

REPUBLIC OF LEBANON
COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION

DETAILED DESIGN OF BISRI DAM PROJECT

CONTRACT NO.17909

DAM FOOTPRINT

GEOTECHNICAL INVESTIGATION REPORT III

FACTUAL

March 2014



DAR AL HANDASAH NAZIH TALEB & PARTNERS
دارالهندسة نزيه طالب وشريك

Table of Content

1.	Introduction.....	1-1
2.	Field Investigation.....	2-1
3.	Scope of Works.....	3-1
4.	Subsurface Strata.....	4-1
5.	Closure	5-1

Appendices

APPENDIX 1. GEOLOGIE DU SITE (PLAN G-02 / MARCH 2014)

APPENDIX 2. LOGS OF BORINGS

APPENDIX 3. PHOTOS OF CORE BOXES

APPENDIX 4. BOREHOLE WATER PERMEABILITY & LUGEON TEST RESULTS

APPENDIX 5. DCPT TEST RESULTS

APPENDIX 6. GROUNDWATER MEASUREMENTS

QC	Ref: L1214D / 1449	
	Revision:	Date: March 31 rd , 2014
	<input type="checkbox"/> Draft	<input checked="" type="checkbox"/> Final
	Signature:	

1. Introduction

Two boreholes (BHVR3 and BHVR5) was located and drilled within the valley (right side of the dam) in a manner to determine the subsurface soil stratum and the depth of underlying bedrock (Appendix 1).

BHVR3: 69m

BHVR5: 50m

One borehole (BHLA2) was located and drilled within the axe of the dam (left side abutment) in a manner to determine the subsurface rock stratum and to estimate their average hydraulic conductivities (Appendix 1).

BHLA2: 103.5m

Two nos. of continuous DCPT (Dynamic Cone Penetration Test) probing (DCPVR8 and DCPVL4) were performed within the valley (right side of the dam) in a manner to estimate the relative densities and/or consistencies of the subsurface soil stratum (Appendix 1).

DCPVR8 (Relocated): 48m (Noncore drilling from 43.10m to 48m)

DCPVR4 (Relocated): 93m

An ambient earth noise survey (March 01, 2014) as shown on Figure 1 was carried out within the dam footprint by using a standard seismometer of CMG-T40-0046 in a manner to check and improve the seismic design criteria of the dam.



Figure 1: Ambient earth noise survey

2. Field Investigation

The field investigation was performed between February 18 and March 11, 2014. Three boreholes to a maximum depth of 103.5m and two nos. of continuous DCPT probing to a maximum depth of 93m were executed at locations shown on Figure 2. One crawler and two truck mounted rotary drill rigs as shown on Figure 3, 4 and 5 were used in field investigation.

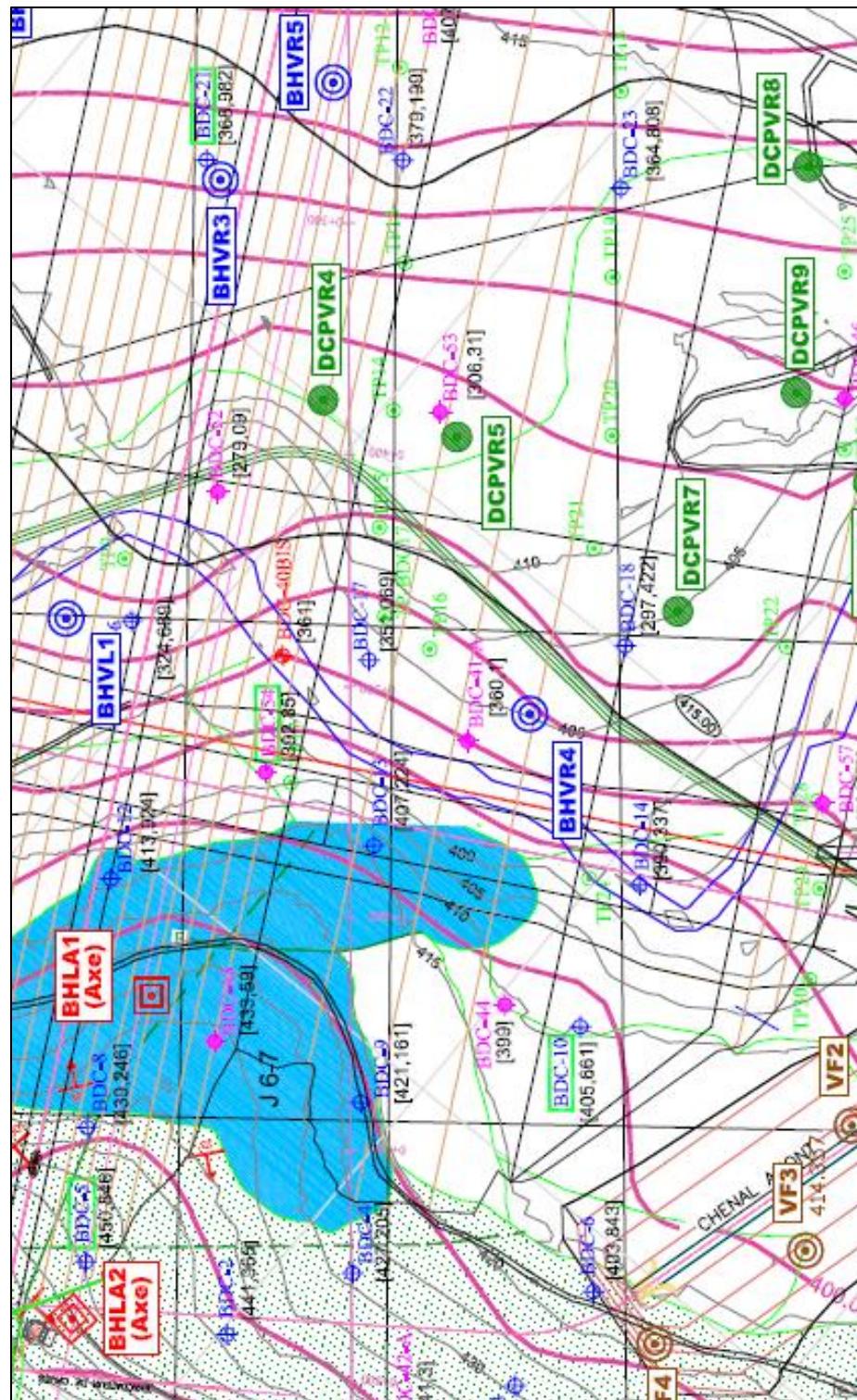


Figure 2: Locations of the boreholes and DCPT probings

BHVR3 / Piezometer (+413.75 NGL): 69 meters deep:

0-43.5m: Lacustrine soil deposits.

43.5-46m: Old colluvial (slopewash) soil deposits.

46-69m: Combination of MARL/MARLSTONE and LIMESTONE (C2b)

BHVR5 / Piezometer (+413 NGL): 50 meters deep:

0-19.5m: Lacustrine soil deposits (repetitive losses of water circulation between 4 and 7m).

19.5-23m: Old colluvial (slopewash) soil deposits.

23-50m: Combination of MARL and LIMESTONE with a layer of disintegrated SANDSTONE (C2b, cavity between 34.5 and 36m, repetitive losses of water circulation between 30 and 39m)

BHLA2 / Piezometer (+459.19 NGL): 103.5 meters deep:

0-97m: Combination of MARLSTONE (dominant) and SANDSTONE (C1).

97-103.5m: LIMESTONE (J7, loss of water circulation at 97.5m).

Groundwater table was detected in boreholes at below given depths (March, 2014) from the natural ground level (NGL).

BHVR3 / Piezometer (+413.75 NGL):

Groundwater table at a depth of 7.98m (+405.77).

BHVR5 / Piezometer (+413 NGL):

Groundwater table at a depth of 8.27m (+404.73).

BHLA2 / Piezometer (+459.19 NGL):

Groundwater table at a depth of 54.12m (+405.07).





Figure 3: Crawler mounted drill rig used in coring (BHLA2).



Figure 4: Truck mounted drill rig used in DCPT probing (DCPVR9).



Figure 5: Truck mounted drill rig used in coring (BHVR3).

3. Scope of Works

The scope of works of this field investigation consisted of the followings:

- Continuous core drilling in soil and rock.
- Performing Standard Penetration Test in soil and obtaining disturbed samples.
- Performing Dynamic Cone Penetration Test (DCPT) in soils contain coarse gravels and cobbles.
- Performing borehole water permeability (Falling Head Test) and Lugeon tests in soil and rock strata respectively.
- Installing standpipe open piezometers into the boreholes and measuring the depth and fluctuations of the groundwater table.
- Continuous DCPT probing.

86mm diameter (OD) double tube ("T" type) and 96mm diameter (OD) wireline ("H" type) core barrels equipped with tungsten carbide and surface-set diamond core bits were used in continuous core drilling with BW drill rods and HW casings (see Figure 6).

Core drilling was performed by using as minimum as possible amount of circulation water, only clean water was used during the drilling, water losses were recorded on site and indicated in logs of borings.

Cores taken from the boreholes were sealed with waterproof plastic tapes and stored in standard wooden core boxes (see Figure 7). All the necessary information related to the runs of coring and boreholes were clearly indicated on the boxes. Photos of core boxes are presented in Appendix 3 of this factual report.

In soil strata, Standard Penetration Test (SPT) was performed at 1.5m intervals by using Split-Spoon SPT sampler in 2 inches outside diameter (see Figure 8) and disturbed samples were obtained, labelled and kept in moisture-proof containers.





Figure 6: Wireline core barrel



Figure 7: Standard wooden core boxes



Figure 8: SPT sampler

Dynamic Cone Penetration Test (DCPT) was performed in boreholes to estimate the relative densities of the subsurface soil strata contain coarse gravels and cobbles.

A solid cone as shown Figure 9 having an apex angle of 60° and an end diameter of 62.5mm was used in DCPT with AW / BW drill rods and automatic trip SPT hammers as shown on Figure 10 and 11

The penetration tests were performed to estimate the relative densities and consistencies of the subsurface soil strata.



Figure 9: Solid cone used in DCPT



Figure 10: Automatic trip SPT hammer used in boreholes.



Figure 11: Automatic trip SPT hammer used in DCPT probing.

The Dynamic Cone Penetration Test was continuously performed in DCPT holes with full casing down to 60m and then with enlarging the hole diameter by the use of tri-cone bit in a manner to minimize the friction losses.

The continuous DCPT probing was performed as shown on Figure 12 to determine dam foundation strength and to evaluate the liquefaction potential.

Recorded numbers of blows were corrected for the amount of energy delivered to the drill rods (energy ratio) depending on the hammering system, Anvil size, blow rate, rod length and borehole diameter.

Computed DCPT values ($N_{cbr}60$) were converted to SPT values ($N60$) according to IS: 4986 (Part II)-1976. The test results are presented in Appendix 5 of this factual report.



Figure 12: Continuous DCPT probing.

Multistage Lugeon test was performed in rock strata as shown on Figure 13 at different depths. The test was conducted in portions (3 meters long) of the boreholes isolated by the single pneumatic packer having a diameter of 66mm. The test results are presented in Appendix 4 of this factual report.



Figure 13: Lugeon Test

In soil strata, Falling Head borehole water permeability test was performed as shown on Figure 14 at 3m intervals. The test results are presented in Appendix 4 of this factual report.



Figure 14: Falling Head Test

Perforated (one third of the standpipe) UPVC pipes, 60mm diameter (OD) and 2mm thick, wrapped with geotextile (PP, 150 gr/m²) were installed into the boreholes as open standpipe piezometers with concrete heading and steel pipe protection as shown on Figure 15 in a manner to measure (see Figure 16) the depth and fluctuations of the groundwater table (Appendix 6).



Figure 15: Concrete heading and steel pipe protection



Figure 16: Measuring the depth of groundwater

All the field works were performed according to ASTM and IS standards (ASTM D6640: Core drilling in soil and rock, ASTM D1586: Standard Penetration Test, IS 4968: Dynamic Cone Penetration Test, ASTM D4630: Standard Test Method for Constant Head Injection Test, Lambe & Whitman: Falling Head Test and ASTM D4750: Determining Subsurface Liquid Levels in a borehole) and were supervised by an engineering geologist.

4. Subsurface Strata

According to the logs of borings, the following subsurface soil and rock strata were encountered within the boreholes BHVR3, BHVR5 and BHLA2. The logs of borings are presented in Appendix 2 of this factual report.

BHVR3 / Piezometer (+413.75 NGL, 69 meters deep):

0-43.5m: Lacustrine soil deposits.

0-8m: Light brown soft to firm sandy CLAY interbedded (5-6m) with light brown very loose to loose SAND

8-30m: Bluish dark grey soft to firm and firm slightly silty and sandy CLAY.

30-43.5m: Bluish dark grey soft to firm and firm CLAY.

43.5-46m: Old colluvial (slopewash) soil deposits.

Admixture of Clay, Sand and Gravel with cobbles of Limestone.

46-69m: C2b

Combination of gravelly argillaceous MARL (dark to light olive and yellowish brown to beige), slightly weathered fractured and crushed karstic sandy LIMESTONE (beige and with transitions of bluish grey sandy calcareous MARLSTONE) and dark olive to light brown moderately to highly and completely weathered argillaceous MARLSTONE.

BHVR5 / Piezometer (+413 NGL, 50 meters deep)::

0-19.5m: Lacustrine soil deposits.

0-4.5m: Light brown soft to firm CLAY.

4.5-6.5m: Light brown very loose clayey SAND (repetitive losses of water circulation between 4 and 7m)

6.5-16.5m: Bluish dark grey to brown soft silty CLAY

16.5-19.5m: Dark brown soft slightly gravelly silty CLAY.

19.5-23m: Old colluvial (slopewash) soil deposits.

Beige to dark olive gravelly argillaceous MARL with cobbles of LIMESTONE.

23-50m: C2b

Combination of argillaceous MARL (olive, brown and beige, sometimes gravelly) and slightly weathered mainly crushed marly LIMESTONE (beige to white and sometimes sandy, cavity: 34.5-36m) interbedded (42-45m) with yellowish brown highly to completely weathered (disintegrated) SANDSTONE (repetitive losses of water circulation between 30 and 39m).

BHLA2 / Piezometer (+459.19 NGL, 103.5 meters deep):

0-97m: C1

0-7.5m: Yellowish and reddish brown highly to completely weathered (disintegrated) very weak highly erodible SANDSTONE.

7.5-13.5m: Grey moderately sometimes moderately to highly weathered weak silty MARLSTONE.

13.5-26m: Beige moderately weathered (disintegrated) fractured sometimes crushed weak to medium strong SANDSTONE with a layer (17-18m) of highly to completely weathered very weak silty MARLSTONE.

26-31m: Yellowish light brown highly to completely weathered (disintegrated) very weak highly erodible SANDSTONE.

31-33m: Dark cream highly to completely and completely weathered very weak sandy MARLSTONE.

33-36m: Bluish green moderately to highly weathered weak sandy MARLSTONE.

36-45.5m: Light cream to white highly to completely weathered (disintegrated) very weak highly erodible SANDSTONE.

45.5-49m: Bluish green moderately sometimes moderately to highly weathered fractured and crushed weak to medium strong sandy MARLSTONE.

49-55.5m: Bluish grey to dark olive highly and highly to completely weathered very weak sandy MARLSTONE with a layer (49-49.5m) of reddish brown moderately weathered (disintegrated) weak to medium strong fractured SANDSTONE.

55.5-60m: Highly to completely weathered (disintegrated) very weak highly erodible SANDSTONE.

60-63m: Light olive moderately weathered (disintegrated) crushed and fractured weak to medium strong SANDSTONE.

63-68m: Reddish brown highly to completely and completely weathered very weak CLAYSTONE with cobbles of Sandstone.

68-68.5m: Multicolor slightly / moderately weathered (disintegrated) fractured weak to medium strong SANDSTONE.

68.5-70.5m: Dark cream highly to completely weathered very weak to weak sandy MARLSTONE.

70.5-97m: Grey sometimes beige slightly and slightly to moderately sometimes highly weathered fractured and crushed weak to moderately strong calcareous MARLSTONE of low permeability with interbeds of highly to completely (78-81.5m) and moderately weathered (93.5-94m) very weak and weak to medium strong SANDSTONE.

97-103.5m: J7

Grey fresh to slightly weathered fractured and crushed medium strong to strong oolitic LIMESTONE (loss of water circulation at 97.5m).

5. Closure

The findings presented in this factual report are based on the assumption that the subsurface soil and rock strata and their conditions do not deviate appreciably from those disclosed in boreholes. There may be conditions pertaining to the site which were not disclosed by this subsurface soil/rock survey, and thus could not be taken into account. Therefore, the findings are valid under this assumption only.



APPENDICES

APPENDIX 1. GEOLOGIE DU SITE (PLAN G-02 / MARCH 2014)

APPENDIX 2. LOGS OF BORINGS

APPENDIX 3. PHOTOS OF CORE BOXES

APPENDIX 4. BOREHOLE WATER PERMEABILITY & LUGEON TEST RESULTS

APPENDIX 5. DCPT TEST RESULTS

APPENDIX 6. GROUNDWATER MEASUREMENTS



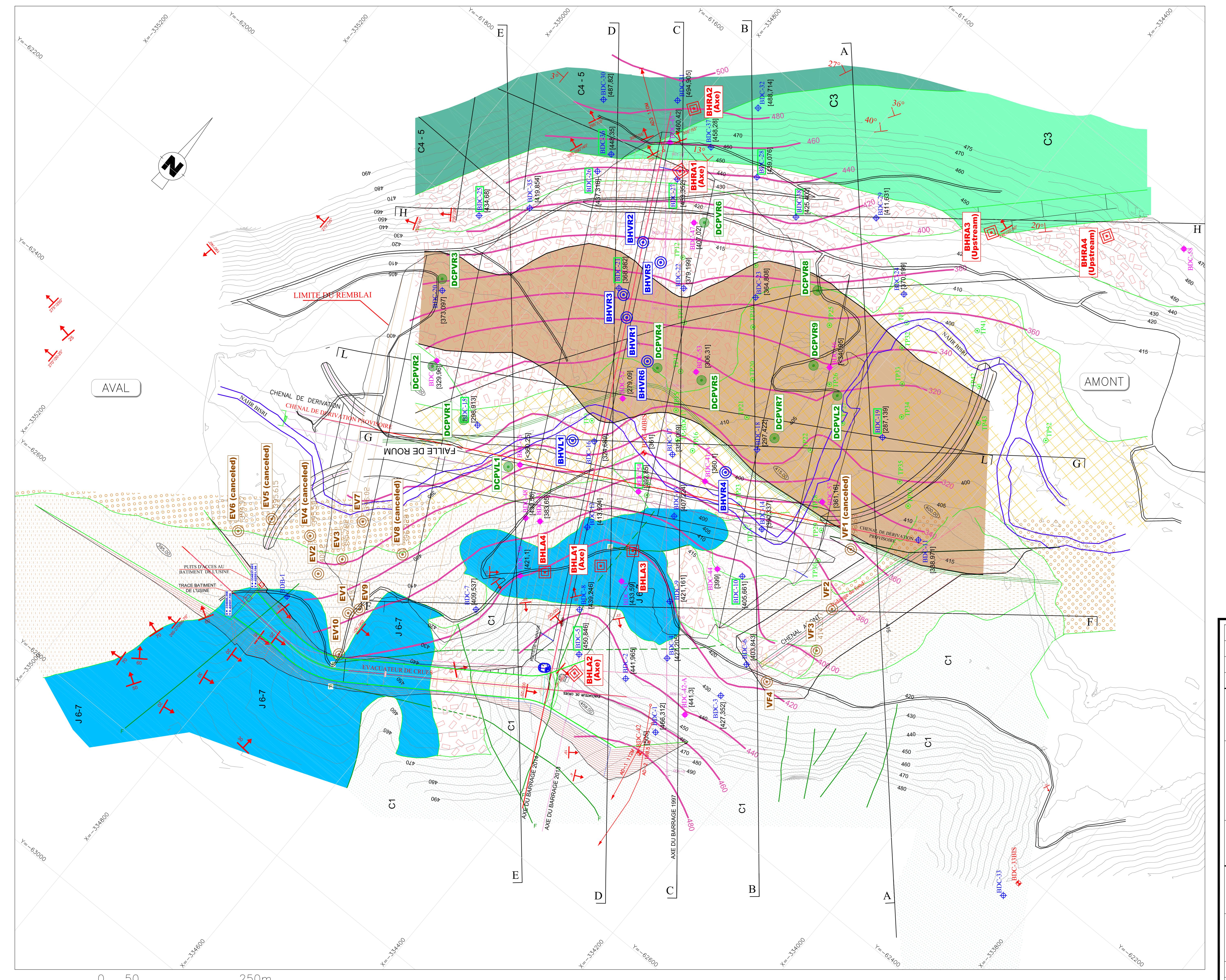
APPENDIX 1. GEOLOGIE DU SITE (PLAN G-02 / MARCH 2014)

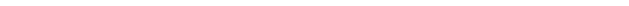


DAR AL HANDASAH NAZIH TALEB & PARTNERS
دار الهندسة نزيح طالب وشريك

Detailed Design Of Bisri Dam: Geo. Inv. Rep.II: (Factual) / Spillway & Bottom Outlet - March 2014

	x	y	z	Estimated depth of Drilling or probing from the existing ground surface (m)
BHLA1	-334,515.0	-62,242.8	431.5	105
BHLA2	-334,452.5	-62,371.9	459.2	95
BHLA3	-334,495.4	-62,201.2	New	25–35
BHLA4	-334,565.8	-62,295.1	New	25–35
BHRA1	-334,761.7	-61,782.4	440.1	125
BHRA2	-334,799.7	-61,708.1	489.9	145
BHRA3	-334,399.6	-61,586.5	430.8	100
BHRA4	-334,281.1	-61,494.7	449.9	100
BHVL1	-334,646.8	-62,140.6	396.6	100
BHVR1	-334,694.2	-61,972.8	Relocated	140
BHVR2	-334,740.0	-61,884.0	Relocated	130
BHVR3	-334,716.2	-61,952.7	413.8	70
BHVR4	-334,467.5	-62,046.0	398.0	75
BHVR5	-334,705.7	-61,889.6	Relocated	65
BHVR6	-334,637.3	-61,999.5	New	115
DCPVL1	-334,689.4	-62,220.0	396.3	40
DCPVL2	-334,419.0	-61,877.0	Relocated	45
DCPVR1	-334,772.9	-62,210.1	397.1	70 or as deeper as possible
DCPVR2	-334,848.2	-62,181.8	397.8	70
DCPVR3	-334,910.9	-62,086.5	405.6	30
DCPVR4	-334,621.9	-61,997.9	Relocated	70 or as deeper as possible
DCPVR5	-334,567.6	-61,973.7	Canceled	70 or as deeper as possible
DCPVR6	-334,695.1	-61,813.6	415.6	20
DCPVR7	-334,446.7	-61,971.5	398.1	70 or as deeper as possible
DCPVR8	-334,525.7	-61,788.1	Relocated	50
DCPVR9	-334,467.6	-61,866.5	411.3	70
EV1	-334,728.7	-62,498.6	415.7	30
EV2	-334,791.3	-62,484.1	402.2	30
EV3	-334,779.2	-62,449.7	395.8	50
EV4	-334,830.5	-62,452.7	395.6	Cancelled
EV5	-334,883.0	-62,467.7	395.6	Cancelled
EV6	-334,906.6	-62,507.4	395.0	Cancelled
EV7	-334,789.7	-62,395.0	396.0	60
EV8	-334,722.9	-62,395.0	396.3	Cancelled
EV9	-334,720.5	-62,485.6	414.9	30
EV10	-334,703.9	-62,547.4	420.1	30
VF1	-334,278.5	-62,019.7	398.6	Cancelled
VF2	-334,248.0	-62,095.0	414.0	40
VF3	-334,229.1	-62,149.3	414.4	40
VF4	-334,253.3	-62,221.5	419.1	40



Echelle : 

LEGENDE:

LITHOLOGIE

		EBOLIS,BRECHE, COUVERTURE: D'EBOLIS DE GRES, D'ARGILE ET DE BLOCS DE CALCAIRE	BDC1	SONDAGES REALISES EN 1982
		SILT. SABLE. GRES DESINTEGRE	BDC45	SONDAGES REALISES EN 1983
		SABLE	BDC47	SONDAGES REALISES EN 1996
		LIMON		SONDAGES REALISES EN 2014 (DCPT Probing, see note 4)
		LIMON ET GALETS		SONDAGES REALISES EN 2013 (Core Drilling, see note 1)
	C4-5	CENOMNIEN - TURONIEN CALCAIRE BLANCHATRE. PEU DUR. A DES NIVEAUX CALCAIRES CRAYEUX ET CALCAIRE BEIGE-BLANCHATRE PARFOIS DOLOMITIQUE. PARFOIS A POINTS ROUGES TANTOT CRYSTALLINS DUR A TRES DUR. TRES KARSTIFIE. GENERALEMENT FISSURE ET FRACTURE		SONDAGES REALISES EN 2014 (Core Drilling, see note 2)
	C3	ALBIEN (BARRE A CARDIUM) : CALCAIRE ORANGE-JAUNATRE. DUR. CRYSTALLIN. KARSTIFIE MARNES ET MARNO-CALCAIRE VERT-JAUNATRE A ABONDANTES COQUILLES	AD-1	GALERIE DE RECONNAISSANCE REALISEE ENTRE 1981 ET 1984
	C1	GRES DE BASE : ALTERNANACE DE SABLE . D'ARGILE. DE MARNE. DE SABLE FERRUGINEUX CIMENTE. PARFOIS TRES DUR. DE TUF PARFOIS CIMENTE ET DE CINERITES		COURBE D'EGALE ELEVATION DU TOIT DU SUBSTRATUM
	J 7	KIMMERIDGIEN: CALCAIRE GRIS. OOLITHIQUE. CRYSTALLIN, DUR. KARSTIFIE. A NIVEAUX MARNEUX		CHUTES D'OUTILS RELEVEES DANS LES SONDAGES
	J 6	PORTLANDIEN: CALCAIRE FIN.MASSIF. RAREMENT OOLITHIQUE. OCRE TANTOT A POINTS ROUGES. A SILEX. CRYSTALLIN. DURE PEU KARSTIFIE.	[329,96]	COTE TOIT DU SUBSTRATUM FAILLE IMPORTANTE

NOTA:

- Continuous core drilling in soil and rock to a depth of reaching the bedrock and penetrating it 5m with SPT and/or DCPT (if needed) in soil at 1.5m intervals by carrying out water permeability and Lugeon tests at 3m intervals in soil and rock respectively.

- 2 - Continuous core drilling in soil and rock to a depth of reaching the bedrock and penetrating it 30m with SPT and/or DCPT (if needed) in

- 3 - Continuous core drilling in rock to a depth of reaching the bottom level of the grout curtain for the bore-holes located within the axe of the dam and reaching the ground water table and penetrating it for the bore-holes located within the lake of the dam by carrying out Lugeon

- 4 - Continuous Dynamic Cone Penetration (DCPT probing) to a depth of reaching the bedrock or as deep as possible with full casing down to 63m maximum by using a solid cone having an apex angle of 60 degrees and an end diameter of 62.5mm with AW drill rods and a probe tip that is true to the DCPT I.

LE TRACE DE LA FAILLE DE ROOM A ETE ETABLIS SUR LA BASE
DES COUPES GEOLOGIQUES INTERPRETATIVES TENANT
COMPTE DES LOGS DE SONDAGES DE RECONNAISSANCES

DATE	REV	TOP	GEO	CIV	ARCH	STRUCT	MECH	ELEC
LEBANESE REPUBLIC COUNCIL FOR DEVELOPMENT & RECONSTRUCTION								
BARRAGE BISRI								
 DAR AL HANDASAH NAZIH TALEB & PARTNERS دارالهندسة نزيح طالب وشركاه 								
 NOVEC <small>CDG DEVELOPPEMENT</small> 								
GEOLOGIE DU SITE								
			DRAWN					
			CHECKED					
			APPROVED					
			SCALE		1/2 000			
			DATE		March 2014			
			FILENAME		PLAN G-02			
PROJECT		DIVISION		SHEET		REVISION		
						13/01/2014		

APPENDIX 2. LOGS OF BORINGS



DAR AL HANDASAH NAZIH TALEB & PARTNERS
دار الهندسة نزيه طالب وشريك

Detailed Design Of Bisri Dam: Geo. Inv. Rep.II: (Factual) / Spillway & Bottom Outlet - March 2014

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR03						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: Bisri		Elevation (m): 413.75			SHEET: 1 OF: 7						
EQUIPMENT: SAT2000		METHOD: Rotary			BOREHOLE DEPTH (m): 69.0						
HOLE DIA. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68			DATE STARTED: 2/21/2014						
ENGINEER: K.S.		DRILLER: N.A.			DATE FINISHED: 3/5/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
1					medium stiff light brown CLAY						No flushing water loss
2			3,3,4 7				27	0	0		
3							21	0	0		
4			2,3,3 6		medium stiff light brown sandy CLAY		64	0	0		
5					medium dense light brown SAND		0	0	0		
6			3,3,3 6		medium stiff light brown sandy CLAY		52	0	0		
7							54	0	0		
8			2,3,3 6		medium stiff dark bluish grey slightly sandy/silty CLAY						
9			1,2,2 4				81	0	0		
10											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR03						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: Bisri		Elevation (m): 413.75			SHEET: 2 OF: 7						
EQUIPMENT: SAT2000		METHOD: Rotary			BOREHOLE DEPTH (m): 69.0						
HOLE DAM. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68			DATE STARTED: 2/21/2014						
ENGINEER: K.S.		DRILLER: N.A.			DATE FINISHED: 3/5/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D. (%)	UCS N/mm ²	Remarks
11					stiff dark bluish grey slightly sandy/silty CLAY	81	0	0			
12					ditto, very stiff	41	0	0			
13						69	0	0			
14					ditto, medium stiff	76	0	0			
15						67	0	0			
16						65	0	0			
17						95	0	0			
18						59	0	0			
19											
20											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR03						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: Bisri		Elevation (m): 413.75		SHEET: 3 OF: 7							
EQUIPMENT: SAT2000		METHOD: Rotary		BOREHOLE DEPTH (m): 69.0							
HOLE DIA. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68		DATE STARTED: 2/21/2014							
ENGINEER: K.S.		DRILLER: N.A.		DATE FINISHED: 3/5/2014							
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D. (%)	UCS N/mm ²	Remarks
21			2,3,3 6		medium stiff dark bluish grey slightly sandy/silty CLAY	59	0	0			
22			2,3,3 6			81	0	0			
23			3,3,3 6			81	0	0			
24			3,3,3 6			90	0	0			
25			3,3,4 7			83	0	0			
26			2,3,4 7			86	0	0			
27			3,4,4 8			95	0	0			
28											
29											
30											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR03						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: Bisri		Elevation (m): 413.75		SHEET: 4 OF: 7							
EQUIPMENT: SAT2000		METHOD: Rotary		BOREHOLE DEPTH (m): 69.0							
HOLE DAM. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68		DATE STARTED: 2/21/2014							
ENGINEER: K.S.		DRILLER: N.A.		DATE FINISHED: 3/5/2014							
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D. (%)	UCS N/mm ²	Remarks
31			3,2,3 5		medium stiff dark bluish grey CLAY		95	0	0		
32			3,4,4 8				88	0	0		
33			3,4,5 9				92	0	0		
34							70	0	0		
35			2,3,4 7				98	0	0		
36			2,4,4 8				90	0	0		
37			3,4,3 7								
38											
39			4,4,3 7								
40							95	0	0		

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR03						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: Bisri		Elevation (m): 413.75			SHEET: 5 OF: 7						
EQUIPMENT: SAT2000		METHOD: Rotary			BOREHOLE DEPTH (m): 69.0						
HOLE DIA. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68			DATE STARTED: 2/21/2014						
ENGINEER: K.S.		DRILLER: N.A.			DATE FINISHED: 3/5/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D. (%)	UCS N/mm ²	Remarks
41					medium stiff dark bluish grey CLAY		95	0	0		
42							100	0	0		
43							76	0	0		
44					greenish beige gravelly MARL with small cobbles of limestone		27	14	0		
45							52	0	0		
46							92	0	0		
47							59	0	0		
48					yellowish brown to beige gravelly MARL		33	0	0		
49											
50											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR03						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: Bisri		Elevation (m): 413.75			SHEET: 6 OF: 7						
EQUIPMENT: SAT2000		METHOD: Rotary			BOREHOLE DEPTH (m): 69.0						
HOLE DAM. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68			DATE STARTED: 2/21/2014						
ENGINEER: K.S.		DRILLER: N.A.			DATE FINISHED: 3/5/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D. (%)	UCS N/mm ²	Remarks
51					ditto		33	0	0		
52							43	0	0		
53							62	0	0		
54										CPT 75/4cm	
55										Refusal	
56											
57											
58					brown to grey moderately weathered crushed and shattered to fractured sandy MARLSTONE		90	0	0		
59					beige gravelly MARL with cobbles of limestone		100	87	31		
60							44	6	0		

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR03						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: Bisri		Elevation (m): 413.75			SHEET: 7 OF: 7						
EQUIPMENT: SAT2000		METHOD: Rotary			BOREHOLE DEPTH (m): 69.0						
HOLE DAM. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68			DATE STARTED: 2/21/2014						
ENGINEER: K.S.		DRILLER: N.A.			DATE FINISHED: 3/5/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
61					beige gravelly MARL with cobbles of limestone		33	5	0		
62							43	16	0		
63							35	0	0		
64											casing down to 64.5m
65							59	27	7		
66							63	5	0		
67							85	0	0		
68											
69											
70					End of Borehole at 69.0m						

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SOIL STUDIES

SOIL SYMBOL	ROCK SYMBOL	SAMPLERS	OTHERS	
		Dolomite		SPT (disturbed)
		Chalky Limestone		Shelby tube
		Calcarenite		Tricone
				Double tube
		Weak Chalky LIMESTONE		
		Sandy Limestone		
		Basalt / volcanics		
		Chert		
		CL		
		Creamy White LIMESTONE		
		Grainstone LIMESTONE		
		MARL		
		SANDSTONE		
		CLAYSTONE		
		Oolitic LIMESTONE		
		Micritic LIMESTONE		
		Mudstone		
		Gypsum		
		Siltstone		

ROCK CLASSIFICATION

% RQD	Classification
<25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
>90	Excellent

GRANULAR SOILS

N-Value	Relative Density
<4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
>50	Very Dense

COHESIVE SOIL

N-Value	Consistency
<2	Very Soft
2 - 4	Soft
4 - 8	Medium Stiff
8 - 15	Stiff
15 - 30	Very stiff
>30	Hard

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR05						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: Bisri		Elevation (m): 413		SHEET: 1 OF: 5							
EQUIPMENT: SAT2000		METHOD: Rotary		BOREHOLE DEPTH (m): 50.0							
HOLE DAM. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68		DATE STARTED: 3/6/2014							
ENGINEER: K.S.		DRILLER: N.A.		DATE FINISHED: 3/11/2014							
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
1					medium stiff light brown CLAY		35	0	0		
2							63	0	0		
3							42	0	0		
4							86	0	0		
5					loose light brown clayey SAND						Repetitive flusing water loss and return between 4 and 7m
6							81	0	0		
7					medium stiff dark bluish grey to brown silty CLAY						
8							91	0	0		
9											
10							81	0	0		

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR05							
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)												
LOCATION: Bisri		Elevation (m): 413		SHEET: 2 OF: 5								
EQUIPMENT: SAT2000		METHOD: Rotary		BOREHOLE DEPTH (m): 50.0								
HOLE DAM. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68		DATE STARTED: 3/6/2014								
ENGINEER: K.S.		DRILLER: N.A.		DATE FINISHED: 3/11/2014								
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D. (%)	UCS N/mm ²	Remarks	
11			3,2,2 4		ditto		81	0	0			
12			2,2,2 4				76	0	0			
13							62	0	0			
14			2,3,3 6				67	0	0			
15			1,2,2 4				70	0	0			
16												
17			2,2,2 4		medium stiff dark brown silty CLAY with occasional small rounded gravels		81	0	0			
18			3,3,2 5									
19							38	0	0			
20			50/0cm Refusal		beige gravelly MARL with small cobbles of limestone		59	0	0			

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR05							
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)												
LOCATION: Bisri		Elevation (m): 413		SHEET: 3 OF: 5								
EQUIPMENT: SAT2000		METHOD: Rotary		BOREHOLE DEPTH (m): 50.0								
HOLE DAM. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68		DATE STARTED: 3/6/2014								
ENGINEER: K.S.		DRILLER: N.A.		DATE FINISHED: 3/11/2014								
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D. (%)	UCS N/mm ²	Remarks	
21					beige gravelly MARL with small cobbles of limestone	59	0	0				
22						57	0	0				
23						88	0	0				
24					hard beige MARL with occasional tiny gravels	89	0	0				
25						80	0	0				
26						90	0	0				
27						80	0	0				
28												
29												
30												

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR05							
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)												
LOCATION: Bisri		Elevation (m): 413		SHEET: 4 OF: 5								
EQUIPMENT: SAT2000		METHOD: Rotary		BOREHOLE DEPTH (m): 50.0								
HOLE DAM. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68		DATE STARTED: 3/6/2014								
ENGINEER: K.S.		DRILLER: N.A.		DATE FINISHED: 3/11/2014								
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks	
31	50/0cm Refusal				whitish grey moderately weathered mainly crushed and shattered partially fractured strong LIMESTONE with pockets of sandy marl	57	0	0				
32						57	13	0				
33						57	33	0				
34						0	0	0				
35					CAVITY							
36					whitish grey moderately weathered mainly crushed and shattered partially fractured strong LIMESTONE with pockets of sandy marl					Repetitive flusing water loss and return between 30 and 39m		
37						24	24	0				
38						31	13	0				
39						35	0	0				
40												

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR05							
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)												
LOCATION: Bisri		Elevation (m): 413		SHEET: 5 OF: 5								
EQUIPMENT: SAT2000		METHOD: Rotary		BOREHOLE DEPTH (m): 50.0								
HOLE DAM. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68		DATE STARTED: 3/6/2014								
ENGINEER: K.S.		DRILLER: N.A.		DATE FINISHED: 3/11/2014								
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D. (%)	UCS N/mm ²	Remarks	
41					ditto		35	0	0			
42					very dense yellowish brown SAND		31	7	0			
43							60	0	0			
44							43	0	0			
45					hard beige gravelly MARL with small cobbles of limestone		25	3	0			
46							26	0	0			
47											Casing down to 48m	
48												
49												
50					End of Borehole at 50.0m							

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SOIL STUDIES

SOIL SYMBOL	ROCK SYMBOL	SAMPLERS	OTHERS	
		Dolomite		SPT (disturbed)
		Chalky Limestone		Shelby tube
		Calcarenite		Tricone
				Double tube
		Weak Chalky LIMESTONE		
		Sandy Limestone		
		Basalt / volcanics		
		Chert		
		CL		
		Creamy White LIMESTONE		
		Grainstone LIMESTONE		
		MARL		
		SANDSTONE		
		CLAYSTONE		
		Oolitic LIMESTONE		
		Micritic LIMESTONE		
		Mudstone		
		Gypsum		
		Siltstone		

ROCK CLASSIFICATION

% RQD	Classification
<25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
>90	Excellent

GRANULAR SOILS

N-Value	Relative Density
<4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
>50	Very Dense

COHESIVE SOIL

N-Value	Consistency
<2	Very Soft
2 - 4	Soft
4 - 8	Medium Stiff
8 - 15	Stiff
15 - 30	Very stiff
>30	Hard

CLIENT: DAR-TALEB				FILE NO.:	14-001	BOREHOLE NO.:				BHLA02	
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				Elevation (m):	459.2	SHEET:				1 OF: 11	
LOCATION: Bisri				METHOD:	Rotary	BOREHOLE DEPTH (m):				103.5	
EQUIPMENT: CMV 1000				CORE DIAM. (mm):	63 to 68	DATE STARTED:				2/13/2014	
HOLE DAM. (mm): 86 to 114				DRILLER:	A.A.	DATE FINISHED:				3/7/2014	
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
1					very dense yellowish brown SAND						
2						50	0	0			
3						36	19	0			
4						48	0	0			CPT 27,24,43,50/7cm
5						40	5	0			
6						33	0	0			
7						67	0	0			
8					light grey MARL with occasional cobbles of sandstone and pockets of sand						
9						71	0	0			
10											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT:	DAR-TALEB	FILE NO.:	14-001	BOREHOLE NO.:	BHLA02						
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)			SHEET:	2 OF: 11						
LOCATION:	Bisri	Elevation (m):	459.2	BOREHOLE DEPTH (m):	103.5						
EQUIPMENT:	CMV 1000	METHOD:	Rotary	DATE STARTED:	2/13/2014						
HOLE DAM. (mm):	86 to 114	CORE DIAM. (mm):	63 to 68	DATE FINISHED:	3/7/2014						
ENGINEER:	K.S.	DRILLER:	A.A.								
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
11					ditto		71	0	0		
12							50	0	0		
13							38	0	0		
14					beige highly weathered crushed and shattered to fractured medium strong SANDSTONE		61	11	0		
15							53	44	0		
16							67	0	0		
17					grey highly to completely weathered (like marl) sandy MARLSTONE						
18					pinkish to yellowish brown moderately to highly weathered crushed and shattered to fractured medium strong SANDSTONE		33	20	20		
19							33	22	0		
20											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.:	14-001	BOREHOLE NO.:			BHLA02	
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				Elevation (m):	459.2	SHEET:			3 OF: 11	
LOCATION: Bisri		Elevation (m):		459.2		BOREHOLE DEPTH (m):			103.5	
EQUIPMENT: CMV 1000		METHOD:		Rotary		DATE STARTED:			2/13/2014	
HOLE DIA. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68		A.A.		DATE FINISHED:			3/7/2014	
DETH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	UCS N/mm ²	Remarks
21					ditto		33	22	0	
22							37	37	22	
23							53	53	0	
24							42	27	0	
25										
26					very dense white SAND with cobbles of sandstone		45	12	0	
27	50/3cm Refusal						0	0	0	
28										
29	50/3cm Refusal						0	0	0	
30										

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT:	DAR-TALEB	FILE NO.:	14-001	BOREHOLE NO.:	BHLA02						
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)										
LOCATION:	Bisri	Elevation (m):	459.2	SHEET:	4 OF: 11						
EQUIPMENT:	CMV 1000	METHOD:	Rotary	BOREHOLE DEPTH (m):	103.5						
HOLE DAM. (mm):	86 to 114	CORE DIAM. (mm):	63 to 68	DATE STARTED:	2/13/2014						
ENGINEER:	K.S.	DRILLER:	A.A.	DATE FINISHED:	3/7/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
31	50/11cm Refusal				bluish grey completely weathered (like marl) sandy MARLSTONE		25	0	0		
32	50/10cm Refusal						39	0	0		
33	50/10cm Refusal						52	0	0		
34	50/7cm Refusal				very dense white SAND		35	0	0		
35	34,50/3cm Refusal						0	0	0		
36	50/13cm Refusal						0	0	0		
37	39,50/5cm Refusal						0	0	0		
38							0	0	0		
39							0	0	0		
40							0	0	0		

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.:	14-001	BOREHOLE NO.:		BHLA02			
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				Elevation (m):	459.2	SHEET:		5 OF: 11			
LOCATION: Bisri		Elevation (m):		METHOD: Rotary		BOREHOLE DEPTH (m):		103.5			
EQUIPMENT: CMV 1000		CORE DIAM. (mm): 63 to 68		DATE STARTED: 2/13/2014		DATE FINISHED: 3/7/2014					
HOLE DAM. (mm): 86 to 114		DRILLER: A.A.									
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
41					ditto		0	0	0		
42					50/5cm Refusal		0	0	0		
43					50/7cm Refusal		0	0	0		
44					50/6cm Refusal		0	0	0		
45					50/5cm Refusal		0	0	0		
46					bluish green highly weathered crushed and shattered weak to moderately strong sandy MARLSTONE		79	17	0		
47							70	59	8		
48					greyish green moderately weathered fractured moderately strong SANDSTONE		40	40	7		
49					brown highly weathered fractured weak to moderately strong SANDSTONE		30	0	0		
50					brown completely weathered MARLSTONE						

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT:	DAR-TALEB	FILE NO.:	14-001	BOREHOLE NO.:	BHLA02						
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)			SHEET:	6 OF: 11						
LOCATION:	Bisri	Elevation (m):	459.2	BOREHOLE DEPTH (m):	103.5						
EQUIPMENT:	CMV 1000	METHOD:	Rotary	DATE STARTED:	2/13/2014						
HOLE DAM. (mm):	86 to 114	CORE DIAM. (mm):	63 to 68	DATE FINISHED:	3/7/2014						
ENGINEER:	K.S.	DRILLER:	A.A.								
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
51					ditto		30	0	0		
52					bluish completely weathered MARLSTONE with cobbles sandstone		47	0	0		
53							0	0	0		
54							40	0	0		
55							0	0	0		
56							0	0	0		
57							0	0	0		
58							0	0	0		
59							0	0	0		
60											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHLA02						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: Bisri		Elevation (m): 459.2			SHEET: 7 OF: 11						
EQUIPMENT: CMV 1000		METHOD: Rotary			BOREHOLE DEPTH (m): 103.5						
HOLE DAM. (mm): 86 to 114		CORE DIAM. (mm): 63 to 68			DATE STARTED: 2/13/2014						
ENGINEER: K.S.		DRILLER: A.A.			DATE FINISHED: 3/7/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
61	50/3cm Refusal				light olive green to brown highly to completely weathered (like marl) MARLSTONE		37	0	0		
62	50/5cm Refusal				light olive green and grey moderately weathered crushed and shattered to fractured medium strong SANDSTONE		33	23	7		
63	50/10cm Refusal				reddish brown CLAY with cobbles of sandstone		45	0	0		
64							34	0	0		
65							37	0	0		
66							100	29	8		
67											
68											
69	32,50/4cm Refusal				white and reddish brown highly weathered crushed and shattered weak SANDSTONE						
70					grey completely weathered (like marl) MARLSTONE		31	0	0		

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT: DAR-TALEB				FILE NO.:	14-001	BOREHOLE NO.: BHLA02					
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				Elevation (m):	459.2						
LOCATION: Bisri				LT	459.2	SHEET: 8 OF: 11					
EQUIPMENT: CMV 1000				METHOD:	Rotary	BOREHOLE DEPTH (m): 103.5					
HOLE DAM. (mm): 86 to 114				CORE DIAM. (mm):	63 to 68	DATE STARTED: 2/13/2014					
ENGINEER: K.S.				DRILLER:	A.A.	DATE FINISHED: 3/7/2014					
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
71					ditto		31	0	0		
72					light olive green moderately weathered crushed and shattered to fractured medium strong SANDSTONE		40	7	0		
73							57	57	8		casing down to 73.5m
74							100	100	18		
75							89	89	25		
76							63	63	0		
77							0	20	0		
78	50/2cm Refusal				very dense grey SAND		0	0	0		
79											
80	50/2cm Refusal										

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT:	DAR-TALEB	FILE NO.:	14-001	BOREHOLE NO.:	BHLA02						
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)			SHEET:	9 OF: 11						
LOCATION:	Bisri	Elevation (m):	459.2	BOREHOLE DEPTH (m):	103.5						
EQUIPMENT:	CMV 1000	METHOD:	Rotary	DATE STARTED:	2/13/2014						
HOLE DAM. (mm):	86 to 114	CORE DIAM. (mm):	63 to 68	DATE FINISHED:	3/7/2014						
ENGINEER:	K.S.	DRILLER:	A.A.								
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
81					ditto		0	0	0		
82					dark grey moderately weathered crushed and shattered medium strong SANDSTONE with pockets of marl	31	14	0			
83					dark to blackish grey highly weathered crushed and shattered to fractured weak to medium strong SANDSTONE	33	30	0			
84						30	30	0			
85						35	33	0			
86						27	17	0			
87						75	59	0			
88											
89											
90											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT:	DAR-TALEB	FILE NO.:	14-001	BOREHOLE NO.:	BHLA02						
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)			SHEET:	10 OF: 11						
LOCATION:	Bisri	Elevation (m):	459.2	BOREHOLE DEPTH (m):	103.5						
EQUIPMENT:	CMV 1000	METHOD:	Rotary	DATE STARTED:	2/13/2014						
HOLE DAM. (mm):	86 to 114	CORE DIAM. (mm):	63 to 68	DATE FINISHED:	3/7/2014						
ENGINEER:	K.S.	DRILLER:	A.A.								
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
91					ditto		47	35	0		
92							39	15	0		
93							33	12	0		
94							39	7	0		
95							42	35	10		
96											
97					light to dark grey moderately weathered crushed and shattered to fractured medium strong sandy LIMESTONE						flushing water loss at 97.50m
98							93	73	29		
99											
100							100	100	7		

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

CLIENT:	DAR-TALEB	FILE NO.:	14-001	BOREHOLE NO.:	BHLA02						
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)			SHEET:	11 OF: 11						
LOCATION:	Bisri	Elevation (m):	459.2	BOREHOLE DEPTH (m):	103.5						
EQUIPMENT:	CMV 1000	METHOD:	Rotary	DATE STARTED:	2/13/2014						
HOLE DAM. (mm):	86 to 114	CORE DIAM. (mm):	63 to 68	DATE FINISHED:	3/7/2014						
ENGINEER:	K.S.	DRILLER:	A.A.								
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
101	Brickwork				ditto		100	100	7		
102							100	100	13		
103							100	100	0		
104											
105											
106											
107											
108											
109											
110											
					End of Borehole @ 103.50m						

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

LEGEND

SOIL STUDIES

SOIL SYMBOL	ROCK SYMBOL	SAMPLERS	OTHERS
 GP	 Dolomite		 Water Level
 GP-GM	 Chalky Limestone		Shelby tube
 GM	 Calcarenite		Tricone
 GC	 Weak Chalky LIMESTONE		
 SW	 Sandy Limestone		
 SP	 SP - SM		
 SP - SM	 Basalt / volcanics		
 SM-SC	 ML		
 CH-MH	 Chert		
 OL	 CL		
 OH	 Creamy White LIMESTONE		
 PT	 Fill Material		
	 MARL		
 CLAY	 SANDSTONE		
 CLAYwith Sand and Gravel	 CLAYSTONE		
	 Oolitic LIMESTONE		
	 Micritic LIMESTONE		
	 Mudstone		
	 Gypsum		
	 Siltstone		
ROCK CLASSIFICATION			
% RQD	Classification		
<25	Very Poor		
25-50	Poor		
50-75	Fair		
75-90	Good		
>90	Excellent		
GRANULAR SOILS			
N-Value	Relative Density		
< 4	Very Loose		
4 - 10	Loose		
10 - 30	Medium Dense		
30 - 50	Dense		
> 50	Very Dense		
COHESIVE SOIL			
N-Value	Consistency		
< 2	Very Soft		
2 - 4	Soft		
4 - 8	Medium Stiff		
8 - 15	Stiff		
15 - 30	Very stiff		
> 30	Hard		

APPENDIX 3. PHOTOS OF CORE BOXES



DAR AL HANDASAH NAZIH TALEB & PARTNERS
دار الهندسة نزيه طالب وشريك

Detailed Design Of Bisri Dam: Geo. Inv. Rep.II: (Factual) / Spillway & Bottom Outlet - March 2014



































APPENDIX 4. BOREHOLE WATER PERMEABILITY & LUGEON TEST RESULTS



PROJECT		Bisri Dam / Second Package				FALLING HEAD BOREHOLE WATER PERMEABILITY TEST									
CLIENT		DAR-TALEB													
Borehole	BHVR3				Date:		21.02.2014								
Test Interval	3		to		6		K(m/sec, FHM):		5.1247E-08						
Diameter of test interval	D		86		mm		Time (min)	Drawdown from R.L (m)	Time (sec)						
Pre-test water depth / Groundwater depth	h_0		3.3		m		0	0.00	0						
Length of uncased test interval below the pre-test water level	L		2.7		m		1	0.15	60						
Falling Head Method (FHM)							2	0.18	120						
$K_{(m/sec)} = \frac{D^2}{8L(t_2-t_1)} \ln\left(\frac{L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)$							3	0.20	180						
							4	0.21	240						
							5	0.23	300						
							6	0.24	360						
H1	2.95			m		7	0.26	420	0.92						
H2	2.61			m		9	0.29	540	0.91						
t1 (as per graph)	780			sec.		11	0.33	660	0.90						
t2	3600			sec.		13	0.35	780	0.89						
Log Time (sec)							15	0.36	900						
10 100 1000 10000							16	0.37	960						
ht/h0							17	0.38	1020						
1.00 0.95 0.90 0.85 0.80 0.75							18	0.40	1080						
ht/h0							19	0.40	1140						
0.57							20	0.42	1200						
ht/h0							25	0.44	1500						
0.59							30	0.57	1800						
ht/h0							35	0.59	2100						
0.61							40	0.61	2400						
ht/h0							45	0.64	2700						
0.65							50	0.65	3000						
ht/h0							55	0.67	3300						
0.69							60	0.69	3600						
Water Permeability (m/sec)		Relative Permeability				Semi-Pervious to Impervious									
1.00E-03	1.00E-05	Pervious				Semi-Pervious to Impervious									
1.00E-05	1.00E-08	Semi-Pervious				Semi-Pervious to Impervious									
1.00E-08	1.00E-12	Impervious				Semi-Pervious to Impervious									

PROJECT		Bisri Dam / Second Package				FALLING HEAD BOREHOLE WATER PERMEABILITY TEST								
CLIENT		DAR-TALEB												
Borehole	BHVR3				Date:		21.02.2014							
Test Interval	6		to		9		K(m/sec, FHM):		2.8480E-08					
Diameter of test interval	D		86		mm		Time (min)	Drawdown from R.L (m)	Time (sec)					
Pre-test water depth / Groundwater depth	h_0		8		m		0	0.00	0					
Length of uncased test interval below the pre-test water level	L		1		m		1	0.02	60					
Falling Head Method (FHM)						2	0.04	120	1.00					
$K_{(m/sec)} = \frac{D^2}{8L(t_2-t_1)} \ln\left(\frac{L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)$						3	0.06	180	0.99					
						4	0.07	240	0.99					
						5	0.08	300	0.99					
						6	0.09	360	0.99					
H1	7.8			m		7	0.12	420	0.99					
H2	7.54			m		9	0.14	540	0.98					
t1 (as per graph)	900			sec.		11	0.17	660	0.98					
t2	3600			sec.		13	0.19	780	0.98					
Log Time (sec)						15	0.20	900	0.97					
ht/h0						16	0.21	960	0.97					
10 100 1000 10000						17	0.22	1020	0.97					
1.01						18	0.24	1080	0.97					
1.00						19	0.24	1140	0.97					
0.99						20	0.25	1200	0.97					
0.98						25	0.28	1500	0.96					
0.97						30	0.31	1800	0.96					
0.96						35	0.33	2100	0.96					
0.95						40	0.36	2400	0.95					
0.94						45	0.39	2700	0.95					
0.93						50	0.42	3000	0.95					
Water Permeability (m/sec)						55	0.44	3300	0.94					
Relative Permeability						60	0.46	3600	0.94					
1.00E-03	1.00E-05	Pervious				Semi-Pervious to Impervious								
1.00E-05	1.00E-08	Semi-Pervious												
1.00E-08	1.00E-12	Impervious												

PROJECT		Bisri Dam / Second Package				FALLING HEAD BOREHOLE WATER PERMEABILITY TEST								
CLIENT		DAR-TALEB												
Borehole	BHVR3				Date:		22.02.2014							
Test Interval	9		to	12		K(m/sec, FHM):		1.6501E-08						
Diameter of test interval	D		86	mm		Time (min)	Drawdown from R.L (m)	Time (sec)	h_t / h_0					
Pre-test water depth / Groundwater depth	h_0		5.1	m		0	0.00	0	1.00					
Length of uncased test interval below the pre-test water level	L		3	m		1	0.12	60	0.98					
Falling Head Method (FHM)						2	0.14	120	0.97					
$K_{(m/sec)} = \frac{D^2}{8L(t_2-t_1)} \ln\left(\frac{L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)$						3	0.16	180	0.97					
						4	0.17	240	0.97					
						5	0.18	300	0.96					
						6	0.19	360	0.96					
H1	4.88			m		7	0.20	420	0.96					
H2	4.66			m		9	0.22	540	0.96					
t1 (as per graph)	540			sec.		11	0.25	660	0.95					
t2	3600			sec.		13	0.26	780	0.95					
Log Time (sec)						15	0.27	900	0.95					
ht/h0						16	0.28	960	0.94					
10 100 1000 10000						17	0.29	1020	0.94					
0.98						18	0.31	1080	0.94					
0.97						19	0.31	1140	0.94					
0.96						20	0.32	1200	0.94					
0.95						25	0.35	1500	0.93					
0.94						30	0.36	1800	0.93					
0.93						35	0.39	2100	0.92					
0.92						40	0.40	2400	0.92					
0.91						45	0.42	2700	0.92					
ht/h0						50	0.43	3000	0.92					
0.98 0.97 0.96 0.95 0.94 0.93 0.92 0.91						55	0.44	3300	0.91					
0.98 0.97 0.96 0.95 0.94 0.93 0.92 0.91						60	0.44	3600	0.91					
Water Permeability (m/sec)		Relative Permeability				Semi-Pervious to Impervious								
1.00E-03	1.00E-05	Pervious				Semi-Pervious to Impervious								
1.00E-05	1.00E-08	Semi-Pervious				Semi-Pervious to Impervious								
1.00E-08	1.00E-12	Impervious				Semi-Pervious to Impervious								

PROJECT		Bisri Dam / Second Package				FALLING HEAD BOREHOLE WATER PERMEABILITY TEST								
CLIENT		DAR-TALEB												
Borehole	BHVR3				Date:		22.02.2014							
Test Interval	15		to		18		K(m/sec, FHM):		2.2157E-08					
Diameter of test interval	D		86		mm		Time (min)	Drawdown from R.L (m)	Time (sec)					
Pre-test water depth / Groundwater depth	h_0		8		m		0	0.00	0					
Length of uncased test interval below the pre-test water level	L		3		m		1	0.03	60					
Falling Head Method (FHM)						2	0.05	120	0.99					
$K_{(m/sec)} = \frac{D^2}{8L(t_2-t_1)} \ln\left(\frac{L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)$						3	0.06	180	0.99					
						4	0.09	240	0.99					
						5	0.10	300	0.99					
						6	0.13	360	0.98					
H1	7.86			m		7	0.15	420	0.98					
H2	7.37			m		9	0.19	540	0.98					
t1 (as per graph)	420			sec.		11	0.23	660	0.97					
t2	3600			sec.		13	0.26	780	0.97					
Log Time (sec)						15	0.31	900	0.96					
10 100 1000 10000						16	0.33	960	0.96					
1.01						17	0.35	1020	0.96					
1.00						18	0.38	1080	0.95					
0.99						19	0.41	1140	0.95					
0.98						20	0.44	1200	0.95					
0.97						25	0.48	1500	0.94					
0.96						30	0.51	1800	0.94					
0.95						35	0.53	2100	0.93					
0.94						40	0.56	2400	0.93					
0.93						45	0.58	2700	0.93					
0.92						50	0.59	3000	0.93					
0.91						55	0.62	3300	0.92					
ht/h0						60	0.63	3600	0.92					
Water Permeability (m/sec)		Relative Permeability				Semi-Pervious to Impervious								
1.00E-03	1.00E-05	Pervious				Semi-Pervious to Impervious								
1.00E-05	1.00E-08	Semi-Pervious				Semi-Pervious to Impervious								
1.00E-08	1.00E-12	Impervious				Semi-Pervious to Impervious								



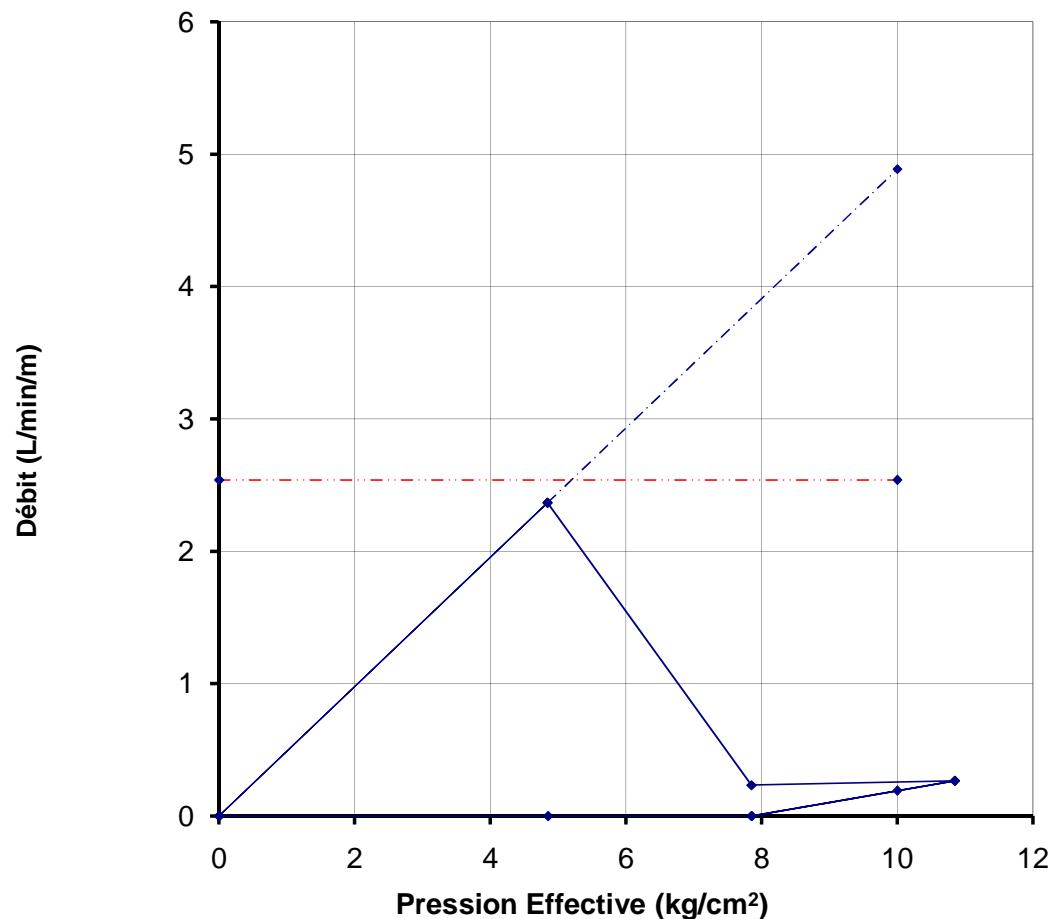
PROJECT: **Bisri Dam / Second Package**
SONDAGE No.: **BHVR03**
TRANCHE ESSAYEE **58.50 m à 61.50 m**

Date: **3/4/2014**
Manomètre **0.50 m**

depth to water: **8.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
4	71	10	3	7.1	2.37	0.85	7.03E-03	4.843
7	7	10	3	0.7	0.23	0.85	6.93E-04	7.849
10	8	10	3	0.8	0.27	0.85	7.92E-04	10.849
7	0	10	3	0	0.00	0.85	0.00E+00	7.850
4	0	10	3	0	0.00	0.85	0.00E+00	4.850



Lugeon = 2.54 L/min/m

PROJECT		Bisri Dam / Second Package				FALLING HEAD BOREHOLE WATER PERMEABILITY TEST								
CLIENT		DAR-TALEB												
Borehole	BHVR5				Date:		08.03.2014							
Test Interval	30	to	33		K(m/sec, FHM):		2.1554E-07							
Diameter of test interval		D	86	mm	Time (min)	Drawdown from R.L (m)	Time (sec)	h_t / h_0	h_t					
Pre-test water depth / Groundwater depth		h_0	8	m	0	0.00	0	1.00	8.00					
Length of uncased test interval below the pre-test water level		L	3	m	1	0.80	60	0.90	7.20					
Falling Head Method (FHM)						2	1.38	120	0.83	6.62				
$K_{(m/sec)} = \frac{D^2}{8L(t_2-t_1)} \ln\left(\frac{L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)$						3	1.70	180	0.79	6.30				
						4	1.99	240	0.75	6.01				
						5	2.18	300	0.73	5.82				
						6	2.35	360	0.71	5.65				
H1	5.82		m		7	2.51	420	0.69	5.49					
H2	3.42		m		9	2.85	540	0.64	5.15					
t1 (as per graph)	300		sec.		11	3.18	660	0.60	4.82					
t2	3000		sec.		13	3.38	780	0.58	4.62					
Log Time (sec)						15	3.48	900	0.56	4.52				
						16	3.52	960	0.56	4.48				
						17	3.57	1020	0.55	4.43				
						18	3.62	1080	0.55	4.38				
						19	3.68	1140	0.54	4.32				
						20	3.73	1200	0.53	4.27				
						25	3.96	1500	0.50	4.04				
						30	4.21	1800	0.47	3.79				
						35	4.31	2100	0.46	3.69				
						40	4.40	2400	0.45	3.60				
						45	4.49	2700	0.44	3.51				
						50	4.58	3000	0.43	3.42				
						55	4.64	3300	0.42	3.36				
						60	4.69	3600	0.41	3.31				
Water Permeability (m/sec)			Relative Permeability											
1.00E-03	1.00E-05		Pervious											
1.00E-05	1.00E-08		Semi-Pervious											
1.00E-08	1.00E-12		Impervious											



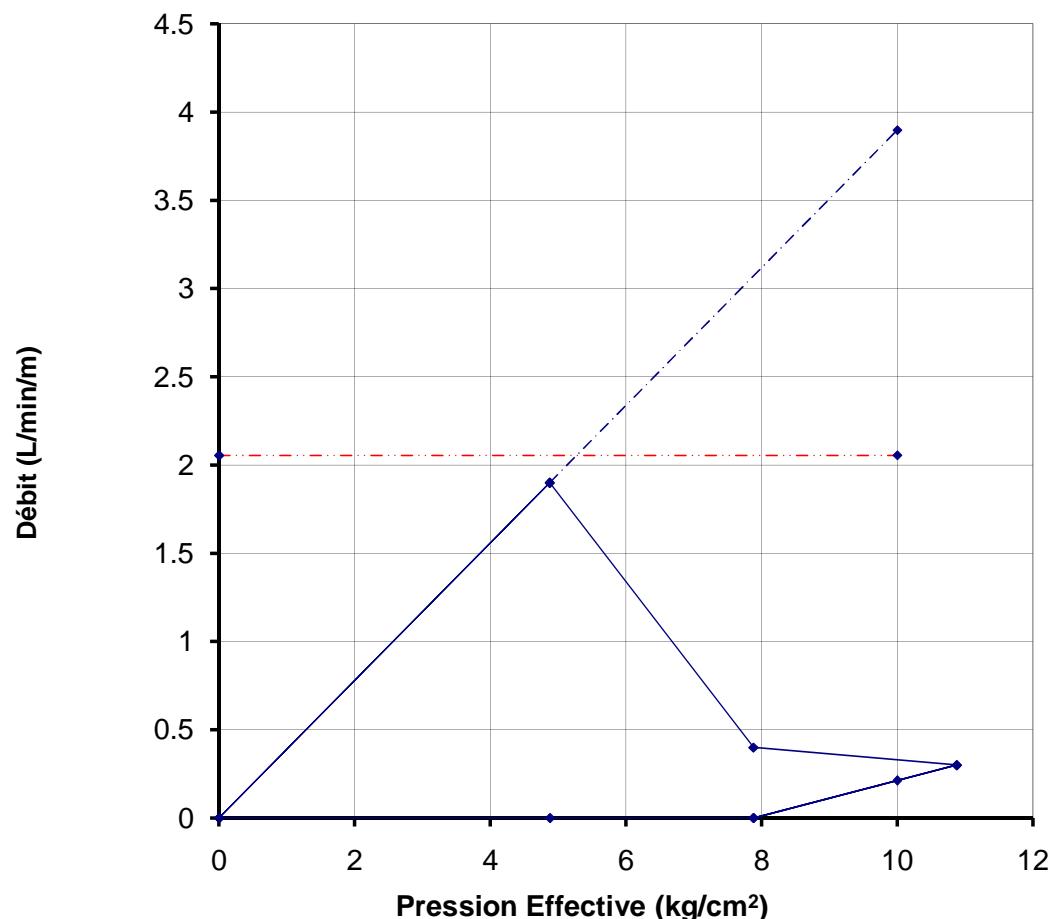
PROJECT: Bisri Dam / Second Package
SONDAGE No.: BHVR05
TRANCHE ESSAYEE 24.00 m à 27.00 m

Date: 3/7/2014
Manomètre 0.50 m

depth to water: 8.30 m

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P -J+ ΔH
4	57	10	3	5.7	1.90	0.88	5.64E-03	4.874
7	12	10	3	1.2	0.40	0.88	1.19E-03	7.879
10	9	10	3	0.9	0.30	0.88	8.91E-04	10.879
7	0	10	3	0	0.00	0.88	0.00E+00	7.880
4	0	10	3	0	0.00	0.88	0.00E+00	4.880



Lugeon = 2.06 L/min/m



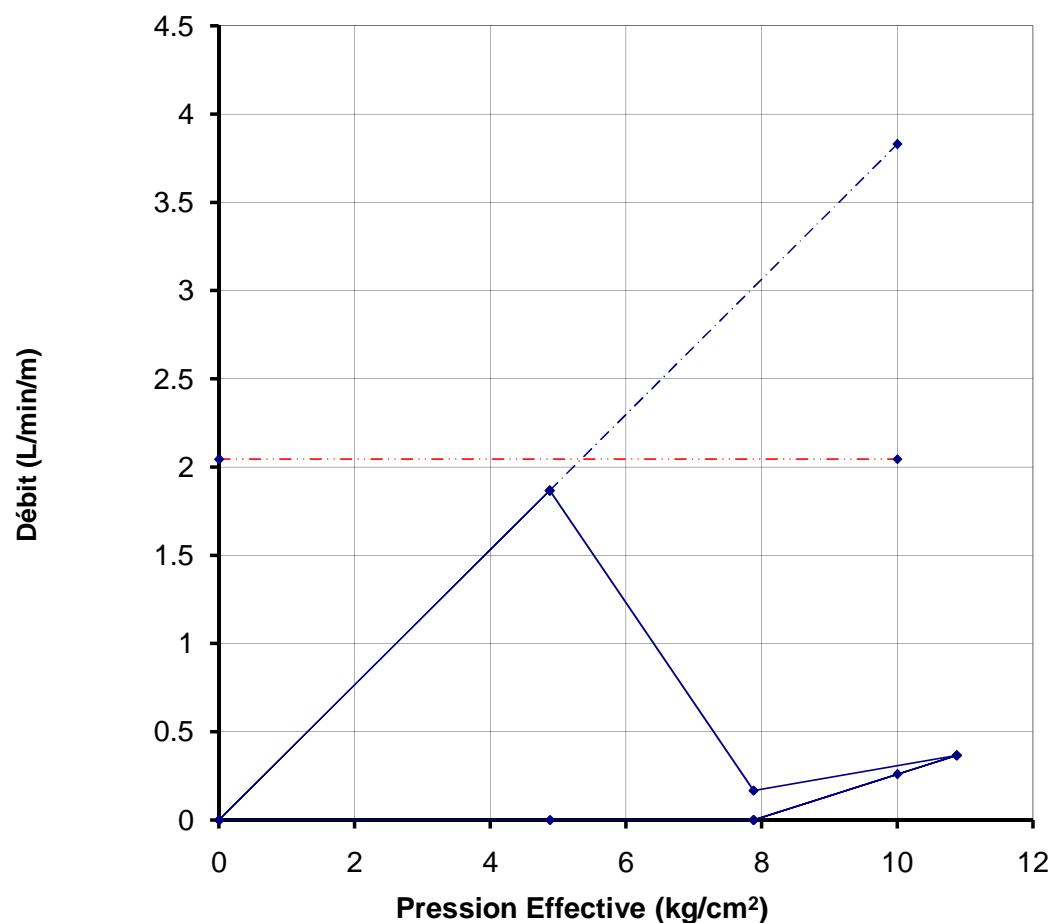
PROJECT: Bisri Dam / Second Package
SONDAGE No.: BHVR05
TRANCHE ESSAYEE 27.00 m à 30.00 m

Date: 3/7/2014
Manomètre 0.50 m

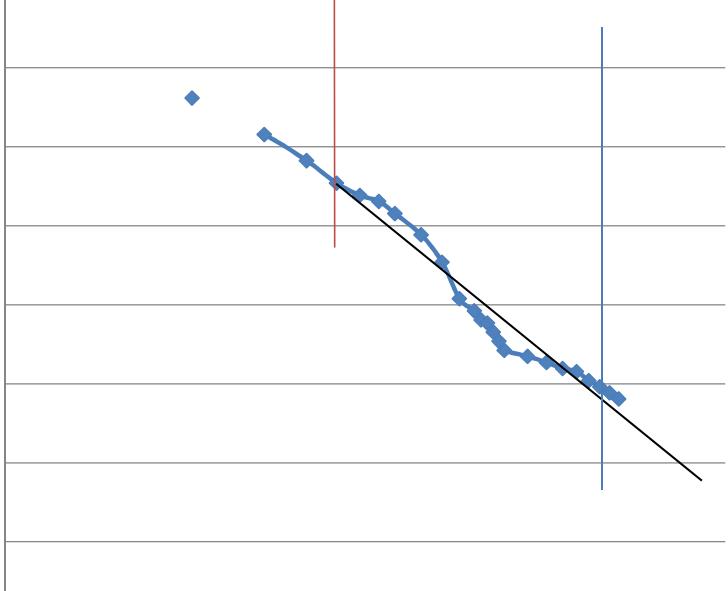
depth to water: 8.30 m

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P -J+ ΔH
4	56	10	3	5.6	1.87	0.88	5.54E-03	4.874
7	5	10	3	0.5	0.17	0.88	4.95E-04	7.880
10	11	10	3	1.1	0.37	0.88	1.09E-03	10.879
7	0	10	3	0	0.00	0.88	0.00E+00	7.880
4	0	10	3	0	0.00	0.88	0.00E+00	4.880



Lugeon = 2.04 L/min/m

PROJECT		Bisri Dam / Second Package				FALLING HEAD BOREHOLE WATER PERMEABILITY TEST						
CLIENT		DAR-TALEB										
Borehole	BHLA2				Date:	2/14/2014						
Test Interval	6	to	9		K(m/sec, FHM):	6.2007E-08						
Diameter of test interval		D	86	mm	Time (min)	Drawdown from R.L (m)	Time (sec)	h_t / h_0				
Pre-test water depth / Groundwater depth		h_0	2.6	m	0	0.00	0	1.00				
Length of uncased test interval below the pre-test water level		L	3	m	1	0.18	60	0.93				
Falling Head Method (FHM)						2	0.24	120				
$K(m/sec) = \frac{D^2}{8L(t_2-t_1)} \ln\left(\frac{L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)$						3	0.28	180				
						4	0.32	240				
						5	0.34	300				
						6	0.35	360				
H1	2.28		m		7	0.37	420	0.86				
H2	1.95		m		9	0.41	540	0.84				
t1 (as per graph)	240		sec.		11	0.45	660	0.83				
t2	3000		sec.		13	0.51	780	0.80				
Log Time (sec)						15	0.53	900				
10 100 1000 10000						16	0.55	960				
ht/h0						17	0.55	1020				
						18	0.57	1080				
1.00						19	0.58	1140				
0.95						20	0.60	1200				
0.90						25	0.61	1500				
0.85						30	0.62	1800				
0.80						35	0.63	2100				
0.75						40	0.63	2400				
0.70						45	0.65	2700				
0.65						50	0.66	3000				
0.60						55	0.67	3300				
Water Permeability (m/sec)						60	0.68	3600				
Relative Permeability												
1.00E-03	1.00E-05	Pervious										
1.00E-05	1.00E-08	Semi-Pervious										
1.00E-08	1.00E-12	Impervious										
						Semi-Pervious to Impervious						

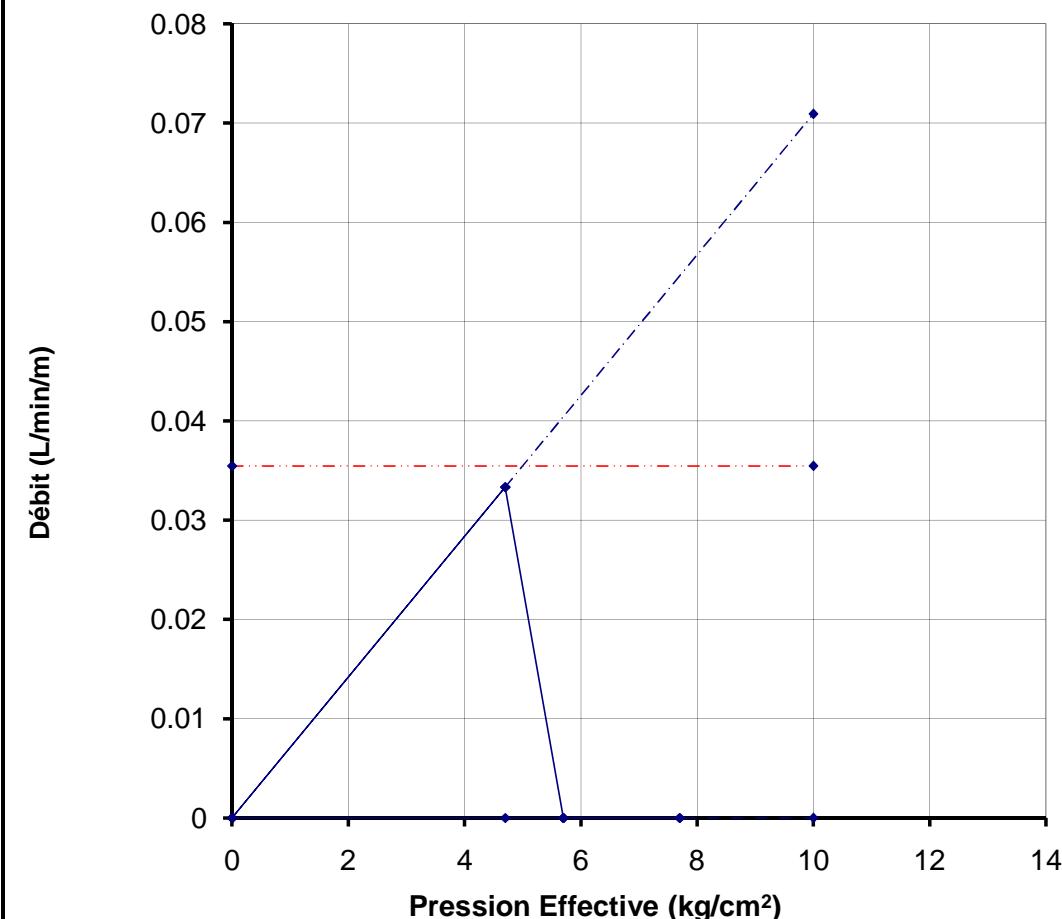
PROJECT		Bisri Dam / Second Package				FALLING HEAD BOREHOLE WATER PERMEABILITY TEST											
CLIENT		DAR-TALEB															
Borehole	BHLA2				Date:		2/17/2014										
Test Interval	18		to		21		K(m/sec, FHM):		2.9940E-08								
Diameter of test interval	D		86		mm		Time (min)	Drawdown from R.L (m)	Time (sec)								
Pre-test water depth / Groundwater depth	h ₀		10.3		m		0	0.00	0								
Length of uncased test interval below the pre-test water level	L		3		m		1	0.04	60								
Falling Head Method (FHM)							2	0.13	120								
$K_{(m/sec)} = \frac{D^2}{8L(t_2-t_1)} \ln\left(\frac{L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)$							3	0.18	180								
							4	0.22	240								
							5	0.27	300								
							6	0.36	360								
H1	10.08			m			7	0.40	420								
H2	9.58			m			9	0.51	540								
t1 (as per graph)	240			sec.			11	0.58	660								
t2	2100			sec.			13	0.59	780								
Log Time (sec)							15	0.61	900								
1 10 100 1000 10000							16	0.62	960								
0.99							17	0.62	1020								
0.98							18	0.63	1080								
0.97							19	0.64	1140								
0.96							20	0.64	1200								
0.95							25	0.66	1500								
0.94							30	0.70	1800								
0.93							35	0.72	2100								
0.92							40	0.74	2400								
0.91							45	0.75	2700								
0.90							50	0.76	3000								
Water Permeability (m/sec)							55	0.78	3300								
Relative Permeability							60	0.78	3600								
1.00E-03	1.00E-05	Pervious							Semi-Pervious to Impervious								
1.00E-05	1.00E-08	Semi-Pervious							Semi-Pervious to Impervious								
1.00E-08	1.00E-12	Impervious							Semi-Pervious to Impervious								

PROJECT		Bisri Dam / Second Package				FALLING HEAD BOREHOLE WATER PERMEABILITY TEST				
CLIENT		DAR-TALEB								
Borehole	BHLA2				Date:		2/24/2014			
Test Interval	57	to	60		K(m/sec, FHM):		4.2225E-09			
Diameter of test interval	D		86	mm	Time (min)	Drawdown from R.L (m)	Time (sec)	h_t / h_0	h_t	
Pre-test water depth / Groundwater depth	h_0		11.6	m	0	0.00	0	1.00	11.60	
Length of uncased test interval below the pre-test water level	L		3	m	1	0.16	60	0.99	11.44	
Falling Head Method (FHM)										
$K(m/sec) = \frac{D^2}{8L(t_2-t_1)} \ln\left(\frac{L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)$										
H1	11.42			m	2	0.18	120	0.98	11.42	
H2	11.32			m	3	0.20	180	0.98	11.41	
t1 (as per graph)	120			sec.	4	0.21	240	0.98	11.39	
t2	2400			sec.	5	0.22	300	0.98	11.38	
Water Permeability (m/sec)	Relative Permeability				6	0.23	360	0.98	11.37	
1.00E-03	1.00E-05	Pervious				7	0.23	420	0.98	11.37
1.00E-05	1.00E-08	Semi-Pervious				8	0.24	540	0.98	11.36
1.00E-08	1.00E-12	Impervious				9	0.25	660	0.98	11.35
1.00E-03	1.00E-05	Pervious				10	0.26	900	0.98	11.34
1.00E-05	1.00E-08	Semi-Pervious				11	0.26	960	0.98	11.34
1.00E-08	1.00E-12	Impervious				12	0.26	1020	0.98	11.34
1.00E-03	1.00E-05	Pervious				13	0.26	1080	0.98	11.34
1.00E-05	1.00E-08	Semi-Pervious				14	0.27	1140	0.98	11.34
1.00E-08	1.00E-12	Impervious				15	0.27	1200	0.98	11.33
1.00E-03	1.00E-05	Pervious				16	0.27	1500	0.98	11.33
1.00E-05	1.00E-08	Semi-Pervious				17	0.28	1800	0.98	11.32
1.00E-08	1.00E-12	Impervious				18	0.28	2100	0.98	11.32
1.00E-03	1.00E-05	Pervious				19	0.28	2400	0.98	11.32
1.00E-05	1.00E-08	Semi-Pervious				20	0.29	2700	0.98	11.31
1.00E-08	1.00E-12	Impervious				21	0.29	3000	0.98	11.31
1.00E-03	1.00E-05	Pervious				22	0.29	3300	0.97	11.31
1.00E-05	1.00E-08	Semi-Pervious				23	0.30	3600	0.97	11.30
1.00E-08	1.00E-12	Impervious				Impervious				

SATCON	PROJECT: BISRI DAM / SECOND PACKAGE	Date: 2/17/2014
SONDAGE No.: BHLA 02	TRANCHE ESSAYEE 15.00 m à 18.00 m	Manomètre 0.50 m
		depth to water:

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
3	1	10	3	0.1	0.03	1.7	9.90E-05	4.700
4	0	10	3	0	0.00	1.7	0.00E+00	5.700
6	0	10	3	0	0.00	1.7	0.00E+00	7.700
4	0	10	3	0	0.00	1.7	0.00E+00	5.700
3	0	10	3	0	0.00	1.7	0.00E+00	4.700

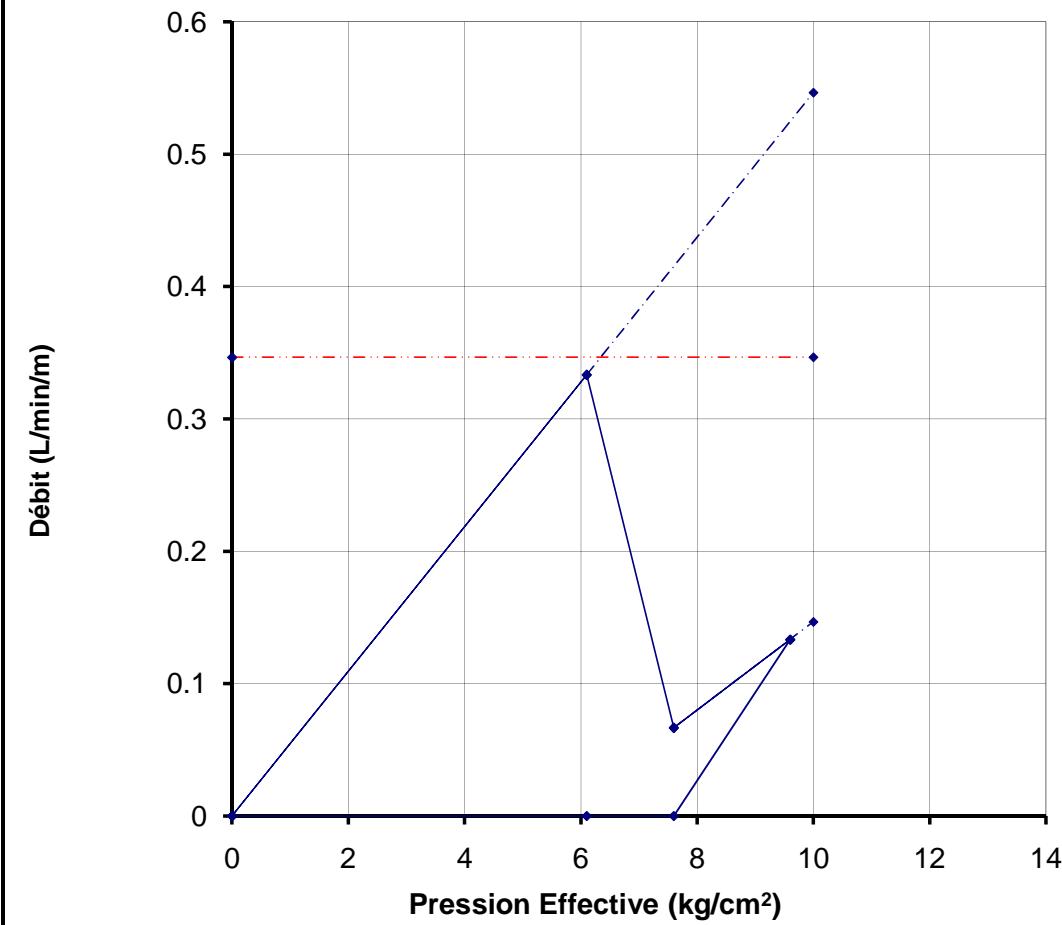


Lugeon = 0.04 L/min/m

SATCON	PROJECT: BISRI DAM / SECOND PACKAGE	Date: 2/20/2014
SONDAGE No.: BH LA 02	TRANCHE ESSAYEE 24.00 m à 27.00 m	Manomètre 0.50 m

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
3.5	10	10	3	1	0.33	2.6	9.90E-04	6.099
5	2	10	3	0.2	0.07	2.6	1.98E-04	7.600
7	4	10	3	0.4	0.13	2.6	3.96E-04	9.600
5	0	10	3	0	0.00	2.6	0.00E+00	7.600
3.5	0	10	3	0	0.00	2.6	0.00E+00	6.100



Lugeon = 0.35 L/min/m



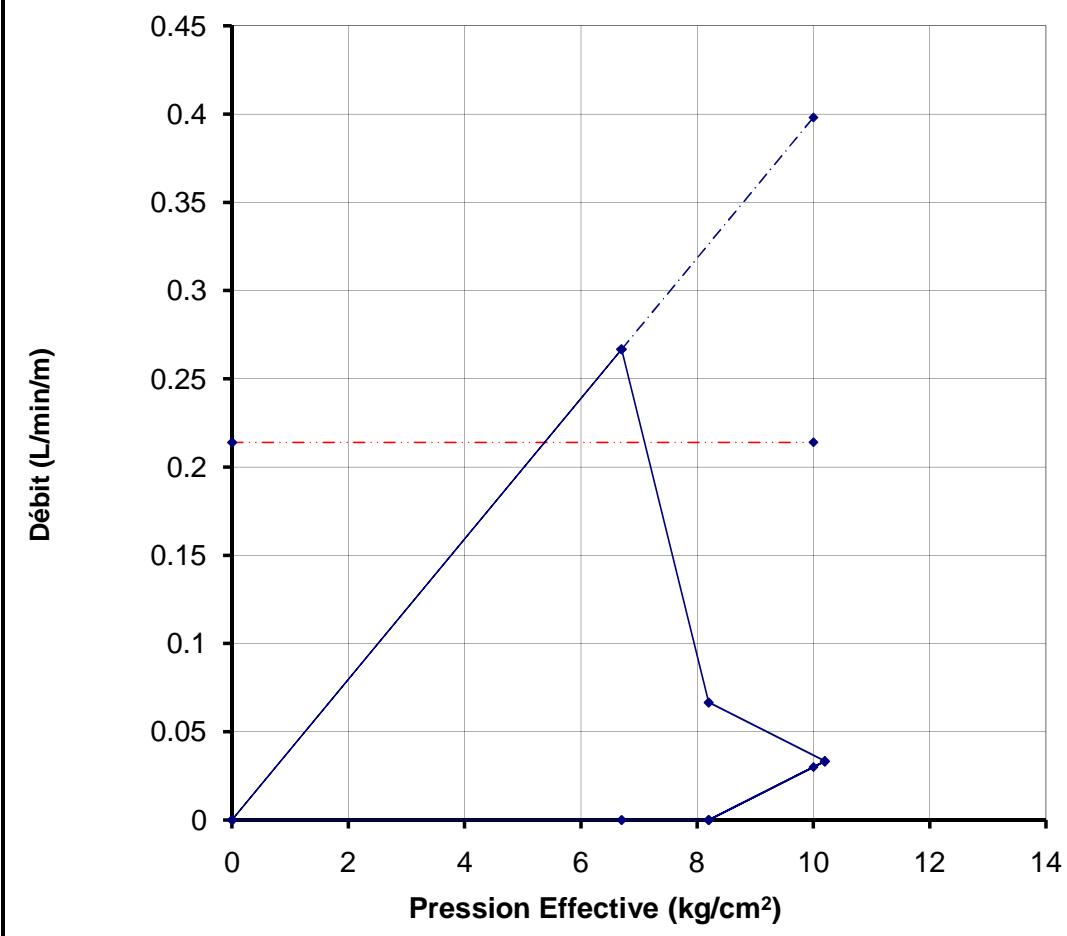
PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BHLA 02**
TRANCHE ESSAYEE **30.00 m à 33.00 m**

Date: **2/20/2014**
Manomètre **0.50 m**

depth to water:

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
3.5	8	10	3	0.8	0.27	3.2	7.92E-04	6.699
5	2	10	3	0.2	0.07	3.2	1.98E-04	8.200
7	1	10	3	0.1	0.03	3.2	9.90E-05	10.200
5	0	10	3	0	0.00	3.2	0.00E+00	8.200
3.5	0	10	3	0	0.00	3.2	0.00E+00	6.700



Lugeon = 0.21 L/min/m



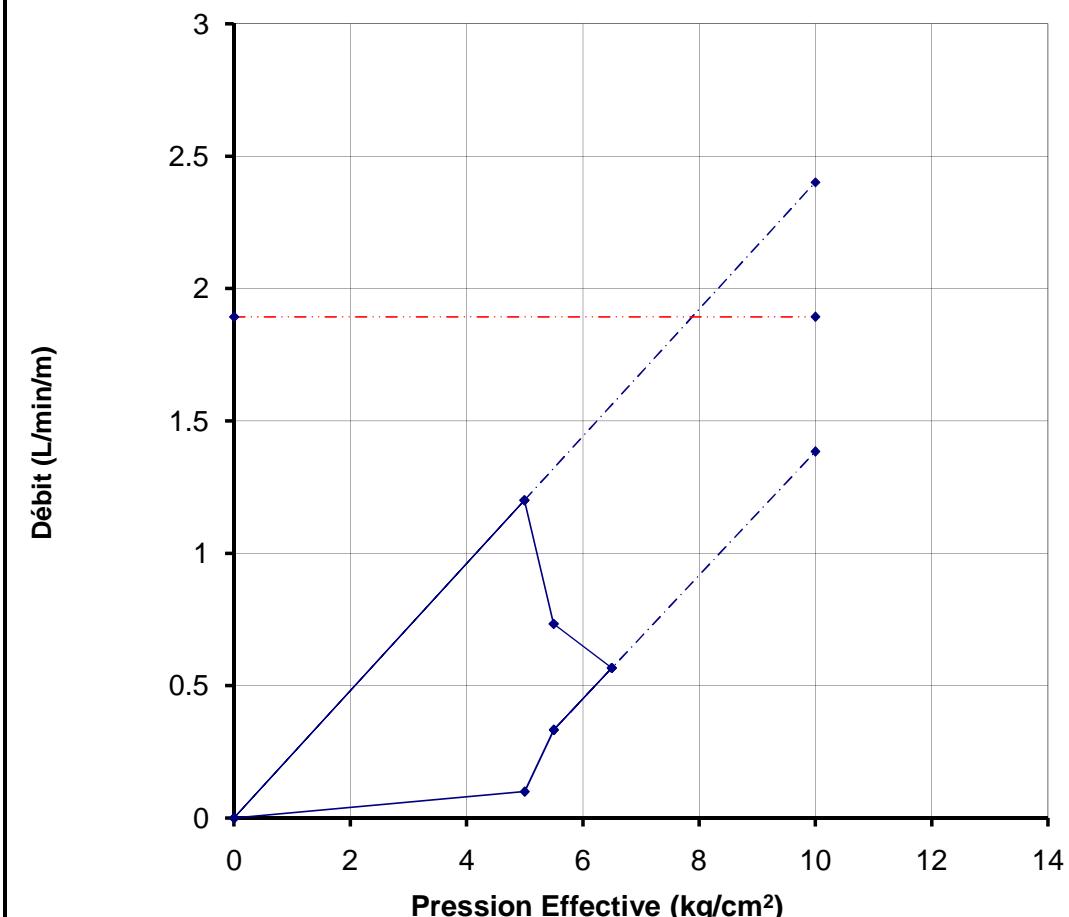
PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BH LA 02**
TRANCHE ESSAYEE **33.00 m à 36.00 m**

Date: **2/20/2014**
Manomètre **0.50 m**

depth to water:

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
1.5	36	10	3	3.6	1.20	3.5	3.56E-03	4.996
2	22	10	3	2.2	0.73	3.5	2.18E-03	5.498
3	17	10	3	1.7	0.57	3.5	1.68E-03	6.498
2	10	10	3	1	0.33	3.5	9.90E-04	5.499
1.5	3	10	3	0.3	0.10	3.5	2.97E-04	5.000



Lugeon = 1.89 L/min/m



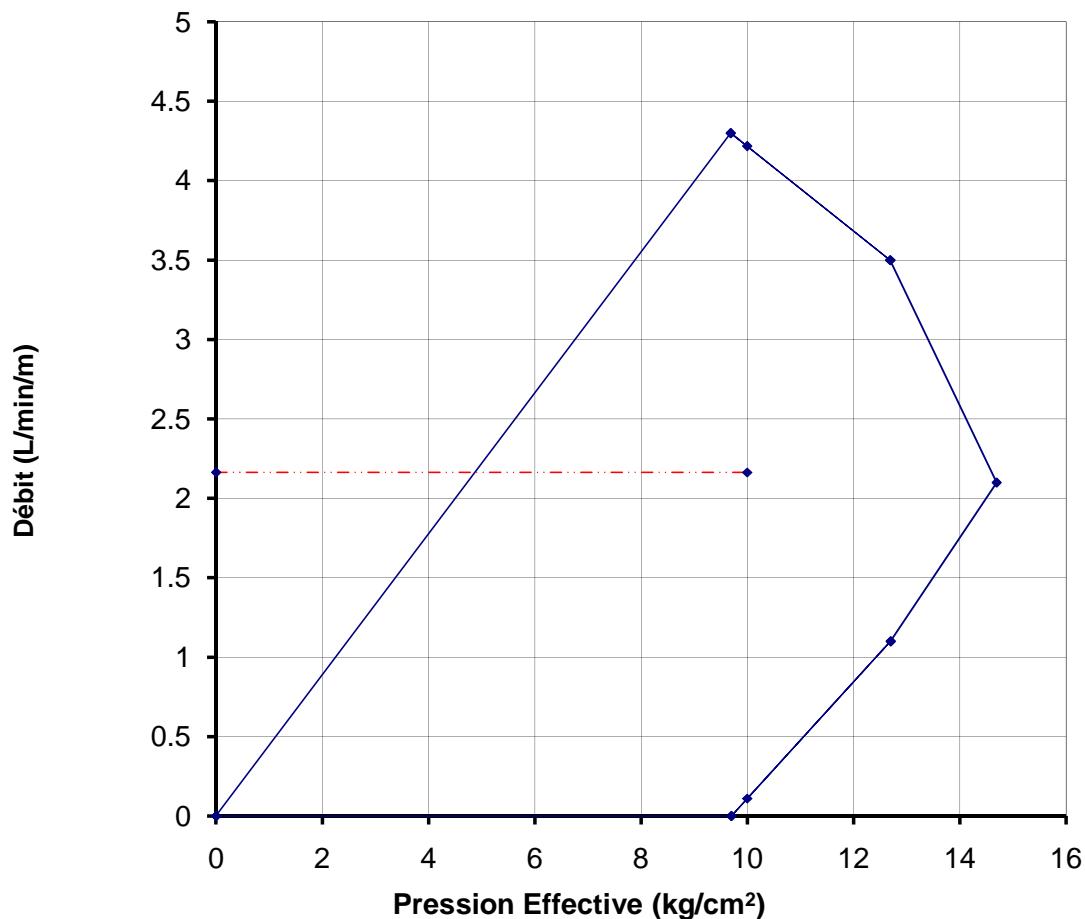
PROJECT:	BISRI DAM / SECOND PACKAGE		
SONDAGE No.:	BHLA 02		
TRANCHE ESSAYEE	45.00 m	à	48.00 m

Date: 2/21/2014

depth to water:

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) $P - J + \Delta H$
5	129	10	3	12.9	4.30	4.7	1.28E-02	9.687
8	105	10	3	10.5	3.50	4.7	1.04E-02	12.690
10	63	10	3	6.3	2.10	4.7	6.24E-03	14.694
8	33	10	3	3.3	1.10	4.7	3.27E-03	12.697
5	0	10	3	0	0.00	4.7	0.00E+00	9.700



Lugeon = 2.16 L/min/m



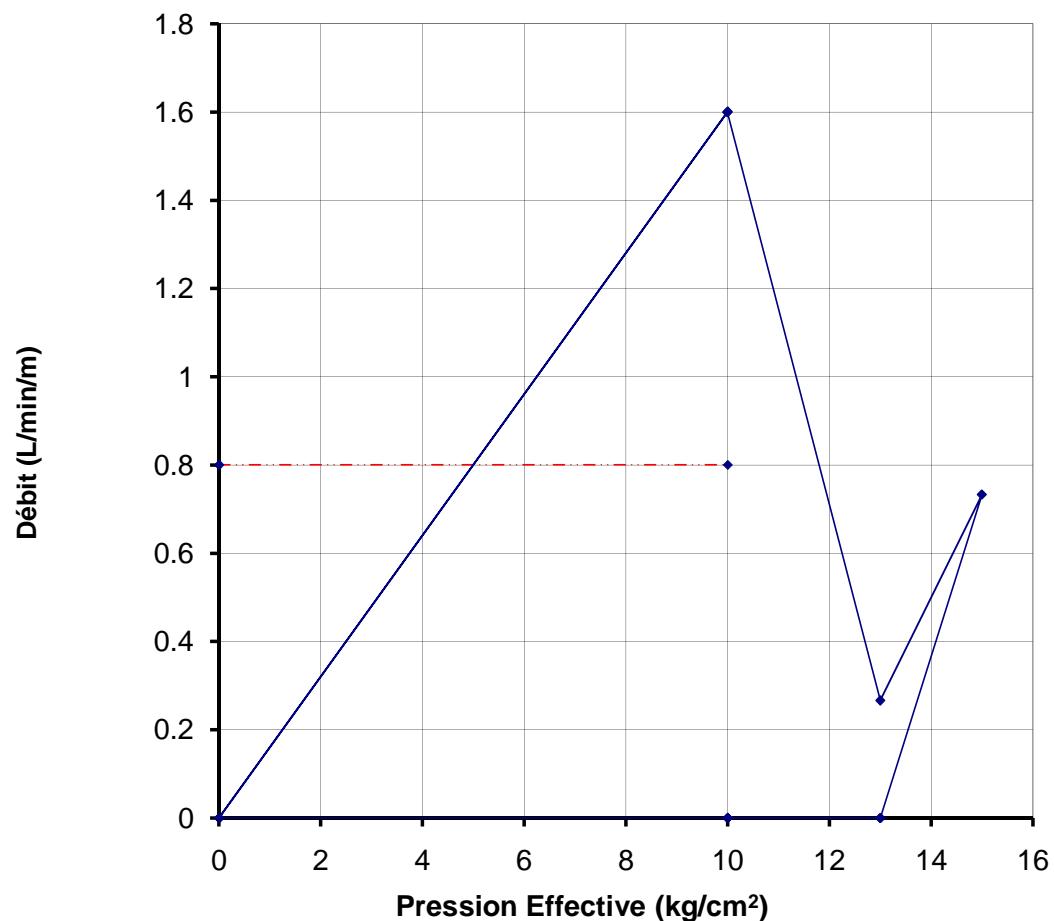
PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BHLA 02**
TRANCHE ESSAYEE **48.00 m à 51.00 m**

Date: **2/22/2014**
Manomètre **0.50 m**

depth to water:

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
5	48	10	3	4.8	1.60	5	4.75E-03	9.995
8	8	10	3	0.8	0.27	5	7.92E-04	12.999
10	22	10	3	2.2	0.73	5	2.18E-03	14.998
8	0	10	3	0	0.00	5	0.00E+00	13.000
5	0	10	3	0	0.00	5	0.00E+00	10.000



Lugeon = 0.80 L/min/m



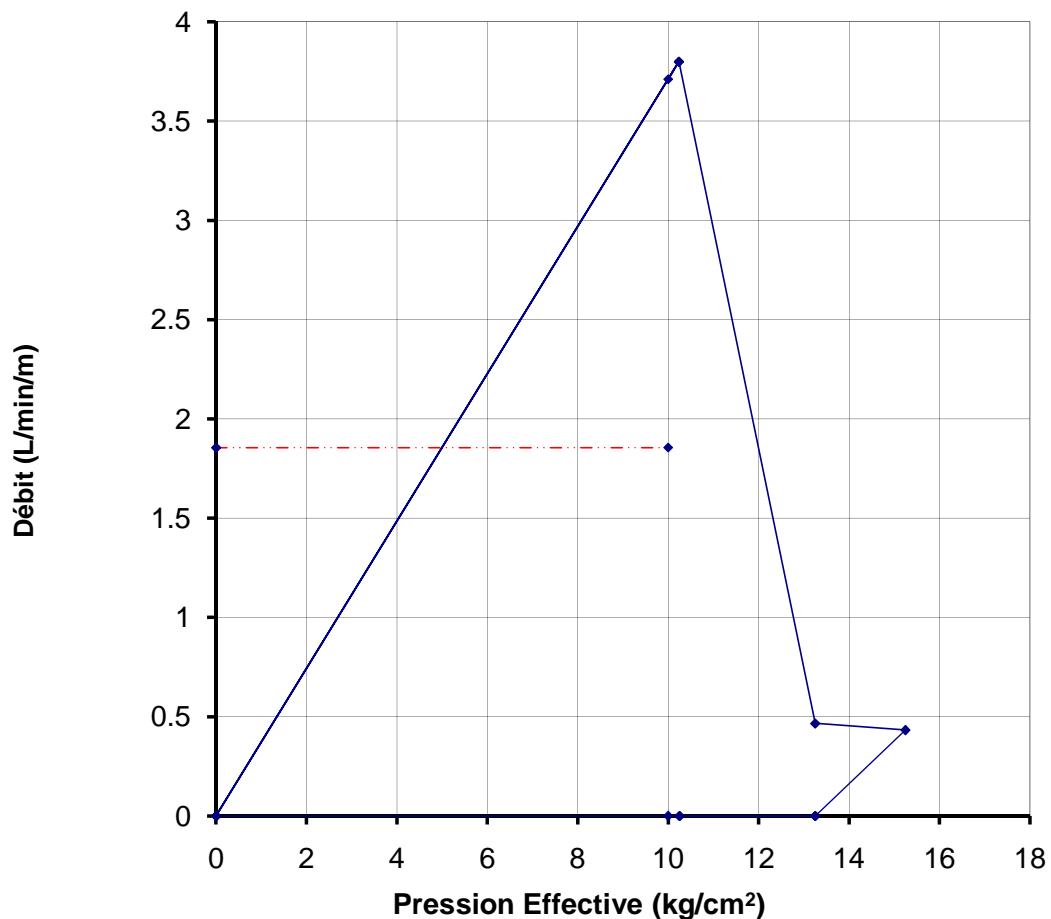
PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BH LA 02**
TRANCHE ESSAYEE **51.00 m à 54.00 m**

Date: **2/22/2014**
Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
5	114	10	3	11.4	3.80	5.25	1.13E-02	10.239
8	14	10	3	1.4	0.47	5.25	1.39E-03	13.249
10	13	10	3	1.3	0.43	5.25	1.29E-03	15.249
8	0	10	3	0	0.00	5.25	0.00E+00	13.250
5	0	10	3	0	0.00	5.25	0.00E+00	10.250



Lugeon = 1.86 L/min/m



PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BH LA 02**
TRANCHE ESSAYEE **60.00 m à 63.00 m**

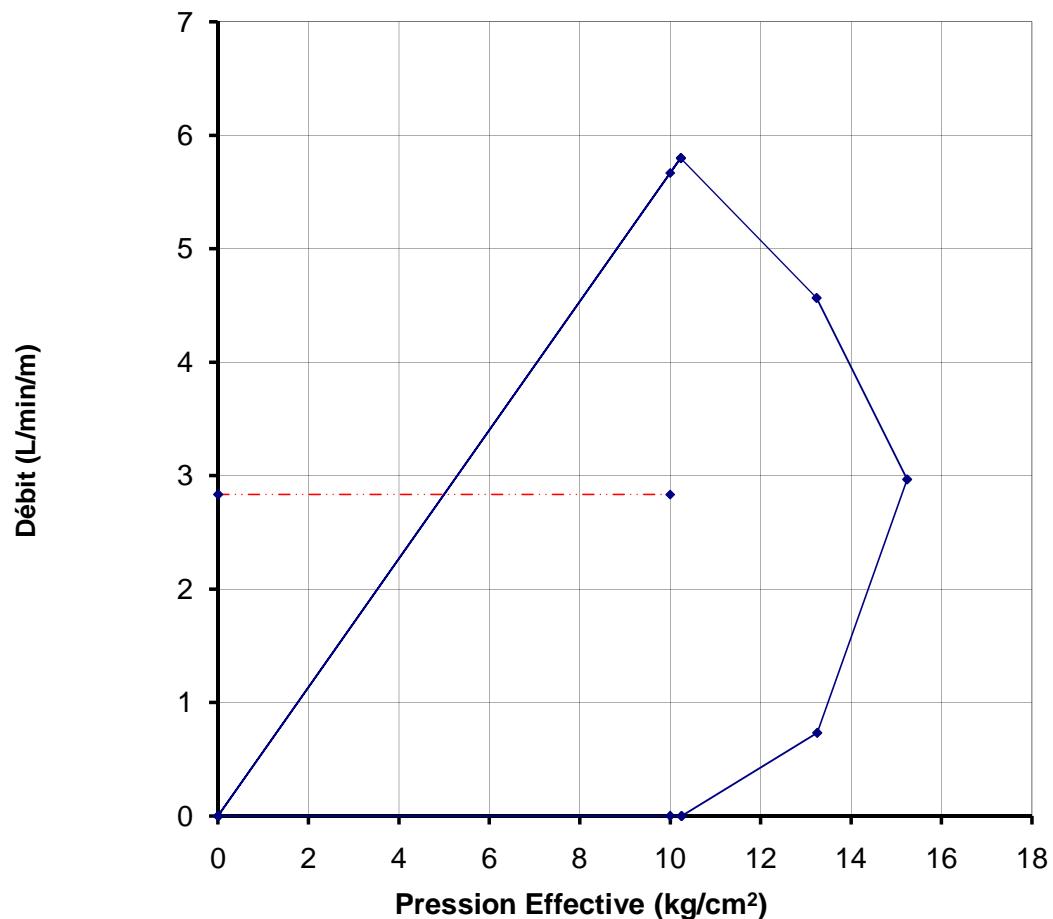
Date: **2/27/2014**

Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
5	174	10	3	17.4	5.80	5.25	1.72E-02	10.233
8	137	10	3	13.7	4.57	5.25	1.36E-02	13.236
10	89	10	3	8.9	2.97	5.25	8.81E-03	15.241
8	22	10	3	2.2	0.73	5.25	2.18E-03	13.248
5	0	10	3	0	0.00	5.25	0.00E+00	10.250



Lugeon = 2.83 L/min/m



PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BH LA 02**
TRANCHE ESSAYEE **63.00 m à 66.00 m**

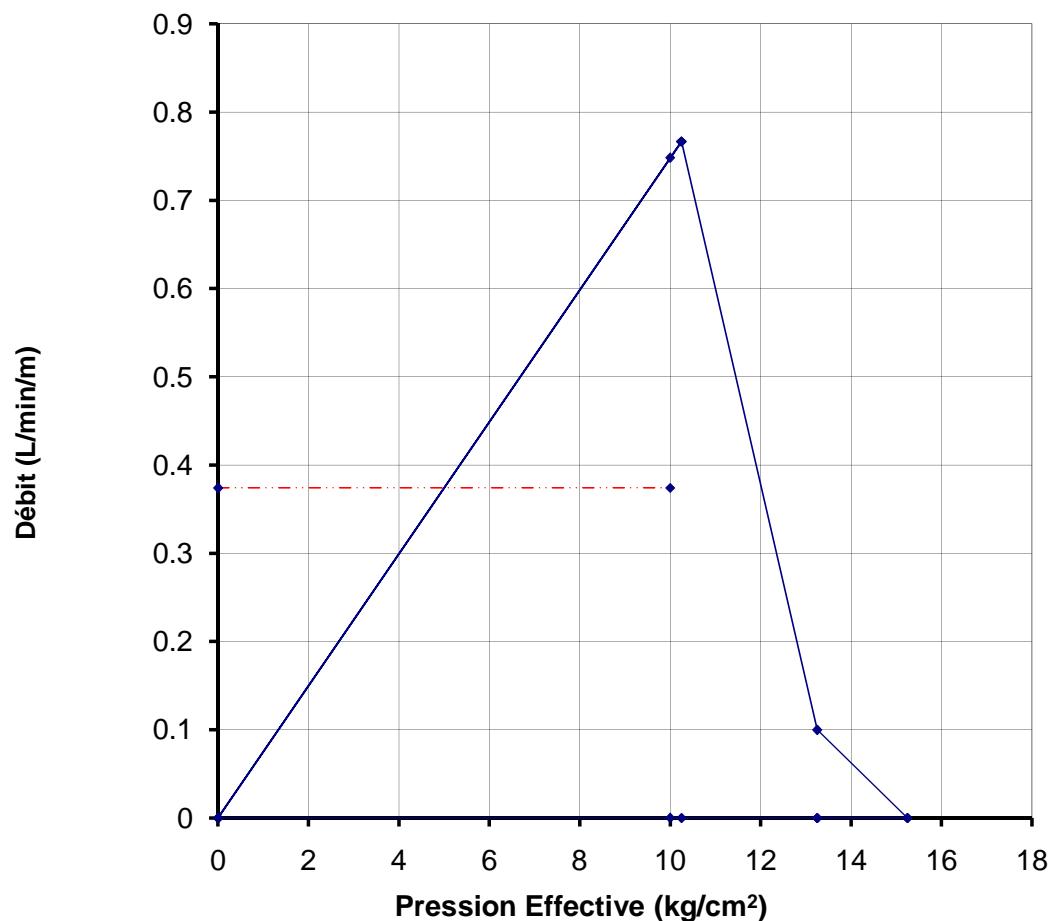
Date: **2/27/2014**

Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
5	23	10	3	2.3	0.77	5.25	2.28E-03	10.248
8	3	10	3	0.3	0.10	5.25	2.97E-04	13.250
10	0	10	3	0	0.00	5.25	0.00E+00	15.250
8	0	10	3	0	0.00	5.25	0.00E+00	13.250
5	0	10	3	0	0.00	5.25	0.00E+00	10.250



Lugeon = 0.37 L/min/m



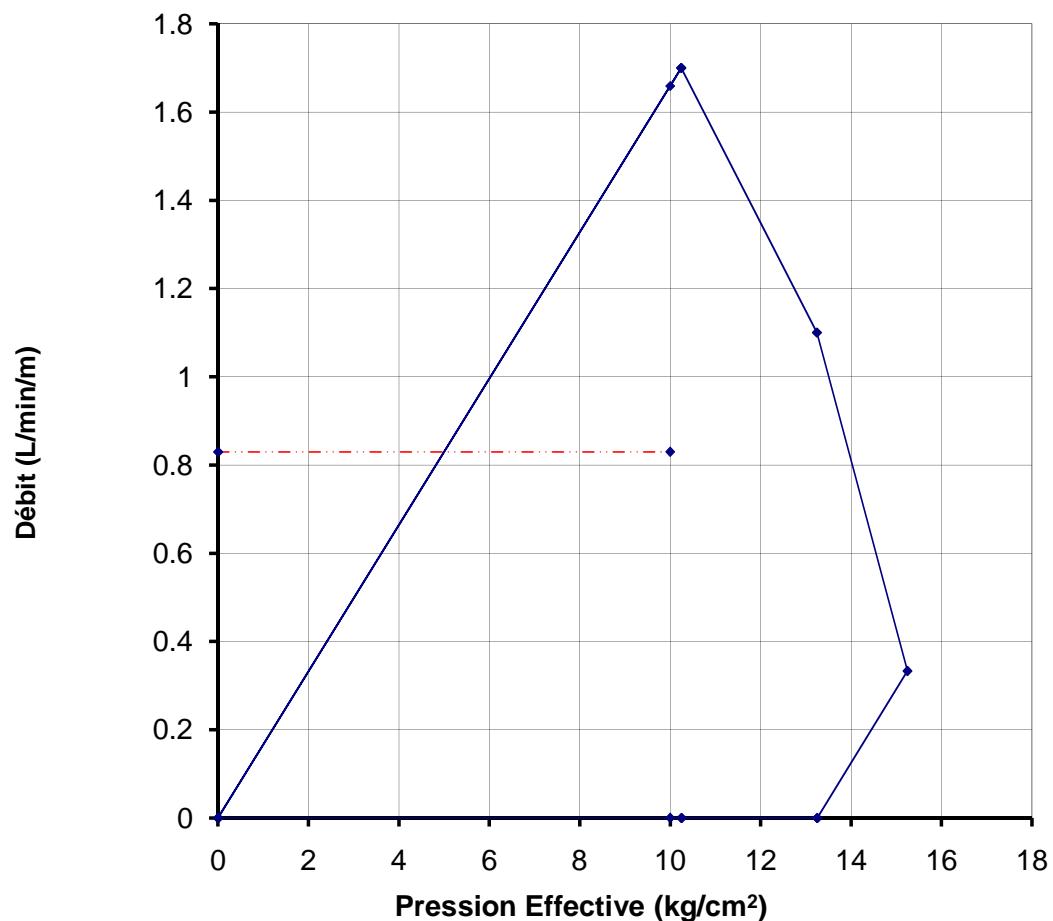
PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BHLA 02**
TRANCHE ESSAYEE **66.00 m à 69.00 m**

Date: **2/28/2014**
Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
5	51	10	3	5.1	1.70	5.25	5.05E-03	10.245
8	33	10	3	3.3	1.10	5.25	3.27E-03	13.247
10	10	10	3	1	0.33	5.25	9.90E-04	15.249
8	0	10	3	0	0.00	5.25	0.00E+00	13.250
5	0	10	3	0	0.00	5.25	0.00E+00	10.250



Lugeon = 0.83 L/min/m



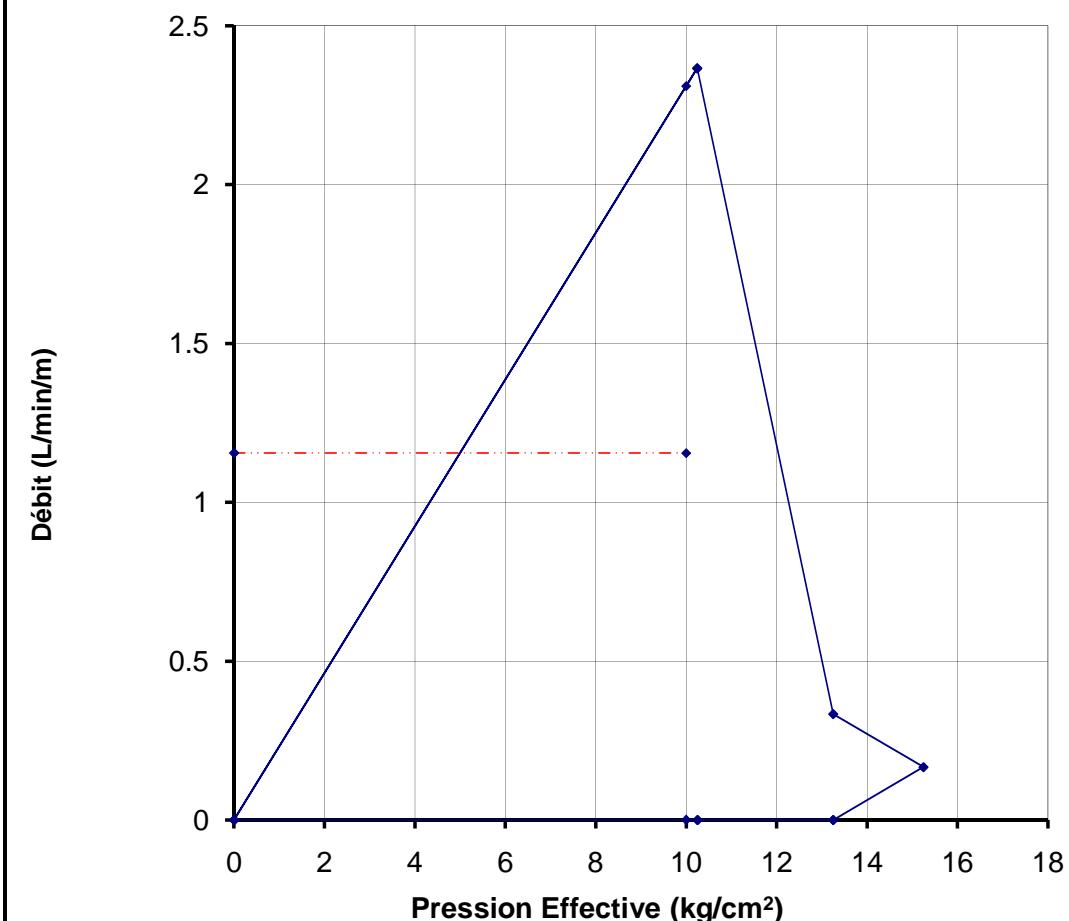
PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BHLA 02**
TRANCHE ESSAYEE **69.00 m à 72.00 m**

Date: **2/28/2014**
Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
5	71	10	3	7.1	2.37	5.25	7.03E-03	10.243
8	10	10	3	1	0.33	5.25	9.90E-04	13.249
10	5	10	3	0.5	0.17	5.25	4.95E-04	15.250
8	0	10	3	0	0.00	5.25	0.00E+00	13.250
5	0	10	3	0	0.00	5.25	0.00E+00	10.250

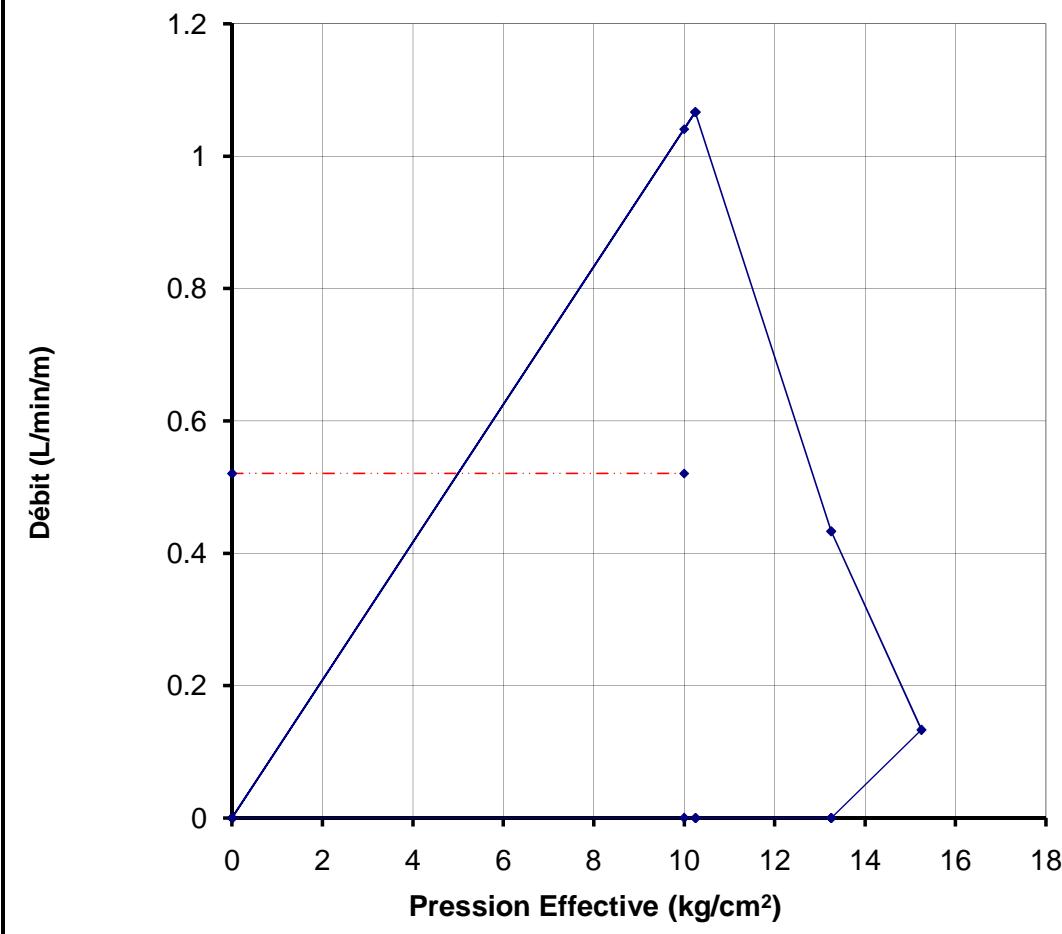


Lugeon = 1.16 L/min/m

SATCON	PROJECT: BISRI DAM / SECOND PACKAGE	Date: 2/28/2014
SONDAGE No.: BH LA 02		
TRANCHE ESSAYEE 72.00 m à 75.00 m	Manomètre 0.50 m	
		depth to water: 52.00 m

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
5	32	10	3	3.2	1.07	5.25	3.17E-03	10.247
8	13	10	3	1.3	0.43	5.25	1.29E-03	13.249
10	4	10	3	0.4	0.13	5.25	3.96E-04	15.250
8	0	10	3	0	0.00	5.25	0.00E+00	13.250
5	0	10	3	0	0.00	5.25	0.00E+00	10.250



Lugeon = 0.52 L/min/m



PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BHLA 02**
TRANCHE ESSAYEE **75.00 m à 78.00 m**

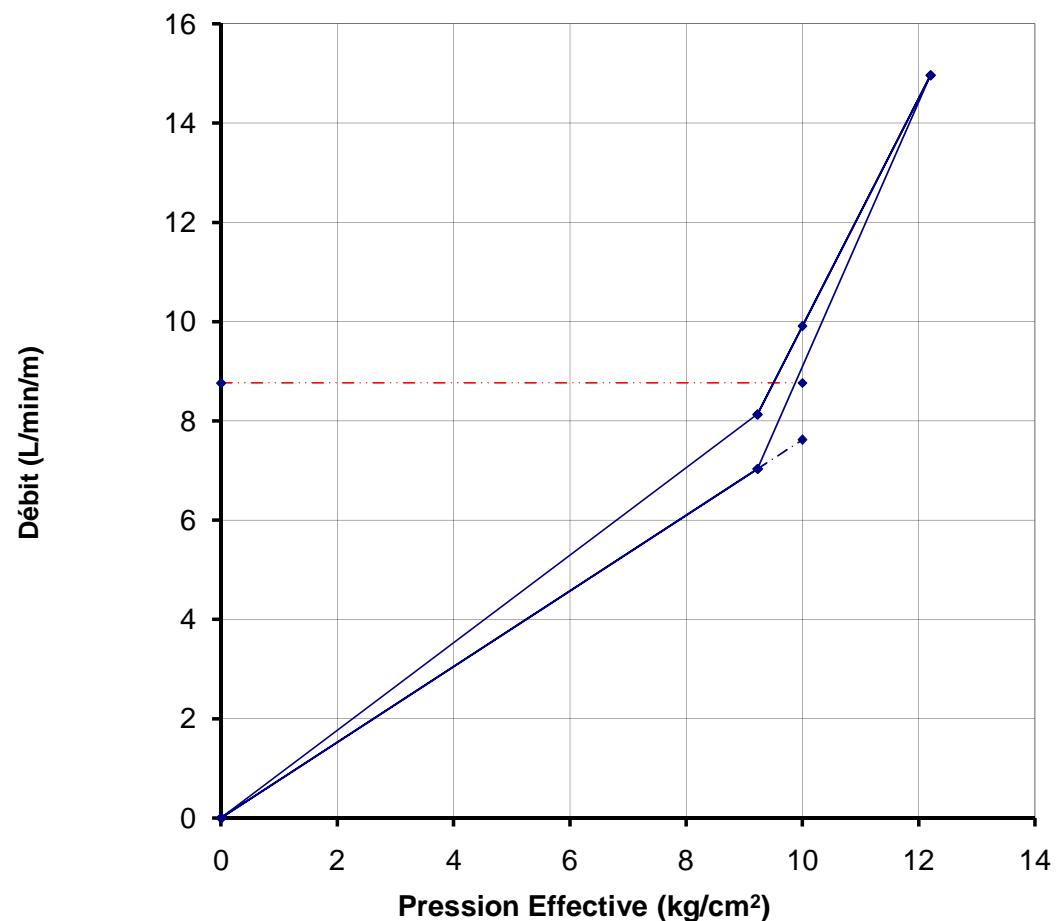
Date: **3/1/2014**

Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
4	211	10	3	21.1	7.03	5.25	2.09E-02	9.229
7	449	10	3	44.9	14.97	5.25	4.45E-02	12.206
4	244	10	3	24.4	8.13	5.25	2.42E-02	9.226



Lugeon = **8.76 L/min/m**



PROJECT: BISRI DAM / SECOND PACKAGE
SONDAGE No.: BHLA 02
TRANCHE ESSAYEE 78.00 m à 81.00 m

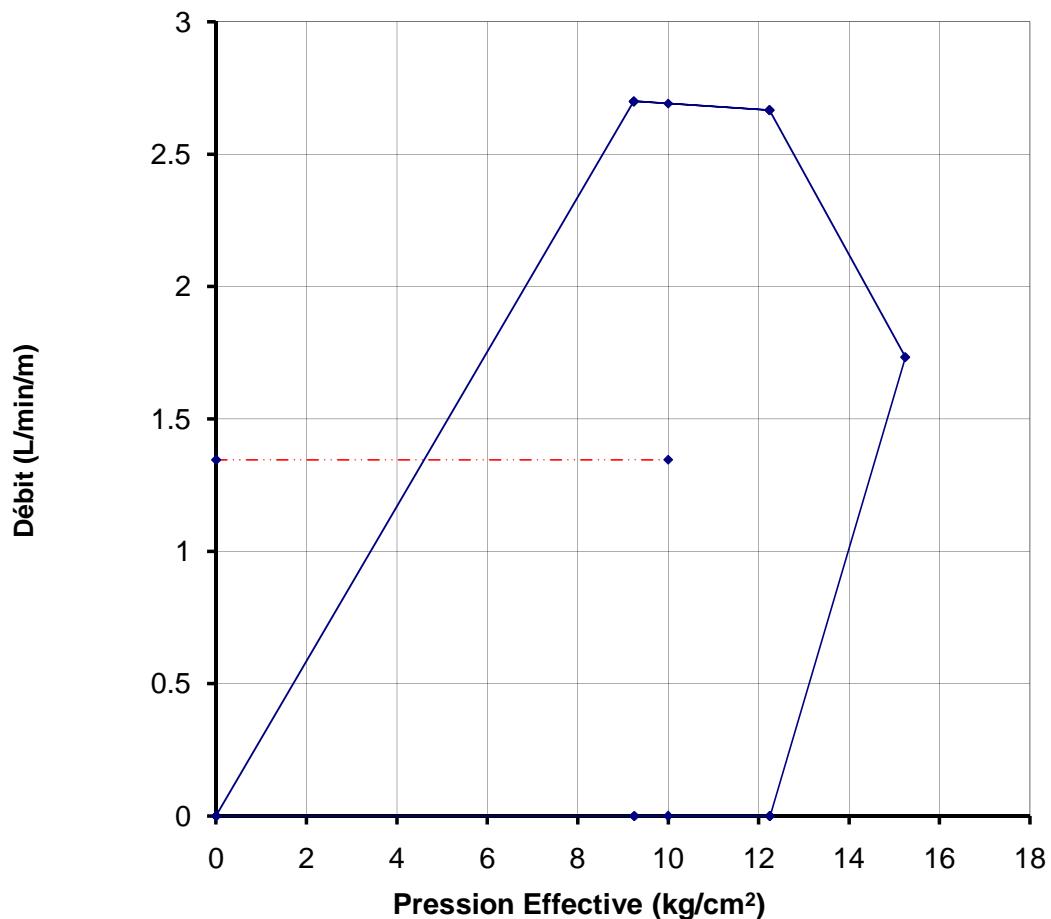
Date: 3/1/2014

Manomètre 0.50 m

depth to water: 52.00 m

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) $P - J + \Delta H$
4	81	10	3	8.1	2.70	5.25	8.02E-03	9.242
7	80	10	3	8	2.67	5.25	7.92E-03	12.242
10	52	10	3	5.2	1.73	5.25	5.15E-03	15.245
7	0	10	3	0	0.00	5.25	0.00E+00	12.250
4	0	10	3	0	0.00	5.25	0.00E+00	9.250



Lugeon = 1.35 L/min/m



PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BH LA 02**
TRANCHE ESSAYEE **81.00 m à 84.00 m**

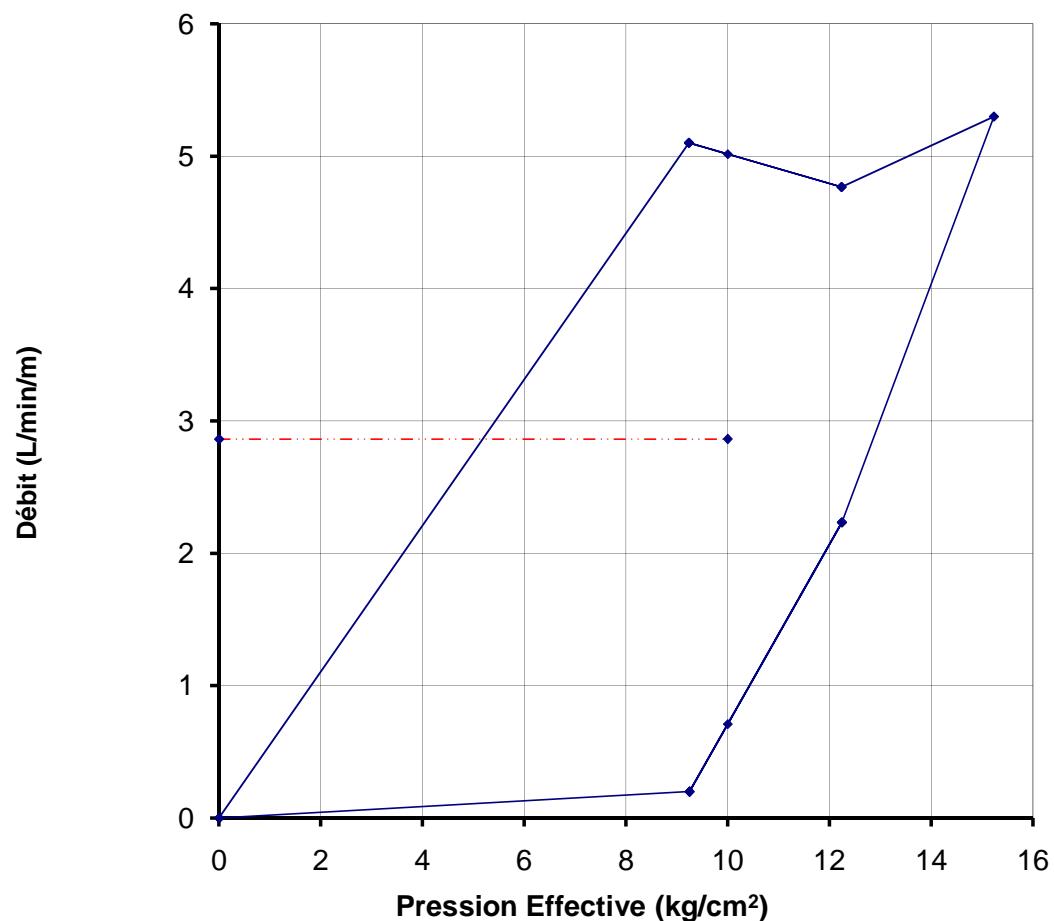
Date: **3/3/2014**

Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
4	153	10	3	15.3	5.10	5.25	1.51E-02	9.235
7	143	10	3	14.3	4.77	5.25	1.42E-02	12.236
10	159	10	3	15.9	5.30	5.25	1.57E-02	15.234
7	67	10	3	6.7	2.23	5.25	6.63E-03	12.243
4	6	10	3	0.6	0.20	5.25	5.94E-04	9.249



Lugeon = 2.86 L/min/m



PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BH LA 02**
TRANCHE ESSAYEE **84.00 m à 87.00 m**

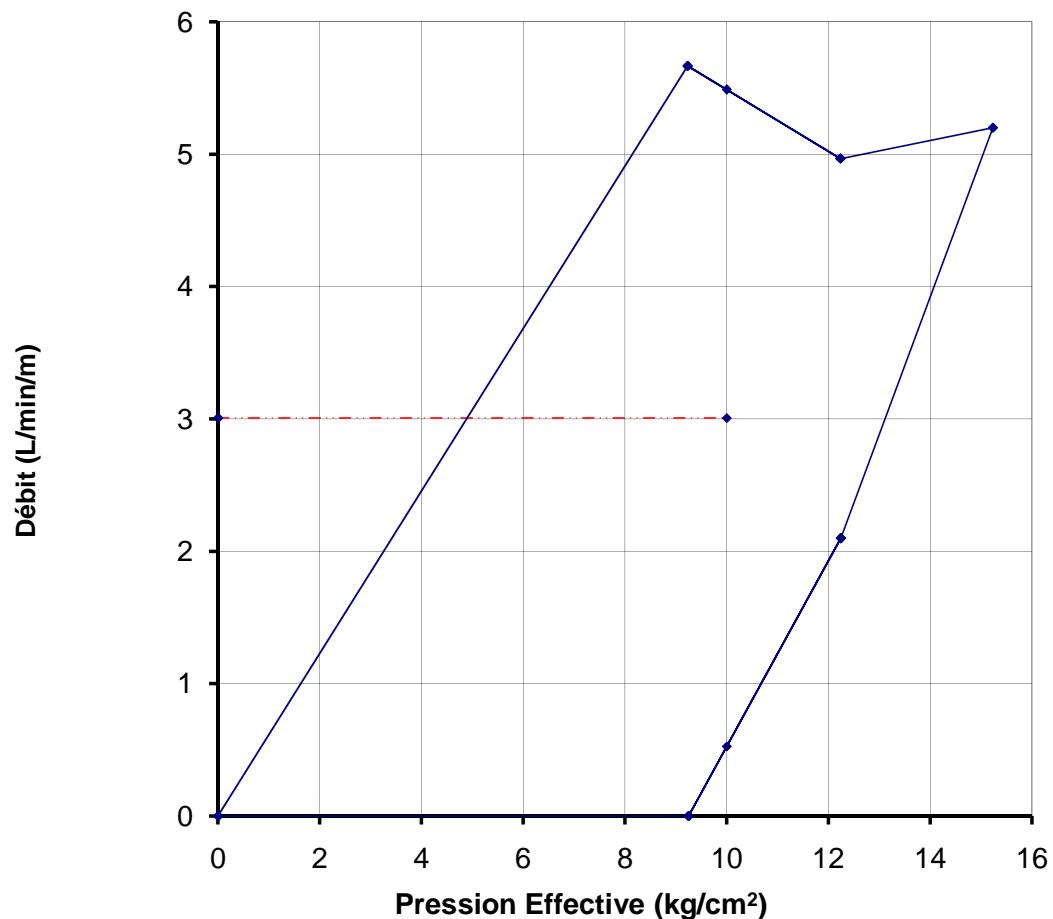
Date: **3/3/2014**

Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
4	170	10	3	17	5.67	5.25	1.68E-02	9.233
7	149	10	3	14.9	4.97	5.25	1.48E-02	12.235
10	156	10	3	15.6	5.20	5.25	1.54E-02	15.235
7	63	10	3	6.3	2.10	5.25	6.24E-03	12.244
4	0	10	3	0	0.00	5.25	0.00E+00	9.250

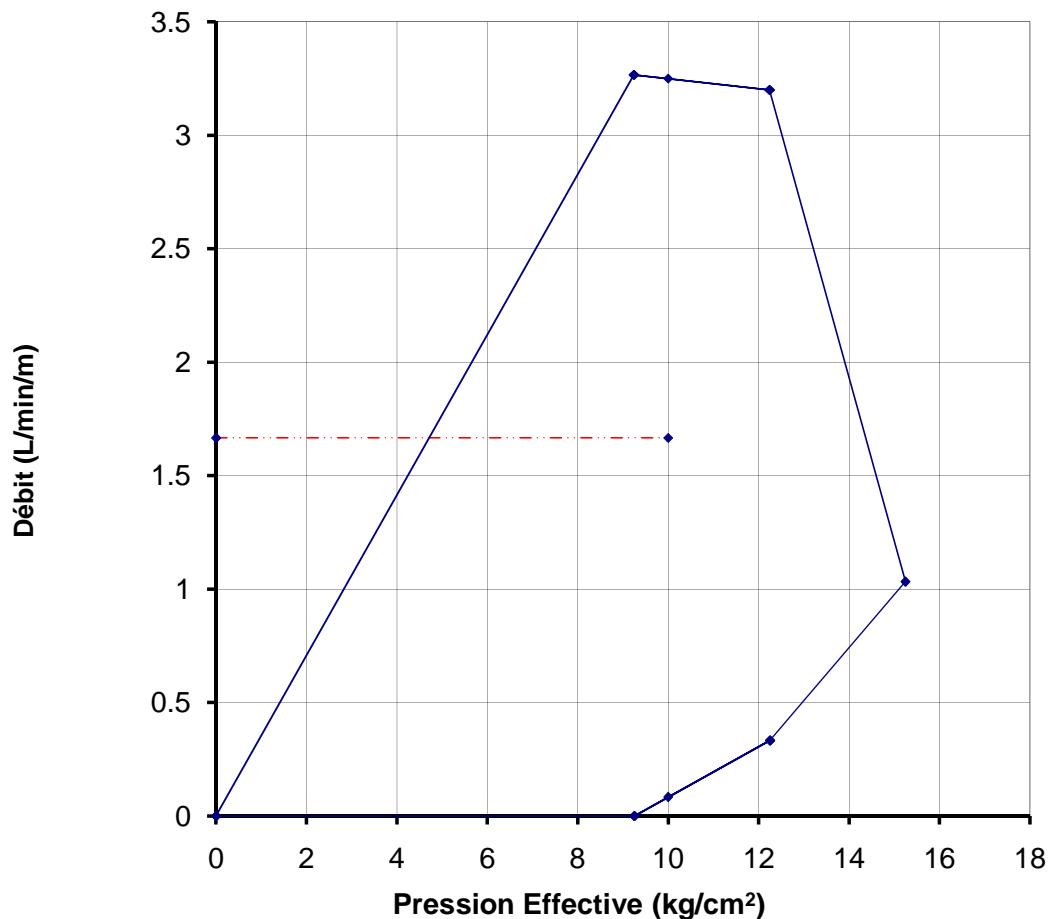


Lugeon = **3.01 L/min/m**

SATCON	PROJECT: BISRI DAM / SECOND PACKAGE	Date: 3/4/2014
SONDAGE No.: BH LA 02		
TRANCHE ESSAYEE 87.00 m	à	90.00 m
Manomètre 0.50 m		
depth to water: 52.00 m		

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
4	98	10	3	9.8	3.27	5.25	9.70E-03	9.240
7	96	10	3	9.6	3.20	5.25	9.50E-03	12.240
10	31	10	3	3.1	1.03	5.25	3.07E-03	15.247
7	10	10	3	1	0.33	5.25	9.90E-04	12.249
4	0	10	3	0	0.00	5.25	0.00E+00	9.250



Lugeon = 1.67 L/min/m



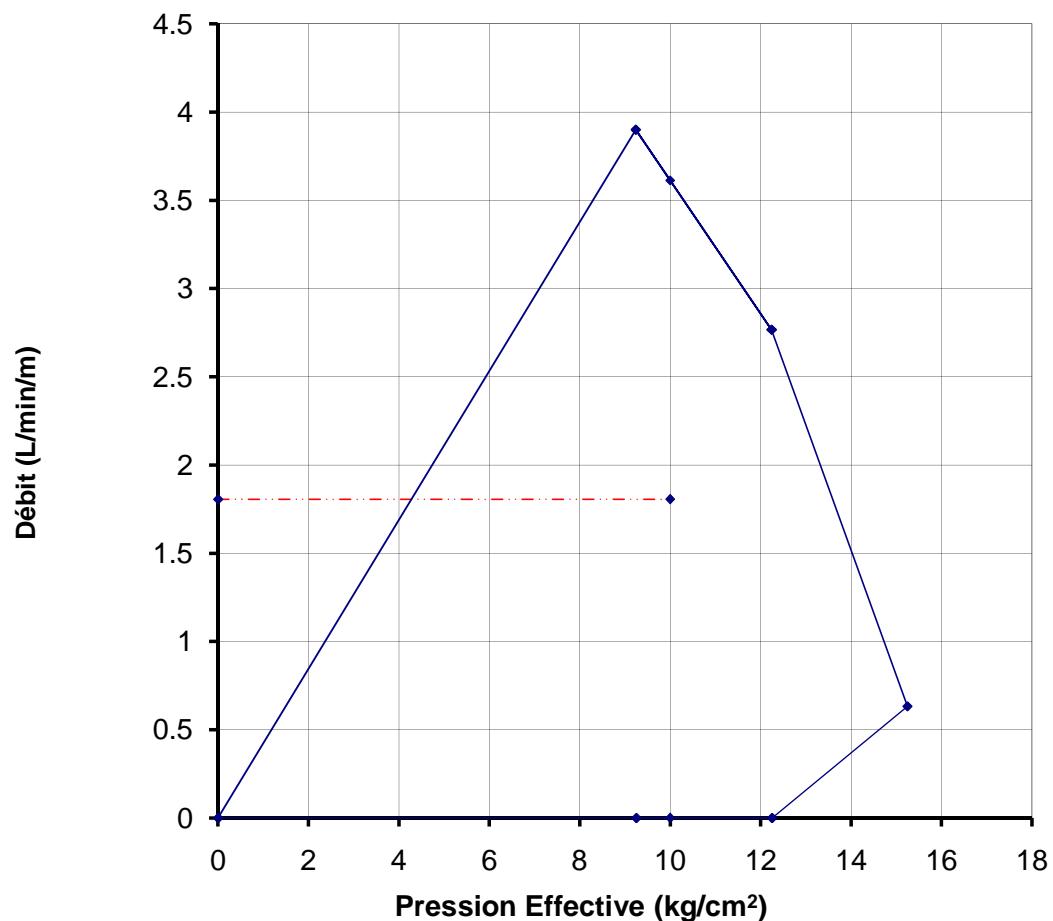
PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BHLA 02**
TRANCHE ESSAYEE **90.00 m à 93.00 m**

Date: **3/5/2014**
Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
4	117	10	3	11.7	3.90	5.25	1.16E-02	9.238
7	83	10	3	8.3	2.77	5.25	8.22E-03	12.242
10	19	10	3	1.9	0.63	5.25	1.88E-03	15.248
7	0	10	3	0	0.00	5.25	0.00E+00	12.250
4	0	10	3	0	0.00	5.25	0.00E+00	9.250



Lugeon = 1.81 L/min/m



PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BHLA 02**
TRANCHE ESSAYEE **93.00 m à 96.00 m**

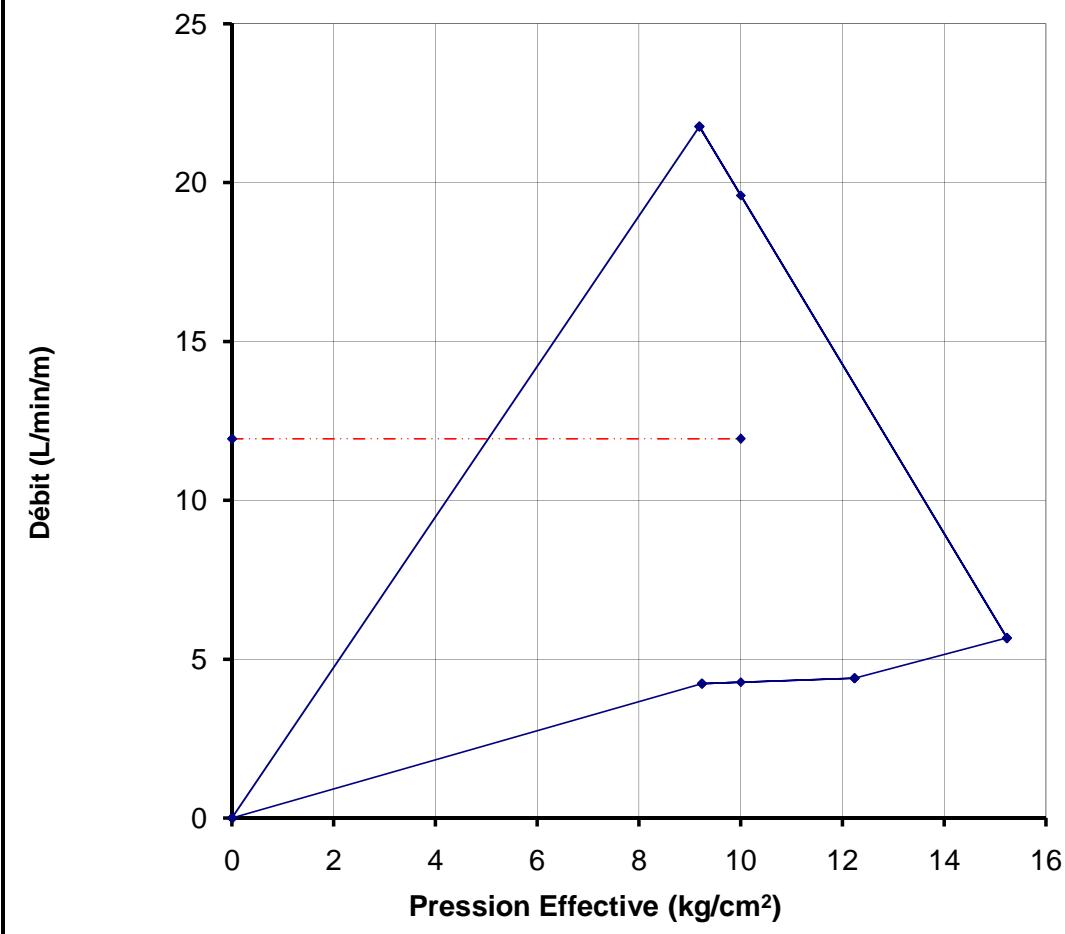
Date: **3/6/2014**

Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
4	127	10	3	12.7	4.23	5.25	1.26E-02	9.237
7	132	10	3	13.2	4.40	5.25	1.31E-02	12.237
10	34	2	3	17	5.67	5.25	1.68E-02	15.233
4	653	10	3	65.3	21.77	5.25	6.46E-02	9.185





PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BHLA 02**
TRANCHE ESSAYEE **96.00 m à 99.00 m**

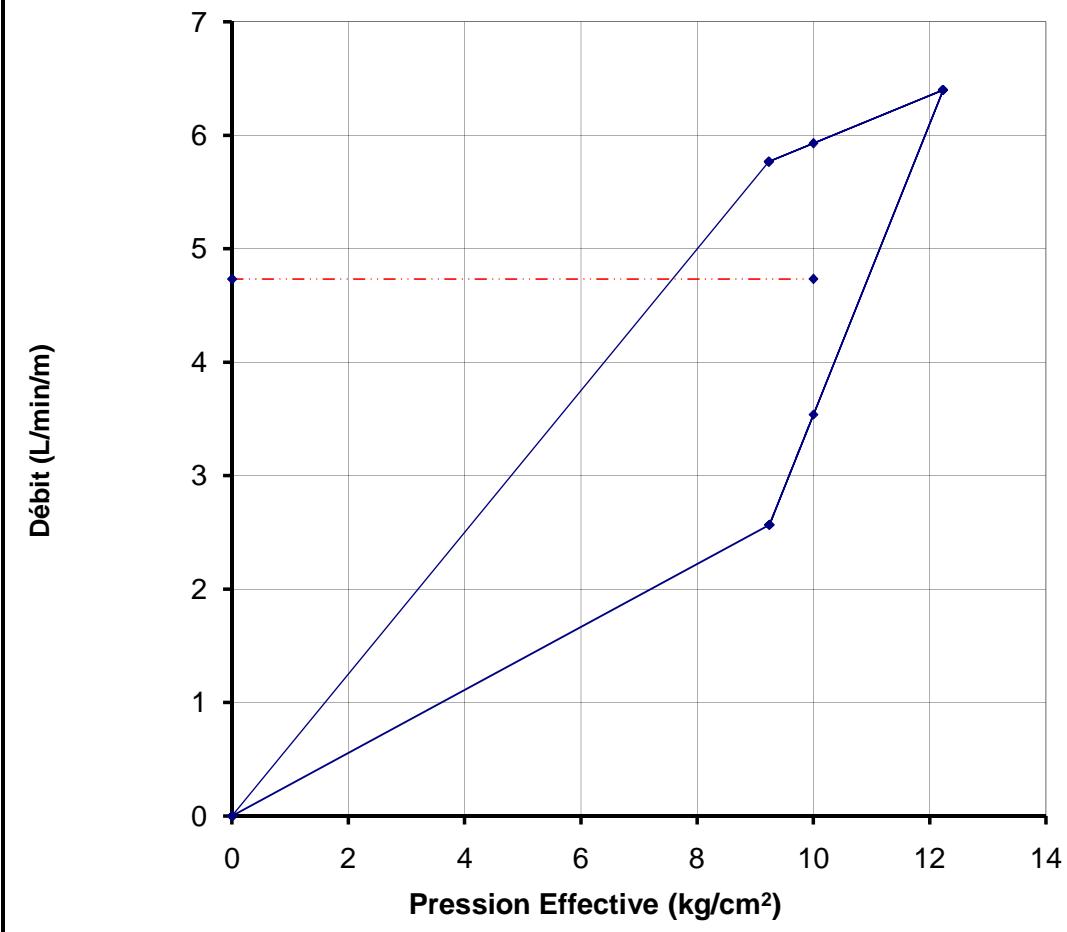
Date: **3/6/2014**

Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
4	173	10	3	17.3	5.77	5.25	1.71E-02	9.233
7	192	10	3	19.2	6.40	5.25	1.90E-02	12.231
4	77	10	3	7.7	2.57	5.25	7.62E-03	9.242



Lugeon = 4.73 L/min/m



PROJECT: **BISRI DAM / SECOND PACKAGE**
SONDAGE No.: **BH LA 02**
TRANCHE ESSAYEE **99.00 m à 102.00 m**

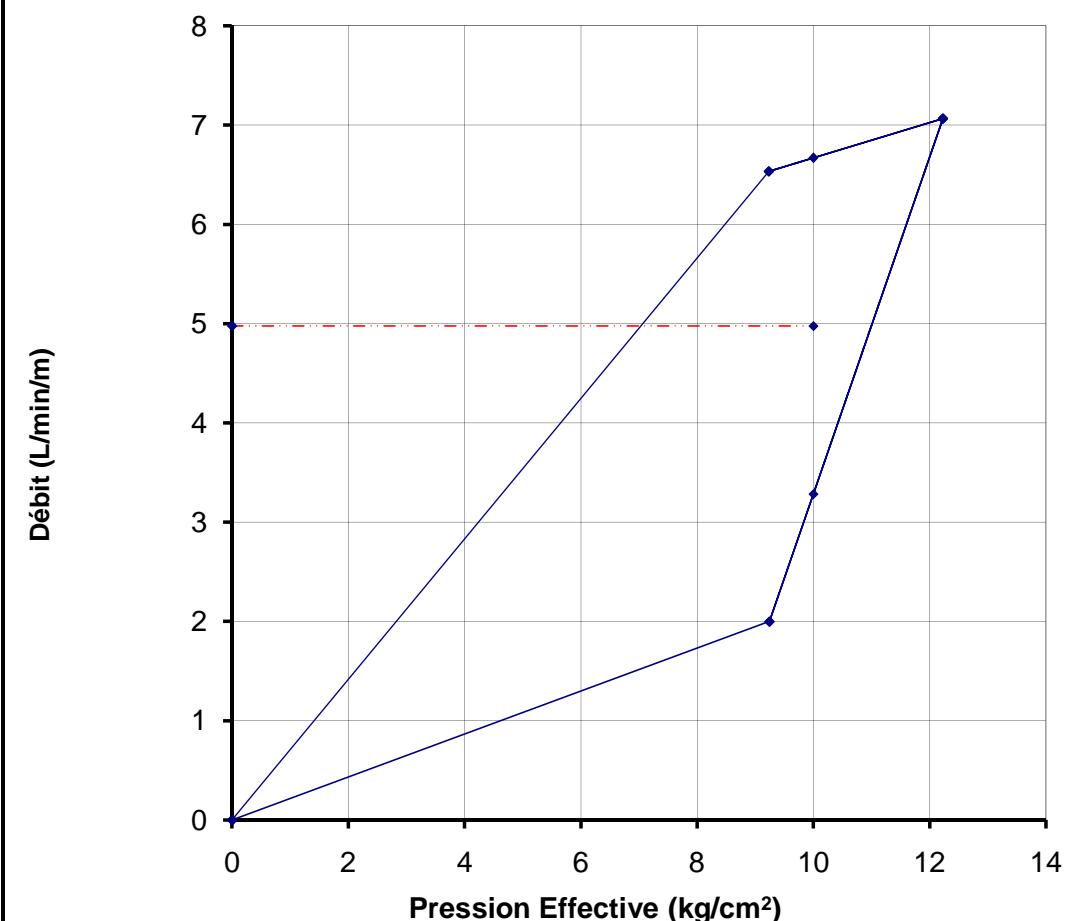
Date: **3/7/2014**

Manomètre **0.50 m**

depth to water: **52.00 m**

ESSAI DE PERMEABILITE LUGEON

Pression de Lecture P (bars)	Eau absorbée en (L)	Durée en (min)	Longueur de Passe en (m)	Débit (L/min)	Débit (L/min/m)	ΔH (bars)	Perte de charge (Bars) J	Pression Effective (bar) P - J + ΔH
4	196	10	3	19.6	6.53	5.25	1.94E-02	9.231
7	212	10	3	21.2	7.07	5.25	2.10E-02	12.229
4	60	10	3	6	2.00	5.25	5.94E-03	9.244



Lugeon = 4.98 L/min/m

APPENDIX 5. DCPT TEST RESULTS



DAR AL HANDASAH NAZIH TALEB & PARTNERS
دار الهندسة نزيه طالب وشريك

Detailed Design Of Bisri Dam: Geo. Inv. Rep.II: (Factual) / Spillway & Bottom Outlet - March 2014



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د/ر الـهـنـدـسـاـتـ الـفـنـيـةـ وـشـرـكـةـ تـصـيـرـ الـسـيـرـاتـ الـفـنـيـةـ

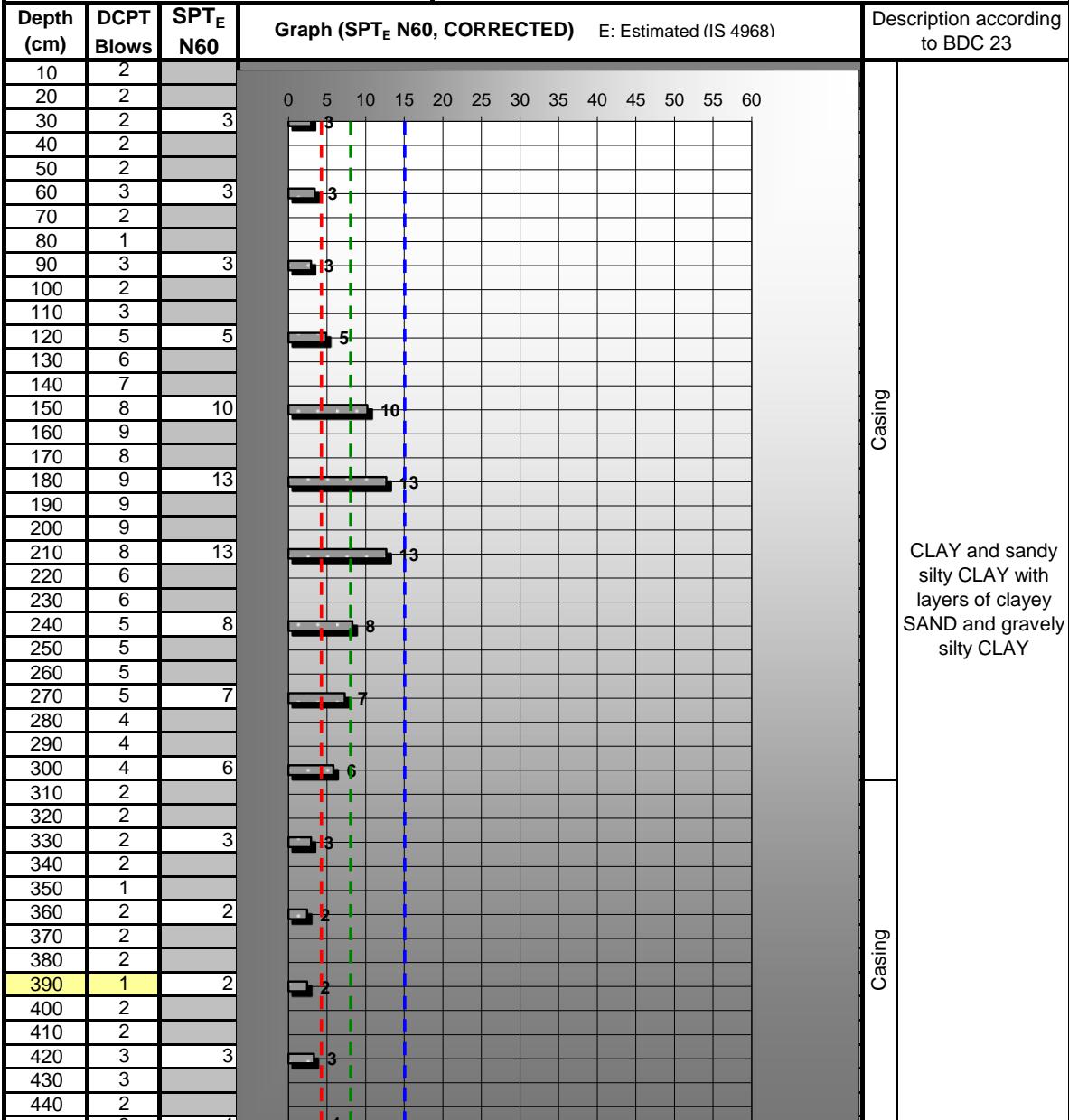
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR8

Client: CDR	Coordinates X: -334525.66 Y: -61788.13 Z: +414.5
Consultant: DAR-TALEB	Depth: 48m Groundwater: +402 (Estimated)
Engineer: E. S. KIRGIZ	C.D. Rod: 45m (HW) / 6m AW & 42m BW H.Dia.: 62.5 to 114mm
Contractor: SATCON Co.	SPT Hammer: Automatic Trip Blow Rate: 36 bpm
Date: From February 18 to February 20, 2014	Anvil: Small (~2Kg) Solid Cone: 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

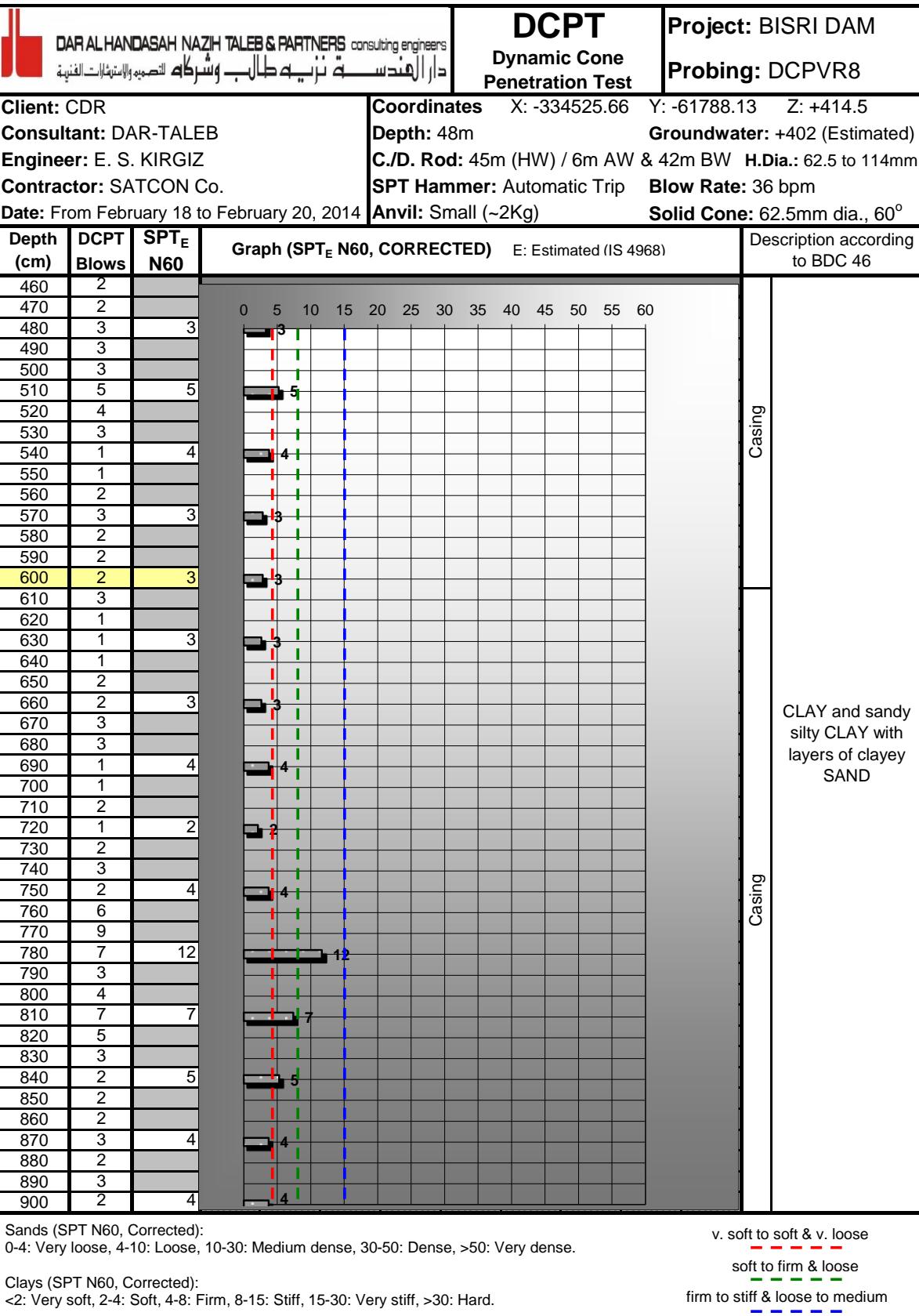
v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium





DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د/ر الـهـنـدـسـةـ نـازـحـ تـالـبـ وـشـرـكـةـ لـلـصـيـادـةـ وـلـلـسـنـافـاتـ الـفـنـيـةـ

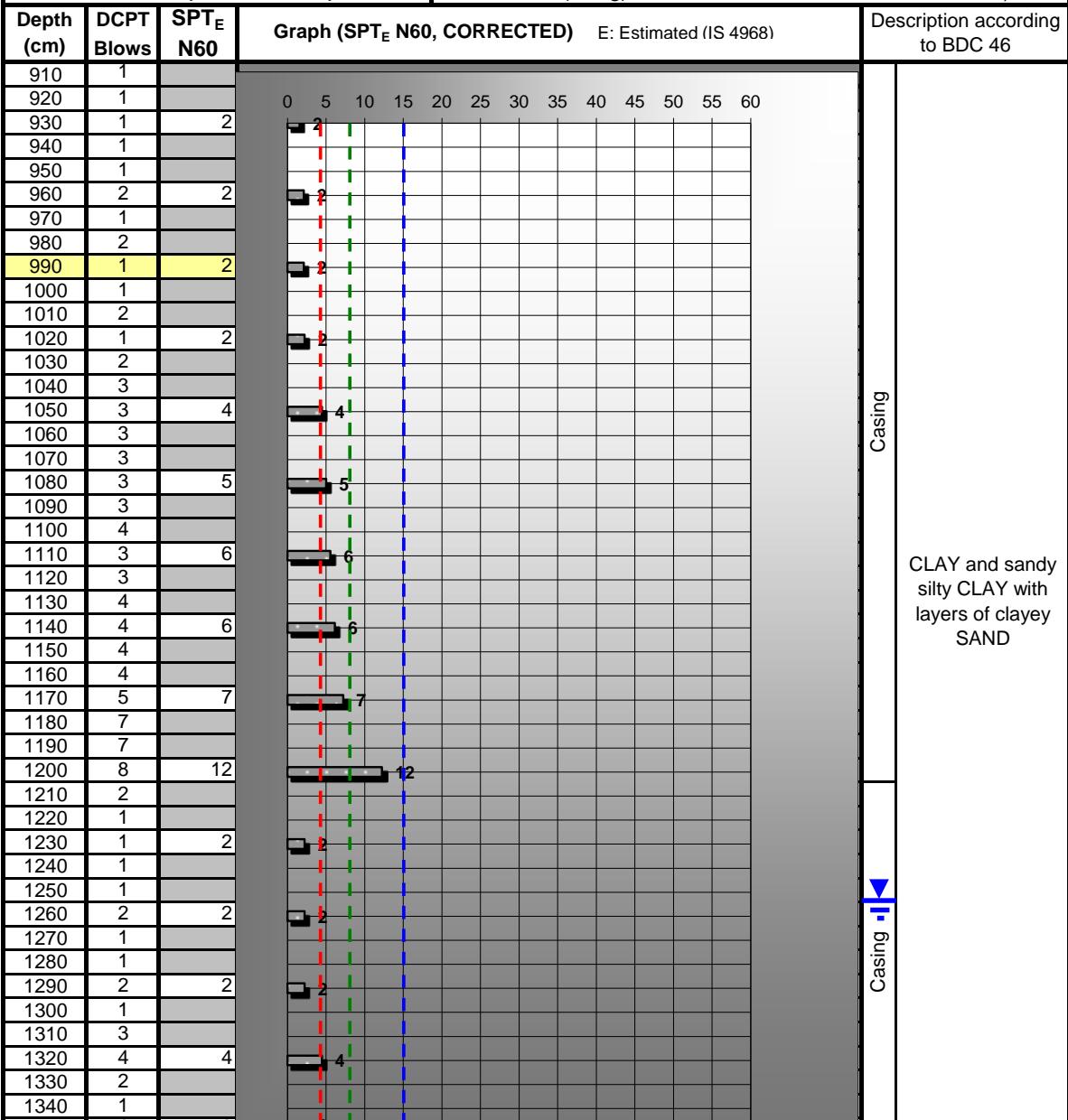
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR8

Client: CDR	Coordinates X: -334525.66 Y: -61788.13 Z: +414.5
Consultant: DAR-TALEB	Depth: 48m Groundwater: +402 (Estimated)
Engineer: E. S. KIRGIZ	C.D. Rod: 45m (HW) / 6m AW & 42m BW H.Dia.: 62.5 to 114mm
Contractor: SATCON Co.	SPT Hammer: Automatic Trip Blow Rate: 36 bpm
Date: From February 18 to February 20, 2014	Anvil: Small (~2Kg) Solid Cone: 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

soft to firm & loose

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

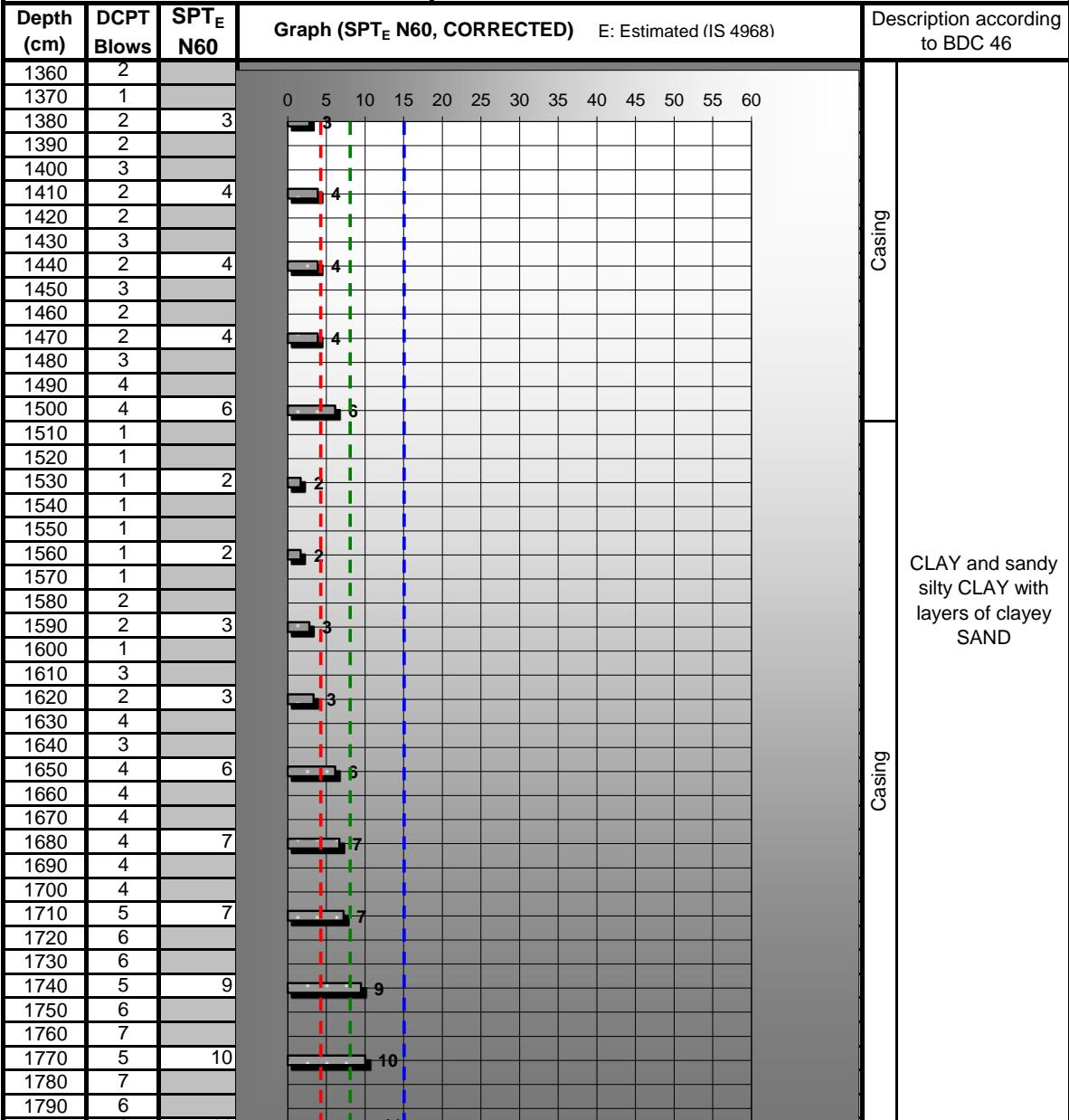
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR8

Client: CDR	Coordinates X: -334525.66 Y: -61788.13 Z: +414.5
Consultant: DAR-TALEB	Depth: 48m Groundwater: +402 (Estimated)
Engineer: E. S. KIRGIZ	C.D. Rod: 45m (HW) / 6m AW & 42m BW H.Dia.: 62.5 to 114mm
Contractor: SATCON Co.	SPT Hammer: Automatic Trip Blow Rate: 36 bpm
Date: From February 18 to February 20, 2014	Anvil: Small (~2Kg) Solid Cone: 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د/ر الـهـنـدـسـةـ نـازـيـهـ تـالـبـ وـشـرـكـةـ لـتـصـيـعـ وـلـمـكـانـاتـ الـفـنـيـةـ

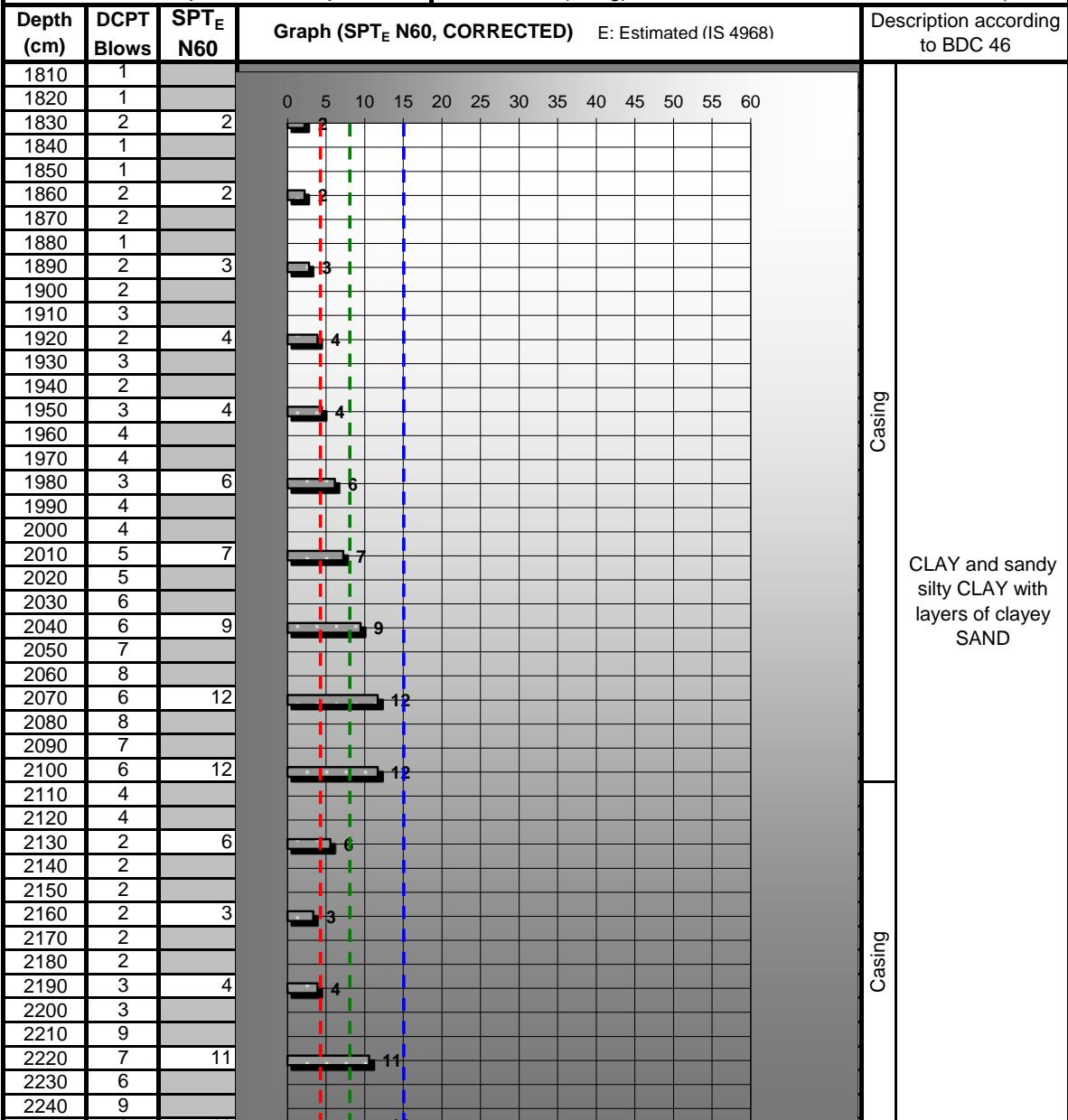
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR8

Client: CDR	Coordinates X: -334525.66 Y: -61788.13 Z: +414.5
Consultant: DAR-TALEB	Depth: 48m Groundwater: +402 (Estimated)
Engineer: E. S. KIRGIZ	C.D. Rod: 45m (HW) / 6m AW & 42m BW H.Dia.: 62.5 to 114mm
Contractor: SATCON Co.	SPT Hammer: Automatic Trip Blow Rate: 36 bpm
Date: From February 18 to February 20, 2014	Anvil: Small (~2Kg) Solid Cone: 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

soft to firm & loose

firm to stiff & loose to medium



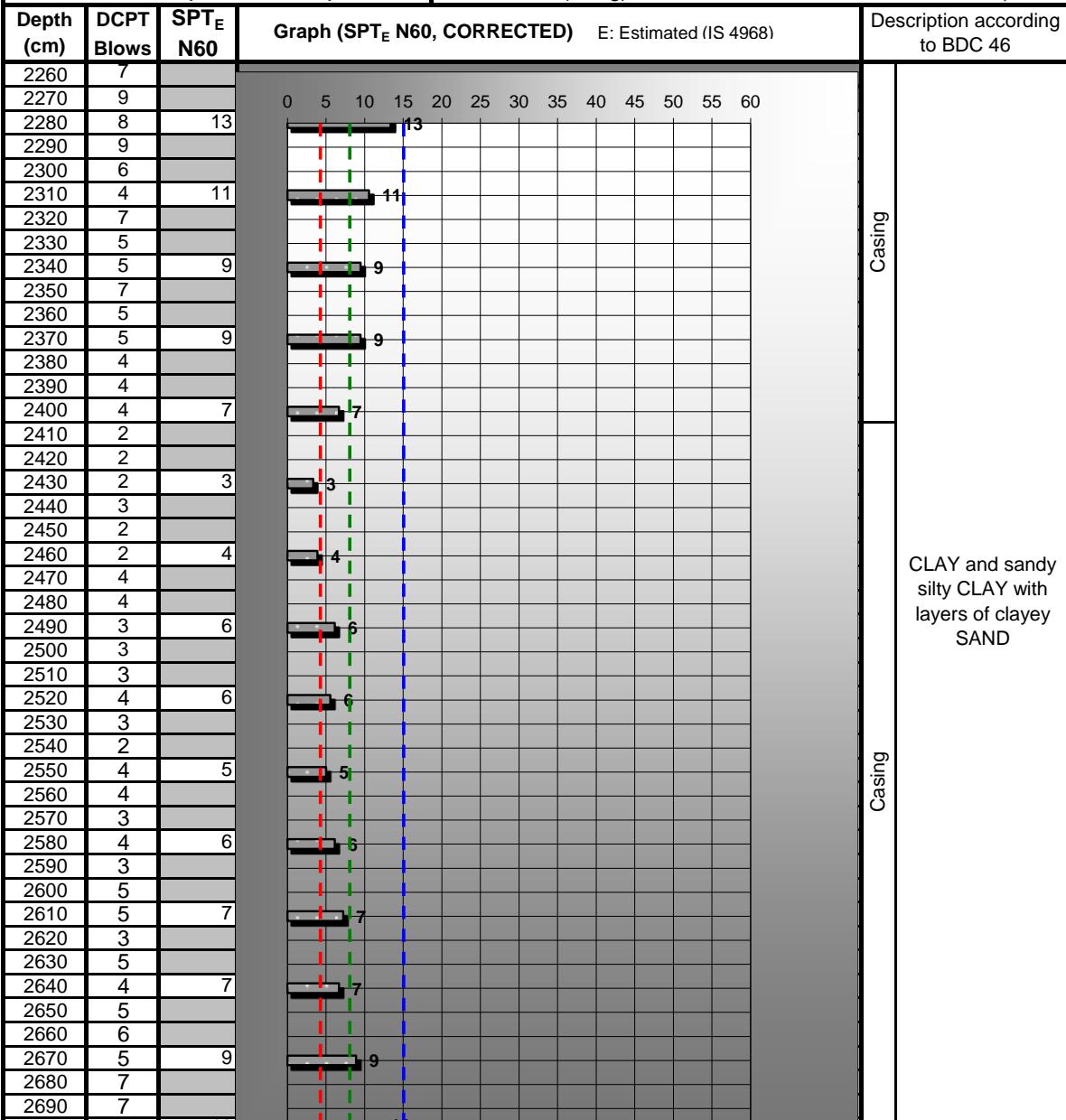
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرَكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR8

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From February 18 to February 20, 2014

Coordinates X: -334525.66 Y: -61788.13 Z: +414.5
Depth: 48m **Groundwater:** +402 (Estimated)
C.D. Rod: 45m (HW) / 6m AW & 42m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د/ر الـهـنـدـسـةـ نـازـحـ تـالـبـ وـشـرـكـةـ لـلـصـيـادـةـ وـالـسـيـادـةـ الـفـنـيـةـ

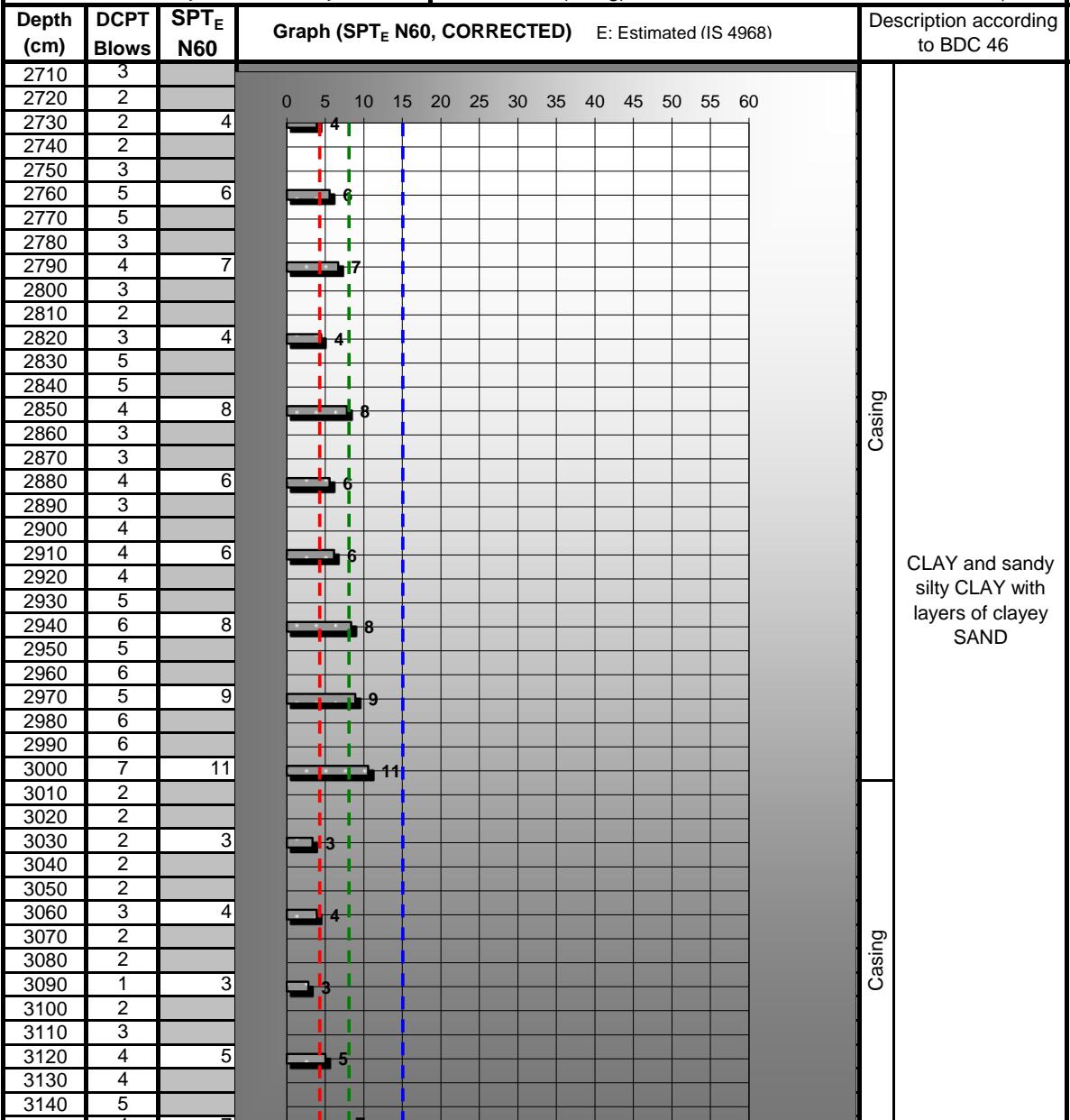
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR8

Client: CDR	Coordinates X: -334525.66 Y: -61788.13 Z: +414.5
Consultant: DAR-TALEB	Depth: 48m Groundwater: +402 (Estimated)
Engineer: E. S. KIRGIZ	C.D. Rod: 45m (HW) / 6m AW & 42m BW H.Dia.: 62.5 to 114mm
Contractor: SATCON Co.	SPT Hammer: Automatic Trip Blow Rate: 36 bpm
Date: From February 18 to February 20, 2014	Anvil: Small (~2Kg) Solid Cone: 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

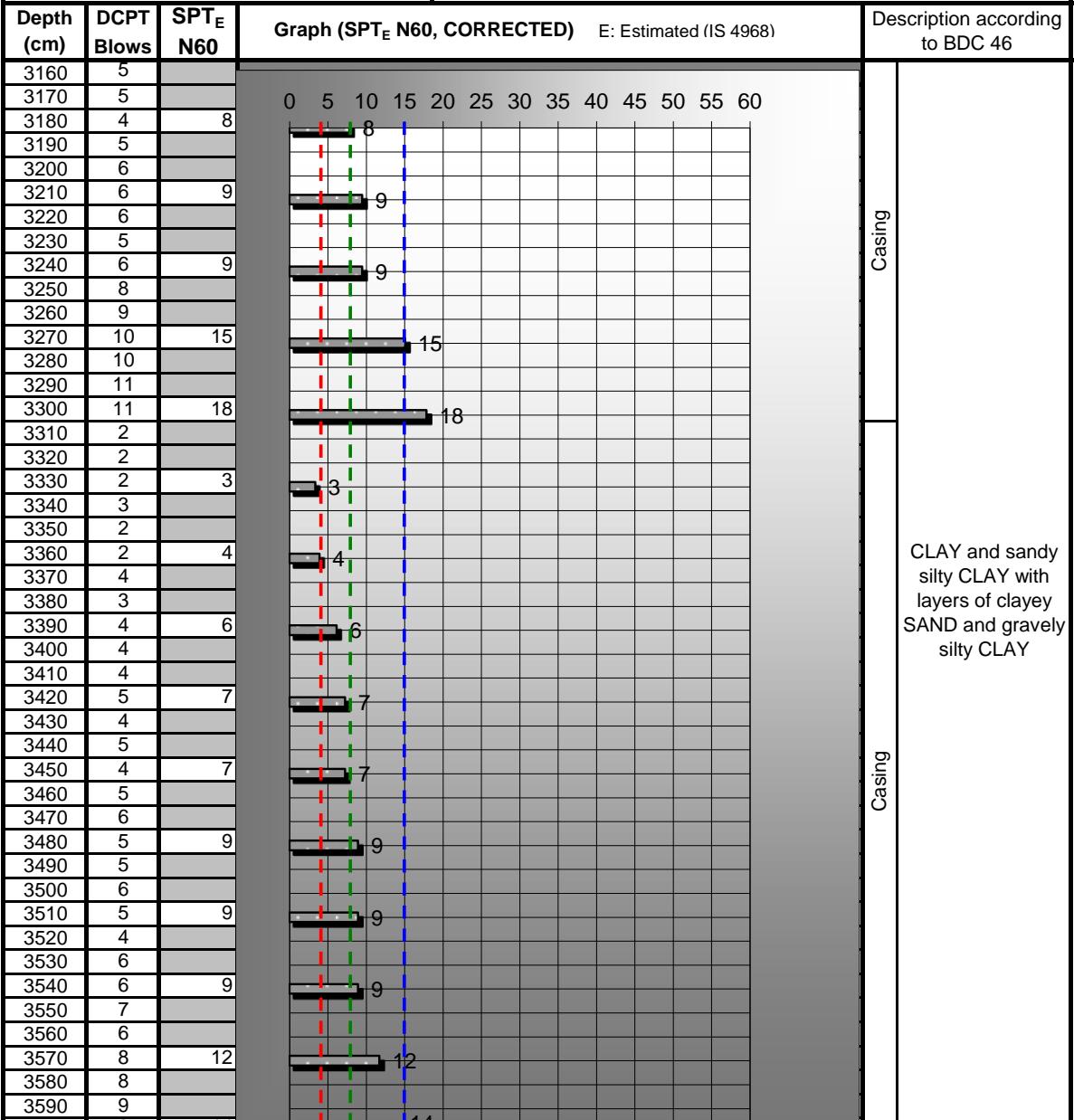
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR8

Client: CDR	Coordinates X: -334525.66 Y: -61788.13 Z: +414.5
Consultant: DAR-TALEB	Depth: 48m Groundwater: +402 (Estimated)
Engineer: E. S. KIRGIZ	C.D. Rod: 45m (HW) / 6m AW & 42m BW H.Dia.: 62.5 to 114mm
Contractor: SATCON Co.	SPT Hammer: Automatic Trip Blow Rate: 36 bpm
Date: From February 18 to February 20, 2014	Anvil: Small (~2Kg) Solid Cone: 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د/ر الـهـنـدـسـةـ نـازـحـ تـالـبـ وـشـرـكـةـ لـلـصـيـادـةـ وـلـلـسـنـافـاتـ الـفـنـيـةـ

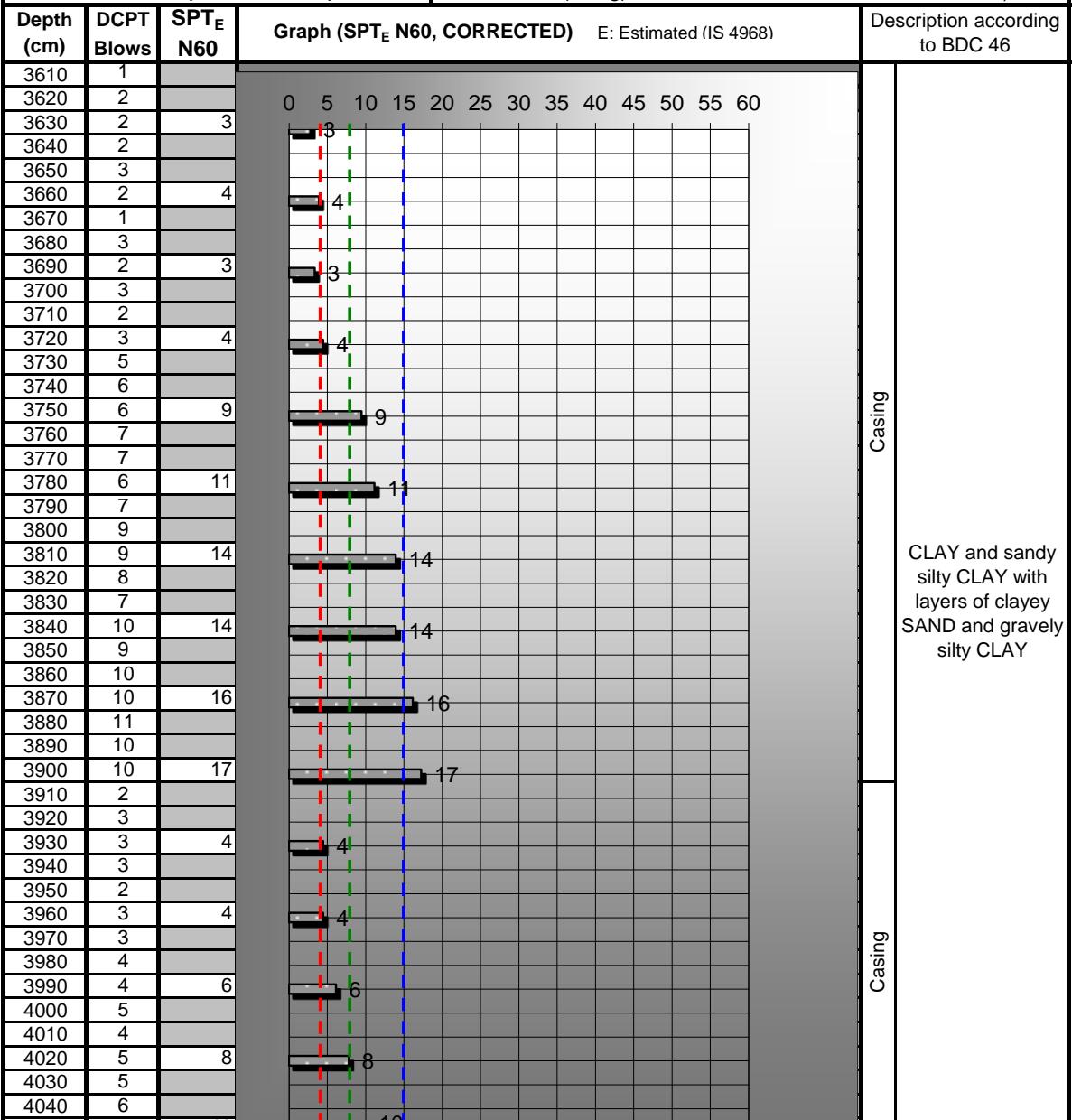
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR8

Client: CDR	Coordinates X: -334525.66 Y: -61788.13 Z: +414.5
Consultant: DAR-TALEB	Depth: 48m Groundwater: +402 (Estimated)
Engineer: E. S. KIRGIZ	C./D. Rod: 45m (HW) / 6m AW & 42m BW H.Dia.: 62.5 to 114mm
Contractor: SATCON Co.	SPT Hammer: Automatic Trip Blow Rate: 36 bpm
Date: From February 18 to February 20, 2014	Anvil: Small (~2Kg) Solid Cone: 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

soft to firm & loose

firm to stiff & loose to medium



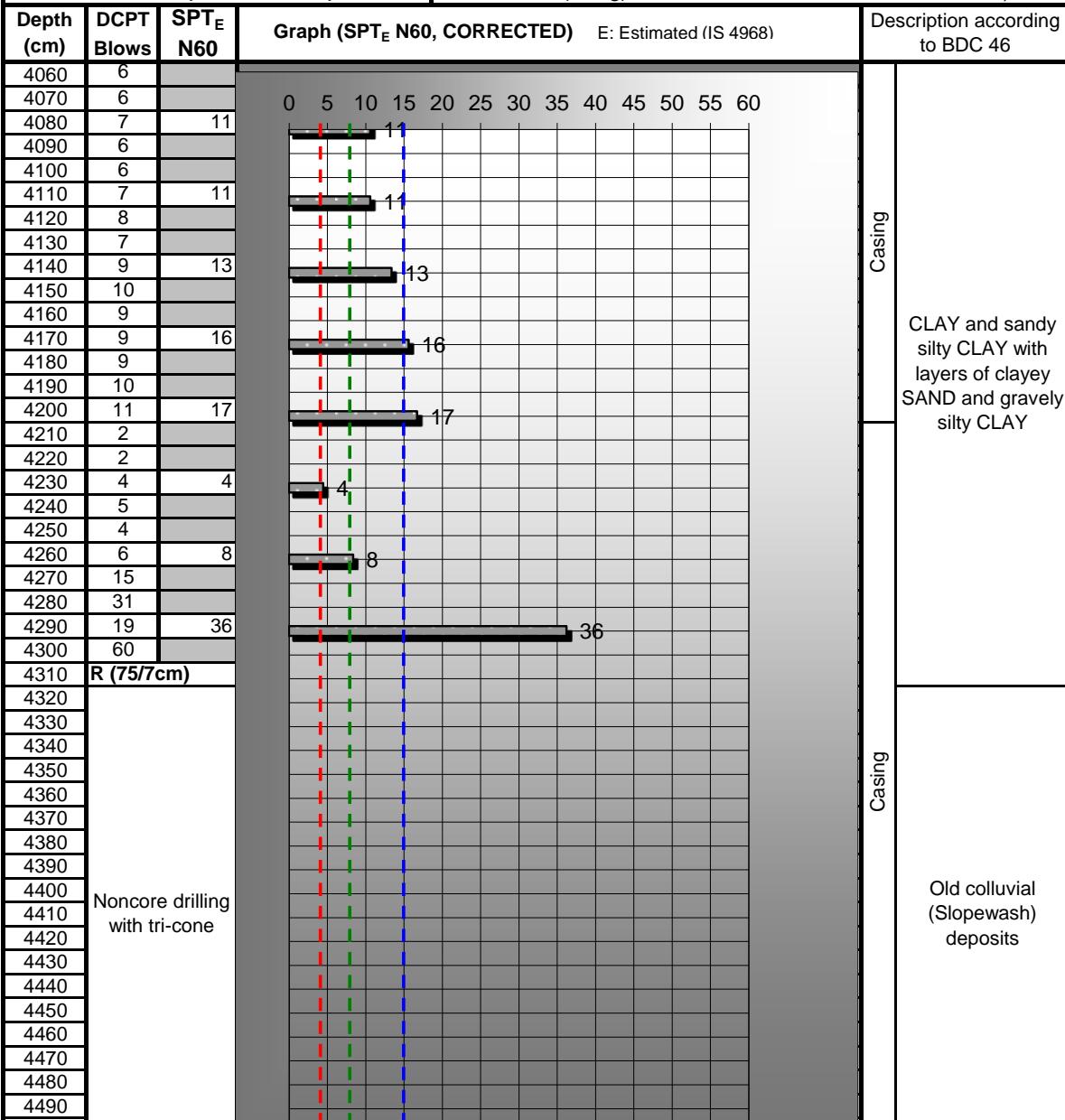
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR8

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From February 18 to February 20, 2014

Coordinates X: -334525.66 Y: -61788.13 Z: +414.5
Depth: 48m **Groundwater:** +402 (Estimated)
C.D. Rod: 45m (HW) / 6m AW & 42m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

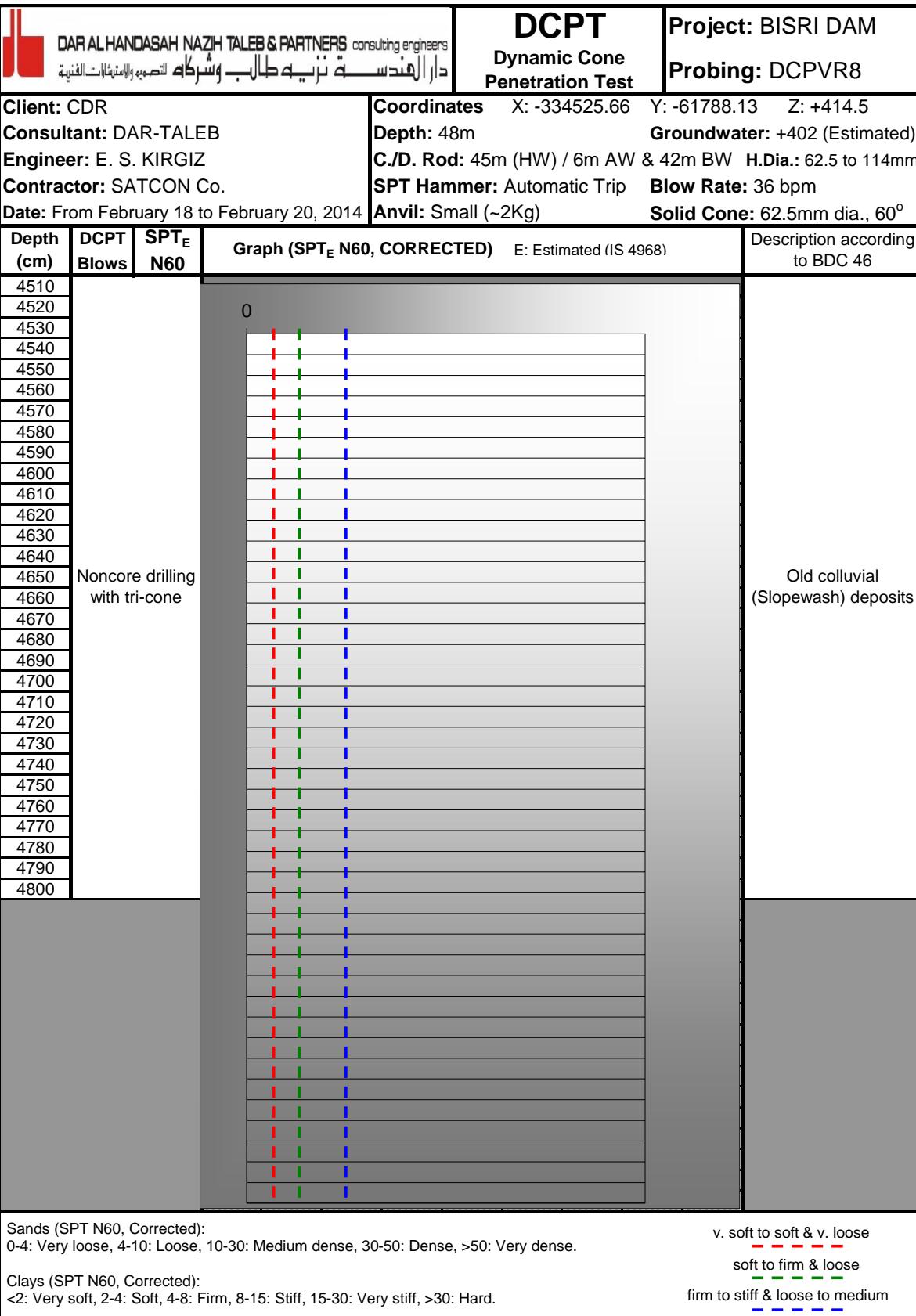
v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium





DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د/ر الـهـنـدـسـاـتـ الـفـنـيـةـ وـشـرـكـةـ تـصـيـرـ الـاسـنـافـ الـفـنـيـةـ

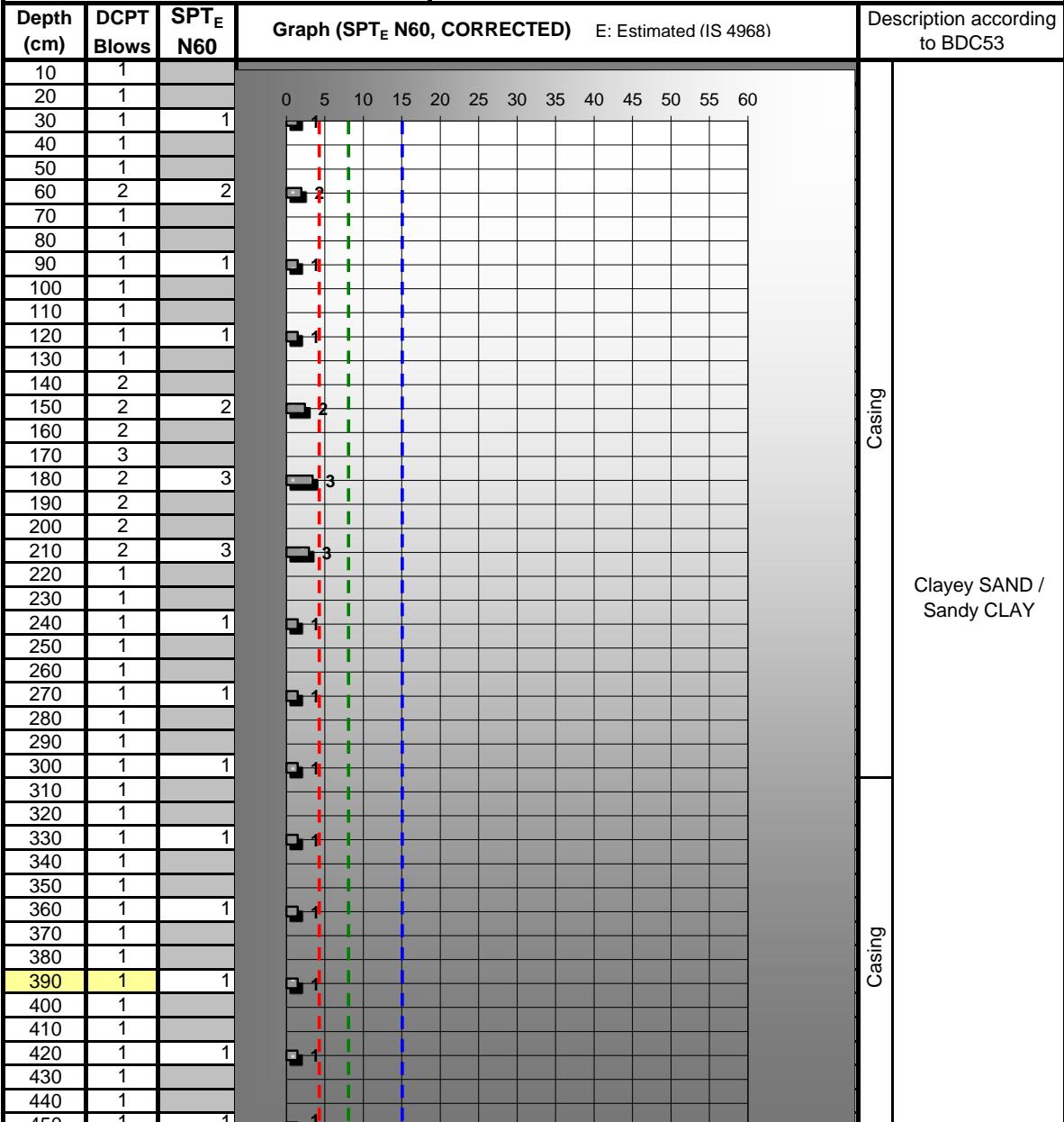
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR4

Client: CDR	Coordinates X: -334,621.9	Y: -61,997.94	Z: +413.75
Consultant: DAR-TALEB	Depth: 93m	Groundwater: +404 (Estimated)	
Engineer: E. S. KIRGIZ	C.D. Rod: 60m (HW) / 6m AW & 87m BW	H.Dia.: 62.5 to 114mm	
Contractor: SATCON Co.	SPT Hammer: Automatic Trip	Blow Rate: 36 bpm	
Date: From January 21 to January 28, 2014	Anvil: Small (~2Kg)	Solid Cone: 62.5mm dia., 60°	



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

soft to firm & loose

firm to stiff & loose to medium



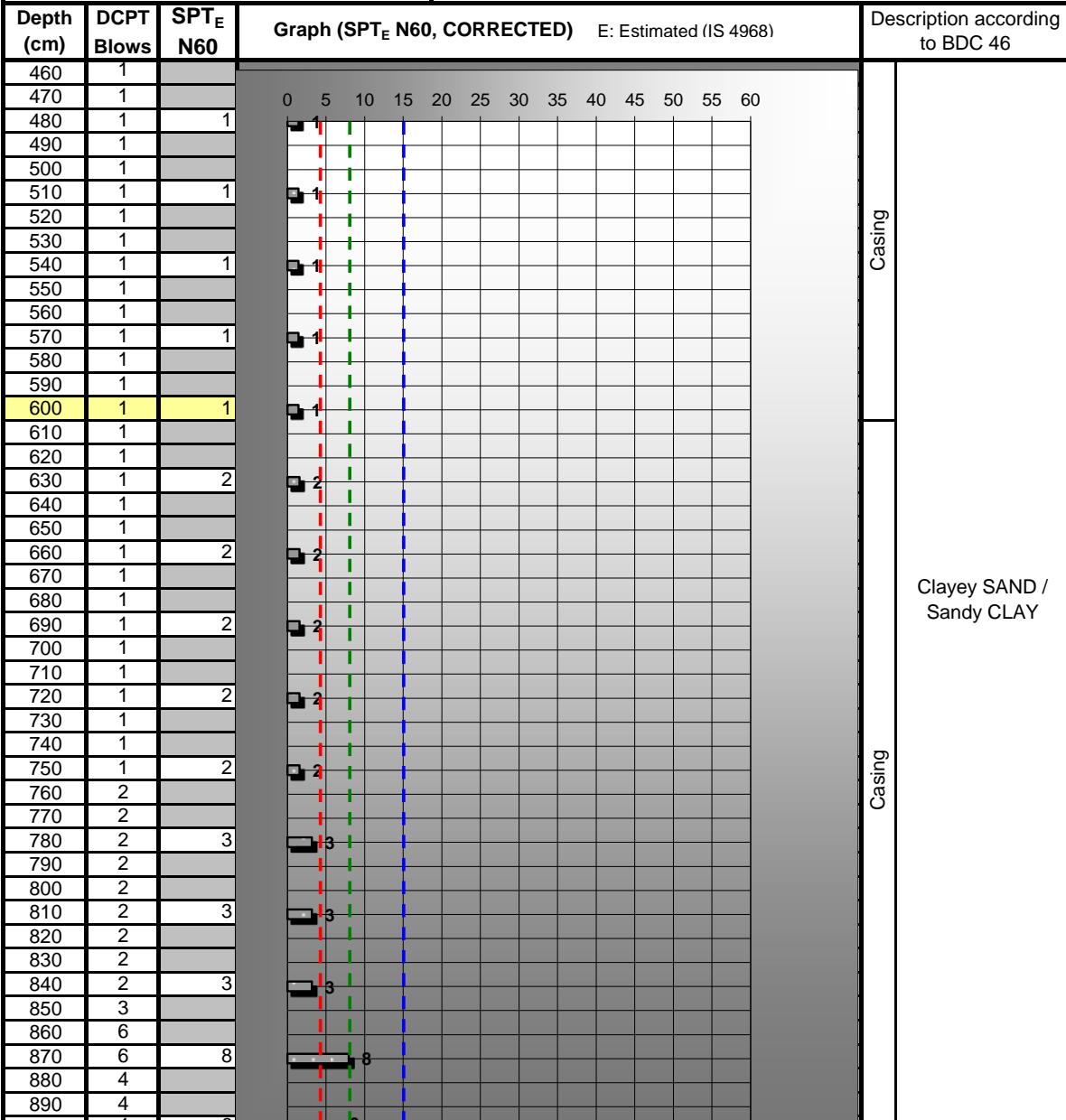
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د/ر الـهـنـدـسـة نـازـحـة تـالـبـ وـشـرـكـة لـلـصـيـرـةـ وـالـسـفـلـاتـ الـفـنـيـة

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C./D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

red dashed

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

soft to firm & loose

green dashed

firm to stiff & loose to medium

blue dashed



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د/ر الـهـنـدـسـةـ نـازـحـ تـالـبـ وـشـرـطـةـ لـلـصـيـادـةـ وـالـسـيـادـةـ الـفـنـيـةـ

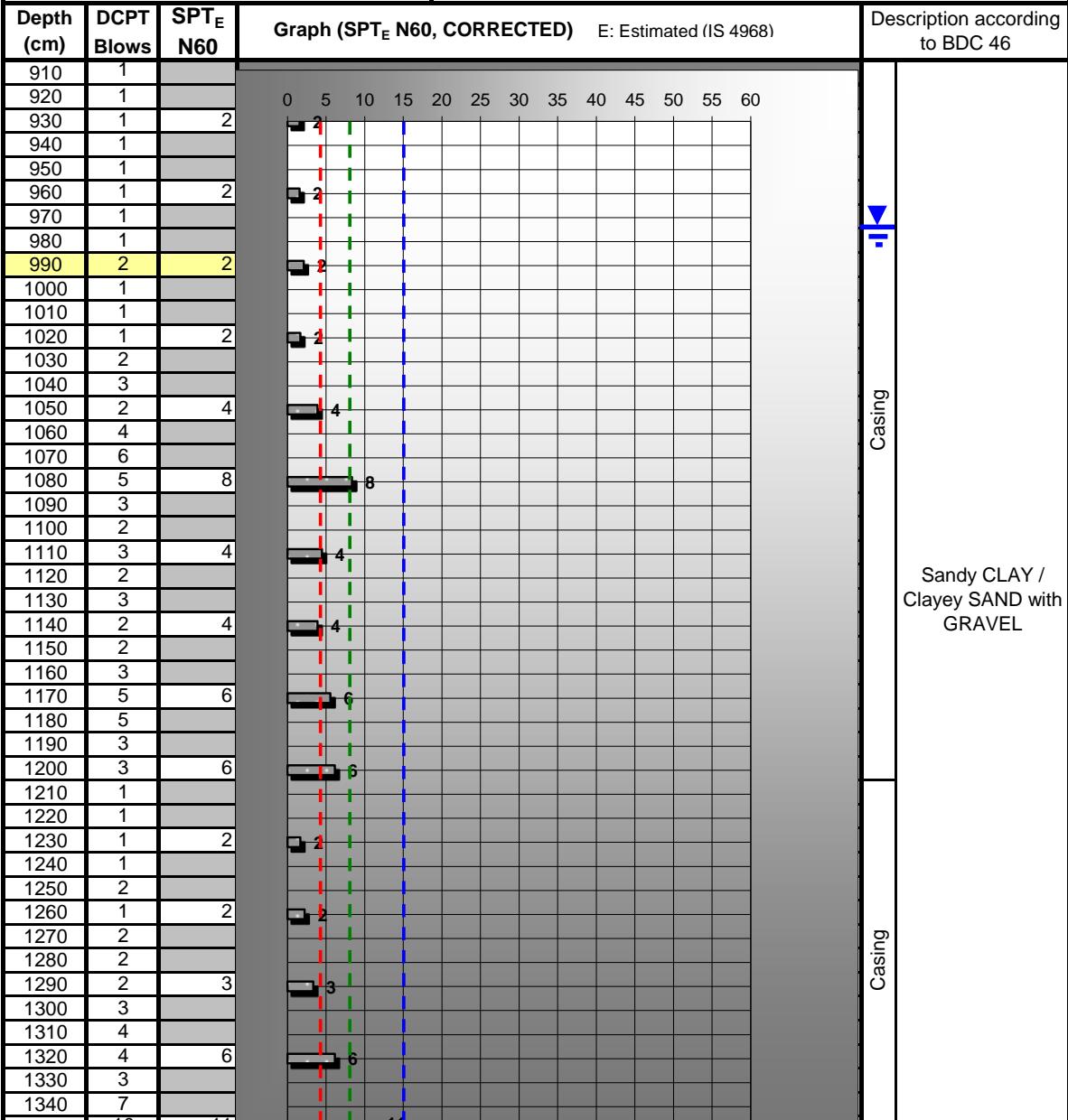
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR4

Client: CDR	Coordinates X: -334,621.9	Y: -61,997.94	Z: +413.75
Consultant: DAR-TALEB	Depth: 93m	Groundwater: +404 (Estimated)	
Engineer: E. S. KIRGIZ	C.D. Rod: 60m (HW) / 6m AW & 87m BW	H.Dia.: 62.5 to 114mm	
Contractor: SATCON Co.	SPT Hammer: Automatic Trip	Blow Rate: 36 bpm	
Date: From January 21 to January 28, 2014	Anvil: Small (~2Kg)	Solid Cone: 62.5mm dia., 60°	



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصَّيْدِ وَالْإِنْجِنِيُورِيَّاتِ الْفُنْدَنِيَّةِ

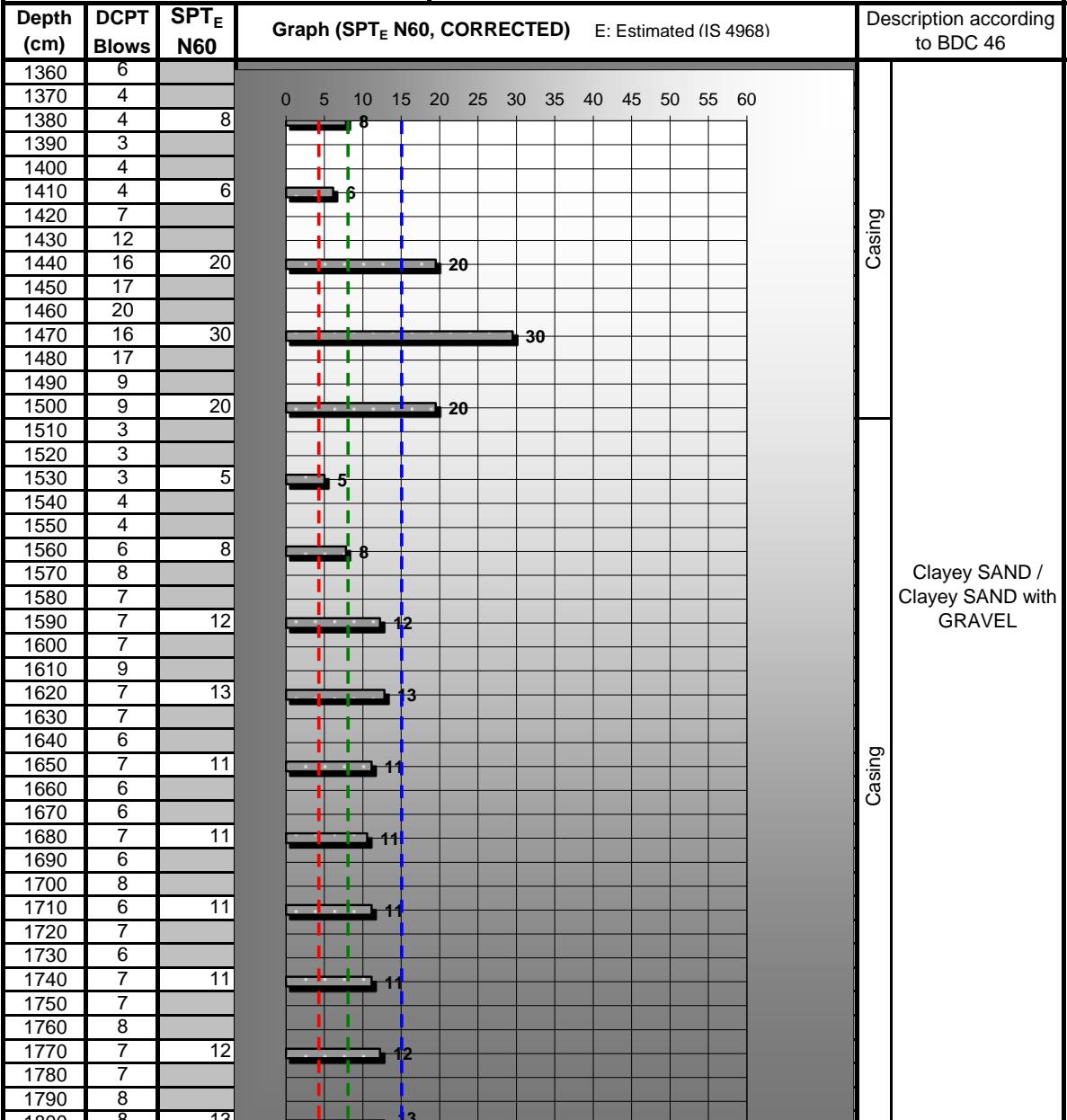
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR4

Client: CDR	Coordinates X: -334,621.9	Y: -61,997.94	Z: +413.75
Consultant: DAR-TALEB	Depth: 93m	Groundwater: +404 (Estimated)	
Engineer: E. S. KIRGIZ	C.D. Rod: 60m (HW) / 6m AW & 87m BW	H.Dia.: 62.5 to 114mm	
Contractor: SATCON Co.	SPT Hammer: Automatic Trip	Blow Rate: 36 bpm	
Date: From January 21 to January 28, 2014	Anvil: Small (~2Kg)	Solid Cone: 62.5mm dia., 60°	



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْإِسْلَامِيَّةِ الْفُنْدَادِيَّةِ

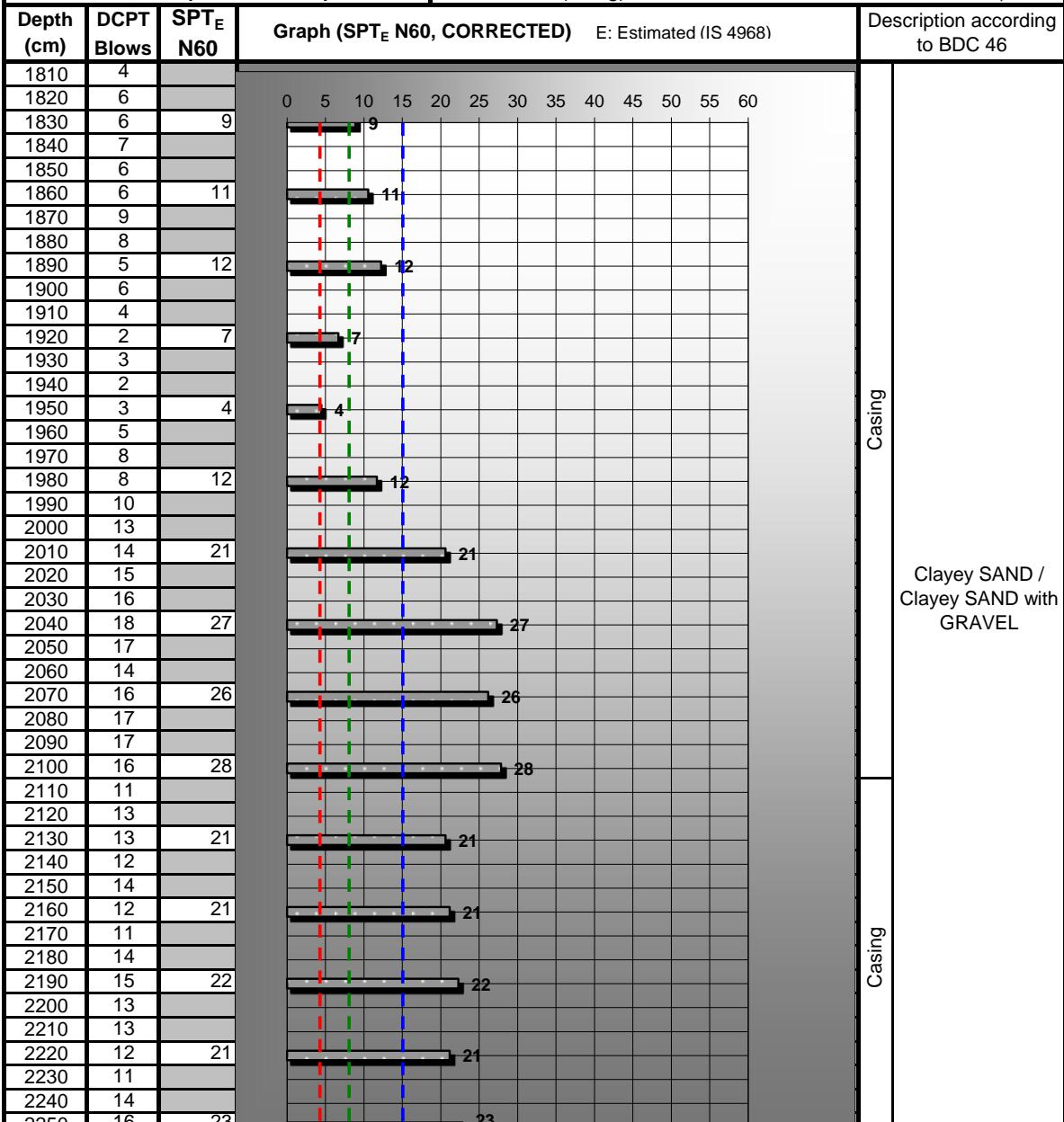
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR4

Client: CDR	Coordinates X: -334,621.9	Y: -61,997.94	Z: +413.75
Consultant: DAR-TALEB	Depth: 93m	Groundwater: +404 (Estimated)	
Engineer: E. S. KIRGIZ	C.D. Rod: 60m (HW) / 6m AW & 87m BW	H.Dia.: 62.5 to 114mm	
Contractor: SATCON Co.	SPT Hammer: Automatic Trip	Blow Rate: 36 bpm	
Date: From January 21 to January 28, 2014	Anvil: Small (~2Kg)	Solid Cone: 62.5mm dia., 60°	



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

soft to firm & loose

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د/ر الـهـنـدـسـةـ نـازـيـهـ تـالـبـ وـشـرـكـةـ لـلـصـيـادـةـ وـلـلـسـنـهـاتـ الـفـنـيـةـ

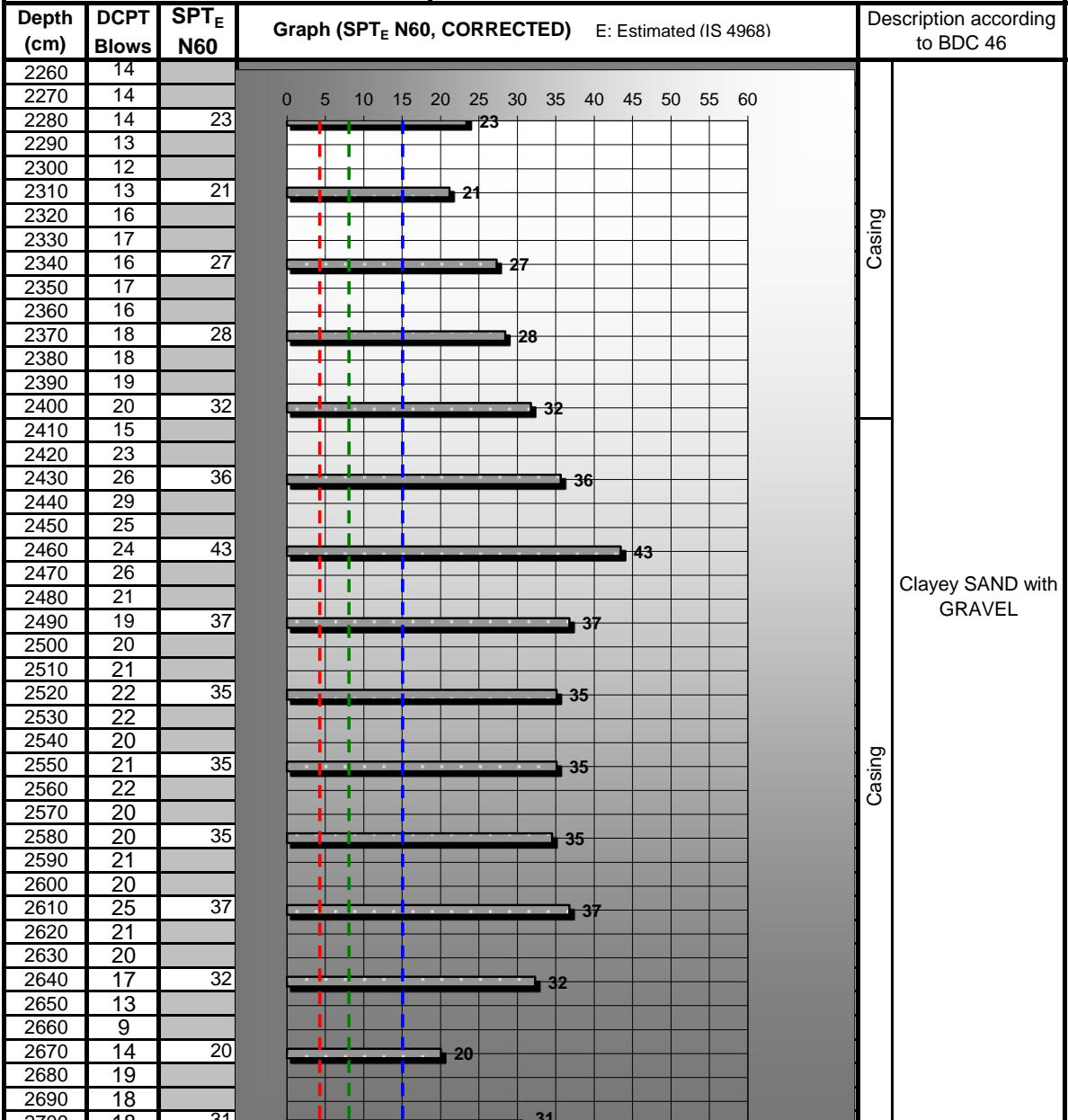
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR4

Client: CDR	Coordinates X: -334,621.9	Y: -61,997.94	Z: +413.75
Consultant: DAR-TALEB	Depth: 93m	Groundwater: +404 (Estimated)	
Engineer: E. S. KIRGIZ	C.D. Rod: 60m (HW) / 6m AW & 87m BW	H.Dia.: 62.5 to 114mm	
Contractor: SATCON Co.	SPT Hammer: Automatic Trip	Blow Rate: 36 bpm	
Date: From January 21 to January 28, 2014	Anvil: Small (~2Kg)	Solid Cone: 62.5mm dia., 60°	



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



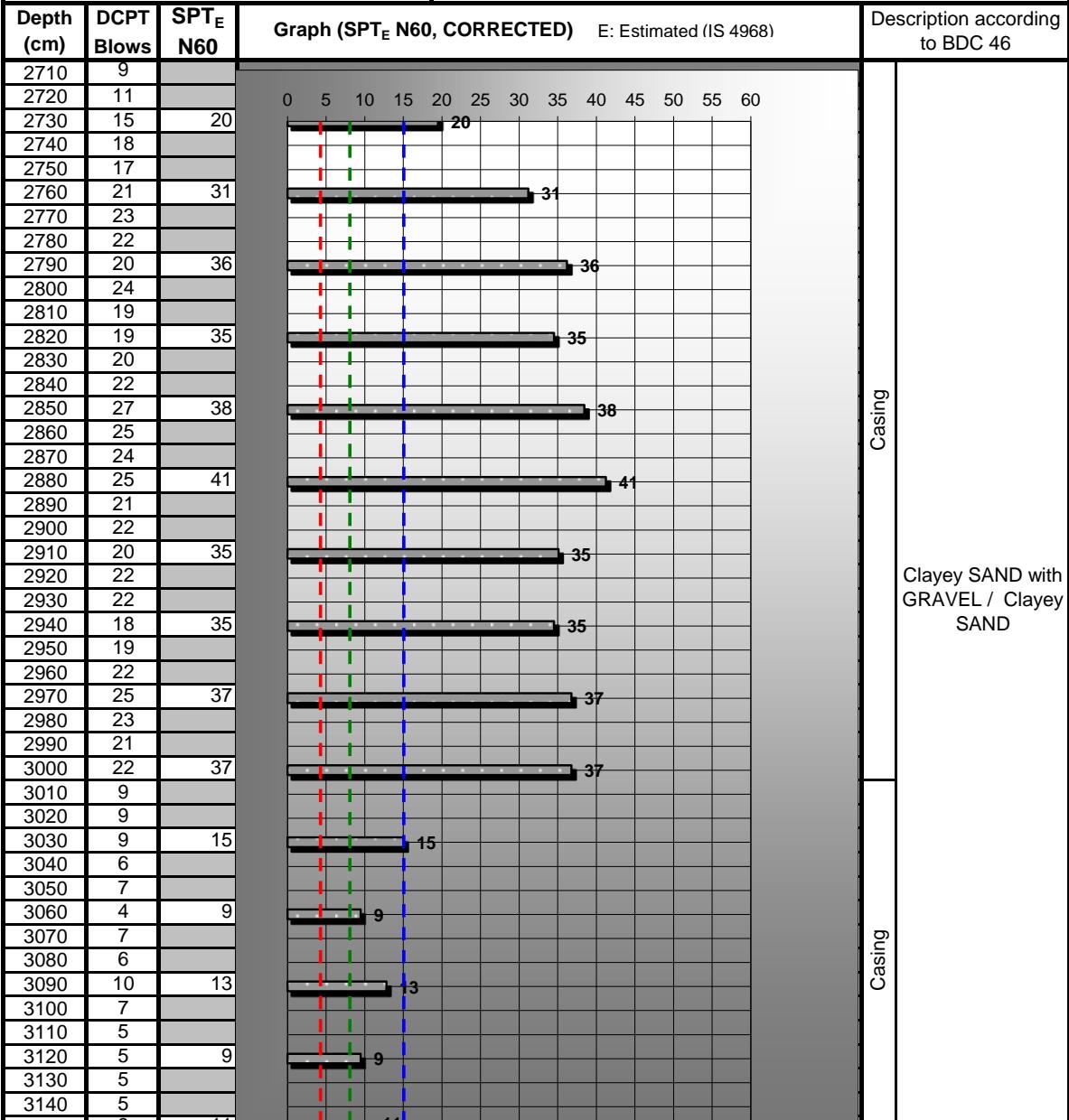
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
Groundwater: +404 (Estimated)
C./D. Rod: 60m (HW) / 6m AW & 87m BW H.Dia.: 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



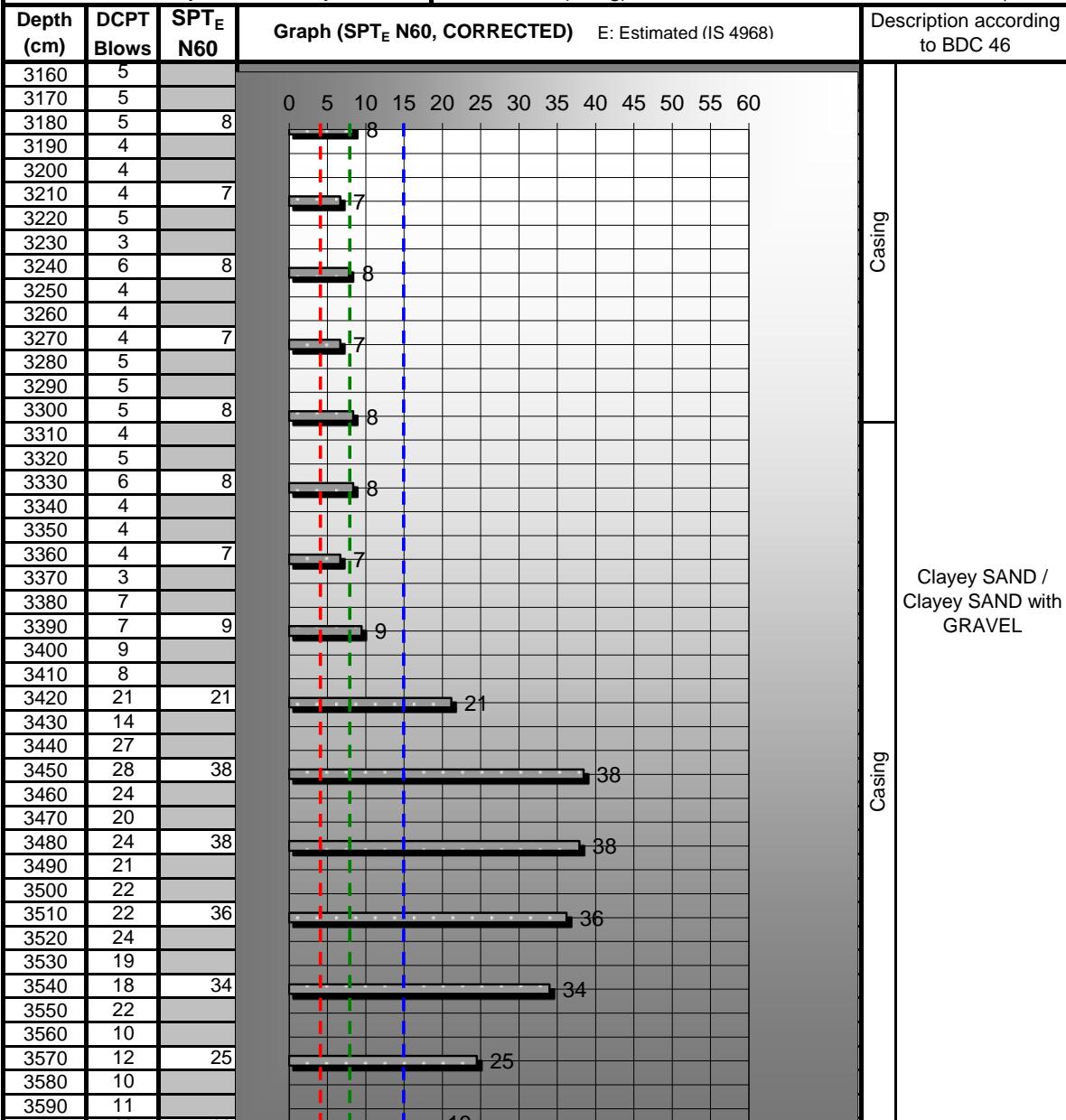
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C./D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

soft to firm & loose

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصَّوْمَلِ وَالْإِسْتَهْلَكِ الْفَنِيَّةِ

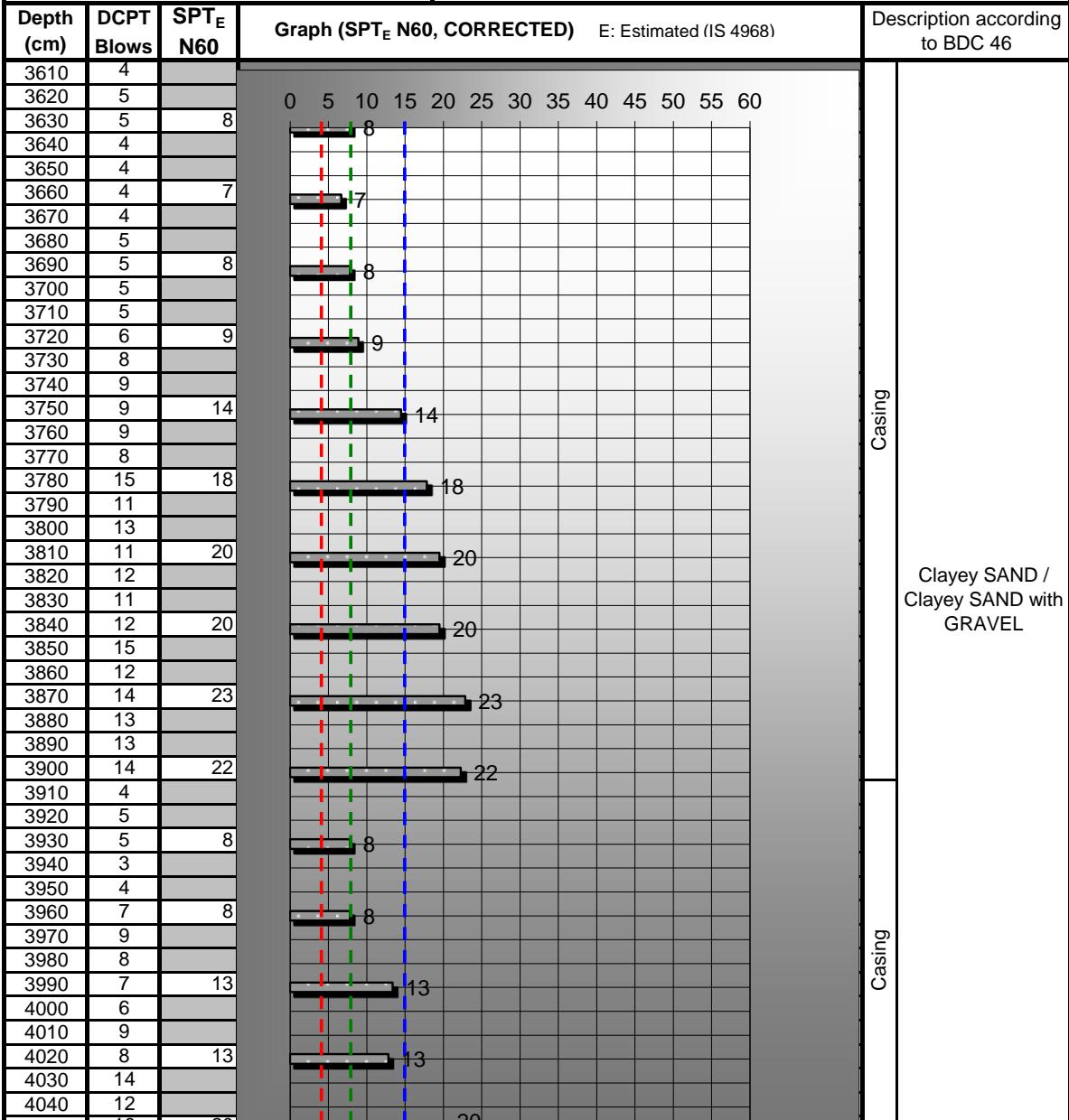
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR4

Client: CDR	Coordinates X: -334,621.9	Y: -61,997.94	Z: +413.75
Consultant: DAR-TALEB	Depth: 93m	Groundwater: +404 (Estimated)	
Engineer: E. S. KIRGIZ	C.D. Rod: 60m (HW) / 6m AW & 87m BW	H.Dia.: 62.5 to 114mm	
Contractor: SATCON Co.	SPT Hammer: Automatic Trip	Blow Rate: 36 bpm	
Date: From January 21 to January 28, 2014	Anvil: Small (~2Kg)	Solid Cone: 62.5mm dia., 60°	



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

soft to firm & loose

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

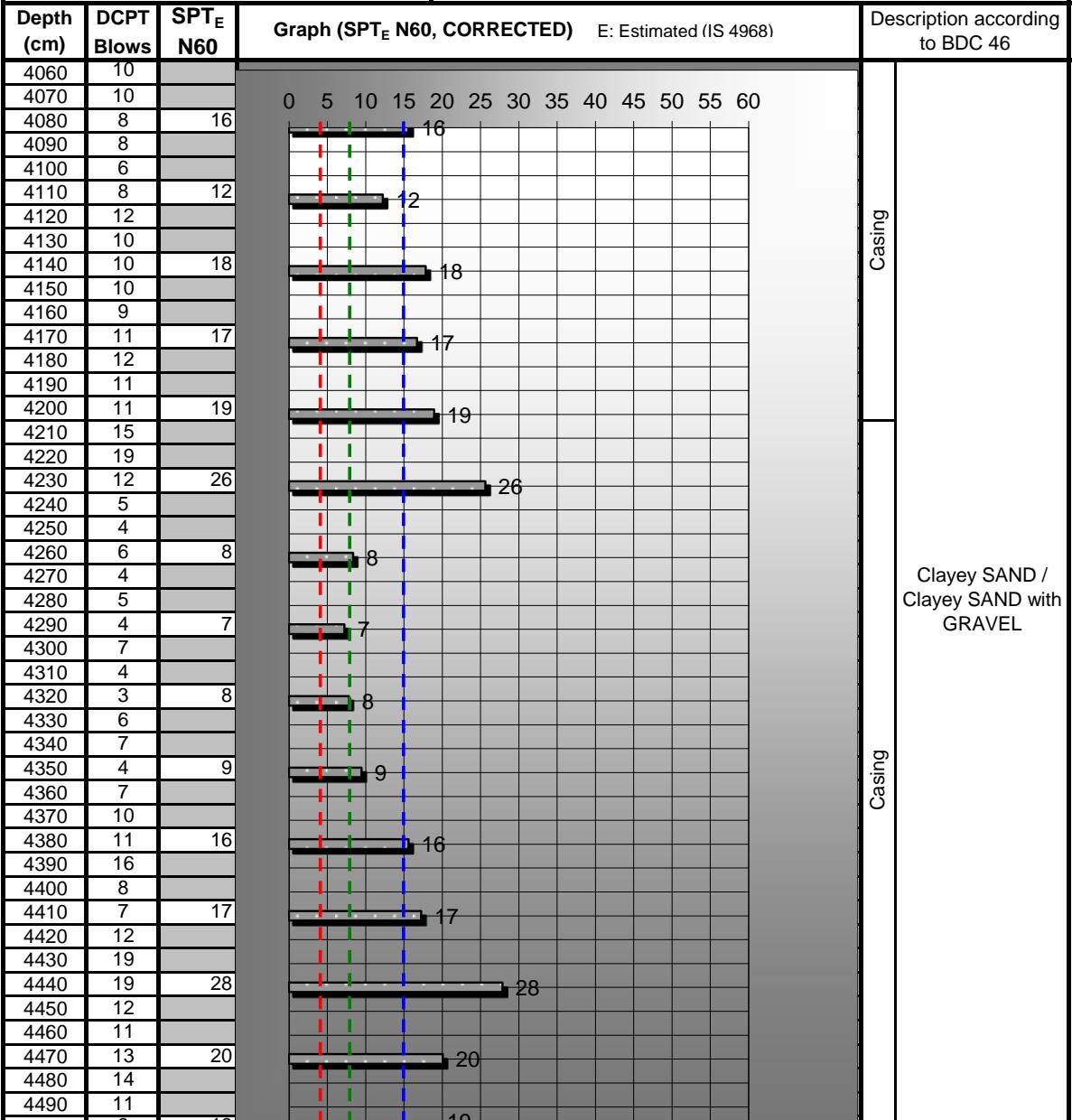
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR4

Client: CDR	Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Consultant: DAR-TALEB	Depth: 93m Groundwater: +404 (Estimated)
Engineer: E. S. KIRGIZ	C.D. Rod: 60m (HW) / 6m AW & 87m BW H.Dia.: 62.5 to 114mm
Contractor: SATCON Co.	SPT Hammer: Automatic Trip Blow Rate: 36 bpm
Date: From January 21 to January 28, 2014	Anvil: Small (~2Kg) Solid Cone: 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د/ر الـهـنـدـسـاـتـ الـفـنـدـيـةـ وـشـرـكـةـ تـصـيـرـ الـسـيـرـاتـ الـفـنـدـيـةـ

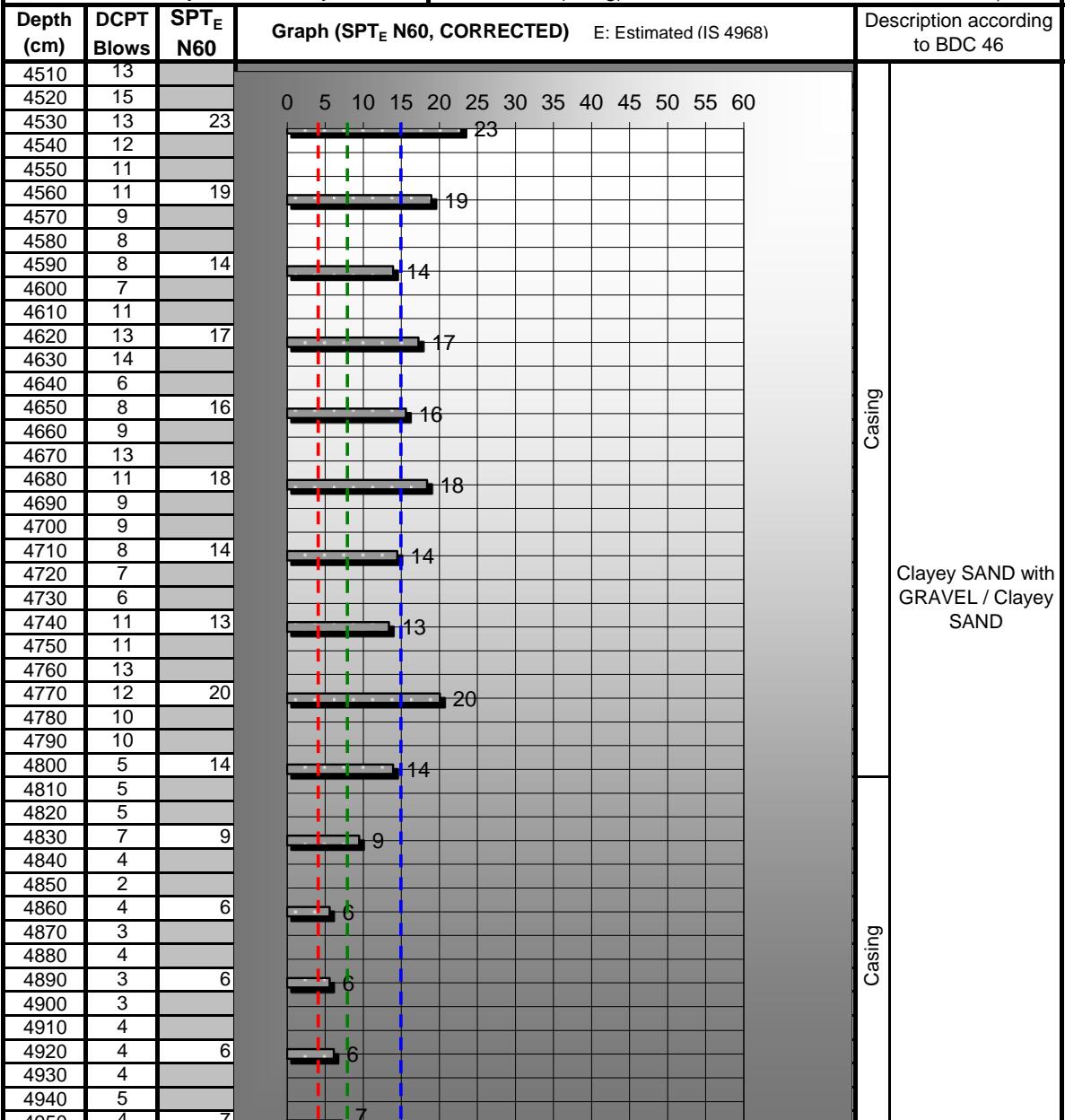
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR4

Client: CDR	Coordinates X: -334,621.9	Y: -61,997.94	Z: +413.75
Consultant: DAR-TALEB	Depth: 93m	Groundwater: +404 (Estimated)	
Engineer: E. S. KIRGIZ	C.D. Rod: 60m (HW) / 6m AW & 87m BW	H.Dia.: 62.5 to 114mm	
Contractor: SATCON Co.	SPT Hammer: Automatic Trip	Blow Rate: 36 bpm	
Date: From January 21 to January 28, 2014	Anvil: Small (~2Kg)	Solid Cone: 62.5mm dia., 60°	



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



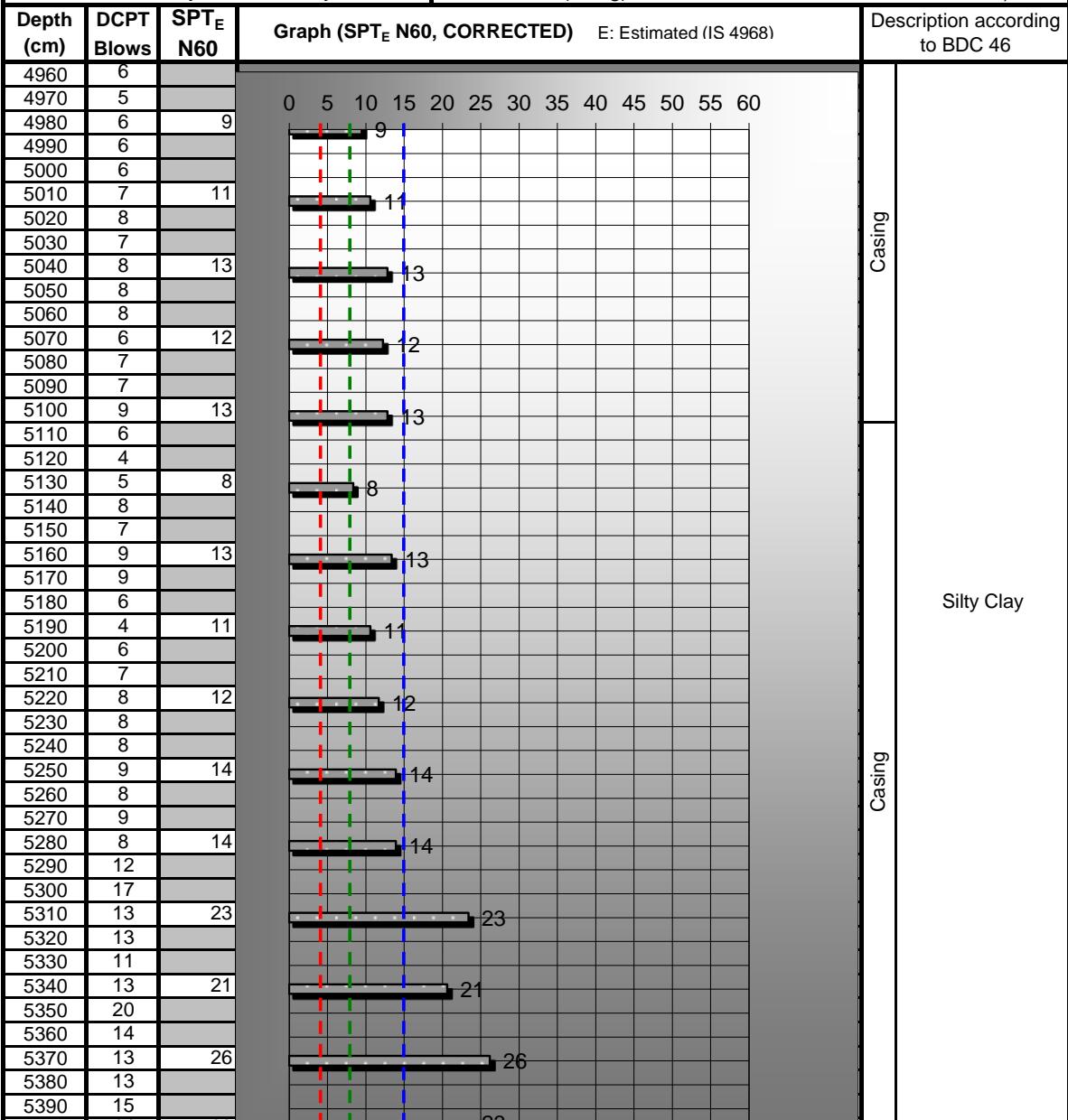
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C.D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



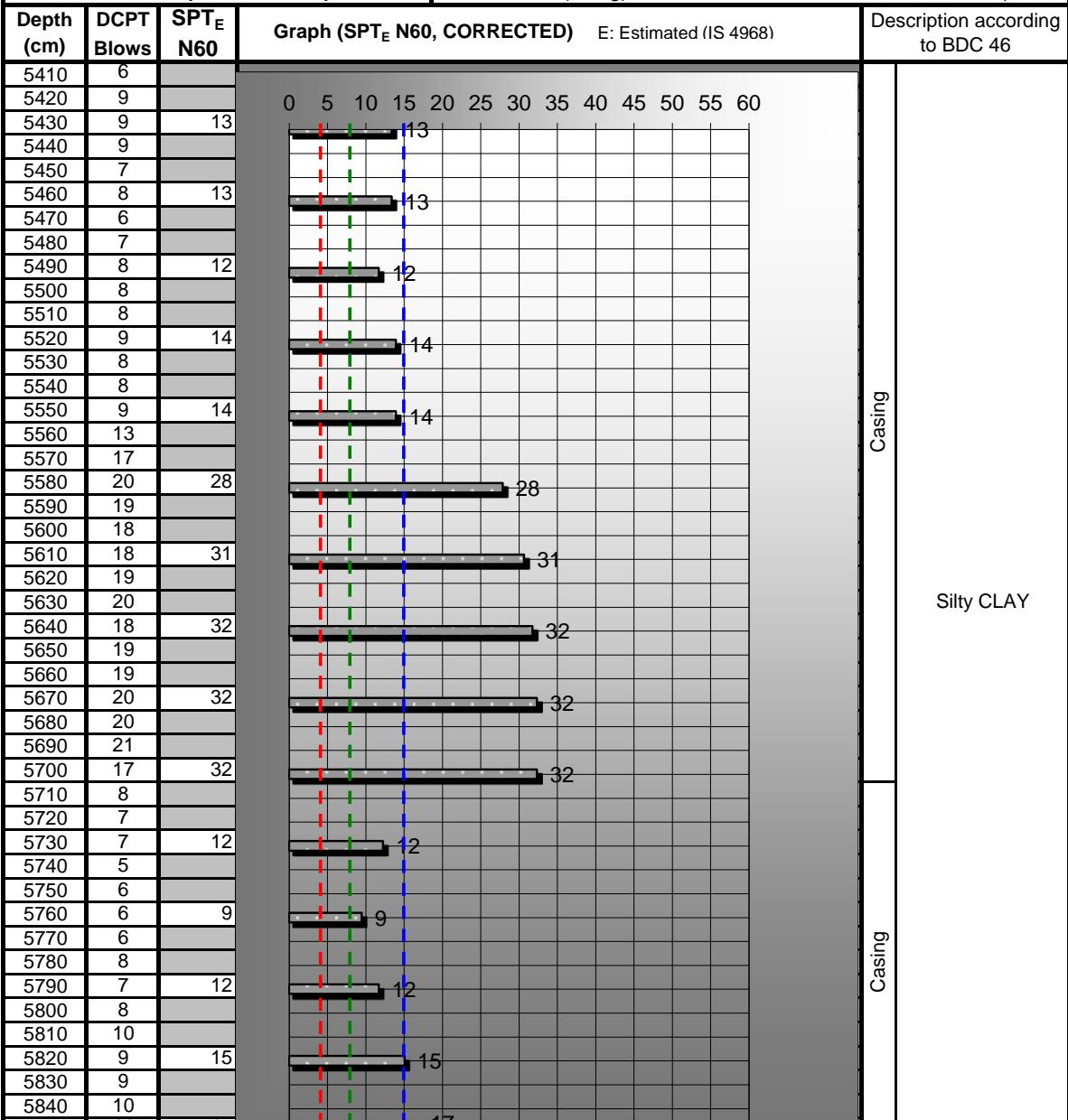
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C.D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



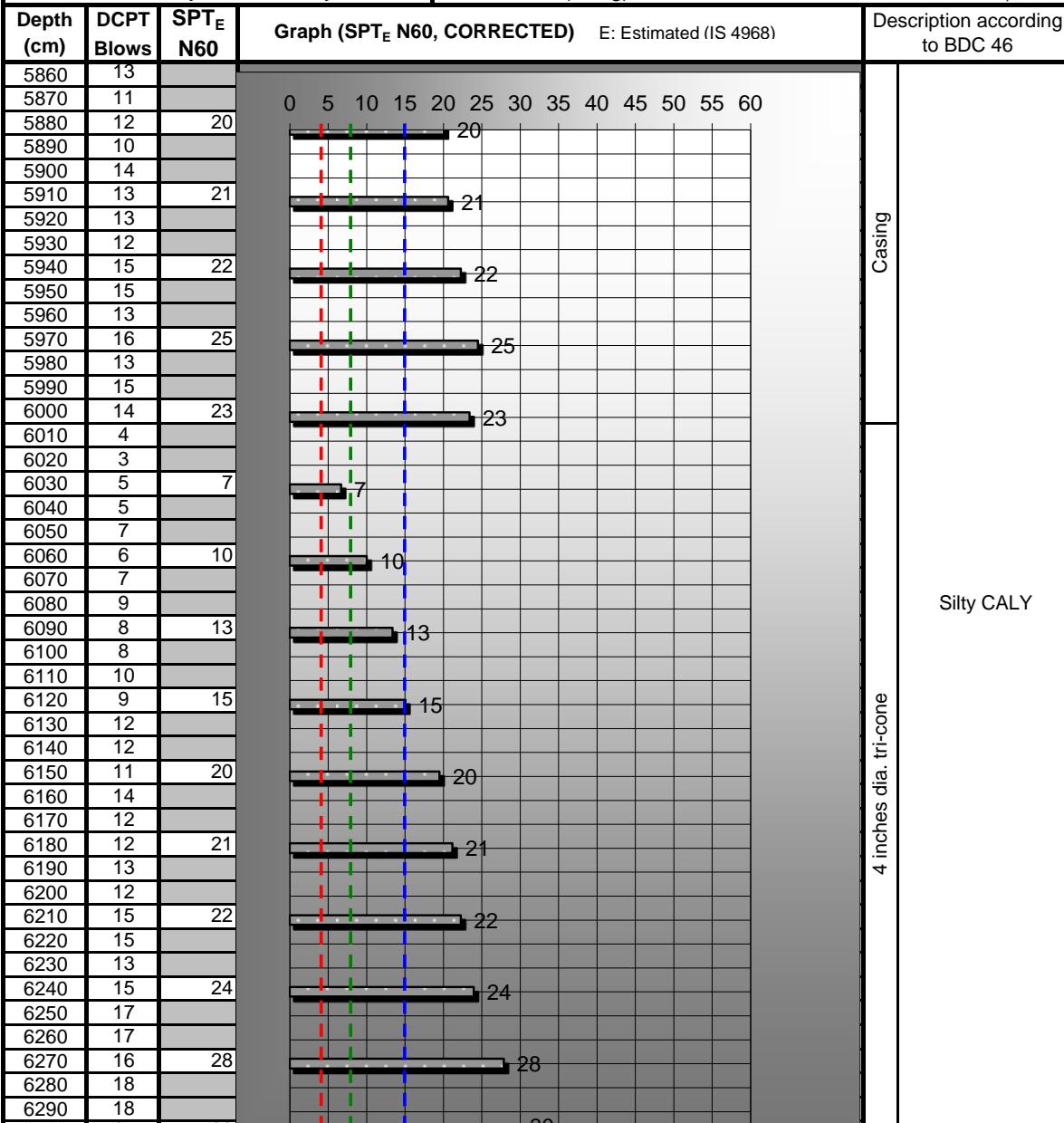
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْإِسْلَامِيِّينَ الْفُنُونِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C./D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



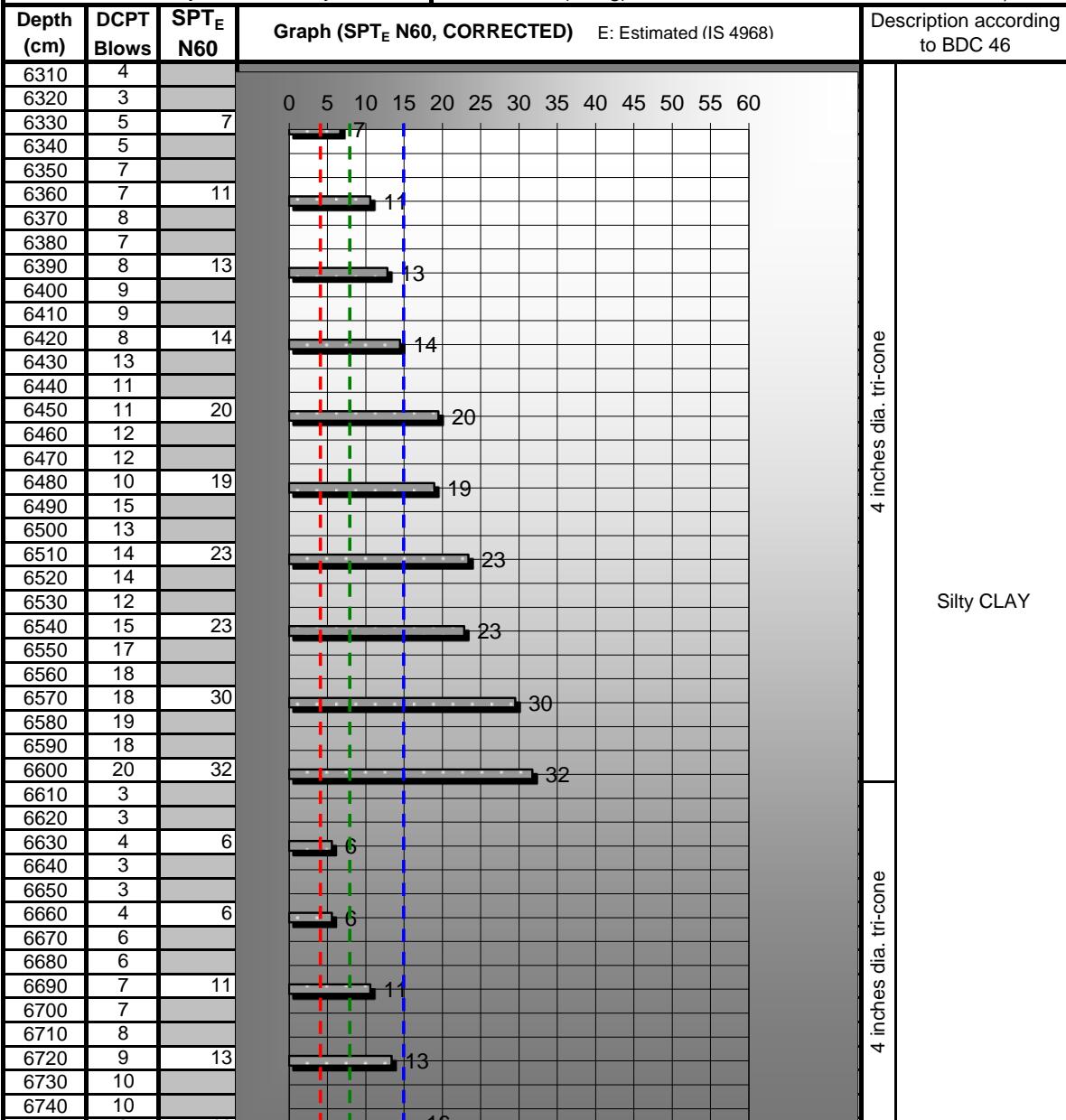
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْإِسْلَامِيَّةِ الْفُنْدَنِيَّةِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C.D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْإِسْلَامِيِّينَ الْفُنُونِ

DCPT

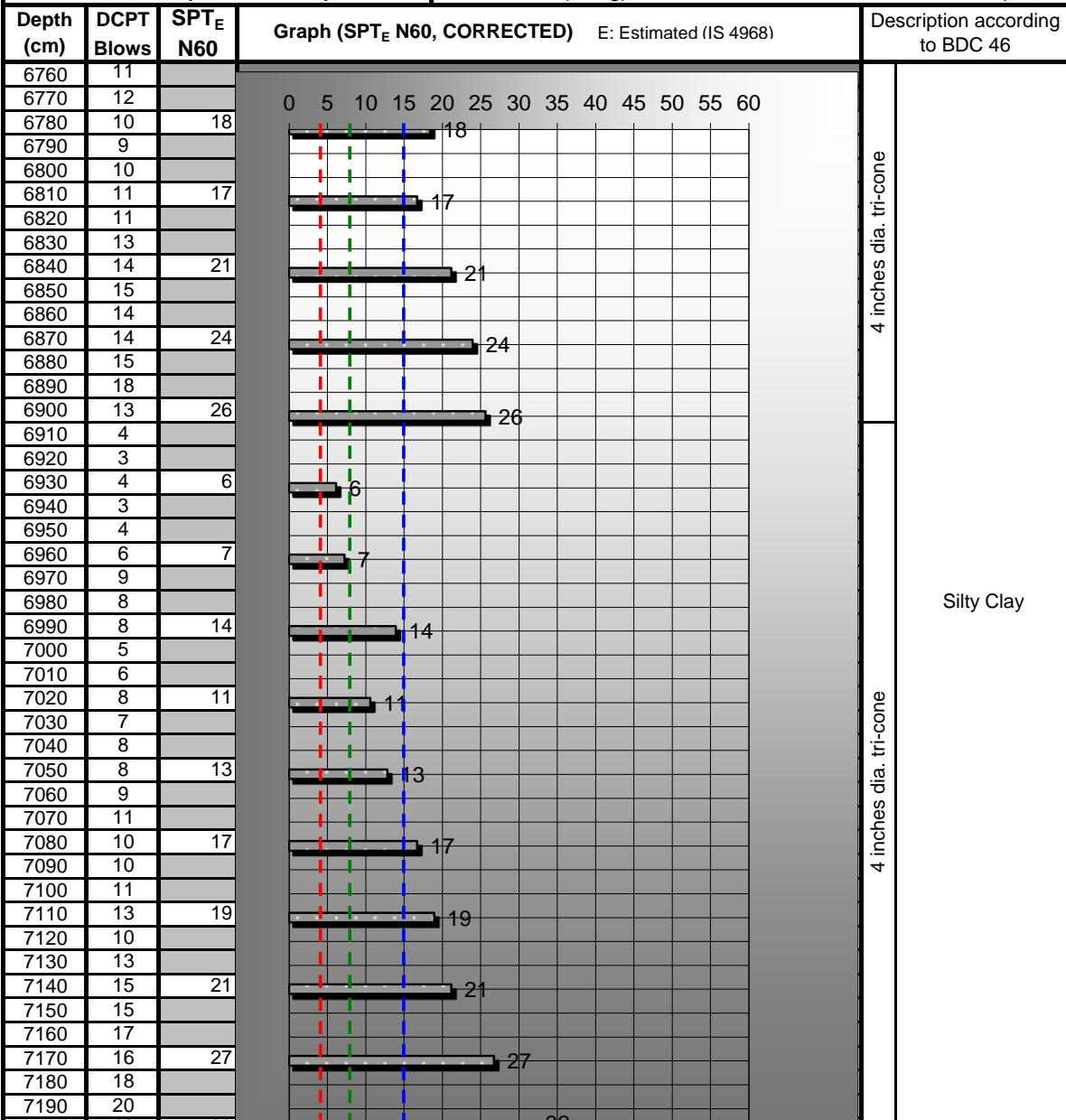
Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C.D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



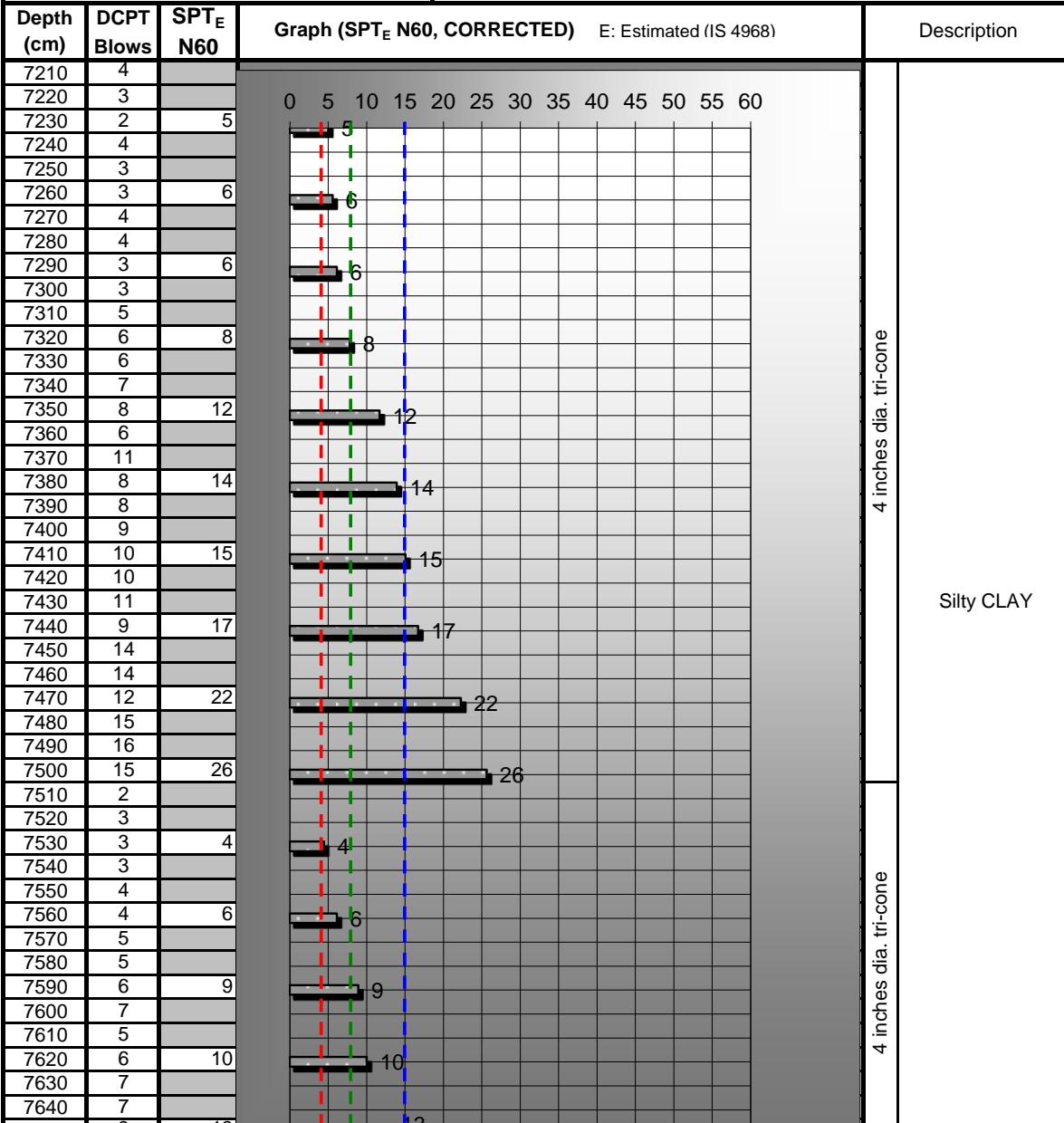
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C.D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْفَنِيَّةِ

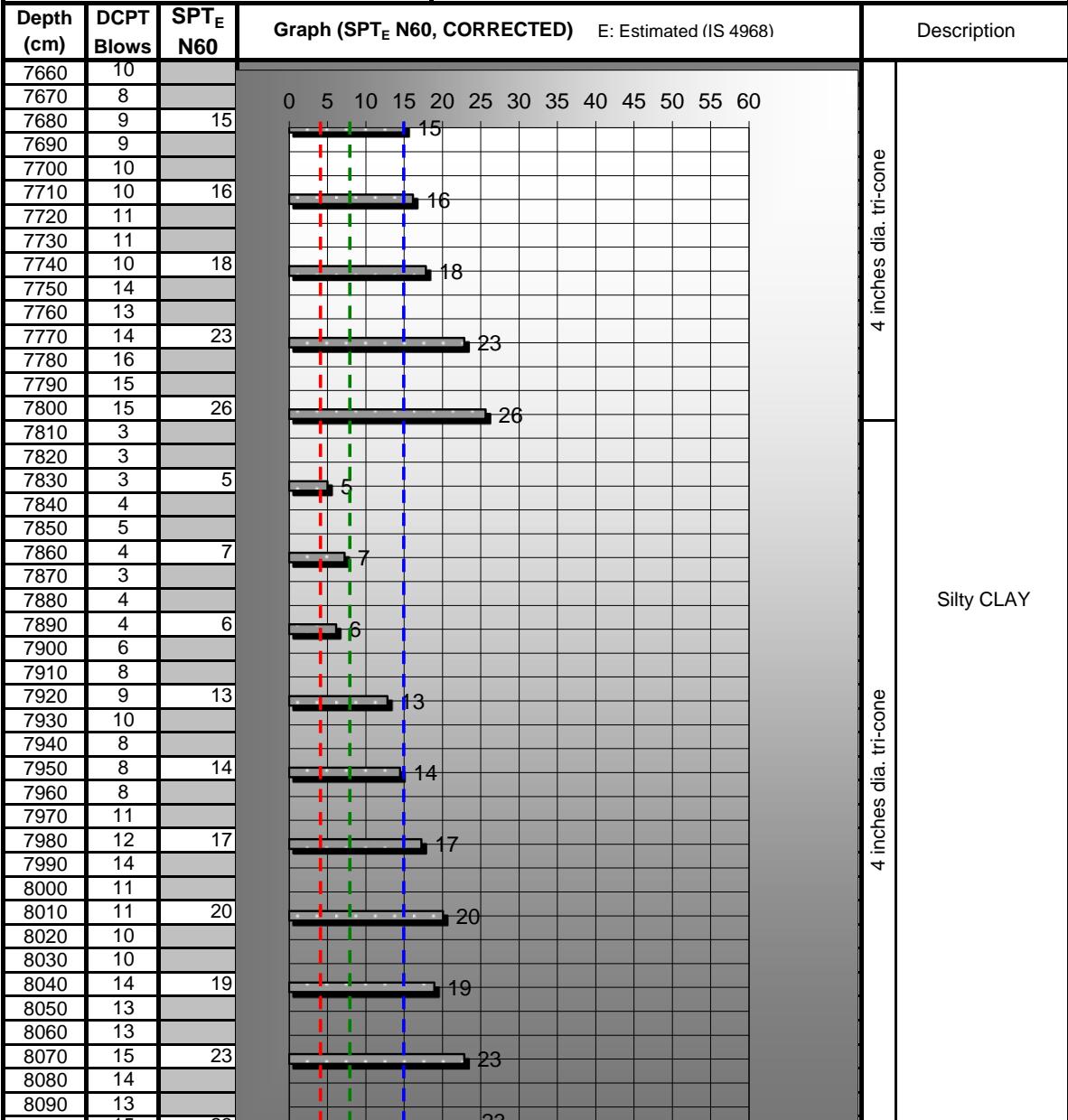
DCPT

Dynamic Cone
Penetration Test

Project: BISRI DAM

Probing: DCPVR4

Client: CDR	Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Consultant: DAR-TALEB	Depth: 93m Groundwater: +404 (Estimated)
Engineer: E. S. KIRGIZ	C./D. Rod: 60m (HW) / 6m AW & 87m BW H.Dia.: 62.5 to 114mm
Contractor: SATCON Co.	SPT Hammer: Automatic Trip Blow Rate: 36 bpm
Date: From January 21 to January 28, 2014	Anvil: Small (~2Kg) Solid Cone: 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

soft to firm & loose

firm to stiff & loose to medium



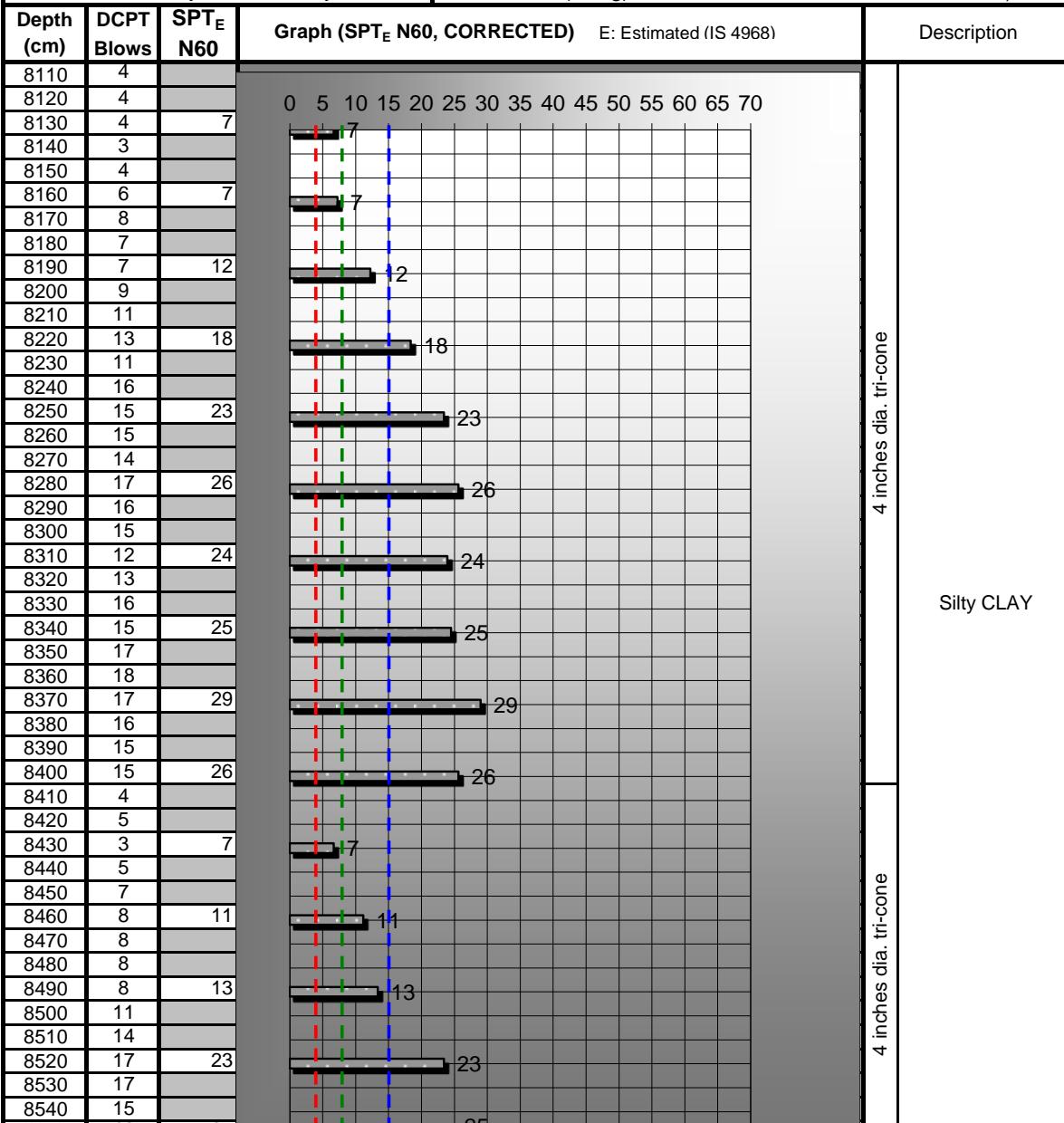
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنُوعِ وَالْإِنْجِنِيُورِيَّاتِ الْفُنْدَنِيَّةِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C./D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



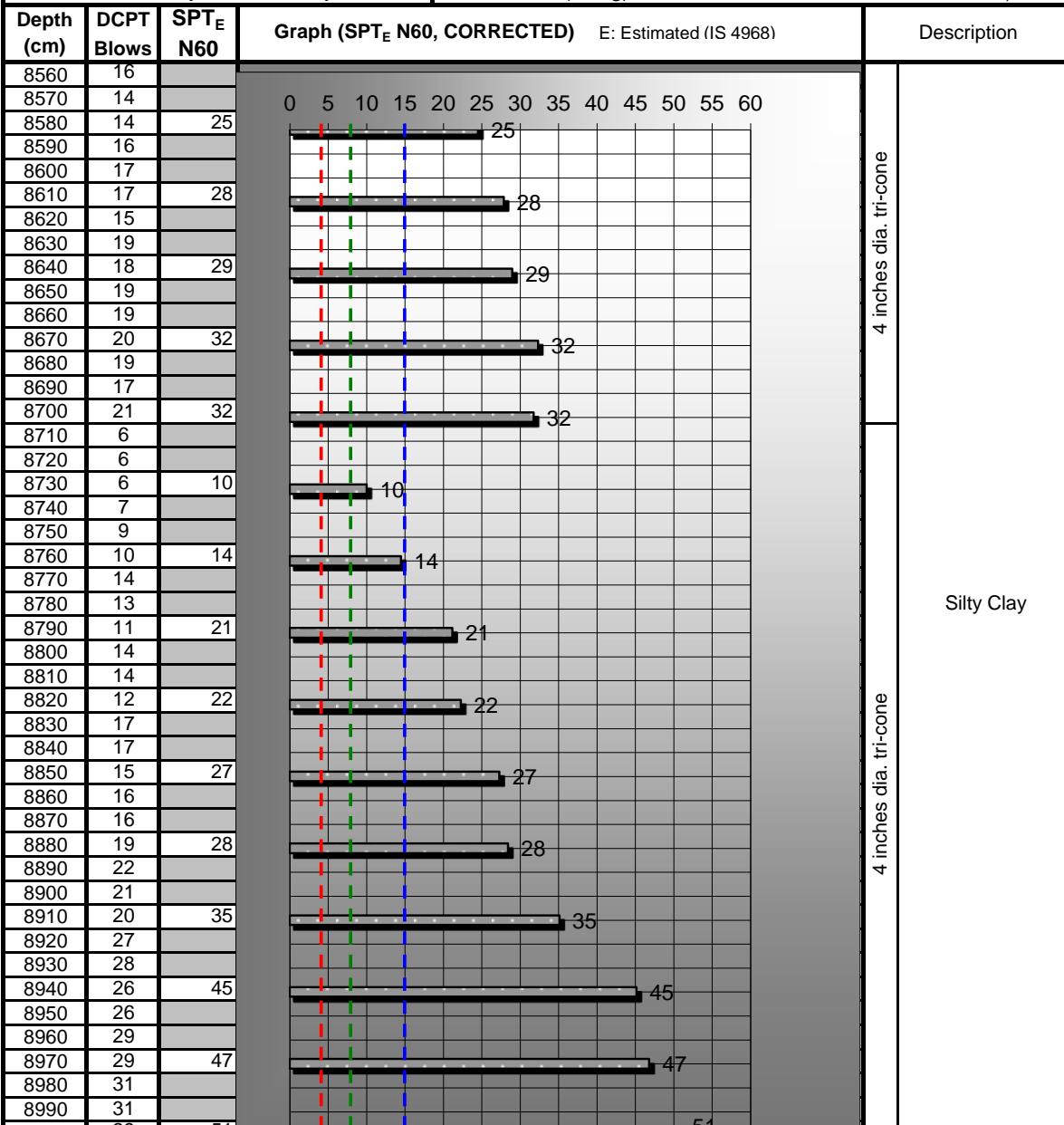
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
د.ن.ت. وشکاف تصميم الاستشارات الفنية

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C.D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium



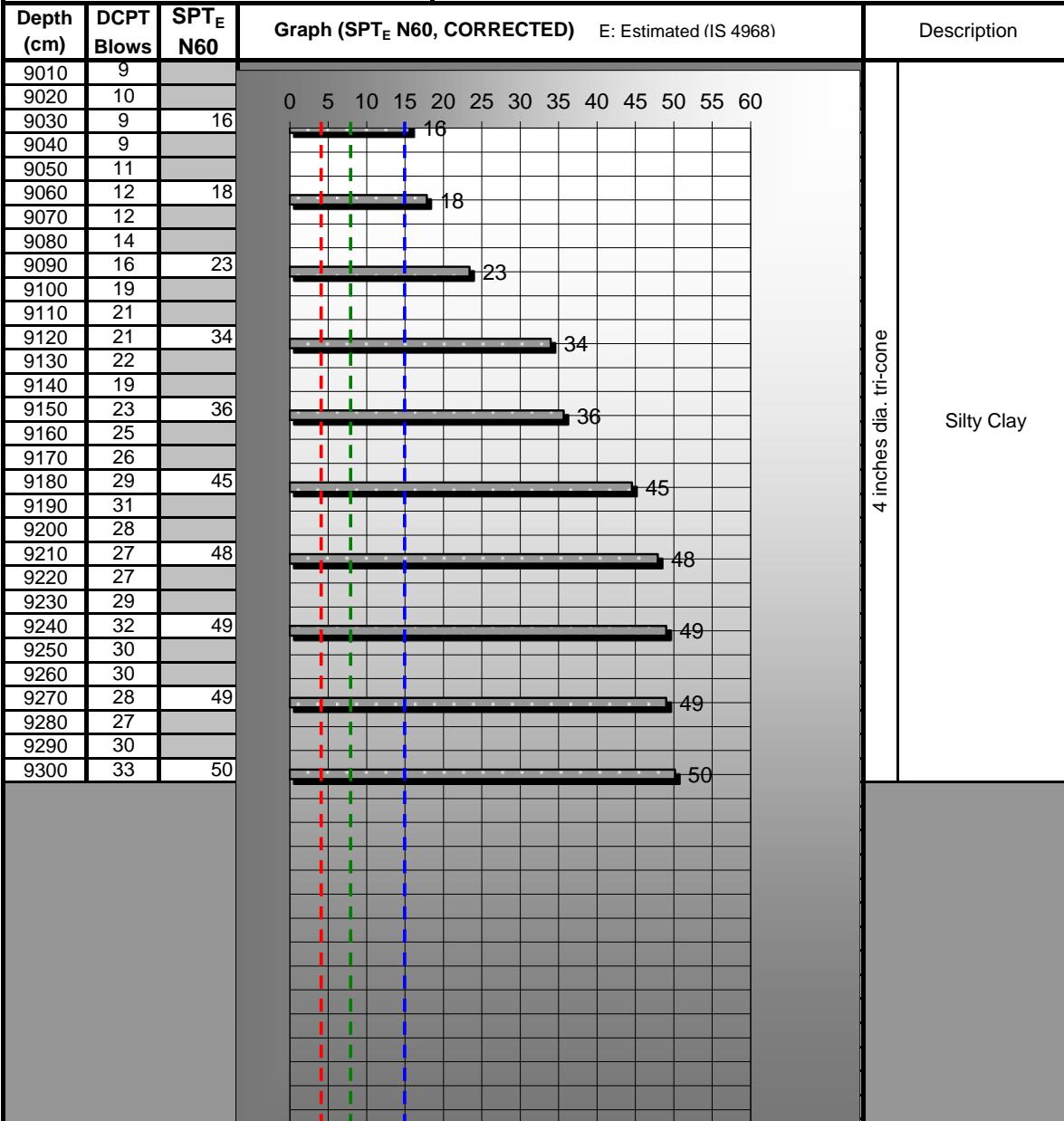
DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دَارُ الْهَنْدَاسَةِ نَازِحٌ طَالِبٌ وَشَرِكَةٌ لِلصُّنْعَادِ الْإِسْلَامِيَّةِ الْفُنْدَادِيَّةِ

DCPT
Dynamic Cone
Penetration Test

Project: BISRI DAM
Probing: DCPVR4

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From January 21 to January 28, 2014

Coordinates X: -334,621.9 Y: -61,997.94 Z: +413.75
Depth: 93m
C./D. Rod: 60m (HW) / 6m AW & 87m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°



Sands (SPT N60, Corrected):

0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

v. soft to soft & v. loose

soft to firm & loose

Clays (SPT N60, Corrected):

<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

firm to stiff & loose to medium

APPENDIX 6. GROUNDWATER MEASUREMENTS



DAR AL HANDASAH NAZIH TALEB & PARTNERS
دار الهندسة نزيح طالب وشريك

Detailed Design Of Bisri Dam: Geo. Inv. Rep.II: (Factual) / Spillway & Bottom Outlet - March 2014

BISRI DAM & LAKE (PIEZOMETERS, MARCH 2014)

Piezometer	Depth of groundwater table (m) from the NGL (updated on December 2013)	Depth of groundwater table (m) from the NGL (updated on January 2014)	Depth of groundwater table (m) from the NGL (updated on February 2014)	Depth of groundwater table (m) from the NGL (updated on March 2014)	NGL (Updated on December 2013)	Depth of groundwater table as project level (December 2013)	Depth of groundwater table as project level (January 2014)	Depth of groundwater table as project level (February 2014)	Depth of groundwater table as project level (March 2014)	Depth of groundwater table as project level (January 2013)	Depth of groundwater table as project level (April 1983)
BDC-2	35	26.2	26.49	26.48	443.16	408.2	417.0	416.7	416.7	417.6	407.4
BDC-3	5	5.75	12.24	12.2	428.353	423.4	422.6	416.1	416.2	421.4	414.5
BDC-4	12	16.8	16.25	16.23	428.585	416.6	411.8	412.3	412.4	423.1	403.1
BDC-5	33	46.28	46.65	44.4	454.435	421.4	408.2	407.8	410.0	408.8	407.8
BDC-6	16	21.6	21.96	21.3	417.86	401.9	396.3	395.9	396.6	396.7	391.5
BDC-7	7.4	8.25	7.54	7	416.33	408.9	408.1	408.8	409.3	409.2	409.1
BDC-8	12.5	17.9	18.25	42.46	440.584	428.1	422.7	422.3	398.1	397.1	397.6
BCD-9	28.6	27.27	26.95	25.93	422.417	393.8	395.1	395.5	396.5	396.1	396.6
BCD-10	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	396.4
BCD-11	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	400.3	401.5
BCD-12	17.57	26.3	17.82	17.2	413.74	396.2	387.4	395.9	396.5	396.4	396.6
BCD-13	15.22	16.4	15.24	No Access	410.7	395.5	394.3	395.5	No Access	394.4	396.5
BDC-14	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	397.7
BDC-15	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged
BDC-16	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	395.7
BDC-17	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	397
BDC-18	2.46	3.1	2.32	1.78	398.35	395.9	395.3	396.0	396.6	396.6	396.3
BDC-19	13	2.7	8.6	Damaged	399.13	386.1	396.4	390.5	Damaged	391.8	392.4
BDC-20	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	398.6
BDC-21	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	406.1
BDC-22	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	405.2	404.9
BDC-23	9.67	8.9	9.42	Damaged	414.46	404.8	405.6	405.0	Damaged	405.9	405.0
BDC-24	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	406.4	405.1
BDC-25	74.1	74.75	74.22		437.555	363.5	362.8	363.3	437.6	364.1	364.6
BDC-26	74.67	75.23	74.82	73.1	437.8	363.1	362.6	363.0	364.7		365.3
BDC-27	51.5	51.22	51.1	51.83	433.202	381.7	382.0	382.1	381.4	>358.4	387.9
BDC-28	35.8	36.3	36.9	36.6	439.6	403.8	403.3	402.7	403.0	386.4	404.5
BDC-29	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	398.2	406
BDC-30	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	>344.4	
BDC-31	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	>366.9	
BDC-32	60.15	60.85	59.63	59.25	490.22	430.1	429.4	430.6	431.0	>370.2	
BDC-38	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	408.7	404.8
BDC-42A	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	414	
BDC43	28.22	28.1	28.36	Damaged	435.71	407.5	407.6	407.4	Damaged	408.6	
BDC-50	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged
BDC-57	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged
BDB-1	19.2	26.8	20.18	Damaged	416.32	397.1	389.5	396.1	Damaged		
EV2		4.6	5.3	4.05	402.2		397.6	396.9	398.15		
EV3		Artesian flow	Artesian flow	Artesian flow	395.8		Artesian flow	Artesian flow	Artesian flow		
EV7		Artesian flow	Artesian flow	Artesian flow	396		Artesian flow	Artesian flow	Artesian flow		
EV10		20.35	21.35	15.8	420.13		399.78	398.78	404.33		
VF2		6.4	6.1	7.2	414		407.6	407.9	406.8		
VF3		5.3	5.65	6	414.4		409.1	408.75	408.4		
VF4		5.9	6.83	6	419.1		413.2	412.27	413.1		
BHVL1				0.4	396.57			396.17	396.17		
BHLA1				35	431.55			396.55	396.55		
BHLA2				54.12	459.19				405.07		
BHVR3				7.98	413.75				405.77		
BHVR5				8.27	413				404.73		