Report
P-19-11
June 2020

Hydraulic interference tests in HFM33 and HFM43–46

Sofia Föhlinger
Birgit Koehler
Johan Harrström

SVENSK KÄRNBRÄNSLEHANTERING AB

SWEDISH NUCLEAR FUEL
AND WASTE MANAGEMENT CO

Box 3091, SE-169 03 Solna
Phone +46 8 459 84 00
skb.se

SVENSK KÄRNBRÄNSLEHANTERING

ISSN 1651-4416
SKB P-19-11
ID 1681684
June 2020

Hydraulic interference tests in HFM33 and HFM43–46

Sofia Föhlinger, Birgit Koehler, Johan Harrström
Geosigma AB

Keywords: Interference test, HFM33, HFM43, HFM44, HFM45, HFM46, Hydraulic response, Interference test, Pumping test, Forsmark, Access area.

Abstract

During June–December 2018, five hydraulic interference tests were carried out in the Forsmark area. The percussion boreholes HFM33 and HFM43–46 served as pumping boreholes while monitoring of pressure head responses was made in selected surrounding (observation) boreholes. The interference tests were designed according to the results of the previously performed impeller flow logging in the boreholes together with supporting geological information.

This report describes the execution, analysis and results of the hydraulic interference tests. Hydraulic parameters and so-called response indices were evaluated from the observed responses assuming an equivalent porous medium and radial flow. Finally, a resulting response matrix with all responding and non-responding sections was compiled.

Pumped flow rates in the five tested intervals varied between around 60 to 270 L/min, with a drawdown in each pumping borehole of about 10–20 m. The estimated transmissivities in the pumping boreholes range from ca 6×10^{-5} to 6×10^{-4} m^2/s (T_{Moye}). These values assume an equivalent homogeneous porous medium and thus constitute average values for a large volume of rock within the influence volume of the test.

During the five interference tests in HFM33 and HFM43–46, 218 clear hydraulic responses exceeding 0.1 m of drawdown were obtained in surrounding observation boreholes. Most of the clear responses were found during the test pumping of HFM43 followed by the test pumping of HFM33. During the test pumping of HFM44–46 fewer responses were detected, but for these tests fewer sections were also included in the analyses. The arithmetic mean radial distance to responding sections was largest when pumping in HFM33 (ca 1.4 km) and smallest when pumping in HFM44 (ca 300 m). Many responses were classified with a higher response Index 1 compared to response Index 2. This implies that the responses were mainly characterized as small but fast. This observation is indicating a flowing fracture system of high hydraulic diffusivity.

In addition to the 218 observed responses exceeding 0.1 m drawdown, several other possible responses were observed. This includes clear responses less than 0.1 m (19 responses), unclear but potential responses (50 responses) and responses with unexpected and unexplained behaviour (14 responses).

Sammanfattning

Fem hydrauliska interferenstester utfördes under juni–december 2018 i Forsmarksområdet. Hammarborrhålen HFM33 och HFM43–46 användes som pumpborrhål medan tryckresponser mättes i utvalda omkringliggande borrhål. Interferenstesterna utformades utifrån resultat från tidigare flödesloggning i pumpborrhålen tillsammans med kompletterande geologisk information. Denna rapport beskriver utförande, analys och resultat från de hydrauliska interferenstesterna. Hydrauliska parametrar och responsindex utvärderades med antagande om poröst medium för observerade responser och resultaten sammanfattas i en responsmatris med samtliga responser och icke-responser.

Pumpflödena för de fem testerna varierade mellan 60 och 270 L/min och med en avsänkning i pumpborrhålen på mellan 10–20 meter. Transmissiviteten i pumpborrhålen uppskattades med hjälp av T_{Moye} till mellan 6×10^{-5} och 6×10^{-4} m^2/s. Beräkningen av dessa värden förutsätter ett ekvivalent homogent poröst medium och utgör medelvärdet för en stor volym bergmassa inom testens influensområden.

Under de fem testerna i HFM33 och HFM43–46 påträffades sammanlagt 218 säkra responser med en tryckavsänkning större än 0,1 m. Flest säkra responser hittades under testet i HFM43 följt av testet i HFM33. Testerna i HFM44–46 gav ett mindre antal responser, men för dessa tester var det också färre observationssektioner. Medelavståndet mellan pumpborrhål och observationssektioner med respons var störst för HFM33 (ca 1,4 km) och minst för HFM44 (ca 300 m). Många observationssektioner klassificerades med högre värden för responsindex 1 än för responsindex 2. Detta innebär att responserna kan ses som snabba men ganska små. Denna observation indikerar att det flödande spricksystemet har hög hydraulisk diffusivitet.

Förutom de 218 tydliga responserna med över 0,1 m avsänkning, observerades flera andra möjliga responser på pumpningarna. Detta omfattar tydliga responser med avsänkning mindre än 0,1 m (19 responser), osäkra men potentiella responser (50 responser) och responser med oförklarligt avvikande utseende (14 responser).

Contents

1 Background and objective

Svensk Kärnbränslehantering AB (SKB) has applied to construct a deep repository for spent nuclear fuel, SFK, at the Forsmark site (Figure 1-1). Site investigations have demonstrated that the upper ca 150 m of bedrock is locally highly transmissive and hydraulically well connected over long distances (Follin 2008).

During June–December 2018, five hydraulic interference tests were conducted to clarify:

1) The hydraulic characteristics and connectivity across the ZFMWNW0001 deformation zone ("Singö zone"),
2) the hydraulic characteristics of the shallow bedrock in the access area of the ramp and the shaft of the SFK repository including the hydraulic characteristics and connectivity across the "ZFMENE0159A deformation zone" (Figure 1-1),
3) presence and location of so called "sheet joints" in the area southwest and northeast of the "Singö zone".

Figure 1-1. *Planned deep repository for spent nuclear fuel, SFK, in the Forsmark area.*

Newly drilled boreholes HFM44, HFM45 and HFM46 as well as the already existing borehole HFM33 were used as pumping boreholes for the interference tests across the Singö deformation zone. HFM43 was used as pumping borehole for the interference test across the ZFMENE0159A zone. The presence and location of so called "sheet joints" was investigated during all tests.

During pumping, pressure heads in 81 surrounding boreholes were monitored (Table 1-1; Figure 1-2 to Figure 1-4). Most of the observation boreholes have permanently installed monitoring sections, where the pressure data is continuously monitored by SKB's Hydro Monitoring System (HMS; see Section 3). The pumping boreholes (HFM33 and HFM44–46) were equipped with temporary installed sections and pressure transducers and used as observation boreholes for the respective three other tests across the Singö zone (i.e. when they did not serve as pumping boreholes).

This work was carried out in according to the activity plan AP SFK-16-005. The controlling documents for performing this activity are listed in Table 1-2. The activity plan and the method descriptions are SKB's internal controlling documents. This report describes the execution, analysis and results of these five hydraulic interference tests. Data and results are also available in the SKB database, Sicada.

Table 1-1. Boreholes for the hydraulic interference tests in HFM33 and HFM43–46.

Pumping boreholes		
HFM33		
HFM44		
HFM45		
HFM46		
HFM43		
Observation boreholes during tests in HFM33, HFM44, HFM45 and HFM46 ***according to Appendix 3 AP SFK-18-023***		
HFM34	HFR105	KFR104
HFM35	KFM11	KFR105
HFM38	KFR01	KFR27
HFR101	KFR09	
HFR102	KFR102A	
Observation boreholes during tests in HFM33 and HFM43 ***according to Appendix 2 AP SFK-18-023***		
HFM01	HFM42	KFM09B
HFM02	KFM01A	KFM10A
HFM03	KFM01B	KFM13
HFM13	KFM01D	KFM14
HFM15	KFM04A	KFM15
HFM19	KFM05A	KFM16
HFM20	KFM07A	KFM17
HFM21	KFM07B	KFM18
HFM22	KFM07C	KFM19
HFM23	KFM08A	KFM20
HFM27	KFM08B	KFM21
HFM28	KFM08C	KFM22
HFM39	KFM08D	KFM23
HFM40	KFM09A	KFM24
HFM41		
Observation boreholes during tests in HFM33 and HFM43 ***added during the testing***		
HFM04	HFM25	SFM000145
HFM05	HFM32	SFM000146
HFM09	KFM02A	SFM000153
HFM14	KFM02B	SFM000163
HFM16	KFM06A	SFM0104
HFM17	KFM06B	SFM0107
HFM18	KFM06C	

Temporary installed observation sections	
HFM33	Evaluated for tests in HFM44, HFM45, HFM46
HFM44	Evaluated for tests in HFM33, HFM45, HFM46
HFM45	Evaluated for tests in HFM33, HFM44, HFM46
HFM46	Evaluated for tests in HFM33, HFM44, HFM45

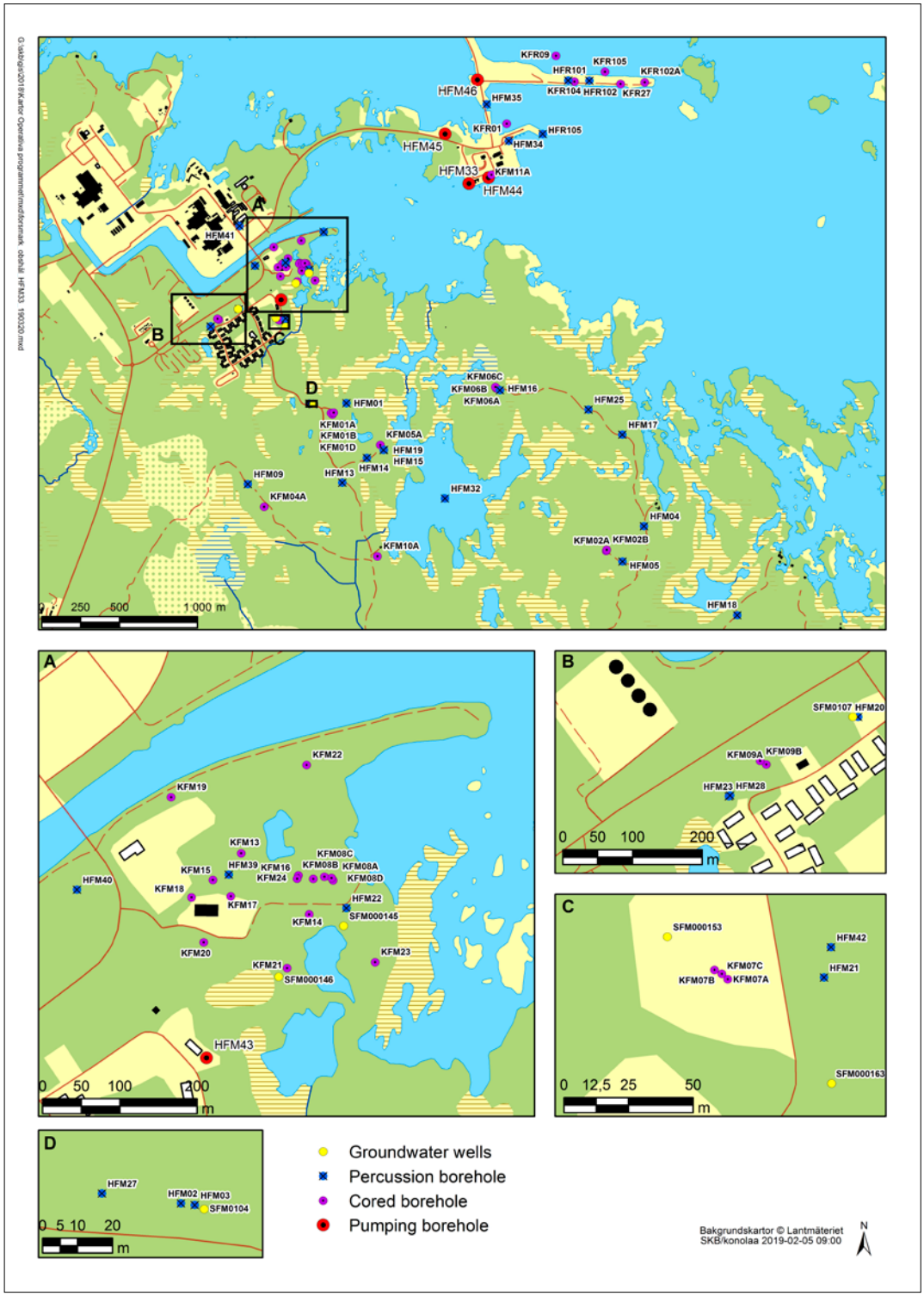


Figure 1-2. *Location of all monitoring boreholes used during the interference tests in HFM33 and HFM43–HFM46. Lines to visualize the direction and length of the boreholes are shown in Figure 1-3 and Figure 1-4.*

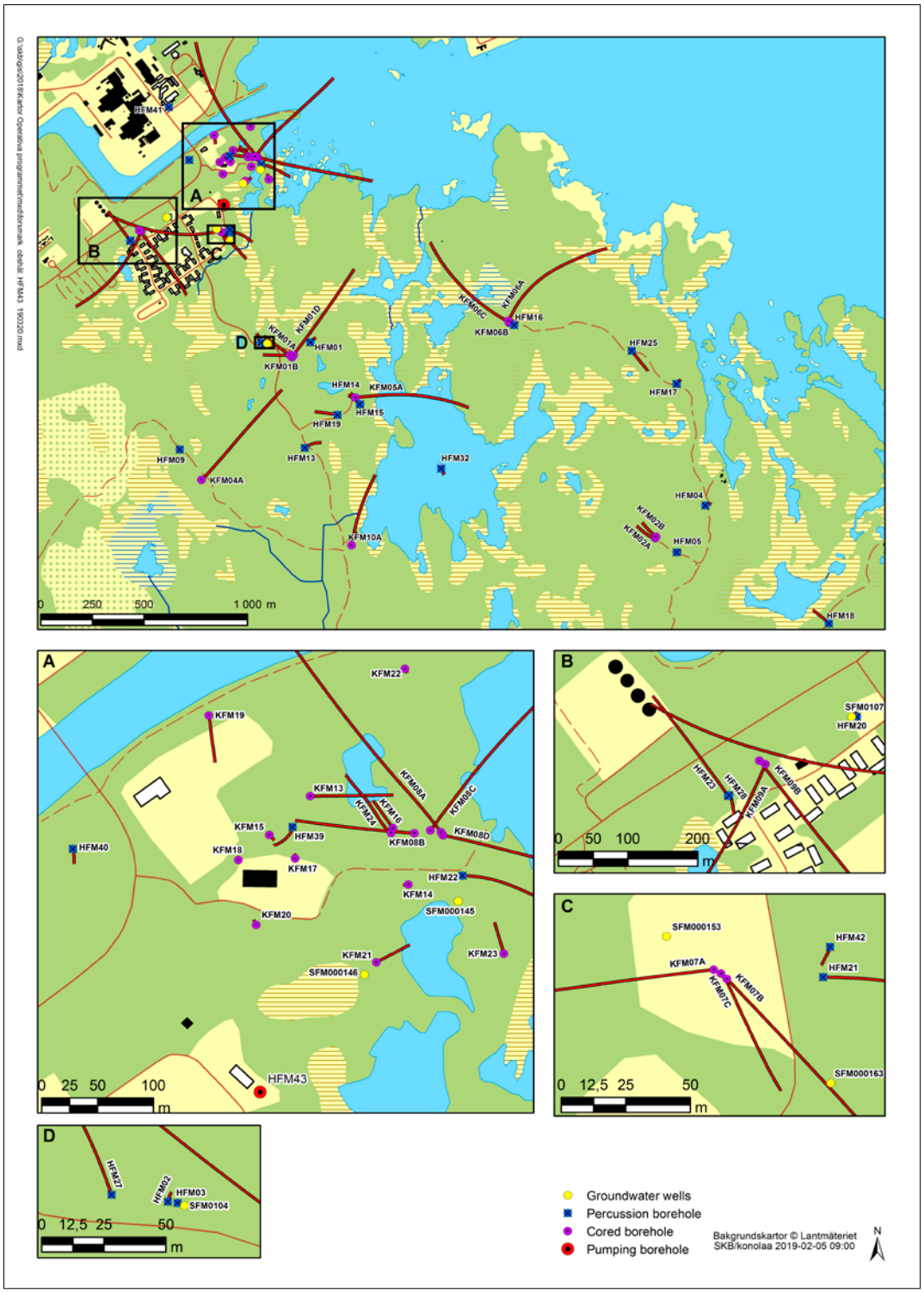


Figure 1-3. *Boreholes included in the analysis of responses to the interference tests in HFM33 and HFM44–46 (according to Appendix 3 in AP SKF-18-023). The lines visualize the direction and length of inclined boreholes.*

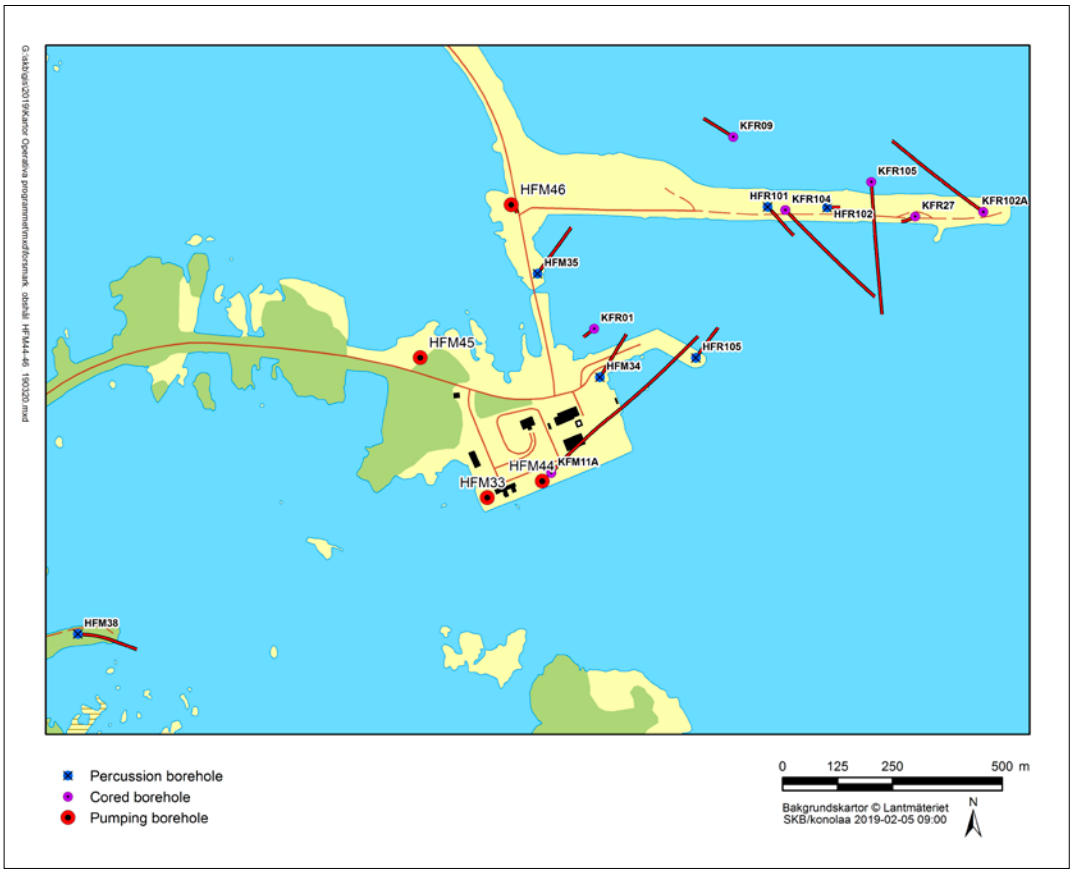


Figure 1-4. *Boreholes included in the analysis of responses to the interference tests in HFM33 and HFM43 (mainly according to appendix 2 in AP SKF-18-023, with some additional boreholes during the testing). The lines visualize the direction and length of inclined boreholes.*

Table 1-2. Controlling documents for performance of the activity.

Activity plan	**Number**	**Version**
Interferenstester i i området för sänkschakt	AP SFK-18-023	1.0
Method descriptions	**Number**	**Version**
Metodinstruktion för analys av injektions- och enhålspumptester	SKB MD 320.004	2.0
Metodbeskrivning för interferenstester	SKB MD 330.003	2.0

2 Material and methods

2.1 General test procedure

The hydraulic interference tests were performed by pumping the entire borehole without any installed sections. The drawdown and recovery as well as the flow rate in the pumping boreholes were monitored.

The pumping time of each test lasted 334–502 hours, followed by a recovery period of about the same duration (Table 2-1). The interference tests were designed according to the results of a previous flow logging in the borehole (Harrström 2019).

Table 2-1. Data of the five performed interference tests.

Pumping borehole ID	Section (mbl TOC)*	Section Elevation (m RH2000)	Pumping start (YYYY-MM-DD tt:mm)	Pumping stop (YYYY-MM-DD tt:mm)	Pumping rate (m^3/s)
HFM43	0–200	−194.75 – +4.33	2018-06-28 10:02	2018-07-19 08:00	4.51E−03
HFM45	0–200	−196.09 – +3.85	2018-08-28 13:45	2018-09-12 09:10	1.24E−03
HFM33	0–140	−110.17 – +2.80	2018-09-27 10:16	2018-10-11 08:36	4.06E−03
HFM44	0–200	−196.16 – +2.94	2018-10-22 10:57	2018-11-05 13:05	1.74E−03
HFM46	0–200	−196.60 – +1.70	2018-11-21 11:36	2018-12-06 12:28	1.05E−03

* mbl TOC = metres borehole length below Top of Casing.

A wide selection of surrounding borehole sections was included in the analysis for potential responses, based on the experience from previous interference tests in the Forsmark site, (Table 1-1, Figure 1-2 to Figure 1-4). Moreover, impeller flow logging was performed prior to the interference tests to detect high flowing fractures. Using the pre-test spinner data, temporary observation sections of interest were installed in HFM33 and HFM44–46, see further AP SFK-18-023. After the tests were completed, inspection of HMS data showed that the pumping test in HFM43 had given responses in numerous observation sections even far away from the pumping well. Therefore, more boreholes were added to the list of observation sections than initially planned in SFK-18-023. As these boreholes were added afterwards, the scan time was sparser than for the planned observation sections which had a more frequent scanning period.

Except for the temporary observation sections in HFM33 and HFM44–46, all the observation boreholes included in the interference tests are part of SKB's hydro monitoring system (HMS), which continuously monitors water level in the boreholes. The point-water head (i.e. water level) within each observation section is continuously calculated by means of pressure transducers, and automatically corrected for air pressure. In most boreholes the uppermost part has a casing to a certain depth. The casing is thus an impervious part of the uppermost section.

Each section is isolated from the adjacent sections by means of packers, expanded with nitrogen gas, strategically isolating specific lengths within boreholes. The isolated sections are hydraulically connected to water-level standpipes by polyamide tubes and lead-through pipes in the packers. The water-level standpipes are installed above the uppermost packer enabling easy pressure gauge maintenance and manual level measurements for each observation section.

Hydraulic properties and response indices were determined for responding borehole sections where the drawdown was at least 0.1 m. The results for each interference test were summarized in a response matrix. All observation borehole sections involved in the five interference tests are listed in Appendix 1.

2.2 Equipment

Pumping was performed, with a submersible pump in open boreholes. The length of the flowing test section varied between 140 and 200 m depending on the borehole. The pump was connected to the surface using plastic tubes. At the surface, a hose was connected to the flow meter. The pressure head in the borehole was monitored by a pressure transducer and logged together with the pumping rate.

Equipment specifications concerning pumping and monitoring of the pumping boreholes are:

- Pump – Debe FN-9 4".
- Absolute pressure transducer – Druck PTX 161/D sg, ± 0.25 % accuracy.
- Flow meter – Krohne, DN40, nominal flow; 30–900 L/min, ± 1.14 % accuracy by 15 L/min, ± 12.3 % accuracy by 1.5 L/min.

While pumping was performed in one of the boreholes HFM33 and HFM44–46 the other "pumping boreholes" had observation sections temporarily installed using waterfilled inflatable packers expanded by nitrogen gas and lowered by a wire. In each section in the observation borehole a pressure transducer with logging function was installed. Since some of the loggers were installed over a long period, the scan period was a bit longer than in the sections monitored by HMS. The non-permanent positions of the observation sections in these boreholes are listed in Table 2-2.

Table 2-2. Temporary installed sections used during pumping tests in HFM33, HFM44–46. The numbering of the sections start from the bottom.

Observation borehole ID	Observation Section 1 (mbl TOC)	Observation Section 2 (mbl TOC)	Observation Section 3 (mbl TOC)
HFM33	120.0–140.2	0–119.0	-
HFM44	90.0–199.6	60.0–89.0	0–88.0
HFM45	190.0–200.3	140.0–189.0	0–188.0
HFM46	150.0–200.0	100.0–149.0	0–144.0

2.3 General test performance

In this section, the performance of each interference test is discussed with special reference to the drawdown and flow-rate conditions in the pumping borehole sections. The total drawdown and final flow rate (Q_p) in the pumping boreholes, the duration of the pumping tests and the calculated stationary transmissivity according to Moye (T_M; Moye 1967) are shown in Table 2-1. Linear plots of observed pressure versus time in the pumping boreholes are presented in Figure 2-1 to Figure 2-5.

Table 2-2. Overview of pump-test data from the five interference tests conducted during June–December, 2018.

Pumping borehole ID	Section (mbl)	Drawdown (m)	Pumping rate (m^3/s)	Pumping rate (L/min)	Pumping time (s)	Pumping time (days)	Specific capacity (m^2/s)	T_M (m^2/s)
HFM43	0–200	9.6	4.51E−03	270.7	1807035	20.9	4.7E−04	6.2E−04
HFM45	0–200	19.1	1.24E−03	74.2	1279497	14.8	6.5E−05	8.5E−05
HFM33	0–140	16.8	4.06E−03	243.4	1203605	13.9	2.4E−04	3.0E−04
HFM44	0–200	18.3	1.73E−03	104.1	1217280	14.1	9.5E−05	1.2E−04
HFM46	0–200	21.7	1.05E−03	62.8	1299120	15.0	4.8E−05	6.4E−05

2.3.1 Interference test in HFM43: 0–200 m

Pumping was performed for about three weeks during the time period 2018-06-28 10:02 to 2018-07-19 08:00 (Figure 2-1a). The final pumping rate was 271 L/min and the total drawdown in the pumping borehole was ca 9.6 m (94 kPa). During pumping in HFM43, sea level dropped by ca 0.2 m shortly after the pumping started and showed little variability during the rest of the pumping period (Figure 2-1b). Air pressure showed no pronounced pattern or trend during pumping in HFM43 however a smaller peak shortly after pumping start and an increase shortly after pumping stop have still led to some smaller concerns regarding uncertain responses (Figure 2-1b).

Of bigger concern was the generally decreasing groundwater levels due to the drought during the summer months 2018. In several sections the pressure was clearly affected by the rainfalls shortly before pumping start and shortly after pumping stop. Rainfall occurred on 2018-06-22, six days before pumping start and on 2018-07-29, ten days after pumping stop.

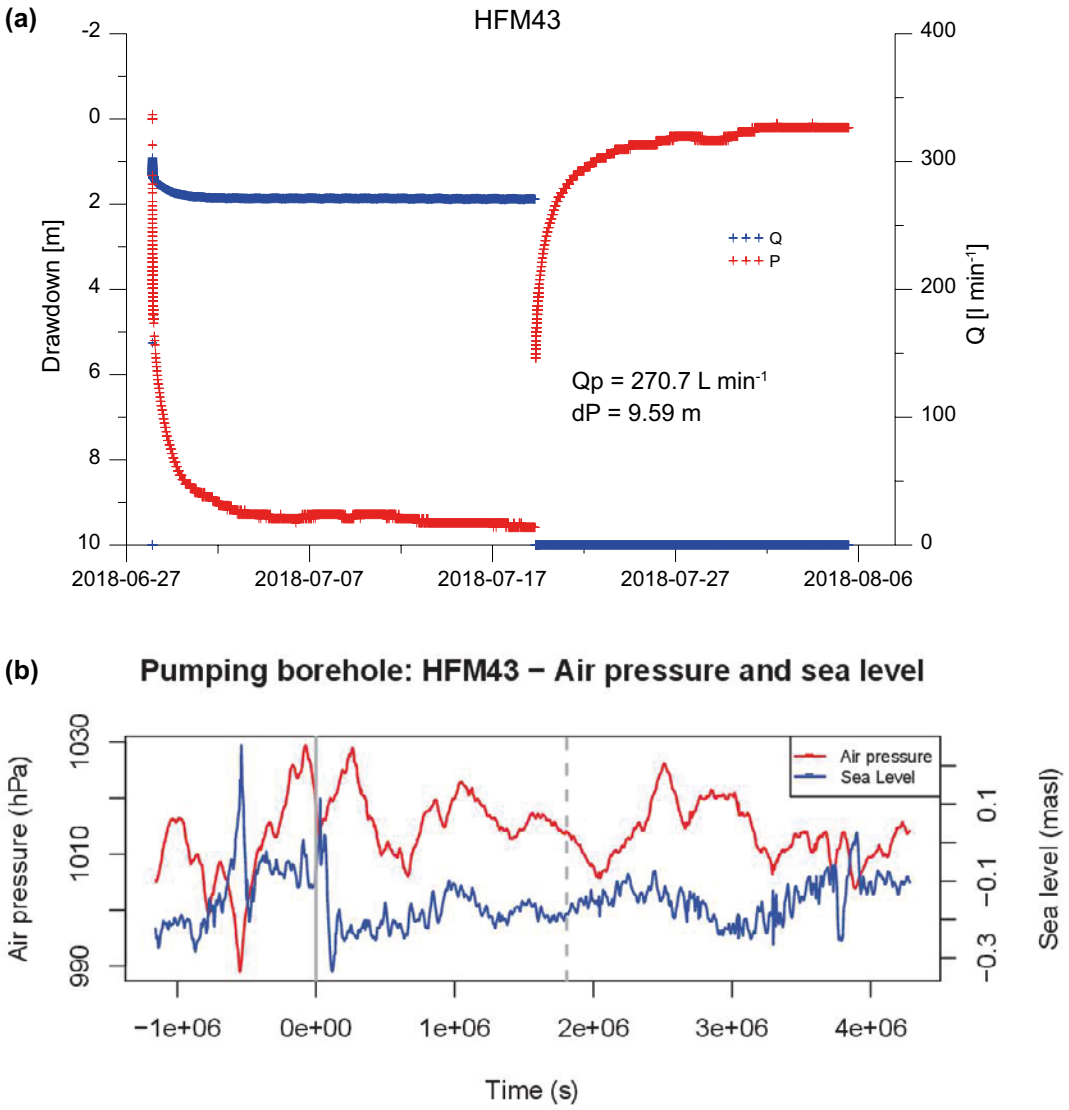


Figure 2-1. *(a) Drawdown and flow during pumping in HFM43. (b) Sea level (blue; m a.s.l.) and air pressure (red; hPa) around the time period of pumping in HFM43. Time "0" marks the start of pumping (solid grey vertical line), pump stop is marked by the dashed grey vertical line.*

2.3.2 Interference test in HFM45: 0–200 m

Pumping was performed for about two weeks during the time period 2018-08-28 13:45 to 2018-09-12 09:10 (Figure 2-2a). The final pumping rate was 74 L/min and the total drawdown in the pumping borehole was ca 19.1 m (187 kPa). The drawdown was swift and stable throughout the test, but with a smaller temporary disturbance in the middle of the pumping phase. During pumping in HFM45 sea level decreased steadily by about 0.25 m (Figure 2-2b). This decrease coincided with the pumping period, with start and stop at more or less the same time. Air pressure varied with a curved formed pattern during the interference test, with highest values in the middle of the test period and a pressure drop of about 20 hPa (ca 0.2 mVp) just before pumping stop (Figure 2-2b).

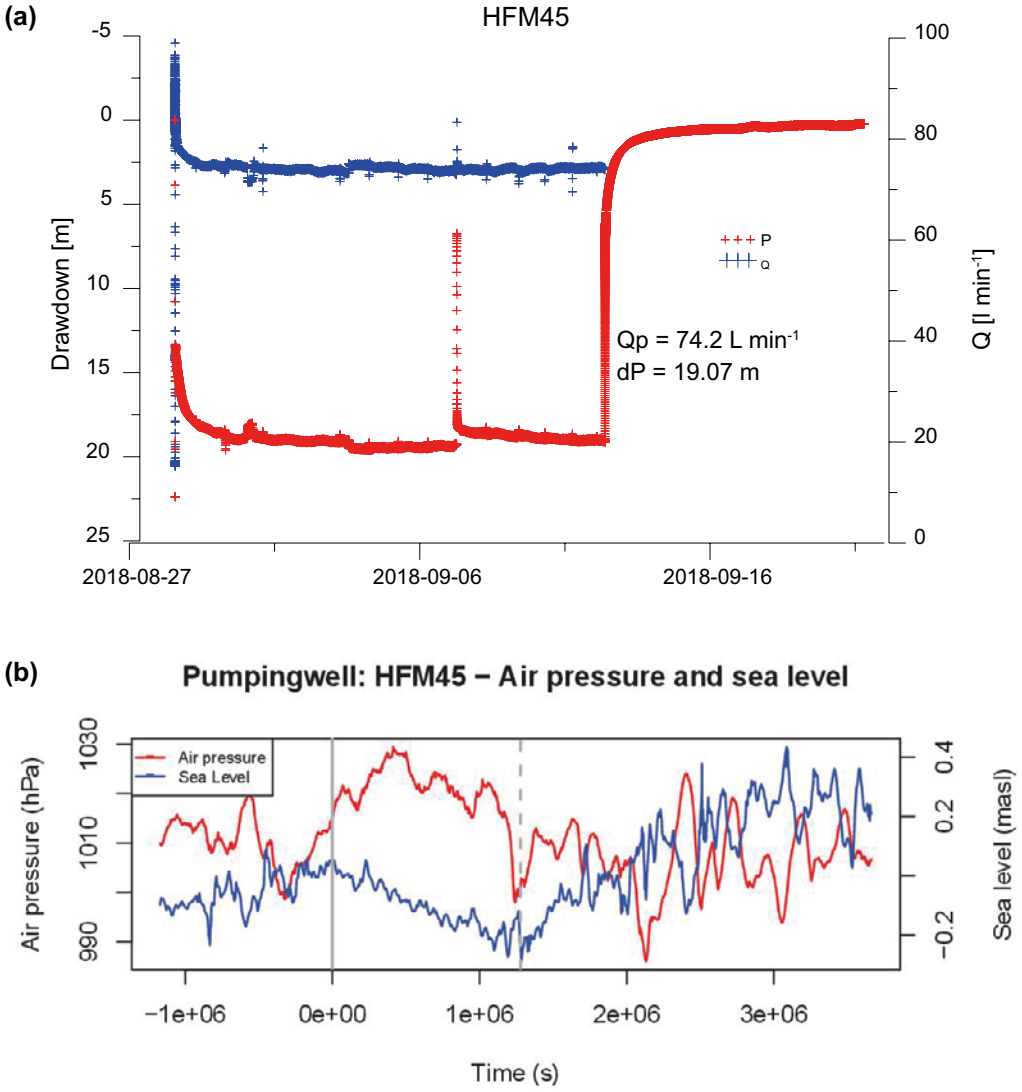


Figure 2-2. *(a) Drawdown and flow during pumping in HFM45. (b) Sea level (blue; m a.s.l.) and air pressure (red; hPa) around the time period of pumping in HFM45. Time "0" marks the start of pumping (solid grey vertical line), pump stop is marked by the dashed grey vertical line.*

2.3.3 Interference test in HFM33: 0–140 m

Pumping was performed for about two weeks during the time period 2018-09-27 10:16 to 2018-10-11 08:36 (Figure 2-3a). The final pumping rate was 243 L/min and the total drawdown in the pumping borehole was ca 16.8 m (165 kPa). The drawdown was swift and stable throughout the test, full recovery occurred almost directly after pumping stop. During pumping in HFM33 both sea level and air pressure varied without pronounced pattern or trend (Figure 2-3b).

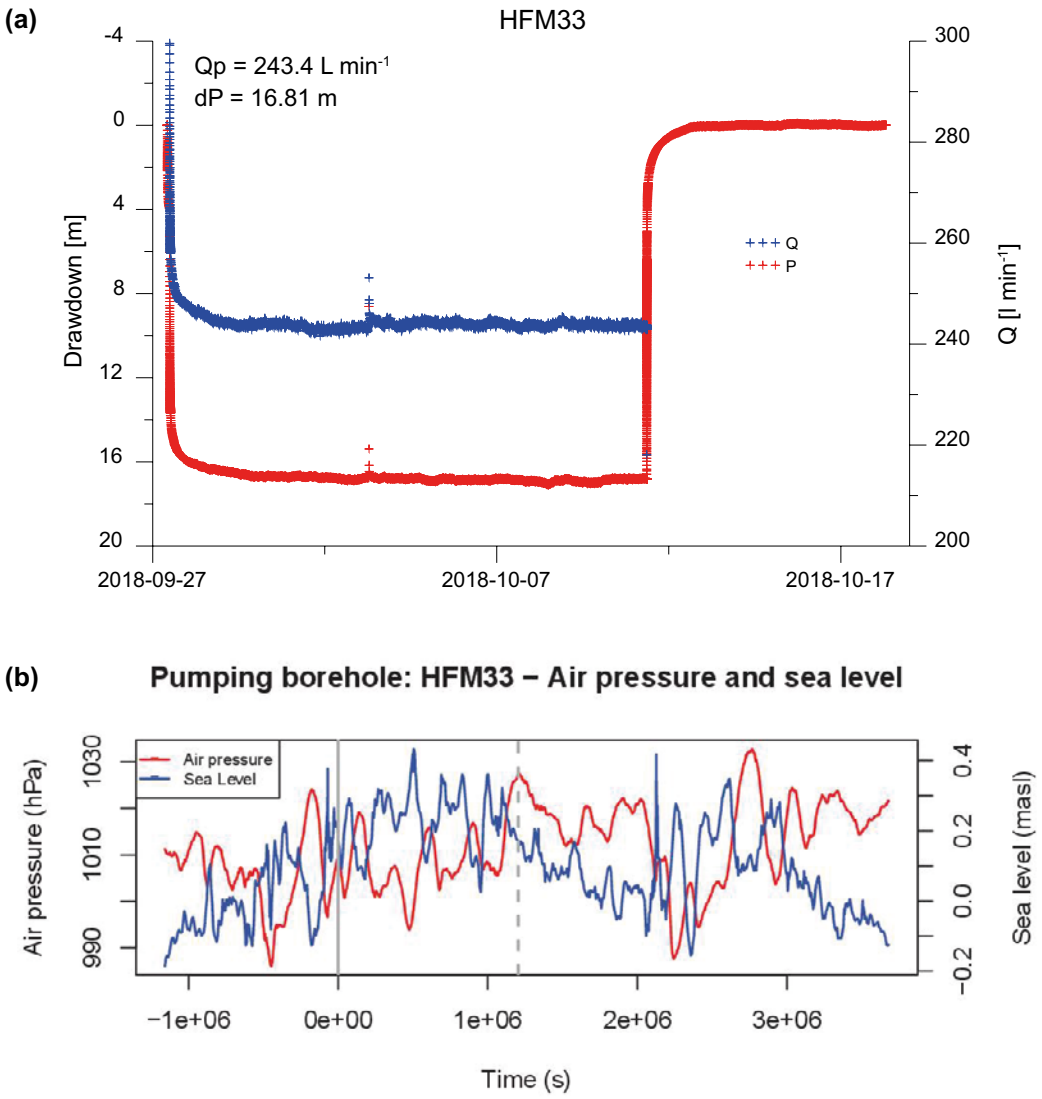


Figure 2-3. *(a) Drawdown and flow during pumping in HFM33. (b) Sea level (blue; m a.s.l.) and air pressure (red; hPa) around the time period of pumping in HFM33. Time "0" marks the start of pumping (solid grey vertical line), pump stop is marked by the dashed grey vertical line.*

2.3.4 Interference test in HFM44: 0–200 m

Pumping was performed for about two weeks during the time period 2018-10-22 10:57 to 2018-11-05 13:05 (Figure 2-4a). During the first days of pumping, the pumping rate was decreased and adjusted several times in order to prevent the water level to drop below the water inlet of the pump. After the third day of pumping the drawdown was swift and stable throughout the test, except for the planned pumping stops. Pumping was temporarily stopped three times for ca four hours each during the test in HFM44. These shorter pump stops were performed to facilitate detection of responses that due to external factors (mainly fluctuations in air pressure, sea level patterns and tidal) may be hard to distinguish otherwise (Table 2-3).

Table 2-3. Pumping starts and stops during the test in HFM44.

	Pumping stop	Pumping start
Pumping start	-	2018-10-22 10:57
1st pumping stop	2018-10-26 08:05	2018-10-26 12:15
2nd pumping stop	2018-10-29 09:00	2018-10-29 13:05
3rd pumping stop	2018-11-01 10:00	2018-11-01 14:10
Pumping stop	2018-11-05 13:05	-

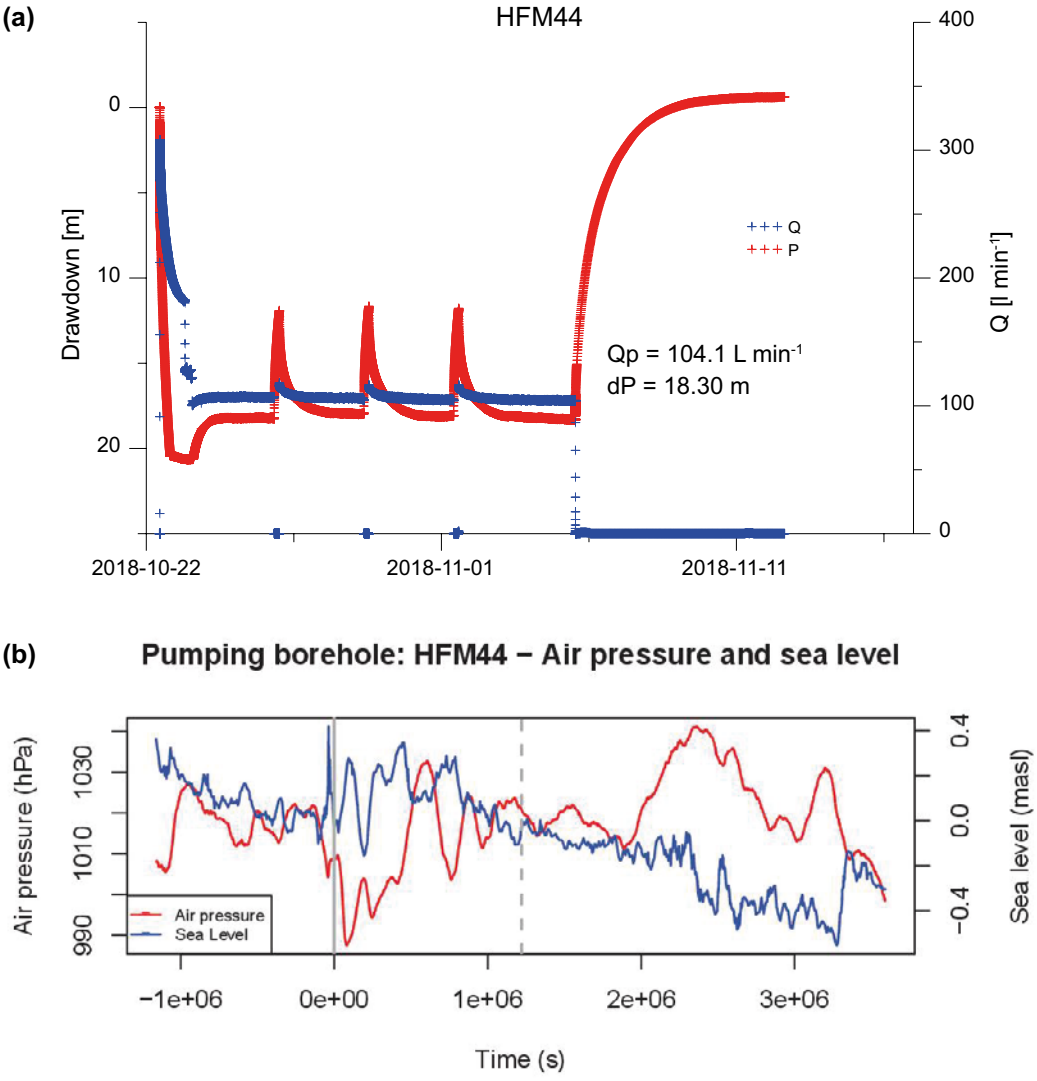


Figure 2-4. *(a) Drawdown and flow during pumping in HFM44. (b) Sea level (blue; m a.s.l.) and air pressure (red; hPa) around the time period of pumping in HFM44. Time "0" marks the start of pumping (solid grey vertical line), pump stop is marked by the dashed grey vertical line.*

The final pumping rate was 104 L/min and the total drawdown in the pumping borehole was ca 18.3 m (180 kPa). During pumping in HFM44 sea level varied without pronounced pattern or trend (Figure 2-4b). Air pressure showed rather large variations during the pumping period, and was generally increasing (Figure 2-4b).

2.3.5 Interference test in HFM46: 0–200 m

Pumping was performed for about two weeks during the time period 2018-11-21 11:36 to 2018-12-06 12:28 (Figure 2-5a). During the first days of pumping, the pumping rate was decreased and adjusted to avoid the water level to sink under the pump inlet. After the third day of pumping the drawdown was swift and stable throughout the test. The final pumping rate was 63 L/min and the total drawdown in the pumping borehole was ca 21.7 m (213 kPa). Full recovery only occurred after the pumping equipment and pressure logger in HFM44 was already removed. During pumping in HFM46, sea level varied without pronounced trend but with a bigger instantaneous increase in the middle of the pumping phase (Figure 2-5b). Air pressure showed a generally decreasing trend during the pumping period (Figure 2-5b).

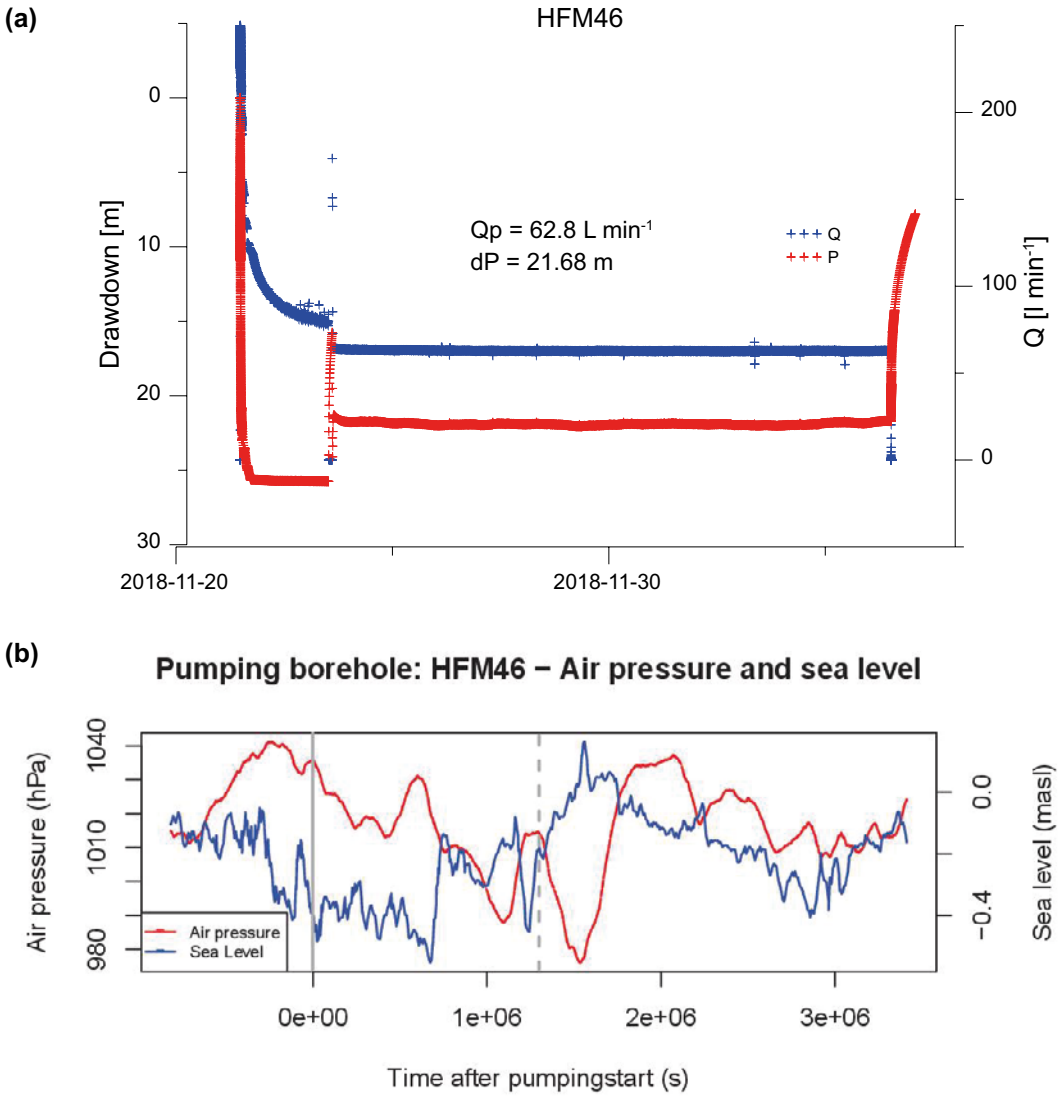


Figure 2-5. *(a) Drawdown and flow during pumping in HFM46. (b) Sea level (blue; m a.s.l.) and air pressure (red; hPa) around the time period of pumping in HFM46. Time "0" marks the start of pumping (solid grey vertical line), pump stop is marked by the dashed grey vertical line.*

3 Analysis and evaluation

3.1 General

Standard methods for constant flow rate interference tests in an equivalent porous medium were used for transient evaluation of the responses in the observation borehole sections, in accordance with the method description for interference tests (SKB MD 330.003 v2.0). The responses in the pumped sections were evaluated according to theories for single-hole tests, taking effects of wellbore storage and skin into account (SKB MD 320.004 v.2.0).

All hydraulic head data from the observation boreholes presented in this report have, prior to evaluation, been corrected automatically in HMS for atmospheric pressure changes by subtracting the latter pressure from the measured (absolute) pressure.

To correct for correlations to sea level and air pressure, data filtering was performed prior response evaluations (see Section 4.3.1). For the test in HFM43, data was also corrected for the drought-induced declining trend in head during the testing time (see Section 3.3.2).

No corrections of the measured drawdown due to e.g. precipitation or tidal effects were made. The pressure in the pumping boreholes was not corrected for atmospheric pressure changes at the site, as this was negligible in relation to drawdown in the pumping borehole.

3.2 Pumping boreholes

Interpretation of the transmissivity based on the assumption of stationary conditions in the pumping boreholes was performed according to Moye's formula (Equation 3-1).

$$T_M = \frac{Q_p \cdot \rho_w \cdot g}{dp_p} \cdot C_M \qquad \text{Equation 3-1}$$

$$C_M = \frac{1 + \ln\left(\frac{L_w}{2r_w}\right)}{2\pi}$$

Q_p = flow rate by the end of the flow period [m^3/s)

ρ_w = density of water [kg/m^3)

g = acceleration of gravity [m/s^2]

C_M = geometrical shape factor [-]

dp_p = $p_p - p_i$ [Pa]

r_w = borehole radius [m]

L_w = section length [m]

3.3 Observation boreholes

During the diagnostic analyses, time series of head from all considered observation sections of each observation hole were studied to identify potential responses (see Figure 3-1 as example). Time series of air pressure and sea-level during the testing period were used to assist the identification of responding sections.

The monitored head (and drawdown) data in the observation borehole sections are subject to natural fluctuations owing to tidal effects, sea-level fluctuations and, possibly, long term trends. These fluctuations may complicate the identification of hydraulic responses, as well as the estimation of response time (see Section 3.3.3). Moreover, the influence of tidal effects and other natural fluctuations generally differ in appearance from one observation section to another. Very weak drawdown responses ($s_p < 0.1$ m) and/or uncertain responses were registered, but not included in the further analysis.

The hydraulic diffusivity of responses (i.e. pressure-propagation rate) is usually determined based on a response time defined for a standard drawdown criterion of 0.01 m. However, owing to fluctuations in monitored head of the observation sections (i.e. the prevailing noise level), the standard drawdown criterion was not possible to apply, and therefore it was not meaningful to calculate hydraulic diffusivity.

3.3.1 Data filtering

The monitored groundwater levels can be strongly affected by fluctuations in sea level and air pressure (Öhman et al. 2012). This background noise in monitored head may complicate the identification of responses (Harrström et al. 2019). The background noise in the time series was therefore reduced before response analysis, using a multiple-regression approach similar as earlier (Harrström et al. 2019). However, in the present analysis we used mixed effects modeling instead of linear regression modeling, to account for autocorrelation of time-series data (Gueorguieva and Krystal 2004, Crawley 2013; see below).

We used several weeks of undisturbed data (i.e. not influenced by pumping activities) from each hole to test whether the groundwater level in each borehole was significantly correlated to air pressure and sea level (Appendix 2). If an effect (i.e. correlation with the variable air pressure and/or sea level) was significant, we corrected the groundwater level (GW) according to:

$$GW_{corrected} = GW_{uncorrected} - \text{correlation coefficient} * variable \qquad \text{Equation 3-2}$$

where *variable* is air pressure or sea level, respectively. If both effects were significant the sum of both correction terms was subtracted from the uncorrected groundwater level.

We used linear mixed effects models to test for correlations, where air pressure and sea level were defined as fixed effects (i.e. influencing the mean of the response variable, groundwater level), and time was defined as random effect (i.e. influencing the variance of the response variable; Gueorguieva and Krystal 2004, Crawley 2013). Before modelling, the variable "time" was mean-centered and normalized [x* = (x-mean (x))/standard error(x)] (Schielzeth 2010). One dataset (KFM11A:1) was logarithmically transformed before modelling to improve the distribution of the model residuals. A first-order temporal autoregressive process, which assumes that correlation between measurements decreases with increasing time distance, was included if this improved the relative goodness of the model fit based on the Akaike Information Criterium (Crawley 2013). Autocorrelation could not be calculated (unstable model) in 18 sections from 11 boreholes and was therefore not included in these cases (see Appendix 1). The final model was checked using diagnostic residual plots, and significance of the fixed effect was assessed based on analysis of variance (Crawley 2013). *P*-values were corrected for multiple testing using the single-step method in the R-package "*multcomp*" (Hothorn, Bretz, & Westfall, 2008). Effects were accepted as statistically significant if *P*-value < 0.05. All analyses were conducted using R version 3.4.3 (R Development Core Team 2017).

This data filtering step reduced the influence of sea level and air pressure variability on the time series of groundwater levels (see Figure 3-1 for an example, and Figure 2-4b for air pressure and sea level during the same time period), and improved detection of responses to pumping (see Figure 3-2 and Figure 2-5b for an example).

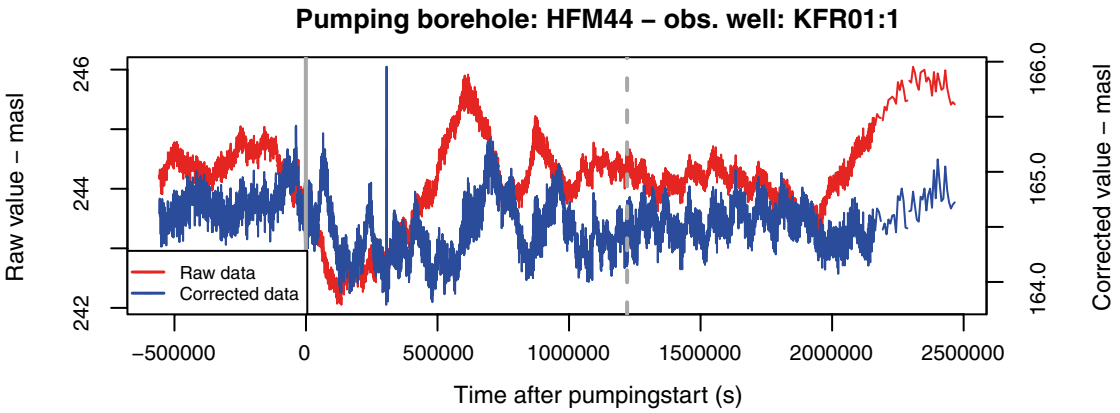


Figure 3-1. *Time series of groundwater level in the observation borehole and section KFR01:1, before, during and after pumping in HFM44, with the uncorrected, "raw" time series as obtained from HMS in red, and the "corrected" time series after filtering for the influence of air pressure and sea level in blue. The grey solid and dashed lines mark pumping start and stop, respectively. Remaining fluctuations are partly due to tidal effects.*

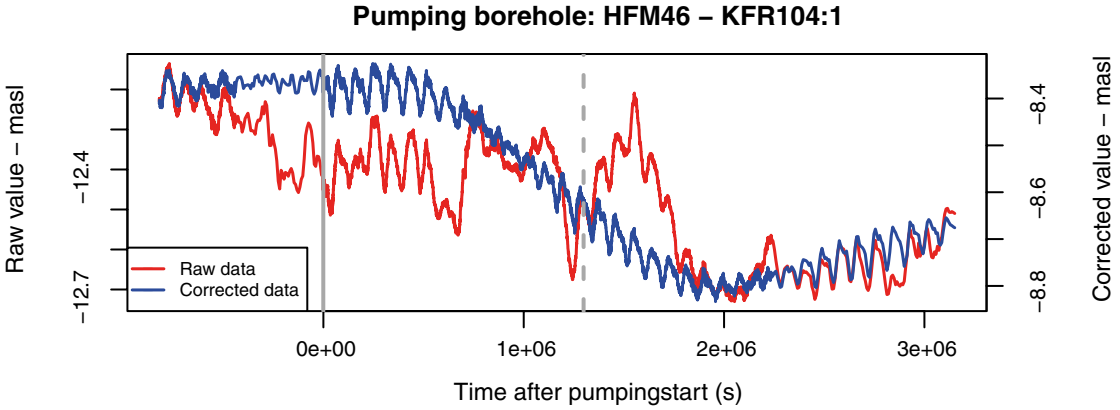


Figure 3-2. *Time series of groundwater level in the observation borehole and section KFR104:1, before, during and after pumping in HFM46, with the uncorrected, "raw" time series as obtained from HMS in red, and the "corrected" time series after filtering for the influence of air pressure and sea level in blue. The grey solid and dashed lines mark pumping start and stop, respectively. Remaining fluctuations are partly due to tidal effects.*

3.3.2 Detrending of time series for HFM43

Due to the drought during the summer of 2018, an overall decreasing trend of groundwater levels could be seen in many of the observation sections during the interference test in HFM43 (2018-06-28 – 2018-07-19). Three rain events occurred during the general drought conditions, specifically shortly before pumping start (2018-06-22) and during the recovery phase (2018-07-29 and 2018-08-02) and affected the groundwater level in some but not all boreholes. To get a picture on how the drought conditions and rain events affected the groundwater levels we looked into the time series of boreholes that are situated far away from the pumping borehole, are not included as observation sections for this test (HFM43) and are not expected to show a pronounced reaction to the pumping test. For example, KFM12A showed a decreasing trend in groundwater level in all its monitoring sections until the end of July, without clear reaction to any of the rainfall events (Figure 3-3, Figure 2-1). In contrast, several of the monitored groundwater levels in KFM03A were affected by the rain events both before and after the pumping period (Figure 3-4).

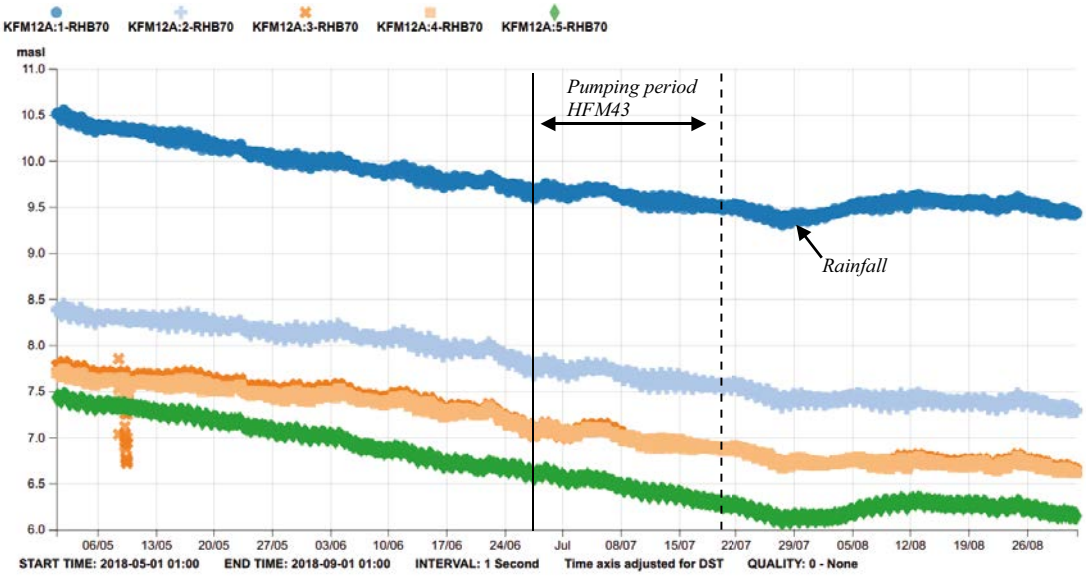


Figure 3-3. *Decreasing trend in KFM12A during the summer 2018. The pumping period of HFM43 is marked by the solid (pumping start) and dashed (pumping stop) vertical lines. KFM12A are located far away from the HFM43 and not used as observation borehole during the pumping test. The increase at 2018-07-29 and 2018-08-02 is due to heavy rainfall. At clear trend could be seen from beginning of June until the rainfall in late July. The rainfall at 2018-06-22 could not be seen in this borehole. Sections included in the figure are KFM12A:1 (491.00 – 601.04 m), KFM12:2 (281.00 – 490.00 m), KFM12:3 (270.00 – 280.00 m), KFM12:4 (166.00 – 269.00 m) and KFM12:5 (0.00 – 165.00 m). All lengths given in mbl TOC.*

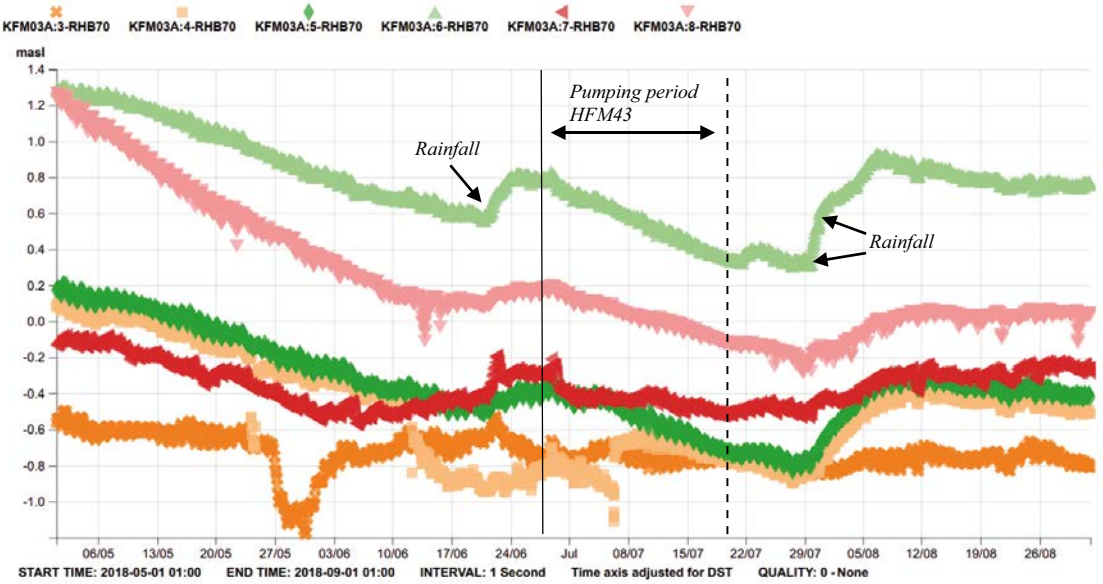


Figure 3-4. *Decreasing trend in KFM03A during the summer 2018. The pumping period of HFM43 is marked by the solid (pumping start) and dashed (pumping stop) vertical lines. KFM03A are located far away from the HFM43 and not used as an observation borehole during that pumping test. The increases at 2018-06-22, 2018-07-29 and 2018-08-02 is due to heavy rainfall. Different trends could be detected in the period from before and after the rain of 2018-06-22. Sections included in the figure are KFM03A:3 (651.00 – 819.50 m), KFM03A:4 (633.50 – 650.00 m), KFM03A:5 (472.50 – 632.50 m), KFM03A:6 (402.50 – 471.50 m), KFM03A:7 (351.50 – 401.50 m) and KFM03A:8 (0.00 – 350.50 m). KFM03A:1 (969.50 – 1001.19 m) and KFM03A:2 (820.50 – 968.50 m) are excluded from the figure since the values for these sections are much lower than for the others. KFM03A:1 and KFM03A:2 shows the same pattern as KFM03A:3. All lengths given in mbl TOC.*

Based on inspection of these time series it was decided to apply a trend correction to the time series included in the analysis of the HFM43 test, as described in Lindquist et al. (2008). In general, the trend for each section was calculated as the difference between the average groundwater level during the day before pumping start (average of 2018-07-27) and the day before the next bigger rainfall (average of 2018-07-28; see Figure 3-5 for an example). All trend correction analyses were conducted using programming in R version 3.4.3 (R Development Core Team 2017).

Following this automatic correction, the uncorrected and corrected time series were manually inspected. For 18 sections the automatic trend correction was deemed not suitable (see Figure 3-6 as example; Appendix 3). These sections were therefore not corrected, which possible led to a small overestimation of the respective responses.

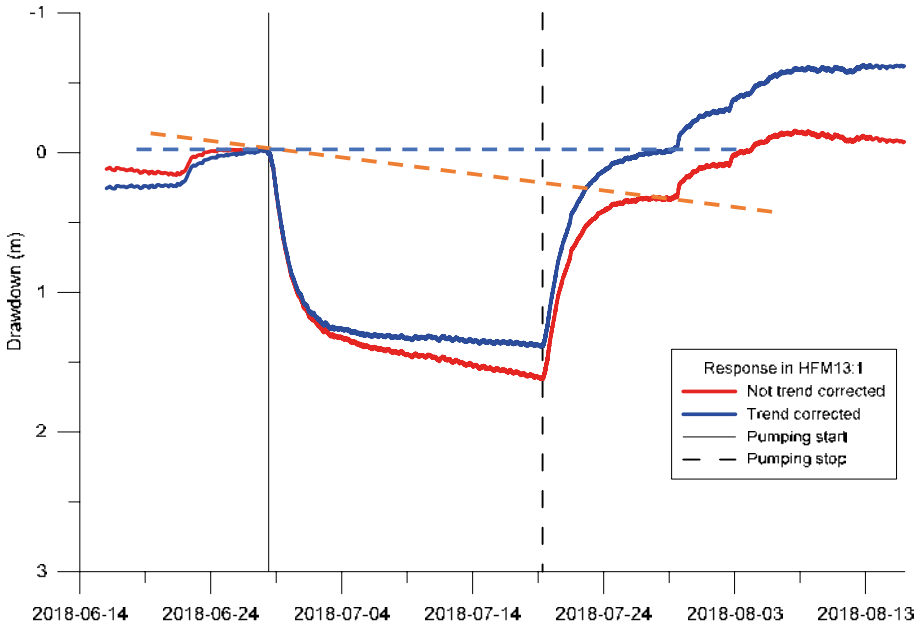


Figure 3-5. *Trend correction of HFM13:1 during the pumping in HFM43. Trend correction based on differences in average values between 2018-07-27 (day before pumping start) and 2018-07-28 (day before next big rainfall). The thin red line illustrates the trend.*

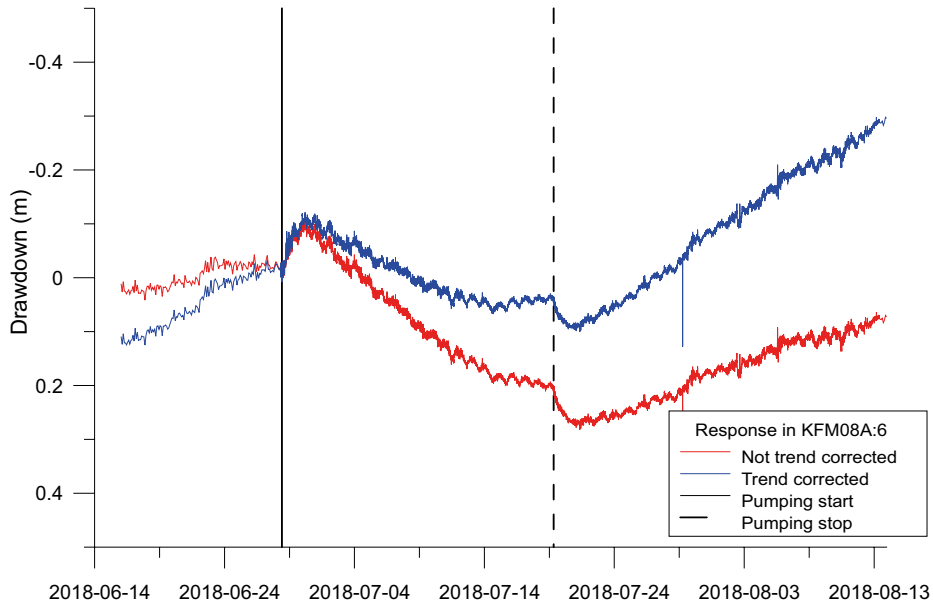


Figure 3-6. *In KFM08A:6 no clear pressure trend could be detected, and the rainfalls have only little impact. No correction has been performed for this section.*

3.3.3 Response analysis and estimation of hydraulic diffusivity

Responding sections where the drawdown, s_p [m], exceeded the response criterion (s_p > 0.1 m) were evaluated by means of the so-called response indices 1 and 2-new (defined below). These indices represent the speed of propagation rate and strength of the responses, respectively, which in turn are assumed to characterize the hydraulic connection between the pumping and the observation sections.

Index 1 is directly related to the hydraulic diffusivity (T/S) of the formation. The maximal drawdown, s_p [m], occurred in several observation sections after the pumping had stopped. The response time, dt_L [s], is defined as the time lag after start of pumping until a response of 0.1 m was observed in the observation section and was automatically calculated based on a moving average of 20 data points. In some cases, fluctuations in monitored head (e.g. due to tidal effects) complicated an accurate determination of the time point for a 0.1 m drawdown. If the visual control of the drawdown appearance indicated problems with the automatically generated values, the values were manually adjusted.

The pumping flow rate, Q_p [m^3/s], was used in combination with the response time (dt_L), spherical distance between the pumped borehole section and the responding borehole section, r_s [m], and maximum drawdown s_p [m] to calculate the response indices 1 and 2-new. The spherical distance is calculated from the midpoints of the pumped borehole section and the observation sections. Since these tests are performed in selected fractures the flow is not uniformly distributed in space. The response indices were calculated as follows:

Index 1 [m^2/s]**:**
Normalized spherical distance (r_s) with respect to the response time dt_L (s = 0.1 m).

$$Index\ 1 = \frac{r_s^2}{dt_L} \qquad \text{Equation 3-3}$$

Index 2 new [s/m^2]**:**
Normalized maximum drawdown (s_p) with respect to the pumping rate by the end of the flow period (Q_p), also considering the distance (r_s) assuming r_0 = 1 m (fictive borehole radius) according to SKB MD 330.003.

$$Index\ 2\ new = \frac{s_p}{Q_p} \cdot ln\left(\frac{r_s}{r_0}\right) \qquad \text{Equation 3-4}$$

The classification of the response indices is given in Table 3-1 below.

Table 3-1. Classification of response indices.

	Limits	Classification	Colour code
Index 1 [m^2/s]	Index 1 > 100 m^2/s	Excellent	Red
	10 < Index 1 ≤ 100 m^2/s	High	Yellow
	1 < Index 1 ≤ 10 m^2/s	Medium	Green
	0.1 < Index 1 ≤ 1 m^2/s	Low	Blue
Index 2 new [s/m^2]	Index 2 new > 5×10^5 s/m^2	Excellent	Red
	5×10^4 < Index 2 new ≤ 5×10^5 s/m^2	High	Yellow
	5×10^3 < Index 2 new ≤ 5×10^4 s/m^2	Medium	Green
	Index 2 new ≤ 5×10^3 s/m^2	Low	Blue
	s_p < 0.1 m	No response	Grey

The maximum drawdown does not always coincide with the stop of pumping, e.g. due to precipitation or other disturbances by the end of the tests. If the response in the observation section is delayed the chosen value for the drawdown in the observation sections is determined as the maximum drawdown, even if it occurs after the time for stop of pumping. The calculated indices are then, for each test, plotted in an index diagram which can be used to easily identify the observation sections with the most

distinct responses, see Figure 3-7. Data that show up in the upper right corner in the response index diagrams are assumed to reflect well-connected responses, i.e. both high hydraulic diffusivities and distinct responses. Data that show up in the lower left corner are assumed to reflect comparatively weak hydraulic connections, with delayed and small responses. The magnitude of responses (i.e. Index 2-new) is primarily dominated by the presence of upstream hydraulic boundaries (Knudby and Carrera 2006), where no-flow boundaries enhance drawdown, while constant-head boundaries dampen the drawdown in an observation section. Likewise, slow responses (i.e. Index 1) indicate poor connectivity or the presence of an apparent storativity term (e.g. dampening of a constant-head boundary).

3.3.4 Estimation of large-scale effective transmissivity

The observed responses were used to estimate a "large-scale effective transmissivity" using the steady-state, radial flow approximation of the Cooper-Jacob method (Equation 3-5).

$$T = \frac{0.366Q}{\Delta s} \qquad \text{Equation 3-5}$$

The large-scale transmissivity (T) was estimated using pumped flow (Q) and the slope (Δs) of the least-squares fit for the drawdown (s) as a function of the logarithmic radial distance of the respective borehole (Follin et al. 2007, Figure 5-2 to 5-6a).

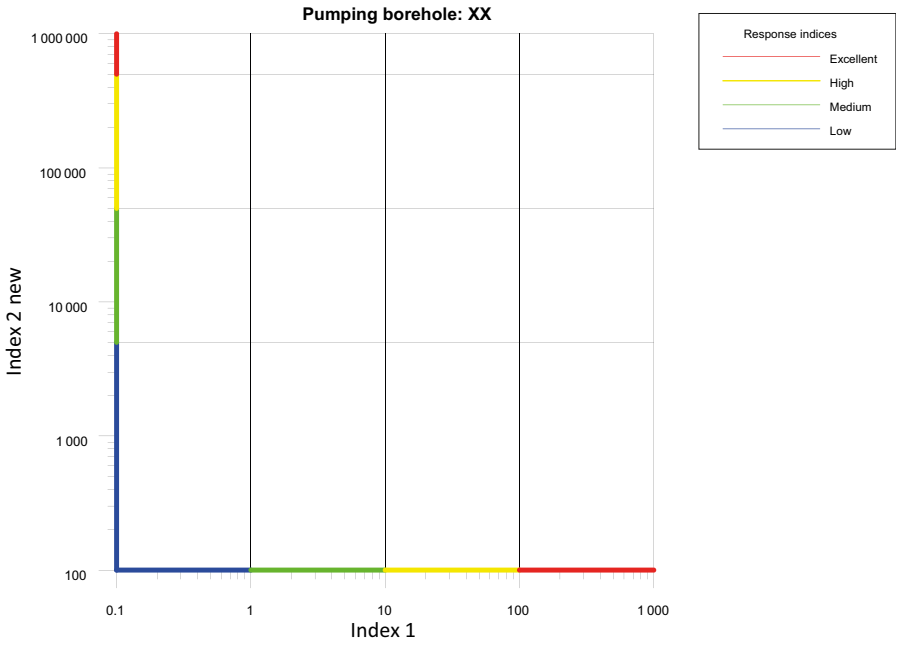


Figure 3-7. *Example of index diagram.*

4 Response analysis of the observation sections

In this section, all 301 individually interpreted responses observed across all five interference tests are listed (Section 4.1 to 4.5). Figures with all responses are presented in Appendix 4 and Appendix 5. Only responses that exceeded the defined response criterion (s_p > 0.1 m) were included in the further response analysis, which include in total 218 sections. Classification criterion and color coding are found under Section 3.3.3, Table 3-1.

Eighty-three responses did not fulfill the criterion for calculating response indices and are listed separately. These responses were classified into three groups (see Table 5-1 for color-codes), specifically, 1) clear responses of less than 0.1 m, in total 19 sections (Figure 4-1a), 2) unclear responses that are hard to distinguish from external impact such as sea water level and air pressure, in total 50 sections (Figure 4-1b) and 3) responses that behave different behavior than expected, in total 14 sections (Figure 4-1c–d).

Table 4-1. Colour codes for other responses and their description.

	Description	Comment	Colour code
Other responses	Response below limit, < 0.1 m	Probably response but < 0.1 m	BL
	Low confidence	Uncertain/unclear response. Could be due to causes other than pumping	LC
	Abnormal response	Section with abnormal behavior	AR

Some responses fulfilled the criterion of drawdown exceeding 0.1 m, but with smaller deviations from expected response appearance. Most common in this category were responses where the pressure temporarily increased in the beginning of the pumping phase and temporarily decreased in the end of the pumping (i.e. opposite to the expected pattern, Figure 4-1e). Another pattern that occurred was repeated small pressure peaks during the drawdown period (Figure 4-1f). For these responses, indexes were calculated and included (separately) in the tables for other responses.

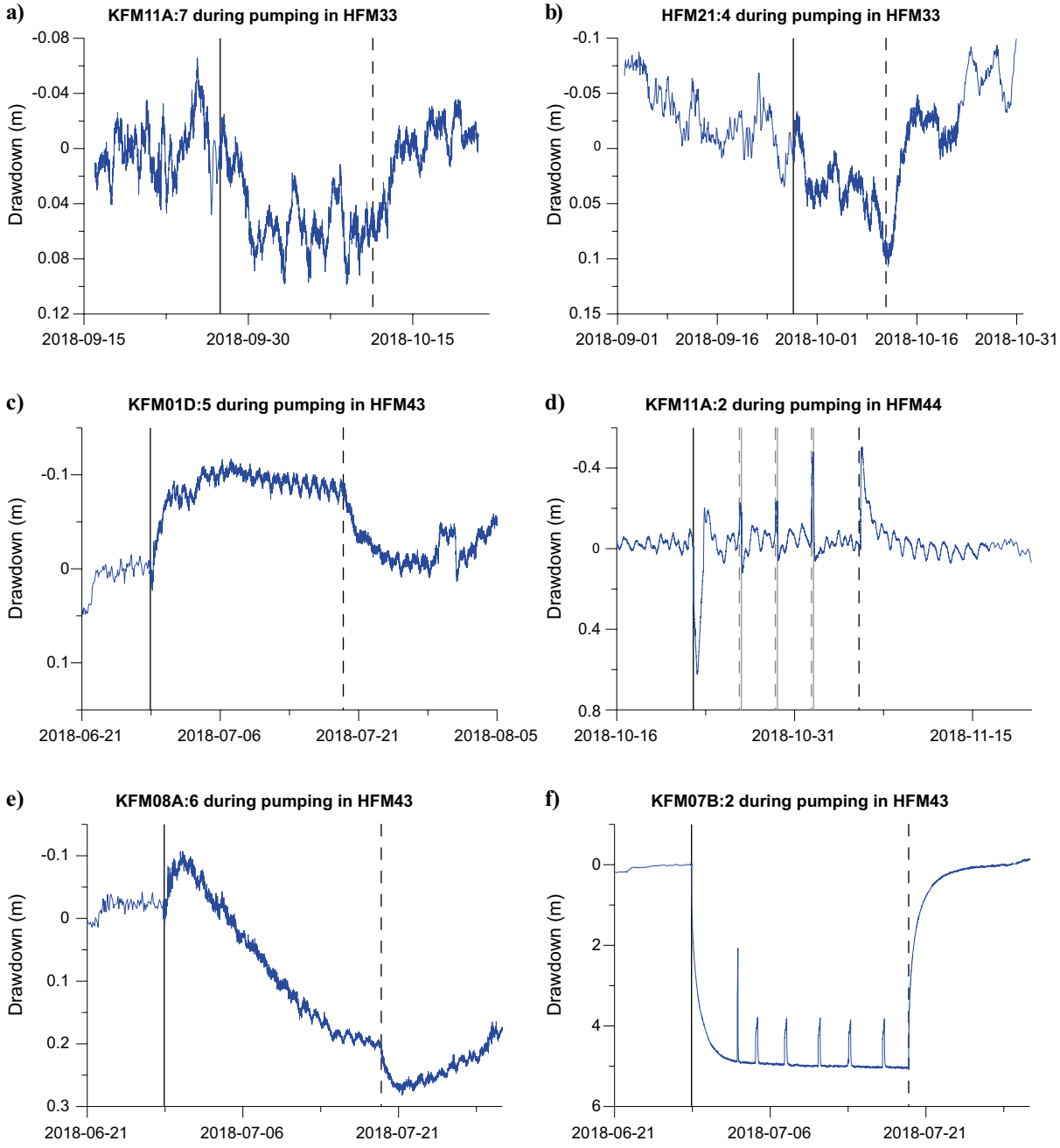


Figure 4-1. *Examples of "other responses" that did not did not show the expected pattern. The grey solid and dashed lines mark pumping start stop, respectively.*
a) Clear response, but < 0.1 m. Response indices are not calculated since the criterium > 0.1 m response was not fulfilled.
b) Unclear response judged as probably non-responding section. Response indices are not calculated.
c) Increased pressure during pumping. Response indices are not calculated.
d) Reacts on pumping start and stop, but without drawdown curve. Response indices are not calculated.
e) Temporary bump with higher pressure after pumping start and corresponding lower pressure after pumping stop. Response indices are calculated from initial pressure, pi, without consideration of the temporary higher pressure.
f) Peaks of high pressure during drawdown. Response indices are calculated.

4.1 Interference test in HFM43: 0–200 m

Pumping in HFM43 resulted in a high number of responses (136, with 122 of these > 0.1 m; Table 4-2 and Figure 4-2).

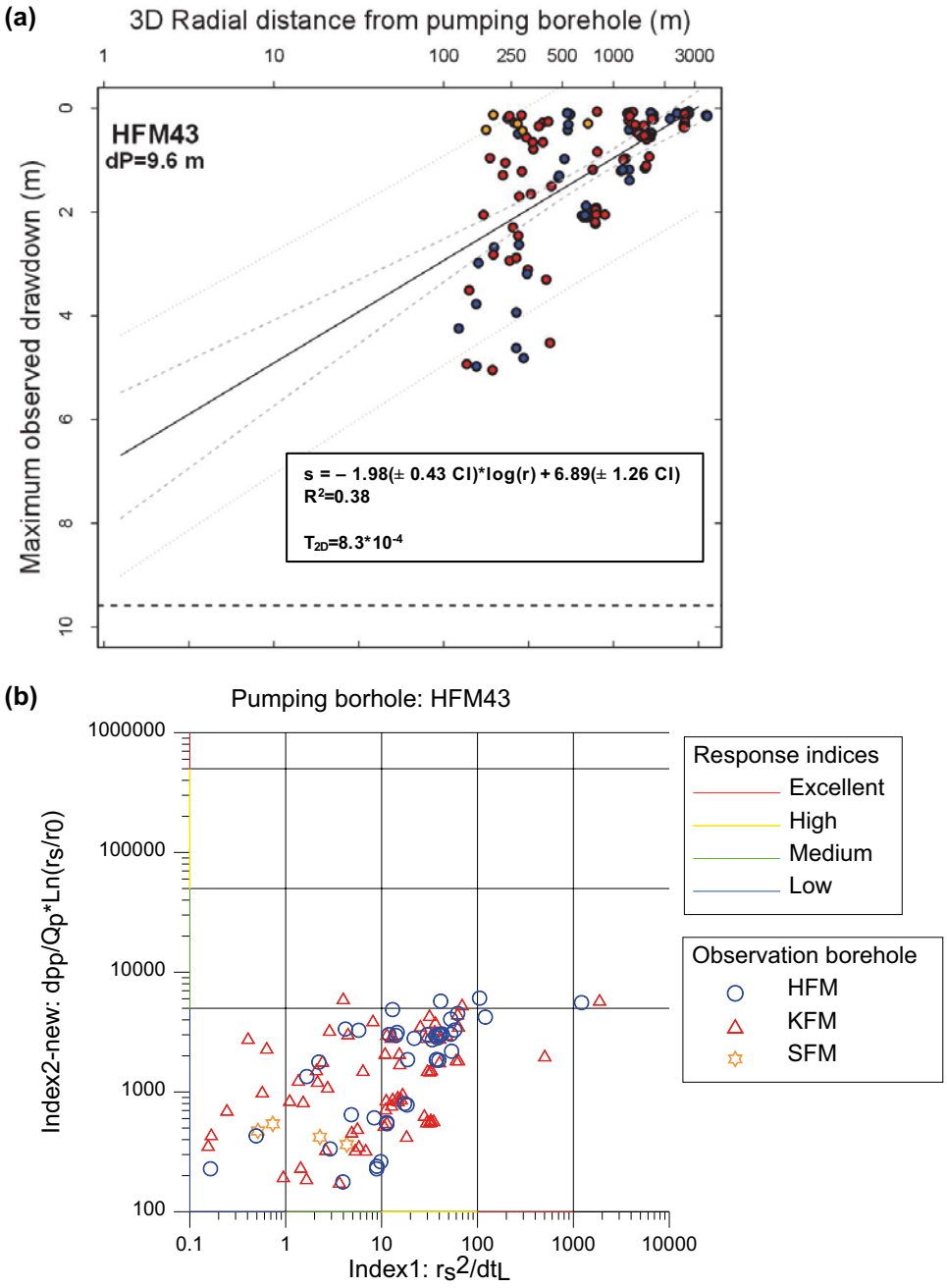


Figure 4-2. *(a) Scatterplot between the maximum observed drawdown in borehole sections (area Forsmark) that showed response when pumping in HFM43, and the logarithm of the 3D radial distance from the pumping borehole, with blue = percussion boreholes, red = core boreholes and orange = soil tubes. The drawdown in HFM43 was 9.6 m at a flow rate of 271 L/min. The dashed horizontal line marks the observed drawdown in the pumping hole. A linear regression was significant (s = −1.98 (± 0.43 CI) · log(r) + 6.89 (± 1.26 CI); n = 138, P < 0.0001, R^2 = 0.38), and the regression line is shown together with 95 % confidence intervals (dashed grey lines) and 95 % prediction intervals (dotted grey lines). A steady-state, radial flow approximation using the slope of the least-squares fit for an estimate of Δs renders a large-scale effective transmissivity of 8×10^{-4} m^2/s. (b) Response diagram showing the responding observation sections when pumping in HFM43. "Index 1" is used as indicator of the response time, and "index 2-new" is used as indicator of response strength. The most extreme values for index 1 are measured at KFM07B:2 (index1 = 1876.67), HFM21:2 (index1 = 1215.13) and KFM07A:1 (index1 = 502.91).*

Most of the strongest responses (exceeding 1 m maximal drawdown) occurred at radial distances of a few hundred meters from the pumping borehole. Responses < 1 m were observed up to large distances from the pumping borehole, exceeding 2–3 km. Using the response indices 1 and 2-new for classification, most responses when pumping in HFM43 showed a "low" response strength and ranged from "slow" to "fast" response times (Figure 4-2b). For the test in HFM43 there are many clear responses that do not exceed 0.1 m (Table 4-3). This is also the test with the highest occurrence of temporary pressure bumps at pumping start and stop (see Figure 4-1e), these are noted in Table 4-3). Observation sections that could not be evaluated are listed in Table 4-4.

In total 183 sections were evaluated (119 cored borehole sections, 58 percussion drilled borehole sections and 6 soil pipe sections). 122 responses > 0.1 m were found 5 Extreme (E), 66 High (H), 35 Medium (M), 12 Low (L) and 4 classified as Below low (N) for which the response occurred to late to fulfill the criteria (Index 1 < 0.1 => Below class Low => N). 16 clear responses < 0.1 m were found. Additional 1 low confidence response was found. See Figure 4-3.

Table 4-2. Results from response analysis of the responses in the observation section during the interference tests in HFM43.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	dt_L [s = 0.1 m] (s)	Index 1: r_s^2/dt_L [s = 0.1 m] (m^2/s)	Index 1 classification	Index 2_new: $s_p/Q_p*\ln(r_s/r_0)$ (s/m^2)	Index 2_new classification[1)]
HFM43	0.00–200.00	HFM01:1	46.50–200.20	781.7	4.51E−03	2.22	10 550	57.92	H	3 284	L
HFM43	0.00–200.00	HFM01:2	33.50–45.50	784.6	4.51E−03	2.05	11 690	52.66	H	3 036	L
HFM43	0.00–200.00	HFM01:3	0.00–32.50	788.2	4.51E−03	2.04	52 070	11.93	H	3 014	L
HFM43	0.00–200.00	HFM02:1	49.00–100.00	694.7	4.51E−03	2.05	13 130	36.75	H	2 968	L
HFM43	0.00–200.00	HFM02:2	38.00–48.00	697.4	4.51E−03	2.10	11 390	42.70	H	3 054	L
HFM43	0.00–200.00	HFM02:3	0.00–37.00	700.7	4.51E−03	2.07	16 370	29.99	H	3 006	L
HFM43	0.00–200.00	HFM03:1	19.00–26.00	702.3	4.51E−03	1.94	12 830	38.44	H	2 822	L
HFM43	0.00–200.00	HFM03:2	0.00–18.00	704.1	4.51E−03	1.93	22 670	21.87	H	2 802	L
HFM43	0.00–200.00	HFM04:2	57.90–65.90	2 747.1	4.51E−03	0.10	1 911 470	3.95	M	177	L
HFM43	0.00–200.00	HFM13:1	159.00–175.60	1 240.5	4.51E−03	1.38	28 670	53.67	H	2 187	L
HFM43	0.00–200.00	HFM13:2	101.00–158.00	1 234.7	4.51E−03	1.18	81 770	18.64	H	1 863	L
HFM43	0.00–200.00	HFM13:3	0.00–100.00	1 235.0	4.51E−03	0.41	315 470	4.83	M	646	L
HFM43	0.00–200.00	HFM14:1	0.00–150.50	1 132.5	4.51E−03	1.18	32 463	39.51	H	1 843	L
HFM43	0.00–200.00	HFM15:1	85.00–99.50	1 105.7	4.51E−03	1.20	32 580	37.52	H	1 870	L
HFM43	0.00–200.00	HFM15:2	0.00–84.00	1 141.3	4.51E−03	1.18	34 970	37.25	H	1 848	L
HFM43	0.00–200.00	HFM16:1	68.00–132.50	1 525.9	4.51E−03	0.33	205 070	11.35	H	543	L
HFM43	0.00–200.00	HFM16:2	54.00–67.00	1 522.4	4.51E−03	0.34	205 070	11.30	H	553	L
HFM43	0.00–200.00	HFM16:3	0.00–53.00	1 524.5	4.51E−03	0.34	205 070	11.33	H	554	L
HFM43	0.00–200.00	HFM18:1	42.00–180.65	3 500.9	4.51E−03	0.13	1 371 470	8.94	M	240	L
HFM43	0.00–200.00	HFM18:2	28.00–41.00	3 546.1	4.51E−03	0.13	1 414 670	8.89	M	228	L
HFM43	0.00–200.00	HFM18:3	0.00–27.00	3 557.5	4.51E−03	0.14	1 292 270	9.79	M	262	L
HFM43	0.00–200.00	HFM20:1	131.00–301.00	295.5	4.51E−03	4.81	830	105.21	E	6 072	M
HFM43	0.00–200.00	HFM20:2	101.00–130.00	267.3	4.51E−03	4.62	1 730	41.29	H	5 726	M
HFM43	0.00–200.00	HFM20:3	49.00–100.00	267.7	4.51E−03	3.93	5 510	13.01	H	4 876	L
HFM43	0.00–200.00	HFM20:4	0.00–48.00	277.4	4.51E−03	2.63	13 310	5.78	M	3 277	L
HFM43	0.00–200.00	HFM21:1	107.00–202.00	197.7	4.51E−03	2.68	2 690	14.54	H	3 140	L
HFM43	0.00–200.00	HFM21:2	33.00–106.00	155.9	4.51E−03	4.98	20	1 215.13	E	5 571	M
HFM43	0.00–200.00	HFM21:3	22.00–32.00	155.4	4.51E−03	3.77	200	120.68	E	4 220	L
HFM43	0.00–200.00	HFM21:4	0.00–21.00	160.0	4.51E−03	2.98	6 110	4.19	M	3 353	L
HFM43	0.00–200.00	HFM22:1	0.00–222.00	309.8	4.51E−03	3.19	1 829	52.47	H	4 057	L
HFM43	0.00–200.00	HFM23:1	0.00–211.50	514.0	4.51E−03	0.97	159 102	1.66	M	1 344	L
HFM43	0.00–200.00	HFM25:1	0.00–187.50	2 153.8	4.51E−03	0.20	1 595 246	2.91	M	335	L
HFM43	0.00–200.00	HFM27:1	59.00–127.50	652.0	4.51E−03	2.07	30 170	14.09	H	2 967	L
HFM43	0.00–200.00	HFM27:2	46.00–58.00	669.7	4.51E−03	2.10	10 970	40.88	H	3 030	L
HFM43	0.00–200.00	HFM27:3	25.00–45.00	677.5	4.51E−03	2.06	11 510	39.88	H	2 975	L
HFM43	0.00–200.00	HFM27:4	0.00–24.00	688.6	4.51E−03	1.88	14 030	33.79	H	2 724	L

Table 4-2. Continued.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	dt_L [s = 0.1 m] (s)	Index 1: r_s^2/dt_L [s = 0.1 m] (m^2/s)	Index 1 classification	Index 2_new: $s_p/Q_p*ln(r_s/r_0)$ (s/m^2)	Index 2_new classification[1)]
HFM43	0.00–200.00	HFM28:1	0.00–151.20	478.1	4.51E−03	1.30	103 159	2.22	M	1 775	L
HFM43	0.00–200.00	HFM32:1	98.00–202.65	1 676.1	4.51E−03	0.47	152 270	18.45	H	779	L
HFM43	0.00–200.00	HFM32:2	32.00–97.00	1 660.8	4.51E−03	0.49	158 870	17.36	H	800	L
HFM43	0.00–200.00	HFM38:1	42.00–200.75	555.3	4.51E−03	0.11	1 122 470	0.27	L	154	L
HFM43	0.00–200.00	HFM38:2	24.00–41.00	537.0	4.51E−03	0.42	52 070	5.54	M	578	L
HFM43	0.00–200.00	HFM39:1	0.00–151.20	237.7	4.51E−03	0.19	343 690	0.16	L	228	L
HFM43	0.00–200.00	HFM40:1	0.00–101.70	274.1	4.51E−03	0.49	8 983	8.37	M	608	L
HFM43	0.00–200.00	HFM41:1	0.00–101.50	541.6	4.51E−03	0.31	597 020	0.49	L	430	L
HFM43	0.00–200.00	HFM42:1	0.00–195.30	122.6	4.51E−03	4.24	242	62.15	H	4 524	L
HFM43	0.00–200.00	KFM01A:4	131.00–204.00	793.0	4.51E−03	1.94	21 780	28.87	H	2 876	L
HFM43	0.00–200.00	KFM01A:5	109.00–130.00	794.9	4.51E−03	2.01	48 470	13.04	H	2 973	L
HFM43	0.00–200.00	KFM01A:6	0.00–108.00	801.8	4.51E−03	0.84	299 270	2.15	M	1 239	L
HFM43	0.00–200.00	KFM01B:1	142.00–500.52	790.9	4.51E−03	1.92	15 470	40.43	H	2 835	L
HFM43	0.00–200.00	KFM01B:2	101.00–141.00	783.0	4.51E−03	1.95	48 770	12.57	H	2 880	L
HFM43	0.00–200.00	KFM01B:3	0.00–100.00	790.2	4.51E−03	2.05	13 070	47.77	H	3 026	L
HFM43	0.00–200.00	KFM01D:6	154.00–252.00	753.7	4.51E−03	1.18	36 770	15.45	H	1 734	L
HFM43	0.00–200.00	KFM01D:7	0.00–153.00	779.5	4.51E−03	2.19	16 970	35.80	H	3 238	L
HFM43	0.00–200.00	KFM02A:3	490.00–518.00	2 630.9	4.51E−03	0.33	212 270	32.61	H	575	L
HFM43	0.00–200.00	KFM02A:4	443.00–489.00	2 628.9	4.51E−03	0.33	197 870	34.93	H	581	L
HFM43	0.00–200.00	KFM02A:5	411.00–442.00	2 627.3	4.51E−03	0.33	233 870	29.52	H	568	L
HFM43	0.00–200.00	KFM02A:6	241.00–410.00	2 625.4	4.51E−03	0.25	377 870	18.24	H	430	L
HFM43	0.00–200.00	KFM02B:2	491.00–506.00	2 585.3	4.51E−03	0.34	205 070	32.59	H	589	L
HFM43	0.00–200.00	KFM02B:3	432.00–490.00	2 586.5	4.51E−03	0.34	205 070	32.62	H	588	L
HFM43	0.00–200.00	KFM02B:4	410.00–431.00	2 588.2	4.51E−03	0.33	212 270	31.56	H	566	L
HFM43	0.00–200.00	KFM02B:5	246.00–409.00	2 594.3	4.51E−03	0.37	241 070	27.92	H	644	L
HFM43	0.00–200.00	KFM02B:7	0.00–130.00	2 628.4	4.51E−03	0.10	1 904 270	3.63	M	178	L
HFM43	0.00–200.00	KFM04A:3	246.00–390.00	1 223.8	4.51E−03	0.23	257 870	5.81	M	355	L
HFM43	0.00–200.00	KFM05A:5	115.00–253.00	1 178.1	4.51E−03	0.96	43 380	31.99	H	1 511	L
HFM43	0.00–200.00	KFM05A:6	0.00–114.00	1 143.7	4.51E−03	0.99	39 470	33.14	H	1 541	L
HFM43	0.00–200.00	KFM06A:2	749.00–826.00	1 243.6	4.51E−03	0.13	1 637 870	0.94	L	198	L
HFM43	0.00–200.00	KFM06A:3	738.00–748.00	1 246.2	4.51E−03	0.15	1 083 470	1.43	M	237	L
HFM43	0.00–200.00	KFM06A:4	363.00–737.00	1 277.9	4.51E−03	0.29	334 670	4.88	M	467	L
HFM43	0.00–200.00	KFM06A:5	341.00–362.00	1 339.0	4.51E−03	0.31	320 270	5.60	M	501	L
HFM43	0.00–200.00	KFM06A:6	247.00–340.00	1 361.4	4.51E−03	0.45	169 070	10.96	H	727	L
HFM43	0.00–200.00	KFM06A:7	151.00–246.00	1 401.9	4.51E−03	0.49	154 670	12.71	H	784	L
HFM43	0.00–200.00	KFM06A:8	0.00–150.00	1 461.2	4.51E−03	0.55	133 070	16.05	H	882	L

Table 4-2. Continued.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	dt_L [s = 0.1 m] (s)	Index 1: r_s^2/dt_L [s = 0.1 m] (m^2/s)	Index 1 classification	Index 2_new: $s_p/Q_p*\ln(r_s/r_0)$ (s/m^2)	Index 2_new classification[1)]
HFM43	0.00–200.00	KFM06B:2	27.00–50.00	1498.4	4.51E−03	0.35	197870	11.35	H	560	L
HFM43	0.00–200.00	KFM06B:3	0.00–26.00	1502.5	4.51E−03	0.33	212270	10.64	H	529	L
HFM43	0.00–200.00	KFM06C:3	647.00–666.00	1724.5	4.51E−03	0.20	557870	5.33	M	331	L
HFM43	0.00–200.00	KFM06C:4	541.00–646.00	1682.3	4.51E−03	0.20	413870	6.84	M	329	L
HFM43	0.00–200.00	KFM06C:5	531.00–540.00	1645.2	4.51E−03	0.56	183470	14.75	H	913	L
HFM43	0.00–200.00	KFM06C:6	402.00–530.00	1607.4	4.51E−03	0.54	197870	13.06	H	882	L
HFM43	0.00–200.00	KFM06C:7	351.00–401.00	1563.5	4.51E−03	0.59	147470	16.58	H	970	L
HFM43	0.00–200.00	KFM06C:8	281.00–350.00	1540.5	4.51E−03	0.53	212270	11.18	H	864	L
HFM43	0.00–200.00	KFM06C:9	187.00–280.00	1516.8	4.51E−03	0.52	154670	14.87	H	853	L
HFM43	0.00–200.00	KFM07A:1	0.00–1002.10	430.2	4.51E−03	> 1.50[2]	368	502.91	E	2017	L
HFM43	0.00–200.00	KFM07B:1	203.00–298.93	274.8	4.51E−03	2.45	6650	11.36	H	3055	L
HFM43	0.00–200.00	KFM07B:2	75.00–202.00	193.7	4.51E−03	5.05	20	1876.67	E	5891	M
HFM43	0.00–200.00	KFM07C:2	161.00–301.00	196.0	4.51E−03	2.82	13430	2.86	M	3301	L
HFM43	0.00–200.00	KFM07C:3	111.00–160.00	141.3	4.51E−03	3.50	550	36.29	H	3847	L
HFM43	0.00–200.00	KFM07C:4	0.00–110.00	136.7	4.51E−03	4.93	270	69.23	H	5379	M
HFM43	0.00–200.00	KFM08A:6	265.00–280.00	382.5	4.51E−03	0.27	941270	0.16	L	361	L
HFM43	0.00–200.00	KFM08A:7	216.00–264.00	363.1	4.51E−03	0.34	787070	0.17	L	444	L
HFM43	0.00–200.00	KFM08A:8	162.00–215.00	336.9	4.51E−03	0.78	199070	0.57	L	1010	L
HFM43	0.00–200.00	KFM08A:9	0.00–161.00	306.5	4.51E−03	0.56	384470	0.24	L	710	L
HFM43	0.00–200.00	KFM08B:1	113.00–200.54	255.9	4.51E−03	2.29	161270	0.41	L	2821	L
HFM43	0.00–200.00	KFM08B:2	71.00–112.00	261.1	4.51E−03	0.28	832670	0.08	N[3)]	343	L
HFM43	0.00–200.00	KFM08B:3	0.00–70.00	278.7	4.51E−03	1.70	7130	10.89	H	2120	L
HFM43	0.00–200.00	KFM08C:5	0.00–145.00	326.1	4.51E−03	1.65	6950	15.31	H	2118	L
HFM43	0.00–200.00	KFM08D:6	161.00–330.00	383.5	4.51E−03	0.65	133670	1.10	M	857	L
HFM43	0.00–200.00	KFM08D:7	0.00–160.00	313.0	4.51E−03	3.11	12050	8.13	M	3963	L
HFM43	0.00–200.00	KFM09A:1	551.00–799.67	888.5	4.51E−03	2.05	176870	4.46	M	3083	L
HFM43	0.00–200.00	KFM09A:3	0.00–300.00	473.7	4.51E−03	1.33	92570	2.42	M	1820	L
HFM43	0.00–200.00	KFM09B:2	201.00–450.00	422.5	4.51E−03	4.52	44870	3.98	M	6061	M
HFM43	0.00–200.00	KFM09B:3	0.00–200.00	401.3	4.51E−03	3.30	5090	31.65	H	4388	L
HFM43	0.00–200.00	KFM10A:1	441.00–500.16	1526.5	4.51E−03	1.15	38870	59.95	H	1866	L
HFM43	0.00–200.00	KFM10A:2	430.00–440.00	1540.2	4.51E−03	1.15	37370	63.48	H	1869	L
HFM43	0.00–200.00	KFM10A:3	353.00–429.00	1558.0	4.51E−03	1.10	60470	40.14	H	1797	L
HFM43	0.00–200.00	KFM10A:4	153.00–352.00	1621.6	4.51E−03	0.93	87470	30.06	H	1523	L
HFM43	0.00–200.00	KFM10A:5	0.00–152.00	1715.8	4.51E−03	0.12	1784870	1.65	M	190	L
HFM43	0.00–200.00	KFM13:1	0.00–150.21	287.2	4.51E−03	0.13	1396431	0.06	N[3)]	160	L

Table 4-2. Continued.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	dt_L [s = 0.1 m] (s)	Index 1: r_s^2/dt_L [s = 0.1 m] (m^2/s)	Index 1 classification	Index 2_new: $s_p/Q_p*ln(r_s/r_0)$ (s/m^2)	Index 2_new classification[1)]
HFM43	0.00–200.00	KFM14:1	0.00–60.18	244.6	4.51E−03	2.93	2361	25.34	H	3579	L
HFM43	0.00–200.00	KFM15:1	0.00–62.30	243.8	4.51E−03	0.14	1416778	0.04	N[3)]	176	L
HFM43	0.00–200.00	KFM16:1	0.00–60.35	288.7	4.51E−03	1.21	13046	6.39	M	1525	L
HFM43	0.00–200.00	KFM17:1	0.00–60.45	230.8	4.51E−03	1.05	39349	1.35	M	1263	L
HFM43	0.00–200.00	KFM18:1	0.00–60.46	223.2	4.51E−03	1.29	23781	2.10	M	1543	L
HFM43	0.00–200.00	KFM20:1	0.00–60.50	171.6	4.51E−03	2.05	46429	0.63	L	2341	L
HFM43	0.00–200.00	KFM21:1	0.00–95.20	187.3	4.51E−03	0.96	12811	2.74	M	1108	L
HFM43	0.00–200.00	KFM22:1	0.00–60.26	412.6	4.51E−03	0.25	64850	2.63	M	334	L
HFM43	0.00–200.00	KFM23:1	0.00–100.64	267.6	4.51E−03	2.88	1130	63.39	H	3571	L
HFM43	0.00–200.00	KFM24:1	0.00–550.17	333.8	4.51E−03	0.65	73200	1.52	M	834	L
HFM43	0.00–200.00	SFM000145:1	0.00–2.00	272.2	4.51E−03	0.29	17067	4.34	M	364	L
HFM43	0.00–200.00	SFM000146:1	0.00–3.10	177.7	4.51E−03	0.41	61414	0.51	L	473	L
HFM43	0.00–200.00	SFM000163:1	0.00–6.88	195.9	4.51E−03	0.12	963595	0.04	N[3)]	144	L
HFM43	0.00–200.00	SFM0104:1	0.00–7.20	706.8	4.51E−03	0.29	219929	2.27	M	419	L
HFM43	0.00–200.00	SFM0107:1	0.00–7.05	290.9	4.51E−03	0.43	115389	0.73	L	541	L

1) The indices [Index 1] and [Index-2 new] are described in Section 3.
2) Pressure transducer mainly above water table during the test due to big drawdown.
3) Calculated Index 1 < 0.1 due to long response time dtL

Table 4-3. Other responses during the interference tests in HFM43. This include responses smaller than 0.1 m (s_p < 0.1 m), responses with abnormal appearances, uncertain/unclear responses and sections with initial deviating reversed bump.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	Class	Comments
HFM43	0.00–200.00	HFM04:1	66.90–221.70	2759.2	4.51E−03	0.05	BL	
HFM43	0.00–200.00	HFM05:1	139.00–200.10	2774.5	4.51E−03	0.10	BL	Just below < 10 cm
HFM43	0.00–200.00	HFM05:2	0.00–138.00	2766.4	4.51E−03	0.07	BL	
HFM43	0.00–200.00	HFM09:1	0.00–50.25	1206.4	4.51E−03	0.09	BL	
HFM43	0.00–200.00	HFM17:1	0.00–210.65	2365.7	4.51E−03	0.09	BL	
HFM43	0.00–200.00	HFM32:3	26.00–31.00	1657.2	4.51E−03	0.08	BL	
HFM43	0.00–200.00	HFM32:4	0.00–25.00	1656.9	4.51E−03	0.08	BL	
HFM43	0.00–200.00	HFM38:3	0.00–23.00	533.3	4.51E−03	0.09	BL	
HFM43	0.00–200.00	KFM01A:3	205.00–373.00	799.7	4.51E−03	0.06	BL	
HFM43	0.00–200.00	KFM02A:7	133.00–240.00	2628.4	4.51E−03	0.10	BL	Just below < 10 cm
HFM43	0.00–200.00	KFM02A:8	0.00–132.00	2635.7	4.51E−03	0.09	BL	
HFM43	0.00–200.00	KFM02B:6	131.00–245.00	2609.4	4.51E−03	0.10	BL	Just below < 10 cm
HFM43	0.00–200.00	KFM04A:4	230.00–245.00	1247.6	4.51E−03	0.08	BL	
HFM43	0.00–200.00	KFM04A:5	186.00–229.00	1256.9	4.51E−03	0.08	BL	
HFM43	0.00–200.00	KFM04A:6	164.00–185.00	1267.7	4.51E−03	0.08	BL	
HFM43	0.00–200.00	KFM04A:7	0.00–163.00	1300.5	4.51E−03	0.07	BL	
HFM43	0.00–200.00	HFM04:3	0.00–56.90	2749.2	4.51E−03	-	AR	Abnormal appearance, uncertain response
HFM43	0.00–200.00	KFM01D:2	429.00–438.00	754.2	4.51E−03	-	AR	Abnormal appearance. Higher pressure during pumping
HFM43	0.00–200.00	KFM01D:3	322.00–428.00	748.0	4.51E−03	-	AR	Abnormal appearance. Higher pressure during pumping
HFM43	0.00–200.00	KFM01D:4	311.00–321.00	746.4	4.51E−03	-	AR	Abnormal appearance. Higher pressure during pumping
HFM43	0.00–200.00	KFM01D:5	253.00–310.00	747.0	4.51E−03	-	AR	Abnormal appearance. Higher pressure during pumping
HFM43	0.00–200.00	KFM08C:4	146.00–310.00	416.3	4.51E−03	-	AR	Abnormal appearance, reaction in different direction by pumping start and stop
HFM43	0.00–200.00	KFM09A:2	301.00–550.00	661.3	4.51E−03	-	AR	Abnormal appearance. Higher pressure during pumping
HFM43	0.00–200.00	KFM19:1	0.00–102.37	328.3	4.51E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM43	0.00–200.00	KFM07B:2	75.00–202.00	193.7	4.51E−03	-	E/M	Clear response, but abnormal recurring pressure spikes during pumping
HFM43	0.00–200.00	HFM13:2	101.00–158.00	1234.7	4.51E−03	1.18	-	Bump at start
HFM43	0.00–200.00	HFM13:3	0.00–100.00	1235.0	4.51E−03	0.41	-	Bump at start
HFM43	0.00–200.00	HFM20:2	101.00–130.00	267.3	4.51E−03	4.62	-	Smaller bump at start
HFM43	0.00–200.00	HFM20:3	49.00–100.00	267.7	4.51E−03	3.93	-	Bump at start
HFM43	0.00–200.00	HFM23:1	0.00–211.50	514.0	4.51E−03	0.97	-	Smaller bump at start and stop
HFM43	0.00–200.00	HFM28:1	0.00–151.20	478.1	4.51E−03	1.30	-	Bump at start and stop
HFM43	0.00–200.00	HFM38:1	42.00–200.75	555.3	4.51E−03	0.11	-	Bump at start

Table 4-3. Continued.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	Class	Comments
HFM43	0.00–200.00	HFM38:2	24.00–41.00	537.0	4.51E−03	0.42	-	Bump at start
HFM43	0.00–200.00	HFM38:3	0.00–23.00	533.3	4.51E−03	0.09	-	Smaller bump at start
HFM43	0.00–200.00	KFM08A:6	265.00–280.00	382.5	4.51E−03	0.27	-	Bump at start and stop
HFM43	0.00–200.00	KFM08A:7	216.00–264.00	363.1	4.51E−03	0.34	-	Bump at start and stop
HFM43	0.00–200.00	KFM08A:8	162.00–215.00	336.9	4.51E−03	0.78	-	Bump at start and stop
HFM43	0.00–200.00	KFM08A:9	0.00–161.00	306.5	4.51E−03	0.56	-	Bump at start and stop
HFM43	0.00–200.00	KFM08B:1	113.00–200.54	255.9	4.51E−03	2.29	-	Bump at start and stop
HFM43	0.00–200.00	KFM08B:2	71.00–112.00	261.1	4.51E−03	0.28	-	Bump at start and stop
HFM43	0.00–200.00	KFM08C:4	146.00–310.00	416.3	4.51E−03	0.00	-	Bump at start and stop
HFM43	0.00–200.00	KFM09A:3	0.00–300.00	473.7	4.51E−03	1.33	-	Smaller bump
HFM43	0.00–200.00	KFM09B:2	201.00–450.00	422.5	4.51E−03	4.52	-	Bump at start and stop
HFM43	0.00–200.00	KFM10A:5	0.00–152.00	1715.8	4.51E−03	0.12	-	Smaller bump at start
HFM43	0.00–200.00	KFM24:1	0.00–550.17	333.8	4.51E−03	0.65	-	Bump at start and stop

Table 4-4. Observation section not possible to evaluate during the interference tests in HFM43.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	Comments
HFM43	0.00–200.00	KFM08D:2	825.00–835.00	877.4	4.51E−03	Missing data
HFM43	0.00–200.00	KFM06B:1	51.00–100.33	1493.2	4.51E−03	Pressure disturbed – evaluation not possible/certain
HFM43	0.00–200.00	KFM06C:10	0.00–186.00	1496.6	4.51E−03	Missing data
HFM43	0.00–200.00	SFM000153:1	0.00–3.20	150.1	4.51E−03	Missing data
HFM43	0.00–200.00	HFM19:1	168.00–185.20	1094.7	4.51E−03	Missing data
HFM43	0.00–200.00	HFM19:2	104.00–167.00	1107.7	4.51E−03	Missing data
HFM43	0.00–200.00	HFM19:3	0.00–103.00	1138.0	4.51E−03	Missing data

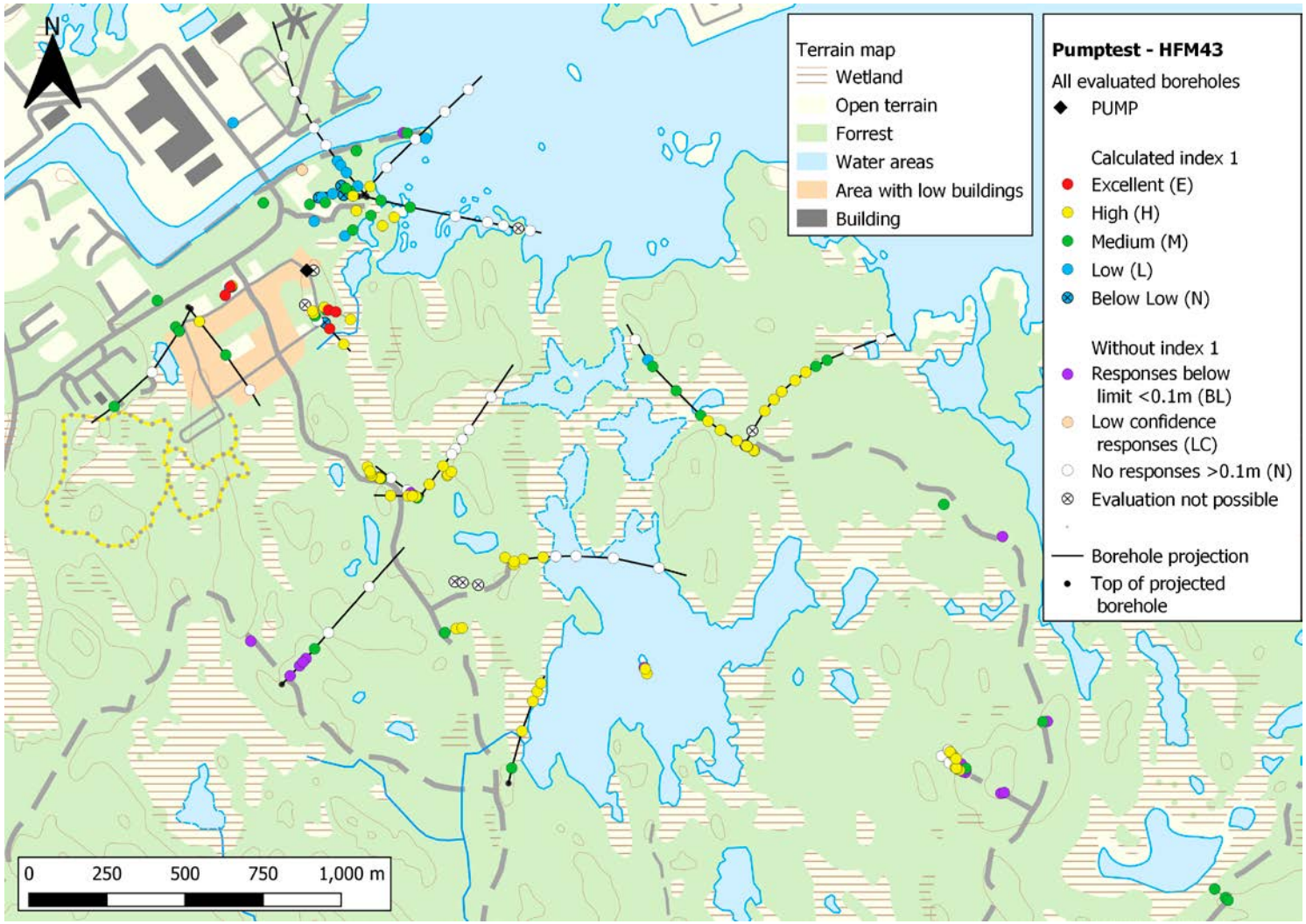


Figure 4-3. *Calculated index 1 from the interference tests in HFM43. All responses are listed in Table 4-2 to Table 4-4. For more detailed figures, divided after borehole type and section depths see Appendix 5, Figure A5-1 to Figure A5-11.*

4.2 Interference test in HFM45: 0–200 m

Pumping in HFM45 resulted in 5 responses < 1 m, at a 3D radial distance of about 400 m from the pumping borehole (Table 4-5 ; Figure 4-4a). These responses clustered at "low" response strengths, and "low" to "medium" response times (Figure 4-4b). Due to the disadvantageous pattern of the sea level that more or less followed the normal pattern of a pumping response during the test time, there are several low confidence responses for the pumping in HFM45 (Table 4-6). These are sections where it was hard to distinguish between the impact of the pumping test and the impact of external factors. Observation sections that could not be evaluated are listed in Table 4-7.

In total 54 sections were evaluated (29 cored borehole sections, 25 percussion drilled borehole sections and 0 soil pipe sections). 5 responses > 0.1 m were found (0 Extreme (E), 0 High (H), 3 Medium (M), 2 Low (L) and 0 classified as Below low (N, Index 1 < 0.1). 0 clear responses < 0.1 m were found. Additional 32 low confidence response were found. See Figure 4-5.

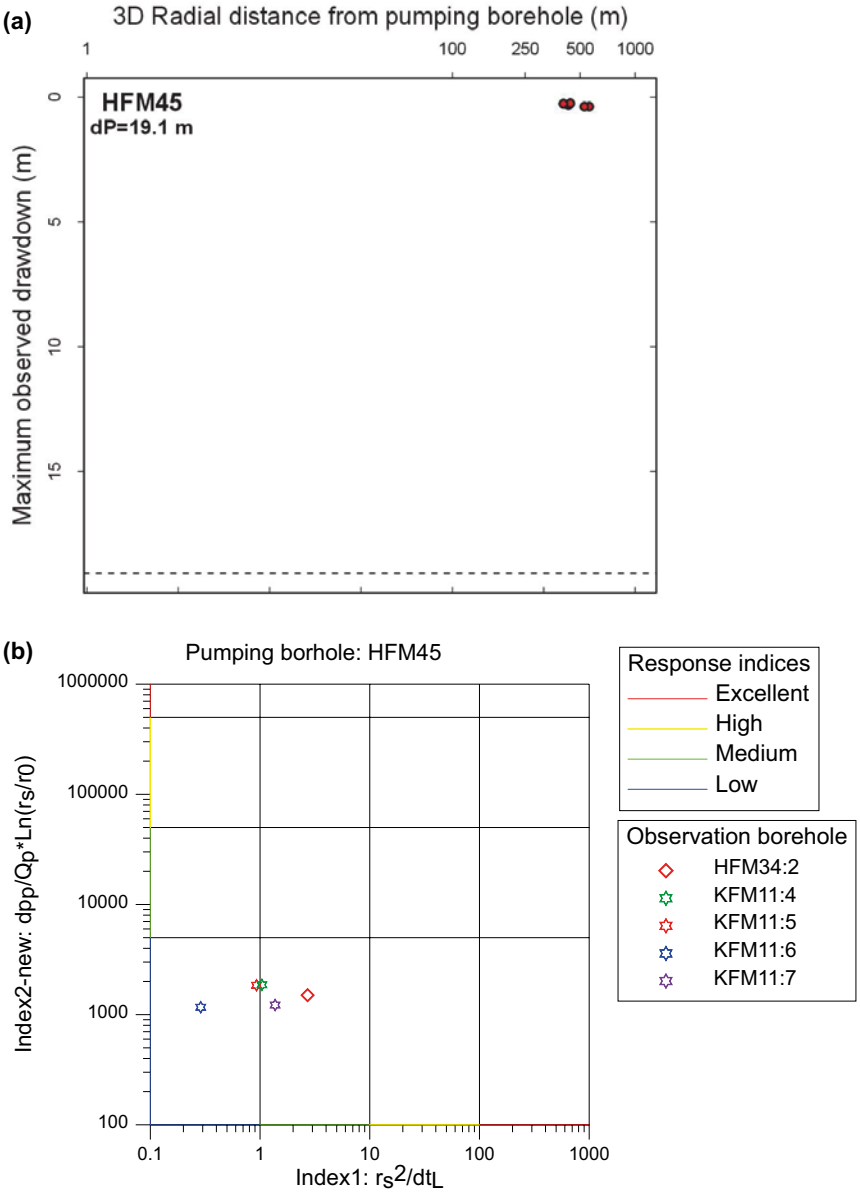


Figure 4-4. *(a) Scatterplot between the maximum observed drawdown in borehole sections (area Forsmark) that showed response when pumping in HFM45, and the logarithm of the 3D radial distance from the pumping borehole, with blue = percussion boreholes, red = core boreholes and orange = soil tubes. The dashed horizontal line marks the observed drawdown in the pumping hole. A linear regression was not significant (n = 5, P = 0.6831, R2 = 0.01); (b) Response diagram showing the responding observation sections when pumping in HFM45. "Index 1" is used as indicator of the response time, and "index 2-new" is used as indicator of response strength.*

Table 4-5. Results from response analysis of the responses in the observation section during the interference tests in HFM45.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	dt_L [s = 0.1 m] (s)	Index 1: r_s^2/dt_L [s = 0.1 m] (m^2/s)	Index 1 classification	Index 2_new: $s_p/Q_p*ln(r_s/r_0)$ (s/m^2)	Index 2_new classification[1]
HFM45	0.00–200.30	HFM34:2	22.00–90.00	431.5	1.24E−03	0.31	68 700	2.71	M	1 502	L
HFM45	0.00–200.30	KFM11A:4	446.00–456.00	561.0	1.24E−03	0.36	302 700	1.04	M	1 866	L
HFM45	0.00–200.30	KFM11A:5	361.00–445.00	527.7	1.24E−03	0.36	299 700	0.93	L	1 849	L
HFM45	0.00–200.30	KFM11A:6	131.00–360.00	441.8	1.24E−03	0.24	678 300	0.29	L	1 167	L
HFM45	0.00–200.30	KFM11A:7	0.00–130.00	405.3	1.24E−03	0.25	119 700	1.37	M	1 223	L

1) The indices [Index 1] and [Index-2 new] are described in Section 3.

Table 4-6. Other responses during the interference tests in HFM45. This include responses smaller than 0.1 m (s_p < 0.1 m), responses with abnormal appearances, uncertain/unclear responses and sections with initial deviating reversed bump.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	Class	Comments
HFM45	0.00–200.30	HFM33:1	120.00–140.20	377.5	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM33:2	0.00–120.00	367.9	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM35:1	182.00–200.75	451.2	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM35:2	151.00–181.00	432.3	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM35:3	34.00–150.00	384.9	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM35:4	0.00–33.00	349.3	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM38:1	42.00–200.75	951.7	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM38:2	24.00–41.00	988.3	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM38:3	0.00–23.00	998.7	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM44:1	90.00–199.60	397.4	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM44:2	60.00–90.00	397.0	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM44:3	0.00–60.00	403.7	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM46:1	150.00–200.00	406.4	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM46:2	100.00–150.00	404.9	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFM46:3	0.00–100.00	408.7	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFR102:1	28.00–55.04	1013.3	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFR102:2	0.00–27.00	1000.8	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	HFR105:1	134.00–200.50	677.5	1.24E−03	-	LC	Possibly an uncertain response in uncorrected data
HFM45	0.00–200.30	HFR105:2	107.00–133.00	662.7	1.24E−03	-	LC	Possibly an uncertain response in uncorrected data
HFM45	0.00–200.30	HFR105:3	61.00–106.00	653.5	1.24E−03	-	LC	Possibly an uncertain response in uncorrected data

Table 4-6. Continued.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	Class	Comments
HFM45	0.00–200.30	KFM11A:2	690.00–710.00	756.7	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR01:1	44.65–62.30	381.3	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR01:2	11.15–43.65	393.4	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR09:1	0.00–80.24	859.0	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR104:3	0.00–97.00	912.2	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR105:1	265.00–306.80	1060.7	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR105:2	170.00–264.00	1063.9	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR105:3	138.00–169.00	1070.9	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR105:4	120.00–137.00	1074.8	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR105:5	4.00–119.00	1088.5	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR27:2	47.00–109.00	1174.8	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFR27:3	0.00–46.00	1177.0	1.24E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM45	0.00–200.30	KFM11A:4	446.00–456.00	561.0	1.24E−03	0.36	-	Small bump at start
HFM45	0.00–200.30	KFM11A:5	361.00–445.00	527.7	1.24E−03	0.36	-	Bump at start and possible at stop
HFM45	0.00–200.30	KFM11A:6	131.00–360.00	441.8	1.24E−03	0.24	-	Bump at start and probably at stop
HFM45	0.00–200.30	KFM11A:7	0.00–130.00	405.3	1.24E−03	0.25	-	Bump at start and probably at stop

Table 4-7. Observation section not possible to evaluate during the interference tests in HFM45.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	Comments
HFM45	0.00–200.30	HFM34:1	91.00–200.75	456.3	1.24E−03	No measurements in this section
HFM45	0.00–200.30	HFR101:1	0.00–209.30	879.8	1.24E−03	Pressure disturbed – evaluation not possible/certain
HFM45	0.00–200.30	KFM11A:1	711.00–851.21	825.9	1.24E−03	Pressure disturbed – evaluation not possible/certain
HFM45	0.00–200.30	KFM11A:3	457.00–689.00	652.4	1.24E−03	Pressure disturbed – evaluation not possible/certain
HFM45	0.00–200.30	KFR102A:3	255.00–422.00	1260.4	1.24E−03	Pressure disturbed – evaluation not possible/certain

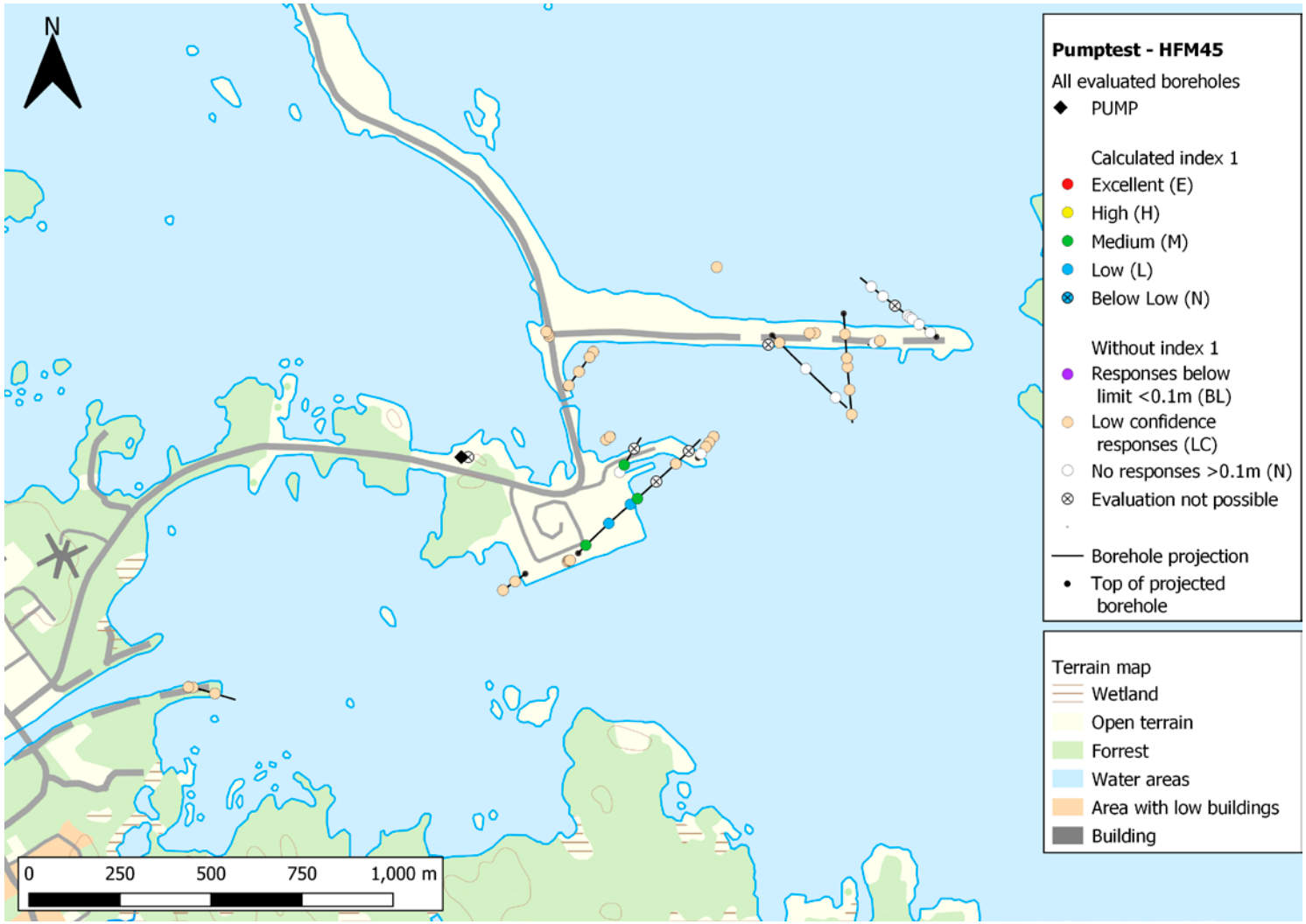


Figure 4-5. *Calculated index 1 from the interference tests in HFM45. All responses are listed in Table 4-5 to Table 4-7. For more detailed figures, divided after borehole type and section depths see Appendix 5, Figure A5-12 to Figure A5-22.*

4.3 Interference test in HFM33: 0–140 m

Pumping in HFM33 resulted in 69 responses > 0.1 m, at a range of 3D radial distances from a few hundred meters to more than 2 km from the pumping borehole (Table 4-8; Figure 4-6a). The responses clustered at "low" response strengths, with "medium" to "high" response times (Figure 4-6a–b). Many unclear and uncertain responses were found when pumping in HFM33 (Table 4-9). Observation sections that could not be evaluated are listed in Table 4-10.

In total 234 sections were evaluated (148 cored borehole sections, 80 percussion drilled borehole sections and 6 soil pipe sections). 69 responses > 0.1 m were found (0 Extreme (E), 51 High (H), 18 Medium (M), 0 Low (L) and 0 classified as Below low (N, Index 1 < 0.1). 2 clear responses < 0.1 m were found. Additional 15 low confidence response were found. See Figure 4-7.

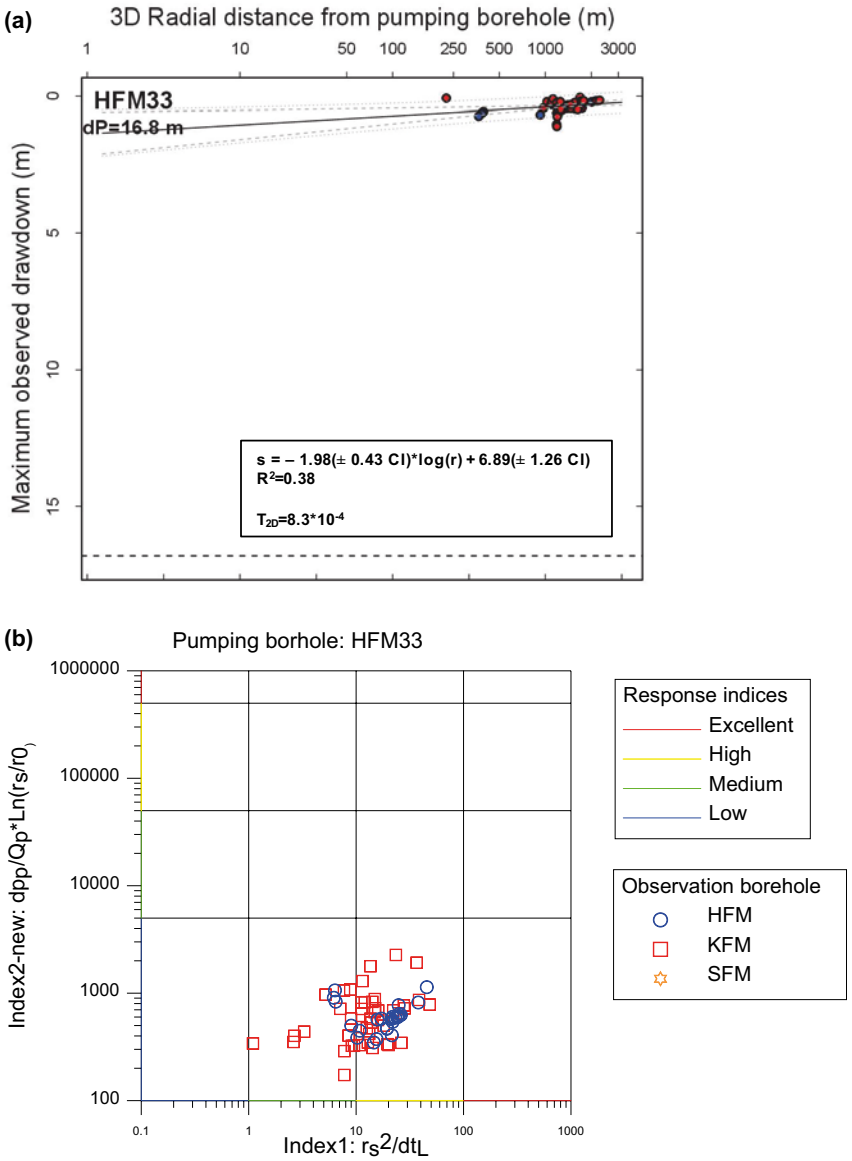


Figure 4-6. *(a) Scatterplot between the maximum observed drawdown in borehole sections (area Forsmark) that showed response when pumping in HFM33, and the logarithm of the 3D radial distance from the pumping borehole, with blue = percussion boreholes, red = core boreholes and orange = soil tubes. The dashed horizontal line marks the observed drawdown in the pumping hole. A linear regression was significant (s = −0.33 (± 0.25 CI) · log(r) + 1.38 (± 0.79 CI); n = 71, P = 0.6831, R2 = 0.01), and the regression line is shown together with 95 % confidence intervals (dashed grey lines) and 95 % prediction intervals (dotted grey lines). The drawdown in HFM33 was 16.8 m at a flow rate of 243 L/min. A steady-state, radial flow approximation using the slope of the least-squares fit for an estimate of Δs renders a large-scale effective transmissivity of 4.5 × 10^{-3} m^2/s. (b) Response diagram showing the responding observation sections when pumping in HFM45. "Index 1" is used as indicator of the response time, and "index 2-new" is used as indicator of response strength.*

Table 4-8. Results from response analysis of the responses in the observation section during the interference tests in HFM33.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	dt_L [s = 0.1 m] (s)	Index 1: r_s^2/dt_L [s = 0.1 m] (m^2/s)	Index 1 classification	Index 2_new: $s_p/Q_p*ln(r_s/r_0)$ (s/m^2)	Index 2_new classification[1]
HFM33	0.00–140.20	HFM01:1	46.50–200.20	1559.3	4.06E−03	0.45	64140	37.91	H	818.47	L
HFM33	0.00–140.20	HFM01:2	33.50–45.50	1570.9	4.06E−03	0.33	113040	21.83	H	602	L
HFM33	0.00–140.20	HFM01:3	0.00–32.50	1575.7	4.06E−03	0.28	275640	9.01	M	499	L
HFM33	0.00–140.20	HFM02:1	49.00–100.00	1693.1	4.06E−03	0.33	114840	24.96	H	613	L
HFM33	0.00–140.20	HFM02:2	38.00–48.00	1694.4	4.06E−03	0.34	110040	26.09	H	628	L
HFM33	0.00–140.20	HFM02:3	0.00–37.00	1695.7	4.06E−03	0.32	124440	23.11	H	592	L
HFM33	0.00–140.20	HFM03:1	19.00–26.00	1695.3	4.06E−03	0.35	114240	25.16	H	643	L
HFM33	0.00–140.20	HFM03:2	0.00–18.00	1695.2	4.06E−03	0.31	135240	21.25	H	575	L
HFM33	0.00–140.20	HFM13:1	159.00–175.60	2001.9	4.06E−03	0.22	186240	21.52	H	406	L
HFM33	0.00–140.20	HFM13:2	101.00–158.00	2009.6	4.06E−03	0.21	393840	10.25	H	385	L
HFM33	0.00–140.20	HFM15:1	85.00–99.50	1741.3	4.06E−03	0.19	207240	14.63	H	347	L
HFM33	0.00–140.20	HFM20:1	131.00–301.00	1648.8	4.06E−03	0.26	140640	19.33	H	466	L
HFM33	0.00–140.20	HFM20:2	101.00–130.00	1637.5	4.06E−03	0.26	138240	19.40	H	471	L
HFM33	0.00–140.20	HFM20:3	49.00–100.00	1636.7	4.06E−03	0.21	173040	15.48	H	374	L
HFM33	0.00–140.20	HFM21:1	107.00–202.00	1382.1	4.06E−03	0.43	76740	24.89	H	773	L
HFM33	0.00–140.20	HFM21:2	33.00–106.00	1402.2	4.06E−03	0.32	124440	15.80	H	569	L
HFM33	0.00–140.20	HFM22:1	0.00–222.00	1076.1	4.06E−03	0.26	107409	10.78	H	447	L
HFM33	0.00–140.20	HFM27:1	59.00–127.50	1689.0	4.06E−03	0.32	165840	17.20	H	580	L
HFM33	0.00–140.20	HFM27:2	46.00–58.00	1696.0	4.06E−03	0.33	117240	24.53	H	60	L
HFM33	0.00–140.20	HFM27:3	25.00–45.00	1699.6	4.06E−03	0.32	119640	24.14	H	596	L
HFM33	0.00–140.20	HFM27:4	0.00–24.00	1704.8	4.06E−03	0.29	132840	21.88	H	541	L
HFM33	0.00–140.20	HFM38:2	24.00–41.00	925.7	4.06E−03	0.68	18840	45.48	H	1138	L
HFM33	0.00–140.20	HFM45:1	190.00–200.30	393.1	4.06E−03	0.57	23936	6.45	M	833	L
HFM33	0.00–140.20	HFM45:2	140.00–190.00	383.9	4.06E−03	0.62	23733	6.21	M	906	L
HFM33	0.00–140.20	HFM45:3	0.00–140.00	366.1	4.06E−03	0.73	21096	6.35	M	1061	L
HFM33	0.00–140.20	KFM01A:4	131.00–204.00	1686.0	4.06E−03	0.39	100440	28.30	H	722	L
HFM33	0.00–140.20	KFM01A:5	109.00–130.00	1684.0	4.06E−03	0.40	188640	15.03	H	723	L
HFM33	0.00–140.20	KFM01B:1	142.00–500.52	1741.3	4.06E−03	0.43	62640	48.40	H	783	L
HFM33	0.00–140.20	KFM01B:2	101.00–141.00	1695.4	4.06E−03	0.36	192840	14.91	H	666	L
HFM33	0.00–140.20	KFM01B:3	0.00–100.00	1686.7	4.06E−03	0.36	113640	25.04	H	651	L
HFM33	0.00–140.20	KFM01D:6	154.00–252.00	1558.4	4.06E−03	0.23	183240	13.25	H	418	L
HFM33	0.00–140.20	KFM01D:7	0.00–153.00	1627.5	4.06E−03	0.47	68700	38.56	H	865	L
HFM33	0.00–140.20	KFM05A:5	115.00–253.00	1708.0	4.06E−03	0.18	320040	9.11	M	324	L
HFM33	0.00–140.20	KFM05A:6	0.00–114.00	1728.2	4.06E−03	0.18	277440	10.77	H	329	L
HFM33	0.00–140.20	KFM06A:2	749.00–826.00	1185.7	4.06E−03	0.23	528240	2.66	M	401	L
HFM33	0.00–140.20	KFM06A:3	738.00–748.00	1185.1	4.06E−03	0.25	427440	3.29	M	438	L

Table 4-8. Continued.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	dt_L [s = 0.1 m] (s)	Index 1: r_s^2/dt_L [s = 0.1 m] (m^2/s)	Index 1 classification	Index 2_new: $s_p/Q_p*ln(r_s/r_0)$ (s/m^2)	Index 2_new classification[1]
HFM33	0.00–140.20	KFM06A:4	363.00–737.00	1 186.0	4.06E−03	0.61	182 640	7.70	M	1 058	L
HFM33	0.00–140.20	KFM06A:5	341.00–362.00	1 218.0	4.06E−03	0.62	168 240	8.82	M	1 081	L
HFM33	0.00–140.20	KFM06A:6	247.00–340.00	1 228.8	4.06E−03	0.33	168 240	8.98	M	582	L
HFM33	0.00–140.20	KFM06A:7	151.00–246.00	1 250.5	4.06E−03	0.41	139 440	11.21	H	714	L
HFM33	0.00–140.20	KFM06A:8	0.00–150.00	1 284.7	4.06E−03	0.50	110 640	14.92	H	882	L
HFM33	0.00–140.20	KFM06C:10	0.00–186.00	1 262.1	4.06E−03	0.47	132 240	12.74	H	824	L
HFM33	0.00–140.20	KFM06C:2	667.00–872.00	1 252.1	4.06E−03	0.20	600 000	2.61	M	352	L
HFM33	0.00–140.20	KFM06C:3	647.00–666.00	1 213.0	4.06E−03	0.55	283 440	5.19	M	970	L
HFM33	0.00–140.20	KFM06C:5	531.00–540.00	1 188.8	4.06E−03	1.30	60 240	23.46	H	2 269	L
HFM33	0.00–140.20	KFM06C:6	402.00–530.00	1 185.6	4.06E−03	1.02	103 440	13.59	H	1 782	L
HFM33	0.00–140.20	KFM06C:7	351.00–401.00	1 188.7	4.06E−03	1.10	38 640	36.57	H	1 923	L
HFM33	0.00–140.20	KFM06C:8	281.00–350.00	1 197.1	4.06E−03	0.74	125 040	11.46	H	1 296	L
HFM33	0.00–140.20	KFM06C:9	187.00–280.00	1 215.5	4.06E−03	0.47	132 240	11.17	H	820	L
HFM33	0.00–140.20	KFM07B:1	203.00–298.93	1 455.8	4.06E−03	0.39	95 640	22.16	H	692	L
HFM33	0.00–140.20	KFM07B:2	75.00–202.00	1 452.3	4.06E−03	0.32	155 040	13.60	H	579	L
HFM33	0.00–140.20	KFM07C:2	161.00–301.00	1 473.7	4.06E−03	0.38	135 240	16.06	H	689	L
HFM33	0.00–140.20	KFM07C:3	111.00–160.00	1 463.6	4.06E−03	0.43	77 040	27.81	H	769	L
HFM33	0.00–140.20	KFM07C:4	0.00–110.00	1 460.3	4.06E−03	0.31	133 440	15.98	H	562	L
HFM33	0.00–140.20	KFM08B:3	0.00–70.00	1 160.5	4.06E−03	0.29	74 640	18.04	H	499	L
HFM33	0.00–140.20	KFM08C:5	0.00–145.00	1 097.8	4.06E−03	0.31	86 940	13.86	H	533	L
HFM33	0.00–140.20	KFM08D:5	331.00–659.00	974.6	4.06E−03	0.42	133 440	7.12	M	716	L
HFM33	0.00–140.20	KFM08D:6	161.00–330.00	1 025.4	4.06E−03	0.20	960 790	1.09	M	340	L
HFM33	0.00–140.20	KFM08D:7	0.00–160.00	1 086.4	4.06E−03	0.28	104 640	11.28	H	484	L
HFM33	0.00–140.20	KFM09B:2	201.00–450.00	1 780.4	4.06E−03	0.22	372 240	8.52	M	403	L
HFM33	0.00–140.20	KFM09B:3	0.00–200.00	1 783.2	4.06E−03	0.17	223 440	14.23	H	309	L
HFM33	0.00–140.20	KFM10A:1	441.00–500.16	2 115.8	4.06E−03	0.18	228 840	19.56	H	335	L
HFM33	0.00–140.20	KFM10A:2	430.00–440.00	2 141.1	4.06E−03	0.17	228 240	20.08	H	329	L
HFM33	0.00–140.20	KFM10A:3	353.00–429.00	2 171.6	4.06E−03	0.17	493 740	9.55	M	324	L
HFM33	0.00–140.20	KFM10A:4	153.00–352.00	2 265.3	4.06E−03	0.15	659 640	7.78	M	289	L
HFM33	0.00–140.20	KFM14:1	0.00–60.18	1 171.9	4.06E−03	0.27	109 292	12.57	H	471	L
HFM33	0.00–140.20	KFM16:1	0.00–60.35	1 163.1	4.06E−03	0.20	105 116	12.87	H	348	L
HFM33	0.00–140.20	KFM22:1	0.00–60.26	1 097.2	4.06E−03	0.20	45 641	26.38	H	345	L
HFM33	0.00–140.20	KFM23:1	0.00–100.64	1 122.1	4.06E−03	0.10	162 156	7.76	M	173	L

1) The indices [Index 1] and [Index-2 new] are described in Section 3.

Table 4-9. Other responses during the interference tests in HFM33. This include responses smaller than 0.1 m (s_p < 0.1 m), responses with abnormal appearances, uncertain/unclear responses and sections with initial deviating reversed bump.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	Class	Comments
HFM33	0.00–140.20	KFM01A:6	0.00–108.00	1684.2	4.06E−03	0.04	BL	
HFM33	0.00–140.20	KFM11A:7	0.00–130.00	224.5	4.06E−03	0.07	BL	
HFM33	0.00–140.20	HFM15:2	0.00–84.00	1753.7	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	HFM20:4	0.00–48.00	1638.4	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	HFM21:3	22.00–32.00	1417.8	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	HFM21:4	0.00–21.00	1425.0	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	HFM32:1	98.00–202.65	2024.2	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	HFM32:2	32.00–97.00	2007.5	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	HFM38:1	42.00–200.75	874.4	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	HFM38:3	0.00–23.00	938.0	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	HFM40:1	0.00–101.70	1433.7	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	KFM08B:1	113.00–200.54	1219.1	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	KFM08D:1	836.00–942.30	1011.4	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	KFM08D:2	825.00–835.00	997.5	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	KFM08D:3	681.00–824.00	983.2	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	KFM08D:4	660.00–680.00	974.3	4.06E−03	-	LC	Uncertain/unclear response. Could be due other causes
HFM33	0.00–140.20	KFM11A:6	131.00–360.00	347.4	4.06E−03	-	LC	Abnormal appearance. Higher pressure during pumping.
HFM33	0.00–140.20	KFM01D:2	429.00–438.00	1441.6	4.06E−03	-	AR	Abnormal appearance. Higher pressure during pumping.
HFM33	0.00–140.20	KFM01D:3	322.00–428.00	1469.8	4.06E−03	-	AR	Abnormal appearance. Higher pressure during pumping.
HFM33	0.00–140.20	KFM01D:4	311.00–321.00	1500.0	4.06E−03	-	AR	Abnormal appearance. Higher pressure during pumping.
HFM33	0.00–140.20	KFM01D:5	253.00–310.00	1517.6	4.06E−03	-	AR	Abnormal appearance. Higher pressure during pumping.
HFM33	0.00–140.20	HFM15:2	0.00–84.00	1753.7	4.06E−03	0.00	-	Bump at start, could have other cause

Table 4-10. Observation section not possible to evaluate during the interference tests in HFM33.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	Comments
HFM33	0.00–140.20	HFM09:1	0.00–50.25	2360.4	4.06E−03	Data not available at time for evaluation
HFM33	0.00–140.20	HFM14:	0.00–150.50	1744.2	4.06E−03	Data not available at time for evaluation
HFM33	0.00–140.20	HFM19:1	168.00–185.20	1872.7	4.06E−03	Missing data
HFM33	0.00–140.20	HFM19:2	104.00–167.00	1864.5	4.06E−03	Missing data
HFM33	0.00–140.20	HFM19:3	0.00–103.00	1852.8	4.06E−03	Missing data
HFM33	0.00–140.20	HFM34:1	91.00–200.75	499.7	4.06E−03	No measurements in this section
HFM33	0.00–140.20	HFM42:1	0.00–195.30	1423.5	4.06E−03	Missing data
HFM33	0.00–140.20	HFR105:3	61.00–106.00	647.7	4.06E−03	Missing data
HFM33	0.00–140.20	KFM01A:1	431.00–1001.49	1796.1	4.06E−03	Pressure disturbed – evaluation not possible/certain
HFM33	0.00–140.20	KFM02B:7	0.00–130.00	2494.5	4.06E−03	Pressure disturbed – evaluation not possible/certain
HFM33	0.00–140.20	KFM06C:4	541.00–646.00	1198.7	4.06E−03	Missing data
HFM33	0.00–140.20	KFM09A:1	551.00–799.67	2210.2	4.06E−03	Pressure disturbed – evaluation not possible/certain
HFM33	0.00–140.20	KFM11A:3	457.00–689.00	649.2	4.06E−03	Pressure disturbed – evaluation not possible/certain
HFM33	0.00–140.20	KFM24:1	0.00–550.17	1191.2	4.06E−03	Missing data
HFM33	0.00–140.20	SFM000146:1	0.00–3.10	1244.0	4.06E−03	Data not available at time for evaluation
HFM33	0.00–140.20	SFM000153:1	0.00–3.20	1469.7	4.06E−03	Missing data
HFM33	0.00–140.20	SFM0104:1	0.00–7.20	1694.5	4.06E−03	Data not available at time for evaluation
HFM33	0.00–140.20	SFM0107:1	0.00–7.05	1646.4	4.06E−03	Data not available at time for evaluation

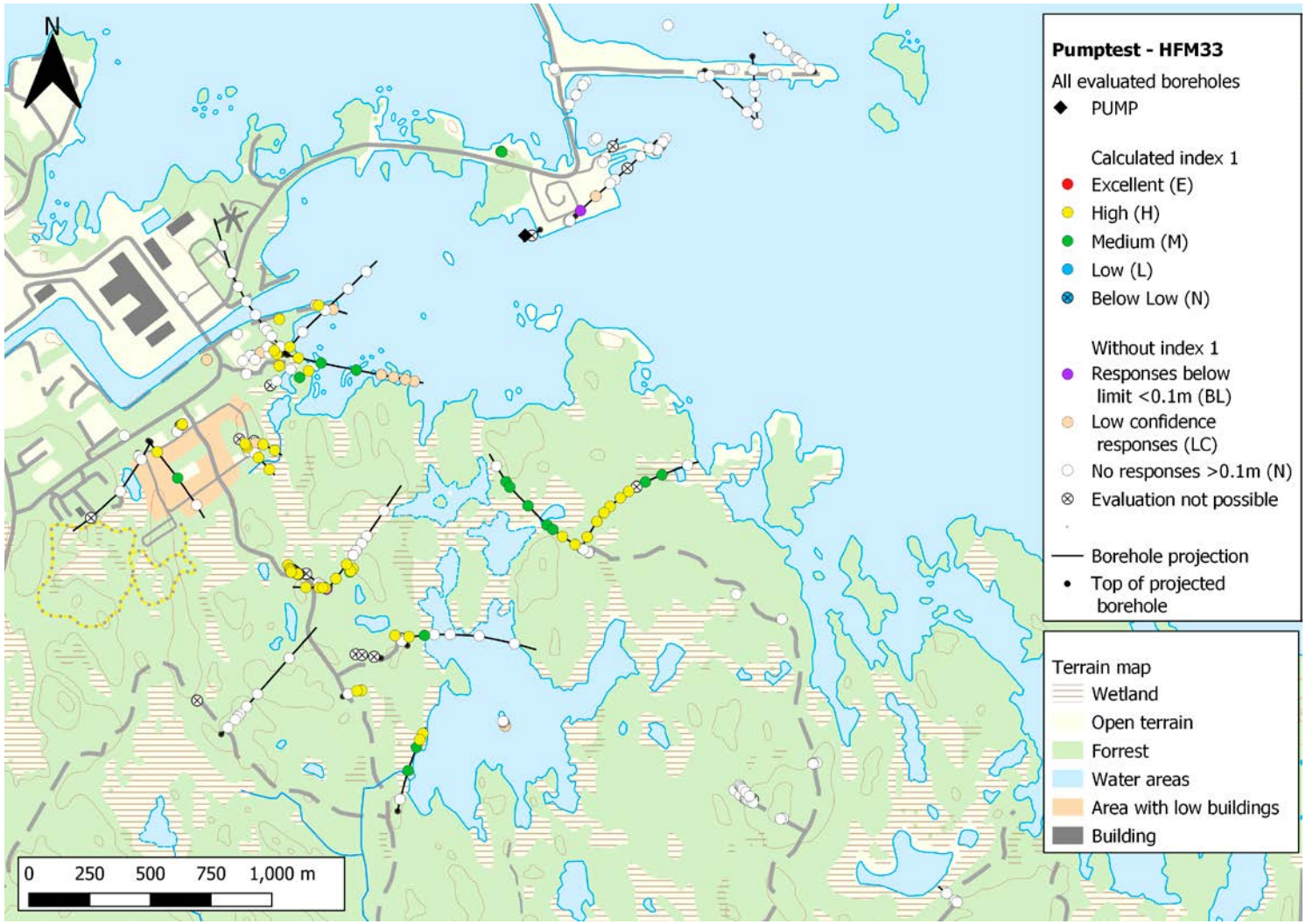


Figure 4-7. *Calculated index 1 from the interference tests in HFM33. All responses are listed in Table 4-8 to Table 4-10. For more detailed figures, divided after borehole type and section depths see Appendix 5, Figure A5-23 to Figure A5-33.*

4.4 Interference test in HFM44: 0–200 m

Pumping in HFM44 resulted in 6 responses > 0.1 m, at 3D radial distances of up to ca 400 m (Table 4-11, Figure 4-8). Four of these responses were of "low" strength, the remaining two responses exhibited a deep drawdown of several meters, classifying as "medium" response strength. Response time ranged from "medium" to "high", but three responses were not possible to classify. The temporary pumping stops in HFM44 led to notable responses in five to six sections (Table 4-13). Two of these did not show any other clear response to the pumping in total (Table 4-12). Observation sections that could not be evaluated are listed in Table 4-14.

In total 54 sections were evaluated (25 cored borehole sections, 29 percussion drilled borehole sections and 0 soil pipe sections). 6 responses > 0.1 m were found (0 Extreme (E), 2 High (H), 1 Medium (M), 0 Low (L), 0 classified as Below low (N, Index 1 < 0.1) and 3 responses where t0.1 could not be determined and Index 1 therefore not calculated. 0 clear responses < 0.1 m were found. Additional 0 low confidence response was found. See Figure 4-9.

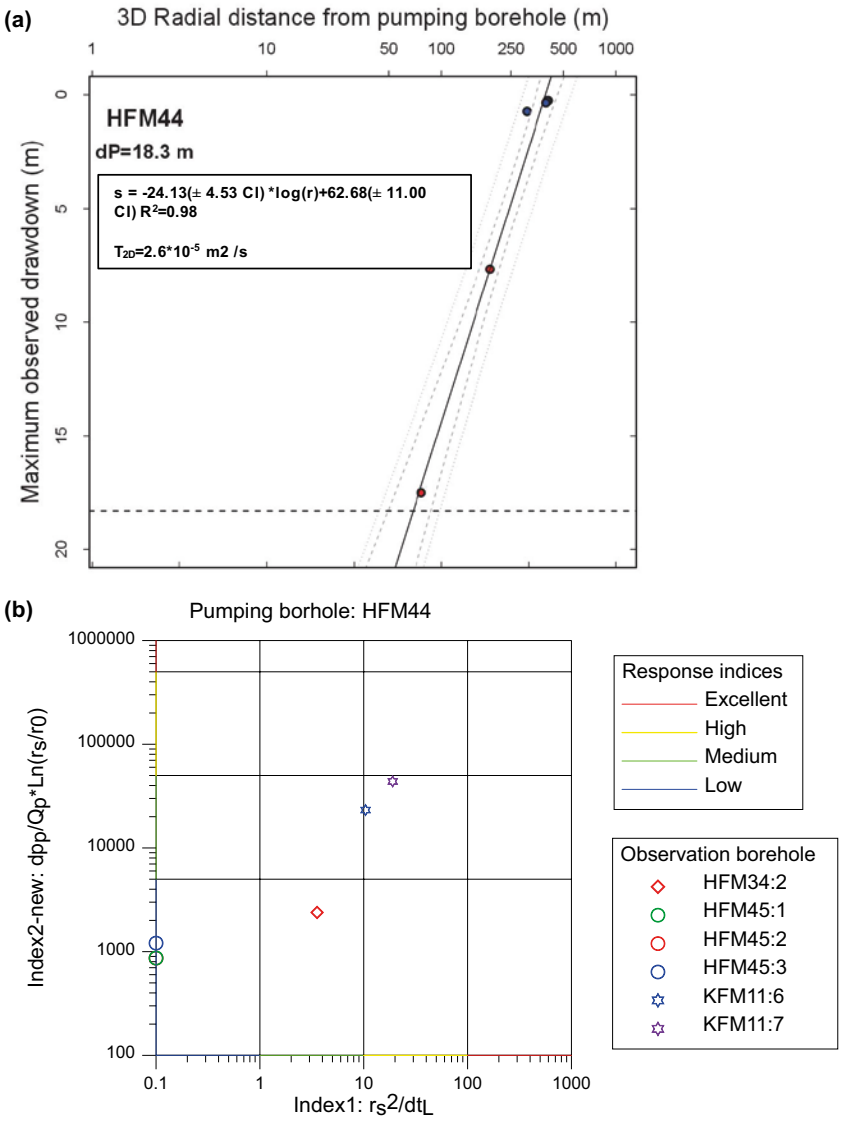


Figure 4-8. *(a) Scatterplot between the maximum observed drawdown in borehole sections (area Forsmark) that showed response when pumping in HFM44, and the logarithm of the 3D radial distance from the pumping borehole, with blue = percussion boreholes, red = core boreholes and orange = soil tubes. The dashed horizontal line marks the observed drawdown in the pumping hole. A linear regression was significant (s = −24.13 (± 4.53 CI) · log(r) + 62.68 (± 11.00 CI) ; n = 6, P = 0.0002, R2 = 0.98), but is based on only six datapoints. The regression line is shown together with 95 % confidence intervals (dashed grey lines) and 95 % prediction intervals (dotted grey lines); The drawdown in HFM44 was 18.3 m at a flow rate of 104 L/min. A steady-state, radial flow approximation using the slope of the least-squares fit for an estimate of Δs renders a large-scale effective transmissivity of 2.6 × 10^{-5} m^2/s. (b) Response diagram showing the responding observation sections when pumping in HFM44. "Index 1" is used as indicator of the response time, and "index 2-new" is used as indicator of response strength.*

Table 4-11. Results from response analysis of the responses in the observation section during the interference tests in HFM44.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	dt_L [s = 0.1 m] (s)	Index 1: r_s^2/dt_L [s = 0.1 m] (m^2/s)	Index 1 classification	Index 2_new: $s_p/Q_p*ln(r_s/r_0)$ (s/m^2)	Index 2_new classification[1]
HFM44	0.00–199.60	HFM34:2	22.00–90.00	309.0	1.74E−03	0.72	26 880	3.55	M	2 389	L
HFM44	0.00–199.60	HFM45:1	190.00–200.30	410.9	1.74E−03	0.25	0[2]	−1.00	N	867	L
HFM44	0.00–199.60	HFM45:2	140.00–190.00	405.6	1.74E−03	0.25	0[2]	−1.00	N	865	L
HFM44	0.00–199.60	HFM45:3	0.00–140.00	398.0	1.74E−03	0.35	0[2]	−1.00	N	1 208	L
HFM44	0.00–199.60	KFM11A:6	131.00–360.00	190.4	1.74E−03	7.67	3 480	10.41	H	23 200	M
HFM44	0.00–199.60	KFM11A:7	0.00–130.00	76.7	1.74E−03	17.50	310	18.99	H	43 778	M

1) The indices [Index 1] and [Index-2 new] are described in Section 3.
2) DtL not classified due to big covariance with sea level and air pressure during the start of the pumping period.

Table 4-12. Other responses during the interference tests in HFM44. This include responses smaller than 0.1 m (s_p < 0.1 m), responses with abnormal appearances, uncertain/unclear responses and sections with initial deviating reversed bump.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	Class	Comments
HFM44	0.00–199.60	KFM11A:1	711.00–851.21	717.5	1.74E−03	-	AR	Only very small responses by the temporary stops during pumping
HFM44	0.00–199.60	KFM11A:2	690.00–710.00	636.4	1.74E−03	-	AR	Abnormal appearance. React on the temporary stops during pumping
HFM44	0.00–199.60	HFM34:2	22.00–90.00	309.0	1.74E−03	0.72	-	Bump at start
HFM44	0.00–199.60	KFM11A:2	690.00–710.00	636.4	1.74E−03	0.00		Bump at start, not reversed

Table 4-13. Sections responding to the temporary pumping stops in HFM44.

Pumping borehole	Section (mbl)	Observation borehole ID: section	Section (mbl)	Distance (m)	Qp (m^3/s)	Response on extra temporary stops
HFM44	0.00–199.60	HFM34:2	22.00–90.00	309.0	1.74E−03	Yes
HFM44	0.00–199.60	KFM11A:1	711.00–851.21	717.5	1.74E−03	Yes, but no general response
HFM44	0.00–199.60	KFM11A:2	690.00–710.00	636.4	1.74E−03	Yes, but no general response
HFM44	0.00–199.60	KFM11A:6	131.00–360.00	190.4	1.74E−03	Yes
HFM44	0.00–199.60	KFM11A:7	0.00–130.00	76.7	1.74E−03	Yes
HFM44	0.00–199.60	KFR01:2	11.15–43.65	360.0	1.74E−03	Unclear

Table 4-14. Observation section not possible to evaluate during the interference tests in HFM44.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	Comments
HFM44	0.00–199.60	HFM34:1	91.00–200.75	357.5	1.74E−03	No measurements in this section
HFM44	0.00–199.60	HFR105:3	61.00–106.00	490.8	1.74E−03	Missing data

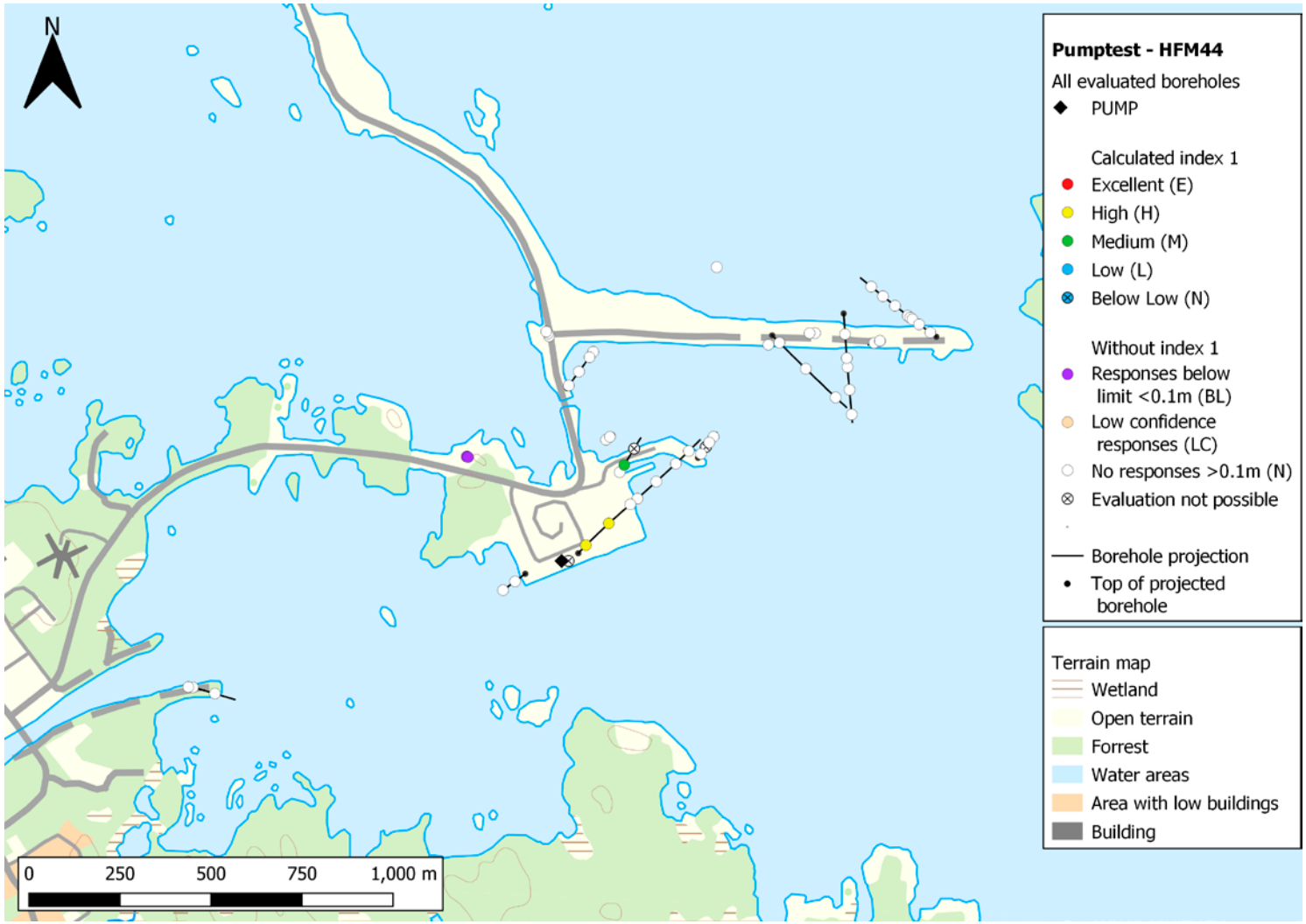


Figure 4-9. *Calculated index 1 from the interference tests in HFM44. All responses are listed in Table 4-11 to Table 4-14. For more detailed figures, divided after borehole type and section depths see Appendix 5, Figure A5-44 to Figure A5-54.*

4.5 Interference test in HFM46: 0–200 m

16 responses > 0.1 m were observed when pumping in HFM46 (Table 4-15; Figure 4-8). The responses were distributed across 3D radial distances of up to ca 800 m from the pumping borehole (Figure 4-8). 13 of these responses classified as "low" to "medium" response strength and time (Figure 4-8b). Three large drawdowns exceeding 15 m were observed in the Forsmark area, at a 3D radial distance of ca 180 m from the pumping borehole, classifying as "high" for both response strength and time. Only a few responses that did not exceed the 0.1 m criterion were detected for HFM46 (Table 4-16). Observation sections that could not be evaluated are listed in Table 4-17.

In total 54 sections were evaluated (29 cored borehole sections, 25 percussion drilled borehole sections and 0 soil pipe sections). 16 responses > 0.1 m were found (0 Extreme (E), 3 High (H), 8 Medium (M), 5 Low (L) and 0 classified as Below low (N, Index 1 < 0.1). 1 clear response < 0.1 m were found. Additional 2 low confidence response were found. See Figure 4-11.

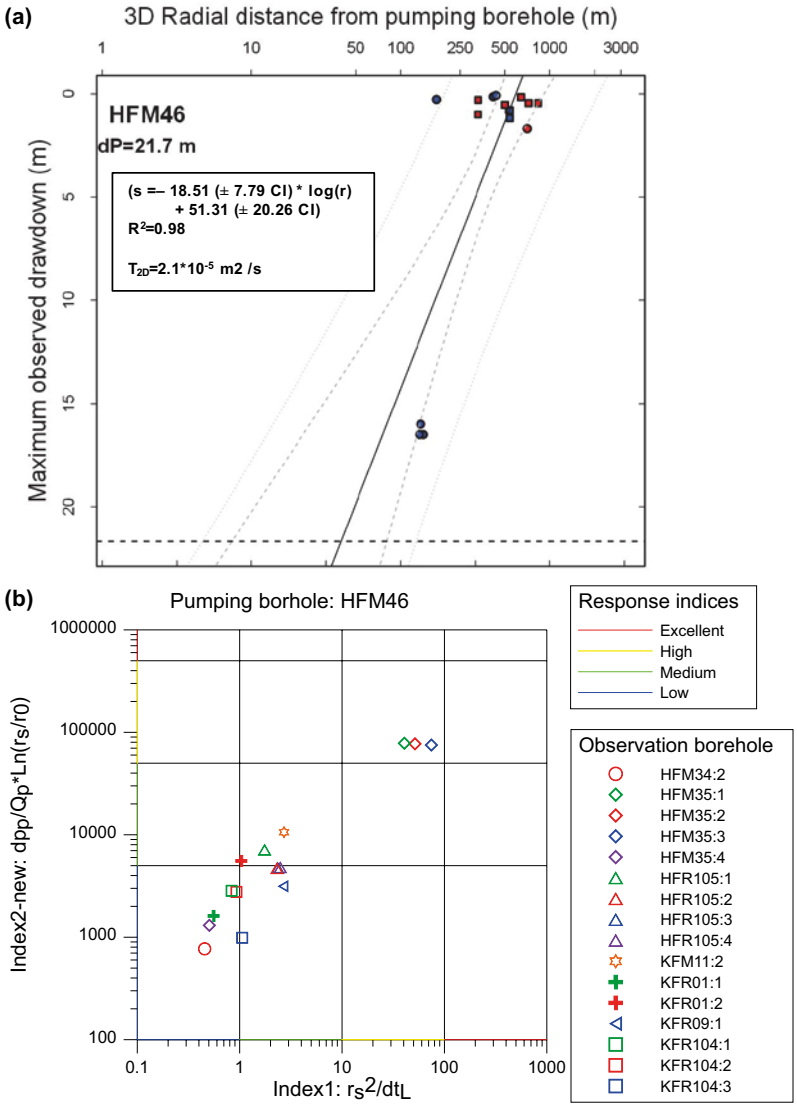


Figure 4-10. *(a) Scatterplot between the maximum observed drawdown in borehole sections (circles: Forsmark area, squares: SFR area) that showed response when pumping in HFM46, and the logarithm of the 3D radial distance from the pumping borehole, with blue = percussion boreholes and red = core boreholes. The dashed horizontal line marks the observed drawdown in the pumping hole. A linear regression was significant (s = −18.51 (± 7.79 CI) · log(r) + 51.31 (± 20.26 CI); n = 17, P = 0.0002, R2 = 0.98), and the regression line is shown together with 95 % confidence intervals (dashed grey lines) and 95 % prediction intervals (dotted grey lines). The drawdown in HFM46 was 21.7 m at a flow rate of 63 L/min. A steady-state, radial flow approximation using the slope of the least-squares fit for an estimate of Δs renders a large-scale effective transmissivity of 2.1×10^{-5} m^2/s. (b) Response diagram showing the responding observation sections when pumping in HFM46. "Index 1" is used as indicator of the response time, and "index 2-new" is used as indicator of response strength.*

Table 4-15. Results from response analysis of the responses in the observation section during the interference tests in HFM46.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	dt_L [s = 0.1 m] (s)	Index 1: r_s^2/dt_L [s = 0.1 m] (m^2/s)	Index 1 classification	Index 2_new: $s_p/Q_p*ln(r_s/r_0)$ (s/m^2)	Index 2_new classification[1]
HFM46	0.00–200.00	HFM34:2	22.00–90.00	419.0	1.05E−03	0.13	386040	0.45	L	770	L
HFM46	0.00–200.00	HFM35:1	182.00–200.75	142.5	1.05E−03	16.50	500	40.59	H	78176	H
HFM46	0.00–200.00	HFM35:2	151.00–181.00	134.4	1.05E−03	16.50	350	51.61	H	77258	H
HFM46	0.00–200.00	HFM35:3	34.00–150.00	136.6	1.05E−03	16.00	250	74.64	H	75165	H
HFM46	0.00–200.00	HFM35:4	0.00–33.00	174.6	1.05E−03	0.26	60240	0.51	L	1306	L
HFM46	0.00–200.00	HFR105:1	134.00–200.50	538.1	1.05E−03	1.19	165240	1.75	M	7133	M
HFM46	0.00–200.00	HFR105:2	107.00–133.00	534.3	1.05E−03	0.78	123240	2.32	M	4707	L
HFM46	0.00–200.00	HFR105:3	61.00–106.00	534.5	1.05E−03	0.79	121440	2.35	M	4753	L
HFM46	0.00–200.00	HFR105:4	0.00–60.00	539.2	1.05E−03	0.80	116640	2.49	M	4804	L
HFM46	0.00–200.00	KFM11A:2	690.00–710.00	704.7	1.05E−03	1.69	183240	2.71	M	10596	M
HFM46	0.00–200.00	KFR01:1	44.65–62.30	331.1	1.05E−03	0.29	197040	0.56	L	1614	L
HFM46	0.00–200.00	KFR01:2	11.15–43.65	330.5	1.05E−03	1.00	105240	1.04	M	5552	M
HFM46	0.00–200.00	KFR09:1	0.00–80.24	500.6	1.05E−03	0.53	94093	2.66	M	3143	L
HFM46	0.00–200.00	KFR104:1	333.00–454.57	836.6	1.05E−03	0.44	838440	0.83	L	2840	L
HFM46	0.00–200.00	KFR104:2	98.00–332.00	719.1	1.05E−03	0.44	555850	0.93	L	2770	L
HFM46	0.00–200.00	KFR104:3	0.00–97.00	640.5	1.05E−03	0.16	387840	1.06	M	987	L

1) The indices [Index 1] and [Index-2 new] are described in Section 3.

Table 4-16. Other responses during the interference tests in HFM46. This include responses smaller than 0.1 m (s_p < 0.1 m), responses with abnormal appearances, uncertain/unclear responses and sections with initial deviating reversed bump.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	s_p (m)	Class	Comments
HFM46	0.00–200.00	HFM34:3	0.00–21.00	437.0	1.05E−03	0.07	BL	
HFM46	0.00–200.00	HFM44:2	60.00–90.00	624.6	1.05E−03	-	LC	Uncertain/unclear response. Could be due other causes. Hard to quantify
HFM46	0.00–200.00	HFM44:3	0.00–60.00	627.3	1.05E−03	-	LC	Uncertain/unclear response. Could be due other causes. Hard to quantify
HFM46	0.00–200.00	HFR101:1	0.00–209.30	607.4	1.05E−03	-	AR	Abnormal appearance, uncertain response. Only reaction on pumping start

Table 4-17. Observation section not possible to evaluate during the interference tests in HFM46.

Pumping borehole	Section (mbl TOC)	Observation borehole ID: section	Section (mbl TOC)	Distance (m)	Qp (m^3/s)	Comments
HFM46	0.00–200.00	HFM34:1	91.00–200.75	394.4	1.05E−03	No measurements in this section

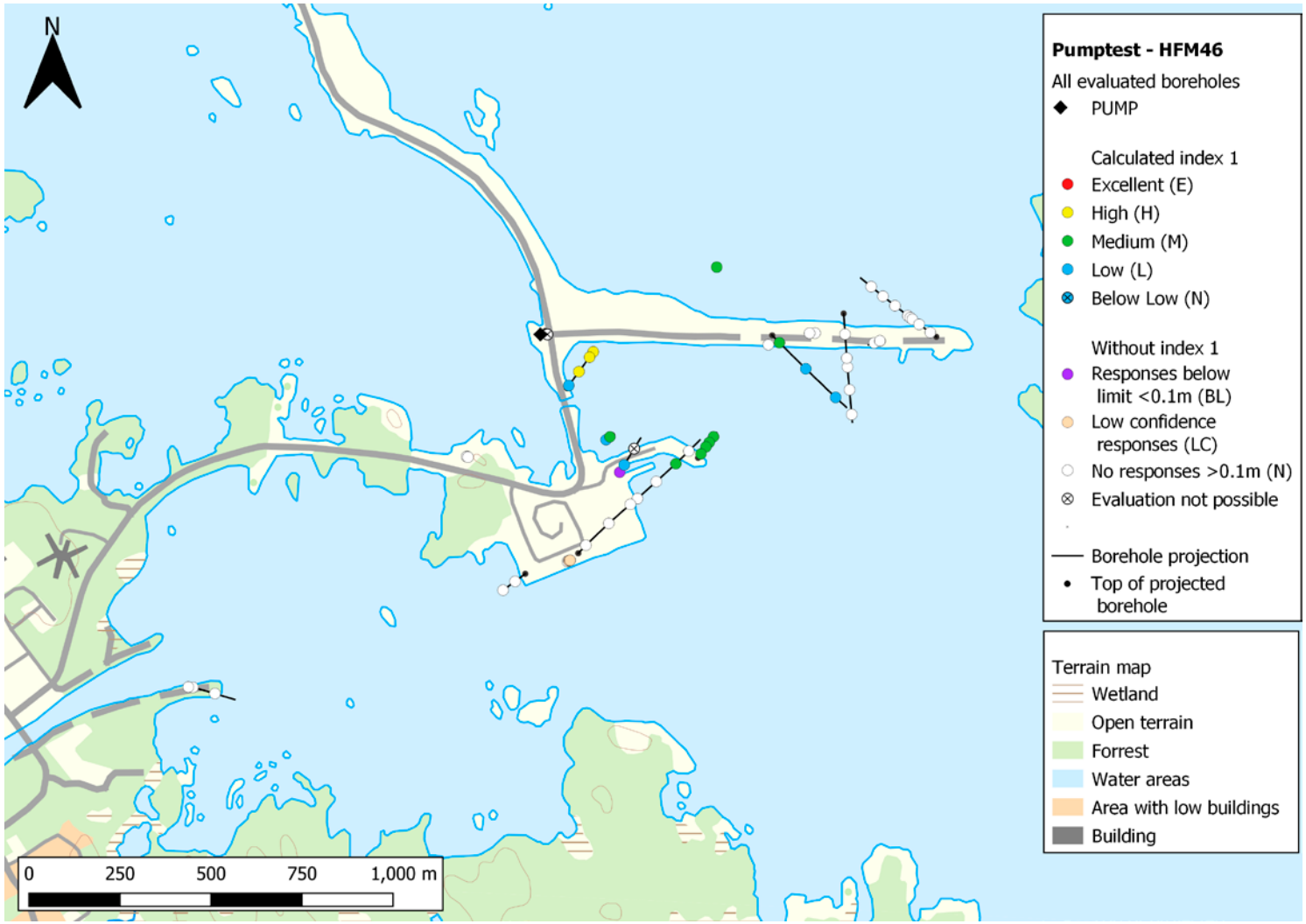


Figure 4-11. *Calculated index 1 from the interference tests in HFM46. All responses are listed in Table 4-15 to Table 4-17. For more detailed figures, divided after borehole type and section depths see Appendix 5, Figure A5-45 to Figure A5-55.*

5 Summary of results

This report presents five interference tests that were conducted in the percussion boreholes HFM33 and HFM43–46 between June and December 2018. Pumped flow rates in the five tested intervals varied between around 60 to 270 L/min (Table 5-1), with a drawdown in each pumping borehole of about 10–20 m (Table 5-2). The calculated transmissivities for the tested pumping boreholes range from ca 6×10^{-5} to 6×10^{-4} m^2/s.

Table 5-1. Data summary from the pumped borehole sections during the interference tests.

Pumping borehole ID	Section (mbl TOC)	Test Type[1)]	Pumped time (s)	Pumped time (days)	s_p (m)	Q_p (m^3/s)	Q_p (L/min)	T_M (m^2/s)	T_{2D} (m^2/s)
HFM43	0–200	1B, 2	1 807 035	20.9	9.6	4.51E−03	270.7	6.2E−04	8.3E−04
HFM45	0–200	1B, 2	1 279 497	14.8	19.1	1.24E−03	74.2	8.5E−05	-
HFM33	0–140	1B, 2	1 203 605	13.9	16.8	4.06E−03	243.4	3.0E−04	4.5E−03
HFM44	0–200	1B, 2	1 217 280	14.1	18.3	1.73E−03	104.1	1.2E−04	2.6E−05
HFM46	0–200	1B, 2	1 299 120	15.0	21.7	1.00E−03	62.8	6.4E−05	2.1E−05

1) 1B: Pumping test-submersible pump, 2: Interference test.

Across all five tests, the number of responses observed (> 0.1 m) in the investigated borehole sections ranged from 5 responses when pumping in HFM45 to 122 responses when pumping in HFM43 (Table 5-2). The mean maximum observed drawdown was largest during pumping in HFM44, and smallest when pumping in HFM45. The largest maximal drawdown was observed when pumping in HFM44. The largest mean radial distance to responding borehole sections occured when pumping in HFM33 (ca 1.4 km), and smallest when pumping in HFM44 (ca 300 m; Table 5-2).

Table 5-2. Summary of responses observed during the five interference tests conducted between June and December 2018.

Pumping borehole	HFM43	HFM45	HFM33	HFM44	HFM46
Number of observed responses > 0.1 m	122	5	69	6	16
Number of observed responses < 0.1 m	16	0	2	0	1
Mean drawdown in responding boreholes (m; ± SE)	1.19 ± 0.11	0.31 ± 0.03	0.35 ± 0.02	4.46 ± 2.87	3.39 ± 1.50
Range of drawdown in responding boreholes (m)	0.05−5.05	0.24−0.37	0.04−1.10	0.25−17.50	0.07−16.50
Mean radial distance between pumping borehole and responding borehole sections (m; ± SE)	1 087.4 ± 73.4	473.5 ± 30.0	1 426.9 ± 48.2	298.4 ± 56.3	450.2 ± 52.6
Range of radial distance between pumping borehole and responding borehole sections (m)	122.6−3 557.5	405.3−561.0	224.5−2 265.3	76.7−410.9	134.4−836.6
Number of evaluated sections	183	54	234	54	54

The index classification of propagation rate in responses (i.e. Index 1) ranged from “low” to “extreme” (Table 5-3). The classification of response strength, as evaluated in terms of *Index 2 new*, ranged mainly from “low” to “medium”, with only a few classified as “high” (Table 5-3). Many responses were classified with a notable higher value of respond Index 1 than for response Index 2. This implies that the responses were mainly characterized as fast but not distinct relative to the distance to the pumping well.

Nomenclature used:

s_p = hydraulic head change at the end of pumping

Q_p = flow rate at stop of pumping

T_M = steady state transmissivity from Moye´s equation

T_{2D} = large-scale effective transmissivity

Table 5-3. Response classification for analysed observation sections. For colour coding see Section 3.3.3, Table 3-1 and Section 4, Table 4-1.

	Pumping Hole	HFM43		HFM45		HFM33		HFM44		HFM46	
	Section (m.b.TOC)	0–200		0–200		0–140		0–200		0–200	
	Flow rate (L/min)	270.7		74.2		243.4		104.1		62.8	
	Drawdown (m)	9.59		19.07		16.81		18.30		21.68	
	Response indices	1	2new [1)]	1	2new [1)]	1	2new [1)]	1	2new [1)]	1	2new [1)]
Observation borehole section	Interval (m)										
HFM33:1	120.00–140.20	-	-	LC	LC	-	-	N	N	N	N
HFM33:2	0.00–120.00	-	-	LC	LC	-	-	N	N	N	N
HFM44:1	90.00–199.60	-	-	LC	LC	N	N	-	-	N	N
HFM44:2	60.00–90.00	-	-	LC	LC	N	N	-	-	LC	LC
HFM44:3	0.00–60.00	-	-	LC	LC	N	N	-	-	LC	LC
HFM45:1	190.00–200.30	-	-	-	-	M	L	-[5)]	L	N	N
HFM45:2	140.00–190.00	-	-	-	-	M	L	-[5)]	L	N	N
HFM45:3	0.00–140.00	-	-	-	-	M	L	-[5)]	L	N	N
HFM46:1	150.00–200.00	-	-	LC	LC	N	N	N	N	-	-
HFM46:2	100.00–150.00	-	-	LC	LC	N	N	N	N	-	-
HFM46:3	0.00–100.00	-	-	LC	LC	N	N	N	N	-	-
Evaluated for HFM33, HFM44–46											
HFM34:1	91.00–200.75	-	-	-	-	-	-	-	-	-	-
HFM34:2	22.00–90.00	-	-	M	L	N	N	M[3)]	L[3)]	L	L
HFM34:3	0.00-21.00	-	-	N	N	N	N	N	N	BL	BL
HFM35:1	182.00–200.75	-	-	LC	LC	N	N	N	N	H	H
HFM35:2	151.00–181.00	-	-	LC	LC	N	N	N	N	H	H
HFM35:3	34.00–150.00	-	-	LC	LC	N	N	N	N	H	H
HFM35:4	0.00–33.00	-	-	LC	LC	N	N	N	N	L	L
HFM38:1	42.00–200.75	[2)]	[2)]	LC	LC	LC	LC	N	N	N	N
HFM38:2	24.00–41.00	[2)]	[2)]	LC	LC	H	L	N	N	N	N
HFM38:3	0.00–23.00	[2)]	[2)]	LC	LC	LC	LC	N	N	N	N
HFR101:1	0.00–209.30	-	-	-	-	N	N	N	N	AR	AR
HFR102:1	28.00–55.04	-	-	LC	LC	N	N	N	N	N	N
HFR102:2	0.00–27.00	-	-	LC	LC	N	N	N	N	N	N
HFR105:1	134.00–200.50	-	-	LC	LC	N	N	N	N	M	M
HFR105:2	107.00–133.00	-	-	LC	LC	N	N	N	N	M	L
HFR105:3	61.00–106.00	-	-	LC	LC	-	-	-	-	M	L
HFR105:4	0.00–60.00	-	-	N	N	N	N	N	N	M	L
KFM11A:1	711.00–851.21	-	-	-	-	N	N	AR	AR	N	N
KFM11A:2	690.00–710.00	-	-	LC	LC	N	N	AR[3)]	AR[3)]	M	M
KFM11A:3	457.00–689.00	-	-	-	-	-	-	N	N	N	N
KFM11A:4	446.00–456.00	-	-	M[3)]	L[3)]	N	N	N	N	N	N
KFM11A:5	361.00–445.00	-	-	L[3)]	L[3)]	N	N	N	N	N	N
KFM11A:6	131.00–360.00	-	-	L[3)]	L[3)]	AR	AR	H	M	N	N
KFM11A:7	0.00–130.00	-	-	M[3)]	L[3)]	BL	BL	H	M	N	N
KFR01:1	44.65–62.30	-	-	LC	LC	N	N	N	N	L	L
KFR01:2	11.15–43.65	-	-	LC	LC	N	N	N	N	M	M
KFR09:1	0.00–80.24	-	-	LC	LC	N	N	N	N	M	L
KFR102A:1	444.00–600.83	-	-	N	N	N	N	N	N	N	N
KFR102A:2	423.00–443.00	-	-	N	N	N	N	N	N	N	N
KFR102A:3	255.00–422.00	-	-	-	-	N	N	N	N	N	N
KFR102A:4	220.00–254.00	-	-	N	N	N	N	N	N	N	N
KFR102A:5	214.00–219.00	-	-	N	N	N	N	N	N	N	N
KFR102A:6	185.00–213.00	-	-	N	N	N	N	N	N	N	N
KFR102A:7	103.00–184.00	-	-	N	N	N	N	N	N	N	N

Table 5-3. Continued.

	Pumping Hole	HFM43		HFM45		HFM33		HFM44		HFM46	
	Section (m.b.TOC)	0–200		0–200		0–140		0–200		0–200	
	Flow rate (L/min)	270.7		74.2		243.4		104.1		62.8	
	Drawdown (m)	9.59		19.07		16.81		18.30		21.68	
	Response indices	1	2new [1]	1	2new [1]	1	2new [1]	1	2new [1]	1	2new [1]
Observation borehole section	**Interval (m)**										
KFR102A:8	0.00–102.00	-	-	N	N	N	N	N	N	N	N
KFR104:1	333.00–454.57	-	-	N	N	N	N	N	N	L	L
KFR104:2	98.00–332.00	-	-	N	N	N	N	N	N	L	L
KFR104:3	0.00–97.00	-	-	LC	LC	N	N	N	N	M	L
KFR105:1	265.00–306.80	-	-	LC	LC	N	N	N	N	N	N
KFR105:2	170.00–264.00	-	-	LC	LC	N	N	N	N	N	N
KFR105:3	138.00–169.00	-	-	LC	LC	N	N	N	N	N	N
KFR105:4	120.00–137.00	-	-	LC	LC	N	N	N	N	N	N
KFR105:5	4.00–119.00	-	-	LC	LC	N	N	N	N	N	N
KFR27:1	110.00–501.64	-	-	N	N	N	N	N	N	N	N
KFR27:2	47.00–109.00	-	-	LC	LC	N	N	N	N	N	N
KFR27:3	0.00–46.00	-	-	LC	LC	N	N	N	N	N	N
Evaluated for HFM33, HFM43											
HFM01:1	46.50–200.20	H	L	-	-	H	L	-	-	-	-
HFM01:2	33.50–45.50	H	L	-	-	H	L	-	-	-	-
HFM01:3	0.00–32.50	H	L	-	-	M	L	-	-	-	-
HFM02:1	49.00–100.00	H	L	-	-	H	L	-	-	-	-
HFM02:2	38.00–48.00	H	L	-	-	H	L	-	-	-	-
HFM02:3	0.00–37.00	H	L	-	-	H	L	-	-	-	-
HFM03:1	19.00–26.00	H	L	-	-	H	L	-	-	-	-
HFM03:2	0.00–18.00	H	L	-	-	H	L	-	-	-	-
HFM13:1	159.00–175.60	H	L	-	-	H	L	-	-	-	-
HFM13:2	101.00–158.00	H[3]	L[3]	-	-	H	L	-	-	-	-
HFM13:3	0.00–100.00	M[3]	L[3]	-	-	N	N	-	-	-	-
HFM15:1	85.00–99.50	H	L	-	-	H	L	-	-	-	-
HFM15:2	0.00–84.00	H	L	-	-	LC[3]	LC[3]	-	-	-	-
HFM19:1	168.00–185.20	-	-	-	-	-	-	-	-	-	-
HFM19:2	104.00–167.00	-	-	-	-	-	-	-	-	-	-
HFM19:3	0.00–103.00	-	-	-	-	-	-	-	-	-	-
HFM20:1	131.00–301.00	E	M	-	-	H	L	-	-	-	-
HFM20:2	101.00–130.00	H[3]	M[3]	-	-	H	L	-	-	-	-
HFM20:3	49.00–100.00	H[3]	L[3]	-	-	H	L	-	-	-	-
HFM20:4	0.00–48.00	M	L	-	-	LC	LC	-	-	-	-
HFM21:1	107.00–202.00	H	L	-	-	H	L	-	-	-	-
HFM21:2	33.00–106.00	E	M	-	-	H	L	-	-	-	-
HFM21:3	22.00–32.00	E	L	-	-	LC	LC	-	-	-	-
HFM21:4	0.00–21.00	M	L	-	-	LC	LC	-	-	-	-
HFM22:1	0.00–222.00	H	L	-	-	H	L	-	-	-	-
HFM23:1	0.00–211.50	M[3]	L[3]	-	-	N	N	-	-	-	-
HFM27:1	59.00–127.50	H	L	-	-	H	L	-	-	-	-
HFM27:2	46.00–58.00	H	L	-	-	H	L	-	-	-	-
HFM27:3	25.00–45.00	H	L	-	-	H	L	-	-	-	-
HFM27:4	0.00–24.00	H	L	-	-	H	L	-	-	-	-
HFM28:1	0.00–151.20	M[3]	L[3]	-	-	N	N	-	-	-	-
HFM38:1	42.00–200.75	L[3]	L[3]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]
HFM38:2	24.00–41.00	M[3]	L[3]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]
HFM38:3	0.00–23.00	BL[3]	BL[3]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]

Table 5-3. Continued.

	Pumping Hole	HFM43		HFM45		HFM33		HFM44		HFM46	
	Section (m.b.TOC)	0–200		0–200		0–140		0–200		0–200	
	Flow rate (L/min)	270.7		74.2		243.4		104.1		62.8	
	Drawdown (m)	9.59		19.07		16.81		18.30		21.68	
	Response indices	1	2new [1)]	1	2new [1)]	1	2new [1)]	1	2new [1)]	1	2new [1)]
Observation borehole section	Interval (m)										
HFM39:1	0.00–151.20	L	L	-	-	N	N	-	-	-	-
HFM40:1	0.00–101.70	M	L	-	-	LC	LC	-	-	-	-
HFM41:1	0.00–101.50	L	L	-	-	N	N	-	-	-	-
HFM42:1	0.00–195.30	H	L	-	-	-	-	-	-	-	-
KFM01A:1	431.00–1 001.49	N	N	-	-	-	-	-	-	-	-
KFM01A:2	374.00–430.00	N	N	-	-	N	N	-	-	-	-
KFM01A:3	205.00–373.00	BL	BL	-	-	N	N	-	-	-	-
KFM01A:4	131.00–204.00	H	L	-	-	H	L	-	-	-	-
KFM01A:5	109.00–130.00	H	L	-	-	H	L	-	-	-	-
KFM01A:6	0.00–108.00	M	L	-	-	BL	BL	-	-	-	-
KFM01B:1	142.00–500.52	H	L	-	-	H	L	-	-	-	-
KFM01B:2	101.00–141.00	H	L	-	-	H	L	-	-	-	-
KFM01B:3	0.00–100.00	H	L	-	-	H	L	-	-	-	-
KFM01D:1	439.00–800.24	N	N	-	-	N	N	-	-	-	-
KFM01D:2	429.00–438.00	AR	AR	-	-	AR	AR	-	-	-	-
KFM01D:3	322.00–428.00	AR	AR	-	-	AR	AR	-	-	-	-
KFM01D:4	311.00–321.00	AR	AR	-	-	AR	AR	-	-	-	-
KFM01D:5	253.00–310.00	AR	AR	-	-	AR	AR	-	-	-	-
KFM01D:6	154.00–252.00	H	L	-	-	H	L	-	-	-	-
KFM01D:7	0.00–153.00	H	L	-	-	H	L	-	-	-	-
KFM04A:1	496.00–1 001.42	N	N	-	-	N	N	-	-	-	-
KFM04A:2	391.00–495.00	BL	BL	-	-	N	N	-	-	-	-
KFM04A:3	246.00–390.00	M	L	-	-	N	N	-	-	-	-
KFM04A:4	230.00–245.00	N	N	-	-	N	N	-	-	-	-
KFM04A:5	186.00–229.00	BL	BL	-	-	N	N	-	-	-	-
KFM04A:6	164.00–185.00	BL	BL	-	-	N	N	-	-	-	-
KFM04A:7	0.00–163.00	BL	BL	-	-	N	N	-	-	-	-
KFM05A:1	699.00–1 002.71	N	N	-	-	N	N	-	-	-	-
KFM05A:2	490.00–698.00	N	N	-	-	N	N	-	-	-	-
KFM05A:3	273.00–489.00	N	N	-	-	N	N	-	-	-	-
KFM05A:4	254.00–272.00	N	N	-	-	N	N	-	-	-	-
KFM05A:5	115.00–253.00	H	L	-	-	M	L	-	-	-	-
KFM05A:6	0.00–114.00	H	L	-	-	H	L	-	-	-	-
KFM07A:1	0.00–1 002.10	E [4)]	L [4)]	-	-	N	N	-	-	-	-
KFM07B:1	203.00–298.93	H	L	-	-	H	L	-	-	-	-
KFM07B:2	75.00–202.00	E	M	-	-	H	L	-	-	-	-
KFM07C:1	302.00–500.34	N	N	-	-	N	N	-	-	-	-
KFM07C:2	161.00–301.00	M	L	-	-	H	L	-	-	-	-
KFM07C:3	111.00–160.00	H	L	-	-	H	L	-	-	-	-
KFM07C:4	0.00–110.00	H	M	-	-	H	L	-	-	-	-
KFM08A:1	695.00–1 001.19	N	N	-	-	N	N	-	-	-	-
KFM08A:2	684.00–694.00	N	N	-	-	N	N	-	-	-	-
KFM08A:3	504.00–683.00	N	N	-	-	N	N	-	-	-	-
KFM08A:4	474.00–503.00	N	N	-	-	N	N	-	-	-	-
KFM08A:5	281.00–473.00	N	N	-	-	N	N	-	-	-	-
KFM08A:6	265.00–280.00	L [3)]	L [3)]	-	-	N	N	-	-	-	-
KFM08A:7	216.00–264.00	L [3)]	L [3)]	-	-	N	N	-	-	-	-
KFM08A:8	162.00–215.00	L [3)]	L [3)]	-	-	N	N	-	-	-	-

Table 5-3. Continued.

	Pumping Hole	HFM43		HFM45		HFM33		HFM44		HFM46	
	Section (m.b.TOC)	0–200		0–200		0–140		0–200		0–200	
	Flow rate (L/min)	270.7		74.2		243.4		104.1		62.8	
	Drawdown (m)	9.59		19.07		16.81		18.30		21.68	
	Response indices	1	2new [1)]	1	2new [1)]	1	2new [1)]	1	2new [1)]	1	2new [1)]
Observation borehole section	Interval (m)										
KFM08A:9	0.00–161.00	L[3)]	L[3)]	-	-	N	N	-	-	-	-
KFM08B:1	113.00–200.54	L[3)]	L[3)]	-	-	LC	LC	-	-	-	-
KFM08B:2	71.00–112.00	N[3) 6)]	L[3)]	-	-	N	N	-	-	-	-
KFM08B:3	0.00–70.00	H	L	-	-	H	L	-	-	-	-
KFM08C:1	761.00–951.08	N	N	-	-	N	N	-	-	-	-
KFM08C:2	611.00–760.00	N	N	-	-	N	N	-	-	-	-
KFM08C:3	311.00–610.00	N	N	-	-	N	N	-	-	-	-
KFM08C:4	146.00–310.00	AR[3)]	AR[3)]	-	-	N	N	-	-	-	-
KFM08C:5	0.00–145.00	H	L	-	-	H	L	-	-	-	-
KFM08D:1	836.00–942.30	N	N	-	-	LC	LC	-	-	-	-
KFM08D:2	825.00–835.00	-	-	-	-	LC	LC	-	-	-	-
KFM08D:3	681.00–824.00	N	N	-	-	LC	LC	-	-	-	-
KFM08D:4	660.00–680.00	N	N	-	-	LC	LC	-	-	-	-
KFM08D:5	331.00–659.00	N	N	-	-	M	L	-	-	-	-
KFM08D:6	161.00–330.00	M	L	-	-	M	L	-	-	-	-
KFM08D:7	0.00–160.00	M	L	-	-	H	L	-	-	-	-
KFM09A:1	551.00–799.67	M	L	-	-	-	-	-	-	-	-
KFM09A:2	301.00–550.00	AR	AR	-	-	N	N	-	-	-	-
KFM09A:3	0.00–300.00	M[3)]	L[3)]	-	-	N	N	-	-	-	-
KFM09B:1	451.00–616.45	N	N	-	-	N	N	-	-	-	-
KFM09B:2	201.00–450.00	M[3)]	M[3)]	-	-	M	L	-	-	-	-
KFM09B:3	0.00–200.00	H	L	-	-	H	L	-	-	-	-
KFM10A:1	441.00–500.16	H	L	-	-	H	L	-	-	-	-
KFM10A:2	430.00–440.00	H	L	-	-	H	L	-	-	-	-
KFM10A:3	353.00–429.00	H	L	-	-	M	L	-	-	-	-
KFM10A:4	153.00–352.00	H	L	-	-	M	L	-	-	-	-
KFM10A:5	0.00–152.00	M[3)]	L[3)]	-	-	N	N	-	-	-	-
KFM13:1	0.00–150.21	N[6)]	L	-	-	N	N	-	-	-	-
KFM14:1	0.00–60.18	H	L	-	-	H	L	-	-	-	-
KFM15:1	0.00–62.30	N[6)]	L	-	-	N	N	-	-	-	-
KFM16:1	0.00–60.35	M	L	-	-	H	L	-	-	-	-
KFM17:1	0.00–60.45	M	L	-	-	N	N	-	-	-	-
KFM18:1	0.00–60.46	M	L	-	-	N	N	-	-	-	-
KFM19:1	0.00–102.37	LC	LC	-	-	N	N	-	-	-	-
KFM20:1	0.00–60.50	L	L	-	-	N	N	-	-	-	-
KFM21:1	0.00–95.20	M	L	-	-	N	N	-	-	-	-
KFM22:1	0.00–60.26	M	L	-	-	H	L	-	-	-	-
KFM23:1	0.00–100.64	H	L	-	-	M	L	-	-	-	-
KFM24:1	0.00–550.17	M[3)]	L[3)]	-	-	-	-	-	-	-	-
HFM04:1	66.90–221.70	BL	BL	-	-	N	N	-	-	-	-
HFM04:2	57.90–65.90	M	L	-	-	N	N	-	-	-	-
HFM04:3	0.00–56.90	AR	AR	-	-	N	N	-	-	-	-
HFM05:1	139.00–200.10	BL	BL	-	-	N	N	-	-	-	-
HFM05:2	0.00–138.00	BL	BL	-	-	N	N	-	-	-	-
HFM09:1	0.00–50.25	BL	BL	-	-	-	-	-	-	-	-
HFM14:	0.00–150.50	H	L	-	-	-	-	-	-	-	-
HFM16:1	68.00–132.50	H	L	-	-	N	N	-	-	-	-
HFM16:2	54.00–67.00	H	L	-	-	N	N	-	-	-	-

Table 5-3. Continued.

	Pumping Hole	HFM43		HFM45		HFM33		HFM44		HFM46	
	Section (m.b.TOC)	0–200		0–200		0–140		0–200		0–200	
	Flow rate (L/min)	270.7		74.2		243.4		104.1		62.8	
	Drawdown (m)	9.59		19.07		16.81		18.30		21.68	
	Response indices	1	2new [1)]	1	2new [1)]	1	2new [1)]	1	2new [1)]	1	2new [1)]
Observation borehole section	Interval (m)										
HFM16:3	0.00–53.00	H	L	-	-	N	N	-	-	-	-
HFM17:1	0.00–210.65	BL	BL	-	-	N	N	-	-	-	-
HFM18:1	42.00–180.65	M	L	-	-	N	N	-	-	-	-
HFM18:2	28.00–41.00	M	L	-	-	N	N	-	-	-	-
HFM18:3	0.00–27.00	M	L	-	-	N	N	-	-	-	-
HFM25:1	0.00–187.50	M	L	-	-	N	N	-	-	-	-
HFM32:1	98.00–202.65	H	L	-	-	LC	LC	-	-	-	-
HFM32:2	32.00–97.00	H	L	-	-	LC	LC	-	-	-	-
HFM32:3	26.00–31.00	BL	BL	-	-	N	N	-	-	-	-
HFM32:4	0.00–25.00	BL	BL	-	-	N	N	-	-	-	-
KFM02A:1	889.00–1002.44	N	N	-	-	N	N	-	-	-	-
KFM02A:2	519.00–888.00	N	N	-	-	N	N	-	-	-	-
KFM02A:3	490.00–518.00	H	L	-	-	N	N	-	-	-	-
KFM02A:4	443.00–489.00	H	L	-	-	N	N	-	-	-	-
KFM02A:5	411.00–442.00	H	L	-	-	N	N	-	-	-	-
KFM02A:6	241.00–410.00	H	L	-	-	N	N	-	-	-	-
KFM02A:7	133.00–240.00	BL	BL	-	-	N	N	-	-	-	-
KFM02A:8	0.00–132.00	BL	BL	-	-	N	N	-	-	-	-
KFM02B:1	507.00–573.87	N	N	-	-	N	N	-	-	-	-
KFM02B:2	491.00–506.00	H	L	-	-	N	N	-	-	-	-
KFM02B:3	432.00–490.00	H	L	-	-	N	N	-	-	-	-
KFM02B:4	410.00–431.00	H	L	-	-	N	N	-	-	-	-
KFM02B:5	246.00–409.00	H	L	-	-	N	N	-	-	-	-
KFM02B:6	131.00–245.00	BL	BL	-	-	N	N	-	-	-	-
KFM02B:7	0.00–130.00	M	L	-	-	-	-	-	-	-	-
KFM06A:1	827.00–1000.64	N	N	-	-	N	N	-	-	-	-
KFM06A:2	749.00–826.00	L	L	-	-	M	L	-	-	-	-
KFM06A:3	738.00–748.00	M	L	-	-	M	L	-	-	-	-
KFM06A:4	363.00–737.00	M	L	-	-	M	L	-	-	-	-
KFM06A:5	341.00–362.00	M	L	-	-	M	L	-	-	-	-
KFM06A:6	247.00–340.00	H	L	-	-	M	L	-	-	-	-
KFM06A:7	151.00–246.00	H	L	-	-	H	L	-	-	-	-
KFM06A:8	0.00–150.00	H	L	-	-	H	L	-	-	-	-
KFM06B:1	51.00–100.33	-	-	-	-	N	N	-	-	-	-
KFM06B:2	27.00–50.00	H	L	-	-	N	N	-	-	-	-
KFM06B:3	0.00–26.00	H	L	-	-	N	N	-	-	-	-
KFM06C:1	873.00–1000.91	N	N	-	-	N	N	-	-	-	-
KFM06C:2	667.00–872.00	-	-	-	-	M	L	-	-	-	-
KFM06C:3	647.00–666.00	N	N	-	-	M	L	-	-	-	-
KFM06C:4	541.00–646.00	M	L	-	-	-	-	-	-	-	-
KFM06C:5	531.00–540.00	M	L	-	-	H	L	-	-	-	-
KFM06C:6	402.00–530.00	H	L	-	-	H	L	-	-	-	-
KFM06C:7	351.00–401.00	H	L	-	-	H	L	-	-	-	-
KFM06C:8	281.00–350.00	H	L	-	-	H	L	-	-	-	-
KFM06C:9	187.00–280.00	H	L	-	-	H	L	-	-	-	-
KFM06C:10	0.00–186.00	H	L	-	-	H	L	-	-	-	-
SFM000145:1	0.00–2.00	M	L	-	-	N	N	-	-	-	-
SFM000146:1	0.00–3.10	L	L	-	-	-	-	-	-	-	-

Table 5-3. Continued.

	Pumping Hole	HFM43		HFM45		HFM33		HFM44		HFM46	
	Section (m.b.TOC)	0–200		0–200		0–140		0–200		0–200	
	Flow rate (L/min)	270.7		74.2		243.4		104.1		62.8	
	Drawdown (m)	9.59		19.07		16.81		18.30		21.68	
	Response indices	1	2new [1)]	1	2new [1)]	1	2new [1)]	1	2new [1)]	1	2new [1)]
Observation borehole section	Interval (m)										
SFM000153 :1	0.00–3.20	-	-	-	-	-	-	-	-	-	-
SFM000163:1	0.00–6.88	N[6)]	L	-	-	N	N	-	-	-	-
SFM0104:1	0.00–7.20	M	L	-	-	-	-	-	-	-	-
SFM0107:1	0.00–7.05	L	L	-	-	-	-	-	-	-	-

1) The indices [Index 1] and [Index 2 new] are described in Section 3. The response indices are also shown in cross-plots in Chapter 4.
2) HFM38 are found in both observation groups specified in the appendices in AP, these sections are therefore found at two places in the table. Values are although only presented at one spot, and are otherwise marked with an [2)].
3) Initial deviating bump, mostly with temporary higher values after start and lower values after pumping stop.
4) Pressure transducer mainly above water table during the test due to big drawdown.
5) Dt_L not classified due to big covariance with sea level and air pressure during the start of the pumping period.
6) Calculated Index 1 < 0.1 due to long response time dtL

References

SKB's (Svensk Kärnbränslehantering AB) publications can be found at www.skb.com/publications.

Crawley M J, 2013. The R book. 2nd ed. Oxford: Wiley-Blackwell.

Follin S, 2008. Bedrock hydrogeology Forsmark. Site descriptive modelling, SDM-Site Forsmark. SKB R-08-95, Svensk Kärnbränslehantering AB.

Follin S, Johansson P-O, Hartley L, Jackson P, Roberts D, Marsic N, 2007. Hydrogeological conceptual model development and numerical modelling using CONNECTFLOW, Forsmark modelling stage 2.2. SKB R-07-49, Svensk Kärnbränslehantering AB.

Gueorguieva R, Krystal J-H, 2004. Move over ANOVA: Progress in analyzing repeated-measures data and its reflection in papers published in the archives of general psychiatry. Archives of General Psychiatry 61, 310–317.

Harrström J, 2019. Pumping tests, flow logging and water sampling in boreholes HFM42–HFM46. SKB P-19-05, Svensk Kärnbränslehantering AB.

Harrström J, Hedberg S, Öhman J, 2019. Hydraulic Interference Tests in KFR27, KFR103, and KFR105. Site investigation SDM-PSU. SKB P-17-20, Svensk Kärnbränslehantering AB.

Hothorn T, Bretz F, Westfall P, 2008. Simultaneous Inference in General Parametric Models. Biometrical Journal, 50, 346-363. http://dx.doi.org/10.1002/bimj.200810425

Knudby C, Carrera J, 2006. On the use of apparent hydraulic diffusivity as indicator of connectivity. Journal of Hydrology 329, 377–389.

Lindquist A, Hjerne C, Nordqvist R, Ludvigson J-E, Harrström J, Carlsten S, 2008. Oskarshamn site investigation. Confirmatory hydraulic interference test and tracer test in Laxemar. SKB P-08-96. Svensk Kärnbränslehantering AB.

Moye D G, 1967. Diamond drilling for foundation exploration. Civil Engineering Transactions, Institute of Engineers (Australia), April, 95–100.

R Development Core Team, 2017. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing (see also http://www.R-project.org/).

Schielzeth H, 2010. Simple means to improve the interpretability of regression coefficients: Interpretation of regression coefficients. Methods in Ecology and Evolution 1, 103–113.

Öhman J, Bockgård N, Follin S, 2012. Bedrock hydrogeology. Site investigation SFR. SKB R-11-03, Svensk Kärnbränslehantering AB.

Appendix 1

Observation borehole sections

Table A1-1. Observation boreholes during tests in HFM33, HFM44, HFM45 and HFM46 *according to Appendix 3 AP SFK-18-023*, Forsmark Investigation Site.

Observation borehole ID	Secup (mbl TOC)	Elevation Secup (m RH200)	Seclow (mbl TOC)	Elevation Seclow (m RH2000)
HFM34:1	91.00	−74.93	200.75	−161.10
HFM34:2	22.00	−16.17	90.00	−74.10
HFM34:3	0.00	2.63	21.00	−15.31
HFM35:1	182.00	−137.15	200.75	−150.23
HFM35:2	151.00	−115.24	181.00	−136.45
HFM35:3	34.00	−26.38	150.00	−114.53
HFM35:4	0.00	2.09	33.00	−25.57
HFM38:1	42.00	−31.21	200.75	−140.50
HFM38:2	24.00	−17.03	41.00	−30.44
HFM38:3	0.00	2.39	23.00	−16.22
HFR101:1	0.00	2.82	209.30	−186.66
HFR102:1	28.00	−21.26	55.04	−43.90
HFR102:2	0.00	2.50	27.00	−20.41
HFR105:1	134.00	−117.31	200.50	−177.79
HFR105:2	107.00	−92.69	133.00	−116.40
HFR105:3	61.00	−50.98	106.00	−91.78
HFR105:4	0.00	3.46	60.00	−50.08
KFM11:1	711.00	−602.37	851.21	−713.05
KFM11:2	690.00	−585.57	710.00	−601.57
KFM11:3	457.00	−394.50	689.00	−584.77
KFM11:4	446.00	−385.21	456.00	−393.66
KFM11:5	361.00	−312.88	445.00	−384.37
KFM11:6	131.00	−112.78	360.00	−312.02
KFM11:7	0.00	3.14	130.00	−111.90
KFR01:1	44.65	−86.46	62.30	−101.75
KFR01:2	11.15	−57.45	43.65	−85.60
KFR09:1	0.00	−77.25	80.24	−84.25
KFR102A:1	444.00	−398.55	600.83	−537.14
KFR102A:2	423.00	−379.90	443.00	−397.66
KFR102A:3	255.00	−229.33	422.00	−379.01
KFR102A:4	220.00	−197.63	254.00	−228.43
KFR102A:5	214.00	−192.19	219.00	−196.73
KFR102A:6	185.00	−165.85	213.00	−191.28
KFR102A:7	103.00	−91.20	184.00	−164.94
KFR102A:8	0.00	2.85	102.00	−90.28
KFR104:1	333.00	−260.42	454.57	−351.53
KFR104:2	98.00	−76.71	332.00	−259.66
KFR104:3	0.00	3.01	97.00	−75.90
KFR105:1	265.00	−150.25	306.80	−156.45
KFR105:2	170.00	−135.21	264.00	−150.10
KFR105:3	138.00	−130.01	169.00	−135.05
KFR105:4	120.00	−127.04	137.00	−129.85
KFR105:5	4.00	−107.34	119.00	−126.87
KFR27:1	110.00	−106.94	501.64	−496.74
KFR27:2	47.00	−43.94	109.00	−105.94
KFR27:3	0.00	3.06	46.00	−42.94

Table A1-2. Observation boreholes during tests in HFM33 and HFM43 *according to Appendix 2 AP SFK-18-02*.

Observation borehole ID	Secup (mbl TOC)	Elevation Secup (m RH200)	Seclow (mbl TOC)	Elevation Seclow (m RH2000)
HFM01:1	46.50	−43.73	200.20	−195.17
HFM01:2	33.50	−30.92	45.50	−42.74
HFM01:3	0.00	1.92	32.50	−29.93
HFM02:1	49.00	−45.71	100.00	−96.68
HFM02:2	38.00	−34.73	48.00	−44.72
HFM02:3	0.00	3.24	37.00	−33.73
HFM03:1	19.00	−15.64	26.00	−22.63
HFM03:2	0.00	3.33	18.00	−14.64
HFM13:1	159.00	−132.45	175.60	−146.62
HFM13:2	101.00	−82.23	158.00	−131.59
HFM13:3	0.00	5.87	100.00	−81.36
HFM15:1	85.00	−55.52	99.50	−65.33
HFM15:2	0.00	4.06	84.00	−54.83
HFM19:1	168.00	−130.57	185.20	−143.75
HFM19:2	104.00	−81.13	167.00	−129.80
HFM19:3	0.00	3.84	103.00	−80.36
HFM20:1	131.00	−127.65	301.00	−297.40
HFM20:2	101.00	−97.66	130.00	−126.65
HFM20:3	49.00	−45.70	100.00	−96.66
HFM20:4	0.00	3.15	48.00	−44.70
HFM21:1	107.00	−83.96	202.00	−153.18
HFM21:2	33.00	−23.66	106.00	−83.17
HFM21:3	22.00	−14.44	32.00	−22.82
HFM21:4	0.00	4.16	21.00	−13.60
HFM22:1	0.00	1.72	222.00	−155.41
HFM23:1	0.00	4.43	211.50	−72.60
HFM27:1	59.00	−51.84	127.50	−114.81
HFM27:2	46.00	−39.90	58.00	−50.92
HFM27:3	25.00	−20.52	45.00	−38.98
HFM27:4	0.00	2.63	24.00	−19.59
HFM28:1	0.00	4.45	151.20	−143.59
HFM39:1	0.00	4.34	151.20	−144.66
HFM40:1	0.00	2.54	101.70	−98.16
HFM41:1	0.00	3.63	101.50	−97.04
HFM42:1	0.00	4.21	195.30	−190.89
KFM01A:1	431.00	−424.59	1001.49	−982.08
KFM01A:2	374.00	−368.19	430.00	−423.60
KFM01A:3	205.00	−200.56	373.00	−367.20
KFM01A:4	131.00	−127.04	204.00	−199.57
KFM01A:5	109.00	−105.16	130.00	−126.04
KFM01A:6	0.00	3.31	108.00	−104.16
KFM01B:1	142.00	−135.59	500.52	−479.16
KFM01B:2	101.00	−95.61	141.00	−134.61
KFM01B:3	0.00	3.28	100.00	−94.64
KFM01D:1	439.00	−347.07	800.24	−612.29
KFM01D:2	429.00	−339.38	438.00	−346.30
KFM01D:3	322.00	−257.01	428.00	−338.62
KFM01D:4	311.00	−248.45	321.00	−256.23
KFM01D:5	253.00	−202.69	310.00	−247.67
KFM01D:6	154.00	−122.81	252.00	−201.89
KFM01D:7	0.00	3.13	153.00	−121.99
KFM04A:1	496.00	−416.67	1001.42	−796.22
KFM04A:2	391.00	−330.71	495.00	−415.87
KFM04A:3	246.00	−207.01	390.00	−329.87
KFM04A:4	230.00	−193.14	245.00	−206.15
KFM04A:5	186.00	−154.74	229.00	−192.27

Table A1-2. Continued.

Observation borehole ID	Secup (mbl TOC)	Elevation Secup (m RH200)	Seclow (mbl TOC)	Elevation Seclow (m RH2000)
KFM04A:6	164.00	−135.41	185.00	−153.86
KFM04A:7	0.00	8.96	163.00	−134.53
KFM05A:1	699.00	−581.25	1002.71	−826.91
KFM05A:2	490.00	−410.38	698.00	−580.43
KFM05A:3	273.00	−229.70	489.00	−409.56
KFM05A:4	254.00	−213.57	272.00	−228.85
KFM05A:5	115.00	−94.01	253.00	−212.72
KFM05A:6	0.00	5.71	114.00	−93.14
KFM07A:1	0.00	3.51	1002.10	−820.75
KFM07B:1	203.00	−160.04	298.93	−237.73
KFM07B:2	75.00	−57.65	202.00	−159.23
KFM07C:1	302.00	−296.85	500.34	−494.17
KFM07C:2	161.00	−156.63	301.00	−295.85
KFM07C:3	111.00	−106.92	160.00	−155.64
KFM07C:4	0.00	3.54	110.00	−105.93
KFM08A:1	695.00	−554.70	1001.19	−759.21
KFM08A:2	684.00	−546.75	694.00	−553.98
KFM08A:3	504.00	−412.37	683.00	−546.03
KFM08A:4	474.00	−389.08	503.00	−411.60
KFM08A:5	281.00	−234.57	473.00	−388.30
KFM08A:6	265.00	−221.46	280.00	−233.75
KFM08A:7	216.00	−180.96	264.00	−220.64
KFM08A:8	162.00	−135.81	215.00	−180.13
KFM08A:9	0.00	2.67	161.00	−134.97
KFM08B:1	113.00	−93.50	200.54	−166.68
KFM08B:2	71.00	−57.96	112.00	−92.65
KFM08B:3	0.00	2.43	70.00	−57.11
KFM08C:1	761.00	−630.69	951.08	−780.62
KFM08C:2	611.00	−510.08	760.00	−629.89
KFM08C:3	311.00	−262.64	610.00	−509.27
KFM08C:4	146.00	−123.56	310.00	−261.81
KFM08C:5	0.00	2.66	145.00	−122.71
KFM08D:1	836.00	−666.97	942.30	−748.10
KFM08D:2	825.00	−658.52	835.00	−666.21
KFM08D:3	681.00	−546.51	824.00	−657.75
KFM08D:4	660.00	−530.01	680.00	−545.73
KFM08D:5	331.00	−266.46	659.00	−529.22
KFM08D:6	161.00	−128.08	330.00	−265.64
KFM08D:7	0.00	2.79	160.00	−127.28
KFM09A:1	551.00	−445.43	799.67	−621.02
KFM09A:2	301.00	−248.09	550.00	−444.68
KFM09A:3	0.00	4.47	300.00	−247.28
KFM09B:1	451.00	−353.53	616.45	−471.82
KFM09B:2	201.00	−158.99	450.00	−352.78
KFM09B:3	0.00	4.49	200.00	−158.19
KFM10A:1	441.00	−303.27	500.16	−337.89
KFM10A:2	430.00	−296.61	440.00	−302.67
KFM10A:3	353.00	−248.39	429.00	−296.00
KFM10A:4	153.00	−110.17	352.00	−247.74
KFM10A:5	0.00	4.69	152.00	−109.44
KFM13:1	0.00	2.98	150.21	−127.44
KFM14:1	0.00	2.15	60.18	−57.85
KFM15:1	0.00	3.65	62.30	−58.30
KFM16:1	0.00	1.69	60.35	−50.32
KFM17:1	0.00	3.82	60.45	−56.47
KFM18:1	0.00	3.65	60.46	−56.71
KFM19:1	0.00	2.96	102.37	−89.94

Table A1-2. Continued.

Observation borehole ID	Secup (mbl TOC)	Elevation Secup (m RH200)	Seclow (mbl TOC)	Elevation Seclow (m RH2000)
KFM20:1	0.00	2.99	60.50	−57.31
KFM21:1	0.00	2.80	95.20	−92.40
KFM22:1	0.00	2.94	60.26	−57.18
KFM23:1	0.00	2.45	100.64	−93.74
KFM24:1	0.00	1.21	550.17	−544.91

Table A1-3. Observation boreholes during tests in HFM33 and HFM43 *added afterwards*.

Observation borehole ID	Secup (mbl TOC)	Elevation Secup (m RH200)	Seclow (mbl TOC)	Elevation Seclow (m RH2000)
HFM04:1	66.90	−62.63	221.70	−213.97
HFM04:2	57.90	−53.65	65.90	−61.63
HFM04:3	0.00	4.06	56.90	−52.65
HFM05:1	139.00	−130.41	200.10	−189.72
HFM05:2	0.00	7.86	138.00	−129.42
HFM09:1	0.00	5.33	50.25	−41.20
HFM14:	0.00	4.10	150.50	−127.14
HFM16:1	68.00	−64.49	132.50	−128.34
HFM16:2	54.00	−50.50	67.00	−63.49
HFM16:3	0.00	3.40	53.00	−49.50
HFM17:1	0.00	3.94	210.65	−203.71
HFM18:1	42.00	−30.34	180.65	−142.53
HFM18:2	28.00	−18.56	41.00	−29.50
HFM18:3	0.00	5.22	27.00	−17.72
HFM25:1	0.00	4.04	187.50	−133.91
HFM32:1	98.00	−96.05	202.65	−198.23
HFM32:2	32.00	−30.73	97.00	−95.07
HFM32:3	26.00	−24.75	31.00	−29.73
HFM32:4	0.00	1.19	25.00	−23.75
KFM02A:1	889.00	−876.61	1002.44	−988.67
KFM02A:2	519.00	−509.71	888.00	−875.63
KFM02A:3	490.00	−480.85	518.00	−508.72
KFM02A:4	443.00	−434.05	489.00	−479.86
KFM02A:5	411.00	−402.18	442.00	−433.05
KFM02A:6	241.00	−232.79	410.00	−401.18
KFM02A:7	133.00	−125.12	240.00	−231.80
KFM02A:8	0.00	7.54	132.00	−124.13
KFM02B:1	507.00	−492.00	573.87	−557.70
KFM02B:2	491.00	−476.27	506.00	−491.02
KFM02B:3	432.00	−418.19	490.00	−475.28
KFM02B:4	410.00	−396.52	431.00	−417.21
KFM02B:5	246.00	−234.89	409.00	−395.54
KFM02B:6	131.00	−121.48	245.00	−233.90
KFM02B:7	0.00	7.80	130.00	−120.50
KFM06A:1	827.00	−690.34	1000.64	−827.28
KFM06A:2	749.00	−627.47	826.00	−689.54
KFM06A:3	738.00	−618.53	748.00	−626.66
KFM06A:4	363.00	−308.07	737.00	−617.72
KFM06A:5	341.00	−289.46	362.00	−307.23
KFM06A:6	247.00	−209.40	340.00	−288.62
KFM06A:7	151.00	−126.77	246.00	−208.55
KFM06A:8	0.00	4.28	150.00	−125.90
KFM06B:1	51.00	−46.37	100.33	−95.38
KFM06B:2	27.00	−22.52	50.00	−45.37
KFM06B:3	0.00	4.31	26.00	−21.53

Table A1-3. Continued.

Observation borehole ID	Secup (mbl TOC)	Elevation Secup (m RH200)	Seclow (mbl TOC)	Elevation Seclow (m RH2000)
KFM06C:1	873.00	−688.71	1 000.91	−781.23
KFM06C:2	667.00	−534.75	872.00	−687.97
KFM06C:3	647.00	−519.70	666.00	−534.00
KFM06C:4	541.00	−438.90	646.00	−518.95
KFM06C:5	531.00	−431.18	540.00	−438.13
KFM06C:6	402.00	−330.58	530.00	−430.41
KFM06C:7	351.00	−289.85	401.00	−329.78
KFM06C:8	281.00	−232.97	350.00	−289.05
KFM06C:9	187.00	−155.33	280.00	−232.15
KFM06C:10	0.00	4.27	186.00	−154.50
SFM000145:1	0.00	1.65	2.00	−0.35
SFM000146:1	0.00	3.29	3.10	0.19
SFM000153 :1	0.00	4.35	3.20	1.15
SFM000163:1	0.00	3.79	6.88	−3.08
SFM0104:1	0.00	3.73	7.20	−3.47
SFM0107:1	0.00	3.33	7.05	−3.72

Table A1-4. Temporary installed observations sections.

Observation borehole ID	Secup (mbl TOC)	Elevation Secup (m RH200)	Seclow (mbl TOC)	Elevation Seclow (m RH2000)
HFM44:1	90.00	−86.78	199.60	−196.16
HFM44:2	60.00	−56.92	90.00	−86.78
HFM44:3	0.00	2.94	60.00	−56.92
HFM45:1	190.00	−185.80	200.30	−196.09
HFM45:2	140.00	−135.82	190.00	−185.80
HFM45:3	0.00	3.85	140.00	−135.82
HFM46:1	150.00	−147.37	200.00	−196.60
HFM46:2	100.00	−97.96	150.00	−147.37
HFM46:3	0.00	1.70	100.00	−97.96

Appendix 2

Correlations with air pressure and sea level

Table A2-1. Correlation coefficients and P-values for relationships between air pressure and sea level, respectively, and the groundwater level for each section of each borehole of "attachment 3" (bilaga 3). The observed groundwater level was corrected according to Equation 3-2 if the multiplicity-adjusted *P*-value of a correlation was ≤ 0.05. Effects that were not corrected for, since they were not significant, are given in parenthese. We used Aug 31 – Dec 31, 2017 as period to test for the correlations. For three boreholes, we used a different period due to missing or disturbed data (KFR01 and KFR105: Dec 1, 2017 – March 31, 2018; KFM11A: Aug 31 – Dec 31, 2016).

Borehole	Section	Relationship between groundwater level and air pressure		Relationship between groundwater level and sea level	
		Correlation coefficient	Multiplicity-adjusted P-value	Correlation coefficient	Multiplicity-adjusted P-value
HFM33	1	0.0002	0.0337	0.8883	< 0.0001
HFM34	2	−0.0011	< 0.0001	0.6825	< 0.0001
	3	−0.0002	0.0005	0.9744	< 0.0001
HFM35	1	−0.0017	< 0.0001	0.5536	< 0.0001
	2	−0.0016	< 0.0001	0.5612	< 0.0001
	3	−0.0016	< 0.0001	0.5601	< 0.0001
	4	−0.0002	< 0.0001	0.9521	< 0.0001
HFM38	1	−0.0004	0.0637	0.7455	< 0.0001
	2	(−0.0002)	(0.1063)	0.8843	< 0.0001
	3	(0.0001)	(0.7325)	0.0114	0.0286
HFR101	1	−0.0032	0.0059	0.1951	< 0.0001
HFR102	1	−0.0018	< 0.0001	0.5049	< 0.0001
	2	−0.0003	0.0138	(0.0036)	(0.7583)
HFR105	1	−0.0023	< 0.0001	0.6336	< 0.0001
	2	−0.0014	< 0.0001	0.7552	< 0.0001
	3	−0.0013	< 0.0001	0.7622	< 0.0001
	4	−0.0019	< 0.0001	0.5018	< 0.0001
KFM11A	1	(−0.0027)	(0.2733)	(0.1849)	(0.3750)
	2	−0.0051	< 0.0001	0.1947	< 0.0001
	3	−0.0049	< 0.0001	0.4244	< 0.0001
	4	−0.0035	< 0.0001	0.5623	< 0.0001
	5	−0.0035	< 0.0001	0.5593	< 0.0001
	6	−0.0016	< 0.0001	0.4692	< 0.0001
	7*	0.0011	< 0.0001	0.5369	< 0.0001
KFR01	1	0.0776	< 0.0001	1.6440	< 0.0001
	2	0.0948	< 0.0001	5.1464	< 0.0001
KFR09	1	0.0912	< 0.0001	8.3045	< 0.0001
KFR27	1	−0.0036	< 0.0001	0.6723	< 0.0001
	2	−0.0011	< 0.0001	0.7296	< 0.0001
	3	0.0004	0.4101	0.1210	< 0.0001
KFR102A	1	−0.0046	< 0.0001	0.5219	< 0.0001
	2	−0.0045	< 0.0001	0.5339	< 0.0001
	3	−0.0036	< 0.0001	0.6666	< 0.0001
	4	−0.0034	< 0.0001	0.6961	< 0.0001
	5	−0.0035	< 0.0001	0.6778	< 0.0001
	6	−0.0034	< 0.0001	0.6953	< 0.0001
	7	−0.0010	< 0.0001	0.7152	< 0.0001
	8	(−0.0002)	(0.8993)	0.1547	< 0.0001

Table A2-1. Continued.

Borehole	Section	Relationship between groundwater level and air pressure		Relationship between groundwater level and sea level	
		Correlation coefficient	Multiplicity-adjusted P-value	Correlation coefficient	Multiplicity-adjusted P-value
KFR104	1	−0.0037	< 0.0001	0.5842	< 0.0001
	2	−0.0026	< 0.0001	0.6706	< 0.0001
	3	−0.0011	< 0.0001	0.6862	< 0.0001
KFR105	1	0.0623	< 0.0001	5.9051	< 0.0001
	2	0.0747	< 0.0001	6.0585	< 0.0001
	3	0.0753	< 0.0001	6.1085	< 0.0001
	4	0.0760	< 0.0001	5.8670	< 0.0001
	5	0.0695	< 0.0001	5.2389	< 0.0001

* This model did not converge with temporal autocorrelation included. Temporal autocorrelation was excluded.

Table A2-2. Correlation coefficients and P-values for relationships between air pressure and sea level, respectively, and the groundwater level for each section of each borehole of "attachment 2" (bilaga 2). The observed groundwater level was corrected according to Equation 3-2 if the multiplicity-adjusted *P*-value of a correlation was ≤ 0.05. Effects that were not corrected for, since they were not significant, are given in parentheses. To test for the correlations, we used a period during 2017 (Oct 15 – Dec 31; i.e. similar time as the current test period and undisturbed/no pumping activity). Three holes were lacking data during this time period. For these three holes (KFM04, KFM10A and KFM20) we used the year before (i.e. Oct 15 – Dec 31, 2016) as time period to test for correlations.

Borehole	Section	Relationship between groundwater level and air pressure		Relationship between groundwater level and sea level	
		Correlation coefficient	Multiplicity-adjusted P-value	Correlation coefficient	Multiplicity-adjusted P-value
HFM01	1	−0.0004	0.0218	0.0296	< 0.0001
	2	−0.0006	0.0009	(−0.0007)	(0.9991)
	3	(0.0002)	(0.4228)	(−0.0002)	(1.0000)
HFM02	1	(−0.0004)	(0.1703)	(0.0016)	(0.9969)
	2	(−0.0005)	(0.1003)	(0.0011)	(0.9988)
	3	−0.0006	0.0298	(−0.0013)	(0.9981)
HFM03	1*	0.0009	< 0.0001	0.1903	< 0.0001
	2	(−0.0002)	(0.6340)	(−0.0006)	(0.9998)
HFM13	1	−0.0009	< 0.0001	(−0.0110)	(0.4319)
	2*	0.0004	0.0463	0.0753	< 0.0001
	3	−0.0006	0.0020	(−0.0030)	(0.9503)
HFM15	1	−0.0008	< 0.0001	(−0.0066)	(0.7607)
	2	−0.0031	< 0.0001	(0.0408)	(0.1636)
HFM19	1	−0.0009	0.0002	(−0.0127)	(0.3104)
	2*	(0.0004)	(0.1144)	0.1457	< 0.0001
	3	−0.0009	0.0001	(−0.0080)	(0.6868)
HFM20	1	(−0.0005)	(0.2947)	0.0397	0.0050
	2	(−0.0003)	(0.5596)	0.0367	0.0041
	3	(−0.0001)	(0.8794)	(0.0210)	(0.1627)
	4	(0.0001)	(0.9931)	(0.0169)	(0.5632)
HFM21	1*	0.0008	< 0.0001	0.2368	< 0.0001
	2*	0.0008	< 0.0001	0.2943	< 0.0001
	3	(−0.0001)	(0.9131)	(0.0112)	(0.4653)
	4*	0.0017	< 0.0001	0.0643	< 0.0001

Table A2-2. Continued.

Borehole	Section	Relationship between groundwater level and air pressure		Relationship between groundwater level and sea level	
		Correlation coefficient	Multiplicity-adjusted P-value	Correlation coefficient	Multiplicity-adjusted P-value
HFM27	1	−0.0006	0.0043	(−0.0053)	(0.8158)
	2	−0.0005	0.0092	(< 0.0001)	(1.0000)
	3	−0.0005	0.0106	(0.0001)	(1.0000)
	4	−0.0006	0.0013	(0.0003)	(0.9999)
HFM38	1	−0.0006	0.0021	0.7809	< 0.0001
	2	−0.0001	0.0209	0.9093	< 0.0001
	3	(−0.0001)	(0.9210)	(0.0074)	(0.3766)
KFM01A	1*	−0.0048	< 0.0001	0.0941	< 0.0001
	2	−0.0033	< 0.0001	(0.0166)	(0.2096)
	3	−0.0031	< 0.0001	(0.0124)	(0.2530)
	4	(−0.0003)	(0.4246)	(0.0089)	(0.6454)
	5*	0.0013	< 0.0001	0.1352	< 0.0001
	6*	(0.0001)	(0.5896)	0.0205	0.0069
KFM01B	1*	(−0.0002)	(0.6888)	(0.0198)	(0.0553)
	2	(0.0002)	(0.5422)	(0.0047)	(0.9002)
	3*	0.0008	< 0.0001	0.1880	< 0.0001
KFM01D	1	−0.0047	< 0.0001	0.0562	< 0.0001
	2	−0.0011	< 0.0001	(0.0109)	(0.0651)
	3	−0.0010	< 0.0001	(−0.0002)	(0.9993)
	4	−0.0007	< 0.0001	(−0.0083)	(0.1617)
	5	−0.0006	< 0.0001	(−0.0066)	(0.2632)
	6	−0.0011	< 0.0001	(−0.0021)	(0.9347)
	7*	0.0008	< 0.0001	0.2322	< 0.0001
KFM04A	1	−0.0058	< 0.0001	(0.0043)	(0.9866)
	2	−0.0044	< 0.0001	(0.0020)	(0.9994)
	3	−0.0023	< 0.0001	(−0.0158)	(0.7188)
	4	−0.0010	< 0.0001	(−0.0030)	(0.9849)
	5	−0.0010	< 0.0001	(−0.0066)	(0.8522)
	6	−0.0013	< 0.0001	(−0.0206)	(0.0515)
	7	−0.0009	0.0002	(−0.0121)	(0.5356)
KFM05A	1	−0.0057	< 0.0001	(0.0290)	(0.0608)
	2	−0.0080	< 0.0001	(0.0201)	(0.3070)
	3	−0.0025	< 0.0001	−0.0249	0.0057
	4	−0.0014	< 0.0001	(−0.0093)	(0.3199)
	5*	0.0006	0.0010	0.1451	< 0.0001
	6*	0.0006	0.0023	0.1564	< 0.0001
KFM07B	1	(−0.0005)	(0.1403)	(0.0115)	(0.5333)
	2*	0.0007	< 0.0001	0.2879	< 0.0001
KFM07C	1	−0.0020	< 0.0001	0.0503	0.0009
	2	−0.0034	< 0.0001	0.0577	0.0010
	3*	0.0008	< 0.0001	0.2399	< 0.0001
	4*	0.0007	< 0.0001	0.2690	< 0.0001
KFM08A	1	−0.0049	< 0.0001	0.2306	< 0.0001
	2	−0.0031	< 0.0001	0.3324	< 0.0001
	3	−0.0056	< 0.0001	0.2090	< 0.0001
	4	−0.0050	< 0.0001	0.2463	< 0.0001
	5	−0.0070	< 0.0001	0.1765	< 0.0001

Table A2-2. Continued.

Borehole	Section	Relationship between groundwater level and air pressure		Relationship between groundwater level and sea level	
		Correlation coefficient	Multiplicity-adjusted P-value	Correlation coefficient	Multiplicity-adjusted P-value
KFM08A	6	−0.0015	< 0.0001	0.3924	< 0.0001
	7	−0.0017	< 0.0001	0.3602	< 0.0001
	8	−0.0009	0.0398	0.2747	< 0.0001
	9	(−0.0001)	(0.9968)	(0.0228)	(0.2178)
KFM08B	1	−0.0033	< 0.0001	0.0734	< 0.0001
	2*	(−0.0008)	(0.0797)	0.1147	< 0.0001
	3*	0.0007	< 0.0001	0.5426	< 0.0001
KFM08C	1	−0.0060	< 0.0001	0.2200	< 0.0001
	2	−0.0082	< 0.0001	(−0.0552)	(0.2053)
	3	−0.0052	< 0.0001	0.3142	< 0.0001
	4	−0.0023	< 0.0001	0.4595	< 0.0001
	5	(−0.0003)	(0.4046)	0.3888	< 0.0001
KFM08D	1	(−0.0001)	(0.6957)	0.0124	0.0091
	2	−0.0008	< 0.0001	0.0199	0.0047
	3	−0.0030	< 0.0001	0.0899	< 0.0001
	4	−0.0039	< 0.0001	0.1037	< 0.0001
	5	−0.0037	< 0.0001	0.2096	< 0.0001
	6	−0.0015	< 0.0001	0.3724	< 0.0001
	7	(−0.0001)	(0.8337)	0.2316	< 0.0001
KFM09A	1	−0.0022	< 0.0001	0.0262	0.0225
	2	−0.0019	< 0.0001	0.0244	0.0037
	3	−0.0004	0.0063	(0.0044)	(0.7394)
KFM09B	1	−0.0065	< 0.0001	(0.0078)	(0.8533)
	2	−0.0008	< 0.0001	(0.0107)	(0.1211)
	3	−0.0003	0.0464	−0.0141	0.0197
KFM10A	1	−0.0008	0.0075	(−0.0028)	(0.9933)
	2	−0.0008	0.0223	(−0.0066)	(0.9374)
	3	(−0.0002)	(0.4885)	(0.0018)	(0.9952)
	4	(−0.0002)	(0.7359)	(0.0107)	(0.6451)
	5	−0.0010	< 0.0001	(−0.0008)	(0.9997)
HFM22	1	(−0.0002)	(0.4339)	0.2425	< 0.0001
HFM23	1	−0.0005	0.0016	(−0.0027)	(0.9243)
HFM28	1	−0.0005	< 0.0001	(−0.0038)	(0.5928)
HFM39	1	−0.0008	0.0072	(−0.0127)	(0.5062)
HFM40	1	(−0.0007)	(0.0707)	0.6943	< 0.0001
HFM41	1*	0.0010	< 0.0001	0.0639	< 0.0001
HFM42	1	Uncorrected due to lack of enough pre-test data			
KFM07A	1	Uncorrected due to lack of enough pre-test data			
	2	Uncorrected due to lack of enough pre-test data			
	3	Uncorrected due to lack of enough pre-test data			
	4	Uncorrected due to lack of enough pre-test data			
	5	Uncorrected due to lack of enough pre-test data			
	6	Uncorrected due to lack of enough pre-test data			
KFM13	1	−0.0008	0.0002	(0.0063)	(0.7808)
KFM14	1	(−0.0002)	(0.7217)	0.2368	< 0.0001

Table A2-2. Continued.

Borehole	Section	Relationship between groundwater level and air pressure		Relationship between groundwater level and sea level	
		Correlation coefficient	Multiplicity-adjusted P-value	Correlation coefficient	Multiplicity-adjusted P-value
KFM15	1	−0.0011	0.0001	(−0.0107)	(0.6067)
KFM16	1	(−0.0009)	(0.0939)	0.1823	< 0.0001
KFM17	1	−0.0006	< 0.0001	(0.0011)	(0.9951)
KFM18	1	−0.0007	< 0.0001	(0.0067)	(0.1259)
KFM19	1	(−0.0003)	(0.0781)	0.8543	< 0.0001
KFM20	1	−0.0007	< 0.0001	0.0249	0.0002
KFM21	1	(−0.0003)	(0.3311)	0.0806	< 0.0001
KFM22	1	(0.0001)	(0.2887)	0.9557	< 0.0001
KFM23	1	(−0.0002)	(0.4832)	0.2281	< 0.0001
KFM24	1	(−0.0009)	(0.5451)	0.1809	0.0017

* This model did not converge with temporal autocorrelation included. Temporal autocorrelation was excluded.

Table A2-3. Correlation coefficients and P-values for relationships between air pressure and sea level, respectively, and the groundwater level for each section of each borehole of the additional boreholes ("tillägg"). The observed groundwater level was corrected according to Equation 3-2 if the multiplicity-adjusted *P*-value of a correlation was ≤ 0.05. Effects that were not corrected for, since they were not significant, are given in parentheses. We used Aug 31 – Dec 31, 2017, as period to test for the correlations.

Borehole	Section	Relationship between groundwater level and air pressure		Relationship between groundwater level and sea level	
		Correlation coefficient	Multiplicity-adjusted P-value	Correlation coefficient	Multiplicity-adjusted P-value
HFM04	1	−0.00256	< 0.0001	0.08909	< 0.0001
	2	−0.00116	0.00006	0.06603	< 0.0001
HFM05	1	(−0.00038)	(0.24733)	(0.00579)	(0.88100)
	2	−0.00113	< 0.0001	0.07344	< 0.0001
HFM09	1	−0.00126	0.00452	(0.00406)	(0.99065)
HFM14	1	−0.00125	< 0.0001	(−0.00593)	(0.48276)
HFM16	1	−0.00206	0.00181	0.09219	0.00026
	2	−0.00053	0.04736	0.09364	< 0.0001
	3	−0.00055	0.02782	0.07810	< 0.0001
HFM17	1[#]	−0.00090	0.00003	0.02670	0.00745
HFM18	1	−0.00004	< 0.0001	0.00262	< 0.0001
	2	−0.00078	0.02527	0.12307	< 0.0001
	3	−0.00081	0.02323	0.10473	< 0.0001
HFM25	1	(0.00042)	(0.75546)	(0.02978)	(0.28834)
HFM32	1	0.00018	0.00005	0.00758	0.00001
	2	−0.00034	0.04378	0.01489	0.01920
	3	(−0.00020)	(0.33930)	(0.00256)	(0.94216)
KFM02A	1	−(0.00027)	(0.09729)	(0.00760)	(0.32119)
	2	−0.00335	< 0.0001	0.16688	< 0.0001
	3	−0.00477	< 0.0001	0.11874	< 0.0001
	4	(−0.00129)	(0.18611)	0.09391	0.00516

Table A2-3. Continued.

Borehole	Section	Relationship between groundwater level and air pressure		Relationship between groundwater level and sea level	
		Correlation coefficient	Multiplicity-adjusted P-value	Correlation coefficient	Multiplicity-adjusted P-value
KFM02A	5	(−0.00104)	(0.25236)	0.12657	0.00007
	6	−0.00164	0.04711	0.11514	0.00055
	7	−0.00225	0.00161	(0.03067)	(0.55005)
	8	−0.00238	0.00483	(−0.01305)	(0.90614)
KFM02B	1	(−0.00145)	(0.16266)	(0.05899)	(0.14465)
	2	−0.00494	< 0.0001	(0.03725)	(0.05822)
	3	−0.00120	< 0.0001	0.11183	< 0.0001
	4	−0.00132	< 0.0001	0.10180	< 0.0001
	5	−0.00172	< 0.0001	0.08323	< 0.0001
	6	−0.00314	< 0.0001	0.05078	0.00010
	7	−0.00189	< 0.0001	(−0.02019)	(0.09873)
KFM06A	1	−0.00121	< 0.0001	0.05791	< 0.0001
	2	−0.00707	< 0.0001	0.04795	< 0.0001
	3	−0.00438	< 0.0001	0.12070	< 0.0001
	4	−0.00437	< 0.0001	0.12867	< 0.0001
	5	−0.00252	< 0.0001	0.02041	0.02243
	6	−0.00304	< 0.0001	0.02828	0.00399
	7	−0.00046	0.00532	0.01400	0.04531
	8	(−0.00032)	(0.08352)	(0.01538)	(0.08650)
KFM06B	1	(< 0.0001)	(0.99999)	(0.00650)	(0.68820)
	2	−0.00091	< 0.0001	0.07097	< 0.0001
	3	−0.00076	< 0.0001	0.05815	< 0.0001
KFM06C	1	−0.00057	0.00005	0.02765	< 0.0001
	2	−0.00555	< 0.0001	0.24857	< 0.0001
	3	−0.00440	< 0.0001	0.20780	< 0.0001
	4	−0.00423	< 0.0001	0.13653	< 0.0001
	5	−0.00436	< 0.0001	0.11498	< 0.0001
	6	−0.00302	< 0.0001	0.13935	< 0.0001
	7	−0.00370	< 0.0001	0.08989	< 0.0001
	8	−0.00145	< 0.0001	0.14756	< 0.0001
	9	(−0.00002)	(0.99900)	0.02930	< 0.0001
	10	(−0.00001)	(0.99977)	(−0.00084)	(0.99866)
SFM0104	1[#]	(0.00042)	(0.39288)	(−0.02757)	(0.06352)
SFM0107	1	−0.00256	< 0.0001	0.08909	< 0.0001
SFM000145	1	−0.00116	0.00006	0.06603	< 0.0001
SFM000146	1	(−0.00038)	(0.24732)	(0.00579)	(0.88100)
SFM000153	1	−0.00113	< 0.0001	0.07344	< 0.0001
SFM000163	1	−0.00126	0.00453	(0.00406)	(0.99065)

[#] The pressure data from these time series was left-skewed. It was log-transformed after adding a constant number (6.5) prior to modeling.

Appendix 3

Trend corrections during pumping in HFM43

Table A3-1. Comments to the observation sections that were not trend corrected, for the pumping test in HFM43.

Observation borehole	Trend correction	Comment
HFM25:1	No	Hard to judge.
KFM01A:6	No	De-trendning gives overcompensated values, better without.
KFM06A:2	No	Hard to judge, seem recover quickly after rainfall.
KFM06A:3	No	Hard to judge, seem recover quickly after rainfall.
KFM07C:2	No	Hard to judge.
KFM08A:6	No	Probably not recovered before the next rainfall, hard to decide what to base correction on. Max drawdown calculated on not trend corrected values.
KFM08A:7	No	Probably not recovered before the next rainfall, hard to decide what to base correction on. Max drawdown calculated on not trend corrected values.
KFM08A:8	No	Probably not recovered before the next rainfall, hard to decide what to base correction on. Max drawdown calculated on not trend corrected values.
KFM08A:9	No	Probably not recovered before the next rainfall, hard to decide what to base correction on. Max drawdown calculated on not trend corrected values.
KFM08B:1	No	Probably not recovered before the next rainfall, hard to decide what to base correction on. Max drawdown calculated on not trend corrected values.
KFM08D:1	No	Data is missing at start, pi is calculated from values after recovery. No trend correction possible but sections seem to recovery quickly after rain so probably not a big problem.
KFM08D:3	No	Data is missing at start, pi is calculated from values after recovery. No trend correction possible but sections seem to recovery quickly after rain so probably not a big problem.
KFM08D:4	No	Data is missing at start, pi is calculated from values after recovery. No trend correction possible but sections seem to recovery quickly after rain so probably not a big problem.
KFM08D:5	No	Data is missing at start, pi is calculated from values after recovery. No trend correction possible.
KFM08D:6	No	Data is missing at start, pi is calculated from values after recovery. No trend correction possible, results probably overestimated.
KFM08D:7	No	Data is missing at start, pi is calculated from values after recovery. No trend correction possible but do probably have little effect on the results.
KFM09A:1	No	Hard to judge.
KFM09B:2	No	Hard to judge.
HFM03:1	yes, but with constants calculated from Section 2	Data is missing during recovery, as data normally follows Section 2 constants from this section is used.
KFM04A:3	yes, but with constants calculated from Section 4	Data is missing during recovery, as data normally follows Section 4 constants from this section is used.

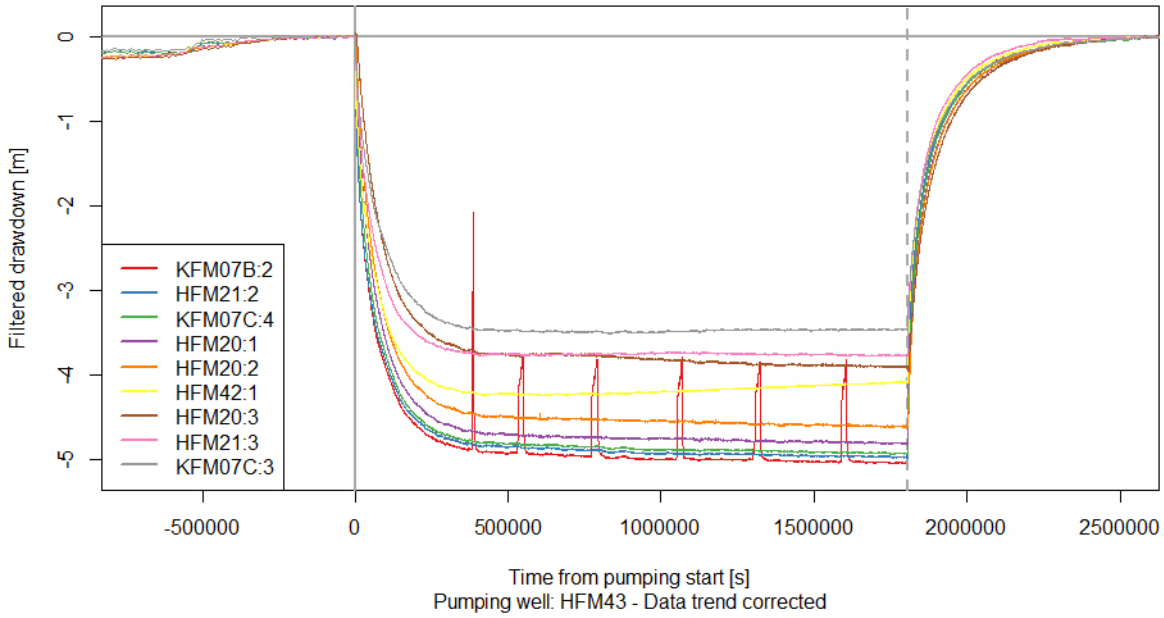
Appendix 4

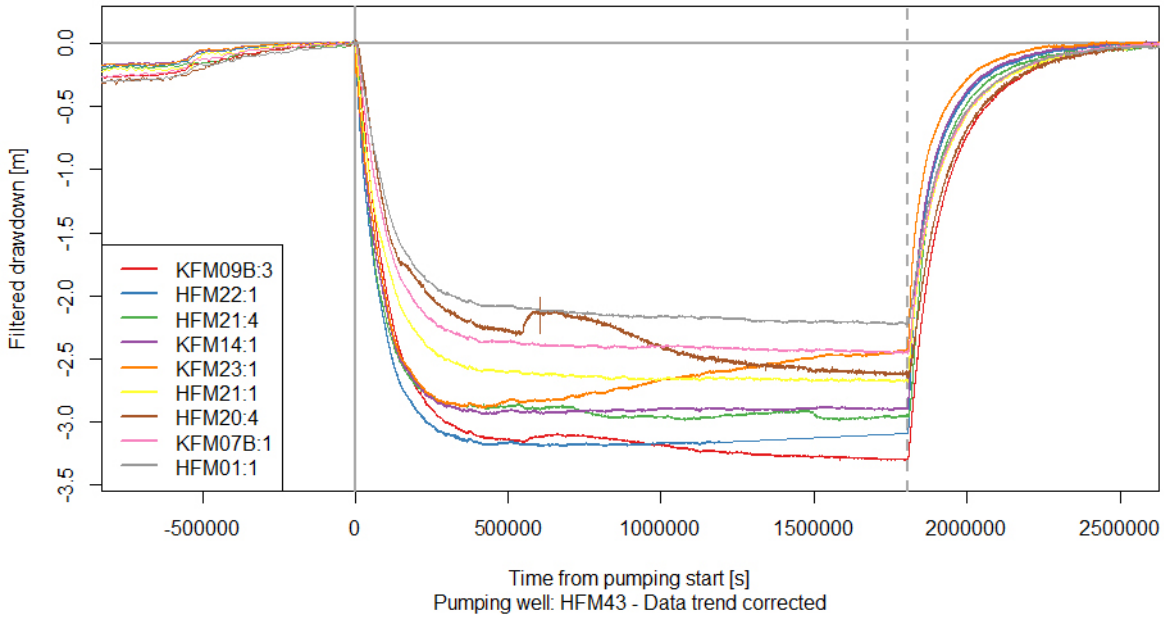
Observed drawdown – Interference test in HFM43

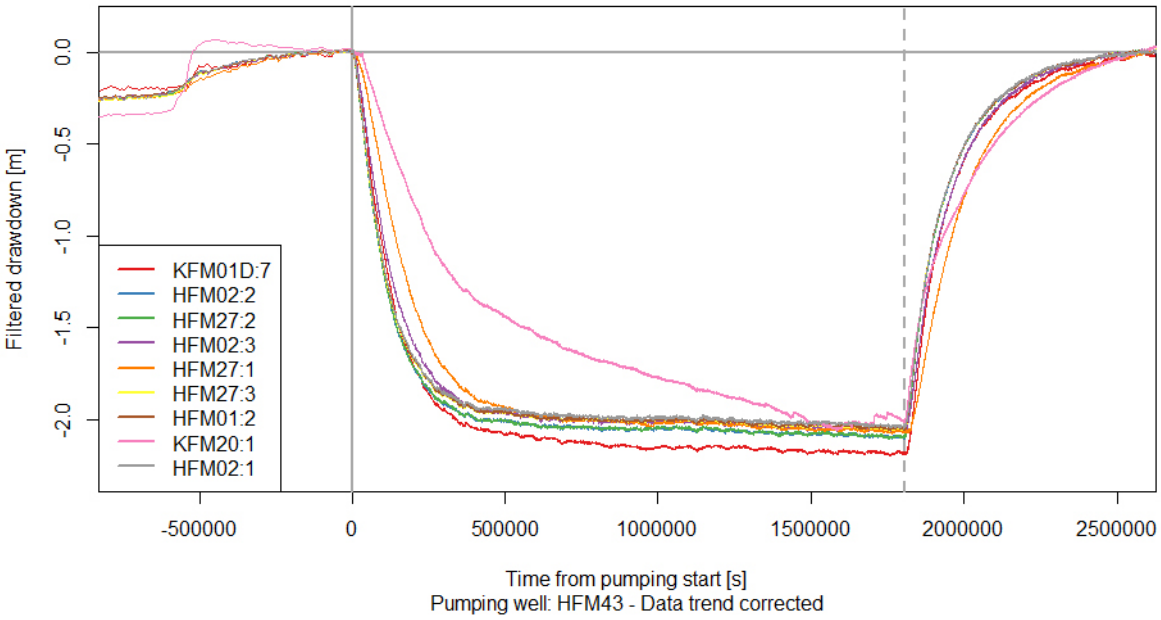
Responses > 0.1 m

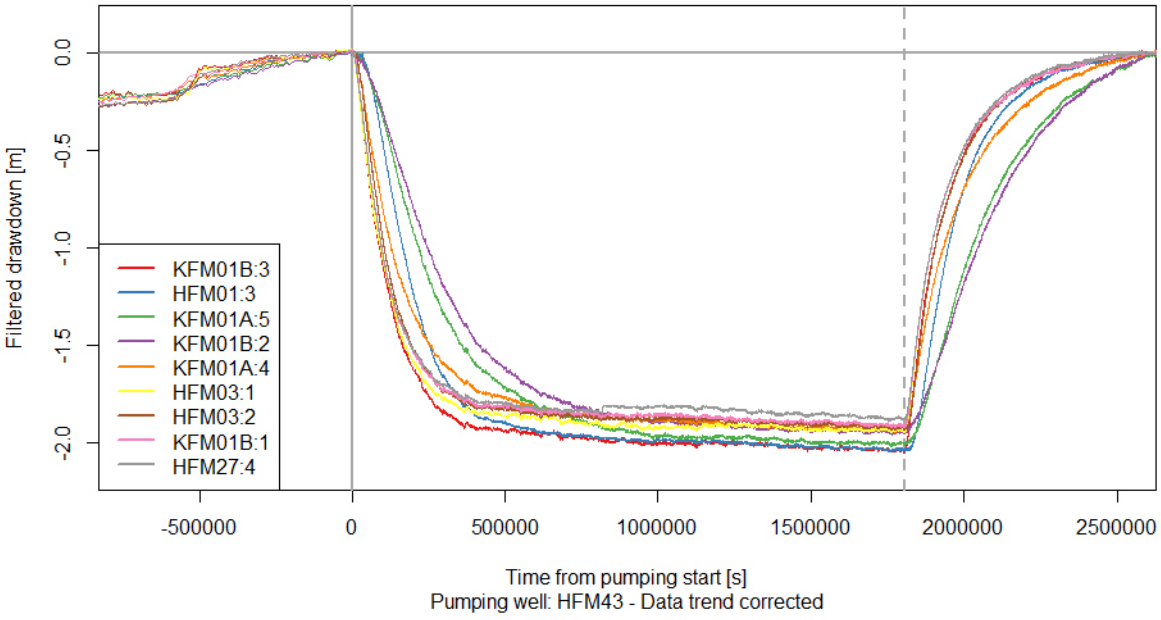
Trend corrected data for sections where drawdown is evaluated using trend correction

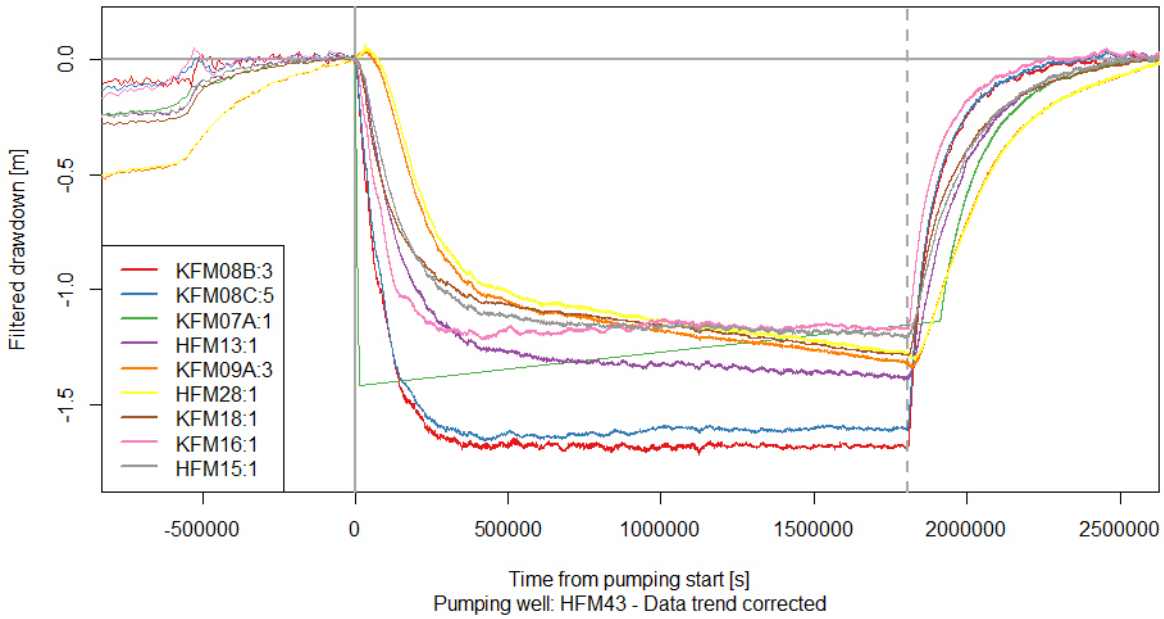
Sections sorted by the magnitude of drawdown.

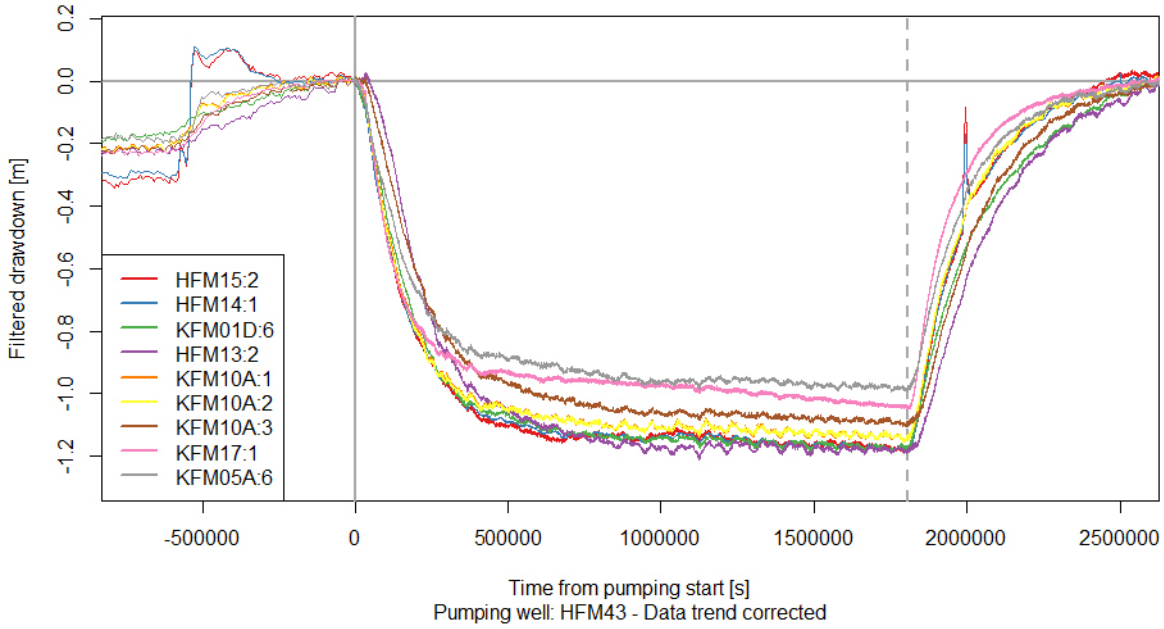


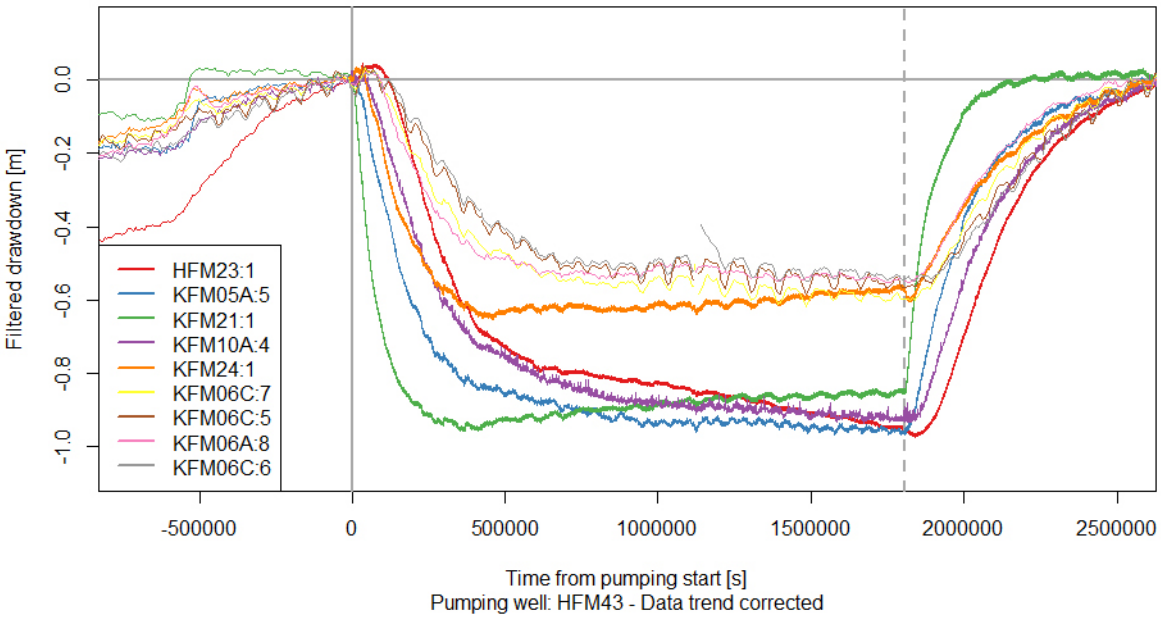


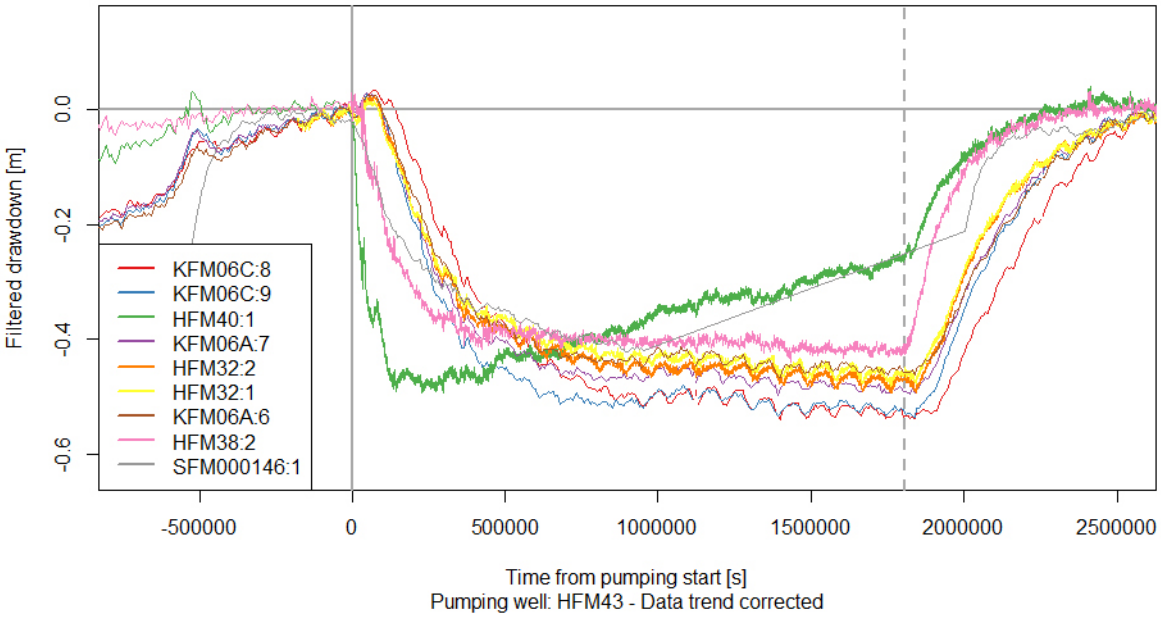

Filtered drawdown [m]
0.0
-0.5
-1.0
-1.5
-2.0
KFM01D:7
HFM02:2
HFM27:2
HFM02:3
HFM27:1
HFM27:3
HFM01:2
KFM20:1
HFM02:1
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected

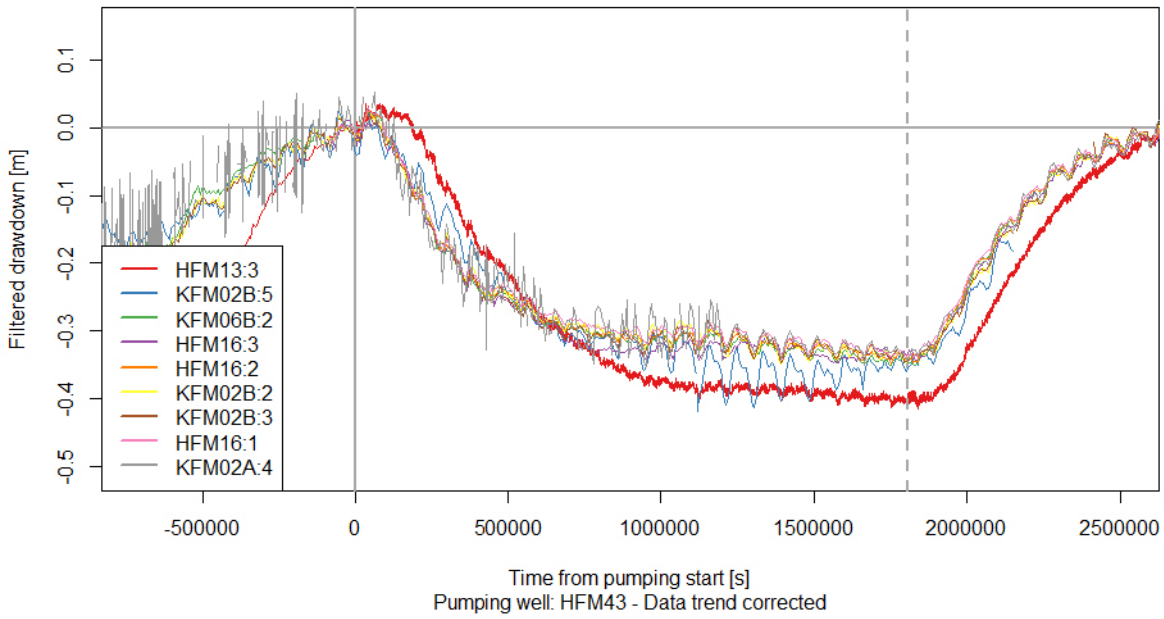

Filtered drawdown [m]
0.0
-0.5
-1.0
-1.5
-2.0
KFM01B:3
HFM01:3
KFM01A:5
KFM01B:2
KFM01A:4
HFM03:1
HFM03:2
KFM01B:1
HFM27:4
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected

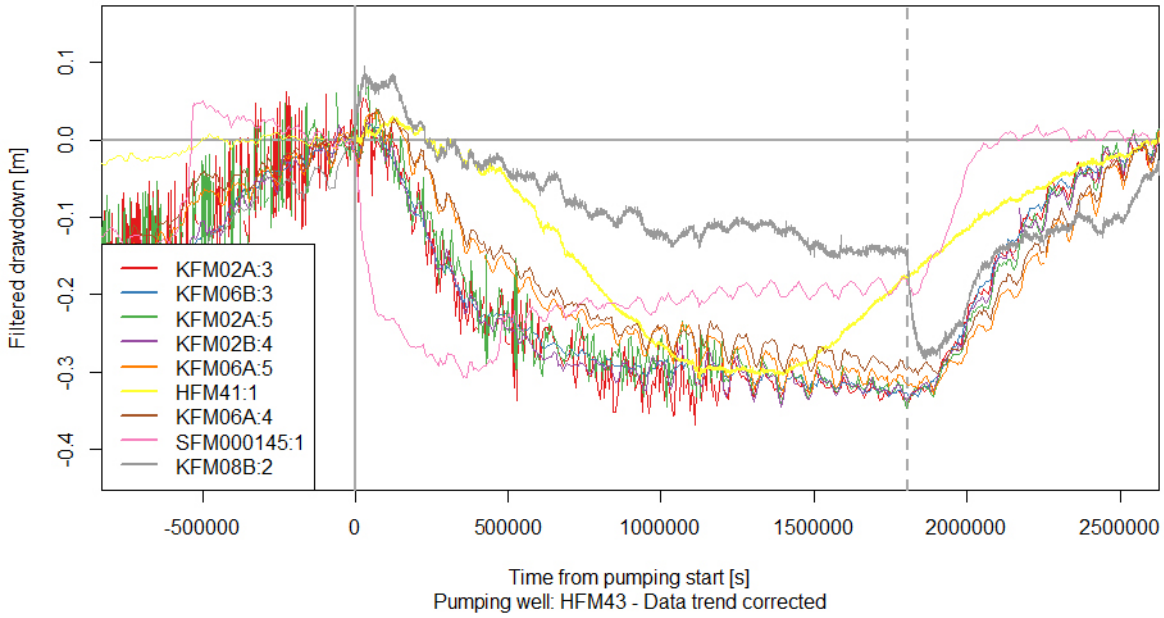

Filtered drawdown [m]
0.0
-0.5
-1.0
-1.5
KFM08B:3
KFM08C:5
KFM07A:1
HFM13:1
KFM09A:3
HFM28:1
KFM18:1
KFM16:1
HFM15:1
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected

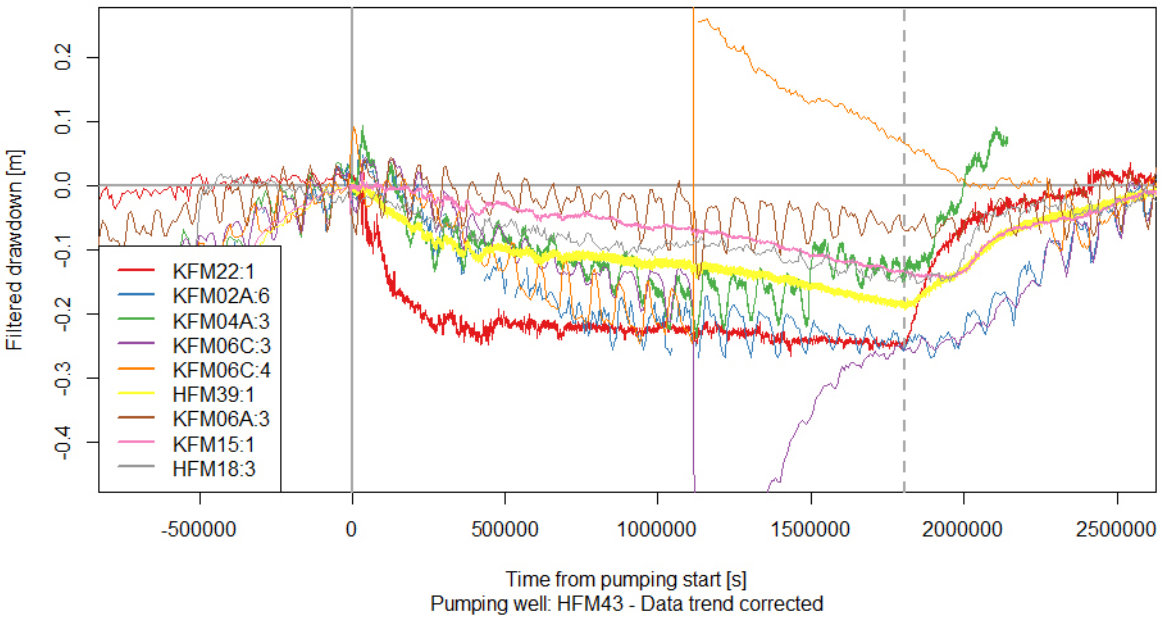

Filtered drawdown [m]
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
HFM15:2
HFM14:1
KFM01D:6
HFM13:2
KFM10A:1
KFM10A:2
KFM10A:3
KFM17:1
KFM05A:6
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected

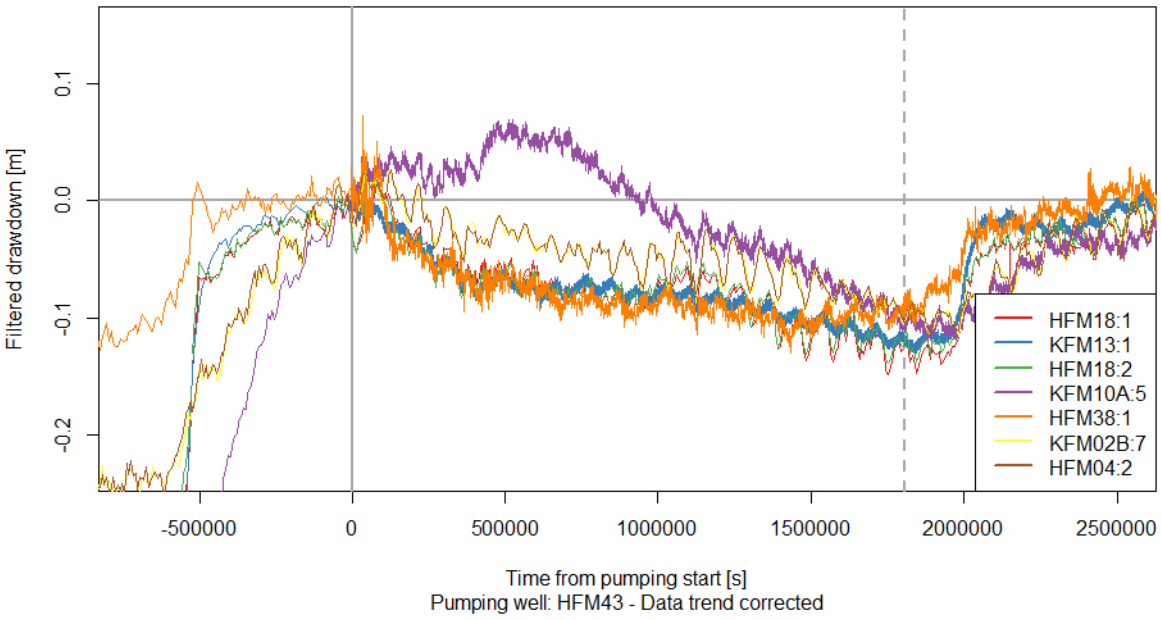

Filtered drawdown [m]
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
HFM23:1
KFM05A:5
KFM21:1
KFM10A:4
KFM24:1
KFM06C:7
KFM06C:5
KFM06A:8
KFM06C:6
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected


Filtered drawdown [m]
0.0
-0.2
-0.4
-0.6
KFM06C:8
KFM06C:9
HFM40:1
KFM06A:7
HFM32:2
HFM32:1
KFM06A:6
HFM38:2
SFM000146:1
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected


Filtered drawdown [m]
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
HFM13:3
KFM02B:5
KFM06B:2
HFM16:3
HFM16:2
KFM02B:2
KFM02B:3
HFM16:1
KFM02A:4
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected

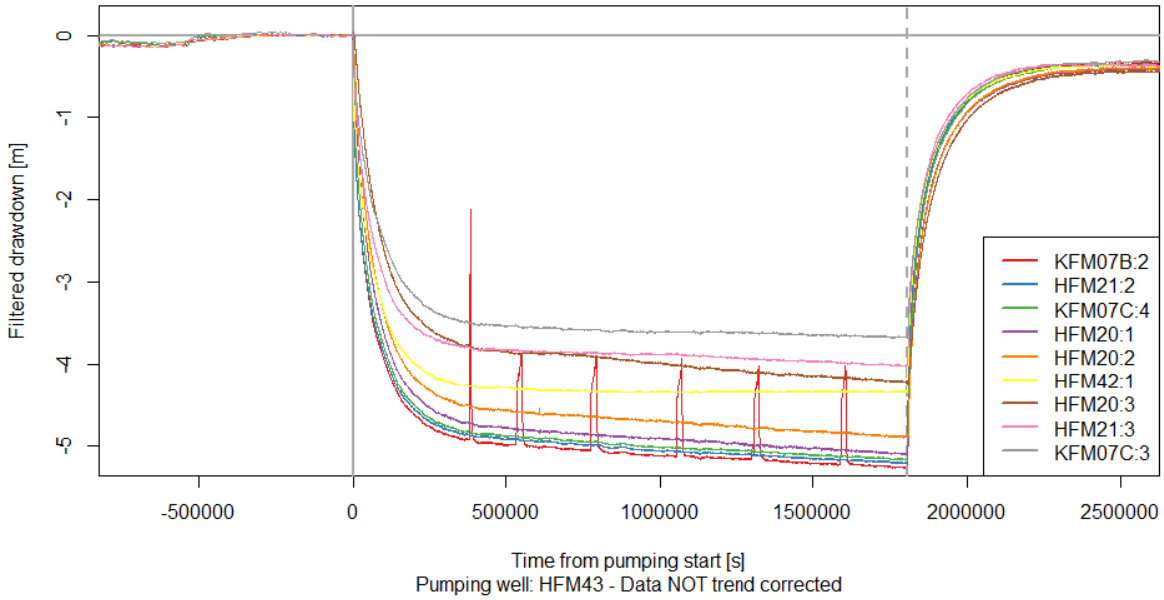

Filtered drawdown [m]
0.1
0.0
-0.1
-0.2
-0.3
-0.4
KFM02A:3
KFM06B:3
KFM02A:5
KFM02B:4
KFM06A:5
HFM41:1
KFM06A:4
SFM000145:1
KFM08B:2
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected

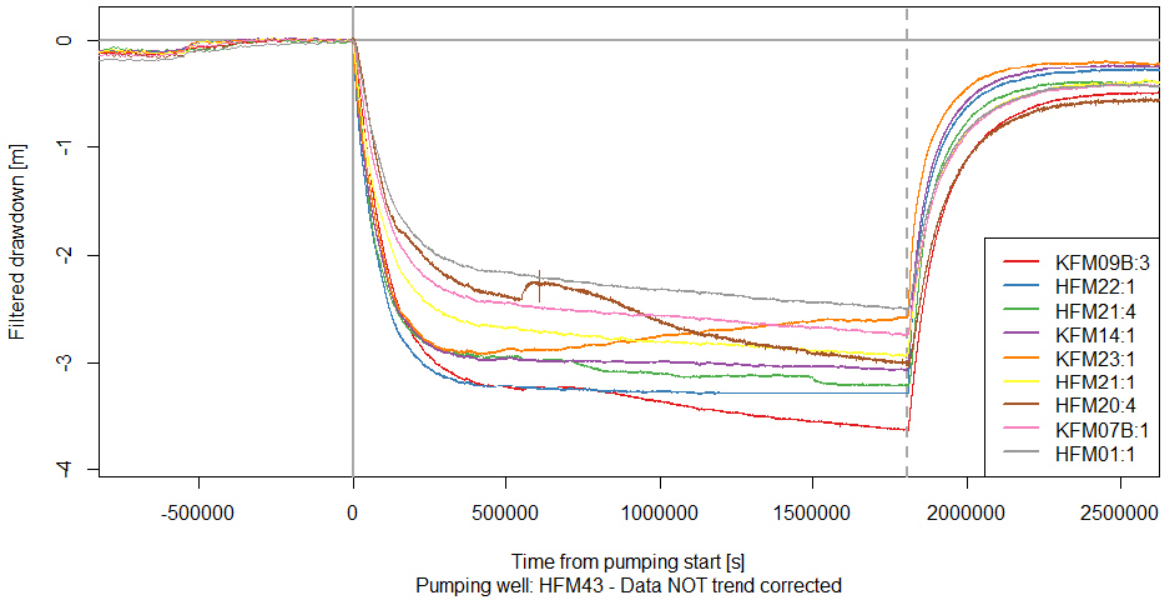

Filtered drawdown [m]
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
KFM22:1
KFM02A:6
KFM04A:3
KFM06C:3
KFM06C:4
HFM39:1
KFM06A:3
KFM15:1
HFM18:3
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected

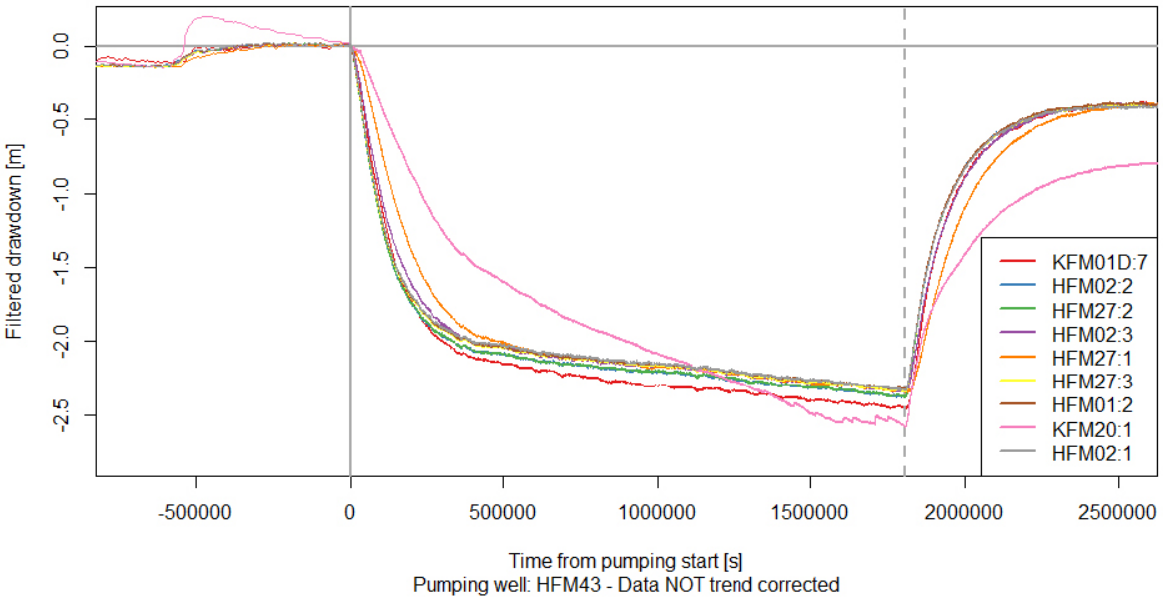

Filtered drawdown [m]
0.1
0.0
-0.1
-0.2
HFM18:1
KFM13:1
HFM18:2
KFM10A:5
HFM38:1
KFM02B:7
HFM04:2
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected

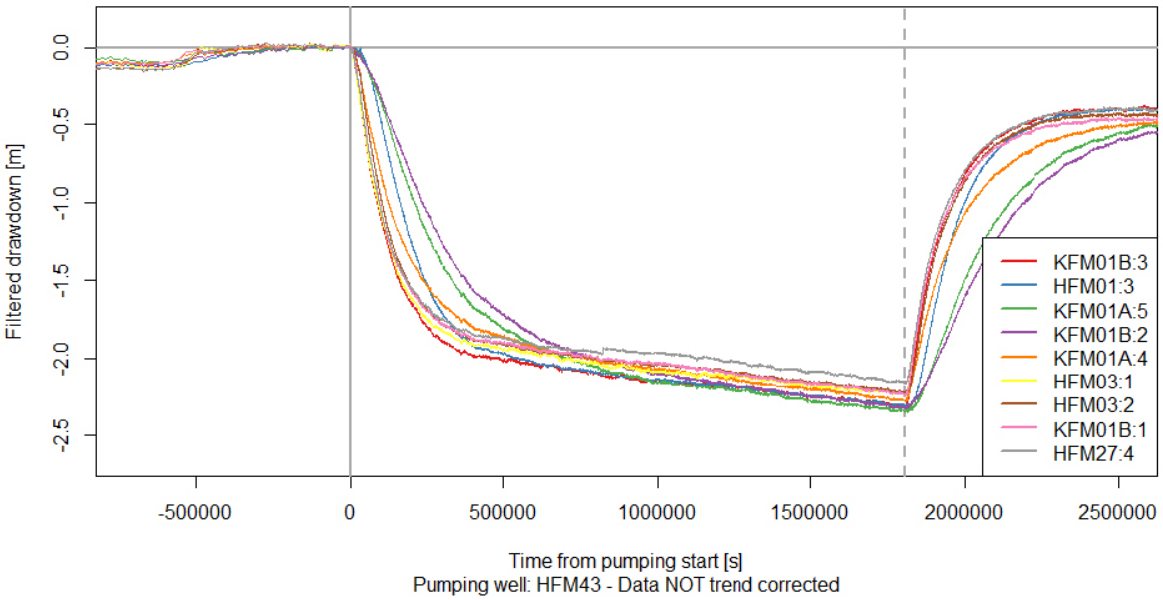
Not trend corrected data for sections where drawdown is evaluated using trend correction (as comparison)

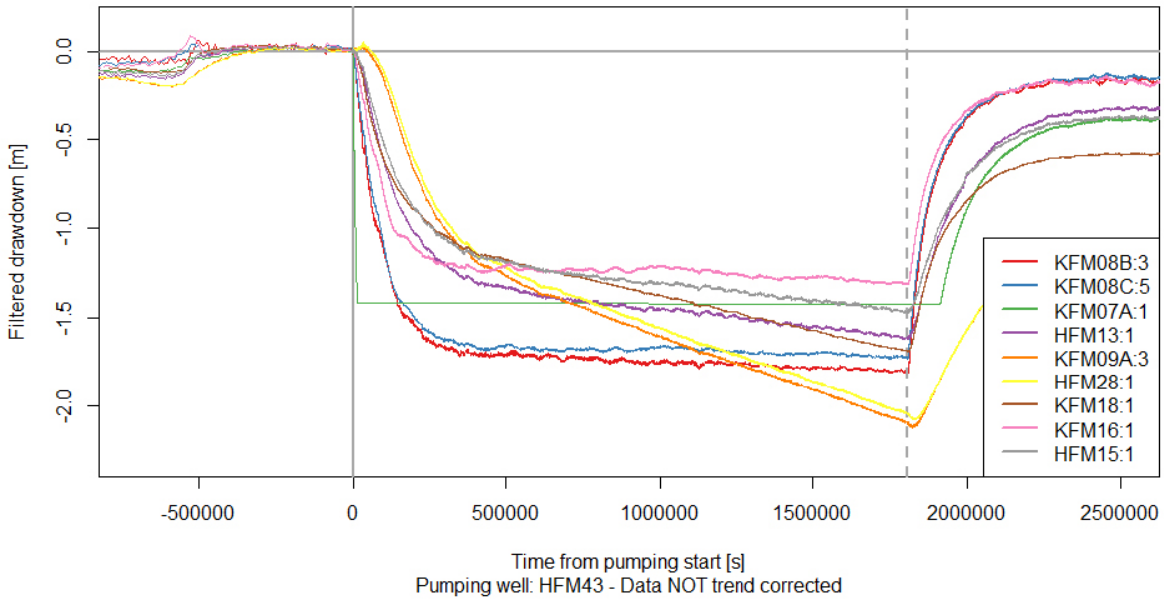
Figures for comparison between trend corrected and not trend corrected data. Sections sorted by the magnitude of drawdown.

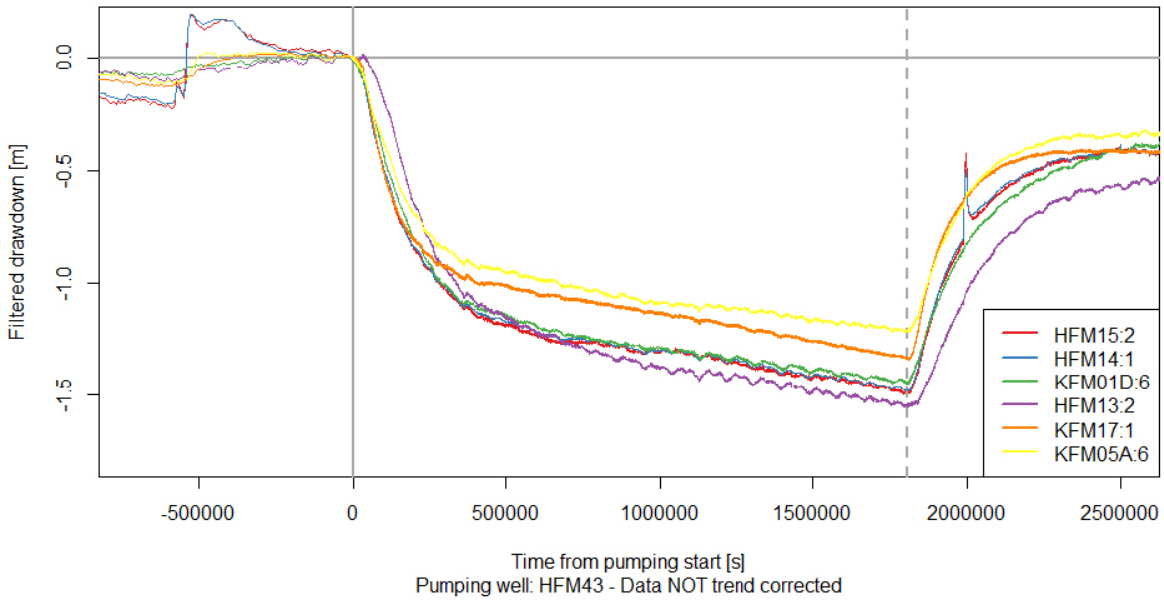


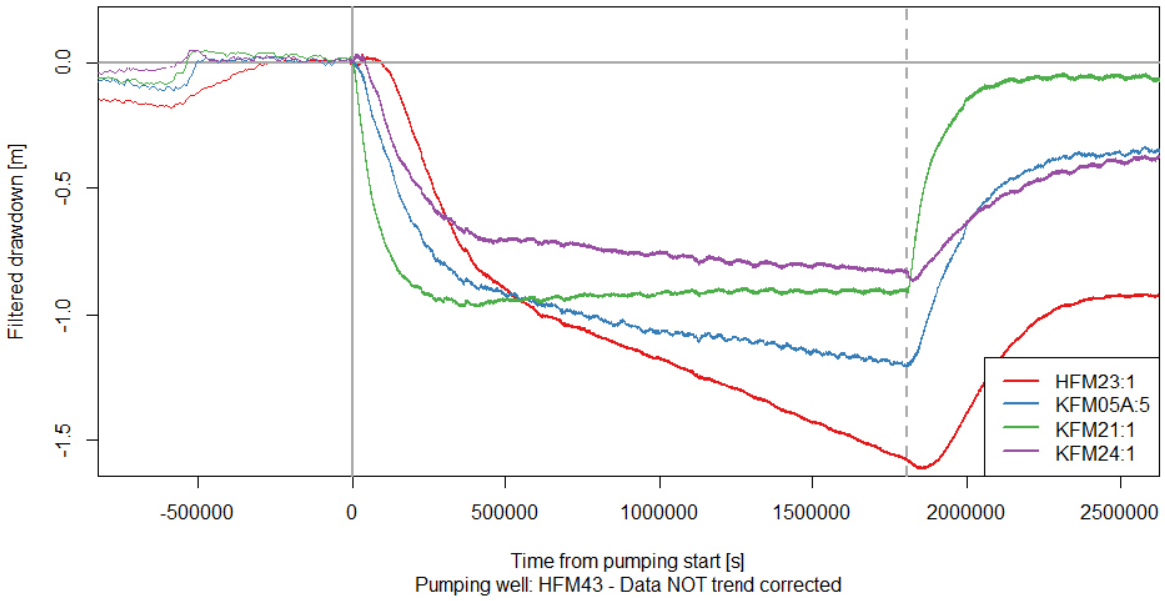


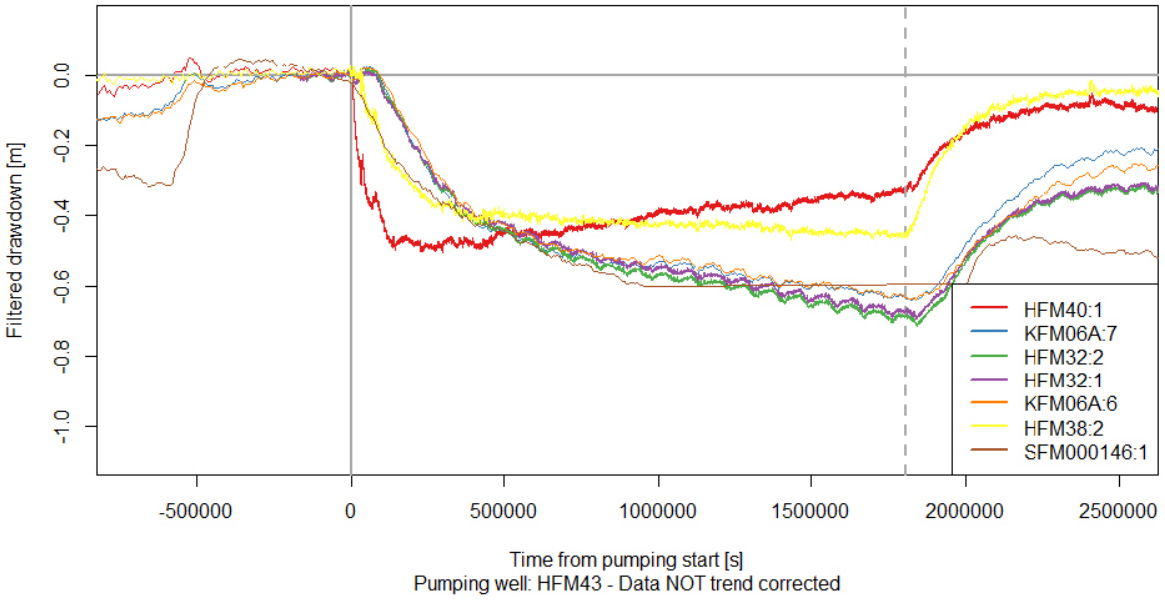

Filtered drawdown [m]
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-500000
0
500000
1000000
1500000
2000000
2500000
KFM01D:7
HFM02:2
HFM27:2
HFM02:3
HFM27:1
HFM27:3
HFM01:2
KFM20:1
HFM02:1
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected

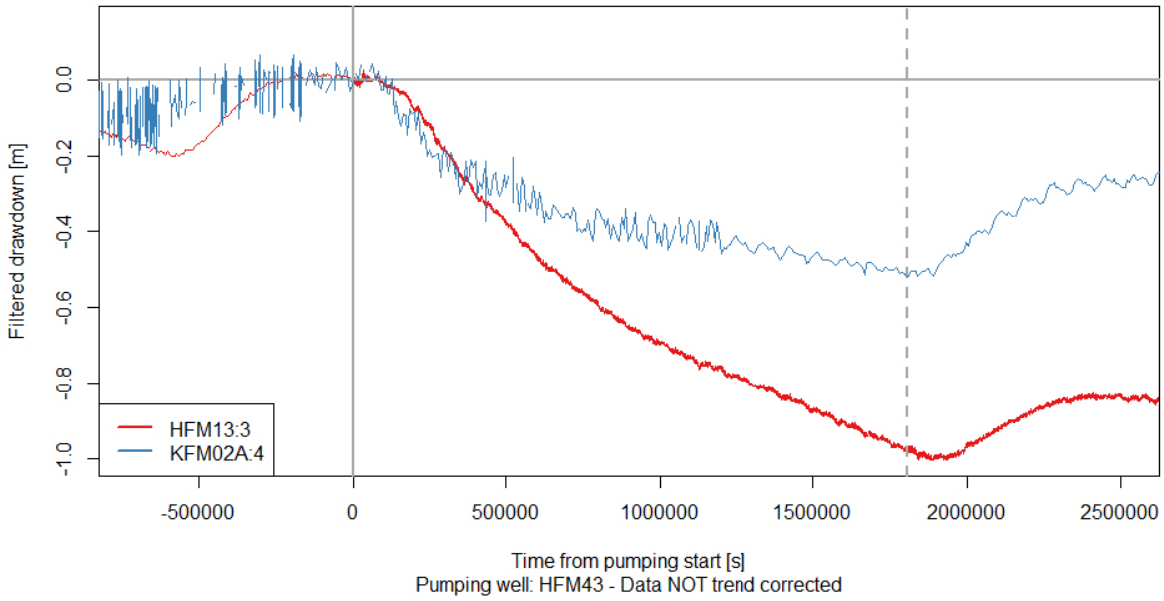

Filtered drawdown [m]
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-500000
0
500000
1000000
1500000
2000000
2500000
KFM01B:3
HFM01:3
KFM01A:5
KFM01B:2
KFM01A:4
HFM03:1
HFM03:2
KFM01B:1
HFM27:4
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected

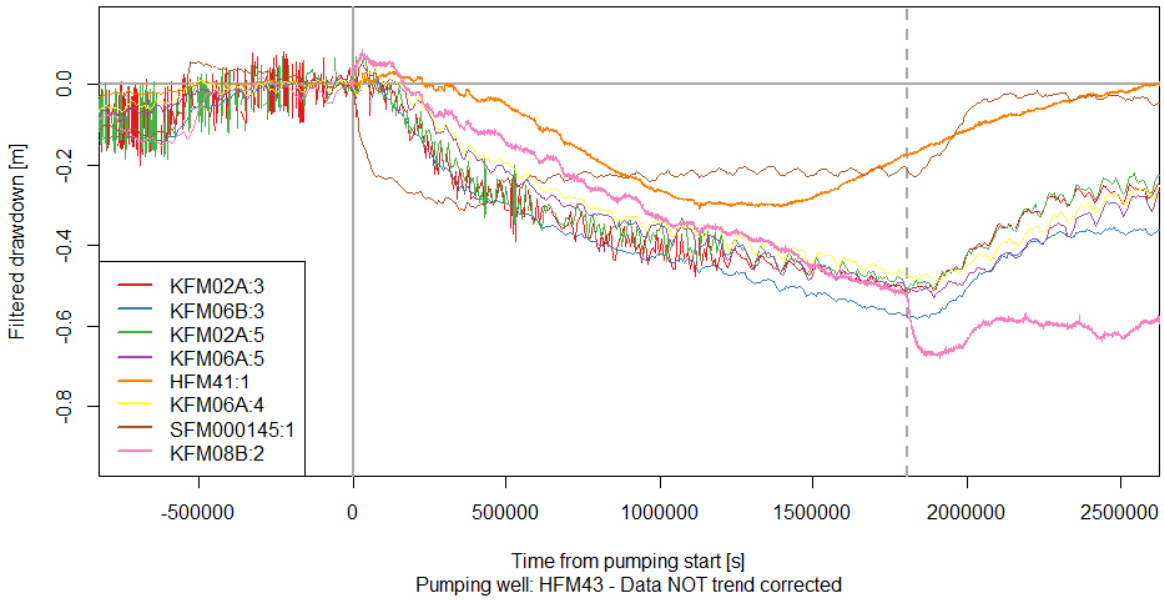

Filtered drawdown [m]
0.0
-0.5
-1.0
-1.5
-2.0
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected
KFM08B:3
KFM08C:5
KFM07A:1
HFM13:1
KFM09A:3
HFM28:1
KFM18:1
KFM16:1
HFM15:1

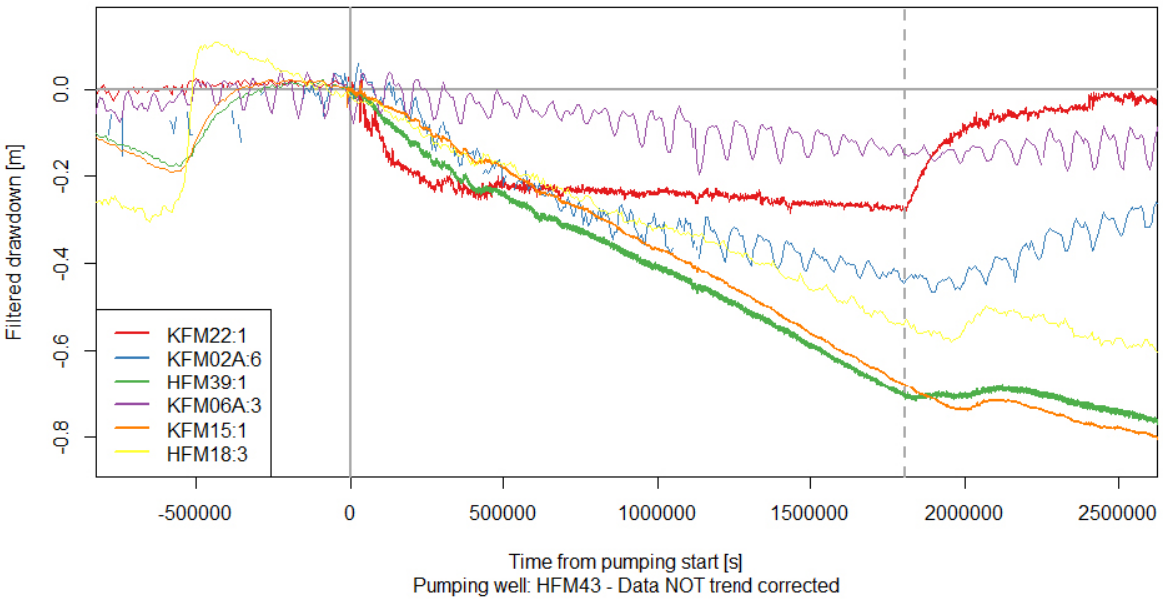

Filtered drawdown [m]
0.0
-0.5
-1.0
-1.5
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected
HFM15:2
HFM14:1
KFM01D:6
HFM13:2
KFM17:1
KFM05A:6

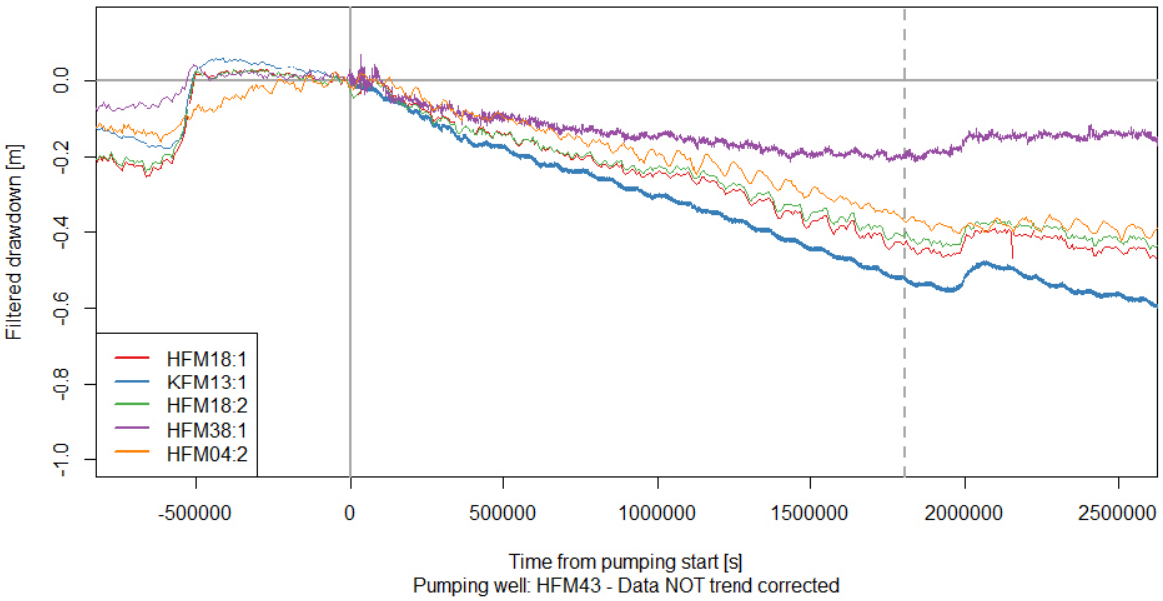

Filtered drawdown [m]
0.0
-0.5
-1.0
-1.5
-500000
0
500000
1000000
1500000
2000000
2500000
HFM23:1
KFM05A:5
KFM21:1
KFM24:1
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected


Filtered drawdown [m]
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-500000
0
500000
1000000
1500000
2000000
2500000
HFM40:1
KFM06A:7
HFM32:2
HFM32:1
KFM06A:6
HFM38:2
SFM000146:1
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected

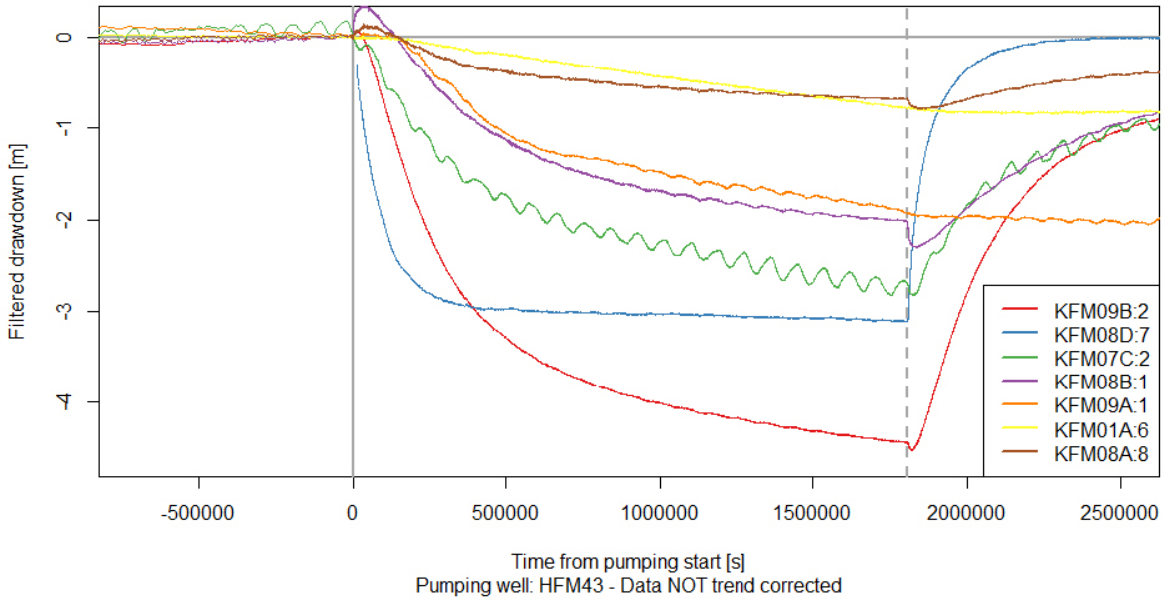

Filtered drawdown [m]
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
HFM13:3
KFM02A:4
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected

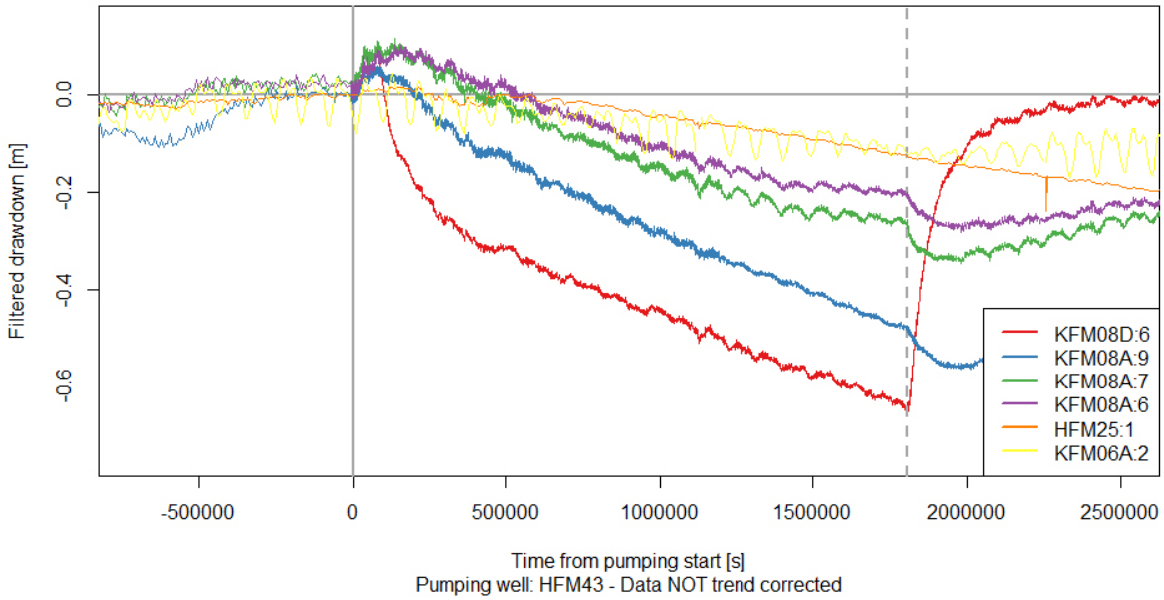

Filtered drawdown [m]
0.0
-0.2
-0.4
-0.6
-0.8
KFM02A:3
KFM06B:3
KFM02A:5
KFM06A:5
HFM41:1
KFM06A:4
SFM000145:1
KFM08B:2
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected


Filtered drawdown [m]
0.0
-0.2
-0.4
-0.6
-0.8
KFM22:1
KFM02A:6
HFM39:1
KFM06A:3
KFM15:1
HFM18:3
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected

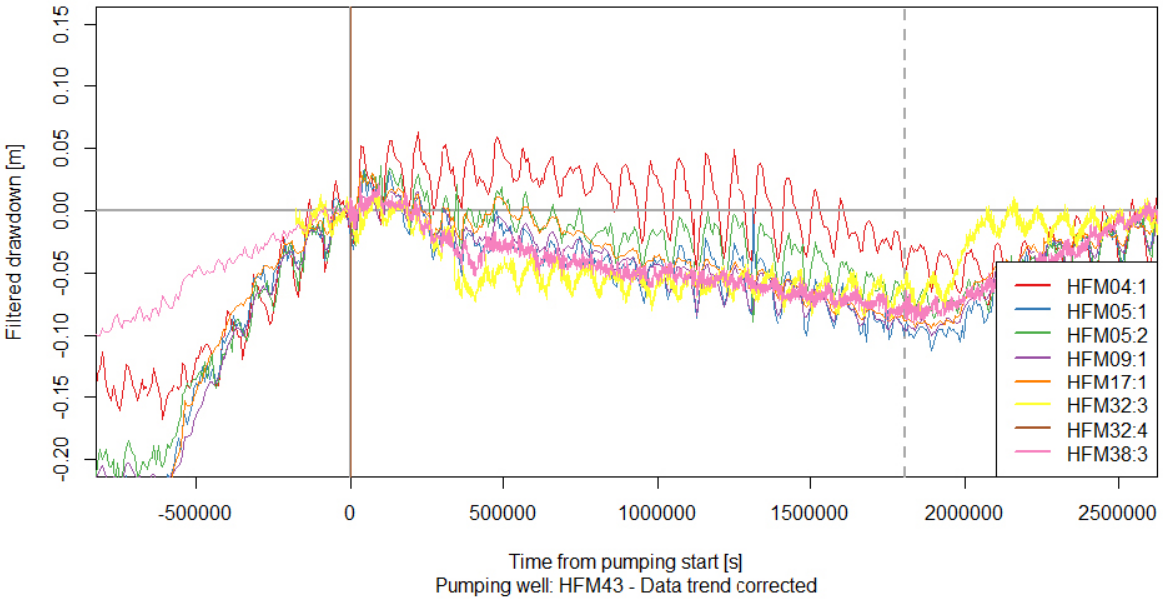

Filtered drawdown [m]
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
HFM18:1
KFM13:1
HFM18:2
HFM38:1
HFM04:2
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected

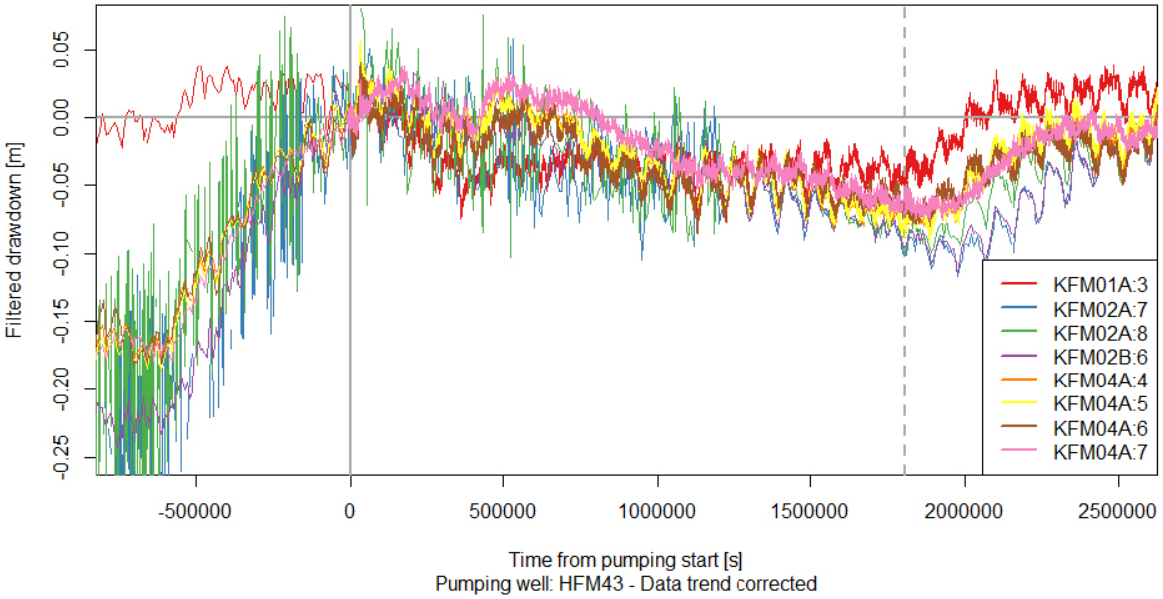
Not trend corrected data for sections where drawdown is evaluated without trend correction

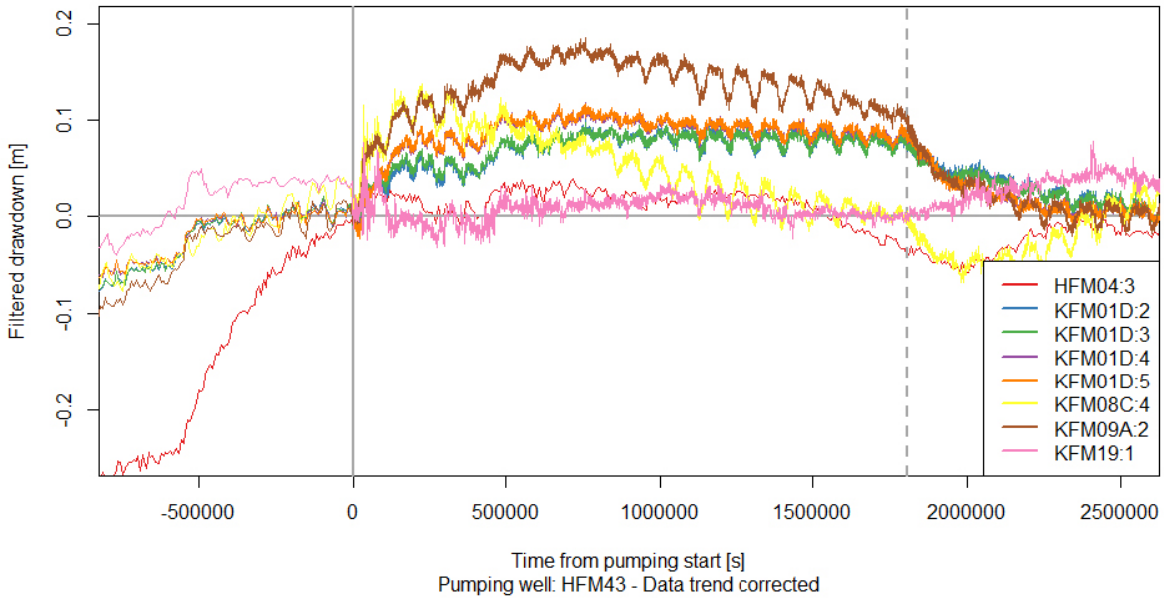


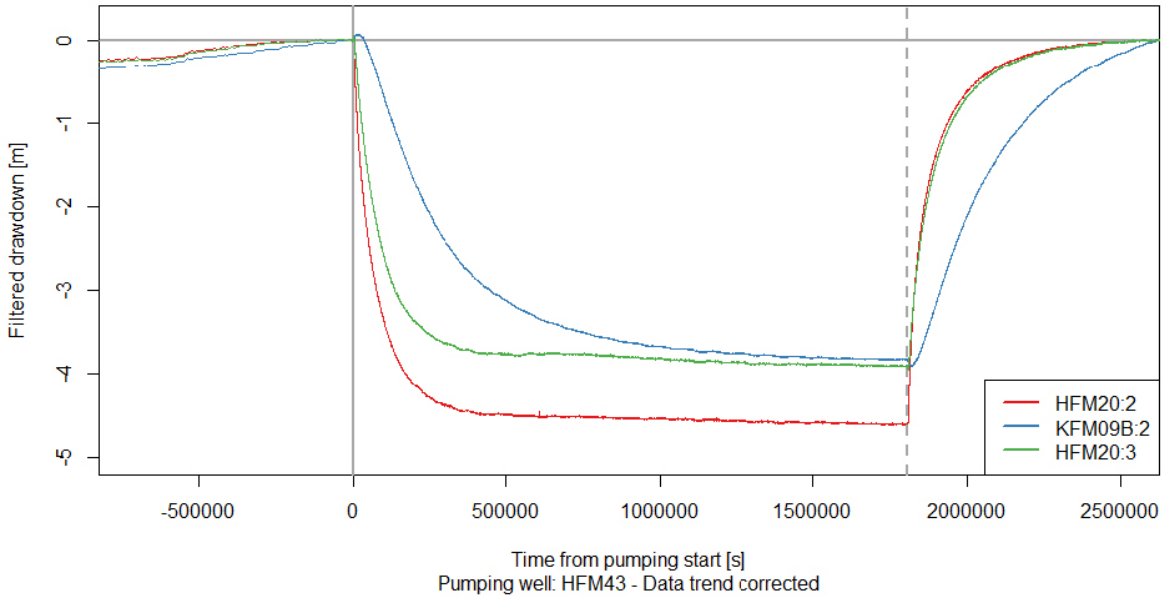


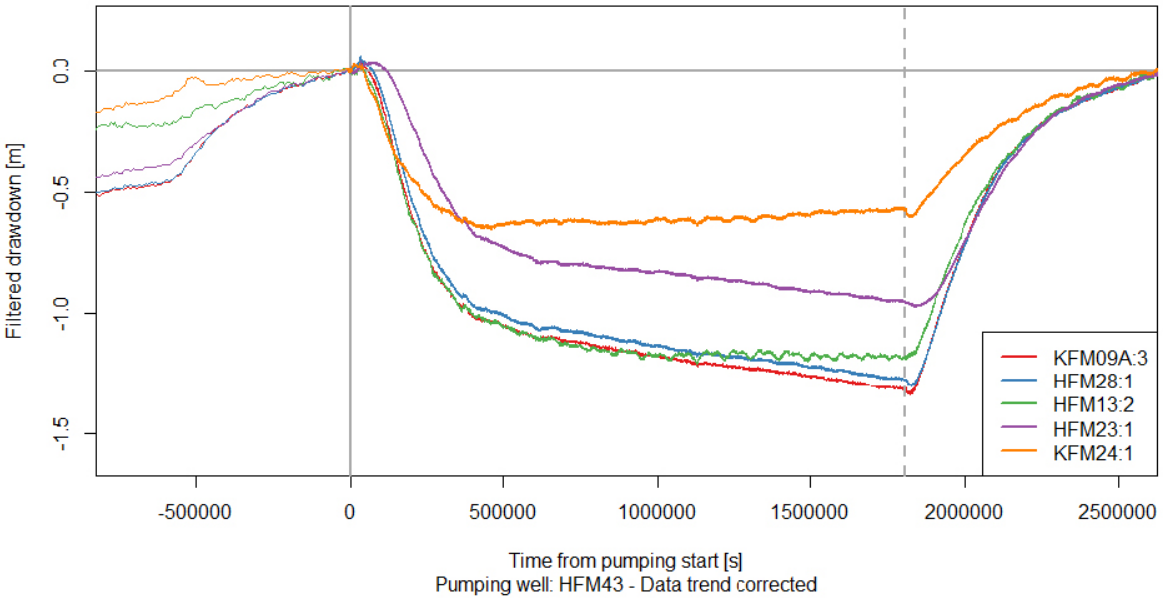
Other responses

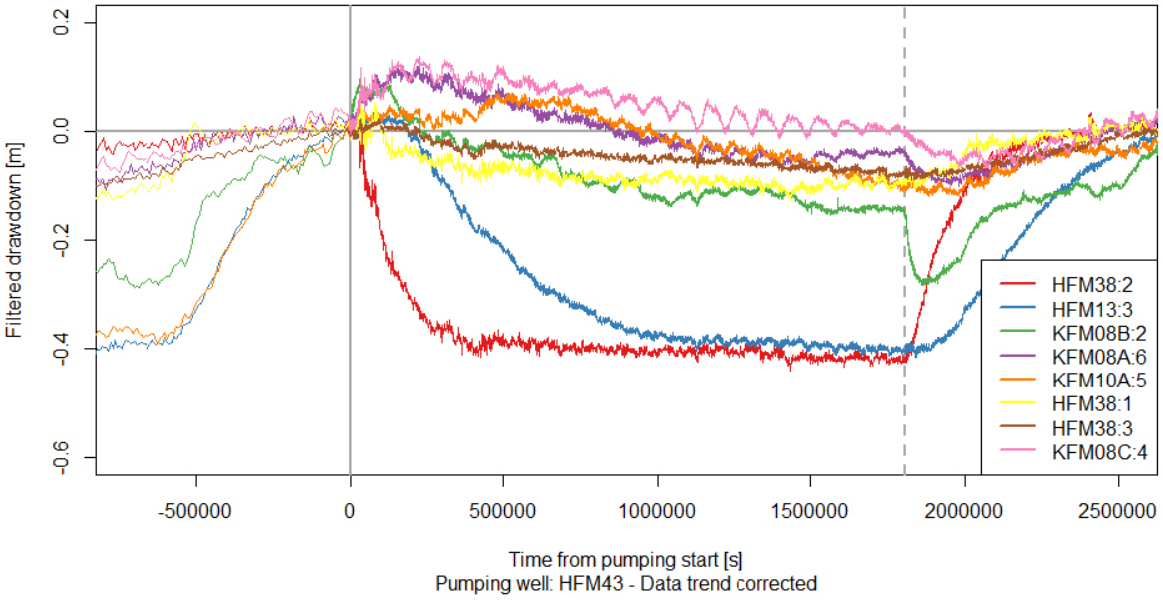


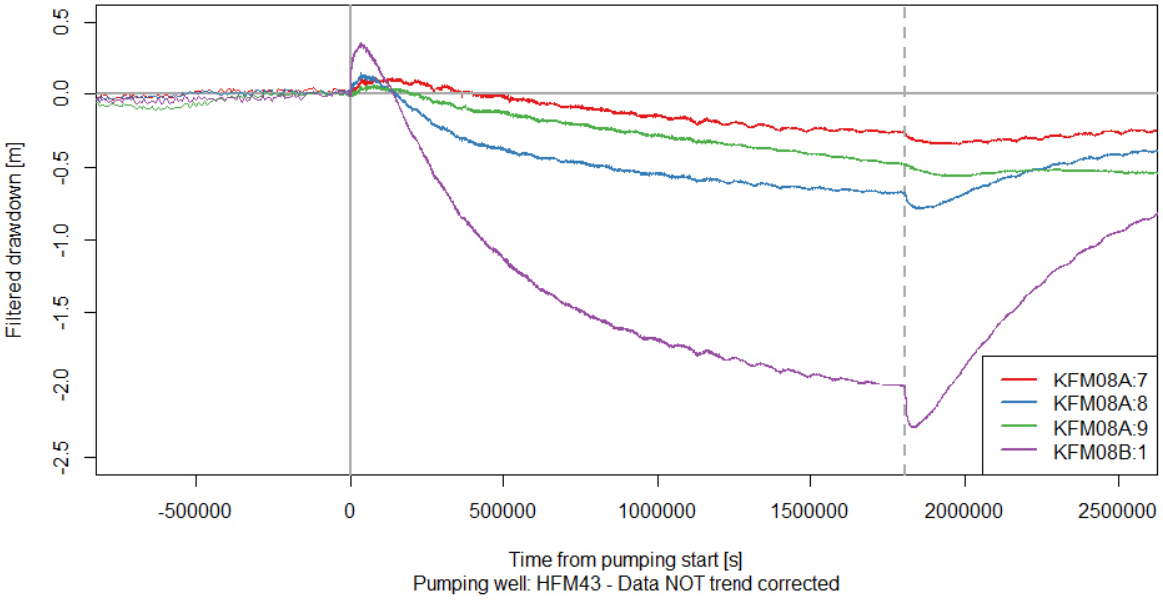



Filtered drawdown [m]
0.2
0.1
0.0
-0.1
-0.2
-500000
0
500000
1000000
1500000
2000000
2500000
HFM04:3
KFM01D:2
KFM01D:3
KFM01D:4
KFM01D:5
KFM08C:4
KFM09A:2
KFM19:1
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected


Filtered drawdown [m]
0
-1
-2
-3
-4
-5
-500000
0
500000
1000000
1500000
2000000
2500000
HFM20:2
KFM09B:2
HFM20:3
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected

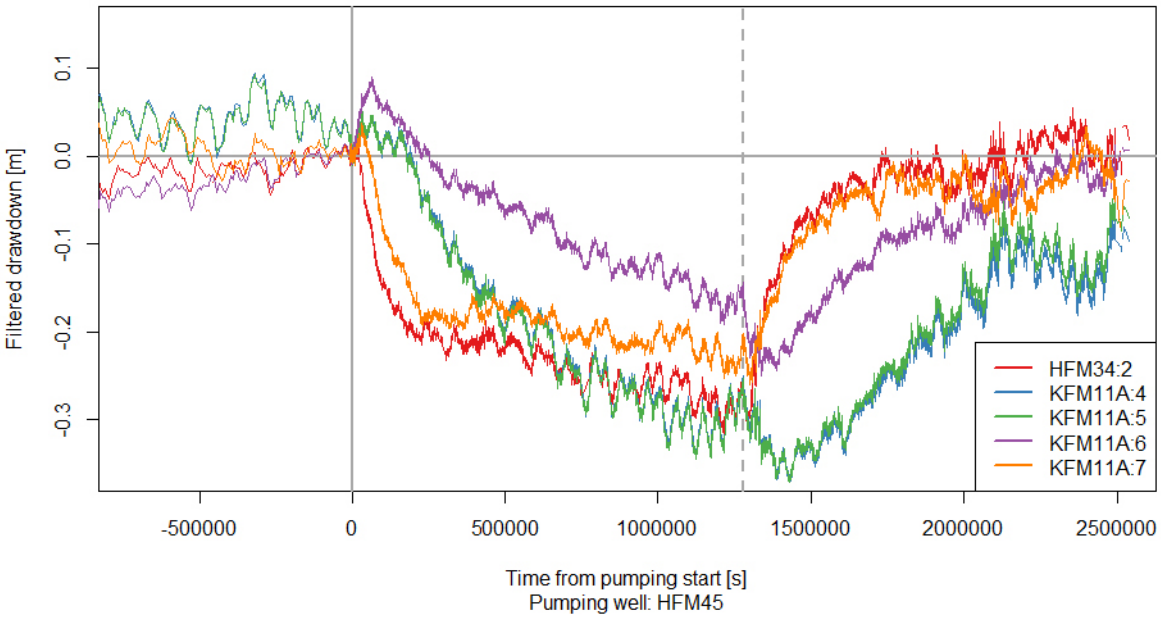

Filtered drawdown [m]
0.0
-0.5
-1.0
-1.5
-500000
0
500000
1000000
1500000
2000000
2500000
KFM09A:3
HFM28:1
HFM13:2
HFM23:1
KFM24:1
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected


Filtered drawdown [m]
0.2
0.0
-0.2
-0.4
-0.6
-500000
0
500000
1000000
1500000
2000000
2500000
HFM38:2
HFM13:3
KFM08B:2
KFM08A:6
KFM10A:5
HFM38:1
HFM38:3
KFM08C:4
Time from pumping start [s]
Pumping well: HFM43 - Data trend corrected

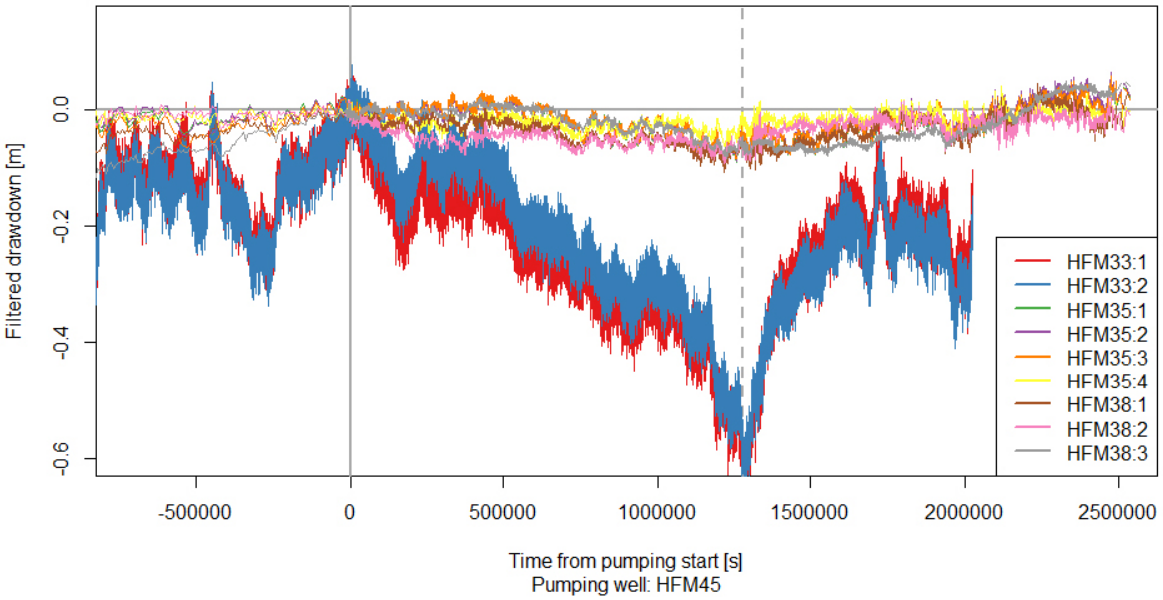

Filtered drawdown [m]
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-500000
0
500000
1000000
1500000
2000000
2500000
KFM08A:7
KFM08A:8
KFM08A:9
KFM08B:1
Time from pumping start [s]
Pumping well: HFM43 - Data NOT trend corrected

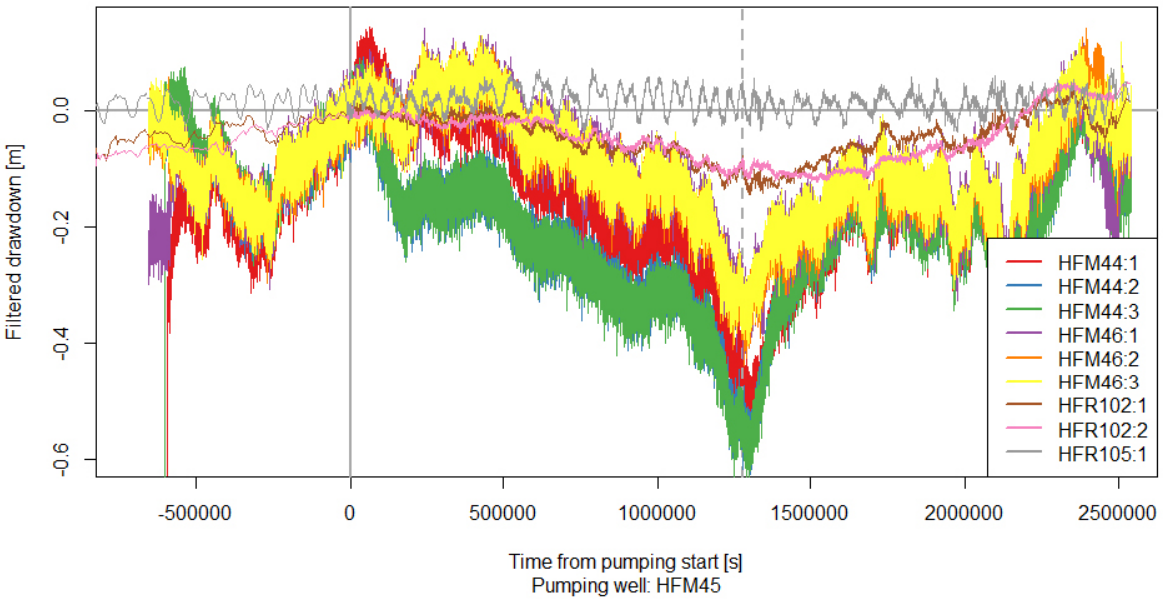
Observed drawdown – Interference test in HFM45

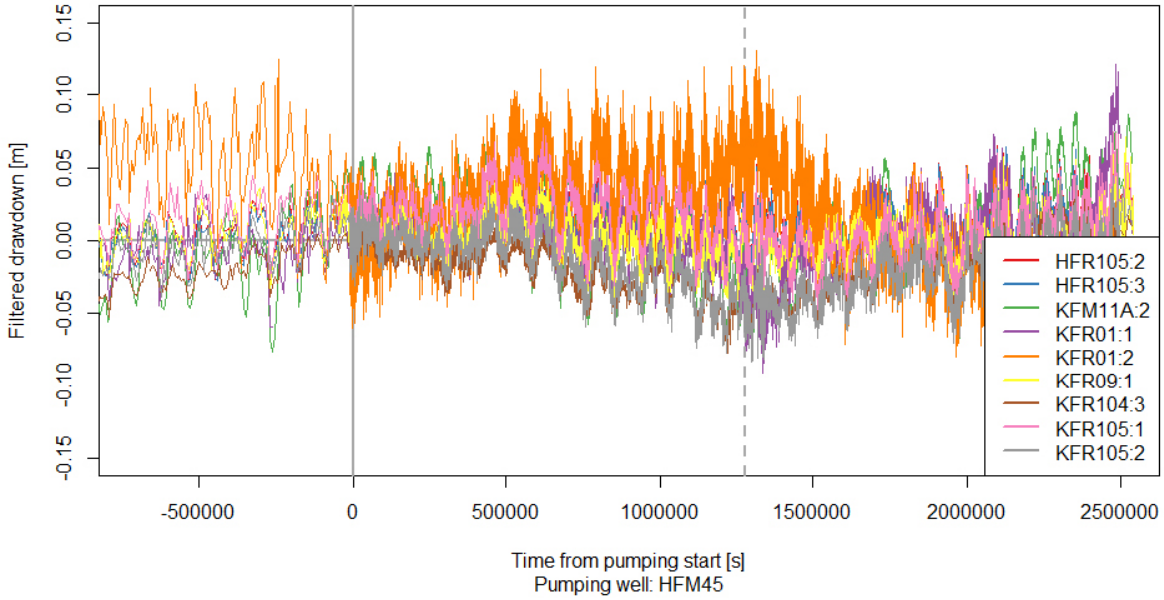
Responses > 0.1 m

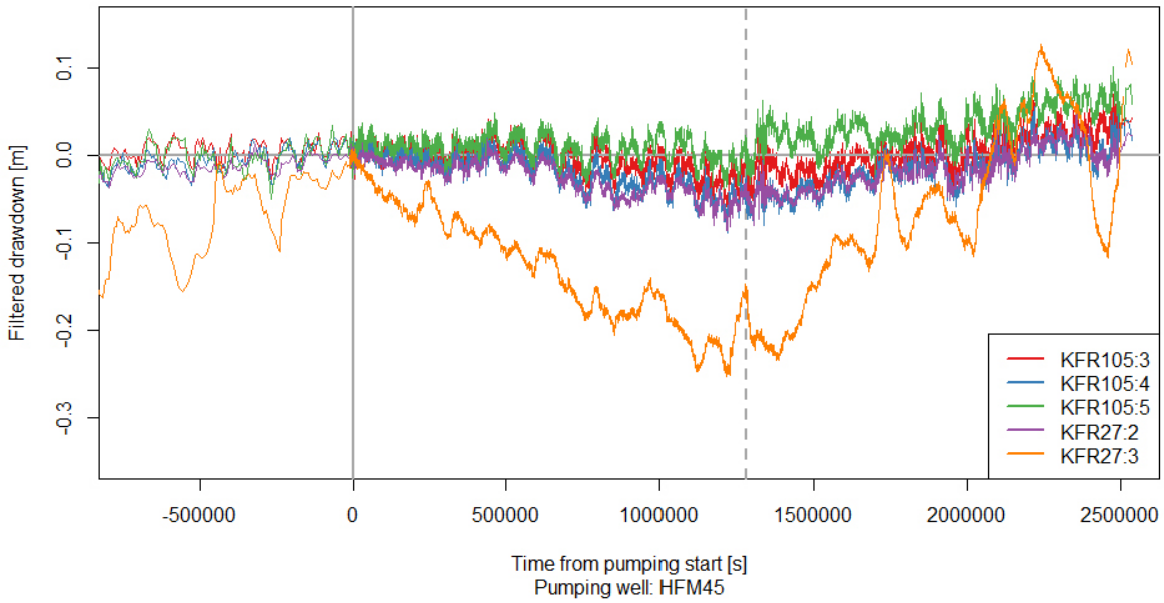


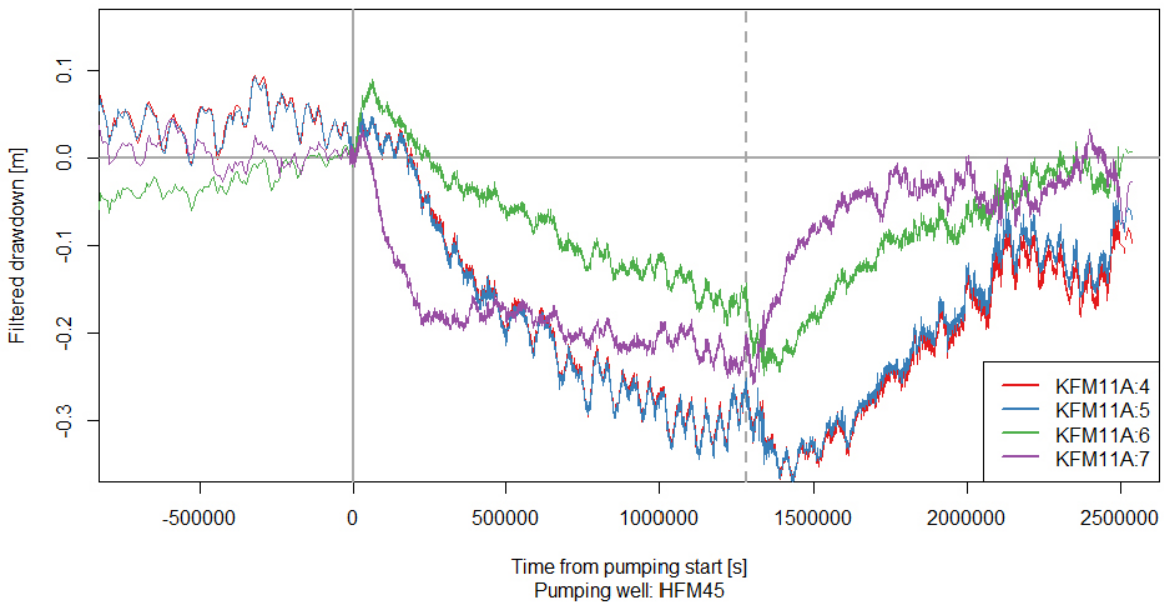
Other responses






Filtered drawdown [m]
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM45
HFR105:2
HFR105:3
KFM11A:2
KFR01:1
KFR01:2
KFR09:1
KFR104:3
KFR105:1
KFR105:2

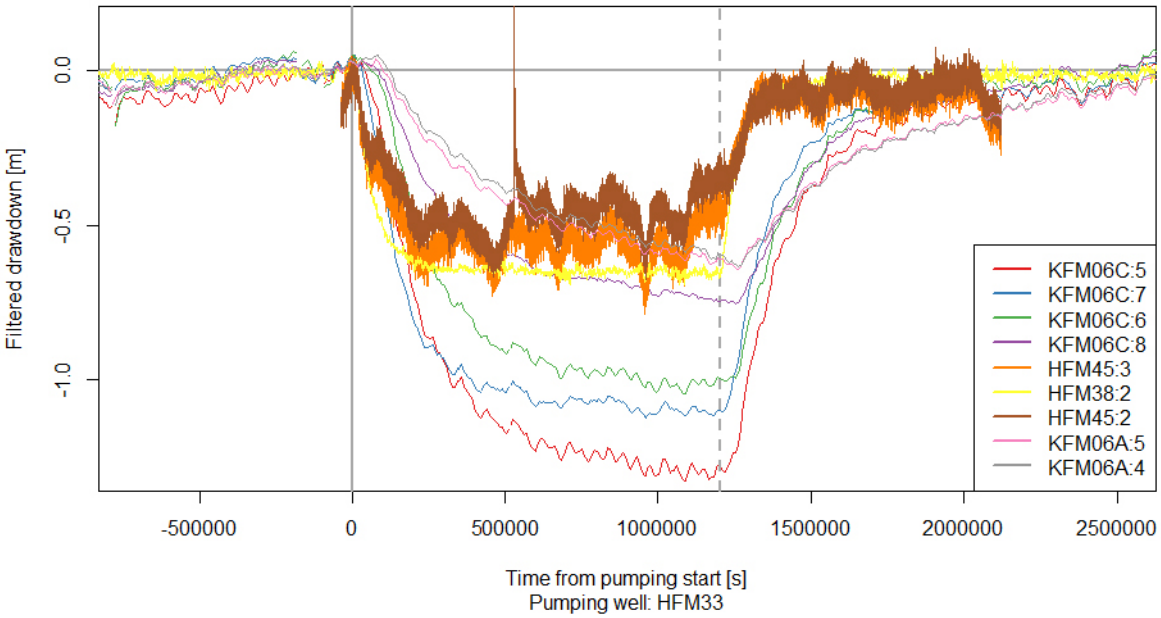

Filtered drawdown [m]
0.1
0.0
-0.1
-0.2
-0.3
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM45
KFR105:3
KFR105:4
KFR105:5
KFR27:2
KFR27:3

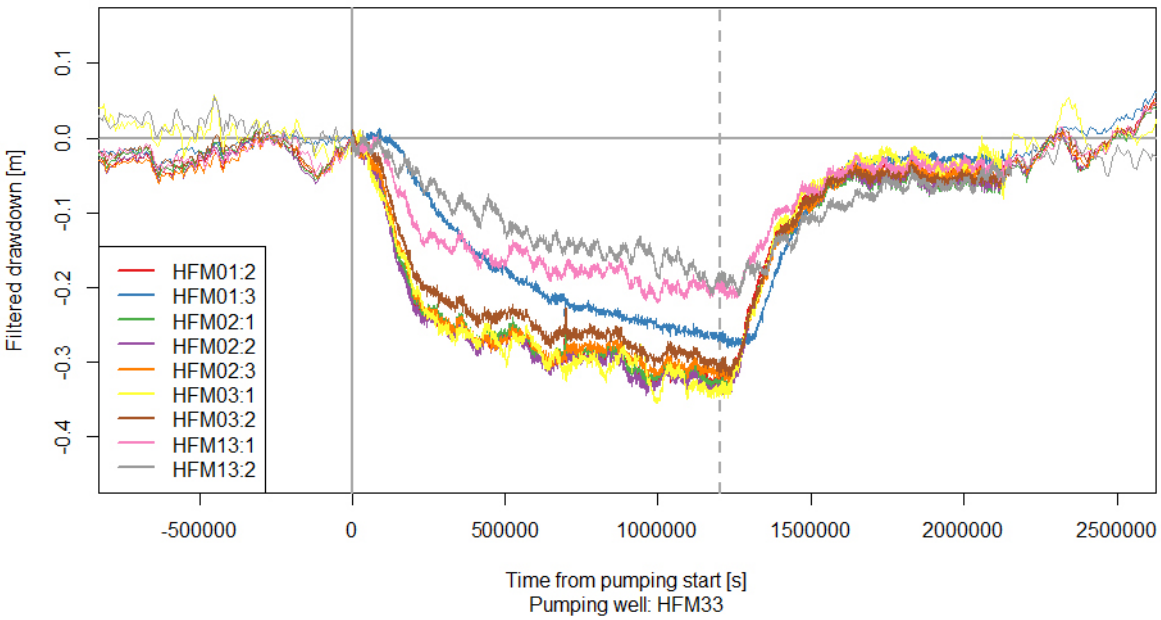

Filtered drawdown [m]
0.1
0.0
-0.1
-0.2
-0.3
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM45
KFM11A:4
KFM11A:5
KFM11A:6
KFM11A:7

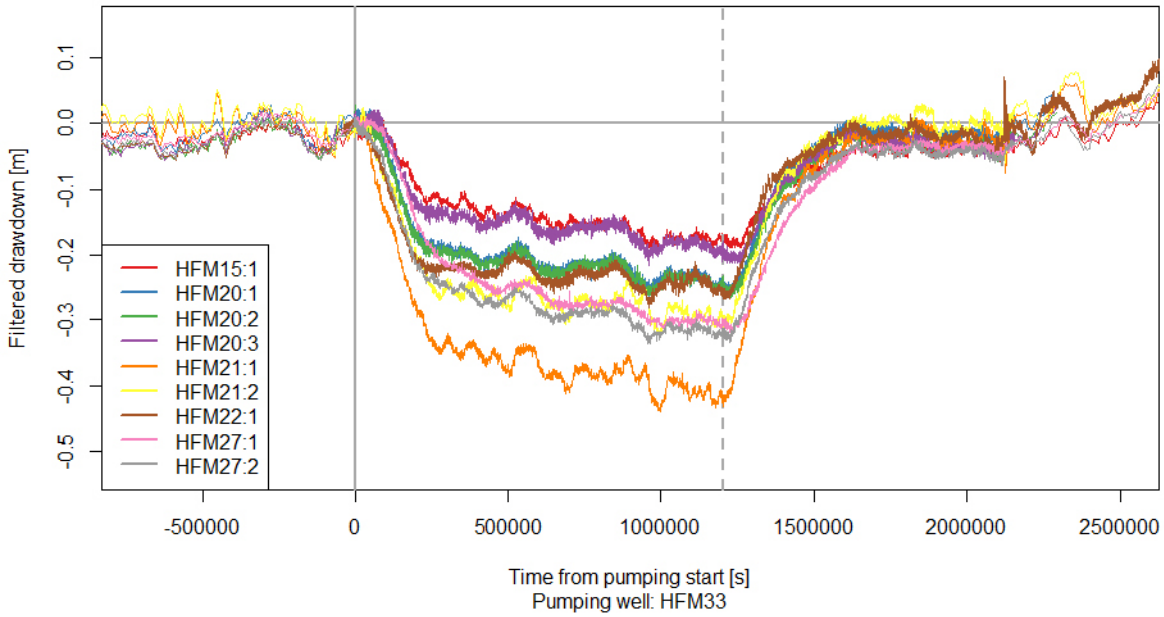
Observed drawdown – Interference test in HFM33

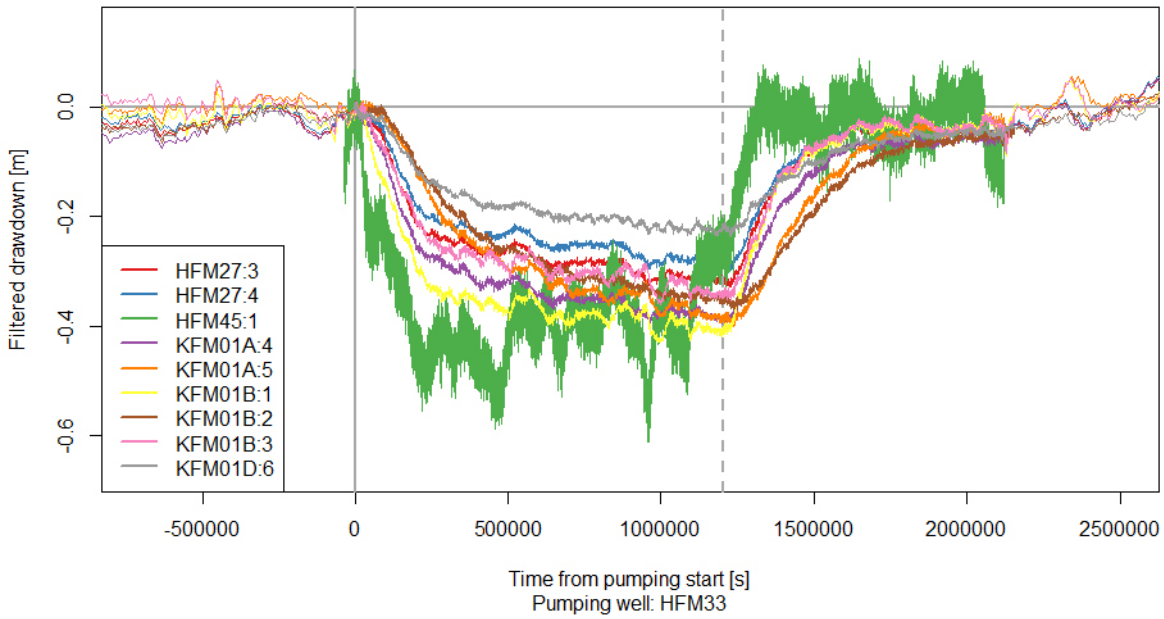
Responses > 0.1 m

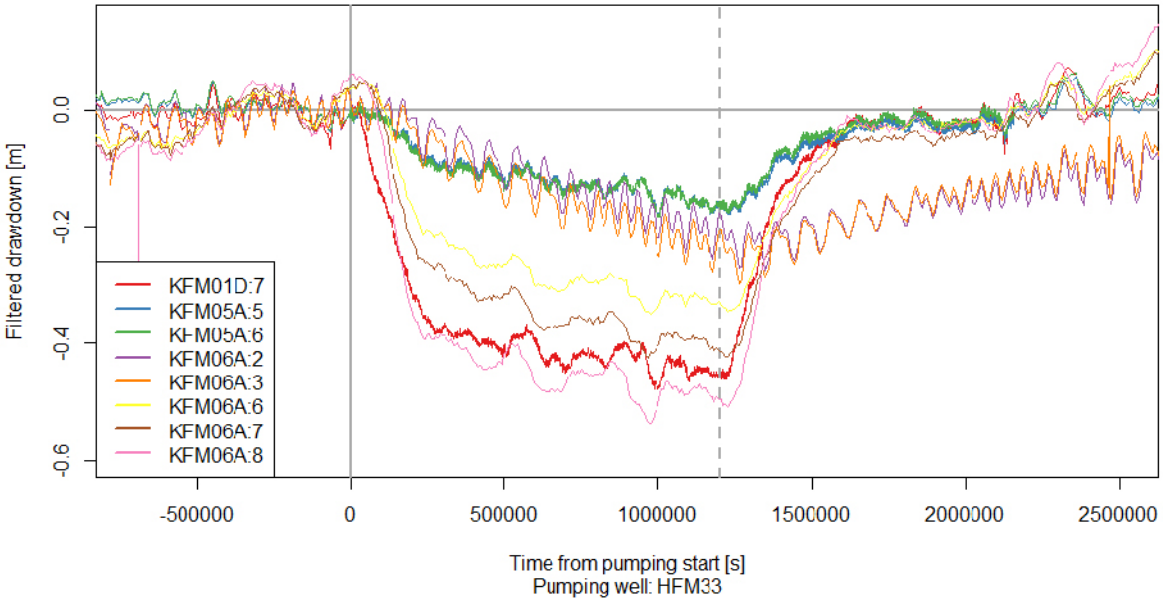
Figures mainly sorted by name. Except the first figure, which contains the sections with biggest drawdown.

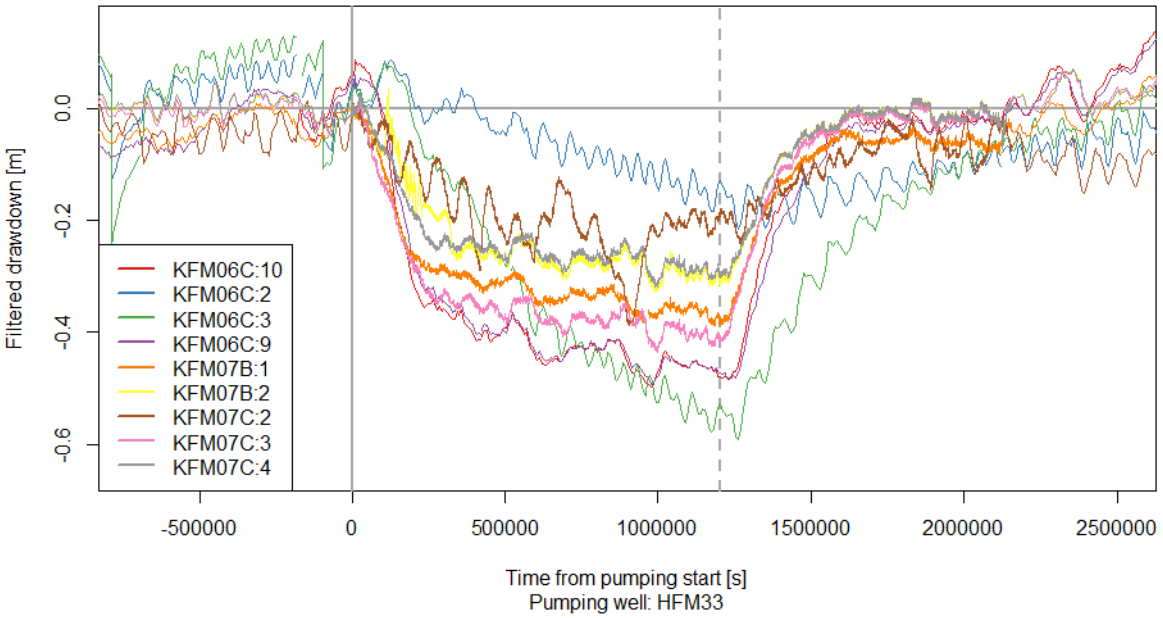


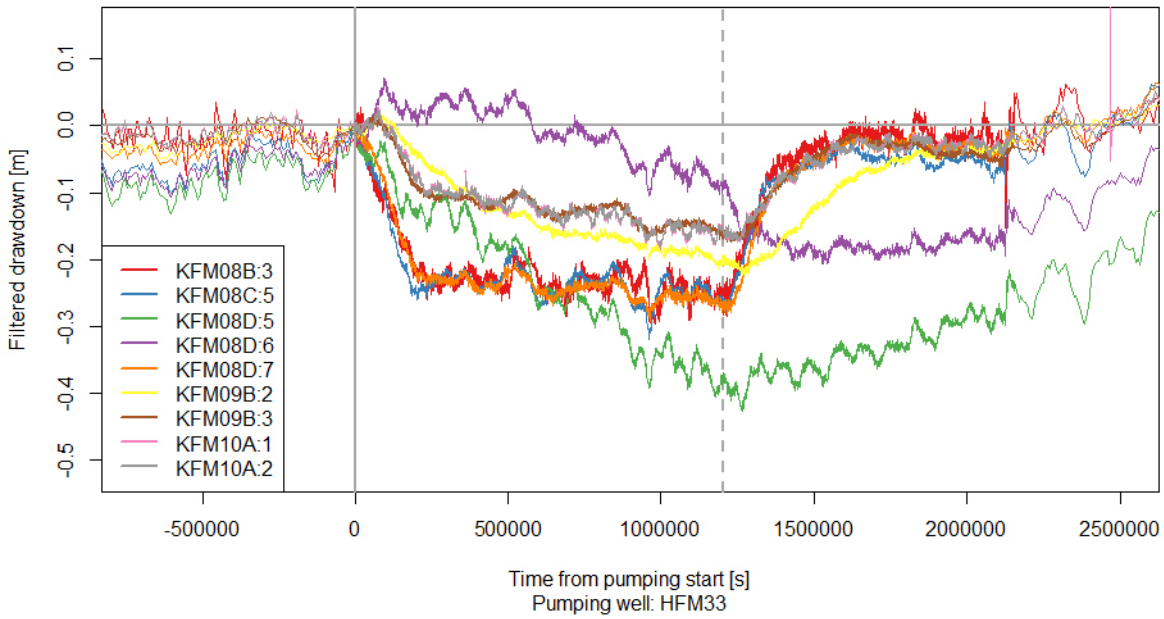


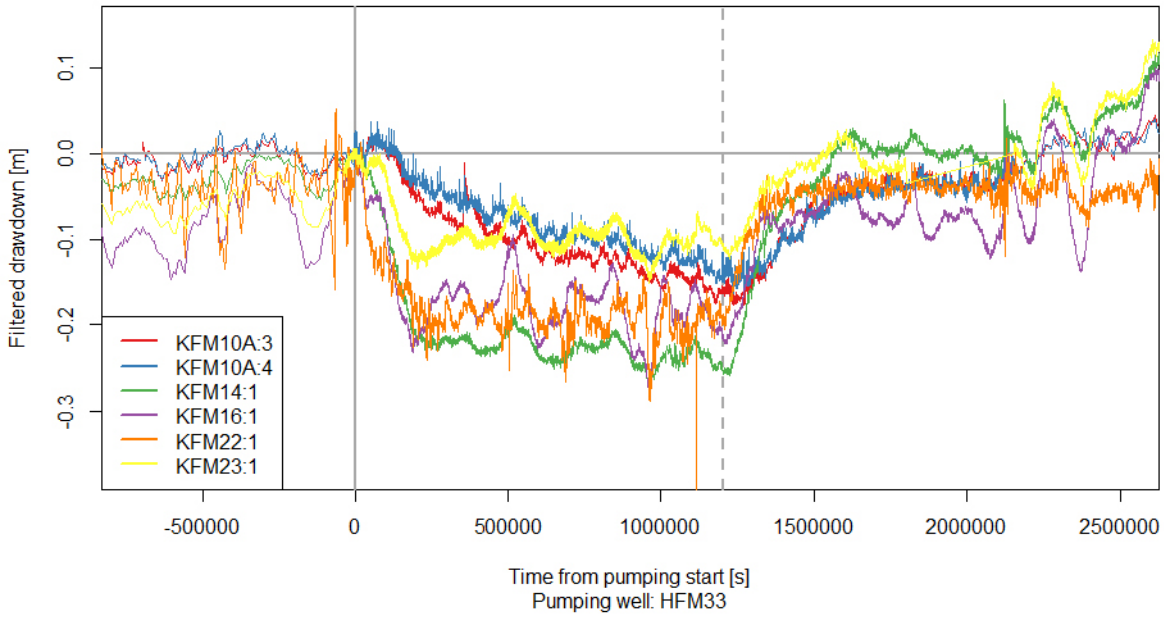

Filtered drawdown [m]
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
HFM15:1
HFM20:1
HFM20:2
HFM20:3
HFM21:1
HFM21:2
HFM22:1
HFM27:1
HFM27:2
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM33


Filtered drawdown [m]
0.0
-0.2
-0.4
-0.6
HFM27:3
HFM27:4
HFM45:1
KFM01A:4
KFM01A:5
KFM01B:1
KFM01B:2
KFM01B:3
KFM01D:6
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM33

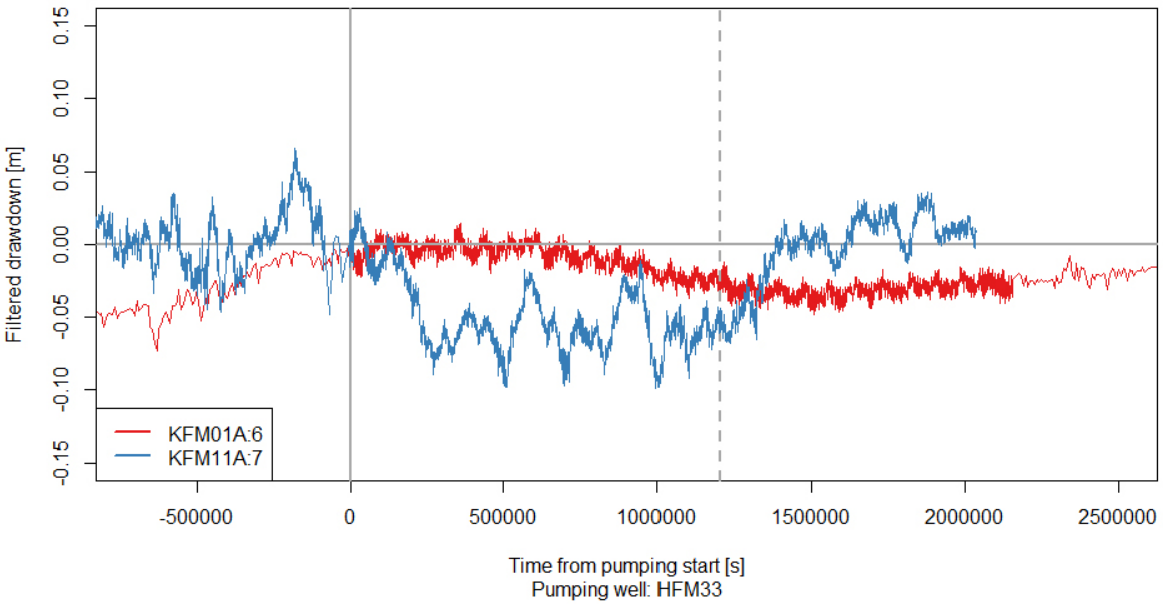

Filtered drawdown [m]
0.0
-0.2
-0.4
-0.6
KFM01D:7
KFM05A:5
KFM05A:6
KFM06A:2
KFM06A:3
KFM06A:6
KFM06A:7
KFM06A:8
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM33

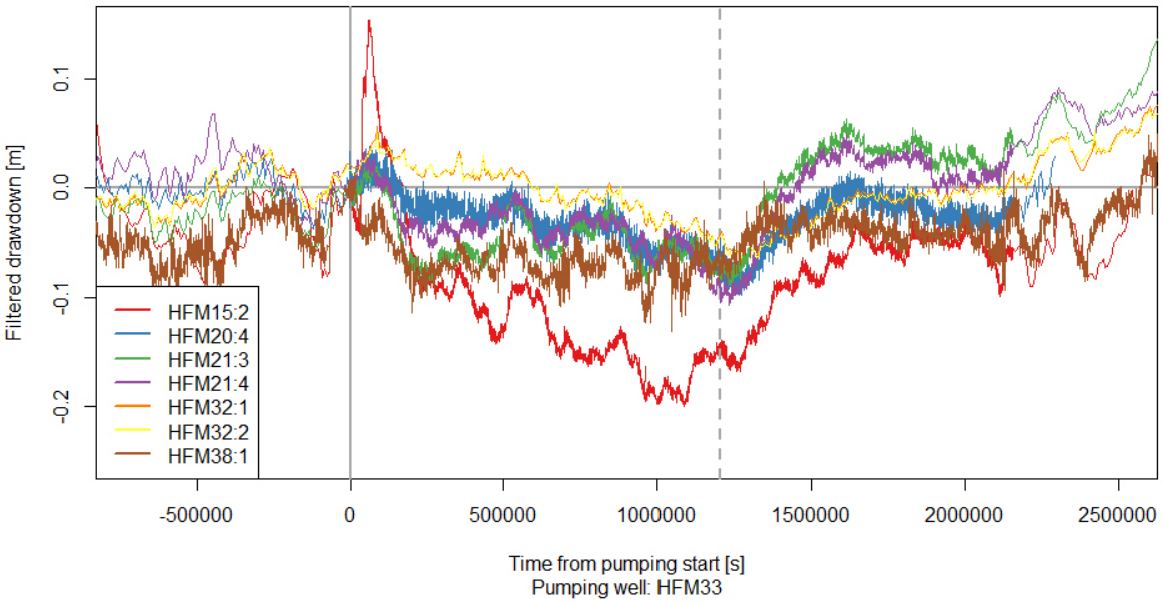

Filtered drawdown [m]
0.0
-0.2
-0.4
-0.6
KFM06C:10
KFM06C:2
KFM06C:3
KFM06C:9
KFM07B:1
KFM07B:2
KFM07C:2
KFM07C:3
KFM07C:4
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM33

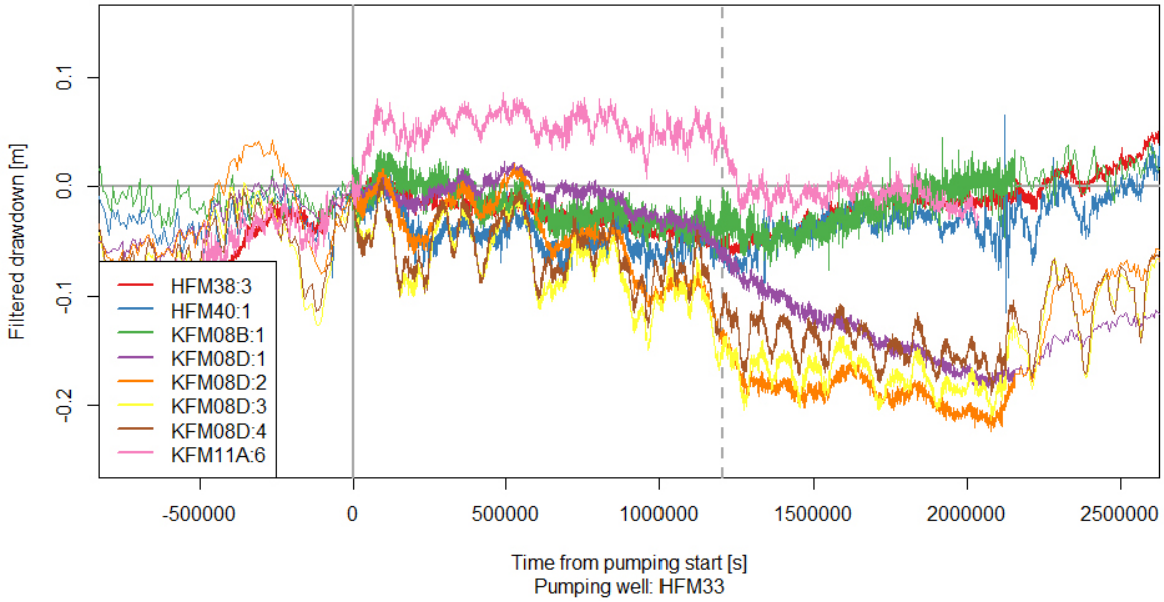

Filtered drawdown [m]
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
KFM08B:3
KFM08C:5
KFM08D:5
KFM08D:6
KFM08D:7
KFM09B:2
KFM09B:3
KFM10A:1
KFM10A:2
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM33

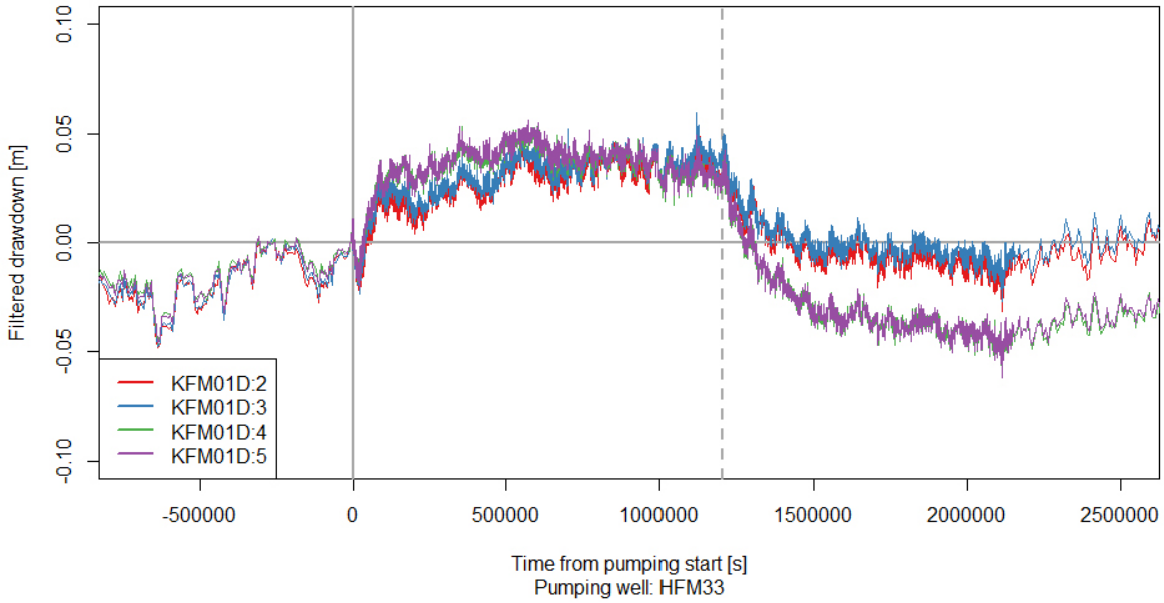

Filtered drawdown [m]
0.1
0.0
-0.1
-0.2
-0.3
KFM10A:3
KFM10A:4
KFM14:1
KFM16:1
KFM22:1
KFM23:1
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM33

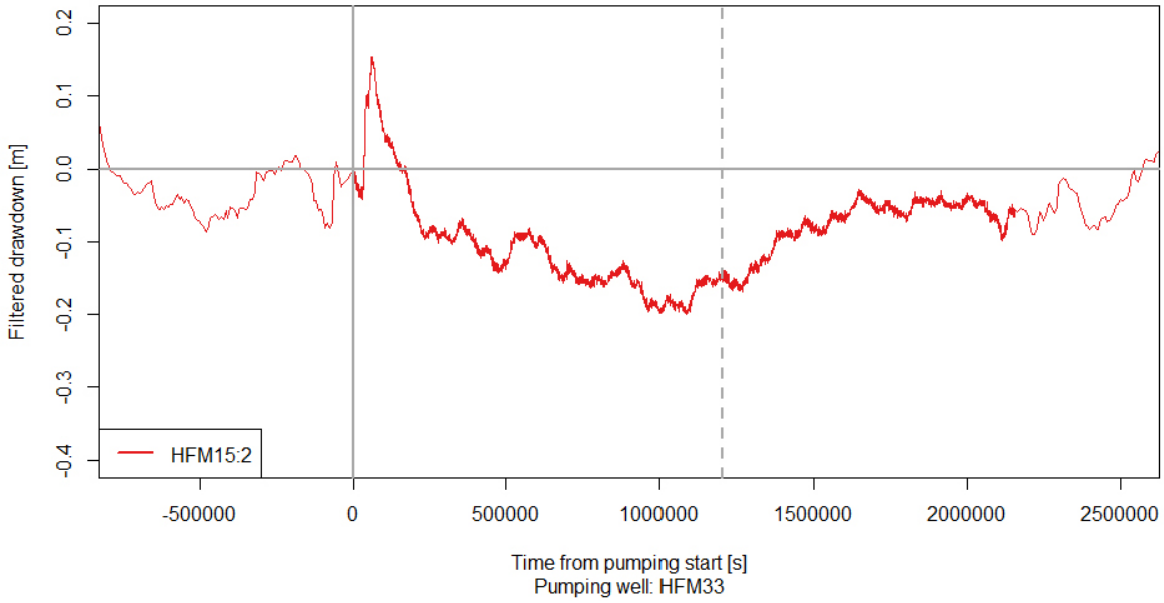
Other responses





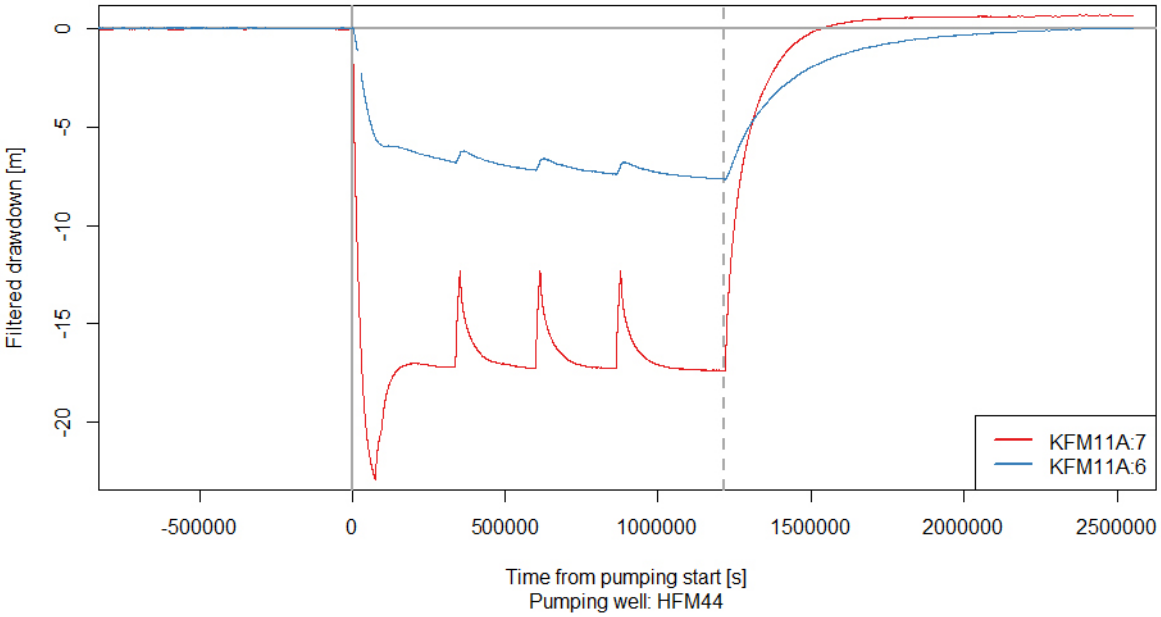

Filtered drawdown [m]
0.1
0.0
-0.1
-0.2
HFM38:3
HFM40:1
KFM08B:1
KFM08D:1
KFM08D:2
KFM08D:3
KFM08D:4
KFM11A:6
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM33

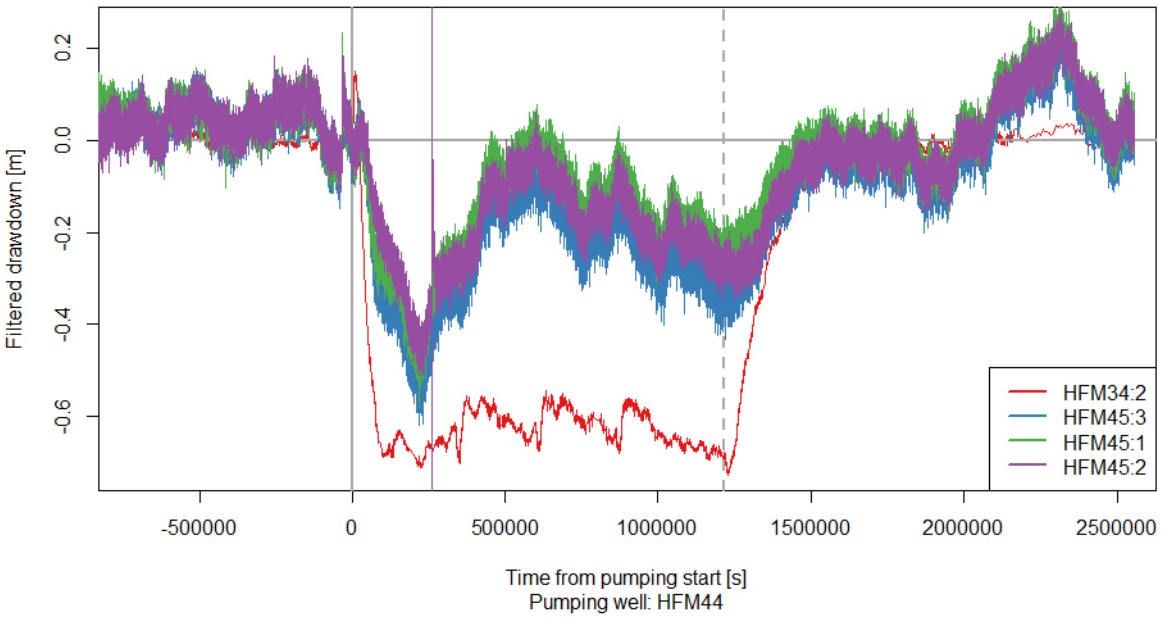

Filtered drawdown [m]
0.10
0.05
0.00
-0.05
-0.10
KFM01D:2
KFM01D:3
KFM01D:4
KFM01D:5
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM33


Filtered drawdown [m]
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
HFM15:2
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM33

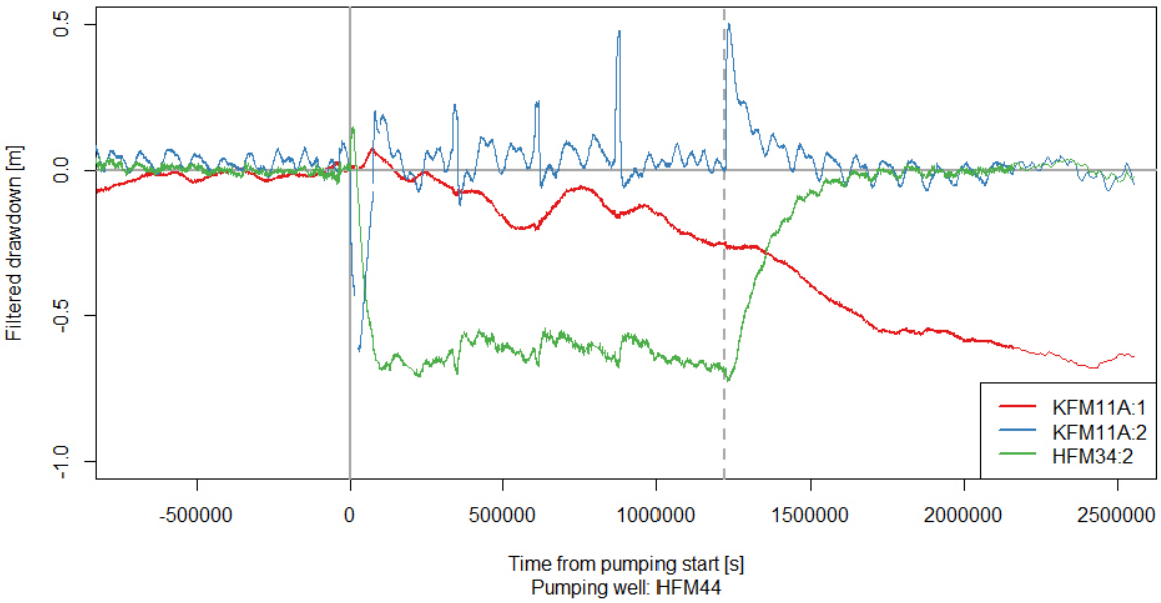
Observed drawdown – Interference test in HFM44

Responses > 0.1 m



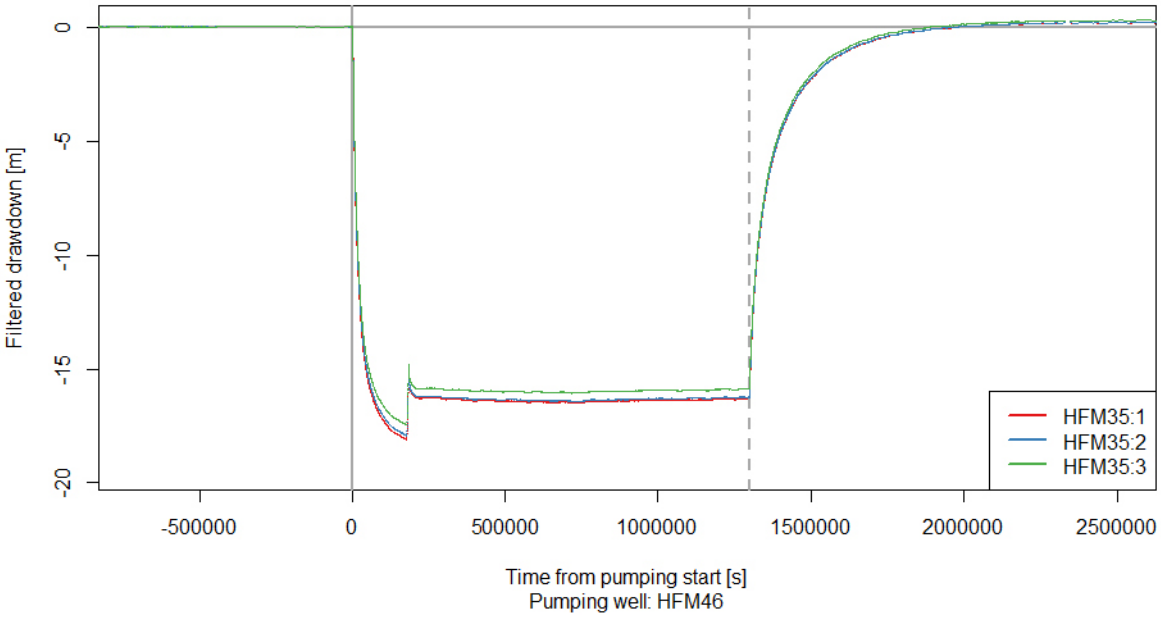


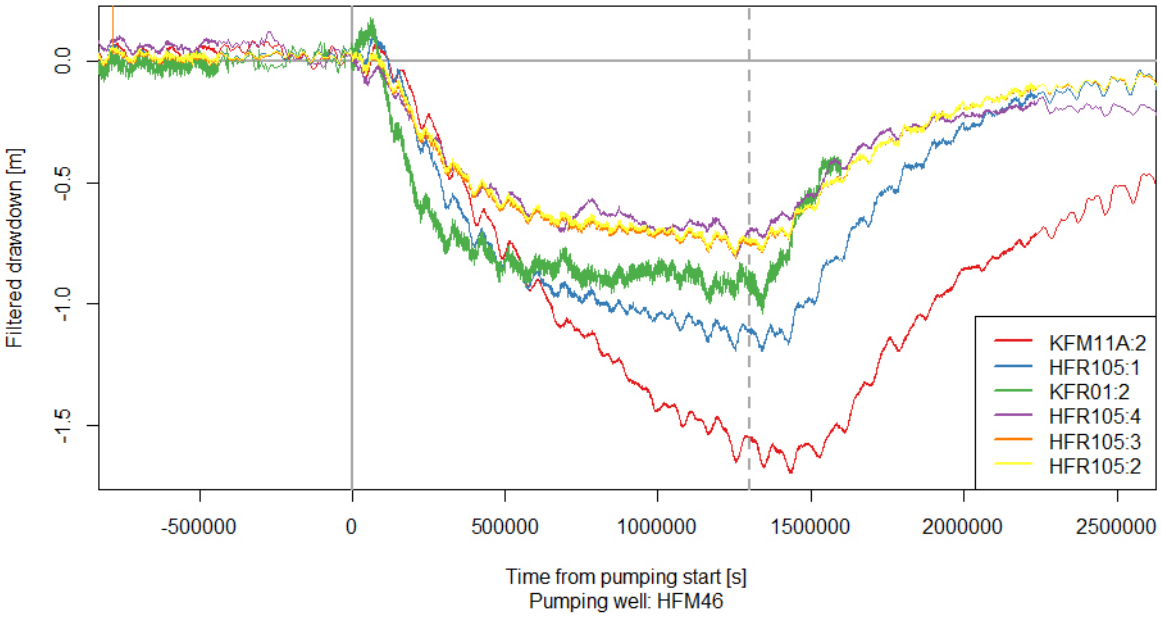
Other responses

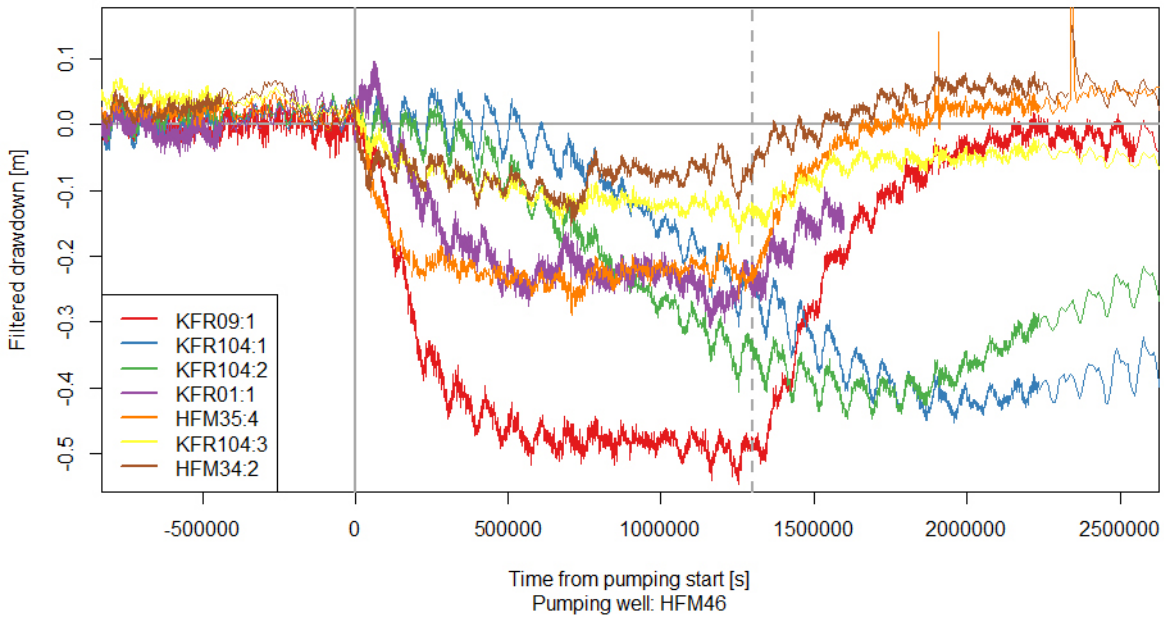


Observed drawdown – Interference test in HFM46

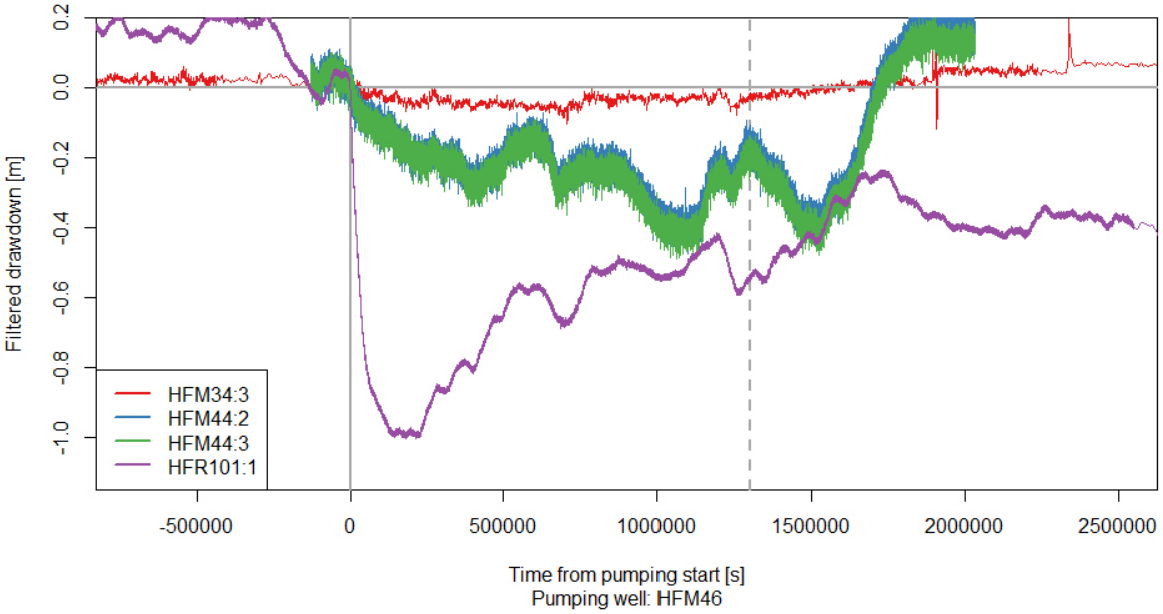
Responses > 0.1 m






Filtered drawdown [m]
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
KFR09:1
KFR104:1
KFR104:2
KFR01:1
HFM35:4
KFR104:3
HFM34:2
-500000
0
500000
1000000
1500000
2000000
2500000
Time from pumping start [s]
Pumping well: HFM46

Other responses



Appendix 5

Observed responses – Maps of Index 1

Interference test in HFM43

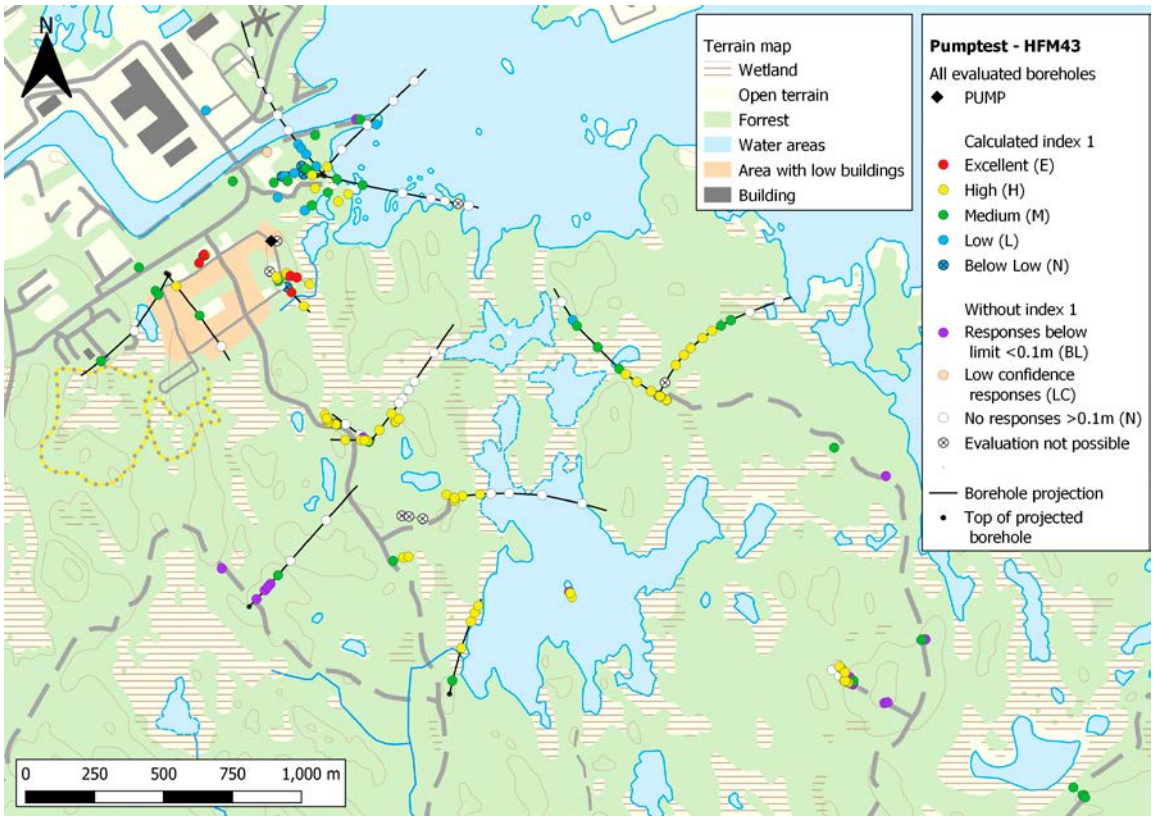


Figure A5-1. *Calculated Index 1 from the interference tests in HFM43. All responses are listed in Table 4-2 to Table 4-4 in the main report. Background map origin: Lantmäteriet.*

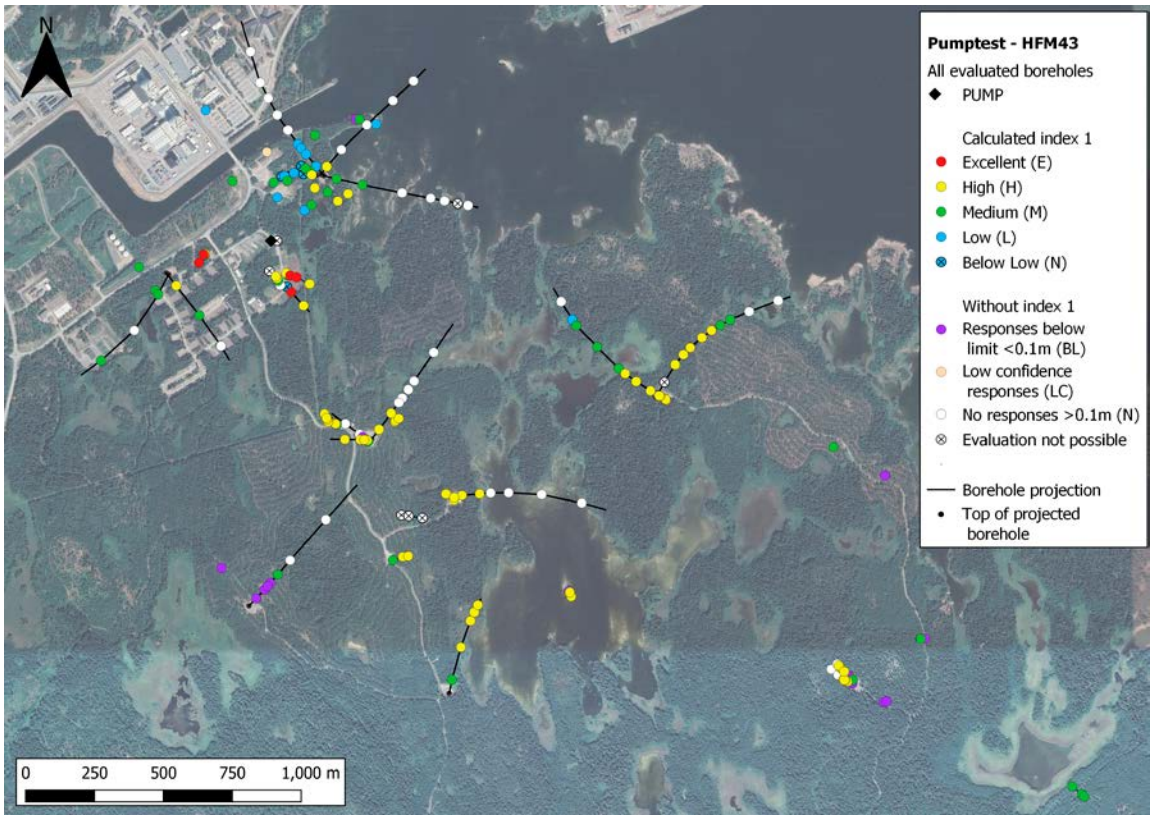


Figure A5-2. *Calculated Index 1 from the interference tests in HFM43. All evaluated boreholes. Background map origin: Google maps.*

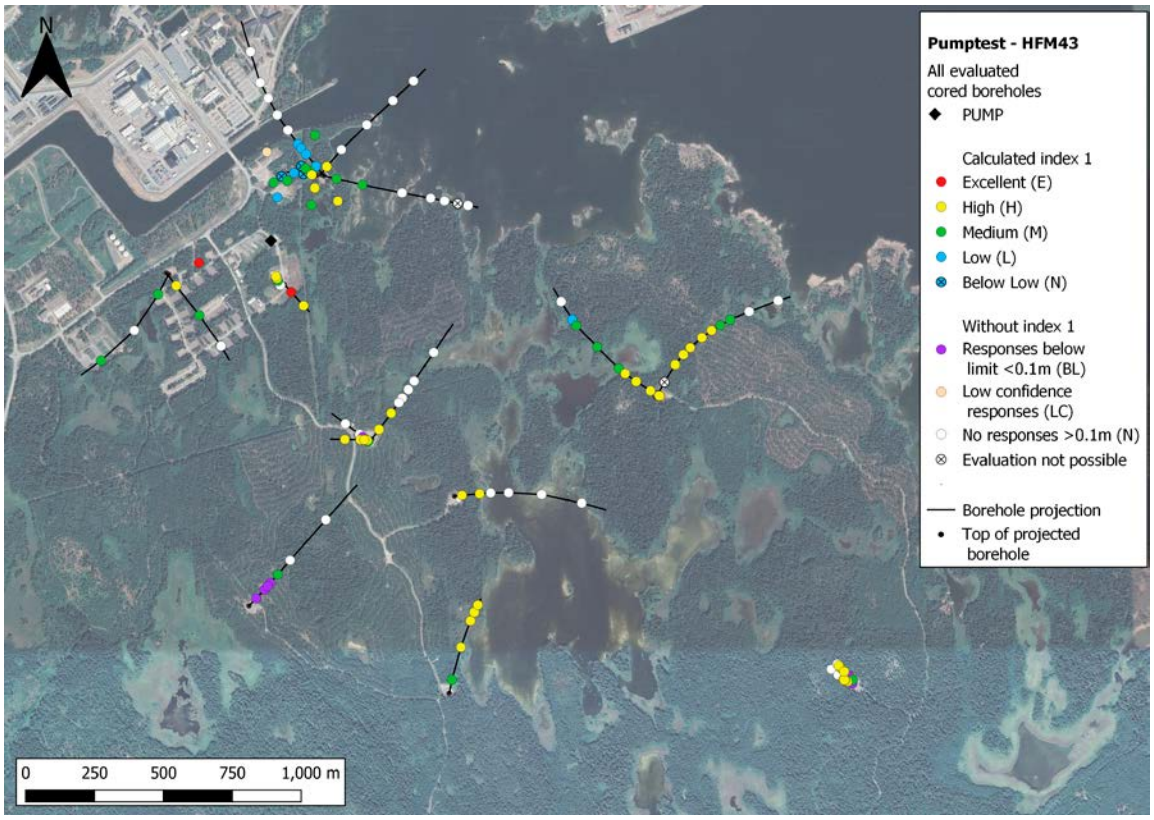


Figure A5-3. *Calculated Index 1 from the interference tests in HFM43. All evaluated cored boreholes. Background map origin: Google maps.*

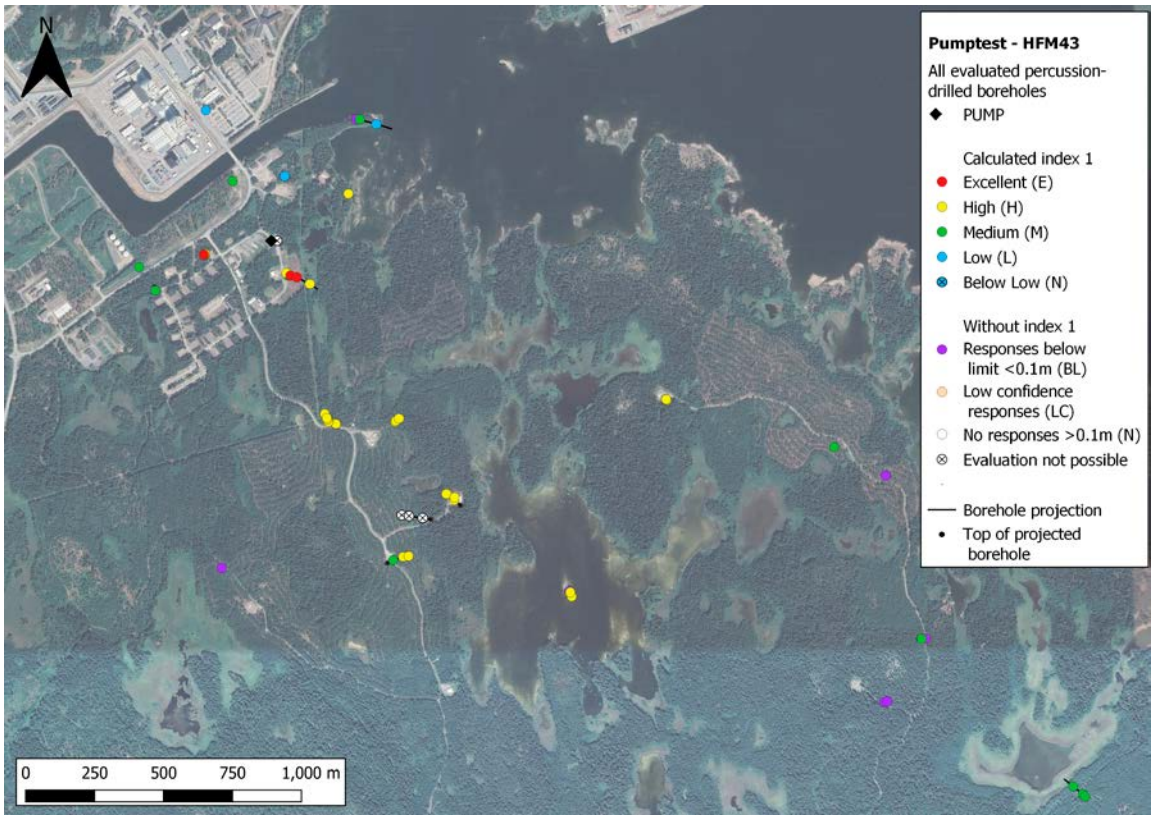


Figure A5-4. *Calculated Index 1 from the interference tests in HFM43. All evaluated percussion drilled boreholes. Background map origin: Google maps.*

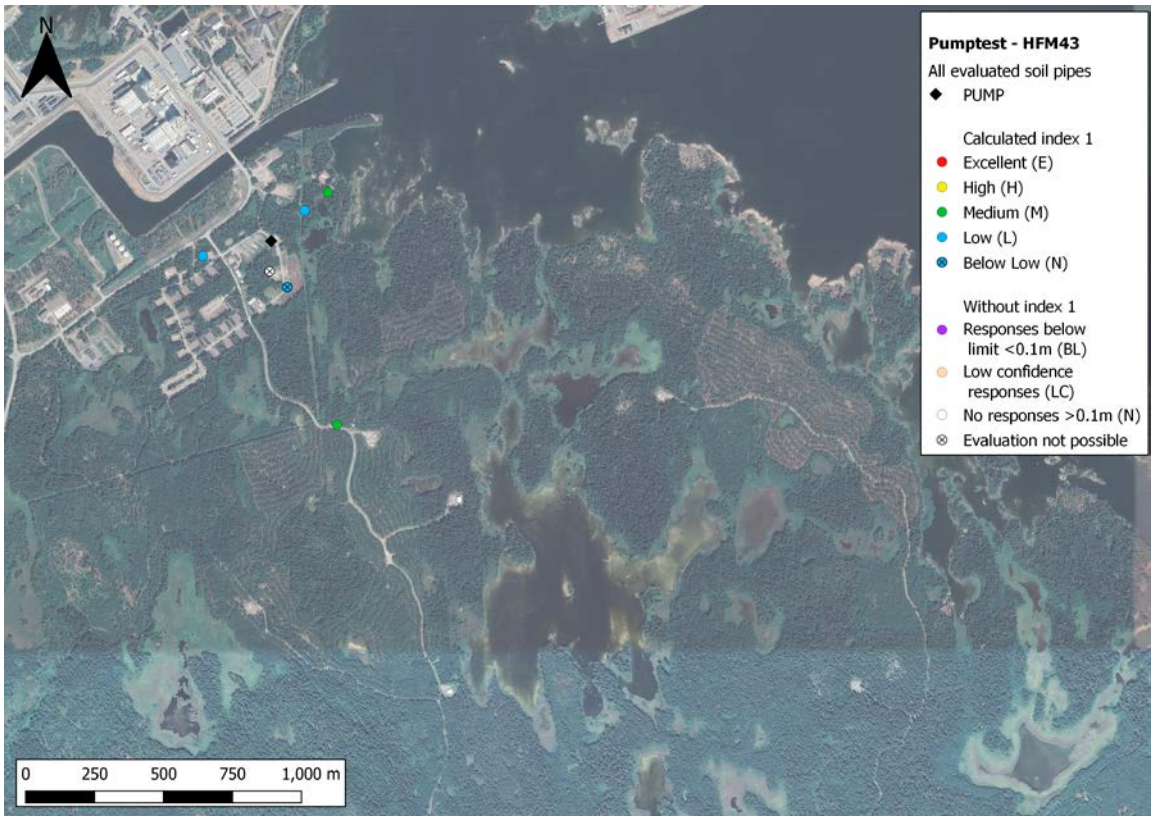


Figure A5-5. *Calculated Index 1 from the interference tests in HFM43. All evaluated soil pipes. Background map origin: Google maps.*

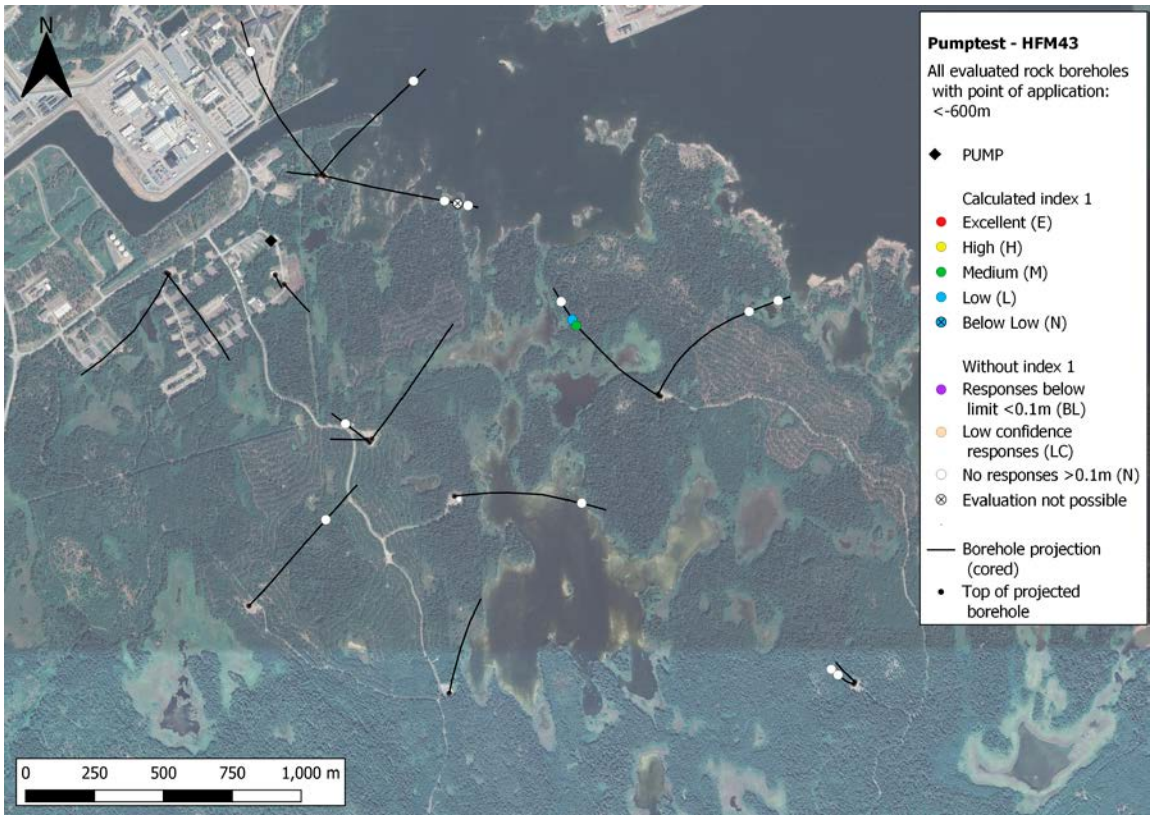


Figure A5-6. *Calculated Index 1 from the interference tests in HFM43. All evaluated rock borehole sections with point of application of < −600 m. Background map origin: Google maps.*

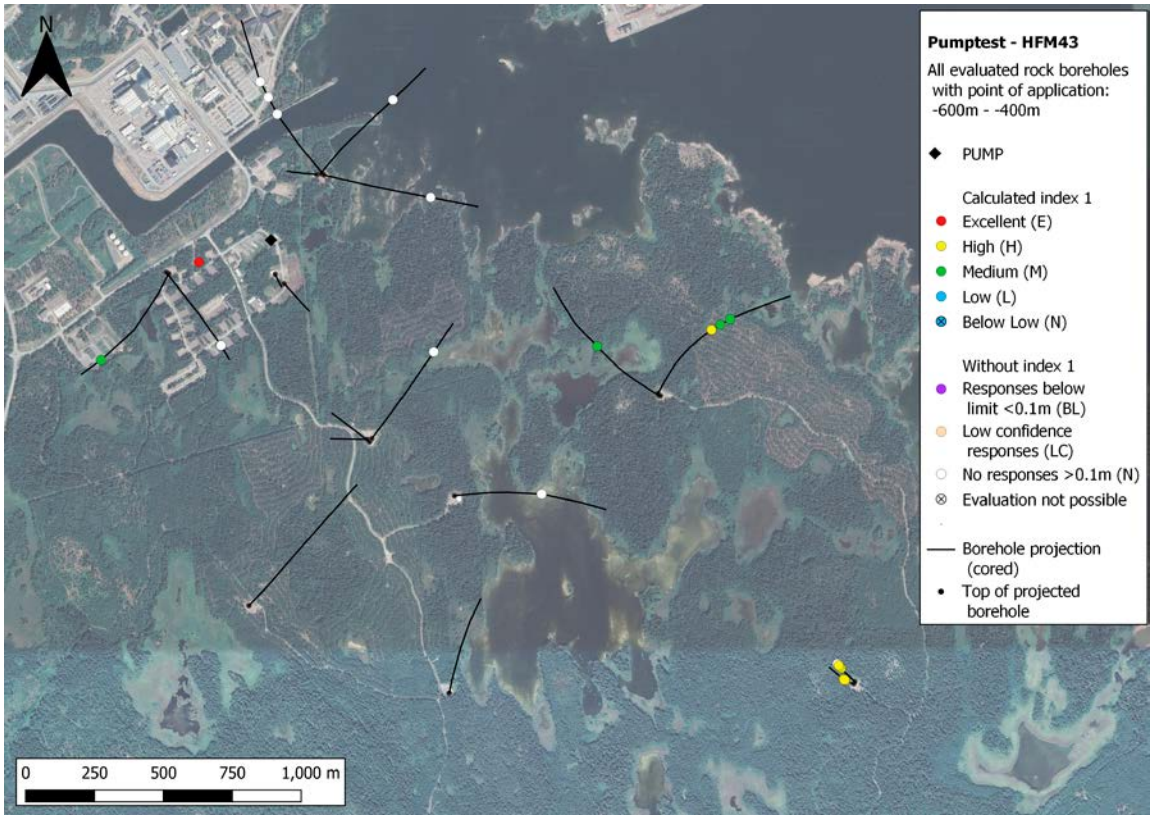


Figure A5-7. *Calculated Index 1 from the interference tests in HFM43. All evaluated rock borehole sections with point of application of −600 to −400 m. Background map origin: Google maps.*

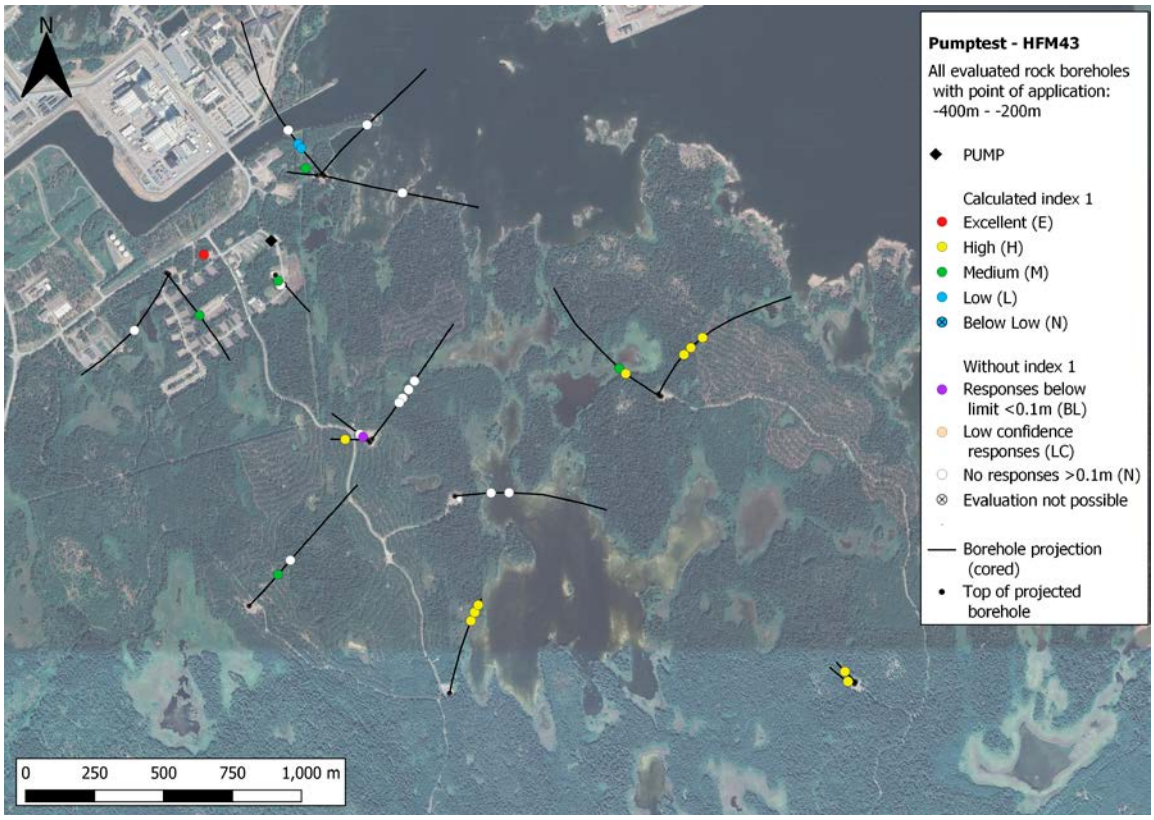


Figure A5-8. *Calculated Index 1 from the interference tests in HFM43. All evaluated rock borehole sections with point of application of −400 to −200 m. Background map origin: Google maps.*

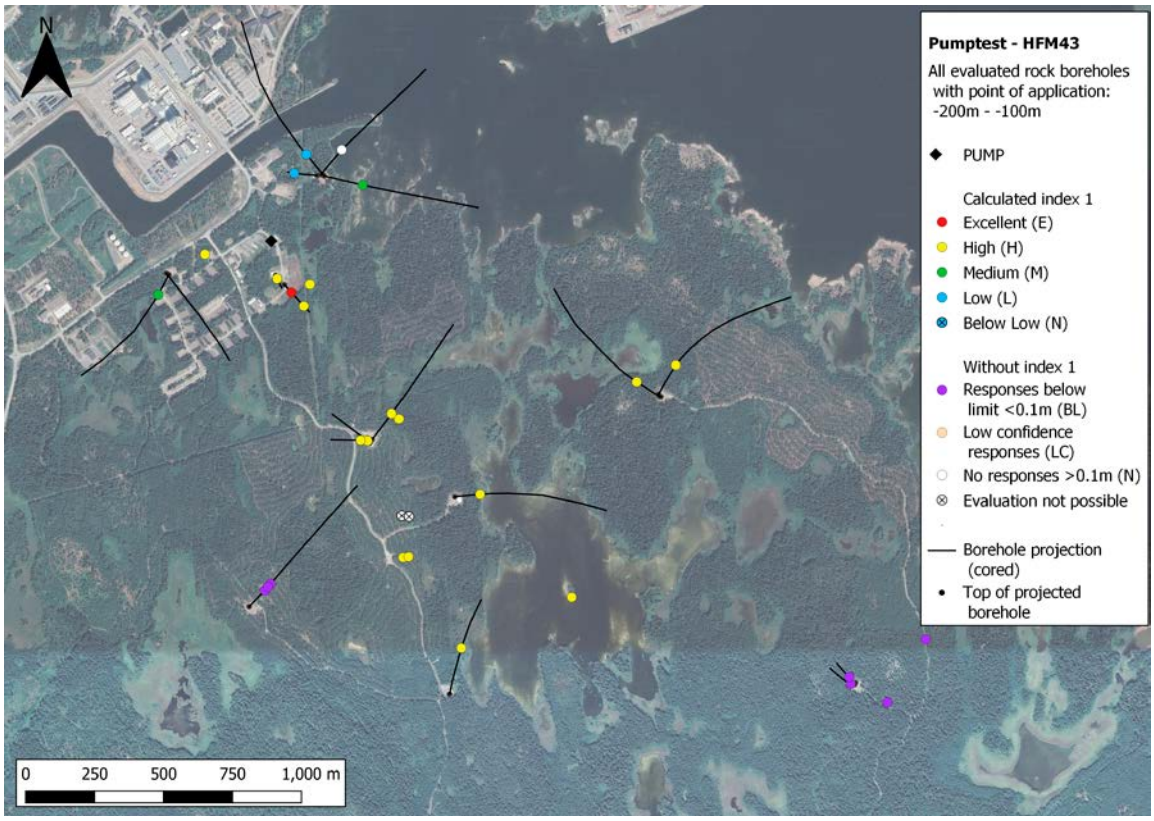


Figure A5-9. *Calculated Index 1 from the interference tests in HFM43. All evaluated rock borehole sections with point of application of −200 to −100 m. Background map origin: Google maps.*

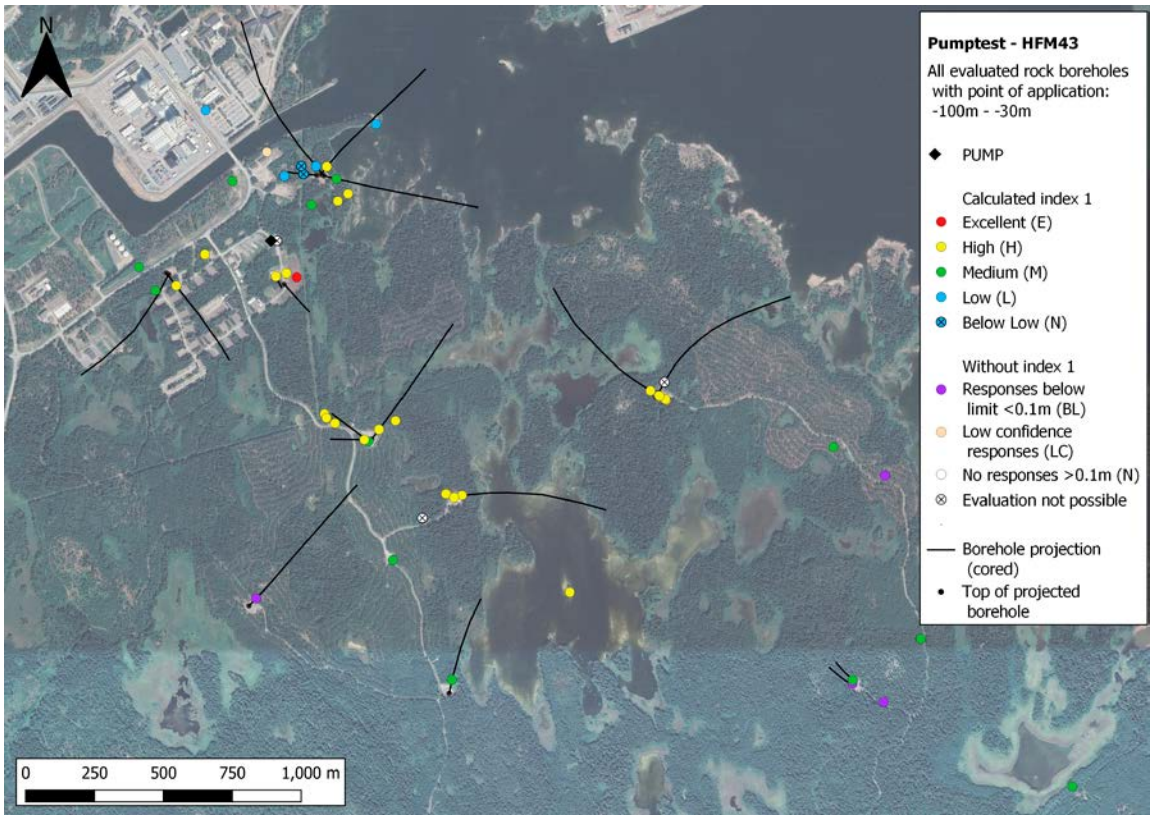


Figure A5-10. *Calculated Index 1 from the interference tests in HFM43. All evaluated rock borehole sections with point of application of −100 to −30 m. Background map origin: Google maps.*

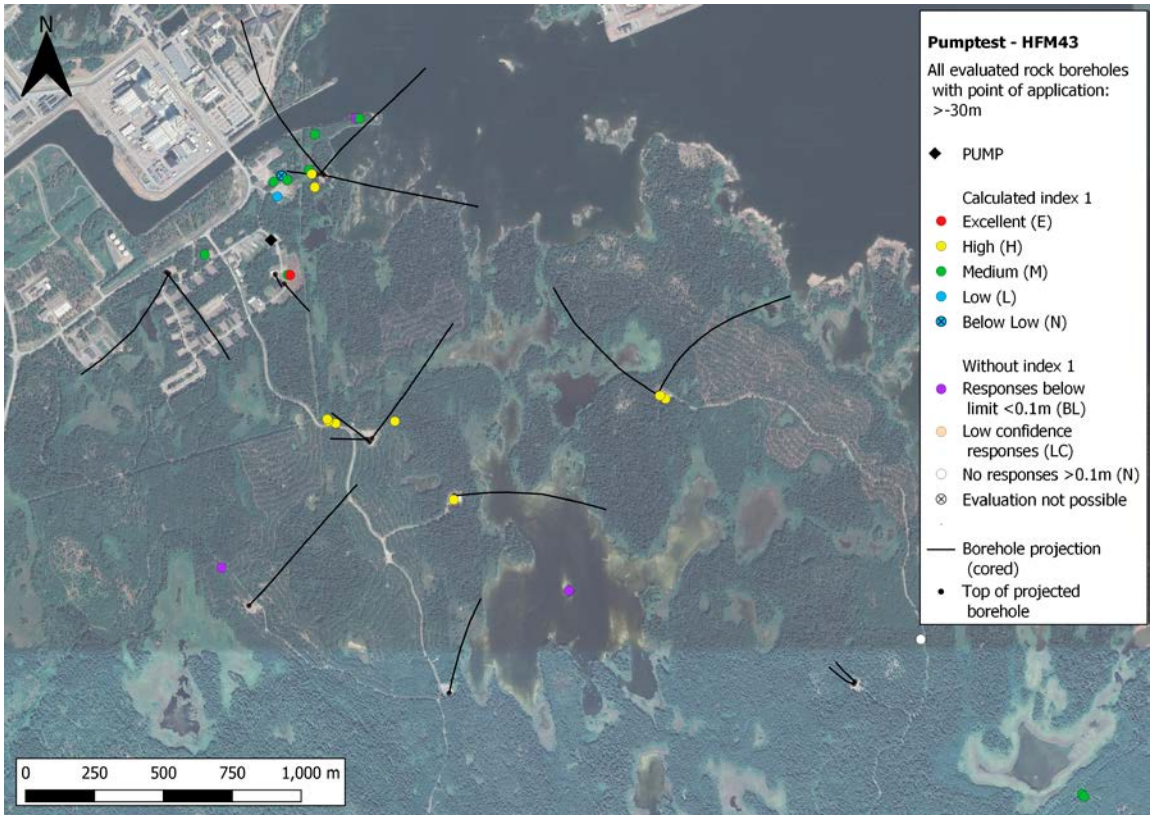


Figure A5-11. *Calculated Index 1 from the interference tests in HFM43. All evaluated rock borehole sections with point of application of > −30 m. Background map origin: Google maps.*

Interference test in HFM45

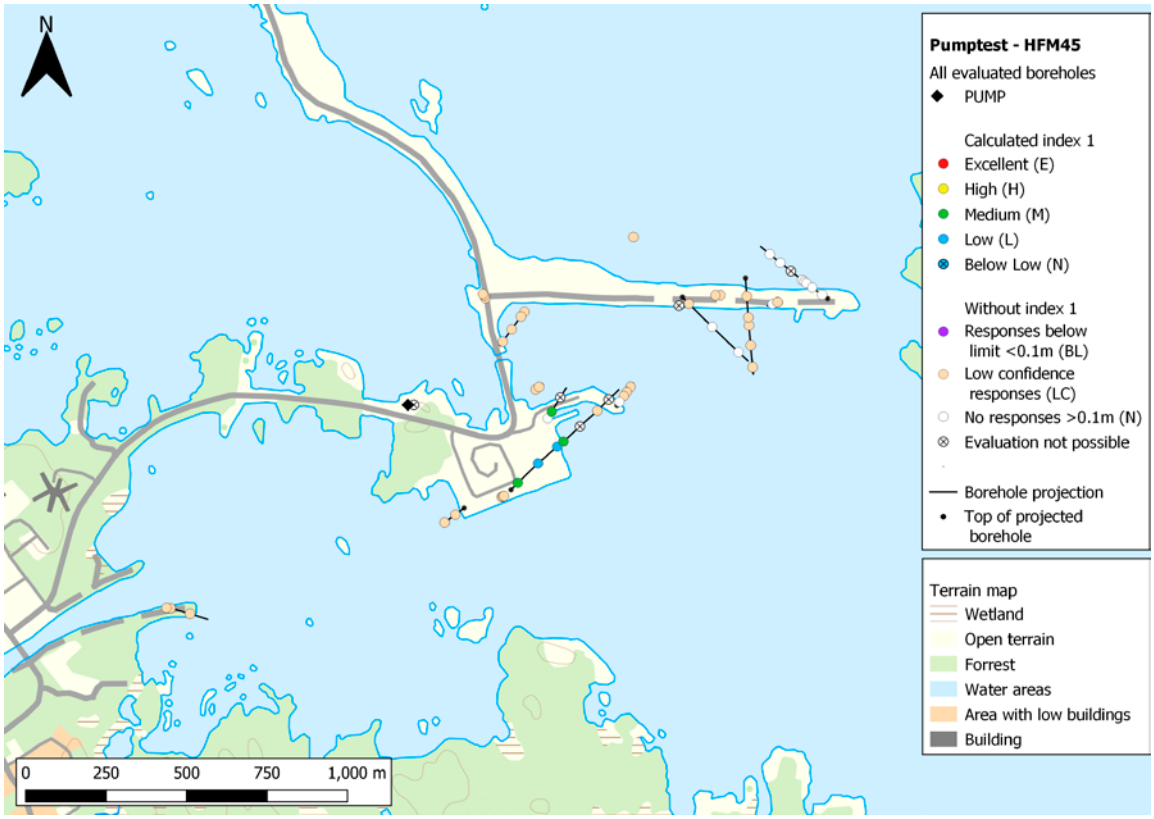


Figure A5-12. *Calculated Index 1 from the interference tests in HFM45. All responses are listed in Table 4-5 to Table 4-7 in the main report. Background map origin: Lantmäteriet.*

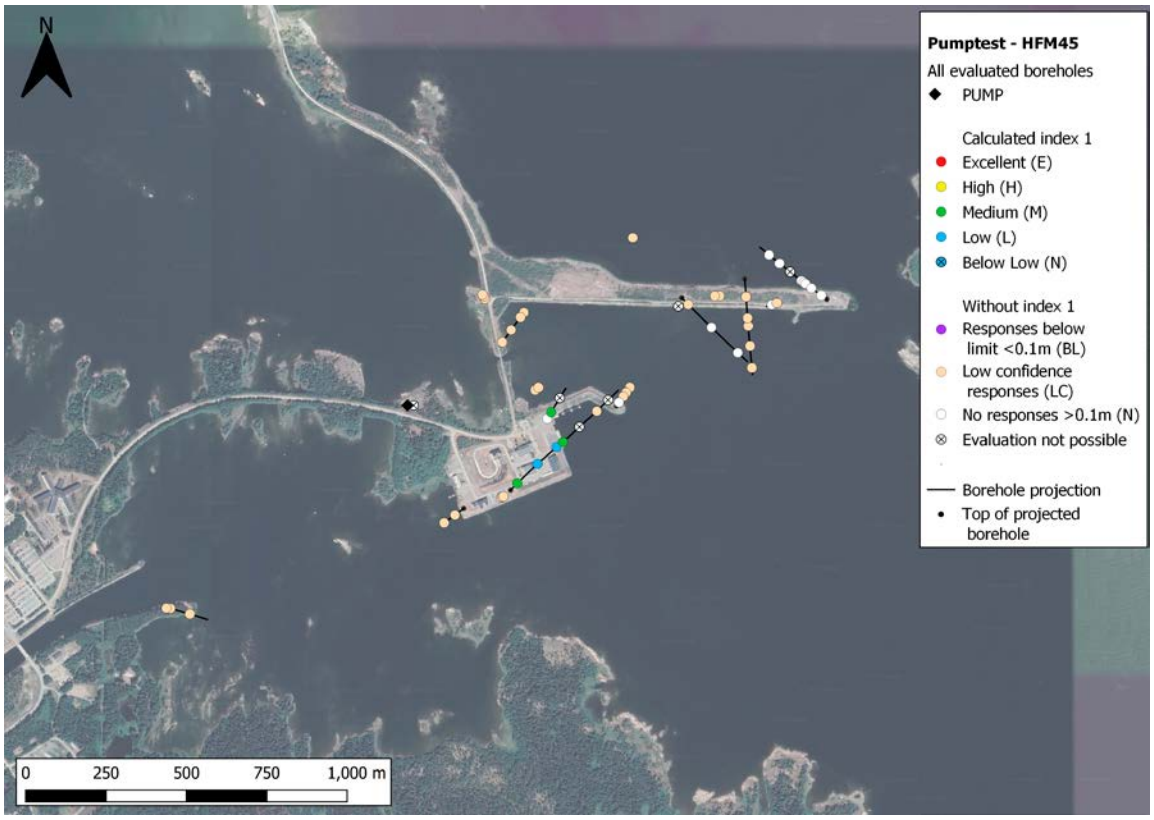


Figure A5-13. *Calculated Index 1 from the interference tests in HFM45 All evaluated boreholes. Background map origin: Google maps.*

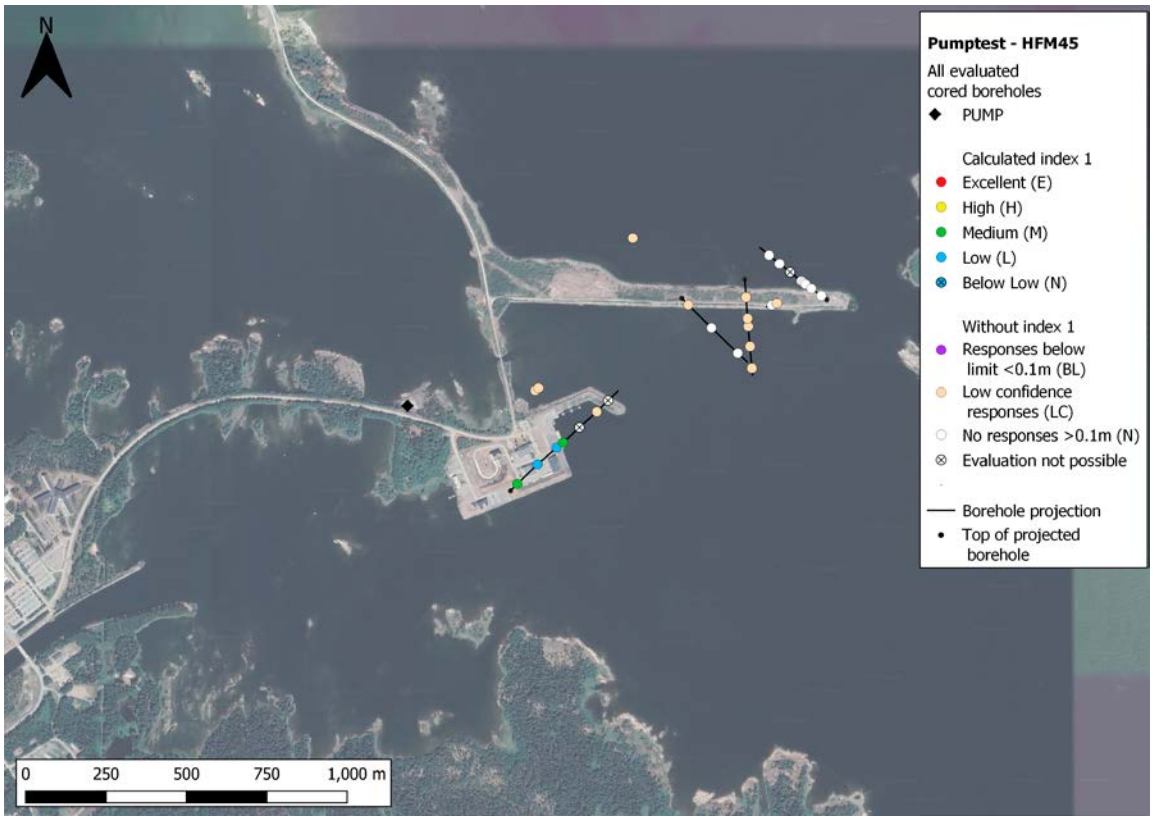


Figure A5-14. *Calculated Index 1 from the interference tests in HFM45. All evaluated cored boreholes. Background map origin: Google maps.*

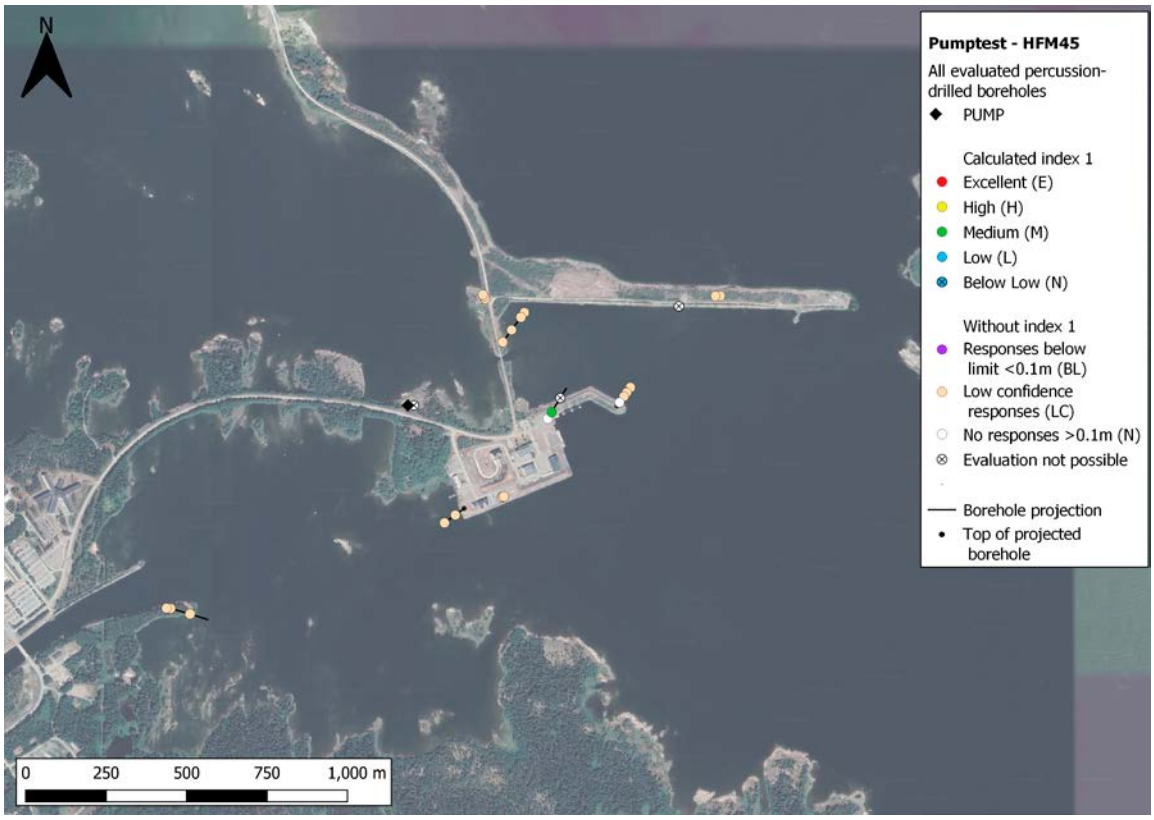


Figure A5-15. *Calculated Index 1 from the interference tests in HFM45. All evaluated percussion drilled boreholes. Background map origin: Google maps.*

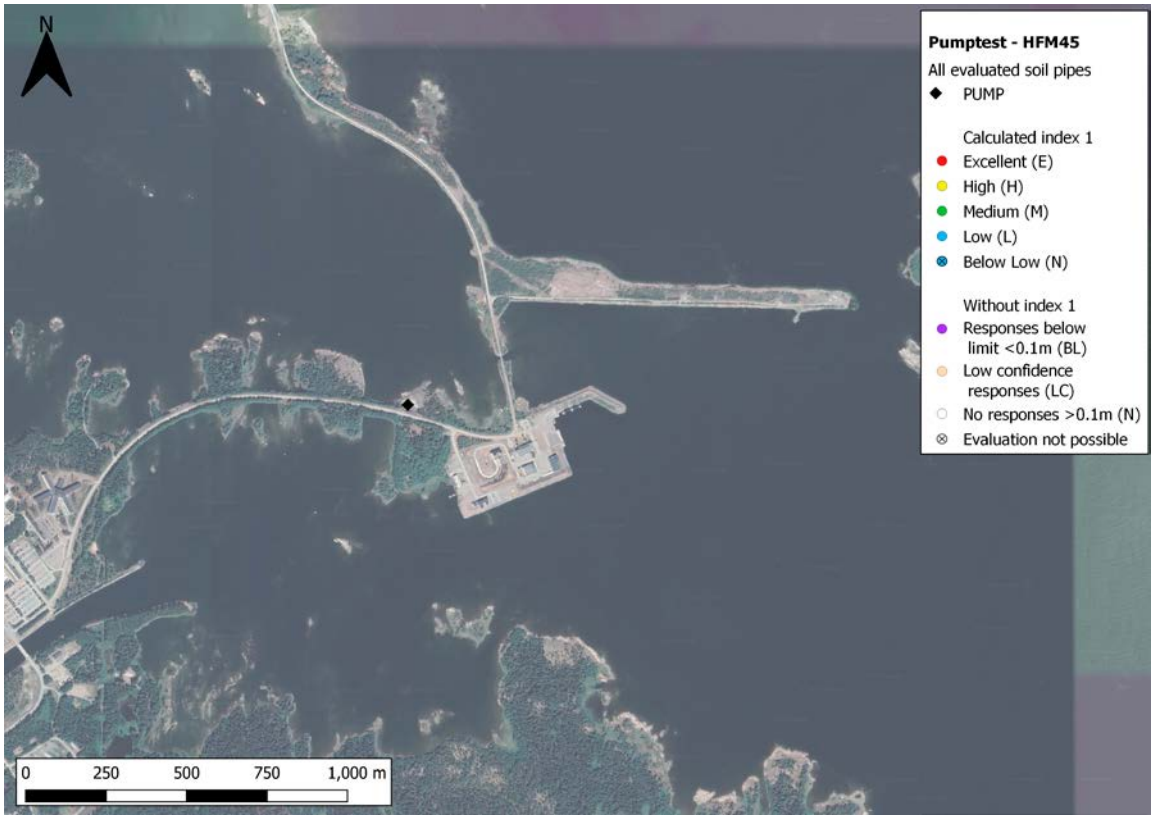


Figure A5-16. *Calculated Index 1 from the interference tests in HFM45. All evaluated soil pipes. Background map origin: Google maps.*

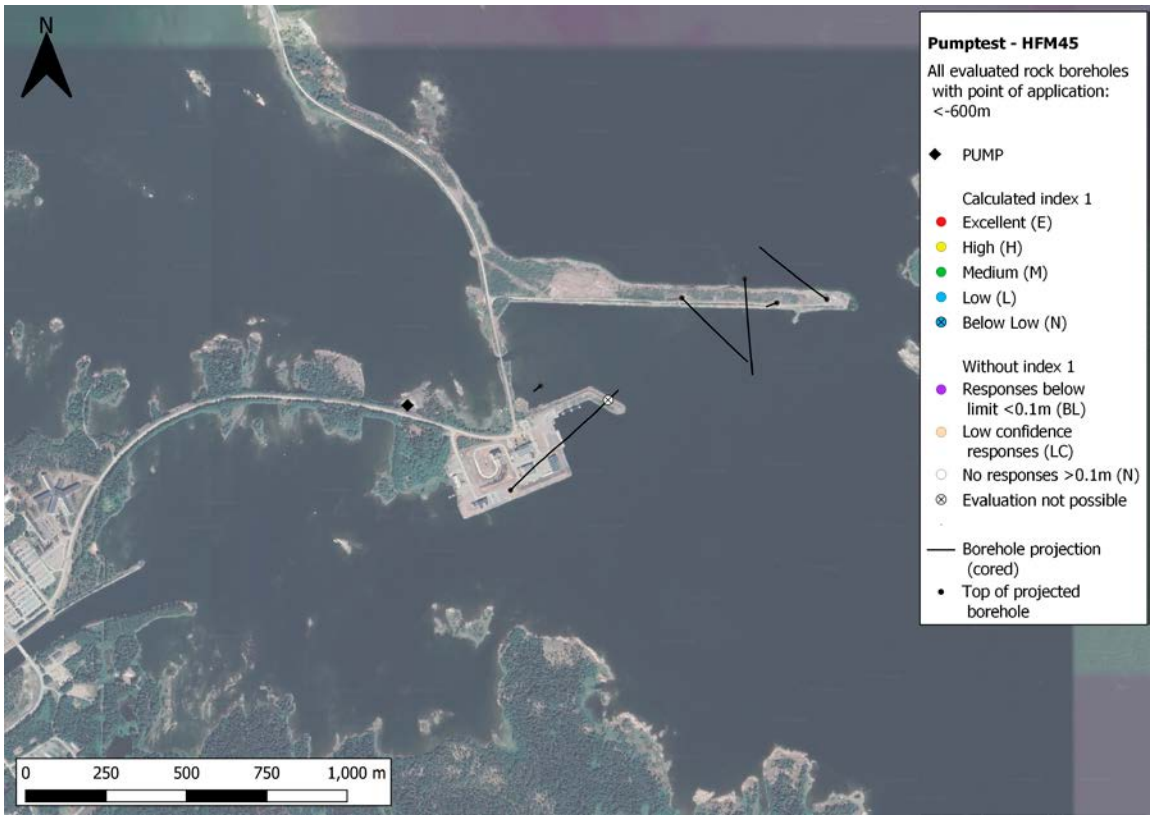


Figure A5-17. *Calculated Index 1 from the interference tests in HFM45. All evaluated rock borehole sections with point of application of < −600 m. Background map origin: Google maps.*

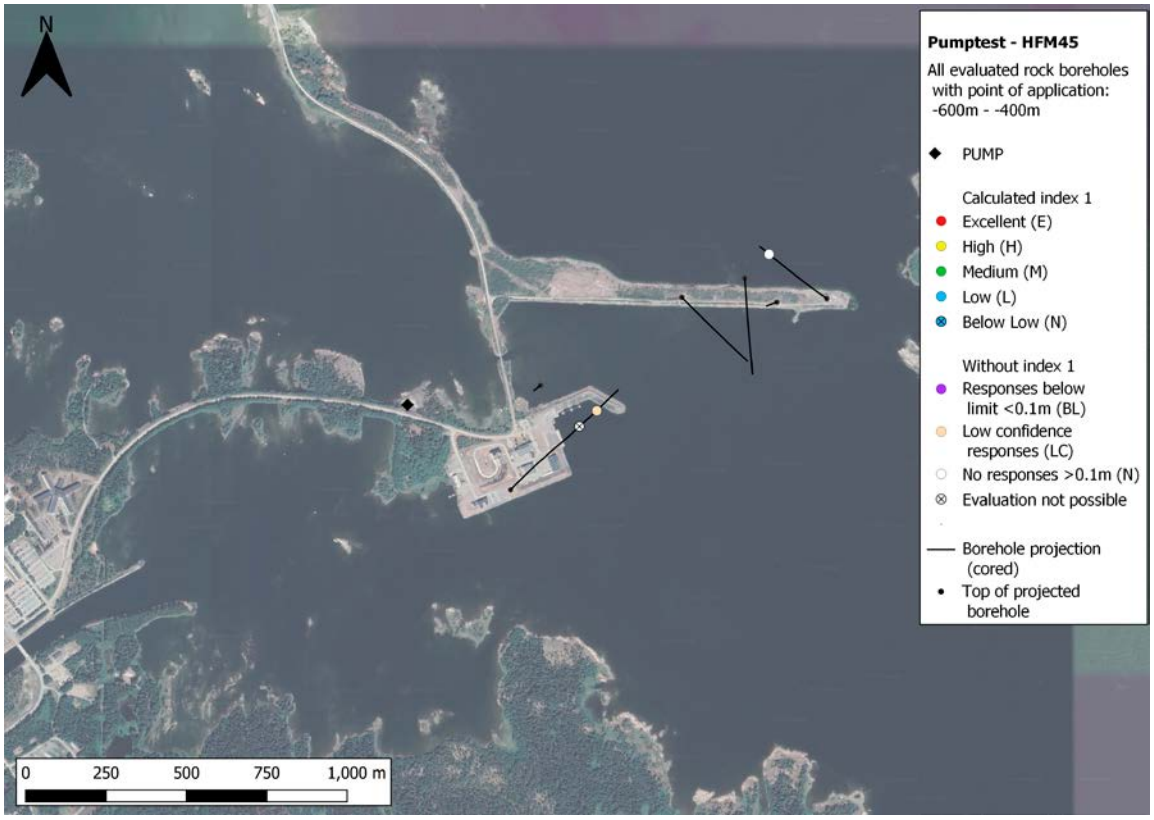


Figure A5-18. *Calculated Index 1 from the interference tests in HFM45. All evaluated rock borehole sections with point of application of −600 to −400 m. Background map origin: Google maps.*

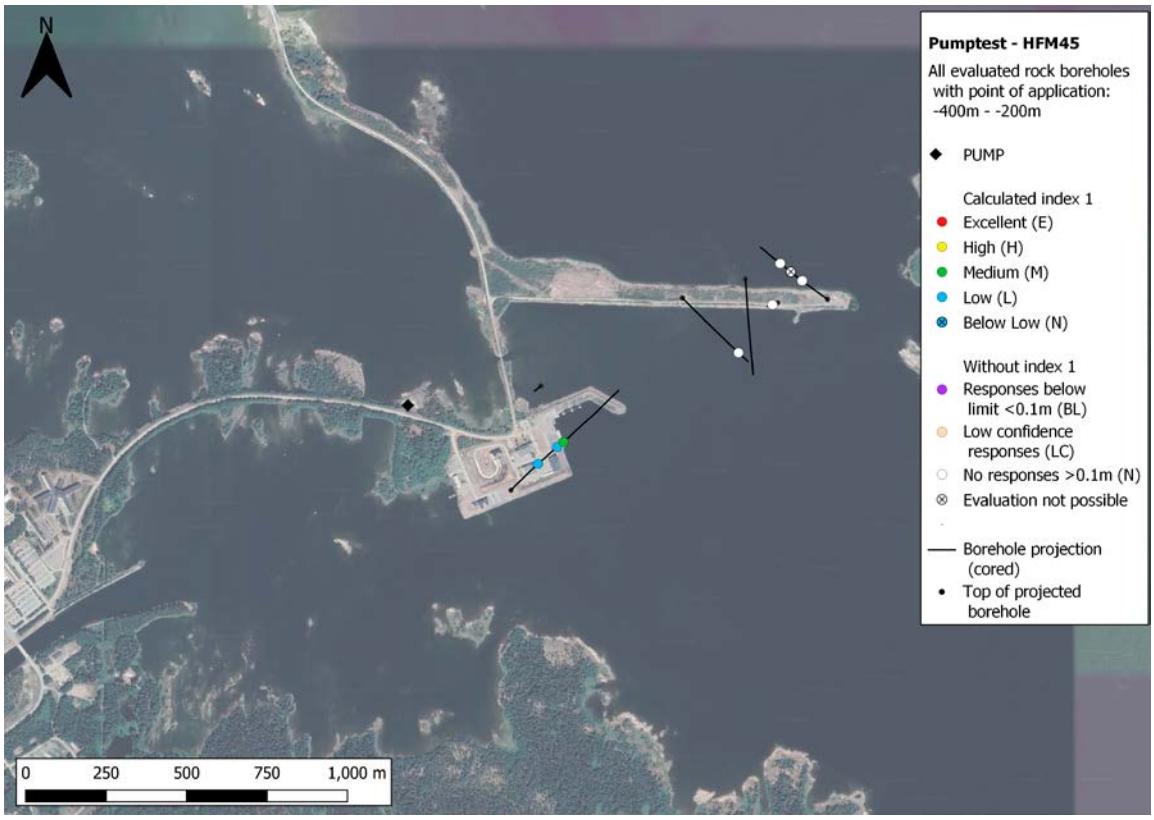


Figure A5-19. *Calculated Index 1 from the interference tests in HFM45. All evaluated rock borehole sections with point of application of −400 to −200 m. Background map origin: Google maps.*

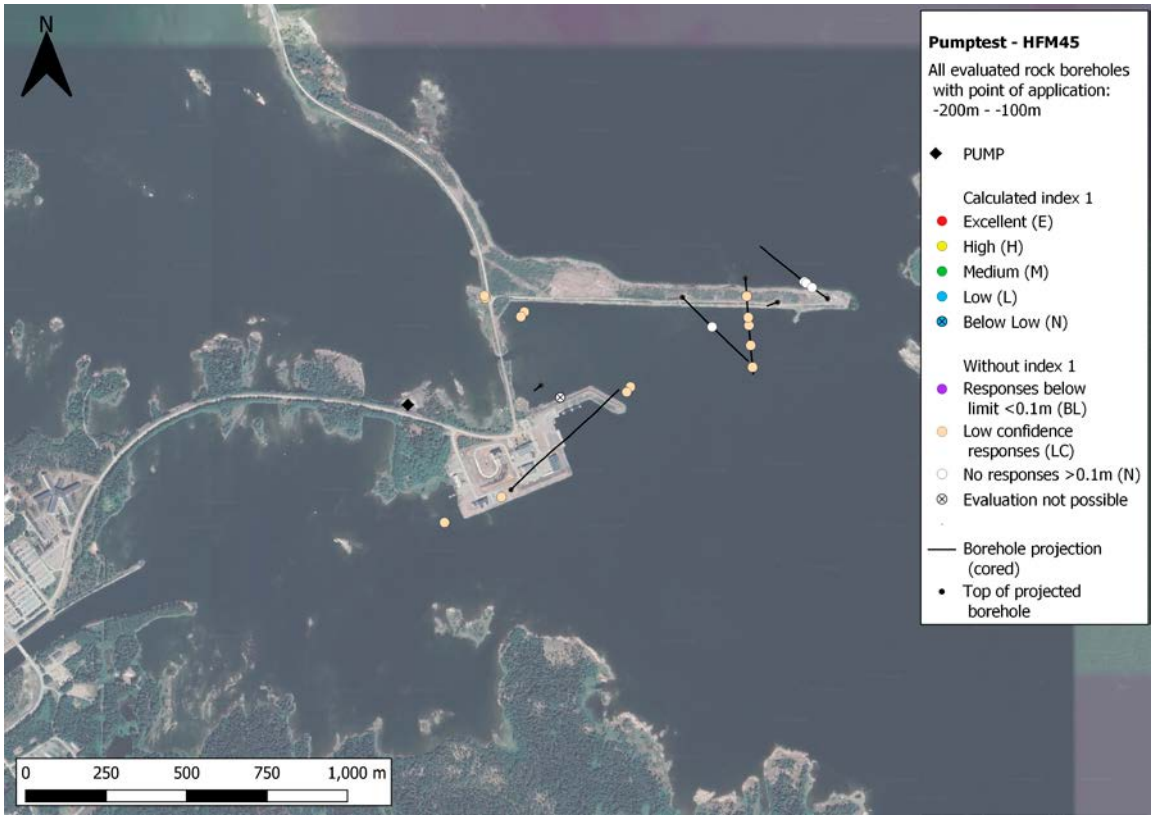


Figure A5-20. *Calculated Index 1 from the interference tests in HFM45. All evaluated rock borehole sections with point of application of −200 to −100 m. Background map origin: Google maps.*

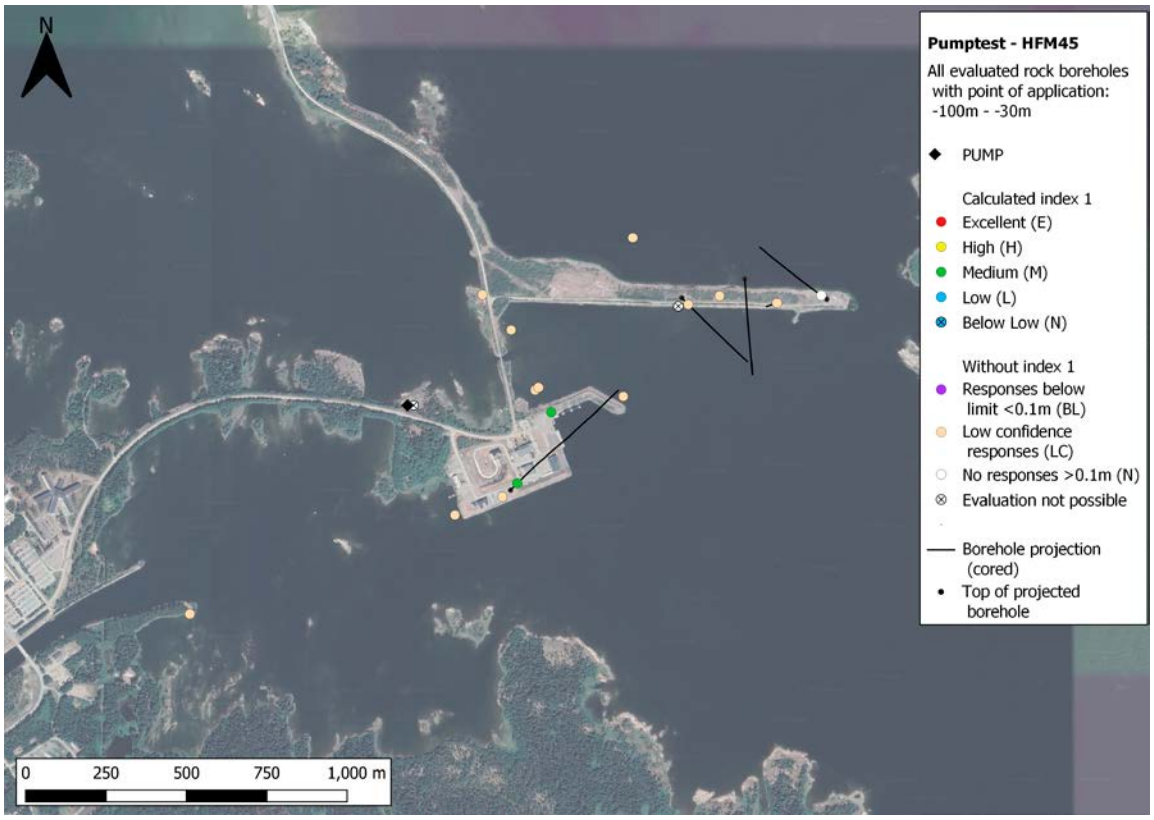


Figure A5-21. *Calculated Index 1 from the interference tests in HFM45. All evaluated rock borehole sections with point of application of −100 to −30 m. Background map origin: Google maps.*

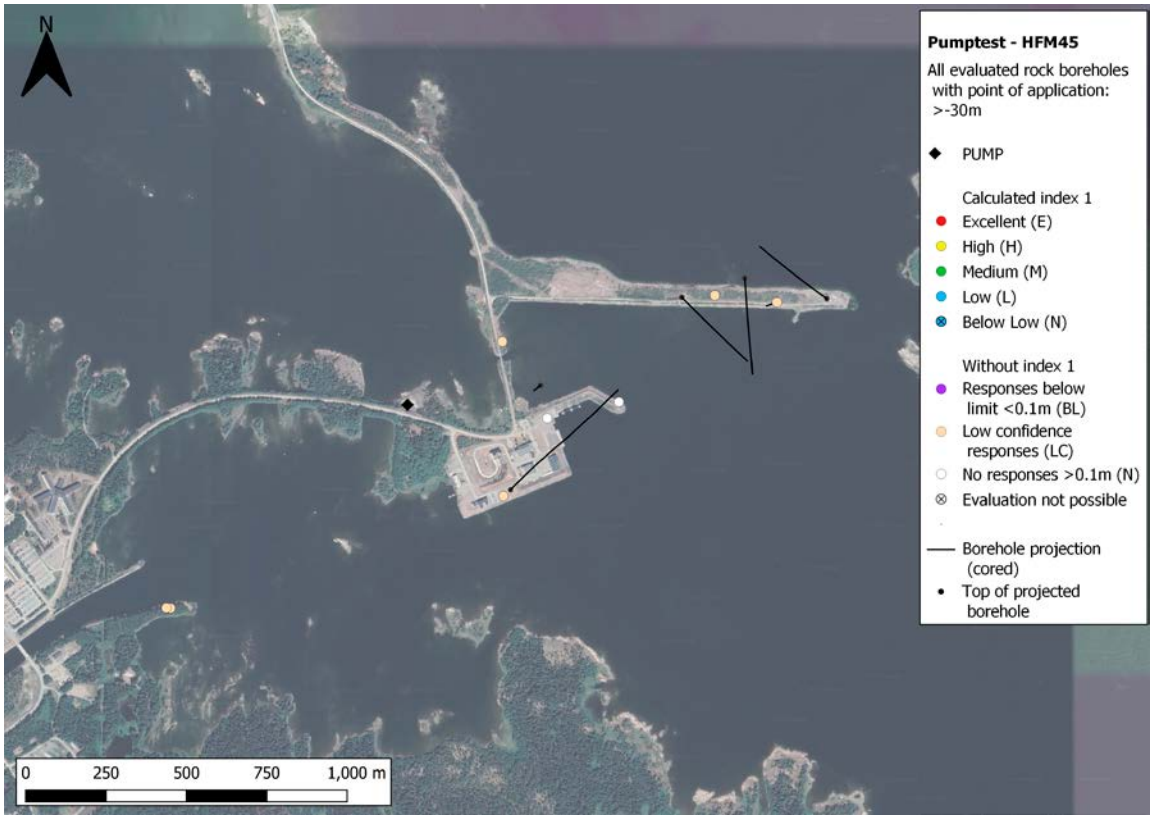


Figure A5-22. *Calculated Index 1 from the interference tests in HFM45. All evaluated rock borehole sections with point of application of > −30 m. Background map origin: Google maps.*

Interference test in HFM33

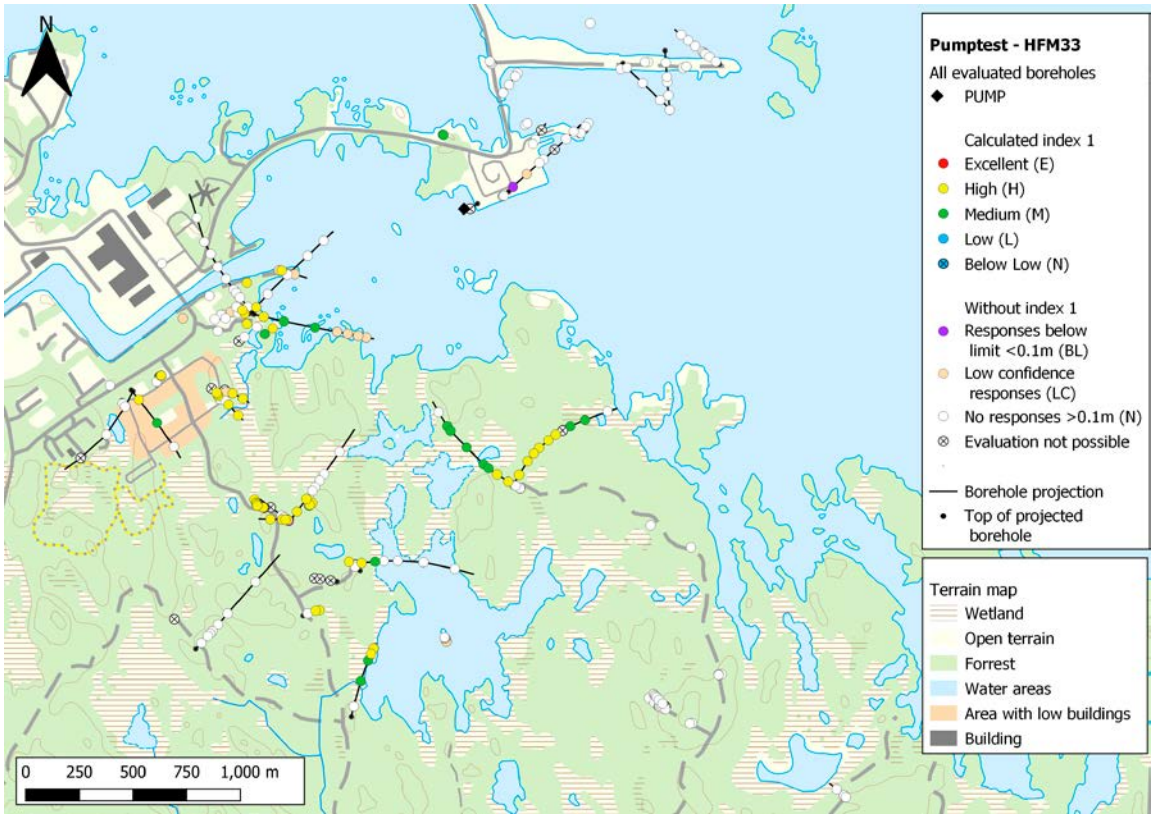


Figure A5-23. *Calculated Index 1 from the interference tests in HFM33. All responses are listed in Table 4-8 to Table 4-10 in the main report. Background map origin: Lantmäteriet.*

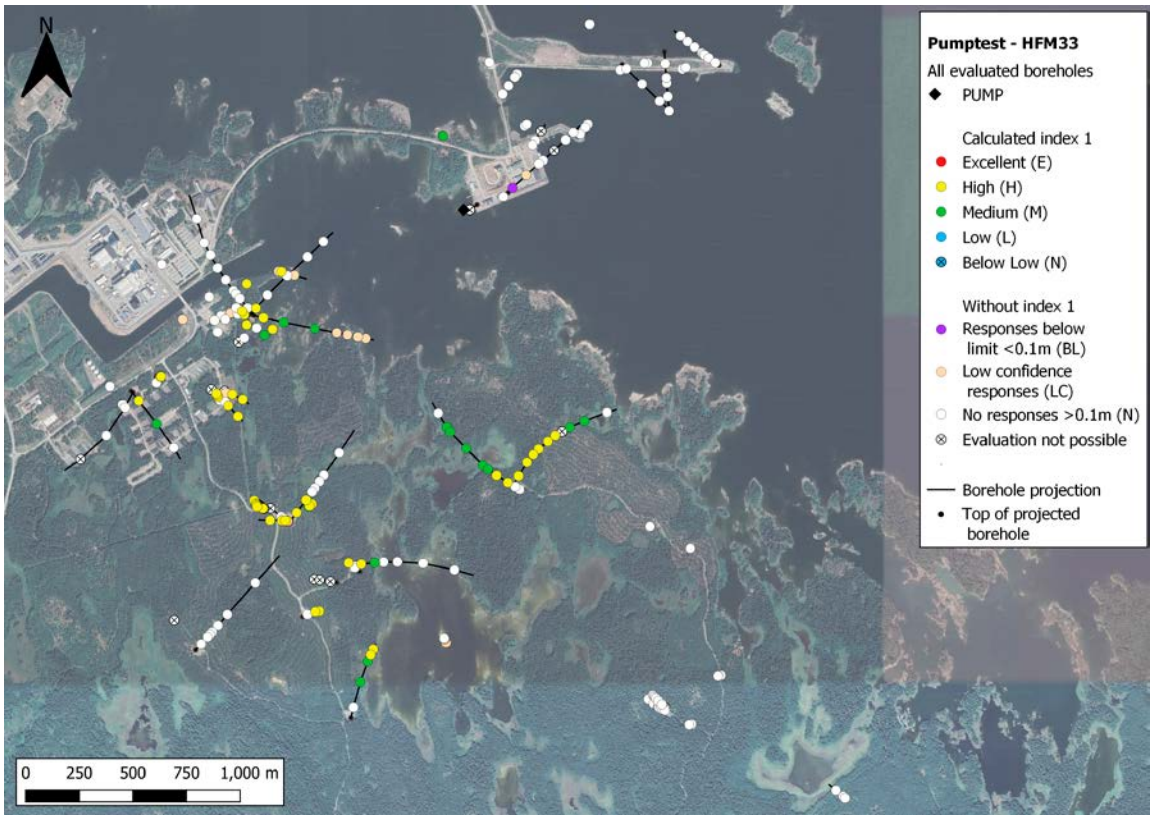


Figure A5-24. *Calculated Index 1 from the interference tests in HFM33. All evaluated boreholes. Background map origin: Google maps.*

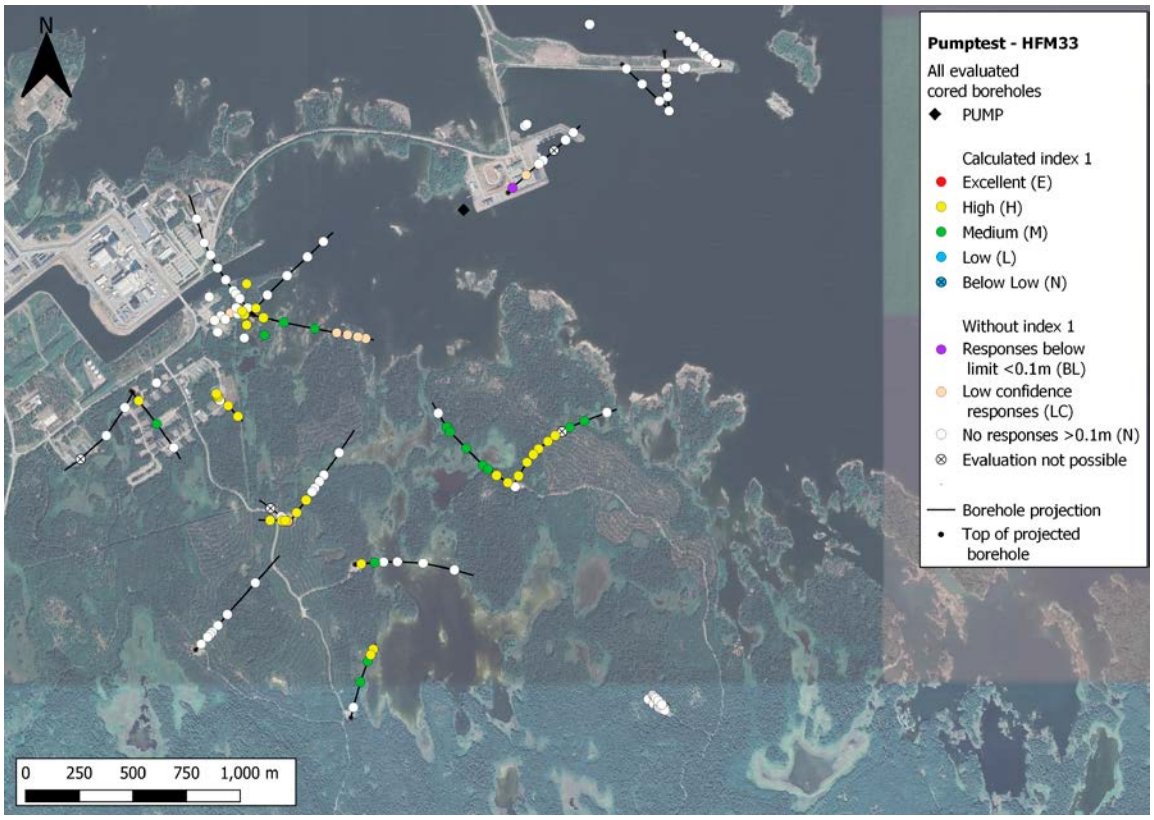


Figure A5-25. *Calculated Index 1 from the interference tests in HFM33. All evaluated cored boreholes. Background map origin: Google maps.*

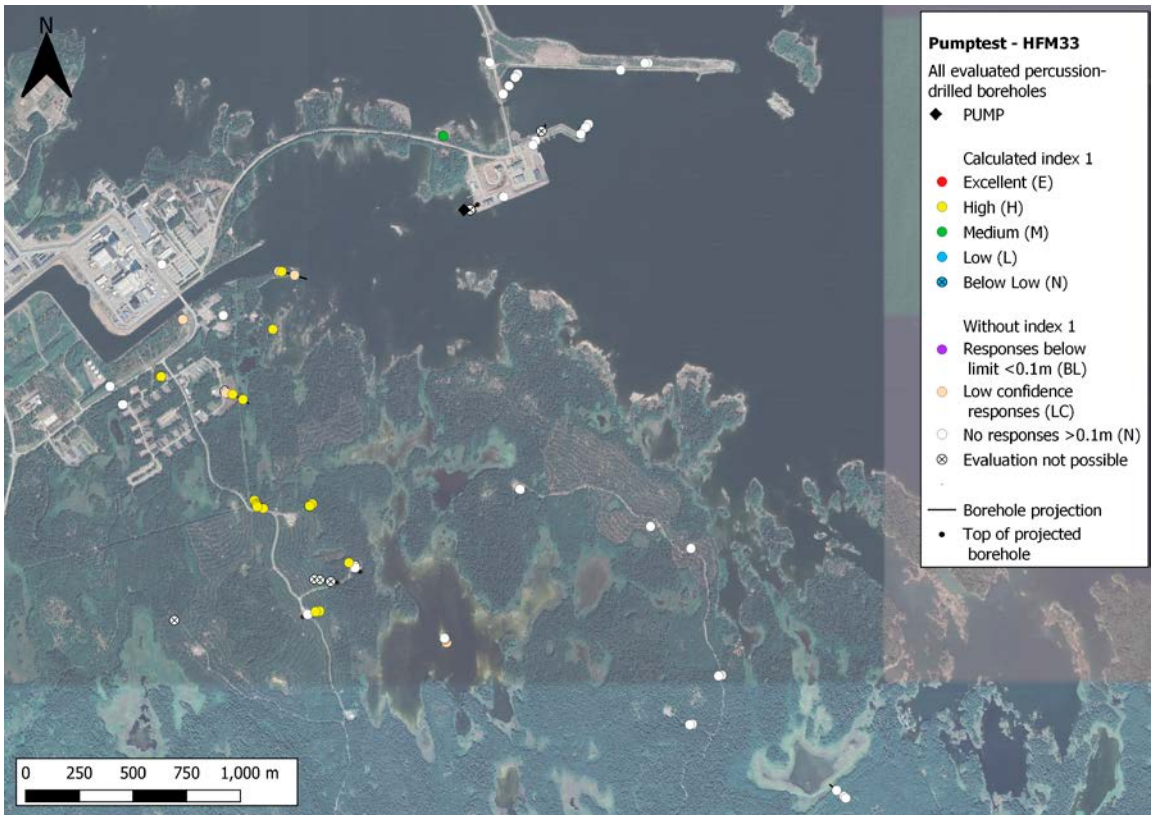


Figure A5-26. *Calculated Index 1 from the interference tests in HFM33. All evaluated percussion drilled boreholes. Background map origin: Google maps.*

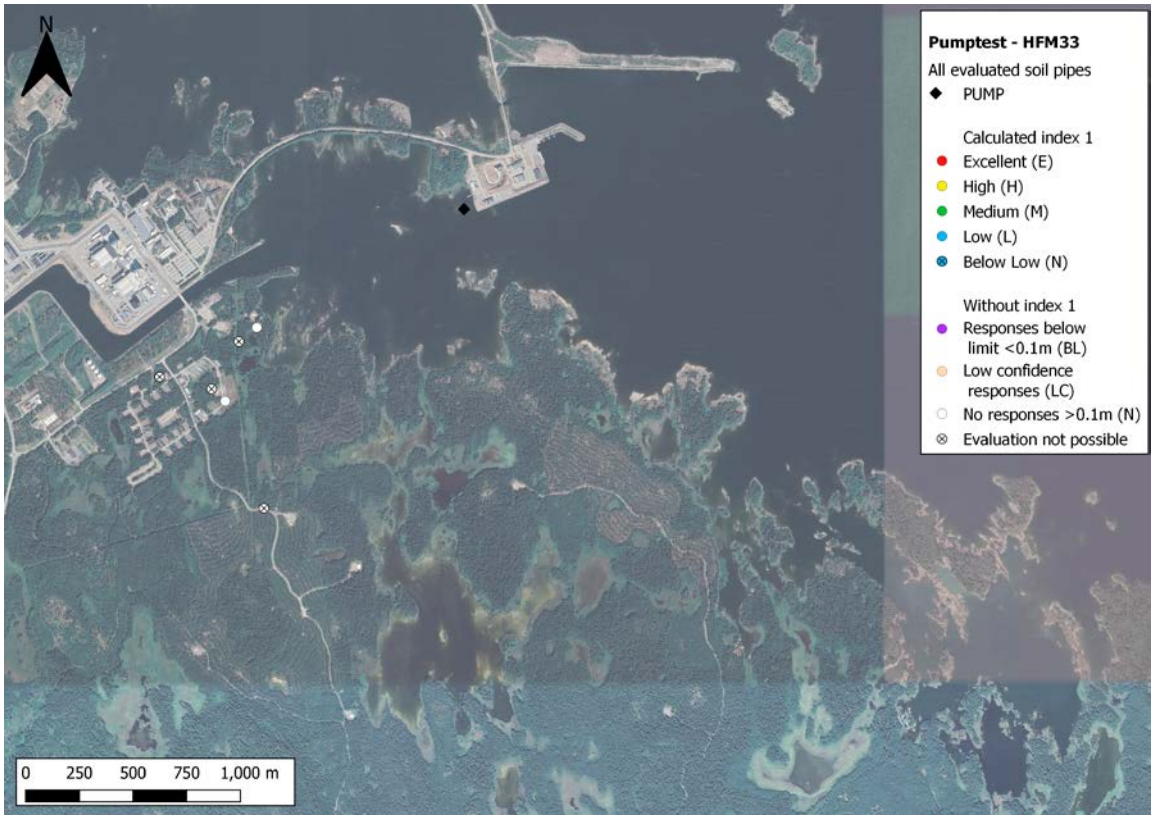


Figure A5-27. *Calculated Index 1 from the interference tests in HFM33. All evaluated soil pipes. Background map origin: Google maps.*

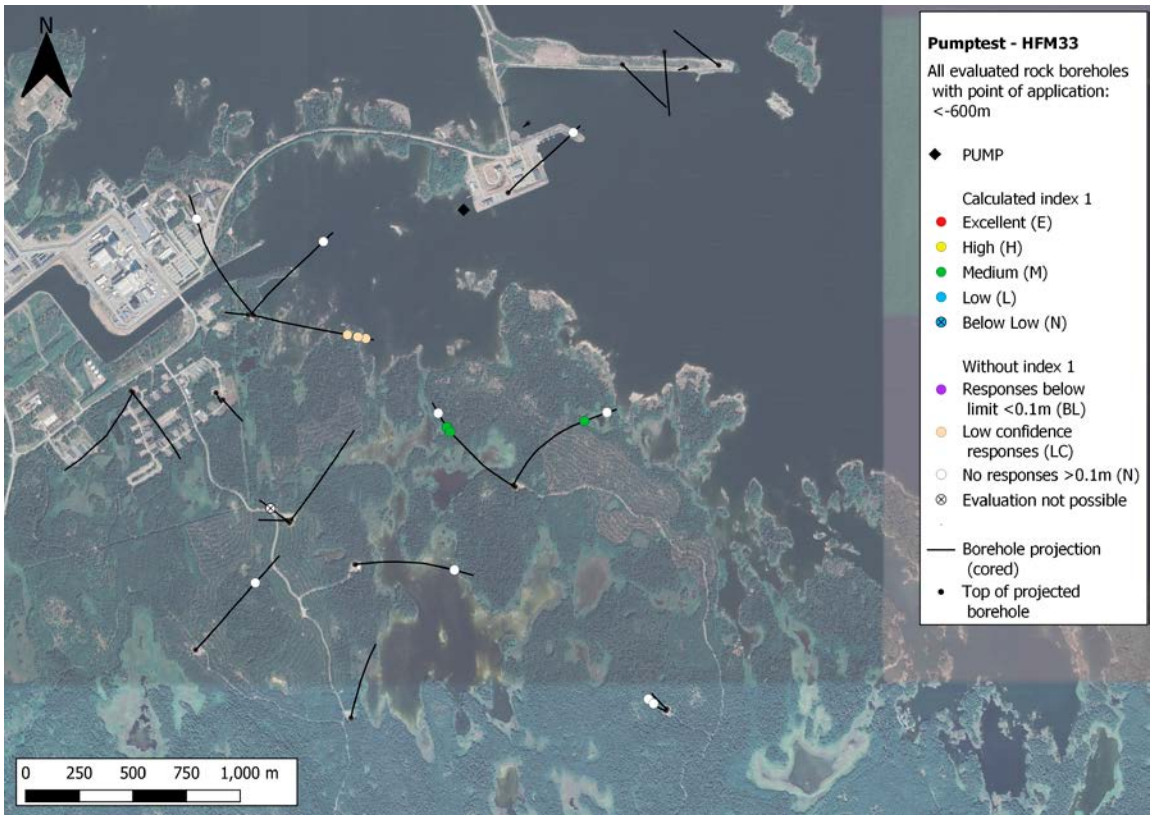


Figure A5-28. *Calculated Index 1 from the interference tests in HFM33. All evaluated rock borehole sections with point of application of < −600 m. Background map origin: Google maps.*

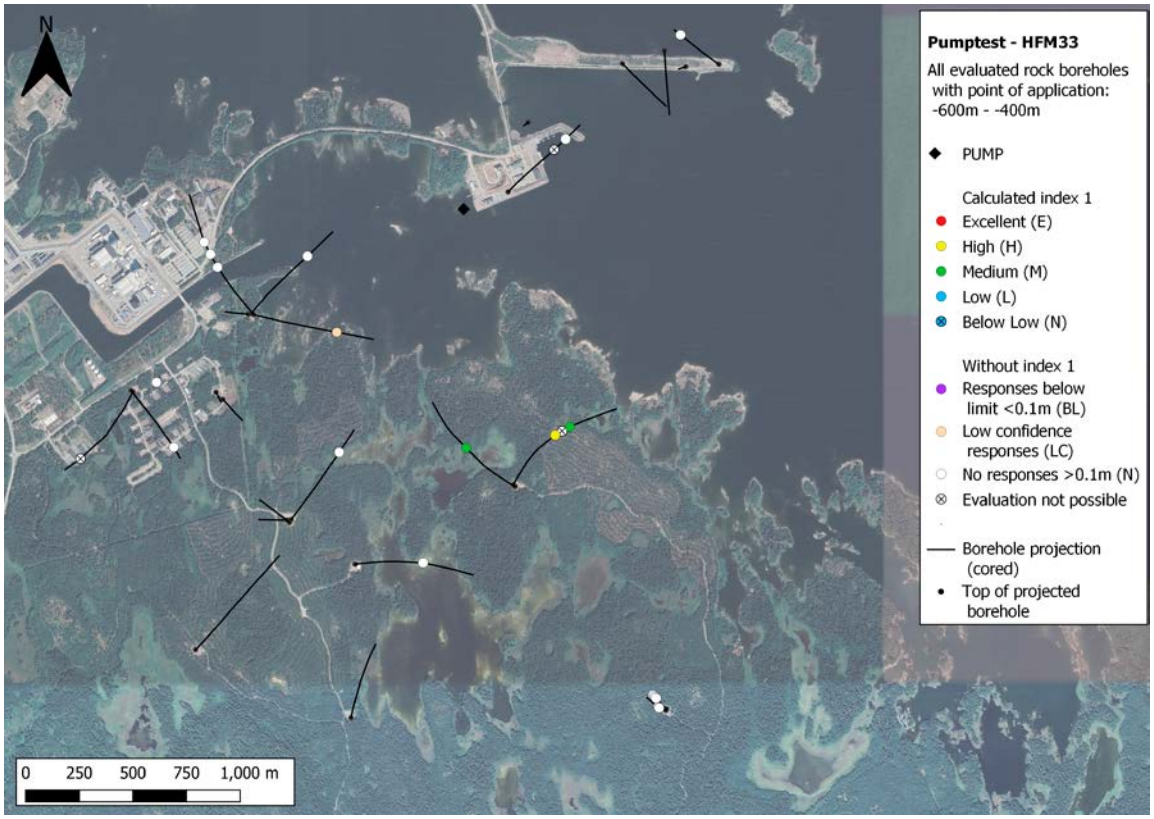


Figure A5-29. *Calculated Index 1 from the interference tests in HFM33. All evaluated rock borehole sections with point of application of −600 to −400 m. Background map origin: Google maps.*

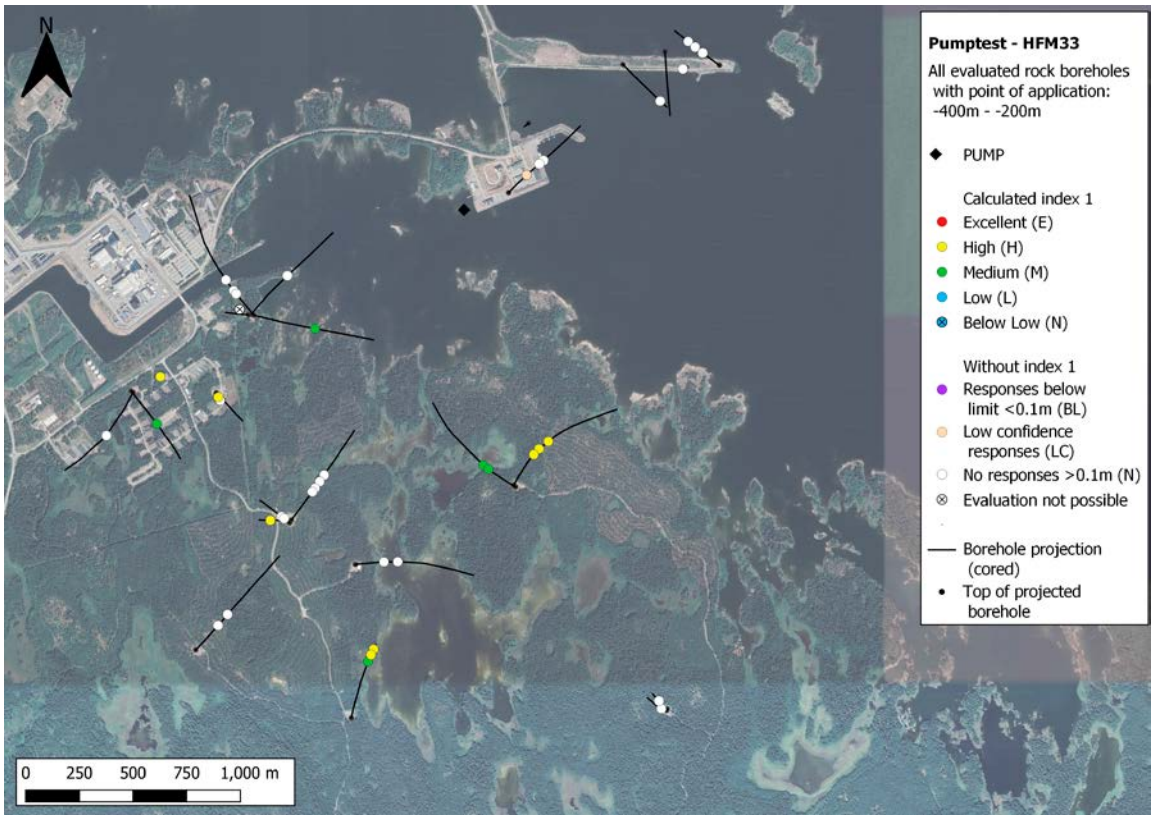


Figure A5-30. *Calculated Index 1 from the interference tests in HFM33. All evaluated rock borehole sections with point of application of −400 to −200 m. Background map origin: Google maps.*

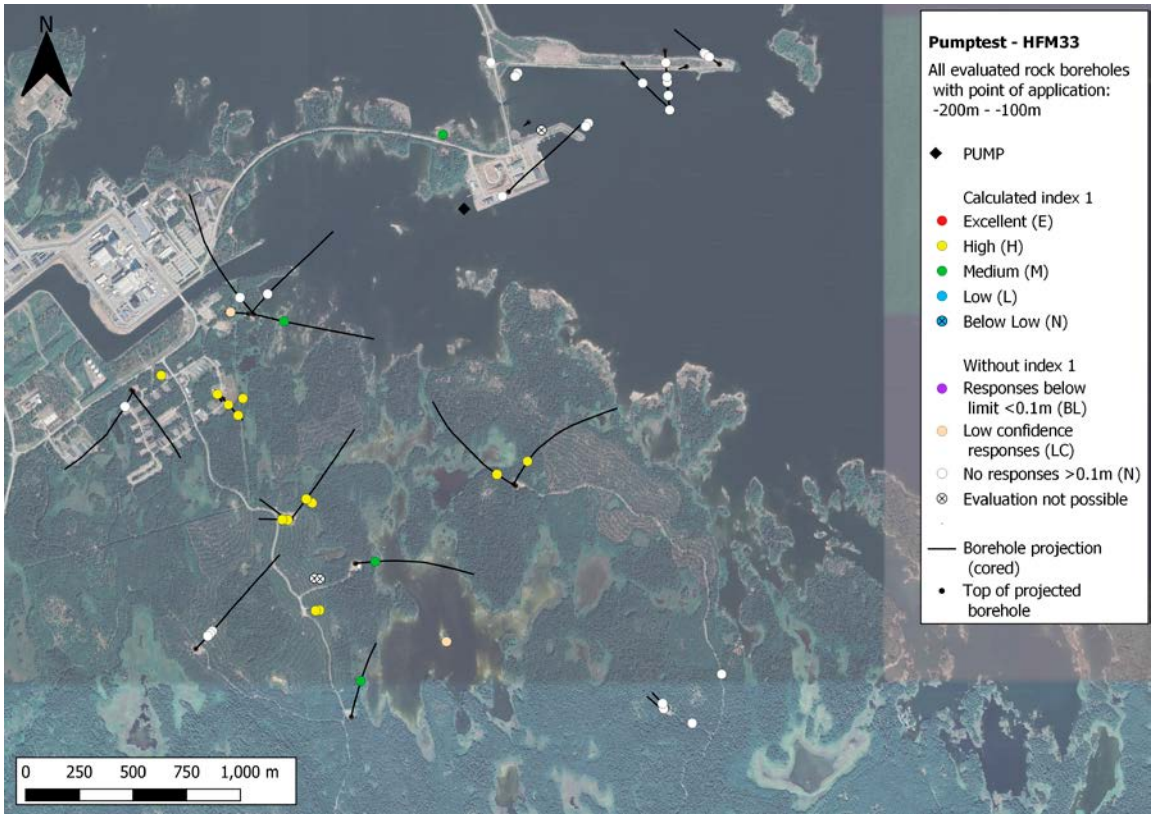


Figure A5-31. *Calculated Index 1 from the interference tests in HFM33. All evaluated rock borehole sections with point of application of −200 to −100 m. Background map origin: Google maps.*

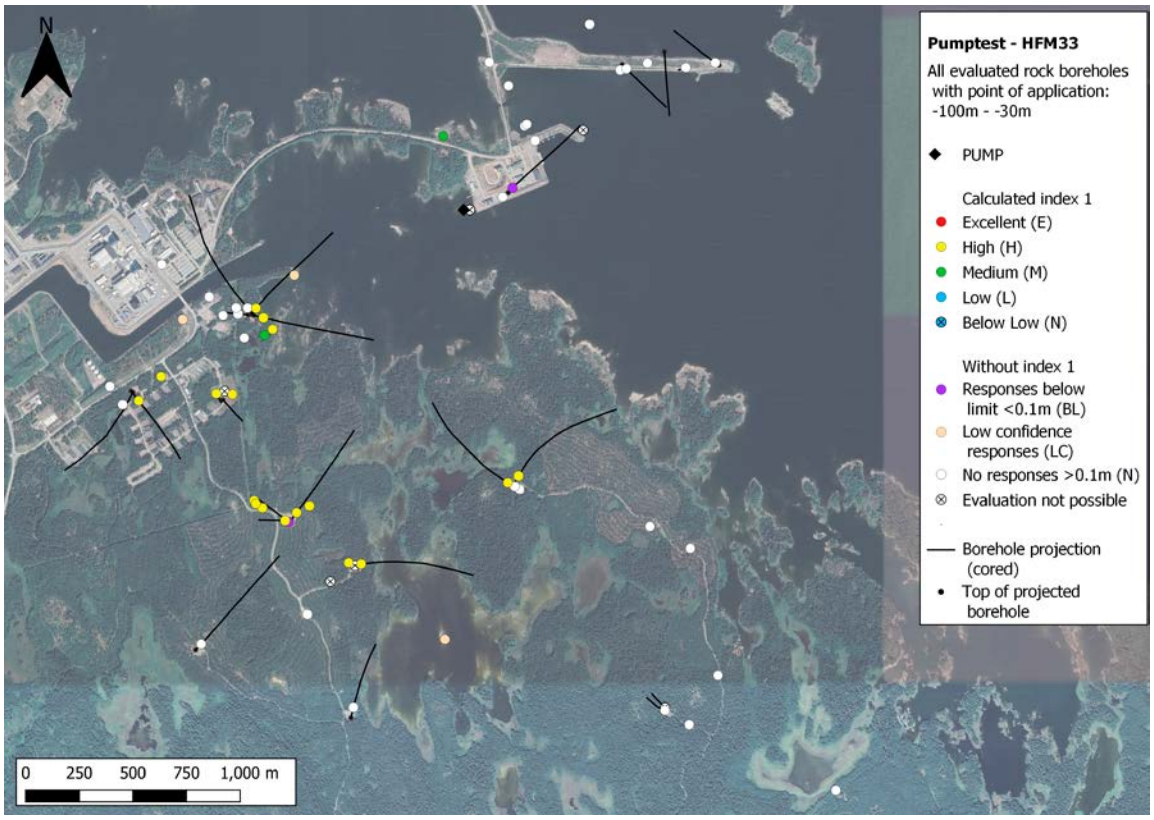


Figure A5-32. *Calculated Index 1 from the interference tests in HFM33. All evaluated rock borehole sections with point of application of −100 to −30 m. Background map origin: Google maps.*

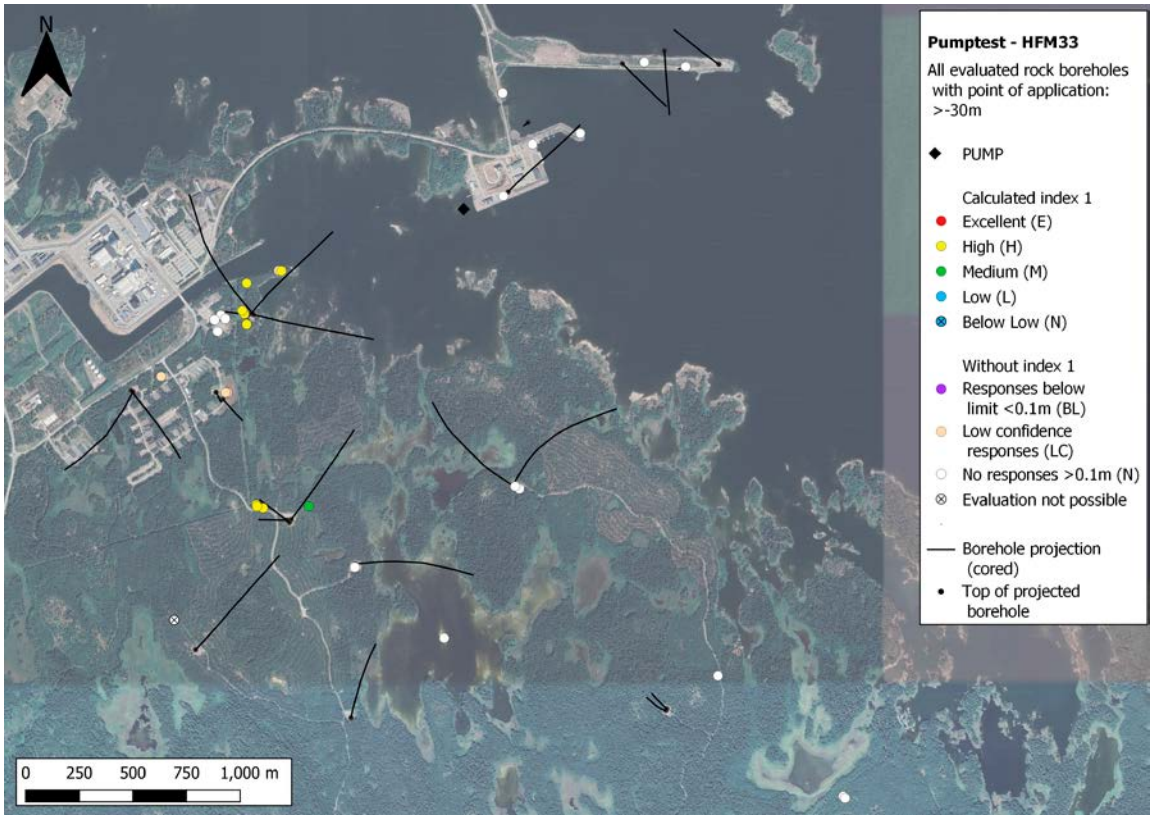


Figure A5-33. *Calculated Index 1 from the interference tests in HFM33. All evaluated rock borehole sections with point of application of > −30 m. Background map origin: Google maps.*

Interference test in HFM44

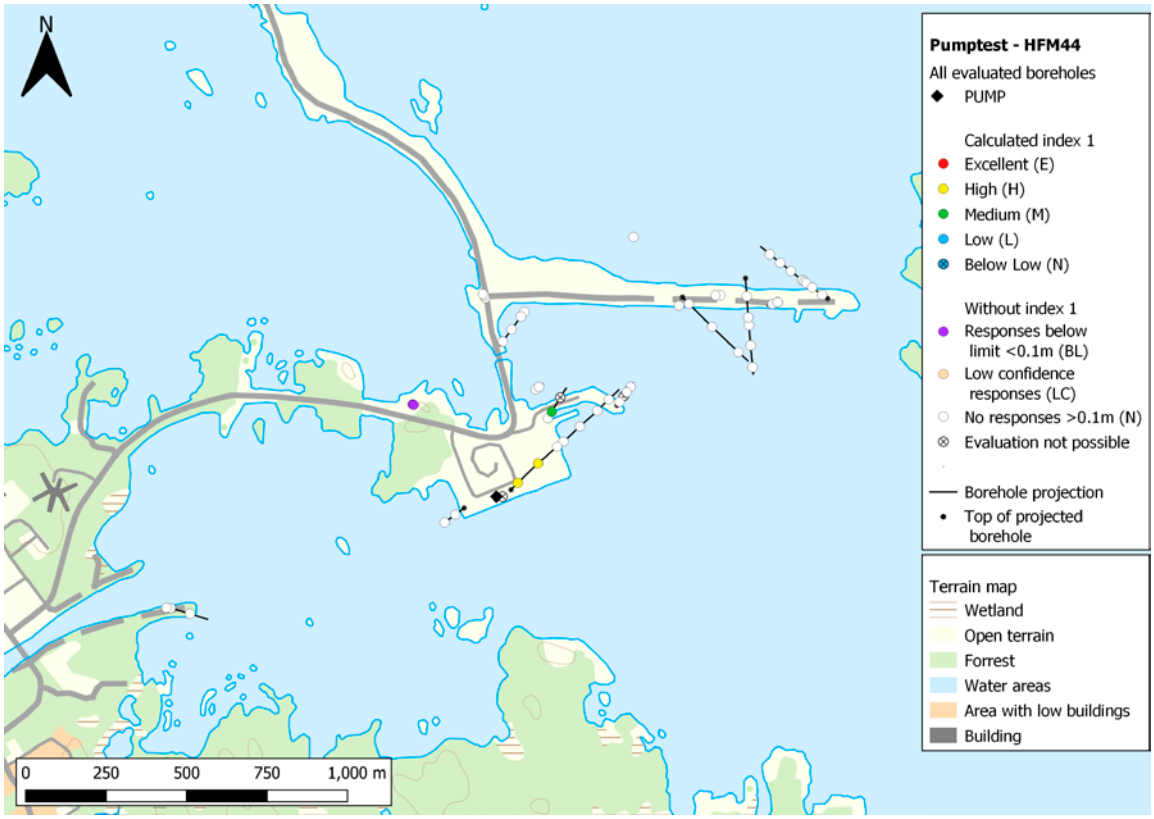


Figure A5-34. *Calculated Index 1 from the interference tests in HFM44. All responses are listed in Table 4-11 to Table 4-14 in the main report. Background map origin: Lantmäteriet.*

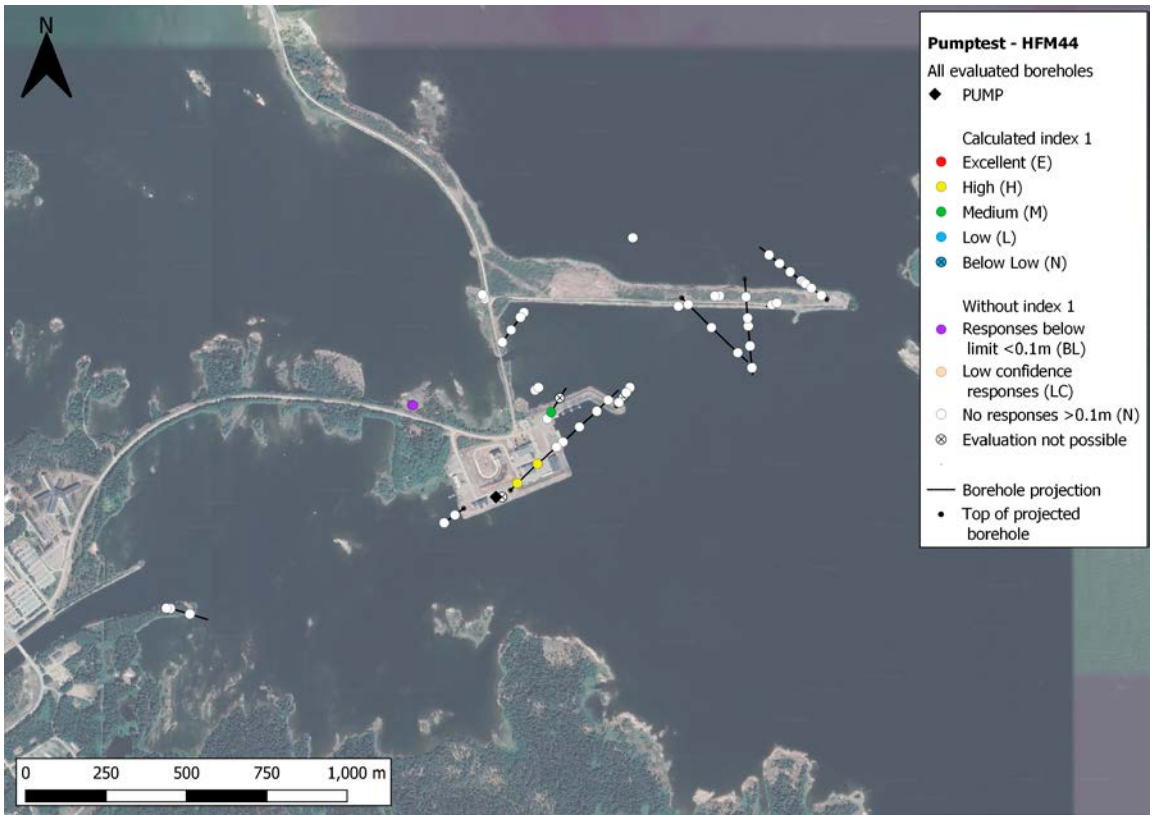


Figure A5-35. *Calculated Index 1 from the interference tests in HFM44. All evaluated boreholes. Background map origin: Google maps.*

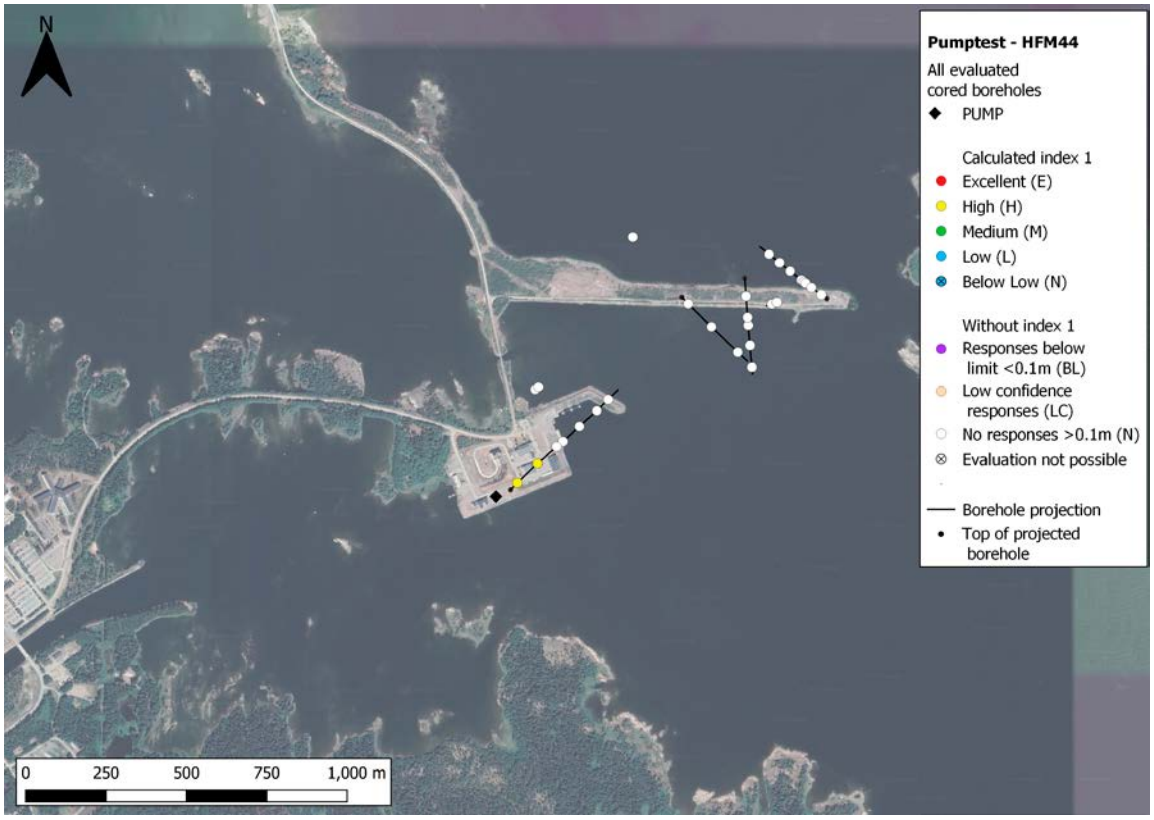


Figure A5-36. *Calculated Index 1 from the interference tests in HFM44. All evaluated cored boreholes. Background map origin: Google maps.*

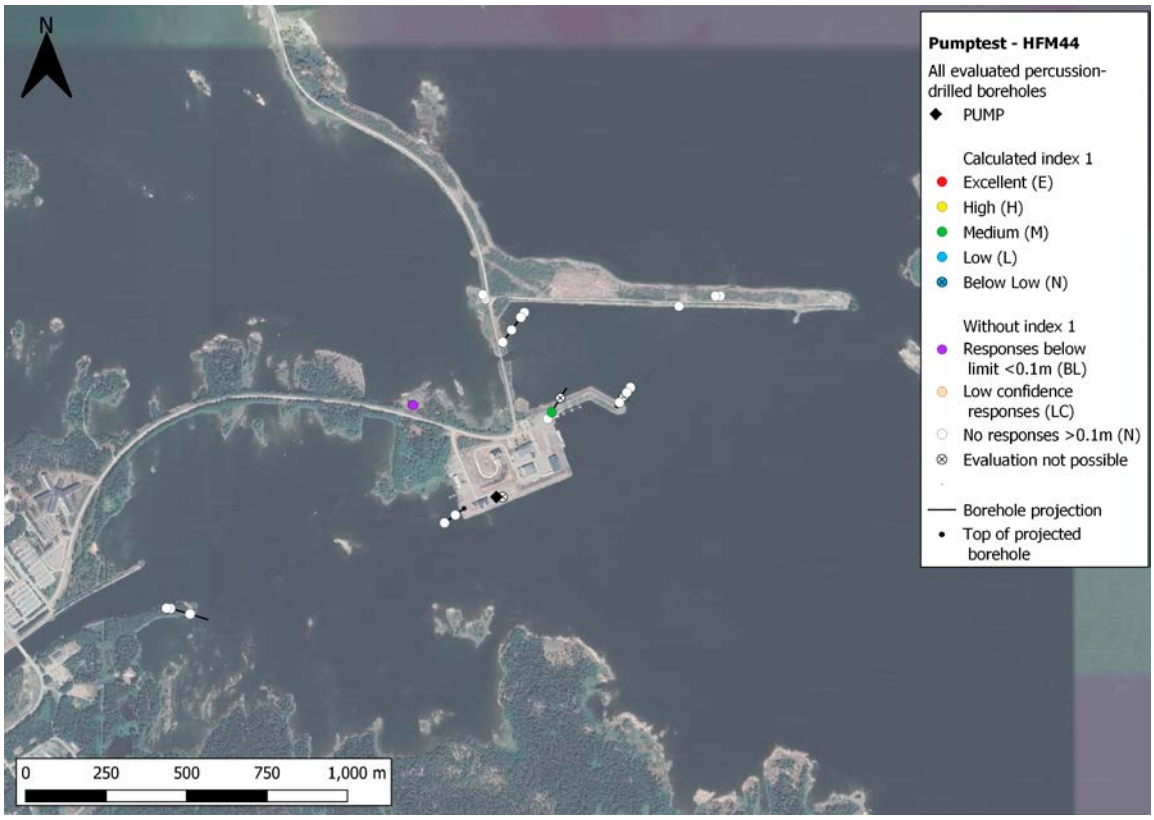


Figure A5-37. *Calculated Index 1 from the interference tests in HFM44. All evaluated percussion drilled boreholes. Background map origin: Google maps.*

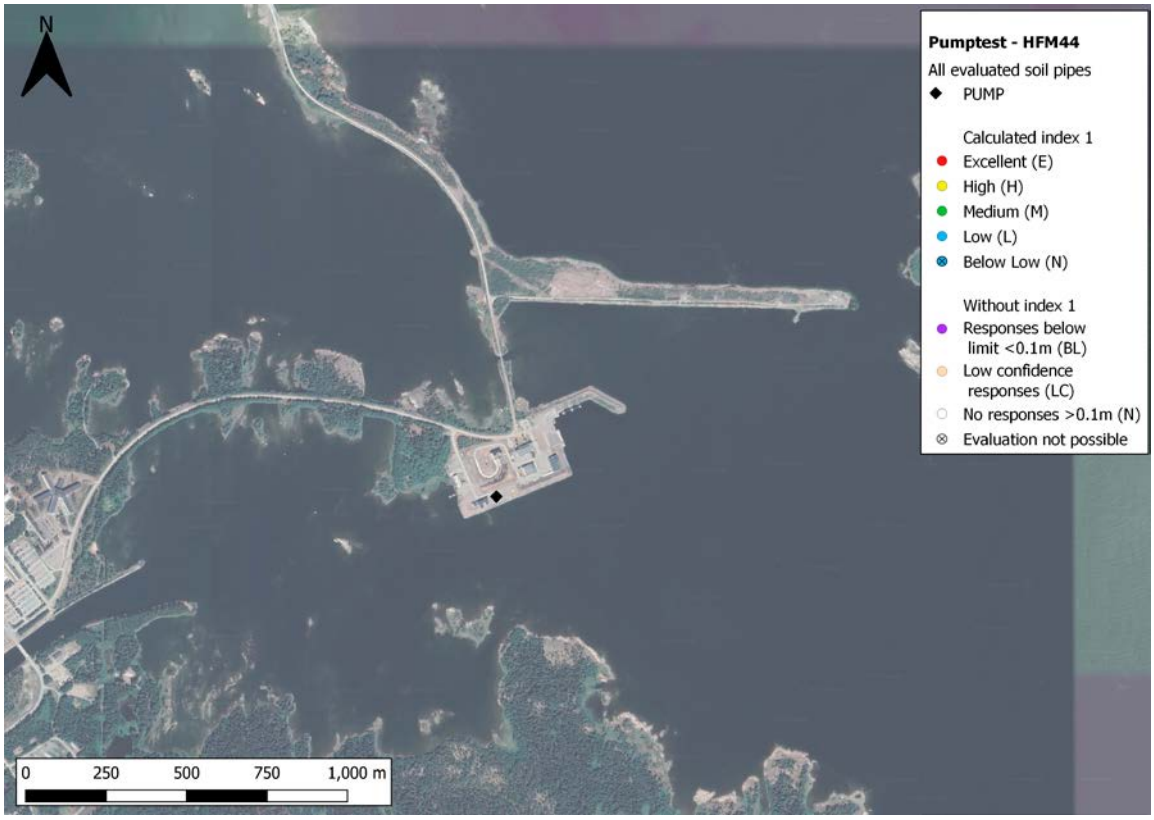


Figure A5-38. *Calculated Index 1 from the interference tests in HFM44. All evaluated soil pipes. Background map origin: Google maps.*

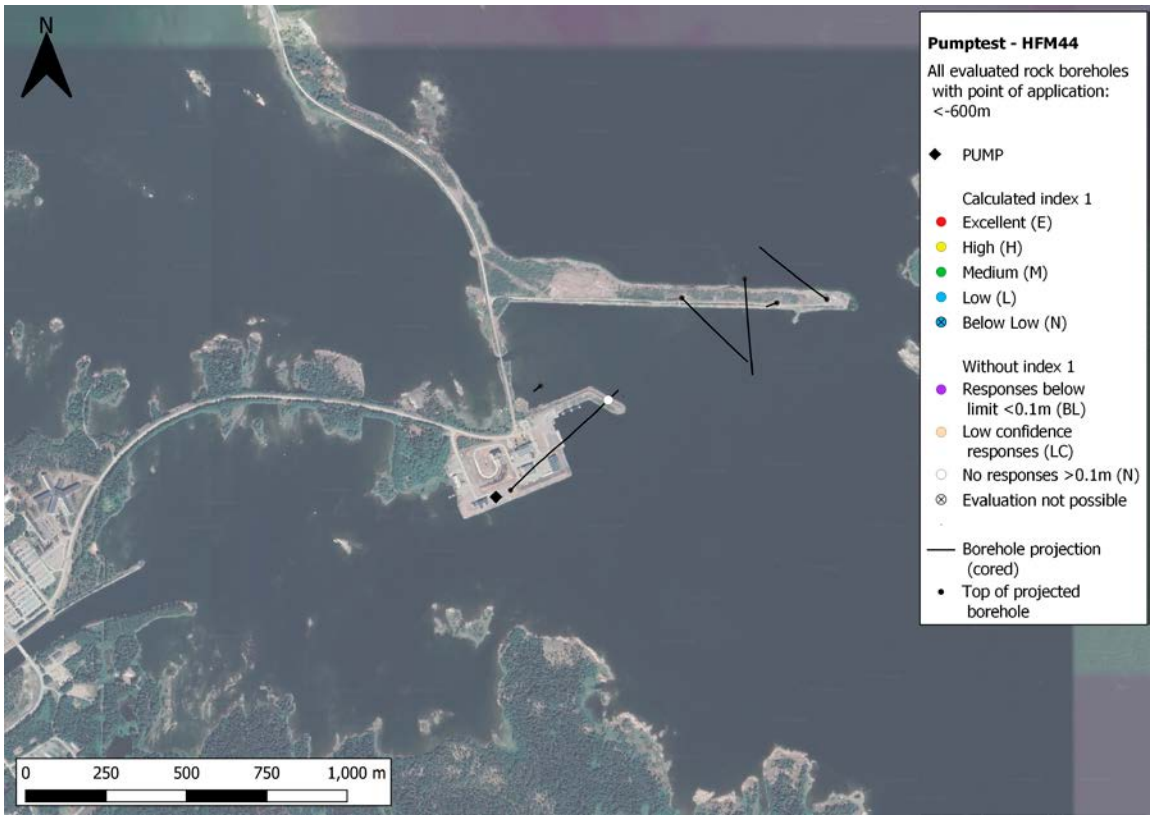


Figure A5-39. *Calculated Index 1 from the interference tests in HFM44. All evaluated rock borehole sections with point of application of < −600 m. Background map origin: Google maps.*

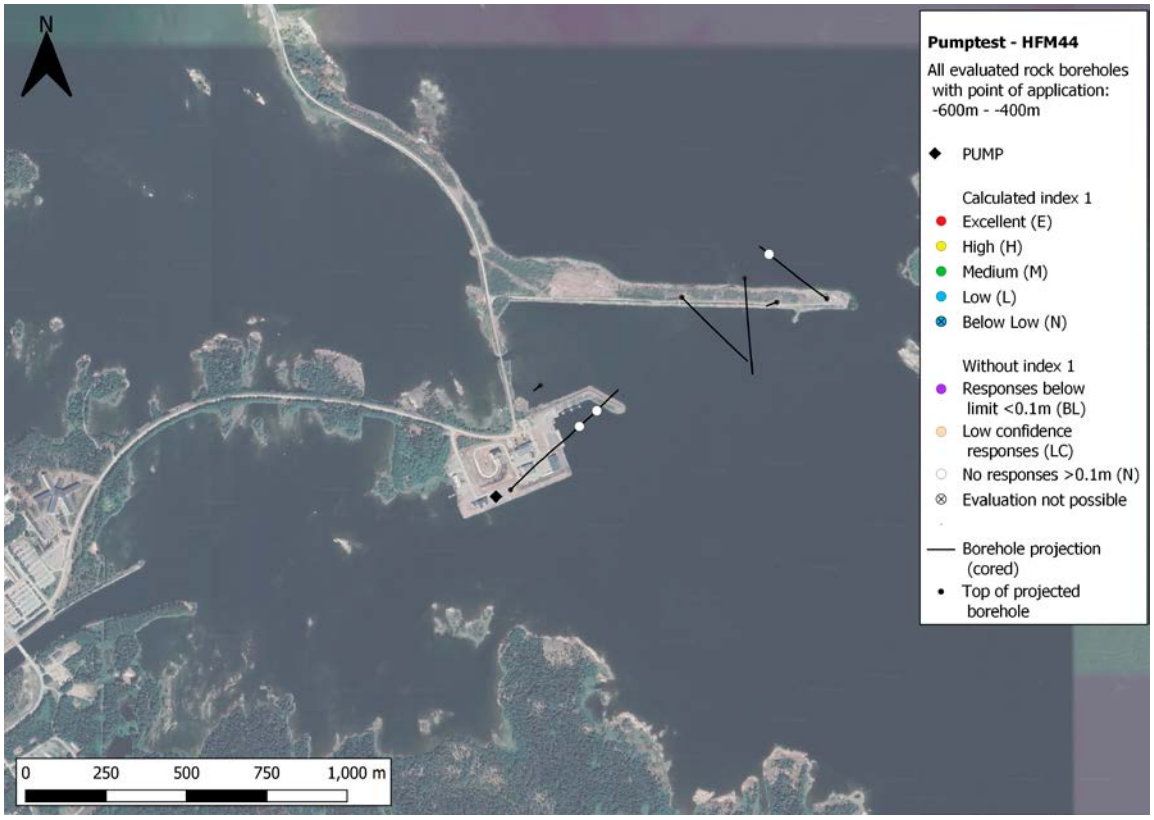


Figure A5-40. *Calculated Index 1 from the interference tests in HFM44. All evaluated rock borehole sections with point of application of −600 to −400 m. Background map origin: Google maps.*

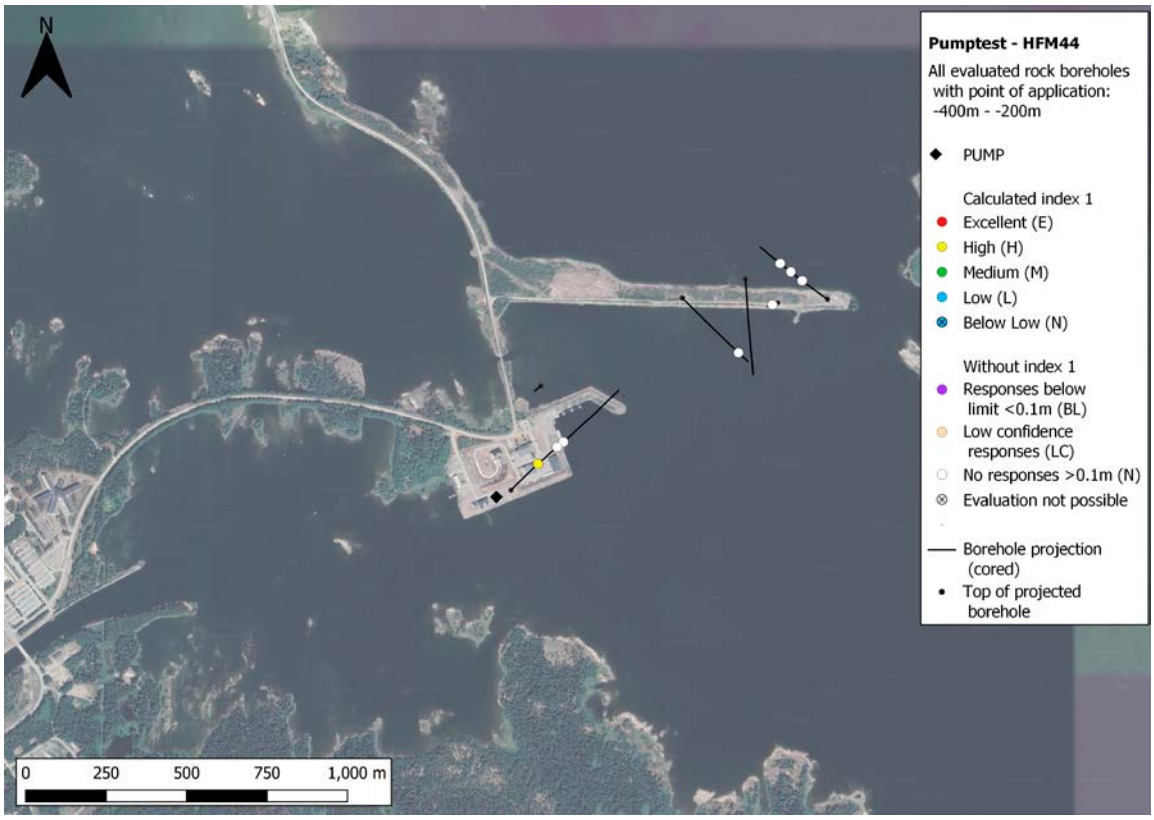


Figure A5-41. *Calculated Index 1 from the interference tests in HFM44. All evaluated rock borehole sections with point of application of −400 to −200 m. Background map origin: Google maps.*

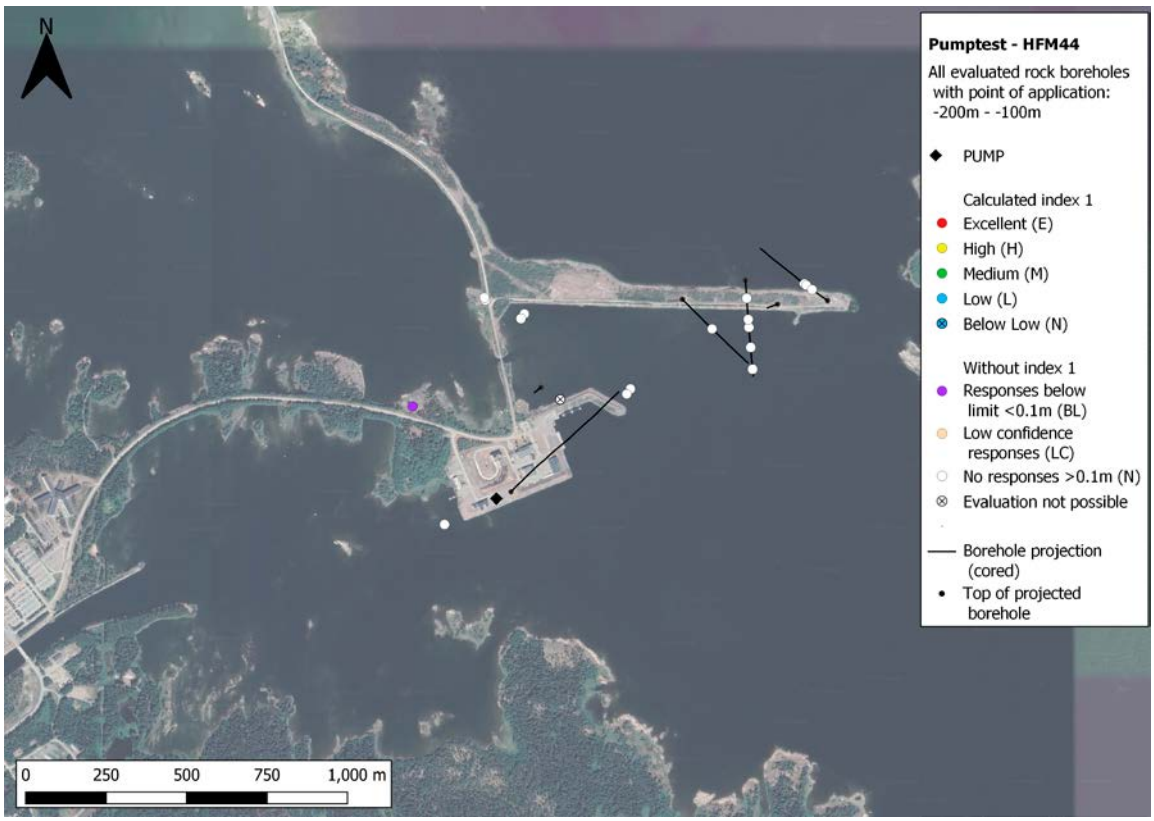


Figure A5-42. *Calculated Index 1 from the interference tests in HFM44. All evaluated rock borehole sections with point of application of −200 to −100 m. Background map origin: Google maps.*

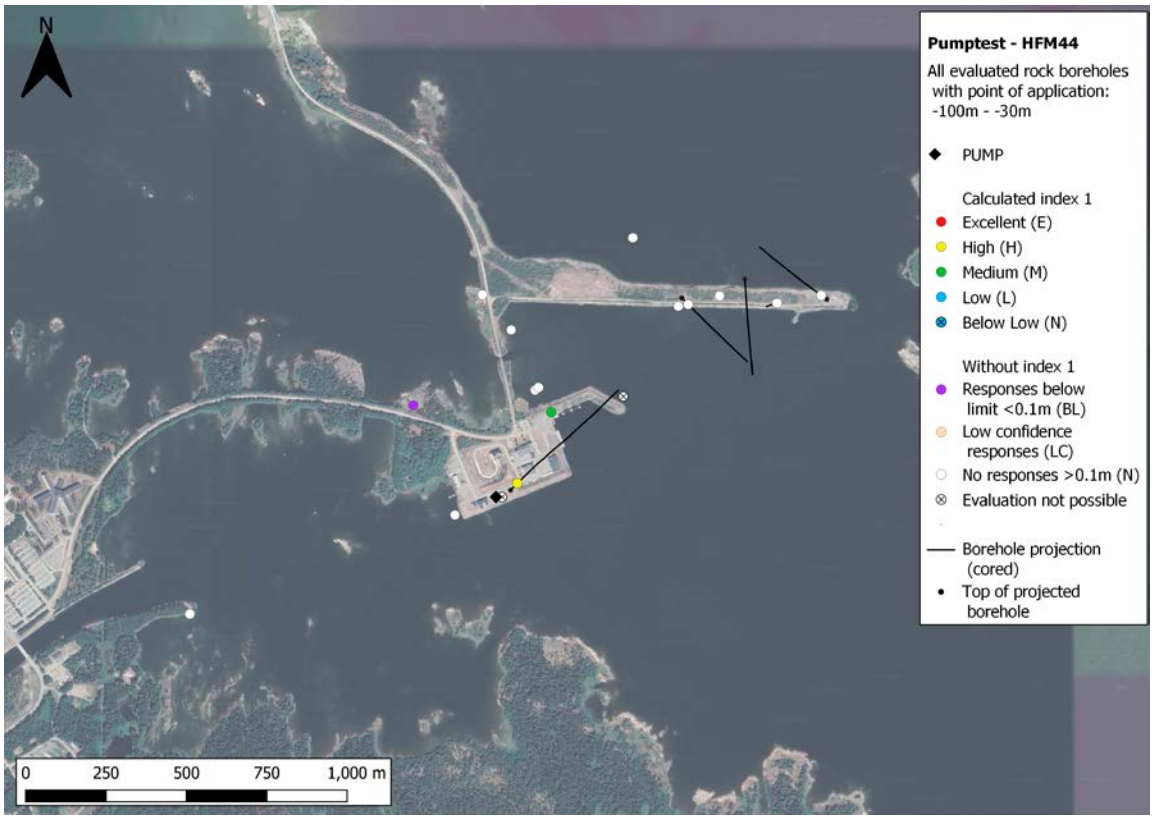


Figure A5-43. *Calculated Index 1 from the interference tests in HFM44. All evaluated rock borehole sections with point of application of −100 to −30 m. Background map origin: Google maps.*

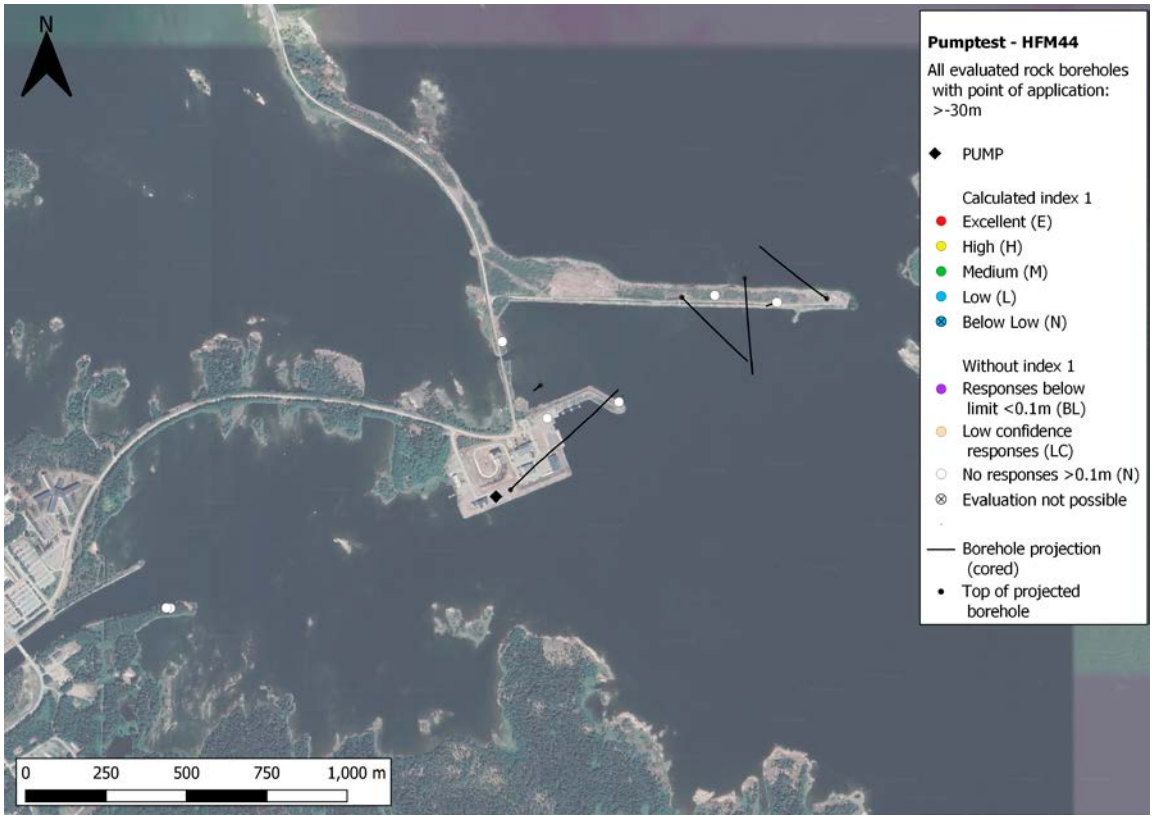


Figure A5-44. *Calculated Index 1 from the interference tests in HFM44. All evaluated rock borehole sections with point of application of > −30 m. Background map origin: Google maps.*

Interference test in HFM46

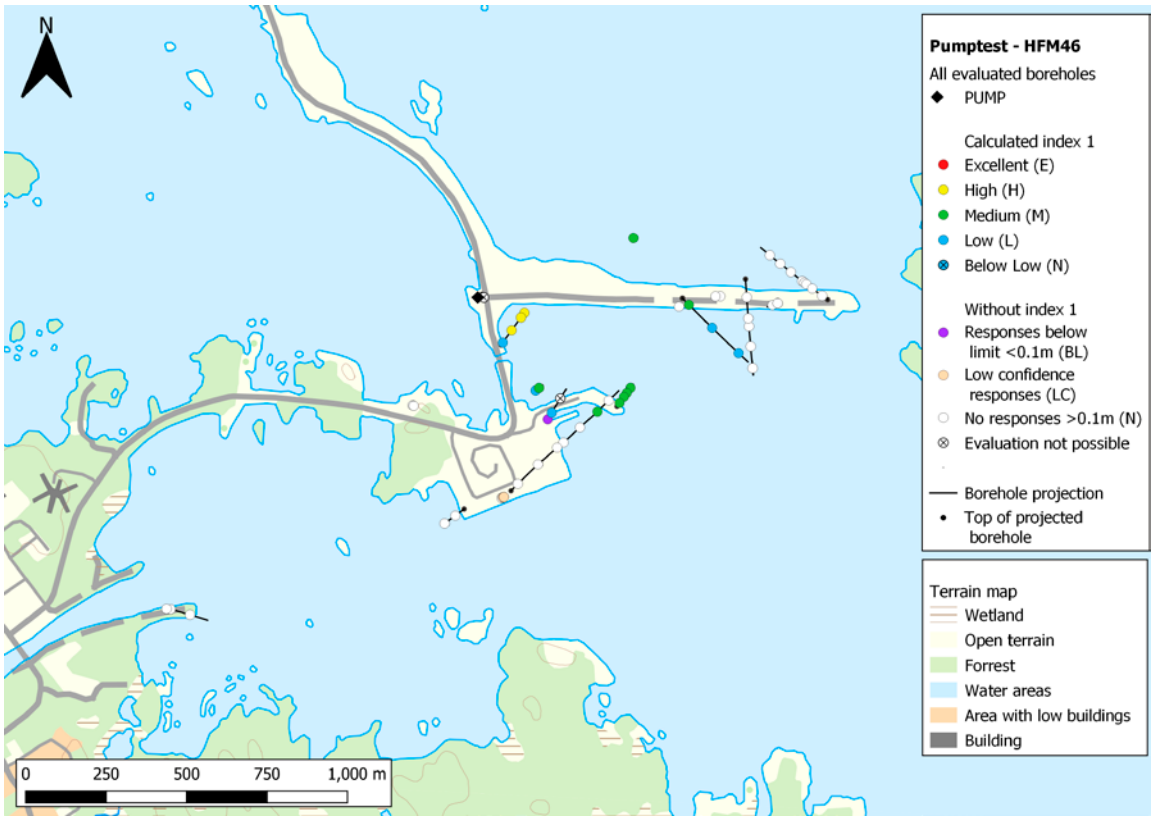


Figure A5-45. *Calculated Index 1 from the interference tests in HFM46. All responses are listed in Table 4-15 to Table 4-17 in the main report. Background map origin: Lantmäteriet.*

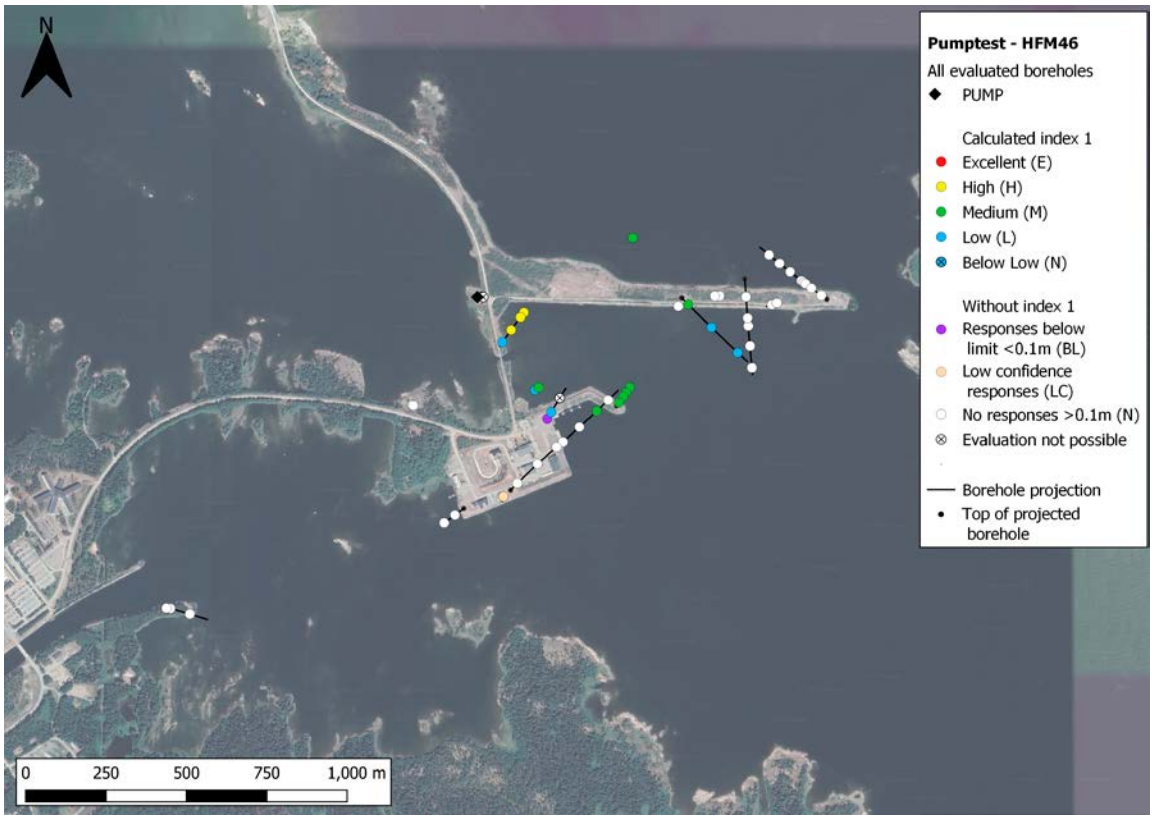


Figure A5-46. *Calculated Index 1 from the interference tests in HFM46. All evaluated boreholes. Background map origin: Google maps.*

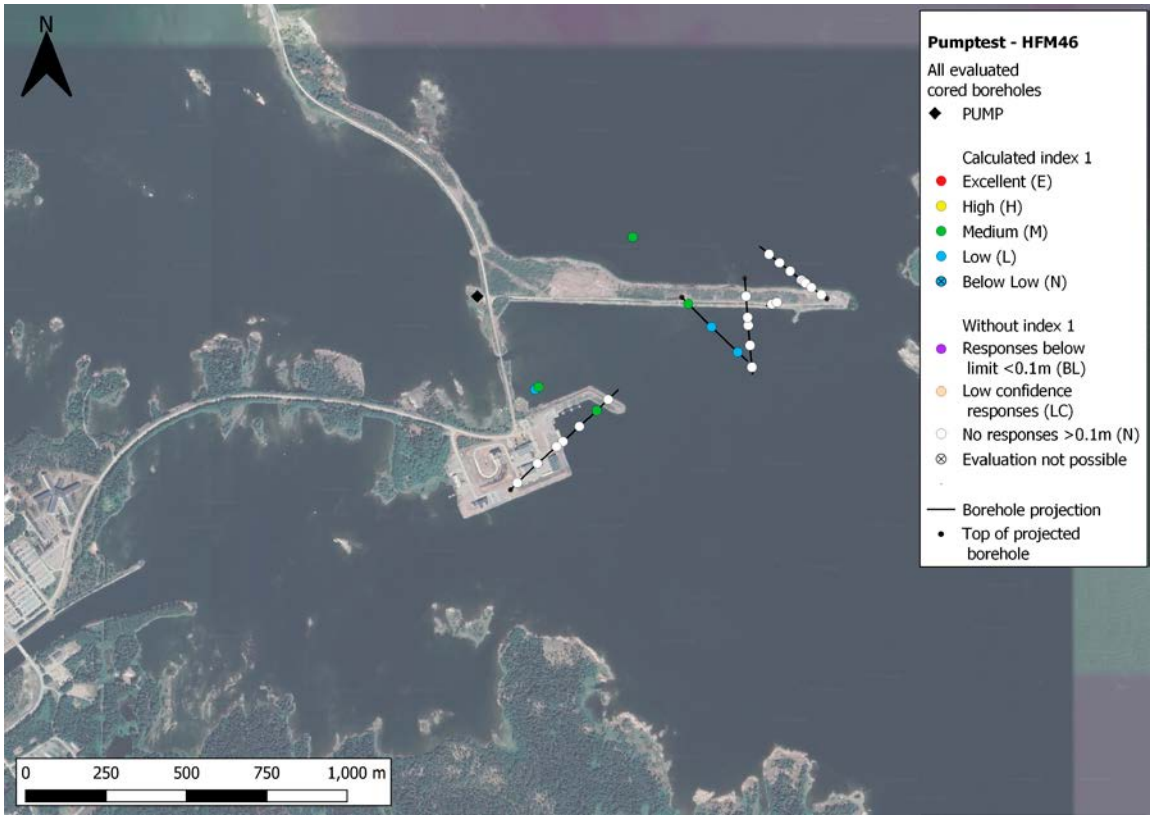


Figure A5-47. *Calculated Index 1 from the interference tests in HFM46. All evaluated cored boreholes. Background map origin: Google maps.*

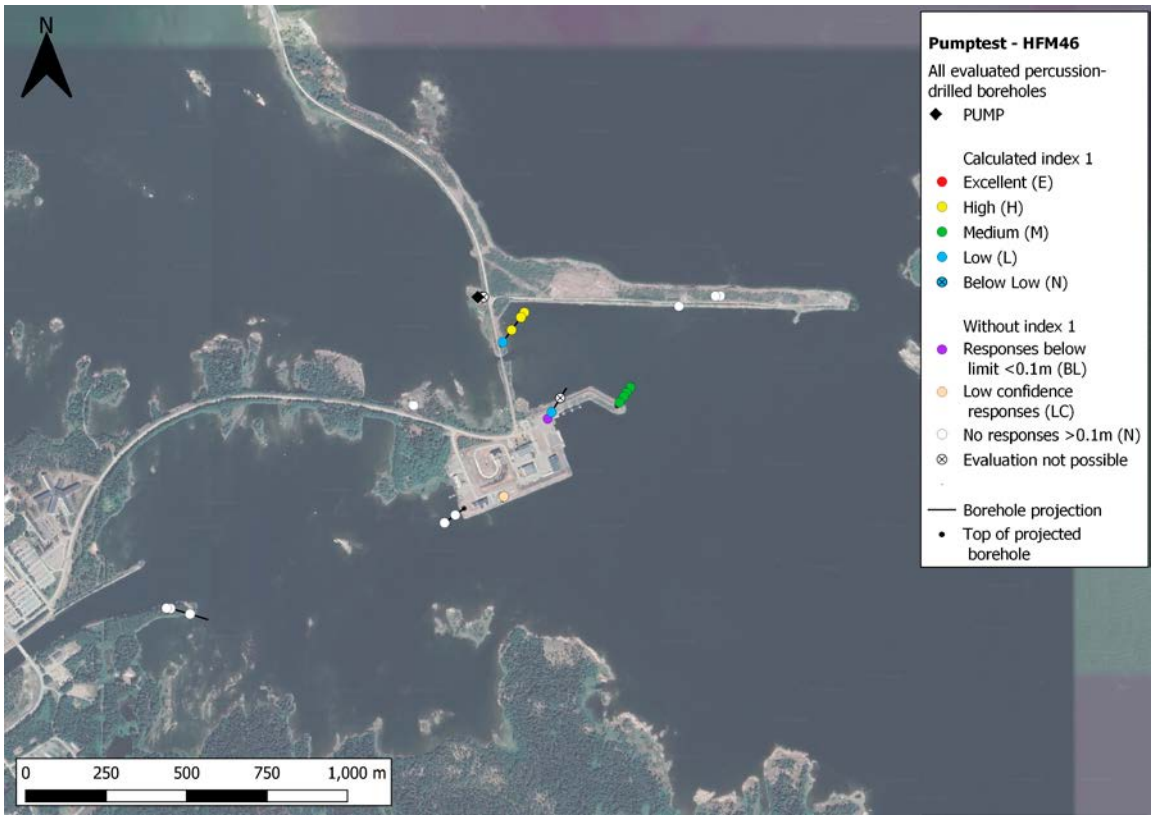


Figure A5-48. *Calculated Index 1 from the interference tests in HFM46. All evaluated percussion drilled boreholes. Background map origin: Google maps.*

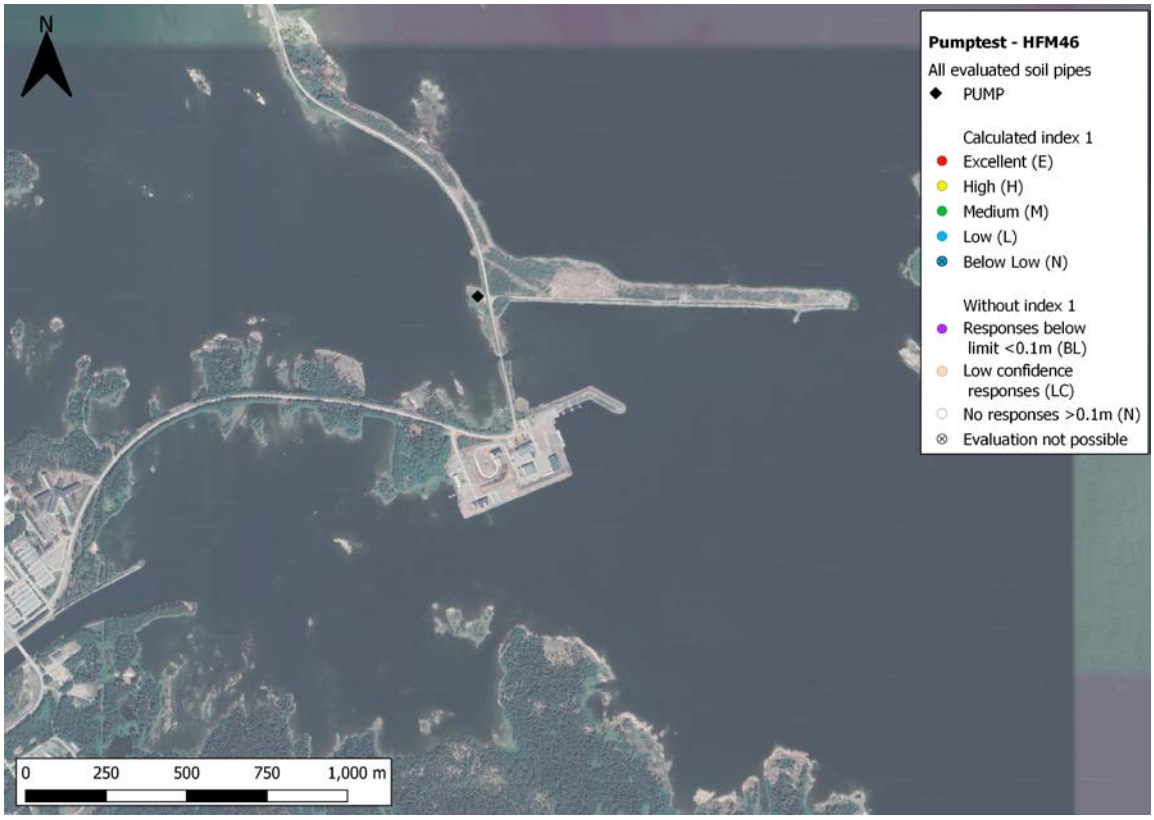


Figure A5-49. *Calculated Index 1 from the interference tests in HFM46. All evaluated soil pipes. Background map origin: Google maps.*

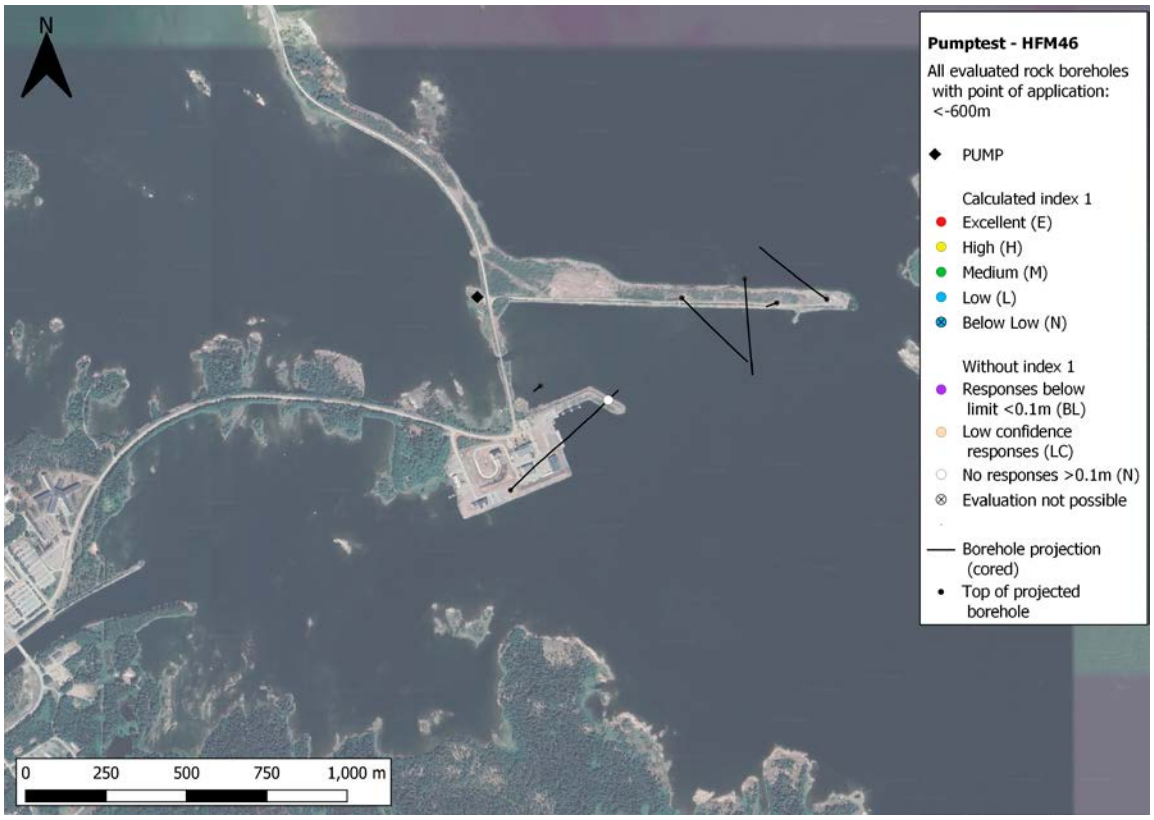


Figure A5-50. *Calculated Index 1 from the interference tests in HFM46. All evaluated rock borehole sections with point of application of < −600 m. Background map origin: Google maps.*

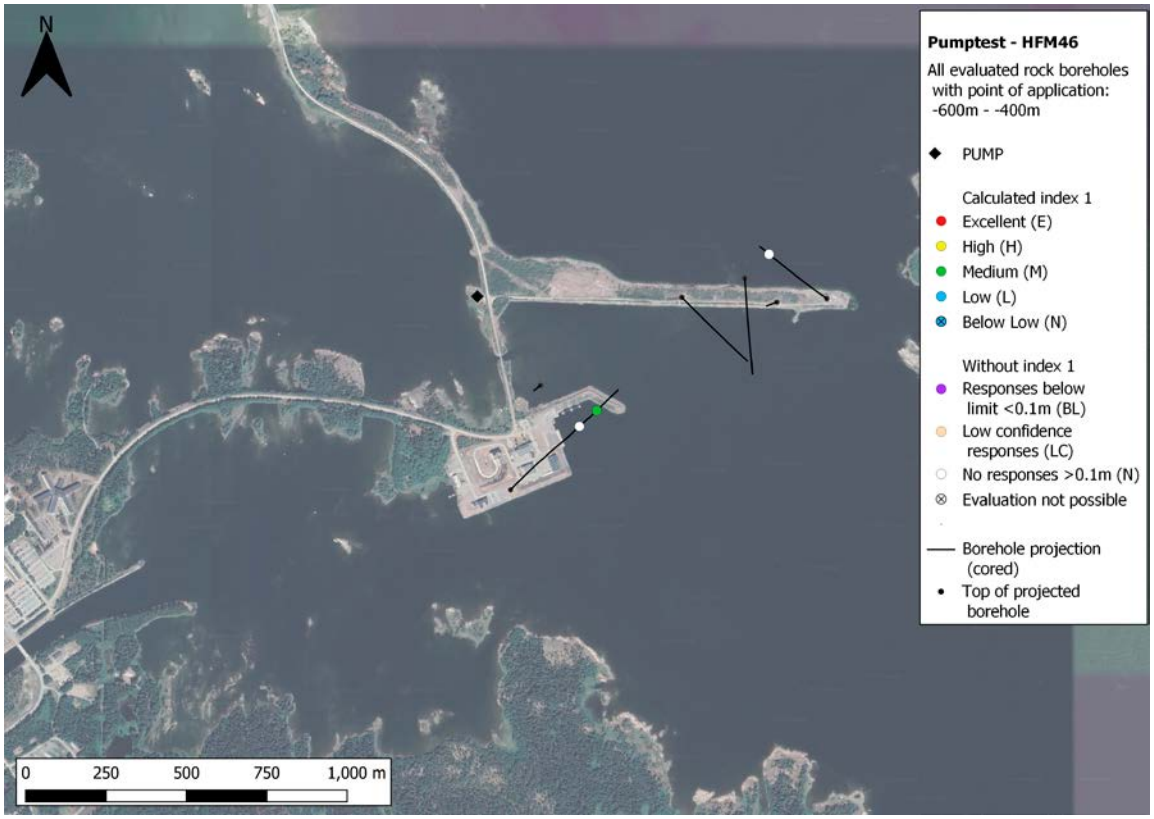


Figure A5-51. *Calculated Index 1 from the interference tests in HFM46. All evaluated rock borehole sections with point of application of −600 to −400 m. Background map origin: Google maps.*

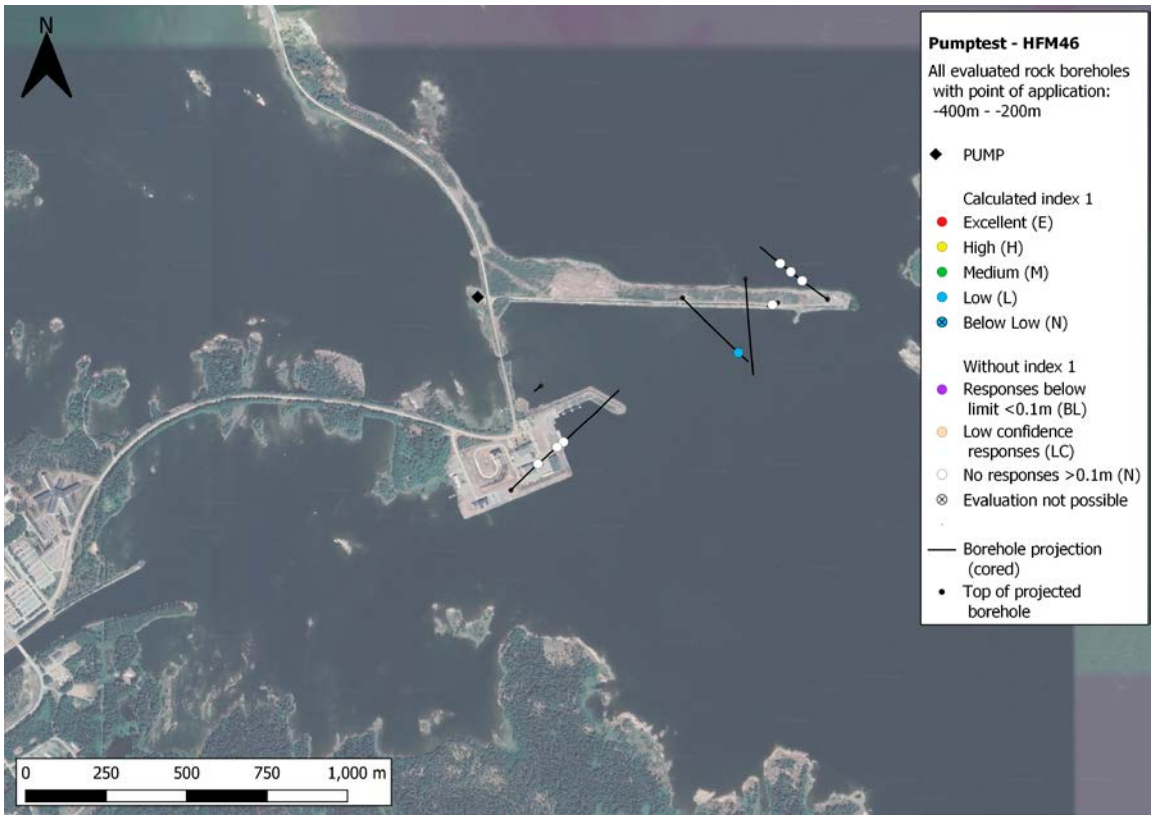


Figure A5-52. *Calculated Index 1 from the interference tests in HFM46. All evaluated rock borehole sections with point of application of −400 to −200 m. Background map origin: Google maps.*

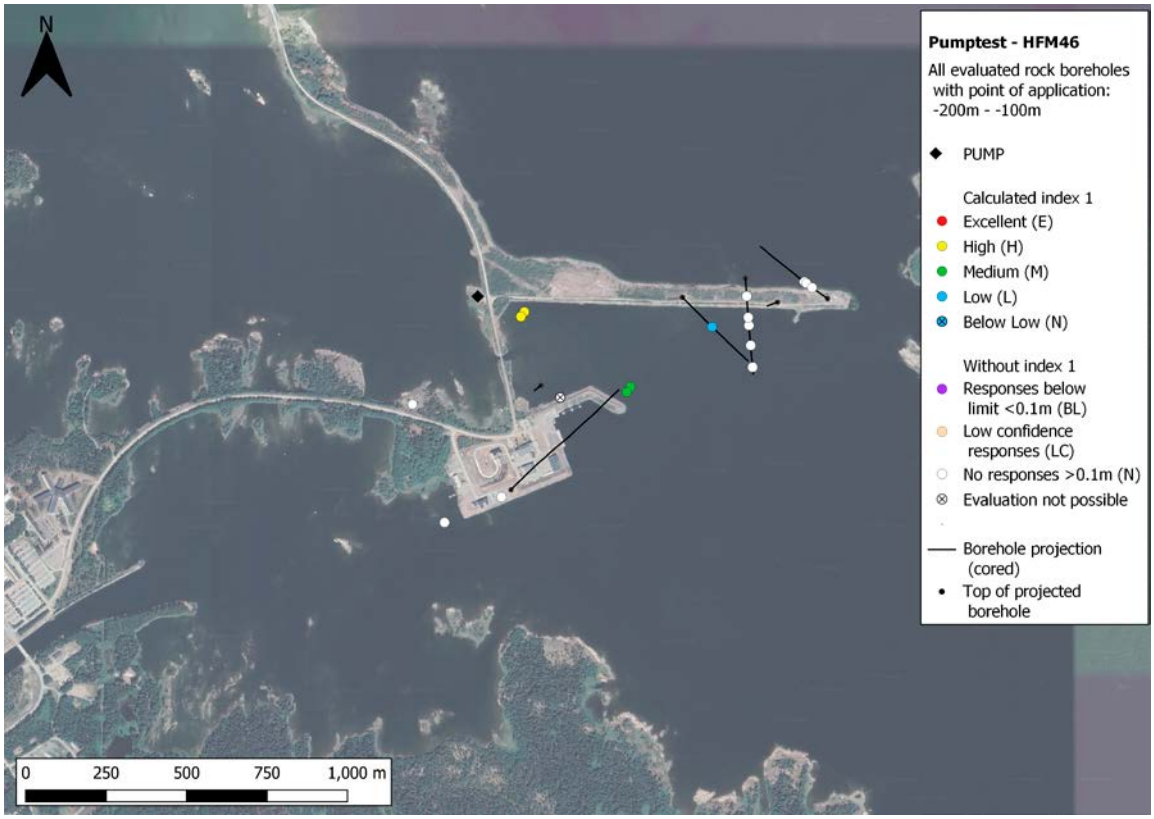


Figure A5-53. *Calculated Index 1 from the interference tests in HFM46. All evaluated rock borehole sections with point of application of −200 to −100 m. Background map origin: Google maps.*

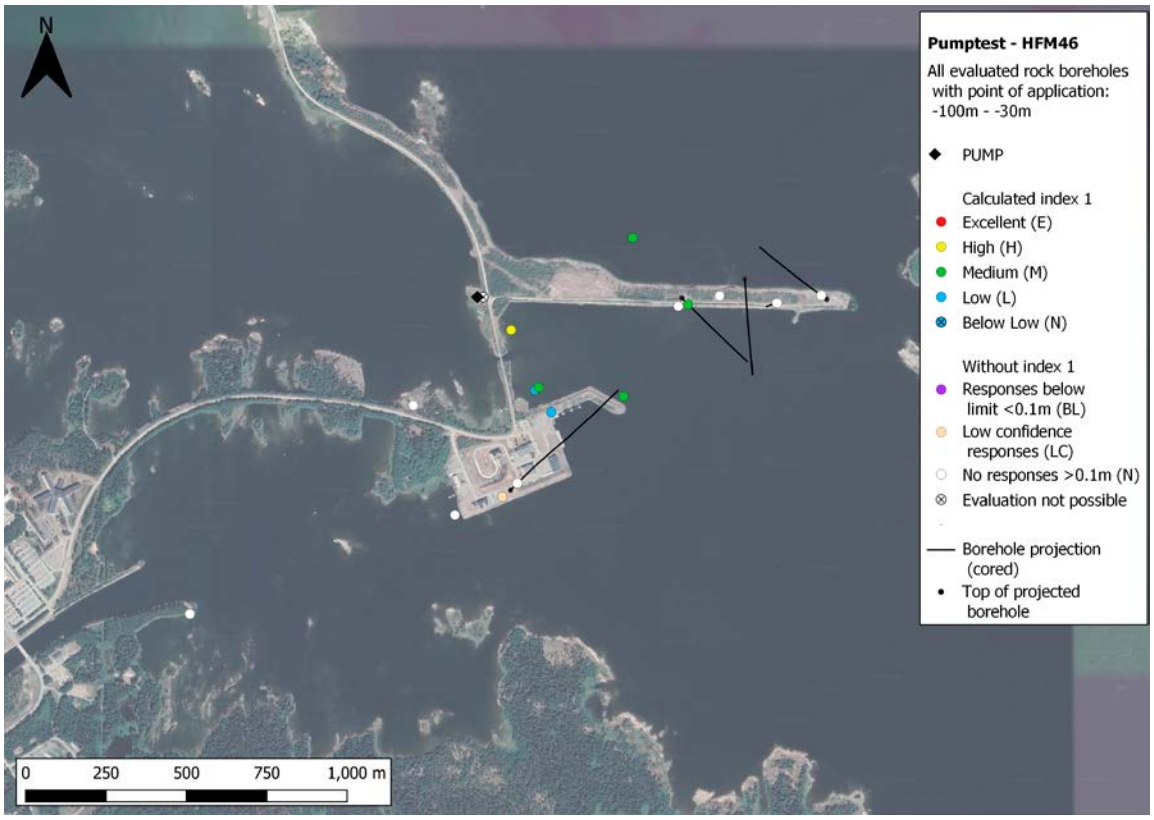


Figure A5-54. *Calculated Index 1 from the interference tests in HFM46. All evaluated rock borehole sections with point of application of −100 to −30 m. Background map origin: Google maps.*

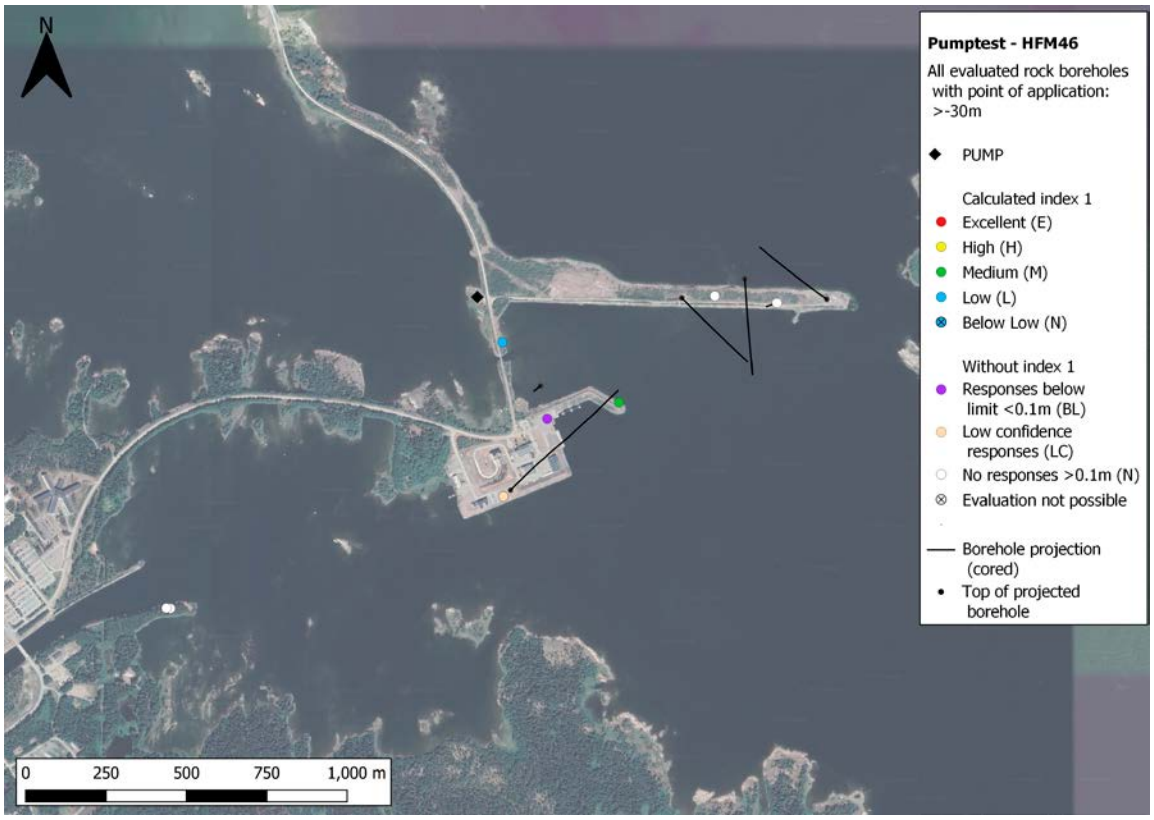


Figure A5-55. *Calculated Index 1 from the interference tests in HFM46. All evaluated rock borehole sections with point of application of > −30 m. Background map origin: Google maps.*

Arkitektkopia AB, Bromma, 2020

SKB is responsible for managing spent nuclear fuel and radioactive waste produced by the Swedish nuclear power plants such that man and the environment are protected in the near and distant future.

skb.se