

## **APPENDIX 7**

**7-1 EXISTING ROAD SURVEY SHEET**

**7-2 EXISTING STUCTURE SURVEY SHEET**

**7-3 HYDROLOGICAL ANALYSIS RESULT**

**7-4 GEOLOGICAL SURVEY AND MATERIAL TEST  
RESULT**

**7-5 OUTLINE DESIGN TECHNICAL SEMINAR**

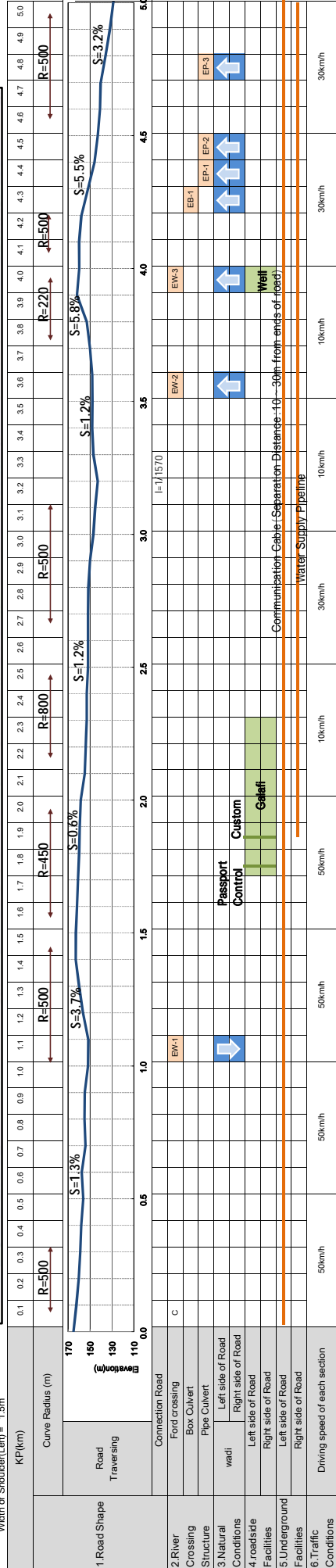
## **7-1 EXISTING ROAD SURVEY SHEET**

Route1 Road Current Situation Survey (1/5)

0.0km(BP) ~ 5.0km



Width of Carriageway = 6.5m  
 Width of Shoulder(Left) = 1.5m  
 Width of Shoulder(Right) = 1.5m



Route1 Road Current Situation Survey (2/5)

5.0km ~ 10.0km



Width of Carriageway = 6.5m  
 Width of Shoulder(Left) = 1.5m  
 Width of Shoulder(Left) = 1.5m

1.Road Shape	KP(km)	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	10.0																																																																																																				
	Curve Radius (m)	R=1500											R=900											R=500																																																																																																																															
Elevation(m)		170	160	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300																																																																																																						
2.River Crossing Structure																																EB-2		EB-3		EW-6		EW-5		EW-4																																																																																																															
3.Natural Conditions	wadi																															↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑																																																																															
4.roadside Facilities	Left side of Road																															Culvert																																																																																																																							
5.Underground Facilities	Left side of Road																																																																																																																																																						
6.Traffic Conditions	Driving speed of each section	10km/h										10km/h										10km/h										50km/h										50km/h										50km/h																																																																																																			
Slopes		S=-1.0%																														S=-0.5%																														S=-0.1%																														S=-0.1%																																																											
Communication Cable (Separation Distance: 10m from ends of road)		Water Supply Pipeline																																																																																																																																																					







Width of Carriageway = 6.5m  
 Width of Shoulder(Left) = 4.5m  
 Width of Shoulder(Right) = 4.5m

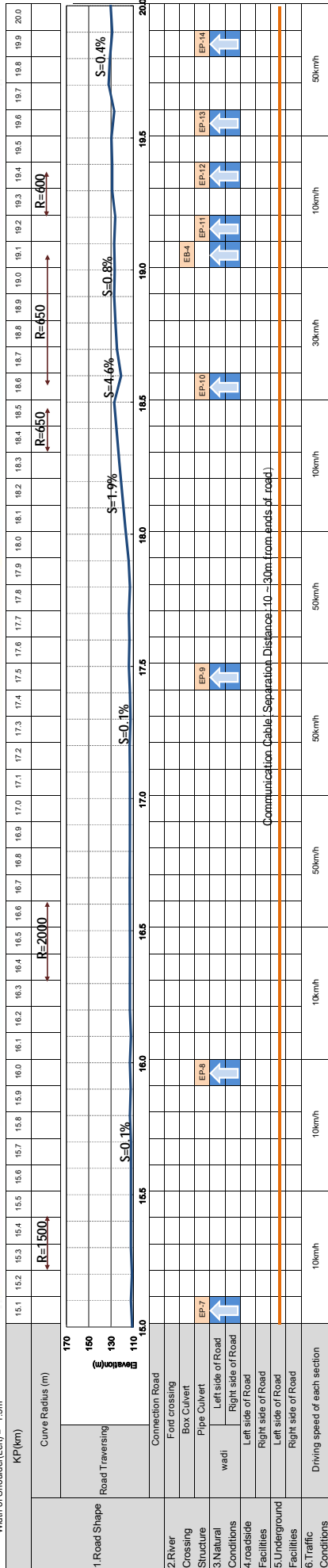
1.Road Shape	KP(km)	Curve Radius (m)															Elevation (m)																																												
		170	160	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	0																																										
2.River Crossing Structure	Road Traversing	R=1000															S=0.1%																																												
		R=1000															S=0.1%																																												
3.Natural Conditions	ward																																																												
5.Underground Facilities	Right side of Road																																																												
																																6.Traffic Conditions	Driving speed of each section																												
S=0.1%															S=0.1%																																														

Communication Cable Separation Distance 10 ~ 30m from bands of road.





Width of Carriageway = 6.5m  
 Width of Shoulder(Left) = 4.5m  
 Width of Shoulder(Right) = 4.5m










Width of Carriageway = 6.5m  
 Width of Shoulder(Left) = 4.5m  
 Width of Shoulder(Right) = 4.5m

1.Road Shape	KP(km)	Curve Radius (m)		Elevation(m)	S=1.0%	R=2000	R=700	S=1.0%	R=700	23.0	23.5	24.0	24.5	25.0
		Left	Right											
2.River Crossing Structure	Connection Road			170										
	Fore crossing			160										
	Box Culvert			150										
3.Natural Conditions	Pipe Culvert			140										
	wadi			130										
4.roadside Facilities	Left side of Road			120										
	Right side of Road			110										
5.Underground Facilities	Left side of Road													
	Right side of Road													
6.Traffic Conditions	Driving speed of each section													












PK	Condition of Existing Road (Driving Record)
<p>approx. 21.5km from boarder (PK197.5)</p>	 <p>A blue truck with a green tarp is driving on a dirt road in a desert landscape. The road is sandy and appears to be in poor condition. The truck is moving away from the camera. The background shows a clear blue sky and distant mountains.</p>
<p>approx. 20.95km from boarder (PK198.05)</p>	 <p>A yellow truck is driving on a dirt road in a desert landscape. The road is sandy and appears to be in poor condition. The truck is moving away from the camera. The background shows a clear blue sky and distant mountains.</p>
<p>approx. 20.5km from boarder (PK198.5)</p>	 <p>A small truck is driving on a dirt road in a desert landscape. The road is sandy and appears to be in poor condition. The truck is moving away from the camera. The background shows a clear blue sky and distant mountains.</p>
<p>approx. 20km from boarder (PK199)</p>	 <p>A dirt road in a desert landscape. The road is sandy and appears to be in poor condition. The background shows a clear blue sky and distant mountains.</p>
<p>approx. 19.5km from boarder (PK199.5)</p>	 <p>A white truck is driving on a dirt road in a desert landscape. The road is sandy and appears to be in poor condition. The truck is moving away from the camera. The background shows a clear blue sky and distant mountains.</p>






PK	Condition of Existing Road (Driving Record)
approx. 19km from boarder (PK200)	
approx. 18.5km from boarder (PK200.5)	
approx. 18km from boarder (PK201)	
approx. 17.55km from boarder (PK201.45)	
approx. 16.95km from boarder (PK202.05)	








PK	Condition of Existing Road (Driving Record)
<p>approx. 16.5km from boarder (PK202.5)</p>	 <p>A dashcam view of a two-lane asphalt road in a desert landscape. A white car is visible in the distance. The road surface appears slightly uneven. A white crosshair is overlaid on the bottom right of the image. Metadata at the bottom reads: E41-935742 N11-505019 NA-14R670 2016/04/04 12:10:01 40462075500</p>
<p>approx. 16km from boarder (PK203)</p>	 <p>A dashcam view of a road with several large trucks. One truck has a red container, and another has a blue container. The road surface is sandy and appears to be in poor condition. A white crosshair is overlaid on the bottom right of the image. Metadata at the bottom reads: E41-932205 N11-508771 NA-15R670 2016/04/04 12:10:01 40462075500</p>
<p>approx. 15.55km from boarder (PK203.45)</p>	 <p>A dashcam view of a road with a white car in the distance. The road surface is sandy and appears to be in poor condition. A white crosshair is overlaid on the bottom right of the image. Metadata at the bottom reads: E41-929492 N11-521705 NA-15R670 2016/04/04 12:10:01 40462075500</p>
<p>approx. 15km from boarder (PK204)</p>	 <p>A dashcam view of a road with a large truck in the distance. The road surface is sandy and appears to be in poor condition. A white crosshair is overlaid on the bottom right of the image. Metadata at the bottom reads: E41-926774 N11-544759 NA-15R670 2016/04/04 12:10:01 40462075500</p>
<p>approx. 14.5km from boarder (PK204.5)</p>	 <p>A dashcam view of a road with a white car in the distance. The road surface is sandy and appears to be in poor condition. A white crosshair is overlaid on the bottom right of the image. Metadata at the bottom reads: E41-924110 N11-548399 NA-14R670 2016/04/04 12:10:01 40462075500</p>

PK	Condition of Existing Road (Driving Record)
approx. 14km from boarder (PK205)	
approx. 13.5km from boarder (PK205.5)	
approx. 13km from boarder (PK206)	
approx. 12.55km from boarder (PK206.45)	
approx. 12km from boarder (PK207)	

PK	Condition of Existing Road (Driving Record)
<p>approx. 11.5km from boarder (PK207.5)</p>	
<p>approx. 11km from boarder (PK208)</p>	
<p>approx. 10.55km from boarder (PK208.45)</p>	
<p>approx. 10km from boarder (PK209)</p>	
<p>approx. 9.4km from boarder (PK209.6)</p>	





PK	Condition of Existing Road (Driving Record)
approx. 9km from boarder (PK210)	
approx. 8.5km from boarder (PK210.5)	
approx. 8km from boarder (PK211)	
approx. 7.5km from boarder (PK211.5)	
approx. 7km from boarder (PK212)	



PK	Condition of Existing Road (Driving Record)
<p>approx. 6.5km from boarder (PK212.5)</p>	 <p>F41-055506-N11-695845-NW-76km/h 2019/04/04 12:49:00 (40450013801)</p>
<p>approx. 6km from boarder (PK213)</p>	 <p>F41-052061-N11-694047-NW-35km/h 2019/04/04 12:49:00 (40450013801)</p>
<p>approx. 5.55km from boarder (PK213.45)</p>	 <p>F41-059440-N11-692225-NW-00km/h 2019/04/04 12:49:00 (40450013801)</p>
<p>approx. 4.95km from boarder (PK214.05)</p>	 <p>F41-055819-N11-701520-NW-30km/h 2019/04/04 12:49:00 (40450013801)</p>
<p>approx. 4.5km from boarder (PK214.5)</p>	 <p>F41-052200-N11-702905-W-Sakayh 2019/04/04 12:49:00 (40450013801)</p>












PK	Condition of Existing Road (Driving Record)
approx. 4km from boarder (PK215)	
approx. 3.5km from boarder (PK215.5)	
approx. 3km from boarder (PK216)	
approx. 2.5km from boarder (PK216.5)	
approx. 2km from boarder (PK217) 国境施設	

PK	Condition of Existing Road (Driving Record)
approx. 1.5km from boarder (PK217.5)	 <p>Driving record image showing a road with a large tanker truck in the foreground and other vehicles in the distance. The road is paved and the surrounding area is arid. Metadata: E41-333512 N11-724534 N 00km/h 2018/03/19 21:05:00 10560132000</p>
approx. 1km from boarder (PK218)	 <p>Driving record image showing a line of tanker trucks on a paved road in a desert landscape. Metadata: E41-333781 N11-724552 N 30km/h 2018/03/19 21:05:00 10560132000</p>
approx. 0.5km from boarder (PK218.5)	 <p>Driving record image showing a white truck with a green container on a road, with another truck ahead. Metadata: E41-334684 N11-724621 N 10km/h 2018/03/19 21:05:00 10560132000</p>
Border (PK219)	 <p>Driving record image showing a road at the border with various vehicles including a white truck and a Toyota pickup truck. Metadata: E41-335425 N11-731075 N 40km/h 2018/03/19 21:05:00 10560132000</p>






## **7-2 EXISTING STUCTURE SURVEY SHEET**






### List of Existing Structures





No.1	Category	EW-1 (Sta.216+765),Box-39	
	Type	Ford crossing	
	Size	B=6.5m, L=30m	
	Condition	<ul style="list-style-type: none"> <li>- For prevention of scouring, concrete structures (W 500 x H 200) and gabion (only on the downstream side) are installed at shoulder</li> <li>- In 2016, pavement was constructed by ADR, but the surface roughness of pavement is intense.</li> </ul>	
No.2	Category	EW-2 (Sta.214+760),Box-38	
	Type	Ford crossing	
	Size	B=6.5m, L=50m	
	Condition	<ul style="list-style-type: none"> <li>- For prevention of scouring, concrete structures (W 500 x H 200) and gabion (only on the downstream side) are installed at shoulder</li> <li>- Intense damage on pavement</li> </ul>	
No.3	Category	EW-3 (Sta.213+852),Box-36	
	Type	Ford crossing	
	Size	L=80m	
	Condition	<ul style="list-style-type: none"> <li>- For prevention of scouring, concrete slab (W: 20m, slope: 15 degree) is installed.</li> <li>- Intense damage on pavement</li> </ul>	
No.4	Category	EB-1 (Sta.213+515),Box-35	
	Type	Box Culvert	
	Size	B2000xH1500, L=10m	
	Condition	<ul style="list-style-type: none"> <li>- Intense damage on head wall</li> <li>- Confirmed numerous cracks on culvert</li> </ul>	

No.5	Category	EP-1 (Sta.213+411),Box-34	
	Type	Pipe Culvert	
	Size	D600, L=9.0m	
	Condition	<ul style="list-style-type: none"> <li>- Slope collapse around inlet part</li> <li>- Damage on backside of headwall</li> </ul>	
No.6	Category	EP-2 (Sta.213+355),Box-33	
	Type	Pipe Culvert	
	Size	D600, L=9.0m	
	Condition	<ul style="list-style-type: none"> <li>- Intense damage on head wall</li> <li>- Inlet part is stocked by collapsed soil from slope (no function as culvert)</li> </ul>	
No.7	Category	EP-3 (Sta.213+127)Box-32	
	Type	Pipe Culvert	
	Size	D600, L=9.0m	
	Condition	<ul style="list-style-type: none"> <li>- Confirmed numerous cracks on culvert</li> </ul>	
No.8	Category	EP-4 (Sta.212+819),Box-31	
	Type	Pipe Culvert(2 piece)	
	Size	D600x2, L=8.8m	
	Condition	<ul style="list-style-type: none"> <li>- Intense damage on head wall</li> <li>- Confirmed numerous cracks on culvert</li> </ul>	
No.9	Category	EB-2 (Sta.212+754),Box-30	
	Type	Box Culvert	
	Size	B1000xH800, L=10.0m	
	Condition	<ul style="list-style-type: none"> <li>- Intense damage on head wall</li> </ul>	





No.10	Category	EW-4 (Sta.212+550),Box-29	
	Type	Ford crossing	
	Size	B=6.5m, L=30m	
	Condition	- For prevention of scouring, concrete structures (W 500 x H 200) and gabion (only on the downstream side) are installed at shoulder - Intense damage on pavement	
No.11	Category	EW-5 (Sta.212+288),Box-28	
	Type	Ford crossing	
	Size	B=6.5m, L=30m	
	Condition	- For prevention of scouring, concrete structures (W 500 x H 200) and gabion (only on the downstream side) are installed at shoulder - Intense damage on pavement	
No.12	Category	EW-6 (Sta.211+992),Box-27	
	Type	Ford crossing	
	Size	B=6.5m, L=30m	
	Condition	- For prevention of scouring, concrete structures (W 500 x H 200) and gabion (only on the downstream side) are installed at shoulder - Intense damage on pavement	
No.13	Category	EB-3 (Sta.211+872),Box-26	
	Type	Box Culvert	
	Size	B2000xH1500, L=8.4m	
	Condition	- Intense damage on head wall - Slope collapse around inlet part	
No.14	Category	EP-5 (Sta.209+192),Box-19	
	Type	Pipe Culvert	
	Size	D600, L=9.2m	
	Condition	- Intense damage on head wall - Slope collapse around inlet part	

No.15	Category	EP-6 (Sta.208+790),Box-18	
	Type	Pipe Culvert	
	Size	D600, L=9.5m	
	Condition	<ul style="list-style-type: none"> <li>- Intense damage on head wall</li> <li>- Slope collapse around inlet part</li> </ul>	
No.16	Category	EP-7 (Sta.202+800),Box-12	
	Type	Pipe Culvert	
	Size	D600, L=9.5m	
	Condition	<ul style="list-style-type: none"> <li>- Inlet part is stocked by collapsed soil from slope (no function as culvert)</li> </ul>	
No.17	Category	EP-8 (Sta.201+943),Box-11	
	Type	Pipe Culvert	
	Size	D600, L=8.7m	
	Condition	<ul style="list-style-type: none"> <li>- Inlet part is stocked by collapsed soil from slope (no function as culvert)</li> </ul>	
No.18	Category	EP-9 (Sta.200+377),Box-9	
	Type	Pipe Culvert	
	Size	D600, L=8.4m	
	Condition	<ul style="list-style-type: none"> <li>- Intense damage on head wall</li> <li>- Inlet part is stocked by collapsed soil from slope (no function as culvert)</li> </ul>	
No.19	Category	EP-10 (Sta.199+279),Box-8	
	Type	Pipe Culvert (2)	
	Size	D1000x2, L=15.0m	
	Condition	<ul style="list-style-type: none"> <li>- Confirmed numerous cracks on culvert</li> <li>- Slope collapse around inlet part</li> </ul>	

No.20	Category	EC-4 (Sta.198+864),Box-7	
	Type	Box Culvert(2 連)	
	Size	B1000xH1000x2, L=11.0m	
	Condition	- Confirmed intense scour on outlet part	
No.21	Category	EP-11 (Sta.198+693),Box-6	
	Type	Pipe Culvert	
	Size	D800, L=9.7m	
	Condition	- Confirmed intense scour on outlet part - Confirmed numerous cracks on culvert	
No.22	Category	EP-12 (Sta.198+485),Box-5	
	Type	Pipe Culvert	
	Size	D800, L=11.0m	
	Condition	- Slope collapse around inlet part	
No.23	Category	EP-13 (Sta.198+270),Box-4	
	Type	Pipe Culvert	
	Size	D800, L=11.0m	
	Condition	- Slope collapse around inlet part	
No.24	Category	EP-14 (Sta.198+019),Box-3	
	Type	Pipe Culvert	
	Size	D800, L=9.7m	
	Condition	- Inlet part is stocked by waste (no function as culvert)	



No.25	Category	EP-15 (Sta.197+793),Box-2	
	Type	Pipe Culvert	
	Size	D800, L=11.0m	
	Condition	- Slope collapse around inlet part	
No.26	Category	EP-16 (Sta.197+485),Box-1	
	Type	Pipe Culvert	
	Size	D1000, L=9.8m	
	Condition	- Intense damage on head wall - Slope collapse around inlet part	

## **7-3 HYDROLOGICAL ANALYSIS RESULT**



# Natural Condition Survey (Hydrologic/River Analysis)

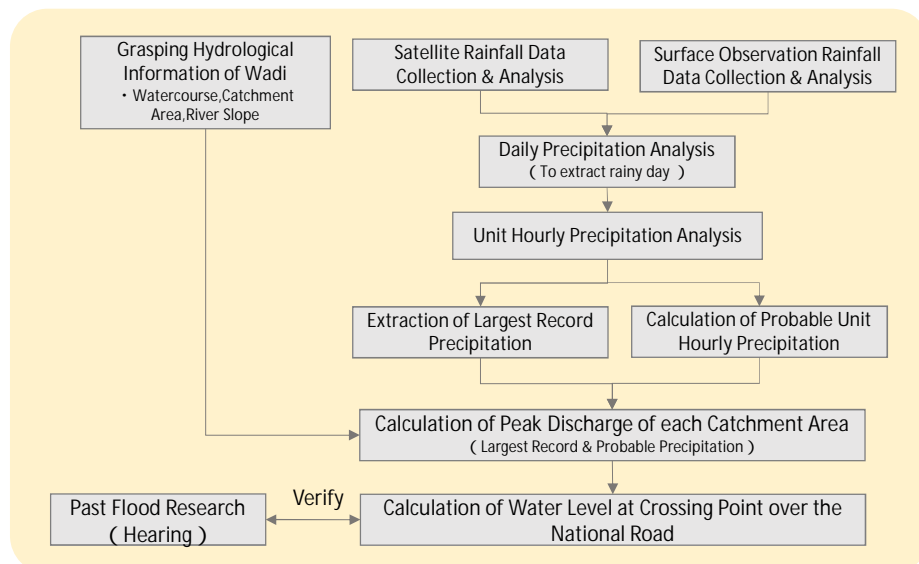
## Implementation Report Summary

### 1. Objective and Study Flow

#### Objective

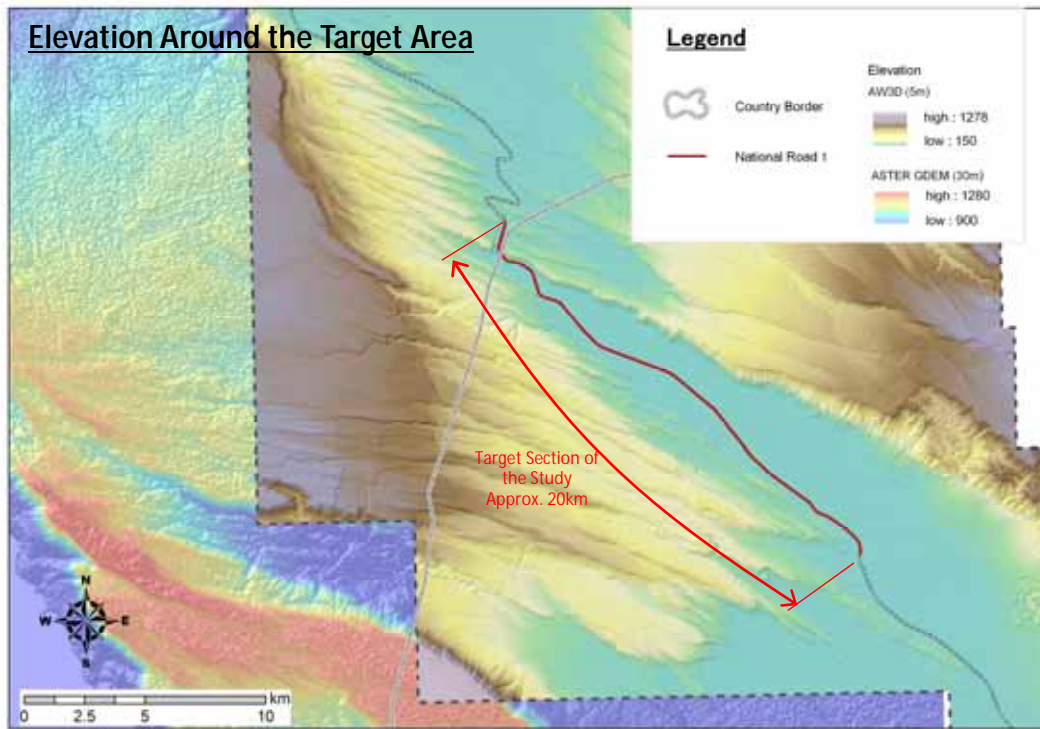
To grasp discharge and water level of wadi (seasonal river) in case of flood in the study area

#### Study Flow



## 2. Grasping Hydrological Information of Wadi – GIS Analysis -

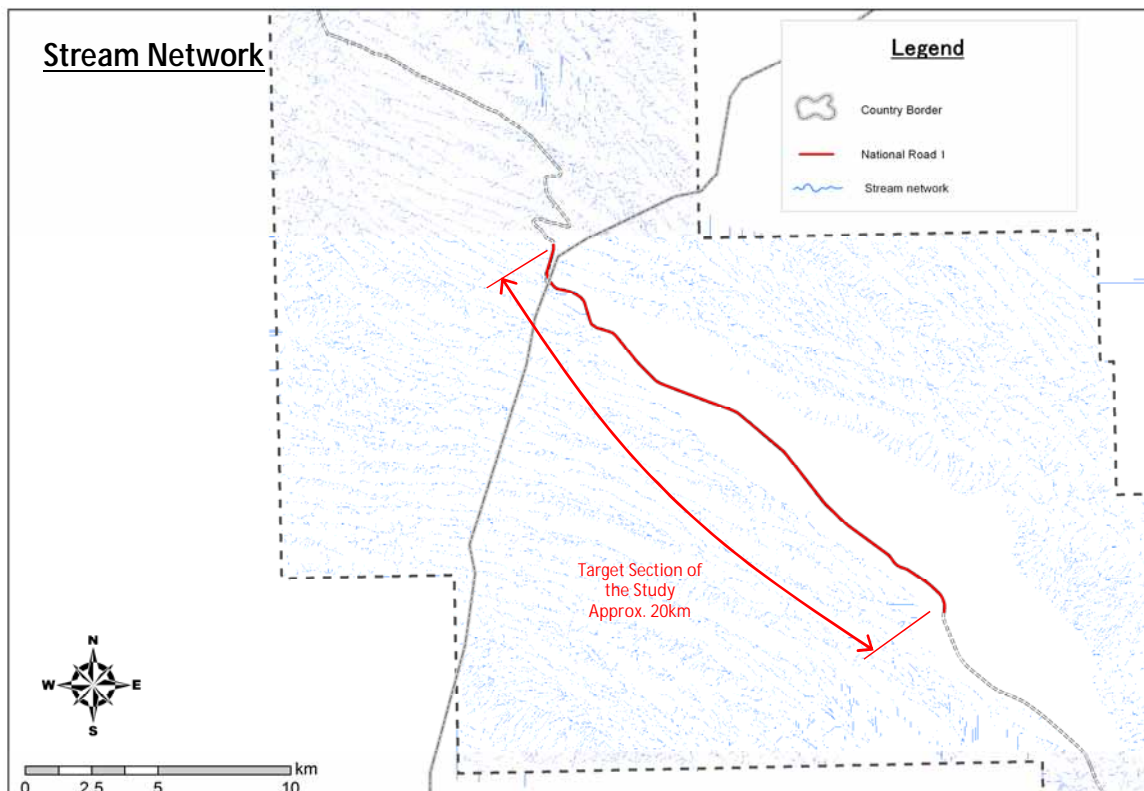
- Hydrological information such as watercourse, catchment area, river slope was analyzed by GIS using digital elevation model
- AW3D 5m DSM Level 2 (5m-resolution) was used
- Aster GDEM (30m-resolution) was also used for part of upper area of catchment area not covered by AW3D



2

## 2. Grasping Hydrological Information of Wadi – GIS Analysis -

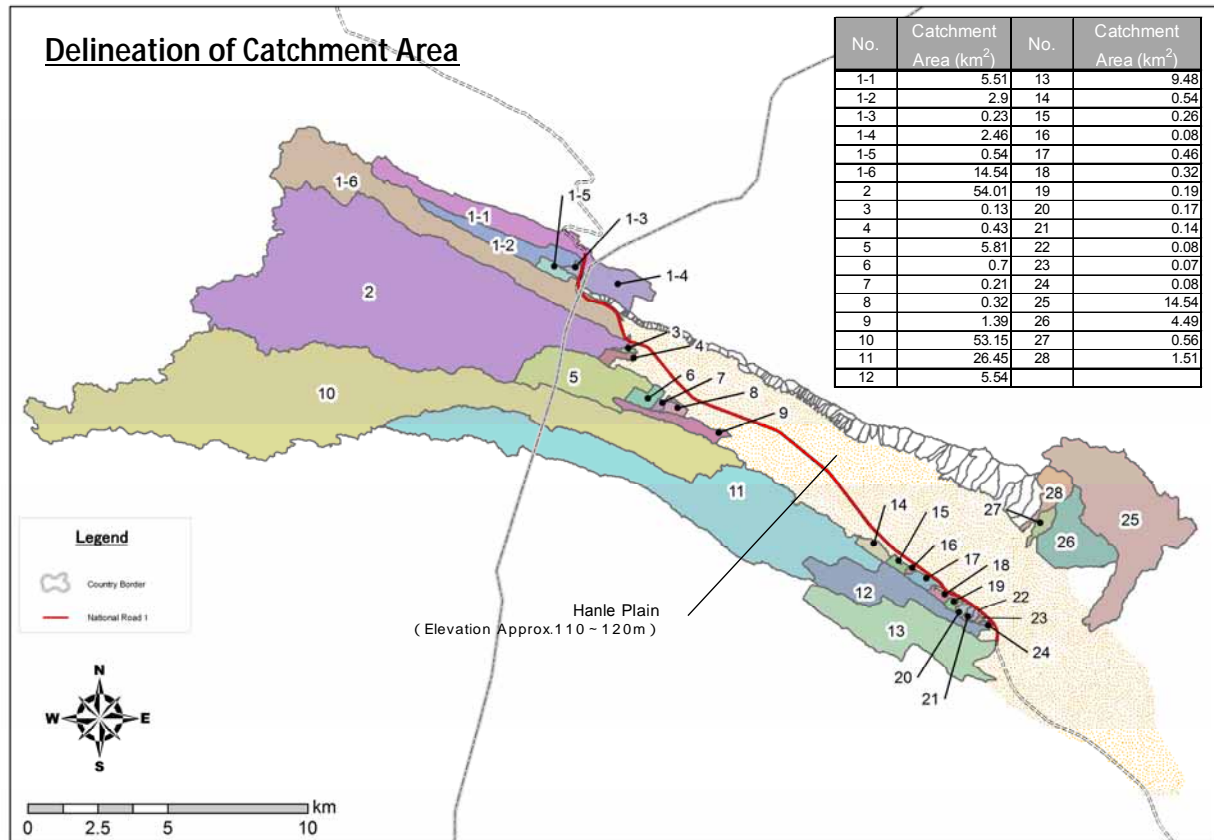
- Stream network was extracted using digital elevation model



3

## 2. Grasping Hydrological Information of Wadi - GIS Analysis -

- Catchment area was delineated using digital elevation model



4

## 2. Grasping Hydrological Information of Wadi - Satellite Image & Field Investigation -

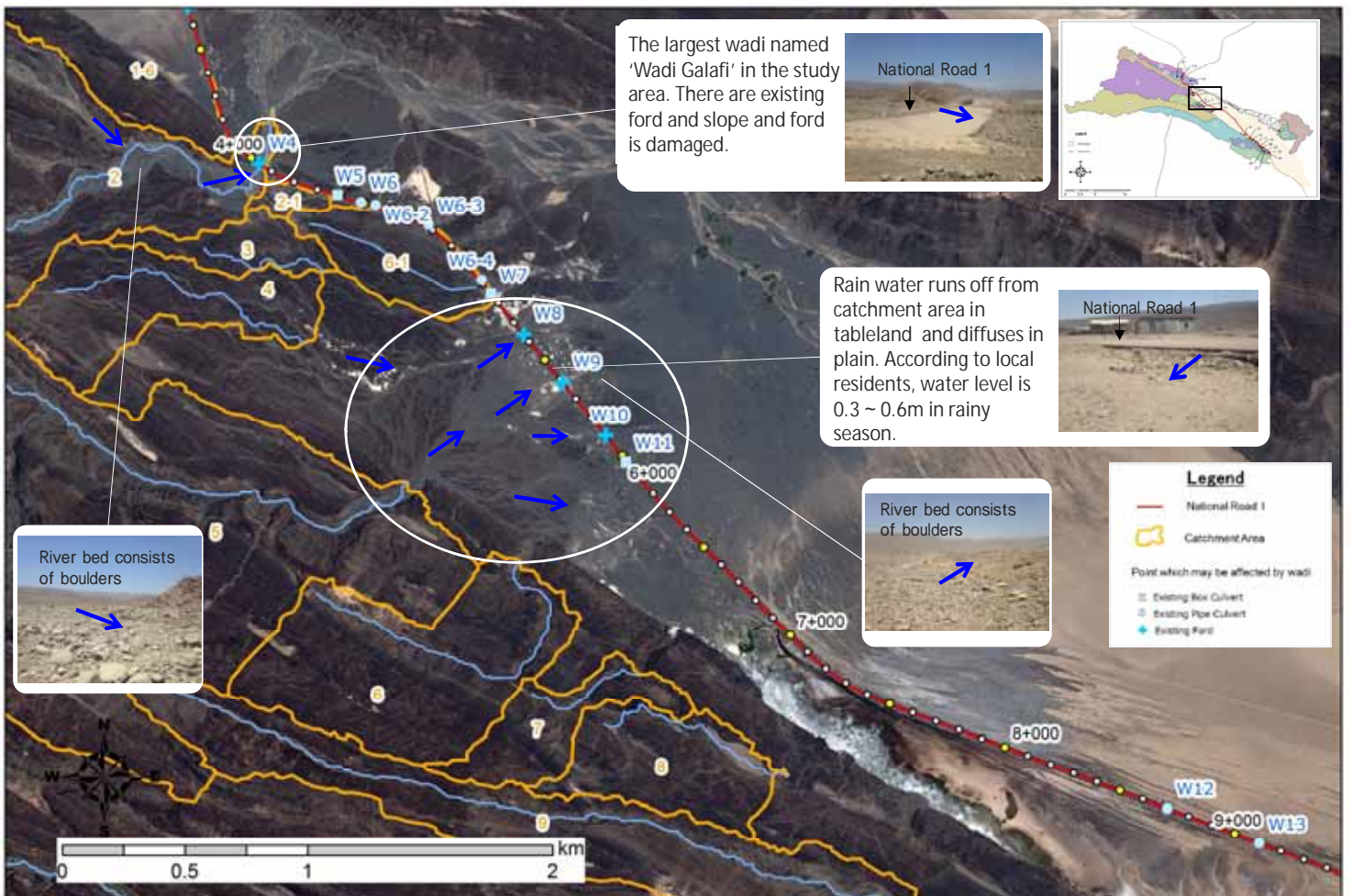
- Condition of wadi flow course and catchment area was confirmed using high resolution satellite image (SPOT 6 I SPOT 7 which is 1.5m- resolution)
- Actual condition was confirmed in field investigation
- Several locations where wadi may affect the national road in rainy season were pointed based on site condition including existing river/drainage structure , etc.

5



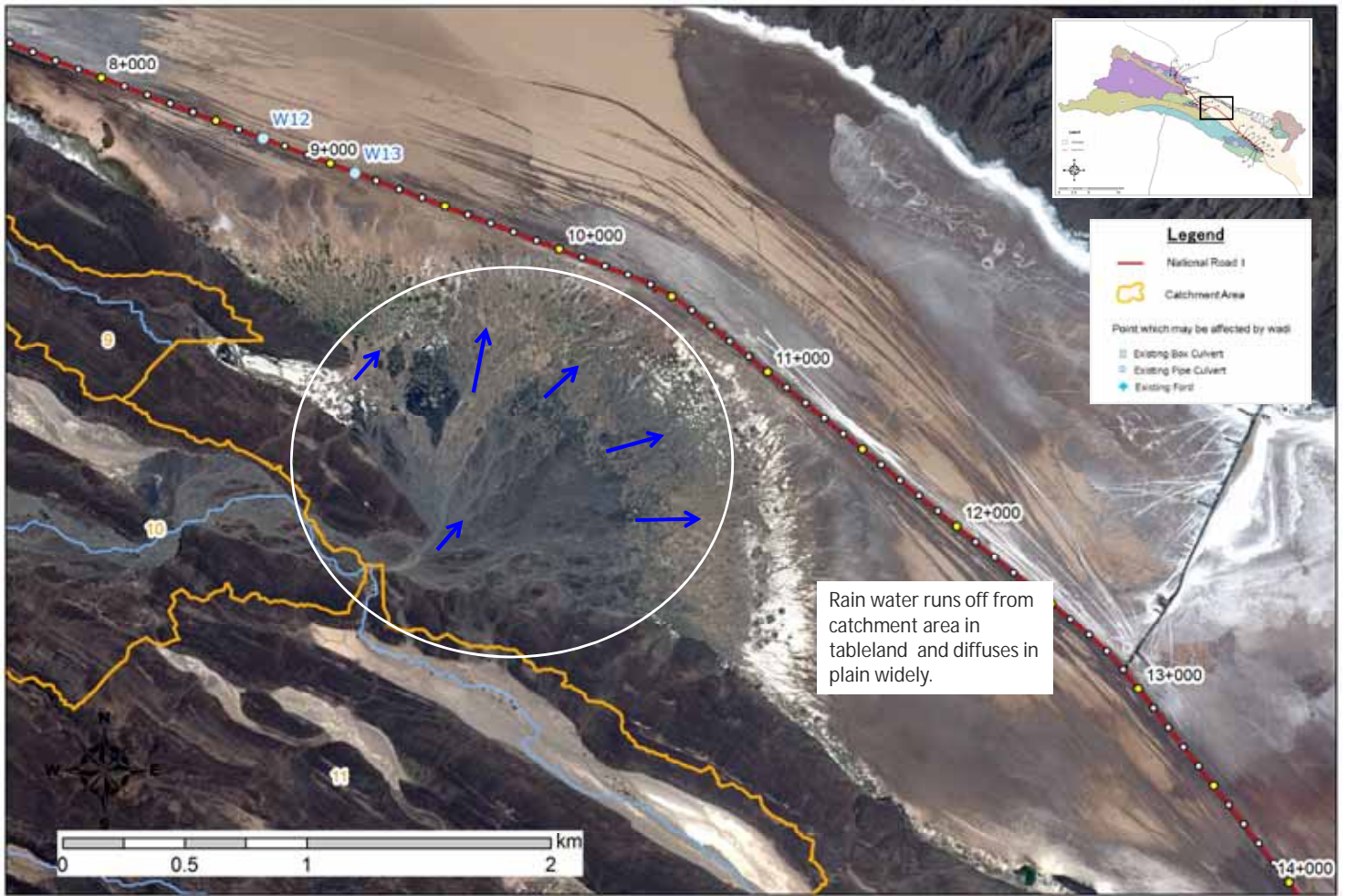


6



7



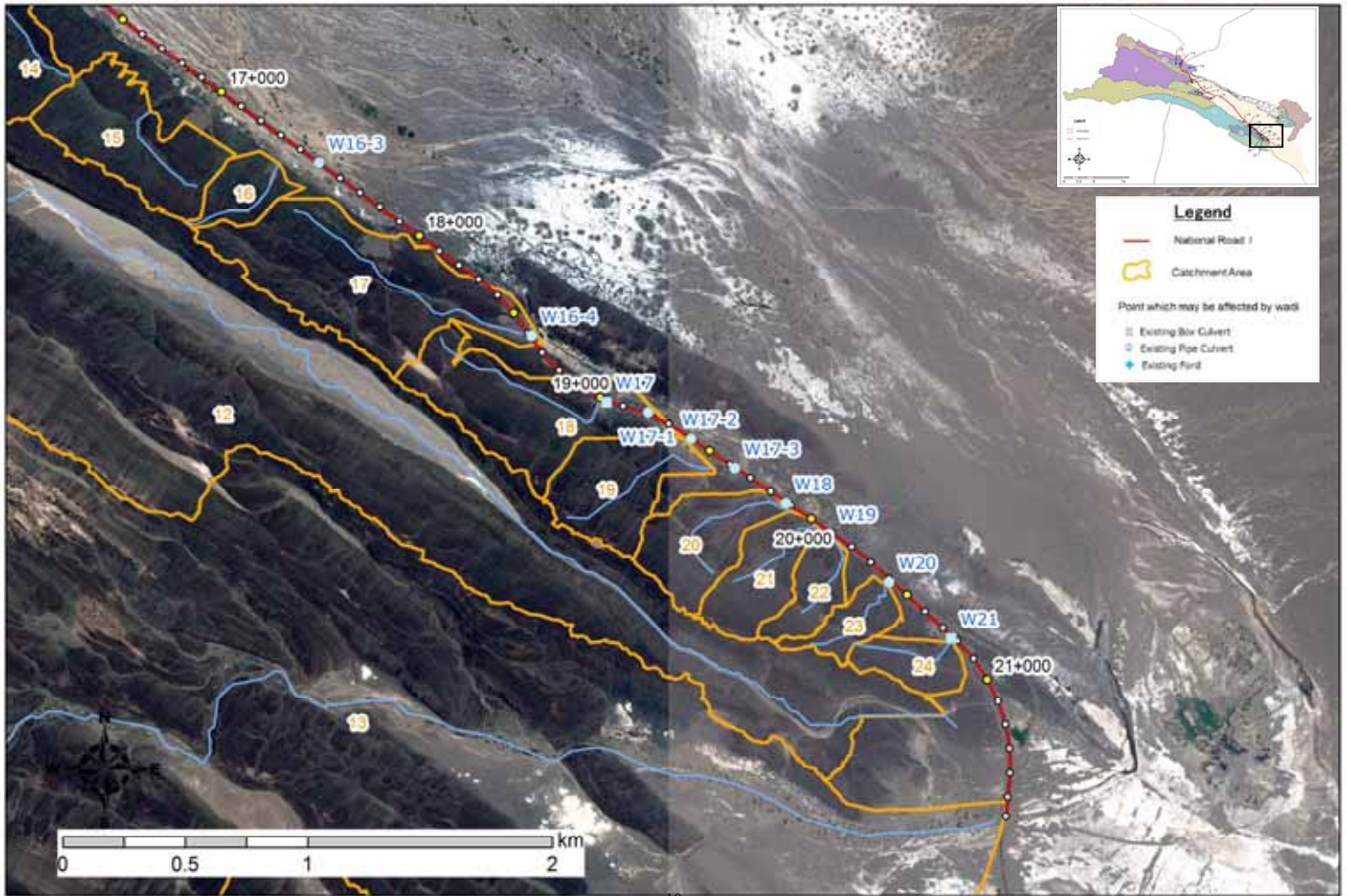


8

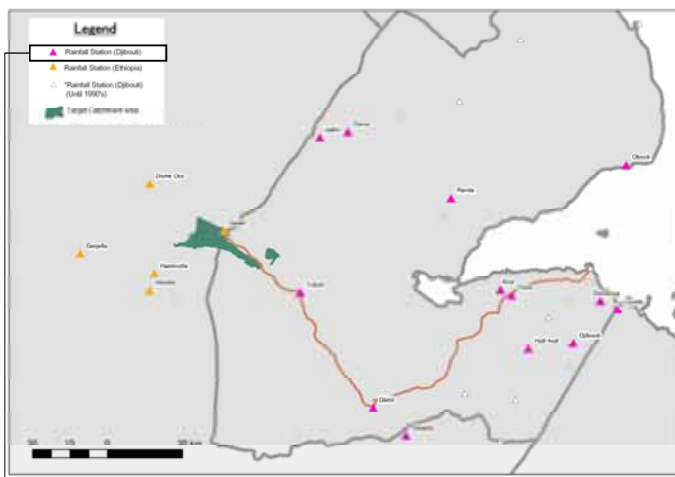


9





### 3. Rainfall Data Collection & Analysis - Surface Observation Data-



#### Circumstance of Surface Observation Data Collection in Djibouti

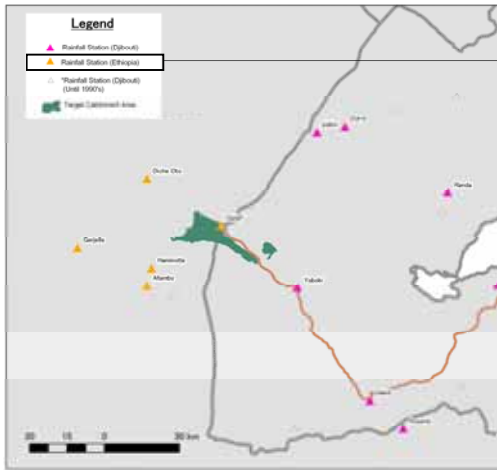
38 meteorological observation stations in Djibouti had been operated since 1983(the oldest). However, after 1990's, data of most of the stations has not been accumulated due to political reasons such as civil war.

Meteorological observation stations have been re-installed ; observation and data collection re-started since 2013 but accumulation of surface observation which covers whole the country is insufficient in the present situation.

Station Name	Lat	Long	Elevation (m)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Arta	11.52	42.83	705																		M	
Assamo	11	42.49	460																			M
balho	12.07	42.18	340																			M
Damerjog	11.48	43.19	35														M	M	M	M	M	M
Dikhil	11.1	42.37	498																			M
Djibouti	11.33	43.09	10	D	D	D	D	D	D	D	D	D/M	D/M	D/M	D/M	M	M	M	M	M	M	M
Dorra	12.09	42.28	295																			M
Galafi	-	-	-																			M
Holl-holl	11.31	42.93	440																			M
Loyada	11.45	43.25	3																			M
Obock	11.97	43.28	20																			M
Ouea	11.5	42.87	453																			M
Randa	11.85	42.65	920																			M
Tadjoura	-	-	-														M	M	M	M	M	M
Yoboki	11.51	42.11	232																			M

D:Daily Data M:Monthly Data

### 3. Rainfall Data Collection & Analysis - Surface Observation Data-



**Circumstance of Surface Observation Data Collection in Ethiopia**

Station Name	Lat	Long	Elevation (m)	2009	2010	2011	2012	2013	2014
Afambo	11.517	41.567	342	D (8,9,11,12)		D (1-12)	D (3-12)	D (1-12)	D (1-6)
Diche Oto	11.9	41.567	462	D (1,4,8,9)	D (1-12)	D (1-8,10,11)	D (4,7,9-12)	D (1-9)	D (1-3,5-11)
Galafi	11.733	41.8333	144		D (3-4)	D (1-4)	D (7-12)	D (1-5)	
Gerjelle	11.65	41.317	370			D (1-3)			
Haminotle	11.578889	41.58333	352		D (2,3,4,5)	D (1,2,3)			

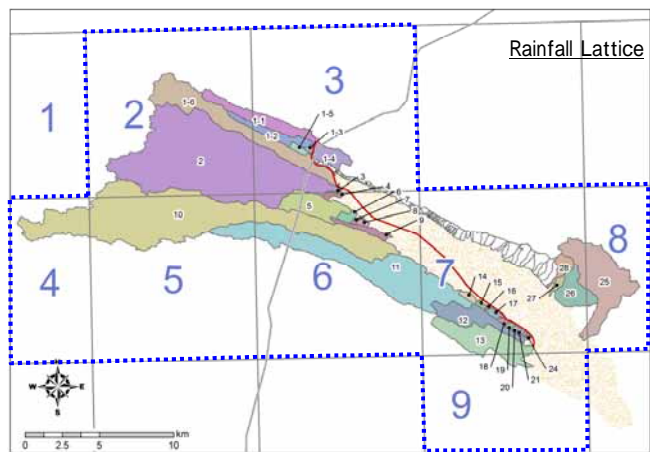
D:Daily Data Available Month in ( )

- Rainfall data which covers the target catchment area and a certain amount of period is necessary
  - Desirable unit of precipitation data is hourly to calculate peak discharge in case of flood
  - Available data in this study is daily or monthly ; observed periods vary depend on each station
- ⇒ Hydrologic analysis was conducted using satellite rainfall data

### 3. Rainfall Data Collection & Analysis - Satellite Data -

**Circumstance of Satellite Data Collection**

- GSMap (Global Satellite Mapping of Precipitation) published by JAXA: Spatial resolution precipitation map that latitude and longitude are 0.1 degree lattice (about 10 km square around the equator)
- Data in March 2000 - February 2014 is available
- 1 hour precipitation data
- Rainfall lattices covering the target catchment area are 8 lattices indicated in figure on the right. Precipitation data of these lattices was collected and analyzed (Daily & Unit hourly (1,2,3 -hour))



**Analysis of Daily data**

- Daily data was arranged and main rainfall days were extracted
- Number of day in one year that daily precipitation is over 5mm is approx. 10 days in average
- Probable daily precipitation was also calculated

**Analysis of unit hourly data**

- The largest unit hourly precipitation in each year in rainfall lattice No.2 is shown in table on the right
- The largest record of 1 hour precipitation is 8.6mm (rainfall lattice No.2 )

単位時間雨量整理結果 (降雨格子2)

	1hr-precipitation		2hr-precipitation		3hr-precipitation	
	mm/1hr	Occurrence Date	mm/2hr	Occurrence Date	mm/3hr	Occurrence Date
1	8.59	2000/9/6	13.85	2000/8/5	20.14	2000/8/5
2	0.66	2001/8/1	1.32	2001/8/1	1.98	2001/8/1
3	2.01	2002/7/24	3.69	2002/7/24	5.32	2002/7/24
4	3.33	2003/12/6	6.56	2003/12/6	9.72	2003/12/6
5	1.71	2004/12/29	3.42	2004/12/29	5.13	2004/12/29
6	5.35	2005/4/26	10.69	2005/4/26	15.62	2005/4/26
7	6.01	2006/8/31	11.01	2006/8/31	14.53	2006/8/31
8	1.83	2007/7/20	3.50	2007/7/20	4.42	2007/7/20
9	5.08	2008/7/12	10.09	2008/7/12	13.66	2008/7/12
10	2.38	2009/4/3	4.07	2009/4/3	5.33	2009/4/3
11	3.34	2010/7/18	6.54	2010/7/18	9.14	2010/7/18
12	1.04	2011/5/26	1.99	2011/5/26	2.93	2011/5/26
13	3.95	2012/7/29	7.26	2012/7/29	10.28	2012/7/29
14	5.3	2013/8/16	10.42	2013/8/16	14.32	2013/8/16

# 3. Rainfall Data Collection & Analysis - Satellite Data -

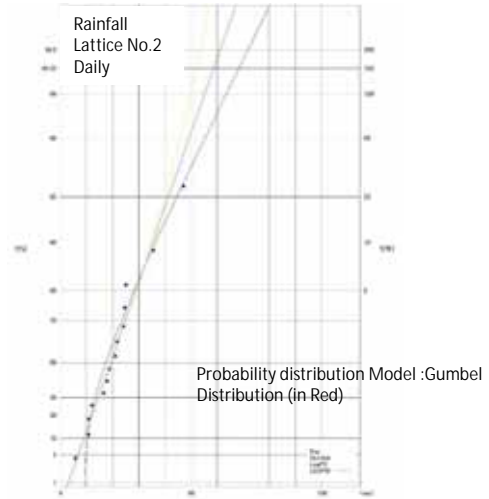
## Calculation of Probable Daily / Unit Hourly Precipitation

Daily precipitation	Return Period						
Rainfall Lattice (0.1 degree)	2	5	10	25	30	50	100
1							
2	19.1	28.7	35.1	43.2	44.7	49.1	55.1
3	18.7	28.8	35.50	44	45.6	50.2	56.5
4	18.2	28	34.5	42.7	44.3	48.8	54.8
5	18.5	29.1	36.2	45	46.8	51.6	58.2
6	17.7	28.7	36	45.2	47	52	58.8
7	17.5	29.4	37.3	47.2	49.2	54.6	61.9
8	19.1	33.2	42.5	54.2	56.5	62.9	71.6
9	17.8	28.7	35.9	45	46.8	51.7	58.5

1hr-precipitation	Return Period						
Rainfall Lattice (0.1 degree)	2	5	10	25	30	50	100
1							
2	3.2	5.3	6.7	8.5	8.8	9.8	11.1
3	3	5	6.30	7.9	8.3	9.2	10.4
4	3	4.9	6.1	7.7	8	8.9	10
5	3.2	5.2	6.6	8.3	8.6	9.5	10.8
6	3	4.8	5.9	7.1	7.3	7.9	8.6
7	2.9	4.7	5.9	7.4	7.7	8.5	9.6
8	2.5	4.4	5.7	7.2	7.5	8.4	9.5
9	2.7	4.5	5.8	7.3	7.6	8.5	9.6

2hr-precipitation	Return Period						
Rainfall Lattice (0.1 degree)	2	5	10	25	30	50	100
1							
2	6	9.8	12.3	15.4	16	17.7	20.1
3	5.7	9.5	12.00	15.2	15.8	17.6	19.9
4	5.5	8.9	11.2	14.1	14.6	16.2	18.3
5	5.8	9.4	11.8	14.8	15.3	17	19.2
6	5.5	8.8	11	13.8	14.3	15.8	17.9
7	5.3	8.7	11	13.9	14.4	16	18.1
8	4.9	8.6	11.1	14.3	14.9	16.6	18.9
9	5	8.5	10.8	13.7	14.3	15.9	18.1

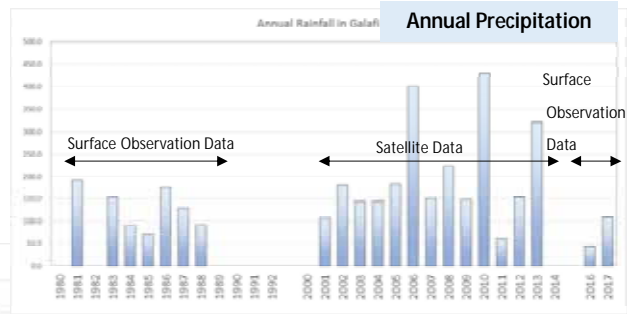
3hr-precipitation	Return Period						
Rainfall Lattice (0.1 degree)	2	5	10	25	30	50	100
1							
2	8.5	13.8	17.3	21.7	22.6	25	28.2
3	8.1	13.4	17.00	21.4	22.3	24.8	28.1
4	7.6	12.4	15.6	19.7	20.5	22.7	25.7
5	8	12.8	16	20	20.8	23	26
6	7.7	12.3	15.4	19.3	20.1	22.2	25
7	7.5	12.4	15.7	19.8	20.6	22.9	25.9
8	6.9	12.3	15.8	20.3	21.2	23.6	26.9
9	7	11.9	15.1	19.3	20.1	22.3	25.3



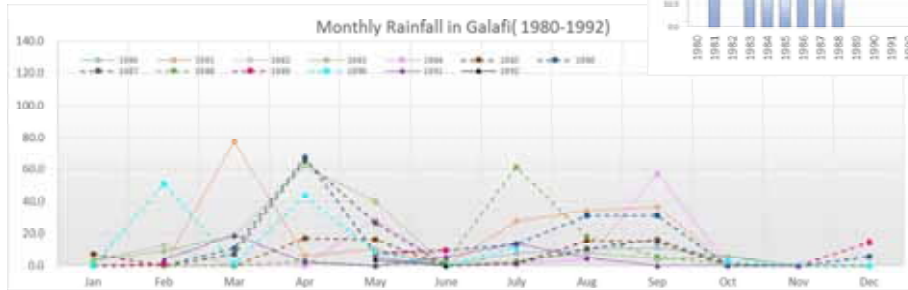
An Example of Probable Daily Precipitation (Rainfall Lattice No.2)

# 3. Rainfall Data Collection & Analysis - Surface Observation & Satellite Data -

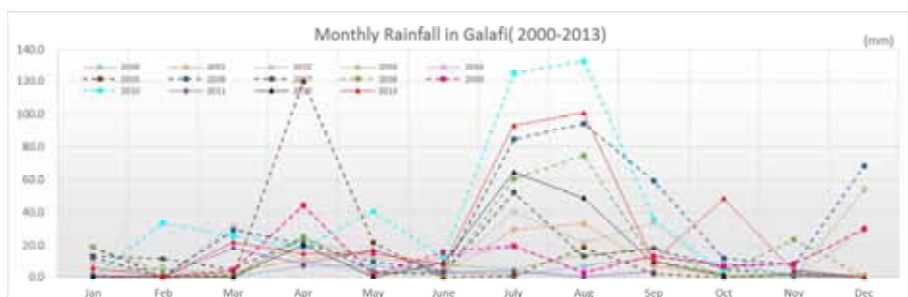
[Reference] Monthly Precipitation in Galafi



### Surface Observation Data



### Satellite Data





## 4. Calculation of Run-off Discharge from Catchment Area

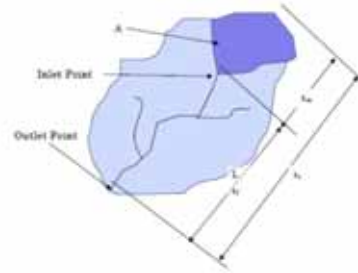
### Rational Formula

Discharge by rational formula is calculated following formula

$$Q = \frac{1}{3.6} f \cdot r \cdot A$$

Where:  $Q$  = maximum flood discharge ( $m^3/s$ )  
 $f$  = dimensionless runoff coefficient  
 $r$  = rainfall intensity within time  $t_c$   
 $A$  = catchment area ( $km^2$ )

\*0.6 is adopted in this study for  $f$



Concentration time ( $t_c$ ) = Inlet time ( $t_1$ ) + Flow time ( $t_2$ )

Kerby formula is used for Inlet time ( $t_1$ )

Flow time ( $t_2$ ) is calculated following formula

$$t_1 = \left( \frac{2}{3} \times 3.28 \cdot \frac{L \cdot n}{\sqrt{S}} \right)^{0.467}$$

$$t_2 = \frac{1}{60} \cdot L/W$$

$t_1$ : Inlet time (min)  
 $L$ : Slope distance (m)  
 $S$ : Slope  
 $n$ : Kerby's roughness coefficient  
 \*0.02 is adopted in this study

$t_2$ : Flow time (min)  
 $L$ : River length (m)  
 $W$ : Flood propagation velocity (m/s)

Relationship between L & W

L	above 1/100	1/100 - 1/200	Below 1/200
W (m/s)	3.5	3	2.1

## 4. Calculation of Run-off Discharge from Catchment Area

### Concentration time & Run-off coefficient

Watershed No.	Catchment Area ( $km^2$ )	L : Slope distance (m)	Elevation Up stream (m)	Elevation Down stream (m)	S:Slope	1/n	n :Kerby	$t_1$ : Inlet Time		$t_2$ : Flow time		$t_1+t_2$ : Concentration time	$f$ : Run-off coefficient
								(min)	(min)	W:Flood propagation velocity (m/s)	(min)		
1-1	5.51	1,109.68	624	490	0.121	8	0.02	10.0	3.5	48.98	59.02	0.6	
1-2	2.9	189.32	560	495	0.344	3	0.02	3.4	3.5	33.03	36.47	0.6	
1-3	0.23	990.75	257	201	0.056	18	0.02	11.4	3.5	2.75	14.14	0.6	
1-4	2.46	332.71	228	173	0.164	6	0.02	5.3	3.5	14.9	20.23	0.6	
1-5	0.54	647.12	334	282	0.082	12	0.02	8.5	3.5	7.9	16.44	0.6	
1-6	14.54	3,029.32	929	711	0.072	14	0.02	18.1	3.5	75.19	93.30	0.6	
2	54.01	4,350.71	970	920	0.011	91	0.02	33.3	3.5	94.91	128.16	0.6	
3	0.13	383.65	196	173	0.061	16	0.02	7.2	3.5	2.85	10.02	0.6	
3-1	0.22	101.00	155	152	0.030	33	0.02	4.5	3.5	3.53	8.07	0.6	
4	0.43	449.49	270	201	0.153	7	0.02	6.2	3.5	5.84	12.07	0.6	
5	5.81	1,662.09	567	468	0.059	17	0.02	14.3	3.5	25.86	40.19	0.6	
6	0.7	489.15	387	265	0.249	4	0.02	5.8	3.5	7.57	13.35	0.6	
7	0.21	703.54	357	215	0.201	5	0.02	7.2	3.5	2.56	9.77	0.6	
8	0.32	645.74	303	182	0.188	5	0.02	7.0	3.5	4.6	11.63	0.6	
9	1.39	476.69	426	376	0.104	10	0.02	7.0	3.5	20.78	27.79	0.6	
10	53.15	5,240.81	1072	962	0.021	48	0.02	31.2	3.5	149.11	180.30	0.6	
11	26.45	3,504.10	893	785	0.031	32	0.02	23.6	3.5	96.38	119.98	0.6	
12	5.54	1,665.83	396	257	0.083	12	0.02	13.3	3.5	38.45	51.70	0.6	
13	9.48	1,841.99	360	245	0.062	16	0.02	14.9	3.5	38.25	53.11	0.6	
14	0.54	618.46	253	153	0.160	6	0.02	7.2	3.5	5.04	12.20	0.6	
15	0.26	407.66	250	182	0.168	6	0.02	5.8	3.5	2.15	7.97	0.6	
16	0.08	250.54	217	165	0.208	5	0.02	4.4	3.5	2.35	6.76	0.6	
17	0.46	546.91	208	175	0.061	16	0.02	8.5	3.5	5.42	13.88	0.6	
18	0.32	245.23	180	159	0.087	11	0.02	5.4	3.5	3.93	9.29	0.6	
19	0.19	409.54	204	153	0.125	8	0.02	6.3	3.5	3.33	9.58	0.6	
20	0.17	321.94	205	164	0.127	8	0.02	5.6	3.5	3.04	8.61	0.6	
21	0.14	344.44	197	143	0.156	6	0.02	5.5	3.5	2.08	7.56	0.6	
22	0.08	306.22	181	146	0.114	9	0.02	5.6	3.5	1.75	7.33	0.6	
23	0.07	285.02	179	151	0.097	10	0.02	5.6	3.5	2.12	7.72	0.6	
24	0.08	208.13	157	140	0.080	13	0.02	5.1	3.5	2.12	7.18	0.6	
25	14.54	4,816.05	742	356	0.080	13	0.02	21.9	3.5	40.41	62.35	0.6	
26	4.49	1,862.43	750	405	0.185	5	0.02	11.6	3.5	12.88	24.45	0.6	
27	0.56	742.59	383	214	0.227	4	0.02	7.2	3.5	8.08	15.26	0.6	
28	1.51	649.32	801	495	0.471	2	0.02	5.7	3.5	11.82	17.51	0.6	

# 4. Calculation of Run-off Discharge from Catchment Area

## Result of Run-off Discharge Calculation

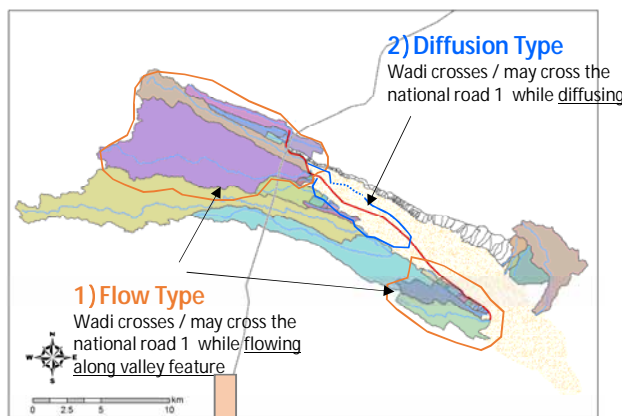
Watershed No.	Largest Record		1/2		1/5		1/10		1/25		1/30		1/50		1/100	
	Rainfall intensity within Concentration time mm/h	Discharge m <sup>3</sup> /s	Rainfall intensity within Concentration time mm/h	Discharge m <sup>3</sup> /s	Rainfall intensity within Concentration time mm/h	Discharge m <sup>3</sup> /s	Rainfall intensity within Concentration time mm/h	Discharge m <sup>3</sup> /s	Rainfall intensity within Concentration time mm/h	Discharge m <sup>3</sup> /s	Rainfall intensity within Concentration time mm/h	Discharge m <sup>3</sup> /s	Rainfall intensity within Concentration time mm/h	Discharge m <sup>3</sup> /s	Rainfall intensity within Concentration time mm/h	Discharge m <sup>3</sup> /s
1-1	7.00	6.5	3.08	2.9	5.12	4.8	6.460	6.0	8.14	7.5	8.5	7.9	9.44	8.7	10.68	9.9
1-2	9.57	4.7	3.96	2	6.06	3	7.460	3.7	9.23	4.5	9.57	4.7	10.53	5.1	11.84	5.8
1-3	10.24	0.4	4.22	0.2	6.5	0.3	8.020	0.4	9.93	0.4	10.3	0.4	11.33	0.5	12.76	0.5
1-4	10.10	4.2	4.16	1.8	6.41	2.7	7.900	3.3	9.8	4.1	10.15	4.2	11.18	4.6	12.58	5.2
1-5	10.20	1	4.20	0.4	6.47	0.6	7.980	0.8	9.89	0.9	10.25	1	11.28	1.1	12.7	1.2
1-6	7.02	17.1	3.13	7.6	5.19	12.6	6.560	15.9	8.29	20.1	8.62	20.9	9.59	23.3	10.85	26.3
2	6.46	58.2	2.96	26.7	4.85	43.7	6.090	54.9	7.65	68.9	7.95	71.6	8.8	79.3	9.98	89.9
3	10.56	0.3	4.21	0.1	6.55	0.2	8.110	0.2	10.08	0.3	10.46	0.3	11.53	0.3	12.99	0.3
3-1	10.82	0.4	4.14	0.2	6.55	0.3	8.140	0.3	10.16	0.4	10.54	0.4	11.64	0.5	13.13	0.5
4	11.17	0.9	4.03	0.3	6.51	0.5	8.150	0.6	10.22	0.8	10.63	0.8	11.75	0.9	13.29	1
5	10.43	10.1	3.74	3.7	6.05	5.9	7.580	7.4	9.51	9.3	9.89	9.6	10.94	10.6	12.37	12
6	11.24	1.4	4.01	0.5	6.49	0.8	8.150	1.0	10.23	1.2	10.64	1.3	11.77	1.4	13.31	1.6
7	11.31	0.4	4.03	0.2	6.53	0.3	8.200	0.3	10.29	0.4	10.7	0.4	11.84	0.5	13.39	0.5
8	11.29	0.7	4.02	0.3	6.52	0.4	8.180	0.5	10.27	0.6	10.68	0.6	11.82	0.7	13.36	0.8
9	10.86	2.6	3.87	0.9	6.27	1.5	7.870	1.9	9.88	2.3	10.28	2.4	11.37	2.7	12.86	3
10	5.81	51.5	2.64	23.4	4.24	37.6	5.300	47.0	6.64	58.9	6.91	61.3	7.64	67.7	8.63	76.5
11	5.89	26	2.74	12.1	4.42	19.5	5.540	24.5	6.96	30.7	7.21	31.8	7.98	35.2	9.03	39.9
12	6.23	5.8	2.90	2.7	4.7	4.4	5.900	5.5	7.4	6.9	7.7	7.2	8.5	7.9	9.6	8.9
13	6.20	9.8	2.87	4.6	4.67	7.4	5.890	9.4	7.39	11.7	7.69	12.2	8.5	13.5	9.6	15.2
14	11.70	1.1	3.97	0.4	6.67	0.7	8.460	0.8	10.7	1	11.16	1.1	12.38	1.2	14.04	1.3
15	11.75	0.6	3.98	0.2	6.69	0.3	8.490	0.4	10.75	0.5	11.2	0.5	12.43	0.6	14.09	0.7
16	11.75	0.2	3.98	0.1	6.69	0.1	8.490	0.2	10.75	0.2	11.2	0.2	12.43	0.2	14.09	0.2
17	11.68	0.9	3.96	0.4	6.65	0.6	8.440	0.7	10.68	0.9	11.13	0.9	12.36	1	14.01	1.1
18	11.75	0.7	3.98	0.3	6.69	0.4	8.490	0.5	10.75	0.6	11.2	0.6	12.43	0.7	14.09	0.8
19	11.75	0.4	3.98	0.2	6.69	0.3	8.490	0.3	10.75	0.4	11.2	0.4	12.43	0.4	14.09	0.5
20	11.75	0.4	3.98	0.2	6.69	0.2	8.490	0.3	10.75	0.4	11.2	0.4	12.43	0.4	14.09	0.4
21	11.75	0.3	3.98	0.1	6.69	0.2	8.490	0.2	10.75	0.3	11.2	0.3	12.43	0.3	14.09	0.4
22	11.75	0.2	3.98	0.1	6.69	0.1	8.490	0.2	10.75	0.2	11.2	0.2	12.43	0.2	14.09	0.2
23	11.75	0.2	3.98	0.1	6.69	0.1	8.490	0.1	10.75	0.2	11.2	0.2	12.43	0.2	14.09	0.2
24	11.75	0.2	3.98	0.1	6.69	0.1	8.490	0.2	10.75	0.2	11.2	0.2	12.43	0.2	14.09	0.2
25	6.42	15.6	2.59	6.3	4.47	10.9	5.750	14.0	7.25	17.6	7.55	18.3	8.42	20.5	9.52	23.1
26	11.52	8.7	3.90	3	6.59	5	8.380	6.3	10.61	8	11.06	8.3	12.28	9.2	13.93	10.5
27	11.62	1.1	3.94	0.4	6.62	0.7	8.400	0.8	10.63	1	11.08	1.1	12.3	1.2	13.95	1.4
28	11.57	3	3.92	1	6.59	1.7	8.360	2.2	10.58	2.7	11.03	2.8	12.24	3.1	13.88	3.5

18

# 5. Calculation of Water Level

## Calculation Method

Calculation method is based on type below



**Normal flow (One-dimensional)**

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

$$Q = AV$$

v = Velocity (m/s)  
 A = Flow Area (m<sup>2</sup>)  
 R = Hydraulic Radius (m)  
 S = Channel Slope  
 Q = Discharge (m<sup>3</sup>/s)  
 n = Manning's Roughness Coefficient

**Two-dimensional unsteady flow (Reproducing complicated flow)**

Two-dimensional unsteady flow model is consisted of (1) continuity formula and (2), (3) of momentum conservation formula.

- continuity formula
 
$$\frac{\partial H}{\partial t} + \frac{\partial M}{\partial x} + \frac{\partial N}{\partial y} = 0 \dots\dots\dots (1)$$
- x direction momentum formula
 
$$\frac{\partial M}{\partial t} + \frac{\partial}{\partial x}(uM) + \frac{\partial}{\partial y}(vM) = -gH \frac{\partial H}{\partial x} - \frac{1}{\rho} \tau_{ix} \dots\dots\dots (2)$$
- y direction momentum formula
 
$$\frac{\partial N}{\partial t} + \frac{\partial}{\partial x}(uN) + \frac{\partial}{\partial y}(vN) = -gH \frac{\partial H}{\partial y} - \frac{1}{\rho} \tau_{iy} \dots\dots\dots (3)$$

Where, h: water depth, H: water level, g: gravitational accelerate, ρ: water density  
 M = uh: x direction discharge flux, N = vh: y direction discharge flux  
 u: x direction current velocity, v: y direction current velocity  
 τ<sub>ix</sub>: Bottom friction in running water, using the Manning formula

$$\tau_{ix} = f \rho g u^2 \sqrt{(u^2 + v^2)} / H^{1/2} \dots\dots\dots (4)$$

## 5. Calculation of Water Level

- Water level at each point was calculated and converted to water depth

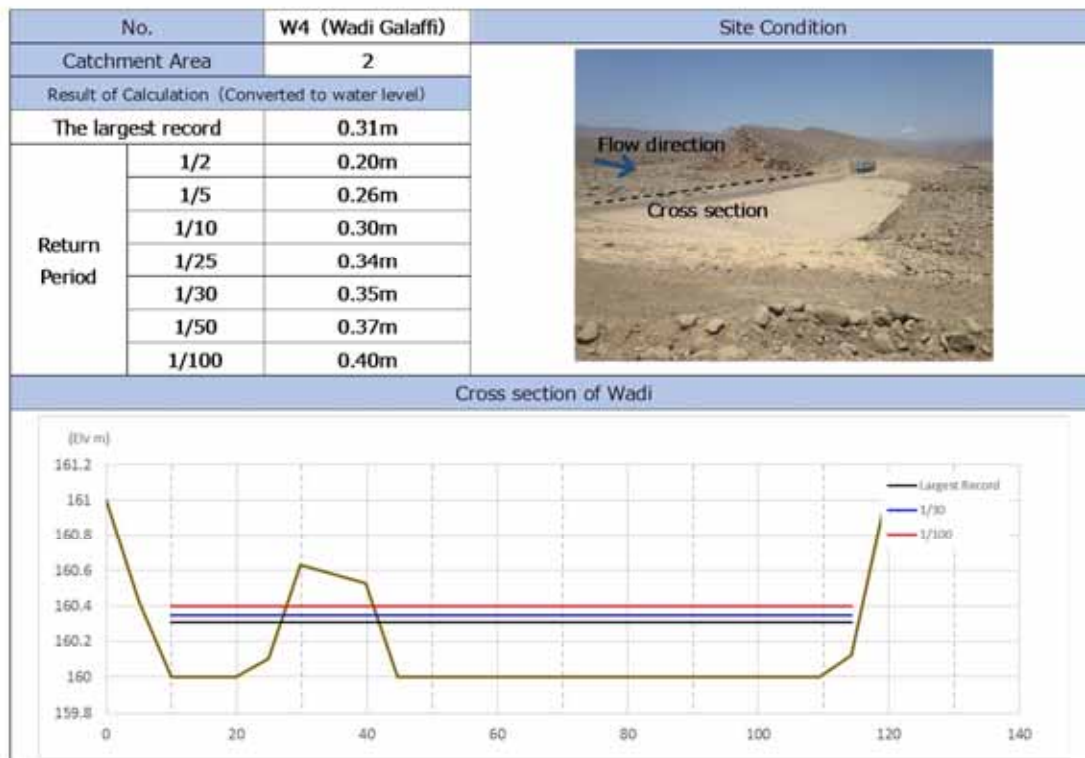
*1 No.	Location	Catchment Area	Type*2	Water Depth(m)							
				The largest record	1/2	1/5	1/10	1/25	1/30	1/50	1/100
W- 1	STA. 1 + 114	1-4,1-1	Flow	0.45	0.33	0.40	0.44	0.48	0.49	0.51	0.54
W- 2,3	STA. 3 + 262	1	Flow	0.30	0.19	0.25	0.28	0.32	0.33	0.35	0.38
W- 4	STA. 4 + 38	2	Flow	0.31	0.20	0.26	0.30	0.34	0.35	0.37	0.40
W- 5	STA. 4 + 385	2	Flow						0.25		
W- 6	STA. 4 + 485	2	Diffusion						-		
W- 6-2	STA. 4 + 547	2	Diffusion						-		
W- 6-3	STA. 4 + 774	2	Diffusion						-		
W- 6-4	STA. 5 + 82	3-1	Flow	0.04	0.03	0.04	0.04	0.04	0.04	0.05	0.05
W- 7	STA. 5 + 151	3-1	Flow	0.04	0.03	0.04	0.04	0.04	0.04	0.05	0.05
W- 8	STA. 5 + 362	3,4,5	Diffusion						0.24 - 0.4		
W- 9	STA. 5 + 616	3,4,5	Diffusion						0.21 - 0.34		
W- 10	STA. 5 + 894	5	Diffusion						0.28 - 0.42		
W- 11	STA. 6 + 28	5	Diffusion						0.46 - 0.54		
-	STA. 6 + 600	5,6,7	Diffusion						0.26 - 0.61		
-	STA. 6 + 780	5,6,7	Diffusion						0.07 - 0.43		
-	STA. 7 + 240	8	Diffusion						0.01 - 0.53		
-	STA. 7 + 800	9,10,11	Diffusion						0.38 - 1.0		
-	STA. 8 + 100	9,10,11	Diffusion						0.57		
-	STA. 8 + 310	9,10,11	Diffusion						0.62 - 0.64		
-	STA. 8 + 410	9,10,11	Diffusion						0.49 - 0.7		
W- 12	STA. 8 + 707	9,10,11	Diffusion						0.22		
W- 13	STA. 9 + 108	9,10,11	Diffusion						-		
-	STA. 9 + 750	9,10,11	Diffusion						0.25 - 0.62		
-	STA. 10 + 350	9,10,11	Diffusion						0.43 - 0.71		
-	STA. 10 + 890	9,10,11	Diffusion						0.49 - 0.78		
-	STA. 12 + 100	9,10,11	Diffusion						0.63 - 1		
-	STA. 13 + 350	9,10,11	Diffusion						0.4 - 1		
W- 16-1	STA. 15 + 86	14	Diffusion						-		
W- 16-2	STA. 15 + 954	14	Diffusion						-		
W-	STA. 16 + 930	15	Flow						0.04		
W- 16-3	STA. 17 + 494	16	Flow	0.0	0.0	0.0	0.0	0.0	0.02	0.02	0.0
W- 16-4	STA. 18 + 618	17	Flow	0.1	0.0	0.1	0.1	0.1	0.07	0.07	0.1
W- 17	STA. 19 + 31	18	Flow	0.1	0.1	0.1	0.1	0.1	0.09	0.10	0.1
W- 17-1	STA. 19 + 207	18	Flow	0.2	0.1	0.2	0.2	0.2	0.18	0.19	0.2
W- 17-2	STA. 19 + 409	19	Flow	0.2	0.1	0.1	0.1	0.2	0.17	0.17	0.2
W- 17-3	STA. 19 + 625	19	Flow	0.1	0.1	0.1	0.1	0.1	0.14	0.14	0.2
W- 18	STA. 19 + 878	20	Flow	0.1	0.1	0.1	0.1	0.1	0.12	0.12	0.1
W- 19	STA. 20 + 95	21,22	Flow	0.1	0.0	0.0	0.1	0.1	0.06	0.06	0.1
W- 20	STA. 20 + 412	23	Flow	0.0	0.0	0.0	0.0	0.0	0.03	0.03	0.0
W- 21	STA. 20 + 752	24	Flow	0.1	0.0	0.0	0.1	0.1	0.06	0.06	0.1

\*1No. : Corresponding to maps in '2. Grasping Hydrological Information of Wadi - Satellite Image & Field Investigation -'  
 \*2 : Only water level by 1/30 return period was calculated in Diffusion type

20

## 5. Calculation of Water Level

A sample of result image of 1) Flow type (Wadi Galaffi)



## 5. Calculation of Water Level

A sample of result image of 2) Diffusion Type ( STA.4+00 ~ STA.8+00 )





## **7-4 GEOLOGICAL SURVEY AND MATERIAL TEST RESULT**

## 7-4 Summary of results of geological survey and material test

### 1. Boring survey

The boring survey was conducted to determine the appropriateness of the foundation ground for three large river-crossing structures. Boring was done at five points with a total length of 50 m. In addition to boring, the standard penetration test was conducted. But the frequency of penetration was fewer than initially planned because of geological nature; debris flow deposit (boulder layer).

As a result of drilling survey of five holes, it was observed that the ground of these five locations consisted of gravel layer including basalt boulder and did not contain white silt layer (less consolidated lacustrine deposits). Except for the surface layer (loose range) of debris flow deposit, a box culvert foundation was judged to be designed as spread foundation type.

### 2. Laboratory soil test

For the road materials of subgrade, subbase and aggregate, the laboratory soil test was recommissioned locally for evaluation, in addition to the simple dynamic cone penetration test conducted by the survey team.

- Subgrade ; Subgrade soil was sampled on the road side and subject to the grain size analysis, liquid plasticity test, compaction test, and CBR test.
- Existing subbase ; The existing subbase material was sampled and subject to the grain size analysis, liquid plasticity test, compaction test, and CBR test.
- Raked gravel ; Raked gravel material was sampled around the old material quarrying site of the existing road and subject to the grain size analysis, liquid plasticity test, compaction test, and CBR test.
- Aggregate and subbase material ; Basalt (debris flow deposit) was sampled mainly from the old material quarrying site of the existing road and subject to the grain size analysis, liquid plasticity test, and abrasion resistance test.

As a result of laboratory soil test, both subgrade and subbase showed that the alluvial fan deposits in the site and deposits making up the existing plain were gravelly soil with a wide grain size range. It was also confirmed that the materials are free from problem and the clay content and water content of the material was low. The CBR characteristics were determined to be CBR at >20% for the subgrade and >40% for the existing road subgrade and raked gravel. Abrasion of aggregate was confirmed to be 15% or less.

As is known from the above, CBR for the subgrade was reviewed in line with the local test (simple penetration test) conducted every 500 m. It was confirmed that the subgrade of existing road and raked gravel had a sufficient strength as the subbase course. Moreover, the materials for base course and aggregate have high abrasion resistance and are of satisfactory characteristics.

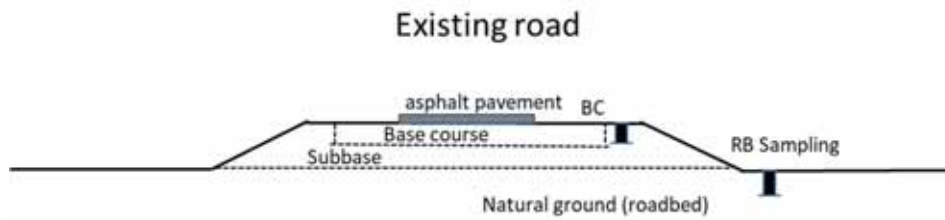


Figure 7-4-1 Schematic view of sampling position

Table 7-4--1 Outline of laboratory test result

Class	Name	Position		Classification	DCP	Particle size		Liquid limit test Plastic limit test(-0.4mm)		Compaction test		CBR test Three point method		Abrasion test	
		Nothing	Easting			-0.075mm	-2.36mm	LL	PL	wopt%	dmax (g/cm3)	%	%		
Subgrade (roadside of existing road)	RB01	11° 37'39.06"N	41° 56'49.28"E	Hanle plan deposit		30.0	54.1	31	21.8	9.1	2.100	23.0	-		
	RB02	11° 38'30.13"N	41° 55'46.57"E	Hanle plan deposit		25.9	55.9	23.5	19.4	7.8	2.145	33.0	-		
	RB03	11° 39'21.08"N	41° 55'6.05"E	Hanle plan deposit		23.3	54.4	NP	NP	6.8	2.359	73.0	-		
	RB04	11° 40'26.62"N	41° 53'54.33"E	Hanle plan deposit (windblown silt)		97.9	100.0	32	19.8	15.0	1.910	22.0	-		
	RB05	11° 40'56.77"N	41° 52'38.04"E	Fan deposit		12.9	25.0	NP	NP	8.6	2.238	52.0	-		
	RB06	11° 41'59.91"N	41° 51'26.51"E	Fan deposit		13.5	30.2	27.5	18.8	8.3	2.230	42.0	-		
	RB07	11° 42'43.93"N	41° 50'44.66"E	Fan deposit		19.8	40.6	NP	NP	8.4	2.200	47.0	-		
Subbase material of existing road	BC01	11° 37'38.81"N	41° 56'49.04"E	Existing road bed BC		19.8	51.4	NP	NP	7.0	2.160	53.0	-		
	BC02	11° 38'29.93"N	41° 55'46.32"E	Existing road bed SBC		15.0	42.5	NP	NP	7.6	2.160	51.5	-		
	BC03	11° 39'21.00"N	41° 55'5.94"E	Existing road bed SBC		4.8	31.2	NP	NP	6.1	2.145	46.0	-		
	BC04	11° 40'26.46"N	41° 53'54.25"E	Existing road bed BC		29.8	57.9	NP	NP	8.8	2.245	73.5	-		
	BC05	11° 40'56.56"N	41° 52'37.96"E	Existing road bed SBC		13.0	43.2	NP	NP	7.4	2.145	54.0	-		
	BC06	11° 41'59.85"N	41° 51'26.42"E	Existing road bed SBC		11.8	39.1	NP	NP	7.3	2.239	64.0	-		
	BC07	11° 42'44.00"N	41° 50'44.80"E	Existing road bed SBC		19.6	49.9	NP	NP	5.6	2.158	48.0	-		
Raked gravel materials	SBC08	11° 42'7.52"N	41° 51'20.89"E	Fan deposit		7.4	30.4	NP	NP	9.8	2.120	47	-		
	SBC09	11° 41'26.62"N	41° 51'41.26"E	Fan deposit		12.7	49.3	NP	NP	7.9	2.234	60	-		
	SBC10	11° 41'54.72"N	41° 51'46.44"E	River deposit		3.3	70.9	NP	NP	7.8	2.070	42.5	-		
Crusher-run	SBC11	11° 40'20.09"N	41° 55'8.12"E	Talus cone deposit		28.3	59.5	NP	NP	8.7	2.270	69.5	-		
	Ma01	11° 42'13.92"N	41° 50'57.42"E	Fan deposit		-	-	NP	NP	-	-	-	-	9.4	
	Ma02	11° 41'27.09"N	41° 51'38.47"E	Fan deposit		6.1	24.3	NP	NP	-	-	-	-	-	
	Ma03	11° 41'24.58"N	41° 51'35.27"E	Talus/Basalt		10.4	34.2	NP	NP	-	-	-	-	-	
	Ma04	11° 42'12.55"N	41° 50'53.89"E	Fan deposit		-	-	NP	NP	-	-	-	-	13.9	
	Ma05	11° 40'14.39"N	41° 55'12.81"E	Talus/Basalt		-	-	NP	NP	-	-	-	-	14.8	
Ma06	11° 40'14.07"N	41° 55'15.32"E	Talus/Basalt		14.3	43.2	NP	NP	-	-	-	-	-		
Total					0	24	24	18	18	3	3				

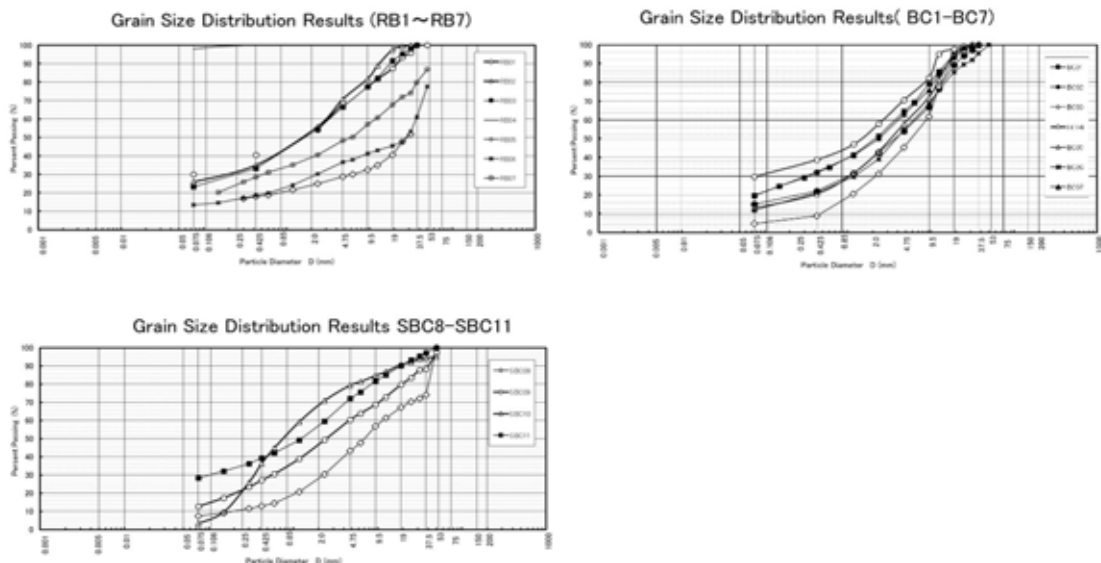


Figure 7-4-2 Grain size curve of materials



# **GEOTECHNICAL STUDY REPORT**

## **SOIL IDENTIFICATION CAMPAIGN**

***FILE N°152-2018 – Réf n°319-18-LCBE***

**SITE:** GALAFI

**PROJECT:** YOBOKI ROAD SECTION REHABILITATION – GALAFI

**CLIENT:** HYDROTERRA ENGINEERING

Version:	Date:	Modification nature:
A	08/07/2018	Version n°1:Original

JULY 2018



# GEOTECHNICAL MISSION

## PRELIMINARY STUDIES - GEOTECHNICAL

Included in this document:

1. A geotechnical report
2. Annex1 :Lithology of boreholes
3. Annex2 : Laboratory results
4. Annex3 : Survey crate pictures
5. Annex4 : Site pictures
6. Annex5 : Définitions des missions U.S.G., norme NF P 94-500

## Table of content

Table of content .....	3
I. PRESENTATION.....	4
1.1 Mission definition .....	4
1.2 Regulation used .....	4
II. SOIL IDENTIFICATION.....	5
2.1 Identification Program :.....	5
2.2 Identification Synthesis .....	6

ANNEX :

# I. PRESENTATION

## 1.1 Mission Definition

### ◆ Mission

At the request of **la Société HYDROTERRA ENGINEERING**, the **CENTRAL BUILDING AND EQUIPMENT LABORATORY (LCBE)** moved to the site of **GALAFI**, to carry out a **SERIE OF IDENTIFICATION OF SOIL** of the ground. This mission should allow:

1. Determine the lithological nature of the formations crossed
2. To identify the geotechnical nature of the samples taken from the section
3. Provide the results of the laboratory tests performed on the samples taken.

## 1.2 Regulation used

The various tests performed (in situ and laboratory tests) comply with AFNOR standards

## II. SOIL IDENTIFICATION

### 2.1 Identification program :

For this study, the investigation program initially planned was modified to take into account the difficulties of access to the site. The initial program also planned, according to the specifications, to stop the depth of investigation if the bedrock is reached with a rock continuity of 6 meters beyond the planned foundation level

The table below gives a summary of the work performed:

Survey points	Longitude (X ; m)	Latitude (Y ; m)	Sieve analysis	Atterberg Limits	Los Angeles test	Modified effort compaction	CBR
RB01	41°56'49.28"E	11°37'39.06"N	0	0		0	0
RB02	41°55'46.57"E	11°38'30.13"N	0	0		0	0
RB03	41°55'6.05"E	11°39'21.08"N	0	0		0	0
RB04	41°53'54.33"E	11°40'26.62"N	0	0		0	0
RB05	41°52'38.04"E	11°40'56.77"N	0	0		0	0
RB06	41°51'26.51"E	11°41'59.91"N	0	0		0	0
RB07	41°50'44.66"E	11°42'43.93"N	0	0		0	0
BC01	41°56'49.04"E	11°37'38.81"N	0	0		0	0
BC02	41°55'46.32"E	11°38'29.93"N	0	0		0	0
BC03	41°55'5.94"E	11°39'21.00"N	0	0		0	0
BC04	41°53'54.25"E	11°40'26.46"N	0	0		0	0
BC05	41°52'37.96"E	11°40'56.56"N	0	0		0	0
BC06	41°51'26.42"E	11°41'59.85"N	0	0		0	0
BC07	41°50'44.80"E	11°42'44.00"N	0	0		0	0
SBC08	41°51'20.89"E	11°42'7.52"N	0	0		0	0
SBC09	41°51'41.26"E	11°41'26.62"N	0	0		0	0
SBC10	41°51'46.44"E	11°41'54.72"N	0	0		0	0
SBC11	41°55'8.12"E	11°40'20.09"N	0	0		0	0
MA01	41°50'57.42"E	11°42'13.92"N	0	0	0		
MA02	41°51'38.47"E	11°41'27.09"N	0	0			
MA03	41°51'35.27"E	11°41'24.58"N	0	0			
MA04	41°50'53.89"E	11°42'12.55"N	0	0	0		
MA05	41°55'12.81"E	11°40'14.39"N	0	0	0		
MA06	41°55'15.32"E	11°40'14.07"N	0	0			
<b>Total :</b>			<b>24</b>	<b>24</b>	<b>3</b>	<b>18</b>	<b>18</b>



In addition to the core drilling and manual sampling of soil samples, the following test has been realized on the site:

1. 1. SPT tests to determine the bearing capacity of crossed layers:
2. 2. laboratory tests to identify and characterize soils in place, including:
  - 24 Sieve analysis [NF P 94-056],
  - 24 Atterberg Limits [NF P 94-051],
  - 3 Los Angeles test [EN1097 - 2],
  - 18 Modified effort compaction [NF P 98-250-6],
  - 18 CBR [NF P 94-078],

The results of all the tests are presented in the appendices to this report.

## 2.2 Identification synthesis

### ◆ Surveying procedures

#### 1. Boreholes drilling with Standard penetration test :

For these types of machines, drillings are carried out by the method of rotation by means of a drill string provided at its base with a perforating tool which rotates in the borehole. Bentonite-based slurry injected into the circuit allows the drill string to be cooled down, the wall to be shielded and the borehole to be cleaned. Tungsten carbide crowns, carbonites and diamond crowns are used depending on the formations encountered. Drilling was carried out by rotation and washing.

The Standard Penetration Test is carried out following a battering of a 450 mm penetration of the split sampler, using a hammer weighing 63.5 kg and falling in free fall from a height of 760 mm on the head of a drill string.

The split sampler used has an outside diameter of 51 mm and does not have a liner inside. The standard penetration tests were performed using an automatic hammer, providing effective energy to the rod train of about 80% of the theoretical potential free fall energy.

This test, carried out in accordance with the French Standard (NF P 94-116), makes it possible to provide information on the nature of the soil and to take samples of remodeled material for carrying out physical tests in the laboratory.

Surveys points	Easting(X ; m)	Northing (Y ; m)	Altitude (Z ; m)	Investigated Depth (m)
Bor 1	41°50'45.83"E	11°42'40.08"N		10
Bor 2	41°50'57.05"E	11°42'15.66"N		10
Bor 3	41°50'57.47"E	11°42'15.40"N		10
Bor 4	41°50'57.83"E	11°42'15.11"N		10
Bor 5	41°51'32.45"E	11°41'52.38"N		10

## 2. Manual Survey :

Manual drilling is done with shovels at depths between 0 and 50cm. These holes thus make it possible to make pits to identify the lithology of the soil and to recover samples.

During the identification campaign, all samples were collected in bags, tagged, photographed and sent to LCBE for identification and analysis.

Survey points	Longitude (X ; m)	Latitude (Y ; m)	Altitude (Z ; m)	Investigated depth (m)
RB01	41°56'49.28"E	11°37'39.06"N		0,5
RB02	41°55'46.57"E	11°38'30.13"N		0,5
RB03	41°55'6.05"E	11°39'21.08"N		0,5
RB04	41°53'54.33"E	11°40'26.62"N		0,5
RB05	41°52'38.04"E	11°40'56.77"N		0,5
RB06	41°51'26.51"E	11°41'59.91"N		0,5
RB07	41°50'44.66"E	11°42'43.93"N		0,5
BC01	41°56'49.04"E	11°37'38.81"N		0,5
BC02	41°55'46.32"E	11°38'29.93"N		0,5
BC03	41°55'5.94"E	11°39'21.00"N		0,5
BC04	41°53'54.25"E	11°40'26.46"N		0,5
BC05	41°52'37.96"E	11°40'56.56"N		0,5
BC06	41°51'26.42"E	11°41'59.85"N		0,5
BC07	41°50'44.80"E	11°42'44.00"N		0,5
SBC08	41°51'20.89"E	11°42'7.52"N		0,5
SBC09	41°51'41.26"E	11°41'26.62"N		0,5
SBC10	41°51'46.44"E	11°41'54.72"N		0,5
SBC11	41°55'8.12"E	11°40'20.09"N		0,5
MA01	41°50'57.42"E	11°42'13.92"N		1
MA02	41°51'38.47"E	11°41'27.09"N		1
MA03	41°51'35.27"E	11°41'24.58"N		1
MA04	41°50'53.89"E	11°42'12.55"N		1
MA05	41°55'12.81"E	11°40'14.39"N		1
MA06	41°55'15.32"E	11°40'14.07"N		1

*NB: the reference zero level for the depths is the natural terrain.*

All the depths above are given to the right of our recognitions (Survey point).

◆ Site plan of Survey points:

The different survey points made are materialized on the ground plan below.



◆ Synthesis of laboratory tests :

The results of the laboratory tests carried out on the soil samples taken from the holes are presented in appendices.

1. *Standard Penetration Test Synthesis*

<b>Standard Penetration Test (SPT)</b>				
Depth (m)	15 cm	15cm	15cm	TOTAL
<b>Bor 05 (0-10m)</b>				
3,50 à 3,80	17	40	38	95
6,00 à 6,30	20	50	-	70
9,00 à 9,30	14	37	40	91
<b>Bor 02 (0-10m)</b>				
5,00 à 5,30	19	37	39	95

2. *Manual excavation synthesis:*

- The samples taken were sent to the laboratory to determine the geotechnical characteristics of the materials. These are mainly identification tests (Sieve analysis, Atterberg Limits and Proctor – CBR).

➤ **Results obtained on the Platform Layer:**

These laboratory tests are performed in accordance with AFNOR standards.

After homogenization and sampling, part of the sample was subjected to Sieve analysis tests (EN 933-1), Atterberg limits (NF P 94-051) and the methylene blue test on the fraction 0/2 mm.

After these initial analyzes, the samples are subjected to Modified Effort Compaction (EN 13286-2) and CBR index measurements after 4 days of imbibitions (EN 13286-47).

The results obtained are listed as follows: **Tableau n°01 : Résultats des essais granulométriques, de limite d'Atterberg et du VBS avant compactage**

Echantillon	Coordinate		Sieve analysis			AtterbergLimites			Classe GTR (NF P11 - 300)
	Abscisse (X ; m)	Ordonnée (Y ; m)	%Ø <50 mm	%Ø < 2,36 mm	%Ø < 0,075 mm	WL (%)	WP (%)	IP (%)	
RB - 01	113739,06 N	415649,28 E	100	54,1	30	31	21,8	9,2	B5
RB - 02	113830,13 N	415546,57 E	100	55,9	25,9	23,5	19,4	4,1	B5
RB - 03	113921,08 N	41556,05 E	100	54,4	23,3	Non Mesurable			B5
RB - 04	114026,62 N	415354,33 E	0	0	97,9	32	19,8	12,2	
RB - 05	114056,77 N	415238,04 E	93,6	25	12,9	Non Mesurable			B6
RB - 06	114159,91 N	415126,51 E	77,7	30,2	13,5	27,5	18,8	8,7	B5
RB - 07	114243,93 N	415044,66 E	86,8	40,6	19,8	Non Mesurable			B5

Tableau n°02 : Résultats des essais Proctor-CBR

Samples	Coordonnées		Modified effort compaction		CBR à 95% OPM
	Easting (X ; m)	Northing (Y ; m)	W%	Xd (T/m³)	
RB - 01	113739,06 N	415649,28 E	9,1	2,1	43
RB - 02	113830,13 N	415546,57 E	7,8	2,145	45
RB - 03	113921,08 N	41556,05 E	6,8	2,359	82
RB - 04	114026,62 N	415354,33 E	15	1,91	38,5
RB - 05	114056,77 N	415238,04 E	8,6	2,238	63,5
RB - 06	114159,91 N	415126,51 E	8,3	2,23	59,5
RB - 07	114243,93 N	415044,66 E	8,4	2,2	56

The results obtained on the various types of tests show that the materials of the platform have the following characteristics:

- - A granulometry comprises between 50 mm and 0.075 mm;
- - An Atterberg limit of between 6.8 and 12.2;
- - Class B5 and B6 samples according to the GTR classification (NF P 11-300)
- - a maximum dry range of between 1.91 and 2.359;
- - Optimum water content between 6.8 and 12.2; Un indice CBR qui varie de 38,5 à 82.



➤ Results obtained on the Base layer:

Table n ° 03: Results of granulometric, Atterberg limit and VBS tests before compacting

Samples	Coordinate		Sieve Analysis			Atterberg Limites			Classe GTR (NF P11 - 300)
	Easting (X ; m)	Northing (Y ; m)	%Ø < 50 mm	%Ø < 2,36 mm	%Ø < 0,075 mm	WL (%)	WP (%)	IP (%)	
BC - 01	113738,81 N	415649,28 E	100	51,4	19,8	Non Mesurable			B5
BC - 02	113829,93 N	415546,57 E	100	42,5	15	Non Mesurable			B5
BC - 03	113921,00 N	41556,05 E	100	31,2	4,8	Non Mesurable			B4
BC - 04	114026,46 N	415354,33 E	100	57,9	29,8	Non Mesurable			B5
BC - 05	114056,56 N	415238,04 E	100	43,2	13	Non Mesurable			B5
BC - 06	114159,85 N	415126,51 E	100	39,1	11,8	Non Mesurable			B4
BC - 07	114244,00 N	415044,66 E	100	49,9	19,6	Non Mesurable			B5

Table n°04 :Results of Proctor-CBR tests

Samples	Coordinate		Modified effort compaction		CBR à 95% OPM
	Easting (X ; m)	Northing(Y ; m)	W%	Xd (T/m <sup>3</sup> )	
BC - 01	113738,81 N	415649,28 E	7	2,16	53
BC - 02	113829,93 N	415546,57 E	7,6	2,16	51,5
BC - 03	113921,00 N	41556,05 E	6,1	2,145	46
BC - 04	114026,46 N	415354,33 E	8,8	2,245	73,5
BC - 05	114056,56 N	415238,04 E	7,4	2,145	54
BC - 06	114159,85 N	415126,51 E	7,3	2,239	64
BC - 07	114244,00 N	415044,66 E	5,6	2,158	48

The results obtained on the various tests show that the materials coming from the platform have the following characteristics:

- A particle size of between 50 mm and 0.075 mm
- An unmeasurable Atteberg limit
- Class B4 and B5 samples according to the GTR classification (NF P 11-300)
- A maximum dry density of between 2.145 and 2.16;
- Optimum water content between 5.6 and 8.8;
- A CBR index which varies from 46 to 73.5.

Results obtained on loan materials:

Tableau n°05: Results of granulometric, Atterberg limit and VBS tests before compacting

Sample	Coordinate		Sieve analysis			Atteberg Limit			Classe GTR (NF P11 - 300)
	Easting (X ; m)	Northing (Y ; m)	%Ø <50 mm	%Ø < 2,36 mm	%Ø < 0,075 mm	WL (%)	WP (%)	IP (%)	
SBC - 08	114141,94 N	415210,00 E	100	30,4	7,4	NON MESURABLE			B5
SBC - 09	114134,76 N	41522,06 E	97,4	49,3	12,7	NON MESURABLE			B5
SBC - 10	113728,84 N	415844,92 E	95,2	70,9	3,3	NON MESURABLE			B5
SBC - 11	113649,74 N	415910,38 E	100	59,5	28,3	NON MESURABLE			B5

Table n°06 :Results of Proctor-CBR tests

Sample	Coordinate		Modified effort Compaction		CBR à 95% OPM
	Easting (X ; m)	Northing (Y ; m)	W%	γd (T/m³)	
SBC - 08	114141,94 N	415210,00 E	9,8	2,12	47
SBC - 09	114134,76 N	41522,06 E	7,9	2,234	60
SBC - 10	113728,84 N	415844,92 E	7,8	2,07	42,5
SBC - 11	113649,74 N	415910,38 E	8,7	2,27	69,5

The results obtained on the various tests show that the materials coming from the platform have the following characteristics:

- A particle size of between 50 mm and 0.075 mm
- An unmeasurable landing limit
- Class B5 samples according to the GTR classification (NF P 11-300)
- A maximum dry density of between 2.244 and 2.27;
- Optimum water content between 7.8 and 9.8;
- A CBR index that varies from 42.5 to 69.5.

➤ Results obtained on crushed material :

Table n°07 :Results of granulometric, Atterberg limit and VBS tests before compacting

Samples	Coordinate		Sieve Analysis			Los Angeles	Classe GTR (NF P11 - 300)
	Easting (X ; m)	Northing(Y ; m)	%Ø <50 mm	%Ø <2,36 mm	%Ø < 0,075 mm		
Material - 01	114213,92 N	415057,42 E	100	0	0	9,43	B4 th
Material - 02	114127,09 N	415138,47 E	88,8	24,3	6,1	-	B4
Material - 03	114124,58 N	415135,27 E	100	34,2	10,4	-	B4
Material - 04	114212,55 N	415053,89 E	100	0	0	13,91	B4 th

Material - 05	114014,39 N	415512,81 E	100	0	0	14,78	B4 th
Material - 06	114014,07 N	415515,32 E	100	43,2	14,3	-	B5

The results obtained on the various tests show that the materials coming from the platform have the following characteristics:

- A particle size of 50 mm to 0.075 mm
- An unmeasurable landing limit
- Class B4th and B5 samples according to the GTR classification (NF P 11-300)
- A Los Angeles coefficient of between 9.43 and 14.73

#### ◆ Hydrogeological synthesis

No tablecloth was encountered. It has been noted during field operations areas of high water loss probably related to the presence of fracturing network of rock formations.

However, we can not exclude the presence of anarchic traffic, linked to preferential flow channels. The surface hydrological regime is likely to vary, depending on the season and rainfall.

### III. CONCLUSIONS

The laboratory tests were carried out on the samples taken, the results obtained are inserted in the report and attached.

The exploitation of the results obtained on the CBR tests is transmitted in the report for the materials coming from the platform, the base layer and the loans.

Done in Djibouti, the *11/07/2018*

**LE DIRECTEUR DU LCBE**

**SOUBANEH SAID ISMAEL**

## ANNEX:

Annex 1 : Lithologycut of Boreholes

Annex 2 : Laboratory test results

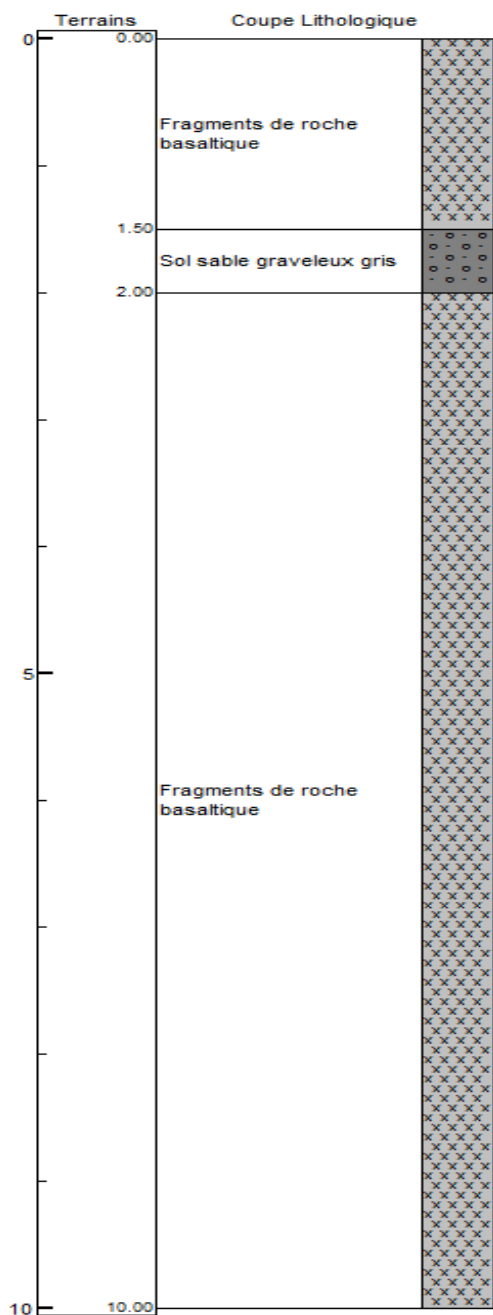
Annex 3 : Survey cratespictures

Annex 4 : Site Project pictures

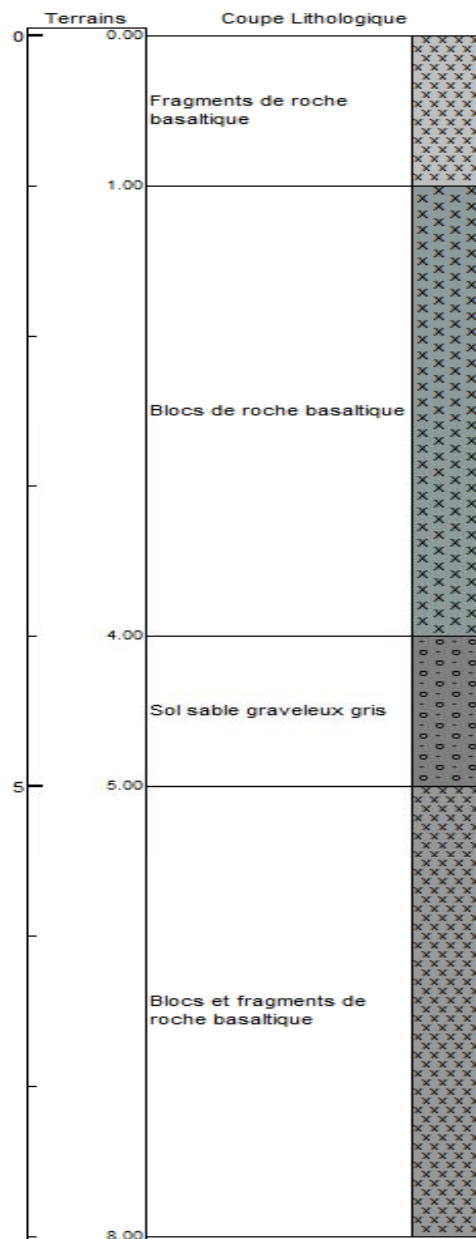


### Annex 1 :Lithologcut of Boreholes

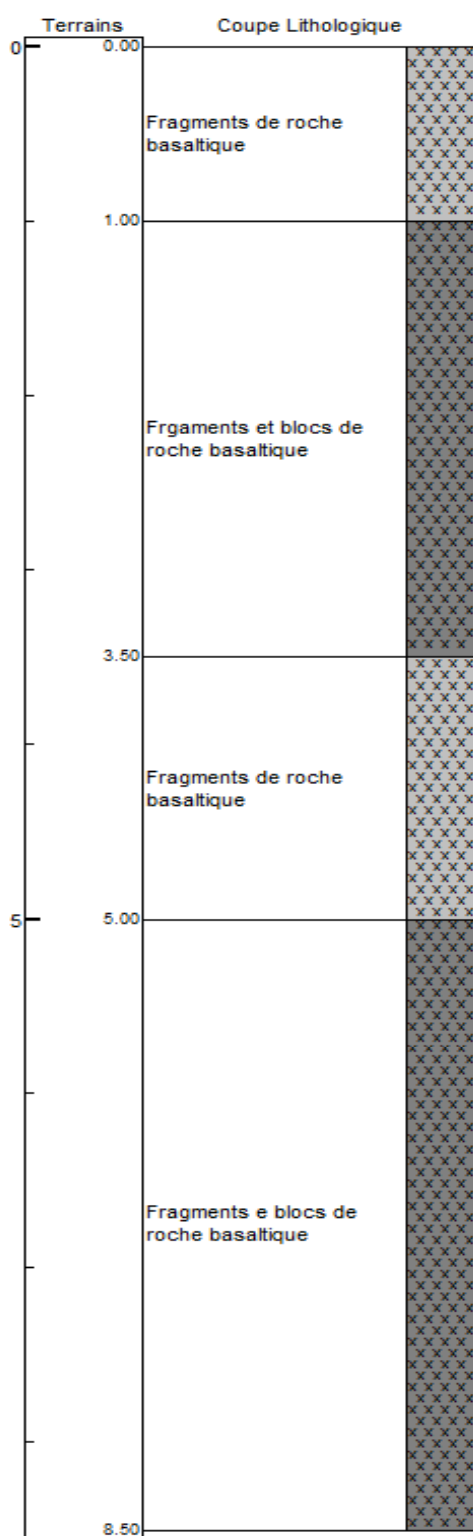
Bor 1



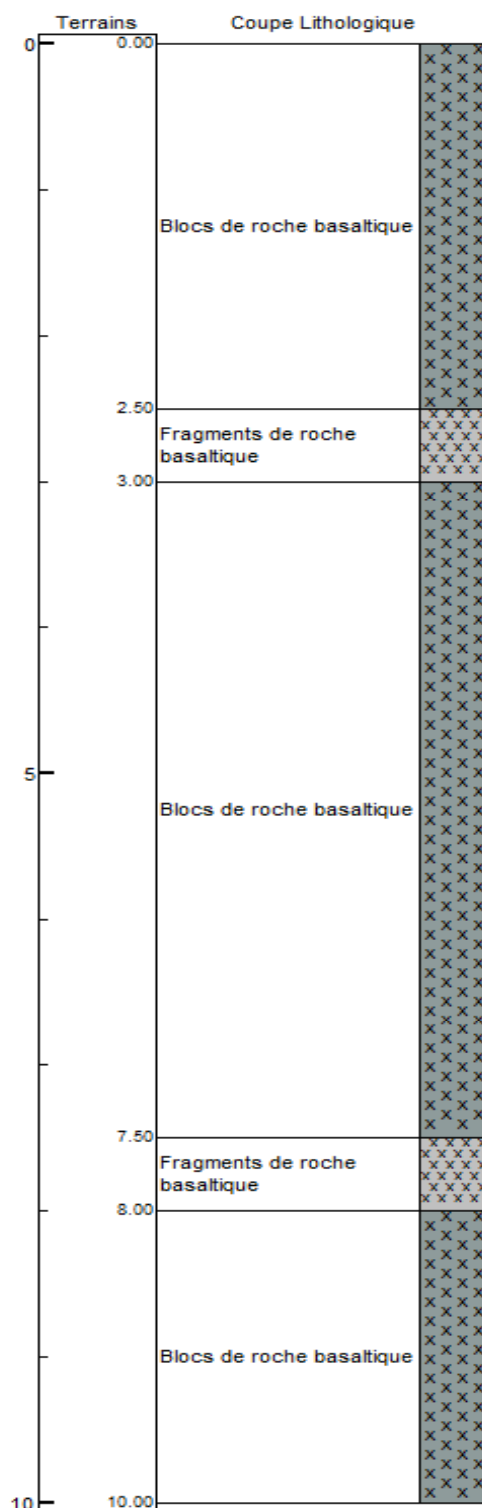
Bor 2



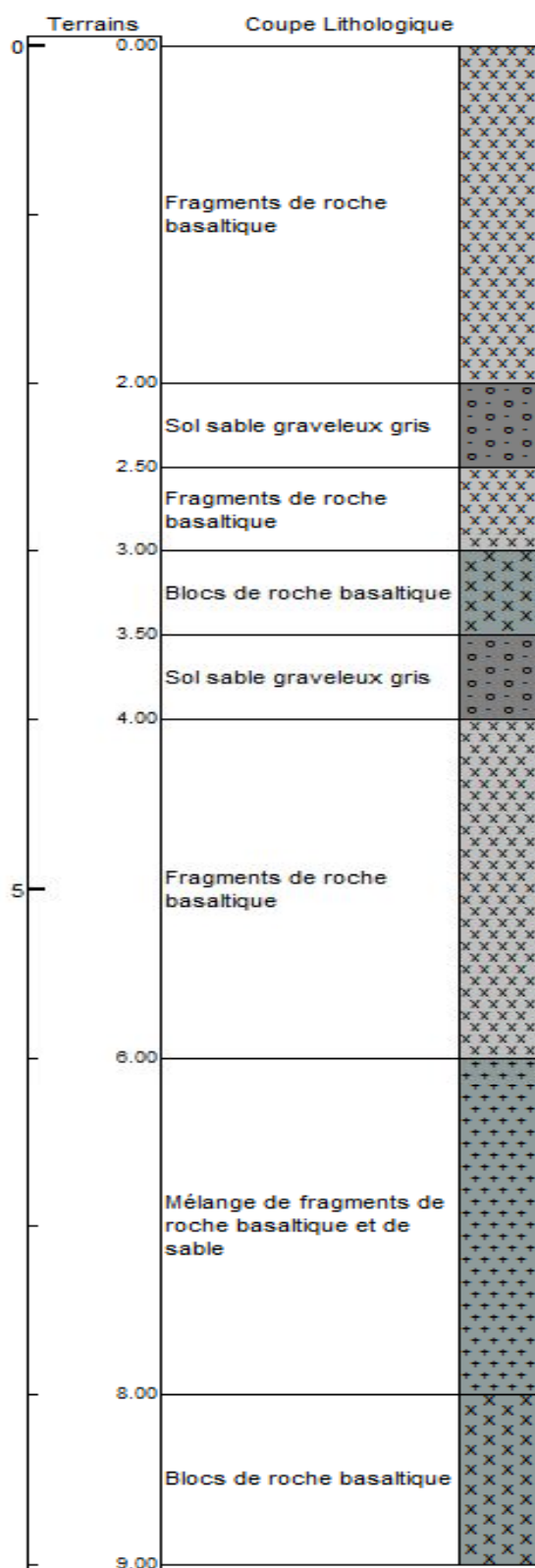
### Bor 3



### Bor 4



## Bor 5



## Annex2 :Laboratory Test Results

Platform layer

RB01

**REPUBLIQUE DE DJIBOUTI**  
Unité - Egalité - Paix

*Ministère de l'Équipement et des Transports*

**المختبر المركزي للبناء والتحصين**

**ESSAI C.B.R. NF P 94-078**

152 - 2018  
Réhabilitation de la Route Nationale N°1 - Djibouti - Gaiaf  
JICA / Hydroteera Engineering Sarl  
Road Base - 01

**Dossier :**  
**Chantier :**  
**Client :**

**Matériaux**

Teneur en Eau de Compactage		Densité à Sec	
N° de Coup	56	25	10
N° de Moule	1	2	3
P. Sol H + Taux (G)	664.4	701.00	625
P. Sol S + Taux (G)	613.9	647.50	578
P. Taux (G)	57.7	61.3	60.5
P. Eau (G)	50.5	53.50	47
P. Sol S (G)	556.2	586.20	517.5
Teneur en Eau %	9.08	9.1	9.08

Teneur en Eau (après 4 jours)	
N° de Coup	56
N° Taux (G)	X
P. Sol H + Taux (G)	644
P. Sol S + Taux (G)	577.1
P. Taux (G)	60.3
P. Eau (G)	66.9
P. Sol S (G)	516.8
Teneur en Eau %	12.9

Densité à Sec	
N° de Coup	56
N° de Moule	1
P. Sol H + Moule (gram)	6055
P. Moule (gram)	3817.4
P. Sol Humide (gram)	5237.6
Volume du Moule (p/cm³)	2284
Densité Humide (p/cm³)	2,293
Teneur en Eau % (N)	9.1
Densité Sèche (p/cm³)	2,102
D Oxygène (p/cm³)	2.1
% de Compaction (N)	100,1

**PENETRATION**

Penetr. mm	56		25		10	
	Reading	Change	Reading	Change	Reading	Change
0,00	0,00	0	0,00	0	0,00	0
0,50	0,50	3	2,00	2	0,50	1
1,00	1,00	4	1	3	1,00	2
2,50	2,50	7	2,5	6	2,50	4
5,00	5,00	11	5,00	10	5,00	8
6,00	6,00	13	6,00	12	6,00	9
7,00	7,00	15	7,00	14	7,00	11
8,00	8,00	17	8	16	8,00	13
9,00	9,00	20	9,00	19	9,00	15
10,00	10,00	23	10,00	21	10,00	18

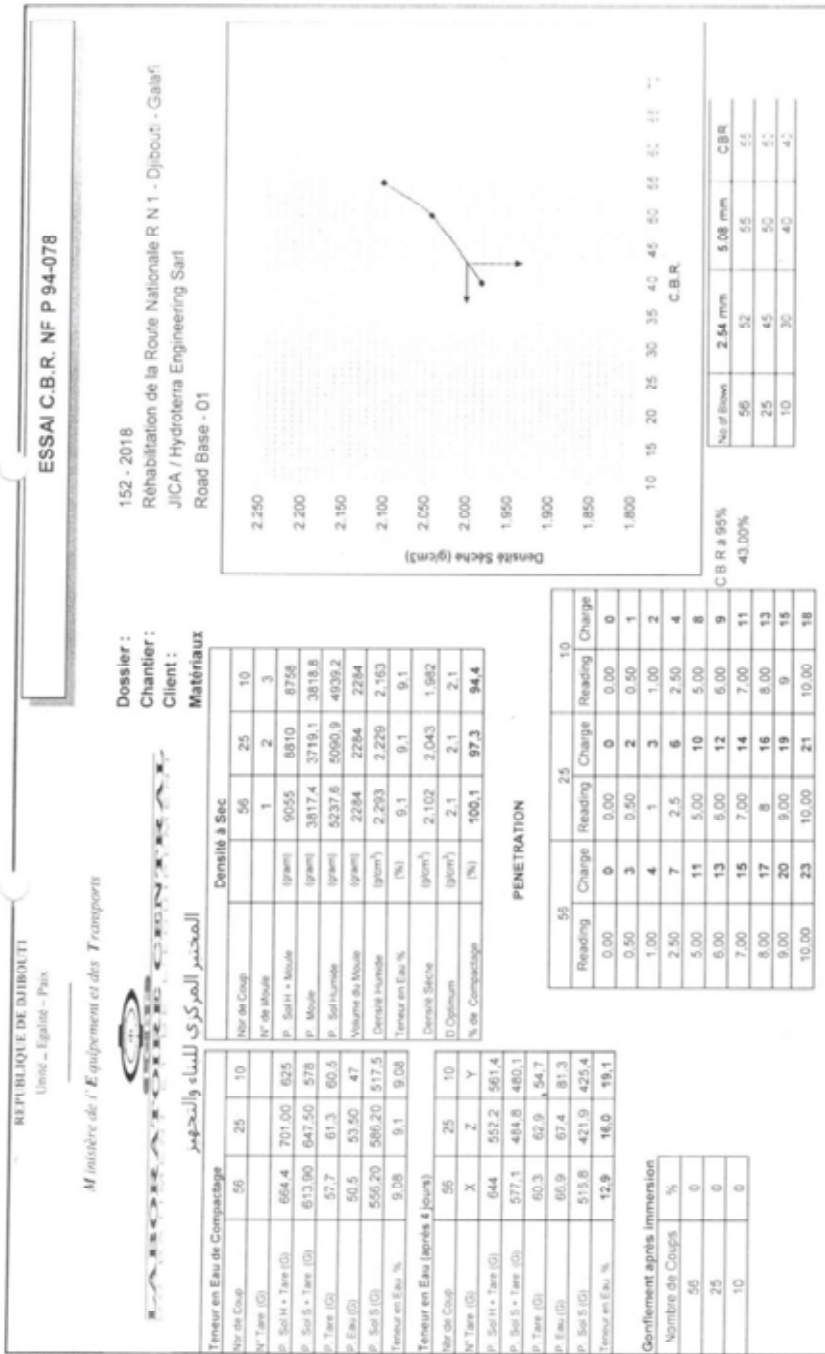
Gonflement après immersion	
Nombre de Coups	%
56	0
25	0
10	0

No of Blows	2.54 mm	5.08 mm	CBR
56	52	55	31
25	45	50	30
10	30	40	40

CBR à 95%  
43,00%

Le Directeur du LCBE.  
**Soubaneh Saïd Ismael**





Observation :

Le Directeur du LCBE  
Soubaneh Saïd Ismael

**LCBE**  
LABORATOIRE CENTRAL  
DE RECHERCHES

REPUBLIQUE DE DJIBOUTI  
Unité - Egalité - Paix

Ministère de l'Équipement et des Transports

LABORATOIRE CENTRAL  
المختبر المركزي للبناء والتجهيز

ESSAI DE PROCTOR MODIFIÉ  
NF P 94-093


Dossier : 152 - 2018  
Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi  
Client : JICA / Hydroterra Engineering Sarl  
Matériaux : Road Base - 01

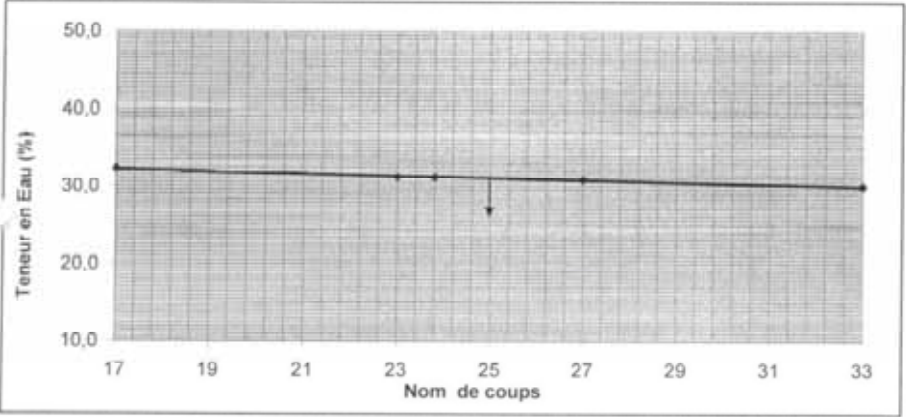
Determination N°	Units	1	2	3
% Eau Ajoutée	%	4	6	8
Poids Total Humide	(grs)	8 829,3	8 950,6	8 933,0
Poids du Moule	(grs)	3 708,8	3 708,8	3 708,8
Poids Net	(grs)	5 120,5	5 241,8	5 224,2
Volume du Moule	(cm <sup>3</sup> )	2 284,0	2 284,0	2 284,0
Densité Humide	(g/cm <sup>3</sup> )	2,242	2,295	2,287
Poids Total Humide	(grs)	722,3	699,4	599,6
Poids Total Sec	(grs)	674,4	644,8	545,0
Poids d' Eau	(grs)	47,9	54,6	54,6
Poids du Tare	(grs)	55,3	56,9	59,1
Poids Net Sec	(grs)	619,1	587,9	485,9
Teneur en Eau	%	7,7	9,3	11,2
Densité Sèche	(g/cm <sup>3</sup> )	2,082	2,100	2,057

D. maximum :	2,100
Eau optimum :	9,1

Observation :

Le Directeur du LCBE,  
Soubaneh Saïd Ismael

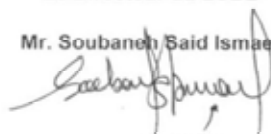
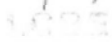
REPUBLIQUE DE DJIBOUTI - Union - Egalité - Paix		ESSAI DE LIMITE D'ATTERBERG NORME NF P 94 - 051					
Ministère de l'Équipement et des Transports							
 <b>LABORATOIRE CENTRAL</b> المختبر المركزي للبناء والتجهيز		Dossier : 152 - 2018 Chantier : Réhabilitation de la Route Nationale R N 1 Djibouti - Galafi Client : JICA / Hydroterra Engineering Sarl Partie de l'Ouvrage : Road Base - 1					
LL: 31,0		LP: 21,8		IP: 9,2			
LIMITE DE LIQUIDITE						LIMITE DE PLASTICITE	
NOMBRE DE COUPS	17	23	27	33	Test n°1	Test n°2	
NUMERO DE LA TARE	1	4	5	6	D	X	
POIDS TOTAL HUMIDE (g)	54,1	50,6	55,9	53,3	36,7	36,2	
POIDS TOTAL SEC (g)	48,7	46,1	50,2	48,3	35,8	35,4	
POIDS DE LA TARE (g)	32	31,7	31,7	31,6	31,8	31,6	
POIDS D'EAU (g)	5,4	4,5	5,7	5	0,9	0,8	
POIDS NET SEC (g)	16,7	14,4	18,5	16,7	4	3,8	
TENEUR EN EAU (%)	32,3	31,3	30,8	29,9	22,5	21,1	


  


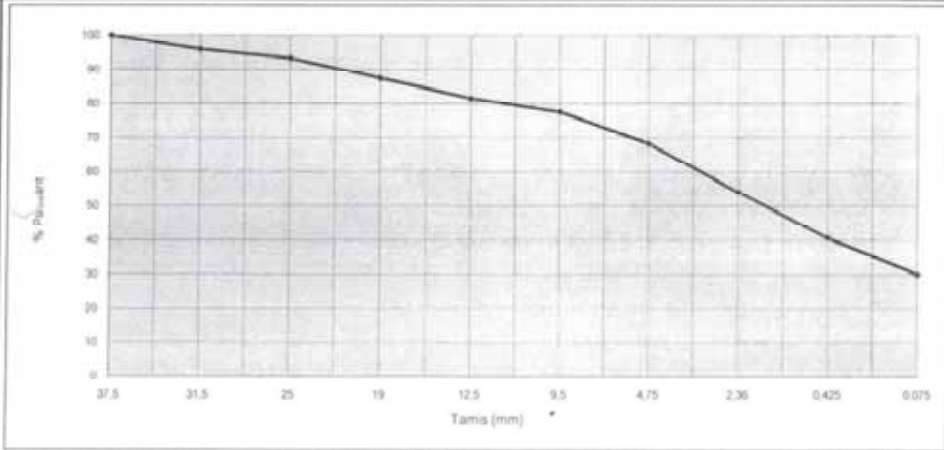
Observation :

Le Directeur du LCBE

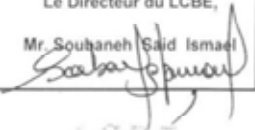
Mr. Soubaneh Said Ismael


  
 LABORATOIRE CENTRAL  
 ÉQUIPEMENT ET DES TRANSPORTS

REPUBLICUE DE DJIBOUTI Union - Egalité - Paix		ANALYSE GRANULOMETRIQUE NORME NF 933 1 - 933 2			
<i>Ministère de l'Équipement et des Transports</i>					
 LABORATOIRE CENTRAL المحجر المركزي للنسأ والنجر		Dossier : 152 - 2018			
		Chantier : Réhabilitation de la Route Nationale R N 1 - Djiboui - Galafi			
		Client : JICA / Hydroterra Engineering Sarl			
		Matériaux : Road Base - 1			
Poids Initial (grs):		<b>1254,5</b>			
Module Afnor	Tamis(mm)	Refus Partiels (gr)	Refus Cumules (gr)	Refus Cumules (%)	Passant (%)
	37,5		0	0,0	100,0
	31,5		50,9	4,1	95,9
	25		83,1	6,6	93,4
	19		157,2	12,5	87,5
	12,5		230,6	18,4	81,6
	9,5		281,6	22,4	77,6
	4,75		396,9	31,6	68,4
	2,36		576,0	45,9	54,1
	0,425		744,8	59,4	40,6
	0,075		877,6	70,0	30,0

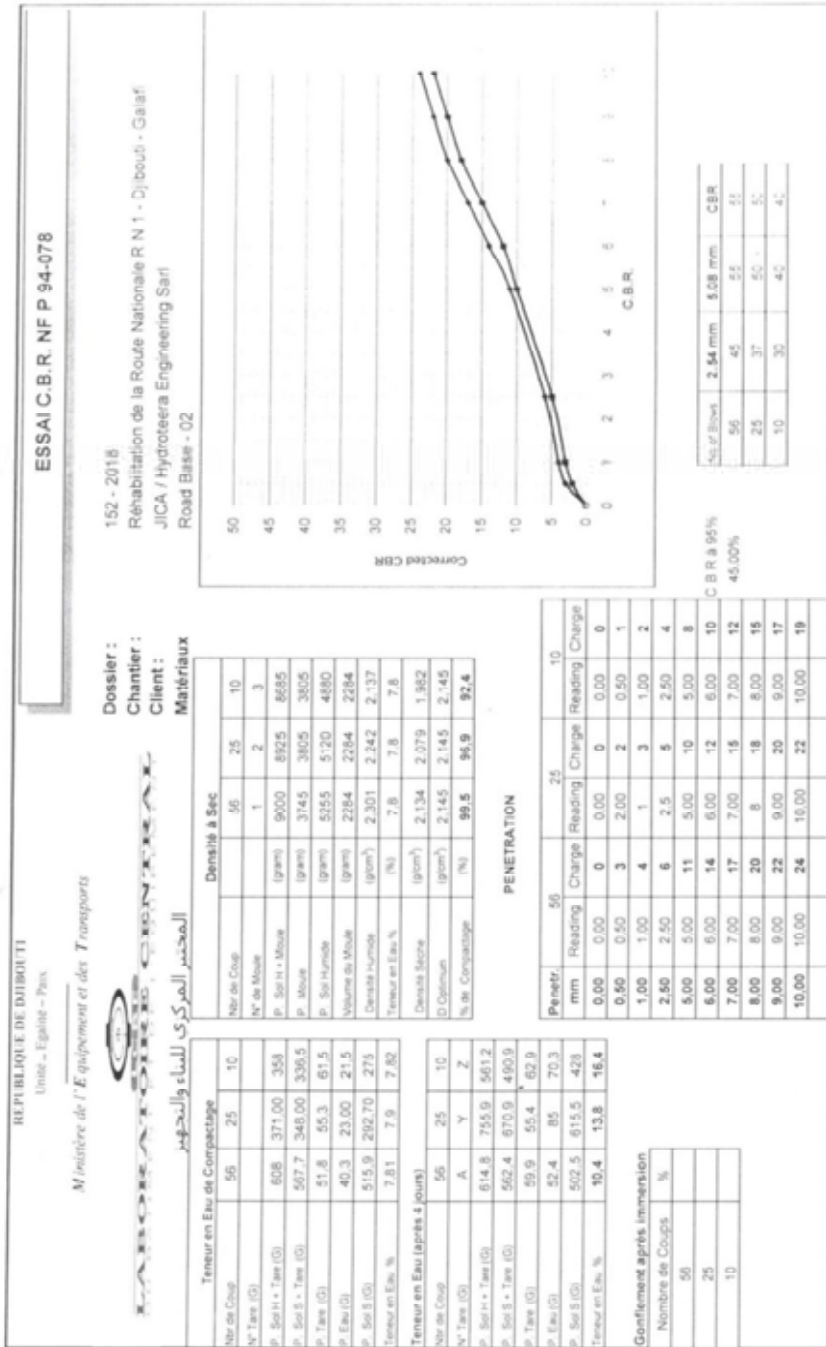
  


Observation :

Le Directeur du LCBE,  
 Mr. Souhaneh Saïd Ismaël  
  
 LCBE  
 LABORATOIRE CENTRAL  
 MINISTRE DE L'EQUIPEMENT ET DES TRANSPORTS



RB02



**REPUBLIQUE DE DJIBOUTI**  
Union - Egalité - Paix

*Ministère de l'Équipement et des Transports*

**المختبر المركزي للبناء والتجهيز**

**ESSAI C.B.R. NF P 94-078**

152 - 2018  
Régénération de la Route Nationale R N1 - Djibouti - Gaaf  
JICA / Hydroterra Engineering Sarl  
Road Base - 02

**Dossier :**  
**Chantier :**  
**Client :**

**Matériaux**

Teneur en Eau de Compactage		Densité à Sec	
Nbr de Coup	%	Nbr de Coup	%
56	7,9	56	2,5
25	21,5	1	2
10	21,5	2	3
<b>Teneur en Eau (après 4 jours)</b>			
Nbr de Coup	%	Nbr de Coup	%
56	25	10	10
A	Y	Z	
614,8	755,9	561,2	
502,4	670,9	450,9	
59,9	55,4	62,9	
52,4	85	70,3	
502,5	615,5	428	
16,4	12,8	16,4	

Teneur en Eau de Compactage		Densité à Sec	
Nbr de Coup	%	Nbr de Coup	%
56	7,8	56	2,5
25	21,5	1	2
10	21,5	2	3
<b>Teneur en Eau (après 4 jours)</b>			
Nbr de Coup <td>%</td> <td>Nbr de Coup <td>%</td> </td>	%	Nbr de Coup <td>%</td>	%
56	25	10	10
A	Y	Z	
614,8	755,9	561,2	
502,4	670,9	450,9	
59,9	55,4	62,9	
52,4	85	70,3	
502,5	615,5	428	
16,4	12,8	16,4	

**PNENETRATION**

Reading	Charge (g/cm <sup>2</sup> )	Reading	Charge	Reading	Charge
0,00	0	0,00	0	0,00	0
0,50	3	0,50	2	0,50	1
1,00	4	1	3	1,00	2
2,50	6	2,5	5	2,50	4
5,00	11	5,00	10	5,00	8
6,00	14	6,00	12	6,00	10
7,00	17	7,00	15	7,00	12
8,00	20	8	18	8,00	16
9,00	22	9,00	20	9	17
10,00	24	10,00	22	10,00	19

**CBR**

No. of Blows	2.54 mm	5.08 mm	CBR
56	45	55	51
25	37	52	51
10	30	42	41

**Densité Séche (g/cm<sup>3</sup>)**

No. of Blows	2.54 mm	5.08 mm	CBR
56	45	55	51
25	37	52	51
10	30	42	41


**CBR à 95%**  
45,00%

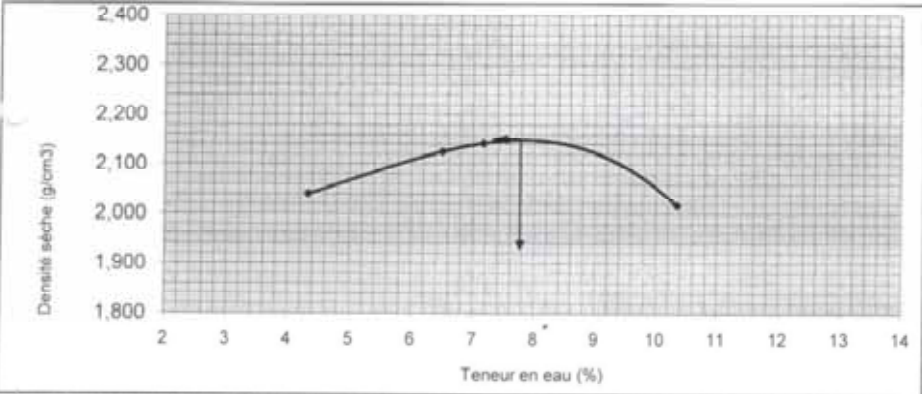
**Observation :**

Le Directeur du LCBE

Soubaneh Saïd Ismael

*(Signature)*

REPUBLIQUE DE DJIBOUTI		ESSAI DE PROCTOR MODIFIE NF P 94-093			
Unité - Egalité - Paix					
Ministère de l'Équipement et des Transports					
 <b>LABORATOIRE CENTRAL</b>		Dossier : 152 - 2018			
المختبر المركزي للبناء والتجهيز		Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi			
		Client : JICA / Hydroterra Engineering Sarl			
		Matériaux : Road Base - 02			
Determination N°	Units	1	2	3	4
% Eau Ajoutée	%	2	4	6	8
Poids Total Humide	(grs)	8 570,0	8 877,6	8 951,8	8 794,9
Poids du Moule	(grs)	3 708,8	3 708,8	3 708,8	3 708,8
Poids Net	(grs)	4 861,2	5 168,8	5 243,0	5 086,1
Volume du Moule	(cm <sup>3</sup> )	2 284,0	2 284,0	2 284,0	2 284,0
Densité Humide	(g/cm <sup>3</sup> )	2,128	2,263	2,296	2,227
Poids Total Humide	(grs)	520,0	644,0	558,1	724,0
Poids Total Sec	(grs)	501,0	608,3	524,7	662,2
Poids d' Eau	(grs)	19,0	35,7	33,4	61,8
Poids du Tare	(grs)	61,5	59,5	58,6	65,2
Poids Net Sec	(grs)	439,5	548,8	466,1	597,0
Teneur en Eau	%	4,3	6,5	7,2	10,4
Densité Sèche	(g/cm <sup>3</sup> )	2,041	2,125	2,141	2,017
D. maximum :					2,145
Eau optimum :					7,8

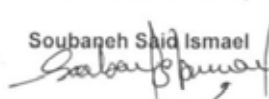
The graph plots Moist Density (g/cm³) on the y-axis (ranging from 1.800 to 2.400) against Water Content (%) on the x-axis (ranging from 2 to 14). A parabolic curve is drawn through the data points, with a vertical line indicating the maximum dry density of 2.145 g/cm³ at an optimum water content of 7.8%.


Observation :

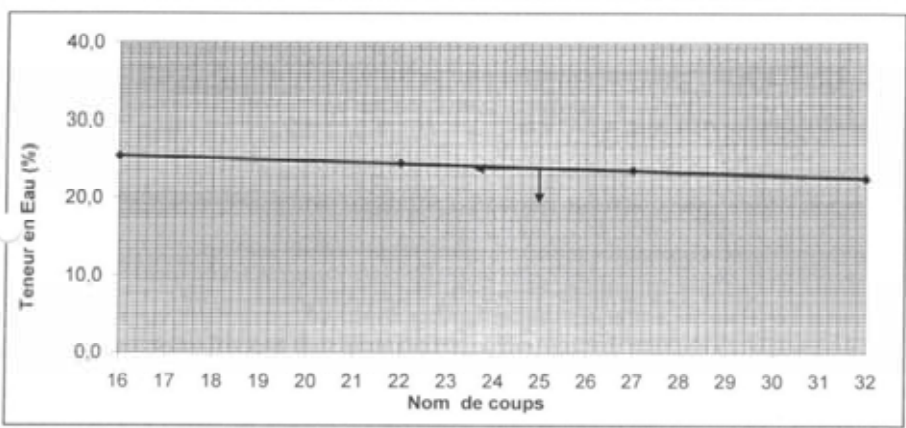
Le Directeur du LCBE,

LCBE  
LABORATOIRE CENTRAL

Soubarah Saïd Ismael



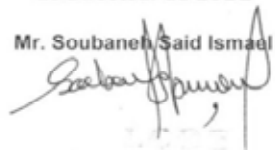
REPUBLIQUE DE DJIBOUTI Unité - Egalité - Paix					ESSAI DE LIMITE D'ATTERBERG NORME NF P 94 - 051	
Ministère de l'Équipement et des Transports						
 <b>LABORATOIRE CENTRAL</b> المختبر المركزي للبناء والتجهيز					Dossier : 152 - 2018 Chantier : Réhabilitation de la Route Nationale R N 1 Djibouti - Galafi Client : JICA / Hydroterra Engineering Sarl Partie de l'Ouvrage : Road Base - 2	
LL: 23,5		LP: 19,4		IP: 4,1		
LIMITE DE LIQUIDITE					LIMITE DE PLASTICITE	
NOMBRE DE COUPS	16	22	27	32	Test n°1	Test n°2
MERO DE LA TARE	9	11	13	14	15	8
POIDS TOTAL HUMIDE (g)	53,1	54,5	53,5	51,3	79,4	36,9
POIDS TOTAL SEC (g)	48,7	49,9	49,3	47,6	78,5	36,1
POIDS DE LA TARE (g)	31,4	31,1	31,5	31,2	74,2	31,6
POIDS D'EAU (g)	4,4	4,6	4,2	3,7	0,9	0,8
POIDS NET SEC (g)	17,3	18,8	17,8	16,4	4,3	4,5
TENEUR EN EAU (%)	25,4	24,5	23,6	22,6	20,9	17,8

Observation :

Le Directeur du LCBE

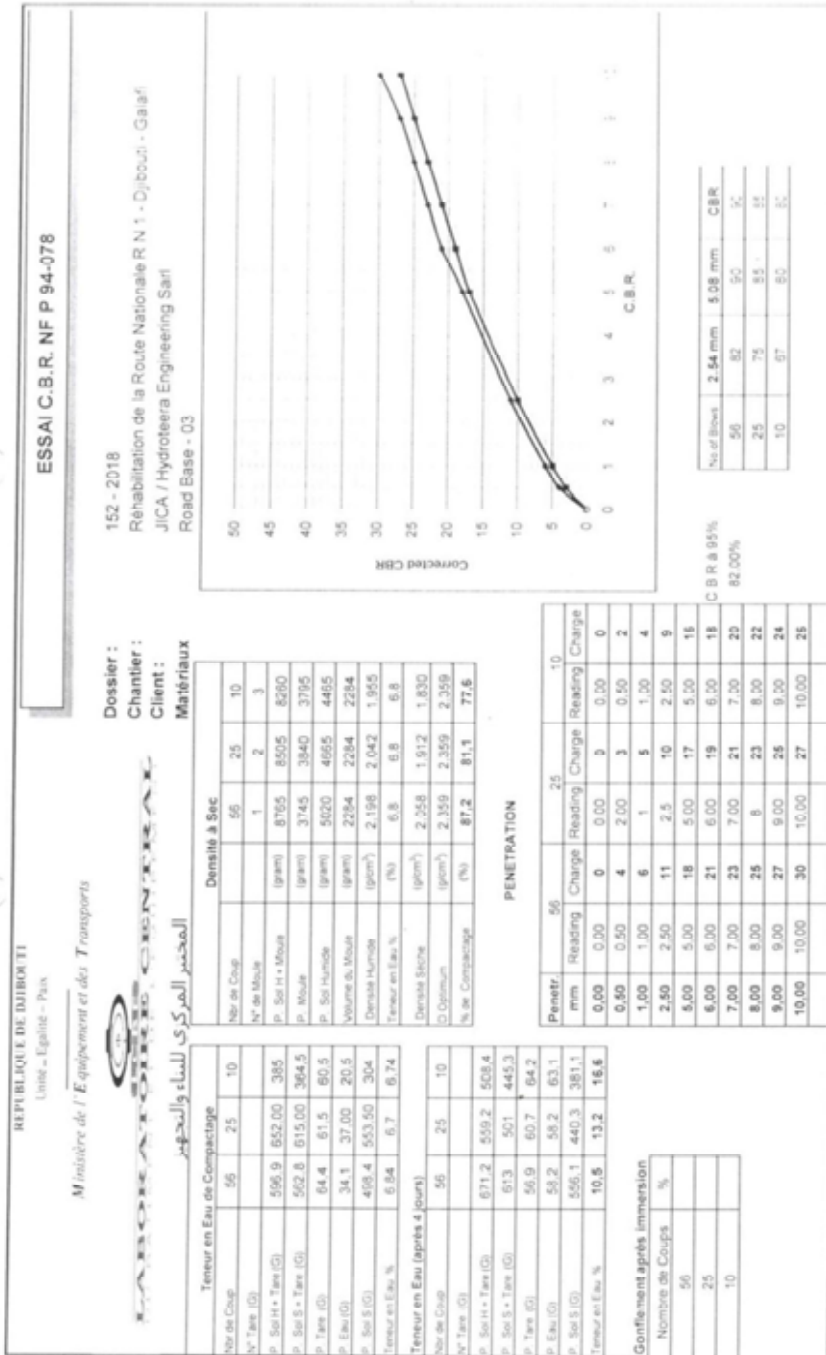
Mr. Soubaneh Said Ismael








RB03



Le Directeur du LCBE  
Soubaneh Saïd Ismael

**REPUBLIQUE DE DJIBOUTI**  
Unité - Egalité - Paix

**Ministère de l'Équipement et des Transports**  
المكتب المركزي للبناء والنقل

**ESSAI C.B.R. NF P 94-078**

**Dossier :** 152 - 2018  
**Chantier :** Réhabilitation de la Route Nationale R N 1 - Djibouti - Galaré  
**Client :** JICA / Hydroterra Engineering Sarl  
**Road Base :** - 03

Teneur en Eau de Compactage		Densité à Sec	
N° de Coup	56	25	10
N° Tare (G)			
P. Sol H + Tare (G)	596.9	652.00	385
P. Sol S + Tare (G)	562.80	615.00	364.5
P. Tare (G)	64.4	61.5	60.5
P. Eau (G)	34.1	37.00	20.5
P. Sol S (G)	498.40	553.50	304
Teneur en Eau %	6.94	6.7	6.74

Teneur in Eau (après 4 jours)		Densité Sèche	
N° de Coup	56	25	10
N° Tare (G)			
P. Sol H + Tare (G)	671.2	559.2	508.4
P. Sol S + Tare (G)	613	501	445.3
P. Tare (G)	56.9	60.7	64.2
P. Eau (G)	58.2	58.2	63.1
P. Sol S (G)	555.1	440.3	381.1
Teneur en Eau %	10.5	13.2	16.6

Densité Sèche (g/cm<sup>3</sup>)

PENETRATION	
56	25
Reading	Reading
0.00	0
0.50	4
1.00	6
2.50	11
5.00	18
6.00	21
7.00	23
8.00	25
9.00	27
10.00	30

Gonflement après Immersion	
Nombre de Coups	%
56	
25	
10	

C.B.R.	
N° de Bous	CBR
56	52
25	15
10	67

C.B.R. à 95% : 82.00%

C.B.R. à 95% : 5.08 mm

Le Directeur du LCBE  
Soubaneh Saïd Ismael

PS

Observation :

REPUBLIQUE DE DJIBOUTI		ESSAI DE PROCTOR MODIFIE			
Unité - Egalité - Paix		NF P 94-093			
Ministère de l'Équipement et des Transports		Dossier : 152 - 2018			
LABORATOIRE CENTRAL		Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi			
المختبر المركزي للبناء والتجهيز		Client : JICA / Hydroterra Engineering Sarl			
		Matériaux : Road Base - 03			
Determination N°	Units	1	2	3	
% Eau Ajoutée	%	2	4	6	
Poids Total Humide	(grs)	8 851,0	9 359,0	9 392,4	
Poids du Moule	(grs)	3 708,8	3 708,8	3 708,8	
Poids Net	(grs)	5 142,2	5 650,2	5 683,6	
Volume du Moule	(cm <sup>3</sup> )	2 284,0	2 284,0	2 284,0	
Densité Humide	(g/cm <sup>3</sup> )	2,251	2,474	2,488	
Poids Total Humide	(grs)	893,1	540,2	607,8	
Poids Total Sec	(grs)	864,5	513,2	565,4	
Poids d' Eau	(grs)	28,6	27,0	42,4	
Poids du Tare	(grs)	138,5	55,5	60,3	
Poids Net Sec	(grs)	726,0	457,7	505,1	
Teneur en Eau	%	3,9	5,9	8,4	
Densité Sèche	(g/cm <sup>3</sup> )	2,167	2,336	2,296	
				D. maximum :	2,359
				Eau optimum :	6,8


The graph plots Dry Density (g/cm³) on the y-axis (ranging from 1.900 to 2.500) against Water Content (%) on the x-axis (ranging from 0 to 12). Three data points are plotted: (3.9, 2.167), (5.9, 2.336), and (8.4, 2.296). A smooth curve is drawn through these points, peaking at a water content of 6.8% and a dry density of 2.359 g/cm³. A vertical arrow points from the peak of the curve down to the x-axis at 6.8%.

Observation :

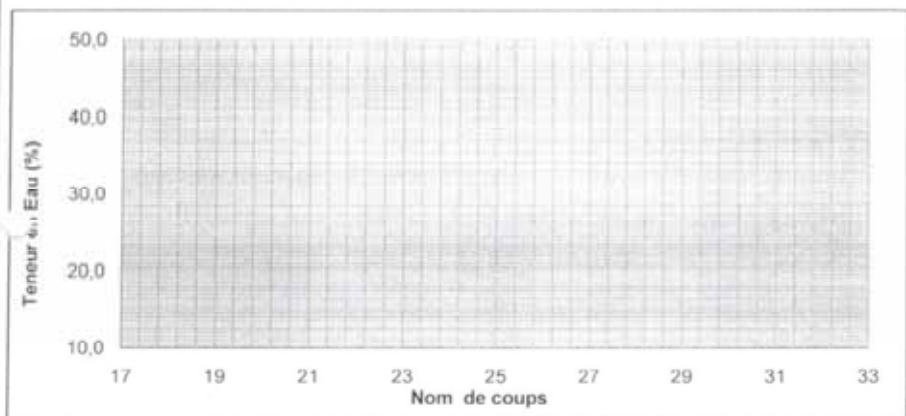
Le Directeur du LCBE,

LCBE  
LABORATOIRE CENTRAL

Soubaneh Said Ismael

REPUBLIQUE DE DJIBOUTI Union Epulata Paix		ESSAI DE LIMITE D'ATTERBERG NORME NF P 94 051			
Ministère de l'Équipement et des Transports					
 <b>LABORATOIRE CENTRAL</b> المختبر المركزي للبناء والتجهيز		Dossier : 152 - 2018 Chantier : Réhabilitation de la Route Nationale R N 1 Djibouti - Galafi Client : JICA / Hydroterra Engineering Sarl Partie de l'Ouvrage : Road Base - 3			
LL:		LP:		IP: N M	
LIMITE DE LIQUIDITE		LIMITE DE PLASTICITE			
NOMBRE DE COUPS				Test n°1	Test n°2
MERO DE LA TARE					
POIDS TOTAL HUMIDE (g)					
POIDS TOTAL SEC (g)		NON MESURABLE			
POIDS DE LA TARE (g)					
POIDS D'EAU (g)					
POIDS NET SEC (g)					
TENEUR EN EAU (%)					

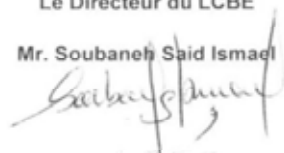
  




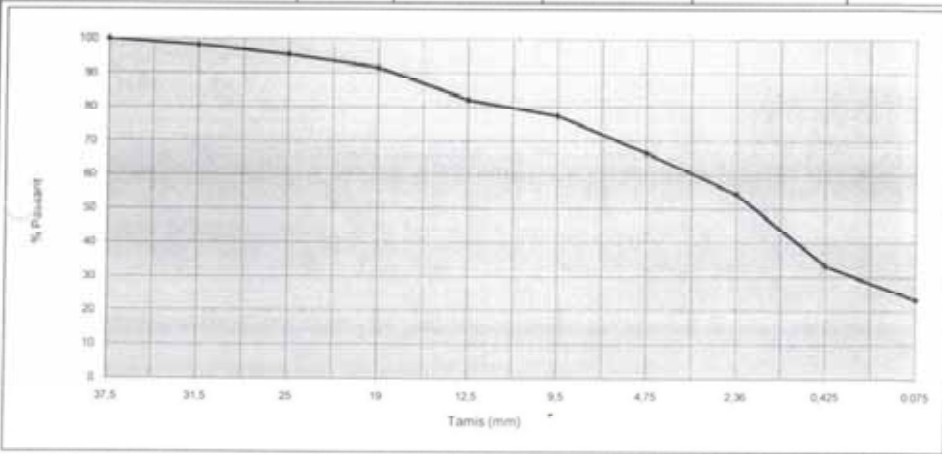
Observation :

Le Directeur du LCBE

Mr. Soubaneh Said Ismael

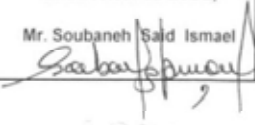
  
 LCBE  
 LABORATOIRE CENTRAL  
 EQUIPEMENT ET TRANSPORTS

REPUBLIQUE DE DJIBOUTI Unité - Egalité - Paix		ANALYSE GRANULOMETRIQUE NORME NF 933-1 - 933-2			
Ministère de l'Équipement et des Travaux Publics					
 LABORATOIRE CENTRAL المختبر المركزي للمباني والبنية التحتية		Dossier : 152 - 2018			
		Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galati			
		Client : JICA / Hydroterra Engineering Sarl			
		Matériaux : Road Base - 3			
Poinds Initial (grs):		6000,0			
Module Afnor	Tamis(mm)	Refus Partiels (gr)	Refus Cumules (gr)	Refus Cumules (%)	Passant (%)
	37,5		0	0,0	100,0
	31,5		111,7	1,9	98,1
	25		273,1	4,6	95,4
	19		504,7	8,4	91,6
	12,5		1069,6	17,8	82,2
	9,5		1357,8	22,6	77,4
	4,75		2007,6	33,5	66,5
	2,36		2734,2	45,6	54,4
	0,425		4002,9	66,7	33,3
	0,075		4601,2	76,7	23,3

Observation :

Le Directeur du LCBE,  
Mr. Soubaneh Saïd Ismael



LCBE  
LABORATOIRE CENTRAL  
D'ÉQUIPEMENT ET DE L'ÉQUIPEMENT



RB04

**REPUBLIQUE DE DJIBOUTI**  
Unité - Egalité - Paix

*Ministère de l'Équipement et des Transports*

**المخبر المركزي لبياء والتجهيز**

**ESSAI C.B.R. NF P 94-078**

152 - 2018  
Réhabilitation de la Route Nationale R N 1 - Djibouti - Galaf  
JICA / Hydrotera Engineering Sarl  
Road Base - 04

**Dossier :** 152 - 2018  
**Chantier :** Réhabilitation de la Route Nationale R N 1 - Djibouti - Galaf  
**Client :** JICA / Hydrotera Engineering Sarl  
**Matériaux :** Road Base - 04

**Le Directeur du LCBE.**  
Soubaneh Saïd Ismael

Teneur en Eau de Compaction		Densité à Sec	
Nbr de Coup	56	25	10
N° Type (G)		1	2
P. Sol H + Tare (G)	567.4	298.00	455
P. Sol S + Tare (G)	459.4	267.00	403.7
P. Tare (G)	48	61.5	61.8
P. Eau (G)	68	31.00	51.3
P. Sol S (G)	451.4	205.50	341.9
Teneur en Eau %	15.06	15.1	15.00

Teneur en Eau (après 4 jours)		Densité à Sec	
Nbr de Coup	56	25	10
N° Type (G)			
P. Sol H + Tare (G)	613.4	579.1	512.4
P. Sol S + Tare (G)	525.6	486	423.3
P. Tare (G)	50	49.2	51.7
P. Eau (G)	87.8	93.1	89.1
P. Sol S (G)	475.6	406.8	371.6
Teneur en Eau %	18.5	21.3	24.0

Gonflement après immersion	
Nombre de Coups	%
56	0.01
25	0.05
10	0.08

**PENETRATION**

Penetr mm	56		25		10	
	Reading	Change	Reading	Change	Reading	Change
0.00	0.00	0	0.00	0	0.00	0
0.50	0.50	3	2.00	2	0.50	1
1.00	1.00	4	1	3	1.00	2
2.50	2.50	6	2.5	5	2.50	4
5.00	5.00	10	5.00	9	5.00	7
6.00	6.00	12	6.00	11	6.00	9
7.00	7.00	14	7.00	13	7.00	11
8.00	8.00	16	8	15	8.00	13
9.00	9.00	18	9.00	17	9.00	16
10.00	10.00	20	10.00	19	10.00	18

No of Bases	2.54 mm	5.08 mm	CBR
56	45	50	50
25	37	45	45
10	30	35	35

CBR à 95%  
38.50%

**Observation :**

**REPUBLIQUE DE DJIBOUTI**  
Unité - Egalité - Paix

**Ministère de l'Équipement et des Transports**

**المختبر المركزي للبناء والمطهر**

**ESSAI C.B.R. NF P 94-078**

**Dossier :** 152 - 2018  
**Chantier :** Réhabilitation de la Route Nationale R N 1 - Djibouti - Gaafu  
**Client :** JICA / Hydroterra Engineering Sarl  
**Matériaux :** Road Base - 04

Teneur en Eau de Compactage		Densité à Sec	
N° de Coup	55	25	10
N° Tare (G)			
P. Sol H + Tare (G)	567,4	298,00	455
P. Sol S + Tare (G)	499,40	297,00	403,7
P. Tare (G)	48	61,5	61,8
P. Eau (G)	68,0	31,00	51,3
P. Sol S (G)	451,40	205,50	341,9
Teneur en Eau %	15,08	15,1	15,00

Teneur en Eau (après 4 jours)		Densité Sèche	
N° de Coup	55	25	10
N° Tare (G)			
P. Sol H + Tare (G)	613,4	579,1	512,4
P. Sol S + Tare (G)	525,6	466	423,3
P. Tare (G)	50	49,2	51,7
P. Eau (G)	87,8	93,1	89,1
P. Sol S (G)	475,6	436,8	371,6
Teneur en Eau %	18,5	21,3	24,0

Gonflement après immersion	
Nombre de Coups	%
56	0,01
25	0,05
10	0,08

PENETRATION	
Reading	Change
0,00	0
0,50	3
1,00	4
2,50	6
5,00	10
6,00	12
7,00	14
8,00	16
9,00	18
10,00	20

Densité à Sec	
N° de Coup	56
N° de Moule	1
P. Sol H + Moule (gram)	8760
P. Moule (gram)	3754
P. Sol Humide (gram)	5006
Volume du Moule (cm³)	2284
Densité Humide (g/cm³)	2,192
Teneur en Eau %	15,0
Densité Sèche (g/cm³)	1,906
D. Optimum (g/cm³)	1,91
% de Compactage	99,8

Densité Sèche (g/cm³)	
N° de Coup	25
10	1,91
15	1,91
20	1,91
25	1,91
30	1,91
35	1,91
40	1,91
45	1,91
50	1,91
55	1,91

**CBR**

CBR à 95%	
N° de Bess	2,54 mm
56	45
25	37
10	30

**CBR à 50%**

CBR à 50%	
N° de Bess	5,08 mm
56	50
25	45
10	35

Observation :

Le Directeur du LCBE

Soubaneh Saïd Ismael

PS

REPUBLIQUE DE DJIBOUTI		ESSAI DE PROCTOR MODIFIE		
Unité - Egalité - Paix		NF P 94-093		
Ministère de l'Équipement et des Transports		Dossier : 152 - 2018		
LABORATOIRE CENTRAL		Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi		
المختبر المركزي للبناء والتجهيز		Client : JICA / Hydroterra Engineering Sarl		
		Matériaux : Road Base - 04		
Determination N°	Units	1	2	3
% Eau Ajoutée	%	2	4	6
Poids Total Humide	(grs)	8 550,0	8 715,0	8 625,0
Poids du Moule	(grs)	3 700,0	3 700,0	3 700,0
Poids Net	(grs)	4 850,0	5 015,0	4 925,0
Volume du Moule	(cm <sup>3</sup> )	2 284,0	2 284,0	2 284,0
Densité Humide	(g/cm <sup>3</sup> )	2,123	2,196	2,156
Poids Total Humide	(grs)	490,8	494,7	567,0
Poids Total Sec	(grs)	441,2	436,0	491,0
Poids d' Eau	(grs)	49,6	58,7	76,0
Poids du Tare	(grs)	66,4	48,3	59,1
Poids Net Sec	(grs)	374,8	387,7	431,9
Teneur en Eau	%	13,2	15,1	17,6
Densité Sèche	(g/cm <sup>3</sup> )	1,876	1,908	1,834
D. maximum :				1,910
Eau optimum :				15,0


The graph plots Dry Density (g/cm³) on the y-axis (ranging from 1,500 to 2,100) against Water Content (%) on the x-axis (ranging from 10 to 22). A parabolic curve is drawn through three data points: (13.2, 1.876), (15.1, 1.908), and (17.6, 1.834). The peak of the curve is at 15.0% water content and 1.910 g/cm³ dry density, which is marked as the optimum point.

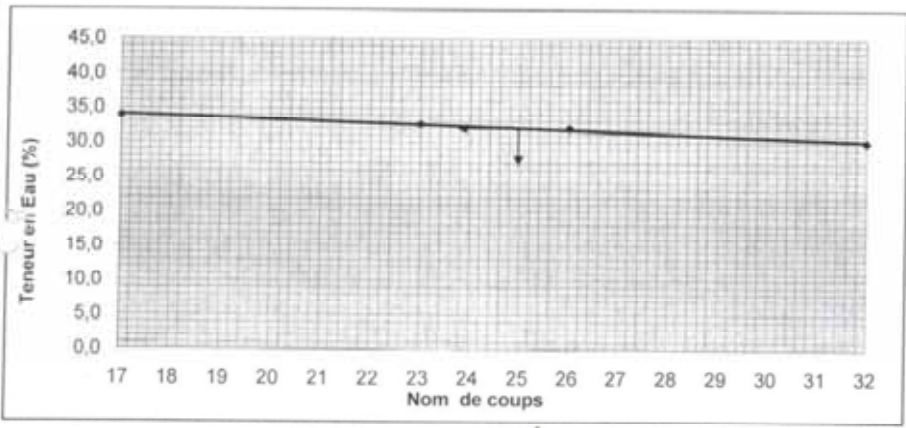
Observation :

LCBE  
LABORATOIRE CENTRAL  
ÉQUIPEMENT ET DES TRANSPORTS

Le Directeur du LCBE,

Soubaneh Saïd Ismael  
*Soubaneh Saïd Ismael*

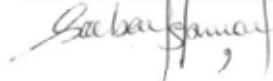
REPUBLIQUE DE DJIBOUTI		ESSAI DE LIMITE D'ATTERBERG				
Union Egarite Pais		NORME NF P 94 051				
Ministère de l'Équipement et des Transports						
 <b>LABORATOIRE CENTRAL</b> المختبر المركزي للبناء والتجهيز		Dossier : 152 - 2018 Chantier : Réhabilitation de la Route Nationale R N 1 Djibouti - Galafi Client : JICA / Hydroterra Engineering Sarl Partie de l'Ouvrage : Road Base - 04				
LL: 32,0		LP: 19,8		IP: 12,2		
LIMITE DE LIQUIDITE				LIMITE DE PLASTICITE		
NOMBRE DE COUPS	17	23	26	32	Test n°1	Test n°2
NOMBRE DE LA TARE	2	9	10	12	13	D
POIDS TOTAL HUMIDE (g)	55,78	54,74	55,16	54,73	36,3	36,1
POIDS TOTAL SEC (g)	49,6	49	49,4	49,3	35,5	35,3
POIDS DE LA TARE (g)	31,4	31,4	31,4	31,2	31,4	31,3
POIDS D'EAU (g)	6,18	5,74	5,76	5,43	0,8	0,8
POIDS NET SEC (g)	18,2	17,6	18	18,1	4,1	4
TENEUR EN EAU (%)	34,0	32,6	32,0	30,0	19,5	20,0

Observation :

Le Directeur du LCBE

Mr. Soubaneh Said Ismael




**REPUBLIQUE DE DJIBOUTI**  
Unité - Egalité - Paix

*Ministère de l'Équipement et des Transports*

**LABORATOIRE CENTRAL**  
المحبر المركزي للبناء والتجهيز

**ANALYSE GRANULOMETRIQUE**  
**NORME NF 933 1 - 933 2**

**Dossier :** 152 - 2018  
**Chantier :** Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi  
**Client :** JICA / Hydroterra Engineering Sarl  
**Matériaux :** Road Base - 4

**Poids Initial (grs):** 2500,2

Module Afnor	Tamis(mm)	Refus Partiels (gr)	Refus Cumules (gr)	Refus Cumules (%)	Passant (%)
	0,6		0	0,0	100,0
	0,425		3,7	0,1	99,9
	0,3		5,3	0,2	99,8
	0,15		18,6	0,7	99,3
	0,075		51,3	2,1	97,9

The graph plots the percentage of material passing through various sieve sizes. The y-axis is labeled '% Passant' and ranges from 0 to 100. The x-axis is labeled 'Tamis (mm)' and shows sieve sizes from 0.6 down to 0.075. A single curve is drawn, starting at 100% for 0.6mm and ending at 97.9% for 0.075mm. The data points from the table are plotted on the graph.

**Observation :**

Le Directeur du LCBE,  
 Mr. Soubaneh Saïd Ismaël

LABORATOIRE CENTRAL  
EQUIPEMENT ET DES TRANSPORTS



RB05

**REPUBLICQUE DE DJIBOUTI**  
Unité - Egalité - Paix

*Ministère de l'Équipement et des Transports*

**المختبر المركزي للبناء والتجهيز**

**ESSAI C.B.R. NF P 94-078**

152 - 2018  
Réhabilitation de la Route Nationale N 1 - Djibouti - Gaaf  
JICA / Hydrotera Engineering Sarl  
Road Base - 05

**Dossier :**  
**Chantier :**  
**Client :**  
**Matériaux**

**Dossier :**  
**Chantier :**  
**Client :**  
**Matériaux**

Teneur en Eau de Compactage		Densité à Sec	
Nbr de Coup	56	25	10
N° Tare (G)			
P. Sol H + Tare (G)	607	677,00	478
P. Sol S + Tare (G)	564	628,50	445
P. Tare (G)	66,2	63	61,2
P. Eau (G)	43	48,50	33
P. Sol S (G)	497,8	565,50	383,8
Teneur en Eau %	8,64	8,6	8,63

Teneur en Eau (après 4 jours)	
Nbr de Coup	56
N° Tare (G)	
P. Sol H + Tare (G)	663
P. Sol S + Tare (G)	600,3
P. Tare (G)	54,5
P. Eau (G)	62,7
P. Sol S (G)	545,8
Teneur en Eau %	11,5

Gonflement après immersion	
Nombre de Coups	%
56	
25	
10	

PENETRATION			
Penetr. mm	56	25	10
0,00	0,00	0,00	0,00
0,50	0,50	4	2,00
1,00	1,00	6	1
2,50	2,50	10	2,5
5,00	5,00	16	5,00
6,00	6,00	18	6,00
7,00	7,00	21	7,00
8,00	8,00	23	8
9,00	9,00	26	9,00
10,00	10,00	28	10,00

Densité à Sec	
Densité Sèche	% de Compactage
2,248	100,4
2,238	97,9
2,238	93,4

**Corrected CBR**

Nbr de Blocs	2,54 mm	5,08 mm	CBR
56	75	80	10
25	60	70	10
10	52	60	10

CBR à 95%  
63,50%

Le Directeur du LCBE.

*Ri Soubaneh Said Ismael*

**REPUBLIQUE DE DJIBOUTI**  
Unité - Egalité - Paix

**Ministère de l'Équipement et des Transports**  
المختبر المركزي للبناء والتجهيز

**ESSAI C.B.R. NF P 94-078**

**Dossier :** 152 - 2018  
**Chantier :** Réhabilitation de la Route Nationale R.N.1 - Djibouti - Gaala  
**Client :** JICA / Hydroterra Engineering Sarl  
**Road Base :** - 05

Teneur en Eau de Compaction		56		25		10	
N° de Coup							
N° Tars (G)							
P. Sol H + Tars (G)		607.0	677.00	478			
D. Sol S + Tars (G)		564.00	628.50	445			
P. Tars (G)		66.2	63	61.2			
P. Eau (G)		43.0	48.50	33			
P. Sol S (G)		497.80	565.50	383.8			
Teneur en Eau %		8.64	8.6	8.80			

Teneur en Eau (après 4 jours)		56		25		10	
N° de Coup							
N° Tars (G)							
P. Sol H + Tars (G)		663	754.3	765.3			
P. Sol S + Tars (G)		600.3	666.3	678.3			
P. Tars (G)		54.5	60.7	63.8			
P. Eau (G)		61.7	88	107			
P. Sol S (G)		545.8	605.6	614.5			
Teneur en Eau %		11.5	14.5	17.4			

Densité à Sec		56		25		10	
N° de Moul							
P. Sol H + Moul	(gram)	9295	9240	9005			
P. Moul	(gram)	3720	3815	3820			
P. Sol Humide	(gram)	5575	5425	5185			
Volumen du Moul	(gram)	2284	2284	2284			
Densité Humide	(g/cm <sup>3</sup> )	2.44	2.375	2.270			
Teneur en Eau %	(%)	8.6	8.6	8.6			
Densité Sèche	(g/cm <sup>3</sup> )	2.248	2.187	2.090			
D. Optimum	(g/cm <sup>3</sup> )	2.238	2.238	2.238			
% de Compaction	(%)	100.4	97.7	93.4			

PENETRATION		25		10	
Reading	Charge	Reading	Charge	Reading	Charge
0.00	0	0.00	0	0.00	0
0.50	4	0.50	3	0.50	2
1.00	6	1	5	1.00	4
2.50	10	2.5	8	2.50	7
5.00	16	5.00	14	5.00	12
6.00	18	6.00	16	6.00	14
7.00	21	7.00	19	7.00	17
8.00	23	8	21	8.00	19
9.00	26	9.00	23	9	21
10.00	28	10.00	25	10.00	24

Densité Sèche (g/cm <sup>3</sup> )		56		25		10	
2.150							
2.100							
2.050							
2.000							
1.950							
1.900							

C.B.R.

C.B.R.		2.54 mm		5.08 mm		C.B.R.	
No. of Blows							
56		7.5	5.0	5.0			
25		6.0	7.0	6.0			
10		5.0	6.0	5.0			

C.B.R. à 95%		63.50%	
25		7.0	7.0
19		8.0	8.0
9		9.0	9.0
21		10.0	10.0

Gonflement après immersion		%	
Nombr de Coups			
56			
25			
10			

Observation :

Le Directeur du LCBE

Soubaneh Saïd Ismael

- REPUBLIQUE DE DJIBOUTI		ESSAI DE PROCTOR MODIFIE			
Unité - Egalité - Paix		NF P 94 093			
Ministère de l'Équipement et des Transports		Dossier : 152 - 2018			
LABORATOIRE CENTRAL		Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi			
المختبر المركزي للبناء والتجهيز		Client : JICA / Hydroterra Engineering Sarl			
		Matériaux : Road Base - 05			
Determination N°	Units	1	2	3	
% Eau Ajoutée	%	6	8	10	
Poids Total Humide	(grs)	9 125,0	9 250,0	9 165,0	
Poids du Moule	(grs)	3 700,0	3 700,0	3 700,0	
Poids Net	(grs)	5 425,0	5 550,0	5 465,0	
V <sub>ne</sub> du Moule	(cm <sup>3</sup> )	2 284,0	2 284,0	2 284,0	
Densité Humide	(g/cm <sup>3</sup> )	2,375	2,430	2,393	
Poids Total Humide	(grs)	742,1	790,8	810,5	
Poids Total Sec	(grs)	694,5	729,9	739,5	
Poids d' Eau	(grs)	47,6	60,9	71,0	
Poids du Tare	(grs)	53,4	55,9	61,8	
Poids Net Sec	(grs)	641,1	674,0	677,7	
Teneur en Eau	%	7,4	9,0	10,5	
Densité Séche	(g/cm <sup>3</sup> )	2,212	2,229	2,165	
				D. maximum :	2,238
				Eau optimum :	8,6


  

The graph plots Dry Density (g/cm³) on the y-axis (ranging from 1.800 to 2.400) against Water Content (%) on the x-axis (ranging from 3 to 15). Three data points are plotted: (7.4, 2.212), (9.0, 2.229), and (10.5, 2.165). A smooth curve is drawn through these points, peaking at approximately 8.6% water content and 2.238 g/cm³ dry density. A vertical line is drawn from the peak to the x-axis at 8.6%.

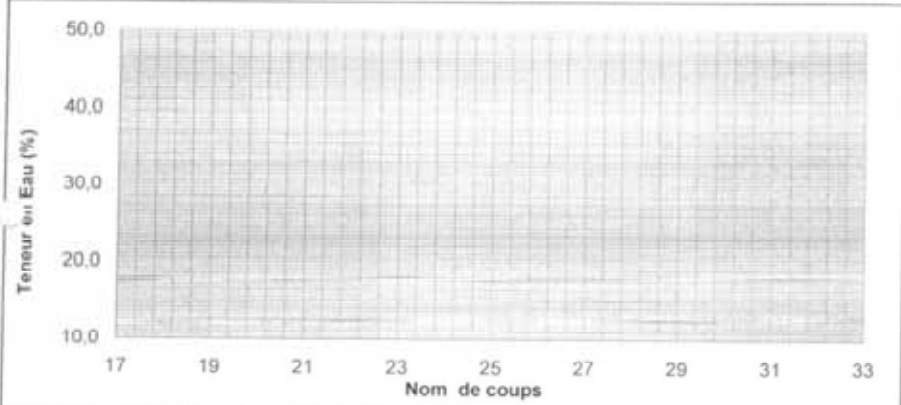
Observation :

Le Directeur du LCBE,

LABORATOIRE CENTRAL  
 Soubaneh Said Ismael  
 Directeur du LCBE

REPUBLIQUE DE DJIBOUTI Union Lydine Pais Ministère de l'Équipement et des Transports		ESSAI DE LIMITE D'ATHERBERG NORME NI P 94 051			
 LABORATOIRE CENTRAL المختبر المركزي للبناء والتجهيز		Dossier : 152 / 2018 Chantier : Réhabilitation de la Route Nationale R N 1 Djibouti - Galafi Client : JICA / Hydroterra Engineering Sarl Partie de l'Ouvrage : Road Base - 5			
LL:		LP:		IP: N M	
LIMITE DE LIQUIDITE		LIMITE DE PLASTICITE			
NOMBRE DE COUPS				Test n°1	Test n°2
MERO DE LA TARE					
POIDS TOTAL HUMIDE (g)					
POIDS TOTAL SEC (g)					
POIDS DE LA TARE (g)		NON MESURABLE			
POIDS D'EAU (g)					
POIDS NET SEC (g)					
TENEUR EN EAU (%)					

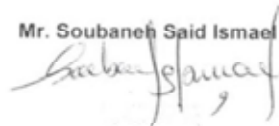
  



Observation :

Le Directeur du LCBE

Mr. Soubaneh Said Ismael



LABORATOIRE CENTRAL  
 15 Nouvelles Routes de l'Équipement

REPUBLIQUE DE DJIBOUTI  
Unité - Egalité - Paix

Ministère de l'Équipement et des Transports

**LCBE**  
LABORATOIRE CENTRAL  
المختبر المركزي للبناء والتجهيز

ANALYSE GRANULOMETRIQUE  
NORME NF 933-1 - 933-2

Dossier : 152 - 2018  
Chantier : Réhabilitation de la Route Nationale R N 1 - Djiboui - Galafi  
Client : JICA / Hydroterra Engineering Sarl  
Matériaux : Road Base - 5

Poids Initial (grs): **3200,3**

Module Afnor	Tamis(mm)	Refus Partiels (gr)	Refus Cumules (gr)	Refus Cumules (%)	Passant (%)
	50		205,8	6,4	93,6
	37,5		1366,5	42,7	57,3
	31,5		1550,3	48,4	51,6
	25		1672,2	52,3	47,7
	19		1905,5	59,5	40,5
	12,5		2082,7	65,1	34,9
	9,5		2160,2	67,5	32,5
	6,3		2239,1	70,0	30,0
	4,75		2283,4	71,3	28,7
	2,36		2401,8	75,0	25,0
	1,18		2511,2	78,5	21,5
	0,6		2602,7	81,3	18,7
	0,425		2627,8	82,1	17,9
	0,3		2660,6	83,1	16,9
	0,15		2752,9	86,0	14,0
	0,075		2788,7	87,1	12,9

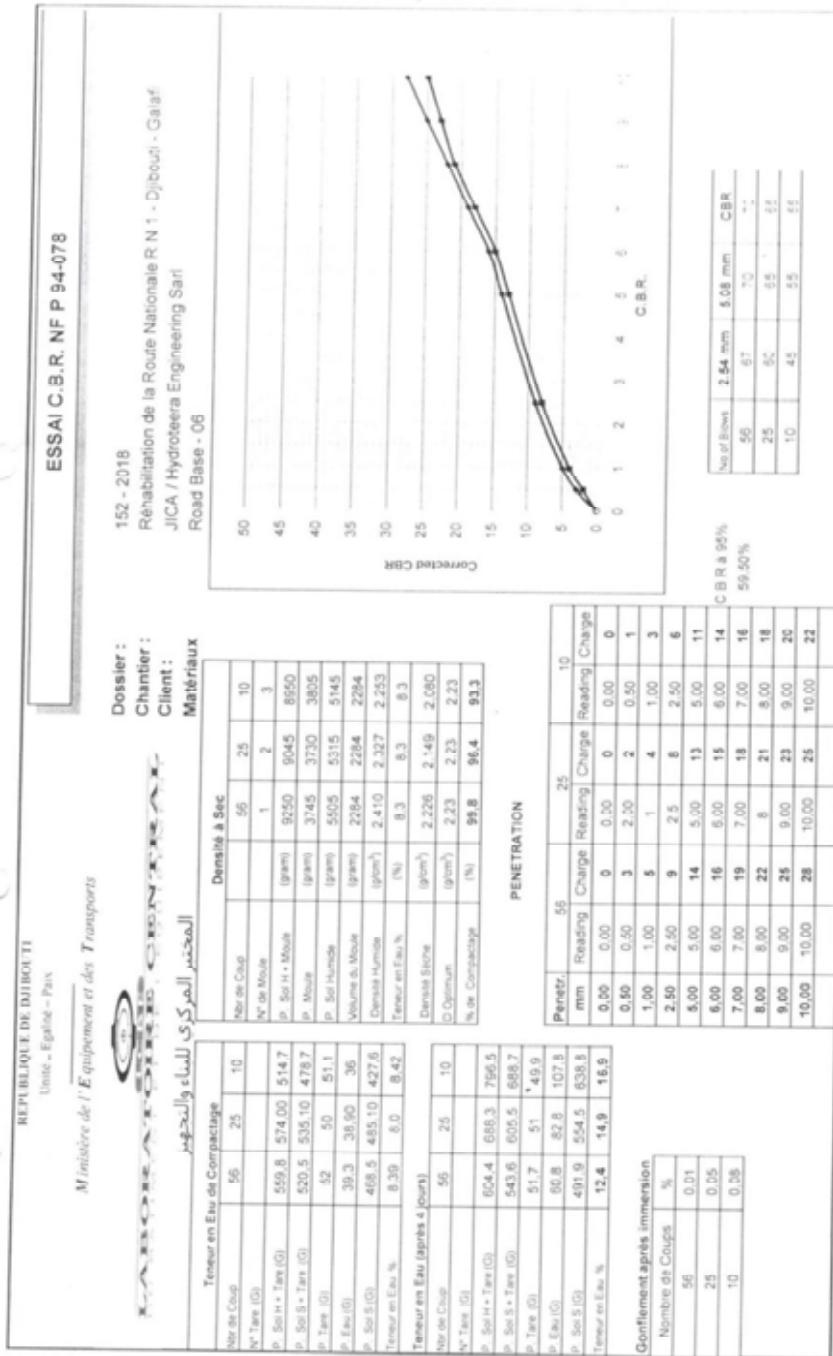
Tamis (mm)

Observation :

Le Directeur du LCBE,  
Mr. Soubaneh Baid Ismael



RB06



Le Directeur du LCBE.

Soubaneh Saïd Ismael

PZ

**REPUBLIQUE DE DJIBOUTI**  
Unité - Egalité - Paix

*Ministère de l'Équipement et des Transports*

**المحضر المركزي للنساء والتجهيز**

**ESSAI C.B.R. NF P 94-078**

**152 - 2018**  
Réhabilitation de la Route Nationale R N 1 - Djibouti - Gaiaf  
JICA / Hydroterra Engineering Sarl  
Road Base - 06

**Dossier :**  
**Chantier :**  
**Client :**  
**Matériaux**

Teneur en Eau de Compactage		Densité à Sec	
N° de Coup	N° Tare (G)	56	25
		1	2
P. Sol H + Tare (G)	559.8	9250	9045
P. Sol S + Tare (G)	520.50	3745	3730
P. Tare (G)	52	5505	5315
P. Eau (G)	39.3	2284	2284
P. Sol S (G)	488.50	2410	2327
Teneur en Eau %	8.39	8.3	8.3

Teneur en Eau (après 4 jours)		Densité Saturée	
N° de Coup	N° Tare (G)	56	25
		2.226	2.149
P. Sol H + Tare (G)	604.4	2.23	2.23
P. Sol S + Tare (G)	543.6	99.8	16.4
P. Tare (G)	51.7		
P. Eau (G)	60.8		
P. Sol S (G)	491.9		
Teneur en Eau %	12.4		

Gonflement après immersion	
Nombre de Coups	%
56	
25	
10	

Densité Sèche (g/cm³)

C.B.R.

Reading	Charge (g/cm²)	Reading	Charge (g/cm²)
0.00	0	0.00	0
0.50	3	0.50	2
1.00	5	1	4
2.50	9	2.5	8
5.00	14	5.00	13
6.00	16	6.00	15
7.00	19	7.00	18
8.00	22	8	21
9.00	25	9.00	23
10.00	28	10.00	25

**PENETRATION**

Reading	Charge (g/cm²)	Reading	Charge (g/cm²)
0.00	0	0.00	0
0.50	3	0.50	2
1.00	5	1	4
2.50	9	2.5	8
5.00	14	5.00	13
6.00	16	6.00	15
7.00	19	7.00	18
8.00	22	8	21
9.00	25	9.00	23
10.00	28	10.00	25

C.B.R. à 95%  
59.50%

Nos. d'Blow	2.54 mm	5.08 mm	C.B.R.
56	67	71	11
25	60	66	11
10	45	55	11

**Observation :**

Le Directeur du LCBE

Soubaneh Said Ismael

PI

REPUBLIQUE DE DJIBOUTI		ESSAI DE PROCTOR MODIFIE			
Unité: Egalité: Paix		NI P 94-093			
Ministère de l'Équipement et des Transports		Dossier : 152 - 2018			
LABORATOIRE CENTRAL		Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galaï			
المختبر المركزي للبناء والتجهيز		Client : JICA / Hydroterra Engineering Sarl			
		Matériaux : Road Base - 06			
Determination N°	Units	1	2	3	
% Eau Ajoutée	%	4	6	8	
Poids Total Humide	(grs)	8 855,0	9 195,0	9 145,0	
Poids du Moule	(grs)	3 700,0	3 700,0	3 700,0	
Poids Net	(grs)	5 155,0	5 495,0	5 445,0	
Volume du Moule	(cm <sup>3</sup> )	2 284,0	2 284,0	2 284,0	
Densité Humide	(g/cm <sup>3</sup> )	2,257	2,406	2,384	
Poids Total Humide	(grs)	656,8	748,8	668,7	
Poids Total Sec	(grs)	623,4	697,8	612,0	
Poids d' Eau	(grs)	33,4	51,0	56,7	
Poids du Tare	(grs)	66,0	59,3	54,7	
Poids Net Sec	(grs)	557,4	638,5	557,3	
Teneur en Eau	%	6,0	8,0	10,2	
Densité Sèche	(g/cm <sup>3</sup> )	2,129	2,228	2,163	
				D. maximum :	2,230
				Eau optimum :	8,3

The graph plots Dry Density (g/cm³) on the y-axis (ranging from 1.800 to 2.400) against Water Content (%) on the x-axis (ranging from 2 to 14). A parabolic curve is drawn through three data points: (6.0, 2.129), (8.0, 2.228), and (10.2, 2.163). The peak of the curve is at 8.3% water content and 2.230 g/cm³ dry density, which is marked as the optimum values.


Observation :

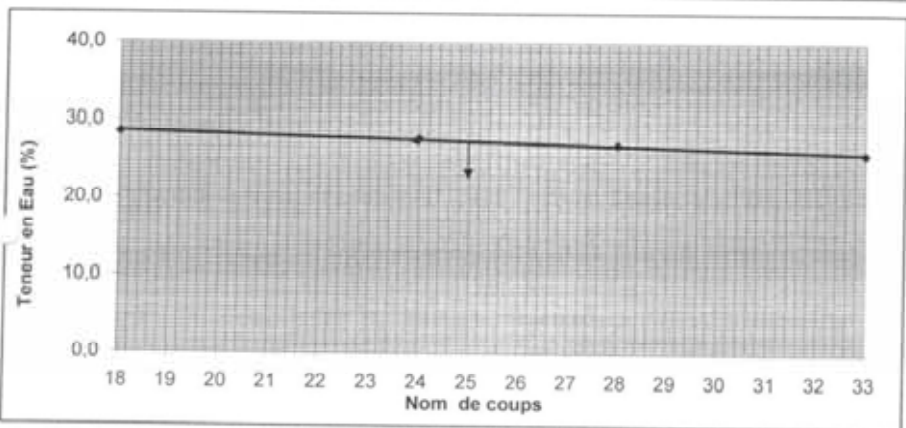
Le Directeur du LCBE,

LABORATOIRE CENTRAL  
ÉQUIPEMENT ET DE L'ÉQUIPEMENT

Soubaneh Saïd Ismael

Soubaneh Saïd Ismael

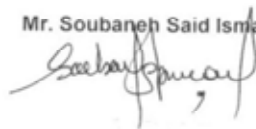

REPUBLIQUE DE DJIBOUTI		ESSAI DE LIMITE D'ATTERBERG					
Unité - Egalité - Paix		NORME NF P 94 - 051					
Ministère de l'Équipement et des Transports							
 <b>LABORATOIRE CENTRAL</b> المختبر المركزي للبناء والتجهيز		Dossier : 152 - 2018		Chantier : Réhabilitation de la Route Nationale R N 1		Djibouti - Galafi	
		Client : JICA / Hydroterra Engineering Sarl		Partie de l'Ouvrage : Road Base - 6			
LL: 27,5		LP: 18,8		IP: 8,7			
LIMITE DE LIQUIDITE				LIMITE DE PLASTICITE			
NOMBRE DE COUPS	18	24	28	33	Test n°1	Test n°2	
NUMERO DE LA TARE	8	9	11	13	14	15	
POIDS TOTAL HUMIDE (g)	57,52	55,4	55,3	55,65	36	36,7	
POIDS TOTAL SEC (g)	51,8	50,2	50,3	50,7	35,2	36	
POIDS DE LA TARE (g)	31,7	31,4	31,7	31,5	31,3	31,9	
POIDS D'EAU (g)	5,72	5,2	5	4,95	0,8	0,7	
POIDS NET SEC (g)	20,1	18,8	18,6	19,2	3,9	4,1	
TENEUR EN EAU (%)	28,5	27,7	26,9	25,8	20,5	17,1	

Observation :

Le Directeur du LCBE

Mr. Soubaneh Said Ismael

<p><b>REPUBLIQUE DE DJIBOUTI</b> Unité - Egalité - Paix</p> <p>Ministère de l'Équipement et des Transports</p> <p><b>LABORATOIRE CENTRAL</b> المختبر المركزي للمباني والتجهيز</p>	<p><b>ANALYSE GRANULOMETRIQUE</b> NORME NF 933-1 - 933-2</p>				
<p><b>Poids Initial (grs):</b> 3560,4</p>	<p>Dossier : 152 - 2018 Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi Client : JICA / Hydroterra Engineering Sarl Matériaux : Road Base - 6</p>				
Module Afnor	Tamis (mm)	Refus Partiels (gr)	Refus Cumules (gr)	Refus Cumules (%)	Passant (%)
	50		795,4	22,3	77,7
	37,5		1389,6	39,0	61,0
	31,5		1665,4	46,8	53,2
	25		1868,9	52,5	47,5
	19		1939,9	54,5	45,5
	12,5		2025,1	56,9	43,1
	9,5		2086,2	58,6	41,4
	6,3		2208,3	62,0	38,0
	4,75		2252,1	63,3	36,7
	2,36		2484,7	69,8	30,2
	1,18		2697,1	75,8	24,2
	0,6		2853,3	80,1	19,9
	0,425		2901,7	81,5	18,5
	0,3		2943,8	82,7	17,3
	0,15		3037,7	85,3	14,7
	0,075		3080,7	86,5	13,5

Observation :

Le Directeur du LCBE,  
Mr. Soubaneh Saïd Ismael



RB07

**REPUBLIQUE DE DJIBOUTI**  
Unité - Egalité - Paix

*Ministère de l'Équipement et des Transports*

**المكتب المركزي للبناء والتجهيز**

**ESSAI C.B.R. NF P 94-078**

152 - 2018  
Régénération de la Route Nationale N 1 - Djibouti - Galafi  
JICA / Hydroteera Engineering Sarl  
Road Base - 07

**Dossier :**  
**Chantier :**  
**Client :**  
**Matériaux**

Teneur en Eau de Compactage		Densité à Sec	
Nbr de Coup	N° Tiers (G)	Nbr de Coup	N° Tiers (G)
56	25	56	25
10		1	2
		2	3
P. Sol H + Tiers (G)	588,5	P. Sol H + Moule (gram)	9250
P. Sol S + Tiers (G)	547,8	P. Moule (gram)	3805
P. Tiers (G)	80,8	P. Sol Humide (gram)	5445
P. Eau (G)	40,7	Volume du Moule (cm³)	2284
P. Sol S (G)	487	Densité Humide (g/cm³)	2,218
Teneur en Eau %	8,36	Teneur en Eau % (N)	8,4
		Densité Sèche (g/cm³)	2,199
		D Optimum (g/cm³)	2,2
		% de Compactage (N)	100,0
			97,2
			94,4

Teneur en Eau (après 4 jours)		Densité Sèche	
Nbr de Coup	N° Tiers (G)	Nbr de Coup	N° Tiers (G)
56	25	10	
P. Sol H + Tiers (G)	574,3	P. Sol H + Tiers (G)	572,7
P. Sol S + Tiers (G)	521,5	P. Sol S + Tiers (G)	496,7
P. Tiers (G)	60,2	P. Eau (G)	52,8
P. Eau (G)	52,8	Teneur en Eau %	11,4
P. Sol S (G)	491,3		14,0
Teneur en Eau %	11,4		17,0

Gonflement après Immersion	
Nombre de Coups	%
56	
25	
10	

PENETRATION	
Penetr mm	Charge Reading
0,00	0,00
0,50	0,50
1,00	1,00
2,50	2,50
5,00	5,00
7,00	7,00
8,00	8,00
9,00	9,00
10,00	10,00

Densité à Sec	
Charge Reading	Charge Reading
0,00	0,00
2,00	2,00
4,00	4,00
6,00	6,00
8,00	8,00
10,00	10,00

C.B.R.	
Charge Reading	Charge Reading
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10

C.B.R. 56.00%

C.B.R. à 95% 56.00%

Nbr de Coups	5.08 mm	C.B.R.
56	25	56
10	37	55

Observation :

Le Directeur du LCBE  
Soubaneh Saïd Ismael

REPUBLIQUE DE DJIBOUTI  
Unité - Egalité - Paix

**Ministère de l'Équipement et des Transports**

**المكتب المركزي للنساء والتجهيز**

**ESSAI C.B.R. NF P 94-078**

152 - 2018  
Régénération de la Route Nationale N°1 - Djibouti - Gaaf  
JICA / Hydroterra Engineering Sari  
Road Base - 07

**Dossier :**  
**Chantier :**  
**Client :**  
**Matériaux :**

Teneur en Eau de Compactage		Densité à Sec	
N° de Coup	N° de Coup	56	25
N° Taux (G)	N° de Mout	1	2
P. Sol H + Taux (G)	P. Sol H + Mout	9250	9000
P. Sol S + Taux (G)	P. Mout	3805	3705
P. Taux (G)	P. Sol Humide	5445	5295
P. Eau (G)	Valeur du Mout	2284	2284
P. Sol S (G)	Densité Humide	2,384	2,318
Teneur en Eau %	Teneur en Eau %	(%)	8,4
			8,4
			2,199
			2,2
			2,2
			94,4

Teneur en Eau (après 4 jours)		Densité Sèche	
N° de Coup	N° de Coup	56	25
N° Taux (G)	N° Taux (G)	574,3	608,1
P. Sol H + Taux (G)	P. Sol S + Taux (G)	521,5	503,5
P. Taux (G)	P. Eau (G)	52,8	74,6
P. Eau (G)	P. Sol S (G)	461,3	534,7
Teneur en Eau %	Teneur en Eau %	11,4	14,0
			17,0

Densité Sèche (g/cm³)

C.B.R.

PENETRATION	
Charge	Reading
0,00	0
0,50	4
1,00	6
2,50	9
5,00	14
6,00	18
7,00	21
8,00	23
9,00	26
10,00	28

Gonflement après immersion	
Nombre de Coups	%
56	
25	
10	

PENETRATION	
Charge	Reading
0,00	0
0,50	4
1,00	6
2,50	9
5,00	14
6,00	18
7,00	21
8,00	23
9,00	26
10,00	28


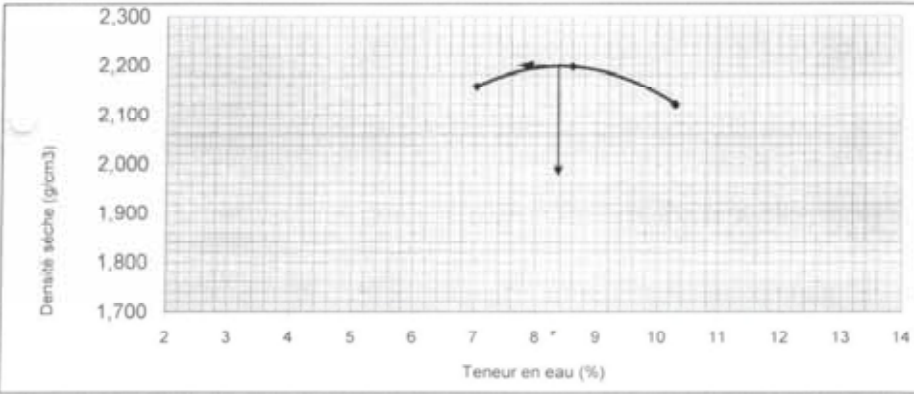
C.B.R.	
N° de Blow	5,08 mm
56	57
25	52
10	37

C.B.R. à 95%  
56,00%

Observation :

Le Directeur du LCBE  
Soubaneh Said Ismael

R  
\_\_\_\_\_

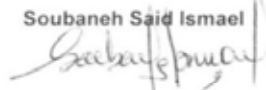
REPUBLIQUE DE DJIBOUTI		ESSAI DE PROCTOR MODIFIE		
Unité Locale Pav.		NI P 94 093		
Ministère de l'Équipement et des Transports				
 <b>LABORATOIRE CENTRAL</b>		<b>Dossier :</b> 152 - 2018 <b>Chantier :</b> Rehabilitation de la Route Nationale R N 1 - Djibouti - Galafi <b>Client :</b> JICA / Hydroterra Engineering Sarl <b>Matériaux :</b> Road Base - 07		
المختبر المركزي للبناء والتجهيز				
Determination N°	Units	1	2	3
% Eau Ajoutée	%	4	6	8
Poids Total Humide	(grs)	8 990,0	9 170,0	9 060,0
Poids du Moule	(grs)	3 720,0	3 720,0	3 720,0
Poids Net	(grs)	5 270,0	5 450,0	5 340,0
Volume du Moule	(cm <sup>3</sup> )	2 284,0	2 284,0	2 284,0
Densité Humide	(g/cm <sup>3</sup> )	2,307	2,386	2,338
Poids Total Humide	(grs)	677,8	620,4	689,2
Poids Total Sec	(grs)	637,0	575,6	630,9
Poids d' Eau	(grs)	40,8	44,8	58,3
Poids du Tare	(grs)	56,9	55,3	64,4
Poids Net Sec	(grs)	580,1	520,3	566,5
Teneur en Eau	%	7,0	8,6	10,3
Densité Sèche	(g/cm <sup>3</sup> )	2,156	2,197	2,120
D. maximum :				2,200
Eau optimum :				8,4
 <p>The graph plots Dry Density (g/cm<sup>3</sup>) on the y-axis (ranging from 1.700 to 2.300) against Water Content (%) on the x-axis (ranging from 2 to 14). A parabolic curve is drawn through the data points, with a peak at approximately 8.4% water content and 2.200 g/cm<sup>3</sup> dry density. A vertical arrow points from the peak of the curve down to the x-axis at 8.4%.</p>				


Observation :

LCBE  
LABORATOIRE CENTRAL  
ÉQUIPEMENT ET DÉVELOPPEMENT

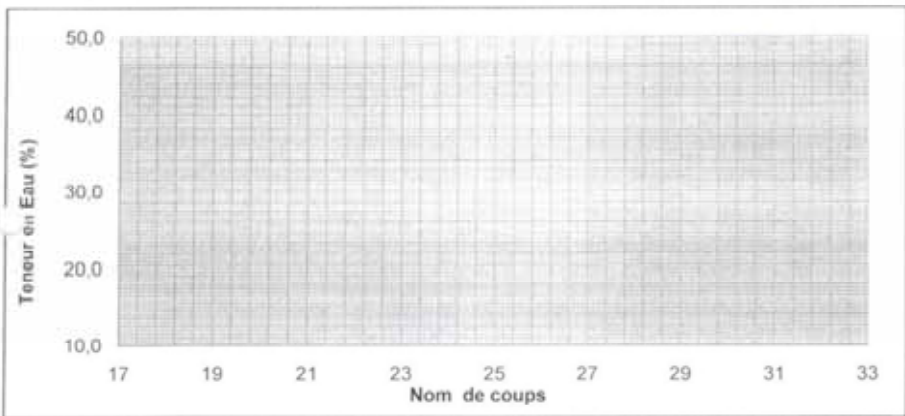
Le Directeur du LCBE,

Soubaneh Said Ismael



REPUBLIQUE DE DJIBOUTI Union Egalité Paix		<b>ESSAI DE LIMITE D'ATTERBERG</b> NORME NF P 94 - 051			
Ministère de l'Équipement et des Transports					
 <b>LABORATOIRE CENTRAL</b> المختبر المركزي للبناء والتجهيز		Dossier : 152 - 2018 Chantier : Réhabilitation de la Route Nationale R N 1 Djibouti - Galafi Client : JICA / Hydroterra Engineering Sarl Partie de l'Ouvrage : Road Base - 7			
LL:		LP:		IP: N M	
<b>LIMITE DE LIQUIDITE</b>		<b>LIMITE DE PLASTICITE</b>			
NOMBRE DE COUPS				Test n°1	Test n°2
MERO DE LA TARE					
POIDS TOTAL HUMIDE (g)					
POIDS TOTAL SEC (g)		<b>NON MESURABLE</b>			
POIDS DE LA TARE (g)					
POIDS D'EAU (g)					
POIDS NET SEC (g)					
TENEUR EN EAU (%)					

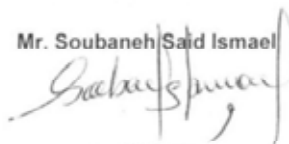
  



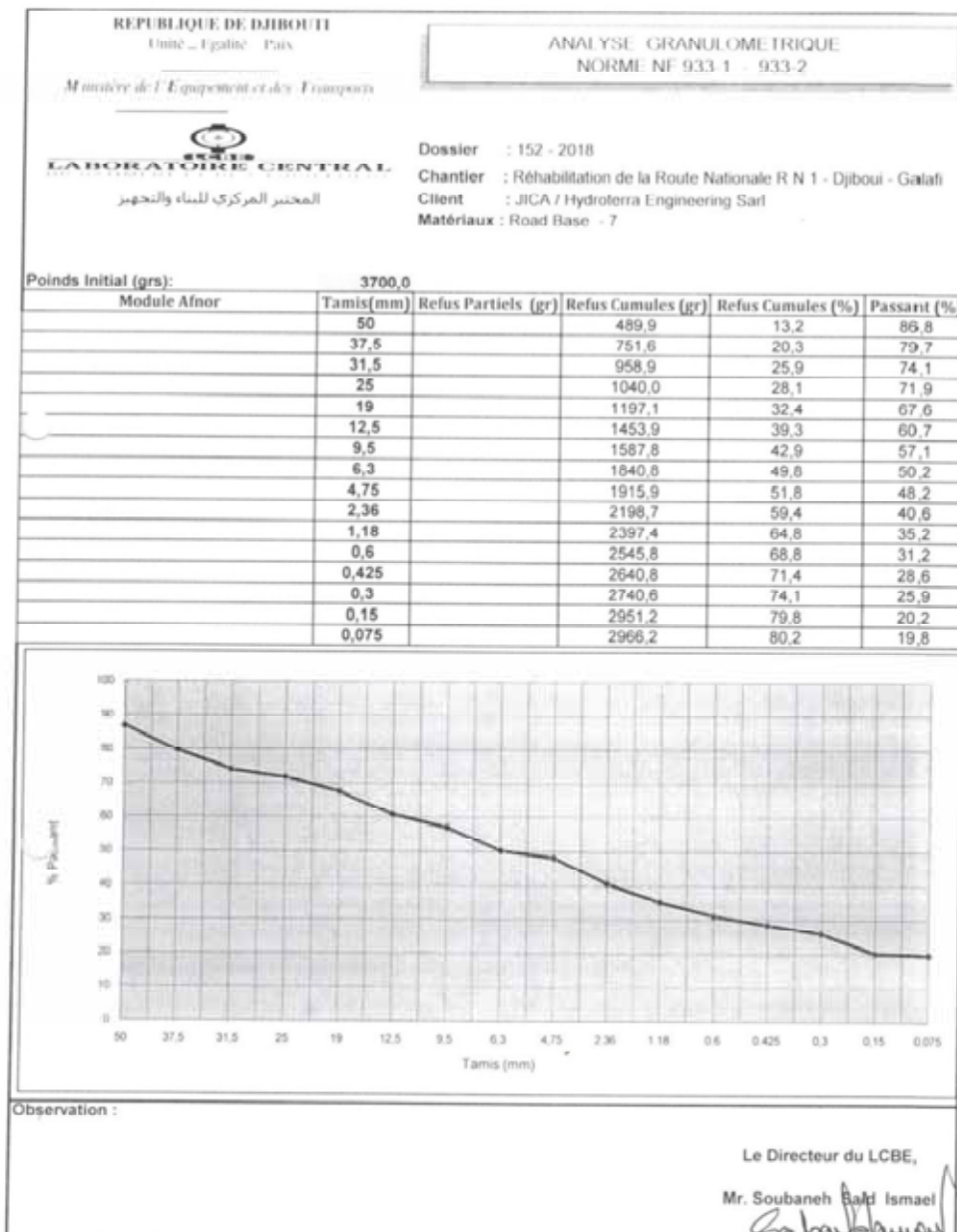
Observation :

Le Directeur du LCBE

Mr. Soubaneh Said Ismael



 LCBE  
 LABORATOIRE CENTRAL  
 MINISTÈRE DE L'ÉQUIPEMENT ET DES TRANSPORTS





Base layer  
BC01

REPUBLIQUE DE DJIBOUTI  
Unité - Egalité - Paix

Ministère de l'Équipement et des Transports  
القطاع الوطني للمواصلات

**Teneur en Eau de Compacts**

N° de Coup	56	25	10
N° Type (O)			
P. Sol H + Tene (O)	550,3	344,03	287
P. Sol S + Tene (O)	517,8	325,50	272,1
P. Tene (O)	52,6	62,3	61,8
P. Eau (O)	32,5	18,95	14,9
P. Sol S (O)	465,2	263,20	210,3
Teneur en Eau %	6,99	7,0	7,09

**Teneur en Eau (après 6 jours)**

N° de Coup	56	25	10
N° Type (O)	S	A	O
P. Sol H + Tene (O)	563,9	541,4	621,4
P. Sol S + Tene (O)	535	483,9	545,6
P. Tene (O)	54,9	48,3	69,3
P. Eau (O)	48,9	57,5	75,8
P. Sol S (O)	480,1	435,6	470,3
Teneur en Eau %	10,2	13,2	15,8

**Densité à Sec**

N° de Coup	56	25	10
N° de Visite			
P. Sol H + Visite	9100	8650	8770
P. Visite	3817,4	3719,1	3811,8
P. Sol Humide	6282,6	5130,9	4958,2
Visure de Visite	2284	2284	2284
Densité Humide	2,313	2,246	2,171
Teneur en Eau %	7,0	7,0	7,0
Densité Sèche	2,162	2,099	2,029
D. Optimum	2,16	2,16	2,16
% de Compaction	100,1	97,2	93,4

**Observation :**

**Penetration**

Penetr.	56	25	10
0,00	0,00	0,00	0,00
0,50	0,50	3	2,00
1,00	1,00	5	1
2,50	2,50	9	2,5
5,00	5,00	14	5,00
6,00	6,00	16	6,00
7,00	7,00	19	7,00
8,00	8,00	21	8
9,00	9,00	24	9,00
10,00	10,00	27	10,00

**CBR à 95%**

No of Blows	2.54 mm	5.08 mm	CBR
56	67	70	70
25	52	50	50
10	37	50	50

**Corrected CBR**

**Dossier :** 152 - 2018  
**Client :** Réhabilitation de la Route Nationale R N 1 - Djibouti - Gaïafi  
**Matériaux :** JICA / Hydrotera Engineering Sarl  
 Base Course - 01

ESSAI C.B.R. NF P 94-078

Le Directeur du LCBE  
Soubaneh Saïd Ismaïl

PI

REPUBLIQUE DE DJIBOUTI  
Unité - Egalité - Paix

Ministère de l'Équipement et des Transports  
المصنر المركزي للبناء والتجهيز

**ESSAI C.B.R. NF P 94-078**

152 - 2018  
Régénération de la Route Nationale R N 1 - Djibouti - Gara  
JICA / Hydroterra Engineering Sarl  
Base Course - 01

**Dossier :**  
**Chantier :**  
**Client :**  
**Matériaux :**

Teneur en Eau de Compactage		Densité à Sec	
Nbr de Coup	56	25	10
N° Type (G)			
P. Sol H + Tare (G)	550,3	344,00	267
P. Sol S + Tare (G)	517,80	325,50	272,1
P. Tare (G)	52,6	62,3	61,8
P. Eau (G)	32,5	18,50	14,9
P. Sol S (G)	485,20	263,20	210,3
Teneur en Eau %	6,99	7,0	7,09

Teneur en Eau (après 4 jours)		Densité à Sec	
Nbr de Coup	56	25	10
N° Type (G)	S	A	Q
P. Sol H + Tare (G)	503,9	541,4	621,4
P. Sol S + Tare (G)	535	483,9	545,6
P. Tare (G)	54,9	48,3	66,3
P. Eau (G)	48,9	57,5	75,8
P. Sol S (G)	480,1	435,6	479,3
Teneur en Eau %	10,2	13,2	15,8

Densité à Sec		Densité Sèche (g/cm <sup>3</sup> )	
Nbr de Coup	56	25	10
N° de Moule			
P. Sol H + Moule (gram)	9100	8850	8770
P. Moule (gram)	3817,4	3719,1	3811,8
P. Sol Humide (gram)	5282,6	5130,9	4958,2
Volume du Moule (cm <sup>3</sup> )	2284	2284	2284
Densité Humide (g/cm <sup>3</sup> )	2,313	2,246	2,171
Teneur en Eau %	7,0	7,0	7,0
Densité Sèche (g/cm <sup>3</sup> )	2,162	2,099	2,029
D. Optimum (g/cm <sup>3</sup> )	2,16	2,16	2,16
% de Compactage	100,1	97,2	93,9

PENETRATION			
Reading	Charge (g/cm <sup>2</sup> )	Reading	Charge
0,00	0	0,00	0
0,50	3	0,50	2
1,00	5	1	3
2,50	9	2,5	7
5,00	14	5,00	12
6,00	16	6,00	14
7,00	19	7,00	16
8,00	21	8	18
9,00	24	9,00	20
10,00	27	10,00	23

**Gonfiement après immersion**

Nombre de Coups	%
56	0
25	0
10	0

**Observation :**

C.B.R.

Nbr de Blocs	2,54 mm	5,08 mm	C.B.R.
56	67	70	53,00%
25	52	60	55
10	37	50	55

Le Directeur du LCBE  
Soubaneh Saïd Ismael

REPUBLIQUE DE DJIBOUTI		ESSAI DE PROCTOR MODIFIE			
Unité - Egalité - Paix		NF P 94-093			
Ministère de l'Équipement et des Transports		Dossier : 152 - 2018			
LABORATOIRE CENTRAL		Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi			
المختبر المركزي للبناء والتجهيز		Client : JICA / Hydroterra Engineering Sarl			
		Matériaux : Base Course - 01			
Determination N°	Units	1	2	3	
% Eau Ajoutée	%	4	6	8	
Poids Total Humide	(grs)	8 840,0	9 020,0	8 940,0	
Poids du Moule	(grs)	3 720,0	3 720,0	3 720,0	
Poids Net	(grs)	5 120,0	5 300,0	5 220,0	
Volume du Moule	(cm <sup>3</sup> )	2 284,0	2 284,0	2 284,0	
Densité Humide	(g/cm <sup>3</sup> )	2,242	2,320	2,285	
Poids Total Humide	(grs)	642,6	804,3	822,4	
Poids Total Sec	(grs)	615,1	768,3	768,0	
Poids d' Eau	(grs)	27,5	36,0	54,4	
Poids du Tare	(grs)	102,3	294,2	185,5	
Poids Net Sec	(grs)	512,8	474,1	582,5	
Teneur en Eau	%	5,4	7,6	9,3	
Densité Sèche	(g/cm <sup>3</sup> )	2,127	2,157	2,091	
				D. maximum :	2,160
				Eau optimum :	7,0


  

Le graphique illustre la relation entre la densité sèche (g/cm³) et la teneur en eau (%). L'axe vertical (Densité sèche) varie de 1,800 à 2,400 g/cm³. L'axe horizontal (Teneur en eau) varie de 1 à 13%. Trois points de données sont tracés et reliés par une courbe en arc de cercle. Le point de densité maximale est à 7,0% de teneur en eau, avec une densité sèche de 2,160 g/cm³. Une flèche pointe vers ce point optimal.

Observation :

Le Directeur du LCBE,

Soubaneh Saïd Ismael

REPUBLIQUE DE DJIBOUTI		ESSAI DE LIMITE D'ATTERBERG			
Unité - Egalité - Paix		NORME NF P 94 - 051			
Ministère de l'Équipement et des Transports					
 <b>LABORATOIRE CENTRAL</b> المختبر المركزي للبناء والتجهيز		Dossier : 152 - 2018 Chantier : Réhabilitation de la Route Nationale R N 1 Djibouti - Galafi Client : JICA / Hydroterra Engineering Sarl Partie de l'Ouvrage : Base Course - 1			
LL:		LP:		IP: N M	
LIMITE DE LIQUIDITE		LIMITE DE PLASTICITE			
NOMBRE DE COUPS		Test n°1		Test n°2	
NOMBRE DE LA TARE					
POIDS TOTAL HUMIDE (g)					
POIDS TOTAL SEC (g)		NON MESURABLE			
POIDS DE LA TARE (g)					
POIDS D'EAU (g)					
POIDS NET SEC (g)					
TENEUR EN EAU (%)					

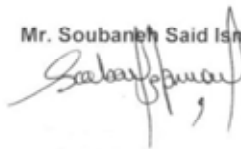
  

50,0									
40,0									
30,0									
20,0									
10,0									
	17	19	21	23	25	27	29	31	33
	Nom de coups								


Observation :

Le Directeur du LCBE

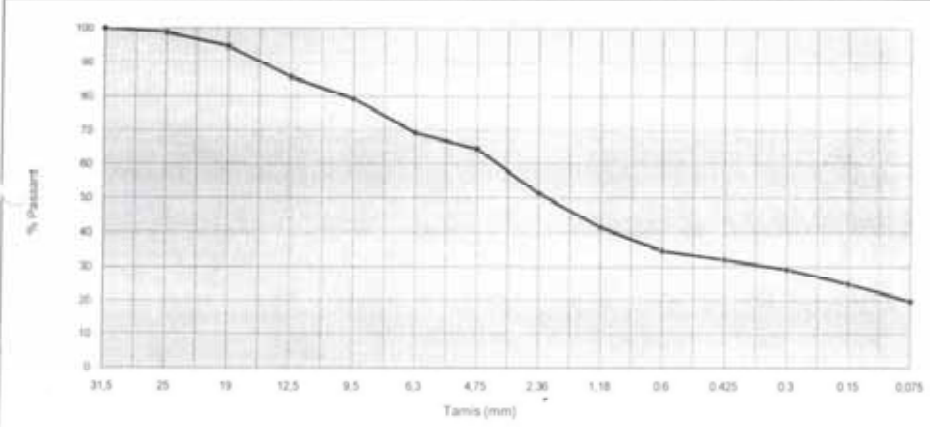
Mr. Soubaneh Said Ismael



LABORATOIRE CENTRAL  
 MINISTRE DE L'EQUIPEMENT ET DES TRANSPORTS

<b>REPUBLIQUE DE DJIBOUTI</b> Unité - Egalité - Paix Ministère de l'Équipement et des Transports		<b>ANALYSE GRANULOMETRIQUE</b> NORME NF 933 1 933 2			
 <b>LABORATOIRE CENTRAL</b> المختبر المركزي للبناء والتجهيز		Dossier : 152 - 2018 Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi Client : JICA / Hydroterra Engineering Sarl Matériaux : Base Course - 1			
Poids Initial (grs): 5000,0					
Module Afnor	Tamis (mm)	Refus Partiels (gr)	Refus Cumulés (gr)	Refus Cumulés (%)	Passant (%)
	31,5		0	0,0	100,0
	25		55,5	1,1	98,9
	19		259,3	5,2	94,8
	12,5		707,9	14,2	85,8
	9,5		1036,8	20,7	79,3
	6,3		1532,9	30,7	69,3
	4,75		1770,9	35,4	64,6
	2,36		2431,2	48,6	51,4
	1,18		2930,7	58,6	41,4
	0,6		3272,0	65,4	34,6
	0,425		3402,4	68,0	32,0
	0,3		3538,4	70,8	29,2
	0,15		3765,5	75,3	24,7
	0,075		4008,1	80,2	19,8

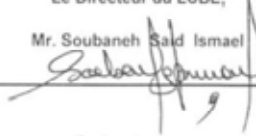
  



Observation :

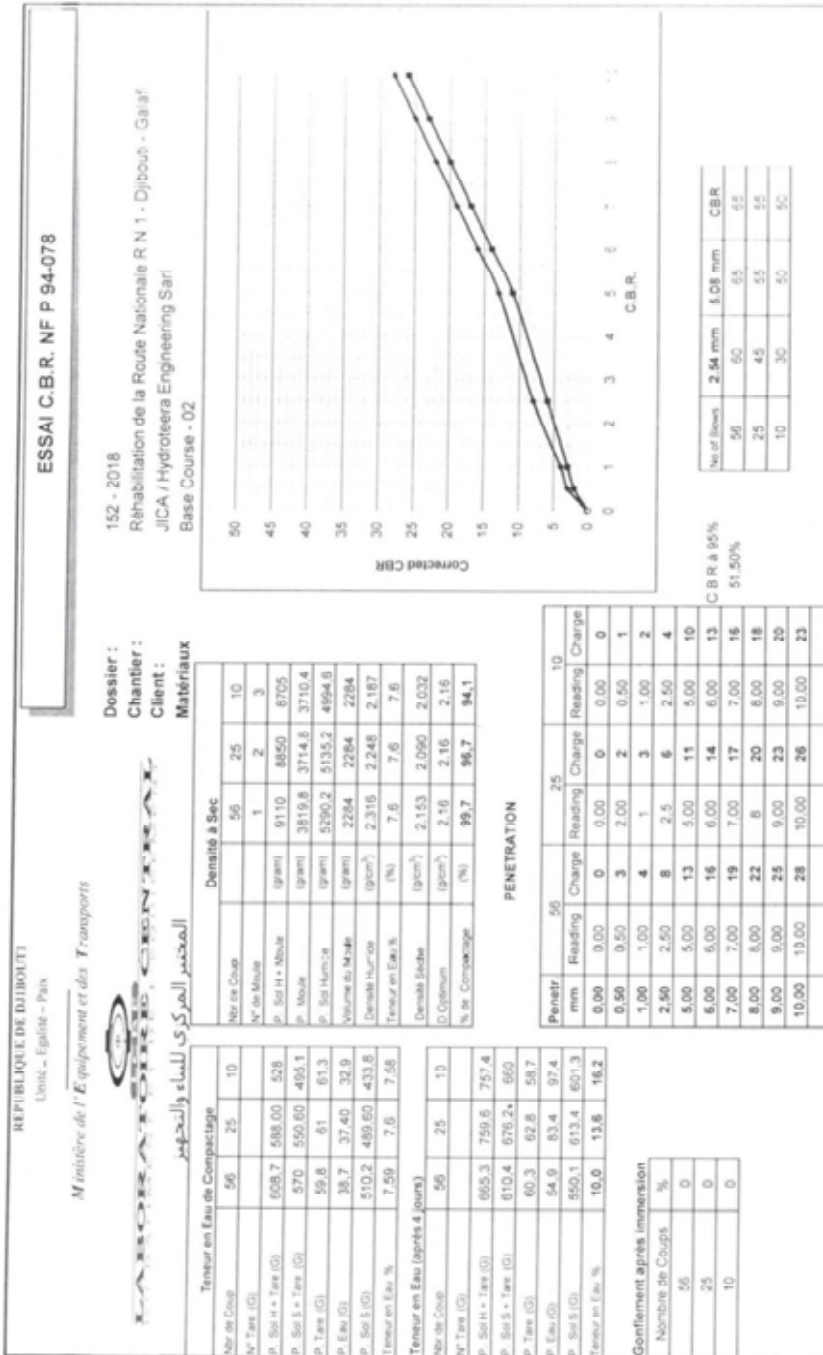
Le Directeur du LCBE,

Mr. Soubaneh Said Ismael





BC02



Le Directeur du LCBE.  
Soubaneh Saïd Ismael

**REPUBLICQUE DE DJIBOUTI**  
Unité - Espérance - Paix

*Ministère de l'Équipement et des Transports*

**المكتب المركزي للنساء والبحير**

**ESSAI C.B.R. NF P 94-078**

152 - 2018  
Régénération de la Route Nationale R N 1 - Djibouti - Galati  
JICA / Hydroterra Engineering Sarl  
Base Course - 02

**Dossier :** 152 - 2018  
**Chantier :** Régénération de la Route Nationale R N 1 - Djibouti - Galati  
**Client :** JICA / Hydroterra Engineering Sarl  
**Matériaux :** Base Course - 02

**Le Directeur du LCBE**  
Soubaneh Said Ismael  
*LCBE*  
LABORATOIRE CENTRAL  
SABAH EL-DELLAL

Teneur en Eau de Compaction		56		25		10	
Nr de Coup							
Nr de Moulins							
P. Sol H + Tars (G)	608,7	568,00	528				
P. Sol S + Tars (G)	570,00	550,60	496,1				
P. Tars (G)	59,8	61	51,3				
P. Eau (G)	38,7	37,40	32,9				
P. Sol S (G)	510,20	489,60	432,8				
Teneur en Eau %	7,59	7,6	7,68				

Densité à Sec		56		25		10	
Nr de Coup							
Nr de Moulins							
P. Sol H + Moulins	911,0	885,0	870,5				
P. Moulins	3819,8	3714,8	3710,4				
P. Sol Humide	5290,2	5135,2	4994,6				
Valeur du Moulins	2284	2284	2284				
Densité Humide	2,316	2,248	2,187				
Teneur en Eau %	7,6	7,5	7,6				

Teneur en Eau (après 4 jours)		56		25		10	
Nr de Coup							
Nr de Moulins							
P. Sol H + Tars (G)	660,3	759,6	757,4				
P. Sol S + Tars (G)	610,4	670,2	660				
P. Tars (G)	60,3	62,8	56,7				
P. Eau (G)	54,9	63,4	67,4				
P. Sol S (G)	550,1	613,4	601,3				
Teneur en Eau %	10,0	13,6	16,2				

Densité à Sec		56		25		10	
Nr de Coup							
Nr de Moulins							
P. Sol H + Moulins	99,7	96,7	94,1				
D. Optimum	2,16	2,16	2,16				
% de Compaction							

Gonflement après immersion		56		25		10	
Nombre de Coups							
%							
56	0						
25	0						
10	0						

PENETRATION		56		25		10	
Reading							
Charge							
0,00	0	0,00	0	0,00	0	0,00	0
0,50	3	0,50	2	0,50	1		
1,00	4	1	3	1,00	2		
2,50	8	2,5	6	2,50	4		
5,00	13	5,00	11	5,00	10		
6,00	16	6,00	14	6,00	13		
7,00	19	7,00	17	7,00	16		
8,00	22	8	20	8,00	18		
9,00	25	9,00	23	9	20		
10,00	28	10,00	26	10,00	23		

Nr de Bous	2,54 mm	5,08 mm	CBR
56	60	55	55
25	45	55	55
10	30	50	55

**Observation :**

CBR à 95% : 51,50%

REPUBLIQUE DE DJIBOUTI		ESSAI DE PROCTOR MODIFIE		
Unité - Egalité - Paix		NF P 94 093		
Ministère de l'Équipement et des Transports		Dossier : 152 - 2018		
LABORATOIRE CENTRAL		Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi		
المختبر المركزي للبناء والتجهيز		Client : JICA / Hydroterra Engineering Sarl		
		Matériaux : Base Course - 02		
Determination N°	Units	1	2	3
% Eau Ajoutée	%	4	6	8
Poids Total Humide	(grs)	8 702,4	8 947,2	8 886,7
Poids du Moule	(grs)	3 708,8	3 708,8	3 708,8
Poids Net	(grs)	4 993,6	5 238,4	5 177,9
V <sub>volume</sub> du Moule	(cm <sup>3</sup> )	2 284,0	2 284,0	2 284,0
Densité Humide	(g/cm <sup>3</sup> )	2,186	2,294	2,267
Poids Total Humide	(grs)	837,3	618,6	648,2
Poids Total Sec	(grs)	803,0	580,3	596,0
Poids d' Eau	(grs)	34,3	38,3	52,2
Poids du Tare	(grs)	186,9	65,2	55,7
Poids Net Sec	(grs)	616,1	515,1	540,3
Teneur en Eau	%	5,6	7,4	9,7
Densité Sèche	(g/cm <sup>3</sup> )	2,070	2,135	2,067
D. maximum :				2,160
Eau optimum :				7,6


Densité sèche (g/cm<sup>3</sup>)

Teneur en eau (%)

Observation :

Le Directeur du LCBE,

Soubaneh Said Ismael

REPUBLIQUE DE DJIBOUTI		ESSAI DE LIMITE D'ATTERBERG			
Unité - Egalité - Paix		NORME NF P 94 - 051			
Ministère de l'Équipement et des Transports					
 <b>LABORATOIRE CENTRAL</b> المختبر المركزي للبناء والتجهيز		Dossier : 152 - 2018		Chantier : Réhabilitation de la Route Nationale R N 1	
		Djibouti - Galafi		Client : JICA / Hydroterra Engineering Sarl	
		Partie de l'Ouvrage : Base Course - 2			
LL:		LP:		IP: N M	
LIMITE DE LIQUIDITE		LIMITE DE PLASTICITE			
NOMBRE DE COUPS		Test n°1		Test n°2	
MERO DE LA TARE					
POIDS TOTAL HUMIDE (g)					
POIDS TOTAL SEC (g)					
NON MESURABLE					
POIDS DE LA TARE (g)					
POIDS D'EAU (g)					
POIDS NET SEC (g)					
TENEUR EN EAU (%)					

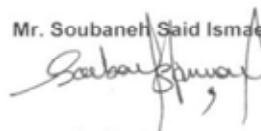
  

50,0										
40,0										
30,0										
20,0										
10,0										
	17	19	21	23	25	27	29	31	33	
	Nom de coups									

Observation :

Le Directeur du LCBE

Mr. Soubaneh Saïd Ismael



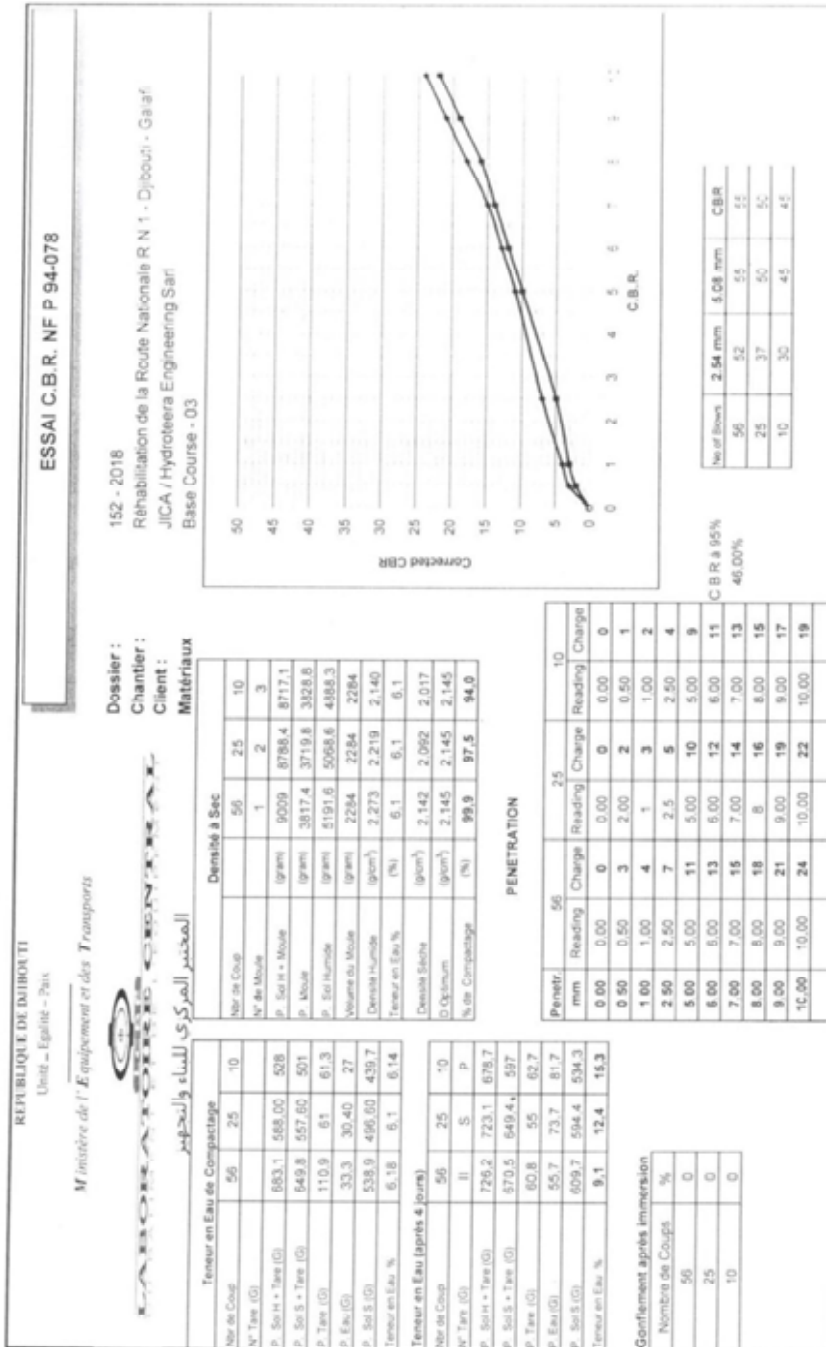
REPUBLIQUE DE DJIBOUTI Unité - Egalité - Paix Ministère de l'Équipement et des Transports LABORATOIRE CENTRAL المعتمد المركزي للمبنا والنهوير		ANALYSE GRANULOMETRIQUE NORME NF 933-1 - 933-2			
Dossier : 152 - 2018 Chantier : Réhabilitation de la Route Nationale R N 1 - Djibouti - Galafi Client : JICA / Hydroterra Engineering Sarl Matériaux : Base Course - 2					
Poids Initial (grs): <b>5000,0</b>					
Module Afnor	Tamis (mm)	Refus Partiels (gr)	Refus Cumules (gr)	Refus Cumules (%)	Passant (%)
	37,5		0	0,0	100,0
	31,5		133,3	2,7	97,3
	25		282,7	5,7	94,3
	19		533,2	10,7	89,3
	12,5		1162,2	23,2	76,8
	9,5		1655,4	33,1	66,9
	4,75		2298,4	46,0	54,0
	2,36		2874,6	57,5	42,5
	1,18		3430,5	68,6	31,4
	0,425		3892,7	77,9	22,1
	0,075		4249,2	85,0	15,0

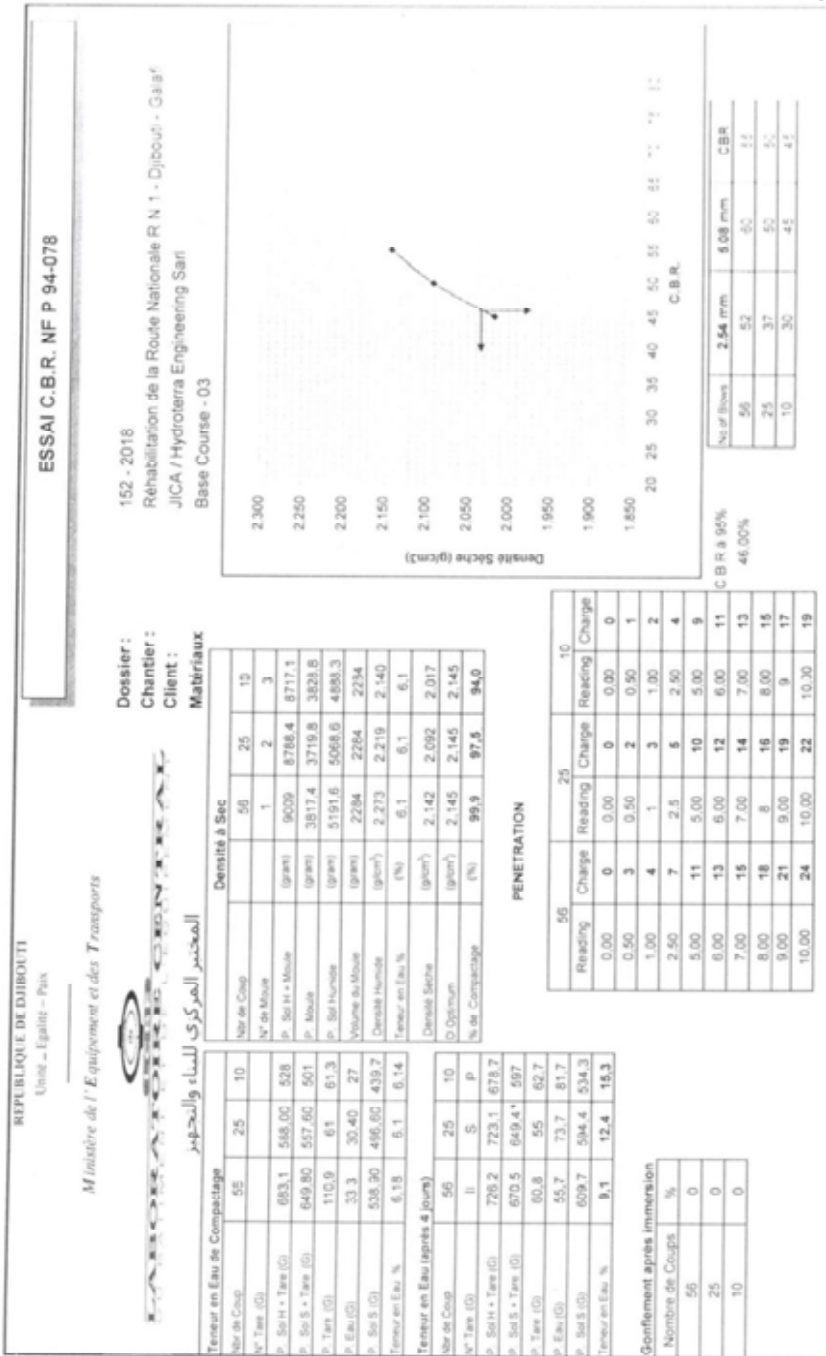
Observation :

Le Directeur du LCBE,  
 Mr. Soubaneh Said Ismael  
*(Signature)*

BC03







Le Directeur du LCBE.

Soubaneh Saïd Ismael

*Soubaneh Saïd Ismael*  
**LABORATOIRE CENTRAL**  
UNIVERSITÉ DE DJIBOUTI