REPUBLIC OF LEBANON

COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION

DETAILED DESIGN OF BISRI DAM PROJECT

CONTRACT NO.17909

SOIL/ROCK SAMPLING & IN-SITU/LABORATORY TESTING (LEBANON)
DAM FOOTPRINT & MATERIAL SOURCES
BOREHOLES/TEST PITS

GEOTECHNICAL INVESTIGATION REPORT VIII

FACTUAL

September 2014

Founded 1956

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

Table of Content

1. Introduction..... 1-1

Appendices

APPENDIX 1. LISTS OF SAMPLING & LABORATORY/IN-SITU TESTING

APPENDIX 2. FIRST PACKAGE

APPENDIX 3. SECOND PACKAGE

APPENDIX 4. THIRD PACKAGE

APPENDIX 5. CLAY-CORE MATERIAL SOURCES (LABORATORY & IN-SITU)

APPENDIX 6. SAND/GRAVEL MATERIAL SOURCES (IN-SITU)

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1. Introduction

Representative soil and rock samples from the boreholes and test pits (material sources, *please refer to Report Volume V and VII*) at different depths were selected and tested in order to determine the physical and chemical properties of the subsurface soil/rock stratums and material sources. Lists of sampling and laboratory/in-situ testing are presented in Appendix 1 of this factual report.

In-situ Field Density (Sand-Cone Method) and Moisture Content (Speedy Moisture Testing Kit) tests were carried out during the execution of the test pits.

In addition to above, Pocket Penetrometer was used to evaluate consistency and approximate unconfined compressive strength/undrained shear strength of the cohesive soil stratums in boreholes BHVR1, BHVR2, BHVR4 and BHVR6 (*please refer to Report Volume VII*).

Laboratory (Lebanon) test results (*except BHRA5 and SAND/GRAVEL material sources*) are presented in Appendices 2 to 6.

APPENDICES

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APPENDIX 1. LISTS OF SAMPLING & LABORATORY/IN-SITU TESTING

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)	15	15	15	12	0	0	0	0	15	5	15	0	0	0	0	0	0	0	8	100
						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
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

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Sampling					Testing																			
					Soil											Rock								
No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Unit (U)	13	13	13	13	0	0	0	0	13	2	13	0	0	0	0	0	0	0	7	87
						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
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	

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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

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Sampling					Testing																			
					Soil											Rock								
					Unit (U)	0	0	0	0	0	0	0	0	0	0	0	3	1	4	4	3	1	1	4	21
No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling		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	

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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
					Unit (U)	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.

Bisri Dam Laboratory Testing Program - Second Package

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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 (Saturated)	PLI (Saturated)	Water Absorption	Unit weight (Saturated)	Soundness ($MgSO_4$)	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
						7	7	7	5	0	0	0	0	5	5	7	0	0	0	0	0	0	0	4	47
BHVR1	5.5	SPT	Light yellowish brown clayey SILT	22.05.2014		1	1	1	1					1	1	1								1	
	23.5		Olive silty fine SAND	23.05.2014		1	1	1								1									
	30		Olive silty fine SAND	24.05.2014		1	1	1								1								1	
	33		Olive brown clayey SILT	24.05.2014		1	1	1	1					1	1	1									
	41.5		Olive brown silty CLAY	26.05.2014		1	1	1	1					1	1	1								1	
	56.5		Olive brown silty CLAY	28.05.2014		1	1	1	1					1	1	1									
	65.5		Olive brown silty CLAY	28.05.2014		1	1	1	1					1	1	1								1	

Bisri Dam Laboratory Testing Program - Second Package

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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 (Saturated)	PLI (Saturated)	Water Absorption	Unit weight (Saturated)	Soundness ($MgSO_4$)	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
						3	3	3	2	0	0	0	0	2	2	3	0	0	0	0	0	0	0	2	20
BHVR2	5.5	SPT	Light yellowish brown clayey SILT	21.04.2014		1	1	1	1					1	1	1								1	
	8.5		Yellowish brown silty fine SAND	21.04.2014		1	1	1								1									
	23.5		Olive brown silty CLAY	23.04.2014		1	1	1	1					1	1	1								1	

Bisri Dam Laboratory Testing Program - Second Package

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Sampling					Testing																		
					Soil											Rock							
No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Moisture Content	Void Ratio	Sieve	Hydrometer	UCS	Triaxial (CU+U)	Triaxial (CD)	Consolidation	Atterberg	Organic Content	Bulk and Saturated Density	Uni-axial CS (Saturated)	PLI (Saturated)	Water Absorption	Unit weight (Saturated)	Soundness ($MgSO_4$)	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
					Unit (U)	0	0	0	0	0	0	0	0	0	0	0	6	6	9	10	3	6	10	6	56
BHRA1	99.4-99.7	Core	Chocolate brown MARLSTONE.	March 15 - April 08, 2014												1	1	1	1		1	1	1	
	136-136.2		Bluish grey MARLSTONE.														1	1	1		1	1		
	142.5-142.7		Bluish grey fossiliferous sandy LIMESTONE.													1		1	1	1		1	1	
BHRA3	22.5-22.65	Core	Beige very sandy marly LIMESTONE	March 17 - 28, 2014													1	1	1		1	1	1	
	52.5-52.7		Bluish grey calcareous MARLSTONE														1	1	1		1	1		
	76.5-76.85		Bluish grey fossiliferous calcareous MARLSTONE													1	1	1	1		1	1	1	
BHRA4	72-72.1	Core	Bluish grey very sandy MARLSTONE	26.05.2014													1		1			1		
BHRA2	36.5-36.8	Core	Light cream to white sandy LIMESTONE	April 04 - May 10, 2014												1		1	1	1		1	1	
	89.8-90.05		Beige sandy marly LIMESTONE													1		1	1		1	1		
	136.8-137.1		Bluish grey sandy calcareous MARLSTONE													1		1	1	1		1	1	

Total of 10 rock and 10 soil samples.

Bisri Dam Laboratory Testing Program - Third Package / Lebanon

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Sampling					Testing																			
						Soil										Rock								
					Unit (U)	15	10	15	10	0	0	0	0	10	6	12	0	0	0	0	0	0	0	7	85
No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling		Moisture Content	Void Ratio	Sieve	Hydrometer	UCS	Triaxial (CU+U)	Shear box-0.2 mm/min	Consolidation	Atterberg	Organic Content	Bulk and Saturated Density	Uni-axial CS (Saturated)	PLI (Saturated)	Water Absorption	Unit weight (Saturated)	Soundness ($MgSO_4$)	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
BHVR6	2.5	SPT	Yellowish brown very clayey SILT	26.04.2014		1	1	1	1					1	1	1									
	5.5		Yellowish brown silty CLAY	26.04.2014		1	1	1	1					1	1	1								1	
	8.5		Brown clayey SILT	26.04.2014		1	1	1	1					1		1									
	11.5		Grey slightly clayey SILT	26.04.2014		1		1	1					1		1								1	
	14.5		Yellowish brown silty fine SAND (NP)	28.04.2014		1	1	1								1									
	22.5		Olive brown slightly gravely coarse to medium SAND	28.04.2014		1	1	1								1								1	
	27		Olive brown slightly gravely coarse to medium SAND	29.04.2014		1		1																	
	28.5		Olive brown medium to fine SAND	29.04.2014		1	1	1								1								1	
	30		Olive brown slightly gravely coarse to medium SAND	29.04.2014		1		1																	
	32.5		Brown slightly clayey SILT	29.04.2014		1	1	1	1					1	1	1								1	
	38.5		Olive brown silty CLAY	14.05.2014		1	1	1	1					1	1	1									
	44.5		Olive brown very clayey SILT	15.05.2014		1		1	1					1		1								1	
	47.5		Olive brown silty CLAY	15.05.2014		1	1	1	1					1	1	1									
	57.5		Olive brown silty CLAY	04.06.2014		1		1	1					1										1	
	68		Olive brown silty CLAY	23.06.2014		1	1	1	1					1	1	1									

Bisri Dam Laboratory Testing Program - Third Package / Lebanon

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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-modulus (E)	Triaxial (CU+U)	Shear box-0.2 mm/min	Consolidation	Atterberg	Organic Content	Bulk and Saturated Density	Uni-axial CS (Saturated)	PLI (Saturated)	Water Absorption	Unit weight (Saturated)	Soundness ($MgSO_4$)	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
						8	7	12	9	3	0	3	0	9	9	7	0	0	0	0	0	0	0	6	73
BHVR4	3	SPT	Brown Silty fine SAND (Non-Plastic)	09.06.2014		1	1	1								1									
	4.5-5	Shelby	Olive brown very clayey SILT	ID card		1	1	1	1	1		1		1	1	1								1	
	8.5	SPT	Olive brown very clayey SILT	09.06.2014				1	1					1	1										
	12		Yellowish brown silty fine SAND (NP)	09.06.2014		1	1	1								1								1	
	16.5		Yellowish brown silty fine SAND (NP)	10.06.2014				1																	
	17.8-18.0	Core	Olive brown very clayey SILT	10.06.2014		1	1	1	1					1	1									1	
	19.5-20	Shelby	Olive brown very clayey SILT	ID card		1		1	1	1		1		1	1	1									
	23.5	SPT	Olive brown silty CLAY	10.06.2014		1	1	1	1					1	1	1								1	
	26.5		Olive brown silty CLAY	10.06.2014				1	1					1	1										
	29-29.5	Shelby	Olive brown silty CLAY	ID card		1	1	1	1	1		1		1	1	1								1	
	32.5	SPT	Olive brown silty CLAY	11.06.2014				1	1					1	1										
	38.5		Olive brown silty CLAY	12.06.2014		1	1	1	1					1	1	1								1	

Bisri Dam Laboratory Testing Program - Third Package / Lebanon

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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)	Shear box-0.2 mm/min	Consolidation	Atterberg	Organic Content	Bulk and Saturated Density	Uni-axial CS (Saturated)	PLI (Saturated)	Water Absorption	Unit weight (Saturated)	Soundness ($MgSO_4$)	Slake Durability	Calcium Carbonate	Sulfate, Chloride, PH	General Total
						0	0	0	0	0	0	0	0	0	0	0	5	0	5	5	5	0	3	2	25
BHLA3	11.5-11.7	Core	Beige slightly dolomitic sandy LIMESTONE	02.06.2014													1		1	1	1		1	1	
	46.3-46.5		Light olive brown LIMESTONE	09.06.2014													1		1	1	1				
BHLA4	16.3-16.5	Core	Light olive brown LIMESTONE	13.06.2014													1		1	1	1		1		
	36.5-36.8		Light olive brown and beige LIMESTONE	16.06.2014													1		1	1	1		1	1	
	50.4-50.7		Light olive brown and beige LIMESTONE	17.06.2014													1		1	1	1				

BISRI DAM LABORATORY TESING - NEW TEST PITS (NTP)

Sampling					Testing															
No. of Test Pit	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Remolding	Void Ratio	Sieve	Hydrometer	Field Density	Triaxial (CU+U)	In-situ Moisture	Consolidation	Atterberg	Organic Content	Bulk and Saturated Density	Proctor	Permeability	Free Swelling Index	Double Hydrometer	Sulfate, Chloride, PH	General Total
				Unit (U)	15	15	15	15	13	5	13	5	15	14	15	5	5	5	5	8	168
NTP1	2.5	Bulk	Clay core material (Area: S1-A/B/C)	29.05.2014	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP2	3	Bulk	Clay core material (Area: N-1)	28.05.2014		1	1	1	1		1		1	1	1						
	5				3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP3	2.5	Bulk	Clay core material (Area: S-3)	28.05.2014	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	3.4					1	1	1					1	1	1						
	3.8					1	1	1					1		1						
NTP4	2.5	Bulk	Clay core material (Area: N-3)	29.05.2014		1	1	1	1		1		1	1	1						
	4					1	1	1	1		1		1	1	1					1	
NTP5	2.7	Bulk	Clay core material (Area: N-3)	28.05.2014	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	5					1	1	1	1		1		1	1	1					1	
NTP6	2.8	Bulk	Clay core material (Area: N-3)	28.05.2014		1	1	1	1		1		1	1	1						
	5.8					1	1	1	1		1		1	1	1					1	
NTP7	2.7	Bulk	Clay core material (Area: N-3)	28.05.2014		1	1	1	1		1		1	1	1						
	5.1				3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP8	1.2	Bulk	Clay core material (Area: S1-A/B/C)	29.05.2014		1	1	1	1		1		1	1	1					1	

Test will be done on compacted/re-molded (98%, Wopt + 2%) soil samples.

BISRI DAM LABORATORY TESING - NEW TEST PITS / SAND & GRAVEL / LEBANON

Sampling					Testing																
No. of Test Pit	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Unit (U)	Sieve (including Cobbles and Boulders)	Sand Equivalent	Clay Content	Atterberg Limits (passing sieve No.40)	Specific Gravity	Bulk (moist) and Saturated Density	Void Ratio	Field Density (Sand-cone method)	In-situ moisture content (Speedy)	Proctor Density	Soaked CBR at 100% Proctor Density	LA (500 Revolutions)	Soundnes	Organic Content	AAR (Alkali aggregate reactions)	Sulfate, Chloride, PH	**General Total**
						13	13	13	13	13	13	13	13	13	9	9	9	9	13	12	8	**186**
NTP9	0.7	Bulk	Slightly silty SAND.			1	1	1	1	1	1	1	1	1					1			
	2		Very gravely SAND with few Cobbles.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP10	2	Bulk	SAND and GRAVEL with few Cobbles.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	3.5					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP11	1.7	Bulk	SAND and GRAVEL with some Cobbles.			1	1	1	1	1	1	1	1	1					1	1	1	
	4					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
NTP12	1.5	Bulk	SAND and GRAVEL with few Cobbles.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	3		SAND and GRAVEL with some Cobbles and few Boulders.			1	1	1	1	1	1	1	1	1					1	1	1	
NTP13	1.5	Bulk	SAND and GRAVEL with many Cobbles.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	3.5		Very gravely SAND with few Cobbles.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP14	1.4	Bulk	SAND and GRAVEL with many Cobbles			1	1	1	1	1	1	1	1	1					1	1	1	
	3.4		SAND and Gravel with many Cobbles and some Boulders.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
NTP15	1.8	Bulk	SAND and GRAVEL with some Cobbles and few Boulders.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

BISRI DAM LABORATORY TESING - NEW TEST PITS / SAND & GRAVEL / LEBANON					Testing																
Sampling																					
No. of Test Pit	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Unit (U)	11	11	11	11	11	11	11	11	11	9	9	9	9	11	11	8	**165**
						Sieve (including Cobbles and Boulders)	Sand Equivalent	Clay Content	Atterberg (passing sieve No.40)	Specific Gravity	Bulk (moist) and Saturated Density	Void Ratio	Field Density (Sand-cone method)	In-situ moisture content (Speedy)	Proctor Density	Soaked CBR at 100% Proctor Density	LA (500 Revolutions)	Soundnes	Organic Content	AAR (Alkali aggregate reactions)	Sulfate, Chloride, PH	**General Total**
NTP16	1.7	Bulk	SAND and GRAVEL with some Cobbles and Boulders.			1	1	1	1	1	1	1	1	1					1	1		
	3.5					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP17	1.8	Bulk	SAND and GRAVEL with some Cobbles and Boulders.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP18	1	Bulk	SAND and GRAVEL with some Cobbles and Boulders.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP19	0.4	Bulk	SAND and GRAVEL.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	1.2		Gravely SAND.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
NTP20	0.8	Bulk	SAND and GRAVEL with few Cobbles.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP21	1.5	Bulk	SAND and GRAVEL with few Cobbles.			1	1	1	1	1	1	1	1	1					1	1		
	3.5					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP22	1	Bulk	SAND and GRAVEL with Cobbles and Boulders.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP23	1.5	Bulk	SAND and GRAVEL with Cobbles and Boulders.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

APPENDIX 2. FIRST PACKAGE

ASSACO S.A.R.L

أساكو ش.م.م.

ENGINEER BILAL ASSAAD MELHEM ASSAAD & Co.

المهندس بلال أسعد ملحم أسعد وشركاه

DESIGN & SUPERVISION - GEOTECHNICAL CONSULTANCY - MATERIALS TESTING

دروس وإشراف - 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

Besharrah El-Khoury Blvd. - Wazzane Bldg. - 1st Floor - Tel.: (961-1) 631882 - 646930
Fax: (961-1) 646931 - Lab: 01 381119 - E-mail:assaco@terra.net.lb
P.O.Box: 11/9217 - Beirut - Lebanon

بولفار بشارة الخوري - بناية الوزان - الطابق الأول - تلفون: ٦٣١٨٨٢ - ٦٤٦٩٣٠ (١ - ٩٦١)
فاكس: ٦٤٦٩٣١ (١ - ٩٦١) - مختبر: ٠١/٣٨١١١٩ - E-mail:assaco@terra.net.lb
ص.ب: ١١/٩٢١٧ بيروت - لبنان

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

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 %								
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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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 Gravel %	Sand %	Fines %	Silt %	Clay %	Atterberg limits LL %	PL %	Moist. cont. %	Bulk dens. g/cm^3	Saturated dens. g/cm^3	Void ratio	Organic content %	$SO4^-$ cont. ppm	CL^- cont. ppm	PH
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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ASSACO
Material Testing - Geotechnical Study

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 Gravel %	Sand %	Fines %	Silt %	Clay %	Atterberg limits LL %	PL %	Moist. cont. %	Bulk dens. g/cm^3	Saturated dens. g/cm^3	Void ratio	Organic content %	SO_4^- cont. ppm	CL^- cont. ppm	PH
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
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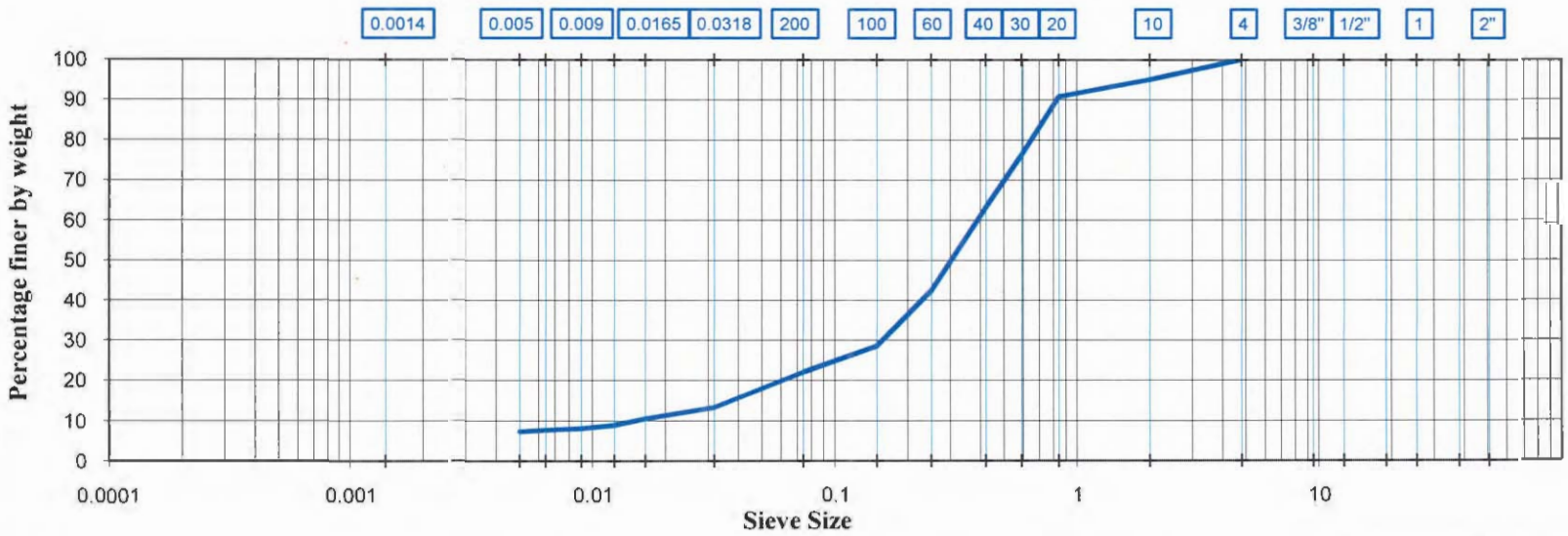

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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	-	5.00	Location : Dam Footprint		

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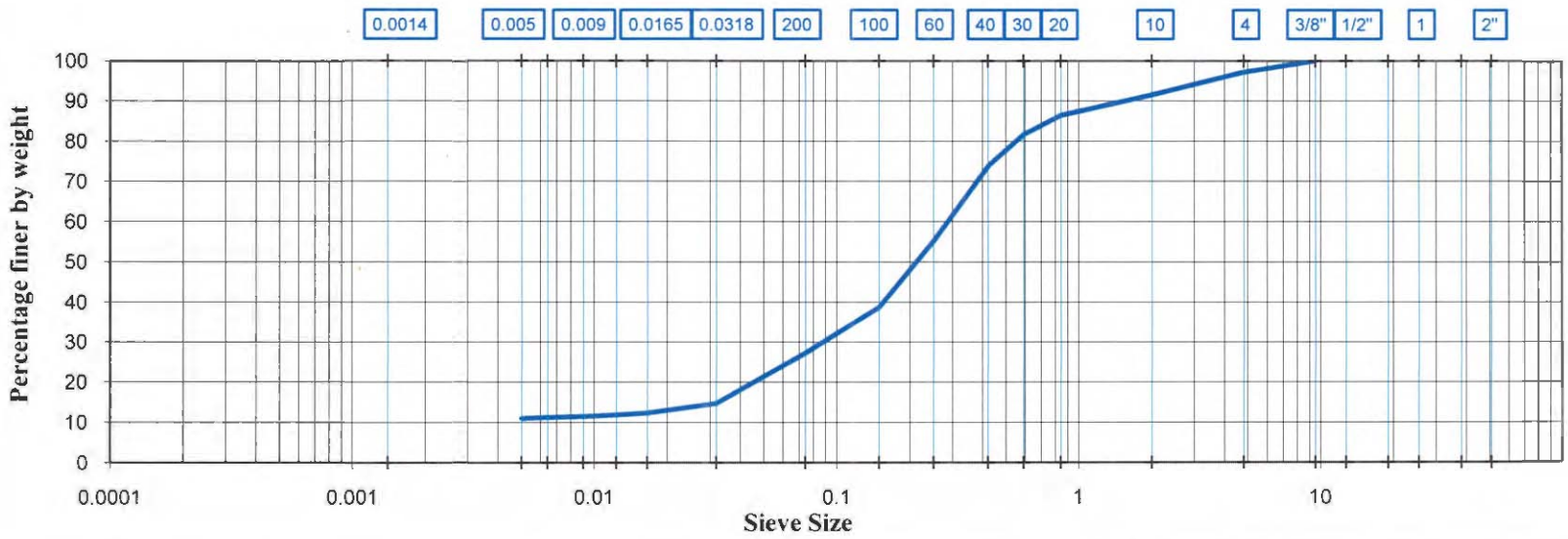

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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	-	9.00	Location : Dam Footprint		

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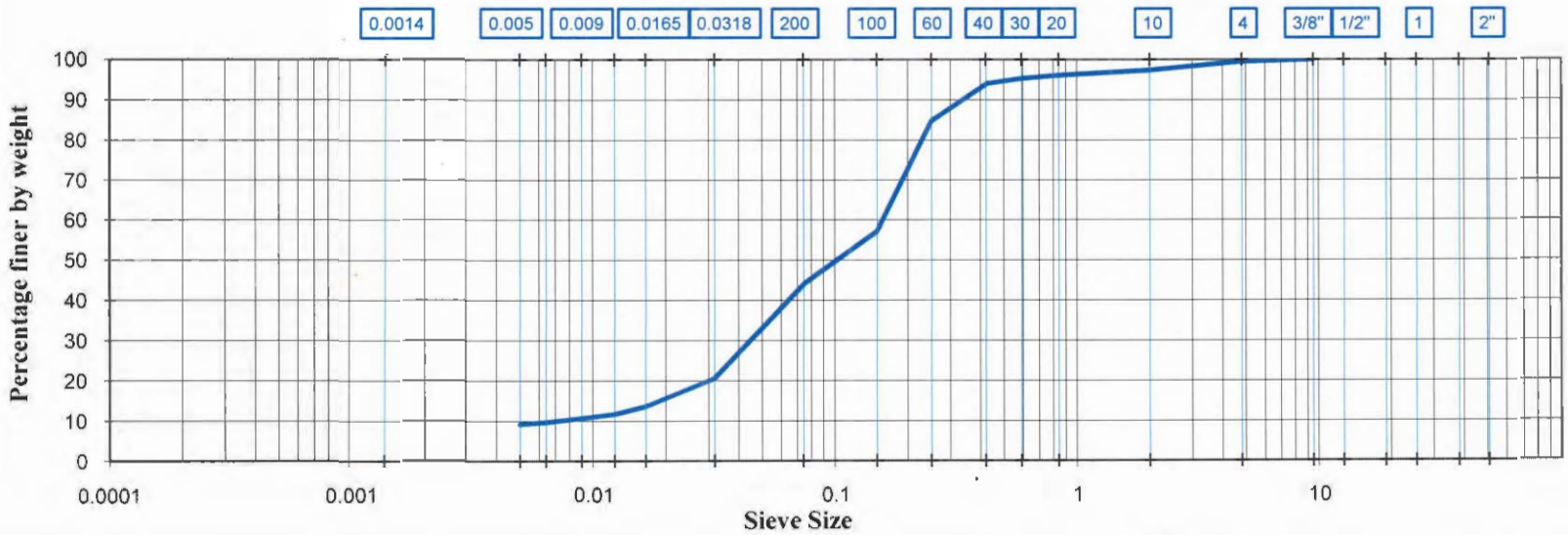

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa Nazib 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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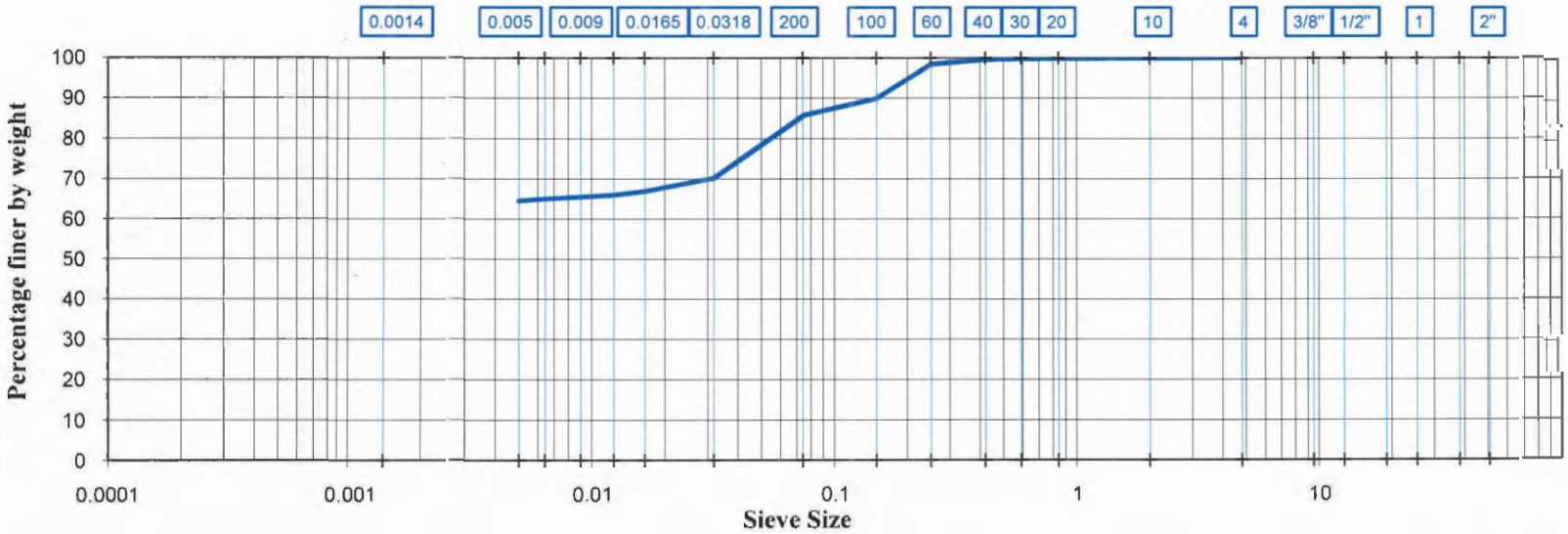

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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	-	16.50	Location : Dam Footprint		

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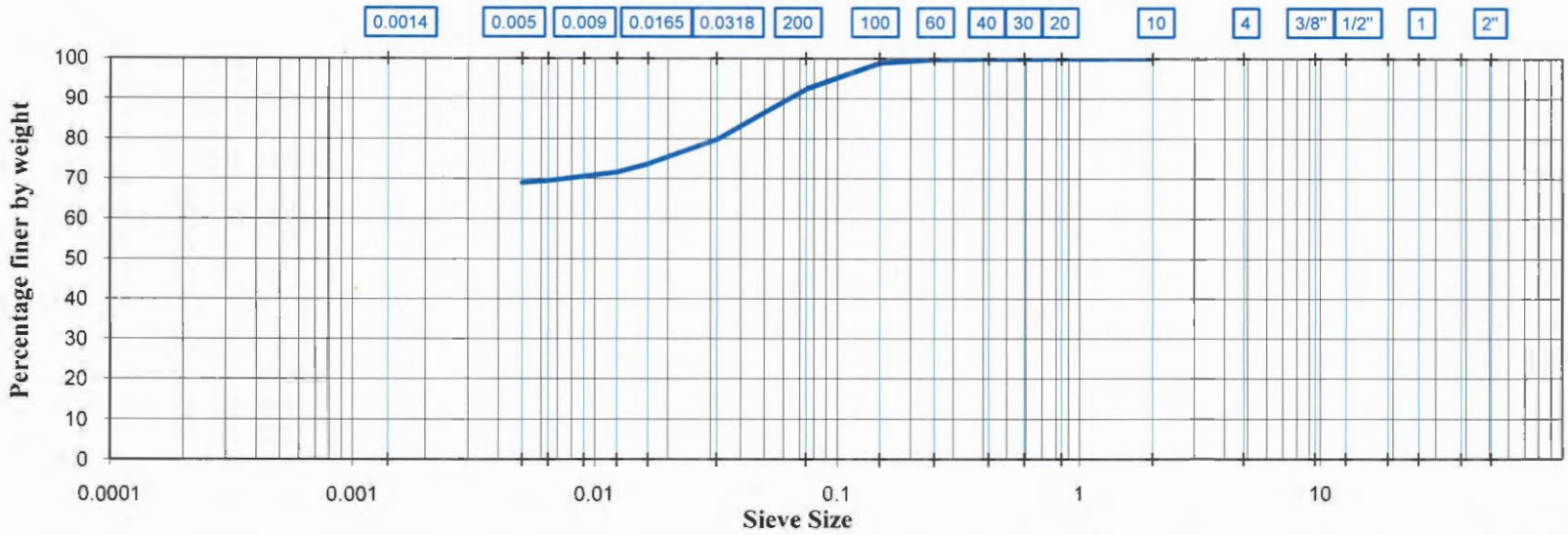

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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		
BHVL1	-	21.00	Location : Dam Footprint		

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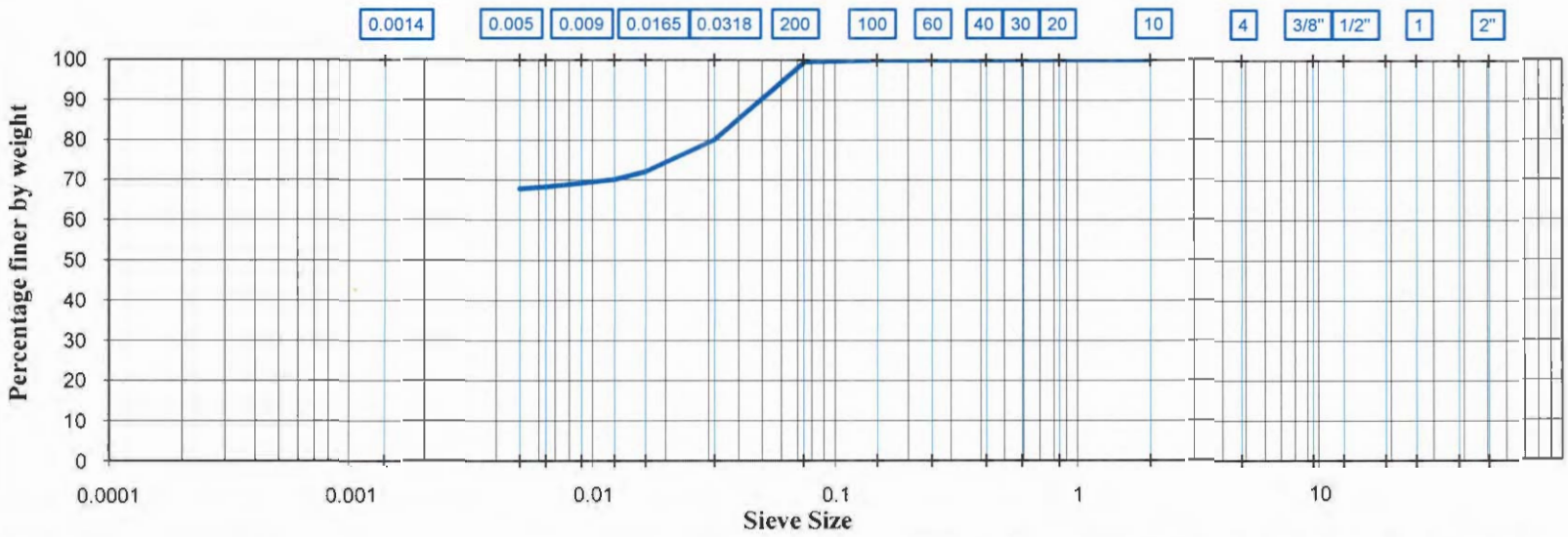

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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		
BHVL1	-	25.50	Location : Dam Footprint		

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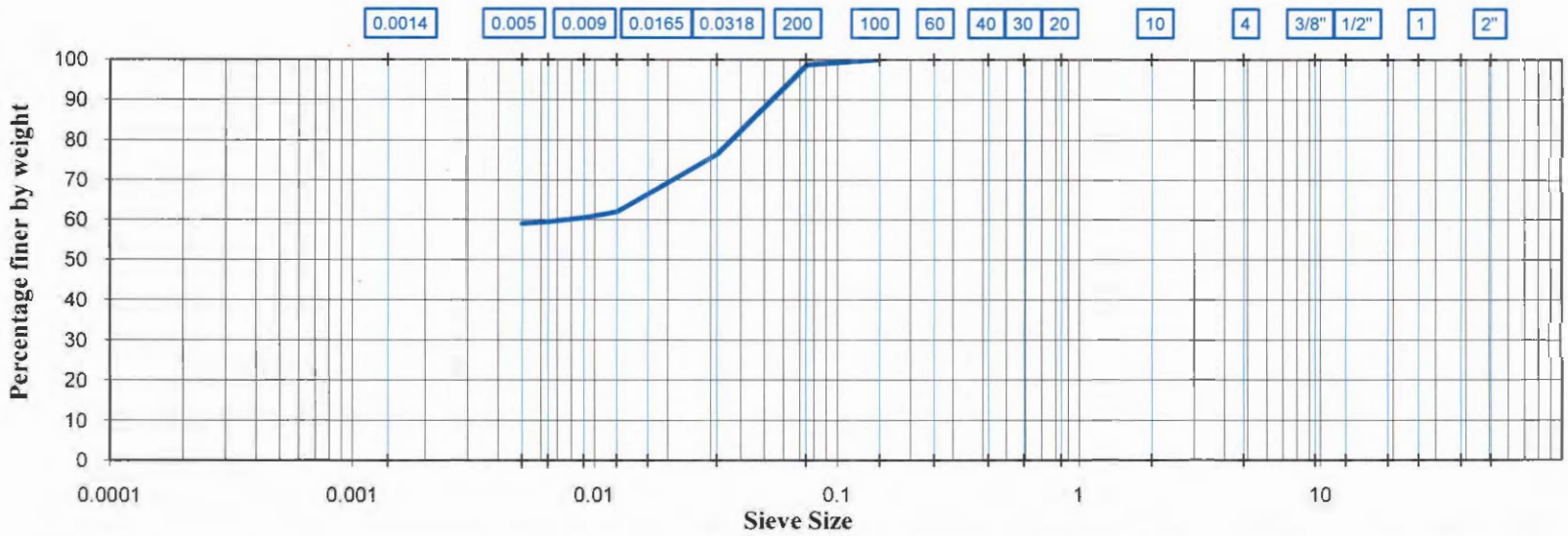

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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		
BHVL1	-	33.00	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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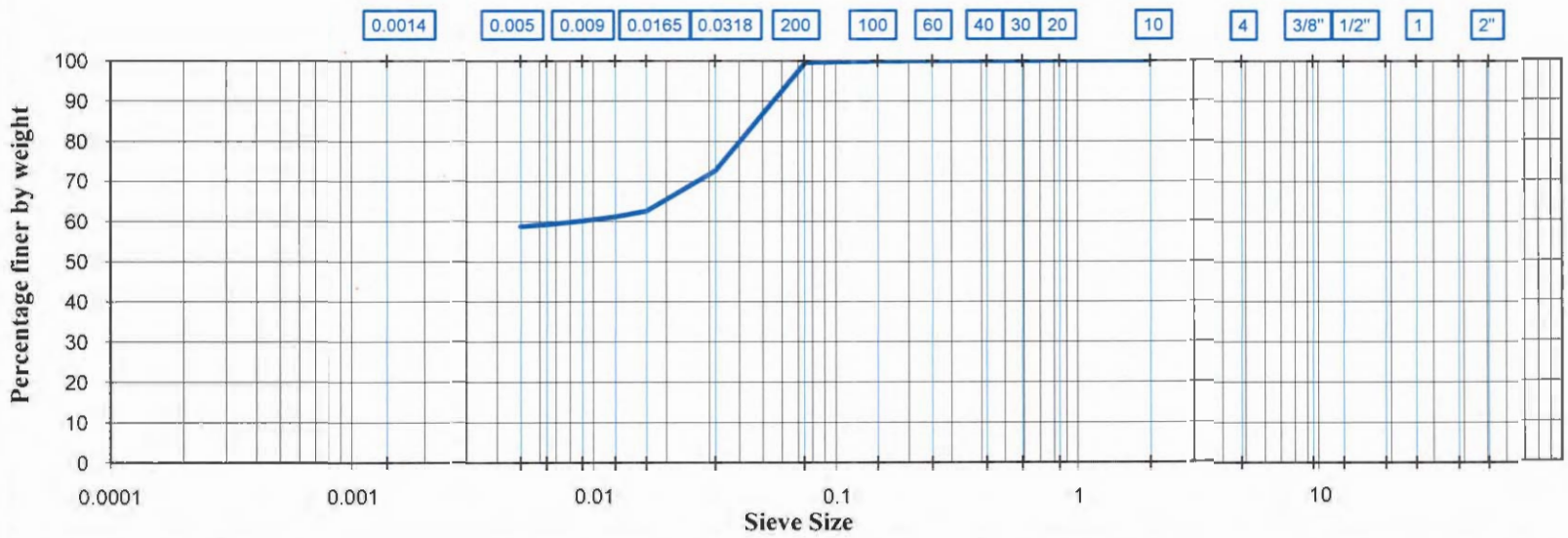

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasa 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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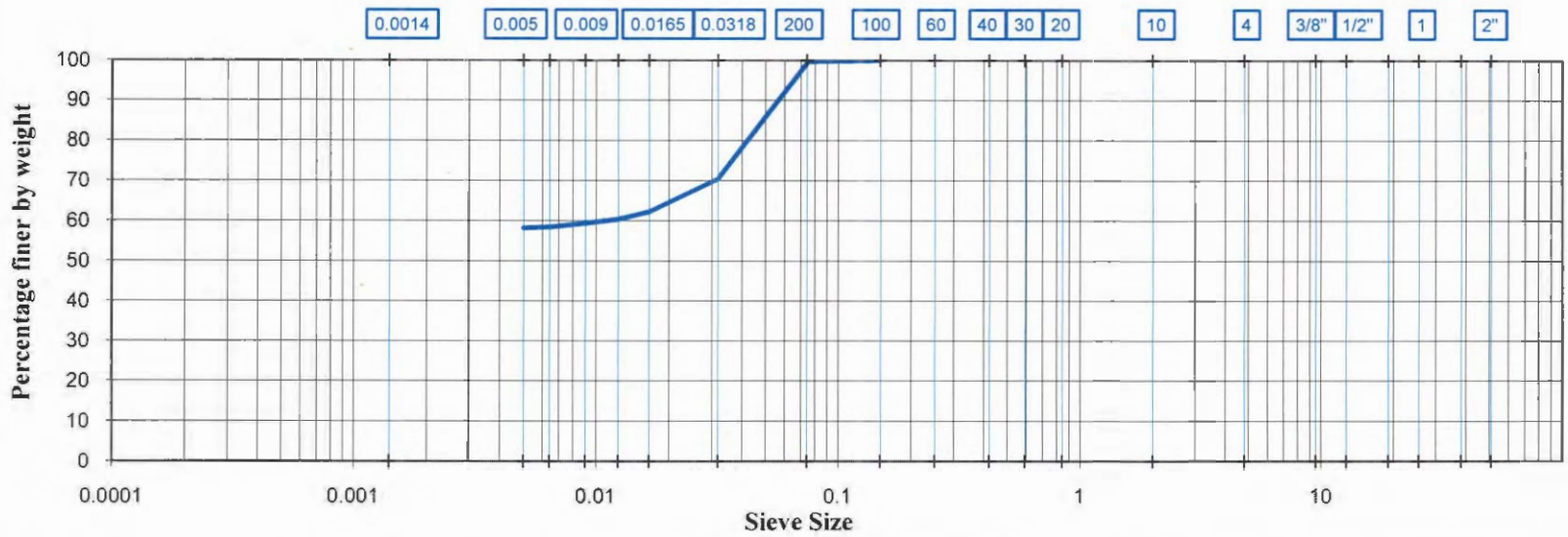

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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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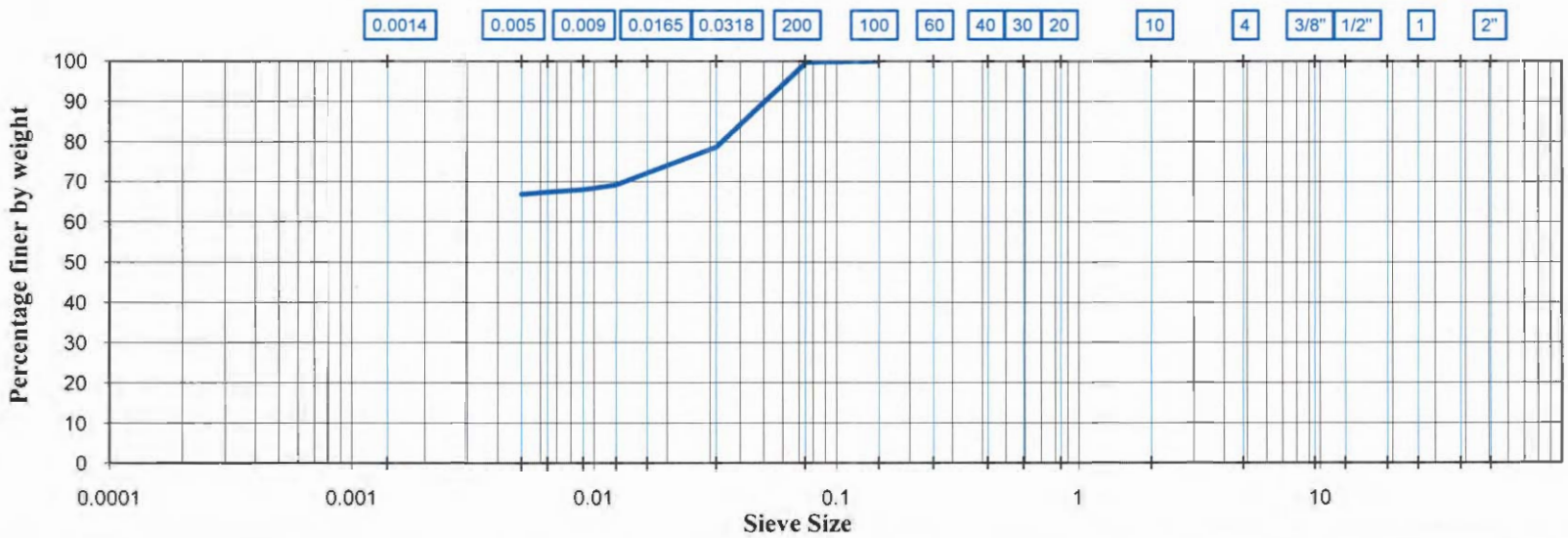

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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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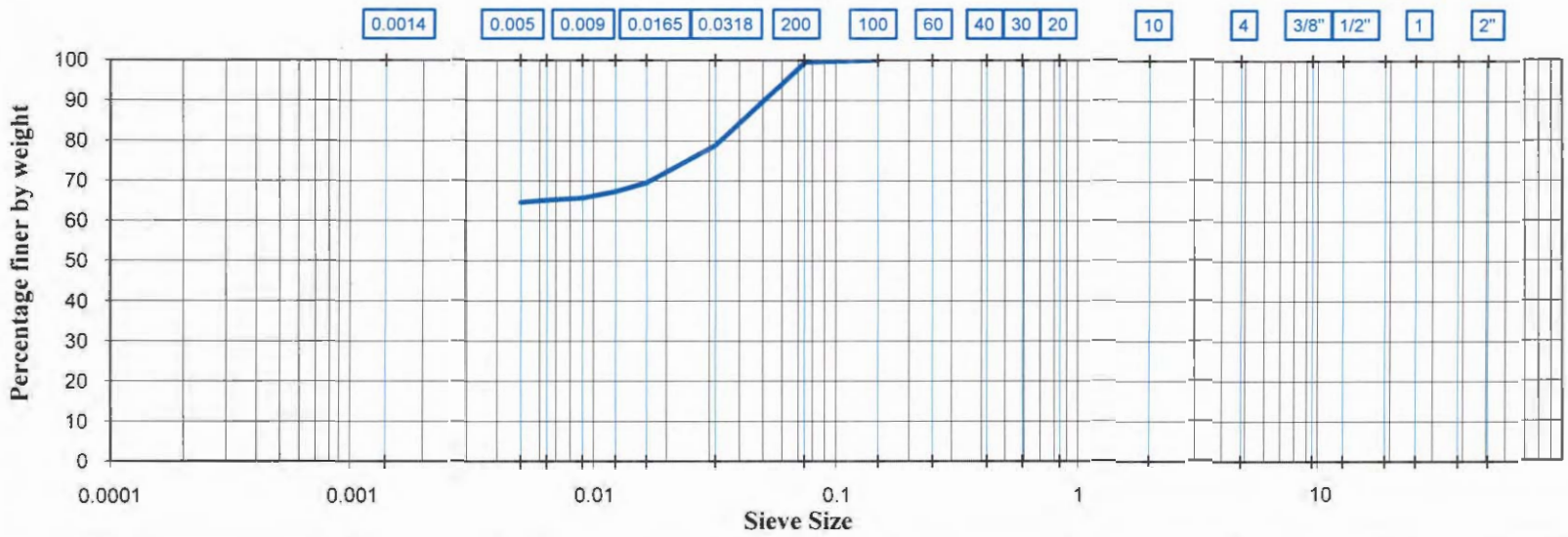

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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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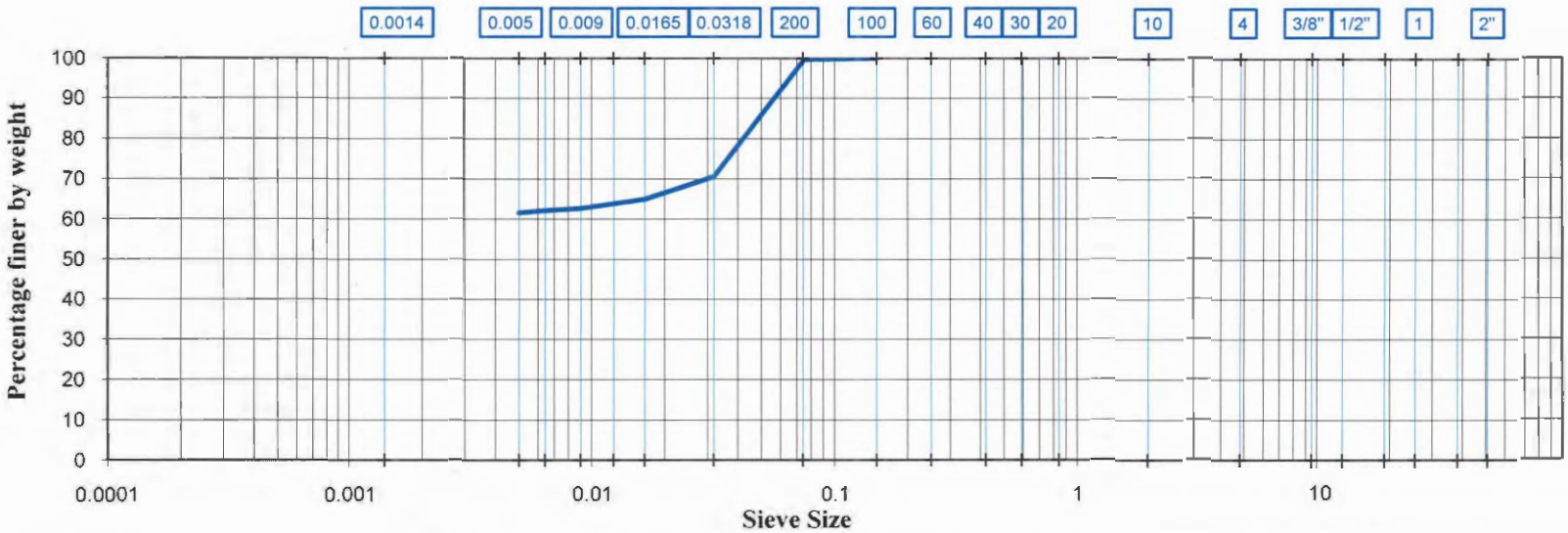
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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	-	64.50	Location : Dam Footprint		

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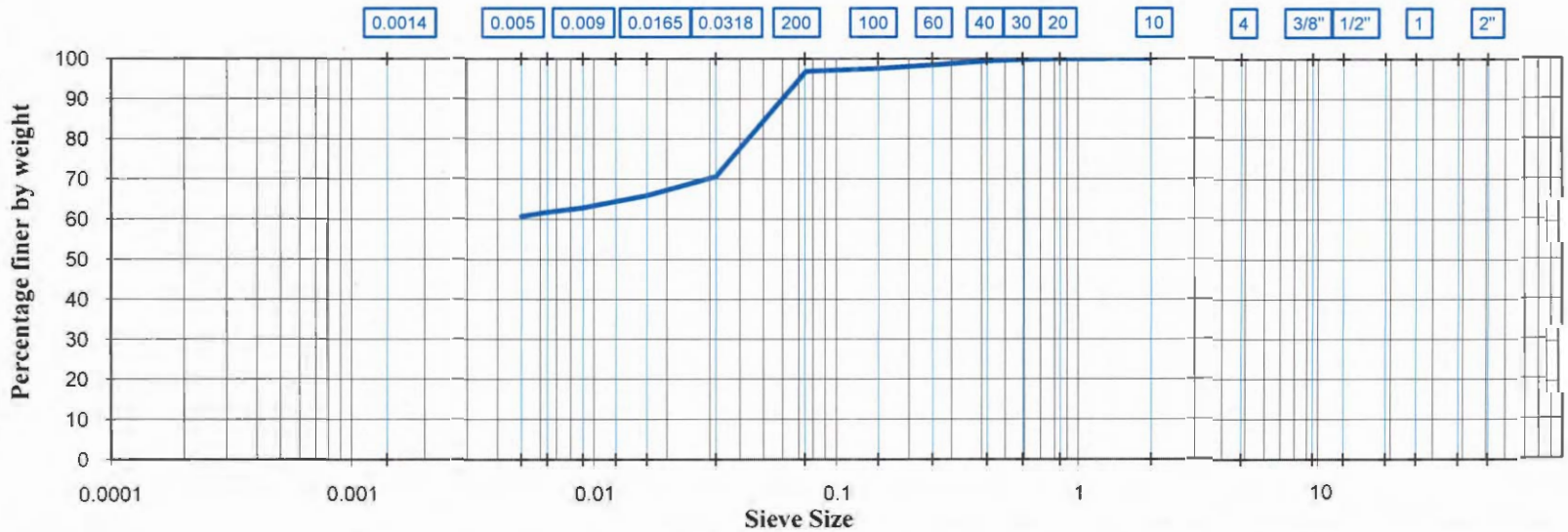
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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	-	66.00	Location : Dam Footprint		

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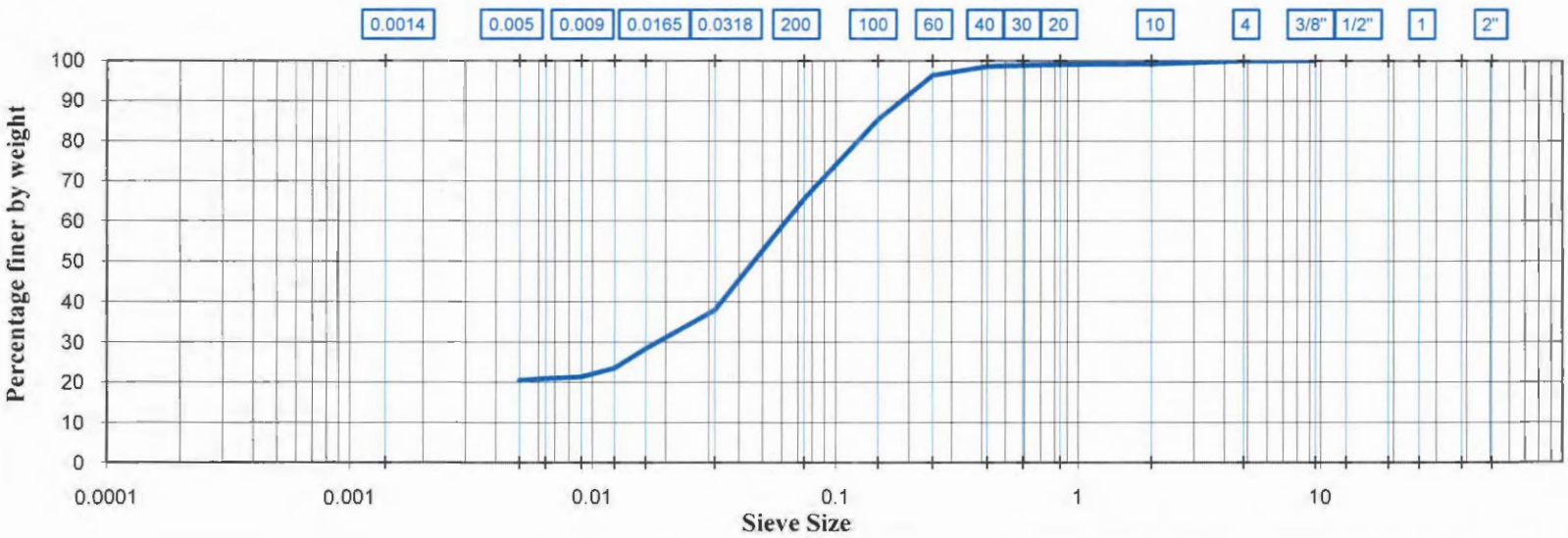
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	3.00	Location : Dam Footprint		

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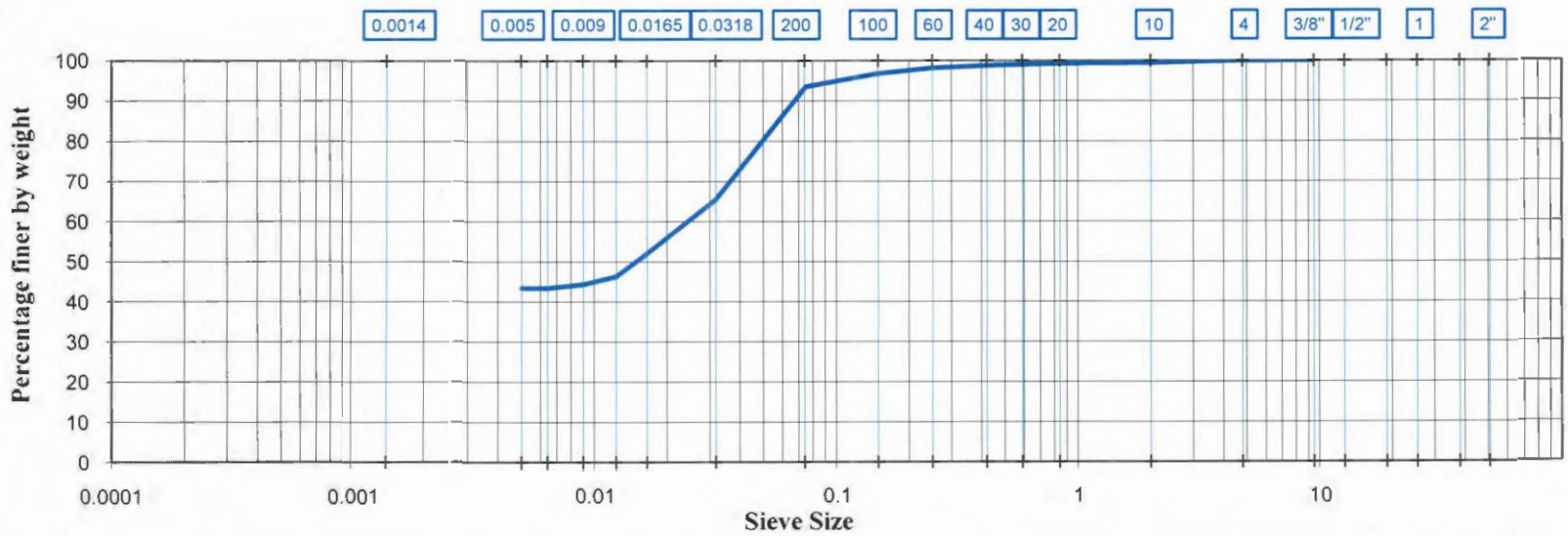
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	4.50	Location : Dam Footprint		

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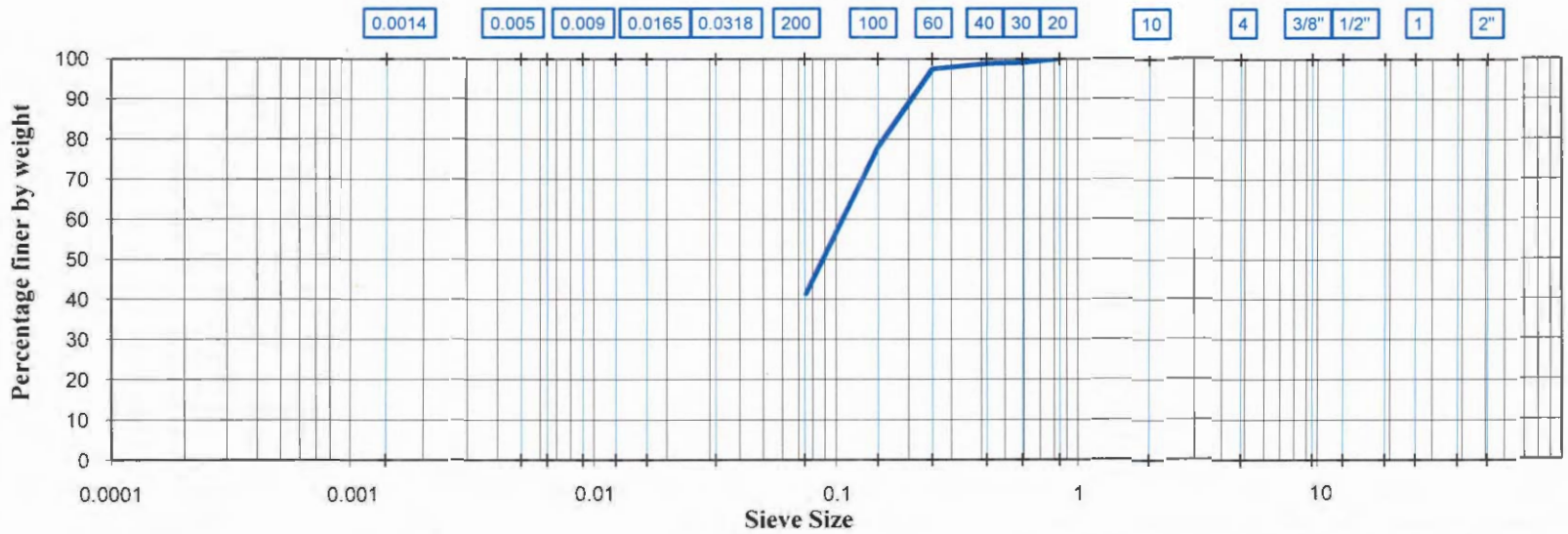
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	6.00	Location : Dam Footprint		

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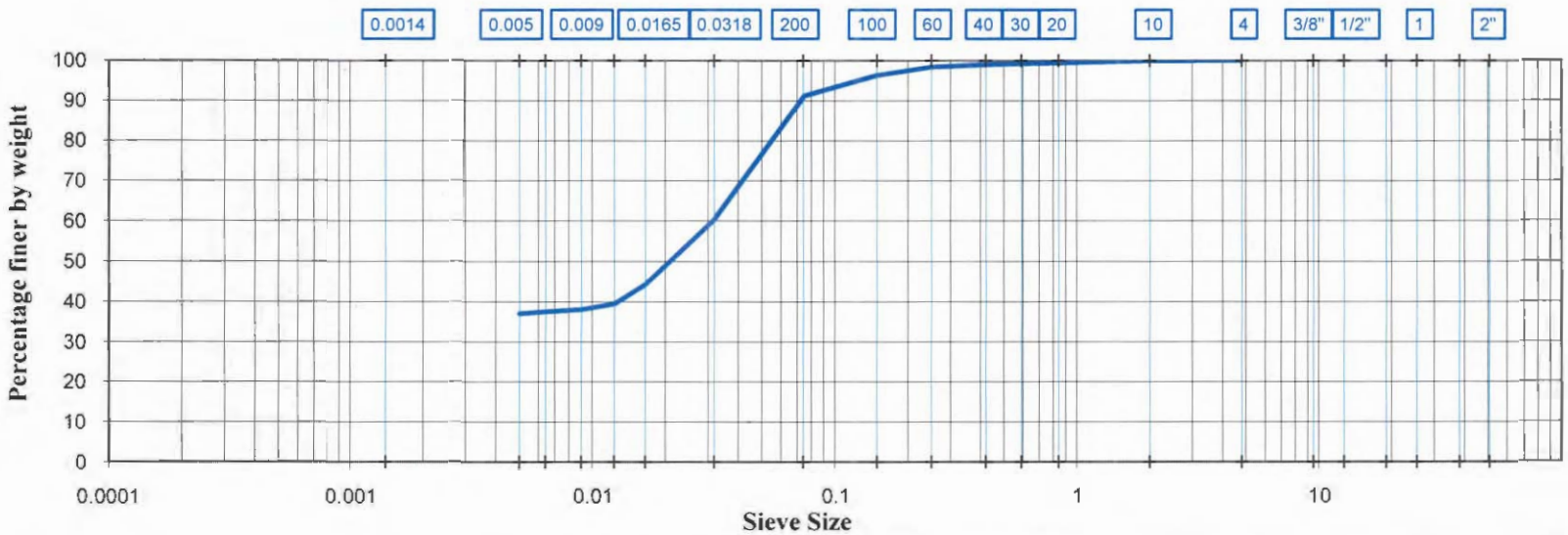
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	7.50	Location : Dam Footprint		

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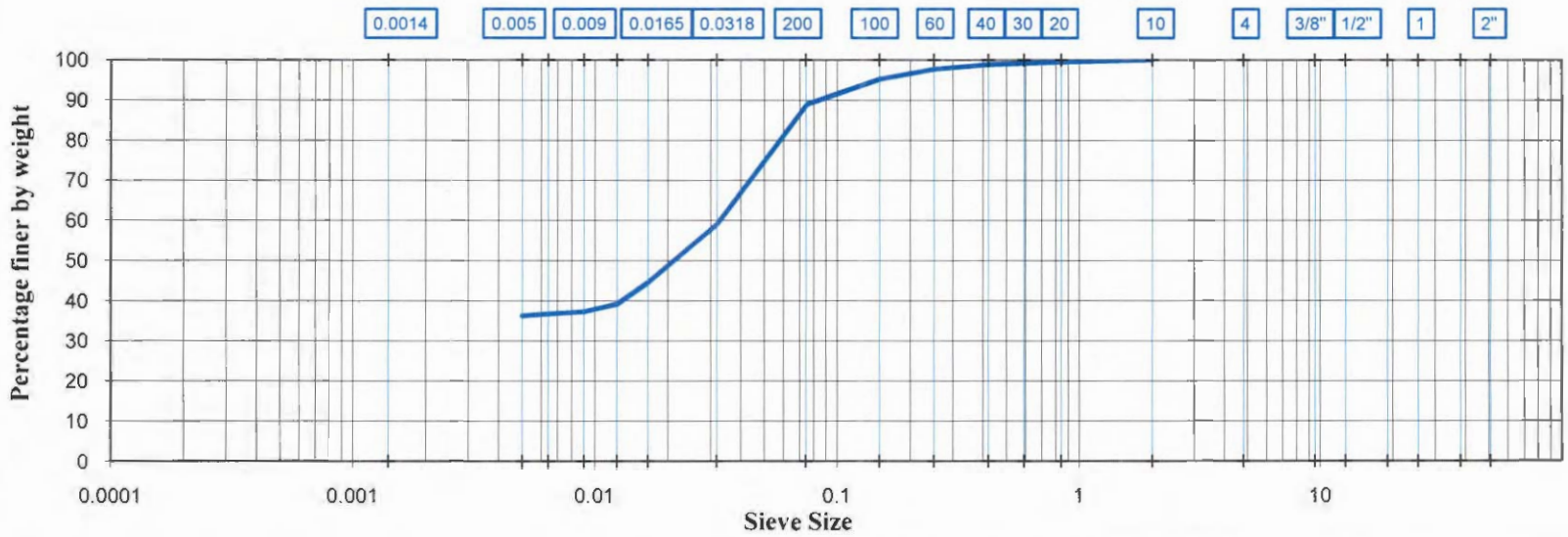
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	9.00	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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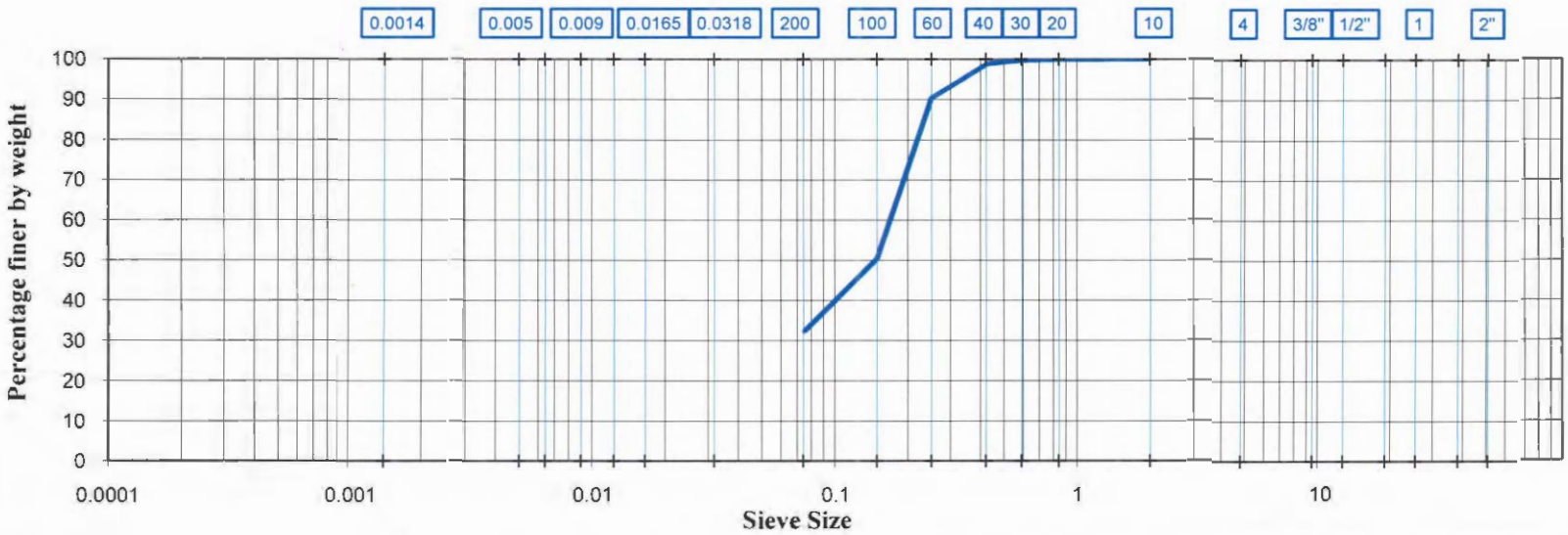

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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		
BHVR3	-	10.50	Location : Dam Footprint		

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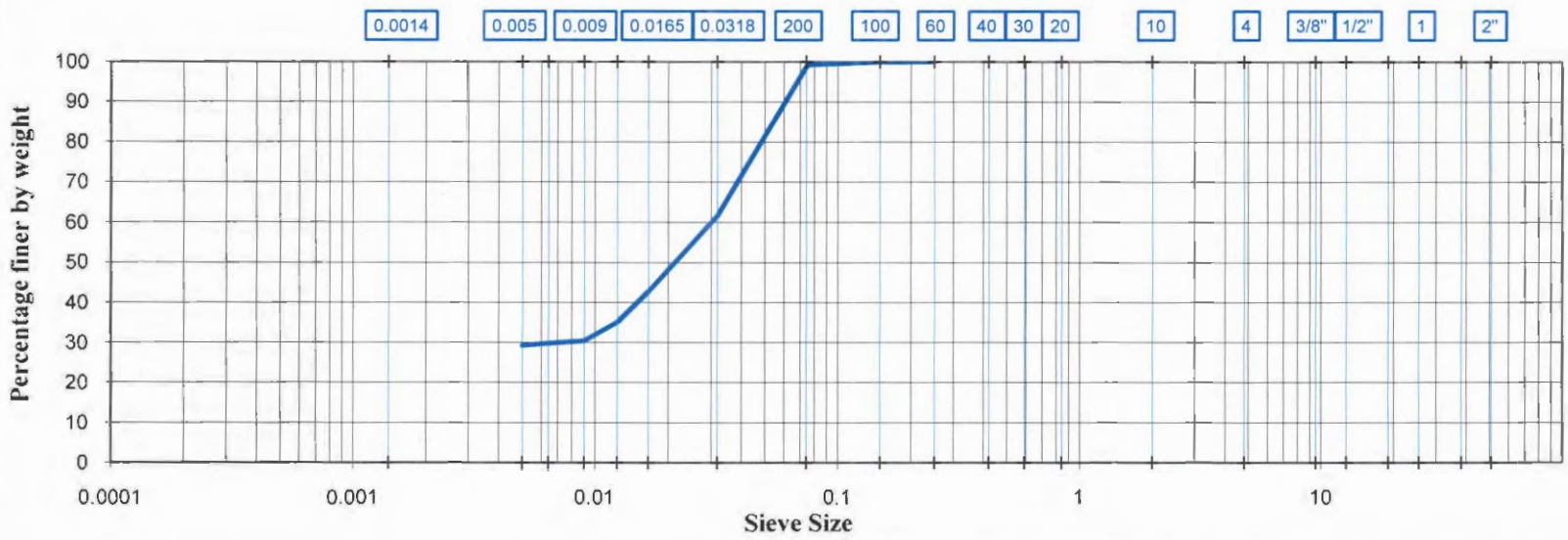
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	13.50	Location : Dam Footprint		

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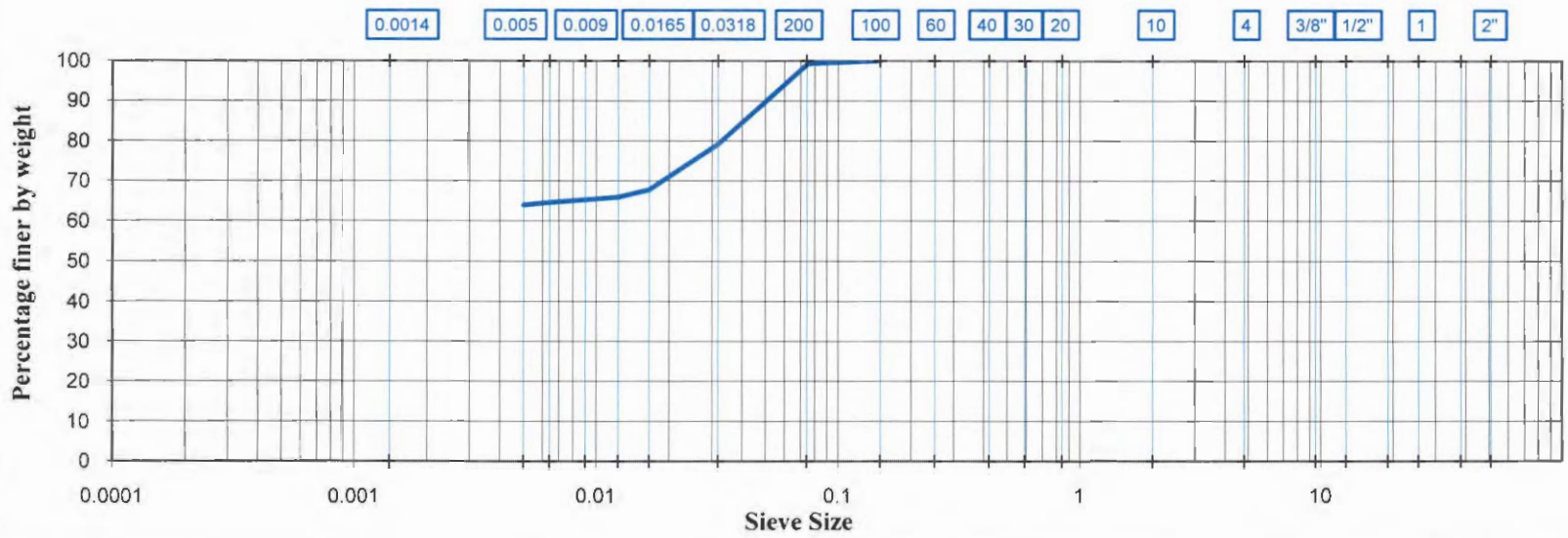
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	16.50	Location : Dam Footprint		

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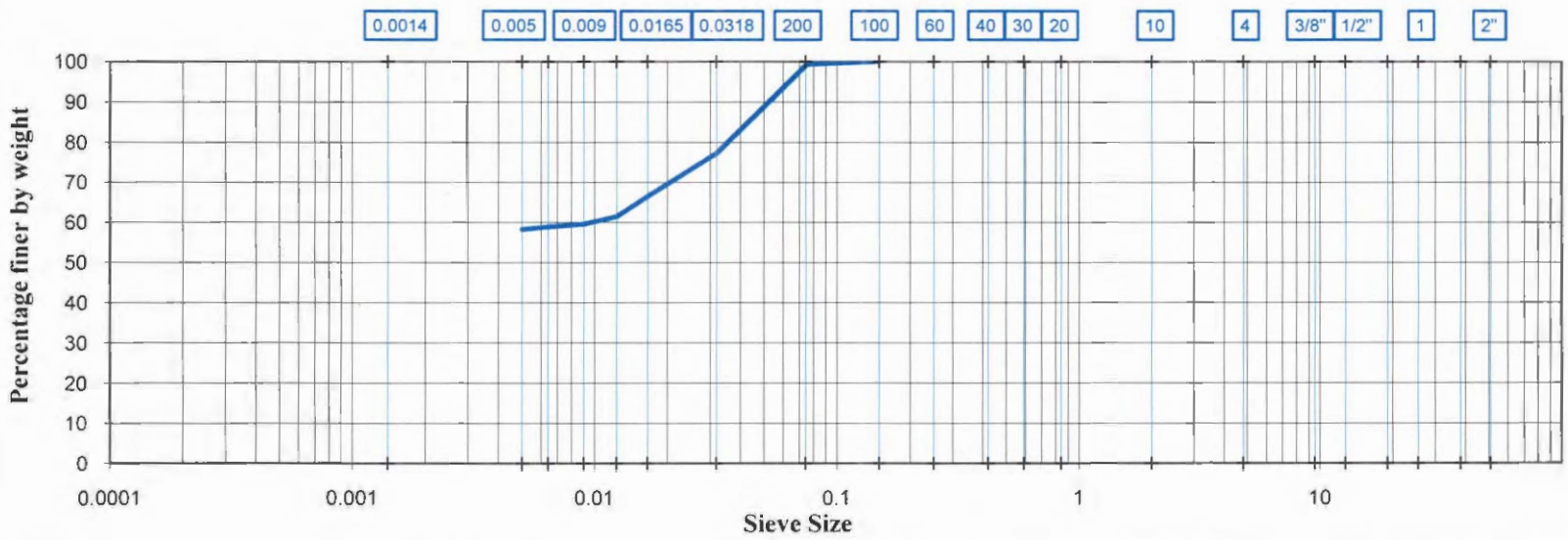
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	21.00	Location : Dam Footprint		

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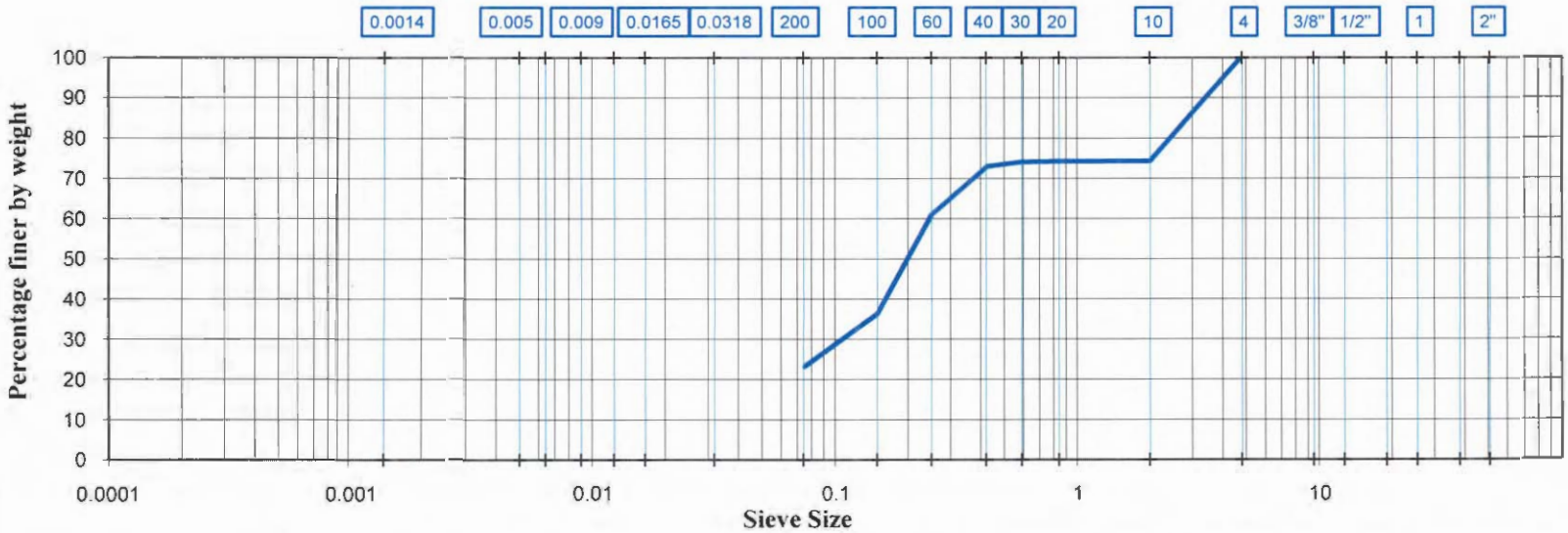
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	24.00	Location : Dam Footprint		

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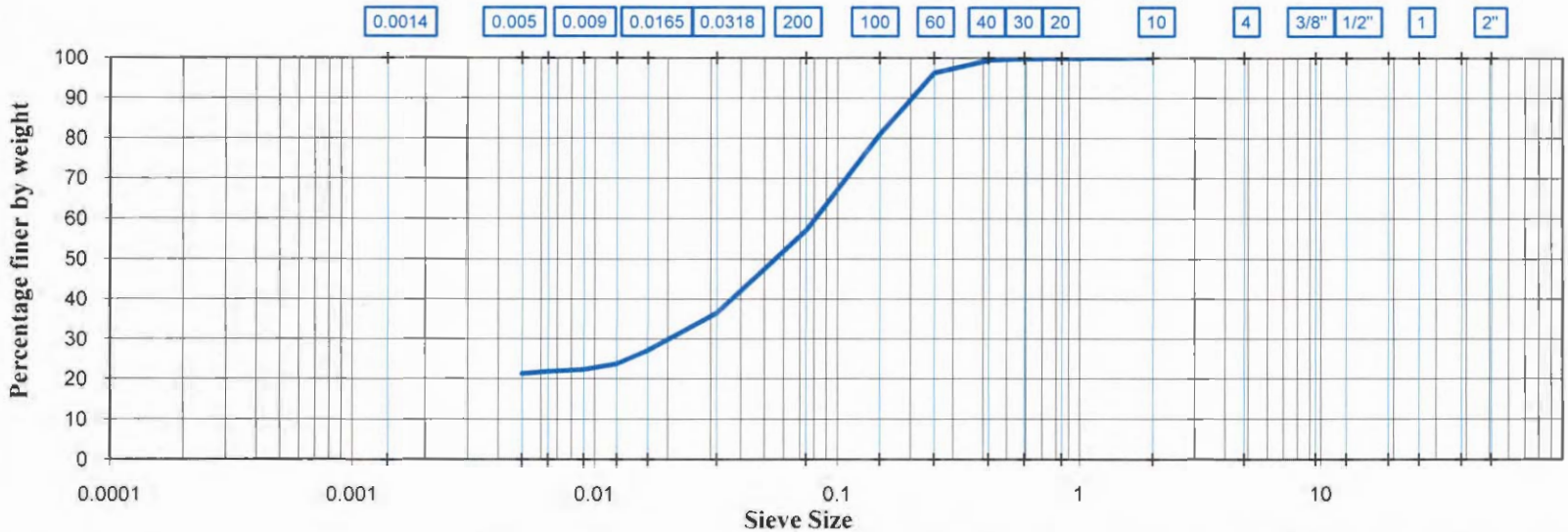
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	27.00	Location : Dam Footprint		

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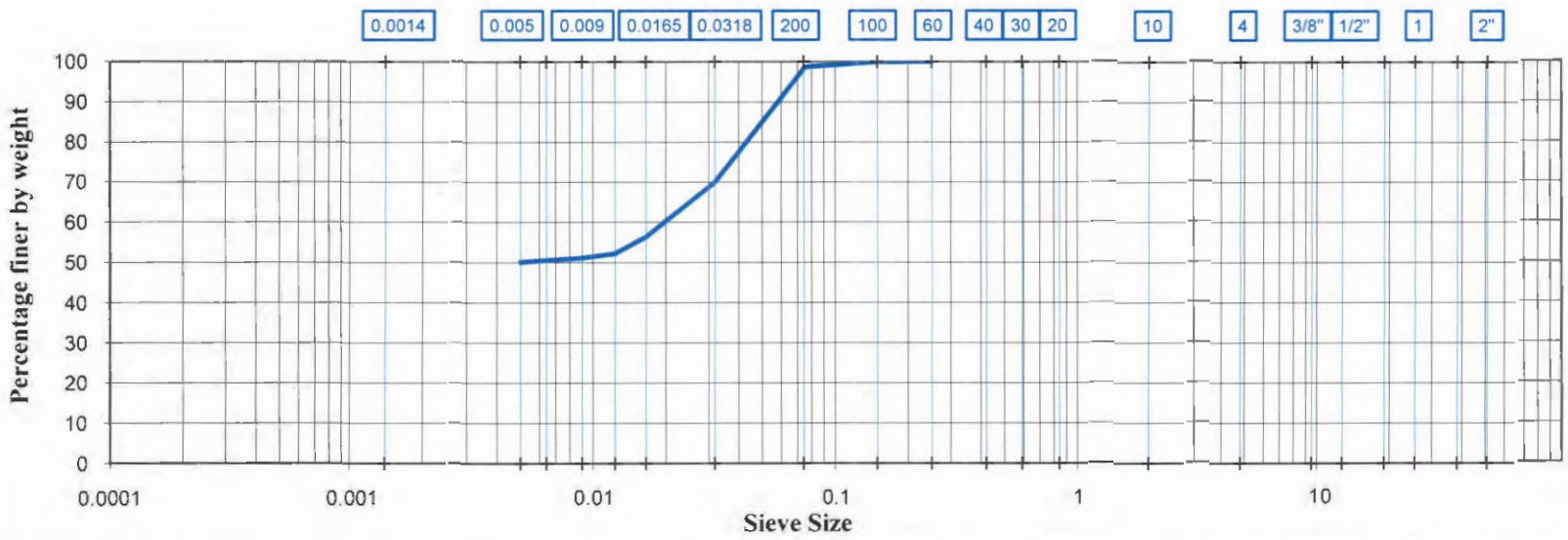
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	30.00	Location : Dam Footprint		

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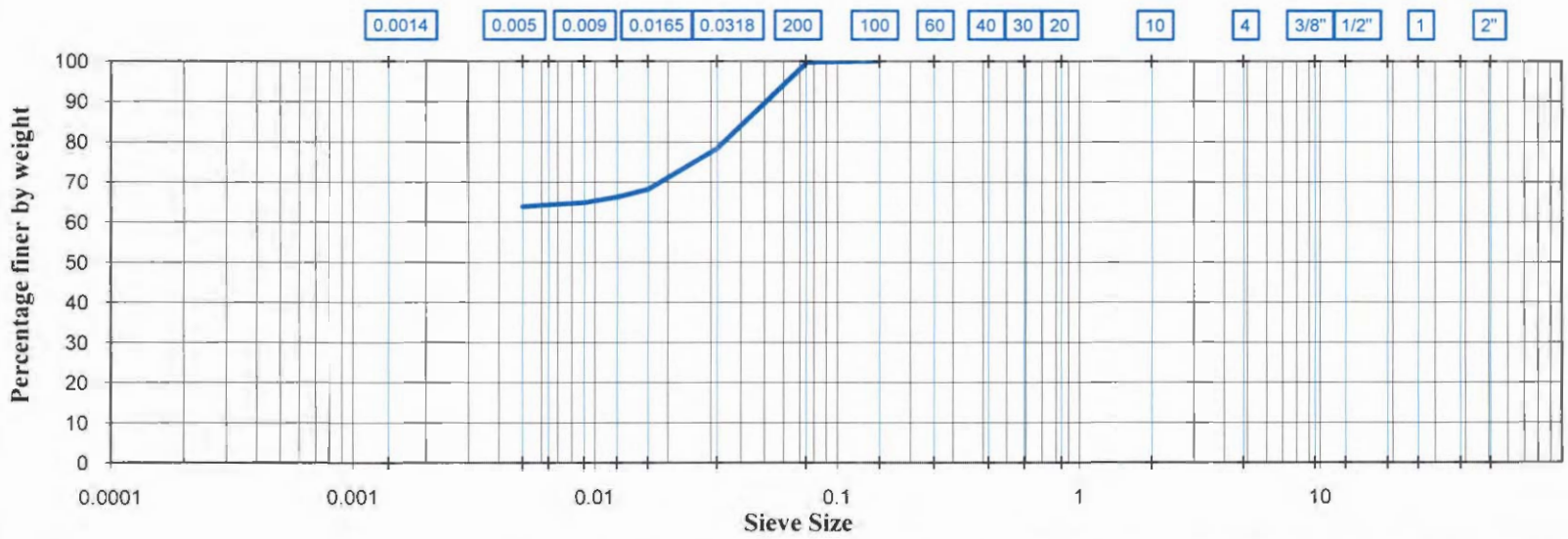
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	34.50	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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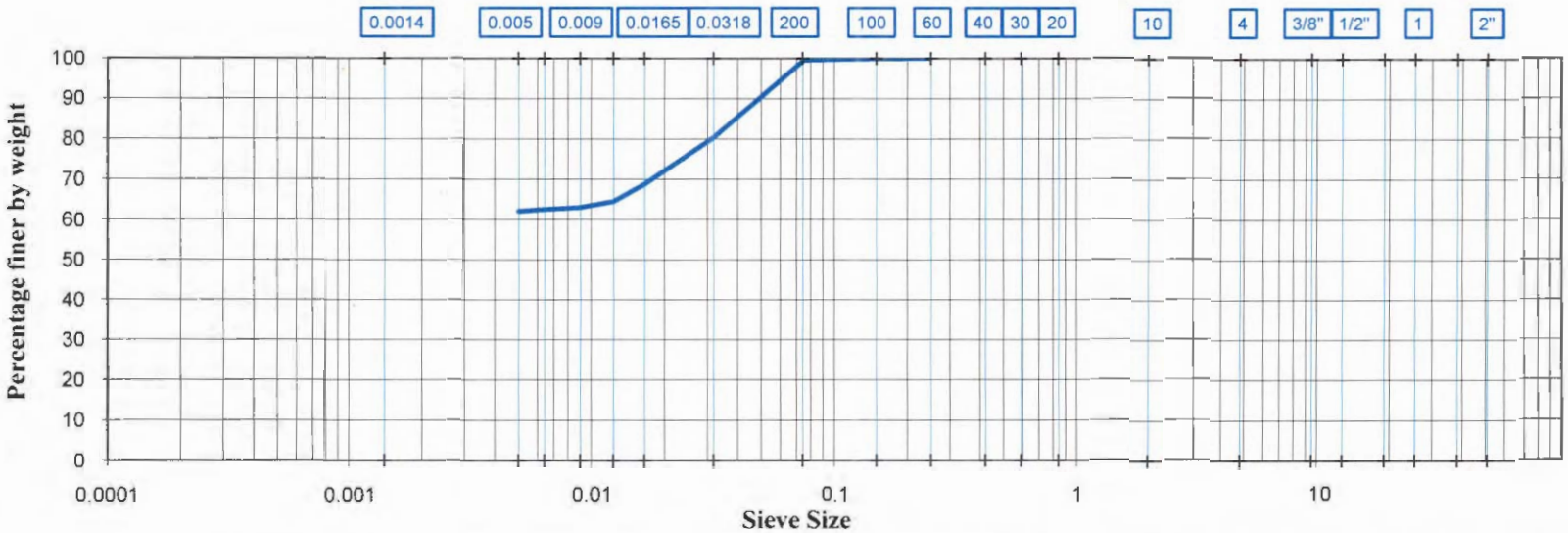

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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		
BHVR3	-	39.00	Location : Dam Footprint		

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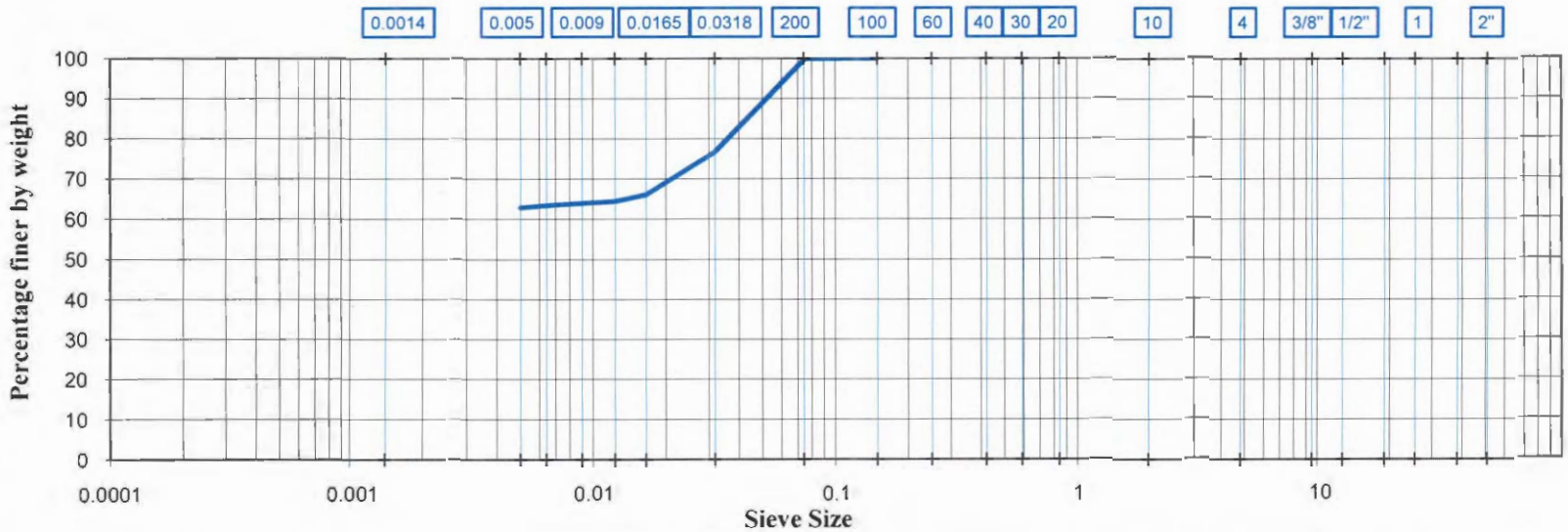
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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		
BHVR3	-	42.00	Location : Dam Footprint		

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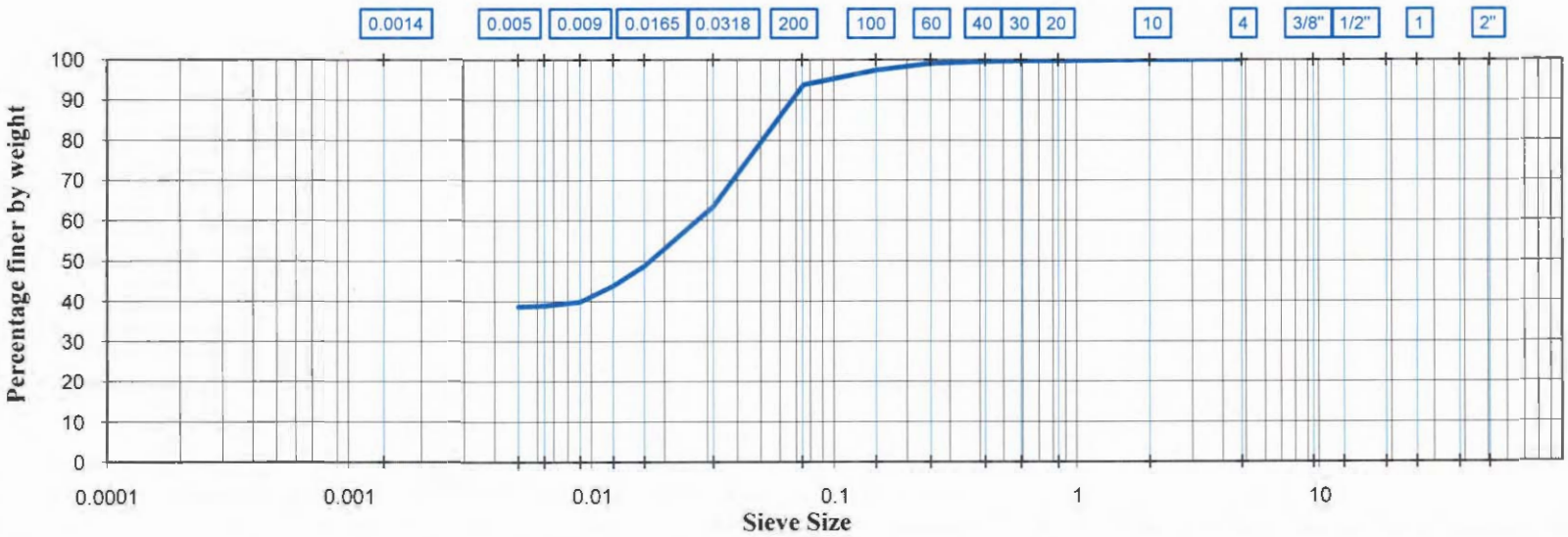
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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	-	3.00	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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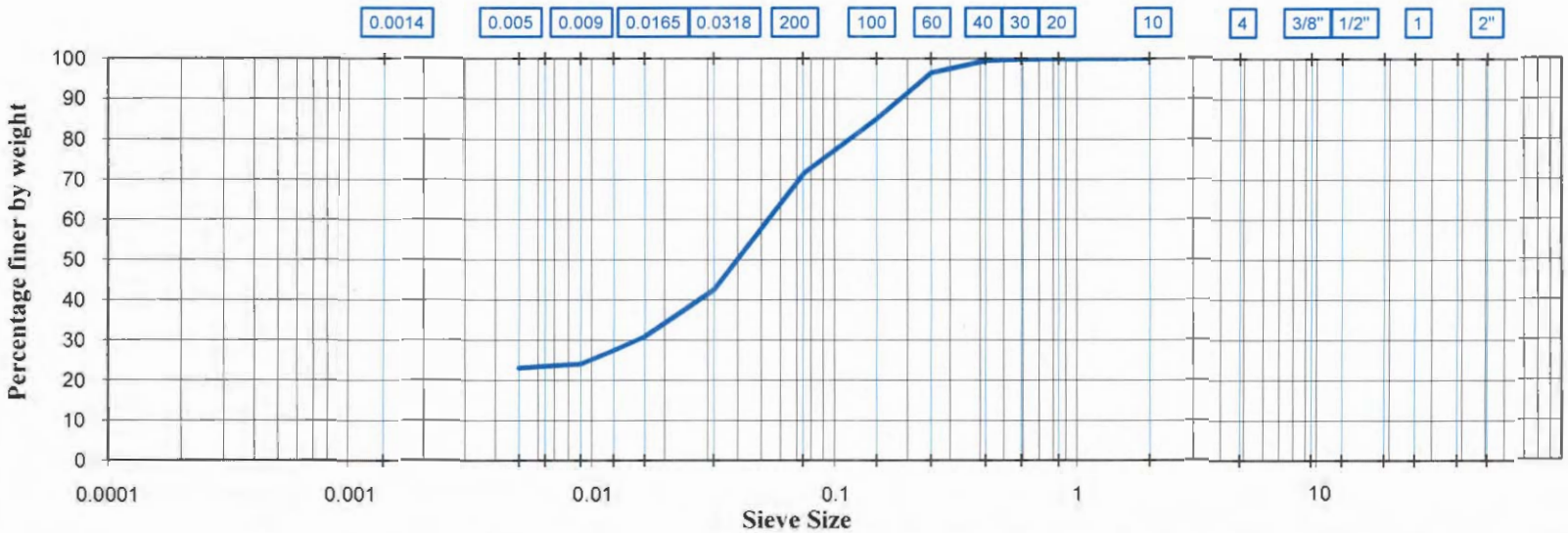

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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		
BHVR5	-	5.5-6.0	Location : Dam Footprint		

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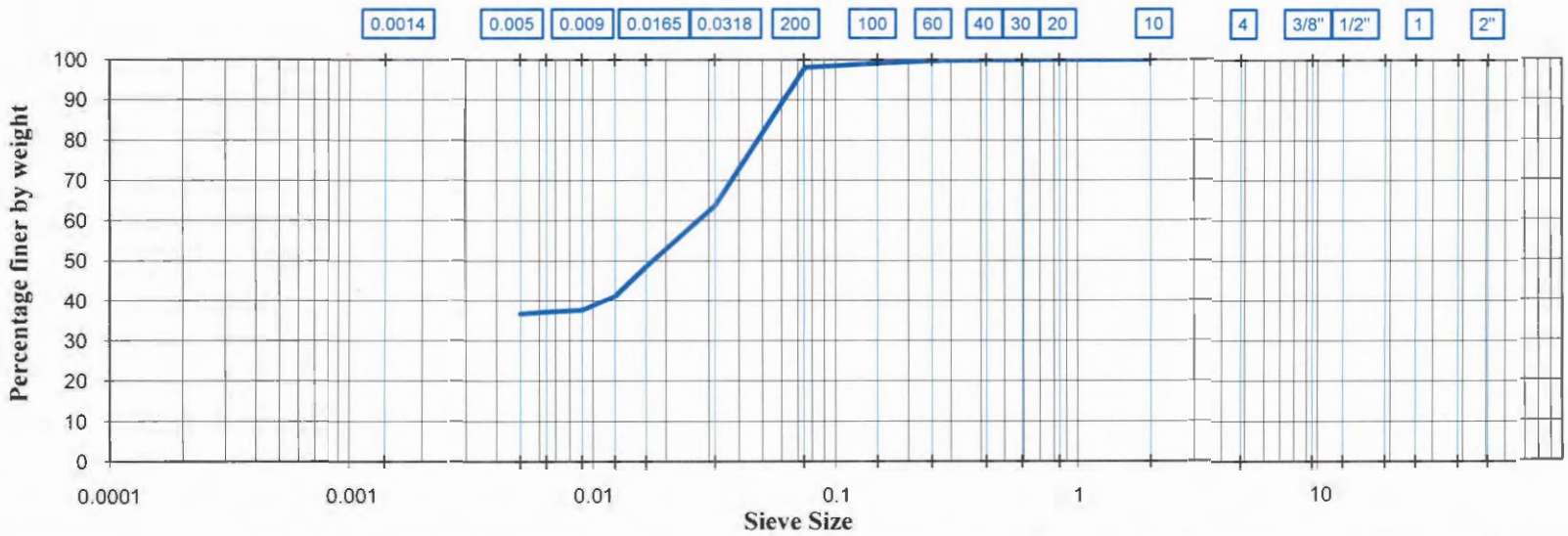
PARTICLE SIZE DISTRIBUTION
ASTM D-422



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	-	9.00	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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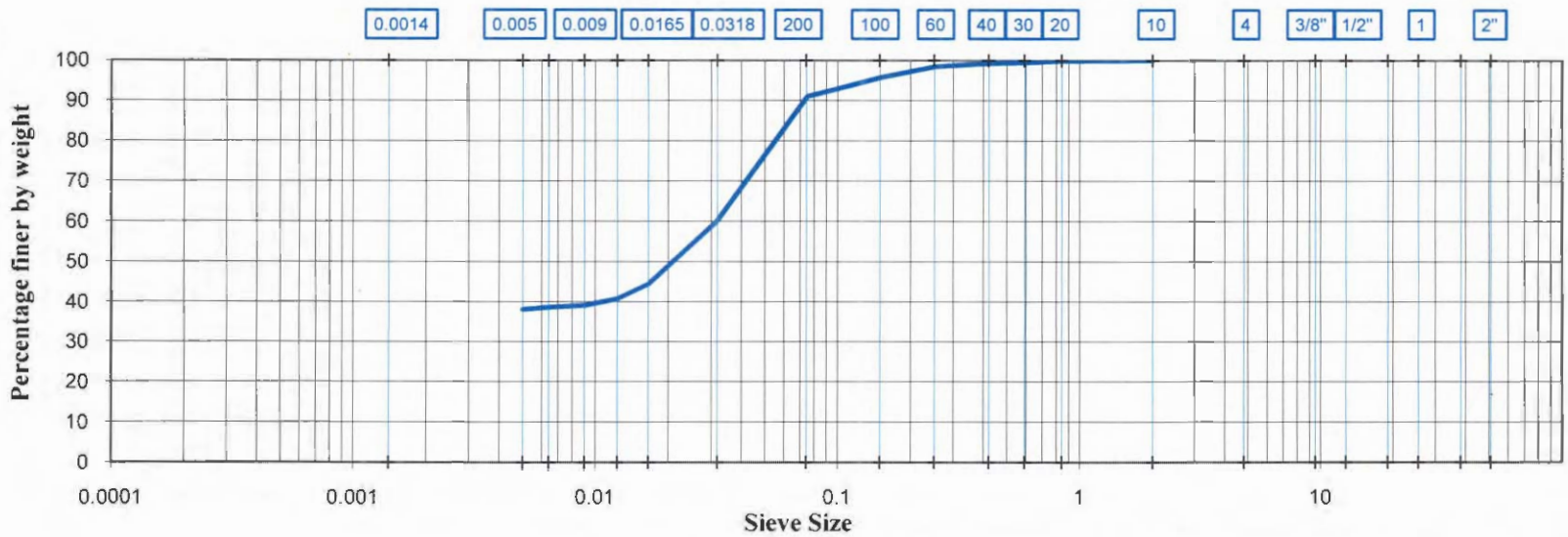

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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		
BHVR5	-	13.50	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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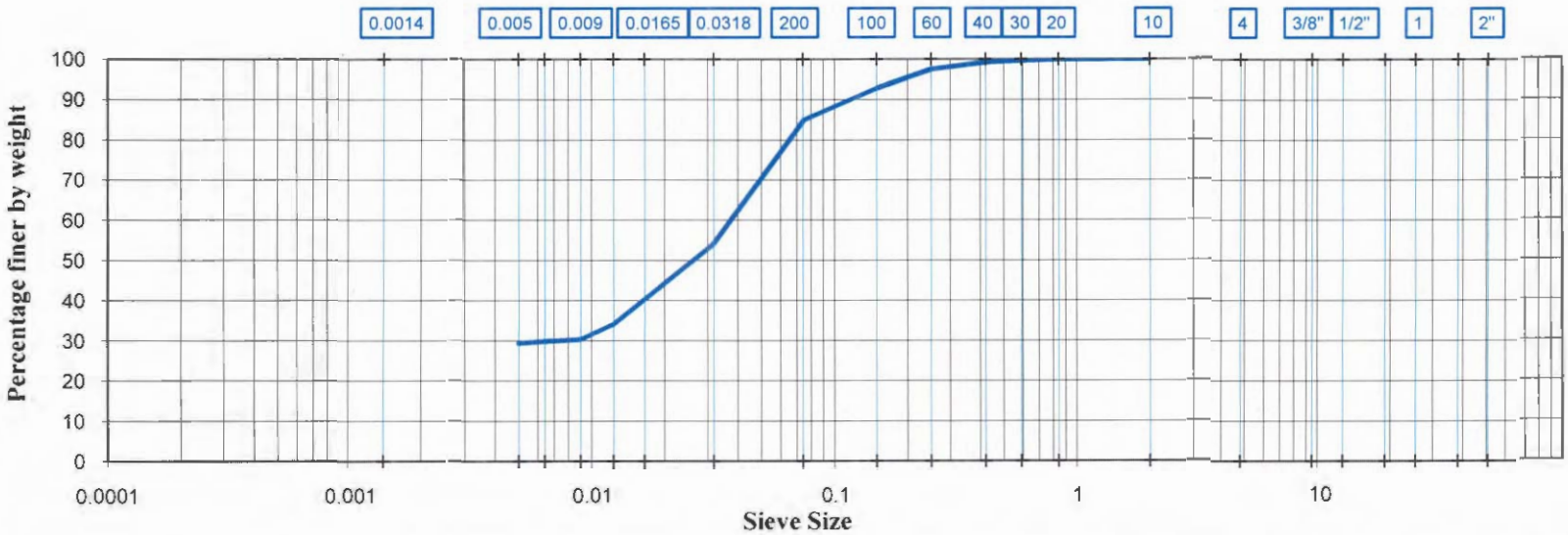

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

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		
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**

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 : 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**

Head of laboratory section

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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
Location : Dam Footprint
Date : 02/05/14

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

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		cm²	g	g/cm³	Kg	kg/cm²
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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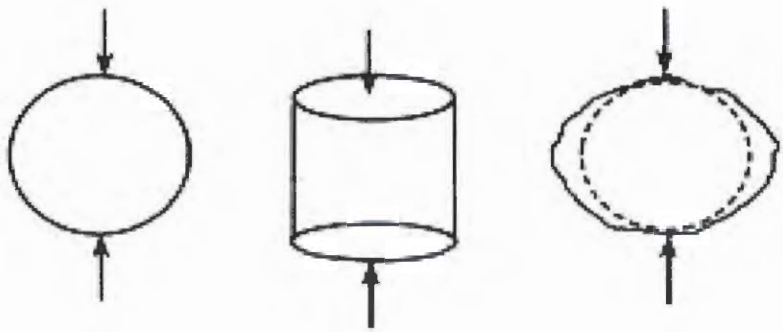
Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 17/04/14

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



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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

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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 : 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 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"	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

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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 : 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

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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

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APPENDIX 3. SECOND PACKAGE

ASSACO S.A.R.L

أساكو ش.م.م.

ENGINEER BILAL ASSAAD MELHEM ASSAAD & Co.

المهندس بلال أسعد ملحم أسعد وشركاه

DESIGN & SUPERVISION - GEOTECHNICAL CONSULTANCY - MATERIALS TESTING

دروس وإشراف - إستشارات جيوتقنية - فحص مواد

M/S DAR AL HANDASAH NAZIH TALEB & PARTNERS SAL

BISRI DAM / DAM FOOTPRINT

LABORATORY TESTING
PACKAGE 2

BOREHOLES: BHVR1 – BHVR2
BHRA1 – BHRA2 – BHRA3 – BHRA4

JULY 2014

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بولفار بشارة الخوري - بناية الوزان - الطابق الأول - تلفون: ٦٣١٨٨٢ - ٦٤٦٩٣٠ (١ - ٩٦١)
فاكس: ٦٤٦٩٣١ (١ - ٩٦١) - مختبر: ٠١/٣٨١١١٩ - E-mail:assaco@terra.net.lb
ص.ب: ١١/٩٢١٧ بيروت - لبنان

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint / Package 2
Date : 11/07/14

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 Gravel %	Sand %	Fines %	Silt %	Clay %	Atterberg limits LL %	PL %	Moist. cont. %	Bulk (Wet) density g/cm³	Saturated dens. g/cm³	Void ratio	Organic content %	SO_4^{--} cont. ppm	CL^- cont. ppm	PH
BHVR1	5.50	CL/ML	0	17	83	45	38	29	21	31.1	2.01	2.05	0.613	5.2	29	63	7.55
	23.50	SM	0	72	28	-	-	-	-	20.0	2.05	2.09	0.421	-	-	-	-
	30.00	SM	0	69	31	-	-	-	-	13.7	1.98	2.01	0.433	-	41	74	7.60
	33.00	CI	0	19	81	31	50	37	22	27.7	1.93	1.99	0.620	5.7	-	-	-
	41.50	CI	0	0	100	27	73	49	26	37.1	2.00	2.06	0.633	6.4	34	66	7.65
	56.50	CH	0	1	99	23	76	51	28	31.1	1.95	1.98	0.629	7.0	-	-	-
	65.50	CH	0	0	100	19	81	54	30	38.3	1.97	2.03	0.634	8.2	31	67	7.64
BHVR2	5.50	CL	0	16	84	37	47	30	19	27.9	2.01	2.06	0.599	2.9	27	73	7.54
	8.50	SM	0	85	15	-	-	-	-	10.8	1.95	1.99	0.405	-	-	-	-
	23.50	CH	0	0	100	26	74	51	25	45.9	1.97	2.05	0.608	6.7	39	72	7.58

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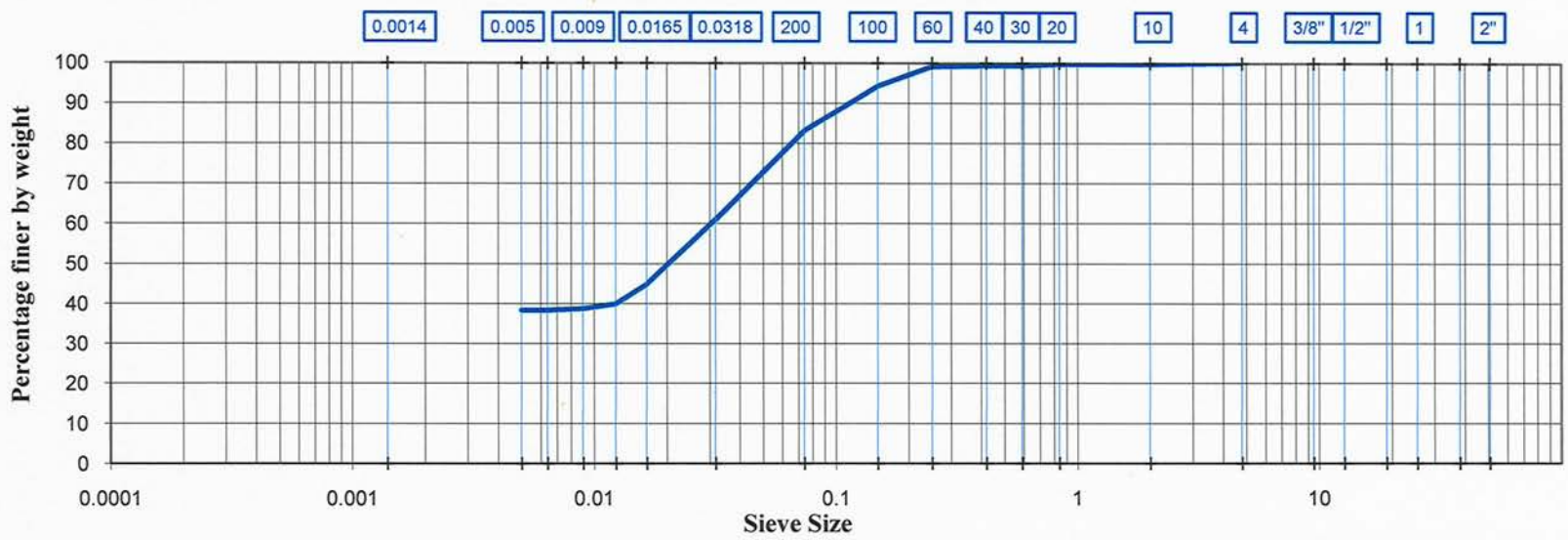
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 24/06/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR1	-	5.50	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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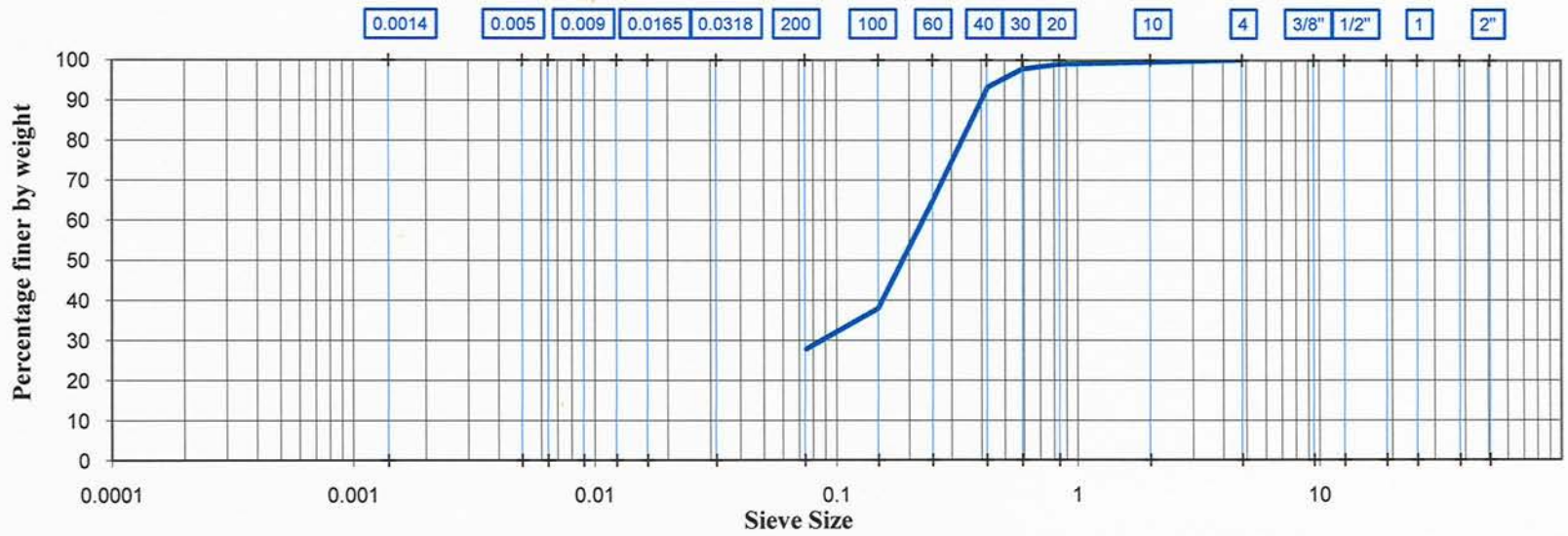

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 24/06/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR1	-	23.50	Location : Dam Footprint		

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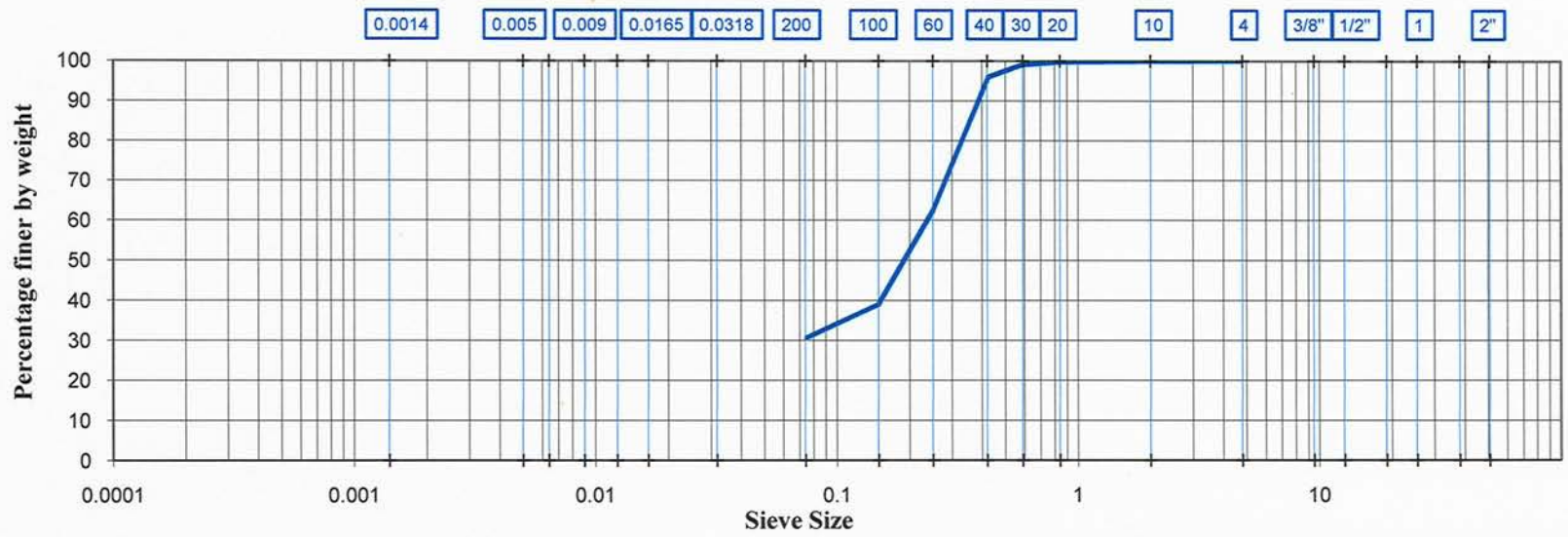

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 24/06/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR1	-	30.00	Location : Dam Footprint		

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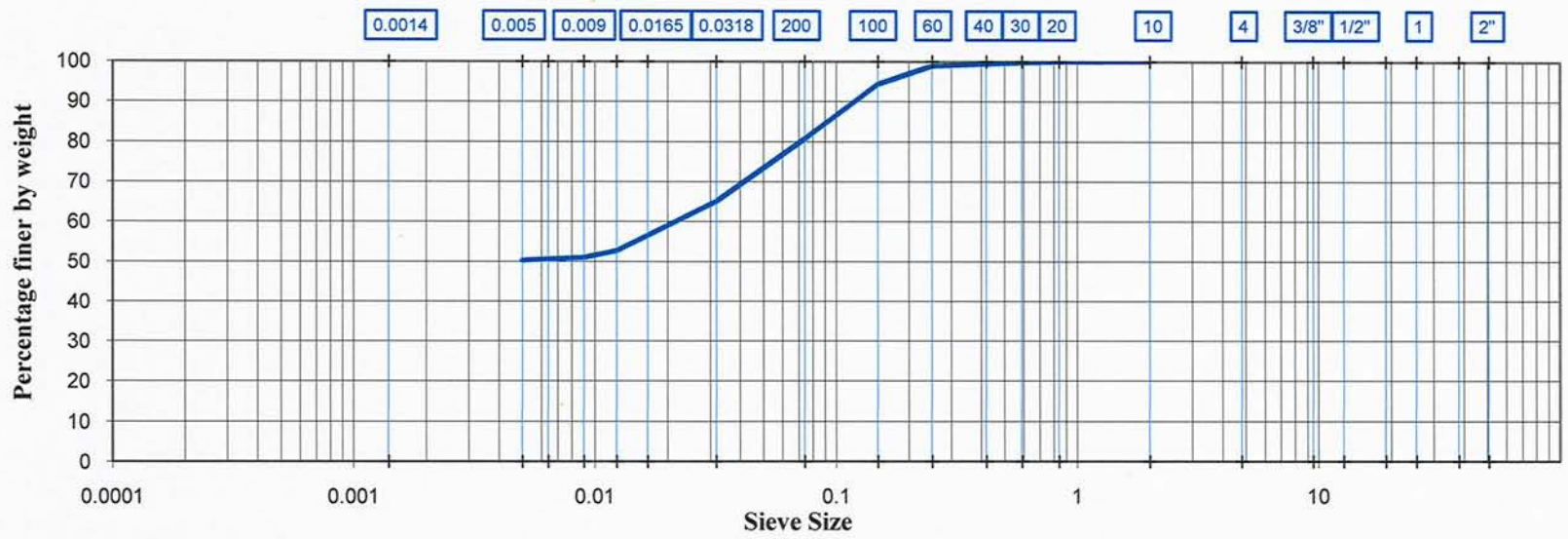

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 24/06/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR1	-	33.00	Location : Dam Footprint		

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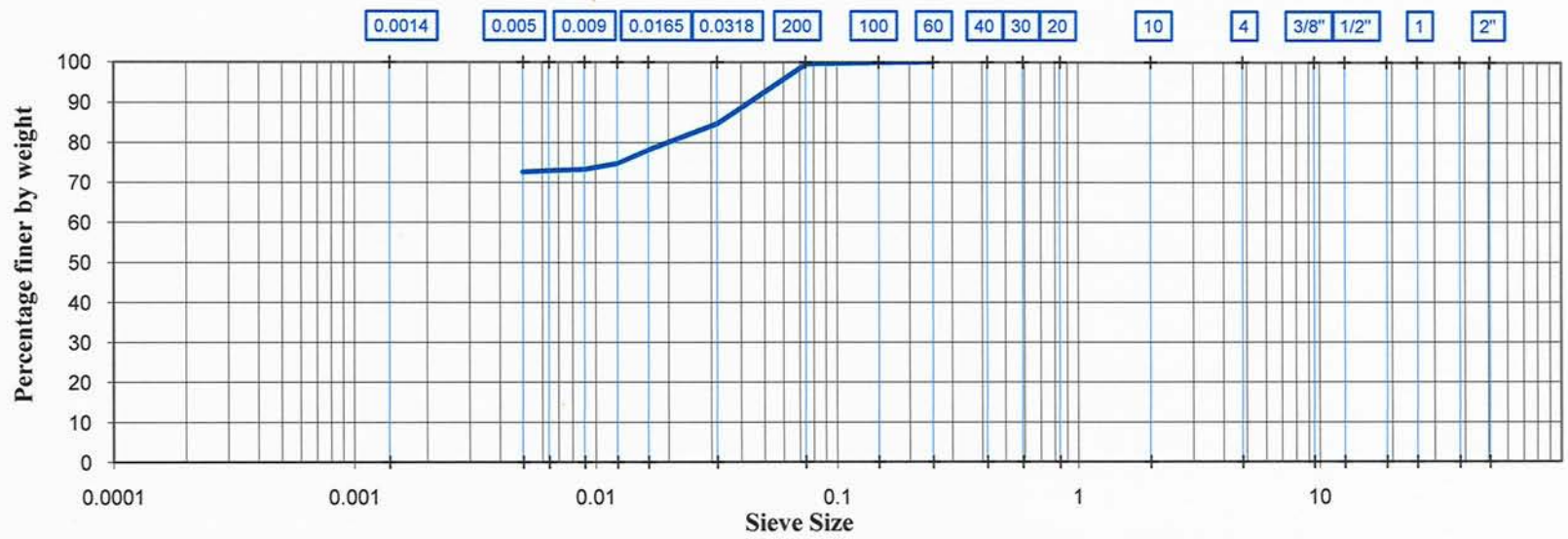

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 24/06/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR1	-	41.50	Location : Dam Footprint		

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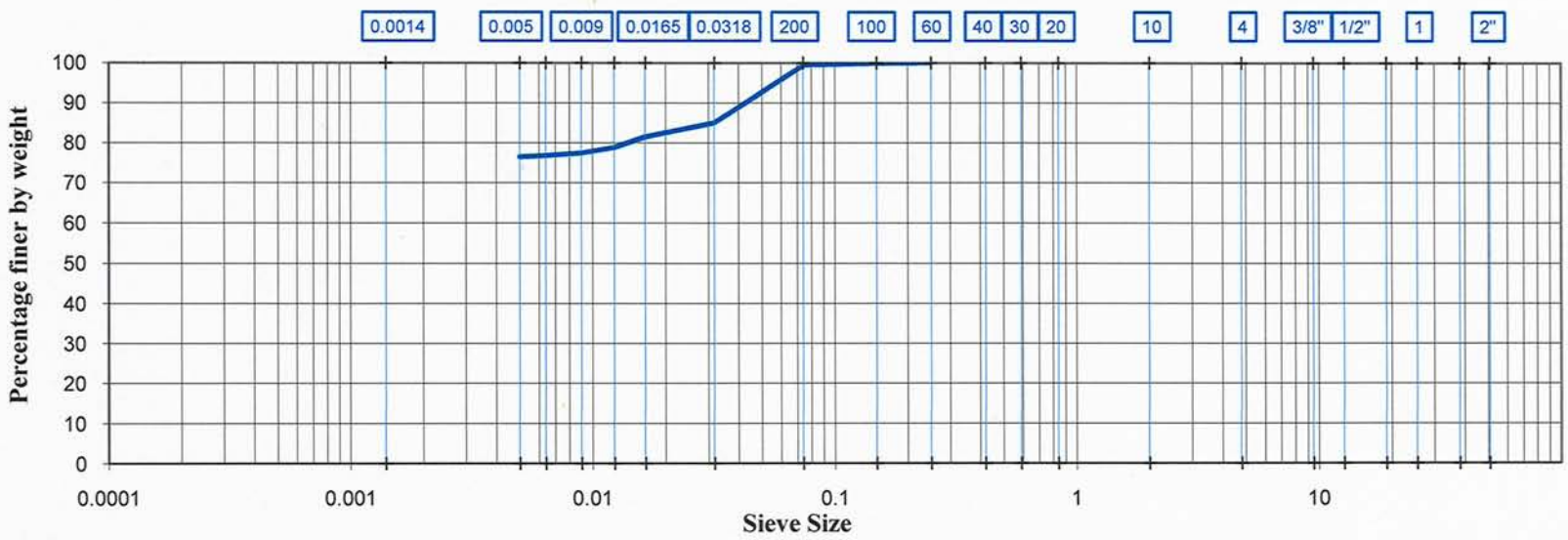

CLAY	SILT	SAND			GRAVEL		Cobbles
		Fine	Medium	Coarse	Fine	Coarse	

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 24/06/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR1	-	56.50	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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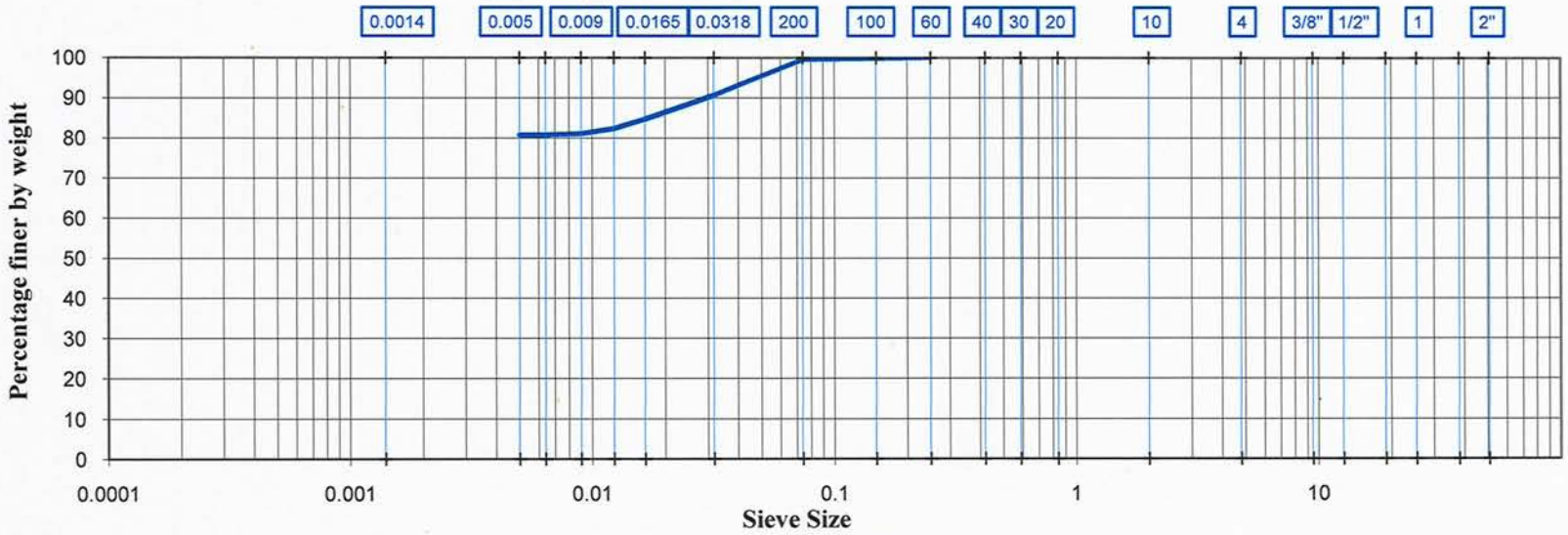

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 24/06/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR1	-	65.50	Location : Dam Footprint		

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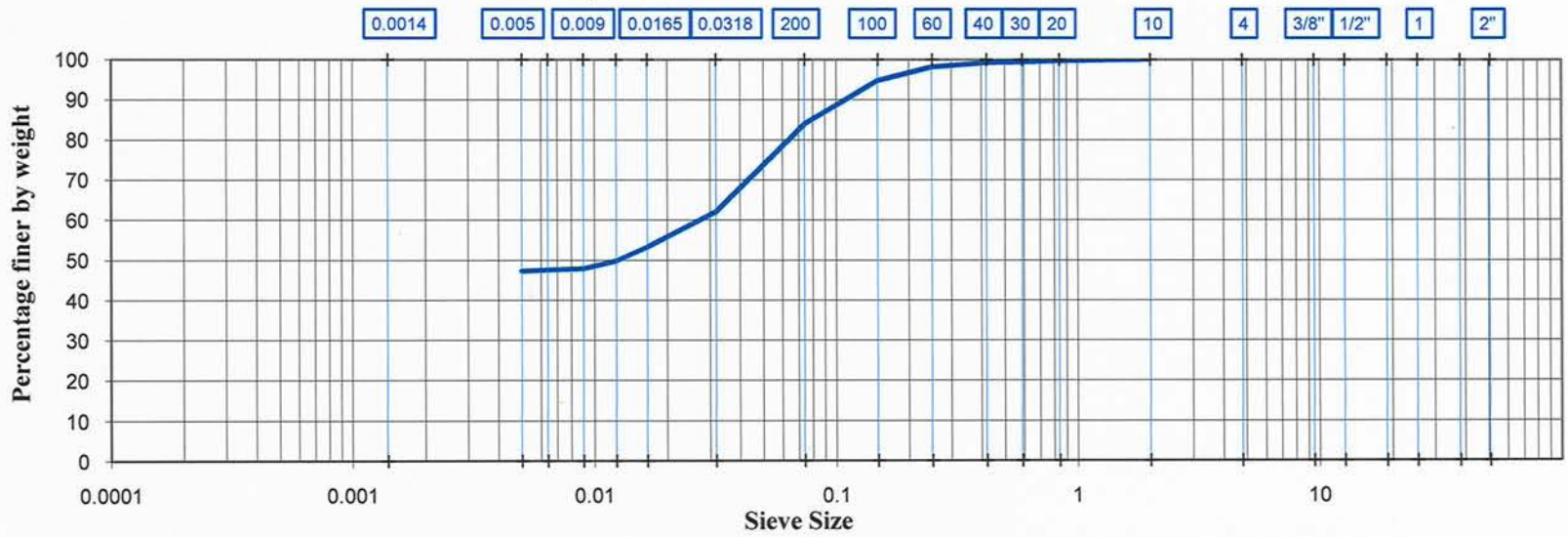

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 24/06/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR2	-	5.50	Location : Dam Footprint		

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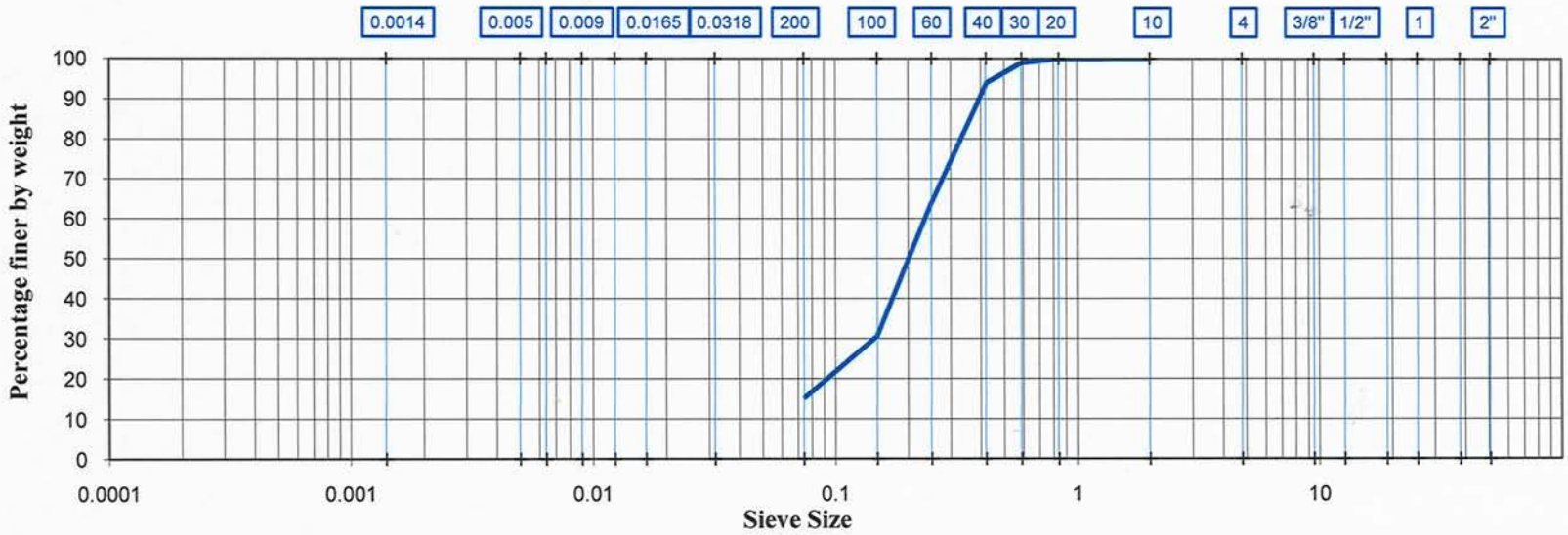

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 24/06/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR2	-	8.50	Location : Dam Footprint		

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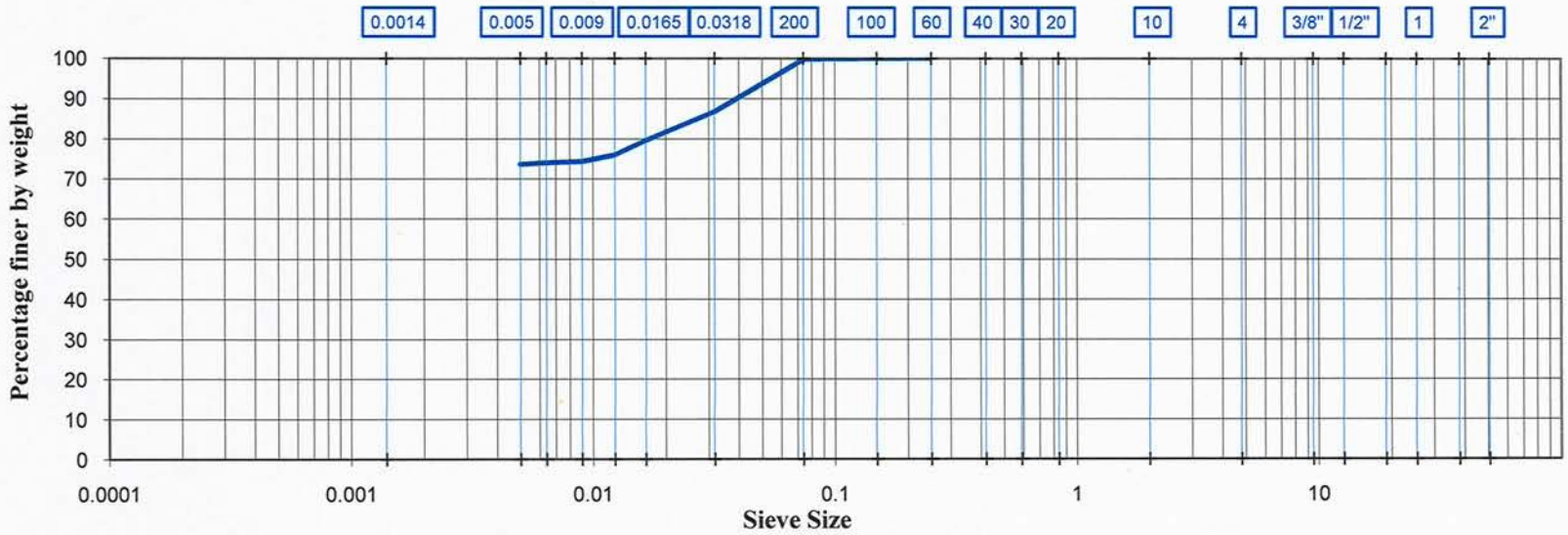
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 24/06/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR2	-	23.50	Location : Dam Footprint		

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Material Testing - Geotechnical Study

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 23/06/14

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		**BHVR1**				
Depth	m	5.50	33.00	41.50	56.50	65.50
CONTAINER NUMBER		1	2	3	4	5
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	28.14	32.28	30.49	34.09	26.95
WT. OF DRY SAMPLE & CONTAINER	g	24.24	26.79	24.07	26.37	21.29
WT. OF WATER	g	3.90	5.49	6.42	7.72	5.66
WT. OF CONTAINER	g	10.91	11.98	10.88	11.21	10.88
WT. OF DRY SAMPLE	g	13.33	14.81	13.19	15.16	10.41
WATER CONTENT (LL)	%	**29**	**37**	**49**	**51**	**54**

PLASTIC LIMIT		**BHVR1**				
Depth	m	5.50	33.00	41.50	56.50	65.50
CONTAINER NUMBER		1	2	3	4	5
WT. OF WET SAMPLE & CONTAINER	g	17.61	18.48	16.81	16.40	16.15
WT. OF DRY SAMPLE & CONTAINER	g	16.44	17.25	15.36	15.20	14.93
WT. OF WATER	g	1.17	1.35	1	1.20	1.22
WT. OF CONTAINER	g	10.99	11.15	9.85	10.94	10.88
WT. OF DRY SAMPLE	g	5.45	6.10	5.51	4.26	4.05
WATER CONTENT (PL)	%	**21**	**22**	**26**	**28**	**30**

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 23/06/14

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		**BHVR2**				
Depth	m	5.50	23.50			
CONTAINER NUMBER		6	7			
NUMBER OF BLOWS		25	25			
WT. OF WET SAMPLE & CONTAINER	g	32.05	28.42			
WT. OF DRY SAMPLE & CONTAINER	g	27.17	22.52			
WT. OF WATER	g	4.88	5.90			
WT. OF CONTAINER	g	10.95	10.97			
WT. OF DRY SAMPLE	g	16.22	11.55			
WATER CONTENT (LL)	%	**30**	**51**			

PLASTIC LIMIT		**BHVR2**				
Depth	m	5.50	33.00			
CONTAINER NUMBER		6	7			
WT. OF WET SAMPLE & CONTAINER	g	14.49	15.38			
WT. OF DRY SAMPLE & CONTAINER	g	13.93	14.49			
WT. OF WATER	g	0.56	0.89			
WT. OF CONTAINER	g	10.98	10.92			
WT. OF DRY SAMPLE	g	2.95	3.57			
WATER CONTENT (PL)	%	**19**	**25**			

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Client: M/S Dar Al Handasah Nazih Taleb & Partners
Project: Bisri Dam
Location: Dam Footprint
Date: 23/06/14

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, %
BHVR1	5.50	68.37	66.92	40.66	5.2
	33.00	70.66	68.89	39.80	5.7
	41.50	40.98	39.41	16.29	6.4
	56.50	74.54	72.12	40.04	7.0
	65.50	43.70	41.49	16.74	8.2
BHVR2	5.50	61.18	60.55	39.75	2.9
	23.50	38.2	36.77	16.71	6.7

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 Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint / Package 2
Date : 12/07/14

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 Mpa	Water Absorption %	Slake Durability Index %	$MgSO_4$ Soundness %	CaCo3 cont. %	$SO3^{--}$ cont. %	CL^{-} cont. %	PH cont.
BHRA1	99.40 - 99.70 Marlstone	2.473	2.567	83	0.19	5.01	85.2	-	61	44	81	7.63
	136.00 - 136.20 Marlstone	2.446	2.536	-	0.13	6.72	76.9	-	50	-	-	-
	142.50 - 142.70 Calcareous Marlstone	2.649	2.683	152	-	3.32	-	6.2	66	35	79	7.54
BHRA2	36.50 - 36.80 Limestone	2.563	2.596	593	-	2.31	-	3.6	95	23	57	7.86
	89.80 - 90.05 Slightly marly limestone	2.605	2.648	463	-	3.08	94.5	-	93	-	-	-
	136.80 - 137.10 Marlstone	2.370	2.403	119	-	3.22	-	5.1	54	41	78	7.60
BHRA3	22.50 - 22.65 Marly limestone	2.662	2.698	-	2.20	1.92	97.0	-	82	33	65	7.57
	52.50 - 52.70 Calcareous Marlstone	2.478	2.517	-	0.59	2.44	86.9	-	65	-	-	-
	76.50 - 76.85 Slightly marly limestone	2.569	2.585	379	2.83	1.16	89.4	-	88	29	58	7.71
BHRA4	72.00 - 72.10 Marlstone	2.436	2.476	-	0.32	-	-	-	63	-	-	-

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 21/06/14

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	cm^2	g	g/cm^3	Kg	kg/cm^2
BHRA1	99.40 - 99.70	6.0	11.9	28.3	863.61	2.567	2345	83
	142.50 - 142.70	6.0	12.1	28.3	918.03	2.683	4293	152
BHRA2	36.50 - 36.80	6.0	11.9	28.3	873.42	2.596	16754	593
	89.80 - 90.05	6.4	12.0	32.2	1022.35	2.648	14908	463
	136.80 - 137.10	6.3	12.0	31.2	899.06	2.403	3722	119
BHRA3	76.50 - 76.85	6.0	11.9	28.3	869.67	2.585	10727	379

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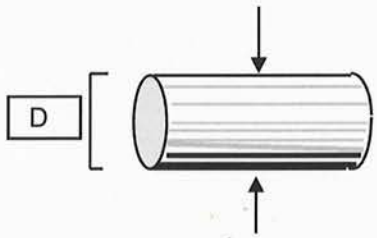
Client : M/S Dar Al Handasah Nazih Taleb & Pa
Project : Bisri Dam
Location : Dam Footprint
Date : 21/06/14

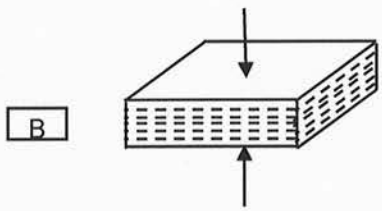
POINT LOAD STRENGTH INDEX TEST
Franklin & Brooch

Borehole no.	Sample depth (m)	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
BHRA1	99.40 - 99.70	A	37	0.3	0.22	0.87	0.19
	136.00 - 136.20	A	41	0.2	0.14	0.91	0.13
BHRA3	22.50 - 22.65	A	59	7.1	2.04	1.08	2.20
	52.50 - 52.70	A	74	2.7	0.49	1.19	0.59
	76.50 - 76.85	A	42	5.4	3.06	0.92	2.83
BHRA4	72.00 - 72.10	A	32	0.4	0.39	0.82	0.32

Remark : The estimated unconfined compressive strength was calculated using a factor K=24.
However the K factor is variable , 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





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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 12/07/14

SLAKE DURABILITY INDEX - ASTM D4644

Sample No.			BHRA1 99.40 - 99.70m	BHRA1 136.00 - 136.20m	BHRA2 89.80 - 90.05m
A	Mass of sample + drum	(g)	770.54	762.17	749.59
B	Mass of oven-dried sample + drum before the first cycle	(g)	759.68	736.97	738.37
C	Mass of drum	(g)	302.08	301.64	302.08
W_F	Mass of oven-dried sample + drum after the second cycle	(g)	692.15	636.54	714.32
W	Natural moisture content	%	1.4	3.4	1.5
Id	Slake durability index	%	85.2	76.9	94.5

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TH/4. Slake durability/ASSACO

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Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 12/07/14

SLAKE DURABILITY INDEX - ASTM D4644

Sample No.			BHRA3 22.50 - 22.65m	BHRA3 52.50 - 52.70m	BHRA3 76.50 - 76.85m
A	Mass of sample + drum	(g)	841.03	866.60	774.42
B	Mass of oven-dried sample + drum before the first cycle	(g)	835.93	858.53	768.66
C	Mass of drum	(g)	302.31	302.74	302.85
W_F	Mass of oven-dried sample + drum after the second cycle	(g)	820.04	785.61	719.17
W	Natural moisture content	%	0.6	0.9	0.8
Id	Slake durability index	%	97.0	86.9	89.4

Head of laboratory section

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Material Testing - Geotechnical Study

TH/4. Slake durability/ASSACO

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 12/07/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D : BHRA1
Depth : 142.5 - 142.7m
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"	21	186.7	175.6	11.1	5.95	1.25
1 1/2"	3/4"	23	241.3	222.9	18.4	7.63	1.75
3/4"	3/8"	29	220.6	201.3	19.3	8.75	2.54
3/8"	No. 4	27	256.8	238.5	18.3	7.13	1.92
Totals		100					6.2

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 12/07/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D : BHRA2
Depth : 36.5 - 36.8 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"	18	173.6	163.2	10.4	5.99	1.08
1 1/2"	3/4"	23	217.8	211.0	6.8	3.12	0.72
3/4"	3/8"	31	258.2	242.8	15.4	5.96	1.85
3/8"	No. 4	28	211.4	203.5	7.9	3.74	1.05
Totals		100					3.6

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 12/07/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D : BHRA2
Depth : 136.8 - 137.1 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"	17	203.1	193.2	9.9	4.87	0.83
1 1/2"	3/4"	23	282.0	266.8	15.2	5.39	1.24
3/4"	3/8"	33	195.6	184.1	11.5	5.88	1.94
3/8"	No. 4	27	216.4	201.0	15.4	7.12	1.92
Totals		100					5.1

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APPENDIX 4. THIRD PACKAGE

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M/S DAR AL HANDASAH NAZIH TALEB & PARTNERS SAL

BISRI DAM / DAM FOOTPRINT

LABORATORY TESTING
PACKAGE 3

BOREHOLES: BHVR4 – BHVR6
BHRA3 – BHRA4

AUGUST 2014

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

Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint / Package 3
Date : 11/08/14

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

Sample I.D	Depth	BS soil classif.	Grain Size distribution					Att. limits		Moist. cont.	Bulk (Wet) density	Saturated density	Void ratio	Shear Box		UCS Modulus	Organic content	$SO4^-$ cont.	CL^- cont.	PH
			Gravel	Sand	Fines	Silt	Clay	LL	PL					C	ϕ					
	m		%	%	%	%	%	%	%	%	g/cm³	g/cm³		kg/cm²	Degree	E (Kg/cm²)	%	ppm	ppm	
BHVR4	3.0	SM	1	62	37	-	-	-	-	8.5	1.710	1.957	0.415	-	-	-	-	-	-	-
	4.5 - 5.0	CI	0	4	96	30	66	43	25	34.7	1.925	1.971	0.563	0.36	24	63.15	4.0	34	81	7.75
	8.5	CL	0	25	75	18	57	32	20	-	-	-	-	-	-	-	7.0	-	-	-
	12.0	SM	0	74	26	-	-	-	-	15.3	2.369	2.156	0.439	-	-	-	-	25	73	7.52
	16.5	SM	0	79	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	17.8 - 18.0	CL	0	45	55	16	39	27	19	19.3	-	-	0.557	-	-	-	5.1	30	69	7.66
	19.5 - 20.0	MS/SM	0	50	50	41	9	0	0	29.7	1.889	1.934	-	0.12	34	110.15	4.5	-	-	-
	23.5	CH	0	1	99	33	66	54	29	37.4	1.919	1.871	0.614	-	-	-	4.3	41	88	7.71
	26.5	CI	0	15	85	26	59	37	23	-	-	-	-	-	-	-	3.4	-	-	-
	29.0 - 29.5	CI	0	28	72	22	50	39	23	34.2	1.941	2.184	0.605	0.29	26	78.57	5.5	43	85	7.68
	32.5	CH	0	0	100	16	84	68	32	-	-	-	-	-	-	-	6.6	-	-	-
	38.5	CH	0	1	99	19	80	57	27	37.0	2.025	1.896	0.623	-	-	-	4.4	49	86	7.72

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint / Package 3
Date : 11/08/14

ASSACO

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 Gravel %	Sand %	Fines %	Silt %	Clay %	Att. limits LL %	PL %	Moist. cont. %	Bulk (Wet) density g/cm³	Saturated density g/cm³	Void ratio	Shear Box C kg/cm²	ϕ Degree	UCS Modulus E (Kg/cm²)	Organic content %	$SO4^-$ cont. ppm	CL^- cont. ppm	PH
BHVR6	2.5	CL	0	20	80	35	45	31	19	23.3	2.020	2.026	0.693	-	-	-	3.6	-	-	-
	5.5	CL	0	20	80	29	51	34	20	24.4	2.082	2.091	0.615	-	-	-	4.1	36	74	7.78
	8.5	CL	0	16	84	32	52	32	19	25.9	2.020	2.024	0.597	-	-	-	-	-	-	-
	11.5	SM/SC	0	53	47	14	33	22	0	24.2	2.005	2.007	-	-	-	-	-	31	69	7.60
	14.5	SP	0	97	3	-	-	-	-	5.7	1.557	1.608	0.408	-	-	-	-	-	-	-
	22.5	SM	0	79	21	-	-	-	-	11.8	2.262	2.266	0.422	-	-	-	-	26	61	7.51
	27.0	SM	6	70	24	-	-	-	-	11.6	-	-	-	-	-	-	-	-	-	-
	28.5	SM	1	77	22	-	-	-	-	11.7	2.094	2.156	0.416	-	-	-	-	29	63	
	30.0	SM	4	79	17	-	-	-	-	13.8	-	-	-	-	-	-	-	-	-	-
	32.5	CL	0	40	60	23	37	33	21	27.0	1.997	2.006	0.534	-	-	-	3.1	33	71	7.53
	38.5	CI	0	15	85	32	53	43	22	29.1	1.894	1.906	0.619	-	-	-	3.8	-	-	-
	44.5	CI	0	20	80	28	52	39	25	34.0	1.894	1.911	-	-	-	-	-	41	78	7.59
	47.5	CI/CH	0	1	99	28	71	50	32	33.4	2.083	2.101	0.627	-	-	-	9.5	-	-	-
	57.5	CI	0	3	97	28	69	45	25	33.4	-	-	-	-	-	-	-	48	83	7.81
	68.0	CH	0	0	100	24	76	54	26	33.3	2.235	2.247	0.634	-	-	-	3.9	-	-	-

Head of laboratory section

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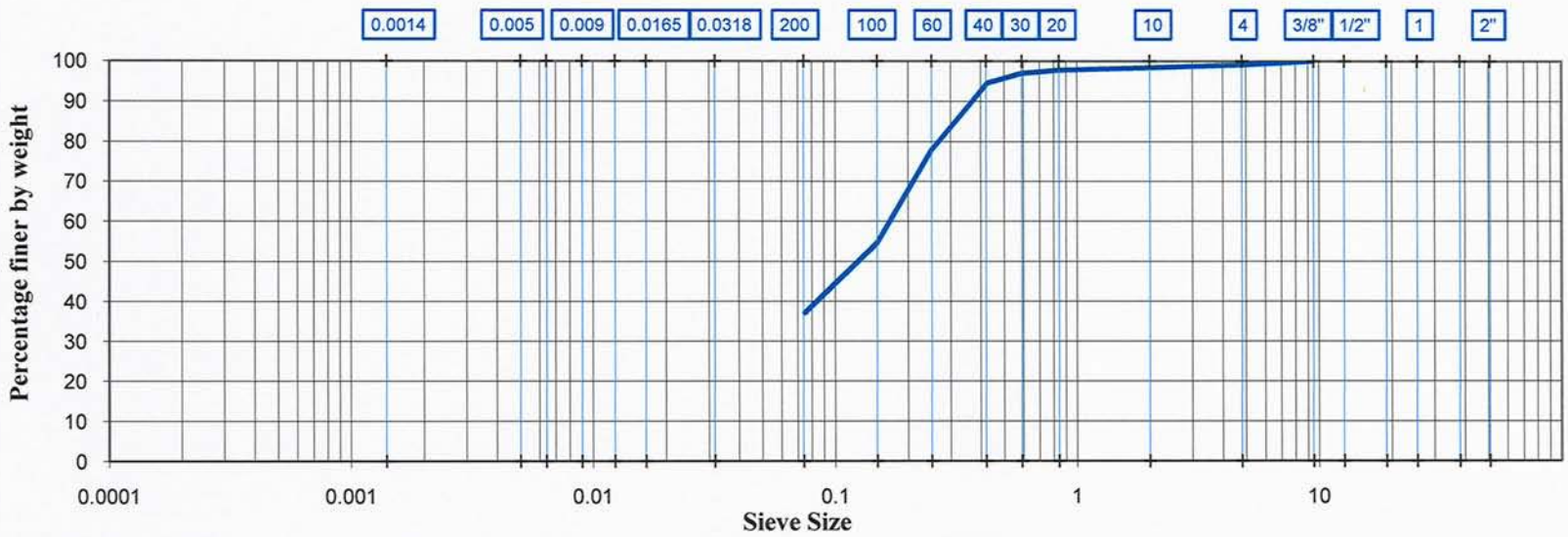
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	3.00	Location : Dam Footprint		

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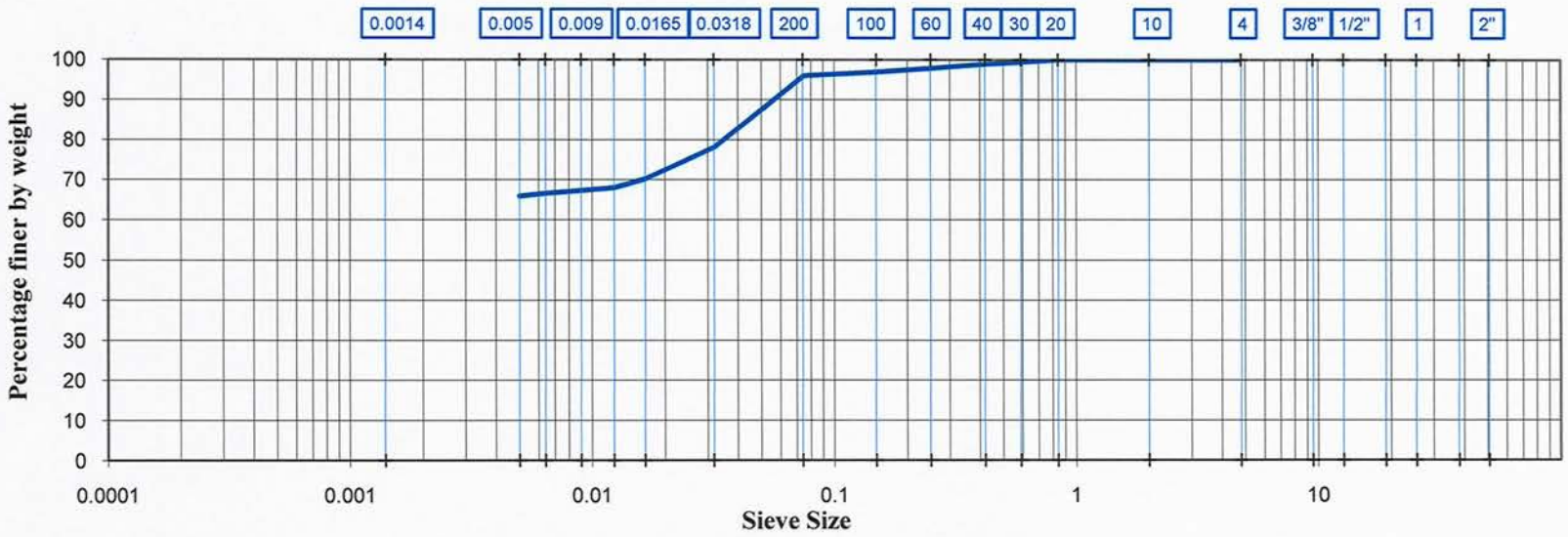

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	4.50-5.00	Location : Dam Footprint		

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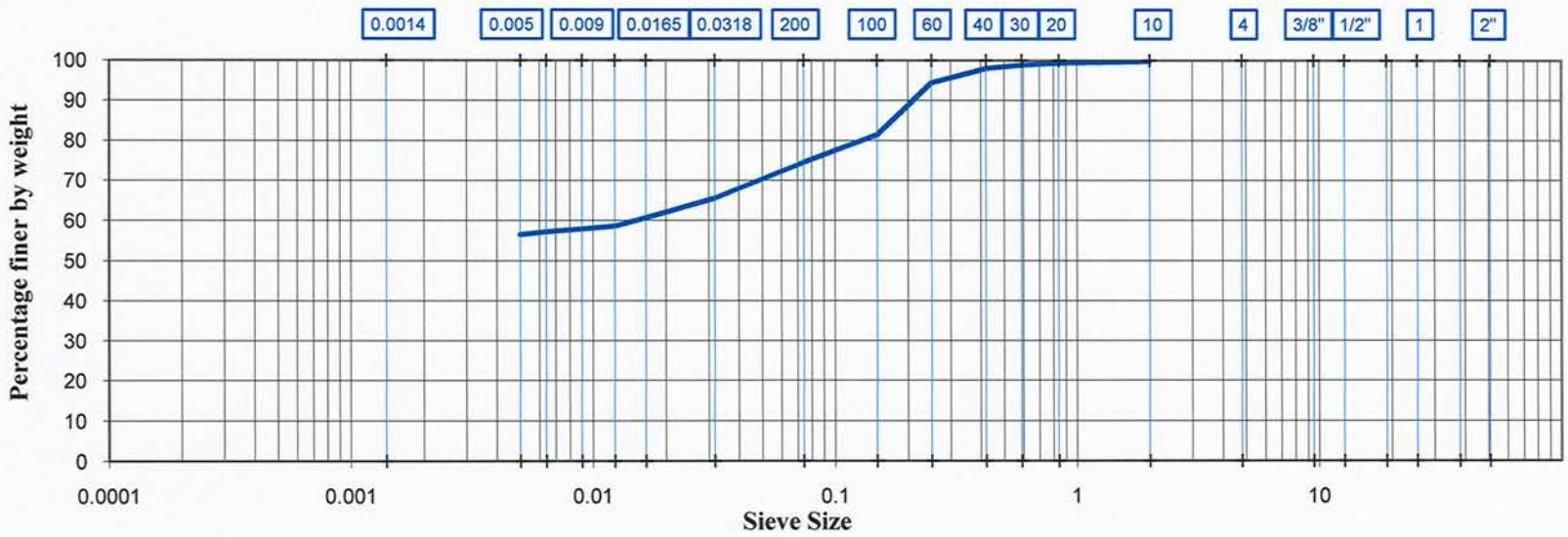

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	8.50	Location : Dam Footprint		

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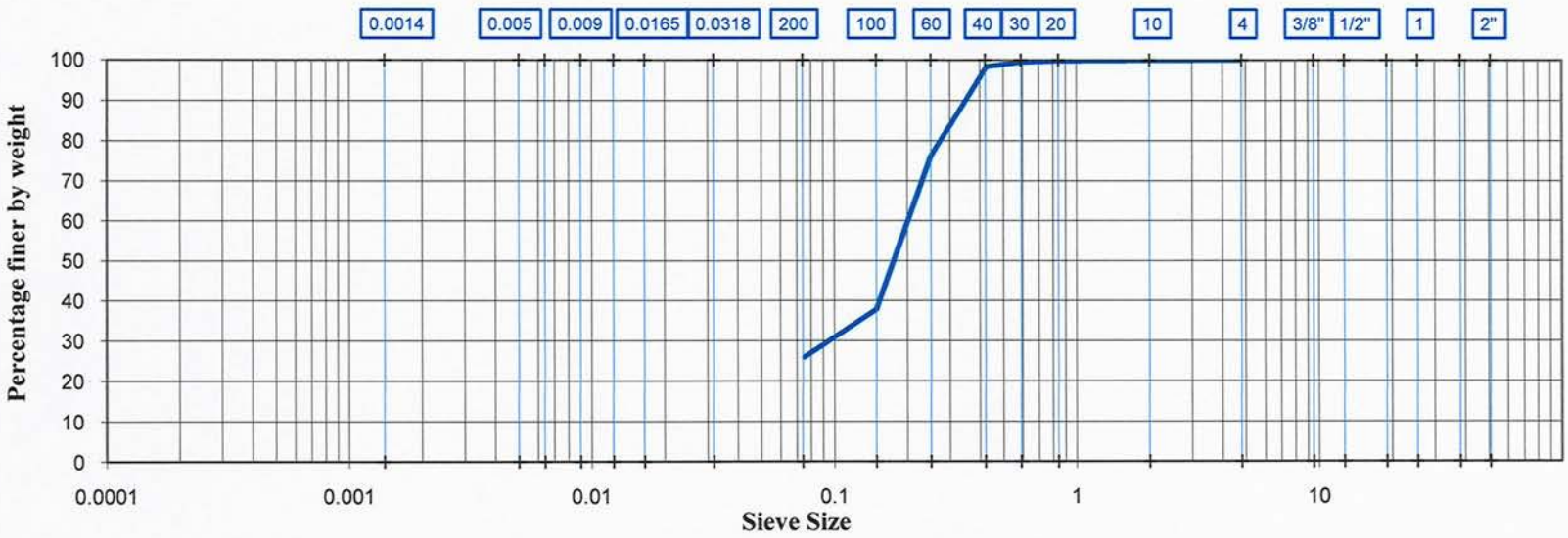

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	12.00	Location : Dam Footprint		

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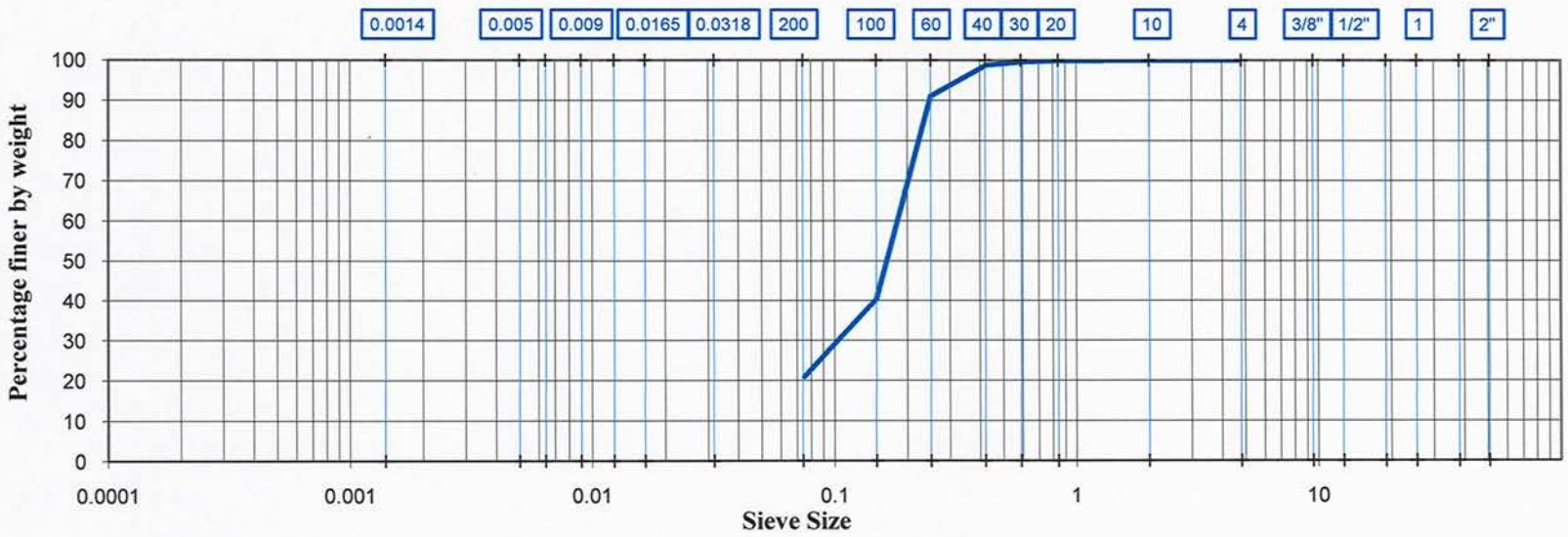

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	16.50	Location : Dam Footprint		

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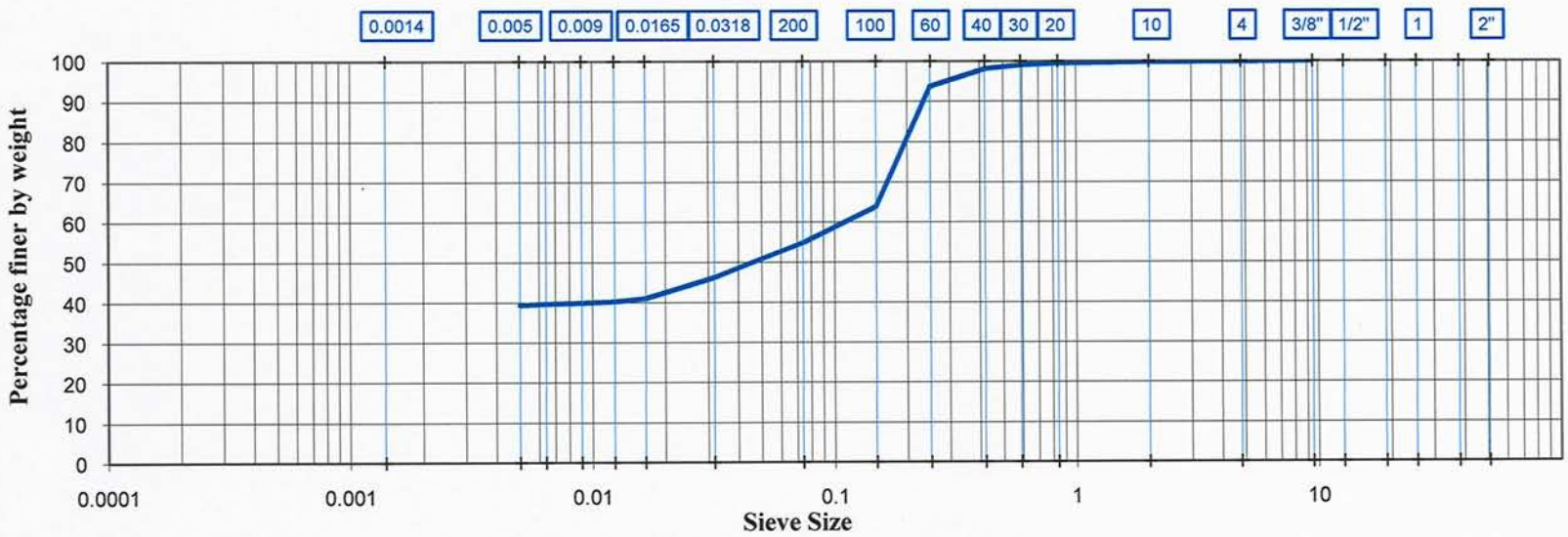

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	17.80-18.00	Location : Dam Footprint		

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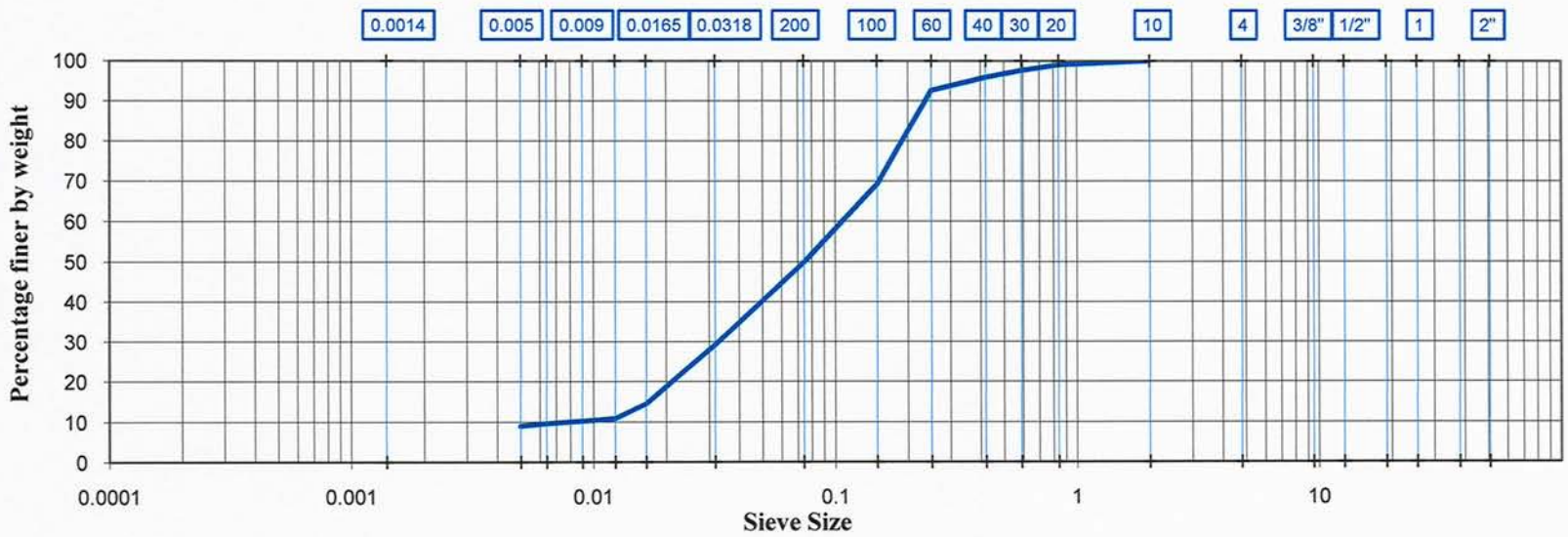

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	19.50-20.00	Location : Dam Footprint		

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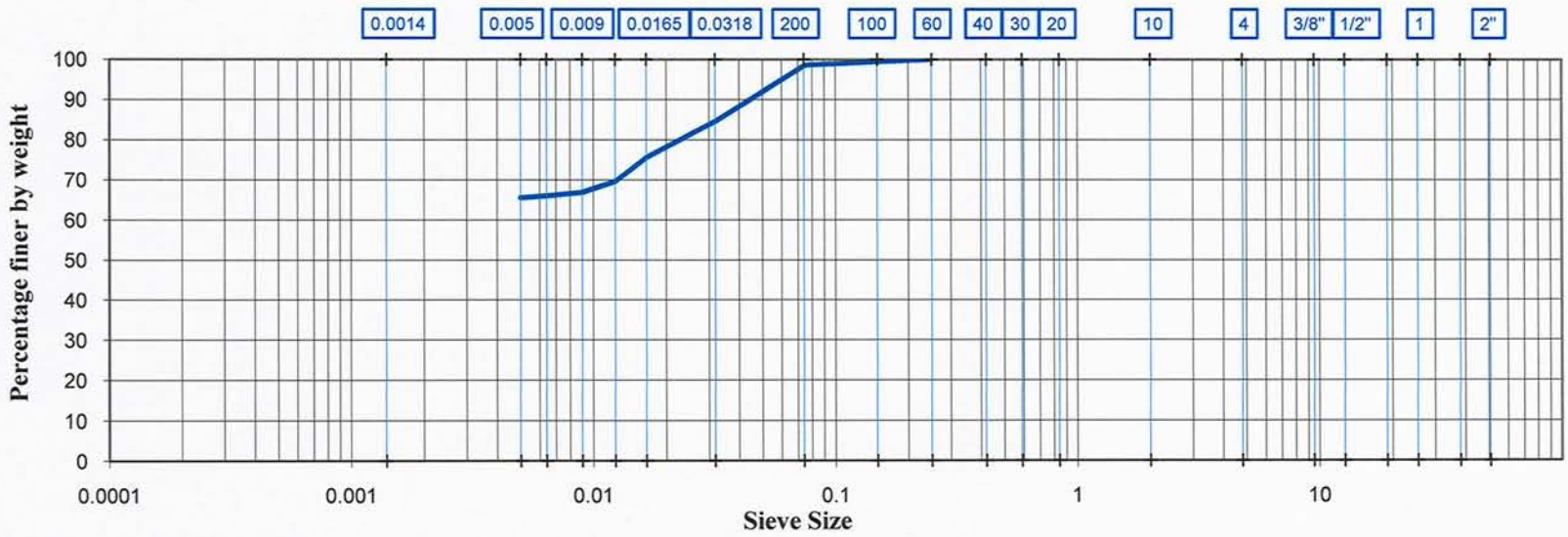

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	23.50	Location : Dam Footprint		

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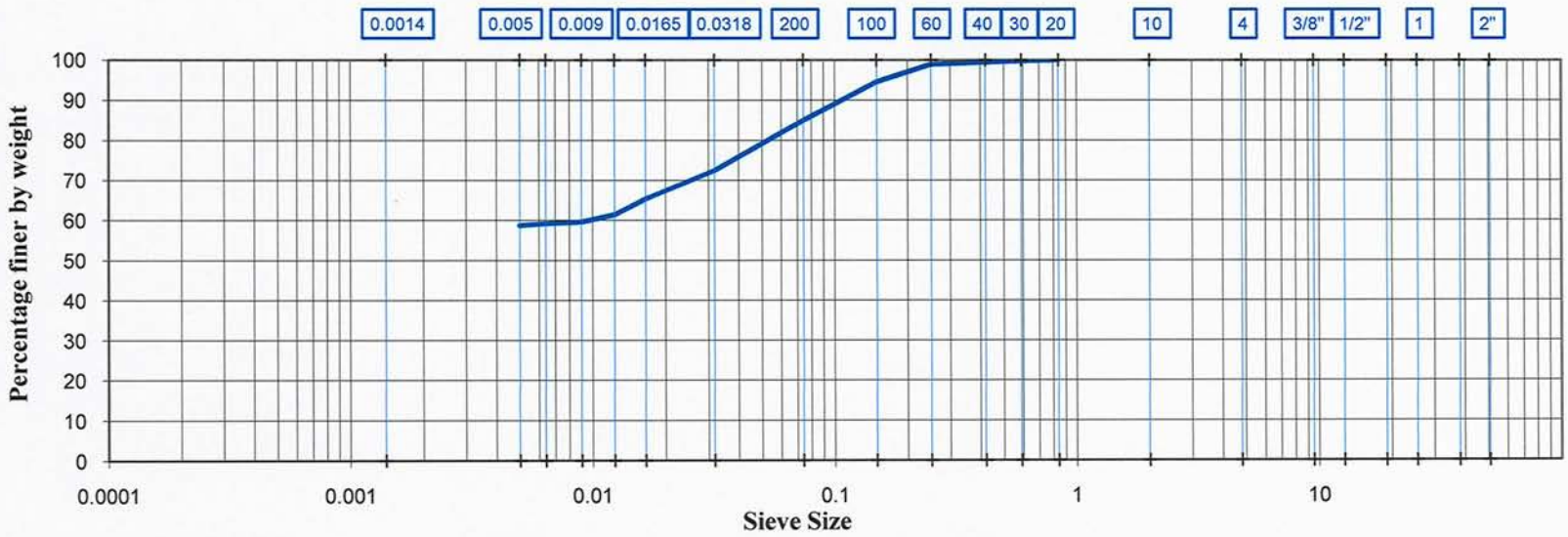

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	26.50	Location : Dam Footprint		

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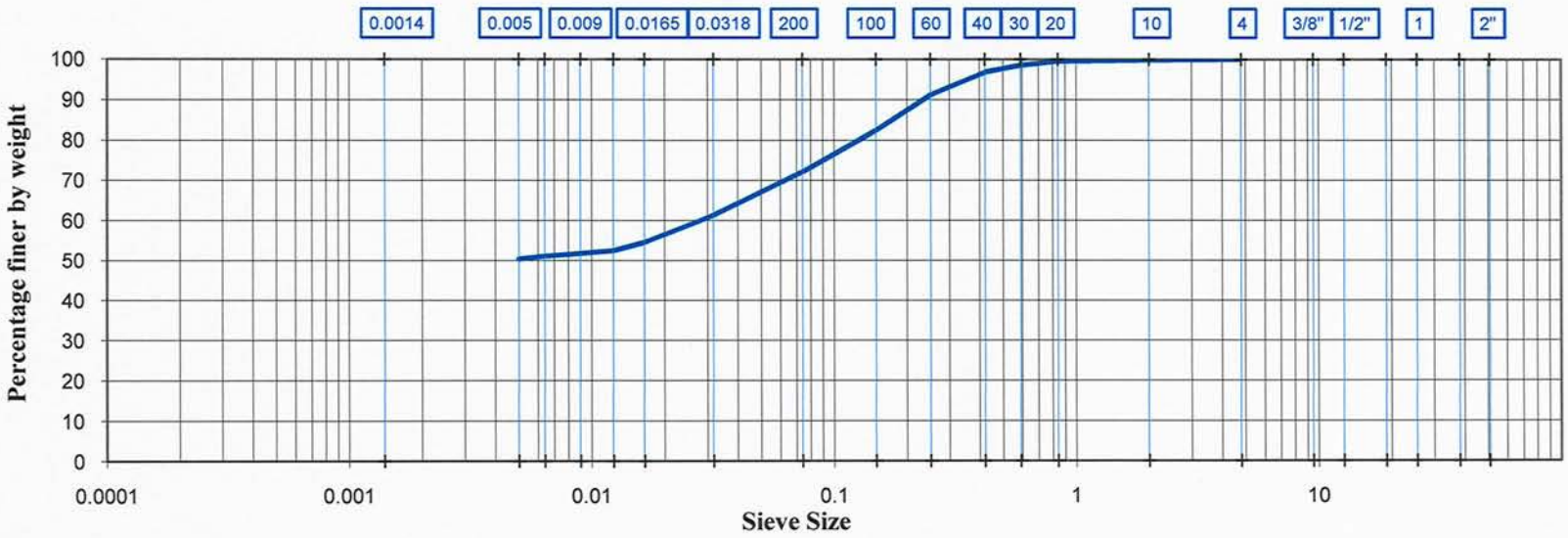

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	29.00-29.50	Location : Dam Footprint		

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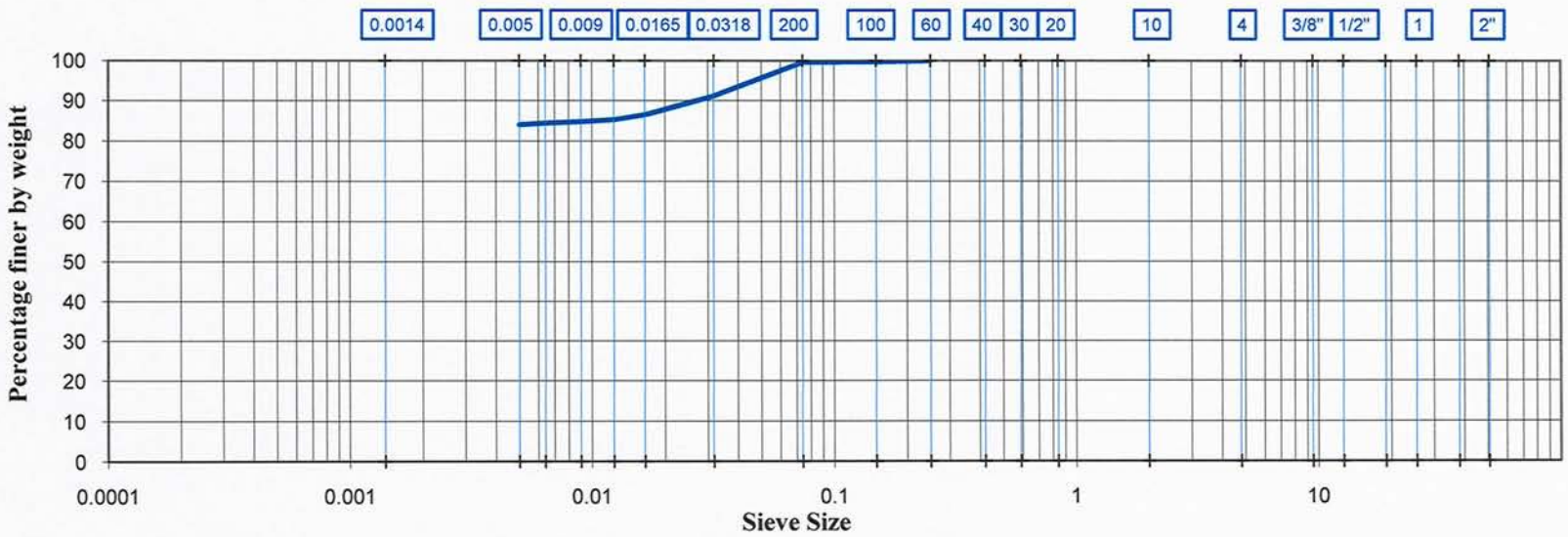
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	32.50	Location : Dam Footprint		

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Material Testing - Geotechnical Study

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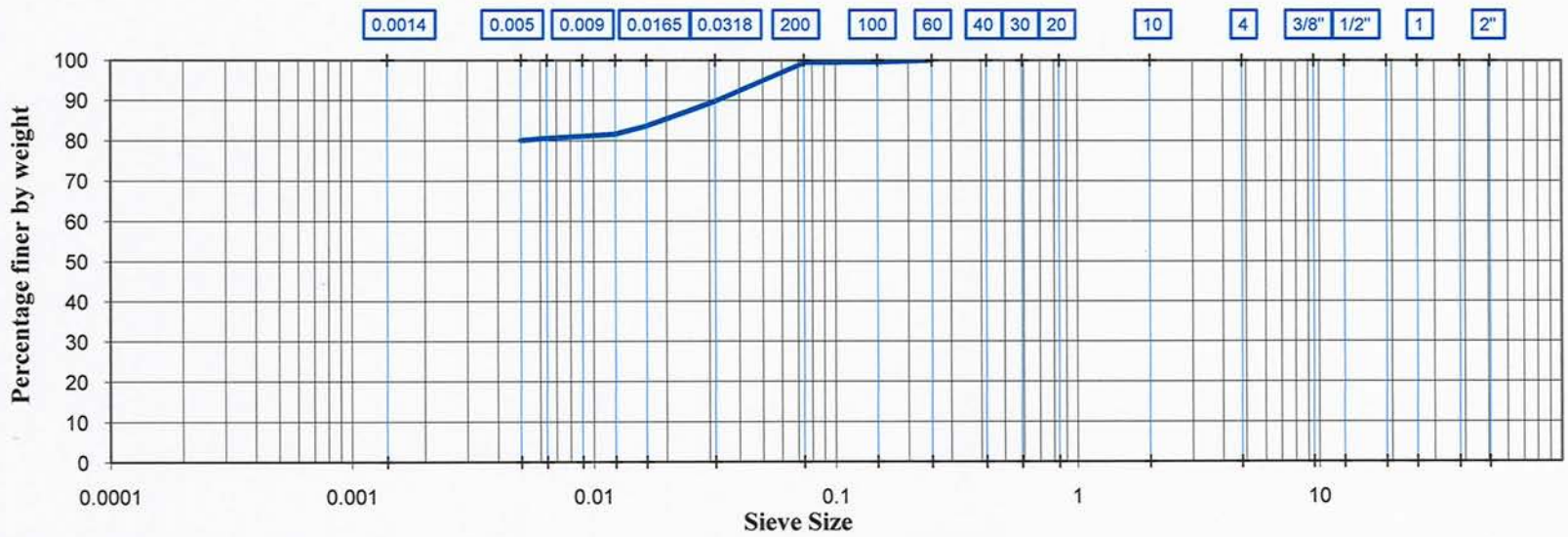
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR4	-	38.50	Location : Dam Footprint		

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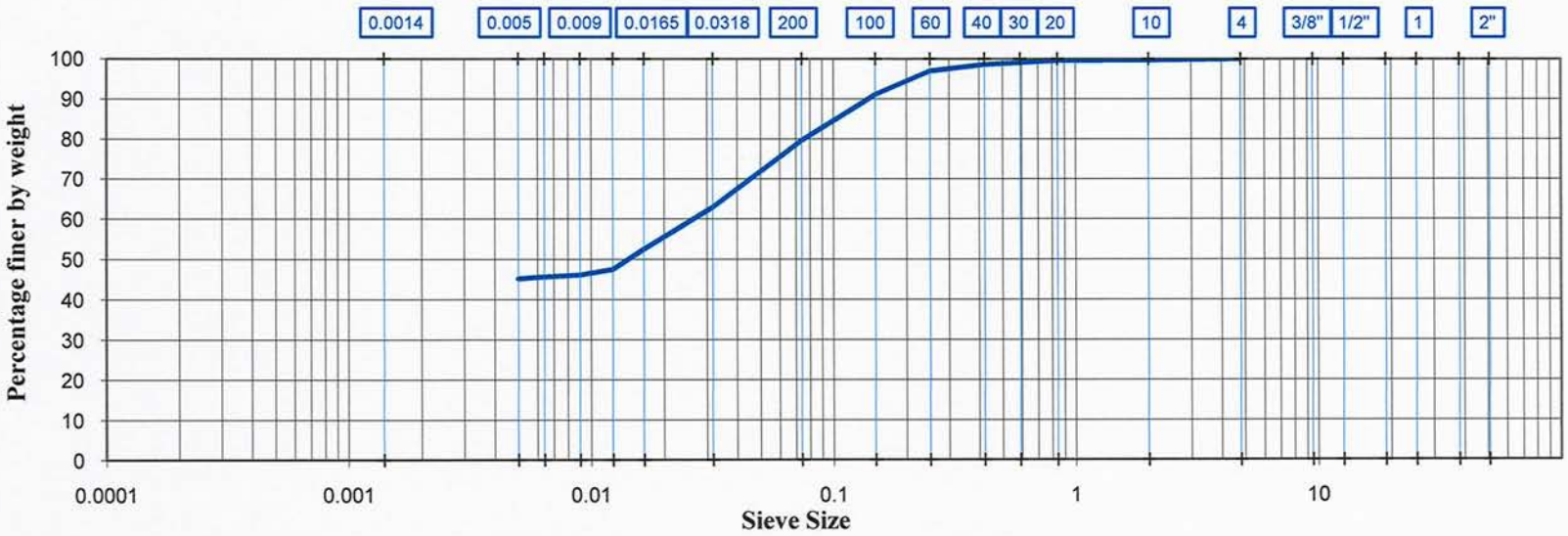
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	2.50	Location : Dam Footprint		

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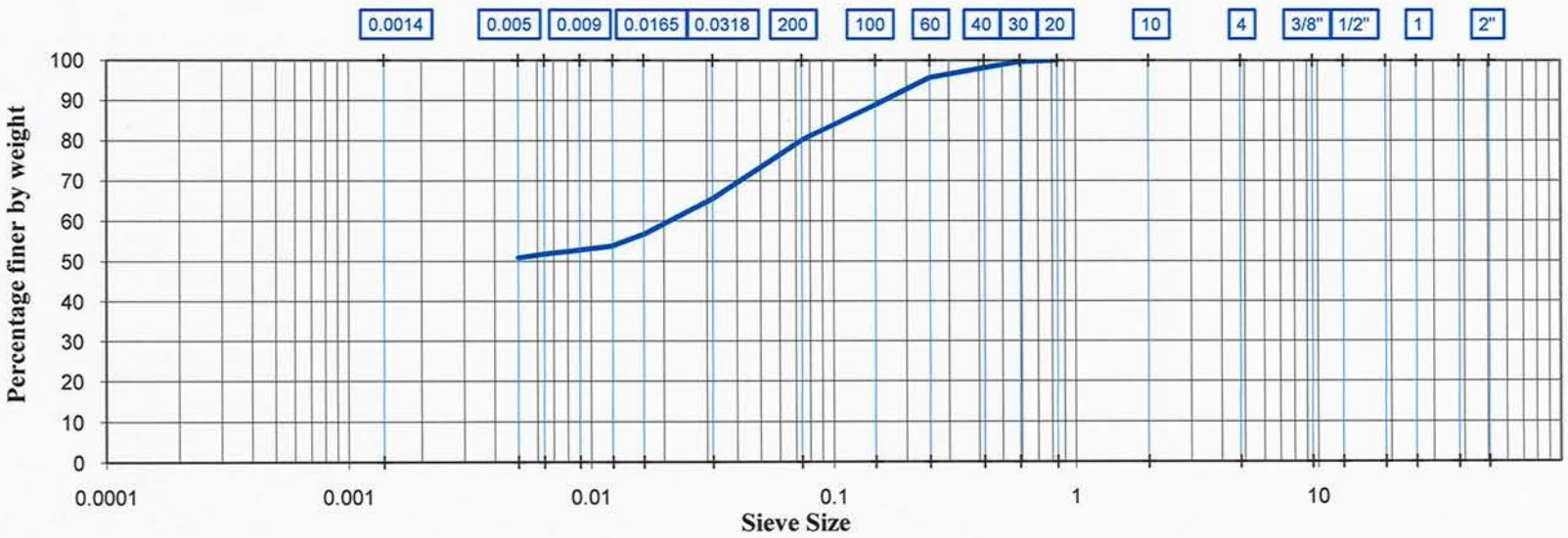
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	5.50	Location : Dam Footprint		

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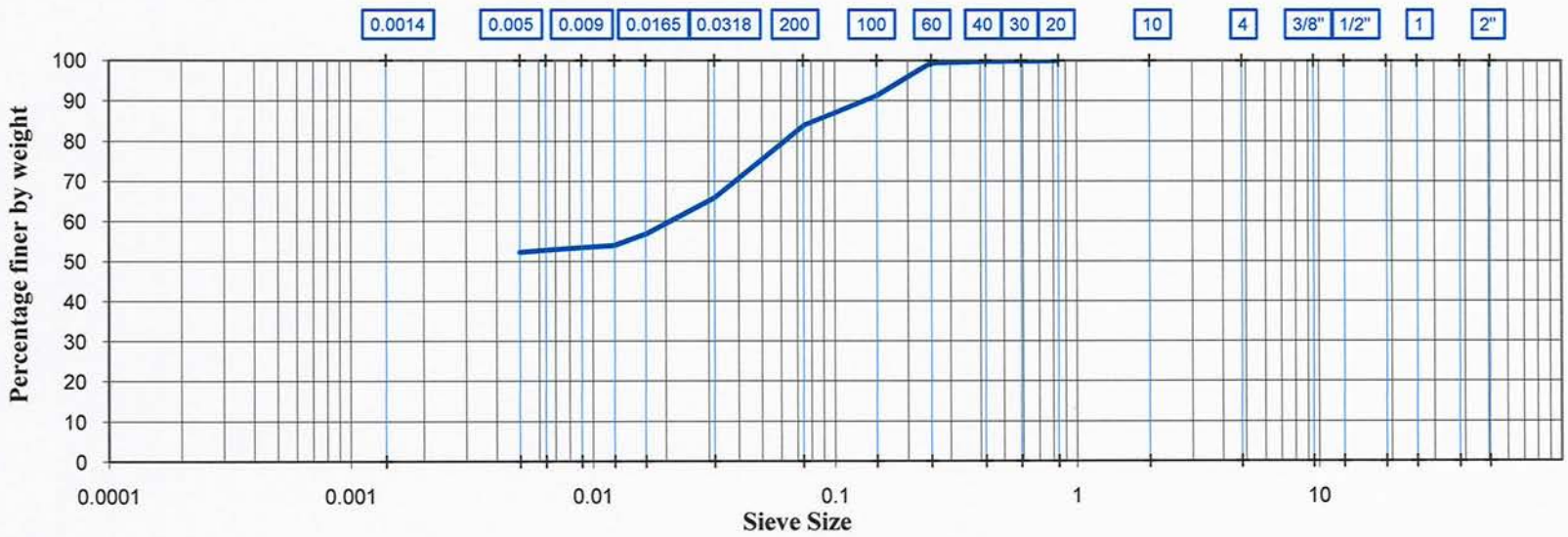

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	8.50	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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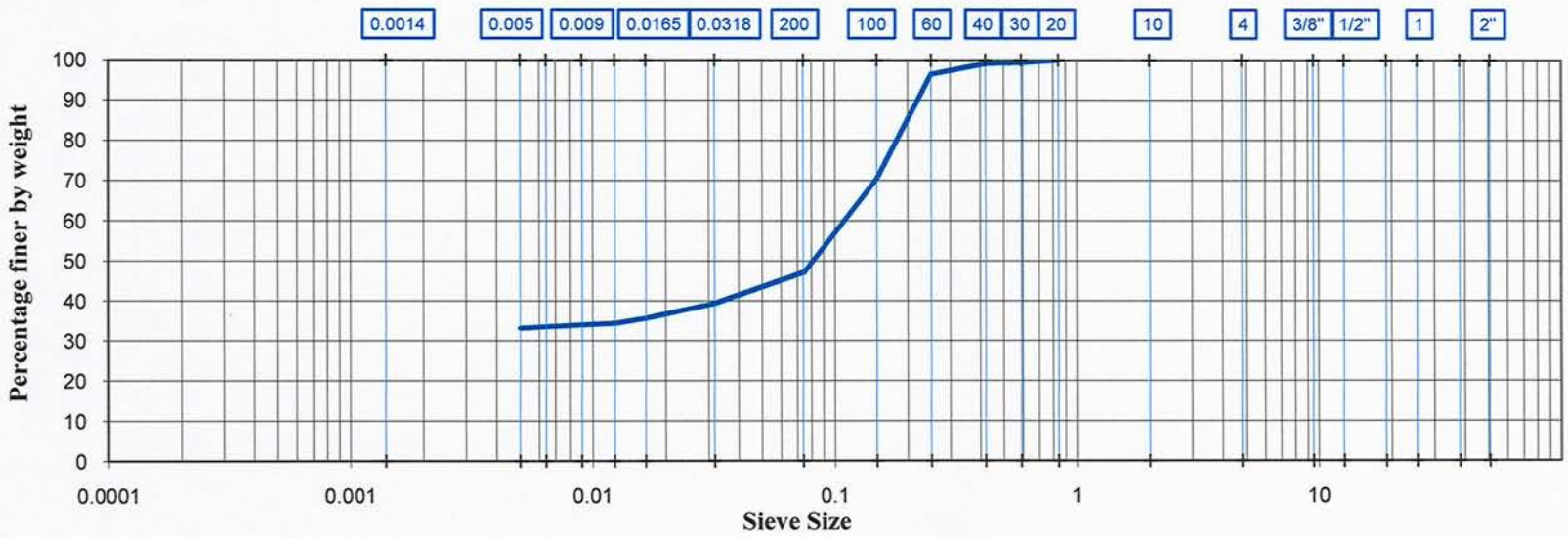

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	11.50	Location : Dam Footprint		

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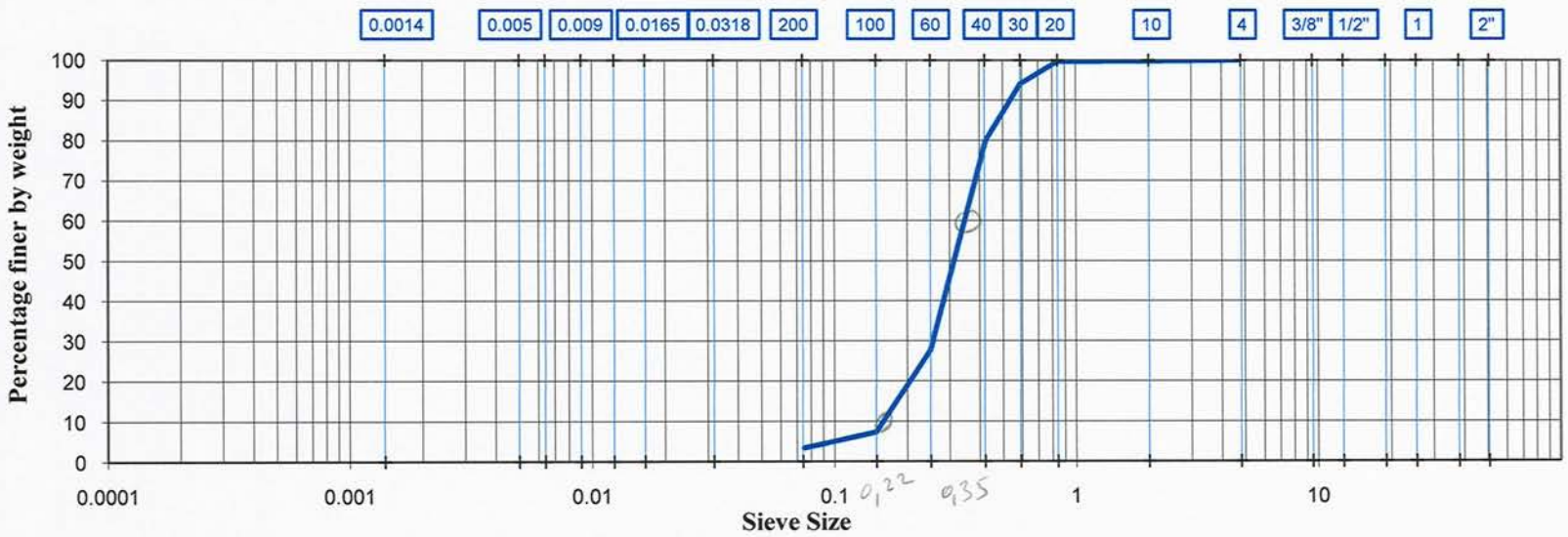

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	14.50	Location : Dam Footprint		

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Material Testing - Geotechnical Study

PARTICLE SIZE DISTRIBUTION
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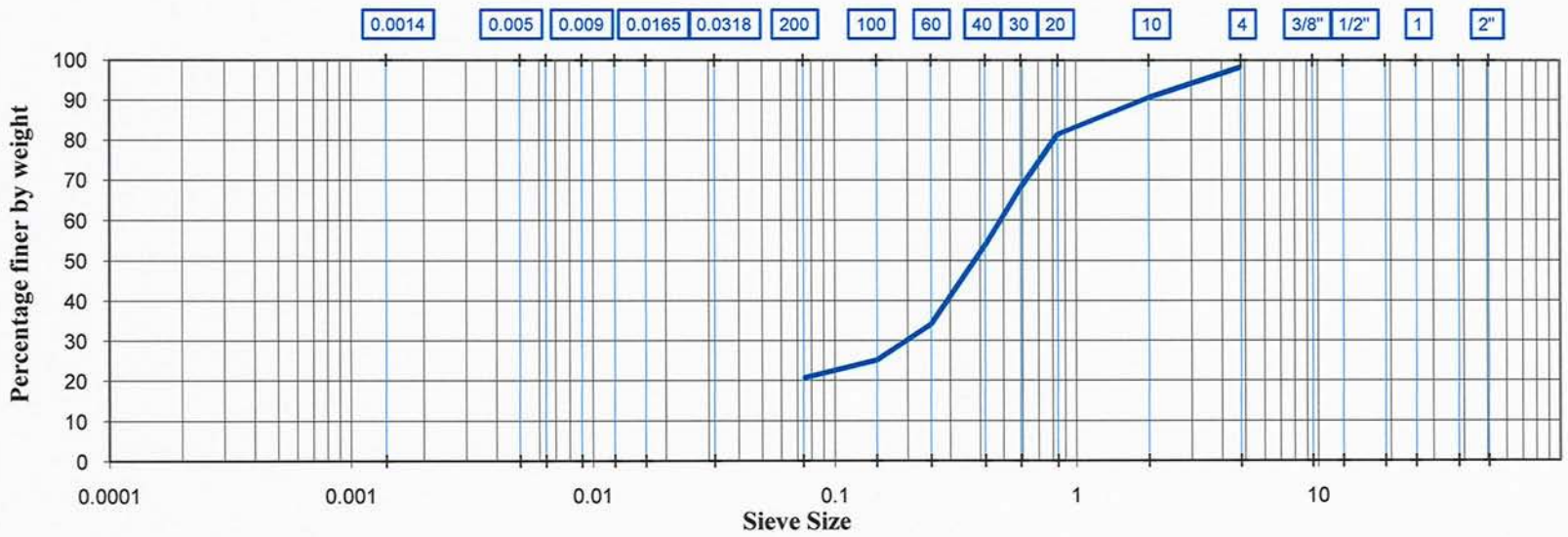

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	22.50	Location : Dam Footprint		

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PARTICLE SIZE DISTRIBUTION
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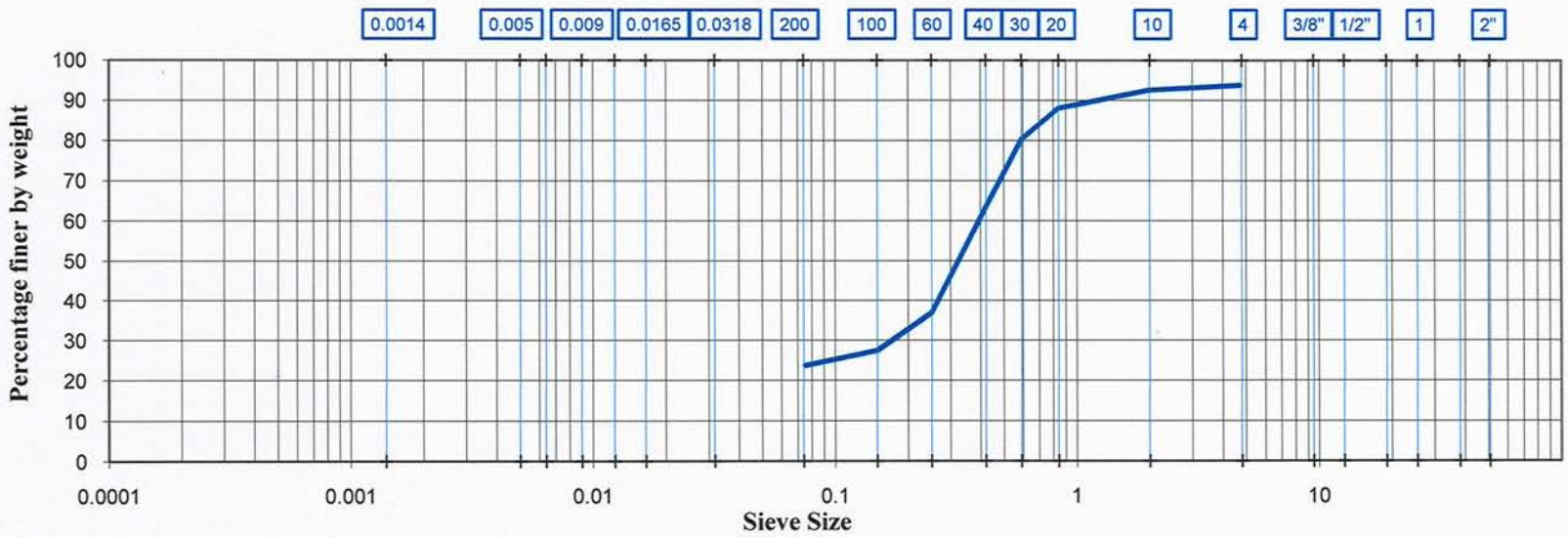

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	27.00	Location : Dam Footprint		

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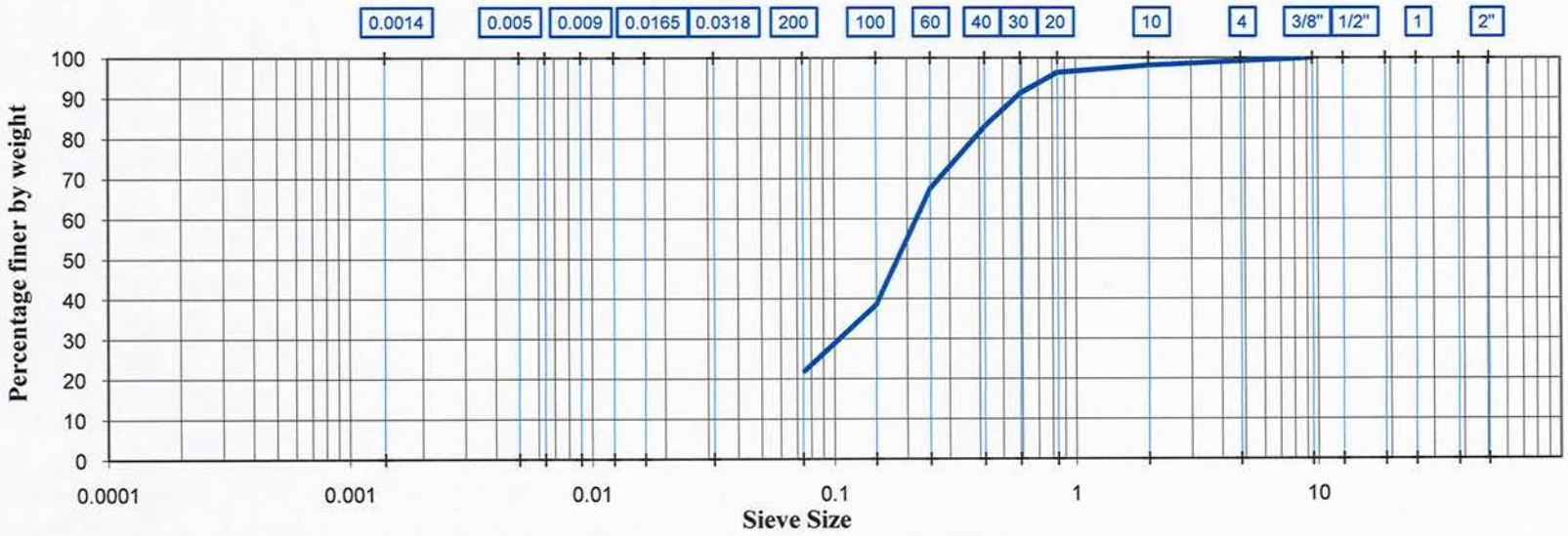

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	28.50	Location : Dam Footprint		

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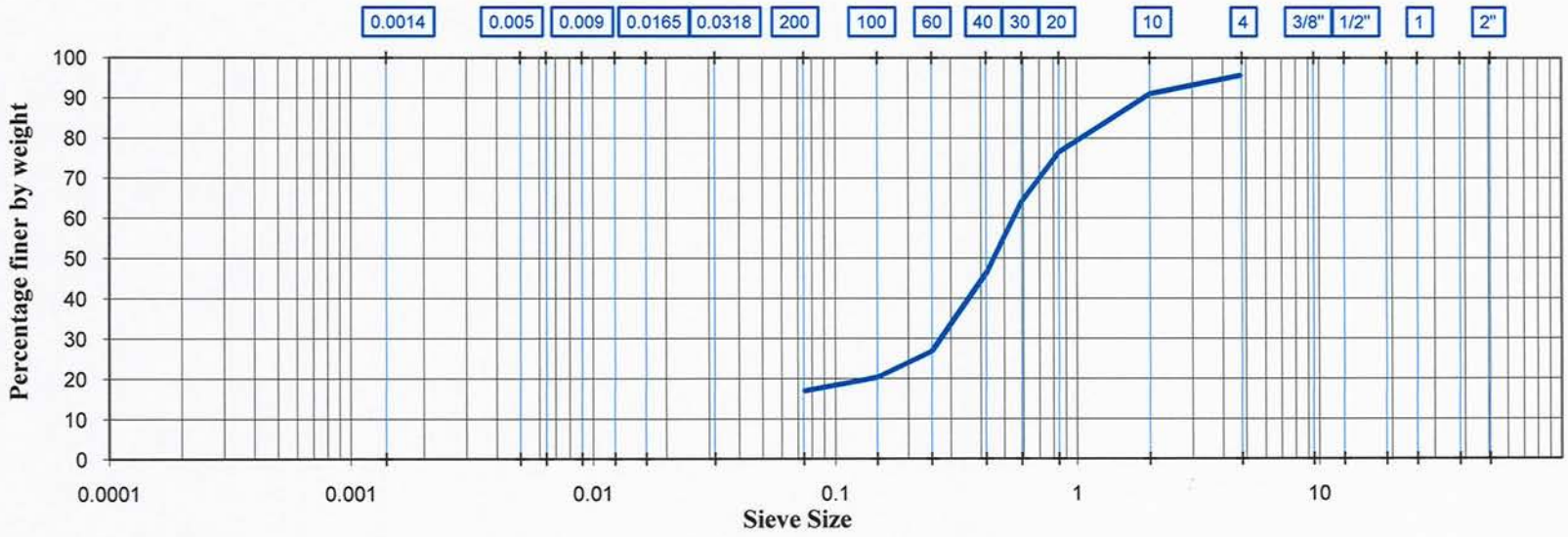

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	30.00	Location : Dam Footprint		

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Material Testing - Geotechnical Study

PARTICLE SIZE DISTRIBUTION
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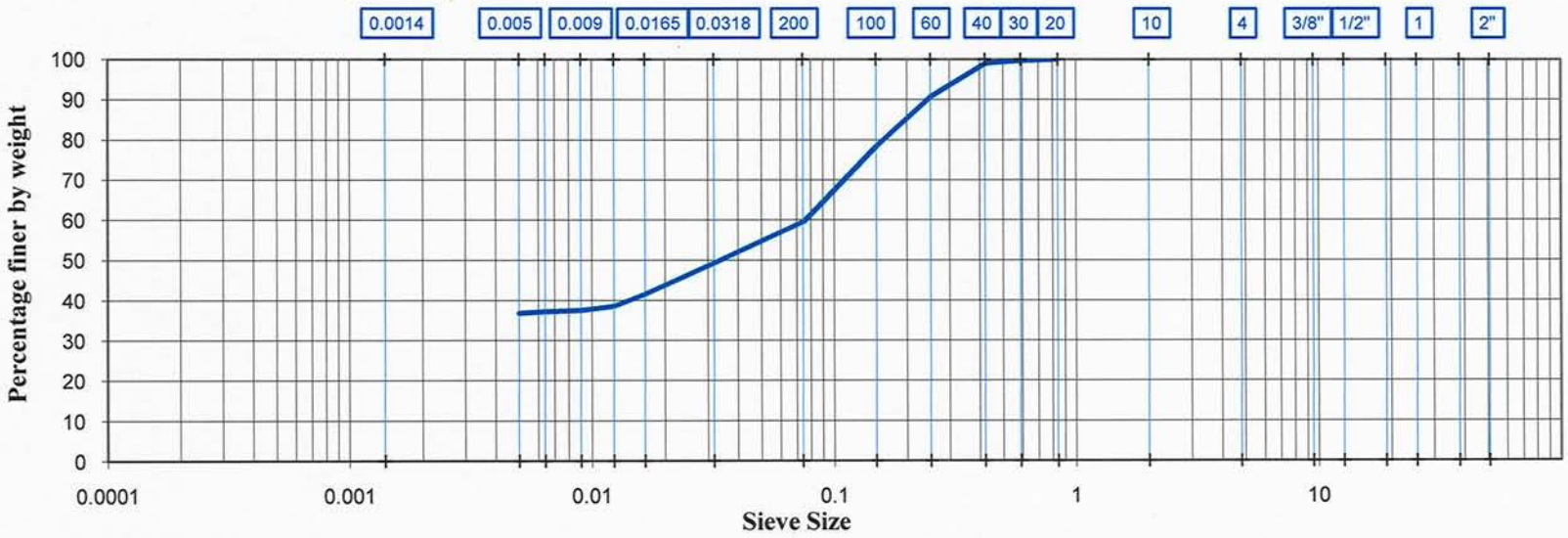

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	32.50	Location : Dam Footprint		

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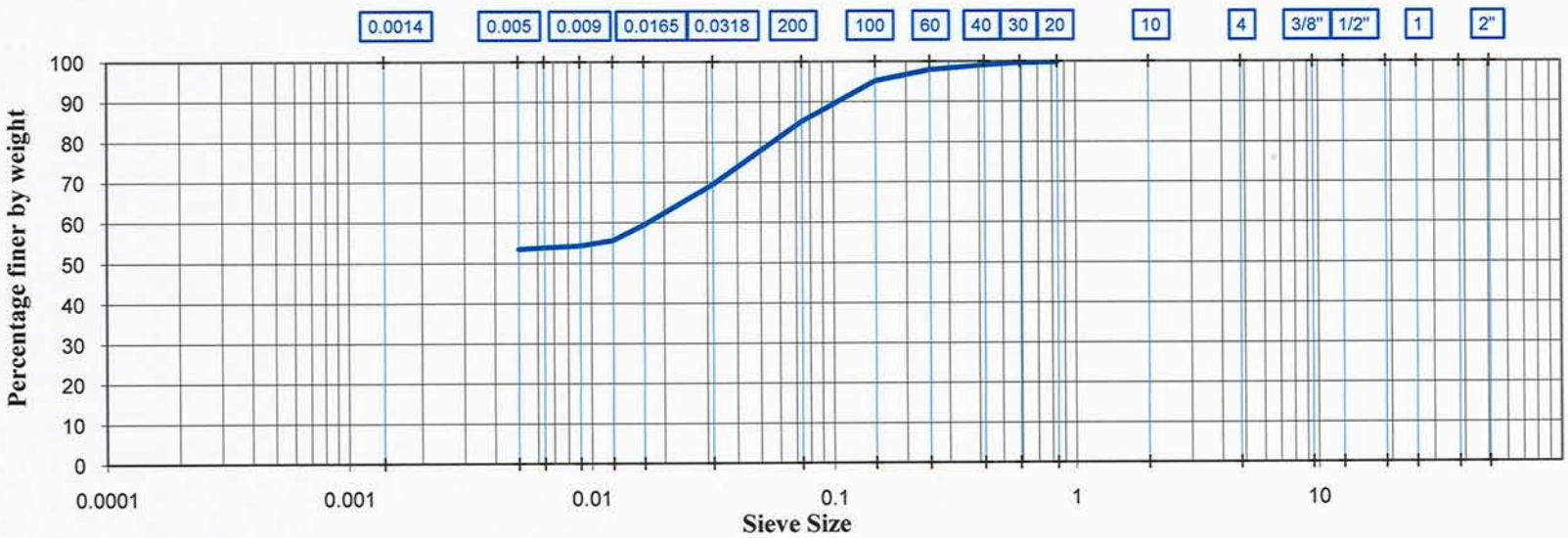

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	38.50	Location : Dam Footprint		

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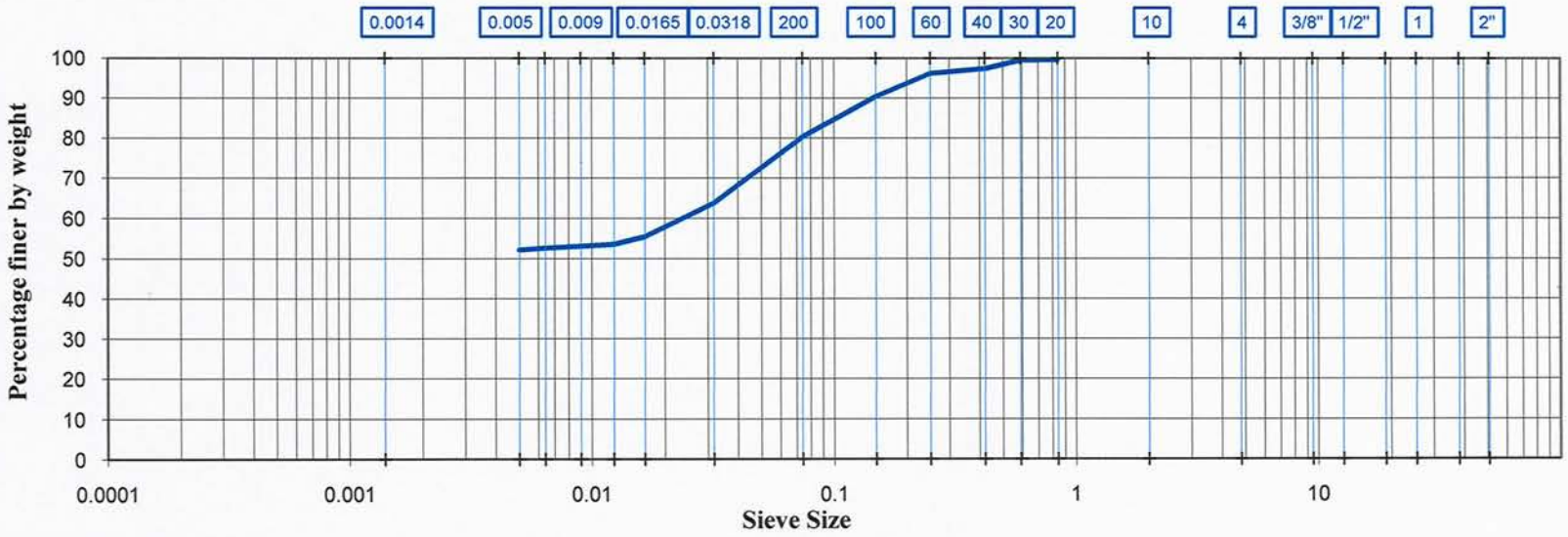

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	44.50	Location : Dam Footprint		

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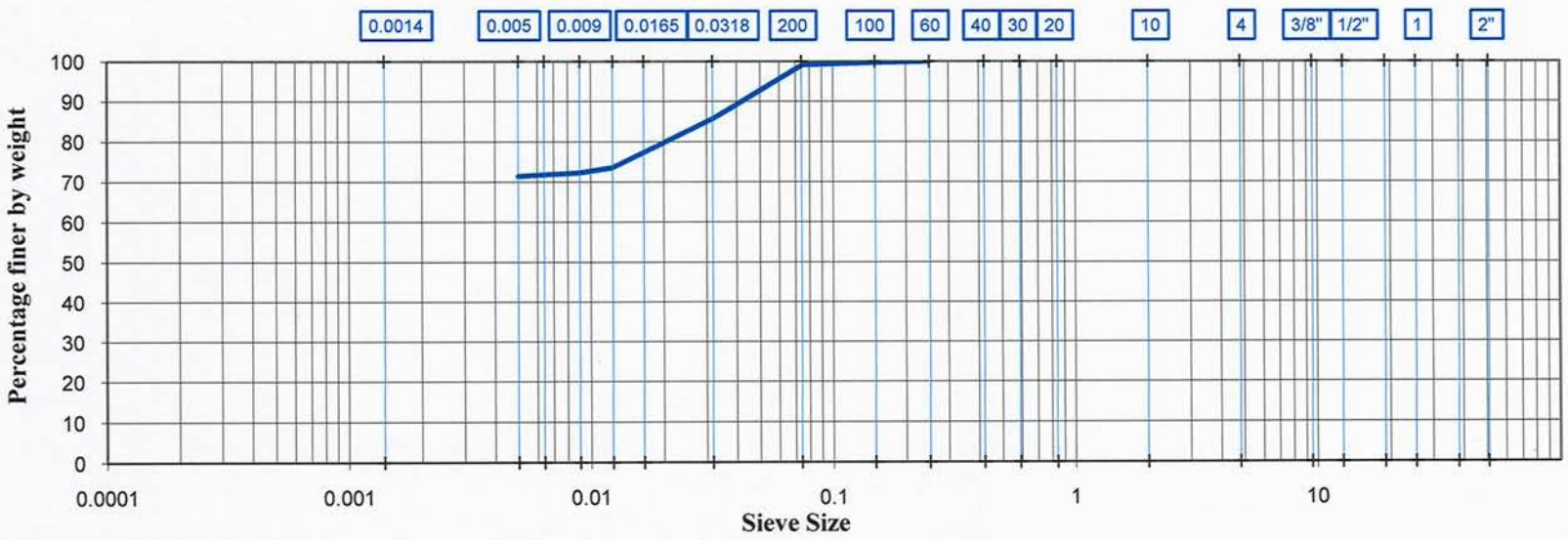

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	47.50	Location : Dam Footprint		

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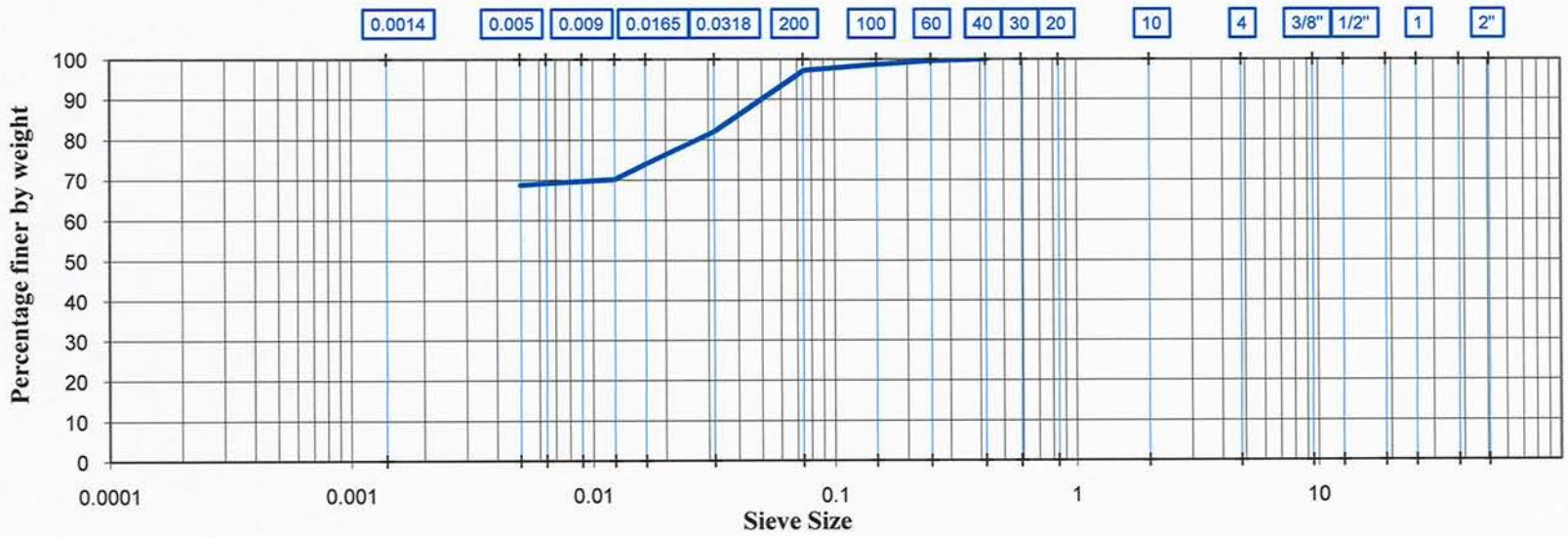

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	57.50	Location : Dam Footprint		

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Material Testing - Geotechnical Study

PARTICLE SIZE DISTRIBUTION
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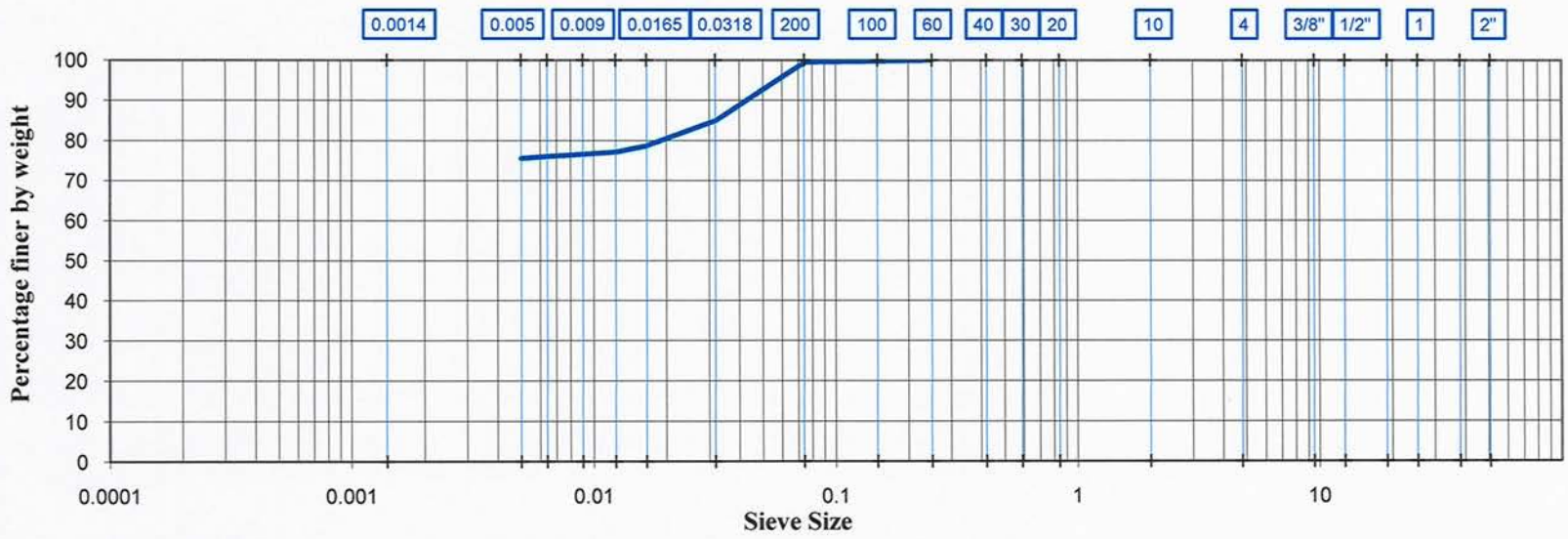

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 01/08/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
BHVR6	-	68.00	Location : Dam Footprint		

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

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		**BHVR4**				
Depth	m	4.5 - 5.0	8.5	17.8 - 18.0	19.5 - 20.0	23.5
CONTAINER NUMBER		1	2	3	4	5
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	36.46	25.51	40.76	-	23.30
WT. OF DRY SAMPLE & CONTAINER	g	28.72	21.98	34.38	-	18.93
WT. OF WATER	g	7.74	3.53	6.38	-	4.37
WT. OF CONTAINER	g	10.85	10.94	10.95	-	10.89
WT. OF DRY SAMPLE	g	17.87	11.04	23.43	-	8.04
WATER CONTENT (LL)	%	**43**	**32**	**27**	**0**	**54**

PLASTIC LIMIT		**BHVR4**				
Depth	m	4.5 - 5.0	8.5	17.8 - 18.0	19.5 - 20.0	23.5
CONTAINER NUMBER		1	2	3	4	5
WT. OF WET SAMPLE & CONTAINER	g	16.90	17.64	17.71	-	11.56
WT. OF DRY SAMPLE & CONTAINER	g	15.74	16.52	16.63	-	9.88
WT. OF WATER	g	1.16	1.12	1.08	-	1.68
WT. OF CONTAINER	g	11.02	10.98	10.92	-	4.13
WT. OF DRY SAMPLE	g	4.72	5.54	5.71	-	5.75
WATER CONTENT (PL)	%	**25**	**20**	**19**	**0**	**29**

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

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		**BHVR4**				
Depth	m	26.5	29.0 - 29.5	32.5	38.5	
CONTAINER NUMBER		1	2	3	4	
NUMBER OF BLOWS		25	25	25	25	
WT. OF WET SAMPLE & CONTAINER	g	24.56	38.59	24.26	27.02	
WT. OF DRY SAMPLE & CONTAINER	g	20.89	30.84	18.44	21.23	
WT. OF WATER	g	3.67	7.75	5.82	5.79	
WT. OF CONTAINER	g	10.98	10.92	9.91	11.01	
WT. OF DRY SAMPLE	g	9.91	19.92	8.53	10.22	
WATER CONTENT (LL)	%	**37**	**39**	**68**	**57**	

PLASTIC LIMIT		**BHVR4**				
Depth	m	26.5	29.0 - 29.5	32.5	38.5	
CONTAINER NUMBER		1	2	3	4	
WT. OF WET SAMPLE & CONTAINER	g	18.64	17.78	12.81	18.40	
WT. OF DRY SAMPLE & CONTAINER	g	17.19	16.49	10.70	16.79	
WT. OF WATER	g	1.45	1.29	2.11	1.61	
WT. OF CONTAINER	g	10.93	10.89	4.12	10.92	
WT. OF DRY SAMPLE	g	6.26	5.60	6.58	5.87	
WATER CONTENT (PL)	%	**23**	**23**	**32**	**27**	

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Project : Bisri Dam
Location : Dam Footprint
Date : 08/08/14

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		**BHVR6**				
Depth	m	2.5	5.5	8.5	11.5	32.5
CONTAINER NUMBER		1	2	3	4	5
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	22.35	19.35	18.30	36.23	23.59
WT. OF DRY SAMPLE & CONTAINER	g	18.01	15.47	14.88	31.62	20.45
WT. OF WATER	g	4.34	3.88	3.42	4.61	3.14
WT. OF CONTAINER	g	4.12	4.13	4.10	10.85	10.87
WT. OF DRY SAMPLE	g	13.89	11.34	10.78	20.77	9.58
WATER CONTENT (LL)	%	**31**	**34**	**32**	**22**	**33**

PLASTIC LIMIT		**BHVR6**				
Depth	m	2.5	5.5	8.5	11.5	32.5
CONTAINER NUMBER		1	2	3	4	5
WT. OF WET SAMPLE & CONTAINER	g	17.10	16.73	16.36	-	17.35
WT. OF DRY SAMPLE & CONTAINER	g	16.12	15.77	15.51	-	16.22
WT. OF WATER	g	0.98	0.96	0.85	-	1.13
WT. OF CONTAINER	g	10.93	10.91	10.95	-	10.88
WT. OF DRY SAMPLE	g	5.19	4.86	4.56	-	5.34
WATER CONTENT (PL)	%	**19**	**20**	**19**	**0**	**21**

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

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		BHVR6				
Depth	m	38.5	44.5	47.5	57.5	68.0
CONTAINER NUMBER		1	2	3	4	5
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	30.27	39.23	37.27	29.75	25.61
WT. OF DRY SAMPLE & CONTAINER	g	24.43	31.22	28.44	23.85	20.50
WT. OF WATER	g	5.84	8.01	8.83	5.90	5.11
WT. OF CONTAINER	g	10.96	10.85	10.86	10.85	10.98
WT. OF DRY SAMPLE	g	13.47	20.37	17.58	13.00	9.52
WATER CONTENT (LL)	%	**43**	**39**	**50**	**45**	**54**

PLASTIC LIMIT		BHVR6				
Depth	m	38.5	44.5	47.5	57.5	68.0
CONTAINER NUMBER		1	2	3	4	5
WT. OF WET SAMPLE & CONTAINER	g	18.47	18.16	17.55	16.64	15.03
WT. OF DRY SAMPLE & CONTAINER	g	17.11	16.71	15.93	15.52	14.18
WT. OF WATER	g	1.36	1.45	1.62	1.12	0.85
WT. OF CONTAINER	g	10.93	10.89	10.91	10.98	10.92
WT. OF DRY SAMPLE	g	6.18	5.82	5.02	4.54	3.26
WATER CONTENT (PL)	%	**22**	**25**	**32**	**25**	**26**

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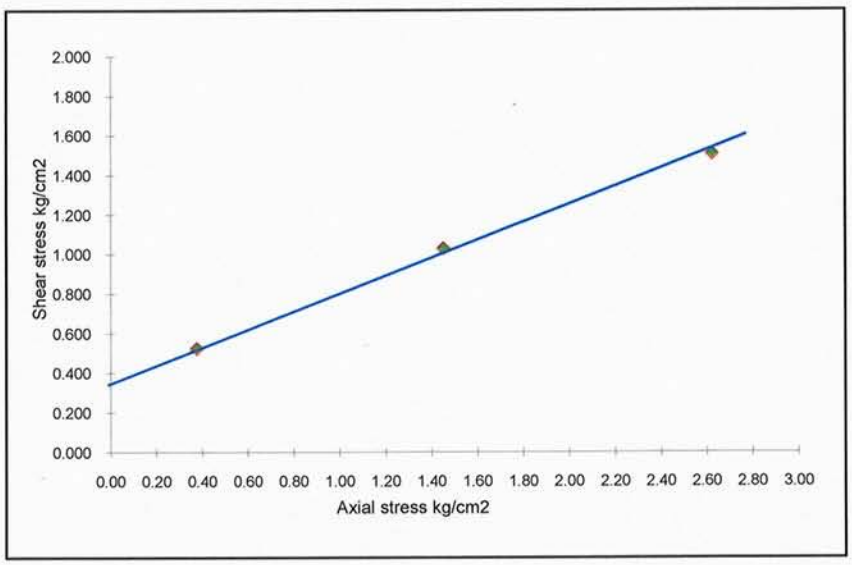
Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 07/08/14

SHEAR BOX TEST

ASTM Designation - D3080
AASHTO T - 236

Sample No : **BHVR4**
Depth : **4.50-5.00 m**

Shear stress kg/cm²	Axial stress kg/cm²
0.527	0.375
1.029	1.451
1.508	2.624



Results : Cohesion **C = 0.36 kg/cm²**
Angle of friction **Φ= 24 °**

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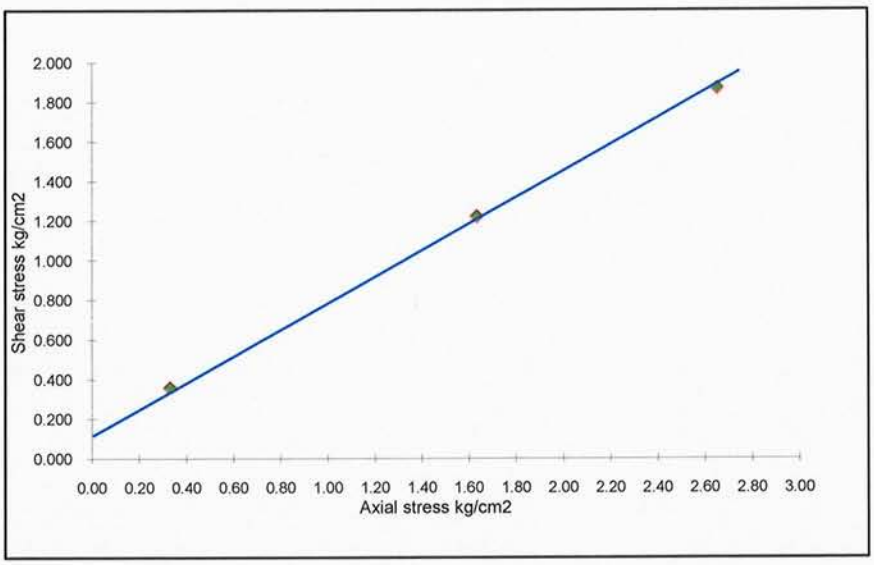
Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 07/08/14

SHEAR BOX TEST

ASTM Designation - D3080
AASHTO T - 236

Sample No. : BHVR4
Depth : 19.50-20.00 m

Shear stress kg/cm²	Axial stress kg/cm²
0.358	0.330
1.221	1.634
1.869	2.654



Results : Cohesion **C = 0.12 kg/cm²**
Angle of friction **Φ= 34 °**

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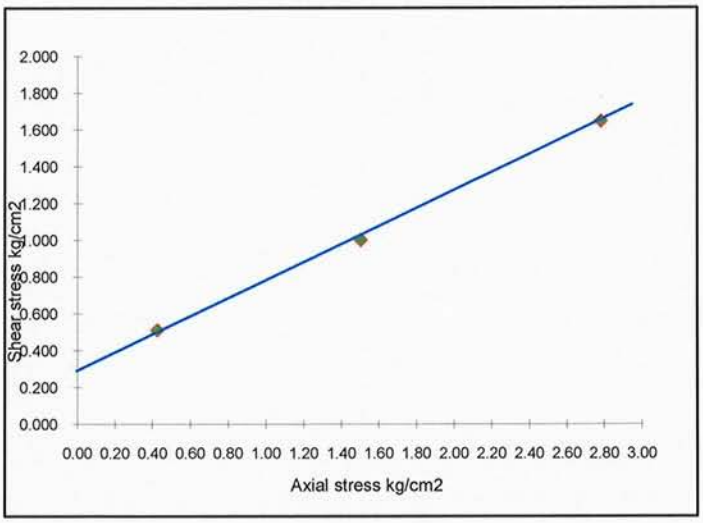
Project : Bisri Dam
Location : Dam Footprint
Date : 07/08/14

SHEAR BOX TEST

ASTM Designation - D3080
AASHTO T - 236

Sample No. : BHVR4
Depth : 29.00-29.50 m

Shear stress kg/cm²	Axial stress kg/cm²
0.512	0.425
1.001	1.502
1.646	2.781



Results : Cohesion **C = 0.29 kg/cm²**
Angle of friction **Φ= 26 °**

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Unconfined Compressive Strength of Cohesive Soil

ASTM Designation D2166 - 91

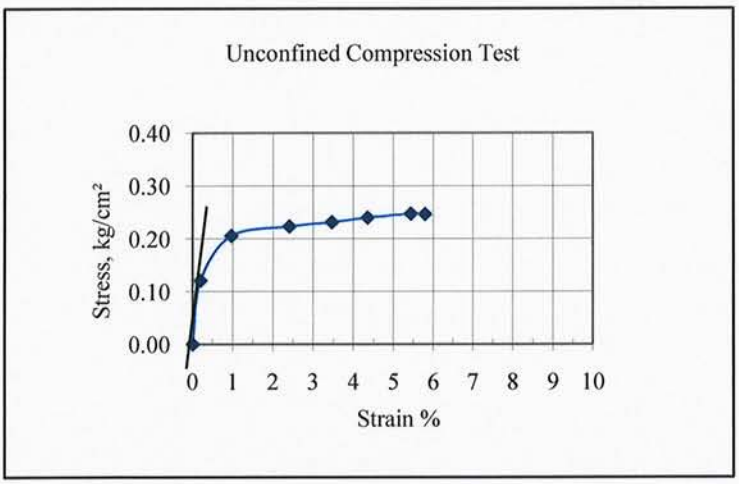
Client :	**M/S Dar Al Handasah Nazih Taleb & Co.**	Date :	04/08/14
Project :	**Bisri Dam**	Sample No. :	-
Location :	**Upstream of the Dam, Clay-Core Material Sources**	Borehole No. :	BHVR4
		Depth (m):	4.5 - 5.0

Initial Diam.	Do =	7 cm	Wet Density	= 1.925 g/cm³
Initial Area	Ao =	38.5 cm²	Water content	= 34.7 %
Initial Height	Ho =	10.4 cm	Dry Density	= 1.429 g/cm³

Proving Ring No. = 24534

Axial strain rate = 1.35 mm/min (1.5%)

Elapsed Time		Load Dial	Strain Dial	Axial Strain	Corr. Area	Load	Axial Stress
min.	sec.	0.0001"	0.01 mm	%	cm²	kg	kg/cm²
0	0	0	0	0.00	38.48	0	0.00
0	10	11	20	0.19	38.56	4.7	0.12
0	20	19	100	0.96	38.86	8.0	0.21
0	30	21	250	2.40	39.43	8.8	0.22
0	40	22	360	3.46	39.86	9.2	0.23
0	50	23	452	4.35	40.23	9.6	0.24
1	0	24	565	5.43	40.70	10.1	0.25
1	10	24	602	5.79	40.85	10.1	0.25



Failure condition : Typical

Failure Stress = 0.25 kg/cm²
Failure Strain = 4.87 %

Stress at 15% strain = - kg/cm²

Undrained Shear strength= 0.13 kg/cm²

UCS Modulus= 63.15 kg/cm²

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Unconfined Compressive Strength of Cohesive Soil

ASTM Designation D2166 - 91

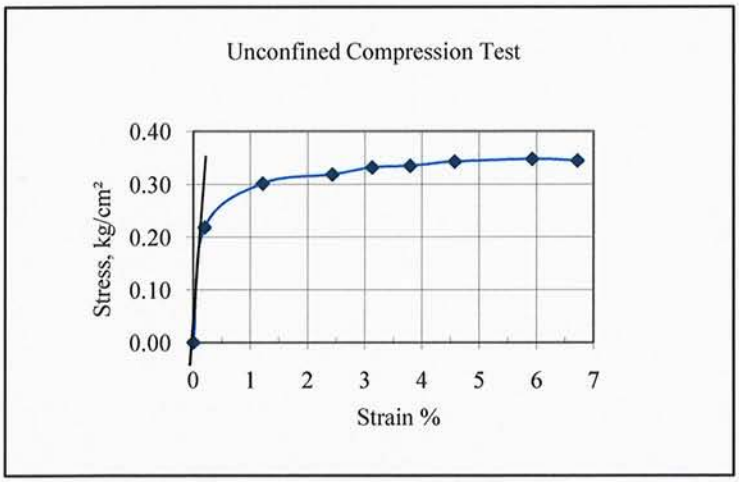
Client :	**M/S Dar Al Handasah Nazih Taleb & Co.**	Date :	04/08/14
Project :	**Bisri Dam**	Sample No. :	-
Location :	**Upstream of the Dam, Clay-Core Material Sources**	Borehole No. :	BHVR4
		Depth (m):	19.5 - 20.0

Initial Diam.	Do =	7 cm	Wet Density	= 1.889 g/cm³
Initial Area	Ao =	38.5 cm²	Water content	= 29.7 %
Initial Height	Ho =	12.8 cm	Dry Density	= 1.45 g/cm³

Proving Ring No. = 24534

Axial strain rate = 1.35 mm/min (1.5%)

Elapsed Time		Load Dial	Strain Dial	Axial Strain	Corr. Area	Load	Axial Stress
min.	sec.	0.0001"	0.01 mm	%	cm²	kg	kg/cm²
0	0	0	0	0.00	38.48	0	0.00
0	10	20	25	0.20	38.56	8.4	0.22
0	20	28	155	1.21	38.96	11.7	0.30
0	30	30	311	2.43	39.44	12.5	0.32
0	40	32	400	3.13	39.73	13.2	0.33
0	50	32	485	3.79	40.00	13.4	0.33
1	0	33	585	4.57	40.33	13.8	0.34
1	10	34	758	5.92	40.91	14.2	0.35
1	20	34	860	6.72	41.26	14.2	0.34



Failure condition : Typical

Failure Stress = 0.35 kg/cm²
Failure Strain = 5.92 %

Stress at 15% strain = - kg/cm²

Undrained Shear strength= 0.18 kg/cm²

UCS Modulus= 110.15 kg/cm²

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Unconfined Compressive Strength of Cohesive Soil

ASTM Designation D2166 - 91

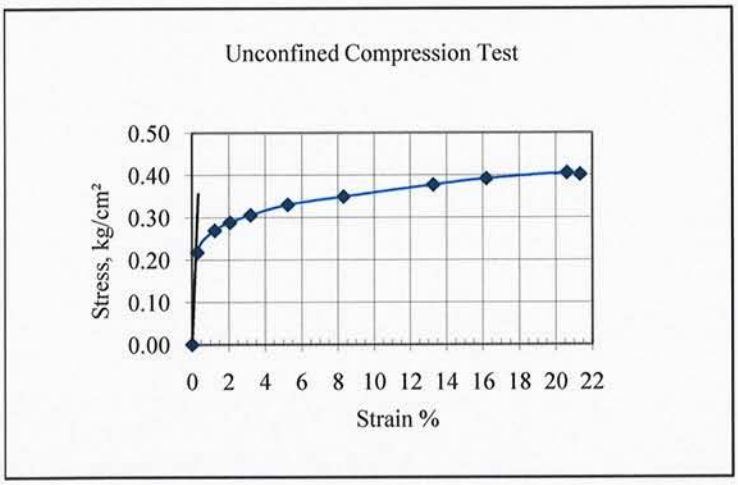
Client :	**M/S Dar Al Handasah Nazih Taleb & Co.**	Date :	04/08/14
Project :	**Bisri Dam**	Sample No. :	-
Location :	**Upstream of the Dam, Clay-Core Material Sources**	Borehole No. :	BHVR4
		Depth (m):	29.0 - 29.5

Initial Diam.	Do =	7 cm	Wet Density	= 2.03 g/cm³
Initial Area	Ao =	38.5 cm²	Water content	= 18.70 %
Initial Height	Ho =	14.3 cm	Dry Density	= 1.71 g/cm³

Proving Ring No. = 24534

Axial strain rate = 1.35 mm/min (1.5%)

Elapsed Time		Load Dial	Strain Dial	Axial Strain	Corr. Area	Load	Axial Stress
min.	sec.	0.0001"	0.01 mm	%	cm²	kg	kg/cm²
0	0	0	0	0.00	38.48	0	0.00
0	10	20	40	0.28	38.59	8.4	0.22
0	20	25	175	1.22	38.96	10.5	0.27
0	30	27	295	2.06	39.30	11.3	0.29
0	40	29	456	3.19	39.75	12.1	0.31
0	50	32	748	5.23	40.61	13.4	0.33
1	0	35	1187	8.30	41.97	14.6	0.35
1	10	40	1896	13.26	44.37	16.7	0.38
1	20	43	2315	16.19	45.92	17.9	0.39
1	30	47	2947	20.61	48.47	19.6	0.40
1	40	47	3050	21.33	48.92	19.6	0.40



Failure condition : Typical

Failure Stress = 0.4 kg/cm²
Failure Strain = 20.61 %

Stress at 15% strain = - kg/cm²

Undrained Shear strength= 0.20 kg/cm²

UCS Modulus= 78.57 kg/cm²

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Client: M/S Dar Al Handasah Nazih Taleb & Partners
Project: Bisri Dam
Location: Dam Footprint
Date: 07/08/14

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, %
BHVR4	4.5 - 5.0	70.01	68.81	39.83	4.0
	8.5	35.35	34.04	16.68	7.0
	17.8 - 18.0	84.31	82.08	40.68	5.1
	19.5 - 20.0	70.00	68.66	40.05	4.5
	23.5	70.00	68.71	39.81	4.3
	26.5	70.00	68.97	40.07	3.4
	29.0 - 29.5	70.00	68.38	40.68	5.5
	32.5	45.39	43.48	16.29	6.6
	38.5	67.00	65.84	40.68	4.4
BHVR6	2.5	73.77	72.54	40.06	3.6
	5.5	80.51	78.83	39.81	4.1
	32.5	40.00	39.27	16.72	3.1
	38.5	40.00	39.09	16.32	3.8
	47.5	44.28	41.67	16.72	9.5
	68.0	40.00	39.1	16.72	3.9

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 Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint /Package 3
Date : 07/08/14

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. Saturated kg/cm²	Water Absorption %	$MgSO_4$ Soundness %	CaCo3 cont. %	$SO3^{--}$ cont. %	CL^{-} cont. %	PH cont.
BHLA3	11.5 - 11.7 Limestone (Sandy).	2.703	2.730	521.7	1.25	3.9	95	25	59	7.76
	46.3 - 46.5 Limestone.	2.668	2.673	433.8	0.27	4.2	-	-	-	-
BHLA4	16.3 - 16.5 Limestone.	2.702	2.708	939.5	0.09	2.9	97	-	-	-
	36.5 - 36.8 Limestone.	2.709	2.726	985.9	0.98	2.8	98	22	57	7.83
	50.4 - 50.7 Limestone.	2.737	2.749	702.0	0.54	3.2	-	-	-	-

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 07/08/14

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	cm²	g	g/cm³	Kg	kg/cm²
BHLA3	11.5 - 11.7	6.3	13.0	31.2	1106.47	2.730	16264	522
	46.3 - 46.5	6.3	12.7	31.2	1058.09	2.673	13521	434
BHLA4	16.3 - 16.5	6.3	12.4	31.2	1044.43	2.702	29286	939
	36.5 - 36.8	6.3	12.7	31.2	1079.39	2.726	30734	986
	50.4 - 50.7	6.3	13.0	31.2	1114.05	2.749	21883	702

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 07/08/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D BHRA3
Depth : 11.50-11.70 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"	18	175.8	163.2	12.6	7.17	1.29
1 1/2"	3/4"	23	218.9	211.0	7.9	3.61	0.83
3/4"	3/8"	31	259.8	242.8	17.0	6.54	2.03
3/8"	No. 4	28	211.4	203.5	7.9	3.74	1.05
Totals		100					3.9

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 07/08/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D BHRA3
Depth : 46.30-46.50 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"	17	185.4	193.2	-7.8	-4.21	-0.72
1 1/2"	3/4"	23	274.3	266.8	7.5	2.73	0.63
3/4"	3/8"	33	191.6	184.1	7.5	3.91	1.29
3/8"	No. 4	27	219.5	201.0	18.5	8.43	2.28
Totals		100					4.2

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 07/08/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D BHRA4
Depth : 16.30-16.50 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"	21	169.5	165.2	4.3	2.54	0.53
1 1/2"	3/4"	19	209.6	204.6	5.0	2.39	0.45
3/4"	3/8"	29	235.9	232.6	3.3	1.40	0.41
3/8"	No. 4	31	215.6	201.6	14.0	6.51	2.02
Totals		100					2.9

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 07/08/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D BHRA4
Depth : 36.50-36.80 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"	21	171.5	164.2	7.3	4.26	0.89
1 1/2"	3/4"	19	208.6	201.6	7.0	3.36	0.64
3/4"	3/8"	29	234.8	231.9	2.9	1.24	0.36
3/8"	No. 4	31	217.9	205.2	12.7	5.83	1.81
Totals		100					2.8

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Dam Footprint
Date : 07/08/14

Soundness Of Aggregate Test

AASHTO T104 - 86
ASTM C88 - 83

Sample I.D BHRA4
Depth : 50.40-50.70 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"	23	177.8	171.5	6.3	3.54	0.81
1 1/2"	3/4"	17	221.5	206.5	15.0	6.77	1.15
3/4"	3/8"	25	239.6	230.9	8.7	3.63	0.91
3/8"	No. 4	35	211.5	204.9	6.6	3.12	1.09
Totals		100					3.2

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APPENDIX 5. CLAY-CORE MATERIAL SOURCES (LABORATORY & IN-SITU)

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ENGINEER BILAL ASSAAD MELHEM ASSAAD & Co.

المهندس بلال أسعد ملحم أسعد وشركاه

DESIGN & SUPERVISION - GEOTECHNICAL CONSULTANCY - MATERIALS TESTING

دروس وإشراف - إستشارات جيوتقنية - فحص مواد

M/S DAR AL HANDASA NAZIH TALEB & PARTNERS

BISRI DAM
UPSTREAM OF THE DAM, CLAY-CORE MATERIAL SOURCES

EXCAVATION OF THE TEST PITS AND IN-SITU TESTING

JUNE 2014

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ص.ب: ١١/٩٢١٧ بيروت - لبنان

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Contents

- **Locations of Test Pits Table**
- **Dimensions of Test Pits**
- **Illustration by Photos**
- **Field Density Tests**
- **In-Situ Moisture Content**
- **Logs of Tests Pits**

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Client: M/S Dar Al Handasa Nazih Taleb & Partners
Project: Bisri Dam
Location: Upstream of the Dam, Clay-Core Material Sources
Date: 02/06/14

Locations of Test Pits Table

New Test Pits (NTP)	Old Test Pits	Area	X (NTP)	Y(NTP)	Z (NGL, NTP)
NTP1	BS1	S1-A/B/C	-334204.15	-62028.56	415.33
NTP2	BN4	N-1	-333852.51	-61528.41	412.71
NTP3	BS3	S-3	-333589.95	-61404.50	407.65
NTP4	TP76	N-3	-333292.35	-61187.57	411.73
NTP5	TP74		-333271.52	-61148.82	413.02
NTP6	TP78		-333233.27	-61143.39	413.36
NTP7	TP77		-333228.91	-61103.93	414.04
NTP8	BS1	S1-A/B/C	-334208.48	-62113.25	414.78

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Project : Bisri Dam
Location : Upstream of the Dam, Clay-Core Material Sources
Date : 02/06/14

DIMENSION OF TEST PITS

TP	width (m)	length (m)	depth (m)	volume (m^3)
NTP1	2.5	5.0	5.5	68.8
NTP2	2.5	5.0	5.0	62.5
NTP3	2.5	5.0	5.5	68.8
NTP4	3.0	5.0	5.0	75.0
NTP5	2.5	5.0	5.2	65.0
NTP6	2.5	5.0	5.8	72.5
NTP7	2.5	5.0	5.1	63.8
NTP8	2.4	5.0	4.5	54.0
	2.0	4.0	1.5	12.0
Total Volume				**542.3**

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NTP1

NTP2

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Date : 29/05/14

NTP3

NTP4

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Date : 29/05/14

NTP5

NTP6

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NTP7

NTP8

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Date : 29/05/14

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Upstream of the Dam, Clay-Core Material Source
Date : 05/06/14

TEST DATA SUMMARY - IN SITU TESTING - ASTM D 1556

Sample I.D	Depth m	In-Situ Moinsture Content Speedy Moisture Testing Kit %	Field Dry density (Sand-Cone Method) g/cm^3
NTP1	2.50	18.5	1.61
NTP2	3.00	21.3	1.67
	5.00	22.7	1.62
NTP3	2.50	32.9	1.50
	3.40	-	-
	3.80	-	-
NTP4	2.50	19.7	1.65
	4.50	27.5	1.43
NTP5	2.70	29.2	1.59
	5.00	30.4	1.44
NTP6	2.80	25.6	1.61
	5.80	31.3	1.46
NTP7	2.70	22.8	1.48
	5.10	28.6	1.55
NTP8	1.20	20.1	1.55

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Project : Bisri Dam
Location : Bisri - South Lebanon
Date : 02/06/14

FIELD DENSITY TEST

(Sand Volume Apparatus)

Standard: ASTM D 1556

	Test Number			**FD1**	**FD2**	**FD3**	**FD4**	**FD5**
	Location			**NTP1**	**NTP2**	**NTP2**	**NTP3**	**NTP4**
	Depth (m)			**2.50**	**3.00**	**5.00**	**2.50**	**2.50**
	Layer			-	-	-	-	-
	Sample I.D.			-	-	-	-	-
A	Wt. sand + container / start		g	7821	8863	8492	7559	8843
B	Wt. sand + container / finish		g	4864	6058	5127	4542	5834
C	Wt. sand used	a - b	g	2957	2805	3365	3017	3009
D	Unit Wt.of sand		g/cm³	1.56	1.56	1.56	1.56	1.56
E	Volume cone + hole	c ÷ d	cm³	1895.5	1798.1	2157.1	1934.0	1928.8
F	Volume of cone		cm³	860	860	860	860	860
G	Volume of test hole	e - f	cm³	1035.5	938.1	1297.1	1074.0	1068.8
H	Wt. excavated material + container		g	1973.0	1895.3	2572.1	2142.0	2115.3
I	Wt. container		g	-	-	-	-	-
J	Wt. excavated material	h - l	g	1973.0	1895.3	2572.1	2142.0	2115.3
K	Wet density of sample	j ÷ g	g/cm³	**1.91**	**2.02**	**1.98**	**1.99**	**1.98**
L	Wt. wet sample		g	-	-	-	-	-
M	Wt. dry sample		g	-	-	-	-	-
N	Wt. container		g	-	-	-	-	-
O	Wt. of water	l - m	g	-	-	-	-	-
P	Wt. of dry sample	m-n	g	-	-	-	-	-
Q	Moisture content 100	o ÷ p	%	**18.5%**	**21.3%**	**22.7%**	**32.9%**	**19.7%**

R	Field density	K÷(1+Q/100)	g/cm³	1.61	1.67	1.62	1.50	1.65
S	Maximum density (Proctor)		g/cm³	-	-	-	-	-
T	Relative compaction	R ÷ S	%	-	-	-	-	-

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FIELD DENSITY TEST

(Sand Volume Apparatus)

Standard: ASTM D 1556

	Test Number			**FD6**	**FD7**	**FD8**	**FD9**	**FD10**
	Location			**NTP4**	**NTP5**	**NTP5**	**NTP6**	**NTP6**
	Depth (m)			**4.50**	**2.70**	**5.00**	**2.80**	**5.80**
	Layer			-	-	-	-	-
	Sample I.D.			-	-	-	-	-
A	Wt. sand + container / start		g	8416	5781	4989	9055	7832
B	Wt. sand + container / finish		g	5268	2732	1740	5838	5154
C	Wt. sand used	a - b	g	3148	3049	3249	3217	2678
D	Unit Wt.of sand		g/cm³	1.56	1.56	1.56	1.56	1.56
E	Volume cone + hole	c ÷ d	cm³	2017.9	1954.5	2082.7	2062.2	1716.7
F	Volume of cone		cm³	860	860	860	860	860
G	Volume of test hole	e - f	cm³	1157.9	1094.5	1222.7	1202.2	856.7
H	Wt. excavated material + container		g	2113.5	2245.6	2293.0	2434.1	1639.2
I	Wt. container		g	-	-	-	-	-
J	Wt. excavated material	h - l	g	2113.5	2245.6	2293.0	2434.1	1639.2
K	Wet density of sample	j ÷ g	g/cm³	**1.83**	**2.05**	**1.88**	**2.02**	**1.91**
L	Wt. wet sample		g	-	-	-	-	-
M	Wt. dry sample		g	-	-	-	-	-
N	Wt. container		g	-	-	-	-	-
O	Wt. of water	l - m	g	-	-	-	-	-
P	Wt. of dry sample	m-n	g	-	-	-	-	-
Q	Moisture content 100	o ÷ p	%	**27.5%**	**29.2%**	**30.4%**	**25.6%**	**31.3%**

R	Field density	K÷(1+Q/100)	g/cm³	1.43	1.59	1.44	1.61	1.46
S	Maximum density (Proctor)		g/cm³	-	-	-	-	-
T	Relative compaction	R ÷ S	%	-	-	-	-	-

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Date : 02/06/14

FIELD DENSITY TEST

(Sand Volume Apparatus)

Standard: ASTM D 1556

	Test Number			**FD11**	**FD12**	**FD13**		
	Location			**NTP7**	**NTP7**	**NTP8**		
	Depth (m)			**2.70**	**5.10**	**1.20**		
	Layer			-	-	-		
	Sample I.D.			-	-	-		
A	Wt. sand + container / start		g	6530	6068	7455		
B	Wt. sand + container / finish		g	3681	3608	4584		
C	Wt. sand used	a - b	g	2849	2460	2871		
D	Unit Wt.of sand		g/cm³	1.56	1.56	1.56		
E	Volume cone + hole	c ÷ d	cm³	1826.3	1576.9	1840.4		
F	Volume of cone		cm³	860	860	860		
G	Volume of test hole	e - f	cm³	966.3	716.9	980.4		
H	Wt. excavated material + container		g	1752.9	1425.7	1827.1		
I	Wt. container		g	-	-	-		
J	Wt. excavated material	h - l	g	1752.9	1425.7	1827.1		
K	Wet density of sample	j ÷ g	g/cm³	**1.81**	**1.99**	**1.86**		
L	Wt. wet sample		g	-	-	-		
M	Wt. dry sample		g	-	-	-		
N	Wt. container		g	-	-	-		
O	Wt. of water	l - m	g	-	-	-		
P	Wt. of dry sample	m-n	g	-	-	-		
Q	Moisture content 100	o ÷ p	%	**22.8%**	**28.6%**	**20.1%**		

R	Field density	K÷(1+Q/100)	g/cm³	1.48	1.55	1.55		
S	Maximum density (Proctor)		g/cm³	-	-	-		
T	Relative compaction	R ÷ S	%	-	-	-		

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Project : Bisri Dam
Location: Bisri - South Lebanon
Date : 02/06/14

Field Determination of Moisture Content of Soil by the Calcium Carbide Gaz Presure Tester

ASTM Designation D4944

TP No.	Depth (m)	Moisture (%)
NTP1	2.50	18.5
NTP2	3.00	21.3
	5.00	22.7
NTP3	2.50	32.9
	3.40	-
	3.80	-
NTP4	2.50	19.7
	4.50	27.5
NTP5	2.70	29.2
	5.00	30.4
NTP6	2.80	25.6
	5.80	31.3
NTP7	2.70	22.8
	5.10	28.6
NTP8	1.20	20.1

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP1 (2.5m x 5m x 5.5m) **Depth : 0.00 - 5.50 m** **Start date : 29/05/14** **End date : 29/05/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.35m: Agricultural top soil.**
						0.35	**Made Ground**
							0.35-1.5m: Yellowish brown fine to medium SAND.
						1.0	
						1.5	**SAND**
							1.50-3.60m: Brown slightly sandy SILT and CLAY.
						2.0	
	Sample						
						3.0	**As above, " " " "**
						3.6	**SILT & CLAY**
							3.60-4.00m: Light brown, fine to medium SAND.
						4.0	**SAND**
							4.00-5.50m: Alluvial soil deposits (Gravely SAND).
						5.0	**As above, " " " "**
						5.5	**GRAVELLY SAND** **End of Pit**
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

Remarks:

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP2 (2.5m x 5m x 5m) **Depth : 0.00 - 5.00 m** **Start date : 28/05/14** **End date : 28/05/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-1.50m: Alluvial soil deposits.(Sand with rounded Gravel)**
						1.0	**As above, " " " "**
						1.5	**SAND with GRAVEL**
							1.50-4.60m: Brown Clayey Silty SAND.
						2.0	
	Sample					3.0	**As above, " " " "**
						4.0	**As above, " " " "**
						4.6	**Clayey Silty SAND**
							4.60-5.00m: Bluish grey Sandy Silty CLAY.
	Sample					5.0	**Sandy Silty CLAY** **End of Pit**
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP3 (2.5m x 5m x 5.5m) **Depth : 0.00 - 5.50 m** **Start date : 28/05/14** **End date : 28/05/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.35m: Agricultural top soil.**
						0.35	**Made Ground**
							0.35-1.50m: Olive brown Sandy Clayey SILT.
						1.0	**As above, " " " "**
						1.5	**Sandy Clayey SILT**
							1.50-3.20m: Brown Silty CLAY.
						2.0	**As above, " " " "**
	Sample					2.5	
28.05.14						3.0	**As above, " " " "**
						3.2	**Silty CLAY**
	Sample						**3.20-4.00m: Bluish grey clayey Silt and Silty CLAY.**
	Sample					4.0	**Clayey Silt and silty CLAY**
							4.00-5.50m: Alluvial soil deposits (Sand with rounded Gravel).
						5.0	**As above, " " " "**
						5.5	**SAND WITH GRAVEL** **End of Pit**
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

Remarks:

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP4 (3m x 5m x 5m) **Depth** : 0.00 - 5.00 m **Start date** : 29/05/14 **End date** : 29/05/14 **Excavation method** : Excavation by using crawler mounted backhoe
						0.0	**0.00-0.30m: Agricultural top soil.**
						0.3	**Made Ground**
							0.30-1.00m: Alluvial soil deposits (Sand with rounded Gravel).
						1.0	**SAND with GRAVEL**
							1.00-2.00m: Yellowish brown fine to medium SAND.
						2.0	**SAND**
							2.00-3.00m: Brown Silty Sandy CLAY.
	Sample						
						3.0	**Silty Sandy CLAY**
							3.00-5.00m: Bluish grey Silty CLAY.
						4.0	**As above, " " " "**
	Sample						
						5.0	**Silty CLAY**
							End of Pit
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

Remarks:

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Project : Bisri Dam - Upstream of the Dam, Clay-Core Material Sources

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP5 (2.5m x 5m x 5.2m) **Depth : 0.00 - 5.20 m** **Start date : 28/05/14** **End date : 28/05/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.50m: Agricultural top soil.**
						0.5	**Made Ground**
							0.50-2.00m: Alluvial soil deposits (Sand with rounded Gravel).
						1.0	**As above, " " " "**
						2.0	**SAND with GRAVEL**
							2.00-4.20m: Brown Silty CLAY.
	Sample						
						3.0	**As above, " " " "**
						4.0	**As above, " " " "**
						4.2	**Silty CLAY**
							4.20-5.20m: Bluish grey Silty CLAY.
	Sample					5.0	**As above, " " " "**
						5.2	**Silty CLAY** **End of Pit**
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	
Remarks:							**Client : M/S Dar Al Handasa Nazih Taleb & Partners** **Project : Bisri Dam - Upstream of the Dam, Clay-Core Material Sources**

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP6 (2.5m x 5m x 5.8m) **Depth : 0.00 - 5.80 m** **Start date : 28/05/14** **End date : 28/05/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.50m: Agricultural top soil.**
						0.5	**Made Ground**
							0.5-1.5m: Alluvial soil deposits (Sand with rounded Gravel).
						1.0	**As above, " " " "**
						1.5	**SAND with GRAVEL**
							1.50-4.90m: Brown Silty CLAY.
						2.0	
	Sample					3.0	**As above, " " " "**
						4.0	**As above, " " " "**
						4.9	**Silty CLAY**
						5.0	**4.90-5.80m: Bluish grey Silty CLAY.**
							As above, " " " "
	Sample					5.8	**Silty CLAY**
						6.0	**End of Pit**
						7.0	
						8.0	
						9.0	
						10.0	

Remarks:

Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam - Upstream of the Dam, Clay-Core Material Sources

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP7 (2.5m x 5m x 5.1m) **Depth : 0.00 - 5.10 m** **Start date : 28/05/14** **End date : 28/05/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.50m: Agricultural top soil.**
						0.5	**Made Ground**
						0.75	**0.50-0.75m: Alluvial soil deposits (Sand with rounded Gravel).**
						1.0	**0.75-4.70m: Brown Silty CLAY.** **SAND with GRAVEL**
						1.5	
						2.0	**As above, " " " "**
	Sample					2.7	
						3.0	**As above, " " " "**
						4.0	**As above, " " " "**
						4.7	**Silty CLAY**
						5.0	**4.70-5.10m: Bluish grey Silty CLAY.**
	Sample					5..1	**CLAY** **End of Pit**
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

Remarks:

Client : M/S Dar Al Handasa Nazih Taleb & Partners
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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP8 (2.4m x 5m x 4.5m) + (2m x 4m x 1.5m) **Depth : 0.00 - 4.50 m** **Start date : 29/05/14** **End date : 29/05/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.30m: Agricultural top soil.**
						0.3	**Made Ground**
							0.30-1.00m: Yellowish brown fine to medium SAND.
						1.0	**SAND**
							1.00-1.50m: Grey Silty CLAY.
						1.5	**Silty CLAY**
							1.50-3.50m: Brown slightly silty fine to medium SAND.
						2.0	
						3.0	**As above, " " " "**
						3.5	**Silty SAND**
							3.50-4.50m: Alluvial soil deposits (Sand with rounded Gravel).
						4.0	
						4.5	**SAND with GRAVEL**
							End of Pit
						5.0	
	Sample						
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	
Remarks:							**Client : M/S Dar Al Handasa Nazih Taleb & Partners** **Project : Bisri Dam - Upstream of the Dam, Clay-Core Material Sources**

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أساكو ش.م.م.

ENGINEER BILAL ASSAAD MELHEM ASSAAD & Co.

المهندس بلال أسعد ملحم أسعد وشركاه

DESIGN & SUPERVISION - GEOTECHNICAL CONSULTANCY - MATERIALS TESTING

دروس وإشراف - إستشارات جيوتقنية - فحص مواد

M/S DAR AL HANDASAH NAZIH TALEB & PARTNERS S.A.L.

BISRI DAM
UPSTREAM OF THE DAM, CLAY-CORE MATERIAL SOURCES

LABORATORY TESTING OF SAMPLES COLLECTED FROM TEST PITS

AUGUST 2014

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Contents

- **Locations of Test Pits Table**
- **Test Data Summary**
- **Sieve analysis Tests**
- **Liquid Limit & Plastic Limit Tests**
- **Modified Proctor Tests**
- **Free Swell Index Tests**
- **Falling Head Permeability Test**
- **Organic Content Test**
- Odometer test on remolded samples 1.
- Triaxial test (CU+U) on remolded samples. 1.

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Client: M/S Dar Al Handasa Nazih Taleb & Partners
Project: Bisri Dam
Location: Upstream of the Dam, Clay-Core Material Sources
Date: 02/06/14

Locations of Test Pits Table

New Test Pits (NTP)	Old Test Pits	Area	X (NTP)	Y(NTP)	Z (NGL, NTP)
NTP1	BS1	S1-A/B/C	-334204.15	-62028.56	415.33
NTP2	BN4	N-1	-333852.51	-61528.41	412.71
NTP3	BS3	S-3	-333589.95	-61404.50	407.65
NTP4	TP76	N-3	-333292.35	-61187.57	411.73
NTP5	TP74		-333271.52	-61148.82	413.02
NTP6	TP78		-333233.27	-61143.39	413.36
NTP7	TP77		-333228.91	-61103.93	414.04
NTP8	BS1	S1-A/B/C	-334208.48	-62113.25	414.78

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Upstream of the Dam, Clay-Core Material Sources
Date : 11/08/14

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TEST DATA SUMMARY - ASTM Designations D422 / D2216 / D3080 / D4318

Sample I.D	Depth m	B.S. Soil Class.	Grain Size distribution Gravel %	Sand %	Fines %	Silt %	Clay %	Double hydrometer dispersion %	Atterberg LL %	PL %	Moist. cont. %	Bulk (Wet) density g/cm³	Sat. dens. g/cm³	Void ratio	Triaxial / CU+U C cohesion kg/cm²	ϕ Degree	Compr-ession index Cc	Modified Proctor Max. dry density g/cm³	Opt. moist. content %	Free swell index %	Perm-eability m/s	Organic Content %	SO_4^{--} cont. ppm	CL^- cont. ppm	pH
NTP1	2.50	ML	0	27	73	51	22	43	27	19	18.5	1.98	1.99	0.571	0.38	26.0	0.143	1.94	12.4	19.8	$3.5x10^{-11}$	1.68	35	70	7.55
NTP2	3.00	ML	0	26	74	49	25	-	33	21	21.3	2.03	2.06	0.574	-	-	-	-	-	-	-	2.56	-	-	-
	5.00	MLS	0	41	59	37	22	40	24	16	22.7	2.00	2.03	0.476	0.35	29.0	0.302	1.98	12.0	18.5	$5.6x10^{-10}$	1.90	36	61	7.56
NTP3	2.50	CI	0	6	94	38	56	35	42	26	32.9	1.97	2.04	0.625	0.48	21.0	0.156	1.74	18.3	32.7	$1.8x10^{-12}$	2.87	29	84	7.61
	3.40	SM	0	53	47	40	7	-	0	0	-	1.99	2.03	0.410	-	-	-	-	-	-	-	1.81	-	-	-
	3.80	SM	0	51	49	38	11	-	25	0	-	2.02	2.06	0.416	-	-	-	-	-	-	-	-	-	-	-
NTP4	2.50	CL	0	23	77	24	53	-	32	24	19.7	1.99	2.04	0.538	-	-	-	-	-	-	-	4.90	-	-	-
	4.50	CL	0	11	89	31	58	-	34	22	27.5	1.80	1.89	0.624	-	-	-	-	-	-	-	3.72	31	79	7.59
NTP5	2.70	CI	0	14	86	26	60	32	44	26	29.2	2.06	2.11	0.614	0.45	24.0	0.156	1.81	17.4	38.2	$2.7x10^{-11}$	3.06	-	-	-
	5.00	CI	0	4	96	32	64	-	37	21	30.4	1.87	1.95	0.633	-	-	-	-	-	-	-	4.45	25	86	7.63
NTP6	2.80	CI	0	2	98	33	65	-	45	24	25.6	2.01	2.06	0.635	-	-	-	-	-	-	-	3.59	-	-	-
	5.80	CI	0	15	85	29	56	-	36	21	31.3	1.89	1.97	0.607	-	-	-	-	-	-	-	2.83	27	83	7.60
NTP7	2.70	CI	0	10	90	32	58	-	37	23	22.8	1.83	1.89	0.611	-	-	-	-	-	-	-	3.44	-	-	-
	5.10	CI	0	2	98	38	60	36	47	28	28.6	1.97	2.05	0.638	0.50	20.5	0.161	1.80	16.7	40.1	$3.4x10^{-12}$	3.78	38	75	7.58
NTP8	1.20	CI/CH	0	17	83	21	62	-	50	27	20.1	1.85	1.93	0.599	-	-	-	-	-	-	-	3.83	29	67	7.55

N.B. : N.B. : The Triaxial, Odometer and permeability tests were carried out on remolded samples (98% of the dry density at a water content of optimum + 2%).

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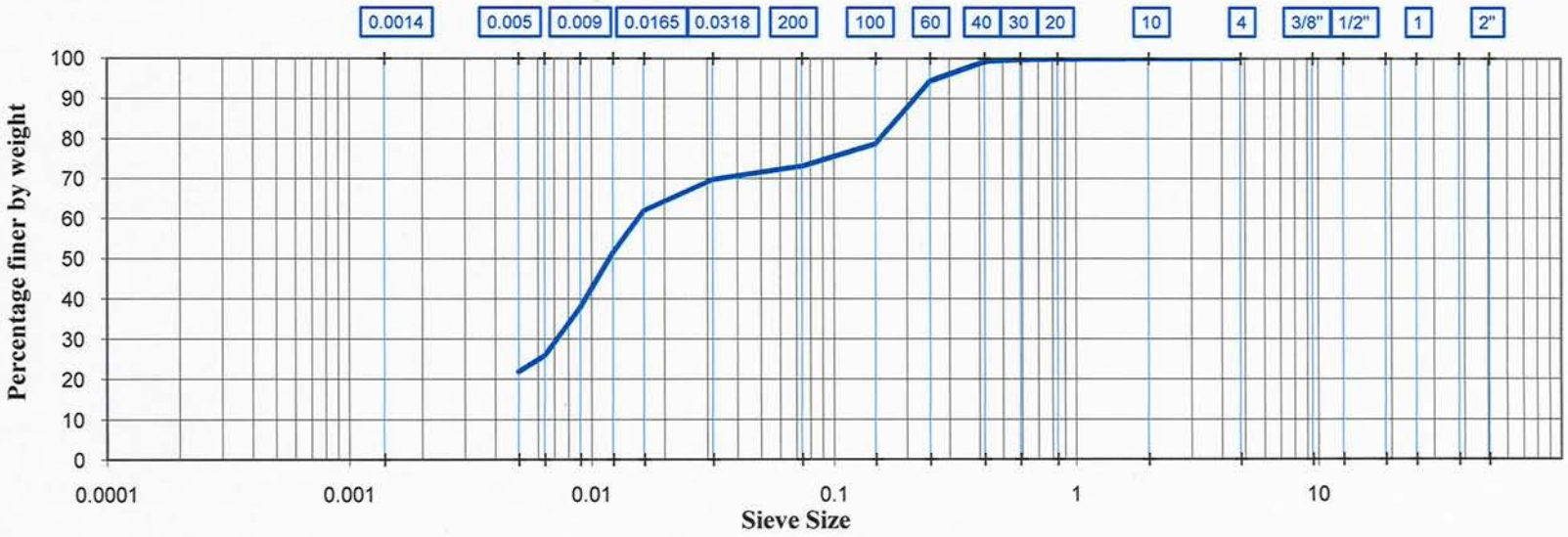

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP1	-	2.50	Location : Upstream of the Dam, Clay-Core Material Sources		

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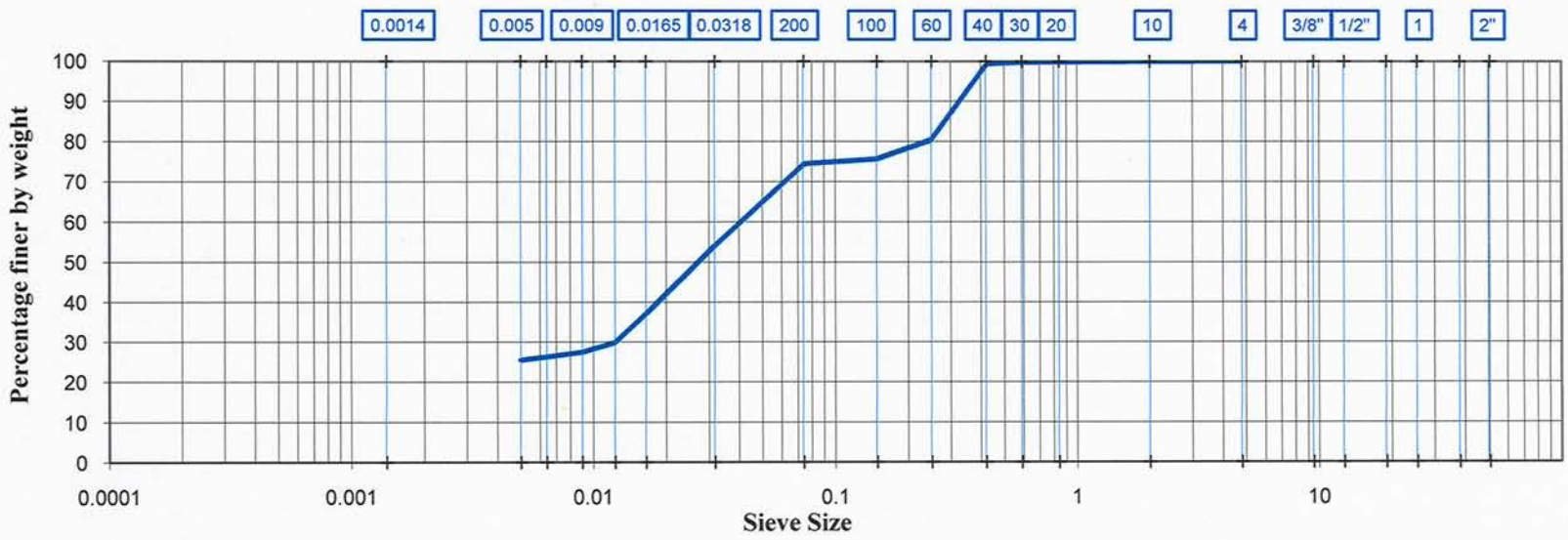

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP2	-	3.00	Location : Upstream of the Dam, Clay-Core Material Sources		

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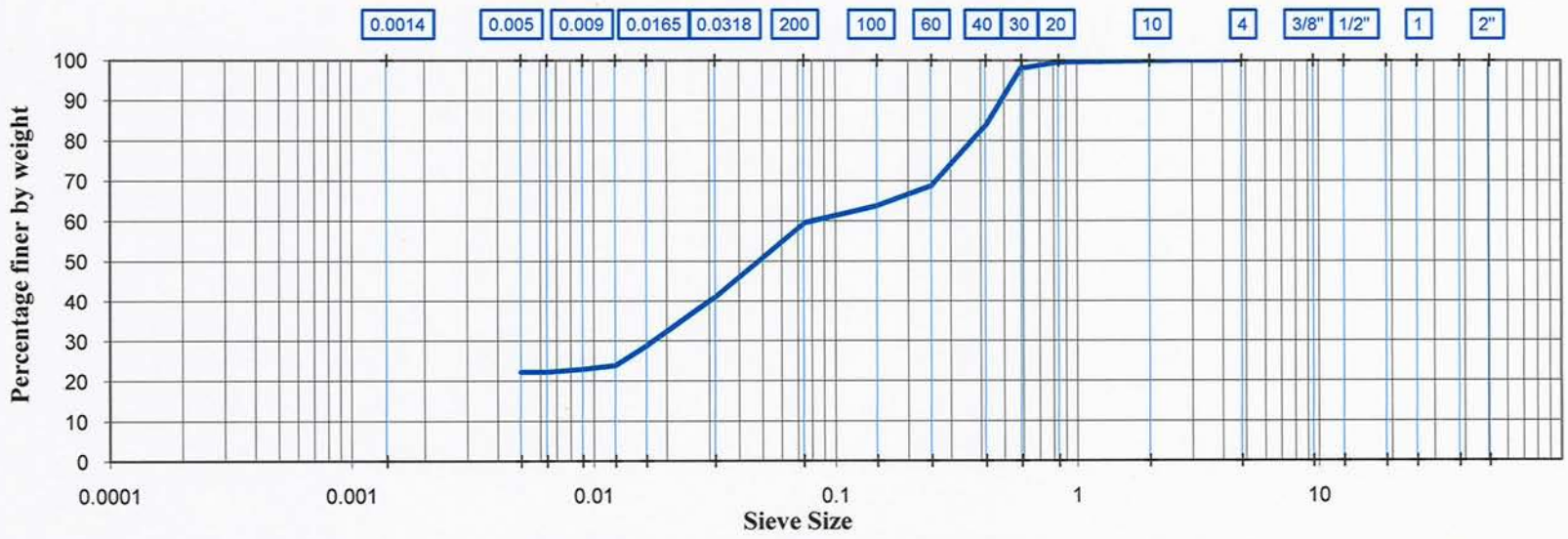

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP2	-	5.00	Location : Upstream of the Dam, Clay-Core Material Sources		

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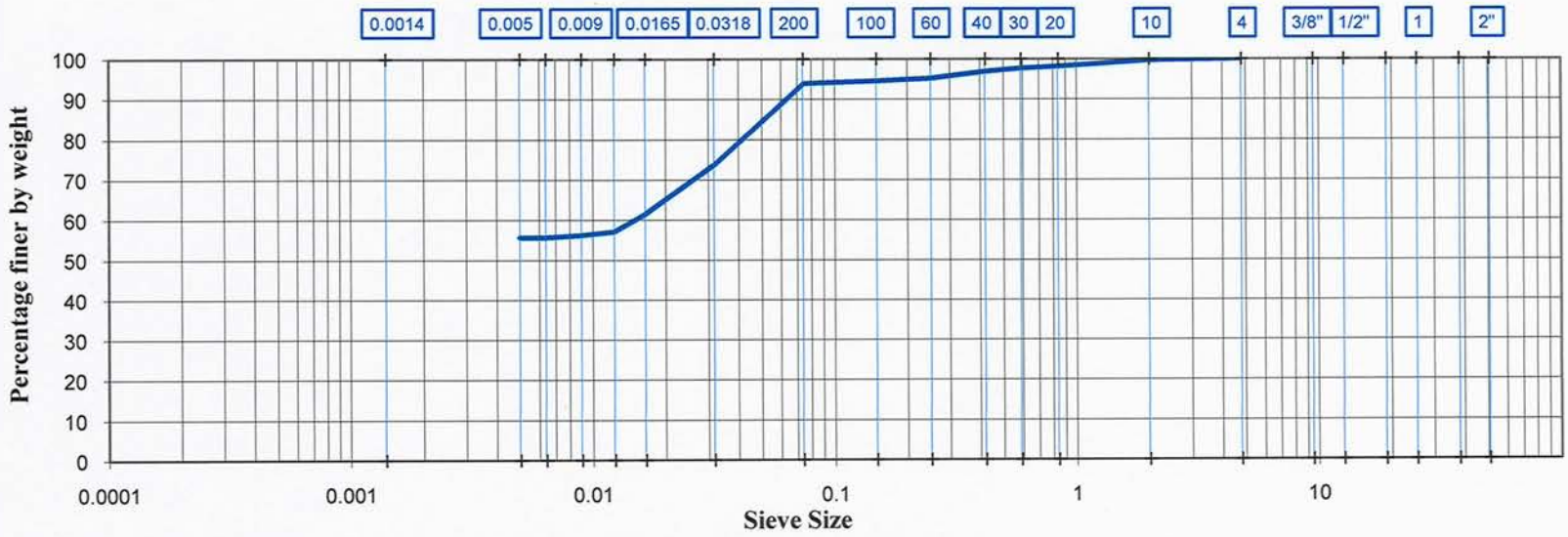

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP3	-	2.50	Location : Upstream of the Dam, Clay-Core Material Sources		

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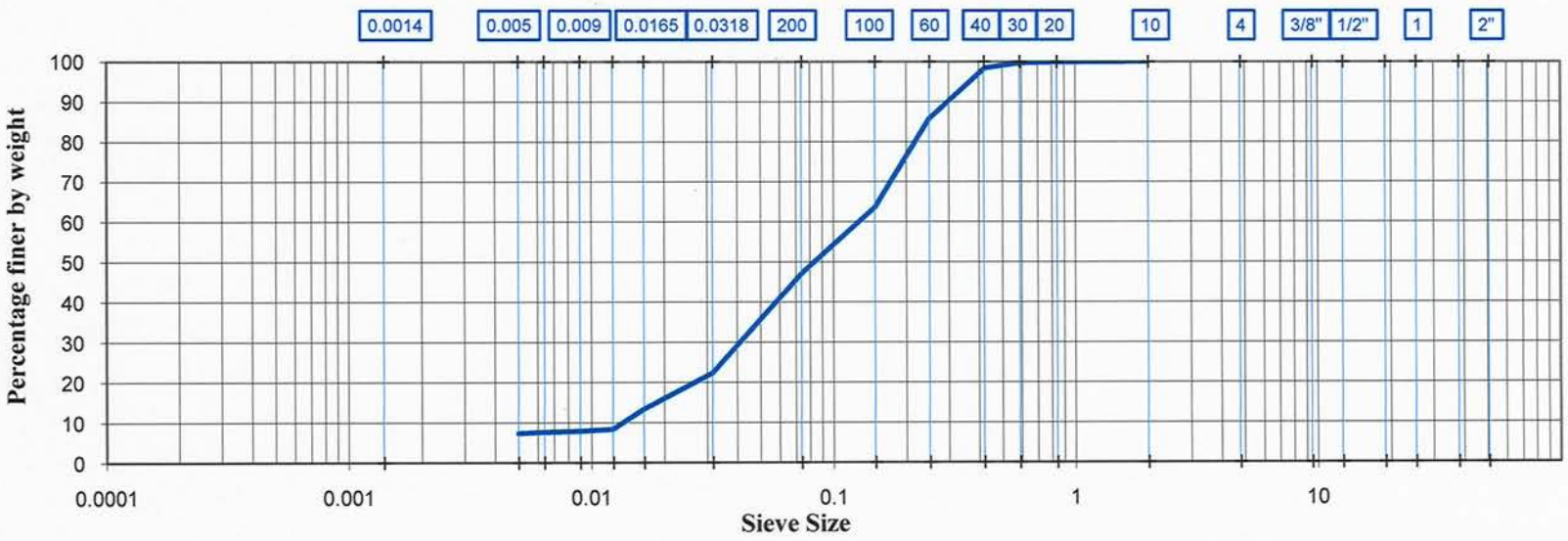

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP3	-	3.40	Location : Upstream of the Dam, Clay-Core Material Sources		

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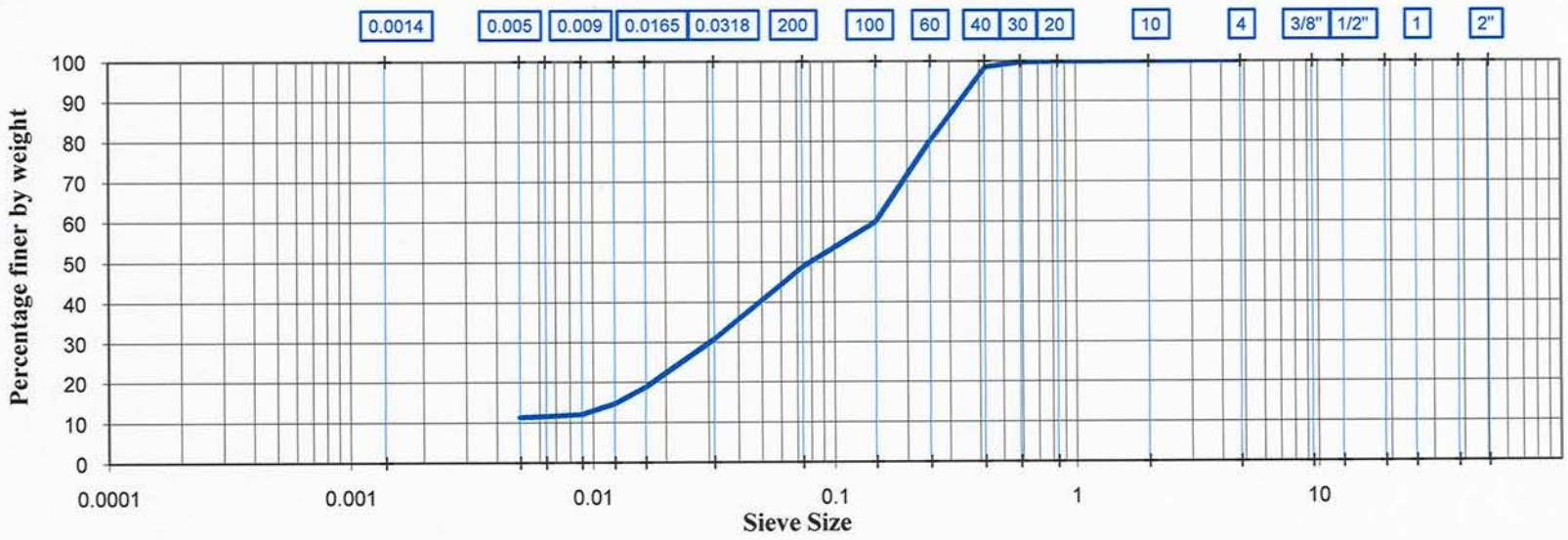

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP3	-	3.80	Location : Upstream of the Dam, Clay-Core Material Sources		

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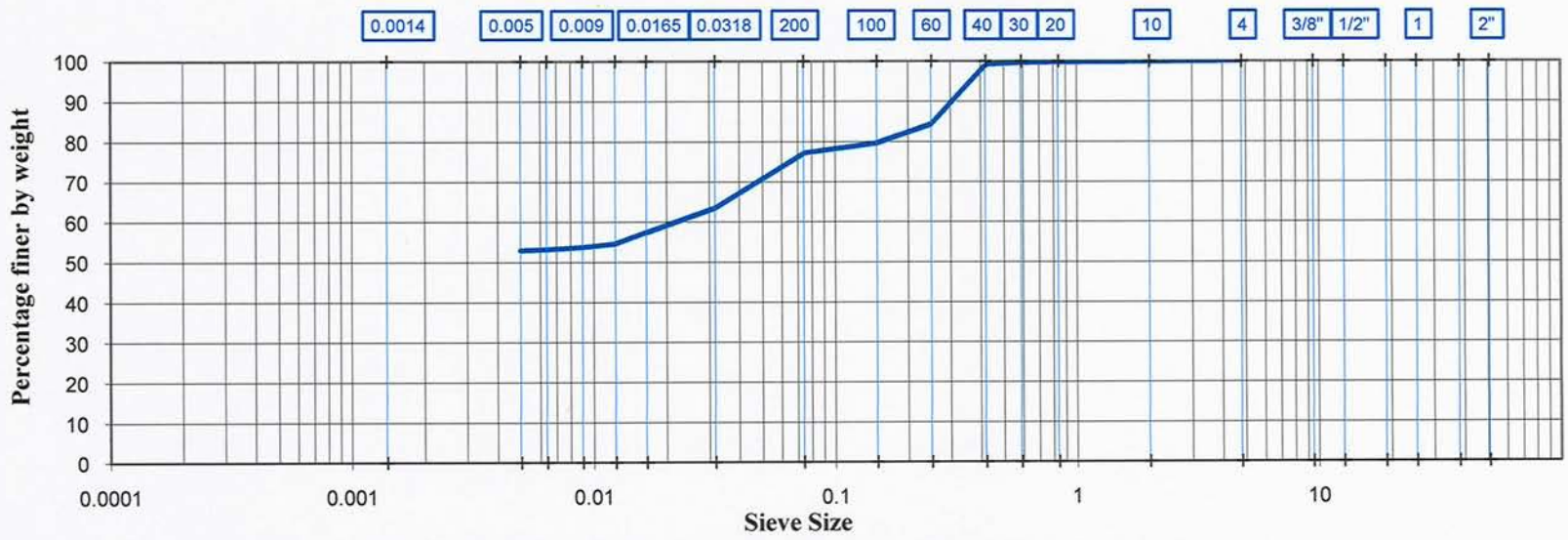

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP4	-	2.50	Location : Upstream of the Dam, Clay-Core Material Sources		

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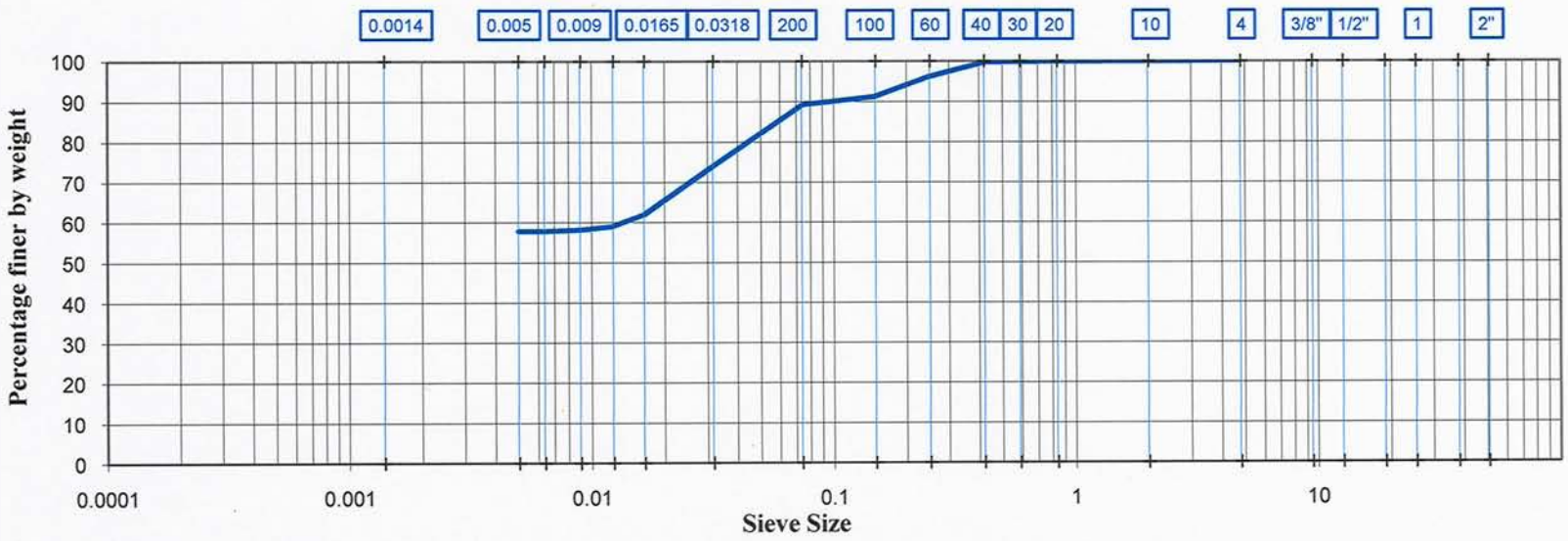

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP4	-	4.50	Location : Upstream of the Dam, Clay-Core Material Sources		

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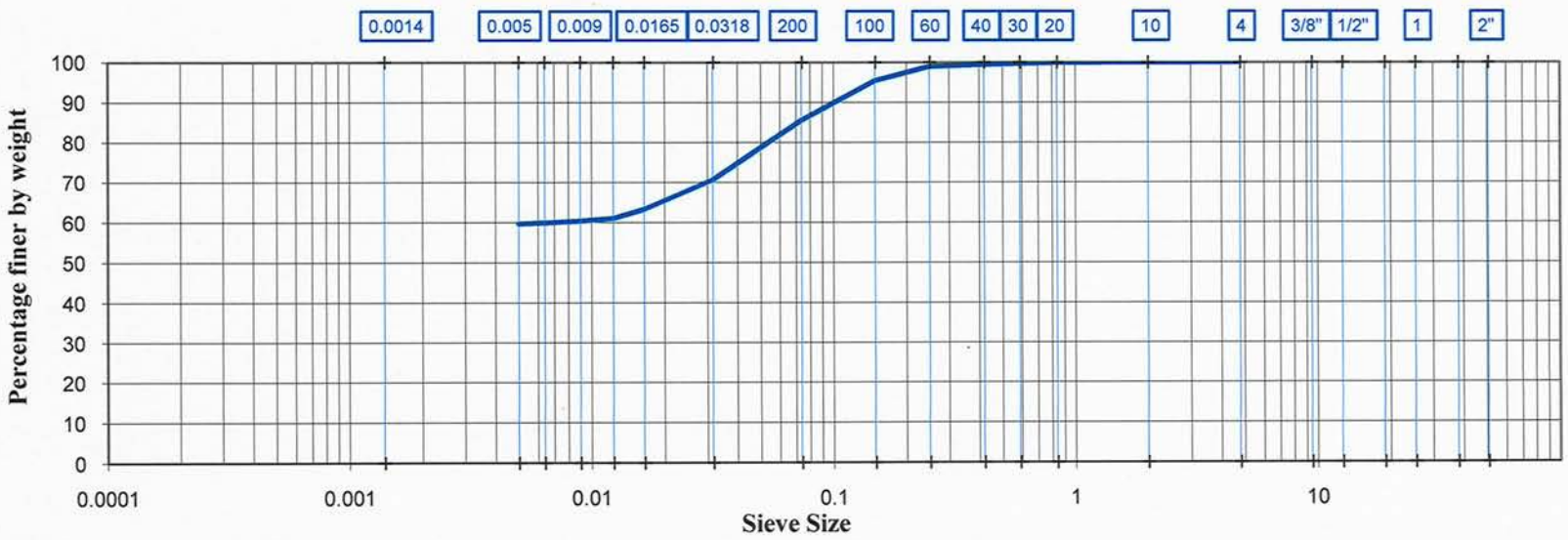

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP5	-	2.70	Location : Upstream of the Dam, Clay-Core Material Sources		

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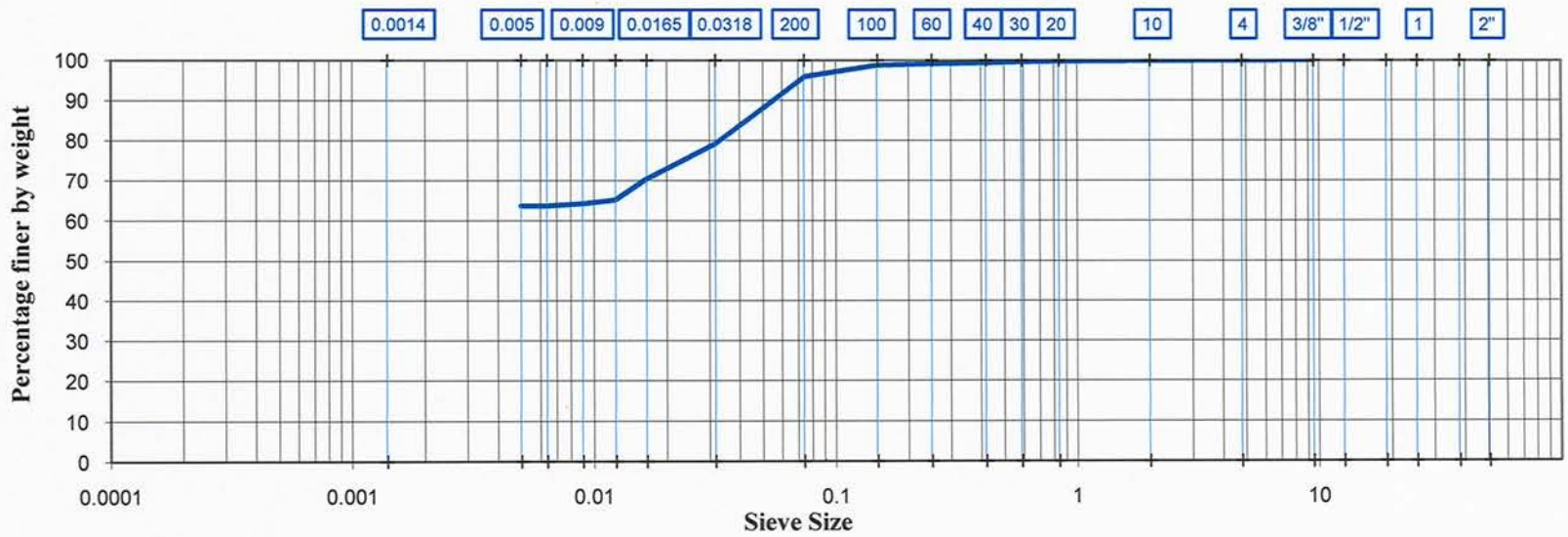

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP5	-	5.00	Location : Upstream of the Dam, Clay-Core Material Sources		

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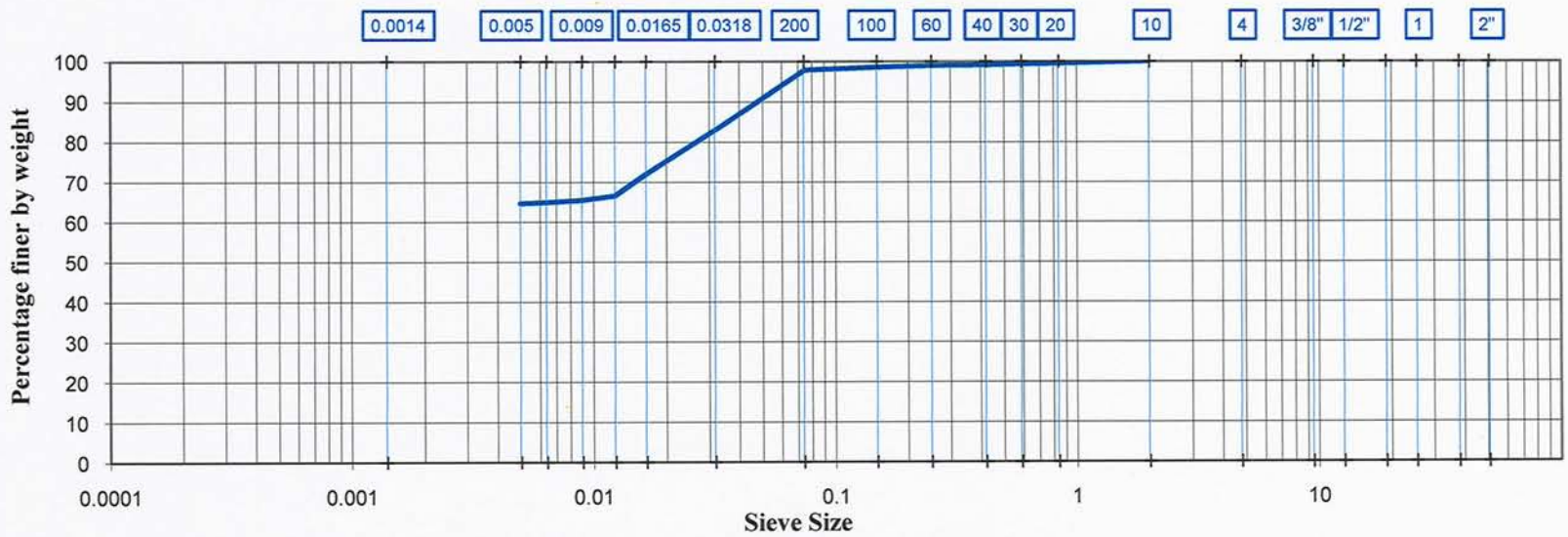

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP6	-	2.80	Location : Upstream of the Dam, Clay-Core Material Sources		

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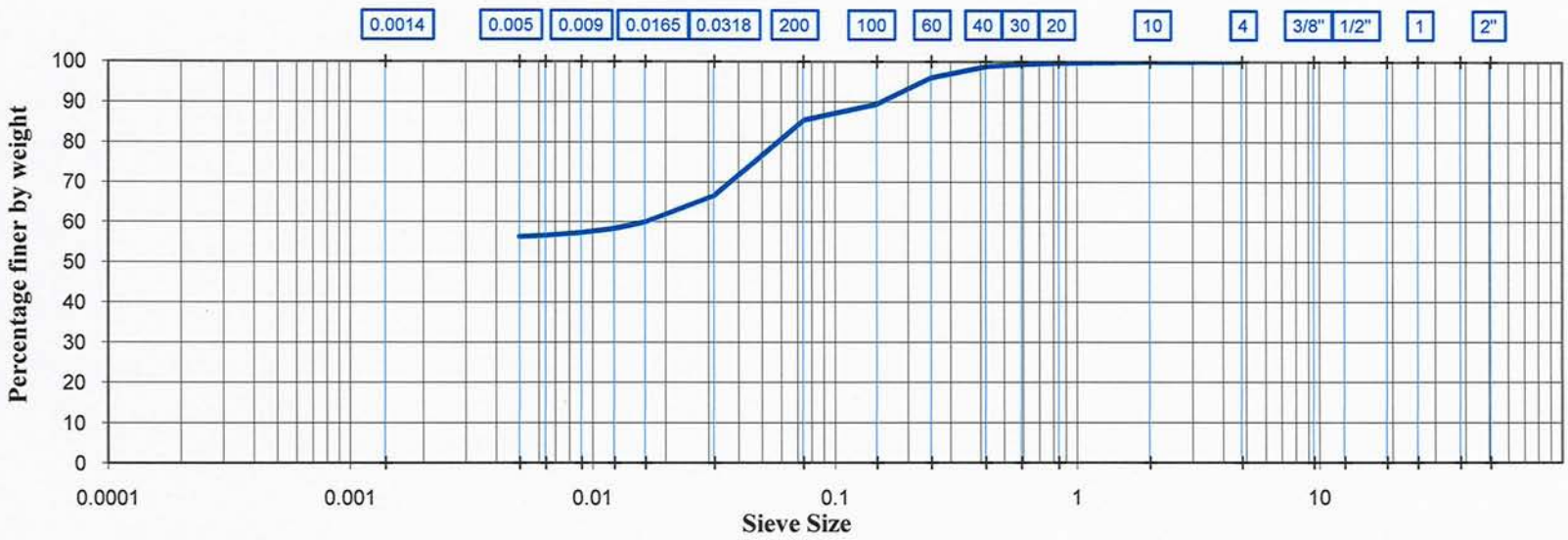

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP6	-	5.80	Location : Upstream of the Dam, Clay-Core Material Sources		

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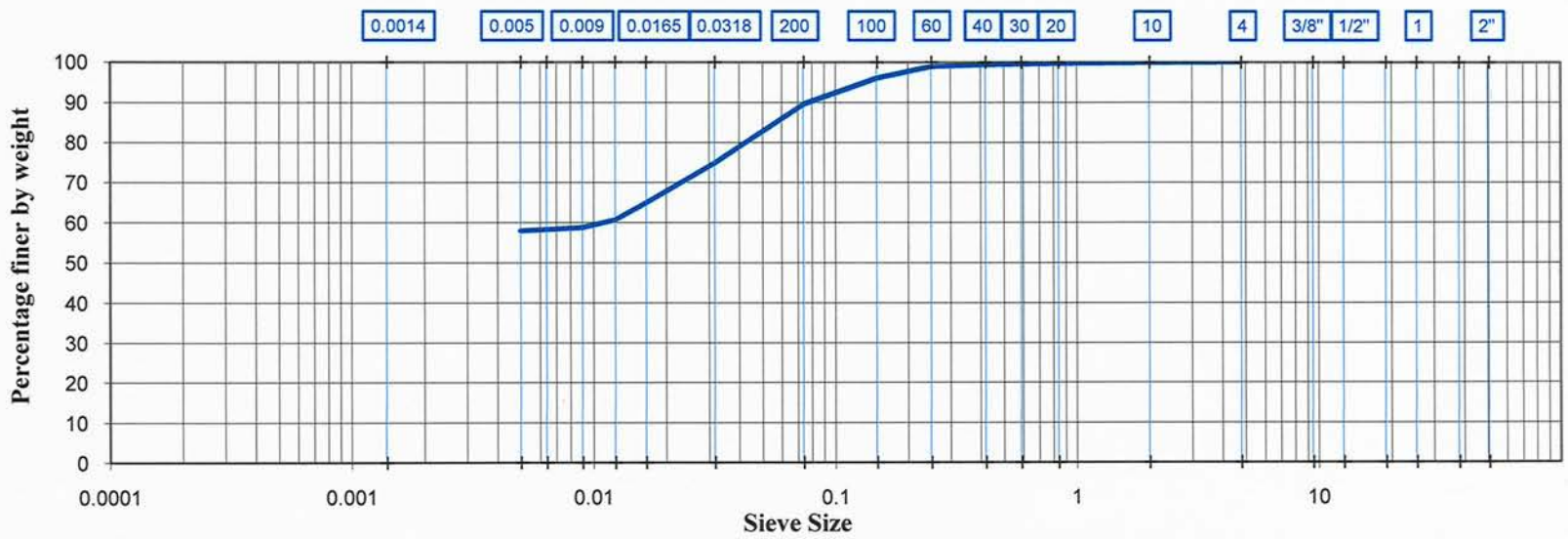

CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP7	-	2.70	Location : Upstream of the Dam, Clay-Core Material Sources		

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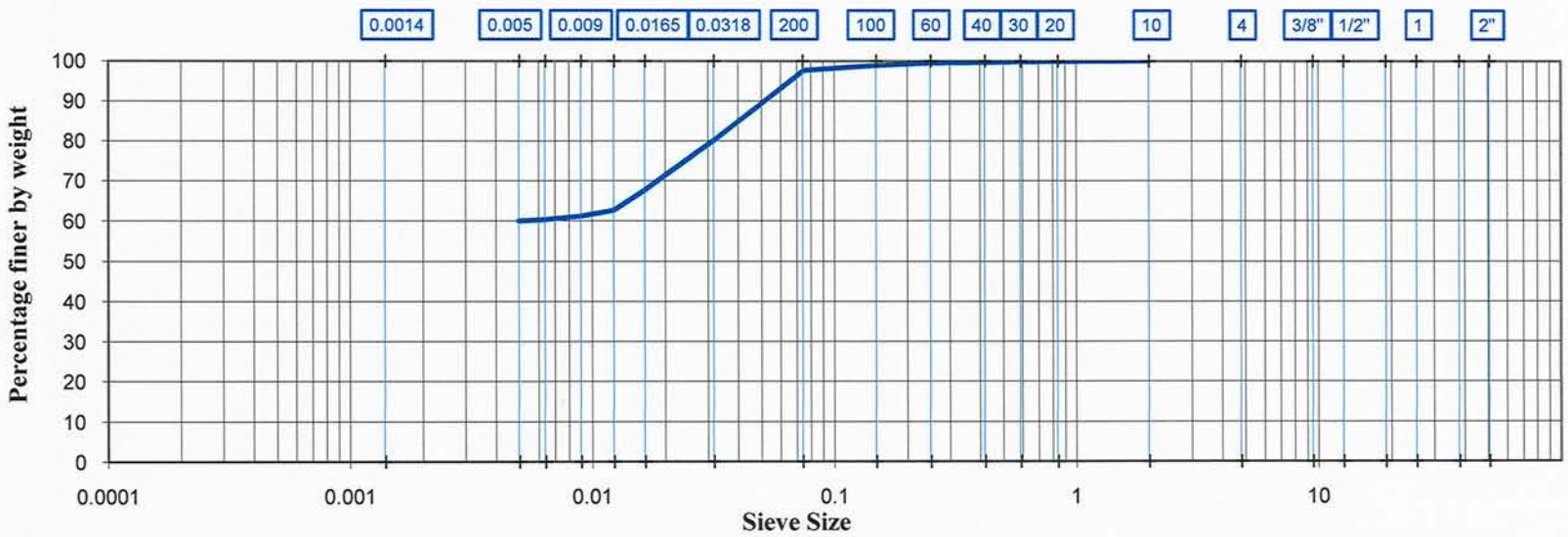
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP7	-	5.10	Location : Upstream of the Dam, Clay-Core Material Sources		

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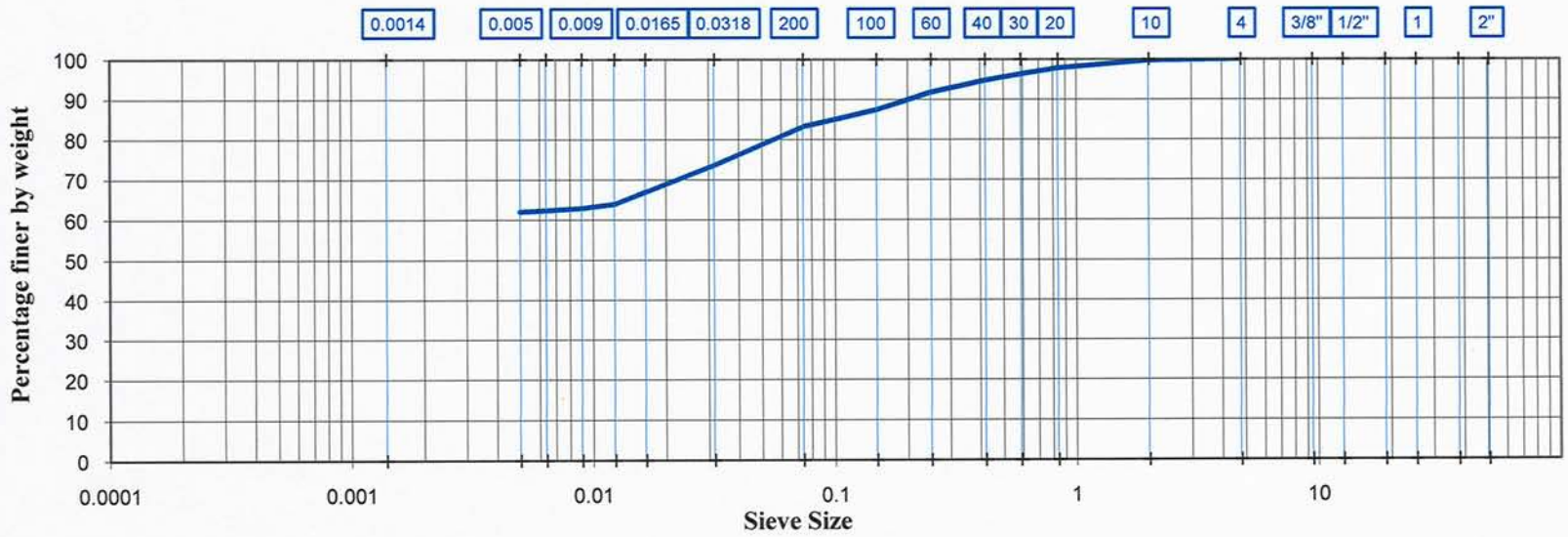
PARTICLE SIZE DISTRIBUTION
ASTM D-422



CLAY	SILT	Fine	Medium	Coarse	Fine	Coarse	Cobbles
		SAND			GRAVEL		

Sample I.D	-		Client : M/S Dar Al Handasah Nazih Taleb & Partners	Date : 17/07/14	ASSACO
BH / TP	Nr	Depth (m)	Project : Bisri Dam		
NTP8	-	1.20	Location : Upstream of the Dam, Clay-Core Material Sources		

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Upstream of the Dam, Clay-Core Material Sources
Date : 17/07/14

Liquid Limit & Plastic Limit

ASTM Designation 4318 - 84

LIQUID LIMIT		NTP1	NTP2		NTP3	
Depth	m	2.50	3.00	5.00	2.50	3.40
CONTAINER NUMBER		1	2	3	4	5
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	28.42	33.96	31.89	23.89	0.00
WT. OF DRY SAMPLE & CONTAINER	g	24.68	28.17	27.85	18.08	
WT. OF WATER	g	3.74	5.79	4.04	5.81	0.00
WT. OF CONTAINER	g	10.89	10.83	11.01	4.13	
WT. OF DRY SAMPLE	g	13.79	17.34	16.84	13.95	0.00
WATER CONTENT (LL)	%	**27**	**33**	**24**	**42**	**0**

PLASTIC LIMIT		NTP1	NTP2		NTP3	
Depth	m	2.50	3.00	5.00	2.50	3.40
CONTAINER NUMBER		1	2	3	4	5
WT. OF WET SAMPLE & CONTAINER	g	18.45	17.63	18.72	20.68	
WT. OF DRY SAMPLE & CONTAINER	g	17.24	16.47	17.65	18.65	
WT. OF WATER	g	1.21	1.16	1.07	2.03	0.00
WT. OF CONTAINER	g	10.93	10.94	10.99	10.95	
WT. OF DRY SAMPLE	g	6.31	5.53	6.66	7.70	0.00
WATER CONTENT (PL)	%	**19**	**21**	**16**	**26**	**0**

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Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		NTP3	NTP4		NTP5	
Depth	m	3.80	2.50	4.50	2.70	5.00
CONTAINER NUMBER		1	2	3	4	5
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	32.51	24.81	22.83	35.52	28.12
WT. OF DRY SAMPLE & CONTAINER	g	28.18	19.78	18.61	28.01	23.50
WT. OF WATER	g	4.33	5.03	4.22	7.51	4.62
WT. OF CONTAINER	g	10.94	4.12	6.27	10.97	10.96
WT. OF DRY SAMPLE	g	17.24	15.66	12.34	17.04	12.54
WATER CONTENT (LL)	%	**25**	**32**	**34**	**44**	**37**

PLASTIC LIMIT		NTP3	NTP4		NTP5	
Depth	m	3.80	2.50	4.50	2.70	5.00
CONTAINER NUMBER		1	2	3	4	5
WT. OF WET SAMPLE & CONTAINER	g		19.17	19.37	18.50	19.07
WT. OF DRY SAMPLE & CONTAINER	g		17.38	17.68	16.95	17.69
WT. OF WATER	g	0.00	1.79	1.69	1.55	1.38
WT. OF CONTAINER	g		10.02	9.91	11.01	10.99
WT. OF DRY SAMPLE	g	0.00	7.36	7.77	5.94	6.70
WATER CONTENT (PL)	%	**0**	**24**	**22**	**26**	**21**

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Date : 17/07/14

Liquid Limit & Plastic Limit
ASTM Designation 4318 - 84

LIQUID LIMIT		**NTP6**		**NTP7**		**NTP8**
Depth	m	2.80	5.80	2.70	5.10	1.20
CONTAINER NUMBER		1	2	3	4	5
NUMBER OF BLOWS		25	25	25	25	25
WT. OF WET SAMPLE & CONTAINER	g	34.72	31.09	41.27	31.20	35.01
WT. OF DRY SAMPLE & CONTAINER	g	27.34	25.75	33.12	24.70	27.14
WT. OF WATER	g	7.38	5.34	8.15	6.50	7.87
WT. OF CONTAINER	g	11.01	10.95	10.95	10.88	10.93
WT. OF DRY SAMPLE	g	16.33	14.80	22.17	13.82	15.81
WATER CONTENT (LL)	%	**45**	**36**	**37**	**47**	**50**

PLASTIC LIMIT		**NTP6**		**NTP7**		**NTP8**
Depth	m	2.80	5.80	2.70	5.10	1.20
CONTAINER NUMBER		1	2	3	4	5
WT. OF WET SAMPLE & CONTAINER	g	19.64	17.02	18.91	19.56	19.11
WT. OF DRY SAMPLE & CONTAINER	g	17.94	15.96	17.42	17.67	17.38
WT. OF WATER	g	1.70	1.06	1.49	1.89	1.73
WT. OF CONTAINER	g	10.88	10.93	11.01	10.95	10.95
WT. OF DRY SAMPLE	g	7.06	5.03	6.41	6.72	6.43
WATER CONTENT (PL)	%	**24**	**21**	**23**	**28**	**27**

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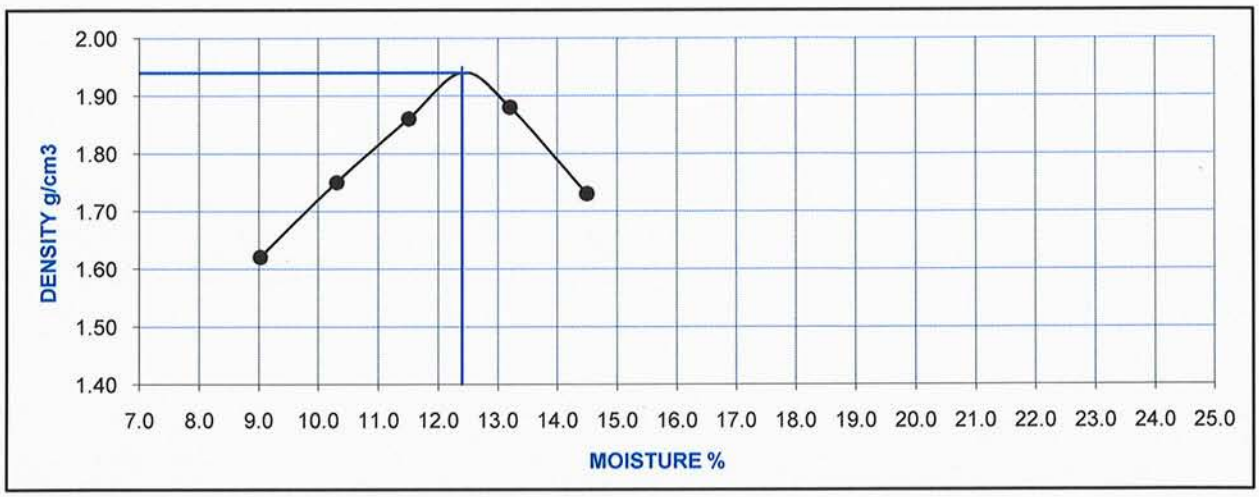
LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING MODIFIED EFFORT (2,700 kN-m/m³)

ASTM Designation D1557-91

Project	:	**Bisri Dam**			
Location	:	**Bisri - South Lebanon**			
Consultant	:	**M/S Dar Al Handasah Nazih Taleb & Partners**			
Contractor	:	-			
Date	:	**17/07/14**	**Procedure**	:	**A**
Sample I.D.	:	**NTP1**	Mold diameter (in)	:	4"
Depth (m)	:	**2.50**	Material passing	:	No. 4
Sample received on	:	**28/05/14**	Layers number	:	5
Sampled by	:	**ASSACO**	Blows per layer	:	25
Sample I.D.	:	-	Mold Wt (g)	:	4220
Classification	:	-	Mold V (cm³)	:	944
			Height of drop (in)	:	18

Optimum moisture content % : **12.4**
Maximum dry density g/cm³ : **1.94**



Description	Trial No.	1	2	3	4	5	
Wt. of wet Sample + Mold	g	5887.2	6042.2	6177.8	6229.0	6089.8	
Wt. of Mold	g	4220	4220	4220	4220	4220	
Wt. of wet sample	g	1667.2	1822.2	1957.8	2009.0	1869.8	
Wet Density	g/cm³	1.77	1.93	2.07	2.13	1.98	
Can number		1	2	3	4	5	
Wt.of can + wet Sample	g	194.8	216.3	188.1	203.0	197.5	
Wt. of can + dry Sample	g	178.7	196.1	168.7	179.3	172.5	
Wt. of moisture	g	16.1	20.2	19.4	23.7	25.0	
Wt. of Can	g	-	-	-	-	-	
Wt.of Dry Sample	g	178.7	196.1	168.7	179.3	172.5	
Moisture content	%	9.0	10.3	11.5	13.2	14.5	
Dry Density	g/cm³	1.62	1.75	1.86	1.88	1.73	

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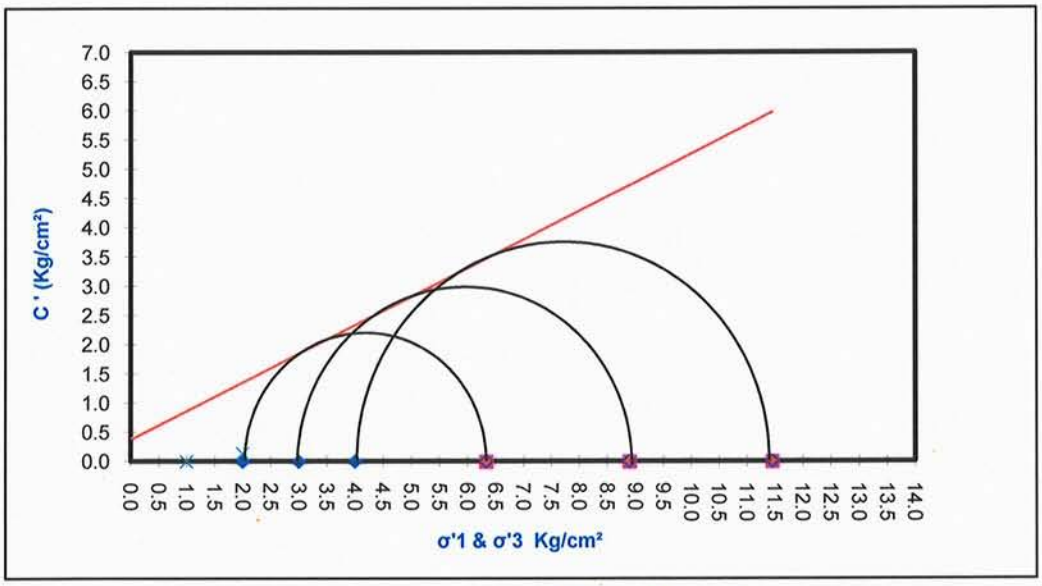
Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Upstream of the Dam, Clay-Core Material Sources
Date : 01/08/14

CONSOLIDATED UNDRAINED TRIAXIAL TEST with PORE PRESSURE MEASUREMENT
ASTM Designation D4767 - 88

Sample ID: **NTP1**
Depth : **2.50 m**

Bulk (Wet) Density of the remolded soil sample = **1.8 g/cm³**
Moisture Content of the remolded soil sample= **14.0%**

CELL PRESSURE kg/cm²	MAX.DEVIATOR STRESS kg/cm²	σ'1 kg/cm²	σ'3 kg/cm²
2.0	4.34	6.34	2.0
3.0	5.90	8.90	3.0
4.0	7.46	11.46	4.0



ϕ'= 26 °
C'= 0.38 Kg/cm²

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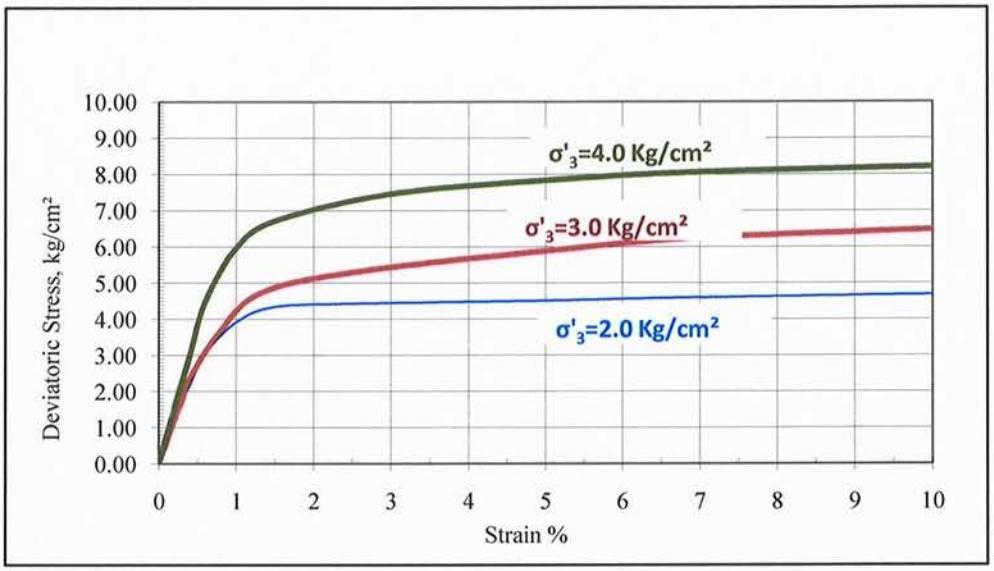
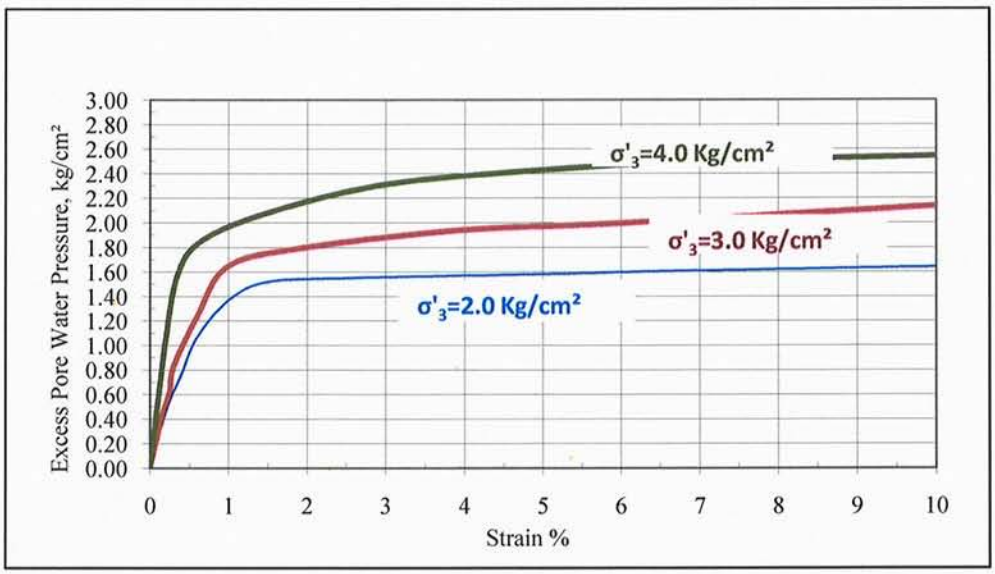
CONSOLIDATED UNDRAINED TRIAXIAL TEST with PORE PRESSURE MEASUREMENT
ASTM Designation D4767 - 88

Sample ID: **NTP1**
Depth : **2.50 m**





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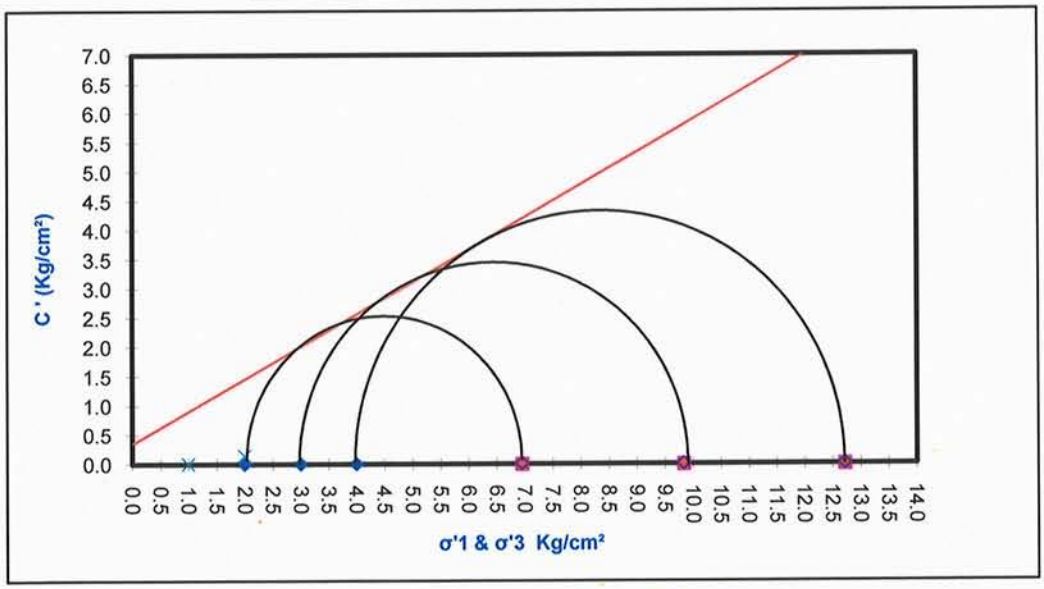
Location : Upstream of the Dam, Clay-Core Material Sources
Date : 01/08/14

CONSOLIDATED UNDRAINED TRIAXIAL TEST with PORE PRESSURE MEASUREMENT
ASTM Designation D4767 - 88

Sample ID: **NTP2**
Depth : **5.00 m**

Bulk (Wet) Density of the remolded soil sample = **1.81 g/cm³**
Moisture Content of the remolded soil sample= **14.0%**

CELL PRESSURE kg/cm²	MAX. DEVIATOR STRESS kg/cm²	σ'1 kg/cm²	σ'3 kg/cm²
2.0	4.95	6.95	2.0
3.0	6.83	9.83	3.0
4.0	8.72	12.72	4.0



ϕ'= 29 °
C'= 0.35 Kg/cm²

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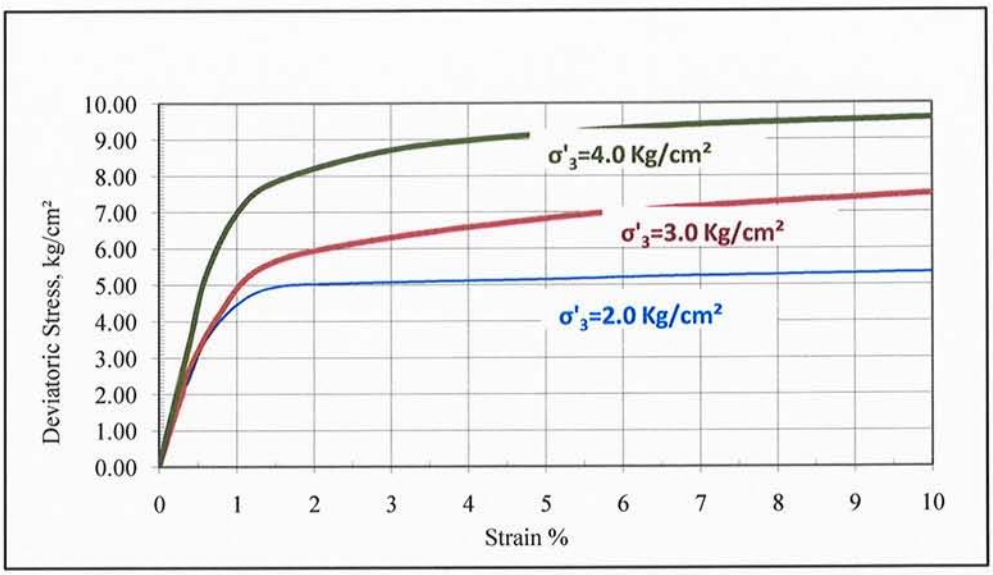
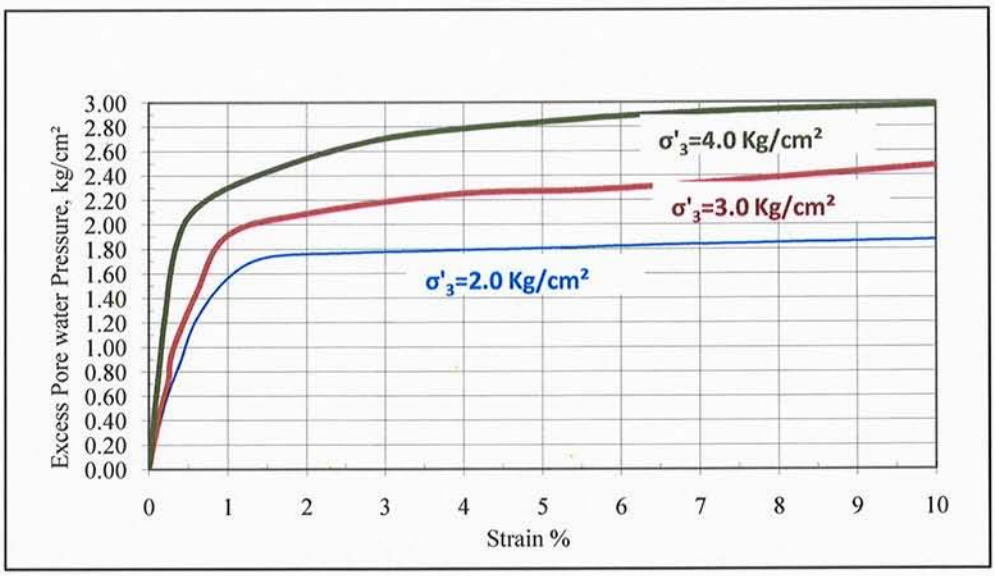
Location : Upstream of the Dam, Clay-Core Material Sources
Date : 01/08/14

CONSOLIDATED UNDRAINED TRIAXIAL TEST with PORE PRESSURE MEASUREMENT
ASTM Designation D4767 - 88

Sample ID: **NTP2**
Depth : **5.00 m**





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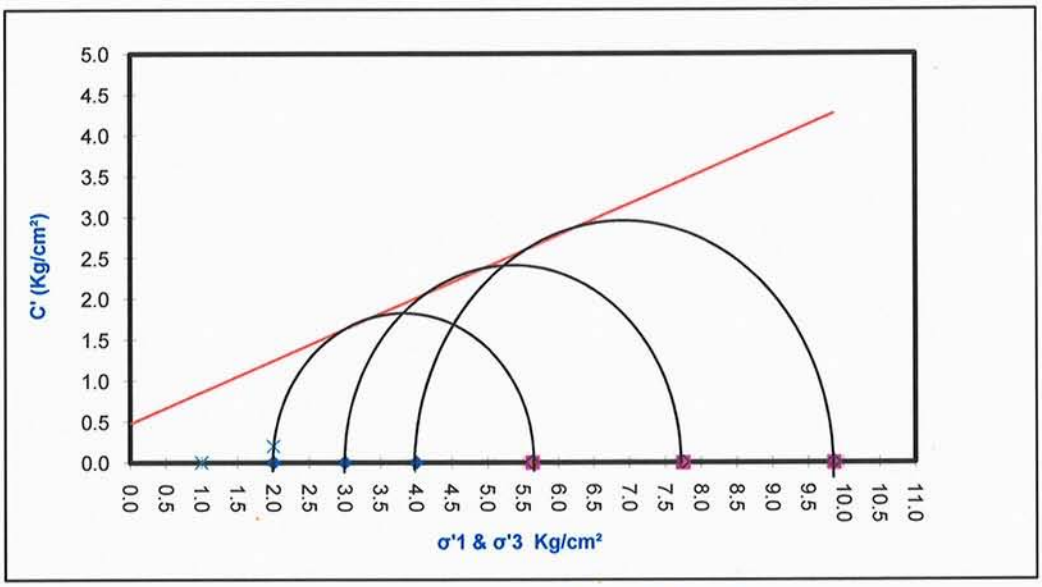
Project : Bisri Dam
Location : Upstream of the Dam, Clay-Core Material Sources
Date : 01/08/14

CONSOLIDATED UNDRAINED TRIAXIAL TEST with PORE PRESSURE MEASUREMENT
ASTM Designation D4767 - 88

Sample ID: **NTP3**
Depth : **2.50 m**

Bulk (Wet) Density of the remolded soil sample = **1.79 g/cm³**
Moisture Content of the remolded soil sample = **20.0%**

CELL PRESSURE kg/cm²	MAX.DEVIATOR STRESS kg/cm²	σ'1 kg/cm²	σ'3 kg/cm²
2.0	3.63	5.63	2.0
3.0	4.75	7.75	3.0
4.0	5.87	9.87	4.0



ϕ'= 21 °
C'= 0.48 Kg/cm²

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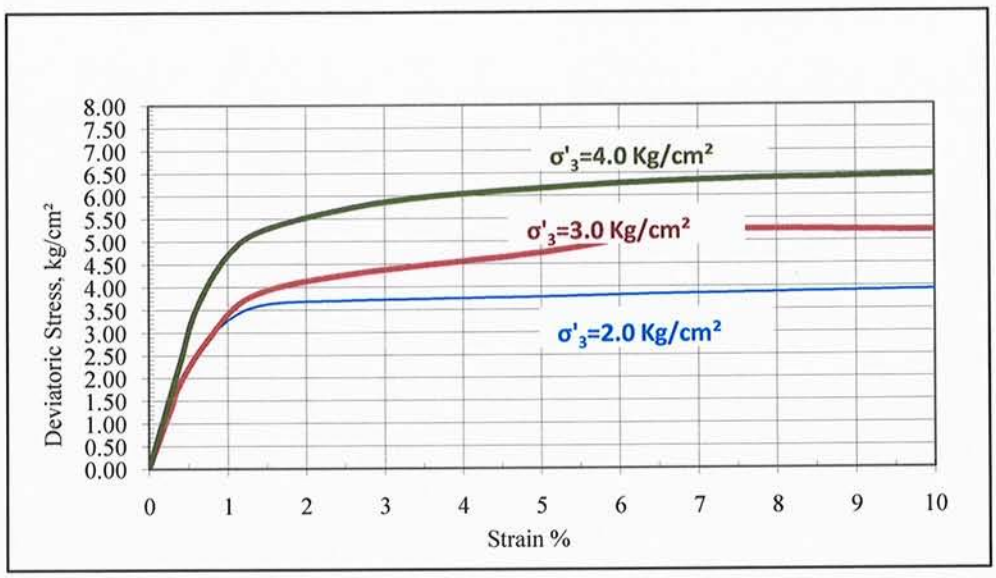
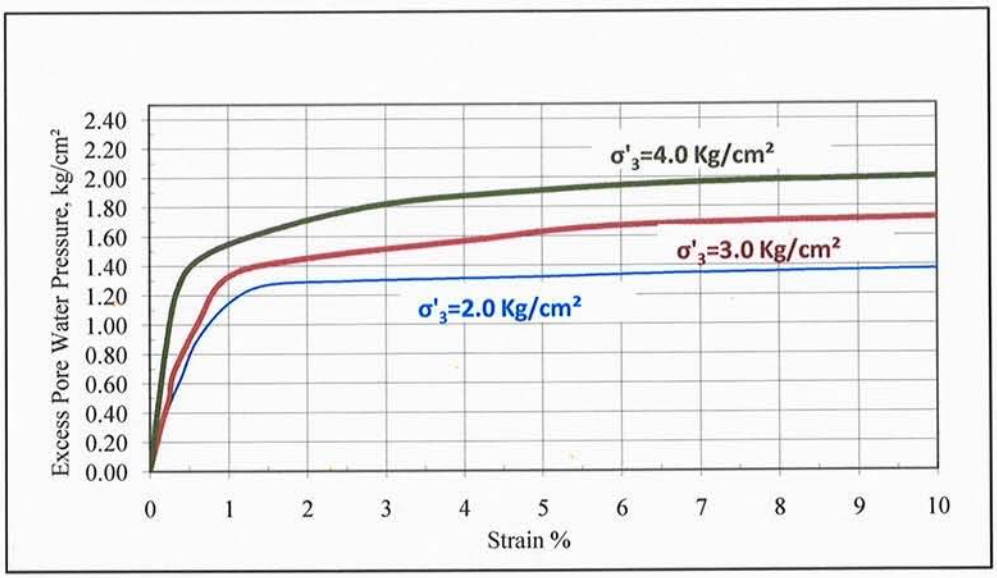
CONSOLIDATED UNDRAINED TRIAXIAL TEST with PORE PRESSURE MEASUREMENT
ASTM Designation D4767 - 88

Sample ID: **NTP3**
Depth : **2.50 m**





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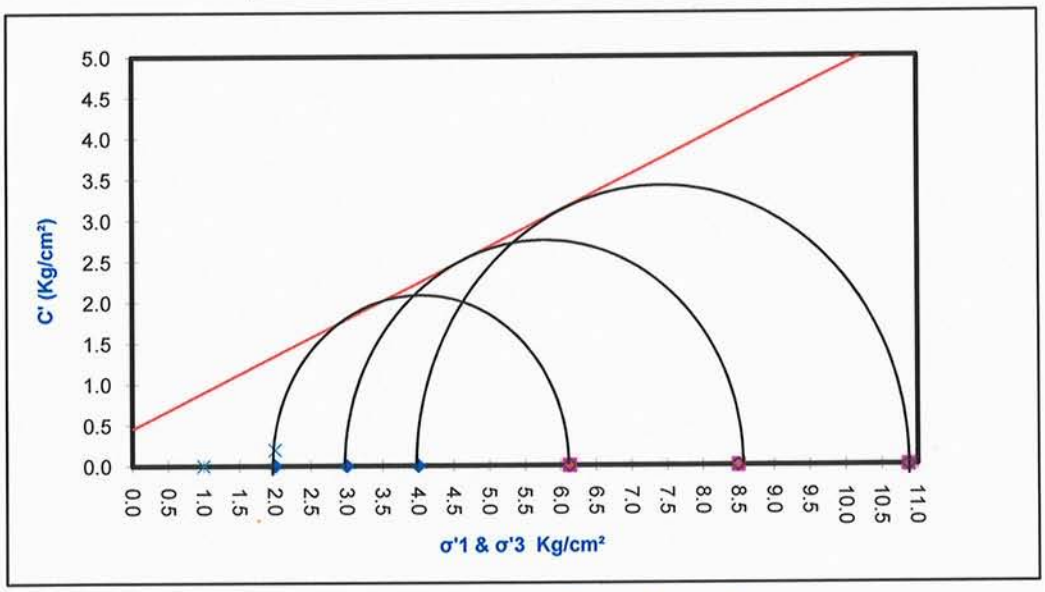
Project : Bisri Dam
Location : Upstream of the Dam, Clay-Core Material Sources
Date : 01/08/14

CONSOLIDATED UNDRAINED TRIAXIAL TEST with PORE PRESSURE MEASUREMENT
ASTM Designation D4767 - 88

Sample ID: **NTP5**
Depth : **2.70 m**

Bulk (Wet) Density of the remolded soil sample= **1.8 g/cm³**
Moisture Content of the remolded soil sample= **19.5%**

CELL PRESSURE kg/cm²	MAX.DEVIATOR STRESS kg/cm²	σ'1 kg/cm²	σ'3 kg/cm²
2.0	4.13	6.13	2.0
3.0	5.50	8.50	3.0
4.0	6.87	10.87	4.0



ϕ'= 24 °
C'= 0.45 Kg/cm²

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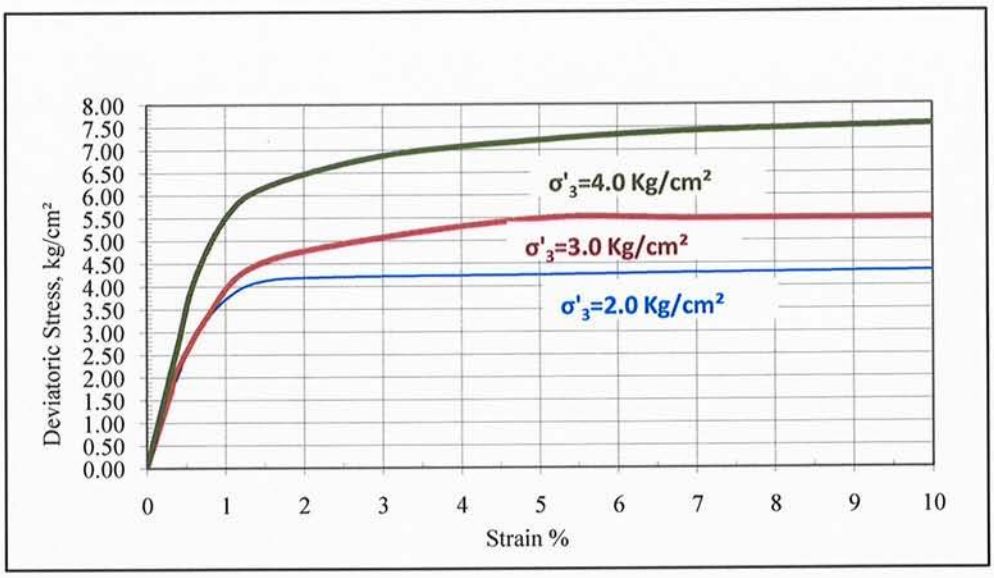
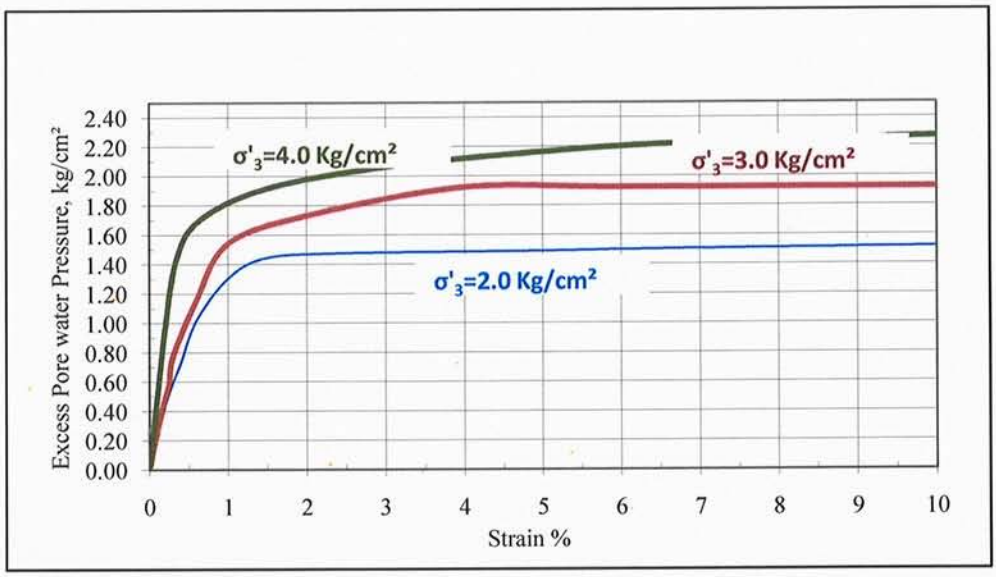
CONSOLIDATED UNDRAINED TRIAXIAL TEST with PORE PRESSURE MEASUREMENT
ASTM Designation D4767 - 88

Sample ID: **NTP5**
Depth : **2.70 m**





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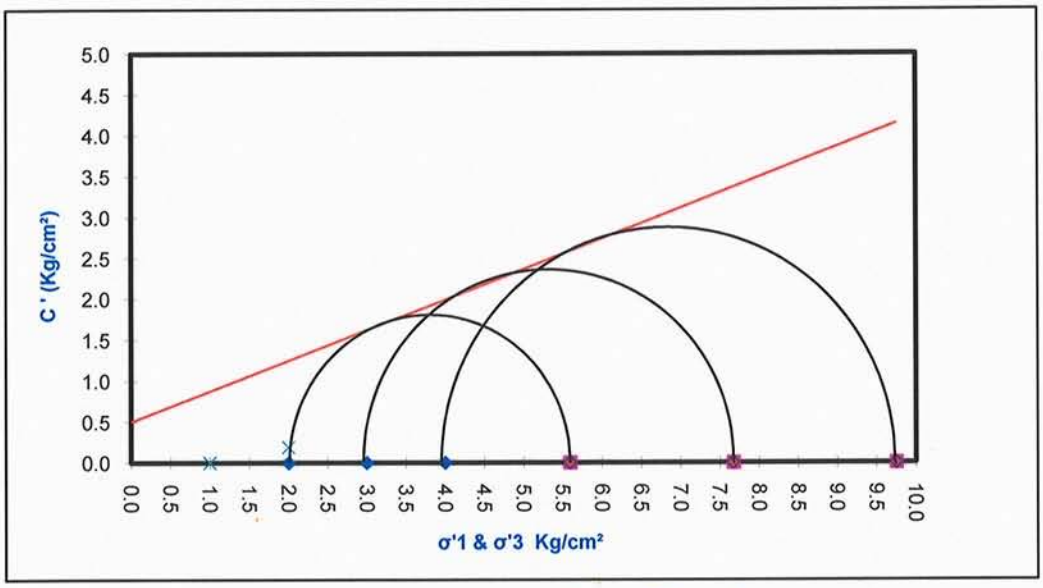
Date : 01/08/14

CONSOLIDATED UNDRAINED TRIAXIAL TEST with PORE PRESSURE MEASUREMENT
ASTM Designation D4767 - 88

Sample ID: **NTP7**
Depth : **5.10 m**

Bulk (Wet) Density of the remolded soil sample= **1.74 g/cm³**
Moisture Content of the remolded soil sample= **19.0%**

CELL PRESSURE kg/cm²	MAX. DEVIATOR STRESS kg/cm²	σ'1 kg/cm²	σ'3 kg/cm²
2.0	3.60	5.60	2.0
3.0	4.68	7.68	3.0
4.0	5.75	9.75	4.0



ϕ'= 20.5 °
C'= 0.50 Kg/cm²

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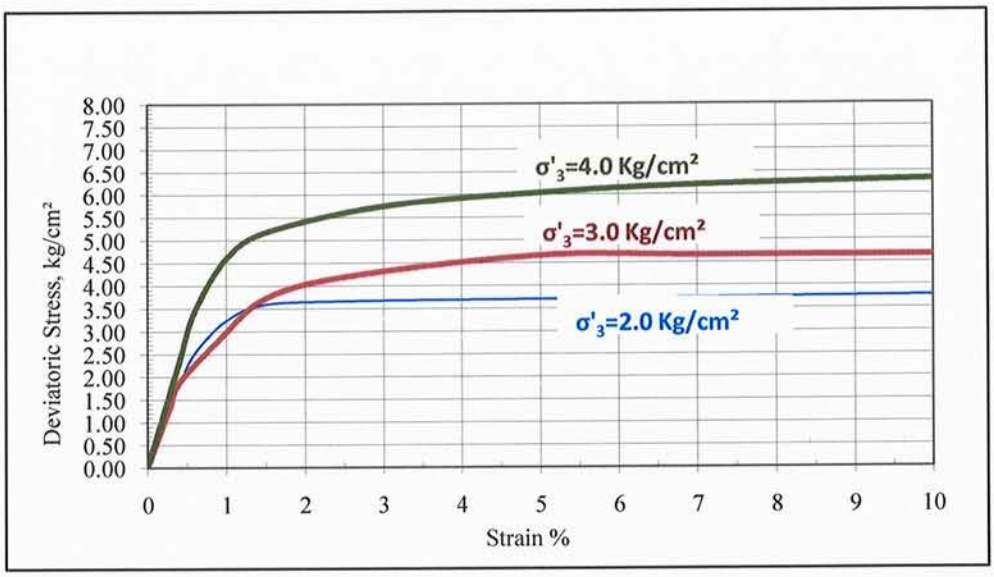
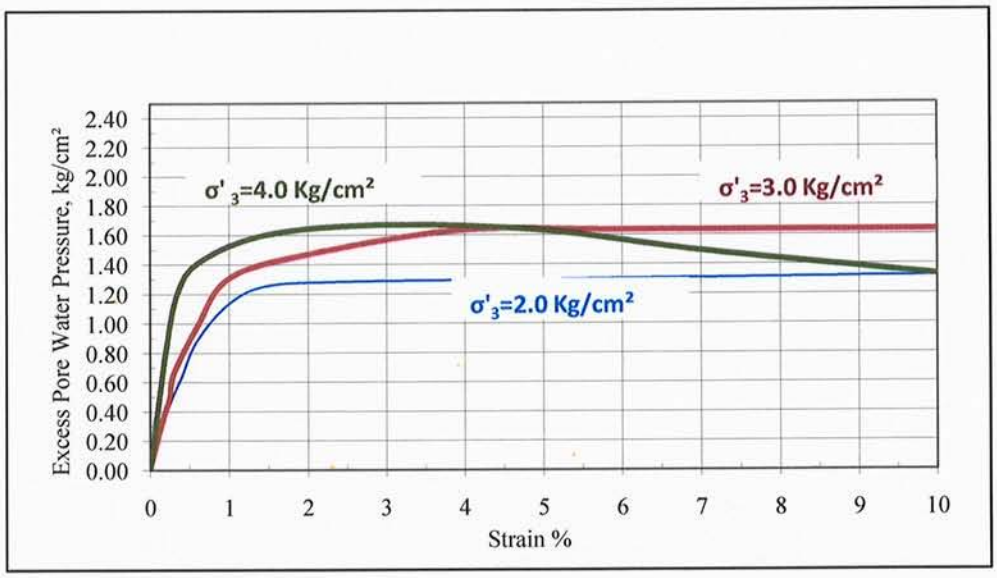
Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Upstream of the Dam, Clay-Core Material Sources
Date : 01/08/14

CONSOLIDATED UNDRAINED TRIAXIAL TEST with PORE PRESSURE MEASUREMENT
ASTM Designation D4767 - 88

Sample ID: **NTP7**
Depth : **5.10 m**





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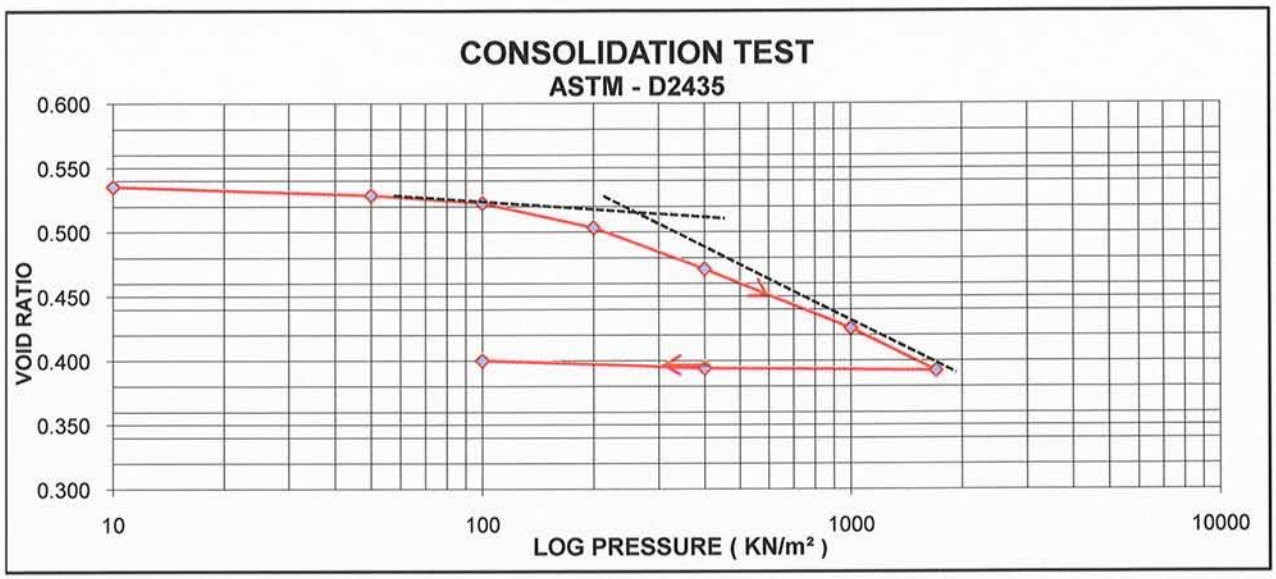
Project : Bisri Dam
Location: Upstream of the Dam, Clay-Core Material Sources
Date : 07/08/14



Borehole : NTP1 Rate of testing = 0.2mm/min	Depth :	2.50 m
Bulk (Wet)Density of the remolded soil sample	:	1.80
Initial void ratio	:	0.531
Moisture content of the remolded soil sample %	:	14.0
Compression index Cc	:	0.143
Swelling index C_S	:	0.020
Preconsolidation Pressure б'p (KN/m^2)	:	235
Coefficient of Consolidation C_v (cm^2/min)	:	0.10
Coefficient of Volume of Compressibility m_v- (m^2/MN)	:	0.78

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Project : Bisri Dam
Location: Upstream of the Dam, Clay-Core Material Sources
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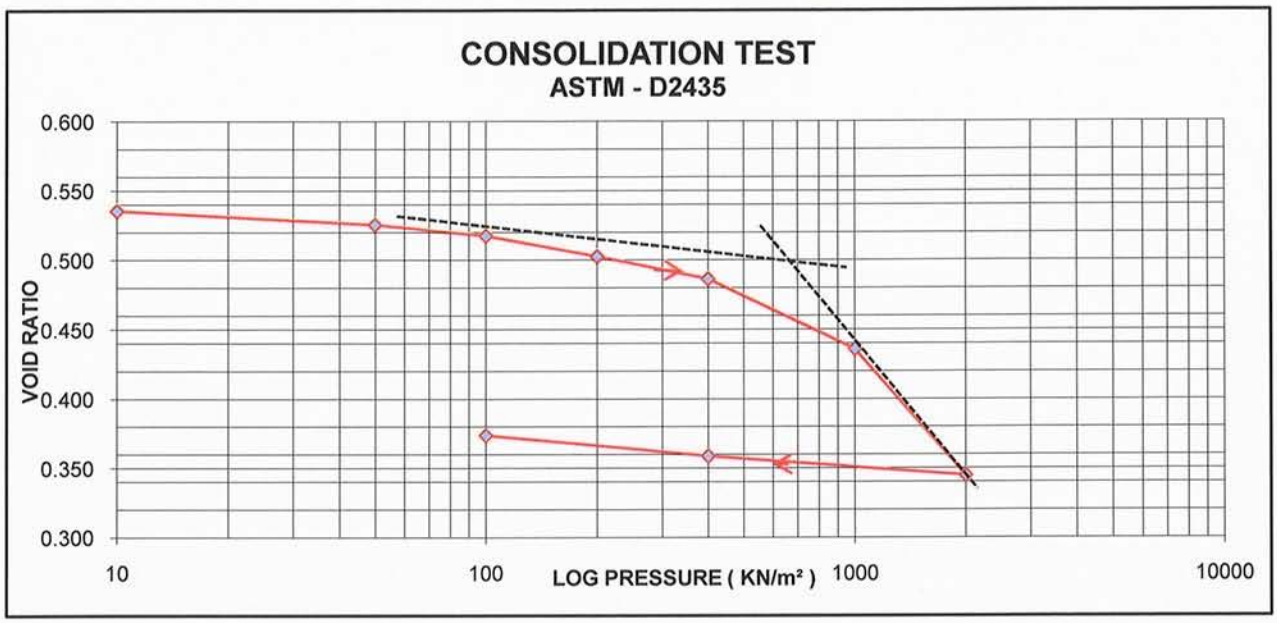

Borehole : NTP2	Depth :	5.00	m
Rate of testing = 0.2mm/min			
Bulk (Wet)Density of the remolded soil sample g/cm³	:	1.81	
Initial void ratio	:	0.536	
Moisture content of the remolded soil sample %	:	14.0	
Compression index Cc	:	0.302	
Swelling index C_S	:	0.027	
Preconsolidation Pressure б'p (KN/m²)	:	695	
Coefficient of Consolidation C_v (cm²/min)	:	0.12	
Compressibility m_v- (m²/MN)	:	0.75	

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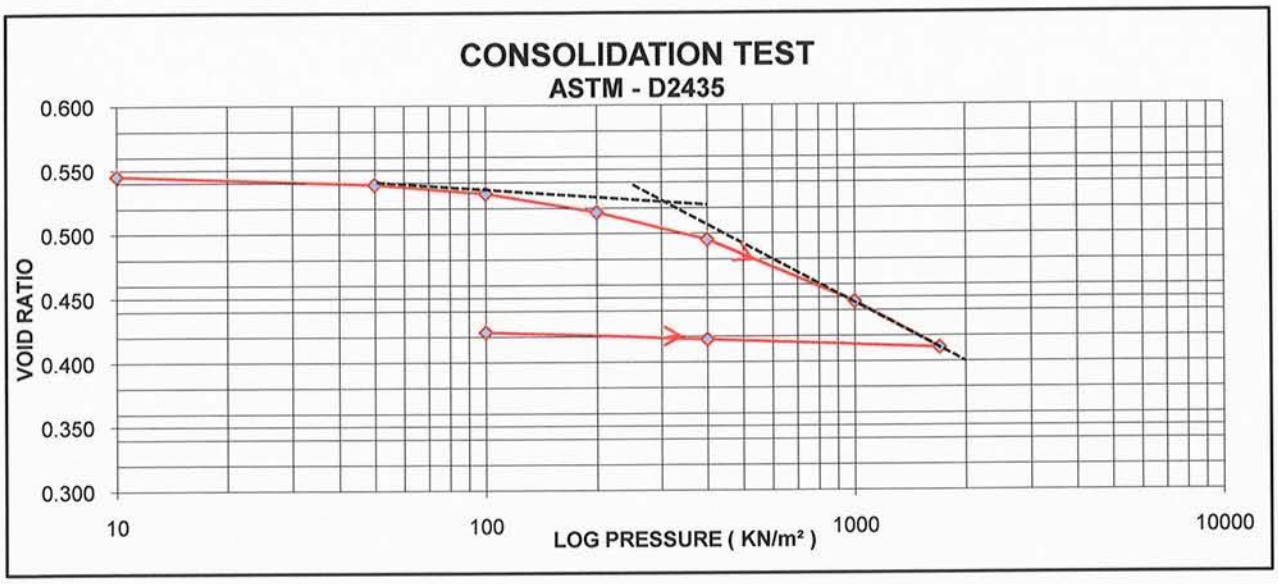
Location: Upstream of the Dam, Clay-Core Material Sources
Date : 07/08/14



Borehole : NTP3	Depth :	2.50	m
Rate of testing = 0.2mm/min			
Bulk (Wet)Density of the remolded soil sample g/cm³	:	1.79	
Initial void ratio	:	0.546	
Moisture content of the remolded soil sample %	:	20.0	
Compression index Cc	:	0.156	
Swelling index C_S	:	0.023	
Preconsolidation Pressure б'p (KN/m²)	:	342	
Coefficient of Consolidation C_v (cm²/min)	:	0.08	
Compressibility m_v- (m²/MN)	:	0.83	

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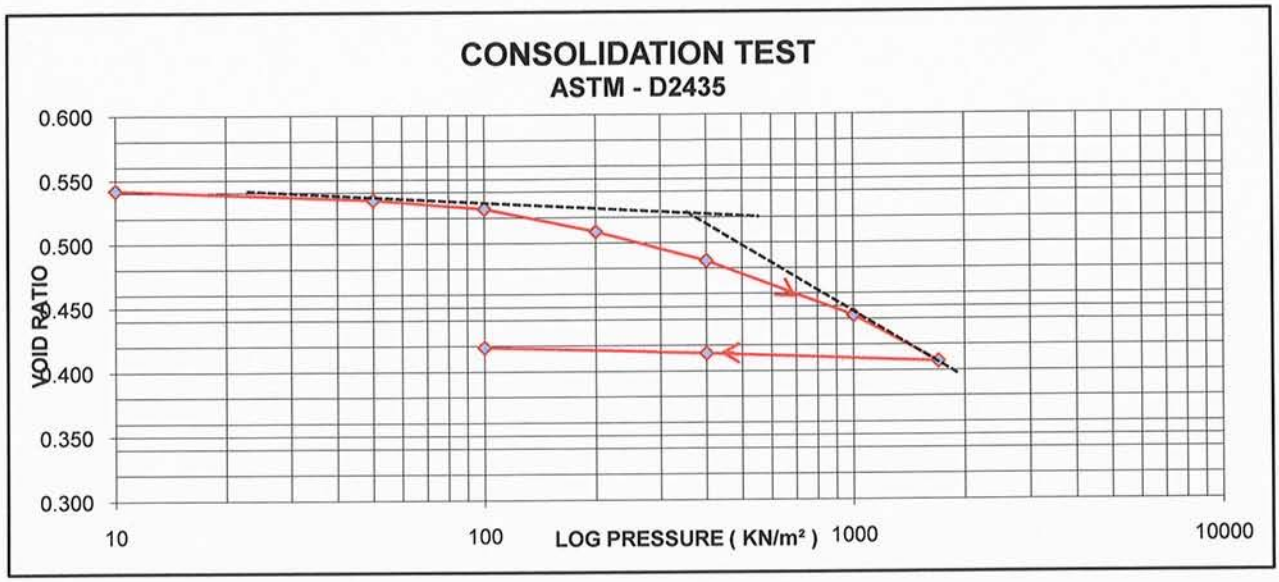
Location: Upstream of the Dam, Clay-Core Material Sources
Date : 07/08/14



Borehole : NTP5	Depth :	2.70	m
Rate of testing = 0.2mm/min			
Bulk (Wet)Density of the remolded soil sample g/cm³	:	1.80	
Initial void ratio	:	0.542	
Moisture content of the remolded soil sample %	:	19.5	
Compression index Cc	:	0.156	
Swelling index C_S	:	0.023	
Preconsolidation Pressure б'p (KN/m²)	:	388	
Coefficient of Consolidation C_v (cm²/min)	:	0.09	
Compressibility m_v- (m²/MN)	:	0.82	

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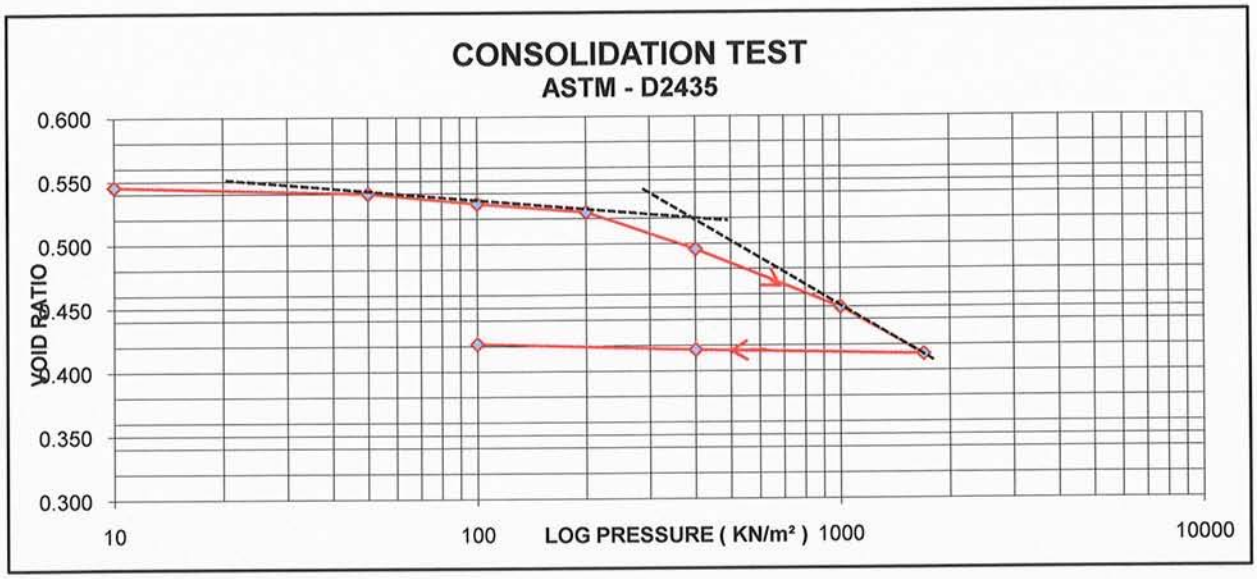
Location: Upstream of the Dam, Clay-Core Material Sources
Date : 07/08/14



Borehole : NTP7	Depth :	5.10	m
Rate of testing = 0.2mm/min			
Bulk (Wet)Density of the remolded soil sample g/cm³	:	1.74	
Initial void ratio	:	0.546	
Moisture content of the remolded soil sample %	:	19.0	
Compression index Cc	:	0.161	
Swelling index C_S	:	0.027	
Preconsolidation Pressure б'p (KN/m²)	:	382	
Coefficient of Consolidation C_v (cm²/min)	:	0.07	
Compressibility m_v- (m²/MN)	:	0.86	

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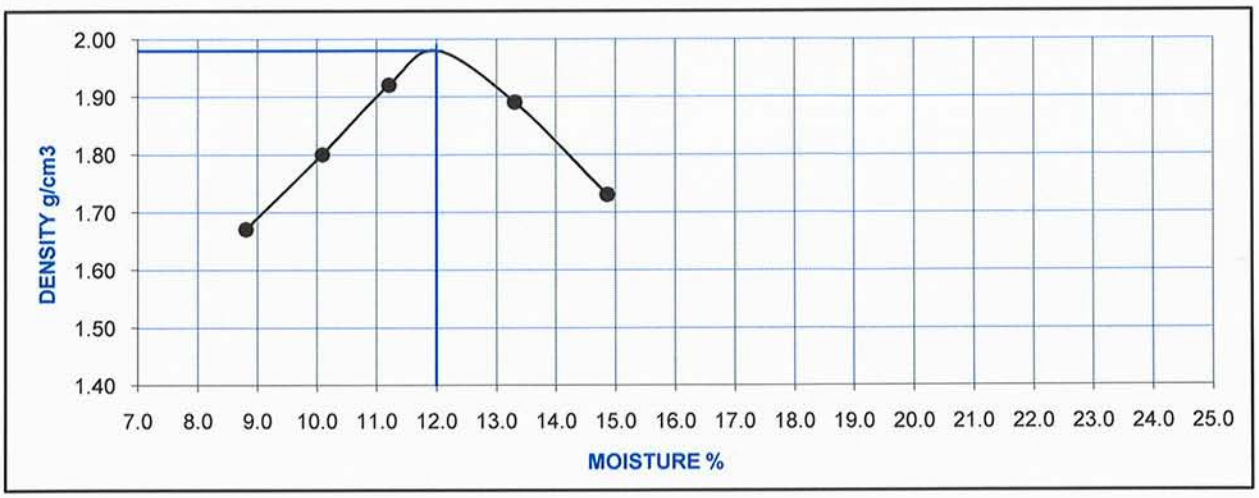
LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING MODIFIED EFFORT (2,700 kN-m/m³)

ASTM Designation D1557-91

Project	:	**Bisri Dam**			
Location	:	**Bisri - South Lebanon**			
Consultant	:	**M/S Dar Al Handasah Nazih Taleb & Partners**			
Contractor	:	-			
Date	:	**17/07/14**	**Procedure**	:	**A**
Sample I.D.	:	**NTP2**	Mold diameter (in)	:	4"
Depth (m)	:	**5.00**	Material passing	:	No. 4
Sample received on	:	**28/05/14**	Layers number	:	5
Sampled by	:	**ASSACO**	Blows per layer	:	25
Sample I.D.	:	-	Mold Wt (g)	:	4220
Classification	:	-	Mold V (cm³)	:	944
			Height of drop (in)	:	18

Optimum moisture content % : **12.0**
Maximum dry density g/cm³ : **1.98**



Description	Trial No.	1	2	3	4	5	
Wt. of wet Sample + Mold	g	5935.2	6090.5	6235.5	6241.5	6095.8	
Wt. of Mold	g	4220	4220	4220	4220	4220	
Wt. of wet sample	g	1715.2	1870.5	2015.5	2021.5	1875.8	
Wet Density	g/cm³	1.82	1.98	2.14	2.14	1.99	
Can number		1	2	3	4	5	
Wt.of can + wet Sample	g	194.8	216.3	188.1	203.0	197.5	
Wt. of can + dry Sample	g	179.0	196.5	169.2	179.2	171.9	
Wt. of moisture	g	15.8	19.8	18.9	23.8	25.6	
Wt. of Can	g	-	-	-	-	-	
Wt.of Dry Sample	g	179.0	196.5	169.2	179.2	171.9	
Moisture content	%	8.8	10.1	11.2	13.3	14.9	
Dry Density	g/cm³	1.67	1.80	1.92	1.89	1.73	

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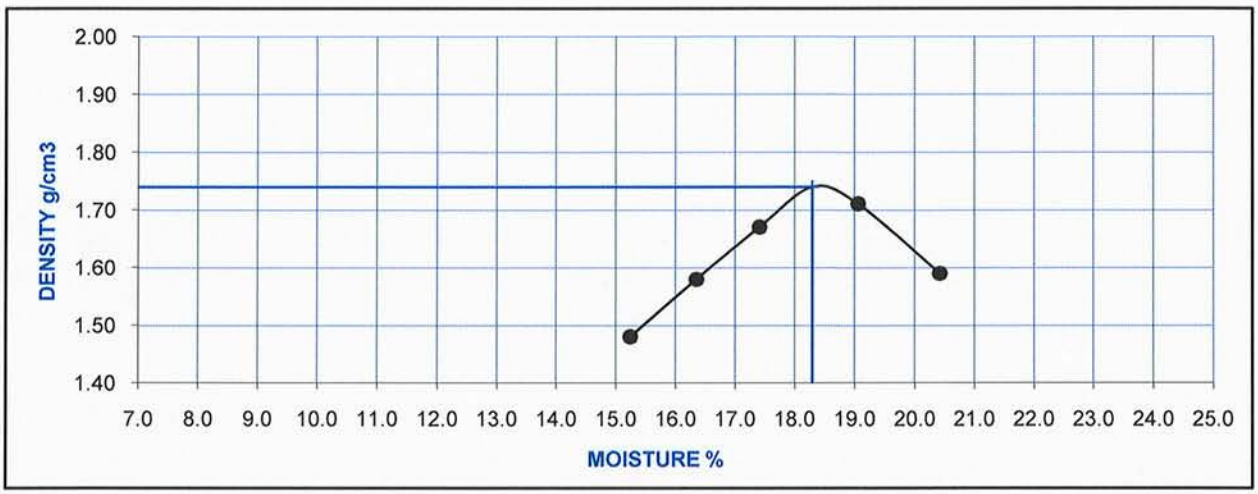
LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING MODIFIED EFFORT (2,700 kN-m/m³)

ASTM Designation D1557-91

Project	:	**Bisri Dam**			
Location	:	**Bisri - South Lebanon**			
Consultant	:	**M/S Dar Al Handasah Nazih Taleb & Partners**			
Contractor	:	-			
Date	:	**17/07/14**	**Procedure**	:	**A**
Sample I.D.	:	**NTP3**	Mold diameter (in)	:	4"
Depth (m)	:	**2.50**	Material passing	:	No. 4
Sample received on	:	**28/05/14**	Layers number	:	5
Sampled by	:	**ASSACO**	Blows per layer	:	25
Sample I.D.	:	-	Mold Wt (g)	:	4220
Classification	:	-	Mold V (cm³)	:	944
			Height of drop (in)	:	18

Optimum moisture content % : **18.3**
Maximum dry density g/cm³ : **1.74**



Description	Trial No.	1	2	3	4	5	
Wt. of wet Sample + Mold	g	5830.0	5955.4	6070.9	6141.8	6027.5	
Wt. of Mold	g	4220	4220	4220	4220	4220	
Wt. of wet sample	g	1610.0	1735.4	1850.9	1921.8	1807.5	
Wet Density	g/cm³	1.71	1.84	1.96	2.04	1.91	
Can number		1	2	3	4	5	
Wt.of can + wet Sample	g	194.8	216.3	188.1	203.0	197.5	
Wt. of can + dry Sample	g	169.0	185.9	160.2	170.5	164.0	
Wt. of moisture	g	25.8	30.4	27.9	32.5	33.5	
Wt. of Can	g	-	-	-	-	-	
Wt.of Dry Sample	g	169.0	185.9	160.2	170.5	164.0	
Moisture content	%	15.2	16.4	17.4	19.1	20.4	
Dry Density	g/cm³	1.48	1.58	1.67	1.71	1.59	

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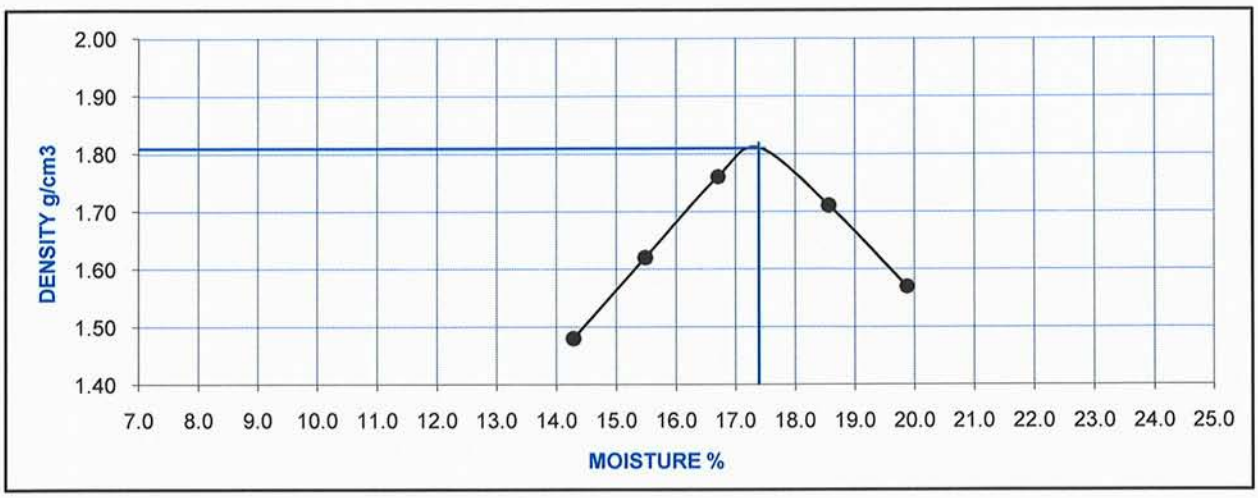
LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING MODIFIED EFFORT (2,700 kN-m/m³)

ASTM Designation D1557-91

Project	:	**Bisri Dam**			
Location	:	**Bisri - South Lebanon**			
Consultant	:	**M/S Dar Al Handasah Nazih Taleb & Partners**			
Contractor	:	-			
Date	:	**17/07/14**	**Procedure**	:	**A**
Sample I.D.	:	**NTP5**	Mold diameter (in)	:	4"
Depth (m)	:	**2.70**	Material passing	:	No. 4
Sample received on	:	**28/05/14**	Layers number	:	5
Sampled by	:	**ASSACO**	Blows per layer	:	25
Sample I.D.	:	-	Mold Wt (g)	:	4220
Classification	:	-	Mold V (cm³)	:	944
			Height of drop (in)	:	18

Optimum moisture content % : **17.4**
Maximum dry density g/cm³ : **1.81**



Description	Trial No.	1	2	3	4	5	
Wt. of wet Sample + Mold	g	5816.6	5986.0	6158.9	6133.8	5996.6	
Wt. of Mold	g	4220	4220	4220	4220	4220	
Wt. of wet sample	g	1596.6	1766.0	1938.9	1913.8	1776.6	
Wet Density	g/cm³	1.69	1.87	2.05	2.03	1.88	
Can number		1	2	3	4	5	
Wt.of can + wet Sample	g	194.8	216.3	188.1	203.0	197.5	
Wt. of can + dry Sample	g	170.5	187.3	161.2	171.2	164.8	
Wt. of moisture	g	24.3	29.0	26.9	31.8	32.7	
Wt. of Can	g	-	-	-	-	-	
Wt.of Dry Sample	g	170.5	187.3	161.2	171.2	164.8	
Moisture content	%	14.3	15.5	16.7	18.6	19.9	
Dry Density	g/cm³	1.48	1.62	1.76	1.71	1.57	

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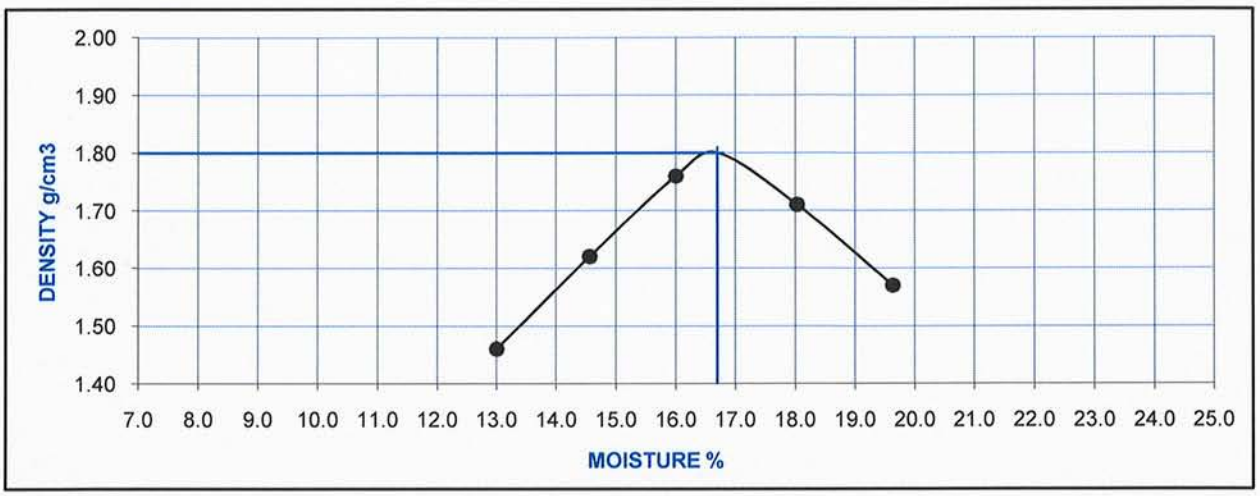
LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING MODIFIED EFFORT (2,700 kN-m/m³)

ASTM Designation D1557-91

Project	:	**Bisri Dam**			
Location	:	**Bisri - South Lebanon**			
Consultant	:	**M/S Dar Al Handasah Nazih Taleb & Partners**			
Contractor	:	-			
Date	:	**17/07/14**	**Procedure**	:	**A**
Sample I.D.	:	**NTP7**	Mold diameter (in)	:	4"
Depth (m)	:	**5.10**	Material passing	:	No. 4
Sample received on	:	**28/05/14**	Layers number	:	5
Sampled by	:	**ASSACO**	Blows per layer	:	25
Sample I.D.	:	-	Mold Wt (g)	:	4220
Classification	:	-	Mold V (cm³)	:	944
			Height of drop (in)	:	18

Optimum moisture content % : **16.7**
Maximum dry density g/cm³ : **1.80**



Description	Trial No.	1	2	3	4	5	
Wt. of wet Sample + Mold	g	5777.4	5971.9	6147.3	6125.3	5993.0	
Wt. of Mold	g	4220	4220	4220	4220	4220	
Wt. of wet sample	g	1557.4	1751.9	1927.3	1905.3	1773.0	
Wet Density	g/cm³	1.65	1.86	2.04	2.02	1.88	
Can number		1	2	3	4	5	
Wt.of can + wet Sample	g	194.8	216.3	188.1	203.0	197.5	
Wt. of can + dry Sample	g	172.4	188.8	162.2	172.0	165.1	
Wt. of moisture	g	22.4	27.5	25.9	31.0	32.4	
Wt. of Can	g	-	-	-	-	-	
Wt.of Dry Sample	g	172.4	188.8	162.2	172.0	165.1	
Moisture content	%	13.0	14.6	16.0	18.0	19.6	
Dry Density	g/cm³	1.46	1.62	1.76	1.71	1.57	

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Client: M/S Dar Al Handasah Nazih Taleb & Partners
Project: Bisri Dam
Location: Upstream of the Dam, Clay-Core Material Sources
Date: 17/07/14

Determination of Free Swell Index of Soils

IS : 2720 (Part 40)

Sample No.	Sample Depth (m)	V_d	V_k	Free Swell Index, %
NTP1	2.50	11.4	9.5	19.8
NTP2	5.00	9.5	8.0	18.5
NTP3	2.50	11.9	9.0	32.7
NTP5	2.70	15.2	11.0	38.2
NTP7	5.10	14.0	10.0	40.1

V_d = Volume of the soil specimen read from the graduated cylinder containing distilled water, in ml.
V_k = Volume of the soil specimen read from the graduated cylinder containing Kerosene, in ml.
Percent Organic Matter = $(V_d-V_k)/(V_k)*100$

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Location : Upstream of the Dam, Clay-Core Material Sources
Date : 17/07/14

FALLING HEAD PERMEABILITY TEST

ASTM Designation D5084-90

Sample I.D.	Depth (m)	Specimen dimensions		Permeability (m/sec.)	Degree of permeability
		Height (mm)	Diameter (mm)		
NTP1	2.50	45.0	40.0	3.5×10^{-11}	Practically Impermeable
NTP2	5.00	46.0	40.0	5.6×10^{-10}	Practically Impermeable
NTP3	2.50	45.0	40.0	1.8×10^{-12}	Practically Impermeable
NTP5	2.70	45.0	40.0	2.7×10^{-11}	Practically Impermeable
NTP7	5.10	44.0	40.0	3.4×10^{-12}	Practically Impermeable

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Client: M/S Dar Al Handasah Nazih Taleb & Partners
Project: Bisri Dam
Location: Upstream of the Dam, Clay-Core Material Sources
Date: 17/07/14

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, %
NTP1	2.50	74.88	74.29	39.81	1.68
NTP2	3.00	79.05	78.05	40.05	2.56
	5.00	76.97	76.28	40.67	1.90
NTP3	2.50	44.28	43.49	16.71	2.87
	3.40	80.47	79.74	40.05	1.81
	3.80	78.18	77.42	39.81	1.98
NTP4	2.50	38.32	37.26	16.69	4.90
	4.50	70.49	69.35	39.81	3.72
NTP5	2.70	38.19	37.52	16.3	3.06
	5.00	42.33	41.19	16.72	4.45
NTP6	2.80	41.62	40.71	16.28	3.59
	5.80	68.63	67.82	40.04	2.83
NTP7	2.70	35.91	35.25	16.7	3.44
	5.10	49.63	48.37	16.29	3.78
NTP8	1.20	71.98	70.78	40.68	3.83

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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APPENDIX 6. SAND/GRAVEL MATERIAL SOURCES (IN-SITU)

ASSACO S.A.R.L

أساكو ش.م.م.

ENGINEER BILAL ASSAAD MELHEM ASSAAD & Co.

المهندس بلال أسعد ملحم أسعد وشركاه

DESIGN & SUPERVISION - GEOTECHNICAL CONSULTANCY - MATERIALS TESTING

دروس وإشراف - إستشارات جيوتقنية - فحص مواد

M/S DAR AL HANDASAH NAZIH TALEB & PARTNERS S.A.L.

BISRI DAM
UPSTREAM OF THE DAM,
SAND & GRAVEL MATERIAL SOURCES

EXCAVATION OF TEST PITS WITH IN-SITU TESTING AND SAMPLING

SEPTEMBER 2014

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Contents

- **Dimension of Test Pits Table**
- **Test Data Summary**
- **In-Situ Moisture content**
- **Field density Test**
- **Test Pits Log**
- **Illustration by photos**

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Client : M/S Dar Al Handasa Nazih Taleb & Partners
Project : Bisri Dam
Location : Upstream of the Dam, Sand and Gravel Material Sources
Date : 12/09/14

DIMENSION OF TEST PITS

TP	width (m)	length (m)	depth (m)	volume (m^3)
NTP9	2.1	4.3	2.6	23.5
NTP10	3.5	6.1	4.2	89.7
NTP11	2.0	4.5	5.0	45.0
NTP12	3.1	5.4	5.3	88.7
NTP13	5.3	3.3	3.8	66.5
NTP14	3.2	5.9	5.5	103.8
NTP15	3.1	4.8	2.7	40.2
NTP16	3.8	6.3	4.0	95.8
NTP17	2.8	4.9	2.2	30.2
NTP18	3.5	5.9	3.5	72.3
NTP19	2.7	6.0	5.6	90.7
NTP20	3.2	6.1	5.4	105.4
NTP21	3.7	6.0	5.3	117.7
NTP22	3.6	4.9	1.8	31.8
NTP23	3.6	3.7	2.1	28.0
Total Volume				**1029.1**

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Upstream of the Dam, SAND and GRAVEL Material Sources
Date : 18/09/14

TEST DATA SUMMARY - IN SITU TESTING - ASTM D 1556

Sample I.D	Depth m	In-Situ Moinsture Content Speedy Moisture Testing Kit %	Field Dry density (Sand-Cone Method) g/cm^3
NTP9	0.70	4.5	1.66
	2.00	6.3	1.99
NTP10	2.00	7.9	2.16
	3.50	5.2	2.17
NTP11	1.70	3.9	2.18
	4.00	4.1	2.14
NTP12	1.50	2.3	2.11
	3.00	4.7	2.13
NTP13	1.50	3.2	2.19
	3.50	7.3	2.15
NTP14	1.40	4.5	2.19
	3.40	5.7	2.17
NTP15	1.80	8.3	2.15
NTP16	1.70	3.8	2.11
	3.50	5.0	2.09
NTP17	1.80	6.2	2.08
NTP18	1.00	4.6	2.10
NTP19	0.40	2.8	2.16
	1.20	4.2	2.13
NTP20	0.80	3.1	2.17
NTP21	1.50	8.6	2.17
	3.50	5.5	2.15
NTP22	1.00	9.0	2.23
NTP23	1.50	3.6	2.22

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Project : Bisri Dam
Location : Upstream of the Dam, SAND & GRAVEL Material Sources
Date : 12/09/14

Field Determination of Moisture Content of Soil by the Calcium Carbide Gaz Pressure Tester

ASTM Designation D4944

TP No.	Depth (m)	Moisture (%)
NTP9	0.70	4.5
	2.00	6.3
NTP10	2.00	7.9
	3.50	5.2
NTP11	1.70	3.9
	4.00	4.1
NTP12	1.50	2.3
	3.00	4.7
NTP13	1.50	3.2
	3.50	7.3
NTP14	1.40	4.5
	3.40	5.7
NTP15	1.80	8.3
NTP16	1.70	3.8
	3.50	5.0
NTP17	1.80	6.2
NTP18	1.00	4.6
NTP19	0.40	2.8
	1.20	4.2
NTP20	0.80	3.1
NTP21	1.50	8.6
	3.50	5.5
NTP22	1.00	9.0
NTP23	1.50	3.6

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Project : Bisri Dam
Location : Upstream of the Dam, SAND and GRAVEL Material Sources
Date : 10/09/14

FIELD DENSITY TEST

(Sand Volume Apparatus)

Standard: ASTM D 1556

	Test Number			FD1	FD2	FD3	FD4	FD5
	Location			NTP9	NTP9	NTP10	NTP10	NTP11
	Depth (m)			0.70	2.00	2.00	3.50	1.70
	Layer			-	-	-	-	-
	Sample I.D.			-	-	-	-	-
A	Wt. sand + container / start		g	5876	6172	5938	6319	6529
B	Wt. sand + container / finish		g	2584	3130	2934	3395	3647
C	Wt. sand used	a - b	g	3292	3042	3004	2924	2882
D	Unit Wt.of sand		g/cm³	1.56	1.56	1.56	1.56	1.56
E	Volume cone + hole	c ÷ d	cm³	2110.3	1950.0	1925.6	1874.4	1847.4
F	Volume of cone		cm³	860	860	860	860	860
G	Volume of test hole	e - f	cm³	1250.3	1090.0	1065.6	1014.4	987.4
H	Wt. excavated material + container		g	2174.0	2304.0	2481.5	2296.1	2235.7
I	Wt. container		g	-	-	-	-	-
J	Wt. excavated material	h - l	g	2174.0	2304.0	2481.5	2296.1	2235.7
K	Wet density of sample	j ÷ g	g/cm³	**1.74**	**2.11**	**2.33**	**2.26**	**2.26**
L	Wt. wet sample		g	-	-	-	-	-
M	Wt. dry sample		g	-	-	-	-	-
N	Wt. container		g	-	-	-	-	-
O	Wt. of water	l - m	g	-	-	-	-	-
P	Wt. of dry sample	m-n	g	-	-	-	-	-
Q	Moisture content 100	o ÷ p	%	**4.5%**	**6.3%**	**7.9%**	**5.2%**	**3.9%**

R	Field density	K÷(1+Q/100)	g/cm³	1.66	1.99	2.16	2.15	2.18
S	Maximum density (Proctor)		g/cm³	-	-	-	-	-
T	Relative compaction	R ÷ S	%	-	-	-	-	-

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Location : Upstream of the Dam, SAND and GRAVEL Material Sources
Date : 10/09/14

FIELD DENSITY TEST

(Sand Volume Apparatus)

Standard: ASTM D 1556

	Test Number			FD6	FD7	FD8	FD9	FD10
	Location			NTP11	NTP12	NTP12	NTP13	NTP13
	Depth (m)			4.00	1.50	3.00	1.50	3.50
	Layer			-	-	-	-	-
	Sample I.D.			-	-	-	-	-
A	Wt. sand + container / start		g	5791	5962	5543	5016	5134
B	Wt. sand + container / finish		g	2996	2836	2557	2061	2172
C	Wt. sand used	a - b	g	2795	3126	2986	2955	2962
D	Unit Wt.of sand		g/cm³	1.56	1.56	1.56	1.56	1.56
E	Volume cone + hole	c ÷ d	cm³	1791.7	2003.8	1914.1	1894.2	1898.7
F	Volume of cone		cm³	860	860	860	860	860
G	Volume of test hole	e - f	cm³	931.7	1143.8	1054.1	1034.2	1038.7
H	Wt. excavated material + container		g	2075.3	2468.9	2346.2	2312.7	2395.6
I	Wt. container		g	-	-	-	-	-
J	Wt. excavated material	h - l	g	2075.3	2468.9	2346.2	2312.7	2395.6
K	Wet density of sample	j ÷ g	g/cm³	**2.23**	**2.16**	**2.23**	**2.24**	**2.31**
L	Wt. wet sample		g	-	-	-	-	-
M	Wt. dry sample		g	-	-	-	-	-
N	Wt. container		g	-	-	-	-	-
O	Wt. of water	l - m	g	-	-	-	-	-
P	Wt. of dry sample	m-n	g	-	-	-	-	-
Q	Moisture content 100	o ÷ p	%	**4.1%**	**2.3%**	**4.7%**	**3.2%**	**7.3%**

R	Field density	K÷(1+Q/100)	g/cm³	2.14	2.11	2.13	2.17	2.15
S	Maximum density (Proctor)		g/cm³	-	-	-	-	-
T	Relative compaction	R ÷ S	%	-	-	-	-	-

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Date : 12/09/14

FIELD DENSITY TEST

(Sand Volume Apparatus)

Standard: ASTM D 1556

	Test Number			FD11	FD12	FD13	FD14	FD15
	Location			NTP14	NTP14	NTP15	NTP16	NTP16
	Depth (m)			1.40	3.40	1.80	1.70	3.50
	Layer			-	-	-	-	-
	Sample I.D.			-	-	-	-	-
A	Wt. sand + container / start		g	8545	7886	6460	6384	5871
B	Wt. sand + container / finish		g	5578	4904	3624	3398	2753
C	Wt. sand used	a - b	g	2967	2982	2836	2986	3118
D	Unit Wt.of sand		g/cm³	1.56	1.56	1.56	1.56	1.56
E	Volume cone + hole	c ÷ d	cm³	1901.9	1911.5	1817.9	1914.1	1998.7
F	Volume of cone		cm³	860	860	860	860	860
G	Volume of test hole	e - f	cm³	1041.9	1051.5	957.9	1054.1	1138.7
H	Wt. excavated material + container		g	2386.9	2416.4	2232.0	2310.0	2502.2
I	Wt. container		g	-	-	-	-	-
J	Wt. excavated material	h - l	g	2387	2416.4	2232.0	2310.0	2502.2
K	Wet density of sample	j ÷ g	g/cm³	**2.29**	**2.30**	**2.33**	**2.19**	**2.20**
L	Wt. wet sample		g	-	-	-	-	-
M	Wt. dry sample		g	-	-	-	-	-
N	Wt. container		g	-	-	-	-	-
O	Wt. of water	l - m	g	-	-	-	-	-
P	Wt. of dry sample	m-n	g	-	-	-	-	-
Q	Moisture content 100	o ÷ p	%	**4.5%**	**5.7%**	**8.3%**	**3.8%**	**5.0%**

R	Field density	K÷(1+Q/100)	g/cm³	2.19	2.17	2.15	2.11	2.09
S	Maximum density (Proctor)		g/cm³	-	-	-	-	-
T	Relative compaction	R ÷ S	%	-	-	-	-	-

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Date : 12/09/14

FIELD DENSITY TEST

(Sand Volume Apparatus)

Standard: ASTM D 1556

	Test Number			FD16	FD17	FD18	FD19	FD20
	Location			NTP17	NTP18	NTP19	NTP19	NTP20
	Depth (m)			1.80	1.00	0.40	1.20	0.80
	Layer			-	-	-	-	-
	Sample I.D.			-	-	-	-	-
A	Wt. sand + container / start		g	6147	6485	8701	8168	7613
B	Wt. sand + container / finish		g	3062	3291	5361	5042	4331
C	Wt. sand used	a - b	g	3085	3194	3340	3126	3282
D	Unit Wt.of sand		g/cm³	1.56	1.56	1.56	1.56	1.56
E	Volume cone + hole	c ÷ d	cm³	1977.6	2047.4	2141.0	2003.8	2103.8
F	Volume of cone		cm³	860	860	860	860	860
G	Volume of test hole	e - f	cm³	1117.6	1187.4	1281.0	1143.8	1243.8
H	Wt. excavated material + container		g	2465.2	2612.2	2845.4	2534.3	2782.5
I	Wt. container		g	-	-	-	-	-
J	Wt. excavated material	h - l	g	2465.2	2612.2	2845.4	2534.3	2782.5
K	Wet density of sample	j ÷ g	g/cm³	**2.21**	**2.20**	**2.22**	**2.22**	**2.24**
L	Wt. wet sample		g	-	-	-	-	-
M	Wt. dry sample		g	-	-	-	-	-
N	Wt. container		g	-	-	-	-	-
O	Wt. of water	l - m	g	-	-	-	-	-
P	Wt. of dry sample	m-n	g	-	-	-	-	-
Q	Moisture content 100	o ÷ p	%	**6.2%**	**4.6%**	**2.8%**	**4.2%**	**3.1%**

R	Field density	K÷(1+Q/100)	g/cm³	2.08	2.10	2.16	2.13	2.17
S	Maximum density (Proctor)		g/cm³	-	-	-	-	-
T	Relative compaction	R ÷ S	%	-	-	-	-	-

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Client : M/S Dar Al Handasah Nazih Taleb & Partners
Project : Bisri Dam
Location : Upstream of the Dam, SAND and GRAVEL Material Sources
Date : 11/09/14

FIELD DENSITY TEST

(Sand Volume Apparatus)

Standard: ASTM D 1556

	Test Number			**FD21**	**FD22**	**FD23**	**FD24**	
	Location			**NTP21**	**NTP21**	**NTP22**	**NTP23**	
	Depth (m)			**1.50**	**3.50**	**1.00**	**1.50**	
	Layer			-	-	-	-	
	Sample I.D.			-	-	-	-	
A	Wt. sand + container / start		g	7252	6886	7941	7267	
B	Wt. sand + container / finish		g	4441	3695	5068	4071	
C	Wt. sand used	a - b	g	2811	3191	2873	3196	
D	Unit Wt.of sand		g/cm³	1.56	1.56	1.56	1.56	
E	Volume cone + hole	c ÷ d	cm³	1801.9	2045.5	1841.7	2048.7	
F	Volume of cone		cm³	860	860	860	860	
G	Volume of test hole	e - f	cm³	941.9	1185.5	981.7	1188.7	
H	Wt. excavated material + container		g	2220.6	2687.2	2386.9	2731.9	
I	Wt. container		g	-	-	-	-	
J	Wt. excavated material	h - l	g	2220.6	2687.2	2387	2731.9	
K	Wet density of sample	j ÷ g	g/cm³	**2.36**	**2.27**	**2.43**	**2.30**	
L	Wt. wet sample		g	-	-	-	-	
M	Wt. dry sample		g	-	-	-	-	
N	Wt. container		g	-	-	-	-	
O	Wt. of water	l - m	g	-	-	-	-	
P	Wt. of dry sample	m-n	g	-	-	-	-	
Q	Moisture content 100	o ÷ p	%	**8.6%**	**5.5%**	**9.0%**	**3.6%**	

R	Field density	K÷(1+Q/100)	g/cm³	2.17	2.15	2.23	2.22	
S	Maximum density (Proctor)		g/cm³	-	-	-	-	
T	Relative compaction	R ÷ S	%	-	-	-	-	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP9 **Depth : 0.00-2.60** **Start date : 10/09/14** **End date : 10/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-1.80m: Cream to light brown, slightly silty,fine to medium, SAND with some organic matters.**
						0.5	
	sample					0.7	
						1.0	**As above, " " "**
						1.5	
						1.8	**SAND**
10.09.14	sample					2.0	**1.80-2.20m: Very gravely SAND with few cobbles.**
@ 2.40m						2.2	**Very gravely SAND**
							2.20-2.60m: Greenish to bluish grey sandy SILT.
						2.6	**sandy SILT**
						3.0	**End of Pit**
						3.6	
						4.0	
						5.0	
						5.5	
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

Remarks:

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP10 **Depth : 0.00-4.20** **Start date : 10/09/14** **End date : 10/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-~~0.80~~m: Agricultural top soil.** 0,20 m.
						0.5	
						0.8	**Made Ground**
						1.0	**~~0.80~~-3.80m: SAND and GRAVEL with few cobbles.** 0,20 m.
						1.5	
	sample					2.0	**As above, " " "**
						2.5	
						3.0	**As above, " " "**
	sample					3.5	
						3.8	**SAND and GRAVEL**
						4.0	**3.80-4.20m: Greenish to bluish grey slightly clayey sandy SILT.**
						4.2	**sandy SILT**
							End of Pit
						5.0	
						5.5	
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP11 **Depth : 0.00-5.00** **Start date : 10/09/14** **End date : 10/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.30m: Agricultural top soil.**
						0.30	**Made Ground**
						0.5	**0.30-5.00m: SAND and GRAVEL with some cobbles.**
						1.0	**As above, " " "**
						1.5	
	sample					1.7	
						2.0	**As above, " " "**
						2.5	
						3.0	**As above, " " "**
						3.5	
	sample					4.0	**As above, " " "**
						5.0	**SAND and GRAVEL**
							End of Pit
						5.5	
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP12 **Depth : 0.00-5.30** **Start date : ~~10~~/09/14** 11 **End date : ~~10~~/09/14** 11 **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.30m: Agricultural top soil.**
						0.30	**Made Ground**
						0.5	**0.30-1.50m: SAND and GRAVEL with few cobbles and a thin layer of medium SAND (30cm).**
						1.0	
	sample					1.5	**SAND and GRAVEL**
							1.50-3.50m: SAND and GRAVEL with some cobbles and few boulders.
						2.0	
						2.5	**As above, " " "**
	sample					3.0	
						3.5	**SAND and GRAVEL**
							3.50-4.00m: Light brown slightly sandy silty CLAY.
						4.0	**silty CLAY**
							4.00-5.30m: Greenish to bluish grey silty CLAY.
						5.0	
						5.3	**silty CLAY**
						5.5	**End of Pit**
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP13 **Depth : 0.00-3.80** **Start date : 11/09/14** **End date : 11/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.40m: Medium SAND with some organic matters.**
						0.40	**SAND**
						0.5	**0.40-2.60m: SAND and GRAVEL with many cobbles and some organic matters.**
						1.0	
	sample					1.5	
						2.0	**As above, " " "**
						2.6	**SAND and GRAVEL**
						3.0	**2.60-3.80m: Very gravely SAND with few cobbles.**
11.09.14 @ 3.70m	sample					3.5	
						3.8	**Very gravely SAND**
						4.0	**End of Pit**
						5.0	
						5.5	
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP14 **Depth : 0.00-5.50** **Start date : 11/09/14** **End date : 11/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-2.00m: SAND and GRAVEL with many cobbles and few organic matters and a thin layer of medium SAND.**
						0.5	
						1.0	**As above, " " "**
	sample					1.4	
						1.5	
						2.0	**SAND and GRAVEL**
							2.00-3.40m: SAND and GRAVEL with many cobbles and some boulders.
						2.6	
						3.0	
	sample					3.4	**SAND and GRAVEL**
						3.5	**3.40-5.00m: SAND and GRAVEL with many cobbles.**
						4.0	
							As above, " " "
						5.0	**SAND and GRAVEL**
11.09.14 @ 5.50m							**5.00-5.50m: Greenish to bluish grey clayey SILT.**
						5.5	**Clayey SILT**
							End of Pit
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP15 **Depth : 0.00-2.70** **Start date : 12/09/14** **End date : 12/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.20m: Agricultural top soil.**
						0.20	1,5m **Made Ground**
						0.5	**0.20-~~2.70m:~~ SAND and GRAVEL with some cobbles and few boulders and organic matters.**
						1.0	7.
						1.5	**As above, without organic matters " " "

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP16 **Depth : 0.00-4.00** **Start date : 12/09/14** **End date : 12/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.70m: Agricultural top soil.**
						0.5	
						0.7	**Made Ground**
						1.0	**0.70-4.00m: SAND and GRAVEL with some cobbles and boulders.**
						1.5	
	sample					1.7	
						2.5	**As above, " " "**
						3.0	
12.09.14 @ 3.80m	sample					3.5	**As above, " " "**
						4.0	**SAND and GRAVEL** **End of Pit**
						5.0	
						5.5	
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP17 **Depth : 0.00-2.20** **Start date : 12/09/14** **End date : 12/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-2.20m: SAND and GRAVEL with some cobbles and boulders and with a thin layer of medium SAND (40cm).**
						0.5	
						1.0	**As above, " " "**
						1.5	
12.09.14 @ 2.20m	sample					1.8	
						2.2	**SAND and GRAVEL**
						2.5	**End of Pit**
						3.0	
						3.5	
						4.0	
						5.0	
						5.5	
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP18 **Depth : 0.00-3.50** **Start date : 12/09/14** **End date : 12/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	
						0.5	**~~0.20~~ 0.00-2.20m: SAND and GRAVEL with some cobbles and boulders.**
	sample					1.0	
12.09.14 @ 1.80m						1.5	**As above, " " "**
						2.2	**SAND and GRAVEL**
						2.5	**2.20-3.50m: Greenish to bluish grey, slightly clayey sandy SILT.**
						3.0	**As above, " " "**
						3.5	**Sandy SILT** **End of Pit**
						4.0	
						5.0	
						5.5	
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP19 **Depth : 0.00-5.60** **Start date : 10/09/14** **End date : 10/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.70m: SAND and Gravel.**
	sample					0.40	
						0.5	
						0.7	**SAND and GRAVEL**
						1.0	**0.70-2.00m:Gravely SAND with some organic matters.**
	sample					1.2	
						1.5	
						2.0	**Gravely SAND**
							2.00-5.60m: Greenish to bluish grey SILT and CLAY.
						2.5	
						3.0	**As above, " " "**
						3.5	
						4.0	**As above, " " "**
						5.0	**As above, " " "**
						5.5	
						5.6	**SILT and CLAY**
						6.0	**End of Pit**
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP20 **Depth : 0.00-5.40** **Start date : 10/09/14** **End date : 10/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-1.30m: SAND and Gravel with some organic matters and few cobbles.**
						0.5	
	sample					0.8	
						1.0	**As above, " " "**
						1.3	**SAND and GRAVEL**
						1.5	**1.30-4.70m: Brown silty fine SAND and clayey sandy SILT with some organic matters.**
						2.0	
						2.5	**As above, " " "**
						3.0	
						3.5	**As above, " " "**
						4.0	
						4.7	**Silty SAND and Clayey sandy SILT**
						5.0	**4.70-5.40m: Greenish to bluish grey clayey SILT.**
						5.4	**Clayey SILT**
						5.5	**End of Pit**
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP21 **Depth : 0.00-5.30** **Start date : 10/09/14** **End date : 10/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-0.30m: Agricultural top soil.**
						0.30	**Made Ground**
						0.5	**0.30-4.20m: SAND and GRAVEL with some organic matters and few cobbles.**
						1.0	
	sample					1.5	**As above, " " "**
						2.0	
						2.5	**As above, " " "**
						3.0	
	sample					3.5	**As above, " " "**
						4.0	
						4.2	**SAND and GRAVEL**
							4.20-4.90m: Reddish brown,slightly silty,medium SAND with few gravels.
10.09.14						4.9	**SAND**
@ 5.00m						5.0	**4.90-5.30m: Greenish to bluish grey silty CLAY.**
						5.3	**Silty CLAY**
						5.5	**End of Pit**
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP22 **Depth : 0.00-1.80** **Start date : 11/09/14** **End date : 11/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-1.80m: SAND and GRAVEL with cobbles and boulders.**
						0.5	
11.09.14 @ 1.40m	sample					1.0	**As above, " " "**
						1.5	
						1.8	**SAND and GRAVEL**
						2.0	**End of Pit**
						2.5	
						3.0	
						3.5	
						4.0	
						4.2	
						5.0	
						5.5	
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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Peizometer Construction	Laboratory	SPT' N Value	Sample Type	Sample Number	Sample Recovery %	Depth (m)	
							Test Pit number : NTP23 **Depth : 0.00-2.10** **Start date : 11/09/14** **End date : 11/09/14** **Excavation method : Excavation by using crawler mounted backhoe**
						0.0	**0.00-2.10m: SAND and GRAVEL with cobbles and boulders.**
						0.5	
						1.0	**As above, " " "**
11.09.14 @ 1.70m	sample					1.5	
						1.7	
						2.0	
						2.1	**SAND and GRAVEL**
						2.5	**End of Pit**
						3.0	
						3.5	
						4.0	
						4.2	
						5.0	
						5.5	
						6.0	
						7.0	
						8.0	
						9.0	
						10.0	

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NTP9

NTP10

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NTP11

NTP12

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NTP13

NTP14

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NTP15

NTP16

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NTP17

NTP18

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NTP19

NTP20

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NTP21

NTP22

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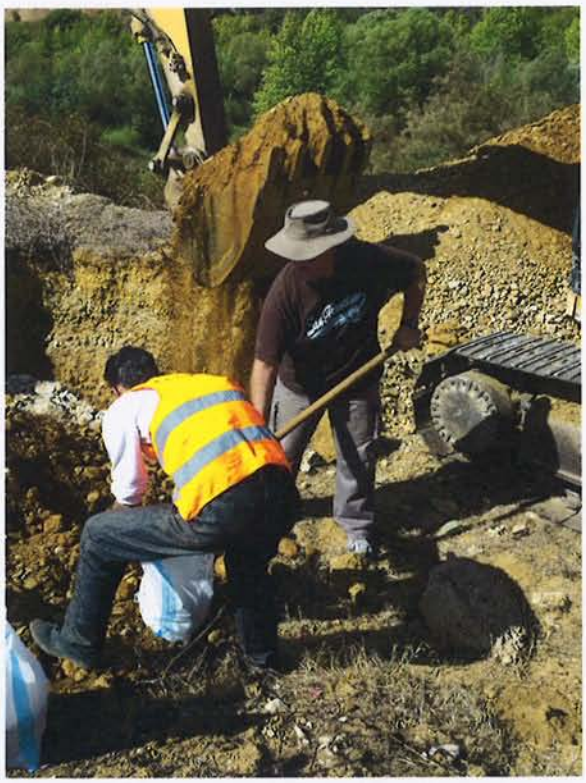
NTP23



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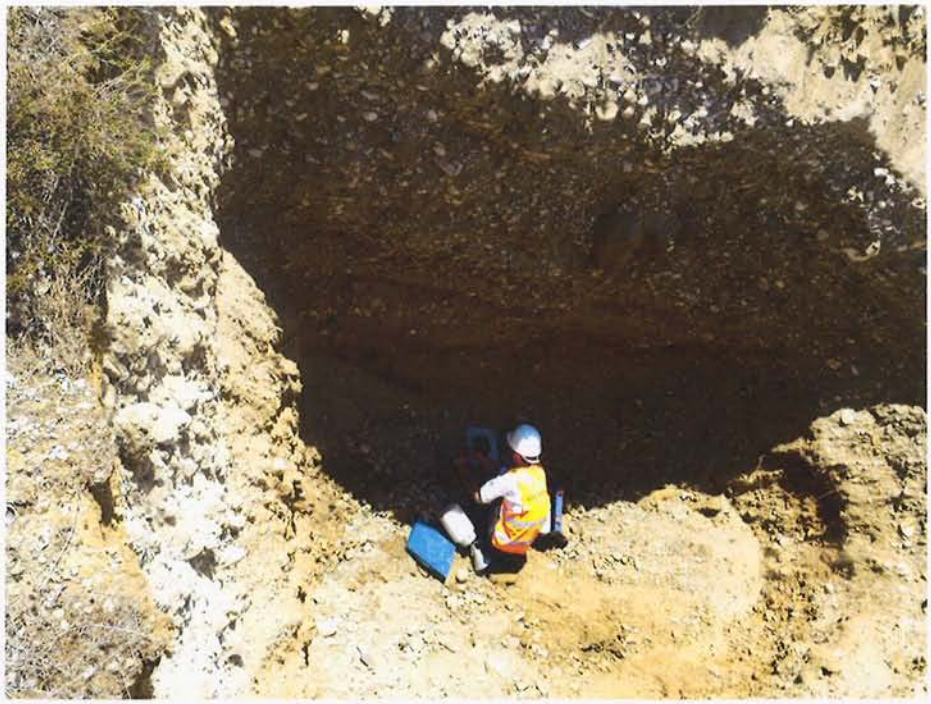

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