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Abstract:	The repo Hvammu were cau geologic	ort contains additio ur power plant area rried out 2012 - 20: al sections and cor	nal information abou i in Lower Þjórsá area L3. The report consis elogs.	ut the geology of the a. Geological investigations ts of overview maps,

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Hvammur Power Plant

Geological investigation 2012–2013





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Geology of The Project area

Stratigraphy of geological units

Geology of the project area has earlier been described in "Hvammsvirkjun. Geological Report. Geological Investigations $2001 - 2006^{"1}$ and in "Hvammur Power Plant Geological report - Geological investigations 2007 and 2008."² Results from the geological investigation 2012 and 2013 do not change the general geological setting and stratigraphy as earlier described in above referred reports, but provide more detailed information on layer boundaries and tectonics in the area.

According to [1] series of tholeiite basalt layers, called the Skarðsfjall tholeiite group (STG), found in the southern part of Skarðsfjall are the oldest rocks in the project area, see figure 1. The basalt has normal magnetic polarity and estimated age is over 2.5 million years. These layers have been found in two boreholes, NK-9 and NK-12, in previous investigations. The Skarðsfjall tholeiite group is quite thick, possibly more than 200 m. The layers have a dip of some 2-7° towards northeast.

On top of (STG) lies a sedimentary horizon named "Þjórsárholt sedimentary series" (SH1). These are layers of siltstone, sandstone and conglomerate/tillite. Layers belonging to (SH1) are found in the lowest section of NK-20 and NK-4 and they were also found in NK-33. Conglomerate in core hole NK-53, which was drilled in 2007, belongs to this geological unit.

On top of (SH1) is the Skarðsfjall hyaloclastite (SH2), visible on surface at several places, see figures 2 and 3. This geological unit was formed during a subglacial eruption near the present top of Skarðsfjall. This is a "móberg formation", a name commonly used for this kind of rock formation in Iceland. The powerhouse area, draft tubes and major part of the tailrace tunnel will be located in this rock unit. Several boreholes were drilled into the hyaloclastite, mostly around the Powerhouse and Tailrace Tunnel.



Figure 1. Geology of Skarðsfjall [1].

¹ Almenna Consulting Engineers (2007). Hvammsvirkjun. Geological Report. Geological Investigations 2001-2006. Prepared for Landsvirkjun. LV-2007/053. July 2007.

² Mannvit (2008). Hvammur Power Plant Geological report - Geological investigations 2007 and 2008. Prepared for Landsvirkjun. LV-2008/197. Desember 2008.



Figure 2. Tuff and Tuffbreccia (SH2) in Skarðsfjall.



Figure 3. Pillow lava breccia (SH2) in Skarðsfjall.

Basalt layers belonging to Núpur tholeiite group (NTG) are found in the northern part of Skarðsfjall, see figure 4, resting on (SH2) (Skarðsfjall hyaloclastite) with thin sediment between. The tholeiite basalt in borehole NK-74 and NK-98 belongs to this geological unit.

These layers have reversed magnetic polarity. This basalt formation is found in the lower part of Núpur as seen in the middle and lower part of borehole NK-8.



Figure 4. Tholeiite basalt (NTG) outcropping in the northern part of Skarðsfjall.

On top of the (NTG) group are several porphyritic basalt layers belonging to Skarðsfjall porphyritic group (SPG). This basalt outcrops in the northern part of Skarðsfjall, see figures 5 and 6, and is found in boreholes NK-75 and NK-74. They are also seen in outcrops and boreholes NK-48 and NK-49 on the west bank of Þjórsá where they form a part of the foundation for the main dam of Hvammur power plant. The porphyritic layers can be traced to the farm Minni-Núpur west of the Þjórsá river.



Figure 5. Jointed porphyritic basalt (SPG) at the northern part of Skarðsfjall.



Figure 6. Weathered porphyritic basalt (SPG) at the northern part of Skarðsfjall.

After the early Quarter volcanic activity in the area ceased erosion began, filling depressions and river courses of deposits (LTS) and interglacial lava flows (HIB) which had their origins outside this area. During this period the glaciers eroded a valley in SW direction from Búrfell down through the project area to the moraines at Búði waterfall. This valley is now filled with sediment (UTS and TS) and covered by the Þjórsá-lava (PL). Evidence of this valley is found in many of the boreholes that penetrate the Þjórsá-lava.

The silt deposits found in NK-11 and NK-18 belong to the lower silt series of the Pleistocene age (LTS). The possibility of encountering this silt formation during the construction phase of the project is considered unlikely¹.

The Holt interglacial basalt (HIB) is present between Skarðsfjall and Núpur. The interglacial lava is found in NK-11, NK-18, NK-90, NK-91, NK-105b, NK106 and NK-92 and it is described as almost fresh in borehole logs for boreholes NK-11, NK-90, NK105b, NK106 and NK-91, or slightly altered logs for holes NK-18 and NK-92. This basalt is classified as olivine-tholeiite basalt. A similar formation is found in the percussion hole NL-14. It resembles the Akbraut interglacial basalt found in the area of Holtavirkjun. Outcrops of (HIB) are found in northern part of Skarðsfjall on top of (SPG), see figure 7.



Figure 7. Outcrop of (HIB) at the northern part of Skarðsfjall.

The formation of the (HIB) was followed with period were glaciers and rivers scraped the surface. After the glacier had retreated from the area, Þjórsá river eroded a channel through the area and created an old riverbed with thick layer of sand and gravel (TS). This material was deposited all over the area on a floodplane extending to the south coast of Iceland and is un-cemented.

Some 8700 years ago the Þjórsá lava flowed over the floodplane and Þjórsá river was more or less forced to its present channel. The Þjórsá lava (ÞL) originates from an eruption in the Veiðivötn area and is the biggest postglacial lava flow known in Iceland, extending from Veiðivötn area to the coast at Eyrarbakki, a distance of about 130 km. The lava is from 20 m thick to over 30 m thick in the Hvammur power plant area. The top 5-10 m of the lava is often scoriaceous but the lower part is solid crystalline basalt, sometimes with zones of weak scoria that divides it into two separate units in the Tailrace canal area. Also, especially close to the river, the lava is quite scoriaceous and open for through flow of water.

Tectonics

Skarðsfjall is marked severely by tectonic displacement³. Three sets of fault directions are most frequent; the oldest north-easterly directed faults that are associated with the period of active volcanism in the area, and younger faults oriented in a northerly direction, probably associated with the active South Iceland seismic zone. The third set has a variable direction of N70°A to N105°A. Faults of various types have been found, both strike–slip faults and normal faults.

Joints and dykes are found in almost all the inclined holes drilled in the area and tectonic breccia is found in borehole NK-98 alongside with several dykes. Possible location of tectonic lineaments is described in corelogs and dykes and breccia in boreholes are shown graphically on corelogs in Appendix A.

No major faults and breccia zones are found in the holes drilled in the Intake and Tailrace tunnel area.

In boreholes drilled in the Surge tunnel area are brecciated zones around basalt intrusions. The brecciated zones are often partly re-cemented.

Many of the dykes found in the inclined boreholes are cone dykes or horizontal intrusions. In some cases it is difficult to see if they are horizontal or vertical.

A fault cutting Skarðsfjall from NNA to SSV was displaced in an earthquake in the 1896. Magnitude estimated is between 7 to 7,5 Richter scale.

³ Maryam et.al. (2007). Hvammsvirkjun. Geological investigation on Skarðfjall in South Iceland Seismic Zone. Basement tectonics, Holexene surface rupture, leakage, and stratigraphy. (SOR-2007/017; LV-2007/65.

Ground Investigations 2012-2013

The aim of the investigations in the Hvammur Power Plant project area, during the summer and winter 2012-2013, was to gather more detailed information on the layer boundaries and tectonics within the area. A total of 17 cored boreholes were drilled. Nine core holes were drilled to investigate geology and layer boundaries in longer tailrace canal than previously decided. Two core holes were drilled to investigate if tectonic features, shown on tectonic map from ISOR [3], existed in the tailrace tunnel route close to the powerhouse. One core hole was drilled in the intake area across changed location of the Intake, two holes in the Access and Surge Tunnel area to map boundaries of the Skarðsfjall hyaloclastite and above laying formations and three in the dam Spillway area, to map massiveness of the Þjórsá lava.

Drilling was carried out by the drilling contractor Ræktunarsamband Flóa og Skeiða (RSFS). The first period of drilling started 08.05.2012 and was completed 14.07.2012. Drilling of core holes continued in 12. – 17. of December. Total drilling was 647,91 m.

One 3" percussion drilling hole NL-104 was drilled in December 2012, for groundwater measurement during pumping test, the hole collapsed and it was not possible to clean it. A new drilling equipment called "Carl Gústav" was transported to the site February 04, 2013 to drill 14" pumping well and two 7" holes for groundwater level monitoring during the pumping test. Drilling was finished 18. February.

Nine test pits were excavated in the Spillway area in February 2013 to map material type and depth to bedrock in the Þjórsá riverbed beneath proposed Dam Spillway.

Cored boreholes

Logs of cored boreholes are found in Appendix A. The core logs contain information about lithology, core recovery, fracture intensity, RQD-values and Q-values for rock units and results from permeability tests where these had been performed. Coordinates of the core holes are presented in Table 1, on next page, and locations are shown on Drawings G-2012-001 and G-2012-002.

Core Photos are found in Appendix B.

Three permeability tests were performed and results are shown graphically in Appendix D along with the pumping test.

Hole	Construction	Coordinate	s, ISNET93	Elevation	Depth	Groundwater	Inclination	Direction
nr.	area	Х	Y	(m.a.s.l.)	(m)	Depth (m)	(°)	(°)
NK-90	Tailrace Canal	442950,65	392604,8	98,82	35,85	Collapsed 7.4		
NK-91	Tailrace Canal	442542,40	392313,6	96,03	33,30	Collapsed 11.7		
NK-92	Tailrace Canal	442083,10	392168,1	96,37	32,40	16,12		
NK-93	Tailrace Canal	441673,23	391882,8	89,60	26,65	9,77		
NK-94	Tailrace Canal	441200,26	391878,9	80,78	17,73	1,00		
NK-95	Tailrace Canal	441665,13	392155,0	89,64	25,77	9,71		
NK-96	Tailrace Canal	442370,55	392367,3	95,74	33,70	14,84		
NK-97	Surge Tunnel	445109,73	393935,2	110,41	66,16	12,98	36,4	256
NK-98	Surge Tunnel	445107,67	393932,7	110,35	50,23	12,51	19,8	89
NK-99	Tailrace Tunnel	444956,85	393897,3	106,97	90,55	11,50	44,4	326
NK-100	Tailrace Tunnel	444976,21	393953,5	104,89	57,62	7,83	46,6	294
NK-101	Intake	444875,13	394250,0	112,64	64,79	17,92	45	131
NK-102	Spillway	444739,01	394319,2	112,83	18,42	11,76		
NK-103	Spillway	444704,74	394288,9	111,98	18,62	11,68		
NK-104	Spillway	444652,37	394251,3	110,02	11,74	Collapsed 8.38		
NK-105b	Tailrace Canal	442709,61	392589,3	98,337	30,64	14,74		
NK-106	Tailrace Canal	442509,58	392468,4	98,17	33,74	16,3		
Total					647,91			

Table 1: Location and depth of core holes drilled at the Hvammur project area, 2012.

Groundwater measurements

After drilling, water level was measured in boreholes. Temperature and conductivity was also measured 1 to 2 m below water level. Values recorded are shown in Table 2. As shown in Table 2, the water level is approximately 0,3 to 0,4 m lower 13.-14. of July than it is in end of May, probably as a result of very dry and warm weather between measurements. In NK-98 sound of streaming water was heard, but the hole collapsed at 12,51 m depth.

Table 2	Groundwater	measurement	in	core h	noles
I avit Z.	Groundwater	measurement		COLEI	10162

Hole nr.	Top of hole Elevation (m a.s.l.)	Inclination ° from vertical	GWT 31/5 (m)	GWT 13-14/7 (m)	GWT 31/5 (m a.s.l.)	GWT 13-14/7 (m a.s.l.)	Temp. °C	Conductivity (µ)
NK-90	98,82		Collapsed 7.4					
NK-91	96,03		Collapsed 11.66					
NK-92	96,37		15,77	16,12	80,60	80,25	6,7	101
NK-93	89,60		9,42	9,77	80,18	79,83	6,6	100
NK-94	80,78		0,66	1,00	80,12	79,78	6,1	125
NK-95	89,64		9,36	9,71	80,28	79,93	6,2	95
NK-96	95,74			14,84		80,90	7	100
NK-97	110,41	36,4		12,98		99,96	6,4	124
NK-98	110,35	19,8		12,51		98,58	5,6	71
NK-99	106,97	44,4		11,50		98,76	6,6	121
NK-100	104,89	46,6		7,83		99,51	6,4	116
NK-101	112,64	45		17,92		99,97	7,5	107
NK-102	112,83			11,76		101,07	6	96
NK-103	111,98			11,68		100,30		
NK-104	110,02			Collapsed 8.38				

Percussion Boreholes

Four percussion boreholes were drilled during winter 2012-2013. Coordinates of the percussion holes is given in Table 3 and location is shown on Drawings G-2012-002 and Figure 10. Borehole logs are in Appendix C.

Hole NL-104 collapsed and could not be used for measuring groundwater. NL-105 was drilled 14" in diameter with casing down to 18 m and then 12" in diameter down to 21 m depth. The casing was then perforated with casing perforator, 20 rows between 13 and 17,5 m depth, in the scoriaceous part of the hole. NL-106 and NL-107 were drilled 7" in diameter with casing down to 18 m and then 6,5" down to 21 m depth. These holes were also perforated through the casing with casing perforator, see Figure 8, 6 rows between 12 and 16 m depth in NL-106 and between 12 and 17 m depth in NL-107. Total drilling of percussion holes was 84 m.

Hole	Construction	Coordination		Elevation	Depth	Casing	Groundwater	Size
nr.		х	Y	m a.s.l.	(m)	(m)	Depth (m)	(")
NL-104	Tailrace Canal	441834.12	392168.90	91.99	21.0	9.15		3
NL-105	Tailrace Canal	441831.42	392170.60	92.27	21.0	18.0	11,87	14/12
NL-106	Tailrace Canal	441834.91	392171.03	92.32	21.0	18.0	11,90	7/6,5
NL-107	Tailrace Canal	441840.07	392171.73	92.41	21.0	18.0	11,95	7/6,5

Table 3. Location and depth of percussion holes drilled at Hvammsvirkjun, 2012-2013.



Figure 8. Casing perforator in NL-105.

Test pits

Nine test pits were excavated 15. and 18. of February, 2013, at the Spillway area. Excavator was 22t Komatsu PS220LC and the excavation bucket was without teeth. Coordinates and elevation of test pits are shown in Table 4. Location of Test pits is shown on Drawing G-2012-005 and detailed description and test pit photos are in Appendix E.

Test pits G1 to G4 were excavated on a sandbank in the Þjórsá river with the water level at the top of the test pits. Test pit G5 was located on land at the side of the river and excavated below the water level in the river but the test pit was dry except small inflow close to the surface. Test pits G6 to G9 were dry although the bottom of G6 and G7 were excavated below the water level of the river.

The geology of test pits G1 to G4 is similar with gravel on top of scoria and scoriaceous basalt filled with light brown silt or clay size material. The geology of test pits G5 to G8 is similar with topsoil and silt on top of scoria and scoriaceous basalt. In test pit G9 is soil on top of crystalline basalt.

Hole	Construction	Coordination		Elevation	Depth	Groundwater
nr.		X	Y	m a.s.l.	(m)	Depth (m)
G1	Spillway	444564.13	394223.68	104.08	4.20	0
G2	Spillway	444523.74	394151.15	103.98	2.00	0
G3	Spillway	444574.68	394251.27	103.98	3.60	0
G4	Spillway	444519.85	394146.75	103.91	3.00	0
G5	Spillway	444551.15	394138.60	104.10	4.50	Dry
G6	Spillway	444577.51	394189.74	106.21	5.50	Dry
G7	Spillway	444607.01	394220.80	108.87	5.90	Dry
G8	Spillway	444654.27	394248.17	109.59	5.30	Dry
G9	Spillway	444682.93	394268.10	110.77	2.70	Dry

Table 4. Coordination table of test pits in the Spillway area.

Summary of results

Tailrace canal

Geology

Seven boreholes were drilled to map the geology on the proposed Tailrace canal route. Results indicate various thickness of the Þjórsá lava (ÞL), with top scoria varying from 0 m to 10 m.

The thickness of the crystalline basalt is also varying from 8 m to 26 m and sometimes with up to 8 m thick weak scoria layers in between the more solid lava, see drawing G-2012-002 and core logs in Appendix A.

The bottom of the Þjórsá lava is at variable elevation controlled by the landscape of the underlying materials when the lava flowed, being highest at about 81,8 m a.s.l. in hole NK-90 to below 63 m a.s.l. in hole NK-93, elevation of layer boundaries are shown in Table 5. Below the Þjórsá lava basalt is loose sediment (TS), consisting of sand and gravel. The thickness is from one to over six meters. Below the sediment is olivine basalt formation (HIB) with maximum elevation in borehole NK-90.

The shape and size of the canal must be adjusted to the geology. The bottom level of the canal should be above the loose sediment (TS) underlying the Þjórsá lava (ÞL) basalt and slope angle defined based on the massiveness of the lava.

Pumping test

Preparation for the pumping test started 20. February 2013, but due to unfavorable weather conditions the test didn't take place until 12. March 2013. Appendix D shows the results of the pumping test in borehole NL-105. The equipment was removed from the area 13. March. Location of the boreholes is shown on Figure 9 and distance between holes is shown on Figure 10.



Figure 9. Location of measuring holes.



Figure 10. Distance between Pump Test hole NL-105 and the measuring holes.

The pump which was used is a multistage pump, and pumping rate was set by means of a frequency regulator. The pump was operated at full power during the test. Care was taken to ensure that pumping rate was as constant as possible during the test. Pumping rate was increased from zero to full power in few seconds after start. A check value in the pump prevented water from flowing backwards from the discharge piping into the well when pumping was stopped.

Discharge from the pump was conveyed through a 180 mm pipe towards the Þjórsá river were the water was released to the ground surface, some 100 m away from the pumping well. Discharge from the pump was measured using a V-notch weir at the outlet of the pipe. At the discharge area water from the pump infiltrated the ground but it not believed to have affected the result of the pumping test over the short time interval, but total time of test was about 7 hours.

Drawdown was recorded with pressure transducers and manually in borehole NL-107 and the pumping well (NL-105) during the pumping test, but drawdown in NL-106 was recorded manually. Pressure transducers with data loggers registered water level automatically at specified time intervals during the course of the pumping test. In addition, pressure transducer with data logger was put 19. December 2012 in NK-92 which is located approx. 250 m from the pumping well, and data from this station was used to evaluate groundwater conditions on a larger scale in the area before, during and after the pumping test. Readings on the pressure transducers were checked for consistency with tape as often as possible.

The reference groundwater lowered in borehole NK-92 during the pumping test, not as a result from pumping but due to natural fluctuation of the regional groundwater level.

Interpretation of results

Prior to the pumping test, Vatnaskil Consulting Engineers estimated both transmissivity and storativity for the area.⁴ Based on their model for groundwater flow in the Lower Þjórsá Basin, transmissivity (T) was estimated being 0,1 to 2 m²/s, with 1 m²/s being the most likely value, and storativity was estimated between 0,1 to 0,3 with 0,2 being the most likely value.

The results from the pumping test of well NL-105 more or less confirm the estimate done by Vatnaskil. Based on calculations from the drawdown in wells NL-106 and NL-107 while pumping 0.081 m³/s from well NL-105, the transmissivity (T) is estimated as 1.6 m/s² and the storativity (S) as 0.09, see Appendix D. These results were obtained using the Hantush-Jacob solution for leaky confined aquifers. The Hantush-Jacob solution gave a much better correlation with the measured values than did the Theis solution for unconfined aquifer.

Tailrace Tunnel

Two inclined boreholes NK-99 and NK-100 were drilled to map the geology and tectonic lineaments on the Tailrace tunnel route close to the Power house area. Logs of the boreholes are found in Appendix A and location of assumed tectonic lineaments in the boreholes is described in text on corelogs in Appendix A. No major faults or breccia zones were located in these two boreholes.

Access and Surge tunnel

Two boreholes were drilled to map the geology of the adit and surge tunnel, see logs in Appendix A. Location of holes and geological section is shown on Drawing G-2012-003. Several dykes (vertical and/or horizontal) were located alongside with tectonic breccia and tectonic joints. Location of tectonic lineaments and dykes found in the holes is shown in Appendix A. These two boreholes gave better information of the elevation of the top of the hyaloclastite formation (SH2) and location of other layer boundaries.

Intake

One borehole was drilled through the basalt and loose sediment and into the hyaloclastite to find the thickness of the basalt (PL) and the loose sediment (TS) and to locate the depth to the hyaloclastite (SH2). Tectonic lineaments were located in the hyaloclastite, but it was not obvious if joints in the basalt are tectonic or cooling joints. No major faults or breccia zones were located. Core log is shown in Appendix A. Location of the borehole and geological section are shown on Drawing G-2012-004.

⁴ Vatnaskil, memo no. 12.11, December 6, 2012.

Spillway

Three holes, NK-102, NK-103 and NK-104 were drilled through the overburden and top scoria and down to the Þjórsá lava (ÞL) to map the thickness down to solid basalt. Core logs are shown in Appendix A. Location and geological section is shown on Drawing G-2012-005. Elevation of the top of crystalline Þjórsá lava (ÞL) was lower in NK-104 than expected.

Because of poor rock quality in NK-104 it was decided to excavate test pits in the Spillway are to map better the loose sediment and scoria on top of the basalt. Nine test pits were excavated in 15 and 18 of February 2013. Location and description of the test pits and photos of them are shown on Drawing G-2012-005 and Appendix E. Solid basalt was only found in test pit G9. Table 5. Elevation of layer boundaries.

							From
	m a.s.l.	m	m a.s.l.	m a.s.l.	m a.s.l.	m a.s.l.	vertical
Hole	Тор	Depth	ÞL-Bottom	SH2-Top	HIB-Top	NTG-Top	Hole Incl.
NK-53	104.36	51.72	89.36	89.36			
NK-54	106.07	54.72	75.17				
NK-55	107.56	54.72	74.54				
NK-56	106.71	54.72	74.89				
NK-57	107.30	39.72	75.35				
NK-58	107.03	45.72	73.59				
NK-59	100.85	33.72	73.79				
NK-60	115.37	30.72	<84.65				
NK-61	115.25	21.72	<93.53				
NK-62	115.74	24.72	<91.02				
NK-63	105.60	57.72	94.01	90.52			
NK-64	105.70	63.48	95.42	92.03			44.5
NK-65	105.06	90.53	94.08	93.56			45
NK-66	104.15	15.72	94.85	92.95			
NK-67	106.52	30.72	83.47	79.67			
NK-68	106.07	29.44	86.07	78.63			
NK-69	112.76	33.72	79.04				
NK-70	112.40	42.72	78.68	72.59			
NK-71	115.98	39.72	77.01				
NK-72	118.04	39.80	79.10				
NK-73	106.93	69.53	91.49	82.89			44.2
NK-74	124.67	90.09				99.58	44.2
NK-75	124.66	39.16					44.9
NK-76	109.59	72.80	77.86	73.05			44
NK-90	98.82	35.85	81.82		79.06		
NK-91	96.03	33.30	79.07		71.68		
NK-92	96.37	32.40	67.43		66.30		
NK-93	89.60	26.65	<62.95				
NK-94	80.78	17.73	<63.05				
NK-95	89.64	25.77	<63.87				
NK-96	95.74	33.70	68.26		63.67		
NK-97	110.41	66.16	97.25	90.49			36.4
NK-98	110.35	50.23	101.54	87.96		95.64	19.8
NK-99	106.97	90.55	95.79	92.54			44.4
NK-100	104.89	57.62	91.22	84.29			46.6
NK-101	112.64	64.79	78.79	75.27			45
NK-102	112.83	18.42	<94.41				
NK-103	111.98	18.62	<93.36				
NK-104	110.02	11.74	<98.28				

References

- [1] Almenna Consulting Engineers (2007). Hvammsvirkjun. Geological Report. Geological Investigations 2001-2006. Prepared for Landsvirkjun. LV-2007/053. July 2007
- [2] Mannvit (2008). Hvammur Power Plant Geological report Geological investigations 2007 and 2008. Prepared for Landsvirkjun. LV-2008/197. Desember 2008.
- [3] Maryam et.al. (2007). Hvammsvirkjun. Geological investigation of Skarðfjall in South Iceland Seismic Zone. Basement tectonics, Holoxene surface ruptures, leakage, and stratigraphy. ÍSOR-2007/017; LV-2007/65.
- [4] Vatnaskil, memo no. 12.11, December 6, 2012.

DRAWINGS:

- Drawing G-2012-001 Powerhouse Area Location of Boreholes
- Drawing G-2012-002 Tailrace Area Location of Boreholes
- Drawing G-2012-003 Access and Surge Tunnel Geological Section
- Drawing G-2012-004 Intake Geological Section
- Drawing G-2012-005 Spillway Geological Section









600	NTH-60 Enginee	ring Consulta	KÍS
	ACCESS AND SURGE TUNNEL	PROCESS INSTALLATION = + NPC NUMBER	LOCATION + NPC REV. BDL
		5.481.203	REV. SHEET
	🍅 ΜΑΝΝΥΙΤ	G-2012-003	





/	DESCRIPTION	DATE	DES.	СНК.	APP.	REV.	DESCRIPTION	DATE	DES.	СНК.	APP.	20.04.2013	
												HHa	
												app. ML	Landsvirkjun
												PAPER SIZE A3	HVAMMUR HEP



		MK DAM	MK-10	
	G7 cal profi	G8 NK. 10 R	Spilling	
6				
	114		< /	
	108	LEGE	END	
Gravel			ay ooria ooria with soil/clay orphyritic basalt < Testpit	
	98	J NI	-XX Cored borehole	
	94 92 300	10 (SCAL	0 10 20 30 40 50 E	m
	NTH	-60 Enginee	PROCESS INSTALLATION = +	KÍS ants Location +
1	SPILLWAY GEOLOGICAL SEC		NPC NUMBER 5.481.203 G-2012-005	REV. BOL REV. SHEET C1 NEXT SH.

0 U
Appendix A – Core logs

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BOREHOLE LOG

CORE DRILLING



BOREHOLE NO .:

SHEET 1 OF 2 SHEET

CLIENT [.]				DATE				SHEET 1 OF 2 SHEETS		
PROJECT		Landsvirkj	un	DRILLED B	Y:	STARTED: 08.05.2	012 CC	DMPLETED: 14.05.2012		
LOCATION:		Neðri Þjór	sá	FOREMAN:		Ræktunarsamband	Flóa og Skeid	ða		
STRUCTURE:		Hvammsv	irkjun	SUPERVISI	ON:	Heiðar Már				
COORDINATES	:	Tailrace C		DRILLBIT T	YPE:	Haraldur Hallsteins	son			
COORDINATE S	SYSTEM:	X: 442950	.645 Y: 392604.86 Z: 98.82	3" diamond drillbit nr.6, NQ triple tube, 76 mm NUMBER OF CORE BOXES:						
HOLE INCLINAT	ION:			CORE RECOVERY:						
CASING LENGT	'H:	VERT		TOP OF CASING, ELEV.:						
DEPTH OF HOL	E:	3.75 m		GROUNDW	ATER ELEVA	98.82 m a.s.l. TION:				
		35.85 m	DRILLING DIRECTION °	CORE	FRACTURE					
ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	RECOVERY (%)	INTENSITY (FRACT/M)	$Q = \frac{RQD \times Jr \times Jw}{Jn \times Ja \times SRF}$	(LU) 10 100 3 30 300	COMMENTS		
-	-		Percussion drilling with 3" casing.	0						
_ 90.0			Þjórsá lava	1						
	-		Scoria, vesicular basalt.	ł						
-	2.0 -	*^×^×^>	High resistance in percussion drilling.							
E		ť×××××								
- 96.0	-									
			Scoria, vesicular basalt.	ļ						
F	-		Porphyritic basalt							
F	4.0 -	$\frac{1}{1}$ \times \times \times	20-30% plagioclase phenocrysts, up to 10 mm. 7-20 % vesicles, empty.	61	6	26/0/0/0				
F	-		Scoria, high core loss.							
- 94.0	-		Porphyritic basalt	ł						
E		$\left\{ \times \right\} \times \left\{ \times$	Vesicular 10-20 %, empty. Three joint sets. Joints, rough and undulating,							
E	-		empty or coated with soft light brown clay. 5% plagioclase phenocrysts.	99	10	42/0/0/0	1			
E	6.0 -	<u>+</u> ************************************								
E	-	txxxxxx								
92.0	_			54	7	17/0/0/0 <u>24x3</u>				
	-		Scoria/Vesicular basalt. High core loss.			20x1 Q=3.6				
E	-		15-20 % vesicles and vugs, empty or coated with light brown clay, some filled.							
E	8.0 -		Partly crushed core.							
	-									
- 90.0	_									
F	-	$\frac{1}{2}$	Faintly microporous.							
F	-	$\left\{ \begin{array}{c} & & \\ & & \\ & & \\ \end{array} \right\}$	/-TU % VESICIES.	100	9	51/0/0/0	1			
F	10.0 -	$\left\{ \times \right\} \times \left\{ \times$								
F	-	<u>}</u>								
0.88	-	}^×^×*								
E	-	t×v×v×								
F	12 0 -	$\left\{ \times \hat{\times} \times \hat{\times} \times \hat{\times} \right\}$								
E	12.0	ţ,×,×,×,×,×,×,×,×,×,×,×,×,×,×,×,×,×,×,×		100	9	61/0/0/0 58x3]			
86.0	-	+^×^×^>				12x1 0=15				
- 00.0		t×v×v×				Q=10				
È ∣		Į×^×^×	Scattered vesicles, empty.					K1/K2		
-	14.0 -	ŧč×č×č	Microporous. Scattered Olivine phenocrysts.							
-		ŧŶ×Ŷ×Ŷ	Joints, empty, rough and undulating.	100	7	76/0/0/0	-			
- 84.0	-	Į×,×,×,×,		100		· · · · -				
F		Į×^×××́				50/0.101	1			
F	-			98	8	56/24/0/0				
F	16.0 -	₹ŶŶŶŶ								
F	-	₹×°×°×`×`								
- 82.0	-	<u>`×^×</u> ×́×́	0,3 m vesicular basalt at the bottom.							
E	-		TS Gravel	0	N/A	0/0/0/0]			
E	-	Po O	Loose sediment.							
E	18.0 -	10000	subrounded.							
E	-	p jo jo				_ /_ /_ /_	1			
80.0	_			25	N/A	0/0/0/0				
E	-	por o		31	N/A	0/0/0/0]			
E	-			100	10	53/0/0/0	4			
		V/V	מוחן	100	IU	53/0/0/0	1			



CORE DRILLING

BOREHOLE NO .:

NK-90 SHEET 2 OF 2 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
78.0	22.0		Olivine-Tholeiite basalt Light gray, fresh, fine grained, slightly microporous. 1% very small plagioclase needles. 3-5 % vesicles, mostly empty. Joints mostly planar and smooth but some rough and undulating, coated with light brown clay. Three joint sets plus random.	100	8	62/19/0/0		
- 76.0	- - - -			100	8	68/0/0/0		K2/K3
- - - - - - - - - - - - - - -	24.0			100	4	94/60/40/0		
 	 26.0 —							
- 72.0			26,9-27,9 m vesicular zone, 20% small vesicles, empty.					
- 70.0	28.0 — 			96	3	96/62/21/0 <u>84x2</u> 12x2 Q=7		
			Massive basalt, scattered small vesicles, empty.	98	3	98/43/19/0		K3/K4
- 68.0 -			Joints horizontal or slightly inclined, empty or coated with clay. Approx. 1% plagioclase phenocrysts. Microporous basalt.					
- - - 66.0	32.0			88	1	88/72/72/0		
	34.0 — 							
64.0 								
62.0								
 60.0								
-								
56.0								

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BOREHOLE LOG

CORE DRILLING



									SHEET <u>1</u> OF <u>2</u> SHEETS	
CLIENT:		Landsvirkj	un	DATE:		STARTE	D: 15.05.20	012 co	OMPLETED: 19.05.2012	
PROJECT:		Neðri Þjór	sá	DRILLED B	Y:	Ræktun	arsamband	Flóa og Skeid	ða	
LOCATION:		Hvammsv	irkiun	FOREMAN: Heiðar Már						
STRUCTURE:		Tailrace C	anal	SUPERVISI	ION:	Haraldu	r Hallsteins	son		
COORDINATES	:	Y: 112512		DRILLBIT T	YPE:	3" diam	3" diamond drillbit nr.6. NQ triple tube. 76 mm			
COORDINATE S	SYSTEM:	A. 442342	r	NUMBER O	F CORE BOX	ES:				
HOLE INCLINAT	ION:			CORE REC	OVERY:	3	<u></u>			
CASING LENGT	H:			TOP OF CASING, ELEV.:				68 %		
DEPTH OF HOL	E:	6.1 m	CASING REMOVED	GROUNDW	ATER ELEVA	96.03 m TION:	ı a.s.l.			
		33.3 m	DRILLING DIRECTION °		L		() 			
ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	Q = <u>RQD x</u> Jn x J	/50/100 <u>Jr x Jw</u> a x SRF	(LU) 10 100 3 30 300	COMMENTS	
- - - - - - - - - - -	20		Þjórsá lava Scoria and scoriaceous basalt. Percussion drilling with odex casing 6.1 m.	0						
			Porphyritic basalt	-						
92.0	4.0		Porpyritic basalt							
			Scoria Porphyritic basalt	-						
90.0	6.0		Scoria High core loss, stumps of vesicular basalt comes up.	19	N/A	9/0/0/ <u>10x3</u> 20x1 Q=1.	/0 3 1 5			
-	-						-			
- - - 88.0 - - -	8.0		Þjórsá lava Porphyritic basalt Fresh, gray, fine grained, microporous. 25-30% plagioclase phenocrysts, up to 15 mm. Approx. 7 % vesicles, empty. More massive basalt, scattered - 2 % vesicles, empty. Scattered olivine phenocrysts	100	7	61/44/3	30/0			
-	-	<`×`×`×`>	Joints rough and undulating, empty.							
- 	10.0		Three sets plus random.	99	3	97/43/ <u>77x3</u> 12x1 Q=1!	0/0 <u>3</u> 1 9			
			Scoria or/and caves	0	N/A	0/0/0/ <u>10x3</u> 20x1	/0 3 1	-		
- 04.0 - - - - - - -	12.0 - - - - - - -		Porpyritic basalt Vesicular zone of basalt. Dark gray, partly reddish gray. 15% vesicles. 5-7% plagioclase phenocrysts.	100	6	75/54/ 75/54/ 7 <u>6x3</u> 12x1 Q=2	0/0 3 1 0			
- 82.0 	14.0 — - - -									
- - - - - - - -	- - - - - - - - -		5-15% vesicles.	100	7	64/0/0	0/0		K1/K2	
- - - - 78.0	 18.0		TS Loose sediment Probably gravel. Only pebbles of subrounded basalt, moberg and rhyolite come up. Very soft to drill.	0	N/A	0/0/0/	/0			
				13	N/A	0/0/0/	/0			



CORE DRILLING

NK-91

BOREHOLE NO .:

SHEET 2 OF 2 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
-				86	N/A	0/0/0/0		
-				9	N/A	0/0/0/0		
_	-			100	N/A N/A	0/0/0/0 / 0/0/0/0		
- 74.0	22.0 -			-				
-	-							
-								
_	-		Sand accumulates during the night in the hole					
- 72.0	24.0 -	000	and comes up when drilling starts in the morning.					
-	-		Olivine-Tholeite basalt	100 100	N/A 5	0/0/0/0		
-			1% very small plagioclase needles.	76 93	2 8	76/0/0/0 48/0/0/0		
-	-		0,5 m at top with 20 % vesicles.					
70.0	26.0 -		Joints rough and undulating, some planar, coated with light brown clay.	98	5	89/51/27/0		
-	-							
-	-			100	7	76/12/0/0		
68.0	28.0 —			100		<u>76x2</u> 12x2		K2/K3
-						Q=6.3		12/10
-								
-	-							
66.0	30.0							
_				100	8	74/0/0/0		
-								
_								
- 64.0	32.0							
-	-							
-								
-								
- 02.0								
-								
-								
- 60.0								
-								
_								
- 58.0								
-								
-								
- 56.0								
-								
54.0								
-								
-								



CORE DRILLING



									SHEET <u>1</u> OF <u>2</u> SHEETS	
CLIENT:		Landsvirkj	un		DATE:		STARTED:	STARTED: 20.05.2012 COMPLETED: 21.05		
PROJECT:		Neðri Þjór:	sá		DRILLED B	Y:	Ræktunars	samband Flóa og Ske	iða	
LOCATION:		Hyammsvi	irkiun		FOREMAN:		Heiðar Má			
STRUCTURE:		Tailrace C	anal		SUPERVISI	ON:	Haraldur H	Hallsteinsson		
COORDINATES	S:			-	DRILLBIT T	YPE:			- t. t 70	
COORDINATE	SYSTEM:	X: 442083	.102 Y: 392168.177 Z: 96.3	1	NUMBER OF CORE BOXES:					
HOLE INCLINA	TION:				4 CORE RECOVERY					
CASING LENG	TH	X VERT		FROM HORIZONTAL	TOP OF CA	SING FLEV		90 %		
		3.1 m	CASING REMOVED				96.37 m a.	.s.l.		
DEFTHOFHO	LE.	32.4 m	DRILLING DIRECTIC	N °	GROUNDW		80.25 m a.	.s.l. (13.7.2012)	
ELEVATION	DEPTH	LOG	DESCRIPT	FION	CORE RECOVERY	FRACTURE-	RQD 10/30/50/ Q = RQD x Jr x	/100 PERMEAB	COMMENTS	
(m a.s.i.)	(m)			-	(%)	(FRACT/M)	Jn x Ja x	SRF 3 30 30	0	
- 96 0	-		Aeolian sand		0					
_ 30.0	-	<××××××	Porphyritic basalt							
F		₹Û×Û×Û>	Vesicular at top. Percussion drilling with 3" of	lev casing 3.1 m						
-	-	×°×°×°	reicussion unining with 5 ou	lex casing 5, 1 m.						
-	-	×Û×Û×Û>								
-	2.0 -	<^×^×^×								
- 94.0	-	×^×^×^								
F	-	<pre></pre>								
L	-	<			0.7		00/70/60/0	22		
-	-	$(\times^{\times}\times^{\times})$	Fresh, gray, fine grained, mid	croporous basalt.	99	2	90/78/62/3			
F	-	$\left\{ \times^{\times} \times^{\times} \times^{\times} \right\}$	25-30% plagioclase phenocr	ysts, up to 12 mm.						
_	4.0 -	$\times \times \times \times$	1% olivine phenocrysts, redd	lish at top, green						
— 92.0	-	$(\times \times \times \times)$	Three joint sets plus random	, joints rough and						
-	-	[×`×`×`	undulating, empty.							
-	-	[×^×^×								
F	-	{×Û×Û×Ì								
-	-	Ĩ×Ĵ×Ĵ×Ĩ								
-	6.0 -	[×Û×Û×]								
- 90.0	-	[×Û×Û×Û			100	0	100/100/100/	/100		
-	-	Ĩ×Ĵ×Ĵ×Ĵ					<u>93x3</u> 12x1			
_		ĺ×^×^×	Massive microporous basalt.				Q=23			
-	-	× × × ×								
_	-	<pre>x × × × ×</pre>								
F	8.0 -	$\langle \times \times \times \times \rangle$								
- 88.0	-	$\times \times \times \times \times$								
_	-	$\langle \times \times \times \times \rangle$								
-	-	≺°×°×°>								
-	-	kû×û×û×			100	0	100/100/100/	/100		
-	10.0-	XÛXÛXÛX								
- 86 0	10.0	≺Ŷ×Ŷ×Ŷ								
- 00.0	-	<^×^×^>								
-	-	*^×^×^>							K1/K2	
-	-	* × × × × ×	Scattered empty vesicles. Verv few joints.							
_	-	$\times \times \times \times$								
-	12.0 -	$\times \times \times \times$								
- 84.0		(×`×`×`			100	2	93/85/85/8	35		
t i	-									
F	-	[×Ĵ×Ĵ×]								
F	-	Į×Ĵ×Ĵ×Ĵ								
F	-	Į×Ŷ×Ŷ×Ì								
F	14.0									
- 82.0	-									
F	-	$\frac{1}{2} \times \frac{1}{2} \times \frac{1}$								
F		$\langle \times \times \times \times \rangle$								
<u> </u>	-	* <u>`</u> * <u>`</u> ***			98	8	59/0/0/0			
-		+ <u>`</u> × <u>`</u> × <u>`</u> >	Reddish brown coating in iai	nts and vesicles						
F	¥ 16.0 —		10% vesicles in the lowest 0,	,5 m.	0	N/A	0/0/0/0			
- 80.0	-	\sim	Scoria and/or cave in the bas	salt.	0	1.07.1	<u>10x3</u>			
L			ragments of vesicular and s	sconaceous basalt.			20x1			
-	-						Q=1.3			
<u> </u>	-									
-	100									
	10.0				58	N/A	0/0/0/0			
- 78.0 -	-	Į×Ĵ×Ĵ×Ĵ	Porphyritic basalt	reasing below 10	100	4	90/42/42/0	0		
F	-	[×Ĵ×Ĵ×Ĵ×]	m.	casing below 19						
-	-	{×Ŷ×Ŷ×Ĵ	5 % plagioclase phenocrysts							
F	-	Į×Ĵ×Ĵ×ĺ	Scattered olivine phenocrvst	S.						
E	-	{×∁×∁×1	Three joint sets plus random							



CORE DRILLING

BOREHOLE NO .:

NK-92

SHEET 2 OF 2 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
- 76.0	-		Joints rough and undulating, empty or coated with very thin clay. More massive and less vesicular.					K2/K3
-			Scattered vesicles. Microporous basalt.	100	3	84/61/25/0		
74.0	22.0							
-								
 - -	24.0-							
- 72.0	24.0			100	4	99/77/30/0 <u>88x3</u>		
-						12x1 Q=22		
- 70.0	26.0							
-								
	- - 28.0 —			100	6	70/25/0/0		K3/K4
- 68.0 -			Vesicular 0,7 m at the bottom of the layer.					
- - 	-		TS Loose sediment Almost no core recovery.	4	N/A	0/0/0/0		
_ 66.0	30.0		HIB Olivine-Tholeiite basalt	100	7	75/17/0/0 <u>75x2</u>		
-	-		Dark gray, fine grained, microporous basalt. 1% very small plagioclase needles. <1% vesicles, empty or filled with green clay. Three ioint sets plus random			12x2 Q=1.5		
-	32.0		Joints rough and undulating, some planar, coated with green and gray clay/silt.					
- 64.0	-						<u> </u>	
-								
62.0								
- - -								
- 60.0 - -								
- - -								
- 58.0								
-								
- 56.0								
 - -								
- 54.0								
-								
_								



CORE DRILLING



								SHEET 1 OF 2 SHEETS	
CLIENT: Landsvirkjun			un	DATE:		STARTED: 21.05.2	STARTED: 21.05.2012 COMPLETED: 22.05.2012		
PROJECT:		Neðri Þiór	sá	DRILLED B	Y:	Ræktunarsamband	Ræktunarsamband Flóa og Skeiða		
LOCATION:		Hvammsv	irkiun	FOREMAN		Heiðar Már	Heiðar Már		
STRUCTURE:		Tailraco C	anal	SUPERVIS	ION:	Haraldur Hallsteins	Haraldur Hallsteinsson		
COORDINATES	6:			DRILLBIT T	DRILLBIT TYPE: 2" diamond drillbit or 6. NO triple tube. 76 mm				
COORDINATE	SYSTEM:	X: 441073	.234 f. 391662.636 Z. 69.6	NUMBER C	NUMBER OF CORE BOXES:				
HOLE INCLINA	TION:			CORE REC	CORE RECOVERY:				
CASING LENGT	ГН·	X VERT	ICAL INCLINED FROM HORIZONTAL	TOP OF CA	TOP OF CASING FLEV				
	E.	3.05 m	CASING REMOVED				89.60 m a.s.l.		
	- -	26.65 m	DRILLING DIRECTION °	GILOUNDA		79.83 m a.s.l.	(1	3.7.2012)	
ELEVATION	DEPTH	LOG	DESCRIPTION	CORE RECOVERY	FRACTURE-	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u>	PERMEAB	COMMENTS	
(m a.s.i.)	(m)			(%)	(FRACT/M)	Jn x Ja x SRF	3 30 300		
_	-	<u>x, 1/</u> . <u>x, 1/</u> .	Aeolian sand and soil Percussion drilling 3 15 m	0					
-	-	1/ 1/ 1/	Casing 3.05 m.						
-		<u> 14 NG</u>							
-	-	11. 11. 3							
- 88.0	-	ĺ×^×^×	Þjórsá lava Porphyritic þasalt						
_	2.0 -	XXXX	Scoria zone	-					
_	-	× × ×	Basalt zone	7					
-	-	$\times \times \times$	Scoria zone	1					
-	-	(×`×`×`	Porphyritic basalt	80	4	61/22/0/0	-		
- 86.0	-	(×°×°×(Fresh, gray, fine grained, microporous.	00					
-	40 -	Ĭ×î×^×	1% olivine phenocrysts.						
-		$\times \times \times \times$	Three joints sets plus random, joints rough and						
_	-	× × × × × ×	undulating, empty, but some with reddish						
-		<^×^×^>	3,5 and 4 m. Core loss zone						
-	-	kî xî xî x							
- 84.0 -		<^^<							
-	6.0 -	×××××							
-	-	(×`×`×`×			-		_		
_		`×^×^×		100	5	87/32/0/0			
-	-	$(\times \times \times \times \times \times $							
- 82.0	-		7.6 m more massive baselt, scattered vesicles						
-	8.0 -	<`×`×`×`;							
_	_	ذ×ٽ×ٽ×							
_	-	<Ŷ×Ŷ×Ŷ							
_		<^ × ^ × ^ × ^ ×							
	-	* × × × ×							
- 00.0	▼	(×`×`×`		100	1	100/100/86/51			
-	10.0	`×^×^×				12x1			
-		xîxîxî				Q=20			
_		$\times \times \times \times$							
_		<`×`×`×`>						K1/K2	
- 78.0	_	<u>(</u> , x,	0		1	17/0/0/0	-		
-	12.0 -		Reddish gray vesicular stumps of scoriaceous	22		17/0/0/0			
F	-		basalt. 2-3% plagioclase phenocrysts						
-	-		Highly crushed core and very high core loss.	22	N/A	8/0/0/0	1		
-	-		Soft to drill.						
76 0	-								
	140-								
E									
<u> </u>	-								
F	_								
F _	-								
- 74.0				41	N/A	0/0/0/0	1		
	16.0 —					<u>21x3</u> 20x1			
E	-	$\langle \langle \rangle \rangle$				Q=3.1	1		
-	-	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	Partly crushed core.	100	N/A	34/0/0/0			
-	-	×××							
72 0		XXXXXX		100	N/A	38/0/0/0	1		
	180-	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		100	8	72/0/0/0	1		
		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	Scoriaceous basalt, better consolidated core.						
F	-	XXX ××		61	6	24/0/0/0	1		
F	_	KXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX							
-	-		Scoria, almost complete core loss.	1					
- 70.0	-	\times \times \times	Porphyritic basalt	100	6	81/40/40/0	1		
		• * * `							



CORE DRILLING

BOREHOLE NO .:

NK-93

SHEET 2 OF 2 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
68.0	22.0		Þjórsá lava Fresh, gray, fine grained, microporous. 3-5% plagioclase phenocrysts, scattered olivine phenocrysts. Scattered empty vesicles. Thin more vesicular zones. Thire joint sets plus random. Joints rough and undulating, empty. Rather jointed basalt.	100	8	63/0/0/0 7 <u>3x3</u> 12x1 Q=18		K2/K3
66.0	 24.0 —		3-5% small vesicles.	100 100	11 6	0/0/0/0 80/46/46/0		
	26.0		1-3% vesicles, massive basait.	100	6	86/0/0/0		
62.0	-	< × × >						
60.0								
- - - - 58.0								
 56.0								
 54.0								
50.0								
48.0								
- 								

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BOREHOLE LOG

CORE DRILLING



OUT				DATE				SHEET 1 OF 1 SHEETS	
CLIENT: Landsvirkjun			jun	DATE: STARTED: 23.05.2012 COMPLETED: 2			OMPLETED: 23.05.2012		
PROJECT:		Neðri Þjó	rsá	Ræktunarsamband Flóa og Skeiða				ða	
LOCATION:		Hvamms	/irkjun	FOREMAN:		Heiðar Már			
STRUCTURE:		Tailrace (Canal	SUPERVIS	SUPERVISION: Haraldur Hallsteinsson				
COORDINATES	S:	X: 441200	0.26 Y: 391878.985 Z: 80.78	DRILLBIT TYPE: 3" diamond drillbit nr.6. NQ triple tube. 76 mm					
COORDINATES	SYSTEM:		т 🔲	NUMBER OF CORE BOXES:					
HOLE INCLINAT	TION:			CORE RECOVERY:					
CASING LENGT	rh:	61m		TOP OF CASING, ELEV.:					
DEPTH OF HOL	E:	17 72		GROUNDW	ATER ELEVA	ATION: 70.79 m c c l		3 7 2012)	
		17.7311	DRILLING DIRECTION *	CORE	FRACTURE	ROD 10/30/50/100	PERMEAB	5.7.2012)	
(m a.s.l.)	(m)	LOG	DESCRIPTION	RECOVERY (%)	INTENSITY (FRACT/M)	$Q = \frac{RQD \times Jr \times Jw}{Jn \times Ja \times SRF}$	(LU) 10_100	COMMENTS	
_		<u>, 1, 1</u>	Aeolian sand and soil.	0	()		3 30 300		
	-		Percussion drilling 6,3 m.						
- 80.0	▼ _								
E			1						
-	-	<u> </u>	4 -						
-	2.0 -	- 11 - 11		-					
F	-	¥∭X×	Scoria and scoriaceous basalt						
- 78.0	-	¥≫¥^×	*						
		t t t t t t t t t t t t t t t t t t t	*						
¢	-	±‱t×č	*						
	40-	±XXX×X	8						
E	- 0	<u>-</u> XXX-X	8						
- 76 0	-	-XXXX-X]						
- 10.0	-	₹∭\$×]						
-	-	₹XXX							
_	-	₹XXX××	*						
-	6.0 -	*XX * `	>						
F	:	ŧ‱x^`	8	64	5	44/11/0/0			
- 74.0	-	t k k k k k k k k k k k k k k k k k k k	1						
E	-	±≪¥××	Porphyritic scoriaceous basalt and scoria Reddish gray, fine grained, microporous.						
E I	-	<u>-XXX</u> ×	2-3% plagioclase phenocrysts, up to 10 mm.						
E	8.0 -	<u>-XXX-</u>	Joints rough and undulating, empty.						
-	-	-XXX××	Partly crushed core. High core loss.						
72.0	-	₹XX[×`)	>						
F		¥XXĮ×^́	8	55	5	30/0/0/0	1		
F	-	XXX IX	3			41x3 20x1			
-	10.0 -	ŧ‱ł××	1			Q=6.1			
F	-	±‱}^×	*						
- 70.0	-	×XXX	*						
-	-	<u>↓∕∕∕</u> ĺ×`	Scoria gradually changes to basalt.	100	7	85/0/0/0	1		
¢	:		Þjórsá lava Porphyritic þasalt	100	9	65/27/0/0			
	120.	×××××	Fresh gray, fine grained, faintly microporous.						
E	12.0 -	±^×~××	5% plagioclase phenocrysts. Scattered olivine phenocrysts.						
- 69 0	-	<u>+</u> °×^×^	3-5% small vesicles, empty.	100	4	88/56/22/0	4		
- 00.0	-	<u></u> {×`×`×`	Joints rough and undulating, empty or with	100		80x3 12×1			
F	:	Į×~×~×	traces of light brown clay.			Q=20			
F		<u>,</u> ×^×^×	*						
F	14.0 -	↓ ×××××	*						
F	-	\$Ç×Ç×č	*						
- 66.0		±^×^××́	×	100	4	100/0/0/0	4	K1/K2	
		<u></u>	Microporous massive basalt. 5% plagioclase phenocrysts.	100					
E I	-	<u> </u>		100	7	74/26/26/0	1		
E	16.0 -	-[×°×°×	1						
-	-	<u></u>							
- 64.0	-	$\frac{1}{2} \times \times$	*						
F		₹Ç×Ç׼	*						
F	-	₹Ŷ×Ŷ×Ŷ	*						
-							<u> </u>		
E									
L 62 0									
- 02.0									
-									
F									
-		1	I	1	1		1		

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70.0

BOREHOLE LOG

CORE DRILLING



								SHEET 1 OF 2 SHEET		
CLIENT:		Landsvirki	un	DATE:		STARTED: 29.05.	STARTED: 29.05.2012 COMPLETED: 30.12.2012			
PROJECT:		Neðri Þiór	sá	DRILLED E	BY:	Ræktunarsamban	d Flóa og Skei	ða		
LOCATION:		Hvammsv	irkjun	FOREMAN	l:	Heiðar Már				
STRUCTURE:		Tailrace C	anal	SUPERVIS	SION:	Haraldur Hallstein	sson			
COORDINATES	S:	X: 441665	.13 Y: 392155.007 Z: 89.64	DRILLBIT	TYPE:	3" diamond drillbit	3" diamond drillbit nr.6, NQ triple tube, 76 mm			
COORDINATE	SYSTEM:	X ISNET		NUMBER	OF CORE BOXES	s: 3	3			
HOLE INCLINA	TION:	X VERT	ICAL INCLINED FROM HORIZONTAL	FROM HORIZONTAL			72 %			
CASING LENG	TH:	3.05 m	CASING REMOVED	TOP OF C	ASING, ELEV.:	89.64 m a.s.l.	89.64 m a.s.l.			
DEPTH OF HO	LE:	25.77 m	DRILLING DIRECTION °	GROUND	WATER ELEVATI	ON: 79.93 m a.s.l.	(1	3.7.2012)		
ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVER (%)	FRACTURE- Y INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS		
_	_	<u></u>	Aeolian sand and soil.	0						
			Pjörsä lava Porphyritic basalt							
- 88 0	-		Scoria Þiórsá lava	-						
	20 -	$\hat{\mathbf{x}}$	Porphyritic basalt							
_		`×`×`×`	25-30% plagioclase phenocrysts, up to 20 mm.							
-	-	ĺ×^×^×	Scattered vesicles, empty.							
-	-	<`×`×`>	Three joint sets plus random. Joints rough and undulating, empty.	07	2	90/78/69/0	_			
- 86 0	-	(\hat{x})		97		00,10,00,0				
	4.0 -	`×`×`×`								
-		ĺ×^×^×								
-	-	<`×`×`>								
-	-	(^×^×^								
- 84.0		$(\times \times \times \times)$								
-	6.0 -	ĺ×^×^×								
-	-	$\langle \rangle \times \rangle \times \rangle \times \rangle$		89	3	75/67/23/0	_			
-	_	$(\hat{x} \hat{x} \hat{x})$				<u>80x3x1</u> 12x1x2.5				
-	-	$(\times \times \times \times)$				Q=20				
- 82.0	-	×××××								
E .	8.0 -	$\langle \times \times \times \times \rangle$								
_	-	$\langle \hat{x} \rangle \langle \hat{x} \rangle \rangle$								
_		$\langle \times \times \times \rangle$				5.1/0/0/0	_			
_	-	×××××		100	6	54/0/0/0				
- 80.0	⊻ -	\times	Scoria	20	N/A	0/0/0/0	_			
_	10.0		Reddish gray stumps of scoriaceous and vesicular basalt.			<u>10x3x1</u> 20x1x2.5				
-	-		Very high core loss. Light vellowish brown clav in vesicles			Q=1.5				
-			1-3% plagioclase phenocrysts.							
-	-		oneven uning, very last in between.							
- 78.0 -										
-	12.0			39	N/A	14/0/0/0	_			
-	-			50						
-	-									
76.0	-		Porphyritic booolt	400	7	84/0/0/0	_			
- 70.0	14.0-	$\langle \times \times \times \times \times \rangle$	Þjórsá lava	100		<u>84x3x1</u> 12×1×2 5		K1/K2		
		$\times \times \times \times$	5% plagioclase phenocrysts.			Q=21				
_		×××××	7-15% vesicles, empty. Three joint sets plus random.							
_		$\langle \times \rangle \times \rangle \times \rangle$	Joints rough and undulating, empty.							
- 74 0		Ň.Ť×Č>		100	5	100/0/0/0				
-	16.0	× X		81	°	23/0/0/0				
-	-	$\times \times$								
 -	-		Scoria/scoriaceous basalt Vesicular, scoriaceous stumps of basalt and							
F	-		scoria fragments.	53	N/A	14/0/0/0	-			
- 72.0	-		Light yellowish brown clay in vesicles.							
	18.0 -		Uneven drilling, very fast in between.							
-	-									
-	-			18	N/A	0/0/0/0 13x3x1				
Ē	-					20x1x2.5 Q=1.9				
-		1111111		1	1			i i		



CORE DRILLING

BOREHOLE NO .:

NK-95

SHEET 2 OF 2 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
	-		Complete core loss in the lowest part of the scoria. Very fast drilling.		10	42/2/2/2		
- 68.0	22.0-		Porphyritic basalt Þjórsá lava 5-10% vesicles in the upper part.	100	10	43/0/0/0	-	
-			Scattered vesicles. Fresh, gray, fine grained, faintly microporous. 5-7% plagioclase phenocrysts. Three ioint sets plus random, rather iointed.	100	,	<u>69x3x1</u> 12x1x2.5 Q=17		
-			Joints rough and undulating, empty.					
- 00.0	24.0			100	10	67/0/0/0	-	K2/K3
	- 							
- 64.0	-							
-								
_ _ 62.0								
-								
- 60.0 -								
- - -								
 58.0								
-								
-								
— 56.0 								
- 								
 54.0								
-								
52.0 								
-								
50.0								
480								
46.0								



CORE DRILLING



BOREHOLE NO .:

SHEET 1 OF 2 SHEETS CLIENT DATE COMPLETED: 01.06.2012 Landsvirkjun STARTED: 31.05.2012 PROJECT DRILLED BY Neðri Þjórsá Ræktunarsamband Flóa og Skeiða FOREMAN: Hvammsvirkjun Heiðar Már STRUCTURE SUPERVISION Haraldur Hallsteinsson Tailrace Canal COORDINATES: DRILL BIT TYPE: X: 442370.546 Y: 392367.371 Z: 95.74 3" diamond drillbit nr.6, NQ triple tube, 76 mm COORDINATE SYSTEM: NUMBER OF CORE BOXES: X ISNET Г 4 HOLE INCLINATION: CORF RECOVERY X VERTICAL INCLINED FROM HORIZONTAL 74 % CASING LENGTH: TOP OF CASING, FLEV. CASING REMOVED 95.74 m a.s.l. 3.15 m Г DEPTH OF HOLE: GROUNDWATER ELEVATION: 8<u>0.90 m a.s.l.</u> 33.7 m DRILLING DIRECTION ° (13.7.2012) CORE RECOVERY (%) FRACTURE INTENSITY (FRACT/M) RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF PERMEAB ELEVATION (m a.s.l.) DEPTH (m) (LU) 10 100 3 30 3 LOG DESCRIPTION COMMENTS 300 <u>x¹/z</u>: <u>x¹/z</u>: Aeolian sand and soil 0 1.1, Odex drilling with 3" casing 3,15m. Þjórsá lava Porphyritic basalt Forsh, gray, fine grained, microporous. 25-30% plagioclase phenocrysts, up to 20 mm, mostly <10 mm. 1-2% olivine phenocrysts. 94.0 2.0 Scattered empty vesicles. Three joints sets. Joints rough and undulating, empty, some with reddish brown colour. 3 84/61/41/41 96 92.0 4.0 90.0 6.0 3 100/61/48/48 100 Vertical vesicular ventilation pipe with cumulative plagioclase phenocrysts. 88.0 8.0 2 81/75/75/75 91 86.0 <u>85x3</u> 9x1 10.0 0=28 K1/K2 84 0 12.0 Vesicular basalt zone 0.5 m thick. Core loss 48/0/0/0 Scattered vesicles. 100 Vesicular zone 13 - 13.5 m depth. Possibly core loss. Þjórsá lava Porphyritic basalt 87/17/0/0 99 5 82.0 87x3 12x1 Q=22 14.0 Forb, gray, fine grained, faintly microporous. 5% plagioclase phenocrysts. 5-15% vesicles, empty. Three joint sets plus random, joints rough and undulating, empty or coated with very thin light brown clay. 0/0/0/0 N/A N/A 0 13 <u>10x3</u> 20x1 Q=1.5 0/0/0/0 Core loss 80.0 Scoria Fragments of subrounded scoria. 16.0 Possibly subrounded by drilling. Very high core loss. 78.0 18.0 100/0/0/0 0/0/0/0 Þjórsá lava 100 79 0 Porphyritic basalt Porphyritic basalt Partly crushed core at top, Fresh, gray, fine grained, faintly microporous. 5% plagioclase phenocrysts. 7-12% vesicles, empty. 5 91/30/19/0 100 77x3 12x1 76.0 Q=19



CORE DRILLING

BOREHOLE NO .:

NK-96

SHEET 2 OF 2 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
- - - - -			Three joint sets plus random, joints rough and undulating, empty. Decreasing vesicles.					K2/K3
- 74.0			Scattered vesicles.	95	6	74/28/28/0		
 72.0	 24.0		5-10% vesicles, 1 m thick zone at bottom.					
-	-		Scoria zone, only small fragments of scoria. High core loss. Þjórsá lava	27 100 100	N/A 770	0/0/0/0 10x3 20x1		
70.0	26.0		Porphyritic basalt Fresh, gray, fine grained. 5% plagioclase phenocrysts. 10-20% vesicles, empty. Three joint sets plus random, joints rough and undulating, empty.	4	N/A	Q=1.5 86/0/0/0 100/100/100/0 <u>97x3</u> 12x1 Q=24 0/0/0/0		
- - - -			Scoria Almost complete core loss. Few small fragments of scoria. Þjórsá lava Pornhvitic basalt	100	6	<u>10x3</u> 20x1 Q=1.5 65/42/0/0		
- 68.0 -	28.0		Fresh, dark gray, fine grained. 5% plagioclase phenocrysts. 10-20% vesicles, empty. Three joint sets plus random, joints rough and undulating, empty.	<u>0</u> 18	<u>N/A</u> N/A	03X3 12x1 Q=16 0/0/0/0 0/0/0/0		
- 66.0			TS Loose sediment Gravel Pebbles of basalt with sand on it.		N/A	34/0/0/0		
-	30.0		Cobbles and stones of basalt, up to 0,3 m.	60	N/A	34/0/0/0		
64.0				29	N/A	15/0/0/0		
- - - - -	32.0		NIB Olivine basalt Fresh, gray, fine grained, microporous. 1% very small plagioclase needles. Scattered vesicles, empty. Three joint sets nus random	100	7	82/0/0/0 82x2 12x2 Q=6.8		K3/K4
62.0	-	/	Sints rough and undulating, some planar and smooth, some coated with very thin clay.					
 60.0								
- - - -								
- 58.0								
-								
56.0 								
- - - - - 54.0								
- 52.0								



CORE DRILLING



										SHEET <u>1</u> OF <u>3</u> SHEETS
CLIENT:		Landsvirkj	un		DATE:		STARTE	D: 05.06.20	012 co	DMPLETED: 15.06.2012
PROJECT:		Neðri Þjórs	sá		DRILLED B	Y:	Ræktun	arsamband	Flóa og Skeid	ða
LOCATION:		Hvammsvi	irkjun		FOREMAN:		Svanlau	igur		
STRUCTURE:		Surge Tun	nel		SUPERVIS	ON:	Haraldu	r Hallsteins	son	
COORDINATES:		X: 445109	.73 Y: 393935.29 Z	: 110.41	DRILLBIT T	YPE:	3" diamo	ond drillbit n	r.6, NQ triple	tube, 76 mm
COORDINATE S	YSTEM:	X ISNET	-		NUMBER C	F CORE BO	KES: 7	7		
HOLE INCLINAT	ION:	VERT		-54.6 FROM HORIZONTAL	CORE REC	OVERY:			83 %	
CASING LENGT	H:	7.94 m	CASING REM	IOVED	TOP OF CA	SING, ELEV.	: 110.41 ı	m a.s.l.		
DEPTH OF HOLI	E:	65 m	DRILLING DIF	RECTION 256°	GROUNDW	ATER ELEV	ATION: 99.83 m	a.s.l.	(1	3.7.2012)
ELEVATION	DEPTH	1.00	DE	SCRIPTION	CORE	FRACTURE-	RQD 10/30/	/50/100	PERMEAB (LU)	COMMENTS
(m a.s.l.)	(m)	100	DE	SCRIFTION	(%)	(FRACT/M)	Jn x Ja	a x SRF	10 ⁻¹ 00 3 30 300	COMMENTS
110.0 			Soil Hole inclined 36° from Odex drilling with 3" ca Direction approx. 280°	vertical. asing down to 7,94 m.	0					
	2.0 -									
- 	4.0									
	-	1. 1. 1.								
	6.0 -		Scoria/soil Scoria filled with soil. Scoria Higher resistance.							
- - - 	8.0		Þjórsá lava Porphyritic basalt Fresh, gray, fine graine flow banded.	ed, microporous, partly	92	3	77/57/3	1/0	-	
	- - - - -		5-7% plagioclase pher phenocrysts. ~10% vesicles, empty Scattered vesicles belo	nocrysts, scattered olivine ow 9,6 m.			72/22/2	12/0	-	
- 	10.0		Joints rough and undu filled with light brown s fillings.	lating, empty, coated or ilt/clay, up to 3 mm thick	94		7 <u>5533</u> 12x1x2 Q=7.	2.5 5		
-	12.0 -	< <u>`</u> ×`×`>								
F. N	<u> </u>	*^×^×^								GWT16.6 2012
	2 14.0		Scoriaceous basalt Vesicular stumps and basalt and scoria. Very high core loss. Yellowish brown clay in vesicles.	fragments of porphyritic n vugs and some	40	4	20/0/0 <u>21x3x0</u> 15x1x2 Q=0.	//0 <u>.333</u> 2.5 6	-	
E		XXX × >								
┣ │	16.0 -	××××			100	11	26/0/0	/0]	
		[}}}	TS		0	N/A	0/0/0/	/0	4	
╞──│		10~~	Loose sediment				0,0/0/	-		
F			Complete core loss.							
- 90.0 - -	18.0 –									
E	-				0	N/A	0/0/0/	0	4	
	 - - -						0,0,0	-		
⊢ ∣		10 10 - 00			1					



ENGINEERING

BOREHOLE LOG

CORE DRILLING

BOREHOLE NO .:

NK-97

SHEET 2 OF 3 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
- 94.0	-							
-	_	Po o Ve						
-								
-								
-	22 0		Unclear boundary due to core loss.	40	N/A	20/0/0/0		
-			Grayish brown.			15x1x2.5		
- 92.0	-		Pebbles and stones moderately cemented in sandy matrix, well compacted.			Q=1.6		
-			Erodes and breaks during drilling and handling.					
-	-							
-	24.0							
-			Unclear boundary due to core loss.					
-	-		SH2 - Móberg	98	15	0/0/0/0	-	K1/K2
- 90.0			Pillow lava, 3-5% plagioclase needles. Very	400	10	<u>32x3x1</u> 12x3x2 5		
-	=		white secondary minerals and dark green clay.	100	10	Q=1.1	J	
-	26.0 -		Basaltic dyke	100	11	38/0/0/0	1	
-	-		Welded contacts, dark gray, fine grained, microporous, cube jointed, joints rough and	100	25	<u>45x3x1</u> 12x3x2.5		
-	_	***	undulating, coated with clay/silt.	100		Q=1.5 0/0/0/0	ł	
_	-		with white secondary minerals.	89	14	31/0/0/0 74/0/0/0	1	
- 88.0	-	$\geq \geq $	Basaltic dyke. Dark grayish green with white healed veins.	100	6	0/0/0/0]	
-	28.0 —		Móberg, Pillow lava, same as above. Very	-		70x3x1 12x3x2 5		
-	_		filled with gray/brown silt/clay			Q=2.3		
-		$\geq \geq $	Welded contest					
-	=		Resolution duke	100	0	100/0/0/0		
-		(Dark gray, fine grained, cube jointed with gray	100	10	02101010		
- 00.0	30.0		vesicles.	100	11	56/0/0/0		
-	-	Minil	Móberg, Pillow lava, same as above. Clav/Silt lense, dark green with dyke fragments	100	5	61/0/0/0	-	
-		7777	Móberg, Pillow lava, same as above.	100	8	79/0/0/0	-	
-	_	KKK	Basaltic dyke Gray, fine grained, microporous, 1%					K2/K3
-	32 0		plagioclase phenocrysts. Joints rough and undulating, coated to filled with gray, silt/clay.					
- 84.0	=		Basaltic dyke	94	12	0/0/0/0	1	
-	_	644	Highly jointed and broken.	100	17	14/0/0/0	1	
-		KKK	smooth, filled or coated with gray silt/clay and		45	0/0/0/0	_	
	_		Moberg, Pillow lava, same as above.	65	15 4	70/0/0/0	-	
-	34.0 -	KKK	Basaltic dyke	99	7	63/26/0/0 <u>47x3x1</u>		
-	-		small vesicles, 2% plagioclase phenocrysts.			12x3x2.5 Q=1.6		
- 82.0	_	444	gray silt/clay, some healed veins. Partly broken					
-	-		Breccia/Brecciated Móberg	100	12	20/0/0/0		
-		11121112	Reddish green broken but recemented. Móberg, Pillow lava, same as above.	100	4	98/36/0/0	-	
	36.0		Some thick green clay fillings in vugs. Joints rough and undulating, coated-filled with green					
-	_		clay and white secondary minerals.					
-		11121112		88	7	60/12/0/0		Surge Tunnel, at 37 - 52.4
- 80.0								m depth.
-	38.0							
-								
-	_							
-								K3/K4
	_	111221112	3 cm thick joint filled with reddish green clay					
- 78.0	40.0 —		and white secondary minerals.	100	6	85/0/0/0	0.3	
-	-	KKK	Basaltic dyke Dark gray, fine grained, 1% plagioclase	100	1	75/0/0/0		
-	-		phenocrysts, joints rough and undulating coated with gray silt/clay.	100	9	51/0/0/0	<<	
_	=	7777	Móberg, Pillow lava, same as above. Basaltic dyke	100	5	84/0/0/0	4	Permeability test interval 35.77-45.77 m
-			Dark gray, fine grained, 1% plagioclase	04	3	94/71/0/0	-	
- 76.0	42.0 —		coated with gray silt/clay.			2 11 11 01 0		
-	-		Dark greenish gray, fine grained altered					
_	_		woberg. 3% plagioclase needles. 7-10% vesicles and vugs filled with white secondary	100	4	90/37/0/0		
-	_		minerals and dark green clay. Some thick green clay fillings in vugs. Joint rough and					
-	_		undulating, coated-filled with green clay and					



CORE DRILLING

BOREHOLE NO .:

NK-97

SHEET 3 OF 3 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
- - - 74.0 - -	- - - - -		white secondary minerals. Joint with red clay fillings, red alteration around joint. Joint filled with red and green clay and white secondary minerals.				0.3	
 72.0 	46.0			100	6	75/20/20/0		K4/K5
- - - - - - 70.0	48.0		Vertical joint with up to 5 mm brown and green clay and white secondary mineral filling.	100	5	82/54/19/0		
- - - - - -	50.0 — - - - - - - - - - -			07	4	74/50/25/0		
- 68.0 	52.0 — - - - - - - -		Joint, red brecciated moberg, recemented, 10 mm joint fylling, tectonic joint.		-	1400200		K5/K6
- - 66.0 	54.0		Joint with reddish alteration. Breaks during drilling.	95	4	73/49/0/0		
- - - - - - 64.0	56.0		Joint, red clay and white secondary mineral filling, > 20 mm, possibly core loss. Joint filled with white secondary mineral and clay 40 mm, red alteration. Joint, red alteration.	100	6	79/44/18/0		
- - - - - - - - - - - - - - - - - - -								
	60.0 			100	4	86/39/0/0 <u>79x3x1</u> 12x3x2.5 Q=2.6		K6/K7
- 60.0 - - -	62.0 — 							
- - - 58.0			Basaltic dyke Dark gray, fine grained, joints rough and undulating some smooth, with clay coating. Móberg Pillow lava, same as above. Basaltic dyke Dark gray, fine grained, joints rough and	100 100 100	3 4 4	100/49/0/0 <u>91x3x1</u> 12x3x2.5 Q=3 83/0/0/0 86/67/0/0		
- - - - - -	_		unduláting somē smooth, with clay coating. Móberg Pillow lava, same as above. Basaltic dyke Dark gray, fine grained, joints rough and undulating some smooth, with clay coating. Brecciated contact, recemented.	100 100 97	<u>5</u> 2 3	80/0/0/0 100/0/0/0 86/0/0/0		
- 56.0 - -			Móberg Pillow lava, same as above.					



CORE DRILLING



				DATE				SHEET 1 OF 3 SHEETS	
CLIENT: Landsvirkjun PROJECT: Neđri bićrcá		Landsvirkj	un	DATE:		STARTED: 16.06.2	STARTED: 16.06.2012 COMPLETED: 19.06.2012		
PROJECT:		Neðri Þjór	sá	DRILLED B	Y:	Ræktunarsamband	Flóa og Skei	ða	
LOCATION:		Hvammsvi	irkjun	FOREMAN:		Svanlaugur			
STRUCTURE:		Surge tuni	nel	SUPERVIS	ION:	Haraldur Hallsteins	son		
COORDINATES	8:	X: 445107	.67 Y: 393932.75 Z: 110.35	DRILLBIT TYPE: 3" diamond drillbit nr.6, NQ triple tube, 76 mm					
COORDINATE S	SYSTEM:	X ISNET	г	NUMBER OF CORE BOXES: 5					
HOLE INCLINAT	FION:		ICAL X INCLINED -70.2 FROM HORIZONTAL	CORE REC	OVERY:	ŭ	- 89 %		
CASING LENGT	ſH:	9.18 m		TOP OF CA	ASING, ELEV.	: 110.35 m a c l	53 /0	5 /0	
DEPTH OF HOL	.E:	50.22 ~		GROUNDW	ATER ELEVA	ATION: 08 58 m c c l	14	3 7 2012)	
		50.∠3 M	DRILLING DIRECTION 89°	CORF	FRACTURE	90.00 M a.s.I. ROD 10/30/50/100	PERMEAB	3.1.2012)	
ELEVATION (m a.s.l.)	UEPTH (m)	LOG	DESCRIPTION	RECOVERY	INTENSITY	$Q = \frac{RQD \times Jr \times Jw}{Jn \times Ja \times SRF}$	(LU) 10_100	COMMENTS	
<u>⊢</u>		NIZ NIL	Soil	0	(,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		3 30 300		
110.0	-	1/	Running water in hole.						
-	-								
F	-	<u>````````</u>							
F	-	받 소설 소							
	2.0 -	<u></u>							
L 108 0	-	1							
- 100.0	-	<u> N/2</u> N/2							
F		1 1							
F	-								
	40 -	<u></u>							
E		4. 24. 7							
— 106.0	-	<u>xi.1/2 · xi 1/2</u>							
F		12 5 12 5							
F	-								
E	6.0 -	1							
	-	7. 41							
- 104.0		1. 56 3							
F	-	<u></u>							
È ∣	-	1 NAVINA	Scoria and brown soil						
E	8.0 -								
F	-		biáraá lava	1					
-102.0	-	××××××××××××××××××××××××××××××××××××××	Porphyritic basalt						
	-	<^×^×^	Fresh gray, fine grained, 7% vesicles, empty.	100	11	0/0/0/0	-		
È I	-		TS Loose sediment	5	N/A	<u>10x3x1</u> 12x1x2 5			
F	10.0 -	Poro	Only few pebbles of móberg and basalt come			Q=1.0	J		
F	-		μμ.			0/0/0/0			
F	-								
- 100.0									
È I	-								
E	12 0 -	000							
╞		^b ^v ^o							
F İ	± -		Conglomerate	100	11	50/0/0/0	1		
- 98.0			matrix at top, green lower, sandy/silty matrix with green glay in vugs. Stones of			<u>20x3x1</u> 15x1x2.5			
	-		various origin up to 0,3 m. Breaks during drilling.			Q=2.3			
E	14.0		······································	90	13	0/0/0/0]		
\vdash	14.0 -			95	N/A	23/0/0/0			
F	-								
F	_								
96.0	-			91	N/A	0/0/0/0	1		
E		////	NTG - Tholeiite basalt	100	N/A	36/0/0/0	1		
E	16.0 -		Gray, cryptocrystalline, very tew vesicles, microporous, joints rough and undulating	100	9	<u>24x3x1</u> 12x3x5	d		
╞──│	-	1725	coated-filled with clay.	73	N/A	Q=0.4 0/0/0/0	4		
F		YTY	Basalt fragments cemented in black/green clay,	100	12	0/0/0/0	1	_ , , ,	
94.0	-	$\chi\chi\chi$	crushed core.	100	16	15x3x5	ł	The dykes are most likely horizontal inrusions.	
t	-	K///	Dark gray, fine grained, 5% small vesicles			Q=0.1 49/0/0/0	1		
E	18.0 —	(JI)	partiy filled, joints rough and undulating, coated with clay.	100	19	0/0/0/0	1		
F	-	////	Brecciated Tholeiite basalt	100	5	0/0/0/0	li l		
F	-	$\checkmark \checkmark \checkmark \land$	crushed.	100	8	53/0/0/0 88/0/0/0	1		
	-		Tholeiite basalt same as above.	100	19	27/0/0/0 46x3x1]		
92.0	-		Dark gray, welded contacts.			12x3x5	ļ	K1/K2	
L	-	$\forall \gamma \gamma \gamma \gamma$	Tholeiite basalt, same as above.	100	14	Q=0.8	J		



CORE DRILLING

BOREHOLE NO .:

NK-98

SHEET 2 OF 3 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
	-		Highly jointed, partly crushed.	100	23	0/0/0/0	/	
	-		Basaltic dyke Grav fine grained highly jointed joints rough	100	12	38/0/0/0	1	
	-		and undulating coated with clay.	100	13	42/0/0/0 44x3x1		
-	-		Brecciated Tholeiite basalt same layer as			15x3x5		
	-		Recemented with dark sand/clay, thick fillings,	00	11	Q=0.6	1	
- 50.0		+ / / /	cryptocrystalline, microporous basalt, scattered	99		12/0/0/0		
_	22.0 -		small vesicles.		20	0/0/0/0	_	
-	-		Sandstone, brown, well compacted.	100	15	0/0/0/0	1	
_	-	\sim	Core loss		N/A	0/0/0/0	,	
	-	\sim	Probably in green clay.			<u>29x3x1</u> 12x3x2.5]	
	-		Sandstone/conglomerate	100	2	Q=1.0		
- 88.0	240-	111 > 1113	SH2	92	4	77/59/0/0	-	
-	24.0	2111211	Móberg	-				
E	-	11121113	Greenish gray, well compacted core.	86	11	38/0/0/0	-	
	-		~3% small plagioclase needles,	00				
_		11121113	10-25% vesicles, filled with white secondary minerals and green clay.					
_	-	$\geq \parallel \geq \parallel$	Joints mostly rough and undulating,					
- 86.0	26.0-		coated/filled with clay and white secondary minerals up to more than 40 mm thick.	100	10	71/26/0/0		
_	- 20.0		24.4 m, 40 mm joint filling.					
-	-							
-	-		27 m, thick white/gray clay filling in joint.	08	5	79/51/17/0	-	K2/K3
-	-	11121113	healed white vein pattern.	00		<u>82x3x1</u>		
- 84 0	280-		····			Q=2.7		
- 01.0		11121113						
_	-	$\geq \geq $						
-	-							
-	-							
	30.0							
- 82.0	-							
		11121113		98	3	90/75/56/39		Surge Tunnel at 30.4 -
-			30.96 m ~50 mm thick joint with bracciated					
_	-	11121113	filling of brown and green clay and white					
-	-	$\leq \leq $	secondary minerals.					
_	32.0		loints rough and undulating coated with clay					
- 80.0	-		Green thin tuff zones.					
-	-							
-	-	11121113						
	-							
-	-	11121113		100	4	86/39/27/0		
	34.0	$\geq \parallel \geq \parallel$						
- 78.0	-							
_	-							
								K3/K4
	-							
-	36.0 -	11121113						
- 76.0	-					0.4/4.0/0/0	_	
_	-	11121113		100	6	84/10/0/0		
-		$\geq \geq $						
-								
_	38.0							
- 74 0	-							
- 74.0	-	2111211						
_	-	11121113						
-	-				4	88/56/34/34	-	
_	40.0	11121113		99	7	00/30/34/34		
	+0.0-	$\geq \parallel \geq \parallel$						
L	-							
72.0	-							
-	-							
	-							
<u> </u>	420-							
F	+2.0 -	11121113						
	-			100	5	100/0/0/0	1	
- 70.0	_		Proceio	100	N/A	0/0/0/0	4	K4/K5
	-		Fault breccia/Tectonic breccia.	64	IN/A	0/0/0/0		
E	-	-32 8 3m	Crushed greenish gray, probably fault.	100	2	88/88/0/0	4	
	-		Moberg	100	۷	00/00/0/0		



CORE DRILLING

NK-98

BOREHOLE NO .:

SHEET 3 OF 3 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
68.0	46.0		Pillow lava Greenish gray, well compacted core. ~3% small plagioclase needles, 10-25% vesicles, filled with white secondary minerals and green clay. Joints mostly rough and undulating, coated/filled with clay and white secondary minerals up to 40 mm thick. 44,4 m, 30 mm thick tectonic joint filling of greenish gray clay and white secondary minerals	100	4	99/86/86/0		
			Very well compacted core pillow lava, almost no tuff.					
64.0				100	3	93/54/54/54	-	
-	50.0		Some green tuff lenses in the lowest 0,5 m.					
62.0								
60.0								
- - - 								
-								
- 56.0								
 54.0 								
- 52.0								
50.0								

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BOREHOLE LOG

CORE DRILLING



								SHEET <u>1</u> OF <u>4</u> SHEETS
CLIENT:		Landsvirkj	un	DATE:		STARTED: 20.06.2	2012 C	OMPLETED: 25.07.2012
PROJECT:		Neðri Þiór	sá	DRILLED B	Y:	Ræktunarsamban	l Flóa og Skei	ða
LOCATION:		Hvammsvi	irkiun	FOREMAN		Svanlaugur		
STRUCTURE:		Tailrace T	unnel	SUPERVIS	ION:	Haraldur Hallstein	son	
COORDINATES	S:	X· 444956	85 Y 393897 39 7 106 97	DRILLBIT T	YPE:	3" diamond drillbit	nr 6. NO trinle	tube 76 mm
COORDINATE	SYSTEM:			NUMBER C	F CORE BOX	ES: 11		
HOLE INCLINA	TION:			CORE REC	OVERY:		04.9/	
CASING LENG	TH:	2.02 m		TOP OF CA	SING, ELEV.:	106 07 m a a l	34 /0	
DEPTH OF HO	LE:	00 EE m		GROUNDW	ATER ELEVA	TION:	(1	2 7 2012)
	DEDTU	90.55 m	DRILLING DIRECTION 320	CORE	FRACTURE	RQD 10/30/50/100	PERMEAB	5.7.2012)
(m a.s.l.)	(m)	LOG	DESCRIPTION	RECOVERY (%)	(FRACT/M)	Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	(LU) 10 100	COMMENTS
_	-	XXXXXXX	Scoria and soil	0			3 30 300	
-		11/24/0						
_		IND NO						
	-							
-	-							
_	2.0 -							
-	-	N. N. K. K. K.	biórsá lava	-				
_		$\hat{\mathbf{x}} \hat{\mathbf{x}} \hat{\mathbf{x}} \hat{\mathbf{x}}$	Porphyritic basalt					
-	-	`×`×`×`	5% plagioclase phenocrysts.					
-		×^×^×	10% vesicles, empty. Joints rough and undulating, empty or coated					
	4.0 -	$\langle \times \times \times \rangle$	with brown clay /silt.	97	7	65/36/0/0		
-		$\langle \times \times \times \times \times \rangle$						
_		$\langle \hat{x} \rangle \langle \hat{x} \rangle \rangle$						
-	_	$(\times,\times,\times,\times)$						
	-	$(\times \hat{\times} \times \hat{\times} \times \hat{\times})$						
_	6.0 -	<`×`×`×`>		100	5	81/66/26/0		
-	-	$\langle \hat{x} \rangle \langle \hat{x} \rangle \rangle$						
		$\times \times \times \times$						
-	-	[×°×°×`	1-3% vesicles 7.2 - 8.4 m depth.					
_		$(\times \times $						
-	8.0 -	<`×`×`×`						
	-	$\hat{\mathbf{x}}$	10-25% vesicles					
_		(×`×`×`	Thin scoriaceous zones.			10/0/0/0	_	
-		×^×^×	Faitiy crushed zones.	96	12	40/0/0/0		
- 100 0	-	$\langle \times \times \times \rangle$						
-	10.0 -	$\langle \times \times \times \times \rangle$						
_		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	Highly jointed vesicular basalt.	81	9	26/0/0/0		
_		XXXXXXX	High core loss.					
	▼ -	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						
_		$\times \times \times$						K1/K2
-	12.0	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		67	7	39/0/0/0	_	
- 98 0	-	××`				<u>54x3x1</u> 12x1x2.5		
- 00.0		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	Derthy environment			Q=5.4		
_	-	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	Faitiy crushed zones.					
-		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						
F	14.0	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						
_	-	XXXXX						
F	_	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		100	10	61/0/0/0	4	
- 96 0	-	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		100		01/0/0/0		
-	-		TS	3	N/A	0/0/0/0	1	
Ľ	- 16.0		Probably gravel					
L	-	000	Stones of various basaltic origin.					
-	_	^r ^v ^o						
F	-	500°			Ν/Δ	10/0/0/0	_	
F	-	^b ^U ^C		20		10/0/0/0		
- - 01 0	18.0	000						
- 34.0	-	5°°°°	Basalt and conglomerate fragments	18	N/A	0/0/0/0	-	
E	_		basan and congionierate iraginerits.					
F	-	^b ^v ^o						
	-		Conglomerate	89	7	46/0/0/0	1	



CORE DRILLING

NK-99

BOREHOLE NO .:

SHEET 2 OF 4 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
-			Greenish gray, sandy matrix, well cemented. SH2 Mohera	100	6	<u>46x3x1</u> 15x1x2.5 Q=3.7		
- 92.0			Pillow lava-Pillow breccia Dark gray, fine-medium grained, microporous	98	9	95/48/0/0 65/0/0/0		
- 52.0	-	Z Z Z Z	basalt pillows, 1-3% plagioclase needles. Pillows cemented in low amount of green tuff.					
-	22.0 —		5-20% vesicles, filled with clay and white secondary minerals.					
-	-	$\mathbb{Z}^{ } \mathbb{Z}^{ }$		100	5	93/22/0/0		
_		///ミ///ミ ニノ//シノ/						
-		11121112						K2/K3
- 90.0	24.0 —	Z Z Z Z	Tectonic joint, filled with 10 mm thick clay/silt and secondary minerals.					
-	-		Tectonic joint 5 mm thick filling.		0	50/0/0/0		
_			2 mm this joint filling	100	5	30/0/0/0		
_	-	///ミ///ミ ニノ// ニノ//	s mm the joint ming.					
-	26.0 —			100	4	96/21/0/0		
-	_	Z Z Z		100				
— 88.0 -								
-	-					00/10/00/0		
-	28.0 —	\Z \Z \Z		95	5	68/40/28/0		
-	=====							
_								
-	-		Two or three slickensided joints.					
- 86.0 -	30.0 —							
-			Tectonic joint with brown clay and alteration.	100	7	63/0/0/0		
-	_		Tectonic joint, 5 mm thick filling.	100	,	03/0/0/0		
-	-		Tectonic joint, 30 mm thick red/green clay and rock fragments and white secondary minerals,					K3/K4
-	320-	Z Z Z Z	Hardened filling. Healed white vein pattern. Teatenia isint red alteration, braken care white	100	38	77/0/0/0		
- 84.0	52.0		secondary mineral filling, 10-20 mm.	100	9	68/0/0/0		
_	_		Tuff	100	6	60/43/0/0		
-			Joints rough and undulating, coated with gray					
	34.0		Móberg Pillow lava	100 100	<u> </u>	0/0/0/0 95/16/0/0		
-			Dark gray, fine-medium grained, microporous basalt pillows, 1-3% plagioclase needles.			81x3x1 12x3x2.5		
_	-	$\geq \geq $	Pillows cemented in low amount of green tuff. 5-20% vesicles, filled with clay and white			Q-2.7		
- 82.0	-		secondary minerals.					
-	36.0							
-	50.0							
-				100	5	88/11/0/0		
_	-	Z Z Z Z						
-	38.0							
- 80.0	50.0							K4/K5
-	_	///ミ///ミ ニノ// ニノ//	Tectonic joint, 20 mm filling of yellowish					
-	-		secondary minerals, reddish alteration on joint walls.					
-	400-			98	3	95/80/47/0		
-	40.0							
- 78.0								
_		\Z \Z \Z						
-	42.0							
-	42.0							
-	-			100	2	82/57/57/0		
		2111211	Welded contact.					
- 76.0		H	Basaltic dyke Dark gray, fine-medium grained, microporous,	100	3	100/60/0/0 <u>100x3x1</u>		



CORE DRILLING

NK-99

BOREHOLE NO .:

SHEET 3 OF 4 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
_	_	J-J-J-	2-5% small vesicles, filled with white secondary minerals.			15x3x2.5 Q=2.7		
-			Joints rough and undulating, coated with white secondary minerals-almost empty. Welded contact	100	5	94/45/0/0	-	
-	-		Móberg Pillow lava-Pillow breccia			75/50/40/0	_	K5/K6
-	46.0 -	Z Z Z Z	Dark gray, fine-medium grained, microporous basalt pillows, 1-3% plagioclase needles.	100	6	75/52/18/0		
- 74.0	-		Pillows cemented in low amount of green tuff. 5-20% vesicles, filled with clay and white secondary minerals					
-	-		Joints rough and undulating coated with clay/silt.					
-	-							
_	48.0 -							
-	-			100	6	74/53/23/0	-	
- 72.0		\Z \Z \Z						
-	50 0 -							
-	-						L	
-				100	6	86/36/0/0		
-	-							
- 70.0	52.0 —							
-	-	Z Z Z						
-	-	Z Z Z Z						
-	 54 0 —			100	7	80/0/0/0		
-	-			100				
- - 68.0								
-	-						3.6	
-	56.0 -	$\mathbb{Z}^{ } \mathbb{Z}^{ }$						
-	-		Tectonic joint.	100	0	100/100/0/0		
-			Móberg Tuff Green, sandy, well compacted with small	96	3	87/59/43/43		
- 66.0	- - 58.0		pillows.					
-								
-			Tectonic joint, 0.5 - 0.2 m thick red					
-	-		silt/clay/sand filling and reddish brown altered joint walls.					
-	60.0 -		Tectonic joint, filled with clay, broken core in joint. Méberg	100	5	83/0/0/0		
- 64.0	-		Pillow lava-Pillow breccia Dark gray, fine-medium grained, microporous	100		100/34/40/0		К7/К8
-			basalt pillows, 1-3% plagioclase needles. Pillows cemented in low amount of green tuff. 5-20% vesicles filled with clay and white					
-	62 0		secondary minerals. Joints rough and undulating coated with					
-	-		clay/silt. Good competent rock.					
-								
- 62.0	-	Z Z Z Z		100	5	92/21/21/0 <u>87x3x1</u>	-	
_	64.0 —	Z Z Z Z				12x3x2.5 Q=2.9		
_	-							
_			White and clear secondary minerals in vugs and vesicles.					
_	 66.0							
- 60.0	-			100	4	81/51/51/0	-	
-	_							
	-							
		11121113						



CORE DRILLING

BOREHOLE NO .:

NK-99

SHEET 4 OF 4 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
- - - 58.0								K8/K9
- - - -	70.0		Pillow lava breccia Increasing breccia content.	100	6	110/41/0/0	-	
-			Móberg Tuff Dark green, glassy sediment, well compacted. Dense but brittle rock, small vugs filled with	100	1	95/95/95/95		
- 56.0 - - - -	72.0		White secondary initialities. Healed white veins with white secondary minerals. Partly with pillow fragments cemented in the glassy matrix. Very few joints.	100	0	100/100/100/100	_	
- - - 54.0	74.0							
- - - -	76.0		Moberg Pillow lava breccia Dark gray pillow basalt cemented in green tuff breccia. Joints rough and undulating, coated to filled with gray clay/silt and hardened secondary	<u>100</u> 100	10 5	52/0/0/0 79/36/0/0		K9/K10
- - - - 52.0	78.0		minerais. Móberg Tuff Dark green, glassy sediment, well compacted. Dense but brittle rock, small vugs filled with white secondary minerals.	100	2	88/72/72/0		
- - 	-		Partly with pillow fragments cemented in the glassy matrix. Very few joints.	99	1	99/90/90/39	-	
- - 50.0 -	80.0		0,6 m pillow basalt.					
-	82.0 — 		Móberg Pillow lava breccia Dark gray pillow basalt cemented in green tuff breccia. Vesicles and vugs filled with white secondary minerals and clay. Joints rough and undulating, coated to filled with green clay/silt and hardened secondary	98	5	88/53/0/0		
48.0 -					4	86/42/30/0	_	K10/K11
- - - - - 46 0				99		00.12.0010		
- - - -								
- - - 44.0	88.0		Móberg Tuff Green glassy sediment. Dense rock but breaks during drilling.	100	6	69/69/0/0 75/34/21/0	-	
- - - -			Healed white veins. Some planar joints but mostly rough and undulating.					
- - 42.0								



CORE DRILLING

								SHEET <u>1</u> OF <u>3</u> SHEETS		
CLIENT:		Landsvirkj	un	DATE:		STARTED: 26.06.2	012 C	OMPLETED: 03.07.2012		
PROJECT:		Neðri Þiórs	sá	DRILLED B	Y:	Ræktunarsamband	Ræktunarsamband Flóa og Skeiða			
LOCATION:		Hvammsvi	irkiun	FOREMAN		Svanlaugur	Svanlaugur			
STRUCTURE:		Tailrace Tu	unnel	SUPERVIS	ION:	Haraldur Hallsteins	son			
COORDINATES:		X: 444976	.21 Y: 393953.56 Z: 104.89	DRILLBIT TYPE: 3" diamond drillbit nr.6, NQ triple tube, 76 mm						
COORDINATE SY	/STEM:	X ISNET	·	NUMBER C	NUMBER OF CORE BOXES: 7					
HOLE INCLINATIO	ON:		ICAL X INCLINED -43.4 FROM HORIZONTAL	CORE REC	OVERY:		03 %			
CASING LENGTH	l:	6.23 m		TOP OF CA	SING, ELEV	.: 104.80 m a s l	33 /0			
DEPTH OF HOLE	:	57.62 m		GROUNDW	ATER ELEV	ATION: 00.51 m a.s.l	(1	3 7 2012)		
ELE MATION	DEDTU	57.02 111	DRILLING DIRECTION 294	CORE	FRACTURE	RQD 10/30/50/100	PERMEAB	5.7.2012)		
(m a.s.l.)	(m)	LOG	DESCRIPTION	RECOVERY (%)	(FRACT/M)	Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	(LU) 10_100	COMMENTS		
-	_	<u>, 1, . , 1,</u>	Topsoil	0	,		3 30 300			
-	-	11. 311 3								
	-									
-104.0	-	<u> </u>								
-	_		Scoria with topsoil infiltration.							
-	2.0 —									
_	_									
-	-									
-										
-	_		biórsá lava	_						
-	40 —	<^×^×^×^>	Porphyritic basalt							
-102.0		<	~5% plagioclase phenocrysts.							
	-	$(\times \times \times \times)$	Fresh, gray, fine grained, microporous, scattered oliving phenocrysts							
_		`×`x`x`	10% vesicles down to 8 m depth.							
-	_	ĺ×^×^×	undulating, empty or coated with red, reddish							
-	_	<pre></pre>	brown and gray clay/silt. Massive, fine grained basaltandesite dyke							
	6.0 -	<`×`×`×`	joints planar and smooth, coated with clay, no							
-	_	kÛ×Û×Û>	vesicles.	100	9	48/0/0/0				
-	_	$\hat{\mathbf{x}}$								
	-	* × × × ×								
F 🖌	, –	[×`×`×`×]		100	11	27/0/0/0	-			
- ¥	8.0 -	`×``×``×`	Scattered vesicles below 8 m denth	100		21101010				
-	_	(×^×^×	Scattered vesicies below of in depth.							
	_	$(\times \times \times \times)$		100	6	75/42/0/0	1			
-		<`x`x`x`								
-	_	<^×^×^×^>								
	10.0	* × × × ×		95	7	66/0/0/0				
- 50.0		`×`×`×`		100	11	22/0/0/0	-			
-	-	`×^×^×								
-		× × × ×		100	13	41/0/0/0				
_	=	<`×`×`×`	Some planar and rough joints							
-		([^] x [^] x [^])		100	9	76/0/0/0	1			
-	12.0 -	<^x^x^x	More massive basalt below 12 m depth.							
_	-	(×`×`×`×`								
- 96.0	_	`×`x`x`				0.1/05/0/0				
-	_	`x^x^x^		100	7	81/25/0/0		K1/K2		
	_	$(\times \times \times \times)$								
-	14.0 —	×`×`×`>								
-	-	<^×^×^>								
	-	$\langle \times \times \rangle$								
-	-	(×`×`×`×`								
-	_	(×()×()×(99	5	94/31/20/0	1			
- 94.0	16.0	(×^×^×				12x1x2.5				
	_	$\langle \times \times \times \times \rangle$				Q=2.9				
\vdash	_	ŧ,×,×,×,×								
-		ŧ^x^×Ŷ								
	_	 x x x x x x x x x x x x x x x x x x x								
F	10 0	(× × × ×								
\vdash	10.0 -	[×^×`×`								
	-	$(\times) \times (\times) \times (\times)$		99	7	67/37/37/0	1			
- 92.0		<`x`x``x`								
\vdash	_	××××××								
	_	<pre>x^x^x^x</pre>								



CORE DRILLING

BOREHOLE NO .:

NK-100

SHEET 2 OF 3 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
			TS Loose sediment Gravel Only few basalt pebbles come up.	0	N/A	0707070		
- 90.0		000		9	N/A	0/0/0/0		
-	22.0		Sandstone	100	1	89/89/89/89		
-	_		23 m. Well cemented but breaks during					K2/K3
-			drilling. Medium grained dark/black sandstone, well					
-	-		cemented but can be scratched with fingernail.					
	24.0		Joints planar, smooth and empty or coated with					
_	24.0 -		iciay.		0	99/99/99/71		
- 88.0	_			99	Ů	<u>88x3x1</u> 20x1x2.5		
-						Q=5.3		
-	-							
_	26.0 -							
-								
_	-							
-	-							
- 86.0	-		Core crushed by drilling.	100	15	27/0/0/0		
-	28.0 —		Conglomerate/Tillite Grav silty-sandy matrix, well cemented, yugs	100	4	84/59/38/0		
-	-		partly filled with white secondary minerals.					
-	_		silt/clay, breaks during drilling.					
-	_							
	-							
-	30.0 —	<u> </u>	SH2	14	N/A	0/0/0/0		
- 84.0	-	- 13 X & 3m	Tectonic breccia related to the dyke below, reddish brown, mostly recemented but partly	67	8	0/0/0/0		K3/K4
-			broken.	0.				
-	_	177	Basaltic Dyke Composite horizontal intrusion.	98	4	85/34/0/0		
_			Dark gray, microporous, 10% small vesicles, some filled with white secondary minerals					
-	32.0	KAA	Fresh gray, very fine grained, no vesicles.	100	10	74/0/0/0		
		XXX	ounts planar and smooth, coated with clay.			15x3x2.5		
-				100	10	Q=0.6		
- 82.0	-	KAA		100	7	72/18/0/0		
-	34.0		microporous, parity altered.	100				
-								
	-	Y						
-					_			
_	-			100		85/40/0/0		
-	36.0 -	KAA			11	22/0/0/0		
- 80.0	-	KK		81		32101010		
-	-		Microporous, 10% small vesicles, empty-filled with white secondary minerals.	100	3	100/35/0/0		
		HH	,					
⊢ ∣	-		Móberg Pillow lava breccia	100	13	19/0/0/0		K4/K5
È I	38.0 -		Broken and tectonized core.					
-	=		filled with clay and white secondary min.	100	2	100/68/41/0		
- 79.0			cemented basalt pillows in green tuff breccia.					
- 70.0	_	VIVI	Vesicles and vugs filled with white secondary minerals.					
-	40.0		Joints rough and undulating, coated with gray clay/silt.	94	3	85/57/42/0		
_	40.0 -		Reddish alteration around tectonic joints.			12x3x2.5	1.2	
-	-					Q=2.2		
	-							
-	_							
- 76.0	420-	NINI,						
- 10.0								
-	-			97	8	62/0/0/0	1	
⊢ ∣	-							
-	-							



CORE DRILLING

NK-100

BOREHOLE NO .:

SHEET 3 OF 3 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
- - 74.0			Tectonic joint.	69	3	60/0/0/0		
-	46.0 — 		Tuff Dark green, glassy tuff, well cemented with small fragments of pillow lava basalt.	100	11 7	0/0/0/0 91/58/35/0	-	K5/K6
- - - - 72.0			Vugs filled with white secondary minerals. Joints rough and undulating, coated with silt/clay.	100	1	100/100/100/100	_	
-			Pillow lava breccia Same as above.	100	8	65/0/0/0	1.2	
- - - - 70 0	50.0 — 		49.72 m, tectonic joint filled with 10 cm thick stiff clay. Tuff Dark green, glassy tuff, well cemented with small framments of pillow laya basalt	88	2	77/77/0/0	-	
-			Vlugs filled with white secondary minerals. Joints rough and undulating, coated with silt/clay.	93	5	63/63/63/63 <u>78x3x1</u> 12x3x2.5 Q=2.6		
-			52.2 m, tectonic joint with >7 cm thick red hardened clay/slit filling. Pillow lava breccia tectonic joints at 53 and 53.2 m depth, with brown clay filling.	95	8	41/0/0/0		K6/K7
- 68.0 - -	- 54.0 — -		Gray pillow lava basalt, well cemented in green tuff, very altered and partly tectonized and broken at top. Crushed partly between 53.2 and 53.44.	98	0	98/98/98		
- 			Fillow lava Gray, vesicular (~15%) pillows. Vugs filled-coated with white-clear secondary minerals.	100	1	100/85/85/0		
- 66.0 				97	7	47/0/0/0	_	
-	_							
- 64.0 								
- 								
- 62.0 								
- - -								
- - 60.0 -								
-								
-								

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BOREHOLE LOG

CORE DRILLING

NK-101

								SHEET 1 OF 3 SHEETS			
CLIENT:		Landsvirkj	un	DATE:		STARTED: 03.07	7.2012 CO	OMPLETED: 12.07.2012			
PROJECT:		Neðri Þjór	sá	DRILLED B	Y:	Ræktunarsamba	nd Flóa og Skei	ða			
LOCATION:		Hvammsv	irkjun	FOREMAN		Svanlaugur					
STRUCTURE:		Intake		SUPERVISION: Haraldur Hallsteinsson							
COORDINATES	S:	X: 444875	.13 Y: 394250.07 Z: 112.64	DRILLBIT TYPE: 3" diamond drillbit nr.6, NQ triple tube, 76 mm							
COORDINATE	SYSTEM:	X ISNET	r 🗖	NUMBER OF CORE BOXES: 8							
HOLE INCLINA	TION:	VERT	ICAL X INCLINED FROM HORIZONTAL	CORE REC	OVERY:		89 %				
CASING LENG	TH:	6.5 m	CASING REMOVED	TOP OF CA	ASING, ELEV.:	112.64 m a.s.l.					
DEPTH OF HOL	LE:	64.79 m	DRILLING DIRECTION 131°	GROUNDWATER ELEVATION: 99.97 m a.s.l. (13.7.2012)							
ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100	COMMENTS			
_	_	<u>x1 1 </u>	Topsoil	0			3 30 300				
_		1/ 1/ 1									
— 112.0		<u> </u>									
_		17. 317. 3									
-											
-	2.0 -	$(\cdots) $									
-	_										
_											
-	_	1/2 · · · · · · · · · · ·									
— 110.0	40	$\underline{\sqrt{1}}$ $\underline{\sqrt{1}}$									
-	4.0	<u>1</u> 2 <u>1</u> 2 <u>1</u> 2 <u>1</u> 2									
-	_		Scoria mixed with topsoil								
_		<u> </u>									
-		<u> 117 - 118</u>									
-	6.0 -										
-	_		Þiórsá lava	_							
		$\langle \times \times \times \rangle$	Porphyritic basalt Fresh, gray, fine grained, microporous	77	8	27/0/0/0					
-		`×^×^×,	5% plagioclase phenocrysts.	61	7	16/0/0/0	_				
-	_	$\langle \times \times \times \rangle$	~5% vesicles, empty.	01		10,010,0					
-	8.0 -	$(\hat{x} \hat{x} \hat{x})$	basalt > 0.3 m.								
_	_	$\langle \times \ \times $	Joints rough and undulating, empty.								
-		$\langle \times \rangle \times \rangle \times \rangle$		87	9	29/0/0/0					
		$\langle \hat{x} \times \hat{x} \times \hat{x} \rangle$		0,							
-		$\langle \times \rangle \times \rangle \times \rangle$									
-	10.0	$\langle \times \times \times \times \times \rangle$		70	10	14/0/0/0					
-	_	$\langle \rangle \times \rangle \times \rangle \rangle$		10		1.10,010					
-		$\langle \hat{\mathbf{x}} \hat{\mathbf{x}} \hat{\mathbf{x}} \rangle$		93	11	44/0/0/0					
-	_	$\langle \times \times \times \times \rangle$									
_	120-	$\langle \rangle \times \rangle \times \rangle \rangle$									
— 104.0		$\langle \hat{x} \times \hat{x} \times \hat{x} \rangle$		100	11	37/0/0/0					
-		$\langle \times \ \times $									
_		$\langle \times \times \times \rangle$	7-10% plagioclase phenocrysts.	97	12	44/0/0/0					
_		$(\hat{x} \hat{x} \hat{x})$	Very jointed and partly broken basalt. Hard to								
-	14.0 -	$\langle \times \ \times $	say if it is tectonic or original joints.	97	9	70/0/0/0					
-		$\langle \times \times \times \times \rangle$									
-		؞ٚ×ؠٚ×ؠ						K1/K2			
-	-	$\langle \times \times \times \rangle$									
-		$\langle \times \times \times \times \times \rangle$		79	10	24/0/0/0					
-	16.0 -	$\langle x \rangle \langle x \rangle \rangle$									
F	-	$(\hat{x},\hat{x},\hat{x})$		98	10	38/0/0/0	-				
-	-	$\langle \times \times \times \rangle$									
L .		$\langle \hat{\mathbf{x}} \rangle$									
— 100.0	₹ 18.0 —	$\langle x x x x \rangle$				E 4/00/00/0					
F	-	$\langle x \rangle x \rangle x \rangle x \rangle$	2-3% vesicles.	100	10	54/29/29/0					
-	=	$\langle \hat{x} \rangle \langle \hat{x} \rangle \rangle$	Decreasing vesicles downwards.								
Ľ.		ذ×××××									
-	-										
-	. –	$\sim \sim \times$	1	1	, I		1	1			



CORE DRILLING

BOREHOLE NO .:

NK-101

SHEET 2 OF 3 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
- - - 98.0			Scattered vesicles.	96	6	64/31/0/0		
-			Core crushed by drilling.			70/00/00	-	
-	22.0			100	ð	78/26/0/0		
-	-			100	5	89/31/31/0	-	K2/K3
- 96.0	-							
-	24.0 —							
- 				100	6	64/0/0/0		
-	26.0			94	9	55/0/0/0	-	
- 94.0 -	20.0 -	$\langle \times \times \times \times \rangle$			12	40/0/0/0	-	
-				100	12	40/0/0/0		
	28.0							
-	-			98	5	84/16/0/0 <u>62x3x1</u> 12x1x2.5		
— 92.0 -			More massive basalt than above.			Q=6.2		K3/K4
-	30.0			0.9	6	76/0/0/0	-	
	-			90		10,0,0,0		
-			Steeply inclined joints according to the core.					
- 90.0 - -	32.0 — - -			100	5	98/50/0/0	-	
-			20-25% plagioclase prieriocrysts.					
-	34.0			96	7	70/30/0/0		
- 88.0	-		5-7% plagioclase phenocrysts below 34.6 m					
-			ucpui.					
-	36.0		More jointed zone between 35.8 m and 39.6 m. Light green and light brown colour on joint walls, very thin clay.	100	10	34/0/0/0		
-	-			100	12	42/0/0/0	-	K4/K5
- 86.0								
-	38.0							
-				100	7	78/34/0/0	-	
-	40.0		More massive basalt.					
- 84.0 -	-							
-								
-	42.0			100	4	91/78/49/0	-	
-	-							
- 82.0	-							K5/K6



CORE DRILLING

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BOREHOLE NO .:

NK-101

							SHEET <u>3</u> OF <u>3</u> SHEETS			
ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVER	FRACTURE- Y INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS		
-	-									
-	_		>	100	4	95/44/23/0	_			
-	-									
- 80.0	46.0 -		>							
	-									
-	-									
-	48.0 -		TS Losse sediment	5	N/A	0/0/0/0	_			
-			Gravel Pebbles and cobbles of basalt and rhyolite	17		0,0,0,0				
78.0 -			come up, subrounded-rounded.							
-	50.0		c	15	N/A	0/0/0/0	_			
	-									
-										
- 76.0				13	N/A	0/0/0/0	_			
-	52.0									
-	-		SH2	23 100	N/A 8	0/0/0/0 57/21/0/0				
-	-		Pillow lava breccia 52.66 m Tectonic joint with brown clay and							
-	54.0		White secondary mineral fillings, brown alteration and broken core around joint. Dark gray pillow basalt, well cemented with							
— 74.0 -	-		green tuff breccia. Vugs 5% filled with clear-white secondary minerals	96	8	43/0/0/0				
-			55.3 and 55.9 m Tectonic joints with brown clay					K6/K7		
-	56.0 -		alteration and broken core around joints.							
-	-			99	5	84/36/0/0 <u>58x3x1</u>				
- 72.0	-		Most joints, rough and undulating, empty or coated with clay, tectonic joint with thick fillings.			12x3x2.5 Q=1.9				
-	58.0 -		Core breaks during driming.							
-		V								
_										
-	60.0			92	9	42/0/0/0				
— 70.0 -										
-	-		Very jointed and broken core. Altered rock, alteration has decreased the rock strength							
- 	62.0-		partly crushed.	95	9	53/21/0/0				
-			61.7 m and 62.8 m Tectonic joints.							
- 68.0				100	10	53/0/0/0		K7/K8		
-										
-	64.0		Slickensided joints in the tuffaceous part.							
-	_	<u>*''''''''''''''''''''''''''''''''''''</u>					+			
-										
— 66.0 -										
1		1	1		1		1	1		

🚳 ΜΛΝΝΥΙΤ

BOREHOLE LOG

CORE DRILLING

NK-102

CLIENT:				DATE				SHEET TOP TOHEETS		
DRO IECT:		Landsvirkj	un	STARTED: 13.07.2012 COMPLETED: 13.07.20						
PROJECT.		Neðri Þjór	sá	Ræktunarsamband Flóa og Skeiða						
LOCATION:		Hvammsv	irkjun	FOREMAN		Svanlaugur				
STRUCTURE:		Spillway		Haraldur Hallsteinsson						
COORDINATES	S:	X: 444739	.01 Y: 394319.29 Z: 112.83	DRILLBIT TYPE: 3" diamond drillbit nr.6, NQ triple tube, 76 mm						
COORDINATE	SYSTEM:	X ISNET	r 🔲	NUMBER OF CORE BOXES: 2						
HOLE INCLINA	TION:			CORE RECOVERY: 00 %						
CASING LENG	TH:	6 79 m		TOP OF CASING, ELEV.:						
DEPTH OF HO	LE:	40.40		GROUNDW	ATER ELEVA	ATION: 404.07 m a.s.l.	(4	4 7 0040		
		16.42 m	DRILLING DIRECTION *	CORE	FRACTURE	ROD 10/30/50/100	PERMEAB	4.7.2012)		
ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	RECOVERY	INTENSITY	$Q = \frac{RQD \times Jr \times Jw}{Jn \times Ja \times SBE}$	(LU) 10_100	COMMENTS		
-		1. N. N. I.	Topsoil	(%)	(110401/14)		3 30 300			
F	-			Ū						
-112.0	-									
-										
_		<u>1</u> 2 <u>1</u> 2 <u>1</u> 2								
	20-	<u> 11 x 11</u>								
-	2.0	1								
F 110 0	-									
- 110.0		XXXXXX	Scoria and soil	-						
-	-									
-										
-	4.0 -	<u>, 1 () , 1 ()</u>								
L	-	<u>12 ~ 22 ~ 2</u>								
- 108.0	_	NI NI								
F			Scoria							
-	-									
-	6.0 -									
-	-	- × × × ×	Þjórsá lava							
- 106 0		Į×^×^×	Fresh, gray, fine grained, microporous.		7	53/13/0/0	_			
		Į×^×^×	3-5% plagioclase phenocrysts.	93		53/13/0/0				
-	-	×××××	Joints rough and undulating, empty.							
-	-	$\times \times \times \times \times$								
-	8.0 -	₹Č×Č×Č>								
F	-	₹Ŷ×Ŷ×Ŷ								
		* × × × ×								
-	-	{×`×`×`×`		94	13	17/0/0/0				
-	-	ĺ×Ĵ×Ĵ×Ĵ	Increasing vesicles 5-7% Increasing plagioclase phenocryst 7-10%.							
E	10.0 -	$(\times \hat{\times} \times \hat{\times} \times \hat{\times})$		100	8	70/30/0/0	-			
F		<pre></pre>		100	-	45x3x1 12x1x2 5				
- 102.0	-	₹×Č×Č×				Q=4.5				
-		}Ç×Ç×Ç×								
-		$\langle \hat{x} \times \hat{x} \times \hat{x} \rangle$								
-	12.0 -	*×××××								
L		Į×°×°×'								
- 100 0		Į×^×^×	More jointed.	00	10	17/0/0/0	-			
E 100.0	-	×××××		90						
F	-	ŧČ×Č×Č>		100	19	0/0/0/0	-			
É	14.0	<u></u> ł^×^×^		93	10	38/0/0/0	1			
F	14.0 -	¦ï×î×î>	Decreasing vesicles, 2-3% small vesicles.							
È	-	$\left\{\times^{\times}\times^{\times}\times^{\times}\right\}$						K1/K2		
- 98.0	_	Į×Č×Č×Č				44101010	4			
F		Į×^×`×`		81	8	41/0/0/0				
E		<u>↓</u> × [°] × [°] × [°] × [°]				00/0/0/0	1			
E	16.0 -	×××××	Core loss, cave.	76	8	39/0/0/0				
F	-	<u></u> ŧČ×Č×Č×								
- 96.0		+î×î×î>								
F	-	₹ <u>`</u> ×^×^	Scattered vesicles.							
F			Drilling problem, the inner rod did not set	77	N/A	N/A/N/A/N/A/N/A	1			
<u> </u>	18.0-	ť×°×°×́	correctly, damaged core.							
F		<u>[×^×`×`</u> ×`								
- 94.0										
F										
F										



CORE DRILLING

NK-103	3
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					SHEET <u>1</u> OF <u>1</u> SHEETS						
CLIENT:		Landsvirkj	un		DATE:		ST	STARTED: 13.07.2012 COMPLETED: 13.07.2012			
PROJECT:		Neðri Þiórs	sá		DRILLED B	Y:	Ra	Ræktunarsamband Flóa og Skeiða			
LOCATION:		Hvammsvi	irkiun		FOREMAN:		SI	Svanlaugur			
STRUCTURE:		Spillway			SUPERVISI	ON:	U/	andur Hallsteinse	Idur Hallsteinsson		
COORDINATES	8:	Spillway	74 V: 204200 00 7	. 111.00	DRILLBIT TYPE: 3" diamond drillbit nr 6. NO triple tube. 76 mm						
COORDINATE	SYSTEM:	X: 444704	<u>.74 Y: 394288.98 Z</u> 	: 111.98	3" diamond drillbit nr.6, NQ triple tube, 76 mm NUMBER OF CORE BOXES:						
HOLE INCLINAT	FION:				2 CORE RECOVERY:						
CASING LENGT	TH:	X VERT		FROM HORIZONTAL	100 DE CASING ELEV:						
	Г.	4.73 m	CASING REM	OVED				1.98 m a.s.l.			
DEPTH OF HOL		18.62 m	DRILLING DIF	RECTION °	GROUNDW		10N:	0.30 m a.s.l.	(1	4.7.2012)	
ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DES	SCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD Q = <u>F</u>	10/30/50/100 <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS	
-	-	<u> 17 17</u> .	Topsoil		0				1 1 1 1 1 1 1 1 1		
-	-	11. 11. 1									
-	-										
-	-										
-	-	꼰 쓰 꼬									
- 110.0	20 -										
_											
-	-										
			Scoria								
_	-	12222									
	-		Þjórsá lava Porphyritic basalt								
-108.0	4.0 -		Fresh, gray, fine graine	ed, microporous.							
_	-	$\times \times \times \times$	1% plagioclase phenod	crysts.							
_	-	$(\times \times \times \times)$	Jointed basalt.					0/0/0/0	-		
		$\times \times \times \times \times$	Joints rough and undul	lating, empty.	<u>100</u>	20	·	<u>0/0/0/0</u> 18/0/0/0	1		
_	-	$\times \times \times \times$	Core loss.		00						
_	-	$(\times \times \times \times)$									
- 106.0	6.0 —	×°×°×°	2-4% vesicles below 6	m depth.	02	12		51/0/0/0	-		
-	-	₹Û×Û×Û>			92						
-	-	}Û×Û×Û>									
_		×Û×Û×Û>									
-	-	<^x^x^x			100	20		0/0/0/0			
-	-										
- 104.0	8.0 -	$\times \times \times \times$	Increasing vesicles bel	ow 8 m depth, 5-7%.	100	13	:	37/0/0/0	-		
_	-	$\times \times \times \times$	Increasing plagioclase	phenocrysts, 7-10%.	100	16		0/0/0/0			
-	-	$\times \times \times \times$	Tellowish brown clay c	oating in joints.	100	19		11/0/0/0	-		
-		* * * * * *									
_	-	$(\times \times \times \times)$									
- 102.0	10.0	[×°×°×]			100	10		48/0/0/0			
- 102.0	10.0 -	[×Û×Û×]			100	11		52/0/0/0	-		
-	-	Į×Ŷ×Ŷ×Ĵ			100			52/0/0/0			
_	-	<pre></pre>									
-	⊻ -	$\times \times \times \times \times$									
- 100.0	12.0 -	$\times \times \times \times$			93	6	6	4/38/0/0 49x3x1		K1/K2	
_		$\langle \times \times \times \times \rangle$					1	2x1x2.5			
_	-	≺`×`×`>						Q=4.9			
		₹Û×Û×Û>									
-	-	}Ç×Ç×Ç≯									
	-	<u>ŧ</u> ŶxŶxŶ									
98.0	14.0 -	<;;×;;×;;>									
-	-	$\times \times \times \times$							-		
F	-	$(\times \times \times \times \times)$			96	8		53/0/0/0			
-		$(\times \times \times \times \times)$									
E I	-		More massive basalt.								
		<u>]×`×`×`</u> ×]			100	11	:	28/0/0/0	1		
- 96.0	16.0 -	[×Ĵ×Ĵ׾×]									
E I	-	[×Ĵ×Ĵ×Ĵ×]			100	5	8	9/56/28/0	{		
<u> </u>	-	{×^×^×			100						
-		$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$									
F	-	$\left\{ \times \times \times \times \right\}$									
- 94 n	180-	< <u>`</u> ×`×`×`>									
	-0.0	< <u>`</u> ×`.×`>									
-	-	$\langle \times \times \times \times \rangle$							<u> </u>		
F											
E I											
-											

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BOREHOLE LOG

CORE DRILLING

NK-104

OUENT.				DATE					SHEET 1 OF 1 SHEETS	
CLIENT:		Landsvirkj	un				STARTED: 13.07.2012 COMPLETED: 14.07.2012			
PROJECT:		Neðri Þjór	sá	DRILLED B	Y:	R	Ræktunarsamband Flóa og Skeiða			
LOCATION:		Hvammsv	irkjun	FOREMAN:		S	Svanlaugur			
STRUCTURE:		Spillway		SUPERVISI	ON:	н	Haraldur Hallsteinsson			
COORDINATES	S:	X· 444652	37 Y: 394251 39 7: 110 02	DRILLBIT TYPE: 3" diamond drillbit nr.6. NQ triple tube. 76 mm					tube 76 mm	
COORDINATE	SYSTEM:			NUMBER OF CORE BOXES: 1						
HOLE INCLINA	TION:			CORE RECOVERY:						
CASING LENGT	FH:			TOP OF CA	SING, ELEV.			61 %		
DEPTH OF HOL	F:	6.06 m	CASING REMOVED	GROUNDW	ATER FLEV	ATION:	10.02 m a.s.l.			
		11.74 m	DRILLING DIRECTION °			1		()		
ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	Q =	D 10/30/50/100 <u>RQD x Jr x Jw</u> Jn x Ja x SRF	(LU) 10 100 3 30 300	COMMENTS	
-	-	<u>, , , , , , , , , , , , , , , , , , , </u>	Topsoil	0						
-	-	4 24 3								
_		1.16.16								
_	-									
-	-	4° ¥ ¥								
- 108.0	2.0 -									
_	-	1. 1. 1								
_	-	34.34								
-	-	XIV XIV	Scoria and soil	1						
-										
È l	-	K XXX								
-106.0	4.0 -	XUXU								
-	-									
_										
-	_	, N 1; X1/	Scoria	-						
F	-									
E I	-									
- 104.0	6.0 -		l Indear boundary do to coro logo	36	N/A	<u> </u>	0/0/0/0			
-	-	$\left(\times \right) \times \left(\times \right)$	Þiórsá lava	100	8	1 1	<u>10x3x0.33</u>			
-		$(\times) \times (\times)$	Porphyritic basalt				20x1x2.5 Q=0.6			
		× × × ×	Fresh, gray, fine grained, microporous.				73/39/0/0			
-	-	× × × × ×	7-10% vesicles, empty.				<u>/3x3x1</u> 12x1x2.5			
-		× × × ×	Joints rough and undulating, empty.				Q=7.3			
- 102.0	8.0 -	XXXX	Scoria	0	N/A		0/0/0/0			
-	-		Almost complete core loss.			1	<u>10x3x0.33</u> 20x1x2 5			
-	-						Q=0.6			
_	-									
-	-									
-			I Inclear boundary do to core loss	100	N/A		0/0/0/0			
	10.0 -		Scoria, very low core recovery.	100	8	h	42/0/0/0			
_	-			100	17		42/0/0/0 52x3x1			
-	-			61	2	1	15x1x2.5			
-			Þiórsá lava	-		<u> </u>	61/31/0/0			
L	-	× × × ×	Porphyritic basalt							
- 00 0			Fresh, gray, fine grained, microporous. Joints rough and undulating, empty.							
- 90.0										
E										
-										
-										
F										
96.0										
F										
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E										
-										
- 94 0										
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- 92 n										
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CORE DRILLING

BOREHOLE NO .:

SHEET 1 OF 2 SHEETS

CLIENT:				DATE			SHEET 1 OF 2 SHEETS			
PROJECT		Landsvirkj	un	DRILI FD B	Y:	STARTED: 13.12.2	STARTED: 13.12.2012 COMPLETED: 14.12.2012			
LOCATION:		Neðri Þjór	sá	FOREMAN		Ræktunarsamband	Ræktunarsamband Flóa og Skeiða			
STRUCTURE		Hvammsv	irkjun	SUPERVIS	ION:	Svanlaugur	Svanlaugur			
	2.	Tailrace C	anal		Haraldur Hallsteinsson DRILLBIT TYPE:					
	SYSTEM.	X: 442709	.61 Y: 392589.39 Z: 98.34	NUMBER OF CORE BOXES: 3" diamond drillbit nr.6, NQ triple tube, 76 mm						
		X ISNET								
CASING LENCT	тн [.]	X VERT	ICAL INCLINED FROM HORIZONTAL	TOP OF CA	SING FLEV		71 %			
		6.1 m	CASING REMOVED	10P OF CASING, ELEV.: 98.34 m a.s.l.						
DEPTH OF HOL		30.64 m	DRILLING DIRECTION °	GROUNDW		83.60 m a.s.l.	(1	9.12.2012)		
ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS		
- 98.0	-	<u>, , , , , , , , , , , , , , , , , , , </u>	Topsoil Aeolian sand with scoria fragments. Very loose	0						
_	-	1 44 4	sediment.							
_		<u> </u>								
-	-	1/ <u>1/</u> .								
_	20									
- 96 0	2.0 -	$1 \xrightarrow{\cdot} \cdot \xrightarrow{\cdot} \cdot \xrightarrow{\cdot} \cdot$								
	-	\times \times \times	Porphyritic basalt	-						
		`×`×`×`	Þjórsá lava Fresh grav, fine grained, micropourous,							
		Į×^×^×	20-30% plagioclase phenocrysts, 1-2% olivine							
-	-	(×^×^×	1-3% vesicles, empty.							
	4.0 -	<`×`×`>	Joints, rough and undulating, empty.							
- 94.0	-	÷^×^×^>								
-		$\langle \times \times \times \rangle$								
_	-	{×~×~×								
-		ĺ×^×^×								
-	6.0 -	$\langle \times \times \times \times \rangle$		100	10	38/0/0/0	_			
- 92.0 -	-	ز×ٽ×ٽ×		100		00/0/0/0				
-	-	<^×^×^×								
-	_	$\langle \times \times \times \rangle$	Possibly core loss at 7 m depth, light brown vellowish clav in vugs							
_	-	{×~×~×								
_	8.0 -		Layer boundary unclear due to core loss.	0	N/A	0/0/0/0	1			
- 90.0	-		Almost complete core loss.							
	-		very low resistance, unlied very last.							
_										
_	-				NI/A	0/0/0/0				
-	10.0 -			0		0/0/0/0				
- 88.0	-									
_	-									
-		<u> </u>	Unclear layer boundary due to core loss.	100	7	60/0/0/0	-			
-		{×~×~×	Porphyritic basalt Fresh grav, fine grained.							
-	120-	ĺ×^×^×	5-7% plagioclase phenocrysts.							
- 86.0	-	$\langle \times \times \times \times \rangle$	Scoria zones.							
-	-	ŧ~×~×~		100	8	74/21/0/0	1			
-		ŧŶ×Ŷ×Ŷ	2-7% vesicles, decreasing with depth.							
-	-	{×ູ×ູ×ູ×	Microporous, faintly flow banded. Joints rough and undulating, empty.							
-	140-	$\left\{\times \hat{\times} \times \hat{\times} \times \hat{\times} \right\}$								
- 84.0		$\langle \times \times \times \times \rangle$								
-	y _	ţ,×,×,×,×,×,×,×,×,×,×,×,×,×,×,×,×,×,×,×								
	-	÷x^x^x^								
-		(× × × × ×								
	16.0	[××××××		100	7	57/26/0/0	1			
82.0	- 10.0	$\left\{\times^{\times}_{\times}\times^{\times}_{\times}\right\}$								
- 52.0	-	<pre>X X X X X X X X X X X X X X X X X X X</pre>								
E	_			15	N/A	7/0/0/0	-			
E			Very high core loss.	10		1,5,0,0				
-			Scoriaceous and vesicular basalt stumps. Small scoria fragments.							
F	18.0		-							
- 80.0 -	-	\sim					1			
F	_			93	N/A	46/0/0/0				
F	-			-	N1/A	0/0/0/0	1			
-	-	[0,0]	Probably loose sediment	0	IN/A	0/0/0/0				
	I	$\nu \sim \rangle$		i	i		i	1		



CORE DRILLING

BOREHOLE NO .:

NK-105b

SHEET 2 OF 2 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
- 78.0 	-		No core recovery.					
 76.0	22.0		Olivine Tholeite basalt NIB Reddish gray down to 23 m, fine grained, fresh basalt	0	N/A 9	0/0/0/0 38/0/0/0	-	
- - - - -	 24.0 —		Scattered plagioclase phenocrysts. 10% vesicles, empty. Joints planar and smooth, up to 5 mm gray silt/clay fillings at top.					
74.0 			Decreasing vesicies.	100	16	14/0/0/0	-	
- - - -	- - - 26.0 —		Highly jointed. Dense basalt, scattered small vesicles. Joints mostly coated with thin gray silt/clay.	100	26	0/0/0/0		
72.0 			Fresh gray basalt.	100	15	52/0/0/0	-	
-	28.0			100	18	20/0/0/0	-	
— 70.0 				100	13	60/0/0/0	-	
- 68.0	30.0 — 			100	6	91/48/0/0		
-								
66.0								
-								
64.0 								
- - - -								
- - 62.0								
60.0 								
— 58.0 _ _ _								
- - - - -								
- 50.0 - - -								


CORE DRILLING

NK-106	
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BOREHOLE NO .:

										SHEET 1 OF 2 SHEETS
CLIENT:		Landsvirkj	un		DATE:		ST	ARTED: 12.12.20	12 CC	OMPLETED: 17.12.2012
PROJECT:		Neðri Þjórs	sá		DRILLED B	<i>(</i> :	R	æktunarsamband	Flóa og Skeið	ða
LOCATION:		Hvammsvi	rkjun		FOREMAN:		S	vanlaugur		
STRUCTURE:		Tailrace C	anal		SUPERVISI	ON:	н	araldur Hallsteinss	on	
COORDINATES:		X· 442509	59 Y [.] 392468.48 7 [.]	· 98 17	DRILLBIT T	YPE:	3'	diamond drillbit n	6 NO triple	tube 76 mm
COORDINATE SY	YSTEM:		·		NUMBER O	F CORE BOX	XES: 2			
HOLE INCLINATI	ON:				CORE REC	OVERY:	2		00.0/	
CASING LENGTH	1:				TOP OF CA	SING, ELEV.	.:		09 %	
DEPTH OF HOLE		10.75 m		OVED	GROUNDW	ATER ELEVA	98 ATION:	3.17 m a.s.l.		
		33.74 m	DRILLING DIR	RECTION °	CODE	EDACTURE	8	1.87 m a.s.l.	(1 PERMEAB	9.12.2012)
ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DES	SCRIPTION	RECOVERY (%)	INTENSITY (FRACT/M)	Q =	10/30/50/100 RQD x Jr x Jw Jn x Ja x SRF	(LU) 10 100 3 30 300	COMMENTS
98.0 			Topsoil Aeolian sand with scori sediment.	ia fragments. Very loose	0					
	2.0									
94.0	4.0		Scoriaceous basalt							
92.0	6.0									
90.0	8.0		Porphyritic basalt bjórsá lava Fresh gray, fine grainer scattered vesicles. 20-30% plagioclase ph olivine phenocrysts. Joints rough and undul	d, microporous, ienocrysts, scattered lating, empty.						
					93	5	7	2/47/32/0		
	12.0				96	10		37/30/0/0		
- - - - 81 0	- - - 14.0 —		Scoria		14	N/A		9/0/0/0		
- 04.0 			Very high core loss. Very low resistance. Small fragments and st scoriaceous and vesicu	tumps of scoria, ular basalt.						
- 82.0 y	16.0 				20	N/A		3/0/0/0		
- 80.0 - 80.0	18.0 				7	N/A		0/0/0/0		



CORE DRILLING

BOREHOLE NO .:

NK-106

SHEET 2 OF 2 SHEETS

ELEVATION (m a.s.l.)	DEPTH (m)	LOG	DESCRIPTION	CORE RECOVERY (%)	FRACTURE- INTENSITY (FRACT/M)	RQD 10/30/50/100 Q = <u>RQD x Jr x Jw</u> Jn x Ja x SRF	PERMEAB (LU) 10 100 3 30 300	COMMENTS
- 78.0	-							
_	-	$\overset{(\times\times\times\times\times)}{\times}$	Porphyritic basalt	100	5	85/0/0/0		
	-		Þjórsá lava Scoriaceous at top 0,4 m. Erceb arou, fina greinad					
	22.0		5-7% plagioclase phenocrysts, up to 12 mm.	100	8	65/27/0/0		
- 76.0	-	$\langle \hat{x} \rangle \langle \hat{x} \rangle \langle \hat{x} \rangle \rangle$	More vesicular zones. Joints rough and undulating, empty, three sets					
_			+ random.					
-	-							
- 74 0	24.0	$\begin{pmatrix} & \times & \times & \times \\ & \times & \times & \times & \times \\ & & & \times & & \times & \times$	a a					
	-			100	4	91/60/24/0		
			More massive basalt.					
_	-		Faintly microporous and flow banded.					
- 72.0	26.0 -		2					
_	-		3 9					
-								
_	-			100	4	100/48/0/0		
- 70.0	28.0							
-	-							
-	-		3 9					
_	30.0-							
- 68.0		$\langle \hat{x} \hat{x} \hat{x} \hat{x} \rangle$						
_				100	4	88/40/0/0		
	-	××× مک	Loose sediment TS	12	N/A	0/0/0/0		
- 66.0	32.0 —		Gravel Few basaltic pebbles.					
- 00.0	-		Almost complete core loss.					
-			Olivine Tholeite basalt NIB Fresh gray, fine grained.	100 100	14 8	0/0/0/0 92/55/0/0		
_	-		3-5% vesicles, empty. Joints planar and smooth, empty or coated with					
- 64.0			very thin gray silt/clay coating.					
_								
_								
62.0								
_								
-								
_								
- 60.0								
_								
- 56.0 -								
-								
_								
56.0								
-								
_		L	1			l		

Appendix B – Core Photos



NK-90 BOREHOLE CORE PHOTO BOX 3-4 OF 4





NK-91 BOREHOLE CORE PHOTO BOX 3 OF 3



NK-92 BOREHOLE CORE PHOTO BOX 1-2 OF 4



NK-92 BOREHOLE CORE PHOTO BOX 3-4 OF 4





NK-93 BOREHOLE CORE PHOTO BOX 3 OF 3



NK-94 BOREHOLE CORE PHOTO BOX 1-2 OF 2



NK-95 BOREHOLE CORE PHOTO BOX 1-2 OF 3



NK-95 BOREHOLE CORE PHOTO BOX 3 OF 3



NK-96 BOREHOLE CORE PHOTO BOX 1-2 OF 4



NK-96 BOREHOLE CORE PHOTO BOX 3-4 OF 4





NK-97 BOREHOLE CORE PHOTO BOX 3-4



NK-97 BOREHOLE CORE PHOTO BOX 5-6



NK-97 BOREHOLE CORE PHOTO BOX 7







NK-98 BOREHOLE CORE PHOTO BOX 5



NK-99 BOREHOLE CORE PHOTO BOX 1-2



NK-99 BOREHOLE CORE PHOTO BOX 3-4



NK-99 BOREHOLE CORE PHOTO BOX 5-6



NK-99 BOREHOLE CORE PHOTO BOX 7-8



NK-99 BOREHOLE CORE PHOTO BOX 9-10



NK-99 BOREHOLE CORE PHOTO BOX 11



NK-100 BOREHOLE CORE PHOTO BOX 1-2



NK-100 BOREHOLE CORE PHOTO BOX 3-4





NK-100 BOREHOLE CORE PHOTO BOX 7



NK-101 BOREHOLE CORE PHOTO BOX 1-2



NK-101 BOREHOLE CORE PHOTO BOX 3-4



NK-101 BOREHOLE CORE PHOTO BOX 5-6



NK-101 BOREHOLE CORE PHOTO BOX 7-8







NK-104 BOREHOLE CORE PHOTO BOX 1



NK-105b BOREHOLE CORE PHOTO BOX 1-2



NK-106 BOREHOLE CORE PHOTO BOX 1-2



Appendix C – Percussion Drillholes



PERCUSSION DRILLING

BOREHOLE NO .:

									S	HEET <u>1</u> OF <u>1</u>				
CLIENT:		Lar	ndsvirkjun		DATE:		STARTED:	19.12.2012	COMPLETED:	19.12.2012				
PROJECT:		Ne	ðri Þjórsá		DRILLED	BY:	Ræktunars	amband Flóa	og Skeiða					
LOCATION:		Hva	ammsvirkjun		FOREMA	N:	Svanlaugu	r						
STRUCTUR	:E:	Tai	Irace Canal		SUPERVI	SION:	Haraldur H	allsteinsson						
COORDINA	TES:	X:	441834.118 Y: 392168.901 Z	Z: 91.99	DRILLBIT	DRILLBIT TYPE: Percussion drilling 3" cross bit, 76 mm								
COORDINA	TE SYSTE	iM:	ISNET		SAMPLIN	G METHOD:								
CASING, LE	NGTH:	9.1	5 m CASING REM	IOVED	SAMPLIN	G STANDARD:								
DEPTH OF	HOLE:	21.	0 m		GROUND	WATER DEPTH:	12.18 m							
					GROUND	WATER ELEVATIO	ON: 79.81 m a.s	s.l.	(8.2.2013)					
ELEVATION	DEPTH	1.00	DES	CRIPTION	DI	RILL RATE (seco	onds/meter)		COMMEN	Te				
(m a.s.l.)	(m)	LUG	DES	CRIFTION	0 30	60 90 120	150 180 210		COMMEN	15				
E	-					: : :	: : :							
		<u> </u>												
<u>-</u> 91.0	1.0	<u> </u>			_ FF ≟									
-		1. 1.1.			<u>Ц</u>									
90.0	2.0													
E														
E														
89.0 	3.0-		Scoria											
-	a de la compañía de l Compañía de la compañía													
88.0	4.0		Porphyritic basalt		╶┈┼┚╧╼									
-		× × ×	Þjórsá Lava Massive þasalt			<u> </u>								
E-87.0	50-	ŧ×~×~×	High percentage of plagiocla	ase phenocrysts.										
	0.0	₹×^×^×												
Ē		₹××××						250						
	6.0	Îxxîxî						344						
-	1	ŧ×`×`×												
85.0	7.0	₹×^×^×												
_		× × × ×						374						
84.0	80-	÷××××						482						
_ 04.0	0.0	× × × ×						530						
Ē	1	ŧ×~×~×						626						
-83.0	9.0	₹×^×^×						-1						
E		×××××												
- 82.0	10.0	Î.X.XX						_						
Ē	1.00	\times	Scoriaceous basalt											
E 91 0	11.0	××												
_ 01.0	11.0	x^×^×	Porphyritic basalt											
Ē	1.00	* × × ×												
- 80.0	▼ 12.0 -		Scoria Very low resistance.											
-			Drill cutting does not come u	Jp.										
79.0	13.0													
Ē														
70.0	14.0													
E 78.0	14.0													
	15.0	XXX	Scoriaceous basalt		+									
-	1	₹X{×`	Drill cutting does not come u	.q.										
- 76.0	16.0-	××¥				Ŀ								
Ē		XXXX												
		₹XXXX												
E /5.0	17.0-	ĺ×^×^×	Porphyritic basalt assumed,	according to other			<u> </u>							
-	1	Ĩ×^×^×	drinnoles, drin cutting does i	iot come up.										
-74.0	18.0	×××××												
E I		₹xxxxx												
-73 0	10.0.													
E	10.0	Į×××××××												
Ē														
-72.0	20.0	<u></u> ≰××××				· ·	1 -							
E														
-	-	+						1 1						



PERCUSSION DRILLING

BOREHOLE NO .:

												5	SHEET	<u>1 OF 1</u>
CLIENT:		Lar	idsvirkjun	DATE	:				STARTED:	07.02.20)13	COMPLETED	: 08	.02.2013
PROJECT:		Ned	ðri Þjórsá	DRILL	DRILLED BY: Ræktunarsamband Flóa og Skeiða									
STRUCTUR	DE-	Hva	ammsvirkjun	FURE					Hermann	Guðmunds	son			
COORDINA	TES:	Tai	race Canal	DRILL	BIT T	YPE:			Haraldur Hallsteinsson					
COORDINA	TE SYSTE	X: 4	441831.416 Y: 392170.602 Z: 91.787	SAMF	PLING	METH	OD:		Percussio	n drilling 14	1" buttoi	<u>ı bit, 14"</u>		
CASING, LE	NGTH:	19.		SAMF	PLING	STAN	DARD:							
DEPTH OF	HOLE:	21		GROU	JNDW	ATER	DEPTH	H:	11 87 m					
				GROU	JNDW	ATER	ELEVA	TION:	79.92 m a	s.l.		(7.3.2013)		
ELEVATION	DEPTH	1.06	DESCRIPTION		DRI	LL RA	ATE (s	econd	ls/meter)			COMME	JTS	
(m a.s.l.)	(m)	1.1.1		0 3	06	09	0 12	0 150	0 180 210					
91.0	1.0-	<u>14</u> <u>14</u> <u>14</u> <u>14</u> <u>14</u> <u>14</u> <u>14</u> <u>14</u>	Topsoil with some scoria fragments. Drilled 14" with casing down to 18 m depth. Drilled 12" from 18-21 m depth without casing.		•									
90.0	2.0-				•									
89.0	3.0-		Scoria		•									
88.0	4.0		Porohyritic basalt											
87.0	5.0		bjórsá Lava Djórsá Lava Massive basalt High percentage of plagioclase phenocrysts.											
86.0	6.0				•									
85.0	7.0													
84.0	8.0-				•									
83.0	9.0				•									
82.0	10.0													
81.0	11.0				•									
-80.0	<u>▼</u> 12.0													
78.0	13.0		Scoria											
77.0	14.0				•									
76.0	15.0				•									
75.0	10.0]	•									
-74.0	18.0		Scoriaceous basalt Vesicular, less porphyritic than above.											
73.0	19.0		Porphyritic basan less porphyritic than above the scoria.			• • •								
72.0	20.0				•									
E ₇₁₀		$\frac{1}{2} \times \times \times \times$:	:								

	Μ	٨	Ν	Ν	V	I	т
--	---	---	---	---	---	---	---

PERCUSSION DRILLING

BOREHOLE NO .:

													SF	HEET <u>1</u> OF <u>1</u>
CLIENT:		Lar	idsvirkjun		DAT	E:				STARTED	: 13.02.20)13	COMPLETED:	14.02.2013
PROJECT:		Ned	ðri Þjórsá		DRI	LLED	BY:			Ræktuna	arsamband F	lóa og Ske	eiða	
LOCATION	:	Hva	ammsvirkjun		FOF	REMAN	N:			Hermanı	n Guðmunds:	son		
STRUCTUR	RE:	Tail	race Canal		SUF	PERVI	SION:			Haraldur	Hallsteinsso	on		
COORDINA	TES:	X: -	441834.905 Y: 392171.029	Z: 91.787	DRI	LLBIT	TYPE:	:		Percussi	on drilling 7"	button bit	, 7 5/8"	
COORDINA	TE SYSTE	M: X	ISNET		SAN	/PLIN	G MET	HOD:						
CASING, LE	ENGTH:	18.	0 m CASING REI	MOVED	SAN	/PLIN	G STA	NDAR	D:					
DEPTH OF	HOLE:	21.	0 m		GRO	DUND	WATE	R DEP	PTH:	11.9 m				
	-				GRO	DUND	WATE	RELE	VATIC	^{N:} 79.89 m	a.s.l.		(7.3.2013)	
ELEVATION	DEPTH	106	DES	CRIPTION		DF	RILL F	RATE	(seco	onds/meter)			COMMENT	rs
(m a.s.l.)	(m)	100	DEC		0	30	60	90	120	150 180 21	0		COMMENT	3
-		<u>, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,</u>	Topsoil with some scoria fra Drilled 7 5/8" with casing do	agments. own to 18 m depth.		:								
- 91.0		<u>// \//</u> \	Drilled 6 1/2" from 18-21 m	depth without casing.		÷	÷	÷	÷					
_	1.0-	<u> \ 1</u> ; <u>\ 1</u> ;				÷	÷	÷	÷					
Ē		1/2· ×1/2·				÷	÷	÷	÷					
= 90.0 E	2.0-	<u> 11 11</u>				÷	÷	÷	-					
E		1/ 3.1/				÷	÷	÷	÷					
89.0	3.0-	<u></u>				÷	÷	÷	÷					
-	3.0					÷	÷	÷	÷					
E	3		Scoria			÷	÷	÷	÷					
Ē	4.0					÷	÷	÷	÷					
Ē	-					÷	÷	÷	÷					
-87.0 E	5.0-					÷	÷		÷					
Ē	-					÷	÷	÷	÷					
	60-					÷	÷	÷	÷					
-	0.0	× × × ×	Porphyritic basalt Þjórsá Lava			÷	÷	÷	÷					
- 85.0		<`x`x`	Massive basalt High percentage of plagiog	ase nhenocrysts		÷	÷	÷	÷					
_	7.0-	$\hat{\mathbf{x}}$	righ percentage of plagioo			÷	÷	÷	÷					
Ē	-	(×~×~×				÷	÷	÷	÷					
84.0	8.0	`×^×^×				÷	÷	÷	÷					
E		<`×`×`×`				÷	÷	÷	÷					
=-83.0	90-	<rp></rp>				÷	÷	-	÷					
-	0.0	××××××				÷	÷	÷	÷					
82.0		`×^×^×												
Ē	10.0	×××××												
E 81 0		<î×î×î				÷	÷	÷	-					
51.0	11.0		Scoriaceous basalt			÷	÷	÷	÷					
Ē	-	XXX × X	Less resistance			÷	÷	÷	÷					
E-80.0 E	▼ 12.0-	××				÷	÷	÷	÷					
E E	-	××				÷	÷	÷	÷					
- 79.0	12.0	××*				÷	÷	:	÷					
-	13.0	× ^ × ^ ×	Porphyritic basalt			÷	÷							
- 		<`×`×`×`				-	-	-	-					
Ē	14.0		Scoria			-	-	-	-					
E 0	-		Very low resistance.			÷	÷	÷	÷					
E 77.0	15.0					÷	÷	÷	÷					
Ē						÷	÷	÷	÷					
	16.0-	XXXX	Vesicular, less porphyritic th	nan above.		÷	÷	-	÷					
-		X X X	Porphyritic basalt			÷	÷	÷	÷					
75.0		×××××	less porphyritic than above	the scoria.		÷	÷	÷	÷					
Ē	17.0	×^×^×				÷	÷	÷	÷					
E 74 0		k,×,×,×,				÷	÷	÷	÷					
- / 4.0 E	18.0-	 x 				÷	÷	÷	÷					
Ē	-	××××××				÷	÷	:	÷					
-73.0	19.0-	(×^×^×				÷	÷	÷	÷					
Ē		×××××				÷	÷	÷	÷					
- 72.0		kî×î×xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx				÷	÷	÷	÷					
Ē	20.0	{×ູ×_×_×				-	-	-	-					
E71 0		×^×^×					-	-	-					



PERCUSSION DRILLING

BOREHOLE NO .:

											SH	EET <u>1</u> OF <u>1</u>
CLIENT:		Lan	dsvirkjun		DATE:			STARTED:	15.02.20	13 coi	VPLETED:	18.02.2013
PROJECT:		Ned	ðri Þjórsá		DRILLED BY:			Ræktunarsamband Flóa og Skeiða				
LOCATION:		Hva	ammsvirkjun	I	FOREMAN:			Hermann	Guðmunds	son		
STRUCTUR	:E:	Tail	race Canal	:	SUPERVISION	N:		Haraldur H	lallsteinsso	n		
COORDINA	TES:	X: 4	441840.072 Y: 392171.725 Z: 9	91.862	DRILLBIT TYP	PE:		Percussion	n drilling 7"	button bit, 7	5/8"	
COORDINA	TE SYSTE	M: 🛛 🗙	ISNET	:	SAMPLING ME	ETHOD:						
CASING, LE	NGTH:	18.0	0 m CASING REMOV	/ED	SAMPLING ST		D:					
DEPTHOF	HOLE:	21.0) m		GROUNDWAI		TH:	11.95 m				
					GROUNDWAI	IER ELEV	VATION:	79.91 m a.	s.l.	(7.3	3.2013)	
ELEVATION	DEPTH	LOG	DESCR	IPTION	DRILL	. RATE ((seconds	s/meter)			COMMENT!	3
(iii a.s.i.) -	(11)	1.1 1.1 3.1	Tanaail with some aparis from	l	0 30 60	90 1	120 150	180 210				
-			Drilled 7 5/8" with casing down	to 18 m depth.	: :	-	÷ ÷	: :				
91.0	10		Drilled 6 1/2" from 18-21 m dep	oth without casing.		-	÷ ÷					
Ē.	1.0	<u> </u>				-	÷ ÷					
		쓰 소설				-	: :					
90.0	2.0-	<u> \ //</u> \ \ / /				-	÷ ÷					
		1/ 1/2				-	÷ ÷					
- 89.0	3.0-		Scoria			÷	÷ ÷					
E					: :	-	: :					
-88.0	40.				: :	-	÷ ÷	: :				
Ē.	4.0	$(\times \times $	Porphyritic basalt		: :	-	÷ ÷					
- 07 0		<`×`×`×`	Massive basalt	nhonocryste	: :	-	÷ ÷					
- 07.0	5.0-	<^×^×^	right percentage of plagloclase	e prienoci ysts.	: :	-	÷ ÷					
		`×`×`×				-	÷					
- -86.0	6.0-	`×^×^×					÷ ÷	: :				
	-	<xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx< td=""><td></td><td></td><td></td><td></td><td>: :</td><td></td><td></td><td></td><td></td><td></td></xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx<>					: :					
-85.0	70-	<rp><p< td=""><td></td><td></td><td>: :</td><td></td><td>÷ ÷</td><td></td><td></td><td></td><td></td><td></td></p<></rp>			: :		÷ ÷					
-	7.0	`×`×`×			: :		÷ ÷					
840		`×^×^×					÷ ÷					
04.0	8.0-	$(\times \times \times \times$: :		÷ ÷					
		$(\hat{x} \times \hat{x} \times \hat{x})$										
- 83.0	9.0-	`×`×`×										
	-	×^×^×										
82.0	10.0-	$(\times \times \times \times$										
-	10.0	$\times \times \times \times \times$										
81.0		`×`×`×			: :	-	÷ ÷	: :				
	11.0-	`×^×^×			: :	-	: :	: :				
	_	$(\times \times \times \times)$: :	-	-	: :				
	¥ 12.0 -	ĺ XÎXÂ	Scoriaceous basalt			-	: :					
	-	$\times \times \times$	Less resistance		: :	÷	: :					
- 79.0	13.0-	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			: :	-	÷ ÷					
E			Scoria Very low resistance.		: :	÷	: :	: :				
-78.0					: :	÷						
Ê	14.0	$\langle \rangle \rangle \rangle$				-						
E												
E /7.0	15.0-											
È	-											
=-76.0	16.0-											
E		XXXXX	Vesicular, less porphyritic than	above.								
75.0	17.0	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX					: :					
E	17.0-	××××	Porphyritic basalt									
	-	<pre>x x x x x x</pre>				÷						
- 14.0	18.0-	$\hat{\mathbf{x}}$				÷	: :					
Ē	-	x x x x				-	÷ ÷	: :				
-73.0	19.0	$\hat{x} \hat{x} \hat{x} \hat{x}$: :	÷	÷ ÷					
É E		x x x v x x			: :	÷	: :	: :				
72.0	20.0-	<pre>x x x x x x x x x x x x x x x x x x x</pre>			: :	-	: :	: :				
E I	20.0	x x x x			: :	-	: :	: :				
Ë 71.0		$(\times \times $: :	÷	: :					
11.0	_				• •	•		• •				

Appendix D – Permeability and pumping test

Hole	Pocktype	Dep	oth	Test interval	Permeability
Nr.	Rocktype	From (m)	To (m)	(m)	(LUGEON)
NK-97	Móberg	35.77	45.77	10	0.3
NK-99	Móberg	50.58	60.22	9.64	3.6
NK-100	Móberg	36.21	54.64	18.43	1.2

Permeability tests in boreholes in Hvammsvirkjun area 2011-2012

PACKER PERMEABILITY TEST

Borehole: NK-97



Borehole: NK-99







Results from the pump testing of well NL-105.

A constant rate test was performed on March 12, 2013.

In order to establish some knowledge of the "natural" variation in groundwater level at the tailrace area, a pressure transducer and a logger were installed in well NK-92 on December 20, 2012, nearly 12 weeks prior to the pump testing. On March 8, 2013, pressure transducers with loggers were also installed in the pumping well NL-105 and observation wells NL-106 and NL-107.

Borehole NK-92 is located 252 m towards east from the pumping well, NL-105. Figure D.1 shows the water level in borehole NK-92, from December 20, 2012 to March 13, 2013, in meters above sea level. The groundwater level in well NL-105 during the pump testing in March 2013 is also shown on the same graph. The groundwater level seems stable from December 2012 until February 25, when a sudden rise occurs due to flooding of rivers in this area in late February, see figure D.2 on next page. During the pump testing of well NL-105, the natural groundwater level in the area was still receding after the sudden change in late February. The drawdown in well NL-105, caused by pumping, seems to be of the same order of magnitude as the sudden rise in groundwater level, in late February 2013. Nevertheless, the pump testing of well NL-105 does not seem to have any effect on the groundwater level in borehole NK-92.







Figure D.2. Flooding of the river Brúará in south Iceland. Picture was taken February 26, 2013 [www.vedur.is, "Tíðarfar í febrúar 2013"].

For the purpose of recording the water level in the tailrace area with high accuracy and high time resolution during the pumping test, pressure transducers and loggers were installed in boreholes NL-105, NL-106, NL-107 and NK-92 and the water level was logged every 5 seconds. Unfortunately, the pressure transducer in observation well NL-106 broke and the drawdown in that particular observation well had to be observed manually with a handheld electronic water level meter. Picture D.3 shows the groundwater level in meters above sea level in well NK-92, NL-105, NL-106 and NL-107 during the pump testing of well NL-105. The recorded water level data is presented in meters above sea level where the reference level is the borehole casing. The elevation of each borehole casing was measured with Trimble GNSS surveying system. The observed drawdowns during a constant discharge test are presented in table D.1. Based on these observations, the transmissivity (T) and storage (S) coefficients were estimated using the Hantush-Jacob solution and the results are presented in table D.1 as well. The results for Transmissivity, T and Storativity, S are in line with those values predicted by Vatnaskil [1].

Based on an analysis of the borehole logs, it was expected that observations of drawdown with time would follow the Theis type curve, representing an unconfined aquifer. However, the Hantush-Jacob solution was chosen, because it gave a much better correlation with the observed drawdown data. The Hantush-Jacob solution normally is valid for leaky confined aquifers [2].


Figure D.3

Table D.1 Drawdown during the constant discharge testing of well NL-105

Well	NL-105	NL-106	NL-107	NK-92
Horizontal distance from pump (m)	0	3.5	8.7	252
Constant rate discharge (m ³ /s)	0.081	-	-	-
Observed drawdown, s (m)	0.52	0.030	0.024	Insignificant
Accuracy of drawdown (m)	0.01	0.005	0.005	0.002
Run time at constant discharge (s)	9400	9400	8380	9400
Transmissivity, T (m ² /s)	-	1.3	1.6	-
Storativity, S ()	-	0.3	0.1	-
Solution Method		H-J	H-J	

[1] Vatnaskil – Memo, Hvammsvirkjun, dæluprófun, December 6, 2012

[2] R. Allan Freeze & John A. Cherry, *Groundwater*, Prentice-Hall, New Jersey 1979, ISBN 0-13-365312-9

Sverrir Óskar Elefsen Mannvit

Appendix E – Test Pits description/photos

Testpit:	G1			
X:	444564.13			
Y:	394223.68			
7.	104 08	mvs		
<i>L</i> .	104.00	in y.s.		
masl	Depth from (m)	Depth to (m)	Thickness (m)	Notes [,]
104 08	0	1	1	Gravel rather fine grained
104.00	U	I	•	Scoriaceous basalt fragments mixed with light
102.00	1	10	2.2	brown clay
00.00	1	4.2	3.2	Bottom in more compact material
99.00	4.2			Bottom in more compact material.
				water level of the river is equal to the top of the
				testpit.
Toctpit	<u></u>			
	62 444500 74			
Λ. V.	444323.74			
Y:	394151.15			
Z:	103.98	m y.s.		
	Double former (m)			Neder
m a.s.i.	Depth from (m)	Depth to (m)	I NICKNESS (M)	Notes:
103.98	0	I	I	Gravel, rather fine grained.
				Jointed scoriaceous basalt and fragments mixed
102.98	1	2	1	with light brown clay.
101.98	2			Bottom in more compact material.
				Water level of the river is equal to the top of the
				testpit.
				•
Testpit:	G3			· · · · · · · · · · · · · · · · · · ·
Testpit: X:	G3 444574.68			
Testpit: X: Y:	G3 444574.68 394251.27			
Testpit: X: Y: Z:	G3 444574.68 394251.27 103.98	m y.s.		
Testpit: X: Y: Z:	G3 444574.68 394251.27 103.98	m y.s.		
Testpit: X: Y: Z: m a.s.l.	G3 444574.68 394251.27 103.98 Depth from (m)	m y.s. Depth to (m)	Thickness (m)	Notes:
Testpit: X: Y: Z: m a.s.l. 103.98	G3 444574.68 394251.27 103.98 Depth from (m) 0	m y.s. Depth to (m) 1	Thickness (m) 1	Notes: Gravel, rather fine grained.
Testpit: X: Y: Z: m a.s.l. 103.98	G3 444574.68 394251.27 103.98 Depth from (m) 0	m y.s. Depth to (m) 1	Thickness (m) 1	Notes: Gravel, rather fine grained. Scoriaceous basalt fragments mixed with light
Testpit: X: Y: Z: m a.s.l. 103.98 102.98	G3 444574.68 394251.27 103.98 Depth from (m) 0 1	m y.s. Depth to (m) 1 3.6	Thickness (m) 1 2.6	Notes: Gravel, rather fine grained. Scoriaceous basalt fragments mixed with light brown clay.
Testpit: X: Y: Z: m a.s.l. 103.98 102.98 100.38	G3 444574.68 394251.27 103.98 Depth from (m) 0 1 3.6	m y.s. Depth to (m) 1 3.6	Thickness (m) 1 2.6	Notes: Gravel, rather fine grained. Scoriaceous basalt fragments mixed with light brown clay. Difficult to excavate in the bottom.
Testpit: X: Y: Z: m a.s.l. 103.98 102.98 100.38	G3 444574.68 394251.27 103.98 Depth from (m) 0 1 3.6	m y.s. Depth to (m) 1 3.6	Thickness (m) 1 2.6	Notes: Gravel, rather fine grained. Scoriaceous basalt fragments mixed with light brown clay. Difficult to excavate in the bottom. Test pit filled with water.
Testpit: X: Y: Z: m a.s.l. 103.98 102.98 100.38	G3 444574.68 394251.27 103.98 Depth from (m) 0 1 3.6	m y.s. Depth to (m) 1 3.6	Thickness (m) 1 2.6	Notes: Gravel, rather fine grained. Scoriaceous basalt fragments mixed with light brown clay. Difficult to excavate in the bottom. Test pit filled with water.
Testpit: X: Y: Z: m a.s.l. 103.98 102.98 100.38 Testpit:	G3 444574.68 394251.27 103.98 Depth from (m) 0 1 3.6 G4	m y.s. Depth to (m) 1 3.6	Thickness (m) 1 2.6	Notes: Gravel, rather fine grained. Scoriaceous basalt fragments mixed with light brown clay. Difficult to excavate in the bottom. Test pit filled with water.
Testpit: X: Y: Z: m a.s.l. 103.98 102.98 100.38 Testpit: X:	G3 444574.68 394251.27 103.98 Depth from (m) 0 1 3.6 G4 444519.85	m y.s. Depth to (m) 1 3.6	Thickness (m) 1 2.6	Notes: Gravel, rather fine grained. Scoriaceous basalt fragments mixed with light brown clay. Difficult to excavate in the bottom. Test pit filled with water.
Testpit: X: Y: Z: m a.s.l. 103.98 102.98 100.38 Testpit: X: Y:	G3 444574.68 394251.27 103.98 Depth from (m) 0 1 3.6 G4 444519.85 394146.75	m y.s. Depth to (m) 1 3.6	Thickness (m) 1 2.6	Notes: Gravel, rather fine grained. Scoriaceous basalt fragments mixed with light brown clay. Difficult to excavate in the bottom. Test pit filled with water.
Testpit: X: Y: Z: m a.s.l. 103.98 102.98 100.38 Testpit: X: Y: Z:	G3 444574.68 394251.27 103.98 Depth from (m) 0 1 3.6 G4 444519.85 394146.75 103.91	m y.s. Depth to (m) 1 3.6 m y.s.	Thickness (m) 1 2.6	Notes: Gravel, rather fine grained. Scoriaceous basalt fragments mixed with light brown clay. Difficult to excavate in the bottom. Test pit filled with water.
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Scoriaceous basalt fragments mixed with light brown clay. Easy to excavate, more compacted with depth. Large better chrystallized rock at 4,6	Testpit: X: Y: Z: m a.s.l. 108.87 105.07 102.97 Testpit: X: Y: Z: m a.s.l. 109 59	G7 444607.01 394220.80 108.87 Depth from (m) 0 3.8 5.9 G8 444654.27 394248.17 109.59 Depth from (m) 0	m y.s. Depth to (m) 3.8 5.9 m y.s. Depth to (m) 3 1	Thickness (m) 3.8 2.1 Thickness (m) 3.1	Notes: Soil. Scoriaceous basalt fragments mixed with light brown clay. Easy to excavate, more compacted with depth. Bottom in same material.
brown clay. Easy to excavate, more compacted with depth. Large better chrystallized rock at 4,6	Testpit: X: Y: Z: m a.s.l. 108.87 105.07 102.97 Testpit: X: Y: Z: m a.s.l. 109.59	G7 444607.01 394220.80 108.87 Depth from (m) 0 3.8 5.9 G8 444654.27 394248.17 109.59 Depth from (m) 0	m y.s. Depth to (m) 3.8 5.9 m y.s. Depth to (m) 3.1	Thickness (m) 3.8 2.1 Thickness (m) 3.1	Notes: Soil. Scoriaceous basalt fragments mixed with light brown clay. Easy to excavate, more compacted with depth. Bottom in same material.
with depth. Large better chrystallized rock at 4,6	Testpit: X: Y: Z: m a.s.l. 108.87 105.07 102.97 Testpit: X: Y: Z: m a.s.l. 109.59	G7 444607.01 394220.80 108.87 Depth from (m) 0 3.8 5.9 G8 444654.27 394248.17 109.59 Depth from (m) 0	m y.s. Depth to (m) 3.8 5.9 m y.s. Depth to (m) 3.1	Thickness (m) 3.8 2.1 Thickness (m) 3.1	Notes: Soil. Scoriaceous basalt fragments mixed with light brown clay. Easy to excavate, more compacted with depth. Bottom in same material. Notes: Soil.
with depth. Large better thrystallized fock at 4,0	Testpit: X: Y: Z: m a.s.l. 108.87 105.07 102.97 Testpit: X: Y: Z: m a.s.l. 109.59	G7 444607.01 394220.80 108.87 Depth from (m) 0 3.8 5.9 G8 444654.27 394248.17 109.59 Depth from (m) 0	m y.s. Depth to (m) 3.8 5.9 m y.s. Depth to (m) 3.1	Thickness (m) 3.8 2.1 Thickness (m) 3.1	Notes: Soil. Scoriaceous basalt fragments mixed with light brown clay. Easy to excavate, more compacted with depth. Bottom in same material. Notes: Soil. Scoriaceous basalt fragments mixed with light brown clay. Fasy to excavate more compacted
106.49 3.1 5.3 2.2 m denth in part of the test nit	Testpit: X: Y: Z: m a.s.l. 108.87 105.07 102.97 Testpit: X: Y: Z: m a.s.l. 109.59	G7 444607.01 394220.80 108.87 Depth from (m) 0 3.8 5.9 G8 444654.27 394248.17 109.59 Depth from (m) 0	m y.s. Depth to (m) 3.8 5.9 m y.s. Depth to (m) 3.1	Thickness (m) 3.8 2.1 Thickness (m) 3.1	Notes: Soil. Scoriaceous basalt fragments mixed with light brown clay. Easy to excavate, more compacted with depth. Bottom in same material. Notes: Soil. Scoriaceous basalt fragments mixed with light brown clay. Easy to excavate, more compacted with depth. Large better chrystallized rock at 4.6
104.29 5.3 Rottom in same material	Testpit: X: Y: Z: m a.s.l. 108.87 105.07 102.97 Testpit: X: Y: Z: m a.s.l. 109.59	G7 444607.01 394220.80 108.87 Depth from (m) 0 3.8 5.9 G8 444654.27 394248.17 109.59 Depth from (m) 0	m y.s. Depth to (m) 3.8 5.9 m y.s. Depth to (m) 3.1	Thickness (m) 3.8 2.1 Thickness (m) 3.1	Notes: Soil. Scoriaceous basalt fragments mixed with light brown clay. Easy to excavate, more compacted with depth. Bottom in same material. Notes: Soil. Scoriaceous basalt fragments mixed with light brown clay. Easy to excavate, more compacted with depth. Large better chrystallized rock at 4,6 m depth in part of the test pit

Testpit:	G9			
X:	444682.93			
Y:	394268.10			
Z:	110.77	m y.s.		
m a.s.l.	Depth from (m)	Depth to (m)	Thickness (m)	Notes:
110.77	0	2.7	2.7	Soil.
				Porphyritic basalt
				Rather smooth and hard surface of crystallized
				basalt, moderately jointed, not possible to
108.07	2.7	2.9	0.2	excavate with the excavator.
107.87	2.9			Bottom in porpyritic basalt

G1 Gravel on top of scoria fragments mixed in light brown clay



G1 Excavating test pit G1





G2 Scoriaceous basalt in bottom of test pit G2



G2 Gravel on top of jointed scoriaceous basalt with brown clay

G3 Excavation in water



G3 Excavated scoriaceous basalt with clay





G4 Gravel on top of scoria and scoriaceous basalt with brown clay

G4 Jointed scoriaceous basalt and scoria with clay filling







G5 Thick clay in test pit G5



G6 Soil with tephra layers on top of scoria fragments in clay



G6 Excavated scoria/scoriaceous basalt in light brown clay







G7 Scoria/scoriacous basalt fragments in light brown clay







G8 Excavated material from test pit G8



G9 Soil with tephra layers



G9 Soil on top of the Þjórsá lava basalt





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