REPUBLIC OF LEBANON

COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION

DETAILED DESIGN OF BISRI DAM PROJECT

CONTRACT NO.17909

DAM FOOTPRINT

GEOTECHNICAL INVESTIGATION REPORT IV

FACTUAL

May 2014

Founded 1956

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دار الهندسة نزيه طالب وشركاه

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	☐ Draft	☑ Final
	Signature:	

1. Introduction

One borehole (BHRA1) was located (Appendix 1) and drilled within the axe of the dam (right side abutment) in a manner to determine the depth of groundwater table (Appendix 6), subsurface rock stratums and their average hydraulic conductivities (Appendix 4) within the concerned grout curtain (depth and extension of the grout curtain).

BHVRA1: 149.5m

One borehole (BHRA3) was located (Appendix 1) and drilled within the right side valley wall (upstream) in a manner to determine the depth of groundwater table (Appendix 6), subsurface rock stratums and their average hydraulic conductivities (Appendix 4) within the area where it will be inundated (water leakage from the lake).

BHRA3: 105m

Three nos. of continuous DCPT (Dynamic Cone Penetration Test) probing (DCPVR1, DCPVR2 and DCPVR3) were performed within the right side valley of the dam (downstream of the axe, Appendix 1) in a manner to estimate the relative densities and consistencies of the subsurface soil stratums (multi-layered foundation soil of the dam, Appendix 5).

DCPVR1: 80m (Noncore drilling from 77.10m to 78m and from 78.30m to 80m)

DCPVR2: 92m (Noncore drilling from 85.70m to 92m)

DCPVR3: 26m (Noncore drilling from 21.50m to 26m)

A surface geology survey as shown on Figure 1 and 2 was carried out within the right side valley wall (upstream and downstream) and abutment of the dam, in a manner to determine the distribution of cretaceous limestones (C4 and C3).

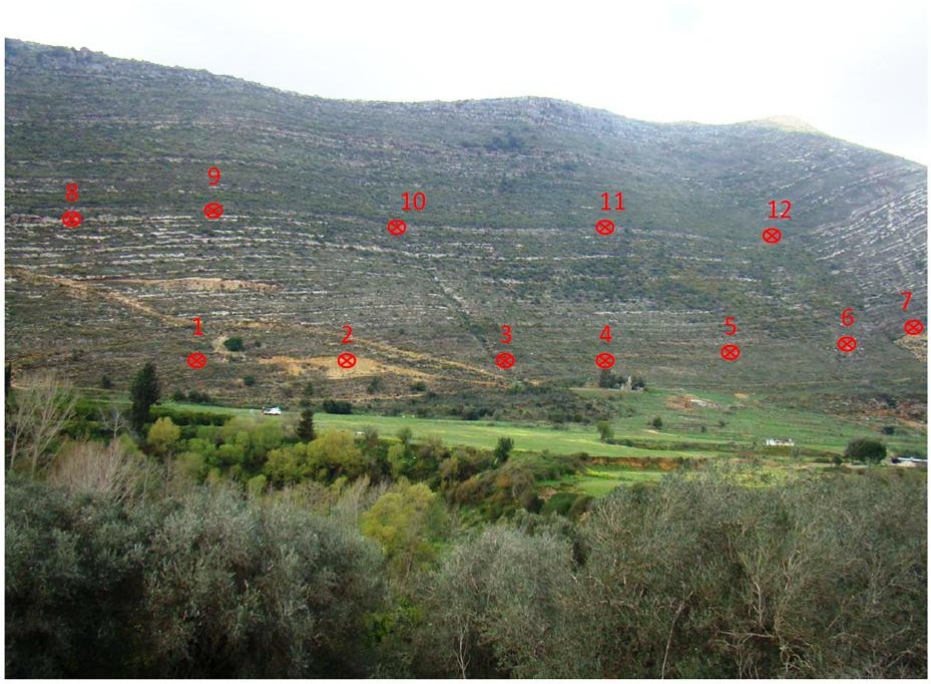


Figure 1

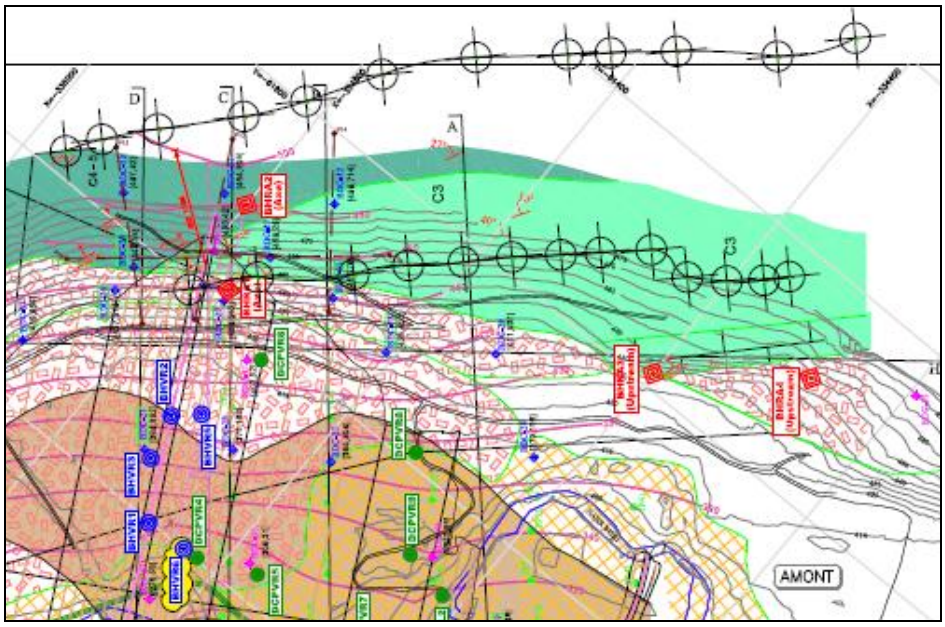


Figure 2

Surface geology of the spillway outlet (relocated) was inspected as shown on Figure 3, 4 and 5 to classify the rock-mass stratums within the outer edges of the outlet.

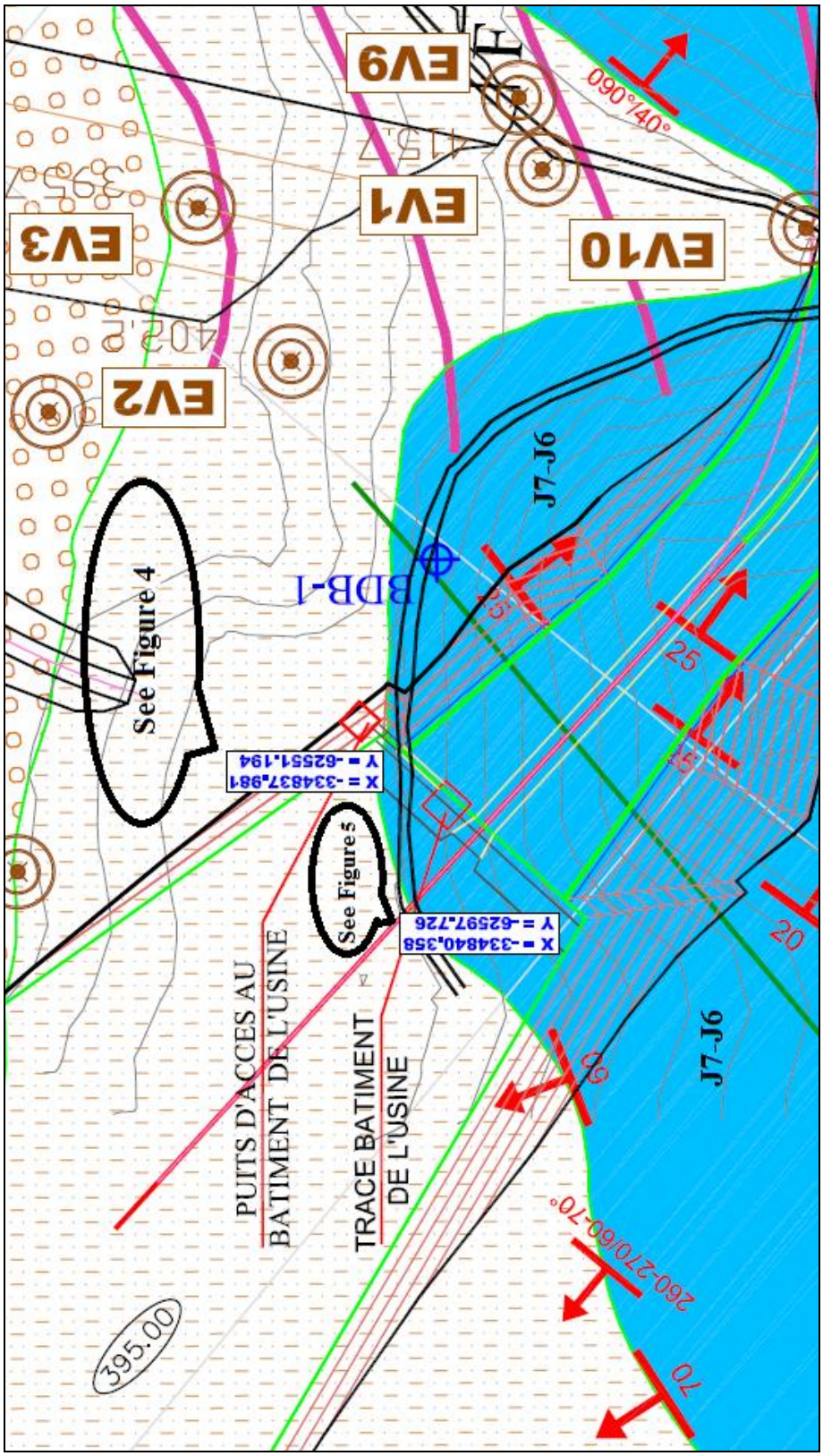


Figure 3

Figure 4

Surface stratum (Figure 4): Soil-like to rock-like rock-mass (lower Saprolite) of J7-J6 (parent rock). Half of the parent rock is disintegrated to soil; parent rock is present either as a discontinuous framework or as corestones.

Figure 5

Surface stratum (Figure 5): Rock-like rock-mass (transition from lower Saprolite to parent rock) of J7-J6 (parent rock). Less than half of the parent rock is disintegrated to soil; parent rock is present as a continuous framework.

2. Field Investigation

The field investigation was performed between March 11 and April 08, 2014. Two boreholes to a maximum depth of 149.5m and three nos. of continuous DCPT probing to a maximum depth of 92m were executed at locations shown on Figure 6. One crawler and two truck mounted rotary drill rigs as shown on Figure 7, 8 and 9 were used in field investigation.

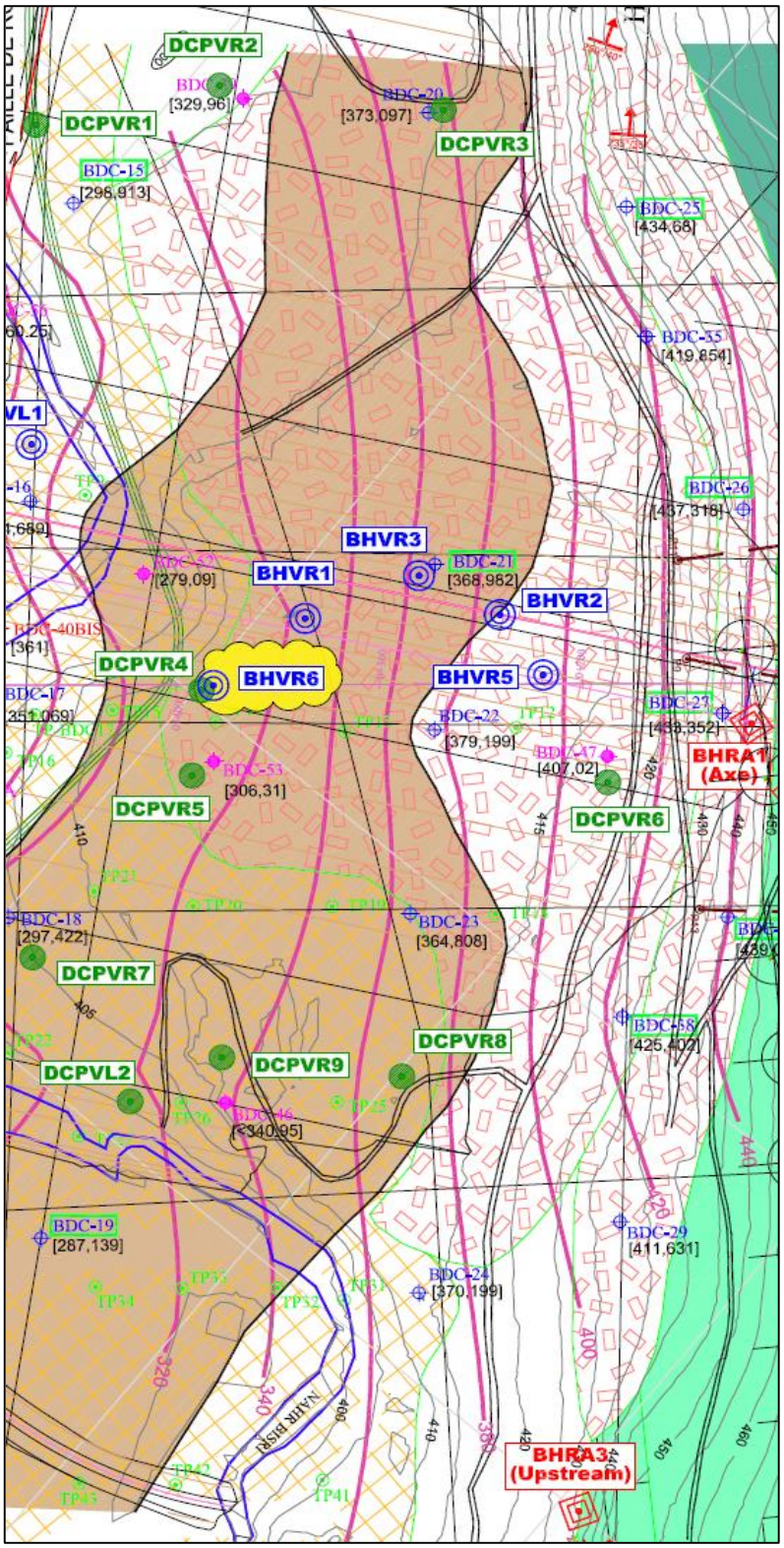


Figure 6: Locations of the boreholes and DCPT probings

BHRA1 / Piezometer (+441.98 NGL): 149.5 meters deep.

0-69m: C3 (loss of water circulation at 7m)

69-140.5m: C2b

140.5-149.5m: C2a

BHRA3 / Piezometer (+430.25 NGL): 105 meters deep.

0-66m: C3 (cavity between 15.5 and 16m, loss of water circulation at 23m)

66-105m: C2b

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

BHRA1 / Piezometer (+441.98 NGL):

Groundwater table at a depth of 37.76m (+404.22)

BHRA3 / Piezometer (+430.25 NGL):

Groundwater table at a depth of 24.55m (+405.70)

Figure 7

Figure 8

Figure 9

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 stratums 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) core barrels equipped with tungsten carbide core bits were used in continuous core drilling with BW drill rods and HW casings (see Figure 10).

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 11). 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 stratums, Standard Penetration Test (SPT) was performed at 1.5m intervals by using Split-Spoon SPT sampler in 2 inches outside diameter (see Figure 12) and disturbed samples were obtained, labelled and kept in moisture-proof containers.

Figure 10: Double tube core barrel

Figure 11: Standard wooden core boxes

Figure 12: SPT sampler

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

A solid cone as shown Figure 13 having an apex angle of 60^{o} 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 14 and 15

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

Figure 13: Solid cone used in DCPT

Figure 14: Automatic trip SPT hammer used in boreholes.

Figure 15: 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 16 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 16: Continuous DCPT probing.

Multistage Lugeon test was performed in rock stratums as shown on Figure 17 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 17: Lugeon Test

In soil stratums, Falling Head borehole water permeability test was performed as shown on Figure 18 at 3m intervals. The test results are presented in Appendix 4 of this factual report.

Figure 18: Falling Head Test

Perforated (one third of the standpipe) UPVC pipes, 60mm diameter (OD) and 2mm thick, wrapped with geotextile (PP, 150 gr/m^2) were installed into the boreholes as open standpipe piezometers with concrete heading and steel pipe protection as shown on Figure 19 in a manner to measure (see Figure 20) the depth and fluctuations of the groundwater table (Appendix 6).

Figure 19: Concrete heading and steel pipe protection

Figure 20: 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 rock stratums were encountered within the boreholes BHRA1 and BHRA3. The logs of borings are presented in Appendix 2 of this factual report.

BHRA1 / Piezometer (+441.98 NGL): 149.5 meters deep.

<u>0-69m: C3</u>

0-24m (loss of water circulation at 7m): Beige slightly and slightly to moderately weathered mainly crushed sometimes fractured medium strong sandy and marly LIMESTONE and MARL (C3)

24-69m: Combination of bluish grey and beige slightly-moderately weathered fractured and crushed weak to medium strong and medium strong fossiliferous calcareous MARLSTONE and sandy marly LIMESTONE (C3).

<u>69-140.5m: C2b</u>

69-79.5m: Bluish grey moderately weathered mainly crushed weak fossiliferous calcareous MARLSTONE (C2b).

79.5-81.5m: Reddish brown moderately to highly and highly weathered mainly crushed weak marly CLAYSTONE (C2b).

81.5-88.5m: Bluish grey slightly-moderately weathered fractured and crushed medium strong sandy calcareous MARLSTONE (C2b).

88.5-93m: Bluish grey moderately sometimes highly weathered mainly crushed weak and weak to medium strong clayey MARLSTONE (C2b).

93-103.5m: Chocolate brown to light olive slightly-moderately sometimes highly weathered fractured and crushed weak to medium strong MARLSTONE (C2b).

103.5-123m: Combination of bluish grey to beige and light brown slightly to moderately weathered fractured and crushed weak to medium strong and medium strong sandy calcareous MARLSTONE, clayey MARLSTONE and sandy marly LIMESTONE (C2b).

123-134m Chocolate brown to olive mainly slightly to moderately sometimes highly to completely weathered fractured and crushed weak to medium strong clayey MARLSTONE (C2b)

134-139.5m: Bluish grey slightly-moderately weathered mainly fractured weak to medium strong MARLSTONE (C2b).

139.5-140.5m: Bluish grey completely weathered (disintegrated to soil) MARLSTONE (C2b).

<u>140.5-149.5m: C2a</u>

140.5-149.5m: Bluish grey to dark cream slightly weathered blocky/seamy to fractured medium strong marly sometimes fossiliferous and sandy LIMESTONE (C2a).

BHRA3 / Piezometer (+430.25 NGL): 105 meters deep.

0-66m: C3

0-28.5m (cavity between 15.5 and 16m, loss of water circulation at 23m): Beige slightly-moderately and moderately weathered fractured and crushed weak to medium strong sandy and marly (in general) sometimes slightly dolomitic and fossiliferous LIMESTONE and MARL (C3)

28.5-66m: Combination of bluish grey to grey and beige slightly-moderately and moderately-highly weathered fractured and crushed weak to medium strong and medium strong slightly dolomitic sometimes fossiliferous and clayey calcareous MARLSTONE and sandy sometimes dolomitic marly LIMESTONE / LIMESTONE with MARL (C3).

66-105m: C2b

66-105m: Bluish grey to grey and dark olive slightly-moderately and moderately-highly sometimes completely weathered (disintegrated to soil) mainly fractured and crushed sometimes blocky/seamy to fractured weak and weak to medium strong fossiliferous sandy calcareous MARLSTONE (C2b).

5. Soil Sampling & Laboratory Testing

Representative soil (disturbed SPT and core samples, 33 nos.) and rock (core, 7 nos.) samples from the boreholes (BHVL1, BHVR3, BHVR5, BHLA1 and BLA2) at different depths were selected (see Figure 21 and 22) and tested in order to determine the physical and chemical properties of the subsurface stratums. List of sampling and laboratory testing is presented in Appendix 7 of this factual report.

The physical tests included:

Soil

Moisture Content, Density, Sieve Analysis, Hydrometer, Atterberg Limits, Void Ratio and Organic content

Rock

Unit Weight, Point Load Strength (PLI), Uni-axial Compressive Strength, Water Absorption, Soundness and Slake Durability

The chemical tests included:

Soil and rock

Sulphate, Chloride, pH and Calcium carbonate.

All the laboratory tests were performed in accordance with ASTM and BS standards. Laboratory test results are presented in Appendix 8 of this factual report.

Figure 21

Figure 22

6. Closure

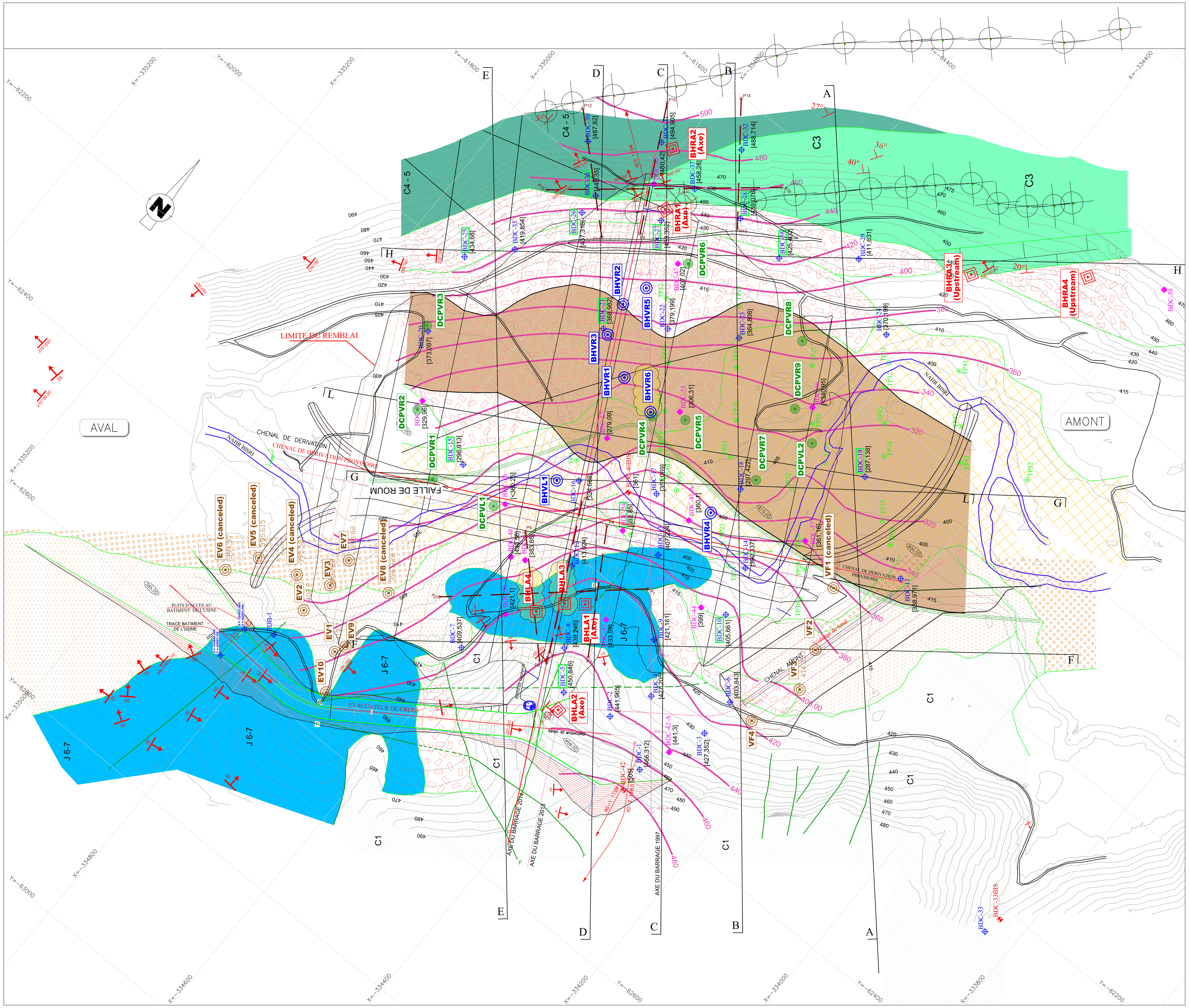
The findings presented in this factual report are based on the assumption that the subsurface soil and rock stratums and their conditions do not deviate appreciably from those disclosed in boreholes. There may be conditions pertaining to the site which were not disclosed by this subsurface soil/rock 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 / APRIL 17, 2014)

AS BUILT				
Name	X	Y	Z	Estimated Depth of Drilling or Probing from the Existing Ground Surface
BHLA1	-334,515.23	-62,242.74	431.50	105
BHLA2	-334,454.79	-62,371.82	459.40	95
BHLA3	-334,536.79	-62,259.09	425.27	50
BHLA4	-334,558.72	-62,290.58	424.18	50
BHRA1	-334,763.01	-61,778.38	441.98	125
BHRA2	-334,806.09	-61,710.80	490.25	145
BHRA3	-334,400.64	-61,589.18	430.25	100
BHRA4	-334,280.82	-61,494.60	449.85	100
BHVL1	-334,647.00	-62,141.55	396.57	100
BHVR1	-334,664.47	-61,981.54	413.97	115
BHVR2	-334,726.90	-61,908.90	414.09	140
BHVR3	-334,716.87	-61,952.20	413.80	70
BHVR4	-334,464.87	-62,045.87	398.14	75
BHVR5	-334,716.83	-61,873.08	414.37	65
BHVR6	-334,609.49	-61,994.66	414.49	115
DCPVL1	-334,689.40	-62,220.00	396.30	40
DCPVL2	-334,420.65	-61,891.76	399.00	45
DCPVR1	-334,773.47	-62,243.00	395.59	70 or as deep as possible
DCPVR2	-334,846.38	-62,186.19	397.75	70
DCPVR3	-334,906.75	-62,093.42	405.09	30
DCPVR4	-334,604.01	-61,997.65	414.40	70 or as deep as possible
DCPVR5	-334,567.60	-61,973.70	Canceled	70 or as deep as possible
DCPVR6	-334,695.07	-61,813.80	415.64	20
DCPVR7	-334,446.51	-61,975.32	397.88	70 or as deep as possible
DCPVR8	-334,515.48	-61,796.85	414.70	50
DCPVR9	-334,466.56	-61,871.24	411.33	70
EV1	-334,728.32	-62,498.94	415.61	30
EV2	-334,794.08	-62,483.06	401.70	30
EV3	-334,788.25	-62,435.79	398.29	50
EV4	-334,830.50	-62,452.70	395.60	Canceled
EV5	-334,883.00	-62,467.70	395.60	Canceled
EV6	-334,906.60	-62,507.40	395.00	Canceled
EV7	-334,790.02	-62,395.20	396.04	60
EV8	-334,722.90	-62,395.00	396.30	Canceled
EV9	-334,721.66	-62,484.86	414.85	30
EV10	-334,703.22	-62,547.08	420.20	30
VF1	-334,278.50	-62,019.70	398.60	Canceled
VF2	-334,245.19	-62,097.10	414.92	40
VF3	-334,228.11	-62,150.17	414.45	40
VF4	-334,250.50	-62,221.66	419.19	40

Profils	Extrémités	X	Y	Profondeur em (m)	Observations
P1-2	P1	-334,465	-62,175	273	La profondeur des investigations est de 60m minimum
	P2	-334,669	-62,357		
P3-4	P3	-334,468	-62,294	175	
	P4	-334,559	-62,145		
P5-6	P5	-334,514	-62,338	202	
	P6	-334,636	-62,219		
P7-8	P7	-334,511	-62,321	170	
	P8	-334,604	-62,142		
P9-10	P9	-334,768	-61,824	175	
	P10	-334,850	-61,669		
P11-12	P11	-334,804	-61,859	170	
	P12	-334,930	-61,745		
P13-14	P13	-334,674	-61,738	171	
	P14	-334,779	-61,603		
P15-16	P15	-334,899	-61,857	307	
	P16	-334,664	-61,659		
Total en (m)				Total en (m) 1,643	



LEGENDE:

1. LITHOLOGIE

QUATERNAIRE		EBOULIS,BRECHE, COUVERTURE: D'EBOULIS DE GRES, D'ARGILE ET DE BLOCS DE CALCAIRE
		SILT. SABLE. GRES DESINTEGRE
		SABLE
		LIMON
		LIMON ET GALETS
	C4-5	CENOMNIEN - TURONIEN CALCAIRE BLANCHATRE. PEU DUR. A DES NIVEAUX CALCAIRES CRAYEUX ET CALCAIRE BEIGE-BLANCHATRE PARFOIS DOLOMITIQUE. PARFOIS A POINTS ROUGES TANTOT CRISTALLINS DUR A TRES DUR. TRES KARSTIFIE. GENERALEMENT FISSURE ET FRACTURE
	C3	ALBIEN (BARRE A CARDIUM) : CALCAIRE ORANGE-JAUNÂTRE. DUR. CRISTALLIN. KARSTIFIE MARNES ET MARNO-CALCAIRE VERT-JAUNÂTRE A ABONDANTES COQUILLES
	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
	J 7	KIMMERIDGIEN: CALCAIRE GRIS. OOLITHIQUE. CRISTALLIN, DUR. KARSTIFIE. A NIVEAUX MARNEUX
	J 6	PORTLANDIEN: CALCAIRE FIN.MASSIF. RAREMENT OOLITHIQUE. OCRE TANTOT A POINTS ROUGES. A SILEX. CRISTALLIN. DURE PEU KARSTIFIE.

2. SYMBOLS

BDC1	SONDAGES REALISES EN 1982
BDC45	SONDAGES REALISES EN 1983
BDC47	SONDAGES REALISES EN 1996
	SONDAGES REALISES EN 2014 (DCPT Probing, see note 4)
	SONDAGES REALISES EN 2013 (Core Drilling, see note 1)
	SONDAGES REALISES EN 2014 (Core Drilling, see note 2)
	SONDAGES REALISES EN 2014 (Core Drilling, see note 3)
	NEW BOREHOLES
AD−1	GALERIE DE RECONNAISSANCE REALISEE ENTRE 1981 ET 1984
	COURBE D'EGALE ELEVATION DU TOIT DU SUBSTRATUM
	CHUTES D'OUTILS RELEVEES DANS LES SONDAGES
[329,96]	COTE TOIT DU SUBSTRATUM
	FAILLE IMPORTANTE
090°/40°	DIRECTION ET PENDAGE
P1 P2	PROFILS SISMIQUES A REALISER

NOTA:

1 - 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 10m 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.

3 - Continuous core drilling in rock to a depth of reaching the bottom level of the grout curtain and/or groundwater table and penetrating it as deep as possible by carrying out Lugeon test at 3m intervals.

BHRA1 shall be drilled to a depth of reaching the C2b and penetrating it 10m.

BHLA3 and BHLA4 shall be drilled in a manner to determine the thickness and distribution of the mylonitized limestone.

4 - Continuous Dynamic Cone Penetration (DCPT probing) to a depth of reaching the bedrock and penetrating it 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 automatic trip standard SPT hammer.

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

No	DATE	REV	TOP	GEO	CIV	ARCH	STRUCT	MECH	ELEC

LEBANESE REPUBLIC

COUNCIL FOR DEVELOPMENT & RECONSTRUCTION

BARRAGE BISRI

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

NOVEC

GEOLOGIE DU SITE

DRAWN	
CHECKED	
APPROVED	
SCALE	1/2 000
DATE	April 17 2014
FILENAME	PLAN G-02

PROJECT	DIVISION	SHEET	REVISION

APPENDIX 2. LOGS OF BORINGS

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	**DAR-TALEB**	**FILE NO.:**	14-001	**BOREHOLE NO.:**	**BHRA01**
PROJECT:	**BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)**				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:** 1	**OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	**3/15/2014**
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	**4/8/2014**

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
1					beige creamy slightly to moderatey weathered fractured and crushed medium strong sandy marly LIMESTONE and marl		53	0	0		
2							27	0	0		
3											
4							43	7	0		
5											
6							34	20	0		
7							34	5	0		flushing water loss at 7.0m
8											
9							30	0	0		
10							50	0	0		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery

ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:** 2	**OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
11					beige creamy slightly to moderatey weathered fractured and crushed medium strong sandy marly LIMESTONE and marl		50	0	0		
12							67	57	15		
13							45	13	0		
14							36	12	0		
15							57	27	0		
16							60	7	0		
17							34	13	0		
18							49	5	0		
19											
20											

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery
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SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:** 3	**OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
21					beige creamy slightly to moderatey weathered fractured and crushed medium strong sandy marly LIMESTONE and marl		49	5	0		
22							40	23	0		
23											
24							43	43	0		
25					bluish light green slightly weathered fractured to blocky seamy and fractured medium strong fossilious calcareous MARLSTONE		90	75	35		
26											
27							73	67	9		
28							87	87	34		
29											
30							57	47	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

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	**DAR-TALEB**	**FILE NO.:**	14-001	**BOREHOLE NO.:**	**BHRA01**
PROJECT:	**BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)**				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:** 4	**OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
31					ditto		40	17	0		
32					beige creamy slightly to moderatey weathered fractured and crushed medium strong sandy marly LIMESTONE and marl		73	30	0		
33											
34							47	16	0		
35					bluish light green slightly weathered fractured to blocky seamy and fractured medium strong fossilious calcareous MARLSTONE		40	28	0		
36											
37							57	16	0		
38											
39							63	41	0		
40					beige creamy slightly to moderatey weathered fractured and crushed medium strong sandy marly LIMESTONE and marl		37	19	10		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery

ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:** 5	**OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
41					ditto		37	19	10		
42							37	20	0		
43							55	25	7		
44					bluish light green slightly weathered fractured to blocky seamy and fractured medium strong fossilious calcareous MARLSTONE		70	70	27		
45											
46							67	40	0		
47											
48							47	23	0		
49					bluish light green slightly weathered fractured to blocky seamy and fractured medium strong fossilious calcareous MARLSTONE with transition from LIMESTONE to MARLSTONE		50	7	0		
50							34	6	0		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery

ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:** 6	**OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
51					ditto		34	6	0		
52							40	13	0		
53							43	29	0		
54											casing down to 54.0m
55							47	21	0		
56											
57							65	65	15		
58							53	34	7		
59											
60							53	31	9		

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
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:** 7	**OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
61					ditto		37	17	0		
62							34	7	0		
63							34	4	0		
64							37	20	0		
65							35	7	0		
66							30	13	7		
67											
68											
69											
70					bluish light green slightly weathered fractured to blocky seamy and fractured medium strong fossilious calcareous MARLSTONE		37	12	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

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:** 8	**OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
71					bluish light green slightly weathered fractured to blocky seamy and fractured medium strong fossilious calcareous MARLSTONE		37	12	0		
72							40	9	0		
73							42	15	0		
74							40	7	0		
75							47	25	0		
76							63	47	0		
77							57	15	0		
78							57	12	0		
79											
80					refer to next page						

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given
TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery
ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:** 9	**OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
81					choclate brown slightly weathered and highyly to completely weathered weak marly CLAYSTONE		57	12	0		
82					bluish green slightly to moderately weathered fractured weak slightly sandy clayey MARLSTONE		77	50	11		
83					bluish light grey fractured and crushed slightly sandy calcareous MARLSTONE						
84							50	38	0		
85							44	36	0		
86											
87					bluish green slightly to moderately and moderately to highly weathered crushed MARLSTONE		43	11	0		
88							40	17	0		
89											
90							57	12	0		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery

ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:**	10 **OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
91					ditto		49	20	0		
92							49	13	0		
93											
94							47	31	0		
95					chocolate brown slightly weathered fractured CLAYSTONE		43	27	0		
96											
97					light olive green slightly to moderately weathered somettimes moderately to highly weathered crushed MARSTONE		47	20	7		
98							40	10	0		
99											
100					chocolate brown slightly to moderately weathered fractured to crushed weak clayey MARLSTONE		40	30	0		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given
TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery
ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	**DAR-TALEB**	**FILE NO.:**	14-001	**BOREHOLE NO.:**	**BHRA01**
PROJECT:	**BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)**				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:**	11 **OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
101					ditto		40	30	0		
102					light olive green slightly to moderately weathered somettimes moderately to highly weathered crushed MARSTONE		53	36	7		
103							53	10	0		
104					combination of bluish green slightly to moderately weathered fractured to crushed and crushed calcareous and sandy MARLSTONE / MARLSTONE/ yellowish beige marly LIMESTONE with sandy gravely clay		57	15	0		
105											
106							45	3	0		
107											
108							44	3	0		
109							67	10	0		
110							57	17	11		
					End of Borehole @ 103.50m						

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery

ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:**	12 **OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
111					combination of bluish green slightly to moderately weathered fractured to crushed and crushed calcareous and sandy MARLSTONE / MARLSTONE/ yellowish beige marly LIMESTONE with sandy gravely clay		57	17	11		
112							73	29	17		
113											
114							60	12	7		
115							67	11	0		
116											
117							76	73	41		
118							79	29	12		
119											
120							72	19	7		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery

ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:**	13 **OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
121					ditto		43	8	0		
122							65	33	0		
123					light olive green slightly to moderately weathered fractured to crushed and crushed weak clayey MARLSTONE sometimes moderately to highly and completely weathered (like clay)		72	11	0		
124							73	27	0		
125							61	29	0		
126							47	13	0		
127							42	0	0		
128											
129											
130											

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
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:**	14 **OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
131					ditto		42	0	0		
132							33	0	0		
133							38	6	0		
134					dark bluish green slightly to moderately weathered fractured tro crushed weak MARLSTONE		40	20	0		
135											
136							37	37	0		
137							40	20	0		
138											
139							31	8	0		
140							80	14	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

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA01
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	441.98	**SHEET:**	15 **OF:** 15
EQUIPMENT:	CMV 1000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	149.5
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/15/2014
ENGINEER:	K.S.	**DRILLER:**	A.A.	**DATE FINISHED:**	4/8/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
141					ditto		80	14	0		
142					light green in general slightly weathered (sometimes slightly to moderately weathered) blocky seamy to fractured medium strong marly LIMESTONE, some times fossilious and sandy		90	80	45		
143											
144							73	51	8		
145							87	87	47		
146											
147							87	72	29		
148							80	80	47		
149							86	86	0		
150											
					End of borehole at 149.50m						

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery

ST Sample Type
SYM Symbol
WT Water Table

SATCON

SOIL STUDIES

LEGEND

SOIL SYMBOL

- GP
- GP-GM
- GM
- GC
- SW
- SP
- SP - SM
- SM-SC
- ML
- CH-MH
- OL
- OH
- PT
- Fill Material
- CLAY
- CLAYwith Sand and Gravel

ROCK SYMBOL

- Dolomite
- Chalky Limestone
- Calcarenite
- Weak Chalky LIMESTONE
- Sandy Limestone
- Basalt / volcanics
- Chert
- CL
- Creamy White LIMESTONE
- Grainstone LIMESTONE
- MARL
- SANDSTONE
- CLAYSTONE
- Oolitic LIMESTONE
- Micritic LIMESTONE
- Mudstone
- Gypsum
- Siltstone

SAMPLERS

- SPT (disturbed)
- Shelby tube
- Tricone
- Double tube

OTHERS

- **Water Level**

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

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA03
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:** 1	**OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
1					beige gravely MARL with cobbles of limestone		29	7	0		
2							38	5	0		
3											
4							27	0	0		
5											
6			50/3CM Refusal				43	0	0		
7											
8					beige slightly to moderately weathered shattered and fractured medium strong slightly sandy and dolomitic marly LIMESTONE		33	3	0		
9			50/0cm Refusal		beige MARL with gravels bluish grey to green MARL		48	25	9		
10							43	0	0		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery

ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA03
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:** 2	**OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
11			50/14cm Refusal		ditto		43	0	0		
12			50/4cm Refusal		ditto		35	0	0		
13					beige slightly weathered crushed and shattered medium strong LIMESTONE		40	11	0		
14					beige gravely MARL		36	0	0		
15					beige gravely MARL						
16					beige slightly weathered crushed and shattered medium strong LIMESTONE		23	23	0		
17					CAVITY						
18					beige slightly weathered crushed and shattered medium strong sandy slightly dolomitic LIMESTONE		36	27	0		
19					beige slightly weathered crushed and shattered medium strong sandy slightly dolomitic LIMESTONE		37	13	0		
20					refert to next page		39	19	0		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given
TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery
ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA03
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:** 3	**OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
21					bluish grey slightly weathered crushed medium strong sandy marly LIMESTONE interbedded with layers of marl		39	19	0		
22					yellowish brown slightly weathered fractured and crushed medium strong very sandy MARLSTONE (calcarous sandstone)		43	34	0		
23											
24							41	11	0		flushing water loss at 23.0m
25					yellowish brown slightly weathered crushed to fractured medium strong sandy LIMESTONE interbedded with layers of sandy clay		47	15	0		
26											
27							46	27	0		
28							35	13	9		
29					grey fractured slightly to moderately weathered fractured and crushed very sandy marly fossilious LIMESTONE		64	51	0		
30											

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given
TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery
ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA03
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:** 4	**OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
31					grey moderately weathered crushed and shattered medium strong very sandy slightly dolomitic calcareous MARLSTONE		46	16	0		
32					ditto, sometimes clayey		46	9	0		
33					yellowish beige slightly to moderately weathered crushed sandy marly slightly dolomitic LIMESTONE with interbeds of marl		34	13	0		
34											
35			50/4cm Refusal				34	3	0		
36											
37					bluish green slightly to moderately weathered crushed calcareous some times clayey MARLSTONE sometimes moderately to highly and completely weathered (like clay)		46	7	0		
38											
39							33	13	0		casing down to 39.0m
40							57	21	0		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given
TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery
ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA03
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:**	5 **OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
41					ditto		57	21	0		
42							57	3	0		
43							57	0	0		
44							65	3	0		
45											
46					beige to light cream slightly to moderately weathered fractured medium strong slightly dolomitic fissilious LIMESTONE		34	34	19		
47											
48					bluish green slightly to moderately weathered crushed some times clayey MARLSTONE sometimes moderately to highly and completely weathered (like clay)		52	3	0		
49							70	4	0		
50							57	29	0		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given
TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery
ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	**DAR-TALEB**	**FILE NO.:**	14-001	**BOREHOLE NO.:**	**BHRA03**
PROJECT:	**BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)**				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:** 6	**OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
51					ditto		57	29	0		
52							57	0	0		
53					bluish grey slightly to moderately weathered fractured to crushed medium strong calcareous sandy MARLSTONE		80	49	0		
54											
55							61	53	0		
56											
57							79	75	32		
58					from yellowish beige to bluish light grey slightly weathered mainly fractured partially crushed fossilious marly LIMESTONE with a layer of gravely sandy clay		70	67	31		
59											
60							31	16	0		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given
TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery
ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA03
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:** 7	**OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
61					ditto		42	19	0		
62					yellowish beige to light grey crushed and shattered medium strong sandy dolomitic LIMESTONE with layers of silty marl and sandy gravely clay		30	0	0		
63							35	6	0		
64							41	3	0		
65							51	12	0		
66							56	4	0		
67					bluish grey crushed sandy calcareous MARLSTONE sometimes slightly to moderately weathered, in general moderately to highly and completely weathered (like clay)		71	0	0		
68											
69			50/0cm Refusal								
70											

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given
TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery
ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	**DAR-TALEB**	**FILE NO.:**	14-001	**BOREHOLE NO.:**	**BHRA03**
PROJECT:	**BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)**				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:** 8	**OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
71			50/3cm Refusal		ditto		71	0	0		
72							90	0	0		
73							77	21	0		
74							71	37	0		
75											
76					bluish grey sometimes beige calcareous MARLSTONE sometimes sandy, in general fossilious and fractured in general slightly weathered some times highly to completely and completely weathered (like clay) with interbeds of brown clayey marl		56	0	0		
77							65	33	27		
78											
79							100	67	43		
80							93	25	12		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given
TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery
ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA03
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:** 9	**OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
81					ditto		93	25	12		
82							68	32	0		
83											
84							69	43	0		
85							64	36	16		
86											
87							77	30	9		
88							57	43	0		
89											
90							57	22	9		

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
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA03
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:**	10 **OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
91					ditto		85	23	9		
92							83	48	22		
93											
94							57	13	0		
95											
96							57	23	8		
97							65	65	48		
98											
99							50	45	15		
100							63	47	23		

SPT Standard Penetration Test
UCS Unconfined Compressive Strength
LT Layer Thickness
N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery
RQD Rock Quality Designation
SCR Solid Core Recovery

ST Sample Type
SYM Symbol
WT Water Table

SATCON
SOIL STUDIES

BORING LOG

CLIENT:	DAR-TALEB	**FILE NO.:**	14-001	**BOREHOLE NO.:**	BHRA03
PROJECT:	BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)				
LOCATION:	BISRI	**Elevation (m):**	430.25	**SHEET:**	11 **OF:** 11
EQUIPMENT:	SAT 2000	**METHOD:**	Rotary	**BOREHOLE DEPTH (m):**	105.0
HOLE DAM. (mm):	86 to 114	**CORE DIAM. (mm):**	63 to 68	**DATE STARTED:**	3/17/2014
ENGINEER:	K.S.	**DRILLER:**	NAWRAS	**DATE FINISHED:**	3/28/2014

DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm2	Remarks
101					ditto		63	47	23		
102							41	23	0		
103							55	41	0		
104							53	17	0		
105											
106											
107											
108											
109											
110											
					End of Borehole @ 105m						

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

SOIL STUDIES

LEGEND

SOIL SYMBOL

- GP
- GP-GM
- GM
- GC
- SW
- SP
- SP - SM
- SM-SC
- ML
- CH-MH
- OL
- OH
- PT
- Fill Material
- CLAY
- CLAYwith Sand and Gravel

ROCK SYMBOL

- Dolomite
- Chalky Limestone
- Calcarenite
- Weak Chalky LIMESTONE
- Sandy Limestone
- Basalt / volcanics
- Chert
- CL
- Creamy White LIMESTONE
- Grainstone LIMESTONE
- MARL
- SANDSTONE
- CLAYSTONE
- Oolitic LIMESTONE
- Micritic LIMESTONE
- Mudstone
- Gypsum
- Siltstone

SAMPLERS

- SPT (disturbed)
- Shelby tube
- Tricone
- Double tube

OTHERS

- **Water Level**

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


Besri Dam II
BHRA:01 Box:01
0.00 → 10.50
3.00
4.50
6.00
7.50
9.00
10.50


Besri Dam II
BH RL
BHRA:01 Box:02
10.50 → 18.00
12.00
13.50
15.00
16.50
18.00


Besri Dam II
BHRA:01 Box:03
18.00 → 25.50
21.00
22.50
24.00
25.50


Besri Dam II
BHRA:01 Box:04
25.50 → 33.00
27.00
28.50
30.00
31.50
33.00


Besri Dam II
BHRA:01 Box:05
33.00 → 40.50
36.00
37.50
39.00
40.50


Besri Dam II
BHRA:01 Box:06
40.50 → 46.50
43.50
43.00
46.50


Besri Dam II
BHRA:01 Box:07
46.50 → 55.50
49.50
51.00
52.50
54.00
55.50


Besri Dam II
BHRA:01 Box:08
55.50 → 63.00
57.00
60.00
63.00


Besri Dam II
BHRA:01 Box:09
63.00 → 73.50
66.00
67.5
69.00
70.50
72.00
73.50


Besri Dam II
BHRA:01 Box: 10
73.00 → 81.00
76.50
78.00
79.50
81.00


Besri Dam II
BHRA:01 Box: 11
81.00 → 88.50
82.50
84.00
85.50
87.00
88.50


Besri Dam II
BHRA:01 Box: 12
88.50 → 96.00
91.50
93.00
94.50
96.00


Besri Dam II
BHRA:01 Box. 13
96.00 → 103.50
97.50
99.00
100.50
102.00
103.50


Besri Dam II
BHRA:01 Box: 14
103.50 → 111.0 m
106.50
108.00
109.50
111.00


Besri Dam II
BHRA:01 Box:15
111.0 → 117.0m
117.00


BH:R
Besri Dam II
BHRA:01 Box:16
117.0 → 123.50m
118.50
120.00
121.50
123.00


Besri Dam II
BHRA:01 Box:17
123.50 → 130.50m
126.00
127.50
129.00
130.50


Besri Dam II
BHRA:01 Box:18
130.50 → 140.50m
133.50
135.00
136.50
138.00
139.50


Besri Dam II
BHRA:01 Box:19
140.50 → 145.50m
142.50
144.00
146.50


Besri Dam II
BHRA:01 Box:20
145.50 → 149.50m
147.00
148.50
149.50


BH: R
Besri Dam II
BH RA: 03 Box: 01
0.00 → 10.50
3.00
4.50
6.00
7.50
8.00 →
10.50


Besri Dam II
BH RA: 03 Box: 02
10.50 → 22 .00
13.50
15.00
18.00
19.50
21.00


Besri Dam II
BH RA:03 Box:03
22.00 → 30.50


Besri Dam II
BH RA:03 Box:04
30.50 → 40.50


Besri Dam II
BH RA:03 Box:05
40.50 → 48.50


Besri Dam II
BH RA:03 Box:06
48.50 → 55.00


Besri Dam II
BH RA:03 Box:07
55.00 → 62.00


Besri Dam II
BH RA:03 Box:08
62.00 → 70.50


Besri Dam II
BH RA:03 Box:09
70.50 → 76.00


Besri Dam II
BH RA:03 Box:10
76.00 → 81.00


Besri Dam II
BH RA:03 Box:11
81.00 → 87.00
82.50
84.00
85.50
87.00


Besri Dam II
BH RA:03 Box:12
87.00 → 93.00
91.50
93.00


Besri Dam II
BHRA:03 Box:13
93.00 → 100.00


Besri Dam II
BHRA:03 Box:14
100.00 → 105.00

APPENDIX 4. BOREHOLE WATER PERMEABILITY & LUGEON TEST RESULTS

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BISRI DAM

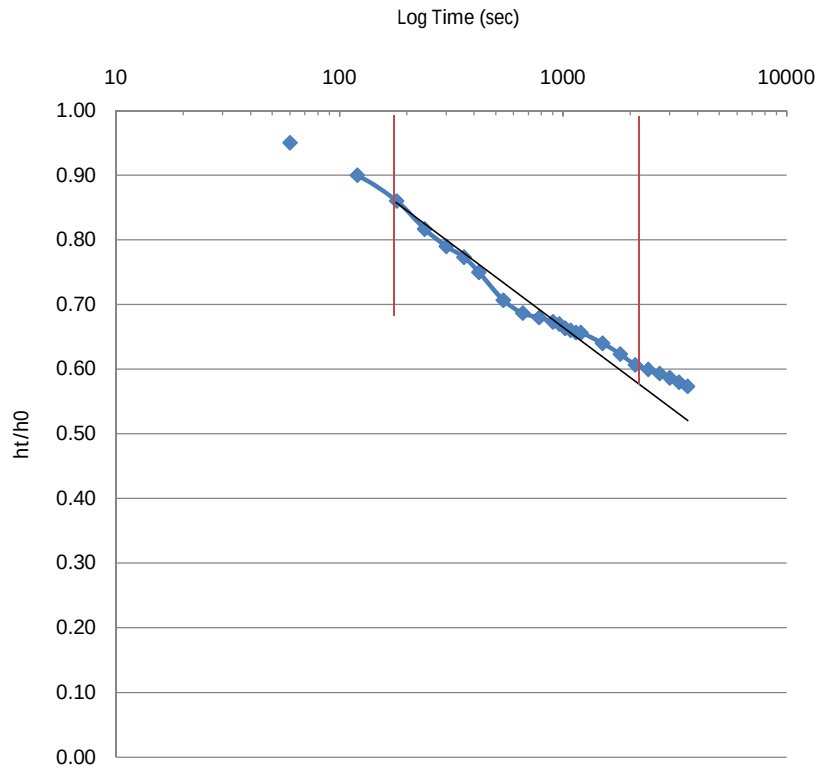
DAM FOOTPRINT

FALLING HEAD BOREHOLE WATER PERMEABILITY TEST

BHRA1	Pre-T.W.D (m):	0	G.W.D (m):	37.76	**Date:**		15.03.2014		
Test Interval	0	to	3		**K(m/sec, FHM):**		**2.3116E-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 (Pre-T.W.D) / Groundwater depth (GWD)		h_0	3	m	0	0.00	0	1.00	3.00
Length of uncased test interval below the pre-test water level		L	3	m	1	0.15	60	0.95	2.85
					2	0.30	120	0.90	2.70
					3	0.42	180	0.86	2.58
					4	0.55	240	0.82	2.45
					5	0.63	300	0.79	2.37
					6	0.68	360	0.77	2.32
H1		2.58	m		7	0.75	420	0.75	2.25
H2		1.72	m		9	0.88	540	0.71	2.12
t1 (as per graph)		180	sec.		11	0.94	660	0.69	2.06
t2		2100	sec.		13	0.96	780	0.68	2.04
					15	0.98	900	0.67	2.02
					16	0.99	960	0.67	2.01
					17	1.01	1020	0.66	1.99
					18	1.02	1080	0.66	1.98
					19	1.03	1140	0.66	1.97
					20	1.03	1200	0.66	1.97
					25	1.08	1500	0.64	1.92
					30	1.13	1800	0.62	1.87
					35	1.18	2100	0.61	1.82
					40	1.20	2400	0.60	1.80
					45	1.22	2700	0.59	1.78
					50	1.24	3000	0.59	1.76
					55	1.26	3300	0.58	1.74
					60	1.28	3600	0.57	1.72

Falling Head Method (FHM)

$$K_{(m/sec)} = \frac{D^2}{8L(t2-t1)} Ln\left(\frac{L}{D}\right) Ln\left(\frac{H1}{H2}\right)$$



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

Semi-Pervious

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BISRI DAM

DAM FOOTPRINT

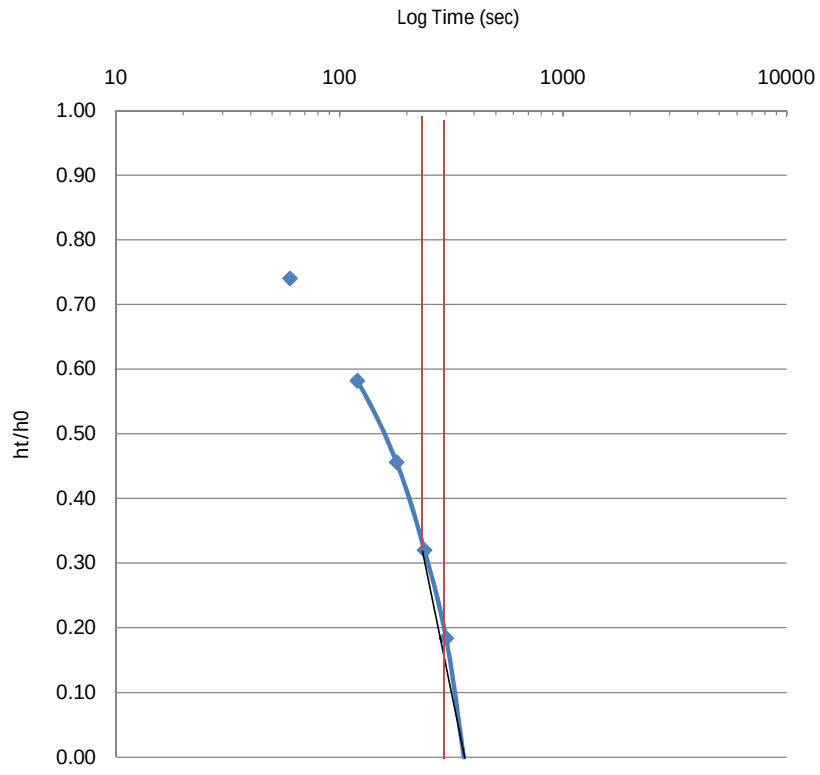
FALLING HEAD BOREHOLE WATER PERMEABILITY TEST

BHRA1	Pre-T.W.D (m):	5	G.W.D (m):	37.76	**Date:**		15.03.2014		
Test Interval	3	to	6		**K(m/sec, FHM):**		**2.0920E-05**		
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 (Pre-T.W.D) / Groundwater depth (GWD)		h_0	5	m	0	0.00	0	1.00	5.00
Length of uncased test interval below the pre-test water level		L	1	m	1	1.30	60	0.74	3.70
					2	2.09	120	0.58	2.91
					3	2.72	180	0.46	2.28
					4	3.40	240	0.32	1.60
					5	4.08	300	0.18	0.92
					6	5.00	360	0.00	0.00

Falling Head Method (FHM)

$$K_{(m/sec)} = \frac{D^2}{8L(t2-t1)} Ln\left(\frac{L}{D}\right) Ln\left(\frac{H1}{H2}\right)$$

H1	1.6	m
H2	0.92	m
t1 (as per graph)	240	sec.
t2	300	sec.



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

Pervious

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BISRI DAM

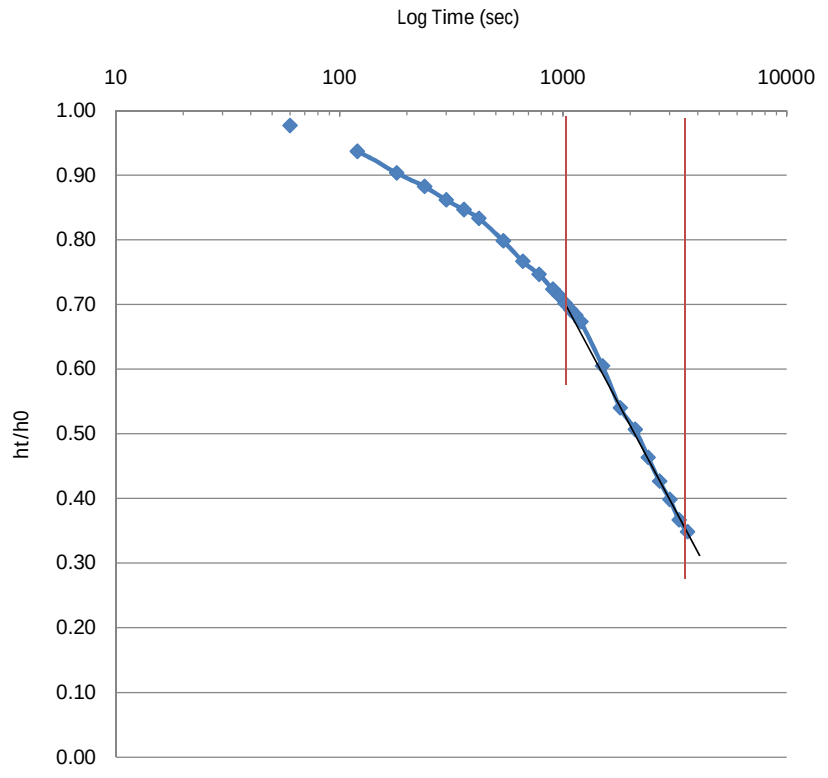
DAM FOOTPRINT

FALLING HEAD BOREHOLE WATER PERMEABILITY TEST

BHRA1	Pre-T.W.D (m):	6	G.W.D (m):	37.76	**Date:**		15.03.2014		
Test Interval	6	to	9		**K(m/sec, FHM):**		**2.9712E-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 (Pre-T.W.D) / Groundwater depth (GWD)		h_0	6	m	0	0.00	0	1.00	6.00
Length of uncased test interval below the pre-test water level		L	3	m	1	0.14	60	0.98	5.86
					2	0.38	120	0.94	5.62
					3	0.58	180	0.90	5.42
					4	0.71	240	0.88	5.29
					5	0.83	300	0.86	5.17
					6	0.92	360	0.85	5.08
H1		4.21	m		7	1.00	420	0.83	5.00
H2		2.09	m		9	1.21	540	0.80	4.79
t1 (as per graph)		1020	sec.		11	1.40	660	0.77	4.60
t2		3600	sec.		13	1.52	780	0.75	4.48
					15	1.66	900	0.72	4.34
					16	1.72	960	0.71	4.28
					17	1.79	1020	0.70	4.21
					18	1.85	1080	0.69	4.15
					19	1.90	1140	0.68	4.10
					20	1.96	1200	0.67	4.04
					25	2.37	1500	0.60	3.63
					30	2.76	1800	0.54	3.24
					35	2.96	2100	0.51	3.04
					40	3.22	2400	0.46	2.78
					45	3.44	2700	0.43	2.56
					50	3.61	3000	0.40	2.39
					55	3.80	3300	0.37	2.20
					60	3.91	3600	0.35	2.09

Falling Head Method (FHM)

$$K_{(m/sec)} = \frac{D^2}{8L(t2-t1)} Ln\left(\frac{L}{D}\right) Ln\left(\frac{H1}{H2}\right)$$



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

Semi-Pervious

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

BISRI DAM

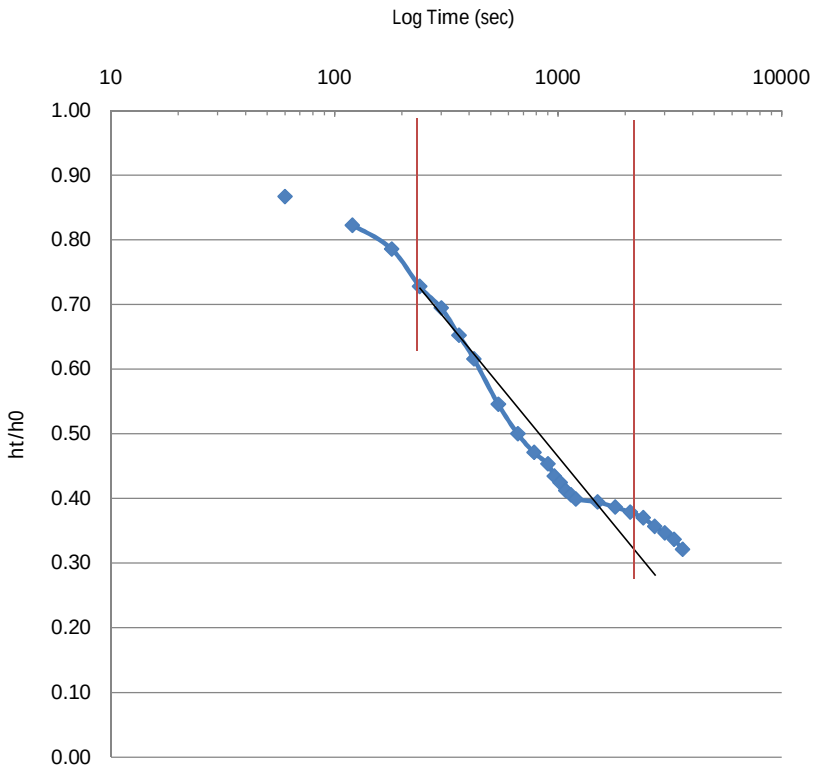
DAM FOOTPRINT

FALLING HEAD BOREHOLE WATER PERMEABILITY TEST

BHRA1	Pre-T.W.D (m):	10.5	G.W.D (m):	37.76	**Date:**		15.03.2014		
Test Interval	9	to	12		**K(m/sec, FHM):**		**7.7511E-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 (Pre-T.W.D) / Groundwater depth (GWD)		h_0	9	m	0	0.00	0	1.00	9.00
Length of uncased test interval below the pre-test water level		L	1.5	m	1	1.20	60	0.87	7.80
					2	1.60	120	0.82	7.40
					3	1.93	180	0.79	7.07
					4	2.45	240	0.73	6.55
					5	2.75	300	0.69	6.25
					6	3.13	360	0.65	5.87
H1		6.55	m		7	3.46	420	0.62	5.54
H2		2.89	m		9	4.09	540	0.55	4.91
t1 (as per graph)		240	sec.		11	4.50	660	0.50	4.50
t2		2100	sec.		13	4.76	780	0.47	4.24
					15	4.92	900	0.45	4.08
					16	5.09	960	0.43	3.91
					17	5.18	1020	0.42	3.82
					18	5.29	1080	0.41	3.71
					19	5.35	1140	0.41	3.65
					20	5.41	1200	0.40	3.59
					25	5.45	1500	0.39	3.55
					30	5.52	1800	0.39	3.48
					35	5.59	2100	0.38	3.41
					40	5.67	2400	0.37	3.33
					45	5.79	2700	0.36	3.21
					50	5.88	3000	0.35	3.12
					55	5.97	3300	0.34	3.03
					60	6.11	3600	0.32	2.89

Falling Head Method (FHM)

$$K_{(m/sec)} = \frac{D^2}{8L(t2-t1)} Ln\left(\frac{L}{D}\right) Ln\left(\frac{H1}{H2}\right)$$



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

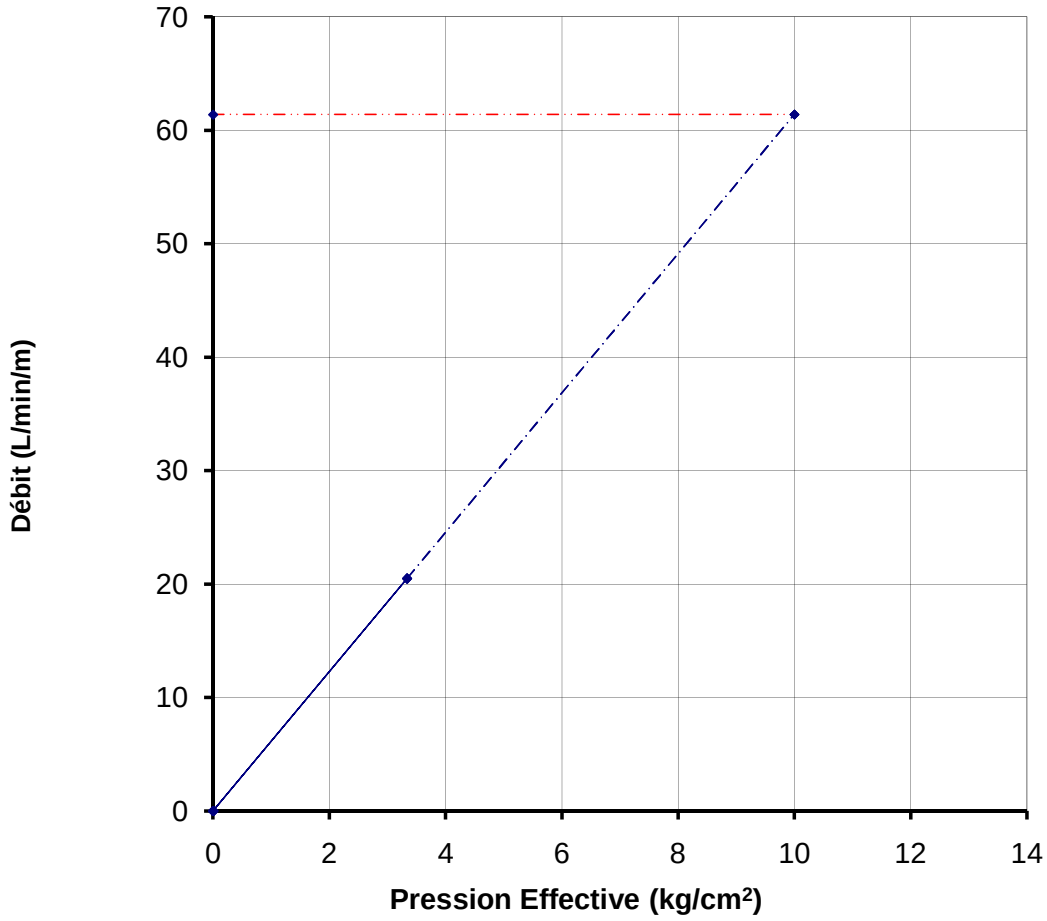
Semi-Pervious to Pervious

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/17/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**12.00 m** à **15.00 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
2	615	10	3	61.5	20.50	1.4	6.09E-02	3.339



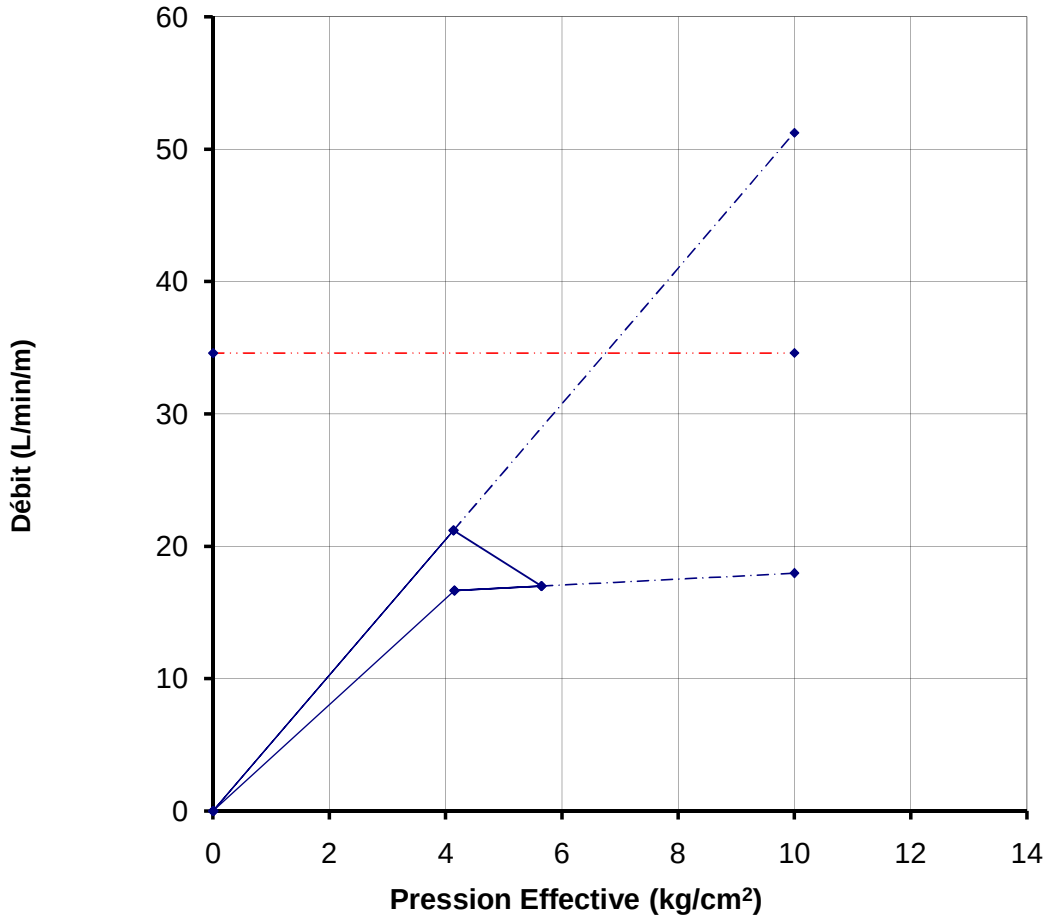
Lugeon = 61.39 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/17/2014**
	SONDAGE No.:	**BHRA 01**	
	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
2.5	500	10	3	50	16.67	1.7	4.95E-02	4.151
4	153	3	3	51	17.00	1.7	5.05E-02	5.650
2.5	636	10	3	63.6	21.20	1.7	6.30E-02	4.137



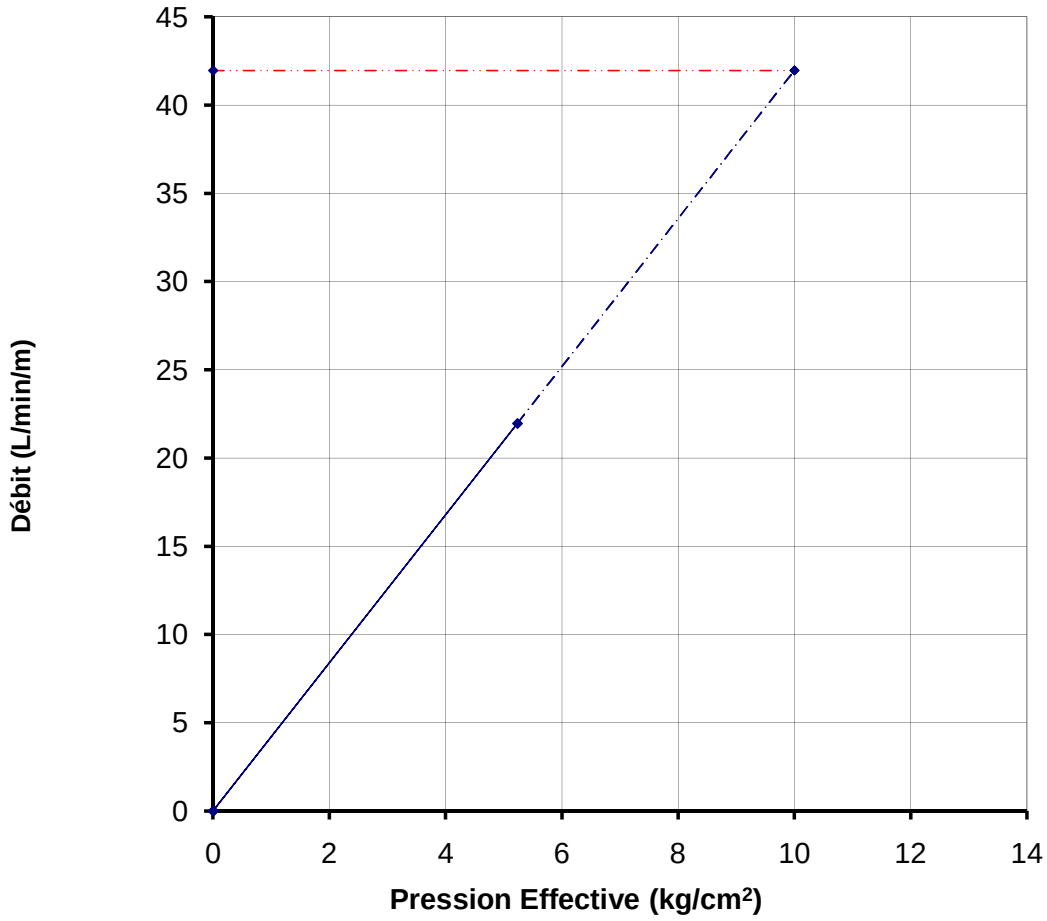
Lugeon = 34.61 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/18/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**21.00 m** à **24.00 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	659	10	3	65.9	21.97	2.3	6.52E-02	5.235



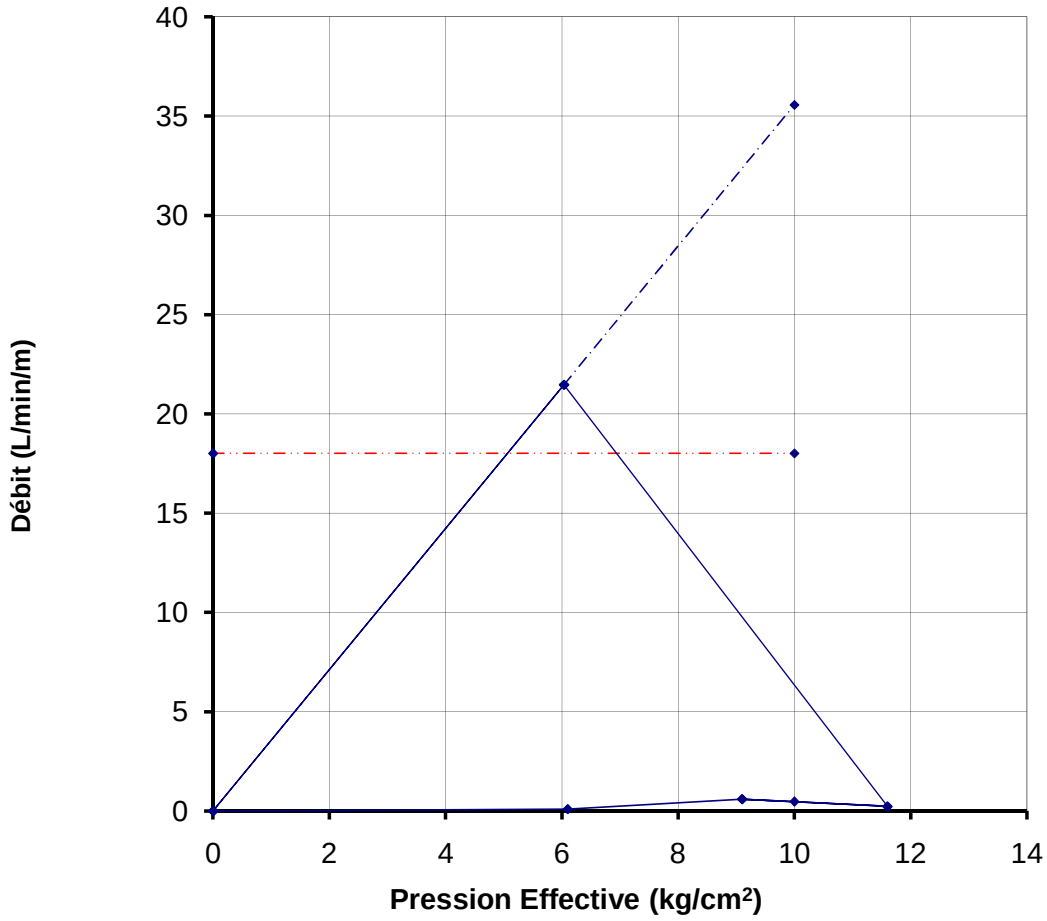
Lugeon = 41.96 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/18/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**24.00 m** à **27.00 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
3.5	3	10	3	0.3	0.10	2.6	2.97E-04	6.100
6.5	18	10	3	1.8	0.60	2.6	1.78E-03	9.098
9	7	10	3	0.7	0.23	2.6	6.93E-04	11.599
3.5	644	10	3	64.4	21.47	2.6	6.38E-02	6.036



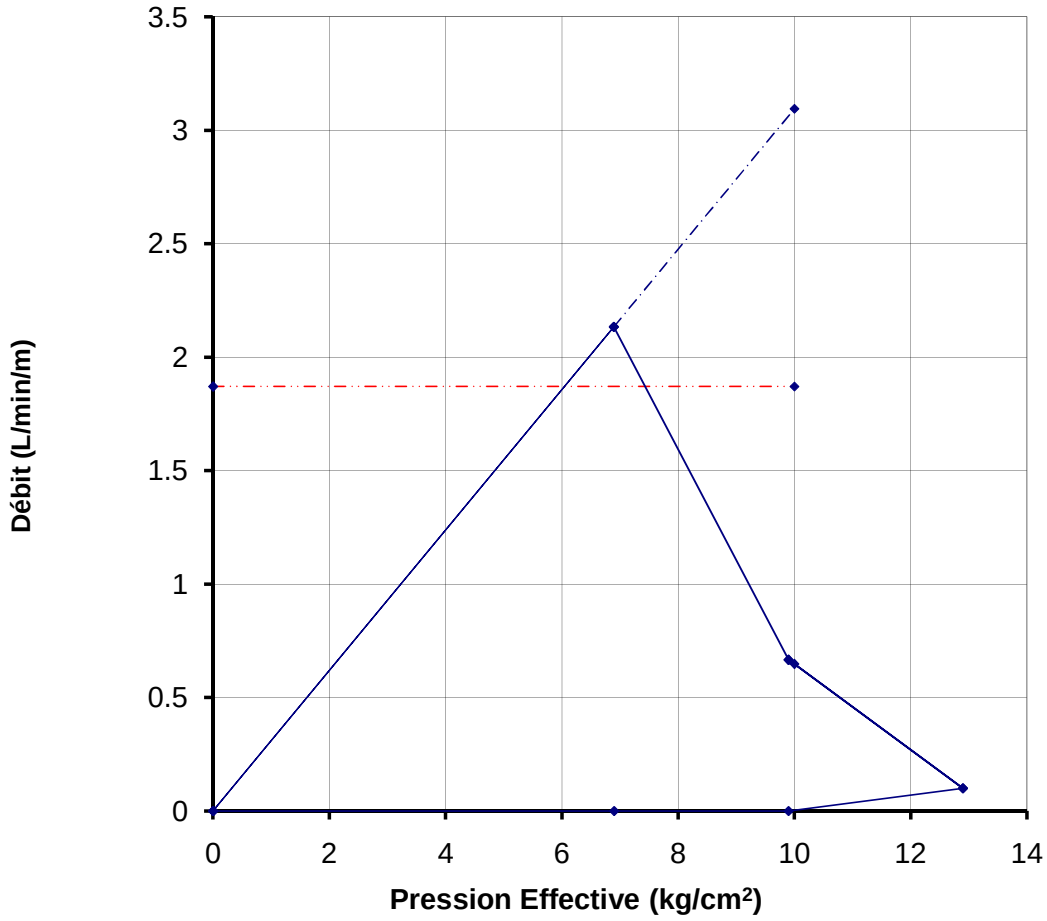
Lugeon = 18.02 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/18/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**27.00 m** à **30.00 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
4	64	10	3	6.4	2.13	2.9	6.34E-03	6.894
7	20	10	3	2	0.67	2.9	1.98E-03	9.898
10	3	10	3	0.3	0.10	2.9	2.97E-04	12.900
7	0	10	3	0	0.00	2.9	0.00E+00	9.900
4	0	10	3	0	0.00	2.9	0.00E+00	6.900



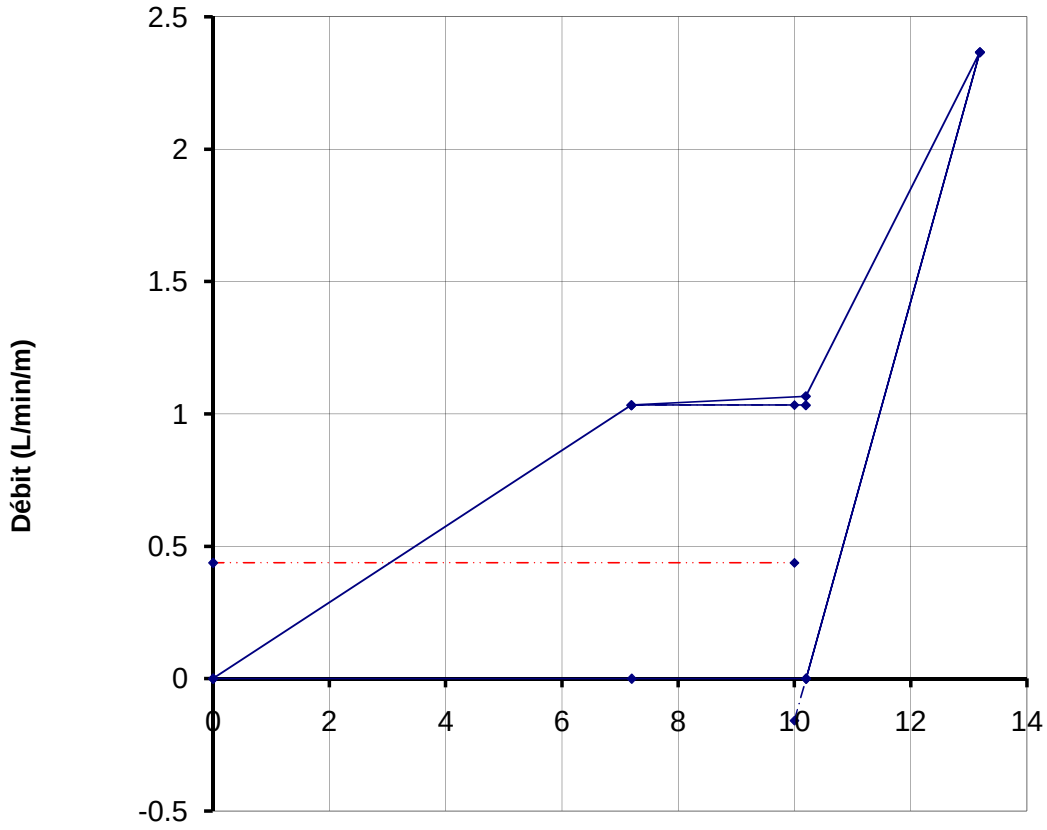
Lugeon = 1.87 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/18/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**30.00 m** à **33.00 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
4	31	10	3	3.1	1.03	3.2	3.07E-03	7.197
7	32	10	3	3.2	1.07	3.2	3.17E-03	10.197
10	71	10	3	7.1	2.37	3.2	7.03E-03	13.193
7	0	10	3	0	0.00	3.2	0.00E+00	10.200
4	0	10	3	0	0.00	3.2	0.00E+00	7.200



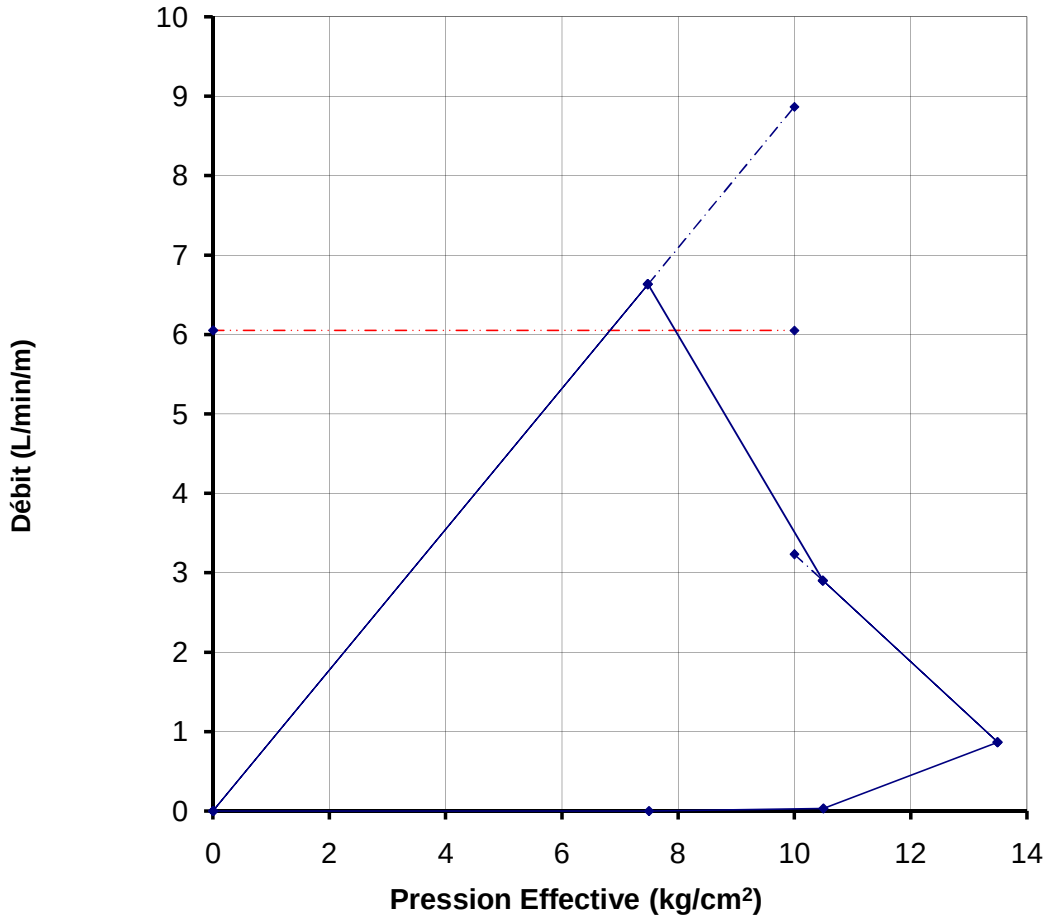
Lugeon = 0.44 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/19/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**33.00 m** à **36.00 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
4	199	10	3	19.9	6.63	3.5	1.97E-02	7.480
7	87	10	3	8.7	2.90	3.5	8.61E-03	10.491
10	26	10	3	2.6	0.87	3.5	2.57E-03	13.497
7	1	10	3	0.1	0.03	3.5	9.90E-05	10.500
4	0	10	3	0	0.00	3.5	0.00E+00	7.500



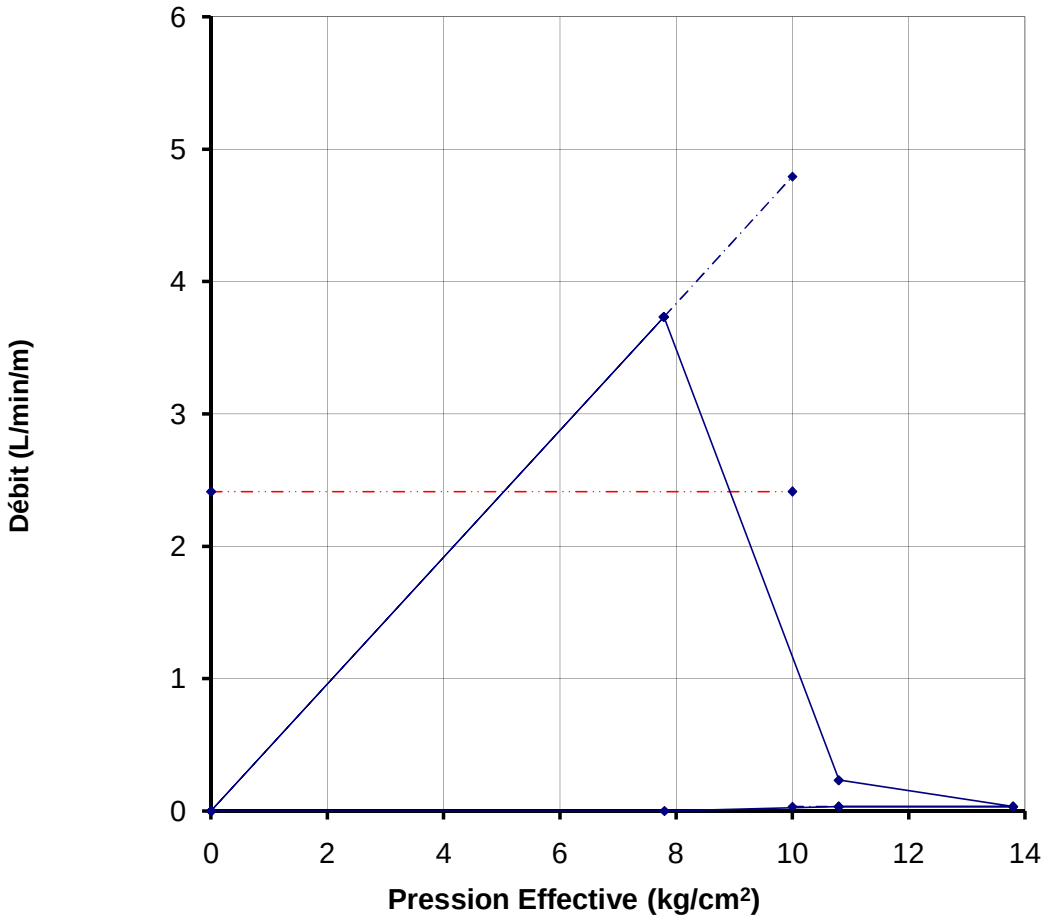
Lugeon = 6.05 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/19/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**36.00 m** à **39.00 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
4	112	10	3	11.2	3.73	3.8	1.11E-02	7.789
7	7	10	3	0.7	0.23	3.8	6.93E-04	10.799
10	1	10	3	0.1	0.03	3.8	9.90E-05	13.800
7	1	10	3	0.1	0.03	3.8	9.90E-05	10.800
4	0	10	3	0	0.00	3.8	0.00E+00	7.800

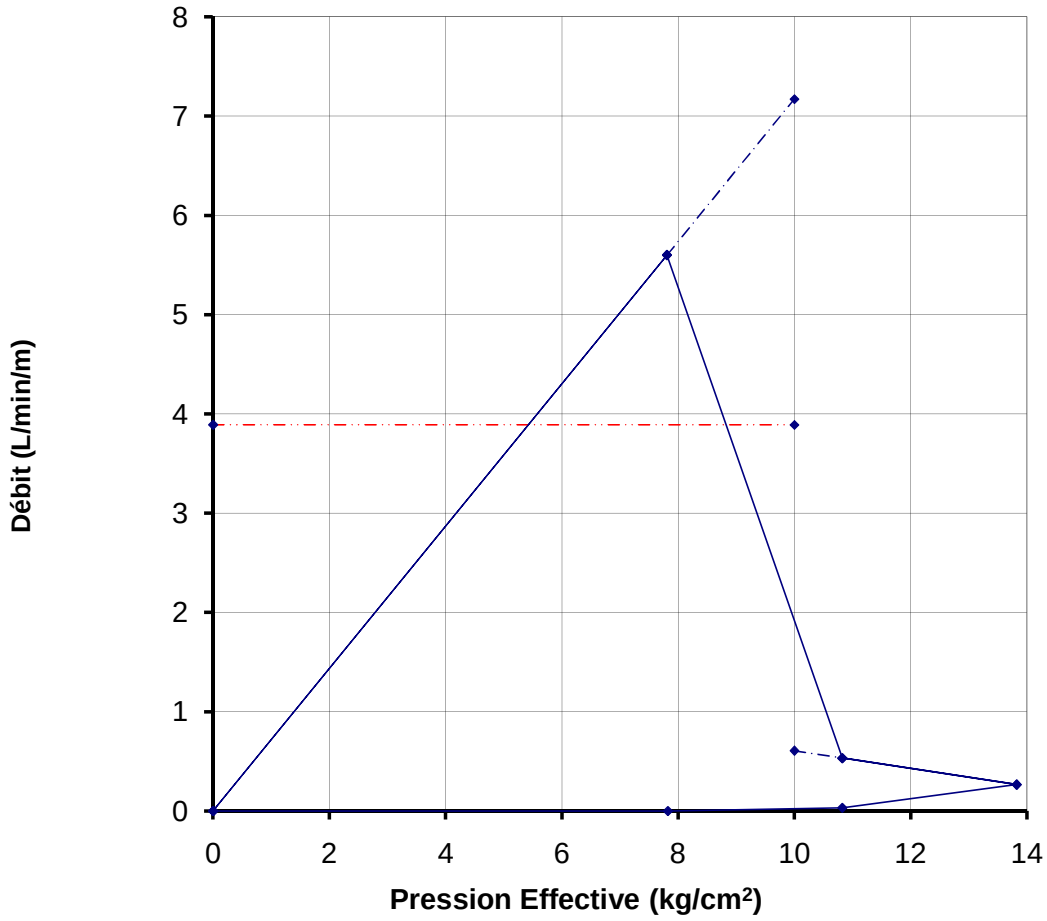


Lugeon = 2.41 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/19/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**39.00 m** à **42.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	168	10	3	16.8	5.60	3.825	1.66E-02	7.808
7	16	10	3	1.6	0.53	3.825	1.58E-03	10.823
10	8	10	3	0.8	0.27	3.825	7.92E-04	13.824
7	1	10	3	0.1	0.03	3.825	9.90E-05	10.825
4	0	10	3	0	0.00	3.825	0.00E+00	7.825

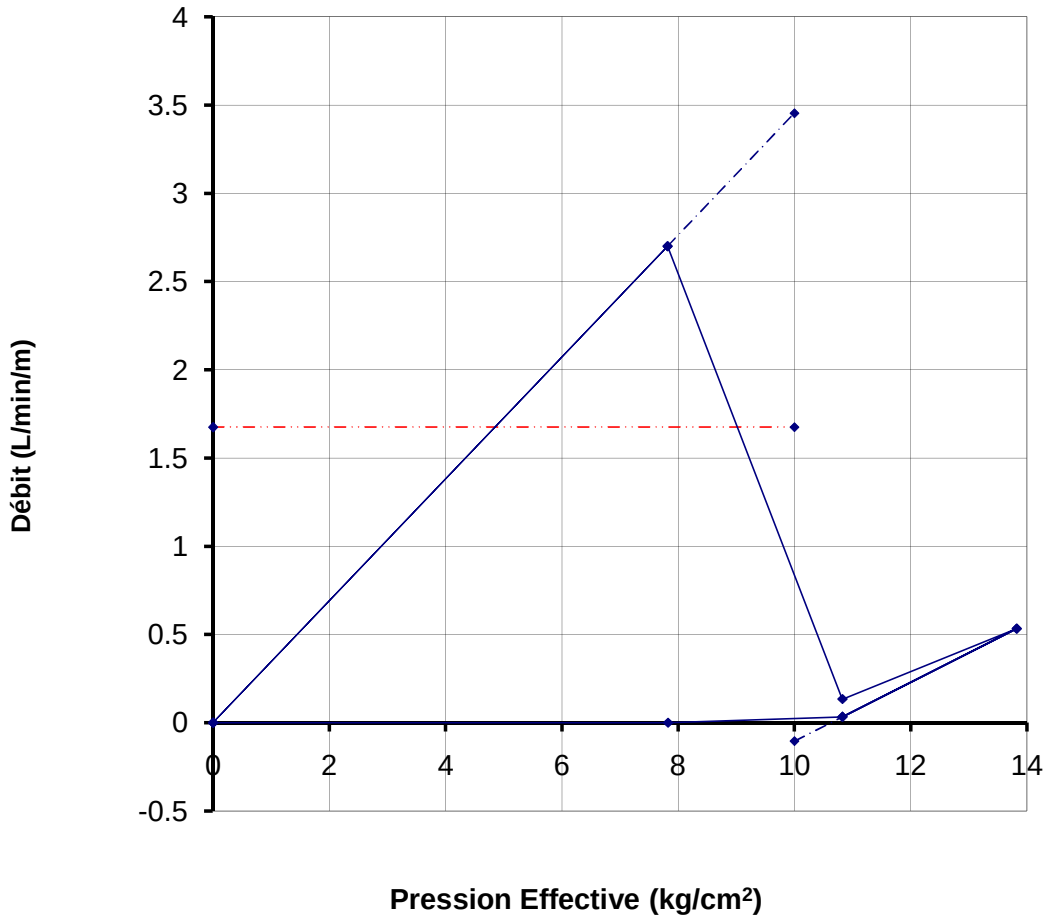


Lugeon = 3.89 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/19/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**42.00 m** à **45.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	81	10	3	8.1	2.70	3.825	8.02E-03	7.817
7	4	10	3	0.4	0.13	3.825	3.96E-04	10.825
10	16	10	3	1.6	0.53	3.825	1.58E-03	13.823
7	1	10	3	0.1	0.03	3.825	9.90E-05	10.825
4	0	10	3	0	0.00	3.825	0.00E+00	7.825

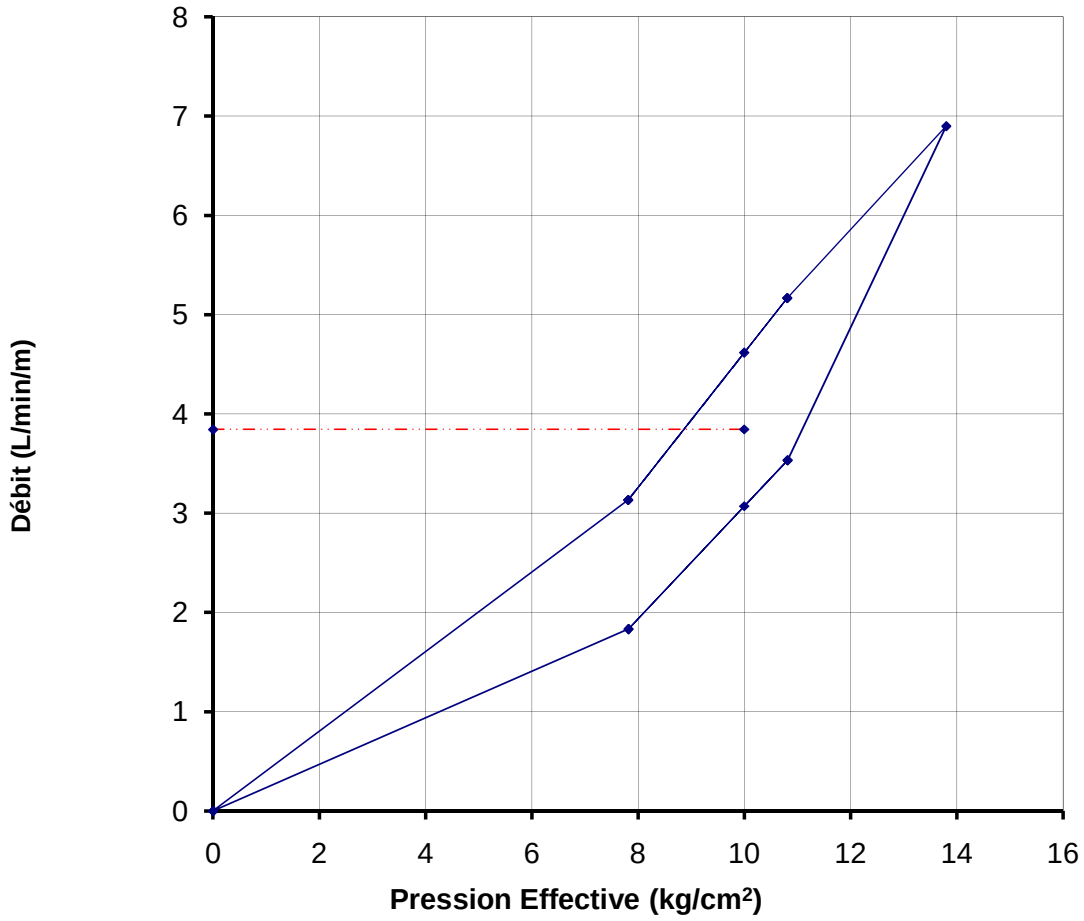


Lugeon = 1.67 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/20/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**45.00 m** à **48.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	94	10	3	9.4	3.13	3.825	9.31E-03	7.816
7	155	10	3	15.5	5.17	3.825	1.53E-02	10.810
10	207	10	3	20.7	6.90	3.825	2.05E-02	13.805
7	106	10	3	10.6	3.53	3.825	1.05E-02	10.815
4	55	10	3	5.5	1.83	3.825	5.45E-03	7.820

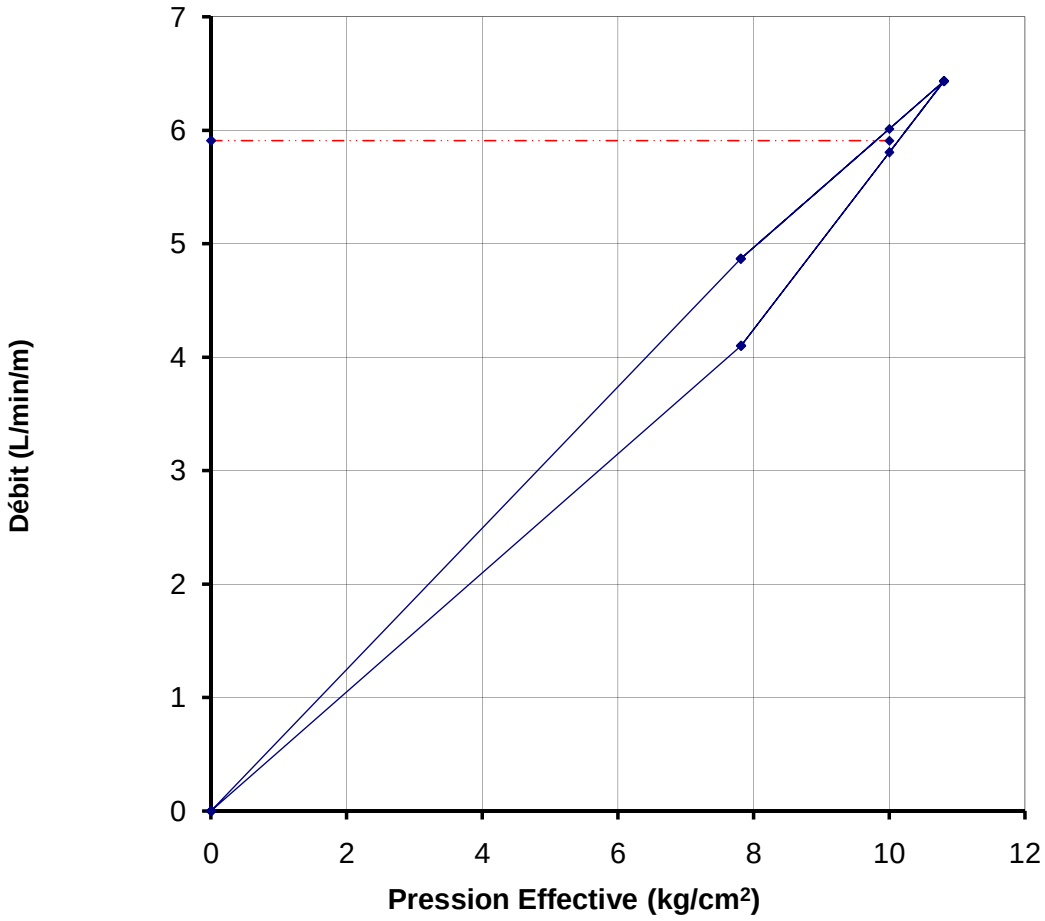


Lugeon = 3.84 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/20/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**48.00 m** à **51.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	146	10	3	14.6	4.87	3.825	1.45E-02	7.811
7	193	10	3	19.3	6.43	3.825	1.91E-02	10.806
4	123	10	3	12.3	4.10	3.825	1.22E-02	7.813

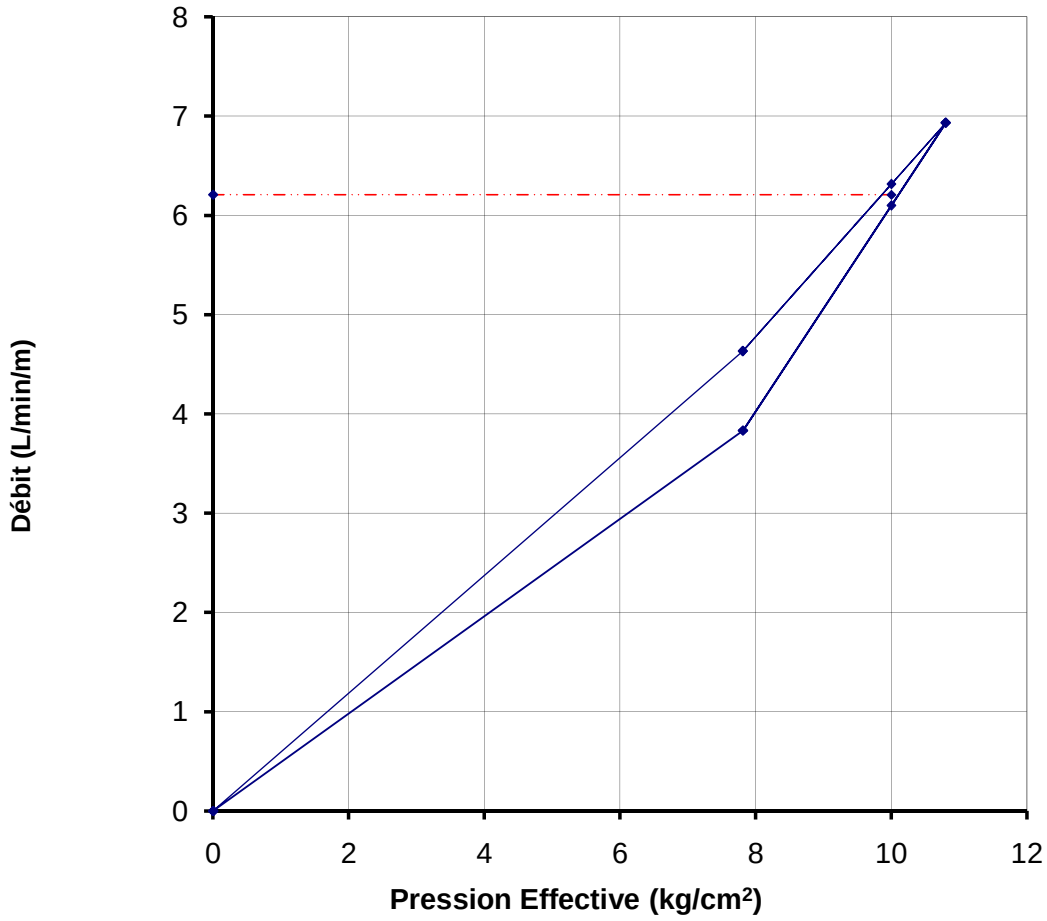


Lugeon = 5.91 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/20/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**51.00 m** à **54.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	139	10	3	13.9	4.63	3.825	1.38E-02	7.811
7	208	10	3	20.8	6.93	3.825	2.06E-02	10.804
4	115	10	3	11.5	3.83	3.825	1.14E-02	7.814

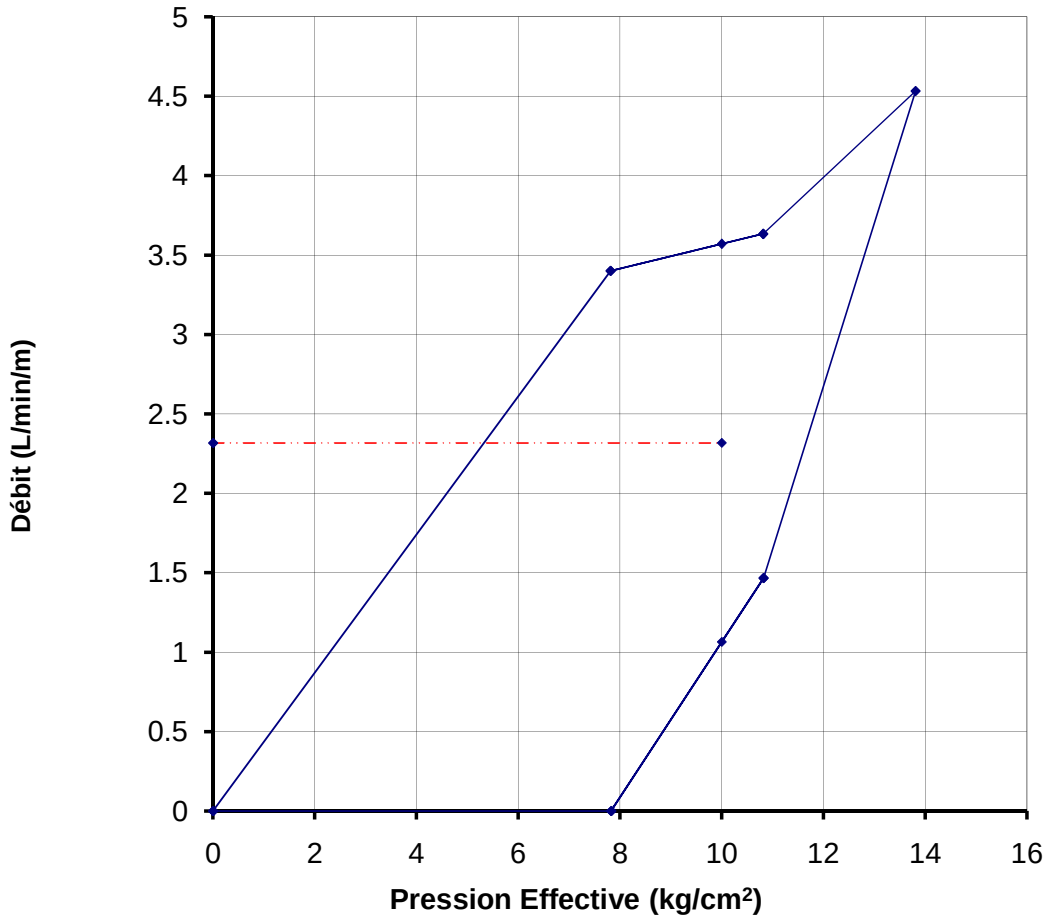


Lugeon = 6.21 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/20/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**54.00 m** à **57.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	102	10	3	10.2	3.40	3.825	1.01E-02	7.815
7	109	10	3	10.9	3.63	3.825	1.08E-02	10.814
10	136	10	3	13.6	4.53	3.825	1.35E-02	13.812
7	44	10	3	4.4	1.47	3.825	4.36E-03	10.821
4	0	10	3	0	0.00	3.825	0.00E+00	7.825

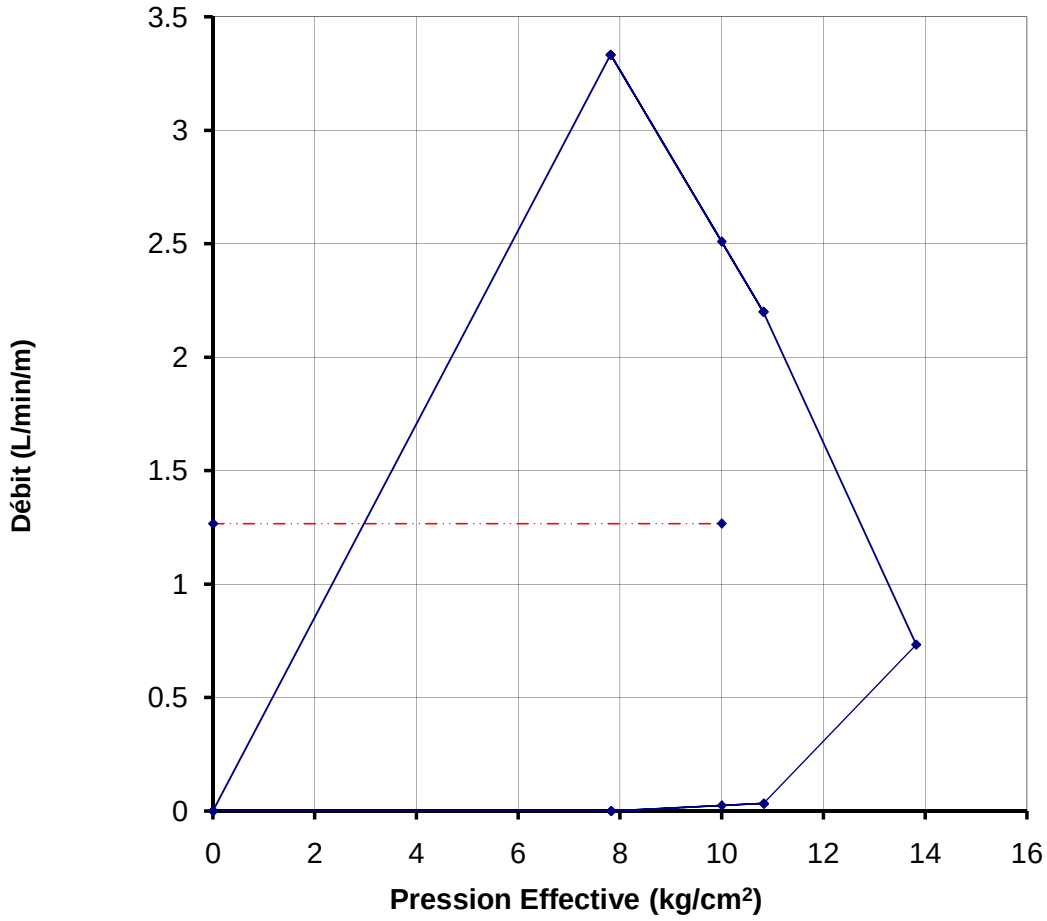


Lugeon = 2.32 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/21/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**54.00 m** à **57.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	100	10	3	10	3.33	3.825	9.90E-03	7.815
7	66	10	3	6.6	2.20	3.825	6.53E-03	10.818
10	22	10	3	2.2	0.73	3.825	2.18E-03	13.823
7	1	10	3	0.1	0.03	3.825	9.90E-05	10.825
4	0	10	3	0	0.00	3.825	0.00E+00	7.825

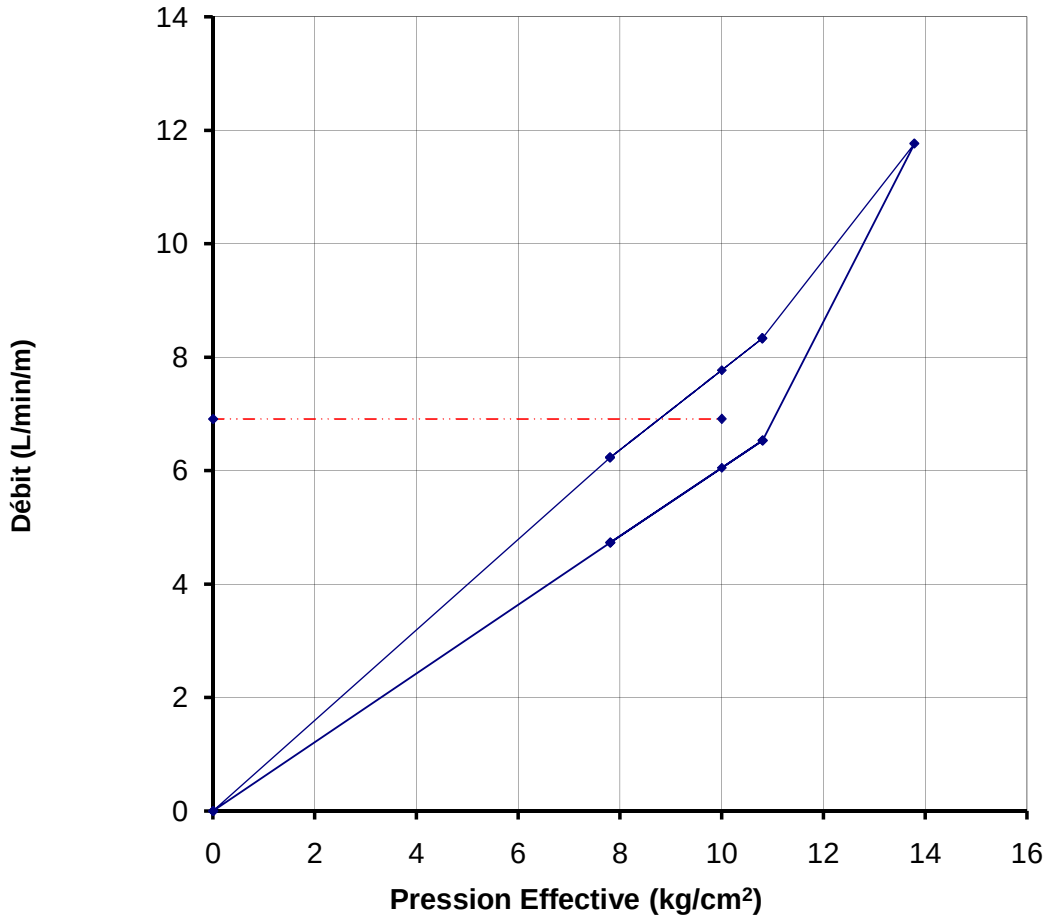


Lugeon = 1.27 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/21/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**60.00 m** à **63.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	187	10	3	18.7	6.23	3.825	1.85E-02	7.806
7	250	10	3	25	8.33	3.825	2.48E-02	10.800
10	353	10	3	35.3	11.77	3.825	3.49E-02	13.790
7	196	10	3	19.6	6.53	3.825	1.94E-02	10.806
4	142	10	3	14.2	4.73	3.825	1.41E-02	7.811

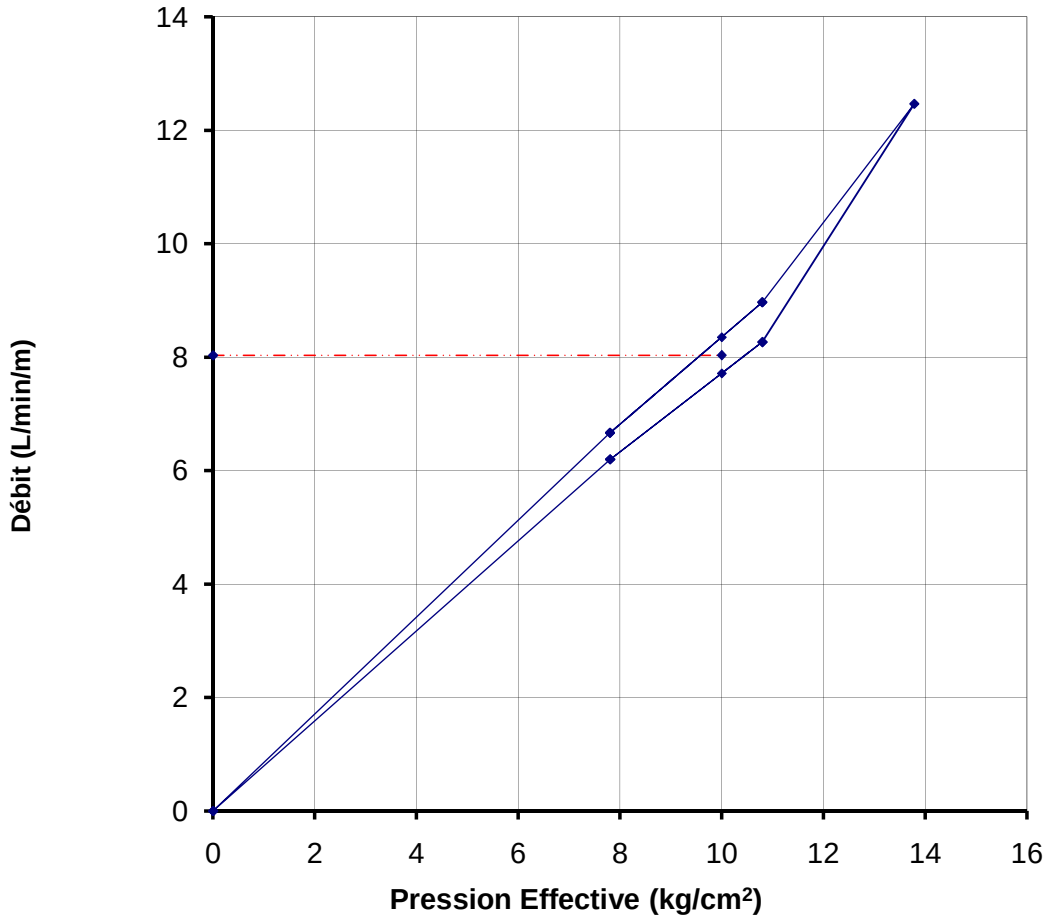


Lugeon = 6.91 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/22/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**63.00 m** à **66.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	200	10	3	20	6.67	3.825	1.98E-02	7.805
7	269	10	3	26.9	8.97	3.825	2.66E-02	10.798
10	374	10	3	37.4	12.47	3.825	3.70E-02	13.788
7	248	10	3	24.8	8.27	3.825	2.46E-02	10.800
4	186	10	3	18.6	6.20	3.825	1.84E-02	7.807

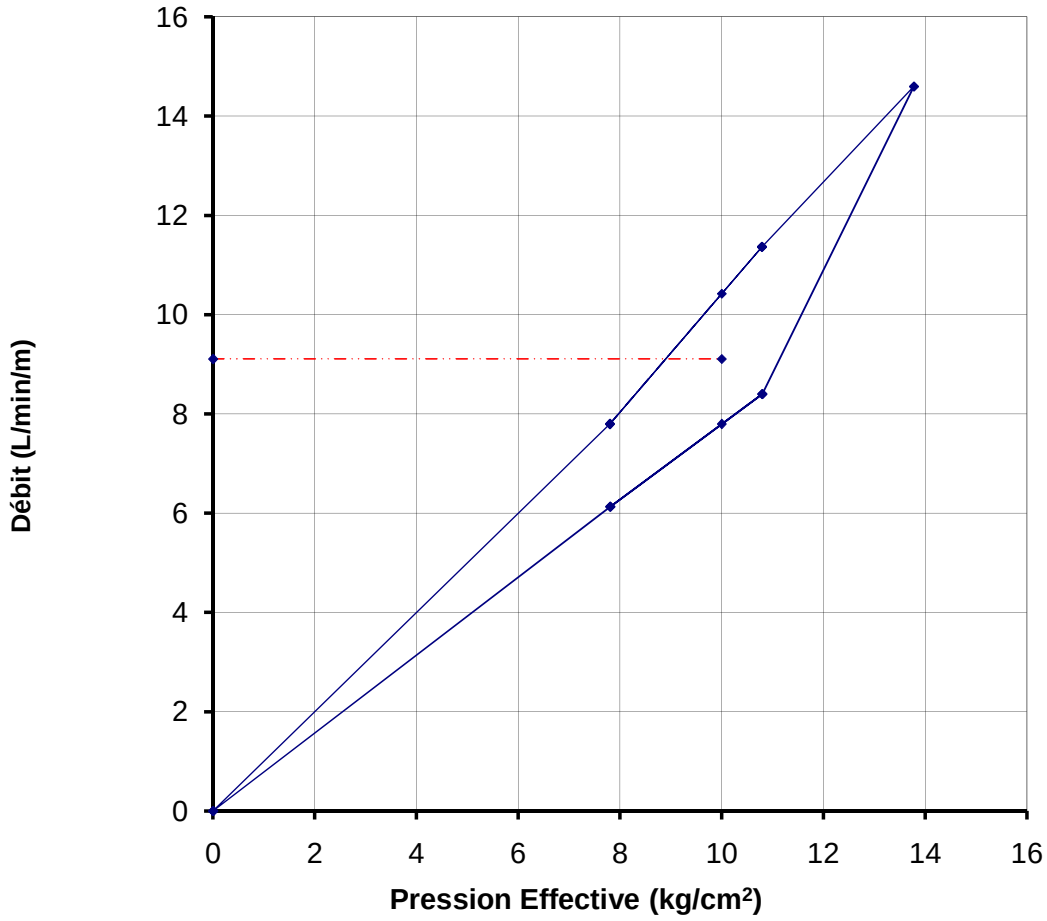


Lugeon = 8.03 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/22/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**66.00 m** à **69.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	234	10	3	23.4	7.80	3.825	2.32E-02	7.802
7	341	10	3	34.1	11.37	3.825	3.38E-02	10.791
10	438	10	3	43.8	14.60	3.825	4.34E-02	13.782
7	252	10	3	25.2	8.40	3.825	2.49E-02	10.800
4	184	10	3	18.4	6.13	3.825	1.82E-02	7.807

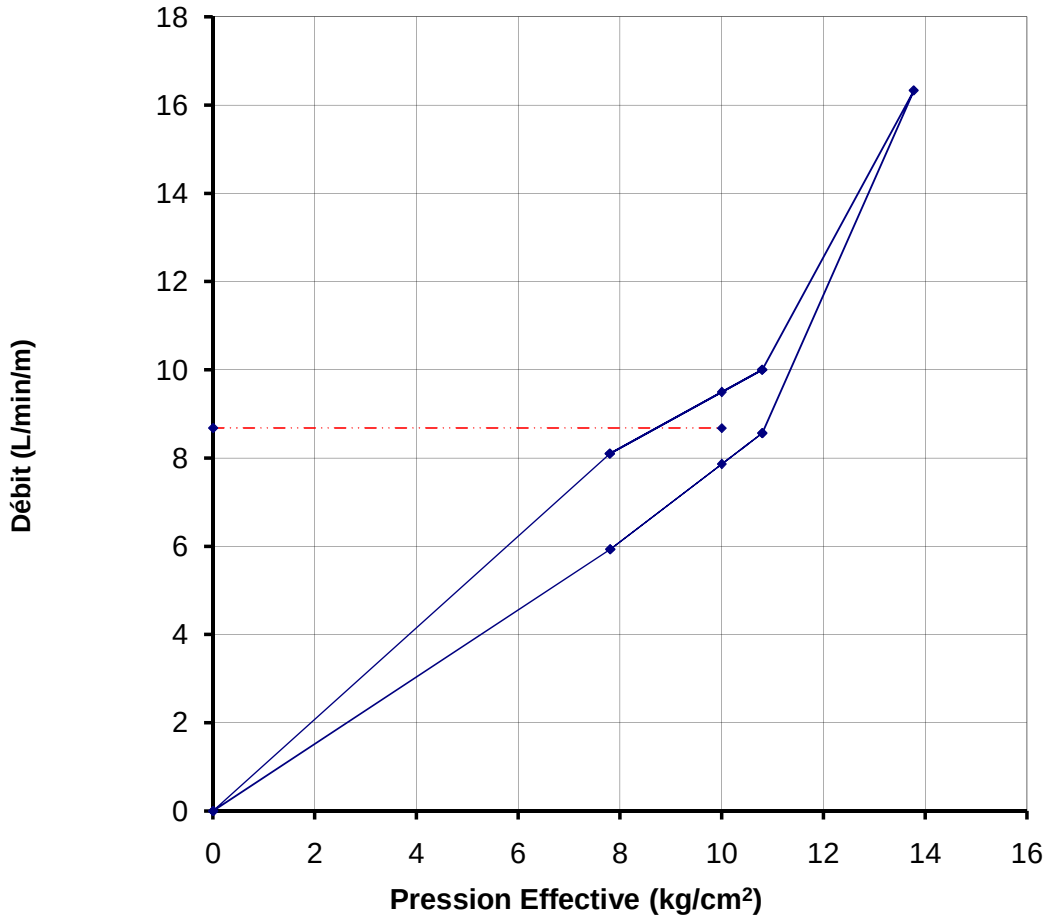


Lugeon = 9.11 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/22/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**69.00 m** à **72.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	243	10	3	24.3	8.10	3.825	2.41E-02	7.801
7	300	10	3	30	10.00	3.825	2.97E-02	10.795
10	490	10	3	49	16.33	3.825	4.85E-02	13.776
7	257	10	3	25.7	8.57	3.825	2.54E-02	10.800
4	178	10	3	17.8	5.93	3.825	1.76E-02	7.807

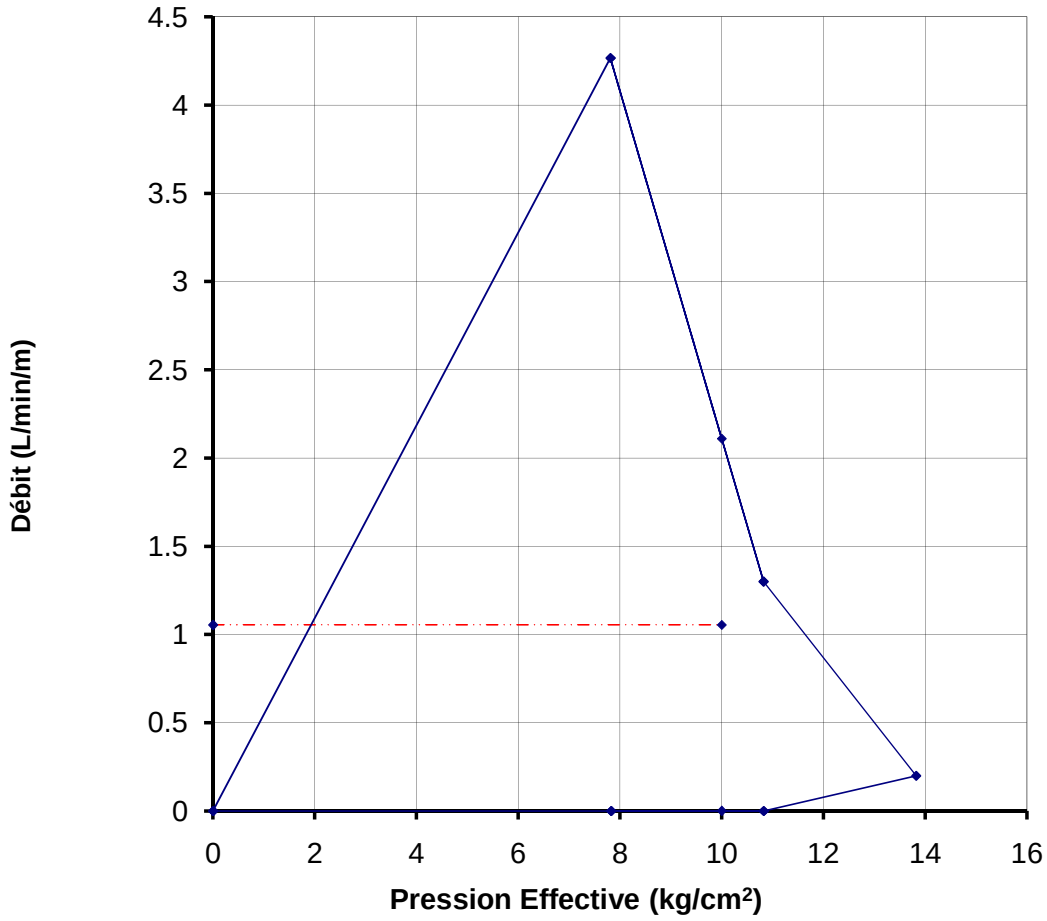


Lugeon = 8.68 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/24/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**72.00 m** à **75.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	128	10	3	12.8	4.27	3.825	1.27E-02	7.812
7	39	10	3	3.9	1.30	3.825	3.86E-03	10.821
10	6	10	3	0.6	0.20	3.825	5.94E-04	13.824
7	0	10	3	0	0.00	3.825	0.00E+00	10.825
4	0	10	3	0	0.00	3.825	0.00E+00	7.825

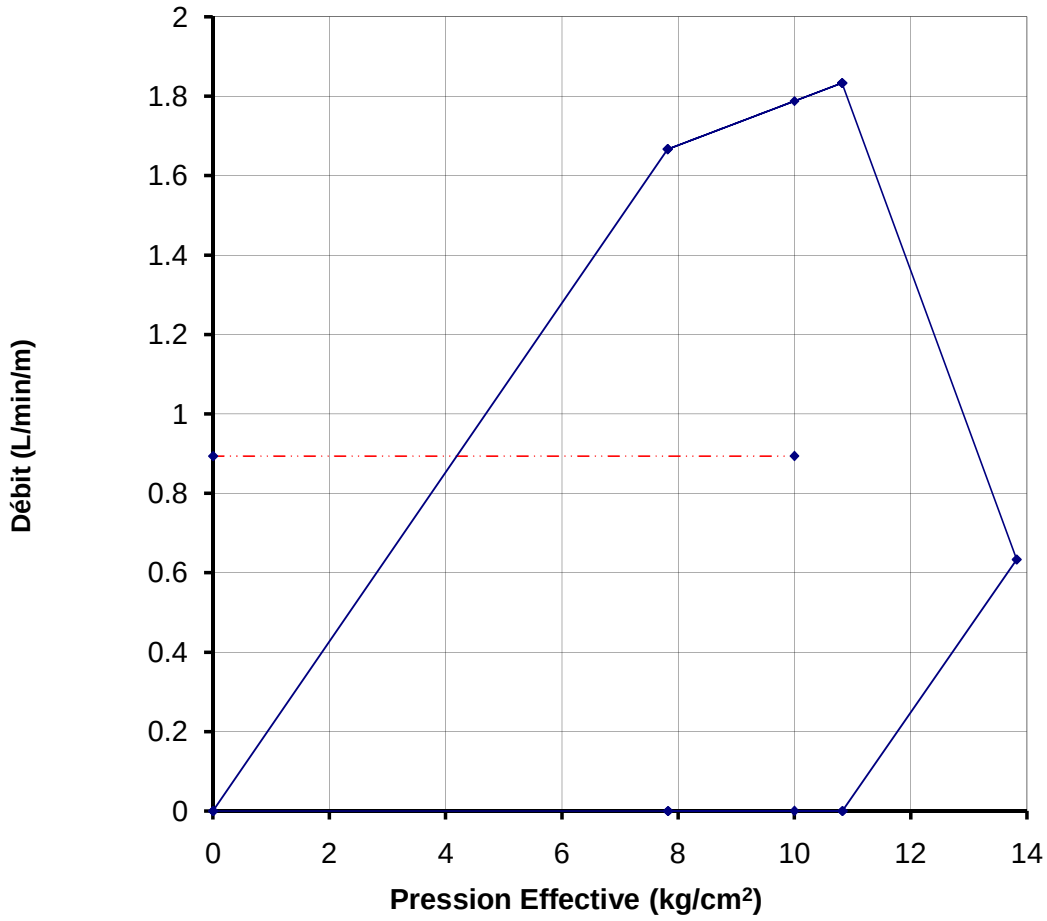


Lugeon = 1.05 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/24/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**75.00 m** à **78.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	50	10	3	5	1.67	3.825	4.95E-03	7.820
7	55	10	3	5.5	1.83	3.825	5.45E-03	10.820
10	19	10	3	1.9	0.63	3.825	1.88E-03	13.823
7	0	10	3	0	0.00	3.825	0.00E+00	10.825
4	0	10	3	0	0.00	3.825	0.00E+00	7.825

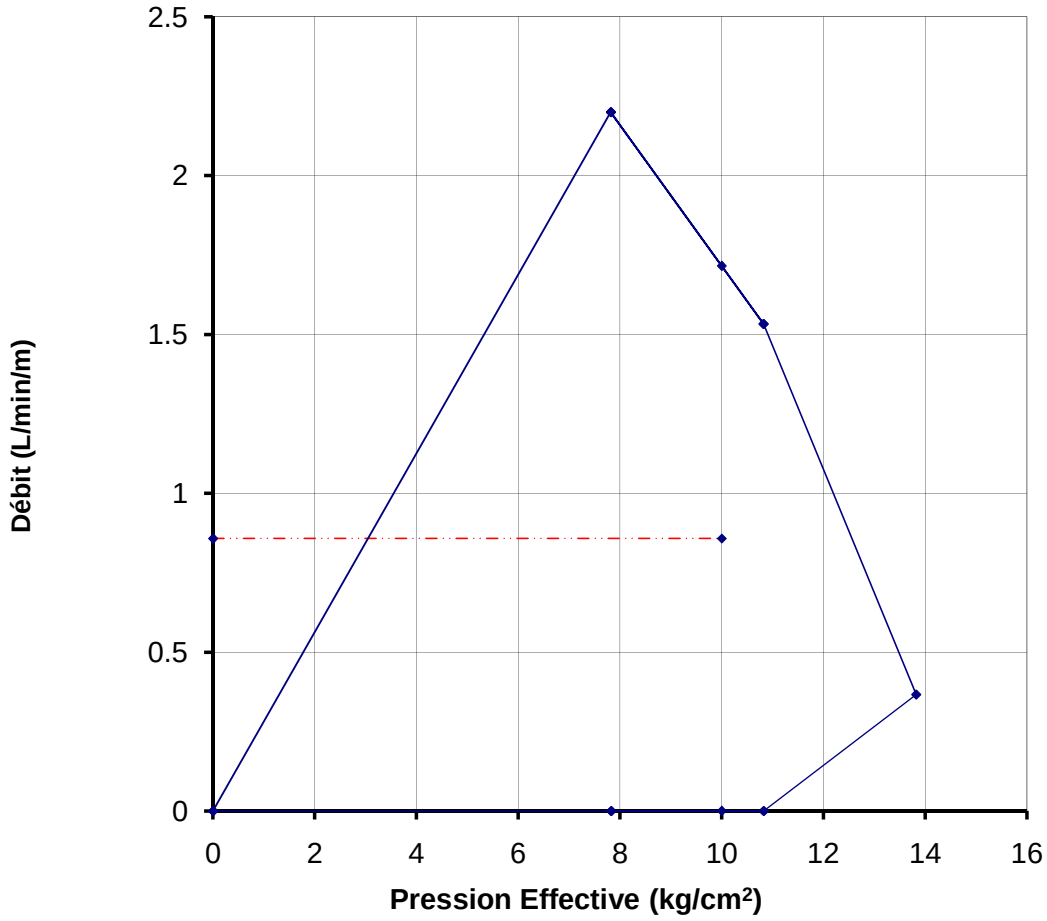


Lugeon = 0.89 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/24/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**78.00 m** à **81.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	66	10	3	6.6	2.20	3.825	6.53E-03	7.818
7	46	10	3	4.6	1.53	3.825	4.55E-03	10.820
10	11	10	3	1.1	0.37	3.825	1.09E-03	13.824
7	0	10	3	0	0.00	3.825	0.00E+00	10.825
4	0	10	3	0	0.00	3.825	0.00E+00	7.825

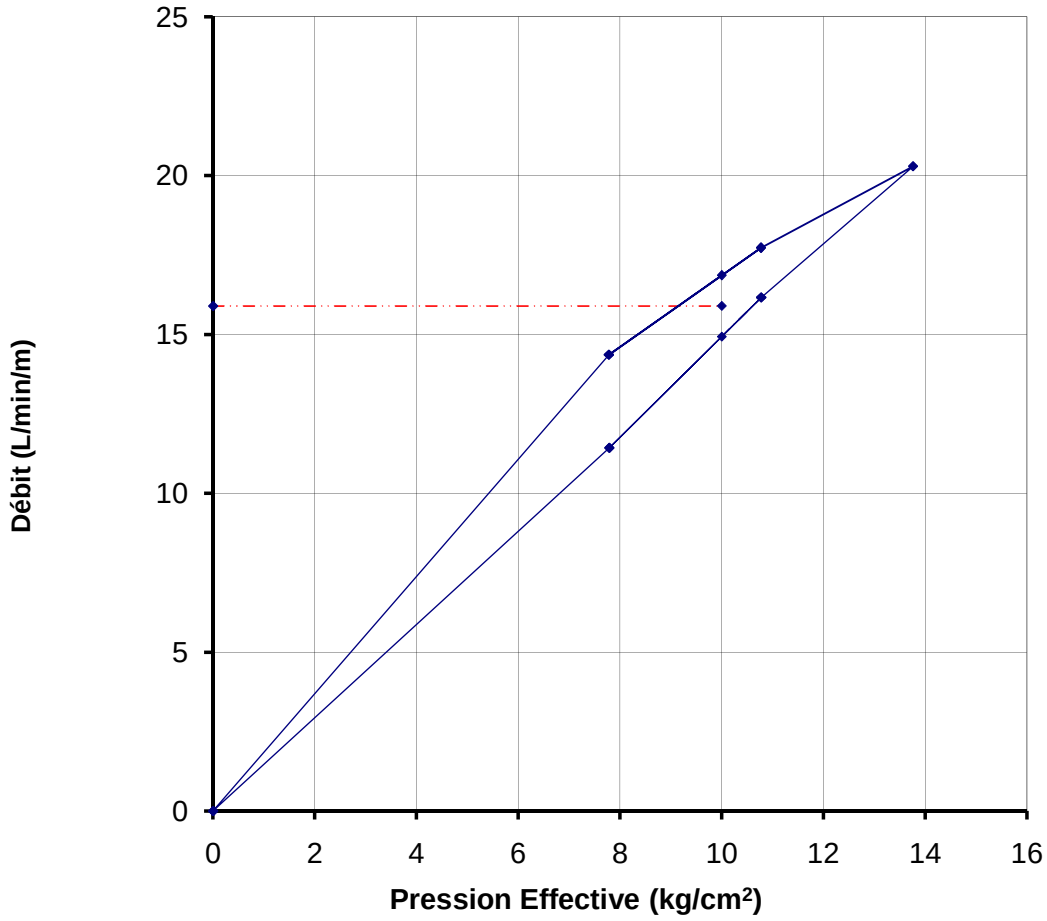


Lugeon = 0.86 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/25/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**81.00 m** à **84.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	431	10	3	43.1	14.37	3.825	4.27E-02	7.782
7	532	10	3	53.2	17.73	3.825	5.27E-02	10.772
10	609	10	3	60.9	20.30	3.825	6.03E-02	13.765
7	485	10	3	48.5	16.17	3.825	4.80E-02	10.777
4	343	10	3	34.3	11.43	3.825	3.40E-02	7.791

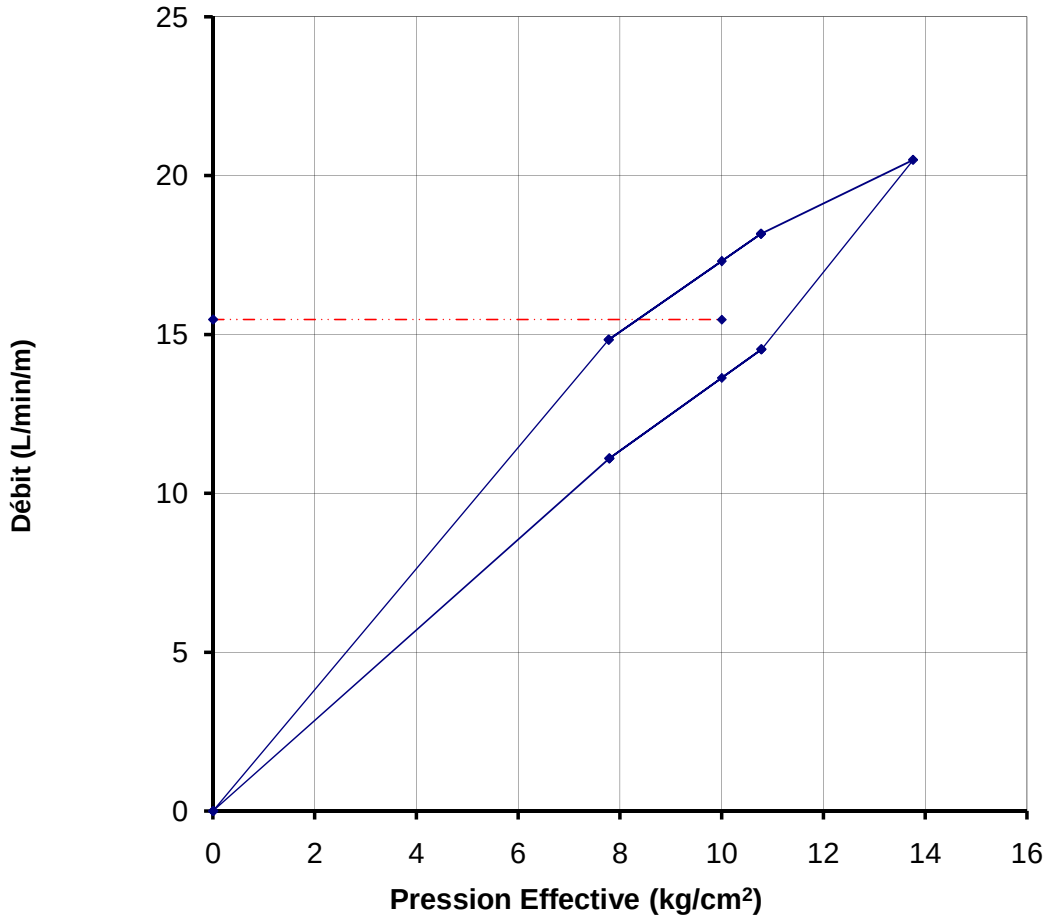


Lugeon = 15.90 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/25/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**84.00 m** à **87.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	445	10	3	44.5	14.83	3.825	4.41E-02	7.781
7	545	10	3	54.5	18.17	3.825	5.40E-02	10.771
10	615	10	3	61.5	20.50	3.825	6.09E-02	13.764
7	436	10	3	43.6	14.53	3.825	4.32E-02	10.782
4	333	10	3	33.3	11.10	3.825	3.30E-02	7.792

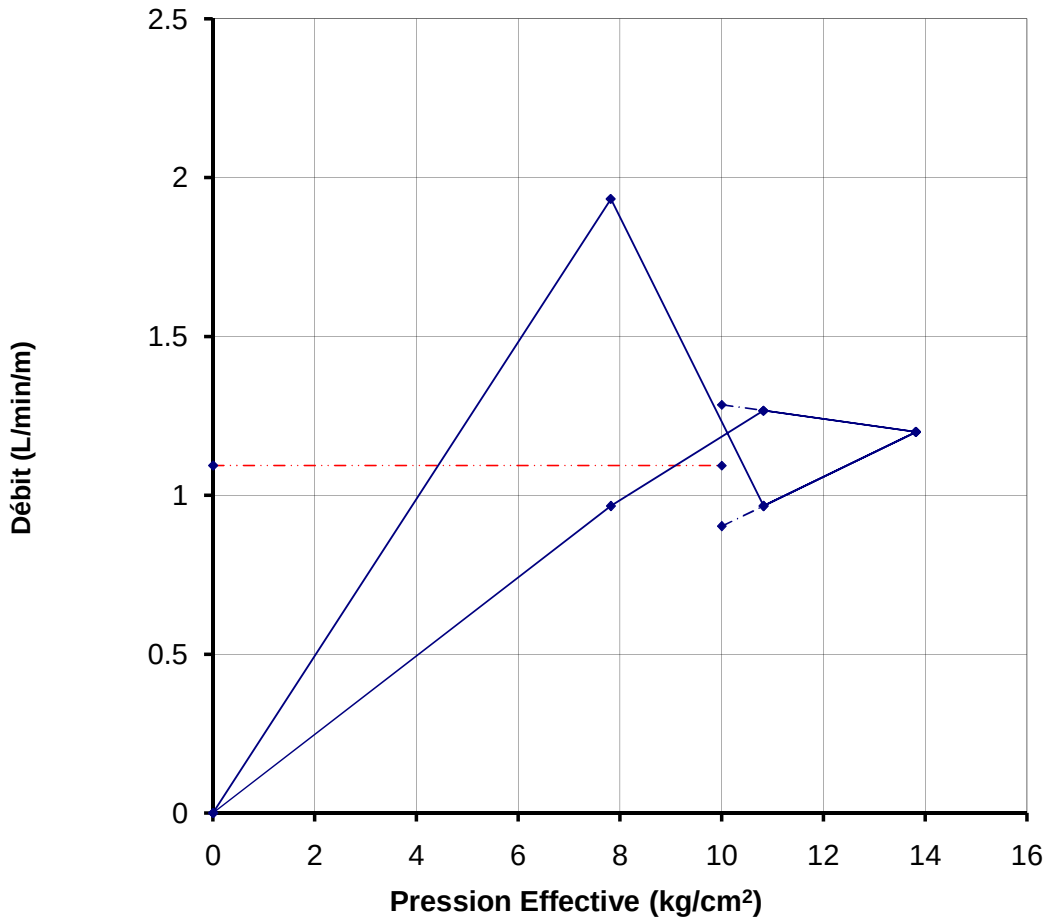


Lugeon = 15.47 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/25/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**87.00 m** à **90.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	58	10	3	5.8	1.93	3.825	5.74E-03	7.819
7	29	10	3	2.9	0.97	3.825	2.87E-03	10.822
10	36	10	3	3.6	1.20	3.825	3.56E-03	13.821
7	38	10	3	3.8	1.27	3.825	3.76E-03	10.821
4	29	10	3	2.9	0.97	3.825	2.87E-03	7.822

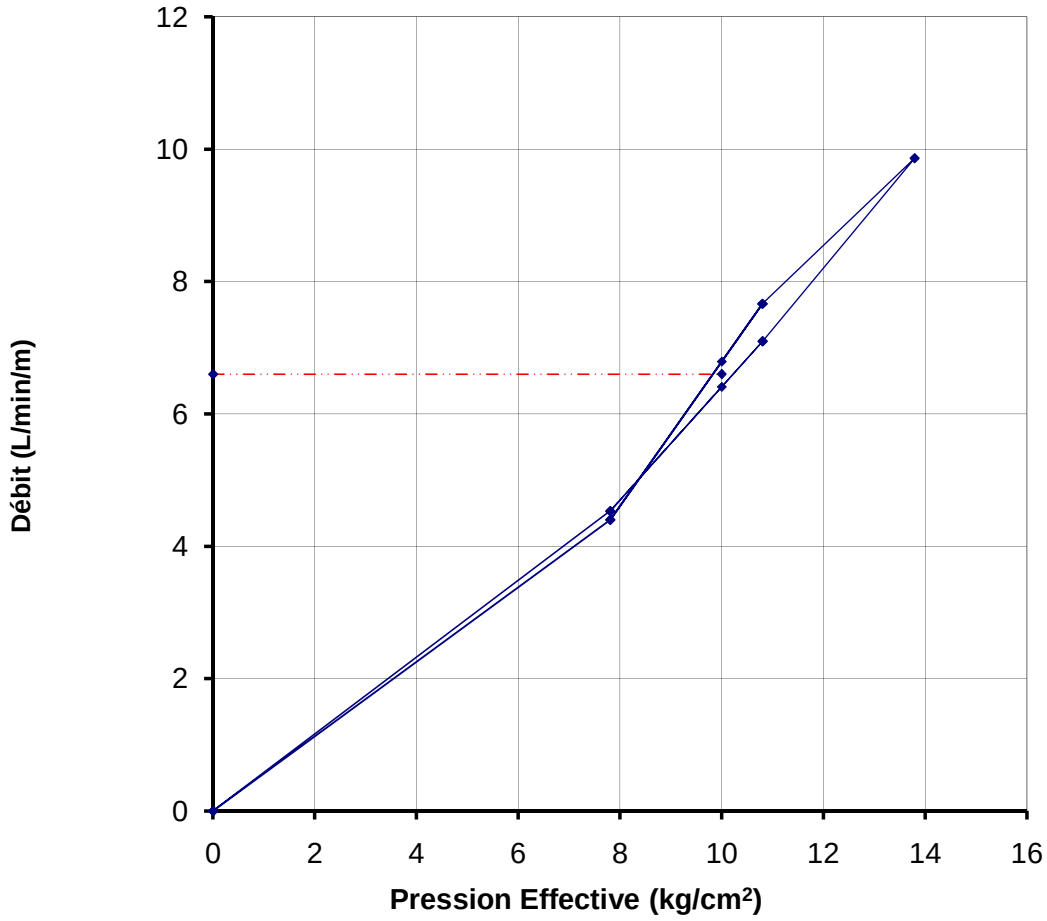


Lugeon = 1.09 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/5/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**90.00 m** à **93.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	136	10	3	13.6	4.53	3.825	1.35E-02	7.812
7	213	10	3	21.3	7.10	3.825	2.11E-02	10.804
10	296	10	3	29.6	9.87	3.825	2.93E-02	13.796
7	230	10	3	23	7.67	3.825	2.28E-02	10.802
4	132	10	3	13.2	4.40	3.825	1.31E-02	7.812

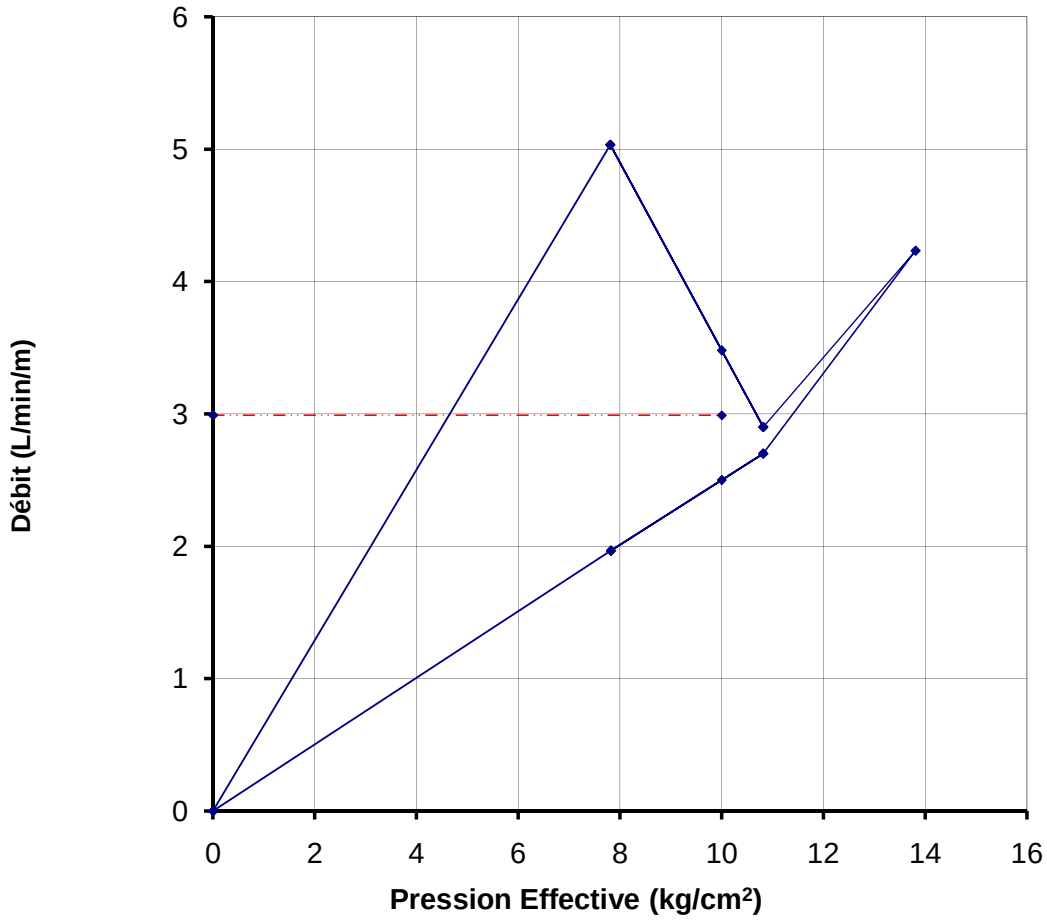


Lugeon = 6.60 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/26/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**93.00 m** à **96.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	151	10	3	15.1	5.03	3.825	1.49E-02	7.810
7	87	10	3	8.7	2.90	3.825	8.61E-03	10.816
10	127	10	3	12.7	4.23	3.825	1.26E-02	13.812
7	81	10	3	8.1	2.70	3.825	8.02E-03	10.817
4	59	10	3	5.9	1.97	3.825	5.84E-03	7.819

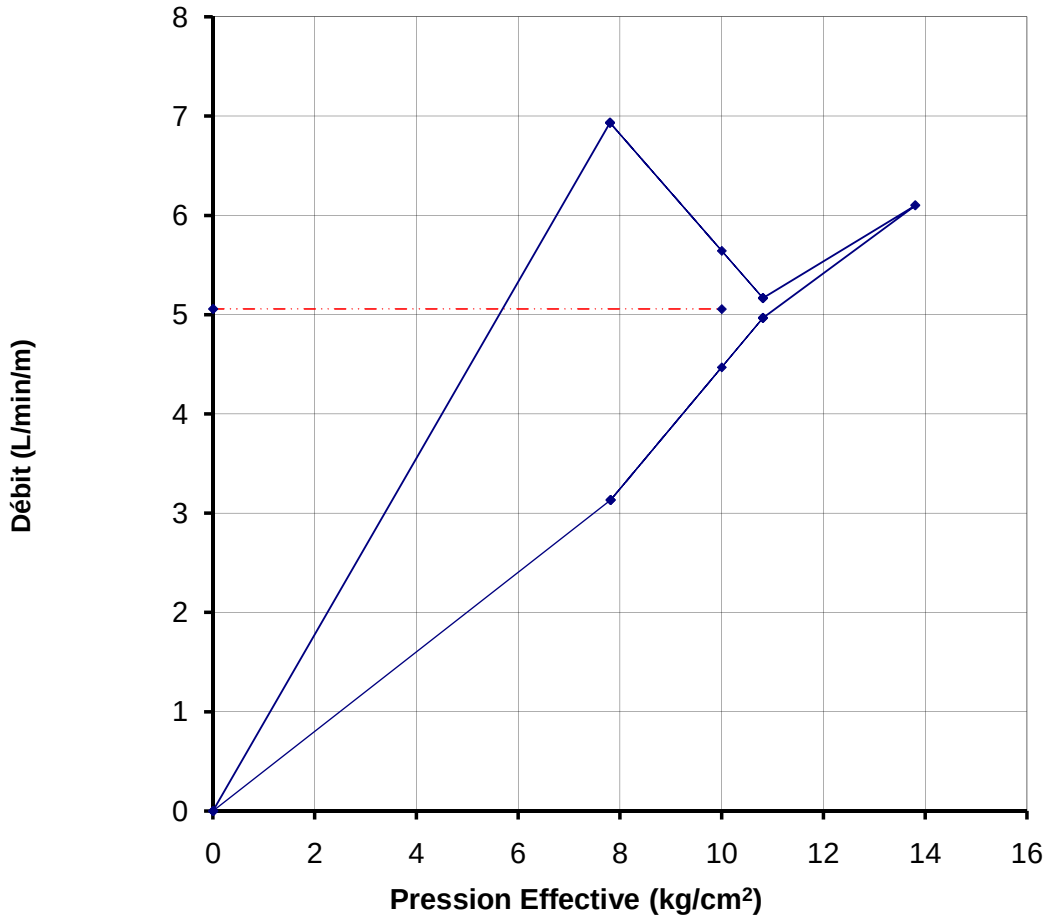


Lugeon = 2.99 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/26/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**96.00 m** à **99.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	208	10	3	20.8	6.93	3.825	2.06E-02	7.804
7	155	10	3	15.5	5.17	3.825	1.53E-02	10.810
10	183	10	3	18.3	6.10	3.825	1.81E-02	13.807
7	149	10	3	14.9	4.97	3.825	1.48E-02	10.810
4	94	10	3	9.4	3.13	3.825	9.31E-03	7.816

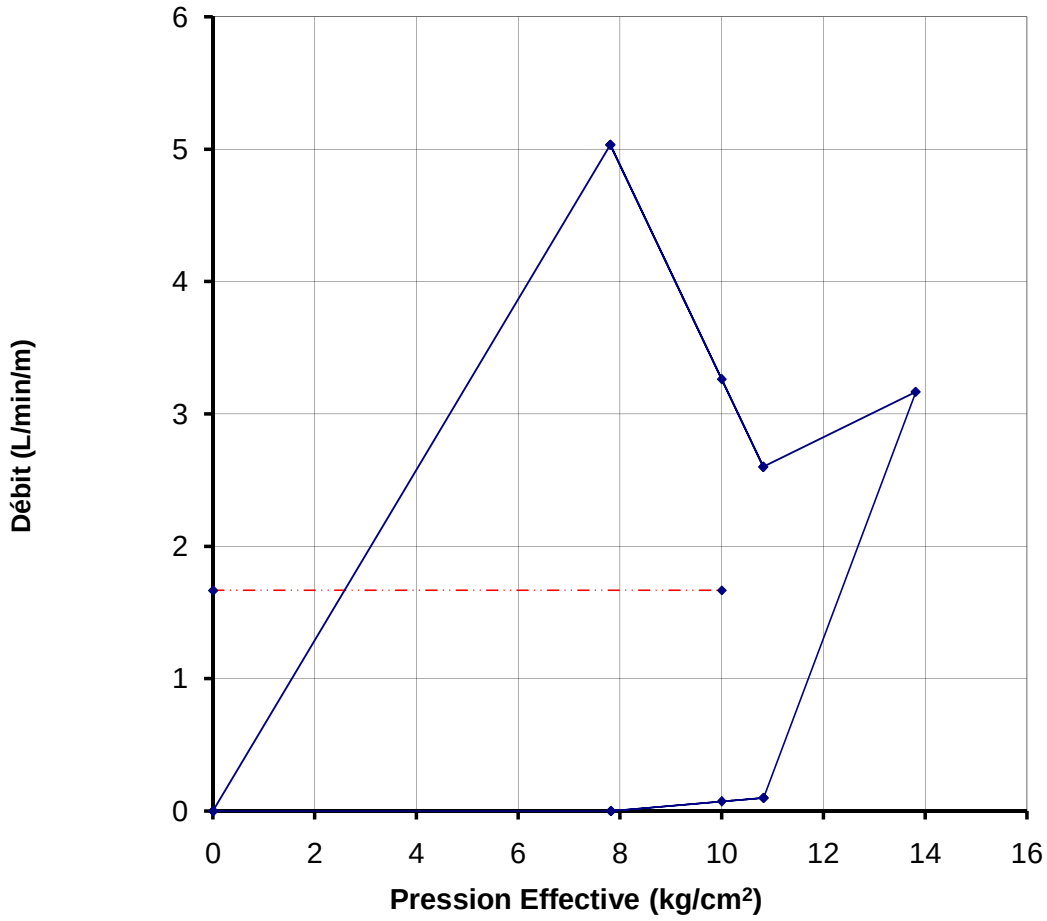


Lugeon = 5.06 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/27/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**99.00 m** à **102.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	151	10	3	15.1	5.03	3.825	1.49E-02	7.810
7	78	10	3	7.8	2.60	3.825	7.72E-03	10.817
10	95	10	3	9.5	3.17	3.825	9.41E-03	13.816
7	3	10	3	0.3	0.10	3.825	2.97E-04	10.825
4	0	10	3	0	0.00	3.825	0.00E+00	7.825

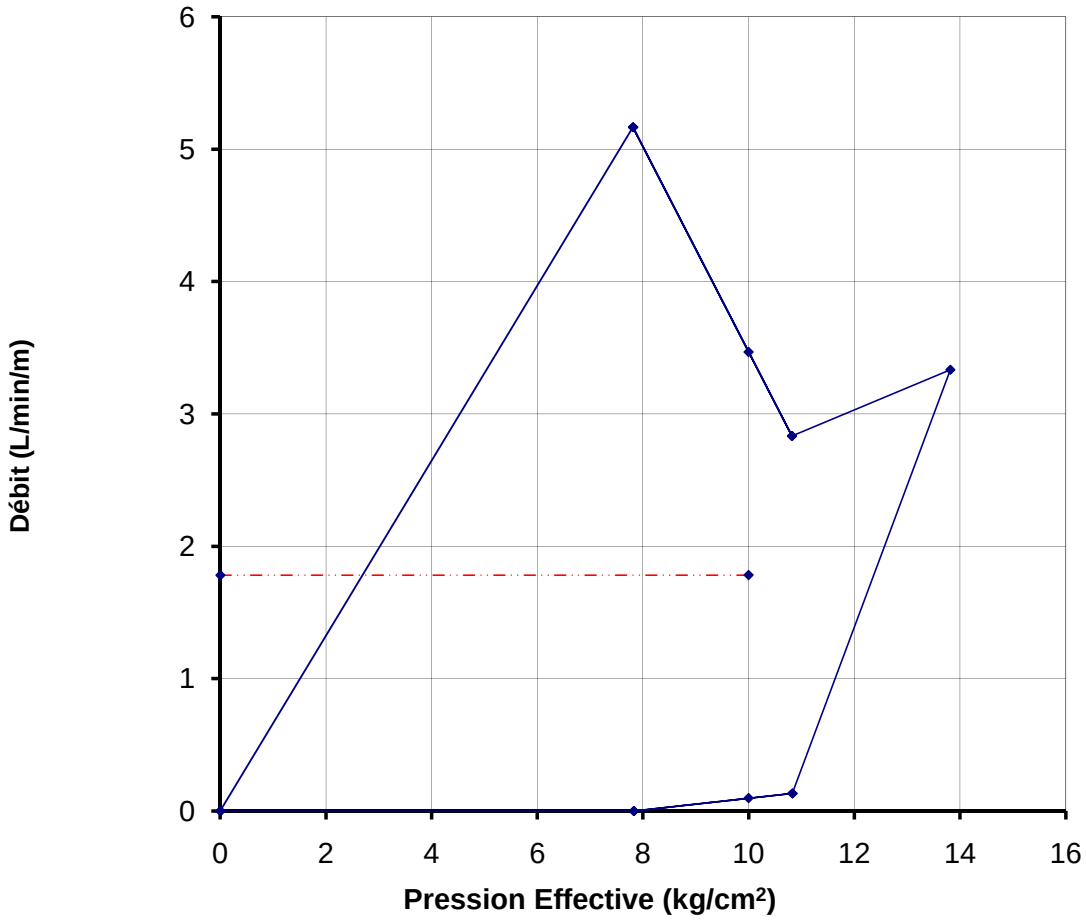


Lugeon = 1.67 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**		Date:	**3/27/2014**
	SONDAGE No.:	**BHRA 01**			
	TRANCHE ESSAYEE	**102.00 m**	à **105.00 m**	Manomètre	**0.50 m**
				depth to water:	**37.75 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	155	10	3	15.5	5.17	3.825	1.53E-02	7.810
7	85	10	3	8.5	2.83	3.825	8.42E-03	10.817
10	100	10	3	10	3.33	3.825	9.90E-03	13.815
7	4	10	3	0.4	0.13	3.825	3.96E-04	10.825
4	0	10	3	0	0.00	3.825	0.00E+00	7.825

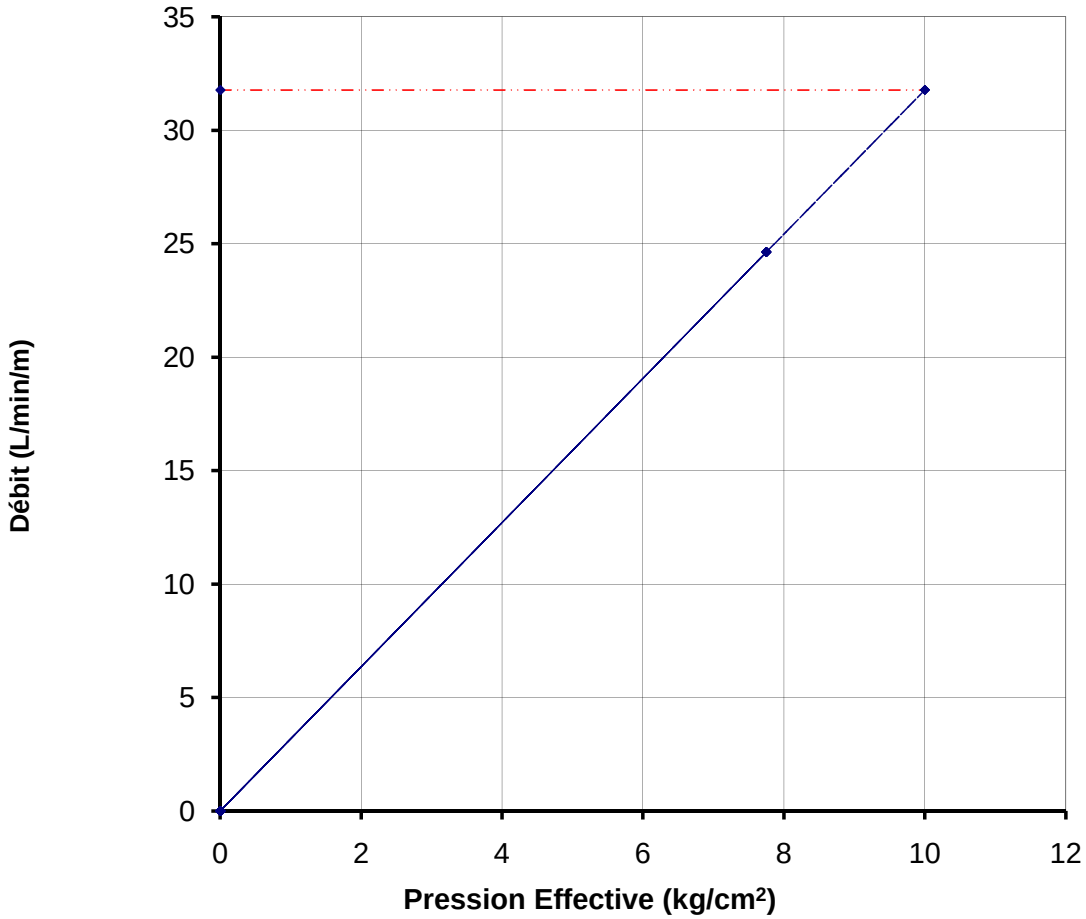


Lugeon = 1.78 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date:	**3/27/2014**
	SONDAGE No.:	**BHRA 01**		
	TRANCHE ESSAYEE	**105.00 m** à **108.00 m**	Manomètre	**0.50 m**
			depth to water:	**37.75 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	739	10	3	73.9	24.63	3.825	7.32E-02	7.752

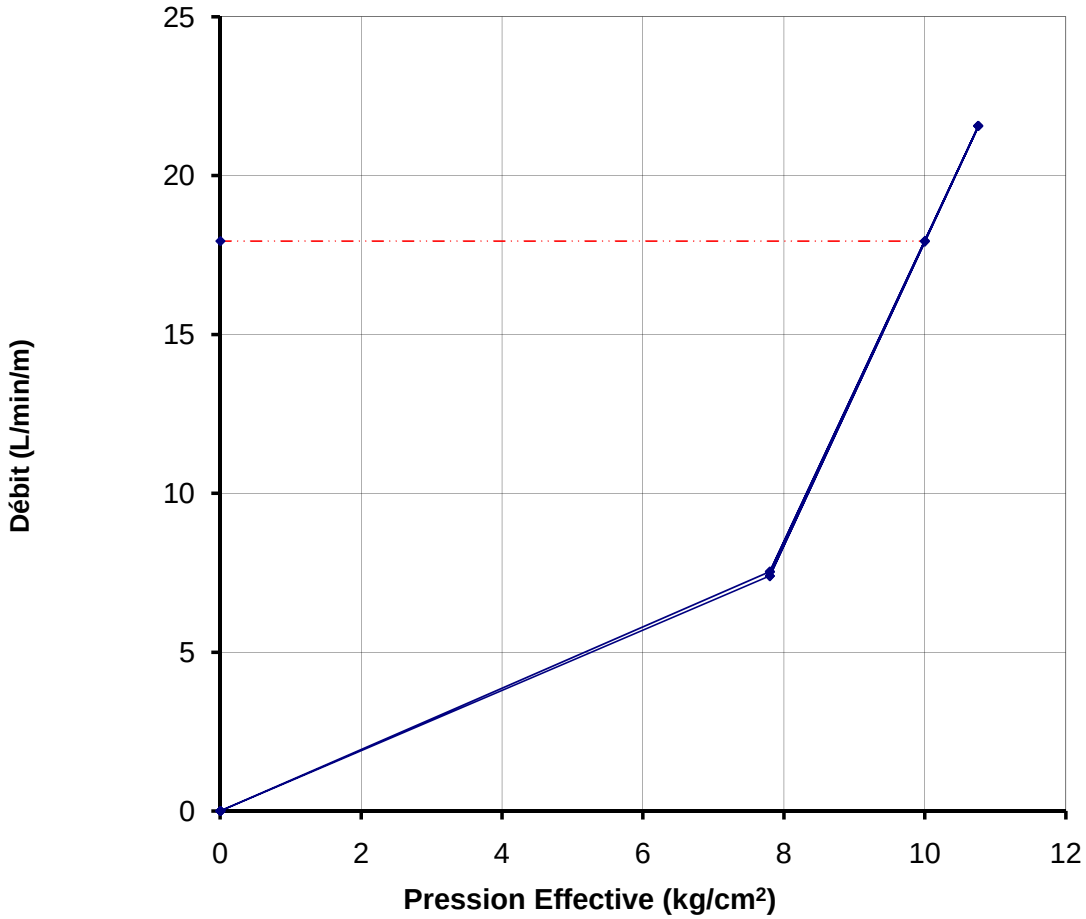


Lugeon = 31.78 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**		Date:	**3/27/2014**
	SONDAGE No.:	**BHRA 01**			
	TRANCHE ESSAYEE	**108.00 m**	à **111.00 m**	Manomètre	**0.50 m**
				depth to water:	**37.75 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	222	10	3	22.2	7.40	3.825	2.20E-02	7.803
7	647	10	3	64.7	21.57	3.825	6.41E-02	10.761
4	226	10	3	22.6	7.53	3.825	2.24E-02	7.803

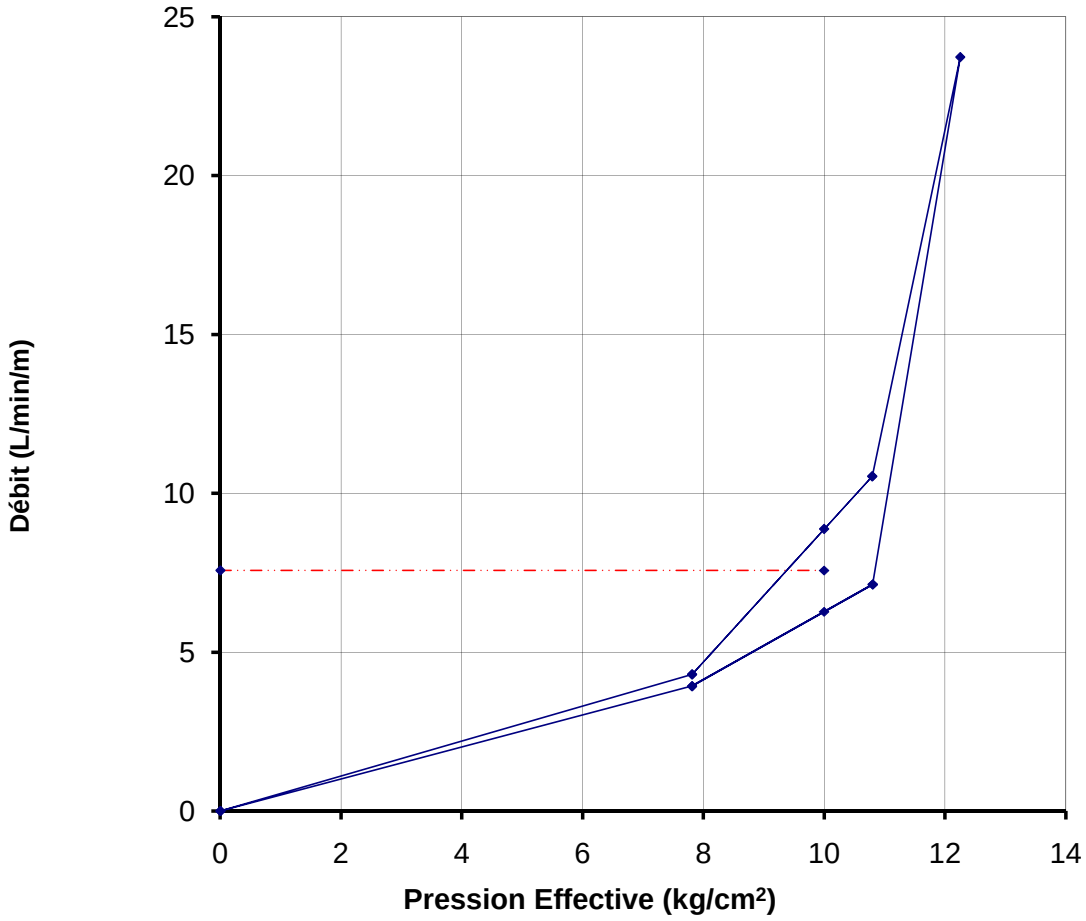


Lugeon = 17.94 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**		Date:	**3/28/2014**
	SONDAGE No.:	**BHRA 01**			
	TRANCHE ESSAYEE	**111.00 m**	à **114.00 m**	Manomètre	**0.50 m**
				depth to water:	**37.75 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	129	10	3	12.9	4.30	3.825	1.28E-02	7.812
7	316	10	3	31.6	10.53	3.825	3.13E-02	10.794
8.5	712	10	3	71.2	23.73	3.825	7.05E-02	12.255
7	214	10	3	21.4	7.13	3.825	2.12E-02	10.804
4	118	10	3	11.8	3.93	3.825	1.17E-02	7.813

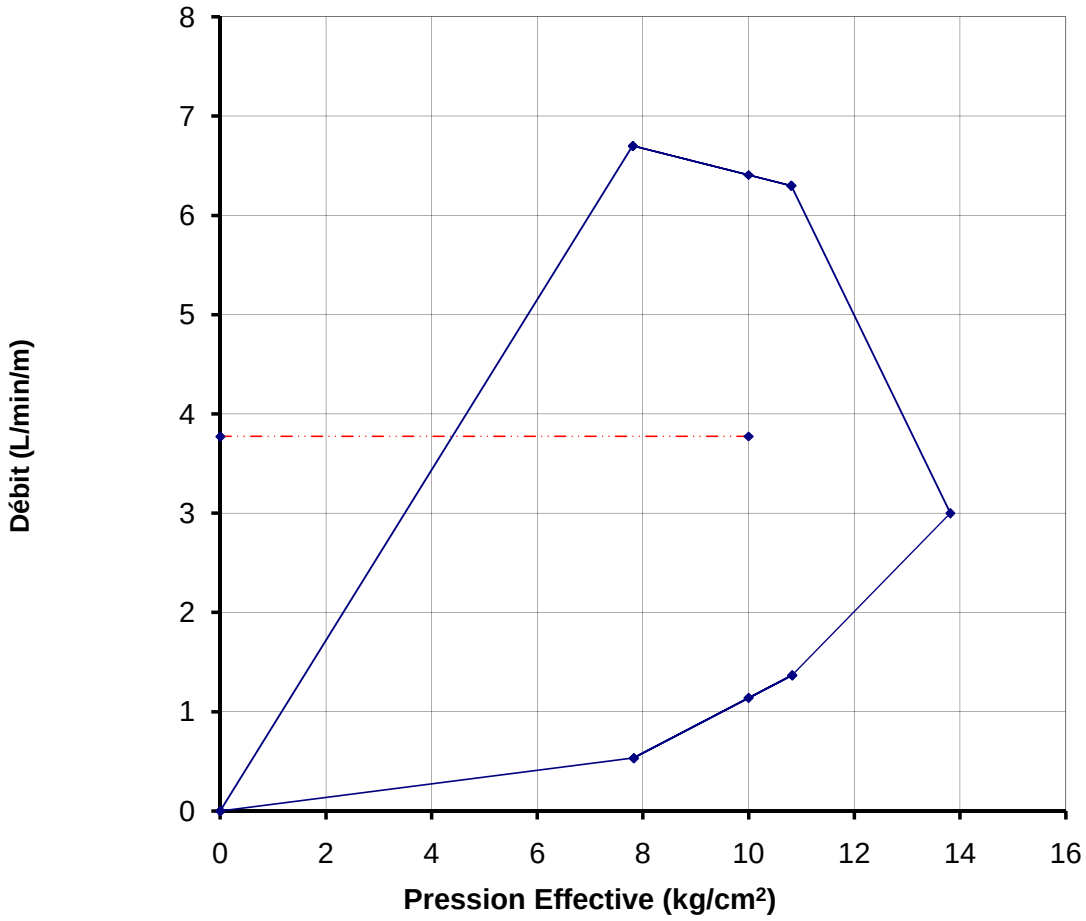


Lugeon = 7.57 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date:	**3/30/2014**
	SONDAGE No.:	**BHRA 01**		
	TRANCHE ESSAYEE	**111.00 m** à **114.00 m**	Manomètre	**0.50 m**
			depth to water:	**37.75 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	201	10	3	20.1	6.70	3.825	1.99E-02	7.805
7	189	10	3	18.9	6.30	3.825	1.87E-02	10.806
10	90	10	3	9	3.00	3.825	8.91E-03	13.816
7	41	10	3	4.1	1.37	3.825	4.06E-03	10.821
4	16	10	3	1.6	0.53	3.825	1.58E-03	7.823

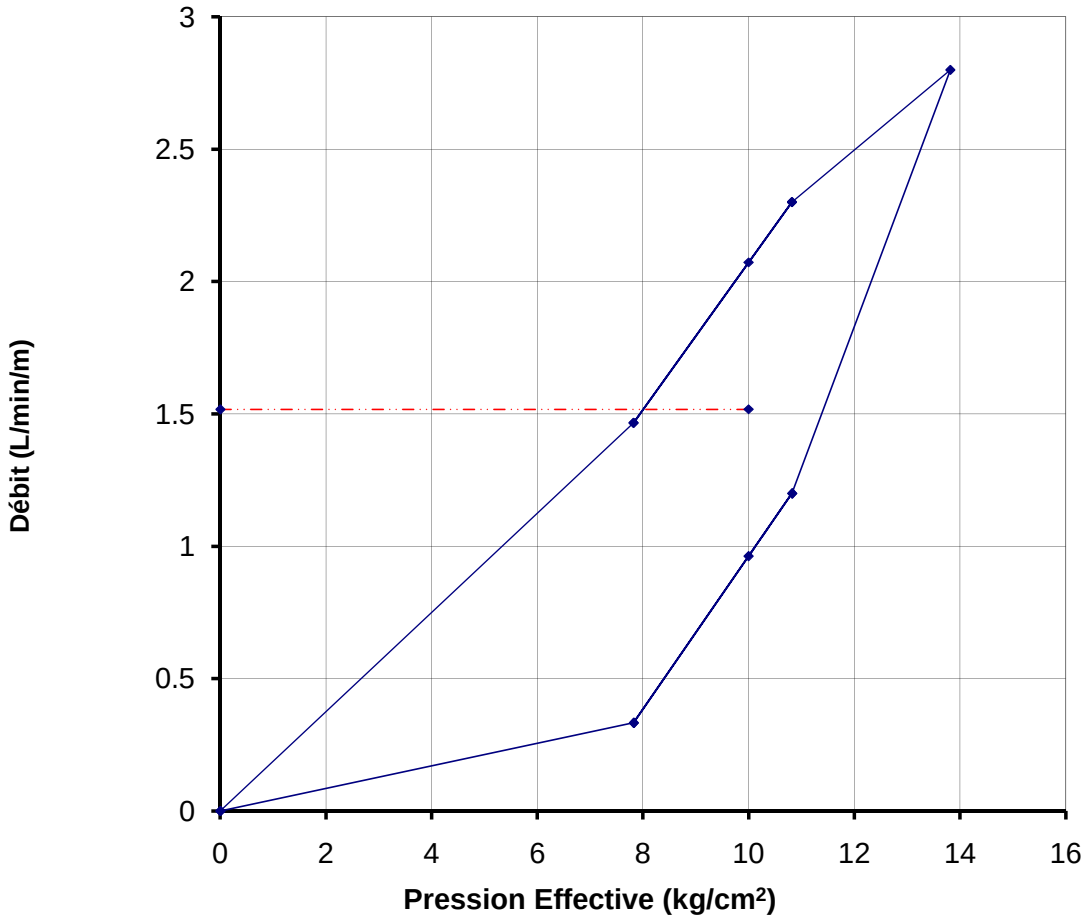


Lugeon = 3.77 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**		Date:	**3/30/2014**
	SONDAGE No.:	**BHRA 01**			
	TRANCHE ESSAYEE	**117.00 m**	à **120.00 m**	Manomètre	**0.50 m**
				depth to water:	**37.75 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	44	10	3	4.4	1.47	3.825	4.36E-03	7.821
7	69	10	3	6.9	2.30	3.825	6.83E-03	10.818
10	84	10	3	8.4	2.80	3.825	8.32E-03	13.817
7	36	10	3	3.6	1.20	3.825	3.56E-03	10.821
4	10	10	3	1	0.33	3.825	9.90E-04	7.824

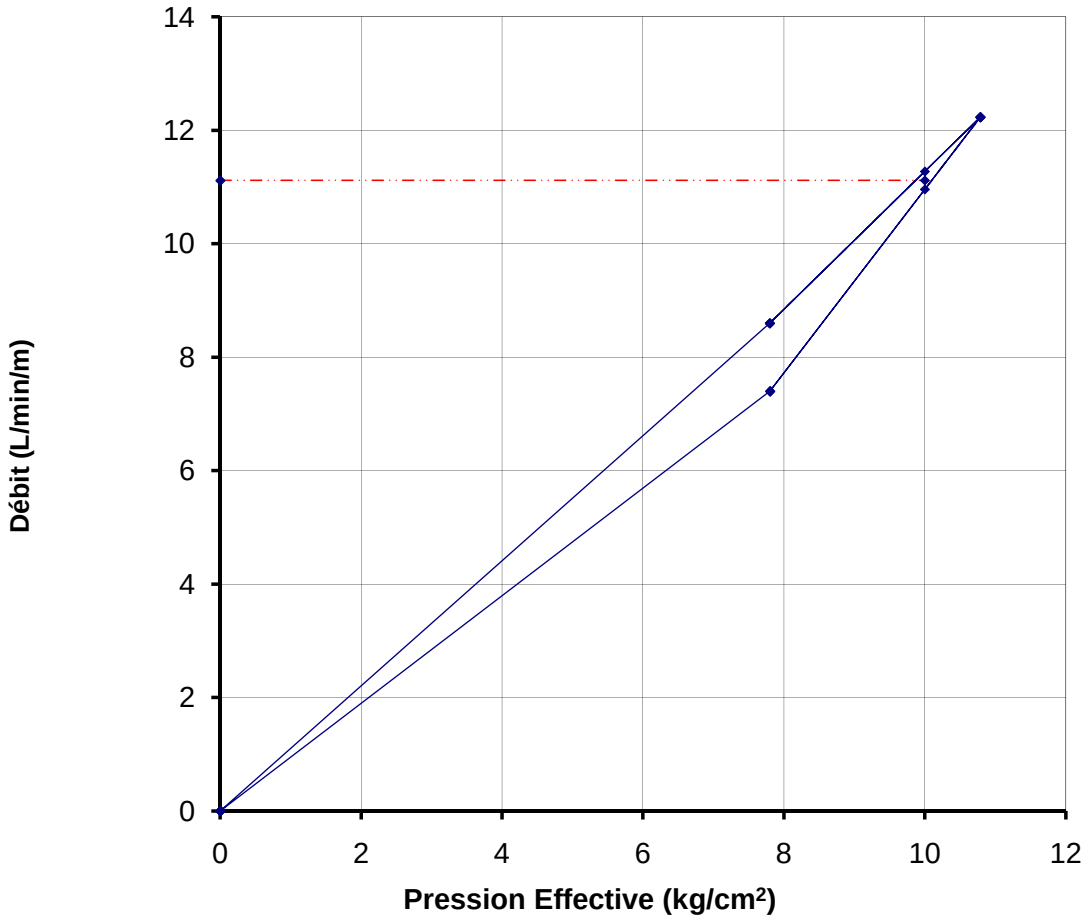


Lugeon = 1.52 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**		Date:	**3/31/2014**
	SONDAGE No.:	**BHRA 01**			
	TRANCHE ESSAYEE	**120.00 m**	à **123.00 m**	Manomètre	**0.50 m**
				depth to water:	**37.75 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	258	10	3	25.8	8.60	3.825	2.55E-02	7.799
7	367	10	3	36.7	12.23	3.825	3.63E-02	10.789
4	222	10	3	22.2	7.40	3.825	2.20E-02	7.803

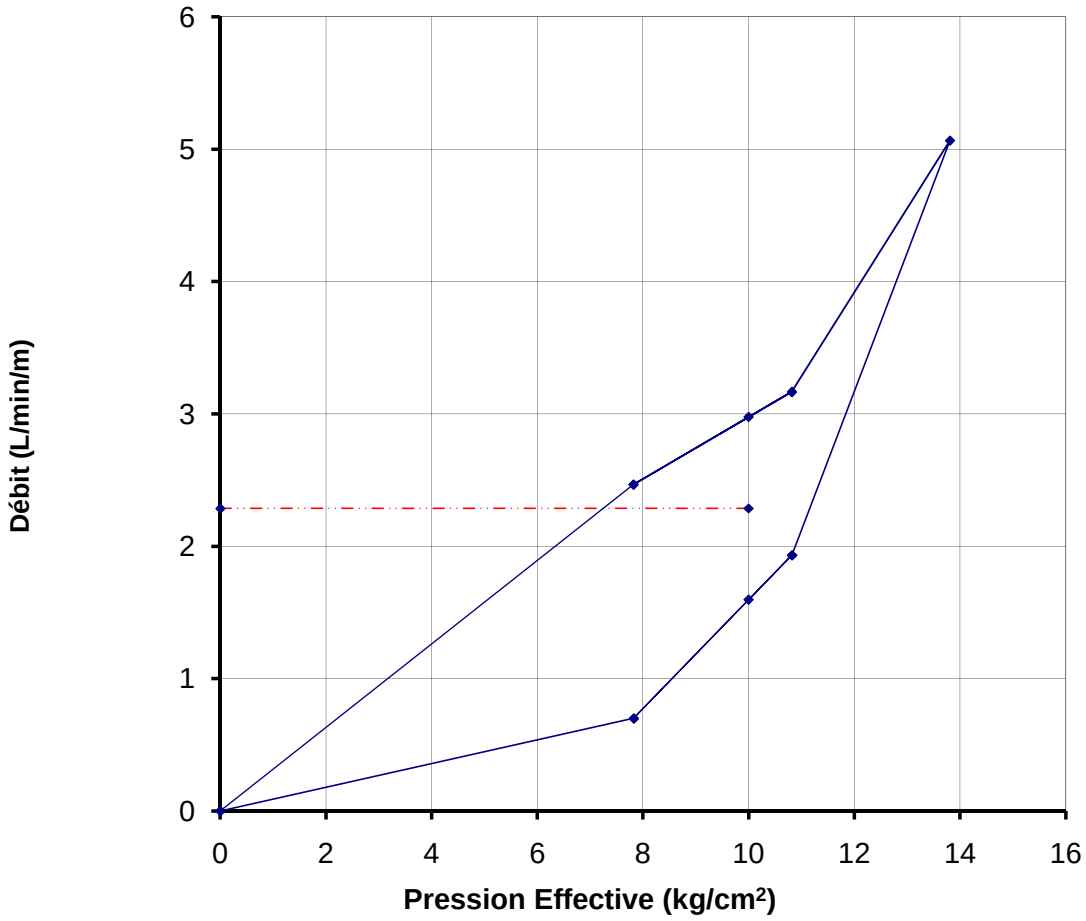


Lugeon = 11.12 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**		Date:	**4/2/2014**
	SONDAGE No.:	**BHRA 01**			
	TRANCHE ESSAYEE	**123.00 m**	à **126.00 m**	Manomètre	**0.50 m**
				depth to water:	**37.75 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	74	10	3	7.4	2.47	3.825	7.33E-03	7.818
7	95	10	3	9.5	3.17	3.825	9.41E-03	10.816
10	152	10	3	15.2	5.07	3.825	1.50E-02	13.810
7	58	10	3	5.8	1.93	3.825	5.74E-03	10.819
4	21	10	3	2.1	0.70	3.825	2.08E-03	7.823

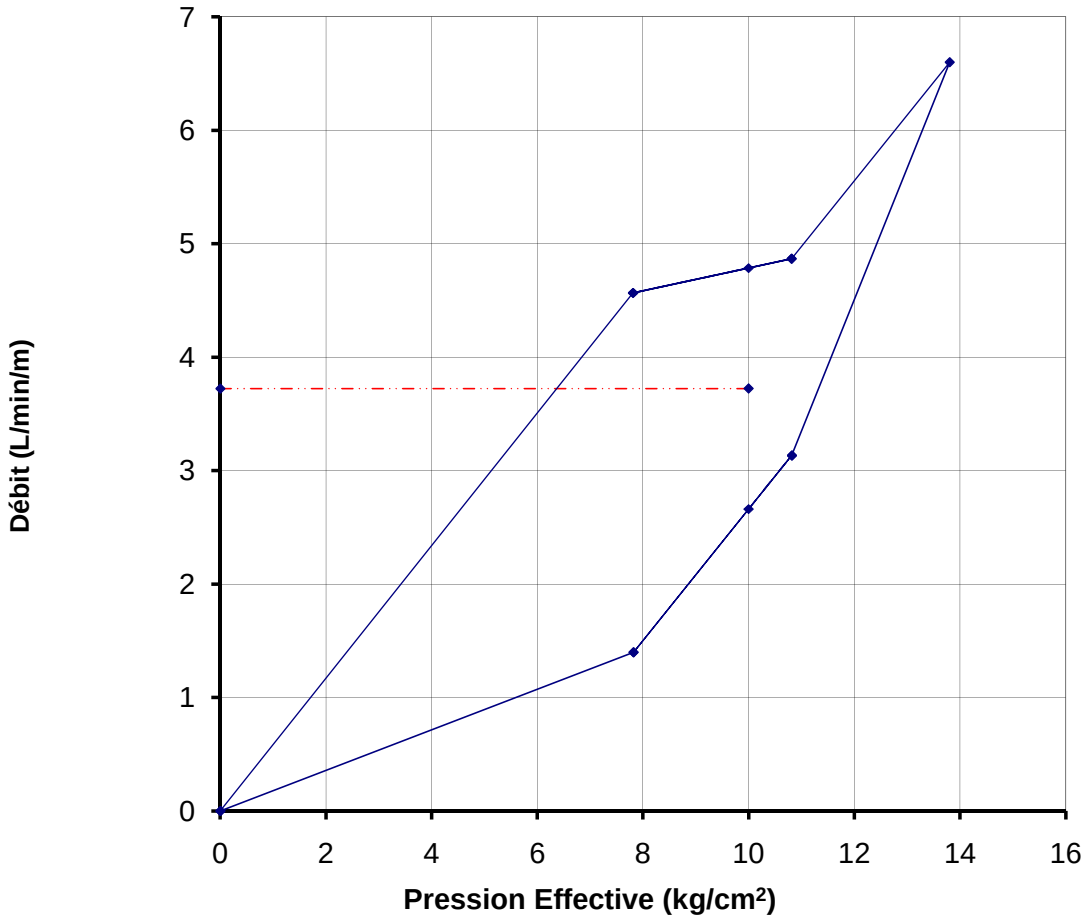


Lugeon = 2.29 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date:	**4/2/2014**
	SONDAGE No.:	**BHRA 01**		
	TRANCHE ESSAYEE	**126.00 m** à **129.00 m**	Manomètre	**0.50 m**
			depth to water:	**37.75 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	137	10	3	13.7	4.57	3.825	1.36E-02	7.811
7	146	10	3	14.6	4.87	3.825	1.45E-02	10.811
10	198	10	3	19.8	6.60	3.825	1.96E-02	13.805
7	94	10	3	9.4	3.13	3.825	9.31E-03	10.816
4	42	10	3	4.2	1.40	3.825	4.16E-03	7.821

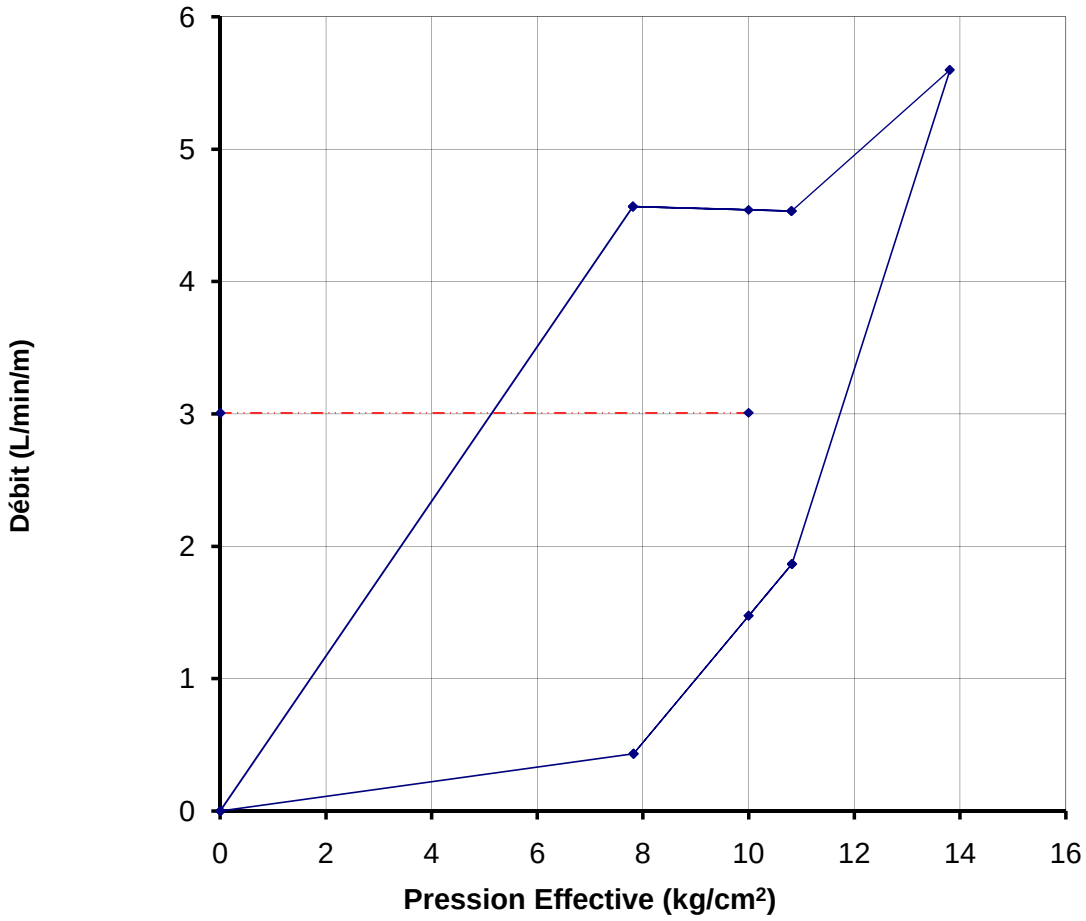


Lugeon = 3.72 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date:	**4/3/2014**
	SONDAGE No.:	**BHRA 01**		
	TRANCHE ESSAYEE	**129.00 m** à **132.00 m**	Manomètre	**0.50 m**
			depth to water:	**37.75 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	137	10	3	13.7	4.57	3.825	1.36E-02	7.811
7	136	10	3	13.6	4.53	3.825	1.35E-02	10.812
10	168	10	3	16.8	5.60	3.825	1.66E-02	13.808
7	56	10	3	5.6	1.87	3.825	5.54E-03	10.819
4	13	10	3	1.3	0.43	3.825	1.29E-03	7.824

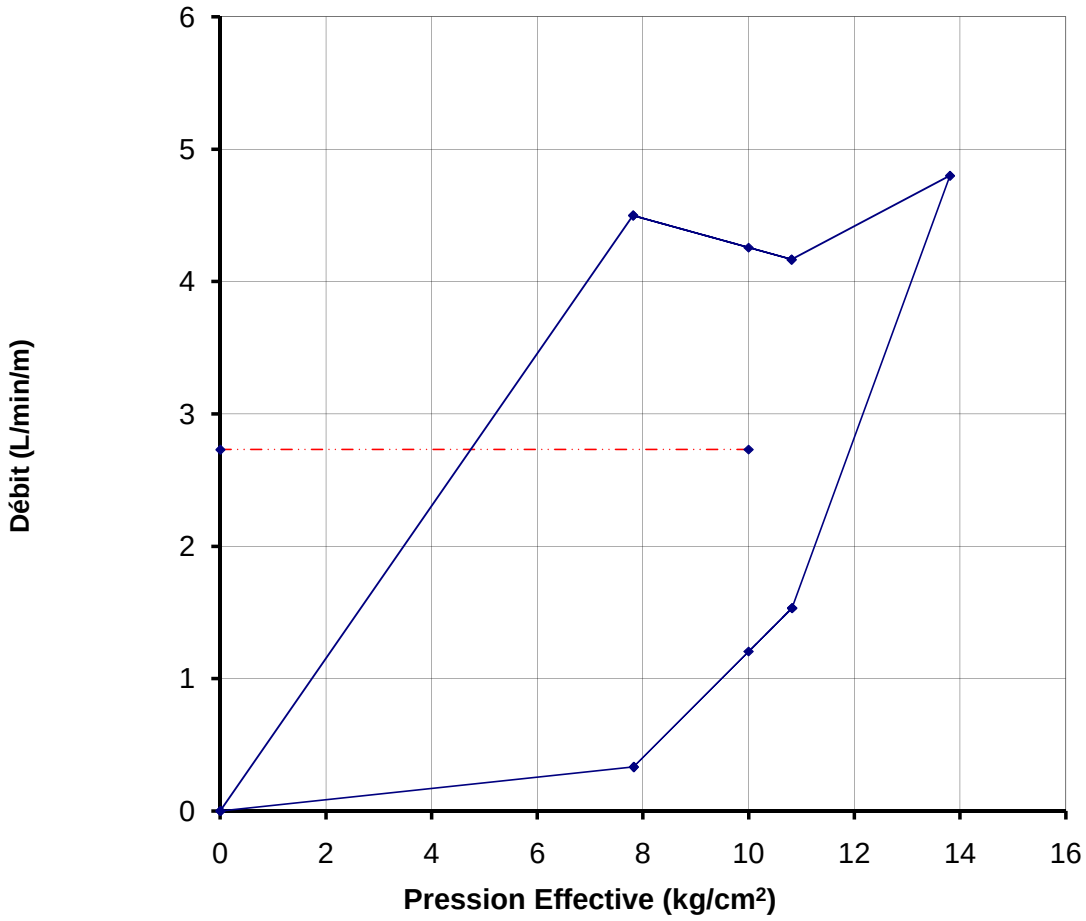


Lugeon = 3.01 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date:	**4/3/2014**
	SONDAGE No.:	**BHRA 01**		
	TRANCHE ESSAYEE	**132.00 m** à **135.00 m**	Manomètre	**0.50 m**
			depth to water:	**37.75 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	135	10	3	13.5	4.50	3.825	1.34E-02	7.812
7	125	10	3	12.5	4.17	3.825	1.24E-02	10.813
10	144	10	3	14.4	4.80	3.825	1.43E-02	13.811
7	46	10	3	4.6	1.53	3.825	4.55E-03	10.820
4	10	10	3	1	0.33	3.825	9.90E-04	7.824

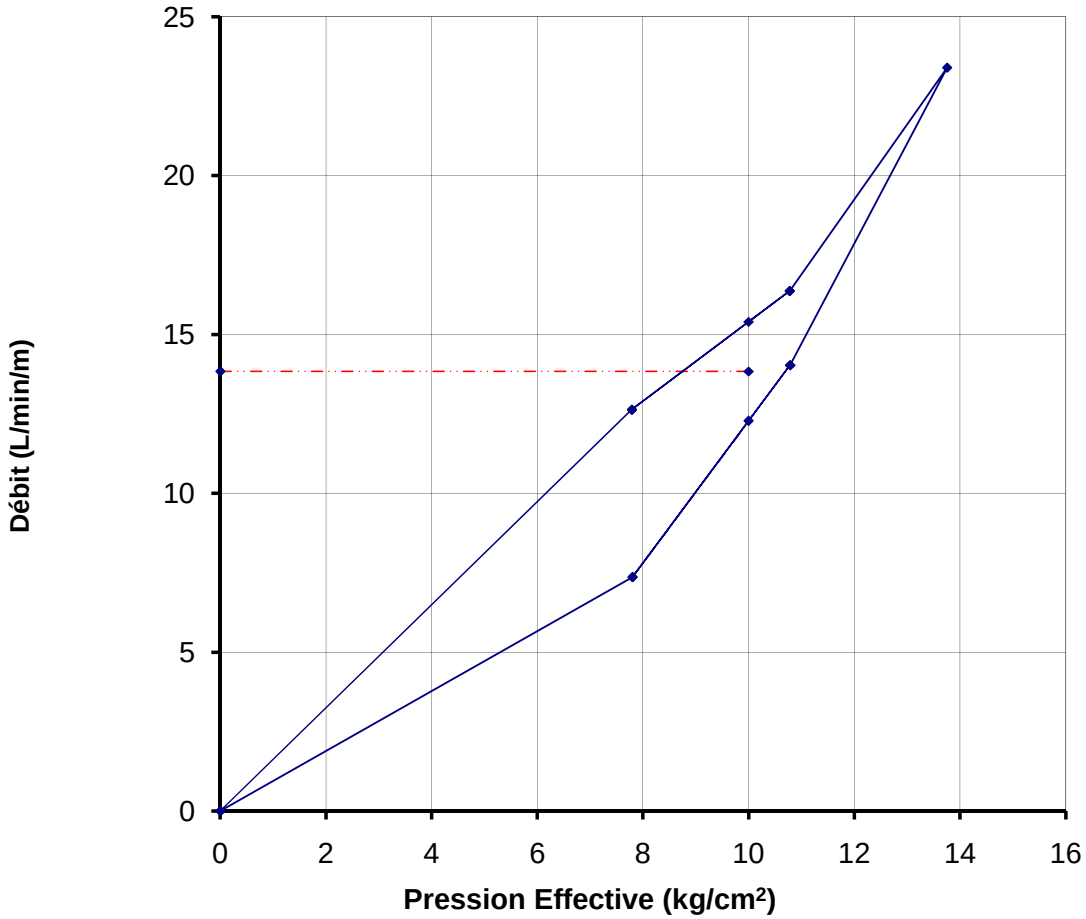


Lugeon = 2.73 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**		Date:	**4/4/2014**
	SONDAGE No.:	**BHRA 01**			
	TRANCHE ESSAYEE	**135.00 m**	à **138.00 m**	Manomètre	**0.50 m**
				depth to water:	**37.75 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	221	10	3	22.1	7.37	3.825	2.19E-02	7.803
7	421	10	3	42.1	14.03	3.825	4.17E-02	10.783
10	702	10	3	70.2	23.40	3.825	6.95E-02	13.756
7	491	10	3	49.1	16.37	3.825	4.86E-02	10.776
4	379	10	3	37.9	12.63	3.825	3.75E-02	7.787

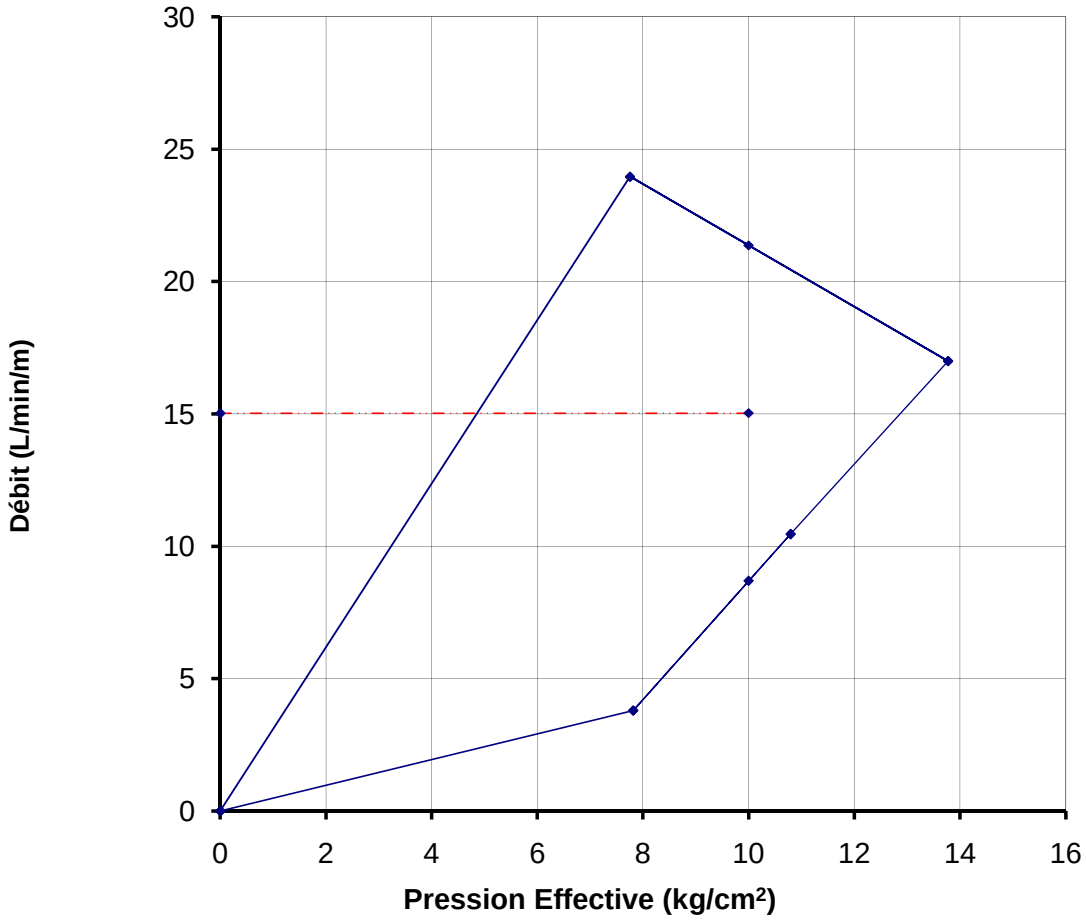


Lugeon = 13.84 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**		Date:	**4/6/2014**
	SONDAGE No.:	**BHRA 01**			
	TRANCHE ESSAYEE	**138.00 m**	à **141.00 m**	Manomètre	**0.50 m**
				depth to water:	**37.75 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	114	10	3	11.4	3.80	3.825	1.13E-02	7.814
7	314	10	3	31.4	10.47	3.825	3.11E-02	10.794
10	153	3	3	51	17.00	3.825	5.05E-02	13.775
4	719	10	3	71.9	23.97	3.825	7.12E-02	7.754

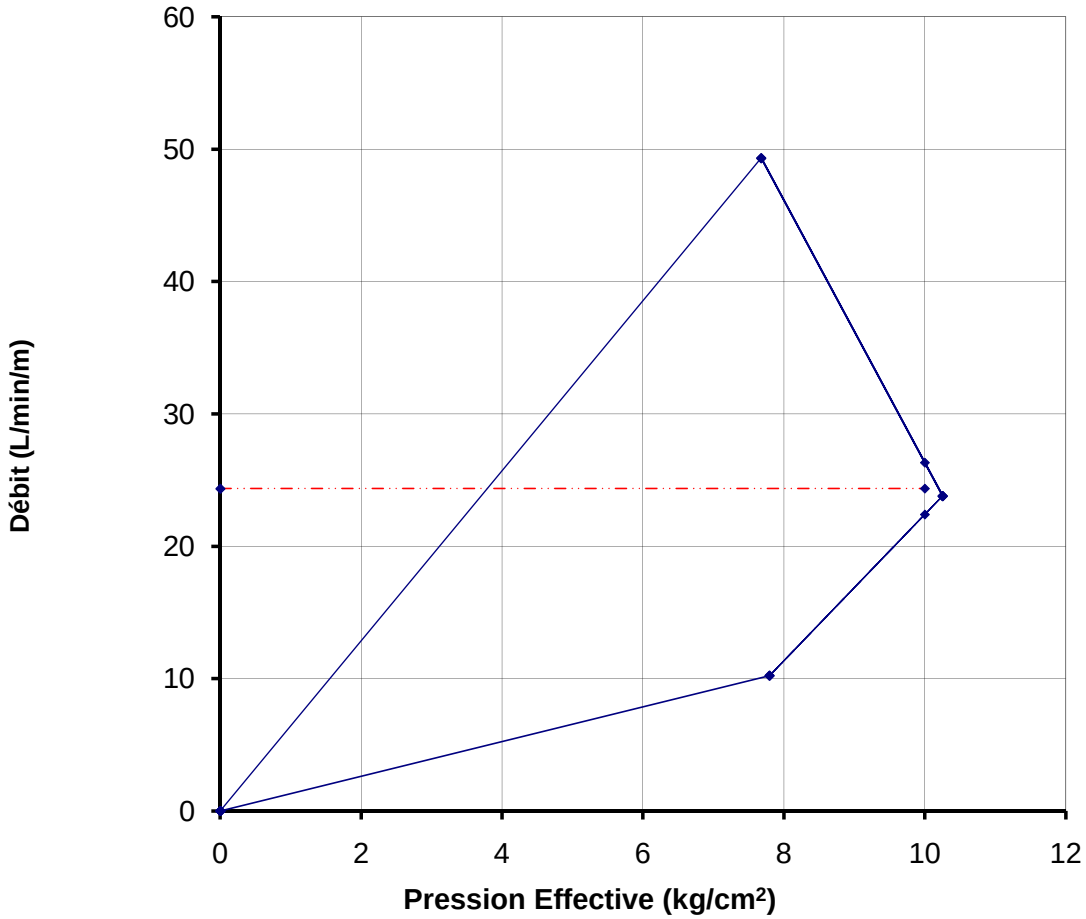


Lugeon = 15.03 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**		Date:	**4/7/2014**
	SONDAGE No.:	**BHRA 01**			
	TRANCHE ESSAYEE	**141.00 m**	à **144.00 m**	Manomètre	**0.50 m**
				depth to water:	**37.75 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	307	10	3	30.7	10.23	3.825	3.04E-02	7.795
6.5	714	10	3	71.4	23.80	3.825	7.07E-02	10.254
4	444	3	3	148	49.33	3.825	1.47E-01	7.678

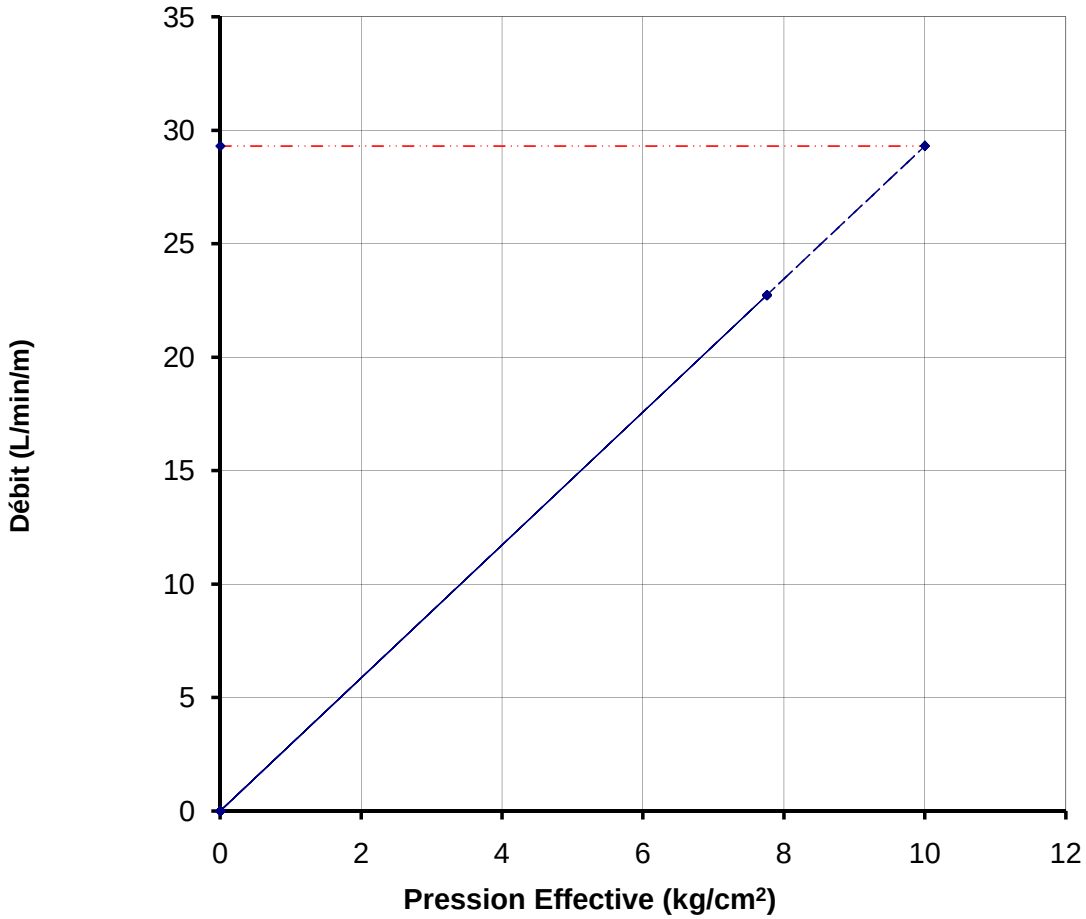


Lugeon = 24.36 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **4/7/2014**
	SONDAGE No.:	**BHRA 01**	
	TRANCHE ESSAYEE	**144.00 m** à **147.00 m**	Manomètre **0.50 m**
			depth to water: **37.75 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	682	10	3	68.2	22.73	3.825	6.75E-02	7.757



Lugeon = 29.31 L/min/m

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BISRI DAM

DAM FOOTPRINT

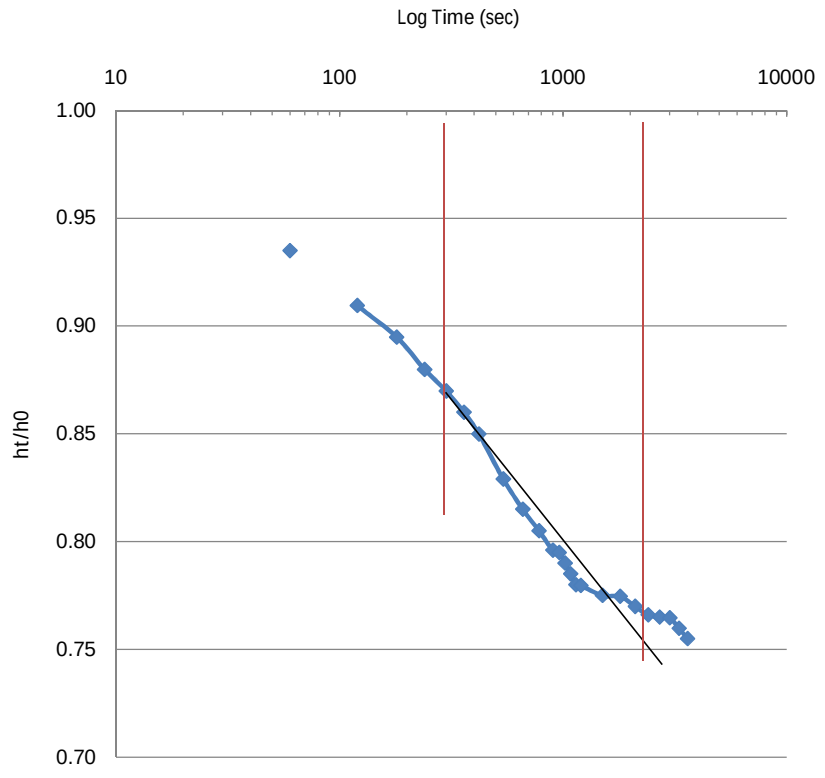
FALLING HEAD BOREHOLE WATER PERMEABILITY TEST

BHRA3	Pre-T.W.D (m):	2	G.W.D (m):	24.55	**Date:**	17.03.2014
Test Interval	0	to	3		**K(m/sec, FHM):**	**1.5313E-07**
Diameter of test interval		D	86	mm		
Pre-test water depth (Pre-T.W.D) / Groundwater depth (GWD)		h_0	2	m		
Length of uncased test interval below the pre-test water level		L	1	m		

Falling Head Method (FHM)

$$K_{(m/sec)} = \frac{D^2}{8L(t2-t1)} Ln\left(\frac{L}{D}\right) Ln\left(\frac{H1}{H2}\right)$$

H1	1.74	m
H2	1.51	m
t1 (as per graph)	300	sec.
t2	2400	sec.



Time (min)	Drawdown from R.L (m)	Time (sec)	h_t / h_0	h_t
0	0.00	0	1.00	2.00
1	0.13	60	0.94	1.87
2	0.18	120	0.91	1.82
3	0.21	180	0.89	1.79
4	0.24	240	0.88	1.76
5	0.26	300	0.87	1.74
6	0.28	360	0.86	1.72
7	0.30	420	0.85	1.70
9	0.34	540	0.83	1.66
11	0.37	660	0.82	1.63
13	0.39	780	0.81	1.61
15	0.41	900	0.80	1.59
16	0.41	960	0.79	1.59
17	0.42	1020	0.79	1.58
18	0.43	1080	0.79	1.57
19	0.44	1140	0.78	1.56
20	0.44	1200	0.78	1.56
25	0.45	1500	0.78	1.55
30	0.45	1800	0.77	1.55
35	0.46	2100	0.77	1.54
40	0.47	2400	0.77	1.53
45	0.47	2700	0.76	1.53
50	0.47	3000	0.76	1.53
55	0.48	3300	0.76	1.52
60	0.49	3600	0.75	1.51

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

Semi-Pervious

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BISRI DAM

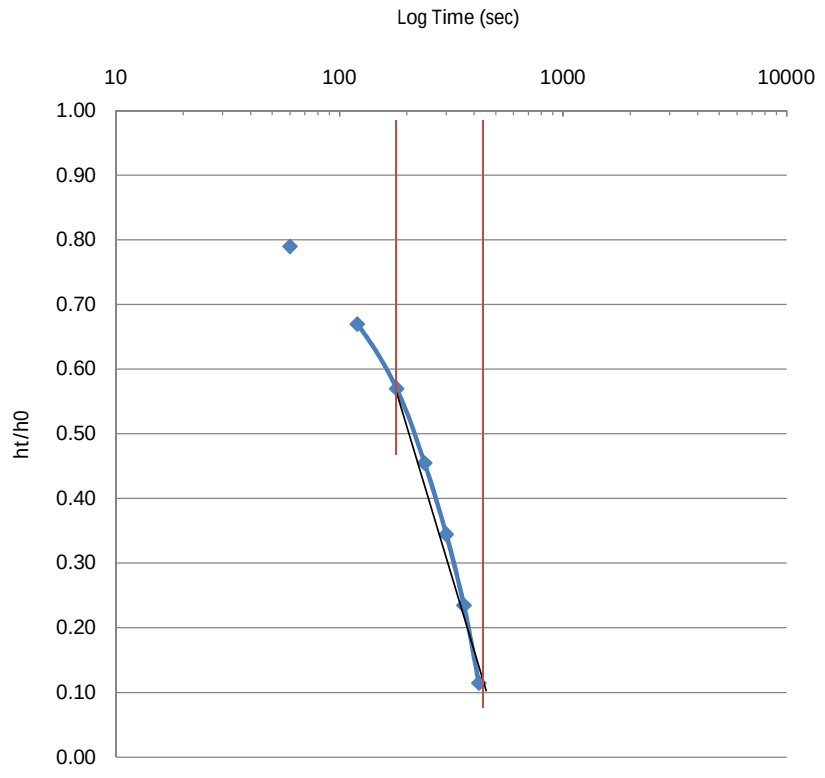
DAM FOOTPRINT

FALLING HEAD BOREHOLE WATER PERMEABILITY TEST

BHRA3	Pre-T.W.D (m):	2	G.W.D (m):	24.55	**Date:**		17.03.2014		
Test Interval	3	to	6		**K(m/sec, FHM):**		**6.4895E-06**		
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 (Pre-T.W.D) / Groundwater depth (GWD)		h_0	2	m	0	0.00	0	1.00	2.00
Length of uncased test interval below the pre-test water level		L	3	m	1	0.42	60	0.79	1.58
					2	0.66	120	0.67	1.34
					3	0.86	180	0.57	1.14
					4	1.09	240	0.45	0.91
					5	1.31	300	0.34	0.69
					6	1.53	360	0.23	0.47
H1		1.14	m		7	1.77	420	0.11	0.23
H2		0.23	m						
t1 (as per graph)		180	sec.						
t2		450	sec.						

Falling Head Method (FHM)

$$K_{(m/sec)} = \frac{D^2}{8L(t2-t1)} Ln\left(\frac{L}{D}\right) Ln\left(\frac{H1}{H2}\right)$$



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

Semi-Pervious to Pervious

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BISRI DAM

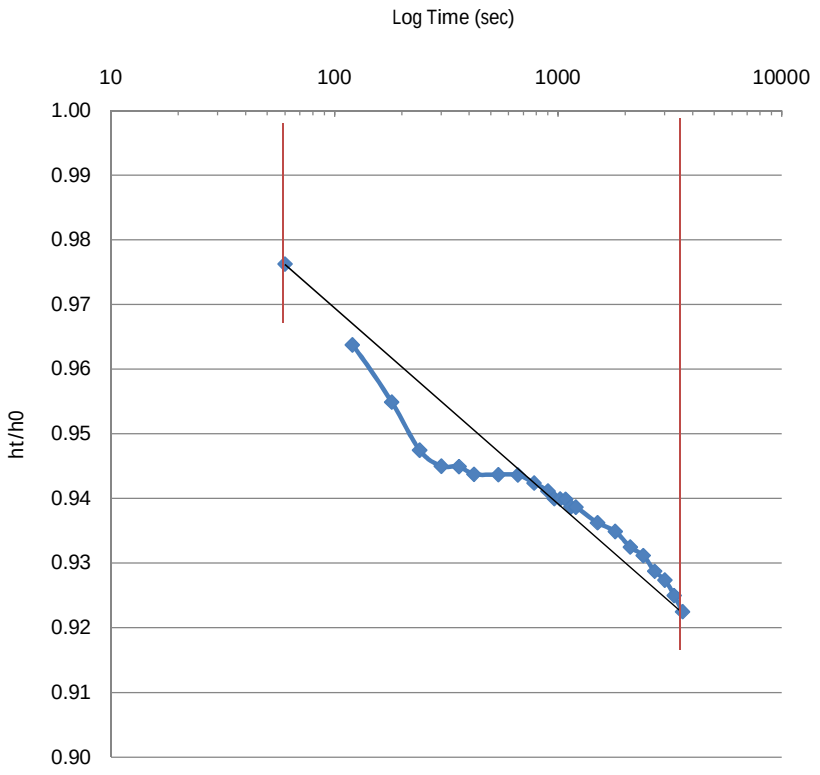
DAM FOOTPRINT

FALLING HEAD BOREHOLE WATER PERMEABILITY TEST

BHRA3	Pre-T.W.D (m):	8	G.W.D (m):	24.55	**Date:**		18.03.2014		
Test Interval	6	to	9		**K(m/sec, FHM):**		**3.6285E-08**		
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 (Pre-T.W.D) / Groundwater depth (GWD)		h_0	8	m	0	0.00	0	1.00	8.00
Length of uncased test interval below the pre-test water level		L	1	m	1	0.19	60	0.98	7.81
					2	0.29	120	0.96	7.71
					3	0.36	180	0.95	7.64
					4	0.42	240	0.95	7.58
					5	0.44	300	0.95	7.56
					6	0.44	360	0.94	7.56
H1		7.81	m		7	0.45	420	0.94	7.55
H2		7.38	m		9	0.45	540	0.94	7.55
t1 (as per graph)		60	sec.		11	0.45	660	0.94	7.55
t2		3600	sec.		13	0.46	780	0.94	7.54
					15	0.47	900	0.94	7.53
					16	0.48	960	0.94	7.52
					17	0.48	1020	0.94	7.52
					18	0.48	1080	0.94	7.52
					19	0.49	1140	0.94	7.51
					20	0.49	1200	0.94	7.51
					25	0.51	1500	0.94	7.49
					30	0.52	1800	0.93	7.48
					35	0.54	2100	0.93	7.46
					40	0.55	2400	0.93	7.45
					45	0.57	2700	0.93	7.43
					50	0.58	3000	0.93	7.42
					55	0.60	3300	0.93	7.40
					60	0.62	3600	0.92	7.38

Falling Head Method (FHM)

$$K_{(m/sec)} = \frac{D^2}{8L(t2-t1)} Ln\left(\frac{L}{D}\right) Ln\left(\frac{H1}{H2}\right)$$



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

Semi-Pervious to Impervious

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BISRI DAM

DAM FOOTPRINT

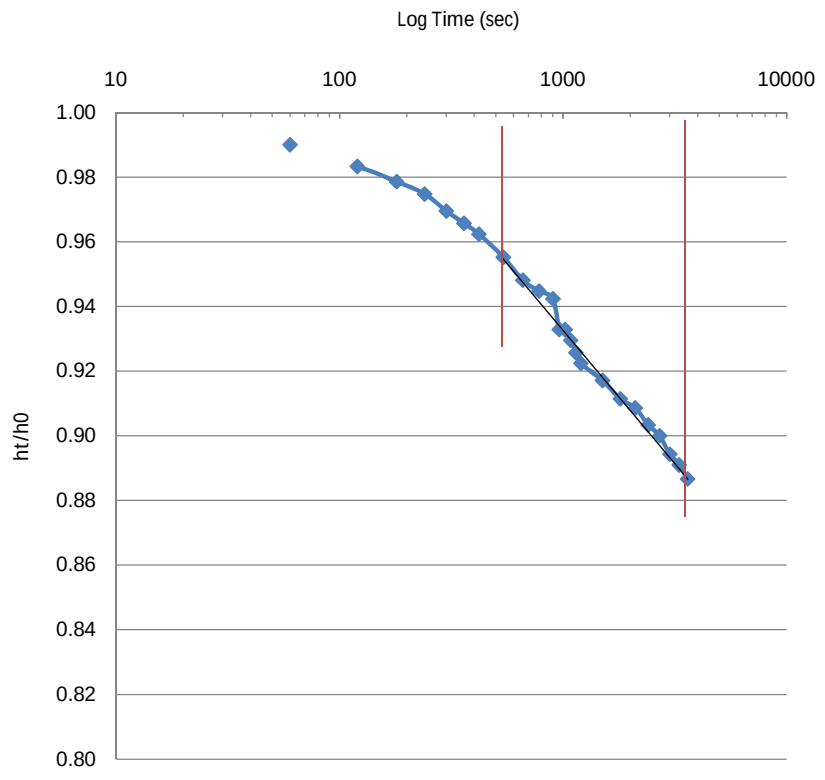
FALLING HEAD BOREHOLE WATER PERMEABILITY TEST

BHRA3	Pre-T.W.D (m):	21	G.W.D (m):	24.55
Test Interval	39	to	42	
Diameter of test interval		D	86	mm
Pre-test water depth (Pre-T.W.D) / Groundwater depth (GWD)		h_0	21	m
Length of uncased test interval below the pre-test water level		L	3	m

Falling Head Method (FHM)

$$K_{(m/sec)} = \frac{D^2}{8L(t2-t1)} Ln\left(\frac{L}{D}\right) Ln\left(\frac{H1}{H2}\right)$$

H1	20.06	m
H2	18.62	m
t1 (as per graph)	540	sec.
t2	3600	sec.



Date: 20.03.2014

K(m/sec, FHM): 2.6647E-08

Time (min)	Drawdown from R.L (m)	Time (sec)	h_t / h_0	h_t
0	0.00	0	1.00	21.00
1	0.21	60	0.99	20.79
2	0.35	120	0.98	20.65
3	0.45	180	0.98	20.55
4	0.53	240	0.97	20.47
5	0.64	300	0.97	20.36
6	0.72	360	0.97	20.28
7	0.79	420	0.96	20.21
9	0.94	540	0.96	20.06
11	1.09	660	0.95	19.91
13	1.16	780	0.94	19.84
15	1.21	900	0.94	19.79
16	1.41	960	0.93	19.59
17	1.41	1020	0.93	19.59
18	1.48	1080	0.93	19.52
19	1.56	1140	0.93	19.44
20	1.63	1200	0.92	19.37
25	1.74	1500	0.92	19.26
30	1.86	1800	0.91	19.14
35	1.92	2100	0.91	19.08
40	2.03	2400	0.90	18.97
45	2.10	2700	0.90	18.90
50	2.22	3000	0.89	18.78
55	2.29	3300	0.89	18.71
60	2.38	3600	0.89	18.62

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

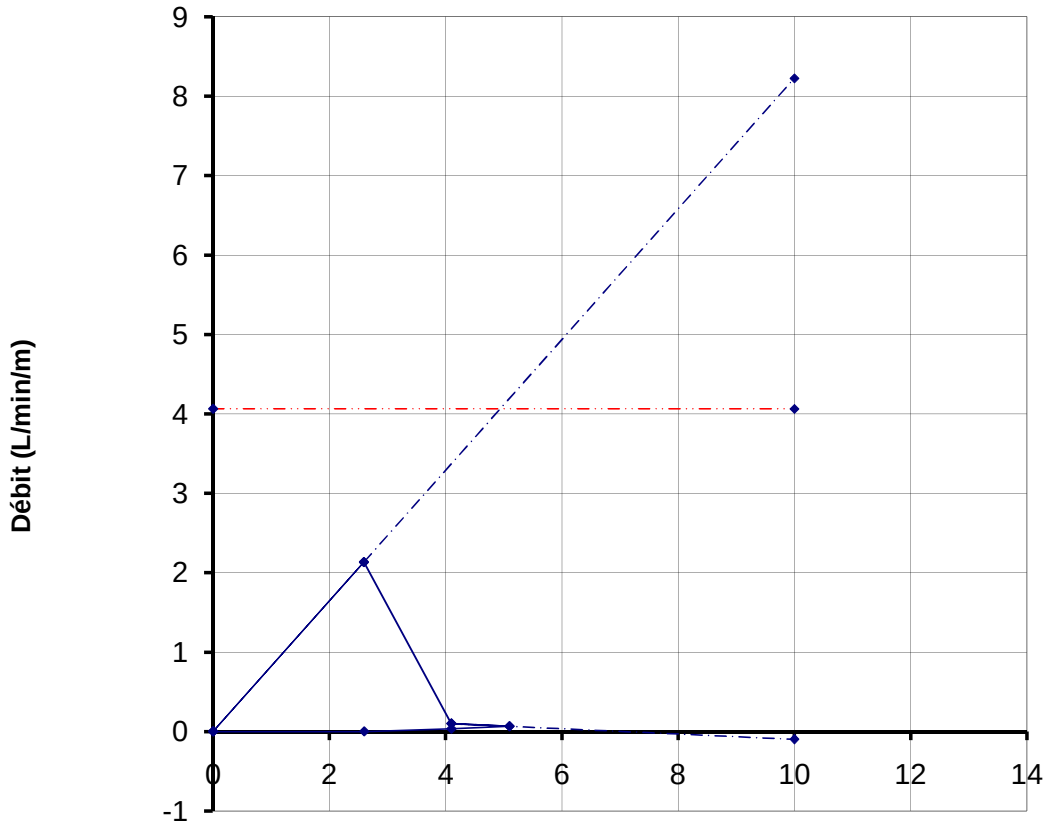
Semi-Pervious to Impervious

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/18/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**9.00 m** à **12.00 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
1.5	64	10	3	6.4	2.13	1.1	6.34E-03	2.594
3	3	10	3	0.3	0.10	1.1	2.97E-04	4.100
4	2	10	3	0.2	0.07	1.1	1.98E-04	5.100
3	1	10	3	0.1	0.03	1.1	9.90E-05	4.100
1.5	0	10	3	0	0.00	1.1	0.00E+00	2.600



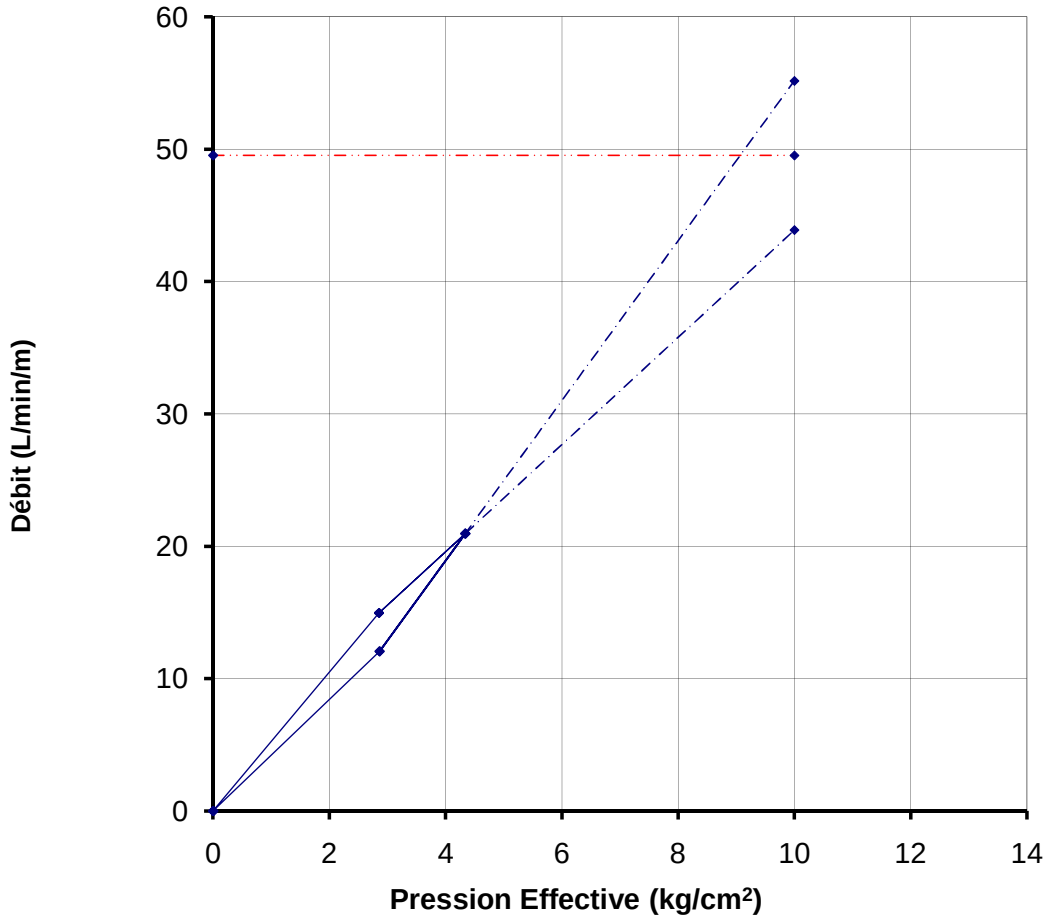
Lugeon = 4.06 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/18/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**12.00 m** à **15.00 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
1.5	362	10	3	36.2	12.07	1.4	3.58E-02	2.864
3	629	10	3	62.9	20.97	1.4	6.23E-02	4.338
1.5	449	10	3	44.9	14.97	1.4	4.45E-02	2.856



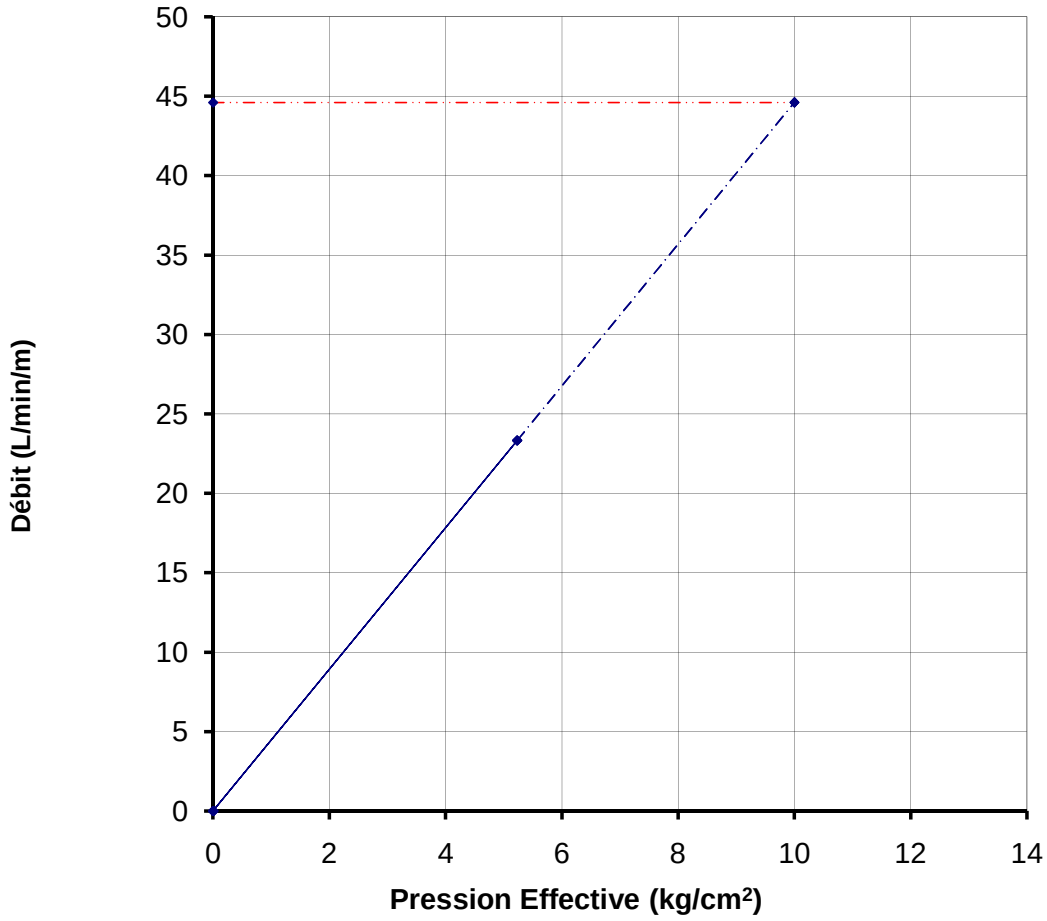
Lugeon = 49.53 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/19/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**21.00 m** à **24.00 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	700	10	3	70	23.33	2.3	6.93E-02	5.231

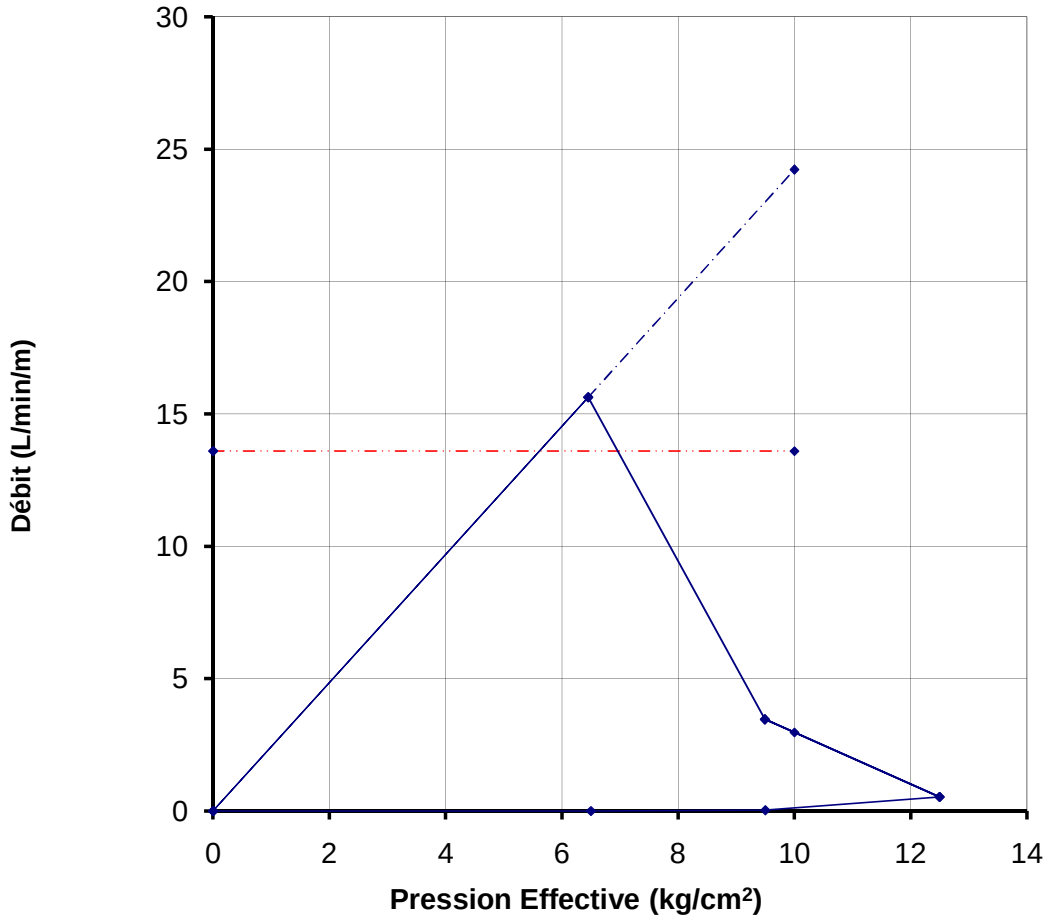


Lugeon = 44.61 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/19/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**27.00 m** à **30.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	469	10	3	46.9	15.63	2.5	4.64E-02	6.454
7	104	10	3	10.4	3.47	2.5	1.03E-02	9.490
10	16	10	3	1.6	0.53	2.5	1.58E-03	12.498
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

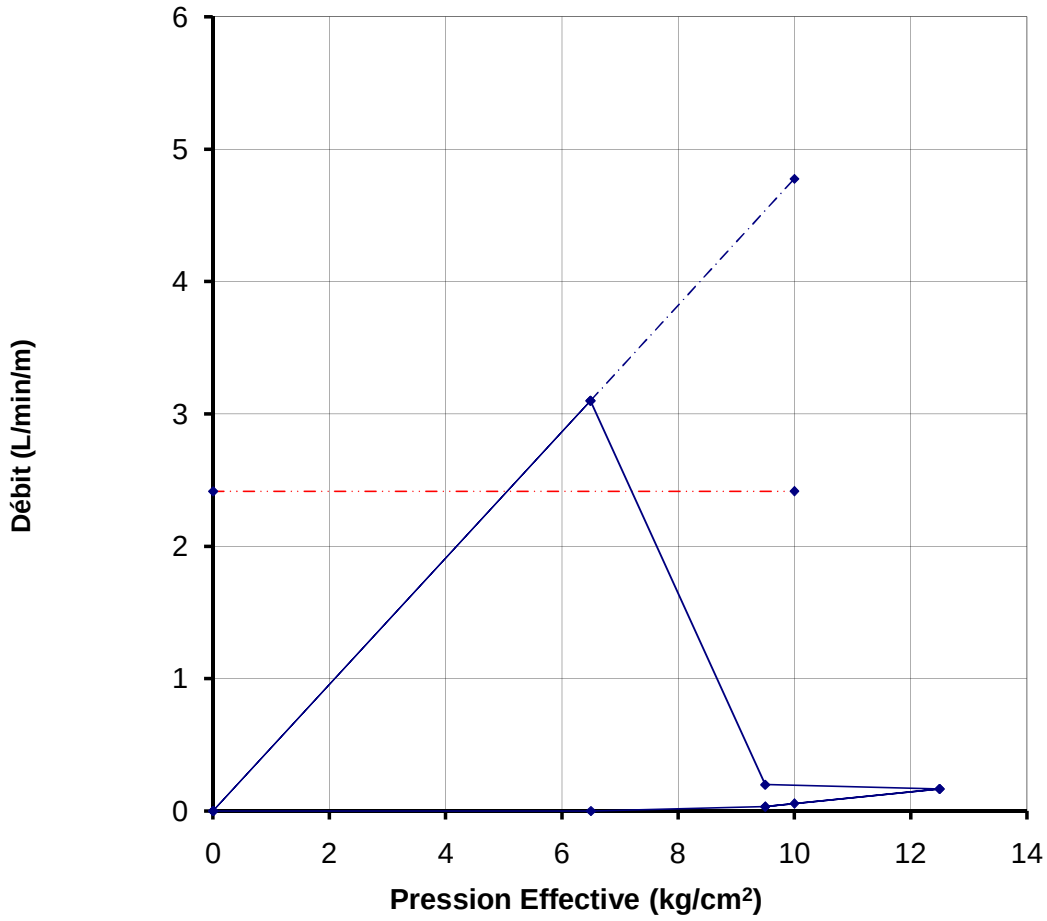


Lugeon = 13.60 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/19/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**30.00 m** à **33.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	93	10	3	9.3	3.10	2.5	9.21E-03	6.491
7	6	10	3	0.6	0.20	2.5	5.94E-04	9.499
10	5	10	3	0.5	0.17	2.5	4.95E-04	12.500
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

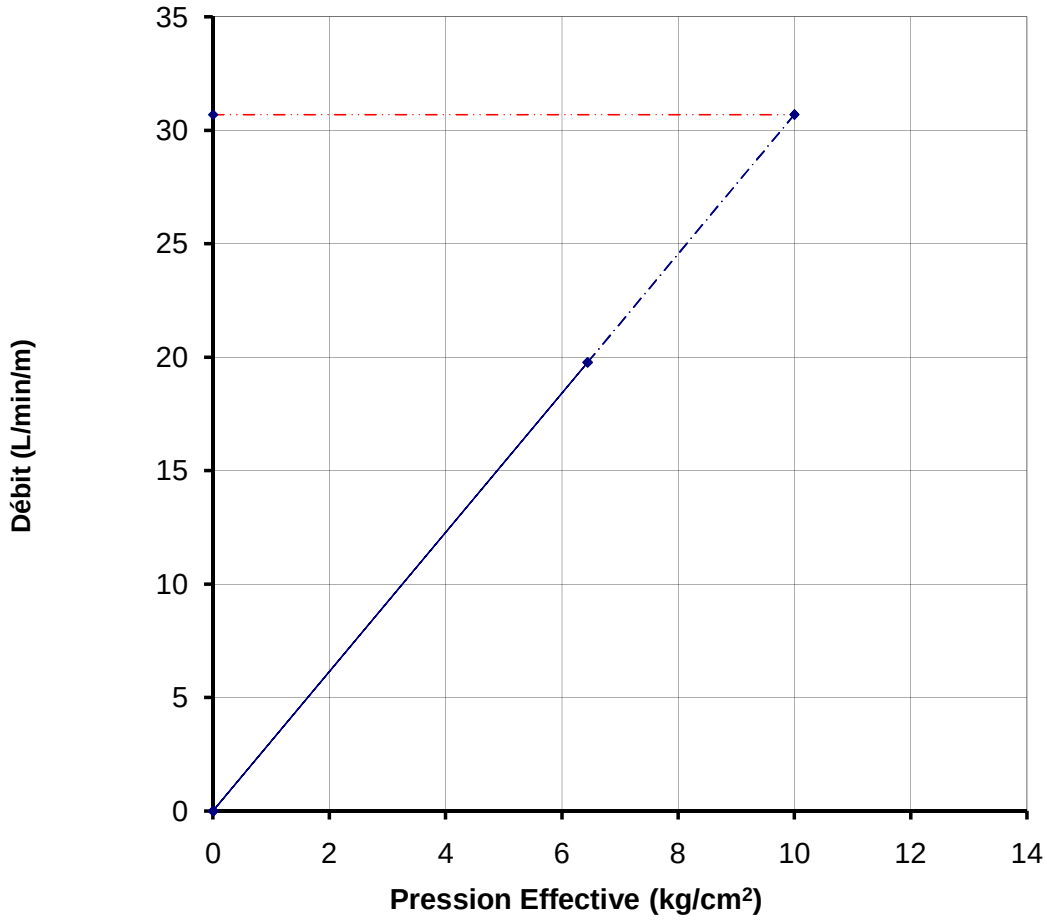


Lugeon = 2.42 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/20/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**33.00 m** à **36.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	593	10	3	59.3	19.77	2.5	5.87E-02	6.441

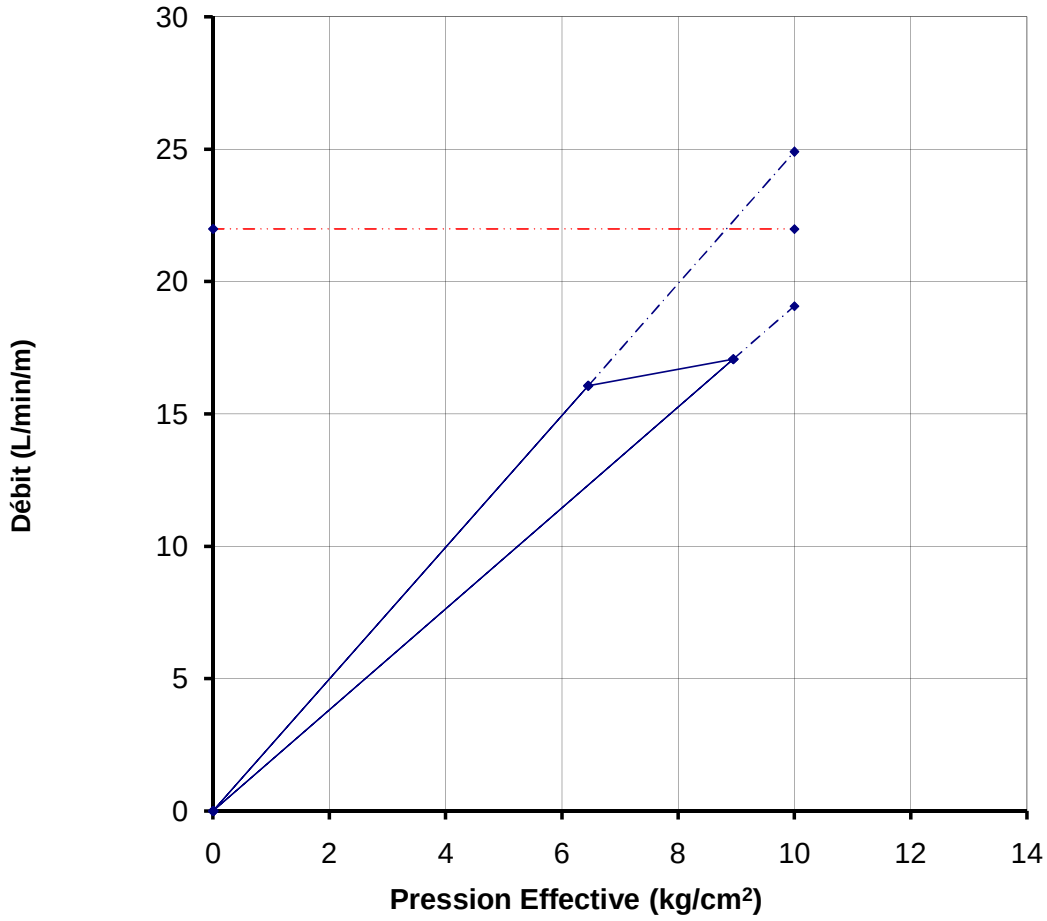


Lugeon = 30.69 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/20/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**36.00 m** à **39.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	482	10	3	48.2	16.07	2.5	4.77E-02	6.452
6.5	512	10	3	51.2	17.07	2.5	5.07E-02	8.949

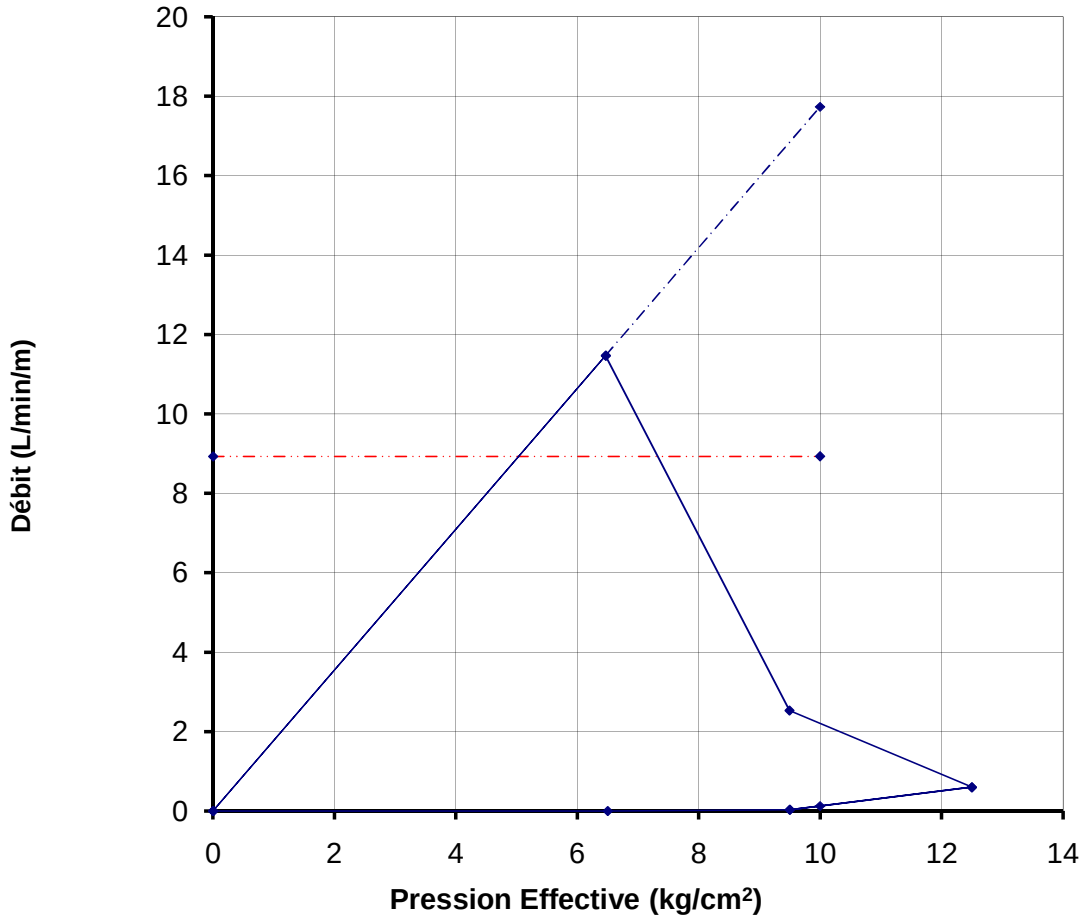


Lugeon = 21.99 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/20/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**42.00 m** à **45.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	344	10	3	34.4	11.47	2.5	3.41E-02	6.466
7	76	10	3	7.6	2.53	2.5	7.52E-03	9.492
10	18	10	3	1.8	0.60	2.5	1.78E-03	12.498
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

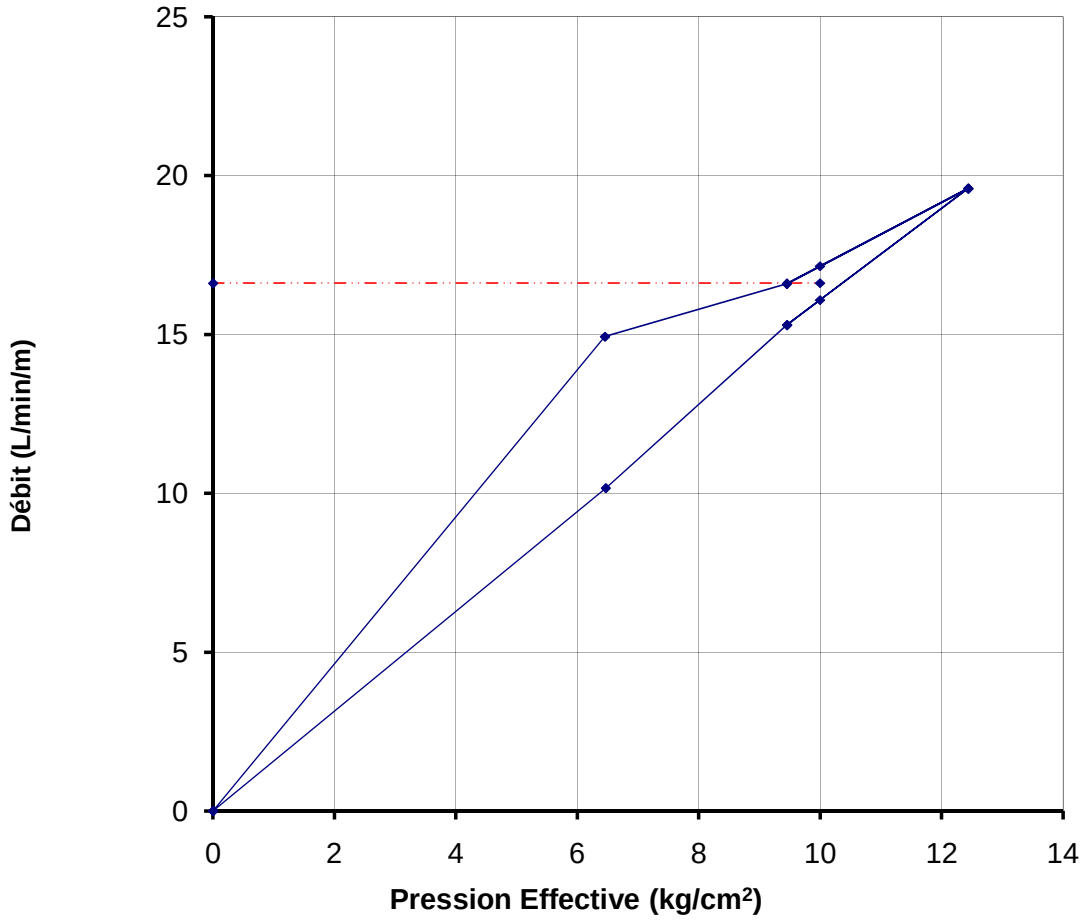


Lugeon = 8.93 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/20/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**45.00 m** à **48.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	448	10	3	44.8	14.93	2.5	4.44E-02	6.456
7	498	10	3	49.8	16.60	2.5	4.93E-02	9.451
10	588	10	3	58.8	19.60	2.5	5.82E-02	12.442
7	459	10	3	45.9	15.30	2.5	4.54E-02	9.455
4	305	10	3	30.5	10.17	2.5	3.02E-02	6.470

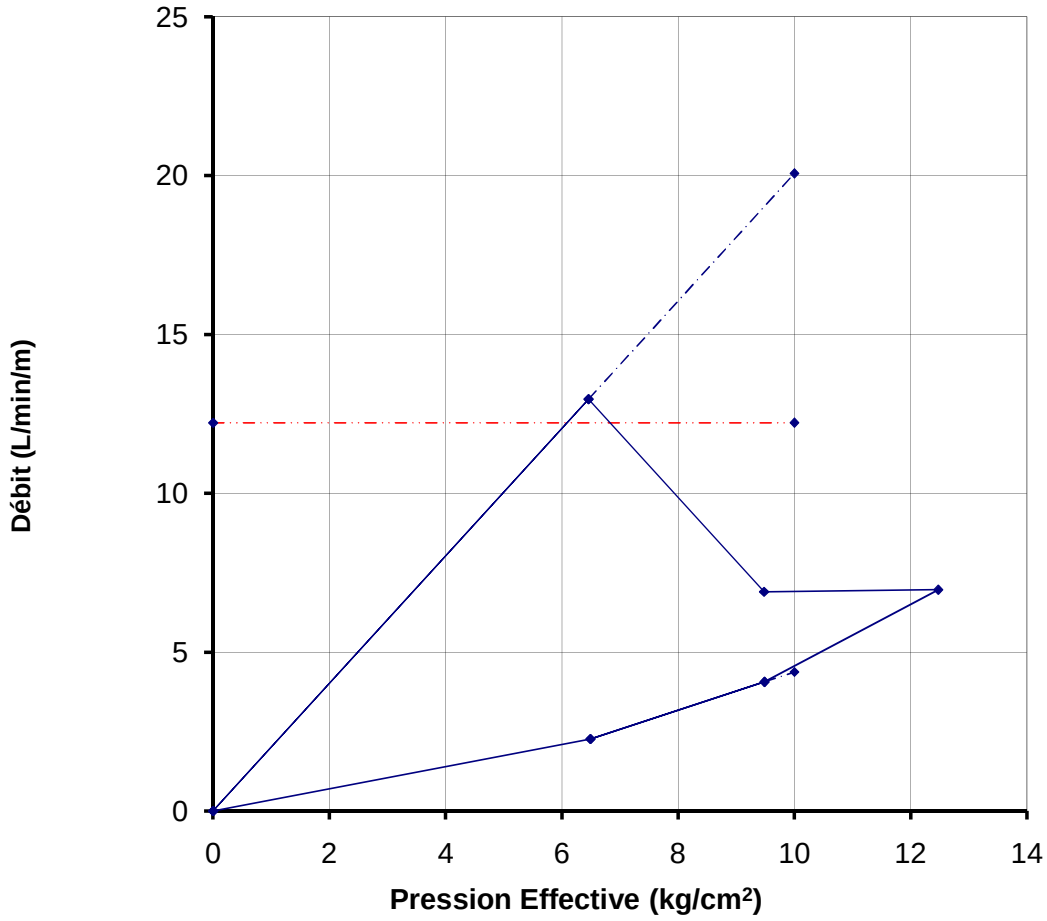


Lugeon = 16.62 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/21/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**48.00 m** à **51.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	389	10	3	38.9	12.97	2.5	3.85E-02	6.461
7	207	10	3	20.7	6.90	2.5	2.05E-02	9.480
10	209	10	3	20.9	6.97	2.5	2.07E-02	12.479
7	122	10	3	12.2	4.07	2.5	1.21E-02	9.488
4	68	10	3	6.8	2.27	2.5	6.73E-03	6.493

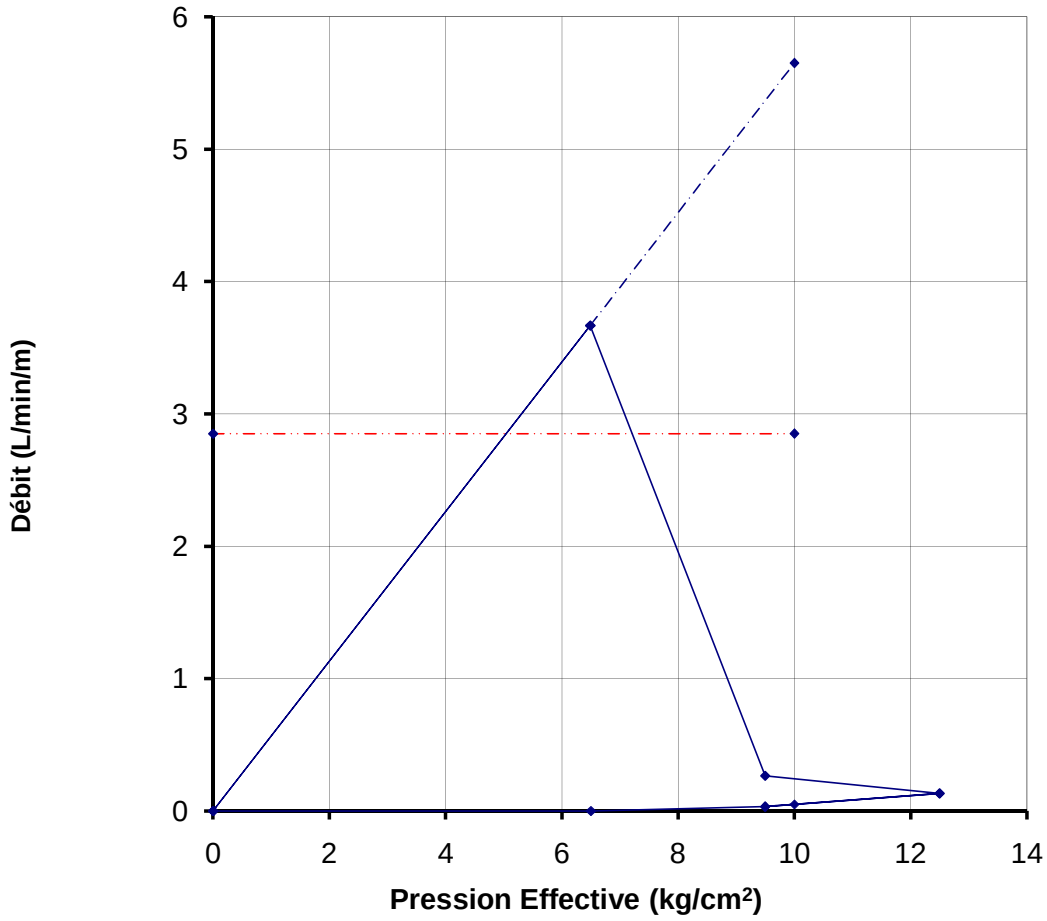


Lugeon = 12.22 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/21/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**51.00 m** à **54.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	110	10	3	11	3.67	2.5	1.09E-02	6.489
7	8	10	3	0.8	0.27	2.5	7.92E-04	9.499
10	4	10	3	0.4	0.13	2.5	3.96E-04	12.500
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

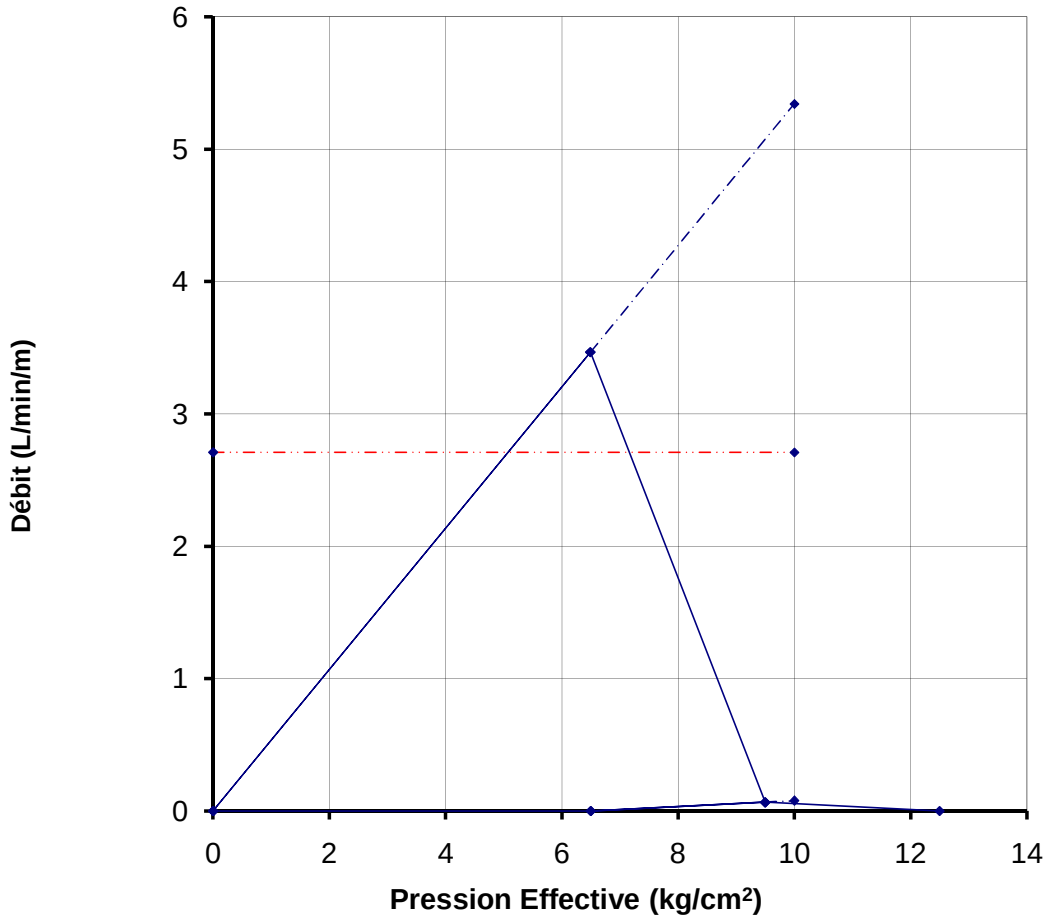


Lugeon = 2.85 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/21/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**54.00 m** à **57.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	104	10	3	10.4	3.47	2.5	1.03E-02	6.490
7	2	10	3	0.2	0.07	2.5	1.98E-04	9.500
10	0	10	3	0	0.00	2.5	0.00E+00	12.500
7	2	10	3	0.2	0.07	2.5	1.98E-04	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

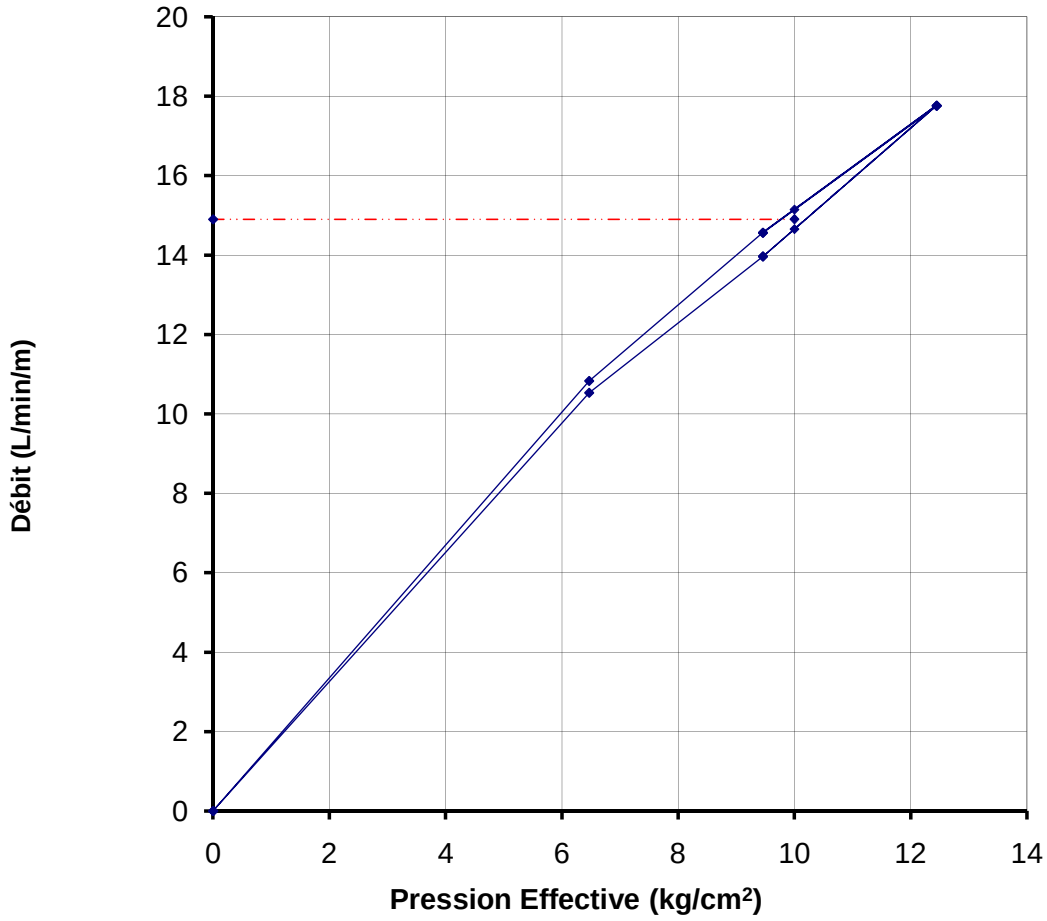


Lugeon = 2.71 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/22/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**57.00 m** à **60.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	325	10	3	32.5	10.83	2.5	3.22E-02	6.468
7	437	10	3	43.7	14.57	2.5	4.33E-02	9.457
10	533	10	3	53.3	17.77	2.5	5.28E-02	12.447
7	419	10	3	41.9	13.97	2.5	4.15E-02	9.459
4	316	10	3	31.6	10.53	2.5	3.13E-02	6.469

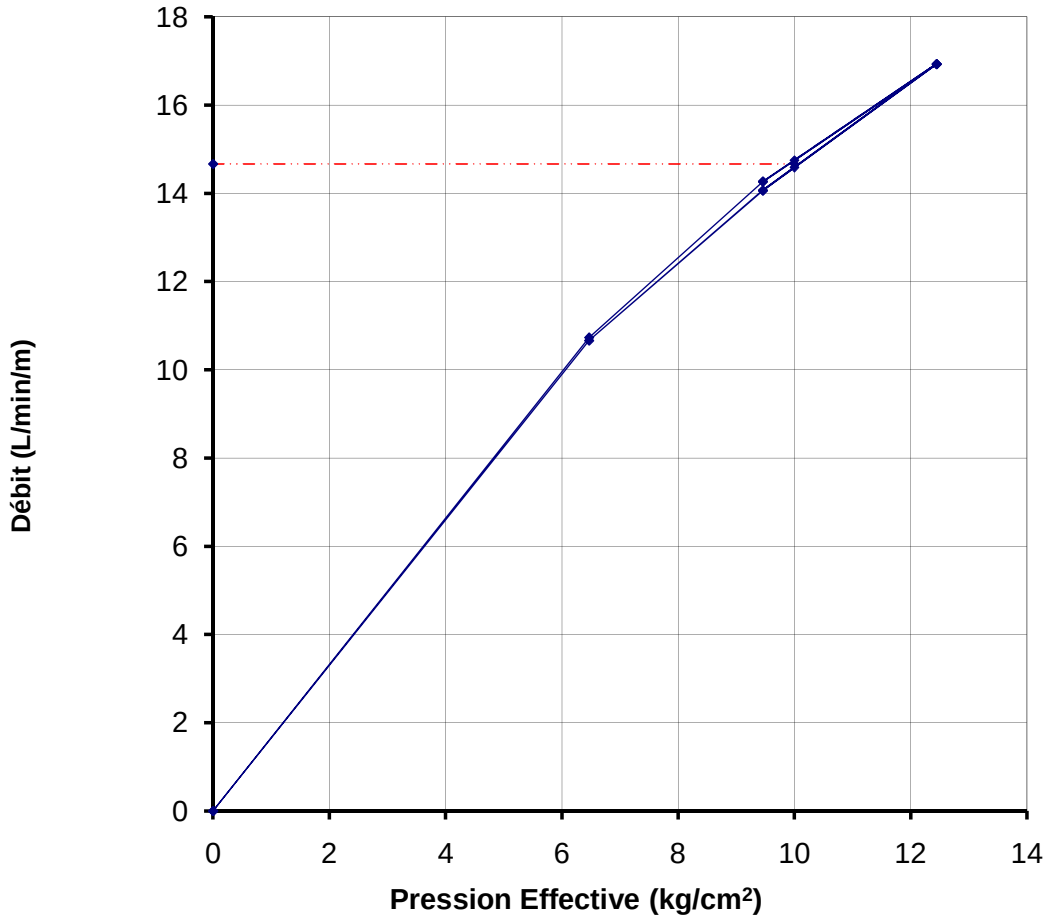


Lugeon = 14.90 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/22/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**60.00 m** à **63.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	322	10	3	32.2	10.73	2.5	3.19E-02	6.468
7	428	10	3	42.8	14.27	2.5	4.24E-02	9.458
10	508	10	3	50.8	16.93	2.5	5.03E-02	12.450
7	422	10	3	42.2	14.07	2.5	4.18E-02	9.458
4	320	10	3	32	10.67	2.5	3.17E-02	6.468

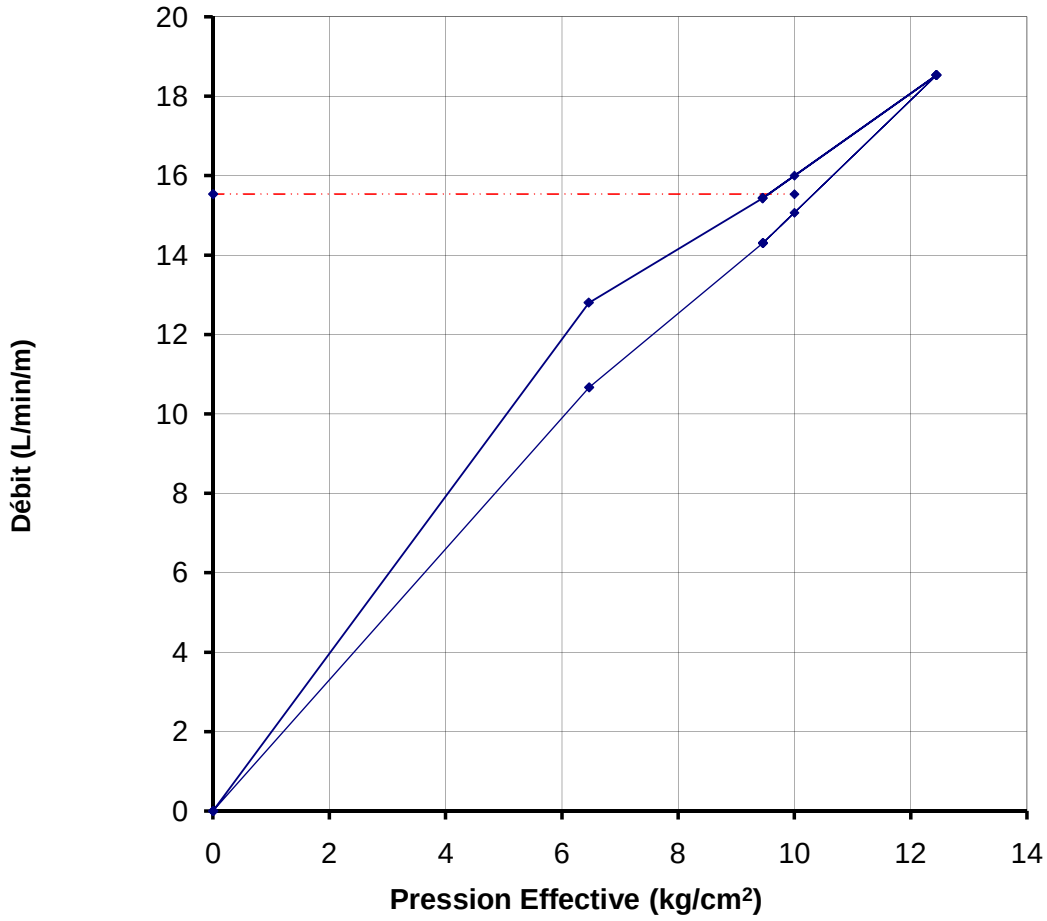


Lugeon = 14.67 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/22/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**63.00 m** à **66.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	384	10	3	38.4	12.80	2.5	3.80E-02	6.462
7	463	10	3	46.3	15.43	2.5	4.58E-02	9.454
10	556	10	3	55.6	18.53	2.5	5.50E-02	12.445
7	429	10	3	42.9	14.30	2.5	4.25E-02	9.458
4	320	10	3	32	10.67	2.5	3.17E-02	6.468

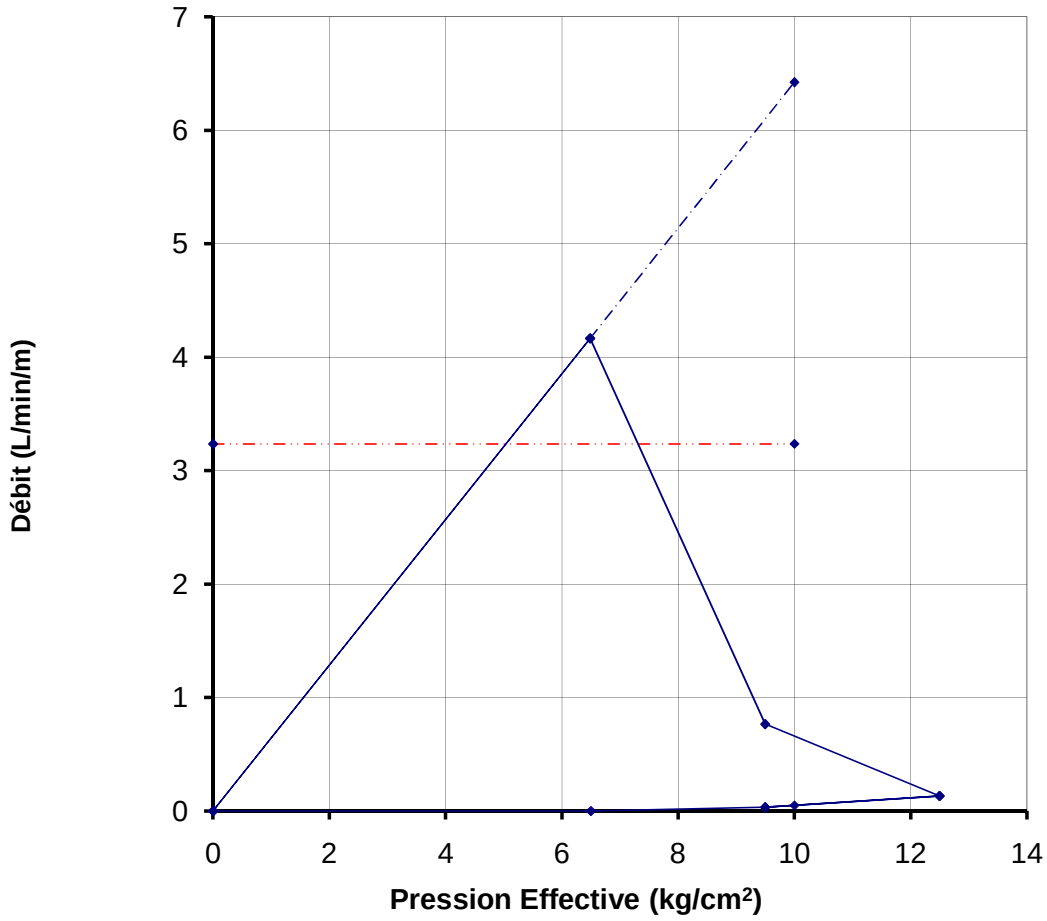


Lugeon = 15.53 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/22/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**66.00 m** à **69.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	125	10	3	12.5	4.17	2.5	1.24E-02	6.488
7	23	10	3	2.3	0.77	2.5	2.28E-03	9.498
10	4	10	3	0.4	0.13	2.5	3.96E-04	12.500
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

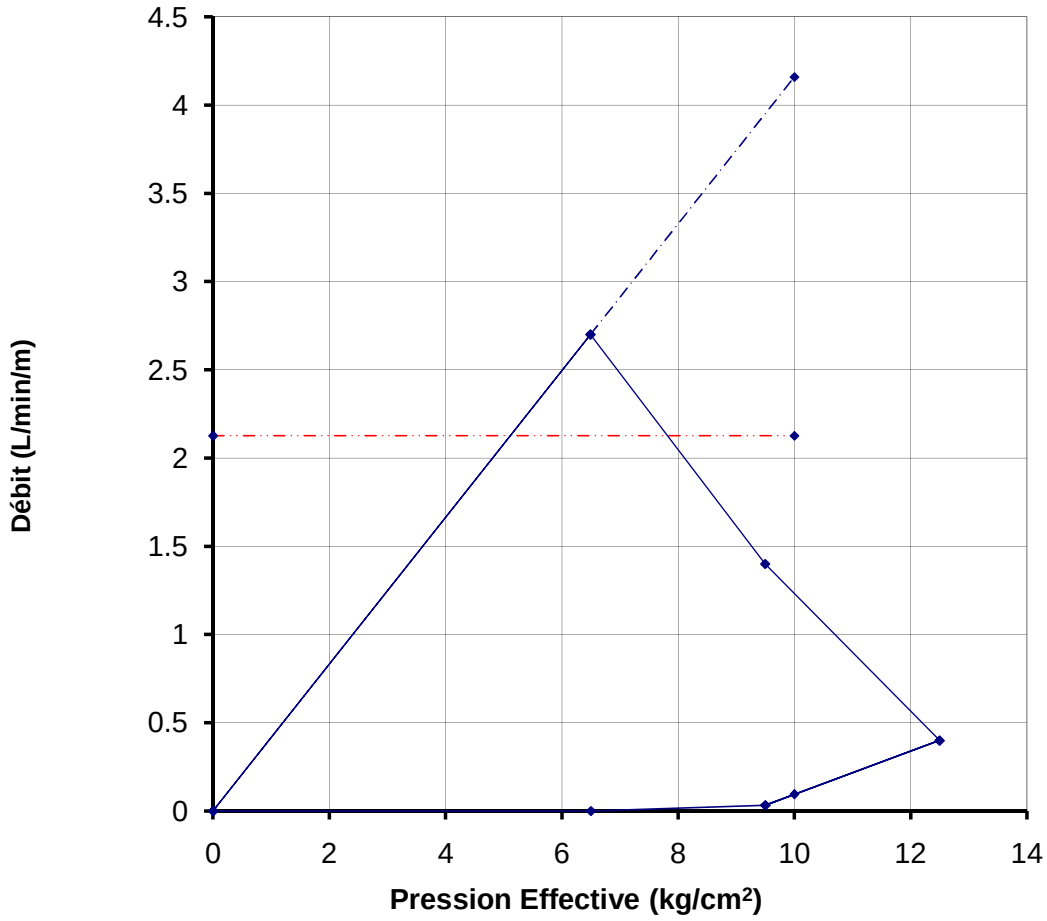


Lugeon = 3.24 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/22/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**69.00 m** à **72.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	81	10	3	8.1	2.70	2.5	8.02E-03	6.492
7	42	10	3	4.2	1.40	2.5	4.16E-03	9.496
10	12	10	3	1.2	0.40	2.5	1.19E-03	12.499
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

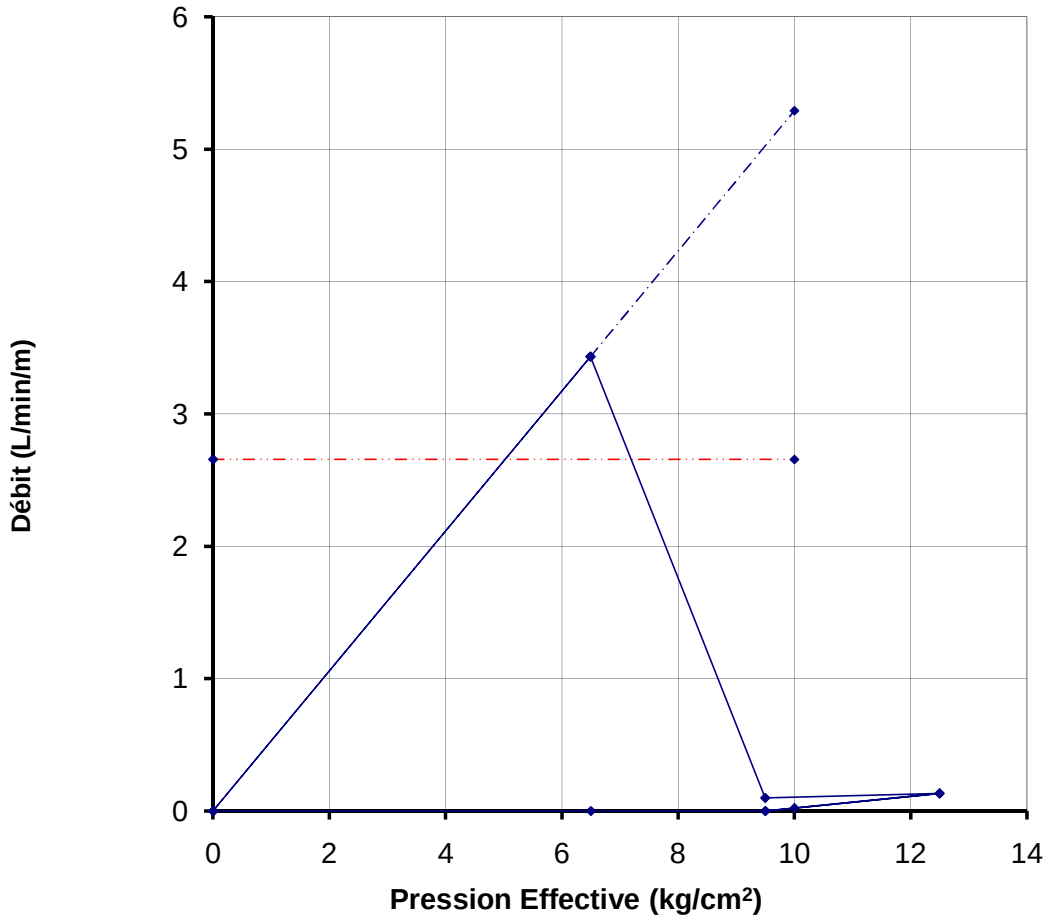


Lugeon = 2.13 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/25/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**72.00 m** à **75.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	103	10	3	10.3	3.43	2.5	1.02E-02	6.490
7	3	10	3	0.3	0.10	2.5	2.97E-04	9.500
10	4	10	3	0.4	0.13	2.5	3.96E-04	12.500
7	0	10	3	0	0.00	2.5	0.00E+00	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

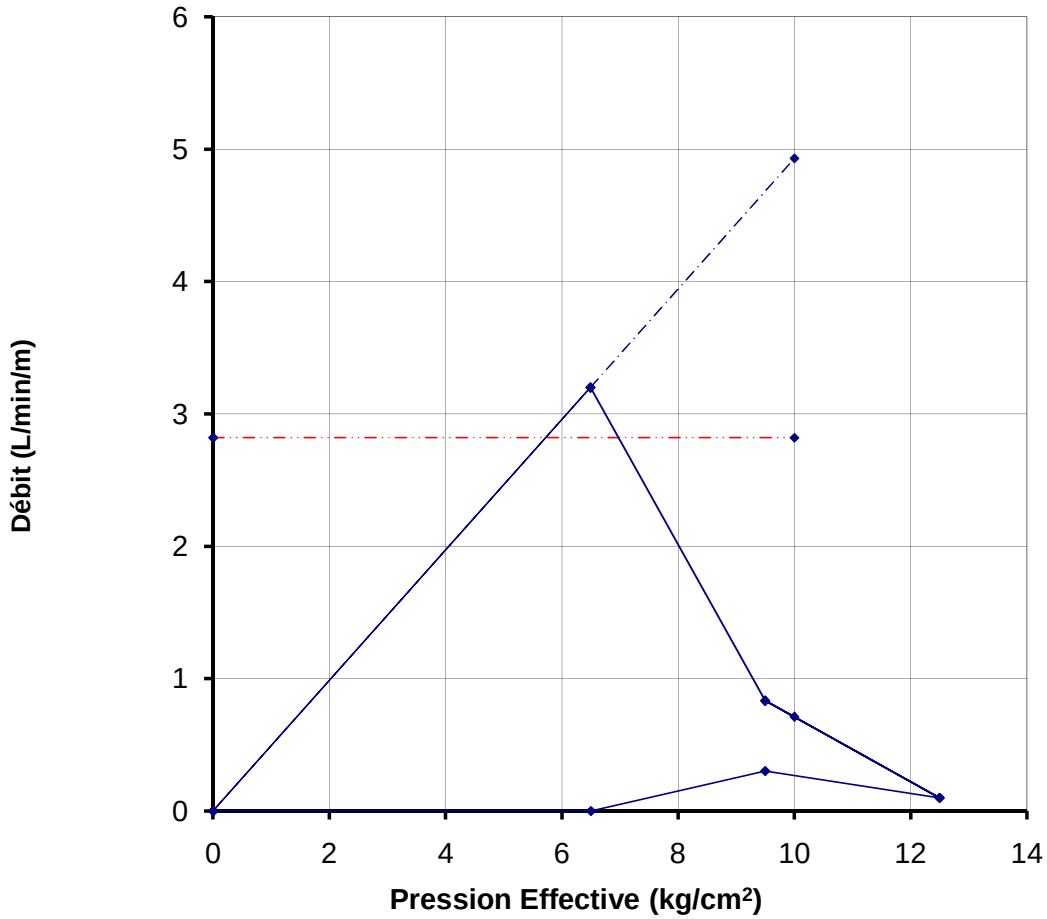


Lugeon = 2.66 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/25/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**75.00 m** à **78.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	96	10	3	9.6	3.20	2.5	9.50E-03	6.490
7	25	10	3	2.5	0.83	2.5	2.48E-03	9.498
10	3	10	3	0.3	0.10	2.5	2.97E-04	12.500
7	10	11	3	0.909091	0.30	2.5	9.00E-04	9.499
4	0	12	3	0	0.00	2.5	0.00E+00	6.500

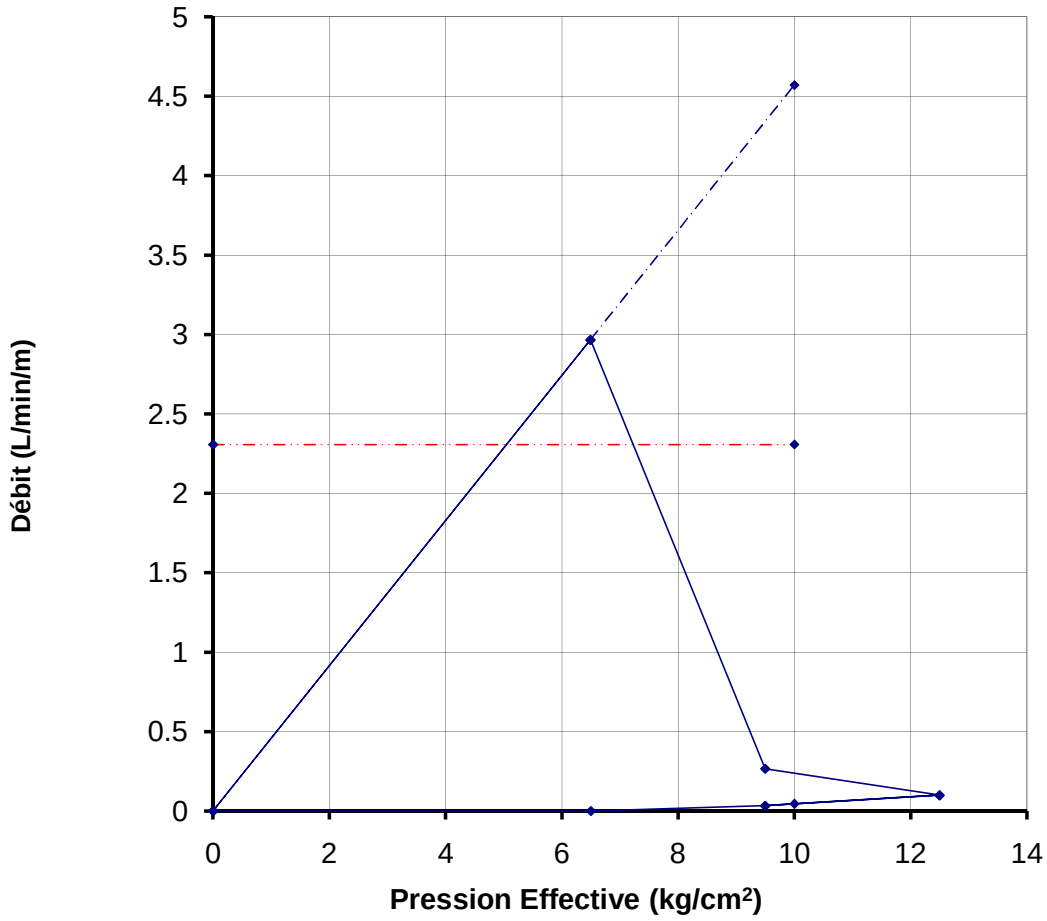


Lugeon = 2.82 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/25/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**78.00 m** à **81.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	89	10	3	8.9	2.97	2.5	8.81E-03	6.491
7	8	10	3	0.8	0.27	2.5	7.92E-04	9.499
10	3	10	3	0.3	0.10	2.5	2.97E-04	12.500
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

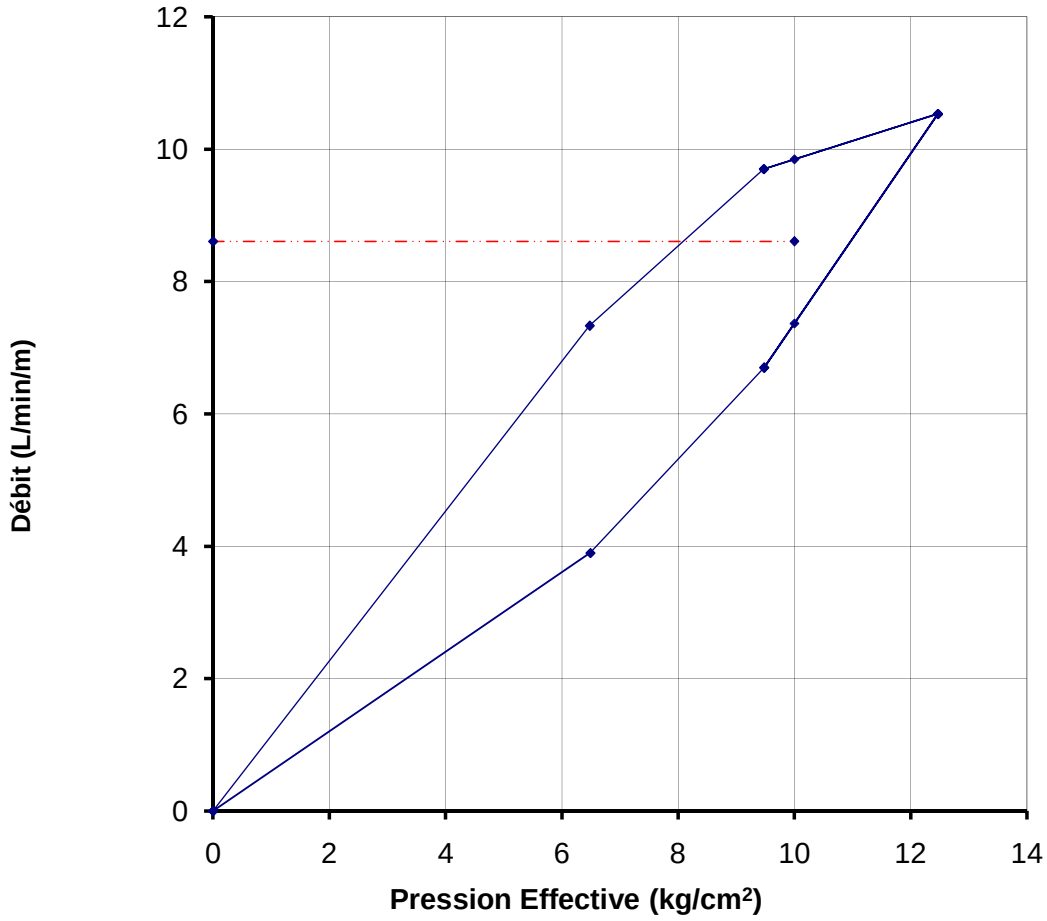


Lugeon = 2.31 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/25/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**81.00 m** à **84.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	220	10	3	22	7.33	2.5	2.18E-02	6.478
7	291	10	3	29.1	9.70	2.5	2.88E-02	9.471
10	316	10	3	31.6	10.53	2.5	3.13E-02	12.469
7	201	10	3	20.1	6.70	2.5	1.99E-02	9.480
4	117	10	3	11.7	3.90	2.5	1.16E-02	6.488

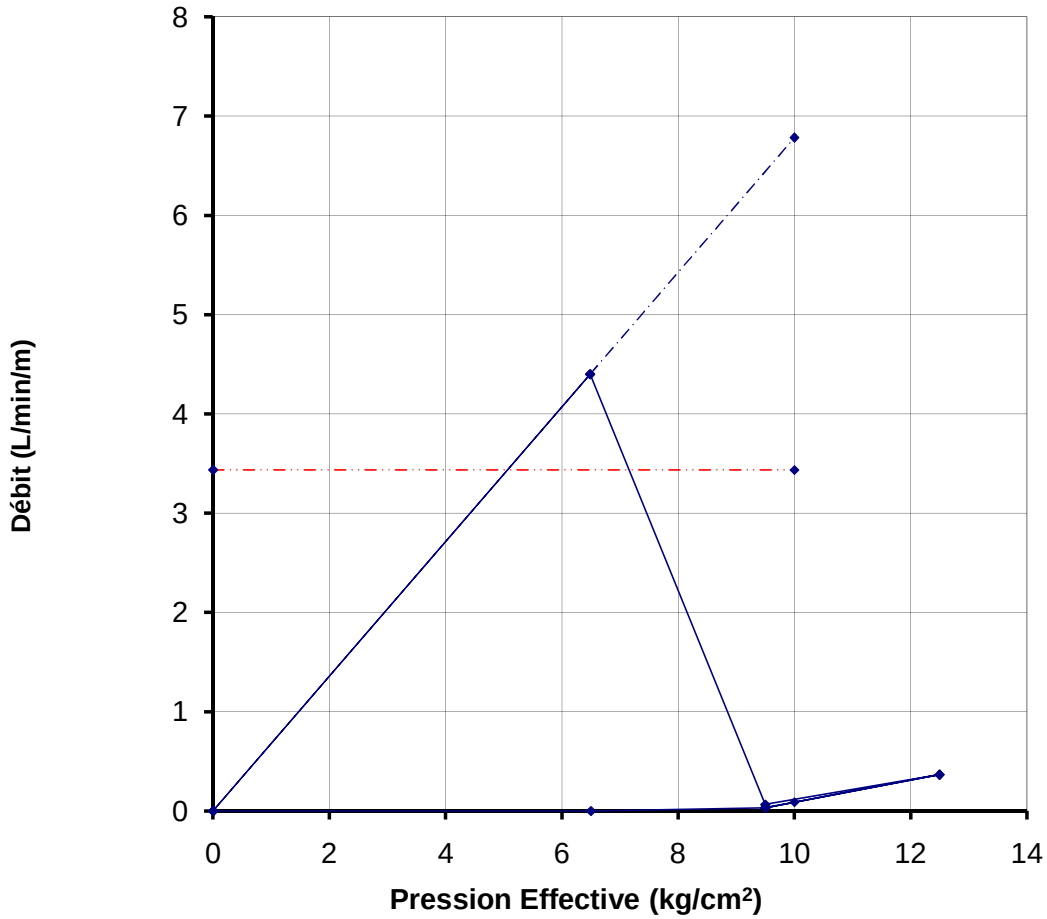


Lugeon = 8.61 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/26/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**84.00 m** à **87.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	132	10	3	13.2	4.40	2.5	1.31E-02	6.487
7	2	10	3	0.2	0.07	2.5	1.98E-04	9.500
10	11	10	3	1.1	0.37	2.5	1.09E-03	12.499
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

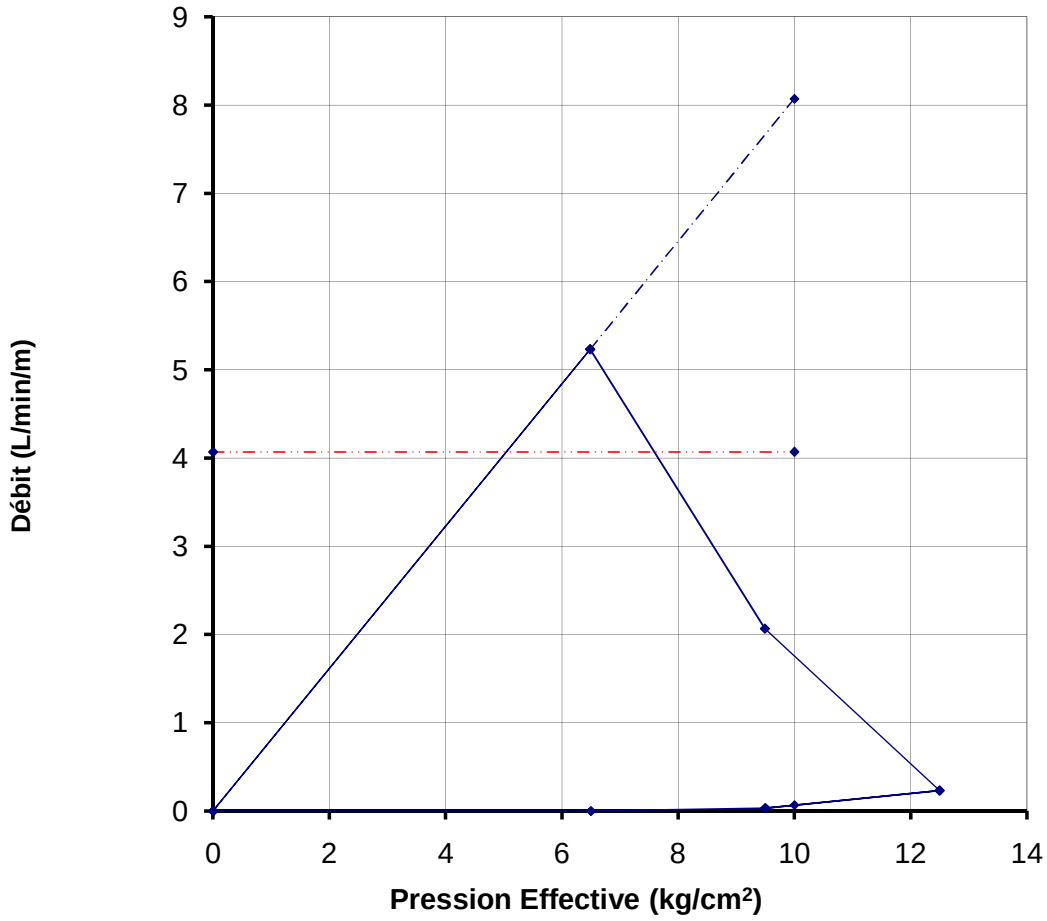


Lugeon = 3.44 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/26/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**87.00 m** à **90.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	157	10	3	15.7	5.23	2.5	1.55E-02	6.484
7	62	10	3	6.2	2.07	2.5	6.14E-03	9.494
10	7	10	3	0.7	0.23	2.5	6.93E-04	12.499
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

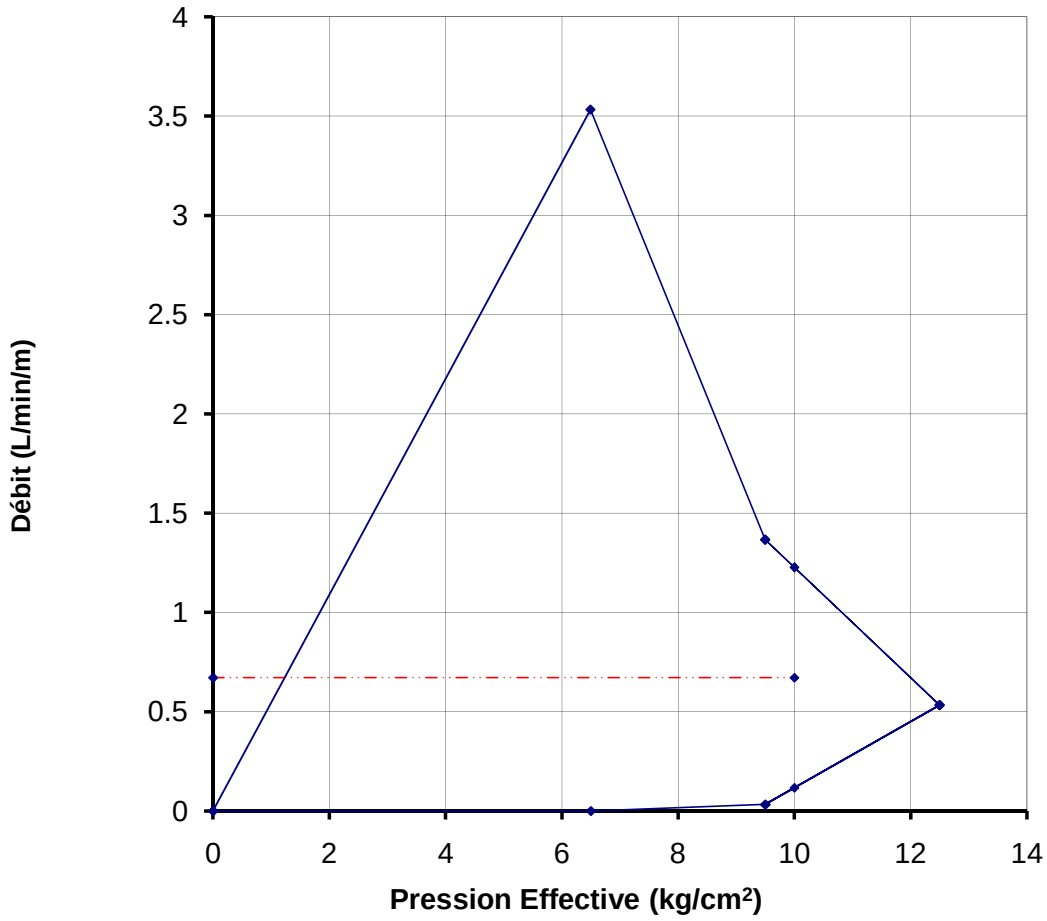


Lugeon = 4.07 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/26/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**90.00 m** à **93.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	106	10	3	10.6	3.53	2.5	1.05E-02	6.490
7	41	10	3	4.1	1.37	2.5	4.06E-03	9.496
10	16	10	3	1.6	0.53	2.5	1.58E-03	12.498
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

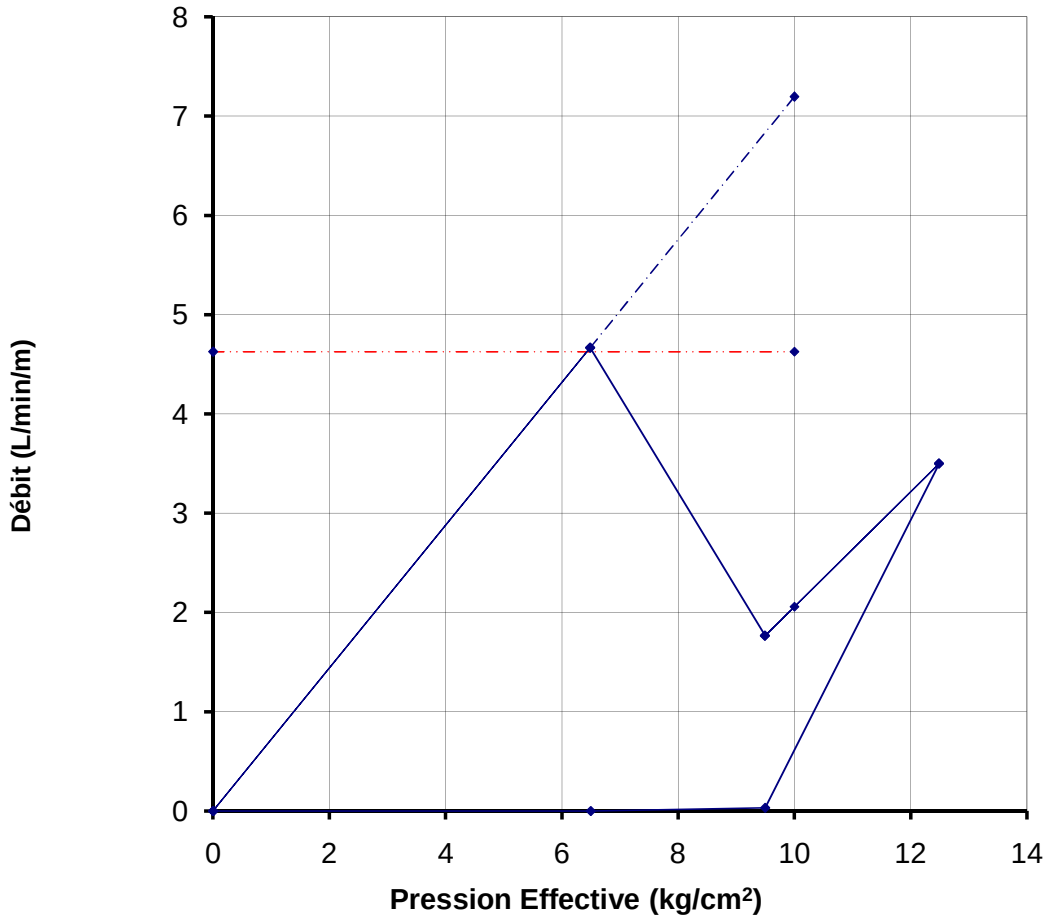


Lugeon = 0.67 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/26/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**93.00 m** à **96.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	140	10	3	14	4.67	2.5	1.39E-02	6.486
7	53	10	3	5.3	1.77	2.5	5.25E-03	9.495
10	21	2	3	10.5	3.50	2.5	1.04E-02	12.490
7	1	10	3	0.1	0.03	2.5	9.90E-05	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500

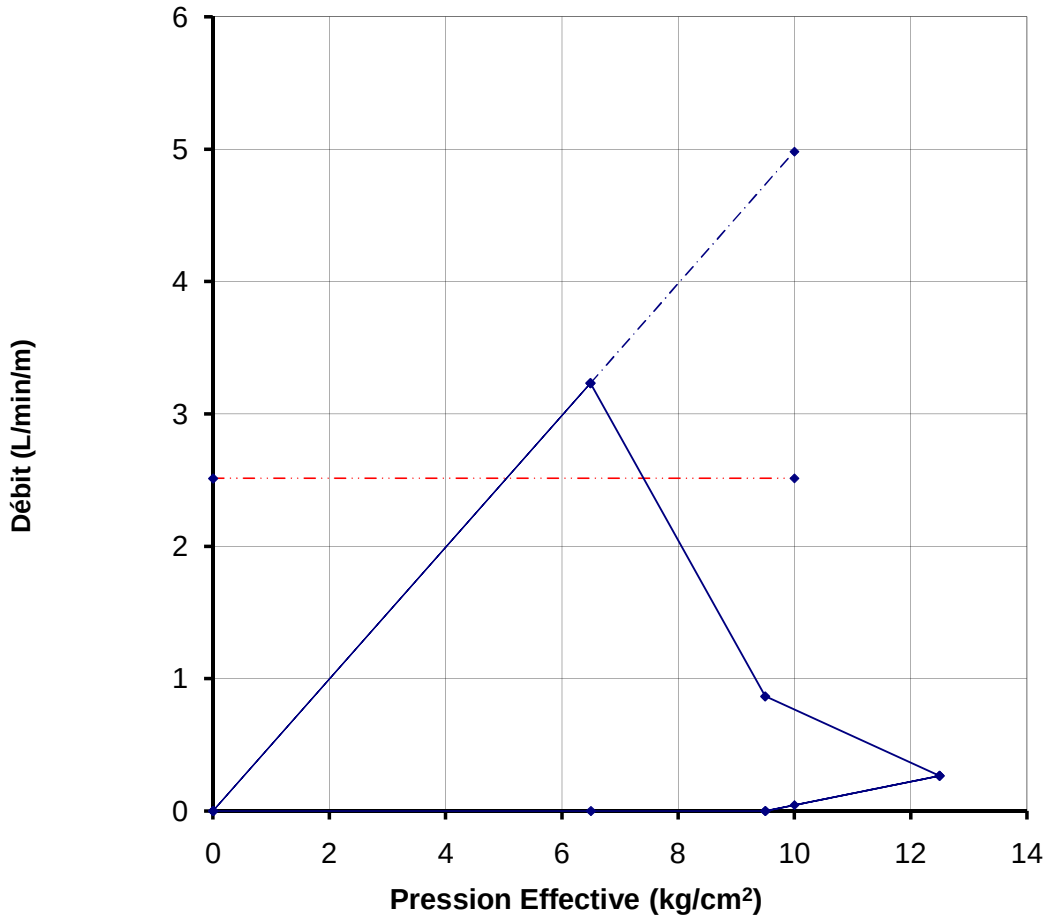


Lugeon = 4.63 L/min/m

SATCON	PROJECT:	**BISRI DAM / SECOND PACKAGE**	Date: **3/28/2014**
	SONDAGE No.:	**BHRA 03**	
	TRANCHE ESSAYEE	**96.00 m** à **99.00 m**	Manomètre **0.50 m**
			depth to water: **24.50 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
4	97	10	3	9.7	3.23	2.5	9.60E-03	6.490
7	26	10	3	2.6	0.87	2.5	2.57E-03	9.497
10	8	10	3	0.8	0.27	2.5	7.92E-04	12.499
7	0	10	3	0	0.00	2.5	0.00E+00	9.500
4	0	10	3	0	0.00	2.5	0.00E+00	6.500



Lugeon = 2.51 L/min/m

APPENDIX 5. DCPT TEST RESULTS

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

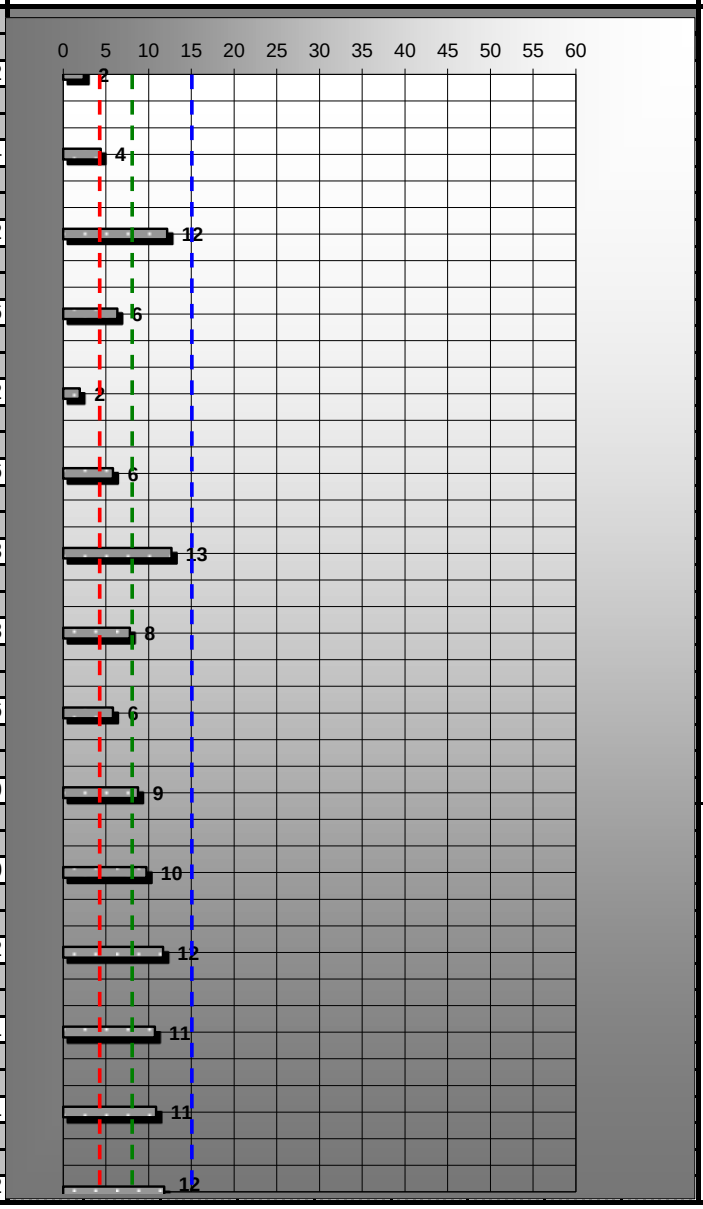
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
10	1	
20	2	
30	2	2
40	3	
50	2	
60	4	4
70	3	
80	10	
90	12	12
100	5	
110	5	
120	3	6
130	2	
140	1	
150	1	2
160	2	
170	3	
180	7	6
190	10	
200	9	
210	7	13
220	6	
230	6	
240	4	8
250	3	
260	4	
270	5	6
280	5	
290	6	
300	7	9
310	4	
320	8	
330	8	10
340	8	
350	8	
360	8	12
370	7	
380	7	
390	8	11
400	7	
410	8	
420	8	11
430	8	
440	9	
450	8	12

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing — Gravely SAND

Casing — Silty SAND

SAND

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

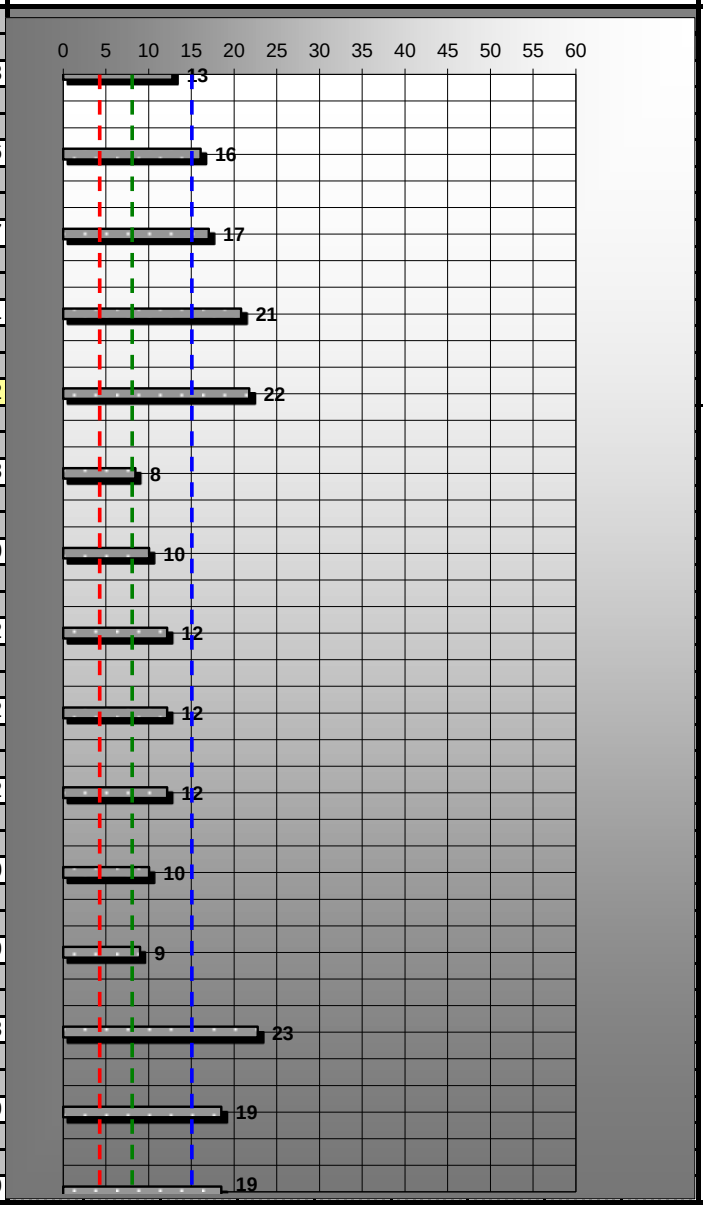
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
460	7	
470	10	
480	10	13
490	11	
500	12	
510	11	16
520	11	
530	13	
540	12	17
550	13	
560	15	
570	16	21
580	15	
590	15	
600	16	22
610	5	
620	5	
630	6	8
640	6	
650	6	
660	7	10
670	8	
680	7	
690	8	12
700	6	
710	7	
720	10	12
730	9	
740	7	
750	7	12
760	7	
770	6	
780	6	10
790	6	
800	6	
810	5	9
820	14	
830	15	
840	14	23
850	14	
860	11	
870	10	19
880	13	
890	11	
900	11	19

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

SAND

Casing

Silty SAND interbedded with SAND

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

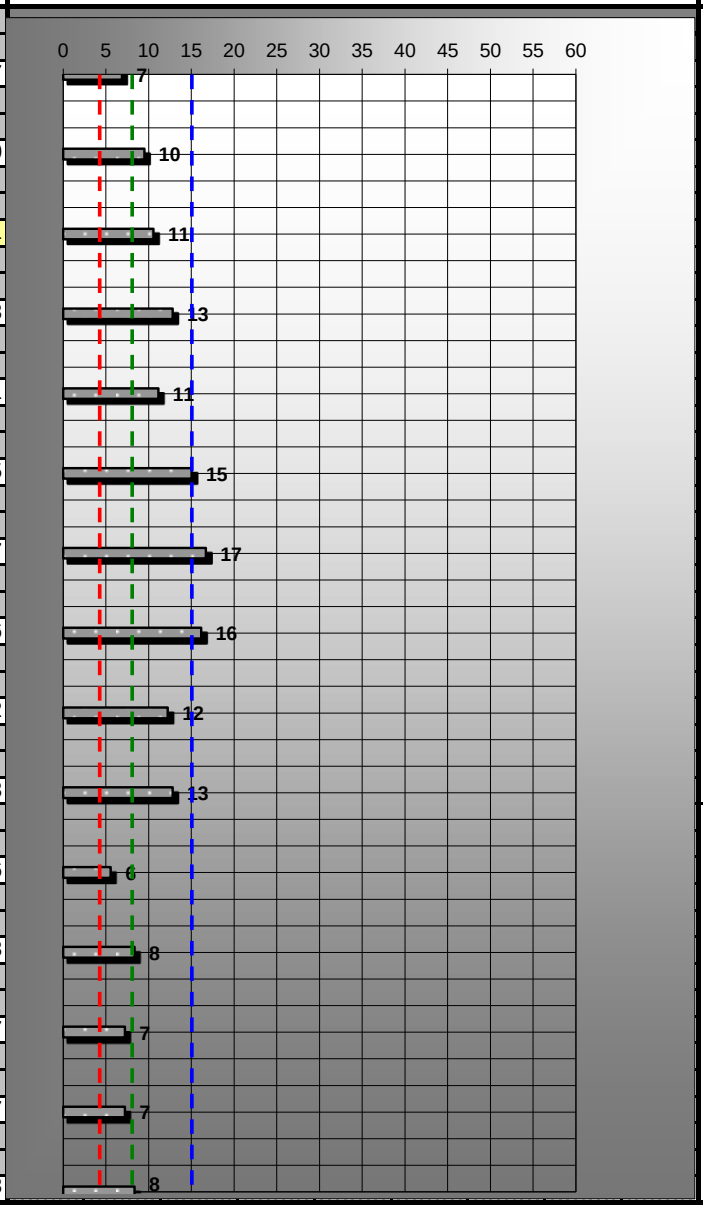
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
910	4	
920	5	
930	4	7
940	6	
950	6	
960	6	10
970	7	
980	6	
990	7	11
1000	8	
1010	8	
1020	7	13
1030	7	
1040	7	
1050	6	11
1060	8	
1070	9	
1080	10	15
1090	11	
1100	10	
1110	9	17
1120	12	
1130	8	
1140	9	16
1150	8	
1160	7	
1170	7	12
1180	7	
1190	8	
1200	8	13
1210	3	
1220	3	
1230	4	6
1240	6	
1250	5	
1260	4	8
1270	5	
1280	4	
1290	4	7
1300	5	
1310	4	
1320	4	7
1330	4	
1340	6	
1350	5	8

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Silty SAND interbedded with SAND

Casing

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

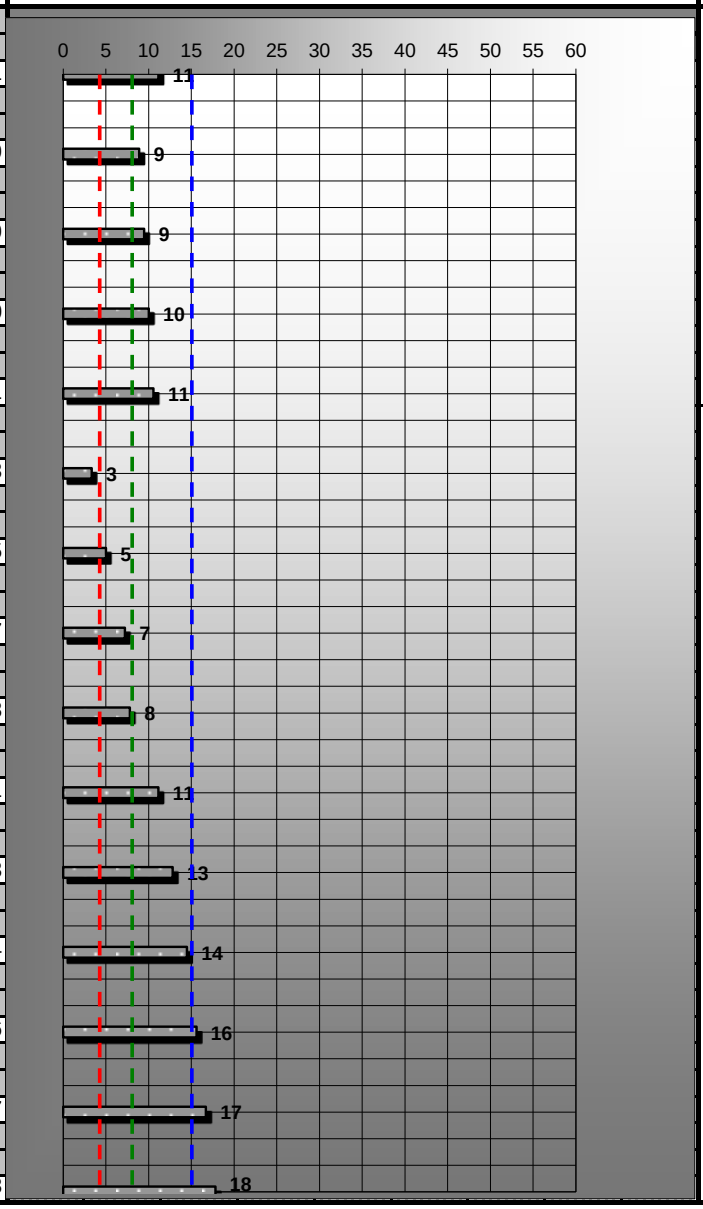
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
1360	5	
1370	7	
1380	8	11
1390	5	
1400	6	
1410	5	9
1420	6	
1430	5	
1440	6	9
1450	6	
1460	6	
1470	6	10
1480	6	
1490	7	
1500	6	11
1510	2	
1520	2	
1530	2	3
1540	3	
1550	3	
1560	3	5
1570	3	
1580	5	
1590	5	7
1600	4	
1610	5	
1620	5	8
1630	6	
1640	8	
1650	6	11
1660	7	
1670	8	
1680	8	13
1690	8	
1700	9	
1710	9	14
1720	9	
1730	9	
1740	10	16
1750	10	
1760	10	
1770	10	17
1780	10	
1790	11	
1800	11	18

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Casing

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
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firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

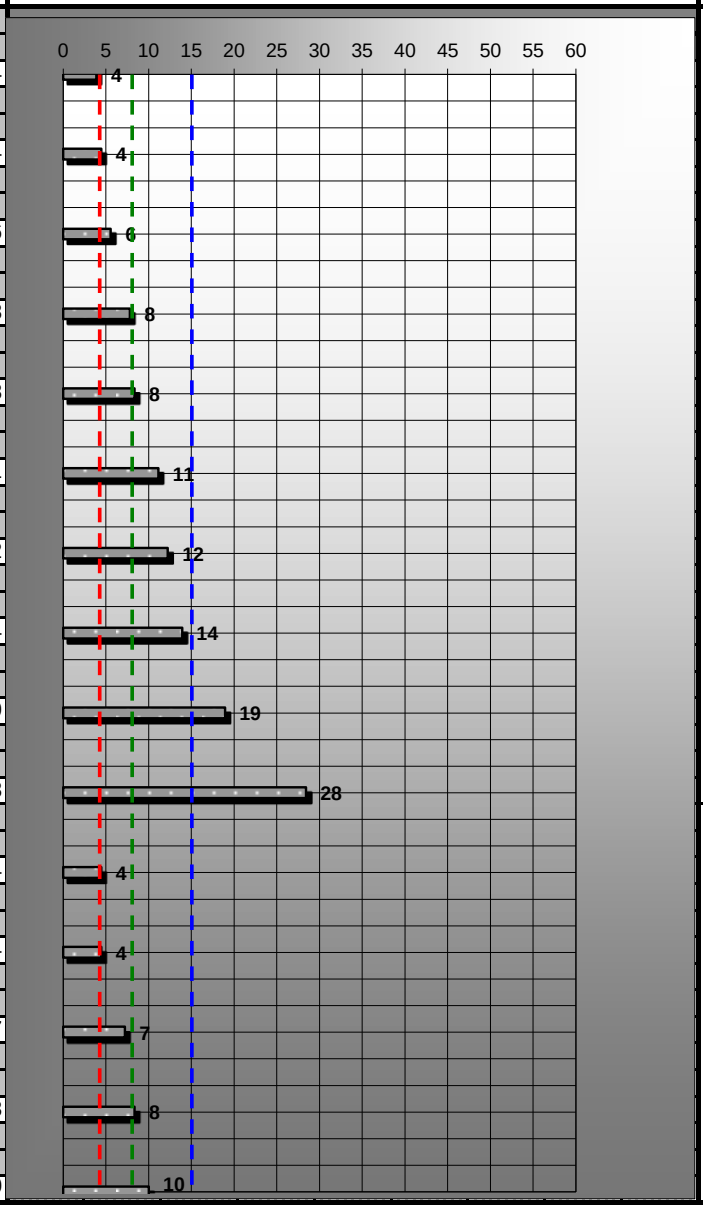
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
1810	2	
1820	2	
1830	3	4
1840	3	
1850	2	
1860	3	4
1870	3	
1880	3	
1890	4	6
1900	4	
1910	5	
1920	5	8
1930	4	
1940	6	
1950	5	8
1960	6	
1970	6	
1980	8	11
1990	8	
2000	6	
2010	8	12
2020	8	
2030	8	
2040	9	14
2050	10	
2060	9	
2070	15	19
2080	22	
2090	15	
2100	14	28
2110	2	
2120	3	
2130	3	4
2140	2	
2150	3	
2160	3	4
2170	4	
2180	4	
2190	5	7
2200	5	
2210	5	
2220	5	8
2230	6	
2240	6	
2250	6	10

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Silty CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

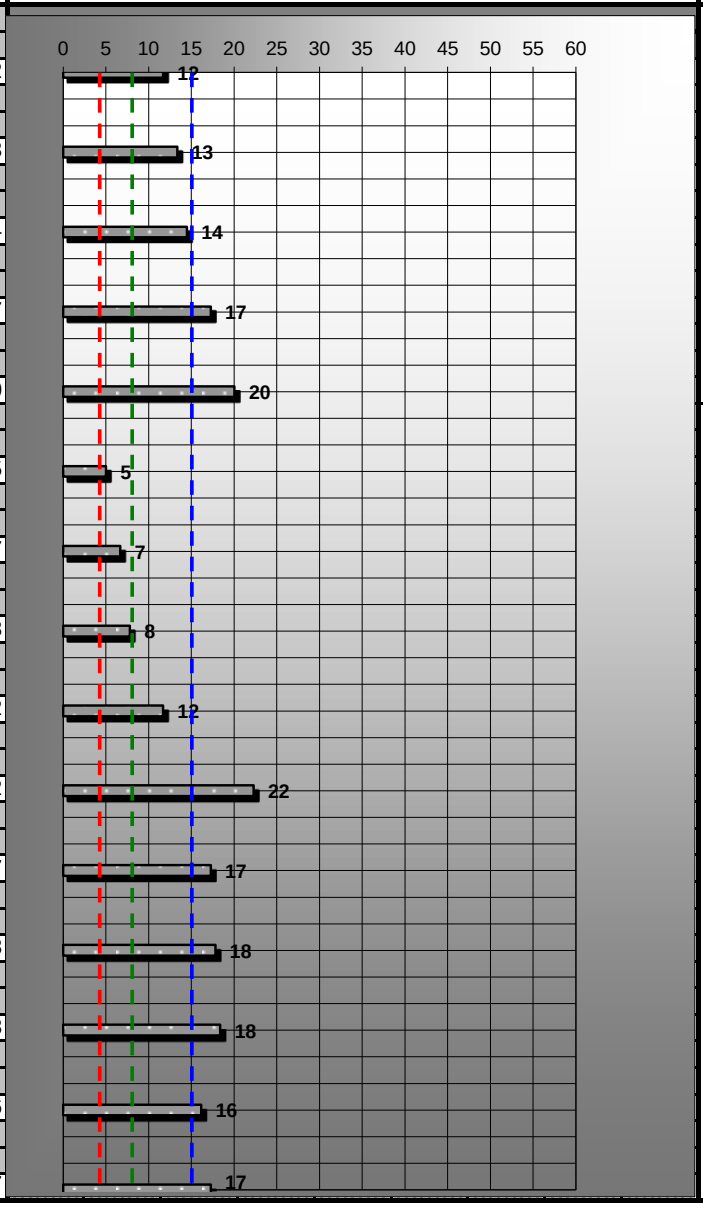
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
2260	7	
2270	7	
2280	7	12
2290	7	
2300	8	
2310	9	13
2320	8	
2330	9	
2340	9	14
2350	10	
2360	9	
2370	12	17
2380	10	
2390	14	
2400	12	20
2410	3	
2420	3	
2430	3	5
2440	4	
2450	3	
2460	5	7
2470	4	
2480	4	
2490	6	8
2500	7	
2510	6	
2520	8	12
2530	9	
2540	14	
2550	17	22
2560	11	
2570	10	
2580	10	17
2590	9	
2600	11	
2610	12	18
2620	11	
2630	12	
2640	10	18
2650	11	
2660	9	
2670	9	16
2680	9	
2690	11	
2700	11	17

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Casing

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

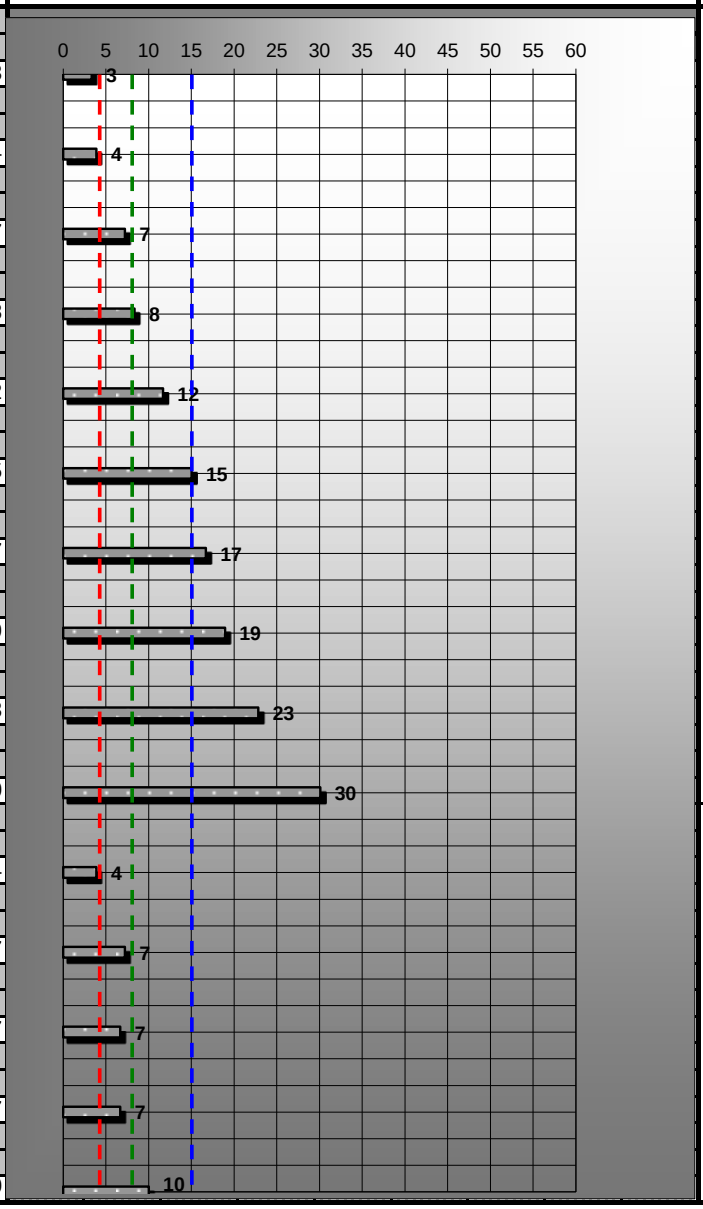
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
2710	2	
2720	2	
2730	2	3
2740	2	
2750	2	
2760	3	4
2770	3	
2780	4	
2790	6	7
2800	5	
2810	5	
2820	5	8
2830	6	
2840	7	
2850	8	12
2860	8	
2870	10	
2880	9	15
2890	9	
2900	10	
2910	11	17
2920	11	
2930	12	
2940	11	19
2950	13	
2960	15	
2970	13	23
2980	17	
2990	19	
3000	18	30
3010	2	
3020	1	
3030	4	4
3040	5	
3050	4	
3060	4	7
3070	6	
3080	3	
3090	3	7
3100	3	
3110	4	
3120	5	7
3130	6	
3140	6	
3150	6	10

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Silty CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

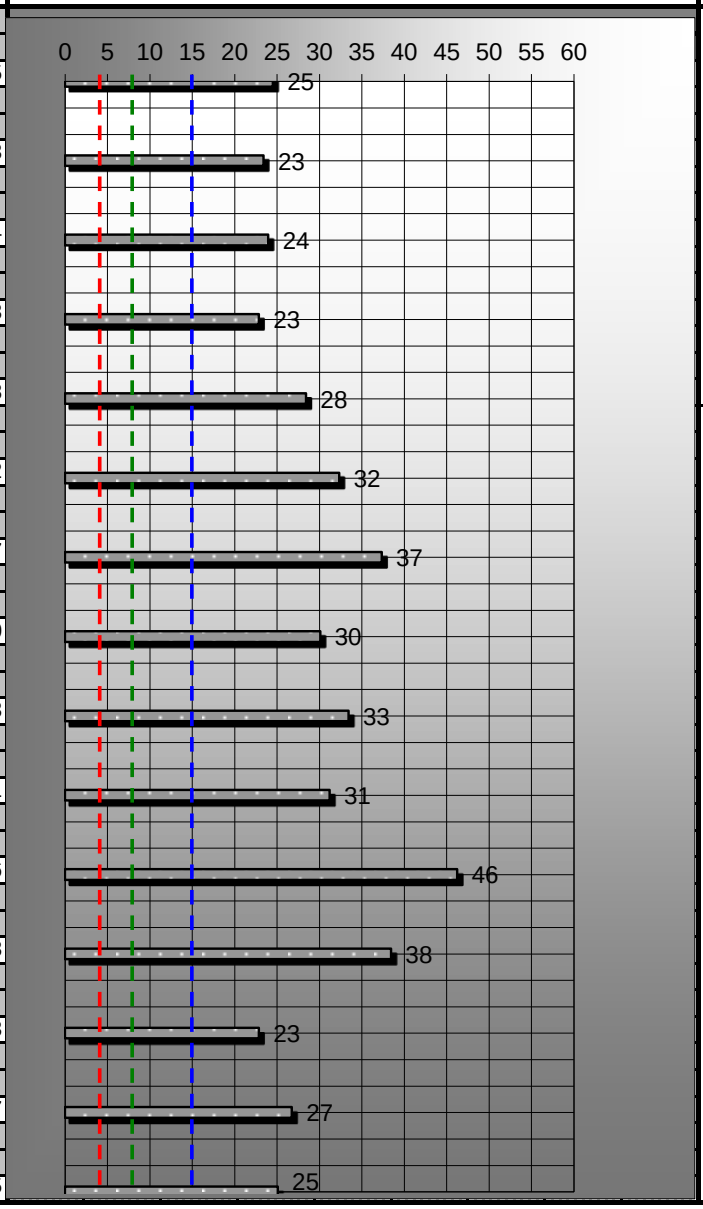
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
3160	14	
3170	16	
3180	14	25
3190	12	
3200	15	
3210	15	23
3220	15	
3230	15	
3240	13	24
3250	12	
3260	14	
3270	15	23
3280	14	
3290	15	
3300	22	28
3310	22	
3320	16	
3330	20	32
3340	28	
3350	19	
3360	20	37
3370	18	
3380	18	
3390	18	30
3400	21	
3410	20	
3420	19	33
3430	20	
3440	24	
3450	12	31
3460	26	
3470	33	
3480	24	46
3490	25	
3500	31	
3510	13	38
3520	11	
3530	15	
3540	15	23
3550	16	
3560	15	
3570	17	27
3580	16	
3590	14	
3600	15	25

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Casing

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

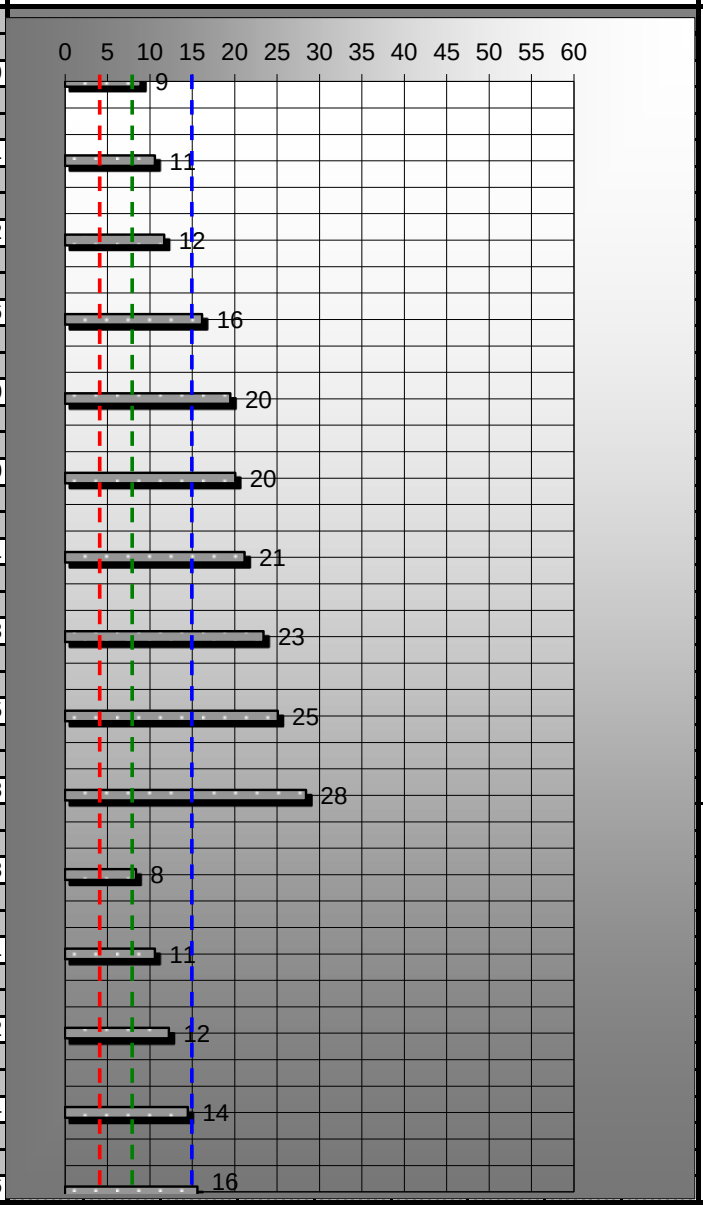
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
3610	4	
3620	6	
3630	6	9
3640	6	
3650	6	
3660	7	11
3670	7	
3680	6	
3690	8	12
3700	8	
3710	10	
3720	11	16
3730	12	
3740	11	
3750	12	20
3760	11	
3770	12	
3780	13	20
3790	13	
3800	13	
3810	12	21
3820	14	
3830	14	
3840	14	23
3850	14	
3860	16	
3870	15	25
3880	17	
3890	16	
3900	18	28
3910	5	
3920	5	
3930	5	8
3940	7	
3950	6	
3960	6	11
3970	6	
3980	7	
3990	9	12
4000	9	
4010	8	
4020	9	14
4030	9	
4040	10	
4050	9	16

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Silty CLAY

Silty SAND interbedded with SAND

Casing

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

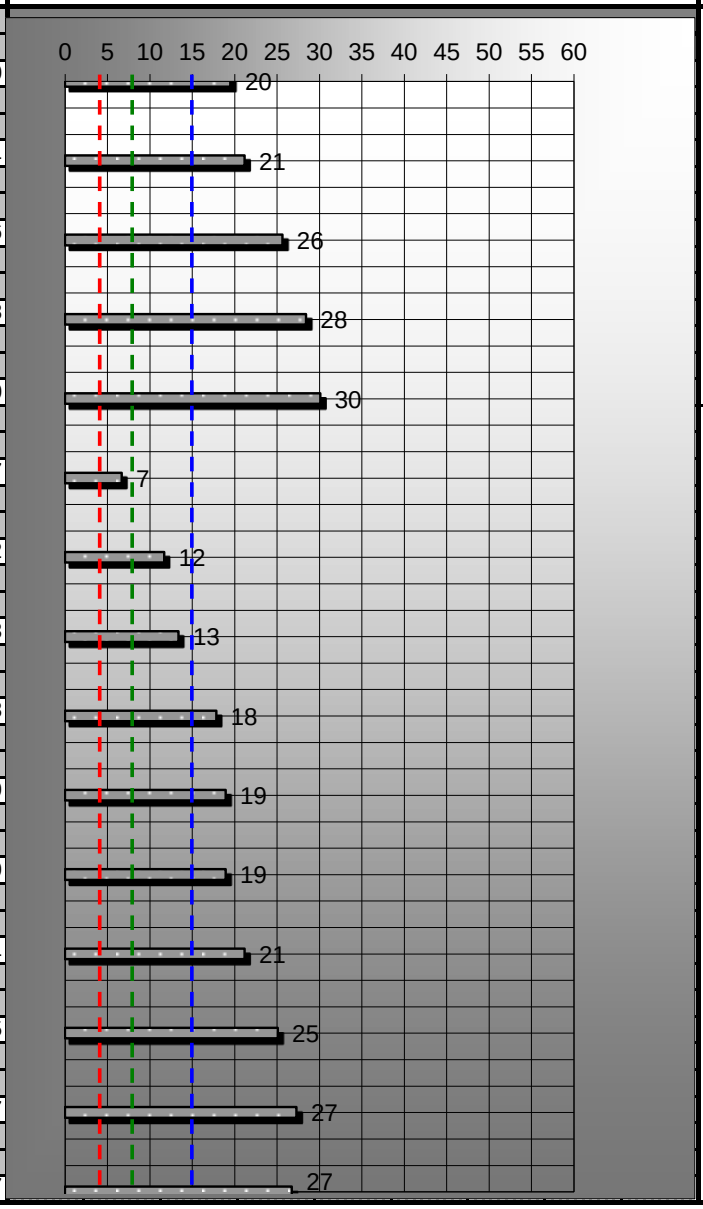
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
4060	12	
4070	12	
4080	11	20
4090	13	
4100	13	
4110	12	21
4120	14	
4130	16	
4140	16	26
4150	15	
4160	17	
4170	19	28
4180	18	
4190	18	
4200	18	30
4210	4	
4220	4	
4230	4	7
4240	7	
4250	7	
4260	7	12
4270	7	
4280	8	
4290	9	13
4300	10	
4310	10	
4320	12	18
4330	10	
4340	12	
4350	12	19
4360	10	
4370	12	
4380	12	19
4390	12	
4400	14	
4410	12	21
4420	14	
4430	16	
4440	15	25
4450	16	
4460	16	
4470	17	27
4480	16	
4490	16	
4500	16	27

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Casing

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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soft to firm & loose
firm to stiff & loose to medium

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DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

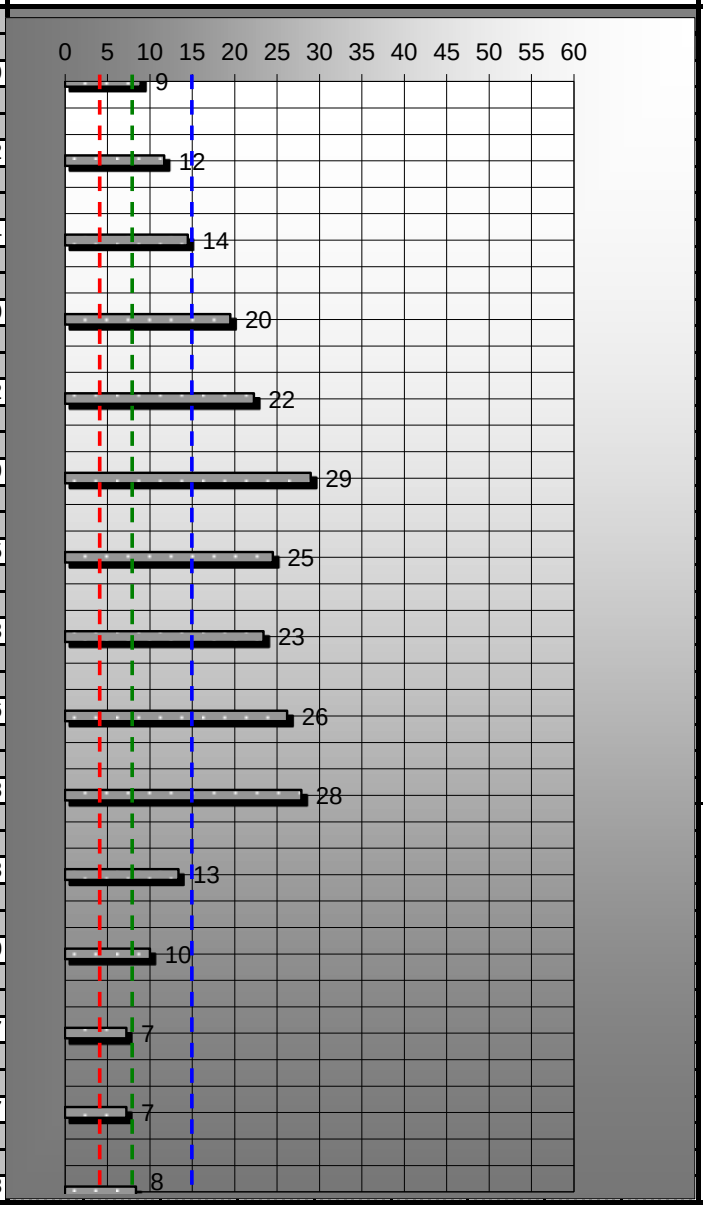
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
4510	5	
4520	5	
4530	6	9
4540	6	
4550	7	
4560	8	12
4570	8	
4580	8	
4590	10	14
4600	12	
4610	12	
4620	11	20
4630	12	
4640	13	
4650	15	22
4660	17	
4670	19	
4680	16	29
4690	14	
4700	15	
4710	15	25
4720	13	
4730	15	
4740	14	23
4750	15	
4760	15	
4770	17	26
4780	17	
4790	17	
4800	16	28
4810	8	
4820	8	
4830	8	13
4840	7	
4850	7	
4860	4	10
4870	4	
4880	4	
4890	5	7
4900	4	
4910	4	
4920	5	7
4930	5	
4940	5	
4950	5	8

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Silty CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

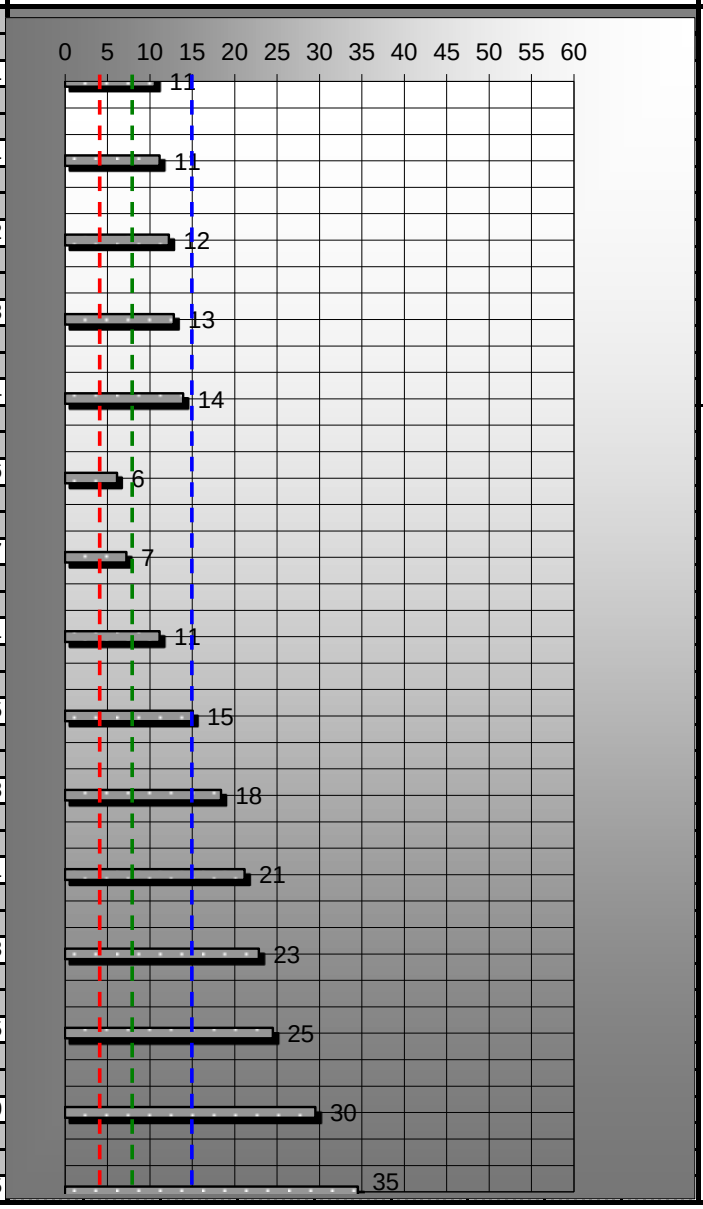
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
4960	6	
4970	7	
4980	6	11
4990	6	
5000	7	
5010	7	11
5020	7	
5030	8	
5040	7	12
5050	7	
5060	8	
5070	8	13
5080	8	
5090	8	
5100	9	14
5110	3	
5120	4	
5130	4	6
5140	4	
5150	4	
5160	5	7
5170	6	
5180	6	
5190	8	11
5200	7	
5210	9	
5220	11	15
5230	10	
5240	10	
5250	13	18
5260	12	
5270	13	
5280	13	21
5290	14	
5300	13	
5310	14	23
5320	14	
5330	15	
5340	15	25
5350	18	
5360	17	
5370	18	30
5380	18	
5390	20	
5400	24	35

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Casing

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

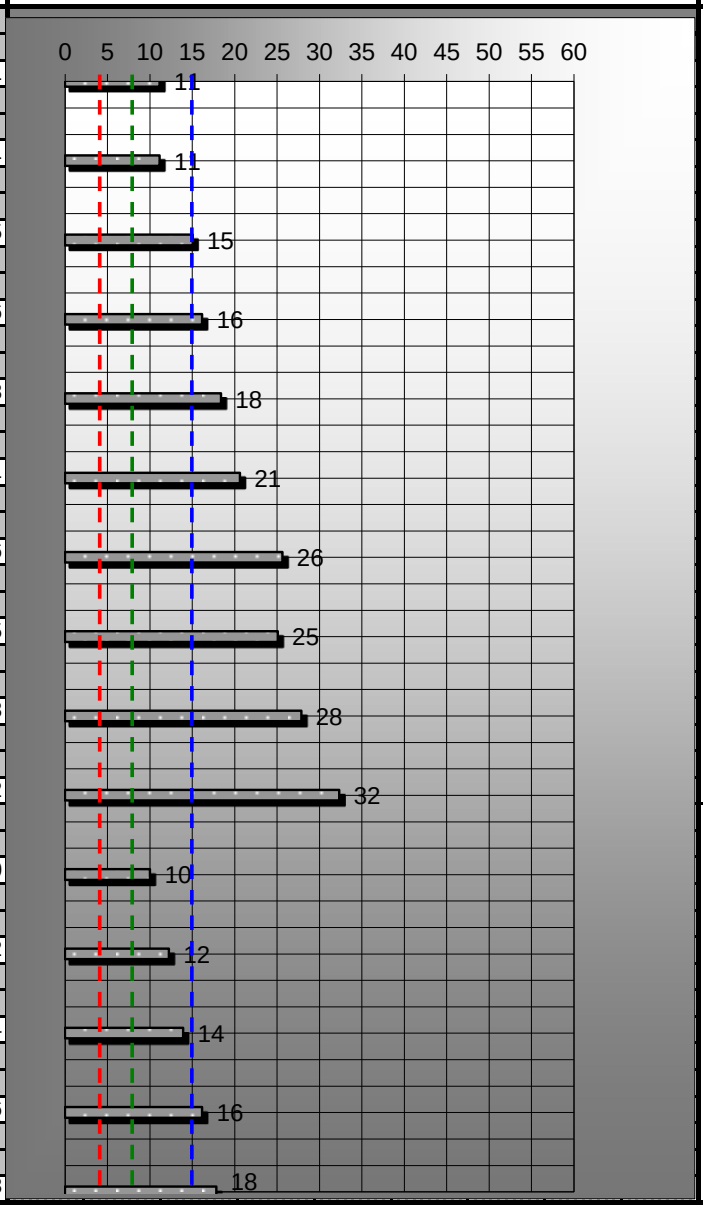
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
5410	6	
5420	7	
5430	7	11
5440	6	
5450	7	
5460	7	11
5470	8	
5480	9	
5490	10	15
5500	9	
5510	10	
5520	10	16
5530	11	
5540	12	
5550	10	18
5560	13	
5570	12	
5580	12	21
5590	13	
5600	18	
5610	15	26
5620	14	
5630	14	
5640	17	25
5650	16	
5660	16	
5670	18	28
5680	19	
5690	19	
5700	20	32
5710	6	
5720	6	
5730	6	10
5740	7	
5750	8	
5760	7	12
5770	8	
5780	8	
5790	9	14
5800	8	
5810	10	
5820	11	16
5830	11	
5840	10	
5850	11	18

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

Silty CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

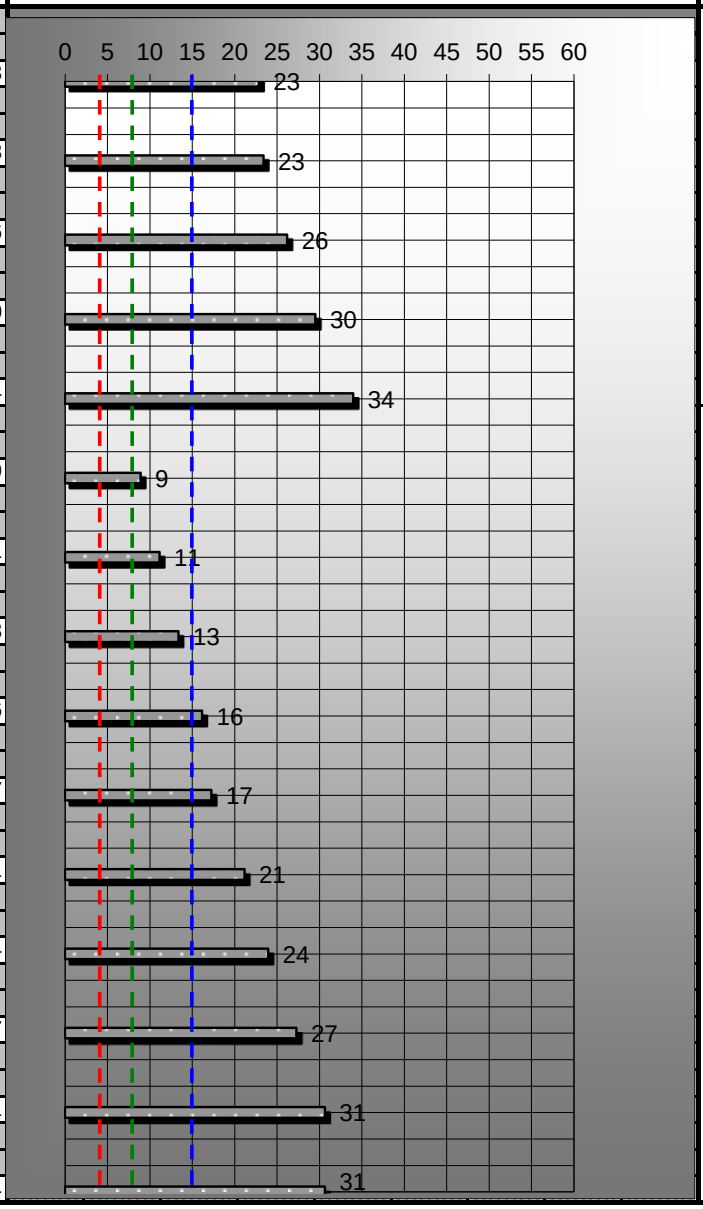
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
5860	13	
5870	14	
5880	14	23
5890	15	
5900	14	
5910	13	23
5920	14	
5930	16	
5940	17	26
5950	16	
5960	18	
5970	19	30
5980	19	
5990	21	
6000	21	34
6010	5	
6020	5	
6030	6	9
6040	7	
6050	7	
6060	6	11
6070	8	
6080	7	
6090	9	13
6100	8	
6110	10	
6120	11	16
6130	10	
6140	10	
6150	11	17
6160	12	
6170	14	
6180	12	21
6190	13	
6200	15	
6210	15	24
6220	16	
6230	17	
6240	16	27
6250	18	
6260	19	
6270	18	31
6280	18	
6290	19	
6300	18	31

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

Casing

4 inches dia. tri-cone

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

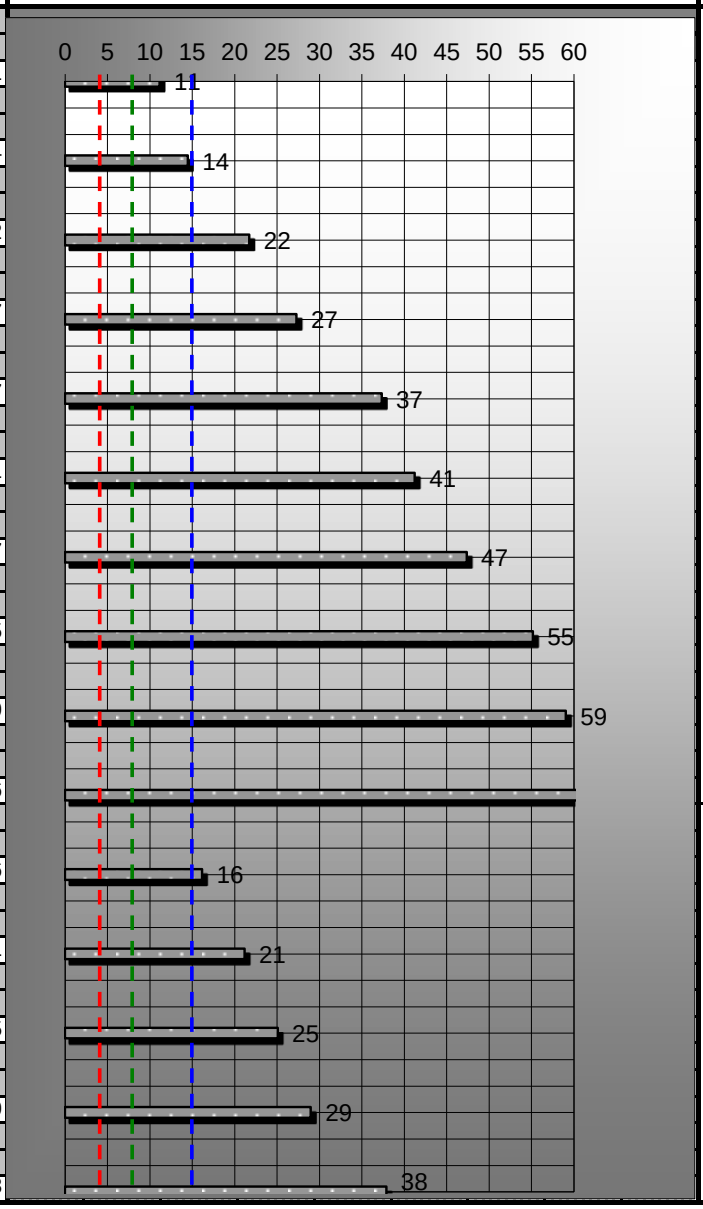
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
6310	7	
6320	7	
6330	6	11
6340	8	
6350	9	
6360	9	14
6370	11	
6380	13	
6390	15	22
6400	15	
6410	17	
6420	17	27
6430	20	
6440	22	
6450	25	37
6460	23	
6470	25	
6480	26	41
6490	26	
6500	30	
6510	29	47
6520	29	
6530	34	
6540	36	55
6550	33	
6560	35	
6570	38	59
6580	39	
6590	39	
6600	40	66
6610	9	
6620	9	
6630	11	16
6640	12	
6650	13	
6660	13	21
6670	15	
6680	14	
6690	16	25
6700	15	
6710	19	
6720	18	29
6730	22	
6740	21	
6750	25	38

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

4 inches dia. tri-cone

Silty CLAY

4 inches dia. tri-cone

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

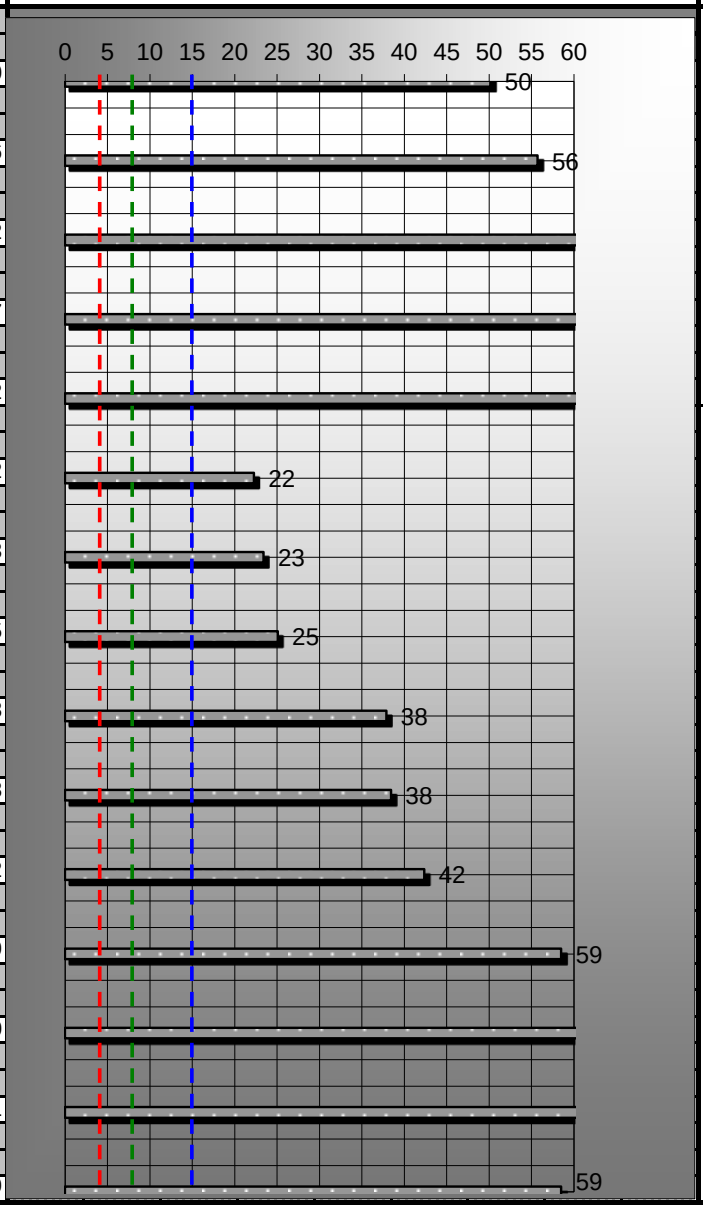
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
6760	28	
6770	29	
6780	33	50
6790	31	
6800	34	
6810	35	56
6820	34	
6830	39	
6840	38	62
6850	42	
6860	40	
6870	38	67
6880	35	
6890	37	
6900	39	62
6910	11	
6920	16	
6930	13	22
6940	13	
6950	14	
6960	15	23
6970	14	
6980	17	
6990	14	25
7000	24	
7010	24	
7020	20	38
7030	25	
7040	22	
7050	22	38
7060	26	
7070	24	
7080	26	42
7090	29	
7100	37	
7110	39	59
7120	43	
7130	43	
7140	39	70
7150	37	
7160	38	
7170	35	61
7180	35	
7190	33	
7200	37	59

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

4 inches dia. tri-cone

Silty CLAY

4 inches dia. tri-cone

Silty SAND

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

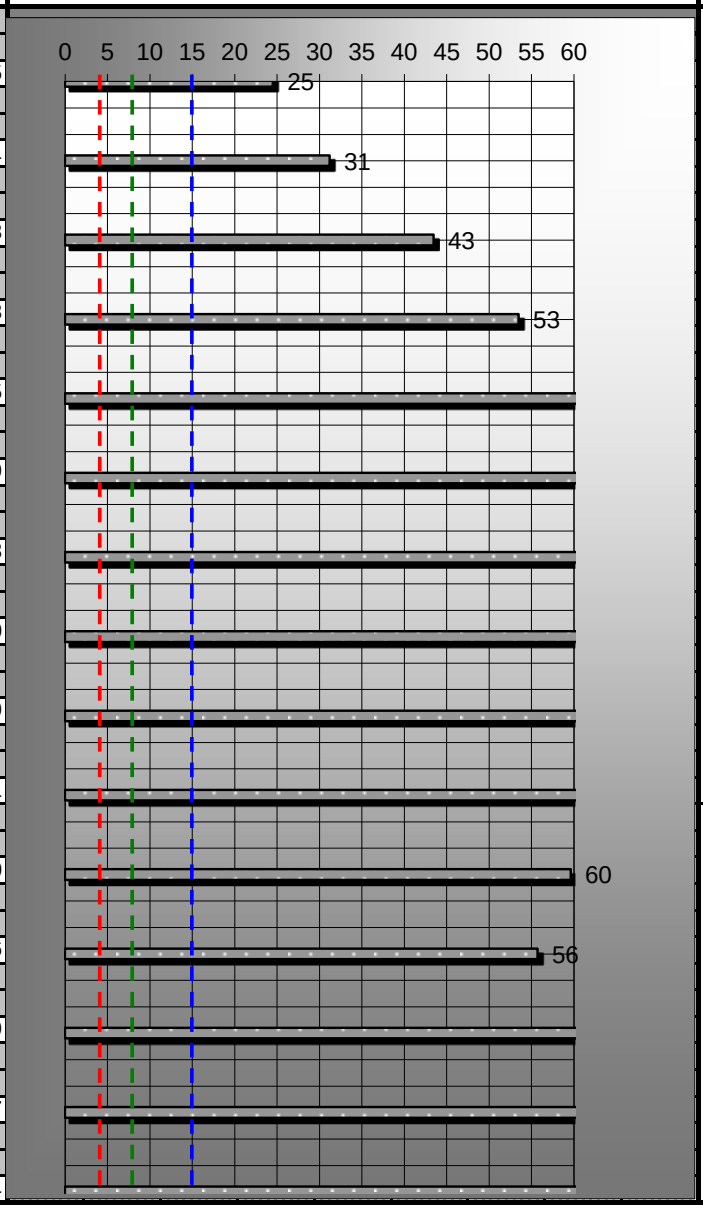
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
7210	13	
7220	15	
7230	16	25
7240	15	
7250	18	
7260	23	31
7270	22	
7280	27	
7290	29	43
7300	28	
7310	33	
7320	35	53
7330	38	
7340	37	
7350	41	65
7360	39	
7370	40	
7380	44	69
7390	43	
7400	45	
7410	43	73
7420	46	
7430	47	
7440	50	80
7450	48	
7460	45	
7470	49	79
7480	53	
7490	55	
7500	55	91
7510	33	
7520	41	
7530	33	60
7540	30	
7550	31	
7560	39	56
7570	40	
7580	43	
7590	40	69
7600	42	
7610	47	
7620	49	77
7630	55	
7640	61	
7650	66	101

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC15

4 inches dia. tri-cone — Silty CLAY

4 inches dia. tri-cone — Silty CLAY with COBBLES

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

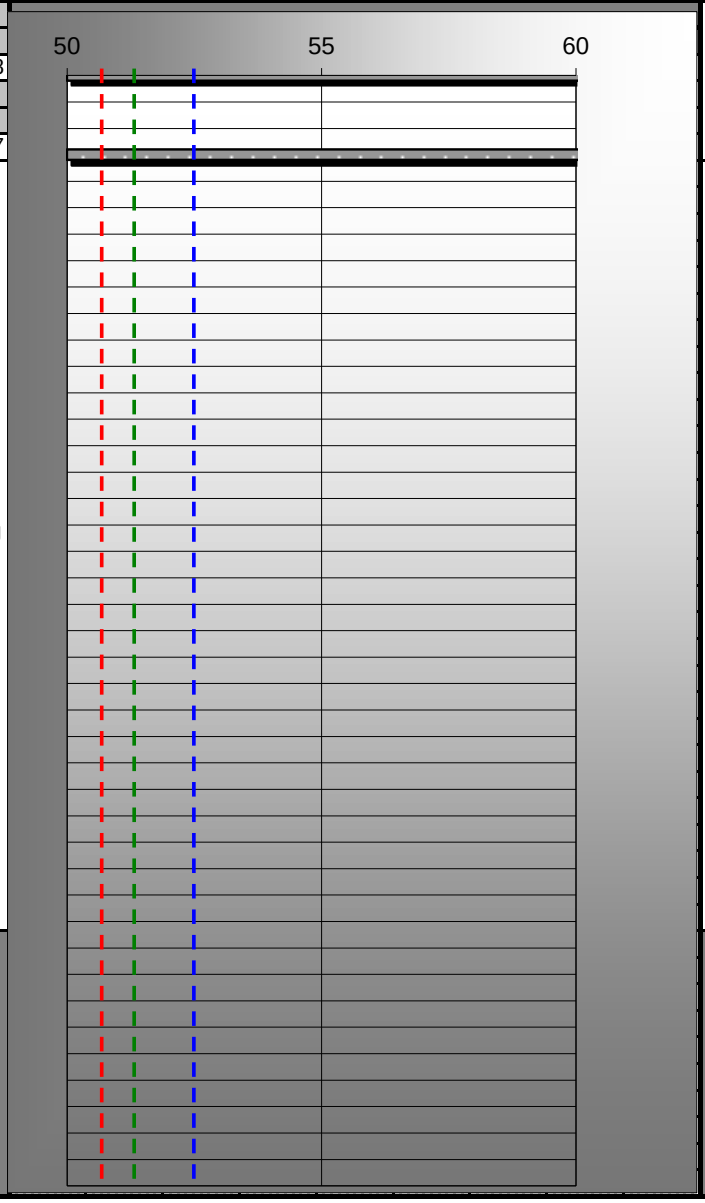
Probing: DCPVR1

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 17 to March 27, 2014

Coordinates X: -334,773.47 Y: -62,243.00 Z: +395.59
Depth: 80m **Groundwater:** +394.5 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 74m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60	Description according to BDC15
7660	67		Silty CAY with COBBLES
7670	71		
7680	74	118	
7690	70		
7700	67		
7710	73	117	
7720	Noncore drilling with tri-cone		Rocky Stratum
7730			
7740			
7750			
7760			
7770			
7780			
7790			
7800			
7810			
7820			
7830			
7840			
7850			
7860			
7870			
7880			
7890			
7900			
7910			
7920			
7930			
7940			
7950			
7960			
7970			
7980			
7990			
8000			

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

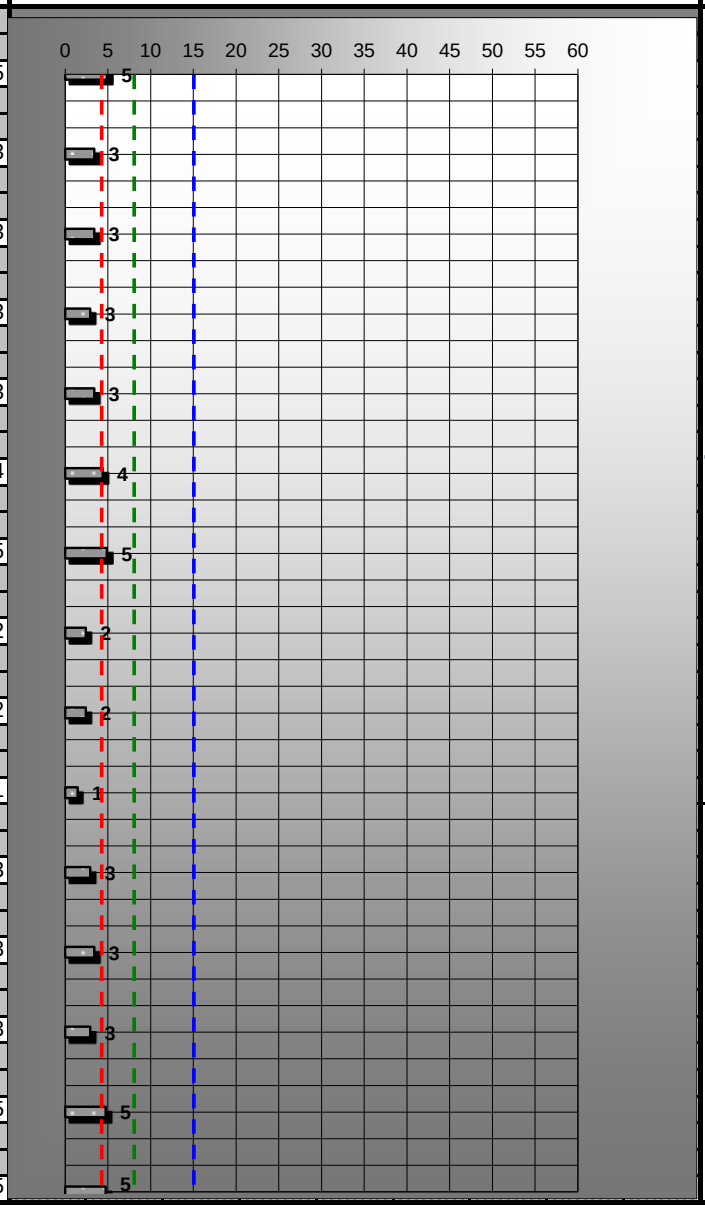
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
10	3	
20	3	
30	4	5
40	2	
50	3	
60	2	3
70	2	
80	2	
90	3	3
100	2	
110	1	
120	3	3
130	2	
140	3	
150	2	3
160	3	
170	3	
180	3	4
190	4	
200	4	
210	2	5
220	2	
230	2	
240	1	2
250	2	
260	2	
270	1	2
280	1	
290	1	
300	1	1
310	2	
320	2	
330	2	3
340	3	
350	3	
360	1	3
370	2	
380	2	
390	2	3
400	3	
410	4	
420	3	5
430	3	
440	4	
450	3	5

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

Silty SAND

Silty CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

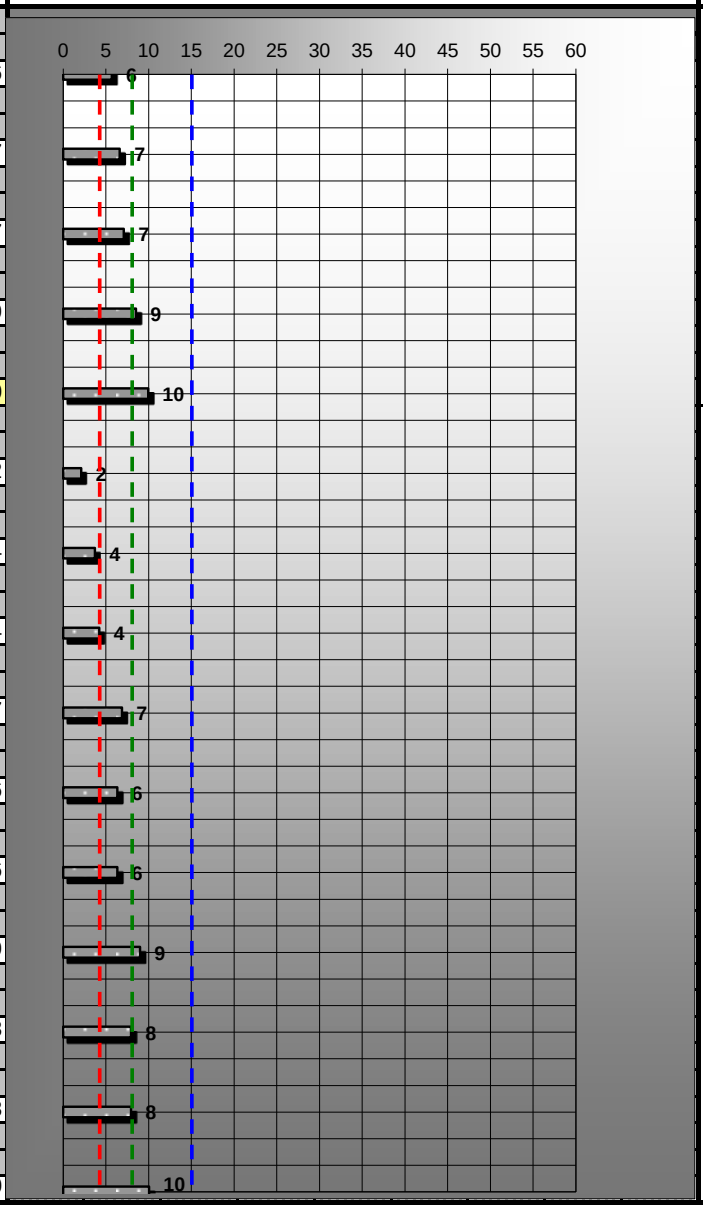
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
460	3	
470	4	
480	5	6
490	4	
500	5	
510	5	7
520	5	
530	5	
540	5	7
550	6	
560	6	
570	6	9
580	7	
590	7	
600	7	10
610	1	
620	1	
630	2	2
640	2	
650	2	
660	3	4
670	2	
680	3	
690	3	4
700	4	
710	5	
720	4	7
730	5	
740	3	
750	4	6
760	4	
770	4	
780	4	6
790	5	
800	6	
810	6	9
820	5	
830	5	
840	5	8
850	5	
860	5	
870	5	8
880	6	
890	7	
900	6	10

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

Casing

Silty CLA

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

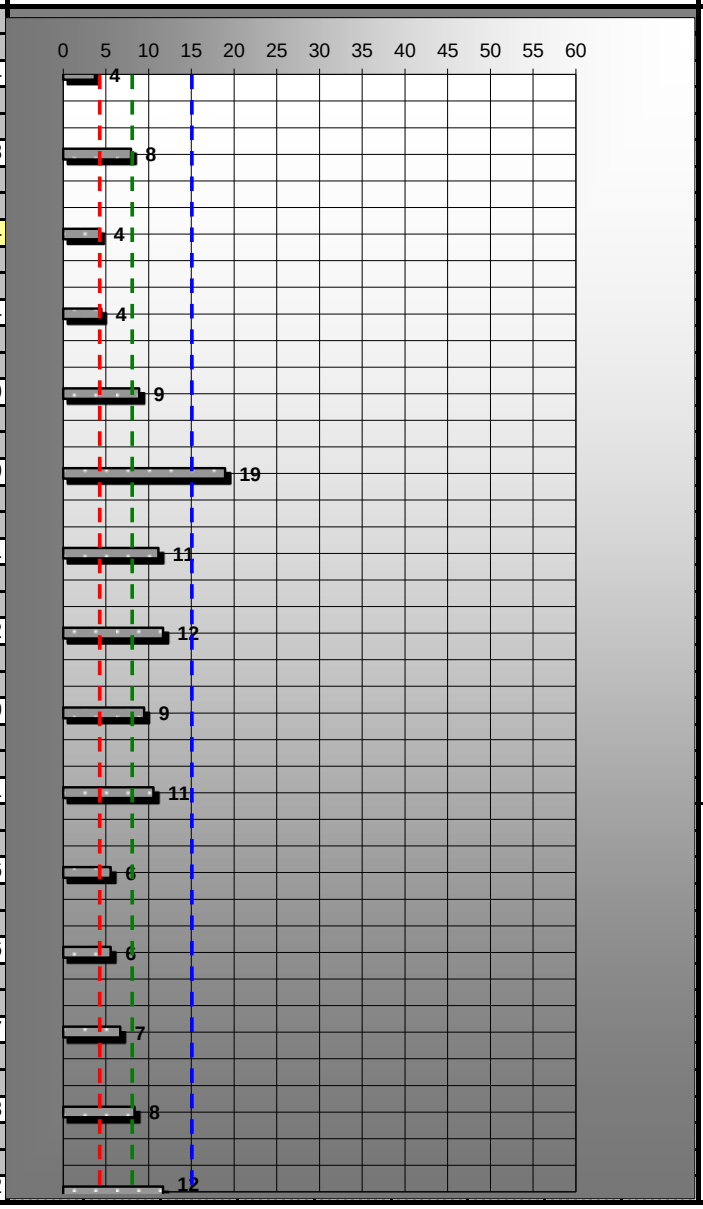
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
910	2	
920	2	
930	3	4
940	3	
950	6	
960	6	8
970	3	
980	3	
990	2	4
1000	2	
1010	3	
1020	3	4
1030	3	
1040	4	
1050	9	9
1060	14	
1070	10	
1080	10	19
1090	6	
1100	6	
1110	8	11
1120	6	
1130	6	
1140	9	12
1150	6	
1160	6	
1170	5	9
1180	6	
1190	6	
1200	7	11
1210	3	
1220	4	
1230	3	6
1240	5	
1250	3	
1260	2	6
1270	5	
1280	4	
1290	3	7
1300	4	
1310	5	
1320	6	8
1330	7	
1340	8	
1350	6	12

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

Silty CLAY

Silty SAND interbedded with silty SAND

Casing

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

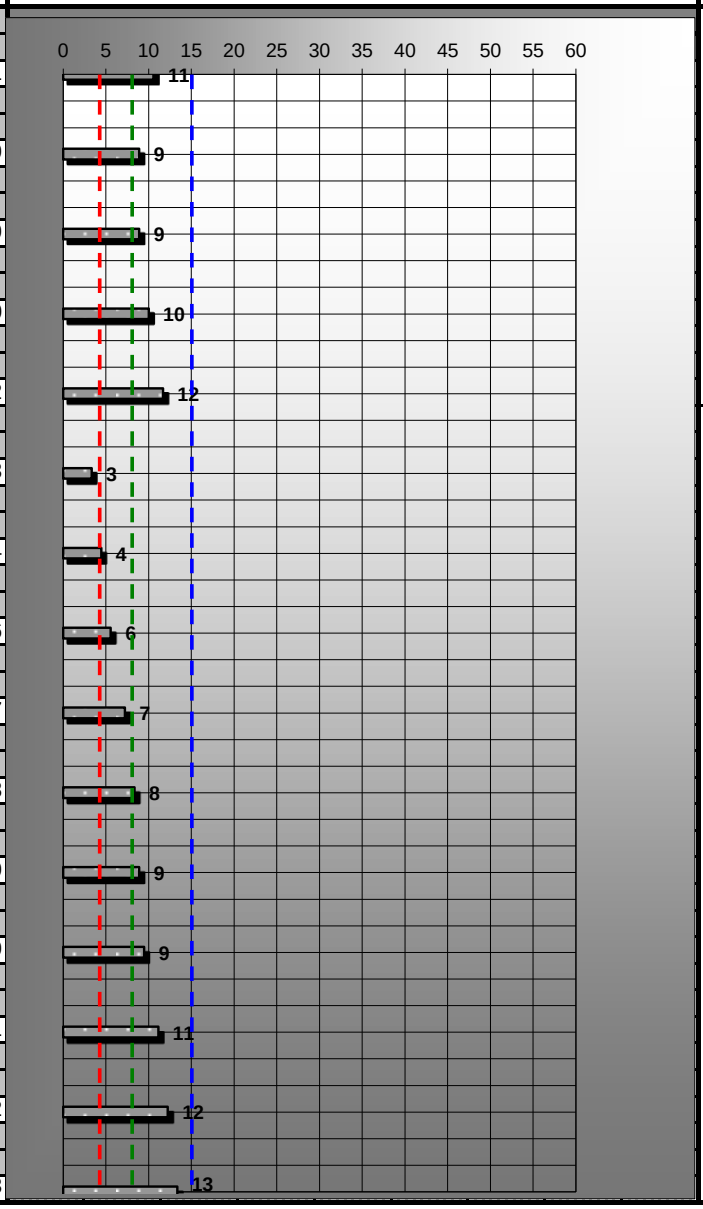
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
1360	5	
1370	7	
1380	7	11
1390	6	
1400	4	
1410	6	9
1420	6	
1430	5	
1440	5	9
1450	4	
1460	7	
1470	7	10
1480	6	
1490	6	
1500	9	12
1510	2	
1520	2	
1530	2	3
1540	3	
1550	2	
1560	3	4
1570	4	
1580	3	
1590	3	6
1600	4	
1610	5	
1620	4	7
1630	5	
1640	5	
1650	5	8
1660	5	
1670	6	
1680	5	9
1690	6	
1700	5	
1710	6	9
1720	7	
1730	6	
1740	7	11
1750	7	
1760	7	
1770	8	12
1780	8	
1790	8	
1800	8	13

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

Casing

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

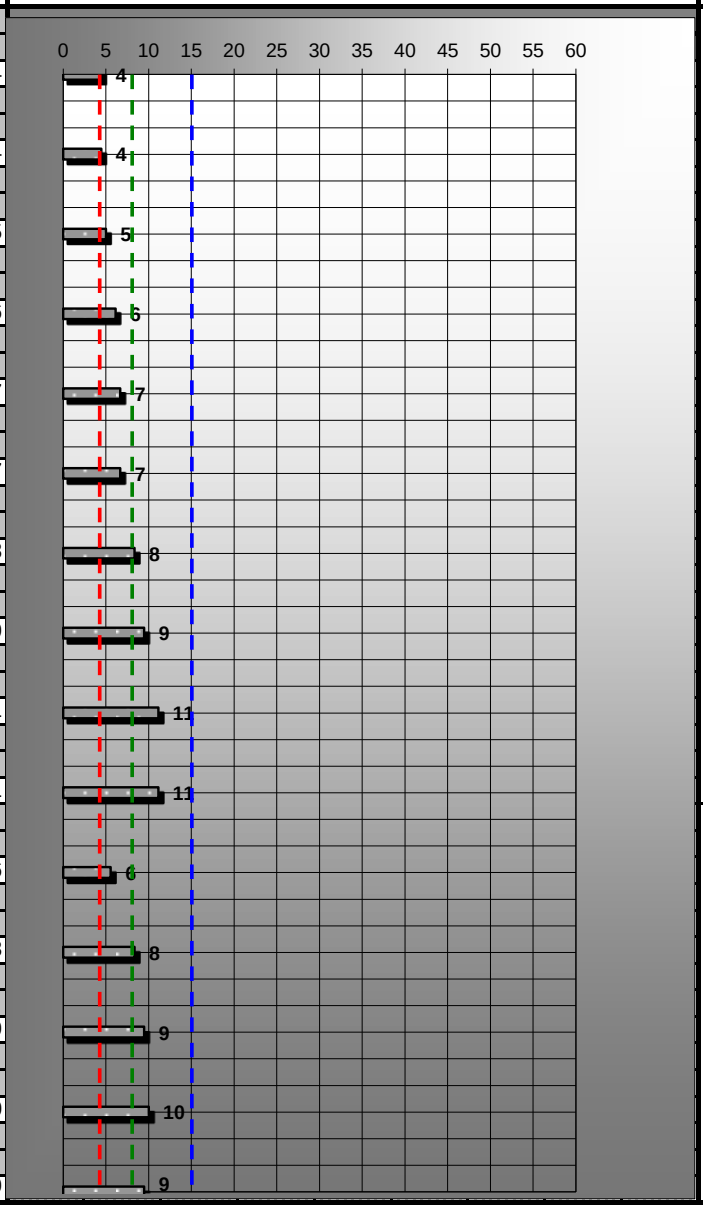
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
1810	3	
1820	3	
1830	2	4
1840	2	
1850	3	
1860	3	4
1870	2	
1880	3	
1890	4	5
1900	4	
1910	3	
1920	4	6
1930	4	
1940	4	
1950	4	7
1960	4	
1970	4	
1980	4	7
1990	5	
2000	5	
2010	5	8
2020	5	
2030	6	
2040	6	9
2050	7	
2060	6	
2070	7	11
2080	6	
2090	7	
2100	7	11
2110	3	
2120	3	
2130	4	6
2140	3	
2150	5	
2160	7	8
2170	5	
2180	5	
2190	7	9
2200	7	
2210	5	
2220	6	10
2230	6	
2240	5	
2250	6	9

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing — Silty CLAY

Casing — Sandy CLAY

Silty CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

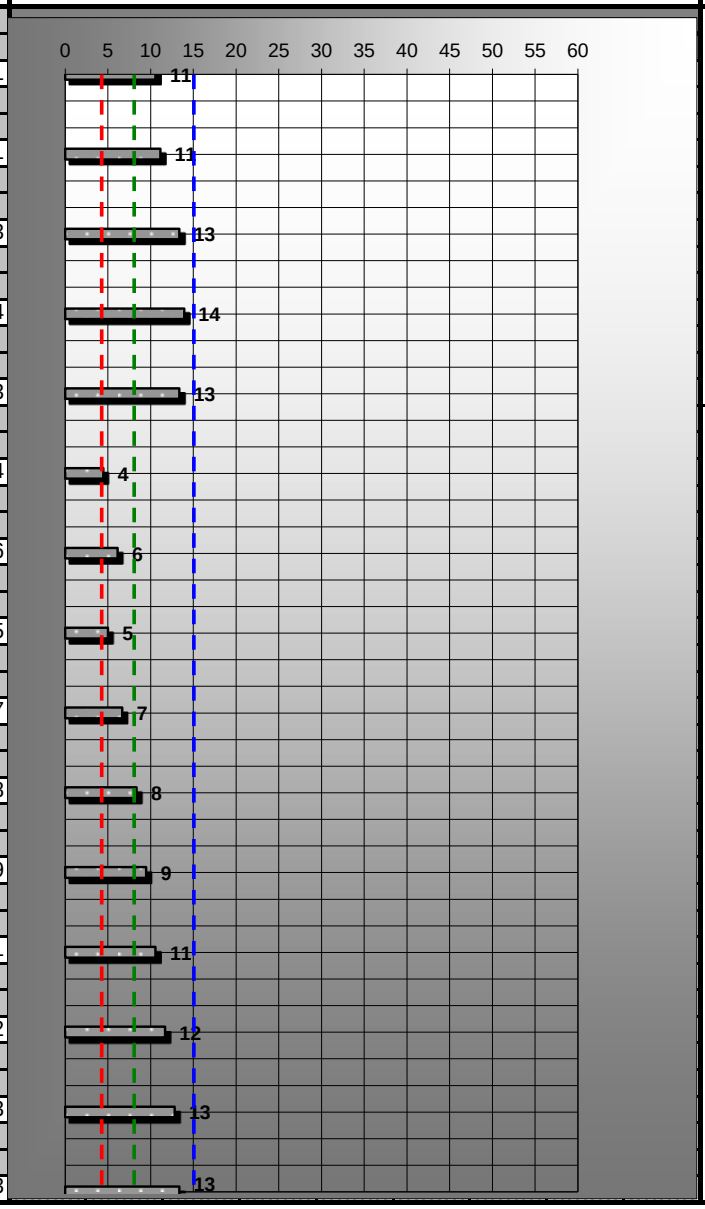
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
2260	6	
2270	6	
2280	7	11
2290	6	
2300	7	
2310	7	11
2320	8	
2330	8	
2340	8	13
2350	8	
2360	8	
2370	9	14
2380	8	
2390	8	
2400	8	13
2410	3	
2420	3	
2430	2	4
2440	3	
2450	4	
2460	4	6
2470	3	
2480	3	
2490	3	5
2500	4	
2510	4	
2520	4	7
2530	5	
2540	5	
2550	5	8
2560	5	
2570	6	
2580	6	9
2590	7	
2600	6	
2610	6	11
2620	6	
2630	7	
2640	8	12
2650	7	
2660	8	
2670	8	13
2680	8	
2690	7	
2700	9	13

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

Silty CLAY

Casing

CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

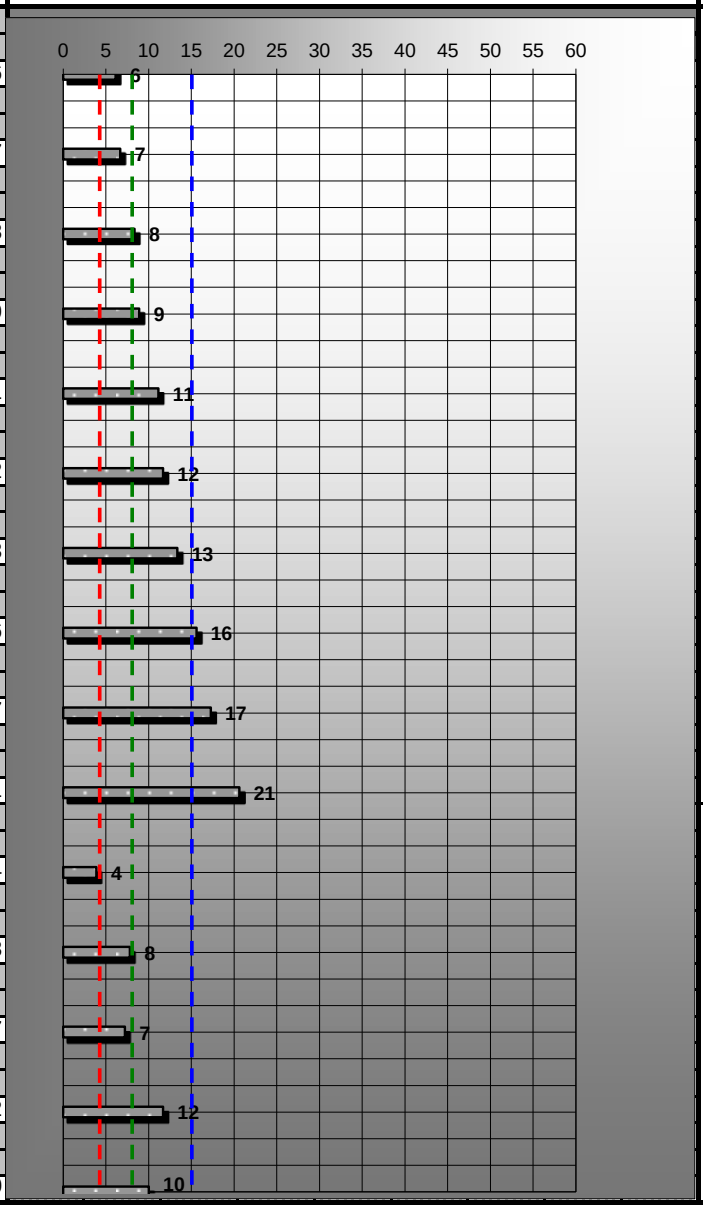
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
2710	4	
2720	3	
2730	4	6
2740	4	
2750	4	
2760	4	7
2770	5	
2780	5	
2790	5	8
2800	6	
2810	5	
2820	5	9
2830	6	
2840	7	
2850	7	11
2860	6	
2870	7	
2880	8	12
2890	7	
2900	8	
2910	9	13
2920	9	
2930	9	
2940	10	16
2950	10	
2960	10	
2970	11	17
2980	12	
2990	12	
3000	13	21
3010	2	
3020	3	
3030	2	4
3040	4	
3050	6	
3060	4	8
3070	6	
3080	4	
3090	3	7
3100	7	
3110	6	
3120	8	12
3130	6	
3140	5	
3150	7	10

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

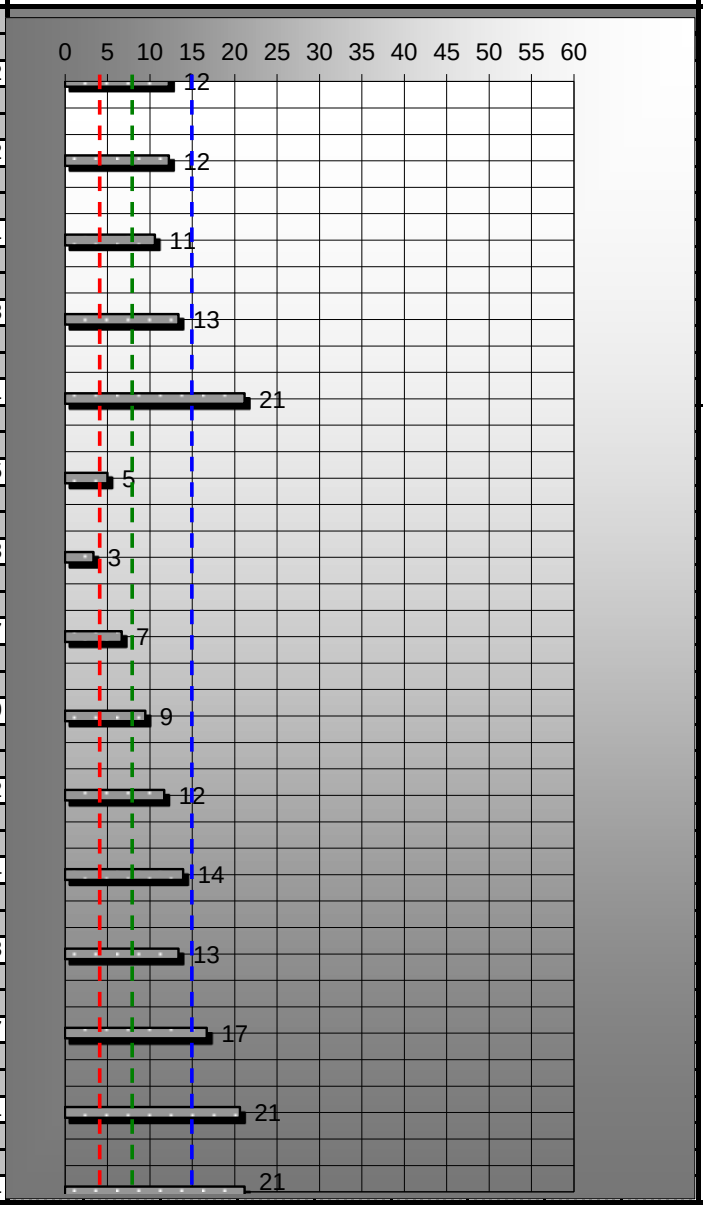
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
3160	6	
3170	8	
3180	8	12
3190	8	
3200	8	
3210	6	12
3220	7	
3230	5	
3240	7	11
3250	9	
3260	7	
3270	8	13
3280	12	
3290	13	
3300	13	21
3310	3	
3320	3	
3330	3	5
3340	2	
3350	2	
3360	2	3
3370	3	
3380	4	
3390	5	7
3400	4	
3410	6	
3420	7	9
3430	8	
3440	6	
3450	7	12
3460	8	
3470	8	
3480	9	14
3490	7	
3500	7	
3510	10	13
3520	9	
3530	10	
3540	11	17
3550	13	
3560	12	
3570	12	21
3580	12	
3590	13	
3600	13	21

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

Casing

CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

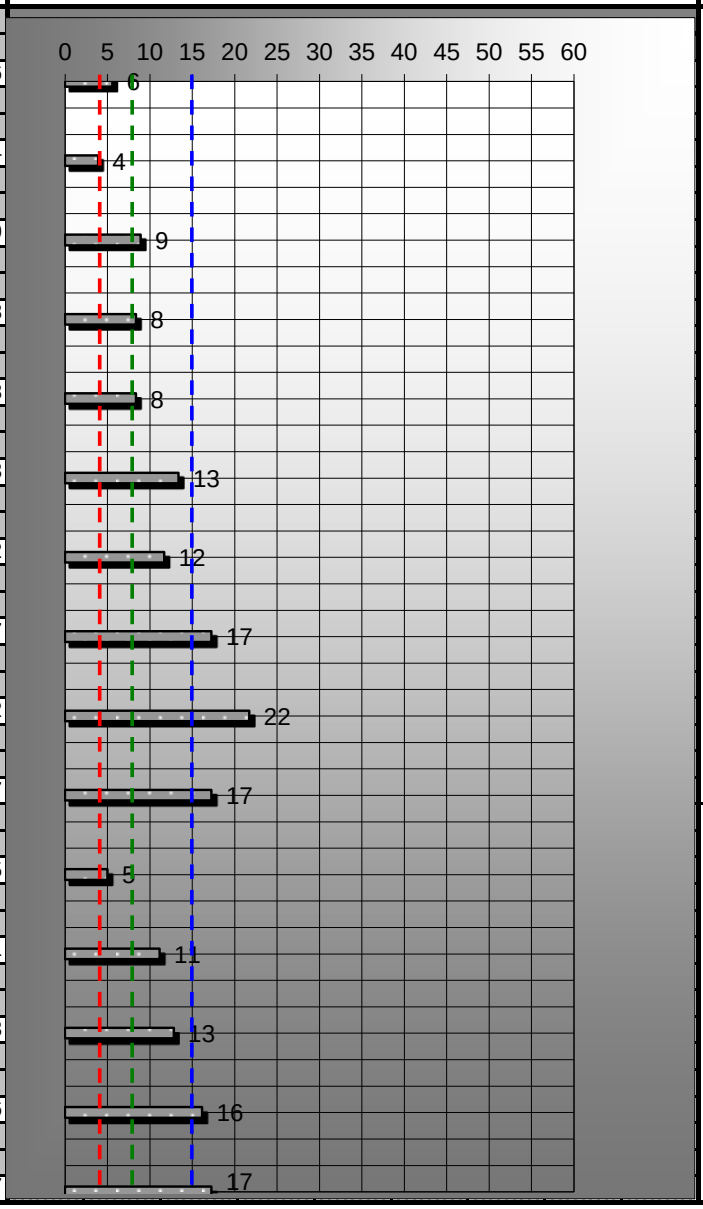
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
3610	3	
3620	3	
3630	4	6
3640	2	
3650	2	
3660	3	4
3670	5	
3680	5	
3690	6	9
3700	4	
3710	5	
3720	6	8
3730	5	
3740	4	
3750	6	8
3760	7	
3770	8	
3780	9	13
3790	6	
3800	8	
3810	7	12
3820	11	
3830	10	
3840	10	17
3850	12	
3860	13	
3870	14	22
3880	11	
3890	10	
3900	10	17
3910	3	
3920	3	
3930	3	5
3940	7	
3950	6	
3960	7	11
3970	7	
3980	8	
3990	8	13
4000	9	
4010	9	
4020	11	16
4030	11	
4040	9	
4050	11	17

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

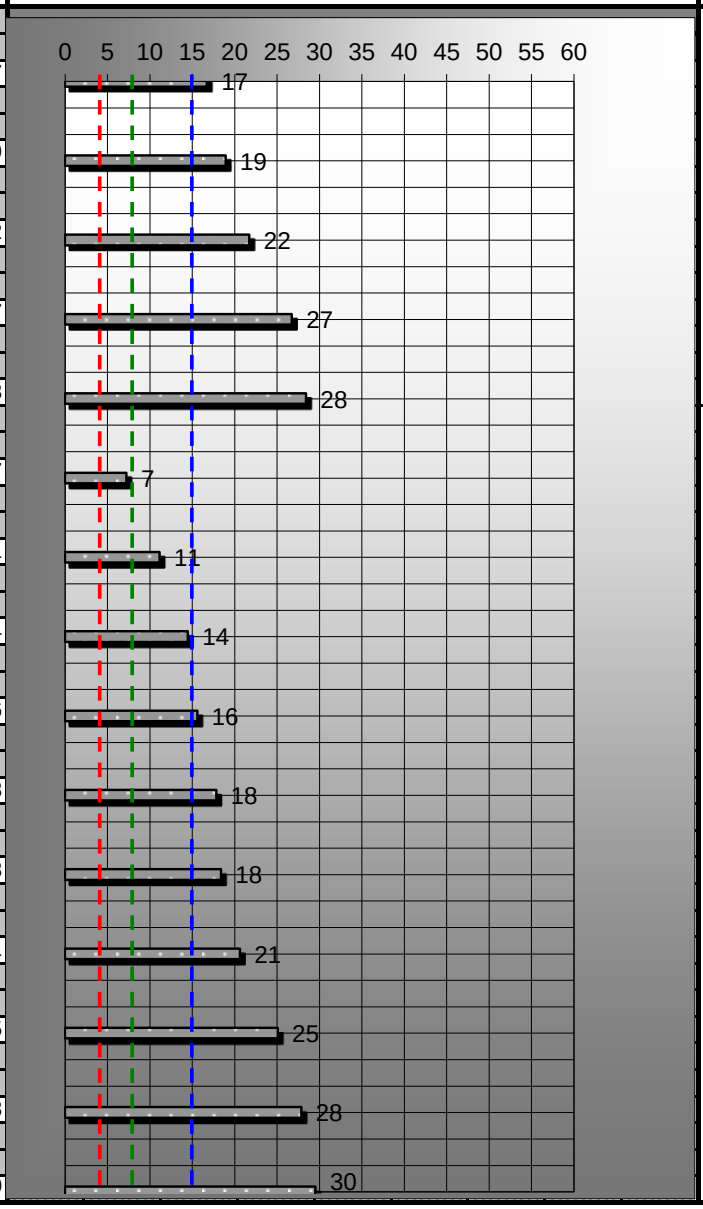
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
4060	9	
4070	11	
4080	10	17
4090	10	
4100	11	
4110	13	19
4120	12	
4130	13	
4140	14	22
4150	16	
4160	15	
4170	17	27
4180	17	
4190	17	
4200	17	28
4210	4	
4220	4	
4230	5	7
4240	7	
4250	7	
4260	6	11
4270	8	
4280	9	
4290	9	14
4300	9	
4310	8	
4320	11	16
4330	10	
4340	11	
4350	11	18
4360	12	
4370	11	
4380	10	18
4390	10	
4400	13	
4410	14	21
4420	14	
4430	16	
4440	15	25
4450	17	
4460	17	
4470	16	28
4480	18	
4490	17	
4500	18	30

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

CLAY

Casing

Silty CLAY

CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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soft to firm & loose
firm to stiff & loose to medium

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دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

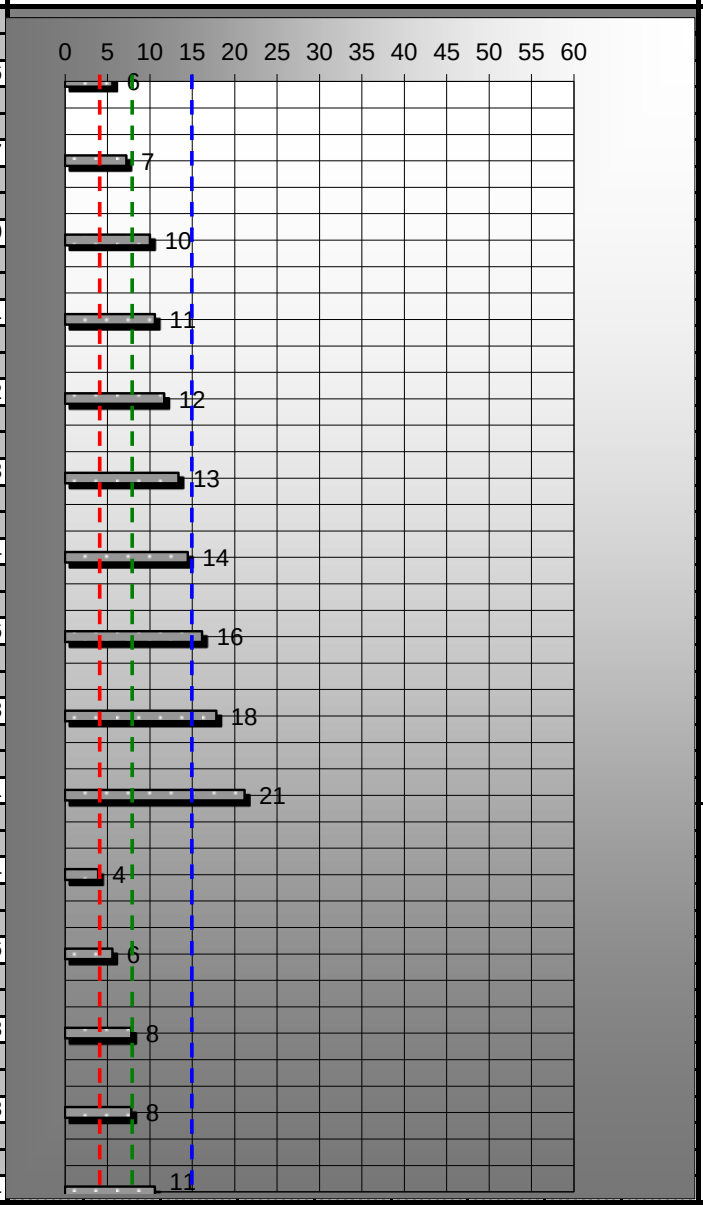
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
4510	3	
4520	4	
4530	3	6
4540	3	
4550	4	
4560	6	7
4570	5	
4580	7	
4590	6	10
4600	6	
4610	6	
4620	7	11
4630	7	
4640	7	
4650	7	12
4660	7	
4670	8	
4680	9	13
4690	9	
4700	8	
4710	9	14
4720	9	
4730	10	
4740	10	16
4750	11	
4760	10	
4770	11	18
4780	13	
4790	12	
4800	13	21
4810	2	
4820	3	
4830	2	4
4840	3	
4850	3	
4860	4	6
4870	5	
4880	4	
4890	5	8
4900	4	
4910	5	
4920	5	8
4930	6	
4940	6	
4950	7	11

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

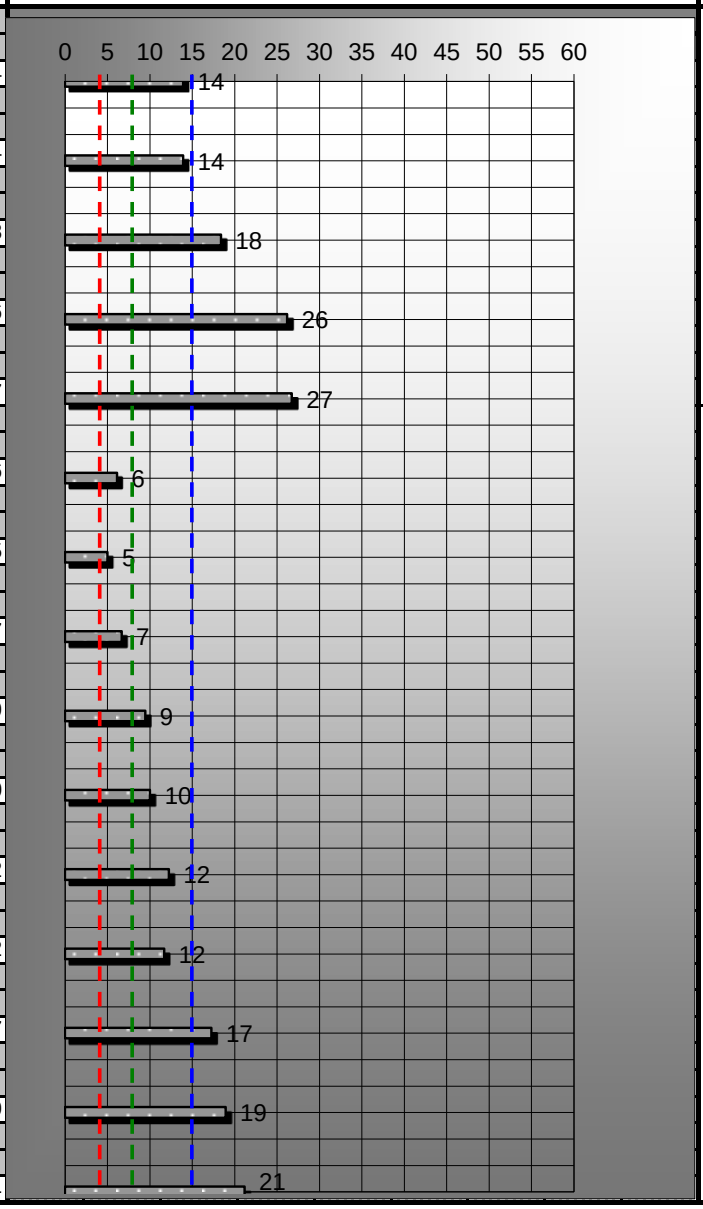
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
4960	8	
4970	9	
4980	8	14
4990	8	
5000	9	
5010	8	14
5020	9	
5030	12	
5040	12	18
5050	10	
5060	19	
5070	18	26
5080	19	
5090	15	
5100	14	27
5110	4	
5120	4	
5130	3	6
5140	2	
5150	4	
5160	3	5
5170	2	
5180	5	
5190	5	7
5200	4	
5210	6	
5220	7	9
5230	7	
5240	6	
5250	5	10
5260	8	
5270	6	
5280	8	12
5290	7	
5300	8	
5310	6	12
5320	9	
5330	10	
5340	12	17
5350	13	
5360	10	
5370	11	19
5380	12	
5390	13	
5400	13	21

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

Casing

CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
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DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

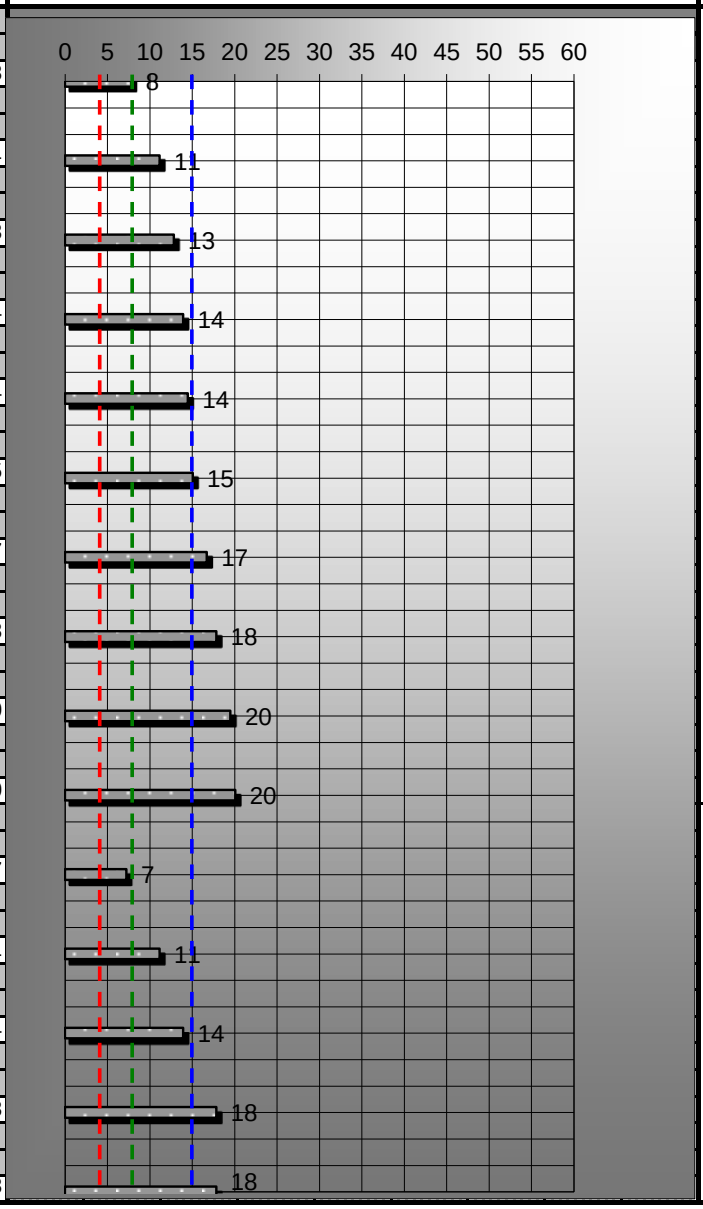
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
5410	3	
5420	5	
5430	6	8
5440	6	
5450	7	
5460	7	11
5470	8	
5480	8	
5490	7	13
5500	9	
5510	8	
5520	8	14
5530	8	
5540	9	
5550	9	14
5560	9	
5570	9	
5580	9	15
5590	8	
5600	12	
5610	10	17
5620	10	
5630	10	
5640	12	18
5650	11	
5660	12	
5670	12	20
5680	12	
5690	12	
5700	12	20
5710	4	
5720	4	
5730	5	7
5740	5	
5750	7	
5760	8	11
5770	7	
5780	9	
5790	9	14
5800	10	
5810	11	
5820	11	18
5830	11	
5840	11	
5850	10	18

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
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DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

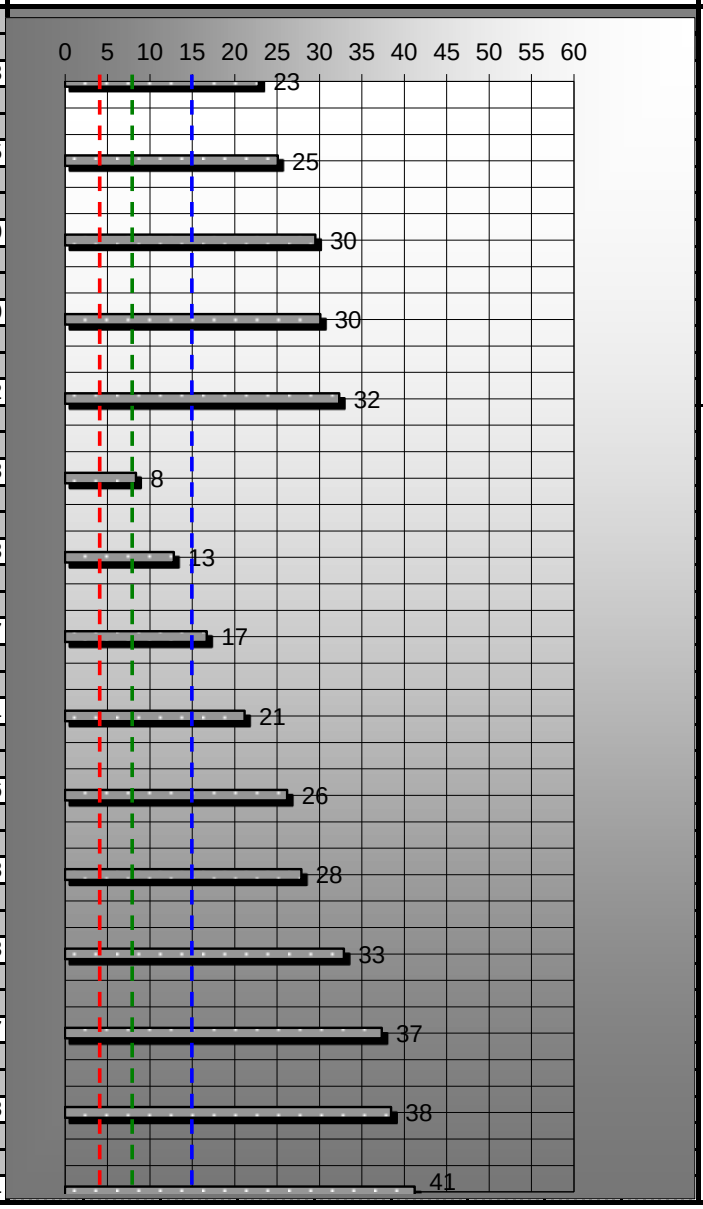
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
5860	13	
5870	14	
5880	14	23
5890	12	
5900	15	
5910	18	25
5920	17	
5930	17	
5940	19	30
5950	18	
5960	17	
5970	19	30
5980	20	
5990	19	
6000	19	32
6010	4	
6020	5	
6030	6	8
6040	7	
6050	8	
6060	8	13
6070	9	
6080	9	
6090	12	17
6100	11	
6110	13	
6120	14	21
6130	16	
6140	15	
6150	16	26
6160	17	
6170	15	
6180	18	28
6190	20	
6200	18	
6210	21	33
6220	22	
6230	23	
6240	22	37
6250	22	
6260	24	
6270	23	38
6280	24	
6290	25	
6300	25	41

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

Casing

4 inches dia. tri-cone

CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
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firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
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DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

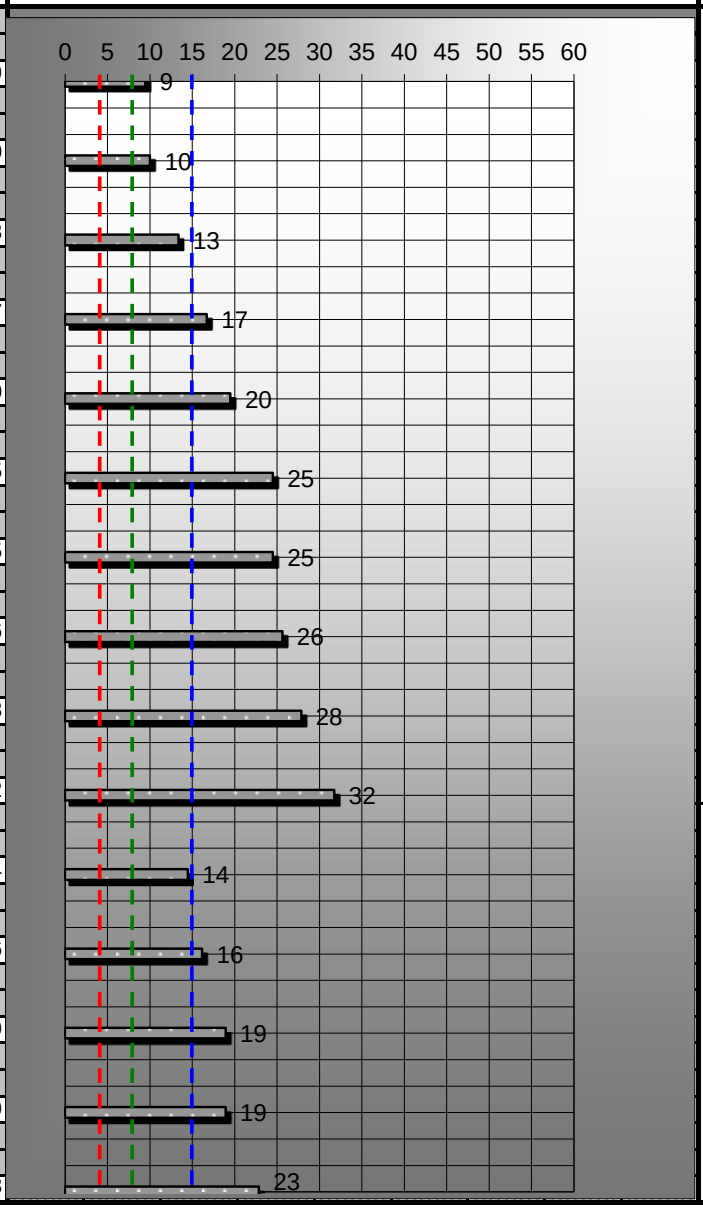
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
6310	5	
6320	5	
6330	7	9
6340	6	
6350	6	
6360	6	10
6370	8	
6380	8	
6390	8	13
6400	9	
6410	11	
6420	10	17
6430	11	
6440	11	
6450	13	20
6460	17	
6470	13	
6480	14	25
6490	14	
6500	14	
6510	16	25
6520	15	
6530	15	
6540	16	26
6550	17	
6560	17	
6570	16	28
6580	18	
6590	19	
6600	20	32
6610	7	
6620	9	
6630	10	14
6640	9	
6650	11	
6660	9	16
6670	11	
6680	11	
6690	12	19
6700	11	
6710	12	
6720	11	19
6730	14	
6740	13	
6750	14	23

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC39

4 inches dia. tri-cone

4 inches dia. tri-cone

CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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firm to stiff & loose to medium

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دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

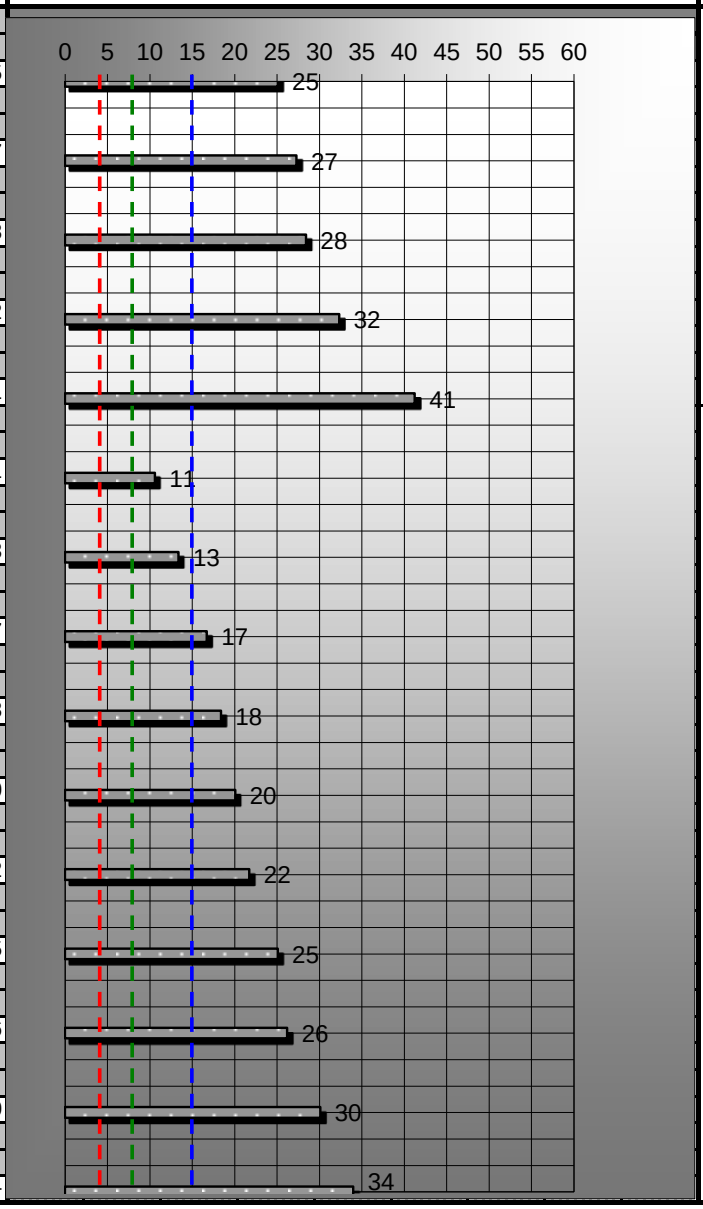
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
6760	13	
6770	15	
6780	17	25
6790	19	
6800	15	
6810	15	27
6820	18	
6830	17	
6840	16	28
6850	18	
6860	20	
6870	20	32
6880	20	
6890	22	
6900	32	41
6910	6	
6920	6	
6930	7	11
6940	8	
6950	8	
6960	8	13
6970	10	
6980	9	
6990	11	17
7000	10	
7010	12	
7020	11	18
7030	11	
7040	12	
7050	13	20
7060	13	
7070	12	
7080	14	22
7090	16	
7100	14	
7110	15	25
7120	16	
7130	16	
7140	15	26
7150	17	
7160	19	
7170	18	30
7180	20	
7190	19	
7200	22	34

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description

4 inches dia. tri-cone

4 inches dia. tri-cone

CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

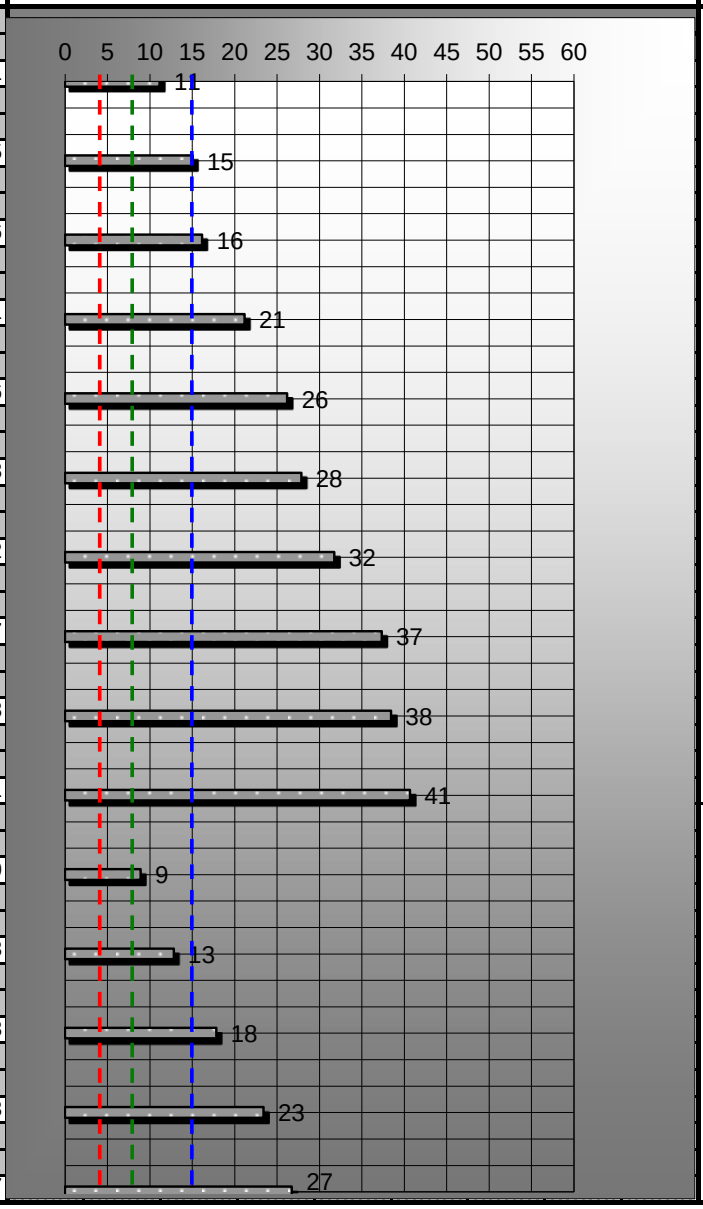
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
7210	7	
7220	7	
7230	6	11
7240	8	
7250	10	
7260	9	15
7270	9	
7280	9	
7290	11	16
7300	13	
7310	13	
7320	12	21
7330	15	
7340	17	
7350	15	26
7360	15	
7370	17	
7380	18	28
7390	18	
7400	20	
7410	19	32
7420	22	
7430	22	
7440	23	37
7450	22	
7460	24	
7470	23	38
7480	23	
7490	25	
7500	25	41
7510	4	
7520	5	
7530	7	9
7540	7	
7550	8	
7560	8	13
7570	9	
7580	12	
7590	11	18
7600	13	
7610	15	
7620	14	23
7630	15	
7640	16	
7650	17	27

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description

4 inches dia. tri-cone

CLAY

4 inches dia. tri-cone

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

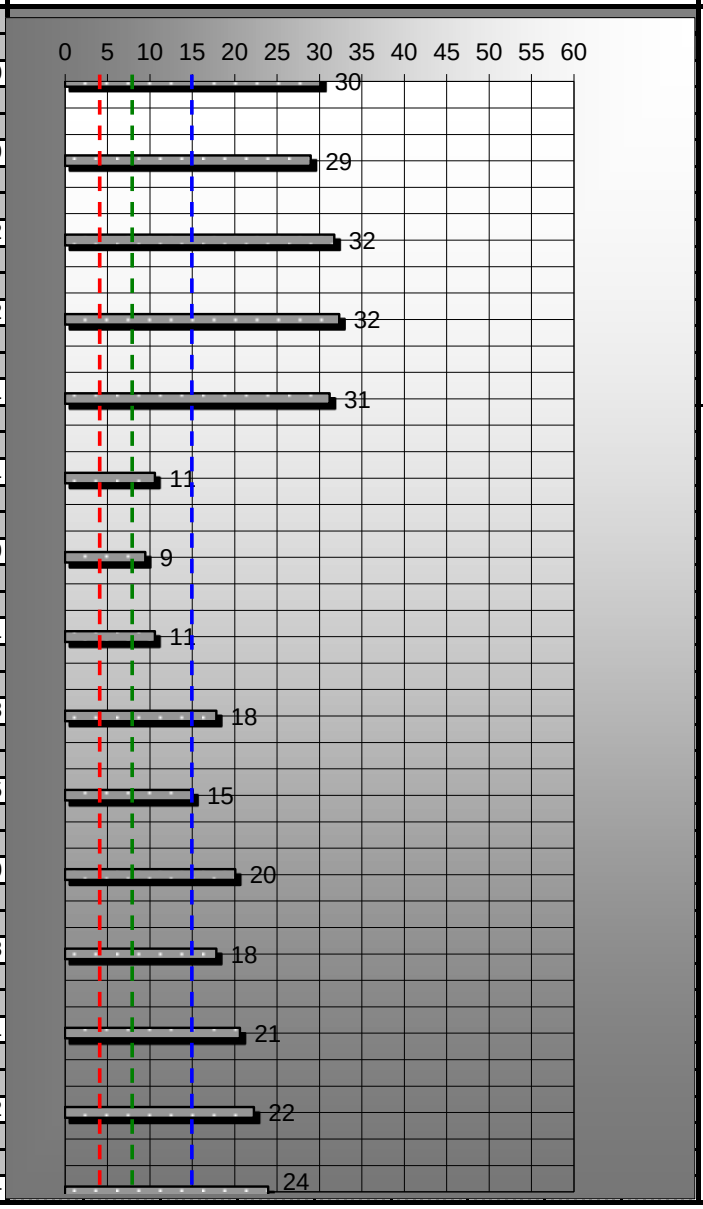
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
7660	18	
7670	18	
7680	18	30
7690	18	
7700	18	
7710	16	29
7720	19	
7730	18	
7740	20	32
7750	21	
7760	20	
7770	17	32
7780	18	
7790	18	
7800	20	31
7810	6	
7820	6	
7830	7	11
7840	6	
7850	5	
7860	6	9
7870	6	
7880	7	
7890	6	11
7900	7	
7910	11	
7920	14	18
7930	9	
7940	9	
7950	9	15
7960	15	
7970	11	
7980	10	20
7990	11	
8000	10	
8010	11	18
8020	12	
8030	12	
8040	13	21
8050	12	
8060	14	
8070	14	22
8080	14	
8090	14	
8100	15	24

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description

4 inches dia. tri-cone

4 inches dia. tri-cone

CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

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دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

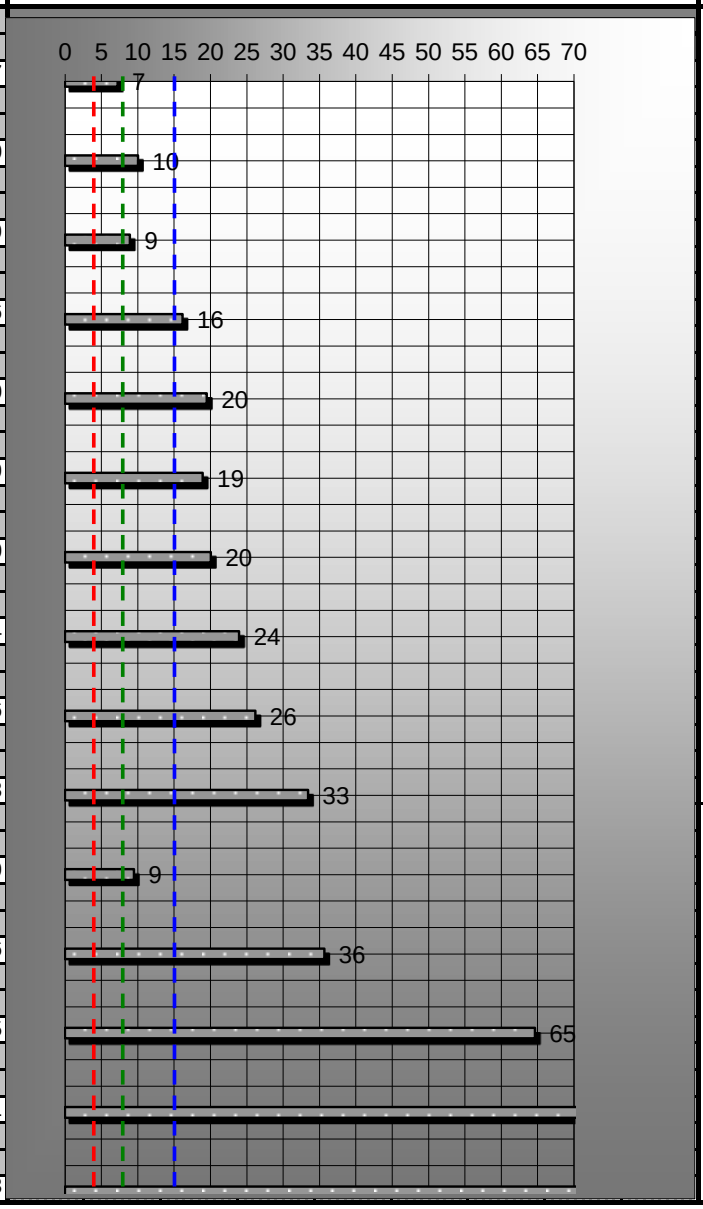
Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
8110	4	
8120	5	
8130	4	7
8140	5	
8150	6	
8160	7	10
8170	5	
8180	5	
8190	6	9
8200	8	
8210	9	
8220	12	16
8230	10	
8240	13	
8250	12	20
8260	11	
8270	12	
8280	11	19
8290	11	
8300	12	
8310	13	20
8320	14	
8330	14	
8340	15	24
8350	16	
8360	15	
8370	16	26
8380	19	
8390	21	
8400	20	33
8410	5	
8420	5	
8430	7	9
8440	12	
8450	25	
8460	27	36
8470	39	
8480	35	
8490	42	65
8500	39	
8510	43	
8520	45	71
8530	42	
8540	55	
8550	70	93

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description

4 inches dia. tri-cone — Clayey SAND

4 inches dia. tri-cone — CLAY with GRAVELS

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

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دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

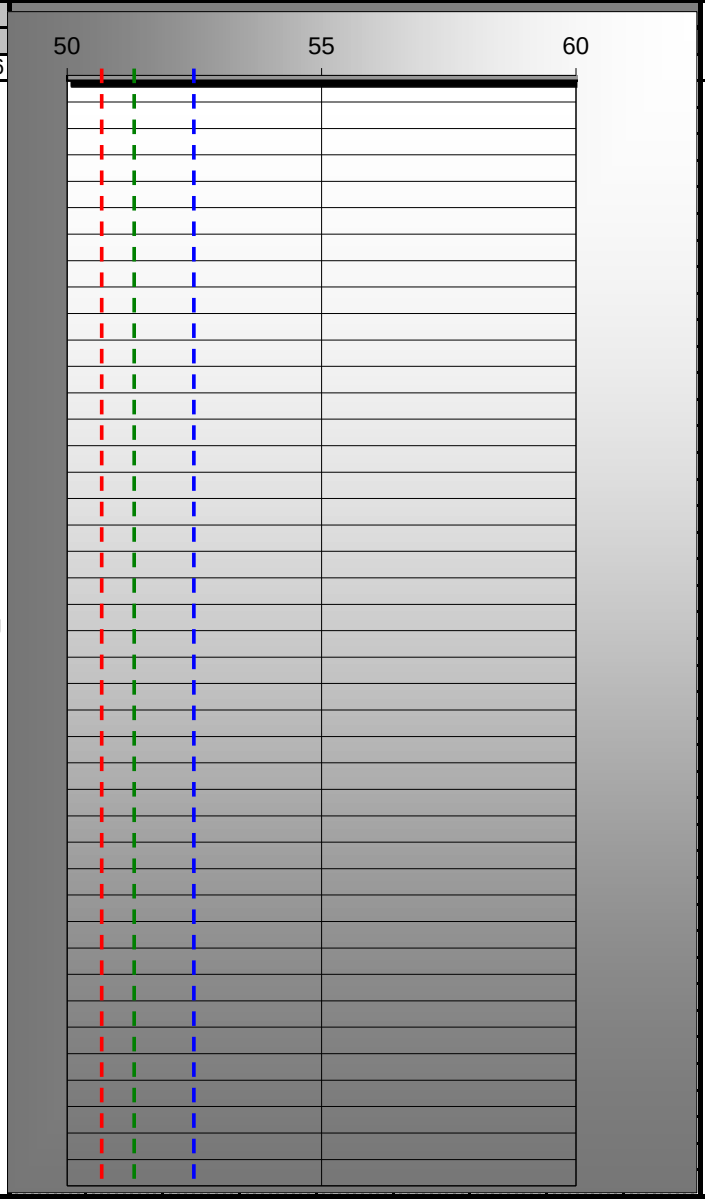
Project: BISRI DAM

Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60	Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)	Description
8560	68			
8570	72			CLAY with GRAVELS
8580	69	116		
8590				
8600				
8610				
8620				
8630				
8640				
8650				
8660				
8670				
8680				
8690				
8700				
8710				
8720				
8730				
8740				
8750				
8760				
8770				
8780				
8790	Noncore drilling with tri-cone			Rocky Stratum
8800				
8810				
8820				
8830				
8840				
8850				
8860				
8870				
8880				
8890				
8900				
8910				
8920				
8930				
8940				
8950				
8960				
8970				
8980				
8990				
9000				



Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

Probing: DCPVR2

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From March 27 to April 02, 2014

Coordinates X: -334,846.38 Y: -62,186.19 Z: +397.75
Depth: 92m **Groundwater:** +396 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 86m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60	Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)	Description
9010	Noncore drilling with tri-cone		0	Rocky Stratum
9020				
9030				
9040				
9050				
9060				
9070				
9080				
9090				
9100				
9110				
9120				
9130				
9140				
9150				
9160				
9170				
9180				
9190				
9200				

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

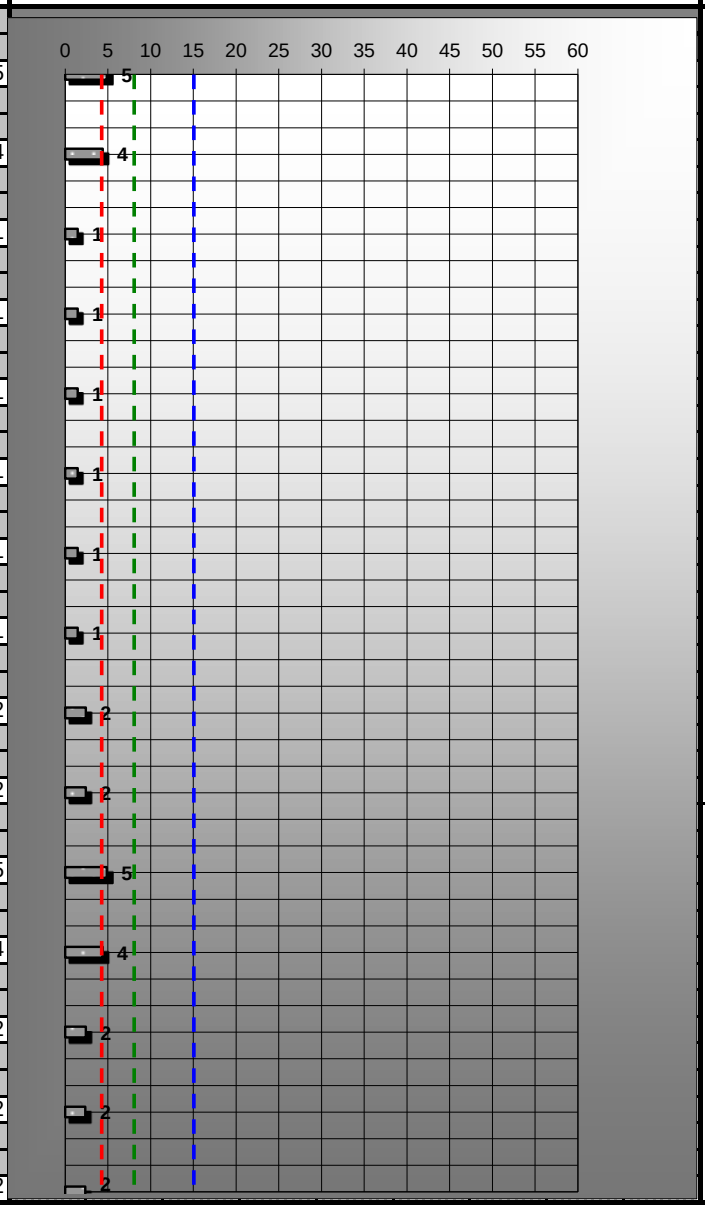
Probing: DCPVR3

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From April 03 to April 04, 2014

Coordinates X: -334,906.75 Y: -62,093.42 Z: +405.09
Depth: 26m **Groundwater:** +400 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 20m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
10	2	
20	3	
30	5	5
40	7	
50	1	
60	1	4
70	1	
80	1	
90	1	1
100	1	
110	1	
120	1	1
130	1	
140	1	
150	1	1
160	1	
170	1	
180	1	1
190	1	
200	1	
210	1	1
220	1	
230	1	
240	1	1
250	1	
260	1	
270	3	2
280	1	
290	2	
300	2	2
310	3	
320	3	
330	4	5
340	2	
350	3	
360	4	4
370	2	
380	2	
390	1	2
400	2	
410	1	
420	2	2
430	3	
440	1	
450	1	2

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC20

Casing

Silty sandy CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

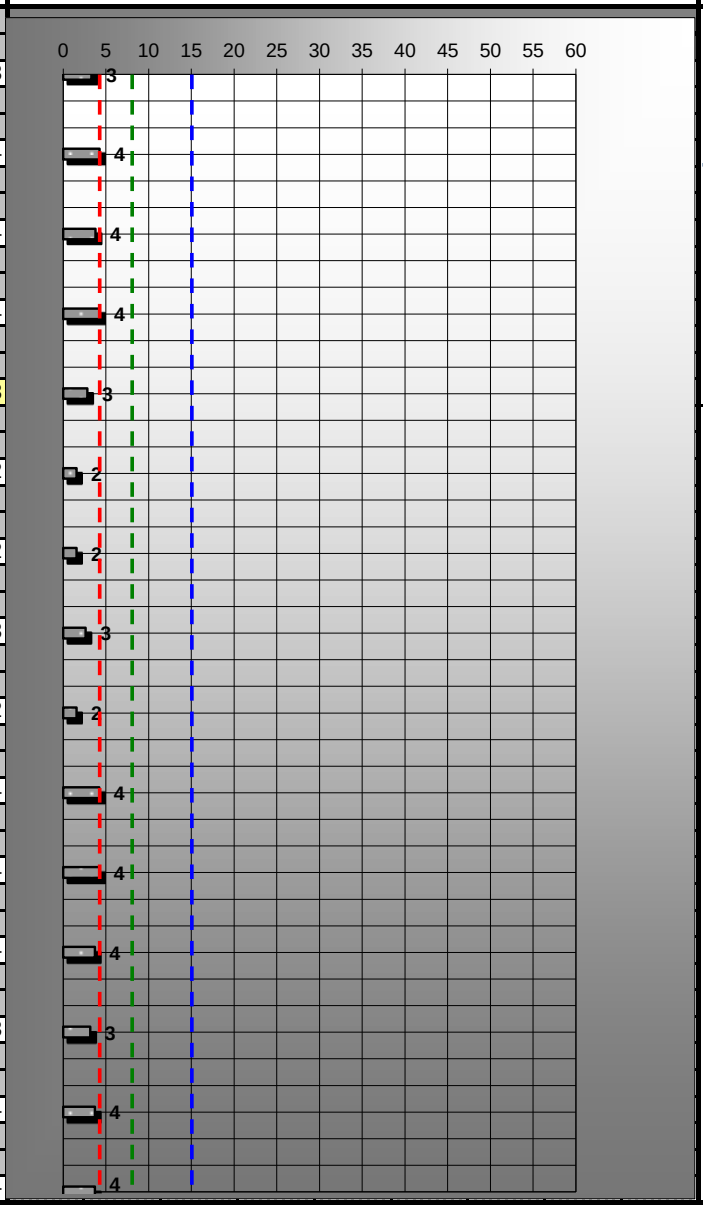
Probing: DCPVR3

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From April 03 to April 04, 2014

Coordinates X: -334,906.75 Y: -62,093.42 Z: +405.09
Depth: 26m **Groundwater:** +400 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 20m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
460	3	
470	2	
480	2	3
490	2	
500	4	
510	3	4
520	2	
530	4	
540	2	4
550	4	
560	2	
570	3	4
580	2	
590	2	
600	2	3
610	1	
620	1	
630	1	2
640	1	
650	1	
660	1	2
670	1	
680	2	
690	2	3
700	1	
710	1	
720	1	2
730	2	
740	3	
750	3	4
760	4	
770	2	
780	2	4
790	2	
800	3	
810	2	4
820	2	
830	1	
840	3	3
850	2	
860	3	
870	2	4
880	2	
890	3	
900	2	4

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC20

Silty sandy LAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

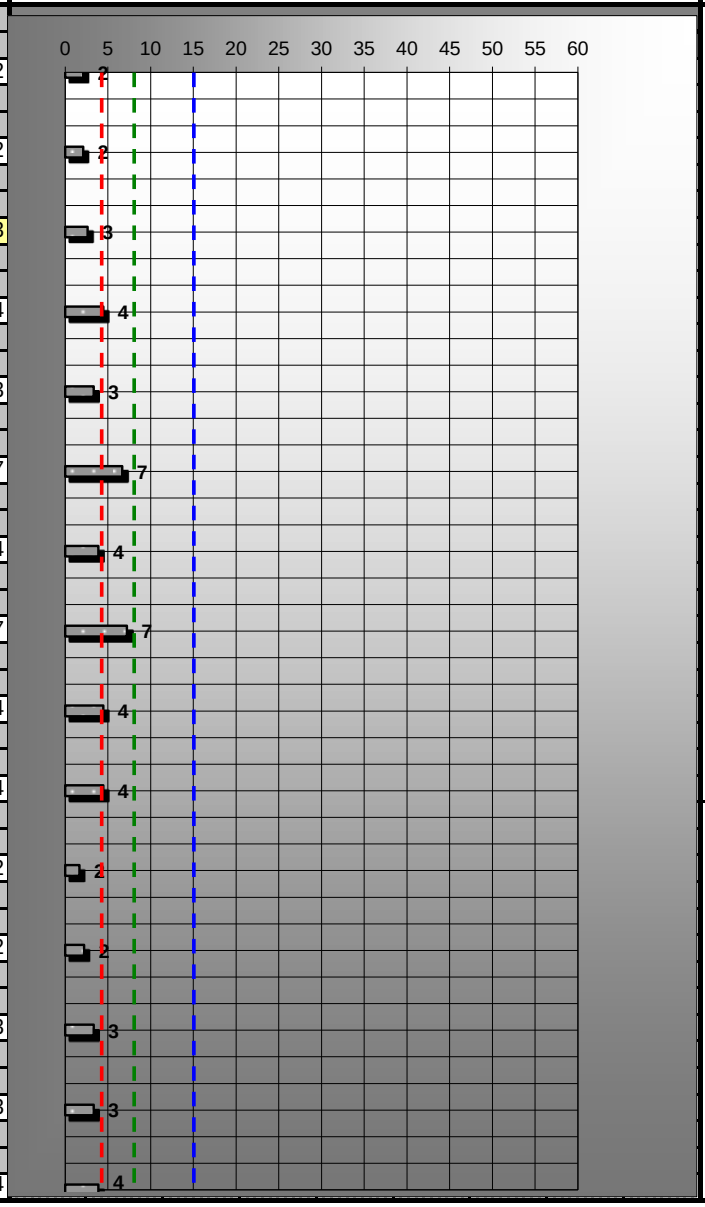
Probing: DCPVR3

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From April 03 to April 04, 2014

Coordinates X: -334,906.75 Y: -62,093.42 Z: +405.09
Depth: 26m **Groundwater:** +400 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 20m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
910	1	
920	1	
930	2	2
940	1	
950	2	
960	1	2
970	1	
980	2	
990	2	3
1000	3	
1010	2	
1020	3	4
1030	2	
1040	2	
1050	2	3
1060	3	
1070	5	
1080	4	7
1090	2	
1100	2	
1110	3	4
1120	4	
1130	5	
1140	4	7
1150	2	
1160	3	
1170	3	4
1180	2	
1190	3	
1200	3	4
1210	1	
1220	1	
1230	1	2
1240	1	
1250	1	
1260	2	2
1270	1	
1280	2	
1290	3	3
1300	3	
1310	2	
1320	1	3
1330	2	
1340	2	
1350	3	4

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC20

Casing

Silty sandy CLAY

Casing

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

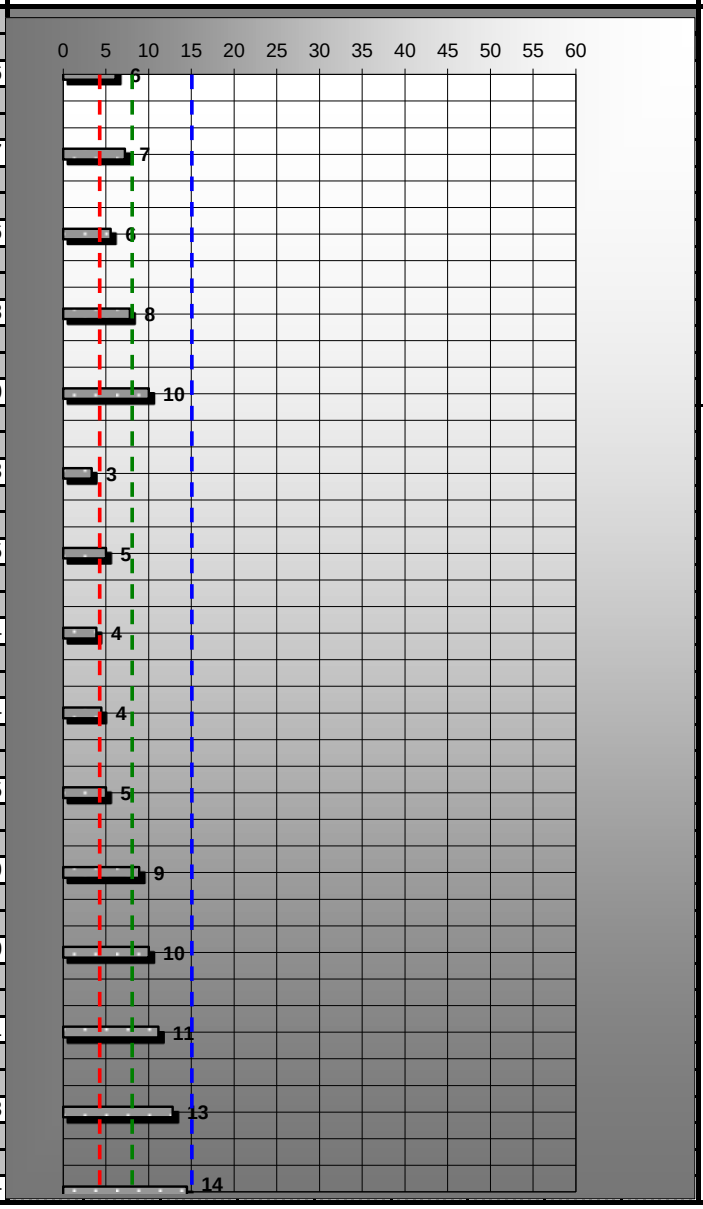
Probing: DCPVR3

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From April 03 to April 04, 2014

Coordinates X: -334,906.75 Y: -62,093.42 Z: +405.09
Depth: 26m **Groundwater:** +400 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 20m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
1360	3	
1370	4	
1380	4	6
1390	5	
1400	4	
1410	4	7
1420	4	
1430	4	
1440	2	6
1450	5	
1460	5	
1470	4	8
1480	6	
1490	6	
1500	6	10
1510	2	
1520	2	
1530	2	3
1540	3	
1550	3	
1560	3	5
1570	2	
1580	3	
1590	2	4
1600	3	
1610	2	
1620	3	4
1630	3	
1640	2	
1650	4	5
1660	5	
1670	5	
1680	6	9
1690	5	
1700	6	
1710	7	10
1720	6	
1730	7	
1740	7	11
1750	7	
1760	8	
1770	8	13
1780	9	
1790	8	
1800	9	14

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC20

Casing

Casing

Silty sandy CLAY

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

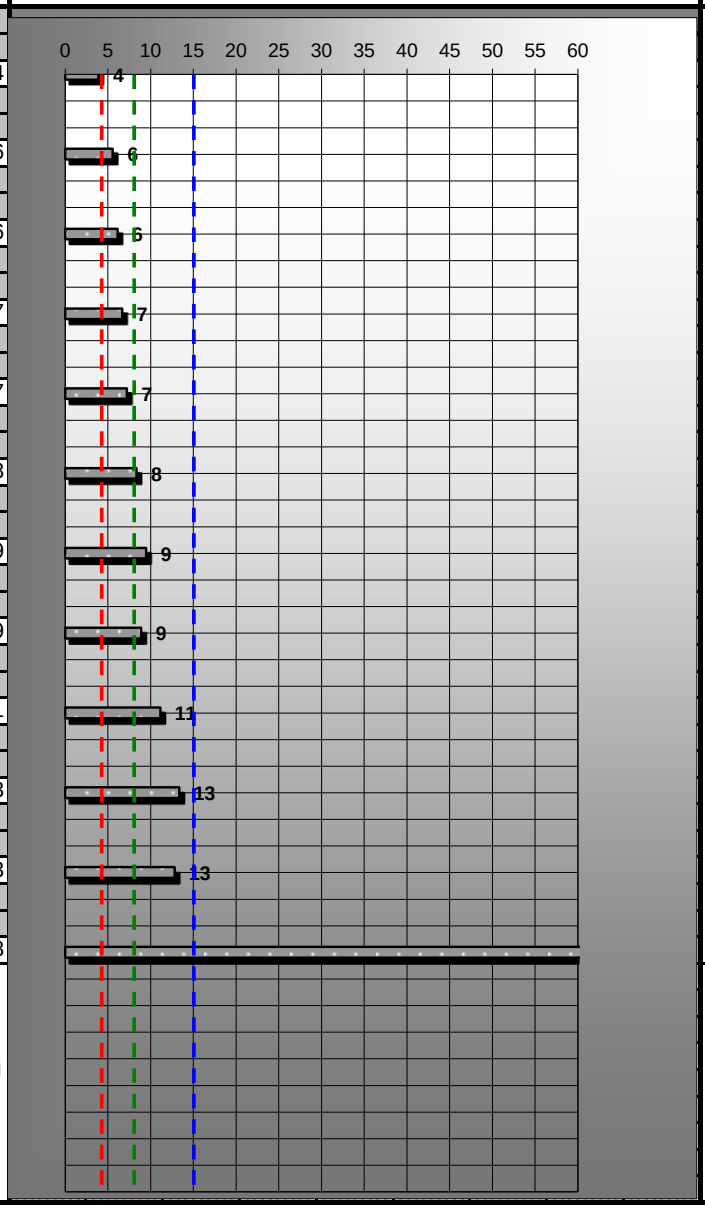
Probing: DCPVR3

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From April 03 to April 04, 2014

Coordinates X: -334,906.75 Y: -62,093.42 Z: +405.09
Depth: 26m **Groundwater:** +400 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 20m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60
1810	3	
1820	2	
1830	2	4
1840	2	
1850	3	
1860	5	6
1870	3	
1880	4	
1890	4	6
1900	4	
1910	4	
1920	4	7
1930	4	
1940	4	
1950	5	7
1960	5	
1970	5	
1980	5	8
1990	5	
2000	5	
2010	7	9
2020	5	
2030	5	
2040	6	9
2050	6	
2060	7	
2070	7	11
2080	7	
2090	8	
2100	9	13
2110	5	
2120	7	
2130	11	13
2140	52	
2150	69	
2160	72	108
2170	Noncore drilling with tri-cone	
2180		
2190		
2200		
2210		
2220		
2230		
2240		
2250		

Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)



Description according to BDC20

Casing

Silty sandy CLAY

Clayey SAND

Rocky Stratum

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

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DCPT
Dynamic Cone Penetration Test

Project: BISRI DAM

Probing: DCPVR3

Client: CDR
Consultant: DAR-TALEB
Engineer: E. S. KIRGIZ
Contractor: SATCON Co.
Date: From April 03 to April 04, 2014

Coordinates X: -334,906.75 Y: -62,093.42 Z: +405.09
Depth: 26m **Groundwater:** +400 (Measured)
C./D. Rod: 60m (HW) / 6m AW & 20m BW **H.Dia.:** 62.5 to 114mm
SPT Hammer: Automatic Trip **Blow Rate:** 36 bpm
Anvil: Small (~2Kg) **Solid Cone:** 62.5mm dia., 60°

Depth (cm)	DCPT Blows	SPT_E N60	Graph (SPT_E N60, CORRECTED) E: Estimated (IS 4968)	Description
2260	Noncore drilling with tri-cone		0	Rocky Stratum
2270				
2280				
2290				
2300				
2310				
2320				
2330				
2340				
2350				
2360				
2370				
2380				
2390				
2400				
2410				
2420				
2430				
2440				
2450				
2460				
2470				
2480				
2490				
2500				
2510				
2520				
2530				
2540				
2550				
2560				
2570				
2580				
2590				
2600				
2610				
2620				
2630				
2640				
2650				
2660				
2670				
2680				
2690				
2700				

Sands (SPT N60, Corrected):
0-4: Very loose, 4-10: Loose, 10-30: Medium dense, 30-50: Dense, >50: Very dense.

Clays (SPT N60, Corrected):
<2: Very soft, 2-4: Soft, 4-8: Firm, 8-15: Stiff, 15-30: Very stiff, >30: Hard.

v. soft to soft & v. loose
soft to firm & loose
firm to stiff & loose to medium

APPENDIX 6. GROUNDWATER MEASUREMENTS INCLUDING DAILY MEASUREMENTS

BISRI DAM - Daily Water Level Measurements / During Execution

BHRA1	DATE	Morning	Evening
	3/27/2014		42.15
	3/28/2014	38.5	41.6
	3/30/2014	39.1	41.17
	3/31/2014	39.3	40.5
	4/2/2014	39	40.8
	4/3/2014	37.2	42.7
	4/4/2014	38.3	44.2
	4/5/2014	39.3	43.2
	4/7/2014	38.2	44.4
	4/8/2014	37.75	43.6
	4/9/2014	38.8	39.6

BISRI DAM & LAKE (PIEZOMETERS)

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)	Depth of groundwater table (m) from the NGL (updated on April 5, 2014)	Depth of groundwater table (m) from the NGL (updated on April 21, 2014)	Depth of groundwater table (m) from the NGL (updated on April 30, 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 (April 5, 2014)	Depth of groundwater table as project level (April 21, 2014)	Depth of groundwater table as project level (April 30, 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	26.5	26.68	26.49	443.16	408.2	417.0	416.7	416.7	416.7	416.5	416.7	417.6	407.4
BDC-3	5	5.75	12.24	12.2	12.05	12.11	12.06	428.353	423.4	422.6	416.1	416.2	416.3	416.2	416.3	421.4	414.5
BDC-4	12	16.8	16.25	16.23	16.32	16.38	16.53	428.585	416.6	411.8	412.3	412.4	412.3	412.2	412.1	423.1	403.1
BDC-5	33	46.28	46.65	44.4	44.53	44.82	44.91	454.435	421.4	408.2	407.8	410.0	409.9	409.6	409.5	408.8	407.8
BDC-6	16	21.6	21.96	21.3	21.7	21.77	21.58	417.86	401.9	396.3	395.9	396.6	396.2	396.1	396.3	396.7	391.5
BDC-7	7.4	8.25	7.54	7	7.24	7.35	7.21	416.33	408.9	408.1	408.8	409.3	409.1	409.0	409.1	409.2	409.1
BDC-8	12.5	17.9	18.25	42.46	42.62	42.33	41.78	440.584	428.1	422.7	422.3	398.1	398.0	398.3	398.8	397.1	397.6
BCD-9	28.6	27.27	26.95	25.93	26.53	26.61	26.42	422.417	393.8	395.1	395.5	396.5	395.9	395.8	396.0	396.1	396.6
BCD-10	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	396.4
BCD-11	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	400.3	401.5
BCD-12	17.57	26.3	17.82	17.2	17.95	17.95	17.82	413.74	396.2	387.4	395.9	396.5	395.8	395.8	395.9	396.4	396.6
BDC-13	15.22	16.4	15.24	No Access	No Access	No Access	No Access	410.7	395.5	394.3	395.5	No Access	No Access	No Access	No Access	394.4	396.5
BDC-14	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	397.7
BDC-15	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged
BDC-16	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	395.7
BDC-17	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	397
BDC-18	2.46	3.1	2.32	1.78	2.28	2.41	2.33	398.35	395.9	395.3	396.0	396.6	396.1	395.9	396.0	396.6	396.3
BDC-19	13	2.7	8.6	Damaged	Damaged	Damaged	Damaged	399.13	386.1	396.4	390.5	Damaged	Damaged	Damaged	Damaged	391.8	392.4
BDC-20	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	398.6
BDC-21	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	406.1
BDC-22	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	405.2	404.9
BDC-23	9.67	8.9	9.42	Damaged	Damaged	Damaged	Damaged	414.46	404.8	405.6	405.0	Damaged	Damaged	Damaged	Damaged	405.9	405.0
BDC-24	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	406.4	405.1
BDC-25	74.1	74.75	74.22	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	364.1	364.6
BDC-26	74.67	75.23	74.82	73.1	72.58	72.86	73.09	437.8	363.1	362.6	363.0	364.7	365.2	364.9	364.7		365.3
BDC-27	51.5	51.22	51.1	51.83	44.85	46.77	48.52	433.202	381.7	382.0	382.1	381.4	388.4	386.4	384.7	>358.4	387.9
BDC-28	35.8	36.3	36.9	36.6	34.6	34.23	35.18	439.6	403.8	403.3	402.7	403.0	405.0	405.4	404.4	386.4	404.5
BDC-29	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	398.2	406
BDC-30	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	>344.4	
BDC-31	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	>366.9	
BDC-32	60.15	60.85	59.63	59.25	59.3	59.81	59.44	490.22	430.1	429.4	430.6	431.0	430.9	430.4	430.8	>370.2	
BDC-38	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	408.7	404.8
BDC-42A	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	414	
BDC43	28.22	28.1	28.36	Damaged	Damaged	Damaged	Damaged	435.71	407.5	407.6	407.4	Damaged	Damaged	Damaged	Damaged	408.6	
BDC-50	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged
BDC-57	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged		Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged
BDB-1	19.2	26.8	20.18	Damaged	Damaged	Damaged	Damaged	416.32	397.1	389.5	396.1	Damaged	Damaged	Damaged	Damaged		
EV2		4.6	5.3	4.05	3.55	3.96	3.18	401.7		397.1	396.4	397.65	398.15	397.74	398.52		
EV3		Artesian flow	Artesian flow	Artesian flow	Artesian flow	Artesian flow	Artesian flow	398.29		Artesian flow	Artesian flow	Artesian flow	Artesian flow	Artesian flow	Artesian flow		
EV7		Artesian flow	Artesian flow	Artesian flow	Artesian flow	Artesian flow	Artesian flow	396		Artesian flow	Artesian flow	Artesian flow	Artesian flow	Artesian flow	Artesian flow		
EV10		20.35	21.35	15.8	20.2	20.34	20.27	420.2		399.85	398.85	404.4	400	399.86	399.93		
VF2		6.4	6.1	7.2	6.48	6.51	6.69	414.92		408.52	408.82	407.72	408.44	408.41	408.23		
VF3		5.3	5.65	6	5.49	5.63	5.72	414.45		409.15	408.8	408.45	408.96	408.82	408.73		
VF4		5.9	6.83	6	5.78	5.89	5.89	419.19		413.29	412.36	413.19	413.41	413.3	413.3		
BHVL1			0.4	0.4	0.68	0.75	0.71	396.57			396.17	396.17	395.89	395.82	395.86		
BHLA1			35	35	35.6	35.7	35.8	431.5			396.5	396.5	395.9	395.8	395.7		
BHLA2				54.12	54.6	54.9	55.15	459.4				405.28	404.8	404.5	404.25		
BHVR3				7.98	8.35	8.17	8.7	413.8				405.82	405.45	405.63	405.1		
BHVR5				8.27	8.98	9.23	9.85	414.37				406.1	405.39	405.14	404.52		
BHRA3					24.16	24.55	25	430.25					406.09	405.7	405.25		
BHRA1						37.76	38.5	441.98						404.22	403.48		

APPENDIX 7. LIST OF SAMPLING & LABORATORY TESTING (FIRST PACKAGE)

Bisri Dam Laboratory Testing - First Package

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

Sampling					Testing																				
					Soil											Rock									
No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Unit (U)	Moisture Content	Void Ratio	Sieve	Hydrometer	UCS	Triaxial (CU+U)	Triaxial (CD)	Consolidation	Atterberg	Organic Content	Bulk and Saturated Density	Uni-axial CS	PLI	Water Absorption	Unit Weight	Soundness	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
						15	15	15	12	0	0	0	0	15	5	15	0	0	0	0	0	0	0	8	100
BHVR3	3	SPT	Mainly CLAY	April 2, 2014		1	1	1	1					1	1	1								1	
	4.5					1	1	1	1					1		1									
	6		Mainly Fine SAND			1	1	1						1		1								1	
	7.5		SILT and CLAY			1	1	1	1					1		1									
	9					1	1	1	1					1		1								1	
	10.5		Mainly Fine SAND			1	1	1						1		1									
	13.5		SILT and CLAY			1	1	1	1					1		1								1	
	16.5		Mainly CLAY			1	1	1	1					1		1									
	21					1	1	1	1					1	1	1								1	
	24		Silty fine SAND			1	1	1						1		1									
	27		SILT and CLAY			1	1	1	1					1		1								1	
	30		Mainly CLAY			1	1	1	1					1	1	1									
	34.5					1	1	1	1					1	1	1								1	
	39					1	1	1	1					1	1	1									
	42		SILT and CLAY			1	1	1	1					1		1								1	

Bisri Dam Laboratory Testing - First Package

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

Sampling					Testing																			
					Soil											Rock								
No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Unit (U)	Moisture Content	Void Ratio	Sieve	Hydrometer	UCS	Triaxial (CU+U)	Triaxial (CD)	Consolidation	Atterberg	Organic Content	Bulk and Saturated Density	Uni-axial CS	PLI	Water Absorption	Unit Weight	Soundness	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
						13	13	13	13	0	0	0	0	13	2	13	0	0	0	0	0	0	0	7	87
BHVL1	5	SPT	Silty SAND	April 2, 2014		1	1	1	1					1		1								1	
	9		Clayey Silty SAND			1	1	1	1					1		1									
	13.5		Silty SAND			1	1	1	1					1		1								1	
	16.5		Mainly CLAY			1	1	1	1					1		1									
	21					1	1	1	1					1	1	1								1	
	25.5					1	1	1	1					1	1	1									
	33		Silty CLAY			1	1	1	1					1		1								1	
	38.8-39	Core				1	1	1	1					1		1									
	45	SPT				1	1	1	1					1		1								1	
	51					1	1	1	1					1		1									
	57					1	1	1	1					1		1								1	
	64.5					1	1	1	1					1		1									
	66					1	1	1	1					1		1								1	

Bisri Dam Laboratory Testing - First Package

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

Sampling						Testing																				
						Soil											Rock									
No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Unit (U)	Moisture Content	Void Ratio	Sieve	Hydrometer	UCS	Triaxial (CU+U)	Triaxial (CD)	Consolidation	Atterberg	Organic content	Bulk and Saturated Density	Uni-axial CS	PLI	Water Absorption	Unit Weight	Soundness	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
						5	5	5	5	0	0	0	0	5	1	5	0	0	0	0	0	0	0	5	36
BHVR5	3	SPT	Mainly CLAY	April 2, 2014		1	1	1	1					1		1								1	
	5.5-6	Core	SILT and CLAY			1	1	1	1					1		1								1	
	9	SPT	Mainly CLAY			1	1	1	1					1	1	1								1	
	13.5		Mainly SILT			1	1	1	1					1		1								1	
	16-16.5	Core	Mainly SILT			1	1	1	1					1		1								1	

Bisri Dam Laboratory Testing - First Package

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

Sampling					Unit (U)	Testing																			
						Soil										Rock									
No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling		0	0	0	0	0	0	0	0	0	0	0	3	1	4	4	3	1	1	4	21
						Moisture Content	Void Ratio	Sieve	Hydrometer	UCS	Triaxial (CU+U)	Triaxial (CD)	Consolidation	Atterberg	Organic Content	Bulk and Saturated Density	Uni-axial CS	PLI	Water Absorption	Unit Weight	Soundness	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
BHLA1	42-42.2	Core	Beige sandy LIMESTONE	April 2, 2014													1		1	1	1			1	
	56-56.2																1		1	1	1			1	
	83.7-83.9		Grey LIMESTONE														1		1	1	1			1	
	100.8-101		Chocolate calcareous MARLSTONE															1	1	1		1	1	1	

Bisri Dam Laboratory Testing - First Package

DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

Sampling					Testing																				
					Soil											Rock									
No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Unit (U)	Moisture Content	Void Ratio	Sieve	Hydrometer	UCS	Triaxial (CU+U)	Triaxial (CD)	Consolidation	Atterberg	Organic Content	Bulk and Saturated Density	Uni-axial CS	PLI	Water Absorption	Unit Weight	Soundness	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
						0	0	0	0	0	0	0	0	0	0	0	2	2	3	3	1	2	1	3	17
BHLA2	19.3-19.5	Core	Beige SANDSTONE	April 2, 2014													1	1	1	1		1		1	
	75-75.15		Grey sandy calcareous MARLSTONE															1	1	1		1	1	1	
	100.5-100.8		Grey oolitic LIMESTONE														1		1	1	1			1	

Total of 261 tests.

APPENDIX 8. LABORATORY TEST RESULTS (FIRST PACKAGE)

ASSACO S.A.R.L

أساكو ش.م.م.

ENGINEER BILAL ASSAAD MELHEM ASSAAD & Co.

المهندس بلال اسعد ملحم اسعد وشركاه

DESIGN & SUPERVISION - GEOTECHNICAL CONSULTANCY - MATERIALS TESTING

دروس واشراف - إستشارات جيوتقنية - فحص مواد

M/S DAR AL HANDASA NAZIH TALEB & PARTNERS

BISRI DAM / DAM FOOTPRINT
LABORATORY TESTINGS

BOREHOLES: BHVL1 – BHVR3 – BHVR5
BHLA1 – BHLA2

MAY 2014

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بولفار بشارة الخوري - بناية الوزان - الطابق الأول - تلفون: ٦٣١٨٨٢ - ٦٤٦٩٣٠ (٩٦١ - ١)
فاكس: ٦٤٦٩٣١ (٩٦١ - ١) - مختبر: ٠١/٣٨١١١٩ - E-mail:assaco@terra.net.lb
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ASSACO

Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 08/05/14

TEST DATA SUMMARY - ASTM Designations D422, D2140, D2216, D2974, D4318, D4972 - BS812_parts117&118

Sample I.D	Depth	BS	Grain Size distribution					Atterberg limits		Moist. cont.	Bulk dens.	Saturated dens.	Void ratio	Organic content	SO_4^{--} cont.	CL^- cont.	PH
		soil	Gravel	Sand	Fines	Silt	Clay	LL	PL								
	m	classif.	%	%	%	%	%	%	%	%	g/cm^3	g/cm^3		%	ppm	ppm	
BHVL1	5.00	SM	0	78	22	15	7	21	5	20	1.69	1.71	0.420	-	43	86	7.60
	9.00	SM	0	73	27	16	11	21	4	30	1.71	1.72	0.435	-	-	-	-
	13.50	SM	0	56	44	35	9	25	3	32	1.72	1.73	0.451	-	41	83	7.58
	16.50	CH	0	14	86	21	65	64	39	33	1.96	2.01	0.596	-	-	-	-
	21.00	CH	0	7	93	24	69	67	32	33	1.95	2.02	0.627	5.6	31	69	7.78
	25.50	CH	0	0	100	32	68	54	26	34	1.92	1.98	0.630	6.7	-	-	-
	33.00	CH	0	1	99	40	59	51	33	42	1.96	2.04	0.622	-	33	71	7.70
	38.80-39.00	CH	0	0	100	41	59	52	32	40	1.86	1.93	0.631	-	-	-	-
	45.00	CH	0	0	100	42	58	56	36	36	1.89	1.96	0.628	-	34	68	7.71
	51.00	CH	0	0	100	33	67	54	35	37	1.83	1.87	0.594	-	-	-	-
	57.00	CH	0	0	100	35	65	57	34	39	1.85	1.94	0.607	-	31	63	7.68
	64.50	CH	0	0	100	38	62	56	35	40	1.83	1.93	0.618	-	-	-	-
	66.00	CH	0	3	97	36	61	57	34	37	1.89	1.96	0.621	-	32	64	7.70

Head of laboratory section

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Material Testing - Geotechnical Study

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ASSACO

Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 08/05/14

TEST DATA SUMMARY - ASTM Designations D422, D2140, D2216, D2974, D4318, D4972 - BS812_parts117&118

Sample I.D	Depth m		BS soil classif.	Grain Size distribution					Atterberg limits		Moist. cont. %	Bulk dens. g/cm^3	Saturated dens. g/cm^3	Void ratio	Organic content %	SO_4^{--} cont. ppm	CL^- cont. ppm	PH
				Gravel %	Sand %	Fines %	Silt %	Clay %	LL %	PL %								
BHVR3	3.00		CL	0	34	66	45	21	28	19	18	1.97	2.01	0.638	1.9	34	59	7.69
	4.50		CI	0	7	93	50	43	40	22	16	2.04	2.26	0.551	-	-	-	-
	6.00		SM	0	59	41	-	-	0	0	14	1.82	1.90	0.436	-	41	78	7.53
	7.50		ML	0	9	91	54	37	35	33	31	1.99	2.03	0.602	-	-	-	-
	9.00		CL	0	11	89	53	36	32	20	32	1.93	1.98	0.613	-	35	64	7.65
	10.50		SM	0	68	32	-	-	0	0	16	1.76	1.76	0.434	-	-	-	-
	13.50		ML	0	1	99	70	29	25	10	29	1.96	2.03	0.587	-	38	81	7.72
	16.50		CH	0	1	99	35	64	62	30	43	1.86	1.97	0.618	-	-	-	-
	21.00		CH	0	1	99	41	58	55	30	39	1.85	2.01	0.626	6.9	32	63	7.73
	24.00		SC	0	77	23	-	-	24	9	27	1.70	1.75	0.410	-	-	-	-
	27.00		FS	0	43	57	36	21	29	15	32	1.75	1.79	0.450	-	31	84	7.69
	30.00		CH/MH	0	1	99	49	50	51	28	33	1.91	1.98	0.616	5.4	-	-	-
	34.50		CH	0	0	100	36	64	54	29	32	2.00	2.06	0.583	4.7	33	65	7.68
	39.00		CH	0	0	100	38	62	51	27	34	1.92	1.99	0.624	6.2	-	-	-
	42.00		MH	0	0	100	37	63	53	31	41	1.86	1.97	0.592	-	41	86	7.59

Head of laboratory section

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Material Testing - Geotechnical Study

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Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 08/05/14

TEST DATA SUMMARY - ASTM Designations D422, D2140, D2216, D2974, D4318, D4972 - BS812_parts117&118

Sample I.D	Depth m		BS soil classif.	Grain Size distribution					Atterberg limits		Moist. cont. %	Bulk dens. g/cm^3	Saturated dens. g/cm^3	Void ratio	Organic content %	SO_4^{--} cont. ppm	CL^- cont. ppm	PH
				Gravel %	Sand %	Fines %	Silt %	Clay %	LL %	PL %								
BHVR5	3.00		CI	0	6	94	55	39	39	22	18	2.09	2.12	0.541	-	32	79	7.69
	5.50-6.00		ML	0	28	72	49	23	34	17	23	2.01	2.05	0.543	-	39	87	7.80
	9.00		MI	0	2	98	61	37	43	24	33	1.90	1.96	0.605	4.9	30	73	7.54
	13.50		MI	0	9	91	53	38	39	27	43	1.82	1.87	0.586	-	43	89	7.86
	16.50		ML	0	15	85	56	29	33	28	43	1.87	1.95	0.574	-	45	86	7.75

Head of laboratory section

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Material Testing - Geotechnical Study

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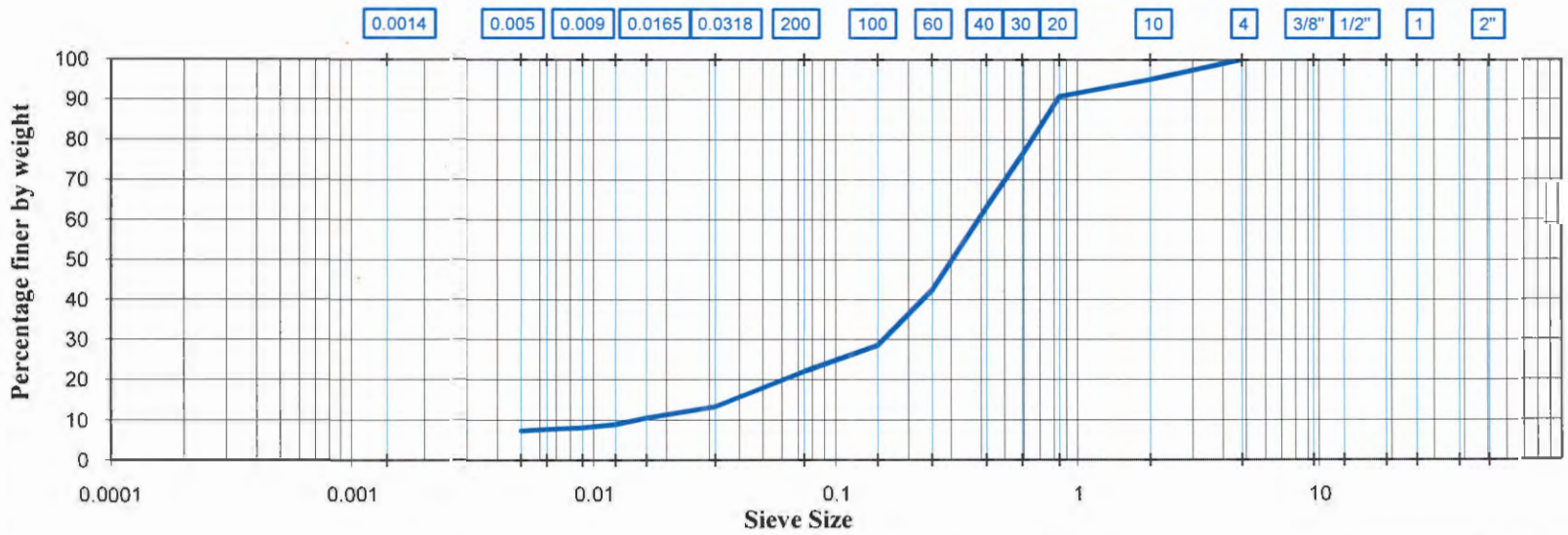
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	SAND			GRAVEL		Cobbles
		Fine	Medium	Coarse	Fine	Coarse	

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	5.00	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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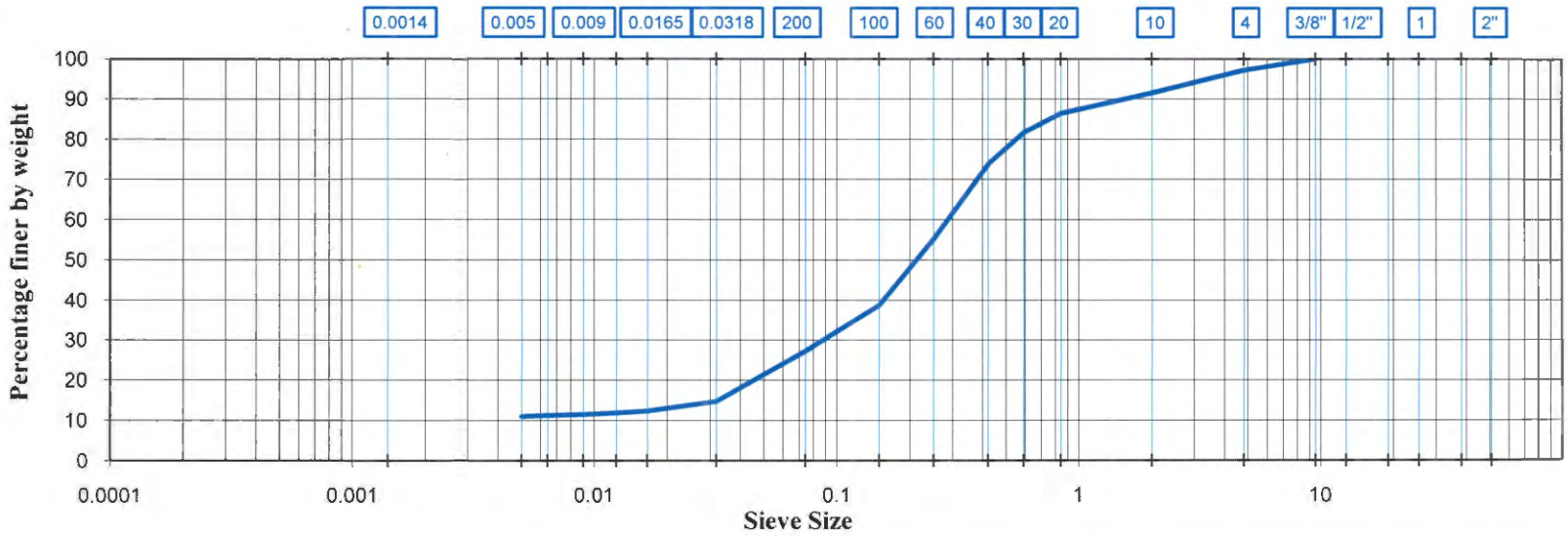

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	9.00	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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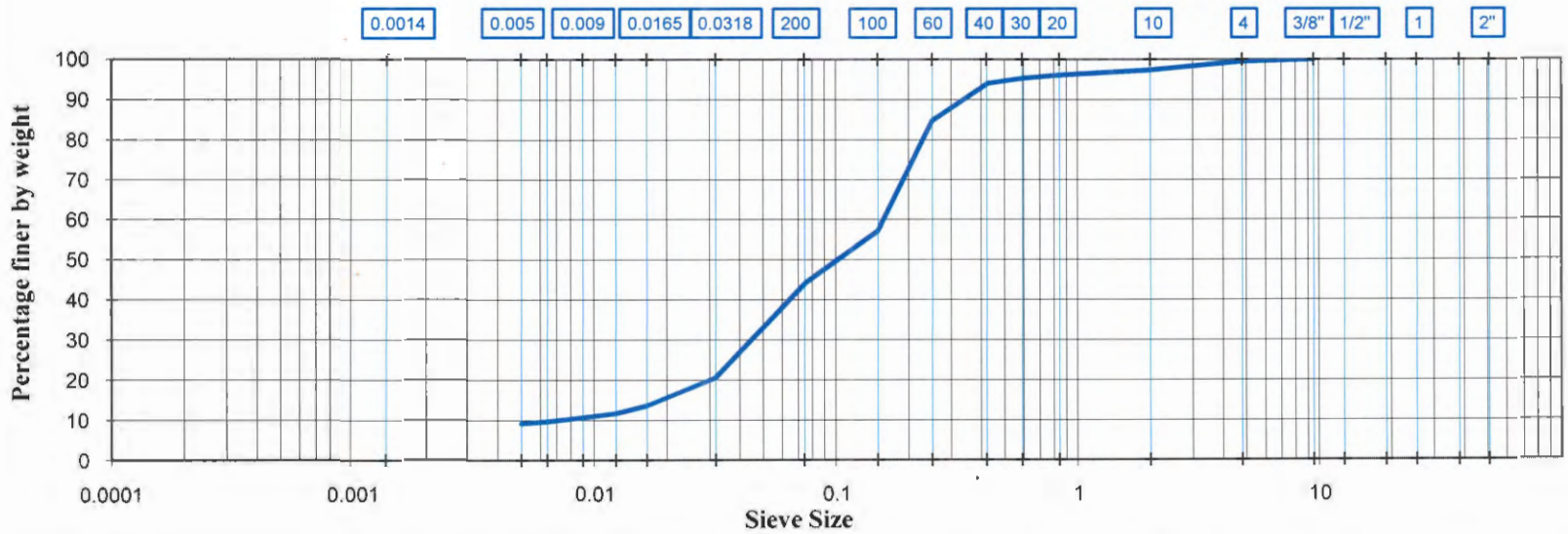

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	13.50	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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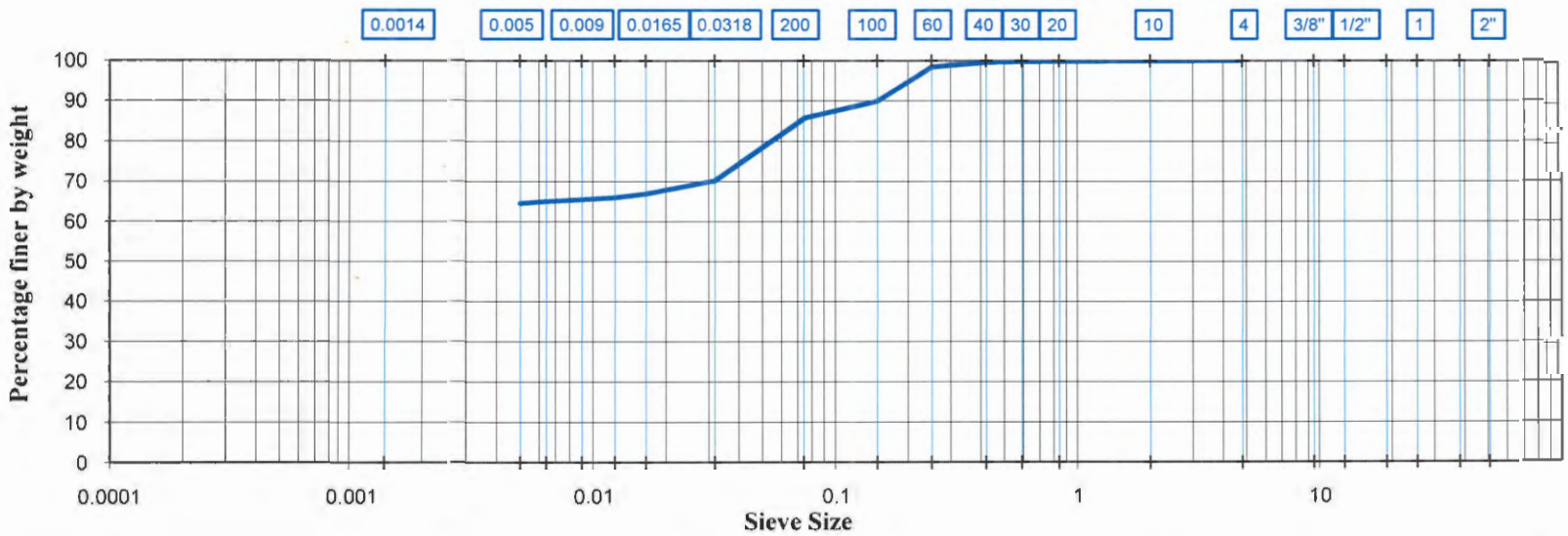

CLAY	SILT	SAND			GRAVEL		Cobbles
		Fine	Medium	Coarse	Fine	Coarse	

Sample I.D	-		Client : M/S Dar Al Handasa Nazib Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	16.50	Location : Dam Footprint		

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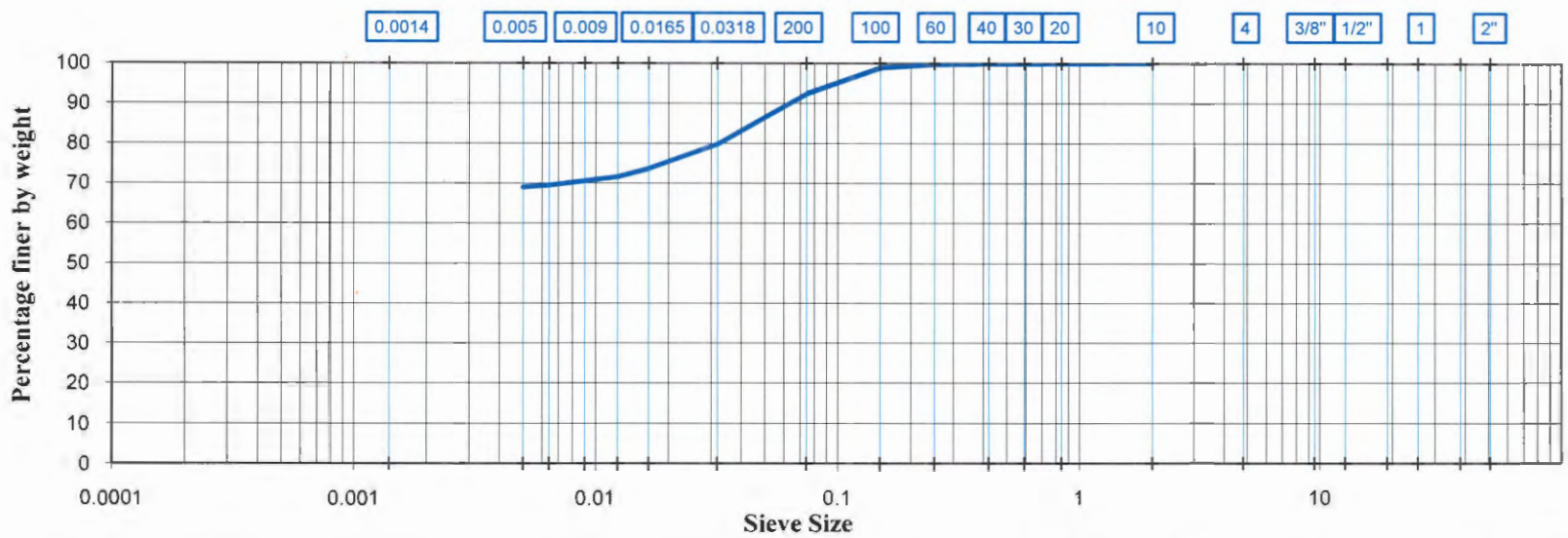
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	21.00	Location : Dam Footprint		

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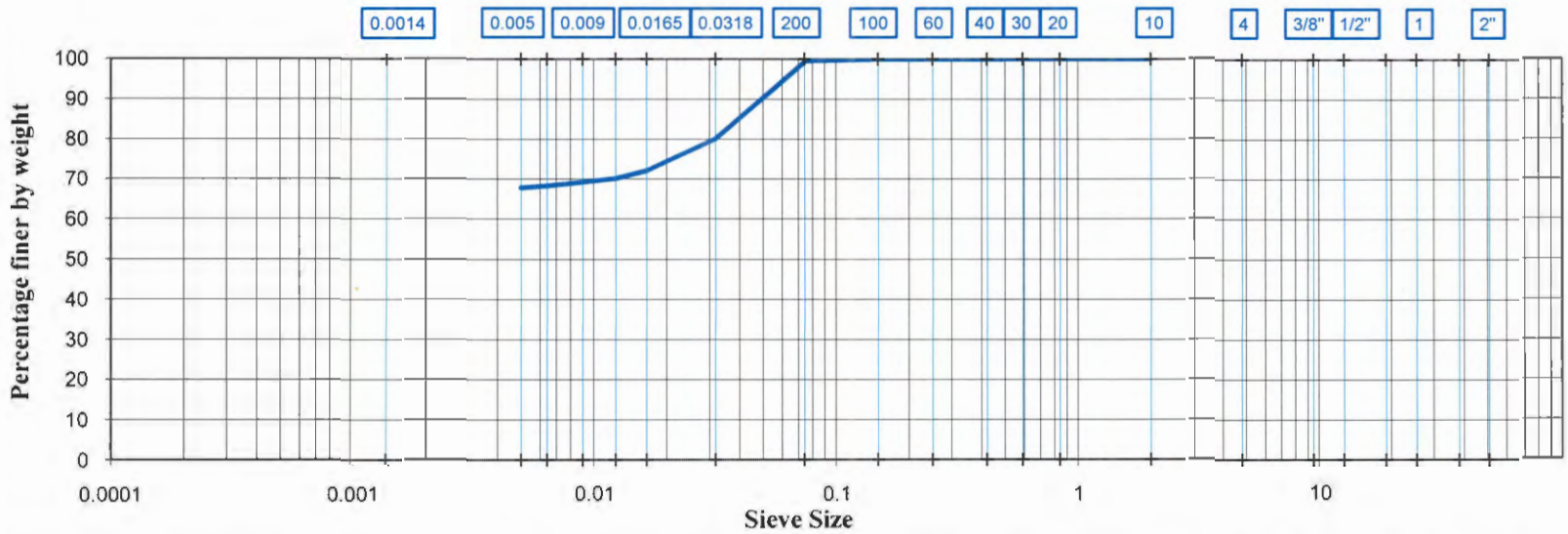
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	25.50	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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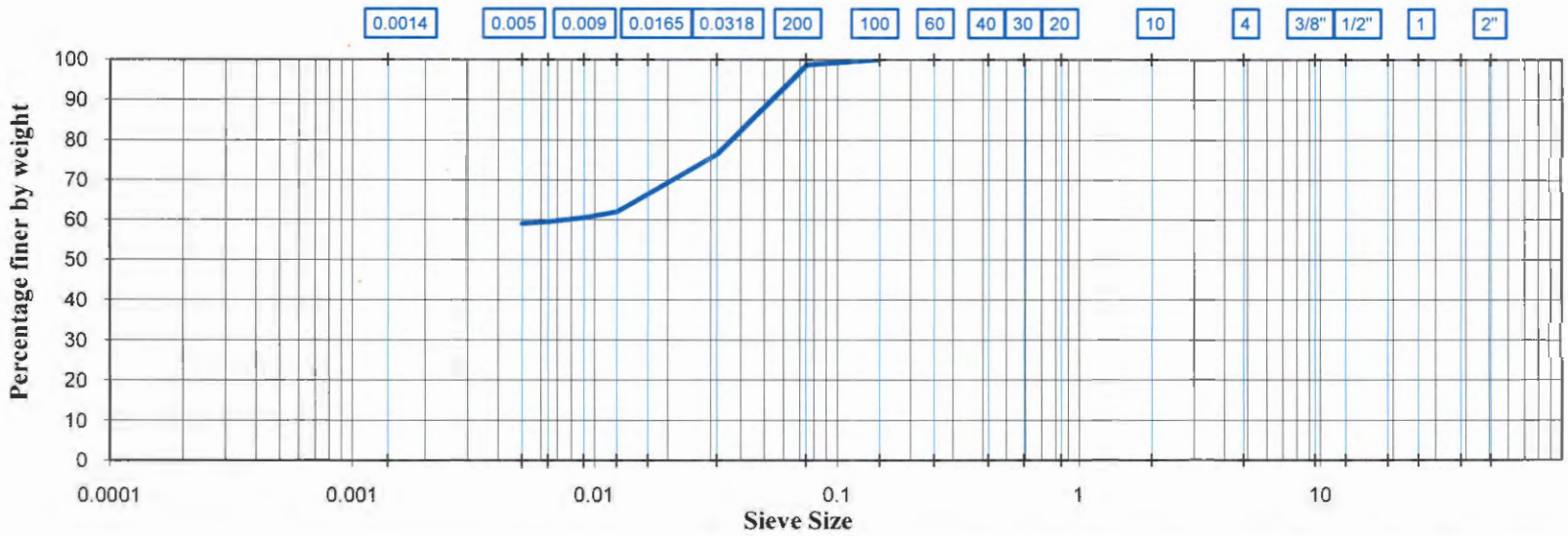

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	33.00	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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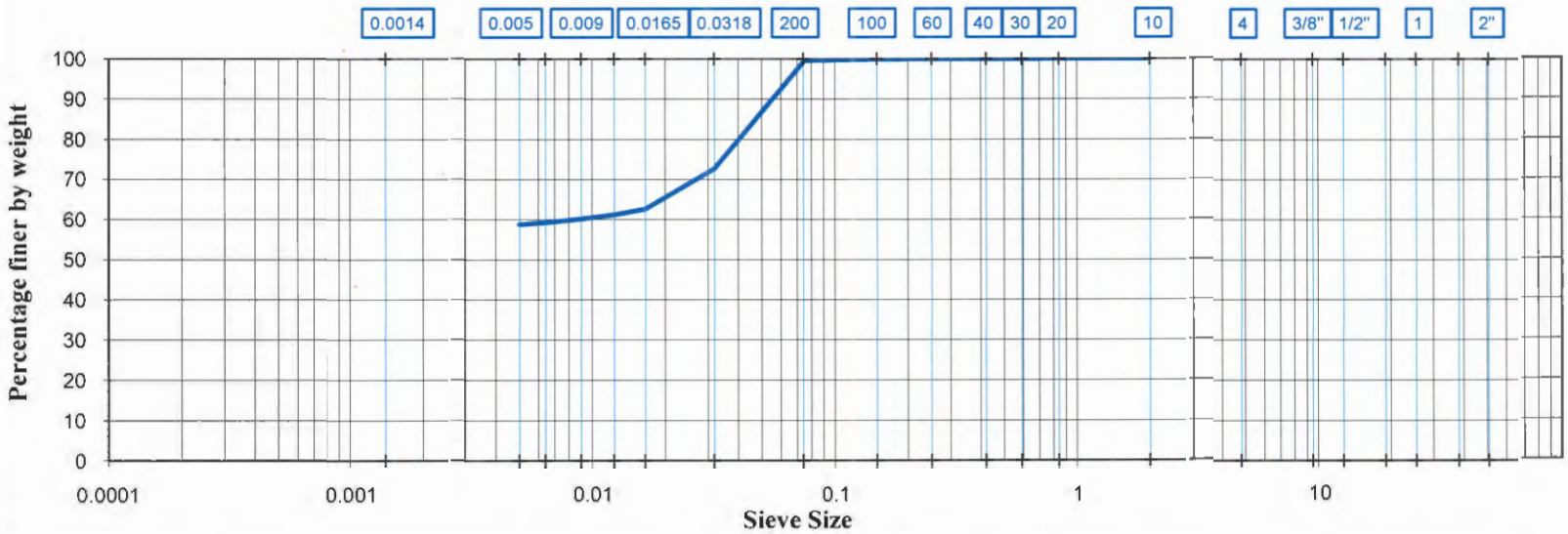

CLAY	SILT	SAND			GRAVEL		Cobbles
		Fine	Medium	Coarse	Fine	Coarse	

Sample I.D	-		Client : M/S Dar Al Handasa Nazib Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	38.80-39.00	Location : Dam Footprint		

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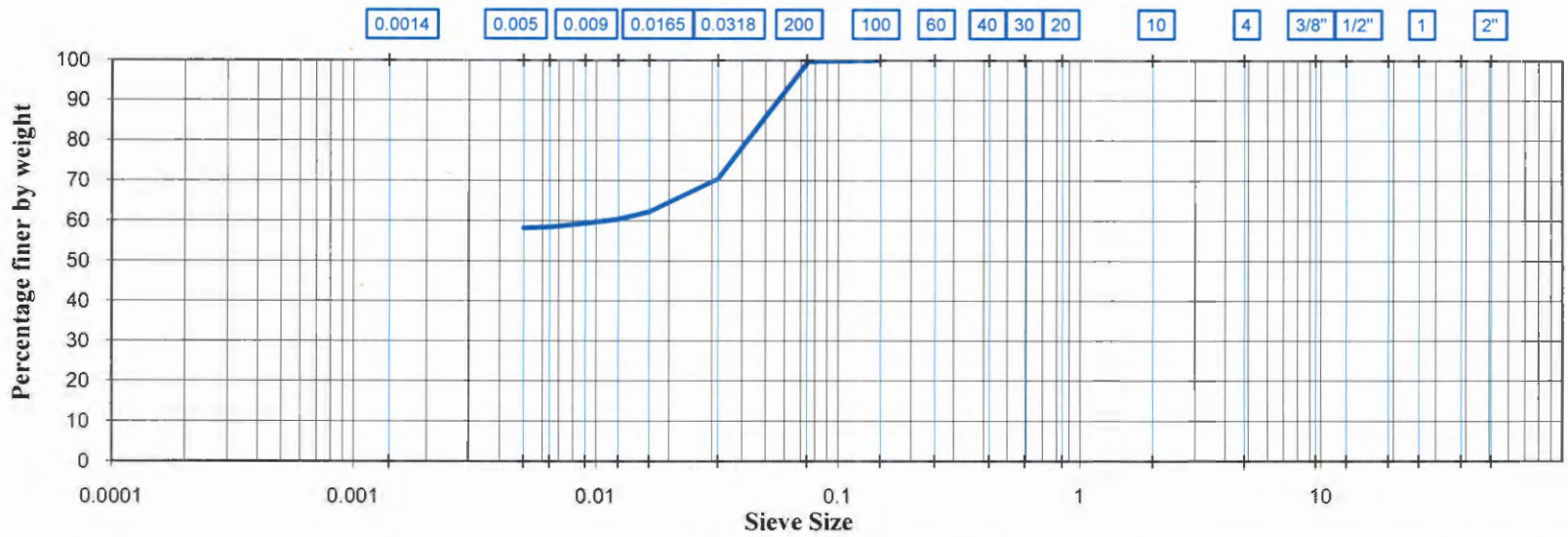

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazib Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	45.00	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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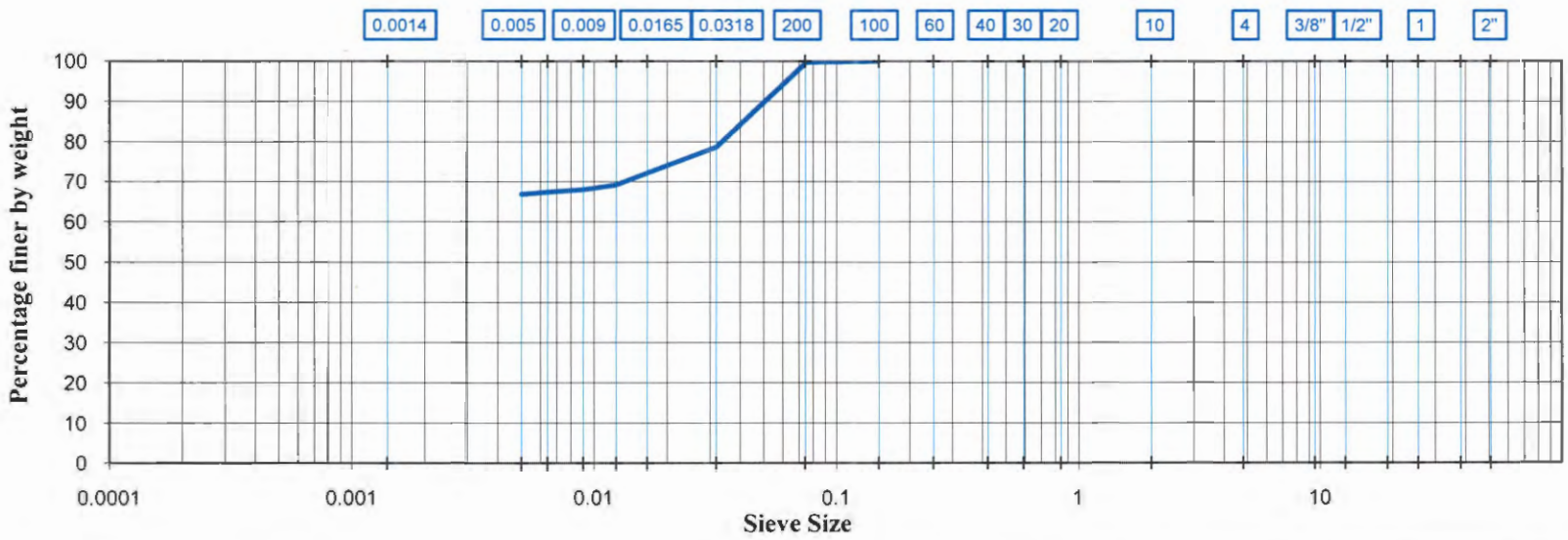

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	51.00	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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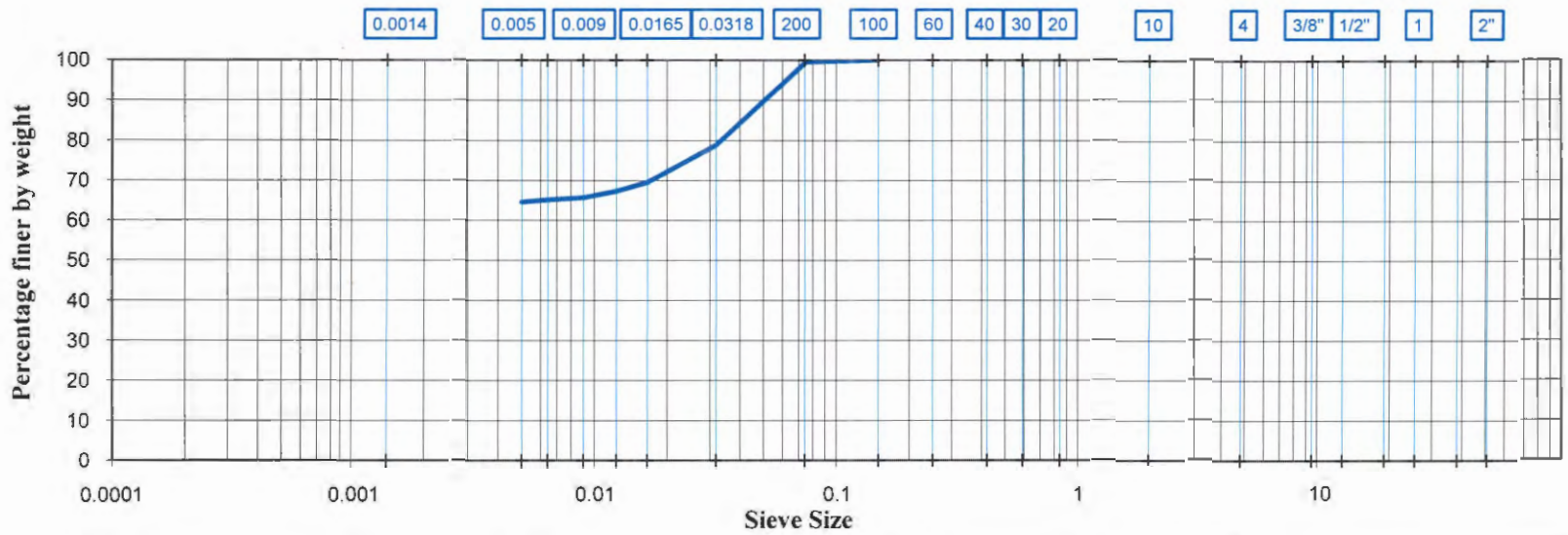

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	57.00	Location : Dam Footprint		

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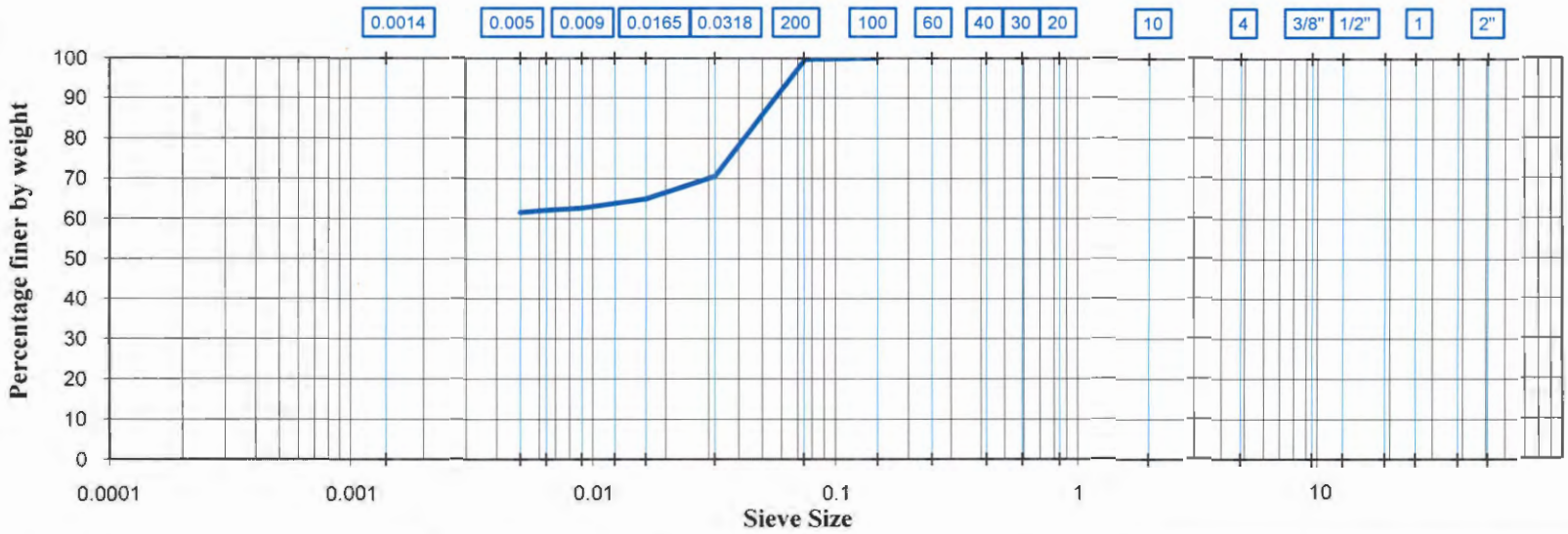

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	64.50	Location : Dam Footprint		

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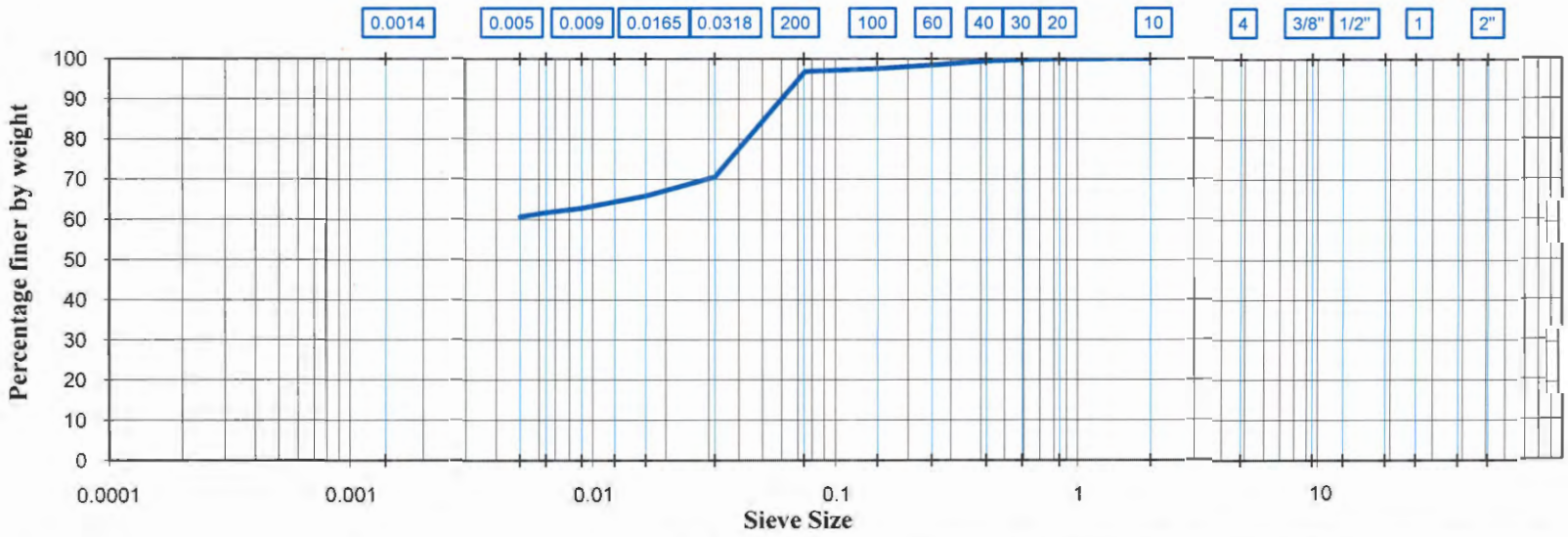

CLAY	SILT	SAND			GRAVEL		Cobbles
		Fine	Medium	Coarse	Fine	Coarse	

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVL1	-	66.00	Location : Dam Footprint		

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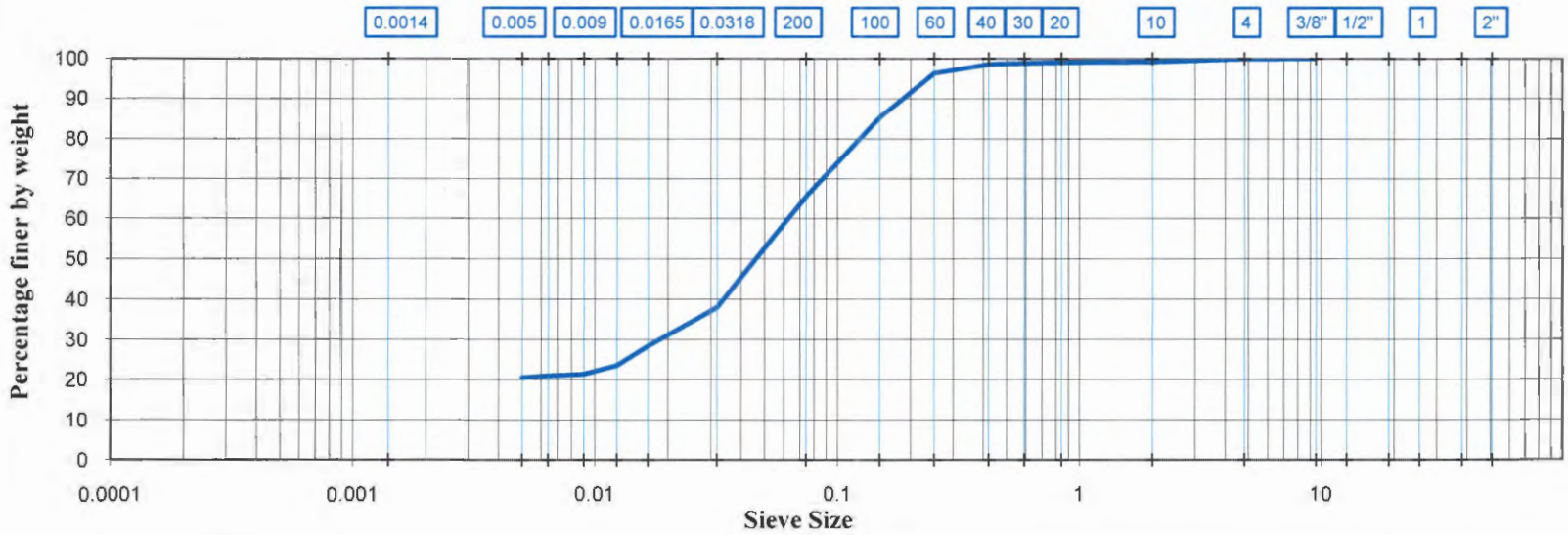

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	3.00	Location : Dam Footprint		

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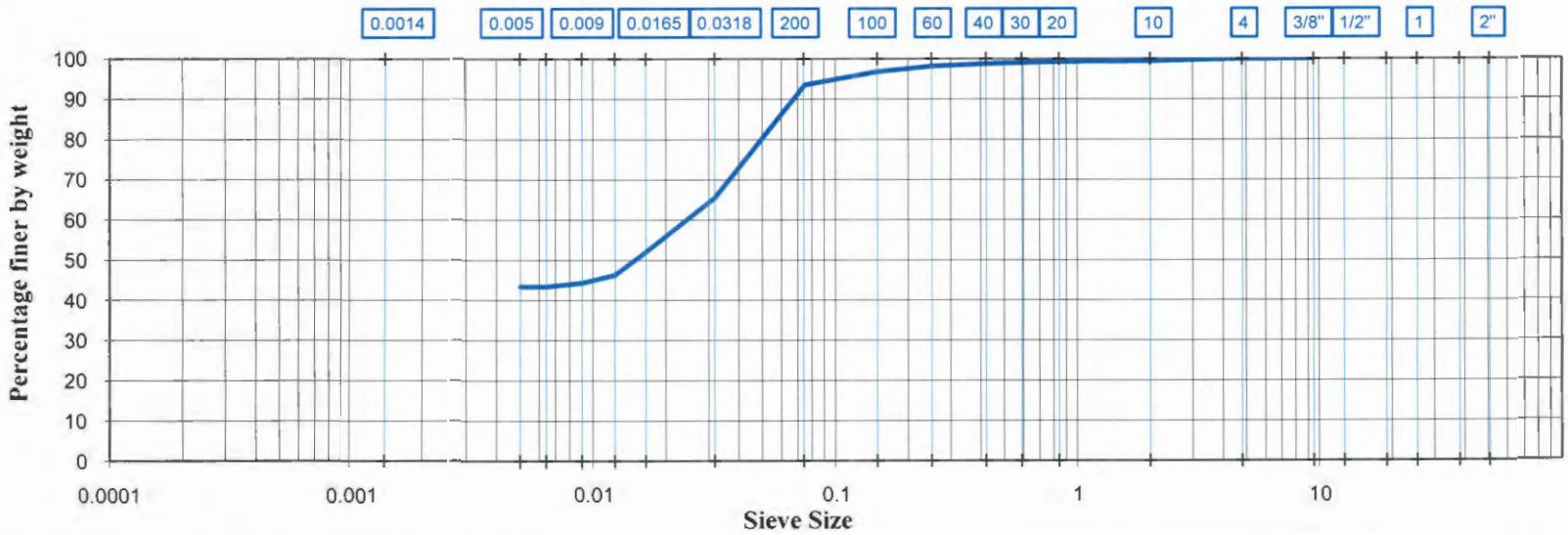

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	4.50	Location : Dam Footprint		

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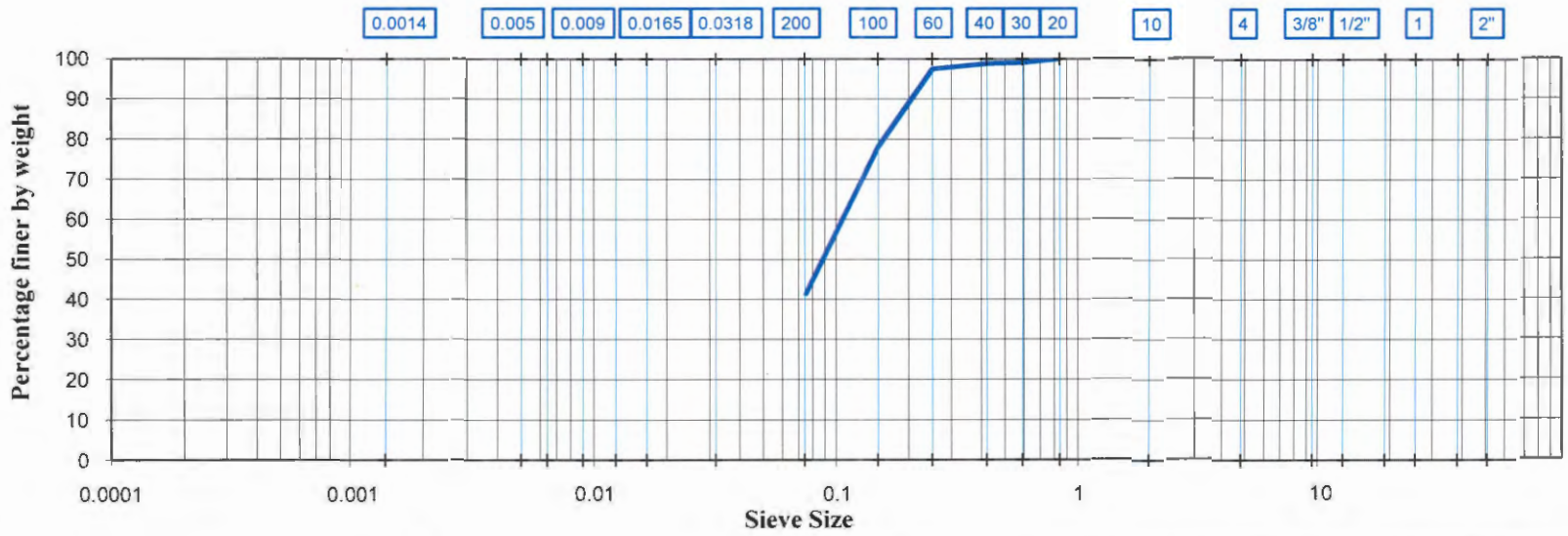

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	6.00	Location : Dam Footprint		

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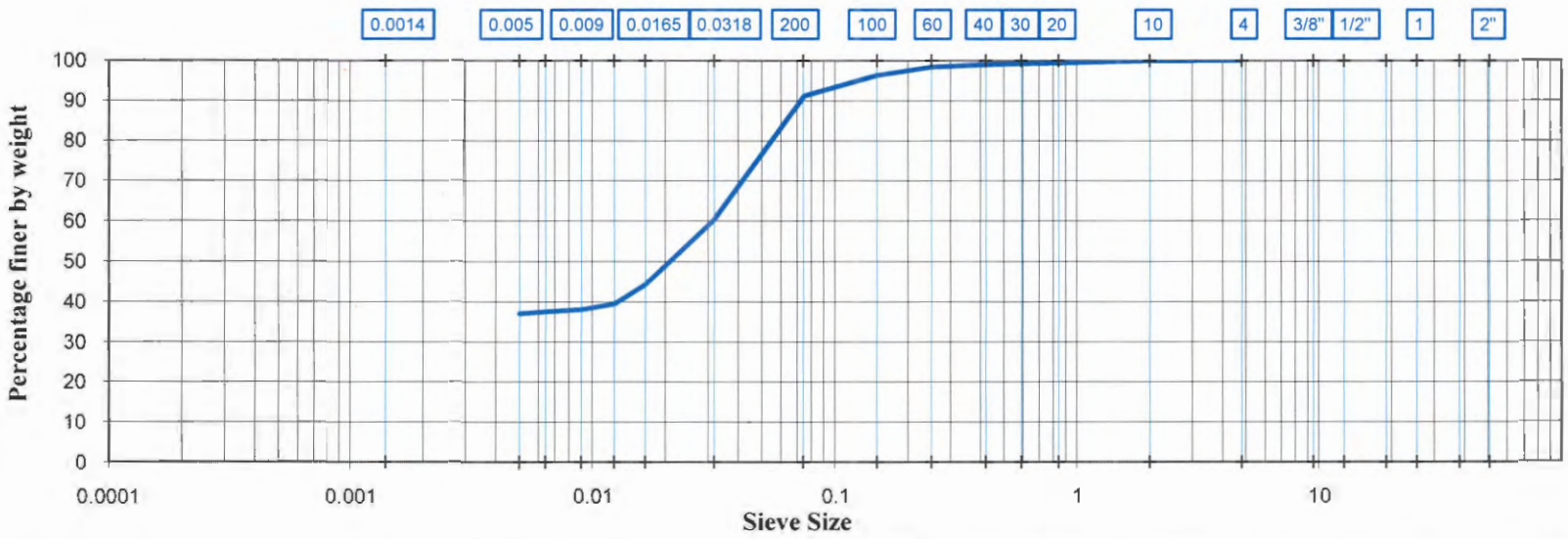

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	7.50	Location : Dam Footprint		

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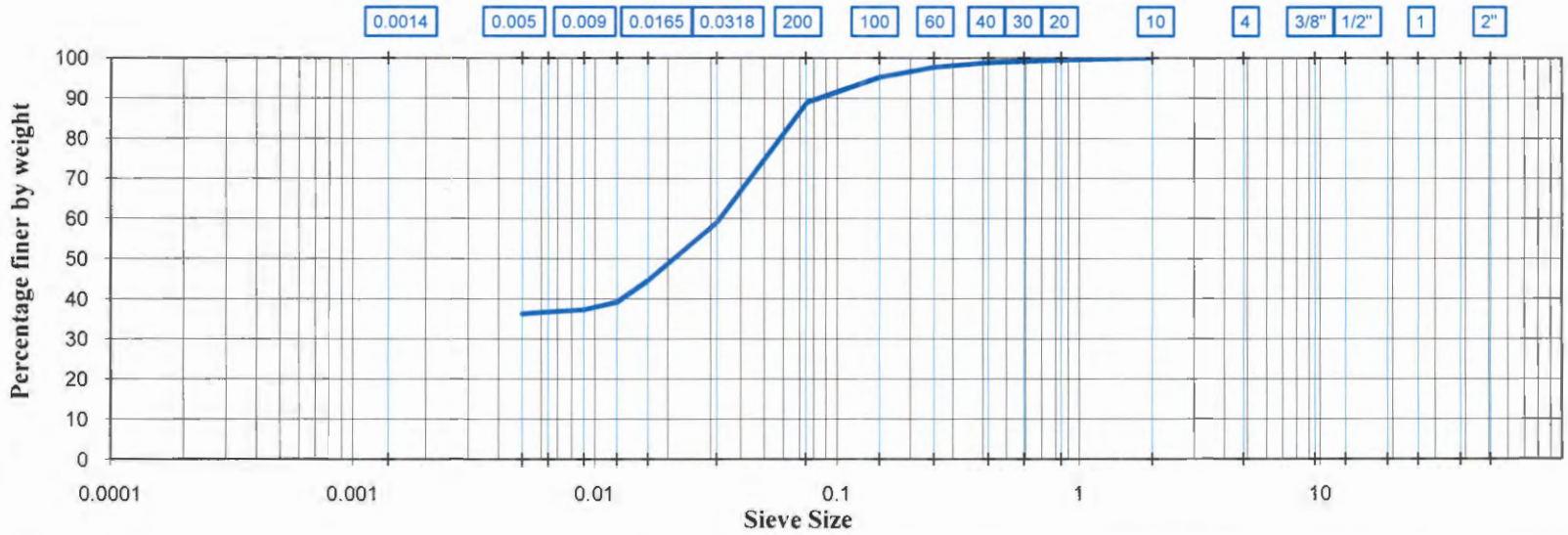

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	9.00	Location : Dam Footprint		

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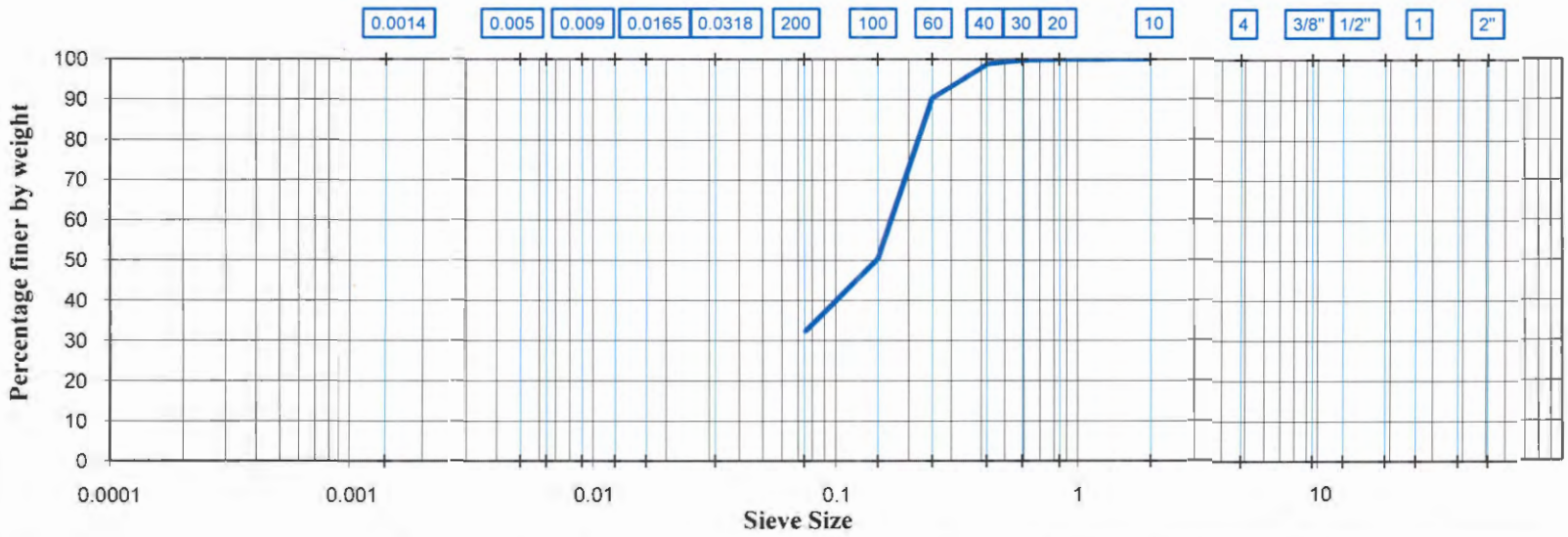
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	10.50	Location : Dam Footprint		

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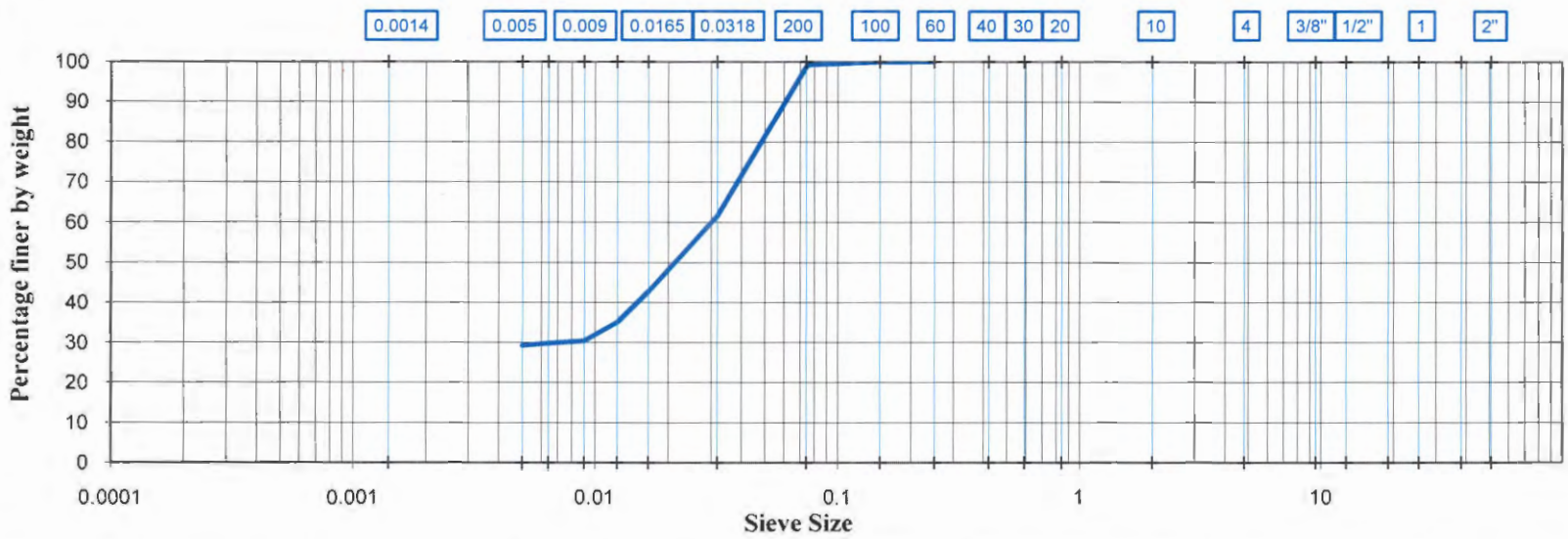

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	13.50	Location : Dam Footprint		

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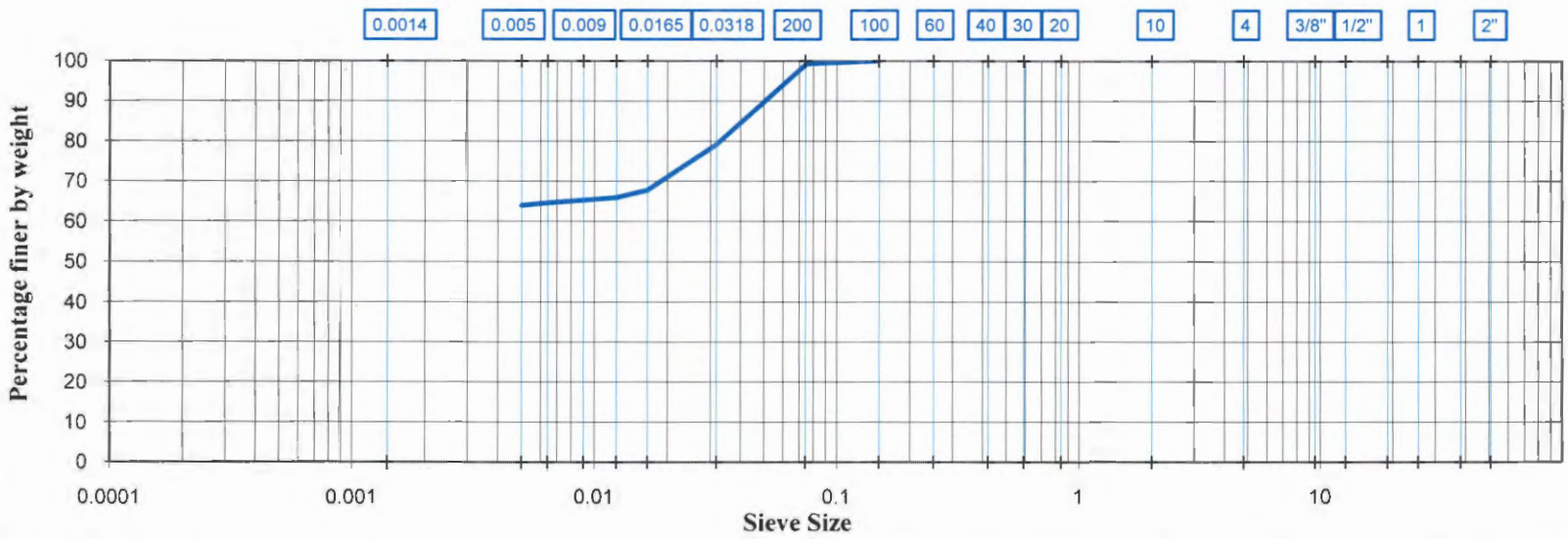

CLAY	SILT	SAND			GRAVEL		Cobbles
		Fine	Medium	Coarse	Fine	Coarse	

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	16.50	Location : Dam Footprint		

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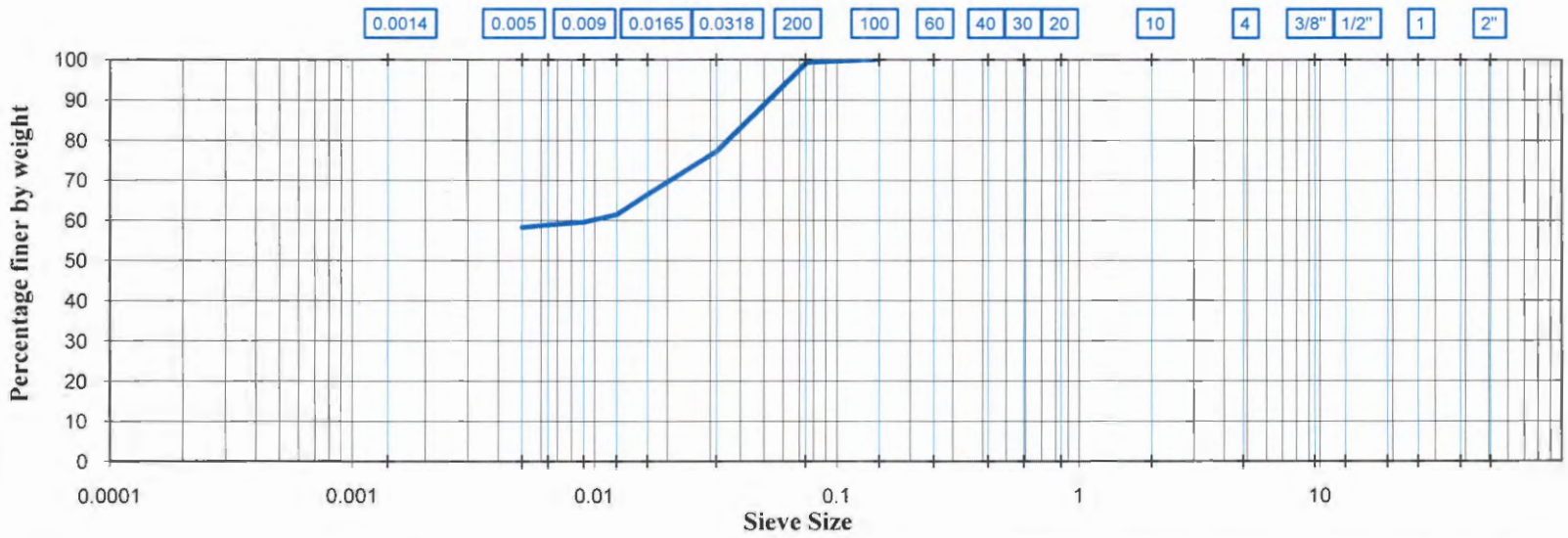

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	21.00	Location : Dam Footprint		

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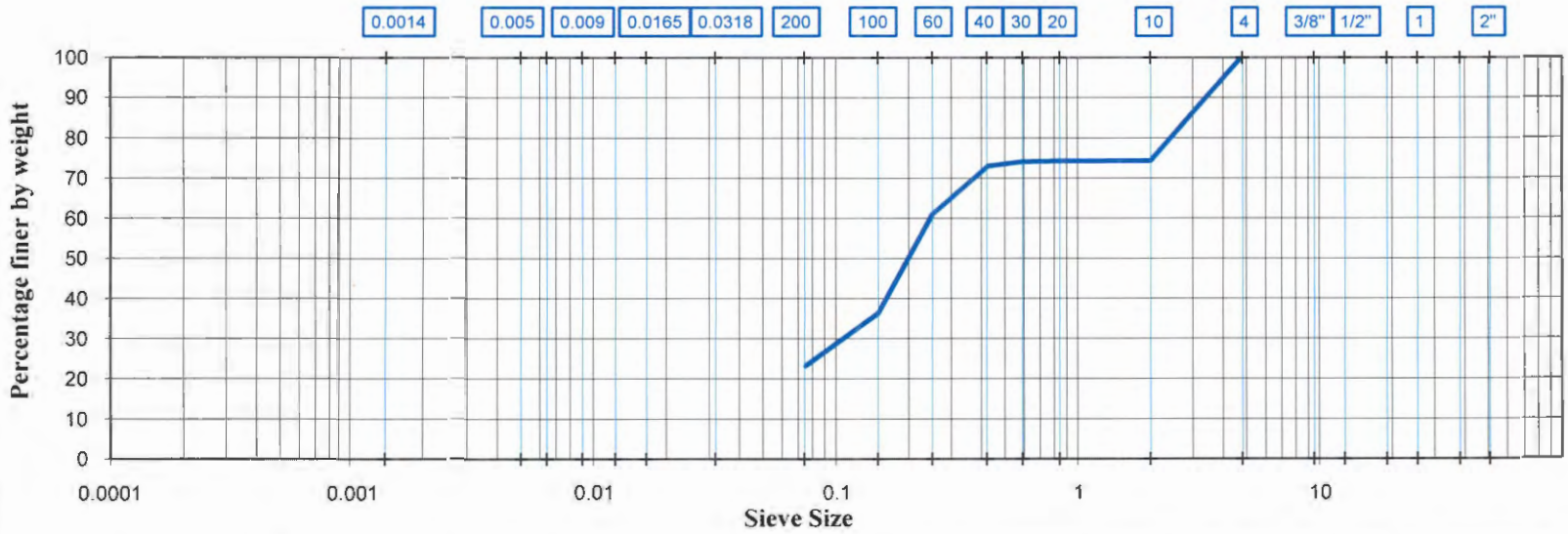

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	24.00	Location : Dam Footprint		

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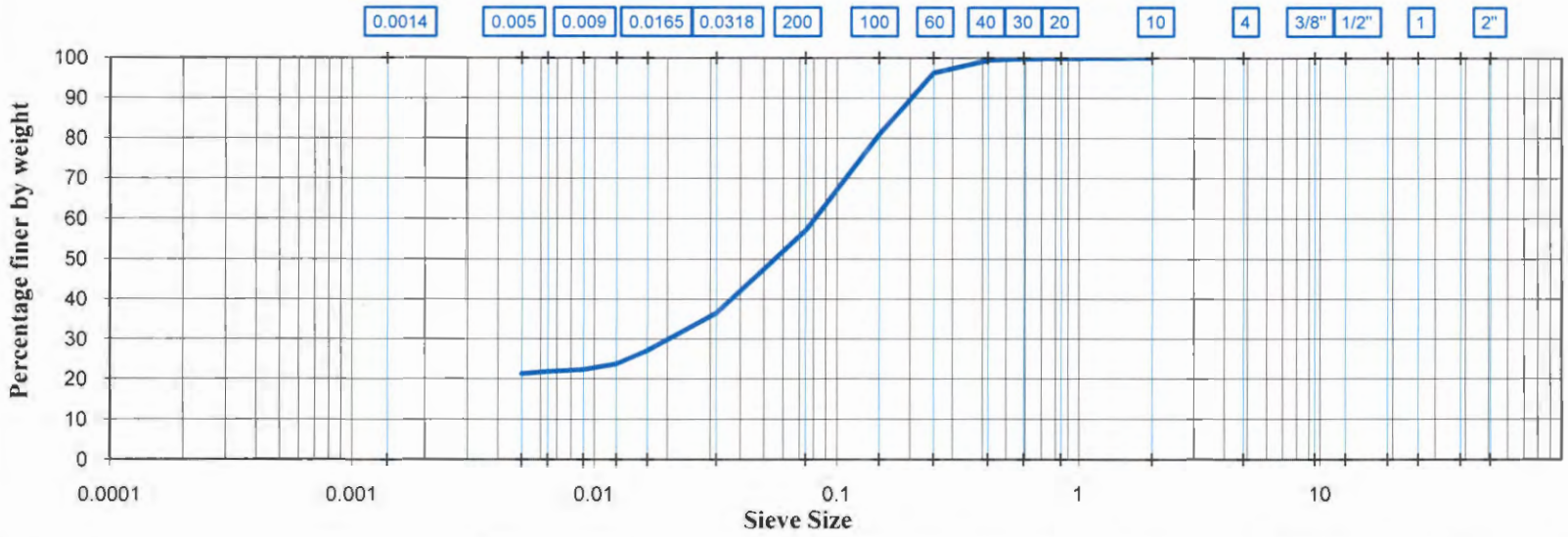

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	27.00	Location : Dam Footprint		

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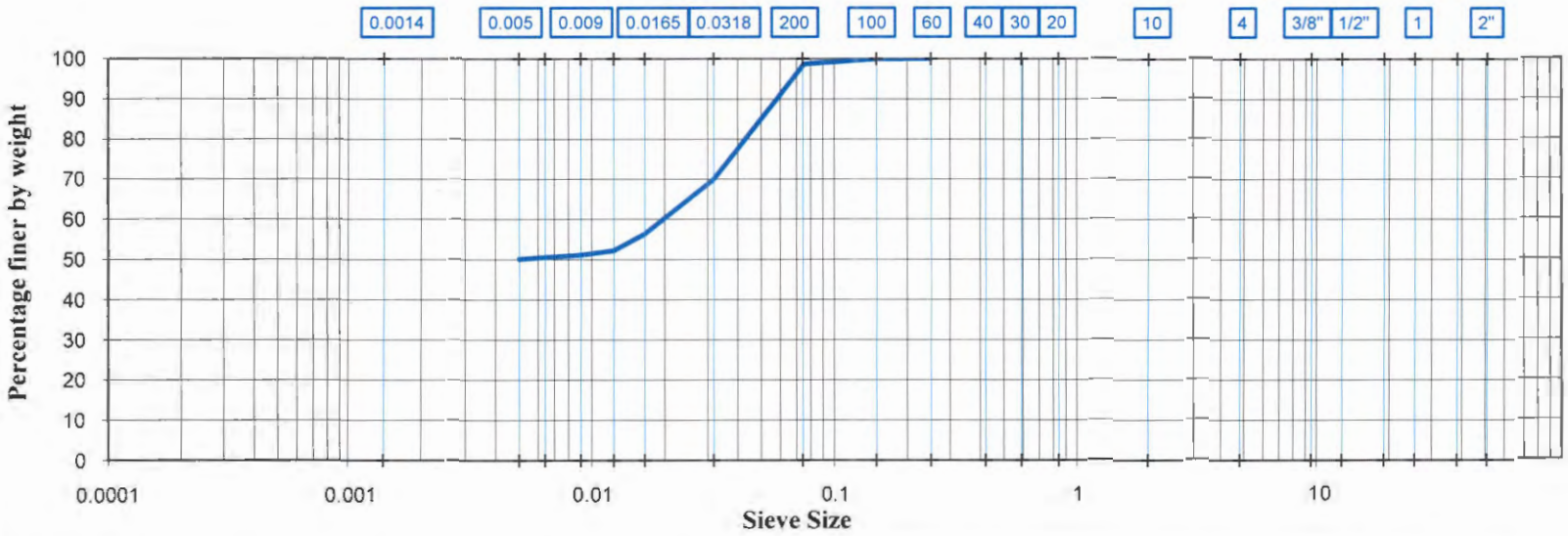

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	30.00	Location : Dam Footprint		

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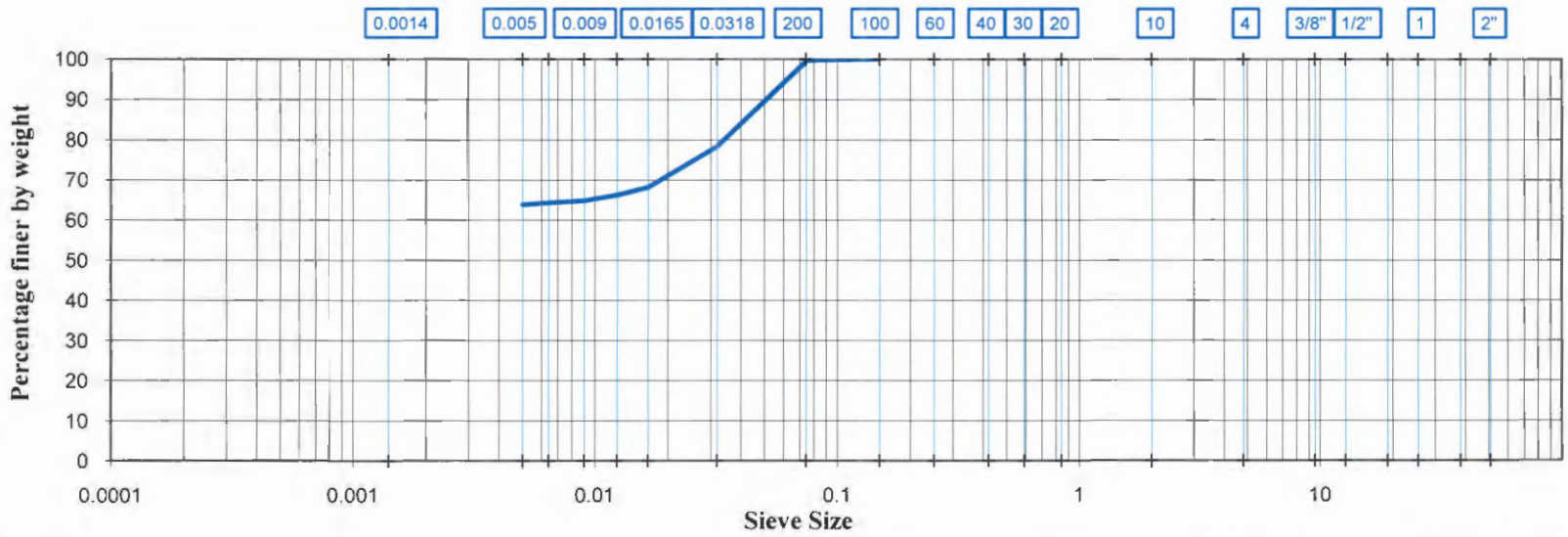

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	34.50	Location : Dam Footprint		

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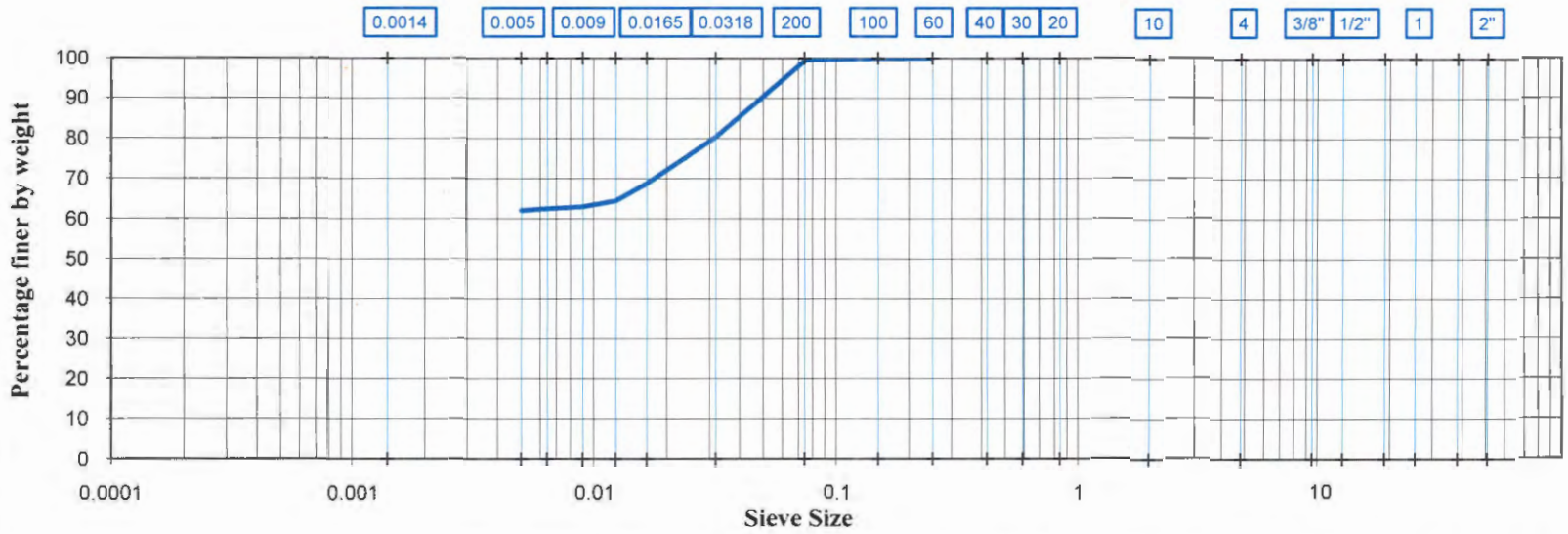

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	39.00	Location : Dam Footprint		

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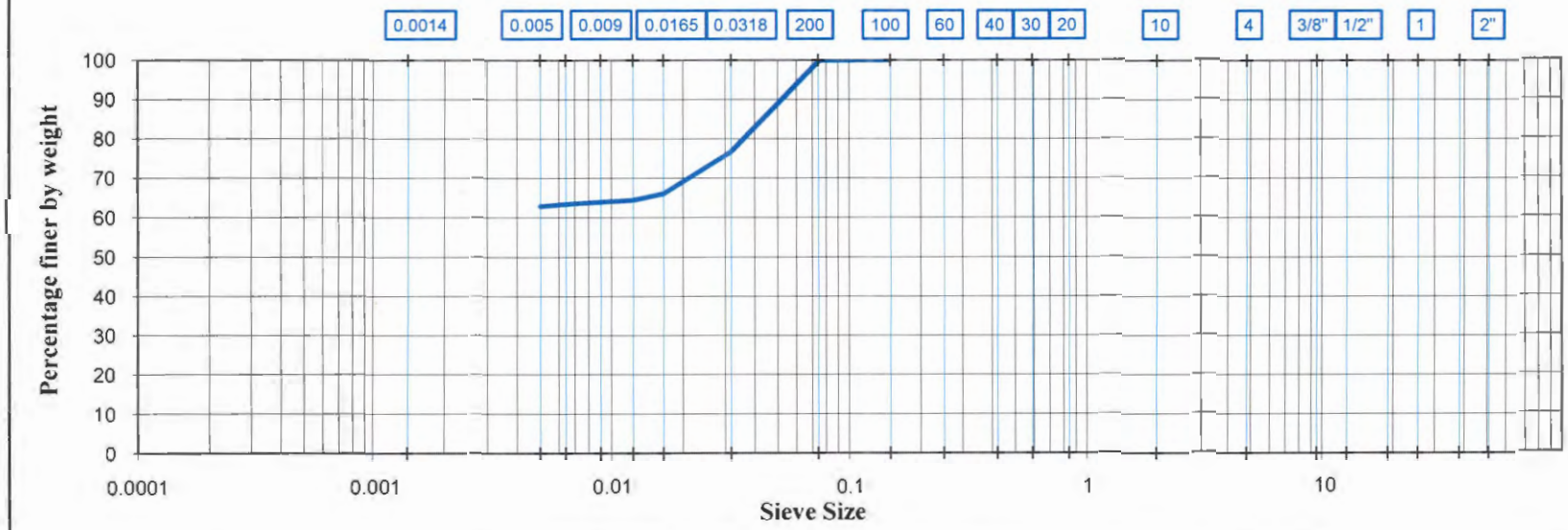

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR3	-	42.00	Location : Dam Footprint		

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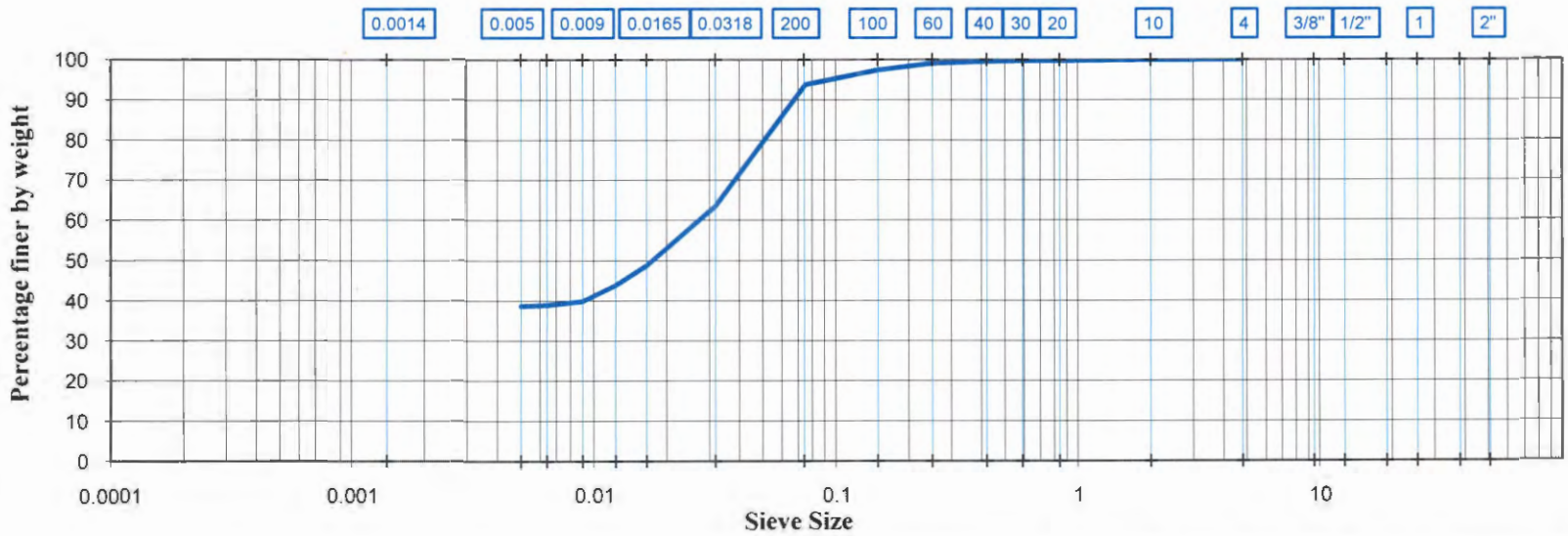

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR5	-	3.00	Location : Dam Footprint		

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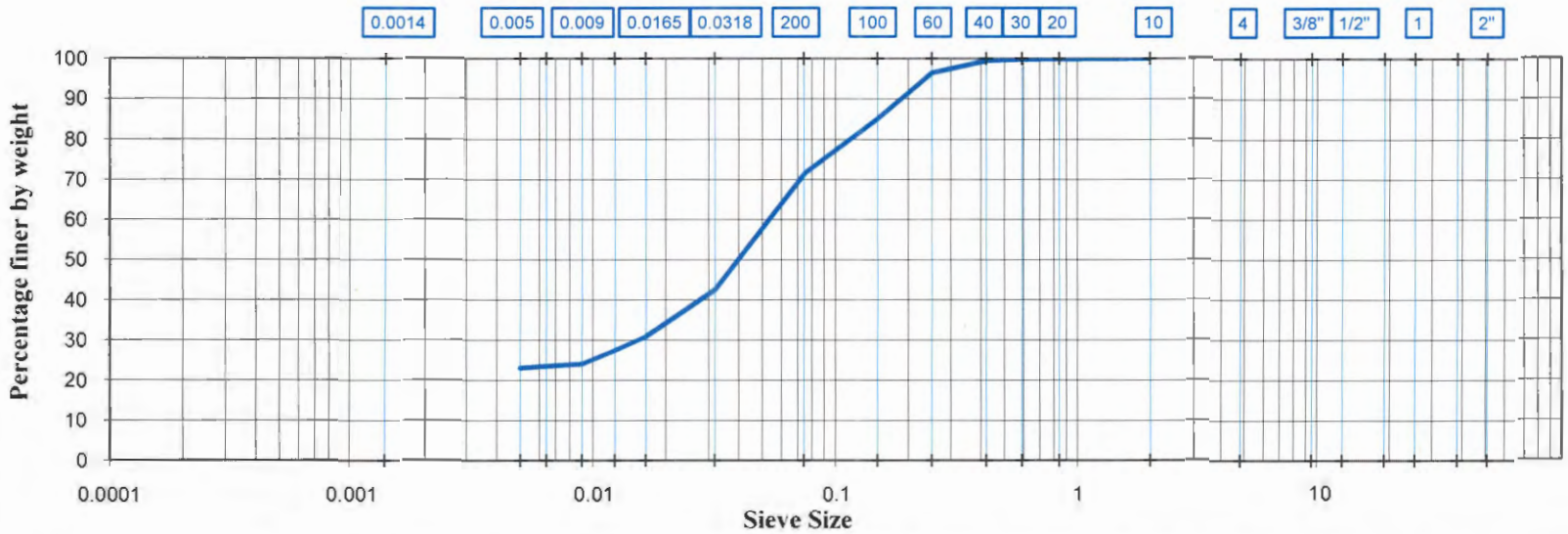
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR5	-	5.5-6.0	Location : Dam Footprint		

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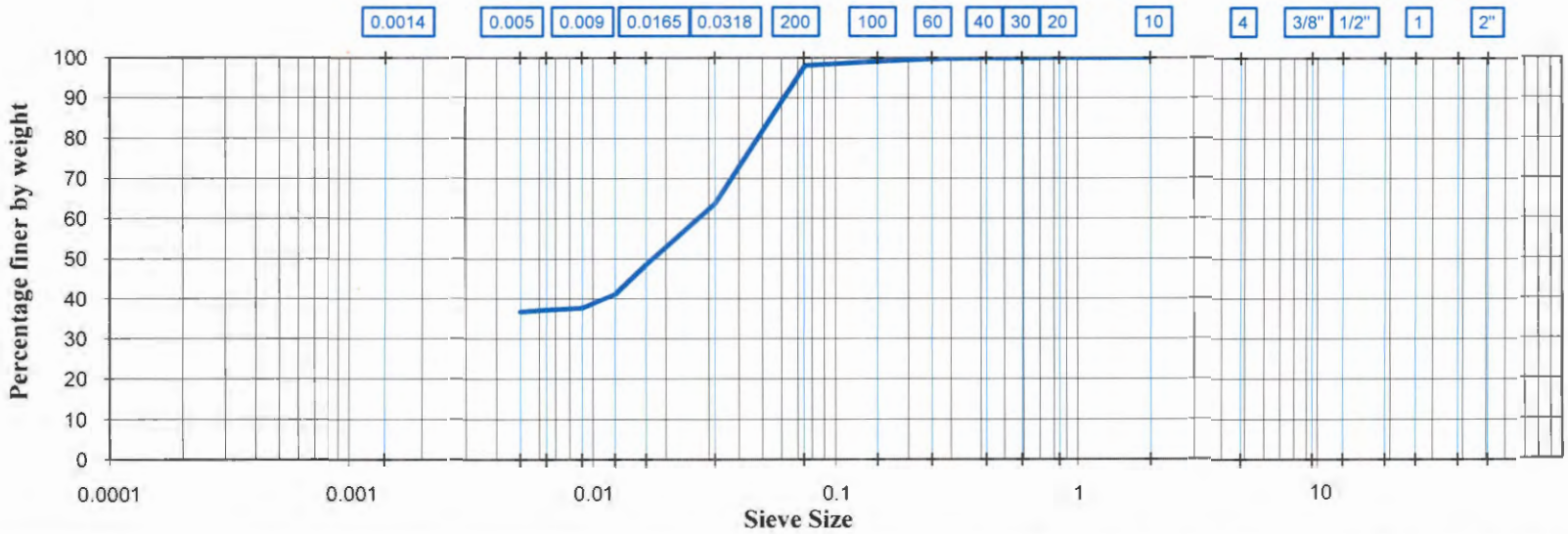

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR5	-	9.00	Location : Dam Footprint		

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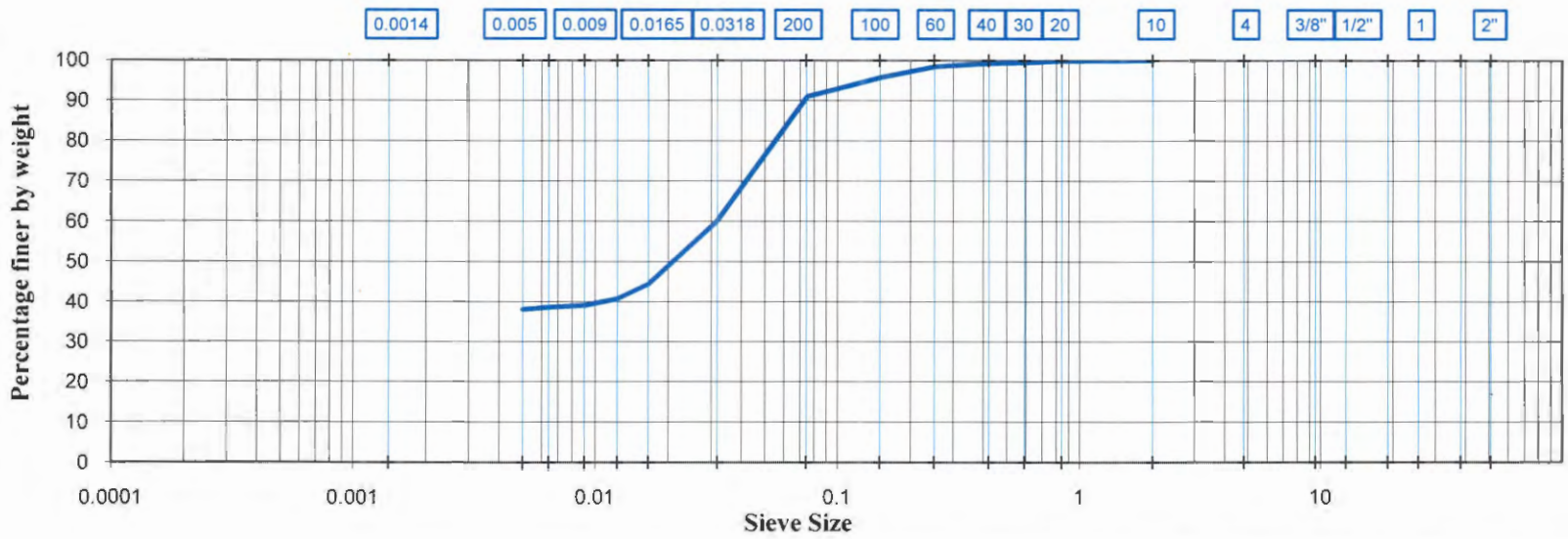

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR5	-	13.50	Location : Dam Footprint		

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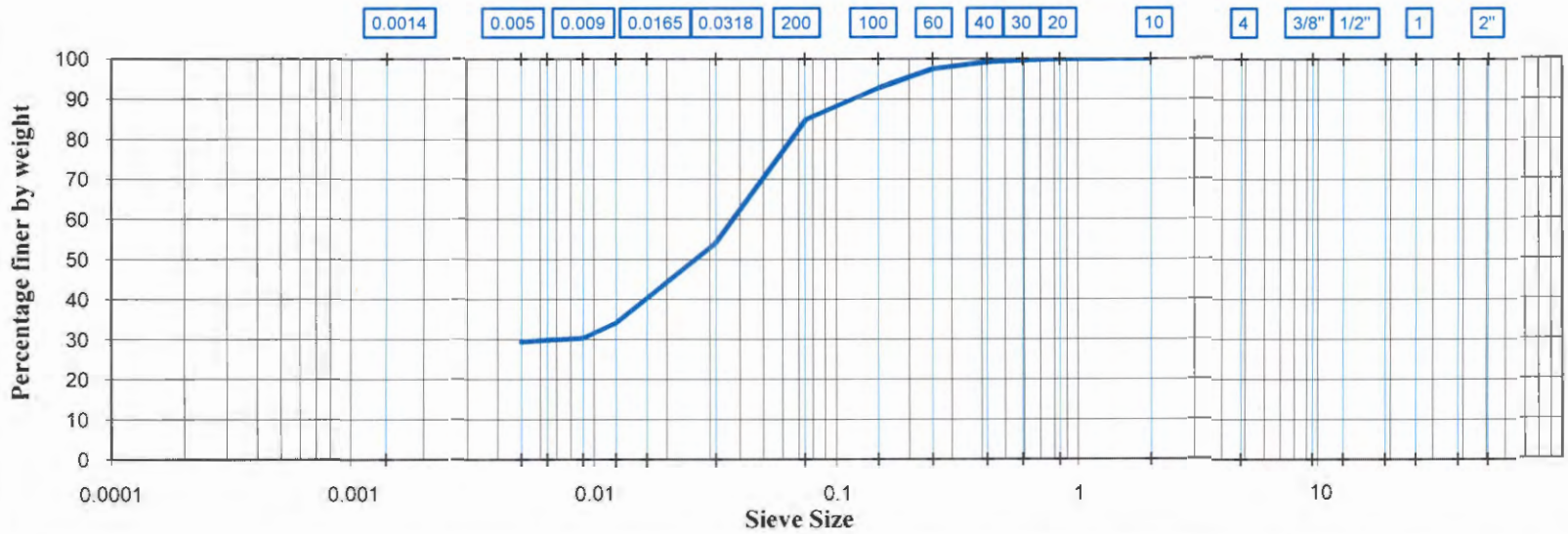

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazih Taleb & Partners	Date : 02/05/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR5	-	16.50	Location : Dam Footprint		

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Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 02/05/14

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		BHVL1			
Depth	m	5.00	9.00	13.50	16.50
CONTAINER NUMBER		1	2	3	4
NUMBER OF BLOWS		25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	21.70	26.26	17.35	20.33
WT. OF DRY SAMPLE & CONTAINER	g	17.99	21.79	13.91	12.41
WT. OF WATER	g	3.71	4.47	3.44	7.92
WT. OF CONTAINER	g	-	-	-	-
WT. OF DRY SAMPLE	g	17.99	21.79	13.91	12.41
WATER CONTENT (LL)	%	**21**	**21**	**25**	**64**

PLASTIC LIMIT		BHVL1			
Depth	m	5.00	9.00	13.50	16.50
CONTAINER NUMBER		1	2	3	4
WT. OF WET SAMPLE & CONTAINER	g	5.13	4.23	5.27	2.16
WT. OF DRY SAMPLE & CONTAINER	g	4.88	4.08	5.14	1.55
WT. OF WATER	g	0.25	0.15	0.13	0.61
WT. OF CONTAINER	g	-	-	-	-
WT. OF DRY SAMPLE	g	4.88	4.08	5.14	1.55
WATER CONTENT (PL)	%	**5**	**4**	**3**	**39**

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Project : Bisri Dam
Location : Dam Footprint
Date : 02/05/14

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		**BHVL1**			
Depth	m	21.00	25.50	33.00	38.80-39.00
CONTAINER NUMBER		5	6	7	8
NUMBER OF BLOWS		25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	18.30	16.93	18.99	39.18
WT. OF DRY SAMPLE & CONTAINER	g	10.98	11.02	12.54	29.50
WT. OF WATER	g	7.32	5.91	6.45	9.68
WT. OF CONTAINER	g	-	-	-	10.90
WT. OF DRY SAMPLE	g	10.98	11.02	12.54	18.60
WATER CONTENT (LL)	%	**67**	**54**	**51**	**52**

PLASTIC LIMIT		**BHVL1**			
Depth	m	21.00	25.50	33.00	38.80-39.00
CONTAINER NUMBER		5	6	7	8
WT. OF WET SAMPLE & CONTAINER	g	6.85	3.10	5.35	18.02
WT. OF DRY SAMPLE & CONTAINER	g	5.19	2.46	4.01	16.31
WT. OF WATER	g	1.66	0.64	1.34	1.71
WT. OF CONTAINER	g	-	-	-	10.89
WT. OF DRY SAMPLE	g	5.19	2.46	4.01	5.42
WATER CONTENT (PL)	%	**32**	**26**	**33**	**32**

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Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 02/05/14

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		BHVL1				
Depth	m	45.00	51.00	57.00	64.50	66.00
CONTAINER NUMBER		1	2	3	4	5
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	22.73	20.96	17.63	16.25	17.63
WT. OF DRY SAMPLE & CONTAINER	g	14.56	13.64	11.22	10.41	11.21
WT. OF WATER	g	8.17	7.32	6.41	5.84	6.42
WT. OF CONTAINER	g	-	-	-	-	-
WT. OF DRY SAMPLE	g	14.56	13.64	11.22	10.41	11.21
WATER CONTENT (LL)	%	**56**	**54**	**57**	**56**	**57**

PLASTIC LIMIT		BHVL1				
Depth	m	45.00	51.00	57.00	64.50	66.00
CONTAINER NUMBER		1	2	3	4	5
WT. OF WET SAMPLE & CONTAINER	g	3.21	2.98	3.96	2.93	3.96
WT. OF DRY SAMPLE & CONTAINER	g	2.36	2.20	2.95	2.17	2.96
WT. OF WATER	g	0.85	0.78	1.01	0.76	1.00
WT. OF CONTAINER	g	-	-	-	-	-
WT. OF DRY SAMPLE	g	2.36	2.20	2.95	2.17	2.96
WATER CONTENT (PL)	%	**36**	**35**	**34**	**35**	**34**

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Project : Bisri Dam
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Liquid Limit & Plastic Limit

ASTM Designation 4318 - 84

LIQUID LIMIT		BHVR3				
Depth	m	3.00	4.50	6.00	7.50	9.00
CONTAINER NUMBER		1	2	3	4	5
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	16.01	30.46	0	28.04	18.35
WT. OF DRY SAMPLE & CONTAINER	g	12.49	24.91	0	20.74	13.86
WT. OF WATER	g	3.52	5.55	0	7.30	4.49
WT. OF CONTAINER	g	-	10.91	-	-	-
WT. OF DRY SAMPLE	g	12.49	14.00	0	20.74	13.86
WATER CONTENT (LL)	%	**28**	**40**	**0**	**35**	**32**

PLASTIC LIMIT		BHVR3				
Depth	m	3.00	4.50	6.00	7.50	9.00
CONTAINER NUMBER		1	2	3	4	5
WT. OF WET SAMPLE & CONTAINER	g	5.20	11.55	0	4.49	5.67
WT. OF DRY SAMPLE & CONTAINER	g	4.37	10.20	0	3.38	4.72
WT. OF WATER	g	0.83	1.35	0	1.11	0.95
WT. OF CONTAINER	g	-	4.10	-	-	-
WT. OF DRY SAMPLE	g	4.37	6.10	0	3.38	4.72
WATER CONTENT (PL)	%	**19**	**22**	**0**	**33**	**20**

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Liquid Limit & Plastic Limit

ASTM Designation 4318 - 84

LIQUID LIMIT		BHVR3				
Depth	m	10.50	13.50	16.50	21.00	24.00
CONTAINER NUMBER		6	7	8	1	2
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	0	22.02	20.34	19.31	27.54
WT. OF DRY SAMPLE & CONTAINER	g	0	17.62	12.57	12.49	22.27
WT. OF WATER	g	0	4.40	7.77	6.82	5.27
WT. OF CONTAINER	g	-	-	-	-	-
WT. OF DRY SAMPLE	g	0	17.62	12.57	12.49	22.27
WATER CONTENT (LL)	%	**0**	**25**	**62**	**55**	**24**

PLASTIC LIMIT		BHVR3				
Depth	m	10.50	13.50	16.50	21.00	24.00
CONTAINER NUMBER		6	7	8	1	2
WT. OF WET SAMPLE & CONTAINER	g	0	6.13	6.32	6.46	7.15
WT. OF DRY SAMPLE & CONTAINER	g	0	5.57	4.88	4.98	6.58
WT. OF WATER	g	0	0.56	1.44	1.48	0.57
WT. OF CONTAINER	g	-	-	-	-	-
WT. OF DRY SAMPLE	g	0	5.57	4.88	4.98	6.58
WATER CONTENT (PL)	%	**0**	**10**	**30**	**30**	**9**

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Project : Bisri Dam
Location : Dam Footprint
Date : 02/05/14

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		BHVR3				
Depth	m	27.00	30.00	34.50	39.00	42.00
CONTAINER NUMBER		3	4	5	6	7
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	22.63	22.06	20.25	19.95	27.03
WT. OF DRY SAMPLE & CONTAINER	g	17.57	14.63	13.19	13.25	17.71
WT. OF WATER	g	5.06	7.43	7.06	6.70	9.32
WT. OF CONTAINER	g	-	-	-	-	-
WT. OF DRY SAMPLE	g	17.57	14.63	13.19	13.25	17.71
WATER CONTENT (LL)	%	**29**	**51**	**54**	**51**	**53**

PLASTIC LIMIT		BHVR3				
Depth	m	27.00	30.00	34.50	39.00	42.00
CONTAINER NUMBER		3	4	5	6	7
WT. OF WET SAMPLE & CONTAINER	g	6.84	7.56	5.56	5.45	4.31
WT. OF DRY SAMPLE & CONTAINER	g	5.96	5.91	4.32	4.29	3.28
WT. OF WATER	g	0.88	1.65	1.24	1.16	1.03
WT. OF CONTAINER	g	-	-	-	-	-
WT. OF DRY SAMPLE	g	5.96	5.91	4.32	4.29	3.28
WATER CONTENT (PL)	%	**15**	**28**	**29**	**27**	**31**

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Project : Bisri Dam
Location : Dam Footprint
Date : 02/05/14

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		BHVR5				
Depth	m	3.00	5.50-6.00	9.00	13.50	16.50
CONTAINER NUMBER		1	2	3	4	5
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	20.94	24.39	19.55	15.51	25.53
WT. OF DRY SAMPLE & CONTAINER	g	15.11	18.23	13.68	11.17	19.21
WT. OF WATER	g	5.83	6.16	5.87	4.34	6.32
WT. OF CONTAINER	g	-	-	-	-	-
WT. OF DRY SAMPLE	g	15.11	18.23	13.68	11.17	19.21
WATER CONTENT (LL)	%	**39**	**34**	**43**	**39**	**33**

PLASTIC LIMIT		BHVR5				
Depth	m	3.00	5.50-6.00	9.00	13.50	16.50
CONTAINER NUMBER		1	2	3	4	5
WT. OF WET SAMPLE & CONTAINER	g	6.06	5.71	5.92	8.02	8.27
WT. OF DRY SAMPLE & CONTAINER	g	4.95	4.89	4.78	6.31	6.47
WT. OF WATER	g	1.11	0.82	1.14	1.71	1.80
WT. OF CONTAINER	g	-	-	-	-	-
WT. OF DRY SAMPLE	g	4.95	4.89	4.78	6.31	6.47
WATER CONTENT (PL)	%	**22**	**17**	**24**	**27**	**28**

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Client: M/S Dar Al Handasa Nazih Taleb & Partners
Project: Bisri Dam
Location: Dam Footprint
Date: 09/05/14

Determination of Organic Content in Soils by Loss On Ignition
AASHTO DESIGNATION T 267-86 (1993)

Sample No.	Sample Depth (m)	A	B	C	Percent Organic Matter, %
BHVL1	21.00	76.08	74.05	40.11	5.6
	25.50	76.36	73.91	39.58	6.7
BHVR3	3.00	70.55	69.98	40.81	1.9
	21.00	44.61	42.67	16.29	6.9
	30.00	69.95	68.35	40.43	5.4
	34.50	41.03	39.88	16.70	4.7
	39.00	45.48	43.71	16.70	6.2
BHVR5	9.00	75.33	73.62	40.72	4.9

A = Weight of crucible or evaporating dish and oven dried soil, before ignition, in g.
B = Weight of crucible or evaporating dish and oven dried soil, after ignition, in g.
C = Weight of crucible or evaporating dish,to the nearest 0.01 g.
Percent Organic Matter = (A-B)/(A-C)*100

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Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 09/05/14

TEST DATA SUMMARY ROCK - ASTM Designations C88, C97-90, D2938, D4373, D464487, D4972, D5731-95, BS812_parts117&118

Sample ID	Depth m	Unit weight g/cm³	Saturated unit weight g/cm³	U.C.S. kg/cm²	P.L.I kg/cm²	Water Absorption %	Slake Durability %	$MgSO_4$ Soundness %	CaCo3 cont. %	$SO3^{-}$ cont. %	CL^{-} cont. %	PH cont.
BHLA1	42.00 - 42.20	2.589	2.600	298	-	2.01	-	5.3	-	24	57	7.85
	56.00 - 56.20	2.608	2.647	353	-	1.82	-	4.6	-	21	54	7.83
	83.70 - 83.90	2.614	2.659	441	-	0.46	-	3.9	-	27	59	7.81
	100.80 - 101.00	2.291	2.363	-	0.4	4.93	46.4	-	67	30	69	7.57
BHLA2	19.30 - 19.50	2.500	2.590	90	2.8	5.07	74.5	-	-	43	82	7.65
	75.00 - 75.15	2.297	2.356	-	0.5	6.12	3.4	-	64	29	54	7.81
	100.50 - 100.80	2.589	2.665	630	-	0.68	-	7.8	-	20	58	7.86

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Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 22/04/14

COMPRESSIVE STRENGTH OF ROCK CORES
ASTM Designation C170 - 90

Borehole No.	Depth	Dimensions		Area	Saturated weight	Unit weight	Load	U.C.S.
		Diam	Height					
	m	cm		cm^2	g	g/cm^3	Kg	kg/cm^2
BHLA1	42.00-42.20	6.7	13.0	35.3	1191.50	2.600	10523	298
	56.00-56.20	6.3	13.0	31.2	1072.54	2.647	10992	353
	83.70-83.90	6.3	13.0	31.2	1077.73	2.659	13756	441
	100.80-101.00	sample fractured upon saturation						
BHLA2	19.30-19.50	6.3	12.4	31.2	1001.20	2.590	2794	90
	75.00-75.15	sample fractured upon saturation						
	100.50-100.80	6.2	12.1	30.3	976.84	2.665	19089	630

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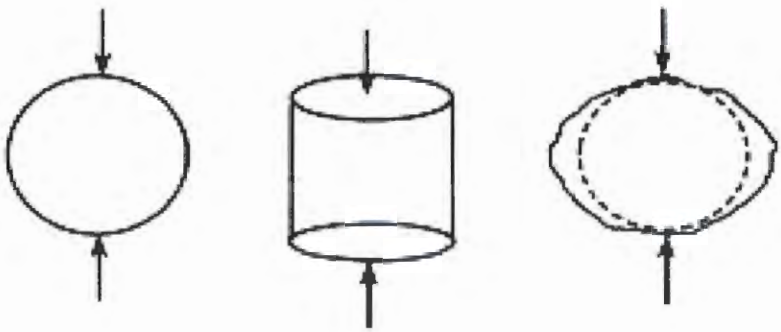
Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 17/04/14

POINT LOAD STRENGTH INDEX TEST
Franklin & Brooch

Borehole no.	Sample depth	Type of test	Dia.or Thic of sample (mm)	Gauge pressure (KN)	Point load index (Is;MPa)	Correction factor (F)	Corrected P.L.I Is(50);Mpa
BHLA1	100.80-101.00	B	47	0.1	0.05	0.97	0.04
	19.30-19.50	D	63	1.0	0.25	1.11	0.28
BHLA2	75.00-75.15	B	65	0.2	0.05	1.13	0.05

Remark : The estimated unconfined compressive strength can be calculated by using a factor K
However the K factor is variable (10 to 24) depending on rock type and other factors.
The formula for the estimated unconfined compressive strength is : $\sigma = K \times Is(50)$

Type of test : D: Diametral. A:Axial. B:Block



Head of laboratory section

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Testing - Geotechnical Study

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Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 09/05/14

SLAKE DURABILITY INDEX - ASTM D4644

Sample No.			BHLA1 100.80 - 101.00m	BHLA2 19.30 - 19.50m	BHLA2 75.00 - 75.15m
A	Mass of sample + drum	(g)	755.21	754.81	763.24
B	Mass of oven-dried sample + drum before the first cycle	(g)	741.61	751.14	751.44
C	Mass of drum	(g)	301.46	301.48	301.48
W_F	Mass of oven-dried sample + drum after the second cycle	(g)	505.73	636.62	316.97
W	Natural moisture content	%	3.1	0.8	2.6
Id	Slake durability index	%	46.4	74.5	3.4

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Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 09/05/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D : BHLA1
Depth : 42.00 - 42.20 m
Source : Bisri Dam Footprint
Sampled by : Client

(Sod. / Mag.) Sulfate : Magnesium Sulfate
Solution Temperature °C : 20
Number of cycles : 5
Immersion hours / cycle : 16

Sieve Size		Grading of original sample retained %	Weight of test fraction before test g	Weight of test fraction after test g	Loss in weight after test g	Actual loss after test in percent %	Corrected weighted percent loss %
Passing	Retained						
No. 100							
No. 50	No. 100						
No. 30	No. 50						
No. 16	No. 30						
No. 8	No. 16						
No. 4	No. 8						
Totals							

2 1/2"	1 1/2"	8	225.6	210.2	15.4	6.83	0.55
1 1/2"	3/4"	22	316.8	297.9	18.9	5.97	1.31
3/4"	3/8"	46	401.5	378.6	22.9	5.70	2.62
3/8"	No. 4	24	175.3	165.3	10.0	5.70	1.37
Totals		100					5.3

Head of laboratory section

F/ ASSACO

ASSACO
Geotechnical Study

Tel: (961 - 1) 646930 - 631882; Fax:(961 - 1) 646931; P.O.Box.:11/9217; E-mail:assaco@terra.net.lb

ASSACO
انساكو

Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 09/05/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D : BHLA1
Depth : 56.0 - 56.2m
Source : Bisri Dam Footprint
Sampled by : Client

(Sod. / Mag.) Sulfate : Magnesium Sulfate
Solution Temperature °C : 20
Number of cycles : 5
Immersion hours / cycle : 16

Sieve Size		Grading of original sample retained	Weight of test fraction before test	Weight of test fraction after test	Loss in weight after test	Actual loss after test in percent	Corrected weighted percent loss
Passing	Retained	%	g	g	g	%	%
No. 100							
No. 50	No. 100						
No. 30	No. 50						
No. 16	No. 30						
No. 8	No. 16						
No. 4	No. 8						
Totals							

2 1/2"	1 1/2"	16	195.3	182.7	12.6	6.45	1.03
1 1/2"	3/4"	19	287.5	274.1	13.4	4.66	0.89
3/4"	3/8"	35	310.5	299.6	10.9	3.51	1.23
3/8"	No. 4	30	159.0	145.9	13.1	8.24	2.47
Totals		100					4.6

Head of laboratory section

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ASSACO
اسساكو

Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 09/05/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D : BHLA1
Depth : 83.7 - 83.9m
Source : Bisri Dam Footprint
Sampled by : Client

(Sod. / Mag.) Sulfate : Magnesium Sulfate
Solution Temperature °C : 20
Number of cycles : 5
Immersion hours / cycle : 16

Sieve Size		Grading of original sample retained %	Weight of test fraction before test g	Weight of test fraction after test g	Loss in weight after test g	Actual loss after test in percent %	Corrected weighted percent loss %
Passing	Retained						
No. 100							
No. 50	No. 100						
No. 30	No. 50						
No. 16	No. 30						
No. 8	No. 16						
No. 4	No. 8						
Totals							

2 1/2"	1 1/2"	25	203.0	195.0	8.0	3.94	0.99
1 1/2"	3/4"	13	267.9	256.8	11.1	4.14	0.54
3/4"	3/8"	28	287.1	275.0	12.1	4.21	1.18
3/8"	No. 4	34	241.0	225.3	15.7	6.51	2.21
Totals		100					3.9

Head of laboratory section

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ASSACO
اساكو

Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 09/05/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D : BHLA2
Depth : 100.5 - 100.8m
Source : Bisri Dam Footprint
Sampled by : Client

(Sod. / Mag.) Sulfate : Magnesium Sulfate
Solution Temperature °C : 20
Number of cycles : 5
Immersion hours / cycle : 16

Sieve Size		Grading of original sample retained %	Weight of test fraction before test g	Weight of test fraction after test g	Loss in weight after test g	Actual loss after test in percent %	Corrected weighted percent loss %
Passing	Retained						
No. 100							
No. 50	No. 100						
No. 30	No. 50						
No. 16	No. 30						
No. 8	No. 16						
No. 4	No. 8						
Totals							

2 1/2"	1 1/2"	19	158.2	146.8	11.4	7.21	1.37
1 1/2"	3/4"	26	239.4	215.9	23.5	9.82	2.55
3/4"	3/8"	33	315.0	286.3	28.7	9.11	3.01
3/8"	No. 4	22	260.7	234.1	26.6	10.20	2.24
Totals		100					7.8

Head of laboratory section

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