10. Rockfall survey and analysis

3. 8 Rockfall Survey

3. 8. 1 Rockfall site identification

（1）RF001 (0+150～0+350)

The basaltic slope where cracks have developed increases its height toward the end. Rockfalls in large blocks are not observed; however, the bed rock with cracks has loosened. In addition, at the foot of the slope, a number of rocks about 30cm in diameter were observed which had exfoliated from the slope surface.

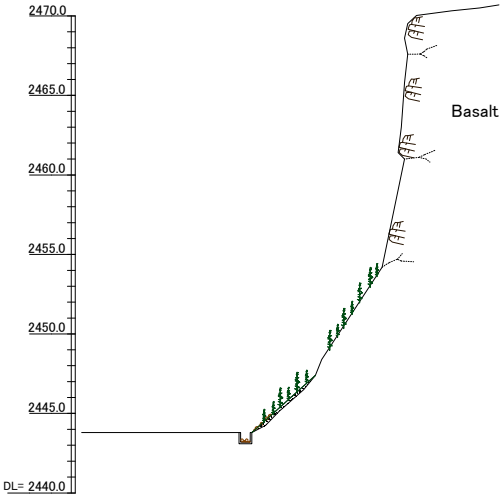


Figure 3. 8.1 Representative section (STA.0+340)

This section extends for 200m width, which is relatively short compared to the others. However, the slope is steep and very close to the road, so that Rockfall has a significant impact on the lives of local people.

Photo 3. 8.1 Entire picture of section RF001 (taken from the section start point)

Photo 3. 8.2 Entire picture of section RF001 (taken from the section end point)

（2）RF002 (0+720～1+140)

This section, located in the landslide area, is composed of the bed rock which mainly consists of basalt.

Cracks have developed on this slope head which has been temporarily monitored in the past. In August 2009, Rockfalls occurred from the slope head.

Constructions of drainage works and of roadbed works are currently underway on the road side. Basaltic detached rocks are also distributed on the slope head, and basaltic cliff walls are consecutively observed behind the slope head section. As cracks have developed on the slope top which reaches 30m or higher, the possibility of unstable basaltic loose rocks falling is high.

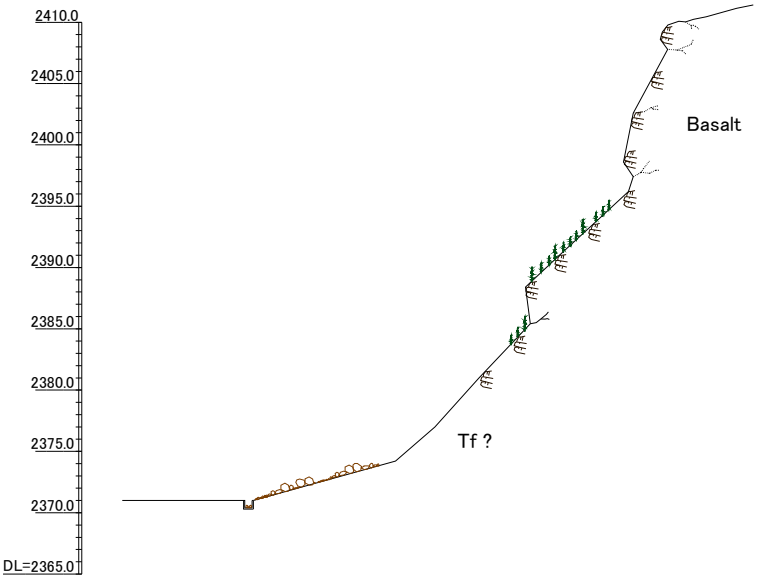


Figure 3. 8.2　Representative section (STA.0+930)

Photo 3. 8.3　Construction work being done by ERA (wastewater work construction and roadbed construction, STA.0+88 – 1+880)

Photo 3. 8.4　Basaltic cliff wall behind the slope head

（3）RF003 (1+160～2+000)

The basaltic cliff wall that continues from section RF002 are the source of Rockfalls.

Large basaltic rocks are distributed at the bottom part of the cliff; the maximum diameter of those blocks is about 3m. These boulders scattered around in this area could be from toppling.

A number of box culverts and debris stoppers have been installed in this section, where small collapse has also been recognized.

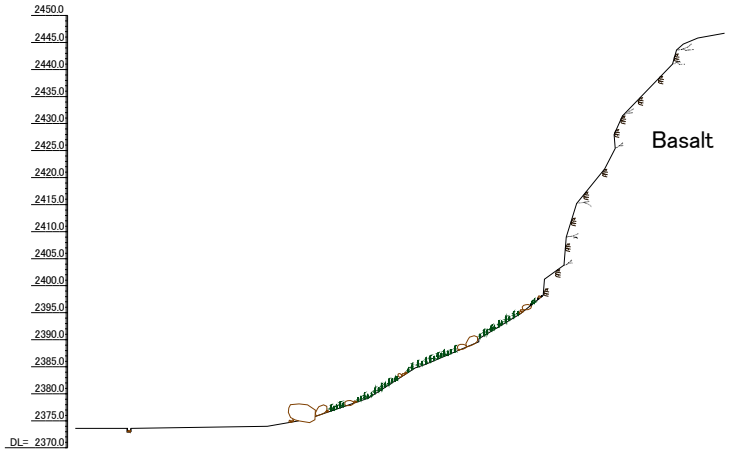


Figure 3. 8.3　Representative section (STA.1+300)

The average slope gradient is 30° to 50° while slope height being 60m or higher. When rock mass failure occurs, fallen rocks would certainly reach the road.

Photo 3. 8.5　Fallen rocks distributed at the bottom (1m – 3m in diameter)

Photo 3. 8.6　Entire picture of section RF003 (taken from the section end)

（4）RF004 (2+080～2+760)

Cut slopes continue in this section, where basaltic blocks with cracks in cubes.

Although the fallen rocks are small in diameter, scattered rocks around the slope foot indicate intensive Rockfalls in the past. Additionally, there are unstable detached rocks on the upper part.

Concave slope where gullies have developed are recognized towards the section end. Small collapses and shallow landslides occur. As weathering progresses on the cut slope while cracks, there is a possibility of Rockfalls by intensive rainfall. For the cut slope is adjacent to the road, even small scale Rockfall would have an impact on the road.

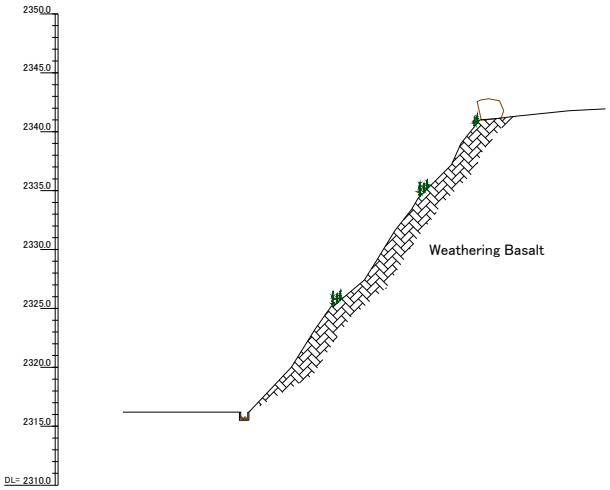


Figure 3. 8.4 Representative section (STA.2+400)

At the end point, gabions are installed as countermeasures for shallow landslides which have occurred in previous years.

Photo 3. 8.7　Entire picture of section RF004 (taken from the section end)

Photo 3. 8.8　Conditions of joints and cracks developing on the cut slope

（5）RF005 (3+850～4+900)

In this section, steep slopes consist mainly of basaltic rocks that are the source of Rockfalls. Here, rocks are currently carved in the section start point (around STA.3+900) where basaltic outcrops continues toward the section's end.

Basaltic cliff walls are distributed in this section located near the road side. Loose rocks and detached rocks also exist on the slopes. If a rock topple occurs, its scale would be significant with the possibility of blocking the road.

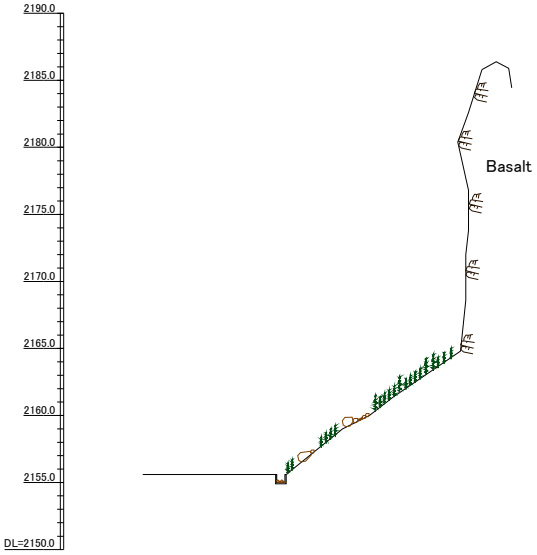


Figure 3. 8.5　Representative section (STA.4+320)

Photo 3. 8.9 Unstable basaltic outcroppings

Photo 3. 8.10 Unstable basaltic outcroppings

Photo 3. 8.11 Unstable basaltic outcroppings

Photo 3. 8.12 Fallen rocks distributed on the slope bottom

（6）RF006 (5+400～5+900)

This section has consecutive slopes consisting mainly of limestone, and unstable detached rocks are distributed on the slopes. Cracks develop in the bed rock, where some rocks have become loose and detached from the cliff.

Weathering has progressed on the lower part in which the soft layers have weathered into small debris. The slope gradient on the lower slope is relatively moderate and vegetation can be seen on the surface.

The lower bed rock on the slope around STA.5+480 exfoliates like sheet form, and the relatively un-weathered layers are overhanging. Further exfoliation and detachment poses a threat of the overhanging to fall.

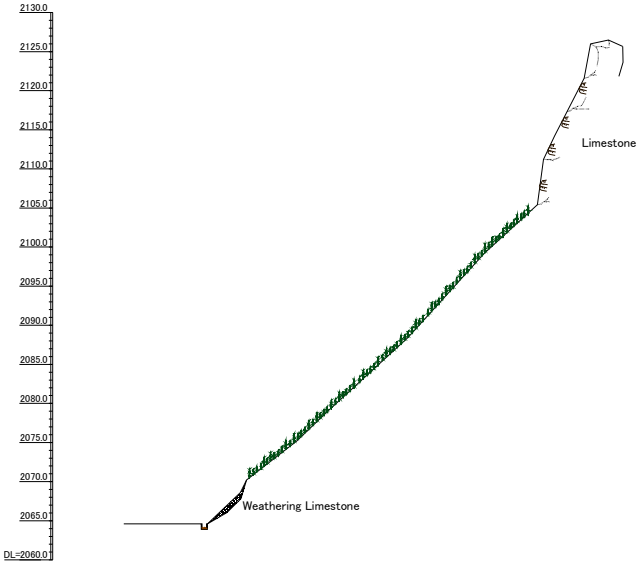


Figure 3. 8.6 Representative section (STA.5+680)

There exist clusters of fallen rocks on the slopes of the lower side of the road indicating that Rockfalls have repeatedly occurred in the past.

Photo 3. 8.13　Limestone cliff walls on the upper part

Photo 3. 8.14　Clusters of fallen rocks distributed on the slopes of the lower side of the road

（7）RF007 (13+500～13+650)

This section is mostly slopes consisting of talus deposits. Meanwhile, slope heights are mostly low.

The surface is bare for the most part, and there are many detached rocks on the slope.

A number of fallen rocks with 50cm or smaller in diameter are distributed at the foot of the slopes, while gravels are scattered along the road.

The scale of Rockfall is small; however, there is a possibility of Rockfall occurrence due to erosion.

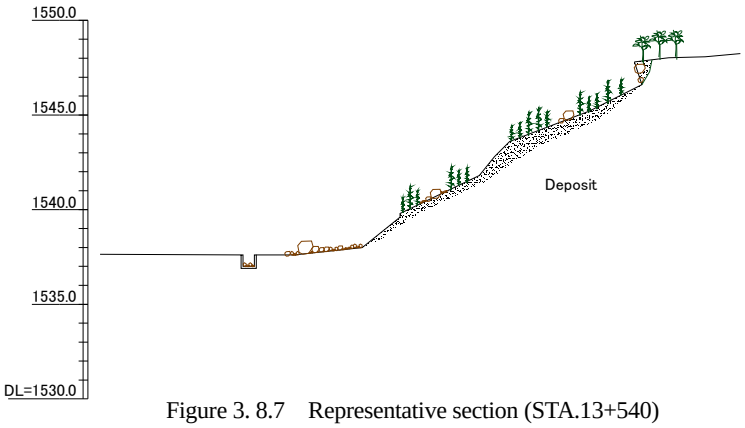


Figure 3. 8.7　Representative section (STA.13+540)

Photo 3. 8.15 Detached rocks distributed on the slopes

Photo 3. 8.16 Fallen rocks deposited at the slope bottom

（8）RF008 (13+650～14+100)

Retaining walls (1.5m high and 100m width) have been installed in this section. The section is cut slopes 40° - 60° in gradient and 30m – 50m in height.

The bed rock is composed of weathered limestone; colluviums and fallen rocks deposits are observed at the back of the retaining walls. Many fallen rocks 0.5m to 1m in diameter are distributed on the small steps of the cut slopes. This shows the possibility of Rockfall risk.

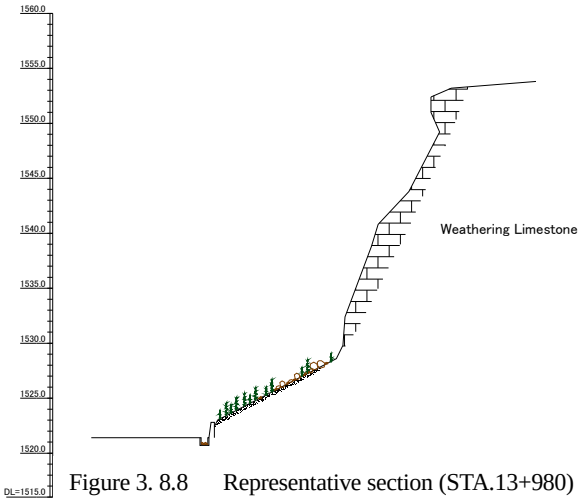


Figure 3. 8.8 Representative section (STA.13+980)

Retaining walls are installed in two locations, and natural slopes continue between both of the walls. Detailed observation cannot be done at the upper part due to vegetation; however, gravels are distributed on the lower parts and a spring water is also observed.

There are fallen rocks 1.5m in diameter on the road side of the retaining wall toward the section end. Behind the retaining wall, there is a large amount of fallen rocks and colluviums. The rocks deposited here are large diameters compared to those near the retaining wall at the beginning of the section; hence, the risk of Rockfall is greater toward the end.

Photo 3. 8.17 Retaining wall on the section start side (1.5m high, extending 100m)

Photo 3. 8.18　Natural slope between both of the retaining walls (a spring can be observed at the layer border)

Photo 3. 8.19　Retaining wall on the section end side (fallen rocks are distributed on the retaining wall side)

（9）RF009 (16+650～18+850)

This section is approximately 2.2km width, which is the longest in the relevant route. The geology consist of alternate layers of sandstone and siltstone. The slope elevation at the section end becomes 100m or higher.

The upper part is a cliff wall, while the lower part has a moderate gradient. The surface of the upper part is rough where loose rocks exfoliate and detach. Talus deposits including fallen rocks are distributed around the lower part, and the bed rocks are broke down to debris from weathering.

Most of the fallen rocks along the road are 0.5m to 1.0m in diameter; some fallen rocks with maximum of 3m are also observed.

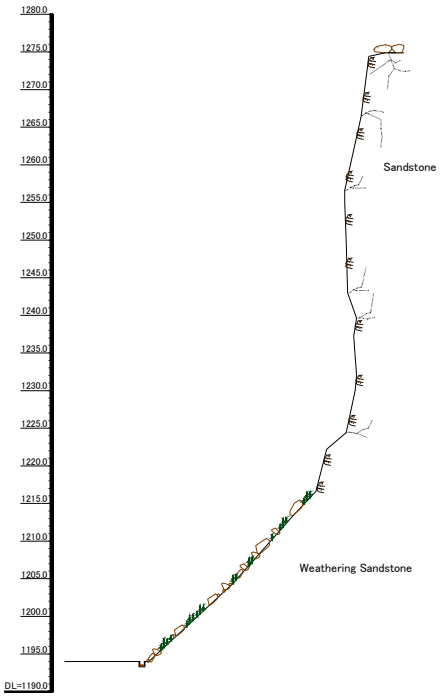


Figure 3. 8.9 Representative section (STA.17+630)

Rockfalls have occurred in STA.17+650 and STA.+18+530 in the past. Rockfalls frequently occur in this section.

Photo 3. 8.20 Sandston and siltstone outcroppings

Photo 3. 8.21 Fallen rocks distributed along the roadside

Photo 3. 8.22 Talus deposits distributed on the lower part

（10）RF010 (20+000～20+520)

This section has similar geological and topographic conditions, and Rockfall characteristics compared to section RF009.

The Rockfall source is the upper part consisting of consecutive sandstone and siltstone. Near the starting point, the area is vegetated with trees, where is hight below the cliffs. Detached rocks about 1m in diameter are observed on the slope surface.

Consecutive overhanging bed rocks exist on the upper part causing unstable slope condition. In some part, the overhanging is partially breaking and falling off.

The lower part consists of weathered soft sandstone. On these slope surfaces developed gullies and colluviums were observed. Unstabilized rock blocks due to erosion are distributed on the upper side resembling the form of “the fall-off type Rockfall”.

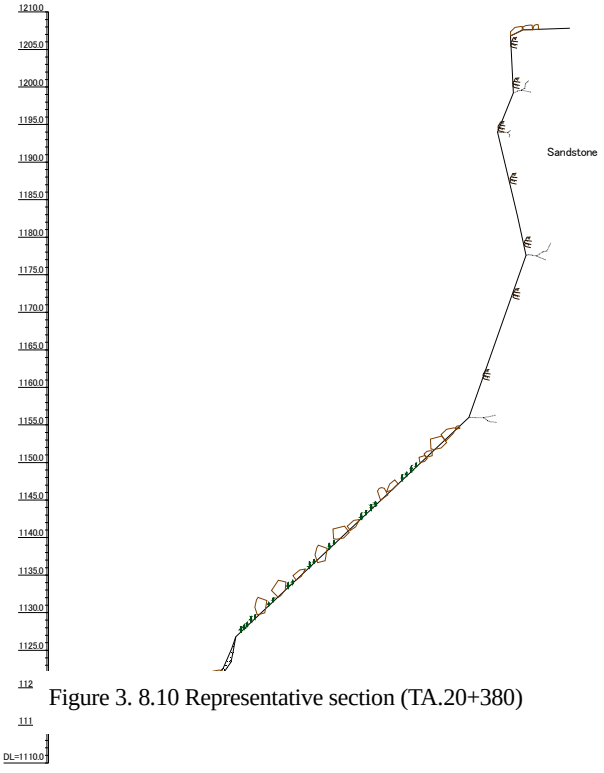


Figure 3. 8.10 Representative section (TA.20+380)

In this section, Rockfalls have occurred around STA.20+400 in the past.

Photo 3. 8.23　Overhanging of upper part

Photo 3. 8.24　Cut slopes softened due to weathering

（11）RF011 (20+540～20+960)

Sources of Rockfalls in this section include the cliff walls continuing from the previous section and the detached rocks scattered around the cut slopes.

The bed rocks with cracks consisted of tight sandstone and siltstone, and destabilized loose rocks exfoliate and detach from the upper part. Many detached rocks are also distributed on the moderate slope at the bottom of the cliffs.

The gradient of the cut slopes is about 60%, and the surfaces are covered with colluviums. In some parts, detached rocks are observed, which have become unstable due to erosion.

Large fallen rocks 2m to 3m in diameter are distributed along the road in this section. This indicates a large scale of Rockfalls.

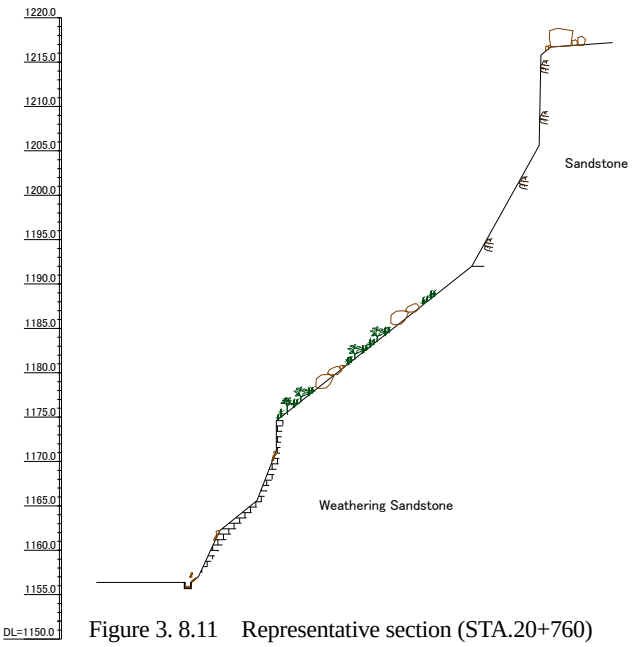


Figure 3. 8.11　Representative section (STA.20+760)

Photo 3. 8.25 Entire picture of section RF0011 (taken from the section start point)

Photo 3. 8.26 Fallen rocks around STA.20+800m

Photo 3. 8.27 A fallen rock 2.5m in diameter

（12）RF012 (20+980～21+400)

This section is a cut slope consisting mainly of sandstone, where a number of unstable detached rocks are observed in the area. They are also distributed on the slope.

The cut slope is composed of tight sandstone overhanging; about 1-m detached rocks are observed on the road side.

Shallow landslides are observed in the slopes on the section end, so that gabions have been installed.

In this section, Rockfalls have occurred around STA.21+400 in the past.

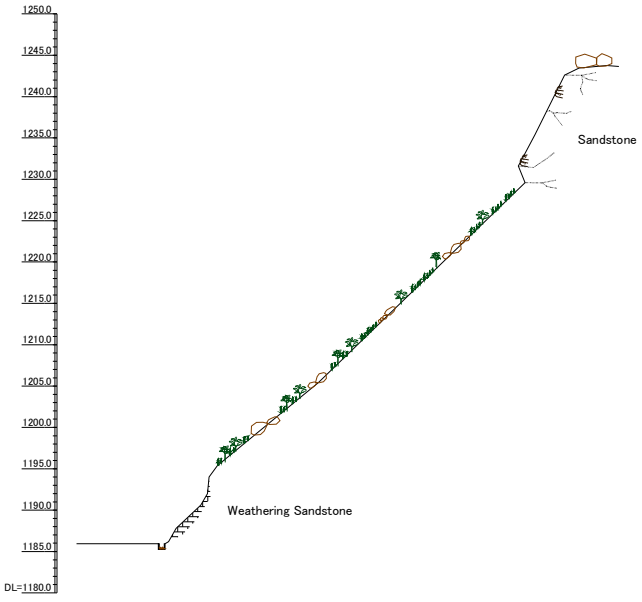


Figure 3. 8.12 Representative section (STA.21+000)

Photo 3. 8.28　Detached rocks distributing on cut slopes

Photo 3. 8.29　Overhanging cut slope (around STA.21+300)

（13）RF013 (30+450～30+650)

This section is located on the landslide portion. From STA.30+400 toward the section end, consecutive cliffs have been formed.

With the 30m slope height and steep gradient, the bed rock is mainly composed of limestone. Cracks have developed in the entire limestone, and loose rocks around the cracks exfoliate and detach from the surface.

At the foot of the cliffs, fallened rocks of about 50cm in diameter are scattered around, while some of them are distributed on the road.

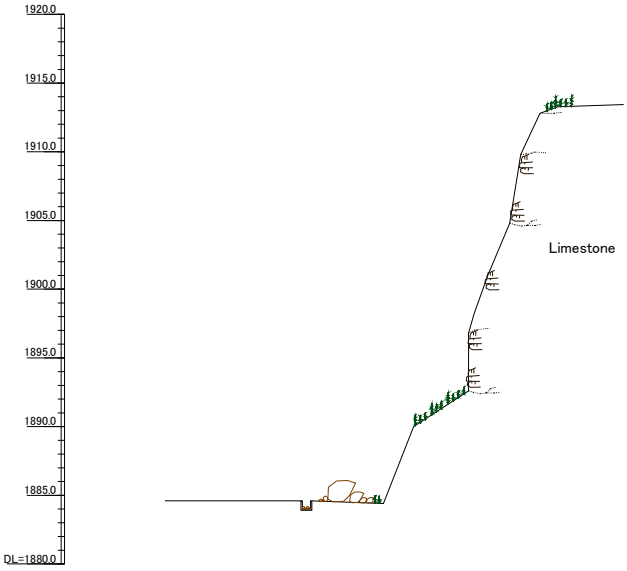


Figure 3. 8.13　Representative section (STA.30+500)

This section is short width and is farther off the road. As Rockfalls have occurred around STA.30+500 in the past, the section has a Rockfall hazard potential.

Photo 3. 8.30 Entire picture of section RF0013 (taken from the section start point)

Photo 3. 8.31 Fallen rocks distributed on the bottom of the cliffs

（14）RF014 (31+00～31+200)

This section has mostly moderate slopes with a gradient of approximately 35° and a 20m height. The slopes consist mainly of talus deposits.

Many detached rocks are observed on the slopes and most of them are about 1.0m in diameter.

Although this section has a short width and sizes of detached rocks are relatively small, several Rockfalls have been reported around STA.31+000 in the past.

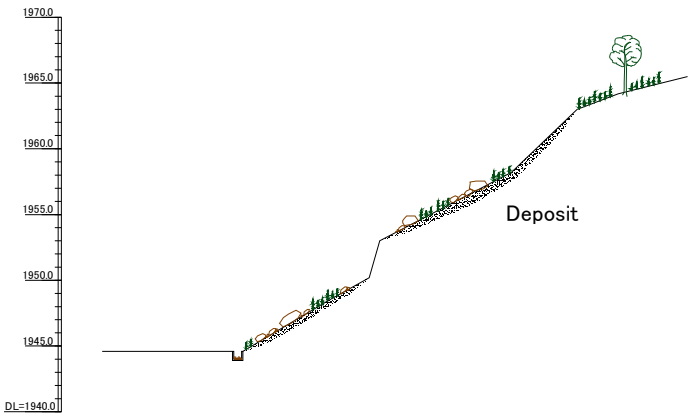


Figure 3. 8.14 Representative section (STA.31+040)

Photo 3. 8.32 Entire picture of section RF0013 (taken from the section end point)

Photo 3. 8.33 Detached rocks distributed on the slopes

（15）RF015 (32+00～32+400)

This cut slopes consist of limestone.

The slope is 20m or lower in height, and steep. Weathering progresses on the entire slope while small loose rocks exfoliate and detach from the surface. Fallen rocks accumulate in the gutters, which causes blockage in some parts.

Most of fallen rocks are 30cm or smaller in diameter, which are also scattered on the road.

Photo 3. 8.34　fallen rocks distributed at the bottom of the cut slope

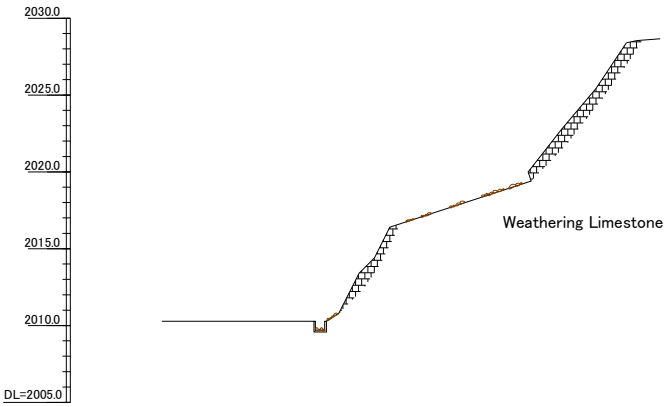


Figure 3. 8.15　Representative section (STA.32+040)

Photo 3. 8.35　Weathered limestone cut slope

（16）RF016 (34+000～34+500)

In this section, loose rocks and detached rocks on the cut slope are the source of Rockfalls.

The slope consists of weathered basaltic rocks with developed cracks. The gradient is steep. Similar to the case of RF004, basaltic blocks exfoliate and detach as in cubic forms.

Natural slopes continue on the upper part, where vegetation grows thickly. Many loose rocks about 50cm in diameter are distributed on the slopes, while unstable loose rocks fall from the ridges.

The section is about 500 m width and fallen rocks are distributed in the gutter and on the road. Rockfalls have occurred nearSTA.34+300 and STA.34+440 in the past.

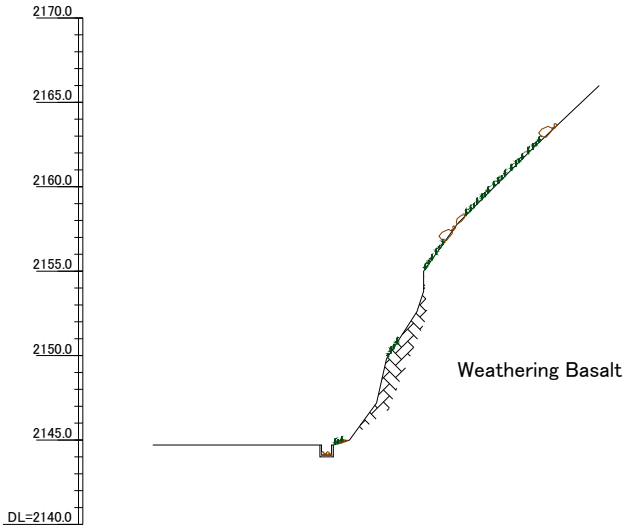


Figure 3. 8.16 Representative section (STA.34+380)

Photo 3. 8.36 Weathered basaltic cut slope

Photo 3. 8.37 Fallen rocks from the cut slope

（17）RF017 (35+300～35+600)

In this section, similarly to RF016, basaltic outcrops with developed cracks appear on the cut slopes. On the other hand, the upper part is moderate compared to the previous one; hence the slope is the source of Rockfalls.

Loose rocks exfoliate and detach from the surface where columnar joints develop. Detached rocks with 30cm or smaller in diameter are scattered around the end of the slope as well as on the road.

In the gutter, many fallen rocks have accumulated which clogged the gutter.

Photo 3. 8.38　Weathered basaltic cut slopes

Photo 3. 8.39　Fallen rocks from the cut slope (the section end side was taken from around area STA.35+350)

Rock Fall Survey

STA.	0+340
Section.No.	1
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～1.5
Figure	square
Geology	Bs
Crack	many

STA.	0+930
Section.No.	2
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～0.5
Figure	square
Geology	Bs
Crack	many

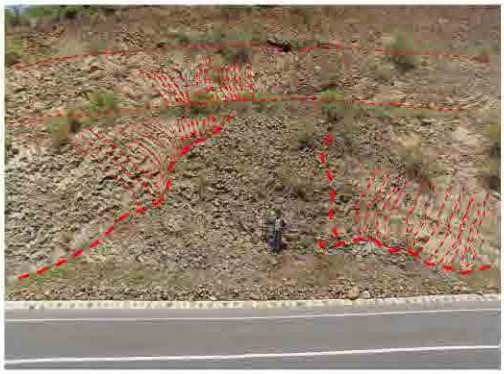
STA.	1+180
Section.No.	3
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～2.6
Figure	square
Geology	Bs
Crack	many

STA.	1+300
Section.No.	4
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～3.0
Figure	square
Geology	Bs
Crack	many

STA.	1+760
Section.No.	5
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～2.1
Figure	square
Geology	Bs
Crack	many

Rock Fall Survey

STA.	2+400
Section.No.	6
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～0.3
Figure	square
Geology	Bs
Crack	many



STA.	2+660
Section.No.	7
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.3
Figure	square
Geology	Bs
Crack	many

STA.	4+020
Section.No.	8
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.5
Figure	square
Geology	Bs
Crack	many

STA.	4+200
Section.No.	9
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～2.0
Figure	square
Geology	Bs
Crack	many

STA.	4+280
Section.No.	10
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.7
Figure	square
Geology	Bs
Crack	opening crack

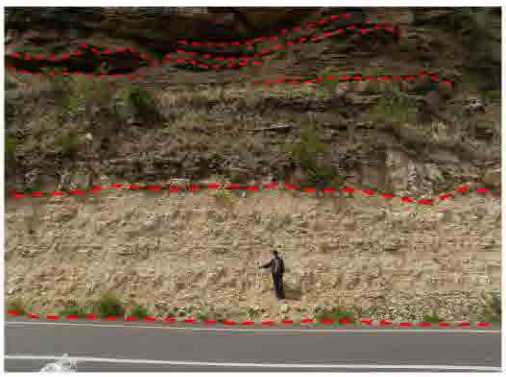
Rock Fall Survey

STA.	4+320
Section.No.	11
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～2.4
Figure	square
Geology	Bs
Crack	opening crack

STA.	4+580
Section.No.	12
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.5
Figure	square
Geology	Bs
Crack	opening crack

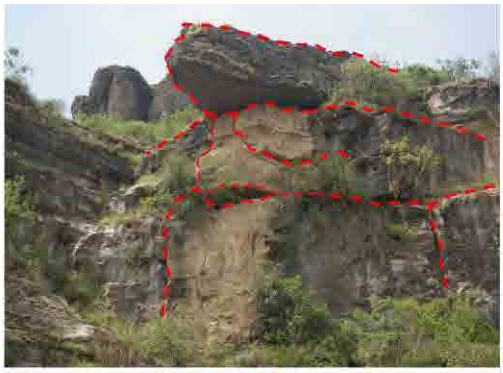
STA.	4+700
Section.No.	13
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～3.1
Figure	square
Geology	Bs
Crack	opening crack

STA.	4+850
Section.No.	14
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.6
Figure	square
Geology	Bs
Crack	opening crack



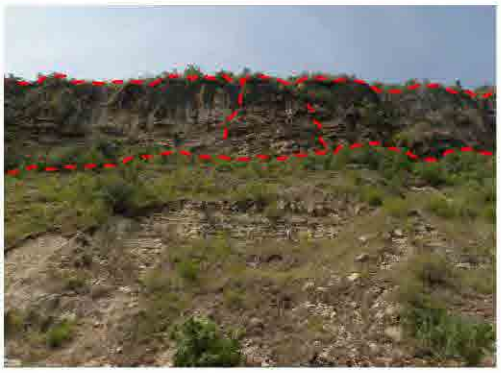
STA.	5+480
Section.No.	15
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～1.3
Figure	square
Geology	Lm
Crack	opening crack

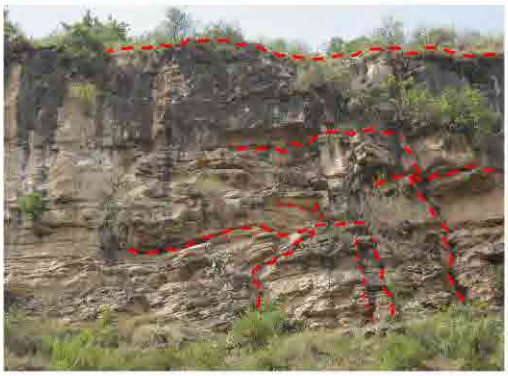
Rock Fall Survey



STA.	5+600
Section.No.	16
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～1.5
Figure	square
Geology	Lm
Crack	many

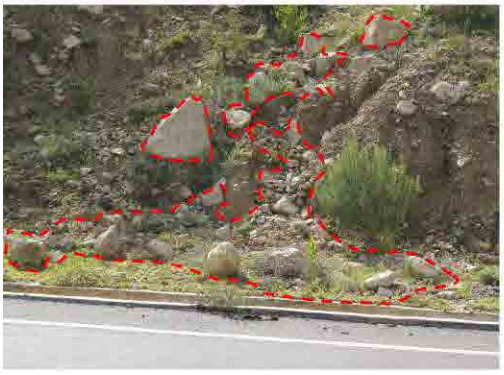
STA.	5+680
Section.No.	17
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～2.1
Figure	square
Geology	Lm
Crack	many





STA.	5+750
Section.No.	18
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～1.4
Figure	square
Geology	Lm
Crack	many

STA.	5+900
Section.No.	19
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～4.5
Figure	square
Geology	Lm
Crack	many



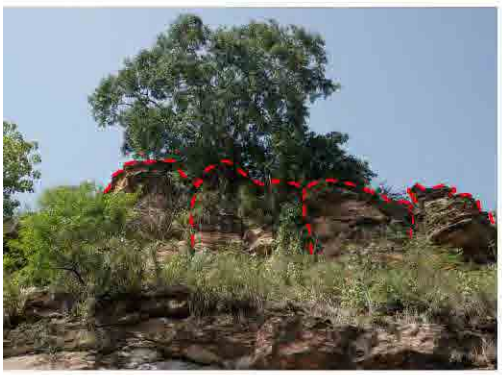
STA.	13+540
Section.No.	20
Boulder stone	○
unsteady stone	
Diameter(m)	0.1～0.7
Figure	sphere
Geology	Dp
Crack	—

Rock Fall Survey

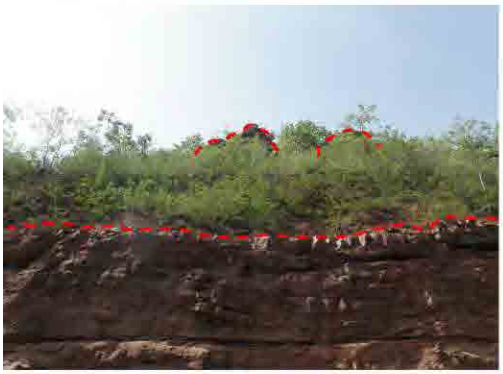
STA.	13+840
Section.No.	21
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～1.2
Figure	square
Geology	Lm
Crack	many

STA.	13+980
Section.No.	22
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.7
Figure	square
Geology	Lm
Crack	many

STA.	14+000
Section.No.	23
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～1.5
Figure	square
Geology	Lm
Crack	many



STA.	16+840
Section.No.	24
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.6
Figure	square
Geology	Ss
Crack	many



STA.	17+100
Section.No.	25
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.4
Figure	square
Geology	Ss
Crack	many

Rock Fall Survey

STA.	17+460
Section.No.	26
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～1.2
Figure	square
Geology	Ss
Crack	many

STA.	17+500
Section.No.	27
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～3.5
Figure	square
Geology	Ss
Crack	many

STA.	17+630
Section.No.	28
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～1.4
Figure	square
Geology	Ss
Crack	many

STA.	17+720
Section.No.	29
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～1.5
Figure	square
Geology	Ss
Crack	many

STA.	17+880
Section.No.	30
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～1.6
Figure	square
Geology	Ss
Crack	many

Rock Fall Survey

STA.	17+940
Section.No.	31
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～2.1
Figure	square
Geology	Ss
Crack	many

STA.	18+080
Section.No.	32
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～1.5
Figure	square
Geology	Ss
Crack	many

STA.	18+480
Section.No.	33
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～1.7
Figure	square
Geology	Ss
Crack	many

STA.	18+640
Section.No.	34
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～1.0
Figure	square
Geology	Ss
Crack	many

STA.	18+720
Section.No.	35
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～2.1
Figure	square
Geology	Ss
Crack	many

Rock Fall Survey

STA.	18+800
Section.No.	36
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.3
Figure	square
Geology	Ss
Crack	many

STA.	18+840
Section.No.	37
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～3.5
Figure	square
Geology	Ss
Crack	many

STA.	20+050
Section.No.	38
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～1.4
Figure	square
Geology	Ss
Crack	many

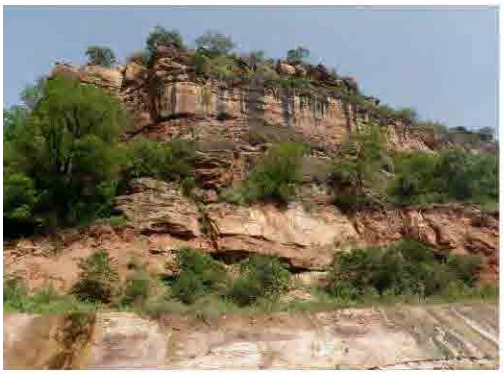
STA.	20+240
Section.No.	39
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～2.1
Figure	square
Geology	Ss
Crack	many

STA.	20+380
Section.No.	40
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～3.6
Figure	square
Geology	Ss
Crack	many

Rock Fall Survey

STA.	20+480
Section.No.	41
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～1.0
Figure	square
Geology	Ss
Crack	many

STA.	20+660
Section.No.	42
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～1.5
Figure	square
Geology	Ss
Crack	many



STA.	20+700
Section.No.	43
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～2.8
Figure	square
Geology	Ss
Crack	many

STA.	20+760
Section.No.	44
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～2.1
Figure	square
Geology	Ss
Crack	many

STA.	20+920
Section.No.	45
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～0.8
Figure	square
Geology	Ss
Crack	many

Rock Fall Survey

STA.	21+000
Section.No.	46
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～1.5
Figure	square
Geology	Lm
Crack	many

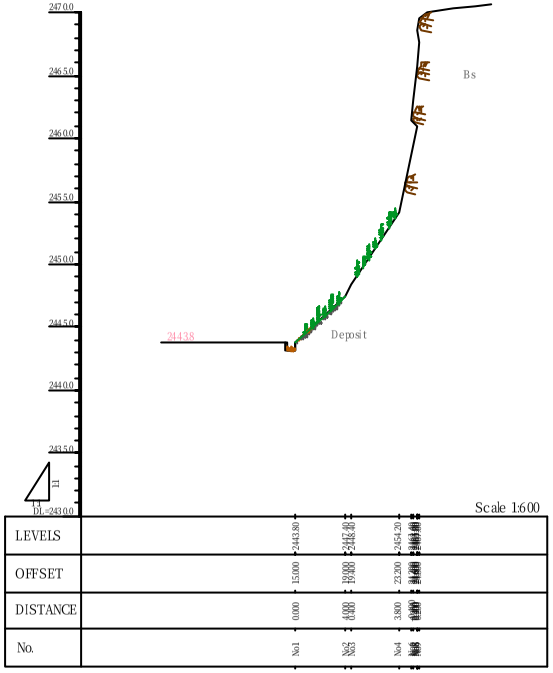
STA.	30+500
Section.No.	47
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.6
Figure	square
Geology	Lm
Crack	many

STA.	31+040
Section.No.	48
Boulder stone	○
unsteady stone	
Diameter(m)	0.1～2.1
Figure	square
Geology	Dp
Crack	—

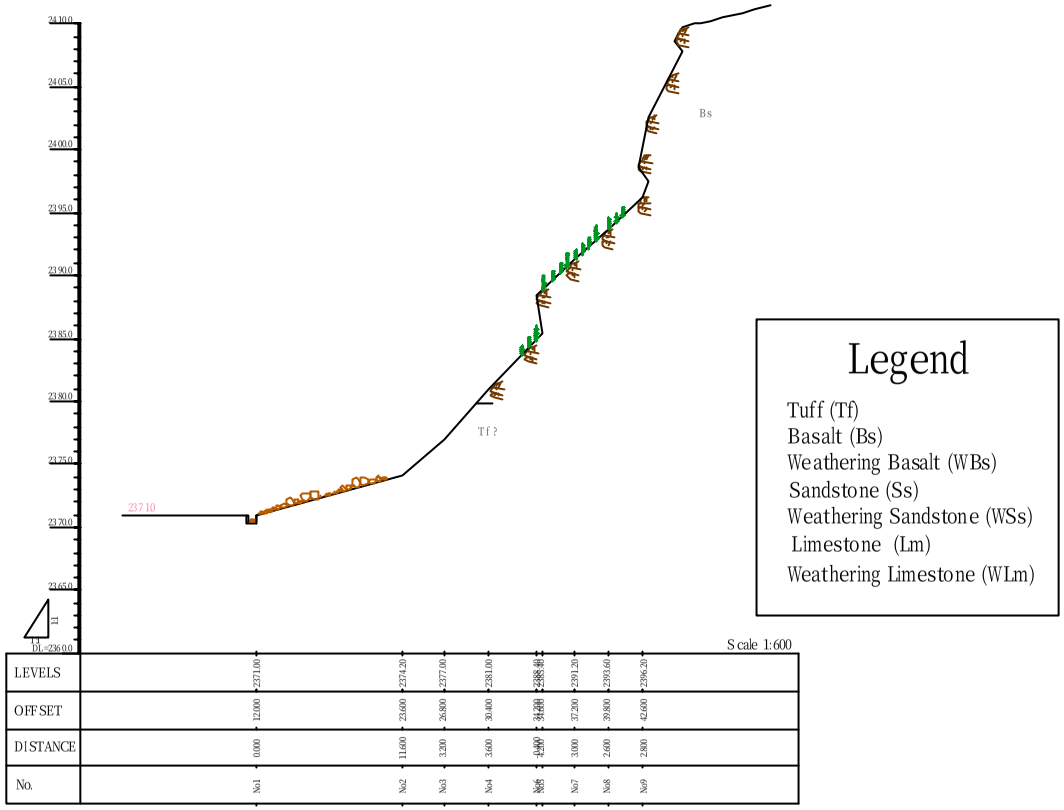
STA.	32+040
Section.No.	49
Boulder stone	
unsteady stone	○
Diameter(m)	0.1～0.6
Figure	square
Geology	Lm
Crack	many

STA.	34+380
Section.No.	50
Boulder stone	○
unsteady stone	○
Diameter(m)	0.1～0.7
Figure	square
Geology	Bs
Crack	many

RF001 (STA.0+340)
(Section 1/50)



RF002 (STA.0+930)
(Section 2/50)



Legend

- Tuff (Tf)
- Basalt (Bs)
- Weathering Basalt (WBs)
- Sandstone (Ss)
- Weathering Sandstone (WSs)
- Limestone (Lm)
- Weathering Limestone (WLm)

Offset value is set as 0 (zero) which is the standing point when the surveyor measure the slope height and distance by the measurement device.

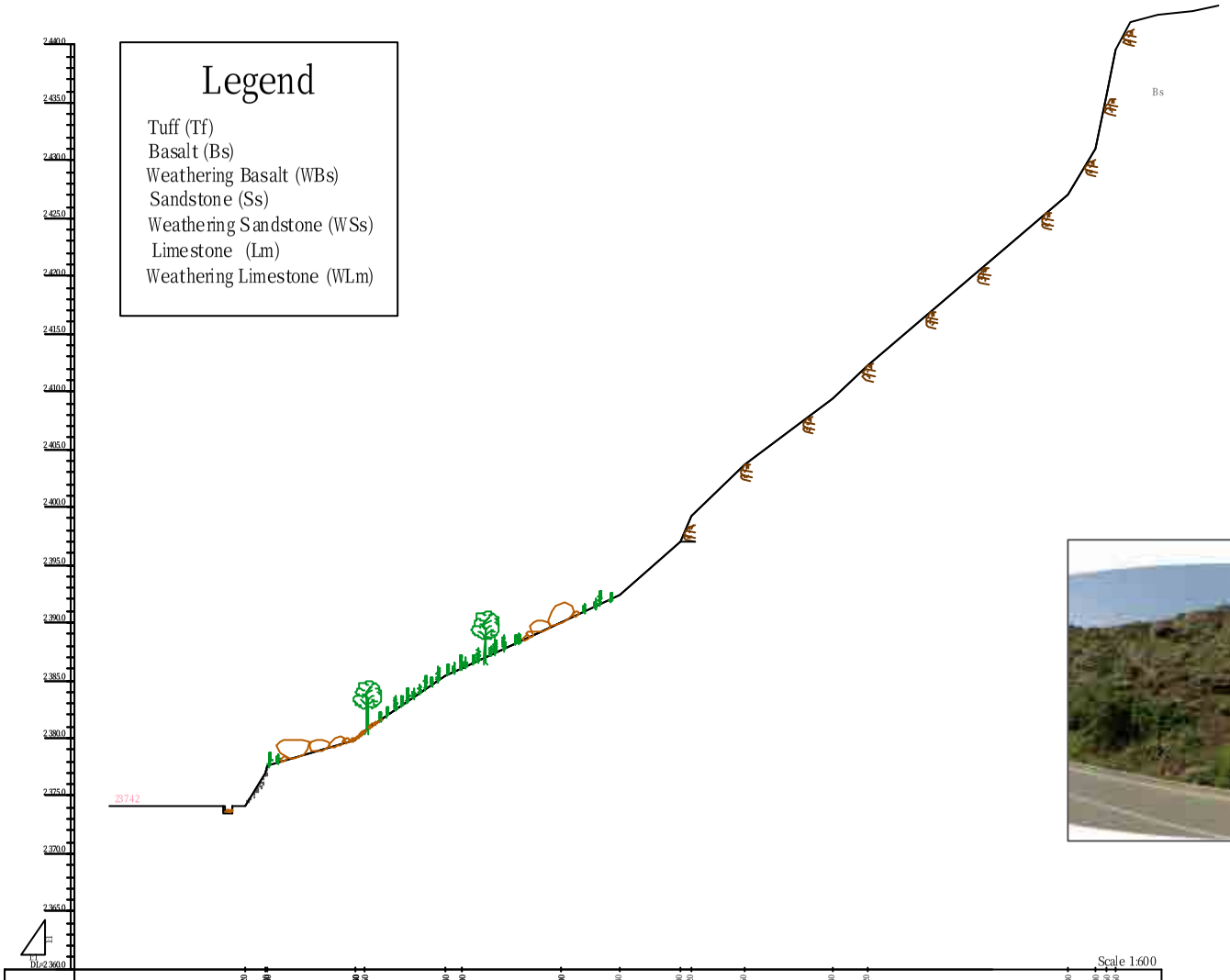
This is a image section of site conditions.

RF003 (STA.1+180)

(Section 3/50)

Legend

Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)



This is a image section of site conditions.

RF003 (STA.1+300)
(Section 4/50)

Legend

Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

Scale 1:600

LEVELS	2373.60		2374.00		2378.00	2375.00		2379.20		2384.80	2385.40				2394.80				2421.60		2431.40	2441.00
OFFSET	10.200		36.400		40.800	42.400		55.800		64.800	66.600				85.000				101.200		104.600	113.200
DISTANCE	0.000		26.200		1.600	6.000		15.000		9.000	1.800				8.000				5.400		1.600	9.600
No.	No1		No2		No4	No3		No5		No6	No7				No10				No16		No19	No20

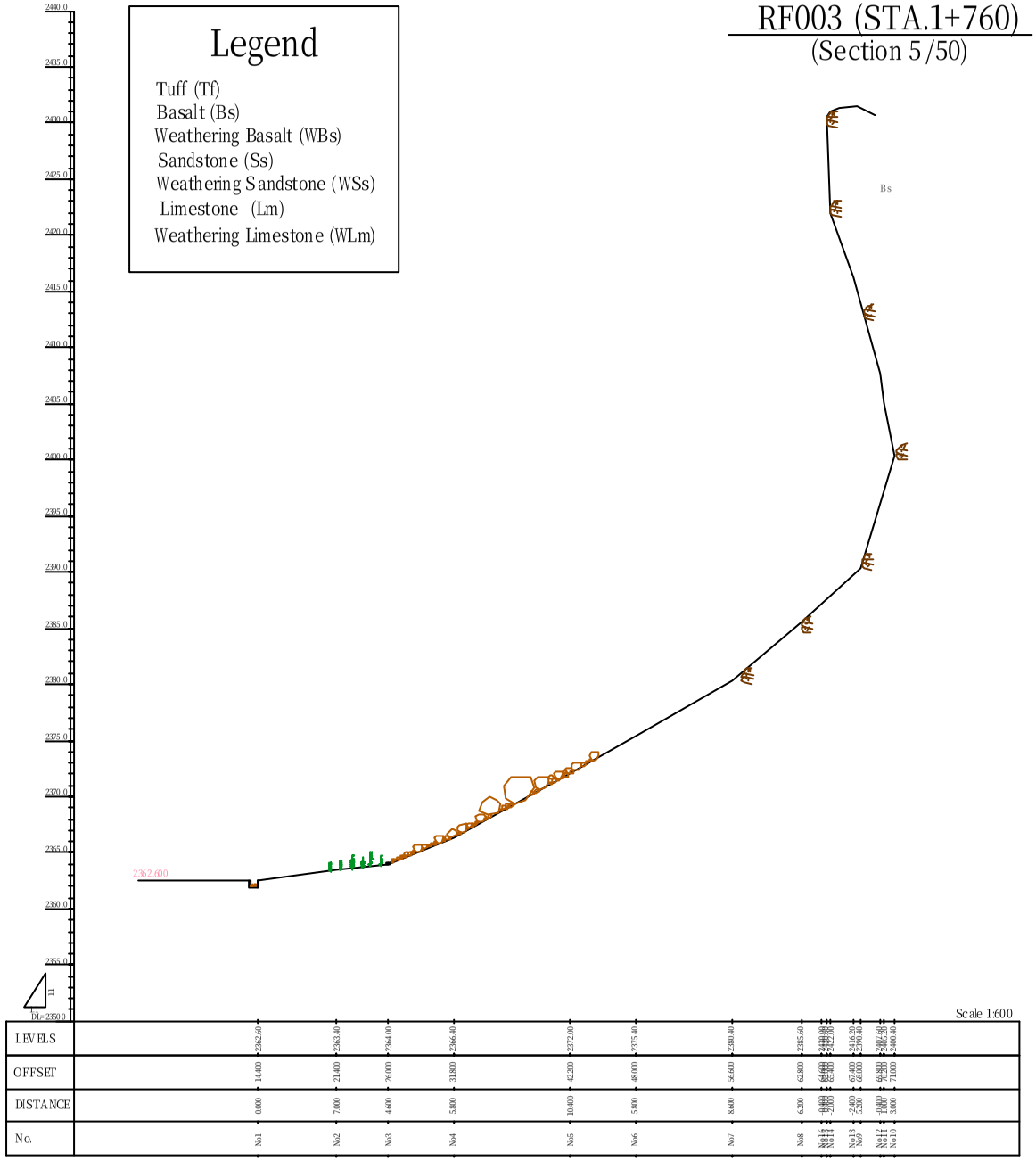
This is a image section of site conditions.

RF003 (STA.1+760)

(Section 5 /50)

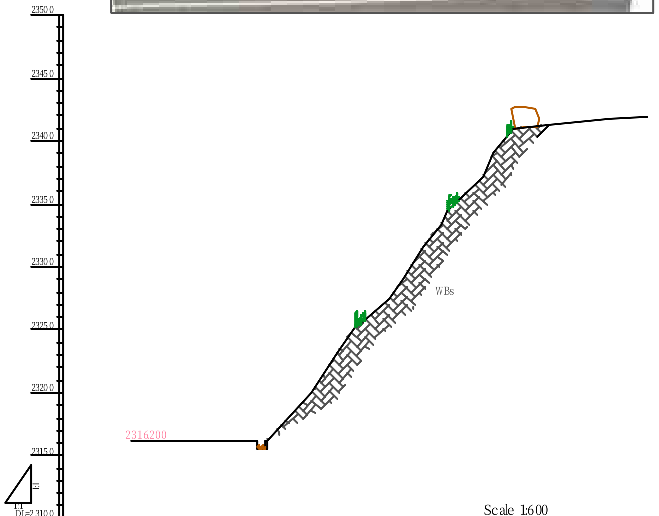
Legend

Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)



This is a image section of site conditions.

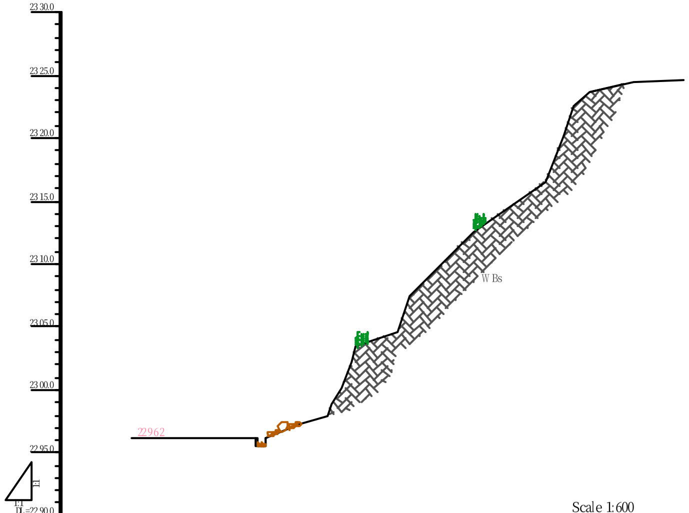
RF004 (STA.2+400)
(Section 6/50)



Scale 1:600

LEVELS	2316.20	2320.00	2323.20	2325.20	2325.40	2327.40	2329.00	2331.60	2333.40	2334.40	2337.20	2339.00	2343.60	2341.00
OFFSET	14.200	17.800	19.800	21.200	21.600	24.000	25.000	26.600	28.000	28.600	31.400	32.200	33.200	33.800
DISTANCE	0.000	3.600	2.000	1.400	0.400	2.400	1.000	1.600	1.400	0.600	1.000	0.800	-0.600	1.600
No.	No1	No2	No3	No4	No5	No6	No7	No8	No9	No10	No11	No12	No14	No13

RF004 (STA.2+660)
(Section 7/50)



Scale 1:600

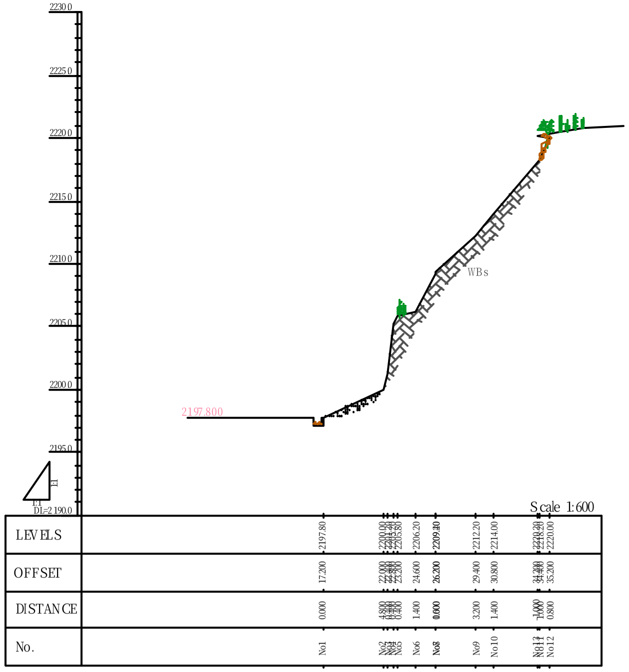
LEVELS	2296.20	2297.20	2298.00	2298.80	2300.20	2303.20	2303.40	2304.60	2307.40	2312.60	2316.60	2320.20	2322.60	2323.60
OFFSET	14.200	16.800	19.000	19.400	20.200	21.000	21.200	24.600	25.600	30.600	36.400	37.800	38.600	39.800
DISTANCE	0.000	2.600	2.200	0.400	0.800	0.800	0.200	3.400	1.000	5.000	1.000	1.400	0.800	1.200
No.	No1	No2	No3	No4	No5	No6	No7	No8	No9	No10	No11	No12	No13	No14

Legend

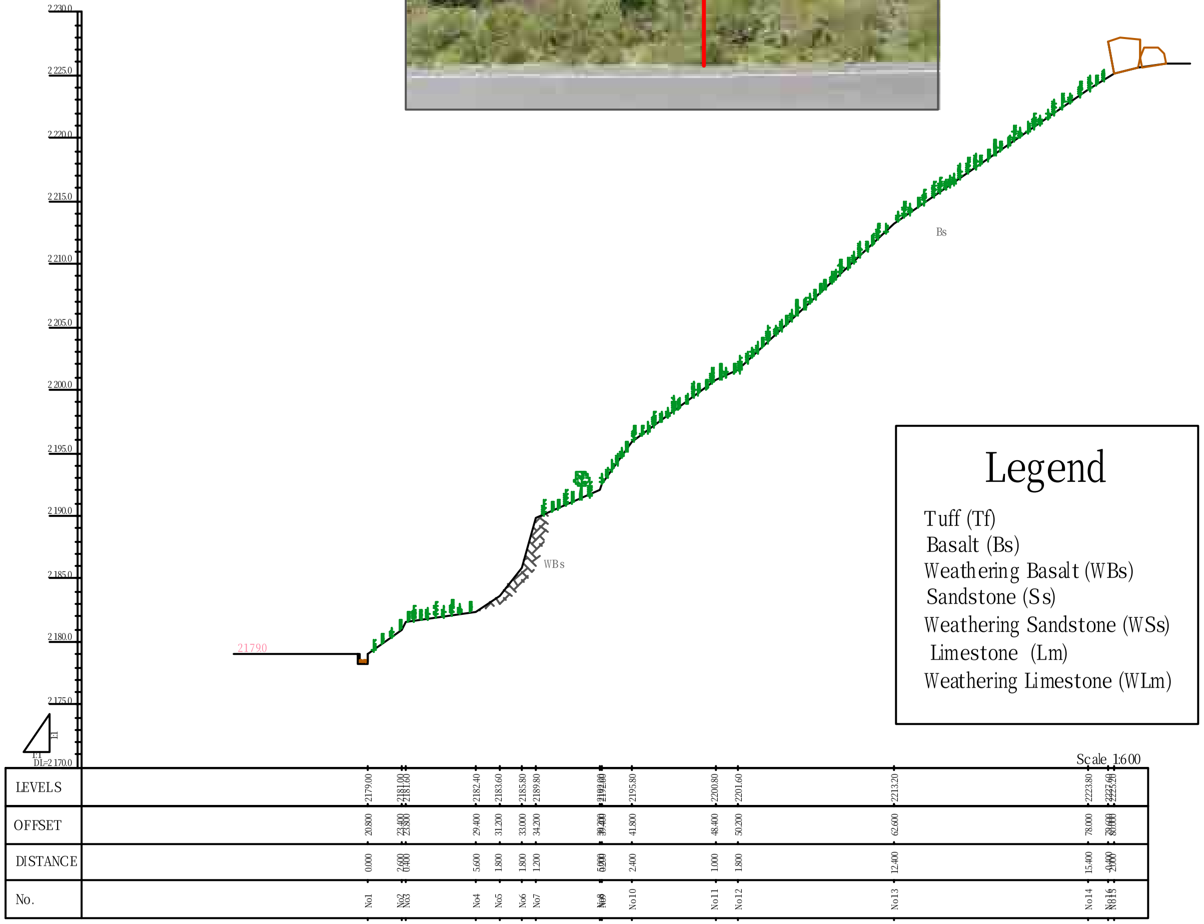
- Tuff (Tf)
- Basalt (Bs)
- Weathering Basalt (WBs)
- Sandstone (Ss)
- Weathering Sandstone (WSs)
- Limestone (Lm)
- Weathering Limestone (WLm)

This is a image section of site conditions.

RF005 (STA.4+020)
(Section 8/50)



RF005 (STA.4+200)
(Section 9/50)

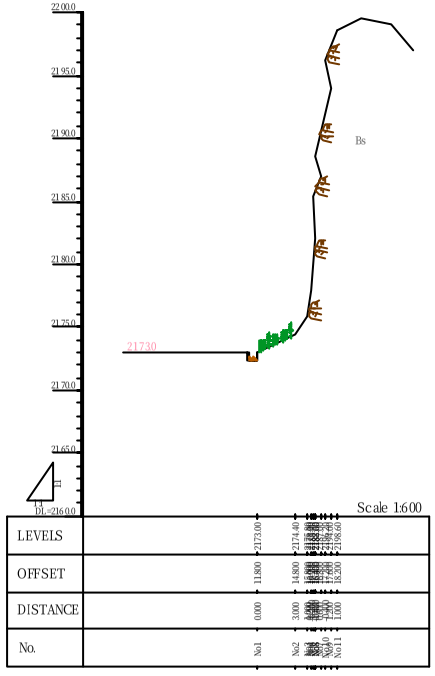


Legend

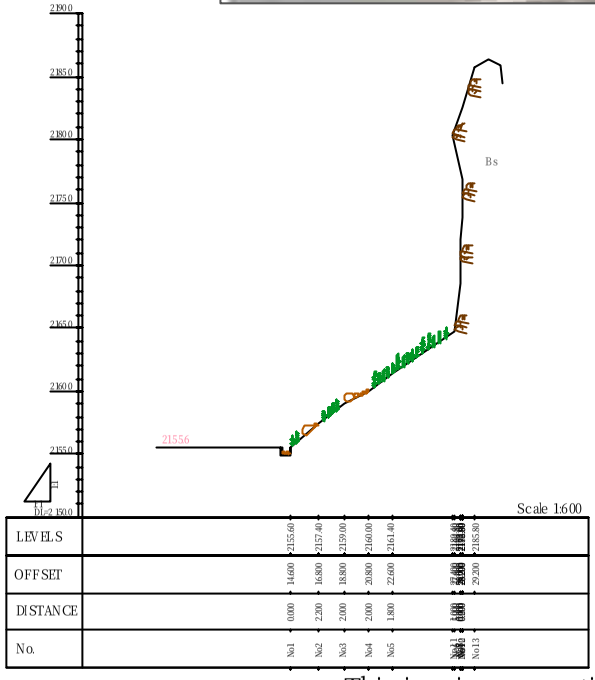
Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

This is a image section of site conditions.

RF005 (STA.4+280)
(Section 10/50)



RF005 (STA.4+320)
(Section 11/50)

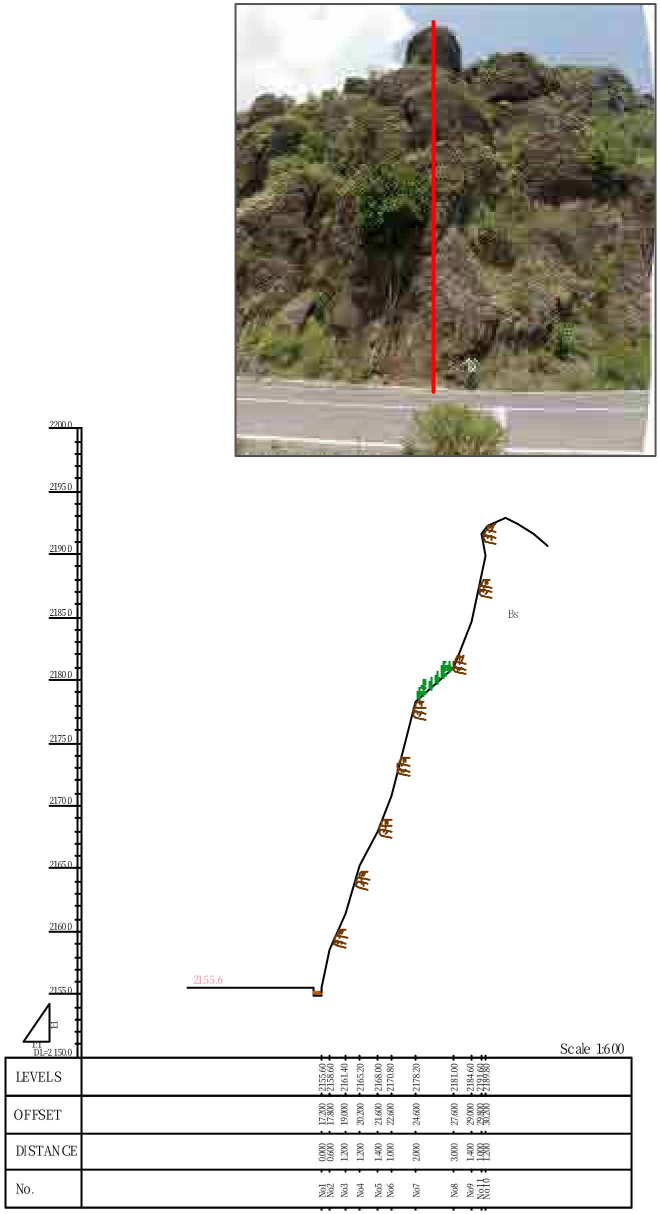


Legend

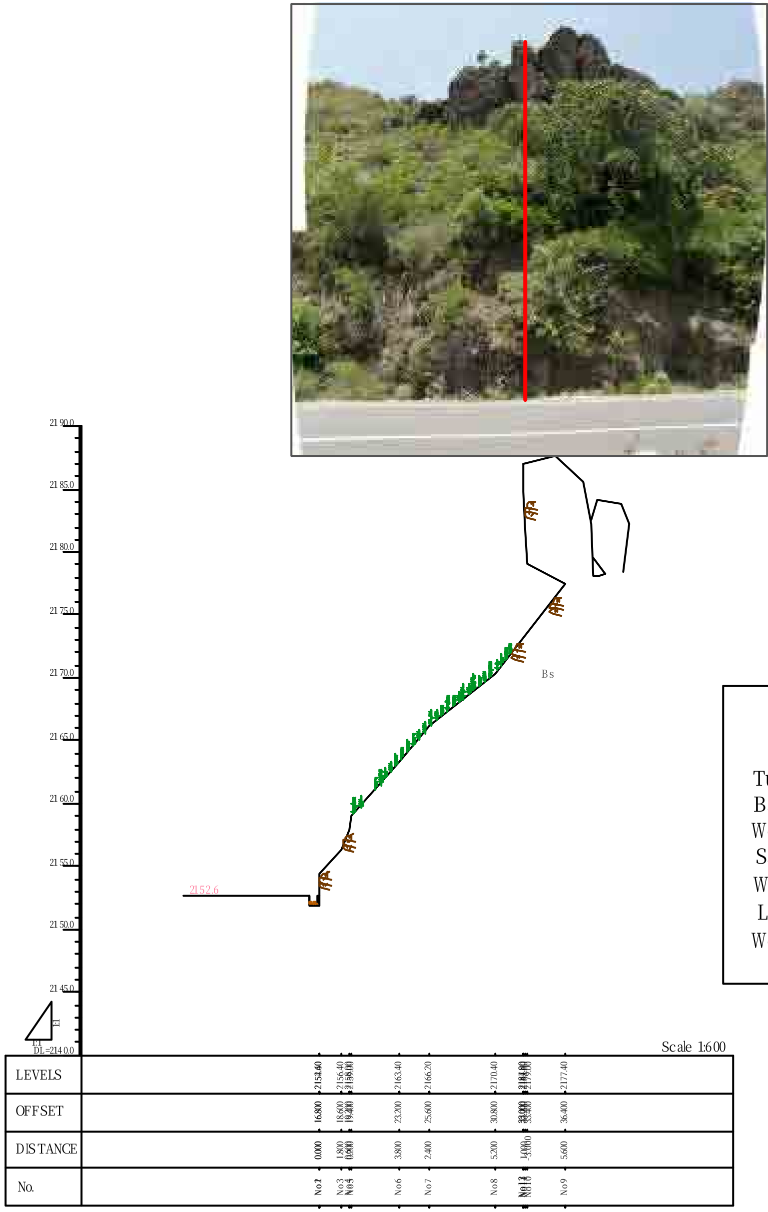
Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

This is a image section of site conditions.

RF005 (STA.4+580)
(Section 12/50)



RF005 (STA.4+700)
(Section 13/50)

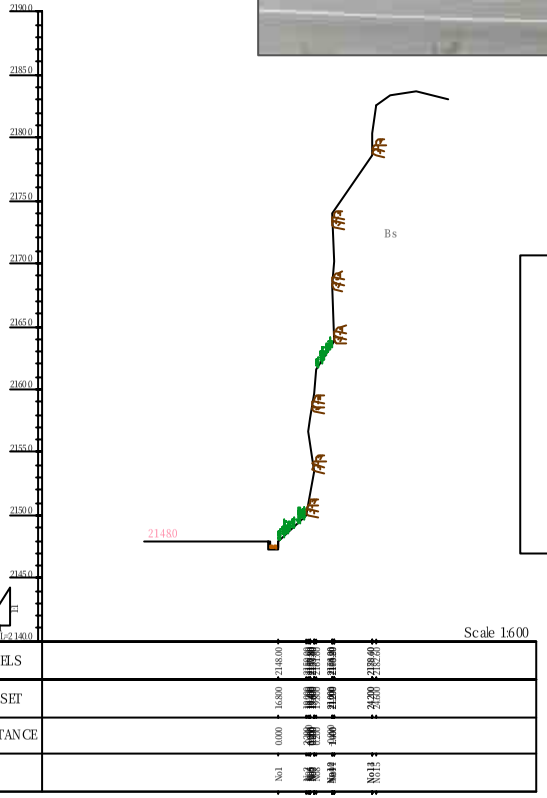


Legend

Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

This is a image section of site conditions.

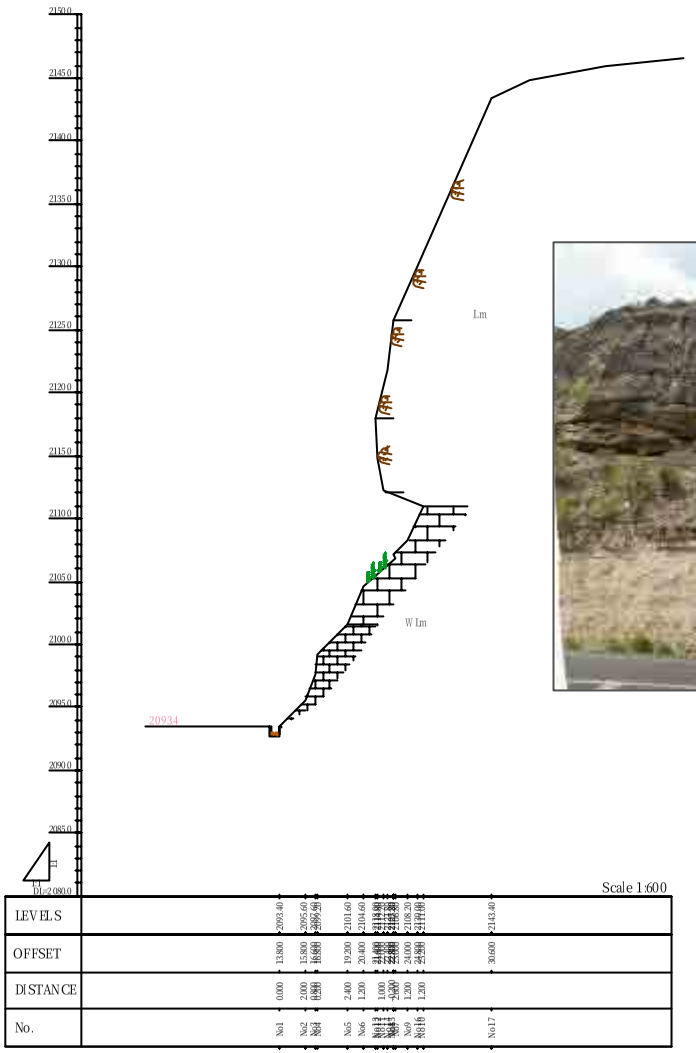
RF005 (STA.4+850)
(Section 14/50)



Legend

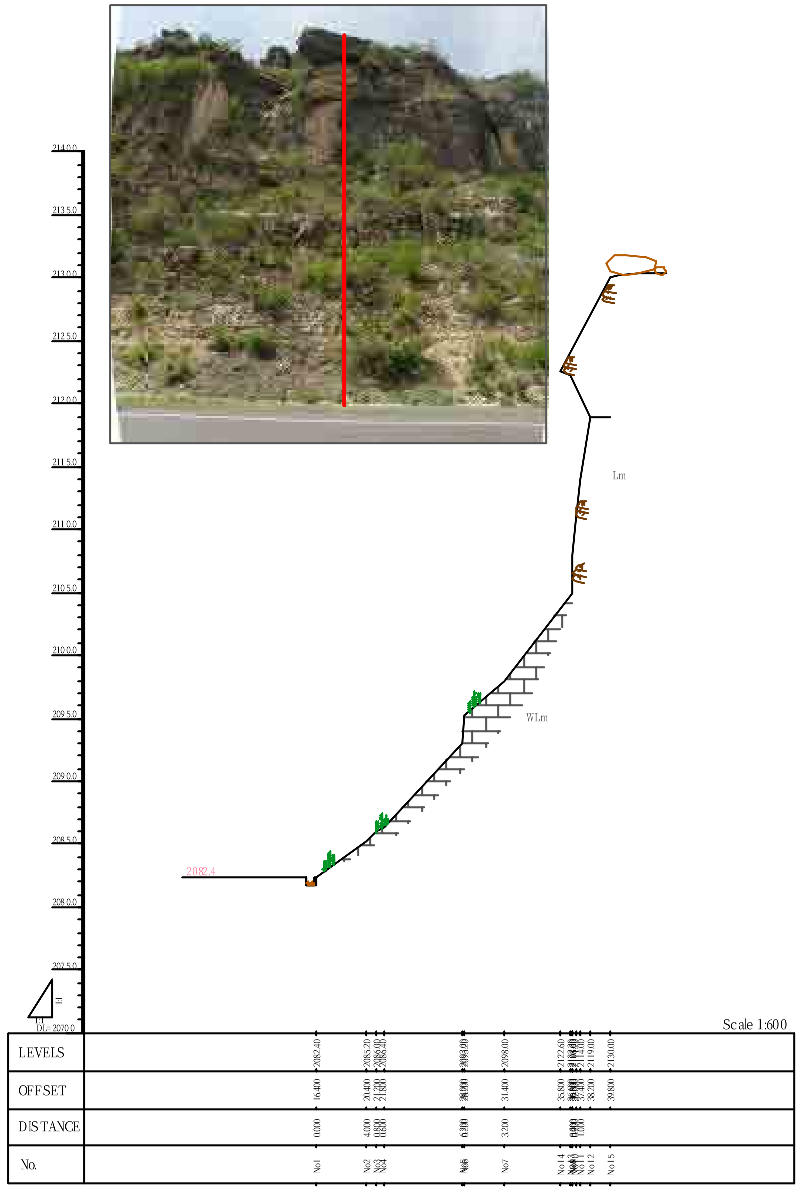
Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

RF006 (STA.5+480)
(Section 15/50)

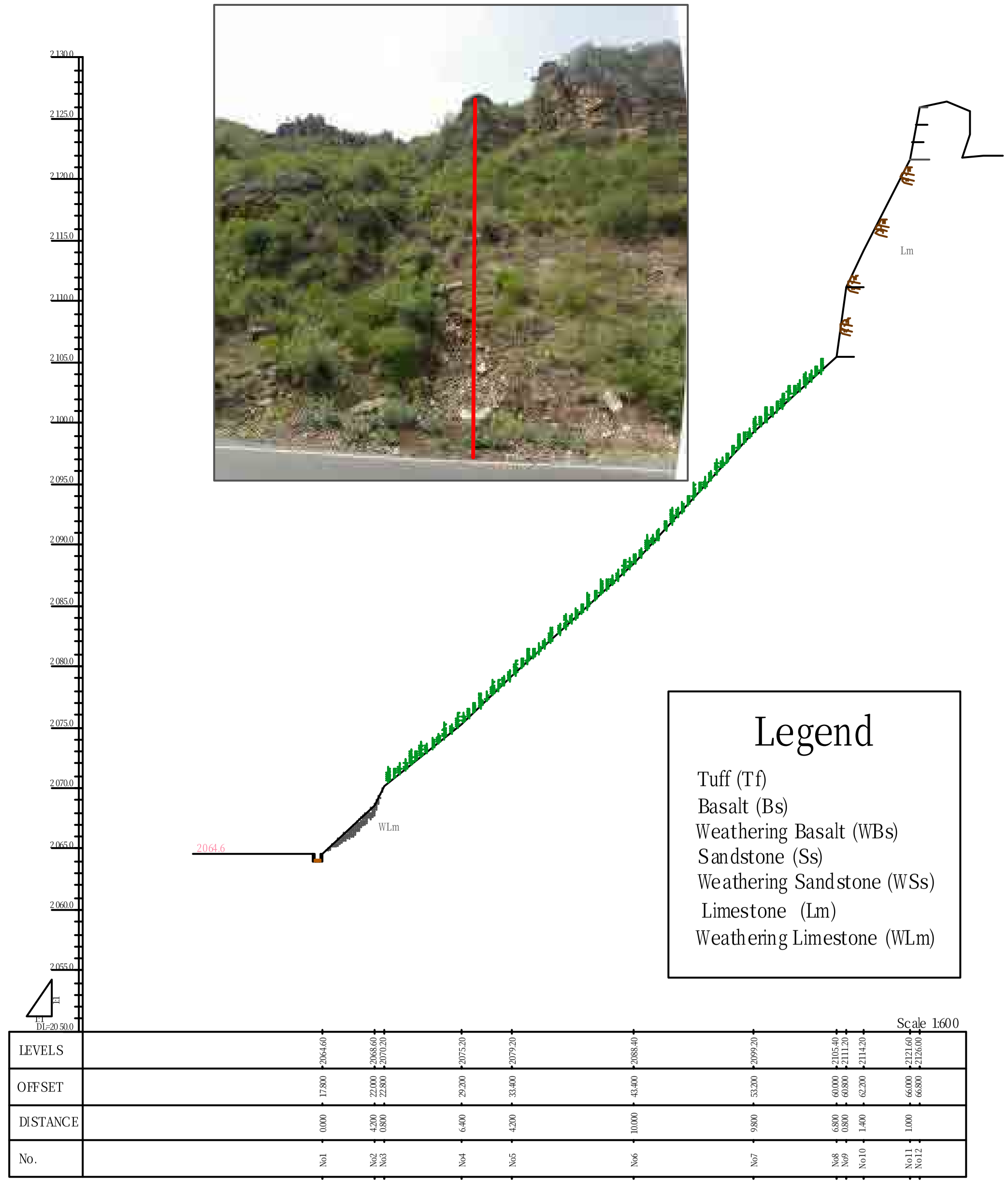


This is a image section of site conditions.

RF006 (STA.5+600)
(Section 16/50)



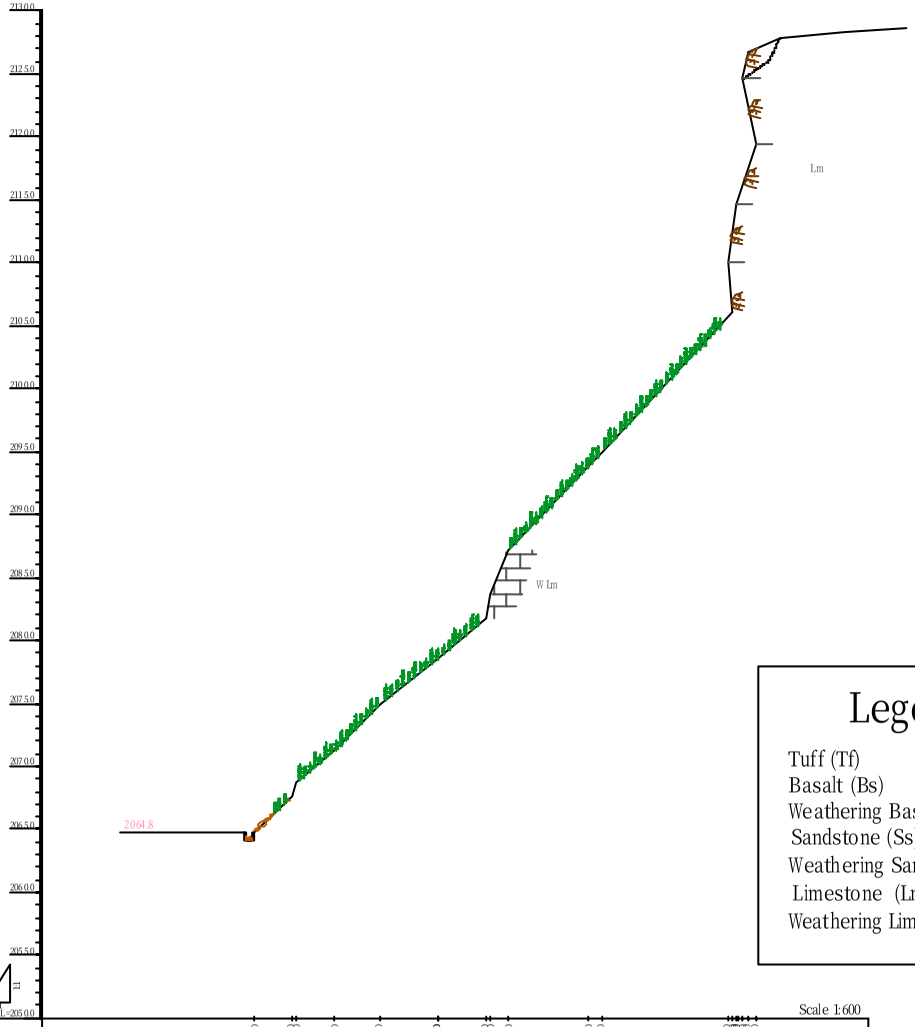
RF006 (STA.5+680)
(Section 17/50)



This is a image section of site conditions.

RF006 (STA.5+750)

(Section 18/50)



Legend

- Tuff (Tf)
- Basalt (Bs)
- Weathering Basalt (WBs)
- Sandstone (Ss)
- Weathering Sandstone (WSs)
- Limestone (Lm)
- Weathering Limestone (WLm)

This is a image section of site conditions.

RF006 (STA.5+900)

(Section 19/50)

Legend

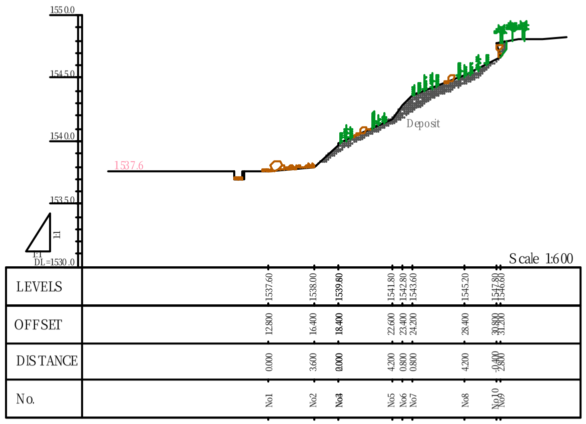
- Tuff (Tf)
- Basalt (Bs)
- Weathering Basalt (WBs)
- Sandstone (Ss)
- Weathering Sandstone (WSs)
- Limestone (Lm)
- Weathering Limestone (WLm)

Scale 1:600

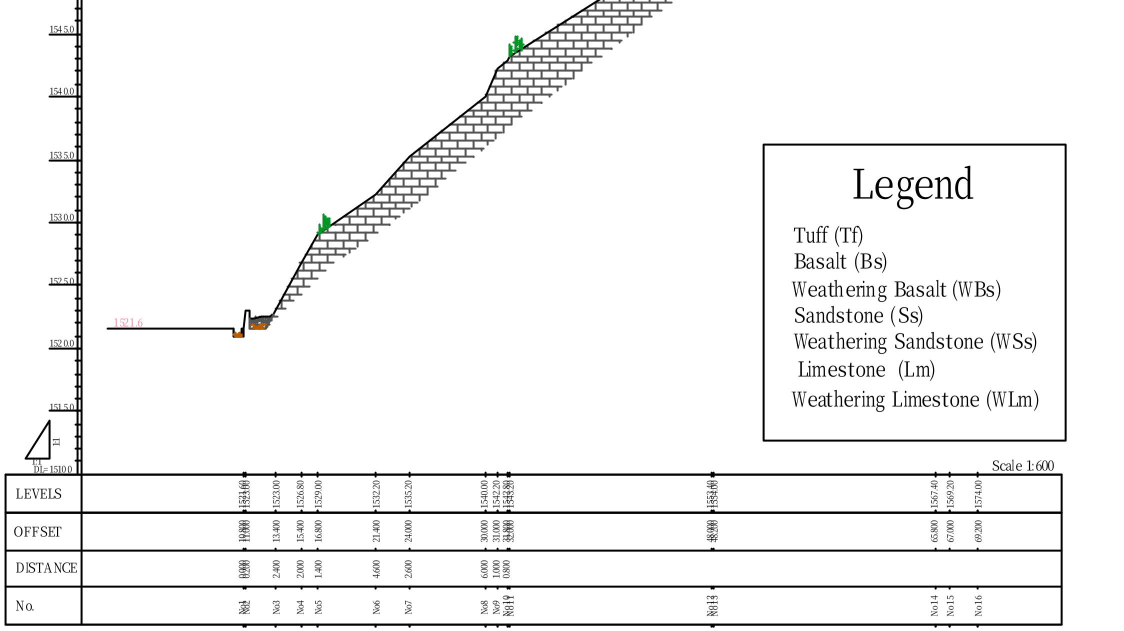
LEVELS	2046.80	2050.60 / 2049.20	2051.80	2054.60	2056.40	2057.80	2069.40	2075.40	2085.00	2093.20 / 2095.20	2106.80	2108.00	2122.20	2118.80 / 2126.80
OFFSET	18.400	22.200 / 22.400	23.600	28.200	30.800	32.400	50.400	62.600	78.600	90.800 / 91.800	102.600	103.400	107.200	108.200 / 108.400
DISTANCE	0.000	-0.200 / 4.000	1.400	4.600	2.600	1.600	18.000	12.200	16.000	1.000				
No.	No1	No3 / No2	No4	No5	No6	No7	No8	No9	No10	No12 / No11	No13	No14	No16	No15 / No17

This is a image section of site conditions.

RF007 (STA.13+540)
(Section 20/50)

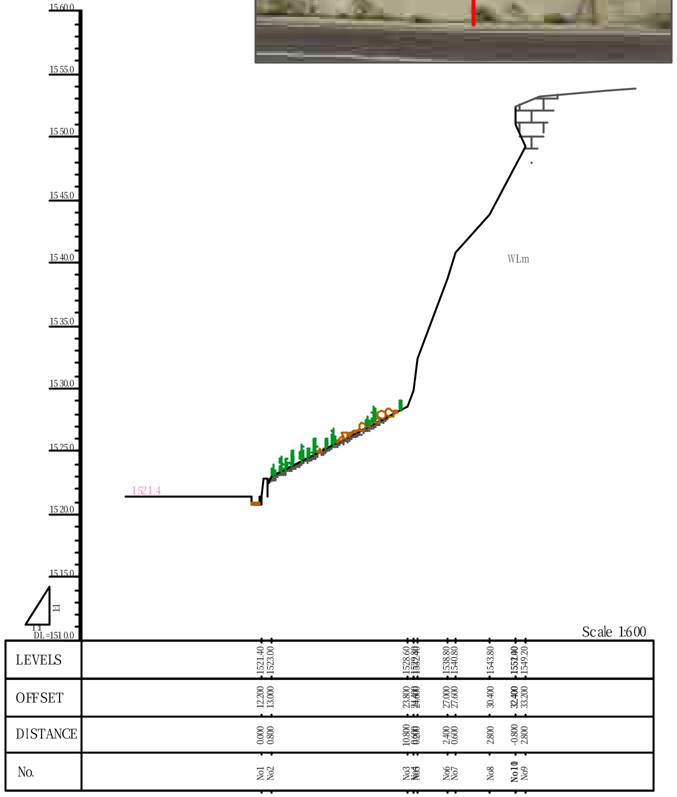


RF008 (STA.13+840)
(Section 21/50)

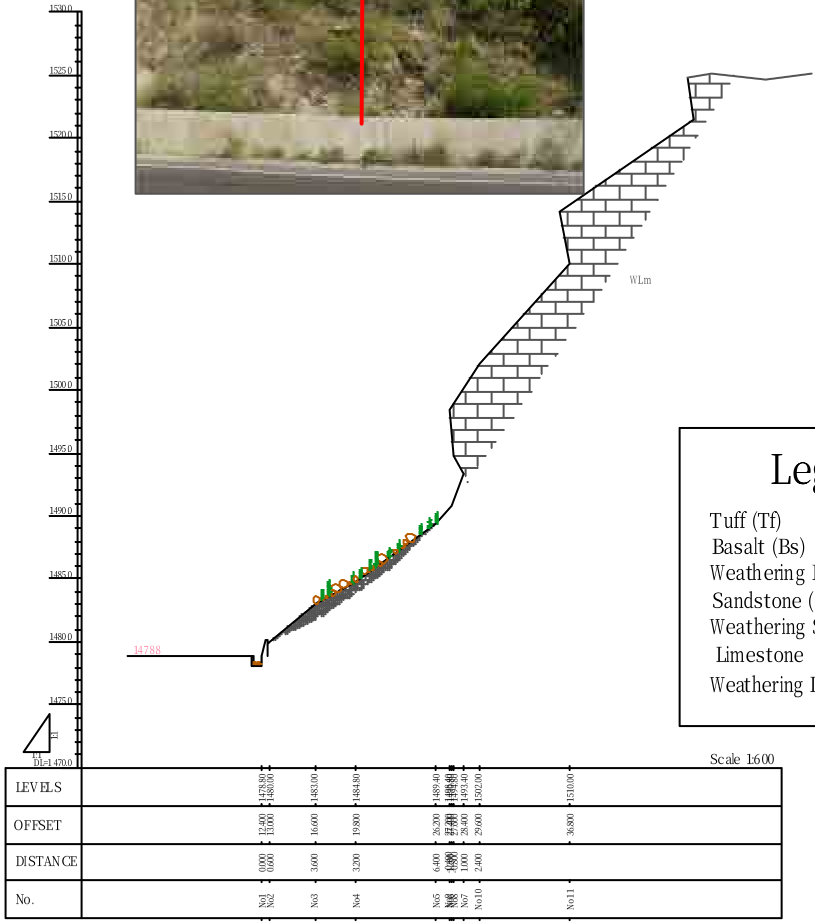


This is a image section of site conditions.

RF008 (STA.13+980)
(Section 22/50)



RF008 (STA.14+000)
(Section 23/50)

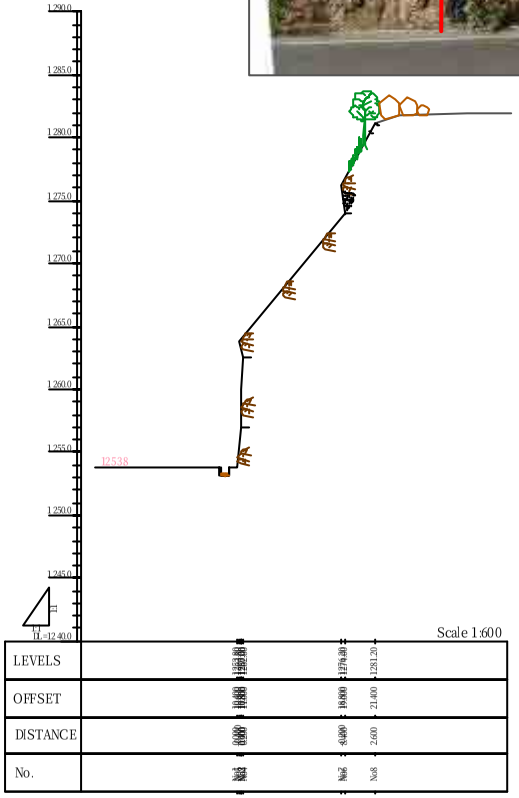


Legend

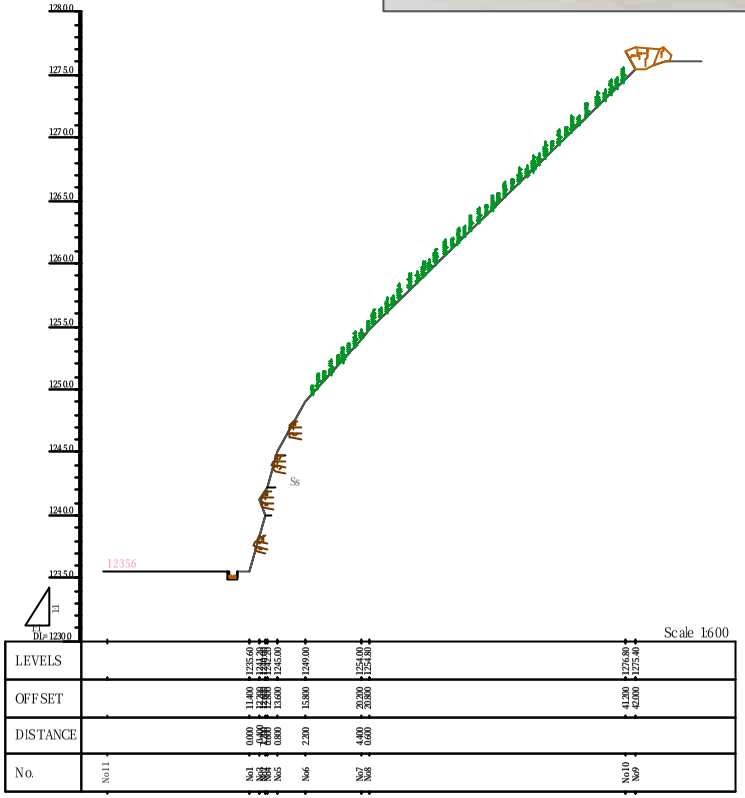
Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

This is a image section of site conditions.

RF009 (STA.16+840)
(Section 24/50)



RF009 (STA.17+100)
(Section 25/50)



Legend

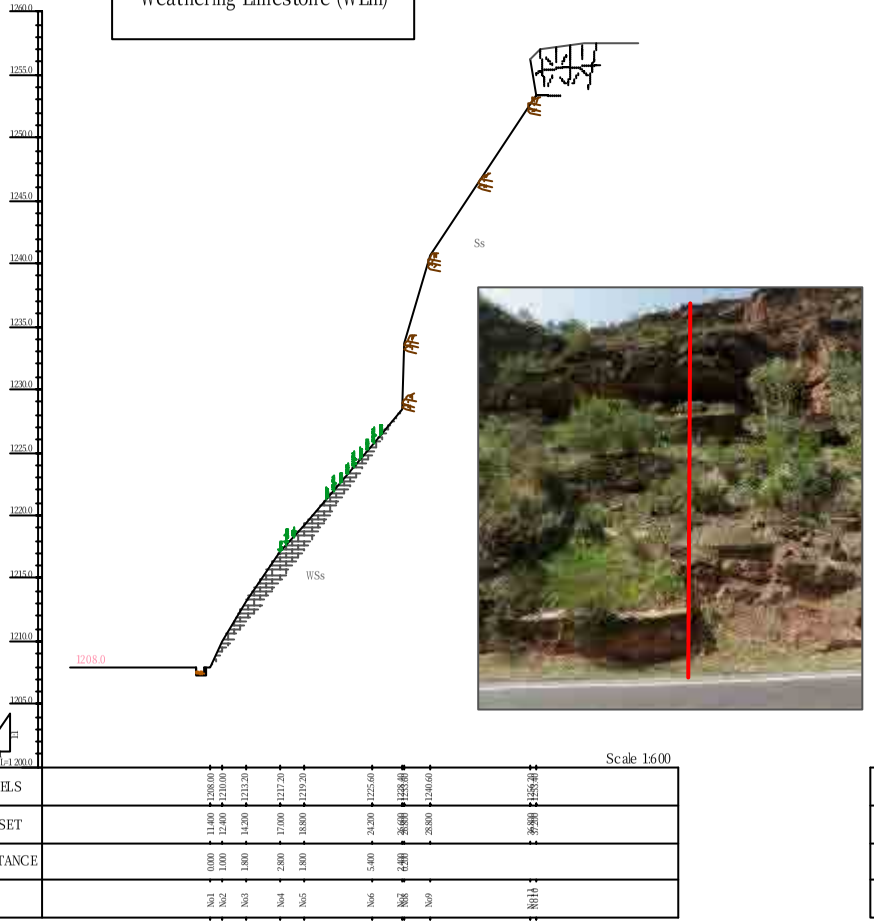
- Tuff (Tf)
- Basalt (Bs)
- Weathering Basalt (WBs)
- Sandstone (Ss)
- Weathering Sandstone (WSs)
- Limestone (Lm)
- Weathering Limestone (WLm)

This is a image section of site conditions.

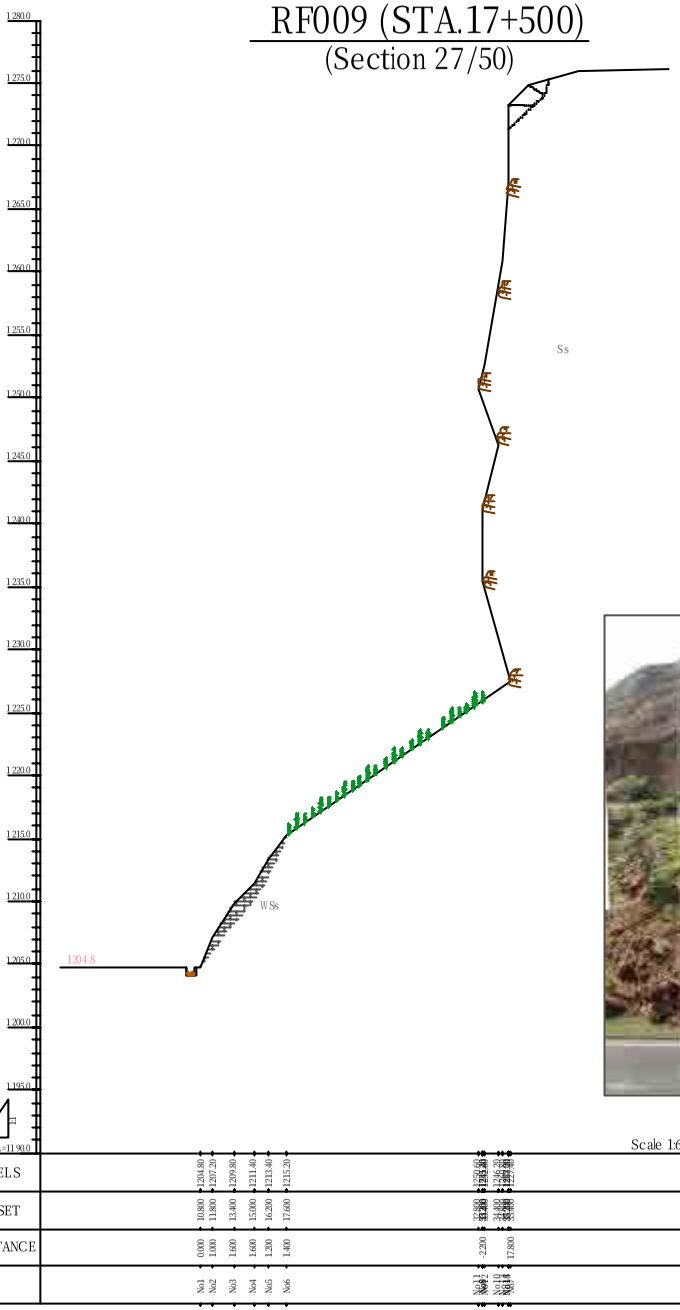
RF009 (STA.17+460)
(Section 26/50)

Legend

Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

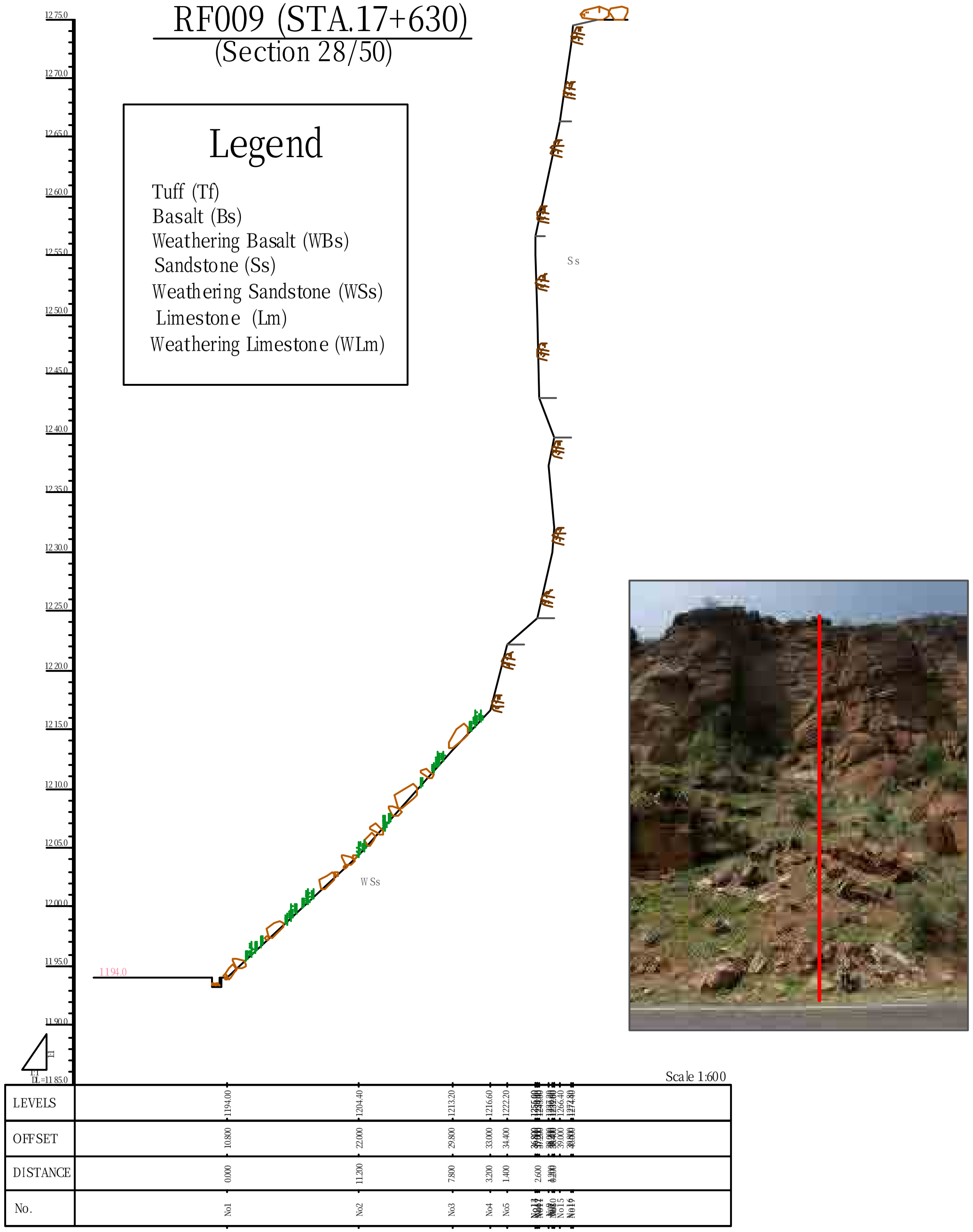


RF009 (STA.17+500)
(Section 27/50)

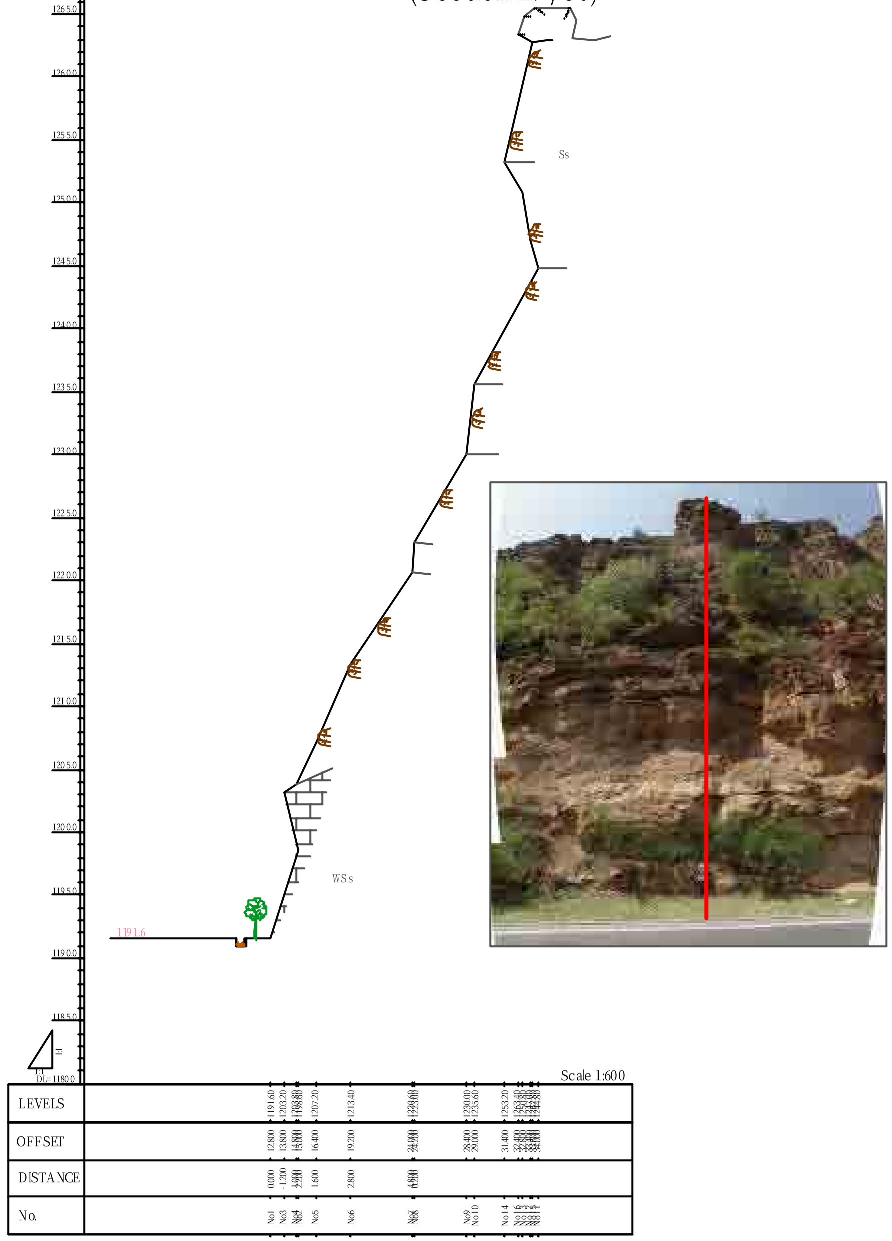


This is a image section of site conditions.

RF009 (STA.17+630)
(Section 28/50)



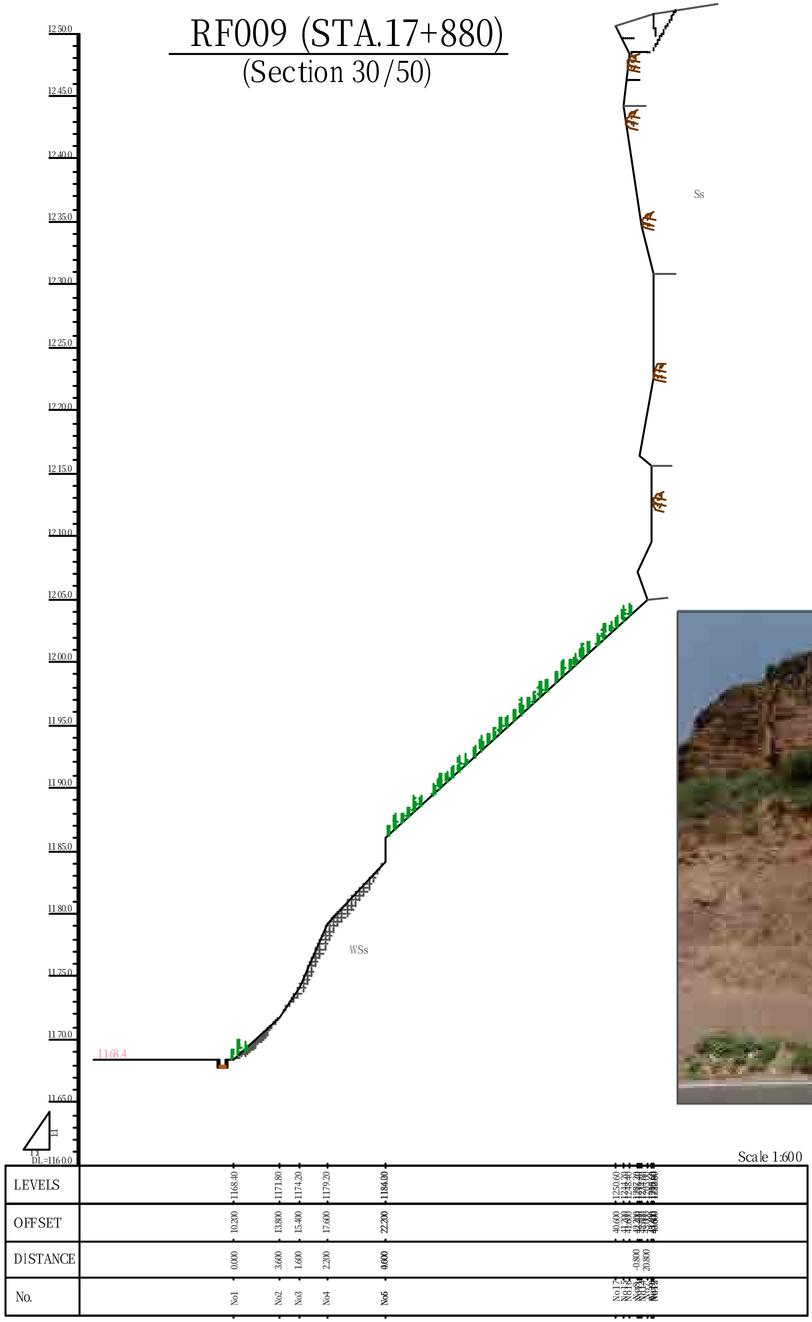
RF009 (STA.17+720)
(Section 29/50)



This is a image section of site conditions.

RF009 (STA.17+880)

(Section 30/50)

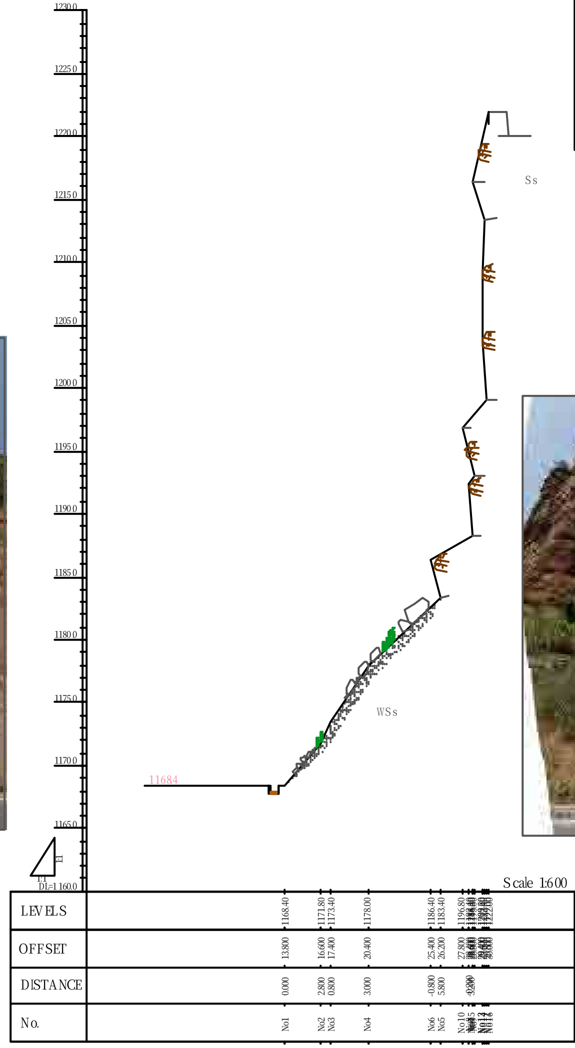


RF009 (STA.17+940)

(Section 31/50)

Legend

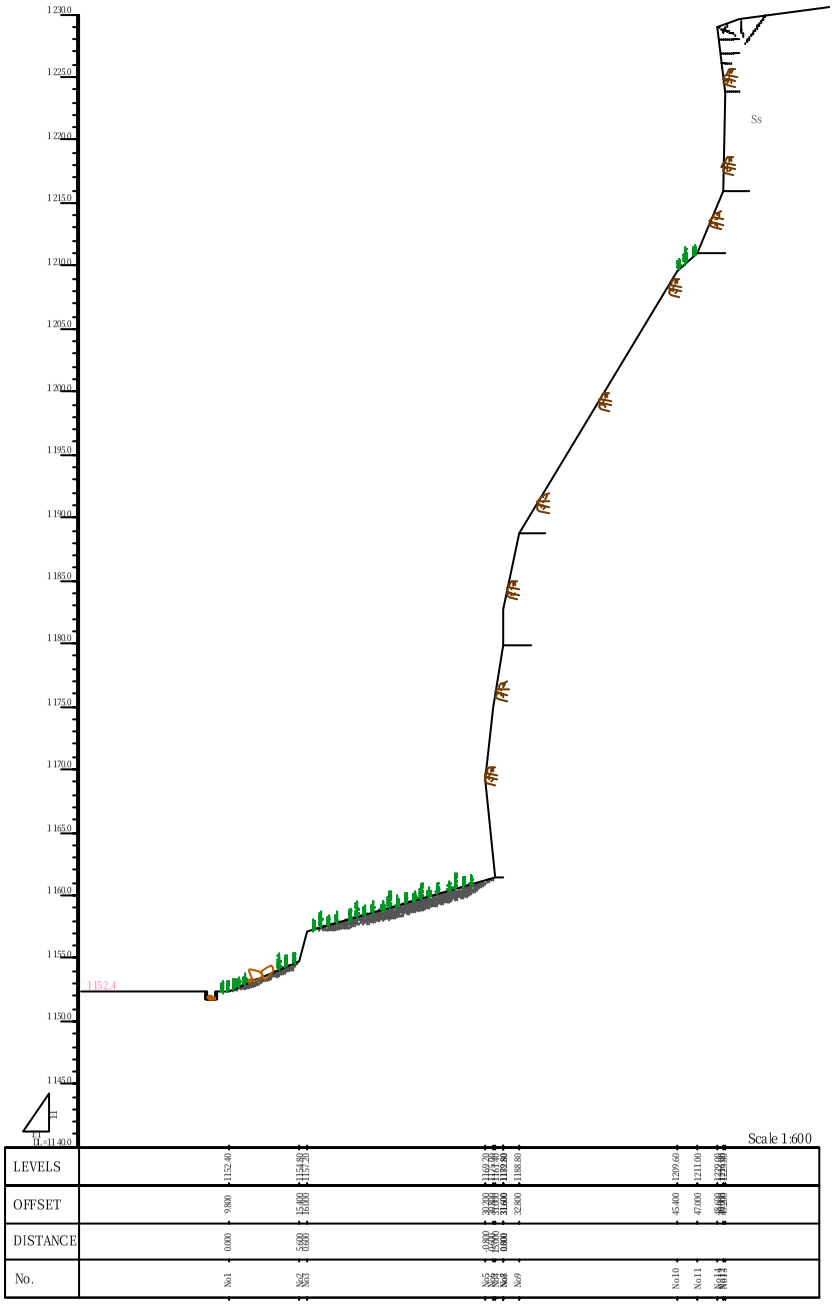
Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)



This is a image section of site conditions.

RF009 (STA.18+080)

(Section 32/50)



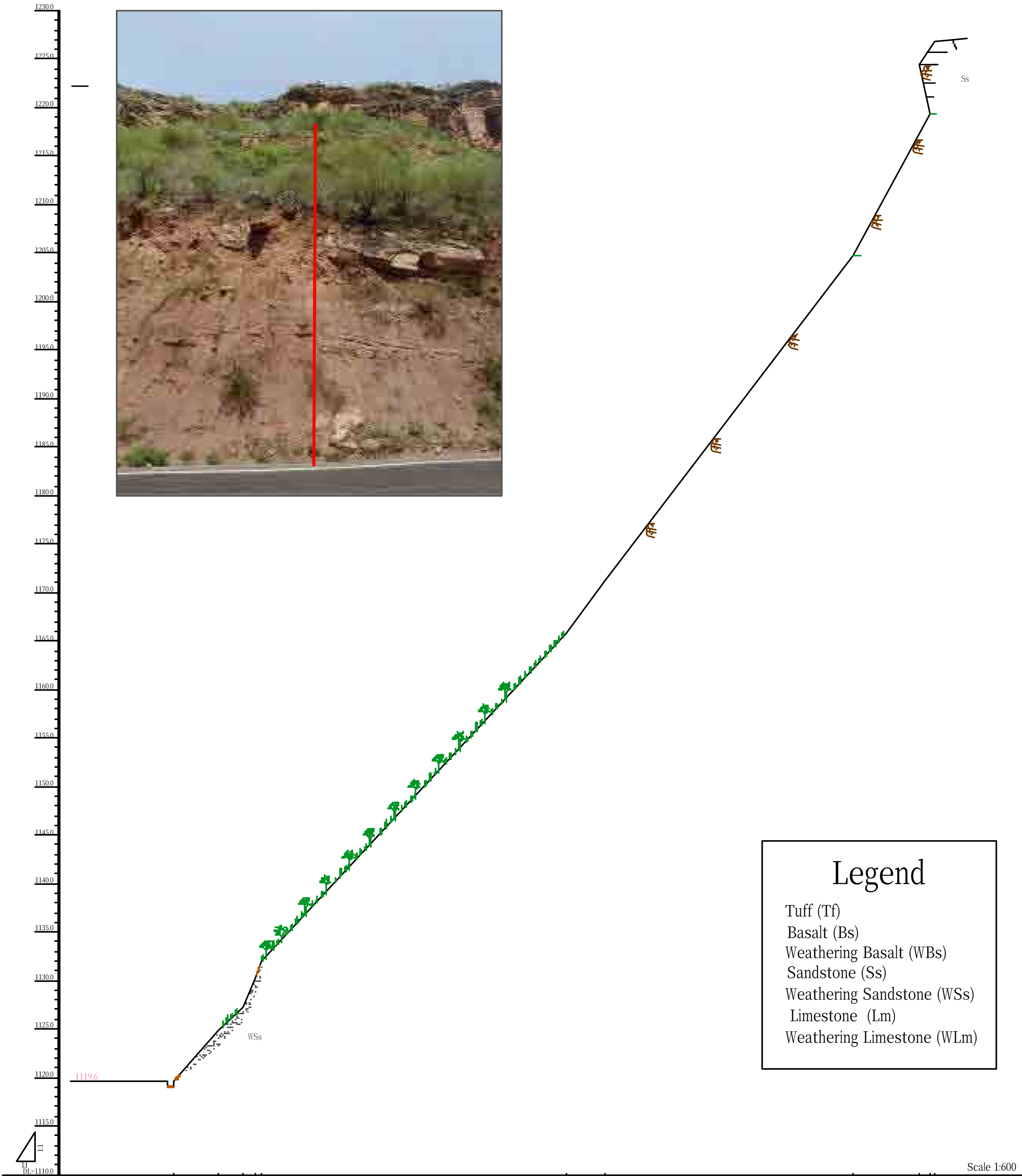
Legend

- Tuff (Tf)
- Basalt (Bs)
- Weathering Basalt (WBs)
- Sandstone (Ss)
- Weathering Sandstone (WSs)
- Limestone (Lm)
- Weathering Limestone (WLm)

This is a image section of site conditions.

RF009 (STA.18+480)

(Section 33/50)



Scale 1:600

LEVELS	1119.60	1124.80	1127.20	1130.20	1132.00	1165.80	1171.20	1204.80	1224.40	[illegible]	[illegible]
OFFSET	9.800	14.400	16.800	18.200	18.800	50.200	54.200	79.800	86.600	[illegible]	[illegible]
DISTANCE	0.000	4.600	2.400	1.400	0.600	31.400	4.000	25.600			
No.	№1	№2	№3	№4	№5	№6	№7	№8	No.10	№9	№11

This is a image section of site conditions.

RF009 (STA.18+640)

(Section 34/50)

Legend

Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

This is a image section of site conditions.

RF009 (STA.18+720)

(Section 35/50)

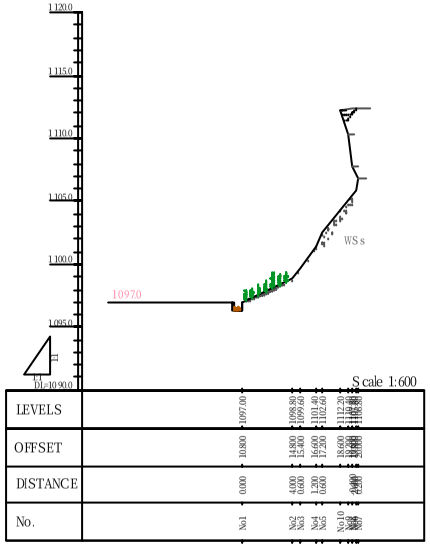
Legend

Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

This is a image section of site conditions.

RF009 (STA.18+800)

(Section 36/50)



Legend

Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

This is a image section of site conditions.

RF009 (STA.18+840)

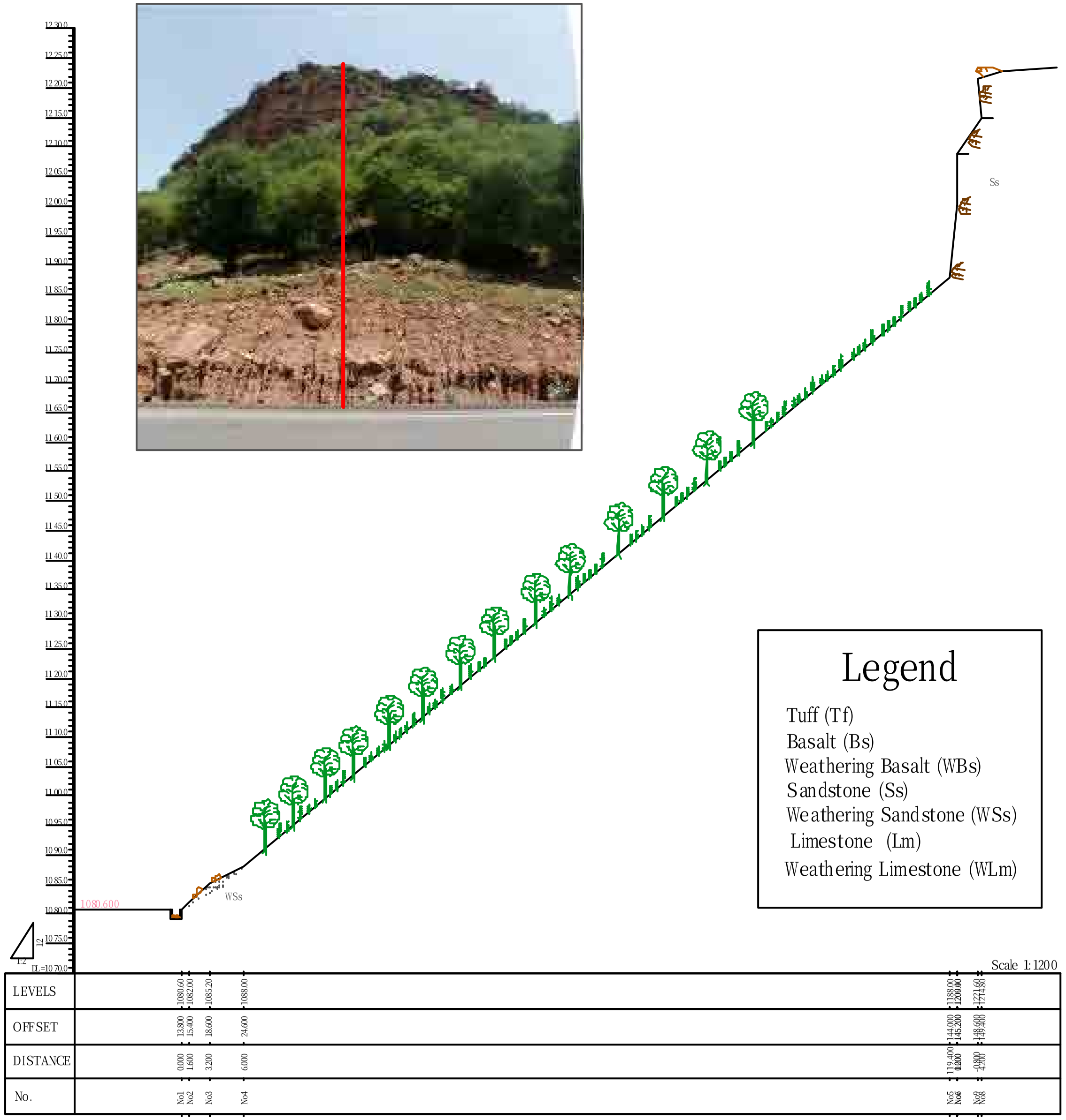
(Section 37/50)

Legend

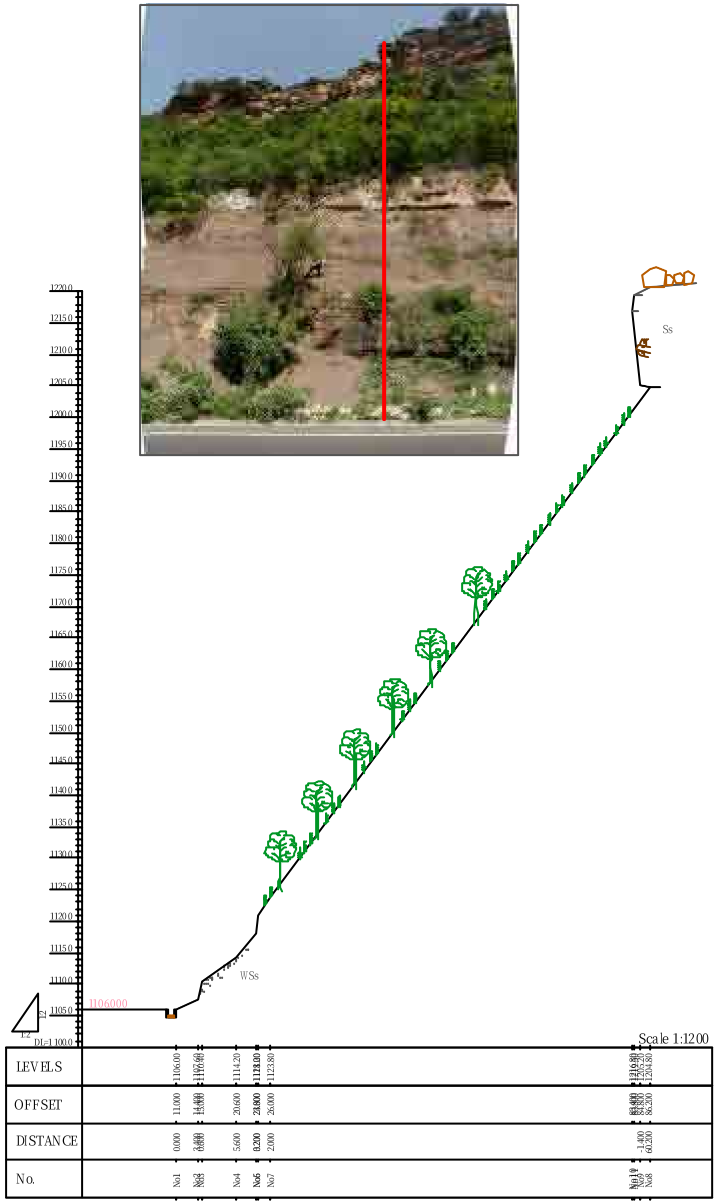
Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

This is a image section of site conditions.

RF010 (STA.20+050)
(Section 38/50)



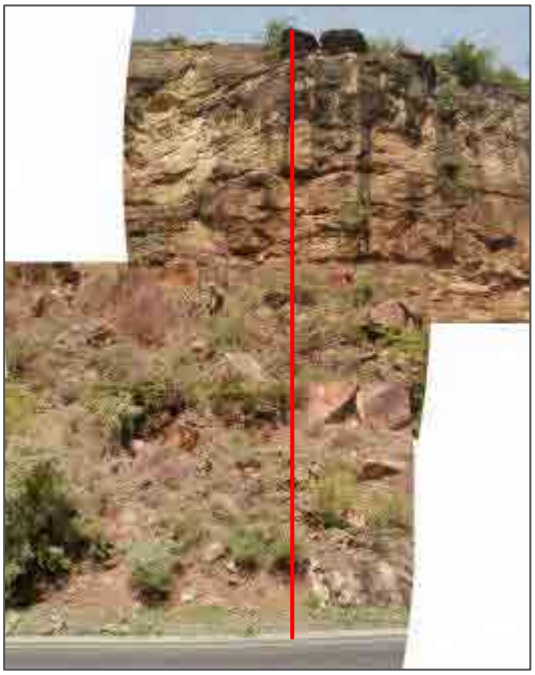
RF010 (STA.20+240)
(Section 39/50)



This is a image section of site conditions.

RF010 (STA.20+380)

(Section 40/50)

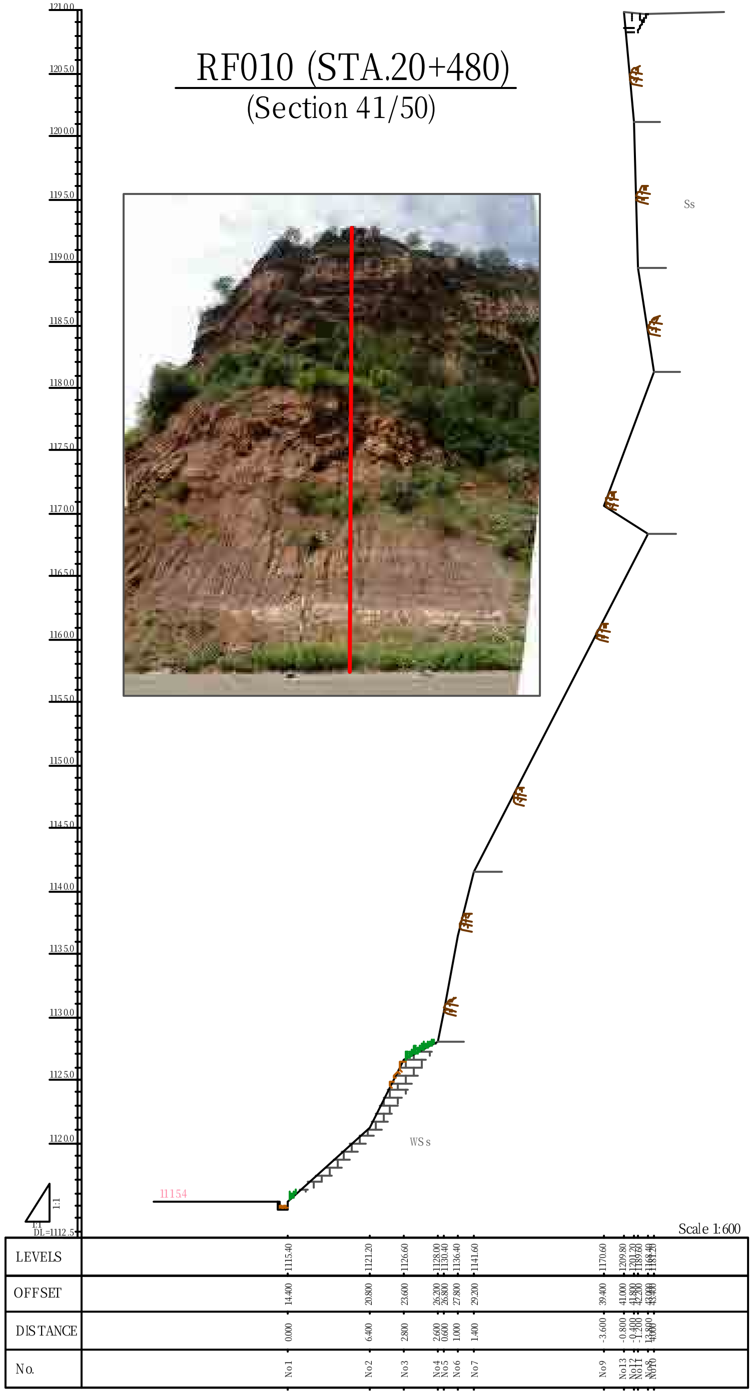


Legend

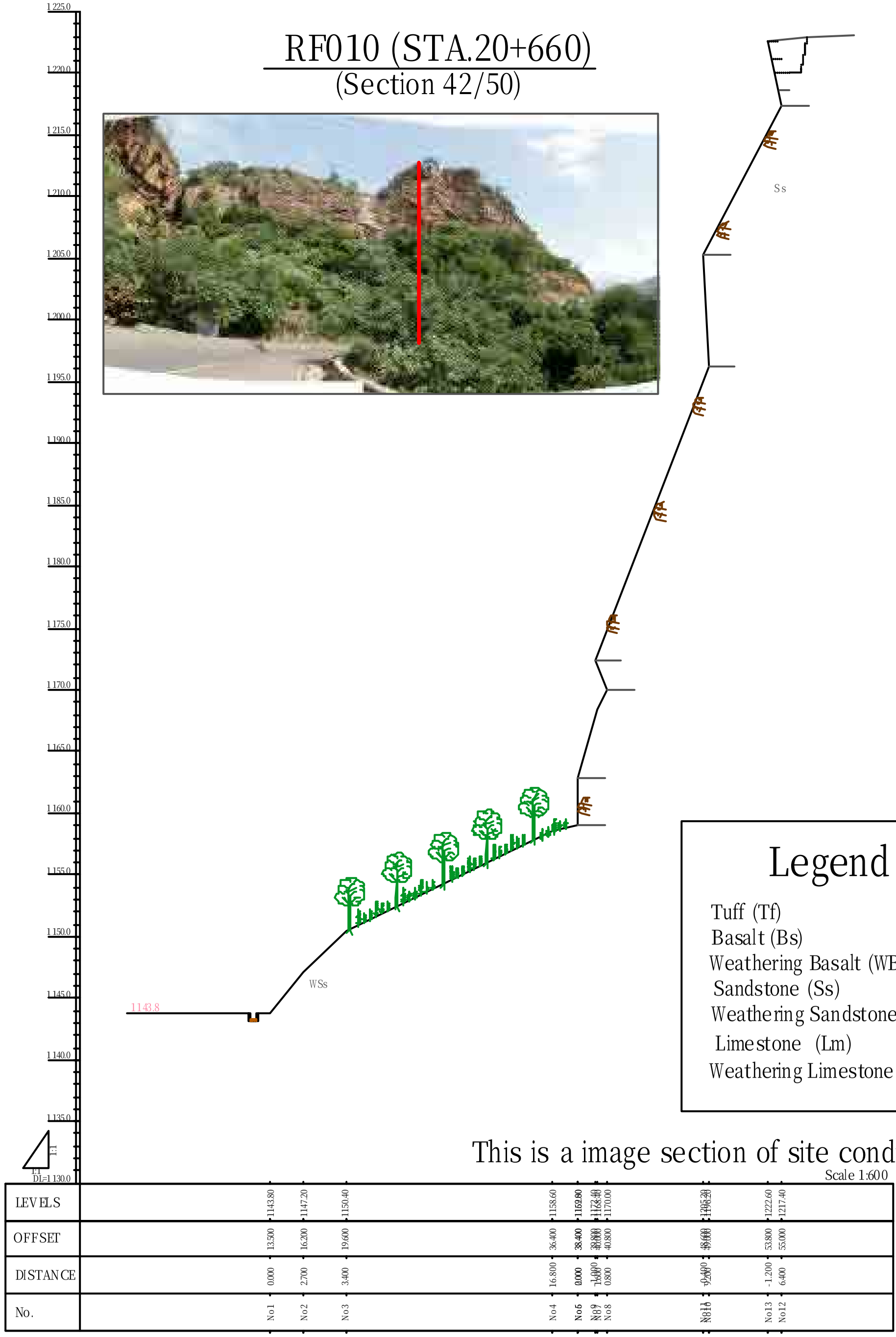
Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

This is a image section of site conditions.

RF010 (STA.20+480)
(Section 41/50)



RF010 (STA.20+660)
(Section 42/50)



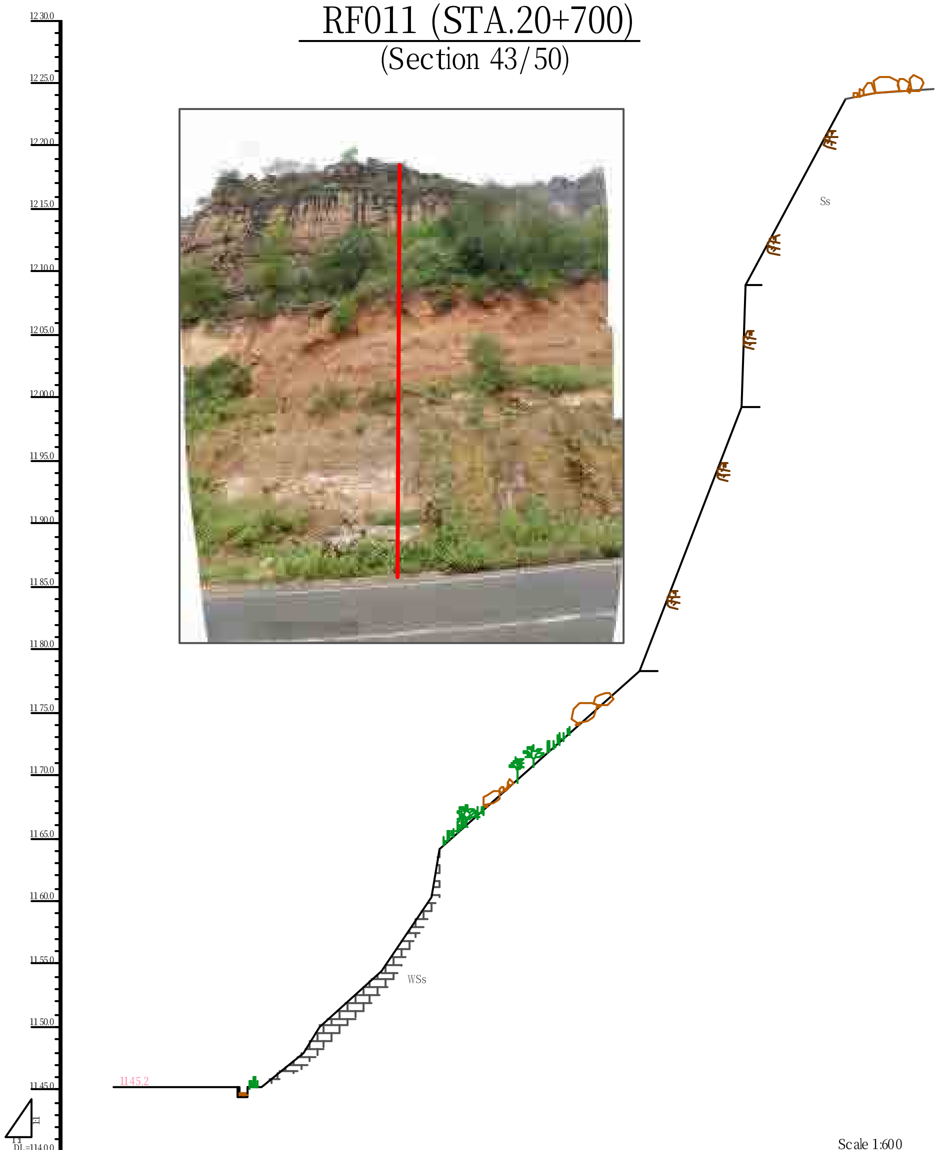
Legend

Tuff (Tf)
Basalt (Bs)
Weathering Basalt (WBs)
Sandstone (Ss)
Weathering Sandstone (WSs)
Limestone (Lm)
Weathering Limestone (WLm)

This is a image section of site conditions.

RF011 (STA.20+700)

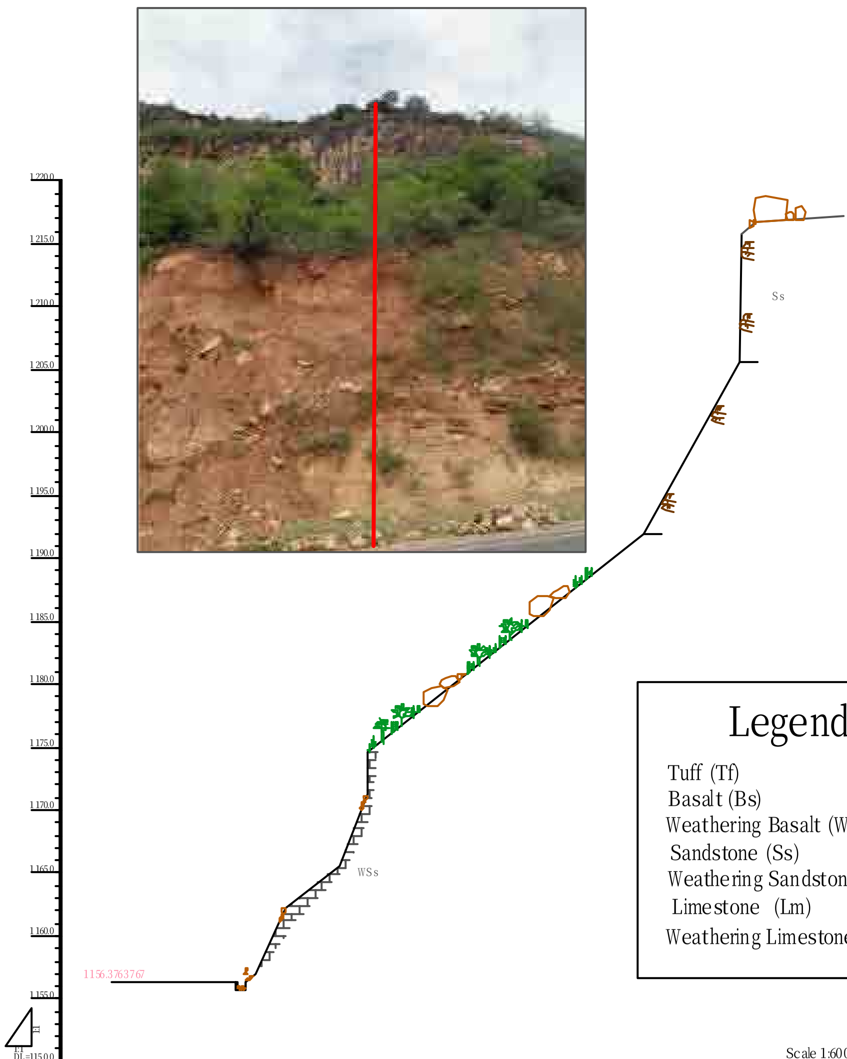
(Section 43/50)



LEVELS	1145.20	1148.00	1150.00	1154.40	1160.40	1164.20	1178.20	[illegible]	[illegible]	1223.80
OFFSET	13.800	17.200	18.400	23.400	27.400	28.000	43.800	[illegible]	[illegible]	60.200
DISTANCE	0.000	3.400	1.200	5.000	4.000	0.600	15.800	[illegible]	[illegible]	8.000
No.	No1	No2	No3	No4	No5	No6	No7	No8	No9	No10

RF011 (STA.20+760)

(Section 44/50)



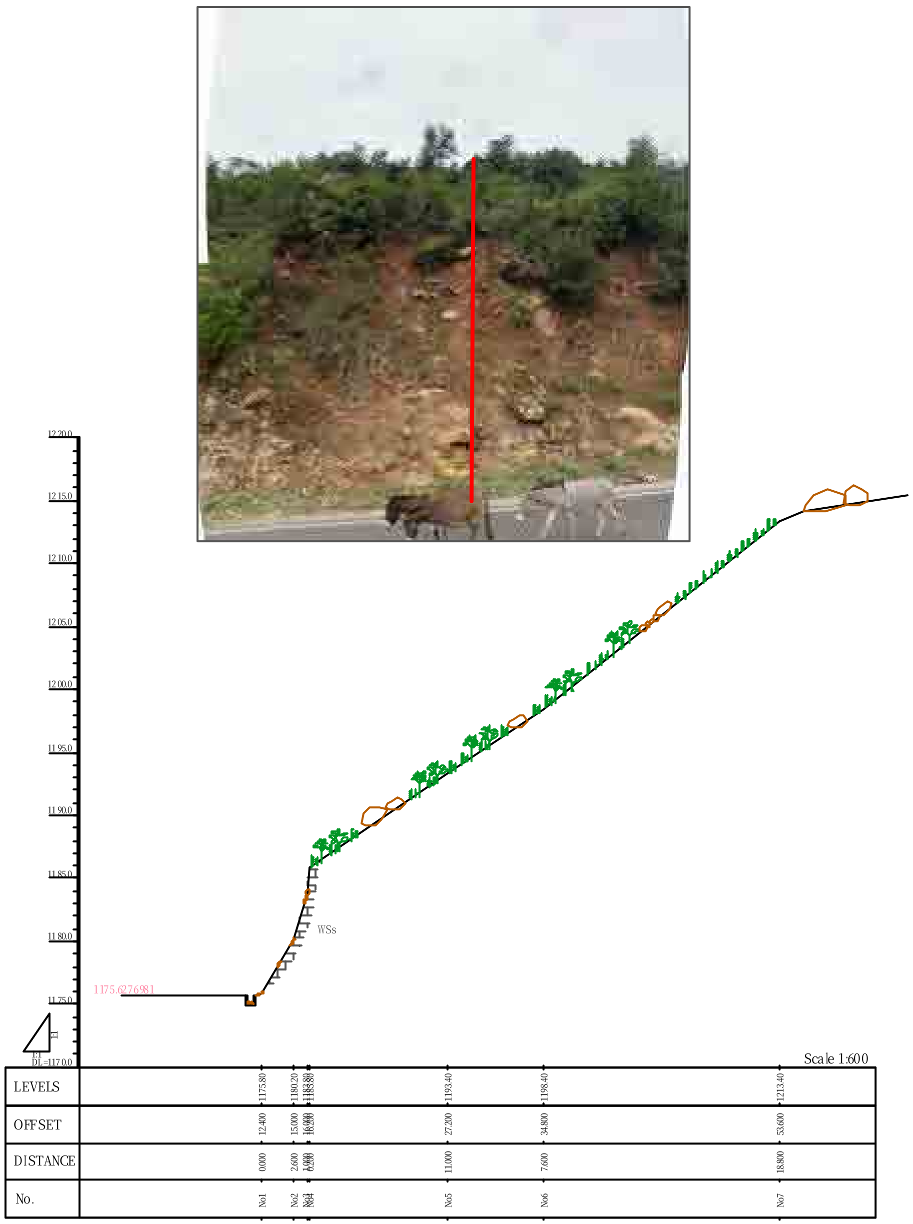
LEVELS	1157.00	1162.20	1165.60	[illegible]	[illegible]	1192.00	[illegible]	[illegible]
OFFSET	13.400	15.800	20.000	[illegible]	[illegible]	44.200	[illegible]	[illegible]
DISTANCE	0.000	2.400	4.200	[illegible]	[illegible]	22.000	[illegible]	[illegible]
No.	No1	No2	No3	No4	No5	No6	No7	No8

Legend

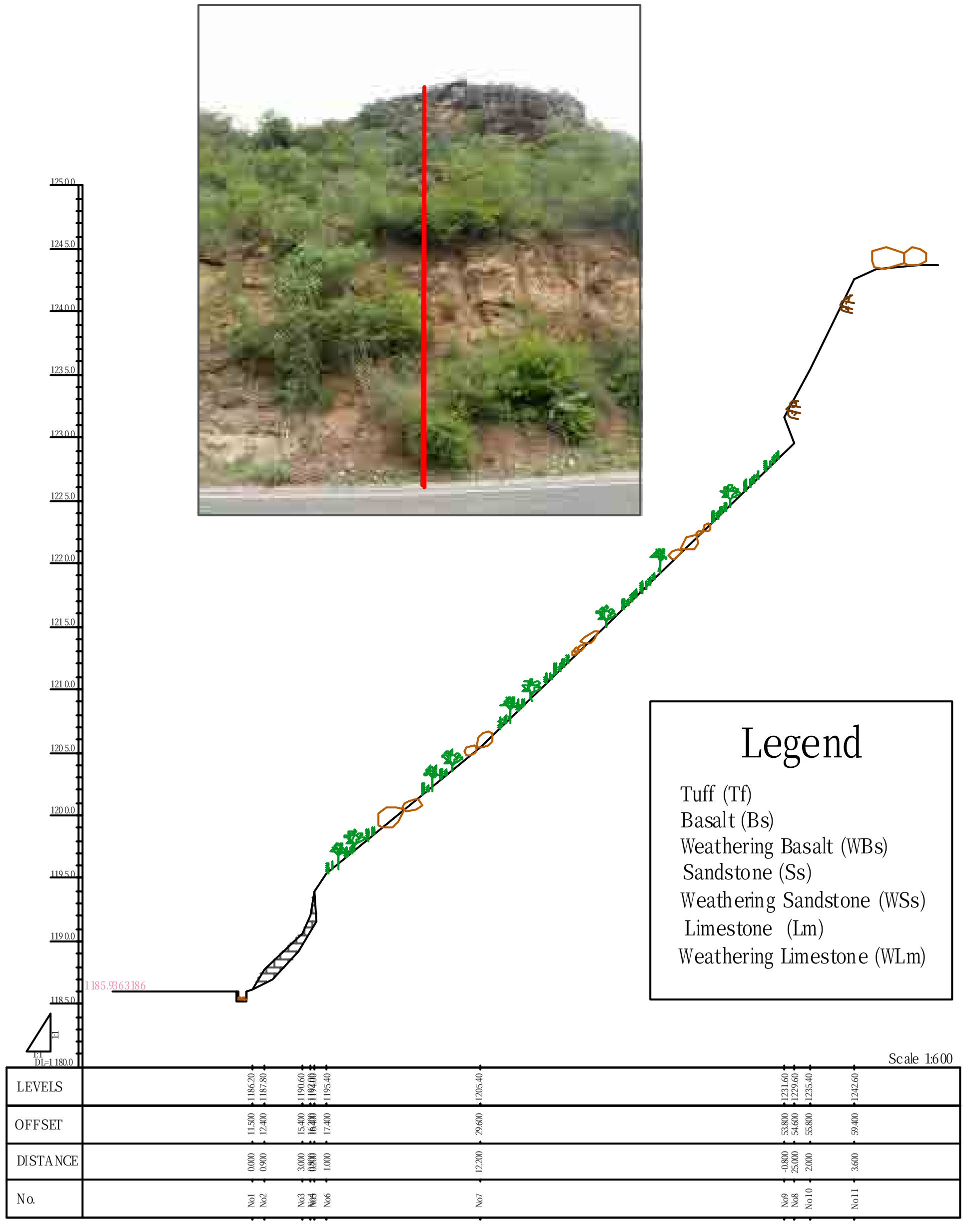
- Tuff (Tf)
- Basalt (Bs)
- Weathering Basalt (WBs)
- Sandstone (Ss)
- Weathering Sandstone (WSs)
- Limestone (Lm)
- Weathering Limestone (WLm)

This is a image section of site conditions.

RF011 (STA.20+920)
(Section 45/50)

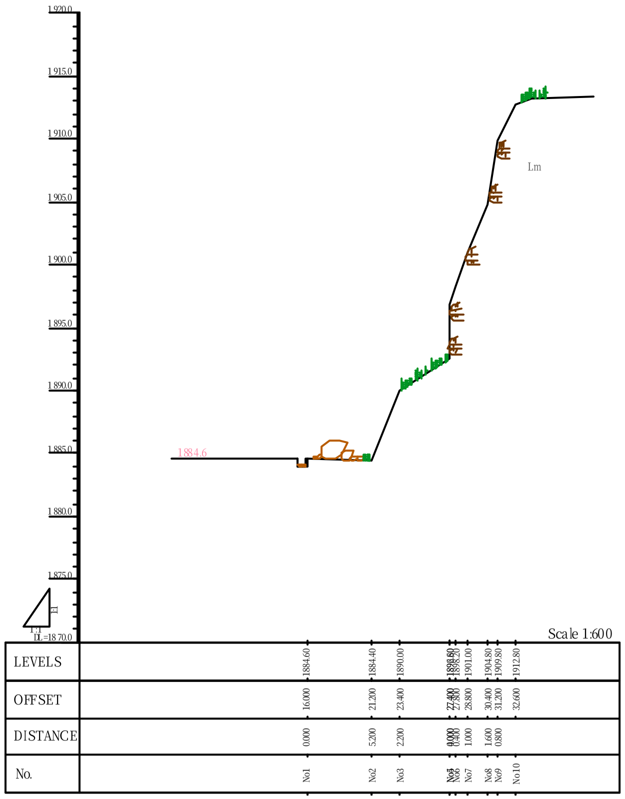


RF012 (STA.21+000)
(Section 46/50)

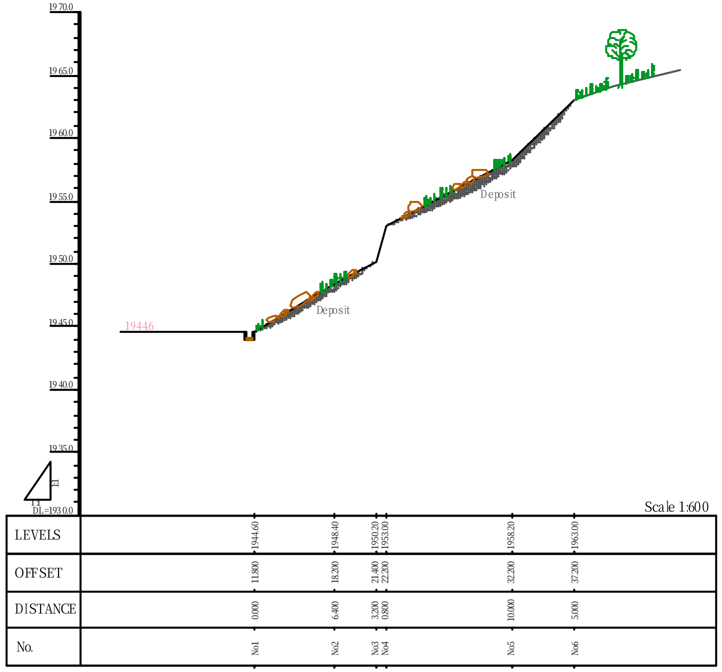


This is a image section of site conditions.

RF013 (STA.30+500)
(Section 47/50)



RF014 (STA.31+040)
(Section 48/50)

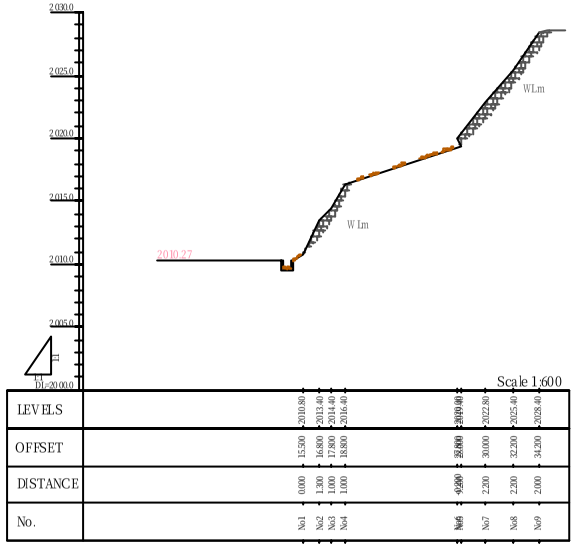


Legend

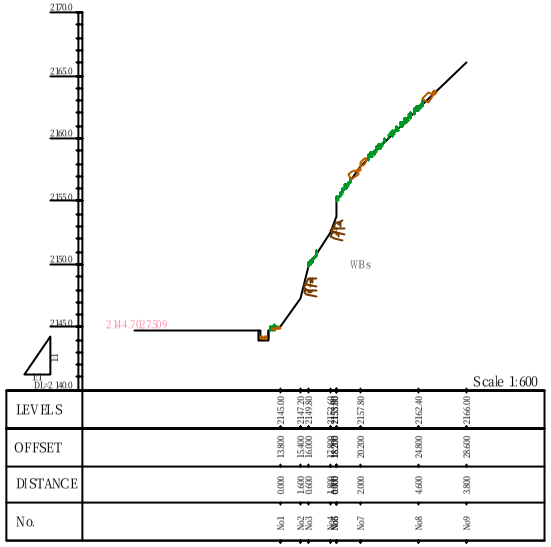
- Tuff (Tf)
- Basalt (Bs)
- Weathering Basalt (WBs)
- Sandstone (Ss)
- Weathering Sandstone (WSs)
- Limestone (Lm)
- Weathering Limestone (WLm)

This is a image section of site conditions.

RF015 (STA.32+040)
(Section 49/50)



RF016 (STA.34+380)
(Section 50/50)



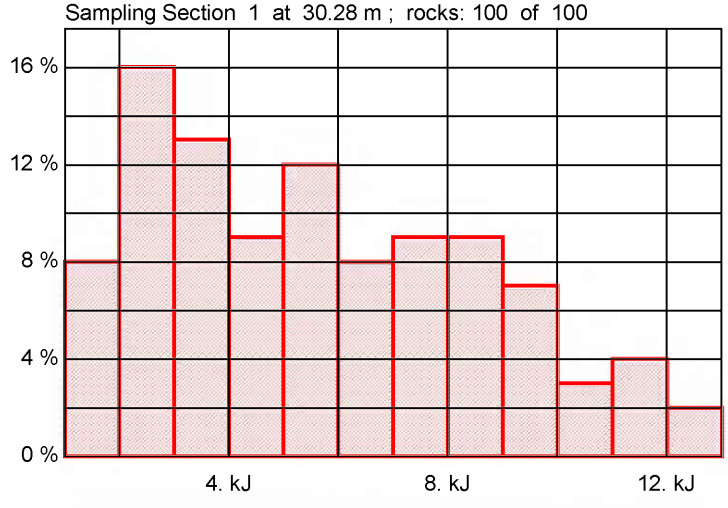
Legend

- Tuff (Tf)
- Basalt (Bs)
- Weathering Basalt (WBs)
- Sandstone (Ss)
- Weathering Sandstone (WSs)
- Limestone (Lm)
- Weathering Limestone (WLm)

This is a image section of site conditions.

Rockfall Path

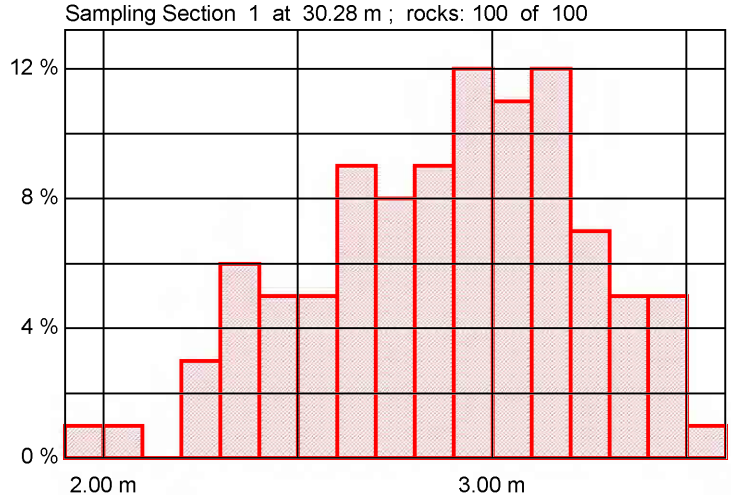
Sampling Section 1 at 30.28 m ; rocks: 100 of 100



total kinetic energy

Class range	:	1.kJ
Minimum value	:	2.kJ
Maximum value	:	12.kJ
Mean value	:	6.kJ
Standard dev.	:	3.kJ
98 % Max	:	12.kJ
95 % Max	:	11.kJ
50 % Max	:	5.kJ

Sampling Section 1 at 30.28 m ; rocks: 100 of 100

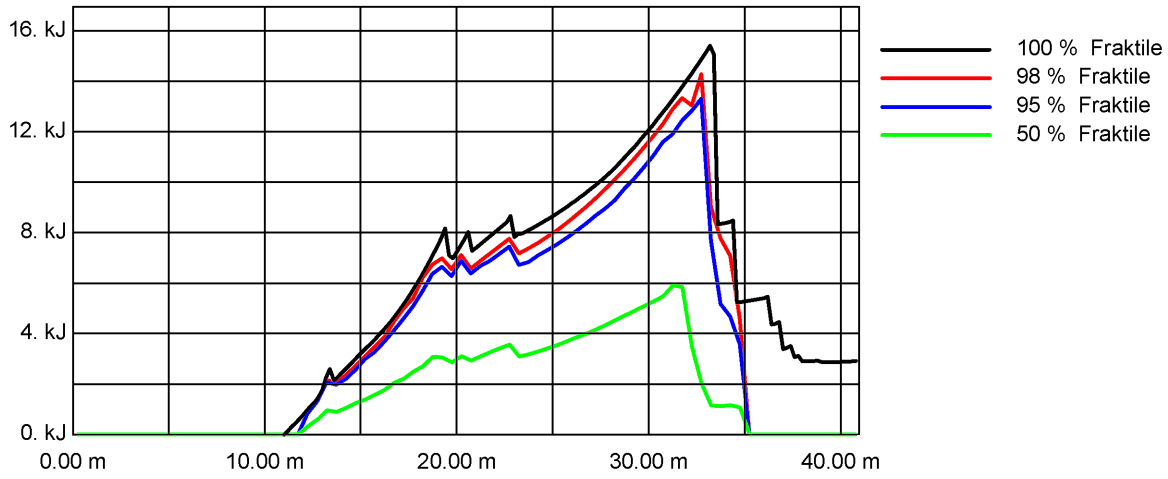


bounce height

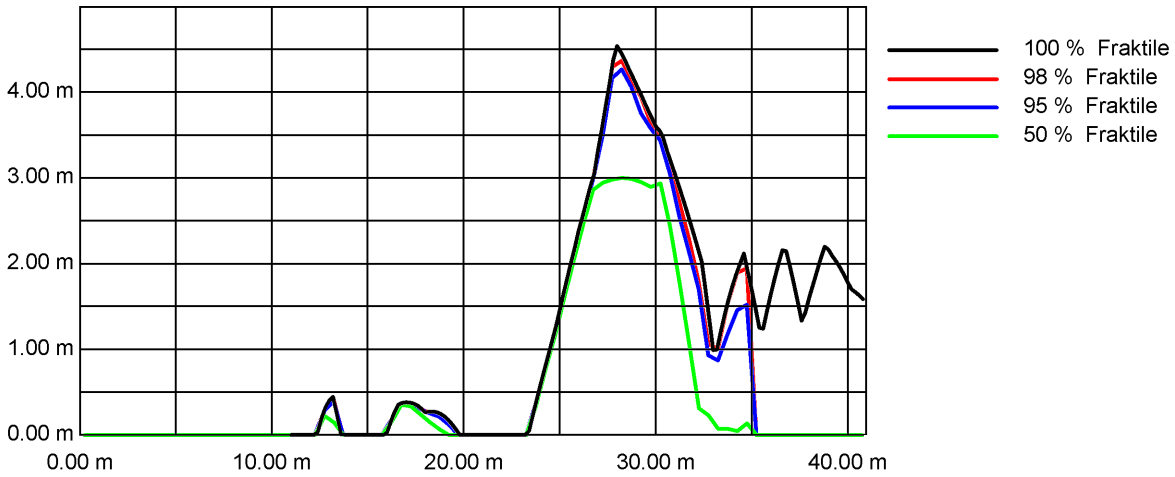
Class range	:	0.10m
Minimum value	:	1.98m
Maximum value	:	3.54m
Mean value	:	2.89m
Standard dev.	:	0.35m
98 % Max	:	3.47m
95 % Max	:	3.43m
50 % Max	:	2.93m

Rockfall Path

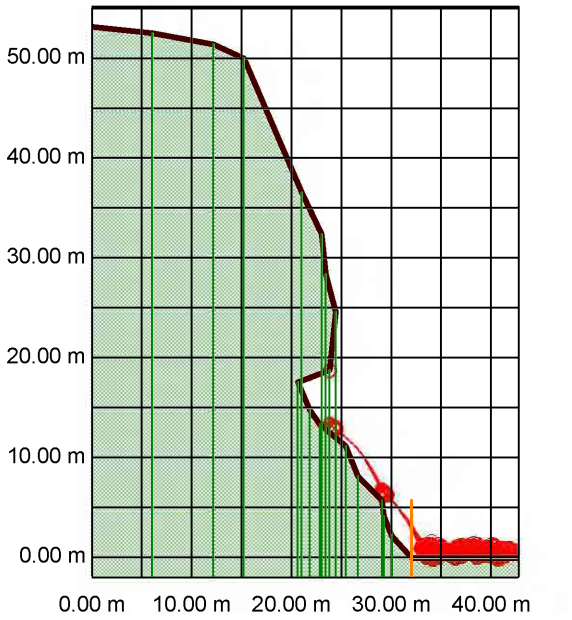
Envelope Curves: Energy



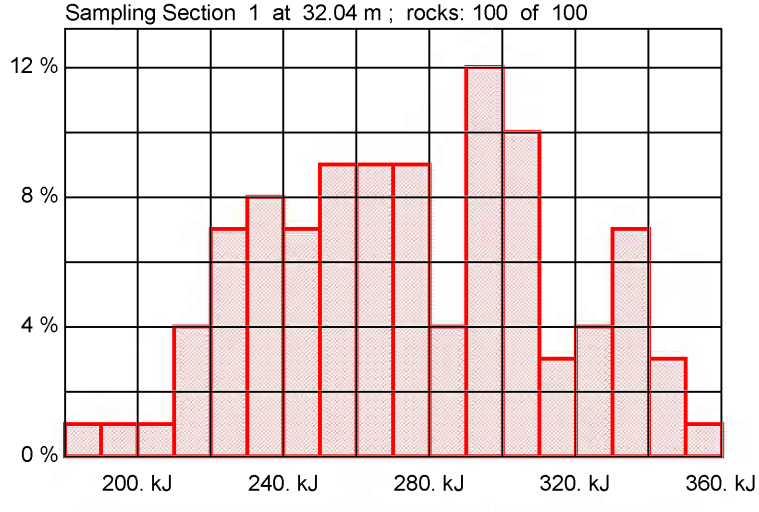
Envelope Curves: Bounce Height



Rockfall Path



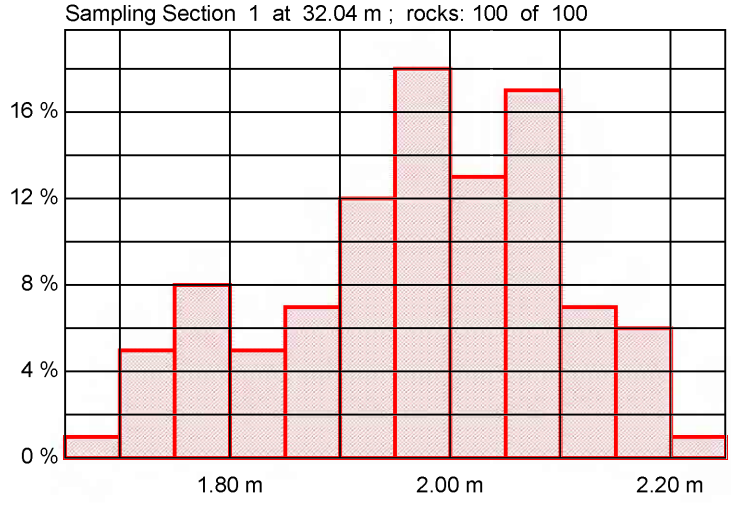
Sampling Section 1 at 32.04 m ; rocks: 100 of 100



total kinetic energy

Class range	:	10.kJ
Minimum value	:	186.kJ
Maximum value	:	352.kJ
Mean value	:	274.kJ
Standard dev.	:	39.kJ
98 % Max	:	350.kJ
95 % Max	:	338.kJ
50 % Max	:	276.kJ

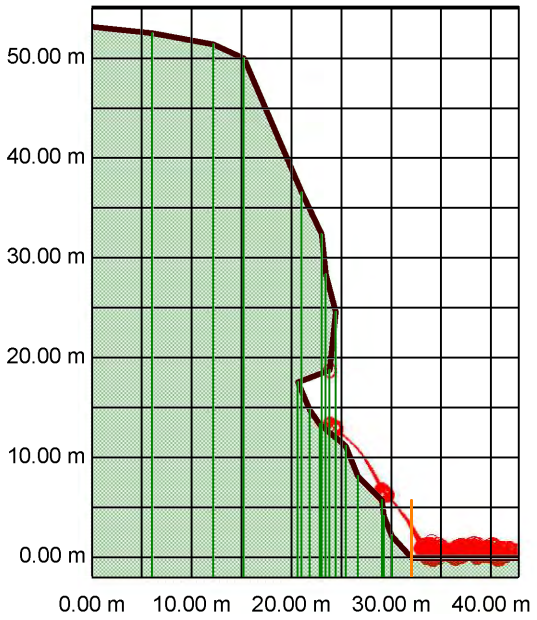
Sampling Section 1 at 32.04 m ; rocks: 100 of 100



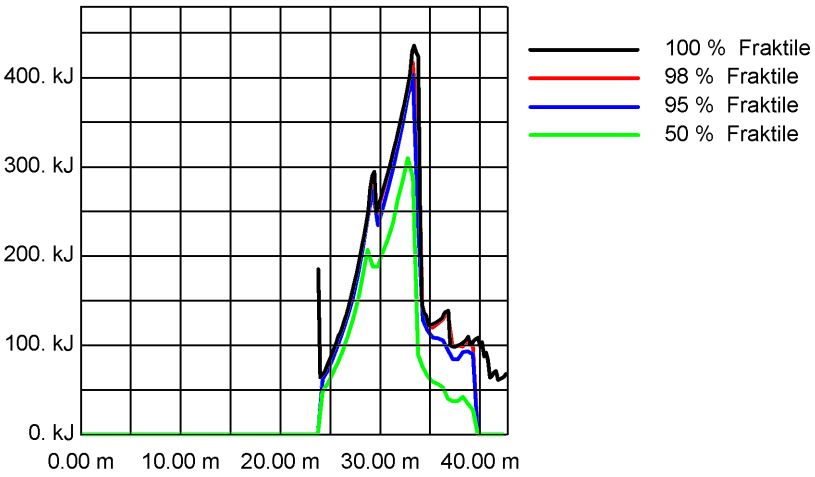
bounce height

Class range	:	0.05m
Minimum value	:	1.69m
Maximum value	:	2.23m
Mean value	:	1.97m
Standard dev.	:	0.13m
98 % Max	:	2.19m
95 % Max	:	2.16m
50 % Max	:	2.00m

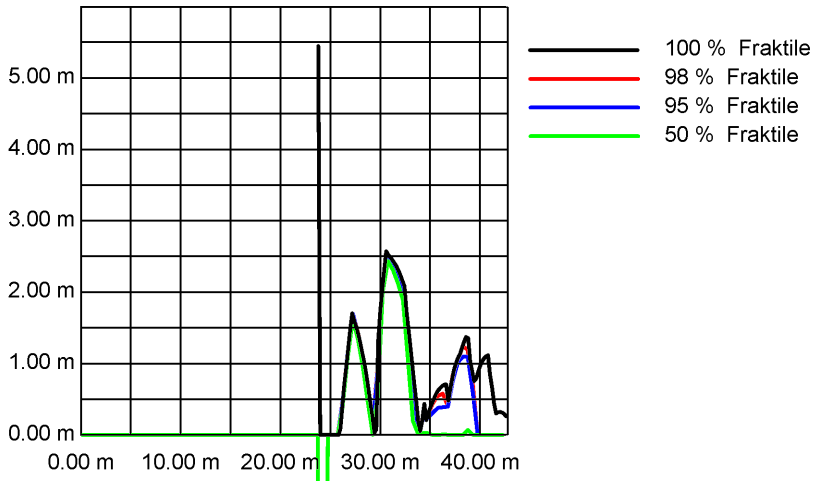
Rockfall Path



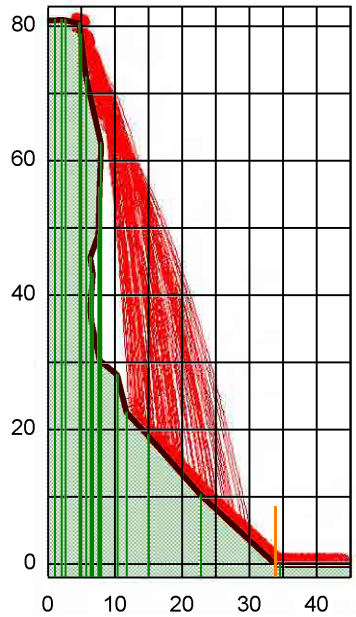
Envelope Curves: Energy



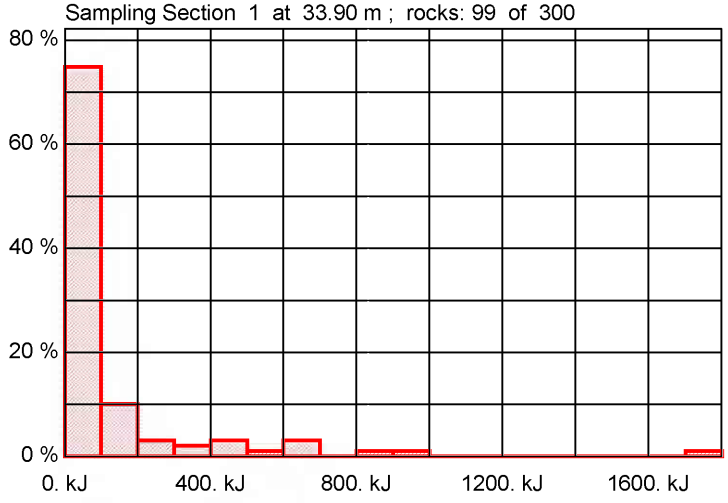
Envelope Curves: Bounce Height



Rockfall Path



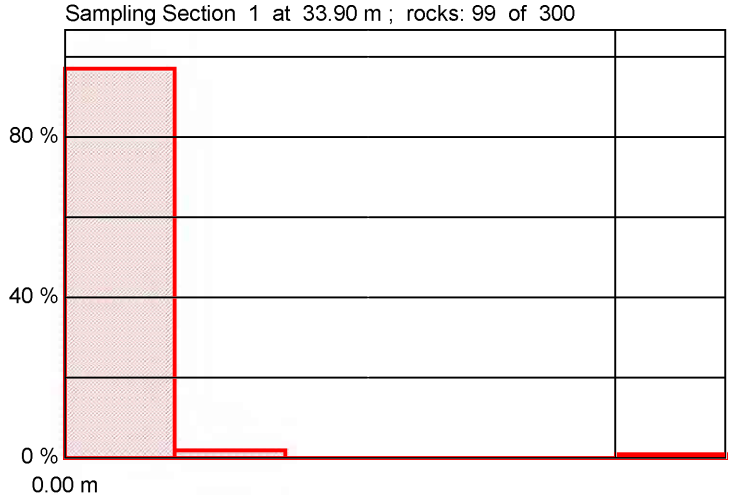
Sampling Section 1 at 33.90 m ; rocks: 99 of 300



total kinetic energy

Class range	:	100.kJ
Minimum value	:	26.kJ
Maximum value	:	1754.kJ
Mean value	:	147.kJ
Standard dev.	:	241.kJ
98 % Max	:	927.kJ
95 % Max	:	672.kJ
50 % Max	:	66.kJ

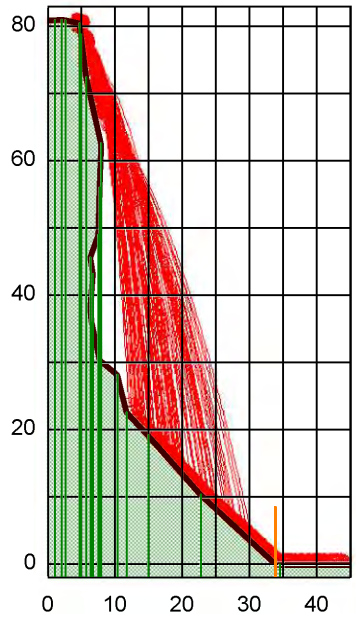
Sampling Section 1 at 33.90 m ; rocks: 99 of 300



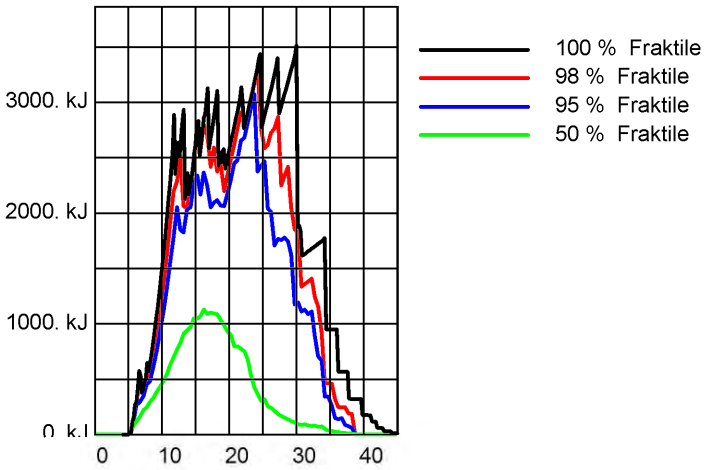
bounce height

Class range	:	0.02m
Minimum value	:	0.00m
Maximum value	:	0.11m
Mean value	:	0.00m
Standard dev.	:	0.01m
98 % Max	:	0.03m
95 % Max	:	0.01m
50 % Max	:	0.00m

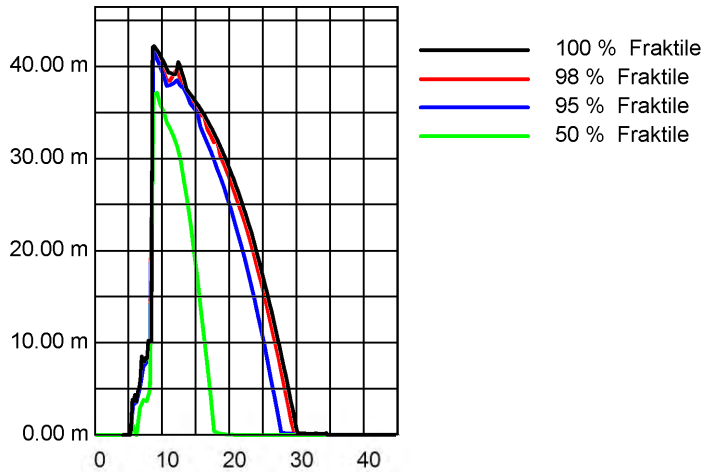
Rockfall Path



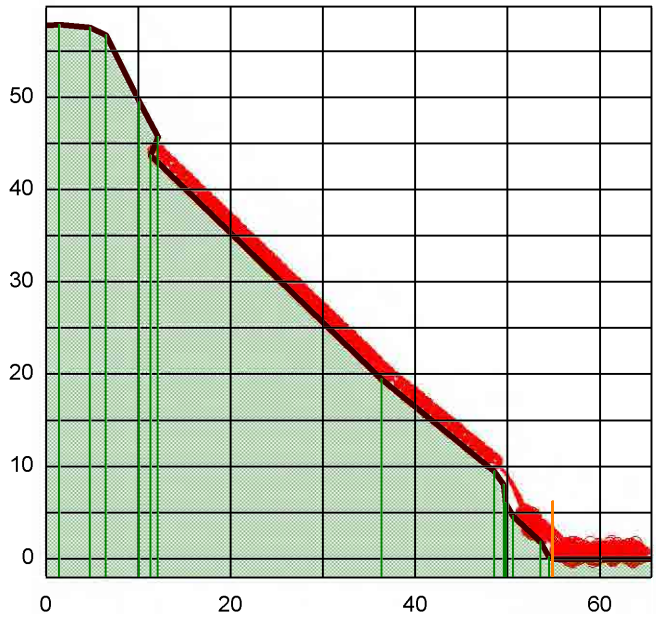
Envelope Curves: Energy



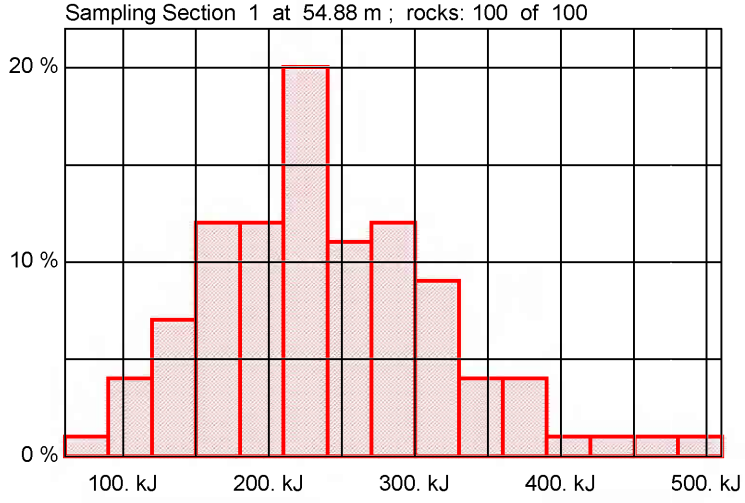
Envelope Curves: Bounce Height



Rockfall Path



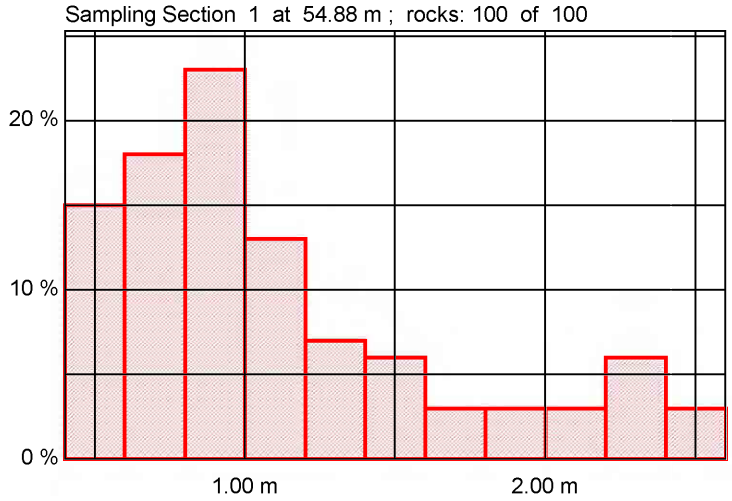
Sampling Section 1 at 54.88 m ; rocks: 100 of 100



total kinetic energy

Class range	:	30.kJ
Minimum value	:	89.kJ
Maximum value	:	492.kJ
Mean value	:	240.kJ
Standard dev.	:	80.kJ
98 % Max	:	439.kJ
95 % Max	:	390.kJ
50 % Max	:	224.kJ

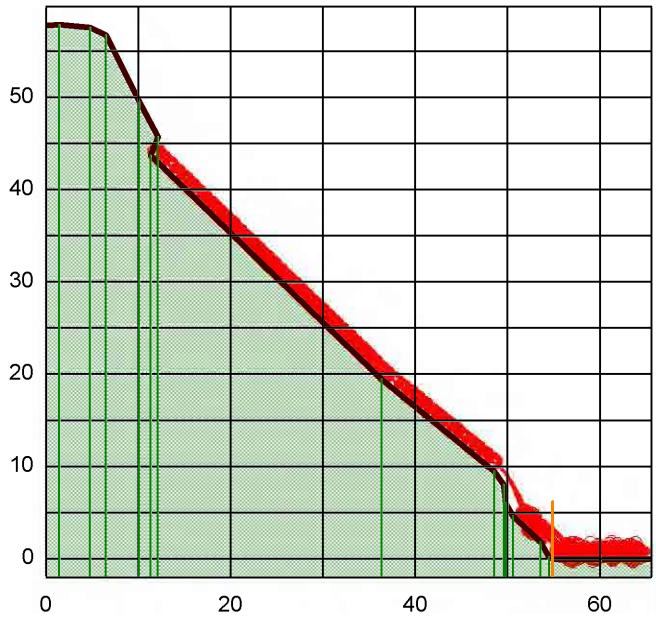
Sampling Section 1 at 54.88 m ; rocks: 100 of 100



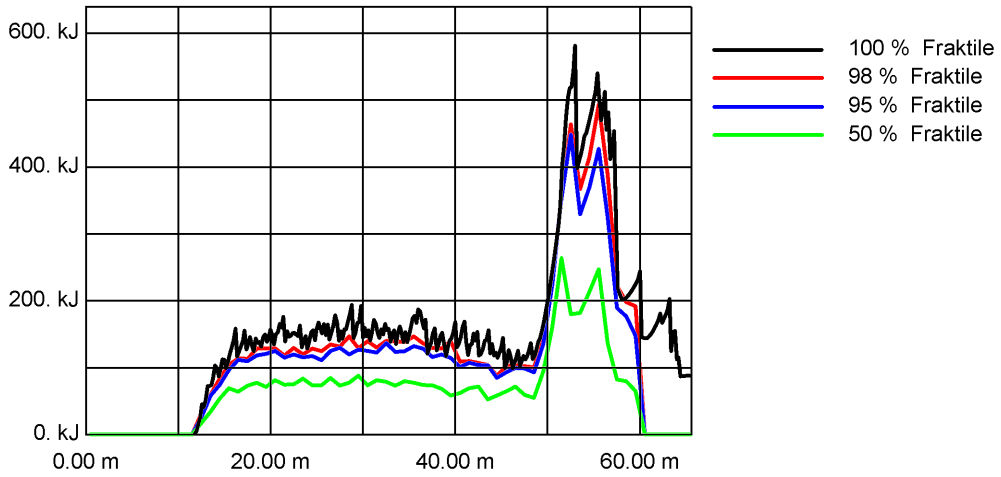
bounce height

Class range	:	0.20m
Minimum value	:	0.41m
Maximum value	:	2.46m
Mean value	:	1.11m
Standard dev.	:	0.54m
98 % Max	:	2.43m
95 % Max	:	2.33m
50 % Max	:	0.98m

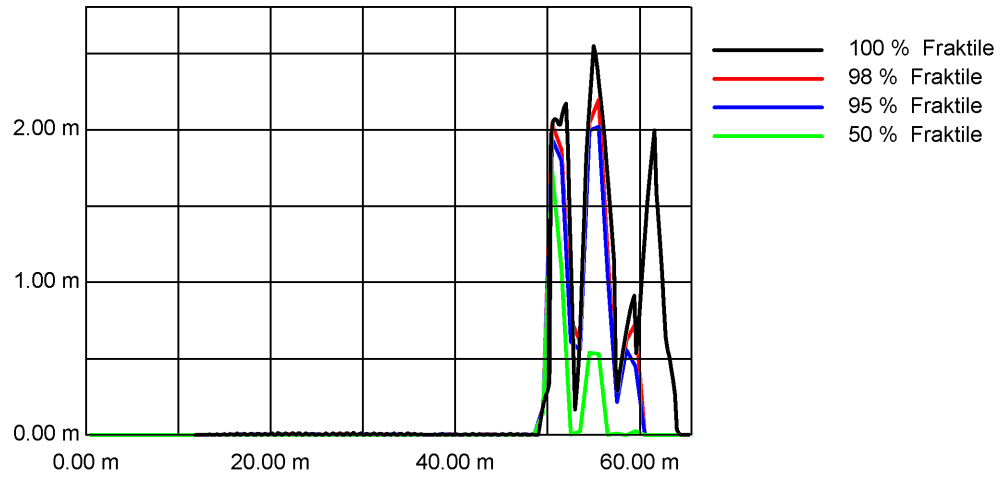
Rockfall Path



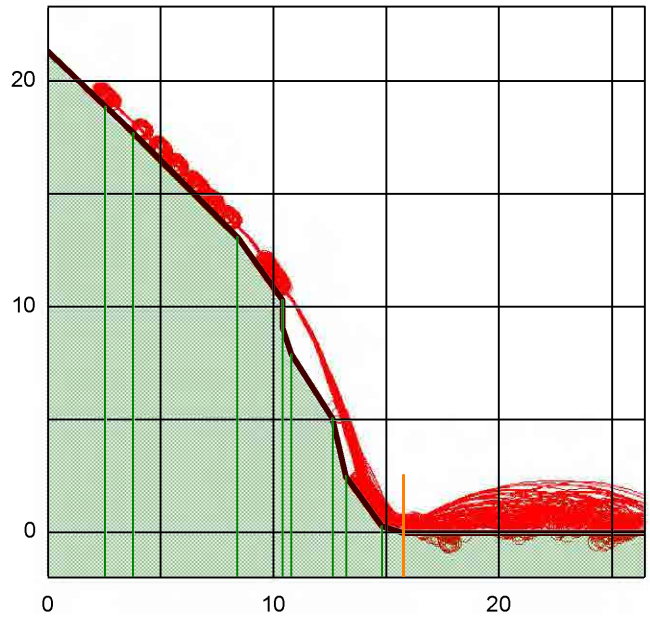
Envelope Curves: Energy



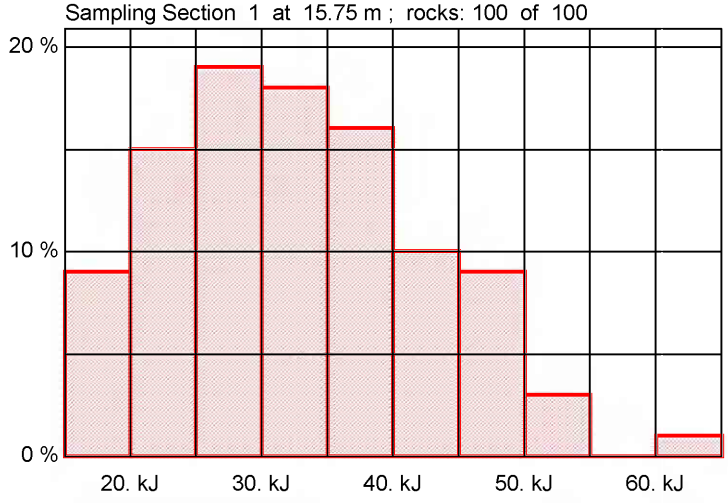
Envelope Curves: Bounce Height



Rockfall Path



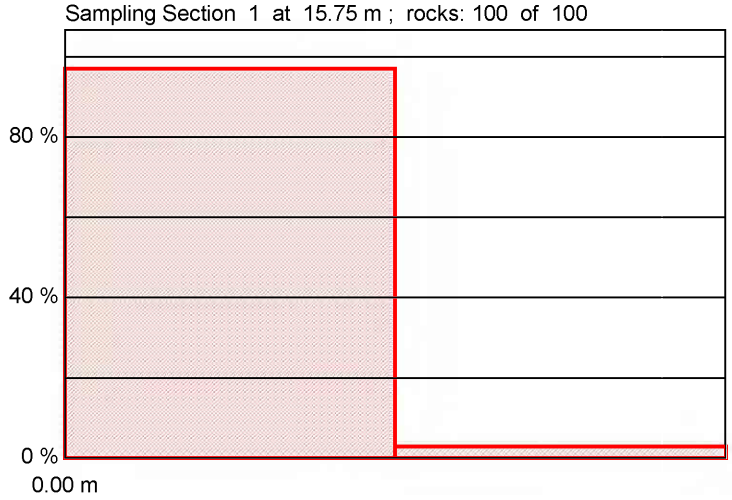
Sampling Section 1 at 15.75 m ; rocks: 100 of 100



total kinetic energy

Class range	:	5.kJ
Minimum value	:	17.kJ
Maximum value	:	64.kJ
Mean value	:	33.kJ
Standard dev.	:	10.kJ
98 % Max	:	54.kJ
95 % Max	:	49.kJ
50 % Max	:	32.kJ

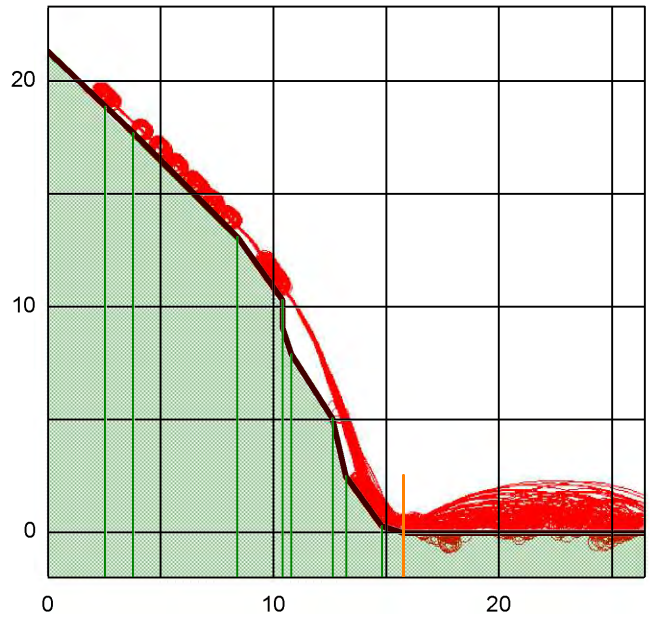
Sampling Section 1 at 15.75 m ; rocks: 100 of 100



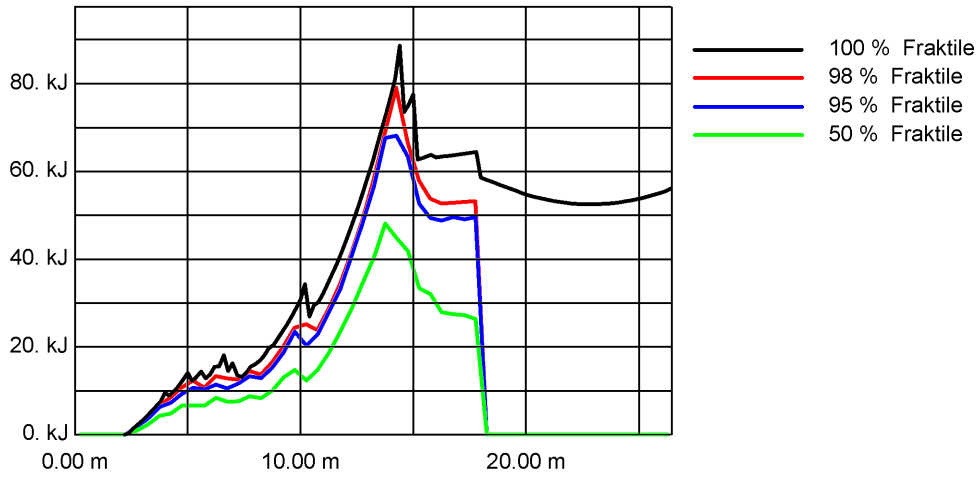
bounce height

Class range	:	0.02m
Minimum value	:	0.00m
Maximum value	:	0.03m
Mean value	:	0.00m
Standard dev.	:	0.01m
98 % Max	:	0.02m
95 % Max	:	0.01m
50 % Max	:	0.00m

Rockfall Path



Envelope Curves: Energy



Envelope Curves: Bounce Height