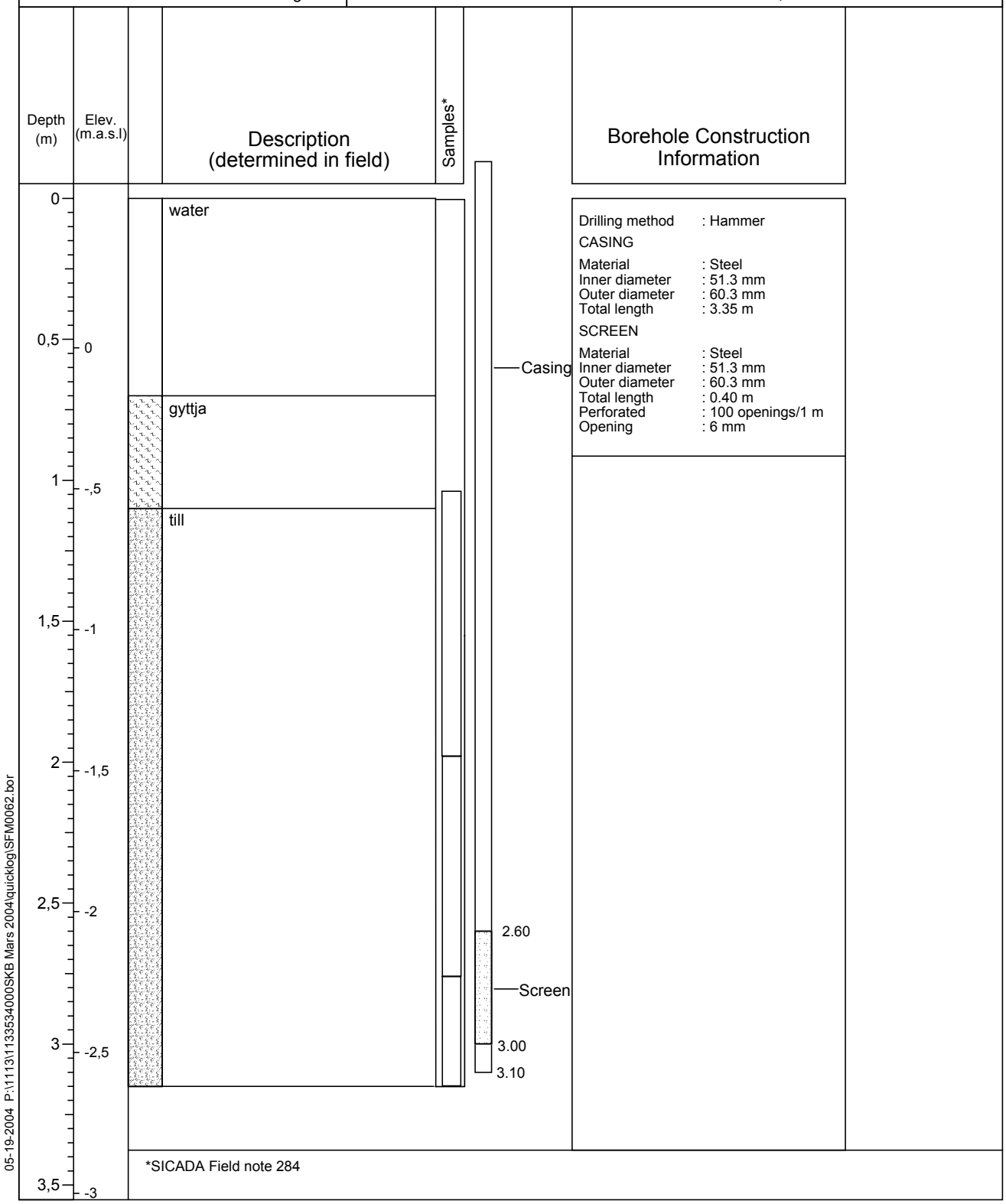
FORSMARK Borehole SFM0062

Company rep.

Leif Lundholm

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 1.182 m.a.s.l
	: RHB 70	Water elevation	: 0.53 m.a.s.l
Northing	: 6698838.715	Total pipe length	: 3.75 m
Easting	: 1631807.986	Groundwater level	: 0.53 m.a.s.l
		Date of completion	: 2004-02-05



*SICADA Field note 284

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SWECO VIAK

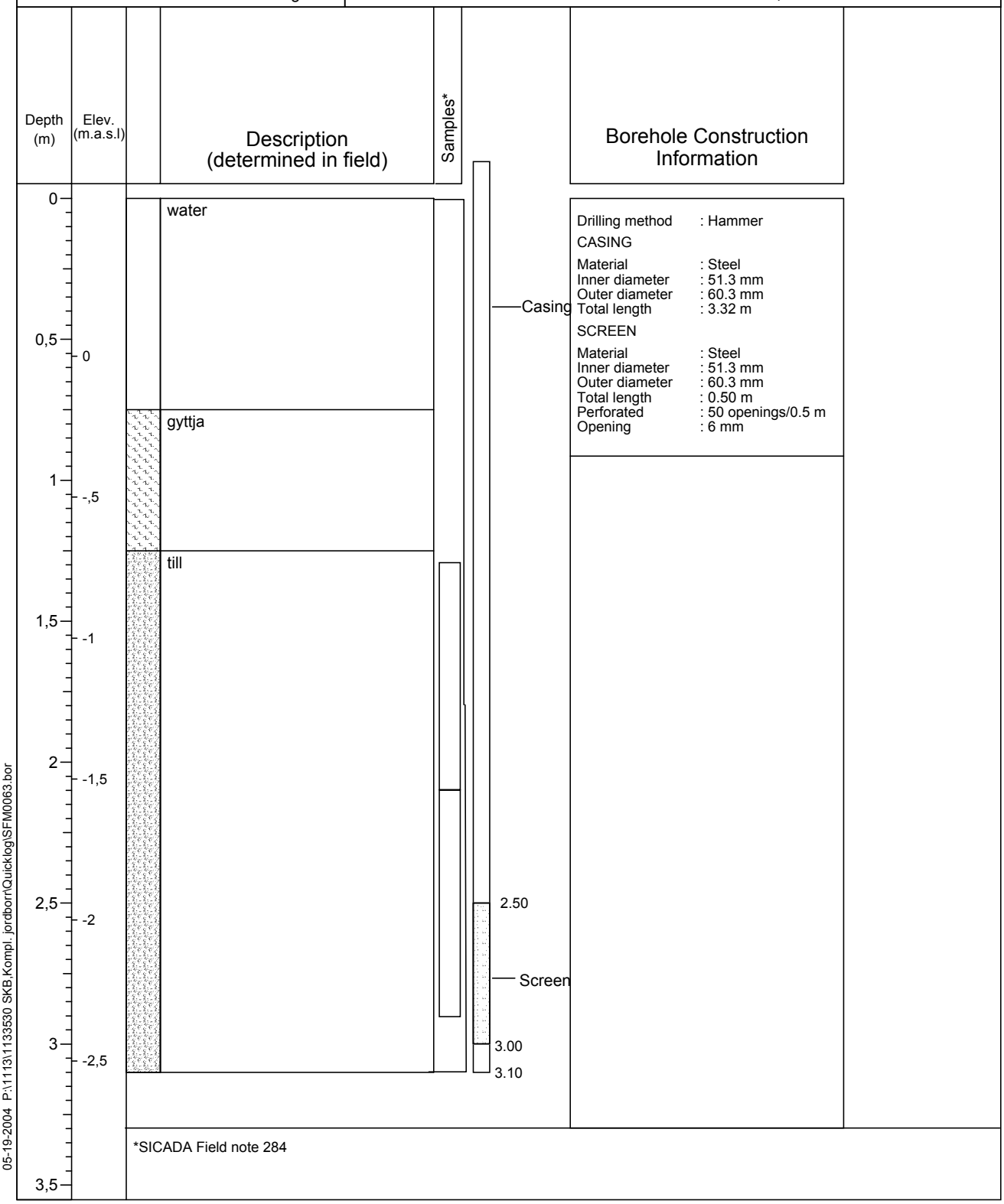
FORSMARK Borehole SFM0063

Company rep.

Leif Lundholm

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 1.276 m.a.s.l
	: RHB 70	Water elevation	: 0.56 m.a.s.l
Northing	: 6698839.048	Total pipe length	: 3.82 m
Easting	: 1631851.405	Groundwater level	: 0.56 m.a.s.l
		Date of completion	: 2004-02-05



*SICADA Field note 284

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SWECO VIAK

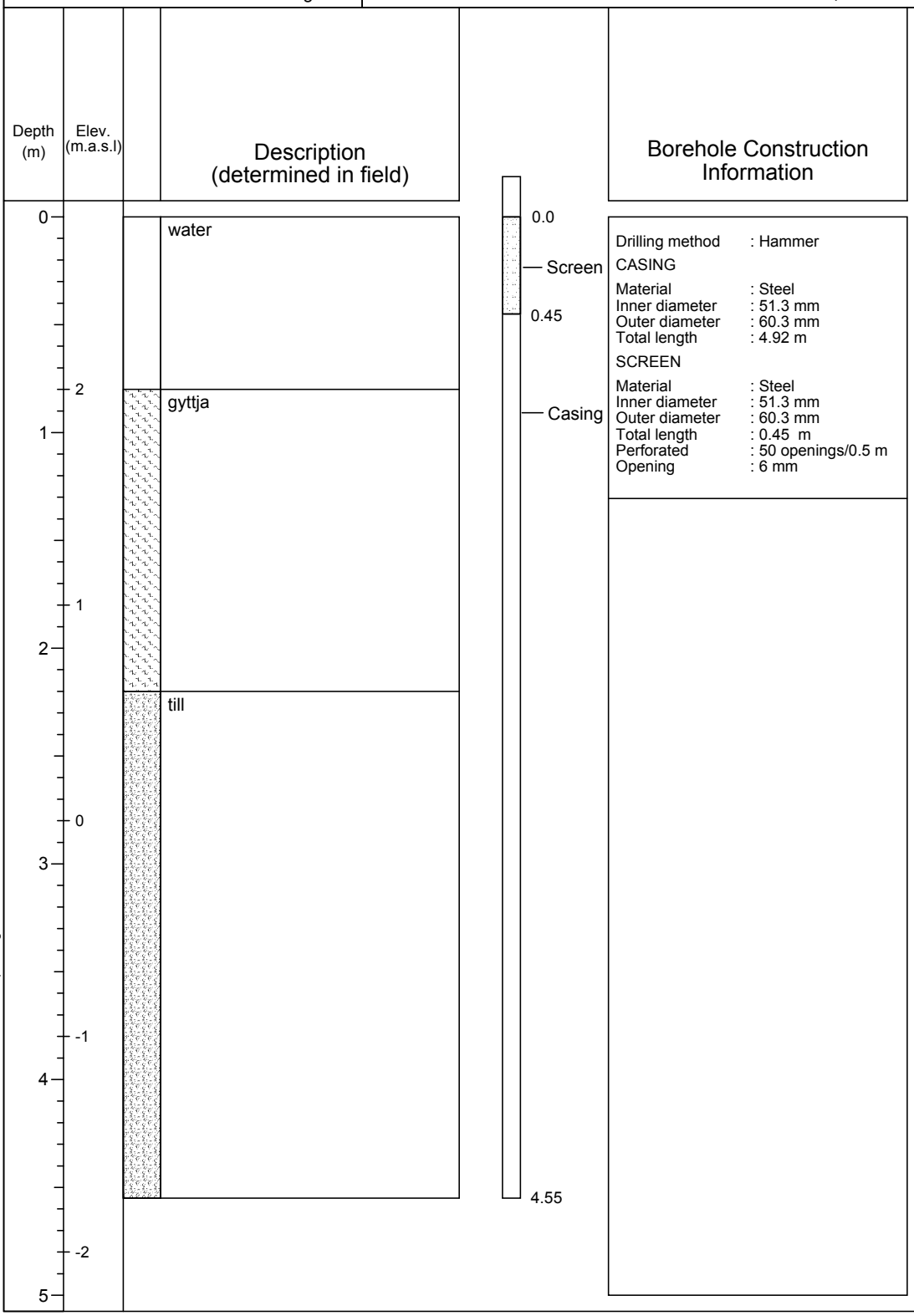
FORSMARK Borehole SFM0064

Company rep.

Leif Lundholm

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 2.80 m.a.s.l
	: RHB 70	Water elevation	: 1.98 m.a.s.l
Northing	: 6698491.57	Total pipe length	: 5.37 m
Easting	: 1630718.38	Groundwater level	: -
		Date of completion	: 2004-02-12



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SWECO VIAK

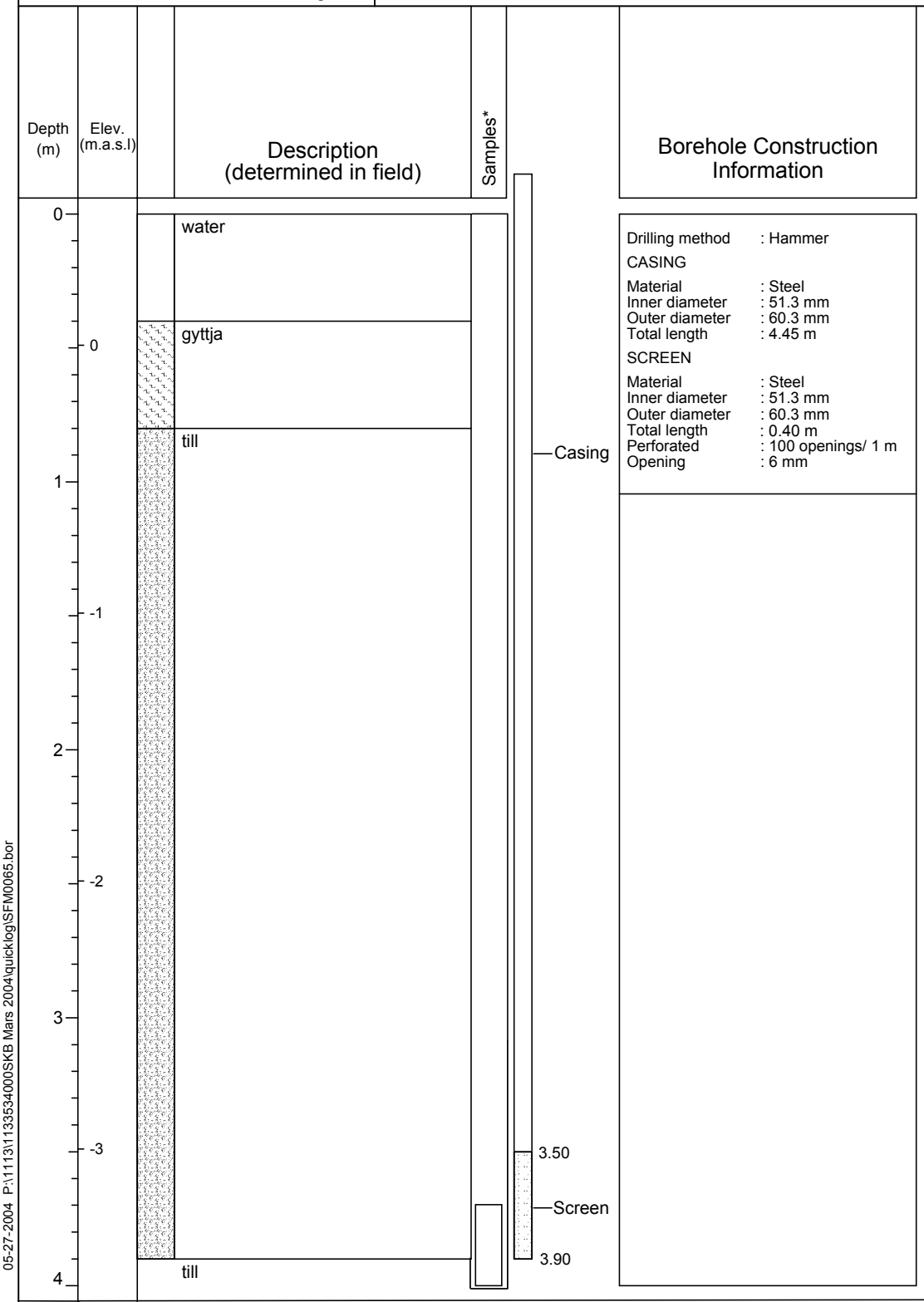
FORSMARK Borehole SFM0065

Company rep.

Leif Lundholm

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 0.972 m.a.s.l
	: RHB 70	Water elevation	: 0.02 m.a.s.l
Northing	: 6698380.941	Total pipe length	: 4.85 m
Easting	: 1633841.578	Groundwater level	: 0.49 m.a.s.l
		Date of completion	: 2004-02-06



Drilling method : Hammer

CASING

Material	: Steel
Inner diameter	: 51.3 mm
Outer diameter	: 60.3 mm
Total length	: 4.45 m

SCREEN

Material	: Steel
Inner diameter	: 51.3 mm
Outer diameter	: 60.3 mm
Total length	: 0.40 m
Perforated	: 100 openings/ 1 m
Opening	: 6 mm

*SICADA Field note 284

05-27-2004 P:\1113\1133534000SKB Mars 2004\quicklog\SFM0065.bor

SWECO VIAK

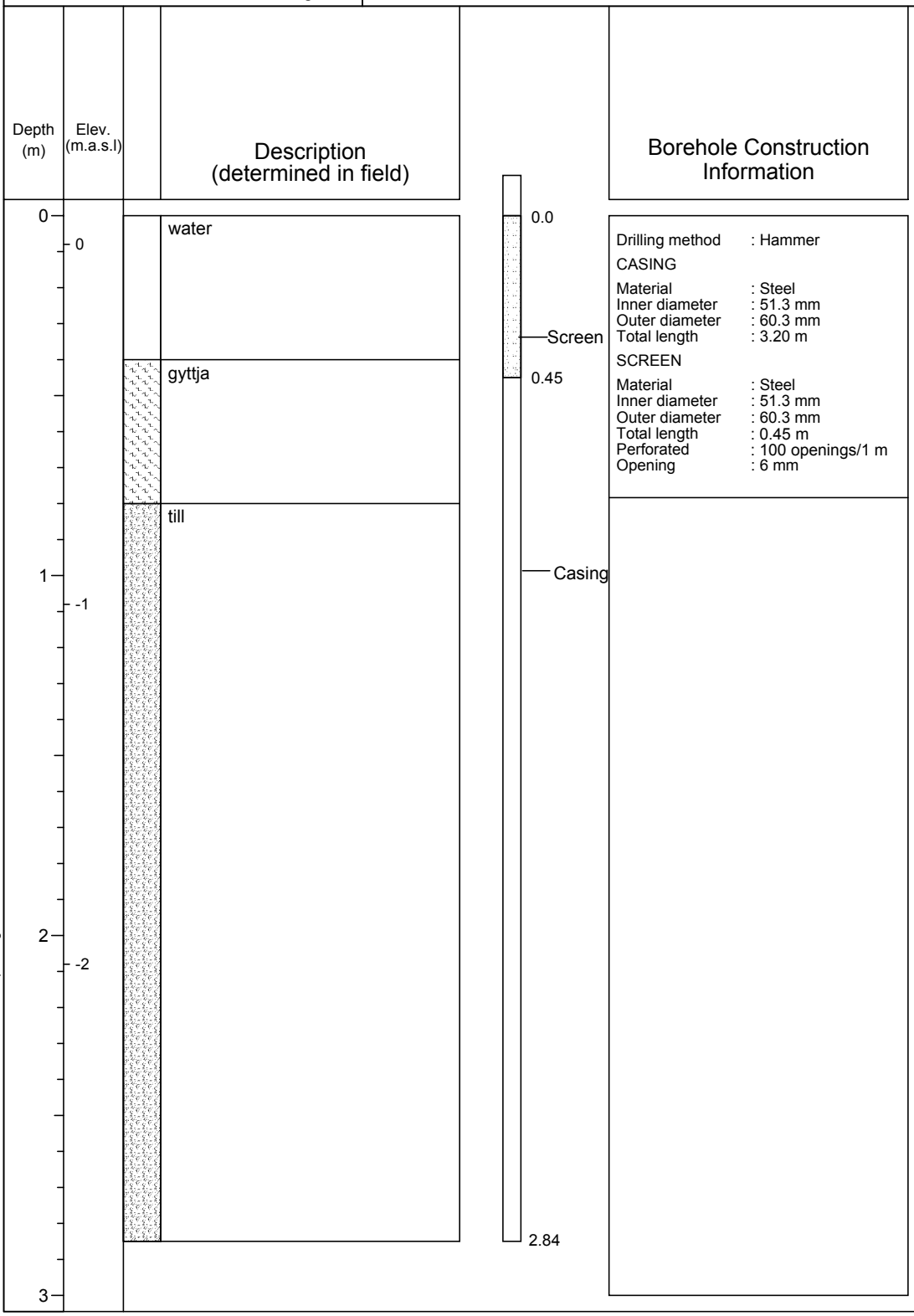
FORSMARK Borehole SFM0066

Company rep.

Leif Lundholm

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 0.886 m.a.s.l
	: RHB 70	Water elevation	: 0.08 m.a.s.l
Northing	: 6698380.465	Total pipe length	: 3.65 m
Easting	: 1633842.377	Groundwater level	: -
		Date of completion	: 2004-02-06



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SWECO VIAK

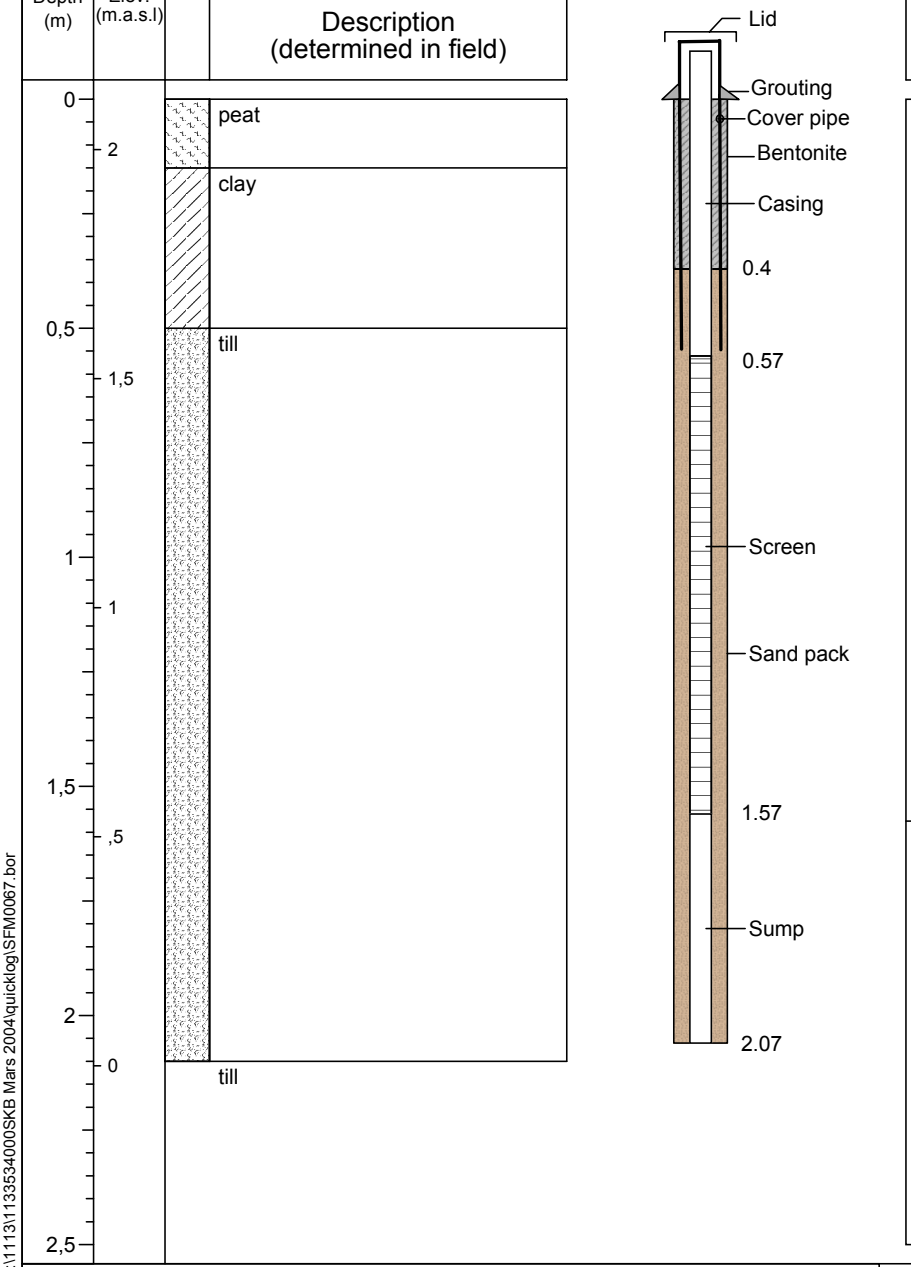
FORSMARK Borehole SFM0067

Company rep.

Nils Lindqvist and Mattias Helmersson

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 2.54 m.a.s.l
	: RHB 70	Ground elevation	: 2.11 m.a.s.l
Northing	: 6699120.60	Total pipe length	: 2.50 m
Easting	: 1630713.36	Groundwater level	: 2.05 m.a.s.l
		Date of completion	: 2004-03-24



Well Construction Information

Drilling method	: Air rotary-casing driver
Borehole diameter	: 115 mm
Sampling method	: Auger
COVER PIPE	
Material	: Stainless steel
Inner diameter	: 80 mm
Outer diameter	: 83 mm
Total length	: 1.00 m
CASING	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
SCREEN	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
Slot	: 0.3 mm
SUMP	
Material	: HDPE
Inner Diameter	: 50 mm
Outer Diameter	: 63 mm
Total length	: 0.50 m
SAND PACK	
Grain size	: 0.4-0.8 mm
Total length	: 1.7 m
ANNULUS SEAL	
Material	: Bentonite clay
Total length	: 0.4 m

05-26-2004 P:\1113\1133534000SKB Mars 2004\quicklog\SFM0067.bor

SWECO VIAK

FORSMARK Borehole SFM0068

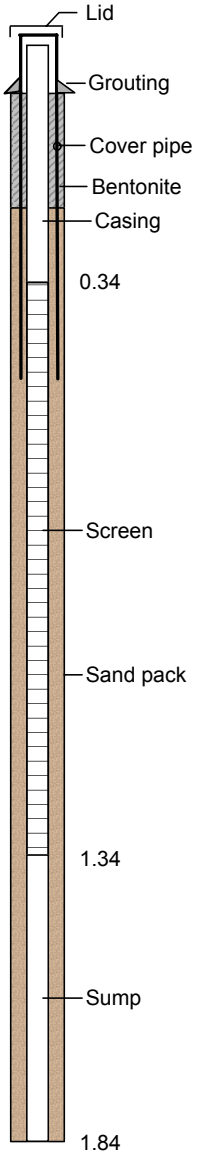
Company rep.

Nils Lindqvist and Mattias Helmersson

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 2.07 m.a.s.l
	: RHB 70	Ground elevation	: 1.61 m.a.s.l
Northing	: 6699706.12	Total pipe length	: 2.30 m
Easting	: 1632489.56	Groundwater level	: 1.29 m.a.s.l
		Date of completion	: 2004-03-23

Depth (m)	Elev. (m.a.s.l)	Description (determined in field)
0		organic soil
		till
	1	
1		
	0	
2		bedrock (heavely fractured)



Well Construction Information

Drilling method	: Air rotary-casing driver
Borehole diameter	: 115 mm
Sampling method	: Auger
COVER PIPE	
Material	: Stainless steel
Inner diameter	: 80 mm
Outer diameter	: 83 mm
Total length	: 1.00 m
CASING	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 0.80 m
SCREEN	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
Slot	: 0.3 mm
SUMP	
Material	: HDPE
Inner Diameter	: 50 mm
Outer Diameter	: 63 mm
Total length	: 0.50 m
SAND PACK	
Grain size	: 0.4-0.8 mm
Total length	: 1.6 m
ANNULUS SEAL	
Material	: Bentonite clay
Total length	: 0.2 m

05-26-2004 P:\1113\113353400SKB Mars 2004\quicklog\SFM0068.bor

SWECO VIAK

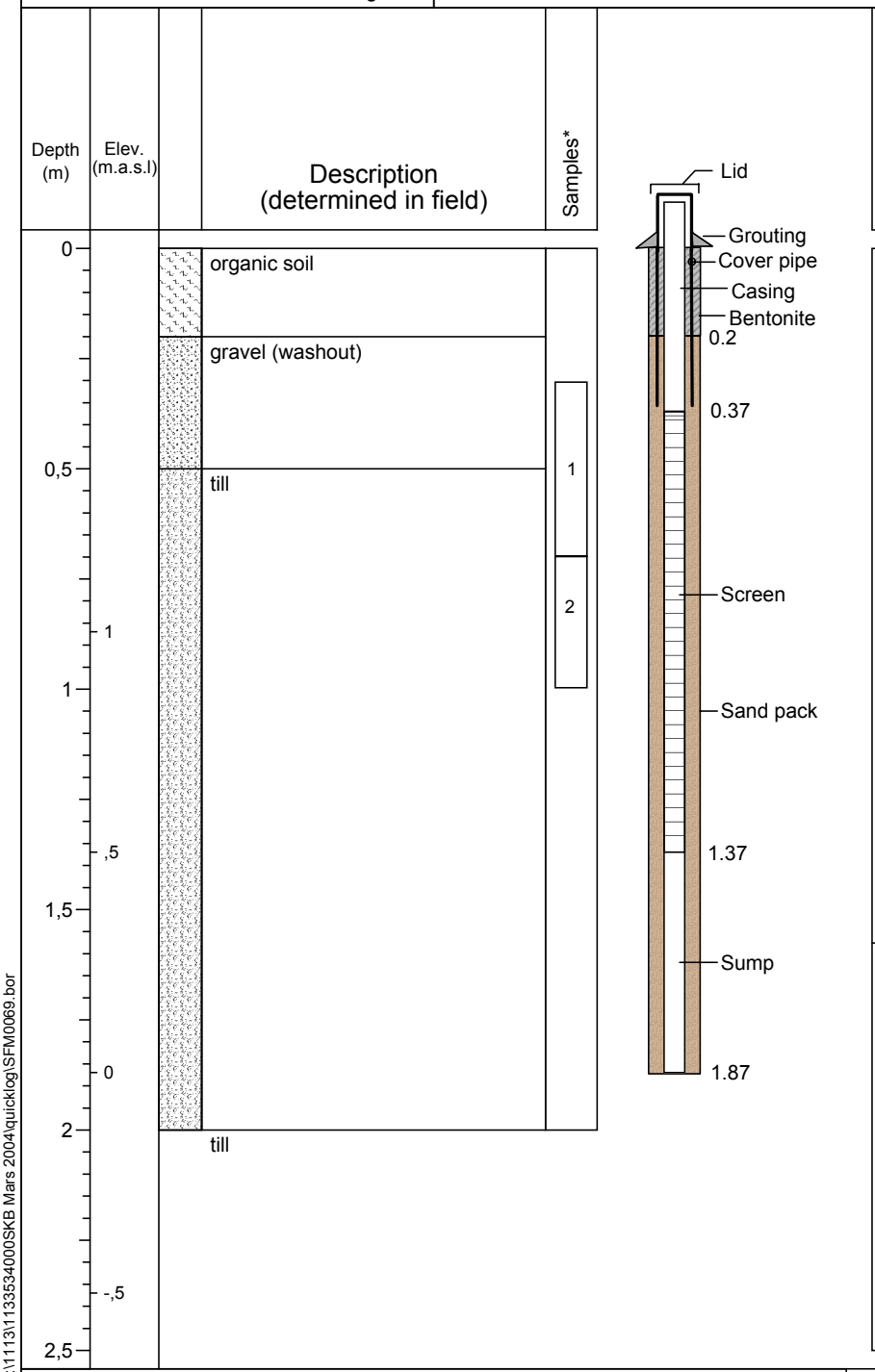
FORSMARK Borehole SFM0069

Company rep.

Nils Lindqvist and Mattias Helmersson

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 2.50 m.a.s.l
	: RHB 70	Ground elevation	: 1.87 m.a.s.l
Northing	: 6698680.22	Total pipe length	: 2.50 m
Easting	: 1631662.25	Groundwater level	: 1.62 m.a.s.l
		Date of completion	: 2004-03-29



Well Construction Information

Drilling method	: Air rotary-casing driver
Borehole diameter	: 115 mm
Sampling method	: Auger
COVER PIPE	
Material	: Stainless steel
Inner diameter	: 80 mm
Outer diameter	: 83 mm
Total length	: 1.00 m
CASING	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
SCREEN	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
Slot	: 0.3 mm
SUMP	
Material	: HDPE
Inner Diameter	: 50 mm
Outer Diameter	: 63 mm
Total length	: 0.50 m
SAND PACK	
Grain size	: 0.4-0.8 mm
Total length	: 1.7 m
ANNULUS SEAL	
Material	: Bentonite clay
Total length	: 0.2 m

*SICADA Field note 284

05-27-2004 P:\1113\1133534000SKB Mars 2004\quicklog\SFM0069.bor

SWECO VIAK

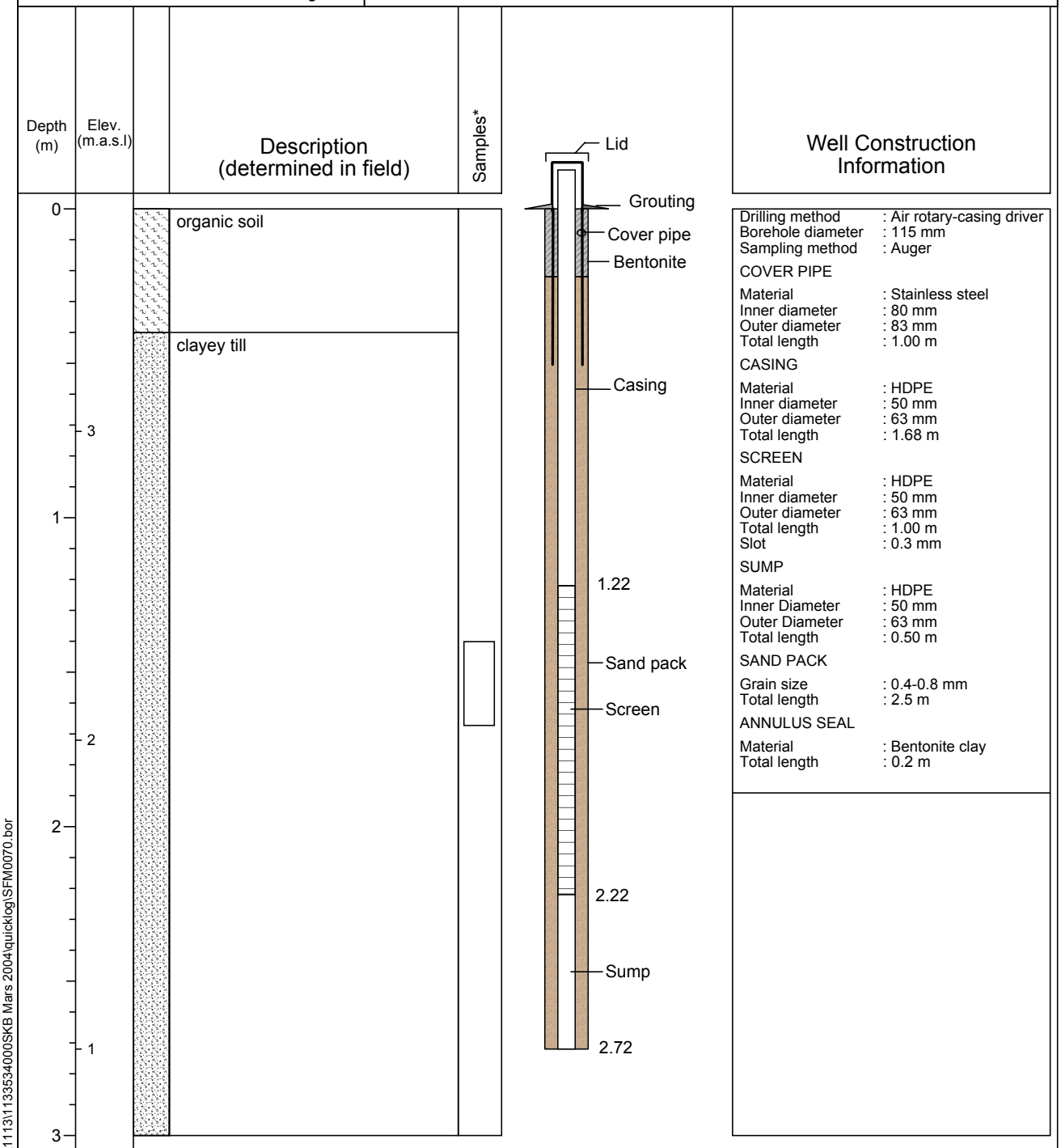
FORSMARK Borehole SFM0070

Company rep.

Nils Lindqvist and Mattias Helmersson

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 3.72 m.a.s.l
	: RHB 70	Ground elevation	: 3.26 m.a.s.l
Northing	: 6697069.55	Total pipe length	: 3.18 m
Easting	: 1634783.49	Groundwater level	: 2.50 m.a.s.l
		Date of completion	: 2004-03-29



Well Construction Information

Drilling method	: Air rotary-casing driver
Borehole diameter	: 115 mm
Sampling method	: Auger
COVER PIPE	
Material	: Stainless steel
Inner diameter	: 80 mm
Outer diameter	: 83 mm
Total length	: 1.00 m
CASING	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.68 m
SCREEN	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
Slot	: 0.3 mm
SUMP	
Material	: HDPE
Inner Diameter	: 50 mm
Outer Diameter	: 63 mm
Total length	: 0.50 m
SAND PACK	
Grain size	: 0.4-0.8 mm
Total length	: 2.5 m
ANNULUS SEAL	
Material	: Bentonite clay
Total length	: 0.2 m

*SICADA Field note 284

05-26-2004 P:\1113\113353400OSKB Mars 2004\quicklog\SFM0070.bor

SWECO VIAK

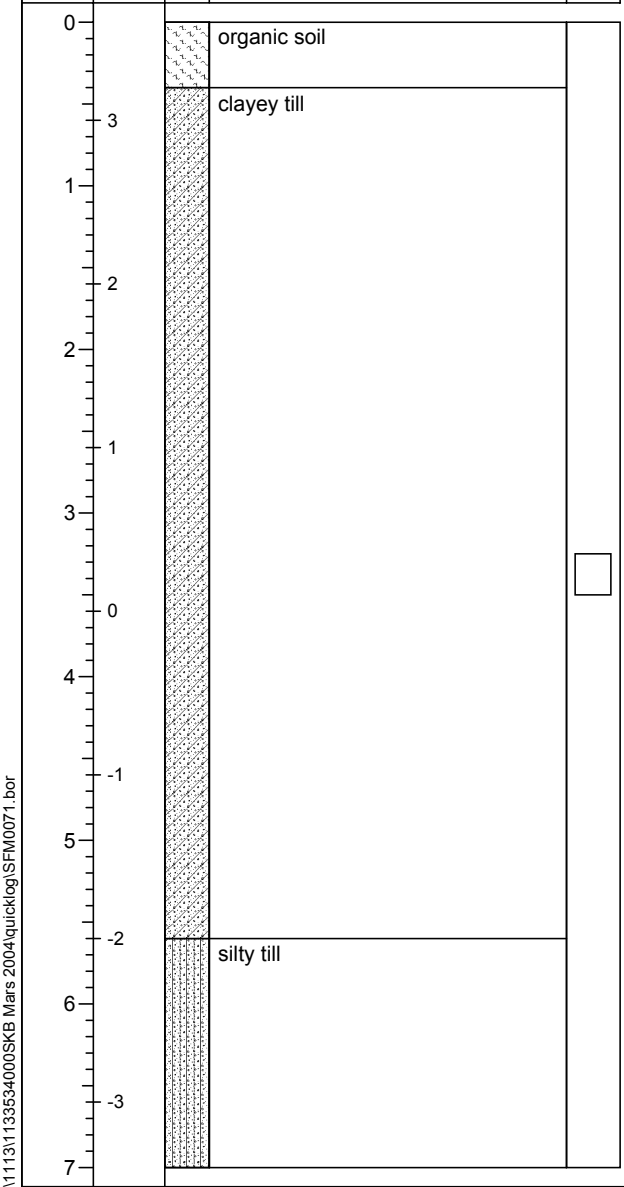
FORSMARK Borehole SFM0071

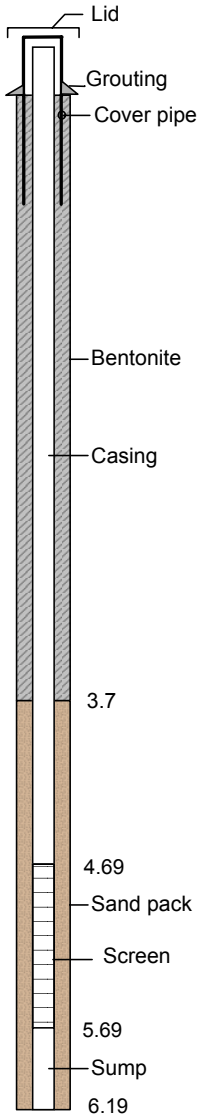
Company rep.

Nils Lindqvist and Mattias Helmersson

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 3.60 m.a.s.l
	: RHB 70	Ground elevation	: 3.29 m.a.s.l
Northing	: 6697069.45	Total pipe length	: 6.50 m
Easting	: 1634785.08	Groundwater level	: 2.45 m.a.s.l
		Date of completion	: 2004-03-29





Well Construction Information

Drilling method	: Air rotary-casing driver
Borehole diameter	: 115 mm
Sampling method	: Auger
COVER PIPE	
Material	: Stainless steel
Inner diameter	: 80 mm
Outer diameter	: 83 mm
Total length	: 1.00 m
CASING	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 5.00 m
SCREEN	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
Slot	: 0.3 mm
SUMP	
Material	: HDPE
Inner Diameter	: 50 mm
Outer Diameter	: 63 mm
Total length	: 0.50 m
SAND PACK	
Grain size	: 0.4-0.8 mm
Total length	: 2.5 m
ANNULUS SEAL	
Material	: Bentonite clay
Total length	: 3.7 m

*SICADA Field note 284

05-26-2004 P:\1113\1133534000SKB Mars 2004\quicklog\SFM0071.bor

SWECO VIAK

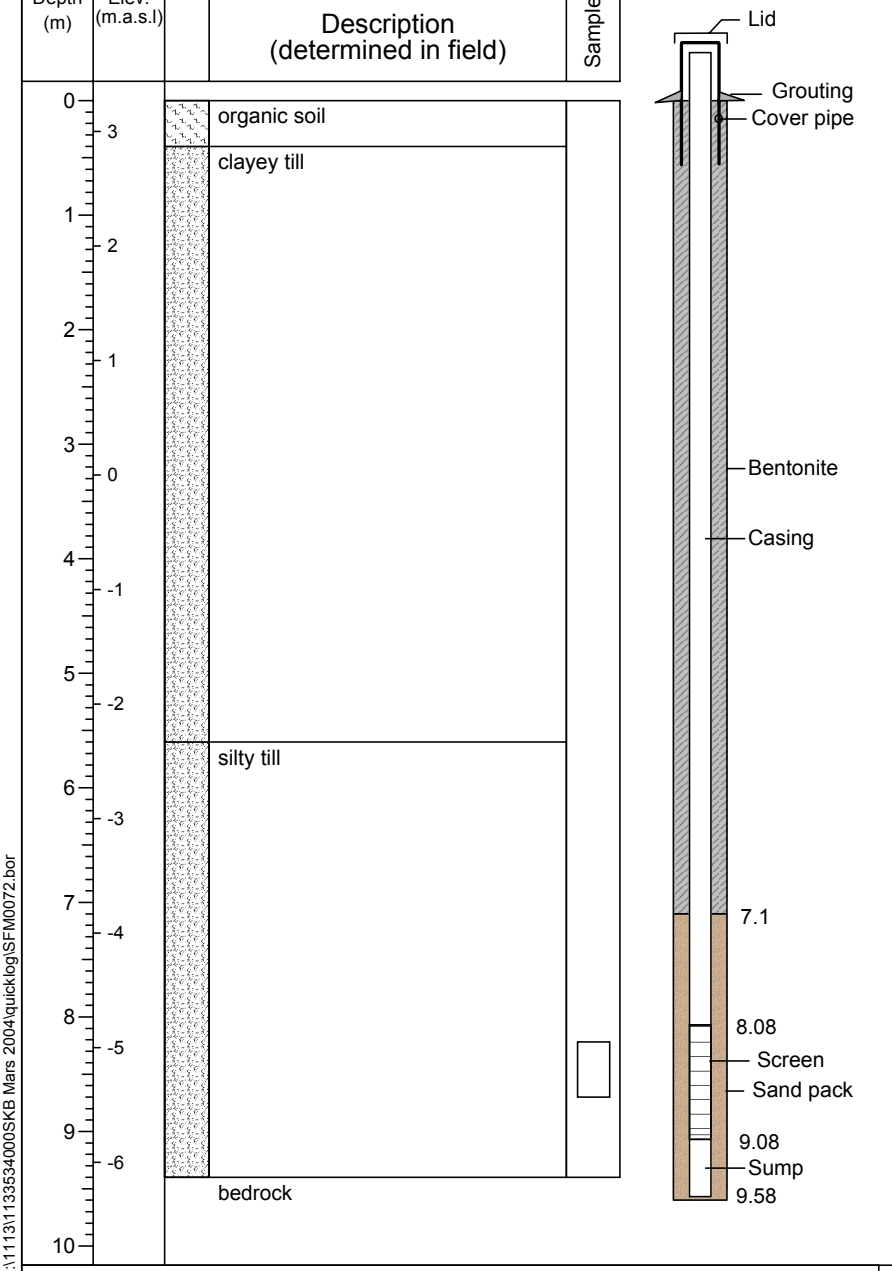
FORSMARK Borehole SFM0072

Company rep.

Nils Lindqvist and Mattias Helmersson

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 3.69 m.a.s.l
	: RHB 70	Ground elevation	: 3.27m.a.s.l
Northing	: 6697069.33	Total pipe length	: 10.00 m
Easting	: 1634789.30	Groundwater level	: 1.97 m.a.s.l
		Date of completion	: 2004-03-25



Well Construction Information

Drilling method	: Air rotary-casing driver
Borehole diameter	: 115 mm
Sampling method	: Auger
COVER PIPE	
Material	: Stainless steel
Inner diameter	: 80 mm
Outer diameter	: 83 mm
Total length	: 1.00 m
CASING	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 8.50 m
SCREEN	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
Slot	: 0.3 mm
SUMP	
Material	: HDPE
Inner Diameter	: 50 mm
Outer Diameter	: 63 mm
Total length	: 0.50 m
SAND PACK	
Grain size	: 0.4-0.8 mm
Total length	: 2.5 m
ANNULUS SEAL	
Material	: Bentonite clay
Total length	: 7.1 m

*SICADA Field note 284

05-27-2004 P:\1113\1133534000SKB Mars 2004\quicklog\SFM0072.bor

SWECO VIAK

FORSMARK Borehole SFM0073

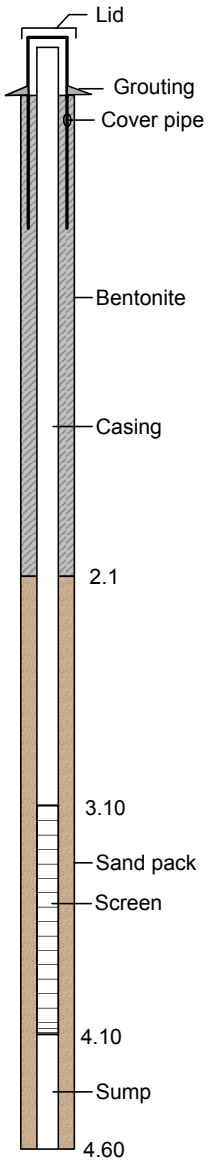
Company rep.

Nils Lindqvist and Mattias Helmersson

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 0.63 m.a.s.l
	: RHB 70	Ground elevation	: 0.23 m.a.s.l
Northing	: 6698513.24	Total pipe length	: 5.00 m
Easting	: 1633585.10	Groundwater level	: 0.42 m.a.s.l
		Date of completion	: 2004-03-24

Depth (m)	Elev. (m.a.s.l)	Description (determined in field)
0	0	peat
		gyttja
1	-1	clay
		till
2	-2	
3	-3	
4	-4	
5		



Well Construction Information

Drilling method : Air rotary-casing driver
Borehole diameter : 115 mm
Sampling method : Auger

COVER PIPE

Material : Stainless steel
Inner diameter : 80 mm
Outer diameter : 83 mm
Total length : 1.00 m

CASING

Material : HDPE
Inner diameter : 50 mm
Outer diameter : 63 mm
Total length : 3.50 m

SCREEN

Material : HDPE
Inner diameter : 50 mm
Outer diameter : 63 mm
Total length : 1.00 m
Slot : 0.3 mm

SUMP

Material : HDPE
Inner Diameter : 50 mm
Outer Diameter : 63 mm
Total length : 0.50 m

SAND PACK

Grain size : 0.4-0.8 mm
Total length : 2.5 m

ANNULUS SEAL

Material : Bentonite clay
Total length : 2.1 m

05-27-2004 P:\1113\113353400SKB Mars 2004\quicklog\SFM0073.bor

SWECO VIAK

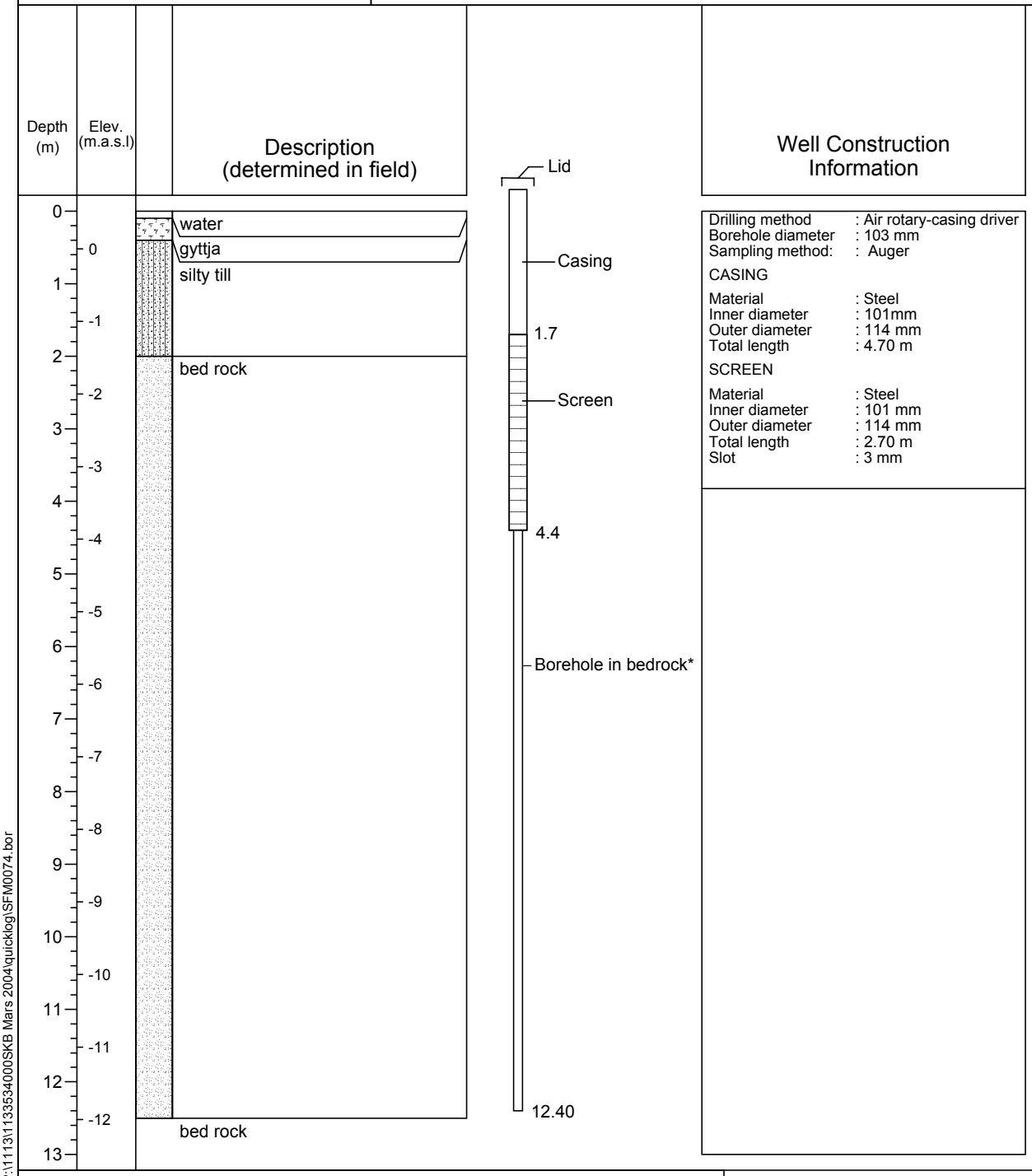
FORSMARK Borehole SFM0074

Company rep.

Nils Lindqvist and Mattias Helmersson

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 0.82 m.a.s.l
	: RHB 70	Ground elevation	: 0.52 m.a.s.l
Northing	: 6698839.08	Total pipe length	: 4.70 m
Easting	: 1631738.02	Groundwater level	: 0.62 m.a.s.l
		Date of completion	: 2004-03-30



Drilling method : Air rotary-casing driver
Borehole diameter : 103 mm
Sampling method: : Auger

CASING

Material : Steel
Inner diameter : 101mm
Outer diameter : 114 mm
Total length : 4.70 m

SCREEN

Material : Steel
Inner diameter : 101 mm
Outer diameter : 114 mm
Total length : 2.70 m
Slot : 3 mm

* 57 mm borehole diameter from 4.4 m to 12.4 m in bed rock

05-26-2004 P:\1113\1133534000SKB Mars 2004\quicklog\SFM0074.bor

SWECO VIAK

FORSMARK Borehole SFM0075

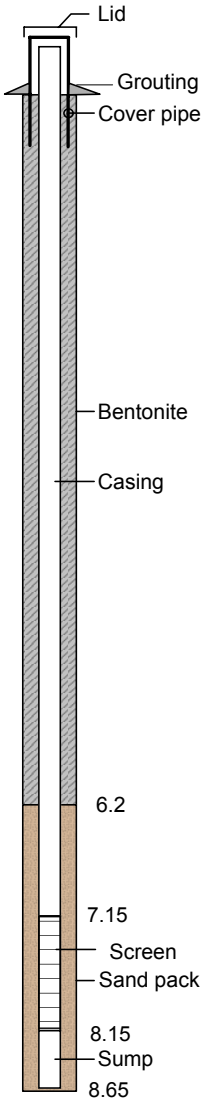
Company rep.

Nils Lindqvist and Mattias Helmersson

Client: Svensk Kärnbränslehantering AB

Coordinate system	: RT 90 2.5 gon W 0:-15	Top of stand pipe	: 3.78 m.a.s.l
	: RHB 70	Ground elevation	: 3.27 m.a.s.l
Northing	: 6697069.45	Total pipe length	: 9.16 m
Easting	: 1634786.84	Groundwater level	: 2.45 m.a.s.l
		Date of completion	: 2004-03-26

Depth (m)	Elev. (m.a.s.l)	Description (determined in field)
0	3	organic soil
1	2	clayey till
2	1	
3	0	
4	-1	
5	-2	
6	-3	silty till
7	-4	
8	-5	
9	-6	bedrock
10		



Well Construction Information

Drilling method	: Air rotary-casing driver
Borehole diameter	: 115 mm
Sampling method	: Auger
COVER PIPE	
Material	: Stainless steel
Inner diameter	: 80 mm
Outer diameter	: 83 mm
Total length	: 1.00 m
CASING	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 7.66 m
SCREEN	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
Slot	: 0.3 mm
SUMP	
Material	: HDPE
Inner Diameter	: 50 mm
Outer Diameter	: 63 mm
Total length	: 0.50 m
SAND PACK	
Grain size	: 0.4-0.8 mm
Total length	: 2.5 m
ANNULUS SEAL	
Material	: Bentonite clay
Total length	: 6.2 m

05-27-2004 P:\1113\113353400OSKB Mars 2004\quicklog\SFM0075.bor

Appendix 2

Photographs of all boreholes

Boreholes SFM0022 and 0042

Borehole SFM0062

Borehole SFM0063

Borehole SFM0064

Boreholes SFM0065 and 0066

Borehole SFM0067

Borehole SFM0068

Borehole SFM0069

Boreholes SFM0070, 0071, 0072, and 0075

Borehole SFM0073

Borehole SFM0074