

## DAFTAR PUSTAKA

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**L**

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**M**

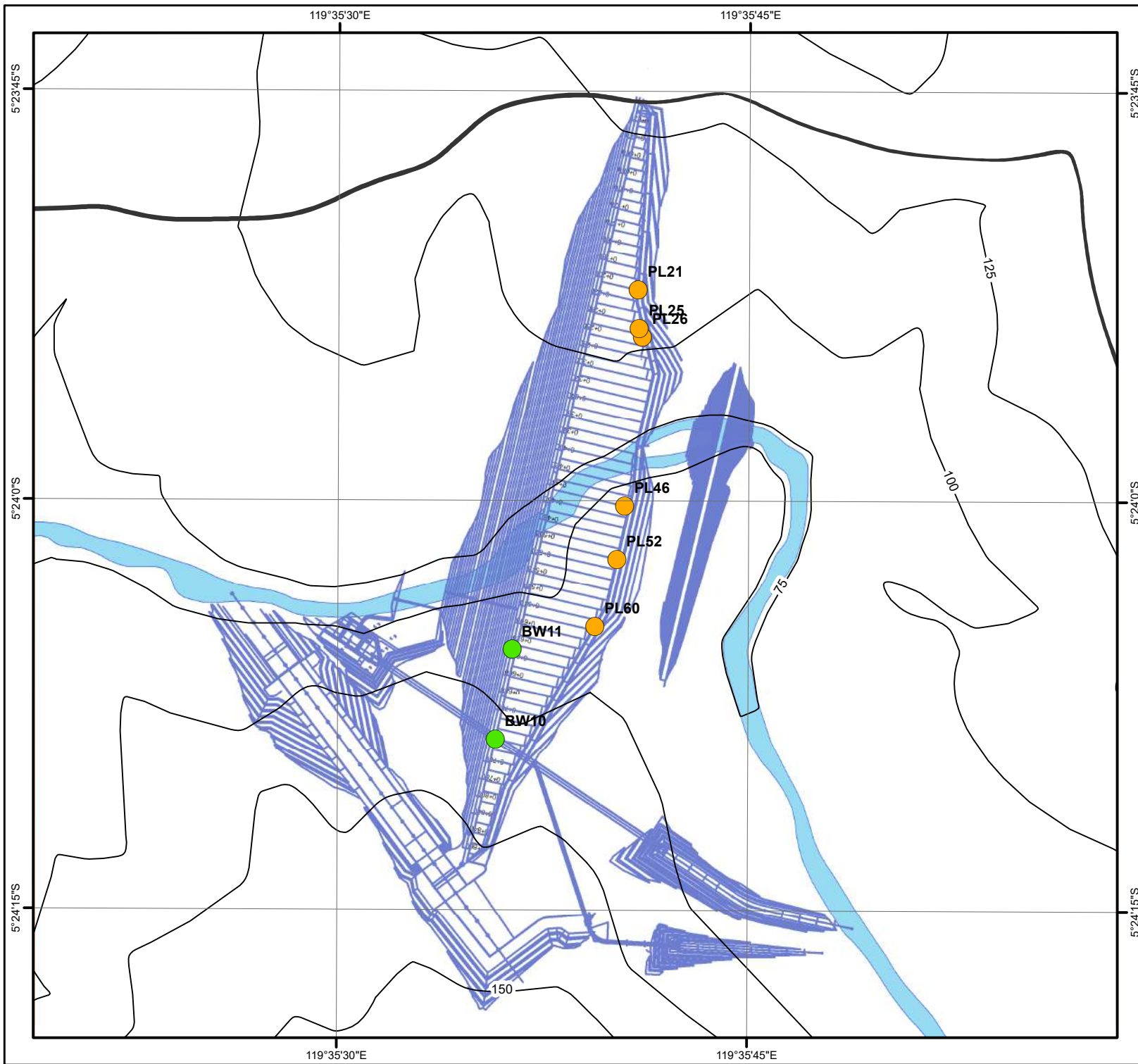
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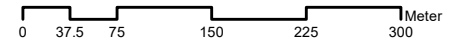
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PETA TITIK BOR BENDUNGAN PAMUKKULU  
 DAERAH KALE KOMARA' KECAMATAN  
 POLONGBANGKENG UTARA KABUPATEN TAKALAR  
 PROVINSI SULAWESI SELATAN



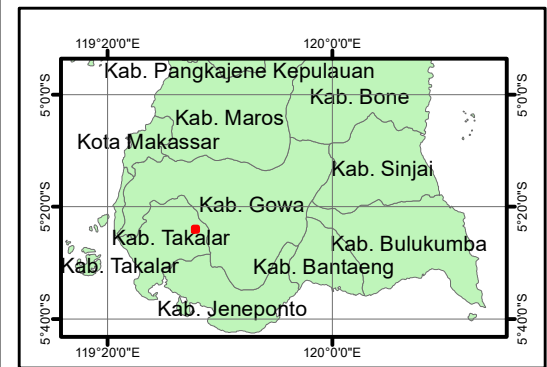
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 SKALA 1 : 6.000

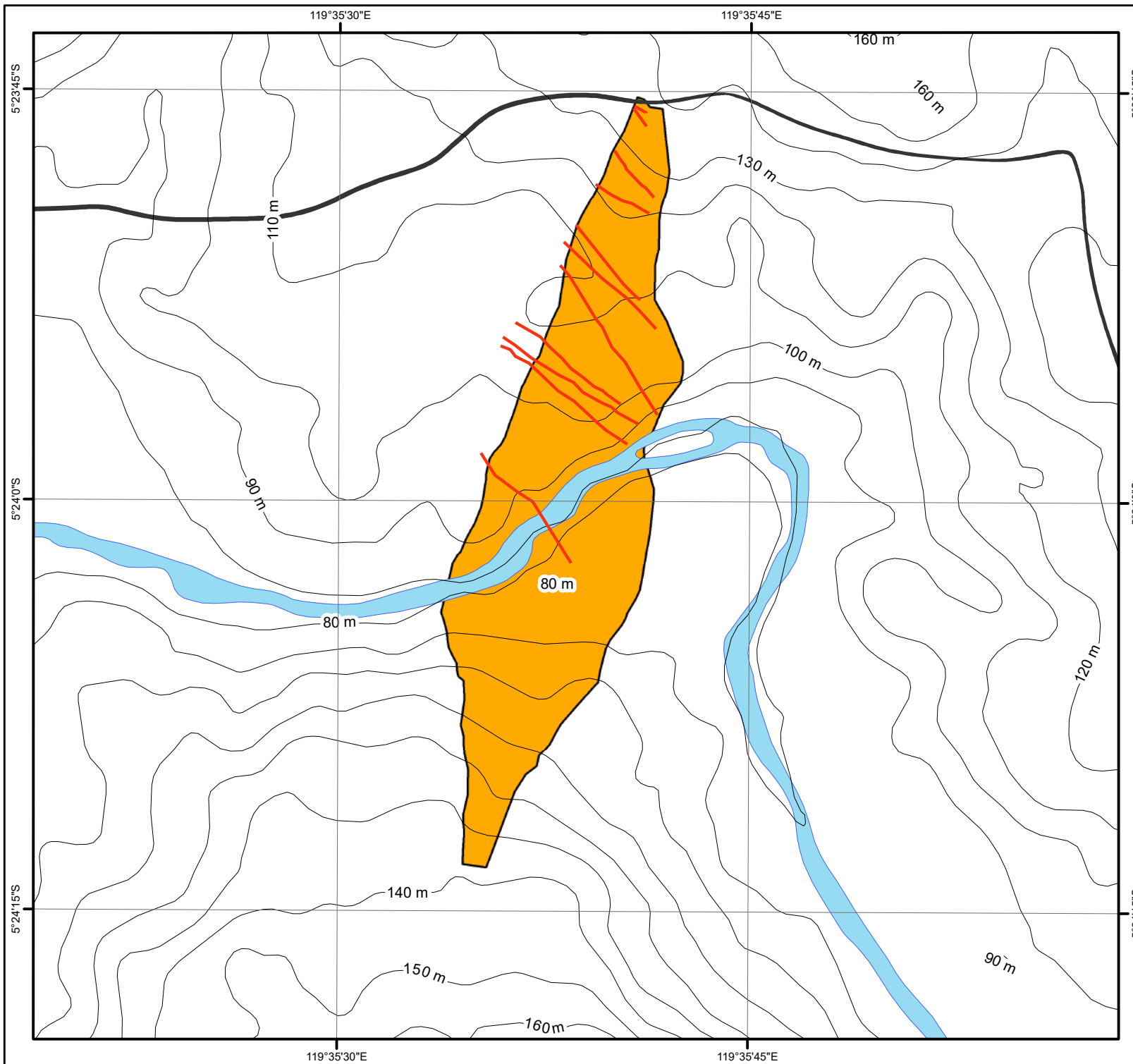
OLEH:  
 ANDI MUHAMMAD YUSRIL  
 D61116009

MAKASSAR  
 2021

KETERANGAN:

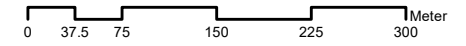
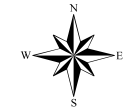
-  TITIK BOR AREA AS DAM
-  TITIK BOR AREA AS PLINTH
-  GARIS KONTUR
-  SUNGAI
-  JALAN
-  DENAH RENCANA BENDUNGAN





KEMENTERIAN PENDIDIKAN KEBUDAYAAN RISET DAN TEKNOLOGI  
 UNIVERSITAS HASANUDDIN  
 FAKULTAS TEKNIK  
 DEPARTEMEN TEKNIK GEOLOGI

**PETA GEOLOGI AREA BENDUNGAN PAMUKKULU**  
 DAERAH KALE KO'MARA KECAMATAN  
 POLONGBANGKENG UTARA KABUPATEN TAKALAR  
 PROVINSI SULAWESI SELATAN



IK = 25 M  
 SKALA 1 : 6.000

OLEH:  
 ANDI MUHAMMAD YUSRIL  
 D61116009

MAKASSAR  
 2022

**KETERANGAN:**

- |  |                        |  |                 |               |
|--|------------------------|--|-----------------|---------------|
|  | RETAS BASAL            |  | BREKSI VULKANIK | UMUR          |
|  | GARIS KONTUR           |  | SUNGAI          | PLIOSEN AKHIR |
|  | JALAN                  |  | PLIOSEN         |               |
|  | AREA RENCANA BENDUNGAN |  |                 |               |

**PETA TUNJUK LOKASI**

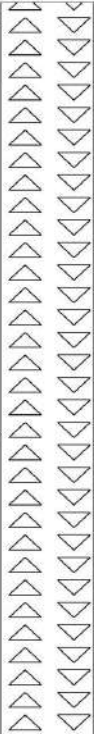



# SOIL TEST BORING SYMBOLIC LOG

**BORING NO. : BW10**

**PROJECT:** PAMUKKULU DAM  
**BORING LOCATION:** Maindam  
**METHOD OF DRILLING:** Rotary Drilling Machine  
**BORING DEPTH:** 30 m  
**INCLINATION :** Vertical  
**ELEVATION:** 102.49 m

**DATE :** 20 - 27 September 2020  
**DRILL MASTER :** Pak Manna  
**LOGGED BY :** Muh. Ichwanto  
**CHECKED BY :** William Triputra  
**GWL :** 12.11 m  
**COORD. X:** 787385.889  
**UTM ZONE :** 50 S

DATE	DEPTH (m)	ELEVATION (m)	SOIL/LITHOLOGY SYMBOL	DESCRIPTION	GWL (m)	Recovery (%)			RQD (%)			ROCK Classification	Lugeon (Lu / K)	Core Barrel Type (d)	Cassing (m)	Sampling	Depth (m)
						0	20	40	60	80	0						
20 - 27 September 2020	0	102		<p>(0.00, 20.00)                      Breccia: Breksi Vulkanik, abu-abu kehitaman, fragmen : batuan beku (Basalt) dan tufa , mudah patah, segar hingga mengalami pelapukan ringan. medium hard rock,</p> <p>Pada kedalaman 0- 8 meter Breksi vulkanik mengalami pelapukan yang kuat (Sempurna), lempung lanau kepasiran, kerikil - berangkal , coklat terang - coklat gelap..</p>	12.11	0			0			D	0.93	Core Barrel Double			0
	5	98				5	5	5	5	5	5						
	20	83		<p>(20.00, 30.00)                      Basalt: fresh, hitam keabuan, tekstur faneritik, mineral piroksin &amp; olivin, kekerasan tinggi, terkekarkan intensif, rendah pelapukan (alterasi)</p>		0			0			CH	2.03			10	
	25	78			25	25	25	25	25	25	25						25
	30	74				0			0				2.42			30	

**NOTES:** Clear weather, sunny, rainy

# SOIL TEST BORING SYMBOLIC LOG

**BORING NO. : BW11**

**PROJECT:** PAMUKKULU DAM  
**BORING LOCATION:** Maindam  
**METHOD OF DRILLING:** 81.506 m  
**BORING DEPTH:** 15 m  
**INCLINATION :** Vertical  
**ELEVATION:** 81.506

**DATE :** 27 Sept - 1 Okt 2020  
**DRILL MASTER :** Pak Manna  
**LOGGED BY :** Muh. Ichwan  
**CHECKED BY :** William Triputra  
**GWL :** 7.5 m  
**COORD. X:** 787406.37 **Y:** 9402340.061  
**UTM ZONE :** 50 S

DATE	DEPTH (m)	ELEVATION (m)	SOIL/LITHOLOGY SYMBOL	DESCRIPTION	GWL (m)	Recovery (%)			RQD (%)			ROCK Classification	Lugeon (Lu / K)	Core Barrel Type (d)	Casing (m)	Sampling	Depth (m)
						0	20	40	60	80	0						
29 Sept - 1 Okt 2020	0	81	△	(0.00, 15.00) Breccia: Breksi Vulkanik, abu-abu kehitaman, fragmen : batuan beku (Basalt) dan tufa , mudah patah, segar hingga mengalami pelapukan ringan. medium hard rock,  Pada kedalaman 0- 1.7 meter Breksi vulkanik mengalami pelapukan yang kuat (Sempurna), lempung lanau kepasiran, kerikil - berangkal , coklat terang - coklat gelap..	7.5							D					0
	5	77	△										Core Barrel Double				5
	7.5	74.5	▽										1.27				7.5
	10	71	△											1.21			10
	15	66.5	△														15

**NOTES:** Clear weather, sunny, rainy

# SOIL TEST BORING SYMBOLIC LOG

**BORING NO. : PL21**

**PROJECT: PAMUKKULU DAM**  
**BORING LOCATION: AS PLINTH 21**  
**METHOD OF DRILLING: Rotary Drilling Machine**  
**BORING DEPTH: 35 m**  
**INCLINATION : Vertical**  
**ELEVATION: 98.433 m**

**DATE : 24 Feb - 10 Maret 2020**  
**DRILL MASTER : Dg. Sija**  
**LOGGED BY : Muh.Ichwanto**  
**CHECKED BY : William Triputra**  
**GWL : 17.3 m**  
**COORD. X : 787547.86 Y : 9402744.533**  
**UTM ZONE : 50 S**

DATE	DEPTH (m)	ELEVATION (m)	SOIL/LITHOLOGY SYMBOL	DESCRIPTION	GWL (m)	Recovery (%)			RQD (%)			ROCK Classification	Lug/Lu /K /Lu	Core Barrel Type (d)	Cassing (m)	Sampling	Depth (m)
						0	20	40	60	80	0						
24 Feb - 10 Maret 2020	0	98.433	△△△△△	(0.00, 35.00) Breccia: Breksi Vulkanik, abu-abu kehitaman, fragmen : batuan beku (Basalt) dan tufa , mudah patah, segar hingga mengalami pelapukan ringan. medium hard rock, interval joint 15 - 30, Pada kedalaman 0 - 7.5 meter Breksi vulkanik mengalami pelapukan yang kuat - sedang, lempung lanau kepasiran, kerikil - berangkal , warna coklat kemerahan - coklat,	17.3							CL	6.74	Core Barrel Single			
	35	65	△△△△△														
	5	93	△△△△△														
	10	89	△△△△△														
	15	84	△△△△△														
	20	78	△△△△△														
	25	74	△△△△△														
	30	68	△△△△△														
	35	65	△△△△△														
<b>NOTES: Clear weather, sunny, rainy</b>																	



# SOIL TEST BORING SYMBOLIC LOG

**BORING NO. : PL.25**

**PROJECT:** PAMUKKULU DAM  
**BORING LOCATION:** Plint  
**METHOD OF DRILLING:** Rotary Drilling Machine  
**BORING DEPTH:** 40 m  
**INCLINATION :** 45  
**ELEVATION:** 86.863

**DATE :** 26 Agustus - 8 Sept 2020  
**DRILL MASTER :** Pak Manna  
**LOGGED BY :** Muh. Ichwanto  
**CHECKED BY :** William Triputra  
**GWL :** 6.5 m  
**COORD. X:** 787549.17 **Y:** 9402701.44  
**UTM ZONE :** 50 S

DATE	DEPTH (m)	ELEVATION (m)	SOIL/LITHOLOGY SYMBOL	DESCRIPTION	GWL (m)	Recovery (%)				RQD (%)				ROCK Classification	Lugeon (Lu / K)	Core Barrel Type (d)	Cassing (m)	Sampling	Depth (m)
						0	20	40	60	80	0	20	40						
26 Agustus - 8 September 2020	0	86.863	△	(0.00, 40.00) Breccia: Breksi Vulkanik, abu-abu kehitaman, fragmen : batuan beku (Basalt) dan tufa , mudah patah, segar hingga mengalami pelapukan ringan. medium hard rock, interval joint 15 - 30. Pada kedalaman 0- 11 meter Breksi vulkanik mengalami pelapukan yang kuat (Sempurna), lempung lanau kepasiran, kerikil - berangkal , coklat terang - coklat gelap..	6.5														
	86	86	△																
	84	84	△																
	83	83	△																
	80	80	△																
	78	78	△																
	77	77	△																
	75	75	△																
	74	74	△																
	72	72	△																
	71	71	△																
	69	69	△																
	68	68	△																
	66	66	△																
	65	65	△																
	63	63	△																
	62	62	△																
	60	60	△																
	59	59	△																
	57	57	△																
56	56	△																	
54	54	△																	
53	53	△																	
51	51	△																	
50	50	△																	
48	48	△																	
40	40	40	△																

**NOTES:** Clear weather, sunny, rainy

# SOIL TEST BORING SYMBOLIC LOG

**BORING NO. : PL26**

**PROJECT:** PAMUKKULU DAM  
**BORING LOCATION:** Plinth  
**METHOD OF DRILLING:** Rotary Drilling Machine  
**BORING DEPTH:** 50 m  
**INCLINATION :** Vertical  
**ELEVATION:** 84.7 m

**DATE :** 16-30 Mei 2020  
**DRILL MASTER :** Pak Manna  
**LOGGED BY :** Muh Ichwanto  
**CHECKED BY :** William Triputra  
**GWL :** 0.7 m  
**COORD. X:** 787553.00 **Y:** 9402691.676  
**UTM ZONE :** 50 S

DATE	DEPTH (m)	ELEVATION (m)	SOIL/LITHOLOGY SYMBOL	DESCRIPTION	GWL (m)	Recovery (%)		RQD (%)		ROCK Classification	Lugeon (Lu / K)	Core Barrel Type (d)	Cassing (m)	Sampling	Depth (m)			
						0	20	40	60							80	0	20
16-30 Mei 2020	0	84.7	▲▲▲▲▲	(0.00, 11.00) Breccia: Breksi Vulkanik, abu-abu kehitaman, fragmen : batuan beku (Basalt) dan tufa , mudah patah, segar hingga mengalami pelapukan ringan. medium hard rock, Pada kedalaman 0- 5 meter Breksi vulkanik mengalami pelapukan yang kuat (Sempurna), lempung lanau kepasiran, kerikil - berangkal , coklat terang - coklat gelap..	0.7					CL		Core Barrel Double						
	5	83	▲▲▲▲▲															
	10	81	▲▲▲▲▲															
	15	80	▲▲▲▲▲															
	20	78	▲▲▲▲▲															
	25	77	▲▲▲▲▲															
	30	75	▲▲▲▲▲															
	35	74	▲▲▲▲▲															
	40	72	▲▲▲▲▲															
	45	71	▲▲▲▲▲															
	50	69	▲▲▲▲▲	(11.00, 25.00) Basalt: fresh, hitam keabuan, tekstur faneritik, mineral piroksin & olivin, kekerasan tinggi, terkekarkan intensif, rendah pelapukan (alterasi)														
	55	68	▲▲▲▲▲															
	60	66	▲▲▲▲▲															
	65	65	▲▲▲▲▲															
	70	63	▲▲▲▲▲															
	75	62	▲▲▲▲▲															
	80	60	▲▲▲▲▲															
	85	59	▲▲▲▲▲	(25.00, 50.00) Breccia: Breksi Vulkanik, abu-abu kehitaman, fragmen : batuan beku (Basalt) dan tufa , mudah patah, segar hingga mengalami pelapukan ringan. medium hard rock,														
	90	57	▲▲▲▲▲															
	95	56	▲▲▲▲▲															
100	54	▲▲▲▲▲																
105	53	▲▲▲▲▲																
110	51	▲▲▲▲▲																
115	50	▲▲▲▲▲																
120	48	▲▲▲▲▲																
125	47	▲▲▲▲▲																
130	45	▲▲▲▲▲																
135	44	▲▲▲▲▲																
140	42	▲▲▲▲▲																
145	41	▲▲▲▲▲																
150	39	▲▲▲▲▲																
155	38	▲▲▲▲▲																
160	36	▲▲▲▲▲																

**NOTES:** Clear weather, sunny, rainy

# SOIL TEST BORING SYMBOLIC LOG

**BORING NO. : PL46**

**PROJECT: PAMUKKULU DAM**  
**BORING LOCATION: Plinth**  
**METHOD OF DRILLING: Rotary Drilling Machine**  
**BORING DEPTH: 35 m**  
**INCLINATION : Vertical**  
**ELEVATION: 78.22 m**

**DATE : 3-9 Juni 2020**  
**DRILL MASTER : Dg. Sija**  
**LOGGED BY : Muh. Ichwanto**  
**CHECKED BY : William Triputra**  
**GWL : 5.8 m**  
**COORD. X : 787532.86 Y : 9402500.998**  
**UTM ZONE : 50 S**

DATE	DEPTH (m)	ELEVATION (m)	SOIL/LITHOLOGY SYMBOL	DESCRIPTION	GWL (m)	Recovery (%)		RQD (%)		ROCK Classification	Lugeon (Lu/K)	Core Barrel Type (d)	Cassing (m)	Sampling	Depth (m)			
						0	20	40	60							80	0	20
3-9 Juni 2020	0	78		(0.00, 6.00) Topsoil: Lapisan Permukaan, Colluvium (Transported Soil), lempung lanau pasiran kerikilan dengan material organik (akar tanaman dll), transported soil dengan material transported kerikil, kerakal, hingga bongkah basalt coklat terang-coklat gelap, lepas,	5.8					CL		Core Barrel Double			0			
	5	74															5	
	10	69		(6.00, 35.00) Breccia: Breksi Vulkanik, abu-abu kehitaman, fragmen : batuan beku (Basalt) dan tufa , mudah patah, segar hingga mengalami pelapukan ringan. medium hard rock, Pada kedalaman 6 - 10 & 16 - 17 meter Breksi vulkanik mengalami pelapukan yang kuat (sempurna), lempung pasiran, kerikil - berangkal , coklat - abu-abu kehitaman.													10	
	15	63												14.30				15
	20	59												22.43				20
	25	54												1.06				25
	30	48													13.9			30
	35	44													13.94			35

**NOTES:** Clear weather, sunny, rainy

# SOIL TEST BORING SYMBOLIC LOG

**BORING NO. : PL 52**


**PROJECT:** PAMUKKULU DAM  
**BORING LOCATION:** Plinth  
**METHOD OF DRILLING:** Rotary Drilling Machine  
**BORING DEPTH:** 40 m  
**INCLINATION :** Vertical  
**ELEVATION:** 72.786 m

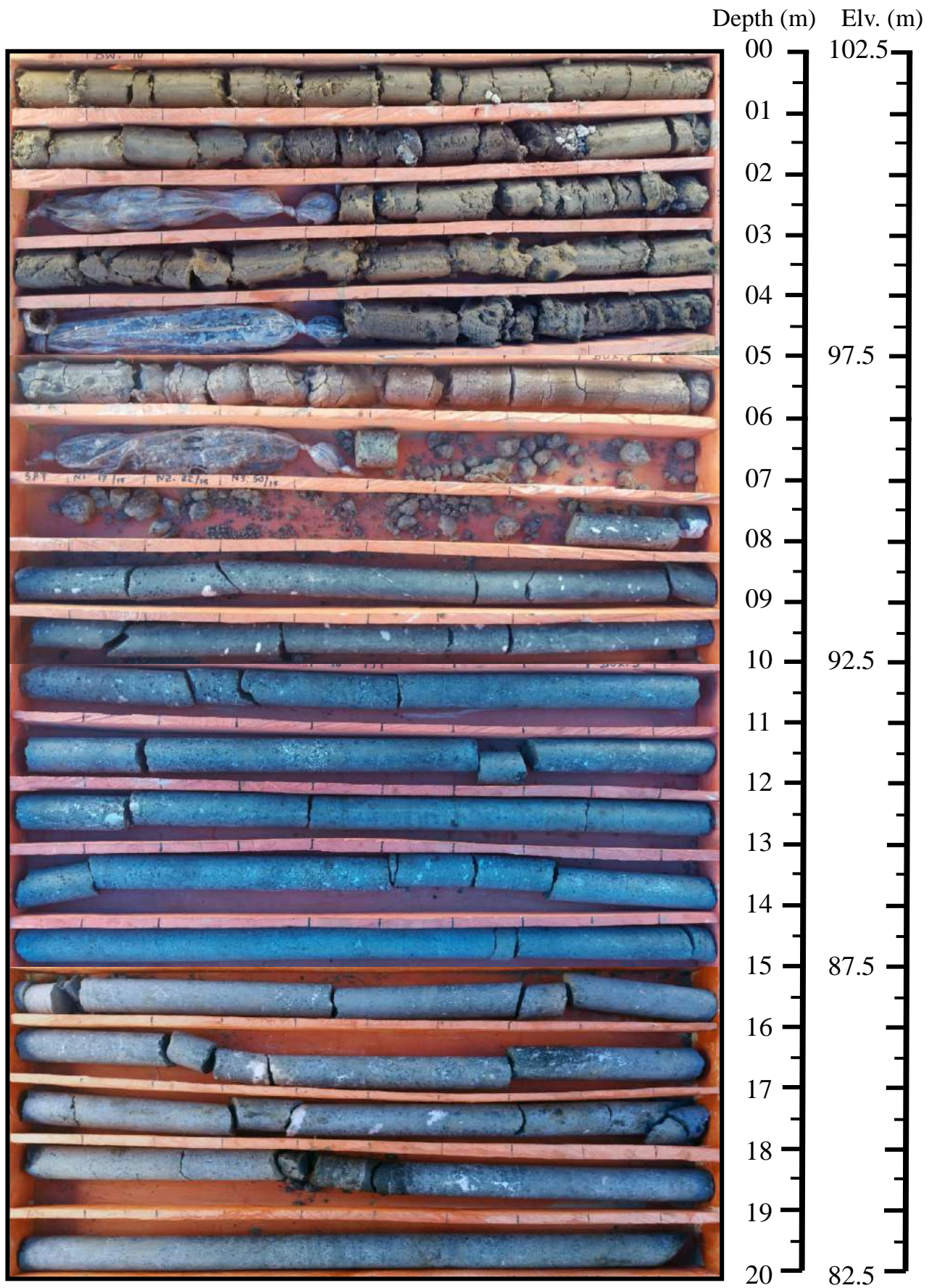
**DATE :** 10 - 19 September 2020  
**DRILL MASTER :** Pak Manna  
**LOGGED BY :** Muh. Ichwanto  
**CHECKED BY :** William Triputra  
**GWL :** 1 m  
**COORD. X:** 787523.93 **Y:** 9402441.124  
**UTM ZONE :** 50 S


DATE	DEPTH (m)	ELEVATION (m)	SOIL/LITHOLOGY SYMBOL	DESCRIPTION	GWL (m)	Recovery (%)				RQD (%)				ROCK Classification	Lugon (Lu/Lu) (d)	Core Barrel Type (d)	Cassing (m)	Sampling	Depth (m)
						0	20	40	60	80	0	20	40						
10 - 19 September 2020	0	72.786		<p>(0.00, 25.00)                      Basalt: fresh, hitam keabuan, tekstur faneritik, mineral piroksin &amp; olivin, kekerasan tinggi, terkekarkan intensif, rendah pelapukan (alterasi)</p> <p>Pada kedalaman 0 - 4 meter basalt mengalami pelapukan yang sempurna, dapat diremas, dan hancur (residual soil). Pada kedalaman 4 - 14 meter basalt mengalami pelapukan yang kuat, terkekarkan intensif.</p>	1														0
	71																		5
	69																		10
	68																		15
	66																		20
	65																		25
	63																		30
	62																		35
	60																		40
	59																		45
	57																		50
	56																		55
	54																		60
	53																		65
	51																		70
	50																		75
	48																		80
	47			<p>(25.00, 40.00)                      Breccia: Breksi Vulkanik, abu-abu kehitaman, fragmen : batuan beku (Basalt) dan tufa , mudah patah, segar hingga mengalami pelapukan ringan. medium hard rock, interval joint 15 - 30</p>															85
	45																		90
	44																		95
	42																		100
	41																		105
	39																		110
	38																		115
	36																		120
	35																		125
	35																		130
	34																		135
	33																		140

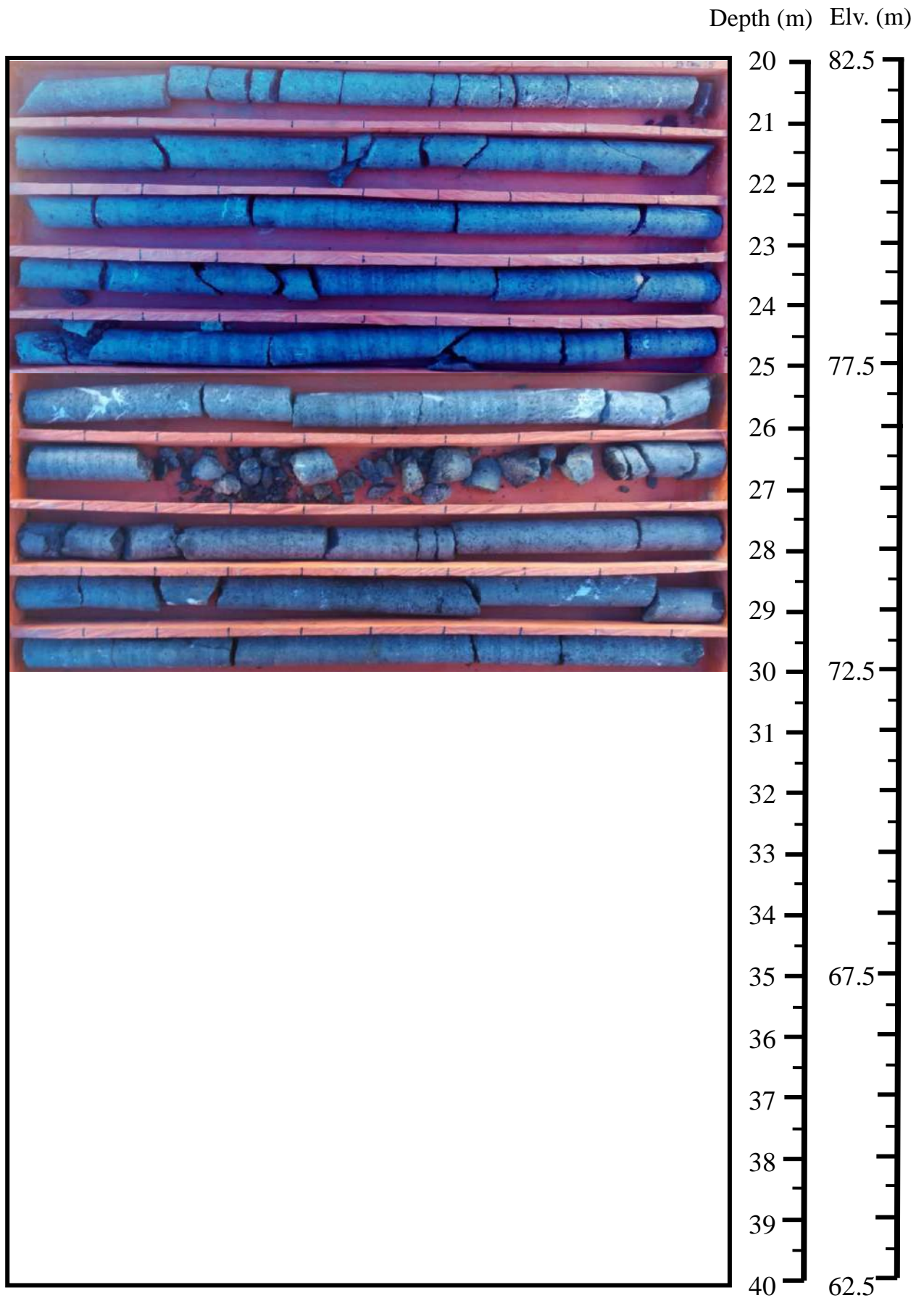
**NOTES:** Clear weather, sunny, rainy




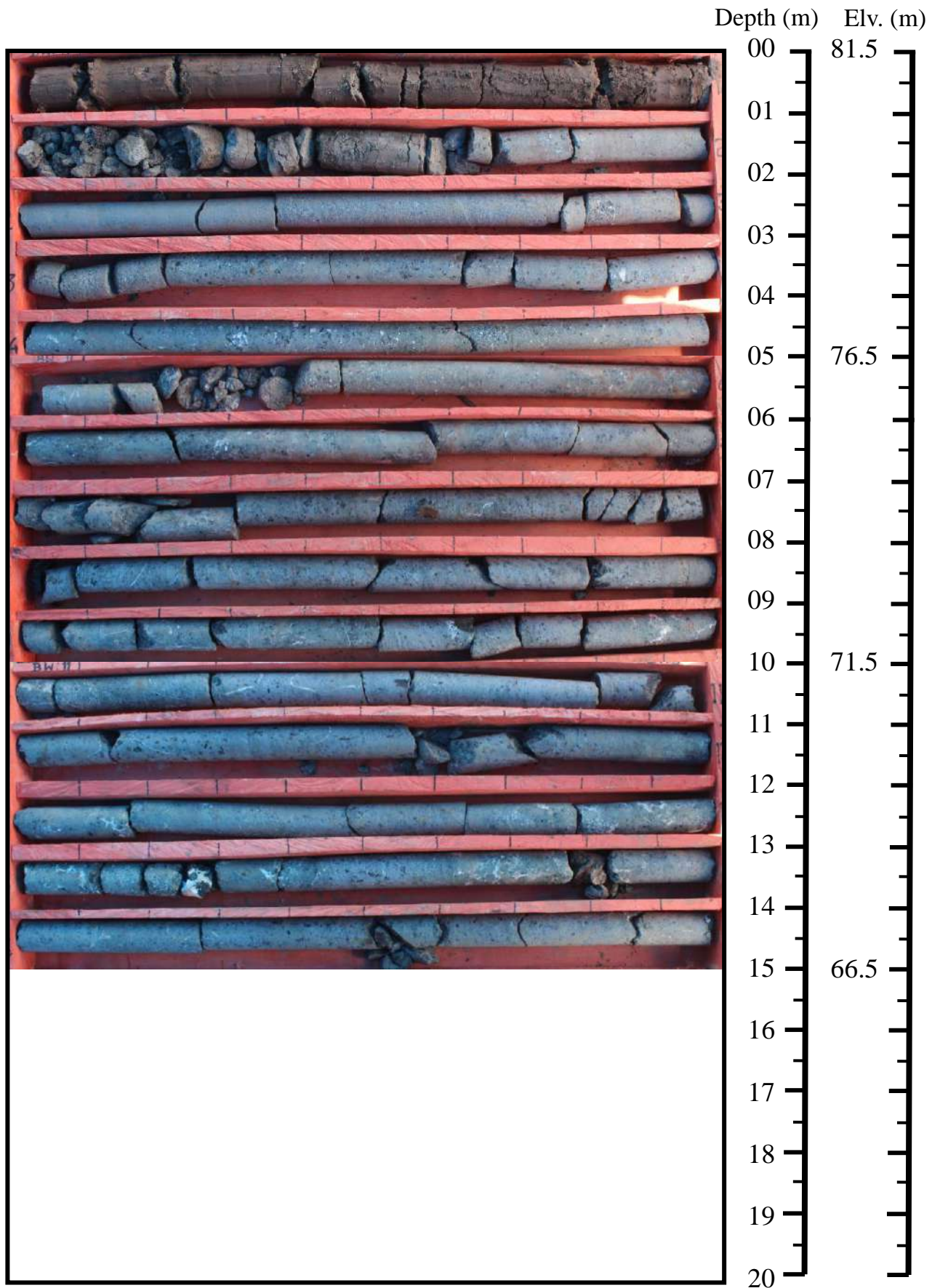
Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	BW-10	Depth of Borehole	30 m
Location	Pertemuan As Tunnel dan As Dam	Depth of Rock Core	0 ~ 20 m
Date of Drilling	20 Sep – 27 Sept 2020	Total Rock Box	6




Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	BW-10	Depth of Borehole	30 m
Location	Pertemuan As Tunnel dan As Dam	Depth of Rock Core	20 ~ 30 m
Date of Drilling	20 Sep – 27 Sept 2020	Total Rock Box	6

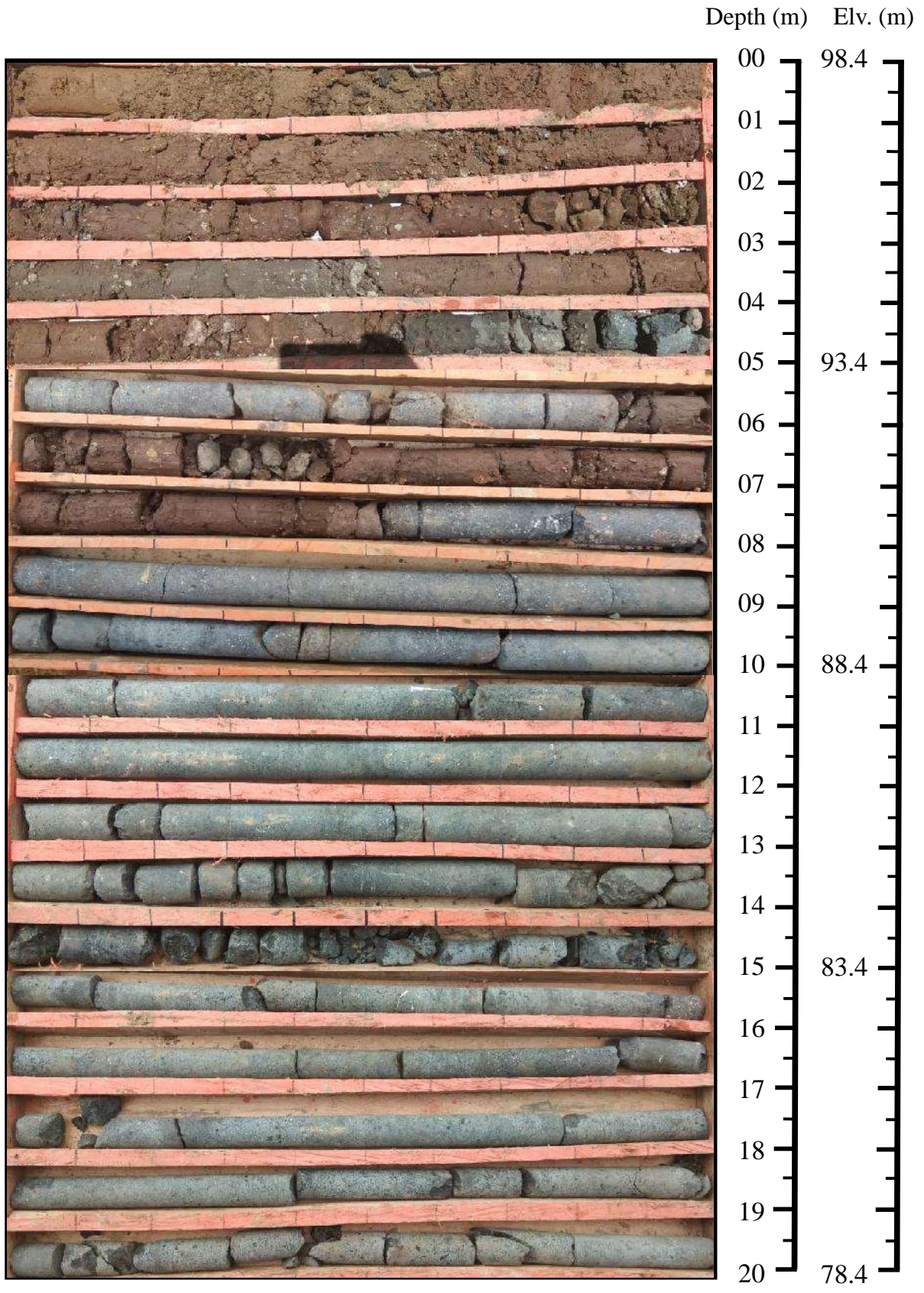



Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	BW-10	Depth of Borehole	15 m
Location	Maindam	Depth of Rock Core	0 ~ 15 m
Date of Drilling	27 Sep – 1 Okt 2020	Total Rock Box	3

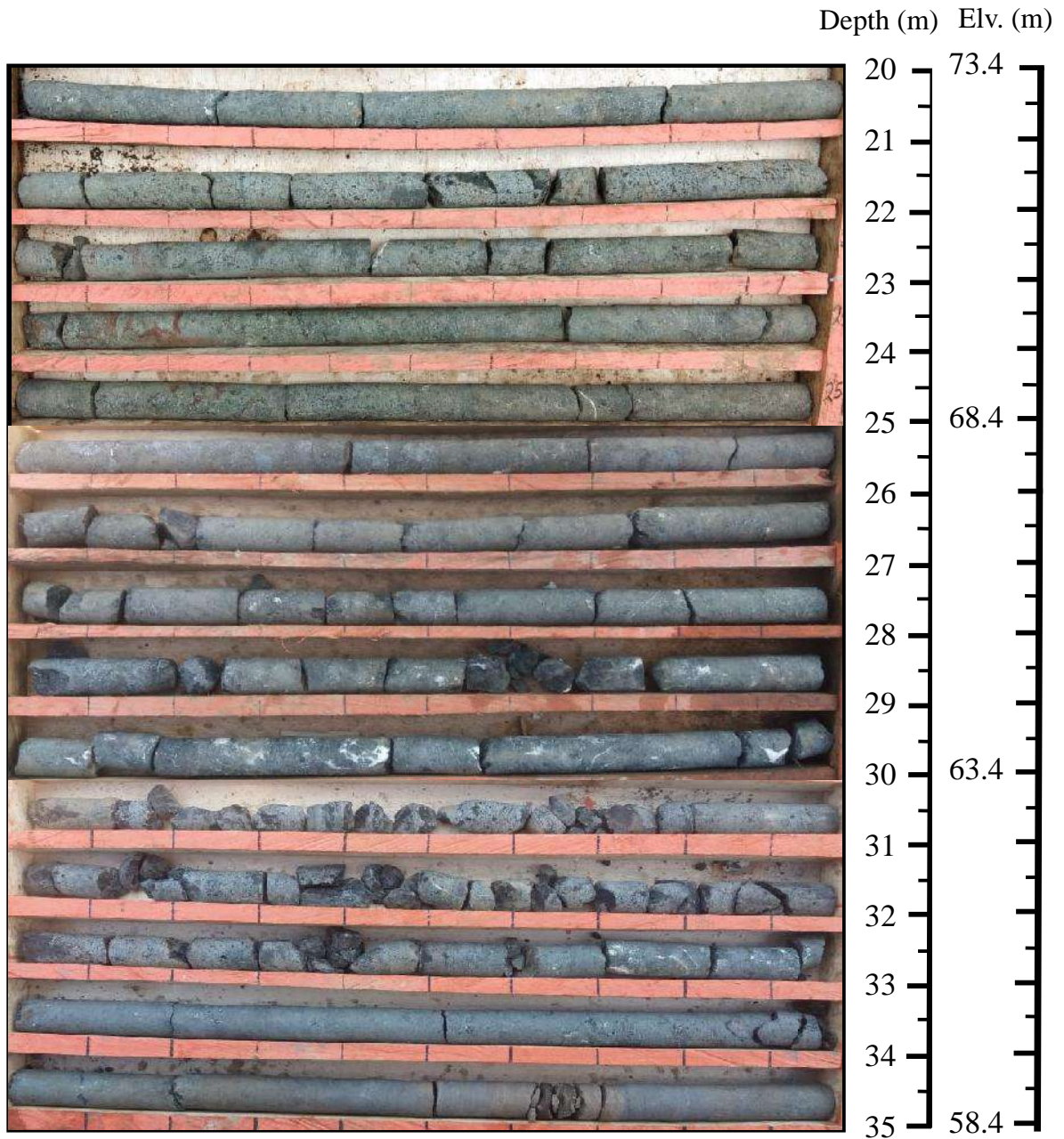





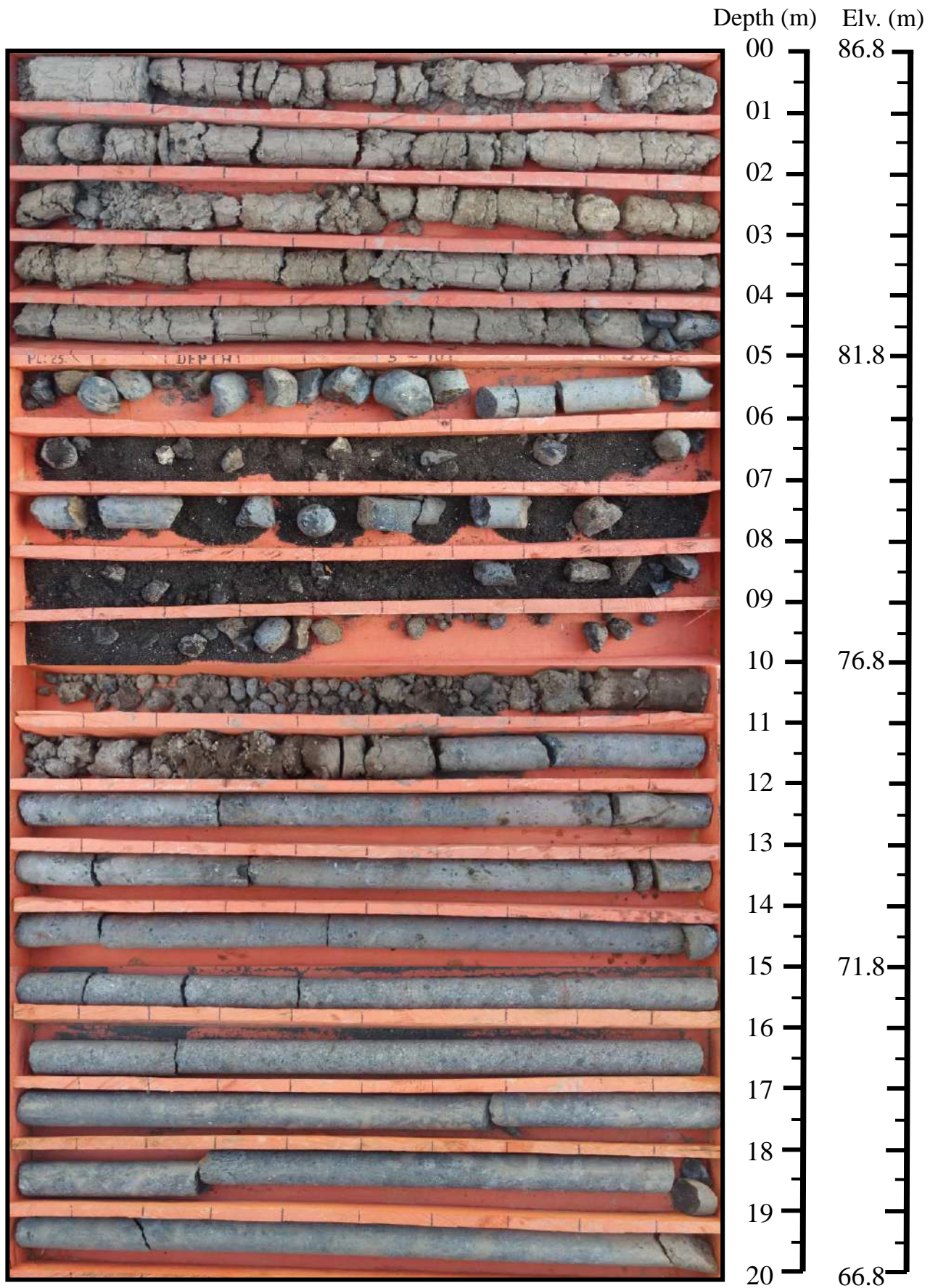
Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-21	Depth of Borehole	20 m
Location	Plinth	Depth of Rock Core	0 ~ 20 m
Date of Drilling	24 Feb – 10 Mar 2020	Total Rock Box	4




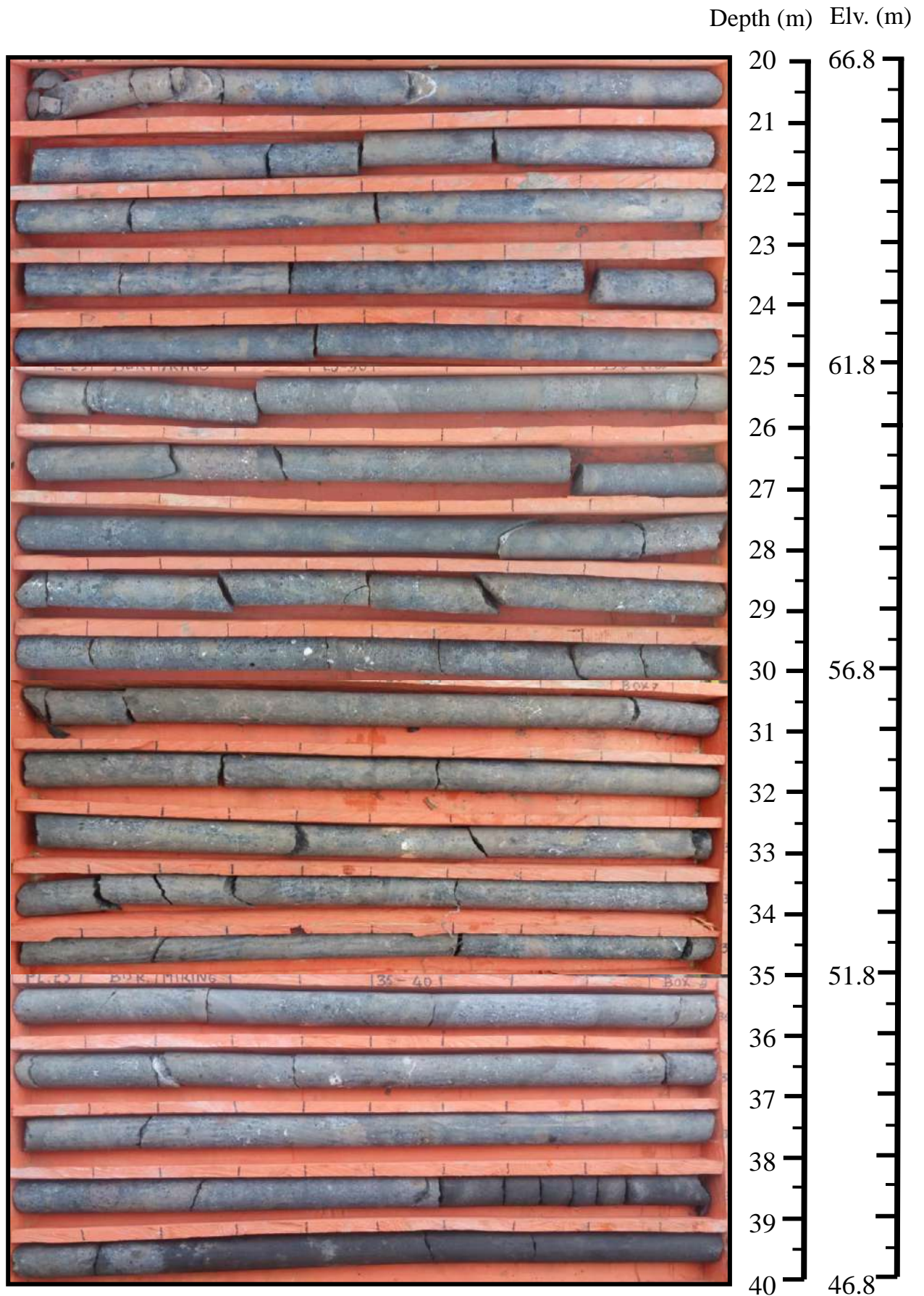
Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-21	Depth of Borehole	35 m
Location	Plinth	Depth of Rock Core	20 ~ 35 m
Date of Drilling	24 Feb – 10 Mar 2020	Total Rock Box	7




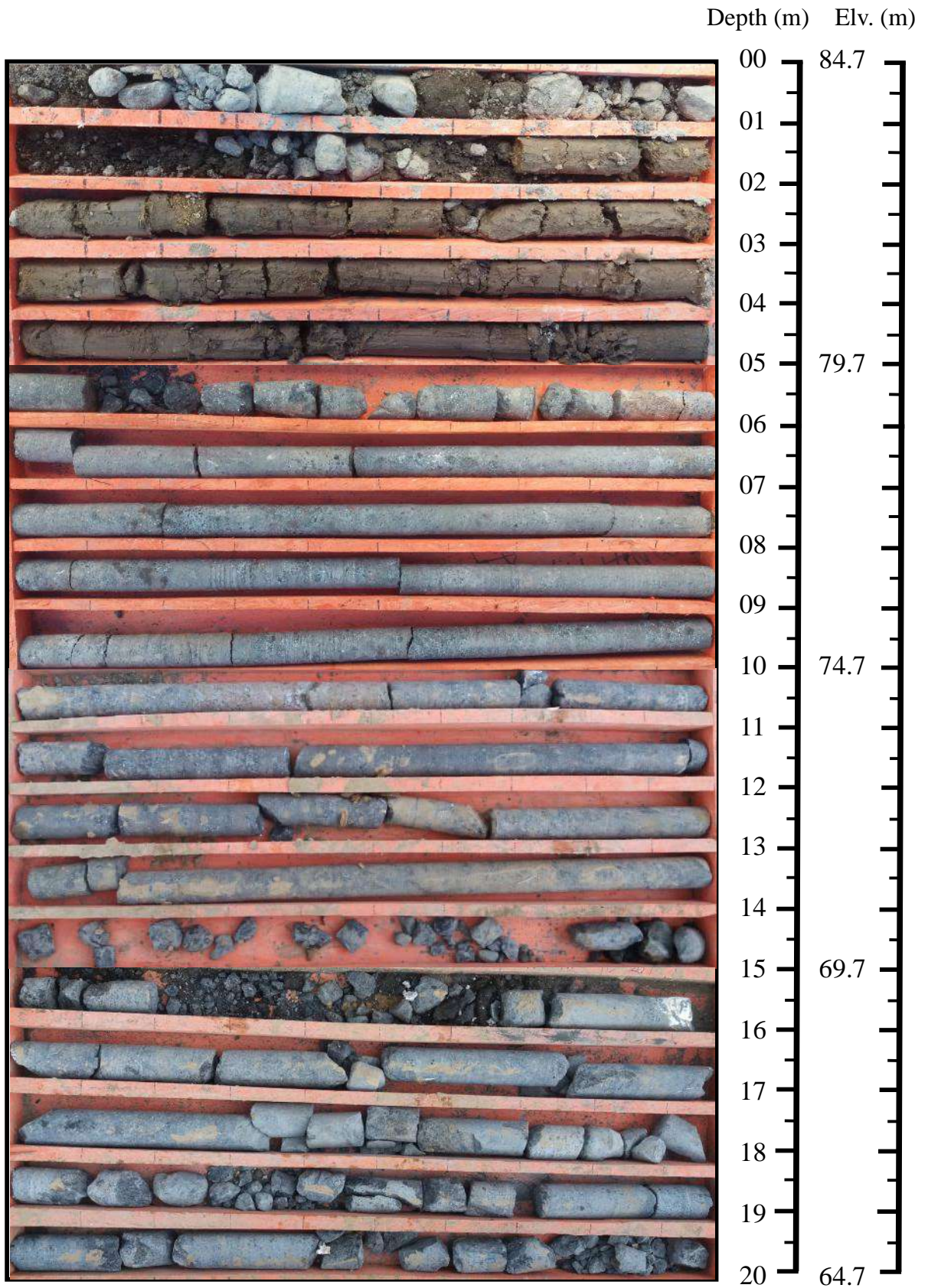
Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-25	Depth of Borehole	40 m
Location	Plinth	Depth of Rock Core	0 ~ 20 m
Date of Drilling	26 Ags – 8 Sept 2020	Total Rock Box	8




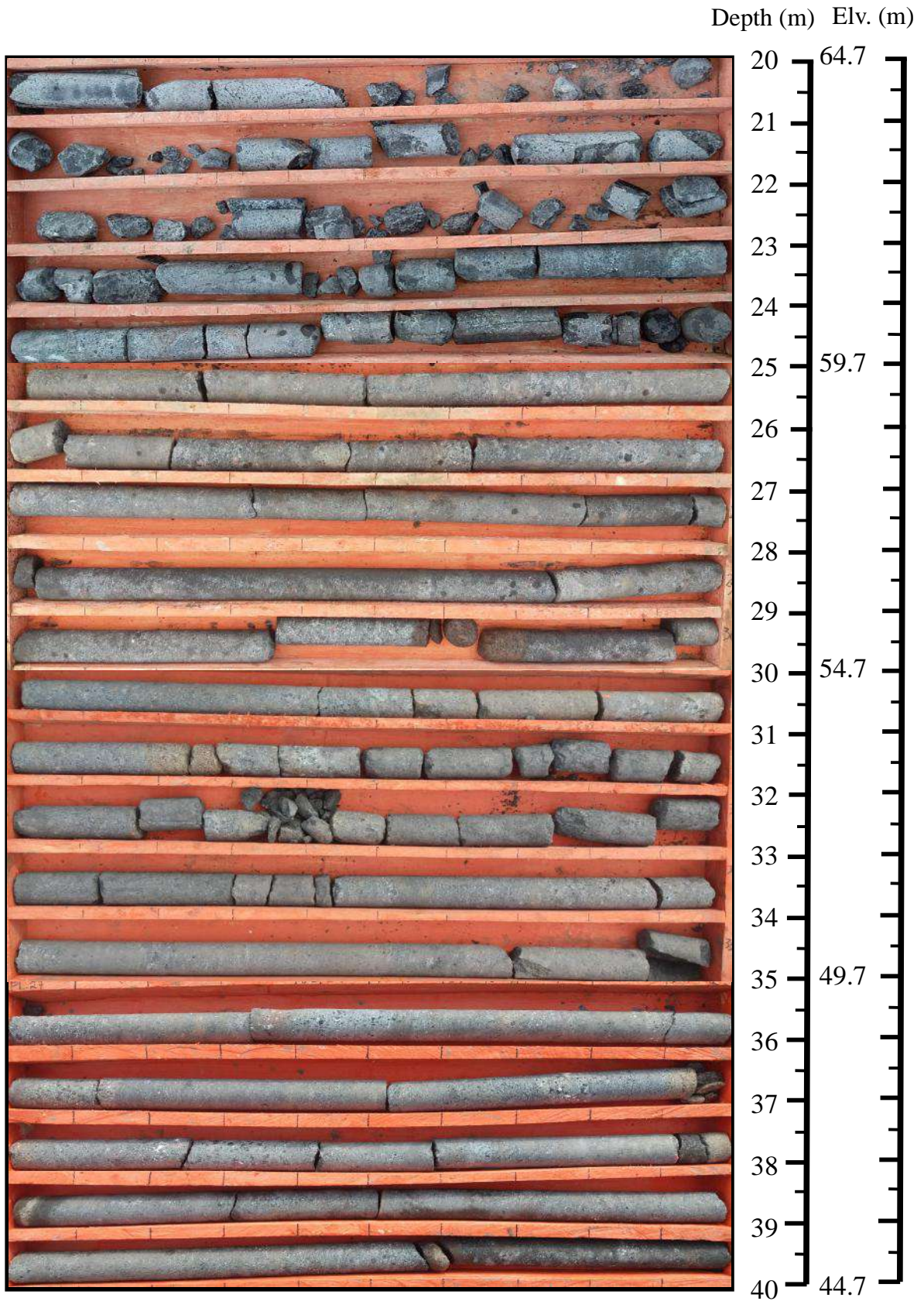
Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-25	Depth of Borehole	40 m
Location	Plinth	Depth of Rock Core	20 ~ 40 m
Date of Drilling	26 Ags – 8 Sept 2020	Total Rock Box	8




Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-26	Depth of Borehole	50 m
Location	Plinth	Depth of Rock Core	0 ~ 20 m
Date of Drilling	16 Mei – 30 Mei 2020	Total Rock Box	10

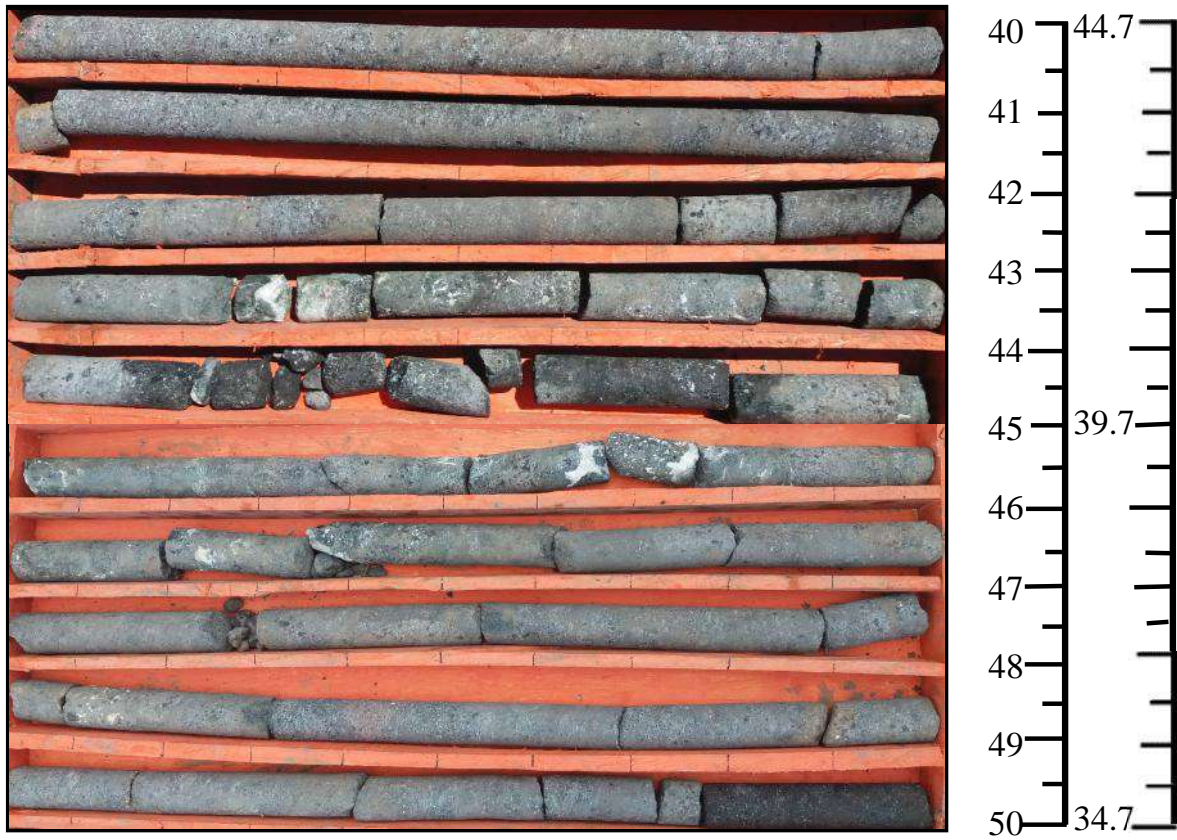



Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-26	Depth of Borehole	50 m
Location	Plinth	Depth of Rock Core	20 ~ 40 m
Date of Drilling	16 Mei – 30 Mei 2020	Total Rock Box	10

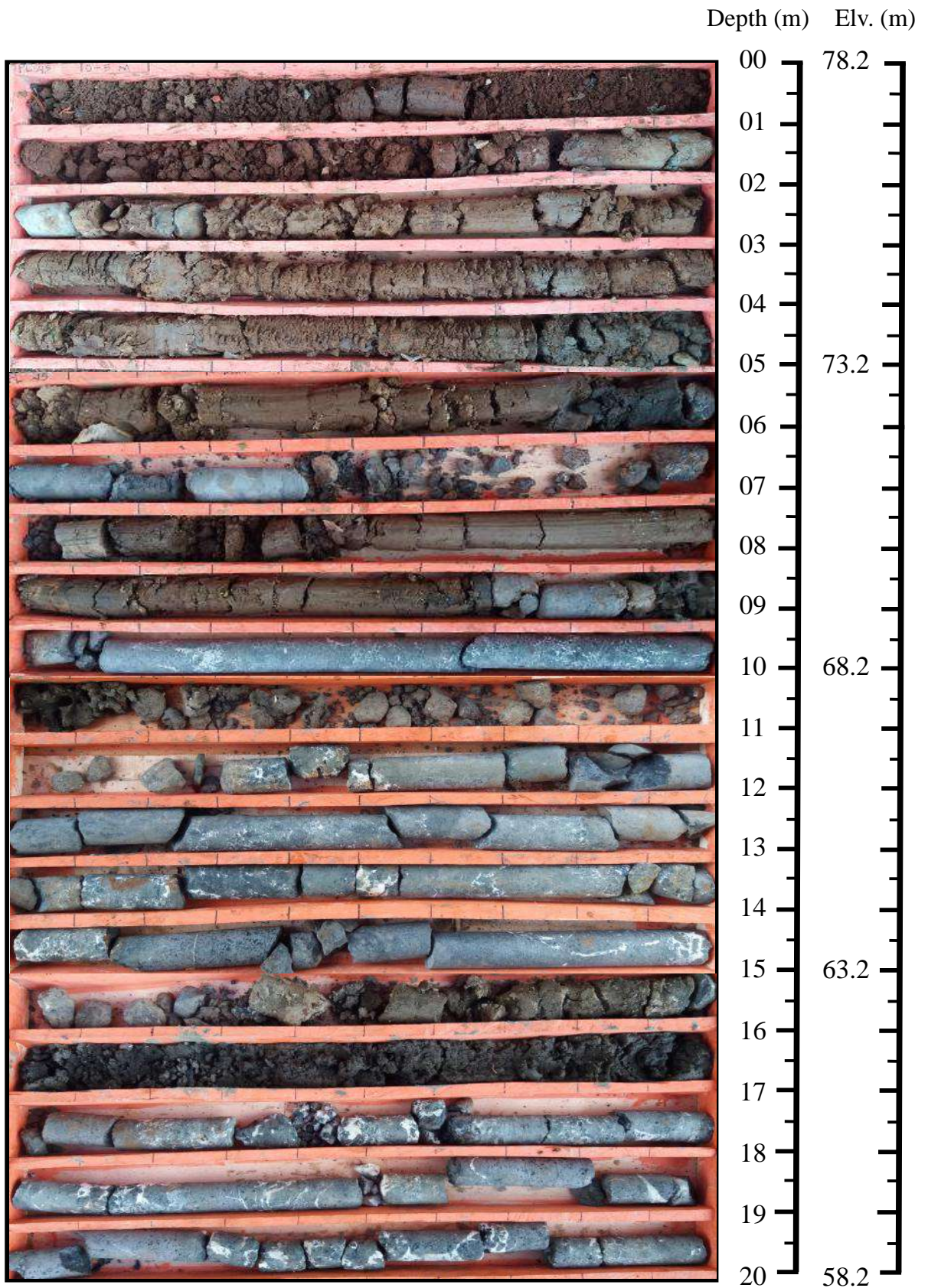


Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-26	Depth of Borehole	50 m
Location	Plinth	Depth of Rock Core	40 ~ 50 m
Date of Drilling	16 Mei – 30 Mei 2020	Total Rock Box	10


Depth (m) Elv. (m)

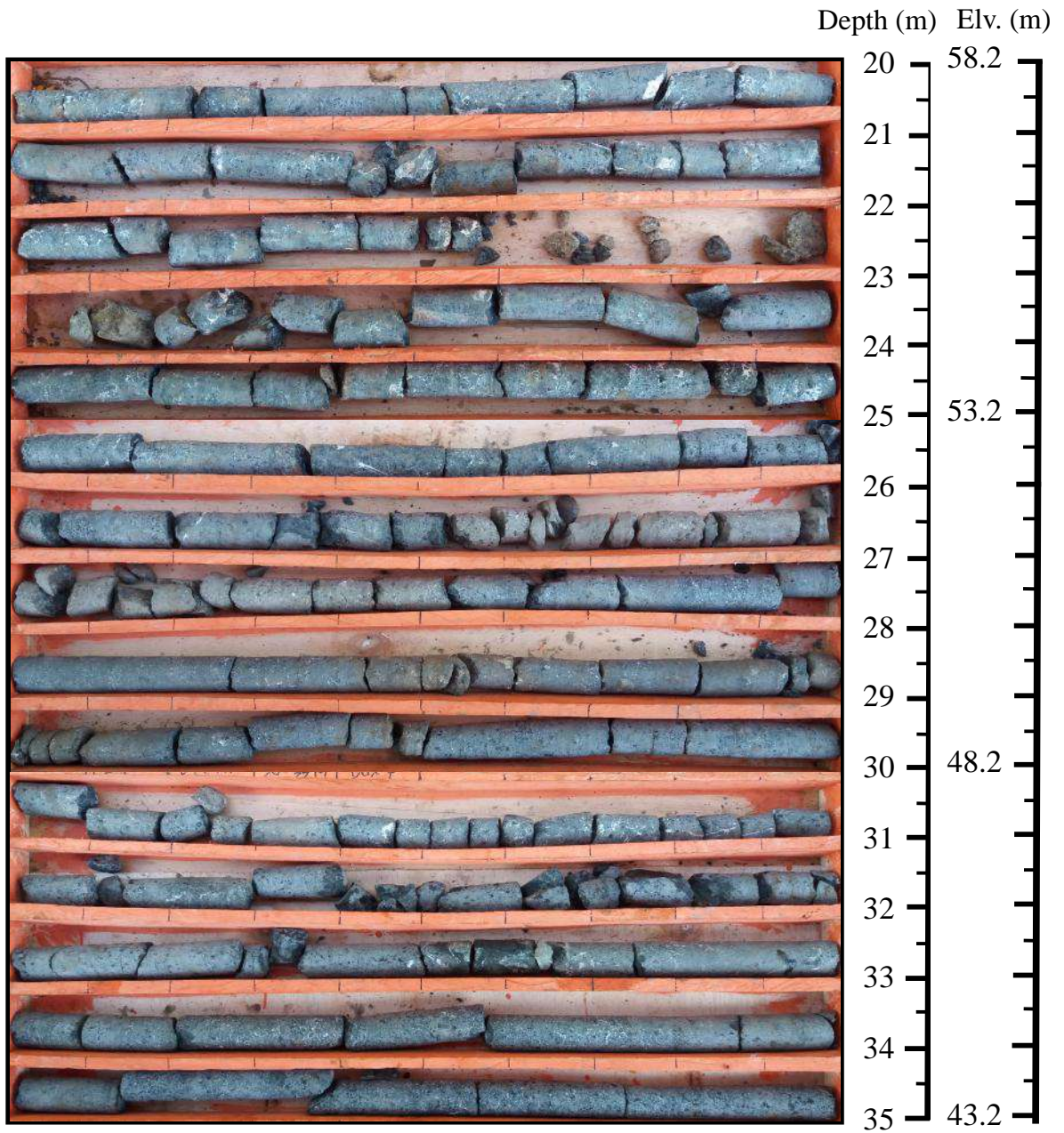



Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-46	Depth of Borehole	20 m
Location	Plinth	Depth of Rock Core	0 ~ 20 m
Date of Drilling	3 – 9 Juni 2020	Total Rock Box	4

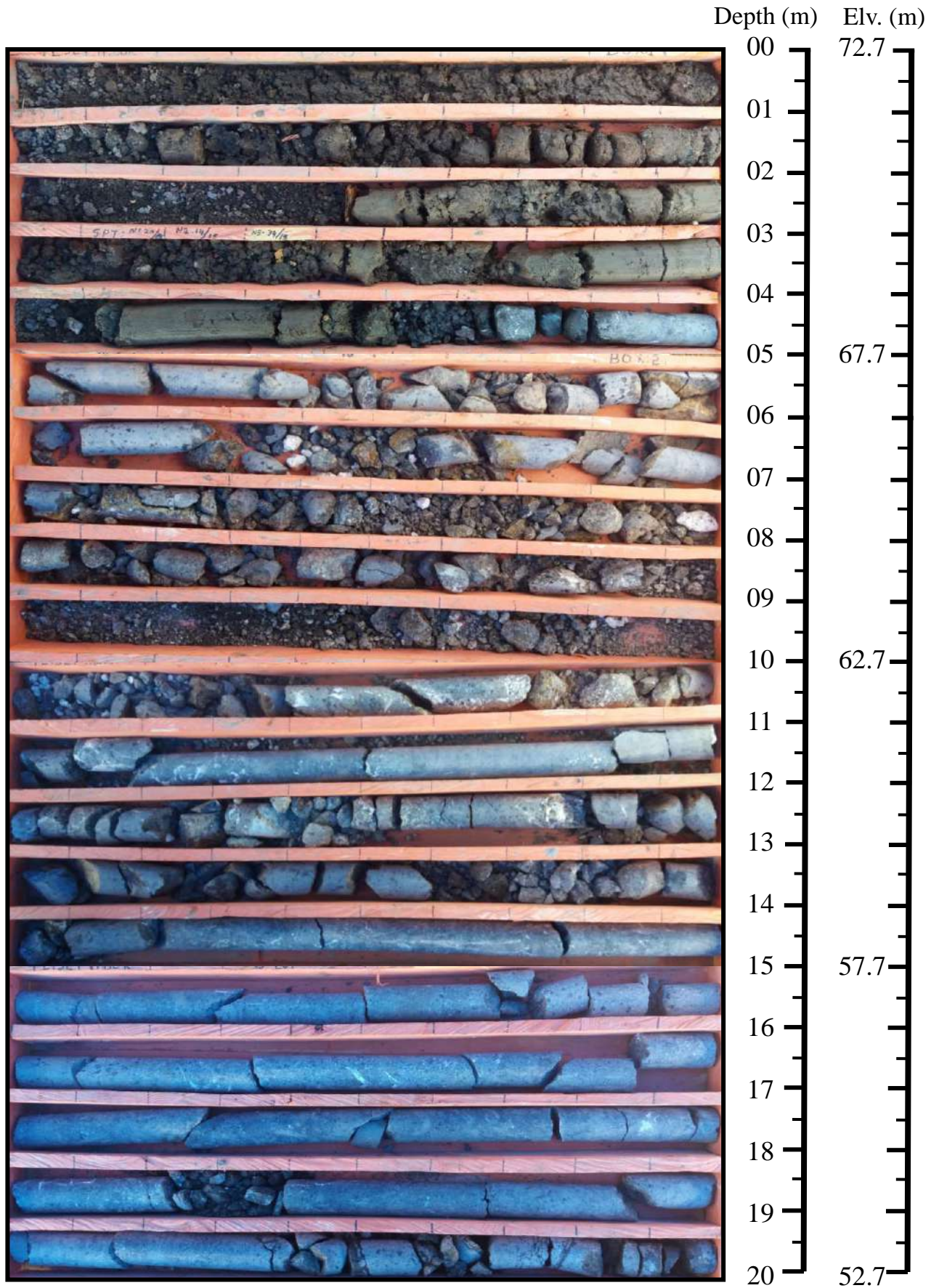





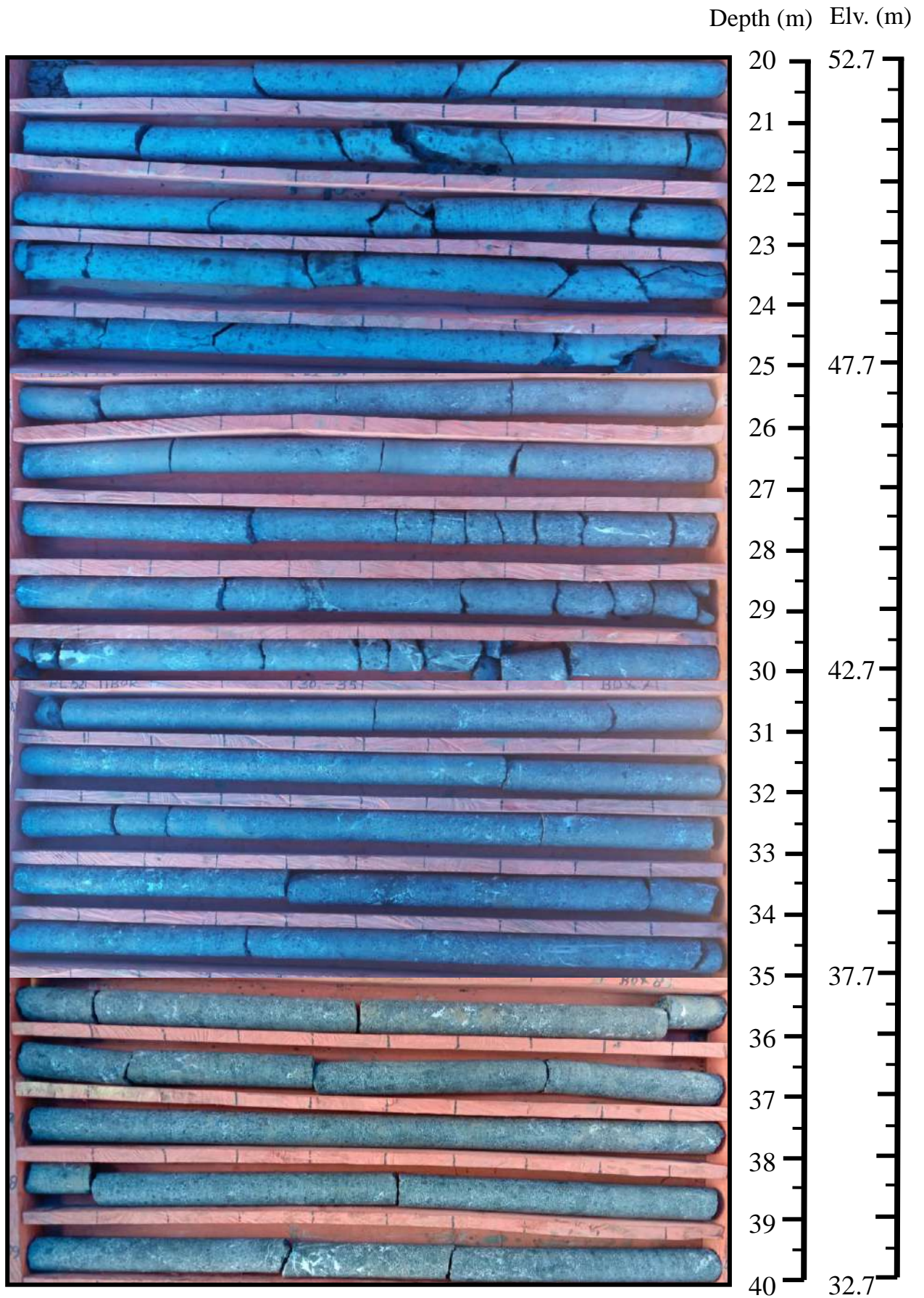
Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-45	Depth of Borehole	35 m
Location	Plinth	Depth of Rock Core	20 ~ 35 m
Date of Drilling	3 – 9 Juni 2020	Total Rock Box	7




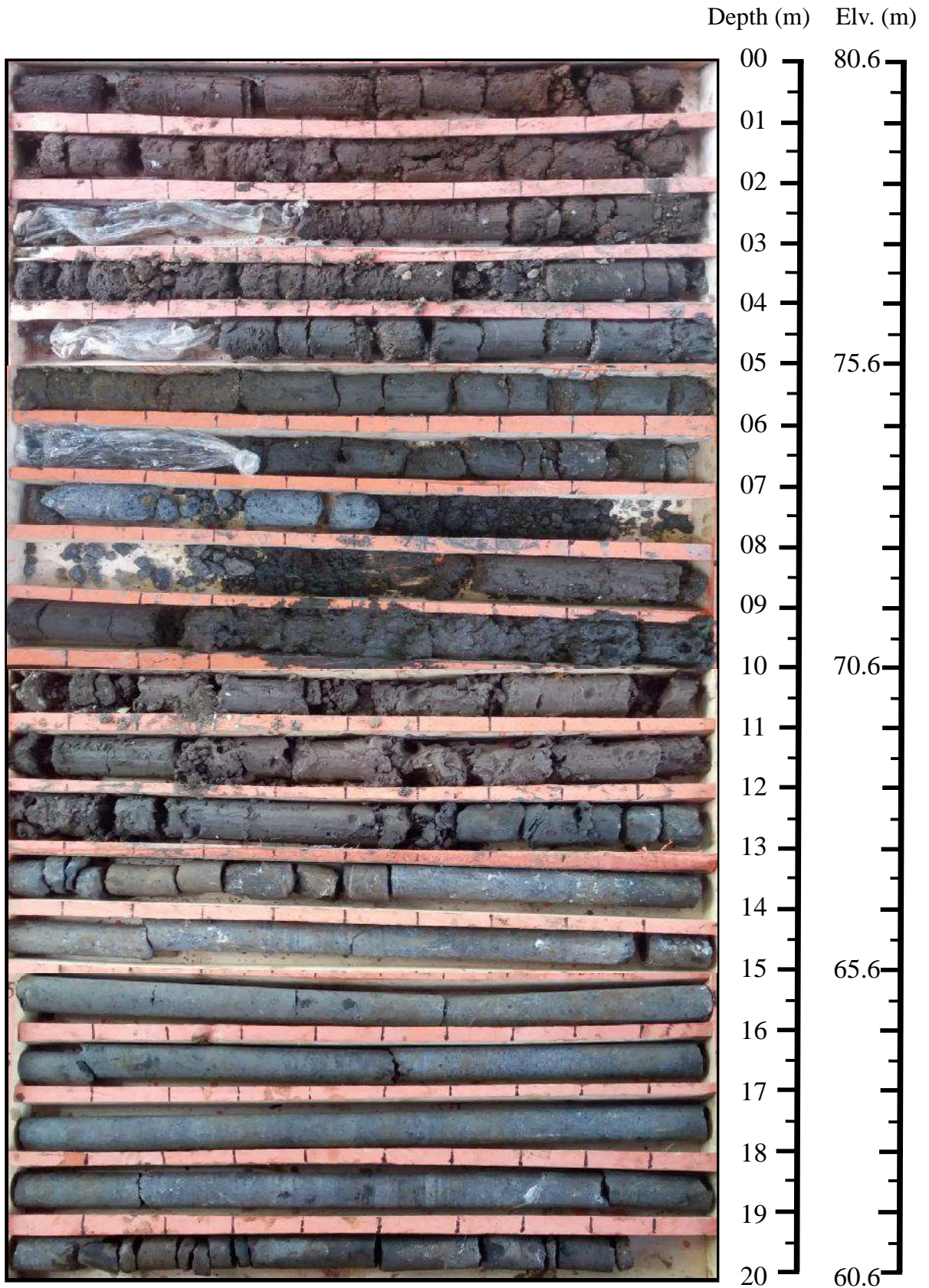
Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-52	Depth of Borehole	40 m
Location	Plinth	Depth of Rock Core	0 ~ 20 m
Date of Drilling	10 Sep – 19 Sept 2020	Total Rock Box	8




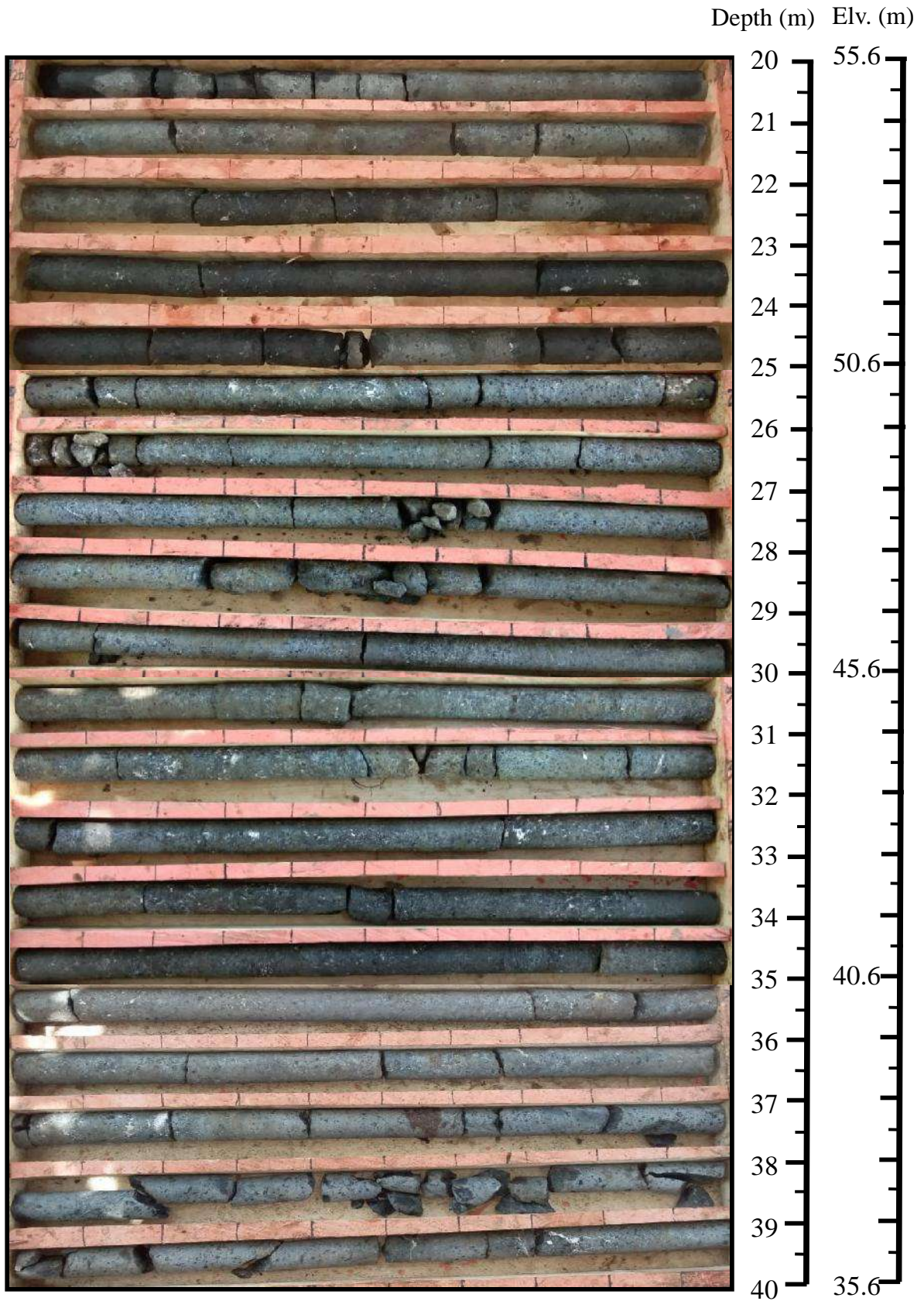
Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-52	Depth of Borehole	40 m
Location	Plinth	Depth of Rock Core	20 ~ 40 m
Date of Drilling	10 Sep – 19 Sept 2020	Total Rock Box	8




Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-60	Depth of Borehole	45 m
Location	Plinth	Depth of Rock Core	0 ~ 13 m
Date of Drilling	11 – 25 Maret 2020	Total Rock Box	8



Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-60	Depth of Borehole	45 m
Location	Plinth	Depth of Rock Core	20 ~ 40 m
Date of Drilling	11 – 25 Maret 2020	Total Rock Box	8



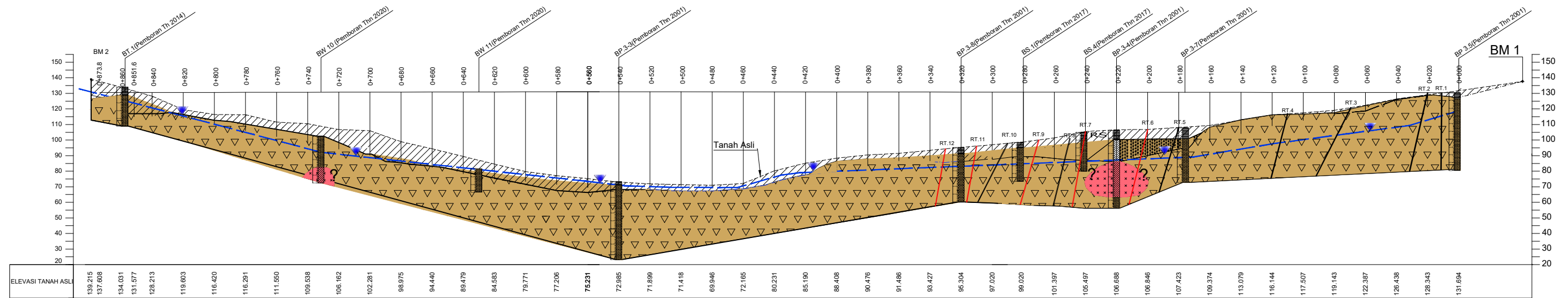
Project	Pamukkulu Dam _ Drilling Investigation		
Borehole No.	PL-60	Depth of Borehole	45 m
Location	Plinth	Depth of Rock Core	20 ~ 40 m
Date of Drilling	11 – 25 Maret 2020	Total Rock Box	8

Depth (m) Elv. (m)



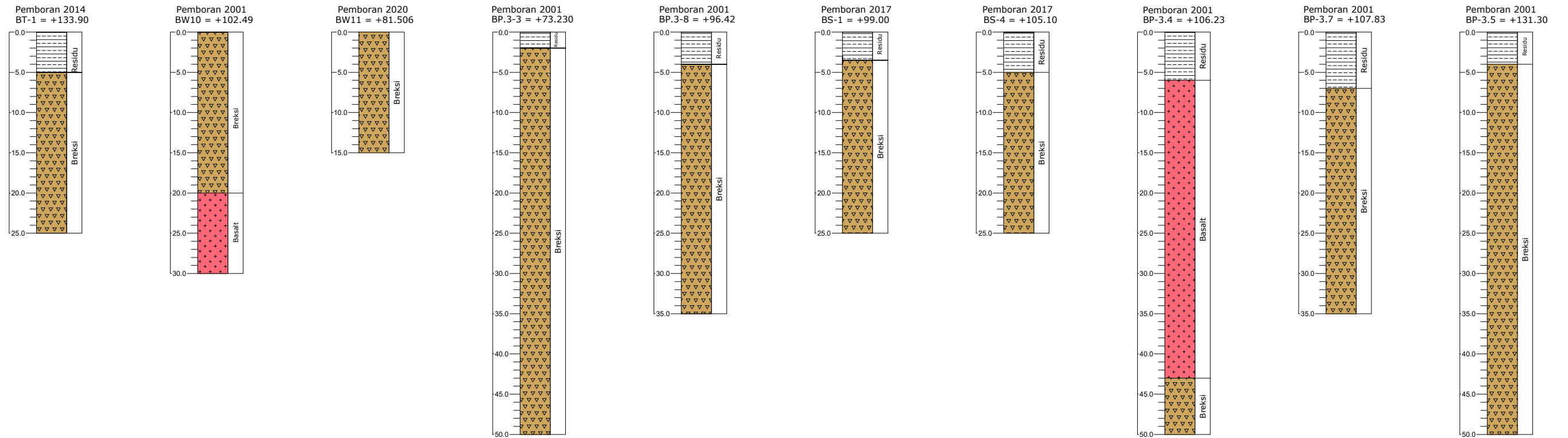
## PENAMPANG GEOLOGI AS DAM

### korelasi data bor th 2020 dan data bor perencanaan



## POTONGAN MEMANJANG AS DAM

Skala 1:3000



#### SUSUNAN BATUAN :

- Residual (Soil)**  
Lempung Lanauan dan Kerikilan - Kerakalan, Coklat kemerahan, Plastis, Gembur
- Breksi**  
Breksi Vulkanik Keras, Tufa Lapili, Lapuk sedang-segar, abu-abu bercak putih dan hitam
- Basalt**  
Segar, Hitam keabuan, Tekstur Faneritik, Mineral Piroksin, dan Olivin, Keras, Terkekarkan

**(MIOSEN AKHIR-SAMPAI PLIOSEN)**

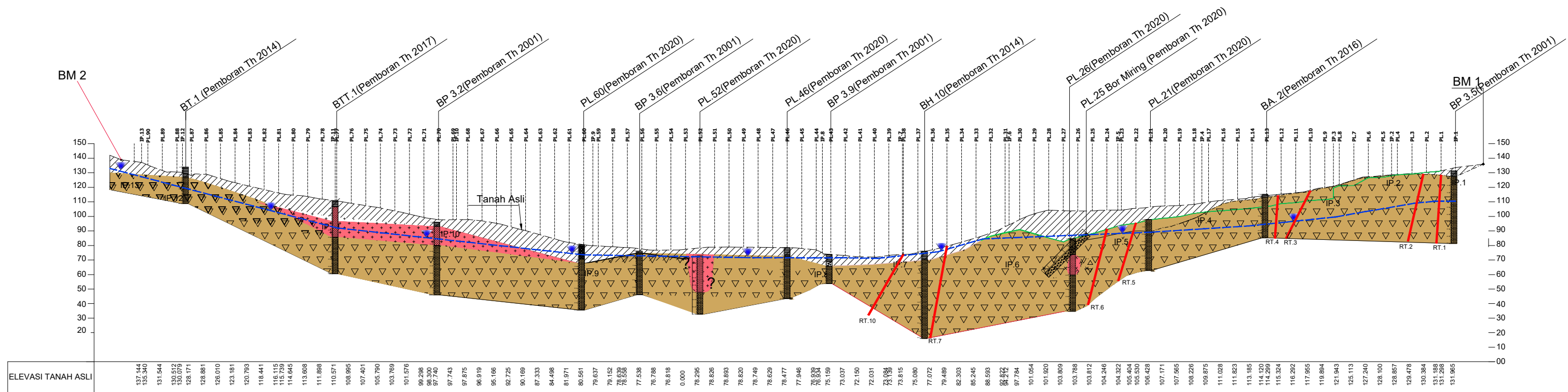
**(PLIOSEN)**

#### KETERANGAN SIMBOL

- Retas (*Dike*)
- Muka Air tanah

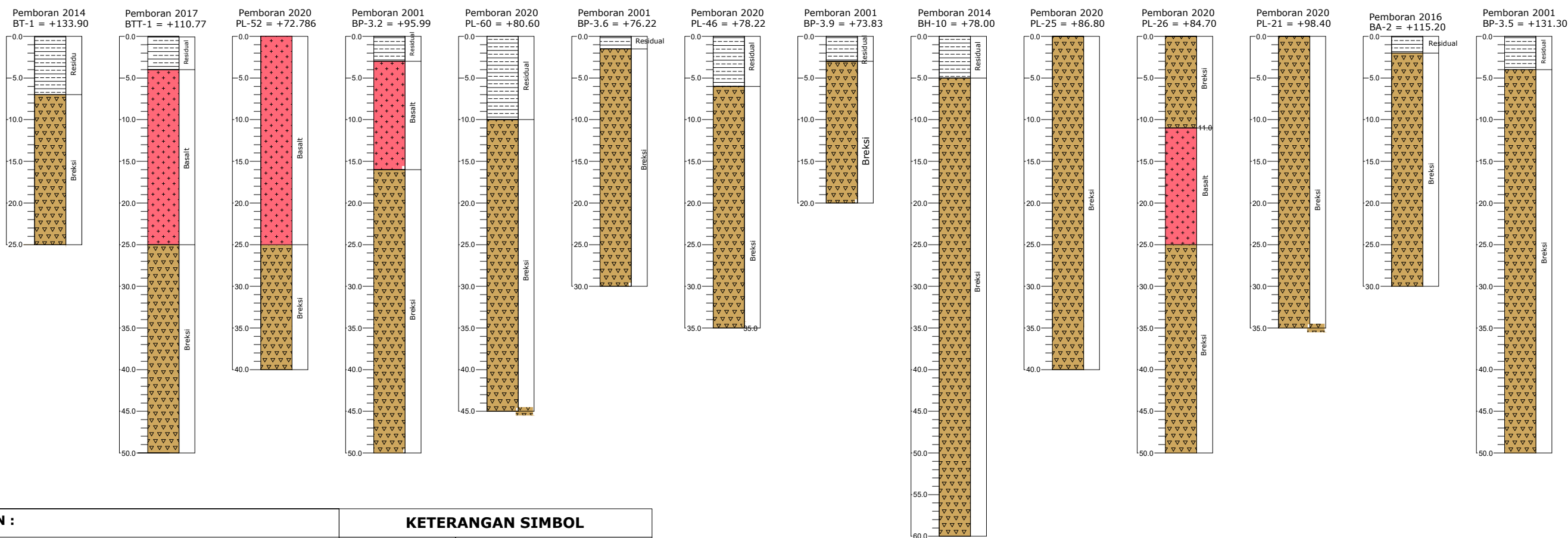
# PENAMPANG GEOLOGI AS PLINTH

## korelasi data bor th 2020 dan data bor perencanaan



### POTONGAN MEMANJANG AS PLINTH

Skala 1:3000



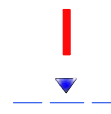
#### SUSUNAN BATUAN :

- Residual (Soil)**  
Lempung Lanauan dan Kerikilan - Kerakalan, Coklat kemerahan, Plastis, Gembur
- Breksi**  
Breksi Vulkanik Keras, Tufa Lapili, Lapuk sedang-segar, abu-abu bercak putih dan hitam
- Basalt**  
Segar, Hitam keabuan, Tekstur Faneritik, Mineral Piroksin, dan Olivin, Keras, Terkekarkan

#### KETERANGAN SIMBOL

**(MIOSEN AKHIR-SAMPAI PLIOSEN)**

**(PLIOSEN)**

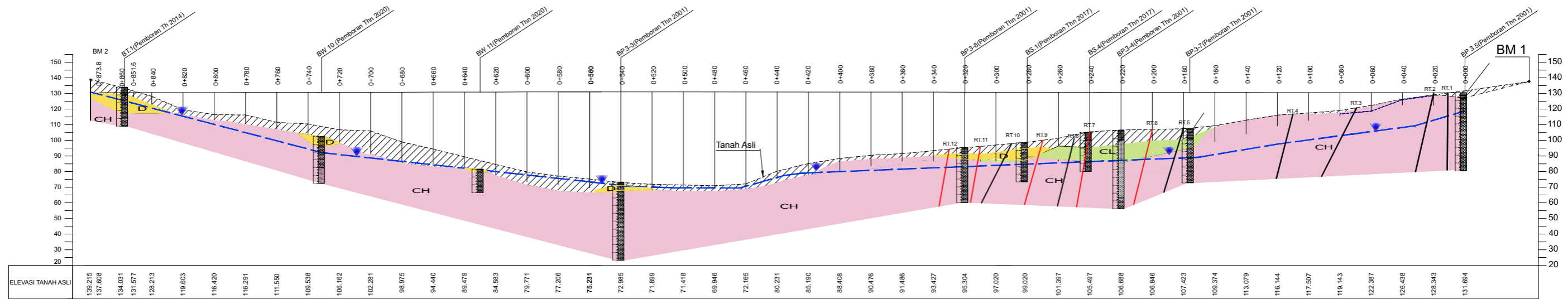


Retas (*Dike*)

Muka Air tanah

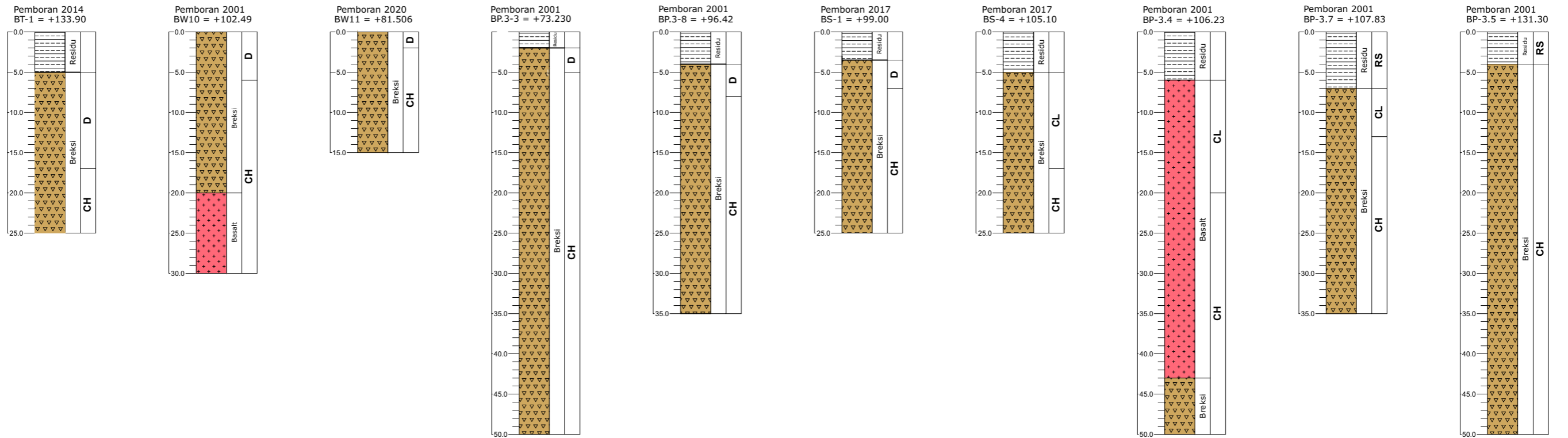


## PENAMPANG KELAS BATUAN AREA AS DAM korelasi data bor th 2020 dan data bor perencana



### POTONGAN MEMANJANG AS DAM

Skala 1:3000

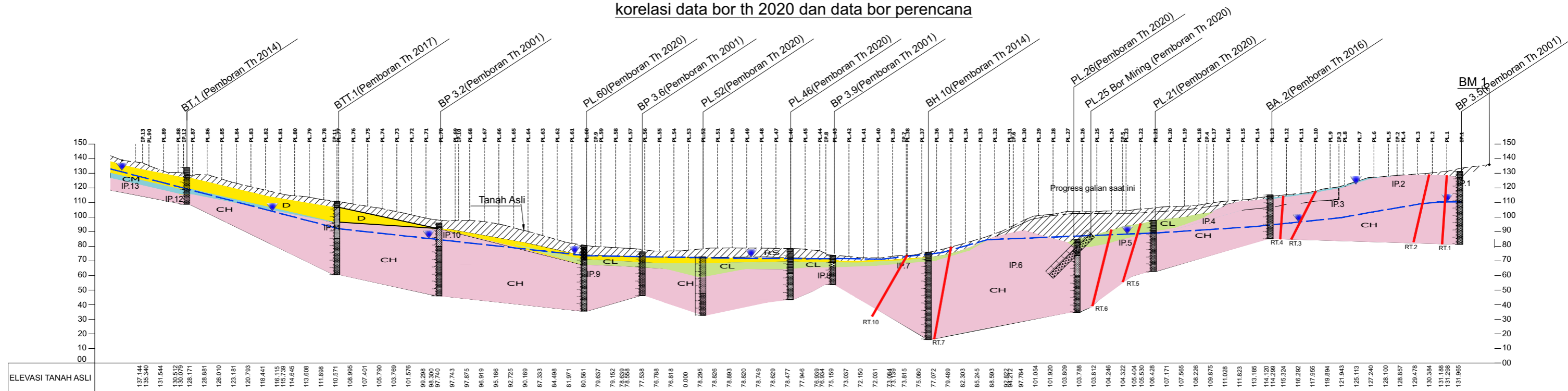


#### LEGENDA :

SUSUNAN BATUAN :	ROCK CLASSIFICATION :	KETERANGAN SIMBOL	
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><b>Residual (Soil)</b> Lempung Lanauan dan Kerikilan - Kerakalan, Coklat kemerahan, Plastis, Gembur</p> <p><b>Breksi</b> Breksi Vulkanik Keras, Tufa Lapili, Lapuk sedang-segar, abu-abu bercak putih dan hitam</p> <p><b>Basalt</b> Segar, Hitam keabuan, Tekstur Faneritik, Mineral Piroksin, dan Olivin, Keras, Terkekarkan</p> </div> <div style="width: 45%;"> <p><b>(MIOSEN AKHIR-SAMPAI PLIOSEN)</b></p> <p><b>(PLIOSEN)</b></p> </div> </div>	<p><b>D</b> Lapuk Sempurna (Deeply Weathered)</p> <p><b>CL</b> Lapuk Kuat (Highly Weathered)</p> <p><b>CM</b> Lapuk Sedang (Moderately Weathered)</p> <p><b>CH</b> Lapuk Ringan (Slightly Weathered)</p> <p><b>B</b> Segar (Fresh Rock)</p>		Retas (Dike)
			Muka Air tanah

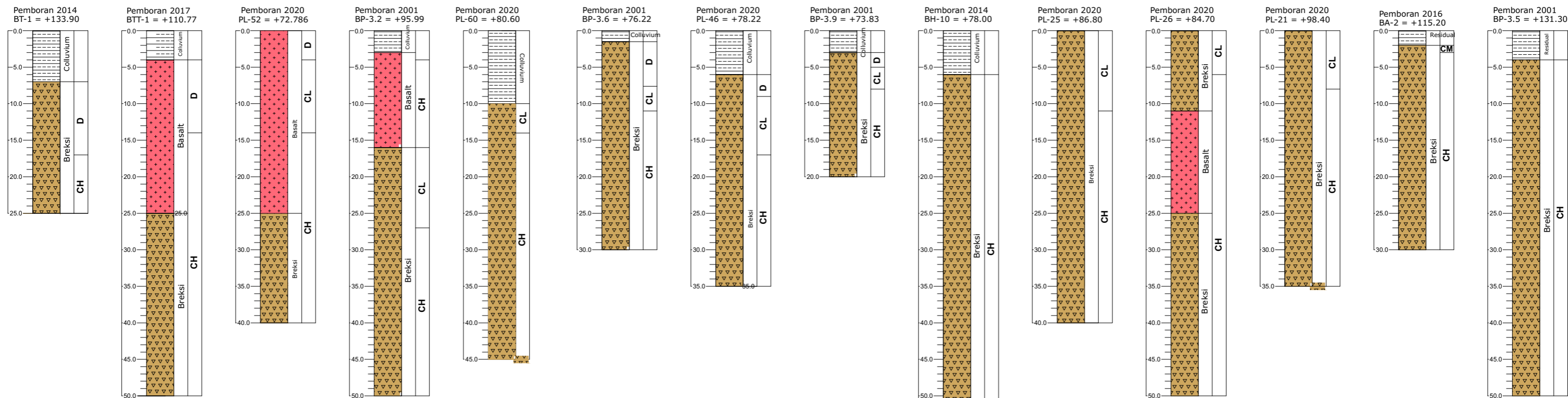
## PENAMPANG KELAS BATUAN AS PLINTH

### korelasi data bor th 2020 dan data bor perencana



### POTONGAN MEMANJANG AS PLINTH

Skala 1:3000



**LEGENDA :**

SUSUNAN BATUAN :	ROCK CLASSIFICATION :	KETERANGAN SIMBOL	
<div style="display: flex; align-items: flex-start;"> <div style="width: 20px; height: 20px; border: 1px solid black; background: repeating-linear-gradient(45deg, transparent, transparent 2px, black 2px, black 4px); margin-right: 5px;"></div> <div> <p><b>Residual (Soil)</b> Lempung Lanauan dan Kerikilan - Kerakalan, Coklat kemerahan, Plastis, Gembur</p> </div> </div>	<div style="display: flex; align-items: center;"> <div style="width: 20px; height: 20px; border: 1px solid black; border-radius: 50%; text-align: center; line-height: 20px; margin-right: 5px;">D</div> <div> <p>Lapuk Sempurna (Deeply Weathered)</p> </div> </div>	<div style="display: flex; flex-direction: column; align-items: center; gap: 10px;"> <div style="width: 10px; height: 10px; background-color: red; border: 1px solid black;"></div> <div style="width: 10px; height: 10px; background-color: yellow; border: 1px solid black;"></div> <div style="width: 10px; height: 10px; background-color: orange; border: 1px solid black;"></div> <div style="width: 10px; height: 10px; background-color: lightblue; border: 1px solid black;"></div> <div style="width: 10px; height: 10px; background-color: lightgreen; border: 1px solid black;"></div> </div>	<p>Retas (Dike)</p>
<div style="display: flex; align-items: flex-start;"> <div style="width: 20px; height: 20px; border: 1px solid black; background: repeating-linear-gradient(-45deg, transparent, transparent 2px, black 2px, black 4px); margin-right: 5px;"></div> <div> <p><b>Breksi</b> Breksi Vulkanik Keras, Tufa Lapili, Lapuk sedang-segar, abu-abu bercak putih dan hitam</p> </div> </div>	<div style="display: flex; align-items: center;"> <div style="width: 20px; height: 20px; border: 1px solid black; border-radius: 50%; text-align: center; line-height: 20px; margin-right: 5px;">CL</div> <div> <p>Lapuk Kuat (Highly Weathered)</p> </div> </div>		<p>Muka Air tanah</p>
<p style="text-align: center;"><b>(MIOSEN AKHIR-SAMPAI PLIOSEN)</b></p> <p style="text-align: center;"><b>(PLIOSEN)</b></p>	<div style="display: flex; align-items: center;"> <div style="width: 20px; height: 20px; border: 1px solid black; border-radius: 50%; text-align: center; line-height: 20px; margin-right: 5px;">CM</div> <div> <p>Lapuk Sedang (Moderately Weathered)</p> </div> </div>		<p>Muka Air tanah</p>
	<div style="display: flex; align-items: center;"> <div style="width: 20px; height: 20px; border: 1px solid black; border-radius: 50%; text-align: center; line-height: 20px; margin-right: 5px;">CH</div> <div> <p>Lapuk Ringan (Slightly Weathered)</p> </div> </div>		<p>Muka Air tanah</p>
	<div style="display: flex; align-items: center;"> <div style="width: 20px; height: 20px; border: 1px solid black; border-radius: 50%; text-align: center; line-height: 20px; margin-right: 5px;">B</div> <div> <p>Segar (Fresh Rock)</p> </div> </div>		<p>Muka Air tanah</p>



**LABORATORY OF GEOMECHANICS  
DEPARTEMENT OF MINING ENGINEERING  
FACULTY OF ENGINEERING  
HASANUDDIN UNIVERSITY, MAKASSAR**

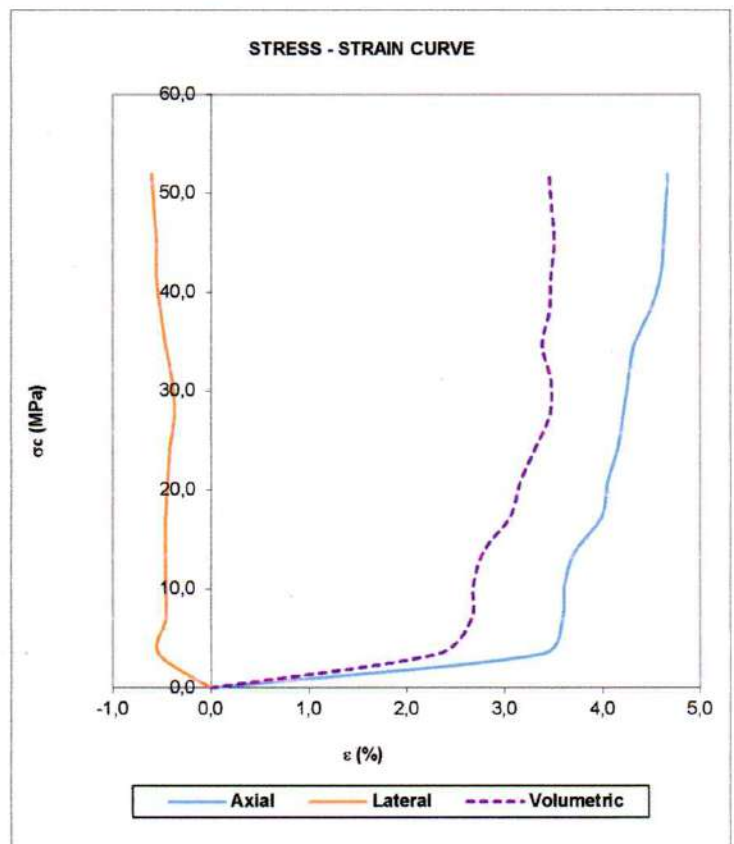
Kampus II Fakultas Teknik Jl. Poros Malino Km. 6 , Gowa 92171, Indonesia.



**UNCONFINED COMPRESSIVE STRENGTH TEST**

Customer : PT Wijaya Karya Tbk - PT DMT, KSO	Date of Received : 20-Nov-20
Made on behalf of : PT Wijaya Karya Tbk - PT DMT, KSO	Date of Test : 23-Nov-20
Address : Dusun Buttadidia, Kabupaten Takalar	Date of Analysis : 25-Nov-20
Project : Unconfined Compressive Strenght Test	Tested By : Safar dan Mulyawan
Sample Code : Breksi B	Prepared By : Safar
Depth (m) : -	Checked By : Nirmana
Lithology : Breksi	
Diameter : 42,88 mm	
Length : 91,49 mm	

No.	$\sigma_c$ (MPa)	$\epsilon$ Lateral (%)	$\epsilon$ Axial (%)	$\epsilon$ Volumetric (%)
1	0,00	0,000	0,000	0,000
2	3,46	-0,536	3,388	2,316
3	6,92	-0,466	3,585	2,652
4	10,38	-0,466	3,607	2,674
5	13,84	-0,466	3,716	2,784
6	17,30	-0,466	3,990	3,057
7	20,77	-0,443	4,044	3,158
8	24,23	-0,420	4,154	3,314
9	27,69	-0,373	4,208	3,462
10	31,15	-0,396	4,263	3,470
11	34,61	-0,466	4,318	3,385
12	38,07	-0,513	4,482	3,455
13	41,53	-0,560	4,591	3,471
14	44,99	-0,560	4,624	3,504
15	48,45	-0,583	4,645	3,479
16	51,91	-0,606	4,667	3,455



$\sigma_c$ (MPa)	51,91
E (MPa)	5106,95
$\nu$	0,21

$\sigma_c$  = Compressive Strength  
 $\epsilon$  = Strain  
 $\nu$  = Poisson's ratio

Approved by

Date : 25-Nov-20



**NIRMANA FIQRA QAIDAHYANI, S.T., M.T.**  
Secretary of Laboratory



**LABORATORY OF GEOMECHANICS  
DEPARTEMENT OF MINING ENGINEERING  
FACULTY OF ENGINEERING  
HASANUDDIN UNIVERSITY, MAKASSAR**

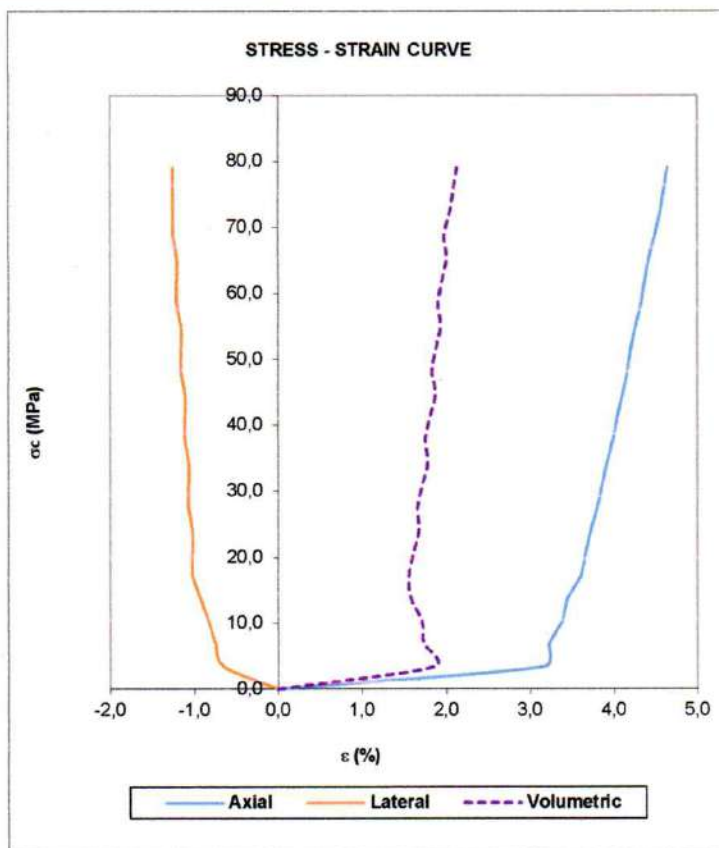
Kampus II Fakultas Teknik Jl. Poros Malino Km. 6 , Gowa 92171, Indonesia.



**UNCONFINED COMPRESSIVE STRENGTH TEST**

Customer : PT Wijaya Karya Tbk - PT DMT, KSO	Date of Received : 20-Nov-20
Made on behalf of : PT Wijaya Karya Tbk - PT DMT, KSO	Date of Test : 23-Nov-20
Address : Dusun Buttadidia, Kabupaten Takalar	Date of Analysis : 25-Nov-20
Project : Unconfined Compressive Strenght Test	Tested By : Safar dan Mulyawan
Sample Code : Basal	Prepared By : Safar
Depth (m) : -	Checked By : Nirmana
Lithology : Basal	
Diameter : 43,03 mm	
Length : 91,63 mm	

No.	$\sigma_c$ (MPa)	$\epsilon$ Lateral (%)	$\epsilon$ Axial (%)	$\epsilon$ Volumetric (%)
1	0,00	0,000	0,000	0,000
2	3,44	-0,651	3,165	1,864
3	6,87	-0,744	3,220	1,732
4	10,31	-0,837	3,383	1,710
5	13,75	-0,930	3,438	1,579
6	17,18	-1,023	3,602	1,556
7	20,62	-1,023	3,656	1,611
8	24,06	-1,023	3,722	1,677
9	27,49	-1,069	3,798	1,660
10	30,93	-1,069	3,853	1,715
11	34,37	-1,069	3,918	1,780
12	37,81	-1,116	3,984	1,753
13	41,24	-1,116	4,038	1,807
14	44,68	-1,116	4,104	1,873
15	48,12	-1,162	4,158	1,834
16	51,55	-1,162	4,202	1,878
17	54,99	-1,162	4,256	1,932
18	58,43	-1,208	4,322	1,905
19	61,86	-1,208	4,366	1,949
20	65,30	-1,208	4,420	2,003
21	68,74	-1,255	4,486	1,976
22	72,17	-1,255	4,551	2,041
23	75,61	-1,255	4,595	2,085
24	79,05	-1,255	4,638	2,129



$\sigma_c$ (MPa)	79,05
E (MPa)	5966,69
$\nu$	0,22

$\sigma_c$  = Compressive Strength  
 $\epsilon$  = Strain  
 $\nu$  = Poisson's ratio

Approved by

Date : 25-Nov-20



**NIRMANA FJORA QAIDAHYANI, S.T., M.T.**  
Secretary of Laboratory

### Lugeon Test (Stage 1)

<b>Hole Number</b> : <b>BW-10</b>	Depth Of Test : 10 15
Ground Water Level : 6.07 m	Length Of Sect : 5
Pressure Gauge Height : 0.62 m	Pipe length : 22
Diameter Of Hole : 0.073 m	Lithology : Breccia
Method of Test : Water Pres. Test	Date Of Tested : 23/9/2020
Packer Type : Pneumatic	Time from 09.51 to 10.48

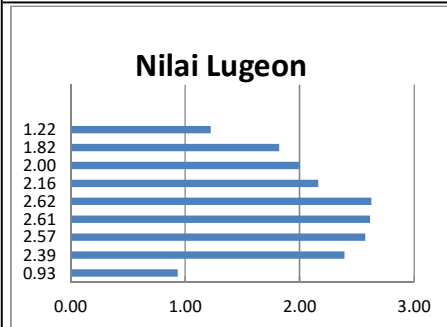
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	830.4	849.2	887.8	942.2	992.6	47.7	89.5	119.5	136.4
	1	831.0	853.6	895.2	951.1	1003.0	55.0	95.1	122.3	137.2
	2	831.8	858.0	902.4	960.0	1013.1	62.3	100.8	125.9	138.2
	3	832.6	862.4	909.6	968.5	1023.4	69.5	106.5	129.3	139.3
	4	833.5	866.7	916.9	977.3	1033.0	76.7	112.1	132.8	140.4
	5	834.3	871.1	924.2	985.7	1042.8	83.7	117.8	136.2	141.5
Total Volume (liter)		3.90	21.90	36.40	43.50	50.20	36	28.3	16.7	5.1
Average	liter/min	0.78	4.38	7.28	8.7	10.04	7.2	5.66	3.34	1.02
Volume	liter/min/m	0.16	0.88	1.46	1.74	2.01	1.44	1.13	0.67	0.20
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.67	3.67	5.66	6.66	7.65	6.66	5.66	3.67	1.67
Koef. Permb (cm/sec)		5.30E-06	1.35E-05	1.46E-05	1.48E-05	1.49E-05	1.23E-05	1.13E-05	1.03E-05	6.93E-06
Lugeon Unit		0.93	2.39	2.57	2.61	2.62	2.16	2.00	1.82	1.22

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 5.30E-06 cm/sec**  
**Lugeon = 0.93 Lu**

### Lugeon Test (Stage 2)

<b>Hole Number</b> : <b>BW-10</b>	Depth Of Test : 15 20
Ground Water Level : 13.6 m	Length Of Sect : 5
Pressure Gauge Height : 0.66 m	Pipe length : 27
Diameter Of Hole : 0.073 m	Lithology : Breccia
Method of Test : Water Pres. Test	Date Of Tested : 24/9/2020
Packer Type : Pneumatic	Time from 08.53 to 09.53

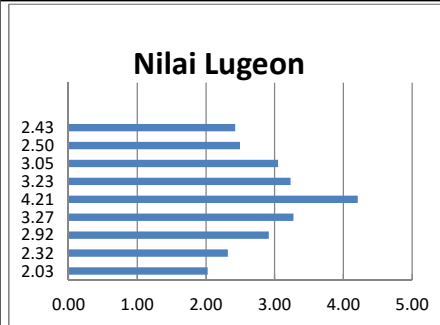
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	172.2	199.3	233.3	299.4	381.9	480.5	554.0	621.8	652.5
	1	174.7	204.6	242.7	312.3	399.6	492.2	562.5	627.3	655.3
	2	177.3	209.7	252.4	323.7	417.1	504.2	572.5	632.8	658.3
	3	179.7	214.9	261.5	335.4	434.8	516.4	582.6	638.4	661.3
	4	182.1	219.9	270.7	347.5	452.2	528.3	592.7	643.9	664.2
	5	184.5	224.9	280.0	359.9	469.9	540.3	602.8	649.4	667.2
Total Volume (liter)		12.30	25.60	46.70	60.50	88.00	59.8	48.8	27.6	14.7
Average Volume	liter/min	2.46	5.12	9.34	12.1	17.6	11.96	9.76	5.52	2.94
	liter/min/m	0.49	1.02	1.87	2.42	3.52	2.39	1.95	1.10	0.59
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.01	0.02	0.03	0.07	0.03	0.02	0.01	0.00
Effective Press. (kgf/cm <sup>2</sup> )		2.42	4.42	6.41	7.39	8.36	7.40	6.41	4.42	2.42
Koef. Permb (cm/sec)		1.15E-05	1.31E-05	1.65E-05	1.85E-05	2.39E-05	1.83E-05	1.73E-05	1.42E-05	1.37E-05
Lugeon Unit		2.03	2.32	2.92	3.27	4.21	3.23	3.05	2.50	2.43

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 1.15E-05 cm/sec**  
**Lugeon = 2.03 Lu**

### Lugeon Test (Stage 3)

<b>Hole Number</b> : <b>BW-10</b>	Depth Of Test : 20 25
Ground Water Level : 10.2 m	Length Of Sect : 5
Pressure Gauge Height : 0.66 m	Pipe length : 32
Diameter Of Hole : 0.073 m	Lithology : Basalt
Method of Test : Water Pres. Test	Date Of Tested : 25/9/2020
Packer Type : Pneumatic	Time from 08.49 to 09.42

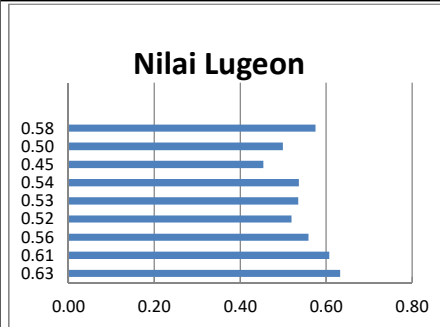
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	677.2	684.7	693.6	705.1	722.5	803.9	814.9	822.4	827.6
	1	677.9	686.1	695.3	706.9	724.7	805.6	816.3	823.4	828.2
	2	678.6	687.3	697.0	708.8	726.8	807.4	817.7	824.5	828.8
	3	679.3	688.5	698.6	710.8	728.9	809.3	819.1	825.5	829.4
	4	679.9	689.7	700.4	712.6	731.2	811.3	820.4	826.5	830.0
	5	680.5	690.9	702.1	714.3	733.3	813.4	821.8	827.5	830.6
Total Volume (liter)		3.30	6.20	8.50	9.20	10.80	9.5	6.9	5.1	3
Average	liter/min	0.66	1.24	1.7	1.84	2.16	1.9	1.38	1.02	0.6
Volume	liter/min/m	0.13	0.25	0.34	0.37	0.43	0.38	0.28	0.20	0.12
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		2.09	4.09	6.09	7.09	8.08	7.09	6.09	4.09	2.09
Koef. Permb (cm/sec)		3.59E-06	3.44E-06	3.17E-06	2.94E-06	3.03E-06	3.04E-06	2.57E-06	2.83E-06	3.26E-06
Lugeon Unit		0.63	0.61	0.56	0.52	0.53	0.54	0.45	0.50	0.58

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 3.10E-06 cm/sec**  
**Lugeon = 0.55 Lu**

### Lugeon Test (Stage 4)

<b>Hole Number : BW-10</b>		Depth Of Test : 25 30
Ground Water Level : 12.11 m		Length Of Sect : 5
Pressure Gauge Height : 0.66 m		Pipe length : 37
Diameter Of Hole : 0.073 m		Lithology : Basalt
Method of Test : Water Pres. Test		Date Of Tested : 27/9/2020
Packer Type : Pneumatic		Time from 09.38 to 10.39

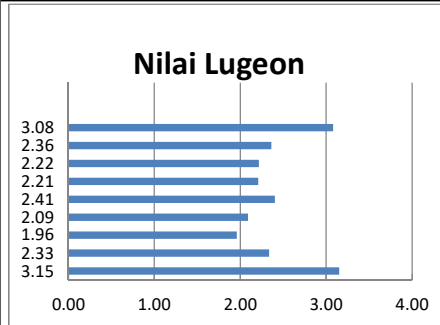
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	864.7	889.8	922.0	1001.3	1058.2	1112.9	1158.4	1198.1	1225.7
	1	868.4	895.1	928.4	1008.9	1068.9	1120.9	1165.5	1203.2	1229.2
	2	872.2	900.1	934.6	1016.6	1079.2	1129.0	1172.5	1208.3	1232.5
	3	875.7	905.1	940.7	1024.1	1089.3	1137.1	1179.4	1213.4	1235.8
	4	879.3	909.9	946.7	1031.8	1098.6	1145.2	1186.2	1218.3	1239.1
	5	882.6	914.7	952.7	1039.2	1107.8	1153.0	1193.1	1223.3	1243.2
Total Volume (liter)		17.90	24.90	30.70	37.90	49.60	40.1	34.7	25.2	17.5
Average	liter/min	3.58	4.98	6.14	7.58	9.92	8.02	6.94	5.04	3.5
Volume	liter/min/m	0.72	1.00	1.23	1.52	1.98	1.60	1.39	1.01	0.70
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.01	0.01	0.02	0.03	0.02	0.01	0.01	0.00
Effective Press. (kgf/cm <sup>2</sup> )		2.27	4.27	6.27	7.26	8.25	7.26	6.26	4.27	2.27
Koef. Permb (cm/sec)		1.79E-05	1.32E-05	1.11E-05	1.18E-05	1.36E-05	1.25E-05	1.26E-05	1.34E-05	1.75E-05
Lugeon Unit		3.15	2.33	1.96	2.09	2.41	2.21	2.22	2.36	3.08

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 1.37E-05 cm/sec**  
**Lugeon = 2.42 Lu**



### Lugeon Test (Stage 1)

<b>Hole Number</b> : BW-11	Depth Of Test : 5 10
Ground Water Level : 3.45 m	Length Of Sect : 5
Pressure Gauge Height : 0.55 m	Pipe length : 18
Diameter Of Hole : 0.073 m	Lithology : Breccia
Method of Test : Water Pres. Test	Date Of Tested : 30/9/2020
Packer Type : Pneumatic	Time from 10.09 to 11.01

Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	286.7	299.6	316.3	339.9	364.0	390.6	415.1	434.2	446.7
	1	288.4	302.4	320.0	344.2	368.8	395.0	418.8	436.7	447.8
	2	290.0	305.1	323.5	348.2	373.5	399.2	422.4	439.2	449.0
	3	291.6	307.7	327.0	352.2	378.2	403.5	425.9	441.6	450.3
	4	293.3	310.3	330.5	356.2	382.9	407.7	429.5	444.2	451.6
	5	294.9	312.8	333.9	360.1	387.5	411.9	433.0	446.7	453.0
Total Volume (liter)		8.20	13.20	17.60	20.20	23.50	21.3	17.9	12.5	6.3
Average	liter/min	1.64	2.64	3.52	4.04	4.7	4.26	3.58	2.5	1.26
Volume	liter/min/m	0.33	0.53	0.70	0.81	0.94	0.85	0.72	0.50	0.25
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.40	3.40	5.40	6.40	7.40	6.40	5.40	3.40	1.40
Koef. Permb (cm/sec)		1.33E-05	8.80E-06	7.39E-06	7.16E-06	7.20E-06	7.55E-06	7.52E-06	8.34E-06	1.02E-05
Lugeon Unit		2.34	1.55	1.30	1.26	1.27	1.33	1.33	1.47	1.80

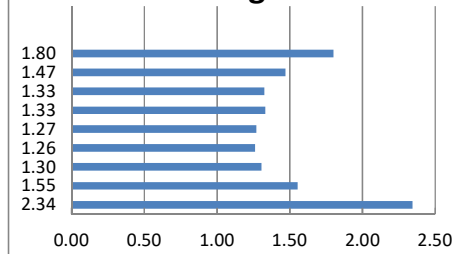
7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

### Nilai Lugeon



**k = 7.20E-06 cm/sec**  
**Lugeon = 1.27 Lu**

### Lugeon Test (Stage 2)

<b>Hole Number</b> : <b>BW-11</b>	Depth Of Test : 10 15
Ground Water Level : 7.52 m	Length Of Sect : 5
Pressure Gauge Height : 0.66 m	Pipe length : 22
Diameter Of Hole : 0.073 m	Lithology : Breccia
Method of Test : Water Pres. Test	Date Of Tested : 1/10/2020
Packer Type : Pneumatic	Time from 08.36 to 09.29

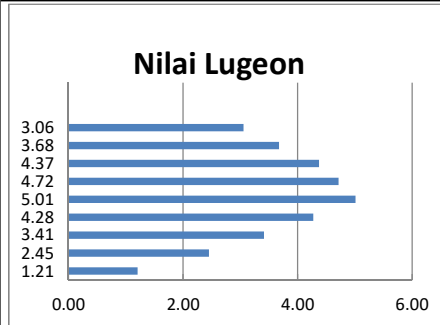
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	468.7	482.7	516.6	578.9	670.1	776.7	871.9	939.2	977.0
	1	469.5	487.4	526.8	592.7	689.5	792.6	883.7	945.7	979.5
	2	470.5	492.7	536.7	607.6	709.3	808.7	896.1	952.7	982.3
	3	471.7	497.2	546.5	622.2	728.5	824.8	909.5	959.9	985.1
	4	472.9	501.7	556.3	636.9	748.1	840.8	922.5	967.1	988.0
	5	474.2	506.1	566.1	651.4	767.2	856.6	935.2	974.2	990.9
Total Volume (liter)		5.50	23.40	49.50	72.50	97.10	79.9	63.3	35	13.9
Average Volume	liter/min	1.1	4.68	9.9	14.5	19.42	15.98	12.66	7	2.78
	liter/min/m	0.22	0.94	1.98	2.90	3.88	3.20	2.53	1.40	0.56
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.02	0.04	0.07	0.05	0.03	0.01	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.82	3.81	5.80	6.78	7.75	6.77	5.79	3.81	1.82
Koef. Permb (cm/sec)		6.86E-06	1.39E-05	1.93E-05	2.42E-05	2.84E-05	2.67E-05	2.48E-05	2.08E-05	1.73E-05
Lugeon Unit		1.21	2.45	3.41	4.28	5.01	4.72	4.37	3.68	3.06

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 6.86E-06 cm/sec**  
**Lugeon = 1.21 Lu**

### Lugeon Test (Stage 1)

<b>Hole Number : PL 21</b>		Depth Of Test :	8 - 13
Ground Water Level :	1.15 m	Length Of Sect :	5
Pressure Gauge Height :	0.44 m	Pipe length :	16
Diameter Of Hole :	0.073 m	Lithology :	Breccia
Method Of Test :	Water Pres. Test	Date Of Tested :	2/26/2020
Packer Type :	Mekanik	Time from :	to

Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		0.5	1	2	3	4	3	2	1	0.5
Time (min)	0	322.70	403.50	631.53	403.20	7848.75	353.85	725.60	8995.69	96.25
	1	329.80	437.95	681.16	476.40	7933.50	420.90	775.85	9009.68	98.50
	2	337.15	467.05	731.40	544.05	8016.60	486.00	824.30	9024.90	100.10
	3	346.73	498.65	779.40	615.20	8100.65	553.95	873.45	9041.85	101.75
	4	353.30	527.10	826.37	686.60	8184.15	620.95	922.60	9060.45	103.70
	5	360.70	555.83	873.90	753.35	8269.70	687.95	971.00	9081.67	107.35
Total Volume (liter)		38.00	152.33	242.37	350.15	420.95	334.10	245.40	85.98	11.10
Average Volume	liter/min	7.6	30.466	48.474	70.03	84.19	66.82	49.08	17.196	2.22
	liter/min/m	1.52	6.09	9.69	14.01	16.84	13.36	9.82	3.44	0.44
Friction Loss (kgf/cm <sup>2</sup> )		0.01	0.12	0.30	0.63	0.91	0.58	0.31	0.04	0.00
Effective Press. (kgf/cm <sup>2</sup> )		0.65	1.04	1.86	2.53	3.25	2.58	1.85	1.12	0.66
Koef. Permb (cm/sec)		1.32E-04	3.32E-04	2.96E-04	3.14E-04	2.94E-04	2.93E-04	3.01E-04	1.74E-04	3.82E-05
Lugeon Unit		23.33	58.62	52.23	55.43	51.88	51.73	53.10	30.68	6.74

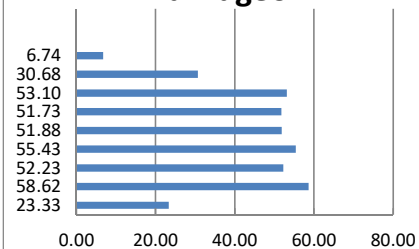
7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2));$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

### Nilai Lugeon



**k = 3.82E-05 cm/sec**  
**Lugeon = 6.74 Lu**

### Lugeon Test (Stage 2)

<b>Hole Number : PL 21</b>		Depth Of Test :	13 - 18
Ground Water Level :	1.25 m	Length Of Sect :	5
Pressure Gauge Height :	0.45 m	Pipe length :	22
Diameter Of Hole :	0.073 m	Lithology :	Breccia
Method Of Test :	Water Pres. Test	Date Of Tested :	3/3/2020
Packer Type :	Pneumatic	Time from :	13:00 - 13:55

Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		0.5	1	2	3	3.5	3	2	1	0.5
Time (min)	0	652.20	667.50	704.10	38.40	454.40	822.60	149.40	382.30	486.20
	1	655.10	673.10	746.40	105.60	523.90	882.90	193.00	403.90	489.70
	2	658.80	678.50	789.10	172.90	590.30	942.70	238.70	422.30	492.50
	3	660.60	684.20	831.30	240.00	657.40	1001.60	282.40	441.10	495.50
	4	663.25	690.90	873.50	306.00	723.60	1062.90	326.50	462.80	499.80
	5	666.90	695.40	916.10	372.90	789.80	1123.10	369.30	481.50	502.80
Total Volume (liter)		14.7	27.9	212	334.5	335.4	300.5	219.9	99.2	16.6
Average Volume	liter/min	2.94	5.58	42.4	66.9	67.08	60.1	43.98	19.84	3.32
	liter/min/m	0.59	1.12	8.48	13.38	13.42	12.02	8.80	3.97	0.66
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.01	0.31	0.77	0.77	0.62	0.33	0.07	0.00
Effective Press. (kgf/cm <sup>2</sup> )		0.67	1.16	1.86	2.40	2.90	2.55	1.84	1.10	0.67
Koeff. Permb (cm/sec)		4.99E-05	5.43E-05	2.58E-04	3.16E-04	2.62E-04	2.67E-04	2.71E-04	2.04E-04	5.63E-05
Lugeon Unit		8.80	9.58	45.54	55.68	46.28	47.12	47.84	35.99	9.94

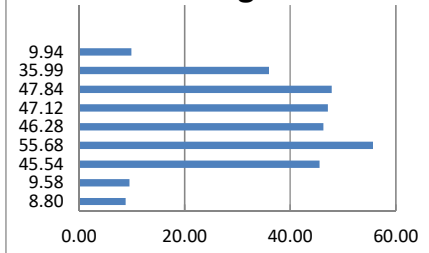
7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2));$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

### Nilai Lugeon



**k = 4.99E-05 cm/sec**  
**Lugeon = 8.80 Lu**

### Lugeon Test (Stage 3)

<b>Hole Number : PL 21</b>		Depth Of Test :	18 - 20
Ground Water Level :	1.25 m	Length Of Sect :	2
Pressure Gauge Height :	0.45 m	Pipe length :	26
Diameter Of Hole :	0.073 m	Lithology :	Breccia
Method Of Test :	Water Pres. Test	Date Of Tested :	3/3/2020
Packer Type :	Pneumatic	Time from :	13:00 - 13:55

Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		0.5	1	2	3	3.5	3	2	1	0.5
Time (min)	0	652.20	667.50	704.10	38.40	454.40	822.60	149.40	382.30	486.20
	1	655.10	673.10	746.40	105.60	523.90	882.90	193.00	403.90	489.70
	2	658.80	678.50	789.10	172.90	590.30	942.70	238.70	422.30	492.50
	3	660.60	684.20	831.30	240.00	657.40	1001.60	282.40	441.10	495.50
	4	663.25	690.90	873.50	306.00	723.60	1062.90	326.50	462.80	499.80
	5	666.90	695.40	916.10	372.90	789.80	1123.10	369.30	481.50	502.80
Total Volume (liter)		14.7	27.9	212	334.5	335.4	300.5	219.9	99.2	16.6
Average Volume	liter/min	2.94	5.58	42.4	66.9	67.08	60.1	43.98	19.84	3.32
	liter/min/m	1.47	2.79	21.20	33.45	33.54	30.05	21.99	9.92	1.66
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.01	0.36	0.90	0.91	0.73	0.39	0.08	0.00
Effective Press. (kgf/cm <sup>2</sup> )		0.67	1.16	1.81	2.27	2.76	2.44	1.78	1.09	0.67
Koeff. Permb (cm/sec)		1.01E-04	1.11E-04	5.41E-04	6.80E-04	5.60E-04	5.67E-04	5.70E-04	4.19E-04	1.15E-04
Lugeon Unit		22.00	23.97	117.26	147.43	121.35	123.02	123.50	90.95	24.86

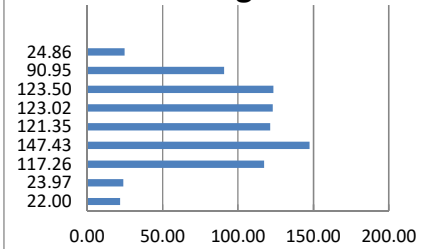
7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2));$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

### Nilai Lugeon



**k = 1.11E-04 cm/sec**  
**Lugeon = 22.00 Lu**

### Lugeon Test (Stage 4)

<b>Hole Number : PL 21</b>		Depth Of Test :	20 - 25
Ground Water Level :	1.32 m	Length Of Sect :	5
Pressure Gauge Height :	0.3 m	Pipe length :	28
Diameter Of Hole :	0.073 m	Lithology :	Breccia
Method Of Test :	Water Pres. Test	Date Of Tested :	3/5/2020
Packer Type :	Pneumatic	Time from :	13:00 - 13:55

Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	4.5	4	3	2	1
Time (min)	0	941.75	968.10	27.20	84.70	251.60	449.00	588.30	626.40	669.80
	1	945.80	975.90	38.00	110.00	285.20	474.70	594.30	635.70	679.40
	2	950.40	977.20	45.90	142.80	320.50	501.70	600.30	641.20	686.00
	3	954.60	979.30	51.20	174.30	357.40	528.70	606.40	646.10	691.40
	4	960.20	982.60	56.80	200.20	393.20	554.10	612.30	652.00	693.40
5	963.60	984.70	60.40	223.30	429.60	580.30	618.40	658.40	695.10	
Total Volume (liter)		21.85	16.6	33.2	138.6	178	131.3	30.1	32	25.3
Average Volume	liter/min	4.37	3.32	6.64	27.72	35.6	26.26	6.02	6.4	5.06
	liter/min/m	0.87	0.66	1.33	5.54	7.12	5.25	1.20	1.28	1.01
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.01	0.17	0.27	0.15	0.01	0.01	0.01
Effective Press. (kgf/cm <sup>2</sup> )		1.16	2.16	3.15	4.00	4.39	4.01	3.15	2.15	1.16
Koef. Permb (cm/sec)		4.28E-05	1.74E-05	2.39E-05	7.86E-05	9.19E-05	7.42E-05	2.16E-05	3.37E-05	4.96E-05
Lugeon Unit		7.55	3.07	4.21	13.87	16.22	13.09	3.82	5.94	8.75

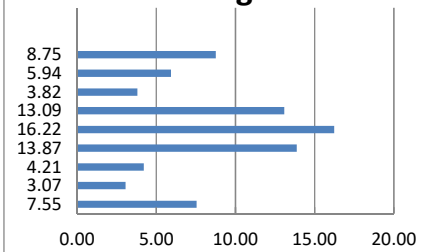
7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2));$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

### Nilai Lugeon



**k = 1.74E-05 cm/sec**  
**Lugeon = 3.07 Lu**

### Lugeon Test (Stage 5)

<b>Hole Number : PL 21</b>		Depth Of Test :	25 - 30
Ground Water Level :	1.2 m	Length Of Sect :	5
Pressure Gauge Height :	0.3 m	Pipe length :	32
Diameter Of Hole :	0.073 m	Lithology :	Breccia
Method Of Test :	Water Pres. Test	Date Of Tested :	3/9/2020
Packer Type :	Pneumatic	Time from :	14:00 - 16:00

Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		0.5	1	2	3	5	3	2	1	0.5
Time (min)	0	775.90	792.20	860.40	912.50	1011.00	181.30	286.00	335.90	343.90
	1	781.10	799.20	868.10	920.80	1044.30	194.20	292.00	336.40	344.60
	2	783.50	800.90	873.60	927.60	1077.10	212.90	299.10	338.10	346.60
	3	786.20	803.00	874.70	930.40	1109.90	234.10	309.20	339.50	348.70
	4	787.00	805.20	876.50	934.60	1143.30	254.60	320.00	340.90	350.60
	5	789.70	807.20	878.20	939.10	1176.50	277.50	330.70	342.40	352.40
Total Volume (liter)		13.80	15.00	17.80	26.60	165.50	96.20	44.70	6.50	8.50
Average	liter/min	2.76	3	3.56	5.32	33.1	19.24	8.94	1.3	1.7
Volume	liter/min/m	0.55	0.60	0.71	1.06	6.62	3.85	1.79	0.26	0.34
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.01	0.27	0.09	0.02	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		0.65	1.15	2.15	3.14	4.88	3.06	2.13	1.15	0.65
Koef. Permb (cm/sec)		4.83E-05	2.96E-05	1.88E-05	1.92E-05	7.69E-05	7.13E-05	4.76E-05	1.28E-05	2.97E-05
Lugeon Unit		8.52	5.23	3.32	3.39	13.57	12.58	8.39	2.26	5.24

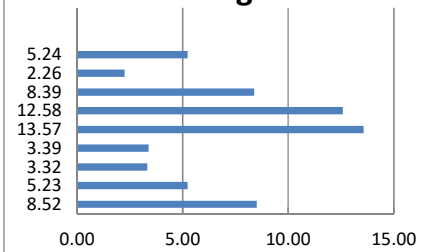
7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2));$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

### Nilai Lugeon



**k = 7.69E-05 cm/sec**  
**Lugeon = 13.57 Lu**

### Lugeon Test (Stage 6)

<b>Hole Number : PL 21</b>		Depth Of Test :	30 - 35
Ground Water Level :	17.33 m	Length Of Sect :	5
Pressure Gauge Height :	0.3 m	Pipe length :	37
Diameter Of Hole :	0.073 m	Lithology :	Breccia
Method Of Test :	Water Pres. Test	Date Of Tested :	3/11/2020
Packer Type :	Pneumatic	Time from :	13:5t - 14:32

Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
				1	2	3	2	1		
Time (min)	0			399.40	2722.90	261.80	3745.30	115.20		
	1			458.00	2785.50	333.40	3813.60	170.60		
	2			509.80	2849.60	404.30	3879.10	226.40		
	3			564.80	2912.30	476.00	3945.20	282.50		
	4			619.50	2977.30	548.10	4011.20	338.90		
5			674.70	3040.10	621.50	4077.60	395.90			
Total Volume (liter)		0.00	0.00	275.30	317.20	359.70	332.30	280.70	0.00	0.00
Average	liter/min	0	0	55.06	63.44	71.94	66.46	56.14	0	0
Volume	liter/min/m	0.00	0.00	11.01	12.69	14.39	13.29	11.23	0.00	0.00
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.88	1.16	1.49	1.28	0.91	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.76	1.76	1.89	2.60	3.27	2.49	1.85	1.76	1.76
Koef. Permb (cm/sec)		0.00E+00	0.00E+00	3.31E-04	2.76E-04	2.49E-04	3.03E-04	3.43E-04	0.00E+00	0.00E+00
Lugeon Unit		0.00	0.00	58.34	48.78	44.02	53.43	60.60	0.00	0.00

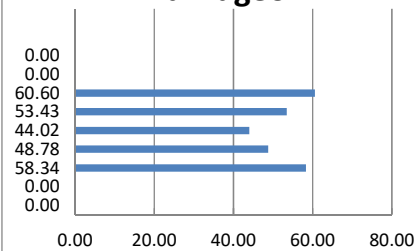
7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2));$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

### Nilai Lugeon



**k = 2.49E-04 cm/sec**  
**Lugeon = 44.02 Lu**



### Lugeon Test (Stage 1)

<b>Hole Number</b> : PL 25 BOR MIRING	Depth Of Test : 15 20
Ground Water Level : 6.4 m	Length Of Sect : 5
Pressure Gauge Height : 0.68 m	Pipe length : 29
Diameter Of Hole : 0.073 m	Lithology : Breccia
Method Of Test : Water Pres. Test	Date Of Tested : 3/9/2020
Packer Type : Pneumatic	Time from 16.08 to 16.25

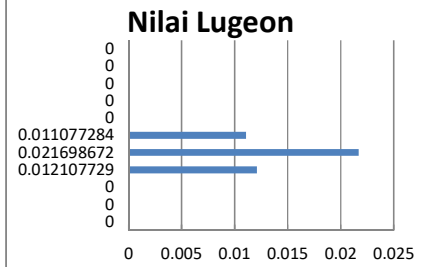
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
					1	2	1			
Time (min)	0				297.9	360.6	522.2			
	1				310.5	389.4	531.3			
	2				319.7	418.3	540.7			
	3				327.7	446.9	550.2			
	4				333.1	476.8	559.7			
	5				349.6	507.5	569.5			
Total Volume (liter)					51.7	146.9	47.3			
Average Volume	liter/min				10.34	29.38	9.46			
	liter/min/m				2.07	5.88	1.89			
Friction Loss (kgf/cm <sup>2</sup> )					0.02	0.19	0.02			
Effective Press. (kgf/cm <sup>2</sup> )					1.68	2.51	1.69			
Koef. Permb (cm/sec)					6.96E-05	1.32E-04	6.35E-05			
Lugeon Unit					12.2804	23.3726	11.2092			

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 6.35E-05 cm/sec**  
**Lugeon = 11.2092 Lu**

### Lugeon Test

<b>Hole Number : PL 25 BOR MIRING</b>		Depth Of Test : 20 25
Ground Water Level : 5.42 m		Length Of Sect : 5
Pressure Gauge Height : 0.68 m		Pipe length : 32
Diameter Of Hole : 0.073 m		Lithology : Breccia
Method of Test : Water Pres. Test		Date Of Tested : 4/9/2020
Packer Type : Pneumatic		Time from : 15.50 to 16.29

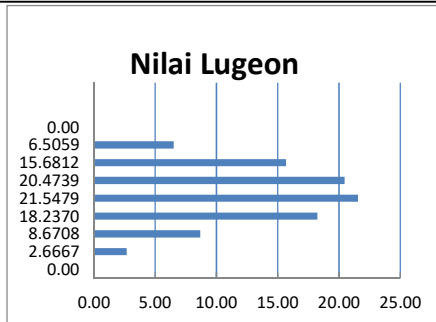
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
			0.5	1	1.5	2	1.5	1	0.5	
Time (min)	0		610.2	622.8	667.6	789.3	935.5	1052.5	1115.9	
	1		611.6	629.8	686.1	807.3	957.3	1064.7	1119.4	
	2		613.2	636	704.7	839.9	978.6	1077.3	1122.9	
	3		614.6	644	723.6	865.3	999.9	1089.4	1126.8	
	4		616	650.8	743.8	897.5	1021.6	1101.7	1130.3	
	5		617.6	657.7	763.8	929.9	1043.5	1114.1	1133.9	
Total Volume (liter)		0.00	7.40	34.90	96.20	140.60	108.00	61.60	18.00	0.00
Average	liter/min	0	1.48	6.98	19.24	28.12	21.6	12.32	3.6	0
Volume	liter/min/m	0.00	0.30	1.40	3.85	5.62	4.32	2.46	0.72	0.00
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.01	0.09	0.20	0.12	0.04	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		0.61	1.11	1.61	2.11	2.61	2.11	1.57	1.11	0.61
Koeff. Permb (cm/sec)		0.00E+00	1.51E-05	4.91E-05	1.03E-04	1.22E-04	1.16E-04	8.89E-05	3.69E-05	0.00E+00
Lugeon Unit		0.00	2.6667	8.6708	18.2370	21.5479	20.4739	15.6812	6.5059	0.00

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 2.67E+00 cm/sec**  
**Lugeon = 2.6667 Lu**

### Lugeon Test (Stage 3)

<b>Hole Number : PL 25 BOR MIRING</b>		Depth Of Test : 25 30
Ground Water Level : 6.8 m		Length Of Sect : 5
Pressure Gauge Height : 0.68 m		Pipe length : 37
Diameter Of Hole : 0.073 m		Lithology : Breccia
Method of Test : Water Pres. Test		Date Of Tested : 7/9/2020
Packer Type : Pneumatic		Time from 09.12 to 10.01

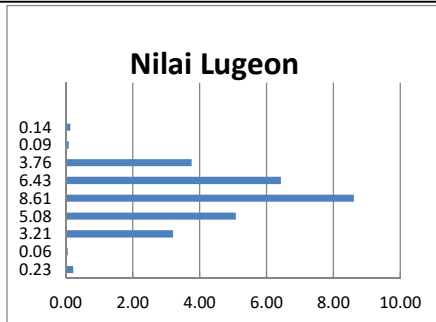
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	376.2	379.0	384.9	439.6	536.0	712.4	822.7	876.7	877.1
	1	376.4	379.1	393.3	457.4	570.3	734.3	833.7	876.8	877.3
	2	376.6	379.2	402.3	474.1	600.0	755.6	844.6	876.9	877.4
	3	376.8	379.4	411.6	490.8	632.3	776.6	855.0	877.1	877.5
	4	377.0	379.5	421.1	507.6	664.3	797.8	865.8	877.3	877.6
	5	377.2	379.6	430.8	524.2	696.3	818.7	876.4	877.5	877.7
Total Volume (liter)		1.00	0.60	45.90	84.60	160.30	106.3	53.7	0.8	0.6
Average Volume	liter/min	0.2	0.12	9.18	16.92	32.06	21.26	10.74	0.16	0.12
	liter/min/m	0.04	0.02	1.84	3.38	6.41	4.25	2.15	0.03	0.02
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.02	0.08	0.30	0.13	0.03	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.75	3.75	5.72	6.66	7.45	6.62	5.71	3.75	1.75
Koeff. Permb (cm/sec)		1.30E-06	3.63E-07	1.82E-05	2.88E-05	4.88E-05	3.64E-05	2.13E-05	4.84E-07	7.78E-07
Lugeon Unit		0.23	0.06	3.21	5.08	8.61	6.43	3.76	0.09	0.14

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 7.78E-07 cm/sec**  
**Lugeon = 0.14 Lu**

### Lugeon Test (Stage 4)

<b>Hole Number : PL 25 BOR MIRING</b>		Depth Of Test : 30 35
Ground Water Level : 6.9 m		Length Of Sect : 5
Pressure Gauge Height : 0.68 m		Pipe length : 47
Diameter Of Hole : 0.073 m		Lithology : Breccia
Method of Test : Water Pres. Test		Date Of Tested : 8/9/2020
Packer Type : Pneumatic		Time from 09.36 to 10.23

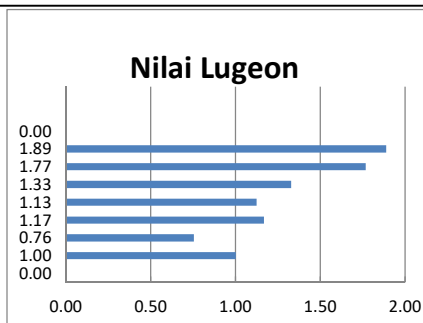
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	1	3	5	6	5	3	1	1
Time (min)	0		1883.7	1891.7	1906.3	1927.7	1962.7	1983.7	2000.7	
	1		1884.6	1893.3	1909.5	1931.3	1966.7	1987.9	2002.5	
	2		1885.6	1895.0	1912.8	1935.2	1970.2	1990.5	2004.3	
	3		1886.5	1896.7	1916.2	1939.1	1974.1	1994.0	2006.1	
	4		1887.3	1898.4	1919.7	1943.0	1978.2	1997.3	2008.0	
	5		1888.1	1898.8	1923.1	1946.7	1981.8	2000.3	2009.0	
Total Volume (liter)		0.00	4.40	7.10	16.80	19.00	19.1	16.6	8.3	0
Average	liter/min	0	0.88	1.42	3.36	3.8	3.82	3.32	1.66	0
Volume	liter/min/m	0.00	0.18	0.28	0.67	0.76	0.76	0.66	0.33	0.00
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.76	1.76	3.76	5.75	6.75	5.75	3.75	1.76	1.76
Koeff. Permb (cm/sec)		0.00E+00	5.68E-06	4.28E-06	6.62E-06	6.38E-06	7.53E-06	1.00E-05	1.07E-05	0.00E+00
Lugeon Unit		0.00	1.00	0.76	1.17	1.13	1.33	1.77	1.89	0.00

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 1.07E-05 cm/sec**  
**Lugeon = 1.89 Lu**

### Lugeon Test (Stage 5)

<b>Hole Number : PL 25 BOR MIRING</b>		Depth Of Test :	35 40
Ground Water Level :	6.55 m	Length Of Sect :	5
Pressure Gauge Height :	0.68 m	Pipe length :	48
Diameter Of Hole :	0.073 m	Lithology :	Breccia
Method of Test :	Water Pres. Test	Date Of Tested :	9/9/2020
Packer Type :	Pneumatic	Time from :	10.10 to 11.02

Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	2029.6	2043.6	2063.9	2090.8	2138.5	2194.3	2237.9	2256.1	2268.1
	1	2031.0	2046.9	2068.0	2098.5	2148.4	2202.2	2241.1	2258.5	2269.6
	2	2033.5	2050.0	2072.1	2106.2	2158.8	2210.0	2244.2	2260.8	2271.1
	3	2035.5	2053.1	2076.2	2114.1	2168.7	2218.1	2247.3	2263.1	2272.6
	4	2037.4	2056.2	2080.2	2121.6	2178.4	2225.6	2250.4	2265.5	2274.1
	5	2039.4	2059.3	2084.3	2129.4	2188.2	2233.6	2253.5	2267.8	2275.6
Total Volume (liter)		9.80	15.70	20.40	38.60	49.70	39.3	15.6	11.7	7.5
Average	liter/min	1.96	3.14	4.08	7.72	9.94	7.86	3.12	2.34	1.5
Volume	liter/min/m	0.39	0.63	0.82	1.54	1.99	1.57	0.62	0.47	0.30
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.01	0.02	0.04	0.02	0.00	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.72	3.72	5.72	6.70	7.69	6.70	5.72	3.72	1.72
Koeff. Permb (cm/sec)		1.29E-05	9.57E-06	8.09E-06	1.31E-05	1.47E-05	1.33E-05	6.18E-06	7.13E-06	9.87E-06
Lugeon Unit		2.28	1.69	1.43	2.30	2.59	2.35	1.09	1.26	1.74

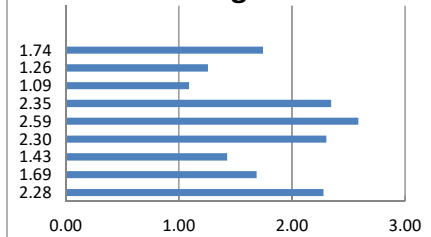
**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

### Nilai Lugeon



**k = 9.87E-06 cm/sec**  
**Lugeon = 1.74 Lu**

Lugeon Test (Stage 1)										
<b>Hole Number : PL-26 (Plinth)</b>					Depth Of Test : 7 - 10					
Ground Water Level : 0.5 m					Length Of Sect : 3					
Pressure Gauge Height : 0.4 m					Pipe length : 14.9					
Diameter Of Hole : 0.073 m					Lithology : Breccia					
Method Of Test : Water Pres. Test					Date Of Tested : 5/18/2020					
Packer Type : Mekanik					Time from : 11:15 - 12:05					
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	5	4	3	2	1
Time (min)	0	908.6	925.2	936.6	945.3	956.1	964.9	974.9	984.3	994.6
	1	911.3	927.4	938.3	947	957.8	966.6	976.3	985.8	997.1
	2	914	929.3	939.9	948.8	959.4	968.3	977.7	987.4	999.7
	3	916.9	931.1	941.4	950.3	961.1	969.9	979	989.1	1002.3
	4	919.6	932.9	943	951.7	962.7	971.6	980.7	990.7	1004.9
	5	922.4	934.8	943.8	953.3	964.2	973.6	982.1	992.2	1007.5
Total Volume (liter)		13.8	9.6	7.2	8	8.1	8.7	7.2	7.9	12.9
Average Volume	liter/min	2.76	1.92	1.44	1.6	1.62	1.74	1.44	1.58	2.58
	liter/min/m	0.92	0.64	0.48	0.53	0.54	0.58	0.48	0.53	0.86
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.09	2.09	3.09	4.09	5.09	4.09	3.09	2.09	1.09
Koef. Pemb (cm/sec)		4.29E-05	1.56E-05	7.89E-06	6.62E-06	5.39E-06	7.20E-06	7.89E-06	1.28E-05	4.01E-05
Lugeon Unit		8.45	3.06	1.55	1.30	1.06	1.42	1.55	2.52	7.90

7.70E-05 : Constant number of rod friction loss for normal boring rod

**Formula :**

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

**Nilai Lugeon**

Time (min)	Lugeon Unit
7.90	7.90
2.52	2.52
1.55	1.55
1.42	1.42
1.06	1.06
1.30	1.30
1.55	1.55
3.06	3.06
8.45	8.45

**k = 5.39E-06 cm/sec**  
**Lugeon = 1.06 Lu**

### Lugeon Test (Stage 2)

<b>Hole Number : PL-26 (Plinth)</b>		Depth Of Test : 10 - 15
Ground Water Level : 0 m		Length Of Sect : 5
Pressure Gauge Height : 0.34 m		Pipe length : 17.9
Diameter Of Hole : 0.073 m		Lithology : Breccia
Method Of Test : Water Pres. Test		Date Of Tested : 5/19/2020
Packer Type : Mekanik		Time from : 16:10 - 17:22

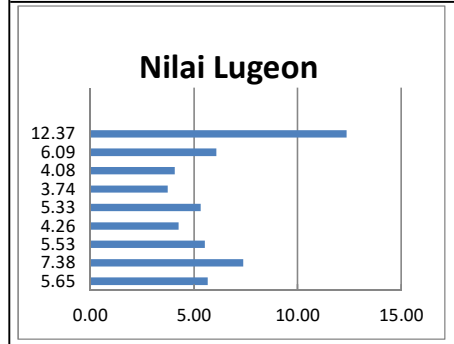
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	5	4	3	2	1
Time (min)	0	29.3	48.6	93.3	137.8	195.3	263.1	301.7	334	367.5
	1	32.2	57.1	102.8	147.8	212	268.6	305.2	337.9	372.9
	2	35.1	64.9	111.8	157	222.8	276.7	311.4	343.8	379.2
	3	38	72.2	119.6	165.6	239.3	284.8	318	350.4	385.8
	4	41	79.2	127	173.3	251	292.1	325.3	357.4	392.6
	5	43.9	86	135.1	180.7	262	300.7	332.6	364.9	399.3
Total Volume (liter)		14.6	37.4	41.8	42.9	66.7	37.6	30.9	30.9	31.8
Average Volume	liter/min	2.92	7.48	8.36	8.58	13.34	7.52	6.18	6.18	6.36
	liter/min/m	0.58	1.50	1.67	1.72	2.67	1.50	1.24	1.24	1.27
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01
Effective Press. (kgf/cm <sup>2</sup> )		1.03	2.03	3.02	4.02	5.01	4.03	3.03	2.03	1.03
Koef. Pemb (cm/sec)		3.20E-05	4.18E-05	3.13E-05	2.42E-05	3.02E-05	2.12E-05	2.31E-05	3.45E-05	7.01E-05
Lugeon Unit		5.65	7.38	5.53	4.26	5.33	3.74	4.08	6.09	12.37

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 3.02E-05 cm/sec**  
**Lugeon = 5.33 Lu**  
**Avg = 6.05**

### Lugeon Test (Stage 3)

<b>Hole Number : PL-26 (Plinth)</b>		Depth Of Test : 17 - 20
Ground Water Level : 1.8 m		Length Of Sect : 3
Pressure Gauge Height : 0.45 m		Pipe length : 23.1
Diameter Of Hole : 0.073 m		Lithology : Breccia
Method Of Test : Water Pres. Test		Date Of Tested : 5/20/2020
Packer Type : Mekanik		Time from : 15:00 - 16:20

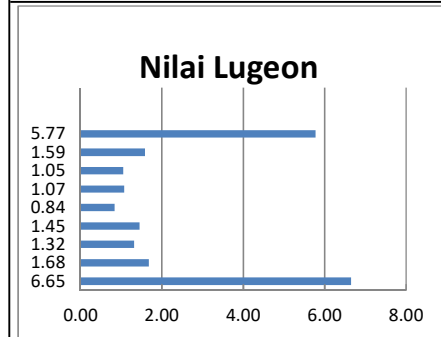
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	5	4	3	2	1
Time (min)	0	540.8	554.6	561	568	578.6	585.8	593.4	600	606.4
	1	543.3	555.8	562.4	569.9	580	587.2	594.4	601.1	608.6
	2	545.6	556.9	563.7	571.8	581.3	588.6	595.5	602.1	610.9
	3	548.1	558	565	573.5	582.6	589.9	597	603.1	613
	4	550.5	559.1	566	575.3	583.9	591.3	597.5	604.2	615.1
	5	553	560.2	567.4	577.2	585.2	592.6	598.5	605.3	617
Total Volume (liter)		12.2	5.6	6.4	9.2	6.6	6.8	5.1	5.3	10.6
Average Volume	liter/min	2.44	1.12	1.28	1.84	1.32	1.36	1.02	1.06	2.12
	liter/min/m	0.81	0.37	0.43	0.61	0.44	0.45	0.34	0.35	0.71
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.22	2.22	3.22	4.22	5.22	4.22	3.22	2.22	1.22
Koef. Pemb (cm/sec)		3.38E-05	8.52E-06	6.72E-06	7.37E-06	4.28E-06	5.45E-06	5.36E-06	8.07E-06	2.93E-05
Lugeon Unit		6.65	1.68	1.32	1.45	0.84	1.07	1.05	1.59	5.77

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

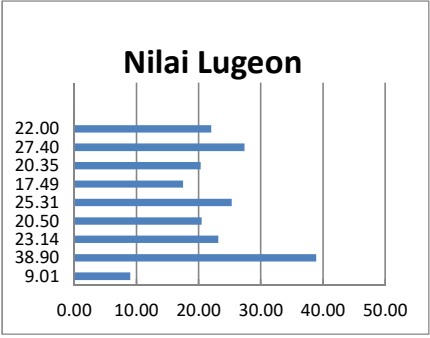


**k = 4.28E-06 cm/sec**  
**Lugeon = 0.84 Lu**



Lugeon Test (Stage 4)																																																																																																																																																																								
<b>Hole Number : PL-26 (Plinth)</b>					Depth Of Test : 22 - 25																																																																																																																																																																			
Ground Water Level : 0.6 m					Length Of Sect : 3																																																																																																																																																																			
Pressure Gauge Height : 0.37 m					Pipe length : 30.6																																																																																																																																																																			
Diameter Of Hole : 0.073 m					Lithology :																																																																																																																																																																			
Method Of Test : Water Pres. Test					Date Of Tested : 5/21/2020																																																																																																																																																																			
Packer Type : Mekanik					Time from : 16:22 - 17:10																																																																																																																																																																			
<table border="1"> <thead> <tr> <th colspan="2">Gauge Pressure (kgf/cm<sup>2</sup>)</th> <th>Po - 1</th> <th>Po - 2</th> <th>Po - 3</th> <th>Po - 4</th> <th>Po - 5</th> <th>Po - 6</th> <th>Po - 7</th> <th>Po - 8</th> <th>Po - 9</th> </tr> <tr> <td colspan="2"></td> <td>1</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>5</td> <td>4</td> <td>3</td> <td>1</td> </tr> </thead> <tbody> <tr> <td rowspan="6">Time (min)</td> <td>0</td> <td>449.3</td> <td>489.6</td> <td>674</td> <td>825.6</td> <td>993.5</td> <td>212.5</td> <td>350.1</td> <td>479.5</td> <td>623.5</td> </tr> <tr> <td>1</td> <td>454.8</td> <td>457</td> <td>712.6</td> <td>866.4</td> <td>1042.6</td> <td>230.5</td> <td>365.2</td> <td>497.6</td> <td>635.5</td> </tr> <tr> <td>2</td> <td>458.9</td> <td>584.6</td> <td>741.2</td> <td>902.9</td> <td>1086.1</td> <td>259.1</td> <td>384.3</td> <td>522.9</td> <td>642.5</td> </tr> <tr> <td>3</td> <td>461.3</td> <td>609.1</td> <td>765.9</td> <td>925.4</td> <td>1128.1</td> <td>285.9</td> <td>418</td> <td>554.1</td> <td>649.2</td> </tr> <tr> <td>4</td> <td>462.7</td> <td>632.8</td> <td>789</td> <td>950.4</td> <td>1168.3</td> <td>313.8</td> <td>443.6</td> <td>576.9</td> <td>654.7</td> </tr> <tr> <td>5</td> <td>464.1</td> <td>655.1</td> <td>810.1</td> <td>975.7</td> <td>1208.3</td> <td>342</td> <td>470.9</td> <td>601</td> <td>659.3</td> </tr> <tr> <td colspan="2">Total Volume (liter)</td> <td>14.8</td> <td>165.5</td> <td>136.1</td> <td>150.1</td> <td>214.8</td> <td>129.5</td> <td>120.8</td> <td>121.5</td> <td>35.8</td> </tr> <tr> <td rowspan="2">Average Volume</td> <td>liter/min</td> <td>2.96</td> <td>33.1</td> <td>27.22</td> <td>30.02</td> <td>42.96</td> <td>25.9</td> <td>24.16</td> <td>24.3</td> <td>7.16</td> </tr> <tr> <td>liter/min/m</td> <td>0.99</td> <td>11.03</td> <td>9.07</td> <td>10.01</td> <td>14.32</td> <td>8.63</td> <td>8.05</td> <td>8.10</td> <td>2.39</td> </tr> <tr> <td colspan="2">Friction Loss (kgf/cm<sup>2</sup>)</td> <td>0.00</td> <td>0.26</td> <td>0.18</td> <td>0.21</td> <td>0.44</td> <td>0.16</td> <td>0.14</td> <td>0.14</td> <td>0.01</td> </tr> <tr> <td colspan="2">Effective Press. (kgf/cm<sup>2</sup>)</td> <td>1.09</td> <td>2.84</td> <td>3.92</td> <td>4.88</td> <td>5.66</td> <td>4.94</td> <td>3.96</td> <td>2.96</td> <td>1.08</td> </tr> <tr> <td colspan="2">Koef. Pemb (cm/sec)</td> <td>4.58E-05</td> <td>1.98E-04</td> <td>1.18E-04</td> <td>1.04E-04</td> <td>1.29E-04</td> <td>8.88E-05</td> <td>1.03E-04</td> <td>1.39E-04</td> <td>1.12E-04</td> </tr> <tr> <td colspan="2">Lugeon Unit</td> <td>9.01</td> <td>38.90</td> <td>23.14</td> <td>20.50</td> <td>25.31</td> <td>17.49</td> <td>20.35</td> <td>27.40</td> <td>22.00</td> </tr> </tbody> </table>										Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9			1	3	4	5	6	5	4	3	1	Time (min)	0	449.3	489.6	674	825.6	993.5	212.5	350.1	479.5	623.5	1	454.8	457	712.6	866.4	1042.6	230.5	365.2	497.6	635.5	2	458.9	584.6	741.2	902.9	1086.1	259.1	384.3	522.9	642.5	3	461.3	609.1	765.9	925.4	1128.1	285.9	418	554.1	649.2	4	462.7	632.8	789	950.4	1168.3	313.8	443.6	576.9	654.7	5	464.1	655.1	810.1	975.7	1208.3	342	470.9	601	659.3	Total Volume (liter)		14.8	165.5	136.1	150.1	214.8	129.5	120.8	121.5	35.8	Average Volume	liter/min	2.96	33.1	27.22	30.02	42.96	25.9	24.16	24.3	7.16	liter/min/m	0.99	11.03	9.07	10.01	14.32	8.63	8.05	8.10	2.39	Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.26	0.18	0.21	0.44	0.16	0.14	0.14	0.01	Effective Press. (kgf/cm <sup>2</sup> )		1.09	2.84	3.92	4.88	5.66	4.94	3.96	2.96	1.08	Koef. Pemb (cm/sec)		4.58E-05	1.98E-04	1.18E-04	1.04E-04	1.29E-04	8.88E-05	1.03E-04	1.39E-04	1.12E-04	Lugeon Unit		9.01	38.90	23.14	20.50	25.31	17.49	20.35	27.40	22.00
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7.70E-05 : Constant number of rod friction loss for normal boring rod

Formula :	
$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$	
$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$	
<p style="text-align: center;"><b>Nilai Lugeon</b></p> 	
<p style="text-align: center;"> <b>k = 1.29E-04 cm/sec</b>  <b>Lugeon = 25.31 Lu</b>  <b>Avg 22.68 Lu</b> </p>	

Lugeon Test (Stage 5)										
<b>Hole Number : PL-26 (Plinth)</b>					Depth Of Test : 27 - 30					
Ground Water Level : 0.5 m					Length Of Sect : 3					
Pressure Gauge Height : 0.37 m					Pipe length : 34.7					
Diameter Of Hole : 0.073 m					Lithology :					
Method Of Test : Water Pres. Test					Date Of Tested : 5/22/2020					
Packer Type : Mekanik					Time from : 15:00 - 16:00					
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	4.5	4	3	2	1
Time (min)	0	42.3	208.9	492.6	873.9	413.1	859.5	324.1	695.1	922
	1	69.8	261.6	559.5	957.2	498.6	937.3	389.2	720.4	939.2
	2	98.2	313.5	627.1	1099.7	586.3	1013.5	455	765.3	957
	3	126.6	366.5	694.4	1123.3	668.5	1091.1	521	811.2	975.2
	4	154.4	418.3	762	1206.4	754.4	1168.2	587.5	856.4	993.7
	5	182.4	465.2	829.7	1290.1	889.9	1243.7	653.6	902	1012.7
Total Volume (liter)		140.1	256.3	337.1	416.2	476.8	384.2	329.5	206.9	90.7
Average Volume	liter/min	28.02	51.26	67.42	83.24	95.36	76.84	65.9	41.38	18.14
	liter/min/m	9.34	17.09	22.47	27.75	31.79	25.61	21.97	13.79	6.05
Friction Loss (kgf/cm <sup>2</sup> )		0.21	0.71	1.23	1.87	2.46	1.60	1.17	0.46	0.09
Effectve Press. (kgf/cm <sup>2</sup> )		0.87	1.38	1.86	2.21	2.13	2.49	1.91	1.62	1.00
Koef. Pemb (cm/sec)		5.42E-04	6.30E-04	6.14E-04	6.37E-04	7.58E-04	5.22E-04	5.83E-04	4.31E-04	3.08E-04
Lugeon Unit		106.77	124.12	120.94	125.34	149.33	102.83	114.83	84.93	60.59

**7.70E-05** : Constant number of rod friction loss for normal boring rod

**Formula :**

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

### Nilai Lugeon

Time (min)	Lugeon Unit
0	60.59
1	84.93
2	114.83
3	102.83
4	149.33
5	125.34
5	120.94
5	124.12
5	106.77

**k = 7.58E-04 cm/sec**  
**Lugeon = 60.59 Lu**

Lugeon Test (Stage 6)										
<b>Hole Number : PL-27 (Plinth)</b>					Depth Of Test : 32 - 35					
Ground Water Level : 0.8 m					Length Of Sect : 3					
Pressure Gauge Height : 0.34 m					Pipe length : 38.9					
Diameter Of Hole : 0.073 m					Lithology :					
Method Of Test : Water Pres. Test					Date Of Tested : 5/29/2020					
Packer Type : Mekanik					Time from : 08:50 - 09:53					
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	35.1	72.4	159.1	228.8	330	406.3	475.8	549.9	626
	1	39.9	88	172.3	242.1	343.6	419.9	489.4	564.5	639.7
	2	43.6	101.8	185.2	255.2	357.3	432.6	503	578.8	653.6
	3	47.2	115.6	198.5	268.4	370.8	445.9	517	592.8	667.5
	4	51	129.1	212	281.4	384.4	459.2	530.3	606.2	681.6
	5	55	142.3	224.7	294.5	398.5	472.4	543.4	621.1	695.6
Total Volume (liter)		19.9	69.9	65.6	65.7	68.5	66.1	67.6	71.2	69.6
Average Volume	liter/min	3.98	13.98	13.12	13.14	13.7	13.22	13.52	14.24	13.92
	liter/min/m	1.33	4.66	4.37	4.38	4.57	4.41	4.51	4.75	4.64
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.06	0.05	0.05	0.06	0.05	0.06	0.06	0.06
Effective Press. (kgf/cm <sup>2</sup> )		1.11	3.05	5.06	6.06	7.06	6.06	5.06	3.05	1.06
Koef. Pemb (cm/sec)		6.07E-05	7.75E-05	4.39E-05	3.67E-05	3.29E-05	3.69E-05	4.52E-05	7.90E-05	2.23E-04
Lugeon Unit		11.96	15.25	8.64	7.23	6.47	7.27	8.91	15.55	43.96

7.70E-05 : Constant number of rod friction loss for normal boring rod

Formula :	
$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$	
$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$	
<p><b>k = 3.29E-05 cm/sec</b>  <b>Lugeon = 6.47 Lu</b></p>	

### Lugeon Test (Stage 7)

<b>Hole Number : PL-26 (Plinth)</b>		Depth Of Test : 37 - 40
Ground Water Level : 0.58 m		Length Of Sect : 3
Pressure Gauge Height : 0.34 m		Pipe length : 44.9
Diameter Of Hole : 0.073 m		Lithology :
Method Of Test : Water Pres. Test		Date Of Tested : 5/29/2020
Packer Type : Mekanik		Time from : 15:15 - 16:07

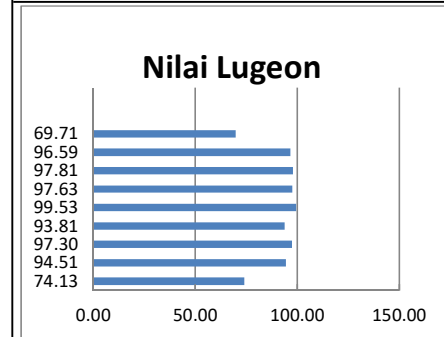
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	4.5	4	3	2	1
Time (min)	0	41900.7	40.8	295.9	634.6	51.7	487.4	421856.4	165.7	387.2
	1	41921.2	92	344.4	703	128	559.7	421914.3	208.2	405.6
	2	41942.2	124.1	402.8	772.9	205.7	631.2	421970.5	250.4	425.7
	3	41963.5	166.3	462.2	842.2	280.1	700.2	422029	293.1	445.8
	4	41984.5	207.9	522	910.2	357.9	768.8	422084.9	336	466.6
	5	42005.2	250.5	581.4	978.5	433.7	837.1	422142.6	377.9	486.9
Total Volume (liter)		104.5	209.7	285.5	343.9	382	349.7	286.2	212.2	99.7
Average Volume	liter/min	20.9	41.94	57.1	68.78	76.4	69.94	57.24	42.44	19.94
	liter/min/m	6.97	13.98	19.03	22.93	25.47	23.31	19.08	14.15	6.65
Friction Loss (kgf/cm <sup>2</sup> )		0.15	0.61	1.14	1.65	2.03	1.70	1.14	0.63	0.14
Effective Press. (kgf/cm <sup>2</sup> )		0.94	1.48	1.96	2.44	2.56	2.39	1.95	1.46	0.95
Koef. Pemb (cm/sec)		3.77E-04	4.80E-04	4.94E-04	4.76E-04	5.06E-04	4.96E-04	4.97E-04	4.91E-04	3.54E-04
Lugeon Unit		74.13	94.51	97.30	93.81	99.53	97.63	97.81	96.59	69.71

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 5.06E-04 cm/sec**  
**Lugeon = 91.22 Lu**

Lugeon Test (Stage 8)										
<b>Hole Number : PL-26 (Plinth)</b>					Depth Of Test : 40 - 45					
Ground Water Level : 0.78 m					Length Of Sect : 5					
Pressure Gauge Height : 0.4 m					Pipe length : 47.7					
Diameter Of Hole : 0.073 m					Lithology :					
Method Of Test : Water Pres. Test					Date Of Tested : 5/30/2020					
Packer Type : Mekanik					Time from : 10:43 - 11:30					
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	500.2	522.1	543.6	566.6	584.8	602.4	615.8	630.6	650.8
	1	503.3	526.1	548.3	569.9	588.1	604.9	618.6	634.5	656.6
	2	506.5	519.8	552	573.2	591.1	607.4	621.3	638.2	662.5
	3	509.6	533.1	556.1	576.2	594.2	609.8	624	641.8	668.3
	4	512.7	536.5	560	579.3	597.3	612.2	626.7	645.2	674.2
	5	516	539.8	564	582.5	600.2	614.6	629.5	648.7	680.1
Total Volume (liter)		15.8	17.7	20.4	15.9	15.4	12.2	13.7	18.1	29.3
Average Volume	liter/min	3.16	3.54	4.08	3.18	3.08	2.44	2.74	3.62	5.86
	liter/min/m	0.63	0.71	0.82	0.64	0.62	0.49	0.55	0.72	1.17
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Effective Press. (kgf/cm <sup>2</sup> )		1.11	3.11	5.11	6.11	7.11	6.12	5.12	3.11	1.11
Koef. Pemb (cm/sec)		3.21E-05	1.29E-05	9.05E-06	5.90E-06	4.91E-06	4.52E-06	6.07E-06	1.32E-05	6.01E-05
Lugeon Unit		5.67	2.27	1.60	1.04	0.87	0.80	1.07	2.33	10.60

7.70E-05 : Constant number of rod friction loss for normal boring rod

**Formula :**

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

### Nilai Lugeon

Time (min)	Lugeon Unit
0	10.60
1	5.86
2	6.625
3	6.683
4	6.742
5	6.801

**k = 4.91E-06 cm/sec**  
**Lugeon = 0.80 Lu**

### Lugeon Test (Stage 9)

<b>Hole Number : PL-26 (Plinth)</b>		Depth Of Test : 40 - 45
Ground Water Level : 0.68 m		Length Of Sect : 5
Pressure Gauge Height : 0.34 m		Pipe length : 53.1
Diameter Of Hole : 0.073 m		Lithology : Breksi
Method Of Test : Water Pres. Test		Date Of Tested : 5/30/2020
Packer Type : Mekanik		Time from : 14:45 - 15:30

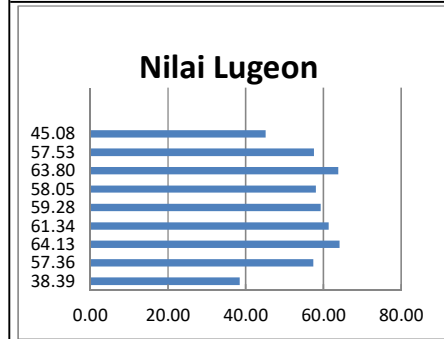
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	5	4	3	2	1
Time (min)	0	837.4	946.6	168.5	503.5	911.9	334.6	680.1	983	197
	1	854.6	987.4	224.9	570.5	990.4	400.2	734.7	1024.8	216.5
	2	873	1028.3	281.5	639.4	1070	467.6	789.9	1063.5	237.4
	3	891.3	1068.6	338.9	706.6	1147.5	534.1	844	1105.1	258.8
	4	910.7	1109.9	396	775.1	1223.9	600.9	899	1146.1	280.1
	5	929.7	1150.2	452.7	842.5	1300.2	666.6	963.7	1186.9	301.1
Total Volume (liter)		92.3	203.6	284.2	339	388.3	332	283.6	203.9	104.1
Average Volume	liter/min	18.46	40.72	56.84	67.8	77.66	66.4	56.72	40.78	20.82
	liter/min/m	3.69	8.14	11.37	13.56	15.53	13.28	11.34	8.16	4.16
Friction Loss (kgf/cm <sup>2</sup> )		0.14	0.68	1.33	1.89	2.48	1.81	1.32	0.68	0.18
Effective Press. (kgf/cm <sup>2</sup> )		0.96	1.42	1.77	2.21	2.62	2.29	1.78	1.42	0.92
Koef. Pemb (cm/sec)		2.18E-04	3.25E-04	3.63E-04	3.48E-04	3.36E-04	3.29E-04	3.62E-04	3.26E-04	2.56E-04
Lugeon Unit		38.39	57.36	64.13	61.34	59.28	58.05	63.80	57.53	45.08

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 3.36E-04 cm/sec**  
**Lugeon = 56.11 Lu**

### Lugeon Test (Stage 1)

<b>Hole Number : PL 45</b>		Depth Of Test : 10 15
Ground Water Level : 6.8 m		Length Of Sect : 5
Pressure Gauge Height : 0.43 m		Pipe length : 17.9
Diameter Of Hole : 0.073 m		Lithology : Breksi
Method Of Test : Water Pres. Test		Date Of Tested : 6/6/2020
Packer Type : Mechanic		Time from 13.55 to 14.40

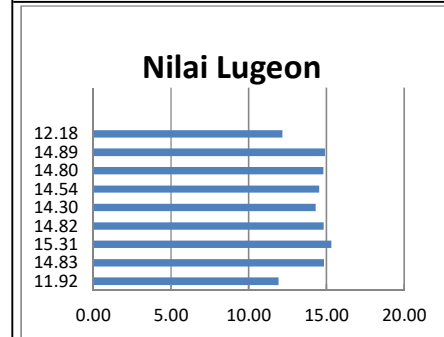
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	5	4	3	2	1
Time (min)	0	404.50	459.90	567.40	722.00	907.80	118.20	300.30	443.30	546.80
	1	414.80	479.40	594.80	756.30	947.10	151.20	327.00	463.50	557.30
	2	425.00	499.20	622.60	789.90	986.30	185.20	353.70	483.20	567.60
	3	435.10	518.90	650.30	823.40	1025.90	217.70	380.60	503.60	578.10
	4	445.30	538.80	678.30	857.10	1064.90	251.00	407.30	522.80	588.50
	5	455.40	558.80	705.80	891.00	1104.60	284.20	434.30	542.60	598.80
Total Volume (liter)		50.9	98.9	138.4	169	196.8	166	134	99.3	52
Average Volume	liter/min	10.18	19.78	27.68	33.8	39.36	33.2	26.8	19.86	10.4
	liter/min/m	2.04	3.96	5.54	6.76	7.87	6.64	5.36	3.97	2.08
Friction Loss (kgf/cm <sup>2</sup> )		0.01	0.06	0.11	0.16	0.22	0.16	0.10	0.06	0.02
Effective Press. (kgf/cm <sup>2</sup> )		1.71	2.67	3.62	4.56	5.50	4.57	3.62	2.67	1.71
Koef. Pemb (cm/sec)		6.75E-05	8.40E-05	8.68E-05	8.40E-05	8.11E-05	8.24E-05	8.39E-05	8.44E-05	6.90E-05
Lugeon Unit		11.92	14.83	15.31	14.82	14.30	14.54	14.80	14.89	12.18

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 8.11E-05 cm/sec**  
**Lugeon = 14.30 Lu**

### Lugeon Test (Stage 2)

<b>Hole Number : PL 45</b>		Depth Of Test : 17 20
Ground Water Level : 8.21 m		Length Of Sect : 3
Pressure Gauge Height : 0.33 m		Pipe length : 24.2
Diameter Of Hole : 0.073 m		Lithology : Breksi
Method Of Test : Water Pres. Test		Date Of Tested : 7/6/2020
Packer Type : Mechanic		Time from 14.47 to 15.42

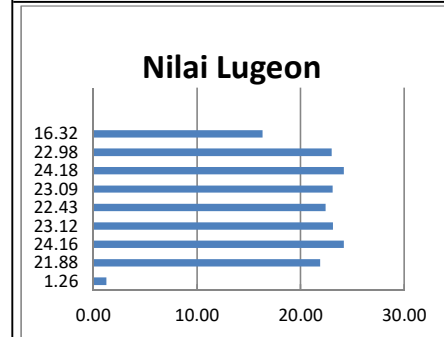
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	5	4	3	2	1
Time (min)	0	19.50	27.10	126.10	275.00	448.80	645.90	815.60	957.20	56.00
	1	20.20	44.50	152.90	307.50	486.60	677.60	842.50	976.70	63.70
	2	20.90	62.50	179.80	339.50	525.70	710.10	869.50	995.60	74.30
	3	21.50	81.20	206.80	371.90	561.30	742.30	896.50	1014.80	83.40
	4	22.30	100.00	233.80	404.20	599.00	774.30	923.40	1034.10	92.30
	5	23.00	118.70	260.80	436.50	636.80	807.20	950.40	1053.20	101.00
Total Volume (liter)		3.5	91.6	134.7	161.5	188	161.3	134.8	96	45
Average Volume	liter/min	0.7	18.32	26.94	32.3	37.6	32.26	26.96	19.2	9
	liter/min/m	0.23	6.11	8.98	10.77	12.53	10.75	8.99	6.40	3.00
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.06	0.14	0.20	0.27	0.20	0.14	0.07	0.02
Effective Press. (kgf/cm <sup>2</sup> )		1.85	2.79	3.72	4.66	5.59	4.66	3.72	2.78	1.84
Koef. Pemb (cm/sec)		6.39E-06	1.11E-04	1.23E-04	1.17E-04	1.14E-04	1.17E-04	1.23E-04	1.17E-04	8.29E-05
Lugeon Unit		1.26	21.88	24.16	23.12	22.43	23.09	24.18	22.98	16.32

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 1.14E-04 cm/sec**  
**Lugeon = 22.43 Lu**



### Lugeon Test (Stage 3)

<b>Hole Number : PL 45</b>		Depth Of Test : 20 25
Ground Water Level : 5.9 m		Length Of Sect : 5
Pressure Gauge Height : 0.36 m		Pipe length : 27.1
Diameter Of Hole : 0.073 m		Lithology : Breksi
Method Of Test : Water Pres. Test		Date Of Tested : 8/6/2020
Packer Type : Mechanic		Time from 11.39 to 12.37

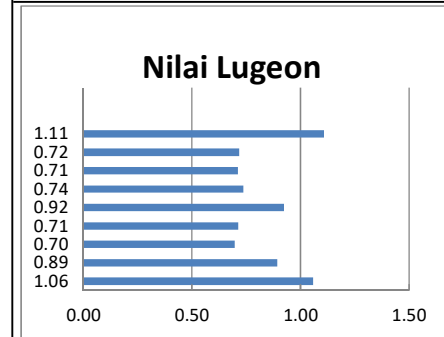
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	339.20	349.90	360.10	371.40	386.30	406.20	419.50	430.40	437.80
	1	340.10	352.40	362.40	373.80	390.40	408.70	421.60	431.60	438.70
	2	341.00	354.30	364.40	376.20	394.20	411.20	423.00	433.00	439.60
	3	341.80	355.60	366.30	378.60	397.50	413.60	425.60	434.30	440.50
	4	342.60	356.80	368.10	381.00	400.70	416.00	427.60	435.60	441.40
	5	343.50	358.00	369.90	383.20	403.90	418.40	429.50	436.90	442.30
Total Volume (liter)		4.3	8.1	9.8	11.8	17.6	12.2	10	6.5	4.5
Average Volume	liter/min	0.86	1.62	1.96	2.36	3.52	2.44	2	1.3	0.9
	liter/min/m	0.17	0.32	0.39	0.47	0.70	0.49	0.40	0.26	0.18
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.63	3.63	5.63	6.62	7.62	6.62	5.63	3.63	1.63
Koef. Pemb (cm/sec)		6.00E-06	5.07E-06	3.95E-06	4.04E-06	5.23E-06	4.18E-06	4.03E-06	4.06E-06	6.27E-06
Lugeon Unit		1.06	0.89	0.70	0.71	0.92	0.74	0.71	0.72	1.11

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG } (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 5.23E-06 cm/sec**  
**Lugeon = 1.06 Lu**

### Lugeon Test (Stage 4)

<b>Hole Number : PL 45</b>		Depth Of Test : 25 30
Ground Water Level : 5.85 m		Length Of Sect : 5
Pressure Gauge Height : 0.55 m		Pipe length : 33.7
Diameter Of Hole : 0.073 m		Lithology : Breksi
Method Of Test : Water Pres. Test		Date Of Tested : 8/6/2020
Packer Type : Mechanic		Time from 08.54 to 09.42

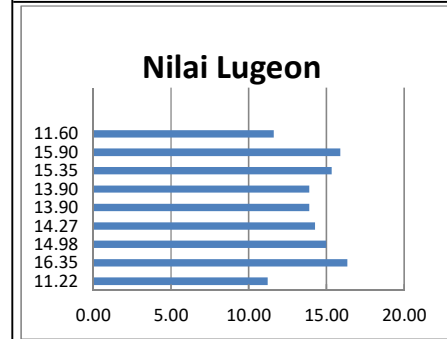
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	4	5	6	5	4	3	1
Time (min)	0	677.80	739.10	891.30	78.40	278.50	509.20	719.00	900.40	43.60
	1	687.10	766.10	923.30	116.00	320.60	547.60	752.40	927.10	52.80
	2	696.30	793.90	956.10	153.90	363.30	586.50	785.90	954.00	62.30
	3	705.40	821.90	988.85	191.00	406.10	625.40	819.00	982.00	71.70
	4	714.20	849.60	1021.60	228.00	448.50	664.20	852.20	1008.70	81.00
	5	723.20	879.40	1054.50	266.30	492.40	692.80	885.80	1037.20	90.50
Total Volume (liter)		45.4	140.3	163.2	187.9	213.9	183.6	166.8	136.8	46.9
Average Volume	liter/min	9.08	28.06	32.64	37.58	42.78	36.72	33.36	27.36	9.38
	liter/min/m	1.82	5.61	6.53	7.52	8.56	7.34	6.67	5.47	1.88
Friction Loss (kgf/cm <sup>2</sup> )		0.02	0.21	0.28	0.37	0.48	0.36	0.29	0.20	0.02
Effective Press. (kgf/cm <sup>2</sup> )		1.62	3.43	4.36	5.27	6.16	5.28	4.35	3.44	1.62
Koef. Pemb (cm/sec)		6.36E-05	9.27E-05	8.49E-05	8.09E-05	7.88E-05	7.88E-05	8.70E-05	9.01E-05	6.58E-05
Lugeon Unit		11.22	16.35	14.98	14.27	13.90	13.90	15.35	15.90	11.60

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 7.88E-05 cm/sec**  
**Lugeon = 13.90 Lu**

### Lugeon Test (Stage 5)

<b>Hole Number : PL 45</b>	Depth Of Test : 30 35
Ground Water Level : 6.05 m	Length Of Sect : 5
Pressure Gauge Height : 0.35 m	Pipe length : 38
Diameter Of Hole : 0.073 m	Lithology : Breksi
Method Of Test : Water Pres. Test	Date Of Tested : 9/6/2020
Packer Type : Mechanic	Time from 15.33 to 16.27

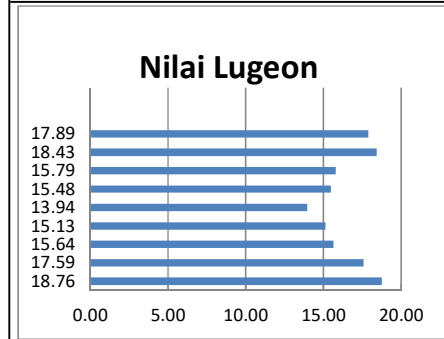
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	274.50	363.10	539.50	770.40	23.40	291.30	552.10	770.70	935.20
	1	289.40	392.00	580.20	815.20	70.80	335.60	591.70	801.80	949.50
	2	304.40	422.30	621.00	860.50	119.60	381.20	633.20	832.10	963.60
	3	319.50	452.20	660.40	906.50	168.60	425.10	674.10	863.20	977.80
	4	334.80	481.90	700.20	952.90	217.50	469.30	714.20	894.10	991.80
	5	348.40	511.70	741.30	998.40	265.60	523.60	755.50	925.40	1005.90
Total Volume (liter)		73.9	148.6	201.8	228	242.2	232.3	203.4	154.7	70.7
Average Volume	liter/min	14.78	29.72	40.36	45.6	48.44	46.46	40.68	30.94	14.14
	liter/min/m	2.96	5.94	8.07	9.12	9.69	9.29	8.14	6.19	2.83
Friction Loss (kgf/cm <sup>2</sup> )		0.06	0.26	0.48	0.61	0.69	0.64	0.49	0.28	0.06
Effective Press. (kgf/cm <sup>2</sup> )		1.58	3.38	5.16	6.03	6.95	6.00	5.15	3.36	1.58
Koef. Pemb (cm/sec)		1.06E-04	9.97E-05	8.87E-05	8.58E-05	7.90E-05	8.77E-05	8.95E-05	1.04E-04	1.01E-04
Lugeon Unit		18.76	17.59	15.64	15.13	13.94	15.48	15.79	18.43	17.89

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 7.90E-05 cm/sec**  
**Lugeon = 13.94 Lu**

### Lugeon Test (Stage 1)

<b>Hole Number</b> : PL 52	Depth Of Test : 12 17
Ground Water Level : 0.31 m	Length Of Sect : 5
Pressure Gauge Height : 0.65 m	Pipe length : 24
Diameter Of Hole : 0.073 m	Lithology : Breccia
Method of Test : Water Pres. Test	Date Of Tested : 14/9/2020
Packer Type : Pneumatic	Time from 09.22 to 10.12

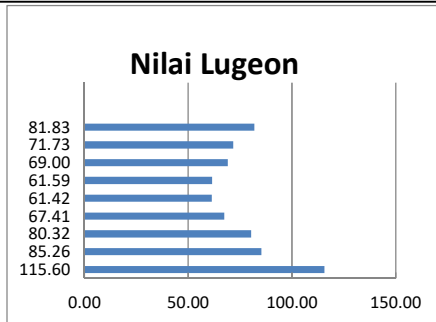
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		0.5	1	1.5	2	3	2	1.5	1	0.5
Time (min)	0	3026.6	3163.4	3364.5	3617.6	3921.6	4297.4	4584.5	4814.8	4985.9
	1	3051.0	3199.3	3419.1	3669.8	3989.5	4346.9	4628.2	4847.1	5006.7
	2	3075.9	3235.3	3454.6	3722.3	4056.9	4396.9	4670.6	4879.2	5027.6
	3	3100.2	3271.3	3498.7	3775.3	4124.0	4446.4	4713.1	4911.4	5048.5
	4	3124.7	3307.9	3544.4	3828.5	4192.3	4496.7	4756.0	4943.4	5069.6
	5	3159.4	3343.5	3599.3	3880.6	4260.5	4546.3	4798.6	4975.5	5090.5
Total Volume (liter)		132.80	180.10	234.80	263.00	338.90	248.9	214.1	160.7	104.6
Average Volume	liter/min	26.56	36.02	46.96	52.6	67.78	49.78	42.82	32.14	20.92
	liter/min/m	5.31	7.20	9.39	10.52	13.56	9.96	8.56	6.43	4.18
Friction Loss (kgf/cm <sup>2</sup> )		0.14	0.25	0.43	0.54	0.89	0.48	0.35	0.20	0.08
Effective Press. (kgf/cm <sup>2</sup> )		0.46	0.84	1.17	1.56	2.21	1.62	1.24	0.90	0.51
Koeff. Permb (cm/sec)		6.55E-04	4.83E-04	4.55E-04	3.82E-04	3.48E-04	3.49E-04	3.91E-04	4.07E-04	4.64E-04
Lugeon Unit		115.60	85.26	80.32	67.41	61.42	61.59	69.00	71.73	81.83

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 3.48E-04 cm/sec**  
**Lugeon = 61.42 Lu**

### Lugeon Test (Stage 2)

<b>Hole Number</b> : PL 52	Depth Of Test : 15 20
Ground Water Level : 0.41 m	Length Of Sect : 5
Pressure Gauge Height : 0.65 m	Pipe length : 28
Diameter Of Hole : 0.073 m	Lithology : Breccia
Method of Test : Water Pres. Test	Date Of Tested : 14/9/2020
Packer Type : Pneumatic	Time from 15.15 to 16.08

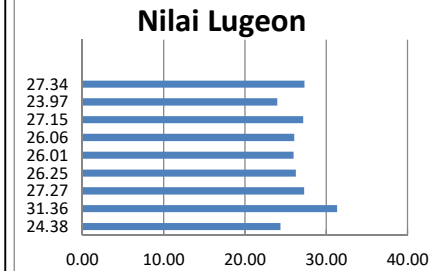
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	5	4	3	2	1
Time (min)	0	5337.3	5426.9	5606.2	5833.7	6122.1	6469.5	6737.0	6934.7	7080.2
	1	5350.0	5458.0	5646.0	5883.3	6189.5	6513.7	6771.0	6958.2	7094.5
	2	5362.3	5487.8	5684.1	5930.5	6235.1	6561.1	6807.4	6984.4	7108.9
	3	5375.6	5517.5	5721.3	5976.6	6290.3	6605.9	6843.6	7010.1	7123.5
	4	5389.1	5546.9	5758.9	6024.1	6346.7	6653.5	6880.0	7036.0	7138.0
	5	5402.4	5576.4	5796.1	6070.4	6407.1	6704.9	6926.2	7053.4	7152.6
Total Volume (liter)		65.10	149.50	189.90	236.70	285.00	235.4	189.2	118.7	72.4
Average	liter/min	13.02	29.9	37.98	47.34	57	47.08	37.84	23.74	14.48
Volume	liter/min/m	2.60	5.98	7.60	9.47	11.40	9.42	7.57	4.75	2.90
Friction Loss (kgf/cm <sup>2</sup> )		0.04	0.20	0.32	0.50	0.72	0.49	0.32	0.13	0.05
Effective Press. (kgf/cm <sup>2</sup> )		1.07	1.91	2.79	3.61	4.38	3.61	2.79	1.98	1.06
Koeff. Permb (cm/sec)		1.38E-04	1.78E-04	1.55E-04	1.49E-04	1.47E-04	1.48E-04	1.54E-04	1.36E-04	1.55E-04
Lugeon Unit		24.38	31.36	27.27	26.25	26.01	26.06	27.15	23.97	27.34

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 1.51E-04 cm/sec**  
**Lugeon = 26.64 Lu**

### Lugeon Test (Stage 3)

<b>Hole Number</b> : PL 52	Depth Of Test : 20 25
Ground Water Level : 0.4 m	Length Of Sect : 5
Pressure Gauge Height : 0.63 m	Pipe length : 33
Diameter Of Hole : 0.073 m	Lithology : Basalt
Method of Test : Water Pres. Test	Date Of Tested : 16/9/2020
Packer Type : Pneumatic	Time from 09.05 to 10.05

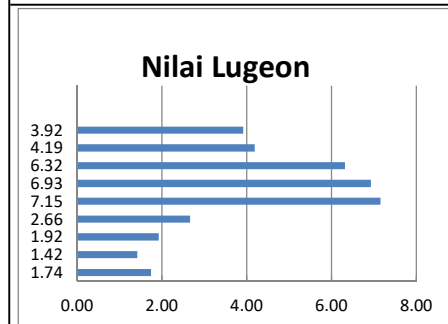
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	7172.8	7183.1	7201.3	7236.0	7291.5	7433.7	7590.2	7667.3	7694.5
	1	7173.6	7185.6	7207.3	7244.0	7316.0	7454.0	7609.5	7672.3	7696.3
	2	7174.6	7187.8	7212.6	7251.8	7340.4	7474.7	7627.7	7680.4	7698.4
	3	7175.6	7190.0	7217.7	7259.7	7365.1	7495.6	7644.7	7687.5	7700.6
	4	7176.6	7192.7	7221.5	7268.9	7390.1	7516.6	7655.4	7694.6	7702.9
	5	7177.6	7194.1	7225.8	7276.5	7415.7	7537.5	7669.8	7699.7	7705.3
Total Volume (liter)		4.80	11.00	24.50	40.50	124.20	103.8	79.6	32.4	10.8
Average	liter/min	0.96	2.2	4.9	8.1	24.84	20.76	15.92	6.48	2.16
Volume	liter/min/m	0.19	0.44	0.98	1.62	4.97	4.15	3.18	1.30	0.43
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.01	0.02	0.16	0.11	0.06	0.01	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.10	3.10	5.10	6.09	6.95	5.99	5.04	3.09	1.10
Koef. Permb (cm/sec)		9.87E-06	8.04E-06	1.09E-05	1.51E-05	4.05E-05	3.93E-05	3.58E-05	2.38E-05	2.22E-05
Lugeon Unit		1.74	1.42	1.92	2.66	7.15	6.93	6.32	4.19	3.92

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 9.87E-06 cm/sec**  
**Lugeon = 1.74 Lu**

### Lugeon Test (Stage 4)

<b>Hole Number</b> : PL 52	Depth Of Test : 25 30
Ground Water Level : 0.4 m	Length Of Sect : 5
Pressure Gauge Height : 0.63 m	Pipe length : 37
Diameter Of Hole : 0.073 m	Lithology : Basalt
Method of Test : Water Pres. Test	Date Of Tested : 17/9/2020
Packer Type : Pneumatic	Time from 08.36 to 09.27

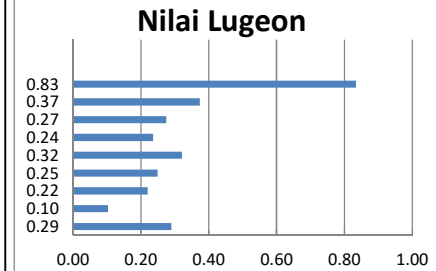
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	7708.5	7710.0	7711.0	7714.5	7719.3	7725.8	7729.8	7733.5	7736.5
	1	7708.7	7710.1	7711.4	7715.2	7720.3	7726.5	7730.6	7734.1	7736.8
	2	7708.8	7710.3	7711.9	7715.9	7721.2	7727.2	7731.3	7734.7	7737.3
	3	7708.9	7710.4	7712.6	7716.7	7722.5	7727.7	7731.9	7735.3	7737.8
	4	7709.1	7710.6	7713.2	7717.5	7723.7	7728.5	7732.6	7735.8	7738.3
	5	7709.3	7710.8	7713.8	7718.3	7725.0	7729.4	7733.3	7736.4	7738.8
Total Volume (liter)		0.80	0.80	2.80	3.80	5.70	3.6	3.5	2.9	2.3
Average	liter/min	0.16	0.16	0.56	0.76	1.14	0.72	0.7	0.58	0.46
Volume	liter/min/m	0.03	0.03	0.11	0.15	0.23	0.14	0.14	0.12	0.09
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.10	3.10	5.10	6.10	7.10	6.10	5.10	3.10	1.10
Koef. Permb (cm/sec)		1.64E-06	5.84E-07	1.24E-06	1.41E-06	1.82E-06	1.34E-06	1.55E-06	2.12E-06	4.73E-06
Lugeon Unit		0.29	0.10	0.22	0.25	0.32	0.24	0.27	0.37	0.83

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 1.83E-06 cm/sec**  
**Lugeon = 0.32 Lu**

### Lugeon Test (Stage 5)

<b>Hole Number</b> : PL 52	Depth Of Test : 30 35
Ground Water Level : 0.37 m	Length Of Sect : 5
Pressure Gauge Height : 0.63 m	Pipe length : 42
Diameter Of Hole : 0.073 m	Lithology : Breksi
Method of Test : Water Pres. Test	Date Of Tested : 18/9/2020
Packer Type : Pneumatic	Time from 08.36 to 09.28

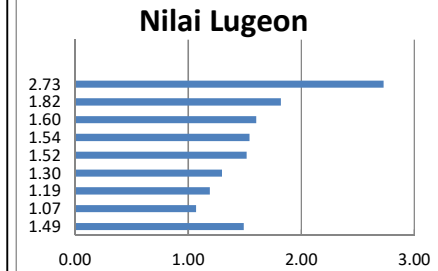
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	8419.3	8425.9	8437.0	8455.5	8482.4	8514.0	8541.9	8564.1	8579.1
	1	8420.2	8427.7	8440.0	8459.4	8487.5	8519.8	8546.0	8566.9	8580.6
	2	8421.1	8429.4	8443.1	8463.2	8492.8	8523.6	8550.1	8569.8	8582.1
	3	8421.9	8431.1	8446.2	8467.1	8498.2	8528.3	8554.2	8572.5	8583.6
	4	8422.7	8432.7	8449.1	8471.1	8503.7	8532.9	8558.2	8575.3	8585.2
	5	8423.4	8434.2	8452.2	8475.3	8509.3	8537.5	8562.3	8578.2	8586.6
Total Volume (liter)		4.10	8.30	15.20	19.80	26.90	23.5	20.4	14.1	7.5
Average	liter/min	0.82	1.66	3.04	3.96	5.38	4.7	4.08	2.82	1.5
Volume	liter/min/m	0.16	0.33	0.61	0.79	1.08	0.94	0.82	0.56	0.30
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.10	3.10	5.10	6.09	7.09	6.09	5.09	3.10	1.10
Koeff. Permb (cm/sec)		8.45E-06	6.07E-06	6.76E-06	7.36E-06	8.60E-06	8.74E-06	9.08E-06	1.03E-05	1.55E-05
Lugeon Unit		1.49	1.07	1.19	1.30	1.52	1.54	1.60	1.82	2.73

**7.70E-05** : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 1.55E-05 cm/sec**  
**Lugeon = 2.73 Lu**



### Lugeon Test (Stage 6)

<b>Hole Number</b> : PL 52	Depth Of Test : 35 40
Ground Water Level : 0.31 m	Length Of Sect : 5
Pressure Gauge Height : 0.63 m	Pipe length : 47
Diameter Of Hole : 0.073 m	Lithology : Breksi
Method of Test : Water Pres. Test	Date Of Tested : 19/9/2020
Packer Type : Pneumatic	Time from 08.52 to 09.45

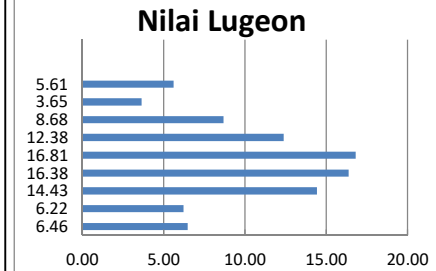
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	708.4	766.5	839.3	1030.2	1265.8	1534.7	1718.4	1804.5	1797.1
	1	711.9	775.5	881.9	1084.3	1317.0	1562.9	1739.1	1808.3	1799.4
	2	715.5	785.2	924.1	1128.1	1368.9	1603.6	1760.8	1813.2	1802.0
	3	718.8	794.9	953.2	1166.6	1420.4	1639.2	1782.3	1819.0	1805.4
	4	722.3	804.5	980.7	1210.3	1471.5	1674.4	1803.7	1825.4	1808.9
	5	726.0	814.1	1008.1	1250.8	1523.4	1709.6	1825.3	1832.6	1812.4
Total Volume (liter)		17.60	47.60	168.80	220.60	257.60	174.9	106.9	28.1	15.3
Average Volume	liter/min	3.52	9.52	33.76	44.12	51.52	34.98	21.38	5.62	3.06
	liter/min/m	0.70	1.90	6.75	8.82	10.30	7.00	4.28	1.12	0.61
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.03	0.41	0.71	0.96	0.44	0.17	0.01	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.09	3.06	4.68	5.39	6.13	5.65	4.93	3.08	1.09
Koef. Permb (cm/sec)		3.66E-05	3.53E-05	8.18E-05	9.28E-05	9.53E-05	7.02E-05	4.92E-05	2.07E-05	3.18E-05
Lugeon Unit		6.46	6.22	14.43	16.38	16.81	12.38	8.68	3.65	5.61

7.70E-05 : Constant number of rod friction loss for normal boring rod

### Formula :

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 3.18E-05 cm/sec**  
**Lugeon = 5.61 Lu**

**Lugeon Test (Stage 1)**

<b>Hole Number</b> : PL-60 (Plinth)	Depth Of Test
Ground Water Level : 7.1 m	Length Of Sect
Pressure Gauge Height : 0.63 m	Pipe length
Diameter Of Hole : 0.073 m	Lithology
Method Of Test : Water Pres. Test	Date Of Tested
Packer Type : Mekanik	Time from

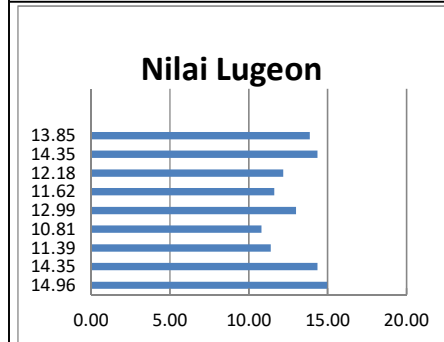
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		0.5	1	2	3	4	3	2	1	0.5
Time (min)	0	765.8	824.4	898.6	4991	106.4	267.8	385.5	478.4	544.9
	1	775.6	837.3	914.7	5011.4	137.5	289.5	402.2	491.5	553.8
	2	785.3	849.8	930.5	5031.3	166.5	310.9	418.8	503.9	562.7
	3	794.4	862.3	946.2	5051.5	197.3	332.3	436	516.2	571.4
	4	803.6	874.9	962	5071.4	227.9	353.5	452.2	528.7	580
	5	812.8	887	976.3	5091	256.1	375	468.4	541	588.5
Total Volume (liter)		47	62.6	77.7	100	149.7	107.2	82.9	62.6	43.6
Average Volume	liter/min	9.4	12.52	15.54	20	29.94	21.44	16.58	12.52	8.72
	liter/min/m	1.88	2.50	3.11	4.00	5.99	4.29	3.32	2.50	1.74
Friction Loss (kgf/cm <sup>2</sup> )		0.02	0.03	0.04	0.07	0.16	0.08	0.05	0.03	0.01
Effective Press. (kgf/cm <sup>2</sup> )		1.26	1.74	2.73	3.70	4.61	3.69	2.72	1.74	1.26
Koef. Permb (cm/sec)		8.48E-05	8.14E-05	6.45E-05	6.13E-05	7.36E-05	6.59E-05	6.90E-05	8.14E-05	7.85E-05
Lugeon Unit		14.96	14.35	11.39	10.81	12.99	11.62	12.18	14.35	13.85

7.70E-05 : Constant number of rod friction loss for normal boring rod

**Formula :**

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 7.36E-05 cm/sec**  
**Lugeon = 12.99 Lu**

Lugeon Test (Stage 2)										
<b>Hole Number : PL-60 (Plinth)</b>					Depth Of Test : 20 - 25					
Ground Water Level : 6.85 m					Length Of Sect : 5					
Pressure Gauge Height : 0.65 m					Pipe length : 27					
Diameter Of Hole : 0.073 m					Lithology : Breccia					
Method Of Test : Water Pres. Test					Date Of Tested : 3/18/2020					
Packer Type : Mekanik					Time from : 11:5 - 12:45					
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		2.5	4	5	6	7	6	5	4	2.5
Time (min)	0	755.6	772	779.6	785.9	795.5	808.5	815.7	821.6	827.2
	1	758.4	773.5	780.7	787.6	797.6	809.9	816.6	822.3	828.8
	2	761.1	774.9	781.8	789.2	799.6	811.1	817.6	823	830.1
	3	764.7	776.6	782.8	790.6	801.6	812.4	819	823.8	831.3
	4	766.7	777.9	784	792.1	803.7	813.7	819.7	824.5	832.2
	5	769.1	778.8	784.7	793.5	805.7	815.1	820.8	825.3	833.8
Total Volume (liter)		13.5	6.8	5.1	7.6	10.2	6.6	5.1	3.7	6.6
Average Volume	liter/min	2.7	1.36	1.02	1.52	2.04	1.32	1.02	0.74	1.32
	liter/min/m	0.54	0.27	0.20	0.30	0.41	0.26	0.20	0.15	0.26
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		3.25	4.75	5.75	6.75	7.75	6.75	5.75	4.75	3.25
Koef. Permb (cm/sec)		9.42E-06	3.25E-06	2.01E-06	2.55E-06	2.98E-06	2.22E-06	2.01E-06	1.77E-06	4.60E-06
Lugeon Unit		1.66	0.57	0.35	0.45	0.53	0.39	0.35	0.31	0.81

7.70E-05 : Constant number of rod friction loss for normal boring rod

**Formula :**

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2));$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

**Nilai Lugeon**

**k = 2.98E-06 cm/sec**  
**Lugeon = 0.53 Lu**

Lugeon Test (Stage 3)																													
<b>Hole Number : PL-60 (Plinth)</b>					Depth Of Test : 27 - 30																								
Ground Water Level : 7.1 m					Length Of Sect : 3																								
Pressure Gauge Height : 0.63 m					Pipe length : 23																								
Diameter Of Hole : 0.073 m					Lithology : Breccia																								
Method Of Test : Water Pres. Test					Date Of Tested : 3/18/2020																								
Packer Type : Mekanik					Time from : 13:3(- 14:29																								
Gauge Pressure (kgf/cm <sup>2</sup> )																													
<table border="1"> <thead> <tr> <th></th> <th>Po - 1</th> <th>Po - 2</th> <th>Po - 3</th> <th>Po - 4</th> <th>Po - 5</th> <th>Po - 6</th> <th>Po - 7</th> <th>Po - 8</th> <th>Po - 9</th> </tr> </thead> <tbody> <tr> <td></td> <td>0.5</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>3</td> <td>2</td> <td>1</td> <td>0.5</td> </tr> </tbody> </table>											Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9		0.5	1	2	3	4	3	2	1	0.5
	Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9																				
	0.5	1	2	3	4	3	2	1	0.5																				
Time (min)	0	765.8	824.4	898.6	4991	106.4	267.8	385.5	478.4	544.9																			
	1	775.6	837.3	914.7	5011.4	137.5	289.5	402.2	491.5	553.8																			
	2	785.3	849.8	930.5	5031.3	166.5	310.9	418.8	503.9	562.7																			
	3	794.4	862.3	946.2	5051.5	197.3	332.3	436	516.2	571.4																			
	4	803.6	874.9	962	5071.4	227.9	353.5	452.2	528.7	580																			
	5	812.8	887	976.3	5091	256.1	375	468.4	541	588.5																			
Total Volume (liter)	47	62.6	77.7	100	149.7	107.2	82.9	62.6	43.6																				
Average Volume	liter/min	9.4	12.52	15.54	20	29.94	21.44	16.58	12.52	8.72																			
	liter/min/m	3.13	4.17	5.18	6.67	9.98	7.15	5.53	4.17	2.91																			
Friction Loss (kgf/cm <sup>2</sup> )	0.02	0.03	0.04	0.07	0.16	0.08	0.05	0.03	0.01																				
Effective Press. (kgf/cm <sup>2</sup> )	1.26	1.74	2.73	3.70	4.61	3.69	2.72	1.74	1.26																				
Koef. Permb (cm/sec)	1.27E-04	1.22E-04	9.64E-05	9.15E-05	1.10E-04	9.84E-05	1.03E-04	1.22E-04	1.17E-04																				
Lugeon Unit	24.93	23.92	18.98	18.02	21.65	19.37	20.30	23.92	23.08																				

7.70E-05 : Constant number of rod friction loss for normal boring rod

**Formula :**

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$

**Nilai Lugeon**

Time (min)	Lugeon Unit
0	23.08
1	23.92
2	20.30
3	19.37
4	21.65
5	18.02
6	18.98
7	23.92
8	24.93

**k = 9.15E-05 cm/sec**  
**Lugeon = 18.02 Lu**

**Lugeon Test (Stage 4)**

<b>Hole Number : PL-60 (Plinth)</b>	Depth Of Test : 30 - 35
Ground Water Level : 6.6 m	Length Of Sect : 5
Pressure Gauge Height : 0.65 m	Pipe length : 37
Diameter Of Hole : 0.073 m	Lithology : Breccia
Method Of Test : Water Pres. Test	Date Of Tested : 3/21/2020
Packer Type : Mekanik	Time from : 09:21- 10:16

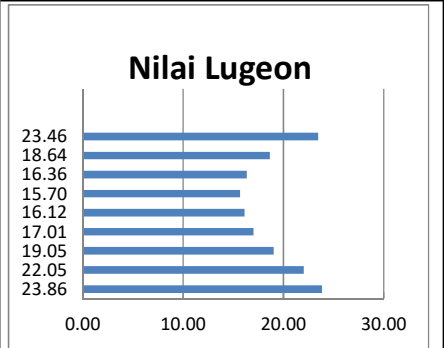
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	658.9	769.8	8980.2	263.4	561	876.4	136	365.3	537.8
	1	677.1	806.1	9029.3	313.8	615.9	924	178	397.5	556.8
	2	696.5	843.4	9076.6	363.4	670.6	975.2	220.4	449.5	576
	3	715.8	880.6	9124.4	415.1	725.7	1019.5	263	461.4	594.9
	4	735	916.3	9172	465.4	781.1	1067.2	305.7	493.2	613.9
	5	755.3	953.4	9220.7	517.3	836.6	1114.4	348.5	525	632.8
Total Volume (liter)		96.4	183.6	240.5	253.9	275.6	238	212.5	159.7	95
Average	liter/min	19.28	36.72	48.1	50.78	55.12	47.6	42.5	31.94	19
Volume	liter/min/m	3.86	7.34	9.62	10.16	11.02	9.52	8.50	6.39	3.80
Friction Loss (kgf/cm <sup>2</sup> )		0.11	0.39	0.68	0.75	0.89	0.66	0.53	0.30	0.11
Effective Press. (kgf/cm <sup>2</sup> )		1.62	3.33	5.05	5.97	6.84	6.06	5.20	3.43	1.62
Koef. Permb (cm/sec)		1.35E-04	1.25E-04	1.08E-04	9.64E-05	9.14E-05	8.90E-05	9.27E-05	1.06E-04	1.33E-04
Lugeon Unit		23.86	22.05	19.05	17.01	16.12	15.70	16.36	18.64	23.46

7.70E-05 : Constant number of rod friction loss for normal boring rod

**Formula :**

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG} (L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 8.90E-05 cm/sec**  
**Lugeon = 15.70 Lu**

**Lugeon Test (Stage 5)**

<b>Hole Number</b> : PL-60 (Plinth)	Depth Of Test
Ground Water Level : 6.6 m	Length Of Sect
Pressure Gauge Height : 0.65 m	Pipe length
Diameter Of Hole : 0.073 m	Lithology
Method Of Test : Water Pres. Test	Date Of Tested
Packer Type : Mekanik	Time from

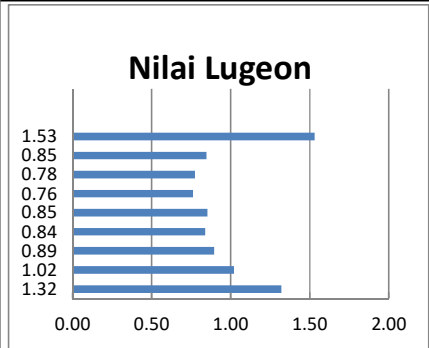
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	3	5	6	7	6	5	3	1
Time (min)	0	28.8	40.7	51.9	67.1	83.1	100.9	114.5	126.6	135.7
	1	30.5	42.9	54.6	69.9	87.8	103.4	116.7	128	137
	2	31.7	44.7	57.2	72.7	90.7	105.9	118.9	129.7	138.3
	3	32.6	46.6	59.8	75.6	93.7	108.5	121.2	131.2	139.8
	4	33.6	48.5	62.3	78.4	96.8	111.1	123.2	132.8	141.1
	5	34.5	50.2	64.7	81.2	99.6	113.7	125.6	134.5	142.3
Total Volume (liter)		5.7	9.5	12.8	14.1	16.5	12.8	11.1	7.9	6.6
Average	liter/min	1.14	1.9	2.56	2.82	3.3	2.56	2.22	1.58	1.32
Volume	liter/min/m	0.23	0.38	0.51	0.56	0.66	0.51	0.44	0.32	0.26
Friction Loss (kgf/cm <sup>2</sup> )		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.72	3.72	5.72	6.72	7.72	6.72	5.72	3.72	1.72
Koef. Permb (cm/sec)		7.49E-06	5.78E-06	5.07E-06	4.76E-06	4.84E-06	4.32E-06	4.40E-06	4.81E-06	8.68E-06
Lugeon Unit		1.32	1.02	0.89	0.84	0.85	0.76	0.78	0.85	1.53

7.70E-05 : Constant number of rod friction loss for normal boring rod

**Formula :**

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (\text{GWL} + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 4.32E-06 cm/sec**  
**Lugeon = 0.76 Lu**

**Lugeon Test (Stage 6)**

<b>Hole Number</b> : PL-60 (Plinth)	Depth Of Test
Ground Water Level : 6.6 m	Length Of Sect
Pressure Gauge Height : 0.65 m	Pipe length
Diameter Of Hole : 0.073 m	Lithology
Method Of Test : Water Pres. Test	Date Of Tested
Packer Type : Mekanik	Time from

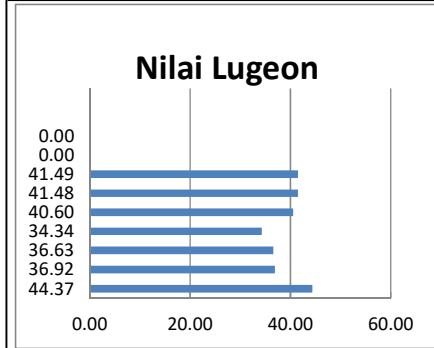
Gauge Pressure (kgf/cm <sup>2</sup> )		Po - 1	Po - 2	Po - 3	Po - 4	Po - 5	Po - 6	Po - 7	Po - 8	Po - 9
		1	2	3	4	3	2	1	0	0
Time (min)	0	193.9	358.5	580.4	861.4	233.7	519.3	744.2	0	0
	1	223.7	400	631.4	919	288.7	562.3	773	0	0
	2	253.9	440	680.5	977.6	340.9	605	802.6	0	0
	3	284.6	479.4	731.3	1036.3	400.6	646.6	831.8	0	0
	4	315.5	517.8	783.7	1095.5	447.7	689.5	861	0	0
	5	346.8	556.4	834.1	1156.3	502.8	732.2	890.3	0	0
Total Volume (liter)		152.9	197.9	253.7	294.9	269.1	212.9	146.1	0	0
Average	liter/min	30.58	39.58	50.74	58.98	53.82	42.58	29.22	0	0
Volume	liter/min/m	6.12	7.92	10.15	11.80	10.76	8.52	5.84	0.00	0.00
Friction Loss (kgf/cm <sup>2</sup> )		0.35	0.58	0.95	1.29	1.07	0.67	0.32	0.00	0.00
Effective Press. (kgf/cm <sup>2</sup> )		1.38	2.14	2.77	3.44	2.65	2.05	1.41	0.73	0.73
Koef. Permb (cm/sec)		2.51E-04	2.09E-04	2.08E-04	1.95E-04	2.30E-04	2.35E-04	2.35E-04	0.00E+00	0.00E+00
Lugeon Unit		44.37	36.92	36.63	34.34	40.60	41.48	41.49	0.00	0.00

7.70E-05 : Constant number of rod friction loss for normal boring rod

**Formula :**

$$k = \frac{2,3 \times Q \times 1000}{2 \times \pi \times 60 \times L \times H} \times \text{LOG}(L/(D/2))$$

$$P = P_o + \gamma_w \times (GWL + L_m - P_f) \quad L_u = \frac{10 \times Q}{L \times H}$$



**k = 1.95E-04 cm/sec**  
**Lugeon = 34.34 Lu**