P-09-51

Forsmark site investigation

Hydrochemical monitoring of groundwaters, surface waters and precipitation

Results from water sampling in the Forsmark area, January 2008–December 2008

Cecilia Berg, Johan Harrström,
Ann-Chatrin Nilsson (ed), Kersti Nilsson
Geosigma AB

Micke Borgiel, Susanne Qvarfordt
Sveriges Vattenekologer AB

August 2009

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co

Box 250, SE-101 24 Stockholm
Phone +46 8 459 84 00

ISSN 1651-4416
SKB P-09-51

Forsmark site investigation

Hydrochemical monitoring of groundwaters, surface waters and precipitation

Results from water sampling in the Forsmark area, January 2008–December 2008

Cecilia Berg, Johan Harrström,
Ann-Chatrin Nilsson (ed), Kersti Nilsson
Geosigma AB

Micke Borgiel, Susanne Qvarfordt
Sveriges Vattenekologer AB

August 2009

Keywords: Forsmark, Long-term monitoring, Percussion borehole, Core borehole, Groundwater, Shallow groundwater, Soil monitoring well, Stand pipe, BAT-filter tip, BAT-sampler, GBIZ programme, Private wells, Drinking water quality, Surface water, Lakes, Streams, Shallow bays, Precipitation, Water sampling, Sample series, Chemical analyses, Water composition, Major constituents, Isotopes, Trace metals, Nutrient salts, AP PF 400-07-38, AP PF 400-07-045, AP PF 400-07-055, AP PF 400-07-39.

Abstract

The fourth year (2008) of hydrochemical monitoring of groundwaters, surface waters and precipitation in Forsmark is documented in the report.

The hydrochemical monitoring programme 2008 included water sampling from:

- percussion- and core boreholes equipped with installations for long-term pressure monitoring, tracer tests and water sampling in packed off borehole sections, sampling and analysis performed twice (spring and autumn),
- near surface groundwaters, performed four times,
- private wells, performed at one occasion, in October 2008,
- surface waters, performed at eleven occasions,
- precipitation, performed at three occasions, January–July 2008.

Generally, the groundwater composition in most borehole sections in the cored boreholes has stayed relatively stable since the initial CCC sampling (Complete Chemical Characterisation). One exception is represented by section KFM01D:2, were the initial non-marine character of the groundwater has changed and a significant Littorina contribution was observed from the start of the monitoring programme. However, pressure responses indicate connections in the fracture system between several borehole sections and contamination by water from a more shallow section is probably the cause. Other issues or remarkable observations from the hydrochemical monitoring are; 1) increase in sulphide concentration with time in most borehole sections and especially in the section mentioned above (mixing of different water types may have contributed to the extreme increase in this borehole section), 2) increase in pH with time in KFM07A, from 8.1 in March 2007 to 10.7 in October 2008, 3) continued high uranium concentrations especially in KFM02A, KFM03A and KFM12A.

The water composition in isolated sections in percussion boreholes varies somewhat more for several reasons: 1) the initial HTHB sampling (HydroTester HammarBorrhål) during pumping tests was conducted from the entire borehole at open-hole conditions, and these initial data are not necessarily comparable to data from monitored sections, 2) hydraulic interference tests and large scale tracer tests have affected the groundwater in some percussion boreholes, and 3) the percussion boreholes intersect large and highly transmissive fracture zones at shallow depths corresponding to the interface between meteoric and brackish water types, and pumping may easily cause mixing of different waters.

Generally, the new data for shallow groundwaters from soil pipes confirm the knowledge and conclusions presented in reports from earlier investigation periods. Results from soil pipe SFM0037 showed high concentrations of total nitrogen in October 2008 similar to the sampling period August–December 2007.

The sampled surface waters in the Forsmark area show similar seasonal variations as last year. The waters are well buffered with high alkalinity, high pH and high calcium concentrations and waters affected or recently affected by brackish sea water show high sodium chloride concentrations. Occasionally, elevated tritium contents in samples collected close to the cooling water outlet from the nuclear power plant (Lake Biotestsjön) were observed also this year. Three samples had enhanced tritium concentrations during the reported time period.

Three precipitation samples were collected during the period January–June 2008. The results show similar seasonal variation as previous years. Especially interesting for modelling purposes are the environmental isotopes ^{3}H, δ^2H and δ^{18}O as precipitation is one of the reference waters included in mixing calculations. The scatter plot δ^{18}O versus δ^2H follows the global meteoric water line.

Sammanfattning

Fjärde årets hydrokemiska monitering (2008) av grundvatten, ytvatten och nederbörd i Forsmark dokumenteras i rapporten.

Det hydrokemiska moniteringsprogrammet 2008 omfattade vattenprovtagning i:

- hammarborrhål och kärnborrhål försedda med utrustning för långtidsövervakning av tryck, utspädningsmätningar och vattenprovtagning i avgränsade borrhålssektioner, provtagning/analys utförd två gånger under året (vår och höst),
- ytnära grundvatten i jordrör, utfört fyra gånger under året,
- privata brunnar, utfört vid ett tillfälle i oktober,
- ytvatten, utfört vid elva provtagningstillfällen,
- nederbörd, utfört vid tre provtagningstillfällen.

Vattensammansättningen, har generellt sett, förblivit stabil i de flesta borrhålssektioner i kärnborrhålen sedan det första provtagningstillfället vid CCC provtagning (Complete Chemical Characterisation). Ett undantag är sektionen KFM01D:2, där den initiala icke-marina karaktären hos grundvattnet har förändrats och ett signifikant bidrag från Littorinahavet kunde observeras redan från starten av moniteringsprogrammet. Tryckresponser indikerar emellertid att spricksystemet binder ihop flera borrhålssektioner och orsaken till förändringen är förmodligen kontaminering med vatten från en mer ytnära sektion. Andra frågeställningar eller speciella observationer från den hydrogeokemiska moniteringen är; 1) ökning av sulfidkoncentration med tiden i de flesta borrhålssektioner och speciellt i sektionen som nämns ovan (blandning av olika vattentyper kan ha bidragit till den extrema ökningen i just den här borrhålssektionen). 2) ökning i pH med tiden i KFM07A, från 8.1 i mars 2007 till 10.7 i oktober 2008, 3) fortsatt höga urankoncentrationer i framförallt KFM02A, KFM03A och KFM12A.

Vattensammansättningen i avgränsade sektioner i hammarborrhålen varierar något mer av olika orsaker: 1) den första HTHB provtagningen (HydroTester HammarBorrhål) under pumptester utfördes från hela borrhålet under öppet-hål förhållanden, och dessa initiala data är inte nödvändigtvis jämförbara med data från moniterade borrhålssektioner, 2) hydrauliska interferenstester och storskaliga spårförsök har påverkat vattensammansättningen i några hammarborrhål, 3) hammarborrhålen korsar stora och högtransmissiva sprickzoner vid de måttliga djup som motsvarar gränsen mellan meteoriskt och bräckt vatten, och pumpning kan lätt orsaka blandning av olika vatten.

De nya data som tillkommit för ytnära grundvatten från jordrör bekräftar den kunskap och de slutsatser som presenterats i föregående rapporter från tidigare undersökningsperioder. Resulten från jordröret SFM0037 visade på samma höga koncentrationer av totalkväve i oktober 2008 som vid provtagningsperioden augusti–december 2007.

De provtagna ytvattnen i Forsmark visar liknande säsongsvariationer som föregående år. Vattnen är väl buffrade med hög alkalinitet, högt pH och höga kalciumkoncentrationer och vatten påverkade eller nyligen påverkade av bräckt havsvatten visar höga natriumkloridkoncentrationer. Tillfälligt förhöjda tritiumvärden i prov insamlade nära kylvattenutsläppet från kärnkraftverket (Biotestsjön) observerades också i år. Tre prov visade förhöjda tritiumvärden under den rapporterade tidsperioden.

Tre nederbördsprov samlades in under perioden januari–juni 2008. Resultaten visar liknande säsongsvariationer som föregående år. Speciellt intressanta för modelleringsändamål är isotoperna ^{3}H, δ^{2}H och δ^{18}O, eftersom nederbörd är ett referensvatten som ingår i blandningsberäkningar. Plottar av δ^{18}O mot δ^{2}H följer *the global meteoric water line*.

Contents

1 Introduction 7

2 Groundwaters in percussion- and core drilled boreholes 9
2.1 Objectives and scope 9
2.2 Sampled boreholes and borehole sections 9
2.3 Borehole history 9
    2.3.1 Cored boreholes 11
    2.3.2 Percussion boreholes 12
2.4 Equipment 16
    2.4.1 Sampling equipment 16
2.5 Performance 18
    2.5.1 General 18
    2.5.2 Water sampling and field measurements 18
    2.5.3 Water sample treatment and analyses 19
    2.5.4 Nonconformities 19
    2.5.5 Data handling and interpretation 20
2.6 Results 20
    2.6.1 Basic water analyses 20
    2.6.2 Trace elements (rare earth metals and others) 20
    2.6.3 Stable and radioactive isotopes 20
2.7 Summary and discussions 24

3 Near surface groundwaters 25
3.1 Objectives and scope 25
3.2 Sampling objects 25
3.3 Equipment 27
    3.3.1 Sampling equipment 27
    3.3.2 Multi-parameter sondes 27
    3.3.3 BAT-equipment 28
3.4 Performance 28
    3.4.1 Sampling programme 28
    3.4.2 Sample handling and analyses 31
    3.4.3 Data handling 31
    3.4.4 Nonconformities 31
3.5 Results 32
    3.5.1 Field measurements 32
    3.5.2 Water analyses 33
3.6 Summary and discussion 38

4 Surface waters 39
4.1 Objectives and scope 39
4.2 Sampling locations and sampling scheme 40
4.3 Equipment 41
    4.3.1 Sampling equipment 41
    4.3.2 Multiparameter sondes 41
    4.3.3 General field equipment 43
4.4 Performance 44
    4.4.1 Preparations 44
    4.4.2 Water sampling 44
    4.4.3 Field measurements 46
    4.4.4 Sample treatment and chemical analyses 46
    4.4.5 Data handling/post processing 46
    4.4.6 Nonconformities 48

4.5 Results 50
4.5.1 General 50
4.5.2 Water analyses 50
4.5.3 Field measurements 53
4.5.4 Water composition 54
4.5.5 The NP-ratio in the surface water 54
4.6 Summary and discussion 54

5 Precipitation 59
5.1 Objective and scope 59
5.2 Equipment 60
5.3 Performance 61
5.3.1 Sampling 61
5.3.2 Sample treatment and chemical analyses 62
5.4 Results 62
5.4.1 Basic water analyses 62
5.4.2 Isotoper analysis 62
5.5 Summary and discussion 64

6 References 65
6.1 Introduction 65
6.2 Groundwaters in percussion – and core drilled boreholes 66
6.3 Surface waters 70
6.4 Precipitation 70

Appendix 1 Sampling routines, analytical methods and data handling (analytical results) 71

Appendix 2 Groundwaters in percussion – and core drilled boreholes 77

Appendix 3 Near surface groundwater 131

Appendix 4 Surface waters 143

Appendix 5 Precipitation 175

1 Introduction

The site investigations in Forsmark /1/ were, on the whole, finished in June 2007, and the less intensive long term monitoring phase commenced. The monitoring programme /2/ encompasses several geoscientific and ecological disciplines, i.e. hydrochemical monitoring, which includes regular sampling and analyses of deep and shallow ground-waters, surface waters and precipitation. This document reports the performance and results from sampling and analyses within the monitoring programme during the period January 2008–December 2008. Results from earlier investigation periods are presented in /3/, /4/ and /5/ (deep groundwaters), /6/, /7/, /8/ (shallow groundwater), /9/, /10/, /11/, /12/, /13/ (surface waters) as well as /14/ and /15/ (precipitation). The P-report for August to December 2007 /16/ is the first concatenated report and presents monitoring of shallow groundwaters, surface waters and precipitation. Besides the regular sampling locations for shallow groundwaters in soil pipes, the present report includes also sampling locations belonging to the GBIZ programme (Geosphere Biosphere Interface Zone).

The controlling documents for the hydrochemical monitoring activities are listed in Table 1-1. Both activity plans and method descriptions are SKB's internal controlling documents. Original data from the reported activities are stored in the primary database Sicada. Data are traceable in Sicada by the activity plan numbers (AP PF 400-07-38, AP PF 400-07-045, AP PF 400-07-055, and AP PF 400-07-039). Only data in databases are accepted for further interpretation and modelling. The data presented in this report are regarded as copies of the original data. Data in the database may be revised, if needed. However, such revision of the database will not necessarily result in a revision of this report, although major revisions are the normal procedure for a P-report. Minor revisions are normally presented as supplements, available at www.skb.se.

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

Activity plans	Number	Version
Hydrokemisk monitering av djupt grundvatten (hammarborrhål och kärnborrhål) 2008–2009.	AP PF 400-07-038	1.0
Hydrokemisk monitering av ytnära grundvatten (jordrör och privata brunnar) under 2008–2009.	AP PF 400-07-045	1.0
Hydrokemisk monitering av ytvatten 2008–2009.	AP PF 400-07-055	1.0
Hydrokemisk monitering av nederbörd.	AP PF 400-07-039	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för vattenprovtagning och analys i instrumenterade borrhål (under framtagning)	SKB MD 425.001	In prep.
Mätsystembeskrivning (MSB) – Handhavande del; System för hydrologisk och meteorologisk datainsamling. Vattenprovtagning och utspädningsmätning i observationshål.	SKB MD 368.010	1.0
Metodbeskrivning för ytvattenprovtagningar vid platsundersökningar.	SKB MD 900.004	2.0
Mätsystembeskrivning för YSI. Multiparametersystem för vattenmätningar.	SKB MD 910.003	1.0
Provtagning och analys av nederbörd	SKB MD 423.003	2.0
Provtagning och Provhantering	SKB MD 452.001	4.0

Water sampling and measurement procedures are also described in SKB PIR-04-09 "Metodik för provtagning av ekologiska parametrar i hav", SKB PIR-04-06, "Metodik för provtagning av ekologiska parametrar i sjöar och vattendrag", and SKB PIR-04-12, "Översikt över provhanterings- och analysrutiner för vattenprov" (SKB internal documents).

2 Groundwaters in percussion- and core drilled boreholes

2.1 Objectives and scope

The long-term hydrochemical monitoring programme for percussion drilled and core drilled boreholes aims at creating long time series of data. The main objective is to check the stability of the water composition and observe possible changes for example due to disturbance from the drilling in early samples. The monitoring will also allow identification of possible perturbation effects from other ongoing investigations. Special issues of concern within the monitoring programme are 1) the enhanced sulphide concentrations revealed in several boreholes already from the start of the monitoring programme, 2) continued high uranium concentrations in some borehole sections and 3) increase in pH in borehole KFR07A.

The monitoring programme comprises groundwater sampling twice a year in borehole sections delimited by stationary straddle-packers. In this context "stationary" means that the equipment stays in the borehole for several years unlike other, short-term investigations where the equipment is removed when the investigation is completed.

The analytical protocol includes sampling and analyses according to SKB chemistry class 3, 4 and 5 as well as field measurements of pH, electric conductivity and temperature.

2.2 Sampled boreholes and borehole sections

The hydrochemical monitoring activity performed during 2008 included water sampling and chemical analyses at two occasions (spring and autumn) in the boreholes and borehole sections listed in Table 2-1.

KFM01A, KFM02A and KFM03A are SKB chemistry-type, subvertical, and approximately 1,000 m long, telescopic boreholes, whereas KFM01D, KFM02B, KFM04A, KFM06A, KFM06C, KFM07A, KFM08A, KFM08D, KFM10A, KFM11A and KFM12A are inclined telescopic boreholes of chemistry-type. HFM01, HFM02, HFM04, HFM13, HFM15, HFM16, HFM19, HFM21, HFM27 and HFM32 are percussion boreholes with lengths varying between 99.5 and 221.7 metres. Technical descriptions and designs of the boreholes are presented in /17–35/ and the installations for long-term monitoring of pressures and chemical compositions are described in /36/. The site investigation area in Forsmark and the location of the monitored boreholes is shown in Figure 2-1.

2.3 Borehole history

In order to evaluate the results and understand possible observed trends in the groundwater composition, it is important to have information about previous investigations in each borehole and to understand their implications on the groundwater chemistry. Investigations which are likely to affect subsequent water sampling are hydraulic pumping and injection tests, tracer tests, SWIW-tests and tracer dilution tests. Besides preceding investigations in a specific borehole/borehole section, on-going activities in nearby situated boreholes, e.g. pumping tests, core drilling and interference tests, may also affect the results from water sampling and analyses.

Table 2-1. Boreholes and borehole sections included in the monitoring programme for percussion- and core drilled boreholes during 2008 and corresponding transmissivity values.

Borehole: section	Section (mbl)#	Section elevation (m.b.s.l)##	Transmissivity (m^2/s)
KFM01A:5	109.0–130.0	105.0–126.2	1.0 E–7*
KFM01D:2	429.0–438.0	339.6–346.5	8.0 E–7*
KFM01D:4	311.0–321.0	248.6–256.4	2.0 E–7*
KFM02A:3	490.0–518.0	481.0–508.9	2.1 E–6*
KFM02A:5	411.0–442.0	402.4–433.2	2.5 E–6*
KFM02B:2	491.0–518.0	476.4–491.2	3.0 E–5**
KFM02B:4	410.0–431.0	396.7–417.4	2.0 E–5**
KFM03A:1	969.5–994.5	956.7–981.5	5.5 E–7*
KFM03A:4	633.5–650.0	622.9–639.3	2.4 E–6*
KFM04A:4	230.0–245.0	193.0–206.3	2.0 E–6*
KFM06A:3	738.0–748.0	618.7–626.8	1.2E–7*
KFM06A:5	341.0–362.0	289.6–307.4	3.5 E–6*
KFM06C:3	647.0–666.0	519.9–534.2	5.3 E–8*
KFM06C:5	531.0–540.0	431.4–438.3	1.1 E–6*
KFM07A:2	962.0–972.0	791.5–798.9	5.0 E–7*
KFM08A:2	684.0–694.0	546.9–554.2	1.0 E–6*
KFM08A:6	265.0–280.0	221.6–233.9	1.0 E–6*
KFM08D:2	825.0–835.0	658.7–666.4	2.0 E–8**
KFM08D:4	660.0–680.0	530.2–545.9	2.0 E–7**
KFM10A:2	430.0–440.0	296.8–302.8	3.0 E–5*
KFM11A:2	690.0–710.0	585.8–601.8	1.0 E–6*
KFM11A:4	446.0–456.0	385.4–393.8	6.0 E–7*
KFM12A:3	270.0–280.0	222.4–231.0	1.0 E–6*
HFM01:2	33.5–45.5	31.1–42.9	4.0 E–5***
HFM02:2	38.0–48.0	34.9–44.9	5.9 E–4***
HFM04:2	58.0–66.0	53.9–61.9	7.9 E–5***
HFM13:1	159.0–173.0	132.6–144.6	2.9 E–4***
HFM15:1	85.0–95.0	55.7–62.5	1.0 E–4***
HFM16:2	54.0–67.0	50.7–63.7	3.5 E–4***
HFM19:1	168.0–182.0	130.8–141.5	2.7 E–4***
HFM21:3	22.0–32.0	14.6–23.0	4.0 E–5***
HFM27:2	46.0–58.0	40.1–51.1	4.0 E–5***
HFM32:3	26.0–31.0	25.0–29.9	2.3 E–4***

mbl = metres borehole length.

m.b.s.l. = metres below sea level (RHB 70 = the national levelling system).

* From injection tests /37–48/.

** From differential flow logging /49, 50/.

*** From flow loggings /51–58/.

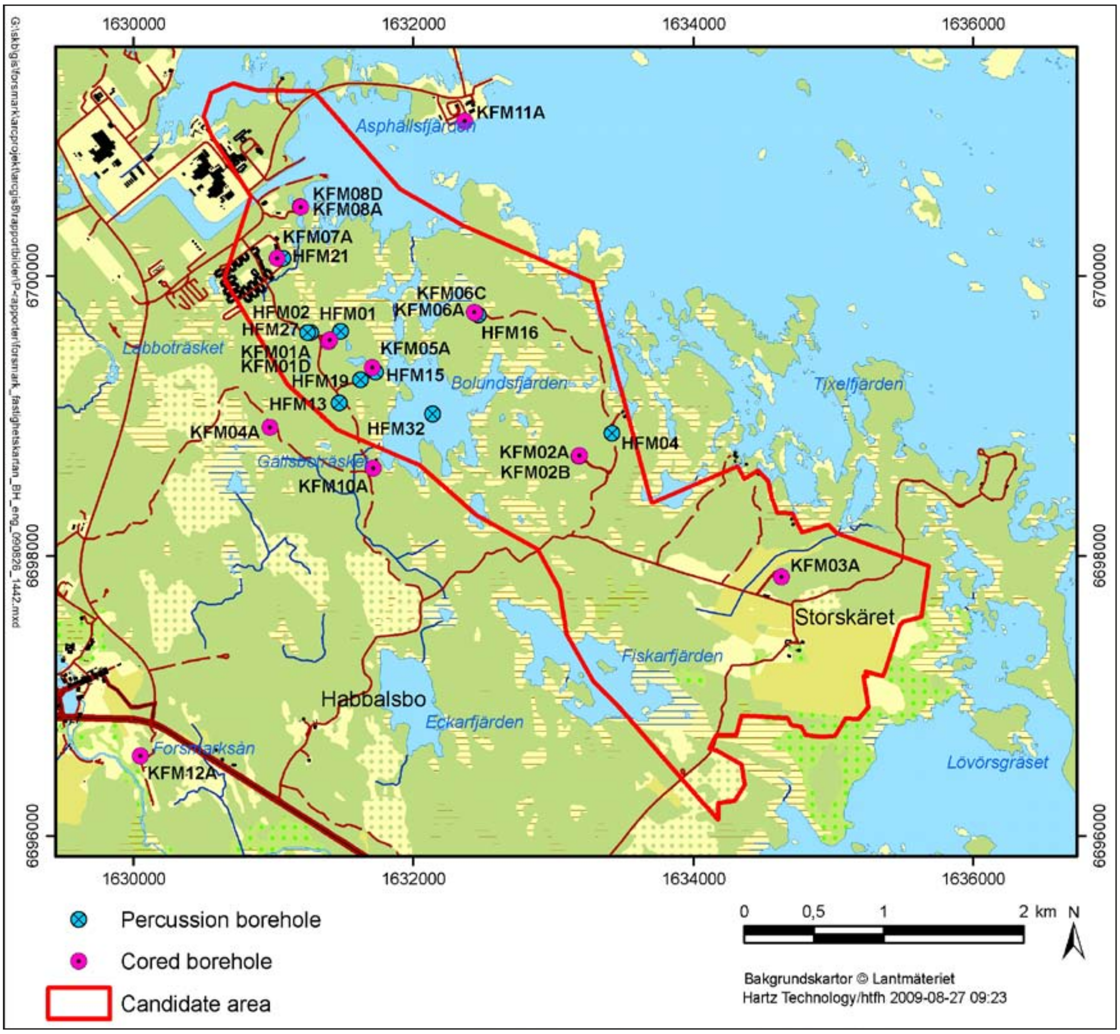


Figure 2-1. *General overview over the Forsmark site investigation area. Sampled boreholes within the monitoring program 2008 are marked with blue (percussion) and pink (telescopic) completed circles.*

2.3.1 Cored boreholes

The flushing water contents in the groundwater samples are important information when evaluating chemical data from core drilled boreholes. The dye Uranine was added as a tracer to the flushing water during drilling and is used to calculate the flushing water content in the groundwater samples. However, Uranine has also been used in some of the late investigations in several borehole sections and in some cases the flushing water content in the samples cannot be calculated any longer.

Injection tests with the PSS equipment /37–48/ was conducted in almost all cored boreholes after the initial hydrochemical characterisation campaign. The relatively small water volumes added to the borehole during injection tests were marked with the dye Uranine to the same concentration as the flushing water, i.e. 0.2 mg/L and the effect on the Uranine concentration in the groundwater should be negligible. Other activities in the cored boreholes with more significant contributions to the concentrations of Uranine and/or trace metals are listed in Table 2-2.

2.3.2 Percussion boreholes

Flushing water was not used during drilling of percussion boreholes and therefore remaining flushing water is not a problem. However, dilution tests conducted in percussion boreholes prior to chemical sampling may possibly affect the section water. Since the shallow borehole sections in the percussion boreholes generally yield much water and the injected volumes during these tests are small, they are not likely to cause significant effects. Interference tests with heavy pumping, on the other hand, are likely to affect the representativity of the samples from percussion boreholes. Such tests, involving pumping in HFM14 located close to HFM15, were conducted during 2006, 2007 and during 2008. All activities performed in the percussion boreholes that might affect the sample quality are listed in Table 2-3.

Table 2-2. Investigations/activities in cored boreholes that might affect the quality of subsequently collected water samples.

Borehole Id code	Section (mbl)	Date (yymmdd)	Activity[1]	Comment	Initial/background Uranine conc. (mg/L)	Final Uranine conc. (mg/L)
KFM01A	117.7–118.8	041106 to 041108	HY215[2]	Injection of Uranine (0.0013 g), ~1.36 mg/L if the section volume is considered.	0.14 (uncertain)	1.2
KFM01A	109.0–130.0	050620 to 050712	HY212, HY210[3]	0.0092 g Uranine injected, total volume of injected fluid 1.8205x10^{-5} m^3.	–	–
	109.0–130.0	050712	HY231[4]	Injection of high amounts, ~20 g, Uranine due to tracer test.	–	–
	109.0–130.0	050818 to 050819	Pumping[4]	Attempt to reduce Uranine content from HY231 after compleded tracer test.	–	–
	109.0–130.0	061123 to 061201	HY212[6]	0.025 g Amino G Acid injected.	–	–
	109.0–130.0	080108 to 080115	HY212[11]	0.0360 g Amino-G Acid injected, total volume of injected fluid 3.47x10^{-5} m^3.	–	–
KFM01D	311.0–321.0	080115 to 080121	HY212[11]	0.0326 g Amino-G Acid injected, total volume of injected fluid 3.14x10^{-5} m^3.	–	–
KFM01D	377.4–378.4	070208 to 070302	HY214[8]	1.04 g Uranine, 0.67 g Caesium and 1.57 g Rubidium was added to the section. Total injected volume of tracer fluid 1.225x10^{-2} m^3.	0.18	0.05 Cs 30 µg/L Rb 90 µg/L
	377.4–378.4	070208 to 070302	HY215[8]	Injection of Uranine (0.0017 g), ~1.66 mg/L if the section volume is considered.	0.03	0.94
KFM01D	431.0–432.0	061214 to 070208	HY214[8]	0.95 g Uranine, 0.67 g Caesium and 1.51 g Rubidium was added to the section. Total injected volume of tracer fluid 1.25x10^{-2} m^3.	0.07 Cs 3 µg/L Rb 50 µg/L	0.02 Cs 20 µg/L Rb 70 µg/L
	431.0–432.0	061214 to 070208	HY215[8]	Injection of Uranine (0.0016 g), ~1.67 mg/L if the section volume is considered.	0.05	0.89
KFM01D	429.0–438.0	080108 to 080115	HY212[11]	0.0425 g Amino-G Acid injected, total volume of injected fluid 4.090x10^{-5} m^3.	–	–
KFM02A	414.7–417.7	050214 to 050302	HY215,	Natural gradient test, injection of Uranine (0.0020 g) up to ~0.75 mg/L considering section volume.	0.05	0.7
			HY214[2]	SWIW-test, 1.04 g Uranine and 1.03 g Caesium was added to the section. Total injected volume of tracer fluid 1.140x10^{-2} m^3. Rubidium is not used.	0.014 Cs 4.35 µg/L	0.031 Cs 74.1 µg/L
KFM02A	411.0–442.0	051116 to 051122	HY212[3]	0.0241 g Uranine injected, total volume of injected fluid 4.862x10^{-5} m^3.		–
	411.0–442.0	060627 to 060711	HY212, HY210[5]	0.0196 g Uranine injected, total volume of injected fluid 4.225x10^{-5} m^3.	–	–
	411.0–442.0	061113 to 061120	HY212[6]	0.021 g Uranine injected, total volume of injected fluid 4.24x10^{-5} m^3.	–	0.82
	411.0–442.0	070315 to 070323	HY212, HY210[9]	0.0199 g Uranine injected, total volume of injected fluid 4.27x10^{-5} m^3.	–	0.148
	411.0–442.0	070327 to 070403	HY230[9]	75.8 g Rhodamine WT injected, total volume of injected fluid 1.7869 m^3.	–	–
	411.0–442.0	070404 to 070413	HY230[9]	125.4 g Uranine, 1,501 g Li, 105 g Cs and 385 g Rb injected. Total volume of injected fluid 2.53 m^3.	–	–
	411.0–442.0	071116 to 071123	HY212[11]	0.0591 g Amino-G Acid injected, total volume of injected fluid 6.090x10^{-5} m^3.	–	–

Borehole Id code	Section (mbl)	Date (yymmdd)	Activity[1]	Comment	Initial/background Uranine conc. (mg/L)	Final Uranine conc. (mg/L)
KFM02A	511.5–514.5	050302 to 050304	HY215[2]	Injection of Uranine (0.0004 g), ~0.15 mg/L if the section volume is considered.	0.01	0.04
KFM02A	490.0–518.0	051122 to 051128	HY212[3]	0.0252 g Uranine injected, total volume of injected fluid 5.085x10^{-5} m^3.	–	–
	490.0–518.0	060630 to 060707	HY212, HY210[5]	0.0209 g Uranine injected, total volume of injected fluid 4.511x10^{-5} m^3.	–	–
	490.0–518.0	061107 to 061113	HY212[6]	0.023 g Uranine injected, total volume of injected fluid 4.53x10^{-5} m^3.	–	0.35
	490.0–518.0	071112 to 071126	HY212[11]	0.0659 g Amino-G Acid injected, total volume of injected fluid 6.790x10^{-5} m^3.	–	–
KFM02B	408.5–434.0	070327 to 070403	HY230[9]	75.8 g Rhodamine WT injected, total volume of injected fluid 1.7869 m^3 (injected in KFM02A 411.0–442.0).	–	–
	408.5–434.0	070404 to 070413	HY230[9]	125.4 g Uranine, 1,501 g Li, 105 g Cs and 385 g Rb injected. Total volume of injected fluid 2.53 m^3 (injected in KFM02A 411.0–442.0).	–	–
KFM02B	410.0–431.0	071119 to 071123	HY212[11]	0.0460 g Amino-G Acid injected, total volume of injected fluid 4.740x10^{-5} m^3.	–	–
KFM02B	491.0–506.0	071112 to 071126	HY212[11]	0.0476 g Amino-G Acid injected, total volume of injected fluid 4.900x10^{-5} m^3.	–	–
KFM03A	643.5–644.5	041214 to 041216	HY215[2]	Injection of Uranine (0.0015), ~1.22 mg/L if the section volume is considered.	0.04	0.8
	643.5–644.5	050107 to 050117	HY214[2]	0.949 g Uranine and 1.03 g Caesium was added to the section. Total injected volume of tracer fluid 1.013x10^{-2} m^3. Rubidium is not used.	0.008 Cs 1.81 µg/L	0.132 Cs 157 µg/L
KFM03A	633.5–650.0	051118 to 051123	HY212[3]	0.0244 g Uranine injected, total volume of injected fluid 4.920x10^{-5} m^3.	–	–
	633.5–650.0	061113 to 061123	HY212[6]	0.024 g Uranine injected, total volume of injected fluid 4.87x10^{-5} m^3.	–	0.38
	633.5–650.0	071116 to 071126	HY212[11]	0.0583 g Amino-G Acid injected, total volume of injected fluid 6.000x10^{-5} m^3.	–	–
KFM03A	986.0–987.0	041119 to 041123	HY215[2]	Injection of Uranine (0.0025 g), ~2.48 mg/L if the section volume is considered.	0.04	2.3
	969.5–994.5	051123 to 051205	HY212[3]	0.0330 g u injected, total volume of injected fluid 6.660x10^{-5} m^3.	–	–
KFM04A	232.0–237.0	060221 to 060223	HY215[2]	Injection of Uranine (0.0019 g), ~0.58 mg/L if the section volume is considered.	0.00	0.006
	230.0–245.0	071113 to 071120	HY212[11]	0.0342 g Amino-G Acid injected, total volume of injected fluid 3.520x10^{-5} m^3.	–	–
KFM06A	341.0–362.0	051117 to 051124	HY212[3]	0.0175 g Uranine injected, total volume of injected fluid 3.520x10^{-5} m^3.	–	–
	341.0–362.0	060626 to 060711	HY212, HY210[5]	0.0156 g Uranine injected, total volume of injected fluid 3.377x10^{-5} m^3.	–	–
	341.0–362.0	061106 to 061110	HY212[6]	0.018 g Uranine injected, total volume of injected fluid 3.52x10^{-5} m^3.	–	0.36
	341.0–362.0	080118 to 080129	HY212[11]	0.0619 g Amino-G Acid injected, total volume of injected fluid 5.960x10^{-5} m^3.	–	–
KFM06A	738.0–748.0	051124 to 051205	HY212[5]	0.0253 g Uranine injected, total volume of injected fluid 5.100x10^{-5} m^3.	–	–
	738.0–748.0	060630 to 0607007	HY212, HY210[5]	0.0233 g Uranine injected, total volume of injected fluid 5.040x10^{-5} m^3.	–	–
	738.0–748.0	061110 to 061117	HY212[6]	0.026 g Uranine injected, total volume of injected fluid 5.15x10^{-5} m^3.	–	0.45
	738.0–748.0	080125 to 080201	HY212[11]	0.0586 g Amino-G Acid injected, total volume of injected fluid 5.870x10^{-5} m^3.	–	–
KFM06C	531.0–540.0	061113 to 061120	HY212[6]	0.0193 g Uranine injected, total volume of injected fluid 3.86x10^{-5} m^3.	–	–
	531.0–540.0	080125 to 080129	HY212[11]	0.0456 g Amino-G Acid injected, total volume of injected fluid 4.390x10^{-5} m^3.	–	–
KFM06C	647.0–666.0	061106 to 061113	HY212[6]	0.0251 g Uranine injected, total volume of injected fluid 5.00x10^{-5} m^3.	–	–

Borehole Id code	**Section (mbl)**	**Date (yymmdd)**	**Activity**[1]	**Comment**	**Initial/background Uranine conc. (mg/L)**	**Final Uranine conc. (mg/L)**
	647.0–666.0	080118 to 080201	HY212[11]	0.0663 g Amino-G Acid injected, total volume of injected fluid 6.390x10^{-5} m^3.	–	–
KFM08A	265.0–280.0	080201 to 080208	HY212[11]	0.0347 g Amino-G Acid injected, total volume of injected fluid 3.480x10^{-5} m^3.	–	–
KFM08A	410.5–413.5	051125 to 060103	HY214[7]	1.04 g Uranine, 0.74 g Caesium and 1.63 g Rubidium was added to the section. Total injected volume of tracer fluid 1.1x10^{-2} m^3.	0.02 Cs 2 µg/L Rb 40 µg/L	0.15 Cs 160 µg/L Rb 360 µg/L
	410.6–413.5	051125 to 060115	HY215[7]	Injection of Uranine (0.002 g), ~0.94 mg/L if the section volume is considered.	0.01	0.45
KFM08A	684.0–694.0	080128 to 080208	HY212[11]	0.0569 g Amino-G Acid injected, total volume of injected fluid 5.480x10^{-5} m^3.	–	–
KFM08D	660.0–680.0	080128 to 080204	HY212[11]	0.0770 g Amino-G Acid injected, total volume of injected fluid 7.710x10^{-5} m^3.	–	–
KFM08D	825.0–835.0	080201 to 080208	HY212[11]	0.0642 g Amino-G Acid injected, total volume of injected fluid 6.430x10^{-5} m^3.	–	–
KFM10A	430.0–440.0	070625 to 070702	HY210, HY212[6]	0.0197 g uinjected, total volume of injected fluid 3.944x10^{-5} m^3.	0.002	0.083
	430.0–440.0	070706	HY230	60.94 g Ho-DTPA injected, total volume of injected fluid 5.044x10^{-2} m^3.	Ho 0.053 µg/L	Ho 10.2 µg/L
	430.0–440.0	071109 to 071116	HY212[11]	0.0398 g Amino-G Acid injected, total volume of injected fluid 4.010x10^{-5} m^3.	–	–
KFM11A	446.0–456.0	080121 to 080204	HY212[11]	0.0420 g Amino-G Acid injected, total volume of injected fluid 4.050x10^{-5} m^3.	–	–
KFM11A	690.0–710.0	080128 to 080204	HY212[11]	0.0687 g Amino-G Acid injected, total volume of injected fluid 6.880x10^{-5} m^3.	–	–
KFM12A	270.0–280.0	080204 to 080208	HY212[11]	0.0319 g Amino-G Acid injected, total volume of injected fluid 3.190x10^{-5} m^3.	–	–
KFM08A	265.0–280.0	080201 to 080208	HY212[11]	0.0347 g Amino-G Acid injected, total volume of injected fluid 3.480x10^{-5} m^3.	–	–
KFM08A	410.5–413.5	051125 to 060103	HY214[7]	1.04 g Uranine, 0.74 g Caesium and 1.63 g Rubidium was added to the section. Total injected volume of tracer fluid 1.1x10^{-2} m^3.	0.02 Cs 2 µg/L Rb 40 µg/L	0.15 Cs 160 µg/L Rb 360 µg/L
	410.6–413.5	051125 to 060115	HY215[7]	Injection of Uranine (0.002 g), ~0.94 mg/L if the section volume is considered.	0.01	0.45
KFM08A	684.0–694.0	080128 to 080208	HY212[11]	0.0569 g Amino–G Acid injected, total volume of injected fluid 5.480x10^{-5} m^3.	–	–
KFM08D	660.0–680.0	080128 to 080204	HY212[11]	0.0770 g Amino-G Acid injected, total volume of injected fluid 7.710x10^{-5} m^3.	–	–
KFM08D	825.0–835.0	080201 to 080208	HY212[11]	0.0642 g Amino-G Acid injected, total volume of injected fluid 6.430x10^{-5} m^3.	–	–
KFM10A	430.0–440.0	070625 to 070702	HY210, HY212[6]	0.0197 g Uranine injected, total volume of injected fluid 3.944x10^{-5} m^3.	0.002	0.083
	430.0–440.0	070706	HY230[10]	60.94 g Ho-DTPA injected, total volume of injected fluid 5.044x10^{-2} m^3.	Ho 0.053 µg/L	Ho 10.2 µg/L
	430.0–440.0	071109 to 071116	HY212[11]	0.0398 g Amino-G Acid injected, total volume of injected fluid 4.010x10^{-5} m^3.	–	–
KFM11A	446.0–456.0	080121 to 080204	HY212[11]	0.0420 g Amino-G Acid injected, total volume of injected fluid 4.050x10^{-5} m^3.	–	–
KFM11A	690.0–710.0	080128 to 080204	HY212[11]	0.0687 g Amino-G Acid injected, total volume of injected fluid 6.880x10^{-5} m^3.	–	–
KFM12A	270.0–280.0	080204 to 080208	HY212[11]	0.0319 g Amino-G Acid injected, total volume of injected fluid 3.190x10^{-5} m^3.	–	–

[1] HY215 = Borehole probe dilution test, natural gradient, HY212 = Dilution test natural gradient, HY210 = Dilution test stressed gradient, HY231 = Tracer injection during tracer tests, HY214 = SWIW-test.

[2] /59/, [3] /60/ [4] /61/ [5] /62/ [6] /63/ [7] /64/ [8] /65/ [9] /66/ [10] /67/ [11] /68/.

Table 2-3. Investigations/activities in percussion boreholes that might affect the quality of collected water samples.

Borehole (Id code)	Section (mbl)	Date (yymmdd)	Activity[1]	Comment
HFM01	33.5–45.5	070625–070702	HY210, HY212[6]	0.020 g Uranine injected, total volume of injected fluid 3.96x10^{-5} m^3.
		070706	HY230[6]	19.88 g Eu-DTPA injected, total volume of injected fluid 4.843x10^{-2} m^3.
		080122–080128	HY212[7]	0.0395 g Amino-G Acid injected, total volume of injected fluid 3.960x10^{-5} m^3.
HFM02	38.0–48.0	050621–050712	HY210, HY212[2]	0.3256 g Uranine injected, total volume of injected fluid 6.409x10^{-4} m^3.
		050712	HY231[2]	Injection of high amounts, 250 g, Amino G Acid due to tracer test.
		051205–051212	HY212[3]	0.1290 g Uranine injected, total volume of injected fluid 2.600x10^{-4} m^3.
		060629–060710	HY210, HY212[4]	0.1426 g Uranine injected, total volume of injected fluid 3.080x10^{-4} m^3.
		061127–061201	HY212[5]	0.1574 g Uranine injected, total volume of injected fluid 3.200x10^{-5} m^3.
		080114–080118	HY212[7]	0.1204 g UAmino-G Acid injected, total volume of injected fluid 1.160x10^{-4} m^3.
HFM04	58.0–66.0	051116–151122	HY212[3]	0.0129 g Uranine injected, total volume of injected fluid 2.595x10^{-5} m^3.
		061107–061114	HY212[5]	0.0151 g Uranine injected, total volume of injected fluid 3.020x10^{-5} m^3.
		071113–071120	HY212[7]	0.0278 g Amino-G Acid injected, total volume of injected fluid 2.860x10^{-5} m^3.
HFM13	159.0–173.0	051206–051212	HY212[3]	0.0216 g Uranine injected, total volume of injected fluid 4.362x10^{-5} m^3.
		060628–060711	HY210, HY212[4]	0.0325 g Uranine injected, total volume of injected fluid 7.020x10^{-5} m^3.
		061114–061122	HY212[5]	0.0160 g Uranine injected, total volume of injected fluid 3.200x10^{-5} m^3.
		070626–070702	HY210, HY212[6]	0.016 g Uranine injected, total volume of injected fluid 3.13x10^{-5} m^3.
		070706	HY230[6]	24.89 g Tb-DTPA injected, total volume of injected fluid 5.011x10^{-2} m^3.
		071109–071116	HY212[7]	0.0397 g Amino-G Acid injected, total volume of injected fluid 4.000x10^{-5} m^3.
HFM15	85.0–95.0	050621–050712	HY210, HY212[2]	0.0197 g Uranine injected, total volume of injected fluid 3.870x10^{-5} m^3.
		050712	HY231[2]	Injection of high amounts Rhodamine WT, ~180–190 g, due to tracer test.
		051205–051212	HY212[3]	0.0190 g Uranine injected, total volume of injected fluid 3.825x10^{-5} m^3.
		060627–060710	HY210, HY212[4]	0.0138 g Uranine injected, total volume of injected fluid 2.989x10^{-5} m^3.
		061120–061127	HY212[5]	0.0153 g Uranine injected, total volume of injected fluid 3.060x10^{-5} m^3.
		070625–070702	HY210, HY212[6]	0.018 g Uranine injected, total volume of injected fluid 3.57x10^{-5} m^3.
		070709	HY230[6]	7.95 g Gd-DTPA injected, total volume of injected fluid 5.181x10^{-2} m^3.
		070924–070925	HY230[6]	187.5 g Uranine and 650.8 g Cs injected, total volume of injected fluid 3.677 m^3.
		080125–080204	HY212[7]	0.0366 g Amino-G Acid injected, total volume of injected fluid 3.530x10^{-5} m^3.
HFM16	54.0–67.0	061106 to 061113	HY212[5]	0.0187 g Uranine injected, total volume of injected fluid 3.740x10^{-5} m^3.
		080118–080125	HY212[7]	0.0458 g Amino-G Acid injected, total volume of injected fluid 4.410x10^{-5} m^3.
HFM19	168.0–182.0	051205–051212	HY212[3]	0.0186 g Uranine injected, total volume of injected fluid 3.750x10^{-5} m^3.
		060628–060710	HY210, HY212[4]	0.0169 g Uranine injected, total volume of injected fluid 3.640x10^{-5} m^3.
		061117–061127	HY212[5]	0.0186 g Uranine injected, total volume of injected fluid 3.710x10^{-5} m^3.
		070626–070702	HY210, HY212[6]	0.244 g Uranine injected, total volume of injected fluid 4.886x10^{-4} m^3.
		070709	HY230[6]	166.7 g Dy-DTPA injected, total volume of injected fluid 6.633x10^{-2} m^3.
		080114–080118	HY212[7]	0.0476 g UAmino-G Acid injected, total volume of injected fluid 4.590x10^{-5} m^3.
HFM21	22.0–32.0	080109–080114	HY212[7]	0.0410 g UAmino-G Acid injected, total volume of injected fluid 3.950x10^{-5} m^3.
HFM27	46.0–58.0	061124–061201	HY212[5]	0.0180 g Uranine injected, total volume of injected fluid 3.600x10^{-5} m^3.
		080204–080208	HY212[7]	0.0400 g Amino-G Acid injected, total volume of injected fluid 4.010x10^{-5} m^3.
HFM32	26.0–31.0	060626–060707	HY210, HY212[4]	0.0082 g Uranine injected, total volume of injected fluid 1.761x10^{-5} m^3.
		061120–061124	HY212[5]	0.0092 g Uranine injected, total volume of injected fluid 1.830x10^{-5} m^3.
		070626–070701	HY210, HY212[6]	0.008 g uinjected, total volume of injected fluid 1.54x10^{-5} m^3.
		070709	HY230[6]	42.60 g ReO_4^- injected, total volume of injected fluid 2.470x10^{-2} m^3.

[1]HY212 = Dilution test natural gradient, HY210 = Dilution test stressed gradient, HY230 = Radially converging Test Hole, HY231 = Tracer injection during tracer tests. [2] /61/, [3]/62/, [4] /63/, [5] /64/, [6] /67/, [7] /68/.

2.4 Equipment

2.4.1 Sampling equipment

The monitored boreholes are divided into different borehole sections sealed off by inflated straddle-packers. Each section is connected to SKB Hydro Monitoring System (HMS) which is a system for pressure monitoring. Outlines of the instrumentation in percussion drilled and telescopic boreholes, respectively, are presented in Figure 2-2.

Twelve identical pump equipments (GEOPUMP UV45) were used to retrieve the water samples from the sampled sections. An outline of the sampling setup is presented in Figure 2-3. Figure 2-4 shows the lowering of the pump into the plastic standpipe. The water passes through a coarse filter to eliminate large particles that may be present in the water, then through a by-pass tubing past the mini-packer which confines the groundwater included in the section and thereafter through the downhole pump on the way to the surface. The flow rate is controlled by varying the capacity of the downhole pump with a voltage regulator at the surface.

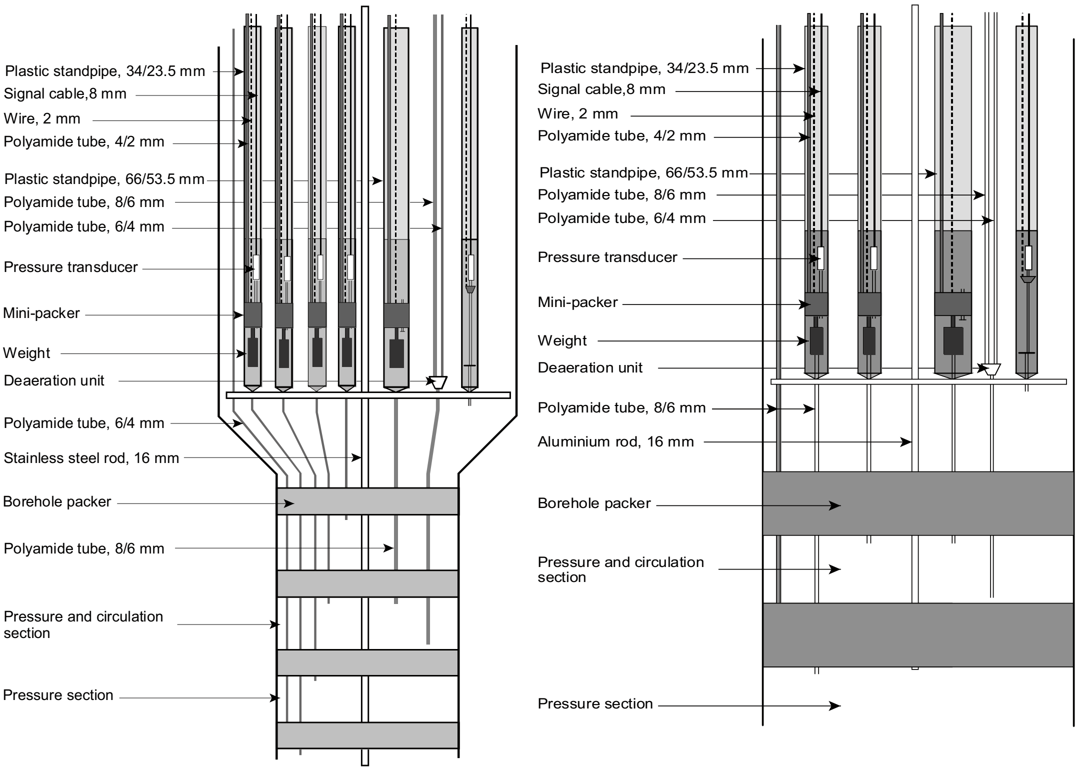


Figure 2-2. *Instrumentation in core boreholes (left) and percussion boreholes (right) including circulation (sampling) sections.*

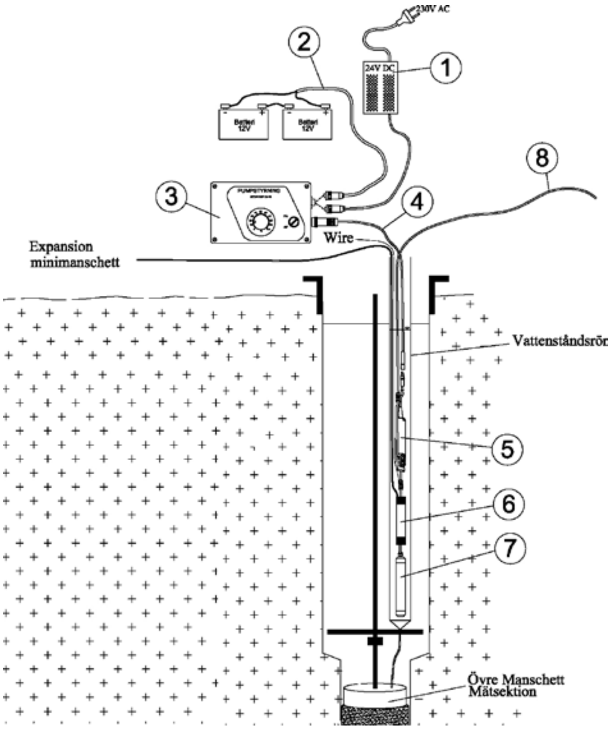


Figure 2-3. *Equipment setup used for sampling of water from circulation sections in monitored percussion drilled and telescopic boreholes. 1) voltage regulator (24 VDC), 2) battery cable (not used), 3) pump regulator, 4) pump cable, 5) pump (GEOPUMP UV 45), 6) small inflatable packer (PU 45), 7) filter (SF 45), 8) 8/6 mm polyamide tube to pump.*

Figure 2-4. *Lowering of equipment in the water stand-pipe in order to pump water from the borehole section. From the bottom; filter, small inflatable packer and pump.*

2.5 Performance

2.5.1 General

Monitored boreholes and borehole sections, sampling dates, collected samples and analyses performed are presented in Table 2-4.

2.5.2 Water sampling and field measurements

Prior to sampling, the water volume in each section was exchanged at least three times to obtain a representative water sample from the section, except in KFM06C:3, see 2.5.4. The pumped total volumes from each section prior to sampling are given in Appendix 2.1. Short circuiting, indicated by pressure responses in one or more sections other than the pumped ones, can be observed in a few cases. Information on these short circuiting phenomena is also included in Appendix 2.1. Pressure diagrams for each borehole and sampling occasion are given in Appendix 2.2 if pressure registra-

Table 2-4. Boreholes, borehole sections, sampling dates, collected samples and analyses performed.

Id code	Section	Sampling no. 1			Sampling no. 2		
	(mbl)	Date	Sample no.	Analyses	Date	Sample no.	Analyses
HFM01:2	33.5–45.5	08-05-21	16031	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-07	16120	Class 5, options
HFM02:2	38.0–48.0	08-05-21	16033	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-07	16119	Class 5, options
HFM04:2	58.0–66.0	08-05-22	16029	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-09-30	16100	Class 5, options
HFM13:1	159.0–173.0	08-05-15	16027	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-09-30	16098	Class 5, options
HFM15:1	85.0–95.0	08-05-15	16023	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-28	16142	Class 5, options
HFM16:2	54.0–67.0	08-05-22	16032	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-17	16135	Class 5, options
HFM19:1	168.0–182.0	08-05-15	16026	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-28	16141	Class 5, options
HFM21:3	22.0–32.0	08-05-15	16024	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-22	16138	Class 5, options
HFM27:2	46.0–58.0	08-05-21	16030	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-07	16121	Class 5, options
HFM32:3	26.0–31.0	08-06-05	16046	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-14	16132	Class 5, options
KFM01A:5	109.0–130.0	08-05-29	16044	Class 5, options**	08-10-03	16109	Class 4 + $^{2}\delta$H, ^{3}H, ^{18}O
KFM01D:4	311.0–321.0	08-05-29	16045	Class 5, options**	08-10-03	16110	Class 5, options
KFM01D:2	429.0–438.0	08-05-29	16042	Class 5, options**	08-10-03	16111	Class 5, options
KFM02A:5	411.0–442.0	08-05-29	16040	Class 5, options**	08-10-01	16102	Class 5, options
KFM02A:3	490.0–518.0	08-05-29	16041	Class 5, options**	08-10-01	16101	Class 5, options
KFM02B:4	410.0–431.0	08-05-29	16043	Class 5, options**	08-10-01	16104	Class 5, options
KFM02B:2	491.0–506.0	08-05-29	16039	Class 5, options**	08-10-01	16103	Class 5, options
KFM03A:4	633.5–650.0	08-05-22	16028	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-24	16140	Class 5, options
KFM03A:1	969.5–994.5	08-05-23	16036	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-11-07	16147	Class 5, options
KFM04A:4	230.0–245.0	08-05-22	16034	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-06	16114	Class 5, options
KFM06A:5	341.0–362.0	08-06-05	16049	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-17	16134	Class 4 + $^{2}\delta$H, ^{3}H, ^{18}O
KFM06A:3	738.0–748.0	08-06-09	16048	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-17	16136	Class 4 + $^{2}\delta$H, ^{3}H, ^{18}O
KFM06C:5	531.0–540.0	08-06-09	16064	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-17	16133	Class 4 + $^{2}\delta$H, ^{3}H, ^{18}O
KFM06C:3	647.0–666.0	08-06-11	16066	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-11-14	16162	Class 3**
KFM07A:2*	962.0–972.0	***			08-10-29	16144	Class 5, options
KFM08A:6	265.0–280.0	08-05-29	16047	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-22	16139	Class 4 + $^{2}\delta$H, ^{3}H, ^{18}O
KFM08A:2	684.0–694.0	08-06-05	16062	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-28	16143	Class 5, options
KFM08D:4	660.0–680.0	08-06-05	16063	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-11-07	16146	Class 4 + $^{2}\delta$H, ^{3}H, ^{18}O
KFM08D:2	825.0–835.0	08-06-09	16065	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-11-11	16157	Class 4 + $^{2}\delta$H, ^{3}H, ^{18}O
KFM10A:2	430.0–440.0	08-05-22	16035	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-09-30	16099	Class 5, options
KFM11A:4	446.0–456.0	08-05-22	16038	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-06	16113	Class 5, options
KFM11A:2	690.0–710.0	08-05-22	16037	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-06	16112	Class 5, options
KFM12A:3	270.0–280.0	08-05-15	16025	Class 3 + $^{2}\delta$H, ^{3}H, ^{18}O	08-10-07	16118	Class 5, options

* Water “pumped” using nitrogen lifting. Not sampled in campaign no. 1.
** SKB class 3 due to high flushing water content.
*** Not sampled, see 2.5.4, Nonconformities.

tions are available. Missing registrations for the spring campaign are boreholes KFM06A, KFM06C, KFM08A, KFM08D and HFM32, and for the autumn campaign KFM04A, KFM06A, KFM06C, KFM07A and KFM12A.

In addition to sampling of ground water, field measurements of temperature, electric conductivity and pH were conducted. The water pumped from the borehole was led through a measurement cell with probes and electrodes as well as a temperature sensor for measurements of field pH (pH_F), field electrical conductivity (EC_F) and groundwater temperature.

Sample portions intended for analysis of major constituents and trace metals (by ICP technique), DOC, iron (by spectrometry) and nutrient salts were filtered on-line. Disposable 0.4 µm filters were fitted directly to the 6/8 mm polyamide-tube leading the pumped water from the borehole section. During the entire sampling, laboratory gloves were used to minimize the risk of contaminating the samples.

2.5.3 Water sample treatment and analyses

An overview of general sample treatment and analysis routines for major constituents, minor anions, trace metals and isotopes is given in Appendix 1. The routines are applicable independently of sampling method or sampling object.

2.5.4 Nonconformities

- Due to pump failures and lack of time at the sampling occasion in May, KFM06C:3 was pumped only for a short time before sampling. Hence, the sample might consist to some extent of old, stagnant water from the section.
- The sampling in the borehole sections in KFM01A, KFM01D, KFM02A and KFM02B in May was performed according to SKB class 5 without options.
- At the sampling occasion in October, the sampling in borehole sections KFM01A:5, KFM06A:3, KFM06A:5, KFM06C:3, KFM06C:5, KFM08A:6, KFM08D:2 and KFM08D:4 was conducted according to SKB class 3 or 4 and not class 5 as planned. The sampling protocol and the reasons behind the changes are given in Table 2-5.
- Electrical conductivity and pH was not measured in October–November in KFM06A:3, KFM06C:3 and KFM07A:2 due to sampling problems and a low pumping rate.
- During test campaign 1 in May, borehole KFM07A had no packers/sections installed, hence no water was sampled.

Table 2-5. Boreholes, borehole sections, sampling dates, collected samples and analyses performed.

Id code	Borehole section (mbl)	Sampling protocol	Reason for change to class 3 or 4
KFM01A:5	109–130	SKB class 4 with δ^2H, ^{3}H, ^{18}O	High amount of Uranine and requirement for sulphide analysis
KFM06A:5 KFM06A:3	341–362 738–748	SKB class 4 with δ^2H, ^{3}H, ^{18}O	High amount of remaining flushing water from drilling and requirement for sulphide analysis
KFM06C:3	647–666	SKB class 3	High amount of remaining flushing water from drilling.
KFM06C:5	531–540	SKB class 4	High amount of remaining flushing water from drilling
KFM08A:6	265–280	SKB class 4 with δ^2H, ^{3}H, ^{18}O	High amount of Uranine and requirement for sulphide analysis
KFM08D:4 KFM08D:2	660–680 825–835	SKB class 4 with δ^2H, ^{3}H, ^{18}O	Due to high amount of remaining flushing water from drilling and requirement for sulphide analysis

2.5.5 Data handling and interpretation

The general routines for quality control and data management applied for hydrochemical analysis data, independently of sampling method or sampling object are presented in Appendix 1.

2.6 Results

2.6.1 Basic water analyses

The basic analyses include the major constituents Na, K, Ca, Mg, Fe, Li, Mn, S, Sr, SO_4^{2-}, Cl^-, Si, HCO_3^-, Br^- and F^-. Samples collected according to SKB chemistry class 5 also include P, I^-, HS^-, NH_4^+, NO_2^-, NO_3^-, TOC and DOC. Furthermore, both laboratory data and field measurement data on pH and electrical conductivity (EC) were obtained and the water temperature was recorded in the field.

For samples collected in core drilled telescopic boreholes, the flushing water content is an important parameter. However, since the dye Uranine, which is used to mark the flushing water during drilling, was used also in other investigations, see Table 2-1, it is not always possible to calculate the amount of flushing water emerging from the drilling of the borehole. Figure 2-5a–b presents Uranine concentrations in collected samples from hydrochemical monitoring as well as from the initial chemical characterisation in the corresponding section /69–83/. As displayed in the diagrams, the Uranine concentration has increased in many borehole sections due to groundwater flow measurements and tracer tests.

The charge balance errors provide an indication of the quality and uncertainty of the analyses of major constituents. The errors did not exceed the acceptable limit of ± 5%, except for one case; KFM01D sample no 16045, with an error of –5.7%. The basic water analysis data and relative charge balance errors are compiled in Appendix 2.3, Table A2-1.

Chloride concentrations are presented in Figure 2-6a–b (cored boreholes) and Figure 2-7 (percussion boreholes) together with the initial concentrations from chemical characterisation (core drilled boreholes) /69–83/ or sampling during pumping tests (percussion boreholes) /51–58/. Generally the chloride concentrations were quite stable, especially in cored boreholes.

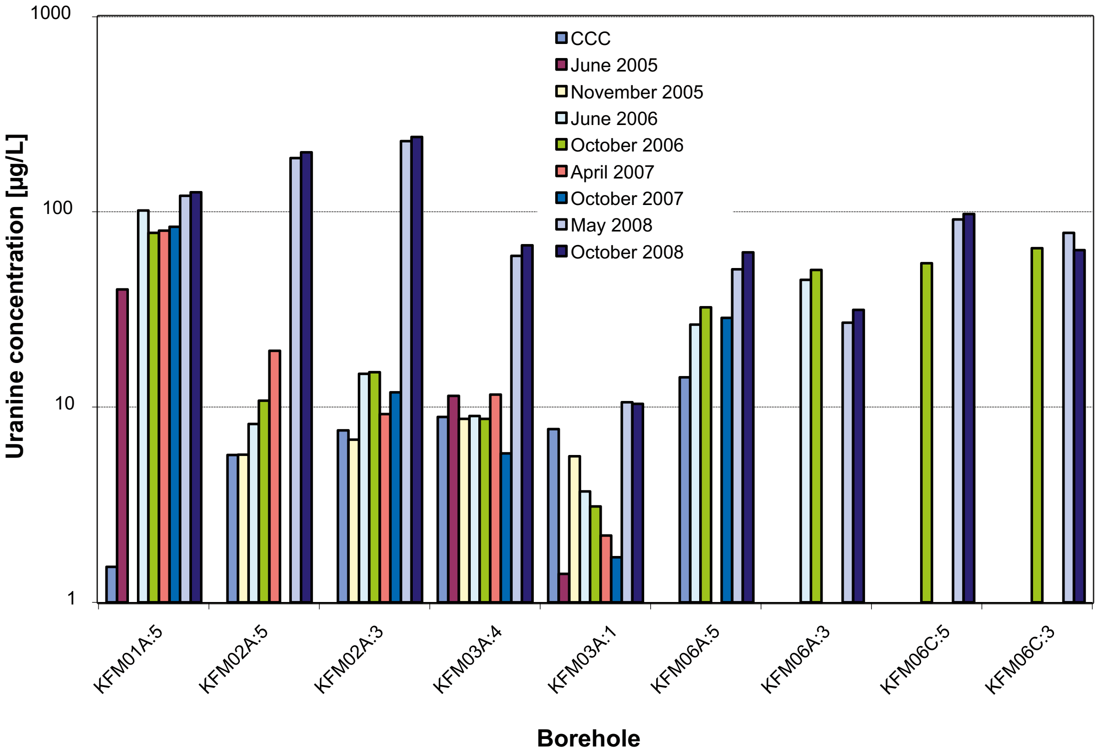
Some striking changes in the sulphide concentrations have been observed from the groundwater monitoring in boreholes after the initial chemical investigations in the corresponding sections. Table 2-6 presents sulphide concentrations in samples collected during the monitoring programme since the start in 2005 /3–5/ as well as from initial hydrochemical investigations (CCC) in corresponding borehole sections.

2.6.2 Trace elements (rare earth metals and others)

The analyses of trace elements include Cr, Cu, Co, Ni, Mo, Pb, Zn, Sb, Al, U, Th, B, As, Sc, Cd, Hg, V, Rb, Y, Zr, In, Cs, Ba, La, Hf, Tl, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb as well as Lu and are compiled in Appendix 2.3, Table A2-2. Due to low natural concentrations and frequent use in different equipments, the risk of contamination is high for common metals like Cr, Cu, Co, Ni, Mo, Zn and Al. The use of caesium or caesium together with rubidium in SWIW-tests might also have contaminated some of the samples. The uranium concentration in section KFM02A:3 continues to be very high /3–5/ and amounts to 168 μg/L in sample 16101 at the late sampling occasion in October.

2.6.3 Stable and radioactive isotopes

The isotope determinations include the stable isotopes δ^2H, $\delta^{18}O$, $^{10}B/^{11}B$, $\delta^{34}S$, $\delta^{13}C$ and $^{87}Sr/^{86}Sr$ as well as the radioactive isotopes ^3H (TU), ^{14}C (pmC), ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra and ^{222}Rn. All samples were analysed for δ^2H, $\delta^{18}O$ and ^3H, except all of the samples collected in KFM06C and the sample from KFM08D:4 collected in June. All other isotopes were determined once (SKB class 5 sampling) except for KFM01A, KFM06A:5, KFM08A:6 and KFM08D, both sections. Available isotope data are compiled in Appendix 2.3 Table A2-3 and A2-4.



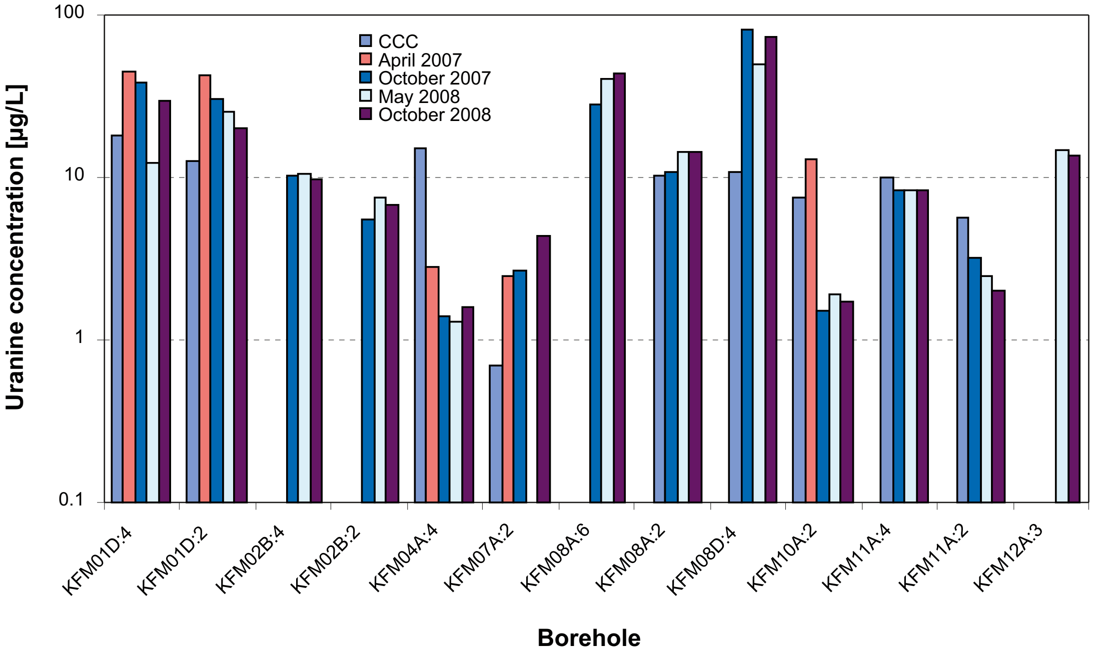
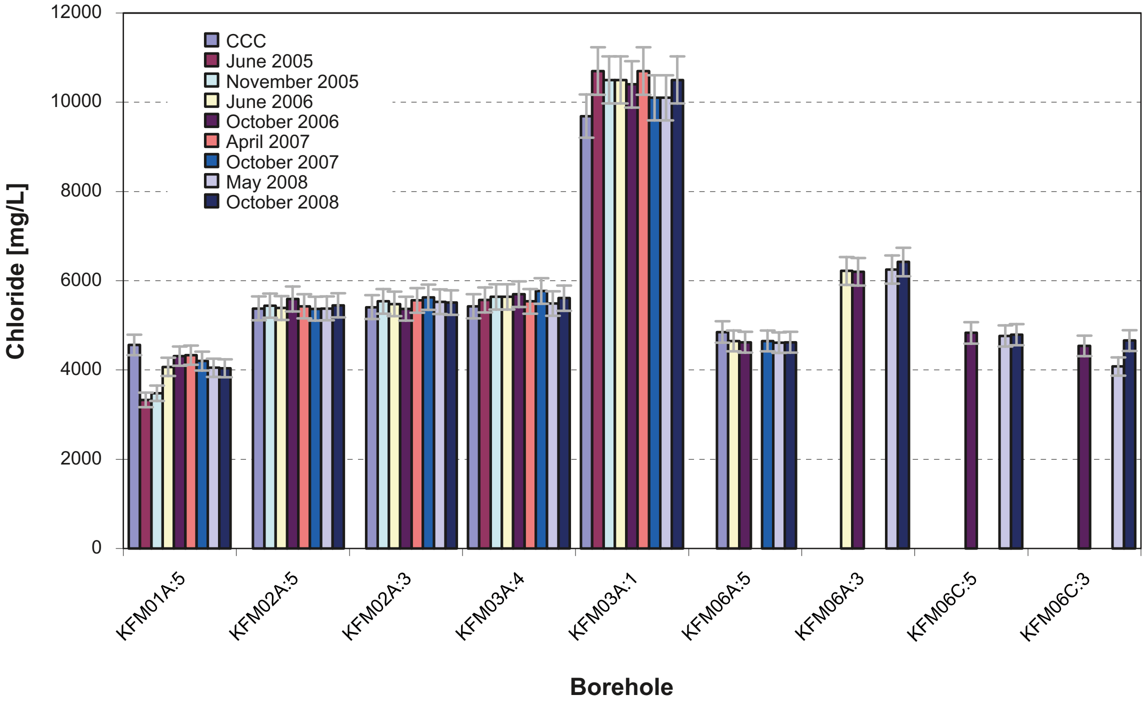


Figure 2-5a–b. *Uranine concentrations in water samples from core drilled boreholes included in the hydrochemical monitoring program. The concentrations from the initial chemical characterisations (CCC) in corresponding borehole sections are given for comparison. The nominal Uranine concentration in the drilling water is 200 µg/L. Boreholes KFM01A, KFM02A, KFM03A, KFM06A and KFM06C are displayed in Figure 2-5a whereas boreholes KFM01D, KFM02B, KFM04A, KFM07A, KFM08A, KFM08D, KFM10A, KFM11A and KFM12A are presented in Figure 2-5b.*



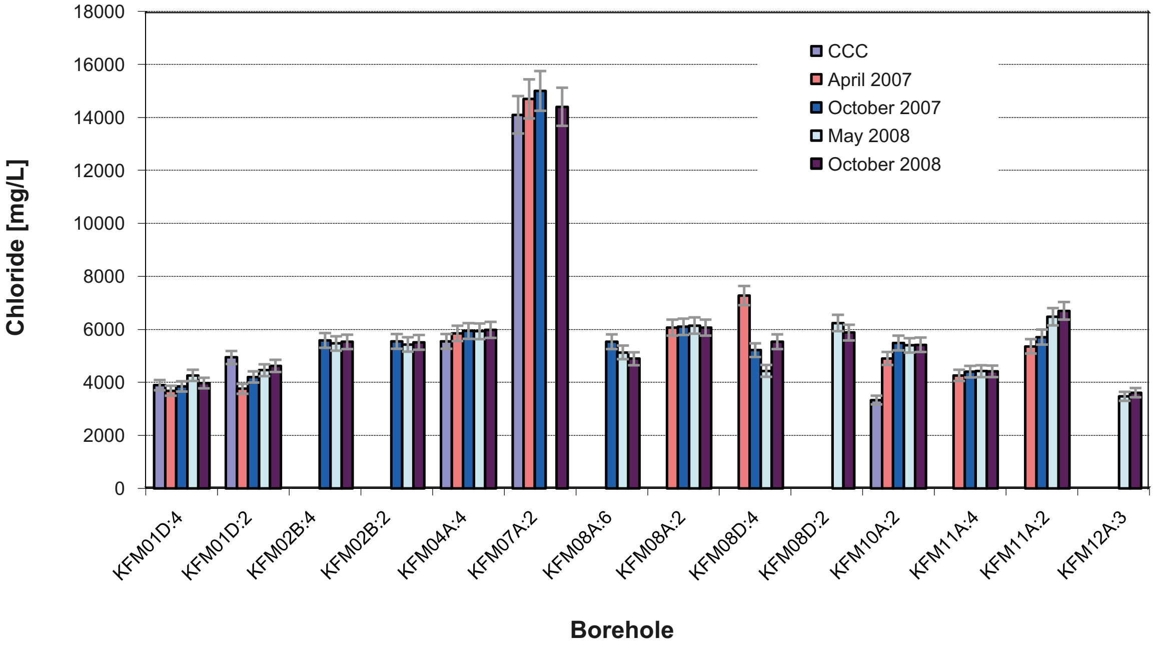


Figure 2-6a–b. *Chloride concentrations in samples collected in core boreholes included in the monitoring program. Results from initial hydrochemical characterisations (CCC) are given for comparison. Boreholes KFM01A, KFM02A, KFM03A, KFM06A and KFM06C are displayed in Figure 2-6a whereas boreholes KFM01D, KFM02B, KFM04A, KFM07A, KFM08A, KFM08D, KFM10A, KFM11A and KFM12A are presented in Figure 2-6b.*

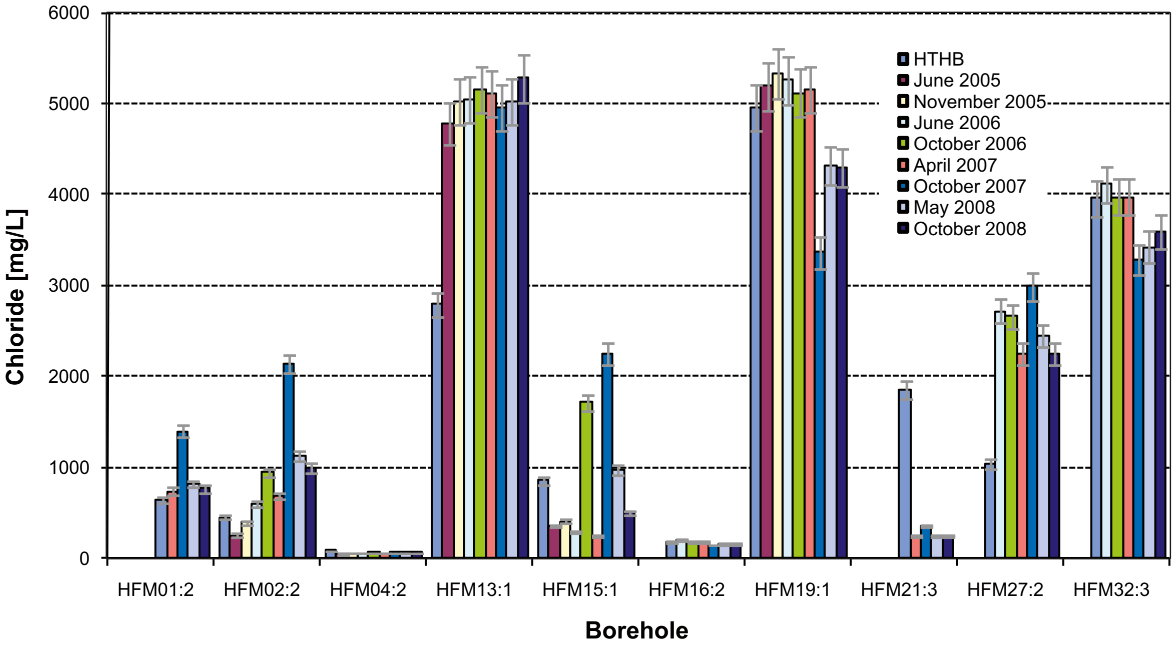


Figure 2-7. *Chloride concentrations in samples collected in percussion boreholes included in the monitoring program. Results from the initial sampling during pumping tests (HTHB) are given for comparison. The initial concentrations are not quite comparable as the early sampling was performed at open hole conditions from the entire borehole and not from packed off sections.*

Table 2-6. Sulphide concentrations (mg/l) in sample series from the monitoring programme with start in 2005. Available concentrations from previous hydrochemical investigations, CCC, /69–79/ are given for comparison.

	CCC	June-05	Oct-05	June-06	Oct-06	Apr-07	Oct-07	Jan-08:1*	Jan-08:2	Jan-08:3	May-08	Oct-08
KFM01A:5	0.014	–	–	–	0.922	–	–	–	–	–	0.328	0.428
KFM01D:4	0.009	–	–	–	–	0.287	–	–	–	–		
KFM01D:2	0.006	–	–	–	–	3.29	–	13.4	1.7	2.38	3.7	5.39
KFM02A:5	<0.002	–	0.058	–	0.129	–	–	–	–	–	0.315	0.956
KFM02A:3	0.009	–	0.066	0.065	0.167	–	0.219	–	–	–	0.118	0.22
KFM03A:4	<0.002	0.133	0.701	–	0.538	–	0.219	–	–	–	–	0.147
KFM03A:1	0.033	–	0.838	–	0.587	–	0.245	–	–	–	–	1.15
KFM06A:5	<0.002	–	0.614	–	0.108	–	–	–	–	–	–	0.298
KFM06A:3	–	–	–	–	–	–	–	–	–	–	–	2.41
KFM07A:2	0.134	–	–	–	–	0.116	0.011	–	–	–		0.963
KFM08A:6											–	0.088
KFM08A:2	0.012	–	–	–	–	–	–	0.19	x	0.025	–	0.031
KFM08D:4	<0.006	–	–	–	–	–	–	3.33	–	–	–	0.031
KFM08D:2	–	–	–	–	–	–	–	–	–	–	–	0.097
KFM10A:4	–	–	–	–	–	–	–	–	–	–	–	0.073
KFM11A:4	0.012	–	–	–	–	–	0.172	–	–	–	–	0.393
KFM11A:2	0.04	–	–	–	–	–	0.145	–	–	–	–	0.307

*Sample series, three samples 1) after exchange of tube volume (tube from borehole section to standpipe) 2) after exchange of section volume and 3) after exchange of at least three section volumes of water.

2.7 Summary and discussions

Groundwaters from a total of 33 borehole sections in 24 boreholes have been sampled (most of them at two occasions) during 2008. The results and conclusions from the analysis programme are summarised below.

- Uranine has been used as a tracer in tests prior to and in between chemical sampling occasions. This is unfavourable when interpreting and evaluating the hydrochemical data from monitoring since it is no longer possible to calculate the flushing water content in the samples from several of the borehole sections. The increase in Uranine concentration that can be observed in many borehole sections after the initial sampling is rather due to groundwater flow measurements and tracer tests than remaining flushing water.
- Preceding investigations in a specific borehole/borehole section or on-going activities in nearby situated boreholes as pumping tests or interference tests affected the results from hydrochemical monitoring in some boreholes/borehole sections. Furthermore, short circuiting of groundwater through fracture systems connecting two or more borehole sections was observed in several boreholes during pumping, especially in KFM01D, KFM03A, KFM08A and KFM08D, see Appendix 2.2. However, it cannot be excluded that observed pressure responses may be caused by leaking connections in the equipment between sections. Hydraulic contact between two or more borehole sections cause contamination.
- Increased sulphide concentrations compared to results from the initial chemical sampling have been observed during groundwater chemical monitoring in several boreholes. There seems to be a relation between sulphide concentration and pumped volume. The concentration is high from the start of the pumping but decreases and stabilises as the pumping continues. This effect will be further studied in the autumn 2009 by collecting series of samples during continuous pumping from selected boreholes/borehole sections. Cleaning of the stand pipes connected to the monitored borehole sections will be performed prior to the sampling.
- The Uranium concentration in section KFM02A:3 continued to be very high and amounted to 168 µg/L at the late sampling occasion in October 2008.
- The groundwater samples from borehole KFM07A section 962–972 m continue to show high pH-values. The sample collected in the autumn 2008 measured pH 10.7. Furthermore, the high TOC and DOC concentrations are also remarkable. A possible reason for the high organic content may be contamination from water in the stand pipe. High pH in groundwater samples is most often explained by contact with injected cement. However, no likely contamination source of this kind is known in this borehole section.

3 Near surface groundwaters

3.1 Objectives and scope

Near surface groundwaters were investigated in order to increase the understanding of processes that occur at the interface between the geosphere and the near surface ecosystem. Furthermore, sampling and analyses of groundwaters from shallow monitoring wells may be used to identify discharge areas. Wells located close to drill sites were monitored in order to identify possible changes in the water composition due to drilling activities.

An extensive, two-year-long sampling campaign designed to characterise near surface groundwaters in different types of environments within the candidate area was in July 2005 followed by a reduced monitoring programme /2/. The site investigation of the candidate area was concluded in June 2007, but the monitoring programme continues in order to monitor the water composition and obtain long time-series of data. During this reported period, objects belonging to both the monitoring programme and the GBIZ programme were sampled at four occasions, in January, April, August and October, 2008. Ten monitoring wells (stand pipes) and eight pipes equipped with BAT-type filter tips were sampled, all in the prioritised north-western part of the candidate area. Furthermore, three private wells are included to check the drinking water quality (sampled once during the year).

The sampling of private wells is mainly performed in order to obtain initial information on the drinking water quality and to monitor eventual changes in the water composition during the site investigation period. The private well data are of limited use for the chemical modelling as they are more or less affected by human activities. However, some additive information on the salinity distribution in the candidate area may be gained.

The activity included water sampling for chemical analysis as well as direct measurements in the field of parameters such as ORP (redox potential), pH, dissolved oxygen, electrical conductivity and water temperature. The analytical protocol included major constituents, nutrient salts, silica, carbon species as well as isotopes and trace metals, see Tables 3-1 and 3-2.

3.2 Sampling objects

The monitoring programme for near surface groundwater includes five stand pipes and one BAT-pipe. Besides these regular objects, additional five stand-pipes and two BAT-type filter tips, belonging to the GBIZ programme were sampled. The GBIZ programme includes seven BAT-type filter tips, but only two could be sampled (see Section 3.4.4). The wells/pipes are of the following types:

1. Single stand pipes made of HDPE (High Density Polyethylene) located close to drill sites, see Appendix 3 for design, Figure A3-1.
2. Double and single stand pipes made of HDPE, see Appendix 3 for design, Figure A3-2. Double pipes meaning, that one of the pipes is equipped with a permanently installed sensor for logging the groundwater level and the other pipe is intended for hydrochemical sampling.
3. Stand pipes installed in the sediment below the water layer in Lake Bolundsfjärden (Figure 3-1). These pipes are made of ordinary, non-stainless iron; see Appendix 3, Figure A3-3 for design. Stand pipes located in till below fen are of the same type.
4. Pipes equipped with BAT-type filter tips as described in Section 3.3.3.

For pipe types 1) to 3), the positions of the filter/screen part, and for type 4) the position of the BAT-type filter tip, correspond to the upper and lower section limits (Secup and Seclow) in the Sicada database. The section limits refer to the top of the stand pipe as zero level (Top Of Casing or TOC).

The sampled monitoring wells and their stand pipe types are listed in Table 3-1. The locations of the different sampling objects, including the three regularly sampled private wells, are displayed in Figure 3-1. Total depths and filter/screen depths, as well as coordinates for the different stand pipes, are given in Appendix 3 together with outlines of the different pipe types.

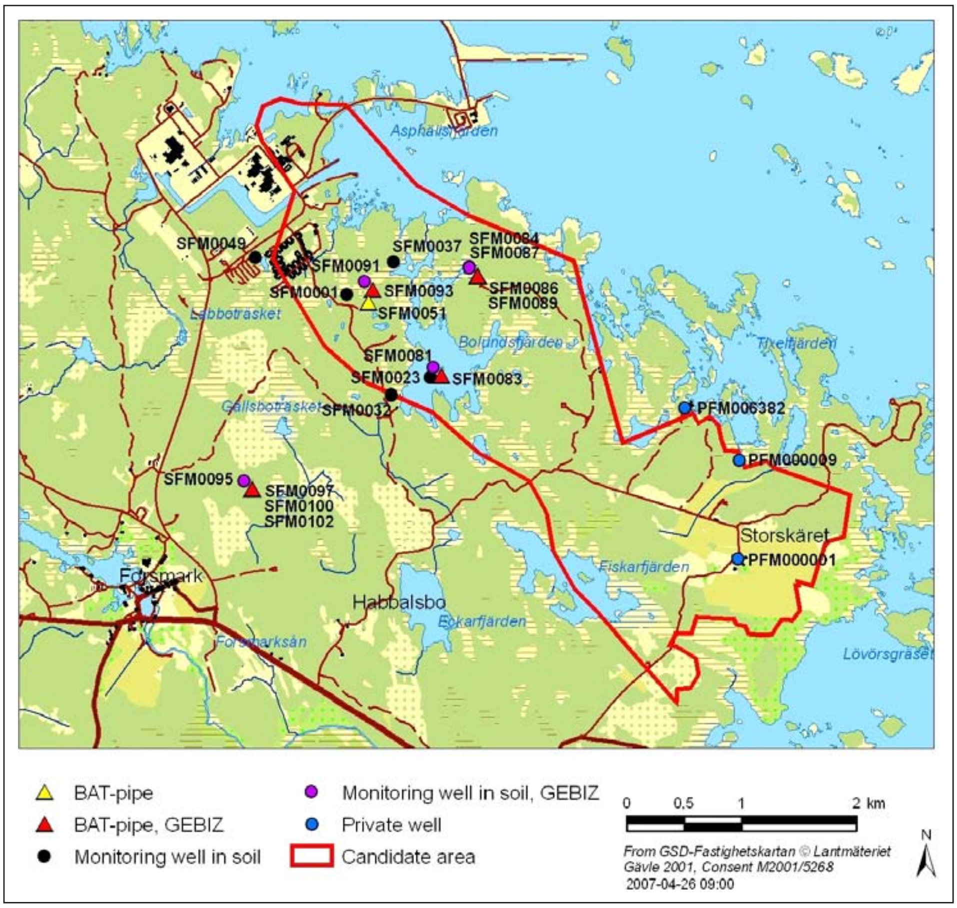


Figure 3-1. Location of sampling objects in the monitoring programme for near surface groundwaters, including different types of soil monitoring wells and private wells.

Table 3-1. List of sampling objects, type of sampling, type of object and to which sampling programme each object belongs.

Id code	Comments on sampled object	Type[a]	Programme
SFM0001	Stand pipe connected to drill site	A	Monitoring
SFM0023	Stand pipe in sediment below water surface (steel pipe)	C	Monitoring
SFM0032	Double-pipe for chemistry	B	Monitoring
SFM0037	Double-pipe for chemistry	B	Monitoring
SFM0049	Double-pipe for chemistry	B	Monitoring
SFM0051	BAT-system, drill site 1	D	Monitoring
SFM0081	Stand pipe in sediment below water surface (steel pipe)	C	GBIZ
SFM0083	BAT-system	D	GBIZ
SFM0084	Stand pipe in till below fen (steel pipe)	C	GBIZ
SFM0086[b]	BAT-system	D	GBIZ
SFM0087	Stand pipe in sand below fen	C	GBIZ
SFM0089[b]	BAT-system	D	GBIZ
SFM0091	Stand pipe in till below fen (steel pipe)	C	GBIZ
SFM0093[b]	BAT-system	D	GBIZ
SFM0095	Stand pipe for chemistry	B	GBIZ
SFM0097[b]	BAT-system	D	GBIZ
SFM0100[b]	BAT-system	D	GBIZ
SFM0102	BAT-system	D	GBIZ
PFM000001	Drinking water well		
PFM000009	Drinking water well		
PFM006382	Drinking water well		

[a] Code used to distinguish between different types of soil monitoring wells/stand pipes included in the monitoring programme, see Appendix 3.

[b] Included in the GBIZ program but not sampled, see Section 3.4.4, Nonconformities.

3.3 Equipment

3.3.1 Sampling equipment

Groundwater samples from the shallow soil monitoring stand pipes were collected using four online pumping setups, each one consisting of a submersible electrical pump (12V, Awimex) connected to a 10–20 m long polyamide-tube (Tecalan) of 8 mm diameter. The inner metal part of the pumps was coated with Teflon. Manually operated electrical regulators (powered by 12 V, 7 Ah cells) were used to adjust the water flow to a maximum of 1 litre/minute. Disposable filters (Millipore, 0.45 µm, ∅ = 22 mm) were fitted directly to the tube from the pump when collecting the sample portions for trace metals and ferrous iron. Separate sampling set-ups were used for the stand pipes made from ordinary iron, i.e. for pipes SFM0023, 81, 84 and 91, in order to minimize the risk to contaminate other samples.

3.3.2 Multi-parameter sondes

Field measurements were performed with either of two multi-parameter sondes (YSI 6600 EDS and YSI 600 QS). A terminal (YSI 650 MDS) is connected to the sonde through a cable for logging data, Figure 3-2. Calibration of the sondes was conducted according to the measurement system description SKB MD 910.003 (see Table 1-1). The measured parameters in near surface groundwaters included pH, water temperature, oxygen, ORP (redox potential) as well as electrical conductivity (EC_F). Measurements were conducted in a simple flow-through cell constructed from a plastic bottle. The upper part of the bottle fitted tightly to the sonde and had a narrow outlet for the circulating water.

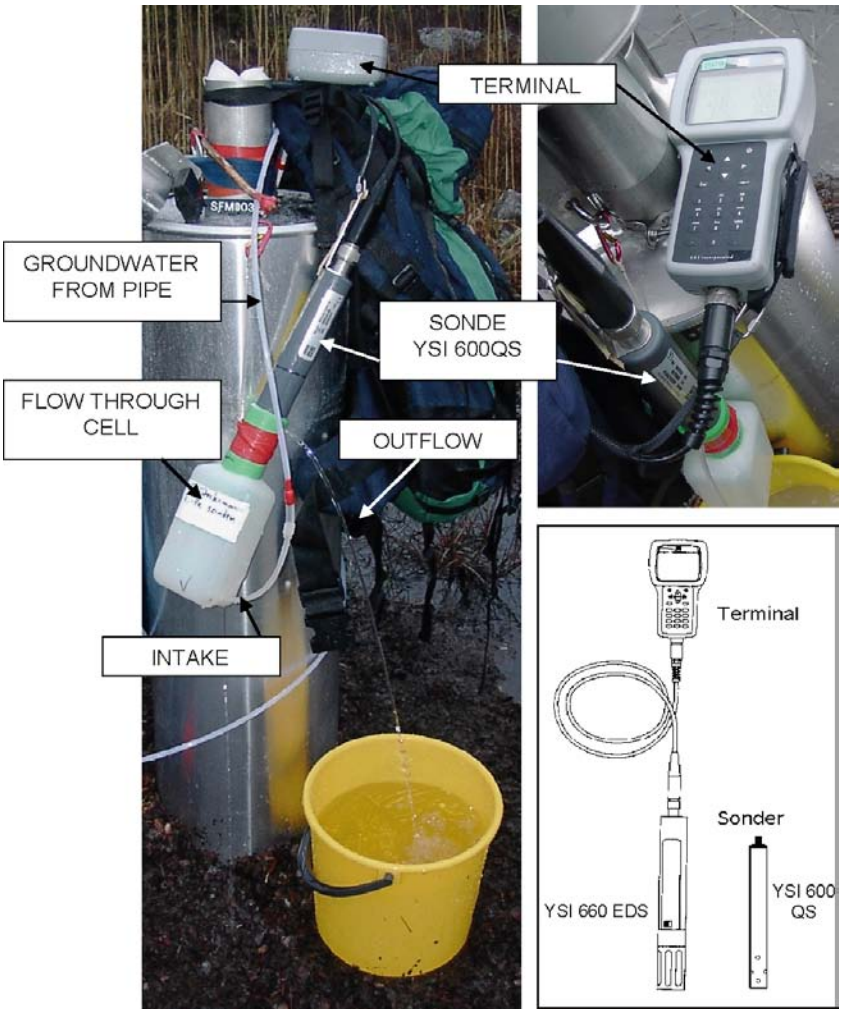


Figure 3-2. The measurement sonde YSI 600 QS and its terminal in field use. A schematic presentation of the sondes and terminal is also shown.

3.3.3 BAT-equipment

Water sampling in the stand pipes equipped with BAT-filter tips was performed with a GeoN BAT-type groundwater sampler. The sampler carries an evacuated and hermetically closed glass sample container (500 mL) and a vial. The vial is fitted with a cap with a rubber disc, similar to the disc in the filter tip. The needle of the sampler, which is "double-ended", penetrates through the two rubber discs, thus connecting the filter tip to the vial cap, see Figure 3-3. Due to the vacuum in the vial, water will be sucked from the aquifer, through the filter and the needle, into the vial.

3.4 Performance

3.4.1 Sampling programme

Sampling scheme

The sampling scheme for the sampling programme is given in Table 3-2. The sampling and analyses performed according to the different SKB chemical classes (class 3 and class 5, respectively) are summarised in Table 3-3. A list of collected samples during the reported sampling period is presented in Table 3-4.

Preparations

Prior to the sampling campaign, sample bottles were cleaned, labelled and packed in insulated boxes/bags according to established routines (SKB MD 452.001). Acid additions were made in advance in the bottles intended for trace metal analyses. Bottles with acid added were kept in a separate plastic bag and kept away from the other sample containers in order to avoid contamination. The different pumping setups were washed and rinsed with deionised water before use and all parts of equipment were well protected in plastic bags or in tight containers. The disposable filters (Millipore, 0.45 µm, Ø=22 mm) were rinsed with sample water before sampling. Calibration of the sonde was performed according to the measurement system description SKB MD 910.003.

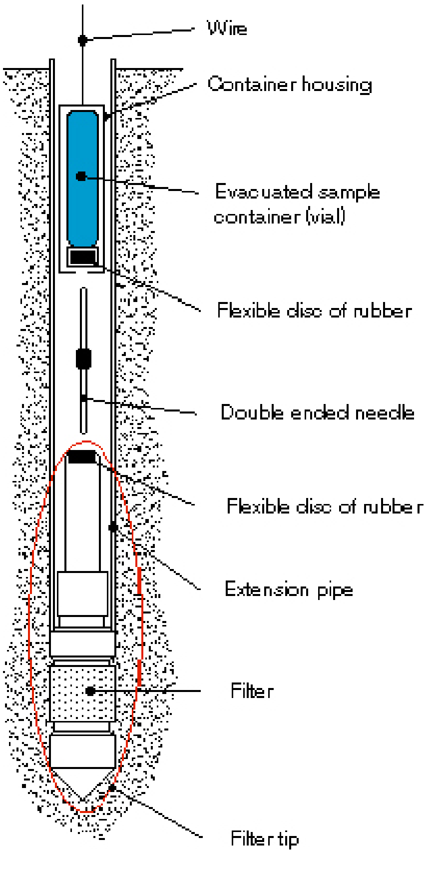


Figure 3-3. *Outline of BAT-sampler system and the BAT-type filter tip.*

Table 3-2. Sampling scheme January 2008–December 2008.

Year	Month	Week	Sampling object*	Sampling and analysis class and options
2008	January	3	Shallow monitoring wells, A, B	SKB class 5
			Shallow monitoring wells, C	SKB class 3 & isotopes
			BAT–pipes, D	SKB class 5
2008	April	15	Shallow monitoring wells, A, B, C	SKB class 3 & isotopes
			BAT-pipes, D (*GBIZ*)	SKB class 3
			BAT-pipe, D (*Monitoring*)	SKB class 5
2008	August	32	Shallow monitoring wells, A, B	SKB class 5
			Shallow monitoring wells, C (*Monitoring programme pipes only*)	SKB class 3 & isotopes
			BAT-pipe, D (*Monitoring*)	SKB class 5
2008	October	41	Shallow monitoring wells, A, B, C (*Monitoring programme pipes only*)	SKB class 3 & isotopes
			Private wells	Drinking water
			BAT-pipe, D (*Monitoring*)	SKB class 5

*The sampling object types A, B, C and D are defined in Table 3-1.

Table 3-3. Sample portions/bottles and preparation procedures for class 3 and class 5 /1/.

Class 3 and 5: 🟦 **Class 5** ⬜

Bottle volume (mL)	Number of bottles	SKB Label	Components	Preparation	Filling instructions
100	1	Green, Br/I	Br, I*.		Fill up
100	1	Green, D/O	Deuterium ^{2}H, ^{18}O	–	Fill up
250	2	Green, Anj./Green	Anions (Br, SO_4, Cl, F), Alkalinity, pH, Electric conductivity	–	Fill up
500	1	Green, ^{3}H	Tritium, ^{3}H	–	Fill up from bottom, Flow over x 3
100	1	Green, N/P	Tot-N, Tot-P	–	Fill 80% of the volume.
25	1	Green, T	TOC	–	Fill 80% of the volume.
250	2	Green, arkiv	For the archives	–	Fill 80% of the volume.
25	4	Green	Ammonia, NOx, Silicate	Filtering with syringe/0.45 µm filter	
25	2	Green, D	DOC, DIC	Filtering with syringe/0.45 µm filter	Fill 80% of the volume.
125	1	Red	Major constituents; cations[1a] and S, Si. Environmental metals[1b], trace metals [1c], B10/B11[*]	Acid addition (1 mL conc. HNO_3) Filtering with syringe/0.45 µm	Fill up
100	2	Red, arkiv	For the archives	Acid addition (1 mL conc. HNO_3) Filtering with syringe/0.45 µm	Fill 80% of the volume.
250	1	Red	Fe(II)/Fetot	Acid addition (2.5 mL conc. HCl) Filtering with 0.45 µm filter	Fill up
1,000	1	^{34}S	^{34}S**		Fill up
1,000	1	U/Th	U/Th-isotoper**		Fill up
1,000	1	Ra/Rn	^{226}Ra, ^{222}Rn **		Fill up
100	2	C-iso	^{13}C, pmC**		Fill up
100	1	^{37}Cl	^{37}Cl**		Fill up
100	1	^{87}Sr	^{87}Sr/^{86}Sr**		Fill up
Winkler bottles 125	2	HS	HS*	0.5 ml ZnAc + 0.5 ml NaOH and mix	Flow over x 3

1a. Na, K, Ca, Mg, Si, Fe, Mn, Li, Sr.

1b. Al, As, Ba, B, Cd, Co, Cr, Cu, Hg, Mo, Ni, P, Pb, V, Zn (only class 5 samples).

1c. Sc, Rb, Y, Zr, I, Sb, Cs, La, Hf, Tl, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, U, Th (only class 5 samples).

* Only class 5 samples.

** Only sampled once a year.

Table 3-4. List of collected samples during the period January 2008 to December 2008 (X = collected sample).

Id code	Name or location	Week/ Year 3/08	15/08	32/08	41/08	Sum (X)
Sonde						
YSI 600 QS		X	X	X	X	4
Soil wells						
SFM 0001	Drill site 1	X	X	X	X	4
SFM 0023	Bolundsfjärden	X	X	X	X	4
SFM 0032	SV-Bolundsfjärden	X	X	X	X	4
SFM 0037	N-Bolundsfjärden	X	X	X	X	4
SFM 0049	Bostadsområdet	X	X	X	X	4
SFM 0081	Bolundsfjärden	X	X			2
SFM 0084	Puttan	X	X			2
SFM 0087	Puttan	X	X			2
SFM 0091	–	X	X			2
SFM 0095	–	X	X			2
BAT pipes						
SFM0051	Drill site 1	X	X	X	X	4
SFM0083	Bolundsfjärden	X	X			2
SFM0102	–	X	X			2
Private wells						
PFM 000001	F3:3				X	1
PFM 000009	F3:34				X	1
PFM 006382	F3:38.Tixelfjärden				X	1
Sum (X)		13	13	6	9	41

Sampling and measurements

The groundwater sampling procedure as described below was generally applied in groundwater pipes and wells, except for the BAT-pipes and the drilled private wells. In the private wells the water was collected directly from the tap.

First, the groundwater level in the pipe was established by sounding and the water volume of the pipe was calculated. The pump with its tubing was lowered carefully in order to prevent dirt from entering the pipe. The water inlet of the submersible pump (Awimex) was lowered to the filter/screen section of the pipe or just above. Pumping was then performed at a maximum flow rate of one litre per minute. The pumped water was disposed of at least 10 m away from the sampling object where it infiltrated back into the ground. The pumping phases were as follows:

- *Exchange of water volume in pipe and tubes:* The water volume was exchanged three to five times (depending on the exchange/recovery time) prior to the actual sampling.
- *Sampling:* All sample bottles, except the ones with added acid, were rinsed three times with pumped water. Disposable filters were used for filtration of water portions for trace metals, Fe(+II) and DOC/DIC. The filters were fitted directly on the outlet tube from the pump. Each filter was rinsed with sample water (approx. 30 mL) before the sample portion/filtrate was collected. The bottles containing acid were the last ones to be filled in order to prevent acid contamination in the other sample portions. Disposable plastic gloves were used during the sampling. The samples were transported back from the field in insulated bags.
- *Field measurement:* A flow-through cell was connected to the pumping setup and measurements were performed with the sonde (YSI 600 QS). The results were recorded when the electrodes and sensors in the flow-through cell showed stable values (minimum 10 minutes). A judgement of the plausibility of the values was made in the field and accepted values were noted in the field protocol.

Sampling performance using BAT-system

Sampling of the BAT-type filter tip pipes followed the sampling scheme for the regular shallow soil pipes with a few days delay. The approximate time to fill one 500 mL container was 15 minutes, 5 minutes and approximately 3-4 hours for SFM0051, SFM0102 and SFM0083, respectively.

A total of four sample containers were filled from each BAT-pipe in order to obtain enough water for the analyses. In order to exchange the water volume in the BAT-pipes before sampling, the first sample container filled was not used for the analyses. The use of the sample portions and the analyses performed are listed in Table 3-5 (SFM0051) and Table 3-6 (SFM0083 and SFM0102).

3.4.2 Sample handling and analyses

Measurements/analyses of $\text{pH}_{\text{(lab)}}$, electrical $\text{conductivity}_{\text{(lab)}}$ and alkalinity as well as spectrophotometric analyses of total iron and ferrous iron (Fe+II) were conducted immediately at the site in the mobile field laboratory. An overview of sample treatment and analytical routines for major constituents, minor anions, trace metals and isotopes is given in Appendix 1. The routines are applicable independent of sampling method or type of sampling object.

3.4.3 Data handling

The general routines for quality control and data management applied for hydrochemical analysis data, independently of sampling method or sampling object are presented in Appendix 1.

3.4.4 Nonconformities

No nonconformities occurred regarding the regular monitoring programme for near surface groundwaters during the time period concerned. The same goes for the additional five stand-pipes belonging to the GBIZ programme.

However, water sampling from BAT-pipes has not been successful from some of the objects in the GBIZ programme. Only two (SFM0102 and SFM0083) out of seven BAT-pipes yielded sufficient amounts of water to allow sampling.

Table 3-5. Sample containers and analyses, SFM0051.

Sample container no.	Analyses and determinations			Total volume
1	Chloride, bromide, fluoride and sulphate by IC. (200 mL+50 mL)	Alkalinity titr, pH and EC. (150 mL)	δ^2H, δ^{18}O (100 mL)	500 mL
2	Tritium (500 mL)			Approx. 500 mL
3	Fe (+II), (Fe(tot) (200 mL)	Major constituents, trace elements, ^{10}B/^{11}B by ICP AES/MS (125 mL)	5 mL of HCl was added to the container prior to sampling.	325 mL

Table 3-6. Sample containers and analyses, SFM0083 and SFM0102.

Sample container no.	Analyses and determinations			Total volume
1	Major constituents, trace elements, ^{10}B/^{11}B by ICP AES/MS (100 mL)	Chloride, bromide, fluoride and sulphate by IC. (200 mL)	Alkalinity titr, pH and EC. (100 mL)	400 mL
2	Tritium (500 mL)			Approx. 500 mL
3	N/P-tot, NO_x, NH_4-N, Silicat, PO_4-P TOC, DOC (250 mL)	δ^2H, δ^{18}O (100 mL)	Br/I (100 mL)	Approx. 450 mL

3.5 Results

3.5.1 Field measurements

The results from the field measurements on pH, electrical conductivity, dissolved oxygen, water temperature and redox potential (ORP) are presented in Appendix 3, Table A3-2.

pH-measurement

Field measurements of pH are plotted against the corresponding laboratory values in Figure 3-4. Some deviation is reasonable considering the change of water temperature, and the time delay prior to the laboratory measurement. However, in a few cases, the disagreement seems to be greater than expected. The five cases with the largest differences between field and laboratory values are from two stand pipes (SFM0023 and SFM0081) in Lake Bolundsfjärden. These two pipes yield little water (ca 3–4 L) and the inflow is very slow (ca 24 h), which means that field measurements have to be performed the day before the water is sampled for laboratory analyses. Thus, measurements in field and laboratory measurements were not done on the same sample portions, which may explain the large differences in pH-values.

Electrical conductivity

Electrical conductivity field values are plotted versus corresponding laboratory values in Figure 3-5 and show good agreement.

Dissolved oxygen

The measurements of dissolved oxygen were checked in April 2005 by comparison to results from laboratory analyses /8/. This control showed that, generally, the field measurement values were somewhat higher, especially at oxygen concentrations below 4 mg/L. Field measurements of dissolved oxygen are presented in Appendix 3, Table A3-2.

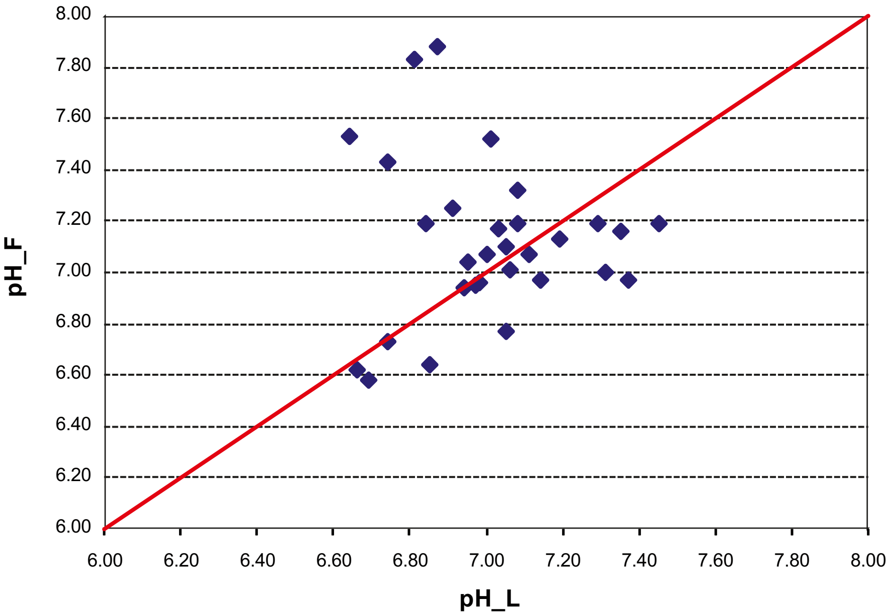


Figure 3-4. *Field-pH (pH_F) values versus laboratory-pH (pH_L) values. Field-pH and laboratory-pH values are measured at prevailing water temperature and at 25°C respectively.*

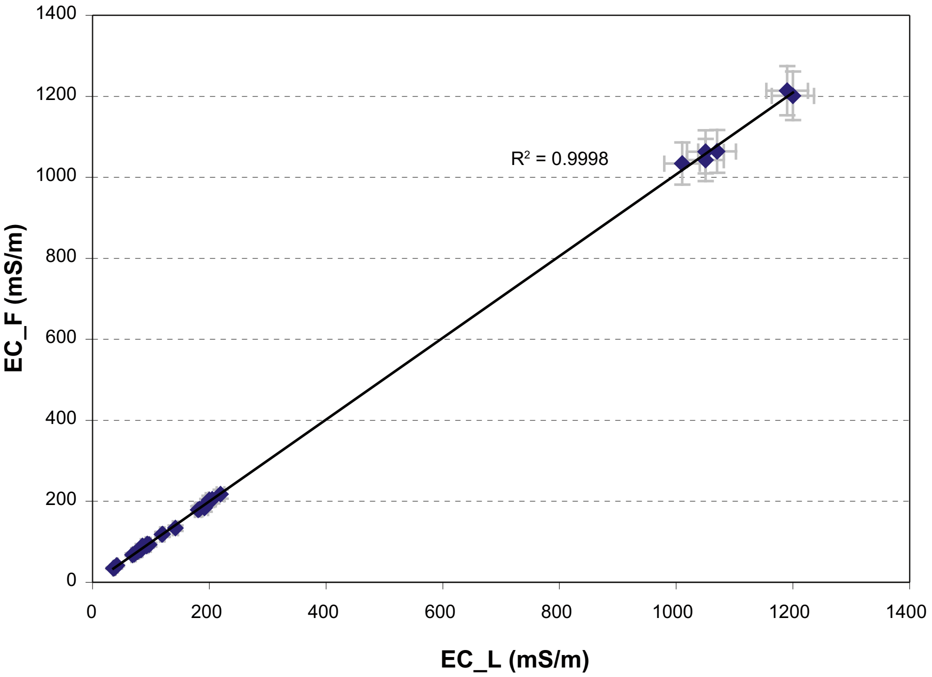


Figure 3-5. *Electrical conductivity (25°C). Field measurements (EC_F) versus laboratory values (EC_L). The measurement uncertainty (Appendix 1) is shown as error bars.*

ORP-measurements and redox conditions

ORP-measurements (Oxidising-Reducing Potential) have been conducted using the multipurpose measurement sonde. The recorded ORP-values (potential against Ag/AgCl reference electrode) should be used with great caution and merely considered as an indication of the redox conditions in the waters. Measured ORP-values are presented in Appendix 3, Table A3-2.

3.5.2 Water analyses

Basic components

The basic water analyses include the major constituents Na, K, Ca, Mg, Sr, S, SO_4^{2-}, Cl^-, Si and HCO^{3-} as well as the minor constituents Fe, Li, Mn, Br, F, I and HS^-. Furthermore, batch measurements of pH and electrical conductivity are included. The basic water analysis data are compiled in Appendix 3, Table A3-3a. The charge balance errors give an indication of the quality and uncertainty of the analyses of major constituents. The errors exceed the acceptance limit ± 5% in a few cases. Duplicate analyses by a second laboratory or another method are conducted regularly for some of the analysed constituents as a further check of the reliability of the analyses.

The chloride concentrations are plotted against the corresponding electrical conductivity values in Figure 3-6 as a rough check and the data agree well with an assumed trend line. The bromide analyses are often uncertain, for example the detection limit of bromide by ion chromatography (< 0.2 mg/L) is often too high for fresh waters. Therefore, duplicate analyses by ICP (bromine) have been performed for most samples. Selected bromide/bromine values for each sample are plotted versus the corresponding chloride concentrations in Figure 3-7 as a consistency check.

Sulphate by ion chromatography and sulphate calculated from total sulphur by ICP are compared in Figure 3-8 and most samples show a satisfactory agreement. However, several samples with high sulphide concentrations diverge. The total sulphur by ICP increases disproportionately at high sulphide concentrations due to hydrogen sulphide gas entering the plasma. In the most obvious cases (Sample no. 12930) the ICP results are rejected in Sicada.

Total silicon concentrations by ICP, and SiO_4 as silicon concentrations (SiO_4-Si) by spectrophotometry, are compared in Figure 3-9. Here the values diverge, but somewhat higher total silicon concentrations may be expected since not all silicon in the water is in the form of SiO_4.

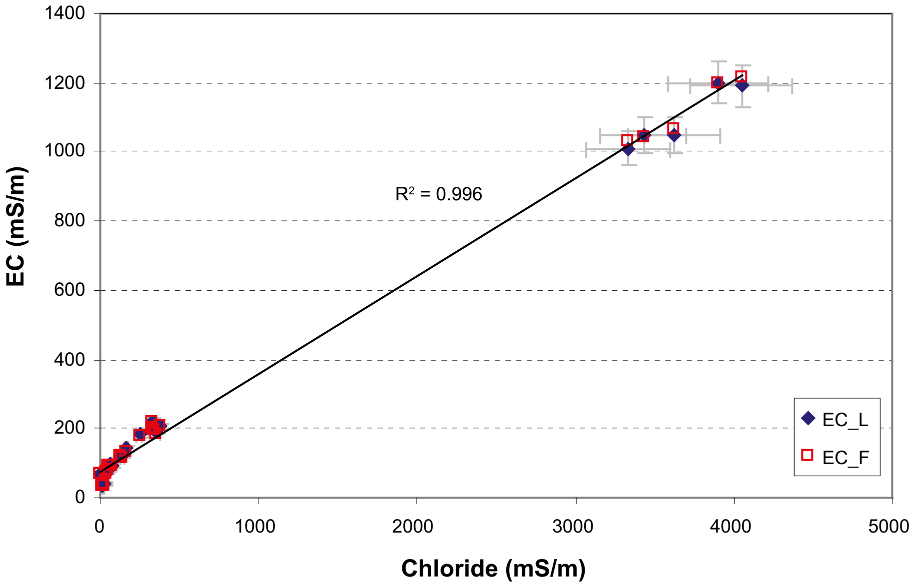


Figure 3-6. *Electrical conductivity (EC) values versus chloride concentrations. EC_L = Laboratory value, EC_F = Field value. The measurement uncertainty (Appendix 1) is shown as error bars.*

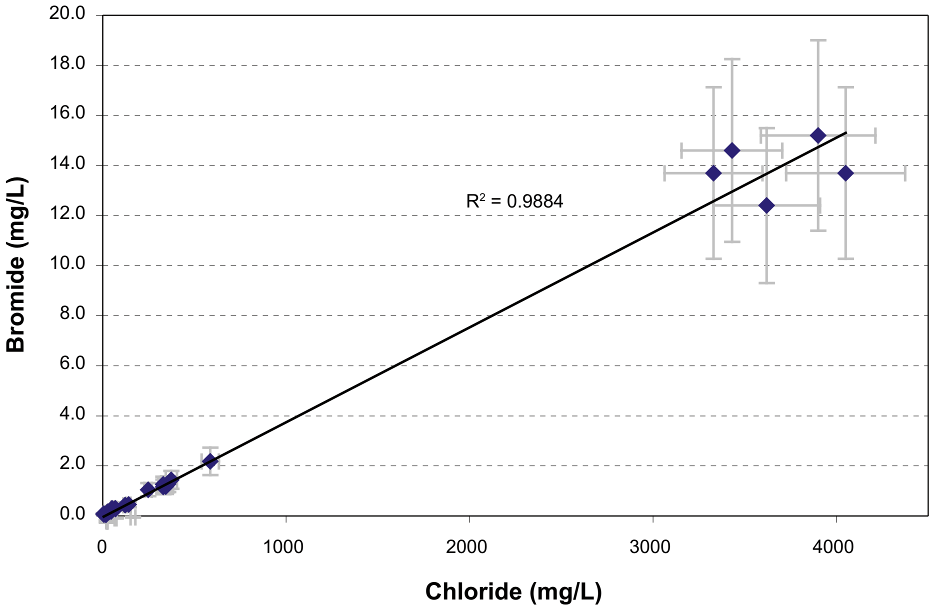


Figure 3-7. *Bromide concentrations versus chloride concentrations. The measurement uncertainty (Appendix 1) is shown as error bars.*

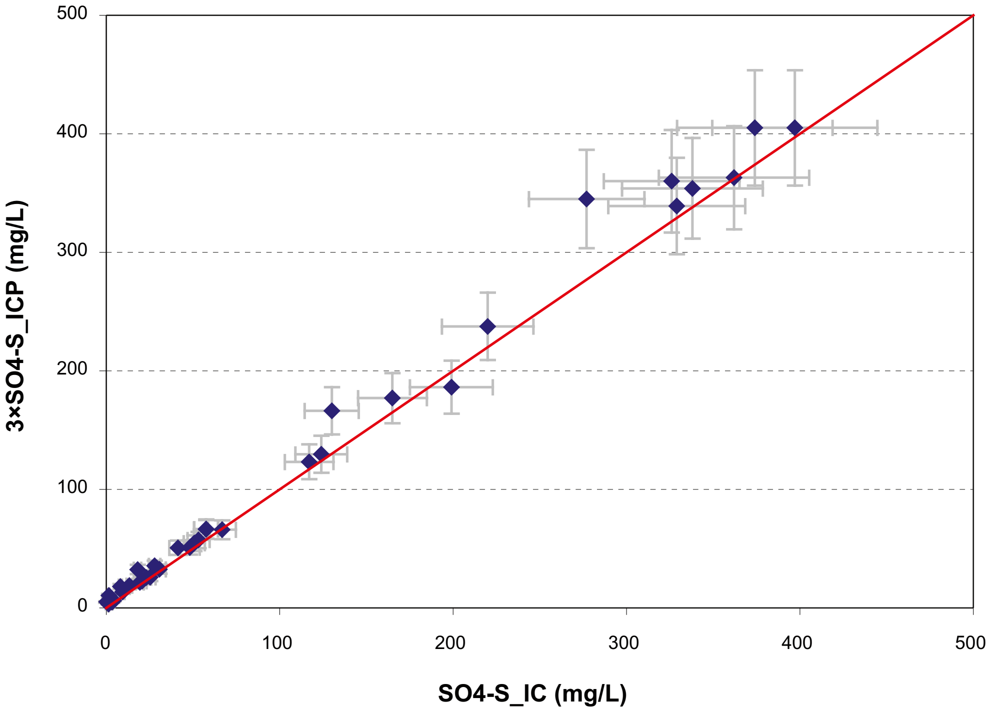


Figure 3-8. *Sulphate (SO_4 by IC) versus sulphate calculated from total sulphur ($3\times SO_4$-S) by ICP. The measurement uncertainty (Appendix 1) is shown as error bars.*

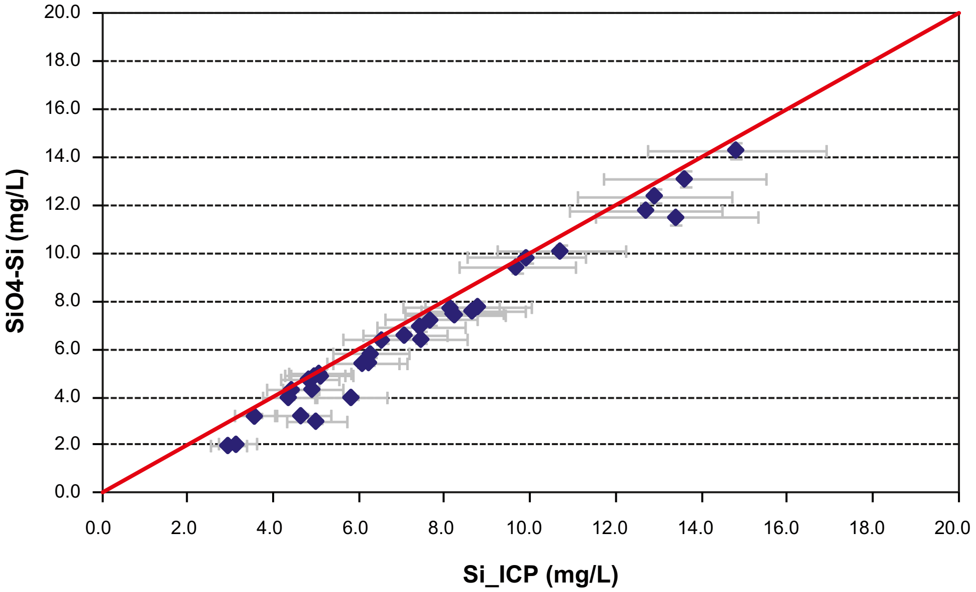


Figure 3-9. *SiO_4-Si determined by spectrophotometry versus total Si analysed by ICP. The measurement uncertainty (Appendix 1) is shown as error bars.*

The iron concentrations determined by ICP-AES (total Fe) and by spectrophotometry (Fe(+II) and Fe-tot) are compared in Figure 3-10. In most cases, the total iron concentrations determined by ICP agree well with the results obtained by spectrophotometry.

A photo showing sampling of near surface groundwater is given in Figure 3-11.

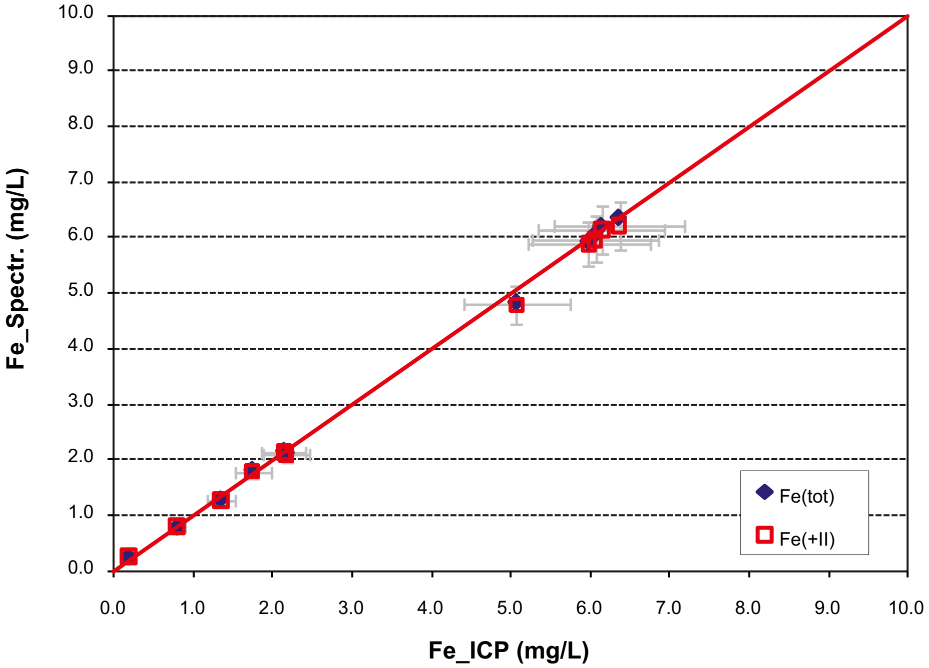


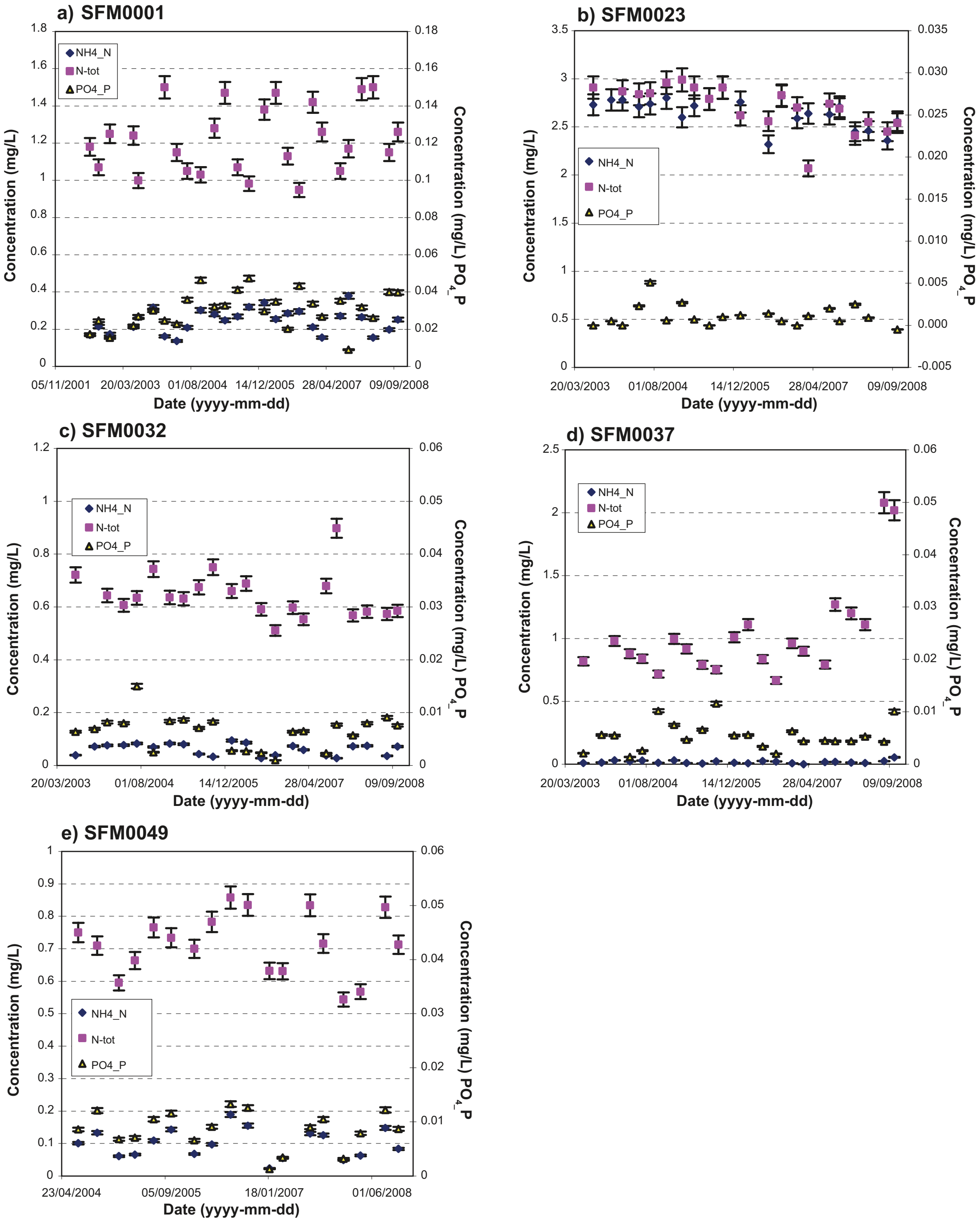
Figure 3-10. *Comparison of iron concentrations obtained by ICP and by spectrophotometry (Fe-tot and FeII).*

Figure 3-11. *Sampling of near surface groundwater in pipe SFM0037.*

Surface water supplements

Shallow groundwater analysis includes the surface water supplements/options NH_4_N, NO_2_N, NO_3_N+NO_2_N, NO_3_N, tot-N, tot-P, PO_4_P, TOC, DOC and DIC. The analytical data are compiled in Appendix 3, Table A3-3c. The DIC values should be used with care. Bicarbonate values (by alkalinity titration) are considered more reliable.

The concentrations of the different nitrogen, phosphorous and carbon compounds are expected to show seasonal variation depending on decomposition processes and varying redox conditions. However, this variation is more pronounced in surface waters than in the present shallow groundwaters. Figures 3-12a to 3-12e show the variations of total nitrogen, ammonium and phosphate in the sampled groundwaters from the five soil pipes included in the long term monitoring programme.



Figures 3-12a–e. *Ammonium, total nitrogen and phosphate concentrations versus sampling date for groundwaters from the stand pipes included in the long-term monitoring programme. Note that phosphate concentrations refer to the secondary Y-axis.*

The figures demonstrate high concentrations of total nitrogen in stand pipe SFM0037 during August and October 2008 compared to previous measurements. The previous report /16/ covering results from the period August to December 2007 showed the highest concentrations ever recorded for the stand pipes SFM0032 and SFM0037. For the stand pipe SFM0032 the total nitrogen concentrations during 2008 were comparable to results from previous years. However, the stand pipe SFM0037 had even higher concentrations of total nitrogen than recorded during 2007. It is difficult to explain these high concentrations, but the continued monitoring will yield more information.

Drinking water quality (private wells)

Data on drinking water quality parameters/components for the investigated private wells are presented in Appendix 3, Table A3-3b.

Trace metals

The analyses of trace and rare earth elements include Al, As, Sc, Cd, Cr, Cu, Co, Hg, Ni, Zn, Pb, V, U, Th , Rb, Y, Zr, Mo, In, Sb, Cs, Ba, La, Hf, Tl, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu. The trace element data are compiled in Appendix 3, Tables A3-3e and A3-3f.

These elements are generally present at low concentrations in the groundwater and the risk for contamination is high. Especially data on common metals such as Al, Cr, Cu, Co, Ni and Zn must be used with caution. Generally, the data conform well, but outliers exist.

Isotopes

Isotope determinations include the stable isotopes δD, $\delta^{18}O$ and $^{10}B/^{11}B$ as well as the radioactive isotope ^{3}H (TU). The isotope data are compiled in Appendix 3, Table A3-3d.

3.6 Summary and discussion

The chemical investigation routines for near surface groundwaters are well established after more than four years of field work, reporting and data administration and this year of the long-term monitoring programme has passed without any major nonconformities or surprises.

The statements/findings regarding the character of the near surface groundwaters within the monitoring programme remain unchanged. However, six out of 38 samples showed relative charge balance (RCB) errors exceeding ± 5% (sample nos. 12931, 12932, 12939, 12988, 12941 and 12993). Two RCB-errors higher than 50% (sample nos. 12941 and 12993) are explained by very low concentrations of the analysed parametres, which means the charge balance will be greatly affected even by very small errors. Both samples are from the same stand pipe, SFM0102. Furthermore, one sulphate concentration is uncertain as the ICP-result seems to be affected by a high content of sulphide and cannot be used to verify the IC analysis.

The high concentrations of total nitrogen that were observed in the stand pipes SFM0032 and SFM0037 in October 2007 compared to previous measurements were not confirmed for SFM0032. However, for stand pipe SFM0037 even higher values were recorded in August and October 2008, perhaps indicating a trend towards higher nitrogen concentrations during autumn. The high concentrations are difficult to explain but the continued monitoring will yield more information.

4 Surface waters

4.1 Objectives and scope

The ongoing surface water monitoring programme started in July 2004 and focuses on sampling locations in the prioritised northwestern part of the Forsmark candidate area /2, 13/. The main objectives are to create long-time series of data in order to obtain further information on natural variations and also to allow identification of perturbation effects from the completed investigation activities, if any. The sampling locations are presented in Figure 4-1.

The monitoring programme includes water sampling and sonde measurements in the different lake systems; Lake Bolundsfjärden, Lake Eckarfjärden and Lake Labboträsket. EC-measurements are performed also in Lake Norra Bassängen in order to monitor salinity changes. One regular sampling location represents a shallow sea bay (Forslingens grund). Sampling of stream water is conducted at four localities (Kungsträsket, Bolundsskogen, Norr Eckarfjärden, Öster Gunnarsbo) and an electrical conductivity logger is installed in Lilleputt-sundet, also to monitor salinity changes. Furthermore, due to observed enhanced tritium contents in the surface waters close to the nuclear power plant, samples for tritium analyses are collected each month close to the cooling water outlet in Lake Biotestsjön.

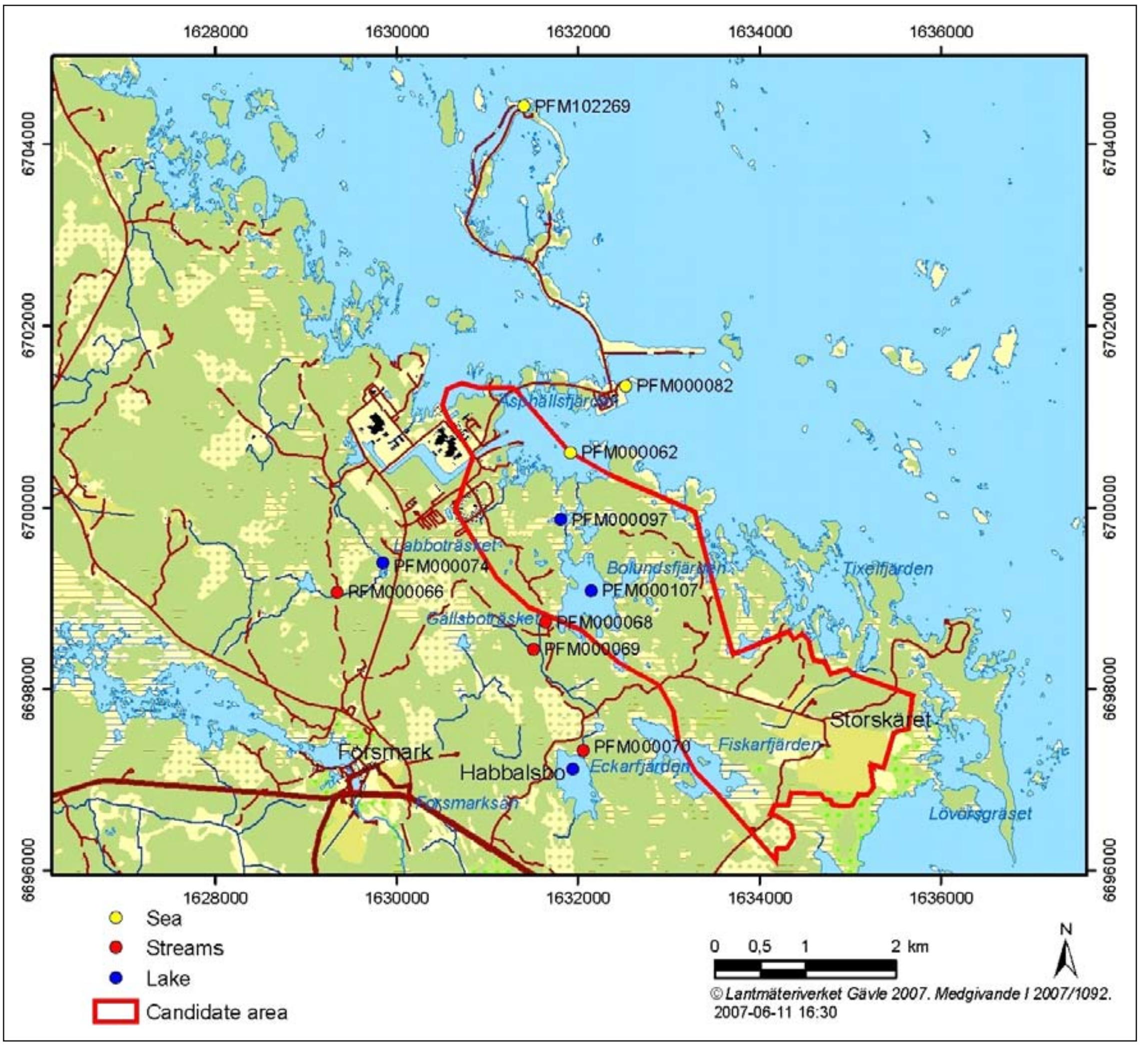


Figure 4-1. *Sampling locations within the surface water monitoring programme. One location constitutes an alternative for a regular sampling position (see Table 4-1). The sampling location in Lake Eckarfjärden has the id code PFM000117.*

Sampling for chemical analysis as well as direct measurements of physical and chemical parameters such as ORP (Oxidising Reducing Potential), pH, dissolved oxygen, electrical conductivity, salinity, measurement depth, barometric pressure, turbidity, chlorophyll, light penetration, PAR (Photosynthetic Active Radiation) and water temperature were conducted at eleven occasions during the reported time period. The extent of the sampling varied at different occasions. Analyses of major constituents and surface water supplements (nutrient salts, chlorophyll etc) were conducted frequently (once a month) while extended analyses including also isotopes and trace elements were performed once per season, i.e. in January, April, August and October. Some special isotopes (δ^{37}Cl, δ^{13}C, ^{14}C (pmC), ^{87}Sr/^{86}Sr, δ^{34}S, U- and Th-isotopes as well as Ra- and Rn-isotopes) were determined only once, in August.

4.2 Sampling locations and sampling scheme

The monitoring programme includes four lakes, one shallow sea bay location and four streams. Furthermore, a sampling location close to the outlet of cooling water from the nuclear power plant is sampled in order to investigate possible tritium contamination.

The sampling locations are presented in Figure 4-1. Table 4-1 lists the location id-codes, coordinates and names together with clarifying comments. The sampling scheme for the period January 2008 to December 2008 is given in Table 4-2. Figure 4-2 is a photo from the field campaign.

Figure 4-2. *Filtering of sample portion in the field.*

Table 4-1. Sampling locations (Id-code, coordinates, name and comments).

Sampling locations	Coordinates (RT90 RHB70)	Name	Comments
Lakes			
PFM000074	16 29 854, 66 99 393	Labboträsket	
PFM000097*	16 31 814, 66 99 868	Norra bassängen	
PFM000107	16 32 065, 66 99 031	Bolundsfjärden	
PFM000117	16 31 946, 66 97 118	Eckarfjärden	
Shallow sea bays and deep sea location			
PFM000062	16 31 921, 67 00 605	SV Forslingens grund	
PFM000082	16 32 528, 67 01 336		Alternative to PFM00062
PFM102269	16 31 405, 67 04 412	Cooling water outlet, Lake Biotestsjön	Check of tritium contamination
Streams			
PFM000066	16 29 343, 66 99 064	Öster Gunnarsboträsket	
PFM000068	16 31 641, 66 98 735	Kungsträsket	
PFM000069	16 31 510, 66 98 440	Bolundsskogen	
PFM000070	16 32 061, 66 97 319	Norr Eckarfjärden	

* Only sonde measurements.

Table 4-2. Surface water sampling scheme from January 2008 to December 2008.

Year	Month	Week	Programme type*
2008	January	3	E
2008	February	9	M
2008	March	12	M
2008	April	15	E
2008	May	21	M
2008	June	25	M
2008	August	32	E+
2008	September	36	M
2008	October	41	E
2008	November	46	M
2008	December	49	M

* M=main programme (SKB class 3 including surface water supplements), E=extended programme (SKB class 5 including surface water supplements), E+=extended programme and special isotopes (δ^{37}Cl, δ^{13}C, ^{14}C (pmC), ^{87}Sr/^{86}Sr, δ^{34}S, U- and Th-isotopes as well as Ra- and Rn-isotopes).

4.3 Equipment

4.3.1 Sampling equipment

Water samples were collected using an online pumping setup consisting of an electrical peristaltic pump system, PPS (ASF Thomas SR 10/100, powered by 12 VDC, 7 Ah cells), connected to 4–8 m long teflon-tubes (FEP 140) of 5 mm inner diameter. A manually operated regulator (ELFA, DCM 24–40 pwm) was used to adjust the water flow to a maximum of 1.3–2.9 litres/minute (depending on tube length, tube diameter and pumping level). The sampling equipment is presented in Figure 4-3.

4.3.2 Multiparameter sondes

Field measurements were performed using two multiparameter sondes (YSI 6600 EDS and YSI 600 QS). A terminal (YSI 650 MDS) is connected to each sonde through a cable for logging data (Figure 4-4). Calibration of the sondes was carried out according to the measurement system description SKB MD 910.003 (SKB internal controlling document, see Table 1-1). Table 4-3 describes the parameters measured by the two sondes.

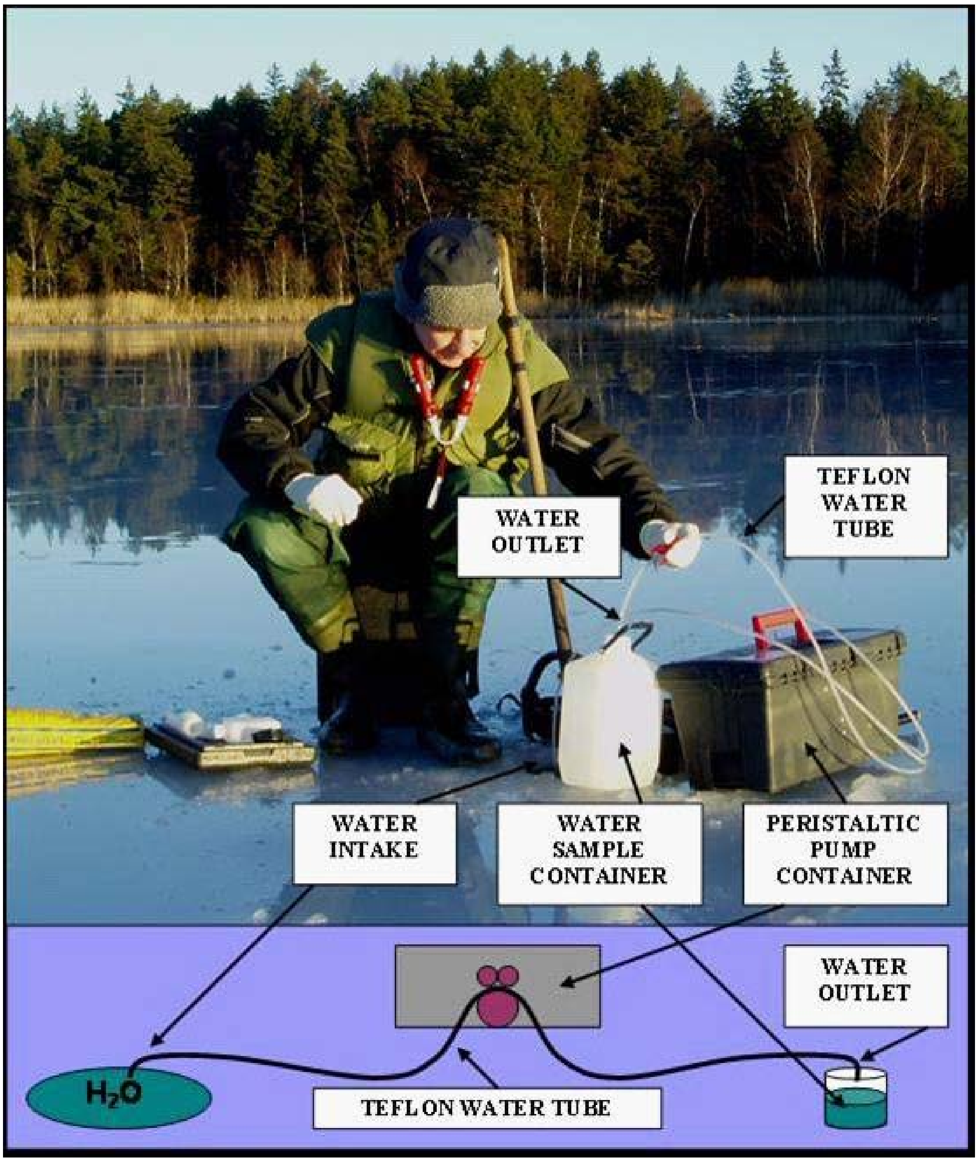


Figure 4-3. *Winter sampling of surface water using the peristaltic pump system (PPS). A schematic presentation of the PPS is also shown.*

Table 4-3. Parameters measured by the two different YSI sondes.

Parameter	YSI 6600 EDS	YSI 600 QS
Date/time	Yes	Yes
Temperature (°C)	Yes	Yes
pH	Yes	Yes
Dissolved oxygen (mg/L)	Yes	Yes
ORP (Redox potential, mV)	Yes	Yes
Electrical conductivity (mS/cm)	Yes	Yes
Salinity (ppt)	Yes	Yes
Depth (m)	Yes	Yes
Barometric pressure (mm Hg)	Yes	Yes
Turbidity (NTU)	Yes	No
Chlorophyll (µg/L)	Yes	No
Light / PAR* (µmoles s^{-1} m^{-2})	Yes	No

* Photosynthetic Active Radiation.

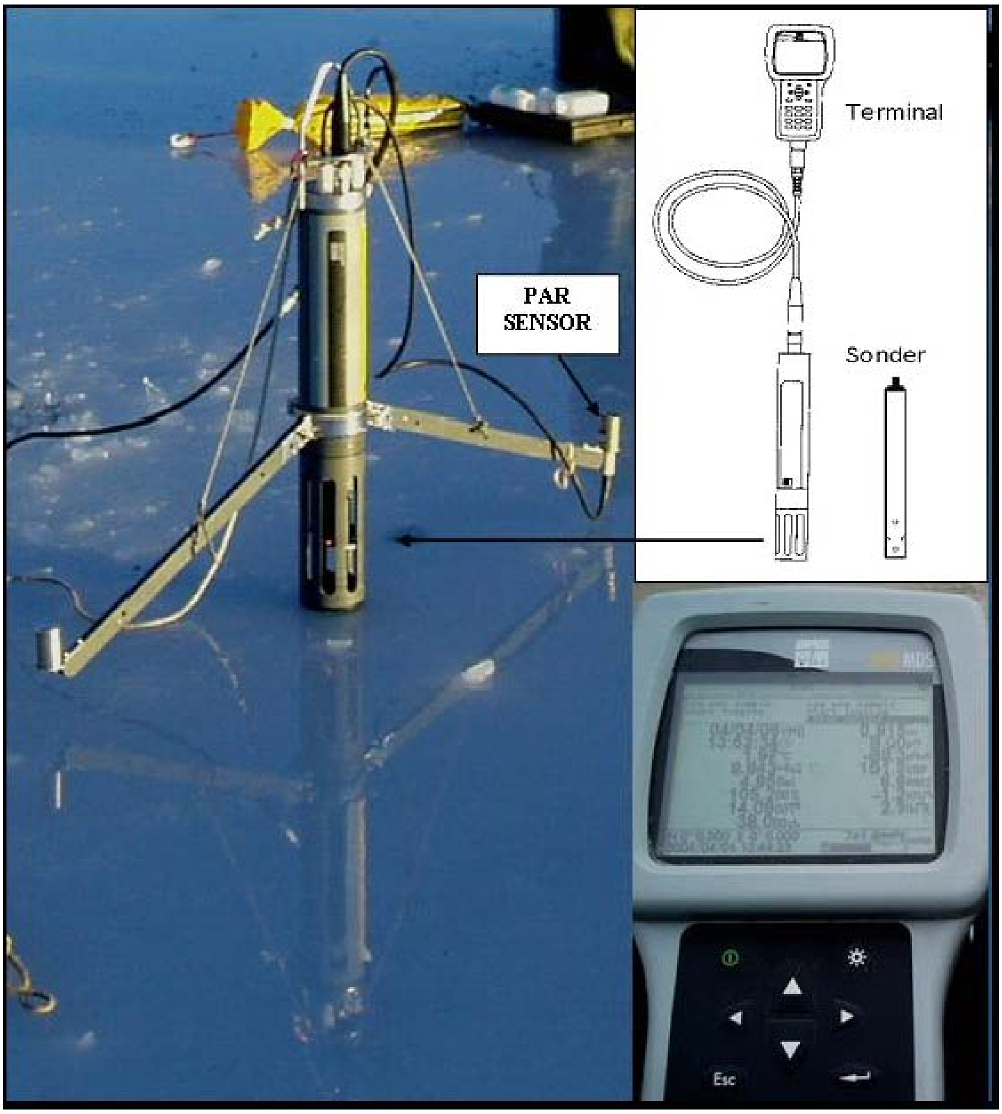


Figure 4-4. The measurement sonde equipped with a PAR sensor used in the field investigations of surface waters. The smaller sond in the schematic presentation is mainly used for measurements of near surface groundwaters. Also shown is a close up of the terminal during measurements.

4.3.3 General field equipment

- Ruttner samplers were used as back up if the portable pump system should fail.
- The exact sampling location positions were found using a GPS (Garmin 172C) with an average accuracy of ± 0.5–1.0 m.
- Water depth was measured using an echo sounder (Plastimo, Echotest, LCD digital sounder) with an accuracy of ± 0.05 m.
- Water transparency was estimated using a Secchi disc and an aqua scope.
- Disposable filters (Millipore, 0.40 µm, ∅ = 22 mm) were used together with 60 mL syringes to filter specific sample portions of the sampled water in the field.
- Stopwatch (GUL), a water-filled plastic bottle (50 mL) and measuring-tape (Hultafors) were used for flow/runoff estimates in stream waters.
- Digital cameras (Olympus 400 mju) were used for documentation of stream waters.

4.4 Performance

4.4.1 Preparations

Prior to sampling, the sample bottles were cleaned (according to the routines for respective SKB class), labelled and packed in insulated boxes/bags. Acid additions were made in advance in bottles intended for trace metal analyses; these were placed in separate plastic bags to avoid contamination. The peristaltic pump system (PPS), including the teflon tubes, was washed using acid (0.5 M HCl) and rinsed with deionised water before use. The equipment was kept well protected in plastic bags or in tight containers. Calibration of the sondes was performed according to the measurement system description SKB MD 910.003.

4.4.2 Water sampling

Water samples were collected using the peristaltic pump system (PPS), see Figure 4-5, and Ruttner samplers were used as backup if the PPS should fail. Lake and sea water samples were collected close to the surface (at 0.5 m depth). In case of ice coverage during winter, water was also collected from approximately 0.5 m above the lake or sea bottom, in order to sample water both above and below stratification in the lake. Stream water samples were collected at approximately 0.1 m depth. The PPS and sample bottles were rinsed with water from the sampling locations prior to filling, except for bottles with acid additions. The disposable filters (Millipore) were rinsed with sample water before filtering and sampling commenced. To avoid contamination, the field crew wore rubber gloves and great care was taken not to contaminate bottles or equipment. Bottles and samples containing added acid were handled and stored separately to avoid contaminating other sample portions.

Each sample consists of several sample portions labelled with the same sample number. The preparation of the sample portions in the field differs depending on their use. Details on collected sample portions, components to be analysed and sample preparations are summarised in Table 4-4.

Figure 4-5. *Sampling from the ice-covered lake, Eckarfjärden (PFM 000117). The peristaltic pump system is kept in an isolated trunk together with bottles of warm water to prevent freezing.*

Table 4-4. Sample volumes, components and preparation of samples.

🟦 Main monthly programme
🟩 Modified performance in the extended programme
🟦 Extended programme four times per year.
⬜ Once a year for lake and sea sites only.

Bottle volume (mL)	Number of bottles	SKB labels	Analyses	Comments	Preparation in field	Filling instructions
250	1	Green	pH, EC, Alkalinity, color determination			Fill up
250	1	Green, Anj.	Cl, SO$_4$, Br, F			Fill up
100	1	Green, Br	Br			Fill up
125	1	Green, HK	Major cations, SO4_S, Si	Acid washed		Fill up
2,000–2,500	1	Green	PON, POP, POC, Chlorophyll a, c and pheophytin			Fill up
100	1	Green, N/P	Tot-N, tot-P			Fill 80%
25	2	Green, D	DIC, DOC		Filtering with syringe/0.45 µm filter	Fill 80%
25	1	Green, T	TOC			Fill 80%
25	2	–	Nutrients: NH4, NO2, NO3, PO4		Filtering with syringe/0.45 µm filter	Fill up
1,000	1	Green, Susp.	Suspended material			Fill up
125[a]	2	Green, O$_2$	O$_2$	calibrated Winkler, glass bottle	1 mL Mn(II) reagent + 2 mL alkaline iodine reagent and mix	Flow over 3x
125[a]	2	Green, HS	HS$^-$	Winkler, glass bottle	1 mL ZnAc + 1 mL 1M NaOH and mix	Flow over 3x
100	1	Green, Br,I	Br, I	Additional anal. in class 5 samples		Fill up
125	1	Red, HK	Major cations, SO4_S, Si, environmental metals	Acid washed, additional anal. in class 5 samples		Fill up
25	3	–	Nutrients: NH4, NO2, NO3, PO4		Filtering with syringe/0.45 µm filter	Fill up
100	1	Green, D/O	Deuterium, ^{18}O			Fill up
500	1	Green, 3H	Tritium, ^{3}H			Flow over 3x
100	2	Red, Arkiv	Archives	Syradiskad	Filtering with syringe/0.45 µm filter	Fill up
250	2	Green, Arkiv	Archives			Fill up
125	1	Red, HK	Major cations, SO4_S, Si, environmental metals, trace metals, B, As, In, 10B/11B	Acid washed, additional anal. in class 5$^+$ samples		Fill up
1,000	1	Green, Ra/Rn	Ra^{226}, Rn^{222}			Fill up
1,000	1	Green, U/Th	U/Th-isotopes			Fill up
100	1	Green, 37Cl	^{37}Cl			Fill up
100	1	Green, 87Sr	^{87}Sr/^{86}Sr			Fill up
1,000	1	Green, 34S	^{34}S			Fill up
100	2	Green, C-iso	^{13}C/pmC			Fill up

a): Winkler samples only when sonde measurements of oxygen show values below 4 mg/L.

4.4.3 Field measurements

The multiparameter sondes were used for measurements of pH, water temperature, barometric pressure, ORP, PAR (Photosynthetic Active Radiation), turbidity, electrical conductivity, salinity, dissolved oxygen and chlorophyll. Light penetration was measured in lakes and at sea locations with a secchi disc according to the Swedish standard BIN SR 111. Photo documentation of stream waters was performed to facilitate evaluation of the investigation data. Photos were taken of each marked out (using a wooden stake) stream water sampling location.

In stream waters, measurements were performed using a YSI 6600 EDS sonde if the water level was high enough, otherwise the smaller YSI 600 QS sonde was used. Chlorophyll, PAR and turbidity data were not reported for streams.

At lake and sea localities the multiple sonde (YSI 6600 EDS) was employed to measure a profile at each sampling point. Measurements were conducted at every metre from the surface to the bottom, see Table 4-5. In addition, PAR was logged just below the surface and during the ice season above the ice, in the air. PAR measurements were performed at discrete depths and as continuous PAR-profile loggings. PAR-profiles were obtained by setting the sonde mode to 'continuous logging'. The sonde was then submerged from surface to bottom and hoisted up again. The produced PAR-data were used for regression analyses of PAR versus depth.

A simple "floating bottle" method /84/ was used to measure water flow/runoff in the streams as a complement to the regular method using discharge weirs and gauges. The cross-section mean area of the stream was estimated, forming a rectangle, see Figure 4-6. The time for the bottle (close to neutral in weight in water) to float the distance (L) from point A to B was measured with a stopwatch. This procedure was repeated three times in each stream. The average water velocity (m/s) multiplied with the average area (m^2) resulted in a rough water runoff estimate (m^3/s).

4.4.4 Sample treatment and chemical analyses

An overview of sample treatment and analytical methods is given in Appendix 1. The routines are applicable independently of sampling method or type of sampling object.

4.4.5 Data handling/post processing

Two field protocols (activity log and sampling protocol) contain meta data (id-code, date, time, sample no, field crew, etc), a few measured data and weather observations as well as comments on field conditions which may influence the analytical results. The field protocols supply basic information for creating activities and activity comments in the SKB Sicada database. In addition, the few measured parameters and weather conditions, noted on the sampling protocol, are stored as data tables in Sicada.

Furthermore, deviations from the sampling programme or from the normal routines, if any, are also documented in special reports/comment files. The comment files are stored in the Sicada file archive, see Table 4-6.

Table 4-5. Logging depths at sampling locations in lakes and shallow sea bays.

Sampling location	Name	Sonde logging depth (m)											
		0.5	1	1.5	2	2.5	3	4	4.5	5	6	6.5	7
Lakes													
PFM000074	Labboträsket	X											
PFM000097	Norra bassängen	X											
PFM000107	Bolundsfjärden	X	X										
PFM000117	Eckarfjärden	X	X	X									
Shallow sea bays													
PFM000062	SV Forslingens grund	X	X		X		X						
PFM000082	Alternative to PFM00062	X	X		X		X	X		X	X	X	

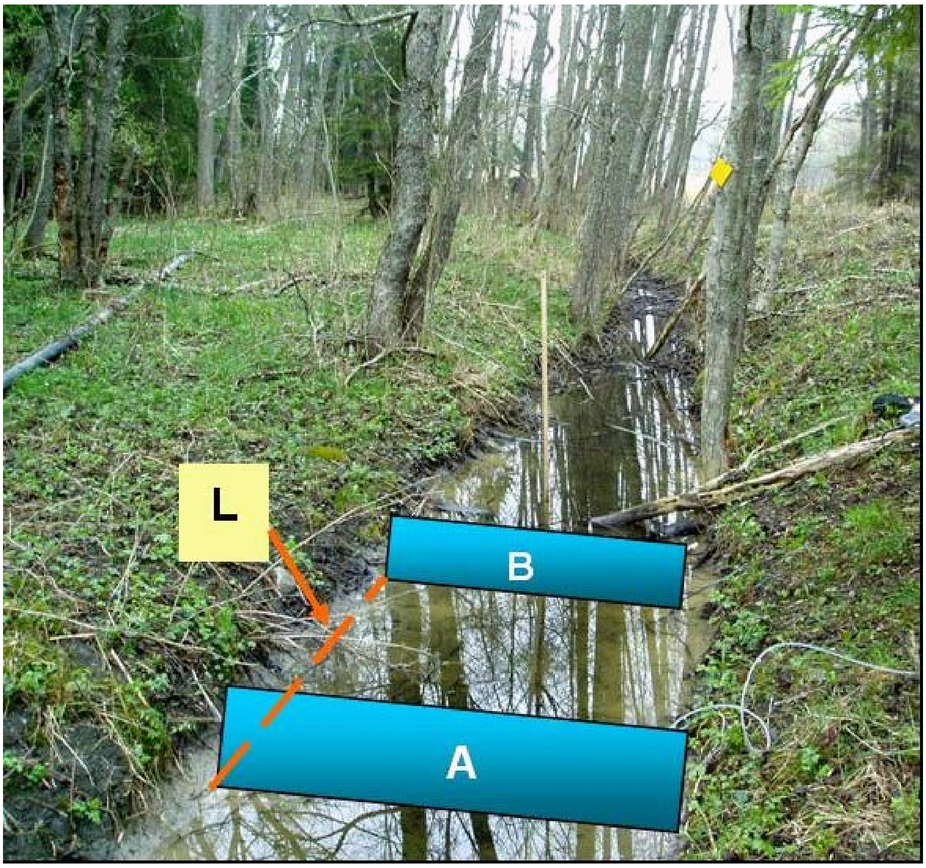


Figure 4-6. Schematic presentation for estimating water runoff in natural stream waters (see text for explanation). Sampling location PFM000073 (Söder Bredviken).

Chemical analytical data

The general routines for quality control and data management applied for hydrochemical analysis data, independently of sampling method or sampling object are presented in Appendix 1.

Field measurement data

The logged data from sonde measurements are exported digitally from the YSI Terminal 650-MDS to the specified Sicada data table. The original raw data file, calibration file and calibration protocol from each sonde, as well as photographs and comments on sampling and measurements, are stored in the Sicada file archive, see Table 4-6.

Table 4-6. File types stored in the Sicada file archive.

Type of file	Example of file name	No. per sampling session
Raw data file	L580438.dat	1 or 2*
Comments	Noterat V38.doc	1
Calibration data file	000113CF.txt	1 or 2*
Calibration protocol	Stora sonden V38år04.xls	1 or 2*
Photography	PFM66.jpg	1–4
Light data file	PAR-profiler V38_04.xls	1

* Depending on the number of measuring sondes used.

Other relevant information and data

Information about weather conditions and related parameters during the sampling occasions are not presented in this report, but are compiled in a separate table in Sicada called “Weather_data” which contains the following columns:

- Air temperature
- Cloudiness
- Precipitation
- Wind velocity
- Wind direction
- Light penetration (lakes and sea)
- Runoff/Water flow
- Water depth
- Snow/ice depth

Figure 4-7 provides an impression of a typical shallow wetland landscape at Forsmark.

4.4.6 Nonconformities

The only nonconformities from the activity plan that occurred during the reported sampling period involve omitted sampling locations due to, for example, problems with ice or dry conditions. The reasons for deviations from the programme are compiled in Tables 4-7 and 4-8.

Figure 4-7. *Weak ice on Labboträsket (PFM000074).*

Table 4-7. Collected samples and conducted measurements.

	Year	08	08	08	08	08	08	08	08	08	08	08	Sum
	Week	**3**	**9**	**12**	**15**	**21**	**25**	**32**	**36**	**41**	**46**	**49**	**(X)**
Sonde													
YSI 6600		X	X	X	X	X	X	X	X	X	X	X	11
YSI 600 QS													
Sea	**Name**												
PFM000062	SV-Forslingen	X	X	X	X	X	X	X	X	X	X	X	11
PFM000082	Alt PFM000062												
PFM102269	Utloppet Biotesten	X*	X*	X*	X*	X*	X*	X*	X*	X*	X*	X*	11
Stream													
PFM000066	Ö-Gunnarsbo	X	X	X	X	X	X	E	X	X	X	X	10
PFM000068	Kungsträsket	X	X	X	X	X	X	E	X	X	X	X	10
PFM000069	Bolundsskogen	X	X	X	X	X	X	E	X	X	X	X	10
PFM000070	N-Eckarfjärden	X	X	X	X	X	X	E	X	X	X	X	10
Lakes													
PFM000074	Labboträsket	X	X	C	X	X	X	X	X	X	X	C	9
PFM000097	Norra bassängen	B	B	B	B	B	B	B	B	B	B	C	10
PFM00107	Bolundsfjärden	X	C	X	X	X	X	X	X	X	X	C	9
PFM00117	Eckarfjärden	X	C	X	X	X	X	X	X	X	X	C	9
Sum (X)		**10**	**8**	**9**	**10**	**10**	**10**	**6**	**10**	**10**	**10**	**6**	**99**

Explanations and abbreviations:

X: Sample collected.

B: No sample, only field measurements with sonde.

C: No sample, due to weak ice.

E: No sample, dry conditions, or too little water to collect a representative sample.

*: Only tritium and anions samples.

Table 4-8. Comments on measurements/water sampling.

	Year	08	08	08	08	08	08	08	08	08	08	08
	Week	**3**	**9**	**12**	**15**	**21**	**25**	**32**	**36**	**41**	**46**	**49**
Sea	**Name**											
PFM000062	SV-Forslingen		J					J		J		
PFM000082	Alt PFM62		J									
PFM102269	Utloppet Biotesten	J					J					
Stream												
PFM000066	Ö-Gunnarsbo						H					
PFM000068	Kungsträsket						H					
PFM000069	Bolundsskogen						H					
PFM000070	N-Eckarfjärden					H	H		H			
Lakes												
PFM000074	Labboträsket											
PFM000097	Norra bassängen	J										
PFM00107	Bolundsfjärden									J		
PFM00117	Eckarfjärden									J	J	

Explanations to codes/abbreviations:

H: Stagnant water or nearly stagnant water – no flow estimation, flow approx 0 m^3/s.

J: Incorrect PAR-values at one or several depths (mainly caused by waves, clouds, vegetation or darkness).

4.5 Results

4.5.1 General

The surface water investigation period from January 2008 to December 2008 includes records of 129 water analyses (i.e. number of analysed samples) and records of 176 field measurements. Furthermore, the accompanying field documentation is quite extensive. The data are compiled in the attached Appendices and stored in the Sicada database where they are traceable by the activity plan number.

Fresh waters in the Forsmark area are well buffered with high alkalinity, high pH and high calcium concentrations. In addition, waters affected or recently affected by brackish sea water still show high sodium chloride concentrations. The relationship between the position of the coastline and the salinity of the water samples collected at the sampling locations in the area has been demonstrated in /9/. Furthermore, a detailed evaluation of surface water data from March 2002 to March 2004 was presented in /85/.

The results presented and compiled in this report are restricted to field work performed between January 2008 and December 2008. Besides results from the regular sampling objects, eleven new tritium results have been obtained from the location close to the cooling water outlet into Lake Biotestsjön.

4.5.2 Water analyses

Major components

The basic water analyses include the major constituents Na, K, Ca, Mg, Sr, S, SO_4^{2-}, Cl^-, Si and HCO_3^- as well as the minor constituents Fe, Li, Mn, Br, F^-, I and HS^-. Furthermore, batch measurements of pH and electrical conductivity are included. The basic water analysis data are compiled together with field measurements of pH and water temperature in Appendix 4, Table A4-4a.

The charge balance errors give an indication of the quality and uncertainty of the analyses of major constituents. None of the 91 samples/datasets show errors exceeding ± 10% and in 13 cases the errors exceed ± 5%.

To provide a rough check of the data, the electrical conductivity values are plotted versus the corresponding chloride concentrations in Figure 4-8. As shown, the surface water data generally agree well with a regression line.

Sulphate by ion chromatography and sulphate calculated from total sulphur by ICP are compared in Figure 4-9. As shown, within the analytical error all the sulphur is present as sulphate.

As established earlier /11/, bromide determinations by ion chromatography may be difficult at high chloride concentrations. Selected bromide values (in most cases ICP results) for each sample are plotted versus the corresponding chloride concentrations in Figure 4-10 as a consistency check. The points do not differ too much from the linear trend and the data are therefore considered acceptable.

Surface water supplements

The surface water supplements include NH_4-N, NO_2-N, NO_3-N+NO_2-N, NO_3-N, tot-N, tot-P, PO_4-P, TOC, DOC, DIC and sometimes at a few sampling occasions also dissolved oxygen. The analytical data are compiled in Appendix 4, Table A4-4b. The DIC values should be used with care and bicarbonate values (by alkalinity titration) are considered more reliable.

Isotopes

The isotope determinations include the stable isotopes δD, $\delta^{18}O$, $^{10}B/^{11}B$, $\delta^{34}S$, $\delta^{13}C$, $\delta^{37}Cl$ and $^{87}Sr/^{86}Sr$ as well as the radioactive isotopes Tr (TU), ^{14}C (pmC), ^{238}U, ^{235}U, ^{234}U, ^{232}Th, ^{230}Th, ^{226}Ra and ^{222}Rn. The isotope data are compiled in Appendix 4, Tables A4-4c and A4-4e.

Tritium

It has been suggested that the adjacent nuclear power plant may have influenced the natural conditions for the tritium and ^{14}C isotopes /11/. Some relation between the presence of these isotopes and distance from the nuclear power reactors was observed during a previous sampling period, March 2004 to

June 2005. In order to better understand the tritium data, repeated tritium determinations from close to the outlet of reactor cooling water commenced in July 2005. One very high tritium value was observed in July 2005 /12/ and also three of the samples collected during the reported period July 2006–June 2007 revealed enhanced tritium concentration (16.5, 40.12 and 17.5 TU) /13/.

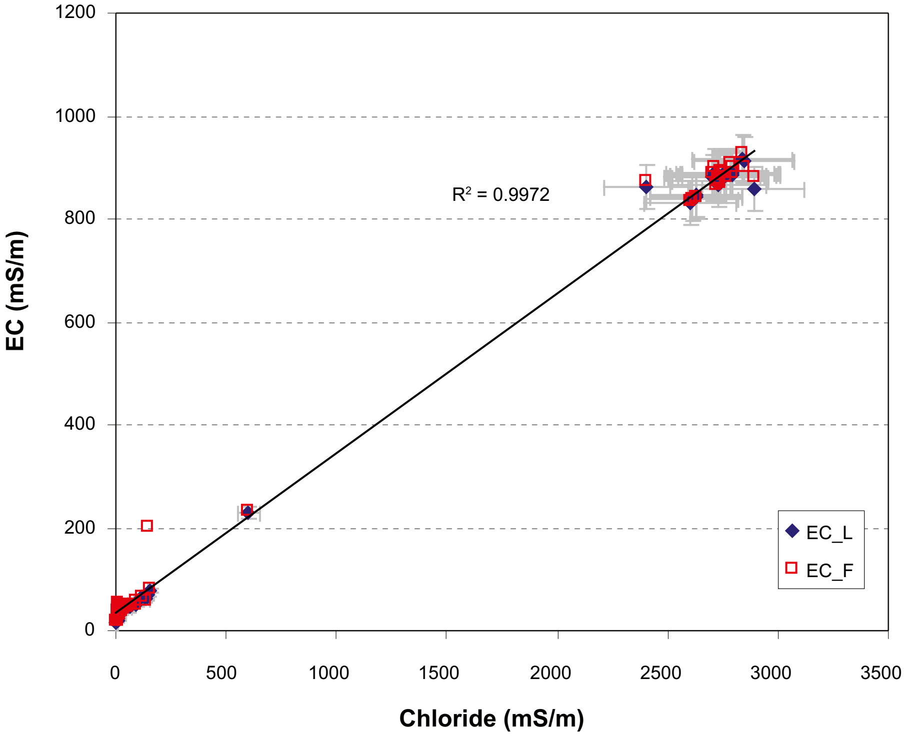


Figure 4-8. *Electrical conductivity versus chloride concentrations. EC_L = Laboratory value, EC_F = Field value. The measurement uncertainty (Appendix 1) is shown as error bars.*

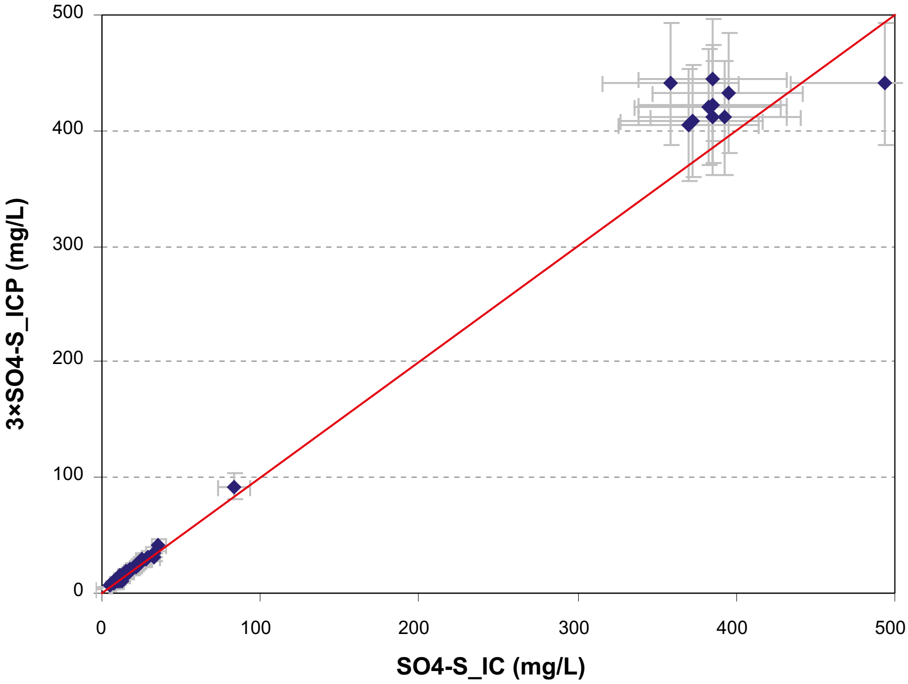


Figure 4-9. *Sulphate (SO_4^- by IC) versus sulphate calculated from total sulphur (3×SO_4^-S) by ICP. The measurement uncertainty (Appendix 1) is shown as error bars.*

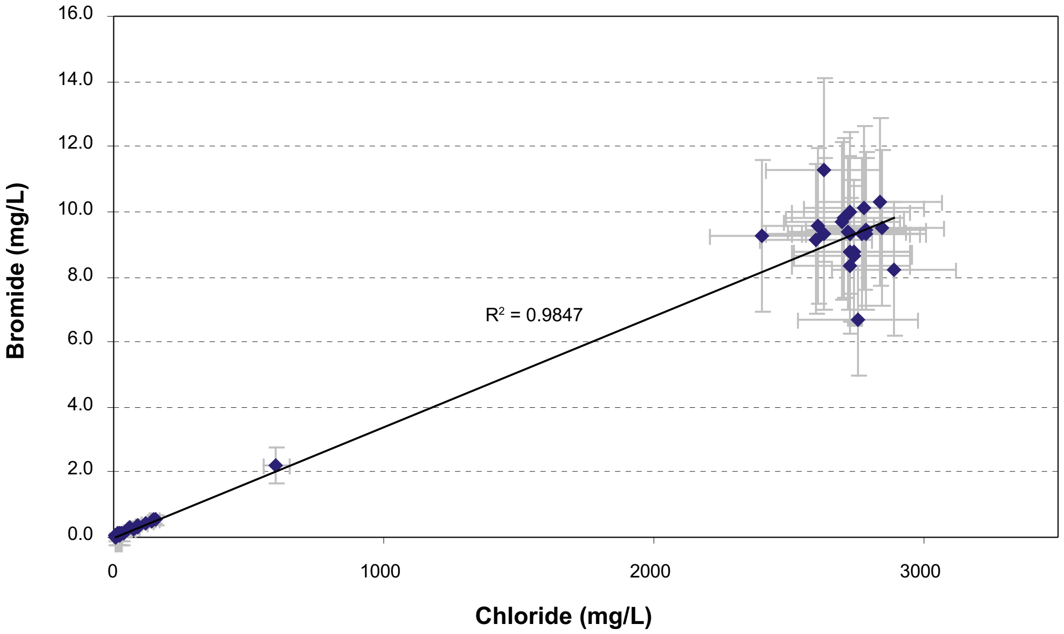


Figure 4-10. Bromide versus chloride. The measurement uncertainty (Appendix 1) is shown as error bars.

Figure 4-11 shows three elevated tritium concentrations for the water from the outlet of reactor cooling water (PFM102269) during 2008. The elevated tritium concentrations occurred in January, May and August. During the other months the tritium concentrations measured in samples from the outlet of cooling water were comparable to concentrations from the regular sampling locations. These circumstances indicate that contamination from the nuclear power plant does occur at times.

Trace metals

The analyses of trace elements include Al, As, Cd, Cr, Cu, Co, Hg, Ni, Zn, Pb, V, Mo, and Ba. The trace element data are compiled in Appendix 4, Table A4-4d.

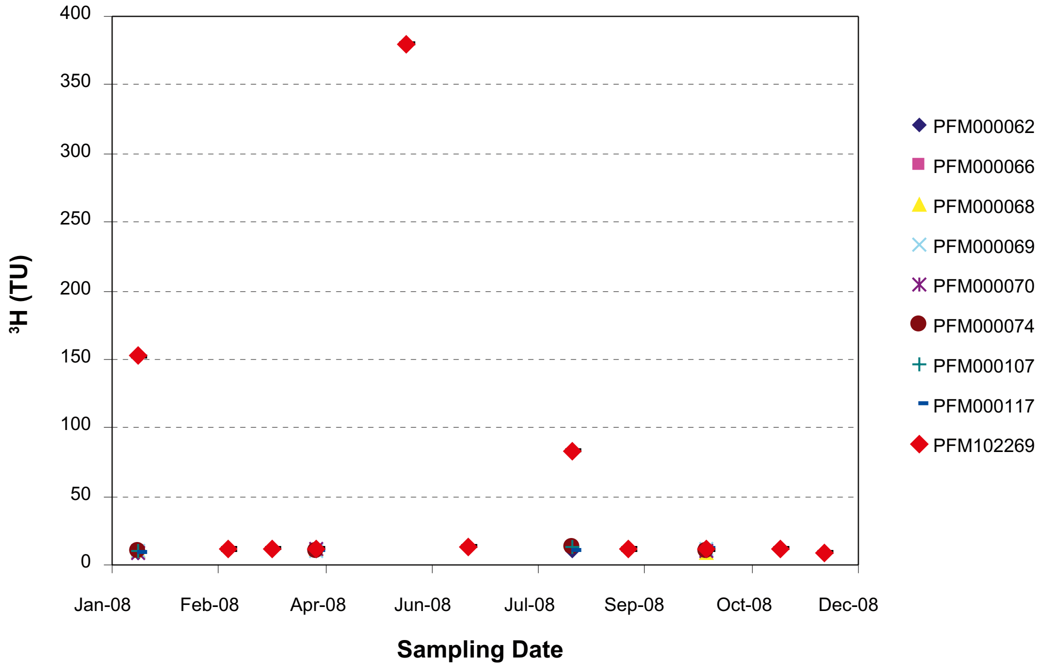


Figure 4-11. Tritium concentrations during January – December 2008. The measurement uncertainty (Appendix 1) is shown as error bars.

These elements are generally present at low concentrations in the surface water and the risk for contamination is high. Especially data on common metals like Al, Cr, Cu, Co, Ni and Zn must be used with caution. Generally, the distribution of data is location specific but outliers do exist; significantly large deviating concentrations for a sampling location are rejected in the Sicada database.

4.5.3 Field measurements

The field measurement data including redox potential, pH, dissolved oxygen, electrical conductivity, salinity, measurement depth, barometric pressure, turbidity, chlorophyll, light penetration, PAR (Photosynthetic Active Radiation) and water temperature are compiled in Appendix 4, Table A4-1. The PAR-profile logs are presented as diagrams including regression constants in Appendix 4, Table A4-2. Three sets of data are of lower quality; 1) water flow rate estimations by the float method, 2) sonde measurements (YSI 6600 EDS) of chlorophyll (see Figure 4-12), and 3) turbidity measurements also by the sonde.

- The water flow rate estimations by the float method /84/ are of low accuracy compared to measurements using discharge weirs and gauges. They were performed in order to allow comparison between early data obtained when there was no other available method and new data from installed measurement stations (Appendix 4, Table A4-3).
- The chlorophyll measurements have been problematic, possibly due to the fact that humic substances and chlorophyll have similar fluorescence in the wavelength used by the sonde. Since the inland waters show high concentrations of humic substances and the sonde interprets humus as chlorophyll, the amount of chlorophyll tends to be overestimated.
- The turbidity measurements performed in the sea and in lakes often display negative values. This may be due to bad probe sensitivity in clear waters (turbidity weak waters) or calibration problems.

Comments on the low quality of chlorophyll and turbidity data as well as explanations to these circumstances are stored in the Sicada database.

Figure 4-12. *Sonde measurements on the ice-covered lake Norra bassängen (PFM000097).*

4.5.4 Water composition

Both in freshwater and in the sea, the major cations are generally calcium, magnesium, sodium and potassium. Sulphate and chloride are the major anions in sea water and also in freshwater together with bicarbonate. The relative proportions between these major constituents differ between sea water and freshwater and also between different freshwater bodies. In the investigated lakes and streams, bicarbonate is by far the most common anion, which is explained by the limestone-rich surroundings. Lake Bolundsfjärden (PFM000107) is however characterised by saltwater inflow and the water composition is a mix between lake water dominated by calcium and bicarbonate and sea water mainly composed of sodium and chloride. In the previous report covering the period August 2007–December 2007 /16/, the water in Lake Bolundsfjärden was more similar in composition to the sea site (PFM000062) than the water in other lakes and streams. This is not the case during the reported period which shows that the inflow of sea water into Lake Bolundsfjärden has been low during 2008. Figures 4-13 and 4-14 show the relative proportions of cations and anions, respectively.

4.5.5 The NP-ratio in the surface water

The nutrients, nitrogen and phosphorus, are often the limiting factors for the primary production. Primary producers such as plants and phytoplankton use nitrogen and phosporus in a ratio of about 16 mol nitrogen to 1 mol phosphorous (also know as the Redfield ratio) or 7:1 in terms of mass. A ratio deviating from 16 (or 7) indicates that the primary production is limited by either nitrogen or phosphorus. When nitrogen is present in excess, the ratio will be higher than 16, indicating that lack of phosphorus is limiting the growth. On the contrary, lower ratios indicate nitrogen limitations, which may favour growth of blue green algae able to use nitrogen from the air. In fresh water, phosphorus is usually the limiting nutrient whereas in the oceans it is usually nitrogen.

Figure 4-15 shows the relationship between nitrogen and phosphorous in the surface water of the investigated streams, lakes and coastal bays in the Forsmark area. The lakes and streams are phosporus limited with high concentrations of nitrogen. The coastal bay in the Baltic Sea (PFM000062) is also phosphorous limited although the ratio is much lower.

4.6 Summary and discussion

The chemical investigation routines for surface waters are well established after more than five years of field work, reporting and data administration, and this period of the long-term surface water monitoring programme has passed without any major nonconformities or surprises. The main experiences and conclusions from surface water sampling and analyses during the sampling period January to December 2008 are summarised below:

- The statements/findings regarding the character of the surface waters after five years of sampling and analyses remain unchanged.
- Sampling performed close to the outlet of cooling water from the power plant for tritium analyses revealed three enhanced values during the reported time period.
- Fresh waters in the Forsmark area are well buffered with high alkalinity, high pH and high calcium concentrations. Surface waters affected or recently affected by brackish sea water show high sodium chloride concentrations.

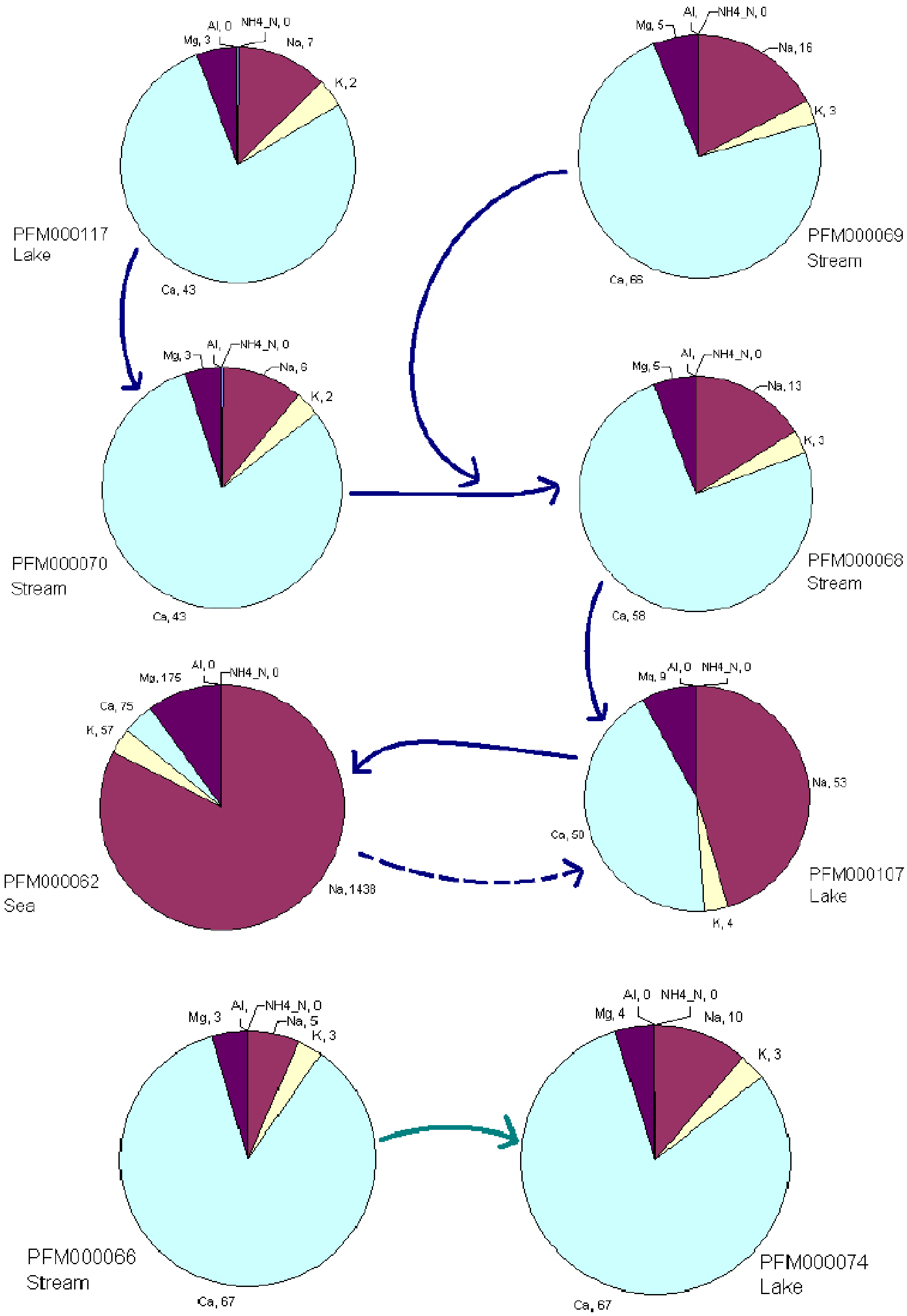


Figure 4-13. *Relative proportions of the cations Na*$^{+}$*, K*$^{+}$*, Ca*$^{2+}$*, Mg*$^{2+}$*, NH*$_{4}$*_N based on average values during the sampling period. The average values (mg/L) are displayed after each cation in the diagrams. The arrows show the path of the surface water between the lakes and streams. The occasional inflow of sea water into Lake Bolundsfjärden (PFM000107) is indicated by a dotted arrow. The Lake Labboträsket (PFM000074) and the stream PFM000066 belong to a different catchment area.*

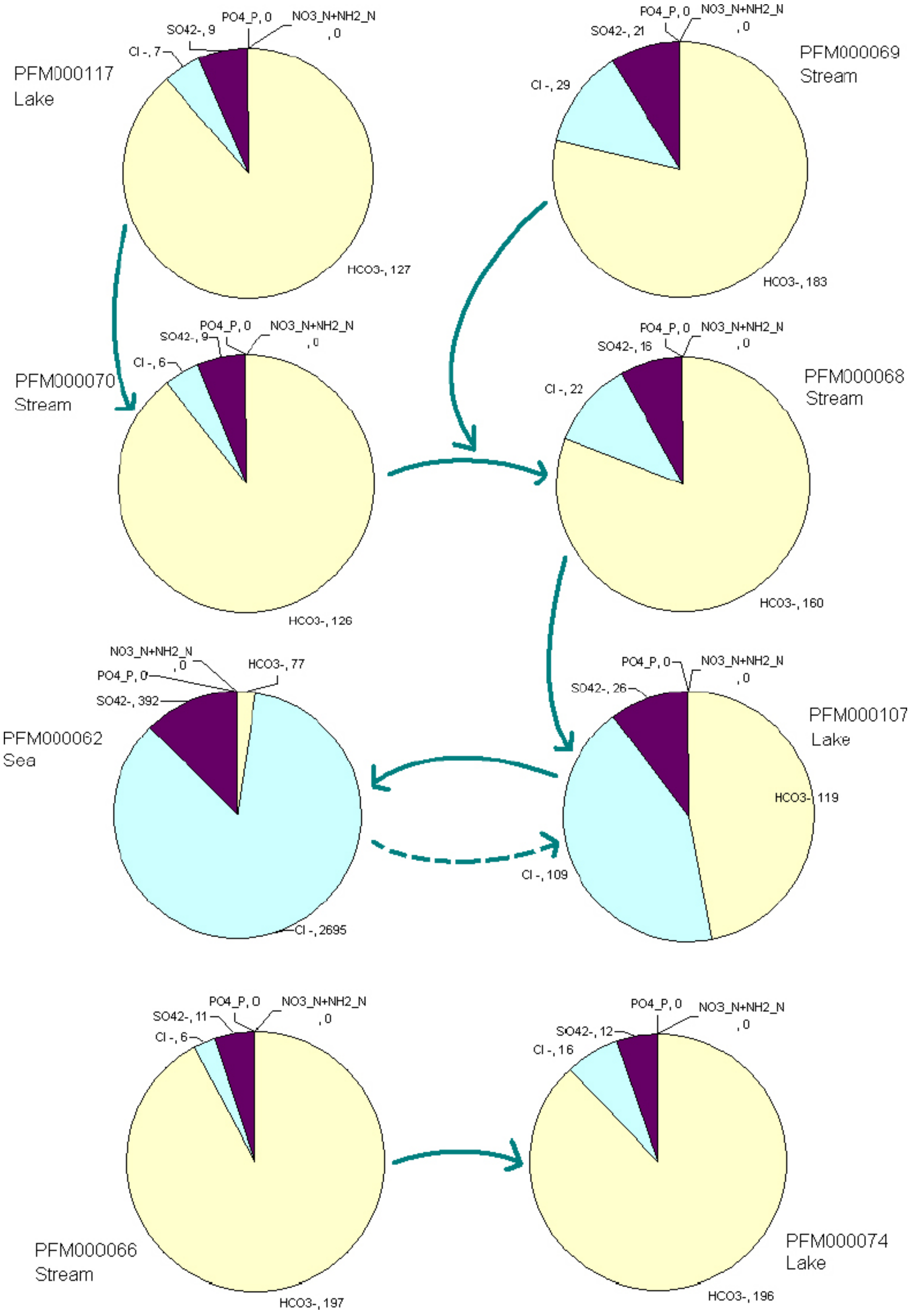


Figure 4-14. *Relative proportions of the anions Cl$^-$, HCO^{3-}, SO$_4^{2-}$, PO$_4^{2-}$_P, NO$_3$_N+ NH$_2$_N based on the average values (given in the diagrams in mg/L) during the sampling period. The arrows show the path of the surface water between the lakes and streams. The occasional inflow of sea water into Lake Bolundsfjärden (PFM000107) is indicated by a dotted arrow. The Lake Labboträsket (PFM000074) and the stream PFM000066 belong to a different catchment area.*

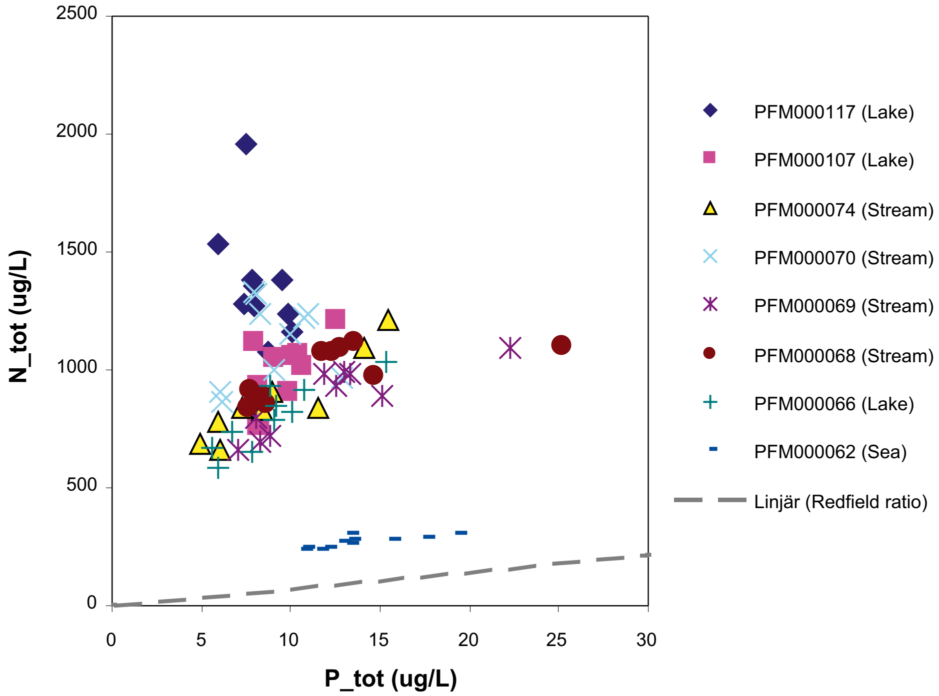


Figure 4-15. *The relationship between nitrogen and phosphorus in the surface water of the investigated streams, lakes and coastal bays in the Forsmark area. The Redfield ratio (7:1) is indicated. Values above and below the line indicate phosphorus limitation and nitrogen limitation, respectively.*

5 Precipitation

5.1 Objective and scope

Information on the chemical composition of precipitation and its variation in Forsmark is useful in the following context:

- to improve the understanding of groundwater formation and other hydogeological conditions at the site,
- as boundary conditions for chemical modelling purposes,
- possible use as reference water in mixing calculations.

Sampling and analysis of precipitation are mainly performed according to the SKB class 3 /1/. However, aluminium and iron are also included in the analytical protocol.

Figure 5-1 shows the sampling location within the site investigation area in Forsmark. The location is situated southeast from the three nuclear power plants in Forsmark. The previous reports treating sampling of precipitation in Forsmark /14, 15, 16/ include results from a reference sampling point, PFM102271, for tritium located in Sjötorp close to Lake Vänern. This point was selected due to the long distance to any nuclear power plant and sampled in order to observe if the closeness to nuclear power plants causes occasional enhancement of tritium in the precipitation.

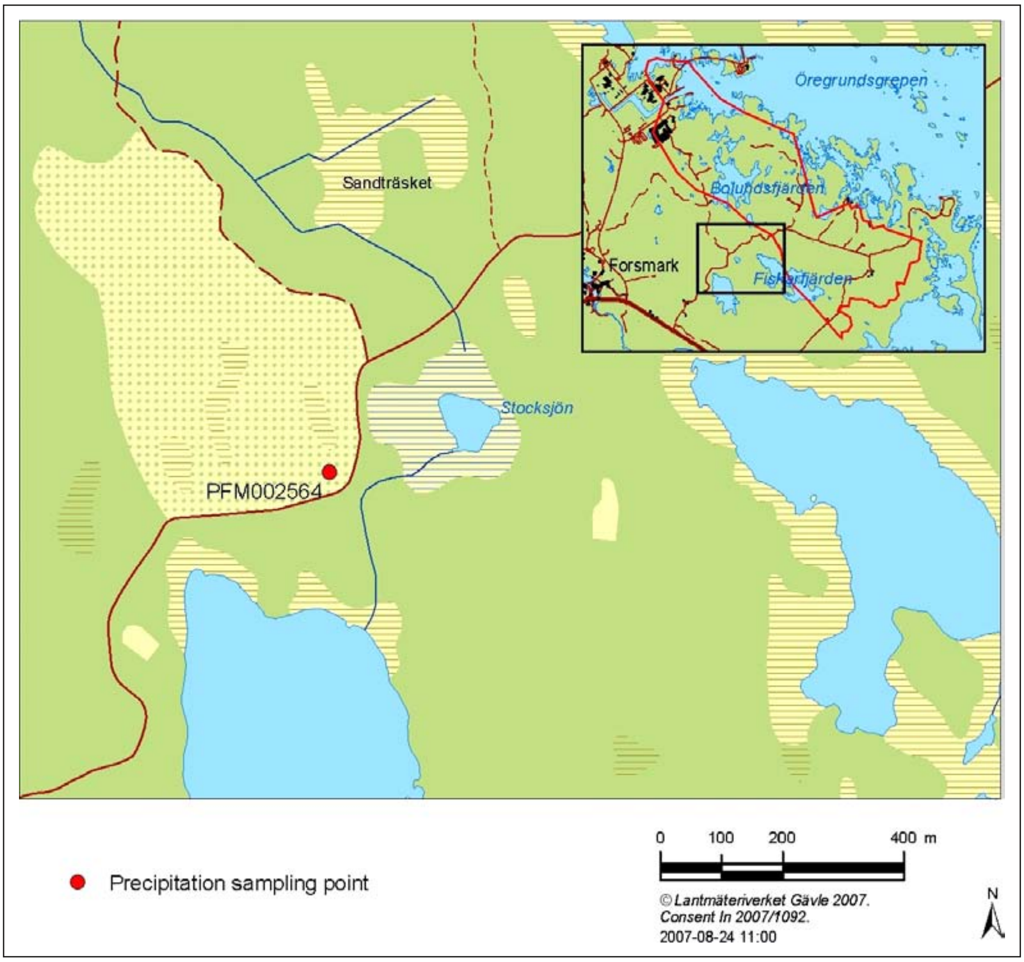


Figure 5-1. *Location of the samplers for precipitation, PFM002564, within the Forsmark investigation area (the area of the map).*

5.2 Equipment

Two different setup's of samplers for precipitation were used during the period, the winter setup (January to April), Figure 5-2, and the summer setup (May to June), Figure 5-3. Both samplers are from NILU, Norway. Two samplers of each type were used simultaneously in order to increase the collected water volumes.

Figure 5-2. *Precipitation sampler, winter setup. Two sampler setups were used simultaneously in order to increase the collected volume of the precipitation.*

Figure 5-3. *Precipitation sampler, summer setup. Two sampler setups were used simultaneously in order to increase the collected volume of the precipitation.*

5.3 Performance

5.3.1 Sampling

Sampling of precipitation within the Forsmark area was carried out according to activity plan AP PF 400-07-039 following the method described in SKB MD 423.003, cf. Table 1-1.

Sampling during summer

During summer the risk for biased isotope analyses due to evaporation was larger than during the winter season. Therefore, collection of precipitation water was conducted more frequently and the necks of the sampler bottles were narrow compared to the bottles for winter use. The sampler bottles were removed from their stands every week and the contents were pooled together with water from previous weeks and stored in a refrigerator. The collected precipitation from a two months period was then portioned into smaller bottles for distribution to the different analytical laboratories, see Figure 5-4, for a schematic outline of the sampling procedure. The bottle belonging to the equipment employed in Sjötorp was used together with a thin inside plastic bag, which was replaced after each sample collection.

Sampling during winter

During winter time the samplers were fetched from the field every second week and placed indoors in order to let the snow melt. Otherwise, the procedure was the same as for the summer samples.

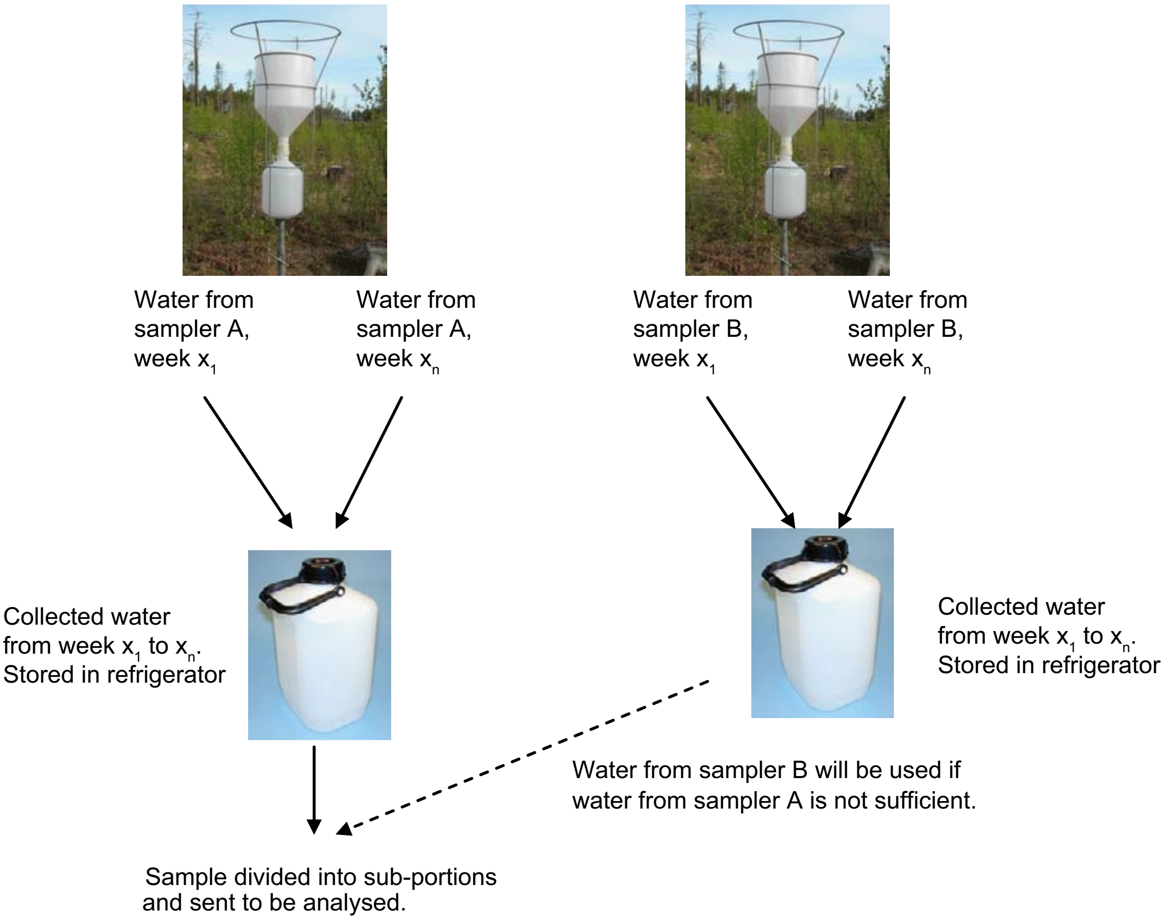


Figure 5-4. *Schematic outline of sample handling procedure.*

5.3.2 Sample treatment and chemical analyses

An overview of sample treatment and analysis routines is given in Appendix 1. The routines are applicable independent of sampling method or type of sampling object. The sub-samples and analyses are listed in Table 5-1.

Table 5-1. Sampling volumes and analysed components.

Sub-sample volume (mL)	Components
250	HCO_3^-, pH, Electric conductivity (EC)
125*	Na, K, Ca, Mg, Mn, Sr, Si, Li, Al, Fe, SO_4–S
100	Br^-
250	Cl^-, Br^-, SO_4^{2-}, F–
500	^3H
100	δD, $\delta^{18}O$

* Filtered 0.4 µm, 1% HNO_3.

Data handling

The handling of hydrochemical data follow the same routine for quality control and data management independently of sampling method or type of sampling object. For description of data handling see Appendix 1.

5.4 Results

5.4.1 Basic water analyses

The basic water analyses include the major components Na, K, Ca, Mg, S, $SO_4^{2-,}$ Cl^-, Si and HCO_3^- and as well as the minor constituents Li, Mn, Sr and Br^-. Furthermore, aluminium analyses and measurements of pH and electric conductivity (EC) were conducted. The basic water analysis data are compiled in Appendix 5, Table A5-1.

Calculations of the relative charge balance error may give an indication of the quality and uncertainty of the major constituents data also for precipitation. Normally, for surface waters, a relative charge balance error within ±10% is considered acceptable. However, the concentrations in precipitation samples are much lower and close to or below the reporting limit for many constituents. Therefore, analytical errors have a large impact on the charge balance, and the precipitation samples often exceed this limit, see Figure 5-5.

5.4.2 Isotoper analysis

The isotope determinations include the stable isotopes δD and $\delta^{18}O$ as well as the radioactive isotope ^3H (Tritium). The isotope data are compiled in Appendix 5, Table A5-2. Sampling for isotope determinations may be biased by evaporation during summer time. The diagram for $\delta^{18}O$ (deviation from Standard Mean Ocean Water) versus δD (dev. SMOW) in Figure 5-6, corresponds well with the "Global meteoric water line" which is based on precipitation data from around the world /86/.

The tritium content in precipitation from Forsmark, July 2005 to June 2008, is displayed in Figure 5-7.

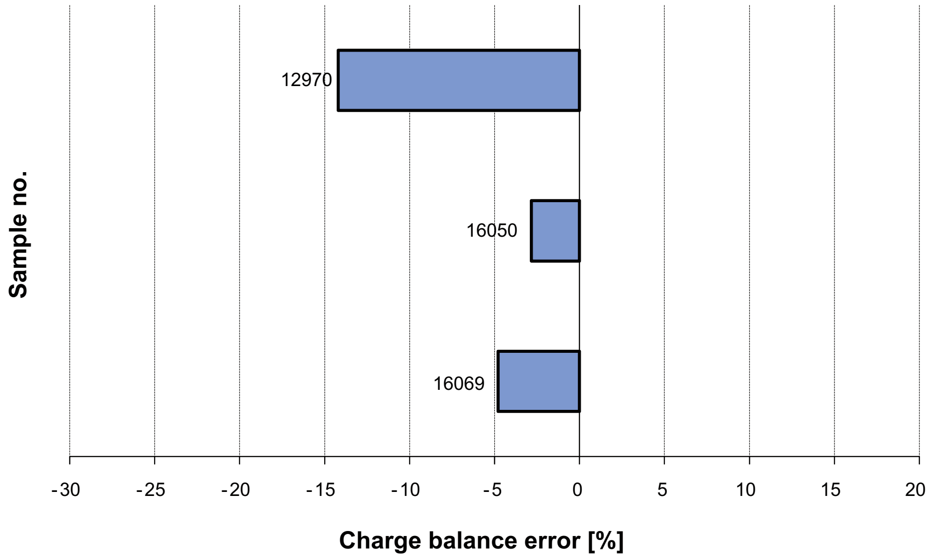


Figure 5-5. *Charge balance errors for the three precipitation samples collected during the reported time period.*

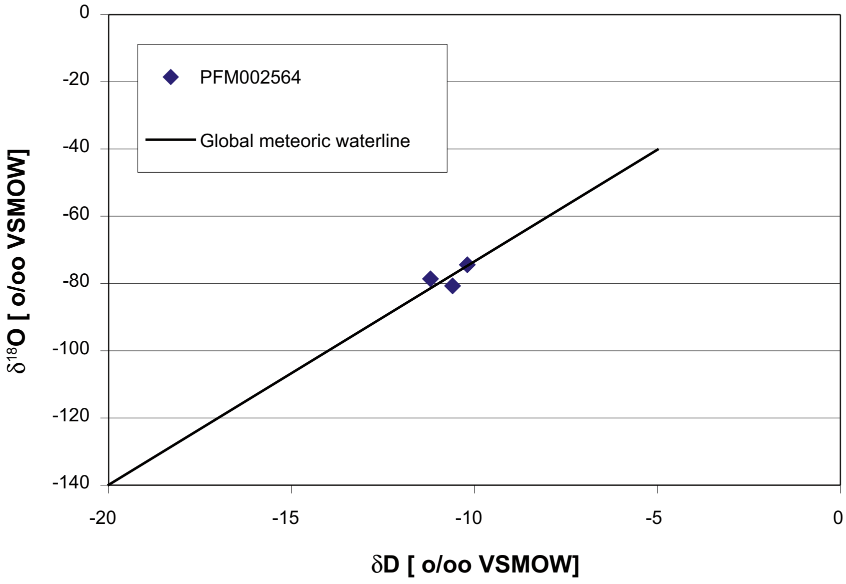


Figure 5-6. *$\delta^{18}O$ plotted versus δD and compared with the "global meteoric water line". PFM002564 = sampling location at the Forsmark site.*

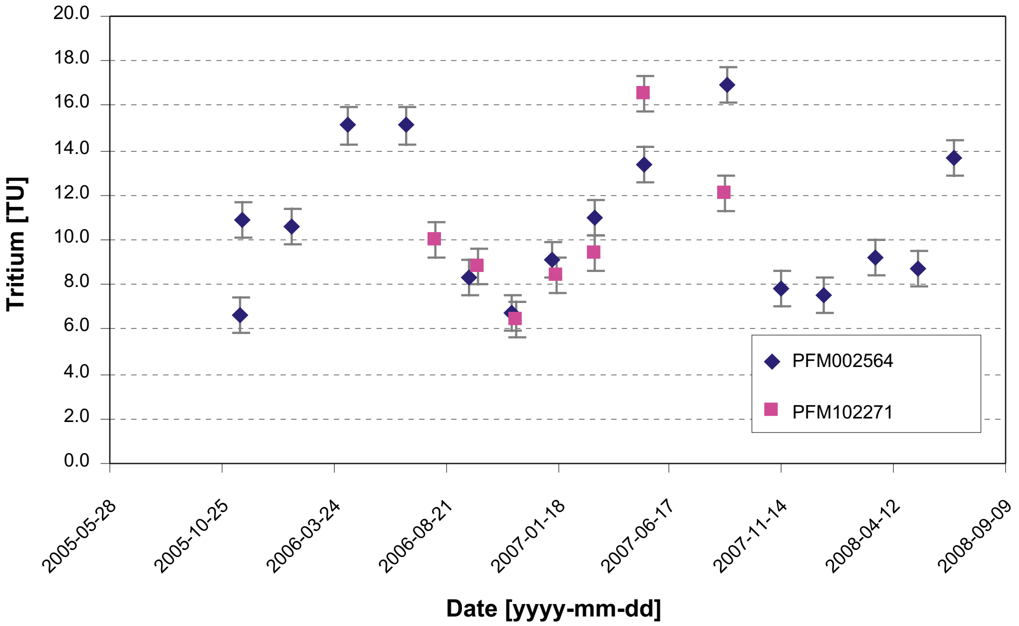


Figure 5-7. *Tritium contents in precipitation collected at the Forsmark site and at the reference location in Sjötorp. PFM002564 = sampling location in Forsmark, PFM102271 = sampling location in Sjötorp.*

5.5 Summary and discussion

The precipitation results in this report are the last ones in the running monitoring programme in Forsmark and no significant changes compared to previous years was observed. Sampling of precipitation was completed in June 2008 and the activity is not included in the monitoring program from July 2008 and onwards. The sampling may easily be resumed if more data are needed for new reasons that may emerge.

6 References

6.1 Introduction

/1/ **SKB, 2001.** Site investigations. Investigation methods and general execution programme. SKB R-01-29, Svensk Kärnbränslehantering AB.

/2/ **SKB, 2007.** Forsmark site investigation. Programme for long-term observations of geosphere and biosphere after completed site investigation 2002–2007. SKB R-07-34. Svensk Kärnbränslehantering AB

/3/ **Berg C, Nilsson A-C, 2006.** Forsmark site investigation. Hydrochemical monitoring of percussion- and core drilled boreholes. Results from water sampling and analyses during 2005. SKB P-06-57. Svensk Kärnbränslehantering AB.

/4/ **Berg C, Nilsson A-C, 2007.** Forsmark site investigation. Hydrochemical monitoring of percussion- and core drilled boreholes. Results from water sampling and analyses during 2006. P-07-47 Svensk Kärnbränslehantering AB.

/5/ **Berg C, Nilsson A-C, 2008.** Forsmark site investigation. Hydrochemical monitoring of percussion- and core drilled boreholes. Results from water sampling and analysis during 2007. SKB P-08-54. Svensk Kärnbränslehantering AB.

/6/ **Nilsson A-C, Borgiel M, 2005.** Forsmark site investigation. Sampling and analyses of near surface groundwaters. Results from sampling of shallow soil monitoring wells, BAT pipes, a natural spring and private wells, May 2003–April 2005. SKB P-05-071, Svensk Kärnbränslehantering AB.

/7/ **Nilsson A-C, Borgiel M, 2005.** Forsmark site investigation. Sampling and analyses of near surface groundwaters. Results from sampling of shallow soil monitoring wells, BAT pipes, a natural spring and private wells, July 2005–April 2006. SKB P-06-304, Svensk Kärnbränslehantering AB.

/8/ **Nilsson A-C, Borgiel M, 2007.** Forsmark site investigation. Sampling and analyses of near surface groundwaters. Results from sampling of shallow soil monitoring wells, BAT pipes, a natural spring and private wells, July 2006–April 2007. SKB P-07-124, Svensk Kärnbränslehantering AB.

/9/ **Nilsson A-C, Karlsson S, Borgiel M, 2003.** Forsmark site investigation. Sampling and analyses of surface waters. Results from sampling in the Forsmark area, March 2002 to March 2003. SKB P-03-27, Svensk Kärnbränslehantering AB.

/10/ **Nilsson A-C, Borgiel M, 2004.** Forsmark site investigation. Sampling and analyses of surface waters. Results from sampling in the Forsmark area, March 2003 to March 2004. SKB P-04-146, Svensk Kärnbränslehantering AB.

/11/ **Nilsson A-C, Borgiel M, 2005.** Forsmark site investigation. Sampling and analyses of surface waters. Results from sampling in the Forsmark area, March 2004 to June 2005. SKB P-05-274, Svensk Kärnbränslehantering AB.

/12/ **Nilsson A-C, Borgiel M, 2007.** Forsmark site investigation. Sampling and analyses of surface waters. Results from sampling in the Forsmark area, July 2005 to June 2006. SKB P-07-095, Svensk Kärnbränslehantering AB.

/13/ **Nilsson A-C, Borgiel M, 2008.** Forsmark site investigation. Sampling and analyses of surface waters. Results from sampling in the Forsmark area, July 2006 to June 2007. SKB P-08-17, Svensk Kärnbränslehantering AB.

/14/ **Nilsson D, 2005.** Forsmark site investigation. Sampling and analysis of precipitation, years 2002 to 2005. SKB P-05-143, Svensk Kärnbränslehantering AB.

/15/ **Berg C, 2007.** Forsmark site investigation. Sampling and analysis of precipitation, September 2005 to June 2007. SKB P-07-170, Svensk Kärnbränslehantering AB.

/16/ **Qvarfordt S, Borgiel M, Berg C, Nilsson A-C 2008.** Forsmark site investigation. Hydrochemical monitoring of near surface groundwater, surface waters and precipitation. Results from sampling in the Forsmark area, August 2007–December 2007. SKB P-08-55, Svensk Kärnbränslehantering AB.

6.2 Groundwaters in percussion – and core drilled boreholes

/17/ **Claesson L-Å, Nilsson G, 2003.** Forsmark site investigation. Drilling of a flushing water well, HFM01, and two groundwater monitoring wells, HFM02 and HFM03, at drillsite DS1. SKB P-03-30. Svensk Kärnbränslehantering AB.

/18/ **Claesson L-Å, Nilsson G, 2003.** Forsmark site investigation. Drilling of a flushing water well, HFM05, and a groundwater monitoring well, HFM04 at HFM03, at drillsite DS2. SKB P-03-51. Svensk Kärnbränslehantering AB.

/19/ **Claesson L-Å, Nilsson G, 2004.** Forsmark site investigation. Drilling of the telescopic borehole KFM01A at drilling site DS1. SKB P-03-32. Svensk Kärnbränslehantering AB.

/20/ **Claesson L-Å, Nilsson G, 2004.** Forsmark site investigation. Drilling of the telescopic borehole KFM02A at drilling site DS2. SKB P-03-52. Svensk Kärnbränslehantering AB.

/21/ **Claesson L-Å, Nilsson G, 2004.** Forsmark site investigation. Drilling of the telescopic borehole KFM03A and the core drilled borehole KFM03B at drilling site DS3. SKB P-03-59. Svensk Kärnbränslehantering AB.

/22/ **Claesson L-Å, Nilsson G, 2004.** Forsmark site investigation. Drilling of the telescopic borehole KFM04A and the percussion drilled borehole KFM04B at drilling site DS4. SKB P-03-82. Svensk Kärnbränslehantering AB.

/23/ **Claesson L-Å, Nilsson G, 2004.** Forsmark site investigation. Drilling of a flushing water well, HFM13, two groundwater monitoring wells in solid bedrock, HFM14-15, and one groundwater monitoring well in soil, SFM0058, at and close to drilling site DS5. SKB P-04-85. Svensk Kärnbränslehantering AB.

/24/ **Claesson L-Å, Nilsson G, 2004.** Forsmark site investigation. Drilling of a monitoring well, HFM16, at drilling site DS6. SKB P-04-94. Svensk Kärnbränslehantering AB.

/25/ **Claesson L-Å, Nilsson G, 2004.** Forsmark site investigation. Drilling of five percussion boreholes, HFM11-12 and HFM17-19, on different lineaments. SKB P-04-106. Svensk Kärnbränslehantering AB.

/26/ **Claesson L-Å, Nilsson G, 2005.** Forsmark site investigation. Drilling of the telescopic borehole KFM06A and the core drilled borehole KFM06B at drill site DS6. SKB P-05-50. Svensk Kärnbränslehantering AB.

/27/ **Claesson L-Å, Nilsson G, 2005.** Forsmark site investigation. Drilling of the telescopic borehole KFM07A at drilling site DS7. SKB P-05-142. Svensk Kärnbränslehantering AB.

/28/ **Claesson L-Å, Nilsson G, 2005.** Forsmark site investigation. Drilling of the telescopic borehole KFM08A and the core drilled borehole KFM08B at drill site DS8. SKB P-05-172. Svensk Kärnbränslehantering AB.

/29/ **Claesson L-Å, Nilsson G, 2006.** Forsmark site investigation. Drilling of the telescopic borehole KFM06C at drill site DS6. SKB P-05-277. Svensk Kärnbränslehantering AB.

/30/ **Claesson L-Å, Nilsson G, 2006.** Forsmark site investigation. Drilling of the percussion boreholes HFM25-HFM27, HFM29-HFM32 and HFM38 for investigation of different lineaments and to be used as monitoring wells. SKB P-06-166. Svensk Kärnbränslehantering AB.

/31/ **Claesson L-Å, Nilsson G, 2006.** Forsmark site investigation. Drilling of the telescopic boreholes KFM08C and KFM08D at drill site DS8. SKB P-06-171. Svensk Kärnbränslehantering AB.

/32/ **Claesson L-Å, Nilsson G, 2006.** Forsmark site investigation. Drilling of the telescopic borehole KFM10A at drill site DS10. SKB P-06-172. Svensk Kärnbränslehantering AB.

/33/ **Claesson L-Å, Nilsson G, Ullberg A. 2006.** Forsmark site investigation. Drilling of borehole KFM01C and the telescopic borehole KFM01D at drill site DS1. SKB P-06-173. Svensk Kärnbränslehantering AB.

/34/ **Claesson L-Å, Nilsson G, Ullberg A, 2007.** Forsmark site investigation. Drilling of the telescopic borehole KFM02B at drilling site DS2. SKB P-07-44. Svensk Kärnbränslehantering AB.

/35/ **Claesson L-Å, Nilsson G, Ullberg A, 2007.** Forsmark site investigation. Drilling of the telescopic borehole KFM11A at drill site DS11. SKB P-07-45. Svensk Kärnbränslehantering AB.

/36/ **Nyberg G, Wass E, 2008.** Forsmark site investigation. Hydro monitoring program. Report for April 2007–April 2008. SKB P-08-72. Svensk Kärnbränslehantering AB.

/37/ **Ludvigson J-E, Levén J, Jönsson S, 2004.** Forsmark site investigation. Single-hole injection tests in borehole KFM01A. SKB P-04-95. Svensk Kärnbränslehantering AB.

/38/ **Källgården J, Ludvigson J-E, Jönsson J, 2004.** Forsmark site investigation. Single-hole injection tests in borehole KFM02A. SKB P-04-100. Svensk Kärnbränslehantering AB.

/39/ **Källgården J, Ludvigson J-E, Hjerne C, 2004.** Forsmark site investigation. Single-hole injection tests in borehole KFM03A. SKB P-04-194. Svensk Kärnbränslehantering AB.

/40/ **Hjerne C, Ludvigson J-E, 2005.** Forsmark site investigation. Single-hole injection tests in borehole KFM04A. SKB P-04-293. Svensk Kärnbränslehantering AB.

/41/ **Gokall-Norman K, Svensson T, Ludvigson J-E, 2005.** Forsmark site investigation. Single-hole injection tests in borehole KFM07A. SKB P-05-133. Svensk Kärnbränslehantering AB.

/42/ **Svensson T, Ludvigson J-E, Hjerne C, 2005.** Forsmark site investigation. Single-hole injection tests in borehole KFM02A, re-measurements after hydraulic fracturing. SKB P-05-145. Svensk Kärnbränslehantering AB.

/43/ **Hjerne C, Ludvigson J-E, Lindquist A, 2005.** Forsmark site investigation. Single-hole injection tests in boreholes KFM06A and KFM06B. SKB P-05-165. Svensk Kärnbränslehantering AB.

/44/ **Lindquist A, Ludvigson J-E, Gokall-Norman K, 2006.** Forsmark site investigation. Single-hole injection tests in borehole KFM06C. SKB P-06-23. Svensk Kärnbränslehantering AB.

/45/ **Walger E, Hjerne C, Ludvigson J-E, Harrström J, 2006.** Forsmark site investigation. Single-hole injection tests and pressure pulse tests in borehole KFM08A. SKB P-06-194. Svensk Kärnbränslehantering AB.

/46/ **Florberger J, Hjerne C, Ludvigson J-E, Walger E, 2006.** Forsmark site investigation. Single-hole injection tests in borehole KFM01D. SKB P-06-195. Svensk Kärnbränslehantering AB.

/47/ **Walger E, Hjerne C, Ludvigson J-E, Harrström J, 2007.** Forsmark site investigation. Single-hole injection tests in borehole KFM10A. SKB P-07-31. Svensk Kärnbränslehantering AB.

/48/ **Harrström J, Svensson T, Ludvigsson J-E, 2007.** Forsmark site investigation. Single-hole injection tests in borehole KFM11A. SKB P-07-177. Svensk Kärnbränslehantering AB.

/49/ **Väisäsvaara J, Pöllänen J, 2007.** Forsmark site investigation. Difference flow logging in borehole KFM02B. SKB P-07-83. Svensk Kärnbränslehantering AB.

/50/ **Kristiansson S, 2007.** Forsmark site investigation. Difference flow logging in borehole KFM08D. SKB P-07-84. Svensk Kärnbränslehantering AB.

/51/ **Ludvigson J-E, Jönsson S, Levén J, 2003.** Forsmark site investigation. Pumping tests and flow logging. Boreholes KFM01A (0–100 m), HFM01, HFM02 and HFM03. SKB P-03-33. Svensk Kärnbränslehantering AB.

/52/ **Ludvigson J-E, Jönsson S, Svensson T, 2003.** Forsmark site investigation. Pumping tests and flow logging. Boreholes KFM02A (0–100 m), HFM04 and HFM05. SKB P-03-34. Svensk Kärnbränslehantering AB.

/53/ **Ludvigson J-E, Jönsson S, Hjerne C, 2004.** Forsmark site investigation. Pumping tests and flow logging. Boreholes KFM06A (0–100 m) and HFM16. SKB P-04-65. Svensk Kärnbränslehantering AB.

/54/ **Ludvigson J-E, Jönsson S, Jönsson J, 2004.** Forsmark site investigation. Pumping tests and flow logging. Boreholes HFM13, HFM14 and HFM15. SKB P-04-71. Svensk Kärnbränslehantering AB.

/55/ **Ludvigson J-E, Källgården J, Hjerne C, 2004.** Forsmark site investigation. Pumping tests and flow logging. Boreholes HFM17, HFM18 and HFM19. SKB P-04-72. Svensk Kärnbränslehantering AB.

/56/ **Jönsson J, Hjerne C, Ludvigsson J-E, 2005.** Forsmark site investigation. Pumping tests and flow logging. Boreholes HFM20, HFM21 and HFM22. SKB P-05-14. Svensk Kärnbränslehantering AB.

/57/ **Jönsson S, Ludvigson J-E, 2006.** Forsmark site investigation. Pumping tests and flow logging. Boreholes HFM24 and HFM32. SKB P-06-96. Svensk Kärnbränslehantering AB.

/58/ **Ludvigson J-E, Jönsson S, 2006.** Forsmark site investigation. Pumping tests and flow logging. Boreholes HFM23, HFM27 and HFM28. SKB P-06-191. Svensk Kärnbränslehantering AB

/59/ **Gustafsson E, Nordqvist R, Thur P, 2005.** Forsmark site investigation. Groundwater flow measurements in boreholes KFM01A, KFM02A, KFM03A, KFM03B and SWIW tests in KFM02A, KFM03A. SKB P-05-77. Svensk Kärnbränslehantering AB.

/60/ **Wass E, 2006.** Forsmark site investigation. Groundwater flow measurements in permanently installed boreholes, Test campaign no. 1. 2005. SKB P-06-59. Svensk Kärnbränslehantering AB.

/61/ **Wass E, Andersson P, 2006.** Forsmark site investigation. Groundwater flow measurements and tracer tests at drill site 1. SKB P-06-125. Svensk Kärnbränslehantering AB.

/62/ **Lindquist A, Wass E, 2006.** Forsmark site investigation. Groundwater flow measurements in conjunction with the interference test with pumping in HFM14. SKB P-06-188. Svensk Kärnbränslehantering AB.

/63/ **Wass E, 2007.** Forsmark site investigation. Groundwater flow measurements in permanently installed boreholes, Test campaign no. 2, 2006. SKB P-07-50. Svensk Kärnbränslehantering AB.

/64/ **Gustafsson E, Nordqvist R, Thur P, 2006.** Forsmark site investigation. Groundwater flow measurements and SWIW tests in borehole KFM08A. SKB P-06-90. Svensk Kärnbränslehantering AB.

/65/ **Thur P, Nordqvist R, Gustafsson E, 2007.** Forsmark site investigation. Groundwater flow measurements and SWIW tests in borehole KFM01D. SKB P-07-52. Svensk Kärnbränslehantering AB.

/66/ **Lindquist A, Hjerne C, Nordqvist R, Byegård J, Walger E, Ludvigson J-E, Wass E. 2008.** Forsmark site investigation. Confirmatory hydraulic interference test and tracer test at drill site 2. SKB P-08-13. Svensk Kärnbränslehantering AB.

/67/ **Lindquist A, Hjerne C, Nordqvist R, Wass E. 2008.** Forsmark site investigation. Large-scale confirmatory multiple-hole tracer test. SKB P-08-59. Svensk Kärnbränslehantering AB.

/68/ **Wass E, 2008.** Groundwater flow measurements in permanently installed boreholes. Test campaign no. 3 2007. Forsmark site investigation. SKB P-08-32. Svensk Kärnbränslehantering AB.

/69/ **Wacker P, Bergelin A, Nilsson A-C, 2004.** Forsmark site investigation. Complete hydrochemical characterisation in KFM01A. Results from two investigated sections, 110.1–120.8 and 176.8–183.9 metres. SKB P-03-94. Svensk Kärnbränslehantering AB.

/70/ **Nilsson K, Bergelin A, Lindquist A, Nilsson A-C, 2006.** Forsmark site investigation. Hydrochemical characterisation in borehole KFM01D. Results from seven investigated sections: 194.0–195.0 m, 263.8–264.8 m, 314.5–319.5 m, 354.9–355.9 m, 369.0–370.0 m, 428.5–435.6 m, 568.0–575.1 m. SKB P-06-227. Svensk Kärnbränslehantering AB.

/71/ **Wacker P, Bergelin A, Nilsson A-C, 2004.** Forsmark site investigation. Hydrochemical characterisation in KFM02A. Results from three investigated borehole sections; 106.5–126.5, 413.5–433.5 and 509.0–516.21 m. SKB P-04-70. Svensk Kärnbränslehantering AB.

/72/ **Wacker P, Bergelin A, Berg C, Nilsson A-C, 2004.** Forsmark site investigation. Hydrochemical characterisation in KFM03A. Results from six investigated borehole sections: 386.0–391.0 m, 448.0–453.0 m, 448.5–455.6 m, 639.0–646.1 m, 939.5–946.6 m, 980.0–1001.2 m. SKB P-04-108. Svensk Kärnbränslehantering AB.

/73/ **Wacker P, Bergelin A, Berg C, Nilsson A-C, 2004.** Forsmark site investigation. Hydrochemical characterisation in KFM04A. Results from two investigated borehole sections, 230.5–237.6 and 354.0–361.1 metres. SKB P-04-109. Svensk Kärnbränslehantering AB.

/74/ **Berg C, Wacker P, Nilsson A-C, 2005.** Forsmark site investigation. Chemical characterisation in KFM07A. Results from the investigated section at 848.0–1001.6 m. SKB P-05-170. Svensk Kärnbränslehantering AB.

/75/ **Berg C, Wacker P, Nilsson A-C, 2005.** Forsmark site investigation. Hydrochemical characterisation in KFM06A. Results from the investigated sections at 266.0–271.0 m, 353.5–360.6 m and 768.0–775.1 m. SKB P-05-178. Svensk Kärnbränslehantering AB.

/76/ **Berg C, Bergelin A, Wacker P, Nilsson A-C, 2006.** Forsmark site investigation. Hydrochemical characterisation in borehole KFM08A. Results from the investigated section at 683.5–690.6 (690.8) m. SKB P-06-63. Svensk Kärnbränslehantering AB.

/77/ **Bergelin A, Lindquist A, Nilsson K, Nilsson A-C, 2007.** Forsmark site investigation. Hydrochemical characterisation in borehole KFM10A. Results from three investigated sections: 298.0–305.1 m, 436.9–437.9 m, 478.0–487.5 m. SKB P-07-42. Svensk Kärnbränslehantering AB.

/78/ **Bergelin A, Lindquist A, Nilsson K, Wacker P, Nilsson A-C, 2007.** Forsmark site investigation. Hydrochemical characterisation in borehole KFM11A. Results from two investigated borehole sections at 447.5–545.6 m and 690.0–710.0 m. SKB P-07-100. Svensk Kärnbränslehantering AB.

/79/ **Bergelin A, Lindquist A, Nilsson K, Wacker P, Nilsson A-C, 2007.** Forsmark site investigation. Hydrochemical characterisation in borehole KFM08D. Results from two investigated sections at 669.7–676.8 m and 828.4–835.5 m. SKB P-07-190. Svensk Kärnbränslehantering AB.

/80/ **Nilsson A-C, 2003.** Forsmark site investigation. Sampling and analyses of groundwater in percussion drilled boreholes and shallow monitoring wells at drillsite DS1. Results from the percussion boreholes HFM01, HFM02, HFM03, KFM01A (borehole section 0–100 m) and the monitoring wells SFM0001, SFM0002 and SFM0003. SKB P-03-47. Svensk Kärnbränslehantering AB.

/81/ **Nilsson A-C, 2003.** Forsmark site investigation. Sampling and analyses of groundwater in percussion drilled boreholes and shallow monitoring wells at drillsite DS2. Results from the percussion boreholes HFM04, HFM05, KFM02A (borehole section 0–100 m) and the monitoring wells SFM0004 and SFM0005. SKB P-03-48. Svensk Kärnbränslehantering AB.

/82/ **Nilsson D, 2004.** Forsmark site investigation. Sampling and analyses of groundwater from percussion drilled boreholes. Results from the percussion boreholes HFM09 to HFM19 and the percussion part of KFM06A. SKB P-04-92. Svensk Kärnbränslehantering AB.

/83/ **Berg C, 2006.** Forsmark site investigation. Sampling and analyses of groundwater from percussion drilled boreholes. Results from the boreholes HFM14, HFM23, HFM24, HFM25, HFM26, HFM27, HFM28, HFM29, HFM30, HFM32, HFM33, HFM34 and HFM35. SKB P-06-231. Svensk Kärnbränslehantering AB.

6.3 Surface waters

/84/ **Johansson P-O, 2005.** Forsmark site investigation. Manual discharge measurements in brooks, April 2002–April 2005. SKB P-05-153. Svensk Kärnbränslehantering AB

/85/ **Sonesten L, 2005.** Evaluation of surface water chemistry data from the Forsmark area. March 2002–March 2004. SKB R-05-41. Svensk Kärnbränslehantering AB.

6.4 Precipitation

/86/ **Craig H, 1961.** Isotopic variations in meteoric waters. Science 133, pp. 1702–1703.

Appendix 1

Sampling routines, analytical methods and data handling (analytical results)

Table A1-1. Sampling routines and analytical methods.

Component group	Component/ element	Sample container (material)	Volume (mL)	Filtering	Preparation/ Conservation*	Analysis method	Analysis within – or delivery time to lab.
Anions 1	HCO_3 pH(lab) cond (lab)	Plastic	250	Yes (not in the field)	No	Titration Pot. meas, Cond. meas	The same day – maximum 24 hours
Anions 2	Cl, SO_4, Br^-, F^-, I^-	Plastic	100	Yes (not in the field)	No	Titration (Cl^-) IC (Cl^-, SO4, Br^-, F^-) ISE (F^-)	Not critical (month)
	Br, I	Plastic	100	Yes (not in the field)	No	ICP MS	Not critical (month)
Cations, Si and S according to SKB class 3	Na, K, Ca, Mg, S(tot), Si(tot), Li, Sr	Plastic (at low conc. acid washed bottles)	100	Yes (not in the field)	Yes (not in the field, 1 mL HNO_3)	ICP-AES ICP-MS	Not critical (month)
Cations, Si and S according to SKB class 4 and 5	Na, K, Ca, Mg, S(tot), Si(tot), Fe, Mn, Li, Sr	Plastic (Acid washed)	100	Yes (immediately in the field)	Yes (1mL HNO_3)	ICP-AES ICP-MS	Not critical (month)
Fe(II), Fe(tot)	Fe(II), Fe(tot)	Plastic (Acid washed)	500	Yes	Yes (5 mL HCl))	Spectrophotometry Ferrozine method	As soon as possible the same day
Hydrogen sulphide	HS–	Glass (Winkler)	About 120×2	No	Ev 1 mL 1 M NaOH+ 1 mL 1M ZnAc	Spectrophotometry	Immediately or if conserved, a few days
Environmental metals	Al, As, Ba, B, Cd, Co, Cr, Cu, Hg, Mo, Ni, P, Pb, V, Zn	Plastic (Acid washed)	100	Yes	Yes (1 mL HNO_3)	ICP-AES ICP-MS	Not critical (month)
Lantanoids, U, Th and so on.	Sc, Rb, Y, Zr, I, Sb, Cs, La, Hf, Tl, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, U, Th	Plastic (Acid washed)	100	Yes	Yes (1 mL HNO_3)	ICP-AES ICP-MS	Not critical (month)
Dissolved organic Carbon, dissolved inorganic Carbon	DOC, DIC	Plastic	250 25	Yes	Frozen, transported in isolated bag	UV oxidation, IR	Short transportation time
Component group	Component/ element	Sample container (material)	Volume (mL)	Filtering	Preparation/ Conservation*	Analysis method	Analysis within – or delivery time to lab.
Total organic Carbon	TOC	Plastic	250 25	No	Frozen, transported in isolated bag	UV oxidation, IR	Short transportation time
Environmental isotopes	^2H, ^{18}O	Plastic	100	No	– –	MS	Not critical (month)
Tritium, Chlorine-37	^3H (enhanced.) Chlorine-37	Plastic (dry bottle) Plastic	500 100	No No	– –	LSC MS	Not critical (month)

Component group	Component/ element	Sample container (material)	Volume (mL)	Filtering	Preparation/ Conservation*	Analysis method	Analysis within – or delivery time to lab.
Carbon isotopes	^{13}C, ^{14}C	Glass (brown)	100×2	No	–	(A)MS	A few days
Sulphur isotopes	^{34}S	Plastic	500 –1,000	Yes	–	Combustion, MS	No limit
Strontium isotopes	$^{87}Sr/^{86}Sr$	Plastic	100	Yes	–	TIMS	Days or week
Uranium and Thorium isotopes	^{234}U, ^{235}U, ^{238}U, ^{232}Th, ^{230}Th,	Plastic	50	Nej	–	Alfa spectroscopy	No limit
Boron isotopes	^{10}B	Plastic	100	Yes	Yes (1 mL HNO_3)	ICP-MS	No limit
Radon and Radium isotopes	^{222}Rn, ^{226}Ra	Plastic	500	No	No	LSS	Immediate transport
Dissolved gas (content and composition)	Ar, N_2, CO_2, O_2, CH_4, H_2, CO, C_2H_2, C_2H_4, C_2H_6, C_3H_8	Cylinder of stainless steel	200	No	No	GC	Immediate transport
Colloids	Filter series and fractionation (see below)	Polycarbonate filter	0.45, 0.2 and 0.05 µm	–	N_2 atmosphere	ICP-AES ICP-MS	Immediate transport
Humic and fulvic acids	Fractionation	Fractions are collected in plastic bottles	250	–	N_2 atmosphere	UV oxidation, IR (DOC)	Immediate transport
Archive samples with acid	–	Plast (washed in acid)	100×2 **	Yes	Yes (1 mL HNO_3)	–	Storage in freeze container
Archive samples without acid	–	Plastic	250×2 **	Yes	No	–	Storage in freeze container
Carbon isotopes in humic and fulvic acids	^{13}C, ^{14}C (pmc)	DEAE cellulose (anion exchanger)	–	–	–	(A)MS	A few days
Nutrient salt + silicate	NO_2, NO_3, NO_2+NO_3, NH_4, PO_4, SiO_4	Sample tubes, plastic	25×2	Yes (in the field)	No, frozen immediately***	Spectrophotometry	Short transportation time
Total concentrations of Nitrogen and Phosphorous	N-tot, P-tot	Plastic	100	No	No, frozen immediately***	Spectrophotometry	Short transportation time
Particulate Carbon, Nitrogen and Phosphorous	POC, PON, POP	Plastic	1,000	Yes (within 4 h) prepared filters. Blank filters	Filtering, the filters are frozen immediately 2 filters/sample	Elementar-analysator (N, C) own method 990121 (P)	Short transportation time
Chlorophyll	Chlorophyll a, c and pheopigment	Plastic	1,000–2,000	Yes (within 4 h)	Filtering, the filters are frozen immediately	Spectrophotometry Fluorometry	Short transportation time
Oxygen	Dissolved O_2	Winkler, glass	2×ca 120	No	Mn (II) reagent Iodide reagent	Spectrophotometry SIS SS-EN 25813	Within 3 days
Archive samples for supplementary radio nuclides		Plastic	5,000	No	50 mL HNO_3	–	Storage in freeze container

* Suprapur acid is used for conservation of samples.

** Minimum number. The number of archive samples can vary depending on the number of similar samples collected at the same occasion.

*** The sample is transported in frozen condition to the laboratory. It is possible that the silicate concentration can change due to polymerisation for this reason.

Abbreviations and definitions:

IC	Ion chromatograph
ISE	Ion selective electrode
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectrometry
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
INAA	Instrumental Neutron Activation Analysis
MS	Mass Spectrometry
TIMS	Thermal Ionization Mass Spectrometer
LSC	Liquid Scintillation Counting
(A)MS	(Accelerator) Mass Spectrometry
GC	Gas Chromatography
LSS	Liquid Scintillation Spectroscopy

Table A1-2. Reporting limits and measurement uncertainties.

Component	Method[1]	Reporting limits (RL), detection limits (DL) or range[2]	Unit	Measurement uncertainty[3]
pH	Potentiometric	3–10	pH unit	±0.1
EC	Electrical Conductivity meas.	1–150 150–10,000	mS/m	5% 3%
HCO_3	Alkalinity titration	1	mg/L	4%
Cl^-	Mohr- titration	≥ 70	mg/L	5%
Cl^-	IC	0.5–70		8%
SO_4	IC	0.5	mg/L	12%
Br^-	IC	DL 0.2, RL 0.5	mg/L	15%
Br	ICP SFMS	0.001, 0.004, 0.010[4]	mg/L	25%[5]
F^-	IC	DL 0.2, RL 0.5	mg/L	13%
F^-	Potentiometric	DL 0.1, RL 0.2		12%
I^-	ICP SFMS	0.001, 0.004, 0.010[4]	mg/L	25%[5]
Na	ICP AES	0.1	mg/L	13%
K	ICP AES	0.4	mg/L	12%
Ca	ICP AES	0.1	mg/L	12%
Mg	ICP AES	0.09	mg/L	12%
S(tot)	ICP AES	0.16	mg/L	12%
Si(tot)	ICP AES	0.03	mg/L	14%
Sr	ICP AES	0.002	mg/L	12%
Li	ICP AES	0.004	mg/L	12.2%
Fe	ICP AES	0.02	mg/L	13.3%[6]
Fe	ICP SFMS	0.0004, 0.002, 0.004[4]	mg/L	20%[6]
Mn	ICP AES	0.003	mg/L	12.1%[5]
Mn	ICP SFMS	0.00003, 0.00004, 0.0001[4]	mg/L	53%[6]
Fe(II), Fe(tot)	Spectrophotometry	DL 0.006, RL 0.02	mg/L	0.005 (0.02–0.05 mg/L) 9% (0.05–1 mg/L) 7% (1–3 mg/L)
HS^-	Spectrophotometry, SKB	SKB DL 0.006, RL 0.02	mg/L	25%
HS^-	Spectrophotometry, external laboratory	0.01	mg/L	0.02 (0.01–0.2 mg/L) 12% (>0.2 mg/L)
NO_2 as N	Spectrophotometry	0.1	µg/L	2%
NO_3 as N	Spectrophotometry	0.2	µg/L	5%
NO_2+NO_3 as N	Spectrophotometry	0.2	µg/L	0.2 (0.2–20 µg/L) 2% (>20 µg/L)
NH_4 as N	Spectrophotometry, SKB	11	µg/L	30% (11–20 µg/L) 25% (20–50 µg/L) 12% (50–1,200 µg/L)
NH_4 as N	Spectrophotometry external laboratory	0.8	µg/L	0.8 (0.8–20 µg/L) 5% (>20 µg/L)

Component	Method[1]	Reporting limits (RL), detection limits (DL) or range[2]	Unit	Measurement uncertainty[3]
PO_4 as P	Spectrophotometry	0.5	µg/L	0.7 (0.7–20 µg/L) 3% (>20 µg/L)
SiO_4	Spectrophotometry	1	µg/L	2.5% (>100 µg/L)
O_2	Iodometric titration	0.2–20	mg/L	5%
Chlorophyll a, c pheopigment[7]	/1/	0.5	µg/L	5%
PON[7]	/1/	0.5	µg/L	5%
POP[7]	/1/	0.1	µg/L	5%
POC[7]	/1/	1	µg/L	4%
Tot-N[7]	/1/	10	µg/L	4%
Tot-P[7]	/1/	0.5	µg/L	6%
Al,	ICP SFMS	0.2, 0.3, 0.7[4]	µg/L	17.6%[6]
Zn	ICP SFMS	0.2, 0.8, 2[4]	µg/L	15.5, 17.7, 25.5%[6]
Ba, Cr, Mo,	ICP SFMS	0.01, 0.04, 0.1[4]	µg/L	Ba 15%[4], Cr 22%[5] Mo 39%[6]
Pb	ICP SFMS	0.01, 0.1, 0.3[4]	µg/L	15%[6]
Cd	ICP SFMS	0.002, 0.02, 0.5[4]	µg/L	15.5%[6]
Hg	ICP AFS	0.002	µg/L	10.7%[6]
Co	ICP SFMS	0.005, 0.02, 0.05[4]	µg/L	25.9%[6]
V	ICP SFMS	0.005, 0.03, 0.05[4]	µg/L	18.1%[6]
Cu	ICP SFMS	0.1, 0.2, 0.5[4]	µg/L	14.4%[6]
Ni	ICP SFMS	0.05, 0.2, 0.5[4]	µg/L	15.8%[6]
P	ICP SFMS	1, 5, 40[4]	µg/L	16.3%[6]
As	ICP SFMS	0.01 (520 mS/m)	µg/L	59.2%[6]
La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu	ICP SFMS	0.005, 0.02, 0.05[4]	µg/L	20%, 20%, 25%[6]
Sc, In, Th	ICP SFMS	0.05, 0.2, 0.5[4]	µg/L	25%[6]
Rb, Zr, Sb, Cs	ICP SFMS	0.025, 0.1, 0.25[4]	µg/L	15%, 20%, 20%[5] 25%[6]
Tl	ICP SFMS	0.025, 0.1, 0.25[4]	µg/L	14.3%[5 and 6]
Y, Hf	ICP SFMS	0.005, 0.02, 0.05[4]	µg/L	15%, 20%, 20%[5] 25%[6]
U	ICP SFMS	0.001, 0.005, 0.01[4]	µg/L	13.5%, 14.3%, 15.9%[5] 19.1%, 17.9%, 20.9%[6]
DOC	UV oxidation, IR Carbon analysator	0.5	mg/L	8%
TOC	UV oxidation, IR Carbon analysator	0.5	mg/L	10%
$\delta^{2}H$	MS	2	‰ SMOW[7]	0.9 (one standard deviation)
$\delta^{18}O$	MS	0.1	‰ SMOW[7]	0.1 (one standard deviation)
^{3}H	LSC	0.8	TU[8]	0.8
$\delta^{37}Cl$	A (MS)	0.2	‰ SMOC[10]	0.2[17]
$\delta^{13}C$	A (MS)	–	‰ PDB[11]	0.3[17]
^{14}C pmc	A (MS)	–	PMC[12]	0.4[17]
$\delta^{34}S$	MS	0.2	‰ CDT[13]	0.4 (one standard deviation)
$^{87}Sr/^{86}Sr$	TIMS	–	No unit (ratio)[14]	0.00002
$^{10}B/^{11}B$	ICP SFMS	–	No unit (ratio)[14]	–
^{234}U, ^{235}U, ^{238}U, ^{232}Th, ^{30}Th	Alfa spectr.	0.0001	Bq/L[15]	≤5% (Counting statistics uncertainty)
^{222}Rn, ^{226}Ra	LSS	0.015	Bq/L	≤5% (Counting statistics uncertainty)

1. Many elements may be determined by more than one ICP technique depending on concentration range. The most relevant technique and measurement uncertainty for the concentrations normally encountered in groundwater are presented. In cases where two techniques were frequently used, both are displayed.
2. Reporting limits (RL), generally 10×standard deviation, if nothing else is stated. Measured values below RL or DL are stored as negative values in Sicada (i.e. –RL value and –DL value).
3. Measurement uncertainty reported by the laboratory, generally as ± percent of measured value in question at 95% confidence interval.
4. Reporting limits at electrical cond. 520 mS/m, 1,440 mS/m and 3,810 mS/m respectively.
5. Measurement uncertainty at concentrations 100×RL.
6. Measurement uncertainty at concentrations 10×RL.
7. Determined only in surface waters. PON, POP and POC refers to Particulate Organic Nitrogen, Phosphorous and Carbon, respectively.
8. Per mille deviation[16] from SMOW (Standard Mean Oceanic Water).
9. TU =Tritium Units, where one TU corresponds to a tritium/hydrogen ratio of 10^{-18} (1 Bq/L Tritium = 8.45 TU).
10. Per mille deviation[16] from SMOC (Standard Mean Oceanic Chloride).
11. Per mille deviation[16] from PDB (the standard PeeDee Belemnite).
12. The following relation is valid between pmC (percent modern carbon) and Carbon-14 age:
$\text{pmC} = 100 \times e^{((1950-y-1.03t)/8274)}$ where y = the year of the C-14 measurement and t = C-14 age.
13. Per mille deviation[16] from CDT (the standard Canyon Diablo Troilite).
14. Isotope ratio without unit.
15. The following expressions are applicable to convert activity to concentration, for uranium-238 and thorium-232:
1 ppm U = 12.4 Bq/kg ^{238}U, 1 ppm Th = 3.93 Bq/kg ^{232}Th.
16. Isotopes are often reported as per mill deviation from a standard. The deviation is calculated as:
$\delta yI = 1{,}000 \times (K_{sample} - K_{standard)} / K_{standard}$, where K = the isotope ratio and ^{y}I = ^{2}H, ^{18}O, ^{37}Cl, ^{13}C or ^{34}S etc.
17. SKB estimation from duplicate analyses by the contracted laboratory.

Data handling, water analysis data

The following routines for quality control and data management are generally applied for hydrogeochemical analysis data, independently of sampling method or sampling object.

Several components are determined by more than one method and/or laboratory. Moreover, duplicate analyses by an independent laboratory are performed as a standard procedure on every fifth or tenth sample. All analytical results are stored in the Sicada database. The applied hierarchy path "Hydrochemistry/Hydrochemical investigation/Analyses/Water in the database" contains two types of tables: raw data tables and primary data tables (final data tables).

Data on **basic water analyses** are inserted into the raw data tables for further evaluation. The evaluation results in a final reduced data set for each sample which are compiled in a primary data table named "water composition". The evaluation is based on:

- Comparison of the results from different laboratories and/or methods. The analyses are repeated if a large disparity is noted (generally more than 10%).
- Calculation of charge balance errors according to the equation below. Relative errors within ± 5% are considered acceptable (in surface waters ± 10%).

$$\text{Relative error}\,(\%) = 100 \times \frac{\sum cations(equivalents) - \sum anions(equivalents)}{\sum cations(equivalents) + \sum anions(equivalents)}$$

- General expert judgement of plausibility based on earlier results and experience.

All results from **special analyses of trace metals and isotopes** are inserted directly into primary data tables. In those cases where the analyses are repeated or performed by more than one laboratory, a "best choice" notation will indicate the results that are considered most reliable.

An overview of the data management is given in Figure A1-1.

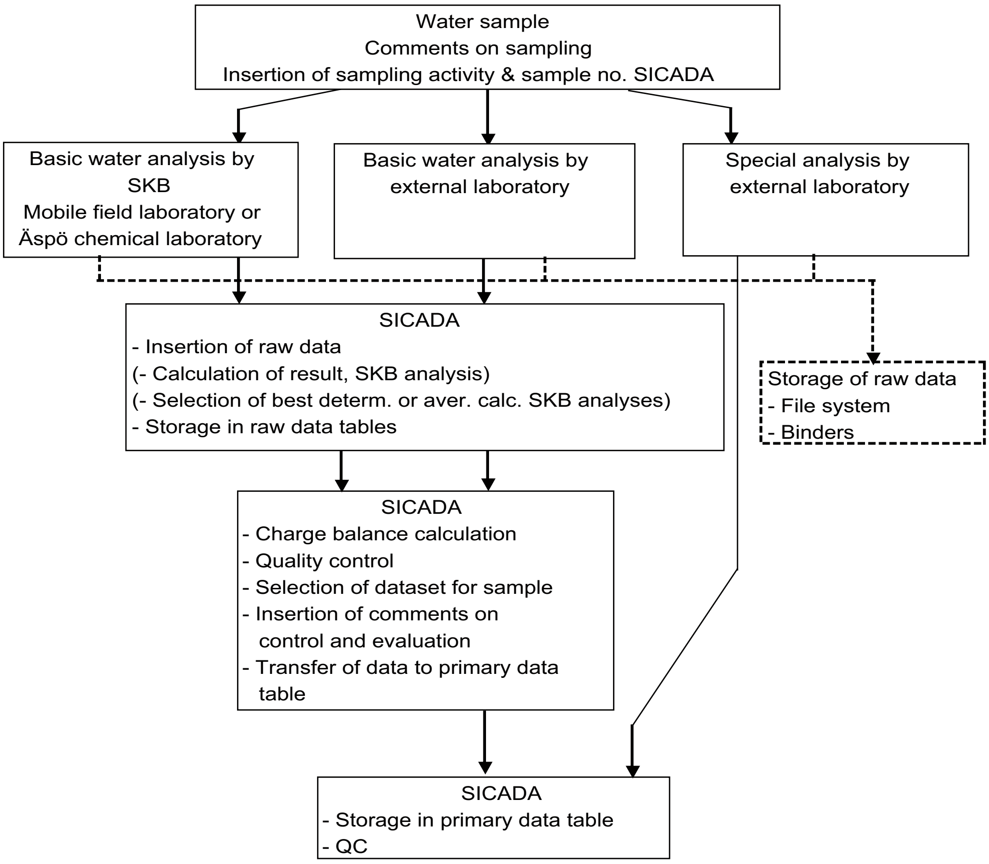


Figure A1-1. *Overview of data management for hydrogeochemical data.*

Appendix 2

Groundwaters in percussion – and core drilled boreholes

A2.1 Sampling information

Id code:section	Volume in tubes (dm^3)	Volume in section (dm^3)	Total volume (dm^3)	Pumped time	Flow rate (mL/min)	Pumped volume (dm^3)	Sampling date	Sample no.	Respons in other sections in borehole
HFM01:2	0.1	30	30.1	30h 32 min	74	136	2008-05-21	16031	No
HFM02:2	0.2	25	25.2	30h 20 min	74	135	2008-05-21	16033	No
HFM04:2	0.8	20	20.8	22h 11 min	86	114	2008-05-22	16029	No
HFM13:1	3.6	35	38.6	44h 9 min	70	185	2008-05-15	16027	No
HFM15:1	1.5	25	26.5	45h 16 min	63	171	2008-05-15	16023	No
HFM16:2	0.7	32.5	33.2	48h 34 min	104	303	2008-05-22	16032	No
HFM19:1	3.9	35	38.9	44h 50 min	66	178	2008-05-15	16026	No
HFM21:3	0.1	25	25.1	49h 51 min	68	203	2008-05-15	16024	No
HFM27:2	0.5	30	30.5	30h 7 min	64	116	2008-05-21	16030	No
HFM32:3	0.1	12.5	12.6	3h 28 min	510	107	2008-06-05	16046	No HMS-data
KFM01A:5	2.0	21	23.0	46h	92	254	2008-05-29	16044	Yes; KFM01A:4
KFM01D:2	11.0	9	20.0	46h 5 min	62	171	2008-05-29	16042	Yes; KFM01D:3, KFM01D:5 and KFM01D:7
KFM01D:4	7.7	10	17.7	46h 34 min	80	224	2008-05-29	16045	see above
KFM02A:3	12.7	28	40.7	45h 45 min	76	209	2008-05-29	16041	No
KFM02A:5	10.5	31	41.5	46h 10 min	100	277	2008-05-29	16040	No
KFM02B:2	12.8	15	27.8	44h 49 min	88	237	2008-05-29	16039	No
KFM02B:4	10.5	21	31.5	45h 15 min	68	185	2008-05-29	16043	see above
KFM03A:1	26.3	25	51.3	21h 8 min	60	76	2008-05-22	16036	Yes; KFM03A:2 and KFM03A:3
KFM03A:4	16.9	16.5	33.4	25h 8 min	84	127	2008-05-22	16028	see above
KFM04A:4	5.4	15	20.4	22h 36 min	96	130	2008-05-22	16034	No
KFM06A:3	19.7	10	29.7	94h 47 min	30	171	2008-06-09	16048	No HMS-data
KFM06A:5	8.5	21	29.5	47h 44 min	100	286	2008-06-05	16049	No HMS-data
KFM06C:3	17.2	19	36.2	27h 2 min	40	65	2008-06-11	16066	No HMS-data
KFM06C:5	13.9	9	22.9	21h 5 min	166	210	2008-06-09	16064	No HMS-data
KFM08A:2	18.2	10	28.2	45h 28 min	104	284	2008-06-05	16062	No HMS-data
KFM08A:6	6.4	15	21.4	27h 51 min	96	160	2008-05-29	16047	Yes; KFM08A:7
KFM08D:2	22.2	10	32.2	137h 45min	20	165	2008-06-09	16065	No HMS-data
KFM08D:4	17.5	20	37.5	41h 39 min	110	275	2008-06-05	16063	No HMS-data
KFM10A:2	11.0	10	21.0	29h	114	198	2008-05-22	16035	Yes; KFM10A:1
KFM11A:2	18.4	20	38.4	42h 36 min	76	194	2008-05-22	16037	Yes; KFM11A:3 and KFM11A:5

Id code:section	Volume in tubes (dm^3)	Volume in section (dm^3)	Total volume (dm^3)	Pumped time	Flow rate (mL/min)	Pumped volume (dm^3)	Sampling date	Sample no.	Respons in other sections in borehole
KFM11A:4	11.5	10	21.5	44h 2 min	76	201	2008-05-22	16038	see above
KFM12A:3	10.2	20.2	30.4	49h 28 min	120	356	2008-05-15	16025	Yes; KFM12A:4.
HFM01:2	0.1	30	30.1	25h 39 min	200	308	2008-10-07 11:34	16120	No
HFM02:2	0.2	25	25.2	25h 35 min	230	353	2008-10-07 15:05	16119	No
HFM04:2	0.8	20	20.8	24h 1 min	160	231	2008-09-30 14:16	16100	No
HFM13:1	3.6	35	38.6	23h 41 min	150	213	2008-09-30 11:16	16098	No
HFM15:1	1.5	25	26.5	3h 38 min	990	216	2008-10-28 13:10	16142	No
HFM16:2	0.7	32.5	33.2	70h 17 min	130	548	2008-10-17 13:50	16135	No
HFM19:1	3.9	35	38.9	3h 20 min	1,100	220	2008-10-28 12:30	16141	No
HFM21:3	0.1	25	25.1	19h 5 min	125	143	2008-10-22 09:30	16138	No
HFM27:2	0.5	30	30.5	24h 22 min	210	307	2008-10-07 13:44	16121	No
HFM32:3	0.1	12.5	12.6	2h 55 min	490	86	2008-10-14 13:49	16132	No
KFM01A:5	2.0	21	23.0	68h 7 min	100	409	2008-10-03 10:46	16109	Yes; KFM01A:4
KFM01D:2	11.0	9	20.0	67h 13 min	126.5	510	2008-10-03 10:37	16111	Yes; KFM01D:3 and KFM01D:5
KFM01D:4	7.7	10	17.7	66h 33 min	160	639	2008-10-03 11:18	16110	see above
KFM02A:3	12.7	28	40.7	42h 55 min	100	257	2008-10-01 10:40	16101	No
KFM02A:5	10.5	31	41.5	43h 19 min	120	312	2008-10-01 10:16	16102	No
KFM02B:2	12.8	15	27.8	43h 3 min	110	284	2008-10-01 11:03	16103	No
KFM02B:4	10.5	21	31.5	42h 41 min	100	256	2008-10-01 11:25	16104	No
KFM03A:1	26.3	25	51.3	34h 15 min	70	144	2008-10-24 15:05	16147	Yes; KFM03A:2 and KFM03A:3
KFM03A:4	16.9	16.5	33.4	5h 10 min	550	170	2008-11-07 13:15	16140	No
KFM04A:4	5.4	15	20.4	70h 23 min	84	355	2008-10-06 13:17	16114	No HMS-data
KFM06A:3	19.7	10	29.7	68h 59 min	40	166	2008-10-17 10:30	16136	No HMS-data
KFM06A:5	8.5	21	29.5	43h	110	284	2008-10-17 13:40	16134	No HMS-data
KFM06C:3	17.2	19	36.2	50h 54 min	40	122	2008-10-17 11:12	16162	No HMS-data
KFM06C:5	13.9	9	22.9	55h 50 min	120	402	2008-11-14 13:30	16133	No HMS-data
KFM07A:2*	26.1	10	36.1	45h 35 min	40	104	2008-10-29 11:35	16144	No HMS-data
KFM08A:2	18.2	10	28.2	11h 35 min	300	209	2008-10-22 12:30	16143	No
KFM08A:6	6.4	15	21.4	12h 10 min	110	80	2008-10-28 14:15	16139	Yes; KFM08A:7
KFM08D:2	22.2	10	32.2	92h 6 min	40	221	2008-11-07 10:35	16157	Yes; KFM08D:1 and KFM08D:4
KFM08D:4	17.5	20	37.5	30h 56 min	120	223	2008-11-11 11:55	16146	Yes; KFM08D:2 and KFM08D:3
KFM10A:2	11.0	10	21.0	22h 46 min	120	164	2008-09-30 12:21	16099	Yes; KFM10A:1
KFM11A:2	18.4	20	38.4	68h 12 min	55	225	2008-10-06 11:16	16112	Yes; KFM11A:5 and KFM11A:3
KFM11A:4	11.5	10	21.5	69h 22 min	50	208	2008-10-06 10:02	16113	see above
KFM12A:3	10.2	20.2	30.4	51h 45 min	115	357	2008-10-07 09:50	16118	No HMS-data

* The borehole was pumped using an air-lift pump.

A2.2 Pressure registrations during pumping and sampling, HMS system

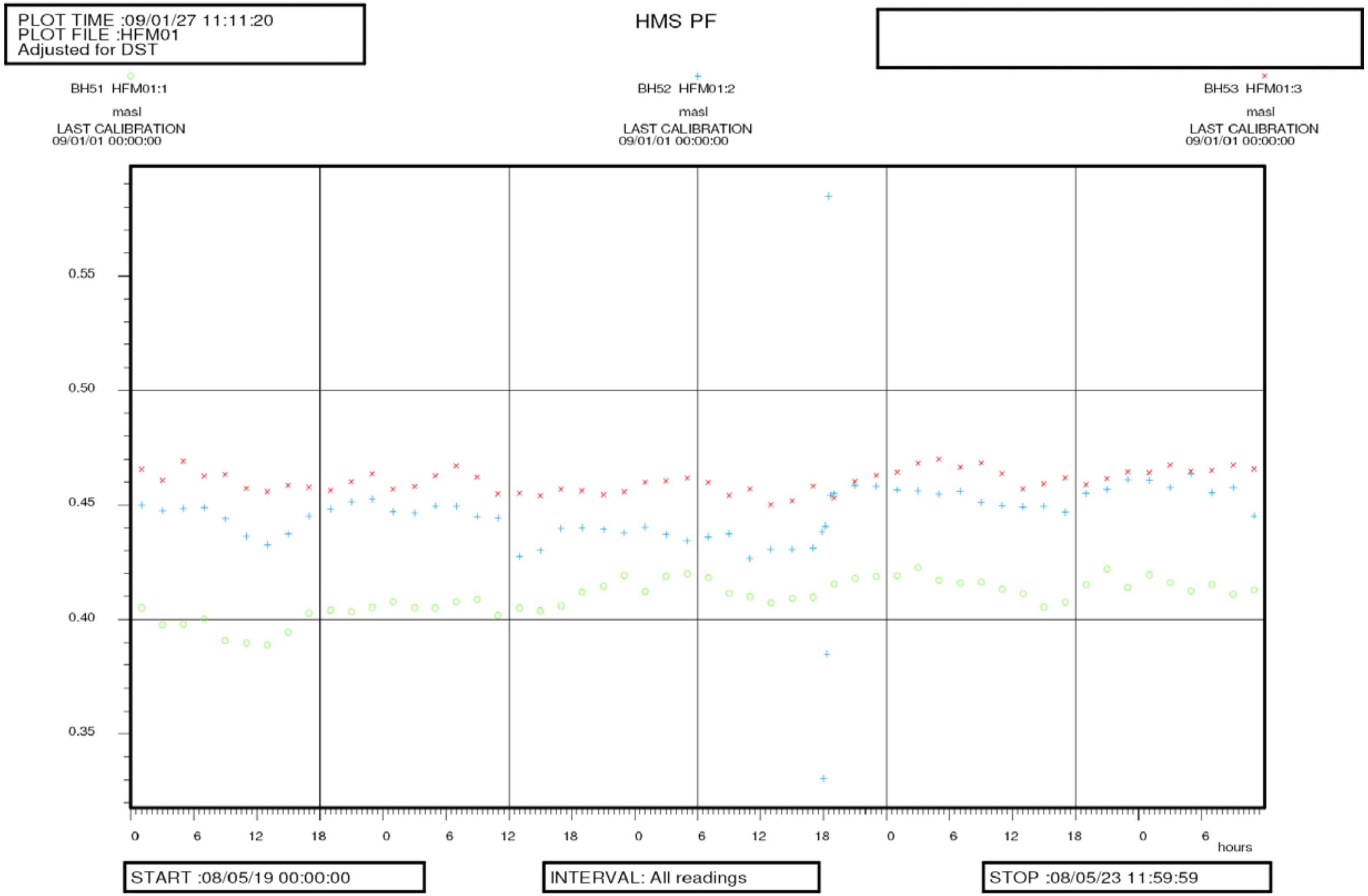


Figure A2-1. *Pumping and minor drawdown in HFM01:2 in May 2008. None of the other sections were affected by the pumping.*

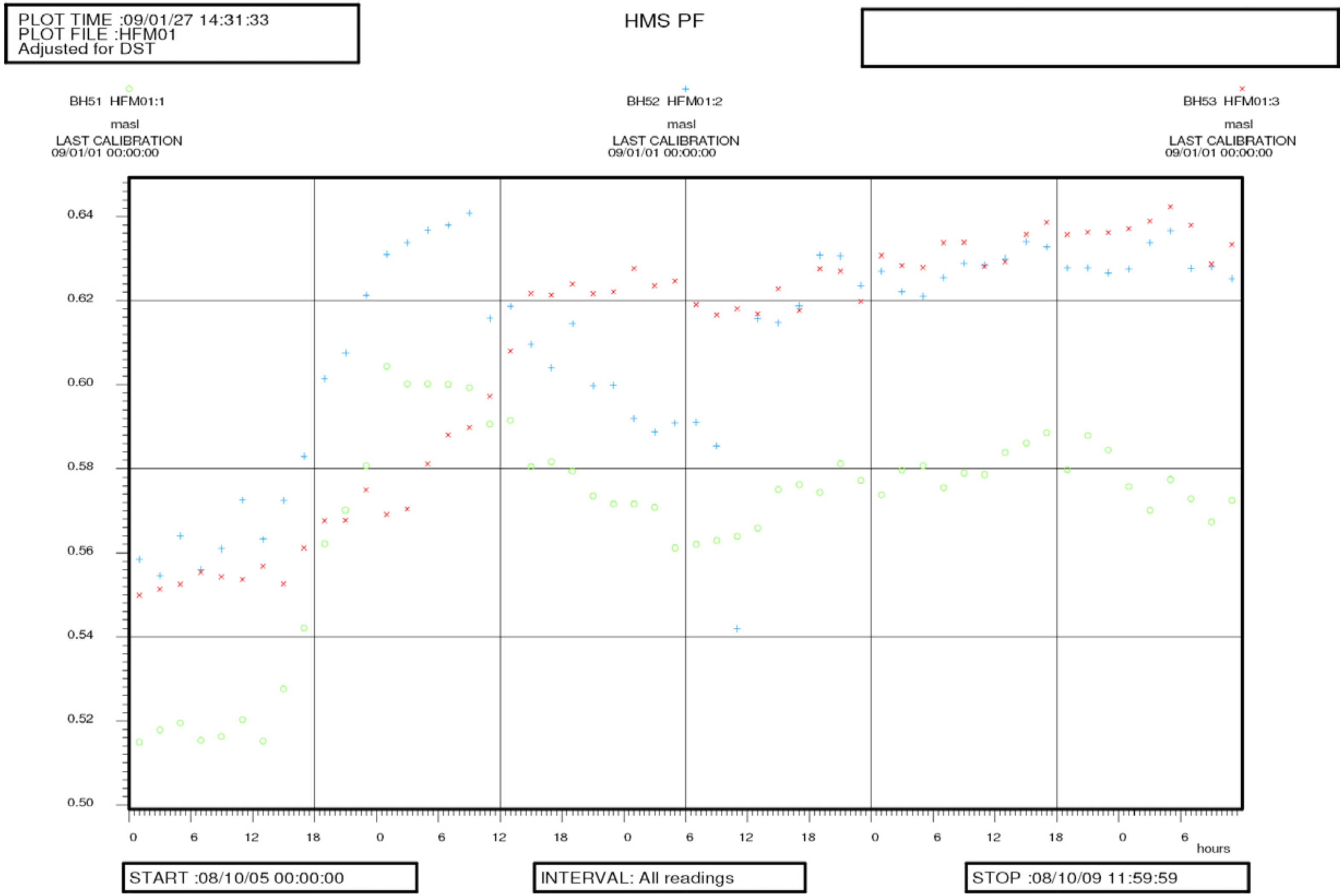


Figure A2-2. *Pumping and drawdown in HFM01:2 in October 2008. None of the other sections were significantly affected by the pumping.*

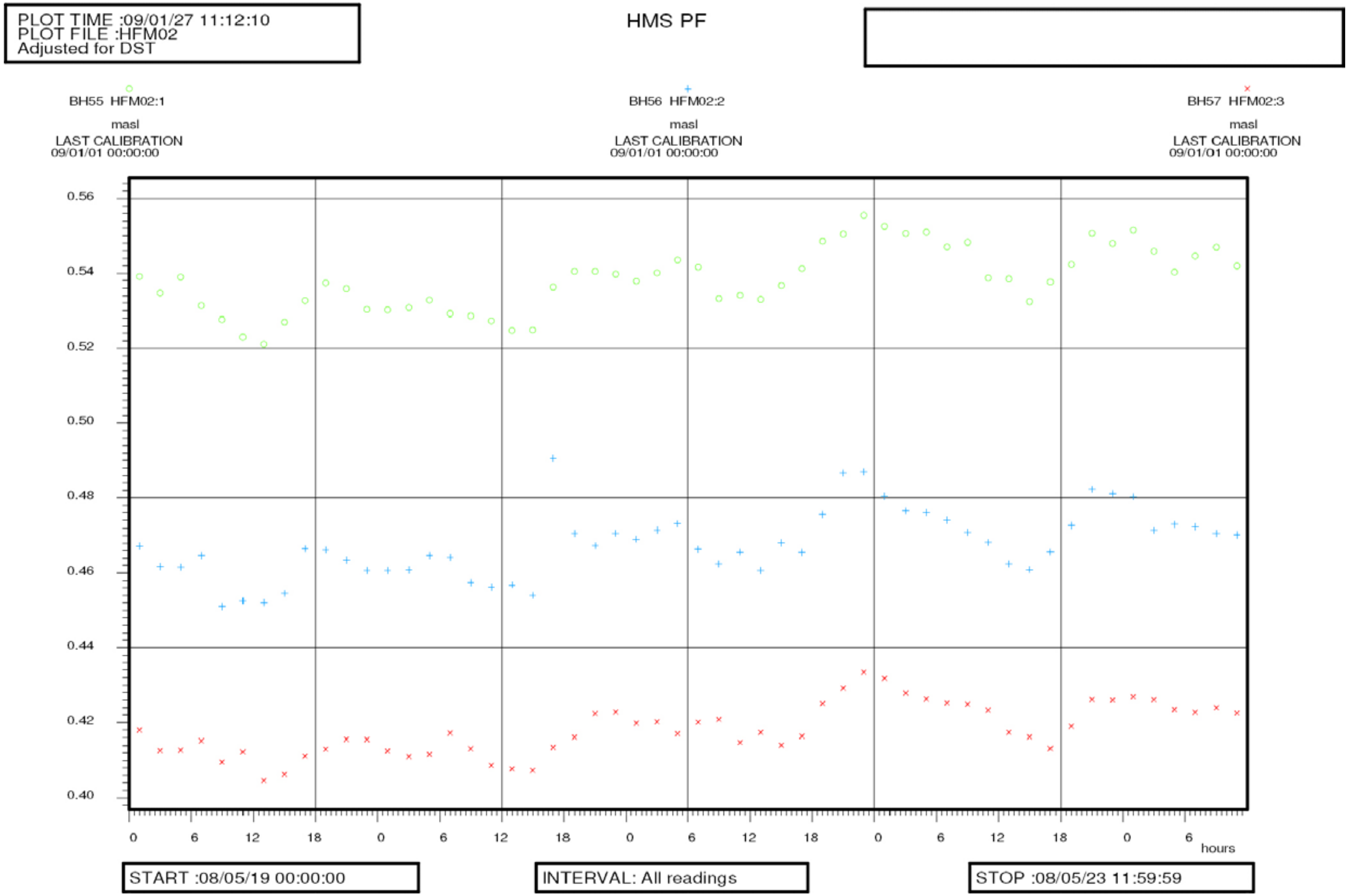


Figure A2-3. *Pumping in HFM02:2 in May 2008. No significant drawdown was observed in any of the borehole sections.*

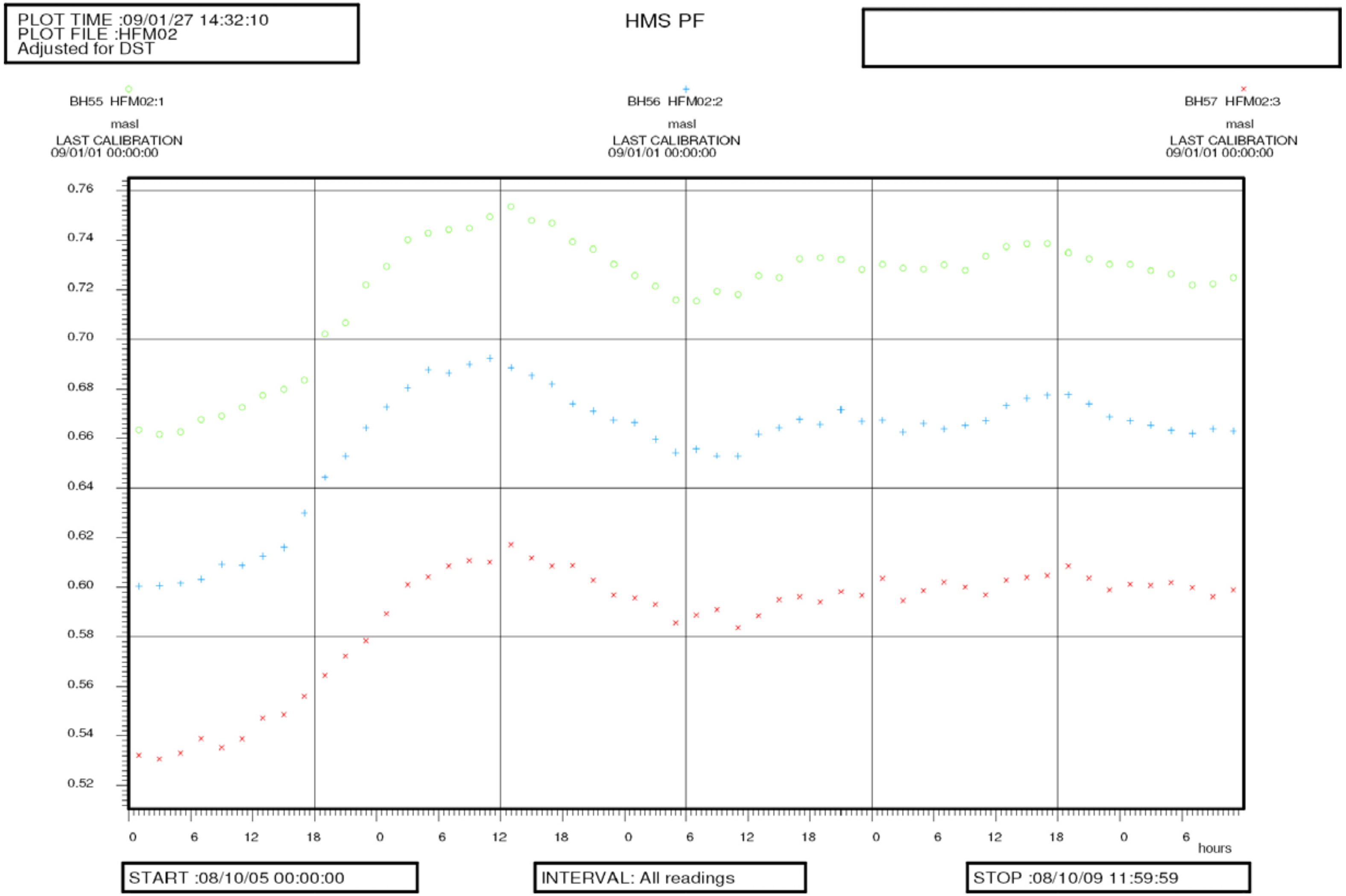


Figure A2-4. *Pumping in HFM02:2 in October 2008. No significant drawdown was observed in any of the borehole sections.*

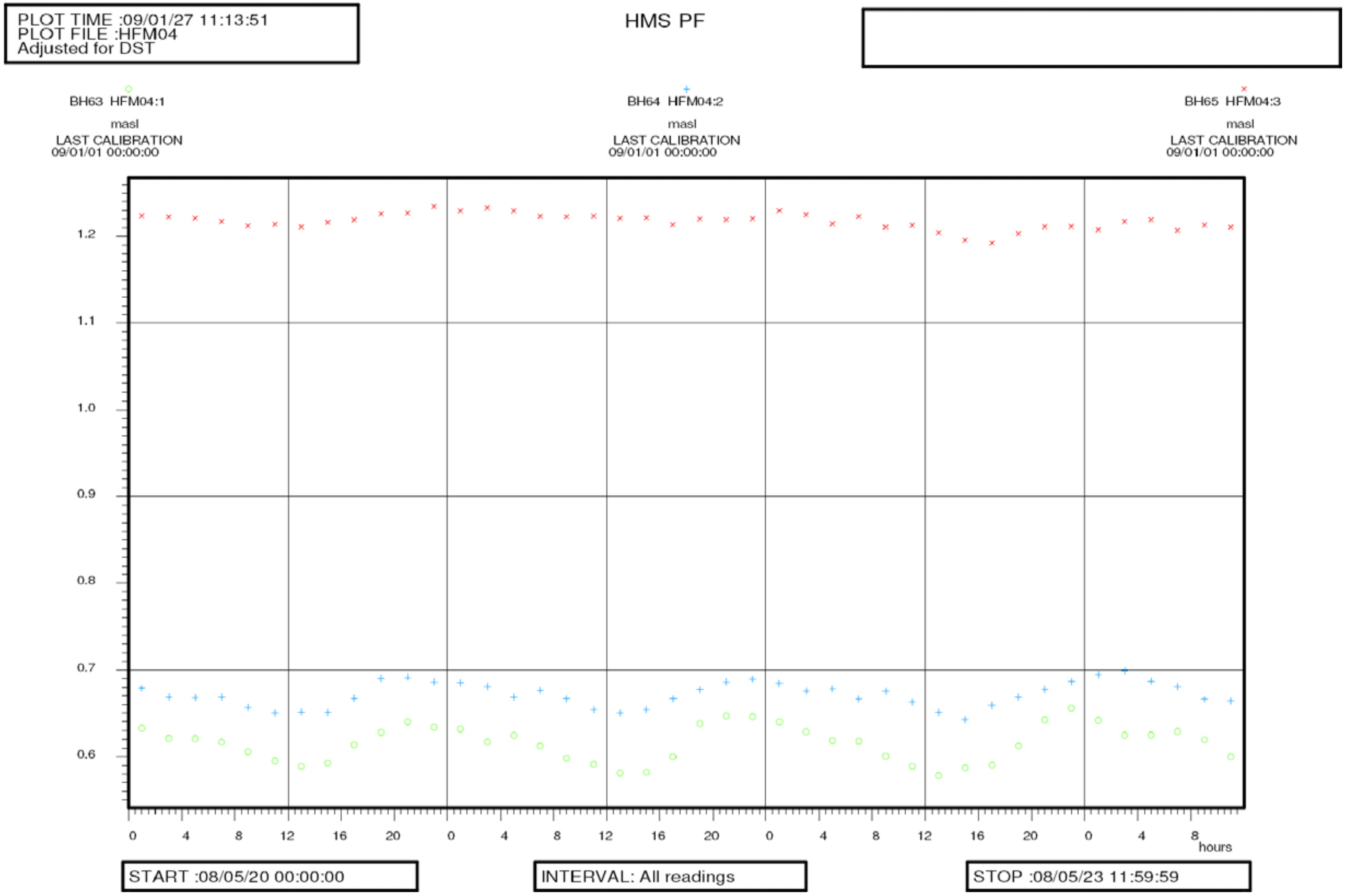


Figure A2-5. *Pumping in HFM04:2 in May 2008. No significant drawdown was observed in any of the borehole sections.*

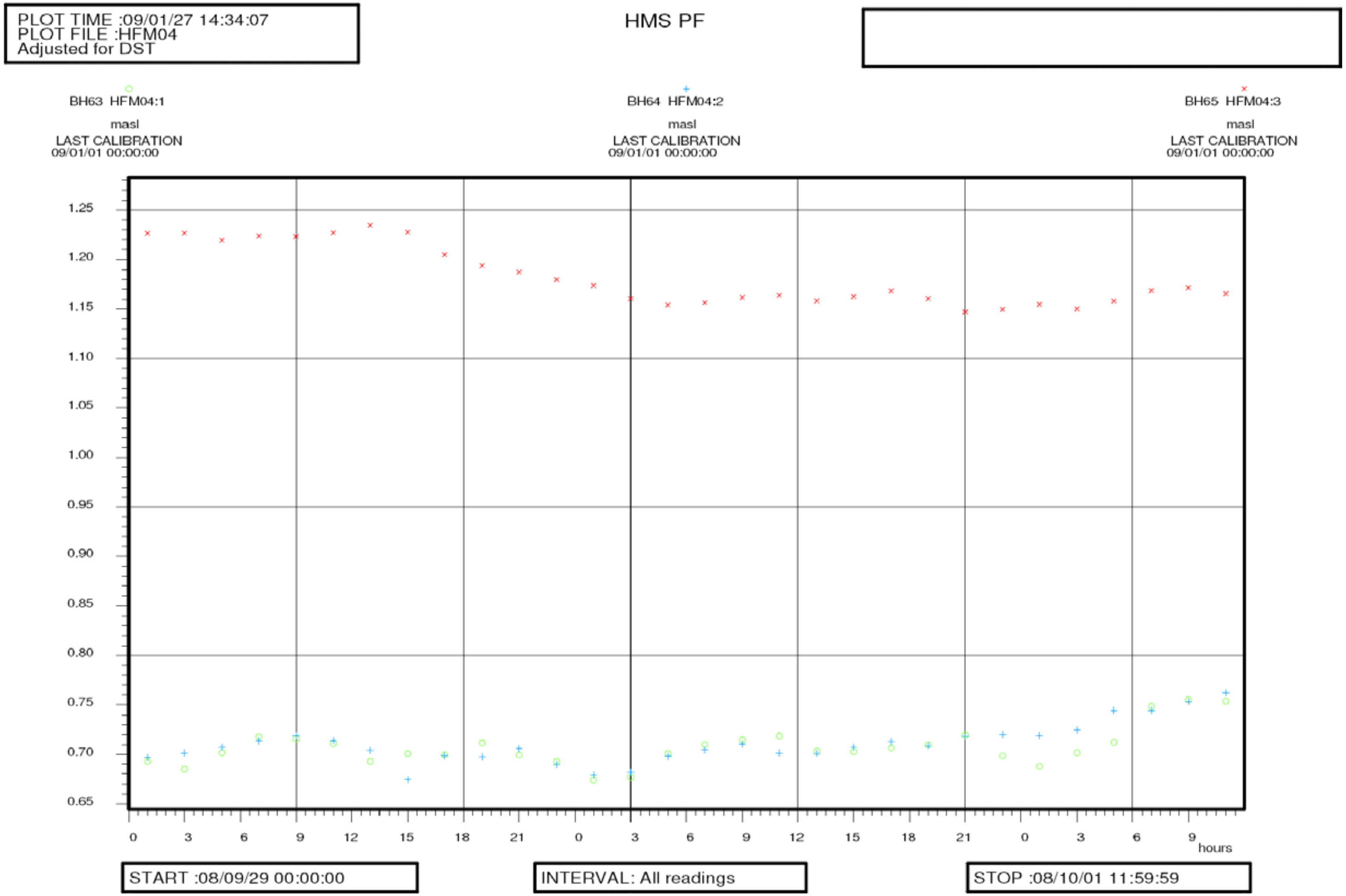


Figure A2-6. *Pumping in HFM04:2 in September–October 2008. No significant drawdown was observed in any of the borehole sections.*

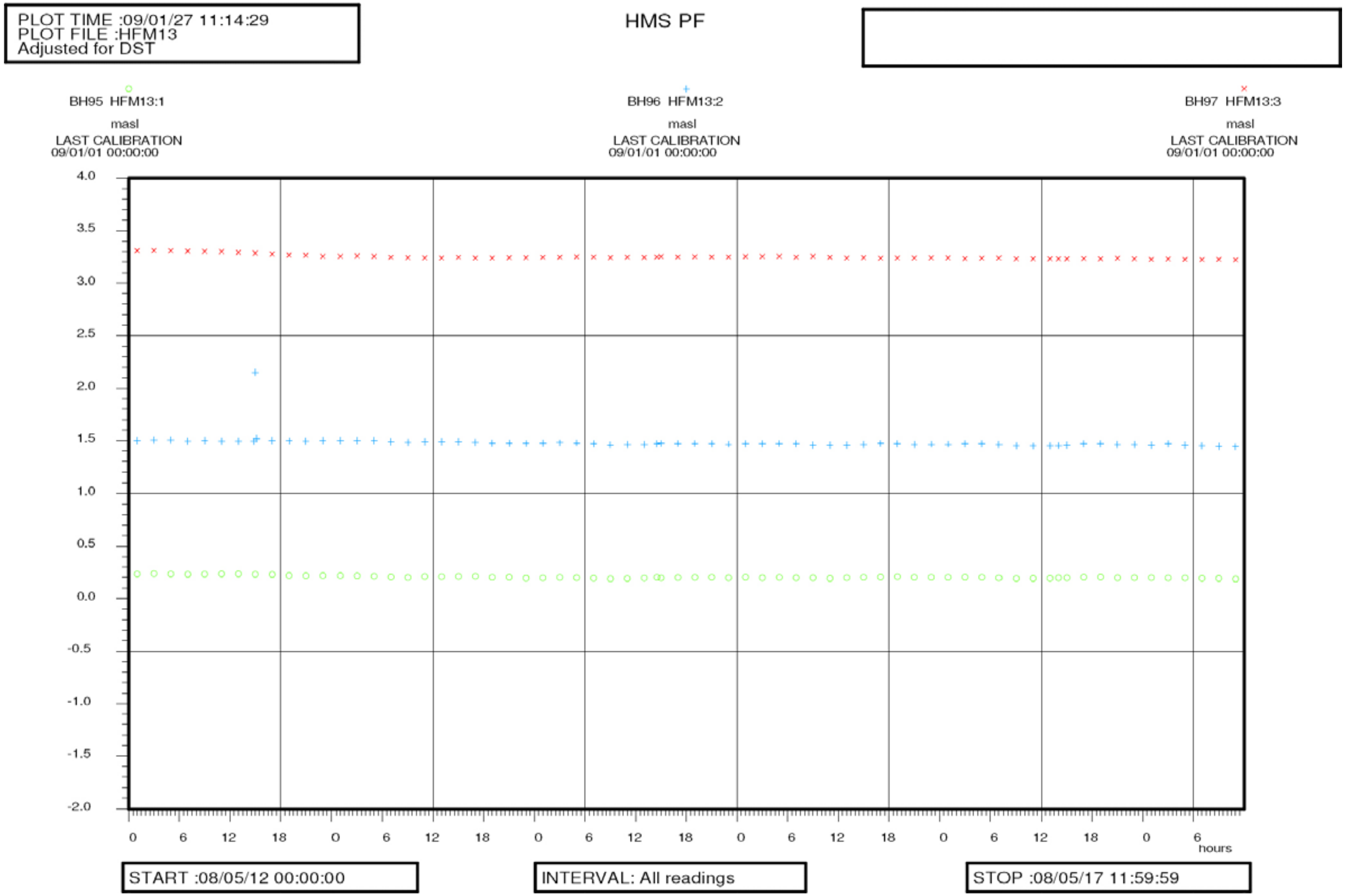


Figure A2-7. *Pumping in HFM13:1 in May 2008. No significant drawdown was observed in any of the borehole sections.*

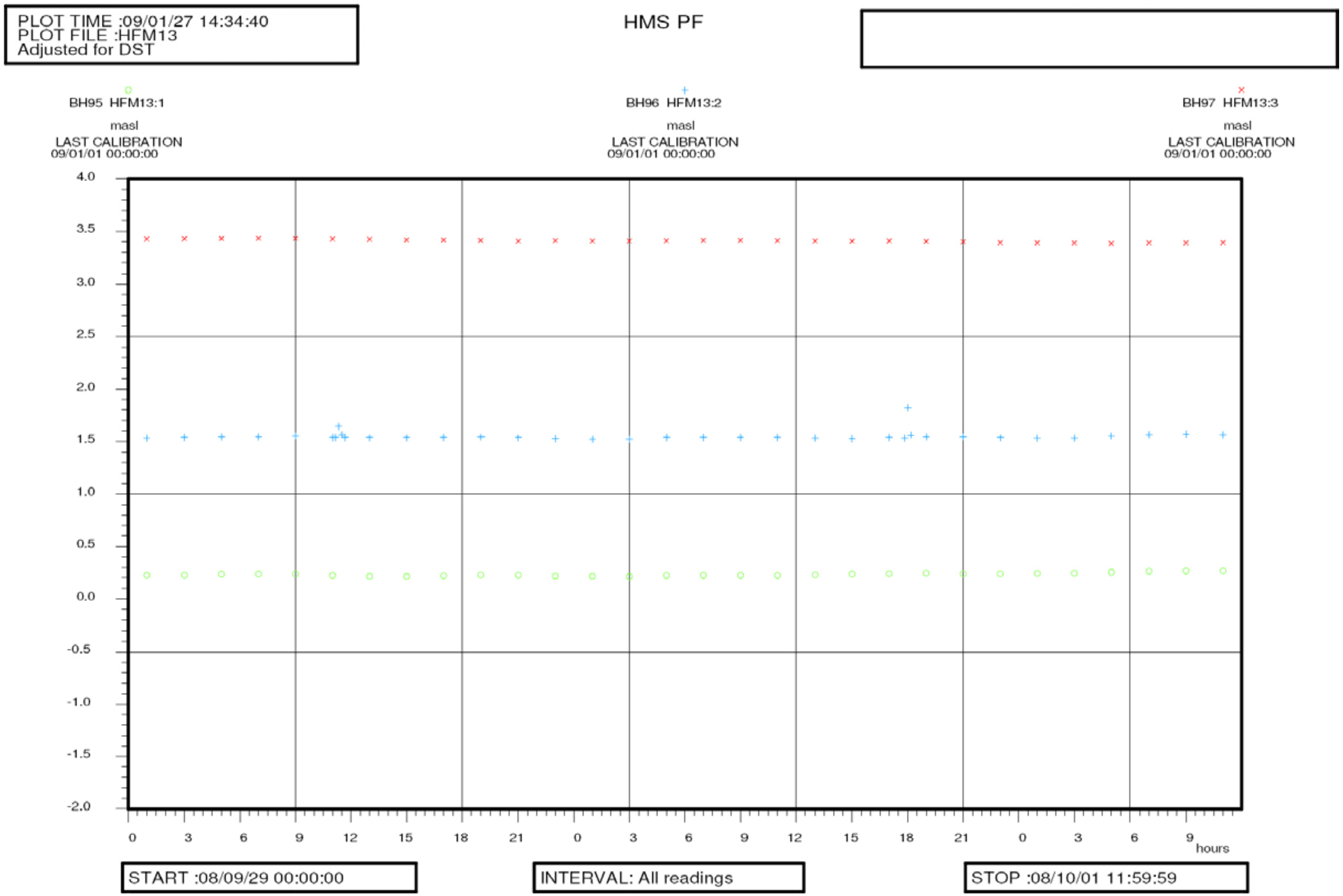


Figure A2-8. *Pumping in HFM13:1 in September–October 2007. No significant drawdown was observed in any of the borehole sections.*

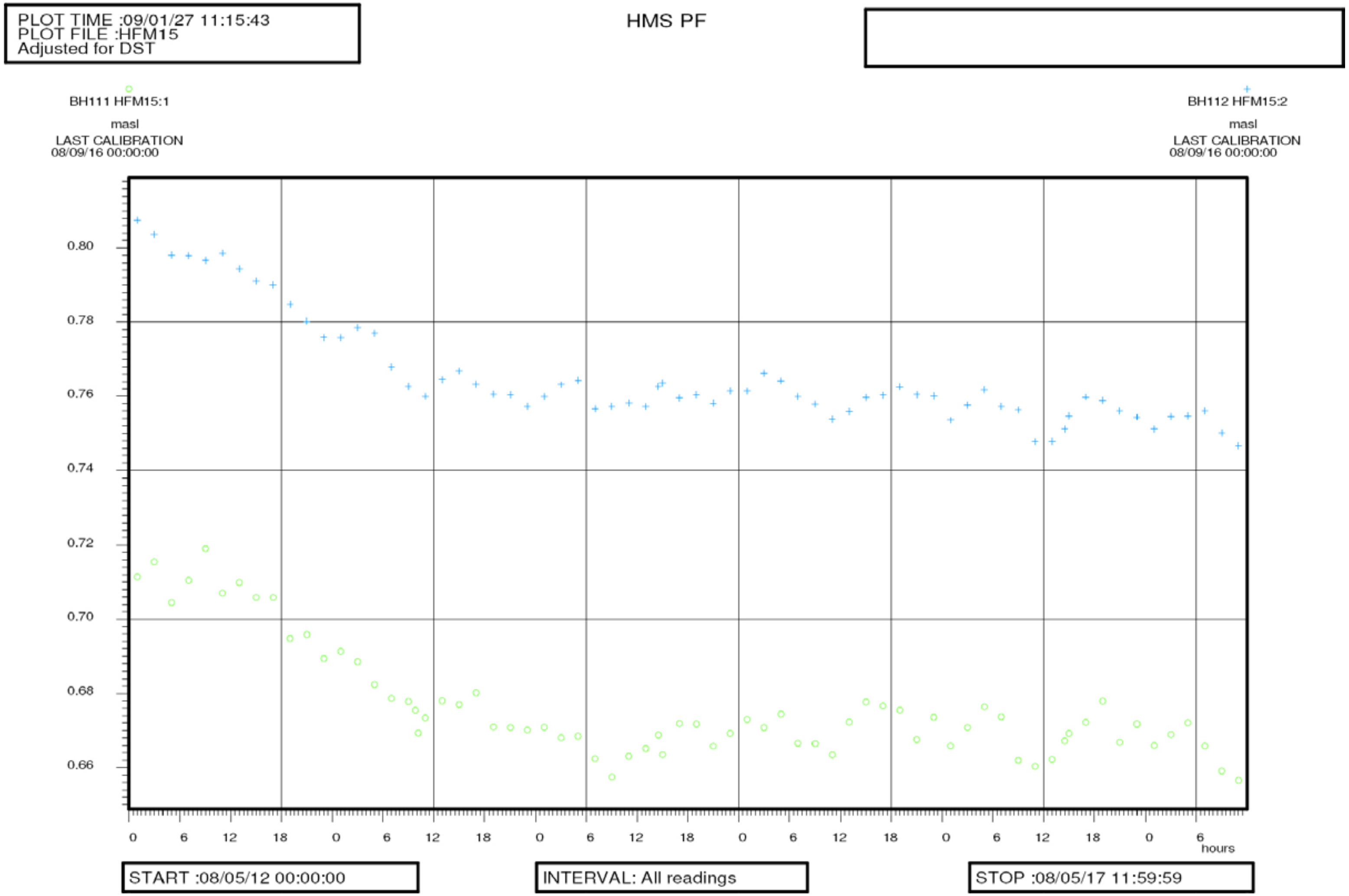


Figure A2-9. *Pumping in HFM15:1 during May 2008. No significant drawdown was observed in any of the borehole sections.*

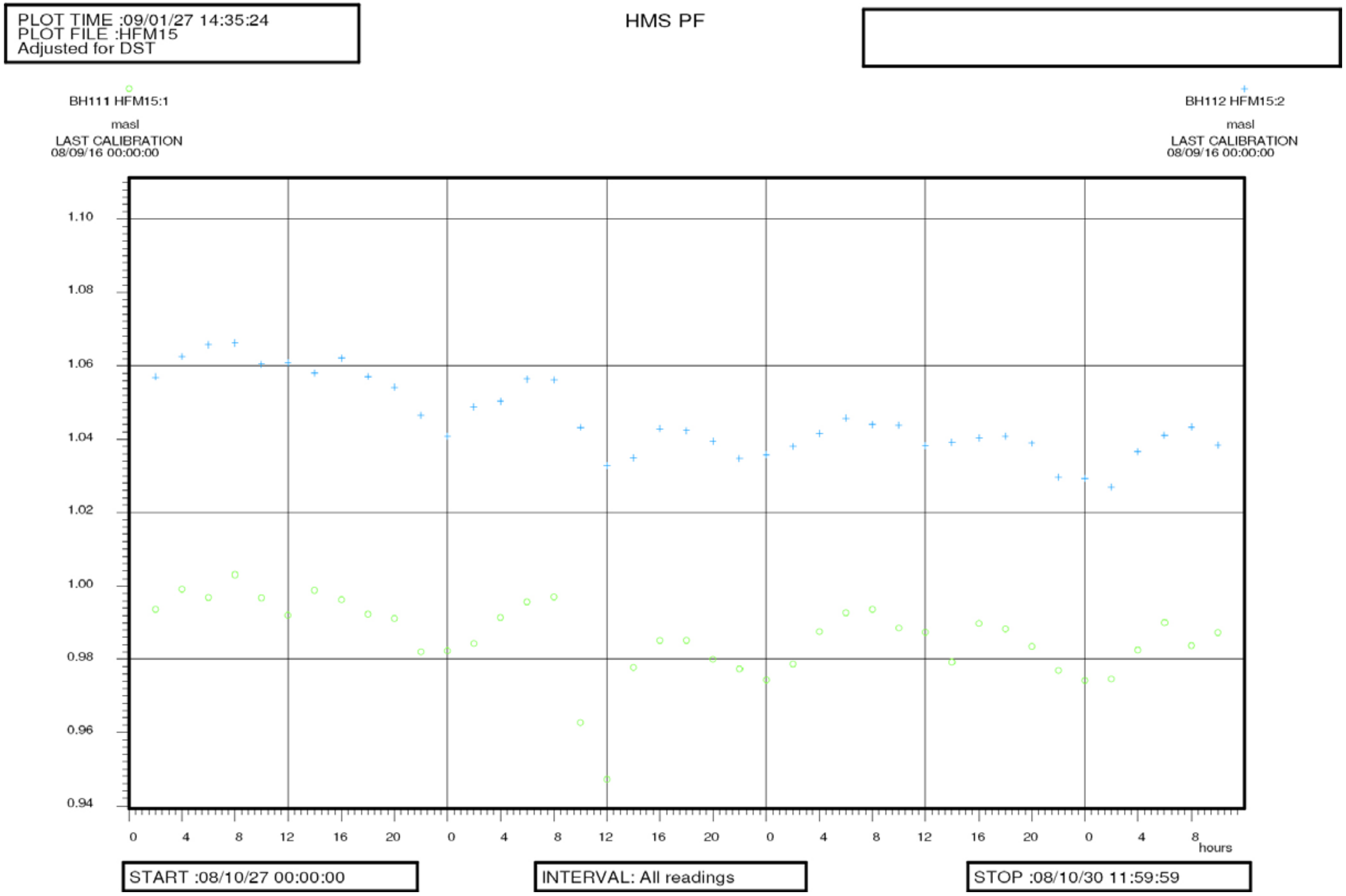


Figure A2-10. *Pumping in HFM15:1 in October 2008. No significant drawdown was observed in any of the borehole sections.*

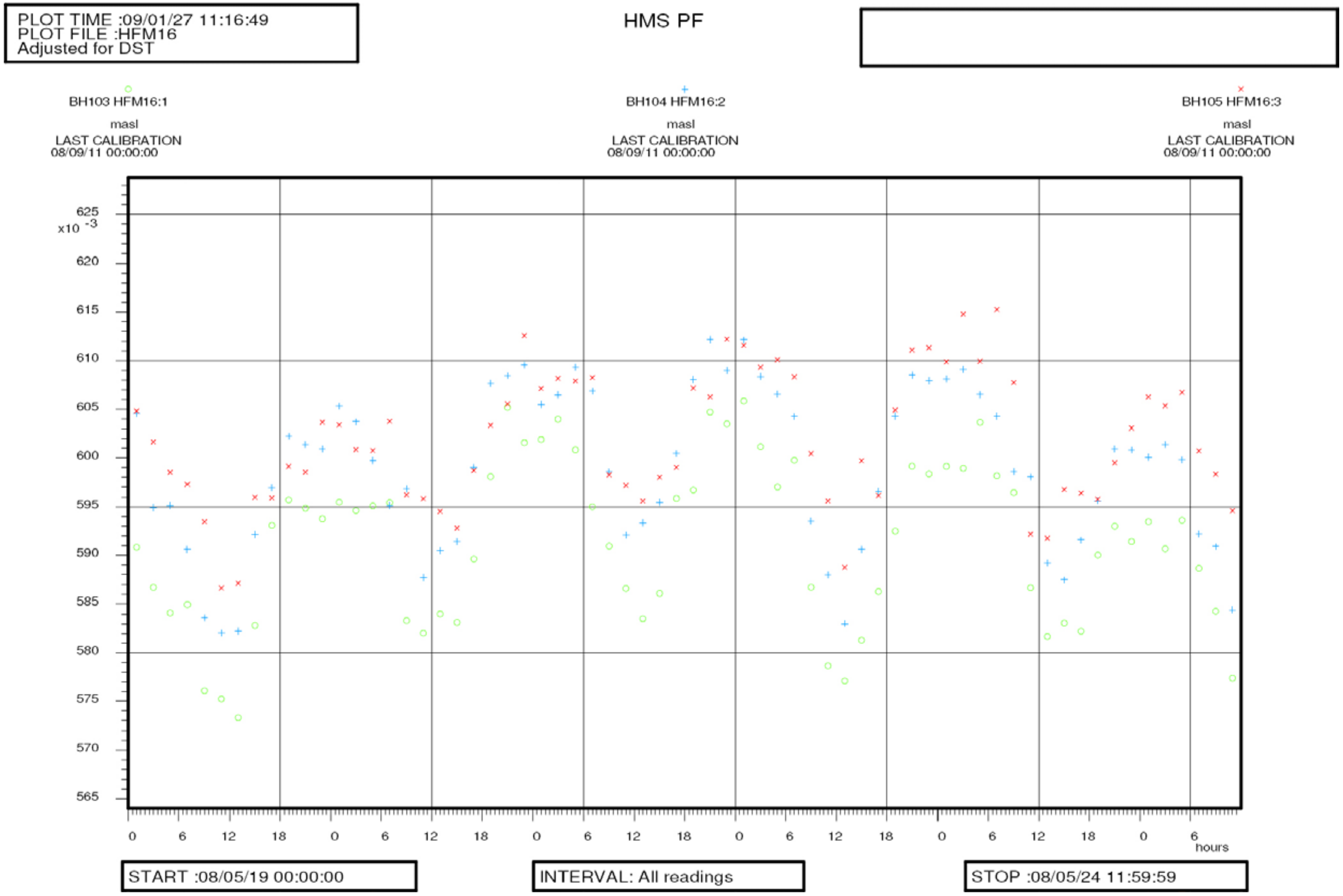


Figure A2-11. *Pumping in HFM16:2 in May 2008. No significant drawdown was observed in any of the borehole sections.*

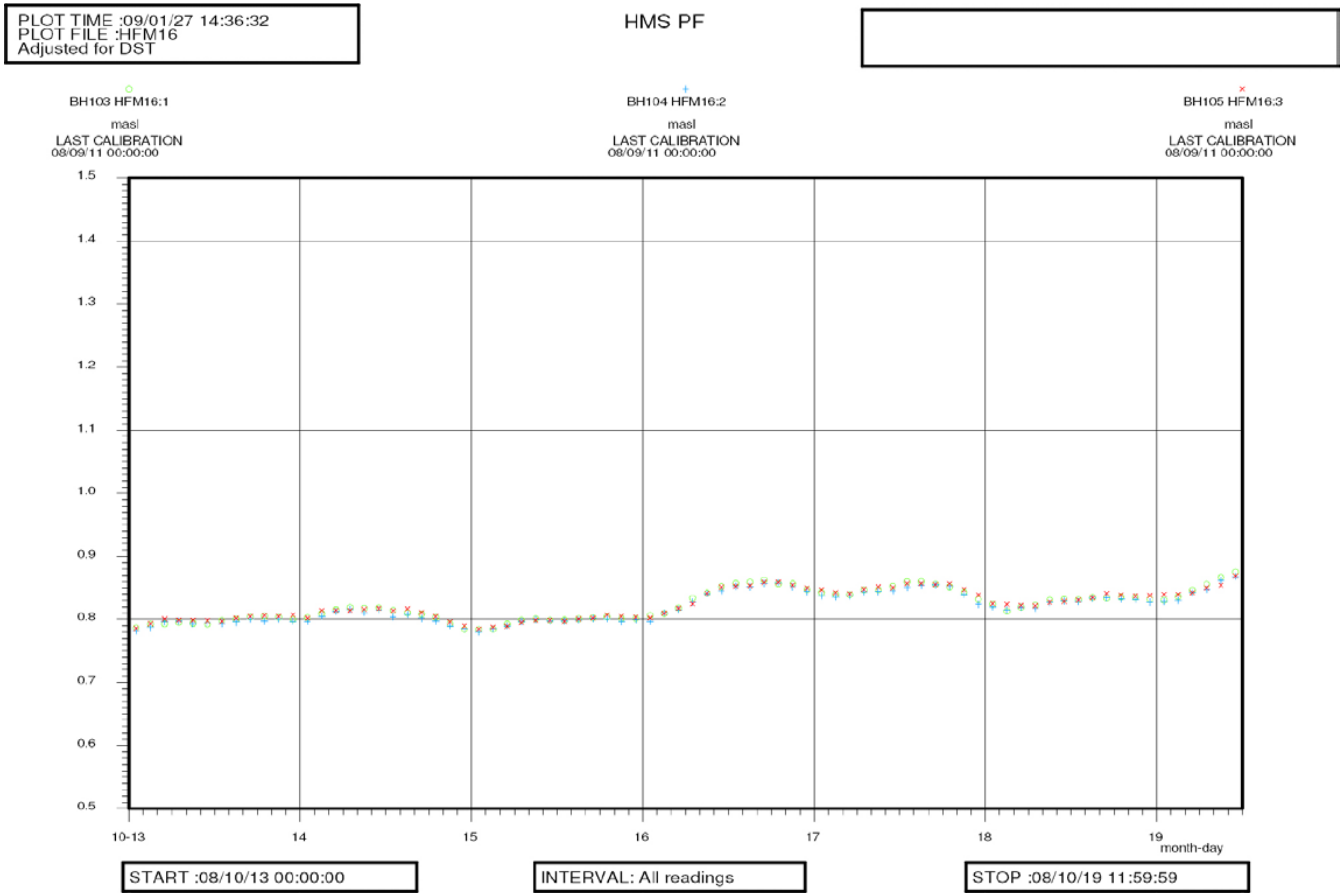


Figure A2-12. *Pumping in HFM16:2 in October 2008. No significant drawdown was observed in any of the borehole sections.*

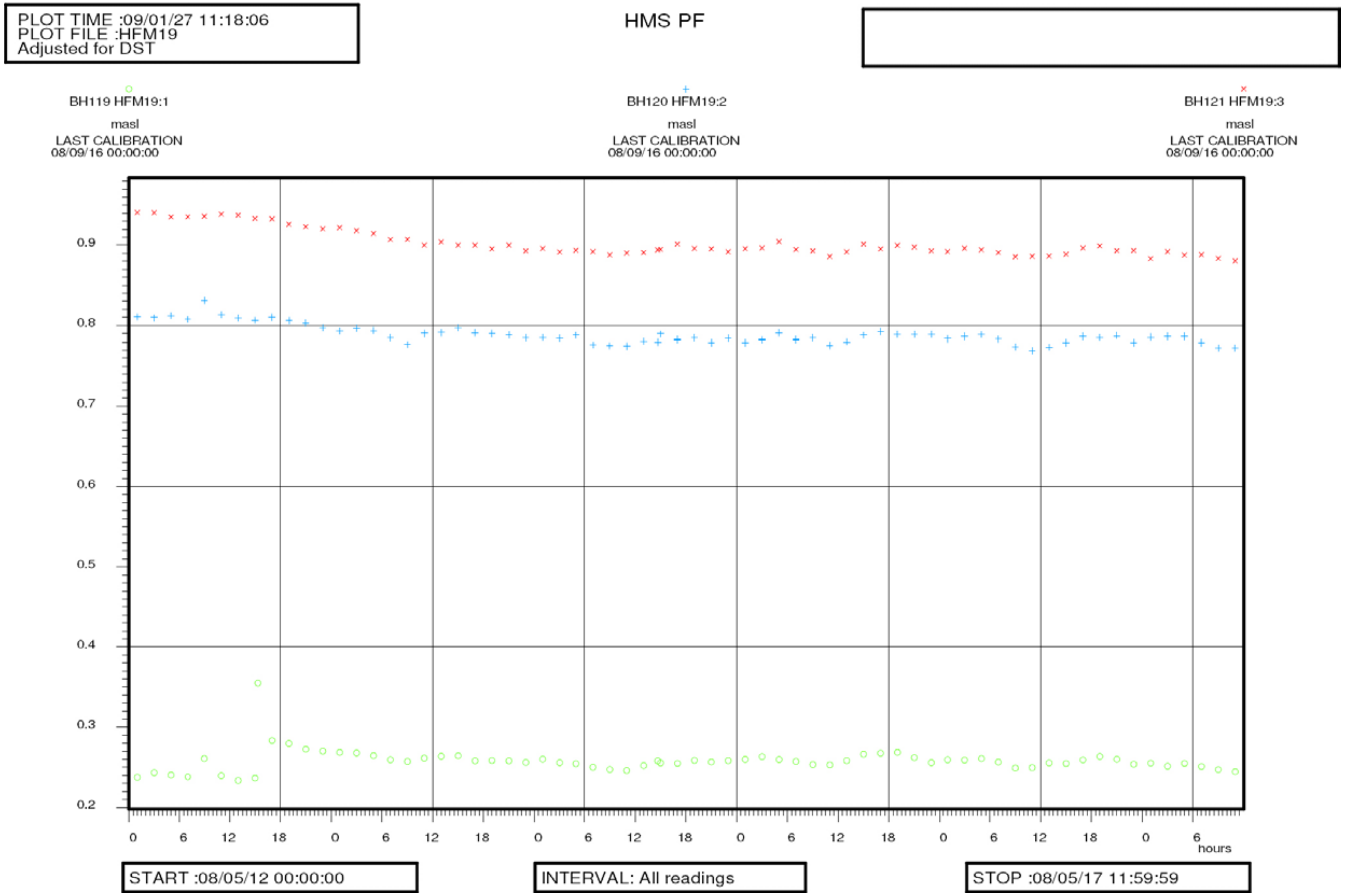


***Figure A2-13.** Pumping in HFM19:1 in May 2008. No significant drawdown was observed in any of the borehole sections.*

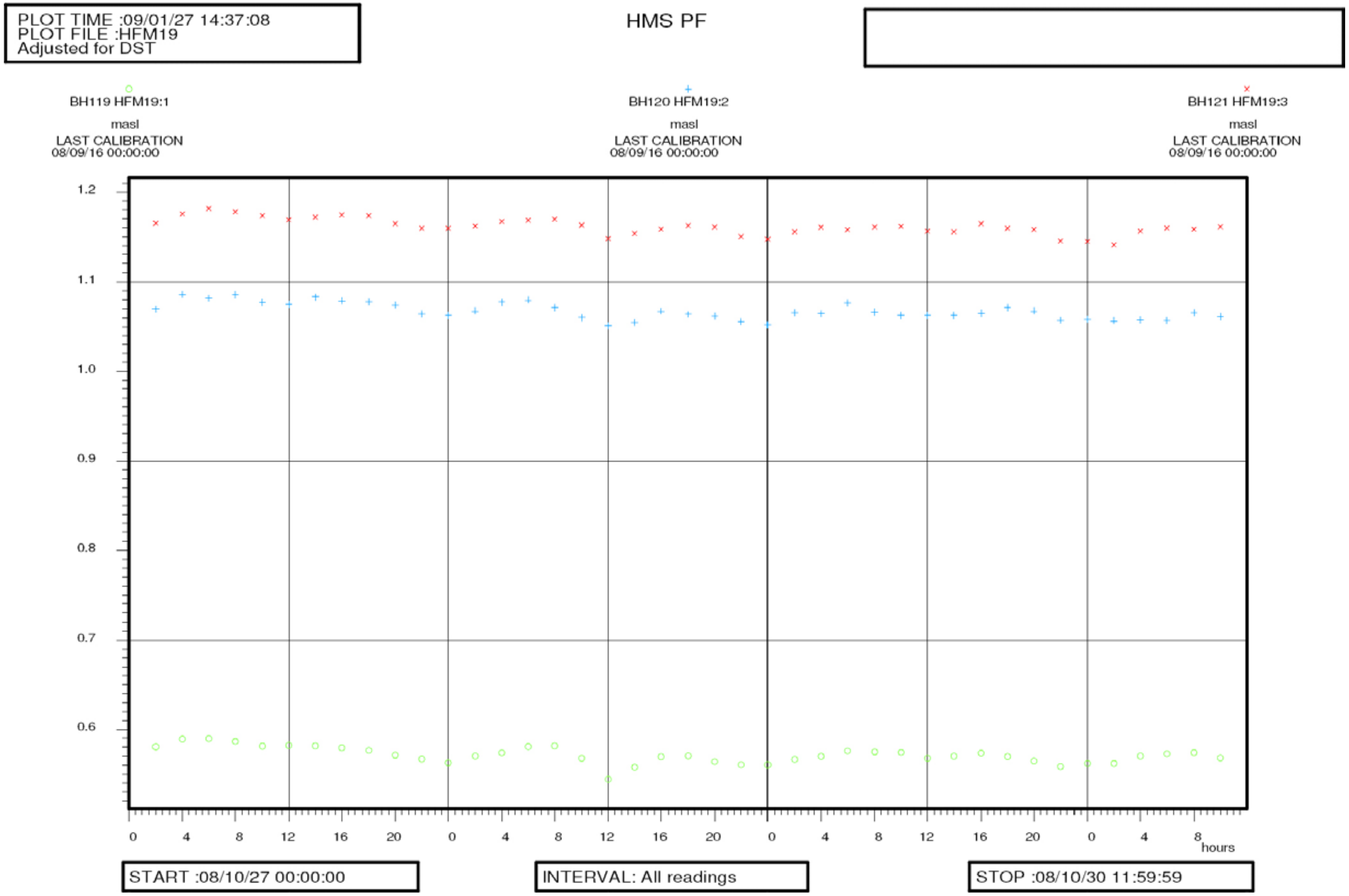


Figure A2-14. *Pumping in HFM19:1 in October 2008. No significant drawdown was observed in any of the borehole sections.*

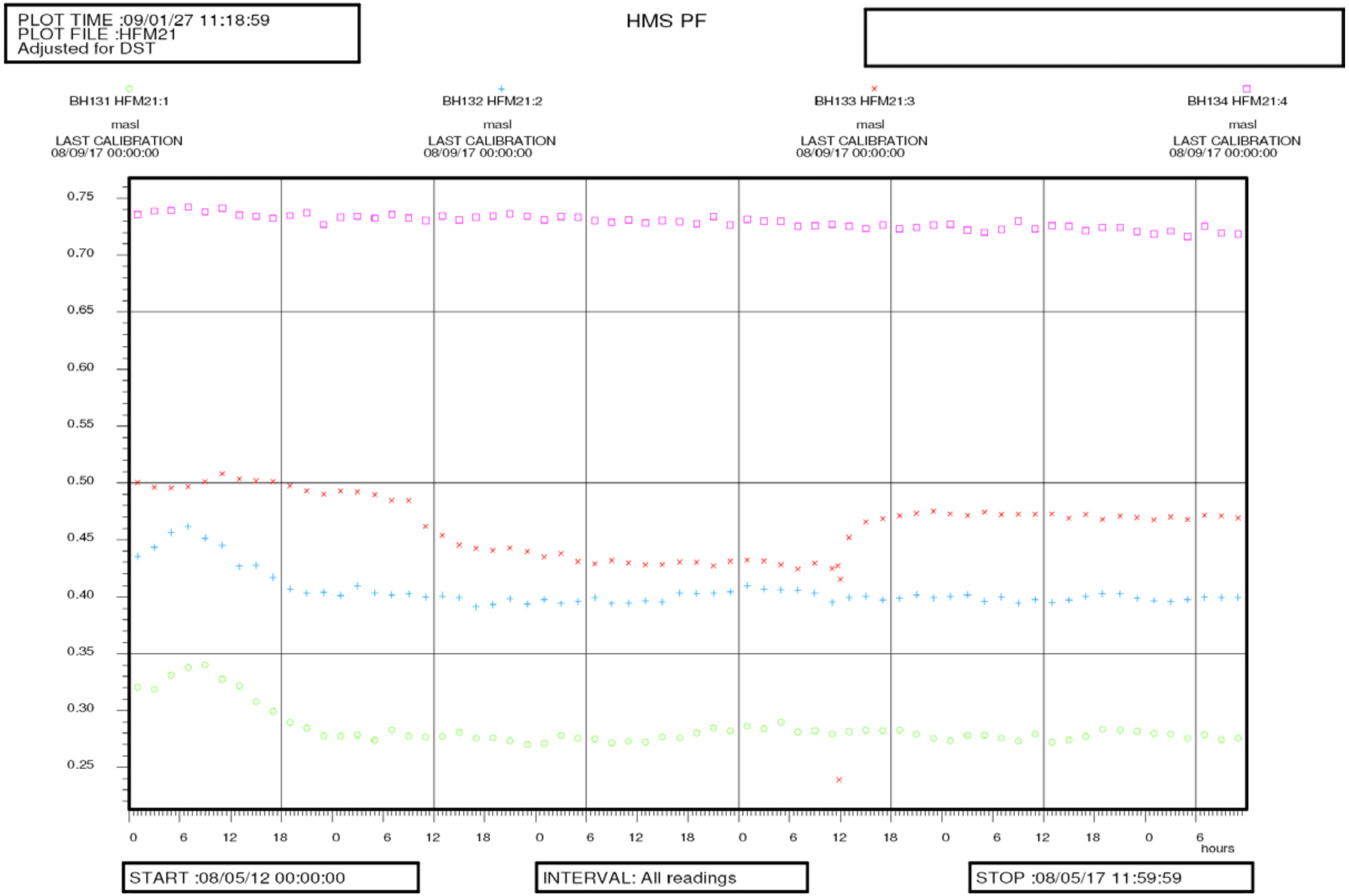


Figure A2-15. *Pumping and drawdown in HFM21:3 in May 2008. None of the other sections were affected by the pumping.*

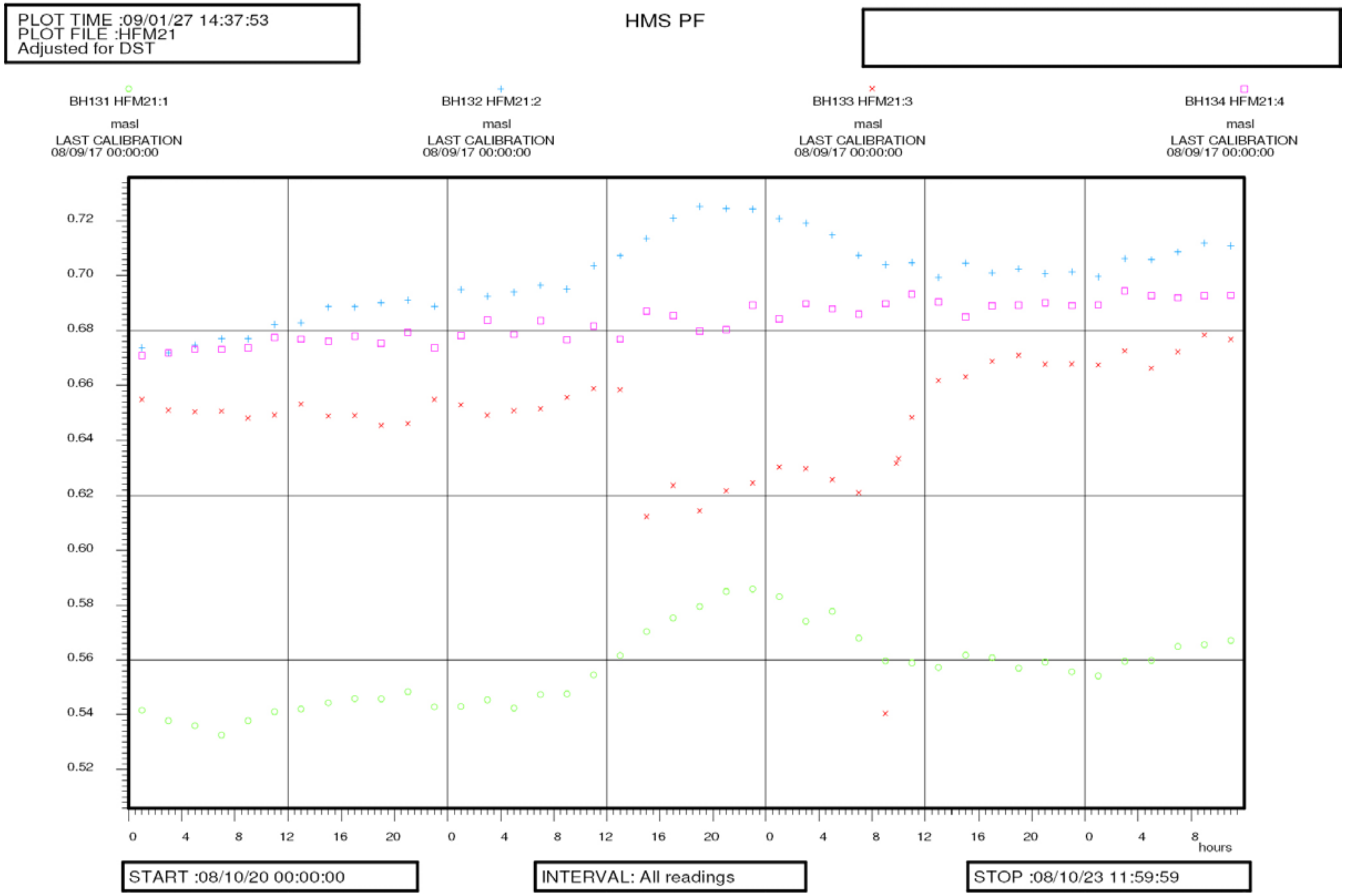


Figure A2-16. *Pumping and drawdown in HFM21:3 in October 2008. None of the other sections were affected by the pumping.*

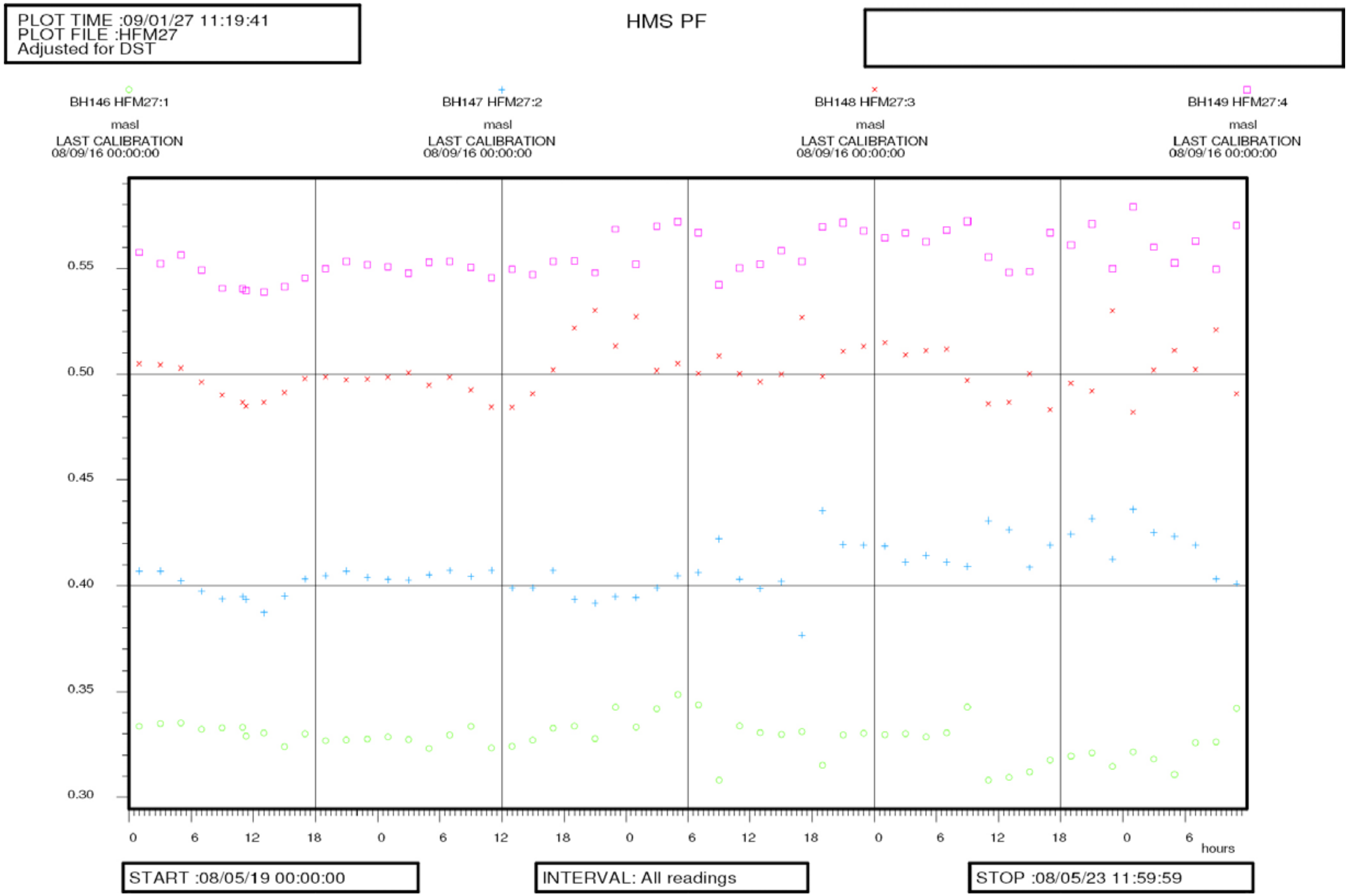


Figure A2-17. *Pumping in HFM27:2 in May 2008. No significant drawdown was observed in any of the borehole sections.*

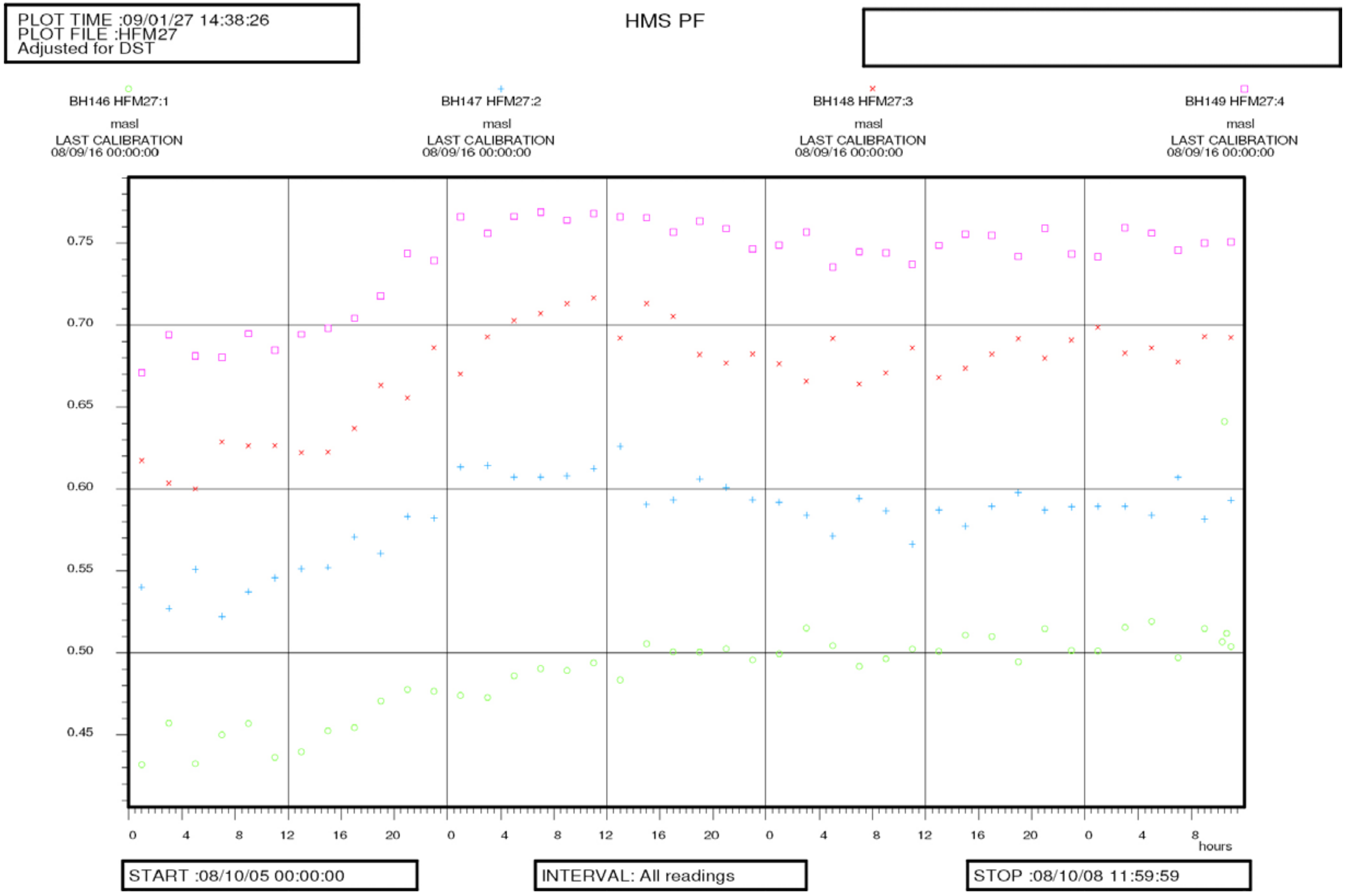


Figure A2-18. *Pumping in HFM27:2 in October 2008. No significant drawdown was observed in any of the borehole sections.*

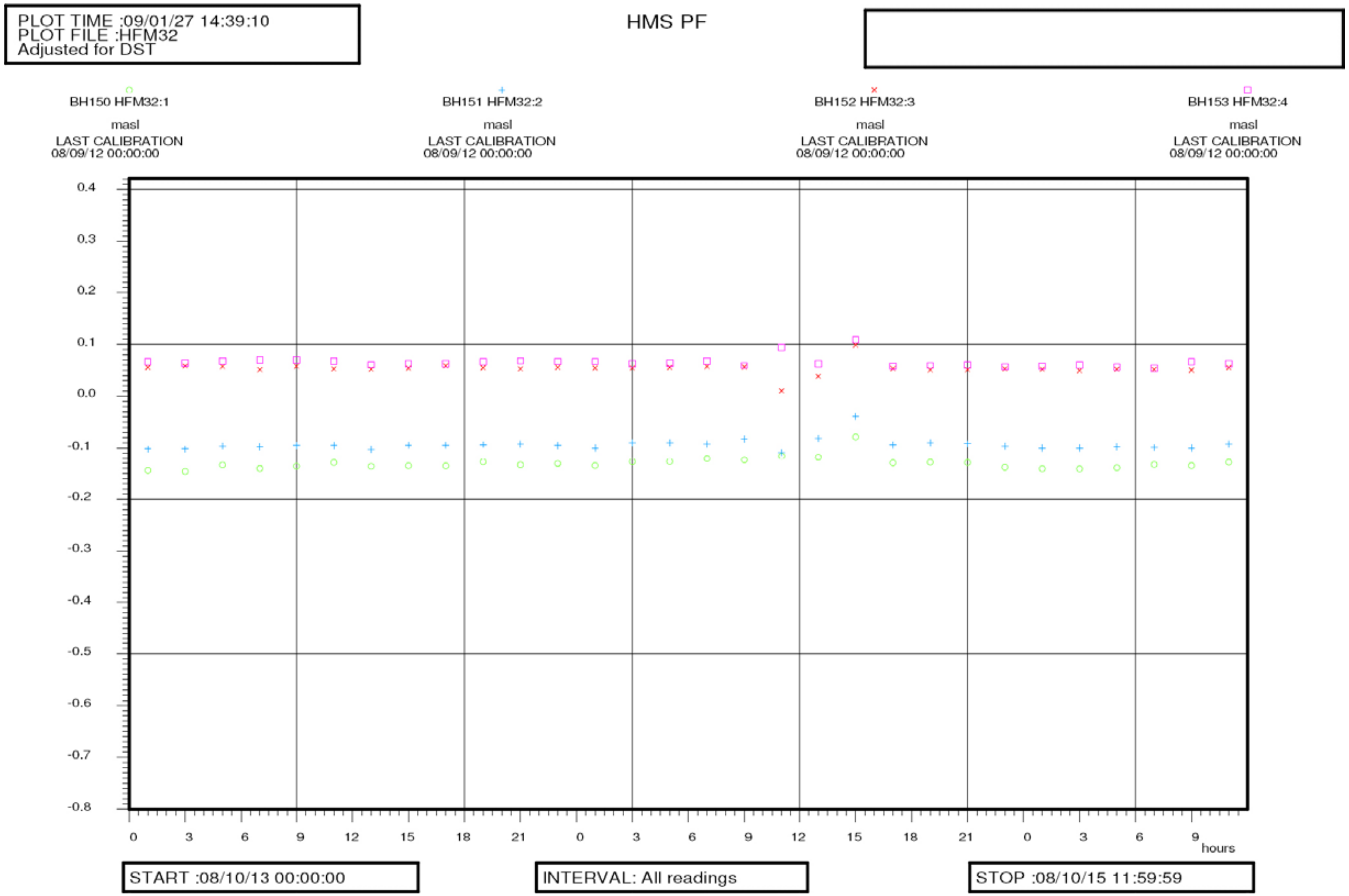


Figure A2-19. *Pumping in HFM32:3 in October 2008. No significant drawdown was observed in any of the borehole sections. The pressure changes seen at pump stop is probably from the pipes affecting the sections.*

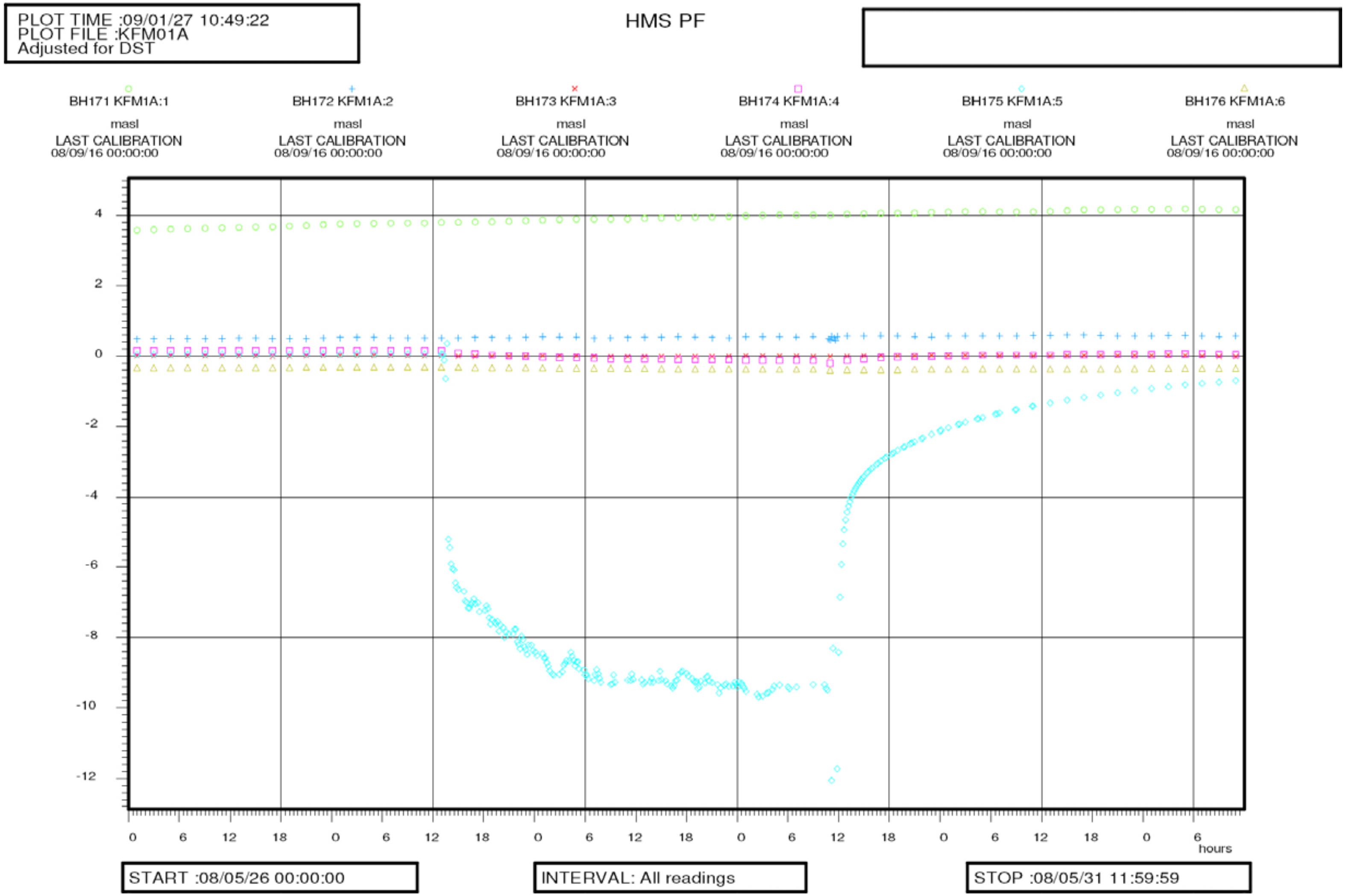


Figure A2-20. *Pumping and drawdown in KFM01A:5 in May 2008. A small response was observed in KFM01A:4.*

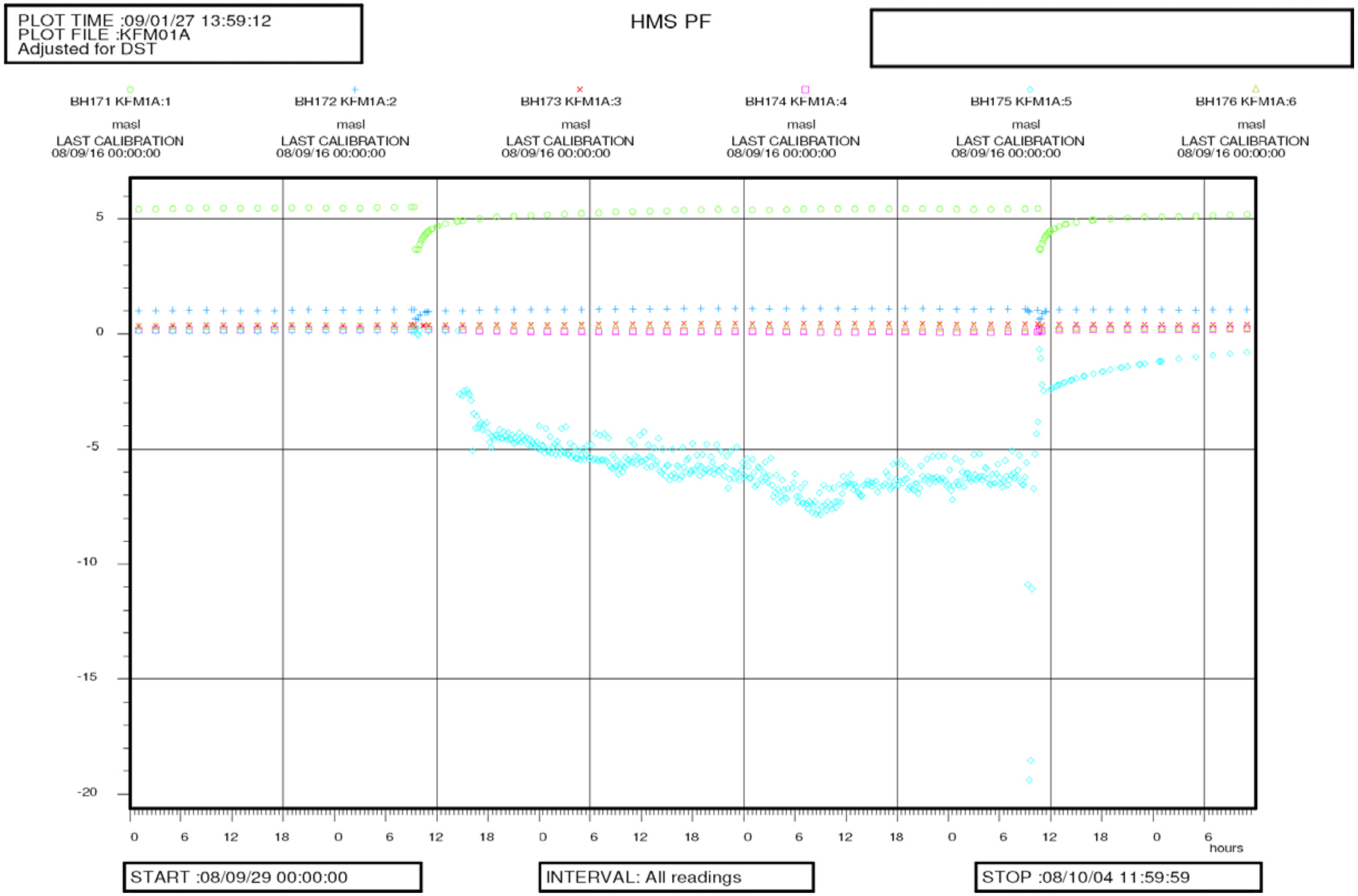


Figure A2-21. *Pumping and drawdown in KFM01A:5 during September–October 2008. A small response was observed in KFM01A:4 but none of the other borehole sections were affected by the pumping.*

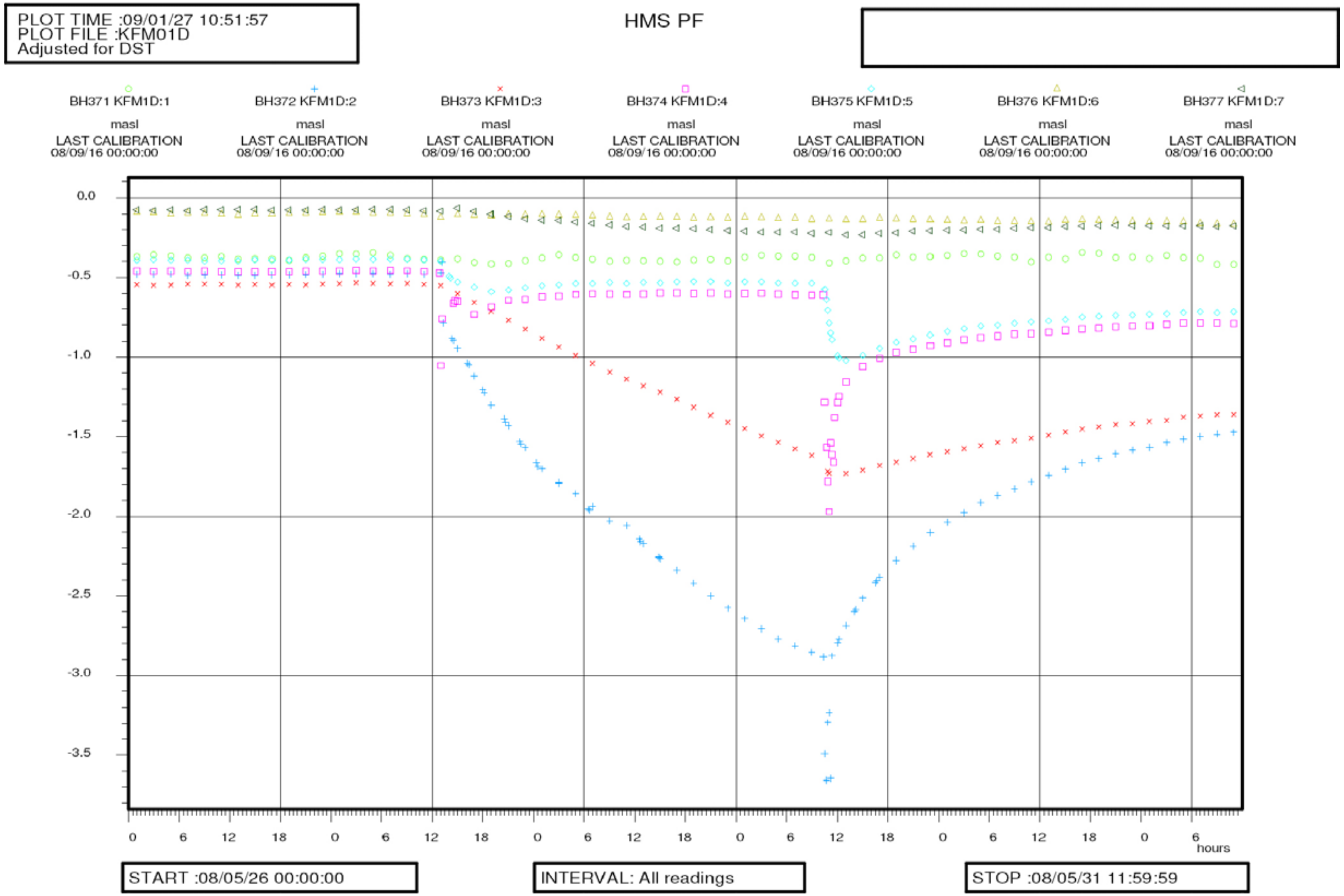


Figure A2-22. *Pumping and drawdown started simultaneously in KFM01D:4 and KFM01D:2 in May 2008. Clear responses were observed in KFM01D:3 and -:5. Some response was seen in KFM01D:7 as well.*

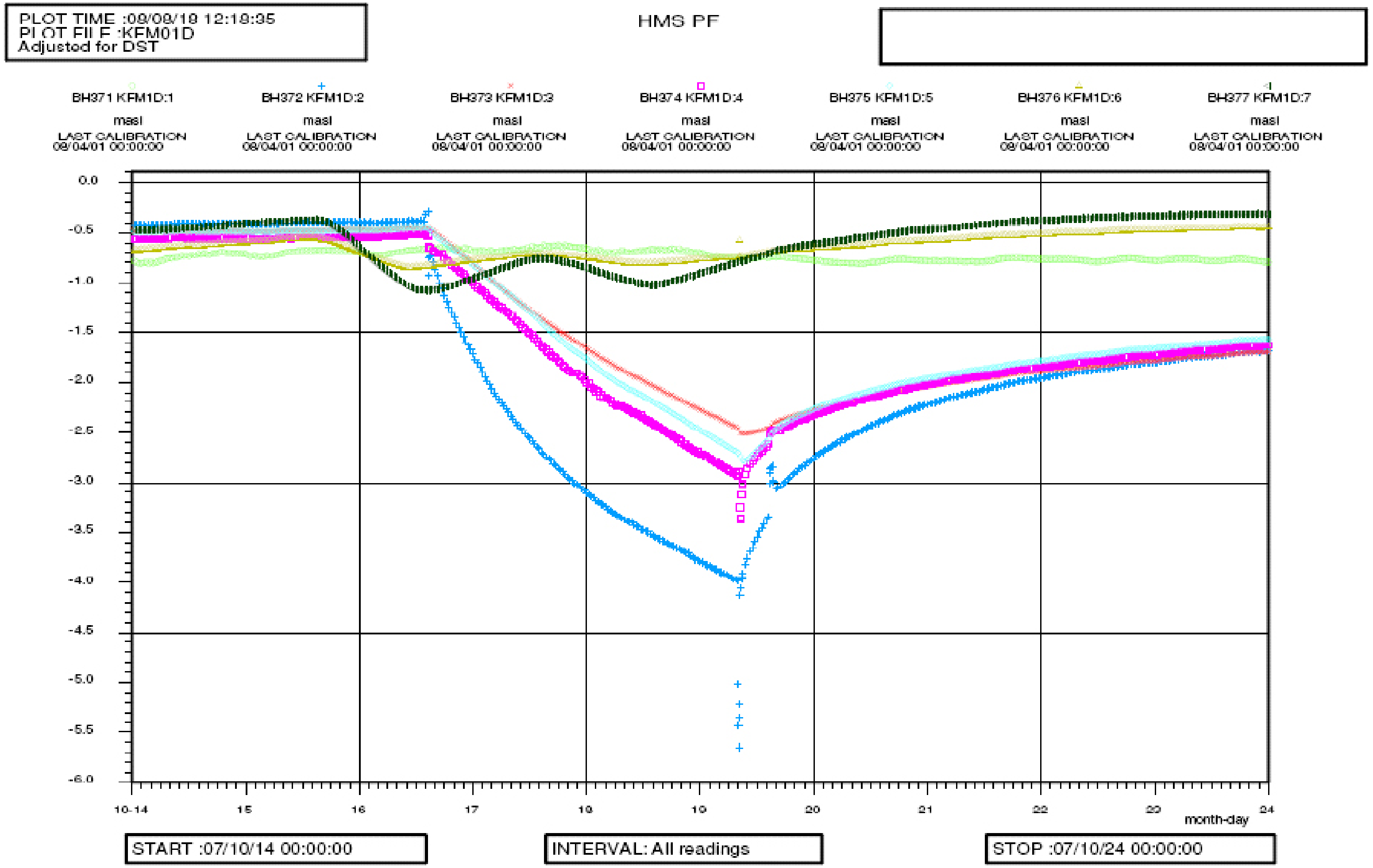


Figure A2-23. *Pumping and drawdown in KFM01D:4 and KFM01D:2 in October 2008. Pumping was performed in both sections at the same time. Clear responses were observed in KFM01D:3 and :5.*

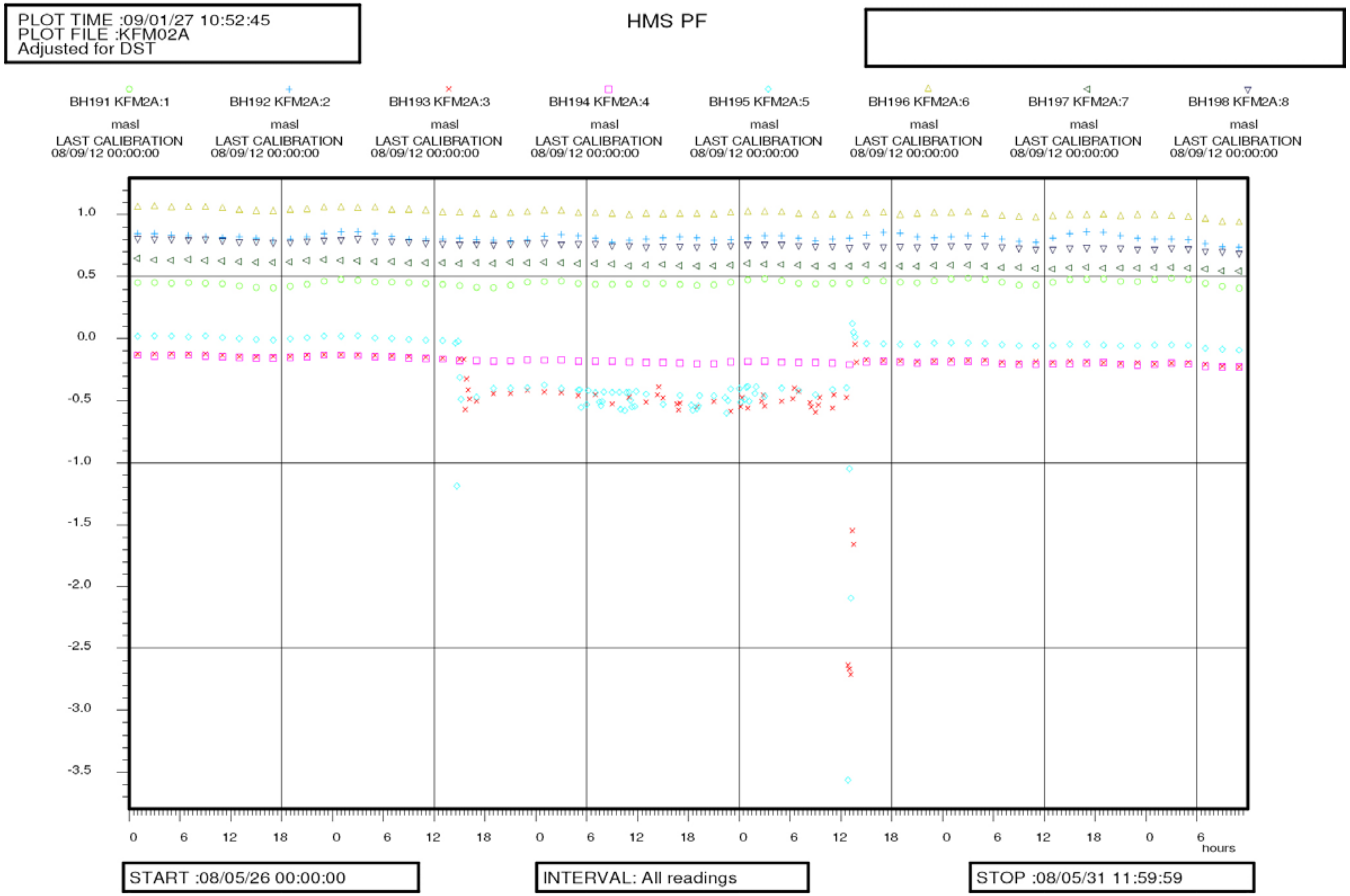


Figure A2-24. *Pumping and drawdown in KFM02A:3 and KFM02A:5 in May 2008. Pumping was performed in both sections simultaneously. None of the other borehole sections were affected by the pumping.*

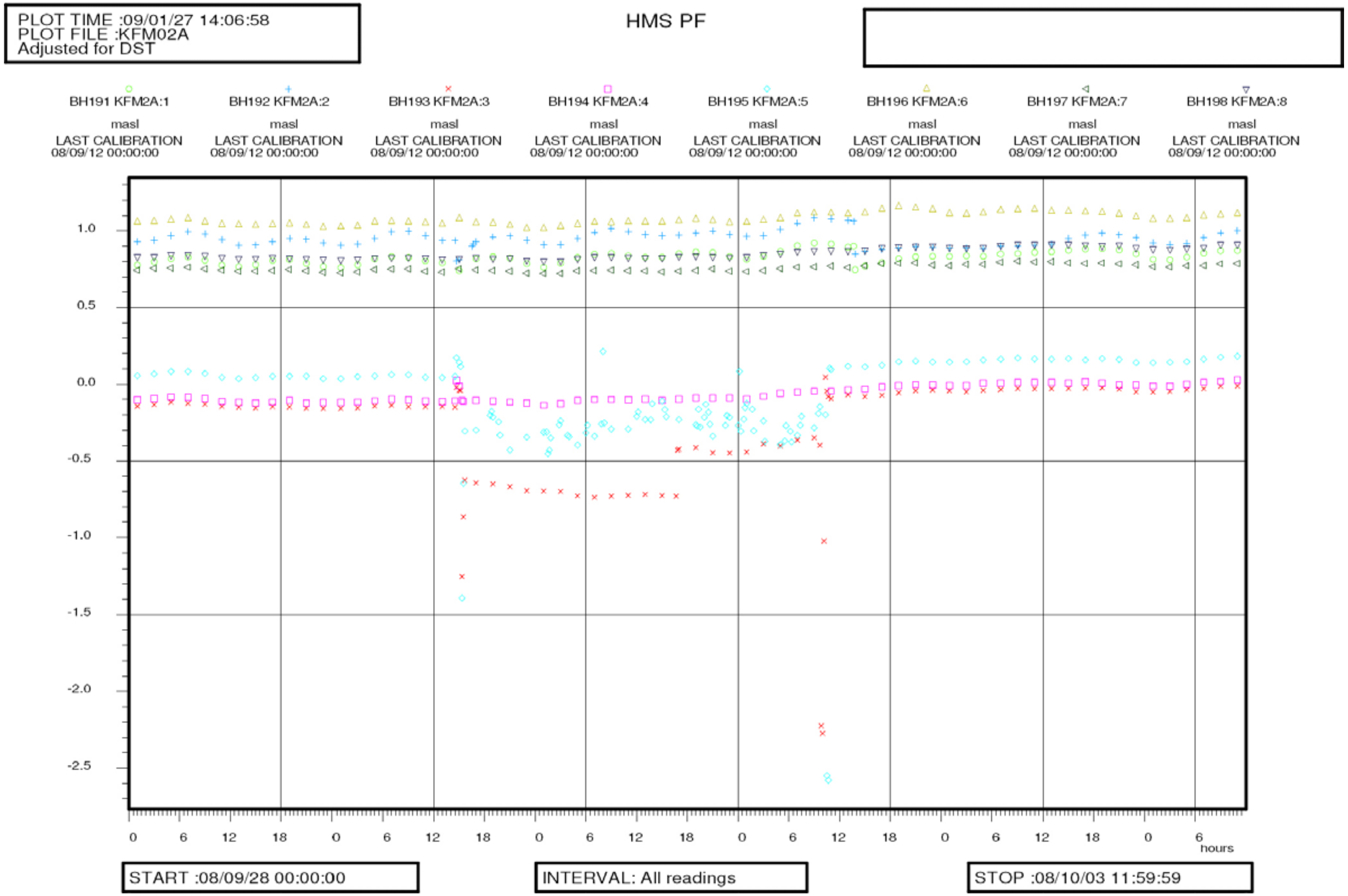


Figure A2-25. *Pumping and drawdown in KFM02A:3 and KFM02A:5 in September–October 2008. Pumping was performed simultaneously in both sections. None of the other borehole sections were affected by the pumping.*

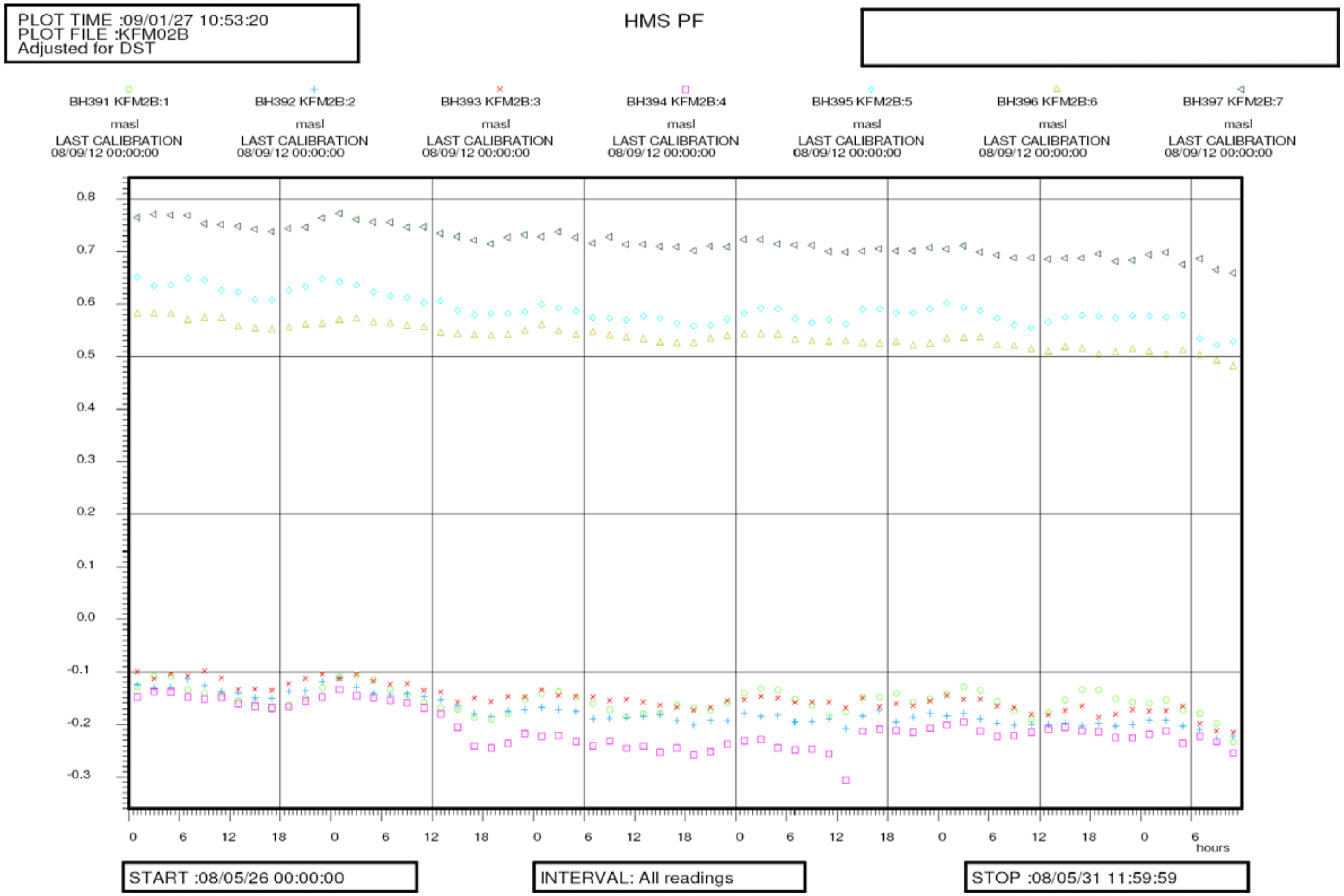


Figure A2-26. *Pumping in KFM02B:2 and KFM02B:4 in May 2008. Pumping was performed simultaneously in both sections. Section KFM02B:4 showed a pressure response from the pumping in the section. The pressures in the other sections were not significantly affected by the pumping.*

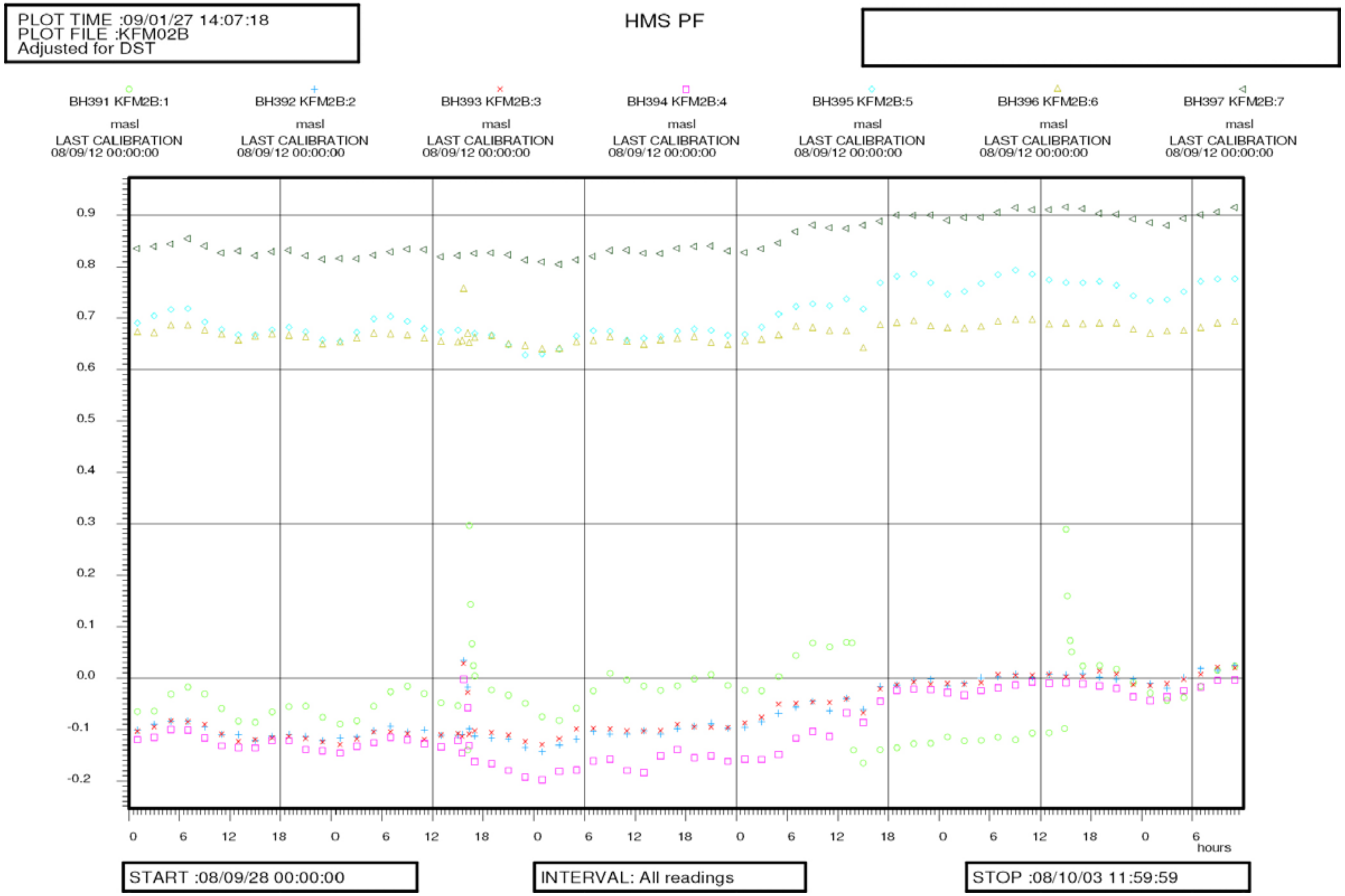


Figure A2-27. *Pumping in KFM02B:2 and KFM02B:4 in September–October 2008. Pumping was performed simultaneously in both sections. Section KFM02B:4 showed a pressure response from the pumping in the section. The pressures in the other sections were not significantly affected by the pumping.*

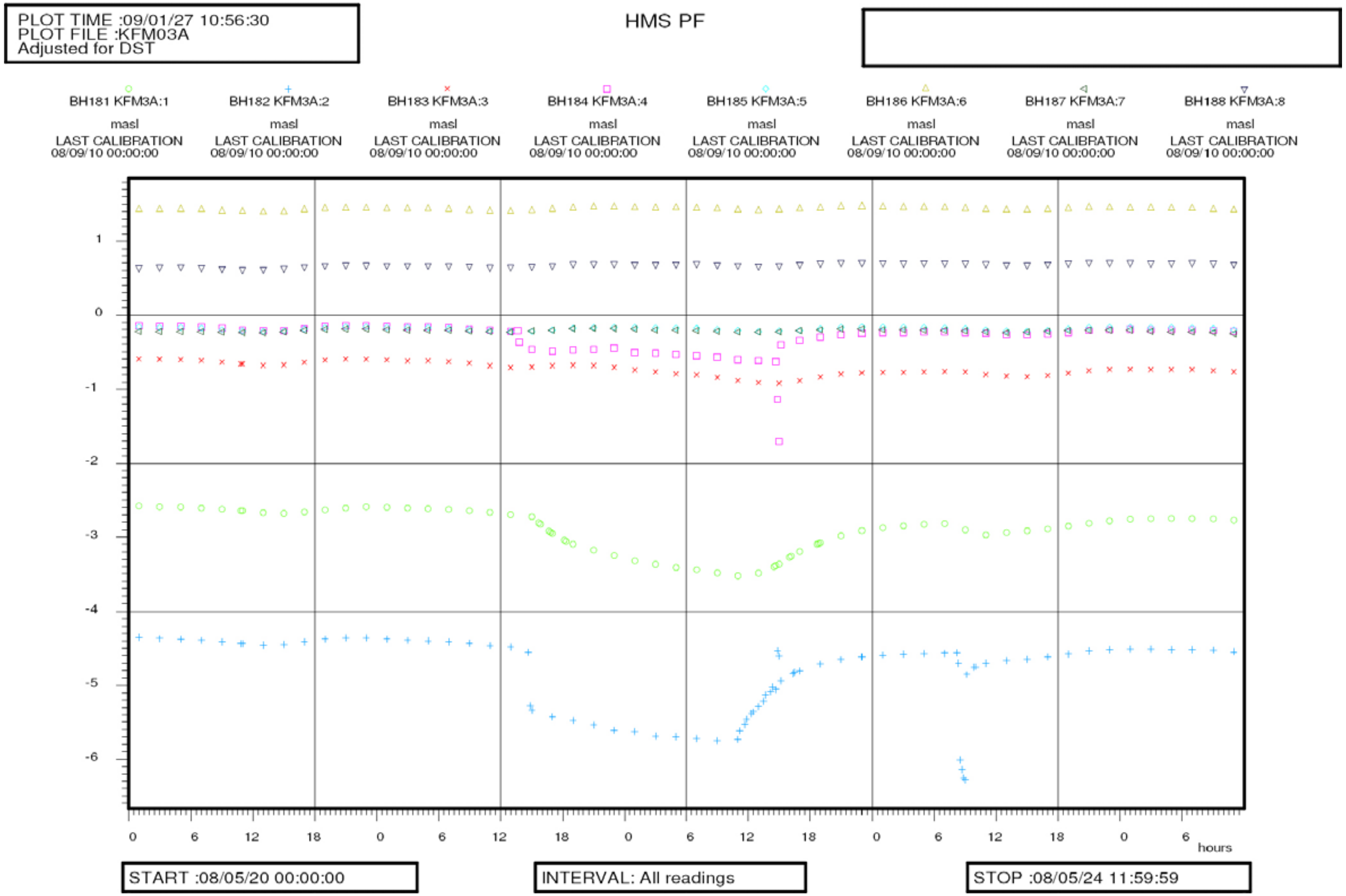


Figure A2-28. *Pumping in KFM03A:1 and KFM03A:4 in May 2008. The pumping was started simultaneously in both sections. A pressure response is observed in section KFM03A:2 and a small response is also seen in KFM03A:3.*

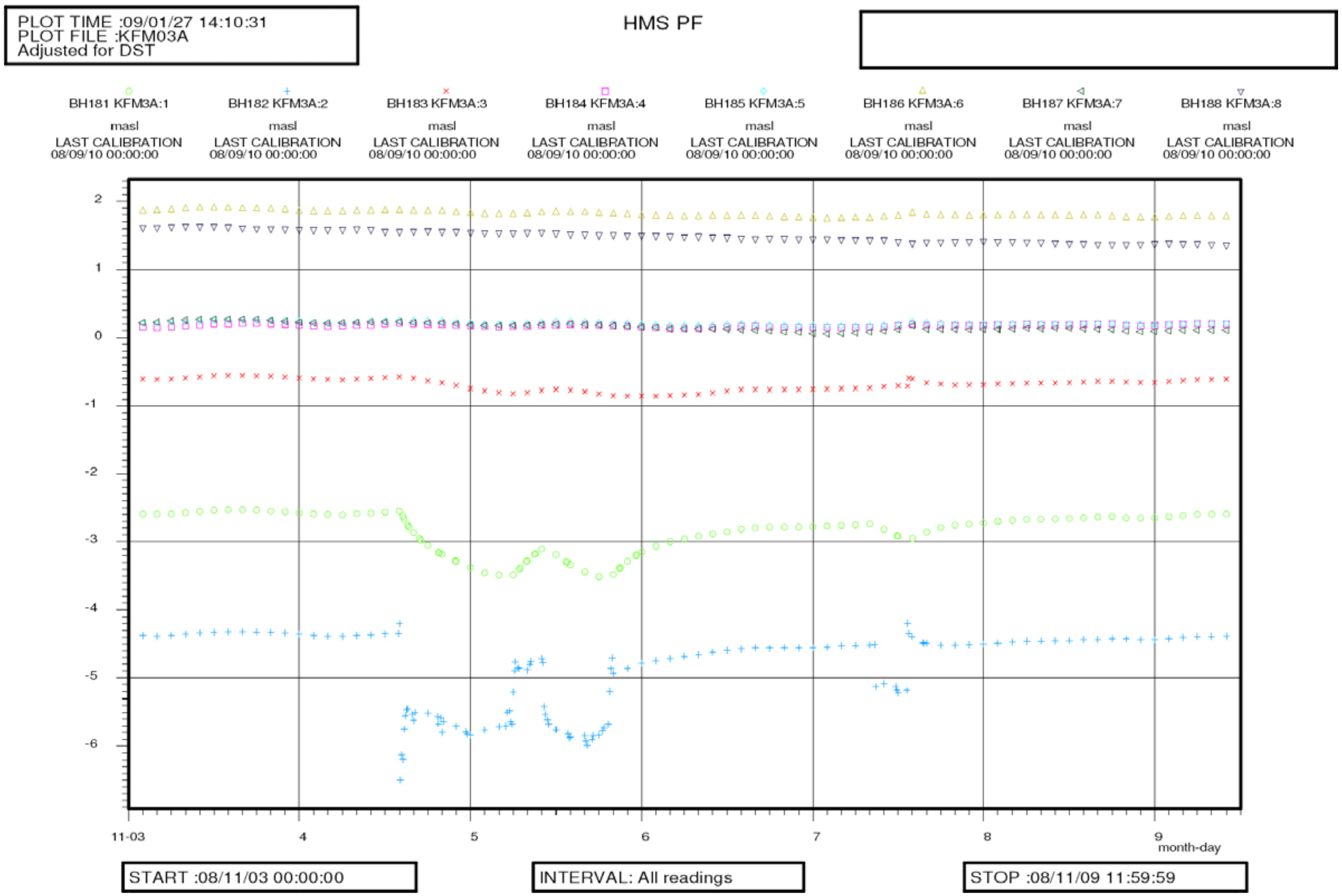


***Figure A2-29.** Pumping and drawdown in KFM03A:1 in November 2008. A pressure response is observed in section KFM03A:2 and a small response is also seen in KFM03A:3.*

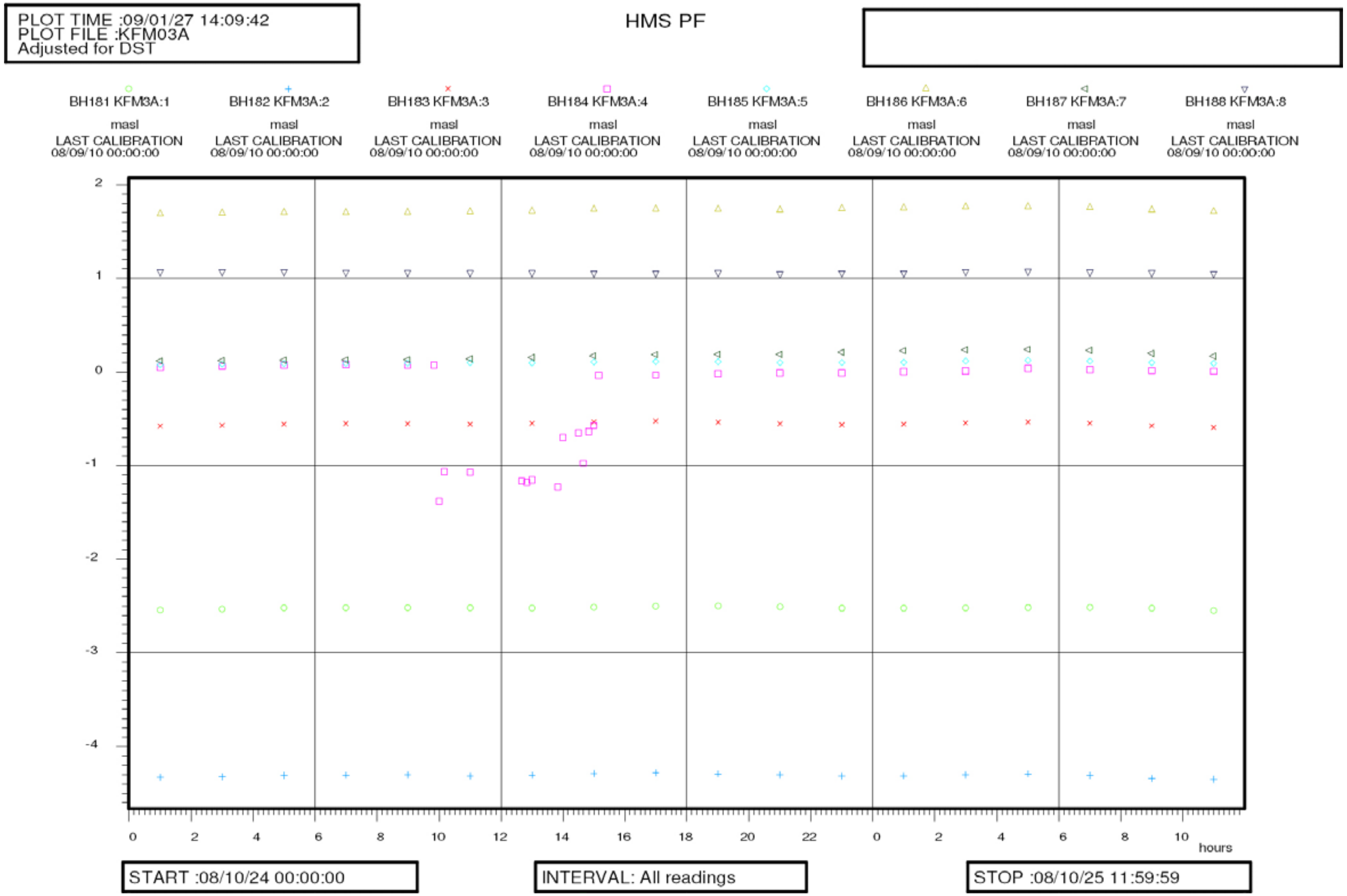


Figure A2-30. *Pumping and drawdown in KFM03A:4 in October 2008. None of the other sections seems affected by the pumping.*

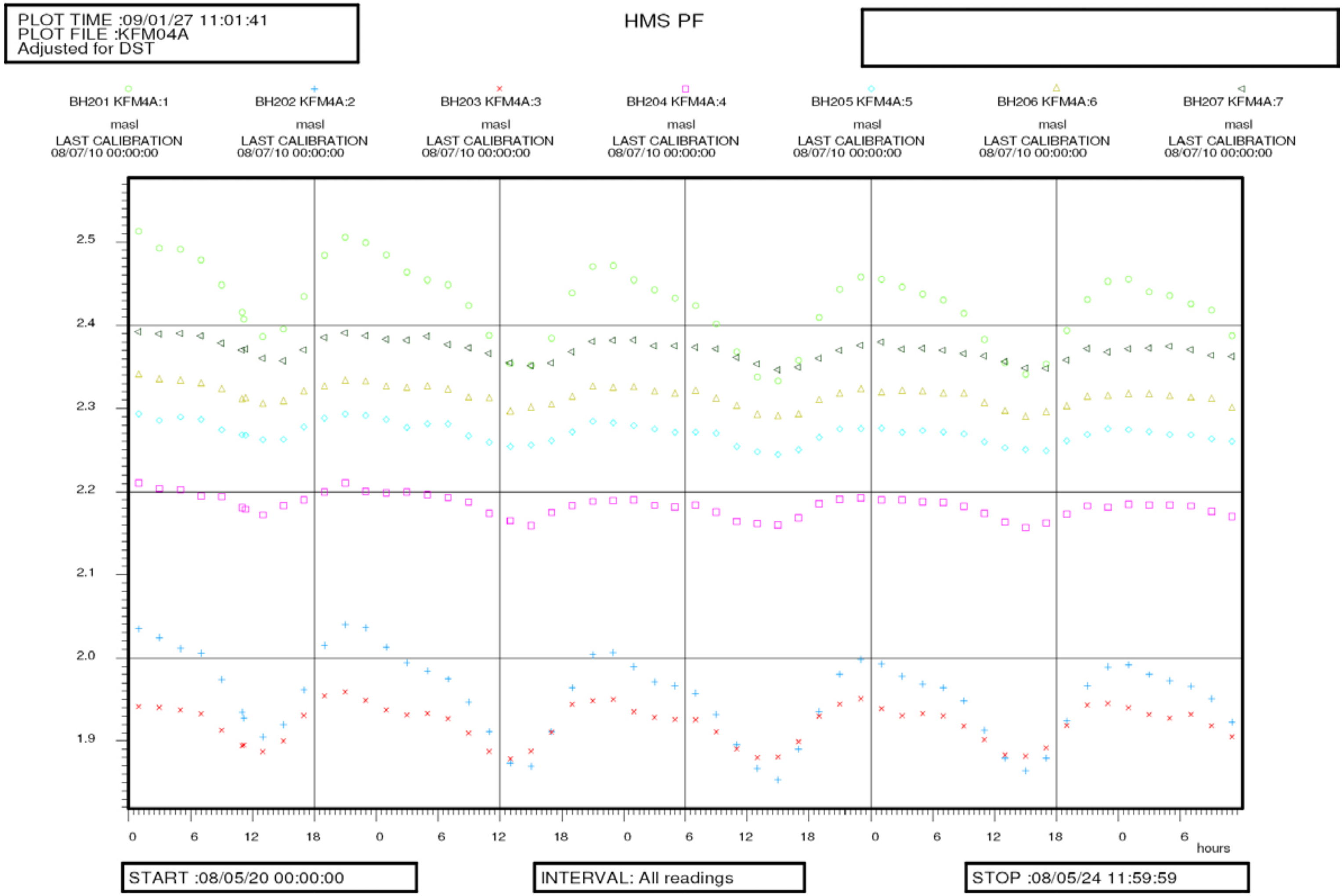


Figure A2-31. *Pumping and drawdown in KFM04A:4 in May 2008. None of the sections seems affected by the pumping.*

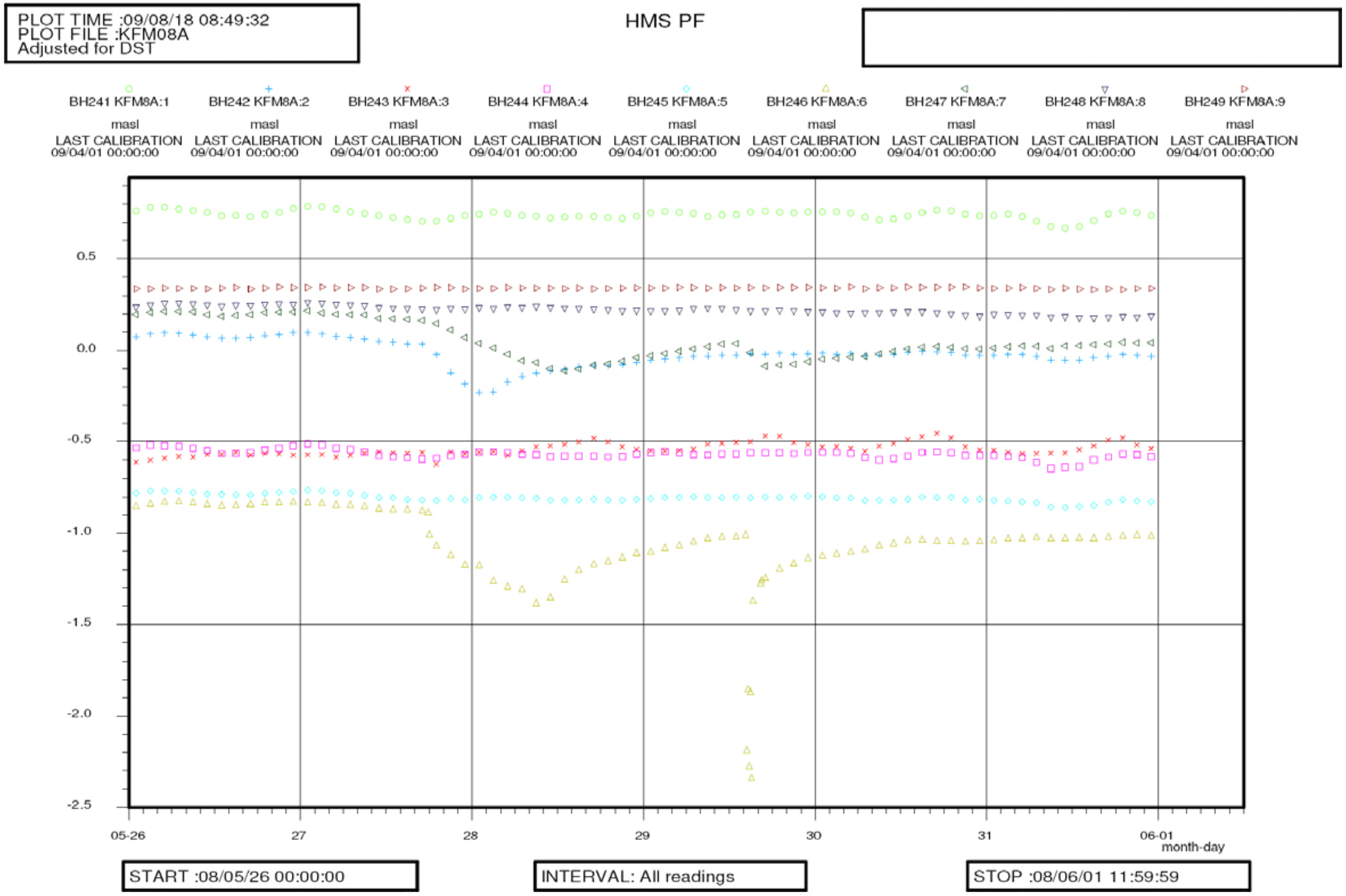


Figure A2-32. *Pumping and drawdown in KFM08A:2 and KFM08A:6 in May and June 2008. The pump in KFM08A:2 stopped after a few hours of pumping and started later but no HMS data are available from this later part of the pumping. Some effect from the pumping in KFM08A:6 is observed in KFM08A:7.*

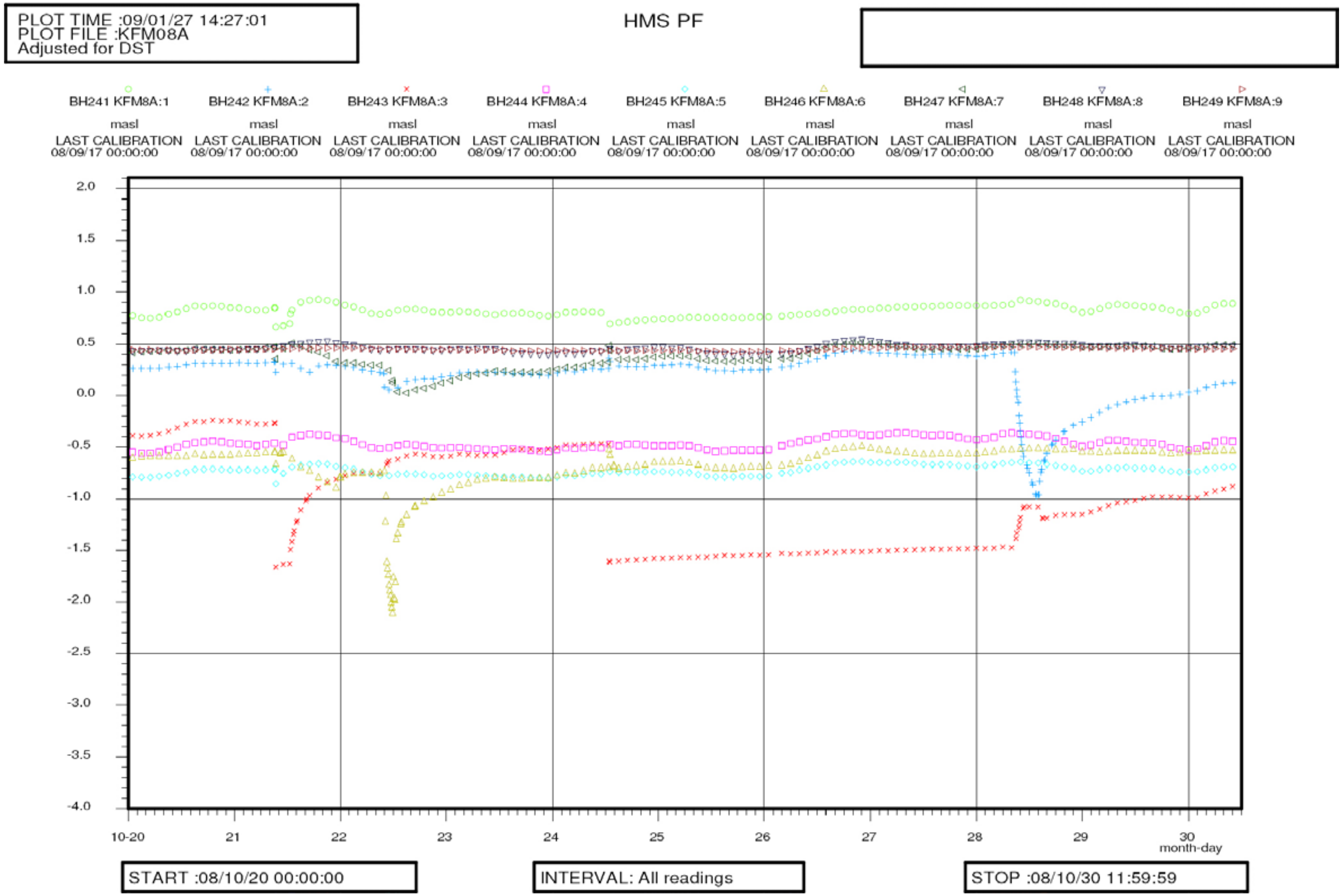


Figure A2-33. *Pumping and drawdown in KFM08A:2 in October 2008. Sampling is conducted 2008-10-28. The response in section KFM08A:7 are caused by the pumping in KFM08A:6. Section KFM08A:3 is only affected by packer deflations.*

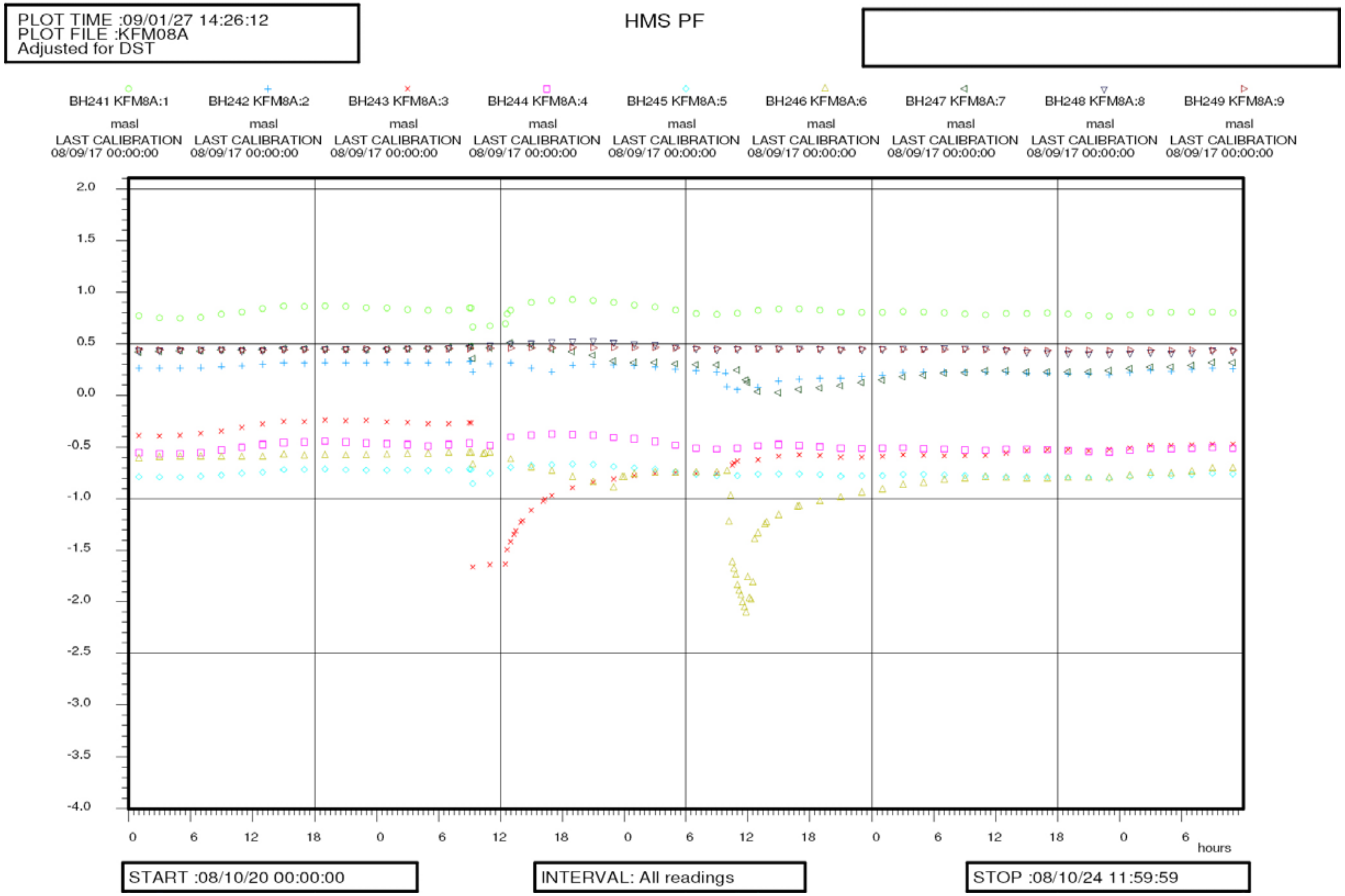


Figure A2-34. *Pumping and drawdown in KFM08A:6 in October 2008. A pressure response is seen in KFM08A:7. Section KFM08A:3 is only affected by packer deflations.*

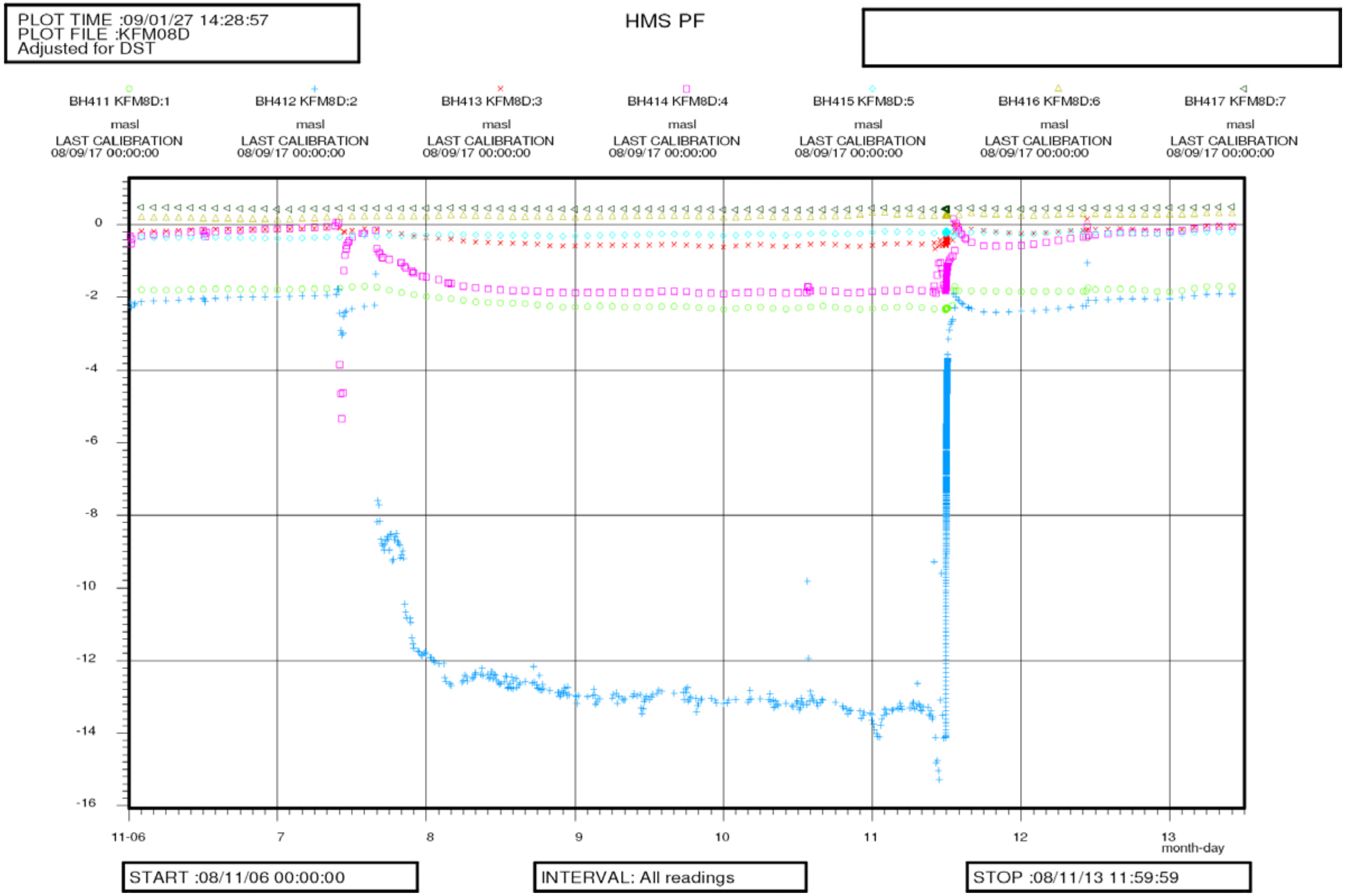


Figure A2-35. *Pumping and drawdown in KFM08D:2 in November 2008. Effects from pumping were observed in section KFM08D:4 and some possible response in KFM08D:1 as well.*

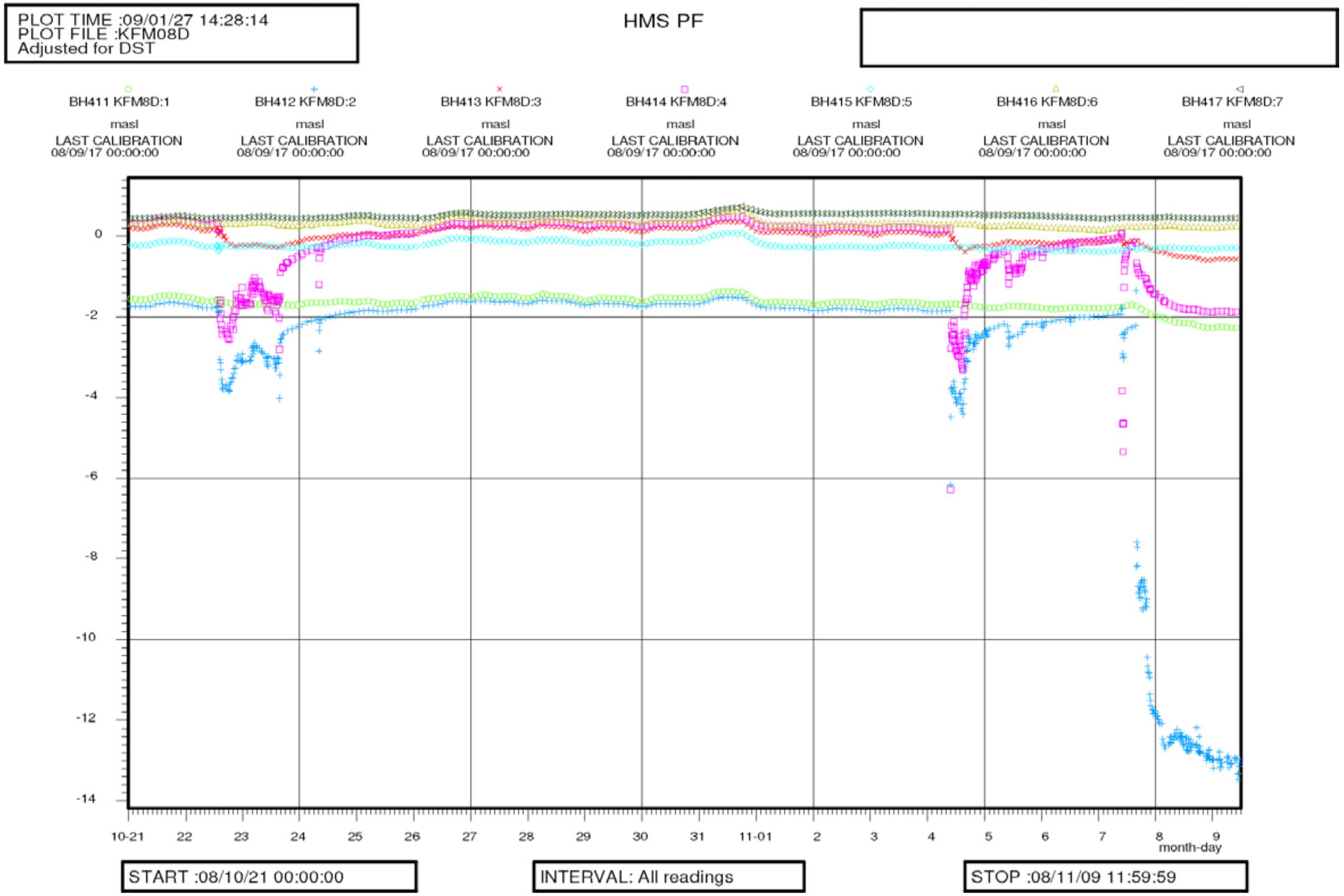


Figure A2-36. *Pumping and drawdown in KFM08D:4 in October–November 2008. Effects from pumping were observed in section KFM08D:2 and KFM08D:3 as well.*

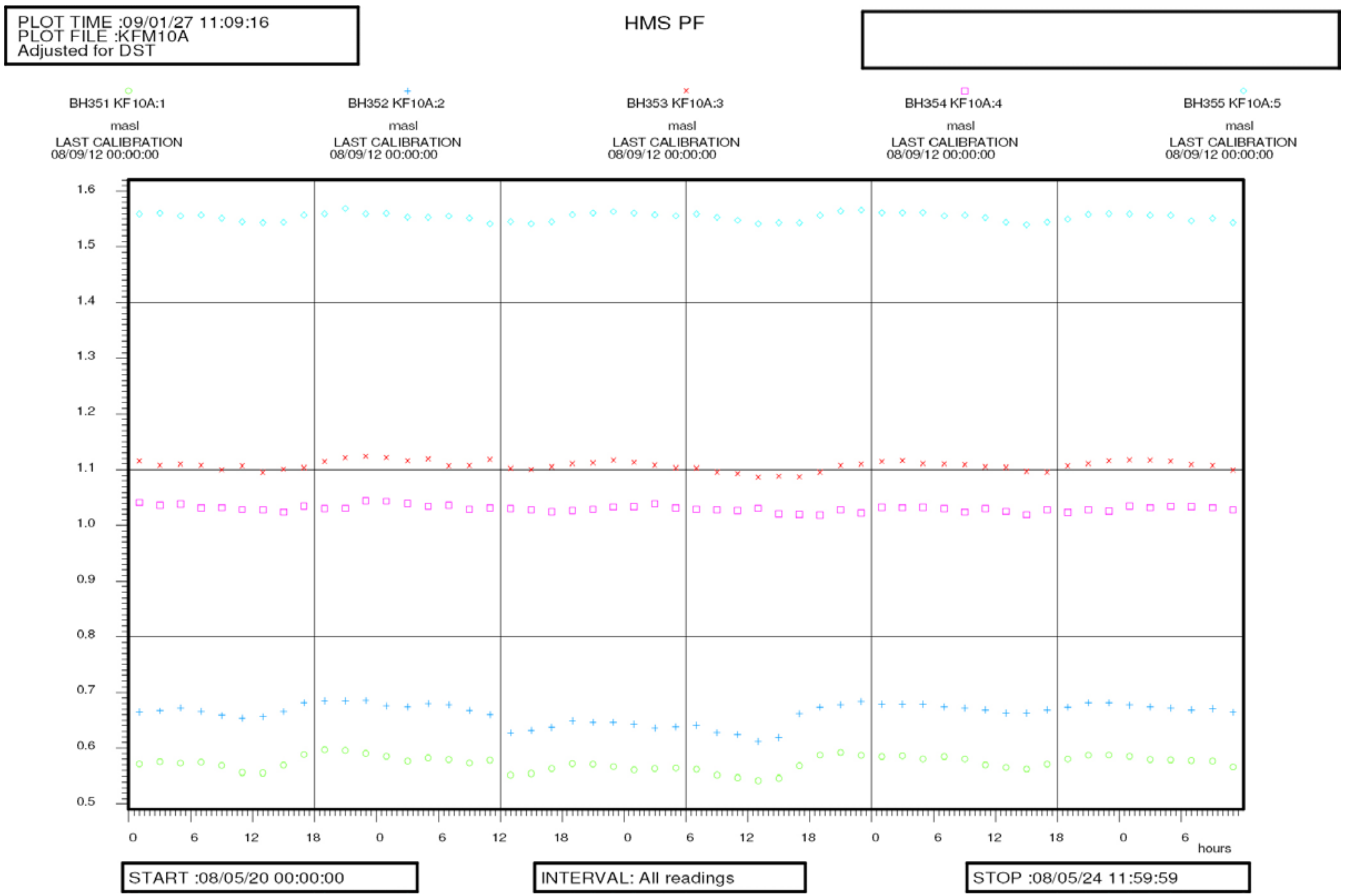


Figure A2-37. *Pumping and drawdown in KFM10A:2 in May 2008. A small pressure response was observed in the deepest section KFM10A:1.*

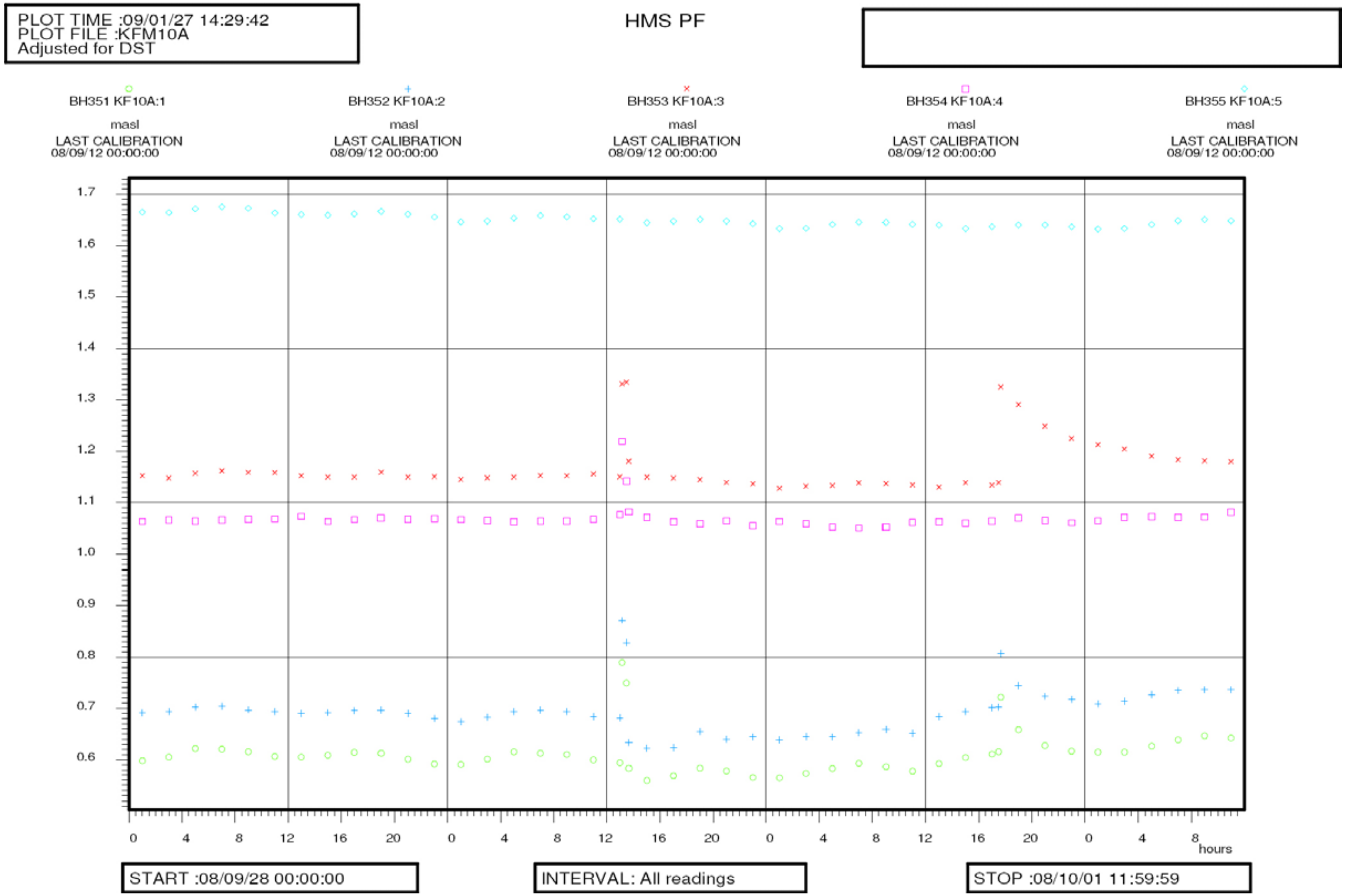


Figure A2-38. *Pumping and drawdown in KFM10A:2 in September 2008. Some pressure responses were observed in section KFM10A:1.*

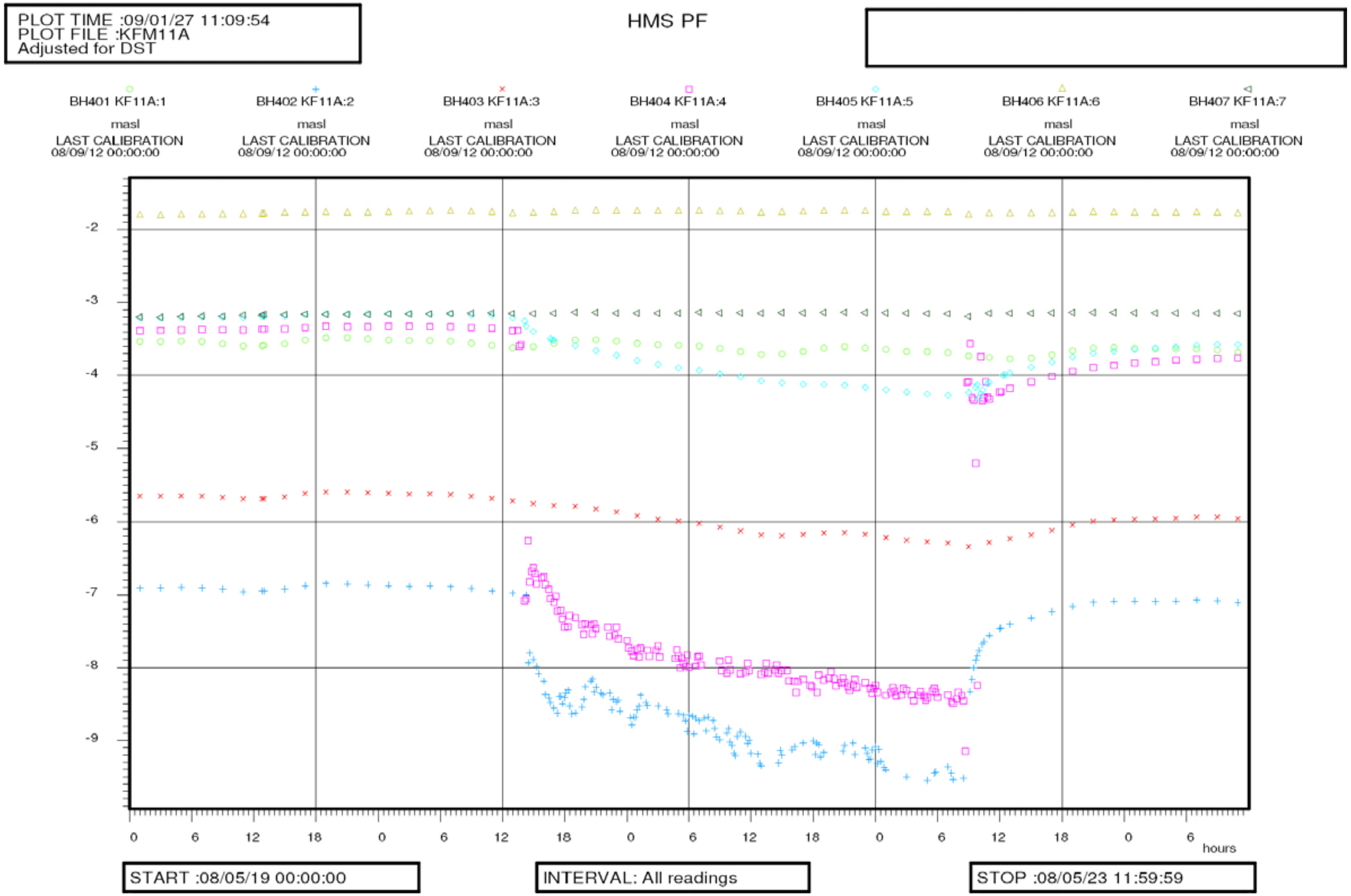


Figure A2-39. *Pumping and drawdown in KFM11A:2 and KFM11A:4 in May 2008. Pumping was performed in both sections simultaneously. Some pressure responses are seen in sections KFM11A:3 and KFM11A:5 and might be caused by pressure changes in the tubing between the sections.*

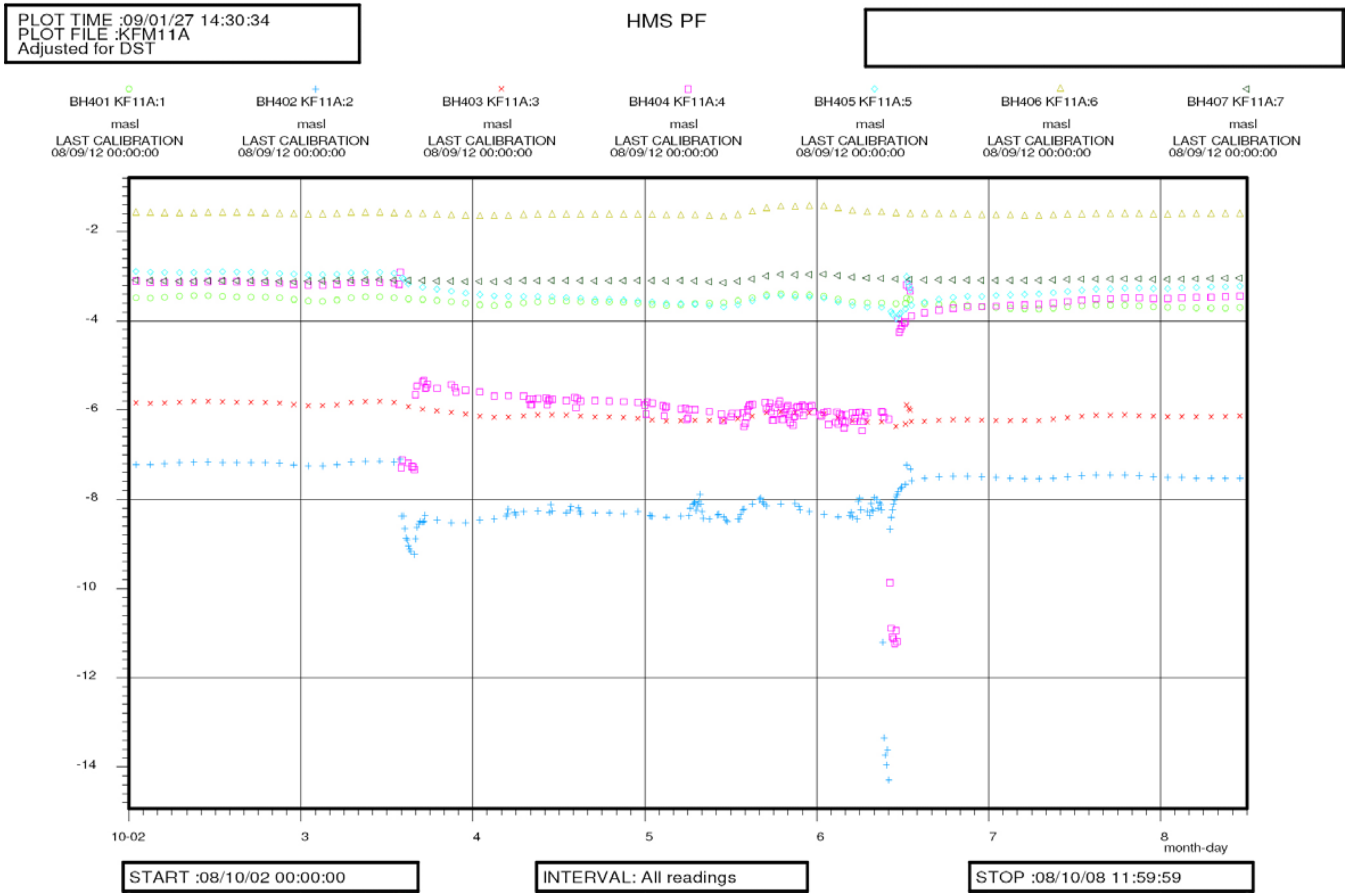


Figure A2-40. *Pumping and drawdown in KFM11A:2 and KFM11A:4 in October 2008. Pumping was performed in both sections simultaneously. Pressure responses seen in sections KFM11A:3 and KFM11A:5 are most probably due to pressure changes in the tubings between the sections.*

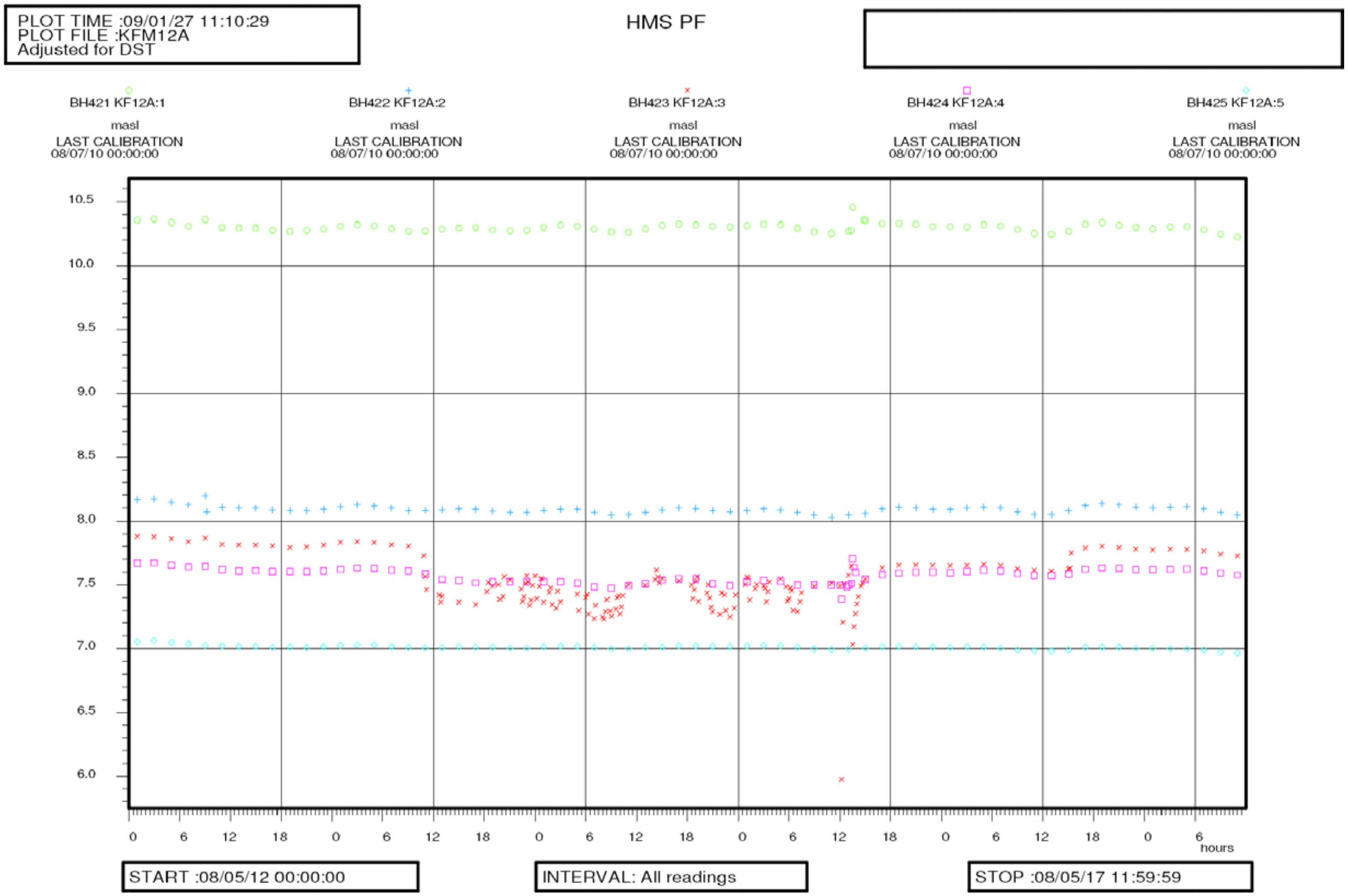


Figure A2-41. *Pumping and drawdown in KFM12A:3 in May 2008. Some pressure responses might be seen in sections KFM12A:1 and KFM12A:4 are most probably due to pressure changes in the tubings between the sections.*

A2.3 Compilation March 2008

Table A2-1. Water Composition.

Id code	Secup m	Seclow m	Sample no.	Sampling date	RCB (%)	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	HCO_3^- mg/L	Cl^- mg/L	SO_4^{2-} mg/L	SO_4–S mg/L	Br mg/l	F^- mg/L	Si mg/L	Fe mg/L	Fe–tot mg/L	FeII mg/L	Mn mg/L	Li mg/L	Sr mg/L
HFM01	33.50	45.50	16031	2008-05-21	–2.25	587	17.4	101	30.4	442	819	195	73.2	2.86	2.34	6.23	–	–	–	–	0.0185	0.572
HFM01	33.50	45.50	16120	2008-10-07	–1.02	567	18.6	96	28.9	441	763	179	65.9	2.50	2.22	6.54	0.622	0.64	0.639	0.158	0.018	0.569
HFM02	38.00	48.00	16033	2008-05-21	–1.41	631	22.2	168	51.3	374	1,130	160	58.4	4.23	1.90	6.72	–	–	–	–	0.0218	1.08
HFM02	38.00	48.00	16119	2008-10-07	–0.78	574	22.4	150	45.6	370	996	143	51.5	3.40	1.71	6.99	0.861	0.85	0.845	0.284	0.0211	0.951
HFM04	57.90	65.90	16029	2008-05-22	–3.27	148	5.97	30.4	7.77	397	61.0	44.7	16.2	0.227	1.93	7.08	–	–	–	–	0.0084	0.213
HFM04	58.00	66.00	16100	2008-09-30	–0.83	156	6.76	30.9	8.18	392	64.6	44.5	15.9	0.241	2.01	7.38	0.393	0.379	0.376	0.0822	0.0092	0.221
HFM13	159.00	175.60	16027	2008-05-15	–2.61	1,620	20.8	1,200	188	128	5,020	463	167	23.1	0.98	8.12	–	–	–	–	0.0525	12.10
HFM13	159.00	173.00	16098	2008-09-30	–1.52	1,800	21.5	1,220	211	120	5,280	468	179	25.5	1.38	8.45	3.67	3.65	3.62	2.55	0.057	12.80
HFM15	85.00	99.50	16023	2008-05-15	–0.31	615	17.6	160	37.2	429	975	156	61.5	3.42	1.65	7.44	–	–	–	–	0.0214	0.955
HFM15	85.00	95.00	16142	2008-10-28	–0.48	396	13.8	90.8	21.6	473	503	92	34.2	1.97	1.61	8.92	0.643	0.612	0.617	0.239	0.0148	0.558
HFM16	54.00	67.00	16032	2008-05-22	–3.61	248	5.87	29.5	7.19	453	151	96.5	34.5	0.547	2.55	6.52	–	–	–	–	0.01	0.231
HFM16	54.00	67.00	16135	2008-10-17	0.86	268	6.23	30.2	7.79	449	158	99.5	36.2	0.566	2.71	6.74	0.358	0.36	0.359	0.0754	0.0109	0.244
HFM19	168.00	185.20	16026	2008-05-15	–	1,590	40.9	723	183	224	4,320	421	x	15.3	1.38	6.86	–	–	–	–	0.0501	5.59
HFM19	168.00	182.00	16141	2008-10-28	3.67	1,890	48.2	860	234	150	4,290	429	191	16.1	1.34	6.99	4.970	5.12	5.12	1.78	0.0596	7.04
HFM21	22.00	32.00	16024	2008-05-15	–4.31	240	12.1	66.6	18.9	454	252	106	38.5	0.994	1.45	7.44	–	–	–	–	0.0152	0.337
HFM21	22.00	32.00	16138	2008-10-22	–3.74	256	12.5	54.2	16.0	455	245	104	36.0	0.874	1.59	7.79	0.526	0.52	0.52	0.143	0.0137	0.293
HFM27	46.00	58.00	16030	2008-05-21	–3.80	1,030	34.1	400	105	271	2,440	293	108	9.20	1.35	6.59	–	–	–	–	0.0342	2.67
HFM27	46.00	58.00	16121	2008-10-07	0.43	1,110	32.0	363	99.7	284	2,250	294	106	7.99	1.58	6.84	2.26	2.24	2.23	0.695	0.0338	2.34
HFM32	26.00	31.00	16046	2008-06-05	–3.65	1,550	56.0	400	135	231	3,420	347	113	15.7	1.12	6.04	–	–	–	–	0.0528	2.70
HFM32	26.00	31.00	16132	2008-10-14	–1.88	1,700	63.1	415	150	217	3,590	324	127	12.9	1.28	6.22	3.22	3.33	3.32	0.716	0.0613	2.90
KFM01A	109.00	130.00	16044	2008-05-29	–4.09	1,510	21.2	749	121	102	4,050	300	116	17.3	1.46	9.88	0.546	0.56	0.569	0.727	0.0415	6.43
KFM01A	109.00	130.00	16109	2008-10-03	–0.39	1,700	21.4	752	126	102	4,040	311	122	15.3	1.64	10.7	0.523	0.54	0.537	0.708	0.0448	6.39
KFM01D	311.00	321.00	16045	2008-05-29	–5.37	1,400	20.9	934	69.1	55.6	4,260	216	88.3	23.7	1.70	14.8	1.83	1.74	1.76	0.698	0.036	9.63
KFM01D	311.00	321.00	16110	2008-10-03	–0.33	1,510	17.8	911	67.7	58.2	3,970	211	80	18.9	1.53	13.6	1.94	1.98	1.95	0.623	0.0357	9.25
KFM01D	429.00	438.00	16042	2008-05-29	–3.49	1,420	16.4	1,090	53.1	77.3	4,460	104	40.3	28.3	1.06	15.5	0.149	0.162	0.158	0.34	0.0327	11.6
KFM01D	429.00	438.00	16111	2008-10-03	–0.43	1,580	12.9	1,210	42.5	56	4,620	121	44.1	26.9	1.29	15.7	0.118	0.116	0.114	0.215	0.0341	13.2
KFM02A	411.00	442.00	16040	2008-05-29	–4.14	1,740	23.3	1,160	189	107	5,380	447	155	24.8	<3	8.62	0.725	0.741	0.583	1.92	2.97	12.0
KFM02A	411.00	442.00	16102	2008-10-01	–1.36	1,940	22.6	1,180	202	109	5,450	421	158	24.2	1.49	8.74	0.684	0.66	0.652	1.91	3.34	12.1
KFM02A	490.00	518.00	16041	2008-05-29	–4.64	2,010	37.2	949	230	130	5,530	553	187	22.8	<3	7.31	1.78	1.79	1.72	2.34	0.0517	8.7
KFM02A	490.00	518.00	16101	2008-10-01	0.39	2,290	36.3	1,010	242	126	5,510	463	193	18.8	1.81	7.44	1.73	1.72	1.7	2.35	0.053	8.64
KFM02B	410.00	431.00	16043	2008-05-29	–3.58	1,890	30.5	1,090	214	116	5,470	447	166	23.7	1.52	9.62	2.49	2.49	2.49	2.29	0.142	10.6

Id code	Secup m	Seclow m	Sample no.	Sampling date	RCB (%)	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	HCO_3^- mg/L	Cl^- mg/L	SO_4^{2-} mg/L	SO_4–S mg/L	Br mg/l	F^- mg/L	Si mg/L	Fe mg/L	Fe–tot mg/L	FeII mg/L	Mn mg/L	Li mg/L	Sr mg/L
KFM02B	410.00	431.00	16104	2008-10-01	–0.10	2,120	28.8	1,140	222	113	5,530	475	170	24.4	1.69	9.93	2.45	2.53	2.52	2.26	0.144	10.4
KFM02B	491.00	506.00	16039	2008-05-29	–3.85	2,040	40.4	910	232	134	5,430	510	183	22.1	<3	8.79	4.48	4.43	4.4	2.27	0.0567	8.15
KFM02B	491.00	506.00	16103	2008-10-01	–0.37	2,270	38.9	974	240	128	5,510	509	190	22.8	1.66	9.25	4.43	4.16	4.2	2.24	0.0571	8.07
KFM03A	633.50	650.00	16028	2008-05-22	–1.26	1,710	17.5	1,530	59.5	33.3	5,490	188	73.0	35.3	1.16	7.43	–	–	–	–	0.0289	17.8
KFM03A	633.50	650.00	16140	2008-10-24	–0.21	1,860	19.2	1,520	67.5	24.3	5,610	194	76.7	33.4	1.59	7.51	0.629	0.648	0.647	0.43	0.036	18.7
KFM03A	969.50	1,001.19	16036	2008-05-23	–1.26	1,990	9.42	3,840	10.6	18.9	10,100	33.5	16.8	93.5	0.86	6.93	–	–	–	–	0.0226	46.1
KFM03A	969.50	994.50	16147	2008-11-07	–0.52	2,180	10.3	3,980	10.4	15.4	10,500	42.0	16.1	98.5	1.51	6.76	1.07	0.996	0.989	0.09	0.0324	47.8
KFM04A	230.00	245.00	16034	2008-05-22	–3.14	1,760	24.9	1,470	228	103	5,930	537	180	32.4	1.28	7.20	–	–	–	–	0.0598	16.0
KFM04A	230.00	245.00	16114	2008-10-06	–1.14	1,960	24.2	1,450	235	101	5,980	504	184	27.1	1.14	7.34	2.28	2.31	2.22	3.36	0.0603	15.9
KFM06A	341.00	362.00	16049	2008-06-05	–3.05	1,360	11.2	1,250	50.8	43.3	4,610	136	48.9	32.5	1.23	5.98	–	–	–	–	0.0502	14.4
KFM06A	341.00	362.00	16134	2008-10-17	0.72	1,510	15.9	1,310	62.1	46.2	4,620	131	56.4	27.8	1.54	7.03	1.42	1.51	1.50	0.541	0.0557	15.4
KFM06A	738.00	748.00	16048	2008-06-09	–2.79	1,580	12.2	1,970	27.1	23.6	6,250	105	40.4	48.8	0.91	7.88	–	–	–	–	0.0398	23.0
KFM06A	738.00	748.00	16136	2008-10-17	–1.20	1,770	14.0	2,000	31.5	39.1	6,420	103.0	38.0	41.7	1.12	8.03	0.167	xx	xx	0.417	0.044	23.9
KFM06C	531.00	540.00	16064	2008-06-09	–2.80	1,520	16.1	1,200	91.6	71.8	4,760	270	98.3	26.8	0.98	5.91	–	–	–	–	0.0463	13.0
KFM06C	531.00	540.00	16133	2008-10-17	0.51	1,660	18.2	1,270	97.6	72.8	4,790	258	101	25.1	0.91	5.99	0.825	0.852	0.852	0.849	0.051	13.5
KFM06C	647.00	666.00	16066	2008-06-11	3.25	1,400	15.7	1,210	78.0	168	4,080	84.4	32.8	27.6	1.29	8.55	–	–	–	–	0.0398	12.5
KFM06C	647.00	666.00	16162	2008-11-14	–2.44	1,330	14.0	1,320	63.6	117	4,660	88.0	37.7	28.2	1.12	8.77	–	–	–	–	0.0397	14.2
KFM07A	962.00	972.00	16144	2008-10-29	0.38	3,130	17.5	5,510	5.19	27	14,400	77.4	33.0	128	1.13	1.56	<0.004	<0.006	<0.006	0.00022	0.0767	67.4
KFM08A	265.00	280.00	16047	2008-05-29	–2.51	1,380	16.7	1,540	39.6	71.4	5,130	74.5	27.6	44.9	1.24	6.26	–	–	–	–	0.0242	18.2
KFM08A	265.00	280.00	16139	2008-10-22	0.20	1,440	18.8	1,500	46.4	79.5	4,890	73	29.8	39.9	1.51	7.36	1.29	1.27	1.28	0.548	0.0303	17.8
KFM08A	684.00	694.00	16062	2008-06-05	–2.01	1,500	12.6	2,030	14.5	14.8	6,140	86.9	32.1	49.1	1.28	5.42	–	–	–	–	0.0198	24.2
KFM08A	684.00	694.00	16143	2008-10-28	0.33	1,670	13.5	2,010	17.6	13.3	6,070	83.4	32.4	48.6	1.27	5.46	0.372	0.398	0.397	0.171	0.024	24.4
KFM08D	660.00	680.00	16063	2008-06-05	–3.63	1,370	19.9	1,160	51.8	108	4,430	199	73.7	30.5	1.26	7.42	–	–	–	–	0.0312	12.9
KFM08D	660.00	680.00	16146	2008-11-07	–0.09	1,670	13.4	1,690	27.2	20.3	5,540	132	50.8	39.0	1.15	6.28	0.117	0.111	0.107	0.167	0.0311	20.0
KFM08D	825.00	835.00	16065	2008-06-09	–3.27	1,560	10.9	1,970	20.2	14.3	6,240	132	50.5	45.9	0.95	6.49	–	–	–	–	0.0287	22.6
KFM08D	825.00	835.00	16157	2008-11-11	–0.53	1,710	13.8	1,830	31.8	44.6	5,880	153	60.6	43.0	1.23	6.66	0.746	0.705	0.709	0.266	0.0352	20.9
KFM10A	430.00	440.00	16035	2008-05-22	–3.27	1,910	30.4	1,110	194	104	5,400	528	186	21.2	1.10	7.65	–	–	–	–	0.0561	11.0
KFM10A	430.00	440.00	16099	2008-09-30	0.54	2,130	29.8	1,150	209	93.9	5,420	509	193	19.9	1.67	7.83	6.61	6.680	6.66	1.61	0.0616	10.7
KFM11A	446.00	456.00	16038	2008-05-22	–1.57	1,250	6.31	1,390	29.4	10.6	4,420	246	89.6	24.6	0.76	5.14	–	–	–	–	0.0493	18.7
KFM11A	446.00	456.00	16113	2008-10-06	0.98	1,360	6.07	1,430	30.2	10.1	4,410	239	96.1	31.3	1.05	5.32	0.254	0.254	0.246	0.14	0.0513	19.0
KFM11A	690.00	710.00	16037	2008-05-22	–2.38	1,740	13.5	1,960	43.5	22.5	6,480	114	45.2	50.8	0.97	6.69	–	–	–	–	0.046	25.4
KFM11A	690.00	710.00	16112	2008-10-06	0.93	1,930	12.2	2,170	38.7	17.9	6,700	105	44.2	52.6	1.32	6.73	0.635	0.638	0.63	0.344	0.0478	27.7
KFM12A	270.00	280.00	16025	2008-05-15	0.57	979	7.56	1,130	45.1	65.3	3,470	127	44.8	20.9	0.97	5.03	–	–	–	–	0.0384	15.4
KFM12A	270.00	280.00	16118	2008-10-07	0.04	975	7.46	1,180	46.3	58.5	3,610	98.6	40.3	21.6	0.94	5.10	0.255	0.256	0.25	0.575	0.0422	16.7

Id code	Secup m	Seclow m	Sample no.	Sampling date	I^- mg/L	pH _L	pH_F	TOC mg/L	DOC mg/L	HS^- mg/L	Drill_water %	Uranine ug/L	EC_L mS/m	EC_F	NH_4N mg/L	NO_2-N mg/L	NO_3-N mg/L	NO_2-N+NO_3-N mg/L	PO_4–P mg/L	PO_4-P HLYSIS mg/L	P mg/L
HFM01	33.50	45.50	16031	2008-05-21	–	7.69	8.11	–	–	–	–	1.10	351	355.0	–	–	–	–	–	–	–
HFM01	33.50	45.50	16120	2008-10-07	0.0144	7.90		9.9	9.2	0.038	–	1.50	335		0.92	0.0004	<0.0003	0.0004	0.0183	0.0458	0.0652
HFM02	38.00	48.00	16033	2008-05-21	–	7.62	7.86	–	–	–	–	0.80	421	427.0	–	–	–	–	–	–	–
HFM02	38.00	48.00	16119	2008-10-07	0.0171	7.73		9.1	9.2	0.048	–	1.00	389		0.893	0.0004	<0.0003	0.0004	0.0050	0.0279	0.0385
HFM04	57.90	65.90	16029	2008-05-22	–	7.78	8.10	–	–	–	–	0.90	87.1	86.8	–	–	–	–	–	–	–
HFM04	58.00	66.00	16100	2008-09-30	0.0128	7.92		9.1	9.2	0.054	–	0.60	89		0.497	<0.0002	<0.0003	0.0003	0.0136	0.0193	0.0267
HFM13	159.00	175.60	16027	2008-05-15	–	7.31	6.42	–	–	–	–	1.10	1,470	x	–	–	–	–	–	–	–
HFM13	159.00	173.00	16098	2008-09-30	0.0626	7.24		2.5	2.3	0.021	–	1.10	1,510		1.43	0.0002	0.0004	0.0006	<0.0005	0.0007	<0.04
HFM15	85.00	99.50	16023	2008-05-15	–	7.43	7.09	–	–	–	–	3.50	387	x	–	–	–	–	–	–	–
HFM15	85.00	95.00	16142	2008-10-28	0.0215	7.42		11.0	12.0	0.409	–	3.80	247		0.845	<0.0002	0.0011	0.0011	0.0147	0.0143	0.0184
HFM16	54.00	67.00	16032	2008-05-22	–	7.90	8.39	–	–	–	–	1.60	133	140.2	–	–	–	–	–	–	–
HFM16	54.00	67.00	16135	2008-10-17	0.0077	8.26		13.0	13.0	0.006	–	2.20	138		0.647	0.0004	0.0090	0.0094	0.0805	0.0788	0.0781
HFM19	168.00	185.20	16026	2008-05-15	–	7.20	7.08	–	–	–	–	2.10	1,310	x	–	–	–	–	–	–	–
HFM19	168.00	182.00	16141	2008-10-28	0.0403	7.01		8.3	2.7	0.131	–	0.50	1,290		2.36	0.0002	0.0044	0.0046	<0.0005	0.0077	0.00797
HFM21	22.00	32.00	16024	2008-05-15	–	7.57	7.27	–	–	–	–	1.50	166	x	–	–	–	–	–	–	–
HFM21	22.00	32.00	16138	2008-10-22	0.0109	7.77		7.5	8.1	0.931	–	1.00	164		0.403	<0.0002	0.0019	0.0020	0.0159	0.0183	0.0254
HFM27	46.00	58.00	16030	2008-05-21	–	7.36	7.44	–	–	–	–	0.80	786	786.0	–	–	–	–	–	–	–
HFM27	46.00	58.00	16121	2008-10-07	0.0209	7.64		6.6	5.4	0.055	–	0.60	748		1.54	<0.0002	<0.0003	0.0003	<0.0005	0.0104	0.0159
HFM32	26.00	31.00	16046	2008-06-05	–	7.23	7.02	–	–	–	–	0.40	1,070	1,069.0	–	–	–	–	–	–	–
HFM32	26.00	31.00	16132	2008-10-14	0.0524	7.28		4.8	4.8	0.214	–	0.20	1,100		1.84	0.0005	0.0005	0.0010	<0.0005	0.0054	0.0076
KFM01A	109.00	130.00	16044	2008-05-29	0.0455	7.66	7.98	–	–	0.328	60.2	120	1,190	1,202.0	0.967	0.0005	0.0027	0.0031	<0.0005	0.0008	
KFM01A	109.00	130.00	16109	2008-10-03	0.0551	7.58		3.0	2.7	0.428	29.9	59.7	1,200		0.922	0.0002	0.0072	0.0074	<0.0005	0.0006	<0.005
KFM01D	311.00	321.00	16045	2008-05-29	0.082	7.22	7.33	6.7	4.4	8.67	6.20	12.4	1,210	1,192.0	0.745	0.0005	0.0036	0.0041	0.0008	0.0161	–
KFM01D	311.00	321.00	16110	2008-10-03	0.0921	7.49		3.9	4.0	0.120	14.9	29.9	1,160		0.527	<0.0002	0.0019	0.0020	<0.0005	0.0127	0.02
KFM01D	429.00	438.00	16042	2008-05-29	0.104	7.63	7.32	3.6	3.5	3.70	12.8	25.5	1,270	1,284.0	0.434	0.0007	0.0252	0.0260	0.0005	0.0015	–
KFM01D	429.00	438.00	16111	2008-10-03	0.135	7.38		6.2	4.3	5.39	10.2	20.3	1,300		0.262	0.0003	0.0045	0.0048	<0.0005	0.0012	0.00753
KFM02A	411.00	442.00	16040	2008-05-29	0.0926	7.32	7.65	5.5	1.8	0.315	–	221	1,530	1,535.0	1.74	0.0014	0.0052	0.0066	<0.0005	0.0005	–
KFM02A	411.00	442.00	16102	2008-10-01	0.0972	7.16		3.4	2.3	0.956	–	225	1,550		1.64	<0.0002	0.0425	0.0425	<0.0005	0.0007	<0.04
KFM02A	490.00	518.00	16041	2008-05-29	0.0955	7.19	7.55	1.5	1.6	0.118	4.65	9.30	1,590	1,535.0	2.63	0.0006	0.0029	0.0035	<0.0005	<0.0005	–
KFM02A	490.00	518.00	16101	2008-10-01	0.113	7.05		1.9	1.9	0.220	3.81	8.50	1,590		2.59	0.0002	0.2050	0.2050	<0.0005	0.0025	<0.04
KFM02B	410.00	431.00	16043	2008-05-29	0.305	7.44	7.81	1.6	1.6	0.113	5.20	10.4	1,560	1,578.0	2.2	0.0005	0.0036	0.0041	<0.0005	<0.0005	–
KFM02B	410.00	431.00	16104	2008-10-01	0.301	7.19		1.6	1.6	0.086	4.90	9.80	1,570		2.15	0.0002	0.0165	0.0166	<0.0005	0.0009	<0.04
KFM02B	491.00	506.00	16039	2008-05-29	2.85	7.36	7.71	1.9	2.1	0.059	3.80	7.60	1,580	1,591.0	2.69	0.0007	0.0011	0.0018	<0.0005	0.0005	–
KFM02B	491.00	506.00	16103	2008-10-01	3.25	7.05		2.2	2.1	0.044	3.35	6.70	1,590		2.65	0.0002	0.0044	0.0046	<0.0005	0.0006	<0.04
KFM03A	633.50	650.00	16028	2008-05-22	–	6.92	8.10	–	–	–	4.15	8.30	1,570	1,536.0	–	–	–	–	–	–	–

Id code	Secup m	Seclow m	Sample no.	Sampling date	I^- mg/L	pH _L	pH_F	TOC mg/L	DOC mg/L	HS^- mg/L	Drill_water %	Uranine ug/L	EC_L mS/m	EC_F	NH_4N mg/L	NO_2-N mg/L	NO_3-N mg/L	NO_2-N+NO_3-N mg/L	PO_4–P mg/L	PO_4-P HLYSIS mg/L	P mg/L
KFM03A	633.50	650.00	16140	2008-10-24	0.132	7.45		<1	1.1	0.147	3.60	7.20	1,580		0.263	0.0007	0.0006	0.0013	<0.0005	0.0007	<0.04
KFM03A	969.50	1001.19	16036	2008-05-23	–	6.82	6.90	–	–	–	0.85	1.70	2630	2,670.0							
KFM03A	969.50	994.50	16147	2008-11-07	0.344	6.48		1.4	1.4	1.15	0.85	1.70	2,680		0.191	0.0004	0.0009	0.0014	0.0016	0.0038	<0.04
KFM04A	230.00	245.00	16034	2008-05-22	–	7.18	7.30	–	–	–	0.65	1.30	1,660	1,636.0							
KFM04A	230.00	245.00	16114	2008-10-06	0.0884	7.02		1.3	1.3	0.090	0.80	1.60	1,680		1.55	<0.0002	0.0015	0.0017	<0.0005	<0.0005	<0.04
KFM06A	341.00	362.00	16049	2008-06-05	–	7.49	7.58	–	–	–	11.4	22.8	1,310	1,303.0							
KFM06A	341.00	362.00	16134	2008-10-17	–	7.45		1.5	1.5	0.298	12.4	24.7	1,320		0.369	<0.0002	0.0025	0.0025	<0.0005	0.0007	
KFM06A	738.00	748.00	16048	2008-06-09	–	7.30	6.96	–	–	–	23.8	47.6	1,730	1,749.0							
KFM06A	738.00	748.00	16136	2008-10-17	–	7.24		–	–	2.41	23.7	47.5	1,720								
KFM06C	531.00	540.00	16064	2008-06-09	–	7.47	7.09	–	–	–	29.4	58.8	1,380	1,393.0							
KFM06C	531.00	540.00	16133	2008-10-17	–	7.62		–	–	0.159	30.3	60.6	1,380		0.599	<0.0002	0.0075	0.0076	<0.0005	0.0015	
KFM06C	647.00	666.00	16066	2008-06-11	–	7.28	7.34	–	–	–	64.1	128	1,310	1,326.0							
KFM06C	647.00	666.00	16162	2008-11-14	–	7.69		–	–	–	40.2	80.4	1,140								
KFM07A	962.00	972.00	16144	2008-10-29	0.412	10.7		27.0	47.0	0.963	2.2	4.40	3,790		0.135	<0.0002	0.0034	0.0035	0.0020	0.0131	<0.04
KFM08A	265.00	280.00	16047	2008-05-29	–	7.58	8.25	–	–	–	20.2	40.4	1,420	1,435.0							
KFM08A	265.00	280.00	16139	2008-10-22	–	7.65		2.1		0.088	21.8	43.5	1,380		0.356	<0.0002	0.0003	0.0003	<0.0005	0.0018	
KFM08A	684.00	694.00	16062	2008-06-05	–	8.37	8.75	–	–	–	7.15	14.3	1,680	1,648.0							
KFM08A	684.00	694.00	16143	2008-10-28	0.287	8.24		<1		0.031	7.15	14.3	1,670		0.107	<0.0002	0.0005	0.0006	<0.0005	0.0008	<0.04
KFM08D	660.00	680.00	16063	2008-06-05	–	7.59	7.88	–	–	–	24.8	49.6	1,280	1,269.0							
KFM08D	660.00	680.00	16146	2008-11-07	–	8.49		–	–	0.312	36.2	72.4	1,570		0.235	<0.0002	0.0034	0.0035	<0.0005	<0.0005	
KFM08D	825.00	835.00	16065	2008-06-09	–	8.14	8.13	–	–	–	14.2	28.3	1,710	1,739.0							
KFM08D	825.00	835.00	16157	2008-11-11	–	7.70		1.8	2.4	0.097	20.1	40.2	1,630		0.293	0.0003	0.0027	0.0030	0.0010	0.0015	
KFM10A	430.00	440.00	16035	2008-05-22	–	7.41	7.70	–	–	–	0.95	1.90	1,560	1,548.0							
KFM10A	430.00	440.00	16099	2008-09-30	0.0519	7.51		2.3	2.2	0.073	0.85	1.70	1,580		1.290	<0.0002	0.0010	0.0012	<0.0005	0.0028	<0.04
KFM11A	446.00	456.00	16038	2008-05-22	–	7.63	6.61	–	–	–	4.94	8.40	1,270	1,260.0							
KFM11A	446.00	456.00	16113	2008-10-06	0.124	7.39		1.1	1.3	0.393	4.88	8.30	1,300		0.0715	<0.0002	0.0005	0.0006	<0.0005	<0.0005	<0.005
KFM11A	690.00	710.00	16037	2008-05-22	–	7.53	7.98	–	–	–	1.47	2.50	1,760	1,750.0							
KFM11A	690.00	710.00	16112	2008-10-06	0.201	7.47		<1	<1	0.307	1.18	2.00	1,810		0.360	0.0002	0.0126	0.0128	<0.0005	0.0012	<0.04
KFM12A	270.00	280.00	16025	2008-05-15	–	7.50	6.83	–	–	–	7.35	14.7	1,040	x							
KFM12A	270.00	280.00	16118	2008-10-07	0.13	7.37		1.3	<1	0.076	6.90	13.8	1,050		0.0611	<0.0002	0.0002	0.0003	<0.0005	<0.0005	<0.005

TableA2-2. Trace elements.

Id code	Secup m	Seclow m	Sample no.	Sampling date	Al ug/L	As ug/L	B ug/L	Ba ug/L	Cd ug/L	Cu ug/L	Cr ug/L	Co ug/L	Hg ug/L	Ni ug/L	V ug/L	U ug/L	Th ug/L
HFM01	33.50	45.50	16120	2008-10-07	3.07	0.53	411	35.1	<0.004	<0.1	0.385	0.0549	<0.002	1.12	1.15	13.0	0.0388
HFM02	38.00	48.00	16119	2008-10-07	1.41	0.28	323	73.1	<0.003	<0.1	0.216	0.0347	<0.002	0.226	0.727	13.7	<0.02
HFM04	58.00	66.00	16100	2008-09-30	4.71	0.24	202	36.0	<0.002	0.17	1.20	0.0363	<0.002	1.07	0.848	2.88	0.0217
HFM13	159.00	173.00	16098	2008-09-30	58.8	<1	591	70.8	<0.05	<0.5	0.387	<0.05	<0.002	0.658	0.0819	16.1	<0.2
HFM15	85.00	95.00	16142	2008-10-28	4.64	<0.1	231	16.2	<0.002	0.404	0.31	0.0345	<0.002	0.313	1.07	6.14	0.0268
HFM16	54.00	67.00	16135	2008-10-17	7.66	1.59	335	21.6	<0.005	<0.1	0.142	0.0403	<0.002	0.19	1.62	5.65	<0.02
HFM19	168.00	182.00	16141	2008-10-28	1.96	<0.5	518	58.6	0.032	<0.2	0.978	<0.02	<0.002	<0.2	0.154	5.45	<0.2
HFM21	22.00	32.00	16138	2008-10-22	20.2	<0.1	221	25.0	<0.002	<0.1	0.495	0.0472	<0.002	0.437	0.872	6.54	<0.02
HFM27	46.00	58.00	16121	2008-10-07	4.97	<0.5	402	47.7	<0.02	<0.2	0.299	<0.02	<0.002	0.28	0.314	17.1	<0.2
HFM32	26.00	31.00	16132	2008-10-14	6.14	2.68	679	57.7	0.035	<0.2	0.305	0.052	<0.002	<0.2	0.221	19.1	<0.2
KFM01A	109.00	130.00	16044	2008-05-29	4.13	<0.1	802	172	<0.002	<0.1	0.163	0.0092	<0.002	0.344	0.0414	2.22	0.0582
KFM01D	311.00	321.00	16045	2008-05-29	8.96	0.40	764	468	<0.002	<0.1	0.667	0.0487	<0.002	0.75	0.288	0.863	0.0692
KFM01D	311.00	321.00	16110	2008-10-03	4.80	0.57	770	464	0.033	0.223	0.984	0.0378	<0.002	0.503	0.177	2.05	<0.2
KFM01D	429.00	438.00	16042	2008-05-29	4.60	0.20	789	545	<0.002	0.196	4.44	0.136	<0.002	2.62	0.232	2.03	0.0459
KFM01D	429.00	438.00	16111	2008-10-03	9.02	0.66	767	613	0.028	0.271	0.766	0.0513	<0.002	0.43	0.144	1.15	<0.2
KFM02A	411.00	442.00	16040	2008-05-29	2.60	<0.5	623	126	<0.02	0.559	0.902	0.408	0.0028	1.21	0.312	43.1	<0.2
KFM02A	411.00	442.00	16102	2008-10-01	5.57	<1	614	136	0.130	2.88	1.01	0.534	<0.002	1.34	0.208	46.2	<0.2
KFM02A	490.00	518.00	16041	2008-05-29	5.28	<0.5	660	84.7	<0.02	0.605	0.899	0.653	0.0024	2.07	0.109	154	<0.2
KFM02A	490.00	518.00	16101	2008-10-01	16.0	<1	653	97.3	<0.05	<0.5	2.01	0.596	<0.002	1.55	0.121	168	<0.2
KFM02B	410.00	431.00	16043	2008-05-29	3.50	<0.5	690	95.5	<0.02	<0.2	0.767	0.233	0.0025	2.10	0.0585	20.8	<0.2
KFM02B	410.00	431.00	16104	2008-10-01	14.2	<1	678	142	<0.05	0.562	0.922	0.501	<0.002	1.61	0.13	22.8	<0.2
KFM02B	491.00	506.00	16039	2008-05-29	1.63	<0.5	660	109	<0.02	<0.2	0.841	0.564	0.0024	3.19	0.0769	8.64	<0.2
KFM02B	491.00	506.00	16103	2008-10-01	2.65	<1	643	121	<0.05	<0.5	0.733	0.668	<0.002	1.57	0.0802	9.37	<0.2
KFM03A	633.50	650.00	16140	2008-10-24	21.2	<1	1,060	163	<0.05	<0.5	0.558	<0.05	<0.002	<0.5	0.141	51.9	<0.2
KFM03A	969.50	994.50	16147	2008-11-07	14.2	1.70	892	1,130	<0.05	<0.5	3.64	0.104	<0.002	2.43	0.171	0.447	<0.2
KFM04A	230.00	245.00	16114	2008-10-06	7.02	<1	582	101	<0.05	<0.5	4.72	8.76	<0.002	3.09	0.151	22.6	<0.2
KFM07A	962.00	972.00	16144	2008-10-29	<0.7	3.30	598	633	<0.05	<0.5	<0.1	<0.05	<0.002	4.29	0.355	0.019	<0.2
KFM08A	684.00	694.00	16143	2008-10-28	2.14	3.00	733	361	<0.05	<0.5	0.821	0.0873	<0.002	0.728	0.0697	4.19	<0.2
KFM10A	430.00	440.00	16099	2008-09-30	3.12	<1	746	110	<0.05	<0.5	0.479	<0.05	<0.002	0.741	0.208	3.68	<0.2
KFM11A	446.00	456.00	16113	2008-10-06	3.62	0.60	1,010	88.3	<0.02	<0.2	0.436	0.130	<0.002	0.299	0.0651	0.385	<0.2
KFM11A	690.00	710.00	16112	2008-10-06	7.53	1.10	871	254	<0.05	<0.5	0.464	<0.05	<0.002	0.618	0.439	0.544	<0.2
KFM12A	270.00	280.00	16118	2008-10-07	9.72	3.50	843	416	<0.02	0.234	0.26	0.508	<0.002	0.843	0.441	44.3	<0.2

Id code	Secup m	Seclow m	Sample no.	Sampling date	Sc ug/L	Rb ug/L	Y ug/L	Zr ug/L	Zn ug/L	In ug/L	Sb ug/L	Cs ug/L	La ug/L	Hf ug/L	Tl ug/L	Ce ug/L	Pr ug/L	Nd ug/L
HFM01	33.50	45.50	16120	2008-10-07	<0.05	12.0	8.42	8.94	0.499	<0.05	0.0224	0.385	0.151	0.0435	<0.01	0.332	0.0639	0.414
HFM02	38.00	48.00	16119	2008-10-07	<0.05	13.0	1.73	6.98	<0.2	<0.05	0.0257	0.412	0.0309	0.0353	<0.01	0.0677	0.0105	0.0543
HFM04	58.00	66.00	16100	2008-09-30	<0.05	8.64	2.04	7.64	0.455	<0.05	0.0103	0.213	0.0999	0.0558	<0.01	0.213	0.0285	0.141
HFM13	159.00	173.00	16098	2008-09-30	<0.5	51.2	18.7	0.369	<2	<0.5	<0.1	2.03	0.778	<0.05	<0.1	1.41	0.191	0.970
HFM15	85.00	95.00	16142	2008-10-28	0.0702	12.9	1.77	10.6	0.568	<0.05	0.0227	193	0.077	0.057	<0.01	0.162	0.0275	0.137
HFM16	54.00	67.00	16135	2008-10-17	<0.05	5.77	0.69	6.68	1.84	<0.05	0.0124	0.0778	0.0245	0.0321	<0.01	0.0537	0.0084	0.0386
HFM19	168.00	182.00	16141	2008-10-28	<0.4	42.8	5.10	0.655	<0.8	<0.2	<0.1	1.84	0.0646	<0.02	<0.05	0.12	0.0222	0.157
HFM21	22.00	32.00	16138	2008-10-22	<0.05	8.79	2.48	5.34	<0.2	<0.05	0.0146	0.164	0.0828	0.0231	<0.01	0.183	0.0283	0.136
HFM27	46.00	58.00	16121	2008-10-07	<0.4	23	1.75	2.69	<0.8	<0.2	<0.1	0.959	0.0823	<0.02	<0.05	0.142	<0.02	0.0917
HFM32	26.00	31.00	16132	2008-10-14	<0.4	38.8	1.20	0.568	<0.8	<0.2	<0.1	0.997	0.0591	<0.02	<0.05	0.0898	<0.02	0.0435
KFM01A	109.00	130.00	16044	2008-05-29	0.113	53.8	13.6	0.27	0.337	<0.05	0.0646	0.493	1.07	0.0248	<0.01	1.50	0.20	1.10
KFM01D	311.00	321.00	16045	2008-05-29	0.0991	47.1	1.62	1.3	0.483	<0.05	0.101	0.286	1.54	0.0299	<0.01	1.68	0.180	0.78
KFM01D	311.00	321.00	16110	2008-10-03	<0.4	46.1	1.20	0.647	2.69	<0.2	0.104	0.468	1.07	<0.02	<0.05	1.21	0.129	0.529
KFM01D	429.00	438.00	16042	2008-05-29	0.119	72.1	7.86	0.673	0.698	<0.05	0.123	6.44	2.05	0.0344	<0.01	2.69	0.368	1.86
KFM01D	429.00	438.00	16111	2008-10-03	<0.4	62.4	6.80	0.309	1.69	<0.2	0.123	7.13	2.04	<0.02	<0.05	2.70	0.361	1.72
KFM02A	411.00	442.00	16040	2008-05-29	<0.4	1,240	3.17	0.201	2.74	<0.2	<0.1	305	0.516	<0.02	<0.05	0.724	0.0837	0.38
KFM02A	411.00	442.00	16102	2008-10-01	<0.5	1530	4.17	<0.3	5.3	<0.5	0.127	389	0.654	<0.05	<0.1	0.966	0.104	0.471
KFM02A	490.00	518.00	16041	2008-05-29	<0.4	53.2	2.19	0.154	2.17	<0.2	0.142	1.57	0.742	<0.02	<0.05	1.19	0.0865	0.384
KFM02A	490.00	518.00	16101	2008-10-01	<0.5	69.6	2.84	<0.3	2.44	<0.5	<0.1	1.96	0.867	<0.05	<0.1	1.58	0.119	0.499
KFM02B	410.00	431.00	16043	2008-05-29	<0.4	68.6	8.40	0.183	2.85	<0.2	<0.1	4.81	0.837	<0.02	<0.05	1.21	0.149	0.764
KFM02B	410.00	431.00	16104	2008-10-01	<0.5	114.0	13.5	<0.3	<2	<0.5	<0.1	7.88	1.35	<0.05	<0.1	2.21	0.244	1.23
KFM02B	491.00	506.00	16039	2008-05-29	<0.4	47.5	2.55	0.295	1.21	<0.2	<0.1	1.39	0.456	0.0204	<0.05	0.575	0.0614	0.277
KFM02B	491.00	506.00	16103	2008-10-01	<0.5	63.1	3.25	<0.3	<2	<0.5	<0.1	2.04	0.575	<0.05	<0.1	0.827	0.0787	0.343
KFM03A	633.50	650.00	16140	2008-10-24	<0.5	43.8	0.394	<0.3	<2	<0.5	<0.1	6.36	0.352	<0.05	<0.1	0.368	<0.05	0.135
KFM03A	969.50	994.50	16147	2008-11-07	<0.5	36.6	0.739	<0.3	<2	<0.5	0.247	0.522	0.931	<0.05	<0.1	1.31	0.115	0.429
KFM04A	230.00	245.00	16114	2008-10-06	<0.5	42.3	1.17	<0.3	3.76	<0.5	0.133	1.77	0.237	<0.05	<0.1	0.216	<0.05	0.0839
KFM07A	962.00	972.00	16144	2008-10-29	<0.5	54.6	0.318	<0.3	<2	<0.5	1.50	0.851	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05
KFM08A	684.00	694.00	16143	2008-10-28	<0.5	32.2	0.108	<0.3	5.1	<0.5	0.171	0.59	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05
KFM10A	430.00	440.00	16099	2008-09-30	<0.5	66.9	6.28	0.616	2.8	<0.5	<0.1	1.09	0.244	<0.05	<0.1	0.359	0.0619	0.477
KFM11A	446.00	456.00	16113	2008-10-06	<0.4	13.9	0.165	<0.1	0.886	<0.2	0.156	0.359	0.0418	<0.02	<0.05	0.0443	<0.02	<0.02
KFM11A	690.00	710.00	16112	2008-10-06	<0.5	21.9	0.168	<0.3	<2	<0.5	0.171	0.223	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05
KFM12A	270.00	280.00	16118	2008-10-07	<0.4	16.4	1.41	<0.1	1.24	<0.2	0.801	0.348	0.122	<0.02	<0.05	0.142	<0.02	0.0865

Id code	Secup m	Seclow m	Sample no.	Sampling date	Sm ug/L	Eu ug/L	Gd ug/L	Tb ug/L	Dy ug/L	Ho ug/L	Er ug/L	Tm ug/L	Yb ug/L	Mo ug/L	Pb ug/L	Se (ug/l)
HFM01	33.50	45.50	16120	2008-10-07	0.387	7.26	1.28	0.339	2.61	0.554	1.49	0.143	0.605	13.0	0.0365	
HFM02	38.00	48.00	16119	2008-10-07	0.0266	<0.005	0.0687	0.0147	0.135	0.0368	0.148	0.0218	0.142	7.99	0.0139	
HFM04	58.00	66.00	16100	2008-09-30	0.0573	<0.005	0.127	0.0254	0.197	0.0539	0.188	0.0262	0.176	4.65	0.0153	
HFM13	159.00	173.00	16098	2008-09-30	0.328	<0.05	0.838	0.215	1.17	0.32	1.06	0.135	0.7880	4.52	<0.3	
HFM15	85.00	95.00	16142	2008-10-28	0.0669	0.0172	0.167	0.0321	0.237	0.0603	0.20	0.0274	0.172	9.23	0.0214	
HFM16	54.00	67.00	16135	2008-10-17	0.0146	<0.005	0.0365	0.0077	0.0652	0.0168	0.0653	0.0089	0.0668	21.2	0.0461	
HFM19	168.00	182.00	16141	2008-10-28	0.17	0.0244	0.684	0.21	2.14	0.33	0.647	0.0608	0.269	4.29	0.103	
HFM21	22.00	32.00	16138	2008-10-22	0.0588	<0.005	0.147	0.0286	0.234	0.061	0.221	0.0315	0.218	6.79	0.0452	
HFM27	46.00	58.00	16121	2008-10-07	0.0262	<0.02	0.0689	<0.02	0.111	0.0326	0.118	<0.02	0.116	8.17	<0.1	
HFM32	26.00	31.00	16132	2008-10-14	<0.02	<0.02	0.0328	<0.02	0.0597	<0.02	0.0661	<0.02	0.0647	12.6	0.133	
KFM01A	109.00	130.00	16044	2008-05-29	0.337	<0.01	0.723	0.115	0.894	0.226	0.712	0.0746	0.374	13.4	<0.01	
KFM01D	311.00	321.00	16045	2008-05-29	0.141	<0.007	0.153	0.0219	0.13	0.0335	0.0874	0.0107	0.0628	2.98	0.0324	0.48
KFM01D	311.00	321.00	16110	2008-10-03	0.104	<0.02	0.12	<0.02	0.0817	0.0213	0.0572	<0.02	0.0379	3.84	<0.1	
KFM01D	429.00	438.00	16042	2008-05-29	0.442	<0.01	0.609	0.0737	0.489	0.115	0.343	0.0375	0.197	0.71	0.014	
KFM01D	429.00	438.00	16111	2008-10-03	0.40	<0.02	0.575	0.0654	0.417	0.101	0.282	0.0299	0.149	<0.3	<0.1	
KFM02A	411.00	442.00	16040	2008-05-29	0.0868	<0.02	0.177	0.0296	0.216	0.0536	0.164	0.0214	0.113	26.0	<0.1	
KFM02A	411.00	442.00	16102	2008-10-01	0.104	<0.05	0.218	<0.05	0.252	0.0681	0.20	<0.05	0.131	30.9	<0.3	
KFM02A	490.00	518.00	16041	2008-05-29	0.0827	<0.02	0.137	0.022	0.146	0.0318	0.0969	<0.02	0.0576	77.8	<0.1	
KFM02A	490.00	518.00	16101	2008-10-01	0.0909	<0.05	0.169	<0.05	0.160	<0.05	0.116	<0.05	0.0842	89.3	<0.3	
KFM02B	410.00	431.00	16043	2008-05-29	0.226	<0.02	0.492	0.0794	0.616	0.142	0.451	0.0514	0.298	7.62	<0.1	
KFM02B	410.00	431.00	16104	2008-10-01	0.365	<0.05	0.783	0.118	0.87	0.229	0.72	0.0787	0.451	11.5	<0.3	
KFM02B	491.00	506.00	16039	2008-05-29	0.0697	<0.02	0.122	<0.02	0.135	0.0322	0.104	<0.02	0.0632	6.41	<0.1	
KFM02B	491.00	506.00	16103	2008-10-01	0.0764	<0.05	0.157	<0.05	0.158	<0.05	0.122	<0.05	0.0802	7.50	<0.3	
KFM03A	633.50	650.00	16140	2008-10-24	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	41.5	<0.3	
KFM03A	969.50	994.50	16147	2008-11-07	0.0607	<0.05	0.0736	<0.05	0.0532	<0.05	<0.05	<0.05	<0.05	11.3	<0.3	
KFM04A	230.00	245.00	16114	2008-10-06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	35.2	<0.3	
KFM07A	962.00	972.00	16144	2008-10-29	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	26.1	<0.3	
KFM08A	684.00	694.00	16143	2008-10-28	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	34.8	<0.3	
KFM10A	430.00	440.00	16099	2008-09-30	0.43	<0.05	1.20	0.203	1.34	4.13	0.742	0.0719	0.29	3.50	<0.3	
KFM11A	446.00	456.00	16113	2008-10-06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	17.5	<0.1	
KFM11A	690.00	710.00	16112	2008-10-06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	30.4	<0.3	
KFM12A	270.00	280.00	16118	2008-10-07	0.0266	<0.02	0.0523	<0.02	0.0681	0.0211	0.0695	<0.02	0.0686			

Table A2-3. Isotopes I (H-, O-, B-, S-, C-, Sr- and Cl-isotopes).

Id code	Secup m	Seclow m	Sample no	Sampling date	δ^{2}H ‰ SMOW	^{3}H TU	δ^{18}O ‰ SMOW	^{10}B/^{11}B no unit	δ^{34}S ‰ CDT	δ^{13}C ‰ PDB	^{87}Sr/^{86}Sr no unit	^{14}C pmC	δ^{37}Cl ‰ SMOC
HFM01	33.50	45.50	16031	2008-05-21	–75.7	4.90	–10.4						
HFM01	33.50	45.50	16120	2008-10-07	–75.4	4.80	–11.4	0.2379	14.5	–9.74	0.726739	47.65	
HFM02	38.00	48.00	16033	2008-05-21	–78.9	5.40	–11.0						
HFM02	38.00	48.00	16119	2008-10-07	–79.4	5.60	–10.6	0.2381	21.4	–11.49	0.724758	62.38	
HFM04	57.90	65.90	16029	2008-05-22	–85.2	6.80	–11.8						
HFM04	58.00	66.00	16100	2008-09-30	–80.2	7.60	–11.8	0.2392	15.4	–12.43	0.719651	72.41	
HFM13	159.00	175.60	16027	2008-05-15	–71.2	1.30	–9.3						
HFM13	159.00	173.00	16098	2008-09-30	–67.7	0.90	–9.4	0.2379	24.0	–5.80	0.717768	17.5	
HFM15	85.00	99.50	16023	2008-05-15	–80.9	4.20	–10.7						
HFM15	85.00	95.00	16142	2008-10-28	–80.2	9.50	–11	0.2369	19.2	–13.17	0.723134		
HFM16	54.00	67.00	16032	2008-05-22	–80.9	4.90	–11.1						
HFM16	54.00	67.00	16135	2008-10-17	–78.6	5.60	–10.8	0.2382	11.3	–10.74	0.719184		
HFM19	168.00	185.20	16026	2008-05-15	–68.6	2.90	–9.00						
HFM19	168.00	182.00	16141	2008-10-28	–66.0	1.30	–8.9	0.2402	24.9	–9.07	0.721422		
HFM21	22.00	32.00	16024	2008-05-15	–82.2	8.50	–11.3						
HFM21	22.00	32.00	16138	2008-10-22	–81.4	8.00	–11.2	0.2384	10.3	–12.47	0.727137		
HFM27	46.00	58.00	16030	2008-05-21	–73.2	2.60	–9.8						
HFM27	46.00	58.00	16121	2008-10-07	–72.0	2.40	–10.5	0.2378	23.4	–8.62	0.724337		
HFM32	26.00	31.00	16046	2008-06-05	–67.5	1.90	–8.7						
HFM32	26.00	31.00	16132	2008-10-14	–65.0	2.20	–8.5	0.2369	28.7	–7.25	0.727014		
KFM01A	109.00	130.00	16044	2008-05-29	–86.9	1.80	–11.3						
KFM01A	109.00	130.00	16109	2008-10-03	–82.5	–	–11.1	0.2360					
KFM01D	311.00	321.00	16045	2008-05-29	–78.9	1.10	–10.5						
KFM01D	311.00	321.00	16110	2008-10-03	–72.7	1.60	–10.3	0.2363	29.2	–14.1	0.720991	45.19	
KFM01D	429.00	438.00	16042	2008-05-29	–73.6	1.10	–10.4						
KFM01D	429.00	438.00	16111	2008-10-03	–74.0	1.20	–10.6	0.2363	41.1	–15.7	0.720376	56.87	
KFM02A	411.00	442.00	16040	2008-05-29	–79.4	2.00	–10.3						
KFM02A	411.00	442.00	16102	2008-10-01	–72.8	2.20	–10.4	0.2371	20.6	–7.01	0.715560		
KFM02A	490.00	518.00	16041	2008-05-29	–66.6	<0.8	–8.7						
KFM02A	490.00	518.00	16101	2008-10-01	–63.8	1.40	–8.8	0.2374	24.6	–5.06	0.718309	17.68	
KFM02B	410.00	431.00	16043	2008-05-29	–73.0	<0.8	–9.5						

Id code	Secup m	Seclow m	Sample no	Sampling date	δ^{2}H ‰ SMOW	^{3}H TU	δ^{18}O ‰ SMOW	^{10}B/^{11}B no unit	δ^{34}S ‰ CDT	δ^{13}C ‰ PDB	^{87}Sr/^{86}Sr no unit	^{14}C pmC	δ^{37}Cl ‰ SMOC
KFM02B	410.00	431.00	16104	2008-10-01	–68.1	<0.8	–9.6	0.2387	25.2	–5.44	0.717476	12.13	
KFM02B	491.00	506.00	16039	2008-05-29	–66.4	<0.8	–8.7						
KFM02B	491.00	506.00	16103	2008-10-01	–62.9	1.00	–8.8	0.2367	24.5	–5.20	0.718481	17.79	
KFM03A	633.50	650.00	16028	2008-05-22	–84.9	<0.8	–11.7						
KFM03A	633.50	650.00	16140	2008-10-24	–81.4	1.10	–11.5	0.2366	27.0	–13.1	0.717496	45.64	
KFM03A	969.50	1,001.19	16036	2008-05-23	–97.5	<0.8	–13.9						
KFM03A	969.50	994.50	16147	2008-11-07	–92.7	<0.8	–13.6	0.2376	33.1	–11.1	0.717777	52.96	
KFM04A	230.00	245.00	16034	2008-05-22	–72.6	1.30	–9.5						
KFM04A	230.00	245.00	16114	2008-10-06	–63.8	<0.8	–9.7	0.2368	25.2	–4.11	0.717613	16.13	
KFM06A	341.00	362.00	16049	2008-06-05	–88.2	1.30	–12.1						
KFM06A	341.00	362.00	16134	2008-10-17	–85.0		–11.8						
KFM06A	738.00	748.00	16048	2008-06-09	–82.9	1.40	–11.8						
KFM06A	738.00	748.00	16136	2008-10-17	–79.3	1.90	–11.6						
KFM07A	962.00	972.00	16144	2008-10-29	–85.5	<0.8	–12.7	0.2392	27.4	–20.10	0.717828	78.85	
KFM08A	265.00	280.00	16047	2008-05-29	–95.9	1.20	–12.9						
KFM08A	265.00	280.00	16139	2008-10-22	–90.6		–12.8						
KFM08A	684.00	694.00	16062	2008-06-05	–92.3	<0.8	–13.1						
KFM08A	684.00	694.00	16143	2008-10-28	–88.0	1.20	–12.9	0.2398	30.4	–13.10	0.718130	42.4	
KFM08D	660.00	680.00	16146	2008-11-07	–77.2		–11.4						
KFM08D	825.00	835.00	16065	2008-06-09	–82.0	0.80	–11.7						
KFM08D	825.00	835.00	16157	2008-11-11	–75.4		–11.2						
KFM10A	430.00	440.00	16035	2008-05-22	–71.4	<0.8	–9.4						
KFM10A	430.00	440.00	16099	2008-09-30	–65.1	1.30	–9.2	0.2365	24.2	–6.30	0.718891		
KFM11A	446.00	456.00	16038	2008-05-22	–89.1	1.50	–12						
KFM11A	446.00	456.00	16113	2008-10-06	–82.9	1.50	–12.6	0.2369	27.7	–13.60	0.716172	66.33	
KFM11A	690.00	710.00	16037	2008-05-22	–85.1	1.30	–11.8						
KFM11A	690.00	710.00	16112	2008-10-06	–79.9	1.50	–12	0.2368	53.1	–14.30	0.717221	64.76	
KFM12A	270.00	280.00	16025	2008-05-15	–105.8	<0.8	–14.4						
KFM12A	270.00	280.00	16118	2008-10-07	–109.6	<0.8	–15.6	0.2374	29.5	–14.60	0.716641	28.44	

Table A2-4. Isotopes II (U-, Th, Ra- and Rn-isotopes).

Id code	Secup m	Seclow m	Sample no.	Sampling date	^{238}U mBq/L	^{235}U mBq/L	^{234}U mBq/L	^{232}Th mBq/L	^{230}Th mBq/L	^{226}Ra Bq/L	^{222}Rn Bq/L At time of analysis	^{222}Rn Bq/L At time of collection
HFM01	33.50	45.50	16120	2008-10-07	159.5	5.61	361.6	0.24	1.08	0.122	68.7	171
HFM02	38.00	48.00	16119	2008-10-07	157.1	4.78	375.6	0.10	0.38	0.342	25.3	59.5
HFM04	58.00	66.00	16100	2008-09-30	42.8	1.93	120.9	0.16	0.40	0.135	71.5	164
HFM13	159.00	173.00	16098	2008-09-30	186.5	8.52	703.5	0.16	0.19	0.668	343	754
HFM15	85.00	95.00	16142	2008-10-28	82.00	2.84	179.7	0.50	1.70			
HFM16	54.00	67.00	16135	2008-10-17	95.5	3.29	245	0.28	1.18			
HFM19	168.00	182.00	16141	2008-10-28	64.8	2.72	188.5	0.25	0.60			
HFM21	22.00	32.00	16138	2008-10-22	64.1	2.27	202.9	0.18	0.58			
HFM27	46.00	58.00	16121	2008-10-07	211	6.96	585.9	0.14	0.12	0.430	107	270
HFM32	26.00	31.00	16132	2008-10-14	236.4	7.28	615.4	0.17	0.71	0.462	57.8	110
KFM01D	311.00	321.00	16110	2008-10-03	27.1	1.07	95.2	0.23	0.12	1.273	103	298
KFM01D	429.00	438.00	16111	2008-10-03	13.3	0.49	41.9	0.20	0.46	4.027	180	449
KFM02A	411.00	442.00	16102	2008-10-01	576.4	20.77	1,677.9	0.10	0.33	0.850	352	739
KFM02A	490.00	518.00	16101	2008-10-01	1,937.2	41.3	4,026.7	0.10	0.32	2.345	1,140	2,329
KFM02B	410.00	431.00	16104	2008-10-01	297.3	9.42	1,487	0.24	0.49	1.482	1,005	2,247
KFM02B	491.00	506.00	16103	2008-10-01	110.4	2.79	307.7	0.19	0.55	1.536	297	643
KFM03A	633.50	650.00	16140	2008-10-24	598.2	19.09	902.7	0.21	0.17			
KFM03A	969.50	994.50	16147	2008-11-07	6.80	0.24	14.0	0.09	0.55			
KFM04A	230.00	245.00	16114	2008-10-06	269.1	9.93	701.2	0.27	0.41	0.514	106	283
KFM07A	962.00	972.00	16144	2008-10-29	0.40	<0.02	13.0	0.11	0.19			
KFM08A	684.00	694.00	16143	2008-10-28	47.3	2.06	100.7	0.27	0.55			
KFM10A	430.00	440.00	16099	2008-09-30	35.6	1.77	113.9	0.19	1.84	0.989	105	237
KFM11A	446.00	456.00	16113	2008-10-06	4.90	0.15	12.5	0.16	0.23	1.144	199	521
KFM11A	690.00	710.00	16112	2008-10-06	7.00	0.24	17.4	0.32	0.49	4.696	160	409
KFM12A	270.00	280.00	16118	2008-10-07	503.6	14.92	1,467.2	0.32	0.84	2.627	21.9	51.9

Appendix 3

Near surface groundwater

Table A3-1. Sampling object coordinates, depth to the upper (Secup) and lower (Seclow) limits of the filter sections and total depths.

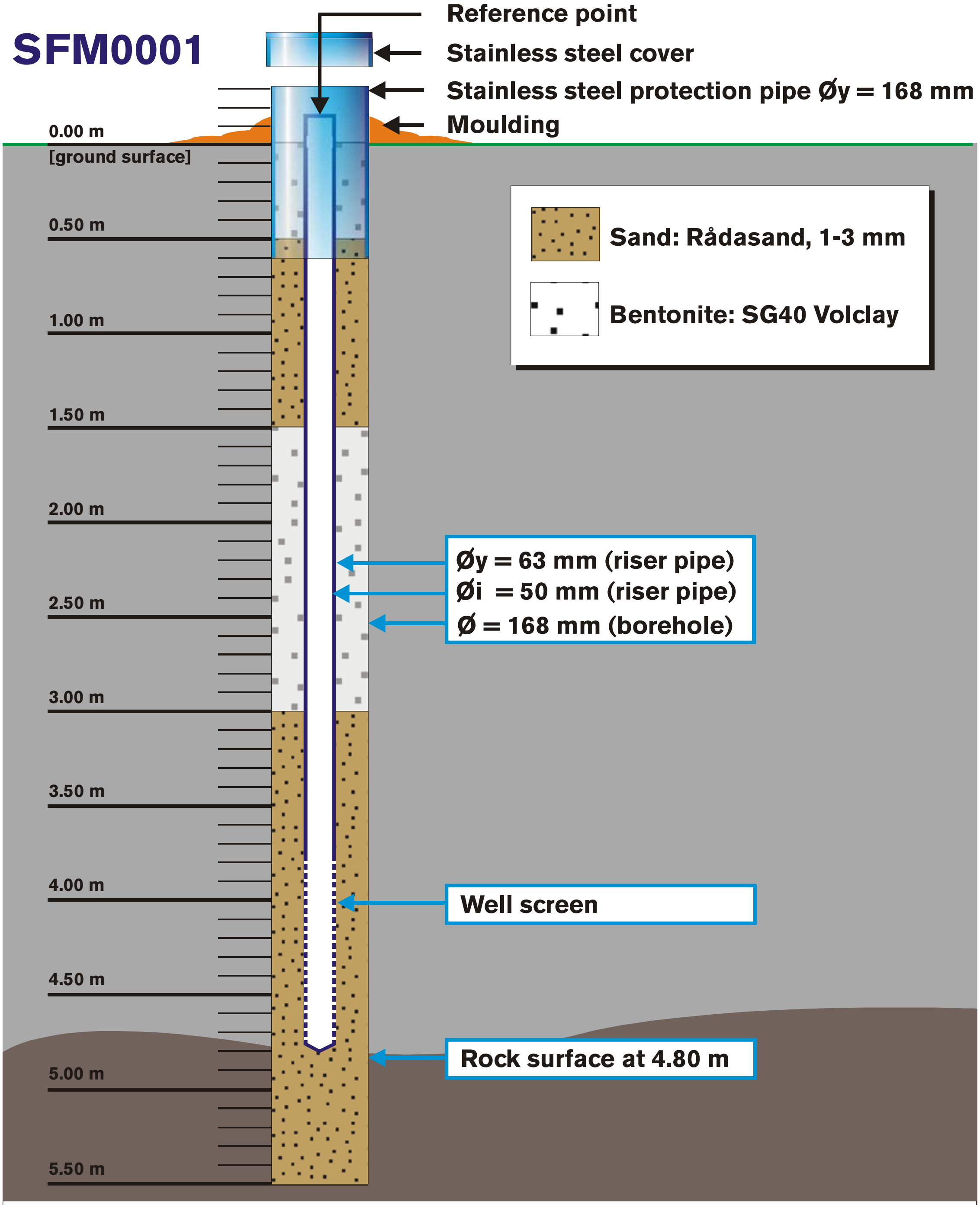
Sampling object*	Coordinates (RT90-RHB70)**			Depths		
Id code	Northing (m)	Easting (m)	Elevation (m RHB70)	Secup*** (m)	Seclow*** (m)	Depth**** (m)
SFM0001	6699713	1631335	1.1	3.95	4.95	4.95
SFM0023	6698983	1632064	1.1	4.42	5.42	5.42
SFM0032	6698838	1631726	1.6	3	4	5
SFM0037	6699992	1631744	1.5	2	3	4
SFM0049	6700028	1630533	4	4	5	6
SFM0051	6699600	1631488	2.2	5.02	5.18	5.27
SFM0081	6698999	1632093	1.31	4.85	5.25	5.25
SFM0083	6699000	1632093	1.36	2.54	2.7	2.75
SFM0084	6699868	1632106	1.23	3.7	4.1	4.1
SFM0086	6699869	1632406	1.69	3.09	3.25	3.3
SFM0087	6699868	1632406	1.31	2	2.2	2.35
SFM0089	6699868	1632406	1.06	2.09	2.25	2.3
SFM0091	6699745	1631490	1.41	1.9	2.3	2.3
SFM0093	6699745	1631490	1.31	1.55	1.71	1.76
SFM0095	6698015	1630437	12.1	5	6	7.1
SFM0097	6698015	1630438	11.49	3.09	3.25	3.3
SFM0100	6698015	1630437	11.48	2.09	2.25	2.3
SFM0102	6698015	1630438	12.03	2.09	2.25	2.3
PFM000001	6697373	1634709	–	45	–	–
PFM000009	6698227	1634724	–	70	–	–
PFM006382	6698691	1634249	–	–	–	–

* The designs of the different types (A, B and C) of monitoring wells/stand pipes are presented in Figures A1-1 to A1-3. Typ D = BAT filter tip installation is described in Section 3.3.3.

** Northing, easting and elevation for the reference point TOC (Top of Casing).

*** Secup = length from TOC to filter/screen part of the pipe (upper section limit).

**** Length/depth of casing/pipe from TOC.

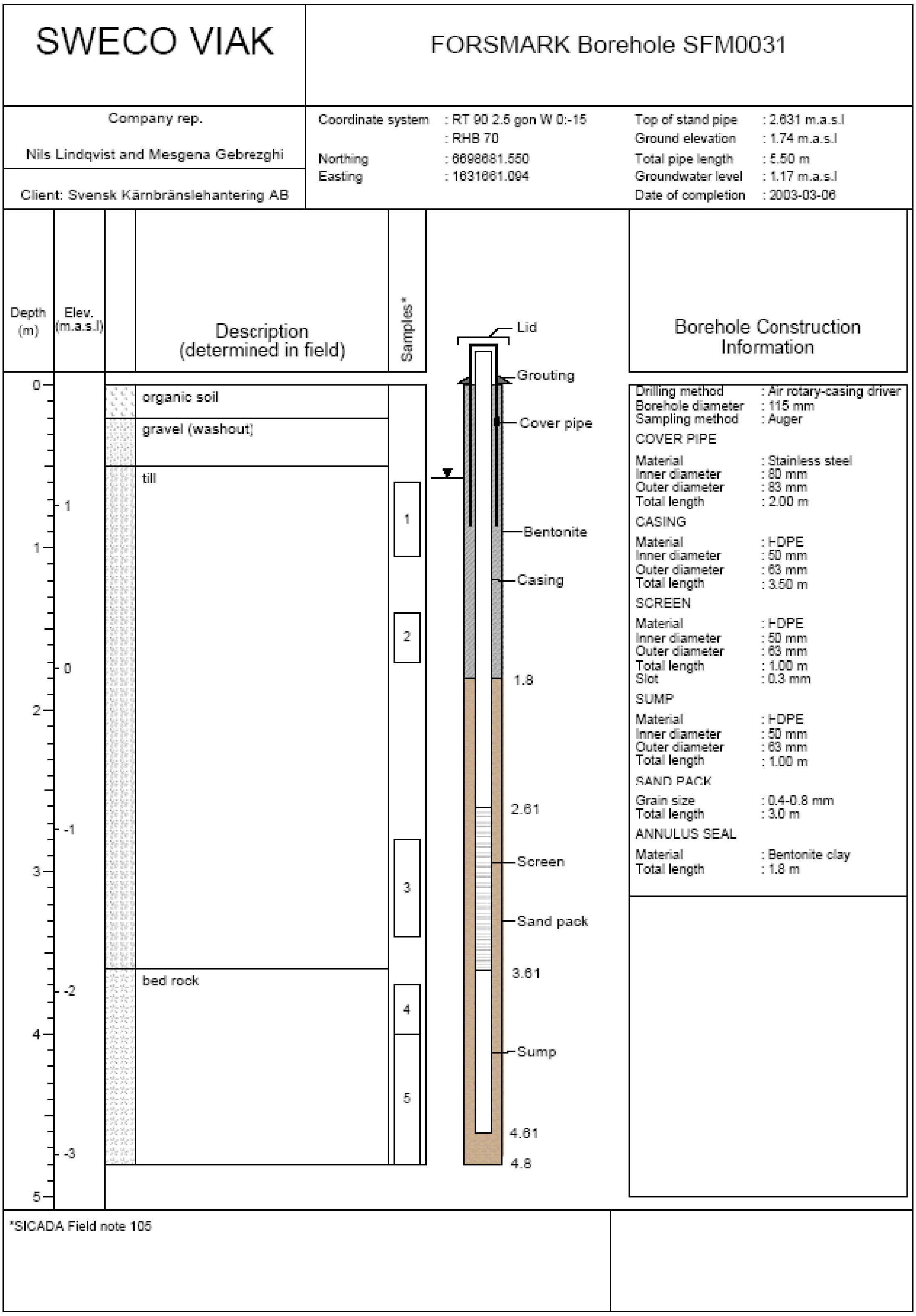


Installation date:
2002-05-23

Reference point

Northing:	**6699713.313 (m), RT90 2.5 gon V 0:-15**
Easting:	**1631335.440 (m), RT90 2.5 gon V 0:-15**
Elevation:	**1.104 (m), RHB 70**

Figure A3-1. *Design of an A-type, drill site connected shallow soil monitoring well (e.g. SFM0001). The filter/screen section is placed at the bottom of the pipe. Note that all length information given in the database Sicada refers to the reference point as zero point.*



SWECO VIAK

FORSMARK Borehole SFM0031

Company rep.

Nils Lindqvist and Mesgena Gebrezghi

Client: Svensk Kärnbränslehantering AB

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

Borehole 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 : 2.00 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 : 1.00 m

SAND PACK

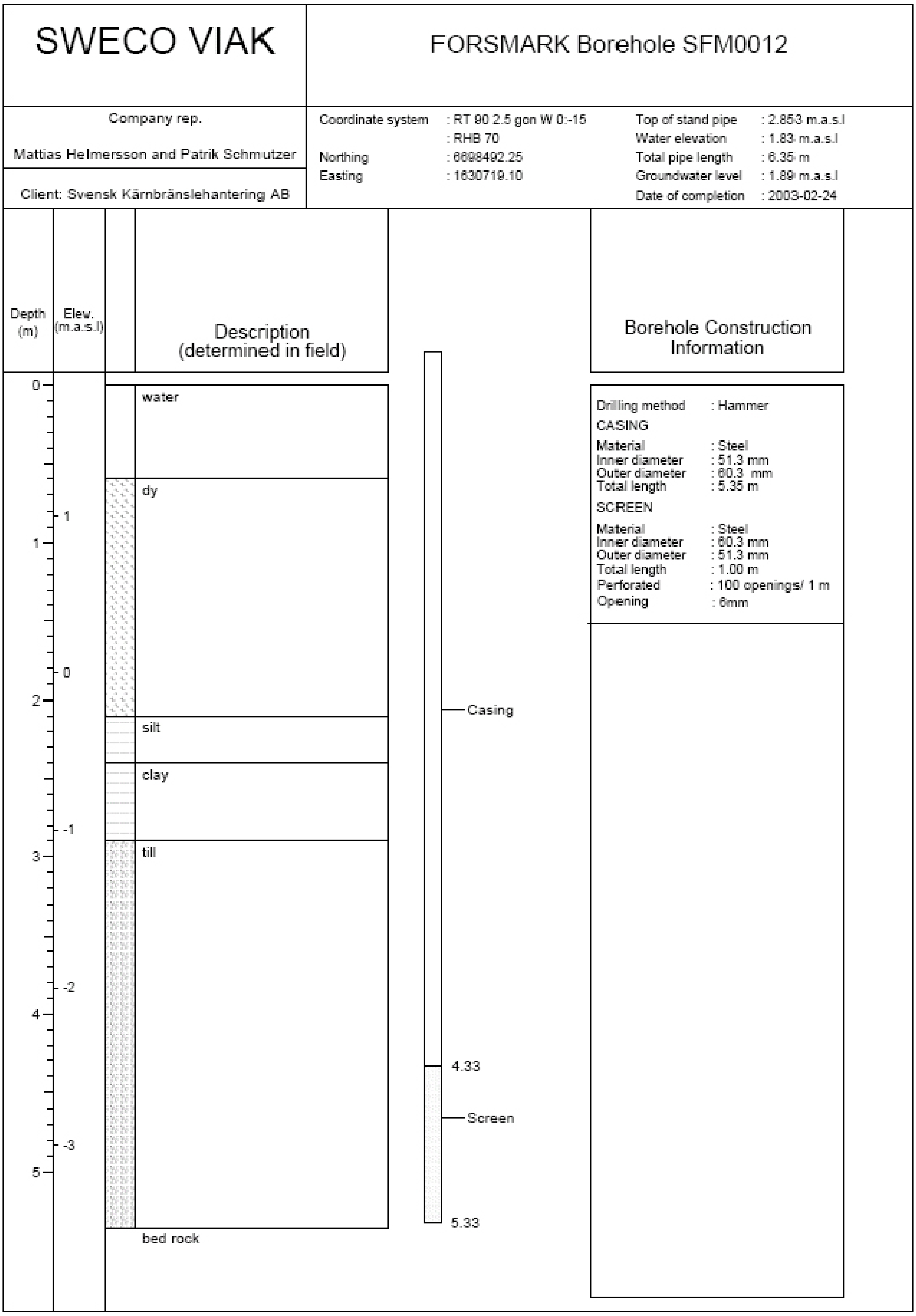
Grain size : 0.4-0.8 mm
Total length : 3.0 m

ANNULUS SEAL

Material : Bentonite clay
Total length : 1.8 m

*SICADA Field note 105

Figure A3-2. *Design of a B-type, double stand pipe for sampling of water. The filter section is placed one metre up from the bottom of the pipe. Note that all length information given in the database Sicada refers to Top Of Casing as zero point.*



SWECO VIAK

FORSMARK Borehole SFM0012

Company rep.

Mattias Helmersson and Patrik Schmutzer

Client: Svensk Kärnbränslehantering AB

Coordinate system : RT 90 2.5 gon W 0:-15
: RHB 70
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

Borehole Construction Information

Drilling method : Hammer

CASING

Material : Steel
Inner diameter : 51.3 mm
Outer diameter : 60.3 mm
Total length : 5.35 m

SCREEN

Material : Steel
Inner diameter : 60.3 mm
Outer diameter : 51.3 mm
Total length : 1.00 m
Perforated : 100 openings/ 1 m
Opening : 6mm

Figure A3-3. Design of a C-type, stand pipe in sediment layer below open water. Note that all length information given in the database Sicada refers to Top Of Casing as zero point.

Table A3-2. Field measurements.

Id code	Start_date yyyy/mm/dd hh:mm	Stop_date yyyy/mm/dd hh:mm	Water temp. (°C)	pH	EC (mS/m)	Salinity (%)	ORP (mV)	O_2 diss. (mg/L)	Oxygen (%)
SFM0001	2008-01-15 17:45	2008-01-15 18:21	6.52	7.01	217.9	1.12	–122.70	0.36	2.9
SFM0001	2008-04-09 09:50	2008-04-09 10:20	5.00	7.13	118.0	0.59	–127.00	0.12	0.9
SFM0001	2008-08-05 20:45	2008-08-05 21:40	7.64	7.19	183.7	0.94	–140.60	3.03	25.5
SFM0001	2008-10-09 10:35	2008-10-09 11:00	8.22	7.19	203.4	1.04	–106.00	0.66	5.6
SFM0023	2008-01-18 09:30	2008-01-18 10:00	7.68	7.52	1,064.0	6.02	–234.00	0.78	6.8
SFM0023	2008-04-10 16:00	2008-04-10 16:21	6.53	7.43	1,063.0	5.99	–231.00	0.34	2.9
SFM0023	2008-08-08 08:30	2008-08-08 09:00	15.36	7.19	1,043.0	5.93	–231.20	2.42	25.1
SFM0023	2008-10-10 09:00	2008-10-10 09:30	11.70	7.53	1,034.0	5.86	–248.00	0.21	2.1
SFM0032	2008-01-15 19:42	2008-01-15 20:14	4.79	7.10	76.1	0.37	–95.40	0.25	1.9
SFM0032	2008-04-09 11:50	2008-04-09 12:20	3.95	7.07	70.0	0.34	–92.00	0.14	1.0
SFM0032	2008-08-06 11:42	2008-08-06 12:24	10.95	6.97	89.6	0.44	–135.20	0.83	7.5
SFM0032	2008-10-07 20:13	2008-10-07 21:00	9.21	6.97	79.7	0.39	–150.00	1.35	11.8
SFM0037	2008-01-17 15:10	2008-01-17 16:10	3.84	7.17	118.8	0.59	–84.40	0.25	1.9
SFM0037	2008-04-11 10:33	2008-04-11 11:50	4.07	7.07	9.2	0.45	–98.00	0.18	1.4
SFM0037	2008-08-06 17:10	2008-08-06 18:30	12.34	7.16	134.0	0.68	29.30	2.58	24.2
SFM0037	2008-10-08 16:15	2008-10-08 16:45	8.56	7.00	80.5	0.40	–120.00	1.40	12.0
SFM0049	2008-01-16 19:30	2008-01-16 20:10	2.96	6.95	34.9	0.17	–12.60	0.44	3.3
SFM0049	2008-04-07 20:04	2008-04-07 20:35	3.29	6.73	36.0	0.17	–57.00	0.34	2.5
SFM0049	2008-08-06 08:30	2008-08-06 09:20	11.79	6.64	41.6	0.20	–145.60	0.72	6.7
SFM0049	2008-10-08 12:09	2008-10-08 12:28	9.90	6.77	35.9	0.17	–62.00	0.63	5.6
SFM0081	2008-01-17 10:50	2008-01-17 11:20	6.33	7.83	1,201.0	6.83	–237.40	0.22	1.8
SFM0081	2008-04-10 15:10	2008-04-10 15:48	5.11	7.88	1,214.0	6.89	–278.00	0.30	2.5
SFM0084	2008-01-16 18:00	2008-01-16 18:40	5.46	7.19	94.6	0.47	–111.80	0.56	4.4
SFM0084	2008-04-07 17:00	2008-04-07 17:40	5.60	7.32	90.0	0.44	–149.00	0.48	3.8
SFM0087	2008-01-15 11:59	2008-01-15 12:35	5.48	6.62	180.6	0.92	–154.20	0.91	7.2
SFM0087	2008-04-07 11:29	2008-04-07 12:05	4.69	6.58	179.0	0.91	–149.00	0.49	3.8
SFM0091	2008-01-15 15:15	2008-01-15 15:50	5.01	6.96	205.4	1.05	–303.10	0.42	3.3
SFM0091	2008-04-10 17:38	2008-04-10 17:58	3.59	7.25	19.6	0.99	–240.00	0.21	1.6
SFM0095	2008-01-16 15:10	2008-01-16 15:45	6.51	7.04	69.9	0.34	–147.20	0.26	2.1
SFM0095	2008-04-09 16:20	2008-04-09 16:40	6.09	6.94	68.0	0.33	–114.00	0.22	1.8

Table A3-3a. Water composition.

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	RCB %	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	HCO3 mg/L	Cl mg/L	SO4 mg/L	SO4-S mg/L	Br mg/l	F$^-$ mg/L	Si mg/L	Fe mg/L	Fe(tot) mg/L	Fe(+II) mg/L	Mn mg/L	Li mg/L	Sr mg/L	pH (lab)	EC (lab) mS/m	HS$^-$ mg/L	I$^-$ mg/L
SFM0001	3.80	4.80	2008-01-15	12932	7.65	287	23.1	123	51.5	358	329	220	79.2	1.16	0.49	8.14	2.90			0.266	0.0202	0.504	7.06	219	0.098	0.012
SFM0001	3.80	4.80	2008-04-09	12984	–0.44	123	12.7	87.0	25.2	335	141	124	43.2	0.462	0.60	7.07					0.0100	0.273	7.19	119		
SFM0001	3.80	4.80	2008-08-05	16080	–2.93	259	19.4	101	38.7	460	348	199	62.1	1.26	0.78	8.24	2.14	2.16	2.13	0.218	0.0159	0.379	7.29	192		0.017
SFM0001	3.80	4.80	2008-10-09	16126	–0.70	261	20.3	106	39.7	471	329	166	58.8	1.26	0.71	8.78					0.0183	0.405	7.45	200		
SFM0023	3.32	4.32	2008-01-18	12939	–7.10	1,300	64.9	475	159.0	194	3,500	326	120	14.4	0.73	5.83					0.0592	3.61	7.01	1,070		
SFM0023	3.32	4.32	2008-04-10	12988	–5.79	1,400	56.9	492	156.0	165	3,620	329	113	12.4	0.79	4.66					0.0511	3.20	6.74	1,050		
SFM0023	3.32	4.32	2008-08-08	16079	–4.88	1,360	66.6	470	150.0	134	3,430	362	121	14.6	0.97	3.58					0.0566	3.30	6.84	1,050		0.064
SFM0023	3.32	4.32	2008-10-10	16125	–2.57	1,440	64.9	449	145.0	157	3,330	277	115	13.7	1.21	5.01					0.0558	3.23	6.64	1,010		
SFM0032	1.94	2.94	2008-01-15	12931		34.0	6.41	117	10.1		38.3	57.6	22.2	0.197	0.65	6.54	1.74	1.82	1.79	0.238	0.0062	0.214	7.05	77.1	0.025	0.006
SFM0032	1.94	2.94	2008-04-09	12985	2.08	24.4	5.22	121	9.4	342	34.7	48.1	17.0	0.182	0.69	6.28					0.0071	0.198	7.11	71.7		
SFM0032	1.94	2.94	2008-08-06	16082	–1.73	44.8	7.72	149	12.1	340	69.8	130	55.4	<0.086	0.78	8.21	2.17	2.13	2.09	0.235	0.0108	0.281	7.14	92.5		0.008
SFM0032	1.94	2.94	2008-10-07	16123	0.97	34.8	6.97	126	10.2	367	49.8	53.2	19.1	0.312	0.70	7.46					0.0091	0.228	7.37	81.4		
SFM0037	1.10	2.10	2008-01-17	12935	–0.02	101	8.88	123	22.9	338	122	165	59.0	0.438	0.66	5.08	1.34	1.29	1.28	0.228	0.0075	0.290	7.03	120	0.034	0.005
SFM0037	1.10	2.10	2008-04-11	12990	–1.41	55.5	6.73	121	17.5	354	69.0	117	41.1	0.285	0.72	5.12					0.0081	0.245	7.00	97.0		
SFM0037	1.10	2.10	2008-08-06	16083	–3.90	145	7.71	122	22.1	218	164.0	338	118	<0.05	0.60	6.09	0.180	0.257	0.267	0.061	0.0114	0.252	7.35	142		<0.005
SFM0037	1.10	2.10	2008-10-08	16124	–0.11	70.6	6.87	93.6	14.2	373	78.6	27.8	11.9	0.397	0.58	8.65					0.0073	0.191	7.31	83.1		
SFM0049	2.90	3.90	2008-01-16	12934	0.73	12.8	3.46	53.7	4.6	184	17.3	4.2	2.10	0.055	0.25	4.84	0.423			0.063	<0.004	0.073	6.97	35.9	0.047	0.003
SFM0049	2.90	3.90	2008-04-07	12983	1.52	10.1	3.02	61.0	4.7	195	18.2	3.3	1.63	0.056	0.28	4.97					<0.004	0.077	6.74	37.2		
SFM0049	2.90	3.90	2008-08-06	16081	0.74	13.9	3.39	69.3	5.2	211	23.9	13.3	6.27	<0.219	0.40	4.37	0.795	0.794	0.791	0.093	<0.004	0.093	6.85	41.8		0.006
SFM0049	2.90	3.90	2008-10-08	16122	2.78	13.0	2.77	61.3	5.0	197	20.2	1.2	1.10	<0.2	0.34	6.24					0.0041	0.084	7.05	38.3		
SFM0051	4.32	4.48	2008-01-15	12940	0.32	18.6	5.22	111	7.4	355	34.4	19.3	7.20	0.168	0.54	7.49	6.06	6.04	5.97	0.234	0.0049	0.167	7.22	68.1		0.007
SFM0051	4.32	4.48	2008-04-08	12991	1.04	15.5	4.72	119	7.6	372	29.6	20.7	7.58	0.143	0.57	7.50	6.14	6.20	6.13	0.245	0.0070	0.170	7.11	66.5		0.007
SFM0051	4.32	4.48	2008-08-05	16084	2.47	14.8	5.17	120	7.9	363	27.0	25.3	8.59	0.164	0.57	7.95	6.36	6.35	6.21	0.254	0.0067	0.174	7.57	66.1		0.009
SFM0051	4.32	4.48	2008-10-09	16127	2.04	14.9	5.27	117	7.8	365	22.7	23.0	8.54	<0.2	0.62	8.58	5.98	5.92	5.89	0.247	0.0067	0.177	7.42	66.2		
SFM0081	4.85	5.25	2008-01-17	12938	–0.17	1,920.0	80.5	294	248.0	148	3,900.0	374.0	135.00	15.2	1.09	2.96					0.0478	2.560	6.81	1,200		
SFM0081	4.85	5.25	2008-04-10	12987	–4.53	1,780.0	71.9	308	241.0	152	4,050.0	397.0	135.00	13.7	1.16	3.15					0.0421	2.640	6.87	1,190		
SFM0083	2.54	2.70	2008-01-16	12942	0.21	302.0	12.10	95.1	40.2	231	586.0	41.3	16.90	2.18	0.34	9.67					0.0096	0.452	6.92	224		0.016
SFM0083	2.54	2.70	2008-04-08	12992	–3.08	178.0	8.54	66.3	27.7	225	355.0	30.7	10.90	1.27	0.36	10.7					0.0058	0.287	6.83	152		
SFM0084	3.70	4.10	2008-01-16	12937	–3.58	42.5	13.2	118	22.3	461	68.6	50.8	18.20	0.312	0.41	7.67					0.0108	0.352	7.08	93.9		
SFM0084	3.70	4.10	2008-04-07	12982	–4.56	29.7	10.5	117	19.9	441	45.4	66.7	22.00	0.181	0.43	7.43					0.0088	0.327	7.08	85.3		
SFM0087	2.00	2.20	2008-01-15	12930		200.0	21.3	103	60.2	774	247.0	2.2		1.05	0.40	13.6	0.248			0.555	0.0212	0.571	6.66	183	1.500	0.028
SFM0087	2.00	2.20	2008-04-07	12981		180.0	18.5	109	60.5	790		1.5	3.51	0.922	0.28	12.7					0.0214	0.580	6.69	181		
SFM0091	1.90	2.30	2008-01-15	12936	–0.60	269.0	19.4	85.3	60.0	634	374.0	18.0	10.80	1.44	0.46	14.8					<0.02	0.521	6.98	205		
SFM0091	1.90	2.30	2008-04-10	12989	–4.66	230.0	16.3	81.1	54.5	653	344.0	8.1	5.99	1.18	0.44	13.4					0.0212	0.495	6.91	196		
SFM0095	5.00	6.00	2008-01-16	12933	0.50	23.3	7.36	103	20.7	403	5.3	57.5	22.10	0.094	0.38	9.91	5.07	4.83	4.79	0.431	0.0072	0.303	6.95	71.6	0.167	0.015
SFM0095	5.00	6.00	2008-04-09	12986	–1.93	25.6	7.88	85.0	24.8	456	4.5	9.4	4.51	0.066	0.41	12.9					0.0092	0.314	6.94	68.3		
SFM0102	2.09	2.25	2008-01-16	12941	57.74	2.9	1.12	13.2	2.6	<1	6.2	<0.2	1.62	0.068	<0.2	4.44	0.309			0.037	<0.004	0.033	4.34	9.5		0.015
SFM0102	2.09	2.25	2008-04-10	12993	58.85	2.9	1.06	14.9	2.7	<1	6.5	0.2	1.71	0.067	<0.2	4.92					<0.004	0.037	4.26	9.4		

< "value" = result below detection or reporting limit.

RCB % = Relativ Charge Balance error %.

EC = Electrical conductivity.

Table A3-3b. Drinking water.

Id code		PFM000001	PFM000009	PFM006382
Date	*yyyy/mm/dd*	2008-10-08	2008-10-08	2008-10-08
Kbact	*no/100mL*	220	<1	34
Microbes	*no/100mL*	120,000	22,000	7,000
Ecoli	*no/100mL*	7	<1	<1
Temp.	*_Field*	–	–	–
Smell	*_Lab*	No smell	No smell	No smell
Colour	*(number)*	63	64	140
pH_L		7.7	7.6	7.8
Temp_pH	*(°C)*	25	25	25
Alk	*mg/L*	760	57	360
EC_L	*mS/m*	140	1,400	240
Ca	*mg/L*	200	770	180
Cl	*mg/L*	68	4,700	560
COD	*mg/L*	9.3	13.0	18.0
Cu	*mg/L*	<0.02	<0.02	<0.02
F	*mg/L*	0.8	0.9	0.7
Fe	*mg/L*	6.0	6.6	4.4
Hardness	*_German*	34	140	31
K	*mg/L*	41	28	13
Mg	*mg/L*	27	140	26
Mn	*mg/L*	0.38	0.92	0.13
Na	*mg/L*	36	1,400	220
NH_4_N	*mg/L*	4.400	1.500	0.053
NH_4	*mg/L*	5.70	1.90	0.07
NO_3_N	*mg/L*	<0.1	<0.1	<0.1
NO_3	*mg/L*	<0.44	<0.44	<0.44
NO_2_N	*mg/L*	<0.002	<0.002	<0.002
NO_2	*mg/L*	<0.01	<0.01	<0.01
PO_4_P	*mg/L*	<0.005	<0.005	<0.005
PO_4	*mg/L*	<0.02	<0.02	<0.02
SO_4	*mg/L*	98	240	120

Explanations:

Kbact	Number of coliform bacteria
Ecoli	Number of escherichia coli bacteria at 35°C
Sediment	Ocular inspection of sediment
EC_L	Electric conductivity

Table A3-3c. Surface water supplements.

Id code	Secup m	Seclow m	Date yyyy/mm/dd	Sample no.	NH_4-N mg/L	NO_2-N mg/L	NO_3-N+NO_2-N mg/L	NO_3-N mg/L	N-tot mg/L	P-tot mg/L	PO_4-P mg/L	SiO_4-Si mg/L	TOC mg/L	DOC mg/L	DIC mg/L
SFM0102	2.09	2.25	2008-01-16	12941	0.103	<0.0002	0.0191	0.0191	2.90	0.1110	0.0144	4.33	136	127	11.8
SFM0102	2.09	2.25	2008-04-10	12993	0.130	0.0006	0.0034	0.0029	2.80	0.1070	0.0149	4.35	135	128	5.40
SFM0095	5.00	6.00	2008-01-16	12933	1.03	0.0010	0.0024	0.0014	2.00	0.0810	0.0592	9.82	34.0	34.3	76.3
SFM0095	5.00	6.00	2008-04-09	12986	1.53	0.0006	0.0028	0.0021	1.92	0.1230	0.0481	12.4	17.2	17.1	68.3
SFM0091	1.90	2.30	2008-01-15	12936	0.0660	0.0006	0.0008	<0.0003	0.460	0.1270	0.0080	14.3	12.6	12.4	105.3
SFM0091	1.90	2.30	2008-04-10	12989	0.0514	0.0006	0.0018	0.0012	0.424	0.1160	0.0017	11.5	10.7	10.7	102.0
SFM0087	2.00	2.20	2008-01-15	12930	0.0052	<0.0002	0.0004	0.0004	0.751	0.0677	0.0508	13.1	19.4	19.1	152.9
SFM0087	2.00	2.20	2008-04-07	12981	0.0073	<0.0002	0.0004	0.0003	0.718	0.0597	0.0518	11.8	18.3	17.8	155.0
SFM0084	3.70	4.10	2008-01-16	12937	0.300	0.0010	0.0033	0.0024	0.787	0.3790	0.0026	7.23	17.7	17.8	70.6
SFM0084	3.70	4.10	2008-04-07	12982	0.290	0.0033	0.0042	0.0009	0.775	0.1480	0.0035	6.97	18.3	18.7	61.3
SFM0083	2.54	2.70	2008-01-16	12942	2.09	0.0003	0.0054	0.0051	2.82	0.0172	0.0020	9.43	14.7	14.2	39.4
SFM0083	2.54	2.70	2008-04-08	12992	2.02	<0.0002	0.0057	0.0056	2.89	0.0089	0.0009	10.1	15.0	14.7	35.4
SFM0081	4.85	5.25	2008-01-17	12938	2.03	0.0002	0.0005	0.0004	2.03	0.0179	<0.0005	2.01	2.5	2.2	20.0
SFM0081	4.85	5.25	2008-04-10	12987	2.09	<0.0002	0.0006	0.0005	2.04	0.0037	<0.0005	2.06	2.0	2.4	14.0
SFM0049	2.90	3.90	2008-01-16	12934	0.0492	0.0005	0.0059	0.0055	0.544	0.0097	0.0032	4.77	16.0	15.5	37.3
SFM0049	2.90	3.90	2008-08-06	16081	0.148	x	x	x	0.828	0.0194	0.0122	4.01	21.3	21.4	44.7
SFM0049	2.90	3.90	2008-04-07	12983	0.0631	<0.0002	0.0008	0.0007	0.568	0.0123	0.0079	4.90	17.7	17.6	38.7
SFM0049	2.90	3.90	2008-10-08	16122	0.0835	0.0003	0.0004	<0.0003	0.713	0.0130	0.0087	5.46	21.0	20.5	38.6
SFM0037	1.10	2.10	2008-01-17	12935	0.0132	0.0005	0.0018	0.0013	1.20	0.0657	0.0044	5.01	36.5	37.0	60.6
SFM0037	1.10	2.10	2008-08-06	16083	0.0246	<0.0002	0.2170	0.2170	2.08	1.2000	0.0043	5.43	36.7	37.8	28.0
SFM0037	1.10	2.10	2008-04-11	12990	0.0090	0.0002	0.0010	0.0008	1.11	0.0942	0.0053	4.90	34.5	34.6	59.8
SFM0037	1.10	2.10	2008-10-08	16124	0.0548	0.0006	0.0014	0.0007	2.02	0.6840	0.0101	7.61	48.3	48.1	67.0
SFM0032	1.94	2.94	2008-01-15	12931	0.0723	0.0006	0.0035	0.0029	0.568	0.0119	0.0057	6.40	17.8	17.9	64.6
SFM0032	1.94	2.94	2008-08-06	16082	0.0362	x	x	x	0.573	0.0151	0.0091	7.50	17.2	17.3	62.1
SFM0032	1.94	2.94	2008-04-09	12985	0.0742	<0.0002	0.0006	0.0006	0.582	0.0113	0.0080	5.82	17.8	17.7	56.5
SFM0032	1.94	2.94	2008-10-07	16123	0.0719	0.0004	0.0007	0.0004	0.585	0.0131	0.0076	6.43	17.5	17.2	61.4
SFM0023	3.32	4.32	2008-01-18	12939	2.45	0.0002	0.0009	0.0008	2.410	0.0145	0.0025	4.01	3.0	3.2	24.6
SFM0023	3.32	4.32	2008-04-10	12988	2.46	0.0009	0.0012	<0.0003	2.55	0.0043	0.0009	3.25	3.2	3.3	14.3
SFM0023	3.32	4.32	2008-08-08	16079	2.36	0.0032	x	x	2.45	0.0018	x	3.23	3.6	x	16.9
SFM0023	3.32	4.32	2008-10-10	16125	2.56	0.0006	0.0013	0.0007	2.54	0.0060	<0.0005	3.02	3.1	4.4	16.2
SFM0001	3.80	4.80	2008-01-15	12932	0.265	0.0003	<0.0003	<0.0003	1.49	0.0409	0.0318	7.73	35.4	34.3	93.8
SFM0001	3.80	4.80	2008-08-05	16080	0.198	x	x	x	1.15	0.0448	0.0401	7.45	27.3	27.3	86.3
SFM0001	3.80	4.80	2008-04-09	12984	0.155	0.0003	0.0013	0.0010	1.50	0.0336	0.0261	6.60	39.0	38.9	58.7
SFM0001	3.80	4.80	2008-10-09	16126	0.252	0.0005	0.0005	<0.0003	1.26	0.0459	0.0398	7.79	30.6	31.3	90.7

<“value” = below reporting limit.

x = no result due to analytical problems.

Table A3-3d. Isotopes 1.

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	^{10}B/^{11}B	∂ D (‰ SMOW)	Tritium (TU)	∂^{18}O (‰ SMOW)
SFM0001	3.80	4.80	2008-01-15	12932	0.2386	–84.0	10.7	–10.4
SFM0001	3.80	4.80	2008-04-09	12984	–	–79.4	10.3	–11.1
SFM0001	3.80	4.80	2008-08-05	16080	0.2376	–71.0	9.1	–10.5
SFM0001	3.80	4.80	2008-10-09	16126	–	–79.7	9.0	–11.0
SFM0023	3.32	4.32	2008-01-18	12939	–	–71.1	3.1	–8.5
SFM0023	3.32	4.32	2008-04-10	12988	–	–62.6	2.8	–8.3
SFM0023	3.32	4.32	2008-08-08	16079	0.2367	–65.3	3.5	–8.1
SFM0023	3.32	4.32	2008-10-10	16125	–	–68.2	3.8	–9.2
SFM0032	1.94	2.94	2008-01-15	12931	0.2408	–88.3	10.2	–11.8
SFM0032	1.94	2.94	2008-04-09	12985	–	–83.0	10.2	–12.0
SFM0032	1.94	2.94	2008-08-06	16082	0.2402	–77.7	8.3	–10.9
SFM0032	1.94	2.94	2008-10-07	16123	–	–83.6	10.9	–11.6
SFM0037	1.10	2.10	2008-01-17	12935	0.2417	–86.9	11.0	–11.2
SFM0037	1.10	2.10	2008-04-11	12990	–	–77.2	10.3	–11.1
SFM0037	1.10	2.10	2008-08-06	16083	0.2381	–70.1	12.2	–9.6
SFM0037	1.10	2.10	2008-10-08	16124	–	–82.3	11.4	–11.4
SFM0049	2.90	3.90	2008-01-16	12934	0.2415	–78.8	10.3	–9.8
SFM0049	2.90	3.90	2008-04-07	12983	–	–78.2	13.8	–10.8
SFM0049	2.90	3.90	2008-08-06	16081	0.2397	–70.3	12.6	–8.6
SFM0049	2.90	3.90	2008-10-08	16122	–	–72.0	11.8	–9.4
SFM0051	4.32	4.48	2008-01-15	12940	0.2446	–87.1	10.0	–12.1
SFM0051	4.32	4.48	2008-04-08	12991	0.2442	–81.1	9.6	–11.5
SFM0051	4.32	4.48	2008-08-05	16084	0.2428	–82.4	8.8	–11.4
SFM0051	4.32	4.48	2008-10-09	16127	0.2442	–85.7	11.6	–11.9
SFM0081	4.85	5.25	2008-01-17	12938	–	–66.5	2.5	–8.0
SFM0081	4.85	5.25	2008-04-10	12987	–	–60.5	2.3	–8.0
SFM0083	2.54	2.70	2008-01-16	12942	0.2401	–59.9	10.0	–6.5
SFM0083	2.54	2.70	2008-04-08	12992	–	–62.0	10.0	–7.9
SFM0084	3.70	4.10	2008-01-16	12937	–	–86.7	9.1	–11.2
SFM0084	3.70	4.10	2008-04-07	12982	–	–80.3	9.7	–11.1
SFM0087	2.00	2.20	2008-01-15	12930	0.2392	–82.9	12.8	–10.9
SFM0087	2.00	2.20	2008-04-07	12981	–	–79.6	10.3	–10.7
SFM0091	1.90	2.30	2008-01-15	12936	–	–86.0	9.7	–10.9
SFM0091	1.90	2.30	2008-04-10	12989	–	–73.4	8.7	–11.0
SFM0095	5.00	6.00	2008-01-16	12933	0.2428	–86.5	8.3	–11.5
SFM0095	5.00	6.00	2008-04-09	12986	–	–78.4	8.0	–11.6
SFM0102	2.09	2.25	2008-01-16	12941	0.2441	–85.5	11.1	–11.7
SFM0102	2.09	2.25	2008-04-10	12993	–	–80.2	9.8	–11.5

Tabell A3-3e. Trace metals 1

Id code	Secup m	Seclow m	Date	Sample no.	Al µg/L	As µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Co µg/L	Hg µg/L	Ni µg/L	Zn µg/L	Pb µg/L	V µg/L	Mo µg/L	Ba µg/L	B µg/L
SFM0001	3.80	4.80	2008-08-05	16080	127		<0.002	0.377	0.521	0.175	<0.002	0.640	1.19	0.0978	2.15	1.56	55.5	–
SFM0001	3.80	4.80	2008-01-15	12932	30.2		0.0044	0.471	0.520	0.250	<0.002	1.37	1.13	0.174	1.59	1.25	76.6	–
SFM0032	1.94	2.94	2008-08-06	16082	237		<0.002	0.327	0.269	0.785	<0.002	1.83	2.67	0.0771	1.55	4.99	80.4	–
SFM0032	1.94	2.94	2008-01-15	12931	13.6		<0.01	0.345	0.673	0.098	<0.002	0.730	1.72	0.0413	1.29	2.71	61.1	–
SFM0037	1.10	2.10	2008-08-06	16083	196		0.0852	0.576	13.0	0.455	0.004	3.73	4.25	0.957	3.95	5.74	85.8	–
SFM0037	1.10	2.10	2008-01-17	12935	58.1		0.0256	0.564	1.48	0.353	<0.002	2.73	3.60	0.526	3.60	2.45	86.1	–
SFM0049	2.90	3.90	2008-08-06	16081	73.0		<0.002	0.204	0.103	0.068	<0.002	0.108	0.680	0.0783	0.773	0.0763	28.2	–
SFM0049	2.90	3.90	2008-01-16	12934	17.2		0.0229	0.153	1.07	0.464	<0.002	0.396	0.355	0.570	0.393	0.202	29.6	–
SFM0051	4.32	4.48	2008-10-09	16127	82.3		0.0036	1.38	0.529	0.088	<0.002	1.35	2.55	0.182	2.53	1.15	90.1	–
SFM0051	4.32	4.48	2008-08-05	16084	54.5		<0.002	2.81	0.381	0.077	<0.002	2.09	1.58	0.128	2.10	0.904	88.6	–
SFM0051	4.32	4.48	2008-04-08	12991	60.2		<0.002	4.15	0.289	0.105	0.003	2.83	1.30	0.122	2.02	1.00	84.3	18.9
SFM0051	4.32	4.48	2008-01-15	12940	89.9		0.0087	1.69	0.451	0.104	<0.002	1.51	2.08	0.352	2.59	1.12	89.6	–
SFM0083	2.54	2.70	2008-01-16	12942	16.1		0.0040	0.603	1.49	0.218	<0.002	2.07	11.4	0.480	0.490	0.0730	64.4	–
SFM0087	2.00	2.20	2008-01-15	12930	10.8		0.0032	0.639	<0.1	0.079	<0.002	0.320	0.372	0.0779	3.09	<0.05	134	–
SFM0095	5.00	6.00	2008-01-16	12933	29.4		<0.002	0.527	0.134	0.121	<0.002	0.334	0.374	0.0148	2.95	0.442	93.2	–
SFM0102	2.09	2.25	2008-01-16	12941	110		0.0149	0.287	<0.1	0.041	0.0044	0.314	25.0	0.847	0.406	<0.05	9.17	–

<“value” = below reporting limit.

Table A3-3f. Trace metals 2

Id code	Secup m	Seclow m	Date yyyy/mm/dd	Sample no.	U µg/L	Th µg/L	Sc µg/L	Rb µg/L	Y µg/L	Zr µg/L	In µg/L	Sb µg/L	Cs µg/L	La µg/L	Hf µg/L	Tl µg/L	Ce µg/L	Pr µg/L	Nd µg/L
SFM0001	3.80	4.80	2008-08-05	16080	3.61	0.1400	0.0675	3.24	2.49	6.93	–	0.0552	<0.03	2.38	0.125	<0.01	6.24	0.519	2.11
SFM0001	3.80	4.80	2008-01-15	12932	4.45	0.2060	0.1080	4.32	2.64	5.67	–	0.0836	<0.03	2.39	0.0823	<0.01	6.21	0.528	2.15
SFM0032	1.94	2.94	2008-08-06	16082	6.21	0.0701	0.0544	2.38	1.87	3.85	–	0.0947	<0.03	4.35	0.0774	0.0451	7.01	0.973	3.82
SFM0032	1.94	2.94	2008-01-15	12931	8.55	0.0757	0.0596	2.18	1.83	4.41	–	0.0406	<0.03	1.40	0.0657	<0.01	1.68	0.286	1.17
SFM0037	1.10	2.10	2008-08-06	16083	14.5	0.2970	<0.05	5.40	4.04	2.91	–	0.2690	0.0324	4.35	0.0774	0.0451	7.01	0.973	3.82
SFM0037	1.10	2.10	2008-01-17	12935	18.4	0.4070	0.1880	4.37	5.22	6.30	–	0.1220	<0.03	3.12	0.123	0.0116	5.42	0.739	3.08
SFM0049	2.90	3.90	2008-08-06	16081	0.204	0.0828	0.0635	3.73	0.953	0.445	–	0.0305	<0.03	1.30	0.0196	<0.01	2.43	0.291	1.12
SFM0049	2.90	3.90	2008-01-16	12934	0.422	0.0771	<0.05	3.26	0.657	0.261	–	0.0660	<0.03	0.967	0.0073	0.0146	1.67	0.204	0.807
SFM0051	4.32	4.48	2008-10-09	16127	0.737	0.1090	0.0679	1.46	0.811	7.51	–	0.0360	0.0333	0.417	0.0856	<0.01	0.758	0.0947	0.390
SFM0051	4.32	4.48	2008-08-05	16084	0.908	0.0841	0.0568	1.11	0.708	5.41	–	0.0305	<0.03	0.317	0.101	<0.01	0.623	0.0813	0.343
SFM0051	4.32	4.48	2008-04-08	12991	0.920	0.1150	0.0782	1.35	0.757	8.34	<0.05	0.0340	0.0307	0.337	0.0966	<0.01	0.681	0.0847	0.372
SFM0051	4.32	4.48	2008-01-15	12940	0.729	0.1210	0.0821	1.35	0.804	7.38	–	0.0284	<0.03	0.344	0.0771	<0.01	0.695	0.0853	0.361
SFM0083	2.54	2.70	2008-01-16	12942	0.273	0.0216	0.0968	7.04	0.314	0.820	–	0.0425	0.0608	0.236	0.0095	<0.01	0.449	0.0551	0.228
SFM0087	2.00	2.20	2008-01-15	12930	0.037	<0.02	0.1000	4.39	0.492	1.92	–	0.0182	<0.03	0.185	0.0308	<0.01	0.277	0.0422	0.204
SFM0095	5.00	6.00	2008-01-16	12933	5.71	0.3470	0.1310	1.70	4.40	7.71	–	0.0447	<0.03	1.37	0.104	<0.01	2.55	0.325	1.49
SFM0102	2.09	2.25	2008-01-16	12941	0.0126	<0.02	<0.05	1.25	0.0511	0.125	–	0.0603	<0.03	0.0366	<0.005	<0.01	0.109	0.0139	0.0546

Table A3-3f. Trace metals 2

Id code	Secup m	Seclow m	Date yyyy/mm/dd	Sample no.	Sm µg/L	Eu µg/L	Gd µg/L	Tb µg/L	Dy µg/L	Ho µg/L	Er µg/L	Tm µg/L	Yb µg/L	Lu µg/L
SFM0001	3.80	4.80	2008-08-05	16080	0.387	0.0385	0.386	0.0531	0.347	0.0712	0.217	0.0299	0.199	0.0318
SFM0001	3.80	4.80	2008-01-15	12932	0.391	0.0500	0.404	0.0568	0.350	0.0737	0.217	0.0307	0.206	0.0306
SFM0032	1.94	2.94	2008-08-06	16082	0.721	0.0589	0.667	0.0954	0.629	0.127	0.387	0.0541	0.359	0.0566
SFM0032	1.94	2.94	2008-01-15	12931	0.200	0.0276	0.223	0.0319	0.195	0.0454	0.145	0.0204	0.141	0.0233
SFM0037	1.10	2.10	2008-08-06	16083	0.721	0.0589	0.667	0.0954	0.629	0.127	0.387	0.0541	0.359	0.0566
SFM0037	1.10	2.10	2008-01-17	12935	0.656	0.0785	0.693	0.111	0.706	0.157	0.488	0.0683	0.485	0.0722
SFM0049	2.90	3.90	2008-08-06	16081	0.218	0.0168	0.181	0.0244	0.156	0.0307	0.0873	0.0123	0.0807	0.0123
SFM0049	2.90	3.90	2008-01-16	12934	0.144	0.0188	0.144	0.0183	0.106	0.0215	0.0571	0.0081	0.0562	0.0080
SFM0051	4.32	4.48	2008-10-09	16127	0.0892	<0.005	0.0918	0.0134	0.0863	0.0233	0.0728	0.0118	0.0986	0.0169
SFM0051	4.32	4.48	2008-08-05	16084	0.0768	<0.005	0.0834	0.0130	0.0960	0.0221	0.0808	0.0128	0.107	0.0185
SFM0051	4.32	4.48	2008-04-08	12991	0.0769	<0.005	0.0904	0.0136	0.100	0.0241	0.0806	0.0132	0.101	0.0193
SFM0051	4.32	4.48	2008-01-15	12940	0.0785	0.0104	0.0836	0.0128	0.0888	0.0215	0.0752	0.0116	0.0948	0.0177
SFM0083	2.54	2.70	2008-01-16	12942	0.0445	0.0117	0.0513	0.0204	0.170	0.0151	0.0282	0.0041	0.0268	<0.005
SFM0087	2.00	2.20	2008-01-15	12930	0.0488	0.0090	0.0601	0.0088	0.0580	0.0133	0.0446	0.0065	0.0493	0.0074
SFM0095	5.00	6.00	2008-01-16	12933	0.321	0.0471	0.414	0.0658	0.455	0.116	0.383	0.0582	0.450	0.0726
SFM0102	2.09	2.25	2008-01-16	12941	0.0137	<0.005	0.0127	<0.005	0.0096	<0.005	0.0057	<0.004	<0.005	<0.005

<“value” = below reporting limit.

Appendix 4

Surface waters

Table A4-1. Field measurements.

Id code	Start date	Stop date	Measured depth (m)	Water depth (m)	Sno	Temp. (°C)	pH	EC (mS/m)	Salinity (per mill)	Turb* (NTU)	Light (µmol/m²s)	O_2 diss. (mg/l)	Chlorophyll (ug/l)	ORP (mV)	Atm. Pressure (hPa)
PFM000062	2008-01-14 09:00:00	2008-01-14 19:30:00	0.5	3.8	12917	1.9	7.73	928	5.10	–0.7	62.4	13.7	1.2	258	1,006.4
PFM000062	2008-01-14 09:00:00	2008-01-14 19:30:00	2.0	3.8		1.9	7.76	928	5.10	–0.7	24.4	13.7	1.1	255	1,006.5
PFM000062	2008-01-14 09:00:00	2008-01-14 19:30:00	3.0	3.8		1.9	7.77	927	5.10	–0.7	16.9	13.7	1.9	253	1,006.7
PFM000062	2008-01-14 09:00:00	2008-01-14 19:30:00	1.0	3.8		1.9	7.75	928	5.10	–0.7	46.7	13.7	1.4	256	1,006.5
PFM000062	2008-02-25 08:30:00	2008-02-25 19:00:00	0.5	4.3	12956	1.9	7.73	888	4.87	0.1	68.7	14.6	1.8	250	993.0
PFM000062	2008-02-25 08:30:00	2008-02-25 19:00:00	1.0	4.3		1.9	7.75	888	4.87	0.3	47.0	14.6	1.3	248	993.2
PFM000062	2008-02-25 08:30:00	2008-02-25 19:00:00	2.0	4.3		1.9	7.78	890	4.88	0.1	24.9	14.7	2.0	244	994.0
PFM000062	2008-02-25 08:30:00	2008-02-25 19:00:00	3.0	4.3		1.9	7.80	891	4.88	0.2	25.4	14.7	2.1	241	994.3
PFM000062	2008-03-17 08:30:00	2008-03-17 19:00:00	2.0	4.3		3.2	7.88	894	4.93	0.1	58.3	14.6	5.3	241	995.7
PFM000062	2008-03-17 08:30:00	2008-03-17 19:00:00	3.0	4.3		3.2	7.93	896	4.94	0.0	33.2	14.6	4.2	236	996.3
PFM000062	2008-03-17 08:30:00	2008-03-17 19:00:00	0.5	4.3	12962	3.2	7.80	894	4.93	0.1	240.7	14.6	2.3	246	995.0
PFM000062	2008-03-17 08:30:00	2008-03-17 19:00:00	1.0	4.3		3.2	7.84	894	4.93	0.2	120.9	14.6	4.1	244	995.4
PFM000062	2008-04-06 08:30:00	2008-04-06 19:30:00	2.0	3.9		2.5	8.43	907	4.99	–0.1	79.0	16.5	5.7	271	1,006.4
PFM000062	2008-04-06 08:30:00	2008-04-06 19:30:00	3.0	3.9		2.5	8.42	908	5.00	–0.2	39.5	16.5	5.4	267	1,006.5
PFM000062	2008-04-06 08:30:00	2008-04-06 19:30:00	0.5	3.9	12973	2.5	8.43	908	5.00	–0.1	247.2	16.5	4.3	278	1,005.8
PFM000062	2008-04-06 08:30:00	2008-04-06 19:30:00	1.0	3.9		2.5	8.43	908	5.00	–0.1	162.3	16.5	4.6	274	1,006.2
PFM000062	2008-05-19 09:00:00	2008-05-19 21:30:00	3.0	4.0		10.4	8.13	844	4.71	–0.2	191.7	11.8	1.4	199	1,017.7
PFM000062	2008-05-19 09:00:00	2008-05-19 21:30:00	2.0	4.0		10.5	8.13	822	4.58	–0.3	427.8	11.8	1.1	200	1,017.9
PFM000062	2008-05-19 09:00:00	2008-05-19 21:30:00	0.5	4.0	16009	10.5	8.12	844	4.72	–0.2	825.7	12.0	0.0	205	1,017.2
PFM000062	2008-05-19 09:00:00	2008-05-19 21:30:00	1.0	4.0		10.5	8.12	845	4.72	–0.3	638.9	11.9	0.7	203	1,017.6
PFM000062	2008-06-17 08:00:00	2008-06-17 21:00:00	3.0	4.0		13.8	8.03	840	4.70	–0.5	268.9	11.6	2.0	210	1,013.1
PFM000062	2008-06-17 08:00:00	2008-06-17 21:00:00	2.0	4.0		13.8	8.02	840	4.70	–0.5	395.4	11.8	1.8	213	1,013.3
PFM000062	2008-06-17 08:00:00	2008-06-17 21:00:00	1.0	4.0		13.8	8.01	836	4.67	–0.3	1,010	12.0	1.7	220	1,013.1
PFM000062	2008-06-17 08:00:00	2008-06-17 21:00:00	0.5	4.0	16054	13.9	8.00	836	4.68	–0.3	2,234	12.2	0.7	224	1,012.4
PFM000062	2008-08-05 08:00:00	2008-08-05 21:00:00	0.5	4.0	16073	15.7	7.99	875	4.91	–0.3	78.6	10.4	2.3	115	1,006.2

Id code	Start date	Stop date	Measured depth (m)	Water depth (m)	Sno	Temp. (°C)	pH	EC (mS/m)	Salinity (per mill)	Turb* (NTU)	Light (µmol/m^2s)	O_2 diss. (mg/l)	Chlorophyll (ug/l)	ORP (mV)	Atm. Pressure (hPa)
PFM000062	2008-08-05 08:00:00	2008-08-05 21:00:00	2.0	4.0		15.7	8.00	875	4.91	–0.3	31.7	10.2	2.5	111	1,006.2
PFM000062	2008-08-05 08:00:00	2008-08-05 21:00:00	1.0	4.0		15.7	8.00	875	4.91	–0.4	57.4	10.3	1.7	112	1,006.1
PFM000062	2008-08-05 08:00:00	2008-08-05 21:00:00	3.0	4.0		15.7	8.00	874	4.90	–0.4	18.4	10.2	2.0	110	1,006.3
PFM000062	2008-09-01 09:00:00	2008-09-01 19:00:00	3.0	4.0		15.6	8.04	873	4.90	–0.4	32.3	9.7	2.4	420	1,017.6
PFM000062	2008-09-01 09:00:00	2008-09-01 19:00:00	2.0	4.0		15.7	8.03	873	4.90	–0.3	70.9	9.7	0.8	419	1,017.4
PFM000062	2008-09-01 09:00:00	2008-09-01 19:00:00	1.0	4.0		15.7	8.03	872	4.89	–0.3	161.3	9.7	–0.4	415	1,017.4
PFM000062	2008-09-01 09:00:00	2008-09-01 19:00:00	0.5	4.0	16075	15.7	8.02	872	4.89	–0.4	223.3	9.8	1.3	412	1,017.4
PFM000062	2008-10-06 09:00:00	2008-10-06 19:00:00	3.0	4.0		10.9	8.01	878	4.92	–0.9	38.6	10.7	1.4	437	1,002.5
PFM000062	2008-10-06 09:00:00	2008-10-06 19:00:00	0.5	4.0	16105	10.9	7.99	879	4.92	–0.9	128.7	10.8	1.7	426	1,000.5
PFM000062	2008-10-06 09:00:00	2008-10-06 19:00:00	1.0	4.0		10.9	8.00	877	4.91	–0.9	72.0	10.8	1.5	432	1,001.3
PFM000062	2008-10-06 09:00:00	2008-10-06 19:00:00	2.0	4.0		10.9	8.00	877	4.91	–0.9	44.3	10.7	1.3	435	1,001.6
PFM000062	2008-11-10 09:00:00	2008-11-10 18:00:00	2.0	4.2		6.2	7.90	901	5.02	–0.7	55.8	11.9	1.9	289	1,002.3
PFM000062	2008-11-10 09:00:00	2008-11-10 18:00:00	3.0	4.2		6.2	7.90	902	5.02	–0.7	42.2	11.8	0.8	288	1,001.7
PFM000062	2008-11-10 09:00:00	2008-11-10 18:00:00	1.0	4.2		6.3	7.88	899	5.01	–0.6	80.0	11.9	0.1	289	1,001.6
PFM000062	2008-11-10 09:00:00	2008-11-10 18:00:00	0.5	4.2	16149	6.3	7.88	902	5.03	–0.7	125.3	12.0	2.7	287	1,001.2
PFM000062	2008-12-01 09:00:00	2008-12-01 18:00:00	0.5	4.1	16164	2.6	7.83	901	4.96	1.0	59.0	12.3	1.0	250	1,000.0
PFM000062	2008-12-01 09:00:00	2008-12-01 18:00:00	1.0	4.1		2.6	7.84	901	4.96	1.1	37.1	12.3	1.7	255	1,000.3
PFM000062	2008-12-01 09:00:00	2008-12-01 18:00:00	2.0	4.1		2.6	7.84	902	4.96	1.2	16.0	12.3	1.4	258	1,000.8
PFM000062	2008-12-01 09:00:00	2008-12-01 18:00:00	3.0	4.1		2.6	7.85	902	4.97	1.1	6.6	12.3	0.7	260	1,001.0
PFM000066	2008-01-14 09:00:00	2008-01-14 19:30:00	0.3	0.4	12924	0.7	7.24	38	0.18			5.4		167	1,002.5
PFM000066	2008-02-25 08:30:00	2008-02-25 19:00:00	0.4	0.4	12960	1.6	7.19	35	0.17			5.7		134	996.9
PFM000066	2008-03-18 07:30:00	2008-03-18 16:00:00	0.4	0.4	12969	0.9	7.45	30	0.14			7.6		129	999.5
PFM000066	2008-04-07 15:00:00	2008-04-07 21:30:00	0.4	0.4	12979	5.5	7.38	33	0.16			7.5		262	1,004.7
PFM000066	2008-05-19 09:00:00	2008-05-19 21:30:00	0.2	0.3	16015	10.0	7.59	35	0.17			10.4		141	1,012.3
PFM000066	2008-06-17 08:00:00	2008-06-17 21:00:00	0.1	0.2	16060	11.2	7.42	32	0.15			7.1		167	1,006.8
PFM000066	2008-09-01 09:00:00	2008-09-01 19:00:00	0.3	0.3	16087	12.4	7.31	35	0.17			5.7		212	1,012.8
PFM000066	2008-10-07 08:00:00	2008-10-07 20:00:00	0.3	0.3	16097	5.6	7.46	39	0.19			7.3		148	1,014.7
PFM000066	2008-11-11 08:00:00	2008-11-11 15:00:00	0.4	0.4	16156	3.0	7.38	36	0.17			7.1		230	999.0
PFM000066	2008-12-01 09:00:00	2008-12-01 18:00:00	0.4	0.5	16168	0.1	7.19	36	0.17			4.3		164	1,001.4
PFM000068	2008-01-14 09:00:00	2008-01-14 19:30:00	0.4	0.5	12925	0.8	7.41	35	0.17			9.0		85	1,003.5
PFM000068	2008-02-25 08:30:00	2008-02-25 19:00:00	0.5	0.6	12959	1.1	7.22	34	0.16			9.0		82	996.2

Id code	Start date	Stop date	Measured depth (m)	Water depth (m)	Sno	Temp. (°C)	pH	EC (mS/m)	Salinity (per mill)	Turb* (NTU)	Light (μmol/m^{2}s)	O_2 diss. (mg/l)	Chlorophyll (ug/l)	ORP (mV)	Atm. Pressure (hPa)
PFM000068	2008-03-18 07:30:00	2008-03-18 16:00:00	0.6	0.7	12968	0.8	7.56	30	0.14			9.2		99	1,000.9
PFM000068	2008-04-07 15:00:00	2008-04-07 21:30:00	0.6	0.6	12980	4.9	7.31	33	0.16			8.3		103	1,006.1
PFM000068	2008-05-19 09:00:00	2008-05-19 21:30:00	0.5	0.5	16014	8.2	7.38	40	0.19			10.2		95	1,012.5
PFM000068	2008-06-17 08:00:00	2008-06-17 21:00:00	0.3	0.3	16059	10.5	7.32	49	0.24			5.5		101	1,008.4
PFM000068	2008-09-01 09:00:00	2008-09-01 19:00:00	0.5	0.5	16086	10.9	7.18	39	0.19			5.8		200	1,013.4
PFM000068	2008-10-07 08:00:00	2008-10-07 20:00:00	0.5	0.6	16096	4.7	7.32	37	0.17			7.6		212	1,023.4
PFM000068	2008-11-10 09:00:00	2008-11-10 18:00:00	0.5	0.5	16154	3.4	7.26	34	0.16			7.7		124	990.6
PFM000068	2008-12-01 09:00:00	2008-12-01 18:00:00	0.8	0.8	16167	0.2	7.12	32	0.15			6.4		172	1,004.3
PFM000069	2008-01-14 09:00:00	2008-01-14 19:30:00	0.2	0.3	12918	1.0	7.26	47	0.22			5.8		79	1,004.7
PFM000069	2008-02-25 08:30:00	2008-02-25 19:00:00	0.2	0.3	12958	1.2	7.18	45	0.21			6.5		93	996.5
PFM000069	2008-03-17 08:30:00	2008-03-17 19:00:00	0.3	0.4	12967	1.5	7.36	35	0.17			7.1		134	998.0
PFM000069	2008-04-06 08:30:00	2008-04-06 19:30:00	0.2	0.3	12977	4.3	7.18	39	0.19			7.2		89	1,005.0
PFM000069	2008-05-19 09:00:00	2008-05-19 21:30:00	0.1	0.2	16013	8.7	7.33	43	0.21			10.2		88	1,011.7
PFM000069	2008-06-17 08:00:00	2008-06-17 21:00:00	0.2	0.1	16058	13.2	7.25	46	0.22			4.0		–42	1,007.2
PFM000069	2008-09-01 09:00:00	2008-09-01 19:00:00	0.2	0.2	16085	11.1	7.14	42	0.20			5.3		255	1,012.9
PFM000069	2008-10-07 08:00:00	2008-10-07 20:00:00	0.2	0.3	16108	4.4	7.33	45	0.22			6.9		359	1,013.7
PFM000069	2008-11-10 09:00:00	2008-11-10 18:00:00	0.2	0.4	16153	3.5	7.21	42	0.20			6.0		153	993.1
PFM000069	2008-12-01 09:00:00	2008-12-01 18:00:00	0.6	0.7	16166	0.4	7.16	42	0.20			4.1		206	1,003.9
PFM000070	2008-01-15 07:00:00	2008-01-15 19:00:00	0.1	0.3	12944	0.9	7.59	18	0.08			12.0		189	992.3
PFM000070	2008-02-25 08:30:00	2008-02-25 19:00:00	0.2	0.3	12957	2.9	7.36	21	0.10			9.6		239	996.4
PFM000070	2008-03-17 08:30:00	2008-03-17 19:00:00	0.2	0.3	12966	3.4	7.67	30	0.14			9.7		243	997.2
PFM000070	2008-04-06 08:30:00	2008-04-06 19:30:00	0.2	0.2	12976	7.2	7.87	29	0.14			11.6		180	1,004.7
PFM000070	2008-05-19 09:00:00	2008-05-19 21:30:00	0.3	0.2	16012	12.2	7.38	26	0.13			10.1		120	1,011.4
PFM000070	2008-06-17 08:00:00	2008-06-17 21:00:00	0.2	0.1	16057	13.2	7.29	28	0.13			8.6		173	1,006.8
PFM000070	2008-09-01 09:00:00	2008-09-01 19:00:00	0.2	0.2	16078	12.3	7.13	23	0.11			6.5		317	1,013.6
PFM000070	2008-10-06 09:00:00	2008-10-06 19:00:00	0.3	0.3	16117	8.7	7.64	23	0.11			10.2		322	1,007.2
PFM000070	2008-11-10 09:00:00	2008-11-10 18:00:00	0.1	0.3	16152	3.6	7.87	26	0.12			12.5		162	993.6
PFM000070	2008-12-01 09:00:00	2008-12-01 18:00:00	0.3	0.3	16165	0.3	7.39	27	0.13			9.2		216	1,003.2
PFM000074	2008-01-15 07:00:00	2008-01-15 19:00:00	0.5	1.1	12943	1.2	7.01	52	0.25	0.1	7.1	4.2	8.4	–175	998.0
PFM000074	2008-02-26 08:00:00	2008-02-26 17:00:00	0.5	0.7	12961	2.3	7.28	55	0.27	–1.0	106.1	5.1	8.0	214	997.1
PFM000074	2008-04-07 15:00:00	2008-04-07 21:30:00	0.5	0.9	12978	5.4	7.46	37	0.18	–1.1	36.6	8.7	7.9	260	1,005.1
PFM000074	2008-05-20 07:00:00	2008-05-20 14:00:00	0.5	0.8	16016	9.5	7.60	39	0.19	–1.2	327.7	10.9	6.6	229	1,019.9

Id code	Start date	Stop date	Measured depth (m)	Water depth (m)	Sno	Temp. (°C)	pH	EC (mS/m)	Salinity (per mill)	Turb* (NTU)	Light (μmol/m^{2}s)	O_2 diss. (mg/l)	Chlorophyll (ug/l)	ORP (mV)	Atm. Pressure (hPa)
PFM000074	2008-06-18 08:00:00	2008-06-18 15:00:00	0.5	0.6	16061	17.2	7.76	39	0.19	0.3	449.9	12.3	7.8	282	1,009.8
PFM000074	2008-08-05 08:00:00	2008-08-05 21:00:00	0.5	0.5	16074	15.3	7.76	39	0.19	–0.3	89.3	7.6	6.1	69	1,009.6
PFM000074	2008-09-02 07:00:00	2008-09-02 13:00:00	0.5	0.9	16088	11.8	7.18	39	0.19	–1.4	40.1	4.8	8.9	291	1,004.3
PFM000074	2008-10-07 08:00:00	2008-10-07 20:00:00	0.5	0.8	16107	6.3	7.45	41	0.20	–1.2	28.2	9.6	7.0	170	1,016.5
PFM000074	2008-11-11 08:00:00	2008-11-11 15:00:00	0.5	1.0	16155	3.2	7.52	38	0.18	–1.4	31.3	9.6	9.6	275	999.7
PFM000097	2008-01-15 07:00:00	2008-01-15 19:00:00	0.5	0.9		3.1	7.33	369	1.92	2.2	–0.7	4.1	4.1	–201	998.7
PFM000097	2008-02-26 08:00:00	2008-02-26 17:00:00	0.5	1.0		4.8	7.41	125	0.62	–0.9	74.5	10.4	8.9	205	997.6
PFM000097	2008-03-18 07:30:00	2008-03-18 16:00:00	0.5	0.9		1.7	7.98	88	0.43	–0.9	73.9	12.9	5.5	211	999.9
PFM000097	2008-04-07 15:00:00	2008-04-07 21:30:00	0.5	1.0		6.7	8.25	73	0.36	–1.1	135.1	13.1	5.9	248	1,005.4
PFM000097	2008-05-20 07:00:00	2008-05-20 14:00:00	0.5	0.9		10.3	8.67	56	0.27	–1.1	235.8	14.2	4.0	204	1,016.4
PFM000097	2008-06-18 08:00:00	2008-06-18 15:00:00	0.5	0.6		17.8	9.12	68	0.33	0.1	449.3	13.0	4.0	283	1,010.3
PFM000097	2008-08-06 08:00:00	2008-08-06 15:00:00	0.5	0.5		17.4	9.08	108	0.54	–0.5	472.0	16.1	3.0	69	1,017.0
PFM000097	2008-09-02 07:00:00	2008-09-02 13:00:00	0.5	0.8		13.1	8.00	72	0.35	–1.2	42.4	9.6	3.3	339	1,004.1
PFM000097	2008-10-07 08:00:00	2008-10-07 20:00:00	0.5	0.9		6.5	8.13	55	0.27	–1.4	288.6	13.2	2.1	191	1,017.7
PFM000097	2008-11-11 08:00:00	2008-11-11 15:00:00	0.5	0.8		3.6	7.52	149	0.74	–0.9	26.7	12.5	5.3	274	998.2
PFM000107	2008-01-14 09:00:00	2008-01-14 19:30:00	0.5	1.8	12920	2.1	7.60	202	1.02	–1.1	9.7	10.7	4.0	267	1,005.9
PFM000107	2008-01-14 09:00:00	2008-01-14 19:30:00	1.0	1.8	12928	2.9	7.55	233	1.18	–1.2	2.2	9.0	4.2	266	1,006.5
PFM000107	2008-03-17 08:30:00	2008-03-17 19:00:00	0.5	1.9	12963	2.7	8.05	80	0.39	–1.0	38.9	13.5	5.9	336	997.9
PFM000107	2008-03-17 08:30:00	2008-03-17 19:00:00	1.0	1.9		2.7	8.00	81	0.39	–1.0	16.0	13.5	5.9	328	998.2
PFM000107	2008-04-06 08:30:00	2008-04-06 19:30:00	1.0	1.9		7.1	8.21	67	0.33	–1.2	76.6	13.5	5.3	301	1,005.8
PFM000107	2008-04-06 08:30:00	2008-04-06 19:30:00	0.5	1.9	12974	7.1	8.23	67	0.33	–1.3	163.5	13.5	6.4	309	1,005.9
PFM000107	2008-05-19 09:00:00	2008-05-19 21:30:00	1.0	1.7		10.0	8.56	51	0.25	–1.1	211.0	15.6	4.1	218	1,014.0
PFM000107	2008-05-19 09:00:00	2008-05-19 21:30:00	0.5	1.7	16010	10.0	8.58	51	0.25	–1.1	337.8	16.4	3.8	222	1,012.7
PFM000107	2008-06-17 08:00:00	2008-06-17 21:00:00	1.0	1.7		17.7	9.21	51	0.25	–1.1	275.5	13.6	3.5	180	1,012.1
PFM000107	2008-06-17 08:00:00	2008-06-17 21:00:00	0.5	1.7	16055	17.7	9.23	51	0.25	–1.1	440.9	14.0	2.3	186	1,011.6
PFM000107	2008-08-04 09:00:00	2008-08-04 18:00:00	0.5	1.5	16071	18.4	8.89	60	0.29	–1.2	105.0	9.0	1.9	72	1,003.9
PFM000107	2008-08-04 09:00:00	2008-08-04 18:00:00	1.0	1.5		18.4	8.87	60	0.29	–1.2	64.8	9.0	1.7	71	1,003.8
PFM000107	2008-09-01 09:00:00	2008-09-01 19:00:00	0.5	1.7	16076	13.9	8.48	57	0.28	–1.2	105.7	10.2	2.0	386	1,015.7
PFM000107	2008-09-01 09:00:00	2008-09-01 19:00:00	1.0	1.7		13.9	8.47	57	0.28	–1.2	59.8	10.2	1.5	386	1,015.8
PFM000107	2008-10-06 09:00:00	2008-10-06 19:00:00	1.0	2.1		7.8	8.22	54	0.26	–1.1	131.6	12.8	3.0	410	1,007.8
PFM000107	2008-10-06 09:00:00	2008-10-06 19:00:00	0.5	2.1	16116	7.8	8.21	54	0.26	–1.0	149.4	13.0	2.9	405	1,007.5

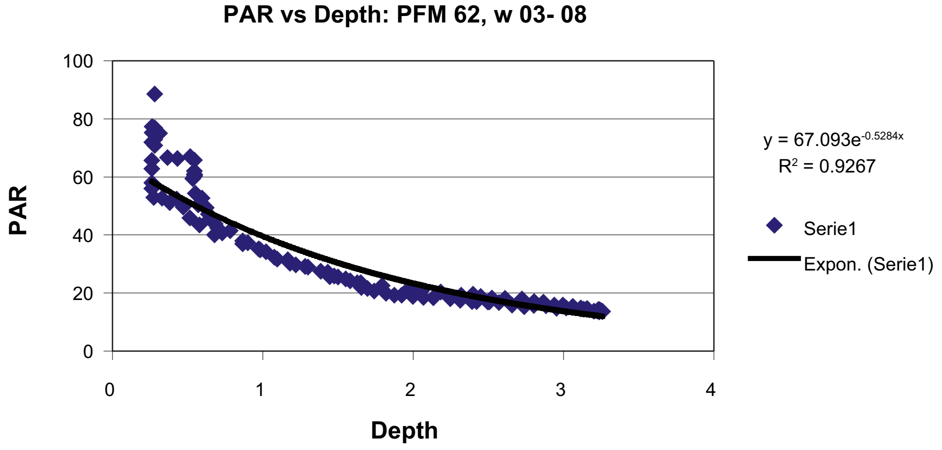
Id code	Start date	Stop date	Measured depth (m)	Water depth (m)	Sno	Temp. (°C)	pH	EC (mS/m)	Salinity (per mill)	Turb* (NTU)	Light (µmol/m^{2}s)	O$_2$ diss. (mg/l)	Chlorophyll (ug/l)	ORP (mV)	Atm. Pressure (hPa)
PFM000107	2008-11-10 09:00:00	2008-11-10 18:00:00	1.0	1.7		3.0	8.11	50	0.24	–0.6	9.2	13.2	11.1	186	997.3
PFM000107	2008-11-10 09:00:00	2008-11-10 18:00:00	0.5	1.7	16150	3.1	8.14	50	0.24	–1.2	26.0	13.2	4.8	185	997.3
PFM000117	2008-01-15 07:00:00	2008-01-15 19:00:00	0.5	2.2	12926	1.6	7.90	26	0.12	–1.0	8.0	13.3	4.5	158	995.3
PFM000117	2008-01-15 07:00:00	2008-01-15 19:00:00	1.0	2.2		2.4	7.84	28	0.13	–1.1	4.6	12.4	6.4	159	995.9
PFM000117	2008-01-15 07:00:00	2008-01-15 19:00:00	1.5	2.2	12927	3.5	7.58	33	0.16	–1.2	2.5	5.1	6.5	156	1,000.8
PFM000117	2008-03-17 08:30:00	2008-03-17 19:00:00	0.5	2.2	12965	3.7	7.85	31	0.15	–1.1	40.2	10.5	6.6	371	997.5
PFM000117	2008-03-17 08:30:00	2008-03-17 19:00:00	1.0	2.2		3.7	7.79	31	0.15	–1.0	21.2	10.3	6.5	362	997.8
PFM000117	2008-03-17 08:30:00	2008-03-17 19:00:00	1.5	2.2		3.7	7.76	31	0.15	–1.1	12.7	10.3	7.2	354	997.7
PFM000117	2008-04-06 08:30:00	2008-04-06 19:30:00	0.5	2.4	12975	7.1	8.31	30	0.14	–1.1	79.9	13.9	6.8	316	1,004.5
PFM000117	2008-04-06 08:30:00	2008-04-06 19:30:00	1.0	2.4		7.1	8.31	30	0.14	–1.0	43.8	13.9	7.3	308	1,004.6
PFM000117	2008-04-06 08:30:00	2008-04-06 19:30:00	1.5	2.4		7.1	8.31	30	0.14	–1.1	26.1	13.9	6.8	304	1,004.5
PFM000117	2008-05-19 09:00:00	2008-05-19 21:30:00	1.5	2.1		10.5	8.46	26	0.13	–1.0	229.3	14.0	4.9	228	1,017.1
PFM000117	2008-05-19 09:00:00	2008-05-19 21:30:00	1.0	2.1		10.6	8.46	26	0.13	–0.9	513.0	14.2	4.5	230	1,016.6
PFM000117	2008-05-19 09:00:00	2008-05-19 21:30:00	0.5	2.1	16011	10.8	8.46	26	0.13	–1.0	941.8	14.4	3.7	233	1,016.2
PFM000117	2008-06-17 08:00:00	2008-06-17 21:00:00	1.5	2.1		17.4	8.71	24	0.11	–0.5	201	12.9	3.9	205	1,012.2
PFM000117	2008-06-17 08:00:00	2008-06-17 21:00:00	1.0	2.1		18.1	8.65	24	0.11	–0.8	1,319	12.2	3.5	207	1,012.6
PFM000117	2008-06-17 08:00:00	2008-06-17 21:00:00	0.5	2.1	16056	18.3	8.64	24	0.11	–1.0	2,539	12.2	2.9	209	1,013.0
PFM000117	2008-08-05 08:00:00	2008-08-05 21:00:00	1.5	2.0		17.5	8.63	20	0.10	–0.5	23.3	9.2	2.7	55	1,002.8
PFM000117	2008-08-05 08:00:00	2008-08-05 21:00:00	0.5	2.0	16072	17.5	8.63	20	0.10	–0.2	69.5	9.3	2.9	56	1,002.7
PFM000117	2008-08-05 08:00:00	2008-08-05 21:00:00	1.0	2.0		17.6	8.64	20	0.10	–0.6	40.2	9.3	3.3	55	1,002.7
PFM000117	2008-09-01 09:00:00	2008-09-01 19:00:00	1.5	2.3		14.8	8.77	21	0.10	–0.4	42.1	10.8	1.7	342	1,015.3
PFM000117	2008-09-01 09:00:00	2008-09-01 19:00:00	1.0	2.3		14.9	8.77	21	0.10	0.0	61.4	10.7	1.6	343	1,015.0
PFM000117	2008-09-01 09:00:00	2008-09-01 19:00:00	0.5	2.3	16077	14.9	8.78	21	0.10	–0.6	92.0	10.8	0.7	343	1,014.8
PFM000117	2008-10-06 09:00:00	2008-10-06 19:00:00	0.5	2.2	16106	8.3	8.42	23	0.11	1.6	114.1	13.4	2.6	397	1,006.7
PFM000117	2008-10-06 09:00:00	2008-10-06 19:00:00	1.0	2.2		8.3	8.42	23	0.11	1.6	80.8	13.2	2.2	396	1,007.4
PFM000117	2008-10-06 09:00:00	2008-10-06 19:00:00	1.5	2.2		8.3	8.42	23	0.11	–1.1	62.6	12.9	2.8	396	1,008.0
PFM000117	2008-11-10 09:00:00	2008-11-10 18:00:00	0.5	2.3	16151	3.0	7.97	26	0.12	–1.3	0.2	12.6	4.8	173	994.4
PFM000117	2008-11-10 09:00:00	2008-11-10 18:00:00	1.0	2.3		3.0	7.98	26	0.12	–1.3	–0.3	12.5	5.1	172	994.7
PFM000117	2008-11-10 09:00:00	2008-11-10 18:00:00	1.5	2.3		3.0	7.98	26	0.12	–1.3	–0.7	12.5	5.5	172	995.0
PFM102269	2008-01-15 07:00:00	2008-01-15 19:00:00	0.5		12929	12.3	7.91	901	5.07	–1.1	–1.3	12.7	1.0	79	998.0
PFM102269	2008-02-26 08:00:00	2008-02-26 17:00:00	0.5		12964	12.1	7.94	866	4.85	–0.1	120.0	13.0	2.0	227	995.8

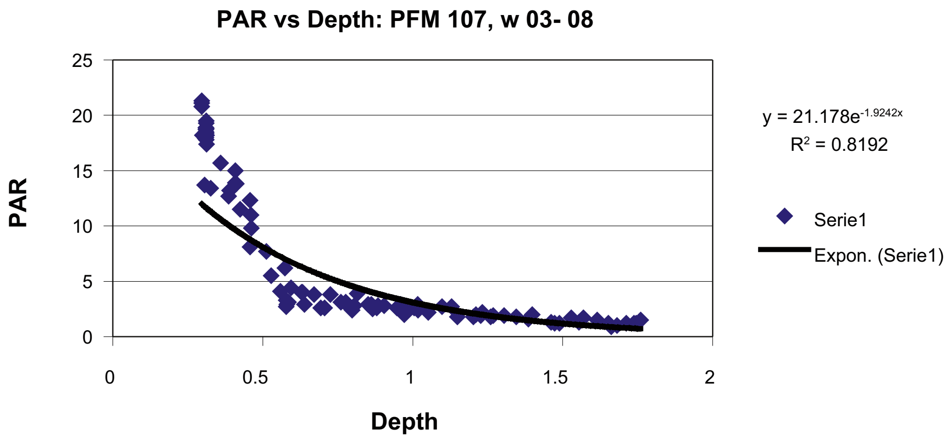
Id code	Start date	Stop date	Measured depth (m)	Water depth (m)	Sno	Temp. (°C)	pH	EC (mS/m)	Salinity (per mill)	Turb* (NTU)	Light (µmol/m^{2}s)	O_2 diss. (mg/l)	Chlorophyll (ug/l)	ORP (mV)	Atm. Pressure (hPa)
PFM102269	2008-03-18 07:30:00	2008-03-18 16:00:00	0.5		12971	13.0	7.88	872	4.89	0.1	245.1	12.8	4.4	149	1,001.0
PFM102269	2008-04-07 15:00:00	2008-04-07 21:30:00	0.5		12972	12.9	8.44	882	4.95	0.3	–0.8	14.2	5.8	170	1,007.5
PFM102269	2008-05-19 09:00:00	2008-05-19 21:30:00	0.5		16008	21.5	8.11	843	4.70	0.1	177.9	13.1	1.7	151	1,016.0
PFM102269	2008-06-17 08:00:00	2008-06-17 21:00:00	0.5		16053	25.1	8.09	837	4.65	–0.1	211.9	11.4	16.4	231	1,011.6
PFM102269	2008-08-05 08:00:00	2008-08-05 21:00:00	0.5		16070	23.6	7.90	877	4.90	–0.6	117.8	9.3	1.0	89	1,011.6
PFM102269	2008-09-01 09:00:00	2008-09-01 19:00:00	0.5		16089	25.8	7.95	883	4.91	–0.6	231.6	9.0	0.9	404	1,017.4
PFM102269	2008-10-07 08:00:00	2008-10-07 20:00:00	0.5		16115	20.9	7.95	889	4.98	–1.2	54.5	11.9	0.7	176	1,016.6
PFM102269	2008-11-11 08:00:00	2008-11-11 15:00:00	0.5		16148	14.6	7.77	891	5.01	–1.2	83.6	11.1	–0.1	232	1,000.5
PFM102269	2008-12-02 08:00:00	2008-12-02 13:00:00	0.5		16163	10.8	7.80	874	4.89	0.7	4.5	11.2	1.4	292	1,000.2

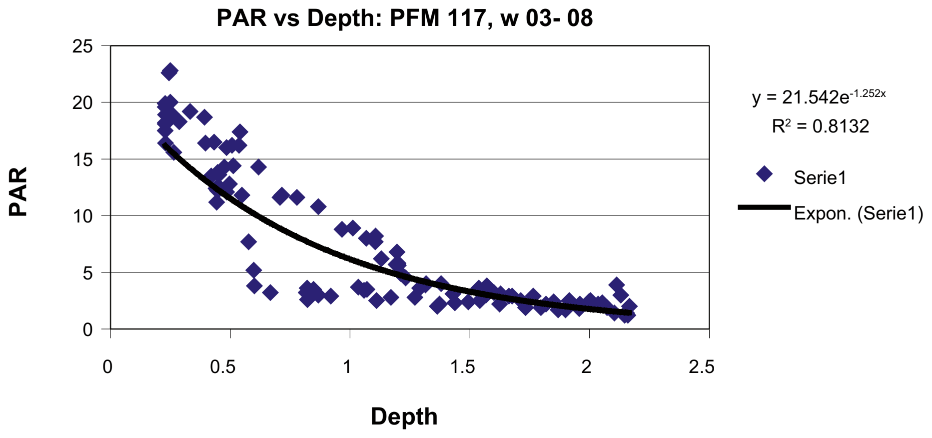
Sno = Corresponding water sample no.
NTU = Nephelometric Turbidiy Unit.
* Measurements with low reliability.
EC = Electrical conductivity.
ORP = Oxidising Reducing Potential.

Table A4-2. PAR-profile logs.

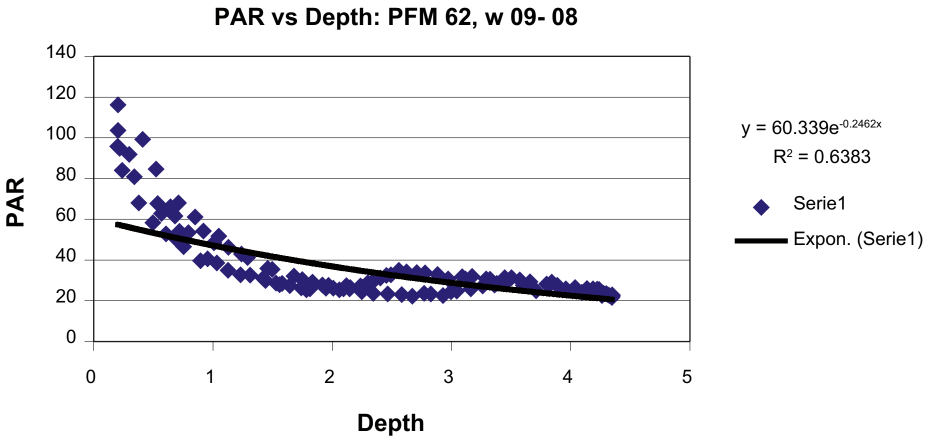
Week 3, 2008







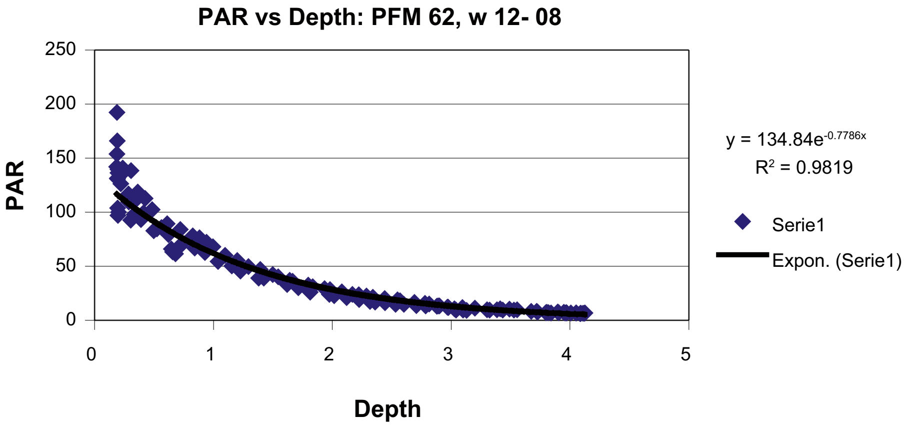
Week 9, 2008

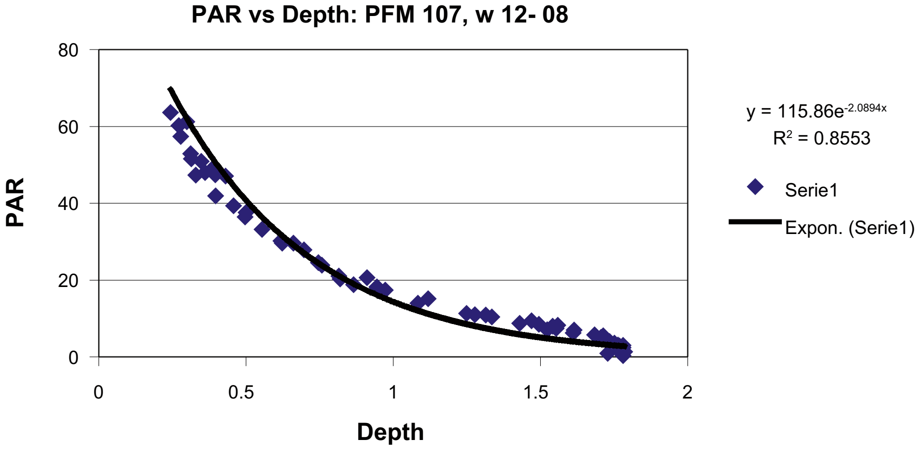


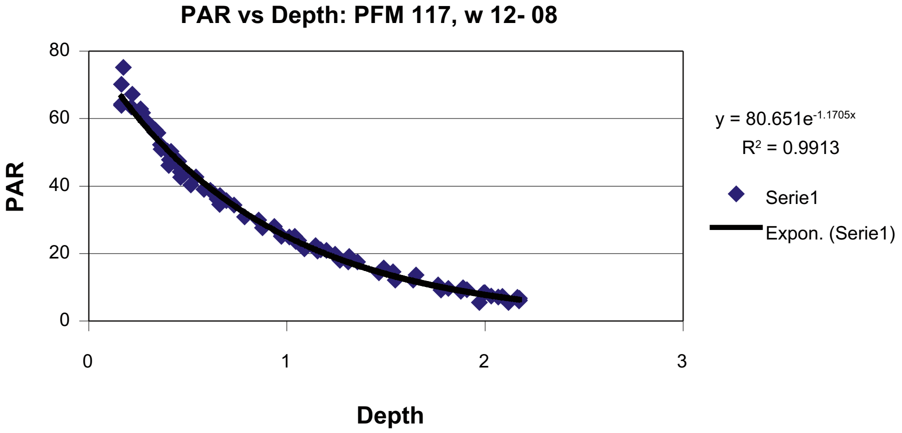
PAR vs Depth: PFM 107, w 09- 08, no data due to weak ice.

PAR vs Depth: PFM 117, w 09- 08, no data due to weak ice.

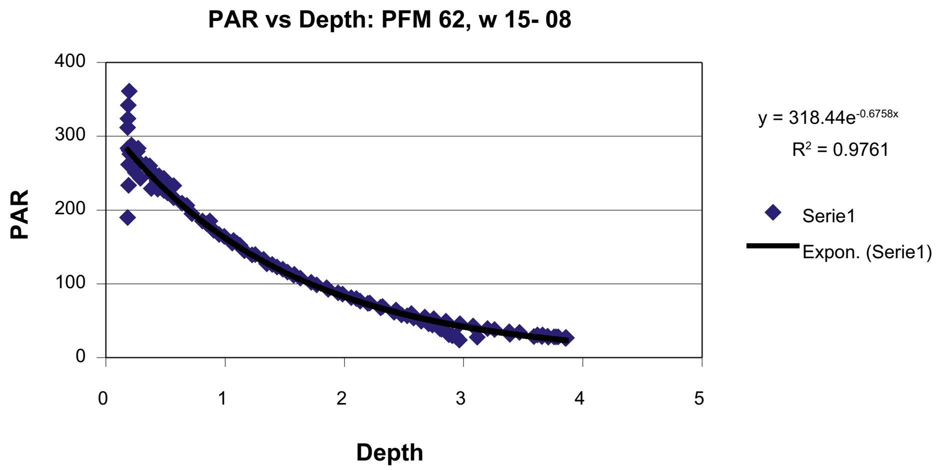
Week 12, 2008

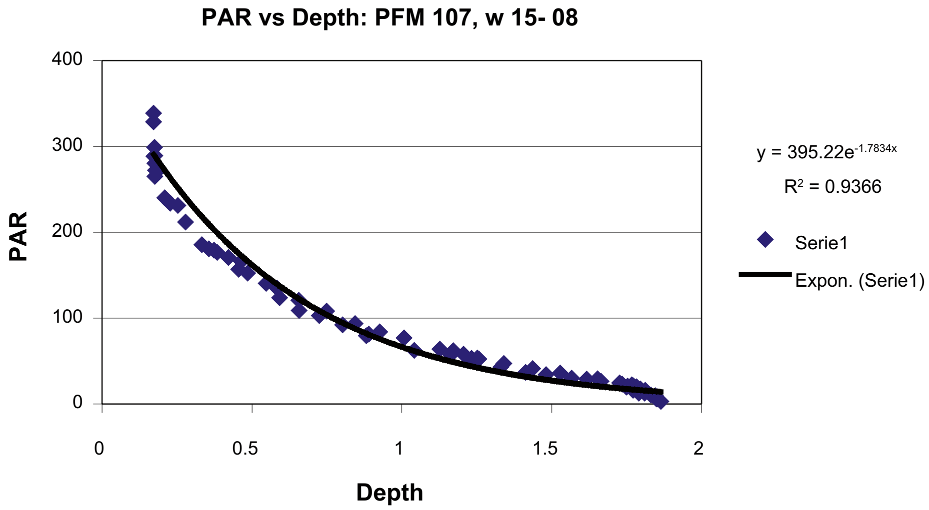

PAR vs Depth: PFM 62, w 12- 08
PAR
250
200
150
100
50
0
0
1
2
3
4
5
Depth
y = 134.84e-0.7786x
R2 = 0.9819
Serie1
Expon. (Serie1)

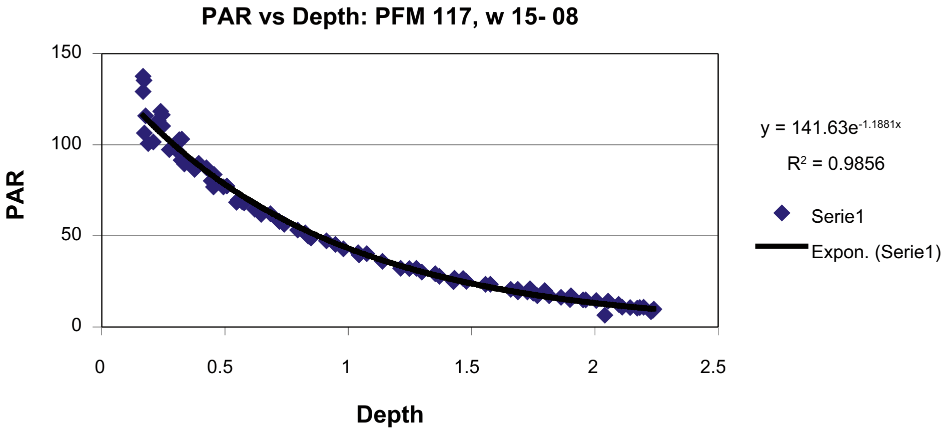

PAR vs Depth: PFM 107, w 12- 08
PAR
80
60
40
20
0
0
0.5
1
1.5
2
Depth
y = 115.86e-2.0894x
R2 = 0.8553
Serie1
Expon. (Serie1)


PAR vs Depth: PFM 117, w 12- 08
PAR
80
60
40
20
0
0
1
2
3
Depth
y = 80.651e-1.1705x
R2 = 0.9913
Serie1
Expon. (Serie1)

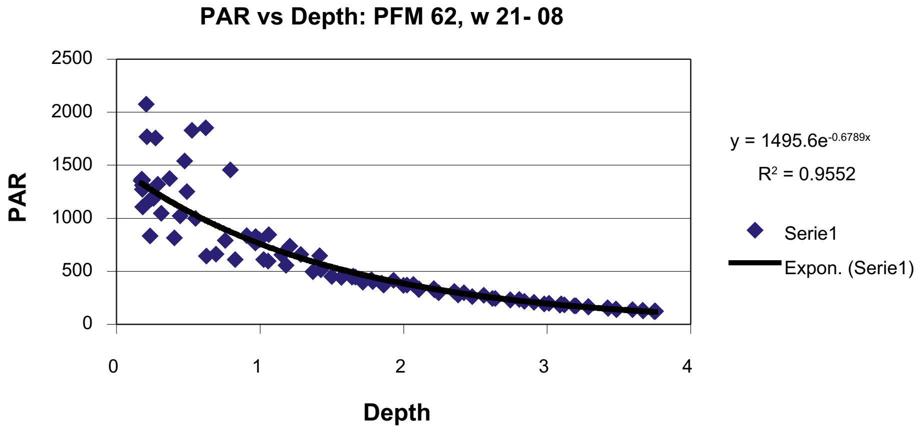
Week 15, 2008

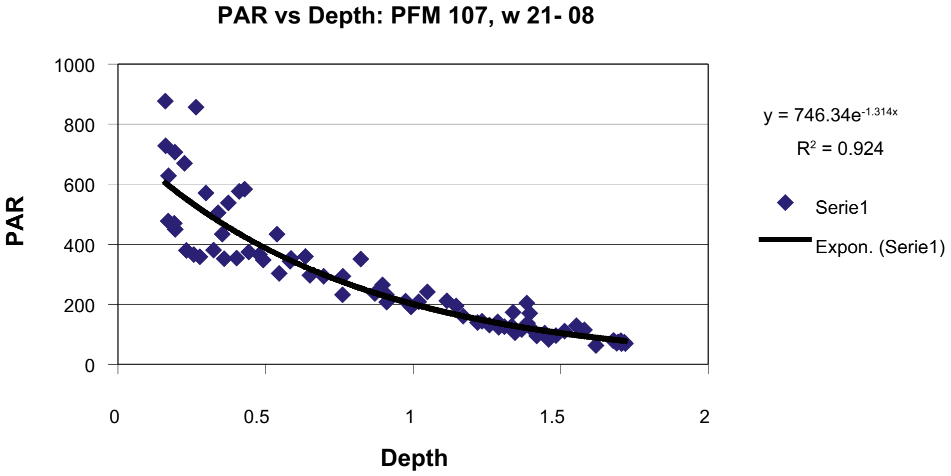

PAR vs Depth: PFM 62, w 15- 08

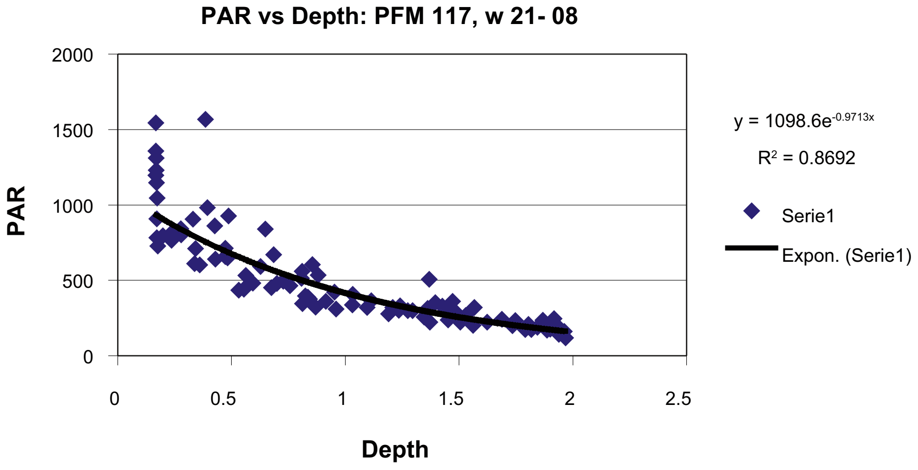

PAR vs Depth: PFM 107, w 15- 08


PAR vs Depth: PFM 117, w 15- 08

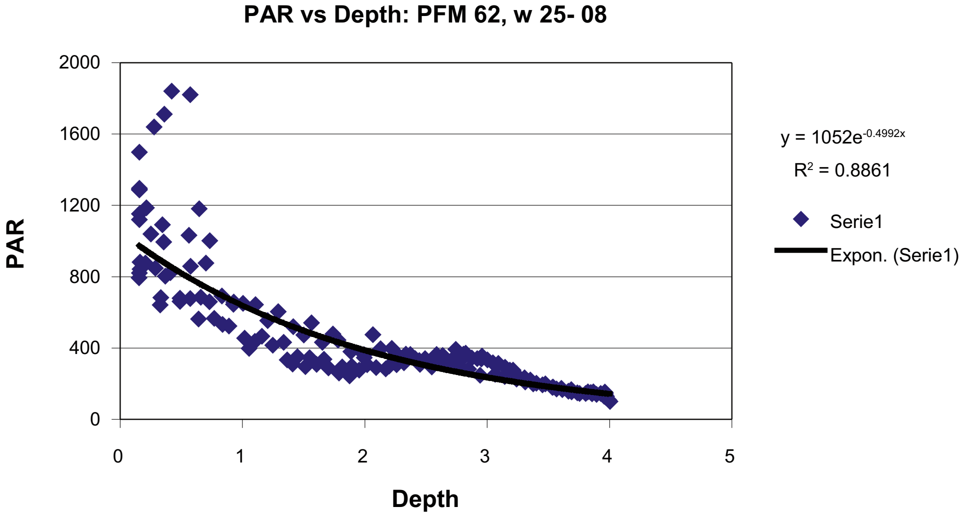
Week 21, 2008

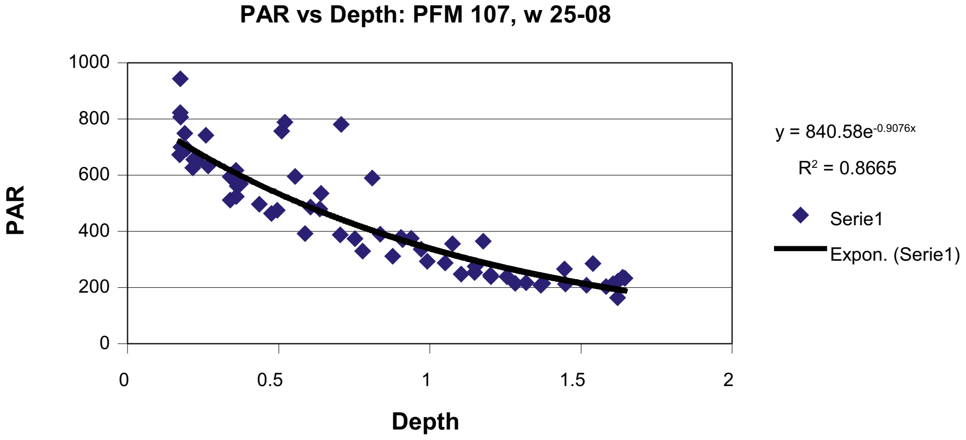

PAR vs Depth: PFM 62, w 21- 08
2500
2000
1500
1000
500
0
PAR
0
1
2
3
4
Depth
y = 1495.6e-0.6789x
R² = 0.9552
Serie1
Expon. (Serie1)

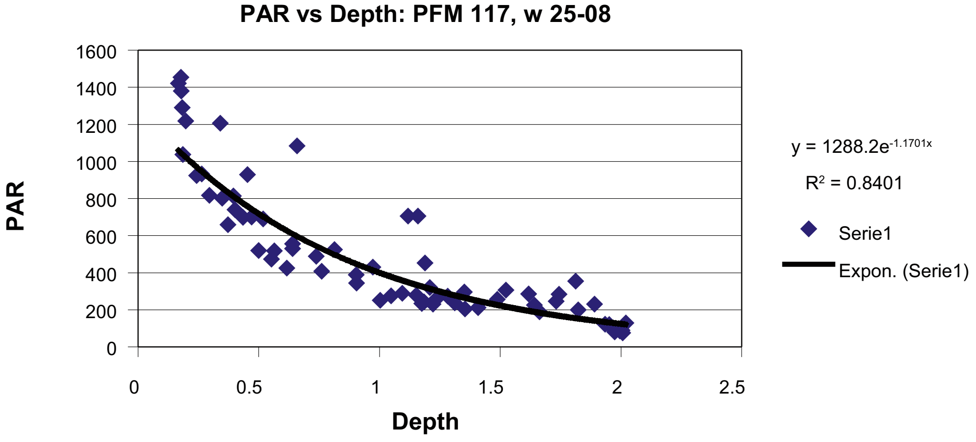

PAR vs Depth: PFM 107, w 21- 08
1000
800
600
400
200
0
PAR
0
0.5
1
1.5
2
Depth
y = 746.34e-1.314x
R² = 0.924
Serie1
Expon. (Serie1)


PAR vs Depth: PFM 117, w 21- 08
2000
1500
1000
500
0
PAR
0
0.5
1
1.5
2
2.5
Depth
y = 1098.6e-0.9713x
R² = 0.8692
Serie1
Expon. (Serie1)

Week 25, 2008

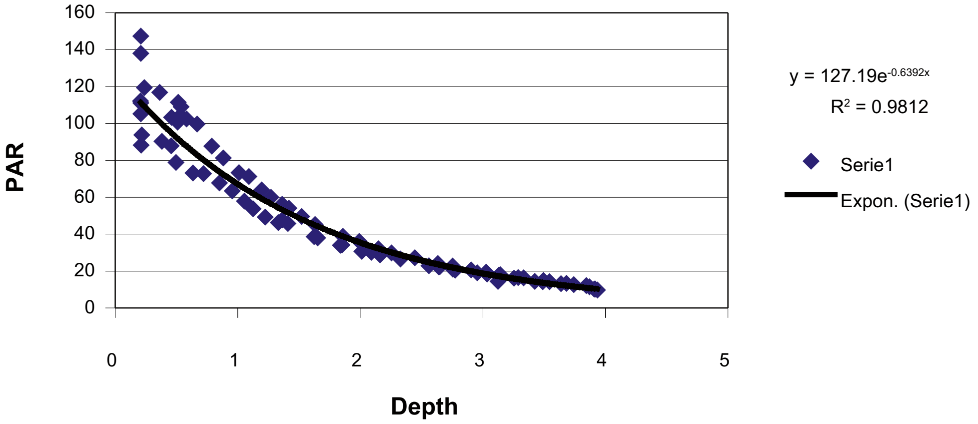

PAR vs Depth: PFM 62, w 25- 08
2000
1600
1200
800
400
0
PAR
0
1
2
3
4
5
Depth
y = 1052e^-0.4992x
R² = 0.8861
Serie1
Expon. (Serie1)


PAR vs Depth: PFM 107, w 25-08
1000
800
600
400
200
0
PAR
0
0.5
1
1.5
2
Depth
y = 840.58e^-0.9076x
R² = 0.8665
Serie1
Expon. (Serie1)

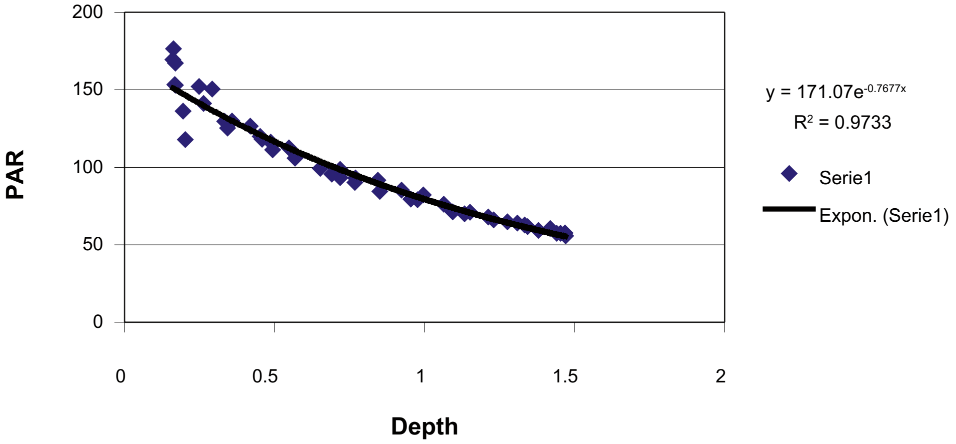

PAR vs Depth: PFM 117, w 25-08
1600
1400
1200
1000
800
600
400
200
0
PAR
0
0.5
1
1.5
2
2.5
Depth
y = 1288.2e^-1.1701x
R² = 0.8401
Serie1
Expon. (Serie1)

Week 32, 2008

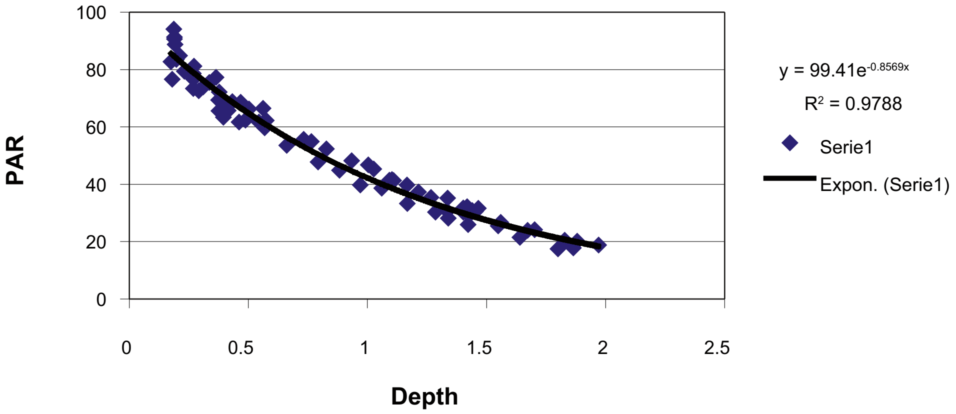
PAR vs Depth: PFM 62, w 32- 08



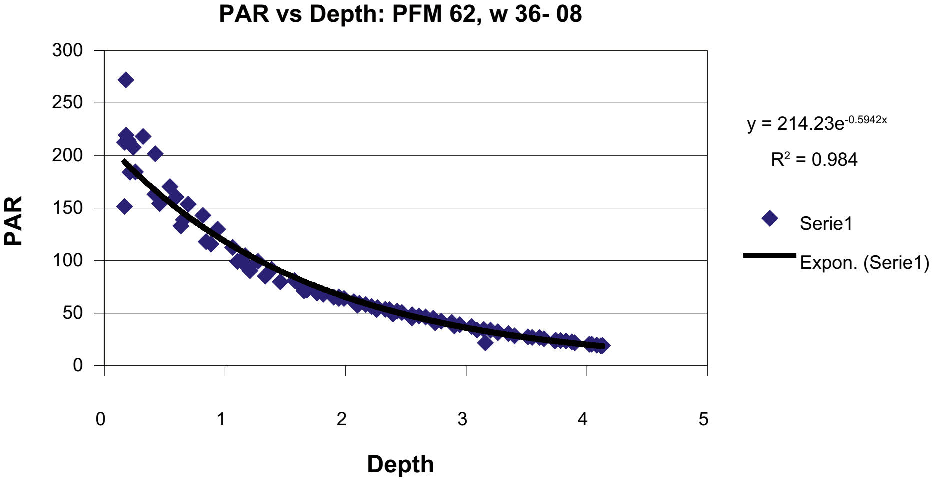
PAR vs Depth: PFM 107, w 32- 08



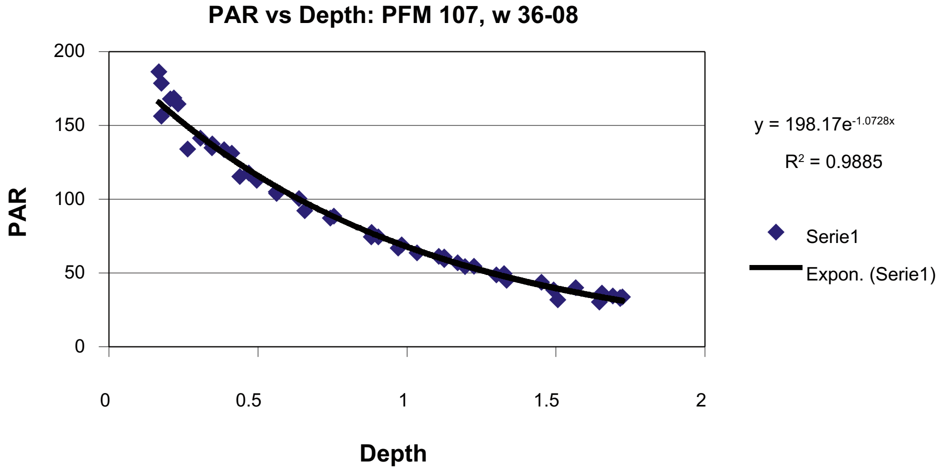
PAR vs Depth: PFM 117, w 32- 08



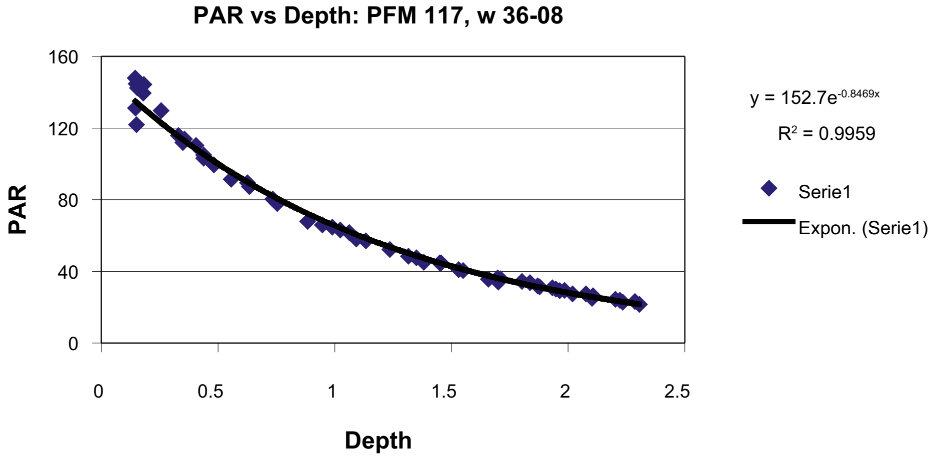
Week 36, 2008



PAR vs Depth: PFM 62, w 36- 08
300
250
200
150
100
50
0
0
1
2
3
4
5
PAR
Depth
y = 214.23e-0.5942x
R2 = 0.984
Serie1
Expon. (Serie1)

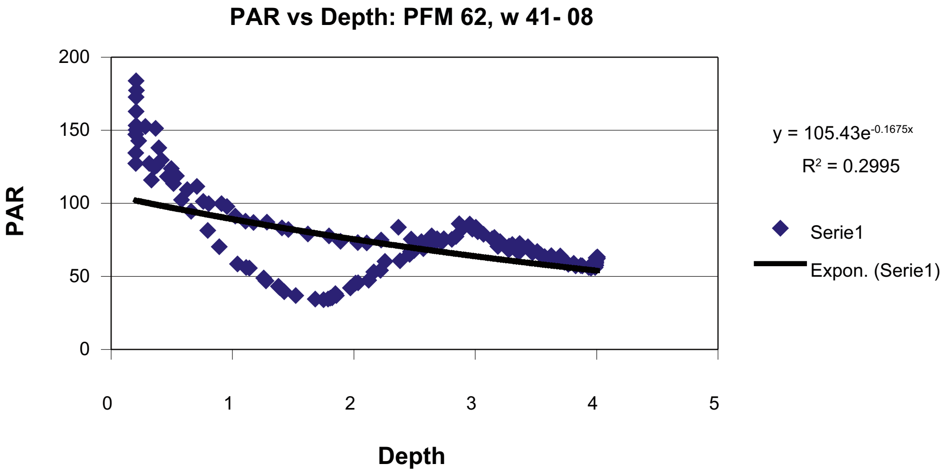


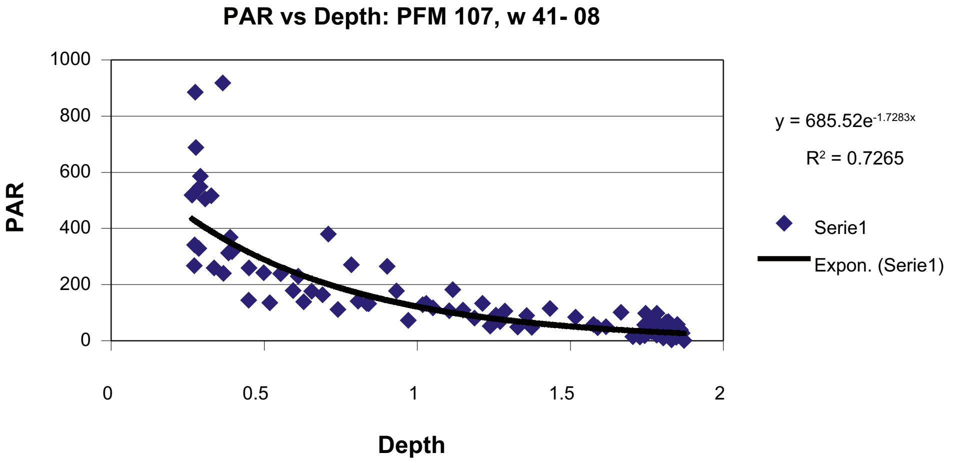
PAR vs Depth: PFM 107, w 36-08
200
150
100
50
0
0
0.5
1
1.5
2
PAR
Depth
y = 198.17e-1.0728x
R2 = 0.9885
Serie1
Expon. (Serie1)

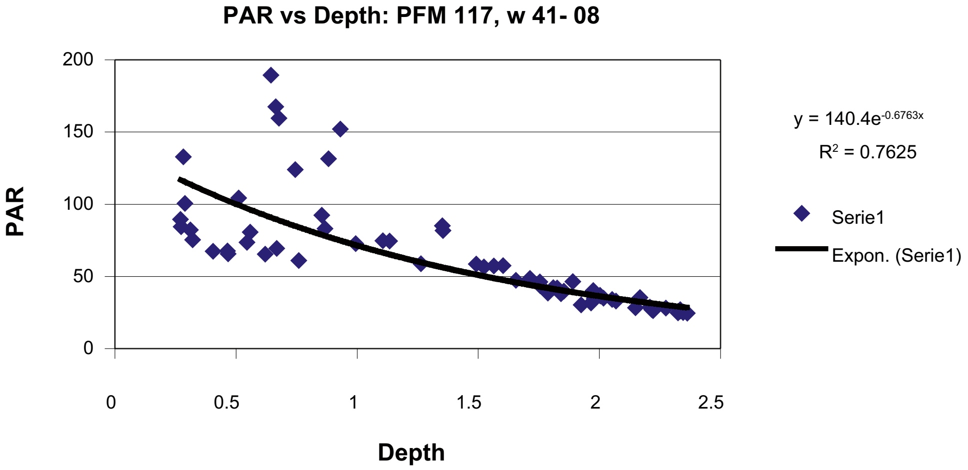


PAR vs Depth: PFM 117, w 36-08
160
120
80
40
0
0
0.5
1
1.5
2
2.5
PAR
Depth
y = 152.7e-0.8469x
R2 = 0.9959
Serie1
Expon. (Serie1)

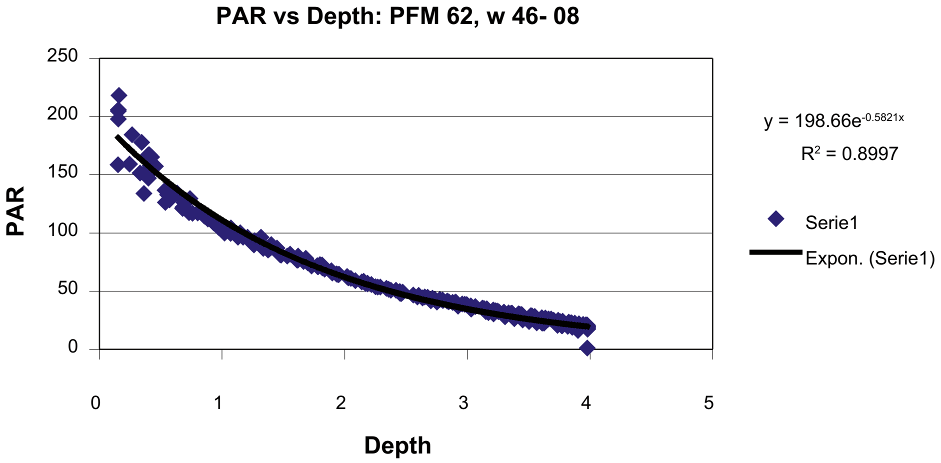
Week 41, 2008

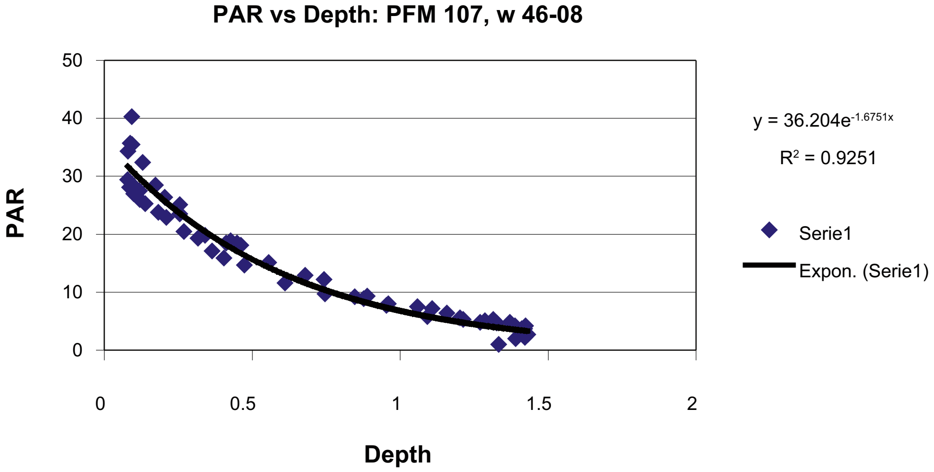

PAR vs Depth: PFM 62, w 41- 08

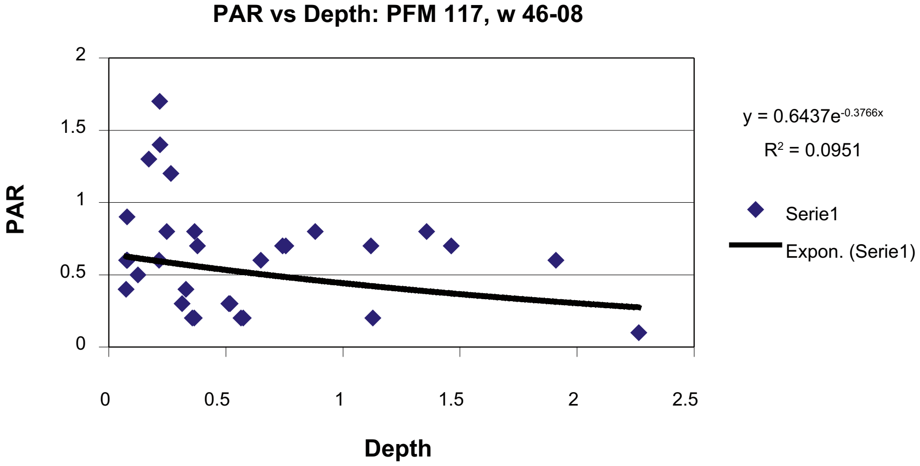

PAR vs Depth: PFM 107, w 41- 08


PAR vs Depth: PFM 117, w 41- 08

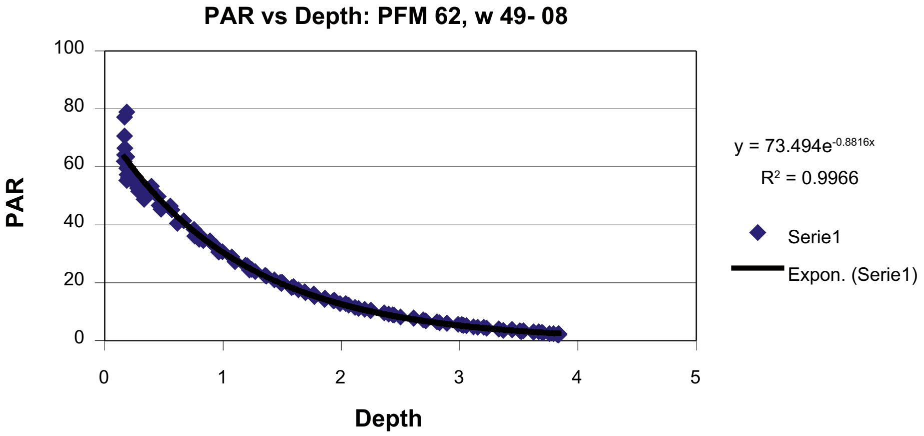
Week 46, 2008


PAR vs Depth: PFM 62, w 46- 08
250
200
150
100
50
0
PAR
0
1
2
3
4
5
Depth
y = 198.66e^-0.5821x
R² = 0.8997
Serie1
Expon. (Serie1)


PAR vs Depth: PFM 107, w 46-08
50
40
30
20
10
0
PAR
0
0.5
1
1.5
2
Depth
y = 36.204e^-1.6751x
R² = 0.9251
Serie1
Expon. (Serie1)


PAR vs Depth: PFM 117, w 46-08
2
1.5
1
0.5
0
PAR
0
0.5
1
1.5
2
2.5
Depth
y = 0.6437e^-0.3766x
R² = 0.0951
Serie1
Expon. (Serie1)

Week 49, 2008



PAR vs Depth: PFM 107, w 49- 08, no data due to weak ice.

PAR vs Depth: PFM 117, w 49- 08, no data due to weak ice.

Table A4-3. Water flow measurements.

Id code	Start date	Stop date	Simple flow rate (m^3/s)	Code
PFM000062	2008-01-14 09:00:00	2008-01-14 19:30:00		N
PFM000062	2008-01-14 09:00:00	2008-01-14 19:30:00		N
PFM000062	2008-01-14 09:00:00	2008-01-14 19:30:00		N
PFM000062	2008-01-14 09:00:00	2008-01-14 19:30:00		N
PFM000062	2008-02-25 08:30:00	2008-02-25 19:00:00		N
PFM000062	2008-02-25 08:30:00	2008-02-25 19:00:00		N
PFM000062	2008-02-25 08:30:00	2008-02-25 19:00:00		N
PFM000062	2008-02-25 08:30:00	2008-02-25 19:00:00		N
PFM000062	2008-03-17 08:30:00	2008-03-17 19:00:00		N
PFM000062	2008-03-17 08:30:00	2008-03-17 19:00:00		N
PFM000062	2008-03-17 08:30:00	2008-03-17 19:00:00		N
PFM000062	2008-03-17 08:30:00	2008-03-17 19:00:00		N
PFM000062	2008-04-06 08:30:00	2008-04-06 19:30:00		N
PFM000062	2008-04-06 08:30:00	2008-04-06 19:30:00		N
PFM000062	2008-04-06 08:30:00	2008-04-06 19:30:00		N
PFM000062	2008-04-06 08:30:00	2008-04-06 19:30:00		N
PFM000062	2008-05-19 09:00:00	2008-05-19 21:30:00		N
PFM000062	2008-05-19 09:00:00	2008-05-19 21:30:00		N
PFM000062	2008-05-19 09:00:00	2008-05-19 21:30:00		N
PFM000062	2008-05-19 09:00:00	2008-05-19 21:30:00		N
PFM000062	2008-06-17 08:00:00	2008-06-17 21:00:00		N
PFM000062	2008-06-17 08:00:00	2008-06-17 21:00:00		N
PFM000062	2008-06-17 08:00:00	2008-06-17 21:00:00		N
PFM000062	2008-06-17 08:00:00	2008-06-17 21:00:00		N
PFM000062	2008-08-05 08:00:00	2008-08-05 21:00:00		N
PFM000062	2008-08-05 08:00:00	2008-08-05 21:00:00		N
PFM000062	2008-08-05 08:00:00	2008-08-05 21:00:00		N
PFM000062	2008-08-05 08:00:00	2008-08-05 21:00:00		N
PFM000062	2008-09-01 09:00:00	2008-09-01 19:00:00		N
PFM000062	2008-09-01 09:00:00	2008-09-01 19:00:00		N
PFM000062	2008-09-01 09:00:00	2008-09-01 19:00:00		N
PFM000062	2008-09-01 09:00:00	2008-09-01 19:00:00		N
PFM000062	2008-10-06 09:00:00	2008-10-06 19:00:00		N
PFM000062	2008-10-06 09:00:00	2008-10-06 19:00:00		N
PFM000062	2008-10-06 09:00:00	2008-10-06 19:00:00		N
PFM000062	2008-10-06 09:00:00	2008-10-06 19:00:00		N
PFM000062	2008-11-10 09:00:00	2008-11-10 18:00:00		N
PFM000062	2008-11-10 09:00:00	2008-11-10 18:00:00		N
PFM000062	2008-11-10 09:00:00	2008-11-10 18:00:00		N
PFM000062	2008-11-10 09:00:00	2008-11-10 18:00:00		N
PFM000062	2008-12-01 09:00:00	2008-12-01 18:00:00		N
PFM000062	2008-12-01 09:00:00	2008-12-01 18:00:00		N
PFM000062	2008-12-01 09:00:00	2008-12-01 18:00:00		N
PFM000062	2008-12-01 09:00:00	2008-12-01 18:00:00		N
PFM000066	2008-01-14 09:00:00	2008-01-14 19:30:00	0.064	
PFM000066	2008-02-25 08:30:00	2008-02-25 19:00:00	0.055	
PFM000066	2008-03-18 07:30:00	2008-03-18 16:00:00	0.057	
PFM000066	2008-04-07 15:00:00	2008-04-07 21:30:00	0.065	
PFM000066	2008-05-19 09:00:00	2008-05-19 21:30:00	0.020	
PFM000066	2008-06-17 08:00:00	2008-06-17 21:00:00		H
PFM000066	2008-08-05 08:00:00	2008-08-05 21:00:00		G
PFM000066	2008-09-01 09:00:00	2008-09-01 19:00:00	0.364	

Id code	**Start date**	**Stop date**	**Simple flow rate (m³/s)**	**Code**
PFM000066	2008-10-07 08:00:00	2008-10-07 20:00:00	0.019	
PFM000066	2008-11-11 08:00:00	2008-11-11 15:00:00	0.101	
PFM000066	2008-12-01 09:00:00	2008-12-01 18:00:00	0.159	
PFM000068	2008-01-14 09:00:00	2008-01-14 19:30:00	0.173	
PFM000068	2008-02-25 08:30:00	2008-02-25 19:00:00	0.080	
PFM000068	2008-03-18 07:30:00	2008-03-18 16:00:00	0.225	
PFM000068	2008-04-07 15:00:00	2008-04-07 21:30:00	0.106	
PFM000068	2008-05-19 09:00:00	2008-05-19 21:30:00	0.065	
PFM000068	2008-06-17 08:00:00	2008-06-17 21:00:00		H
PFM000068	2008-08-05 08:00:00	2008-08-05 21:00:00		G
PFM000068	2008-09-01 09:00:00	2008-09-01 19:00:00	0.086	
PFM000068	2008-10-07 08:00:00	2008-10-07 20:00:00	0.072	
PFM000068	2008-11-10 09:00:00	2008-11-10 18:00:00	0.190	
PFM000068	2008-12-01 09:00:00	2008-12-01 18:00:00	0.321	
PFM000069	2008-01-14 09:00:00	2008-01-14 19:30:00	0.045	
PFM000069	2008-02-25 08:30:00	2008-02-25 19:00:00	0.060	
PFM000069	2008-03-17 08:30:00	2008-03-17 19:00:00	0.090	
PFM000069	2008-04-06 08:30:00	2008-04-06 19:30:00	0.047	
PFM000069	2008-05-19 09:00:00	2008-05-19 21:30:00	0.045	
PFM000069	2008-06-17 08:00:00	2008-06-17 21:00:00		H
PFM000069	2008-08-05 08:00:00	2008-08-05 21:00:00		G
PFM000069	2008-09-01 09:00:00	2008-09-01 19:00:00	0.045	
PFM000069	2008-10-07 08:00:00	2008-10-07 20:00:00	0.044	
PFM000069	2008-11-10 09:00:00	2008-11-10 18:00:00	0.063	
PFM000069	2008-12-01 09:00:00	2008-12-01 18:00:00	0.156	
PFM000070	2008-01-15 07:00:00	2008-01-15 19:00:00	0.033	
PFM000070	2008-02-25 08:30:00	2008-02-25 19:00:00	0.047	
PFM000070	2008-03-17 08:30:00	2008-03-17 19:00:00	0.066	
PFM000070	2008-04-06 08:30:00	2008-04-06 19:30:00	0.031	
PFM000070	2008-05-19 09:00:00	2008-05-19 21:30:00		B
PFM000070	2008-06-17 08:00:00	2008-06-17 21:00:00		H
PFM000070	2008-08-05 08:00:00	2008-08-05 21:00:00		G
PFM000070	2008-09-01 09:00:00	2008-09-01 19:00:00		B
PFM000070	2008-10-06 09:00:00	2008-10-06 19:00:00	0.026	
PFM000070	2008-11-10 09:00:00	2008-11-10 18:00:00	0.044	
PFM000070	2008-12-01 09:00:00	2008-12-01 18:00:00	0.045	
PFM000074	2008-01-15 07:00:00	2008-01-15 19:00:00		N
PFM000074	2008-02-26 08:00:00	2008-02-26 17:00:00		N
PFM000074	2008-03-18 07:30:00	2008-03-18 16:00:00		N
PFM000074	2008-04-07 15:00:00	2008-04-07 21:30:00		N
PFM000074	2008-05-20 07:00:00	2008-05-20 14:00:00		N
PFM000074	2008-06-18 08:00:00	2008-06-18 15:00:00		N
PFM000074	2008-08-05 08:00:00	2008-08-05 21:00:00		N
PFM000074	2008-09-02 07:00:00	2008-09-02 13:00:00		N
PFM000074	2008-10-07 08:00:00	2008-10-07 20:00:00		N
PFM000074	2008-11-11 08:00:00	2008-11-11 15:00:00		N
PFM000074	2008-12-02 08:00:00	2008-12-02 13:00:00		N
PFM000097	2008-01-15 07:00:00	2008-01-15 19:00:00		N
PFM000097	2008-02-26 08:00:00	2008-02-26 17:00:00		N
PFM000097	2008-03-18 07:30:00	2008-03-18 16:00:00		N
PFM000097	2008-04-07 15:00:00	2008-04-07 21:30:00		N
PFM000097	2008-05-20 07:00:00	2008-05-20 14:00:00		N
PFM000097	2008-06-18 08:00:00	2008-06-18 15:00:00		N

Id code	Start date	Stop date	Simple flow rate (m^3/s)	Code
PFM000097	2008-08-06 08:00:00	2008-08-06 15:00:00		N
PFM000097	2008-09-02 07:00:00	2008-09-02 13:00:00		N
PFM000097	2008-10-07 08:00:00	2008-10-07 20:00:00		N
PFM000097	2008-11-11 08:00:00	2008-11-11 15:00:00		N
PFM000097	2008-12-02 08:00:00	2008-12-02 13:00:00		N
PFM000107	2008-01-14 09:00:00	2008-01-14 19:30:00		N
PFM000107	2008-01-14 09:00:00	2008-01-14 19:30:00		N
PFM000107	2008-02-25 08:30:00	2008-02-25 19:00:00		N
PFM000107	2008-02-25 08:30:00	2008-02-25 19:00:00		N
PFM000107	2008-03-17 08:30:00	2008-03-17 19:00:00		N
PFM000107	2008-03-17 08:30:00	2008-03-17 19:00:00		N
PFM000107	2008-04-06 08:30:00	2008-04-06 19:30:00		N
PFM000107	2008-04-06 08:30:00	2008-04-06 19:30:00		N
PFM000107	2008-05-19 09:00:00	2008-05-19 21:30:00		N
PFM000107	2008-05-19 09:00:00	2008-05-19 21:30:00		N
PFM000107	2008-06-17 08:00:00	2008-06-17 21:00:00		N
PFM000107	2008-06-17 08:00:00	2008-06-17 21:00:00		N
PFM000107	2008-08-04 09:00:00	2008-08-04 18:00:00		N
PFM000107	2008-08-04 09:00:00	2008-08-04 18:00:00		N
PFM000107	2008-09-01 09:00:00	2008-09-01 19:00:00		N
PFM000107	2008-09-01 09:00:00	2008-09-01 19:00:00		N
PFM000107	2008-10-06 09:00:00	2008-10-06 19:00:00		N
PFM000107	2008-10-06 09:00:00	2008-10-06 19:00:00		N
PFM000107	2008-11-10 09:00:00	2008-11-10 18:00:00		N
PFM000107	2008-11-10 09:00:00	2008-11-10 18:00:00		N
PFM000107	2008-12-01 09:00:00	2008-12-01 18:00:00		N
PFM000107	2008-12-01 09:00:00	2008-12-01 18:00:00		N
PFM000117	2008-01-15 07:00:00	2008-01-15 19:00:00		N
PFM000117	2008-01-15 07:00:00	2008-01-15 19:00:00		N
PFM000117	2008-01-15 07:00:00	2008-01-15 19:00:00		N
PFM000117	2008-02-25 08:30:00	2008-02-25 19:00:00		N
PFM000117	2008-02-25 08:30:00	2008-02-25 19:00:00		N
PFM000117	2008-02-25 08:30:00	2008-02-25 19:00:00		N
PFM000117	2008-03-17 08:30:00	2008-03-17 19:00:00		N
PFM000117	2008-03-17 08:30:00	2008-03-17 19:00:00		N
PFM000117	2008-03-17 08:30:00	2008-03-17 19:00:00		N
PFM000117	2008-04-06 08:30:00	2008-04-06 19:30:00		N
PFM000117	2008-04-06 08:30:00	2008-04-06 19:30:00		N
PFM000117	2008-04-06 08:30:00	2008-04-06 19:30:00		N
PFM000117	2008-05-19 09:00:00	2008-05-19 21:30:00		N
PFM000117	2008-05-19 09:00:00	2008-05-19 21:30:00		N
PFM000117	2008-05-19 09:00:00	2008-05-19 21:30:00		N
PFM000117	2008-06-17 08:00:00	2008-06-17 21:00:00		N
PFM000117	2008-06-17 08:00:00	2008-06-17 21:00:00		N
PFM000117	2008-06-17 08:00:00	2008-06-17 21:00:00		N
PFM000117	2008-08-05 08:00:00	2008-08-05 21:00:00		N
PFM000117	2008-08-05 08:00:00	2008-08-05 21:00:00		N
PFM000117	2008-08-05 08:00:00	2008-08-05 21:00:00		N
PFM000117	2008-09-01 09:00:00	2008-09-01 19:00:00		N
PFM000117	2008-09-01 09:00:00	2008-09-01 19:00:00		N
PFM000117	2008-09-01 09:00:00	2008-09-01 19:00:00		N
PFM000117	2008-10-06 09:00:00	2008-10-06 19:00:00		N
PFM000117	2008-10-06 09:00:00	2008-10-06 19:00:00		N

Id code	Start date	Stop date	Simple flow rate (m^3/s)	Code
PFM000117	2008-10-06 09:00:00	2008-10-06 19:00:00		N
PFM000117	2008-11-10 09:00:00	2008-11-10 18:00:00		N
PFM000117	2008-11-10 09:00:00	2008-11-10 18:00:00		N
PFM000117	2008-11-10 09:00:00	2008-11-10 18:00:00		N
PFM000117	2008-12-01 09:00:00	2008-12-01 18:00:00		N
PFM000117	2008-12-01 09:00:00	2008-12-01 18:00:00		N
PFM000117	2008-12-01 09:00:00	2008-12-01 18:00:00		N
PFM102269	2008-01-15 07:00:00	2008-01-15 19:00:00		N
PFM102269	2008-02-26 08:00:00	2008-02-26 17:00:00		N
PFM102269	2008-03-18 07:30:00	2008-03-18 16:00:00		N
PFM102269	2008-04-07 15:00:00	2008-04-07 21:30:00		N
PFM102269	2008-05-19 09:00:00	2008-05-19 21:30:00		N
PFM102269	2008-06-17 08:00:00	2008-06-17 21:00:00		N
PFM102269	2008-08-05 08:00:00	2008-08-05 21:00:00		N
PFM102269	2008-09-01 09:00:00	2008-09-01 19:00:00		N
PFM102269	2008-10-07 08:00:00	2008-10-07 20:00:00		N
PFM102269	2008-11-11 08:00:00	2008-11-11 15:00:00		N
PFM102269	2008-12-02 08:00:00	2008-12-02 13:00:00		N

Simple flow rate = based on simple “floating bottle” method.

Code description

A	Blocked flow; no measurement
B	Too much water vegetation, no measurement
C	Water compleately frosen, no measurement
D	Too much ice, no measurement
E	Flow rate too high, no measurement
F	Flow rate too low, no measurement
G	Dry conditions, no measurements
H	Measurement not possible, estimated value
I	Measurement not possible, see protocol
K	Comment missing
L	Flow rate value available
M	Low water level
N	Lake, Sea, no measurement
O	Too much wind, no measurement
P	Stationary water

Table A4-4a. Water composition.

Id code	Sample no.	Depth (m)	Sampling date	RCB (%)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	HCO_3- (mg/L)	Cl^- (mg/L)	SO_4^{2-} (mg/L)	SO_4-S (mg/L)	Br (mg/L)	F^- (mg/L)	Si (mg/L)	Fe (mg/L)	Mn (mg/L)
PFM000062	12917	0.50	2008-01-14	–5.79	1,390	62.8	74.6	180	78.9	2,840	395	144	10.3	0.32	0.67	0.0020	0.0016
PFM000062	12956	0.50	2008-02-25	–4.19	1,390	53.3	71.3	167	78.2	2,700	372	136	9.70	0.31	0.91	–	–
PFM000062	12962	0.50	2008-03-17	–2.64	1,470	54.7	73.6	169	78.6	2,740	382	140	8.76	0.32	0.60	–	–
PFM000062	12973	0.50	2008-04-06	–2.33	1,480	55.8	78.4	178	79.1	2,780	393	137	10.1	0.33	<0.2	0.0035	0.0013
PFM000062	16009	0.50	2008-05-19	–3.76	1,360	54.5	73.6	166	75.1	2,630	370	135	9.34	0.34	0.28	–	–
PFM000062	16054	0.50	2008-06-17	–3.73	1,340	55.8	72.1	169	73.9	2,600	385	137	9.16	<1.2	0.27	–	–
PFM000062	16073	0.51	2008-08-05	–3.19	1,440	59.8	72.9	174	75.3	2,730	494	147	9.97	0.34	0.46	0.0026	0.0027
PFM000062	16075	0.50	2008-09-01	1.32	1,390	55.8	75.4	178	74.1	2,400	359	147	9.25	0.24	0.46	–	–
PFM000062	16105	0.50	2008-10-06	0.19	1,570	55.0	74.3	176	76.8	2,730	x	147	9.30	0.34	0.60	0.0022	0.0013
PFM000062	16149	0.50	2008-11-10	–0.30	1,570	60.9	76.7	184	79.5	2,790	385	148	9.31	0.31	0.63	–	–
PFM000062	16164	0.50	2008-12-01	–2.67	1,420	57.8	78.6	182	78.8	2,710	385	141	9.80	0.32	0.93	–	–
PFM000066	12924	0.28	2008-01-14	1.92	6.5	2.73	68.2	3.63	192.0	7.3	23.4	8.77	0.050	<0.2	5.06	–	–
PFM000066	12960	0.38	2008-02-25	0.88	5.0	2.36	63.4	3.25	191.0	5.9	14.9	5.58	0.040	<0.2	4.89	–	–
PFM000066	12969	0.38	2008-03-18	2.38	3.8	1.75	55.6	2.77	163.0	4.6	11.2	4.20	0.030	<0.2	4.31	–	–
PFM000066	12979	0.39	2008-04-07	2.24	4.3	2.20	63.5	2.96	186.0	5.2	12.5	4.65	0.036	0.22	4.31	–	–
PFM000066	16015	0.23	2008-05-19	4.85	5.0	2.34	71.6	3.45	205.0	5.5	9.04	3.59	0.042	0.24	3.28	–	–
PFM000066	16060	0.14	2008-06-17	1.48	5.4	2.32	59.8	3.28	188.0	5.2	8.30	3.28	0.054	0.24	3.00	–	–
PFM000066	16087	0.27	2008-09-01	3.79	5.2	2.09	68.4	3.37	198.0	6.8	12.6	3.59	0.065	0.30	5.58	–	–
PFM000066	16097	0.27	2008-10-07	3.85	5.9	3.50	77.5	3.99	235.0	5.9	6.54	2.79	<0.2	0.25	6.77	–	–
PFM000066	16156	0.42	2008-11-11	5.74	5.3	3.53	70.8	3.81	207.0	5.9	5.39	2.31	0.071	0.22	6.18	–	–
PFM000066	16168	0.44	2008-12-01	5.60	4.7	2.61	69.6	3.65	202.0	5.5	5.66	2.17	0.076	0.23	6.09	–	–
PFM000068	12925	0.37	2008-01-14	2.75	12.3	2.43	53.5	4.33	144.0	18.7	22.6	8.50	0.091	0.21	4.40	–	–
PFM000068	12959	0.53	2008-02-25	1.46	9.8	2.19	53.6	4.03	149.0	16.2	20.4	7.62	<0.2	0.23	4.55	–	–
PFM000068	12968	0.62	2008-03-18	1.76	7.7	1.73	50.6	3.50	143.0	13.3	15.2	5.57	0.055	0.24	4.06	–	–
PFM000068	12980	0.62	2008-04-07	2.88	9.2	2.24	55.2	3.84	154.0	15.5	15.8	5.69	0.073	0.27	3.93	–	–
PFM000068	16014	0.47	2008-05-19	2.99	15.4	2.49	63.8	5.25	176.0	28.7	15.7	6.18	0.127	0.32	4.58	–	–
PFM000068	16059	0.29	2008-06-17	1.35	26.6	2.63	65.8	7.02	191.0	53.1	13.1	4.80	0.224	0.40	5.54	–	–
PFM000068	16086	0.52	2008-09-01	4.74	13.8	2.54	65.3	4.97	169.0	22.7	22.1	8.24	0.133	0.29	5.51	–	–
PFM000068	16096	0.54	2008-10-07	5.12	13.3	3.43	60.7	5.01	172.0	20.1	11.6	4.92	<0.2	0.31	6.26	–	–
PFM000068	16154	0.51	2008-11-10	5.10	10.1	3.21	57.0	4.37	160.0	15.0	12.3	4.84	0.110	0.30	5.42	–	–
PFM000068	16167	0.80	2008-12-01	5.26	7.3	2.30	51.4	3.83	142.0	12.0	12.0	4.03	0.058	0.28	5.41	–	–
PFM000069	12918	0.16	2008-01-14	1.55	18.3	2.63	69.4	5.85	191.0	30.3	28.7	10.6	0.138	0.26	5.69	–	–

Id code	Sample no.	Depth (m)	Sampling date	RCB (%)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	HCO_3^- (mg/L)	Cl^- (mg/L)	SO_4^{2-} (mg/L)	SO_4-S (mg/L)	Br (mg/L)	F^- (mg/L)	Si (mg/L)	Fe (mg/L)	Mn (mg/L)
PFM000069	12958	0.24	2008-02-25	1.18	14.0	2.59	68.2	5.19	186.0	25.4	27.4	9.94	0.104	0.28	5.48	–	–
PFM000069	12967	0.29	2008-03-17	2.02	10.4	1.90	57.1	3.99	153.0	19.1	20.5	7.55	0.069	0.28	4.56	–	–
PFM000069	12977	0.20	2008-04-06	2.46	12.4	2.29	62.6	4.62	167.0	24.0	21.2	7.61	0.092	0.29	4.63	–	–
PFM000069	16013	0.14	2008-05-19	2.14	18.4	2.51	65.9	5.73	182.0	36.1	17.3	6.58	0.144	0.36	5.22	–	–
PFM000069	16058	0.21	2008-06-17	0.06	27.4	2.61	64.6	7.26	190.0	54.7	17.6	6.25	0.227	0.48	5.32	–	–
PFM000069	16085	0.20	2008-09-01	2.93	15.6	2.57	67.4	5.25	181.0	28.3	22.6	8.00	0.151	0.32	5.55	–	–
PFM000069	16108	0.18	2008-10-07	3.95	18.5	3.52	72.2	6.13	206.0	29.9	15.9	6.18	<0.2	0.34	7.29	–	–
PFM000069	16153	0.20	2008-11-10	4.27	13.8	3.93	70.5	5.32	196.0	22.3	17.7	6.67	0.136	0.32	6.50	–	–
PFM000069	16166	0.55	2008-12-01	4.31	10.7	2.81	65.8	4.96	179.0	18.5	17.7	6.52	0.108	0.31	6.79	–	–
PFM000070	12944	0.14	2008-01-15	4.27	4.4	1.35	26.7	1.74	74.3	4.2	9.01	3.61	0.023	<0.2	1.88	–	–
PFM000070	12957	0.23	2008-02-25	4.49	4.5	1.47	31.9	2.01	86.7	5.0	10.4	4.10	0.026	<0.2	2.67	–	–
PFM000070	12966	0.24	2008-03-17	–0.22	5.8	1.70	50.1	2.82	159.0	7.3	9.93	3.70	0.036	<0.2	3.03	–	–
PFM000070	12976	0.17	2008-04-06	3.27	6.0	1.97	51.9	2.90	153.0	7.1	9.85	3.71	0.038	<0.2	2.76	–	–
PFM000070	16012	0.25	2008-05-19	4.11	5.9	1.61	47.8	2.83	140.0	6.8	8.18	3.20	0.033	<0.2	1.17	–	–
PFM000070	16057	0.20	2008-06-17	2.98	6.5	0.95	51.4	3.10	163.0	6.1	<5	1.41	0.056	0.25	3.44	–	–
PFM000070	16078	0.23	2008-09-01	4.73	6.5	1.76	39.9	2.68	114.0	7.9	9.20	3.30	0.048	0.22	3.50	–	–
PFM000070	16117	0.25	2008-10-06	5.07	7.0	2.25	38.6	3.11	115.0	6.8	8.39	3.36	0.040	0.22	3.19	–	–
PFM000070	16152	0.09	2008-11-10	5.82	6.9	2.27	44.0	3.17	129.0	6.7	7.64	3.06	0.048	0.23	3.35	–	–
PFM000070	16165	0.26	2008-12-01	8.03	5.0	1.92	45.2	2.93	124.0	6.0	5.31	2.22	0.044	0.22	4.40	–	–
PFM000074	12943	0.50	2008-01-15	1.27	9.7	2.82	69.9	3.88	194.0	14.8	25.5	9.52	0.058	<0.2	5.17	0.0325	0.0113
PFM000074	12961	0.50	2008-02-26	0.80	5.4	2.30	62.4	3.23	186.0	7.5	15.5	5.69	0.038	<0.2	4.91	–	–
PFM000074	12978	0.50	2008-04-07	2.93	6.4	2.29	64.7	3.19	183.0	10.8	12.7	4.73	0.038	0.23	4.08	0.0314	0.0040
PFM000074	16016	0.50	2008-05-20	3.83	8.7	2.39	72.1	3.70	205.0	15.1	8.87	3.58	0.049	0.27	3.46	–	–
PFM000074	16061	0.50	2008-06-18	2.62	14.8	2.17	63.0	4.46	185.0	24.7	10.1	4.02	0.071	0.29	5.49	–	–
PFM000074	16074	0.48	2008-08-05	2.43	16.2	2.09	55.9	4.47	162.0	28.6	10.4	4.03	0.108	0.30	7.96	0.0177	0.0061
PFM000074	16088	0.51	2008-09-02	3.15	9.6	2.41	72.1	3.74	206.0	17.4	11.8	3.73	0.074	0.32	5.79	–	–
PFM000074	16107	0.51	2008-10-07	4.62	8.5	3.66	77.9	4.12	229.0	12.0	6.09	2.74	<0.2	0.27	6.86	0.0756	0.0045
PFM000074	16155	0.51	2008-11-11	1.91	6.9	3.91	67.7	4.00	213.0	9.1	6.26	3.03	0.1	0.25	6.05	–	–
PFM000107	12920	0.51	2008-01-14	5.31	81.8	4.69	65.1	11.4	125.0	147	35.8	13.8	0.6	0.22	3.55	0.1090	0.0255
PFM000107	12928	1.01	2008-01-14	0.82	305	12.2	107.0	35.1	155.0	601	83.4	30.8	2.2	0.40	1.12	0.0706	0.0591
PFM000107	12963	0.51	2008-03-17	–1.05	72.8	3.82	58.7	10.7	128.0	155	32.2	11.8	0.5	0.26	2.03	–	–
PFM000107	12974	0.50	2008-04-06	–0.89	53.0	3.51	57.5	9.11	137.0	115	27.8	9.87	0.4	0.27	1.66	0.0667	0.0042
PFM000107	16010	0.50	2008-05-19	1.05	36.4	3.11	51.3	7.48	131.0	73.5	21.5	8.04	0.3	0.28	0.43	–	–

Id code	Sample no.	Depth (m)	Sampling date	RCB (%)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	HCO_3^- (mg/L)	Cl^- (mg/L)	SO_4^{2-} (mg/L)	SO_4-S (mg/L)	Br (mg/L)	F^- (mg/L)	Si (mg/L)	Fe (mg/L)	Mn (mg/L)
PFM000107	16055	0.50	2008-06-17	1.04	44.7	3.32	37.2	8.49	90.5	87.0	22.5	8.58	0.3	0.27	0.36	–	–
PFM000107	16071	0.50	2008-08-04	–3.70	61.7	4.81	37.3	10.3	81.1	140	32.5	10.2	0.5	0.40	0.93	0.0280	0.0066
PFM000107	16076	0.51	2008-09-01	2.99	48.7	3.60	43.1	9.01	105.0	87.5	25.0	9.61	0.4	0.28	1.00	–	–
PFM000107	16116	0.50	2008-10-06	1.90	42.5	3.78	49.6	8.54	134.0	78.1	22.2	8.25	0.2	0.31	1.38	0.0681	0.0068
PFM000107	16150	0.50	2008-11-10	3.44	36.0	3.90	51.9	7.89	143.0	63.0	18.5	7.05	0.3	0.30	1.92	–	–
PFM000117	12926	0.50	2008-01-15	3.61	7.8	2.46	42.0	3.09	130.0	7.5	8.47	3.50	0.1	<0.2	2.46	0.0100	0.0141
PFM000117	12927	1.50	2008-01-15	3.40	8.5	2.86	55.4	3.56	166.0	8.3	12.4	5.08	0.1	<0.2	3.32	0.0264	0.0429
PFM000117	12965	0.50	2008-03-17	2.25	6.1	1.87	53.5	2.95	161.0	7.3	9.95	3.87	0.0	<0.2	3.13	–	–
PFM000117	12975	0.50	2008-04-06	3.62	6.0	1.96	52.7	2.93	154.0	7.1	9.91	3.77	0.0	<0.2	2.74	0.0277	0.0113
PFM000117	16011	0.51	2008-05-19	4.60	6.0	1.78	49.1	2.93	141.0	6.9	8.87	3.48	0.0	0.21	0.73	–	–
PFM000117	16056	0.50	2008-06-17	2.71	6.6	2.01	40.4	3.07	125.0	7.0	9.40	3.58	0.0	<0.2	1.09	–	–
PFM000117	16072	0.50	2008-08-05	5.62	7.5	2.36	31.8	3.30	92.3	8.4	11.0	3.88	0.1	0.24	2.61	0.0033	0.0009
PFM000117	16077	0.51	2008-09-01	4.75	6.8	2.01	32.0	3.07	94.9	7.4	9.70	3.57	0.0	0.21	2.74	–	–
PFM000117	16106	0.50	2008-10-06	5.21	7.0	2.22	38.4	3.08	114.0	6.7	8.73	3.37	0.0	0.22	3.11	0.0083	0.0026
PFM000117	16151	0.50	2008-11-10	6.06	7.6	2.38	44.3	3.30	131.0	6.8	7.62	3.15	0.042	0.23	3.34		
PFM102269	12929	0.50	2008-01-15	–	–	–	–	–	79.8	2,850	386	–	9.5	0.32	–	–	–
PFM102269	12964	0.50	2008-02-26	–	–	–	–	–	78.6	2,720	370	–	9.4	0.31	–	–	–
PFM102269	12971	0.50	2008-03-18	–	–	–	–	–	78.3	2,740	384	–	8.7	0.31	–	–	–
PFM102269	12972	0.51	2008-04-07	–	–	–	–	–	78.9	2,770	394	–	9.3	0.35	–	–	–
PFM102269	16008	0.50	2008-05-19	–	–	–	–	–	75.1	2,630	371	–	11.3	0.33	–	–	–
PFM102269	16053	0.50	2008-06-17	–	–	–	–	–	74.4	2,610	390	–	9.6	0.27	–	–	–
PFM102269	16070	0.50	2008-08-05	–	–	–	–	–	75.4	2,730	382	–	8.3	0.24	–	–	–
PFM102269	16089	0.50	2008-09-01	–	–	–	–	–	74.1	2,890	362	–	8.2	0.22	–	–	–
PFM102269	16115	0.50	2008-10-07	–	–	–	–	–	76.8	2,760	397	–	6.7	0.30	–	–	–
PFM102269	16148	0.50	2008-11-11	–	–	–	–	–	79.2	2,790	382	–	9.5	0.34	–	–	–
PFM102269	16163	0.50	2008-12-02	–	–	–	–	–	79.2	2,730	370	–	8.8	0.33	–	–	–

<“value” = below reporting limit.

x = no result due to analytical problems.

Table A4-4a continue. Water composition.

Id code	Sample no.	Depth (m)	Sampling date	Li (mg/L)	Sr (mg/L)	I^- (mg/L)	pH_L	pH_F	Temp_F (°C)	EC_L (mS/m)
PFM000062	12917	0.50	2008-01-14	0.028	1.24	0.013	7.80	7.73	1.9	917
PFM000062	12956	0.50	2008-02-25	0.024	1.10	–	7.85	7.73	1.9	880
PFM000062	12962	0.50	2008-03-17	0.026	1.10	–	7.92	7.80	3.2	882
PFM000062	12973	0.50	2008-04-06	0.025	1.12	0.011	8.19	8.43	2.5	890
PFM000062	16009	0.50	2008-05-19	0.026	1.04	–	7.97	8.12	10.5	843
PFM000062	16054	0.50	2008-06-17	0.025	1.08	–	7.93	8.00	13.9	831
PFM000062	16073	0.51	2008-08-05	0.028	1.15	0.014	7.82	7.99	15.7	880
PFM000062	16075	0.50	2008-09-01	0.026	1.16	–	7.92	8.02	15.7	862
PFM000062	16105	0.50	2008-10-06	0.024	1.13	–0.020	7.90	7.99	10.9	887
PFM000062	16149	0.50	2008-11-10	0.029	1.19	–	7.96	7.88	6.3	889
PFM000062	16164	0.50	2008-12-01	0.026	1.16	–	7.74	7.83	2.6	891
PFM000066	12924	0.28	2008-01-14	<0.004	0.072	–	7.11	7.24	0.7	38
PFM000066	12960	0.38	2008-02-25	<0.004	0.066	–	7.20	7.19	1.6	35
PFM000066	12969	0.38	2008-03-18	<0.004	0.056	–	7.34	7.45	0.9	30
PFM000066	12979	0.39	2008-04-07	<0.004	0.063	0.004	7.34	7.38	5.5	33
PFM000066	16015	0.23	2008-05-19	0.0046	0.072	–	7.59	7.59	10.0	36
PFM000066	16060	0.14	2008-06-17	<0.004	0.069	–	7.52	7.42	11.2	32
PFM000066	16087	0.27	2008-09-01	<0.004	0.074	–	7.59	7.31	12.4	35
PFM000066	16097	0.27	2008-10-07	<0.004	0.086	–	7.65	7.46	5.6	40
PFM000066	16156	0.42	2008-11-11	<0.004	0.075	–	7.72	7.38	3.0	36
PFM000066	16168	0.44	2008-12-01	<0.004	0.071	–	7.52	7.19	0.1	35
PFM000068	12925	0.37	2008-01-14	<0.004	0.079	–	7.16	7.41	0.8	35
PFM000068	12959	0.53	2008-02-25	<0.004	0.074	–	7.21	7.22	1.1	34
PFM000068	12968	0.62	2008-03-18	<0.004	0.065	–	7.31	7.56	0.8	31
PFM000068	12980	0.62	2008-04-07	<0.004	0.075	0.0044	7.29	7.31	4.9	33
PFM000068	16014	0.47	2008-05-19	0.0042	0.092	–	7.42	7.38	8.2	40
PFM000068	16059	0.29	2008-06-17	<0.004	0.113	–	7.49	7.32	10.5	49
PFM000068	16086	0.52	2008-09-01	<0.004	0.103	–	7.49	7.18	10.9	39
PFM000068	16096	0.54	2008-10-07	<0.004	0.096	–	7.43	7.32	4.7	37
PFM000068	16154	0.51	2008-11-10	<0.004	0.079	–	7.61	7.26	3.4	34
PFM000068	16167	0.80	2008-12-01	<0.004	0.068	–	7.42	7.12	0.2	29
PFM000069	12918	0.16	2008-01-14	<0.004	0.102	–	7.12	7.26	1.0	47
PFM000069	12958	0.24	2008-02-25	<0.004	0.093	–	7.12	7.18	1.2	44
PFM000069	12967	0.29	2008-03-17	<0.004	0.074	–	7.16	7.36	1.5	35
PFM000069	12977	0.20	2008-04-06	<0.004	0.087	0.0044	7.21	7.18	4.3	39
PFM000069	16013	0.14	2008-05-19	0.004	0.097	–	7.36	7.33	8.7	44
PFM000069	16058	0.21	2008-06-17	<0.004	0.115	–	7.61	7.25	13.2	50
PFM000069	16085	0.20	2008-09-01	0.0054	0.103	–	7.37	7.14	11.1	42
PFM000069	16108	0.18	2008-10-07	<0.004	0.116	–	7.52	7.33	4.4	46
PFM000069	16153	0.20	2008-11-10	<0.004	0.099	–	7.62	7.21	3.5	43
PFM000069	16166	0.55	2008-12-01	<0.004	0.086	–	7.32	7.16	0.4	38
PFM000070	12944	0.14	2008-01-15	<0.004	0.031	–	7.11	7.59	0.9	17
PFM000070	12957	0.23	2008-02-25	<0.004	0.035	–	7.10	7.36	2.9	19
PFM000070	12966	0.24	2008-03-17	<0.004	0.050	–	7.59	7.67	3.4	30
PFM000070	12976	0.17	2008-04-06	<0.004	0.052	0.0040	7.74	7.87	7.2	29
PFM000070	16012	0.25	2008-05-19	<0.004	0.049	–	7.33	7.38	12.2	27
PFM000070	16057	0.20	2008-06-17	<0.004	0.058	–	7.36	7.29	13.2	28
PFM000070	16078	0.23	2008-09-01	<0.004	0.046	–	7.37	7.13	12.3	24
PFM000070	16117	0.25	2008-10-06	<0.004	0.052	–	7.86	7.64	8.7	23
PFM000070	16152	0.09	2008-11-10	<0.004	0.054	–	8.12	7.87	3.6	26
PFM000070	16165	0.26	2008-12-01	<0.004	0.050	–	7.54	7.39	0.3	24
PFM000074	12943	0.50	2008-01-15	<0.004	0.078	0.0036	7.09	7.01	1.2	41
PFM000074	12961	0.50	2008-02-26	<0.004	0.068	–	7.32	7.28	2.3	35
PFM000074	12978	0.50	2008-04-07	0.0014	0.070	0.0033	7.43	7.46	5.4	35

Id code	Sample no.	Depth (m)	Sampling date	Li (mg/L)	Sr (mg/L)	I$^-$ (mg/L)	pH_L	pH_F	Temp_F (°C)	EC_L (mS/m)
PFM000074	16016	0.50	2008-05-20	0.0041	0.076	–	7.56	7.60	9.5	39
PFM000074	16061	0.50	2008-06-18	<0.004	0.087	–	7.82	7.76	17.2	39
PFM000074	16074	0.48	2008-08-05	<0.004	0.083	0.0094	7.77	7.76	15.3	37
PFM000074	16088	0.51	2008-09-02	<0.004	0.083	–	6.99	7.18	11.8	40
PFM000074	16107	0.51	2008-10-07	0.0017	0.090	0.0090	7.68	7.45	6.3	42
PFM000074	16155	0.51	2008-11-11	<0.004	0.077	–	7.87	7.52	3.2	38
PFM000107	12920	0.51	2008-01-14	0.0049	0.172	0.0044	7.22	7.60	2.1	70
PFM000107	12928	1.01	2008-01-14	0.0088	0.492	0.0063	7.49	7.55	2.9	229
PFM000107	12963	0.51	2008-03-17	0.0045	0.166	–	7.78	8.05	2.7	78
PFM000107	12974	0.50	2008-04-06	0.0030	0.143	0.0041	8.03	8.23	7.1	65
PFM000107	16010	0.50	2008-05-19	0.0047	0.115	–	8.34	8.58	10.0	50
PFM000107	16055	0.50	2008-06-17	<0.004	0.119	–	9.00	9.23	17.7	49
PFM000107	16071	0.50	2008-08-04	0.00420	0.144	0.0109	8.72	8.89	18.4	60
PFM000107	16076	0.51	2008-09-01	0.00450	0.132	–	8.41	8.48	13.9	54
PFM000107	16116	0.50	2008-10-06	0.00270	0.132	0.0082	7.15	8.21	7.8	53
PFM000107	16150	0.50	2008-11-10	<0.004	0.120	–	8.34	8.14	3.1	48
PFM000117	12926	0.50	2008-01-15	<0.004	0.051	0.0052	7.84	7.90	1.6	26
PFM000117	12927	1.50	2008-01-15	<0.004	0.062	0.0060	7.50	7.58	3.5	33
PFM000117	12965	0.50	2008-03-17	<0.004	0.053	–	7.74	7.85	3.7	30
PFM000117	12975	0.50	2008-04-06	0.0012	0.052	0.0042	8.10	8.31	7.1	29
PFM000117	16011	0.51	2008-05-19	<0.004	0.050	–	8.30	8.46	10.8	27
PFM000117	16056	0.50	2008-06-17	<0.004	0.051	–	8.48	8.64	18.3	24
PFM000117	16072	0.50	2008-08-05	<0.004	0.052	0.0060	8.60	8.63	17.5	20
PFM000117	16077	0.51	2008-09-01	<0.004	0.048	–	8.77	8.78	14.9	20
PFM000117	16106	0.50	2008-10-06	0.0012	0.052	0.0058	8.49	8.42	8.3	33
PFM000117	16151	0.50	2008-11-10	<0.004	0.055	–	8.32	7.97	3.0	25
PFM102269	12929	0.50	2008-01-15	–	–	–	7.79	7.91	12.3	914
PFM102269	12964	0.50	2008-02-26	–	–	–	7.82	7.94	12.1	881
PFM102269	12971	0.50	2008-03-18	–	–	–	7.96	7.88	13.0	874
PFM102269	12972	0.51	2008-04-07	–	–	–	8.22	8.44	12.9	885
PFM102269	16008	0.50	2008-05-19	–	–	–	7.99	8.11	21.5	848
PFM102269	16053	0.50	2008-06-17	–	–	–	7.80	8.09	25.1	838
PFM102269	16070	0.50	2008-08-05	–	–	–	7.80	7.90	23.6	865
PFM102269	16089	0.50	2008-09-01	–	–	–	7.88	7.95	25.8	859
PFM102269	16115	0.50	2008-10-07	–	–	–	7.88	7.95	20.9	891
PFM102269	16148	0.50	2008-11-11	–	–	–	7.85	7.77	14.6	884
PFM102269	16163	0.50	2008-12-02	–	–	–	7.76	7.80	10.8	885

RCB = Relative Charge Balance error.

pH_L = lab. pH.

pH_F = field pH.

Temp_F = water temperature in the field.

EC = Electrical Conductivity.

Table A4-4b. Surface water supplements.

Id code	Sample no.	Sampling date	Depth (m)	NH$_4$_N (mg/L)	NO$_2$_N (mg/L)	NO$_3$_N+NO$_2$_N (mg/L)	N TOT (mg/L)	P TOT (mg/L)	PO$_4$_P (mg/L)	POP (mg/L)	PON (mg/L)	SIO$_2$_SI (mg/L)	Chl. C (ug/L)	Chl. A (ug/L)	Pheop. (ug/L)	POC (mg/L)	TOC (mg/L)	DOC (mg/L)	DIC (mg/L)	Abs. coeff. (1/m)
PFM000062	12917	2008-01-14	0.5	0.0017	0.0008	0.0612	0.2620	0.0132	0.0072	0.0015	0.00790	0.645	–0.2	0.6	–0.2	0.07	3.7	3.7	15.1	0.18
PFM000062	12956	2008-02-25	0.5	0.0013	–	0.0737	0.3010	0.0132	0.0052	0.0044	0.02130	0.789	0.3	2.2	0.2	0.17	4.3	4.3	14.7	0.30
PFM000062	12962	2008-03-17	0.5	0.0020	–	0.0368	0.2760	0.0133	0.0011	0.0080	0.04700	0.599	1.6	10.1	1.5	0.30	4.2	4.2	14.7	0.10
PFM000062	12973	2008-04-06	0.5	0.0014	0.0002	0.0004	0.2470	0.0120	0.0006	0.0070	0.05110	0.114	1.7	9.0	1.5	0.50	4.3	4.1	13.1	0.28
PFM000062	16009	2008-05-19	0.5	0.0014	–	0.0004	0.2380	0.0115	–0.0005	0.0066	0.04280	0.097	0.2	2.0	0.2	0.29	4.4	4.4	14.0	0.34
PFM000062	16054	2008-06-17	0.5	0.0014	–	0.0002	0.2360	0.0106	0.0008	0.0053	0.04130	0.229	0.2	1.7	0.2	0.25	4.3	4.3	13.4	0.28
PFM000062	16073	2008-08-05	0.5	0.0033	0.0004	0.0018	0.2820	0.0156	0.0010	0.0097	0.05310	0.387	0.4	3.6	0.4	0.32	4.0	4.1	12.1	0.84
PFM000062	16075	2008-09-01	0.5	0.0025	–	0.0016	0.3070	0.0192	0.0017	0.0103	0.05370	0.363	0.4	2.5	0.7	0.34	3.9	4.0	14.3	0.30
PFM000062	16105	2008-10-06	0.5	0.0009	0.0004	0.0021	0.2450	0.0108	–0.0005	0.0046	0.03440	0.521	0.4	2.9	0.6	0.20	4.2	4.3	13.6	0.26
PFM000062	16149	2008-11-10	0.5	0.0106	–	0.0280	0.2680	0.0128	0.0038	0.0053	0.02400	0.522	0.3	1.8	0.6	0.21	4.1	4.2	18.8	1.60
PFM000062	16164	2008-12-01	0.5	0.0060	–	0.0624	0.2920	0.0175	0.0082	0.0060	0.03070	0.717	0.3	2.2	0.8	0.25	4.1	4.2	15.0	0.32
PFM000066	12924	2008-01-14	0.3	0.0047	0.0013	0.0445	0.7400	0.0067	–0.0005	0.0016	0.01320	4.960	–	–	–	0.11	18.0	17.7	33.0	2.40
PFM000066	12960	2008-02-25	0.4	0.0056	–	0.0141	0.6680	0.0056	0.0006	0.0013	0.00960	4.880	–	–	–	0.08	18.3	18.2	38.2	2.26
PFM000066	12969	2008-03-18	0.4	0.0055	–	0.0192	0.5880	0.0059	0.0006	0.0018	0.01600	4.070	–	–	–	0.14	15.2	15.1	26.8	2.06
PFM000066	12979	2008-04-07	0.4	0.0007	0.0004	0.0118	0.6530	0.0078	–0.0005	0.0034	0.02450	4.170	–	–	–	0.24	16.4	16.4	27.6	2.38
PFM000066	16015	2008-05-19	0.2	0.0130	–	0.0028	0.8220	0.0101	0.0009	0.0050	0.04510	3.070	–	–	–	0.34	20.2	21.1	37.2	2.74
PFM000066	16060	2008-06-17	0.1	0.0809	–	0.0234	1.0300	0.0153	0.0033	0.0087	0.04910	2.840	–	–	–	0.36	20.1	20.2	25.1	2.86
PFM000066	16087	2008-09-01	0.3	0.0084	0.0005	0.0034	0.9170	0.0108	0.0010	0.0038	0.02530	5.290	–	–	–	0.21	24.6	21.7	39.7	3.34
PFM000066	16097	2008-10-07	0.3	0.0210	0.0007	0.0109	0.9360	0.0088	–0.0005	0.0026	0.02210	5.960	–	–	–	0.20	22.6	23.7	36.8	3.52
PFM000066	16156	2008-11-11	0.4	0.0112	–	0.0129	0.8470	0.0092	–0.0005	0.0031	0.02500	5.640	–	–	–	0.21	xx	22.2	39.8	3.10
PFM000066	16168	2008-12-01	0.4	0.0097	–	0.0115	0.7920	0.0091	0.0006	0.0021	0.01930	5.540	–	–	–	0.15	21.5	21.6	39.9	3.06
PFM000068	12925	2008-01-14	0.4	0.0189	0.0011	0.1060	0.8910	0.0084	0.0007	0.0024	0.02020	4.360	–	–	–	0.20	19.0	18.5	25.9	2.92
PFM000068	12959	2008-02-25	0.5	0.0139	–	0.0716	0.9130	0.0077	0.0007	0.0018	0.01950	4.430	–	–	–	0.15	22.5	22.7	26.4	3.18
PFM000068	12968	2008-03-18	0.6	0.0232	–	0.0722	0.8360	0.0076	0.0006	0.0035	0.03650	3.910	–	–	–	0.44	19.5	19.2	23.0	2.74
PFM000068	12980	2008-04-07	0.6	0.0099	0.0011	0.0560	0.8530	0.0086	–0.0005	0.0031	0.02220	3.870	–	–	–	0.21	20.4	20.6	23.2	3.18
PFM000068	16014	2008-05-19	0.5	0.0201	–	0.0121	0.9760	0.0147	0.0018	0.0055	0.03930	4.090	–	–	–	0.30	24.5	24.3	32.5	3.94
PFM000068	16059	2008-06-17	0.3	0.0823	–	0.0176	1.1000	0.0252	0.0046	0.0136	0.09170	5.110	–	–	–	0.75	22.4	23.1	28.5	4.36
PFM000068	16086	2008-09-01	0.5	0.0114	0.0008	0.0025	1.1200	0.0136	0.0017	0.0036	0.02110	5.210	–	–	–	0.19	33.1	29.0	34.4	5.66
PFM000068	16096	2008-10-07	0.5	0.0083	0.0007	0.0117	1.0800	0.0118	–0.0005	0.0039	0.03230	5.420	–	–	–	0.34	26.9	26.9	31.3	4.62
PFM000068	16154	2008-11-10	0.5	0.0165	–	0.0583	1.0900	0.0128	0.0006	0.0035	0.03600	4.960	–	–	–	0.34	25.8	26.1	31.8	3.88
PFM000068	16167	2008-12-01	0.8	0.0337	–	0.0385	1.0800	0.0123	0.0008	0.0043	0.03130	4.990	–	–	–	0.26	28.5	28.3	29.9	4.72
PFM000069	12918	2008-01-14	0.2	0.0026	0.0004	0.0108	0.7230	0.0088	–0.0005	0.0027	0.01360	5.640	–	–	–	0.13	19.4	19.6	35.5	3.02
PFM000069	12958	2008-02-25	0.2	0.0058	–	0.0243	0.7930	0.0081	0.0007	0.0023	0.01610	5.470	–	–	–	0.13	22.3	22.3	35.9	3.18
PFM000069	12967	2008-03-17	0.3	0.0073	–	0.0419	0.6630	0.0071	0.0008	0.0028	0.01600	4.320	–	–	–	0.12	17.8	17.4	27.5	2.74
PFM000069	12977	2008-04-06	0.2	0.0074	–0.0002	0.0062	0.6930	0.0083	0.0007	0.0038	0.02730	4.450	–	–	–	0.18	18.3	18.5	26.5	3.18
PFM000069	16013	2008-05-19	0.1	0.0127	–	0.0011	0.8920	0.0151	0.0018	0.0045	0.03570	5.020	–	–	–	0.28	24.0	23.0	33.5	3.88
PFM000069	16058	2008-06-17	0.2	0.0514	–	0.0255	1.0900	0.0223	0.0053	0.0074	0.05230	5.010	–	–	–	0.43	22.6	22.6	25.0	4.20
PFM000069	16085	2008-09-01	0.2	0.0088	0.0005	0.0014	0.9840	0.0133	0.0011	0.0024	0.01590	5.150	–	–	–	0.15	25.3	25.7	36.4	4.86
PFM000069	16108	2008-10-07	0.2	0.0043	0.0005	0.0043	0.9850	0.0119	–0.0005	0.0034	0.02370	6.450	–	–	–	0.20	28.1	25.8	35.8	4.60
PFM000069	16153	2008-11-10	0.2	0.0066	–	0.0557	0.9940	0.0130	0.0008	0.0046	0.02500	6.060	–	–	–	0.23	25.4	25.1	36.9	4.14

Id code	Sample no.	Sampling date	Depth (m)	NH$_4$_N (mg/L)	NO$_2$_N (mg/L)	NO$_3$_N+NO$_2$_N (mg/L)	N TOT (mg/L)	P TOT (mg/L)	PO$_4$_P (mg/L)	POP (mg/L)	PON (mg/L)	SIO$_2$_SI (mg/L)	Chl. C (ug/L)	Chl. A (ug/L)	Pheop. (ug/L)	POC (mg/L)	TOC (mg/L)	DOC (mg/L)	DIC (mg/L)	Abs. coeff. (1/m)
PFM000069	16166	2008-12-01	0.6	0.0056	–	0.0163	0.9360	0.0125	0.0008	0.0050	0.03430	6.200	–	–	–	0.26	26.6	26.6	37.1	4.28
PFM000070	12944	2008-01-15	0.1	0.1280	0.0016	0.1490	0.9110	0.0061	0.0007	0.0023	0.02600	1.850	–	–	–	0.22	13.7	13.6	14.4	2.00
PFM000070	12957	2008-02-25	0.2	0.0556	–	0.0416	0.8670	0.0062	0.0007	0.0017	0.02120	2.590	–	–	–	0.17	21.5	20.7	16.1	2.96
PFM000070	12966	2008-03-17	0.2	0.3130	–	0.0412	1.3200	0.0081	0.0005	0.0036	0.05040	3.080	–	–	–	0.40	19.3	19.1	25.0	1.68
PFM000070	12976	2008-04-06	0.2	0.1310	0.0016	0.0364	1.1500	0.0100	0.0016	0.0068	0.07320	2.680	–	–	–	0.57	19.7	19.9	21.3	1.96
PFM000070	16012	2008-05-19	0.3	0.0273	–	0.0092	1.0000	0.0091	0.0010	0.0045	0.04800	1.120	–	–	–	0.34	21.0	20.3	25.8	1.80
PFM000070	16057	2008-06-17	0.2	0.0193	–	0.0021	0.9690	0.0129	0.0015	0.0067	0.05350	3.340	–	–	–	0.40	22.5	22.5	23.2	3.02
PFM000070	16078	2008-09-01	0.2	0.0923	0.0007	0.0084	1.2200	0.0107	0.0008	0.0038	0.03660	3.290	–	–	–	0.33	22.3	22.0	23.4	2.18
PFM000070	16117	2008-10-06	0.3	0.0349	0.0008	0.0121	1.2400	0.0083	–0.0005	0.0034	0.04200	2.870	–	–	–	0.39	21.4	21.0	19.0	1.24
PFM000070	16152	2008-11-10	0.1	0.1670	–	0.0308	1.3300	0.0079	–0.0005	0.0037	0.05000	3.080	–	–	–	0.47	21.6	21.2	23.7	1.66
PFM000070	16165	2008-12-01	0.3	0.1030	–	0.0254	1.2400	0.0110	0.0010	0.0035	0.03640	4.110	–	–	–	0.30	30.8	30.7	25.0	4.54
PFM000074	12943	2008-01-15	0.5	0.0160	0.0006	0.0935	0.7830	0.0059	–0.0005	0.0012	0.01720	5.150	–0.2	–0.2	–0.2	0.16	17.0	17.0	34.4	2.36
PFM000074	12961	2008-02-26	0.5	0.0039	–	0.0530	0.6850	0.0049	–0.0005	0.0013	0.00990	4.870	–0.2	–0.2	–0.2	0.09	17.2	17.4	36.3	2.62
PFM000074	12978	2008-04-07	0.5	0.0148	0.0005	0.0262	0.6590	0.0061	–0.0005	0.0021	0.01610	3.900	–0.2	0.5	–0.2	0.13	16.0	15.9	25.1	2.46
PFM000074	16016	2008-05-20	0.5	0.0071	–	0.0011	0.8400	0.0115	0.0007	0.0033	0.03790	3.290	–0.2	1.1	–0.2	0.27	22.1	20.6	39.6	2.60
PFM000074	16061	2008-06-18	0.5	0.0075	–	0.0015	1.0900	0.0141	0.0015	0.0098	0.11300	5.180	–0.2	5.6	1.0	0.98	22.1	21.3	26.7	2.52
PFM000074	16074	2008-08-05	0.5	0.0167	0.0013	0.0038	1.2100	0.0154	0.0028	0.0055	0.05630	7.240	0.2	2.8	0.7	0.45	22.1	21.3	28.9	2.00
PFM000074	16088	2008-09-02	0.5	0.0038	0.0002	0.0011	0.9030	0.0089	–0.0005	0.0025	0.01340	5.510	0.2	0.8	0.4	0.11	22.4	23.3	42.3	3.28
PFM000074	16107	2008-10-07	0.5	0.0030	0.0003	0.0032	0.8420	0.0073	–0.0005	0.0022	0.01740	5.990	0.4	0.6	x	0.17	21.2	21.6	41.3	3.20
PFM000074	16155	2008-11-11	0.5	0.0055	–	0.0159	0.8280	0.0084	–0.0005	0.0024	0.01600	5.730	0.3	0.4	0.4	0.13	21.3	20.7	35.5	3.00
PFM000107	12920	2008-01-14	0.5	0.0435	0.0013	0.0972	0.9320	0.0082	–0.0005	0.0029	0.04410	3.440	–0.2	0.3	–0.2	0.39	17.8	17.7	23.6	2.00
PFM000107	12928	2008-01-14	1.0	0.2020	0.0010	0.0263	1.1200	0.0079	–0.0005	0.0023	0.01780	1.210	0.2	1.2	0.3	0.17	16.8	16.9	24.8	1.98
PFM000107	12963	2008-03-17	0.5	0.0189	–	0.0204	0.7600	0.0082	0.0014	0.0026	0.02740	1.940	0.2	1.3	0.3	0.19	16.3	16.7	22.0	2.00
PFM000107	12974	2008-04-06	0.5	0.0080	0.0002	0.0022	0.7590	0.0083	0.0009	0.0038	0.03790	1.610	0.2	1.8	0.2	0.33	17.2	17.1	23.2	2.42
PFM000107	16010	2008-05-19	0.5	0.0045	–	0.0006	0.9060	0.0098	0.0012	0.0037	0.04390	0.345	–0.2	1.5	0.2	0.32	20.5	19.8	20.6	2.06
PFM000107	16055	2008-06-17	0.5	0.0078	–	0.0017	1.0200	0.0106	0.0013	0.0038	0.03950	0.336	–0.2	1.1	0.2	0.28	20.8	21.2	11.8	1.50
PFM000107	16071	2008-08-04	0.5	0.0205	0.0006	0.0028	1.2100	0.0125	0.0027	0.0050	0.04480	0.840	0.2	2.1	0.4	0.33	22.0	22.0	11.5	0.18
PFM000107	16076	2008-09-01	0.5	0.0208	–0.0002	-0.0003	1.0600	0.0101	0.0011	0.0034	0.03850	0.939	–0.2	0.9	0.3	0.33	20.1	20.0	19.5	1.52
PFM000107	16116	2008-10-06	0.5	0.0539	0.0004	0.0019	1.0700	0.0104	–0.0005	0.0025	0.02780	1.250	0.3	1.2	0.2	0.19	20.1	19.7	18.4	2.14
PFM000107	16150	2008-11-10	0.5	0.0782	–	0.0130	1.0500	0.0091	–0.0005	0.0034	0.04200	1.760	0.7	1.4	–0.2	0.35	20.9	19.8	25.6	2.16
PFM000117	12926	2008-01-15	0.5	0.3580	0.0011	0.0459	1.5300	0.0059	0.0006	0.0019	0.03380	2.240	0.4	2.7	–0.2	0.30	18.1	18.8	20.2	1.06
PFM000117	12927	2008-01-15	1.5	0.6820	0.0011	0.0448	1.9600	0.0075	–0.0005	0.0024	0.04470	3.260	0.3	1.7	0.6	0.43	22.1	22.3	23.8	1.66
PFM000117	12965	2008-03-17	0.5	0.3440	–	0.0324	1.3600	0.0080	0.0005	0.0035	0.05610	3.040	0.4	2.8	0.7	0.44	19.1	19.0	26.8	1.60
PFM000117	12975	2008-04-06	0.5	0.1460	0.0009	0.0224	1.1600	0.0101	0.0010	0.0059	0.06260	2.640	0.5	4.5	0.4	0.50	19.8	19.4	21.4	1.94
PFM000117	16011	2008-05-19	0.5	0.0126	–	0.0018	1.0800	0.0087	0.0012	0.0040	0.05820	0.703	–0.2	1.8	0.2	0.44	21.5	21.2	24.3	1.72
PFM000117	16056	2008-06-17	0.5	0.0180	–	0.0024	1.2400	0.0099	0.0020	0.0040	0.05490	1.030	0.4	1.8	0.3	0.45	21.6	21.3	15.8	1.34
PFM000117	16072	2008-08-05	0.5	0.0207	0.0006	0.0032	1.3800	0.0095	0.0025	0.0060	0.06620	2.380	0.8	4.7	0.5	0.61	23.4	22.6	14.7	0.84
PFM000117	16077	2008-09-01	0.5	0.0148	–0.0002	0.0009	1.2700	0.0079	0.0011	0.0036	0.05060	2.610	0.7	2.6	0.8	0.47	21.0	20.9	17.4	0.94
PFM000117	16106	2008-10-06	0.5	0.0519	0.0004	0.0033	1.2800	0.0074	–0.0005	0.0025	0.04800	2.810	0.2	1.8	0.3	0.43	22.2	20.9	18.7	1.14
PFM000117	16151	2008-11-10	0.5	0.2060	–	0.0142	1.3800	0.0078	–0.0005	0.0034	0.04800	3.080	0.4	1.9	0.5	0.46	22.5	21.5	23.3	1.68

Pheop. = Pheopigment.

Abs. Coeff. = Absorption Coefficient 436 nm (colour).

Chl. A = Chlorophyll a.

Chl. C = Chlorophyll c.

Table A4-4c. Isotopes 1.

Id code	Sample no.	Sampling date	Depth m	^{14}C pmC	∂^{13}C ‰ PDB	∂^{34}S ‰ CDT	∂^{37}Cl ‰ SMOC	^{86}Sr/^{87}Sr	∂^{2}H ‰ SMOW	^{3}H TU	∂^{18}O ‰ SMOW
PFM000062	12917	2008-01-14	0.5	–	–	–	–	–	–69.9	9.4	–8.0
PFM000062	12973	2008-04-06	0.5	–	–	–	–	–	–66.9	10.1	–7.7
PFM000062	16073	2008-08-05	0.5	105.79	–0.89	20.3	0.23	0.70950	–59.2	9.5	–7.6
PFM000062	16105	2008-10-06	0.5	–	–	–	–	–	–59.2	10.8	–8.1
PFM000066	12924	2008-01-14	0.3	–	–	–	–	–	–85.1	9.5	–11.3
PFM000066	12979	2008-04-07	0.4	–	–	–	–	–	–83.6	9.6	–11.6
PFM000066	16097	2008-10-07	0.3	–	–	–	–	–	–77.9	10.8	–10.8
PFM000068	12925	2008-01-14	0.4	–	–	–	–	–	–84.7	9.8	–11.1
PFM000068	12980	2008-04-07	0.6	–	–	–	–	–	–75.8	11.8	–10.0
PFM000068	16096	2008-10-07	0.5	–	–	–	–	–	–73.9	9.4	–10.0
PFM000069	12918	2008-01-14	0.2	–	–	–	–	–	–86.0	10.7	–11.4
PFM000069	12977	2008-04-06	0.2	–	–	–	–	–	–83.6	9.8	–11.2
PFM000069	16108	2008-10-07	0.2	–	–	–	–	–	–77.0	11.8	–11.1
PFM000070	12944	2008-01-15	0.1	–	–	–	–	–	–64.9	8.8	–7.6
PFM000070	12976	2008-04-06	0.2	–	–	–	–	–	–73.8	11.4	–8.4
PFM000070	16117	2008-10-06	0.3	–	–	–	–	–	–57.3	10.7	–6.6
PFM000074	12943	2008-01-15	0.5	–	–	–	–	–	–83.8	10.9	–11.2
PFM000074	12978	2008-04-07	0.5	–	–	–	–	–	–83.3	9.8	–11.2
PFM000074	16074	2008-08-05	0.5	116.11	–8.06	3.3	0.49	0.72188	–57.7	13.8	–6.0
PFM000074	16107	2008-10-07	0.5	–	–	–	–	–	–77.8	10.3	–10.9
PFM000107	12920	2008-01-14	0.5	–	–	–	–	–	–76.1	10.8	–9.2
PFM000107	12928	2008-01-14	1.0	–	–	–	–	–	–63.8	9.9	–7.5
PFM000107	12974	2008-04-06	0.5	–	–	–	–	–	–80.8	10.3	–10.0
PFM000107	16071	2008-08-04	0.5	108.43	–8.52	7.3	–0.24	0.72071	–46.8	12.9	–3.6
PFM000107	16116	2008-10-06	0.5	–	–	–	–	–	–58.8	10.6	–7.2
PFM000117	12926	2008-01-15	0.5	–	–	–	–	–	–60.8	8.8	–6.5
PFM000117	12927	2008-01-15	1.5	–	–	–	–	–	–67.2	10.2	–7.1
PFM000117	12975	2008-04-06	0.5	–	–	–	–	–	–75.1	10.4	–8.6
PFM000117	16072	2008-08-05	0.5	107.99	–1.99	2.7	BQL	0.72415	–54.3	10.6	–4.9
PFM000117	16106	2008-10-06	0.5	–	–	–	–	–	–57.0	11.9	–6.6
PFM102269	12929	2008-01-15	–	–	–	–	–	–	–	152.5	–
PFM102269	12964	2008-02-26	–	–	–	–	–	–	–	11.7	–
PFM102269	12971	2008-03-18	–	–	–	–	–	–	–	12.3	–
PFM102269	12972	2008-04-07	–	–	–	–	–	–	–	11.9	–
PFM102269	16008	2008-05-19	–	–	–	–	–	–	–	379.8	–
PFM102269	16053	2008-06-17	–	–	–	–	–	–	–	13.7	–
PFM102269	16070	2008-08-05	–	–	–	–	–	–	–	83.3	–
PFM102269	16089	2008-09-01	–	–	–	–	–	–	–	11.6	–
PFM102269	16115	2008-10-07	–	–	–	–	–	–	–	11.2	–
PFM102269	16148	2008-11-11	–	–	–	–	–	–	–	12.2	–
PFM102269	16163	2008-12-02	–	–	–	–	–	–	–	9.1	–

Table A4-4d. Trace metals.

Id code	Sample no.	Sampling date	Depth m	Al (ug/L)	Cd (ug/L)	Cr (ug/L)	Cu (ug/L)	Co (ug/L)	Hg (ug/L)	Ni (ug/L)	Zn (ug/L)	Pb (ug/L)	V (ug/L)	Mo (ug/L)	Ba (ug/L)
PFM000062	12917	2008-01-14	0.5	9.52	0.0210	0.134	0.80	0.026	<0.002	1.0400	1.09	0.134	0.20	1.64	16.70
PFM000062	12973	2008-04-06	0.5	14.20	<0.02	<0.04	0.81	<0.02	0.0042	0.9570	1.42	<0.1	0.20	1.62	17.30
PFM000062	16073	2008-08-05	0.5	5.85	<0.02	0.267	0.72	0.041	0.0029	<0.2	1.54	<0.1	0.19	1.32	15.40
PFM000062	16105	2008-10-06	0.5	2.25	<0.02	0.127	0.72	<0.02	<0.002	1.1200	1.22	<0.1	0.15	1.58	15.80
PFM000074	12943	2008-01-15	0.5	16.40	<0.002	0.118	1.18	0.049	<0.002	0.5260	0.87	0.025	0.20	0.61	26.00
PFM000074	12978	2008-04-07	0.5	219.00	<0.002	0.180	1.49	0.061	0.0047	0.6560	2.18	0.199	0.32	0.69	23.00
PFM000074	16074	2008-08-05	0.5	24.30	<0.002	0.067	0.19	0.021	<0.002	0.0729	0.85	0.049	0.19	0.26	22.40
PFM000074	16107	2008-10-07	0.5	8.34	<0.002	0.161	0.74	0.051	0.0040	0.7360	1.48	0.020	0.21	0.55	28.60
PFM000107	12920	2008-01-14	0.5	21.00	0.0047	0.158	0.98	0.086	<0.002	0.6670	1.84	0.083	0.22	0.64	25.40
PFM000107	12928	2008-01-14	0.5	8.22	0.0050	0.132	0.49	0.079	<0.002	0.3730	1.72	0.067	0.16	0.81	43.90
PFM000107	12974	2008-04-06	0.5	31.70	<0.002	0.166	1.01	0.046	0.0067	0.5510	1.43	0.057	0.28	0.64	19.10
PFM000107	16071	2008-08-04	0.5	11.70	<0.002	0.090	0.44	0.057	<0.002	0.1370	0.81	0.108	0.38	0.70	15.10
PFM000107	16116	2008-10-06	0.5	5.55	<0.002	1.850	0.42	0.064	<0.002	1.5500	0.66	0.095	0.22	0.82	21.00
PFM000117	12926	2008-01-15	0.5	5.34	<0.002	0.066	0.43	0.026	<0.002	0.2290	0.82	0.029	0.19	0.22	14.90
PFM000117	12927	2008-01-15	0.5	12.00	<0.002	0.103	0.62	0.048	<0.002	0.3190	0.80	0.031	0.22	0.23	20.70
PFM000117	12975	2008-04-06	0.5	29.30	<0.002	0.124	0.90	0.042	0.0065	0.3250	1.54	0.056	0.31	0.28	15.60
PFM000117	16072	2008-08-05	0.5	4.99	<0.002	0.054	0.41	0.039	0.0023	0.1610	0.51	<0.01	0.25	0.20	9.75
PFM000117	16106	2008-10-06	0.5	3.37	<0.002	0.068	0.38	0.037	<0.002	0.2350	0.58	0.010	0.19	0.23	14.10

Id code	Sample no.	Sampling date	Depth m	U (ug/L)	Th (ug/L)	Sc (ug/L)	Rb (ug/L)	Y (ug/L)	Zr (ug/L)	Sb (ug/L)	Cs (ug/L)	La (ug/L)	Hf (ug/L)	Tl (ug/L)	Ce (ug/L)
PFM000062	16073	2008-08-05	0.5	0.549	<0.2	<0.4	15.3000	0.034	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.02
PFM000074	16074	2008-08-05	0.5	0.867	<0.02	<0.05	1.6800	0.053	0.07	0.04	<0.03	0.0188	<0.005	<0.01	0.024
PFM000107	16071	2008-08-04	0.5	1.840	<0.02	<0.05	3.9400	0.042	0.08	0.10	0.0990	0.0338	<0.005	<0.01	0.051
PFM000117	16072	2008-08-05	0.5	0.827	<0.02	<0.05	2.1100	0.023	0.08	0.08	<0.03	0.0053	<0.005	<0.01	<0.005

Id code	Sample no.	Sampling date	Depth m	Pr (ug/L)	Nd (ug/L)	Sm (ug/L)	Eu (ug/L)	Gd (ug/L)	Tb (ug/L)	Dy (ug/L)	Ho (ug/L)	Er (ug/L)	Tm (ug/L)	Yb (ug/L)	Lu (ug/L)
PFM000062	16073	2008-08-05	0.5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
PFM000074	16074	2008-08-05	0.5	0.0060	0.0255	<0.005	<0.005	0.0061	<0.005	0.0073	<0.005	0.0051	<0.004	0.0054	<0.005
PFM000107	16071	2008-08-04	0.5	0.0078	0.0339	0.0079	<0.005	0.0068	<0.005	0.0170	<0.005	0.0053	<0.004	0.0052	<0.005
PFM000117	16072	2008-08-05	0.5	<0.005	0.0085	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.004	<0.005	<0.005

< “value” = below reporting limit.

Table A4-4e. Isotopes 2.

Id code	Sample no.	Sampling date	Depth m	^{238}U mBq/kg	^{234}U mBq/kg	Th^{230} mBq/kg	Ra^{226} Bq/l	Rn^{222} Bq/l
PFM000062	16073	2008-08-05	0.5	7.0	8.4	0.53	<0.015	<0.015
PFM000074	16074	2008-08-05	0.5	13.3	14.8	0.87	<0.015	0.017
PFM000107	16071	2008-08-04	0.5	25.6	31.1	0.77	<0.015	0.010
PFM000117	16072	2008-08-05	0.5	12.7	13.3	0.32	<0.015	<0.015

Appendix 5

Precipitation

Table A5-1. Water composition.

Id code	Sampling period (yyyy-mm-dd)		Sample no.	Al µg/L	Br mg/l	Ca mg/L	Cl^- mg/L	EC_L mS/m	F^- mg/L	Fe mg/L	HCO_3^- mg/L	K mg/L
PFM002564	2008-01-10	2008-03-18	12970	<60	0.003	<0.1	0.7	1.79	<0.5	<0.02	<1	<0,4
PFM002564	2008-03-18	2008-05-15	16050	<60	0.003	<0.1	0.7	2.13	<0.5	<0.02	<1	<0.4
PFM002564	2008-05-15	2008-07-01	16069	<60	0.009	0.53	<1	1.24	<0.5	<0.02	<1	0.45

Id code	Sampling period (yyyy-mm-dd)		Sample no.	Li mg/L	Mg mg/L	Mn mg/L	Na mg/L	pH_L	Si mg/L	SO_4_S mg/L	SO_4 mg/L	Sr mg/L
PFM002564	2008-01-10	2008-03-18	12970	<0.004	<0.09	<0.003	0.14	4.44	<0.03	0.326	0.95	<0.002
PFM002564	2008-03-18	2008-05-15	16050	<0.004	<0.09	<0.003	0.34	4.92	0.03	0.368	1.26	<0.002
PFM002564	2008-05-15	2008-07-01	16069	<0.004	0.115	0.0124	0.50	5.02	<0.03	0.749	<5	<0.002

Table A5-2. Isotopes (H- and O-isotopes).

Id code	Sampling date		Sample no.	δ^2H dev SMOW	^{3}H TU	δ^{18}O dev SMOW
PFM002564	2008-01-10	2008-03-18	12970	–88.4	9.2	–11.00
PFM002564	2008-03-18	2008-05-15	16050	–82.2	8.7	–11.00
PFM002564	2008-05-15	2008-07-01	16069	–59.0	13.7	–6.60