Rangitaiki River Stopbanks Assessment

Section 7 - Waiari

Left Bank 17700 to 18500m

Prepared for

Environment Bay of Plenty

April 2011

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Contents

1 Introduction

A section of the left bank of the Rangitaiki River upstream of the Kokohinau Marae (17,700 to 18,000m) suffered severe erosion during the flood of July 2004. The erosion almost undermined the toe of the stopbank. Rock rip rap was quickly placed along the river bank to protect the stopbank toe. During this work a tomo was observed just below the natural ground level at the toe of the stopbank. Investigations showed that there is a fine sand layer overlying a thin layer of peat and pumice gravel in this area. The hole was repaired and this length of stopbank noted as requiring further investigation. The investigation was extended upstream to 18,500m due to the presence of an old stream bed depression behind the stopbank.

This report presents the results of an investigation into the integrity of this length of stopbank and includes the following:

- the results of in situ investigations,
- the results of seepage analyses for the estimated 100 year return period flood,
- the results of slope stability analyses and
- possible remedial measures.

This report is the property of our client, Environment Bay of Plenty and Ice Geo and Civil Ltd. The comments within relate only to the length of stopbank along the Rangitaiki River left bank from 17,700m to 18,500m. The conclusions of this report are based on the interpretation of in situ investigations carried out at isolated points only and two dimensional analyses. Due to the complex geology in the area, there could be ground conditions more detrimental to the integrity of the stopbank than those that have been identified and which could lead to problems with the stopbank and seepage in a significant flood.

2 Background and Site Description

This section of stopbank is about 1km upstream from where the fault which ruptured in 1987 crosses the Rangitaiki River. This upstream side of the fault was up-thrown relative to the downstream side, leading to rapid down-cutting of the river bed and over-steepening of the toes of the river banks. This over-steepening could have contributed to the slope stability and erosion problems along the river bank in subsequent floods. During the 1987 earthquake there was extensive cracking and slumping of the river berm.

The 1976 construction drawings for the stopbank show a reasonably broad low level river berm from about 17,700m to 18,200m and a higher berm up to about 30m wide from 18,200m to 18,500m. This higher berm was used as a borrow area during stopbank construction. After the 2004 flood there was little of the river berm remaining downstream of 18,200m and a berm up to about 30m wide upstream.

The level of the stopbank crest varies from RL10.9 to RL11.2. The low point is in the middle of the investigation length rather than at the downstream end. The variation in the stopbank crest level is probably due to the uplift during the 1987 earthquake and subsequent repairs. The low point in the crest still has at least 1.2m freeboard above the design flood level.

From 17,700m to 17,900m the stopbank crest is up to 2.8m high compared to the inland ground level. Between 17,900m and 18,300m the crest is typically 2.2 to 2.4m high and at the upstream end of the section, in the old stream channel, it is up to 3.4m high. Over most of the length under investigation there is a slight fall in the ground away from the stopbank. At the old stream channel the ground rises from the stopbank toe.

3 Subsurface Investigations

The subsurface investigations carried out consisted of 13 hand augers to up to 4m depth. These were supplemented by three hand augers carried out in 2004 at the downstream end of the length under investigation. The augers were arranged in seven cross sections, roughly at right angles to the stopbank (Figure 1). Figures 2 to 8 show the soil profiles interpreted from the hand augers.

Nearly all the hand augers showed layers of fine to coarse sands at between 1 and 3m from the ground surface. Many of the augers were stopped in a coarse sand / pumice gravel layer below the ground water level as further samples could not be obtained. The gravel was typically up to 10mm in diameter but was up to 50mm in diameter at the downstream end of the investigation. A hole, or very loose sand and gravel layer was found at 2.2m depth in hand auger P2. It was thought that this hole could be due to a stump rotting out as rotten timber was found below it.

The upper silty fine sands and fine sands are very light and there was evidence of rabbit holes where these are exposed in the river bank and in the ground behind the stopbank. The tomo observed in 2004 was in this layer.

Thin layers of grey pumiceous silt and clayey silt were found between sand layers in many of the augers. Some thin layers of organic rich soil or peat were found; typically above the pumice gravel. Angular pumice gravel in a silt matrix was found below RL3.0 in HA10. This layer has been found at depth right down the river to Thornton.

The augers in the river berm showed silty fine sands, not necessarily consistent with those found on the inside of the stopbank. Some of these sands could be recent river deposits.

Two hand augers were drilled in the stopbank crest to investigate the stopbank soils. In HA6 900mm of well graded sand was found at the top of the stopbank. This was probably placed during the repairs after the earthquake and as it is above the design flood level it will not have an effect on seepage through the stopbank. Similarly 600mm of gravelly coarse sand was found at the stopbank crest in HA15. The remainder of the stopbank soils are lower permeability sandy silts and silty sands, except for a 250mm thick layer of medium to coarse sand found close to natural ground level in HA15. This is in the area of the rabbit holes.

4 Analyses

4.1 Discussion

The in situ investigations carried out provide subsoil profiles in isolated locations only and may not have located the most critical sub-surface flow paths. Although an effort has been made to build a degree of conservatism into the analysis of the stopbank cross sections, it is possible that in terms of the seepage response to a flood in the river there are worse combinations of soil layers than those assumed.

The computer programmes used to analyse the seepage problems and slope stability problems, Geo-Slope Seep/W and Slope/W (2004), are two dimensional programmes. Therefore, three dimensional effects such as seepage along old river channels can not be accurately modelled. For a linear problem like a stopbank, the lack of a third dimension should not have much influence on the slope stability issues but the seepage analyses must be considered indicative only.

Four possible problems could arise due to a flood in the river:

- excessive flows under the stopbank
- piping of soils leading to collapse of the stopbank
- heave of upper soil layers resulting in rapid piping and stopbank collapse
- failure of either face of the stopbank due to high water level or draw down conditions.

The critical hydraulic gradient (that at which soil particles can be washed away) for the light pumice soils in the area is considered to be 0.7. Therefore a maximum hydraulic gradient of 0.4 is considered acceptable in the seepage analyses.

Heave of upper soil layers develops when water under pressure is trapped under a lower permeability layer. Heave is often observed in the layer of surface organic silts held together by grass roots. Seepage of only small volumes of water from the ground surface can significantly reduce the uplift pressures acting on a surface layer with a higher permeability layer beneath it. Seepage from the ground surface has therefore been allowed for in the computer models except for across the sealed road.

4.2 Flood Hydrograph

EBoP has provided a 100 year return period flood flow hydrograph for the Rangitaiki River at 17,950m, allowing for climate change to 2040 and 1 in 20 year storm conditions at the river outlet (Figure 9). This is a 14 day hydrograph that rises to a peak of RL9.4 on the seventh day of the flood. The peak part of the hydrograph is about four days long. In the analyses the hydrograph was adjusted to suit each cross section. At the upstream end of the study section the hydrograph peak will be at about RL9.7; this means that there is at least 1.2m of freeboard along this length of stopbank.

4.3 Soil Model - Seepage

The subsurface profiles were divided into broad layers based on soil permeability (Table 1). It was assumed that the site is underlain by layered silts and sands as found in deep investigations further down stream. The permeabilities assumed were conservatively based on the grading test and falling head test results for other sites along the river. The permeability in the horizontal and vertical directions was varied to reflect the layering observed on site.

Table 1: Assumed Soil Permeabilities

soil	k_h (m/s)	k_v (m/s)
stopbank fill	4×10^{-6}	2×10^{-6}
silt	4×10^{-7}	4×10^{-7}
silty fine sand	4×10^{-6}	4×10^{-6}
layered silty fine sand and fine to medium sand	5×10^{-5}	5×10^{-6}
medium to coarse sand	5×10^{-4}	5×10^{-4}
layered silts and sands	5×10^{-5}	5×10^{-7}

The Geo-Slope Seep/W (2004) computer package used for the seepage analyses contains a library of soil grading curves with corresponding hydraulic conductivity and water content versus water pressure relationships. The particle gradings observed on site were compared to those in the Seep library and the closest fit chosen as the soil model to be used in the seepage analysis.

The cross sections were generally modelled to about 80m from the inland toe of the stopbank. Infinite elements were then used to model flow outside the model in both the initial steady state analysis and the transient flood analysis. During the initial steady state analysis a head was specified at the infinite elements and another in the river. The inland head was assumed to be RL5.0 and that in the river RL4.4. The depth of the river bed was taken as RL2.0 from the nearest surveyed river cross section. Rainfall was not modelled.

4.4 Soil Model – Slope Stability

Stability analyses have been carried out on the steeper cross sections for high river, low river and rapid draw down conditions. The soil parameters used in these analyses are given in Table 2.

Table 2: Assumed Soil Parameters

soil	density (kN/m^3)	effective cohesion (kPa)	friction angle (degrees)
stopbank fill	16	2	26
silt	15	2	24
silty fine sand	14	0	26
layered silty fine sand and fine to medium sand	14	0	35
medium to coarse sand	14	0	35
clayey silt	15	5	24

4.5 Cross Section 1

At Cross Section 1 the peak flood level is about 1.8m above the ground level on the inland side of the stopbank. A transient seepage analysis using the permeabilities given in Table 1 showed that the duration of high river flows (about 40 hours above ground level) is insufficient for the ground water level to rise to ground level behind the stopbank. No piping or heave problems are therefore expected.

A second seepage analysis was carried out to check the effects of possible sand layers within the stopbank by assuming the horizontal permeability of the stopbank soil was 2×10^{-5}m/s. As for the initial analysis the ground water level did not rise to the ground surface.

4.6 Cross Sections 2 and 3

At Cross Sections 2 and 3 the flood level is only above the inland ground level for about 14 hours with a peak height of about 600mm. A seepage analysis was carried out assuming that the coarse sand layer found in HA3 and HA5 was exposed at the stopbank face. This showed that the ground water level should remain below ground level in the design flood.

4.7 Cross Sections 4, 5 and 6

No seepage problems are expected at cross sections 4, 5 and 6 as the design flood only rises to about 800mm above ground level on the inland side of the stopbank.

There is minimal river berm at these cross sections and a stability analysis showed a factor of safety against slope failure of 1.4 when the river is low (between RL3.0 and RL4.0, Figure 10). The factor of safety increases with higher river levels but is considered to be a low in conditions which are not unusual. In rapid drawdown conditions after a flood peak the factor of safety could drop to 1.3; which is acceptable for this short term condition.

A rock berm has been built along the stopbank toe downstream of Cross Section 6. A stability analysis was carried out allowing for a similar berm about 5m wide at RL6.5 (Figure 11). The minimum factor of safety with the river at RL3.0 was found to be 1.6. It is therefore recommended that the existing rock berm be extended upstream to join the natural berm at Cross Section 3.

4.8 Cross Sections 7

Due to the design flood peak rising to only about 800mm above the inland ground level and the presence of a rock berm, no seepage or stability problems are expected at this cross sectio; however the light soils exposed on the river bank and close to ground level on the inland side of the stopbank are prone to rabbit burrowing. Therefore it is suggested that a clayey overlay be placed over the light soils on the river side of the stopbank to above the design flood level to discourage the rabbits.

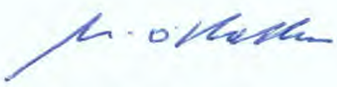
5 Conclusions

1. The pressure applied by floods to this length of stopbank was reduced by the relative ground uplift caused by the rupture of the fault just downstream in 1987.

2. No problems arising from seepage are expected along this length.

3. It is recommended that a 5m wide rock berm be placed between the existing rock berm, at the downstream end of the investigation length, and the natural berm, at the upstream end, to improve the stability of the stopbank in low river level and rapid draw down conditions.

4. It is suggested that a clayey overlay be placed across the river bank where light soils are exposed to deter rabbits from burrowing.



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April 2011

Figure 1: Hand auger and cross section layout

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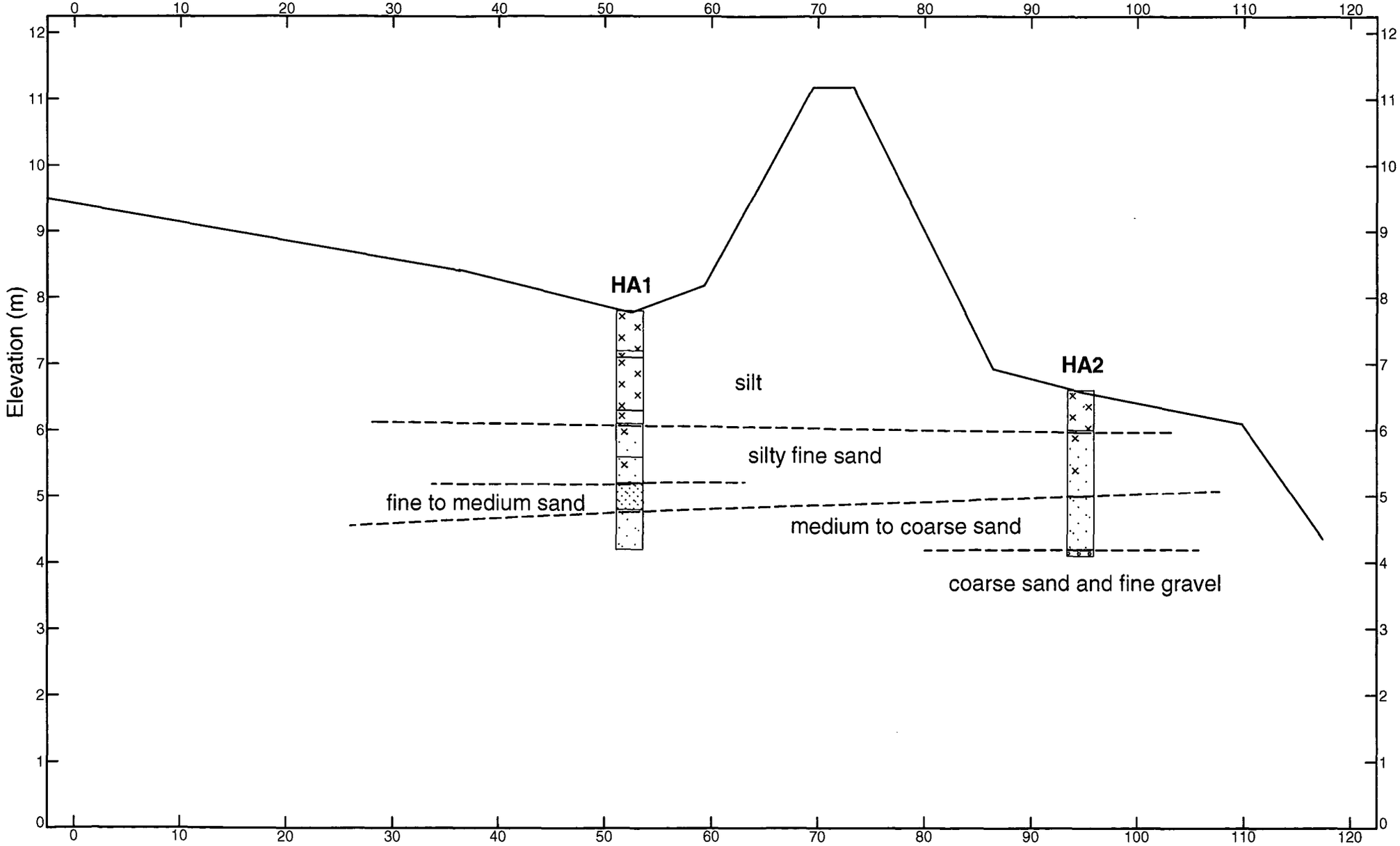
Number: 2

Figure 2 Subsurface Cross Section 1



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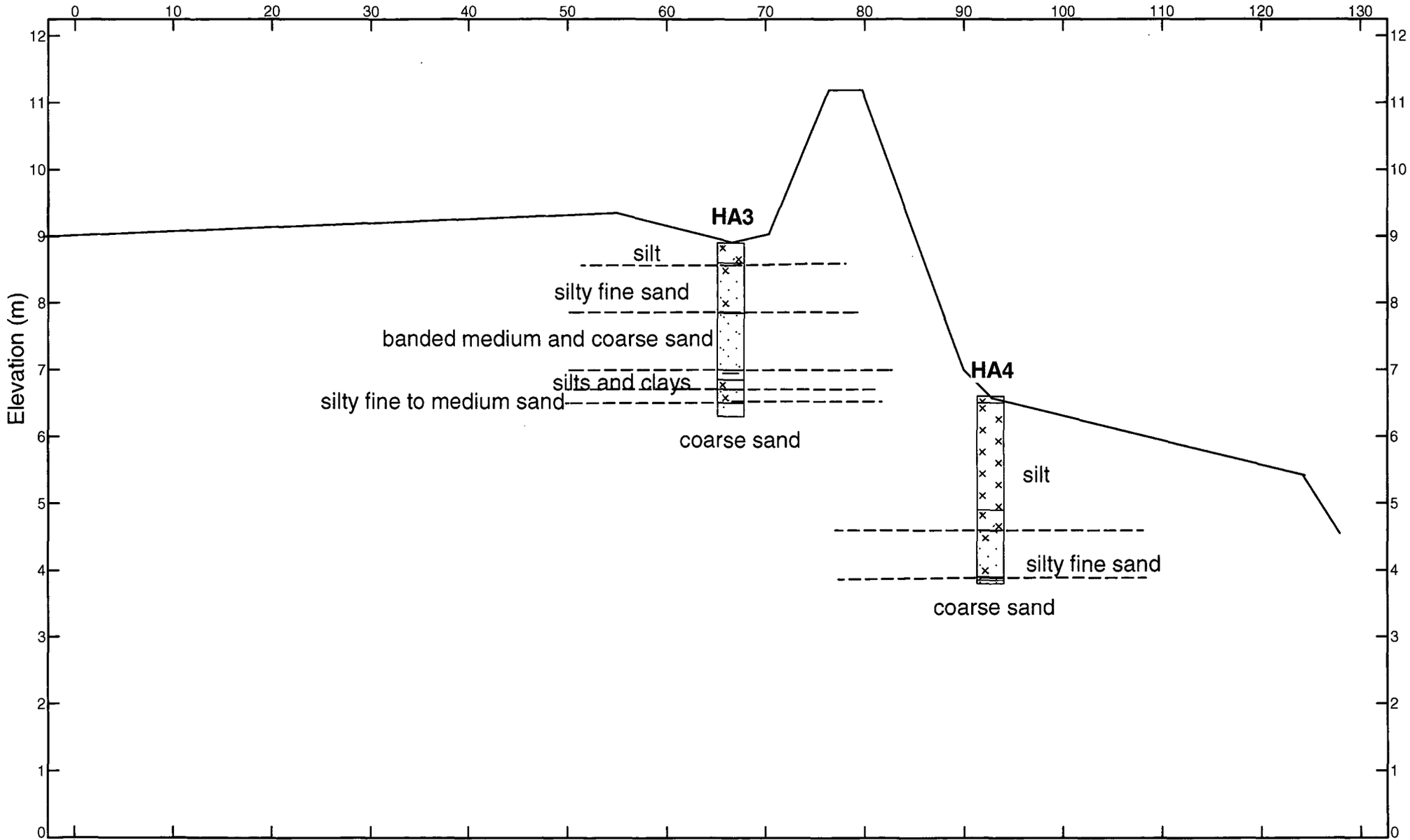
Number: 2

Figure 3 Subsurface Cross Section 2



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Number: 2

Figure 4 Subsurface Cross Section 3

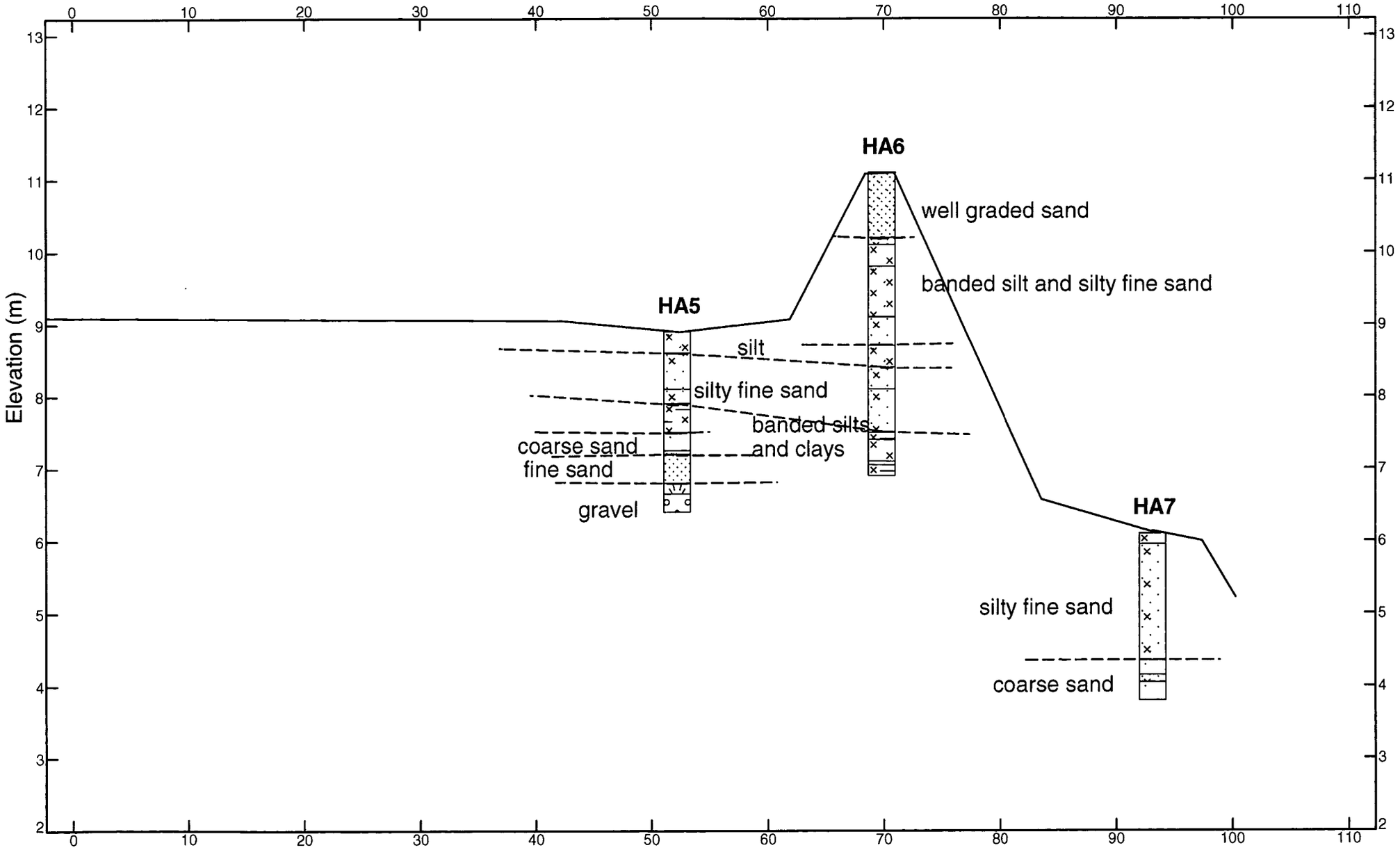

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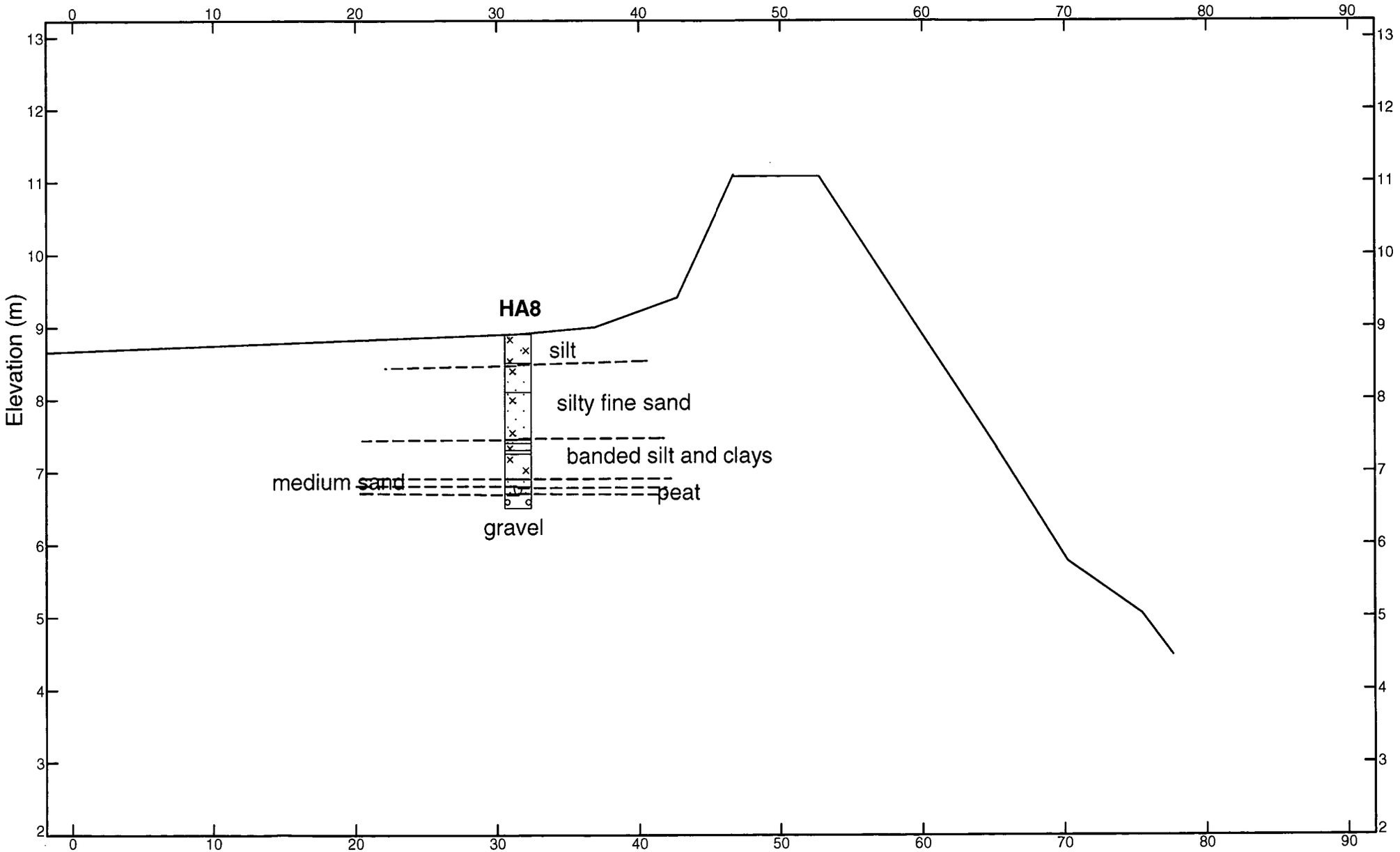
Figure 5 Subsurface Cross Section 4



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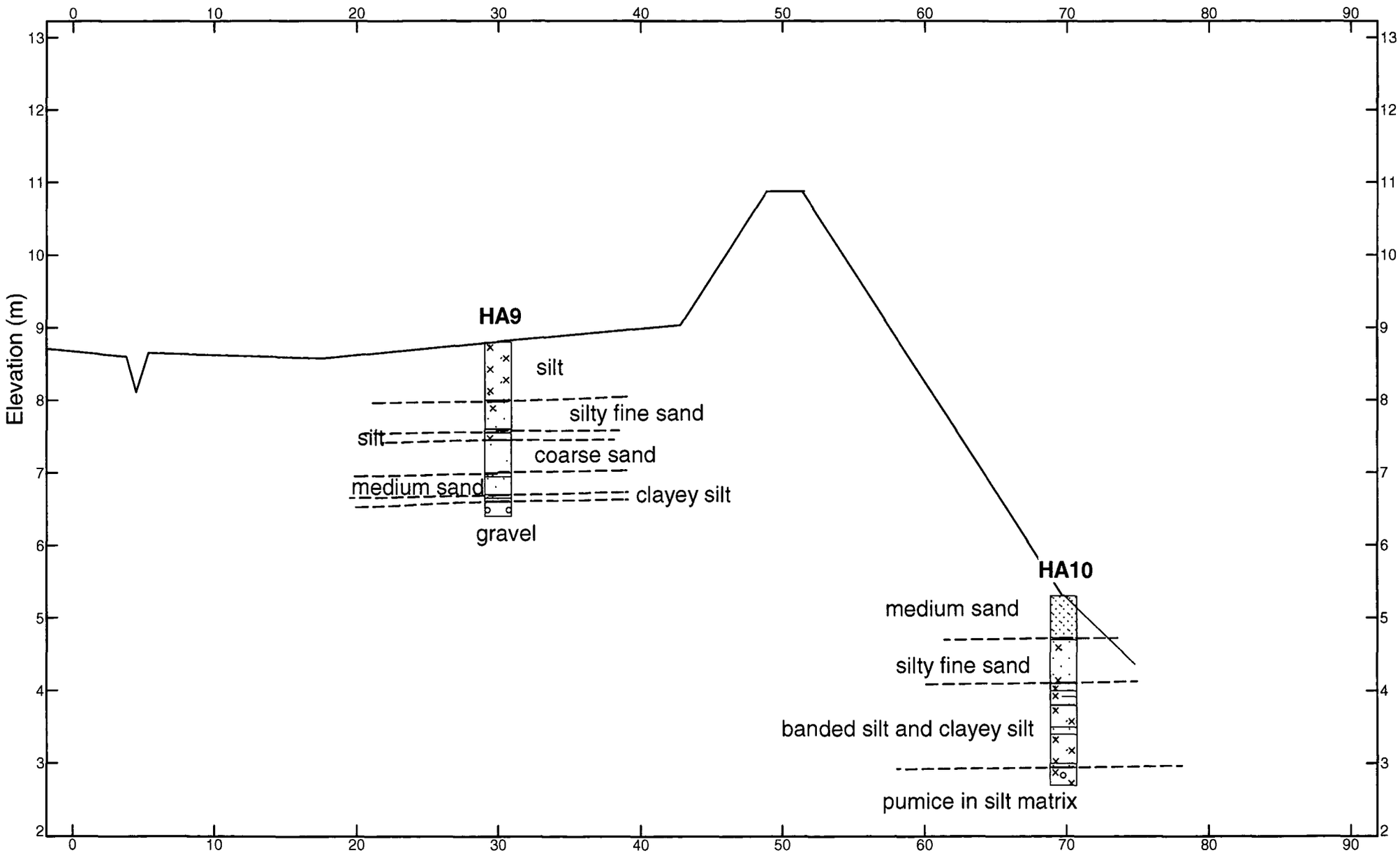
Number: 2

Figure 6 Subsurface Cross Section 5



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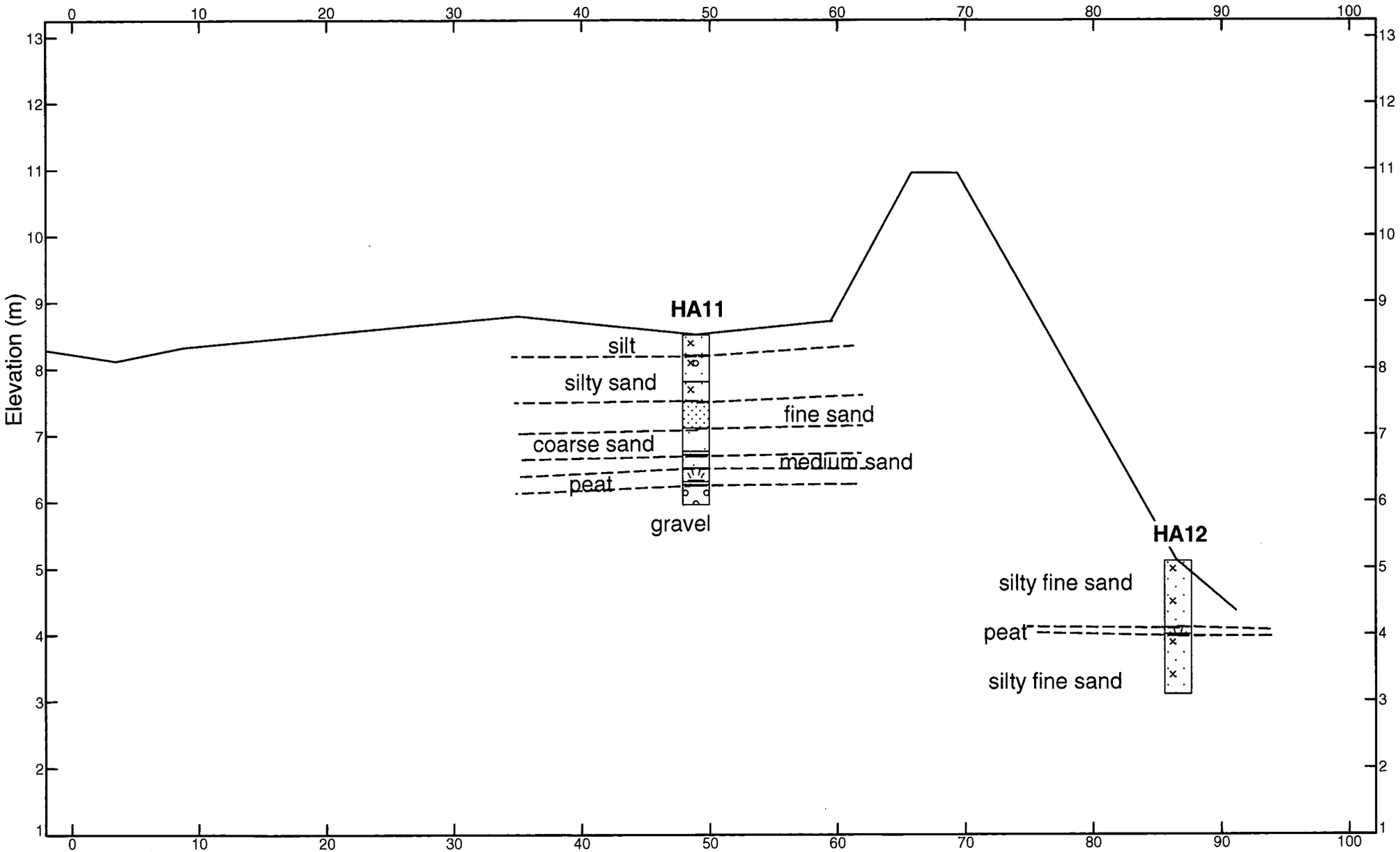
Location: Pryor's / Waiari Bend
Number: 2

Figure 7 Subsurface Cross Section 6



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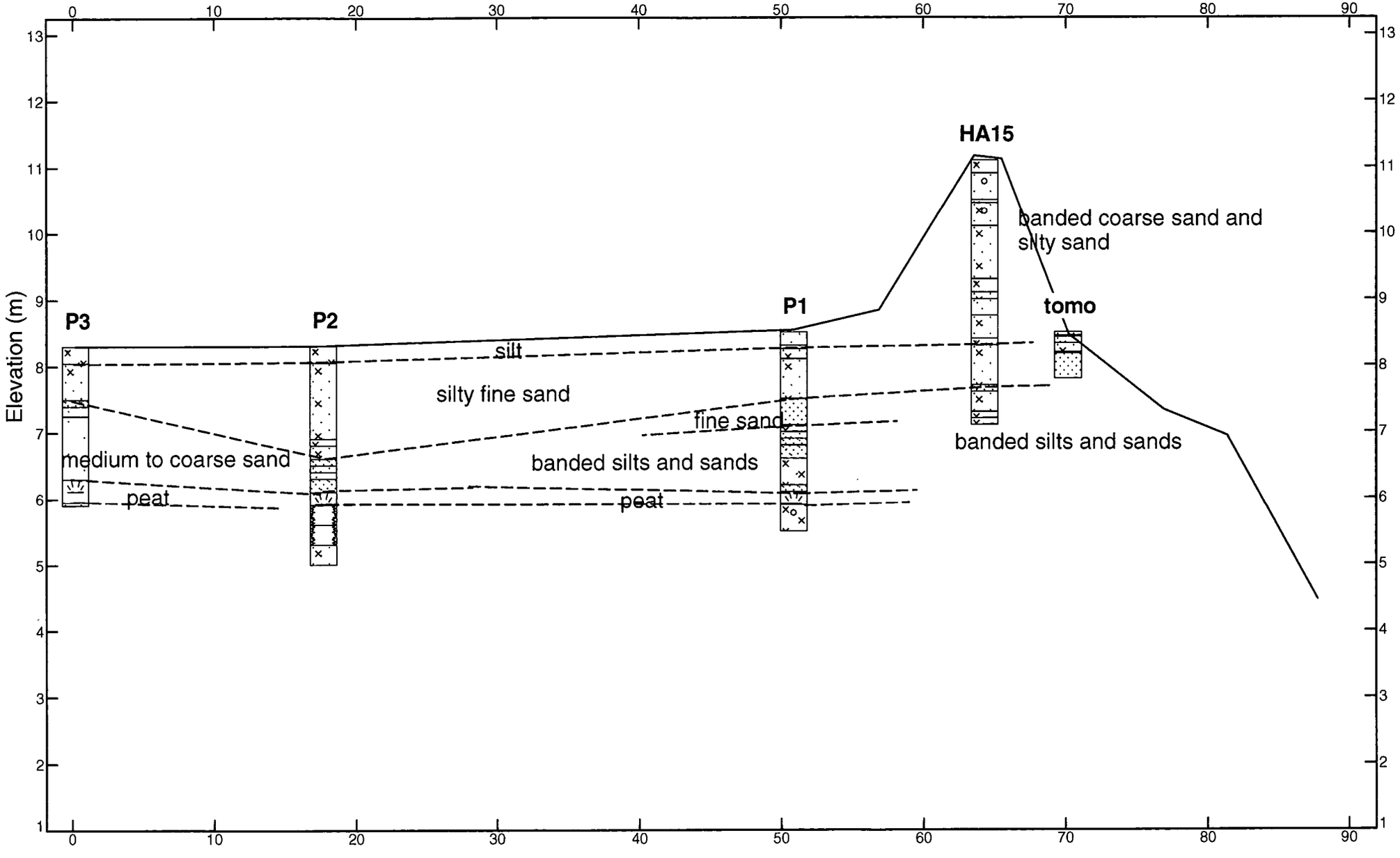
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Figure 8 Subsurface Cross Section 7



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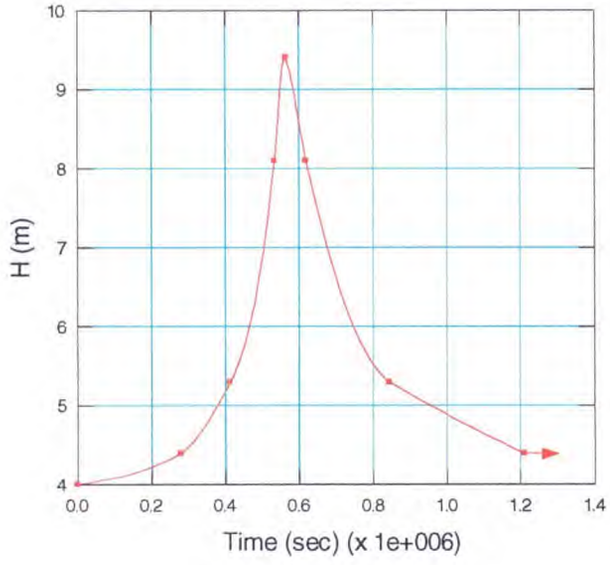


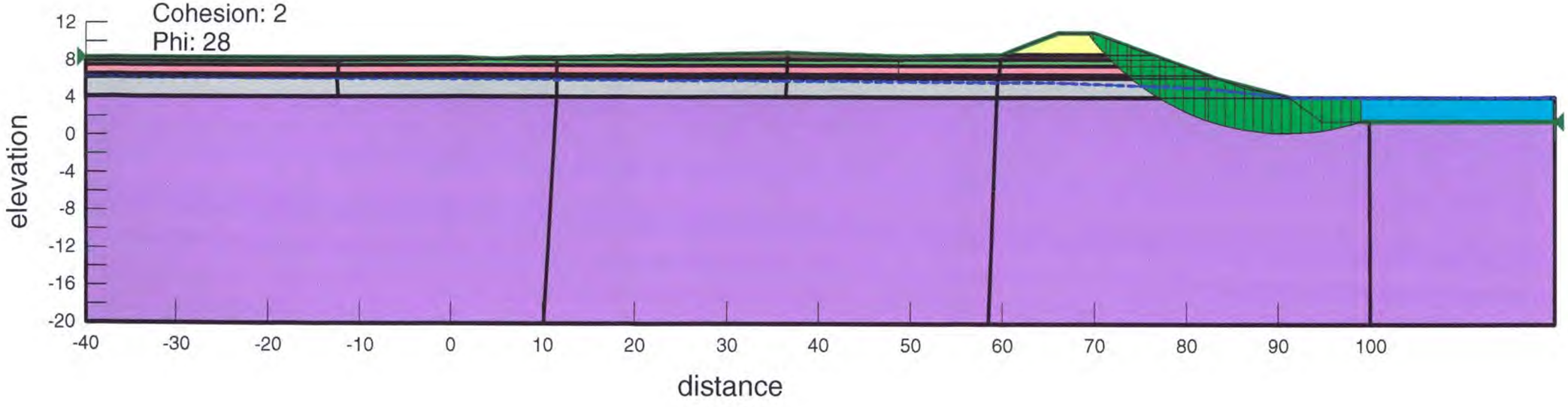
Figure 9: Design flood flow hydrograph
(1% AEP river, 5% AEP storm, 2040 climate change)

Description: stopbank fill
Wt: 16
Cohesion: 2
Phi: 26
Description: silt
Wt: 14
Cohesion: 2
Phi: 24
Description: silty sand
Wt: 14
Cohesion: 0
Phi: 26
Description: layer silts and clays
Wt: 15
Cohesion: 5
Phi: 24
Description: coarse sand and gravel
Wt: 14
Cohesion: 0
Phi: 35
Description: layered sands and silts
Wt: 15
Cohesion: 2
Phi: 28

Figure 10

Name: cross section 6 100yr.gsz
Title: Rangitaiki River, Waiari
Comments: Cross Section 6 100 year flood flow hydrograph
Date: 16/04/2011 Time: 4:27:44 p.m.

River level RL 4.0

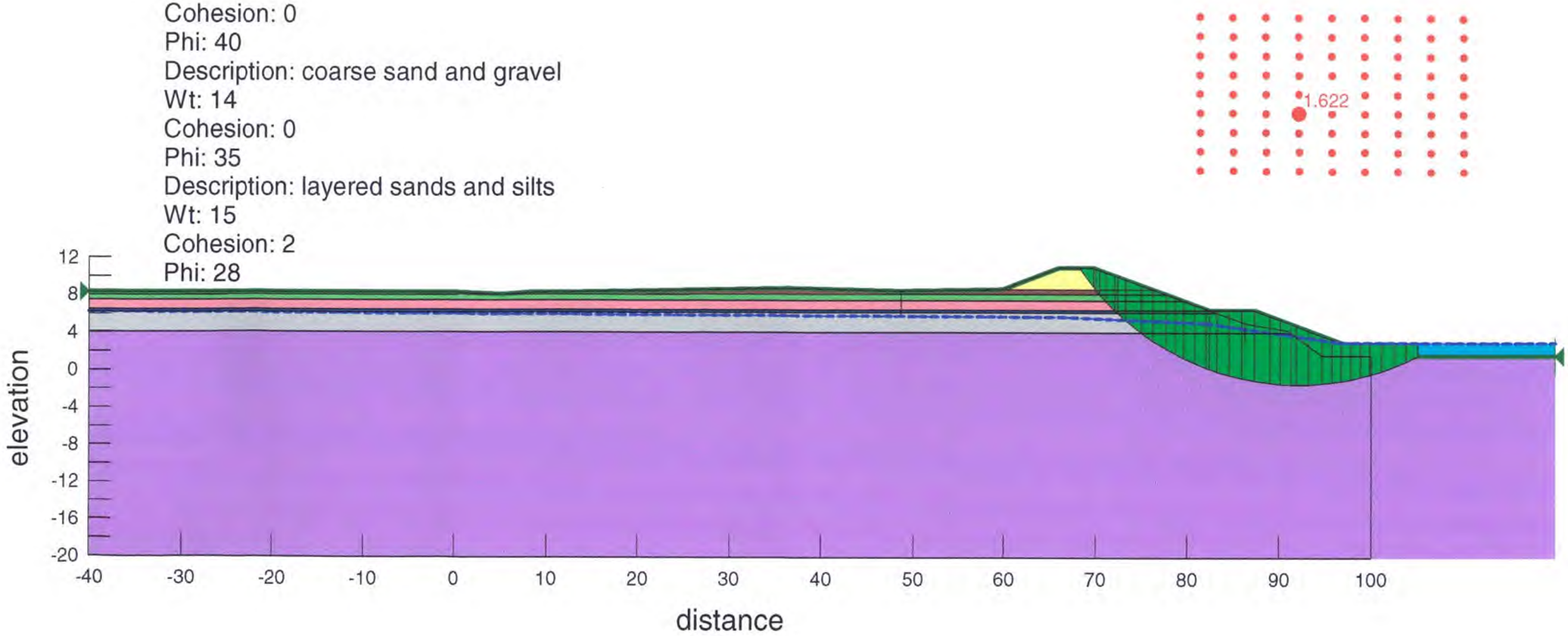


Description: stopbank fill
Wt: 16
Cohesion: 2
Phi: 26
Description: silt
Wt: 14
Cohesion: 2
Phi: 24
Description: silty sand
Wt: 14
Cohesion: 0
Phi: 26
Description: layer silts and clays
Wt: 15
Cohesion: 5
Phi: 24
Description: rock
Wt: 18
Cohesion: 0
Phi: 40
Description: coarse sand and gravel
Wt: 14
Cohesion: 0
Phi: 35
Description: layered sands and silts
Wt: 15
Cohesion: 2
Phi: 28

Figure 11: 5m wide rock berm at RL 6.4

Name: cross section 6 stab berm.gsz
Title: Rangitaiki River, Waiari
Comments: Cross Section 6 100 year flood flow hydrograph
Date: 16/04/2011 Time: 4:34:21 p.m.

River Level RL 3.0



Appendix A

Hand Auger Logs

Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA1**
Elevation: 7.8
Date: 13/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**SILT, trace fine sand**, some Tarawera Ash grit, dark brown, damp, firm	
	7.2			
	7.1		**coarse pumiceous sandy SILT**, brown, damp, firm	
			SILT, some clay, brown mottled with grey, firm, damp	
1.5	6.3		**SILT**, grey, damp	
	6.1		**silty fine SAND**, light fluffy, grey	
2.0	5.6		banded **silty fine SAND and fine to medium SAND**, bands approx. 50mm, grey, damp	
2.5	5.2		fine to medium **SAND**, grey	dis.
3.0	4.8		medium to coarse **SAND**, grey	dis.
3.5	4.2		EOB washing in	
4.0				

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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA2**

Elevation: 6.6
Date: 13/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			fine **sandy SILT**, grey, dense, damp	
	6		**silty fine SAND**, light fluffy, grey, damp	
	5		medium to coarse **SAND**, some rounded gravel to 10mm, grey with orange staining, moist	dis.
	4.2			
	4.1		**coarse SAND / fine GRAVEL**, pumice and greywacke to 3mm	
			EOB, washing in	

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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA3**

Elevation: 8.9
Date: 14/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			fine **sandy SILT**, dark brown, damp	
	8.6			
0.5			**silty fine SAND**, rare pumice to 10mm, brown, damp	
1.0				
	7.85			
			medium **pumice SAND, some coarse sand bands / fine lapilli,** grey, loose	
1.5				
	7			
2.0			**organic CLAY**, brown, soft, moist	
	6.85			
			pumiceous **SILT**, grey	
	6.7			
			silty fine to medium SAND, grey	
	6.5			
2.5			**coarse SAND / fine LAPILLI**, some silt, grey	
	6.3			
			EOB washing in	
3.0				
3.5				
4.0				

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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA4**

Elevation: 6.6
Date: 13/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0	6.5		**SILT**, brown, damp, firm	
			SILT, brown stained grey, damp, firm	
0.5				
1.0				
1.5				
	4.9		**fine sandy SILT**, trace fine pumice lapilli to 2mm, trace fine roots, grey, moist, firm	
2.0	4.6		**silty fine SAND / sandy SILT**, grey, spongy, moist	
			▼	
2.5				
	3.9			
	3.85		**organic SILT**, brown, spongy	
	3.8		**medium to coarse gravelly SAND**, rare pumice to 40mm, hard gravel to 10mm, speckled grey	
3.0			EOB losing sample	
3.5				
4.0				

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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA5**

Elevation: 8.9
Date: 14/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**fine sandy SILT**, brown, damp	
	8.6		**silty fine SAND**, brown, damp	
0.5				
	8.1		**silty fine SAND**, grey,damp	
1.0	7.9		**clayey SILT**, orange stained grey, damp	
	7.5		**coarse pumice SAND**, light grey	dis.
1.5				
	7.25		pumiceous **SILT**, light grey	
	7.2		**fine pumice SAND**, light grey	
2.0				
	6.8		fibrous **PEAT**, black, low perm.	
▼	6.65		pumice **GRAVEL** to 30mm	
2.5	6.4		EOB, UTP	
3.0				
3.5				
4.0				

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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA6**
Elevation: 11.1
Date: 14/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**well graded SAND**, some gravel, brown, damp, dense	
0.5				
	10.2			
1.0	10.1		**silty fine SAND**, brown, dense, damp	
			SILT, grey, damp, dense	
	9.8			
			fine sandy SILT, grey, damp, firm	
1.5				
2.0	9.1		**silty fine SAND**, grey, damp	
	8.7			
2.5			**fine sandy SILT**, grey, damp, dense	
	8.4		**silty fine SAND**, brown, firm, damp	
3.0	8.1		**silty fine SAND**, grey, fluffy, light	
3.5				
	7.5			
	7.4		**clayey SILT**, grey, moist	
			SILT, grey with orange mottles, moist	
4.0	7.1			

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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA6**

Elevation: 11.1
Date: 14/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
4.0	7.05		**coarse pumice SAND**	
	6.9		**clayey SILT**, grey, moist	
			EOB	

4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0

HAND AUGER HAND AUGERS.GPJ HAND AUGER BASIC.GDT 16/4/11

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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA7**
Elevation: 6.1
Date: 14/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0	5.95		**SILT**, brown, firm, damp	
			silty fine SAND, orange stained grey, light fluffy, firm, damp	
0.5				
1.0				
1.5				
	4.35		**coarse SAND**, black and white speckled	
2.0	4.15		**silty fine SAND**, grey	
	4.05		**coarse SAND**, black and white speckled	
	3.8		EOB washing in	
2.5				
3.0				
3.5				
4.0				

ICE GEO & CIVIL
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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA8**

Elevation: 8.9
Date: 14/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**fine sandy SILT**, brown, dense	
	8.5			
0.5			**silty fine SAND**, brown, dense, damp	
	8.1			
			silty fine SAND, light brown, light, fluffy	
1.0				
	7.45			
1.5	7.4		**clayey SILT**, brown, moist, firm	
	7.3		pumice **SILT**, light grey, damp	
	7.25		**coarse pumice SAND**, light grey	
			SILT, some clay, grey with orange mottles, damp	
2.0	6.9			
	6.8		medium pumice **SAND**, light grey	
	6.7		**PEAT**, black	
			pumice **GRAVEL** to 30mm	
	6.5			
2.5			EOB	
3.0				
3.5				
4.0				

ICE GEO & CIVIL
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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA9**

Elevation: 8.8
Date: 15/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**fine sandy SILT**, brown, damp	
	8		**silty fine SAND**, brown, med. dense, damp	
	7.6			
	7.55		coarse pumice **SAND**	
	7.45		pumice **SILT**, orange stained grey, damp	
			coarse pumice **SAND**, light grey	
	7			
	6.95		**SILT**, grey, moist	
			medium pumice **SAND**, light grey	
	6.7			
	6.65		**clayey SILT**, brown, plastic, moist	
	6.6		**clayey SILT**, orange stained grey, moist	
			pumice **GRAVEL** to 30mm, orange stained, wet	
	6.4			
			EOB utp	

ICE GEO & CIVIL
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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA10**

Elevation: 5.3
Date: 15/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			fine to medium **SAND**, brown	
	4.7		**silty fine SAND**, grey, moist	
1.0			▼	
	4.1		**fine sandy SILT**, grey, moist	
	4		**clayey SILT**, some finr roots, grey, soft, moist	
1.5	3.8		**fine sandy SILT**, some fine roots, grey, soft	
	3.5		**organic SILT**, with fine fibres/peat, brown	
	3.4		**fine sandy SILT**, some fine roots, grey, soft	
2.0				
	3			
	2.95		**silty fine SAND**, grey	
2.5			angular **PUMICE** to 30mmin **SILT** matrix, grey, stiff	
	2.7		EOB losing sample	
3.0				
3.5				
4.0				

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ICE GEO & CIVIL
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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA11**

Elevation: 8.5
Date: 15/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**silty fine SAND / sandy SILT**, brown, damp	
	8.2			
0.5			**silty gravelly fine to medium SAND**, gravel to 20mm, brown, damp	
	7.8			
			silty fine to medium SAND, some gravel to 5mm, brown	
1.0	7.5			
			fine pumice SAND, some silt, orange stained grey, light, fluffy, dry	
	7.1			
1.5			**coarse pumice SAND / LAPILLI** to 3mm, light grey, dry	
	6.75			
	6.7		**fine sandy pumice SILT**, light grey, damp	
			medium pumice SAND, light grey, mod. dense, damp	
2.0	6.5			
			organic clayey SILT / PEAT, dark brown, soft, moist	
	6.3			
	6.25		pumice **GRAVEL in SILT** matrix, grey	
			pumice **GRAVEL** to 30mm, orange stained grey	
2.5	5.95			
			EOB UTP	
3.0				
3.5				
4.0				

ICE GEO & CIVIL
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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA12**

Elevation: 5.1
Date: 15/01/2007
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**silty fine SAND**, brown, damp	
1.0	4.1			
	4		**organic clayey SILT / PEAT**, brown, soft, spongy, moist	
			silty fine SAND, grey	
2.0	3.1		EOB washing in	

ICE GEO & CIVIL
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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA15**

Elevation: 11.1
Date: 15/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**fine sandy SILT**, brown, damp, firm	
	10.9		**fine gravelly coarse SAND**, brown	
0.5				
	10.5			
	10.45		**SILT**, grey, stiff	
			silty fine gravelly fine to coarse SAND, brown, dense	
1.0	10.1		**silty fine SAND**, grey, dense	
1.5				
	9.3		**fine sandy SILT**, grey	
2.0	9.1		**silty fine pumice SAND**, brown, light, fluffy, dense, dry	
	9		**medium to coarse SAND**, some silt, brown	
	8.75		**silty fine pumice SAND**, brown, light, fluffy, dense, dry	
2.5				
	8.4		**fine sandy SILT**, brown, dense, damp	
	8.3		**silty fine SAND**, brown, dense, damp	
3.0				
	7.7			
3.5	7.6		**fine to coarse pumice SAND**, some silt, brown	
			silty fine SAND, orange stained grey, light, fluffy	
	7.3			
	7.2		**clayey SILT**, brown, plastic, damp	
4.0	7.1		**clayey SILT**, orange stained grey, plastic, damp	

ICE GEO & CIVIL
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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **HA15**

Elevation: 11.1
Date: 15/07/2010
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
4.0			EOB	

4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0

ICE GEO & CIVIL
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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **P1**

Elevation: 8.5
Date: 15/09/2004
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0	8.3		**organic silty fine SAND**, brown, topsoil	
	8.25		**coarse SAND**, black, Tarawera Ash	
	8.1		**silty fine SAND and Tarawera Ash**, brown	
0.5			**silty fine pumice SAND**, some fine pumice lapilli, dark grey / brown	
1.0	7.5		**fine pumice SAND**, light orangy grey	
	7.1			
1.5	7		**clayey SILT**, orange stained grey , plastic, damp to moist	
	6.9		**silty fine SAND**, orange stained yellow, damp	
	6.8		**fine to medium pumice SAND**, orange stained light grey, damp	
			well graded pumice SAND, light grey, damp, becoming moist	
	6.6			
2.0			**fine sandy SILT**, orange stained light grey, some clay	
	6.2			
	6.1		**fine to medium pumice SAND**, light grey	
2.5			**organic CLAY/PEAT**, dark brown, very plastic, soft	
	5.9			
			pumice **sandy SILT** and pumice **GRAVEL** to 50mm, light grey	
3.0	5.5			
			EOB	
3.5				
4.0				

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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **P2**

Elevation: 8.3
Date: 15/09/2004
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			organic fine **sandy SILT**, topsoil	
	8.05		**fine silty SAND**, some fine lapilli, dark grey/brown	
0.5				
1.0				
	6.9			
1.5	6.8		**SILT**, some clay, orange stained light yellow/grey, plastic	
			silty fine SAND, orange stained light yellow/grey	
	6.6			
	6.5		**fine to medium pumice SAND**, orange stained light grey	
	6.4		**silty fine pumice SAND**, light grey	
2.0	6.3		**coarse pumice SAND / fine LAPILLI**, light grey	
			fine to medium pumice SAND, light grey	
	6.1		**PEAT**	
	5.9		hole	
2.5				
	5.6		no resistance, silty SAND and pumice gravel to 30mm, wet	
3.0	5.3		**silty SAND** and pumice **GRAVEL** to 30mm, rotten timber, sulphur smell, wet	
	5		EOB hard, losing sample	
3.5				
4.0				

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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **P3**

Elevation: 8.3
Date: 15/09/2004
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**sandy SILT**, brown, topsoil	
	8.05		**silty fine SAND**, some pumice lapilli, dark grey / brown	
0.5				
	7.5		**fine to medium pumice SAND**, orange stained light yellow/grey	
	7.4		**fine to medium SAND**, some silt, orange stained light yellow	
1.0	7.25		**coarse pumice SAND / fine LAPILLI**, light grey, coarse, dry	
1.5				
2.0	6.3		**PEAT**	
	5.95			
	5.9		**silty SAND and pumice GRAVEL** to 50mm, light grey	
2.5			EOB	
3.0				
3.5				
4.0				

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Project: **Rangitaiki River - Section 7**
Client: EBOP
Location: Pryor's / Waiari Bend
Number: 2

Test: **tomo**

Elevation: 8.5
Date: 15/09/2004
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0	8.45		**silty medium to coarse pumice SAND**, brown	
	8.43		**well graded pumice SAND** and **fine LAPILLI** to 3mm, brown	
	8.33		**silty fine SAND / sandy SILT**, brown	
	8.2		**silty fine SAND**, brown	
	8.18		**coarse SAND**, black, Tarawera Ash	
0.5			**fine SAND**, some silt, dark grey	
	7.8		base of tomo	
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				
4.0				

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