

**Forsmark site investigation**

**Drilling and sampling in soil**

**Installation of groundwater monitoring  
wells and surface water level gauges**

Per-Olof Johansson, SWECO VIAK

June 2003

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*Keywords:* Forsmark, hydrogeology, soil, drilling, sampling, groundwater monitoring wells, surface water gauges.

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

Drilling and sampling of soil, and installation of groundwater monitoring wells and surface water level gauges were performed in the Forsmark area February–April, 2003. At 8 locations only drilling, soil sampling and check of soil depth were performed. In total 28 groundwater monitoring wells were installed, of which 5 were installed in soil below open water. Furthermore, installations were made for surface water level measurements at 5 locations.

The objective of the investigation was to obtain information on soil depth, soil composition, and groundwater and surface water levels from boreholes distributed within the investigation area. In connection to the check of soil depth, drill cuttings were to be sampled for the determination of type of bedrock. The groundwater monitoring wells shall, beside to enable groundwater level measurements, also give possibilities for characterisation of the hydraulic properties of the soil layer by slug tests and for water sampling.

The drilling was performed by two track driven drilling rigs, GeoMachine 100 GTT and Geotech 604D. The latter, which is a lighter rig, was mainly used for installation of the groundwater monitoring wells and surface water gauges below open water. These installation was performed during the winter from the ice.

The soil sampling was mainly performed by auger drilling ( $\varnothing$  100 mm). At some location a front sampler was used. Air-rotary drilling with a casing driver system was used for check of soil depth, sampling of drill cuttings and for installation of groundwater monitoring wells on land. The groundwater monitoring wells below open water and the surface water gauges were driven directly by top hammer technique.

The groundwater monitoring wells on land were installed inside the drill casing. HDPE screens ( $\varnothing$ : 63/50 mm, length: 1 m, slot: 0.3 mm) and casings ( $\varnothing$ : 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 ( $\varnothing$ : 83/80 mm) and caps of stainless steel (SS2333) were installed at the top to protect the HDPE casings. For the groundwater monitoring wells in sediments below open water steel pipes (SMS 327,  $\varnothing$ : 61.3/51.3 mm) were used. The steel pipes were perforated by approximately 100 openings ( $\varnothing$ : 6 mm) at a length of one metre at the bottom.

For the surface water level gauges, steel pipes (SMS 327,  $\varnothing$ : 61.3/51.3 mm) were installed. If possible the pipes were driven to a depth of at least 2 m into inorganic sediments. The steel pipes were perforated by approximately 50 openings/0.5 m ( $\varnothing$ : 6 mm) just below the present water level.

The soil depth at the boreholes varied between 1.4 and 17.1 m. Till was the dominating soil type. The composition of the till varies from sandy silty to clayey till. At many locations the till is overlain by peat, gyttja, dy and/or clay meaning that semi-confined to confined conditions prevail. At other locations the till extend to the ground surface or is overlain by relatively conductive sand deposits and unconfined conditions prevail.

# Sammanfattning

Jordborring, jordprovtagning samt installation av grundvattenrör och rörpegel utfördes i Forsmarksområdet under februari–april, 2003. I 8 punkter utfördes endast borring, jordprovtagning och kontroll av jorddjup. Totalt installerades 28 grundvattenrör, varav 5 under öppet vatten. Installationer för ytvattennivåmätning utfördes i 5 punkter.

Målet med undersökningarna var att erhålla information om jorddjup, jordartssammansättning samt grund- och ytvattennivåer inom området. I samband med jorddjupskontrollen provtogs borrhax för bergartsbestämning. Grundvattenrören skall förutom för grundvattennivåmätning användas för bestämning av jordlagrens hydrauliska egenskaper genom slugtester och för vattenprovtagning.

Borringarna utfördes med två borrhandsvagnar, GeoMachine 100 GTT och Geotech 604D. Den senare, som är en lättare bandvagn, användes huvudsakligen för installationerna av pegelrör och grundvattenrör under öppet vatten, vilka gjordes vintertid från isen.

Jordprovtagningen utfördes huvudsakligen med skruvborr (Ø 100 mm). I några punkter användes istället frontprovtagare. Foderrörborring användes vid jorddjupsbestämning, kaxprovtagning och vid installationen av grundvattenrören på land. Grundvattenrören och pegelrören under öppet vatten drevs direkt med tophammare.

Grundvattenrören på land installerades i borrhoderröret. HDPE-filter (Ø: 63/50 mm, längd: 1 m, slitsvidd: 0,3 mm) and -rör (Ø: 63/50 mm) användes för dessa rör. Filtersand (0,4-0,8 mm) and bentonit (Volclay SG40) fylldes utanför grundvattenröret medan borrhoderröret drogs upp. Skyddsror (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: 61,3/51,3 mm). Rören var perforerade med ca 100 hål (Ø: 6 mm) på en längd av 1 m längst ner.

För pegelrören användes också vanliga stålrör (SMS 327, Ø: 61,3/51,3 mm). Om möjligt drivs rören minst 2 m ner i oorganiska sediment eller morän. Pegelrören var perforerade med ca 50 hål/0,5 m (Ø: 6 mm) just under den aktuella vattenytan.

Jorddjupet i borrhålen varierade mellan 1,4 och 17,1 m. Morän var den dominerande jordarten i undersökningspunkterna. Moränens sammansättning varierade från sandig siltig till lerig morän. I många punkter överlagrades moränen av torv, gyttja, dy och/eller lera vilket betydde att läckande till slutna grundvattenförhållanden rådde. I andra punkter var det morän ända upp till markytan eller så överlagrades moränen av genomsläppliga sandiga sediment och öppna grundvattenförhållanden rådde.

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# 1 Introduction

The Swedish Nuclear Fuel and Waste Management Co (SKB) performs site investigations to locate a deep repository for high level radioactive waste /1/. Site investigations are performed at two locations; Forsmark /2/ and Oskarshamn. In this report drilling and soil sampling, and installation of groundwater monitoring wells and surface water level gauges at Forsmark according to the Activity Plan AP PF 400-02-31 are documented.

## 2 Objectives

The objective of the present study is to obtain information on soil depth, soil composition and groundwater and surface water levels from boreholes distributed within the investigation area. In connection to the determination of soil depth, drill cuttings were be sampled for determination of type of bedrock, AP PF 400-02-31. The groundwater monitoring wells shall, beside to enable groundwater level measurements, also give possibilities for characterisation of the hydraulic properties of the soil layer by slug tests and for water sampling.

### 3 Equipment

Most of the drillings and sampling of soil and drill cuttings were performed with a track driven drilling rig, GeoMachine GM 100 GTT with a 8 bar Dynaset HKL 4100/8-113 air compressor (Figure 3-1). For SFM0012, SFM0015, SFM0023-25, SFM0039-41, SFM0043 (all located below open water), and PFM2461-62 and PFM2465 a lighter track driven drilling rig was used, Geotech 604D (Figure 3-2).



*Figure 3-1. Drilling rig GeoMachine GM 100 GTT with a 8 bar Dynaset air compressor was used for most of the work.*





*Figure 3-2. The light drilling rig Geotech 604D was used mainly for the drillings performed from the ice-covered lakes.*

## 4 Execution

The work was performed according to SKB's method descriptions for soil drilling /3/, soil mapping /4/ and according to Activity Plan 400-02-31 and included: preparation and mobilisation, drilling and sampling soil and drill cuttings, installation of groundwater monitoring wells, installation of surface water level gauges, finishing of work, surveying of boreholes, environmental control programme, and data handling.

### 4.1 Mobilisation and preparation

In the preparation stage, service and function control of all equipment were conducted. It was checked that type of fuel, oil and grease was in accordance with SKB's instruction for chemical products used for drill works /5/. Finally, the equipment was cleaned according to SKB's instruction /6/.

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.

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.

### 4.2 Drilling and sampling in soil

The soil sampling was performed by auger drilling ( $\varnothing$ : 100 mm) (Figure 4-1) . At some locations a front sampler was used.

When the soil sampling was finished, air-rotary drilling with a casing driver system, Symmetrix N-82 (borehole diameter 115 mm) was performed in the same borehole. To assure that the bedrock was reached, the drilling continued approximately one metre into the bedrock and drill cuttings were sampled. The soil and drill cutting sampling was performed within the activity according to AP PF 400-02-12 and the results are presented separately.



*Figure 4-1. Soil sampling by auger drilling.*

At the investigation points under open water, sampling of sea and lake sediments was performed within the activity according to AP PF 400-02-49. The results are presented separately.

### **4.3 Installation of groundwater monitoring wells**

Groundwater monitoring wells on land were installed inside the drill casing. HDPE screens ( $\text{\O}$ : 63/50 mm, length: 1 m, slot: 0.3 mm) and casings ( $\text{\O}$ : 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 ( $\text{\O}$ : 83/80 mm) and caps of stainless steel (SS2333) were installed at the top to protect the HDPE casings (Figure 4-2).



**Figure 4-2.** Groundwater monitoring well SFM0027. Cover pipe in stainless steel for protection of the HDPE stand pipe.

For the groundwater monitoring wells in sediments or till below open water steel pipes (SMS 327, Ø: 61.3/51.3 mm) were directly driven by top hammer technique. The steel pipes were perforated by approximately 100 openings (Ø: 6 mm) at a length of one metre at the bottom (Figure 4-3).

After installation, function tests were performed. The water was pumped out by submersible pumps (type Grundfos MP 1 or Awimex Amazon). If < 20% of the drawdown was recovered after one hour, the well was developed by water from borehole Bh5. For development of the monitoring wells below open water, lake water was used for development. After development pumping was performed until the original electric conductivity of the groundwater was obtained or of at least five times the quantity of water used for development.



*Figure 4-3. Groundwater monitoring well SFM0012 placed in the sediments below open water.*

After installation, function test and when necessary also well development, water samples were taken.

#### **4.4 Installation of surface water level gauges**

To enable registration of surface water levels, steel pipes (SMS 327, Ø: 61.3/51.3 mm) were driven by top hammer technique. If possible the pipes were driven to a depth of at least 2 m into inorganic sediments. The steel pipes were perforated by approximately 50 openings (Ø: 6 mm) at a length of 0.5 metre just below the present water level.

## **4.5 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 before and after the work.

## **4.6 Surveying**

After finishing the work, all investigation points were surveyed by precision GPS, x-, y- and z-coordinates. The surveying is reported separately.

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

## **4.7 Environmental programme**

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

## **4.8 Data handling**

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 storage.

## 5 Results

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

The soil depth at the boreholes varied between 1.4 and 17.1 m. Till is dominating in the area. The composition of the till varies from sandy silty to clayey till. At many locations the till is overlain by peat, gyttja, dy and/or clay meaning that semi-confined to confined conditions prevail. At other locations the till extend to the ground surface or is overlain by relatively conductive sand deposits and unconfined conditions prevail.

Drawings of all boreholes are presented in Appendix 1, and photos before and after the work in Appendix 2.

All water samples taken are listed in Table 5-2 together with field measurements of water temperature and electrical conductivity.

All results have been delivered to the Activity Leader also in digital form for quality control and storage.

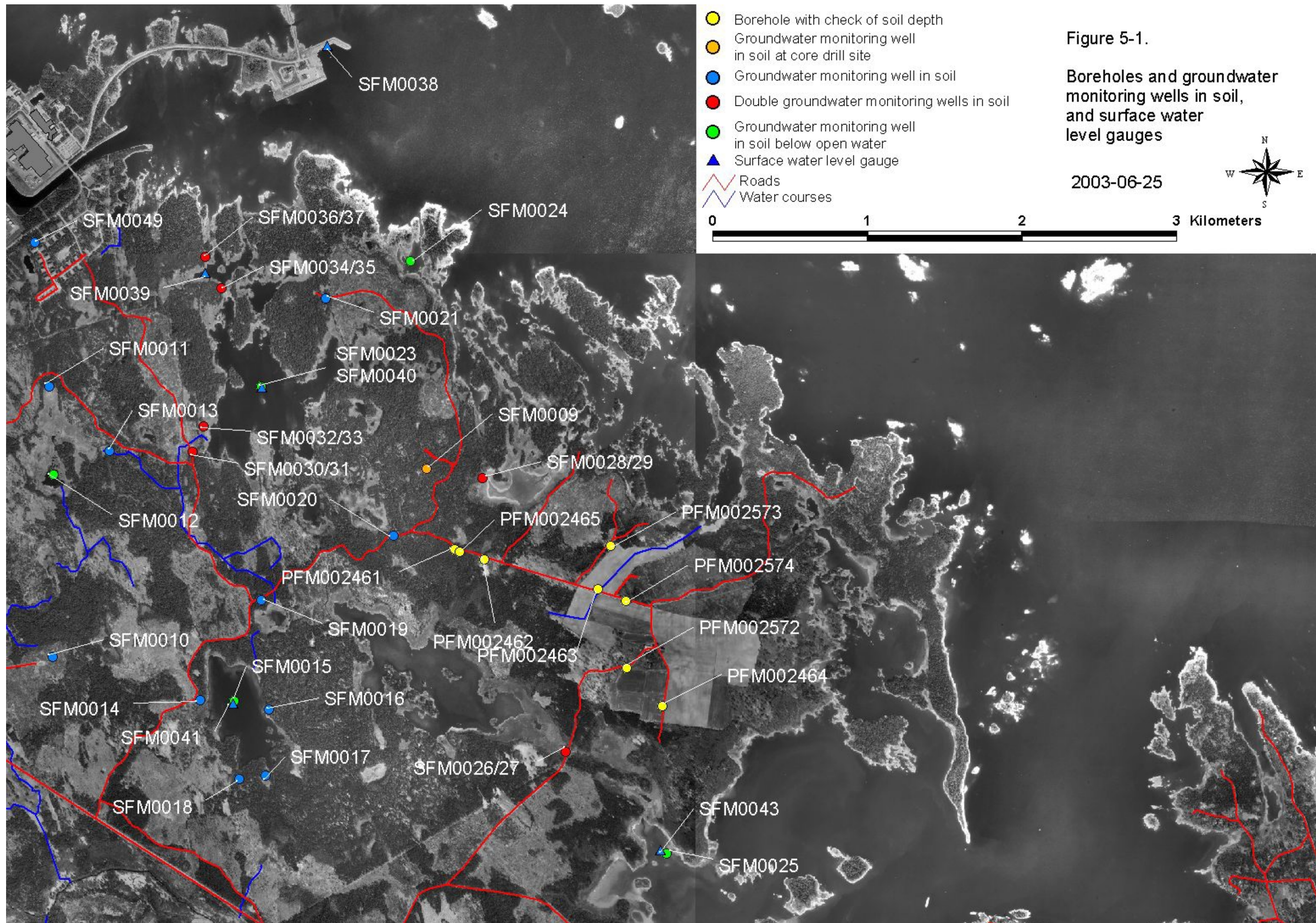
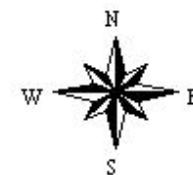


Figure 5-1.

Boreholes and groundwater monitoring wells in soil, and surface water level gauges

2003-06-25





**Table 5-1. Coordinates and type for all boreholes.**

<b>Borehole</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>Type</b>
SFM0009	6698577.50	1633223.50	4.638	Groundwater monitoring well at core drill site
SFM0010	6697313.87	1630734.94	13.536	Groundwater monitoring well, not at core drill site
SFM0011	6699117.11	1630711.39	6.439	Groundwater monitoring well, not at core drill site
SFM0012	6698492.25	1630719.10	2.853	Groundwater monitoring well below open water
SFM0013	6698698.54	1631122.63	4.395	Groundwater monitoring well, not at core drill site
SFM0014	6697027.00	1631715.50	6.611	Groundwater monitoring well, not at core drill site
SFM0015	6697009.79	1631964.04	5.925	Groundwater monitoring well below open water
SFM0016	6696976.139	1632173.940	6.185	Groundwater monitoring well, not at core drill site
SFM0017	6696504.809	1632138.155	6.687	Groundwater monitoring well, not at core drill site
SFM0018	6696557.50	1631950.00	6.671	Groundwater monitoring well, not at core drill site
SFM0019	6697700.72	1632118.35	4.772	Groundwater monitoring well, not at core drill site
SFM0020	6698126.800	1632993.654	2.248	Groundwater monitoring well, not at core drill site
SFM0021	6699706.354	1632492.992	1.970	Groundwater monitoring well, not at core drill site
SFM0023	6698982.51	1632064.42	1.568	Groundwater monitoring well below open water
SFM0024	6699944.40	1633108.79	0.469	Groundwater monitoring well below open water
SFM0025	6696039.39	1634774.05	0.858	Groundwater monitoring well below open water
SFM0026	6696702.648	1634151.843	1.585	Groundwater monitoring well, not at core drill site
SFM0027	6696685.210	1634146.664	1.745	Groundwater monitoring well, not at core drill site
SFM0028	6698507.93	1633588.91	1.066	Groundwater monitoring well, not at core drill site
SFM0029	6698510.19	1633588.89	1.081	Groundwater monitoring well, not at core drill site
SFM0030	6698678.20	1631662.72	2.786	Groundwater monitoring well, not at core drill site
SFM0031	6698681.55	1631661.09	2.631	Groundwater monitoring well, not at core drill site
SFM0032	6698838.26	1631725.79	1.626	Groundwater monitoring well, not at core drill site
SFM0033	6698839.01	1631728.18	1.694	Groundwater monitoring well, not at core drill site
SFM0034	6699757.487	1631858.504	1.575	Groundwater monitoring well, not at core drill site
SFM0035	6699756.250	1631859.162	1.488	Groundwater monitoring well, not at core drill site
SFM0036	6699991.991	1631746.072	1.505	Groundwater monitoring well, not at core drill site
SFM0037	6699991.932	1631744.409	1.499	Groundwater monitoring well, not at core drill site
SFM0038	6701375.07	1632560.63	2.549	Surface water gauge
SFM0039	6699867.01	1631751.42	1.404	Surface water gauge
SFM0040	6698983.16	1632063.77	1.064	Surface water gauge
SFM0041	6697010.49	1631963.34	5.766	Surface water gauge
SFM0043	6696040.29	1634774.45	0.396	Surface water gauge
SFM0049	6700027.549	1630533.057	4.029	Groundwater monitoring well, not at core drill site

**Table 5-1. Continued**

<b>Borehole</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>Type</b>
PFM002461	6698021.088	1633434.719	2.24	Borehole with check of soil depth
PFM002462	6697981.318	1633574.162	2.48	Borehole with check of soil depth
PFM002463	6697762.263	1634369.523	2.79	Borehole with check of soil depth
PFM002464	6697000.099	1634785.085	2.87	Borehole with check of soil depth
PFM002465	6698020.95	1633435.01	2.27	Borehole with check of soil depth
PFM002472	6697247.281	1634551.886	4.21	Borehole with check of soil depth
PFM002473	6698062.048	1634435.668	3.64	Borehole with check of soil depth
PFM002474	6697702.375	1634535.466	6.54	Borehole with check of soil depth

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

Location	Sample no.	Datum	Elec. Cond. ( $\mu\text{S/cm}$ )	Temp. ( $^{\circ}\text{C}$ )
SFM0009	4674	2003-03-31	29	5.6
SFM0010	4672	2003-04-03	43	2.0
SFM0011	4668	2003-03-31	577	4.4
SFM0012	4730	2003-04-24	502	8.0
SFM0013	4671	2003-03-31	556	4.3
SFM0014	4513	2003-02-18	406	3.2
SFM0015	4517	2003-02-26	132	8.8
SFM0016	4512	2003-02-27	121	6.2
SFM0017	4515	2003-02-25	176	5.9
SFM0018	4519	2003-02-27	132	5.2
SFM0019	4667	2003-03-25	239	4.6
SFM0020	4631	2003-03-17	270	4.5
SFM0021	4725	2003-04-08	40	2.9
SFM0023	4516	2003-03-04	5625	2.3
SFM0024	4670	2003-03-26	563	4.5
SFM0025	4634	2003-03-20	1360	2.4
SFM0026	4633	2003-03-24	401	5.7
SFM0027	4729	2003-04-25	56	3.2
SFM0028	4636	2003-03-19	292	5.8
SFM0030	4616	2003-03-11	501	2.8
SFM0032	4514	2003-03-04	320	3.2
SFM0034	4617	2003-03-11	1004	3.2
SFM0036	4632	2003-03-12	692	2.8
SFM0049	4673	2003-04-01	33	2.3
Eckarfjärden	4518	2003-02-26	64	0.9
Bolundsfjärden	4511	2003-03-03	98	0.4
Kallrigafjärden	4635	2003-03-20	330	0.5
Tixelfjärden	4669	2003-03-26	246	3.9
Gällsboträsket	4729	2003-04-24	25	

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**Borehole profiles**

<b>SWECO VIAK</b>		<b>FORSMARK Soil Sample PFM002461</b>	
Company rep. Mattias Helmersson and Patrik Schmutzer		Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70	Ground elevation : 2.24 m.a.s.l Sampling method : Auger
Client: Svensk Kärnbränslehantering AB		Northing : 6698021.088 Easting : 1633434.719	Borehole diameter : 100 mm Date of completion : 2003-02-27
Depth (m)	Elev. (m.a.s.l)	Description (determined in field)	Samples*
0		Organic soil	
2		sandy silty till	
1			1
			2
2			3
*SICADA Field note 105			

# SWECO VIAK

# FORSMARK Soil Sample PFM002462

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6697981.318 Easting : 1633574.162	Ground elevation : 2.48 m.a.s.l Sampling method : Auger Borehole diameter : 100 mm Date of completion : 2003-02-27
Client: Svensk Kärnbränslehantering AB		

Depth (m)	Elev. (m.a.s.l)	Description (determined in field)	Samples*
0		organic soil	
		sand (wash out)	1
			2
2		clayey till	
1		sandy silty till	
			3
2			
			4
0			
3			
			5
-1			
4			

\*SICADA Field note 105

# SWECO VIAK

# FORSMARK Soil Sample PFM002463

Company rep.  
Nils Lindqvist and Mesgena Gebrezghi

Coordinate system : RT 90 2.5 gon W 0:-15  
: RHB 70  
Northing : 6697762.263  
Easting : 1634369.523

Ground elevation : 2.79 m.a.s.l  
Sampling method : Auger  
Borehole diameter : 100 mm  
Date of completion : 2003-03-31

Client: Svensk Kärnbränslehantering AB

Depth (m)	Elev. (m.a.s.l)	Description (determined in field)	Samples*
0		clayey till	
1	2		1
2	1		2
3	0		3
4	-1	silty clayey till	4
5	-2		5
6	-3		6
7	-4	silty till	7
8	-5		8
9	-6		9
10	-7		10
11	-8		12
11		bed rock (heavily fractured)	11
12	-9	bed rock	

\*SICADA Field note 105



# SWECO VIAK

# FORSMARK Soil Sample 002464

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70	Ground elevation : 2.87 m.a.s.l Sampling method : Auger
Client: Svensk Kärnbränslehantering AB	Northing : 6697000.099 Easting : 1634785.085	Borehole diameter : 100 mm Date of completion : 2003-04-03

Depth (m)	Elev. (m.a.s.l.)	Description (determined in field)	Samples*
0		organic soil	
1	2	clayey till	1
2	1		2
3	0		3
4	-1		4
5	-2		5
6	-3		6
7	-4	silty till	7
8	-5		8
9	-6		9
			10
			11
10	-7	bed rock	12

\*SICADA Field note 105

# SWECO VIAK

# FORSMARK Soil Sample PFM002465

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6698020.95 Easting : 1633435.01	Ground elevation : 2.270 m.a.s.l Sampling method : Auger Borehole diameter : 100 mm Date of completion : 2003-03-28
Client: Svensk Kärnbränslehantering AB		

Depth (m)	Elev. (m.a.s.l)	Description (determined in field)	Samples*
0		organic soil	1
2		sand	2
1		clay	3
1		till	4
2			
0			
3			

\*SICADA Field note 105

<b>SWECO VIAK</b>		<b>FORSMARK Soil Sample PFM002572</b>	
Company rep. Nils Lindqvist and Mesgena Gebrezghi		Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70	Ground elevation : 4.21 m.a.s.l Sampling method : Auger
Client: Svensk Kärnbränslehantering AB		Northing : 6697247.281 Easting : 1634551.886	Borehole diameter : 100 mm Date of completion : 2003-04-07
Depth (m)	Elev. (m.a.s.l)	Description (determined in field)	Samples*
0		organic soil	
4		clayey till	1
1			2
3			3
2			4
2			5
3			6
1			
4		silty till	
0			
5		bed rock or very hard till	
-1			
6			
-2			
7			
-3		bed rock	
8			
*SICADA Field note 105			

SWECO VIAK		FORSMARK Soil Sample PFM002573	
Company rep. Nils Lindqvist and Mesgena Gebrezghi		Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70	Ground Elevation : 3.64 m.a.s.l Sampling method : Auger
Client: Svensk Kärnbränslehantering AB		Northing : 6698062.048 Easting : 1634435.668	Borehole diameter : 100 mm Date of completion : 2003-04-08
Depth (m)	Elev. (m.a.s.l)	Description (determined in field)	Samples*
0		organic soil	
		clayey till	1
3			
1		(clayey) silty till	2
2			
2			
1		silty till	3
3			
0			4
4			
-1			5
5		bed rock	6
-2			7
6			

\*SICADA Field note 105

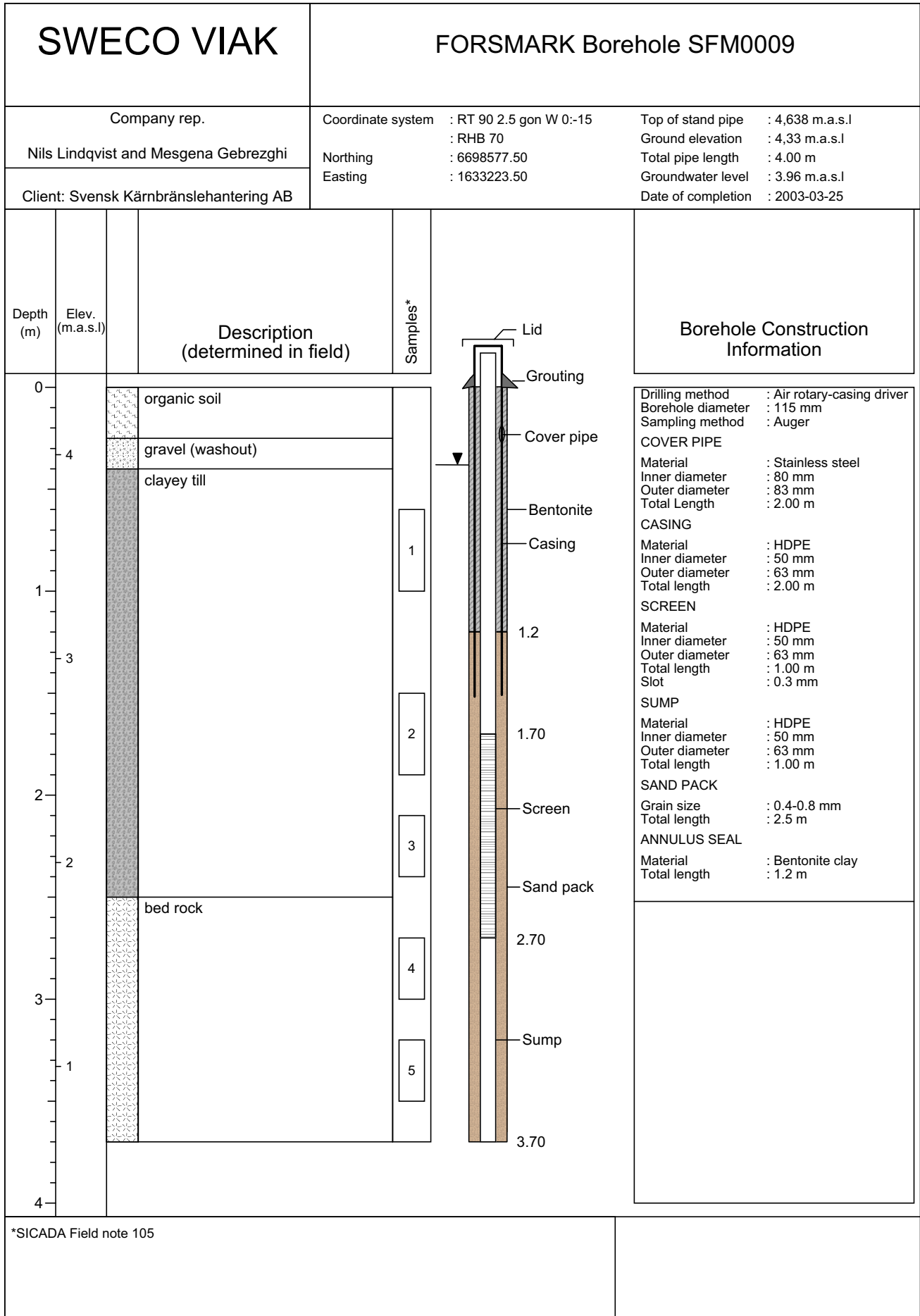
# SWECO VIAK

# FORSMARK Soil Sample PFM002574

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6697702.375 Easting : 1634535.466	Ground elevation : 6.54 m.a.s.l Sampling method : Auger Borehole diameter : 100 mm Date of completion : 2003-04-09
Client: Svensk Kärnbränslehantering AB		

Depth (m)	Elev. (m.a.s.l)	Description (determined in field)	Samples*
0		organic soil	
6		(clayey) silty till	1
5			2
2		bed rock	3
4			
3			

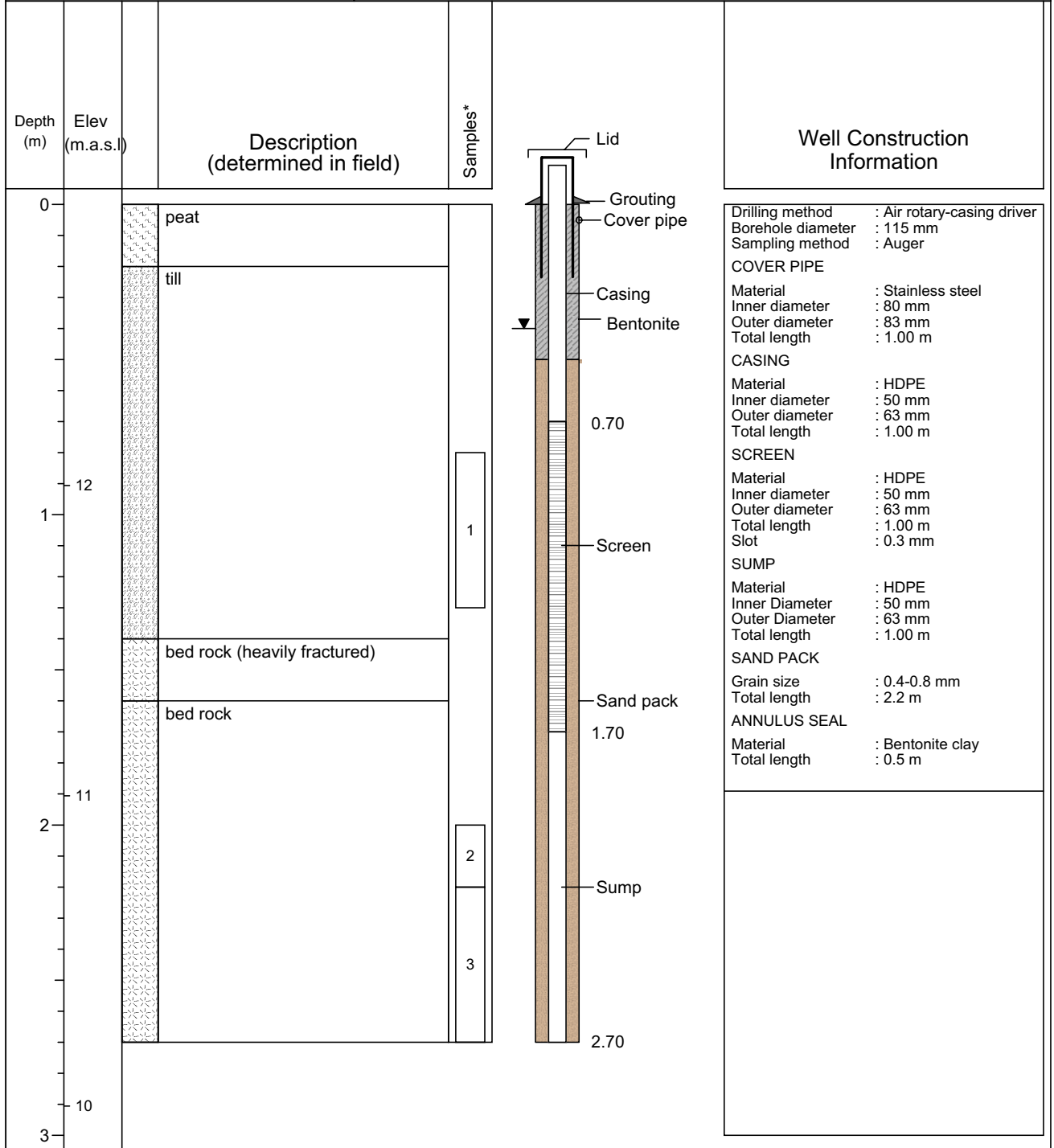
\*SICADA Field note 105



# SWECO VIAK

# FORSMARK Borehole SFM0010

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6697313.871 Easting : 1630734.944	Top of stand pipe : 13.536 m.a.s.l Ground elevation : 12.90 m.a.s.l Total pipe length : 3.00 m Groundwater level : 12.84 m.a.s.l Date of completion : 2003-03-27
Client: Svensk Kärnbränslehantering AB		

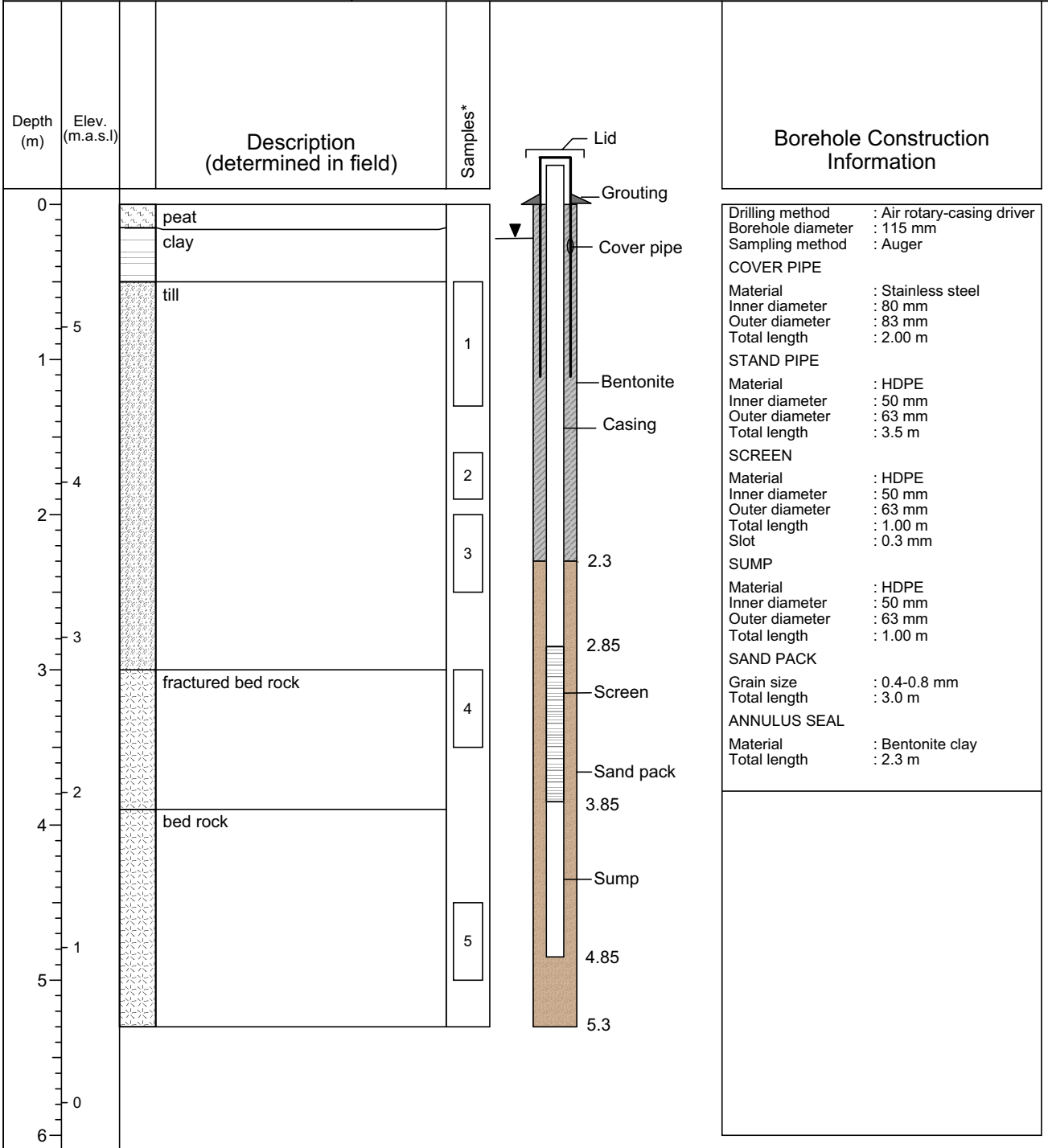


\*SICADA Field note 105

# SWECO VIAK

# FORSMARK Borehole SFM0011

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0-15 : RHB 70 Northing : 6699117.105 Easting : 1630711.386	Top of stand pipe : 6.439 m.a.s.l Ground elevation : 5.79 m.a.s.l Total pipe length : 5.50 m Groundwater level : 5.57 m.a.s.l Date of completion : 2003-03-26
Client: Svensk Kärnbränslehantering AB		



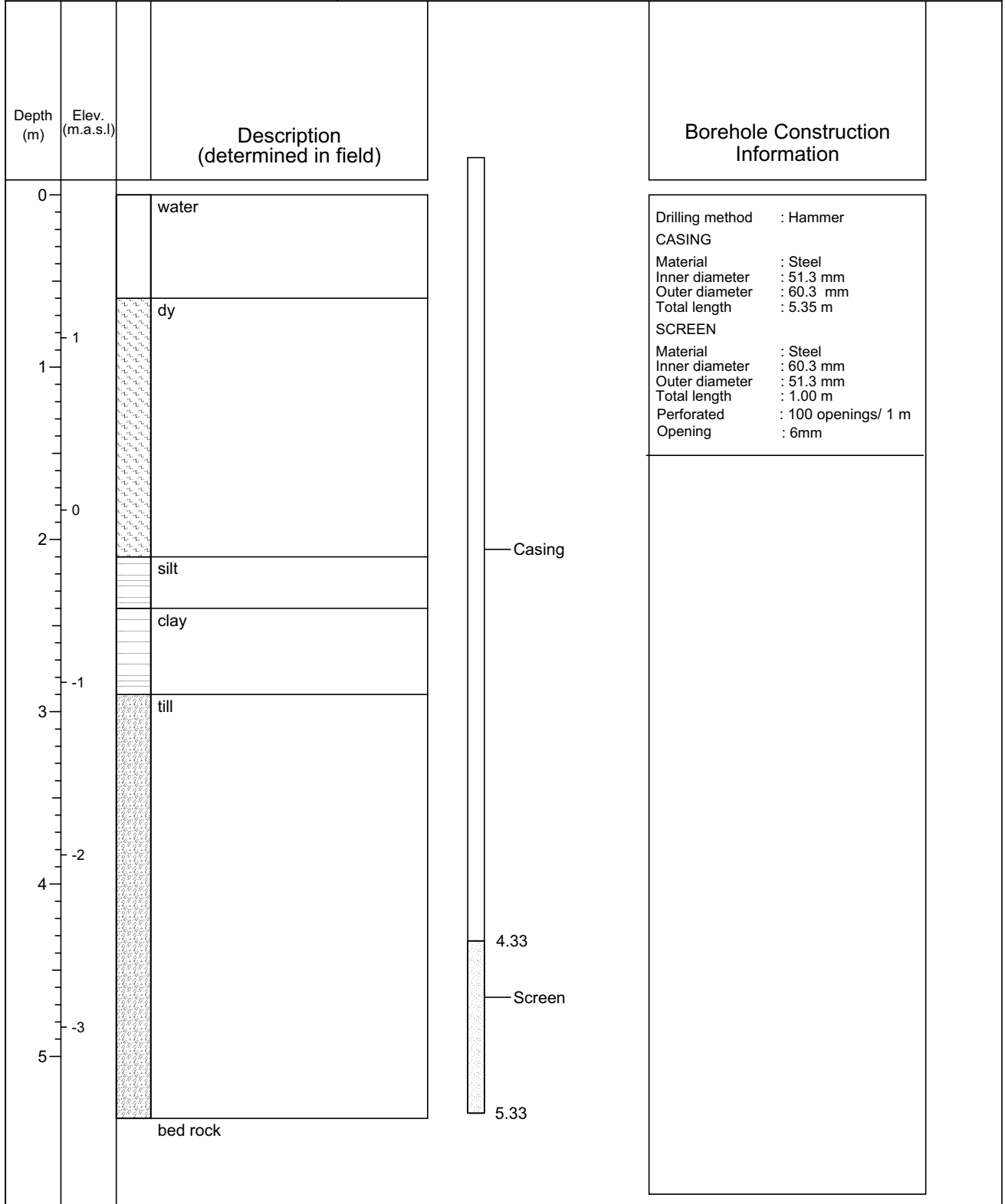
\*SICADA Field note 105



# SWECO VIAK

# FORSMARK Borehole SFM0012

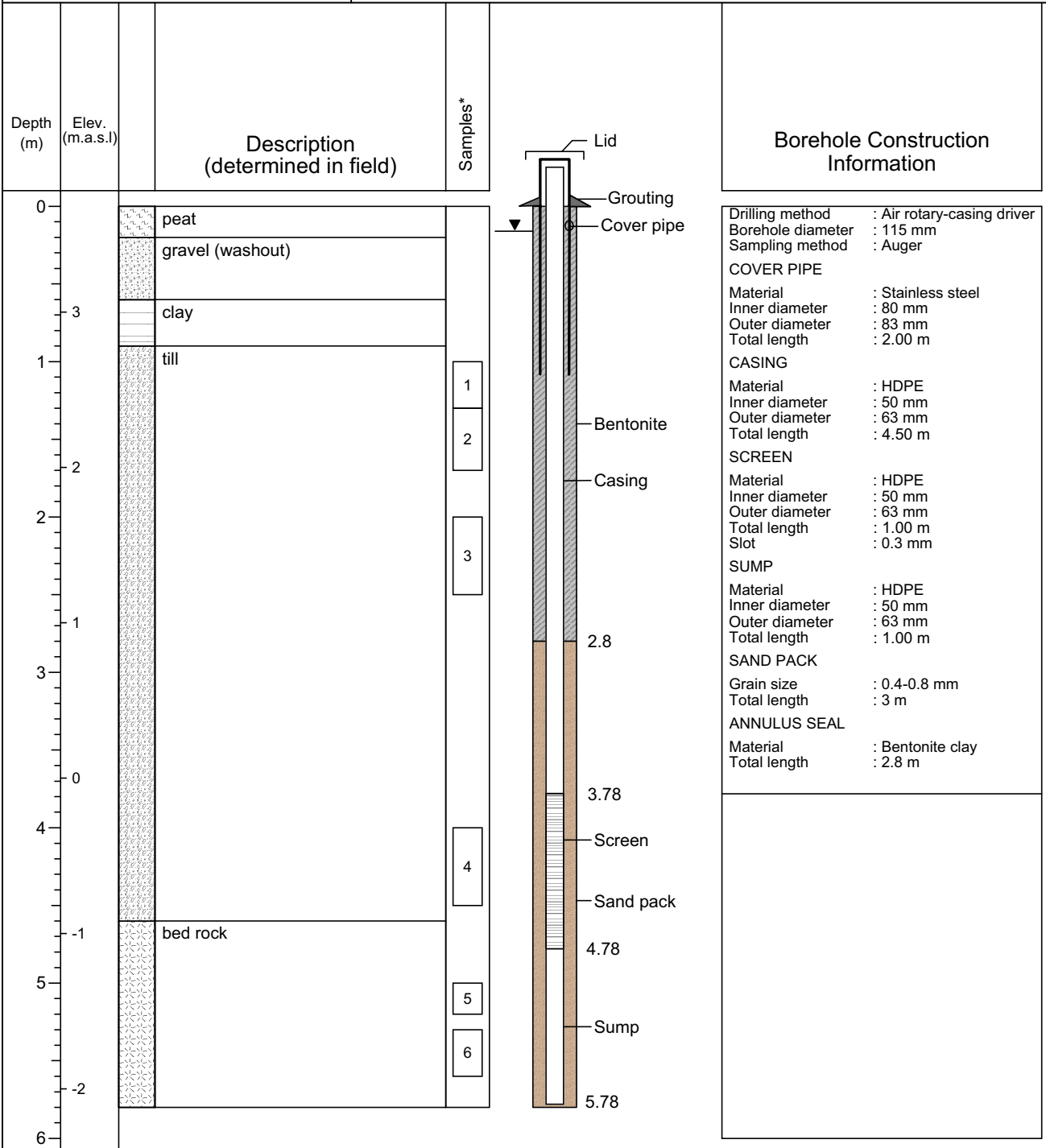
Company rep. Mattias Helmersson and Patrik Schmutzer	Coordinate system : RT 90 2.5 gon W 0:-15 Northing : 6698492.25 Easting : 1630719.10	Top of stand pipe : 2.853 m.a.s.l Water elevation : 1.83 m.a.s.l Total pipe length : 6.35 m Groundwater level : 1.89 m.a.s.l Date of completion : 2003-02-24
Client: Svensk Kärnbränslehantering AB		



# SWECO VIAK

# FORSMARK Borehole SFM0013

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70	Top of stand pipe : 4.395 m.a.s.l Ground elevation : 3.68 m.a.s.l
	Northing : 6698698.535 Easting : 1631122.632	Total pipe length : 6.50 m Groundwater level : 3.52 m.a.s.l Date of completion : 2003-03-29
Client: Svensk Kärnbränslehantering AB		

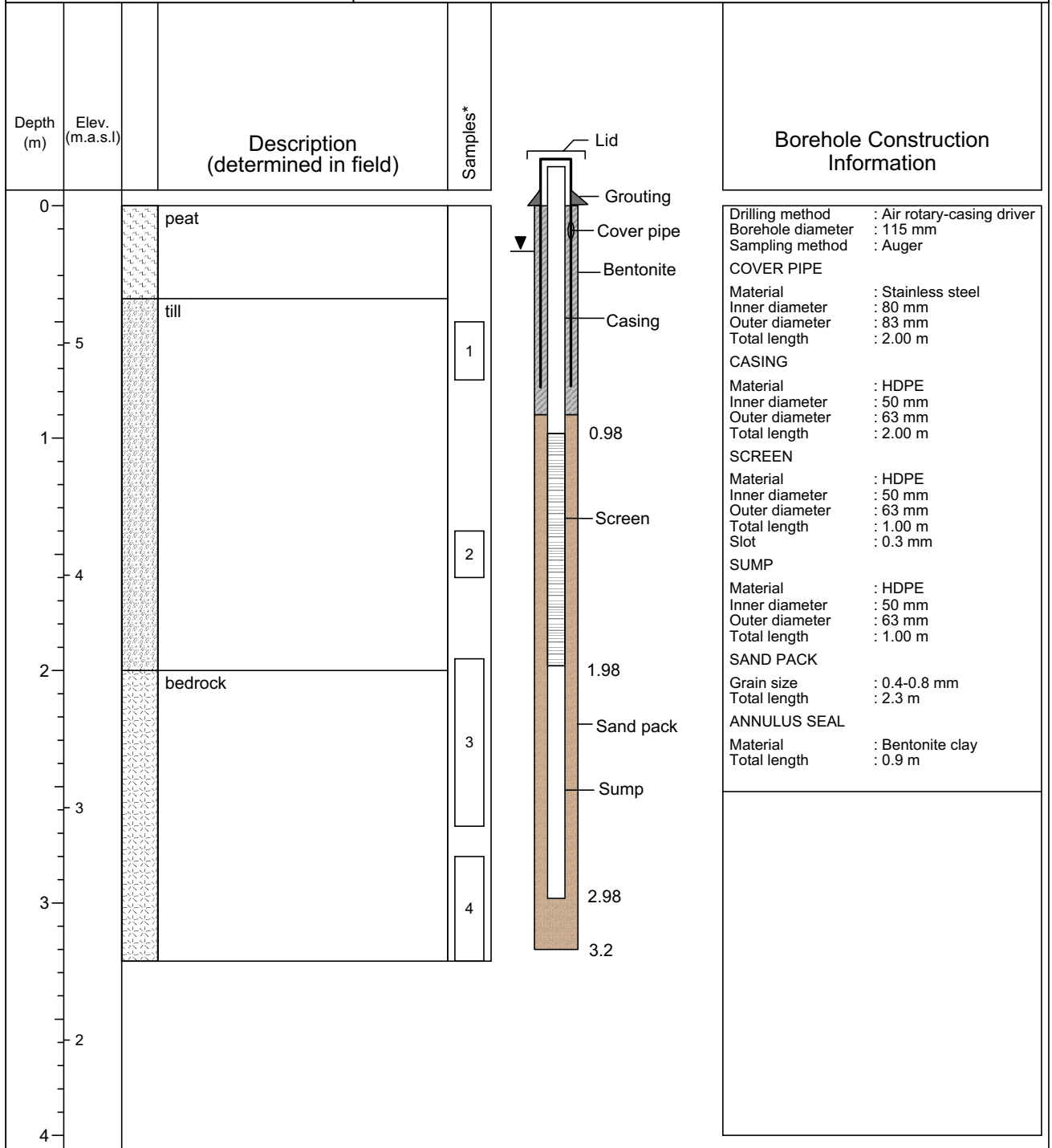


\*SICADA Field note 105

# SWECO VIAK

# FORSMARK Borehole SFM0014

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6697025.678 Easting : 1631715.724	Top of stand pipe : 6.611 m.a.s.l Ground elevation : 5.59 m.a.s.l Total pipe length : 4.00 m Groundwater level : 5.40 m.a.s.l Date of completion : 2003-02-18
Client: Svensk Kärnbränslehantering AB		

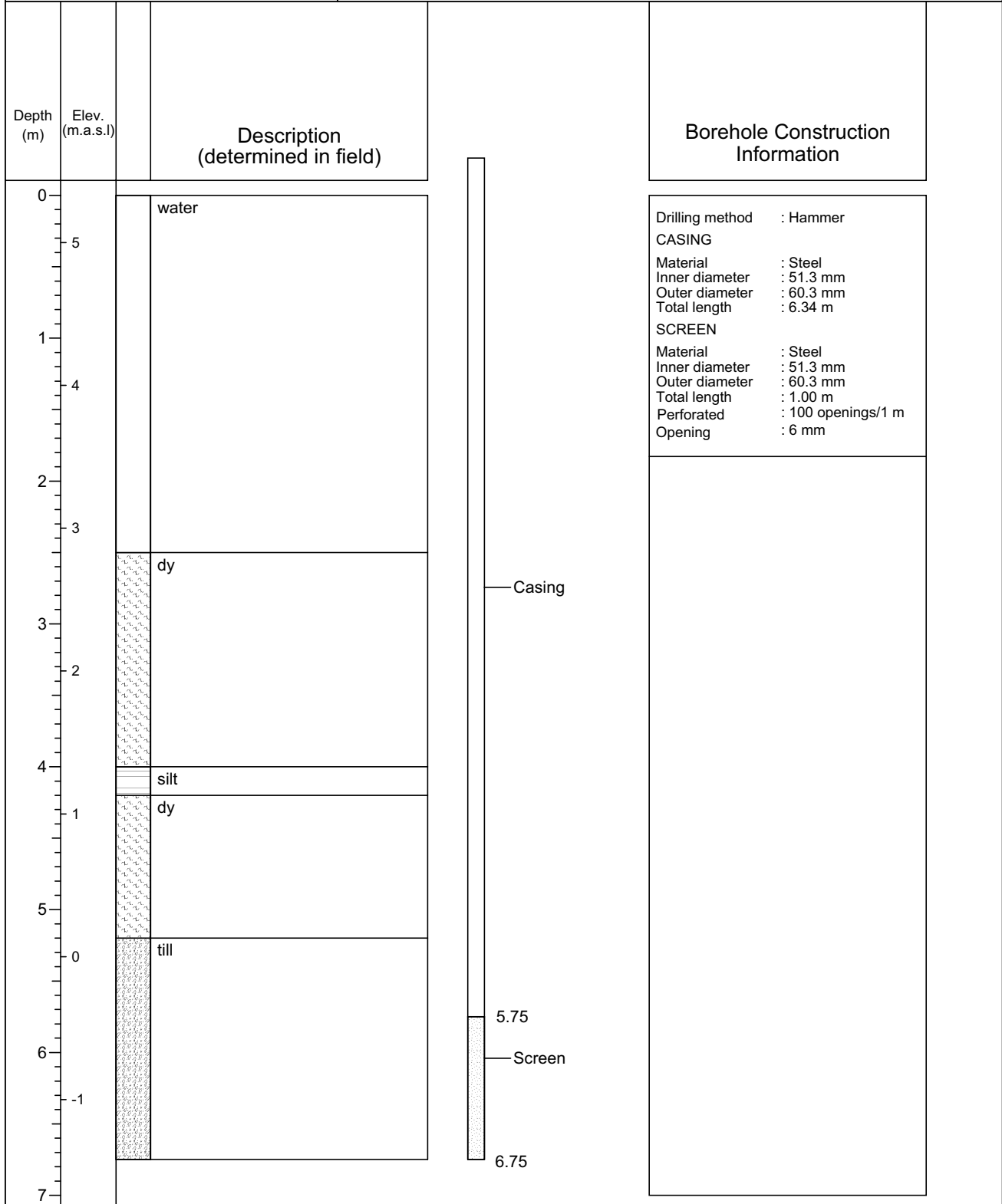


\*SICADA Field note 105

# SWECO VIAK

## FORSMARK Borehole SFM0015

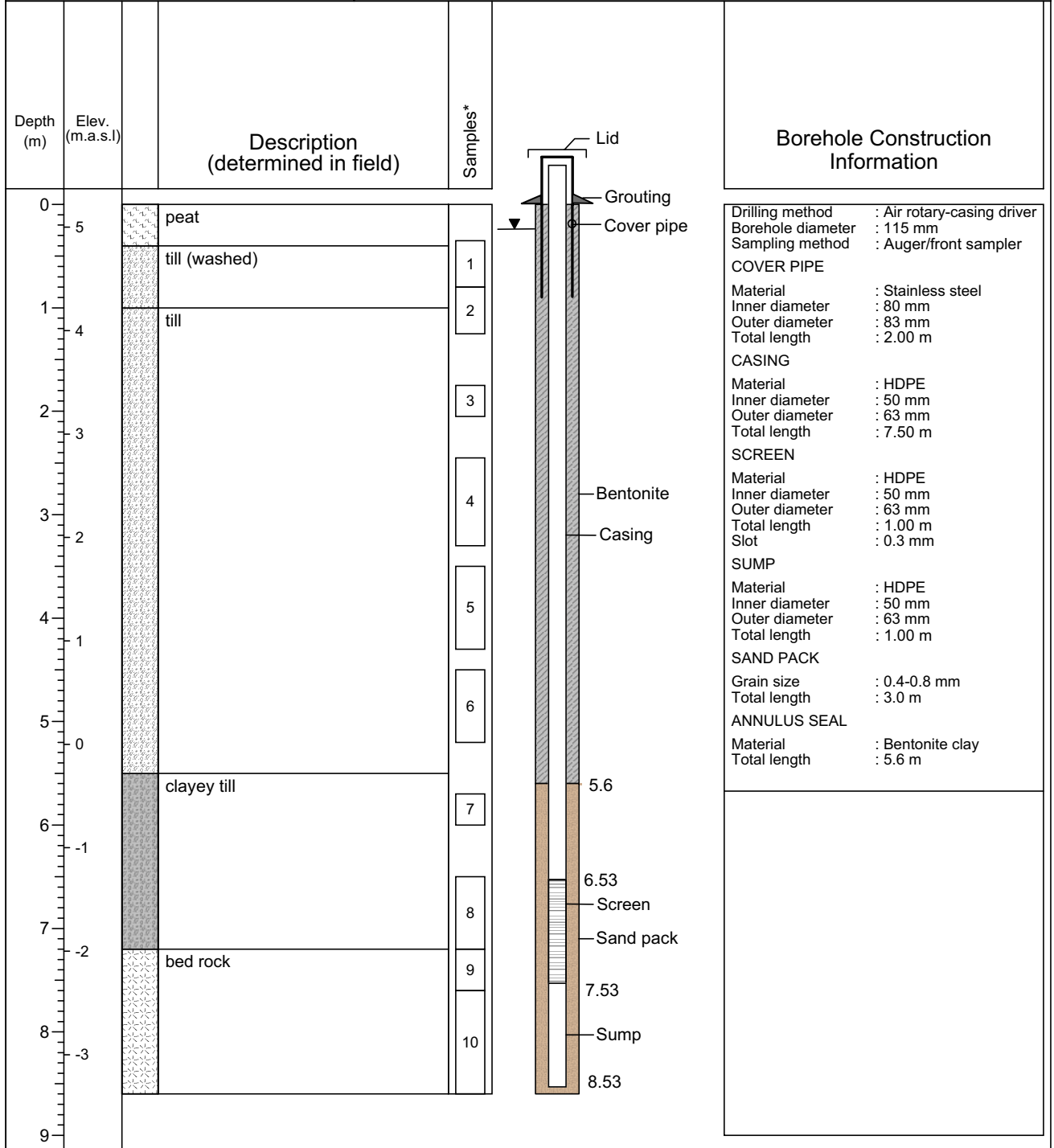
Company rep. Mattias Helmersson and Patrik Schmutzer	Coordinate system : RT 90 2.5 gon W 0:-15 RHB 70 Northing : 6697009.79 Easting : 1631964.04	Top of stand pipe : 5.925 m.a.s.l Water elevation : 5.33 m.a.s.l Total pipe length : 7.34 m Groundwater level : 5.33 m.a.s.l Date of completion : 2003-02-20
Client: Svensk Kärnbränslehantering AB		



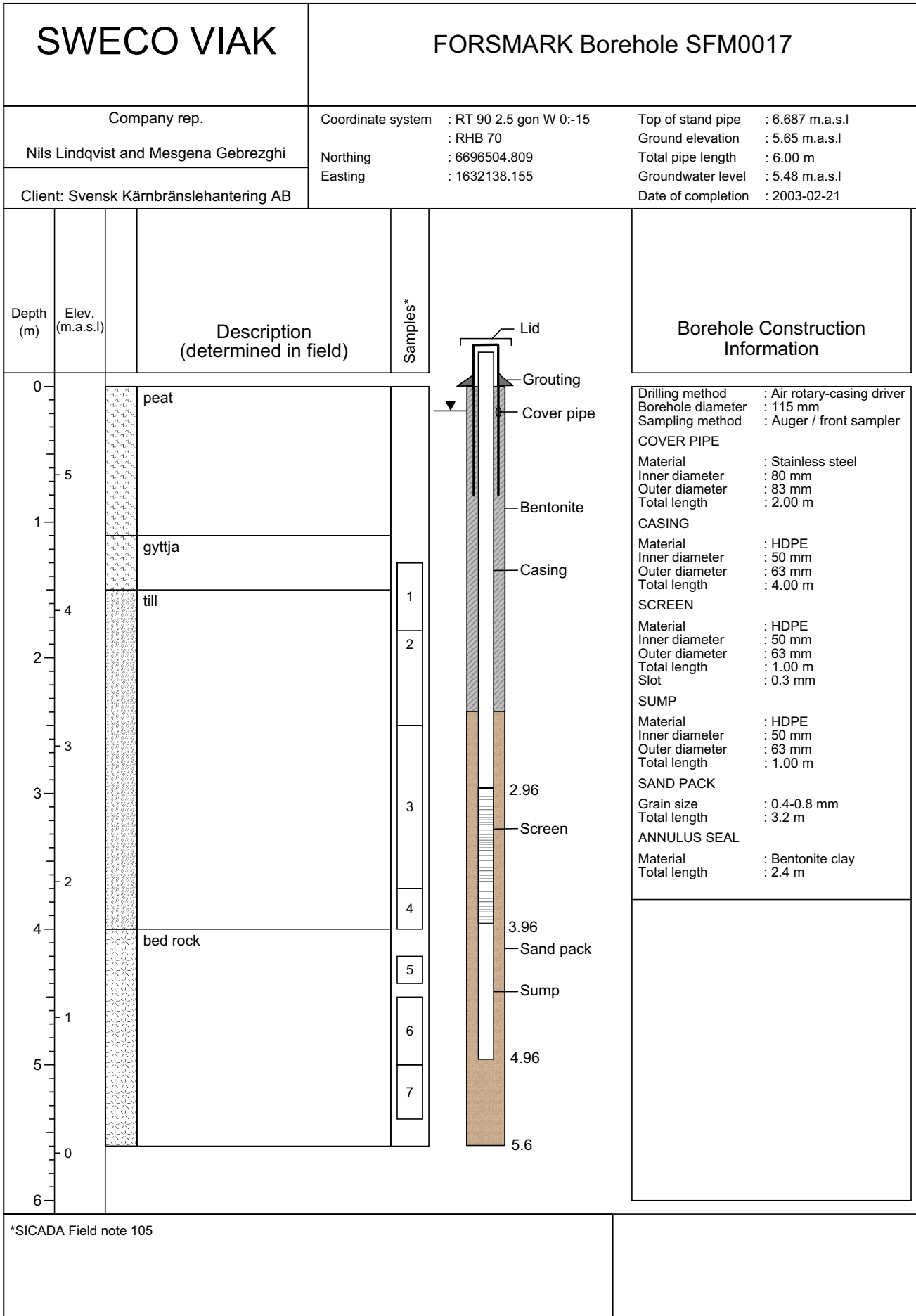
# SWECO VIAK

# FORSMARK Borehole SFM0016

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6696976.139 Easting : 1632173.940	Top of stand pipe : 6.185 m.a.s.l Ground elevation : 5.22 m.a.s.l Total pipe length : 9.50 m Groundwater level : 5.12 m.a.s.l Date of completion : 2003-02-19
Client: Svensk Kärnbränslehantering AB		



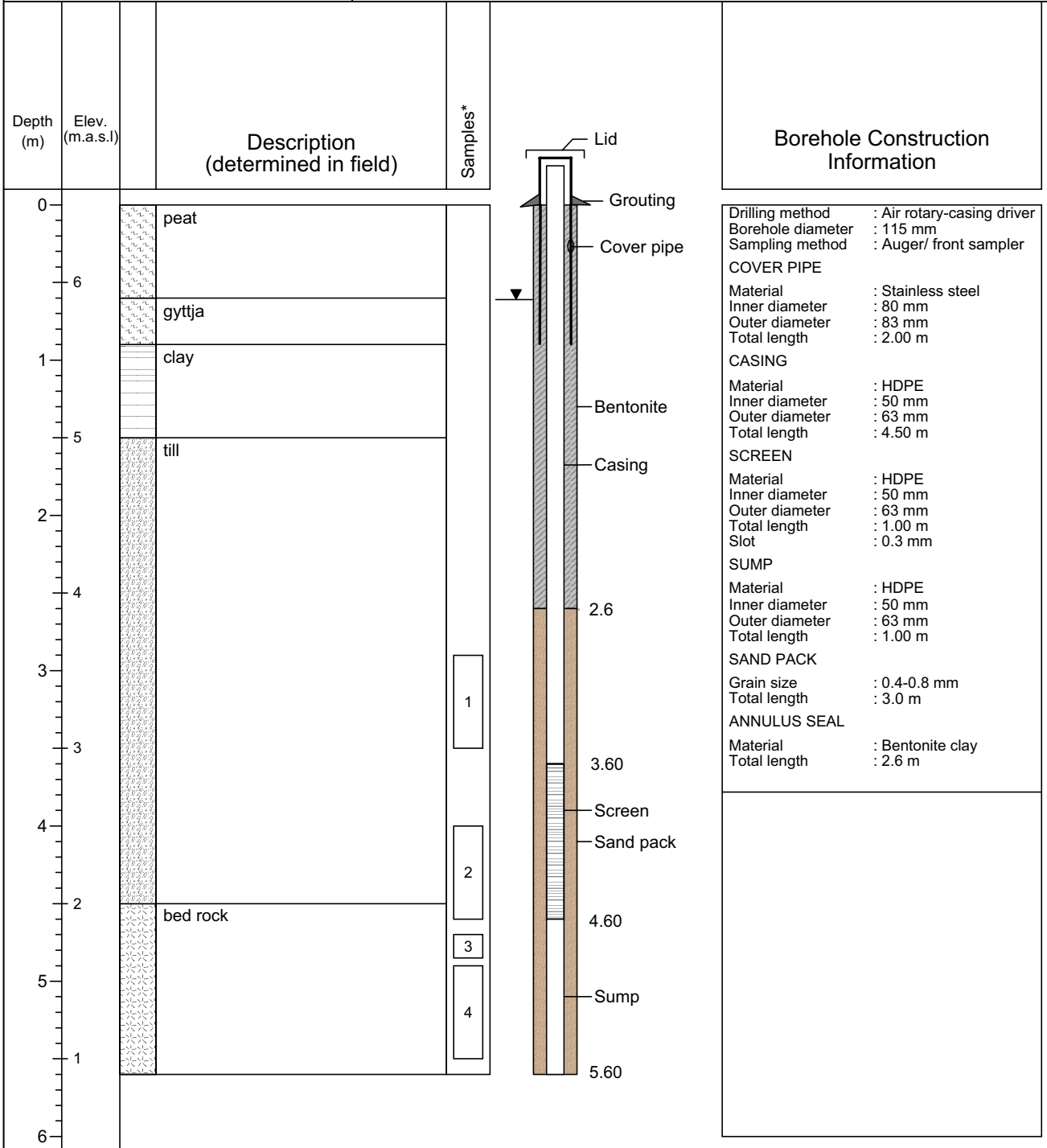
\*SICADA Field note 105



# SWECO VIAK

# FORSMARK Borehole SFM0018

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15	Top of stand pipe : 6.671 m.a.s.l
	Northing : 6696557.50	Ground elevation : 5.77 m.a.s.l
Client: Svensk Kärnbränslehantering AB	Easting : 1631950.00	Total pipe length : 6.50 m
		Groundwater level : 5.17 m.a.s.l
		Date of completion : 2003-02-25

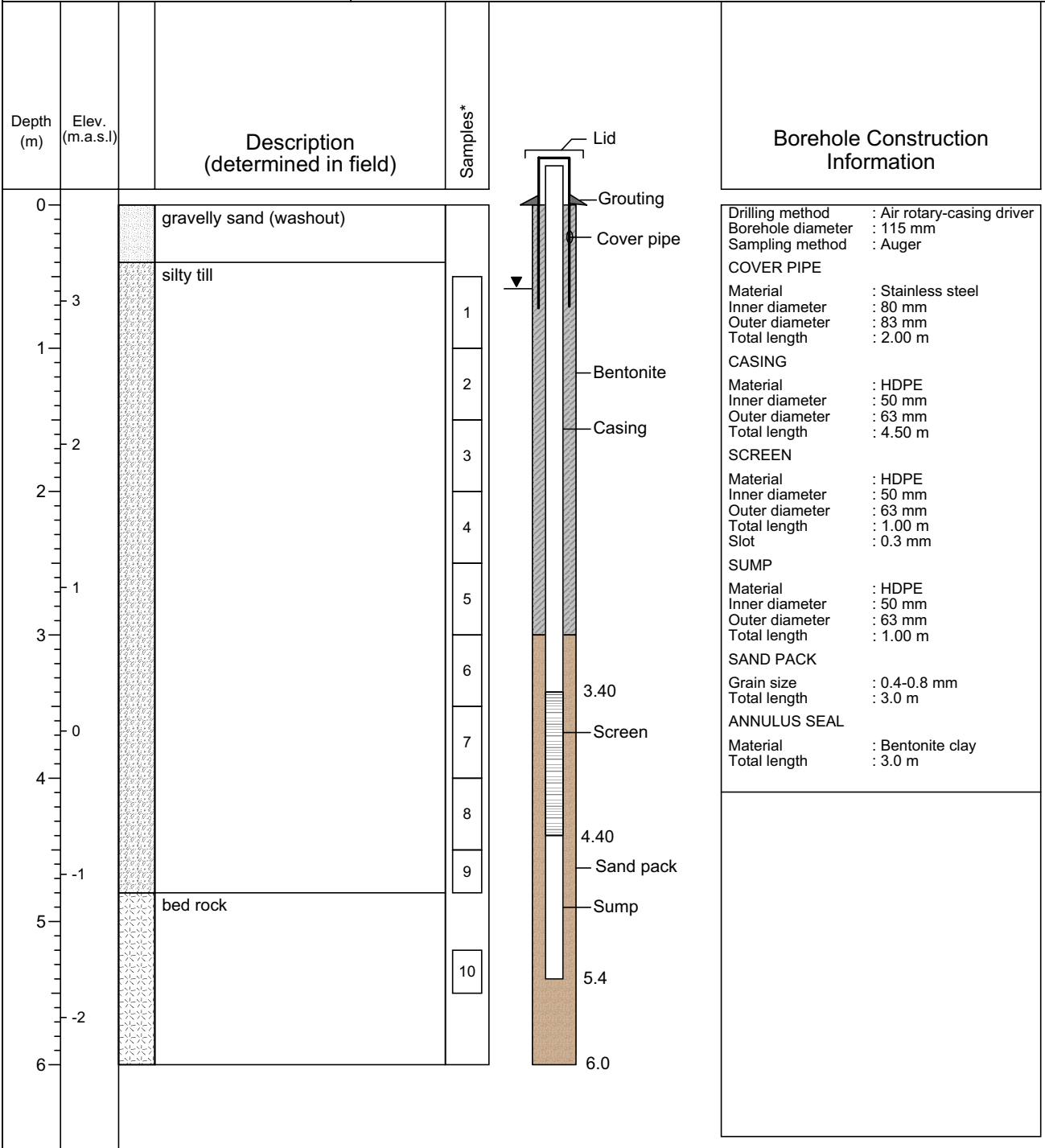


\*SICADA Field note 105

# SWECO VIAK

# FORSMARK Borehole SFM0019

Company rep.		Coordinate system : RT 90 2.5 gon W 0:-15	Top of stand pipe : 4.772 m.a.s.l
Nils Lindqvist and Mesgena Gebrezghi		: RHB 70	Ground elevation : 3.67 m.a.s.l
Client: Svensk Kärnbränslehantering AB		Northing : 6697700.720	Total pipe length : 6.50 m
		Easting : 1632118.353	Groundwater level : 3.09 m.a.s.l
			Date of completion : 2003-03-21



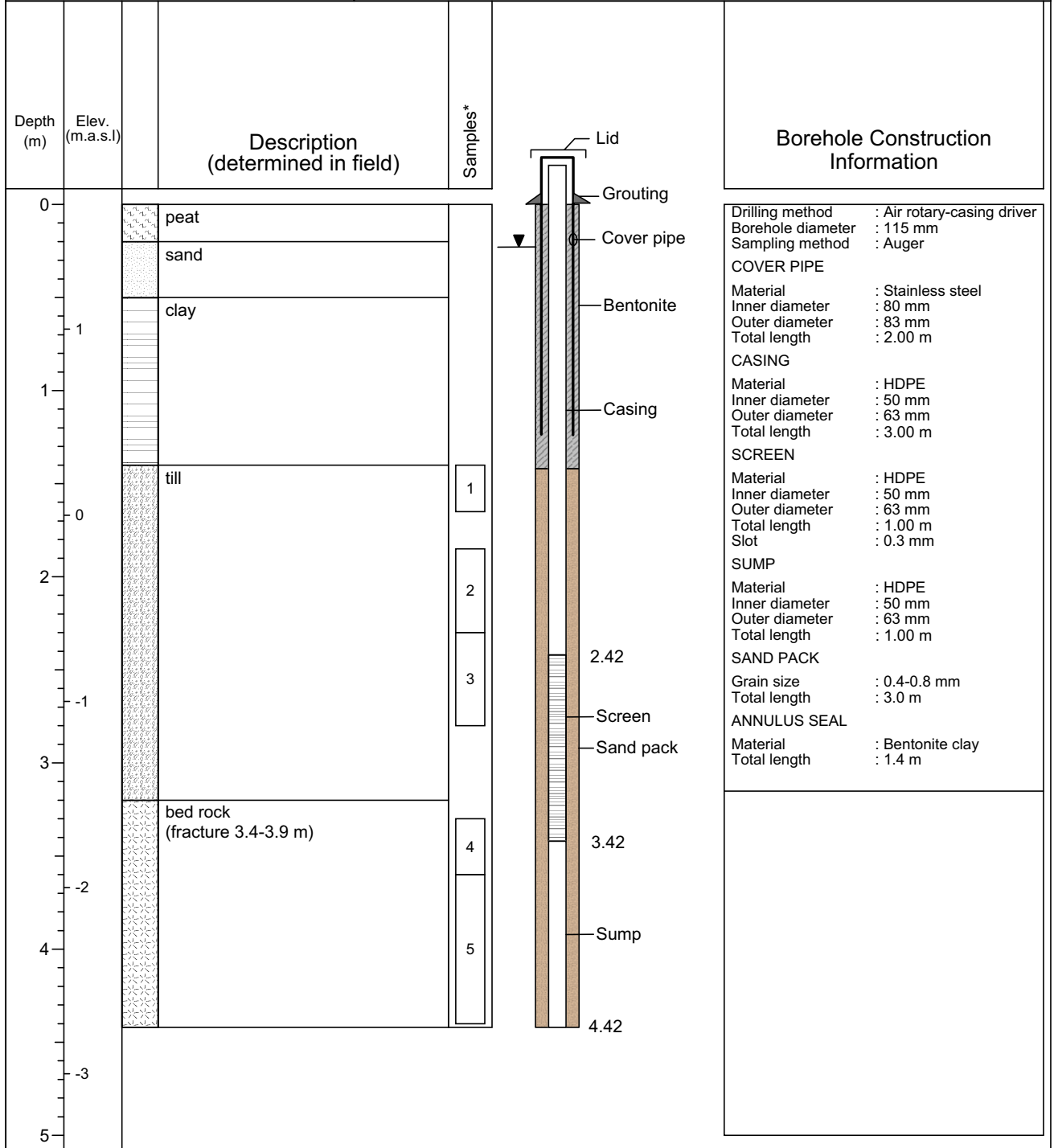
\*SICADA Field note 105



# SWECO VIAK

# FORSMARK Borehole SFM0020

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6698126.800 Easting : 1632993.654	Top of stand pipe : 2.248 m.a.s.l Ground elevation : 1.67 m.a.s.l Total pipe length : 5.00 m Groundwater level : 1.44 m.a.s.l Date of completion : 2003-03-12
Client: Svensk Kärnbränslehantering AB		

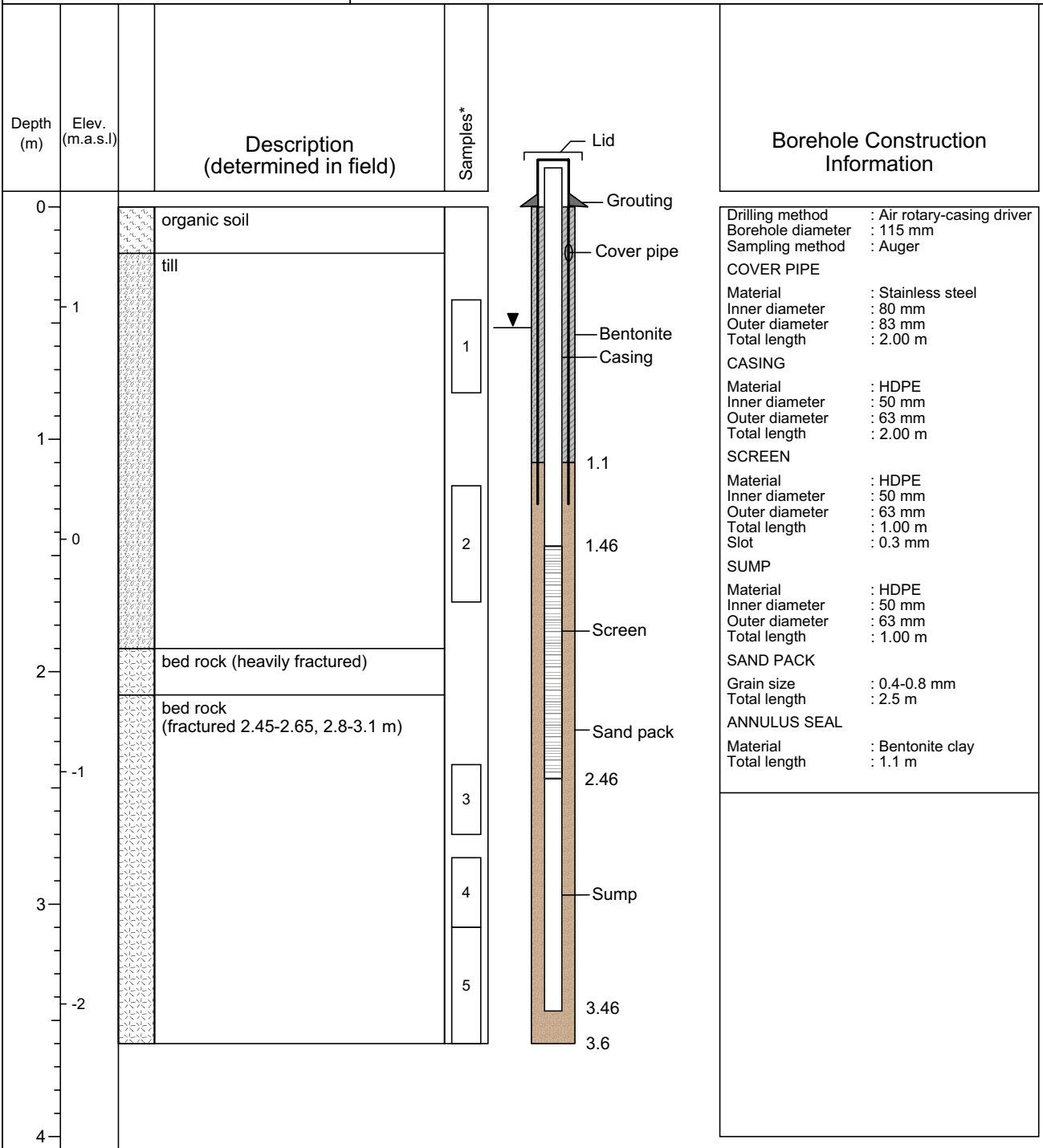


\*SICADA Field note 105

# SWECO VIAK

# FORSMARK Borehole SFM0021

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6699706.354 Easting : 1632492.992	Top of stand pipe : 1.970 m.a.s.l Ground elevation : 1.43 m.a.s.l Total pipe length : 4.00 m Groundwater level : 0.91 m.a.s.l Date of completion : 2003-03-24
Client: Svensk Kärnbränslehantering AB		

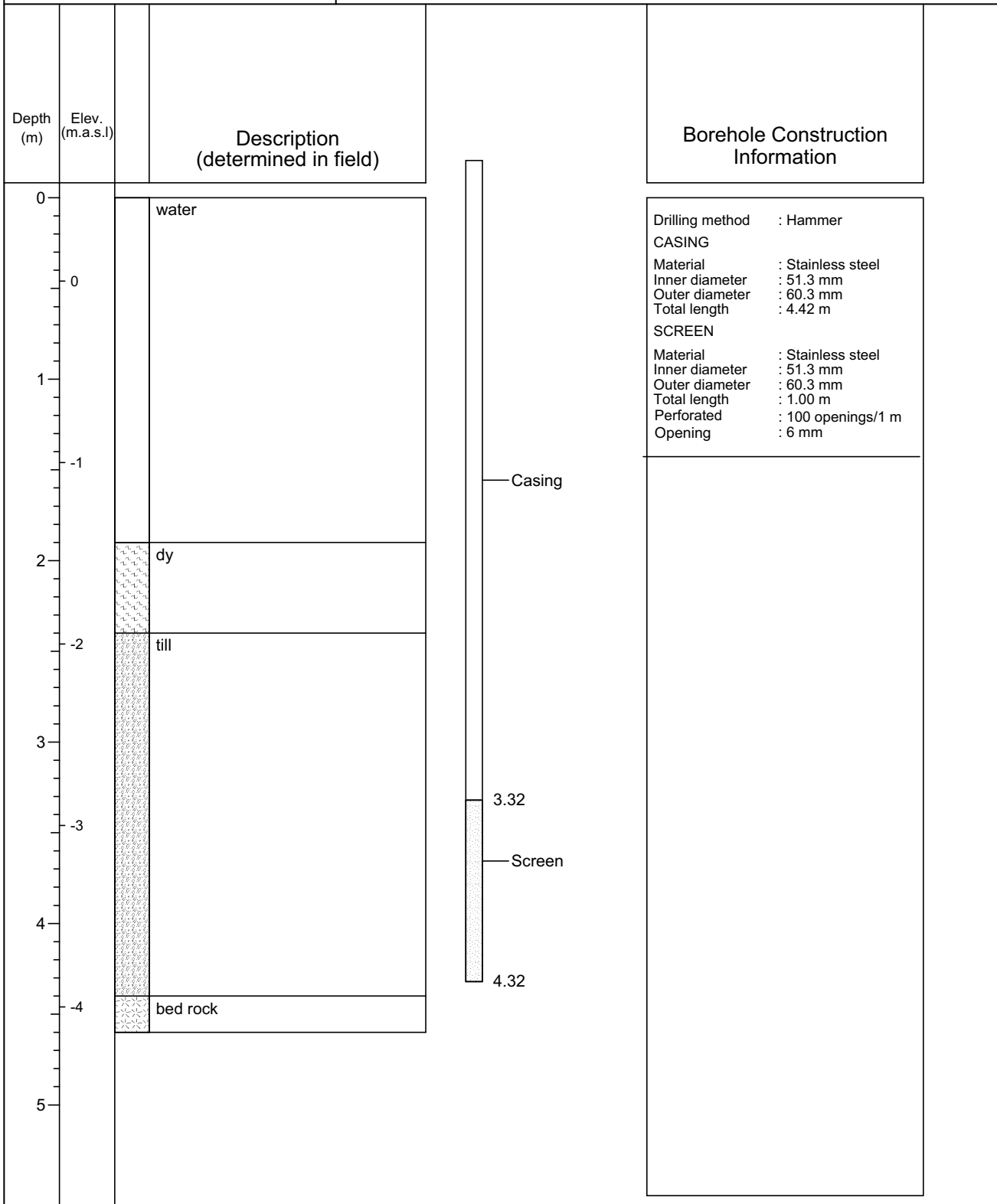


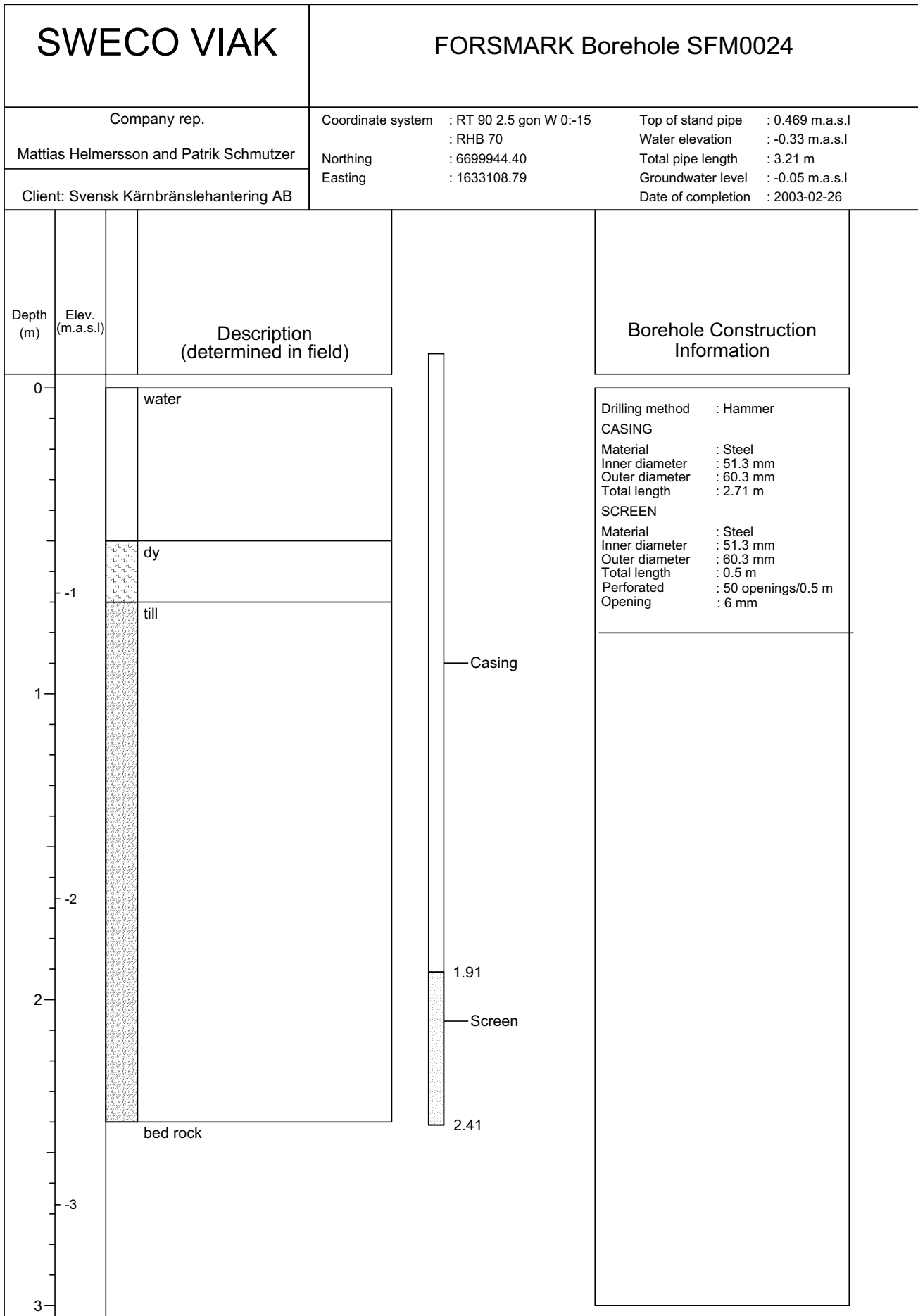
\*SICADA Field note 105

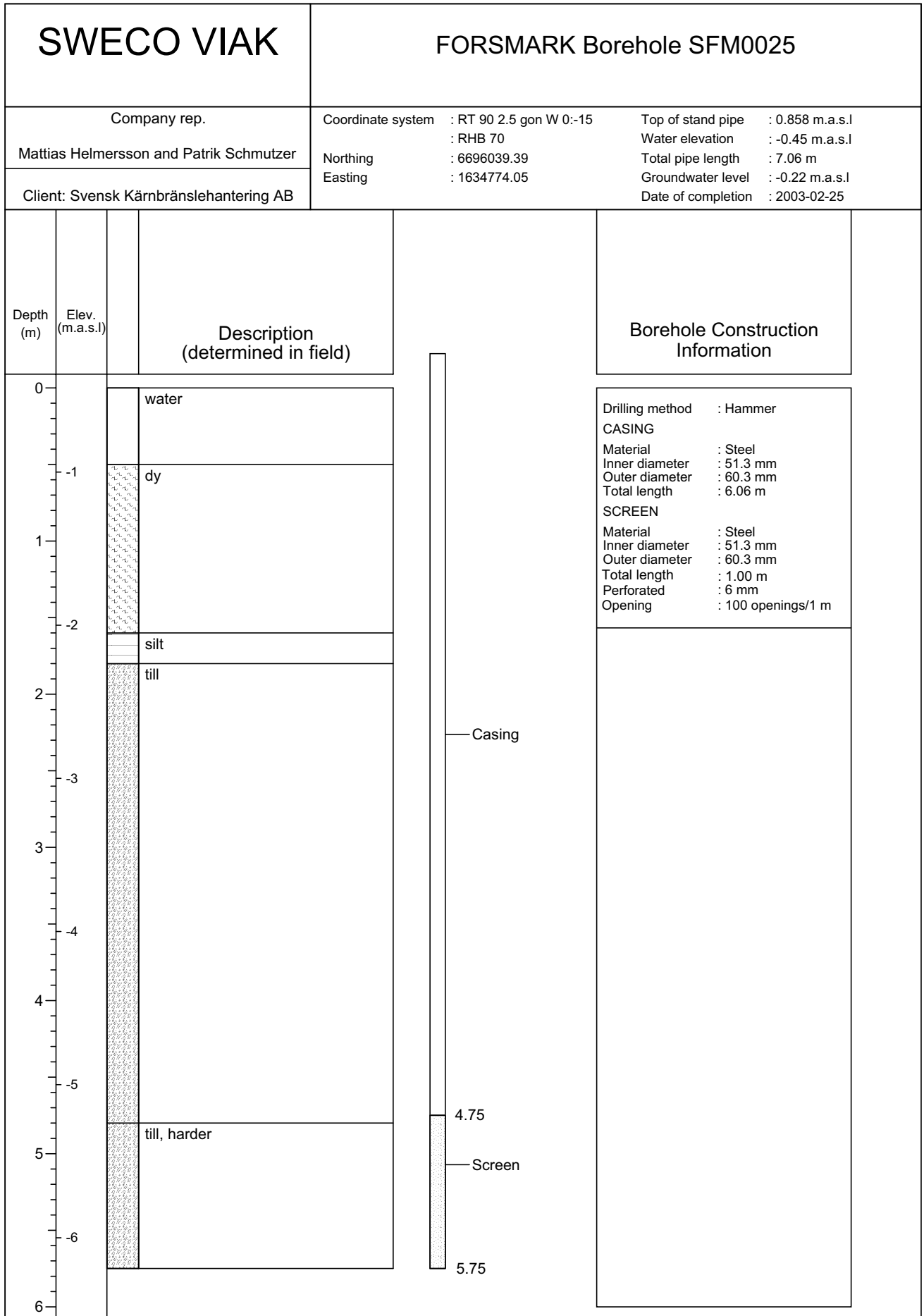
# SWECO VIAK

# FORSMARK Borehole SFM0023

Company rep. <b>Mattias Helmersson Patrik Schmutzer</b>	Coordinate system : RT 90 2.5 gon W 0:-15	Top of stand pipe : 1.568 m.a.s.l
	: RHB 70	Water elevation : 0.47 m.a.s.l
Client: Svensk Kärnbränslehantering AB	Northing : 6698982.51	Total pipe length : 5.42 m
	Easting : 1632064.42	Groundwater level : 1.04 m.a.s.l
		Date of completion : 2003-02-21

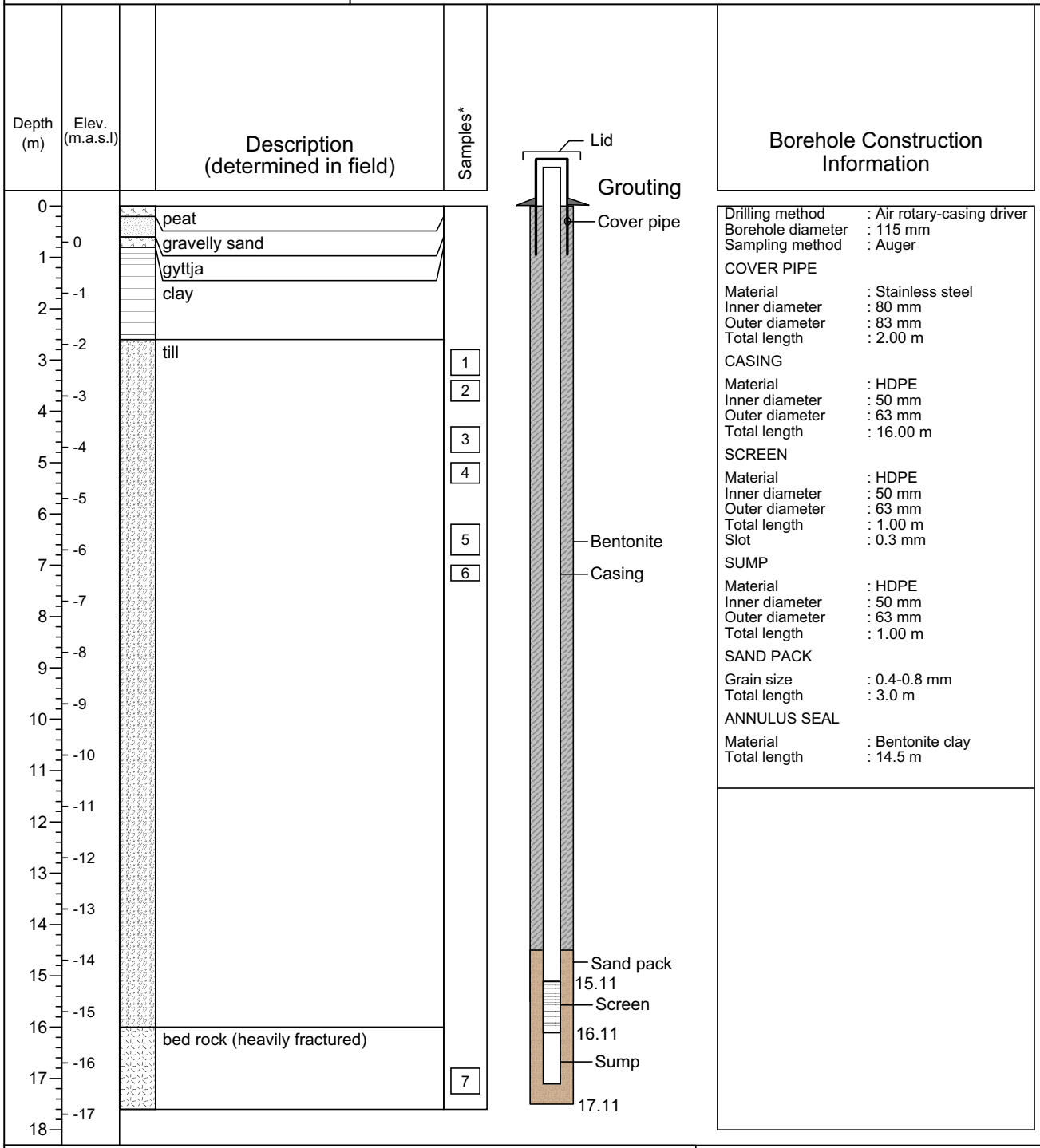






<h1 style="margin:0;">SWECO VIAK</h1>	<h2 style="margin:0;">FORSMARK Borehole SFM0026</h2>
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Company rep. Nils Lindqvist and Mesgena Gebrezghi Client: Svensk Kärnbränslehantering AB	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6696702.648 Easting : 1634151.843	Top of stand pipe : 1.585 m.a.s.l Ground elevation : 0.70 m.a.s.l Total pipe length : 18.00 m Groundwater level : 0.92 m.a.s.l Date of completion : 2003-03-18
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### Borehole Construction Information

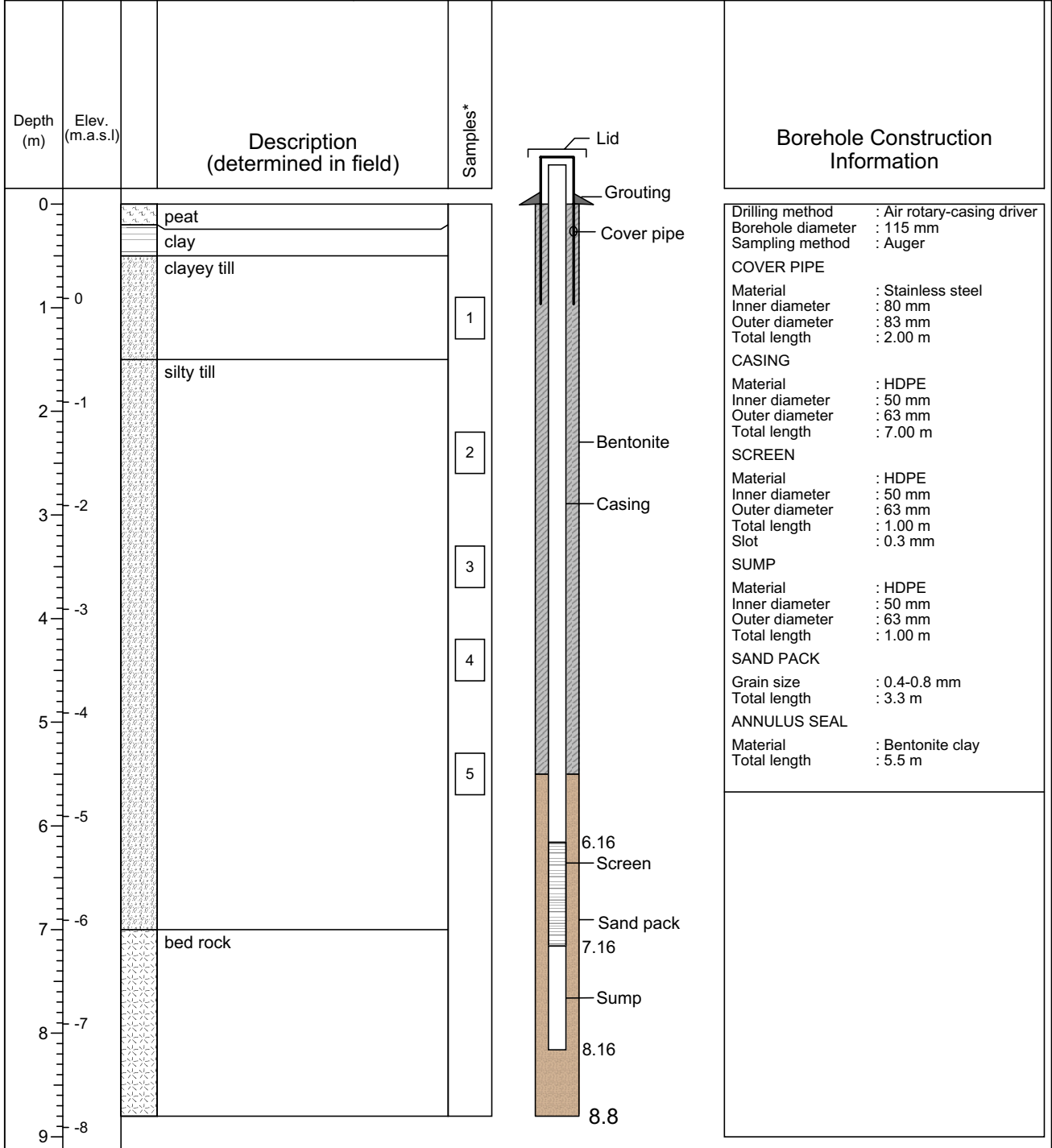
Drilling method	: Air rotary-casing driver
Borehole diameter	: 115 mm
Sampling method	: Auger
<b>COVER PIPE</b>	
Material	: Stainless steel
Inner diameter	: 80 mm
Outer diameter	: 83 mm
Total length	: 2.00 m
<b>CASING</b>	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 16.00 m
<b>SCREEN</b>	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
Slot	: 0.3 mm
<b>SUMP</b>	
Material	: HDPE
Inner diameter	: 50 mm
Outer diameter	: 63 mm
Total length	: 1.00 m
<b>SAND PACK</b>	
Grain size	: 0.4-0.8 mm
Total length	: 3.0 m
<b>ANNULUS SEAL</b>	
Material	: Bentonite clay
Total length	: 14.5 m

\*SICADA Field note 105

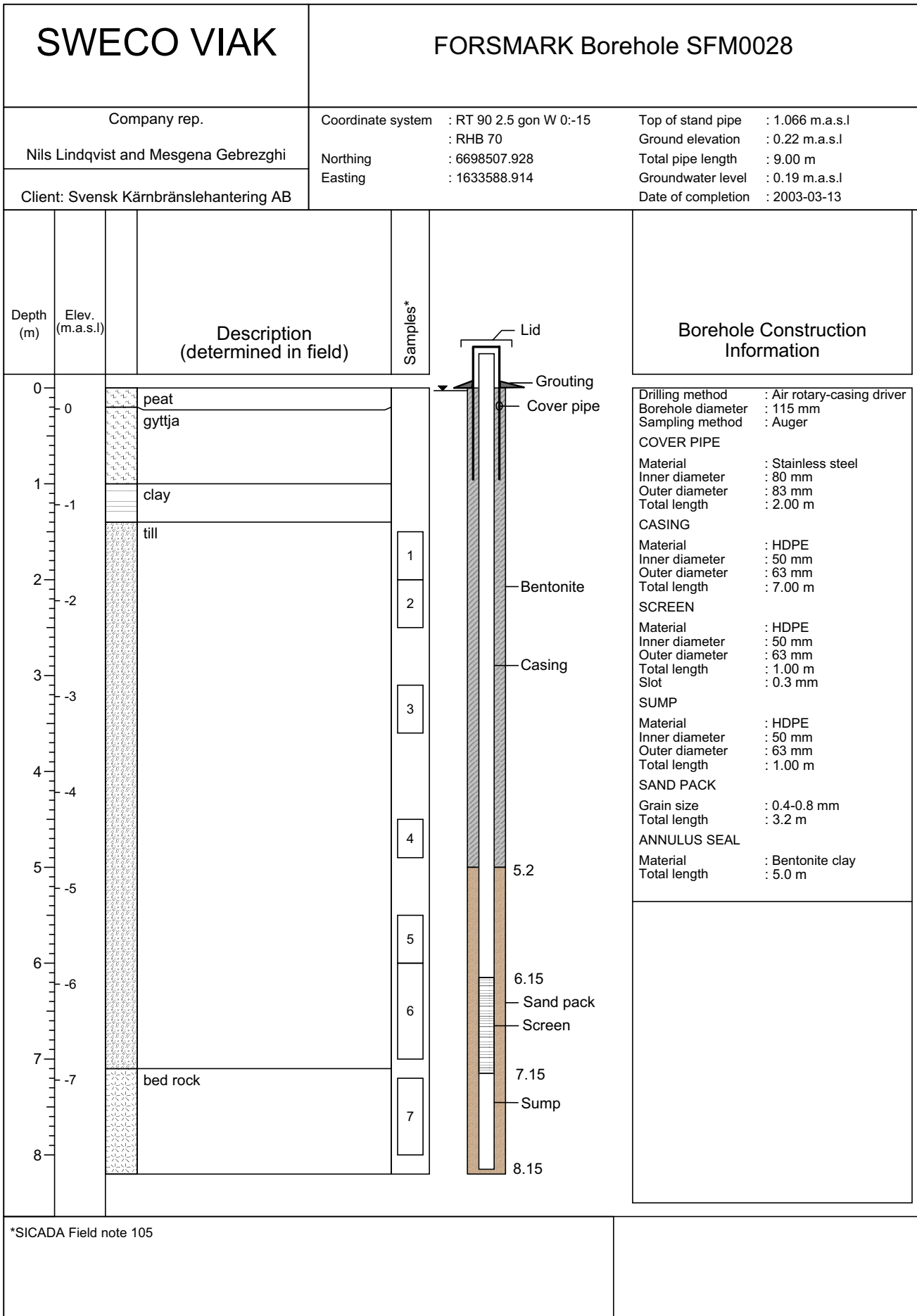
# SWECO VIAK

# FORSMARK Borehole SFM0027

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15	Top of stand pipe : 1.745 m.a.s.l
	Northing : 6696685.210	Ground elevation : 0.91 m.a.s.l
Client: Svensk Kärnbränslehantering AB	Easting : 1634146.664	Total pipe length : 9.00 m
		Groundwater level : 1.05 m.a.s.l
		Date of completion : 2003-04-09



\*SICADA Field note 105

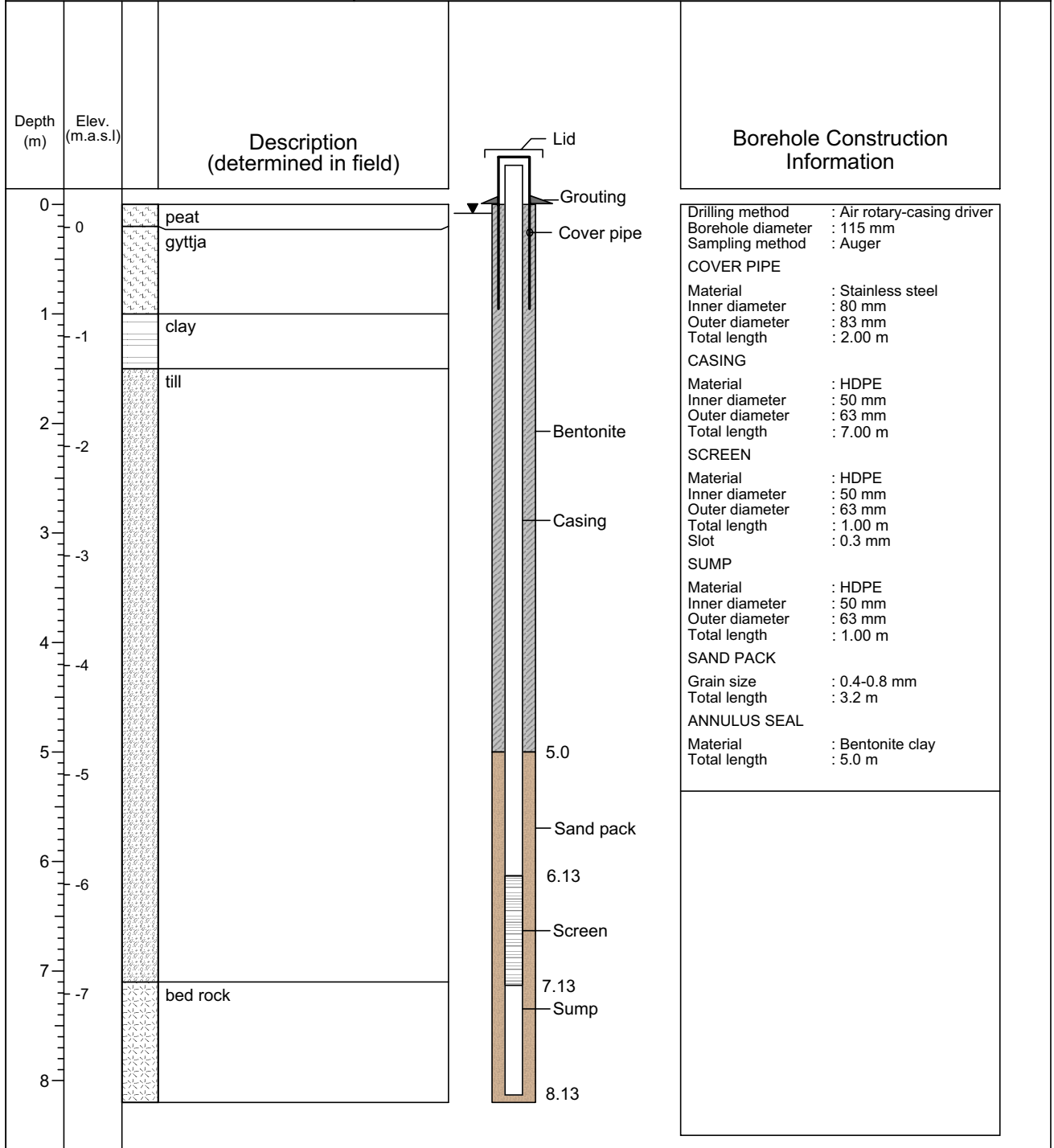




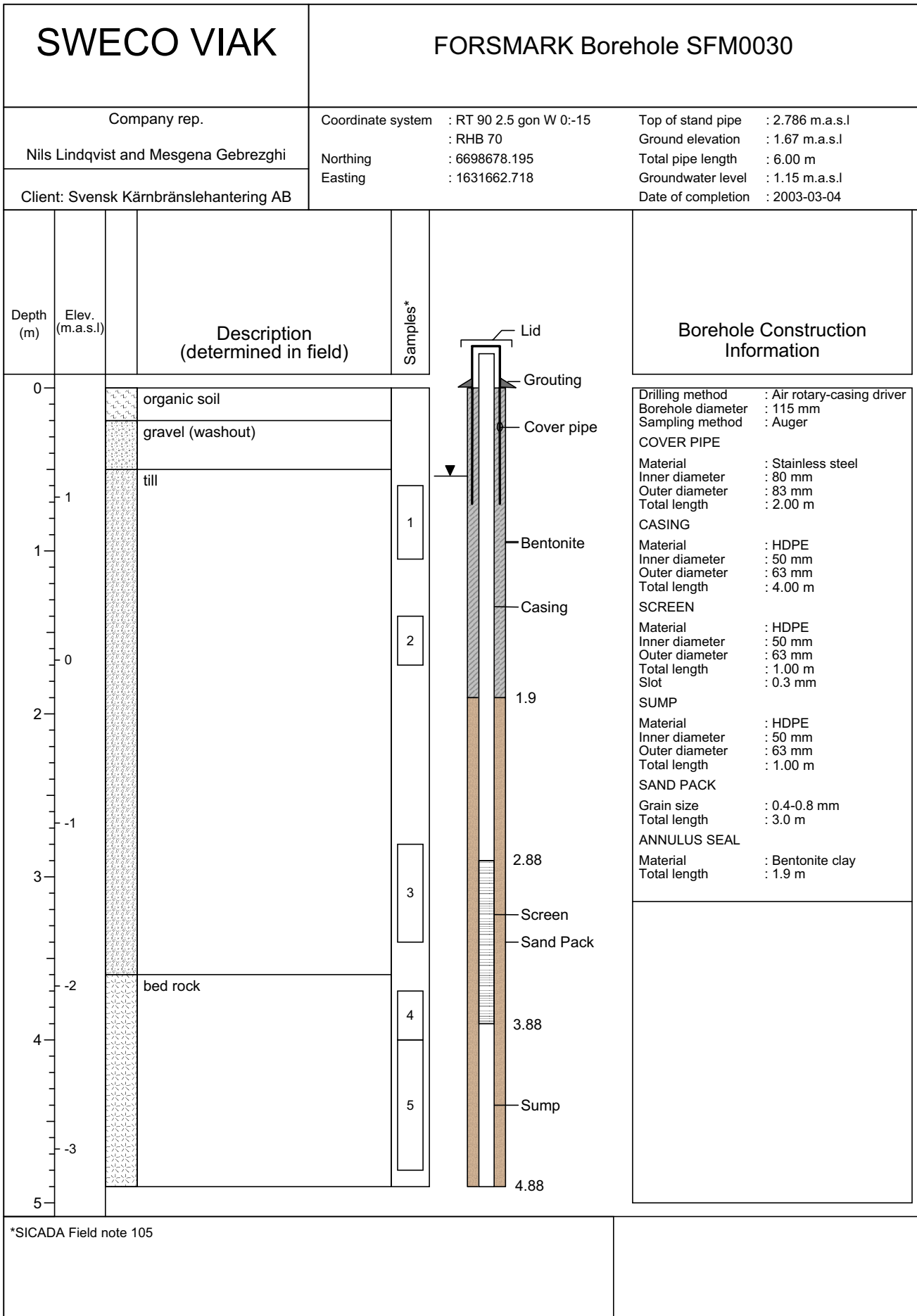
# SWECO VIAK

# FORSMARK Borehole SFM0029

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6698510.191 Easting : 1633588.888	Top of stand pipe : 1.081 m.a.s.l Ground elevation : 0.21 m.a.s.l Total pipe length : 9.00 m Groundwater level : 0.13 m.a.s.l Date of completion : 2003-03-14
Client: Svensk Kärnbränslehantering AB		



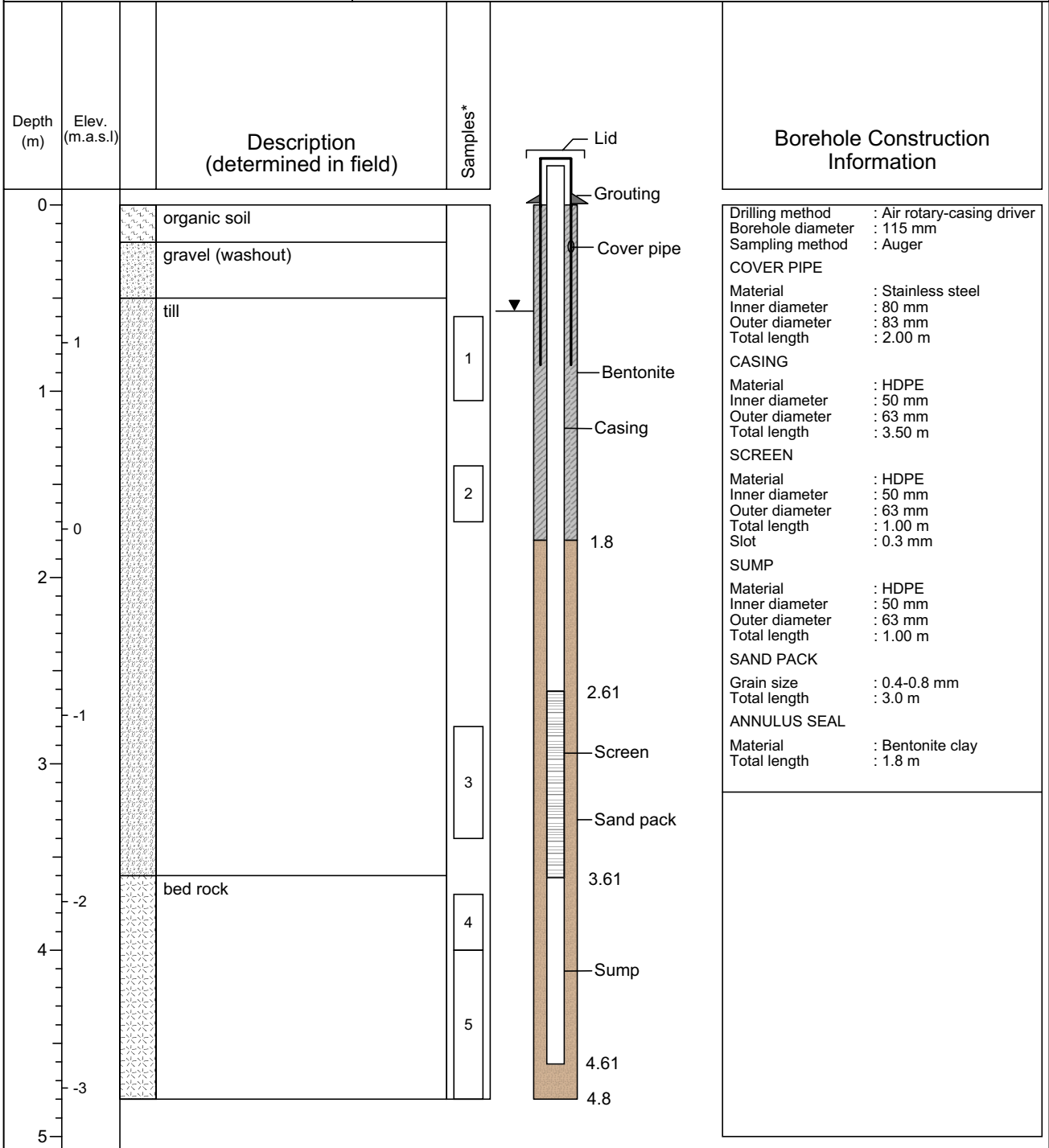
\*No samples taken



# SWECO VIAK

# FORSMARK Borehole SFM0031

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6698681.550 Easting : 1631661.094	Top of stand pipe : 2.631 m.a.s.l Ground elevation : 1.74 m.a.s.l Total pipe length : 5.50 m Groundwater level : 1.17 m.a.s.l Date of completion : 2003-03-06
Client: Svensk Kärnbränslehantering AB		

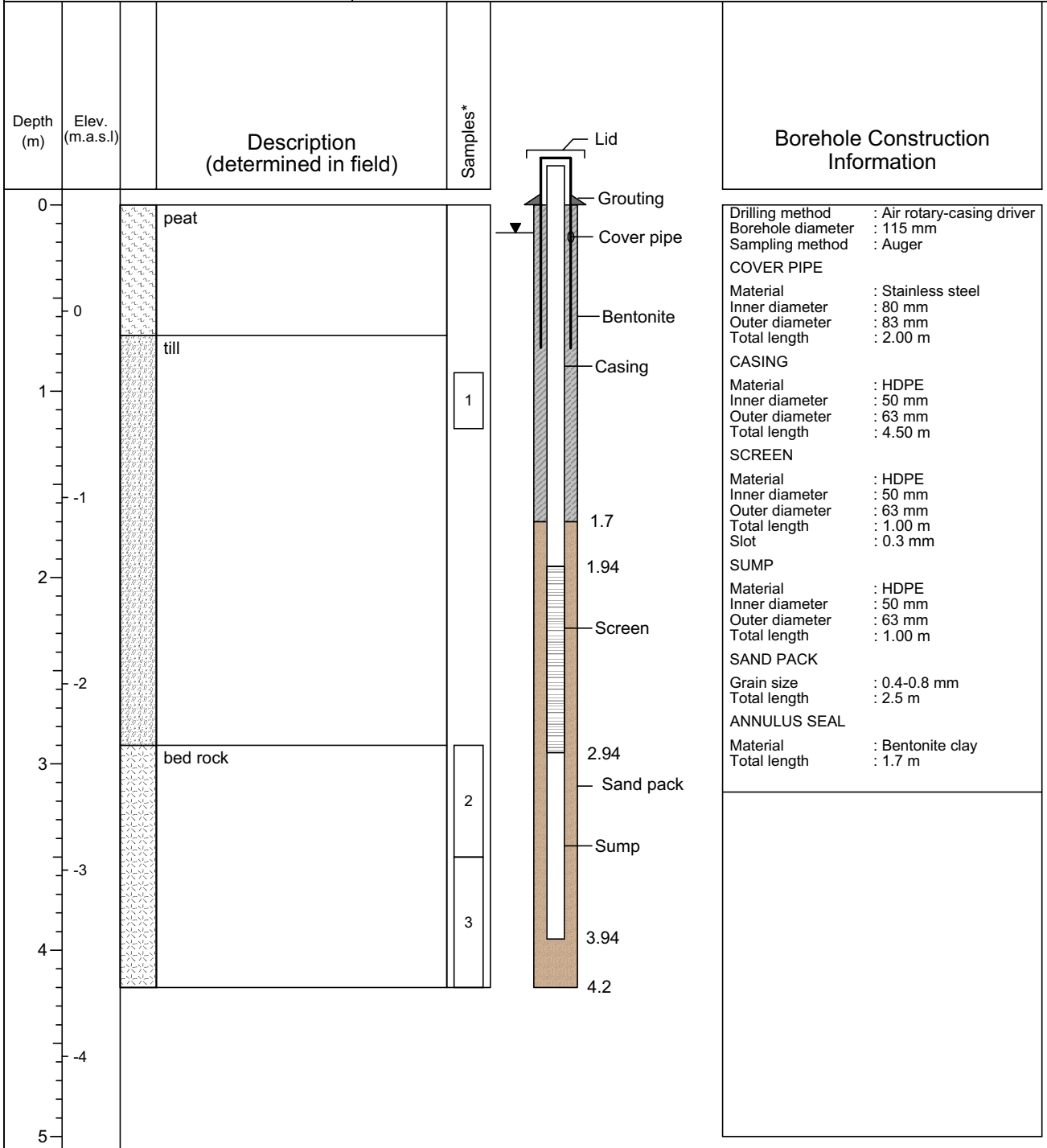


\*SICADA Field note 105

# SWECO VIAK

# FORSMARK Borehole SFM0032

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6698838.258 Easting : 1631725.793	Top of stand pipe : 1.626 m.a.s.l Ground elevation : 0.57 m.a.s.l Total pipe length : 5.00 m Groundwater level : 0.42 m.a.s.l Date of completion : 2003-03-03
Client: Svensk Kärnbränslehantering AB		

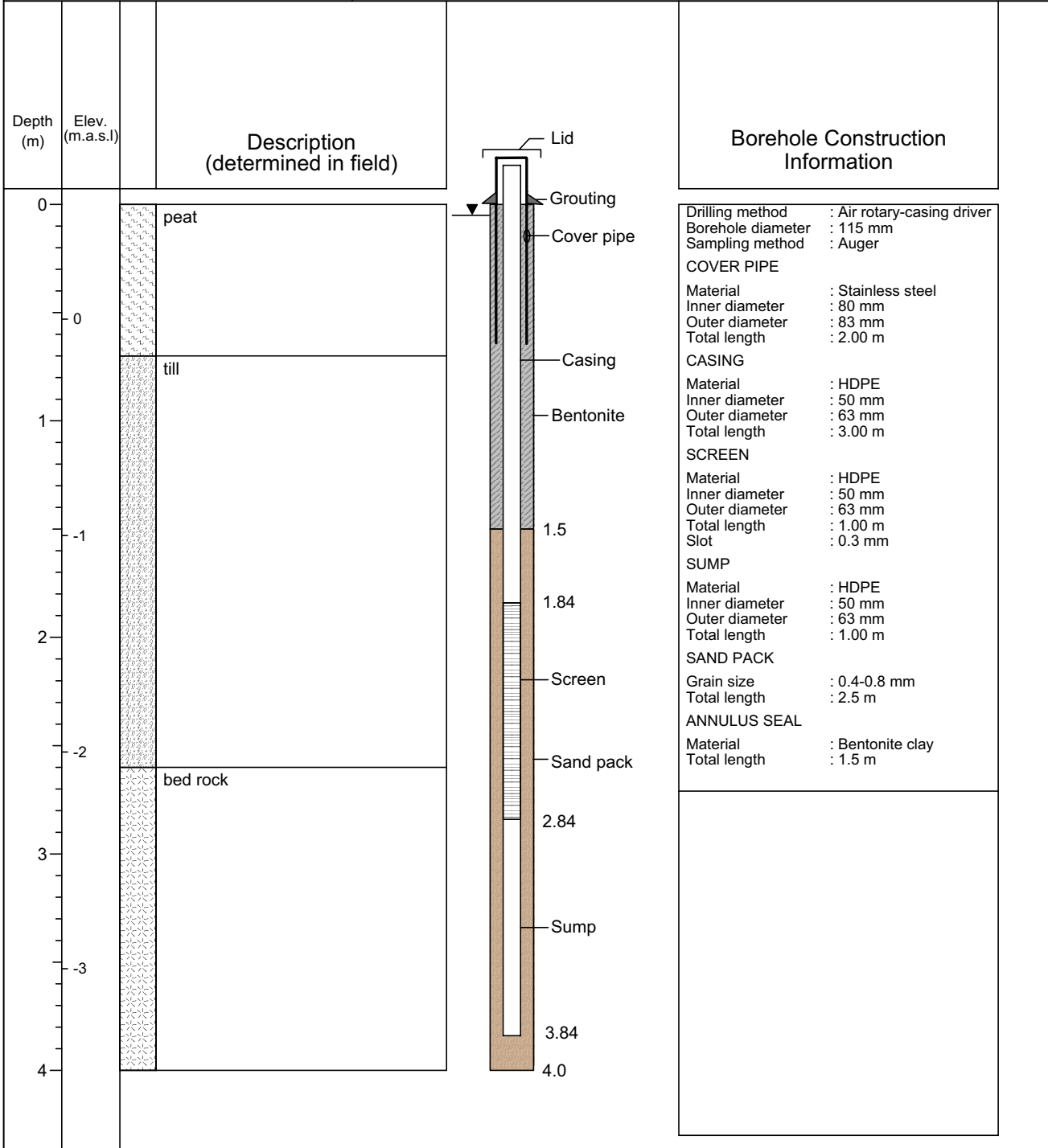


\*SICADA Field note 105

# SWECO VIAK

# FORSMARK Borehole SFM0033

Company rep.		Coordinate system : RT 90 2.5 gon W 0:-15	Top of stand pipe : 1.694 m.a.s.l
Nils Lindqvist and Mesgena Gebrezghi		: RHB 70	Ground elevation : 0.53 m.a.s.l
Client: Svensk Kärnbränslehantering AB		Northing : 6698839.005	Total pipe length : 5.00 m
		Easting : 1631728.181	Groundwater level : 0.48 m.a.s.l
			Date of completion : 2003-03-04



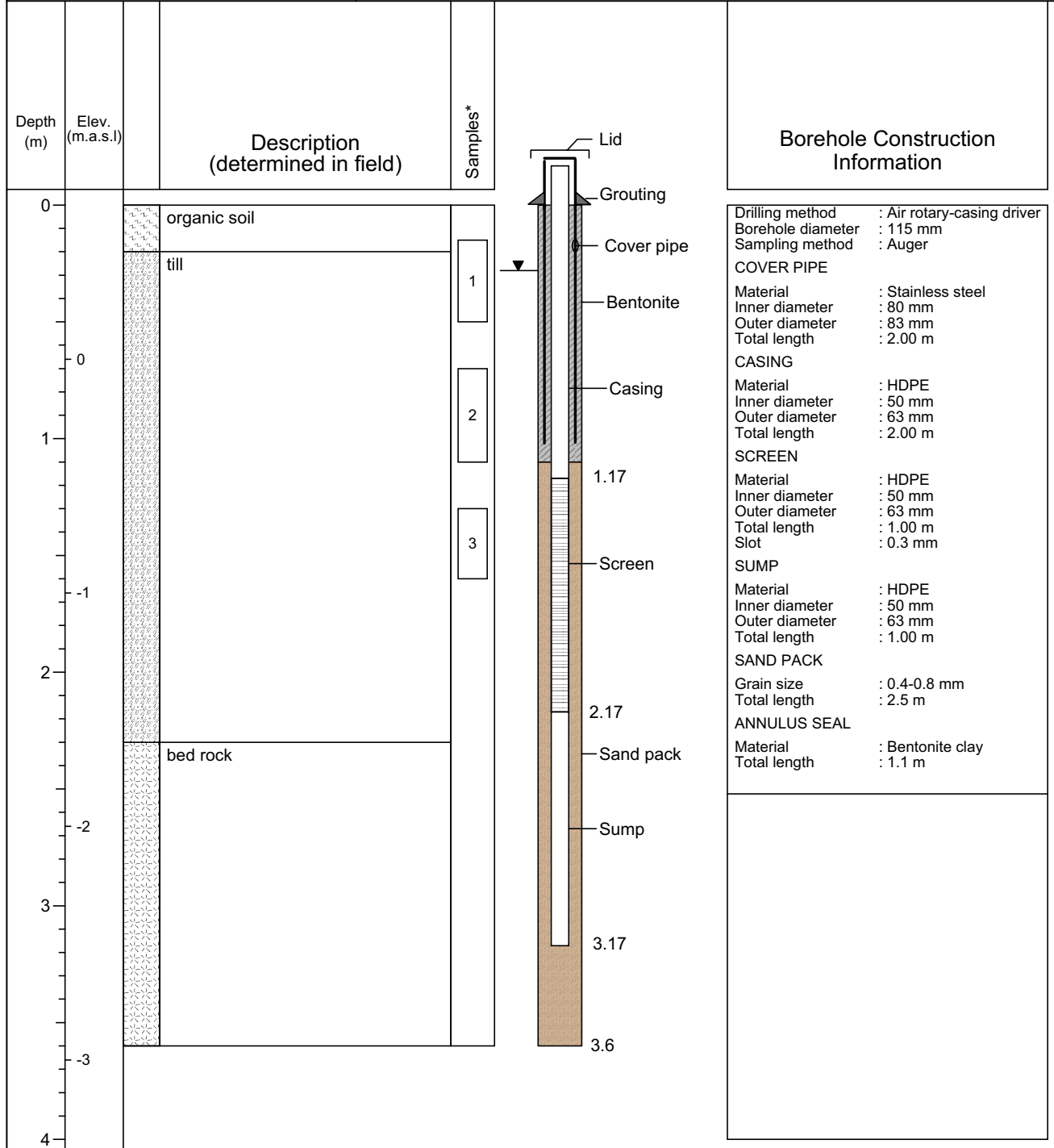
\*SICADA Field note 105

SWECO VIAK		FORSMARK Borehole SFM0034	
Company rep. Nils Lindqvist and Mesgena Gebrezghi		Coordinate system : RT 90 2.5 gon W 0:-15 RHB 70 Northing : 6699757.487 Easting : 1631858.504	Top of stand pipe : 1.575 m.a.s.l Ground elevation : 0.67 m.a.s.l Total pipe length : 4.00 m Groundwater level : 0.42 m.a.s.l Date of completion : 2003-03-10
Client: Svensk Kärnbränslehantering AB			
Depth (m)	Elev. (m.a.s.l)	Description (determined in field)	Samples*
0		till	1
0			2
1			3
-1			
2		bed rock (waterbearing fracture 2.7-2.9 m)	
-2			
3			
-3			
4			
		<b>Borehole Construction Information</b> Drilling method : Air rotary-casing driver Borehole diameter : 115 mm Sampling method : Auger <b>COVER PIPE</b> Material : Stainless steel Inner diameter : 80 mm Outer diameter : 83 mm Total length : 2.00 m <b>CASING</b> Material : HDPE Inner diameter : 50 mm Outer diameter : 63 mm Total length : 2.00 m <b>SCREEN</b> Material : HDPE Inner diameter : 50 mm Outer diameter : 63 mm Total length : 1.00 m Slot : 0.3 mm <b>SUMP</b> Material : HDPE Inner diameter : 50 mm Outer diameter : 63 mm Total length : 1.00 m <b>SAND PACK</b> Grain size : 0.4-0.8 mm Total length : 2.2 m <b>ANNULUS SEAL</b> Material : Bentonite clay Total length : 1.0 m	
*SICADA Field note 105			

# SWECO VIAK

# FORSMARK Borehole SFM0035

Company rep.		Coordinate system : RT 90 2.5 gon W 0:-15	Top of stand pipe : 1.488 m.a.s.l
Nils Lindqvist and Mesgena Gebrezghi		: RHB 70	Ground elevation : 0.66 m.a.s.l
Client: Svensk Kärnbränslehantering AB		Northing : 6699756.250	Total pipe length : 4.00 m
		Easting : 1631859.162	Groundwater level : 0.38 m.a.s.l
			Date of completion : 2003-03-07

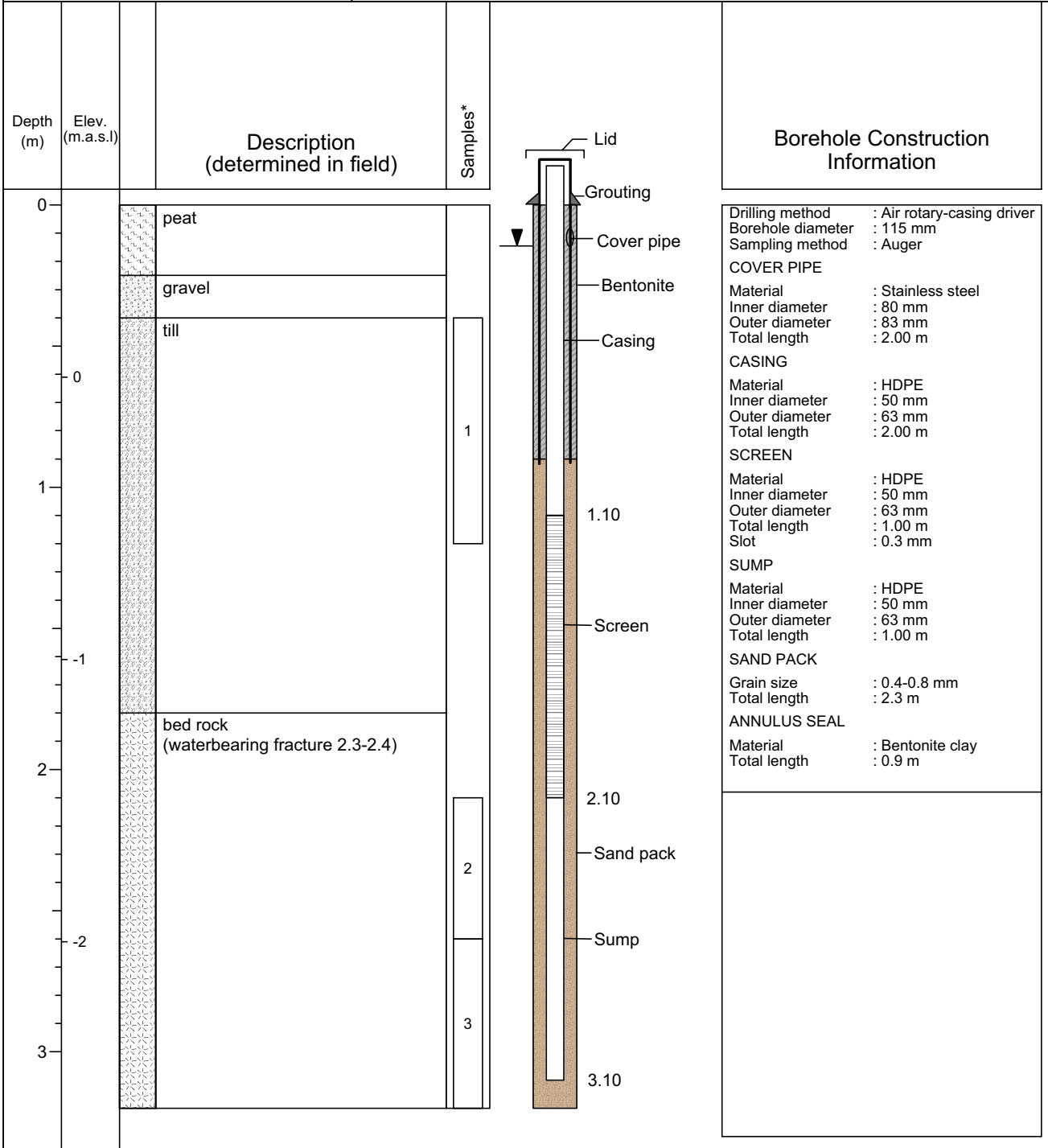


\*SICADA Field note 105

# SWECO VIAK

# FORSMARK Borehole SFM0036

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6699991.991 Easting : 1631746.072	Top of stand pipe : 1.505 m.a.s.l Ground elevation : 0.61 m.a.s.l Total pipe length : 4.00 m Groundwater level : 0.46 m.a.s.l Date of completion : 2003-03-11
Client: Svensk Kärnbränslehantering AB		



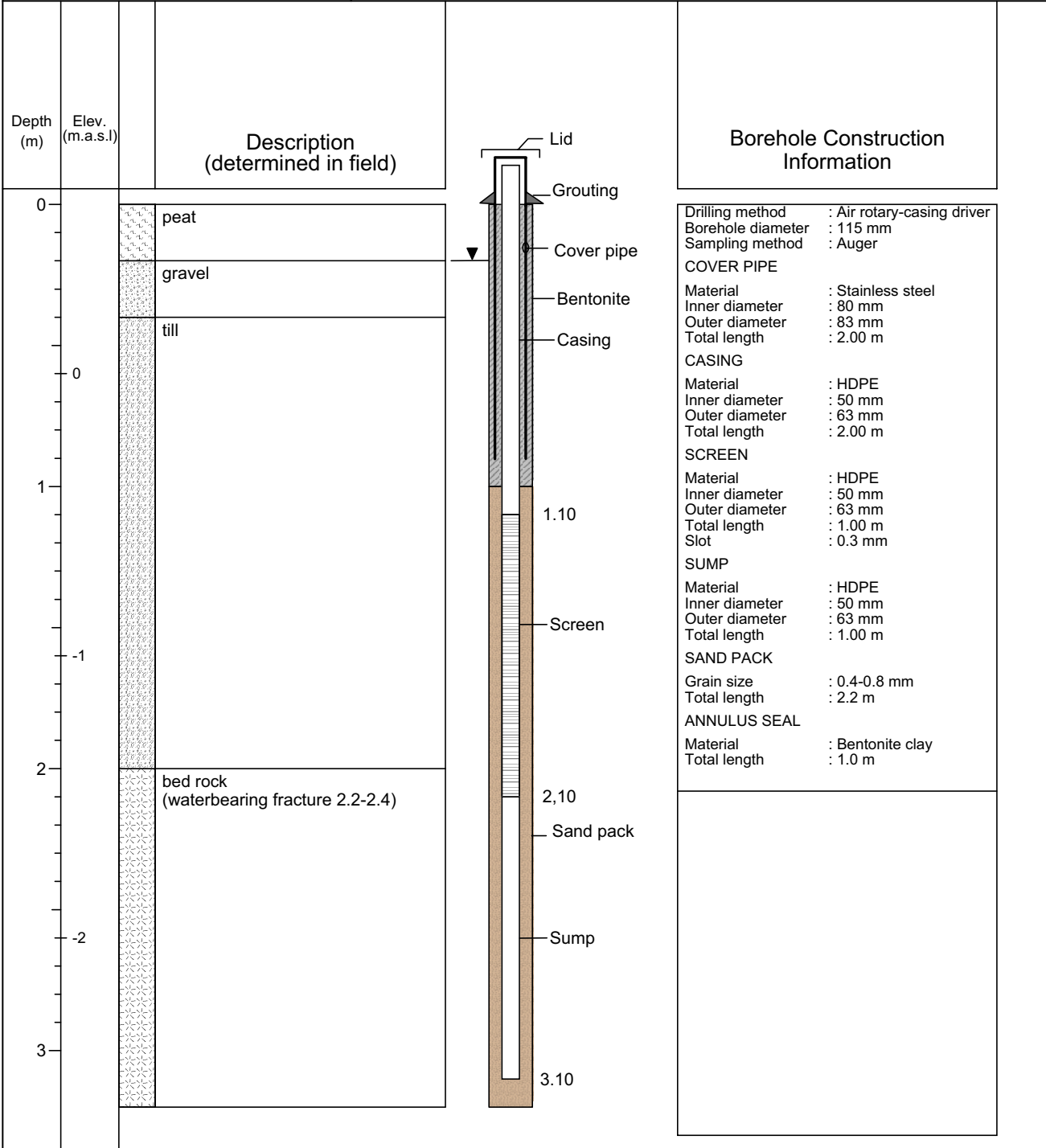
\*SICADA Field note 105

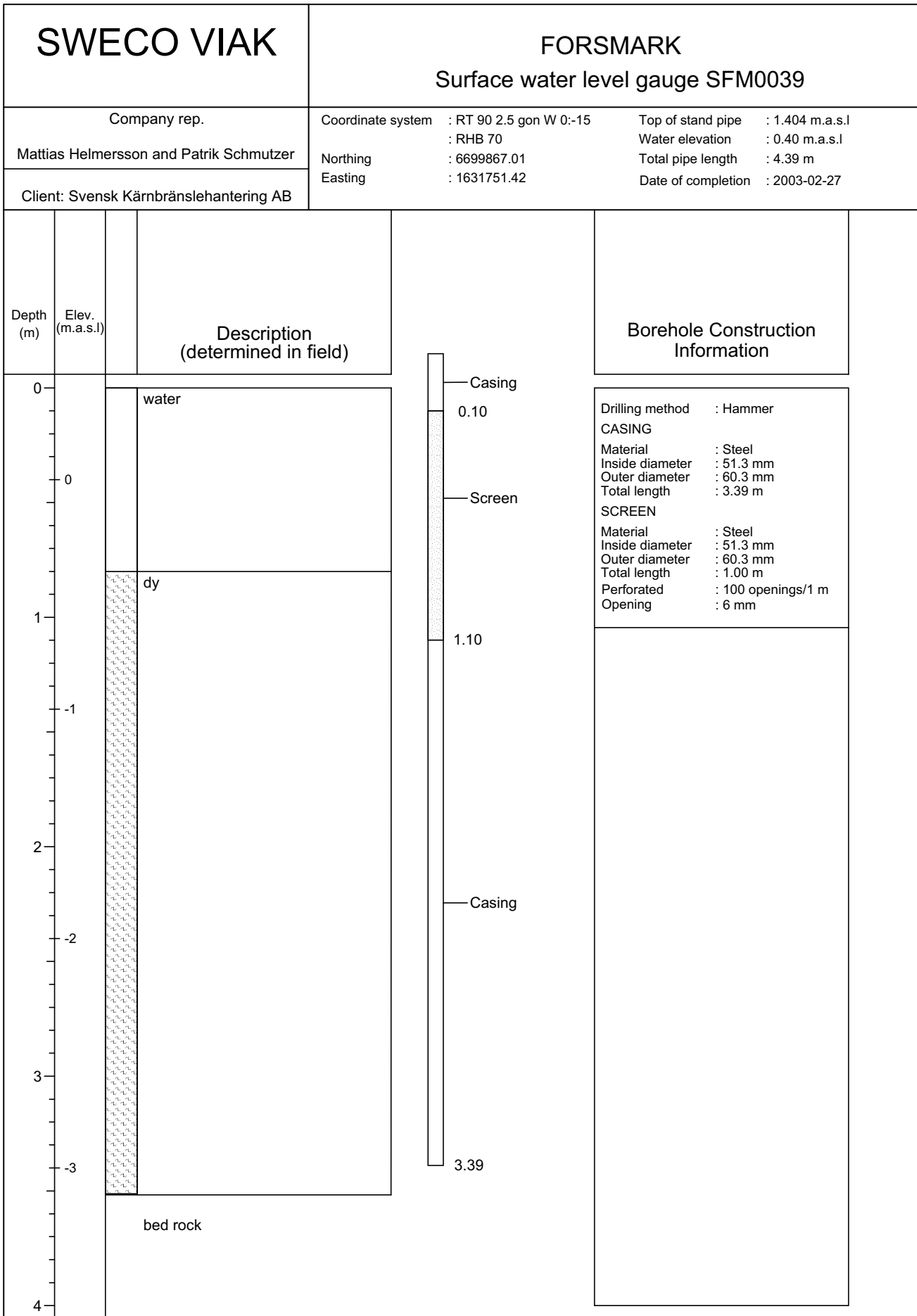


# SWECO VIAK

# FORSMARK Borehole SFM0037

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6699991.932 Easting : 1631744.409	Top of stand pipe : 1.499 m.a.s.l Ground elevation : 0.60 m.a.s.l Total pipe length : 4.00 m Groundwater level : 0.40 m.a.s.l Date of completion : 2003-03-11
Client: Svensk Kärnbränslehantering AB		





# SWECO VIAK

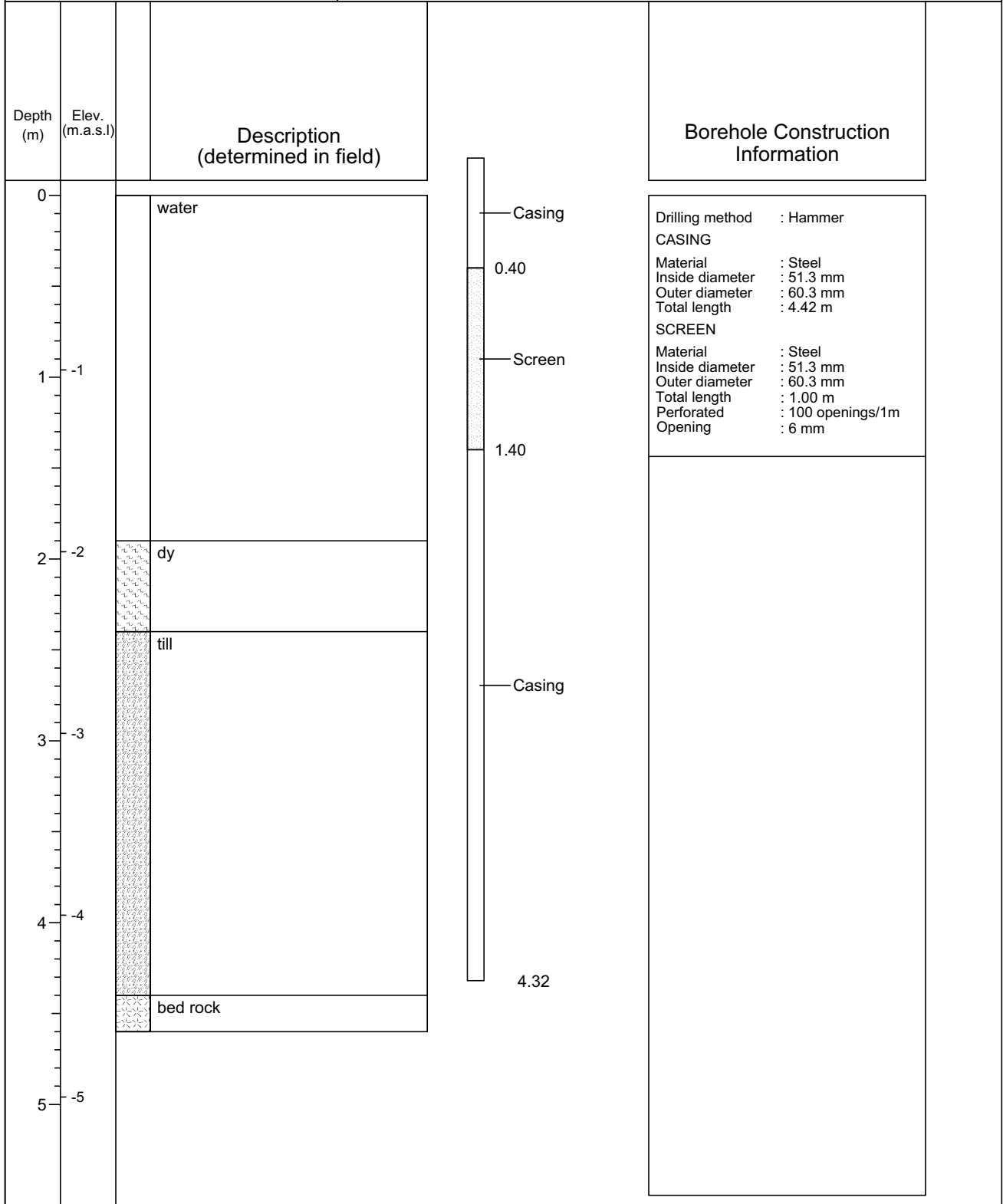
## FORSMARK Surface water level gauge SFM0040

Company rep.  
Mattias Helmersson and Patrik Schmutzer

Coordinate system : RT 90 2.5 gon W 0:-15  
: RHB 70  
Northing : 6698983.16  
Easting : 1632063.77

Top of stand pipe : 1.064 m.a.s.l  
Water elevation : -0.04 m.a.s.l  
Total pipe length : 5.42 m  
Date of completion : 2003-02-21

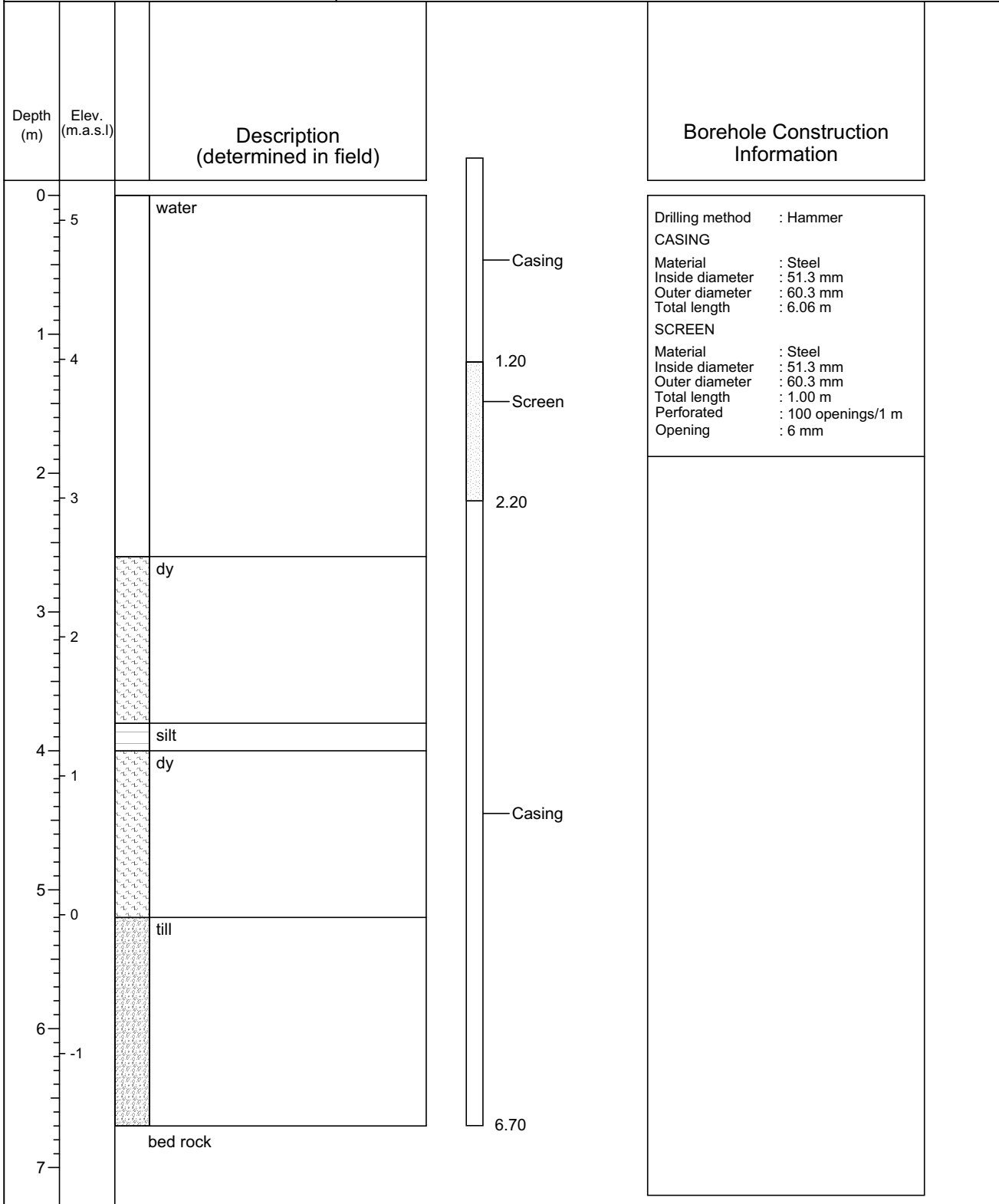
Client: Svensk Kärnbränslehantering AB

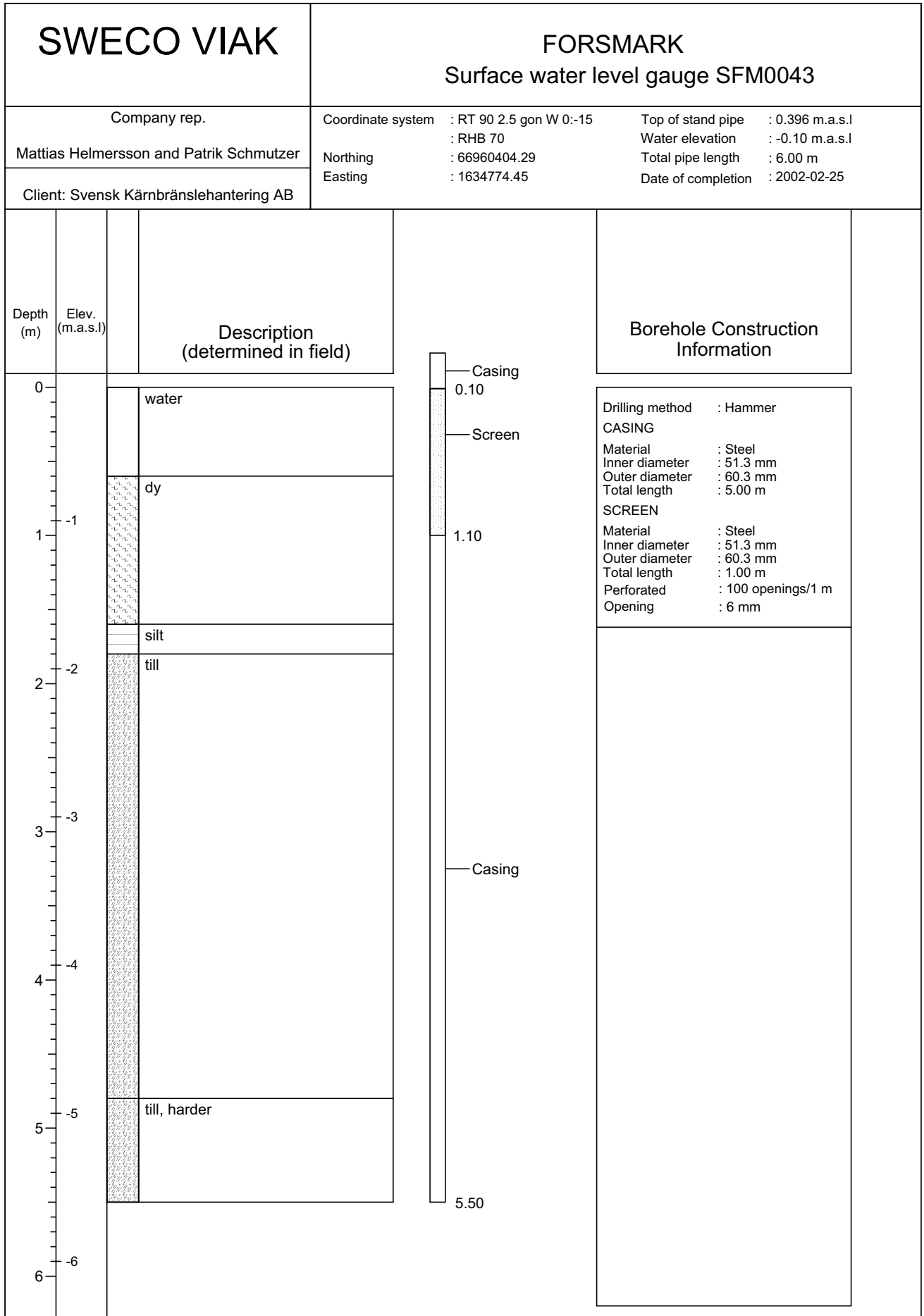


# SWECO VIAK

## FORSMARK Surface water level gauge SFM0041

Company rep. Mattias Helmersson and Patrik Schmutzer	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6697010.49 Easting : 1631963.34	Top of stand pipe : 5.766 m.a.s.l water elevation : 5.126 m.a.s.l Total pipe length : 7.34 m Date of completion : 2003-02-20
Client: Svensk Kärnbränslehantering AB		

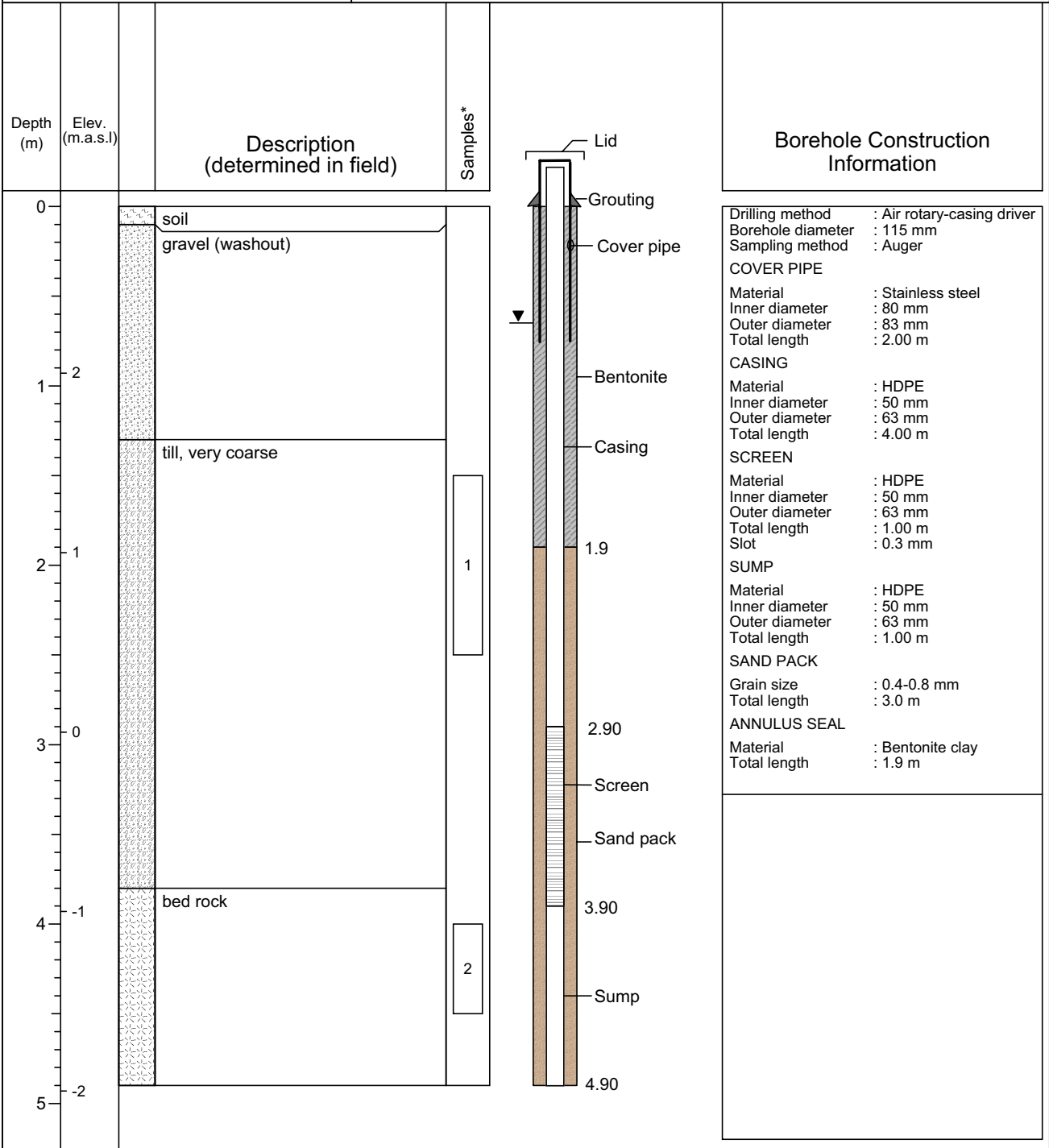




# SWECO VIAK

# FORSMARK Borehole SFM0049

Company rep. Nils Lindqvist and Mesgena Gebrezghi	Coordinate system : RT 90 2.5 gon W 0:-15 : RHB 70 Northing : 6700027.549 Easting : 1630533.057	Top of stand pipe : 4.029 m.a.s.l Ground elevation : 2.93 m.a.s.l Total pipe length : 6.00 m Groundwater level : 2.28 m.a.s.l Date of completion : 2003-03-28
Client: Svensk Kärnbränslehantering AB		



\*SICADA Field note 105

## **Appendix 2**

**Photos before and after work at all boreholes**

## Borehole PFM002461

After



## Borehole PFM002462

After





## Borehole SFM002463

After



# Borehole PFM002464

Before



After



# Borehole PFM002572

Before



After



# Borehole PFM002573

Before



After



# Borehole PFM002574

Before



After



## Borehole SFM0009

Before



After



## Borehole SFM0010

After



# Borehole SFM0011

Before



After





# Borehole SFM0012

Before



After



## Borehole SFM0013

After



# Borehole SFM0014

Before



After



# Borehole SFM0015

Before



## Borehole SFM0016

Before



After



# Borehole SFM0017

Before



After



## Borehole SFM0018

After



## Borehole SFM0019

Before



After





## Borehole SFM0020

After



# Borehole SFM0021

Before



After



# Borehole SFM0024

Before



After



## Borehole SFM0026

Before



After



# Borehole SFM0027

Before



After



# Borehole SFM0028-29

Before



After



# Borehole SFM0030-31

Before



After

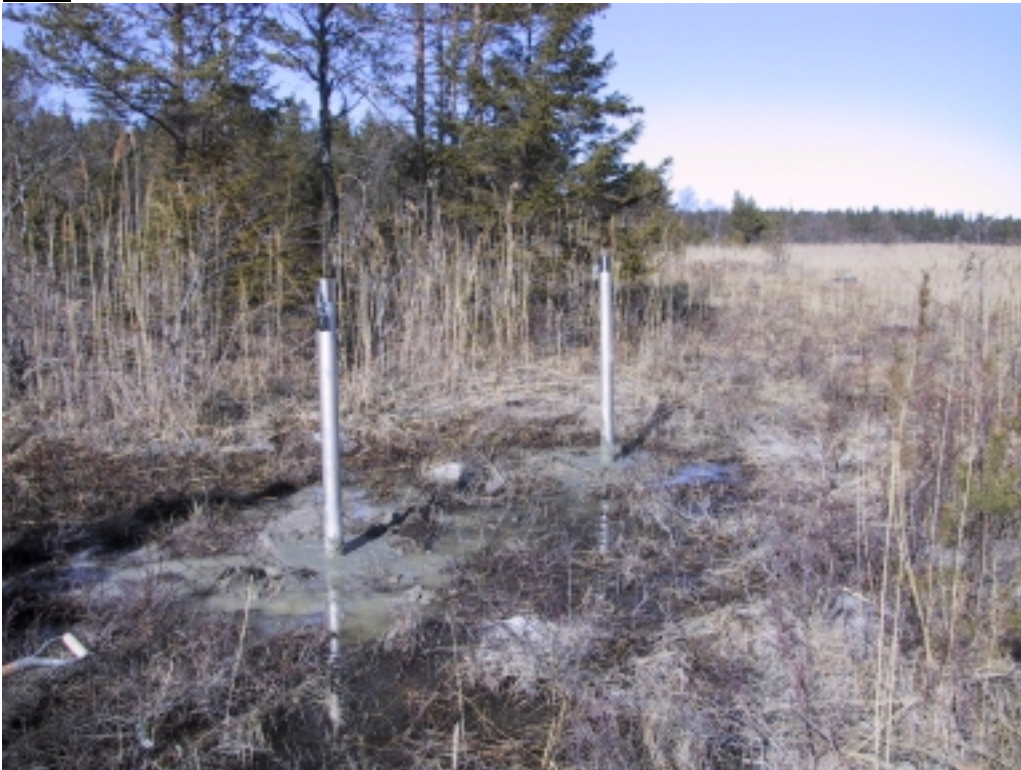


## Borehole SFM0032-33

Before



After



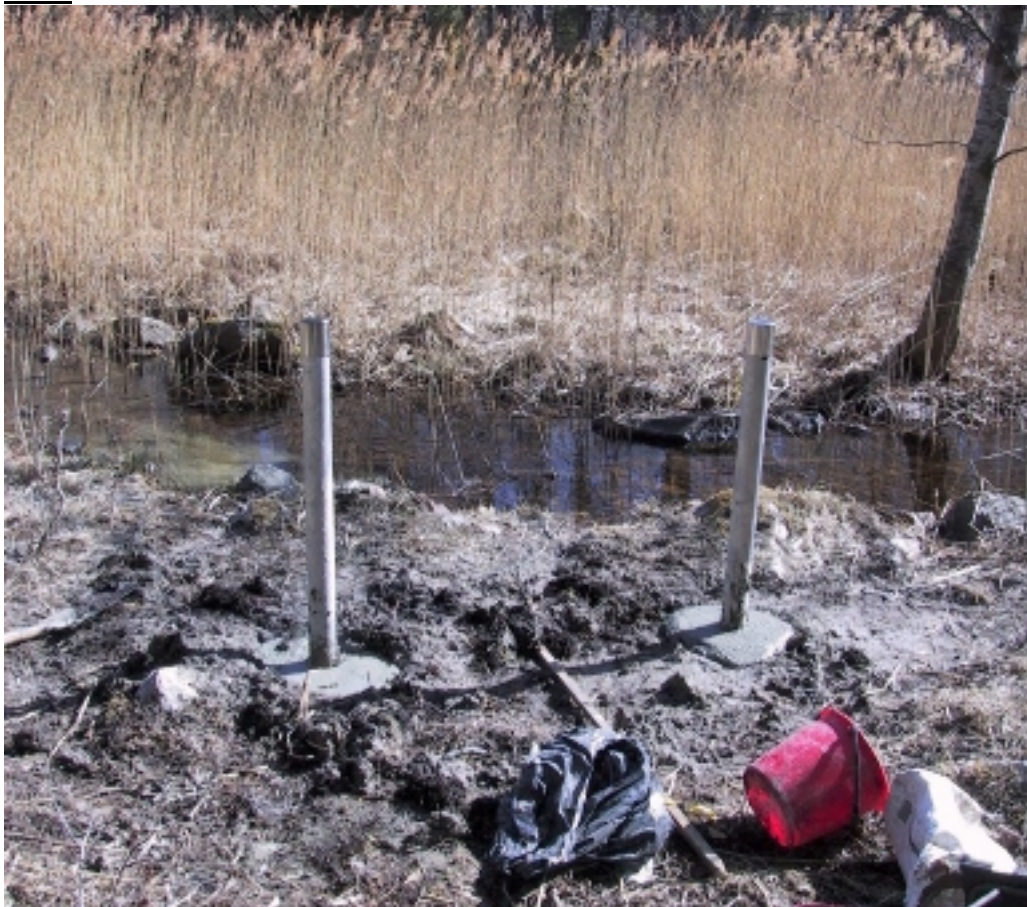


# Borehole SFM0034-35

Before



After



# Borehole SFM0036-37

Before



After



# Borehole SFM0039

*Before*



*After*



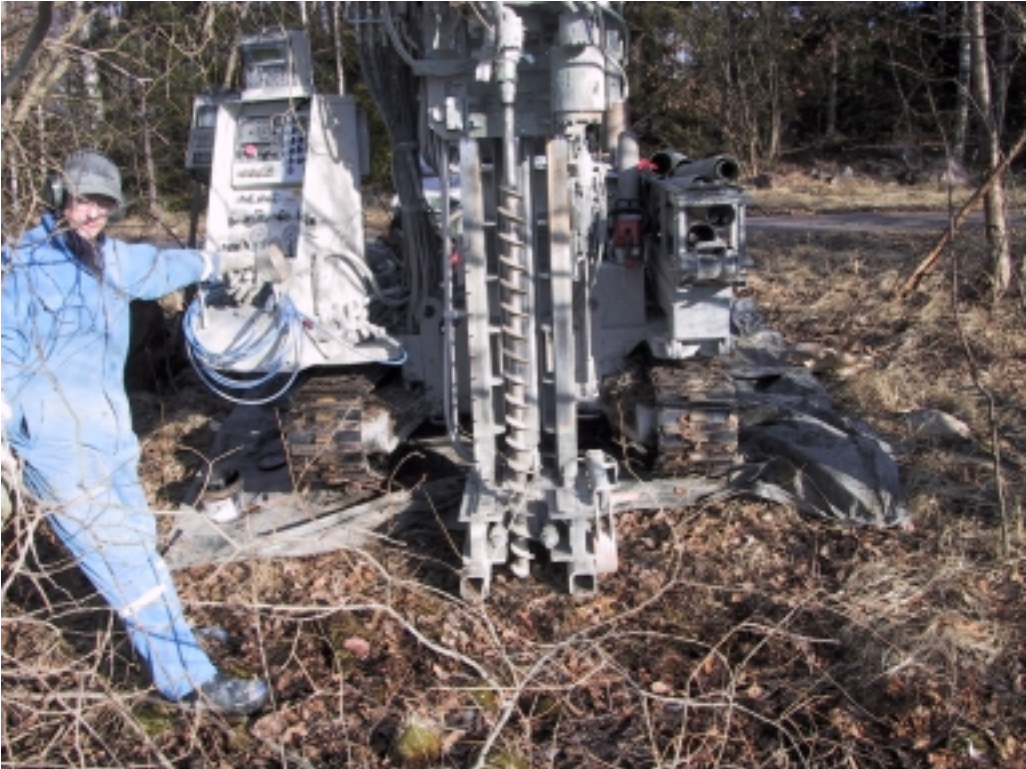
# Borehole SFM0041

Before



# Borehole SFM0049

*Before*



*After*

