

LV-2015-092



Landsvirkjun



# Burfell Wind Farm

Site investigation report



## Lykilsíða



Skýrsla LV nr: LV-2015-092

Dags: 25.9.2015

Fjöldi síðna: 128

Upplag: 3

Dreifing:

- Birt á vef LV
- Opin
- Takmörkuð til

Titill: Burfell Wind Farm - Site investigation report

Höfundar/fyrirtæki: Jónas Þór Ingólfsson, Efla Verkfræðistofa

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Unnið fyrir: Landsvirkjun

Samvinnuaðilar: Engir

Útdráttur: Í þessari skýrslu er fjallað um jarðkönnun sem var framkvæmd í fyrirhuguðum vindlundi við Búrfell árin 2013 og 2014. Í desember árið 2013 var borað með bensínknúnum slagbor til að meta þykkt lausra jarðefna á yfirborði svæðisins. Í október og nóvember árið 2014 voru boraðar loftbors- og kjarnaholur til að meta jarðlagaskipan undir lausu jarðlögum. Að auki voru námur í nágrenninu skoðaðar og sýni tekin.

**Lykilorð:** Búrfellslundur, kjarnaborun, loftborun, slagborun, námur, jarðkönnun

ISBN nr:

Samþykki verkefnisstjóra  
Landsvirkjunar

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Skýrsla nr. LV-2015-092



# Burfell Wind Farm

Site investigation report

September 2015



## REPORT - INFORMATION SHEET

Report Title <b>Búrfell Wind Farm – Site investigations</b>		Report Type Geological report	
Project HAF-60 – Wind farm near Búrfell		Client Landsvirkjun	
Project Manager – EFLA Eysteinn Einarsson		Project Manager / Client Representative Margrét Arnardóttir	
Authors Jónas Þór Ingólfsson	Report Nr.	Project Nr. 1611-159	Total pages 128
Summary  This report covers the site investigations conducted in the proposed Búrfell Wind Farm area in 2013 and 2014. In December 2013 ram sounding drilling was conducted to evaluate the extent of loose surface overburden. In October and November 2014 core- and percussion drilling was employed in the area in order to explore the bedrock stratigraphy. Also borrow areas in the vicinity were investigated and samples collected.			
Keywords Búrfell wind farm, core drilling, percussion drilling, ram sounding, borrow areas, site investigation			
Report status <input checked="" type="checkbox"/> Draft <input type="checkbox"/> Copy editing <input type="checkbox"/> Final		Report distribution <input type="checkbox"/> Open <input checked="" type="checkbox"/> With client permission <input type="checkbox"/> Confidential	



Version history						
Nr.	Author		Reviewed		Approval	
	Name	Date	Name	Date	Name	Date
<b>1</b>	Jónas Þór Ingólfsson	22.4.15	Jón Haukur Steingríms	22.4.15		



## SUMMARY

This report covers the site investigations conducted in the proposed Búrfell Wind Farm area in 2013 and 2014.

In December 2013 ram sounding was conducted in the Haf area, north of Búrfell in order to obtain overview of the extent of loose surface materials. The drilling revealed varying thickness of the overburden which is mainly made of volcanic ash and pumice (tephra) and aeolian sand, from 1,3 m to 10,5 m.

In October and November of 2014 percussion and core drilling were employed to estimate the thickness and extends of lava layers encountered in previous site investigations in relation to the hydropower projects in Búrfell, Sultartangi and Búðarháls. Three core holes were drilled and 2 holes were drilled with Odex percussion drilling and cuttings samples extracted. The holes showed multiple layers of Holocene porphyritic basalt lava fields, interbedded with tephra or sand layers. Firm evidence for “old” bedrock could not be confirmed within the drilling depth of this campaign. The rock quality of the lava formations was assessed and core samples tested in the laboratory.

Additionally, search for suitable fill material in nearby borrow areas was carried out and samples gathered for laboratory testing with regards to aggregate quality for concrete, road construction and cable backfill material.



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## 1 INTRODUCTION

Landsvirkjun is investigating and planning a potential wind farms in the Þjórsár- and Tungnaár area on the lava fields east of mount Þúrfell. This work is a part of research and development project conducted by Landsvirkjun to study the feasibility of wind turbines in Iceland. Geological and geotechnical investigations were performed at the proposed construction area and in neighbouring borrow areas. Two proposals are under consideration, layout 1 and 2 as shown in Figure 1.

Efla Consulting Engineers has supervised the investigations. Árni ehf. carried out core and percussion drilling and Neseý ehf. provided excavator for trial pits and sampling in the borrow areas.

Field investigations were carried out for this project in the years 2013, 2014 and in the beginning of the year 2015. Results from earlier research programs from the hydropower projects in Þúrfell, Sultartangi and Búðarháls has revealed great thickness of Holocene (less than 10.000 years old) lavas and unconsolidated interbeds in the area. The stratigraphy of the proposed wind farm area was therefore studied by drilling was in October and November 2014. Previously the thickness of the tephra and loose overburden at the surface had been investigated with ram sounding in late 2013.

This report presents the main findings of these site investigations..

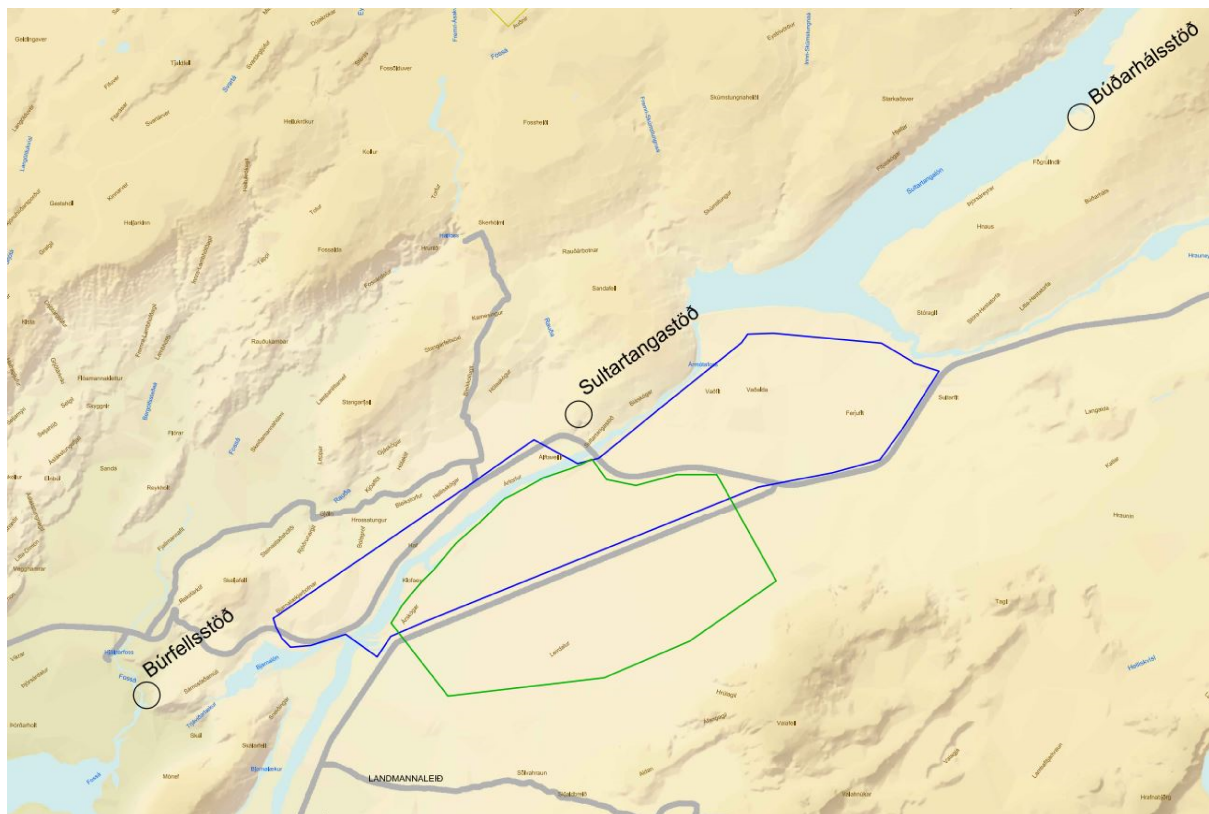


Figure 1: Proposed wind farm areas. Proposal 1 in green and proposal 2 in blue.

## 2 GEOLOGICAL SETTING

### 2.1 General geology

The area between Búrfell and Sámstaðamúli in the west and Valafjall and Sandfell in the east has been greatly affected by volcanism since the ending of last ice age ~10.000 years ago, where two of the most active volcanic systems in Iceland, Hekla and Bárðarbunga, play the largest role.

Since the retreat of the ice age glacier at least 11 lava flows have been recorded from the Veiðivötn fissure swarm of Bárðarbunga volcanic system and 7 of them (Vilmundardóttir, 1977) reached the area south of Búðarháls. The lava flows from the Veiðivötn fissure swarm have been collectively named Tungnaárhraun and are clearly distinguishable by abundance of large plagioclase phenocrysts, up to 10 mm dia. The distribution of each flow in Hafid has not been completely mapped, but of the 11 flows of the Tungnaárhraun lavas 6 might have reached the proposed wind farm area. The two youngest flows that can be found there cover most of the plains, the 3000 years old Búrfellshraun being on the surface under loose material; tephra and aeolian sand. The other four flows are likely to have run in channels, as they have not been seen in as many boreholes in the area as the others have. Sölvahraun and Taglgígahraun lavas are the only Holocene lava formations in the Búrfell wind farm area not originating from the Veiðivötn fissure swarm, but from Hekla. They are around 1200 years old and are composed of at least 3 different lava flows each (Vilmundardóttir, Guðmundsson and Snorrason, 1985). Hekla also contributes to the overall strata in the form of tephra interbeds between the other layers, and the loose material on the surface. The total thickness of the Tungnaárhraun lavas and interbeds has been estimated to be about 100 m in a section between Búrfell and Sauðafellssalda (Vilmundardóttir, 1976, p.86). The thickness in the plains where the wind farms have been proposed has not been confirmed, as no boreholes have reached bedrock, except ones close to bedrock on surface.

#### 2.1.1 Seismic risk

The proposed area lies within the seismically active region of Iceland, close to the South Iceland Seismic Zone (SISZ). Design parameters for seismic design will be addressed in a separate report, pending ongoing investigation, scheduled for 2015.

#### 2.1.2 Volcanic risk

The proposed areas are almost completely within Holocene lava plains, although the most recent lava flow occurred around 3000 years ago. However, it must be noted that it is still the most likely flow path upon a major event in the Veiðivötn fissure swarm.

More recent and recurring volcanic risk is posed by Hekla volcano, mainly in the form of tephra fallout. As can be seen in Figure 2 the area has been covered on many occasions by tephra from Hekla through the years. In addition to tephra fallout, at least two separate lava flow events have reached Haf, that is Sölvahraun (~1200 years ago) and Taglgígahraun (~1200 years ago). The southern boundary of proposal 1 in Figure 1 lies along the boundary of Sölvahraun and Taglgígahraun is on surface in the NE corner of proposal 2.

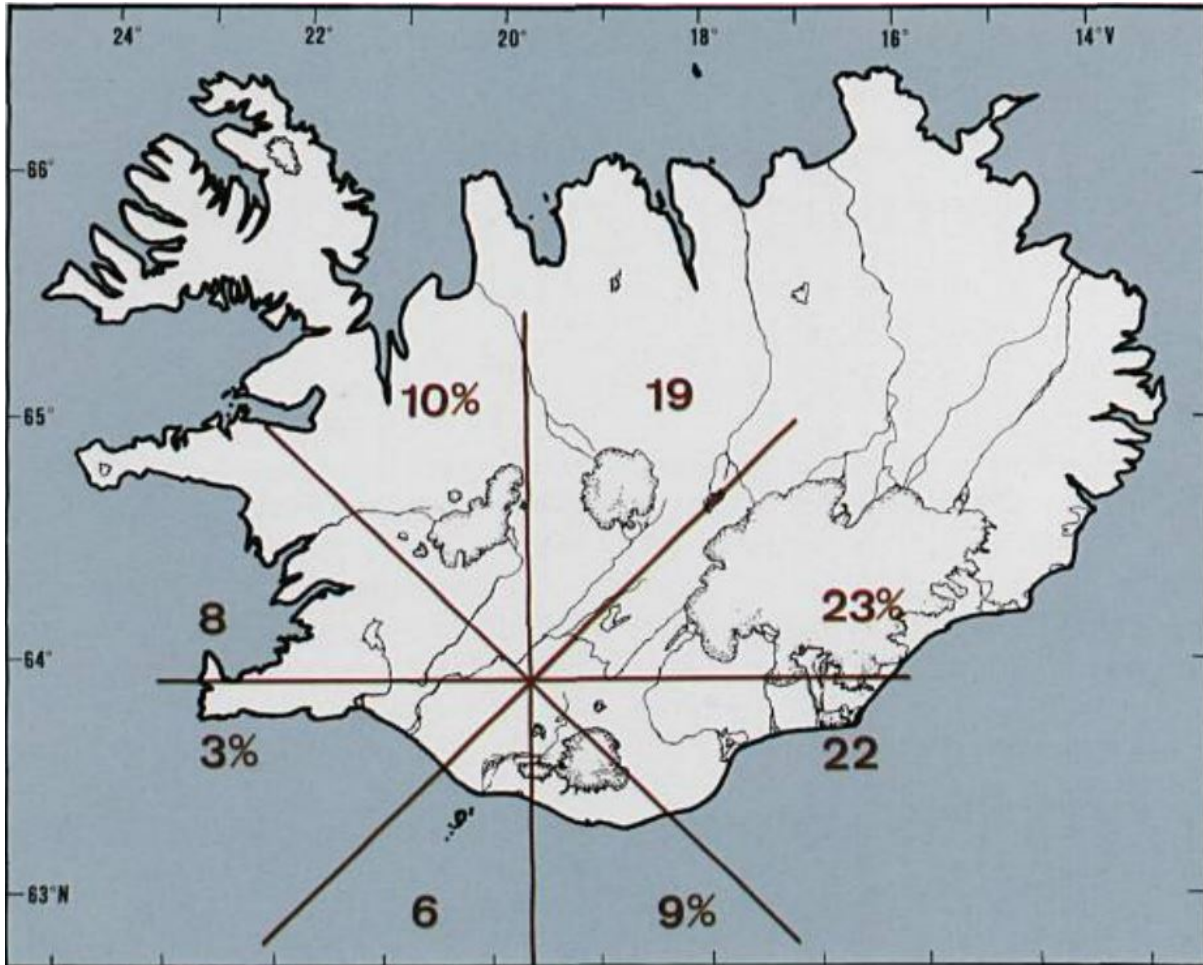


Figure 2: Probability of tephra fallout distribution based on 500hPa wind direction estimates over 20 year period from 1958 – 1977. The proposed area is within the 19% probability sector (Jónsson, 1990).

### 3 GEOLOGICAL SITE INVESTIGATIONS

#### 3.1 Ram sounding

##### 3.1.1 Execution

A petrol-powered ram sounding drill from Atlas Copco was used for the ram sounding. The drilling rods are 1 m long, have a diameter of 25 mm with a coned drill bit. The penetration rate for each 0,2 m is measured with a stopwatch and registered. When interpreting the ram soundings the following is taken to consideration: Penetration rate, depth to firm ground/bottom and an evaluation of the type of soils which accumulate on the drill rods or in the drill rod notches. Generally, soils are considered to be sufficiently consolidated for road constructions when the penetration rate is  $\geq 10$  sec for each 0,2 m interval, commonly referred to as “bearing” ground/bottom in the sense of road construction, not as for high load structures. Likewise it is considered that firm, well consolidated ground or bedrock is reached when the penetration rate for each 0,2 m interval is  $\geq 60$  sec. Bearing and firm ground/bottom are not always confined to layers boundaries. Since soils like silt, sand, gravel and moraine can be loose at the top but become more consolidated and firm with increasing depth. When a penetration rate of 60 sec per 0,2 m interval is reached, the soil at that particular depth is generally well consolidated and compacted and hard to excavate.

The ram sounding survey was planned in a grid of 1x1 km. The sounding locations were chosen with the objective to establish a general overview of the area. Less emphasis was placed on the northeastern parts of the survey area close to Sultartangi Dam and southernmost closest to mount Valafell.

The survey was conducted between 4<sup>th</sup> – 6<sup>th</sup> December 2013. The weather conditions were good, but windy with temperatures around -20 °C.

##### 3.1.2 Results

Table 1 shows summarized and interpreted results of the survey while table 2 shows statistical key points of the results. Long drilling times at the surface is due to surface frost. An overview of drillhole locations and results are shown appendix 1. Bore logs of individual drillholes are in appendix 5

Table 1. Interpreted results from ram sounding.

Drillhole ID	X [ÍSN93]	Y [ÍSN93]	Surface [m a.s.l.]	Bearing bottom elevation [m a.s.l.]	Firm bottom (bedrock) elevation [m a.s.l.]	Bearing bottom depth [m]	Firm bottom (bedrock) depth [m]
HC-03	468041	404903	259,3	255,6	255,6	3,7	3,7
HC-04	464506	399953	240,39	236,6	236,6	3,8	3,8
HC-05	465213	400660	243,68	240,9	240,9	2,8	2,8
HC-06	465920	401367	248,05	245,3	245,3	2,8	2,8
HC-08	467342	402821	259,26	249,5	248,8	9,8	10,5
HC-10	468748	404196	259,64	258,5	258,3	1,1	1,3
HC-12	470163	405610	262,7	259,6	259,6	3,1	3,1
HC-13	470870	406317	268,35	266,6	266,6	1,8	1,8
HC-21	467334	401367	253,41	251,0	249,5	2,4	3,9
HC-22	468041	402074	257,14	255,7	255,7	1,4	1,4
HC-24	469455	403488	261,61	258,4	258,0	3,2	3,6
HC-25	470163	404196	264,47	261,1	261,1	3,4	3,4
HC-26	470870	404903	264,38	260,6	260,5	3,8	3,9
HC-28	472284	406317	276,31	273,6	270,6	2,7	5,7
HC-38	470163	402781	263,24	258,0	258,0	5,2	5,2
HC-40	471577	404196	266,97	264,2	263,1	2,8	3,9
HC-41	472284	404903	269,23	264,0	263,7	5,2	5,5
HC-43	473698	406317	284,23	281,8	281,0	2,4	3,2
HC-54	472284	403488	269,11	268,1	267,8	1,0	1,3
HC-57	474405	405610	286,79	284,8	284,7	2,0	2,1

Table 2. Statistical results of ram sounding.

	BB depth [m]	FB depth [m]
Average (20)	3,2	3,6
Standard deviation	1,9	2,1
Min depth / thickness	1,0	1,3
Max depth / thickness	9,8	10,5
Average - 1 standard deviation (16,7% tolerance)	1,3	1,6
Average + 1 standard deviation (83,3 % tolerance)	5,1	5,7

### 3.1.3 Geological situation, surface

The entire survey area is located on the Búrfellshraun lava field, which is around 3000 years old (Vilmundardóttir, 1977). It is characterized by pseudocraters and flat tephra plains that cover large areas of the lava field. The tephra is mostly ash (<2 mm Ø) and is continuous from the surface down to firm bottom, which is on average at a depth of less than four meters. Minimum depth to firm bottom is at 1,3 meters, whereas maximum depth lies at 10,5 m. Aeolian sands are in the lower part of a few drillholes. Firm bottom is in most cases coarse lava/scoria or solid rock.

## 3.2 Core drilling

Three holes were drilled in 2014 and core samples retrieved. The holes were drilled with NQ wireline core drilling method. The rock is drilled with round drill bit producing 47,6 mm core secured in the inner tube of the drill string that is pulled up through the hollow drill rods. In all three holes, Odex method was included for drilling casing through layers of loose material between the lava layers. As the stratigraphy of these upper layers is characterized by lava field interbedded with loose tephra, the drilling had to be carried out in multiple stages, shifting between NQ core drilling and Odex drilling with casing to support the loose tephra interbeds and prevent hole collapse. The drilling was therefore more demanding and time consuming compared to normal core drilling in solid bedrock.

The holes are placed on a perpendicular line across the longitudinal axis of the proposed wind farm, from north to south.

Hole BFC-02 is located just north of Landvegur Rd.26, about 2 km east of Ísakot.

Hole BFC-03 is located close to the northern boundary of Sölvahraun lava.

Hole BFC-04 is located in Sölvahraun lava, just north of Landmannaleið (Rd. F225).

Each hole is further described below, borehole logs can be seen in appendix 2 and pictures of the cores are presented in appendix 3.

### 3.2.1 BFC-02

Borehole BFC-02 was drilled from 7<sup>th</sup> – 18<sup>th</sup> November 2014. Prior to the drilling it was decided to drill through the Búrfellshraun lava (THi), the topmost lava layer, and the underlying unconsolidated interbedded with Odex bit and casing, to seal off the loose tephra layers. The hole was drilled with Odex to depth of 21 m. The cuttings samples and the drilling rate indicated lava at the depth interval of 3,0-14,5 m and loose material to 18,5 m, where cuttings of pumice were collected. The casing was drilled through the scoria of the second lava layer (THf). The top 4,9 m of the core retrieved were more vesicular and jointed than the rest of the layer. The total thickness of the second lava layer was 29,5 m. At 48,0 m depth, loose material under the lava was entered. It proved impossible to drill with the core equipment so casing drilling was resumed and drilled down to depth of 55,7 m, the last 0,9 m then being in scoria. Samples of the cuttings were collected. The rest of that third lava layer (THe or THd) was drilled with core equipment and. The lava layer was porphyritic basalt, vesicular and jointed in the top and vesicular in the bottom 45 cm. The total thickness of the third lava layer was 5,7 m. Then again entering loose material under the lava. Small core fragments were retrieved from stones in the loose material with rounded surfaces indicating fluvial origin. Fragments on the last 1 m of the core might be originated from pillow lava formation, there is as well one fragment of hyaloclastite (moberg). However, for full confirmation it would have been necessary to drill deeper. Drilling of the loose layer proved very problematic and it was impossible to continue with the Odex drill as well, so drilling was halted at the final depth of 69,5 m. Three layers of lava and 4 loose interbeds were encountered in the hole, bedrock could not be fully confirmed although there are indications of the older moberg bedrock at 68 m depth.



### 3.2.2 BFC-03

Borehole BFC-03 was drilled from 15<sup>th</sup> – 23<sup>rd</sup> of October 2014. The drilling proved problematic due to the unconsolidated interbeds. The hole caved in repeatedly and the drill string was repeatedly jammed which delayed the drilling operations significantly. Lava, Búrfellshraun (THi) was encountered at 5,4 m depth. It is heavily jointed in the top and bottom and highly permeable, as water pumped down during drilling did not return to the top of the casing from depth of 8 m. The lava was easily drilled and the bottom of it is at 14,1 m. Under that first lava came 4,7 m thick layer of pumice and highly vesicular lava blocks. Almost no samples could be recovered from that layer. The little that came up were fragments from the vesicular lava blocks. In the unconsolidated interbed under the lava drilling was problematic as the drill string repeatedly got jammed. At the depth of 18,8 m drilling rate significantly slowed, indicating intact rock. The core sample extracted was porphyritic basalt, jointed and vesicular in the top scoriaceous layer, but denser as the thickness increased (THd). The bottom was then again similar to the top. The bottom of the second lava was at 35,4 m depth. Under that second lava layer came another layer of loose material where no samples could be extracted. In this layer the drilling became even more difficult and at 39,5 m depth the drill string was completely jammed when trying to pull up. Eventually, the drill string broke and could not be removed from the hole. Drilling of BFC-03 was therefore stopped, at the maximum depth of 39,5 m after going through 2 layers of unconsolidated interbeds and 2 layers of porphyritic basalt lava layers, without reaching the older bedrock.

### 3.2.3 BFC-04

BFC-04 was drilled in the Sölvahraun lava in order to assess the thickness of it and the underlying interbed, as well as collecting core samples for laboratory testing. Drilling operations started November 19<sup>th</sup> 2014 and were finished November 22<sup>nd</sup> 2014. The hole was percussion drilled with 4'' casing to 6 m depth, through overburden of tephra and aeolian sand. Rock was encountered at 4,5 m and cuttings showed scoriaceous basalt. The basalt was cored as it got denser and the casing had been drilled 1,5 m into the lava. The same massive, fine-grained, fresh basalt continued to 26,5 m depth, with occasional ~0,2 m cavities. At 26,5 m an interbed of tephra started and the hole had to be reamed with the 4'' casing all the way to continue the drilling through the unconsolidated interbed, as the core drill string repeatedly got stuck when entering the loose tephra. However, the casing stopped in the interbed as well. Eventually the core drill reached the bottom of the interbed at 32,0 m. Core sample was retrieved from the scoriaceous upper part of the underlying lava, with the characteristics of the Kvíslahraun lava THf. Drilling was stopped at 35 m.

## 3.3 Percussion drilling

Two holes were drilled with ODEX method percussion drilling, where the casing is pulled down with the drill string and down-the-hole percussion hammer is used for breaking the rock. Samples of the drill cuttings are collected for lithological analysis and the drilling rate is recorded for stratigraphical interpretation.

The percussion drill holes are located across the wind farm area in east – west direction, BFP-03 being by Landvegur (Rd. 26) south of Ísakot and BFP-02 located by the trail to Áfangagil, just west of the embankment that lies between Landvegur and the trail. Borehole logs can be seen in appendix 2.

### 3.3.1 BFP-02

Borehole BFP-02 was drilled from 10<sup>th</sup> – 15<sup>th</sup> of October 2014. The overburden, consisting of tephra, was 4,5 m thick, where Búrfellshraun lava (THi) was encountered. During drilling in the lava, a weld on

the casing broke, so another parallel hole had to be drilled. Drilling of that hole proved problematic as well and at 10 m depth, no cuttings returned to the surface, so yet another borehole was drilled next to the other two. At the third hole the overburden was 4,5 m and the Búrfellshraun lava (THi) was 9 m thick. Under the lava was 3,5 m of unconsolidated sediment of fluvial origin. Under the fluvial sediment, at 17 – 27 m, tephra cuttings emerged, mostly pumice. At 27 m depth cuttings of porphyritic basalt, Kvíslahraun lava (THf), reached surface. At 32,5 m a 1 m drop occurred and cuttings of tephra started emerging again, and continued down to depth of 47 m, where drilling was stopped. As the borehole log differs strongly from the surrounding lithology, it has been excluded from the interpretation in generalized geological profile A-A' in appendix 1.

### 3.3.2 BFP-03

Borehole BFP-03 was drilled from 7<sup>th</sup> – 10<sup>th</sup> of October 2014. The overburden of tephra was 5 m thick above the Búrfellshraun lava (THi), which extends down to depth of 16 m. Under THi, unconsolidated tephra reached down to 19 m depth, and cuttings of scoriaceous porphyritic basalt belonging to Kvíslahraun lava (THf) came up. However, the hole was abandoned at 23 m due to problems in drilling through the loose material, and new hole drilled a few meters away. In the new hole the casing was taken down to 23 m in order to seal off the unconsolidated interbed. The scoriaceous part of THf was 1 m thick and the massive rock reached down to depth of 30,5 m. Unconsolidated sediment under THf reached 35,0 m depth. At 35,0 m drilling times indicated intact rock, most likely THe or THd, according to surrounding stratigraphy. However, no cuttings reached surface, possibly due to cavities in the tephra above. Drilling was stopped at 38,0 m.

## 4 BORROW AREAS

Quite many quarries and borrow areas have been opened and / or investigated for the large hydroelectric projects in the upper Þjórsá region. In an effort to evaluate where suitable material is located for various applications for the Búrfellslundur Wind farm, samples were acquired from several viable borrow areas in the vicinity of the project area. The field work was carried out on January 28<sup>th</sup> and 29<sup>th</sup> 2015. Baldvin Jónbjarnarson from EFLA carried out the sampling in cooperation with the contractor Nesity. Samples were collected from five borrow areas with CAT 325B excavator and shipped in 0,6 m<sup>3</sup> plastic containers to the laboratory.

The location of borrow areas close to proposed Búrfell wind farm areas are shown on Figure 3. Samples were collected from Guðmundareyri, Bjarnalón, Rip-rap Quarry, Glacial deposit and Tungnaá. Earlier, samples had been gathered from the surface sand/tephra at the wind farm area on Haf along with sand samples from Tungnaá.



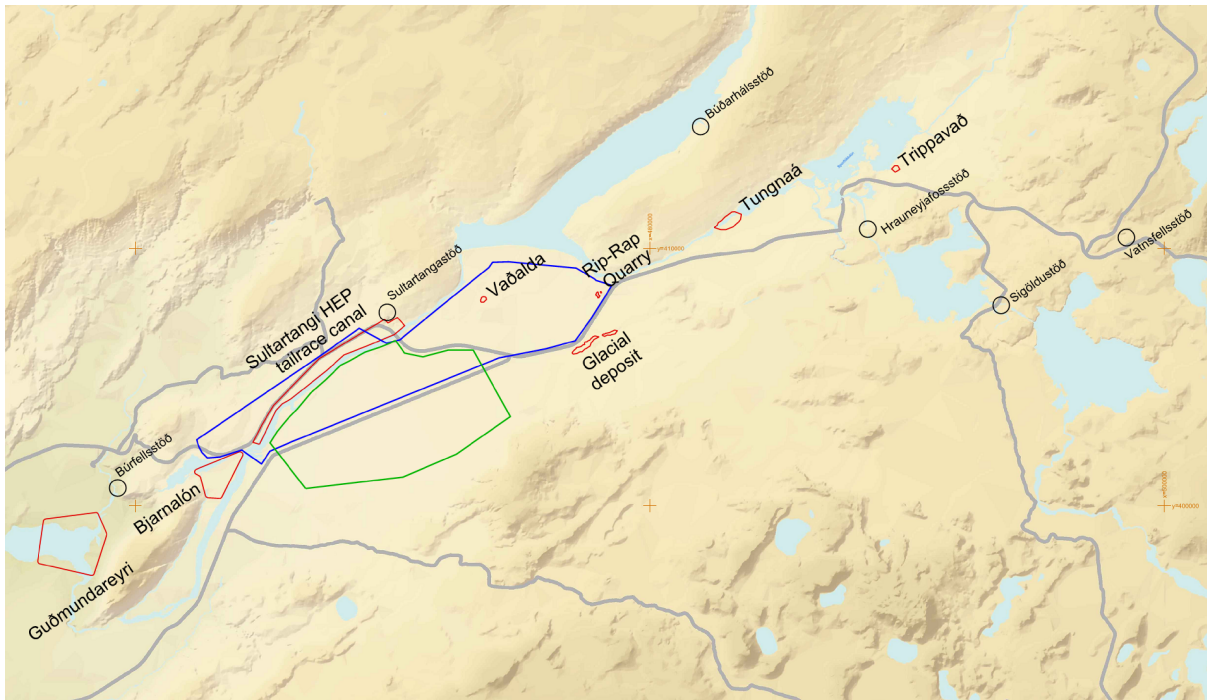


Figure 3: Borrow areas near Búrfell wind farm.

#### 4.1.1 Guðmundareyri

At the junction of the rivers Þjórsá and Fossá below Búrfell are large sandbanks called Guðmundareyri. Four test pits were excavated on the eastern bank. The sandbank has boulders and some vegetation on the surface but under thin layer of sand mixed with organic matter are layers of fluvial sediment made of sandy gravel with occasional layers of tephra.

The first test pit, GE1, was excavated at rather short distance out onto the sandbank. In the top 0,5-1,0 m was sandy mud due to high groundwater level and high content of fines and organic matter.

The second test pit, GE2, was excavated further out on the sandbank. The groundwater table was at 1,5 m and the layer of sand mixed with organic and fine matter was minimal. Two containers of 0,6 m<sup>3</sup> each were collected at this location.

Further out on the sandbar the test pit GE3 was excavated. It was quite similar to GE2 and two plastic bags were collected as to compare the material from the two pits.

The last test pit, GE4, was excavated on a barren area furthest into the sandbank of all the test pits. The groundwater level was at 2,5 m depth but the site was at little higher altitude than the other pits. Two 0,6 m<sup>3</sup> samples were collected.

Transport to the proposed areas is around 20 km, including the steep incline of Sámstaðamúli. This material will be tested for concrete aggregate suitability and for cable backfill. Results of the concrete testing will be addressed in a separate report, still in press.

#### 4.1.2 Tungnaá

The Tungnaá borrow area (Karstens Ø) is located approximately 3-4 km downstream of the Sporðalda dam. The borrow area is relatively large, but the depth of the fluvial deposits has not been estimated. The sandy gravel has been tested with regards to concrete use, not fulfilling requirements for weathering resistance concrete. However, the material can be used and has been accepted in other projects for sub-surface concrete. The material was used during the recent construction of the Búðarháls HEP and Sultartangi HEP.

The borrow area is located approximately 20 km from the centre of the proposed wind farm.

#### **4.1.3 Sultartangi Rip-Rap Quarry**

A quarry approx 700 m southeast of Sultartangi dam (figure 2). Material has been produced from a fresh, dense lava field originating from Hekla, most likely for rip-rap embankments of the Sultartangi dam. The lava, where the quarry is located, is quite large and the height of the rock wall is about 5-6 m in the open pit, therefore quite large quantities can still be produced if needed. The quarry is not landscaped or closed and there are some material heaps laying around. A sample was obtained from one of the piles. This material can possibly be used as concrete aggregate, road fill or fill under foundations if needed. However the production includes more processing as blasting and crushing, resulting in increased production cost. Transport to the centre of the wind farm is around 13 km.

#### **4.1.4 Unnamed Glacial deposit**

About 5 km northeast of the wind farm is a small glacial deposit with sandy, silty gravel. Manmade piles in the deposit suggest that construction materials have been produced there, but no records of usage have been found. Considering the fine grained nature of the material it could possibly serve as cable backfill material.

#### **4.1.5 Bjarnalón**

Great amount of fine sand has been pumped from the bottom of the reservoir through the decades. As the sand is rather fine the only possible use of it could be as cable backfill material, but high content of tephra, vesicular and glassy particles suggest rather high thermal resistivity rendering the material not suitable.

#### **4.1.6 Sultartangi HEP tailrace canal**

Excavated material from the tailrace canal is stock piled along the canal. The material is composed of both loose volcanic material and crushed rock from the Búrfellshraun (THi) lava. Long sections of the then proposed tailrace canal shows that the thickness of the lava is greater closer to the Sultartangi power station, thus the fraction of crushed rock is likely to be larger in the piles there (Pétursson, Kristinsson and Hjartarson, 1982). The excavated material from the canal should be more than enough for the fill and the subgrade parts of the roads in the wind farm and, depending on the quality, the sub-base as well. The stock pile along the canal is on the opposite side of Þjórsá river resulting in a average transport distance of 15 km to the centre of the wind farm, assuming that the bridge by Sultartangi power station is used.

#### **4.1.7 Vaðalda**

In Vaðalda, rock blocks have been produced for the construction of Sultartangi dam from a quarry in the topmost basalt layer of the hill. Material could be produced for the road construction by blasting and crushing. Distance to the centre of the wind farm is about 12 km.

#### **4.1.8 Trippavað**

Trippavað borrow area (figure 1) is a fluvial deposit in Tungnaá, now under water in Sporðalda reservoir. The material has been used and tested as fill material for concrete, just barely fulfilling all requirements. It was used in construction of both Búðarháls HEP and Hrauneyjafoss HEP. Before impoundment of Sporðalda reservoir some 25.000 m<sup>3</sup> were removed and stockpiled on higher ground near Trippavað. The stockpile is on the southeast side of the reservoir, with approx 30 km transport distance to the proposed wind farm area.

## 4.2 Material needs

The requirements for materials used in road construction are based on the guidelines implemented by the Icelandic Road and Coastal Administration (IRCA). It should be noted that traffic on the service roads planned will be minimal and mainly during construction. The road construction requirements are thus not as demanding as specified in the guide.

Table 3: List of approximate material need, listed by application.

Application	Proposal 1	Proposal 2
	Quantity (m <sup>3</sup> )	Quantity (m <sup>3</sup> )
Concrete	25.000	25.000
Cable backfill	35.000	45.000
Fill, unspecified material	121.000	202.000
Subgrade	216.000	337.000
Sub-base	210.000	321.000
Basecourse	45.000	65.000

**Concrete aggregate:** Aggregate used for concrete must be of appropriate grain size distribution. Tests need to be carried out in the laboratory for alkali-aggregate reaction, air-void properties and weathering resistivity (freeze/thaw cycles). Those requirements are difficult to estimate out in the field, so samples need to be collected. Aggregate research for concrete will be presented in separate report.

**Cable backfill:** The main concern for cable backfill material is the thermal resistivity. The material should be capable of conducting heat generated by the cables away from them to prevent overheating. Generally, thermal resistivity of maximum 1,5-2,5 m\*K/w at 5% water content is recommended. Most cable manufacturers do not allow use of crushed material so sedimentary deposits containing aggregates of 0-8 mm in diameter are preferred.

**Fill:** The main requirement for general fill material is that organic content is less than 3 wt%. Suitable material is abundant in the area.

**Subgrade:** Material used in the subgrade layer of the roads needs to meet requirements regarding strength and resistance to fragmentation and grain size distribution.

**Sub-base:** Sub-base material needs to meet requirements regarding petrographic properties, grain size distribution, grain shape and strength and resistance to fragmentation. Depending on the petrographic properties, it might be necessary to carry out freeze-thaw cycle tests. General aggregate size is 0-100 mm.

**Basecourse:** Basecourse material needs to meet requirements of maximum amount of organic material, grain size distribution, petrographic properties, grain shape and strength and resistance to fragmentation. General aggregate size is 0-32 mm or 0-63 mm.

## 5 LAB TESTS AND RESULTS

### 5.1 Rock Quality

The rock mass quality was assessed by applying the Q-system to the core samples, with enhanced values for joint set number,  $J_n$ , to account for columnar jointing in the basalt. Overall, the Q value assigned to the core samples ranges from 3 – 32, and is commonly around 20. The basalt is fresh and dense, excluding the occasional scoriaceous parts in the top and the bottom of individual layers. Some silt/clay fillings can be seen in few of the otherwise unaltered joints. Nearly all joints are rough and irregular or undulating. Minor flow and vesicle banding and can be seen in all the lava units, especially Sölvahraun lava. No tectonic fractures were observed. Joints are ranging from 1-4 joints/m in the dense middle parts of the lava units, but reach up to 20 joints/m in the scoria and the scoriaceous parts. The rock quality assessment is detailed in the bore logs in appendix 2

### 5.2 Unconfined compressive strength (UCS)

The unconfined compressive strength (UCS) was tested on core samples according to ASTM D 2938 – 95 (2002). Total of 36 samples were tested, minimum 3 samples from homogenous parts of each geological unit in order to obtain representative value for both poor and strong zones in the units. The samples were surface dry and saturated when tested. Axial stress was applied at constant rate of 0,5 MPa/s until failure occurred and the load at failure recorded. Table 4 shows the results from each sample as well as dimensions of samples. The results are ranging from moderate to very strong according to ISRM UCS rating chart, the lower values being from the more scoriaceous parts of the lava flows.

Table 4: Results from UCS tests.

Sample ID	Depth in hole [m]	Sample length [mm]	Sample diameter [mm]	Max load [kN]	UCS, $\sigma_c$ [MPa]	UCS, $\sigma_{c50;2,5}$ [MPa]	ISRM UCS classification	Geological unit	Average UCS of unit, $\sigma_{c50}$ (Min/Max) [MPa]
BFC2-01	26,3	114,8	47,1	86,4	49,6	43,8	Moderate	Kvísilahraun, TH <sub>f</sub>	69,7 (39,2 / 69,6)
BFC2-02	27,2	113,3	47,1	69,8	44,5	39,2	Moderate		
BFC2-03	28,3	113,0	47,1	101,0	58,0	51,0	High		
BFC2-04	35,3	113,8	47,2	191,1	109,2	96,6	High		
BFC2-05	35,5	113,6	47,2	93,4	53,4	47,2	Moderate		
BFC2-06	36,4	114,0	47,2	151,6	86,6	76,7	High		
BFC2-07	39,6	113,8	47,1	169,1	97,1	85,5	High		
BFC2-08	40,4	114,1	47,2	140,9	80,5	71,3	High		
BFC2-09	41,3	114,0	47,2	131,8	75,3	66,7	High		
BFC2-10	45,0	113,8	47,2	182,4	104,2	92,2	High		
BFC2-11	45,8	113,8	47,2	163,2	93,3	82,5	High		
BFC2-12	46,9	113,2	47,3	165,3	94,1	83,5	High		
BFC2-13	59,1	47,2	107,2	61,3	54,2	High	TH <sub>e</sub> eða TH <sub>d</sub>	57,4 (54,2 / 61,5)	
BFC2-14	59,6	113,8	47,2	111,5	63,7	56,4			High
BFC2-15	59,9	114,3	47,2	121,5	69,4	61,5			High

Sample ID	Depth in hole [m]	Sample length [mm]	Sample diameter [mm]	Max load [kN]	UCS, $\sigma_c$ [MPa]	UCS, $\sigma_{c50;2,5}$ [MPa]	ISRM UCS classification	Geological unit	Average UCS of unit, $\sigma_{c50}$ (Min/Max) [MPa]
BFC3-01	8,3	113,2	47,3	99,7	56,7	50,3	High	Bürfellshraun, Th <sub>i</sub>	80,8 (50,3 / 114,2)
BFC3-02	8,7	113,9	47,3	115,9	66,0	58,6	High		
BFC3-03	9,6	113,9	47,3	174,9	99,5	88,4	High		
BFC3-04	10,5	113,8	47,2	225,9	129,1	114,2	High		
BFC3-05	11,0	113,8	47,3	142,8	81,3	72,2	High		
BFC3-06	11,8	114,1	47,4	200,4	113,6	101,3	High		
BFC3-07	19,4	113,8	47,4	58,4	33,1	29,5	Moderate	Kvísilahraun, TH <sub>f</sub>	42,5 (29,5 / 57,4)
BFC3-08	19,9	113,8	47,4	69,2	39,2	35,0	Moderate		
BFC3-09	20,7	113,9	47,4	63,2	35,8	31,9	Moderate		
BFC3-10	25,6	113,9	47,3	89,7	51,0	45,4	Moderate		
BFC3-11	25,8	113,7	47,3	110,7	63,0	55,9	High		
BFC3-12	26,8	113,8	47,3	113,6	64,6	57,4	High		
BFC4-01	9,4	115,2	47,1	214,0	122,8	108,5	High	Sölvahraun	113,4 (83,5 / 180,1)
BFC4-02	9,7	115,1	47,1	271,5	155,8	137,7	Very high		
BFC4-03	11,7	115,1	47,1	208,7	119,8	105,8	High		
BFC4-04	12,2	111,2	47,1	165,8	95,2	83,5	High		
BFC4-05	12,8	111,9	47,1	183,9	105,5	92,7	High		
BFC4-06	13,1	111,9	47,1	174,7	100,3	88,1	High		
BFC4-07	21,2	114,0	47,2	215,5	123,2	109,0	High		
BFC4-08	22,0	114,1	47,2	226,7	129,6	114,7	High		
BFC4-09	23,1	113,9	47,2	356,1	203,5	180,1	Very high		

### 5.3 Density and water content

Alongside the UCS test, the density and water content of the samples were measured. The density is in the lower range of average density of basalt, ranging from 2730 – 2850 kg/m<sup>3</sup> on average. The water content is relatively low, ranging from 0,5 – 1,8 wt%.

Table 5: Density and water content measurements.

Sample ID	Depth in hole [m]	Geological unit	Sample length [mm]	Sample diameter [mm]	SSD weight [g]	SSD density [kg/m <sup>3</sup> ]	Dry density [kg/m <sup>3</sup> ]	Water content [%]	Average dry density of unit [kg/m <sup>3</sup> ]
BFC2-01	26,3	Kvísilahraun, TH <sub>f</sub>	114,8	47,1	546,7	2733,2	2694,1	1,5	2848,6
BFC2-02	27,2		113,3	47,1	546,1	3073,0	3032,2	1,3	
BFC2-03	28,3		113,0	47,1	558,5	2836,7	2802,6	1,2	
BFC2-04	35,3		113,8	47,2	573,3	2879,2	2860,0	0,7	
BFC2-05	35,5		113,6	47,2	564,1	2837,9	2811,5	0,9	
BFC2-06	36,4		114,0	47,2	573,8	2876,6	2855,5	0,7	
BFC2-07	39,6		113,8	47,1	575,9	2904,5	2885,0	0,7	

Sample ID	Depth in hole [m]	Geological unit	Sample length [mm]	Sample diameter [mm]	SSD weight [g]	SSD density [kg/m <sup>3</sup> ]	Dry density [kg/m <sup>3</sup> ]	Water content [%]	Average dry density of unit [kg/m <sup>3</sup> ]
BFC2-08	40,4		114,1	47,2	570,8	2859,1	2837,4	0,8	
BFC2-09	41,3		114,0	47,2	573,3	2874,1	2853,9	0,7	
BFC2-10	45,0		113,8	47,2	576,1	2893,2	2865,2	1,0	
BFC2-11	45,8		113,8	47,2	572,7	2876,1	2854,2	0,8	
BFC2-12	46,9		113,2	47,3	569,2	2861,6	2831,3	1,1	
BFC2-13	59,1	The eða THd	113,8	47,2	559,2	2808,3	2785,1	0,8	2786,0
BFC2-14	59,6		113,8	47,2	560,6	2815,4	2793,6	0,8	
BFC2-15	59,9		114,3	47,2	561,1	2805,6	2779,3	0,9	
BFC3-01	8,3	Búrfellshraun, Thi	113,2	47,3	561,0	2820,4	2771,3	1,8	2838,4
BFC3-02	8,7		113,9	47,3	572,9	2862,5	2820,0	1,5	
BFC3-03	9,6		113,9	47,3	577,5	2885,5	2849,7	1,3	
BFC3-04	10,5		113,8	47,2	579,0	2907,8	2873,4	1,2	
BFC3-05	11,0		113,8	47,3	576,7	2884,0	2849,4	1,2	
BFC3-06	11,8		114,1	47,4	583,8	2899,6	2866,7	1,1	
BFC3-07	19,4	Kvíslahraun, THf	113,8	47,4	493,4	2457,0	2413,1	1,8	2824,6
BFC3-08	19,9		113,8	47,4	517,2	2575,5	2533,2	1,7	
BFC3-09	20,7		113,9	47,4	507,6	2525,5	2486,2	1,6	
BFC3-10	25,6		113,9	47,3	571,6	2856,0	2816,8	1,4	
BFC3-11	25,8		113,7	47,3	572,1	2863,5	2825,1	1,4	
BFC3-12	26,8		113,8	47,3	573,8	2869,5	2832,0	1,3	
BFC4-01	9,4	Sölvahraun, HH2	115,2	47,1	556,6	2773,1	2739,3	1,2	2731,6
BFC4-02	9,7		115,1	47,1	557,3	2779,0	2750,2	1,0	
BFC4-03	11,7		115,1	47,1	554,3	2764,0	2729,3	1,3	
BFC4-04	12,2		111,2	47,1	526,8	2719,0	2675,3	1,6	
BFC4-05	12,8		111,9	47,1	535,8	2748,2	2708,3	1,5	
BFC4-06	13,1		111,9	47,1	537,6	2757,4	2716,3	1,5	
BFC4-07	21,2		114,0	47,2	554,7	2780,9	2748,9	1,2	
BFC4-08	22,0		114,1	47,2	553,1	2770,4	2739,1	1,1	
BFC4-09	23,1		113,9	47,2	556,7	2793,3	2778,2	0,5	

## 5.4 Aggregate research

Thermal resistivity was measured in material from all possible locations, as well as surface sand that was measured to obtain in-situ value. Overall, the thermal properties of the material proved to be poor in all borrow areas. All samples showed higher thermal resistivity values than commonly used reference materials. Samples from Guðmundareyri showed the lowest resistivity of the borrow areas, or ~2 K\*m/W at 5% water content.

Petrographical analysis were carried out on two samples from Guðmundareyri and one from Tunгнаreyrar. The samples from Guðmundareyri were from test pits GE2 and GE4. The sample from GE2 showed higher quality regarding concrete fill where 4,7 % of grains were in 3. class, compared to 10,8% in GE4. Apparently, the aggregate quality is lower further out on the sandbank. The difference lies mostly in grains of hyaloclastite in GE4. Both samples consist mostly of fresh basalt of varying vesicularity. The sample from Tunгнаreyri was of similar quality as the sample from GE2. Detailed results from the analysis and grain size distribution can be seen in appendix 6.

Table 6: All measurements of thermal resistivity carried out. The surface sand tested is from the locations of corresponding ram sounding drill holes and can be seen on drawing 2 in appendix 1.

Location	Unit	Measurement		
Guðmundareyri	Resistivity [K*m/W]	2,48	2,03	1,93
	Water content [%]	4,1	5,3	6,9
Tungnaáreyrar	Resistivity [K*m/W]	3,68	2,45	1,88
	Water content [%]	1,8	4,6	8,8
Glacial deposit	Resistivity [K*m/W]	2,72	1,16	
	Water content [%]	9,6	17,0	
Bjarnalón	Resistivity [K*m/W]	2,41	1,84	
	Water content [%]	6,6	14,3	
Surface sand HC-06	Resistivity [K*m/W]	1,91		
	Water content [%]	28,1		
Surface sand HC-21	Resistivity [K*m/W]	1,83	1,44	
	Water content [%]	6,3	15,2	

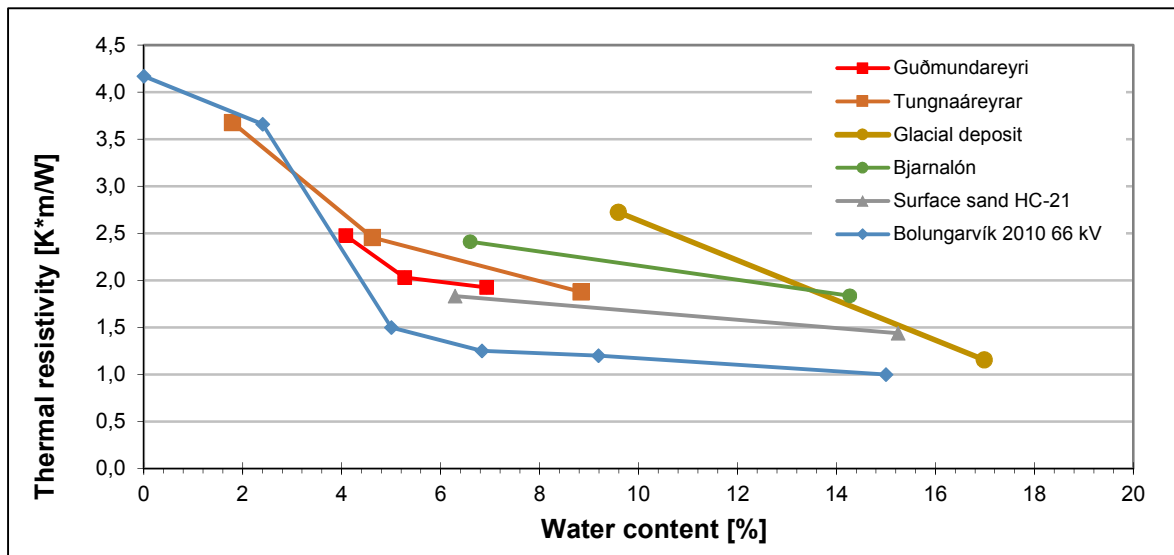


Figure 4: Thermal resistivity measured in samples from borrow areas. The blue line shows reference for backfill material used for Bolungarvík 66kV ground cable in 2010.



## 6 CONCLUSION AND DISCUSSION

The drilling operations confirmed the extensive thickness of the Holocene lavas and interbeds in the area, or at least 70 m thick strata in the center at BFC-02. Only small amounts of samples could be extracted from the interbeds. Most of it was acidic pumice, but in some fluvial sediment could also be seen. The plains have been built up by massive lava flows and rivers have run in channels in periods between volcanic events. Alongside that formation, thick layers of tephra have been spewed from Hekla, covering the area. Three of the Tungnaá lavas that were encountered in the channel between Búrfell and Sauðafellssalda were encountered in the boreholes, that is THf, THi and either THd or THe. Búrfellshraun lava, THi, is the topmost lava in the majority of the proposed wind farm area. The UCS was tested and is classified as high strength rock, ranging from 50,3 - 114,2 MPa. According to Vilmundardóttir (1977), average thickness in all boreholes to that date was 12,4m. However, in the boreholes in the Haf area, the average thickness is 18,5 m and ranging from 6,8 - 29,1 m. The unconsolidated sediment underlying THi is on average 4,3 m in the same boreholes, ranging from 1,5 – 10,1 m. The borehole logs from the earlier site investigations can be seen in appendix 4.

Material needed for road construction is most likely readily available; if not fully in the Sultartangi tailrace canal stockpile, then with material from either Tungnaá borrow area, Vaðalda quarry or the Rip/Rap quarry near Sultartangi dam.

However, material for concrete in the wind turbine foundations and the cable backfill material is of more concern. Material from Trippavað has been approved in tests for concrete production, but barely enough material is accessible and the transport distance is quite long. Ongoing research on concrete aggregate will be presented in separate report.

Although sand is abundant in the area, most of it is aeolian sand, volcanic ash, tephra and pumice, with high thermal resistivity. Alternative solutions might be necessary, like low resistivity additives. That can prove costly with long distance transport and expansive materials.

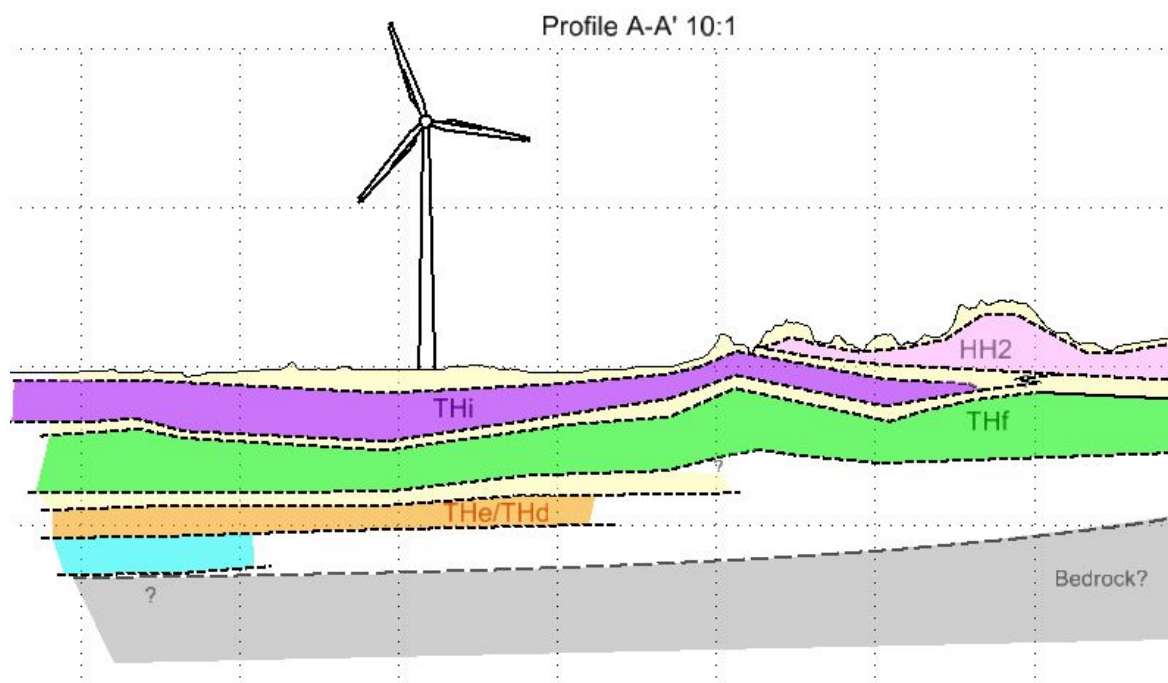


Figure 5: Schematic section of the Holocene lavas above bedrock in the area, with 10x vertical exaggeration. The grid is 500x50 m (w x h). The figure shows Sölvahraun HH2 in pink, Búrfellshraun THi in purple, Kvíslahraun THf in green and THe/THd in orange. The pale yellow is interbed and overburden of tephra and other unconsolidated sediment. As the bedrock was not reached definitively, the depth to it cannot be confirmed. Complete section can be seen in appendix 1.



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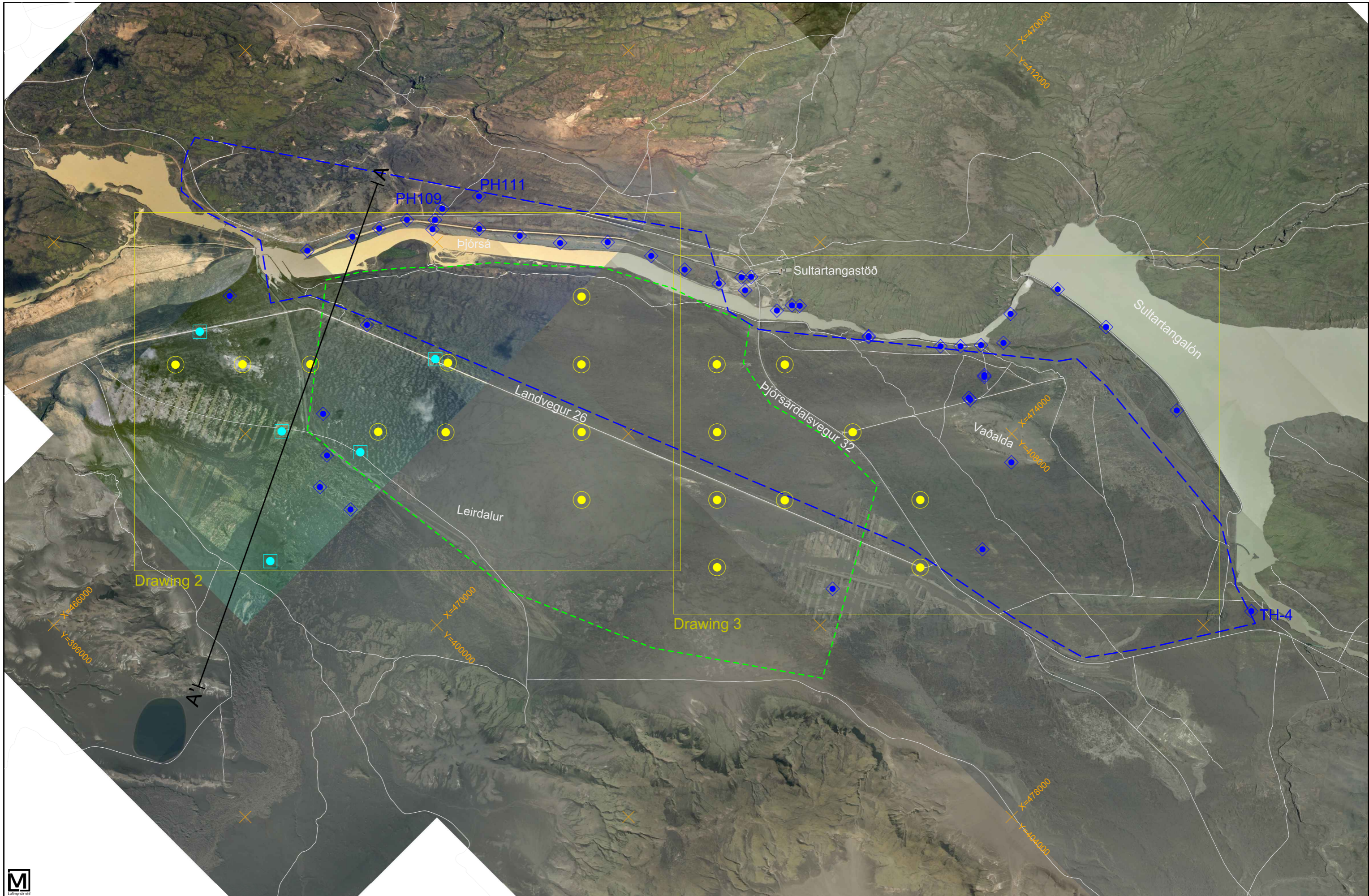


## **APPENDIX 1**

### **DRAWINGS**

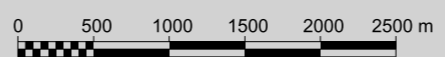






**Legend:**

	Ram sounding location Site investigation 12.2013
	Boreholes 2014
	Older borehole location
	Wind farm proposal 1
	Wind farm proposal 2
	Road



Coordinate system: ISN93



EFLA CONSULTING ENGINEERS		
DATE	NAME	
DESIGN 05.11.2013	BJ	
DRAWING 05.03.2015	GEÓ	
REVIEW 12.03.2015	BJ	
APPROVED		

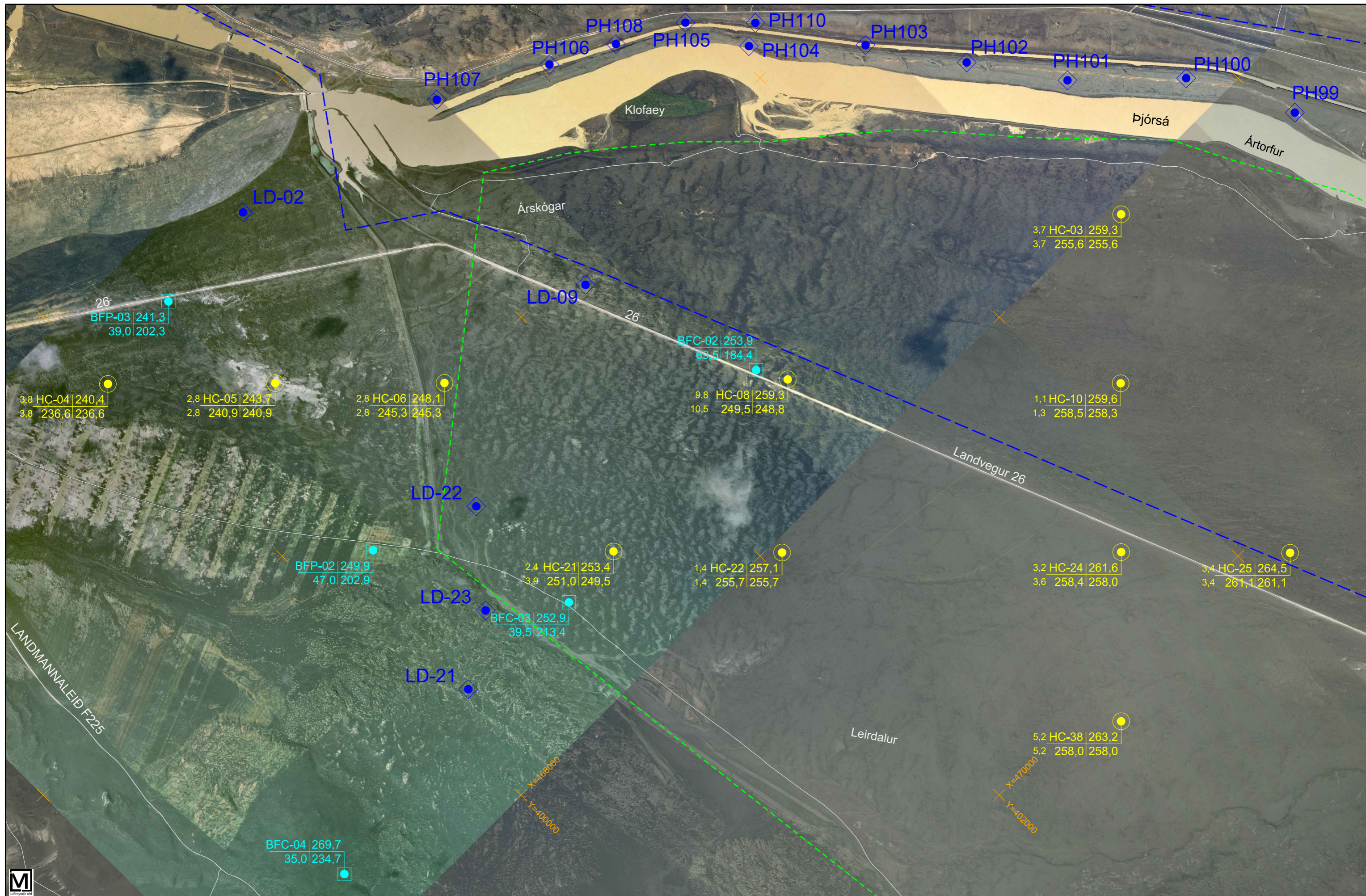


Project nr.		1611-159	
Project leader		EE	
Div.		JAR	
Drawing nr.		1	
<b>HAF-60 Wind Farm near Búrfell</b>			
Site investigation Ram sounding and boreholes Overview			
CAD file	Scale (A3)	EFLA drawing nr.	Riv. Page
1611-159_land.dgn	1:50.000	HAF-60 JAR	2 Page 1









**Legend:**

	Ram sounding location Site investigation 12.2013		Borehole location Drilled 10.-11.2014		Older borehole location
BB depth	Drillhole ID   GL m a.s.l.	GL: Ground Level	BB: Bearing Bottom		BFP: Percussion drilled borehole
FB depth	BB m a.s.l.   FB m a.s.l.	FB: Firm Bottom	BFC: Core borehole		Road
	Borehole ID   GL m a.s.l.	Depth m   Bottom m a.s.l.			

0	200	400	600	800	1000 m
Coordinate system: ISN93					

	<b>EFLA</b> CONSULTING ENGINEERS
DESIGN	05.11.2013   BJ
DRAWING	29.01.2014   GEO
REVIEW	12.03.2015   BJ
APPROVED	

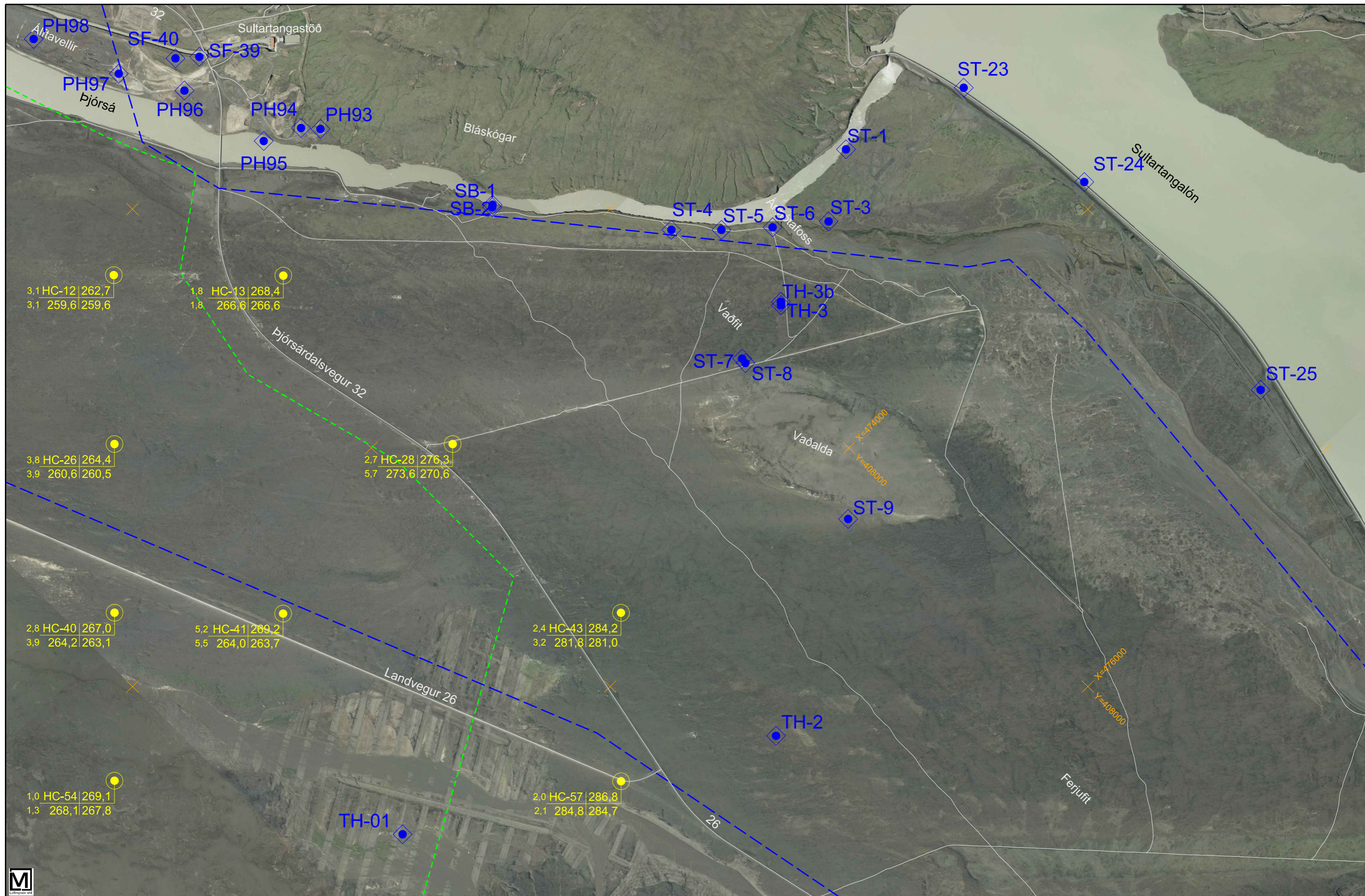
	<b>Landsvirkjun</b> National Power Company of Iceland
--	--

<b>HAF-60 Wind Farm near Búrfell</b>		Project nr.	1611-159
Site investigation Ram sounding and boreholes		Project leader	EE
		Div.	JAR
CAD file	Scale (A3)	EFLA drawing nr.	Rev. Page
1611-159_Jardk.dgn	1:20,000	HAF-60 JAR	2 2
Page 1			2





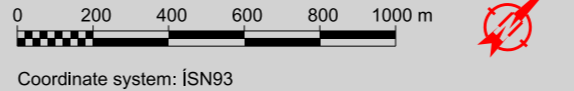




**Legend:**

- Ram sounding location Site investigation 12.2013
- Older borehole location
- Road

GL: Ground Level	BB: Bearing Bottom	FB: Firm Bottom
BB depth	Drillhole ID	GL m a.s.l.
FB depth	BB m a.s.l.	FB m a.s.l.



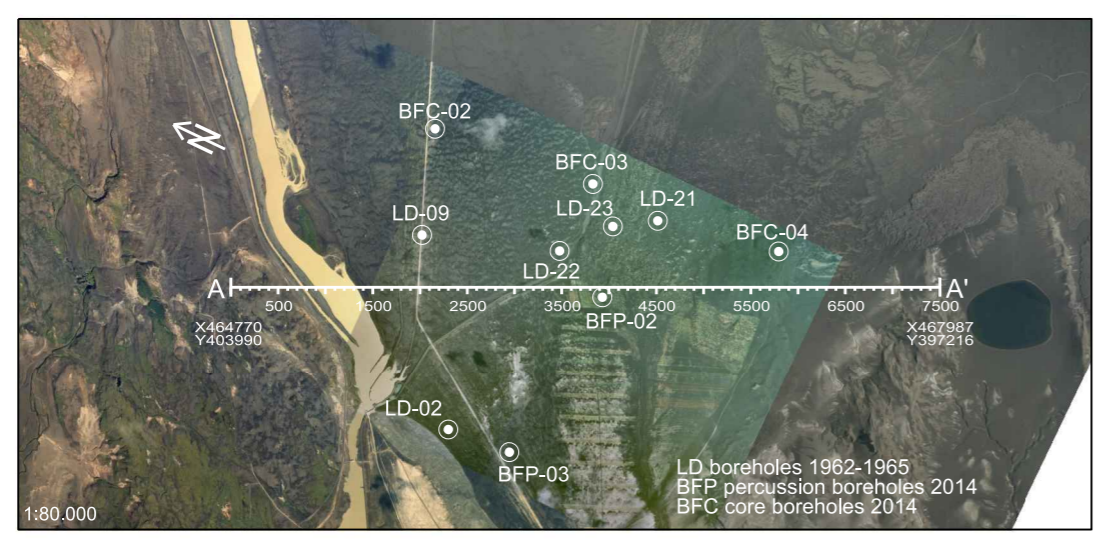
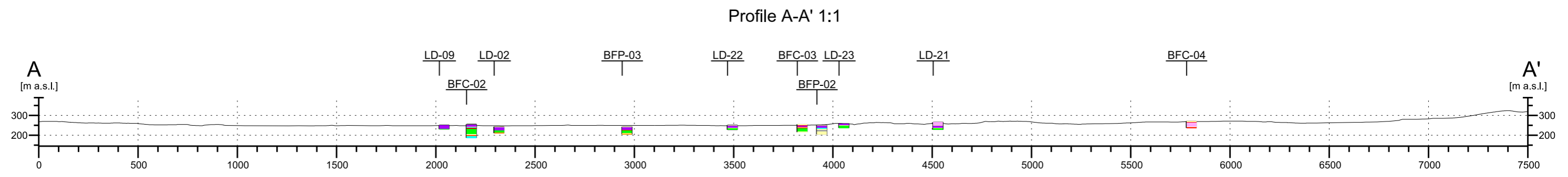
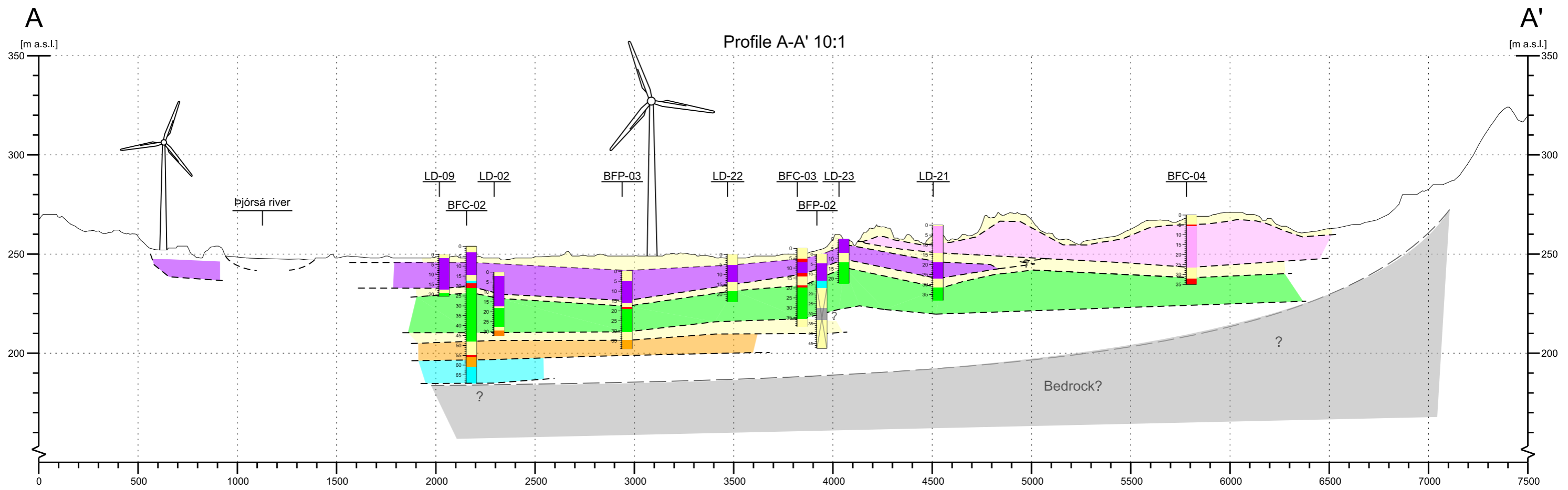
<b>EFLA</b> CONSULTING ENGINEERS		
DATE	NAME	
DESIGN 05.11.2013	BJ	
DRAWING 05.03.2015	GEO	
REVIEW 12.03.2015	BJ	
APPROVED		



<b>HAF-60 Wind Farm near Búrfell</b>		Project nr.	1611-159
Site investigation Ram sounding and boreholes		Project leader	EE
		Div.	JAR
CAD file	Scale (A3)	EFLA drawing nr.	Rev. Page
1611-159_Jarok.dgn	1:20,000	HAF-60 JAR	2 Page 1
Drawing nr.			3







- HH2 Sölvahraun (~1200 a)
- THi Búrfellshraun (~3000 a)
- THf Kvíslahraun (~4500 a)
- THe/THd (~5500 a)
- Scoria
- Tephra / Pumice
- Fluvial sediments

				HAF-60 Wind Farm near Búrfell		Project nr. 1611-159
				Geological profile A-A'		Project leader EE
DESIGN	15.02.2015	GEO		Div. GEO		Drawing nr. 4
DRAWING	15.02.2015	GEO				
REVIEW	26.02.2015	JHS				
APPROVED						
CAD file 1611-159_landk.dgn		Scale (A3)	EFLA drawing nr. HAF-60 JAR 1	Rev. / Page Bls. 01		



## **APPENDIX 2**

### **BORELOGS**



**BFP-02****BOREHOLE LOG  
PERCUSSION DRILLING**

Printed 20.4.2015, scale 1:250

DRILLING DATE 10.-15.10.2014

PROJECT HAF-60 Wind Farm near Búrfell

PROJECT NR. 1611-159

LOCATION Búrfellslundur

RECORDED BY GEÓ

COORDINATES X: 466355,14 Y: 400404,92 Z: 249,91 COORD. SYSTEM ÍSN93 INCLINATION 0° from vertical

CASING Ø ["] 4 CASING AGL [m] 0,25 TOTAL DEPTH [m] 47,5 DRILLED OUTSIDE CASING [m] 17,5 CASING LENGHT [m] 30

CONTRACTOR Árni ehf. OPERATOR Árni Hjaltason DRILL RIG Nemek 407 TS DRILL BIT Odex 3 1/2"

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m] 0 sec (mm:ss) 360
---------------	-----------	---------	-------------	---

249	1		Tephra and aeolian sand on surface.	
248	2			
247	3			
246	4			
245	5		THi, Búrfellshraun. Porphyritic basalt.	160 (02:40)
244	6			656 (10:56)
243	7			274 (04:34)
242	8			340 (05:40)
241	9			598 (09:58)
240	10			1073 (17:53)
239	11			
238	12			
237	13			
236	14		Sediment, sand.	
235	15			
234	16			
233	17		Tephra and pumice.	
232	18			
231	19			
230	20			
229	21			
228	22			
227	23			
226	24			53 (00:53)
225	25			
224	26			
223	27			110 (01:50)
222	28		THf, Kvíslahraun. Porphyritic basalt, most likely scoria at the top.	
221	29			
220	30			
219	31			
218	32			
217	33		Tephra and pumice	
216	34			
215	35			
214	36			
213	37			
212	38			170 (02:50)
211	39			119 (01:59)
210	40			255 (04:15)
209	41			122 (02:02)
208	42			199 (03:19)
207	43			196 (03:16)
206	44			
205	45			
204	46			194 (03:14)
203	47		GWL 16., 18. and 20.10.2014 @ 17,45 m depth from casing (17,20 m from surface / 232,7 m a.s.l.).	240 (04:00)

**BFP-03****BOREHOLE LOG  
PERCUSSION DRILLING**

Printed 20.4.2015, scale 1:250

DRILLING DATE 07.-10.2014

PROJECT HAF-60 Wind Farm near Búrfell

PROJECT NR. 1611-159

LOCATION Búrfellslundur

RECORDED BY GEÓ

COORDINATES X: 464458,19 Y: 400590,06 Z: 241,32 COORD. SYSTEM ÍSN93 INCLINATION 0° from vertical

CASING Ø ["] 4 CASING AGL [m] 0,25 TOTAL DEPTH [m] 39 DRILLED OUTSIDE CASING [m] 16 CASING LENGHT [m] 23

CONTRACTOR Árni ehf. OPERATOR Árni Hjaltason DRILL RIG Nemek 407 TS DRILL BIT Odex 3 1/2"

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m] 0 sec (mm:ss) 360
---------------	-----------	---------	-------------	---

241	0			
240	1		Tephra and aeolian sand on surface.	
239	2			
238	3			
237	4			
236	5			
235	6		THi, Búrfellshraun lava. Light gray porphyritic basalt. Large plagioclase phenocrysts. Slight water inflow at 8,3 m depth. no signs of alteration.	53 (00:53)
234	7			232 (03:52)
233	8			200 (03:20)
232	9			318 (05:18)
231	10			355 (05:55)
230	11			267 (04:27)
229	12			261 (04:21)
228	13			342 (05:42)
227	14			310 (05:10)
226	15			298 (04:58)
225	16			338 (05:38)
224	17		Tephra and pumice. Drilling rather difficult due to unconsolidated layer.	60 (01:00)
223	18			
222	19		Scoria. Porphyritic vesicular basalt. Large plagioclase phenocrysts.	
221	20		THf, Kvislahraun lava. Light gray porphyritic basalt. Large plagioclase phenocrysts.	
220	21			
219	22			340 (05:40)
218	23			290 (04:50)
217	24			298 (04:58)
216	25			290 (04:50)
215	26			286 (04:46)
214	27			298 (04:58)
213	28			296 (04:56)
212	29			210 (03:30)
211	30			
210	31		Tephra and pumice.	
209	32			
208	33			35 (00:35)
207	34			90 (01:30)
206	35		No cuttings, drilling stopped. According to drilling time most likely basalt (THe/THd)	180 (03:00)
205	36			175 (02:55)
204	37			170 (02:50)
203	38		GWL on 18. and 20.10.2014 @14,20 m depth from casing (13,95 m depth from surface / 227,4 m a.s.l.).	
	39			





**BFC-02**

**BOREHOLE LOG**

**CORE DRILLING**



Printed 22.4.2015, scale 1:250

PROJECT NR. 1611-159

Elev. [m asl]	Depth [m]	Lithol.	Description	UCS	Core recov. (%)	Joints/m	RQD 10 (%)	$Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}$
200	54		Scoria. Percussion drilled with 4" casing.					
199	55		The/THd. Porphyritic basalt. Large plagioclase phenocrysts, more abundant than in other layers. Olivine crystals visible. Vesicular in the top 1 m and in the bottom 0,45 m. Silt/clay fillings in fractures, up to 2 mm thick. Minor flow banding. 57,4 MPa <input checked="" type="checkbox"/>		100	3,33	75	$Q=(75/12)*(3/2)*(1/1) Q=9$
198	56		Tephra and fluvial sediments. Only small bits of core are extracted with rounded edges, including fragments of hyaloclastite.					
197	57							
196	58							
195	59							
194	60							
193	61							
192	62							
191	63							
190	64							
189	65							
188	66							
187	67		No valid measurement for groundwater table					
186	68							
185	69		Basalt fragments. Homogenous, dark gray, vesicular basalt with no phenocrysts. Possibly pillow basalt from bedrock but not confirmed.					

BFC-03

BOREHOLE LOG  
CORE DRILLING

Printed 20.4.2015, scale 1:250

DRILLING DATE 15.-23.10.2014

PROJECT Wind Farms in Thjorsá-Tungnaá area

PROJECT NR. 1611-159

LOCATION Búrfellslundur

RECORDED BY JPI/GEÓ

COORDINATES X: 467392,81 Y: 401006,84 Z: 252,94 COORD. SYSTEM íSN93 CORE Ø [mm] 47 CORE RECOV. (%) 72

TOTAL DEPTH [m] 39,5 CASING Ø ["] 4 CASING DEPTH [m] 5,4 CASING AGL [m] 0,2 WITHOUT CASING [m] 34,1 CORE BOX QTY 5

CONTRACTOR Árni ehf. OPERATOR Árni Hjaltason DRILL RIG Nemek 407 TS DRILL BIT Odex/NQ

Elev. [m asl]	Depth [m]	Lithol.	Description	UCS	Core recov. (%)	Joints/m	RQD 10 (%)	$Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}$
---------------	-----------	---------	-------------	-----	-----------------	----------	------------	---

0								
252	1		Aeolian sand and tephra in the surface.					
251	2							
250	3							
249	4							
248	5							
247	6		Scoriaceous and fractured top of the light gray porphyritic basalt. Plagioclase phenocrysts. Clay coatings/staining on fracture surfaces. Large elongated vesicles.	100	12,0	50		$Q=(50/9)*(3/1-2)*(1/1) Q=8-17$
246	7							
245	8							
244	9		THi, Búrfellshraun lava. Light gray porphyritic basalt. Large plagioclase phenocrysts. Joint walls generally unaltered, but occasional silt/clay coatings can be seen. Minor flow banding.	65,8 MPa <input checked="" type="checkbox"/> 95,9 MPa <input checked="" type="checkbox"/>	100	4,4	85	$Q=(85/9)*(3/1-2)*(1/1) Q=14-28$
243	10							
242	11							
241	12							
240	13		Scoria and consolidated tephra in the lower boundary of the lava.	36		>20	0	$Q=(10/12)*(3/1)*(1/1) Q=3$
239	14							
238	15		Tephra and lava blocks.	9				
237	16							
236	17							
235	18							
234	19		Scoria. Highly fractured. Reddish fracture coatings on dark porphyritic basalt. Plagioclase phenocrysts. Top scoria of Kvislahraun THf.	32,1 MPa <input checked="" type="checkbox"/>	92	17,5	0	$Q=(10/12)*(3/1)*(1/1) Q=3$
233	20							
232	21		THf, Kvislahraun lava. Vesicular light gray porphyritic basalt, massive with fracture zones. Joint walls unaltered. Minor flow banding.	98	4,17	90		$Q=(95/9)*(2-3/1)*(1/1) Q=21-32$
231	22							
230	23							
229	24		THf. Massive and dense, light gray porphyritic basalt. Large plagioclase phenocrysts and less abundant small olivine crystals. Unaltered joint walls. Minor flow banding.	52,9 MPa <input checked="" type="checkbox"/>				
228	25							
227	26							
226	27							
225	28							
224	29							
223	30							
222	31							
221	32							
220	33							
219	34							
218	35							
217	36		Tephra. No core samples retrieved.					
216	37							
215	38							
214	39		GWL on 18., 20., 21.10.2014 @15,36 m depth from casing (15,16 m depth from surface / 237,8 m a.s.l.).					

BFC-04

## BOREHOLE LOG

## CORE DRILLING



Printed 20.4.2015, scale 1:250

DRILLING DATE 19.-22.11.2014

PROJECT HAF-60 Wind Farm near Búrfell

PROJECT NR. 1611-159

LOCATION Búrfellslundur

RECORDED BY JPI/GEÓ

COORDINATES X: 467590,27 Y: 398930,37 Z: 269,71

COORD. SYSTEM ISN93

CORE Ø [mm] 47

CORE RECOV. (%) 77

TOTAL DEPTH [m] 35

CASING Ø ["] 4

CASING DEPTH [m] 26,4

CASING AGL [m] 0,2

WITHOUT CASING [m] 8,6

CORE BOX QTY 5

CONTRACTOR Árni ehf.

OPERATOR Árni Hjaltason

DRILL RIG Nemek 407 TS

DRILL BIT Odex/NQ

Elev. [m asl]	Depth [m]	Lithol.	Description	UCS	Core recov. (%)	Joints/m	RQD 10 (%)	$Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}$
---------------	-----------	---------	-------------	-----	-----------------	----------	------------	---

269	1		Tephra and aeolian sand in the surface. Percussion drilled with 4" casing.					
268	2							
267	3							
266	4							
265	5							
264	6		Scoria. Percussion drilled with 4" casing.					
263	7		HH2, Sölvahraun lava. Basalt. Percussion drilled with 4" casing.	95	2,4	90		$Q=(90/12)*(3/1)*(1/1) Q=23$
262	8		Sölvahraun lava HH2. Dense and massive, light gray fine grained basalt. Occasional surface staining on fracture surfaces. Minor flow banding.					
261	9			117,3 MPa				
260	10							
259	11			88,1 MPa				
258	12							
257	13							
256	14							
255	15		GWL on 21.11.2014, 16:00 @14,76 m depth from surface (254,95 m a.s.l.).	97	1,1	95		$Q=(95/12)*(3/1)*(1/1) Q=24$
254	16							
253	17							
252	18							
251	19							
250	20							
249	21							
248	22			134,6 MPa				
247	23							
246	24							
245	25							
244	26		HH2. Bottom section of the basalt, slightly more broken and gradually more vesicular with depth. Minor flow banding.	81	6,0	70		$Q=(70/12)*(3/1)*(1/1) Q=18$
243	27							
242	28		Tephra. No samples retrieved.	0	0	0		
241	29							
240	30							
239	31							
238	32							
237	33		Basaltic scoria, top of THf, Kvíslahraun lava. Highly fractured porphyritic basalt. Large vesicles.	24	>10	25		$Q=(25/12)*(2-3/1)*(1/1) Q=4-6$
236	34							
235	35		THf, Kvíslahraun lava. Vesicular porphyritic basalt, highly fractured. Large plagioclase phenocrysts. Unaltered joint walls.					

**APPENDIX 3**  
**PICTURES OF CORE**  
**SAMPLES**

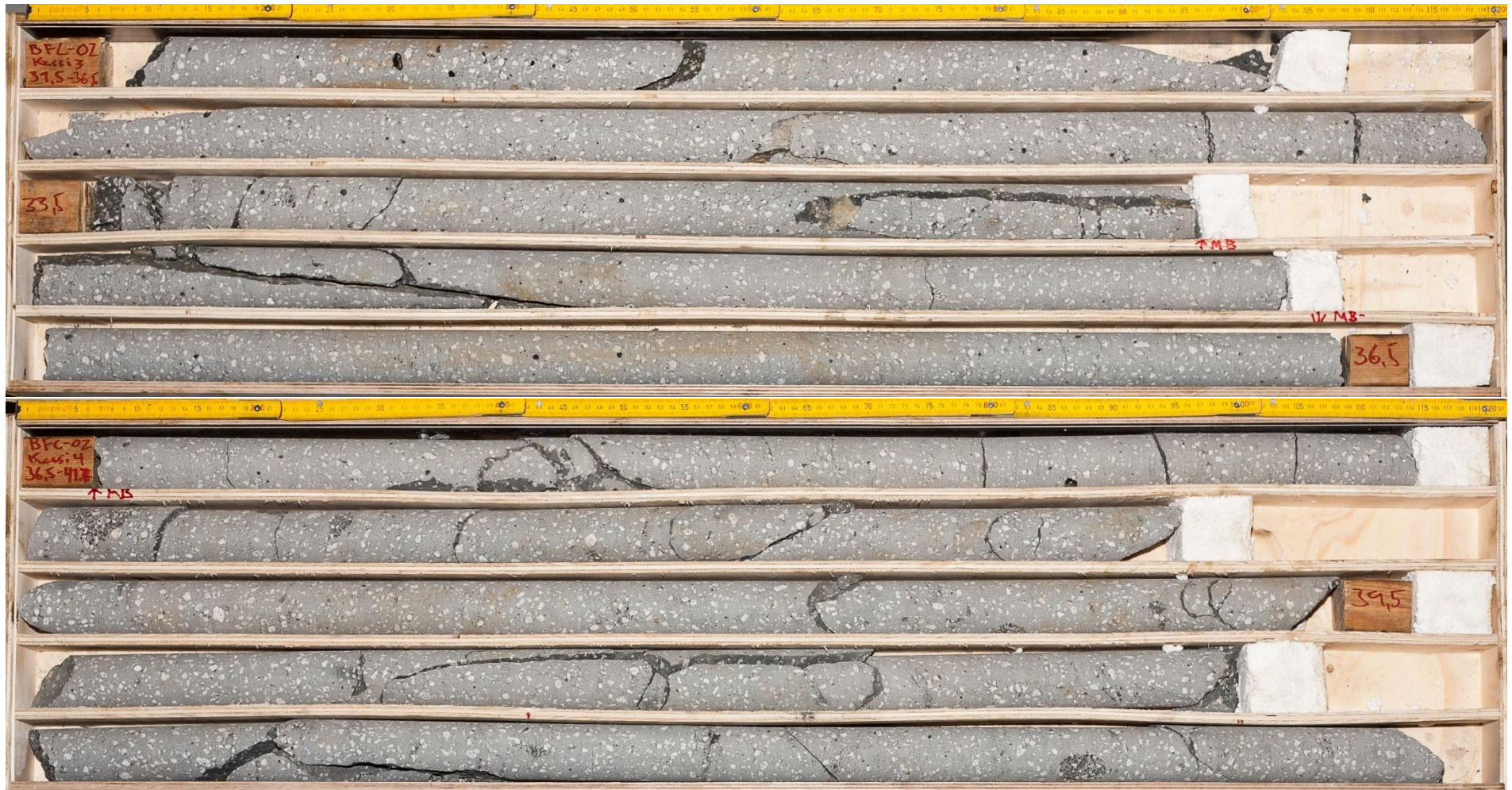




# BFC-02

















# BFC-03













# BFC-04











**APPENDIX 4**  
**BORELOGS FROM**  
**EARLIER RESEARCH**



TH-01

BOREHOLE LOG  
PERCUSSION DRILLING



Printed 14.4.2015, scale 1:250

DRILLING DATE 1965

PROJECT Wind Farms in Thjorsa - Tungnaá area PROJECT NR. 1611-159

LOCATION HAF RECORDED BY

COORDINATES X: 473749.29 Y: 404512.43 Z: 269.5 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 28,4 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
269	0	[Yellow dotted pattern]	Sand and gravel		
268	1				
267	2				
266	3				
265	4				
264	5				
263	6				
262	7				
261	8				
260	9	[Orange vertical lines]	Pophyritic basalt THe		
259	10				
258	11	[Yellow diamond pattern]	Sand and gravel		
257	12				
256	13				
255	14				
254	15				
253	16				
252	17	[Pink vertical lines]	Pophyritic basalt THd		
251	18				
250	19				
249	20				
248	21				
247	22				
246	23				
245	24				
244	25				
243	26	[Yellow diamond pattern]	Sand and gravel		
242	27				
242	28				

TH-02

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE

1965

PROJECT

Wind Farms in Thjorsa - Tungnaá area

PROJECT NR.

1611-159

LOCATION

SE of Vaðalda

RECORDED BY

COORDINATES

X: 474900.70 Y: 406488.35 Z: 289.7

COORD. SYSTEM

ISN93

INCLINATION

0° from vertical

CASING Ø ["]

CASING AGL [m]

TOTAL DEPTH [m]

48,0

DRILLED OUTSIDE CASING [m]

CASING LENGHT [m]

CONTRACTOR

OPERATOR

DRILL RIG

DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
289	1	Overburden		
288	2	Basalt THi Búrfellshraun		
287	3			
286	4			
285	5			
284	6			
283	7			
282	8			
281	9			
280	10			
279	11			
278	12			
277	13			
276	14	Interbed, Rhyolitic pumice and basaltic sand		
275	15			
274	16			
273	17	Basalt THf Kvíslahraun		
272	18			
271	19			
270	20			
269	21			
268	22			
267	23			
266	24			
265	25			
264	26			
263	27			
262	28			
261	29			
260	30			
259	31	Interbed, Rhyolitic pumice and basaltic sand		
258	32			
257	33			
256	34			
255	35			
254	36			
253	37	Basalt THE		
252	38			
251	39			
250	40	Interbed (sand and gravel)		
249	41			
248	42			
247	43			
246	44			
245	45	Basalt THd		
244	46			
243	47			
242	48			

TH-03

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE

1965

PROJECT

Wind Farms in Thjorsa - Tungnaá area

PROJECT NR.

1611-159

LOCATION

Sultartangi

RECORDED BY

COORDINATES

X: 473117.78 Y: 408313.20 Z: 284.1

COORD. SYSTEM

ISN93

INCLINATION

0° from vertical

CASING Ø ["]

CASING AGL [m]

TOTAL DEPTH [m]

48,3

DRILLED OUTSIDE CASING [m]

CASING LENGHT [m]

CONTRACTOR

OPERATOR

DRILL RIG

DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

284	0				
283	1		Overburden		
282	2				
281	3				
280	4				
279	5		Basalt THi Búrfellshraun		
278	6				
277	7				
276	8				
275	9				
274	10				
273	11				
272	12				
271	13				
270	14				
269	15				
268	16				
267	17				
266	18		Loose interbed (sand and gravel)		
265	19				
264	20				
263	21				
262	22				
261	23				
260	24				
259	25				
258	26		Basalt THf Kvíslahraun		
257	27				
256	28				
255	29				
254	30				
253	31				
252	32				
251	33				
250	34				
249	35				
248	36				
247	37				
246	38				
245	39				
244	40				
243	41				
242	42				
241	43		Loose interbed (sand and gravel)		
240	44				
239	45				
238	46				
237	47				
236	48				



TH-03b

BOREHOLE LOG  
PERCUSSION DRILLING



Printed 14.4.2015, scale 1:250

DRILLING DATE 1971

PROJECT Wind Farms in Thjorsa - Tungnaá area PROJECT NR. 1611-159

LOCATION Sultartangi RECORDED BY

COORDINATES X: 473115,79 Y: 408312,17 Z: 284,2 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 59,5 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
284	0			
283	1	Overburden		
282	2			
281	3	Basalt THi Búrfellshraun		
280	4			
279	5			
278	6			
277	7			
276	8			
275	9			
274	10			
273	11			
272	12			
271	13			
270	14			
269	15			
268	16			
267	17	Interbed		
266	18			
265	19			
264	20			
263	21			
262	22			
261	23			
260	24			
259	25			
258	26			
257	27	Basalt THf Kvíslahraun		
256	28			
255	29			
254	30			
253	31			
252	32			
251	33			
250	34			
249	35			
248	36			
247	37			
246	38			
245	39			
244	40			
243	41			
242	42			
241	43	Interbed		
240	44			
239	45			
238	46			
237	47			
236	48			
235	49			
234	50			
233	51			
232	52			
231	53	Old bedrock		
230	54			

TH-03b

## BOREHOLE LOG

## PERCUSSION DRILLING



Printed 14.4.2015, scale 1:250

PROJECT NR.

1611-159

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m] [mm:ss]
230	54			
229	55			
228	56			
227	57			
226	58			
225	59			

TH-04

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 22.4.2015, scale 1:250

DRILLING DATE 1965

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi

RECORDED BY

COORDINATES X: 478354,61 Y: 408650,05 Z: 300,1 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 32,3 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
300	0			
299	1		Overburden	
298	2			
297	3		Basalt THi Búrfellshraun	
296	4			
295	5			
294	6			
293	7			
292	8			
291	9			
290	10			
289	11			
288	12			
287	13			
286	14			
285	15			
284	16			
283	17			
282	18			
281	19			
280	20			
279	21			
278	22			
277	23			
276	24			
275	25			
274	26		Loose interbed	
273	27			
272	28			
271	29			
270	30			
269	31		Old bedrock	
268	32			

LD-02

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 22.4.2015, scale 1:250

DRILLING DATE 1962

PROJECT Wind Farms in Thjorsá-Tungnaá area

PROJECT NR. 1611-159

LOCATION Búrfellslundur

RECORDED BY

COORDINATES X: 486272 Y: 393456 Z: 240,9 COORD. SYSTEM ÍSN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 32 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
240	1		Tephra / pumice	
239	2			
238	3		THi, Búrfellshraun lava.	
237	4			
236	5			
235	6			
234	7			
233	8			
232	9			
231	10			
230	11			
229	12			
228	13			
227	14			
226	15			
225	16			
224	17			
223	18		Tephra / pumice	
222	19			
221	20		THf, Kvíslahraun lava.	
220	21			
219	22			
218	23			
217	24			
216	25			
215	26			
214	27			
213	28		Tephra / pumice	
212	29			
211	30		THe/THd, lava	
210	31			
209	32			



LD-09

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 22.4.2015, scale 1:250

DRILLING DATE

1962

PROJECT

Wind Farms in Thjorsá-Tungnaá area

PROJECT NR.

1611-159

LOCATION

Búrfellslundur

RECORDED BY

COORDINATES

X: 486203

Y: 393969

Z: 249,7

COORD. SYSTEM

ÍSN93

INCLINATION

0° from vertical

CASING Ø ["]

CASING AGL [m]

TOTAL DEPTH [m]

21

DRILLED OUTSIDE CASING [m]

CASING LENGHT [m]

CONTRACTOR

OPERATOR

DRILL RIG

DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
249	1		Tephra / pumice		
248	2		THi, Búrfellshraun lava.		
247	3				
246	4				
245	5				
244	6				
243	7				
242	8				
241	9				
240	10				
239	11				
238	12				
237	13				
236	14				
235	15				
234	16				
233	17				
232	18		Tephra / pumice		
231	19		THf, Kvíslahraun lava.		
230	20				
229	21				

LD-21

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 22.4.2015, scale 1:250

DRILLING DATE

1965

PROJECT

Wind Farms in Thjorsá-Tungnaá area

PROJECT NR.

1611-159

LOCATION

Búrfellslundur

RECORDED BY

COORDINATES

X: 486825

Y: 394007

Z: 264,6

COORD. SYSTEM

ÍSN93

INCLINATION

0° from vertical

CASING Ø ["]

CASING AGL [m]

TOTAL DEPTH [m]

39,7

DRILLED OUTSIDE CASING [m]

CASING LENGHT [m]

CONTRACTOR

OPERATOR

DRILL RIG

DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

264	0	V.V.V.	Tephra / pumice		
263	1				
262	2				
261	3		HH2, Sölvahraun		
260	4				
259	5				
258	6				
257	7				
256	8				
255	9				
254	10				
253	11				
252	12				
251	13				
250	14	V.V.V.	Tephra / pumice		
249	15				
248	16				
247	17				
246	18				
245	19				
244	20		THi, Búrfellshraun lava.		
243	21				
242	22				
241	23				
240	24				
239	25				
238	26				
237	27	V.V.V.	Tephra / pumice		
236	28				
235	29				
234	30				
233	31				
232	32		THf, Kvíslahraun lava.		
231	33				
230	34				
229	35				
228	36				
227	37				

LD-22

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 22.4.2015, scale 1:250

DRILLING DATE 1965

PROJECT Wind Farms in Thjorsá-Tungnaá area

PROJECT NR. 1611-159

LOCATION Búrfellslundur

RECORDED BY

COORDINATES X: 486566 Y: 393927 Z: 249,7 COORD. SYSTEM ÍSN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 23,7 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
249	1		Tephra / pumice		
248	2				
247	3				
246	4				
245	5				
244	6		THi, Búrfellshraun lava.		
243	7				
242	8				
241	9				
240	10				
239	11				
238	12				
237	13		Tephra / pumice		
236	14				
235	15				
234	16				
233	17		THf, Kvíslahraun lava.		
232	18				
231	19				
230	20				
229	21				
228	22				
227	23				
226					

LD-23

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 22.4.2015, scale 1:250

DRILLING DATE 1965

PROJECT Wind Farms in Thjorsá-Tungnaá area

PROJECT NR. 1611-159

LOCATION Búrfellslundur

RECORDED BY

COORDINATES X: 486706 Y: 393992 Z: 257,6 COORD. SYSTEM ÍSN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 22,4 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
257	1	[Purple hatched pattern]	THi, Búrfellshraun lava.		
256	2				
255	3				
254	4				
253	5				
252	6				
251	7				
250	8	[Dotted pattern]	Tephra / pumice		
249	9				
248	10				
247	11				
246	12	[Green hatched pattern]	THf, Kvíslahraun lava.		
245	13				
244	14				
243	15				
242	16				
241	17				
240	18				
239	19				
238	20				
237	21				
236	22				



SB-01

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1971

PROJECT Wind Farms in Thjorsá - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi

RECORDED BY

COORDINATES X: 471489.17 Y: 407526.41 Z: 272.1 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 14,2 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
272	0				
271	1		Overburden		
270	2		Basalt THi Búrfellshraun		
269	3				
268	4				
267	5				
266	6				
265	7				
264	8				
263	9		Interbed		
262	10		Old bedrock		
261	11				
260	12				
259	13				
258	14				

SB-02

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1971

PROJECT Wind Farms in Thjorsá and Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi

RECORDED BY



COORDINATES X: 471498.36 Y: 407514.56 Z: 271.7 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 16,7 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
271	1		Overburden		
270	2		Basalt THi Búrfellshraun		
269	3				
268	4				
267	5				
266	6				
265	7				
264	8				
263	9				
262	10				
261	11		Interbed		
260	12				
259	13				
258	14		Old bedrock		
257	15				
256	16				
255					

BOREHOLE ID <b>SF-39</b>		PAGE 1 / 1		<b>BOREHOLE LOG</b> <b>PERCUSSION DRILLING</b>			
Printed 14.4.2015, scale 1:250		DRILLING DATE 1996					

PROJECT	Wind Farms in Thjorsa - Tungnaá area	PROJECT NR.	1611-159
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

























LOCATION	Sultartangi	RECORDED BY	
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COORDINATES	X: 469641.74 Y: 406918.17 Z: 267.0	COORD. SYSTEM	ISN93	INCLINATION	0° from vertical
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CASING Ø ["]	CASING AGL [m]	TOTAL DEPTH [m]	25,6	DRILLED OUTSIDE CASING [m]	CASING LENGHT [m]	6,0
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CONTRACTOR	RFS	OPERATOR		DRILL RIG		DRILL BIT	
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Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	0	sec (mm:ss)	360
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267	0		Superficial sediments, eolian sand with thin topsoil [...].				
266	1						
265	2						
264	3		Scoriaceous top of the lava				
263	4						
262	5		Postglacial lava THi, highly vesicular in the top and gradualli denser downwards				
261	6						
260	7						
259	8						
258	9						
257	10						
256	11						
255	12						
254	13						
253	14						
252	15						
251	16						
250	17		Most probably mix of sand and scoria fragments, no core recovery [...]				
249	18						
248	19						
247	20						
246	21						
245	22						
244	23						
243	24		Olivine basalt [...]				
242	25						

DATA SOURCE

Ágúst Guðmundsson (1996). Sultartangi HEP - Powerhouse area, geological investigations 1996. Jarðfræðistofan ehf for Landsvirkjun. JFS 12-1996. 32 pages.

BOREHOLE ID <b>SF-40</b>		PAGE 1 / 1		<b>BOREHOLE LOG</b> <b>PERCUSSION DRILLING</b>			
Printed 14.4.2015, scale 1:250		DRILLING DATE 1996					

PROJECT	Wind Farms in Thjorsa - Tungnaá area	PROJECT NR.	1611-159
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





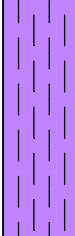

















LOCATION	Sultartangi	RECORDED BY	
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COORDINATES	X: 469548.42 Y: 406811.69 Z: 265.2	COORD. SYSTEM	ISN93	INCLINATION	0° from vertical
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CASING Ø ["]	CASING AGL [m]	TOTAL DEPTH [m]	24,1	DRILLED OUTSIDE CASING [m]	CASING LENGHT [m]	6,0
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CONTRACTOR	RFS	OPERATOR		DRILL RIG		DRILL BIT	
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Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

265	0		Superficial sediments, aeolian sand with thin topsoil		
264	1				
263	2				
262	3				
261	4				
260	5		Scoria gradually becoming solid lava		
259	6		Postglacial lava THi, Búrfellshraun. Highly vesicular and almost scoriaceous in upper part. [Lower half] Sould basalt with micropores. Plagioclas phenocrysts [...]		
258	7				
257	8				
256	9				
255	10				
254	11				
253	12				
252	13				
251	14				
250	15				
249	16		Sand, black volcanic ash or tephra disintegrates very easily [...].		
248	17				
247	18				
246	19				
245	20				
244	21				
243	22				
242	23		Olivine basalt [...]		
	24				

DATA SOURCE

Ágúst Guðmundsson (1996). Sultartangi HEP - Powerhouse area, geological investigations 1996. Jarðfræðistofan ehf for Landsvirkjun. JFS 12-1996. 32 pages.



ST-01

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1971

PROJECT Wind Farms in Thjorsá - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi

RECORDED BY

COORDINATES X: 472737.13 Y: 409238.21 Z: 286.9 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 50,0 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
286	1	Overburden		
285	2			
284	3			
283	4	Basalt THi Búrfellshraun		
282	5			
281	6			
280	7			
279	8			
278	9			
277	10			
276	11			
275	12			
274	13			
273	14			
272	15			
271	16			
270	17			
269	18			
268	19			
267	20			
266	21			
265	22			
264	23			
263	24			
262	25			
261	26			
260	27	Interbed		
259	28			
258	29			
257	30	Tillite		
256	31			
255	32	Old bedrock		
254	33			
253	34			
252	35			
251	36			
250	37			
249	38			
248	39			
247	40			
246	41			
245	42			
244	43			
243	44			
242	45			
241	46			
240	47			
239	48			
238	49			
237	50			

ST-03

BOREHOLE LOG  
PERCUSSION DRILLING



Printed 22.4.2015, scale 1:250

DRILLING DATE 1971

PROJECT Wind Farms in Thjorsa - Tungnaá area PROJECT NR. 1611-159

LOCATION Sultartangi RECORDED BY

COORDINATES X: 472966,08 Y: 408862,81 Z: 285,6 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 55,3 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	sec (mm:ss) 360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
285	1	Overburden		
284	2	Basalt THi Búrfellshraun		
283	3			
282	4			
281	5			
280	6			
279	7			
278	8			
277	9			
276	10			
275	11			
274	12			
273	13			
272	14			
271	15			
270	16			
269	17			
268	18			
267	19			
266	20			
265	21			
264	22			
263	23			
262	24			
261	25			
260	26			
259	27			
258	28		Interbed	
257	29	Basalt THf Kvíslahraun		
256	30			
255	31			
254	32			
253	33			
252	34			
251	35			
250	36			
249	37			
248	38			
247	39			
246	40			
245	41			
244	42			
243	43		Tillite	
242	44			
241	45			
240	46			
239	47			
238	48			
237	49			
236	50			
235	51			
234	52			
233	53			
232	54			

ST-03

## BOREHOLE LOG

## PERCUSSION DRILLING



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PROJECT NR. 1611-159

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m] [mm:ss]
231	54 55		Old bedrock	0 360

ST-04

## BOREHOLE LOG

## PERCUSSION DRILLING



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DRILLING DATE 1971

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi

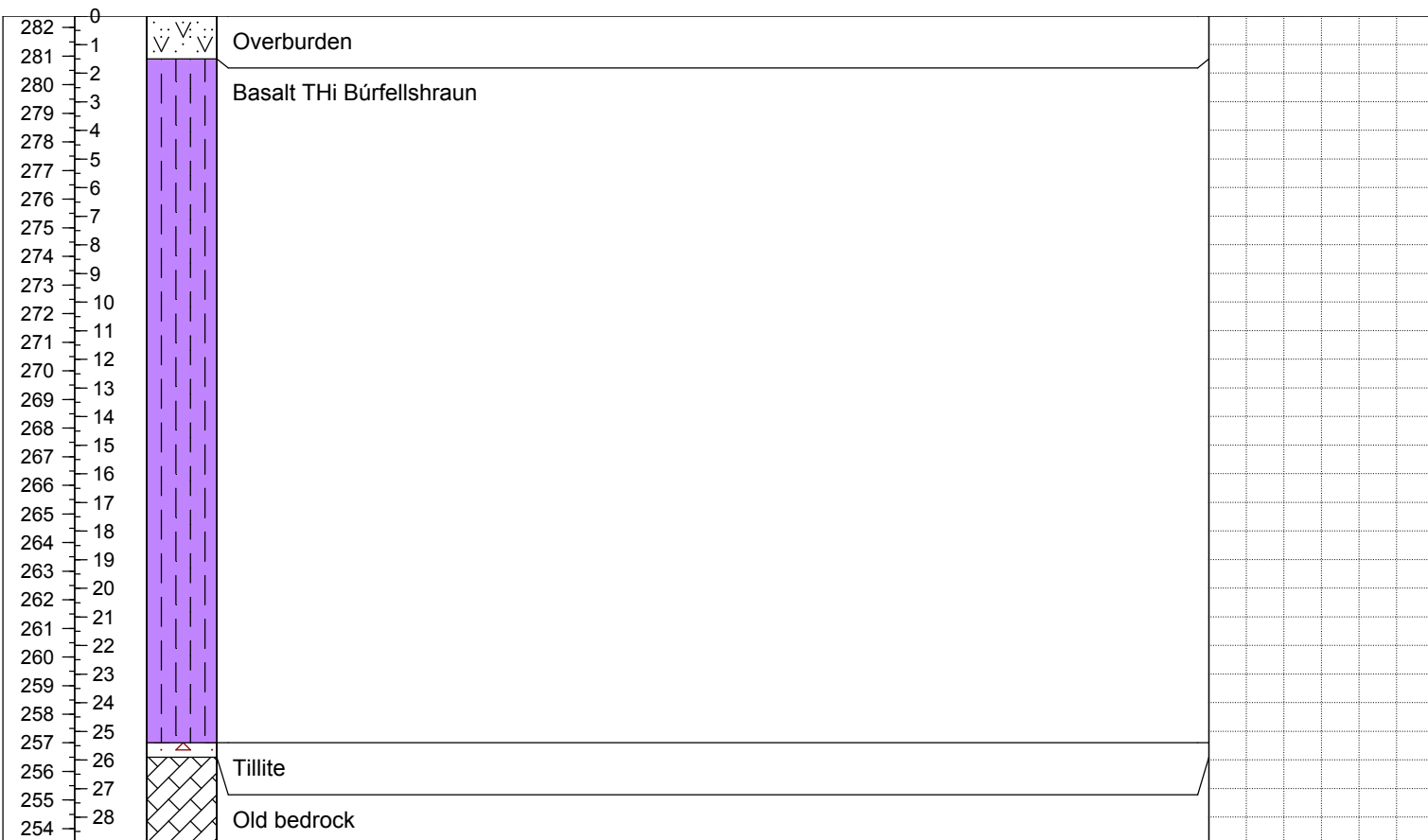
RECORDED BY

COORDINATES X: 472343.02 Y: 408169.94 Z: 282.4 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 28,9 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360





ST-05

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE

1971

PROJECT

Wind Farms in Thjorsa - Tungnaá area

PROJECT NR.

1611-159

LOCATION

Sultartangi

RECORDED BY

COORDINATES

X: 472552.72 Y: 408379.26 Z: 284.3

COORD. SYSTEM

ISN93

INCLINATION

0° from vertical

CASING Ø ["]

CASING AGL [m]

TOTAL DEPTH [m]

35,1

DRILLED OUTSIDE CASING [m]

CASING LENGHT [m]

CONTRACTOR

OPERATOR

DRILL RIG

DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m] 0	360
284	0				
283	1		Overburden		
282	2				
281	3				
280	4		Porphyritic basalt THi Búrfellshraun		
279	5				
278	6				
277	7				
276	8				
275	9				
274	10				
273	11				
272	12				
271	13				
270	14				
269	15				
268	16				
267	17				
266	18				
265	19				
264	20				
263	21				
262	22				
261	23				
260	24				
259	25				
258	26				
257	27				
256	28				
255	29		Old bedrock		
254	30				
253	31				
252	32				
251	33				
250	34				
	35				

ST-06

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1971

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi

RECORDED BY

COORDINATES X: 472756.16 Y: 408604.49 Z: 282.5 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 35,2 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
				0 360
282	0			
281	1		Porphyritic basalt THi Búrfellshraun	
280	2			
279	3			
278	4			
277	5			
276	6			
275	7			
274	8			
273	9			
272	10			
271	11			
270	12			
269	13			
268	14			
267	15			
266	16			
265	17			
264	18			
263	19			
262	20			
261	21			
260	22			
259	23			
258	24			
257	25			
256	26		Tillite	
255	27			
254	28			
253	29			
252	30			
251	31			
250	32			
249	33			
248	34		Old bedrock	
	35			

# ST-07

Printed 14.4.2015, scale 1:250

DRILLING DATE 1971

## BOREHOLE LOG PERCUSSION DRILLING



PROJECT PROJECT NR. 1611-159  
Wind Farms in Thjorsa - Tungnaá area

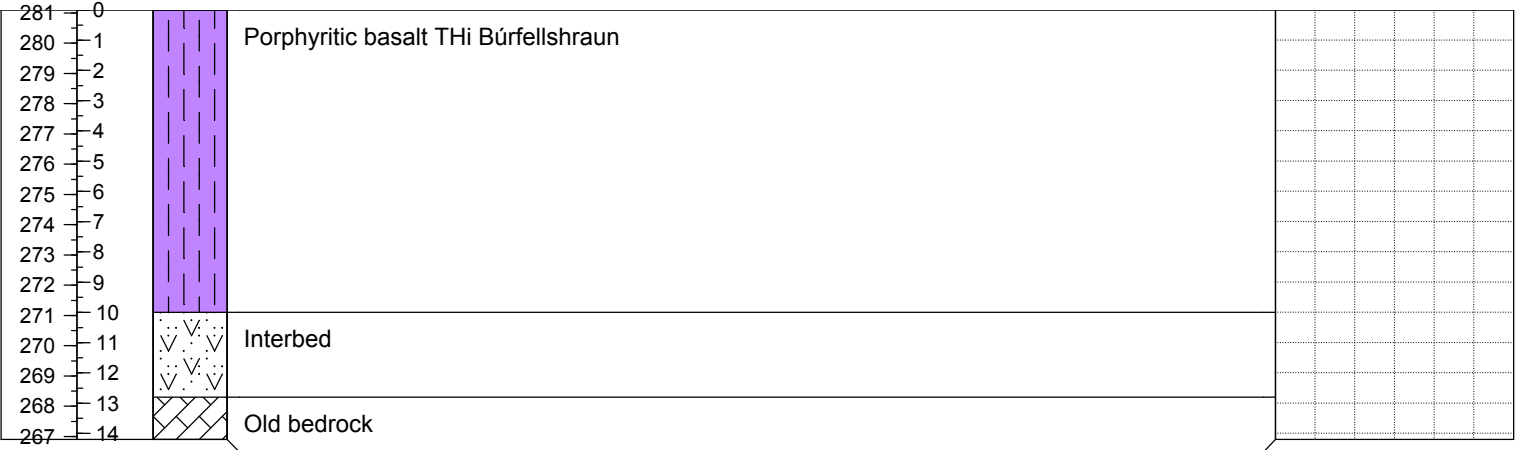
LOCATION RECORDED BY  
Vaðalda

COORDINATES X: 473178.89 Y: 407927.15 Z: 281.1 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 14,2 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360
281	0				
280	1				
279	2				
278	3				
277	4				
276	5				
275	6				
274	7				
273	8				
272	9				
271	10				
270	11				
269	12				
268	13				
267	14				



ST-08

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1971

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Vaðalda

RECORDED BY

COORDINATES X: 473210.98 Y: 407921.66 Z: 281.6 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 13,0 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
281	1		Porphyritic basalt THi Búrfellshraun		
280	2				
279	3				
278	4				
277	5				
276	6				
275	7				
274	8				
273	9		Interbed		
272	10		Old bedrock		
271	11				
270	12				
269	13				



ST-09

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 22.4.2015, scale 1:250

DRILLING DATE 1971

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Vaðalda

RECORDED BY

COORDINATES X: 474294,53 Y: 407698,79 Z: 289,7 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 22,3 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	sec (mm:ss) 360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
289	1	Porphyrritic basalt THi		
288	2			
287	3			
286	4			
285	5			
284	6			
283	7			
282	8			
281	9			
280	10			
279	11	Moraine		
278	12	Tillite		
277	13			
276	14			
275	15			
274	16			
273	17			
272	18			
271	19			
270	20			
269	21			
268	22	Old bedrock		

# ST-23

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980

## BOREHOLE LOG PERCUSSION DRILLING



PROJECT Wind Farms in Thjorsa - Tungnaá area PROJECT NR. 1611-159

LOCATION Sultartangastífla RECORDED BY

COORDINATES X: 472972.27 Y: 409988.95 Z: 287.8 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 32,5 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
287	1	Loose overburden		
286	2	Scoria		
285	3			
284	4			
283	5			
282	6			
281	7	Porphyritic basalt THi Búrfellshraun		
280	8			
279	9			
278	10			
277	11			
276	12			
275	13			
274	14			
273	15			
272	16			
271	17			
270	18			
269	19			
268	20			
267	21			
266	22			
265	23			
264	24			
263	25			
262	26	Loose sediment		
261	27			
260	28			
259	29	Old bedrock		
258	30			
257	31			
256	32			

ST-24

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE

1980

PROJECT

Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION

Sultartangastífla

RECORDED BY

COORDINATES

X: 473871,54 Y: 410099,19 Z: 288,0

COORD. SYSTEM

ISN93

INCLINATION

0° from vertical

CASING Ø ["]

CASING AGL [m]

TOTAL DEPTH [m]

54,0

DRILLED OUTSIDE CASING [m]

CASING LENGHT [m]

CONTRACTOR

OPERATOR

DRILL RIG

DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

288	0				
287	1		Loose overburden		
286	2		Scoria		
285	3				
284	4				
283	5				
282	6		Porphyritic basalt THi Búrfellshraun. Occasional Xenoliths. Very jointed in the top. Vesicular but dense closer to the bottom. Thin siltcoatings in joints. Scoriaceous in the bottom		
281	7				
280	8				
279	9				
278	10				
277	11				
276	12				
275	13				
274	14				
273	15				
272	16				
271	17				
270	18				
269	19				
268	20				
267	21				
266	22				
265	23				
264	24				
263	25				
262	26				
261	27				
260	28				
259	29				
258	30				
257	31		Basalt gravel w. ryol. pebbles		
256	32				
255	33				
254	34				
253	35		Brown, fine-sand		
252	36				
251	37				
250	38		Sediment. Fine sand and silt		
249	39				
248	40				
247	41				
246	42				
245	43				
244	44				
243	45				
242	46				
241	47				
240	48				
239	49				
238	50				
237	51				
236	52				
235	53				
234	54				

DATA SOURCE:

Björn Jónasson (1980). Sultartangavirkjun. Boranir og jarðlagaskipan á stíflustæði. Orkustofnun.

ST-25

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangastífla

RECORDED BY

COORDINATES X: 475480.70 Y: 409966.62 Z: 289.2 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 40,5 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
289	0			
288	1		Loose overburden	
287	2			
286	3		Scoria	
285	4			
284	5		Porphyritic basalt THi Búrfellshraun	
283	6			
282	7			
281	8			
280	9			
279	10			
278	11			
277	12			
276	13			
275	14			
274	15			
273	16			
272	17			
271	18			
270	19			
269	20			
268	21			
267	22			
266	23			
265	24			
264	25			
263	26			
262	27			
261	28			
260	29		Gravel and sand, silty. Alluvial deposits, originally tephra.	
259	30			
258	31			
257	32			
256	33			
255	34			
254	35			
253	36			
252	37			
251	38			
250	39			
249	40			

BOREHOLE ID PAGE 1 / 1

# PH-93

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

## BOREHOLE LOG

### PERCUSSION DRILLING



PROJECT PROJECT NR. 1611-159

Wind Farms in Thjorsa - Tungnaá area

LOCATION RECORDED BY

Sultartangaskurður

COORDINATES X: 470451.52 Y: 407122.99 Z: 270.9 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 25 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
				0 sec (mm:ss) 360

0				
270	1		Aeolian sand	
269	2			
268	3			
267	4			
266	5			
265	6			
264	7			
263	8		Loose overburden	
262	9			
261	10		Clayey sand	
260	11			
259	12			
258	13			
257	14		Tillite	
256	15			
255	16			
254	17			
253	18			
252	19			
251	20			
250	21		Old bedrock	
249	22			
248	23			
247	24			
246	25			

DATA SOURCE

Pétur Pétursson, Bjarni Kristinsson and Árni Hjartarson (1982). Sultartangaskurður - Frárennisliskurður. Orkustofnun. OS82029/VOD19 B. 42 pages.



# PH-94

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

## BOREHOLE LOG PERCUSSION DRILLING



PROJECT Wind Farms in Thjorsa - Tungnaá area PROJECT NR. 1611-159

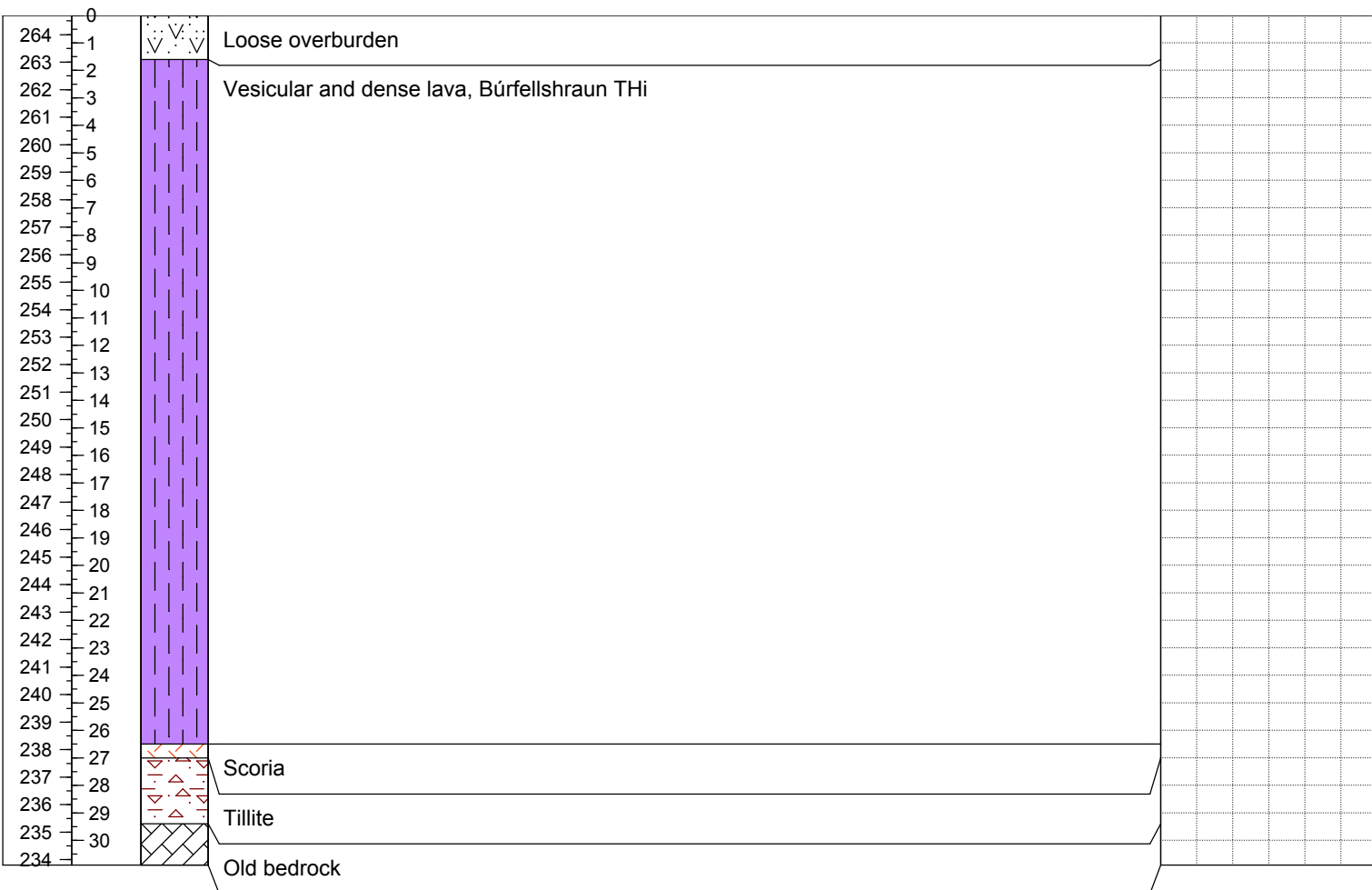
LOCATION Sultartangi - Frárennslisskurður RECORDED BY

COORDINATES X: 470365.75 Y: 407045.63 Z: 264.7 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 30,9 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360



PH-95

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 470264.07 Y: 406835.01 Z: 263.1 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 32,4 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
263	0			
262	1		Loose overburden	
261	2			
260	3			
259	4		Scoria	
258	5			
257	6		Vesicular and dense lava, Búrfellshraun THi	
256	7			
255	8			
254	9			
253	10			
252	11			
251	12			
250	13			
249	14			
248	15			
247	16			
246	17			
245	18			
244	19			
243	20			
242	21			
241	22		Scoria	
240	23			
239	24		Interbed, pumice	
238	25			
237	26		Old bedrock?	
236	27			
235	28			
234	29			
233	30			
232	31			
231	32			

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BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennsliskurður

RECORDED BY

COORDINATES X: 469720.96 Y: 406714.42 Z: 261.6 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 32,0 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
261	0			
260	1		Loose overburden	
259	2			
258	3		Vesicular and dense lava, Búrfellshraun THi	
257	4			
256	5			
255	6			
254	7			
253	8			
252	9			
251	10			
250	11			
249	12			
248	13			
247	14			
246	15			
245	16			
244	17			
243	18			
242	19			
241	20			
240	21			
239	22			
238	23			
237	24			
236	25			
235	26			
234	27			
233	28		Pumice	
232	29			
231	30		Old bedrock	
230	31			
	32			

# PH-97

## BOREHOLE LOG PERCUSSION DRILLING



Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area PROJECT NR. 1611-159

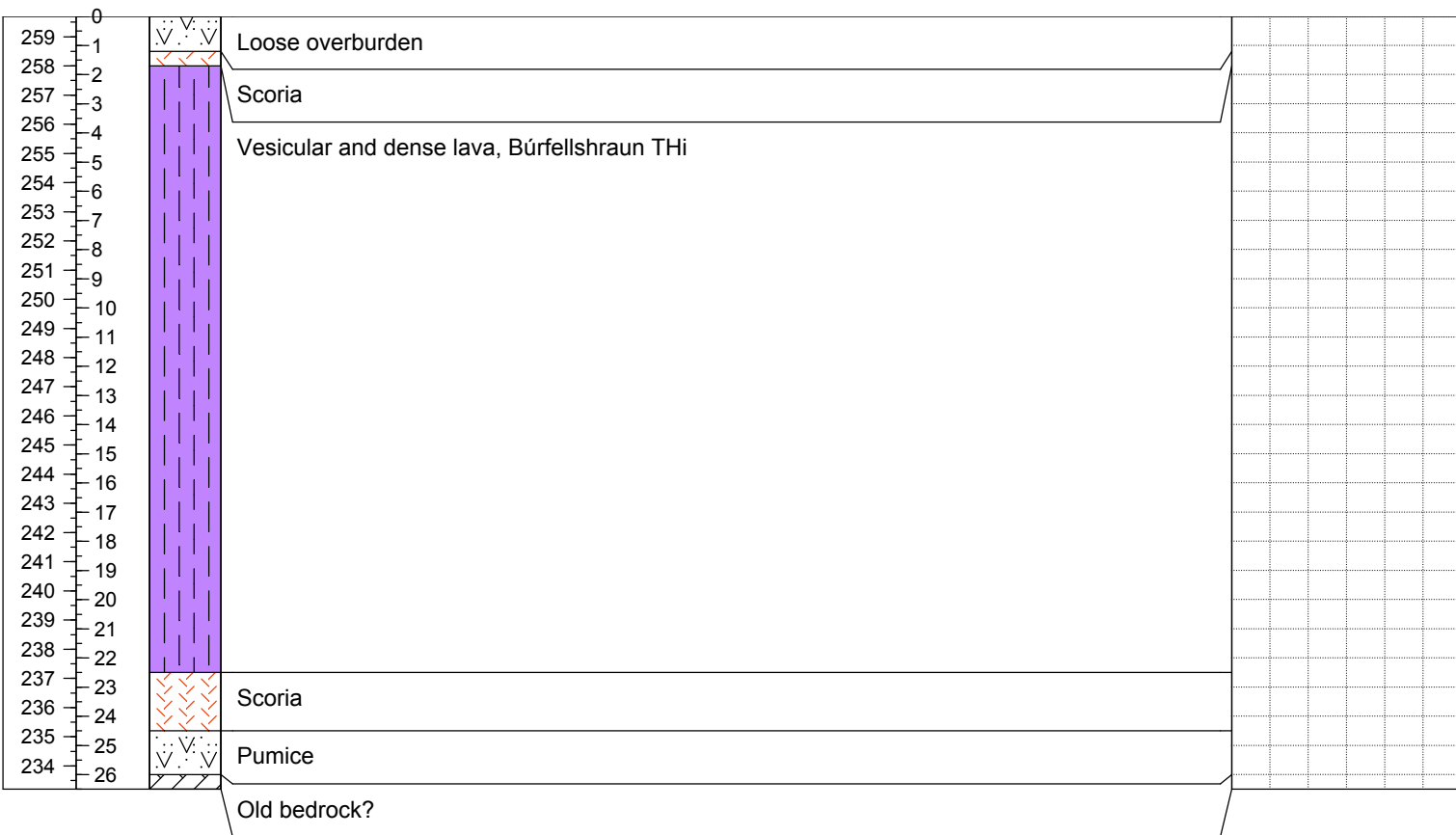
LOCATION Sultartangi - Frárennslisskurður RECORDED BY

COORDINATES X: 469375.19 Y: 406509.94 Z: 259.7 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 26,5 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360



PH-98

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 468873.51 Y: 406299.00 Z: 260.4 COORD. SYSTEM ISN-93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 16,0 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
260	0				
259	1	∇ ∇ ∇ ∇	Loose overburden		
258	2	∇ ∇ ∇ ∇			
257	3	∇ ∇ ∇ ∇			
257	3	∇ ∇ ∇ ∇	Scoria		
256	4				
255	5		Vesicular and dense lava, Búrfellshraun THi		
254	6				
253	7				
252	8				
251	9				
250	10				
249	11				
248	12				
247	13				
246	14				
245	15				
245	16				



PH-99

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE

1980/1981

PROJECT

Wind Farms in Thjorsa - Tungnaá area

PROJECT NR.

1611-159

LOCATION

Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES

X: 468380.75 Y: 406093.20 Z: 258.9

COORD. SYSTEM

ISN93

INCLINATION

0° from vertical

CASING Ø ["]

CASING AGL [m]

TOTAL DEPTH [m]

35,5

DRILLED OUTSIDE CASING [m]

CASING LENGHT [m]

CONTRACTOR

OPERATOR

DRILL RIG

DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
0				
258	1		Loose overburden	
257	2			
256	3		Scoria	
255	4		Vesicular and dense lava, Bürfellshraun THi	
254	5			
253	6			
252	7			
251	8			
250	9			
249	10			
248	11			
247	12			
246	13			
245	14			
244	15			
243	16			
242	17			
241	18			
240	19			
239	20			
238	21			
237	22			
236	23			
235	24		Scoria	
234	25		Tephra and pumice	
233	26			
232	27			
231	28		Tillite?	
230	29			
229	30		Old bedrock	
228	31			
227	32		Interbed?	
226	33			
225	34			
224	35			

PH-100

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 467782.64 Y: 405782.73 Z: 257.4 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 14,3 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360
257	0				
256	1		Loose overburden		
255	2				
254	3				
253	4				
252	5		Vesicular and dense lava, Búrfellshraun THi		
251	6				
250	7				
249	8				
248	9				
247	10				
246	11				
245	12				
244	13				
	14				

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360
257	0				
256	1		Loose overburden		
255	2				
254	3				
253	4				
252	5		Vesicular and dense lava, Búrfellshraun THi		
251	6				
250	7				
249	8				
248	9				
247	10				
246	11				
245	12				
244	13				
	14				

# PH-101

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

## BOREHOLE LOG PERCUSSION DRILLING



PROJECT Wind Farms in Thjorsa - Tungnaá area PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður RECORDED BY

COORDINATES X: 467294.63 Y: 405276.99 Z: 256.0 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 27,0 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
256	0			
255	1		Loose overburden	
254	2			
253	3		Scoria	
252	4			
251	5		Vesicular and dense lava, Búrfellshraun THi	
250	6			
249	7		Scoria	
248	8			
247	9		Vesicular and dense lava, Búrfellshraun THi	
246	10			
245	11			
244	12			
243	13			
242	14			
241	15			
240	16			
239	17			
238	18			
237	19			
236	20			
235	21			
234	22			
233	23			
232	24			
231	25			
230	26		Scoria	
229	27		Pumice	

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BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 466798.10 Y: 404930.13 Z: 256.7 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 16,0 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
256	1		Loose overburden		
255	2				
254	3		Vesicular and dense lava, Búrfellshraun THi		
253	4				
252	5		Scoria		
251	6				
250	7		Scoria		
249	8				
248	9		Vesicular and dense lava, Búrfellshraun THi		
247	10				
246	11				
245	12				
244	13				
243	14				
242	15				
241	16				

PH-103

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 466302.64 Y: 404579.28 Z: 255.4 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 29,3 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
255	0				
254	1	∇ ∇ ∇ ∇	Loose overburden		
253	2				
252	3	∇ ∇ ∇ ∇	Scoria		
251	4				
250	5				
249	6				
248	7				
247	8				
246	9		Vesicular and dense lava, Bürfellshraun THi		
245	10				
244	11				
243	12				
242	13				
241	14				
240	15				
239	16				
238	17				
237	18				
236	19				
235	20				
234	21				
233	22				
232	23				
231	24				
230	25				
229	26				
228	27	∇ ∇ ∇ ∇	Pumice		
227	28				
	29				



# PH-104

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

## BOREHOLE LOG PERCUSSION DRILLING



PROJECT PROJECT NR. 1611-159  
Wind Farms in Thjorsa - Tungnaá area

LOCATION RECORDED BY  
Sultartangi - Frárennslisskurður

COORDINATES X: 465818.40 Y: 404087.60 Z: 252.7 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 15,0 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
				0 sec (mm:ss) 360

0				
252	1	▽▽▽▽	Loose overburden	
251	2	▽▽▽▽		
250	3	▽▽▽▽	Scoria	
249	4	▽▽▽▽		
248	5		Vesicular and dense lava, Búrfellshraun THi	
247	6			
246	7			
245	8			
244	9			
243	10			
242	11			
241	12			
240	13			
239	14			
238	15			

PH-105

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 465454.04 Y: 403919.83 Z: 252.3 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 26,5 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
252	0				
251	1		Loose overburden		
250	2				
249	3				
248	4				
247	5				
246	6				
245	7				
244	8		Scoria		
243	9				
242	10		Vesicular and dense lava, Búrfellshraun THI		
241	11				
240	12				
239	13				
238	14				
237	15				
236	16				
235	17				
234	18				
233	19				
232	20				
231	21				
230	22				
229	23				
228	24				
227	25		Pumice		
226	26				

PH-106

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 465060.80 Y: 403175.59 Z: 249.3 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 13,3 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360



PH-107

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

BOREHOLE LOG  
PERCUSSION DRILLING

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 464736.57 Y: 402557.44 Z: 246.1 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 21,0 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
246	0				
245	1	Scoria			
244	2				
243	3				
242	4	Vesicular and dense lava, Búrfellshraun THi			
241	5				
240	6				
239	7				
238	8				
237	9				
236	10				
235	11				
234	12	Tillite			
233	13				
232	14	Old bedrock			
231	15				
230	16				
229	17				
228	18				
227	19				
226	20				
	21				

PH-108

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 465254.05 Y: 403539.66 Z: 250.7 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 16,4 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
250	1		Loose overburden		
249	2				
248	3		Scoria		
247	4				
246	5				
245	6		Vesicular and dense lava, Búrfellshraun THi		
244	7				
243	8				
242	9				
241	10				
240	11				
239	12				
238	13				
237	14		Scoria		
236	15				
235	16		Sediment		



PH-109

## BOREHOLE LOG

## PERCUSSION DRILLING



Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 465706.38 Y: 404404.84 Z: 253.9 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 29,5 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	0	360
0					
253	1		Loose overburden		
252	2				
251	3		Scoria		
250	4				
249	5				
248	6		Scoria		
247	7				
246	8				
245	9				
244	10				
243	11		Vesicular and dense lava, Bürfellshraun THi		
242	12				
241	13				
240	14				
239	15				
238	16				
237	17				
236	18				
235	19				
234	20				
233	21				
232	22				
231	23				
230	24				
229	25				
228	26				
227	27				
226	28				
225	29		Scoria		

# PH-110

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

## BOREHOLE LOG PERCUSSION DRILLING



PROJECT PROJECT NR. 1611-159  
Wind Farms in Thjorsa - Tungnaá area

LOCATION RECORDED BY  
Sultartangi - Frárennslisskurður

COORDINATES X: 465748.44 Y: 404211.50 Z: 253.0 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 23,4 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

253	0	V.V.V	Loose overburden		
252	1	[Scoria pattern]	Scoria		
251	2				
250	3				
249	4				
248	5				
247	6				
246	7				
245	8				
244	9	[Vesicular and dense lava pattern]	Vesicular and dense lava, Búrfellshraun THi		
243	10				
242	11				
241	12				
240	13				
239	14				
238	15				
237	16				
236	17				
235	18				
234	19	V.V.V	Tephra		
233	20				
232	21				
231	22				
230	23				

PH-111

BOREHOLE LOG  
PERCUSSION DRILLING

Printed 14.4.2015, scale 1:250

DRILLING DATE 1980/1981

PROJECT Wind Farms in Thjorsa - Tungnaá area

PROJECT NR. 1611-159

LOCATION Sultartangi - Frárennslisskurður

RECORDED BY

COORDINATES X: 465962.30 Y: 404915.90 Z: 255.4 COORD. SYSTEM ISN93 INCLINATION 0° from vertical

CASING Ø ["] CASING AGL [m] TOTAL DEPTH [m] 30,5 DRILLED OUTSIDE CASING [m] CASING LENGHT [m]

CONTRACTOR OPERATOR DRILL RIG DRILL BIT

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]	
				0	360

Elev. [m asl]	Depth [m]	Lithol.	Description	Drilling speed [sec/m]
255	0			
254	1	∇ ∇ ∇	Loose overburden	
253	2	∇ ∇ ∇		
252	3	∇ ∇ ∇		
251	4	∇ ∇ ∇	Scoria	
250	5	∇ ∇ ∇		
249	6	∇ ∇ ∇		
248	7	∇ ∇ ∇		
247	8	∇ ∇ ∇		
246	9	∇ ∇ ∇		
245	10	∇ ∇ ∇		
244	11	∇ ∇ ∇		
243	12	∇ ∇ ∇	Vesicular and dense lava, Búrfellshraun THi	
242	13	∇ ∇ ∇		
241	14	∇ ∇ ∇		
240	15	∇ ∇ ∇		
239	16	∇ ∇ ∇		
238	17	∇ ∇ ∇		
237	18	∇ ∇ ∇		
236	19	∇ ∇ ∇		
235	20	∇ ∇ ∇		
234	21	∇ ∇ ∇		
233	22	∇ ∇ ∇		
232	23	∇ ∇ ∇		
231	24	∇ ∇ ∇		
230	25	∇ ∇ ∇		
229	26	∇ ∇ ∇		
228	27	∇ ∇ ∇		
227	28	∇ ∇ ∇		
226	29	∇ ∇ ∇		
225	30	∇ ∇ ∇	Tephra	

## **APPENDIX 5**

### **RAM SOUNDING DATA**





Ram sounding hole: HC-03  
Date: 5.12.2013  
Worker: BJ, GEÓ

XYZ 468041,934 404903,066 259,3

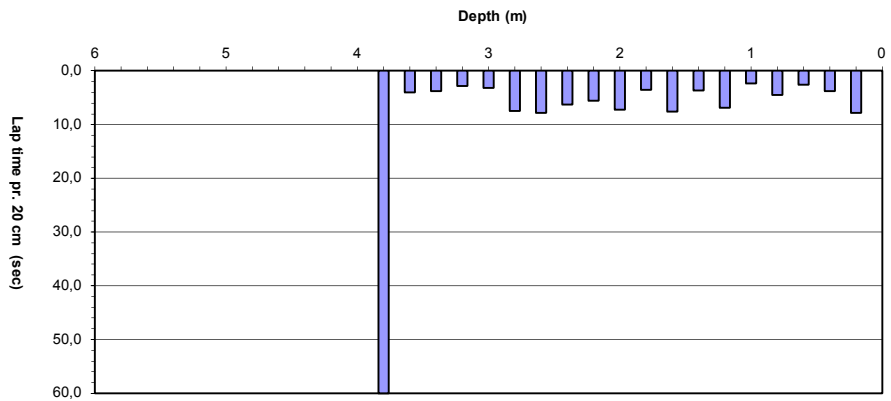
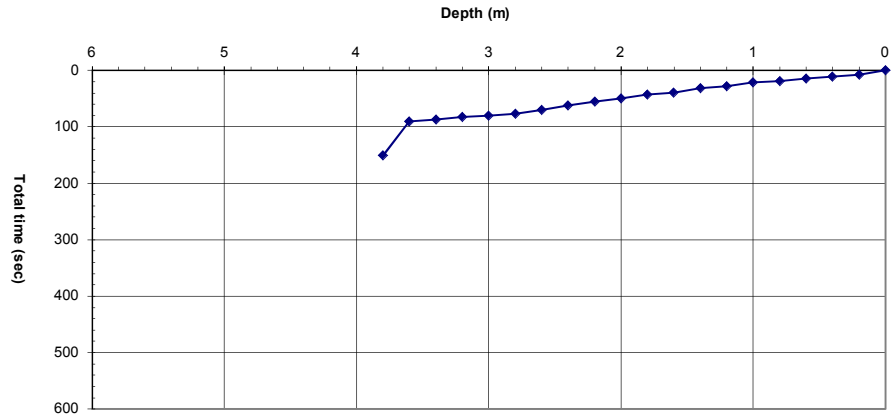
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	7,8	8
0,40	3,8	12
0,60	2,6	14
0,80	4,5	19
1,00	2,3	21
1,20	6,9	28
1,40	3,7	32
1,60	7,6	39
1,80	3,5	43
2,00	7,2	50
2,20	5,5	55
2,40	6,3	62
2,60	7,8	70
2,80	7,5	77
3,00	3,2	80
3,20	2,8	83
3,40	3,8	87
3,60	4,0	91
3,80	60,0	151
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	3,7	m
Firm B.	3,7	m
Stop	3,7	m
GWL:	2,7	m

**Description**

Tephra plain with larger lava rocks on the surface. Sand from the surface down to the bottom. Water below 2,7 m depth. Probably stopped in solid rock.



Ram sounding hole: HC-04  
Date: 4.12.2013  
Worker: BJ, GEÓ

XYZ 464512,542 399954,175 240,39

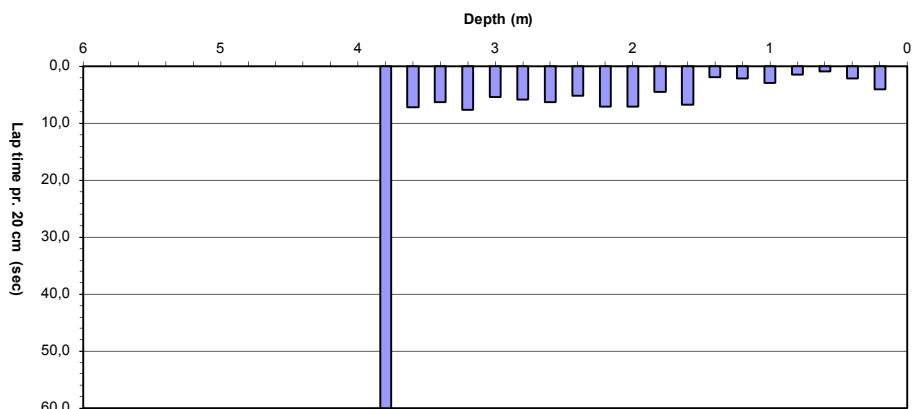
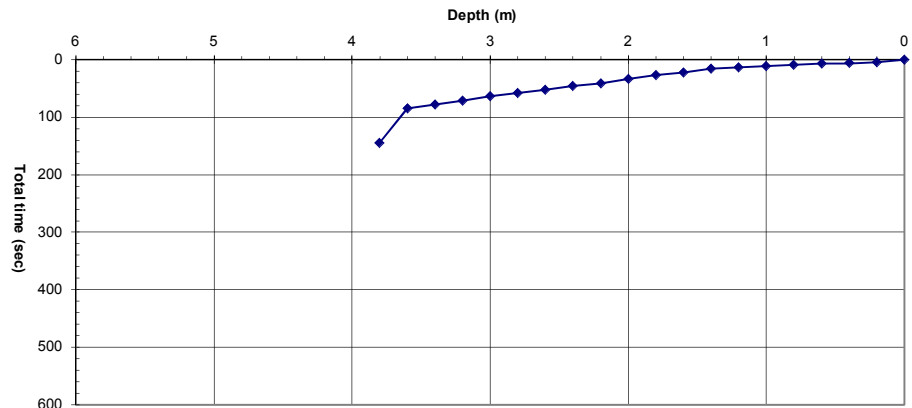
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	4,1	4
0,40	2,1	6
0,60	0,9	7
0,80	1,5	9
1,00	2,9	12
1,20	2,1	14
1,40	1,9	16
1,60	6,7	22
1,80	4,5	27
2,00	7,1	34
2,20	7,1	41
2,40	5,2	46
2,60	6,3	52
2,80	5,9	58
3,00	5,4	64
3,20	7,6	71
3,40	6,3	78
3,60	7,2	85
3,80	60,0	145
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	3,8	m
Firm B.	3,8	m
Stop	3,8	m
GWL:	3,6	m

**Description**

Tephra plain and low hills on the surface. It was difficult to turn the drill just above solid rock, but at the bottom the turning gets easy. Sand from the surface down to the bottom.



Ram sounding hole: HC-05  
Date: 4.12.2013  
Worker: BJ, GEÓ

XYZ 465208,924 400657,222 243,68

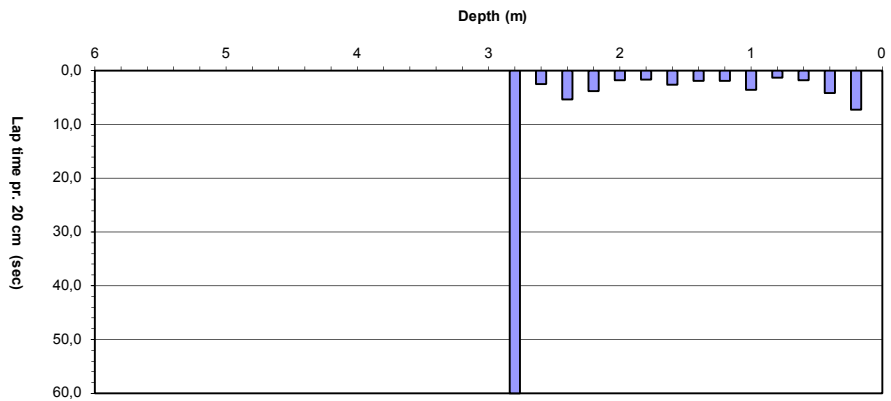
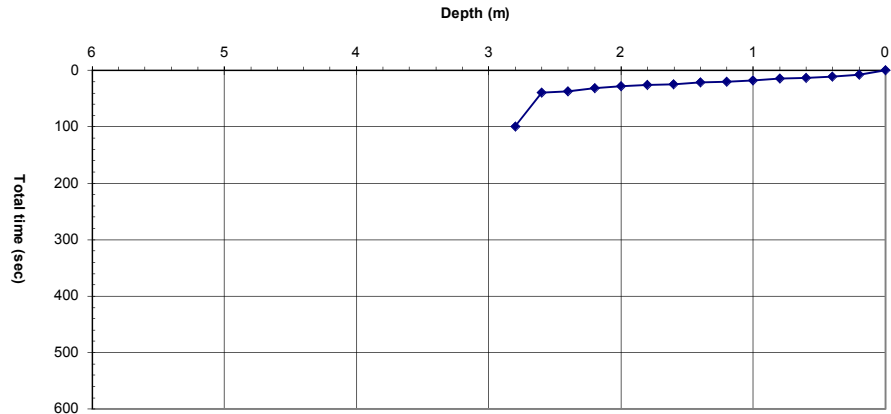
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	7,2	7
0,40	4,1	11
0,60	1,8	13
0,80	1,3	14
1,00	3,5	18
1,20	1,9	20
1,40	1,9	22
1,60	2,6	24
1,80	1,6	26
2,00	1,7	28
2,20	3,8	31
2,40	5,3	37
2,60	2,4	39
2,80	60,0	99
3,00		
3,20		
3,40		
3,60		
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	2,8	m
Firm B.	2,8	m
Stop	2,8	m
GWL:	2,3	m

**Description**

Tephra plain and low hills on the surface with a few pseudocraters protruding the sand. Drill stops rather abruptly on solid rock. Fine aeolian sand and tephra in notches at 1,8 m and 2,8 m depth.



Ram sounding hole: HC-06  
Date: 6.12.2013  
Worker: BJ, GEÓ

XYZ 465916,537 401366,605 248,05

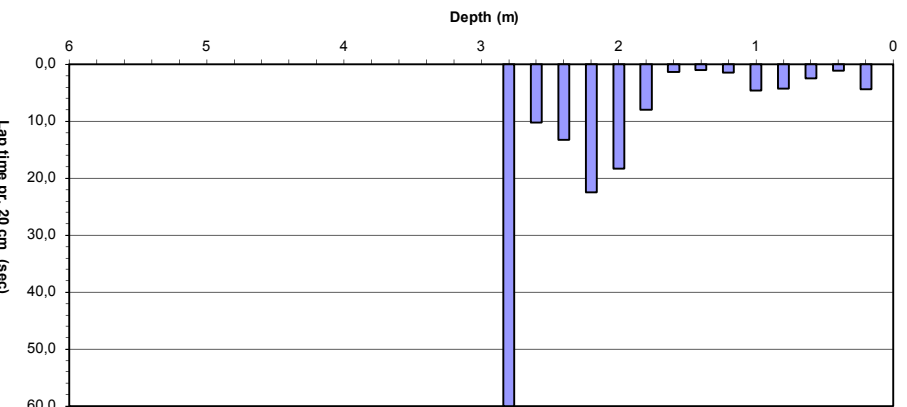
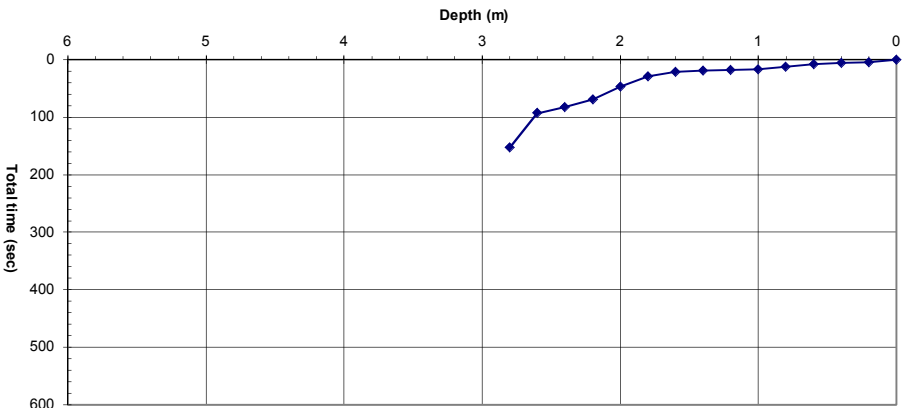
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	4,4	4
0,40	1,1	6
0,60	2,5	8
0,80	4,3	12
1,00	4,6	17
1,20	1,5	18
1,40	1,0	19
1,60	1,4	21
1,80	8,0	29
2,00	18,3	47
2,20	22,5	70
2,40	13,3	83
2,60	10,2	93
2,80	60,0	153
3,00		
3,20		
3,40		
3,60		
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	2,0	m
Firm B.	2,8	m
Stop	2,8	m
GWL:	-	m

**Description**

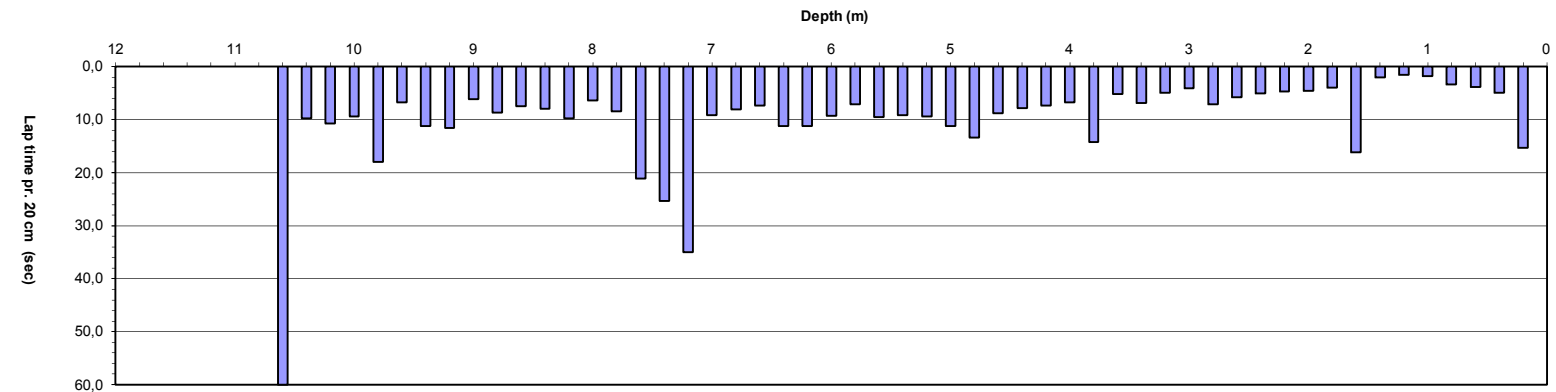
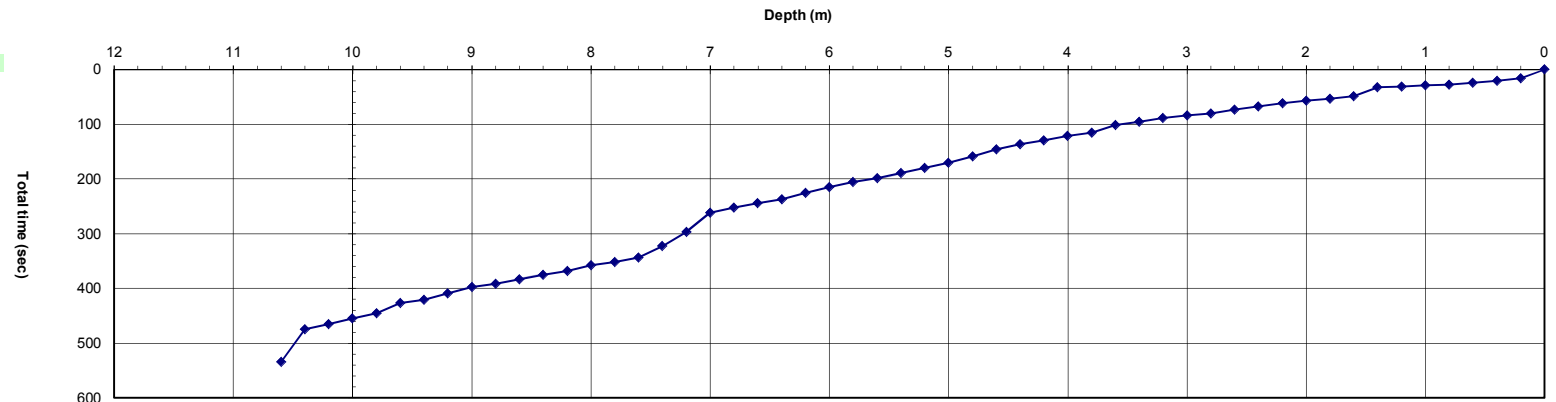
Tephra and lava on the surface. Drill stops quickly, most likely in solid rock. Sand from the surface down to bottom. Silt in drill rod notches near the bottom (probably aeolian sediment). Drilling rods are dry. Gjóskumelur og hraun á yfirborði. Stöppar snögglega, líklega klöpp. Sandur frá yfirborði niður. Silt eða borsallí í hökum í botni. Stál þurr.



Ram sounding hole: HC-08  
Date: 6.12.2013  
Worker: GEÓ, BJ

XYZ 467337,730 402817,614 259,26

Depth (m)	Lap time (sec)	Time (sec)
0,0	0,0	0
0,2	15,3	15
0,4	4,9	20
0,6	3,8	24
0,8	3,4	27
1,0	1,8	29
1,2	1,5	31
1,4	2,0	33
1,6	16,1	49
1,8	4,0	53
2,0	4,5	57
2,2	4,7	62
2,4	5,0	67
2,6	5,7	73
2,8	7,1	80
3,0	4,1	84
3,2	4,9	89
3,4	6,8	96
3,6	5,1	101
3,8	14,2	115
4,0	6,7	122
4,2	7,3	129
4,4	7,8	137
4,6	8,8	146
4,8	13,4	159
5,0	11,2	170
5,2	9,4	180
5,4	9,2	189
5,6	9,5	198
5,8	7,1	205
6,0	9,3	215
6,2	11,2	226
6,4	11,2	237
6,6	7,3	244
6,8	8,1	252
7,0	9,2	262
7,2	35,0	297
7,4	25,3	322
7,6	21,1	343
7,8	8,4	351
8,0	6,4	358
8,2	9,8	368
8,4	7,9	376
8,6	7,4	383
8,8	8,7	392
9,0	6,1	398
9,2	11,5	409
9,4	11,2	420
9,6	6,7	427
9,8	17,9	445
10,0	9,4	454
10,2	10,7	465
10,4	9,7	475
10,6	60,0	535
10,8		
11,0		
11,2		
11,4		
11,6		
11,8		
12,0		



**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	9,8	m
Firm B.	10,5	m
Stop	10,5	m
GWL:	-	m

**Description**

Location of drill hole slightly altered due to a fiber optics cable nearby. Slightly hilly lava on the surface, whereas the depressions between are filled with tephra. Drilling indicates sand from the surface down to the bottom.

Ram sounding hole: HC-10  
Date: 5.12.2013  
Worker: BJ, GEÓ

XYZ 468747,209 404194,197 259,64

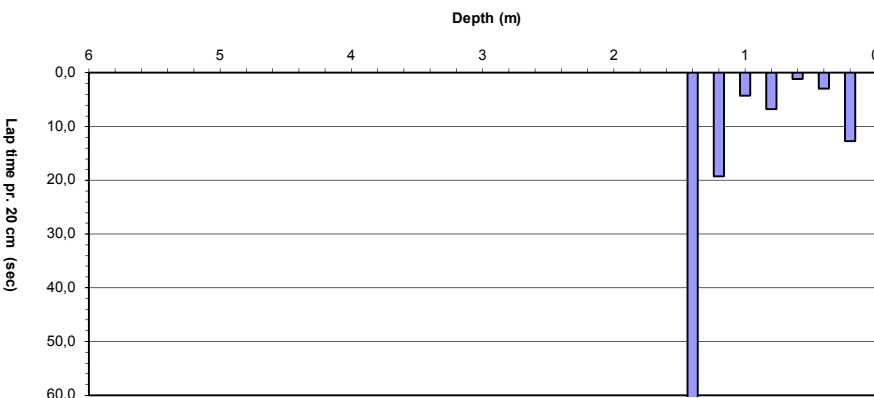
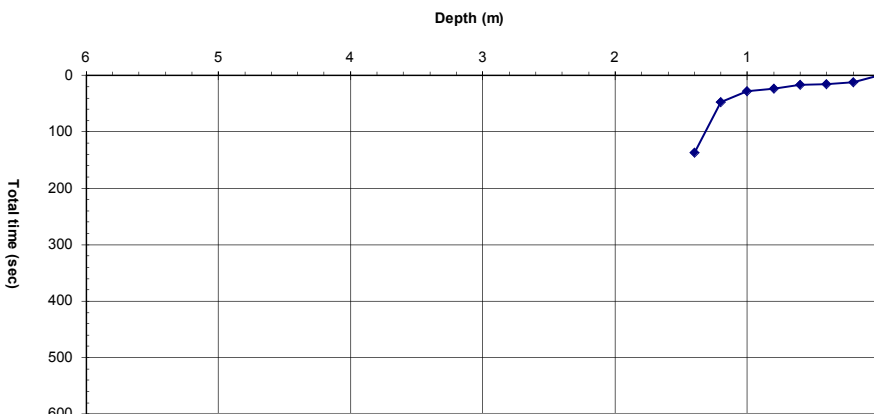
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	12,7	13
0,40	2,9	16
0,60	1,1	17
0,80	6,7	23
1,00	4,3	28
1,20	19,3	47
1,40	90,0	137
1,60		
1,80		
2,00		
2,20		
2,40		
2,60		
2,80		
3,00		
3,20		
3,40		
3,60		
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	1,1	m
Firm B.	1,3	m
Stop	1,3	m
GWL:	-	m

**Description**

Tephra plain and lava rocks on the surface. Sand from the surface down. Stopped in coarse lava/scoria at the bottom, most likely on a large rock. Not far down to solid rock.



Ram sounding hole: HC-12  
Date: 6.12.2013  
Worker: BJ, GEÓ

XYZ 470160,377 405607,924 262,7

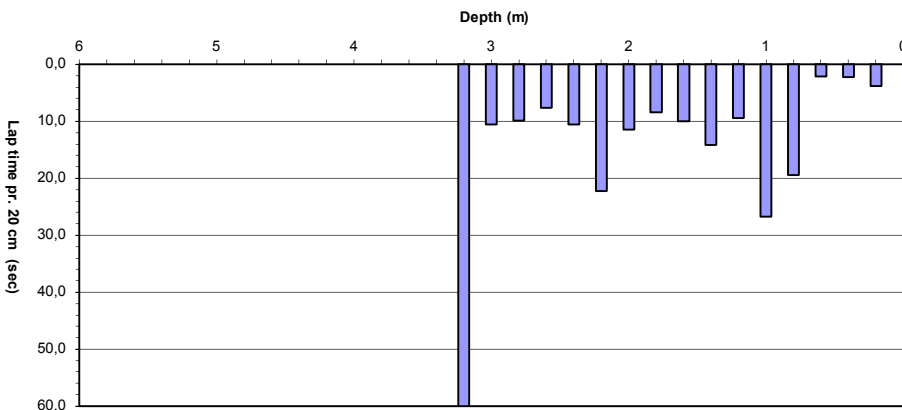
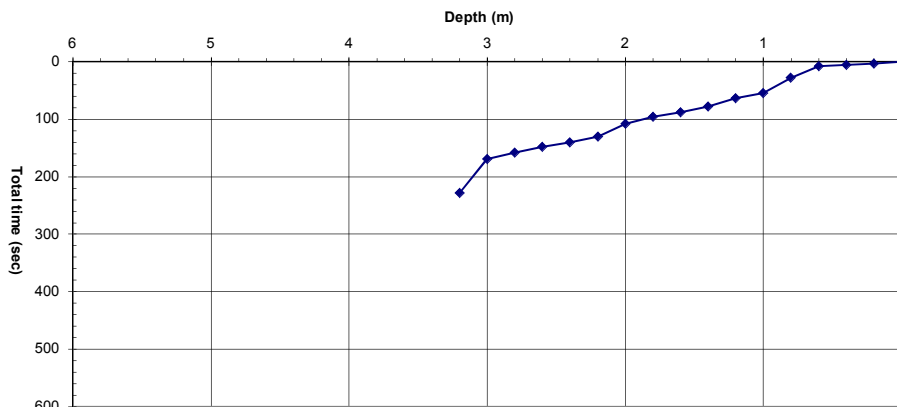
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	3,8	4
0,40	2,2	6
0,60	2,1	8
0,80	19,5	28
1,00	26,7	54
1,20	9,4	64
1,40	14,2	78
1,60	10,0	88
1,80	8,4	96
2,00	11,5	108
2,20	22,3	130
2,40	10,6	141
2,60	7,7	148
2,80	9,9	158
3,00	10,6	169
3,20	60,0	229
3,40		
3,60		
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	3,1	m
Firm B.	3,1	m
Stop	3,1	m
GWL:	2,8	m

**Description**

Tephra plain and lava rocks on the surface. Rocky below 0,6 m depth. Drill stops suddenly and it is not possible to turn the drill at the end. Drill stopped in solid rock. The two meters of drilling rods at the bottom are bent. Sand/tephra in drill rod notches.



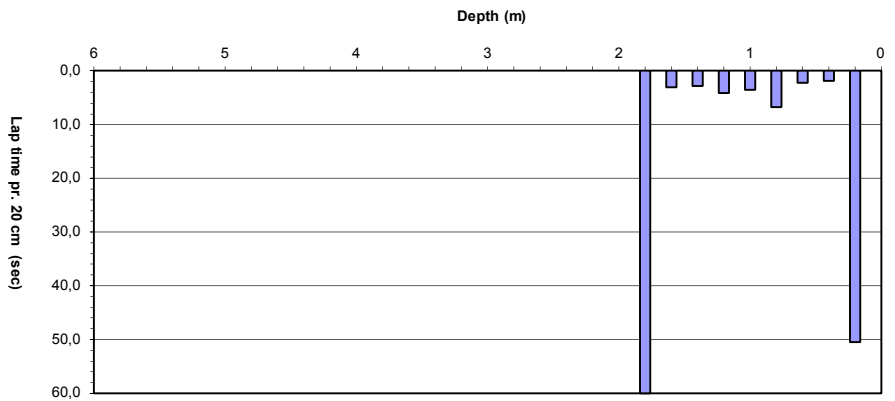
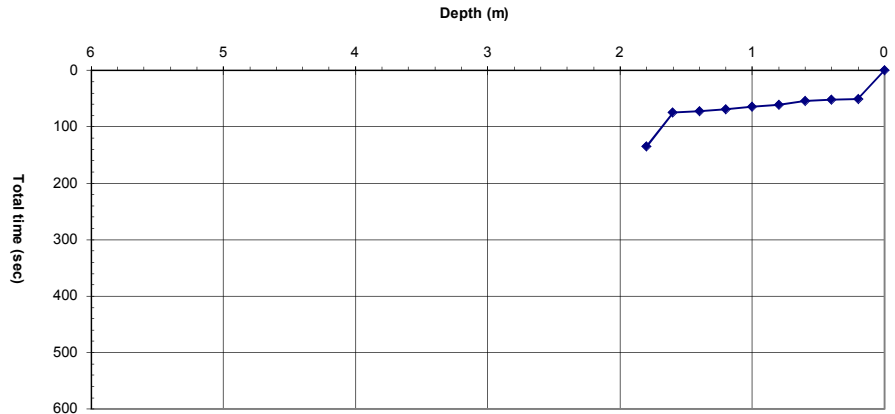
Ram sounding hole: HC-13  
Date: 6.12.2013  
Worker: BJ, GEÓ

XYZ 470872,432 406315,691 268,35

Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	50,5	51
0,40	1,9	52
0,60	2,2	55
0,80	6,8	61
1,00	3,5	65
1,20	4,1	69
1,40	2,8	72
1,60	3,1	75
1,80	60,0	135
2,00		
2,20		
2,40		
2,60		
2,80		
3,00		
3,20		
3,40		
3,60		
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**  
By hand 0,0 m  
Organics 0,0 m  
Bearing B. 1,8 m  
Firm B. 1,8 m  
Stop 1,8 m  
GWL: - m

**Description**  
Tephra plain and a few larger lava rocks on the surface.  
Long drilling time at the surface is due to frost. Sand from the surface down to the bottom.



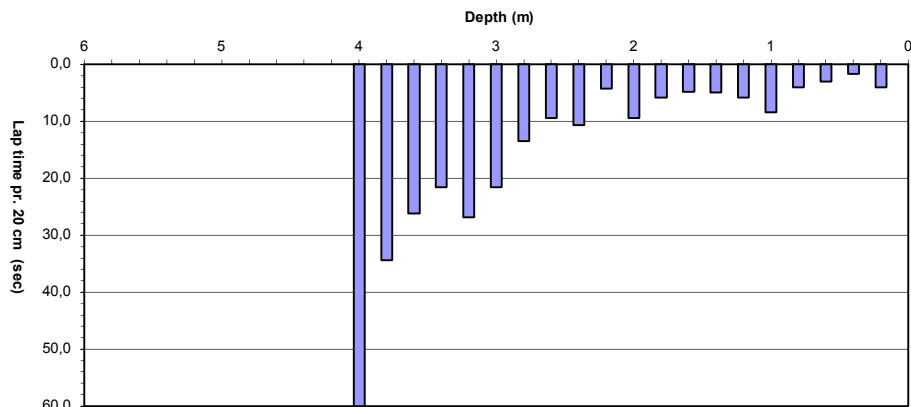
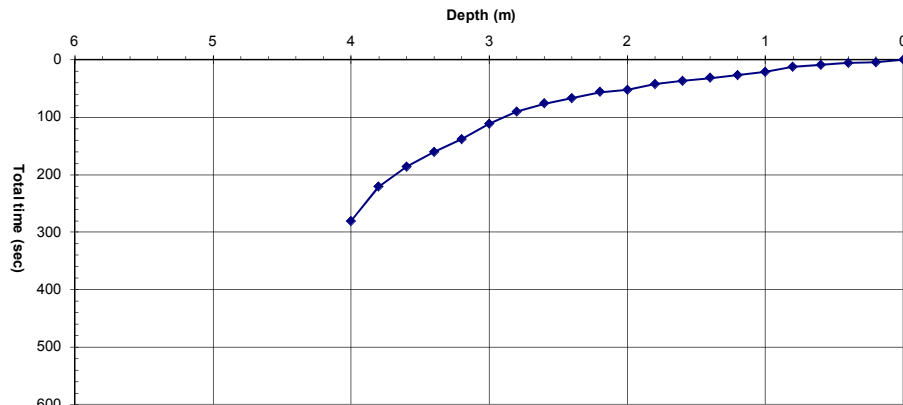
Ram sounding hole: HC-21  
Date: 4.12.2013  
Worker: BJ, GEÓ

XYZ 467328,722 401368,643 253,41

Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	4,1	4
0,40	1,7	6
0,60	3,0	9
0,80	4,0	13
1,00	8,4	21
1,20	5,8	27
1,40	4,9	32
1,60	4,8	37
1,80	5,8	43
2,00	9,5	52
2,20	4,3	56
2,40	10,7	67
2,60	9,4	76
2,80	13,5	90
3,00	21,6	112
3,20	26,9	138
3,40	21,6	160
3,60	26,2	186
3,80	34,4	221
4,00	60,0	281
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**  
By hand 0,0 m  
Organics 0,0 m  
Bearing B. 2,4 m  
Firm B. 3,9 m  
Stop 3,9 m  
GWL: 2,0 m

**Description**  
Tephra plain on the surface. Sand and silt below 2,0 m depth down to the bottom. Water at 2,0 m, but dry silt at the bottom (most likely aeolian sediment). It was not possible to turn the drill below 2,4 m depth.





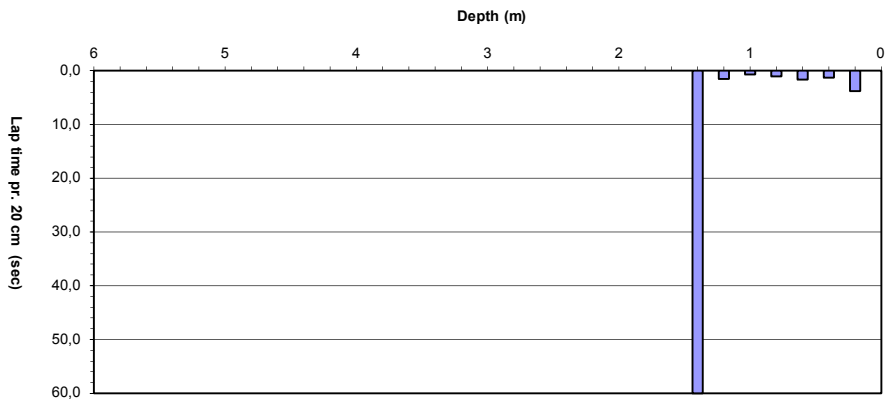
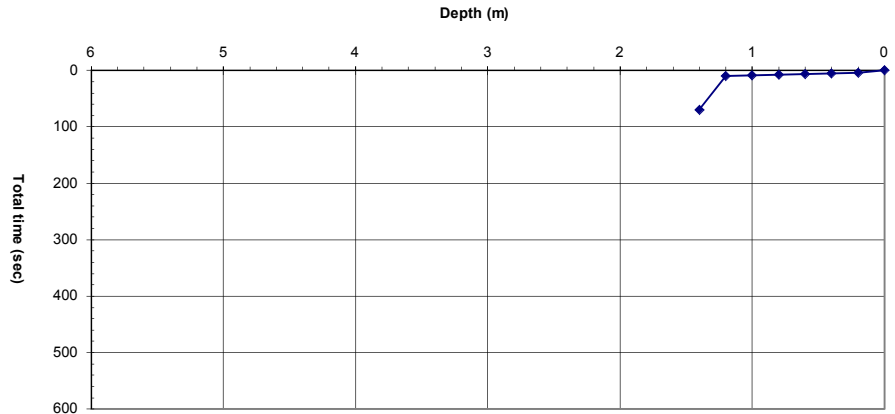
Ram sounding hole: HC-22  
Date: 4.12.2013  
Worker: BJ, GEÓ

XYZ 468038,546 402069,114 257,14

Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	3,8	4
0,40	1,3	5
0,60	1,6	7
0,80	1,0	8
1,00	0,7	8
1,20	1,5	10
1,40	60,0	70
1,60		
1,80		
2,00		
2,20		
2,40		
2,60		
2,80		
3,00		
3,20		
3,40		
3,60		
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**  
By hand 0,0 m  
Organics 0,0 m  
Bearing B. 1,4 m  
Firm B. 1,4 m  
Stop 1,4 m  
GWL: 1,0 m

**Description**  
Tephra plain and lava rocks on the surface. Sand from the surface down to bottom. Drill slows down to a halt and stops in solid rock. Drill rods are loose and the tip is hot.



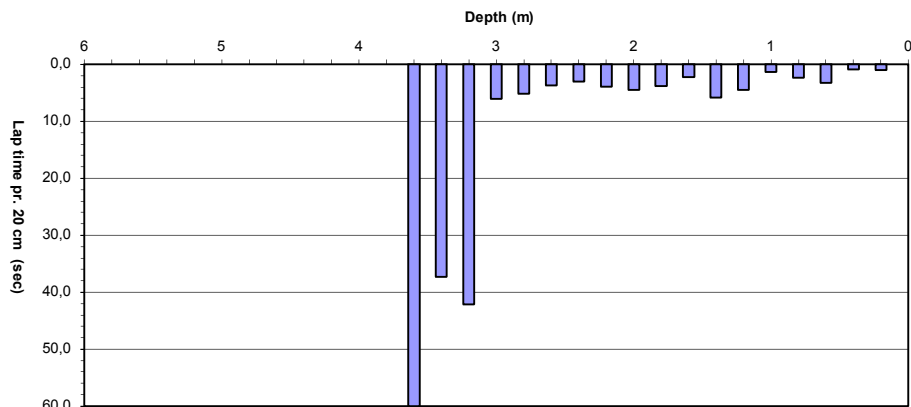
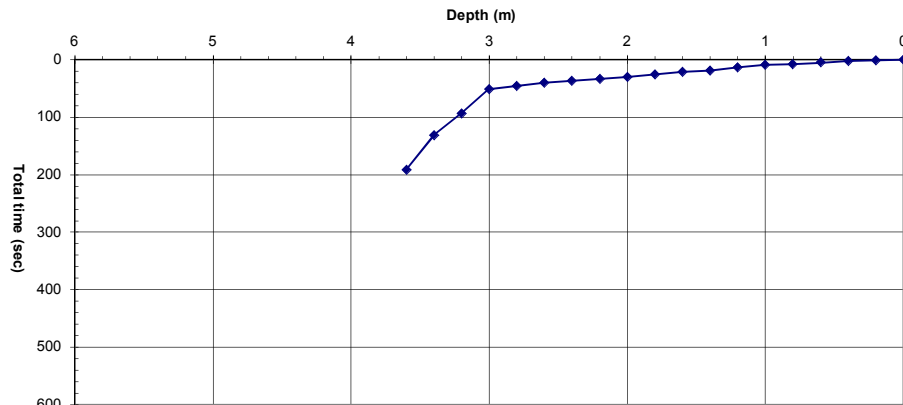
Ram sounding hole: HC-24  
Date: 5.12.2013  
Worker: BJ, GEÓ

XYZ 469455,708 403489,923 261,61

Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	1,0	1
0,40	0,9	2
0,60	3,3	5
0,80	2,4	8
1,00	1,3	9
1,20	4,5	13
1,40	5,9	19
1,60	2,3	22
1,80	3,8	25
2,00	4,5	30
2,20	3,9	34
2,40	3,0	37
2,60	3,7	41
2,80	5,2	46
3,00	6,1	52
3,20	42,2	94
3,40	37,3	131
3,60	60,0	191
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**  
By hand 0,0 m  
Organics 0,0 m  
Bearing B. 3,2 m  
Firm B. 3,6 m  
Stop 3,6 m  
GWL: 2,6 m

**Description**  
Tephra plain and lava rocks on the surface. It gets more and more difficult to turn the drill with depth and it is not possible at the end. The bottom drill rod is bent and scratched, indicating a possible joint or fracture at the bottom. Fine sand at 2,6 and 3,6 m depth.



Ram sounding hole: HC-25  
Date: 5.12.2013  
Worker: BJ, GEÓ

XYZ 470165,392 404193,785 264,47

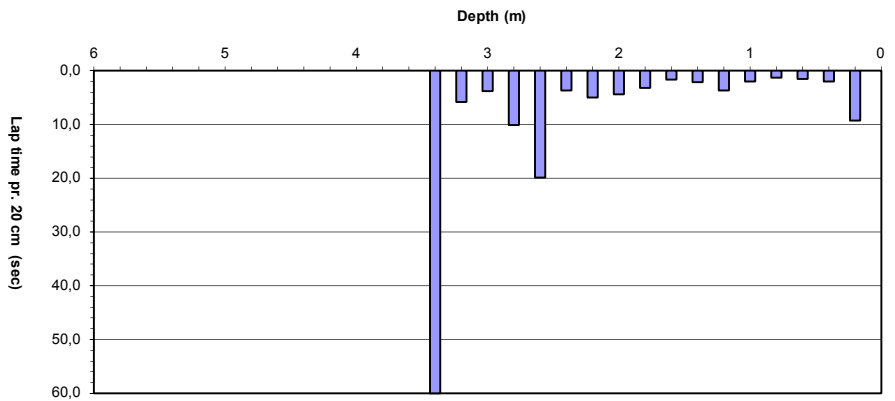
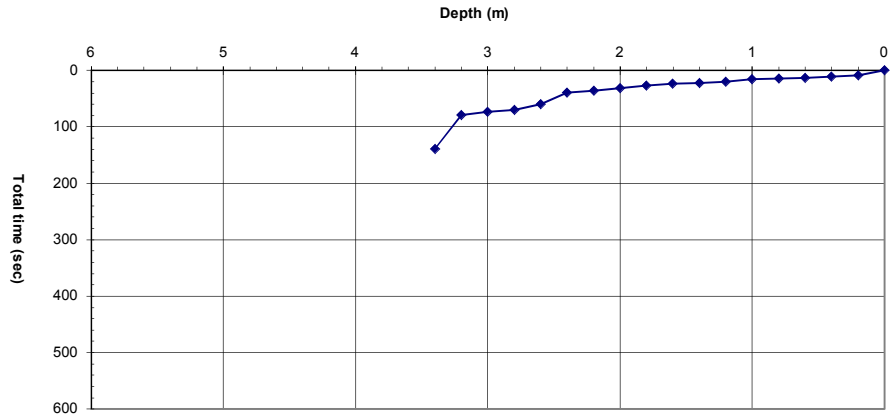
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	9,3	9
0,40	2,0	11
0,60	1,5	13
0,80	1,3	14
1,00	2,0	16
1,20	3,7	20
1,40	2,1	22
1,60	1,6	24
1,80	3,2	27
2,00	4,4	31
2,20	4,9	36
2,40	3,7	40
2,60	19,9	60
2,80	10,1	70
3,00	3,8	74
3,20	5,8	79
3,40	60,0	139
3,60		
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	3,4	m
Firm B.	3,4	m
Stop	3,4	m
GWL:	-	m

**Description**

Tephra plain and lava rocks on the surface. Drilling slows down at 2,6 m depth because of a rock. Dark brown, moist sand in the notches at 2,2 m depth and at the bottom. Most likely coarse lava / scoria at the bottom.



Ram sounding hole: HC-26  
Date: 6.12.2013  
Worker: BJ, GEÓ

XYZ 470870,732 404903,042 264,38

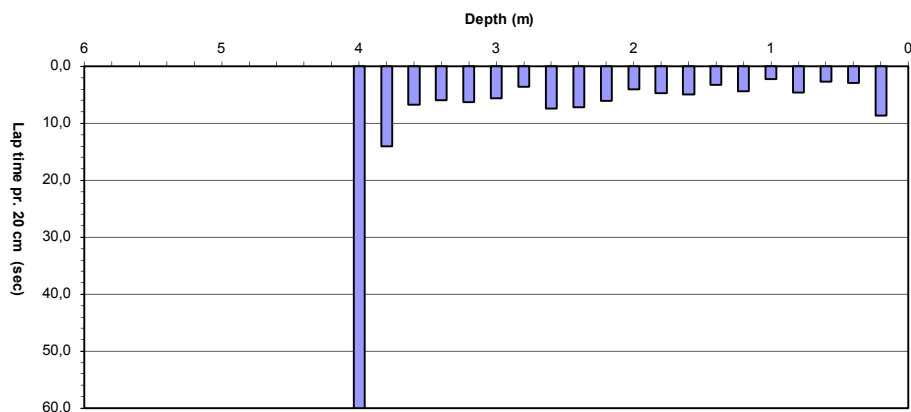
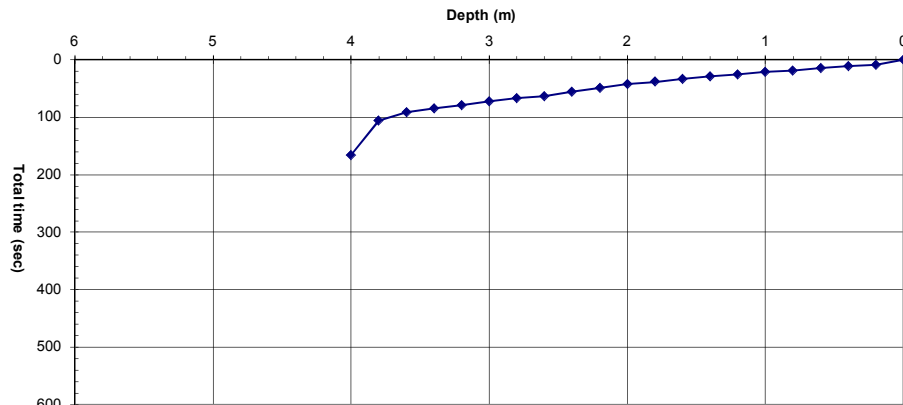
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	8,7	9
0,40	2,9	12
0,60	2,7	14
0,80	4,6	19
1,00	2,3	21
1,20	4,4	26
1,40	3,3	29
1,60	5,0	34
1,80	4,7	39
2,00	4,1	43
2,20	6,1	49
2,40	7,2	56
2,60	7,4	63
2,80	3,6	67
3,00	5,6	73
3,20	6,3	79
3,40	6,0	85
3,60	6,8	92
3,80	14,1	106
4,00	60,0	166
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	3,8	m
Firm B.	3,9	m
Stop	3,9	m
GWL:	3,3	m

**Description**

Slightly hilly lava with pseudocraters on the surface, whereas the depressions between are filled with tephra. Sand from the surface down to the bottom.



Ram sounding hole: HC-28  
Date: 6.12.2013  
Worker: BJ, GEÓ

XYZ 472286,792 406319,025 276,31

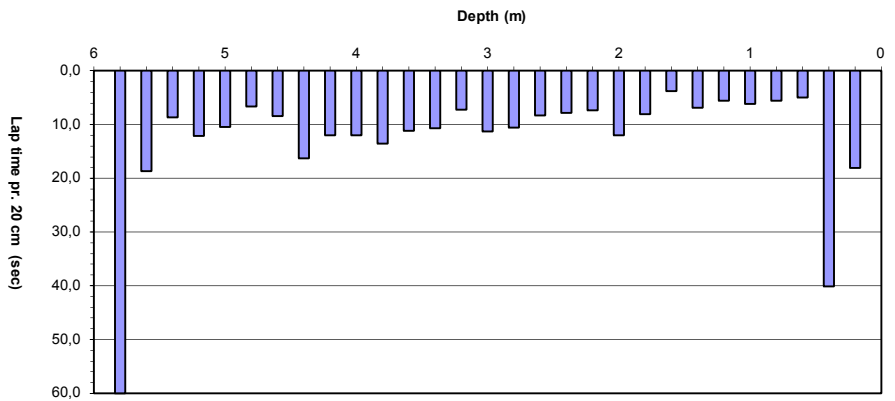
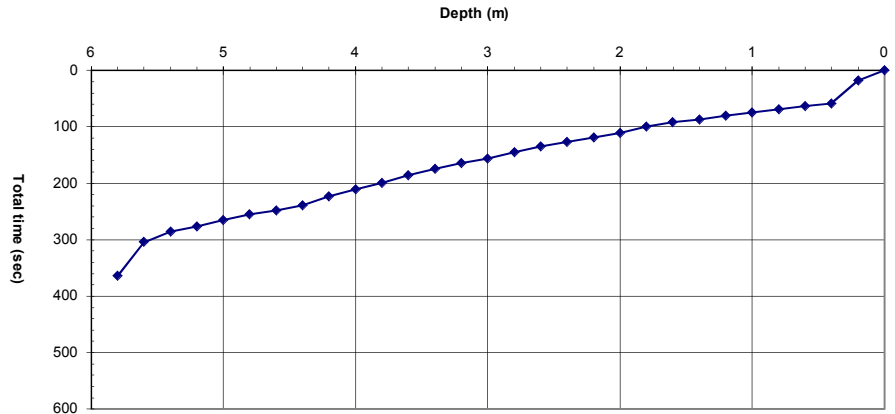
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	18,1	18
0,40	40,1	58
0,60	5,0	63
0,80	5,6	69
1,00	6,2	75
1,20	5,6	81
1,40	6,9	88
1,60	3,8	91
1,80	8,0	99
2,00	12,0	111
2,20	7,4	119
2,40	7,8	127
2,60	8,3	135
2,80	10,6	145
3,00	11,3	157
3,20	7,2	164
3,40	10,7	175
3,60	11,1	186
3,80	13,5	199
4,00	12,0	211
4,20	12,0	223
4,40	16,3	240
4,60	8,4	248
4,80	6,6	255
5,00	10,4	265
5,20	12,1	277
5,40	8,6	286
5,60	18,7	304
5,80	60,0	364
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	2,7	m
Firm B.	5,7	m
Stop	5,7	m
GWL:	4,0	m

**Description**

Drilled in the centre of an access road - the top three meters are therefore disturbed. Difficult to turn the drill below 3,6 m depth. Fine sand below 4,0 m. Not possible to turn at the end.



Ram sounding hole: HC-38  
Date: 5.12.2013  
Worker: BJ, GEÓ

XYZ 470163,530 402781,803 263,24

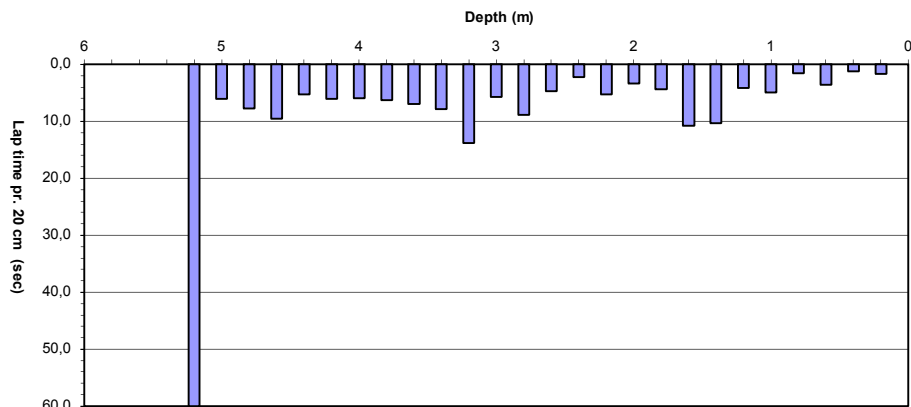
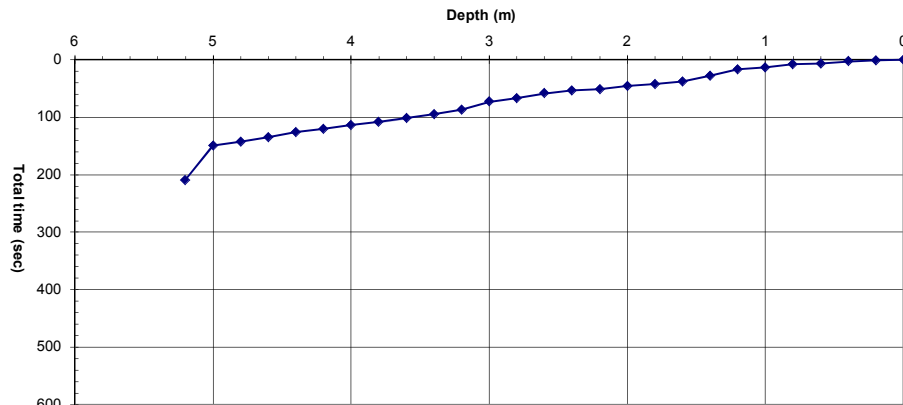
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	1,7	2
0,40	1,2	3
0,60	3,6	7
0,80	1,6	8
1,00	5,0	13
1,20	4,2	17
1,40	10,3	28
1,60	10,8	38
1,80	4,4	43
2,00	3,4	46
2,20	5,3	52
2,40	2,3	54
2,60	4,7	59
2,80	8,9	67
3,00	5,7	73
3,20	13,8	87
3,40	7,9	95
3,60	7,0	102
3,80	6,3	108
4,00	6,0	114
4,20	6,1	120
4,40	5,3	126
4,60	9,6	135
4,80	7,8	143
5,00	6,1	149
5,20	60,0	209
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	5,2	m
Firm B.	5,2	m
Stop	5,2	m
GWL:	-	m

**Description**

Pseudocraters and lava rocks on the surface, along with thepra (lapilli). Drilled through sand down to the bottom. Not difficult to turn the drill, stopped abruptly in solid rock. Drill rod moist below 1,8 m depth, sand in notches. Groundwater level not certain.



Ram sounding hole: HC-40  
Date: 5.12.2013  
Worker: BJ, GEÓ

XYZ 471577,660 404196,808 266,97

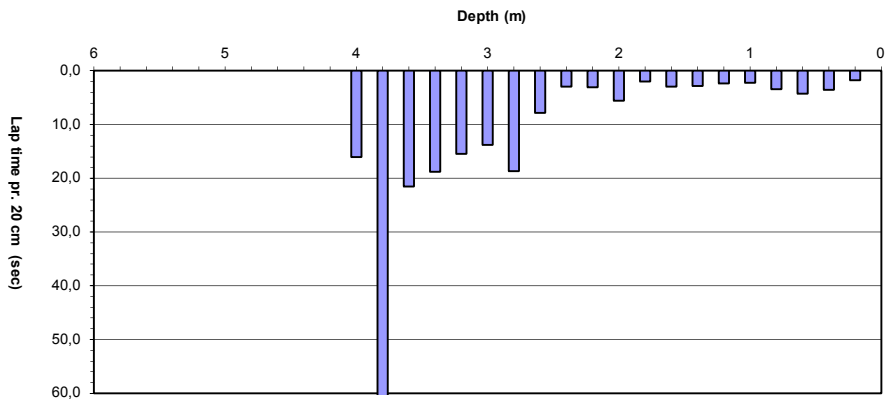
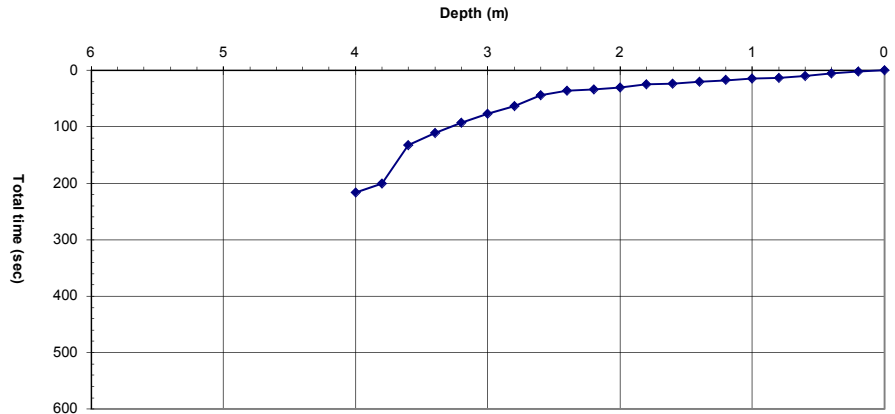
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	1,7	2
0,40	3,5	5
0,60	4,2	9
0,80	3,4	13
1,00	2,2	15
1,20	2,3	17
1,40	2,8	20
1,60	2,9	23
1,80	2,0	25
2,00	5,6	31
2,20	3,0	34
2,40	2,9	37
2,60	7,8	44
2,80	18,7	63
3,00	13,8	77
3,20	15,4	92
3,40	18,8	111
3,60	21,5	133
3,80	68,0	201
4,00	16,0	217
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	2,8	m
Firm B.	3,9	m
Stop	3,9	m
GWL:	3,8	m

**Description**

Tephra in a lava field. Pseudocraters and lava rocks protrude from the sand. Not possible to turn the drill below 3,0 m depth. Sand in the bottom notch, drilling rod bent at the tip, slightly warm.



Ram sounding hole: HC-41  
Date: 5.12.2013  
Worker: BJ, GEÓ

XYZ 472287,178 404898,974 269,23

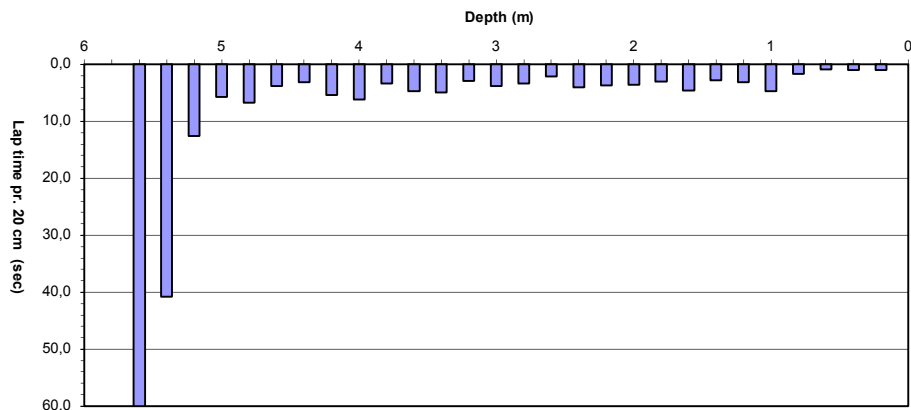
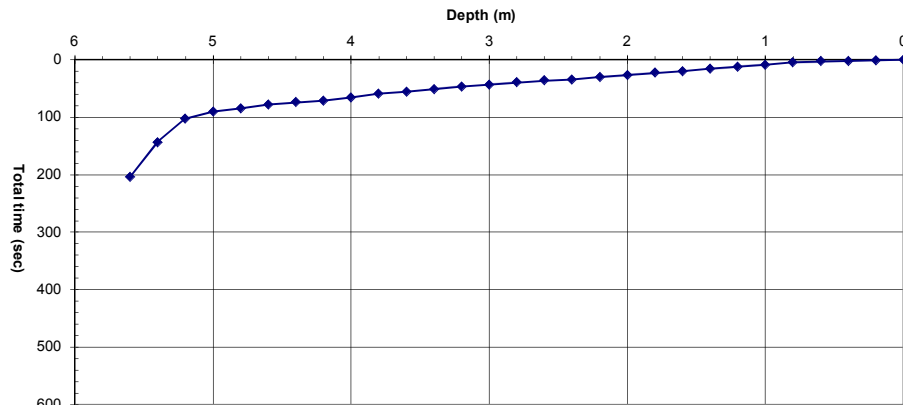
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	1,0	1
0,40	1,0	2
0,60	0,9	3
0,80	1,7	5
1,00	4,7	9
1,20	3,2	13
1,40	2,8	15
1,60	4,6	20
1,80	3,0	23
2,00	3,6	27
2,20	3,7	30
2,40	4,0	34
2,60	2,1	36
2,80	3,4	40
3,00	3,8	44
3,20	2,9	46
3,40	5,0	51
3,60	4,7	56
3,80	3,4	60
4,00	6,2	66
4,20	5,4	71
4,40	3,1	74
4,60	3,8	78
4,80	6,7	85
5,00	5,7	90
5,20	12,6	103
5,40	40,8	144
5,60	60,0	204
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	5,2	m
Firm B.	5,5	m
Stop	5,5	m
GWL:	4,8	m

**Description**

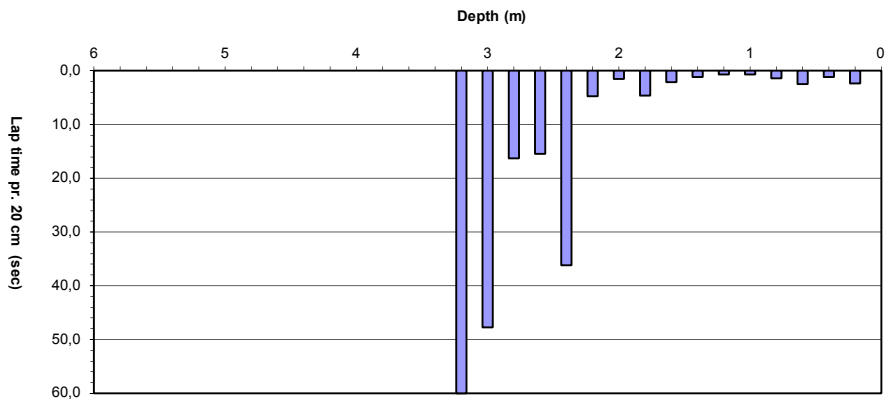
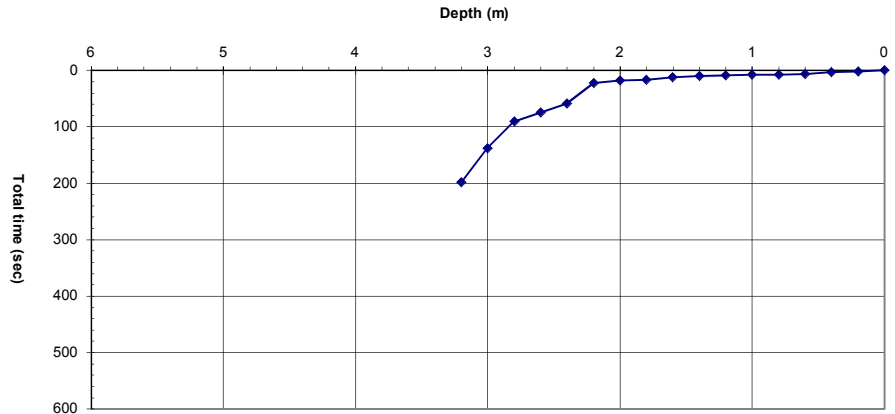
Tephra plain and lava rocks on the surface. It was not possible to turn the drill at the bottom; the drill rod most likely gets stuck in coarse lava / scoria. Sand from the surface down.



Ram sounding hole: HC-43  
Date: 5.12.2013  
Worker: BJ, GEÓ

XYZ 473698,336 406317,137 284,23

Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	2,3	2
0,40	1,2	4
0,60	2,5	6
0,80	1,4	7
1,00	0,7	8
1,20	0,7	9
1,40	1,1	10
1,60	2,1	12
1,80	4,6	17
2,00	1,5	18
2,20	4,7	23
2,40	36,2	59
2,60	15,4	74
2,80	16,3	91
3,00	47,7	138
3,20	60,0	198
3,40		
3,60		
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		



**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	2,4	m
Firm B.	3,2	m
Stop	3,2	m
GWL:	-	m

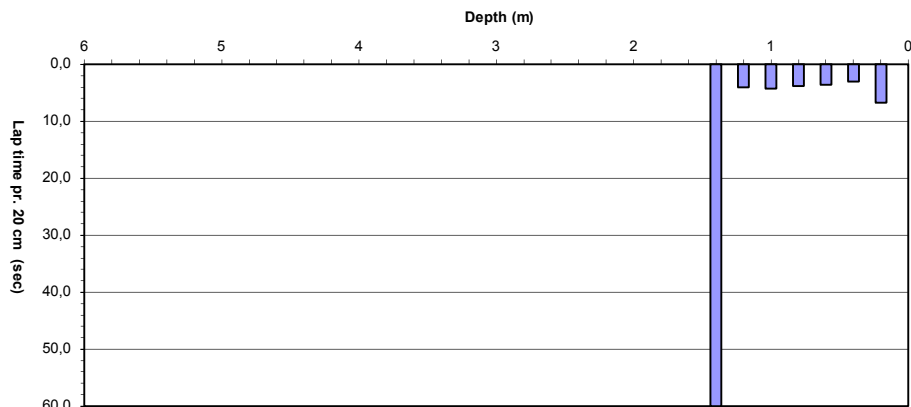
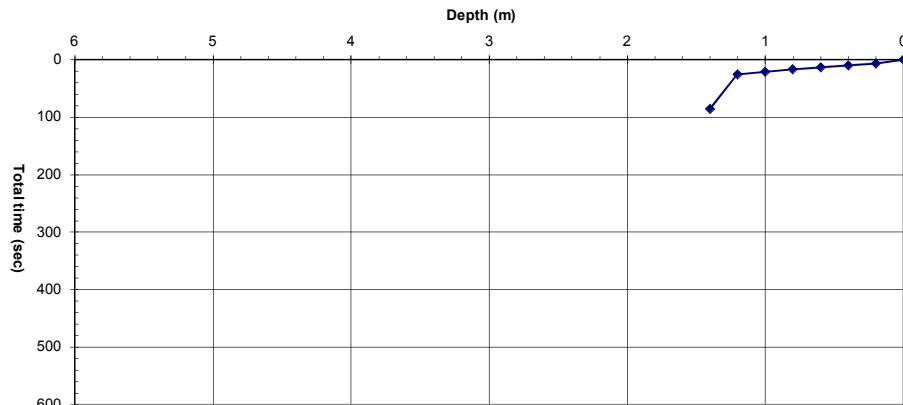
**Description**

Tephra plain and lava rocks (up to 60 cm diameter) on the surface. Not possible to turn the drill at the bottom. The tip is warm and dry, coarse sand in the bottom notches.

Ram sounding hole: HC-54  
Date: 6,12,13  
Worker: BJ, GEÓ

XYZ 472280,996 403493,000 269,11

Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	6,7	7
0,40	3,0	10
0,60	3,6	13
0,80	3,8	17
1,00	4,3	21
1,20	4,1	26
1,40	60,0	86
1,60		
1,80		
2,00		
2,20		
2,40		
2,60		
2,80		
3,00		
3,20		
3,40		
3,60		
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		



**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	1,0	m
Firm B.	1,3	m
Stop	1,3	m
GWL:	1,0	m

**Description**

Tephra plain and lava rocks on the surface. Hole drilled around 5 m north of planned location. Drill stops abruptly at the bottom, difficult to turn at the end. Sand in the bottom notches, tip is slightly warm; most likely stopped in solid rock.

Ram sounding hole: HC-57  
Date: 5.12.2013  
Worker: BJ, GEÓ

XYZ 474404,537 405611,911 286,79

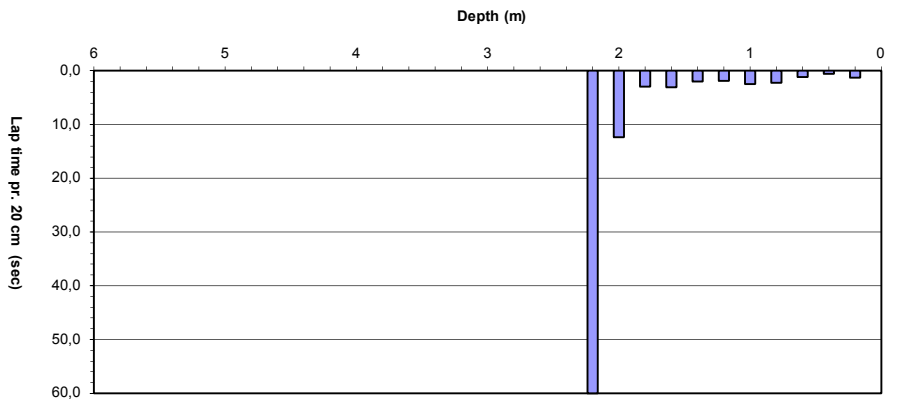
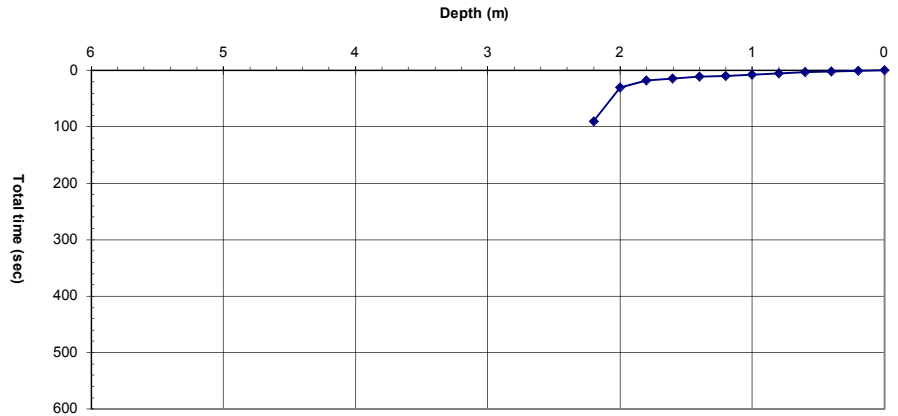
Depth (m)	Lap time (sec)	Time (sec)
0,00		0
0,20	1,3	1
0,40	0,6	2
0,60	1,1	3
0,80	2,2	5
1,00	2,5	8
1,20	1,9	10
1,40	2,0	12
1,60	3,1	15
1,80	2,9	18
2,00	12,4	30
2,20	60,0	90
2,40		
2,60		
2,80		
3,00		
3,20		
3,40		
3,60		
3,80		
4,00		
4,20		
4,40		
4,60		
4,80		
5,00		
5,20		
5,40		
5,60		
5,80		
6,00		

**Interpretation**

By hand	0,0	m
Organics	0,0	m
Bearing B.	2,0	m
Firm B.	2,1	m
Stop	2,1	m
GWL:	1,0	m

**Description**

Lava, tephra and lava rocks on the surface. Tip is warm, most likely stopped in solid rock.







## **APPENDIX 6**

### **AGGREGATE TESTING**



# Grain size distribution

Customer  
**Landsvirkjun**  
Requested by

Project no.  
**1611-159**  
Date printed  
**22.4.2015**

## Information regarding sample

Sample, source  
**Möl og sandur Guðmundareyri (GE2)**  
Sample, marking  
**Guðmundareyri (GE2)**

Project  
**Vindlundir á Þórsár- og Tungnaársvæði**  
Sample, type  
**0-63 mm**

Sample no.  
**586**  
Index no.  
**828**

## Properties

Moisture content [%] **11,20%**  
Clay content (< 0.063mm) [%] **1,5%**  
Humus [-]  
Slam [%]

Grain density  $r_{cm}$  [Mg/m<sup>3</sup>]  
Saturation  $W_{cm}$  [%]  
Bulk density (dry) [kg/m<sup>3</sup>]  
Bulk density (ssd) [kg/m<sup>3</sup>]

Flakiness index FI  
Surface [m<sup>2</sup>/kg]  
Clorine [%]  
Porosity [%]

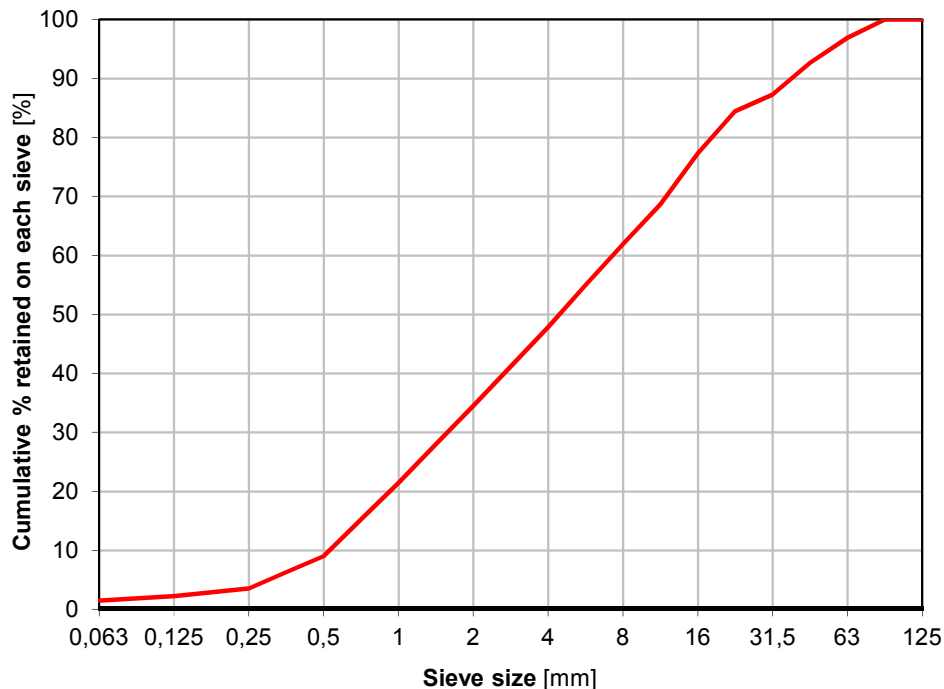
## Grain size distribution

Testing standard  
**ÍST EN 933-1:1997, ÍST EN 933-2**  
Method  Washing and sieving  
Dry sieving

Testing date  
**6.2.2015**

Executed by  
**EÁP**

Sieve size	[mm]	0,063	0,125	0,25	0,5	1	2	4	5,6	8	11,2	16	22,4	31,5	45	63	88	125
<b>Guðmundareyri (GE2)</b>	<b>[%]</b>	<b>1,5</b>	<b>2</b>	<b>4</b>	<b>9</b>	<b>21</b>	<b>34</b>	<b>48</b>	<b>55</b>	<b>62</b>	<b>69</b>	<b>77</b>	<b>84</b>	<b>87</b>	<b>93</b>	<b>97</b>	<b>100</b>	<b>100</b>



Mark lines:  
Sample: **1611-159 - Möl og sandur Guðmundareyri (GE2)**

## Technical properties

D <sub>10</sub>	0,53	D <sub>50</sub>	4,43	<b>Classification according to U.S.C.S system</b>	
D <sub>15</sub>	0,70	D <sub>60</sub>	7,25		Uniformity coefficient $C_u = D_{60}/D_{10} =$ 13,74
D <sub>30</sub>	1,58	D <sub>85</sub>	23,95		Coefficient of gradation $C_c = D_{30}^2/(D_{60} \cdot D_{10}) =$ 0,65

## Comments

# Grain size distribution

Customer  
**Landsvirkjun**  
Requested by

Project no.  
**1611-159**  
Date printed  
**22.4.2015**

## Information regarding sample

Sample, source

**Möl og sandur Guðmundareyri (GE4)**

Sample, marking

**Guðmundareyri (GE4)**

Project

**Vindlundir á Þjórsár- og Tungnaárvæði**

Sample, type

**0-45 mm**

Sample no.

**587**

Index no.

**830**

## Properties

Moisture content [%] **9,29%**  
Clay content (< 0.063mm) [%] **1,2%**  
Humus [-]  
Slam [%]

Grain density  $r_{cm}$  [Mg/m<sup>3</sup>]  
Saturation  $W_{cm}$  [%]  
Bulk density (dry) [kg/m<sup>3</sup>]  
Bulk density (ssd) [kg/m<sup>3</sup>]

Flakiness index FI  
Surface [m<sup>2</sup>/kg]  
Clorine [%]  
Porosity [%]

## Grain size distribution

Testing standard

**ÍST EN 933-1:1997, ÍST EN 933-2**

Method **x** Washing and sieving  
Dry sieving

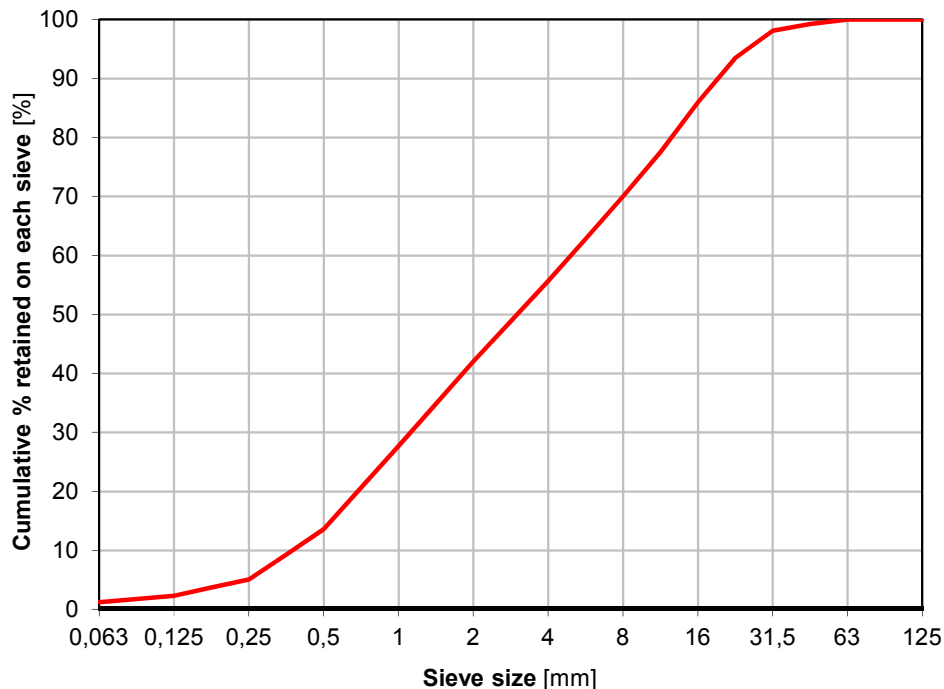
Testing date

**23.2.2015**

Executed by

**EÁP**

Sieve size	[mm]	0,063	0,125	0,25	0,5	1	2	4	5,6	8	11,2	16	22,4	31,5	45	63	88	125
<b>Guðmundareyri (GE4)</b>	<b>[%]</b>	<b>1,2</b>	<b>2</b>	<b>5</b>	<b>14</b>	<b>28</b>	<b>42</b>	<b>56</b>	<b>63</b>	<b>70</b>	<b>78</b>	<b>86</b>	<b>93</b>	<b>98</b>	<b>99</b>	<b>100</b>	<b>100</b>	<b>100</b>



Mark lines:  
Sample: **1611-159 - Möl og sandur Guðmundareyri (GE4)**

## Technical properties

D <sub>10</sub>	0,37	D <sub>50</sub>	3,00	<b>Classification according to U.S.C.S system</b>	
D <sub>15</sub>	0,54	D <sub>60</sub>	4,91		Uniformity coefficient $C_u = D_{60}/D_{10} =$ 13,11
D <sub>30</sub>	1,12	D <sub>85</sub>	15,34		Coefficient of gradation $C_c = D_{30}^2/(D_{60} \cdot D_{10}) =$ 0,68

## Comments

# Grain size distribution

Customer  
**Landsvirkjun**  
Requested by

Project no.  
**1611-159**  
Date printed  
**22.4.2015**

## Information regarding sample

Sample, source

**Möl og sandur Tungnaáreyrar**

Sample, marking

**Tungnaáreyrar (TÁ1)**

Project

**Vindlundir á Þjórsár- og Tungnaárvæði**

Sample, type

**0-63 mm**

Sample no.

**588**

Index no.

**831**

## Properties

Moisture content [%] **5,90%**  
Clay content (< 0.063mm) [%] **2,2%**  
Humus [-]  
Slam [%]

Grain density  $r_{cm}$  [Mg/m<sup>3</sup>]  
Saturation  $W_{cm}$  [%]  
Bulk density (dry) [kg/m<sup>3</sup>]  
Bulk density (ssd) [kg/m<sup>3</sup>]

Flakiness index FI  
Surface [m<sup>2</sup>/kg]  
Clorine [%]  
Porosity [%]

## Grain size distribution

Testing standard

**ÍST EN 933-1:1997, ÍST EN 933-2**

Method **x** Washing and sieving  
Dry sieving

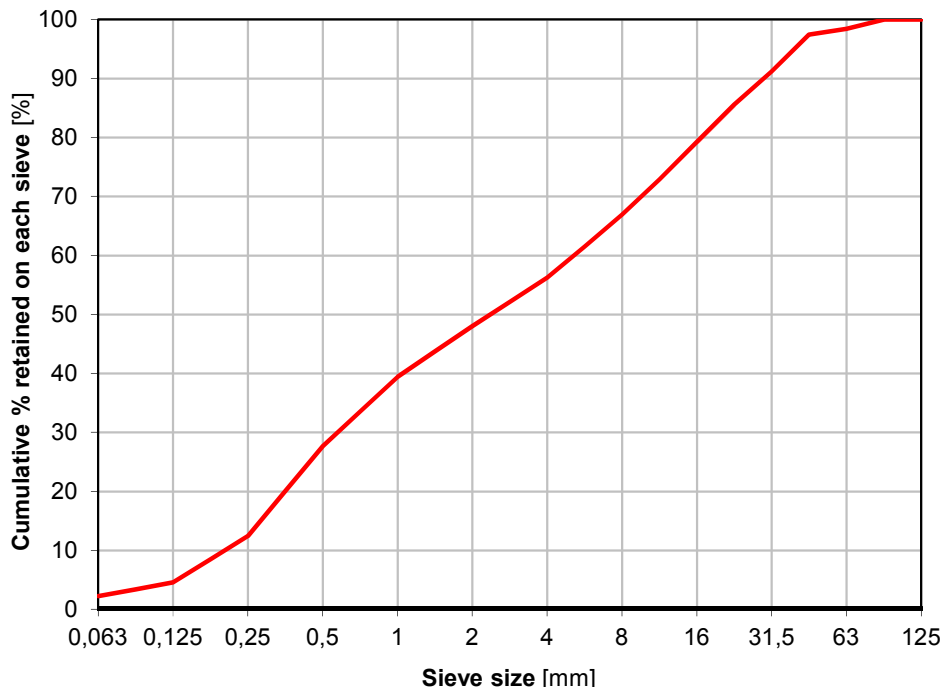
Testing date

**23.2.2015**

Executed by

**EÁP**

Sieve size	[mm]	0,063	0,125	0,25	0,5	1	2	4	5,6	8	11,2	16	22,4	31,5	45	63	88	125
<b>Tungnaáreyrar (TÁ1)</b>	<b>[%]</b>	<b>2,2</b>	<b>5</b>	<b>12</b>	<b>28</b>	<b>39</b>	<b>48</b>	<b>56</b>	<b>62</b>	<b>67</b>	<b>73</b>	<b>79</b>	<b>86</b>	<b>91</b>	<b>97</b>	<b>98</b>	<b>100</b>	<b>100</b>



Mark lines:  
Sample: **1611-159 - Möl og sandur Tungnaáreyrar**

## Technical properties

D <sub>10</sub>	0,20	D <sub>50</sub>	2,37	<b>Classification according to U.S.C.S system</b>	
D <sub>15</sub>	0,28	D <sub>60</sub>	5,09		Uniformity coefficient $C_u = D_{60}/D_{10} =$ 25,20
D <sub>30</sub>	0,57	D <sub>85</sub>	21,78		Coefficient of gradation $C_c = D_{30}^2/(D_{60} \cdot D_{10}) =$ 0,32

## Comments



# Grain size distribution

Customer  
**Landsvirkjun**  
Requested by

Project no.  
**1611-159**  
Date printed  
**22.4.2015**

## Information regarding sample

Sample, source <b>Jökulruðningur</b>	Project <b>Vindlundir á Þjósár- og Tungnaárvæði</b>	Sample no. <b>590</b>
Sample, marking <b>Jökulruðningur (GD1)</b>	Sample, type <b>0-63 mm</b>	Index no. <b>832</b>

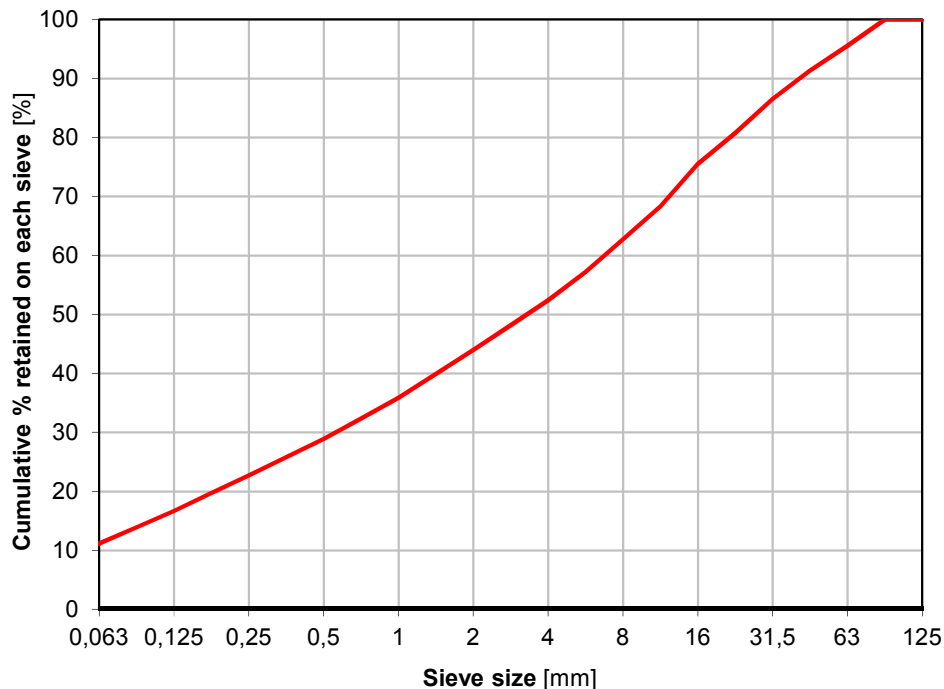
## Properties

Moisture content [%]	<b>16,19%</b>	Grain density $r_{cm}$ [Mg/m <sup>3</sup> ]	Flakiness index FI
Clay content (< 0.063mm) [%]	<b>11,1%</b>	Saturation $W_{cm}$ [%]	Surface [m <sup>2</sup> /kg]
Humus [-]		Bulk density (dry) [kg/m <sup>3</sup> ]	Clorine [%]
Slam [%]		Bulk density (ssd) [kg/m <sup>3</sup> ]	Porosity [%]

## Grain size distribution

Testing standard <b>ÍST EN 933-1:1997, ÍST EN 933-2</b>	Testing date <b>24.2.2015</b>	Executed by <b>EÁP</b>
Method <b>x</b> Washing and sieving Dry sieving		

Sieve size	[mm]	0,063	0,125	0,25	0,5	1	2	4	5,6	8	11,2	16	22,4	31,5	45	63	88	125
<b>Jökulruðningur (GD1)</b>	<b>[%]</b>	<b>11,1</b>	<b>17</b>	<b>23</b>	<b>29</b>	<b>36</b>	<b>44</b>	<b>52</b>	<b>57</b>	<b>63</b>	<b>68</b>	<b>76</b>	<b>81</b>	<b>87</b>	<b>91</b>	<b>96</b>	<b>100</b>	<b>100</b>



Mark lines:  
— Sample: 1611-159 - Jökulruðningur

## Technical properties

D <sub>10</sub>	-	D <sub>50</sub>	3,29	<b>Classification according to U.S.C.S system</b> Uniformity coefficient $C_u = D_{60}/D_{10} =$ - Coefficient of gradation $C_c = D_{30}^2/(D_{60} \cdot D_{10}) =$ -
D <sub>15</sub>	0,10	D <sub>60</sub>	6,70	
D <sub>30</sub>	0,56	D <sub>85</sub>	29,10	

## Comments

# Grain size distribution

Customer  
**Landsvirkjun**  
Requested by

Project no.  
**1611-159**  
Date printed  
**22.4.2015**

## Information regarding sample

Sample, source

**Sandur**

Sample, marking

**Bjarnalón (BL1)**

Project

**Vindlundir á Þjórsár- og Tungnaárvæði**

Sample, type

**0-8 mm**

Sample no.

**589**

Index no.

**829**

## Properties

Moisture content [%] **14,66%**  
Clay content (< 0.063mm) [%] **1,6%**  
Humus [-]  
Slam [%]

Grain density  $r_{cm}$  [Mg/m<sup>3</sup>]  
Saturation  $W_{cm}$  [%]  
Bulk density (dry) [kg/m<sup>3</sup>]  
Bulk density (ssd) [kg/m<sup>3</sup>]

Flakiness index FI  
Surface [m<sup>2</sup>/kg]  
Clorine [%]  
Porosity [%]

## Grain size distribution

Testing standard

**ÍST EN 933-1:1997, ÍST EN 933-2**

Testing date

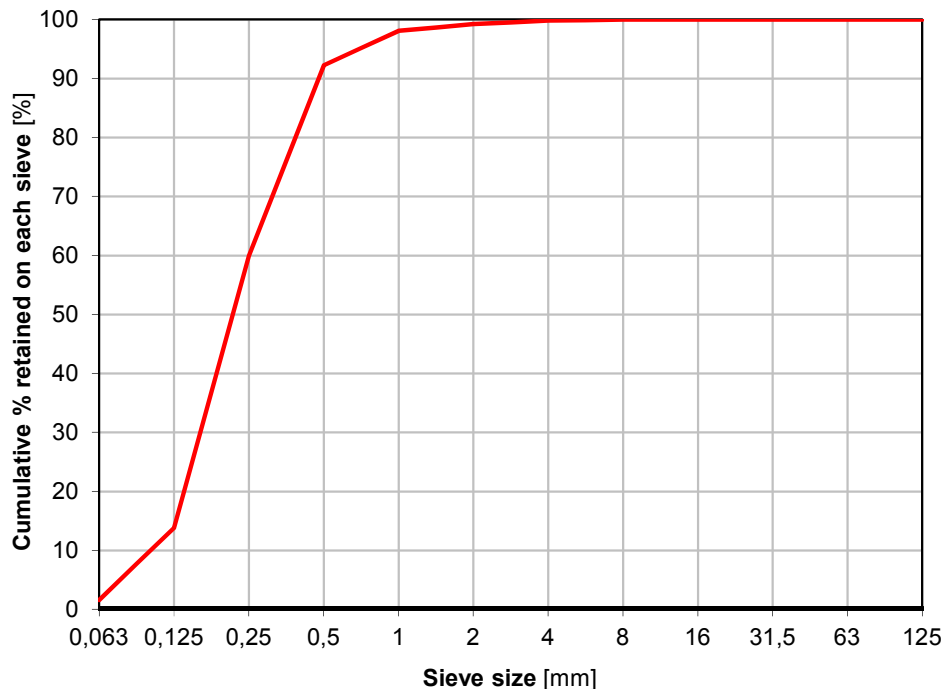
**11.2.2015**

Executed by

**JÞI**

Method  Washing and sieving  
 Dry sieving

Sieve size	[mm]	0,063	0,125	0,25	0,5	1	2	4	5,6	8	11,2	16	22,4	31,5	45	63	88	125
<b>Bjarnalón (BL1)</b>	<b>[%]</b>	<b>1,6</b>	<b>14</b>	<b>60</b>	<b>92</b>	<b>98</b>	<b>99</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>



Mark lines:  
Sample: **1611-159 - Sandur**

## Technical properties

D <sub>10</sub>	0,10	D <sub>50</sub>	0,22	<b>Classification according to U.S.C.S system</b> Uniformity coefficient $C_u = D_{60}/D_{10} =$ 2,49 Coefficient of gradation $C_c = D_{30}^2/(D_{60} \cdot D_{10}) =$ 1,01
D <sub>15</sub>	0,13	D <sub>60</sub>	0,25	
D <sub>30</sub>	0,16	D <sub>85</sub>	0,43	

## Comments

## Aggregate Petrographical analysis

### Laboratory

Hofðabakki 9, 110 Reykjavík  
Tel: 412 6000  
www.efla.is - efla@efla.is

Customer

**Landsvirkjun**

Requested by

Project no.

**1611-159**

Date printed

**21.4.2015**

### Information regarding sample

Sample, marking

**Guðmundareyri G1**

Sample site

**Guðmundareyri**

Sampling location

**Guðmundareyri GE2**

Geological information of sample

Project

**Búrfell Wind Farm**

Location/coordinates

Method of sampling

**Excavator**

Sample no.

**586**

Date of sampling

**29.1.2015**

Sample type

**River sandbank**

### Results

Test standard

**IST EN 932-3**

Executed by

**JÞI**

Date of test

**26.2.2015**

Grain size analyzed

**5,6-8,0 mm**

Analyzed in

**Hand sample - Stereoscope**

### Petrographical type:

Quality group	No of Grains	%	Rock type - Alteration - Porosity
<b>Concrete - Pavement - Base course</b>			
1 - 1 - 1	176	43,2%	Basalt - fresh - dense
1 - 2 - 1	166	40,8%	Basalt - fresh - vesicular
2 - 3 - 2	8	2,0%	Basalt - fresh - very vesicular
2 - 2 - 2	31	7,6%	Basalt - altered - dense
2 - 2 - 2	7	1,7%	Basalt - altered - vesicular
3 - 3 - 2	7	1,7%	Basalt glass
3 - 3 - 3	12	2,9%	Amygdale
<b>Total:</b>	<b>407</b>	<b>100,0%</b>	

### Quality grouping:

	Concrete %	Pavement %	Base course %
1. class	84,0%	43,2%	85,1%
2. class	11,3%	50,1%	13,2%
3. class	4,7%	6,6%	1,7%
	100,0%	100,0%	100,0%

### Shape:

Shape: 81,8% of grains are cubic, 10,7% are flat, 1,7% flat and elongated and 5,8% cubic and elongated

Roundness: 63,6% of grains are sub-rounded, 14,0% rounded and 22,4% angular

Roughness: 81,8% of grains are smooth and 18,2% are rough

### Technical characteristics:

Fines: The sample has been washed, thus no fines.

Particle strength:

Humus (visual): No organic material

Plasticity (visual): Sample is considered non-plastic

### Additional notes:

## Aggregate Petrographical analysis

### Laboratory

Hofðabakki 9, 110 Reykjavík  
Tel: 412 6000  
www.efla.is - efla@efla.is

Customer

**Landsvirkjun**

Requested by

Project no.

**1611-159**

Date printed

**22.4.2015**

### Information regarding sample

Sample, marking  
**Guðmundareyri G2**

Sample site  
**Guðmundareyri**

Sampling location  
**Guðmundareyri GE4**

Geological information of sample

Project

**Búrfell Wind Farm**

Location/coordinates

Method of sampling

**Excavator**

Sample no.

**587**

Date of sampling

**29.1.2015**

Sample type

**River sandbank**

### Results

Test standard

**IST EN 932-3**

Executed by

**JÞI**

Date of test

**26.2.2015**

Grain size analyzed

**5,6-8,0 mm**

Analyzed in

**Hand sample - Stereoscope**

### Petrographical type:

Quality group	No of Grains	%	Rock type - Alteration - Porosity
<b>Concrete - Pavement - Base course</b>			
1 - 1 - 1	173	40,6%	Basalt - fresh - dense
1 - 2 - 1	137	32,2%	Basalt - fresh - vesicular
2 - 3 - 2	9	2,1%	Basalt - fresh - very vesicular
2 - 2 - 2	21	4,9%	Basalt - altered - dense
2 - 2 - 2	33	7,7%	Basalt - altered - vesicular
3 - 3 - 3	20	4,7%	Hyaloclastite
3 - 3 - 2	16	3,8%	Basalt glass
3 - 3 - 3	10	2,3%	Tephra
2 - 2 - 2	7	1,6%	Rhyolite
<b>Total:</b>	<b>426</b>	<b>100,0%</b>	

### Quality grouping:

	Concrete %	Pavement %	Base course %
1. class	72,8%	40,6%	72,8%
2. class	16,4%	46,5%	20,2%
3. class	10,8%	12,9%	7,0%
	100,0%	100,0%	100,0%

### Shape:

Shape: 56,6% of grains are cubic, 29,8% are flat, 4,5% flat and elongated and 9,2% cubic and elongated

Roundness: 67,6% of grains are sub-rounded, 11,7% rounded and 20,7% angular

Roughness: 72,5% of grains are smooth and 27,5% are rough

### Technical characteristics:

Fines: The sample has been washed, thus no fines.

Particle strength:

Humus (visual): No organic material

Plasticity (visual): Sample is considered non-plastic

### Additional notes:

## Aggregate Petrographical analysis

### Laboratory

Hofðabakki 9, 110 Reykjavík  
Tel: 412 6000  
www.efla.is - efla@efla.is

Customer  
**Landsvirkjun**  
Requested by

Project no.  
**1611-159**  
Date printed  
**22.4.2015**

### Information regarding sample

Sample, marking <b>Karstensö</b>	Project <b>Búrfell Wind Farm</b>	Sample no. <b>588</b>
Sample site <b>Tungnaáreyrar</b>	Location/coordinates	Date of sampling <b>29.1.2015</b>
Sampling location <b>Tungnaáreyrar</b>	Method of sampling <b>Excavator</b>	Sample type <b>River sandbank</b>
Geological information of sample		

### Results

Test standard <b>IST EN 932-3</b>	Executed by <b>JÞI</b>	Date of test <b>26.2.2015</b>	Grain size analyzed <b>5,6-8,0 mm</b>	Analyzed in <b>Hand sample - Stereoscope</b>
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### Petrographical type:

Quality group	No of Grains	%	Rock type - Alteration - Porosity
<b>Concrete - Pavement - Base course</b>			
1 - 1 - 1	123	36,8%	Basalt - fresh - dense
1 - 2 - 1	137	41,0%	Basalt - fresh - vesicular
2 - 3 - 2	3	0,9%	Basalt - fresh - very vesicular
2 - 2 - 2	20	6,0%	Basalt - altered - dense
2 - 2 - 2	25	7,5%	Basalt - altered - vesicular
3 - 3 - 3	8	2,4%	Hyaloclastite
3 - 3 - 2	10	3,0%	Basalt glass
3 - 3 - 2	3	0,9%	Tephra
2 - 2 - 2	5	1,5%	Rhyolite
<b>Total:</b>	<b>334</b>	<b>100,0%</b>	

### Quality grouping:

	Concrete %	Pavement %	Base course %
1. class	79,8%	37,7%	80,2%
2. class	14,7%	55,8%	17,3%
3. class	5,5%	6,4%	2,5%
	100,0%	100,0%	100,0%

### Shape:

Shape: 61,4% of grains are cubic, 22,5% are flat, 3,3% flat and elongated and 12,9% cubic and elongated  
Roundness: 62,9% of grains are sub-rounded, 9,9% rounded and 27,2% angular  
Roughness: 70,4% of grains are smooth and 29,6% are rough

### Technical characteristics:

Fines: The sample has been washed, thus no fines.  
Particle strength:  
Humus (visual): No organic material  
Plasticity (visual): Sample is considered non-plastic

### Additional notes:







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