USAID | WEST BANK/GAZA

ASSESSMENT STUDY FOR FAILURES ON VARIOUS USAID-FUNDED ROADWAYS

AUGUST 16, 2012

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List of Acronyms

B&V	Black & Veatch
CBR	California Bearing Ratio
CMC	Construction Management Consultant
DOT	Department of Transportation
ICGES	Int'l Center for Geotechnical & Engineering Studies
INP I	Infrastructure Needs Program I
INP II	Infrastructure Needs Program II
MoPWH	Ministry of Public Works & Housing
PA	Palestinian Authority
TO	Task Order
USAID	United States Agency for International Development
WBG	West Bank/Gaza

1. 0 Introduction

1. 1 Executive Summary

The United States Agency for International Development, West Bank/Gaza Mission (USAID/WBG) funded $11.9M of roadway-related work in 2010, through the Infrastructure Needs Program (INP I). However, by late 2011, many of these roadways were showing premature defects and wear. USAID/WBG hired Black & Veatch (B&V) to study these early life roadway failures, under the Infrastructure Needs Program II (INP II) in May of 2012.

The study had a two-fold purpose. First, the intent of study was to review the defects and failures for each task order, and make recommendations for each. In addition to the recommendations, B&V was tasked to determine the responsible party or parties. And lastly, B&V was tasked to determine root causes and lessons learned, thereby protecting and preserving future USAID/WBG investments by minimizing the likelihood of future failures.

Most of the remediations have either taken place or are under design, with the following exceptions:

1. USAID/WBG approval is required to proceed with the design of permanent repairs for the Wadi Al Nar embankment failure.
2. USAID/WBG approval is required to design and procure embankment and drainage remediation for Qabatya.

B&V has identified the following root causes and proposes the following recommendations:

Root Cause	Recommendation
Non-comforming Materials	Study of material specifications, design, manufacture, quality control, quality assurance, and placement of base course and asphalt recommended
Poor Workmanship	Material Testing and Sampling should be under direct contract with Owner or Engineer, not Contractor
Embankment Instability (slope)	Roadways built or widened over existing slopes and embankments should have slope stability analyzed as part of design.
Poor Drainage	Contractor submittals should include a drainage submittal showing grades and structures.

1. 0 Introduction

1.2 Program Description

The United States Agency for International Development (USAID), through its West Bank/Gaza (WBG) Mission, has hired Black & Veatch (B&V) for multi-discipline engineering, construction management, capacity development and overall program management services in support of the implementation of the Infrastructure Needs Program Phase II (INP II). The primary goal of the INP II is to provide increased access for Palestinians to improve public infrastructure, thereby providing a critical foundation to support an independent and viable Palestinian state.

Though other project types may be included, INP II efforts are currently focused primarily on projects in the West Bank related to road rehabilitation and construction, water supply, and wastewater collection and treatment/sanitation.

1.3 Project Overview

The quantity of roadways and interconnectivity of roadways that Palestinians are able to travel on throughout the West Bank is very limited, and the quality of those roadways is relatively poor overall. Over the past few years, the USAID WBG has funded a number of roadway construction and rehabilitation projects to improve the quantity and quality of Palestinian roadways. Unfortunately, failures have occurred in a number of recently-constructed roadway segments.

1.3.1 Purpose

The USAID/WBG Mission authorized the B&V team to perform an assessment study (Study) for multiple roadway segments that have experienced various problems and modes of failure recently, including poor asphalt quality, longitudinal cracks and weak structure, as evidenced by differential settlement and patching.

The purpose of the Study was to determine the likely root cause(s) of the failures and develop recommendations for the remedial measures necessary to repair the roadways.

1.3.2 Scope

The scope of the Study was defined in an original Scope of Services dated February 20, 2012, which was approved and authorized by the USAID WBG Mission. This original Scope of Services focused on investigating failures in several sections of the Qabatya-Alzababdah-Tubas Road (constructed under USAID Task Order 17), defining and analyzing causes, and providing appropriate recommendations to remedy the defects.

The main activities defined in the scope consisted of the following:

- Have an expatriate roads expert visit the West Bank to initiate the Study.
- Review and analyze road design reports, design drawings and as-built drawings for the identified roads to address the adequacy of the design.
- Initiate and oversee any necessary field and laboratory testing according to the Jordanian Specifications for damaged road sections.
- Based on the design analysis, physical inspections, field and laboratory test results, provide recommendations and appropriate corrective measures to remedy the deficient sections of road.

Subsequent to approval of the original scope, USAID requested that other roadways be added to the scope of the Study. As a result, the following six (6) locations have been included:

1. Qabatya-Alzababdah-Tubas Road, constructed under Task Order (TO) 17.
2. Wadi Al Nar Road, constructed under TO 37.
3. Nuba Internal Roads, constructed under TO 50.
4. Beit Dajan Roads, constructed under TO 50.
5. Rawabi City Roads, constructed under TO 51.
6. Dura Pipe Trench, which consisted of reviewing the pipe trench backfill occurring as part of the Dura Cluster Water Storage and Distribution System Project, constructed under TO 45.

1.4 Description of Project Area

The West Bank consists of an area of approximately 5,680 square kilometers and generally consists of rugged mountainous terrain down the center from north to south and barren desert-like terrain in the east. Elevations range from a low of approximately -408 meters at the Dead Sea to the highest point of approximately 1,016 meters at Tall Asur in the Ramallah and Al Bireh Governorate. The climate is generally characterized as subtropical with rainfall typically limited to the winter months, resulting in hot, dry summers and cool, rainy winters.

The roadways included in the Study are located in various locations throughout the West Bank. Figure 1 on the following page includes a map showing the general topography of the West Bank with the approximate locations of the six (6) roadways included in the Study.

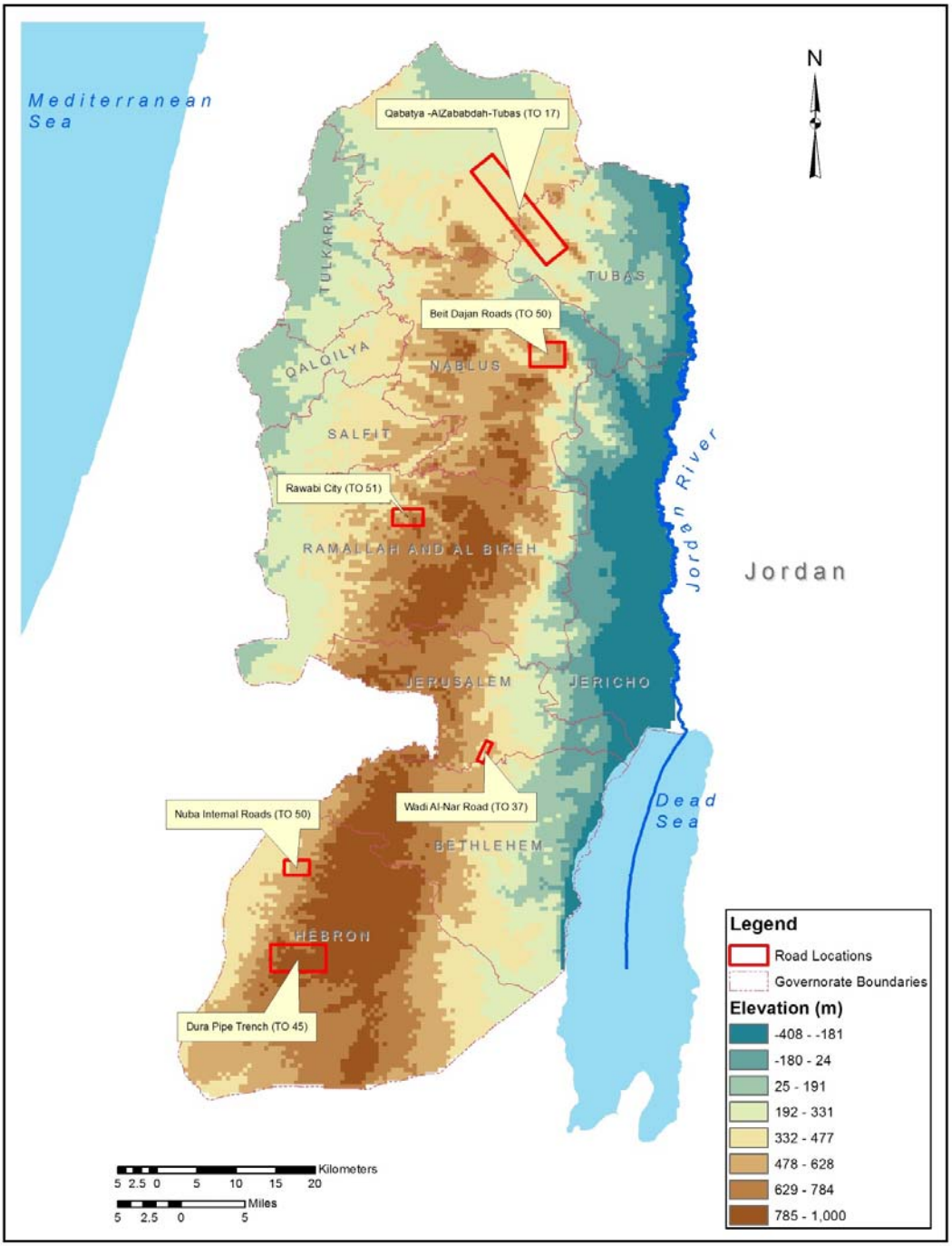
1.5 Reference Materials

A significant number of previous design documents, as-built drawings, reports and other reference materials were obtained and reviewed during the course of the Study, including, but not limited to:

- Design and Preparation of Tender Documents of Roads in West Bank, Engineering Report, Qabatya-Zababdah-Alkufeir Road, Ein Shibli-Alhamra Road by Arabtech Jardeneh, June 2009.
- Roads Rehabilitation and Reconstruction Project, Geotechnical Investigation (Qabatia-Al Zababdeh-Al Kfair- Tubas Roads) by Hijjawi Construction Labs, May 2009.
- Roads Rehabilitation and Reconstruction Project, Geotechnical Investigation (Tubas Southern Entrance) by Hijjawi Construction Labs, June 2009.
- Qabatya-Zababdah-Alkufeir-Tubas Road (Phase V), Final Design, July 2009 by MWH.
- Qabatya-Zababdah-Alkufeir-Tubas Road (Phase V), As-Built Drawings, October 2010 by APCO/Arcon.
- Qabatya-Zababdah-Alkufeir-Tubas Road (Phase V), Final Design, July 2009 by MWH.
- Final Report for TO#51, Rawabi City Internal Roads, by APCO/ArCon, October 2011.
- Rawabi City Internal Roads, As-Built Drawings, by APCO/ArCon, September 2011.
- Wadi Al-Nar Road (Phase IV) Task Order #37, As-built Drawings, June 2011 by IRD.
- Slope Face Stabilization for Critical Slope Surfaces, State of California Department of Transportation (DOT), District 04, by David W. Yam.
- Guidelines for Embankment Construction, Geotechnical Engineering Manual GEM-12, Revision #2, New York State DOT.
- Embankment Widening Design Guidelines and Construction Procedures, Richard J. Deschamps, Purdue University, 1999.
- Prevention of Failures Related to Geotechnical Works on Soft Ground, S.S.Gue & Y.C. Tan.

- USACE Slope Stability, Course No: G04-001, Gilbert Gedeon, PE, October 2003.
- Chapter 9, Embankments Design Specifications, Wisconsin DOT, January 2010.
- Chapter 2, Settlements, Stability, Construction and Drainage of the Embankment. Application of Light-Weight Materials and Geotextiles, Delft University of Technology.
- Nuba Internal Roads - As Built Drawings, Al Jarrar Road, May 2011.
- Specifications for Highway and Bridge Construction, Ministry of Public Works & Housing, Hashemite Kingdom of Jordan, 1991.

Figure 1: General Topography of West Bank and Location of Roadways in Study



2.0 Data Collection and Site Visits

2.2 Meetings and Site Visits

In fulfillment of the Scope of Services to have an expatriate roads expert visit the West Bank to initiate the Study, Robert C. Mendoza (herein referred to as "expat") of Trigon Associates, LLC (subcontractor to B&V) initially visited the West Bank between March 17, 2012 and March 31, 2012, with a follow-up visit between July 8, 2012 and August 17, 2012. The general purpose of the visit by the expat was to investigate failures in roadways identified by USAID WBG Mission staff. Specific efforts performed included meeting USAID and INP II staff; Gathering information; Conducting field visits for roadways that have experienced failures; Interviewing owner, design, construction management, and contractor staff; Understanding local customs in construction management, construction means and methods, construction materials, geography and geology; Reviewing maps of the area and becoming familiar with documents, document control, and nomenclature relative to roadway construction projects in the West Bank.

In preparation for the visit, the expat and other Home Office staff performed a preliminary compilation and review of documents in an attempt to obtain information that may prove useful for the expat visit and study. An example of information obtained included geotechnical reports, final design report, as-built drawings, and digital photographs of the road failures near Qabatya (TO 17). During expat's two-week visit, much of the additional material referenced in Subsection 1.5 was obtained.

The following subsections summarize the meetings and site visits that occurred relative to the specific six (6) roadways included in the Study, while a complete summary of expat's initial visit was previously documented in a Technical Memorandum ("Visit Report") dated April 5, 2012, which was submitted to USAID and is attached herein as *Appendix A*. Selected photos are included, while others can be found in *Appendix A*.

2.2.1 Qabatya (TO 17)

The first day of the visit mainly involved meeting with local INP II program staff, receiving additional documents such as final design drawings, warranty correspondence, bill of materials, variance orders, and additional photographs for Qabatya. Available project files were also transmitted to the expat.

Interviews were conducted with Dr. Daoud Qawasmeh and Adnan Safi from the INP II team. Both currently are employed by Trigon Associates as part of the B&V INP II team but were previously employed by APCO/Arcon, the contractor for Qabatya and Rawabi. Both provided valuable insight concerning each project. However, because of the possibility of a conflict of interest, both refrained from providing any opinion on the defects and limited their comments to facts concerning contractor understanding of documents and scope of work, general contractor means and methods, materials and equipment available to contractors, a basic chronology of events, as well conditions encountered during construction.

An initial visit to Qabatya was performed on Wednesday, March 21, 2012. This field visit included a drive through of all three (3) damaged road segments (2+600 to 3+250, 3+600 to 4+900, 0+220 to 0+720). Segment One was inspected on foot, which included review of remedial work performed to date, review of new defects developing, evaluation of ride quality in the vehicle, and visual inspection of the embankment slopes and conditions at the toe of the embankment. Paved areas that underwent significant remedial action in October 2011 were generally in good condition, but

longitudinal cracks still existed in the unpaved shoulders. Pavement areas directly adjacent to remedial areas showed new longitudinal cracks. It was also noted that the area near the Jenin intersection, which was previously reinforced with stone boulders, showed some evidence of longitudinal cracks in the area between the guard rail and stone reinforcement. Standing water was observed in areas near the toe of the embankment, and soils were very soft. It had rained in the area in the days just prior to the visit.

Figure 2: Longitudinal Cracks in Roadway and Shoulder at Qabatya

A meeting with George Odeh of Diyar Consultants Company (Diyar) occurred in the Ramallah offices of B&V on March 27, 2012. Diyar provided roadway design services to MWH under the INP I. The interview was to determine the contractual relationships, responsibilities, means and methods, and standard operating procedure for design projects and to understand specific constraints and considerations for the Qabatya project. Mr. Odeh also provided his insight into the warranty issues, as well as a copy of a report he prepared in response to the warranty issues.

A second visit to Qabatya was performed on March 28, 2012 with Dr. Mohammad Alsayyed, Director General of the International Center for Geotechnical & Engineering Studies (ICGES) and owner of GeoTest. Expat previously met with Dr. Alsayyed to discuss material testing methods available in the area and discuss engineering studies on embankment and soil mechanics. This field visit allowed expat and Dr. Alsayyed to review and discuss the Qabatya sites together.

A third visit to Qabatya was performed on July 16, 2012. No new cracks have appeared, and stone reinforced embankments have dried and also appear stable. However, areas of asphalt slippage have still not been corrected by the contractor, nor have all the cracks in the shoulder or asphalt been addressed and sealed. Areas where the asphalt is flushed appear to be spreading.

2.2.2 Wadi Al Nar (TO 37)

Wadi Al-Nar was visited on Monday, March 19, 2012. The visit included walking the entire roadway segment; inspecting all the culverts, paved ditches, and outfall pavement and revetments; and checking the embankment. Wadi Al-Nar roadway, at Station 0+380, displayed a shear failure of the embankment, resulting in a crescent-shaped roadway failure. Inspection of the pipe culvert under this section of roadway showed that the final three joints had settled or been pulled apart and downward as part of the shear failure and had separated. Embankment along additional sections of the roadway showed some settlement, but the result of the settlement was mainly areas of embankment separation from the concrete drainage protection, or separation of the concrete protection from the roadway. Except for Station 0+380, the embankment separation observed was

less than 1 cm. Other culverts in the roadway were inspected and were generally straight with no joint separation.

A follow-up visit was conducted on Wednesday, July 10, 2012. Expat observed that contractor remediation work was completed. The remediation work included a concrete base section, asphalt wearing overlay, sealing of separated concrete drainage joints, and additional concrete protection of the exposed slope. Photographs show that concrete embankment protection is beginning to separate. Asphalt patch also appears heavily flushed (shiny, excess bitimun).

2.2.3 Nuba (TO 50)

On March 24, 2012, project-related files for TO 50 were compiled and reviewed by expat. A site visit to the failed roadway section (Al Jarrar Road) occurred on March 26, 2012. This visit involved assessing longitudinal cracks developing in the roadway. Al Jarrar was previously an unpaved roadway. According to the Contractor's representative onsite and Warranty staff the roadway was paved at the request of the local municipality, but no formal design was performed and the required roadway pavement section was constructed based on past cross sections used on local roads. The cracks developed recently after rainfall events and appear to be shear failure of the terrace supporting the road, which is retained by a stone wall. It should be noted that sections of stone walls supporting terraces over the roadway have collapsed as well. The longitudinal cracks did not appear to be the result of roadway stresses associated with an insufficient cross section but instead completely related to shear embankment failure.

A follow-up visit was conducted on Wednesday, July 11, 2012. The local road was closed because of continued embankment failures. Overall, the embankment failures were in roughly the same condition as the March visit, with the exception that exposed embankment showed the soils were dry now and likely stable as long as loads are kept off the roadway.

2.2.4 Beit Dajan (TO 50)

On March 24, 2012, project-related files for TO 50 were compiled and reviewed by expat. A site visit was performed on March 28, 2012. The roads under this TO were widened as part of the project and included scarifying and compacting the 20 cm of sub-base in accordance with Section 2.07 of the Jordanian specifications, as well as installing 20 cm of base course and 5 cm of asphalt. These roads had recently developed longitudinal cracks. The cracks did not appear to be shear plane failure but instead sub-base failure.

A follow-up visit was conducted on Monday, July 16, 2012. Contractor had performed remediation work on sites visible during March visit. Remediation included concrete replacement of base, asphalt wearing course topping, and concrete shoulder protection in select areas. Remediation work appears to be performed well. However, some new aligator cracking and longitudinal cracking has appeared which has not been remediated.

2.2.5 Rawabi (TO 51)

Rawabi was visited on Wednesday, March 21, 2012. This site visit included excavating the roadway within one of the failure locations and interviewing field engineers from Rawabi. Failures were located along sections of the roadway where water flow is directed by the grades and pitch of the embankment, and the base and sub-base were observed to be very moist. With the exception of this area subject to water runoff, the rest of the paved roadway appeared in very good shape.

A follow-up visit occured on Monday, July 23, 2012. Included in the site visit was a complete tour of all the base course and pavement installed as part of Task Order 51. Although alligator and block cracking had expanded, failure still appeared generally confined to the section of roadway identified in the March visit and have not expanded to any of the internal roads.

Figure 3: Checking Base and Sub-base at Rawabi

2.2.6 Dura Pipe Trench (TO 45)

USAID requested that expat review roadway trench restoration work that was in progress as part of the Dura Cluster Water Storage and Distribution System project. A visit to Dura was performed on March 25, 2012. The contractor had requested construction management consultant (CMC) staff to approve a variation (reduction) of the asphaltic pavement section depth along a portion of the roadway from 10 cm to 5 cm. CMC staff initially denied the request, but final resolution of the matter had not been settled at the time of the visit. The trench backfill along the length of the project had been backfilled and compacted. On local roads where only 5 cm of pavement was required, the contractor had already paved the trench. Along the main road where 10 cm of pavement was required, the contractor had paved the first 5 cm of pavement, and vehicles were allowed to drive on the trench.

A follow-up visit occured on Wednesday July 11, 2012. The entire length of the Dura trench pavement was viewed, including sections along internal roads and main roads. Pavement placement and compaction appear to be well done. In addition, cold joints between existing and new pavement appeared tight with a good bond. Overall smoothness felt good when driving on the new pavement, and trench cuts across the pavement match the existing grade well with little or no bump felt.

2.3 Additional Testing and Analysis

The following subsections summarize additional field sampling, lab testing, and analysis that were performed, when necessary, for each of the six (6) failed roadway sections. Any testing and analysis described here was performed locally by the labs of the ICGES under the direction of Dr. Alsayyed.

2.3.1 Qabatya (TO 17)

Three (3) distinct items were further tested and/or analyzed for the Qabatya roads:

1. Evaluation of the original structural design of the roads.
2. Analysis of the stability of stone retaining walls at Stations 0+280 to 0+450 and 3+120 to 3+210. The stability of the walls was investigated by determining the factor of safety for three (3) different failure criteria – overturning, sliding and bearing capacity.
3. Detailed geotechnical and structural evaluation based on records review, field testing, and lab testing. Testing results were analyzed for the asphalt pavement, base course, and the fill and subgrade.

The data and results of the above analyses are included in *Appendices B, C* and *D*, respectively.

2.3.2 Wadi Al Nar (TO 37)

A detailed geotechnical and structural evaluation of the failing embankment slope was performed based on field testing, lab testing, and computer modeling. The data and results are included in *Appendix E*.

2.3.3 Nuba (TO 50)

No additional sampling or testing was required for this location.

2.3.4 Beit Dajan (TO 50)

No additional sampling or testing was required for this location.

2.3.5 Rawabi (TO 51)

Material sampling and testing was performed for the asphalt and the base course materials at this location. The data and results are included in *Appendix F*.

2.3.6 Dura Pipe Trench (TO 45)

No additional sampling or testing was required for this location.

3.0 Evaluation and Recommendations

Based on the site visits; the review of available documentation; field sampling, lab testing and analysis performed; this section presents the results of the evaluation for each roadway, including recommendations.

3.2 Qabatya (TO 17)

3.2.1 Construction

Base course tests revealed that only 11 of 33 samples were compacted to specifications. A high variation in thickness existed. Several samples had a high percentage of materials passing sieve #200 and nearly 25% did not meet California Bearing Ratio specification.

Asphalt samples showed only 2 of 38 were compacted to specification. Asphalt wearing course slippage and potholing show evidence of smooth binder course below demonstrating missing or inadaquate application of tack coating to adhere pavement layers. In addition, open mixture on patches is likely the result of cold placement.

The rock fill layer does not appear to adhere to any known standard. Because of large voids in rock fill, segregation of upper base course and topping is likely, but design does not provide any way to mitigate the segregations.

Recommendation 1 - Although sampling only occured at road failures, which would increase the probability of deficiencies in materials and workmanship being found, the high percentage of failures and types of failures points to a systemic problem. Material sampling and testing is currently done directly under the contractor's supervision and should be moved to Engineer or Owner, since the primary purpose is to provide quality control and assurance to the Owner.

Recommendation 2 – Cracks in asphalt should be sealed properly with wide cracks being completely filled. Asphalt with popouts should be removed and properly worked.

Recommendation 3 – Cavities in the rock fill layer should be grouted with a sand-cement-water mixture under low pressure. Contractor is responsible for costs to seal crack and replace poorly constructed sections of pavement.

3.2.2 Engineering/Design

As confirmed by the structural evaluation performed by ICGES and documented in *Appendix B*, the original structural design of the failing roadway sections appears to be satisfactory.

Conditions observed by expat during the site visits indicated that poor drainage could be contributing to the failures, and a previous geotechnical report by Hijjawi Construction Labs specifically stated:

> *"5.3….Surface water should be controlled in such a manner that it does not discharge onto cut slopes in overburden above the highway (from natural stream courses). Ditches should be*

constructed so as not to pond water nor allow infiltration of water into soils under the highway. In order to protect the integrity of the highway embankments in the drainage areas, it will be necessary to extend the culverts to move the point of discharge well beyond the toe of such embankments."

From a review of the design documents for the project, the drawings provided for the installation of culverts but did not provide adequate direction to the contractor for construction of the ditches. The drawings and submittals for Qabatya only showed the grade line of the new and existing roadway. As a result, it appears that the contractor would have only depended on the existing grades along the newly constructed embankment to provide for drainage.

Recommendation – In future design/construction documents, the cross-section drawings should show elevation/grade lines for each of the following:

- Centerline of roadway
- Gutter lines and/or ditch grades
- Edge of right-of-way

Following this recommendation would allow construction and design managers the ability to verify that water travels in a predictable direction and that existing and new culverts tie into ditches correctly. This recommendation would also help in confirming that runoff will not be directed onto private property. Lastly, within congested areas like urban centers, this recommendation will allow designers to prevent gutter lines from being constructed in conflict with building and building entrances directly adjacent to the edge of the roadway.

3.2.3 Stone Wall Stability

The stability of two stone retaining walls along the roadway were investigated and evaluated for three (3) different failure criteria – overturning, sliding and bearing capacity. The wall from Station 0+280 to 0+450 was included in the original design, while the second wall from Station 3+120 to 3+210 was added later to stabilize a failing section of roadway.

Figure 4: Lateral Movement of Stone Boulders Used to Stabilize Road at Qabatya

As documented in the ICGES report in *Appendix C*, the first wall is unstable in two of the criteria – sliding and bearing capacity. The second wall appears to be stable except in cases where there is a change in water content that would cause the soil to swell and shrink.

Recommendation 1 – For the first stone wall from Station 0+280 to 0+450, either two more rows of stone blocks could be added in front of the current wall or passive fill could be added in front of the wall to a height of approximately 2.0 meters.

Recommendation 2 – For both walls, water should be directed away from the base of the walls to prevent destabilization.

Recommendation 3 – Drainage should be improved along the roadway by surveying the grades along the toe of the embankments and establishing grade lines to ensure water is directed properly away from the toe and that all culverts tie into drainage ditches properly. Failed culvert wall and pipes should be repaired, and the damaged asphalt over it should be realigned.

3.3 Wadi Al Nar (TO 37)

The Wadi Al Nar roadway displays a shear failure of the embankment at Station 0+380, resulting in a crescent-shaped roadway failure. A geotechnical and structural evaluation for slope stability of the embankment at this location was performed, the data and details of which are presented in *Appendix E*.

Figure 5: Crescent-Shaped Shear Roadway/Embankment Failure at Wadi Al Nar

Two (2) boreholes were drilled at the site, and the material was tested in the laboratory for physical and mechanical properties. The slope stability analysis was performed by applying three (3) separate models in the analysis of slopes. *PROKON* software, which is based on the Limit Equilibrium Method, was used to aid in the analysis.

Very low values for safety factor were obtained in all cases, indicating an unstable slope condition. As a result, the embankment needs to be stabilized.

Recommendation – The embankment near Station 0+380 should be stabilized, which could be accomplished by using any one (1) of the following techniques:

- Install a series of secant piles in the form of a curtain wall that goes down to intersect the failure surface. Analysis for this option could be done using the same program from the evaluation.
- Use the jet grouting method of soil stabilization or fixation under the road as well as the slope. The jet grouting columns are to go down below the failure surface.
- Build a retaining wall at the toe of the slope on stable ground. The wall should be designed to prevent slope movement and be enough to have the side slope more flat while carrying the loads. This wall could take the form of a gravity or reinforced wall.
- Dismantle the pavement and build it again using appropriate methods of construction as well as the appropriate material to the depth recommended by the designer. If soil from the site is to be used, it should be modified by mixing with stabilizing material, such as cement or lime before compaction; Trial mixes can be done to determine the appropriate cement or lime to soil ratio.
- Dismantle the pavement and perform deep compaction on two stages, each of approximately 4 meters.

In all cases of backfilling, the backfill should be installed in layers of 25 cms before compaction and tested to a minimum of 98% degree of compaction on modified proctor, within +/- 2% of optimum moisture content.

The contractor should be compensated for this work, and USAID may consider this failure the result of an error and omission of the design engineer. The design engineer should be responsible for Owner costs of temporary remediation and procurement cost of establishing permanant remediation.

3.4 Nuba (TO 50)

As stated previously, this roadway was paved at the request of the local municipality, but no formal design was performed. The cracks in the Al Jarrar Road appear to be the result of a shear failure of the terrace supporting the road, which is retained by a stone wall. Current drainage appears insufficient as well and requires improvement.

Sections of the roadway also pose a safety hazard to road users where the natural ground level is much lower than the existing asphalt.

Recommendation **–** The following measures are recommended to remediate the road and provide required safety procedures for road users:

1. Construction of stone boulders to support the roadway at the embankment side for the section where side slope is insufficient or cannot be achieved (approximately 150m in length).
2. Reconstruction of defective shoulder areas (approximately 150m in length).
3. Casting concrete protection up to existing stone walls (approximately 700m in length).
4. Construction of edge beams for the sections super elevated to the embankment side in order to collect drainage water at the low point and provide a proper outfall point.
5. Installation of guardrail for the sections where the natural ground level is below the existing asphalt by 2.5 meters or greater.

The total cost of the above mentioned works is estimated to be approximately $220,000 and included in a current RFTOP.

3.5 Beit Dajan (TO 50)

The longitudinal cracking in this roadway observed during the site visit appears to be due to sub-base related failure, which requires repair.

It should be noted that, since the time of expat's initial visit, existing cracks have expanded and new cracks have appeared in other locations throughout the roadway from Station 0+200 to 2+900.

Recommendation 1 – The contractor should repair the defected area between Station 2+640 and 2+660 where 40 cm of rock fill was installed during construction. (completed before final report)

Recommendation 2 – Newly-identified defective areas should be remedied under the short term emergency roads maintenance material supply program to be implemented by the MoPWH through B&V's direction. (Currently included in Short Term Asphalt Pavement Patching program starting in September 2012)

3.6 Rawabi (TO 51)

The road failures at this location display as alligator cracks and represent base failure. Contractor has claimed that since asphalt paving is temporary and is not part of the original scope, the contractor is not responsible for repairs. However, material sampling and testing was performed by ICGES for the asphalt pavement and base course. The detailed report is presented in *Appendix F*. Testing revealed that base course gradation and CBR do not meet specifications. Asphalt compaction is low, but that could be the result of weakness of the base course as well.

Recommendation – Owner should perform additional sampling of base course to determine full extent of non-compliant material. The contractor should remove and restore improper base course and asphalt at no cost to the Owner.

3.7 Dura Pipe Trench (TO 45)

Expat was requested to review trench restoration work within a roadway following the installation of a water pipeline. The contractor had requested a reduction of the required asphalt pavement section depth from 10 cm to 5 cm.

This location did not involve an actual roadway failure. As such, no specific remedial measures are required. However, as indicated previously in the April 5, 2012 Technical Memorandum ("Visit Report") attached herein as *Appendix A,* the following observations and recommendations are issued based on the site visit:

- The pavement design for the main road requires the contractor to install 10 cm of asphalt pavement, and CMC and USAID should not approve a variance to reduce the thickness to 5 cm to match existing.
- CMC recommendation to install the first 5 cm of asphalt pavement well in advance of final pavement should be a standard practice. Installation of an initial pavement layer allows traffic to use the road and helps speed up trench settlement, thereby reducing potential for settlement of the final layer of asphalt. Installation of an initial pavement layer also helps stabilize the existing roadway and reduces block cracking and pavement failure of the existing roadway, thereby reducing patching needed outside the trench.
- Whenever two layers of asphalt can be paved, attempt to offset the construction joint of the two layers by milling a straight joint for the final top layer of asphalt slightly wider than the bottom layer of asphalt.

- Whenever possible, prevent the construction joint from being aligned with the expected wheel-patch of vehicles.
- Expat observed many trench pavement sections throughout the West Bank and noticed settlement of the trenches with loss of cohesion between the old roadway and the patch. CMC personnel should ensure all cold joints are clean and well coated with a tack coat to ensure a good bond between asphalt layers.
- Discussion was observed by expat concerning use of concrete in trench backfills to offset settlement. Installing a rigid base and sub-base treatment under flexible pavement should be avoided since it will result in reflective cracks and differential settlement.

3.7 Root Causes and Lessons Learned

3.7.1 Materials

The two primary materials used in roadbuilding are base course and asphalt pavement. As a result, the quality and consistency of these two materials dramatically affect the cost and quality of roadway construction. A significant portion of the specifications relate to these two materials, including the component elements used to create these materials. The process equipment used to create these materials**,** the physical performance of the final processed materials**,** the placement of these materials, and the testing procedures should ensure that these materials meet specifications after placement.

Testing results during the study showed variations in materials used across samples taken within a very small area. This was true even when materials were within tolerances of the specifications.

With regard to base course, testing showed that the material conformed to specifications, even though samples taken were very often silty with a very high level of fines passing the#200 sieve.

With regard to asphalt pavement, the testing generally shows the material to be within specified tolerances. However the Expat has observed that most pavement appeared flushed. Flushed pavement appears very smooth and shiny because of the migration of bitumen to the surface of the pavement. This creates a pavement that has a Low skid resistance and wears out quickly. The most common cause of this pavement distress is insufficient voids in the pavement or excessive bitumen. Less common causes of this pavement distress include job mix formulas and specification that do not account for primary and secondary compaction, or low quality or dirty aggregates within the matrix, which prevents bitumen from adhering to the aggregates and therefore allows it to bleed to the surface.

A study to evaluate these two materials from formulation to placement is recommended. As part of a material study, it will be necessary to perform the following:

- Review and evaluate specification including specifications of source materials and equipment for manufacturing and placement
- Review and evaluate raw material (aggregates, sand/ sand equivalents, butimun) sources, storage, handling, quality control, and quality assurance
- Review and evaluate manufacturing facilities, equipment, storage, processes, operator training, quality assurance, and quality control
- Review and evaluate transport and placement equipment
- Review and evaluate material placement
- Review and evaluate job mix formulation
- Material testing and sampling to mirror manufacturer and contractor quality assurance and quality control testing

- Report to USAID

3.7.2 Materials Sample and Test

Material testing was performed on two sites evaluated. The test results showed an unusually high incidence of materials or workmanship not conforming to specifications. In addition, several of the other sites showed similar defects in workmanship, and had testing been performed, it is highly likely the same results would have been found.

Material sampling and testing provides either acceptance testing or monitoring. Acceptance testing is performed in order to make sure that materials meet specifications, and that work techniques and means and methods provide an in-place application that conforms to specifications and will perform as designed. Monitor testing is performed in order to make sure that construction methods do not adversely affect the surrounding environment.

When the specifications are provided by the contractor, such as an internal quality control or quality assurance program, it is appropriate for the contractor to provide his own testing services. However when the specifications are provided by the owner, such as the specifications provided in the contract documents between the owner and contractor, then the appropriate contract relationship with the testing lab should be with the owner or the owner's representative.

Under the current situation, the testing lab is working with the contractor to verify the contractor's quality control and quality assurance program, not necessarily the owner's requirements. And while testing service companies adhere to the ethical standards of an engineering company, the interest of the contractor is not necessarily the same as the interest of the owner.

3.7.3 Embankment Stability

Embankment stability engineering and review were omitted is the design phase of all the projects studied. However, adding embankment engineering to every project would result in higher design costs, with marginal benefits. Therefore , a targeted set of factors should be used to determine when embankment stability will be part of the design process. These factors should include the following:

- Roads that require the construction of a new or widened terrace on hillside.
- Roads built on existing terraces whose traffic count is expected to change significantly, in particular is truck volume is expected to increase over 25% over the service life of the road
- When new embankments are constructed to support a roadway over soft clay or silt material
- When road edges are constructed directly adjacent to a steep embankment

3.7.4 Drainage

The West Bank is classified as subtropical and experiences a significant rainy and dry season. This fact, combined with the high plasticity of the soils upon which roadways are built, requires that drainage be properly considered and designed into each roadway project. With natural drainage channels well defined by the terrain, drainage design requires relatively modest efforts. Therefore, it is recommended that, as part of the submittal process, the contractor be required to provide a submittal showing proposed drainage grades showing ditches, swales, culverts, catch basins, and other drainage conveyances. In this way, the engineer can verify the contractor's intent for drainage.

4.0 Appendix A: Expatriate Visit Report

The attached Technical Memorandum ("Visit Report") dated April 5, 2012 was submitted to the USAID WBG Mission as a summary of expat's initial visit to the West Bank to initiate the Study.

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TECHNICAL MEMORANDUM

To:	Anan Masri Mariam Amro USAID West Bank/Gaza	**Date:**	April 5, 2012
From:	Robert C Mendoza	**DN:** **File No.:**	1518 P020.5.3

Subject: Expatriate Visit Report for Roadway-Related Tasks

INTRODUCTION

This Technical Memorandum (TM) serves to document the visit by expatriate staff to initiate efforts related to roadways.

The original general purpose of this visit by the expatriate staff was to investigate failures in roadways recently constructed under Task Order 17 near Qabatya. Specific efforts to be performed included meeting USAID West Bank/Gaza Mission (Mission) and INP II staff; Gather information; Conduct field visits for roadways that have experienced failures; Interview owner, design, construction management, and contractor staff; understand local customs in construction management, construction means and method, construction materials, geography and geology; Review maps and territories of the West Bank and become familiar with document, document control, and nomenclature relative to roadway construction projects.

Shortly before the visit and during the visit, additional roadways were added to the scope of what expatriate staff was to review to assess damages and possible reasons for failure. During the visit, the expatriate staff was also asked to assist the Mission by reviewing and providing comments and recommendations for a roadway design manual. Expatriate staff also initiated preliminary efforts on the separate task related to a study to develop a roadway maintenance management system for the Ministry of Public Works and Housing (MoPWH). The remainder of this TM discusses the efforts performed during the visit for these three (3) general tasks.

The expatriate staff that performed the visit was Robert C Mendoza (herein referred to as “expat”) of Trigon Associates, LLC (Trigon). The expat arrived in the West Bank on Saturday, March 17, 2012 and departed on Saturday, March 31, 2012.

PRE-VISIT EFFORTS

In preparation for the visit, the expat and other Trigon Home Office staff performed a preliminary compilation and review of documents in an attempt to obtain information that may prove useful for the expat visit and study. An example of information obtained included geotechnical reports, final design report, as-built drawings, and digital photographs of the road failures near Qabatya (Task Order 17).

Immediately prior to departure, the expat was informed that two (2) additional sites were requested to be reviewed: Wadi Al Nar (Task Order 37), for a failure near Station 0+380; and Rawabi City (Task Order 51), for a failure near the front access road. As a result, documents were not available for review prior to the expat visit.

During the visit, two (2) more road failures were added to the scope: Nuba Internal Roads (Task Order 50), for longitudinal cracks from station 0+200 to 0+700; and Deir El Hatab and Salem Internal Roads (Task Order 50), for longitudinal cracks in various locations. Expat was also asked to review and comment on a pipe trench backfill occurring as part of the Dura Cluster Water Storage and Distribution System project (Task Order 45).

Lastly, Mission staff arranged for a presentation by Chemonics on the Palestinian Authority Capacity Enhancement Project (PACE) recently completed, which included capacity building in roadway maintenance and the development of a roadway maintenance manual.

MEETINGS AND SITE VISITS

The first days of the visit, Sunday March 18, 2012, mainly involved meeting with local INP II program staff, receiving additional documents such as final design drawings, warranty correspondence, bill of materials, variance orders, and additional photographs for Qabatya. Available project files were also transmitted to the expat.

Following is a description of the site investigations performed and meetings conducted during the expat visit. A few photographs representative of the site investigations are included at the end of this TM.

Wadi Al-Nar (Task Order 37) was visited on Monday, March 19, 2012 with Adnan Azazmeh from the INP II team. The visit included walking the entire roadway segment; inspecting all the culverts, paved ditches, and outfall pavement and revetments; and checking the embankment. Wadi Al-Nar roadway, at Station 0+380, displayed a shear failure of the embankment, resulting in a crescent-shaped roadway failure. Inspection of the pipe culvert under this section of roadway showed that the final three joints had settled or been pulled apart and downward as part of the shear failure and had separated. Embankment along additional sections of the roadway showed some settlement, but the result of the settlement was mainly areas of embankment separation from the concrete drainage protection, or separation of the concrete protection from the roadway. Except for Station 0+380, the embankment separation observed was less than 1 cm. Other culverts in the roadway were inspected and were generally straight with no joint separation.

On Tuesday, March 20, 2012, interviews were conducted with Dr. Daoud Qawasmeh and Adnan Safi from the INP II team. Both currently are employed by Trigon as part of the Black & Veatch (BV) INP II team but were previously employed by Apco, the contractor for Qabatya (Task Order 17) and Rawabi (Task Order 51). Both provided valuable insight concerning each project. However, because of the possibility of a conflict of interest, both refrained from providing any opinion on the defects and confined their comments to facts concerning contractor understanding of documents and scope of work, general contractor means and methods, materials and equipment available to contractors, a basic chronology of events, as well conditions encountered during construction.

Rawabi (Task Order 51) and Qabatya (Task Order 17) were visited on Wednesday, March 21, 2012 with Adnan Azazmeh and Rasha Arafeh of the INP II team. The site visit to Rawabi included excavating the

roadway within one of the failure locations and interviews with field engineers from Rawabi. Failures were located along sections of the roadway where water flow is directed by the grades and pitch of the embankment, and the base and sub-base were observed to be very moist. With the exception of this area subject to water runoff, the rest of the paved roadway appeared in very good shape.

The field visit to Qabatya (Task Order 17) included a drive through of all three segments. Segment one was inspected on foot, which included review of remedial work performed to date, review of new defects developing, evaluation of ride quality in the vehicle, and visual inspection of the embankment slopes and conditions at the toe of the embankment. Paved areas that underwent significant remedial action in October 2011 were generally in good condition, but longitudinal cracks still existed in the unpaved shoulders. Pavement areas directly adjacent to remedial areas showed new longitudinal cracks. It was also noted that the area near the Jenin intersection, which was previously reinforced with stone boulders, shows some evidence of longitudinal cracks in the area between the guard rail and stone reinforcement. Standing water was observed in areas near the toe of the embankment, and soils were very soft. It had rained in the area in the days just prior to the visit.

Thursday, March 22, 2012 consisted mainly of a meeting in Tel Aviv with Mission Staff, including Anan Masri and Mariam Amro, as well as Sal Mansour from the INP II team. The meeting served as an introduction between expat and the Mission and also a verification of the purpose behind the Root Cause Analysis, which is to determine the cause of each roadway failure, verify that remediation efforts conducted will work or recommend further remediation, and lastly to apply lessons learned for future road projects.

The meeting in Tel Aviv also included a presentation by Chemonics. The presentation involved the roadway portion of the PACE project, and a transmittal of PACE documents including GIS roadway layers (GIS training, pavement condition assessment classification, survey training, and pavement management training), PACE presentations to the MoPWH, and a current roadway assessment database. In addition, Chemonics delivered Roadway Maintenance Manuals developed with MoPWH, which Mission staff has requested expat review and provide comments and feedback. This meeting also served as an initial step in starting the task related to developing a roadway maintenance management system for the MoPWH.

Sunday, March 24, 2012 was spent primarily in the Ramallah INP II office. Documents and photographs were compiled, and additional files were compiled such as as-built drawings for Task Order 50 (Nuba Internal Roads and Salem Internal Roads). Expat determined which sites to re-visit to collect additional information and reviewed credentials of the testing and geotechnical engineer best suited to conduct further field studies and stability analyses.

Monday, March 25, 2012 included a visit to Dura (Task Order 45) to review water distribution roadway trench restoration work currently in progress. Contractor has requested construction management consultant (CMC) staff to approve a variation (reduction) of the asphaltic pavement section depth along a portion of the roadway from 10 cm to 5 cm. CMC initially denied the request, but final resolution of the matter has not been settled at the time of the visit. The trench backfill along the length of the project has been backfilled and compacted. On local roads where only 5 cm of pavement is required, the contractor has already paved the trench. Along the main road where 10 cm of pavement is required, the contractor has paved the first 5 cm of pavement, and vehicles are allowed to drive on the trench.

On Tuesday, March 26, 2012, a meeting with Dr. Mohammad Alsayyed, Director General of International Center for Geotechnical & Engineering Studies and owner of GeoTest, occurred in the Dura offices of BV. The interview was primarily for expat to meet Dr. Alsayyed, discuss material testing methods available in the area and discuss engineering studies on embankment and soil mechanics. As a result of the meeting, a field visit was scheduled with Dr. Alsayyed to review Qabatya. The afternoon was spent looking over longitudinal cracks developing on internal roads paved in Nuba (Al Jarar Road; Task Order 50). Al Jarar was previously an unpaved roadway. According to the Contractor's representative on the site and Warranty staff, the roadway was paved at the request of the local municipality, but no formal design was performed, and the required roadway pavement section was constructed based on past cross sections used on local roads. The cracks developed recently after rainfall events and appear to be shear failure of the terrace supporting the road, which is retained by a stone wall. It should be noted that sections of stone walls supporting terraces over the roadway have collapsed as well. The longitudinal cracks do not appear to be the result of roadway stresses associated with an insufficient cross section.

On Wednesday, March 27, 2012, a meeting with George Odeh of Diyar Consultants Company occurred in the Ramallah offices of BV. The interview was to determine the contractual relationships, responsibilities, means and methods, and standard operating procedure for design projects and specifically constraints and considerations for the Qabatya project (Task Order 17). Mr. Odeh also provided his insight into the warranty issues and submitted a copy of the report he prepared in response to the warranty issues.

On Thursday, March 28, 2012, the site visit referenced and scheduled above on March 26 was conducted with Dr. Alsayyed. In addition, a site visit of an embankment failure and attempted repair near Nablus on a MoPWH road was arranged. This MoPWH embankment failure was reviewed because it closely mirrored the failure mode on the Wadi Al-Nar (Task Order 37) project. Interviews were held with the contractor performing the remediation work, as well as a MoPWH official who was overseeing the work.

Lastly, expat staff met with Rasha Arafeh of the INP II team to visit Salem Internal Roads and Al Mawares local roads paved under Task Order 50. The roads were made wider as part of the project and included scarifying and compacting the 20 cm of sub-base in accordance with Section 2.07 of the Jordanian specifications, installing 20 cm of base course and 5 cm of asphalt. These roads recently developed longitudinal cracks. The cracks do not appear to be shear plane failure but instead sub-base related failure. Contractors have agreed to repair most of the cracks, except for IRD for the longitudinal crack from station 2+640 to 2+700.

SUMMARY OF FINDINGS, ASSUMPTIONS AND CHALLENGES AND FUTURE SCHEDULE

Based on the results of the visit and information reviewed to date, following are a few of the primary findings, assumptions and challenges identified, as well as the planned schedule for remaining efforts:

- **Qabatya (Task Order 17):**
    - The longitudinal cracks in the roadway appear to be shear embankment failure related. Possible contributing factors include overall embankment stability of the initial design, drainage along the embankment toe, contractor compliance with sub-base preparation, embankment materials and compaction, and embankment slope ratios. In order to determine how much each factor contributed, the expat will need to review the following additional documents:

        - Report and Study commissioned by Contractor to be delivered to expat next week.
        - GeoTest to complete boring and material samples.
        - GeoTest to complete embankment and geotechnical calculation of the initial design, and constructed embankment based on borings and material samples.
    - Upon receipt of the Contractor study and GeoTest result, expat will submit a Root Cause Analysis report and recommended remedial actions, if needed. Target for completion of this report is five (5) weeks.

- **Wadi Al-Nar (Task Order 37):**
    - The road failure is related to a shear embankment failure of the slope near station 0+380. Possible contributing factors include the stability of the initial design and sub-base preparation required in the design, drainage culvert and revetment design, and contractor compliance with sub-base preparation and embankment construction. Expat shall submit report upon receipt and review of the following additional documents:
        - GeoTest borings and material sampling report.
        - GeoTest embankment stability analysis and recommendation.
    - Target for completion of Root Cause Analysis report is five (5) weeks.

- **Rawabi City (Task Order 51)**
    - The road failures are alligator cracks in nature and represent base failure. Probable cause of failure appears to be excessive moisture of the base and sub-base caused by lack of drainage, drainage protection, and grades and slopes that direct water run-off to the failure locations. Final report shall be submitted by expat upon receipt and review of the following:
        - GeoTest borings and material sampling report
    - Target for completion is two (2) weeks.

- **Dura Pipe Trench (Task Order 45)**
    - Expat issues the following observations and recommendations:
        - The pavement design for the main road requires the contractor to install 10 cm of asphalt pavement, and CMC and Mission should not approve a variance to reduce the thickness to 5 cm to match existing.
        - CMC recommendation to install the first 5 cm of asphalt pavement well in advance of final pavement should be a standard practice.
            - Installation of an initial pavement layer allows traffic to use the road and helps speed up settlement of the trench, thereby reducing potential for settlement of the final top layer of asphalt.
            - Installation of an initial pavement layer helps stabilize the existing roadway and reduces block cracking and pavement failure of the existing roadway, thereby reducing patching needed outside the original trench.
        - Whenever two layers of asphalt can be paved, attempt to offset the construction joint of the two layers by milling a straight joint for the final top layer of asphalt slightly wider than the bottom layer of asphalt.
        - Whenever possible, prevent the construction joint from being aligned with the expected wheel-patch of vehicles.
        - Expat observed many trench pavement sections throughout the West Bank and noticed settlement of the trenches, with loss of cohesion between the old roadway and the patch. CMC personnel should make sure all cold joints are clean and well coated with a tack coat to ensure a good bond.

        - Some discussion was observed by expat concerning use of concrete in trench backfills to offset settlement. Installing a rigid base and sub-base treatment under flexible pavement should be avoided since it will result in reflective cracks and differential settlement.

- **Nuba (Task Order 50):**
    - Longitudinal cracks in roadway are evidence of embankment shear failure. However, the stone walls where the cracks occur appear to be stable at this time. These local roads were unpaved prior to the project, but now a mostly impermeable section has been added on top, with permeable layers exposed on the outer shoulder adjacent to the stone walls holding up the terrace.
        - Pavement and shoulders where cracks occurred should be removed and re-paved. Remediation should include removing the base course and re-scarifying and compacting the sub-base. Drainage protection should be added to the outer shoulder, in particular at low points where water discharges to the lower terrace and/or where water is discharged from an upper terrace. Care needs to be taken that locations where water is released to a lower terrace do not discharge water at the base of the stone supporting walls under the roadway, but instead are directed away from the base of these walls.
        - Contractor should be compensated for all work, except for repairs between station 0+000 and 0+050. Warranty determination should await inspection of the sub-base to determine if the failure occurred within or below the specified scarification and compaction layer.

- **Dier El Hatab and Salem Internal Roads (Task Order 50):**
    - Longitudinal cracks in roadway are of sufficient width that they need to be remediated. The local roads received a relatively thin section of pavement and base course but are not exhibiting extensive failures that point to additional roadway pavement and base thickness being required along the entire length. Recommendation for remedial actions and for future consideration include:
        - Pavement where cracks occurred should be removed and re-paved. Remediation should include removing the base course and re-scarifying and compacting the sub-base. With regard to IRD's claim that they are not responsible for the cracks near 2+600 to 2+700, IRD should make the repair, and if the ground under the sub-base reveals failure, then the resident engineer should be alerted and determine how much additional excavation and base course is required. If not, the work should be considered warranty work.
        - In general, any pavement repair that can be attributed to base or sub-base failure and not pavement failure (loss of cohesion, poor finish, sliding, etc.) needs to involve removal and re-application of the sub-base and base treatments.
        -

- **Roadway Design Manual**
    - A more detailed scope of work/effort shall be submitted as a separate document regarding the effort by MoPWH to establish its own design and maintenance manuals for roadway construction. It is important to establish standards that reflect local means and methods and technical resources. The inclusion of outside references such as, for example, Jordanian Specifications, AASHTO, ASCE, ANSI, IEEE is usually recommended. However, conflicts can arise when local standards and outside standards are not updated

simultaneously and must be carefully managed. Expat therefore recommends the following course of action going forward:

- Review of Design and Maintenance Manuals prepared by the MoPWH
- Review of Jordanian Specifications (currently in use on West Bank projects)
- Review of US reference documents such as specifications by The Federal Highway Administration, State Highway Departments (Louisiana Department of Transportation, for example), and local municipal standards (City of New Orleans, for example).
- Interview MoPWH staff to determine what level of effort is planned for the maintenance, up-keep, and revising of the Design and Maintenance Manuals.
- Prepare a preliminary report initially focusing on the structure of the MoPWH Design and Maintenance Manual and comparing it to reference documents.
- Prepare presentation for Mission and MoPWH on preliminary report.

- **Initial Study for Maintenance Management System:**
  - The efforts associated with the Maintenance Management System were outlined in the scope of services recently approved by the Mission. The GIS-based maps and asset inventory developed by PACE establish an excellent foundation upon which to develop a maintenance program and formal asset management system for roads under MoPWH jurisdiction. The next steps to a successful maintenance management system include:
    - An expansion of the GIS licenses and resources available to MoPWH, as well the introduction of GIS-compatible systems, which are now fairly widely available.
    - Reviewing MoPWH crews in the field performing day-to-day tasks.
    - Reviewing MoPWH contracts related to maintenance type work in the field.
    - Preparing a report on MoPWH self-performance ability and use of contract resources, with a specific focus on typical roadway needs.

Expat compiled this memorandum based on the recent visit to the West Bank and data currently available. Comments, opinions, or suggestions by Mission staff or others are welcomed and will be incorporated into the final reports that are submitted for each roadway under assessment. Expat is anticipated to return to the West Bank in the next 4-6 weeks, unless circumstances require an earlier return.

cc: C. Decker, BV
S. Mansour, Trigon
G. Kolenovsky, Trigon

Representative Photographs from Roadway Site Visits

Wadi Al Nar: Minor Separation of Embankment away from 0+380

Wadi Al Nar: Light Pole on Embankment Shifting with Embankment

Wadi Al Nar: Curvature in Culvert at 0+380

Wadi Al Nar: Crescent-Shaped Shear Embankment Failure

Rawabi: Checking Depth of Base

Rawabi: Moist Base/Sub-base under Failed Section

Qabatya: New Longitudinal Crack in Roadway

Qabatya: Longitudinal Crack in Shoulder next to Remediation Work

Qabatya: Lateral Movement of Stone Boulders Previously used to Stabilize Road

Qabatya: Longitudinal Crack in Embankment Previously Stabilized by Stone Boulders

5.0 Appendix B: Structural Design Evaluation for Qabatya

The attached letter from the ICGES documents the adequacy of the original structural design for the Qabatya roadway.

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FOR GEOTECHNICAL & ENGINEERING STUDIES

مختبـــرات
المركـــز الـــدولي
للـــدراسات الهنـــدسية والجيولوجية

Date: May 16th, 2012 *No.:102/2012*

To:
Black & Veatch
Ramallah, Palestine
Attn:
Eng. Robert Mendoza
Eng. Adnan Azazmah

SUBJECT: Evaluation Report for
Qabatya-Zababdah-Alkufeir-Tubas Road *Project*

Dear Sirs:

Regarding the above mentioned project, I would like to inform you that the structural design of the four areas was checked and the design is satisfactory using all the available data. Because of that no report was submitted. I counted only 600$US instead of 1600.

I would like to thank you for your confidence and look forward to further cooperation in the near future.

Respectfully Submitted,
M. Alsayyed
Dr. Mohammad Alsayyed, PhD, PE
Director General

المركز الدولي للدراسات الهندسية والجيولوجية
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6.0 Appendix C: Stone Wall Stability Evaluation for Qabatya

The attached report from the ICGES documents the stability evaluation for stone retaining walls along the Qabatya roadway.

STONE WALLS STABILITY EVALUATION
FOR
Qabatya-Zababdah-Alkufeir-Tubas Road
Jenin - Palestine

Date: May 12th, 2012 *No.:Road/03/2012*

To:
Black & Veatch
Ramallah, Palestine
Attn:
Eng. Robert Mendoza
Eng. Adnan Azazmah

SUBJECT: Evaluation Report for Stone Wall
Stations (0+280 to 0+450 and 3+120 to 3+210)
Qabatya-Zababdah-Alkufeir-Tubas Road *Project*

Dear Sirs:

You can find herein the report of our stability evaluation report for the above-mentioned project.

This report includes, the analysis of the stone retaining wall and recommendations needed to stabilize it.

In the event that additional information or clarifications are needed, please don't hesitate to contact us at your earliest convenience.

I would like to thank you for your confidence and look forward to further cooperation in the near future.

Respectfully Submitted,

M. T. Alsayyed, Ph.D., P.E.
Director General

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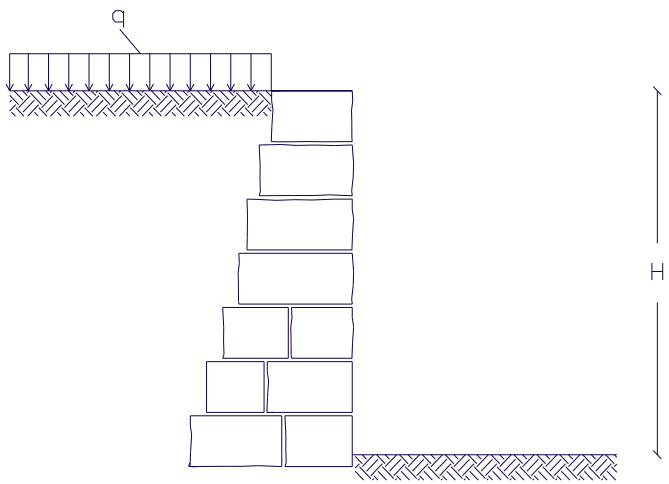
1.0 INTRODUCTION

The project is a road of about 6 kilometers comes from Qabatya in Jenin Governerate to Tubas. The road was constructed by ApcoArCon in 2010. At the begining of the road at station 0+280 to 0+450 and 3+120 to 3210, a stone wall was built of big stone blocks stacked over each other to support the side of the embankment. No design is available for the stone wall. Some movement was noticed in the shoulder and some cracks happened in the asphalt pavement itself. Black & Veatch contracted the International Center for Geotechnical & Engineering Studies (ICGES) to study the case and issue recommendations for solution.

The wall was treated as gravity retaining wall. The stability of the wall was investigated by determining the factor of safety for the different failure criterias; overturning, sliding, and bearing capacity.



Section in Stone Wall

2.0 ANALYSIS OF THE WALL (0+280 to 0+450)

The wall is loaded from active side only. No backfill is placed at the passive side of the wall. In analysis, the following loads will be acting on the wall:

- Active earth pressure force that is due to the earth pressure and the surcharge load. These forces acting horizontally, E_a.
- The weight of the wall itself which acts downwards, W.

The wall dimensions are as follows:

The height is about 4.0 meters

The width of the wall at the top is about 1.0 meter.

The width of the wall at the bottom is assumed 2.0 meters.

Two cases are investigated; the first when there is no surcharge and the second when there is surcharge load.

A. No surcharge Case:

$E_a = 0.5\gamma H^2 K_a$

$K_a = K_a = (1-\sin \Phi) / (1 + \sin \Phi)$

Take Φ=30, then K_a = 0.33

E_a = 0.5*2.2*4*4*0.33 = 5.87 t/m

Weight of the wall, W1 + W2 where W1 is the triangle part weight and W2 is the rectangular weight. Taking the unit weight of the stone blocks 2.6 t/m^3

W1 = 0.5*(2-1)*4*2.6 = 5.2 t/m

W2 = 1*4*2.6 = 10.4 t/m

W3 = the weight of fill over the inclined interior part of the wall. Taking the moist unit weight is 2.2 t/m^3 = 0.5*(2-1)*4*2.2 = 4.4 t/m

Check of overturning:

Overturning Force is Ea = 5.87 t/m

Overturning moment = Ea*H/3 = 5.87*4/3 = 7.83 t.m/m

Overturning resisting moment = W2(2-1)/2 + W1*(1+(2-1)/3)+W3*(1+2*(2-1)/3)

= 10.4*0.5+5.2*(1+.33)+4.4*(1+.67)

= 19.46 t.m/m

FOS = Overturning Resisting moment/ Overturning Moment

= 19.46/7.83 = 2.5 >1.5 OK

Check of sliding:

Sliding Force is Ea = 5.87 t/m

Sliding resisting force is the vertical weights multiplied by the adhesion between soil and base = (W1+W2+W3)* adhesion = 20*.4 = 8.0 t/m

FOS = Sliding Resisting force/ Sliding force

= 8/5.87 = 1.36 accepted but it should be >1.5.

Check for bearing capacity:

Vertical weight of 20 tons and wall width about 2 meters means bearing capacity of 1.0 kg/cm^2 which is much higher than the bearing capacity for such soil.

A. With surcharge Case, q=ton/m^2:
   It is logic that the addition of surcharge will take the wall more towards the unsafety state. It is expected to have the sliding and bearing capacity stabilities unsafe.
   It is requested to bring the wall to the safe side to increase the width of the wall or to a height of 2 meters or have a passive side fill.

   Analysis with the same above procedure and with increasing the wall width by additional 2 meters to a height of 2 meters will yield the following safety factors:

   Overturning becomes much higher than before which was very safe.
   Sliding safety factor will become 1.8>1.5 which is ok.
   Bearing capacity will become about 0.5 kg/cm2 and this is also accepted and conservative.

3.0 ANALYSIS OF THE WALL (3+120 to 3+210)

The wall is loaded from active side only. Some nonuniform shallow backfill is placed at the passive side of the wall. In analysis, the following loads will be acting on the wall:

- Active earth pressure force that is due to the earth pressure and the surcharge load. These forces acting horizontally, E_a.
- The weight of the wall itself which acts downwards, W.

The wall dimensions are as follows:

The height is about 1.0 meters
The width of the wall at the top is about 1.0 meter.
The width of the wall at the bottom is assumed 2.0 meters.

Two cases are investigated; the first when there is no surcharge and the second when there is surcharge load.

C. No surcharge Case:

$E_a = 0.5\gamma H^2 K_a$

$K_a = K_a = (1-\sin \Phi) / (1 + \sin \Phi)$

Take Φ=30, then K_a = 0.33

E_a = 0.5*2.2*1*1*0.33 = 0.37 t/m

Weight of the wall, W1 + W2 where W1 is the triangle part weight and W2 is the rectangular weight. Taking the unit weight of the stone blocks 2.6 t/m^3

W1 = 0.5*(1.5-1)*1*2.6 = 0.65 t/m

W2 = 1*1.0*2.6 = 2.6 t/m

W3 = the weight of fill over the inclined interior part of the wall. Taking the moist unit weight is 2.2 t/m^3 = 0.5*(1.5-1)*1*2.2 = 0.55 t/m

Check of overturning:

Overturning Force is Ea = 0.37 t/m

Overturning moment = Ea*H/3 = 0.37*1/3 = 0.12 t.m/m

Overturning resisting moment = W2(1.5-1)/2 + W1*(1+(1.5-1)/3)+W3*(1+2*(1.5-1)/3)

= 2.6*0.25+0.65*(1+.167)+0.55*(1+.333)

= 2.25 t.m/m

FOS = Overturning Resisting moment/ Overturning Moment

= 2.25/0.12 >>>1.5 OK

Check of sliding:

Sliding Force is Ea = 0.37 t/m

Sliding resisting force is the vertical weights multiplied by the adhesion between soil and base = (W1+W2+W3)* adhesion = 3.8*.4 = 1.52 t/m

FOS = Sliding Resisting force/ Sliding force >>1.5

This proves that the stability of the base regarding the change in water content which could flucuate as water is allowed to run by the wall and the natural soil slope towards the embankment and not away from it.

Check for bearing capacity:

Vertical weight of 3.8 tons and wall width about 1.5 meters means bearing capacity of 0.25 kg/cm^2 which is much very much reasonable.

4.0 CONCLUSIONS & RECOMMENDATIONS

As a result of this evaluation study and after analyzing the two cases, the first wall is unstable in two criterias; sliding and bearing capacity. It is recommended that another two rows of stone blocks to be added in front of the current wall or have passive fill in front of it to aheight of about 2.0 meters.

The second shallow wall is stable except in change in the water content which permits the soil to swell and shrink.

For Both cases, water should be directed away from the walls. Additional pile foundations can be installed to carry the walls' foundations to deeper strata. Design can be made available free of charge if a decision is taken.

7.0 Appendix D: Geotechnical & Structural Evaluation for Qabatya

The attached report from the ICGES documents the geotechnical and structural evaluation for the Qabatya roadway.

GEOTECHNICAL & STRUCTURAL EVALUATION
FOR
Qabatya-Zabadeh-AlKufeir-Tubas Road
Submitted to
BLACK & VEATCH

Date: May 11th, 2012 *No.:Road/02/2012*

To:
Black & Veatch
Ramallah, Palestine
Attn:
Eng. Robert Mendoza
Eng. Adnan Azazmah

SUBJECT: Evaluation Report for
Qabatya-Zababdah-Alkufeir-Tubas Road *Project*

Dear Sirs:

You can find herein the report of our structural evaluation report for the above-mentioned project.

This report includes, review of existing documents related to the project, the results of the laboratory tests, analysis and recommendations for the correction measure to be taken for the problems in the road.

In the event that additional information or clarifications are needed, please don't hesitate to contact us at your earliest convenience.

I would like to thank you for your confidence and look forward to further cooperation in the near future.

Respectfully Submitted,

Dr. Mohammad Alsayyed, PhD, PE
Director General

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APPENDIX (A)

TEST RESULTS FOR THE FILL & SUBGRADE

1. *Moisture Content Test Report*
2. *Unconfined Compression Test*
3. *Direct Shear Test*
4. *Atterberg Limits Determination*
5. *Test Report for Soil Classification*

APPENDIX (B)

TEST RESULTS FOR ASPHALT PAVEMENT

1. *Testing Bituminous Paving Mixture Report*

APEENDIX (C)

TEST RESULTS FOR THE BASE COURSE

1. Modified Proctor (Compaction)
2. Atterberg Limits Determination
3. California Bearing Ratio
4. Field Density of Soil Test Report (Sand Cone Method)
5. Sieve Analysis of Base Course

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

The project is a road of about 6 kilometers comes from Qabatya in Jenin Governerate to Tubas. The road was constructed by ApcoArCon in 2010. The area which the road passes through is mostly agriculture area. The nature of soil in most of the road stations is clay or sandy clay or clayey sand. Designs were made by Diyar Consultants engineering office in Ramallah. The design requested a rock fill layer of 40 cms underneath the asphalt and the base course layers. Several stations of the road suffered cracks and settlements. Efforts were exerted to identify the problem causes in order to fix the problem correctly. The consultant in charge is Black & Veatch who took the place of MWH (the consultant at time of construction of this project) contacted the International Center for Geotechnical & Engineering Studies (ICGES) for the purpose of structural evaluation of the road.

1.2 PURPOSE OF STUDY

The purpose of this study is to indentify the causes of the defects occured in the pavement at early stage after construction.

1.3 SCOPE OF WORK

The scope of work included as requested by our client and summarized in the following table:

Boreholes and test pits will be made as follows:

Area	Station	# of Boreholes	Borehole Depth	Total Depth per station	Testing of Boreholes	Test Pits	Test Pits Depth	Asphalt Cores	Asphalt Tests
1	0+280	1 @ each side @ each station	7	14	Layer thickness, soil classification, moisture content, shear parameters when applicable. Description of the samples obtained	2 @ each area	From GS to Top of Rock fill or natural soil. Test for type of base course, layer/s thickness, proctor, gradation, atterberg limits and plasticity index, degree of compaction, field density, degree of compaction of base course, CBR	1 @ each side @ each station (only in shoulders as per your request, if unpaved no cores) to get the degree of compaction for the asphalt	1 plate sample at each area @ either side to be tested for bitumen content, aggregate gradation, flow and stability, air voids, specific gravity, GMM
	0+360		5	10					
	0+450		5	10					
2	2+610		5	10					
	2+700		5	10					
	2+320		5	10					
	2+430		5	10					
3	2+780		5	10					
	2+870		5	10					
4	3+120		5	10					
	3+210		5	10					
	3+290		5	10					

Analysis includes:

1. Review of the design report, geotechnical report, Al Najah University report and diyar.
2. Description of the current situation regarding cleaning of ditches, culverts and water drainage near the embankment.
3. Perform the needed analysis as per our test results regarding the stability and sufficiency of the design.
4. Perform slope stability analysis for each of the areas using geotechnical software package.
5. Present conclusions and recommendations regarding to any deficiency, and the needed remedial and/or precautional measures to be adopted.

2.0 FIELD INVESTIGATION

2.1 BOREHOLES

Twenty four boreholes were drilled at both sides of the road to the depths shown in the next table. Samples were obtained at different levels from each borehole and tested for their physical and mechanical properties.

Borehole no.	Station	Elevation	Drilled depth(m)
BH1R	0+280	295.988	5.5
BH2R	0+360	296.610	7
BH3R	0+450	297.240	5
BH4R	2+320	308.690	5
BH5R	2+430	309.190	5
BH6R	2+610	308.830	5
BH7R	2+700	309.120	5
BH8R	2+780	309.520	5
BH9R	2+870	309.970	5
BH10R	3+120	311.220	5
BH11R	3+210	311.670	5
BH12R	3+290	312.070	5
BH1L	0+280	295.988	5
BH2L	0+360	296.610	5
BH3L	0+450	297.240	5
BH4L	2+320	308.690	5
BH5L	2+430	309.190	5
BH6L	2+610	308.830	5
BH7L	2+700	309.120	5
BH8L	2+780	309.520	5
BH9L	2+870	309.970	5
BH10L	3+120	311.220	4
BH11L	3+210	311.670	5
BH12L	3+290	312.070	5

2.2 TEST PITS

Eight test pits were made two on each side in each of the four areas. At each of the test pits, asphalt slabs were cut and the asphalt mix was tested for its bitumen content, gradadtion, stability and flow. The following table shows the locations of these test pits:

TEST PIT #	1	2	3	4	5	6	7	8
Station	0+280	0+280	2+340	2+430	2+610	2+780	3+113	3+290
Side	R	L	R	L	L	R	L	R

2.3 TAKING ASPHALT CORES & TEST PITS

Twenty four core samples were taken from places near the boreholes. The cores were tested for degree of compaction and layers thicknesses. The following table shows the locations and thicknesses of each of these cores.

BOREHOLE #	Station	Total thickness of core (cms)	Notes
1R	0+280	11	2 Layers
1L	0+280	8	2 Layers
2R	0+360	7	1 Layer
2L	0+360	6	1 Layer
3R	0+450	6.7	1 Layer
3L	0+450	6.2	1 Layer
4R	2+320	6.2	1 Layer
4L	2+320	5.5	1 Layer
5R	2+430	6.8	1 Layer
5L	2+430	6	1 Layer
6R	2+610	7.6	1 Layer
6L	2+610	12.2	2 Layers
7R	2+700	8	1 Layer
7L	2+700	12.7	2 Layers
8R	2+780	7	1 Layer
8L	2+780	12.9	2 Layers
9R	2+870	7.6	1 Layer
9L	2+870	13.7	2 Layers
10R	3+120	6.7	1 Layer
10L	3+120	6	1 Layer
11R	3+210	6.5	1 Layer
11L	3+210	7	1 Layer
12R	3+290	6.5	1 Layer
12L	3+290	6.4	1 Layer

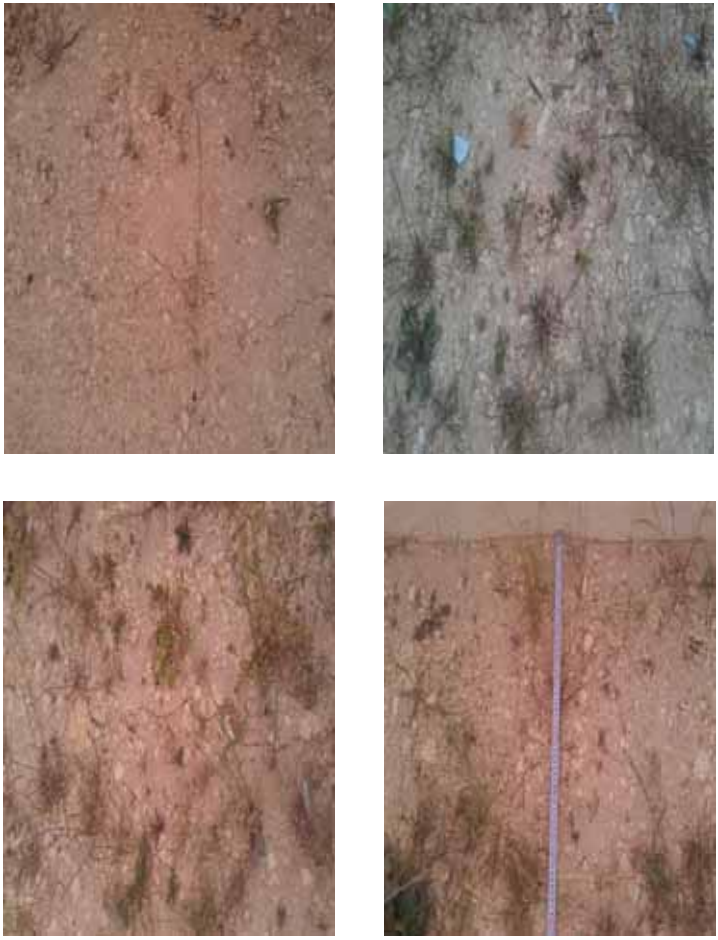
2.4 PAVEMENT VISUAL SURVEY

The survey process took place through several visits to the site.

The following table summarize the condition of the existing shoulder:

Area	From Station	To Station	Right Side	Left Side
Area 1	0+280	0+450	A separation started between the stone wall and the shoulder material (pictures attached)	Ditches are not clean, trees have been planted in the course of water ditch and dirt is left to close the path of water.
	0+300	0+312	Cracks in shoulder itself away from the stone wall (pictures attached)	
	Several spots		Water collects at some spots in the shoulder area as the shoulder is uneven	
			Unpaved shoulder width is 2.8 to 3.0 meters width	Unpaved shoulder width is 60 cms
Area 2	2+430			Ahoulder is open most of the way except at the location of dumping the marble factories slurry waste
Area 3	2+610			Shoulder cracks longitudinal away from stone wall about 60 to 110 cms

Pictures show separation of shoulder from stone wall 0+280 to 0+450



Pictures show cracks in Base Course shoulder away from the stone wall 0+300 to 0+312

The following table describes the traffic lane pavement condition:

Area	From Station	To Station	Right Side	Left Side
Area 1	0+380	0+430		Alligator cracks under the outside wheel path
Area 2	2+435	2+440		Alligator cracks under the outside wheel path
	2+460	2+465		Longitudinal cracks in the asphalt near the centerline
Area 3	2+610	2+730	Longitudinal cracks in the asphalt, parts of it are sealed	
	2+770		Slippage in the asphalt	
	2+805		Slippage in the asphalt	
	2+780	2+870		Popouts
Area 4	3+120	3+160	Longitudinal crack	
	3+210		Slippage failure start	
	3+270	3+290	Popouts	Popouts

Slipping of asphalt at station 3+210

Allegator cracking at station 2+435 to 2+440

3.0 REVIEW OF AVAILABLE DESIGNS AND REPORTS

3.1 DESIGN REPORT BY DIYAR CONSULTANTS CO.

The design was prepared by Diyar Consultants using AASHTO design procedure. The designer conducted traffic cout for two days of twelve hours each. The designer concluded that according to the traffic and the geotechnical soil investigation results, the pavement section requires 6 cms asphalt, 40 cms granular base course and 40 cms rockfill. No recommendation regarding the method of dealing with the rock fill or any limitations stated in the design report.

3.2 GEOTECHNICAL REPORT BY HIJAWI CENTER

The geotechnical investigation report was prepared by Hijjawi Construction Labs. Twenty three test pits were dug in the site at the stage of preparation for design to subsurface investigate the whole road (about 6 kms). According to the report, most of the soil was found to be silty clay with a possibility of volume change due to the high plasticity. No test results are attached with the report, so it was not possible to judge the data. However, in soil classification the engineer classified some of the soils as silty clays while they have less than 50% passing #200. That might have not affected his recommendations for the designer. In all the test pits, the silty clay material was encountered except in TP7RS and TP8RS.

The geotechnical report recommended that water (surface or groundwater) should be controlled so that it doesn't discharge onto cut slopes, ditches should be constructed and culverts should be built were needed.

3.3 AL-NAJAH UNIVERSITY REPORT

The contractor contracted Al-Najah University to evaluate the road stations 2+540 to 3+200. The report investigated the types of defects that exist in this section by taking samples from asphalt only and tested them in the university labs. The number of marshall test specimens was inadequate. The evaluation process took place after the contractor had overlain some parts of the target section, while the pictures showed several locations of cracks in the asphalt as well as in the shoulders.

In reviewing the report, it is clear that the defects were treated in this section and the situation became better. The severity of the defects didn't appear again. However, the recommendations

stated in the report were not followed completely. Most important of these recommendations are the control of water drainage and the milling of the old layer before being ovelain by a 4 cms asphalt layer. The report investigated the asphalt properties and concluded that the low % of air voids and thus the low specific gravity could have contributed to the slippage cracking but they are not major at this very early stage of the road life. Water due to pipe line leakage or rain water collected and not drained near the road is the cause for the other cracking problems.

No investigation about the properties of other materials is included in the report.

3.4 DIYAR CONSULTANT REPORT FOR MAINTENANCE

The report just listed with sections' drawings of the stations were overlay, milling or reconstruction were applied. It tells that about 6000 m2 of the road was treated in several stations from 0+220 to 3+270.

The following table showed the stations where maintenance took place in 2011;(extracted from Diyar Consultants report):

No	Station		Side	Area (m2)	Remarks
	From	To			
1	0+220	0+280	Full	673	Milling & Overlay
2	0+280	0+340	Full	674	Milling & Overlay+R
3	0+630	0+665	Full	392	Milling & Overlay
4	0+665	0+720	R.H.S	308	Milling & Overlay+R
6	2+300	2+370	Full	783	Milling & Overlay
7	2+435	2+470	Full	400	Milling & Overlay
8	2+544	2+557	Full	257	Milling & Overlay
9	2+580		L.H.S	2	Patching Works
10	2+595	2+705	L.H.S	902	Milling & Overlay+R & Boulders
13	2+705	2+890	L.H.S	373	Reconstruction & Boulders
16	2+915	2+950	L.H.S	196	Milling & Overlay
17	2+990	3+030	R.H.S	227	Milling & Overlay
18	3+120	3+165	L.H.S	142	Milling & Overlay +R & boulders
19	3+160	3+250	R.H.S	456	Milling & Overlay
21	3+270	3+290	L.H.S	61	Milling & Overlay

Notes :

1. Milling & Overlay Asphalt 4cm
2. Reconstruction :- Remove and replace asphalt and (2) base course layers
3. R :- Remove and replace asphalt and (2) base course layers along the longitudinal cracks.

4.0 SITE DATA COLLECTION

Reliable evaluation of newly constructed road requires the collection and analysis of key data for the pavement. Such data are categorized as follows:

1. Historic data collection (records review)
2. Pavement design.
3. Pavement shoulders conditions.
4. Traffic lane pavement condition
5. Past maintenance activities.
6. Drainage adequacy.

Overall pavement condition and problem definition can be determined by evaluating the following major aspects of the existing pavement:

- Structural adequacy (load related).
- Slope stability of sides and stability of stone walls.
- Materials used and their compliance with specifications used.
- Drainage adequacy.
- Shoulder condition.
- Type and extent of maintenance activities performed in the past.

4.1 HISTORIC DATA COLLECTION

- The design was made by Diyar Consultants in 2009 and As-Built in 2011.
- The project was done by ApcoArCon Construction & Services in 2010.
- Maintenance activities took place in 2011 as some sections in the road found to be defected, a report by Diyar Consultants was issued to show places where asphalt batches were used to correct the defected areas.
- An-Najah National University was contracted by the contractor and issued a report regarding the defects in the road.

4.2 PAVEMENT DESIGN

As mentioned, the design was made ready in July 2009 by Diyar Consultants. The designer conducted traffic counting for two days and used AASHTO design procedure for the cross section design.

Geotechnical parameters were used according to soil investigation conducted by Hijjawi Center. The designer found out that three layer are needed for the section under investigation (Asphalt = 6.0cm, Base coarse = 40.0 and Rock fill layer = 40.0cm.

4.3 SHOULDER CONDITION

The previuos table describes the shoulder condition.

4.4 TRAFFIC LANE PAVEMENT CONDITION

The previous table describes the traffic lane pavement condition.

4.5 PAST MAINTENANCE ACTIVITIES

The maintenance which took place is shown in the table in the previous section.

4.6 DRAINAGE ADEQUACY

The following table shows the drainage condition at each of the studied areas:

Area	From Station	To Station	Right Side	Left Side
Area 1	0+280	0+450	No ditches, 4.0 meters high stone wall is built at this side over the clay soil, water collects close to the wall	There is a ditch, water drainage is interrupted by some dirt closures made by people planting trees along the road side; so drainage is insufficient and water bonds buit up between each two trees
Area 2	2+320	2+450	Ditch needs to be cleaned	Unpaved shoulder is variable from about 2 meters to about 5 meters away from the paved road. Natural ground is lower than pavement by about 50 cms with very low or no slope
Area 3	2+595			The culvert west wall at the intersection is in failure condition. The wall is cracked, the wall is pulging, movement in pipes that crosses the main road, deflection of asphalt above the culvert
	2+610 to 2+870		water collects and water path is interrupted by secondary farmers entries to their farms	Stone wall of 0.8 to 1.1 meters height was built at the sight. Passive natural ground slope is towards the wall and not away from it
				water collects close to the body of the pavement

Pictures show ramps built on the road side and interrupt the water drainage

5.0 LABORATORY TESTING

1. Drilling of 24 borholes with depths mostly 5 meter. This depth was chosen based on the current road elevations compared with the-before-construction elevations to make sure that in all situations the original ground was reached and exceeded. Drilling was conducted in the period from April 5th, 2012 to April 9th, 2012. Efforts were exerted to obtaion undistrubed sample with no success. This is due to the type of materials which compose the soil profile (asphalt,base course, rockfill and original brown soil). Four types of drilling tools were used (Core, DTH, Drill bit and Auger). No SPT was possible to use.

   Due to the nature of material that was encountered, especialy the rock fill, obtaining a core was not possible. The air pressure of the compressor was lost in the rockfill voids and cavities.
   However, core samples were obtained form the underneath brown soil.
2. A total number of 8 test pits were dug at both sides of the assigned four areas. The purpose was to determine the layers' thicknesses, obtain asphalt and base course samples for testing and measure the degree of compaction.
3. A total number of 16 field density points for each of the two base course layers were taken to measure the degree of compaction.
4. 24 asphalt cores were obtained close to shoulder area. These cores were to verify the asphalt thickness and the degree of compaction.

5. Soil samples were obtained from the boreholes. Disturbed samples were obtained using a solid stem auger. It was not possible to get representing values for SPT due to the gravel portion existing in the top soil. Shelby tube was not used also for the same reason. Down the hole hammer and fish tail roll bit were used in order to advance the boring. Some cores were obtained from the clay soil below the pavement. The recovered samples were examined, labeled, described and classified by the geotechnical engineer. Samples were identified according to project name and or number, borehole number and depth, encased in polyethylene plastic bags and transported to the laboratory to be tested. Water level observations were made during the boring operations and the results are noted on the boring logs.

A field log was prepared for each boring. Each log contained information concerning the boring method, indications of the presence of various materials such as silt, clay, gravel or sand and observations of ground water. The boring logs are included in Appendices.

The following tests were performed on samples obtained from the boreholes as well as the test pits for asphalt, basecourse and subgrade materials as applicable:

Type of Tests	*Standards*
1.Natural Moisutre Content	*ASTM C 566*
2.Grain Size Analysis	*ASTM C 136*
3.Atterberg limits & Plasticity Index	*AASHTO T89&90*
4.Modified proctor	*AASHTO T180*
5.California Bearing Ration CBR	*ASTM D 1883*
6.Soil Classification	*AASHTO M 145*
7.Field Density	*ASTM D 1556*
8.Obtain core Samples	*ASTM 3549*
9.Density of Core Samples	*AASHTO T166*
10.Asphalt Extraction	*AASHTO T164*
11.Gradation of Asphalt Mixture	*ASTM C 136*
12.Maximum Theoretical Specific Gravity of Asphalt Mixture	*AASHTO T209*
13.Marshall Tests for Samples	*AASHTO T245*

The results of the tests performed on the different materials are summarized in the following tables while the detailed test reports are shown in the appedices:

Water Content, Thicknesses & Degree of Compaction for Base Course

Slab	Station	Location	Layer	Water Content (%)	Thickness (cm)	Degree of ompaction (%)
1	0+280	1R	1st Layer	3.9	23	97
			2nd Layer	3.6	24	96
		1L	1st Layer	3.9	23	102
			2nd Layer	4.0	17	97
2	0+360	2R	1st Layer	3.6	30	96
			2nd Layer	5.2	15	97
		2L	1st Layer	4.7	28	95
			2nd Layer	4.5	13	96
3	0+450	3R	1st Layer	4.5	20	95
			2nd Layer	4.0	22	98
		3L	1st Layer	5.0	26	95
			2nd Layer	3.6	16	96
4	2+340	4R	1st Layer	4.5	32	95
			2nd Layer	3.6	27	97
5	2+430	5L	1st Layer	4.8	27	96
			2nd Layer	3.1	16	100
6	2+610	6R	1st Layer	5.9	18	97
			2nd Layer	6.4	21	100
7	2+700	7L	1st Layer	4.1	24	101
			2nd Layer	4.2	23	95
8	2+780	8R	1st Layer	2.7	20	100
			2nd Layer	5.4	24	101
9	2+870	9L	1st Layer	4.3	21	97
			2nd Layer	3.6	18	95
10	3+118	10R	1st Layer	4.8	20	102
			2nd Layer	5.6	21	98
	3+113	10L	1st Layer	5.1	22	95
			2nd Layer	2.7	20	101
11	3+210	11L	1st Layer	5.5	18	97
			2nd Layer	4.1	23	98
12	3+290	12R	1st Layer	6.4	35	95
			2nd Layer	6.4	10	97

CBR & Mod. Proctor for Base Course

Pit	Station	Location	Layer	Mod. Proctor		CBR	
				γ_d max.	$W_{opt.}$	2.5	5
1	0+280	1R	1st Layer	2.23	7.2	90	93
			2nd Layer	2.23	7.2	46	85
		1L	1st Layer	2.23	7.2	90	93
			2nd Layer	2.25	6.3	65	92
2	0+360	2R	2nd Layer	2.16	8.5	14	16
3	2+340	4R	1st Layer	2.23	7.2	57	73
			2nd Layer	2.23	6.8	57	73
4	2+430	5L	1st Layer	2.23	7.2	90	93
			2nd Layer	2.25	7.0	72	125
5	2+610	6R	1st Layer	2.23	7.2	90	93
			2nd Layer	2.23	7.2	46	85
6	2+700	7L	1st Layer	2.23	7.2	90	93
			2nd Layer	2.23	7.2	90	93
7	3+113	10L	1st Layer	2.23	7.2	90	93
			2nd Layer	2.23	7.2	58	95
8	3+290	12R	1st Layer	2.23	7.2	90	93
			2nd Layer	2.17	7.0	29	43

Sieve Analysis & Atterberg Limits for Base Course

Slab ID.	Station	Location	Layer	Sieve Analysis ASTM C136-2006										Atterberg Limits AASHTO T89-10 / T90-10		
				2" (%)	1 1/2" (%)	1" (%)	3/4" (%)	1/2" (%)	3/8" (%)	#4 (%)	#10 (%)	#40 (%)	#200 (%)	LL (%)	PL (%)	PI (%)
1	0+280	1R	1st Layer	100	95	79	69	54	56	33	22	13	9	17.6	15.8	1.8
			2nd Layer	100	94	90	82	69	62	49	38	25	18	21.5	17.3	4.3
2	0+280	1L	1st Layer	100	89	79	72	58	50	37	27	17	12	19.9	16.0	3.9
			2nd Layer	100	82	75	62	54	42	31	21	12	8	18.0	16.1	1.9
3	0+360	2R	2nd Layer	100	98	90	82	75	71	60	49	36	28	26.2	16.5	9.7
4	2+340	4R	1st Layer	100	94	86	76	60	53	39	28	17	12	19.3	15.5	3.8
			2nd Layer	100	100	86	74	59	51	40	30	20	13	19.6	15.7	3.9
5	2+430	5L	1st Layer	100	93	89	81	65	57	41	27	15	10	22.2	16.9	5.3
			2nd Layer	100	98	77	64	49	42	30	22	16	10	20.5	15.6	4.9
6	2+610	6R	1st Layer	100	94	86	76	63	57	43	31	20	14	19.3	14.9	4.4
			2nd Layer	100	100	93	85	71	63	49	36	25	18	20.7	15.4	5.3
7	2+700	7L	1st Layer	100	98	89	79	64	54	41	28	17	12	19.5	16.3	3.2
			2nd Layer	100	100	90	81	68	58	43	30	19	14	20.6	14.9	5.7
8	3+113	10L	1st Layer	100	95	88	78	64	54	39	26	16	9	16.9	15.0	1.9
			2nd Layer	100	94	71	62	45	41	32	26	20	16	17.6	15.8	1.8
9	3+290	12R	1st Layer	100	100	83	71	59	52	39	28	17	12	18.3	16.2	2.1
			2nd Layer	100	96	87	80	67	60	46	33	21	15	22.2	16.4	5.8

Sieve Analysis, Extraction & GMM for Asphalt Tests Results

Pit	Station	Location	Layer	Sieve Analysis ASTM C 136-06									Extraction Test Results AASHTO T164-10		Theoritical Max. Sp.Gr (GMM) AASHTO T209-10
				3/4" (%)	1/2" (%)	3/8" (%)	#4 (%)	#8 (%)	#20 (%)	#50 (%)	#80 (%)	#200 (%)	Bituminous content by wt. of total mix %	Bituminous content by wt. of aggregate %	
1	0+280	1R	wearing per original design	99.3	86.1	73.5	53.0	37.6	19.7	11.7	7.7	3.7	4.33	4.53	2.440
			wearing overlay	100.0	86.7	76.1	58.6	46.9	24.4	11.7	9.1	6.3	4.50	4.71	2.430
2	0+280	1L	wearing per original design	100.0	86.5	72.0	56.5	44.8	27.0	13.6	9.3	6.5	4.67	4.89	2.438
			wearing overlay	100.0	87.7	71.1	55.2	42.7	24.7	11.7	8.2	5.3	4.83	5.08	2.438
3	2+340	4R	wearing per original design	100.0	87.2	73.9	52.6	33.5	17.5	9.5	7.2	5.4	4.67	4.90	2.430
4	2+430	5L	wearing per original design	100.0	84.3	69.4	47.4	31.3	17.7	9.3	6.3	4.5	4.67	4.90	2.433
5	2+610	6L	wearing per original design	100.0	87.3	75.4	59.1	48.6	25.4	13.4	9.6	6.8	4.33	4.53	2.427
			wearing overlay	100.0	87.0	75.0	59.9	51.1	26.1	13.1	7.5	5.4	4.83	5.08	2.433
6	2+780	8R	wearing per original design	100.0	90.6	74.2	49.1	31.4	17.4	10.6	8.4	5.2	4.33	4.53	2.434
7	3+113	10L	wearing per original design	100.0	86.0	71.0	49.0	39.4	14.8	9.4	7.5	5.8	4.50	4.71	2.443
8	3+290	12R	wearing per original design	100.0	93.5	75.2	53.0	35.8	18.4	10.1	7.3	5.1	4.67	4.89	2.436

Location and Slabs Thicknesses for Asphalt

Slab ID.	Station	Location	Layer	Thickness (cm)
1	0+280	1R	wearing per original design	6.0
			Wearing overlay	5.0
		1L	wearing per original design	4.5
			Wearing overlay	3.5
2	0+360	2R	wearing per original design	7.0
		2L	wearing per original design	6.0
3	0+450	3R	wearing per original design	6.7
		3L	wearing per original design	6.2
4	2+320	4R	wearing per original design	6.2
		4L	wearing per original design	5.5
5	2+430	5R	wearing per original design	6.8
		5L	wearing per original design	6.0
6	2+610	6R	wearing per original design	7.6
		6L	wearing per original design	7.5
			Wearing overlay	4.7
7	2+700	7R	wearing per original design	8.0
		7L	wearing per original design	6.0
			Wearing overlay	6.7
8	2+780	8R	wearing per original design	7.0
		8L	wearing per original design	7.7
			Wearing overlay	5.2

Location and Slabs Thicknesses for Asphalt (Cont.)

Slab ID.	Station	Location	Layer	Thickness (cm)
9	2+870	9R	wearing per original design	7.6
		9L	wearing per original design	7.2
			Wearing overlay	6.5
10	3+118	10R	wearing per original design	6.7
	3+113	10L	wearing per original design	6.0
11	3+210	11R	wearing per original design	6.5
		11L	wearing per original design	7.0
12	3+290	12R	wearing per original design	6.5
		12L	wearing per original design	6.4

Cores Thicknesses & Degree of Compaction for Asphalt

Core ID.	Station	Layer	Thickness (cm)	Degree of Compaction (%)
1R	0+280	wearing per original design	5.7	96.1
		wearing overlay	5.5	97.4
1L		wearing per original design	8.0	94.9
		wearing overlay	3.5	95.5
2R	0+360	wearing per original design	6.7	96.4
2L		wearing per original design	5.7	93.3
3R	0+450	wearing per original design	6.1	97.1
3L		wearing per original design	6.0	95.9
4R	2+340	wearing per original design	6.5	97.5
4L		wearing per original design	6.2	96.1
5R	2+430	wearing per original design	7.3	97.8
5L		wearing per original design	7.0	97.9
6R	2+610	wearing per original design	6.3	98.0
		wearing overlay	3.2	95.0
6L		wearing per original design	6.2	97.6
		wearing overlay	6.5	94.7
7R	2+700	wearing per original design	8.0	97.4
		wearing overlay	2.7	95.8
7L		wearing per original design	5.9	96.6
		wearing overlay	6.0	93.6
8R	2+780	wearing per original design	7.8	97.8
		wearing overlay	3.2	94.5
8L		wearing per original design	8.3	96.6
		wearing overlay	5.8	96.1
9R	2+870	wearing per original design	8.0	97.3
		wearing overlay	3.4	94.6
9L		wearing per original design	8.2	97.9
		wearing overlay	6.2	94.4

Cores Thicknesses & Degree of Compaction for Asphalt (Cont.)

Core ID.	Station	Layer	Thickness	Degree
10R	3+118	wearing per original design	7.3	96.5
		wearing overlay	2.8	91.9
10L	3+113	wearing per original design	7.1	97.7
		wearing overlay	3.9	92.4
11R	3+210	wearing per original design	6.4	95.2
11L		wearing per original design	5.3	98.0
		wearing overlay	3.7	93.0
12R	3+290	wearing per original design	7.2	97.4
12L		wearing per original design	7.3	96.4
		wearing overlay	3.2	92.6

Summary of Borehole Logs

BH NO.	Station	Depth (m)	W.C	L.L	P.L	P.I	% Gravel	% Sand	% Fines	UCS Kg/cm²	Classification & Color
1R	0+280	0-0.05	4.8	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		0.05-0.35	14.2								
		0.35-0.42	10.8								
		0.42-5	***	***	***	***	***	***	***	***	Rock Fill
		5-5.5	1.4	21.9	17.2	4.7	4.7	58.6	36.7	1.27	Pink Marlstone
1L	0+280	0-0.08	***	***	***	***	***	***	***	***	Asphalt
		0.08-0.48	6.1	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.48-1.0	***	***	***	***	***	***	***	***	Rock Fill
		1-2.0	7.8	21.9	17.2	4.7	4.7	58.6	36.7	1.27	Pink Marlstone
		2-3.5	6.5								
		3.5-5	10.7								
2R	0+360	0-0.45	5.5	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.45-1.0	***	***	***	***	***	***	***	***	Rock Fill
		1-2.0	5.8	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		2-3.5	0.7	***	NP	***	3.3	62.8	33.9	***	Very Pale Brown Clayey Sand with Cobbles
		3.5-5.8	9.0	21.9	17.2	4.7	4.7	58.6	36.7	1.27	Pink Marlstone
		5.8-7.0	1.0	***	NP	***	3.3	62.8	33.9	***	Very Pale Brown Clayey Sand with Cobbles
2L	0+360	0-0.06	***	***	***	***	***	***	***	***	Asphalt
		0.06-0.47	2.7	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.47-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.5	10.1	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		2.5-3	5.4	21.9	17.2	4.7	4.7	58.6	36.7	1.27	Pink Marlstone
		3-3.40	3.0	***	NP	***	3.3	62.8	33.9	***	Very Pale Brown Clayey Sand with Cobbles
		3.40-5	9.0	21.9	17.2	4.7	4.7	58.6	36.7	1.27	Pink Marlstone

Summary of Borehole Logs (Cont.)

BH NO.	Station	Depth (m)	W.C	L.L	P.L	P.I	% Gravel	% Sand	% Fines	UCS Kg/cm²	Classification & Color
3R	0+450	0-0.42	3	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.42-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.5	2.4	***	NP	***	3.3	62.8	33.9	***	Very Pale Brown Clayey Sand with Cobbles
		2.5-3.8	1.1								
		3.8-5	4.2	21.9	17.2	4.7	4.7	58.6	36.7	1.27	Pink Marlstone
3L	0+450	0-0.06	***	***	***	***	***	***	***	***	Asphalt
		0.06-0.48	4.9	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.48-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.0	13.8	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
		2-2.5	10.2								
		2.5-4	16.2	26.0	21.5	4.5	***	***	***	***	Yellow Marlstone
		4-5.0	18.1	21.9	17.2	4.7	4.7	58.6	36.7	1.27	Pink Marlstone
4R	2+320	0-0.06	***	***	***	***	***	***	***	***	Asphalt
		0.06-0.65	4.2	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.65-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.5	16.5	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
		2.5-5	16.7								
4L	2+320	0-0.06	***	***	***	***	***	***	***	***	Asphalt
		0.06-0.50	7.2	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.5-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.0	7.8	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
		2-3.0	6.8								
		3-5.0	10.8								
5R	2+430	0-0.07	***	***	***	***	***	***	***	***	Asphalt
		0.07-0.50	3.7	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.50-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.0	2.7	***	NP	***	3.3	62.8	33.9	***	Very Pale Brown Clayey Sand with Cobbles
		2-3.5	8.3	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
		3.5-5	***	***	***	***	***	***	***	***	No Sample

Summary of Borehole Logs (Cont.)

BH NO.	Station	Depth (m)	W.C	L.L	P.L	P.I	% Gravel	% Sand	% Fines	UCS Kg/cm²	Classification & Color
5L	2+430	0-0.06	***	***	***	***	***	***	***	***	Asphalt
		0.06-0.49	3.2	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.49-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.0	10.6	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		2-3.5	11.3								
		3.5-5	10.5	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
6R	2+610	0-0.08	***	***	***	***	***	***	***	***	Asphalt
		0.08-0.47	3.9	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.47-5	***	***	***	***	***	***	***	***	Rock Fill
6L	2+610	0-0.12	***	***	***	***	***	***	***	***	Asphalt
		0.12-0.50	3.9	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.50-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.0	6.5	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
		2-2.5	5.7	***	NP	***	3.3	62.8	33.9	***	Very Pale Brown Clayey Sand with Cobbles
		2.5-5	***	***	***	***	***	***	***	***	There is some water but no samples
7R	2+700	0-0.08	***	***	***	***	***	***	***	***	Asphalt
		0.08-0.53	1.6	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.53-1	***	***	***	***	***	***	***	***	Rock Fill
		1-3.0	5.9	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		3-5.0	5.8	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
7L	2+700	0-0.13	***	***	***	***	***	***	***	***	Asphalt
		0.13-0.60	3.1	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.60-1	***	***	***	***	***	***	***	***	Rock Fill
		1-1.5	7.9	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		1.5-2.5	11.2	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
		2.5-4	25.2	52.1	38.8	13.4	0.0	13.0	87.0	0.60	Dark Brown Sandy Clay
		4-5.0	24.4								

Summary of Borehole Logs (Cont.)

BH NO.	Station	Depth (m)	W.C	L.L	P.L	P.I	% Gravel	% Sand	% Fines	UCS Kg/cm²	Classification & Color
8R	2+780	0-0.07	***	***	***	***	***	***	***	***	Asphalt
		0.07-0.51	3.1	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.51-1	***	***	***	***	***	***	***	***	Rock Fill
		1-1.5	9.0	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		1.5-2	11.4	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
		2-2.5	14.4								
		2.5-3.5	***	***	***	***	***	***	***	***	No Sample
		3.5-5	5.2	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
8L	2+780	0-0.13	***	***	***	***	***	***	***	***	Asphalt
		0.13-0.55	4.1	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.55-1	***	***	***	***	***	***	***	***	Rock Fill
		1-3.0	10.0	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		3-4.0	10.6								
		4-5.0	10.5								
9R	2+870	0-0.08	***	***	***	***	***	***	***	***	Asphalt
		0.08-0.48	2.0	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.48-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.5	11.0	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		2.5-5	18.9	52.1	38.8	13.4	0.0	13.0	87.0	0.60	Dark Brown Sandy Clay
9L	2+870	0-0.14	***	***	***	***	***	***	***	***	Asphalt
		0.14-0.53	3.9	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.53-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2	6.4	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		2-3.5	10.9	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
		3.5-5	24.7	52.1	38.8	13.4	0.0	13.0	87.0	0.60	Dark Brown Sandy Clay

Summary of Borehole Logs (Cont.)

BH NO.	Station	Depth (m)	W.C	L.L	P.L	P.I	% Gravel	% Sand	% Fines	UCS Kg/cm²	Classification & Color
10R	3+120	0-0.07	***	***	***	***	***	***	***	***	Asphalt
		0.07-0.50	5.9	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.50-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.0	8.9	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		2-2.5	12.2								
		2.5-4	10.1								
		4-5.0	31.0	52.1	38.8	13.4	0.0	13.0	87.0	0.60	Dark Brown Sandy Clay
10L	3+120	0-0.06	***	***	***	***	***	***	***	***	Asphalt
		0.06-0.46	2.8	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.46-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.0	11.6	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		2-4.0	10.6								
11R	3+210	0-0.07	***	***	***	***	***	***	***	***	Asphalt
		0.07-0.47	4.1	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.47-1	***	***	***	***	***	***	***	***	Rock Fill
		1-2.5	7.3	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		2.5-4	10.6								
		4-5.0	35.3	52.1	38.8	13.4	0.0	13.0	87.0	0.60	Dark Brown Sandy Clay
11L	3+210	0-0.07	***	***	***	***	***	***	***	***	Asphalt
		0.07-0.48	4.1	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.48-1	***	***	***	***	***	***	***	***	Rock Fill
		1-3.0	9.2	22.8	18.7	4.1	12.6	43.5	43.9	1.08	Strong Brown Sandy Clay with Cobbles
		3-4.0	8.4								
		4-5.0	32.5	52.1	38.8	13.4	0.0	13.0	87.0	0.60	Dark Brown Sandy Clay

Summary of Borehole Logs (Cont.)

BH NO.	Station	Depth (m)	W.C	L.L	P.L	P.I	% Gravel	% Sand	% Fines	UCS Kg/cm^2	Classification & Color
12R	3+290	0-0.07	***	***	***	***	***	***	***	***	Asphalt
		0.07-0.52	4.2	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.52-1	***	***	***	***	***	***	***	***	Rock Fill
		1-1.80	***	***	***	***	***	***	***	***	Rock Fill
		1.80-2.80	35.6	52.1	38.8	13.4	0.0	13.0	87.0	0.60	Dark Brown Sandy Clay
		2.80-4	33.8								
		4-5.0	28.6								
12L	3+290	0-0.06	***	***	***	***	***	***	***	***	Asphalt
		0.06-0.50	4.2	18.6	16.2	2.4	35.7	47.1	16.4	***	Light Yellowish Brown Base Course
		0.50-1	***	***	***	***	***	***	***	***	Rock Fill
		1-1.5	10.8	29.3	18.2	11.1	7.9	44.2	47.9	1.42	Very Dark Grayish Brown Sandy Clay with Gravel
		1.5-3	34.0	52.1	38.8	13.4	0.0	13.0	87.0	0.60	Dark Brown Sandy Clay
		3-5.0	37.9								

6.0 STONE WALLS STABILITY

Stone wall stability was investigated for two areas; the first is near the stone wall located in area 1 (st. 00+280 to st. 00+480 with a height of about 4.0 meters) and the second is the stone wall added in area 3 (st. 3+120 to st. 3+200 with a height of about 1.0 meter). The wall were treated as gravity retaining walls. The investigation showed that the walls in both locations passed the overturning stability as well as the bearing capacity stability criterias. Both locations failed the sliding criteria when soil get submerged due to insuffiecient and inappropriate water drainage. Ehen clay or clayey soil becomes submerged, then there will be no adhesion with the wall base or very low amount of adhesion due to the high degree of stone blocks roughness. So the unstability in the stone walls is due to building the walls directly on the current clay based soil without any foundation protection. The unstability will not stop unless an action is taken to protect the wall foundation from volume changes due to water content change. Protection can be achieved by deepeneng the foundation, level to a stable water content zone or increase the base width so more area can help to develop some sliding resisting force. In all cases water drainage problem should be dealt with to take water away from the walls.

7.0 CONCLUSIONS & RECOMMENDATIONS

7.1 CONCLUSIONS

As a result of this evaluation study and after analyzing the lab. test results, the following conclusions are withdrawn:

1. **Asphalt:**
   - Although most of the results of the asphalt are accepted especially the manufacturing properties, there are some bad workmanship in some areas especially in area 4. The asphalt is pealing off and aggregate particles are started to separate. Many places of popouts are noticed. This can be attributed to the lower tempreture of asphalt when the asphalt was spread and compacted.
   - Degree of compaction in most of the obtained cores are less than 98%. This shows lower quality work and quality control as well. Degrees of compaction can be accepted for one time with a

discount applied and close monitoring put on the next times so this is not repeated. And if the contractor stil has the same results, work should be rejected.

- Asphalt overly was carried out in several places without milling the old asplalt layer. This makes the new layer to come out. The pealing of the new layer is clear in area 4. Slipping in this area also is clear and shown in the previous tables which describes the existing condition.
- Deflection was noticed in the asphalt at this area under the wheels.

2. **Base Course:**

- Base course tests results show some places were high percentags of material passing sieve #200. This again shows either segregation during hauling and spreading of the basecourse or using different sources. In both cases, this again shows insufficient quality control.
- Few places show degree of compaction that reaches 100%. Again, limitted number of points with 1 or 2% less may be accepted, and if this continues then different action should be taken by the engineer.
- Non uniform thicknesses of base course layers. Although the thicknesses are as requested by the designer, but the nonuniformities in thicknesses are another indication of poor quality control.
- CBR values in some places are lower than the specifications requirements (2R, 4R, 12R). In the rest of tested areas they fulfill the requirements.

3. **Rock fill:**

- Rockfill layer is what the designer got from the design. However, rockfill should be placed and compacted properly. During drilling it was clear that the rockfill has appreciable volume of voids. During drilling, the air was dissipated at the level of the rockfill layer. The existing of cavities will allow part of the base course material to drop down into these cavities and then cause deflection and/or cracking in the asphalt. The cavities in the rock fill and the unprotected sides of the pavement will allow the water to travel underneath the whole pavement and reaches all the subgrade silty clay or clayey silt natural soil. In some places, this soil has high swelling potential (7L, 9R, 9L, 10R, 11R, 11L, 12R and 12L). This means that this soil will be susceptable to volume changes.a since Although most of the results of the asphalt are accepted,

there is some bad workmanship in some Base Course:

- Base course tests results show some places were high percentages of material passing sieve #200. This again shows either segregation during hauling and spreading of the base course or using several sources for base course supply. In both cases, this again shows insufficient quality control.

7.2 RECOMMENDATIONS

As a result of this evaluation study and after analyzing the lab. test results, the following are the recommendations:

Drainage:

- Ditches should be made and existing one should be cleaned.
- Shoulders should not allow water to stay, they should allow water to drain away.
- Water should not be allowed to stay next to the stone walls, should be directed away of them.
- Failed culvert wall should be repaired as well as the pipes and the deflected part of asphalt over it should be realligned.

Rockfill:

- Cavities in the rockfill layer can be grouted by sand-cement-water mixture under low pressure. This will help sealing this planket and prohibts water from reaching the whole area underneath the pavement. Also filling these voids will stop any movement of base course particles into the cavities and concequently stopping related surface pavement defects.

Asphalt:

- Cracks should be sealed properly. Wide cracks should be filled.
- Asphalt with popouts have to be removed and properly worked.

Stone Walls:

- Stone walls are failing the sliding criteria due to the type of foundation layer, so this can be controlled by either adding more stone blocks in front of the current wall (2meters width for both locations while the height is 2 meters for area 1 and 1 meter for area 3) or installing a series of piles next to the stone wall and let the piles cap go under part of the stone wall.

8.0 ADDITIONAL SERVICES & CLOSURE

8.1 ADDITIONAL SERVICES

The recommendations presented in this report are contingent on ICGES observing and/or monitoring.

ICGES staff are able to do the grouting part for the rockfill.

ICGES staff is ready to provide the designs for the solution you need to implement without additional charge.

8.2 CLOSURE

We trust that this report will assist you in evaluating this pavement condition and provide applicable affordable solution as well.

ICGES appreciates the opportunity to provide our services on this project and looks forward to working with you in future projects. Should you have any questions, please do not hesitate to contact us.

This report was prepared by Dr. Mohammad Alsayyed.

APPENDIX A
TEST RESULTS FOR ASPHALT PAVEMENT

Testing Bituminous Paving Mixture Report

Asph : 01/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing per original design on 1R. 2R & 3R st. (0+280-0+450).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1148
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.440
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	52.00
Percent of Bitumen by Weight of Total Mix %	4.33
Percent of Bitumen by Weight of Aggregate %	4.53
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	99.3	99.2	±5
1/2"	12.5	86.1	82.8	±5
3/8"	9.5	73.5	69.1	±5
#4	4.75	53.0	48.4	±4
#8	2.36	37.6	32.7	±4
#20	0.850	19.7	20.0	±4
#50	0.300	11.7	11.4	±4
#80	0.180	7.7	7.4	±4
#200	0.075	3.7	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1212.0	1226.0	690.0	2.287	2.261	7.3	16.9
2	1208.0	1220.0	688.0	2.293	2.271	6.9	16.6
3	1202.0	1210.0	682.0	2.292	2.277	6.7	16.4
4	1200.0	1206.0	680.0	2.293	2.281	6.5	16.2
5	1210.0	1220.0	688.0	2.293	2.274	6.8	16.4
6	1204.0	1214.0	686.0	2.299	2.280	6.5	16.2
		Average		2.293	2.274	6.8	16.5

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	19.86	18.39	18.24	18.83
Corrected marshall stability Kg	1986.0	1839.0	1824.0	1883.0
Flow mm	2.2	2.9	2.7	2.6
Stiffiness kg/mm	735.5			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	16.3	16.15	16.36	16.3
Corrected marshall stability Kg	1630.0	1615.0	1636.0	1627.0
Flow mm	2.8	2.8	2.6	2.7
Loss of stability = %	13.6			

D- Analysis of Core Specimens:

Specimen No.	1	2	3					
Station	0+280	0+360	0+450					
Location	1R	2R	3R					
Layer	Wearing	Wearing	Wearing					
Thickness cm	5.7	6.7	6.1					
Dry Weight gm	868.0	1054.0	936.0					
SSD Dry Weight gm	876.0	1064.0	942.0					
Weight in Water	479.0	583.0	518.0					
SSD Bulk Specific Gravity	2.186	2.191	2.208					
Degree of Compaction %	96.1	96.4	97.1					
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.274		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 02/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing overlay on 1R St.(0+280)	Sampled By:	Lab./Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1146
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.430
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	54.00
Percent of Bitumen by Weight of Total Mix %	4.50
Percent of Bitumen by Weight of Aggregate %	4.71
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	100.0	99.2	±5
1/2"	12.5	86.7	82.8	±5
3/8"	9.5	76.1	69.1	±5
#4	4.75	58.6	48.4	±4
#8	2.36	46.9	32.7	±4
#20	0.850	24.4	20.0	±4
#50	0.300	12.7	11.4	±4
#80	0.180	9.1	7.4	±4
#200	0.075	6.3	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1218.0	1226.0	696.0	2.313	2.298	5.4	15.6
2	1216.0	1226.0	692.0	2.296	2.277	6.3	16.3
3	1214.0	1224.0	694.0	2.309	2.291	5.7	15.8
4	1226.0	1234.0	696.0	2.294	2.279	6.2	16.3
5	1206.0	1216.0	688.0	2.303	2.284	6.0	16.1
6	1202.0	1214.0	686.0	2.299	2.277	6.3	16.4
		Average		2.302	2.284	6.0	16.1

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	17.52	17.59	17.82	17.64
Corrected marshall stability Kg	1752.0	1759.0	1782.0	1764.3
Flow mm	2.7	2.6	2.6	2.6
Stiffiness kg/mm	670.0			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	15.16	15.47	15.64	15.4
Corrected marshall stability Kg	1516.0	1547.0	1564.0	1542.3
Flow mm	3.3	3.2	3.0	3.2
Loss of stability = %	12.6			

D- Analysis of Core Specimens:

Specimen No.	1							
Station	0+280							
Location	1R							
Layer	Wearing							
Thickness cm	5.5							
Dry Weight gm	850.0							
SSD Dry Weight gm	852.0							
Weight in Water	470.0							
SSD Bulk Specific Gravity	2.225							
Degree of Compaction %	97.4							
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.284		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 03/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing per original design on 1L, 2L & 3L St.(0+280-	Sampled By:	Lab./Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1144
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.438
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	56.00
Percent of Bitumen by Weight of Total Mix %	4.67
Percent of Bitumen by Weight of Aggregate %	4.90
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	100.0	99.2	±5
1/2"	12.5	86.5	82.8	±5
3/8"	9.5	72.0	69.1	±5
#4	4.75	56.5	48.4	±4
#8	2.36	44.8	32.7	±4
#20	0.850	27.0	20.0	±4
#50	0.300	13.6	11.4	±4
#80	0.180	9.3	7.4	±4
#200	0.075	6.5	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1212.0	1230.0	696.0	2.303	2.270	6.9	17.3
2	1208.0	1224.0	692.0	2.301	2.271	6.9	17.3
3	1196.0	1212.0	686.0	2.304	2.274	6.7	17.1
4	1202.0	1214.0	688.0	2.308	2.285	6.3	16.7
5	1204.0	1216.0	688.0	2.303	2.280	6.5	16.9
6	1200.0	1210.0	686.0	2.309	2.290	6.1	16.5
		Average		2.305	2.278	6.6	17.0

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	16.09	16.13	16.31	16.18
Corrected marshall stability Kg	1609.0	1613.0	1631.0	1617.7
Flow mm	2.87	2.26	2.28	2.47
Stiffiness kg/mm	654.9			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	14.27	14.89	14.56	14.6
Corrected marshall stability Kg	1427.0	1489.0	1456.0	1457.3
Flow mm	2.8	2.9	2.3	2.7
Loss of stability = %	9.9			

D- Analysis of Core Specimens:

Specimen No.	1	2	3					
Station	0+280	0+360	0+450					
Location	1L	2L	3L					
Layer	Wearing	Wearing	Wearing					
Thickness cm	5.0	5.7	6.0					
Dry Weight gm	696.0	850.0	924.0					
SSD Dry Weight gm	700.0	862.0	936.0					
Weight in Water	378.0	462.0	513.0					
SSD Bulk Specific Gravity	2.161	2.125	2.184					
Degree of Compaction %	94.9	93.3	95.9					
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.278		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 04/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing overlay on 1L st. (0+280).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1142
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.438
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	58.00
Percent of Bitumen by Weight of Total Mix %	4.83
Percent of Bitumen by Weight of Aggregate %	5.08
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	100.0	99.2	±5
1/2"	12.5	87.7	82.8	±5
3/8"	9.5	71.1	69.1	±5
#4	4.75	55.2	48.4	±4
#8	2.36	42.7	32.7	±4
#20	0.850	24.7	20.0	±4
#50	0.300	11.7	11.4	±4
#80	0.180	8.2	7.4	±4
#200	0.075	5.3	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1210.0	1218.0	690.0	2.307	2.292	6.0	16.9
2	1202.0	1214.0	688.0	2.308	2.285	6.3	17.1
3	1204.0	1216.0	692.0	2.321	2.298	5.8	16.6
4	1200.0	1208.0	686.0	2.314	2.299	5.7	16.6
5	1210.0	1220.0	690.0	2.302	2.283	6.4	17.2
6	1206.0	1218.0	688.0	2.298	2.275	6.7	17.4
		Average		2.308	2.289	6.1	17.0

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	17.46	17.42	17.66	17.51
Corrected marshall stability Kg	1746.0	1742.0	1766.0	1751.3
Flow mm	2.8	2.7	2.6	2.7
Stiffiness kg/mm	648.6			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	15.06	15.22	15.44	15.2
Corrected marshall stability Kg	1506.0	1522.0	1544.0	1524.0
Flow mm	3.2	3.1	2.9	3.1
Loss of stability = %	13.0			

D- Analysis of Core Specimens:

Specimen No.	1							
Station	0+280							
Location	1L							
Layer	Wearing							
Thickness cm	3.5							
Dry Weight gm	496.0							
SSD Dry Weight gm	498.0							
Weight in Water	271.0							
SSD Bulk Specific Gravity	2.185							
Degree of Compaction %	95.5							
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.289		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 05/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing per original design on 4R & 5R st. (2+320, 2+430).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1144
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.430
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	56.00
Percent of Bitumen by Weight of Total Mix %	4.67
Percent of Bitumen by Weight of Aggregate %	4.90
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	100.0	99.2	±5
1/2"	12.5	87.2	82.8	±5
3/8"	9.5	73.9	69.1	±5
#4	4.75	52.0	48.4	±4
#8	2.36	33.5	32.7	±4
#20	0.850	17.5	20.0	±4
#50	0.300	9.5	11.4	±4
#80	0.180	7.2	7.4	±4
#200	0.075	5.4	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1216.0	1230.0	696.0	2.303	2.277	6.3	16.7
2	1216.0	1232.0	698.0	2.307	2.277	6.3	16.7
3	1200.0	1208.0	684.0	2.305	2.290	5.8	16.2
4	1212.0	1224.0	692.0	2.301	2.278	6.2	16.7
5	1212.0	1220.0	690.0	2.302	2.287	5.9	16.4
6	1206.0	1214.0	688.0	2.308	2.293	5.6	16.1
		Average		2.304	2.284	6.0	16.5

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	21.44	22.93	21.60	21.99
Corrected marshall stability Kg	2144.0	2293.0	2160.0	2199.0
Flow mm	2.8	2.7	2.6	2.7
Stiffiness kg/mm	814.4			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	19.94	19.73	19.10	19.6
Corrected marshall stability Kg	1994.0	1973.0	1910.0	1959.0
Flow mm	3.4	3.3	3.4	3.4
Loss of stability = %	10.9			

D- Analysis of Core Specimens:

Specimen No.	1	2						
Station	2+320	2+430						
Location	4R	5R						
Layer	Wearing	Wearing						
Thickness cm	6.5	7.3						
Dry Weight gm	980.0	1112.0						
SSD Dry Weight gm	990.0	1122.0						
Weight in Water	550.0	624.0						
SSD Bulk Specific Gravity	2.227	2.233						
Degree of Compaction %	97.5	97.8						
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.284		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 06/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing per original design on 4L, 5L st. (2+320, 2+430).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1144
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.433
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	56.00
Percent of Bitumen by Weight of Total Mix %	4.67
Percent of Bitumen by Weight of Aggregate %	4.90
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	100.0	99.2	±5
1/2"	12.5	84.3	82.8	±5
3/8"	9.5	69.4	69.1	±5
#4	4.75	47.4	48.4	±4
#8	2.36	31.3	32.7	±4
#20	0.850	17.7	20.0	±4
#50	0.300	9.3	11.4	±4
#80	0.180	6.3	7.4	±4
#200	0.075	4.5	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1190.0	1202.0	680.0	2.303	2.280	6.3	16.7
2	1200.0	1210.0	686.0	2.309	2.290	5.9	16.4
3	1204.0	1218.0	690.0	2.307	2.280	6.3	16.7
4	1218.0	1232.0	698.0	2.307	2.281	6.3	16.7
5	1212.0	1220.0	692.0	2.311	2.295	5.7	16.2
6	1202.0	1212.0	686.0	2.304	2.285	6.1	16.5
		Average		2.307	2.285	6.1	16.5

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	21.03	21.27	21.43	21.24
Corrected marshall stability Kg	2103.0	2127.0	2143.0	2124.3
Flow mm	2.6	2.5	2.5	2.5
Stiffiness kg/mm	834.2			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	18.20	17.39	18.40	18.0
Corrected marshall stability Kg	1820.0	1739.0	1840.0	1799.7
Flow mm	3.3	3.4	3.1	3.3
Loss of stability = %	15.3			

D- Analysis of Core Specimens:

Specimen No.	1	2						
Station	2+320	2+430						
Location	4L	5L						
Layer	Wearing	Wearing						
Thickness cm	6.2	7.0						
Dry Weight gm	914.0	1074.0						
SSD Dry Weight gm	922.0	1082.0						
Weight in Water	506.0	602.0						
SSD Bulk Specific Gravity	2.197	2.238						
Degree of Compaction %	96.1	97.9						
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.285		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 07/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing overlay on 6L, 7L, 8L, 9L & 6R,7R, 8R, 9R on same st. (2+610, 2+700, 2+780, 2+870).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1142
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.433
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	58.00
Percent of Bitumen by Weight of Total Mix %	4.83
Percent of Bitumen by Weight of Aggregate %	5.08
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	100.0	99.2	±5
1/2"	12.5	87.0	82.8	±5
3/8"	9.5	75.0	69.1	±5
#4	4.75	59.9	48.4	±4
#8	2.36	51.1	32.7	±4
#20	0.850	26.1	20.0	±4
#50	0.300	13.1	11.4	±4
#80	0.180	7.5	7.4	±4
#200	0.075	5.4	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1205.0	1215.0	692.0	2.323	2.304	5.3	16.2
2	1222.0	1238.0	706.0	2.327	2.297	5.6	16.5
3	1227.0	1240.0	708.5	2.333	2.309	5.1	16.1
4	1223.0	1232.0	703.0	2.329	2.312	5.0	15.9
5	1225.5	1235.0	702.0	2.317	2.299	5.5	16.4
6	1223.0	1234.0	703.0	2.324	2.303	5.3	16.2
		Average		2.326	2.304	5.3	16.2

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	22.21	22.39	23.31	22.64
Corrected marshall stability Kg	2221.0	2239.0	2331.0	2263.7
Flow mm	2.69	2.85	2.77	2.8
Stiffiness kg/mm	817.2			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	19.23	19.20	20.95	19.8
Corrected marshall stability Kg	1923.0	1920.0	2095.0	1979.3
Flow mm	3.3	3.5	3.3	3.4
Loss of stability = %	12.6			

D- Analysis of Core Specimens:

Specimen No.	1	2	3	4	5	6	7	8
Station	2+610	2+610	2+700	2+700	2+780	2+780	2+870	2+870
Location	6L	6R	7L	7R	8L	8R	9L	9R
Layer	Wearing	Wearing	Wearing	Wearing	Wearing	Wearing	Wearing	Wearing
Thickness cm	6.5	3.2	6.0	2.7	5.8	3.2	6.2	3.4
Dry Weight gm	864.0	418.0	832.0	318.0	828.0	405.0	1000.0	414.0
SSD Dry Weight gm	872.0	421.0	846.0	324.0	836.0	410.0	1008.0	420.0
Weight in Water	476.0	230.0	460.0	180.0	462.0	224.0	548.0	230.0
SSD Bulk Specific Gravity	2.182	2.188	2.155	2.208	2.214	2.177	2.174	2.179
Degree of Compaction %	94.7	95.0	93.6	95.8	96.1	94.5	94.4	94.6
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.304		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 08/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing per original design on 6L, 7L, 8L & 9L st. (2+610, 2+700, 2+780, 2+870).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1148
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.427
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	52.00
Percent of Bitumen by Weight of Total Mix %	4.33
Percent of Bitumen by Weight of Aggregate %	4.53
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	100.0	99.2	±5
1/2"	12.5	87.3	82.8	±5
3/8"	9.5	75.4	69.1	±5
#4	4.75	59.1	48.4	±4
#8	2.36	48.6	32.7	±4
#20	0.850	25.4	20.0	±4
#50	0.300	13.4	11.4	±4
#80	0.180	9.6	7.4	±4
#200	0.075	6.8	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1218.0	1228.0	696.0	2.308	2.289	5.7	15.4
2	1218.5	1226.0	697.0	2.318	2.303	5.1	14.9
3	1223.5	1230.0	694.0	2.295	2.283	5.9	15.6
4	1218.0	1228.0	700.0	2.326	2.307	5.0	14.8
5	1225.0	1232.0	700.0	2.316	2.303	5.1	14.9
6	1219.0	1226.0	697.0	2.318	2.304	5.1	14.8
		Average		2.313	2.298	5.3	15.1

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	19.77	20.54	20.21	20.17
Corrected marshall stability Kg	1977.0	2054.0	2021.0	2017.3
Flow mm	2.36	2.50	2.60	2.5
Stiffiness kg/mm	811.3			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	18.07	18.20	18.93	18.4
Corrected marshall stability Kg	1807.0	1820.0	1893.0	1840.0
Flow mm	3.11	3.54	2.28	3.0
Loss of stability = %	8.8			

D- Analysis of Core Specimens:

Specimen No.	1	2	3	4				
Station	2+610	2+700	2+780	2+870				
Location	6L	7L	8L	9L				
Layer	Wearing	Wearing	Wearing	Wearing				
Thickness cm	6.2	5.9	8.3	8.2				
Dry Weight gm	1072.0	884.0	1208.0	1260.0				
SSD Dry Weight gm	1078.0	890.0	1220.0	1262.0				
Weight in Water	600.0	492.0	676.0	702.0				
SSD Bulk Specific Gravity	2.243	2.221	2.221	2.250				
Degree of Compaction %	97.6	96.6	96.6	97.9				
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.298		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 09/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing per original design on 6R, 7R, 8R & 9R st. (2+610, 2+700, 2+780, 2+870).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1148
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.434
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	52.00
Percent of Bitumen by Weight of Total Mix %	4.33
Percent of Bitumen by Weight of Aggregate %	4.53
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	100.0	99.2	±5
1/2"	12.5	90.6	82.8	±5
3/8"	9.5	74.2	69.1	±5
#4	4.75	49.1	48.4	±4
#8	2.36	31.4	32.7	±4
#20	0.850	17.4	20.0	±4
#50	0.300	10.6	11.4	±4
#80	0.180	8.4	7.4	±4
#200	0.075	5.2	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1223.0	1232.5	684.5	2.249	2.232	8.3	17.8
2	1233.0	1243.5	693.5	2.261	2.242	7.9	17.4
3	1232.0	1243.5	694.5	2.265	2.244	7.8	17.3
4	1227.5	1236.5	690.5	2.265	2.248	7.6	17.2
5	1223.5	1236.5	684.5	2.240	2.216	8.9	18.4
6	1223.5	1239.0	684.0	2.232	2.205	9.4	18.8
		Average		2.252	2.231	8.3	17.8

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	21.51	21.04	21.64	21.40
Corrected marshall stability Kg	2151.0	2104.0	2164.0	2139.7
Flow mm	2.50	2.60	2.70	2.6
Stiffiness kg/mm	822.9			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	16.78	16.90	16.96	16.9
Corrected marshall stability Kg	1678.0	1690.0	1696.0	1688.0
Flow mm	2.81	3.24	3.22	3.1
Loss of stability = %	21.1			

D- Analysis of Core Specimens:

Specimen No.	1	2	3	4				
Station	2+610	2+700	2+780	2+870				
Location	6R	7R	8R	9R				
Layer	Wearing	Wearing	Wearing	Wearing				
Thickness cm	6.3	8.0	7.8	8.0				
Dry Weight gm	940.0	1212.0	1152.0	1188.0				
SSD Dry Weight gm	950.0	1224.0	1168.0	1207.0				
Weight in Water	520.0	666.0	640.0	660.0				
SSD Bulk Specific Gravity	2.186	2.172	2.182	2.172				
Degree of Compaction %	98.0	97.4	97.8	97.3				
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.231		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 10/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing per original design on 10L, 11L & 12L st. (3+113, 3+210, 3+290).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1146
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.443
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	54.00
Percent of Bitumen by Weight of Total Mix %	4.50
Percent of Bitumen by Weight of Aggregate %	4.71
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	100.0	99.2	±5
1/2"	12.5	86.0	82.8	±5
3/8"	9.5	71.0	69.1	±5
#4	4.75	49.0	48.4	±4
#8	2.36	39.4	32.7	±4
#20	0.850	14.8	20.0	±4
#50	0.300	9.4	11.4	±4
#80	0.180	7.5	7.4	±4
#200	0.075	5.8	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1224.5	1231.0	682.5	2.244	2.232	8.6	18.5
2	1224.5	1231.0	691.0	2.280	2.268	7.2	17.2
3	1231.5	1238.0	693.0	2.272	2.260	7.5	17.5
4	1214.5	1219.5	683.5	2.275	2.266	7.3	17.2
5	1211.5	1219.0	686.5	2.289	2.275	6.9	16.9
6	1222.0	1231.0	686.5	2.261	2.244	8.1	18.0
		Average		2.270	2.257	7.6	17.6

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	852	845	786.00	827.67
Corrected marshall stability Kg	1891.4	1875.9	1744.9	1837.4
Flow mm	2.88	2.76	2.72	2.8
Stiffiness kg/mm	659.4			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	674.00	718	700.00	697.3
Corrected marshall stability Kg	1496.3	1594.0	1554.0	1548.1
Flow mm	3.60	3.85	3.78	3.7
Loss of stability = %	15.7			

D- Analysis of Core Specimens:

Specimen No.	1	2	3					
Station	3+113	3+210	3+290					
Location	10L	11L	12L					
Layer	Wearing	Wearing	Wearing					
Thickness cm	7.1	5.3	7.0					
Dry Weight gm	1054.0	748.0	1040.0					
SSD Dry Weight gm	1056.0	752.0	1052.0					
Weight in Water	578.0	414.0	574.0					
SSD Bulk Specific Gravity	2.205	2.213	2.176					
Degree of Compaction %	97.7	98.0	96.4					
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.257		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 11/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing overlay on 10L, 11L & 12L st. (3+113, 3+210, 3+290).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density
1	1218.0	1226.0	696.0	2.313	2.298
2	1216.0	1226.0	692.0	2.296	2.277
3	1214.0	1224.0	694.0	2.309	2.291
4	1226.0	1234.0	696.0	2.294	2.279
5	1206.0	1216.0	688.0	2.303	2.284
6	1202.0	1214.0	686.0	2.299	2.277
		Average		2.302	2.284

B- Analysis of Core Specimens:

Specimen No.	1	2	3					
Station	3+113	3+210	3+290					
Layer	10L	11L	12L					
Thickness cm	Wearing	Wearing	Wearing					
Thickness (Average) cm	3.9	3.7	3.2					
Dry Weight gm	536.0	510.0	440.0					
SSD Dry Weight gm	540.0	512.0	444.0					
Weight in Water	286.0	272.0	236.0					
SSD Bulk Specific Gravity	2.110	2.125	2.115					
Degree of Compaction %	92.4	93.0	92.6					
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.284		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

Testing Bituminous Paving Mixture Report

Asph : 12/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing per original design on 10R, 11R & 12R st. (3+118, 3+210, 3+290).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Sample (gm)	1200
Weight of Extracted Aggregate (gm)	1144
Theoretical Maximum Specific Gravity(GMM) of Asphalt Sample gm/cm^3	2.436
Specific Gravity of Extracted Aggregate gm/cm^3 *	2.65
Weight of Asphalt in the Sample (gm)	56.00
Percent of Bitumen by Weight of Total Mix %	4.67
Percent of Bitumen by Weight of Aggregate %	4.90
Specific weight of Asphalt in Mix gm/cm^3 *	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits According to Job Mix Design	
in	mm		Passing No.	Tolerances
3/4"	19	100.0	99.2	±5
1/2"	12.5	93.5	82.8	±5
3/8"	9.5	75.2	69.1	±5
#4	4.75	53.0	48.4	±4
#8	2.36	35.8	32.7	±4
#20	0.850	18.4	20.0	±4
#50	0.300	10.1	11.4	±4
#80	0.180	7.3	7.4	±4
#200	0.075	5.1	5.0	±1.5

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density	Air Voids %	VMA %
1	1213.0	1224.0	687.0	2.279	2.259	7.3	17.6
2	1206.5	1213.0	686.0	2.302	2.289	6.0	16.5
3	1221.5	1230.5	695.5	2.300	2.283	6.3	16.7
4	1216.5	1226.0	684.0	2.262	2.244	7.9	18.1
5	1228.5	1237.0	694.0	2.278	2.262	7.1	17.5
6	1209.0	1217.0	687.0	2.296	2.281	6.4	16.8
		Average		2.286	2.270	6.8	17.2

C-Stability and Flow

	Soaked in water Bath @ 60C°			Average
	for 30 minutes			
Specimen No.	1	2	3	
Stability Reading	780	845	828.00	817.67
Corrected marshall stability Kg	1731.6	1875.9	1838.2	1815.2
Flow mm	2.85	2.56	2.94	2.8
Stiffiness kg/mm	652.2			

	Soaked in water Bath @ 60C			Average
	for 24 hours			
Specimen No.	1	2	3	
Stability Reading	622.00	663.00	656.00	647.0
Corrected marshall stability Kg	1380.8	1471.9	1456.3	1436.3
Flow mm	3.15	3.71	3.44	3.4
Loss of stability = %	20.9			

D- Analysis of Core Specimens:

Specimen No.	1	2	3					
Station	3+118	3+210	3+290					
Location	10R	11R	12R					
Layer	Wearing	Wearing	Wearing					
Thickness cm	7.3	6.4	7.2					
Dry Weight gm	1108.0	942.0	1044.0					
SSD Dry Weight gm	1120.0	954.0	1052.0					
Weight in Water	614.0	518.0	580.0					
SSD Bulk Specific Gravity	2.190	2.161	2.212					
Degree of Compaction %	96.5	95.2	97.4					
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.270		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

*** According to Job Mix Design**

	Limits as per Job Mix	**Jordinian Specifications limits**
Void ratio	5.2	4-7
Stability	1840	900
Flow	2.7	2-3.5
VMA	14.48	13
By total weight of mix.	4.6	max. 25%
Stiffness	681	min .500% Kg/mm

Testing Bituminous Paving Mixture Report

Asph : 13/2012

Client	Black & Veatch	Address	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Sample Source:	Project Site	Sampling Date:	18/04/2012
Description of Sample:	Asphalt from wearing overlay on 10R st. (3+118).	Sampled By:	Lab.Engineers

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM Standards

1-AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
2-AASHTO T209-10 "Theoretical maximum specific Gravity (GMM)"
3-AASHTO T 166-10 "Bulk specific gravity of compacted hot mix asphalt using saturated surface-dry"
4-ASTM D 3549-97 "Test method for thickness or height of compacted bituminous

Tests Results

A- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water	S.G SSD (gm/cm^3)	Bulk Density (gm/cm^3)
1	1205.0	1207.5	698.5	2.372	2.367
2	1222.0	1225.5	711.5	2.384	2.377
3	1227.0	1231.0	708.5	2.356	2.348
4	1223.0	1225.5	707.0	2.364	2.359
5	1225.5	1228.5	710.0	2.369	2.364
6	1223.0	1226.0	711.5	2.383	2.377
		Average		2.371	2.365

B- Analysis of Core Specimens:

Specimen No.	1							
Station	3+118							
Layer	10R							
Thickness cm	Wearing							
Thickness (Average) cm	2.8							
Dry Weight gm	352.0							
SSD Dry Weight gm	358.0							
Weight in Water	196.0							
SSD Bulk Specific Gravity	2.173							
Degree of Compaction %	91.9							
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was						2.365		
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.								

APPENDIX B
TEST RESULTS FOR THE BASE COURSE

Test Report for Compaction Test

Report No.	Proc /01/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

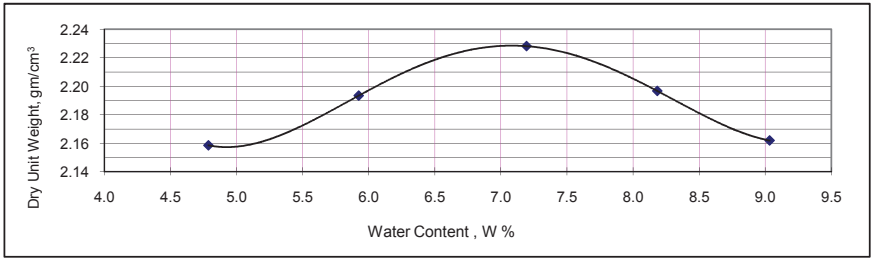
Description of Soil	Base Course Material 1R, 2nd Layer from st. (0+280)			
Test Method	AASHTO T180-10		AASHTO T99-10	
	5 Layers	4.54 Kg Rammer	3 Layers	2.5Kg Rammer
	Method D		Mold Volume cm^3	2183.0
Test Date	23/04/2012			

Water Content Determination

Mass of can + wet soil	1	2	3	4	5		
Mass of can , g	56.2	55.7	56	54.8	55.6		
Mass of can + wet soil	248.8	232.7	264.6	259.7	229.4		
Mass of can + dry soil	240.0	222.8	250.6	244.2	215.0		
Mass of water	9	10	14	16	14		
Mass of dry soil , g	184	167	195	189	159		
Water content , *w%*	4.79	5.92	7.19	8.18	9.03		

Density and unit Weight : $p=M_{ws}/vol$ gm/cm^3 ;

Mass of soil + mold , g	14718	14852	14994	14968	14926		
Mass of mold , g	9780	9780	9780	9780	9780		
Mass of soil in mold , M_{ws}	4938	5072	5214	5188	5146		
Wet unit weight, gm/cm^3	2.26	2.32	2.39	2.38	2.36		
Water content , *w%*	4.79	5.92	7.19	8.18	9.03		
Dry unit weight ,gm/cm^3	2.16	2.19	2.23	2.20	2.16		



Optimum moisture % = 7.2 Maximum dry unit weight, Y_{d} = 2.23 gm/cm^3

Test Report for Compaction Test

Report No.	Proc /02/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

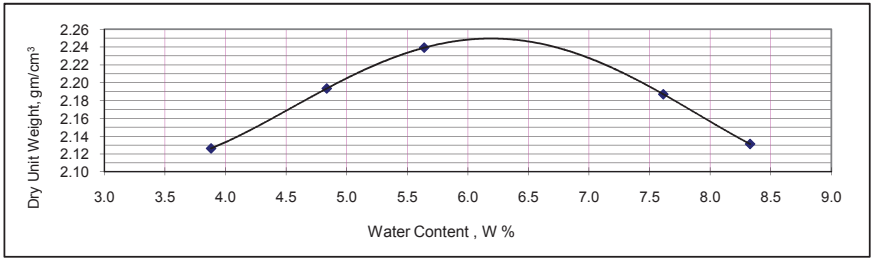
Description of Soil	Base Course Material 1L, 2nd Layer from st. (0+280)			
Test Method	AASHTO T180-10		AASHTO T99-10	
	5 Layers	4.54 Kg Rammer	3 Layers	2.5Kg Rammer
	Method D		Mold Volume cm^3	2183.0
Test Date	23/04/2012			

Water Content Determination

Mass of can + wet soil	1	2	3	4	5		
Mass of can , g	55.1	56	56.3	55.6	55.1		
Mass of can + wet soil	400.4	266.3	438.4	274.7	255.4		
Mass of can + dry soil	387.5	256.6	418.0	259.2	240.0		
Mass of water	13	10	20	16	15		
Mass of dry soil , g	332	201	362	204	185		
Water content , *w%*	3.88	4.84	5.64	7.61	8.33		

Density and unit Weight : $p=M_{ws}/vol$ gm/cm^3 ;

Mass of soil + mold , g	14602	14800	14944	14918	14820		
Mass of mold , g	9780	9780	9780	9780	9780		
Mass of soil in mold , M_{ws}	4822	5020	5164	5138	5040		
Wet unit weight, gm/cm^3	2.21	2.30	2.37	2.35	2.31		
Water content , *w%*	3.88	4.84	5.64	7.61	8.33		
Dry unit weight ,gm/cm^3	2.13	2.19	2.24	2.19	2.13		



Optimum moisture % = 6.3 Maximum dry unit weight, Y_d = 2.25 gm/cm^3

Test Report for Compaction Test

Report No.	Proc /03/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

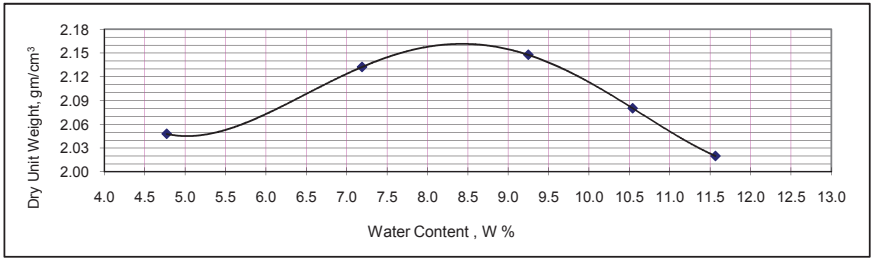
Description of Soil	Base Course Material 2R, 2nd Layer from st. (0+360)			
Test Method	AASHTO T180-10		AASHTO T99-10	
	5 Layers	4.54 Kg Rammer	3 Layers	2.5Kg Rammer
	Method D		Mold Volume cm^3	2183.0
Test Date	28/04/2012			

Water Content Determination

Mass of can + wet soil	1	2	3	4	5		
Mass of can , g	56	56.3	56.1	56.2	56		
Mass of can + wet soil	266.8	293.3	326.6	303.7	220.0		
Mass of can + dry soil	257.2	277.4	303.7	280.1	203.0		
Mass of water	10	16	23	24	17		
Mass of dry soil , g	201	221	248	224	147		
Water content , *w%*	4.77	7.19	9.25	10.54	11.56		

Density and unit Weight : $p=M_{ws}/vol$ gm/cm^3 ;

Mass of soil + mold , g	14464	14770	14902	14800	14700		
Mass of mold , g	9780	9780	9780	9780	9780		
Mass of soil in mold , M_{ws}	4684	4990	5122	5020	4920		
Wet unit weight, gm/cm^3	2.15	2.29	2.35	2.30	2.25		
Water content , *w%*	4.77	7.19	9.25	10.54	11.56		
Dry unit weight ,gm/cm^3	2.05	2.13	2.15	2.08	2.02		



Optimum moisture % = 8.5 Maximum dry unit weight, Y_{d} = 2.16 gm/cm^3

Test Report for Compaction Test

Report No.	Proc /04/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

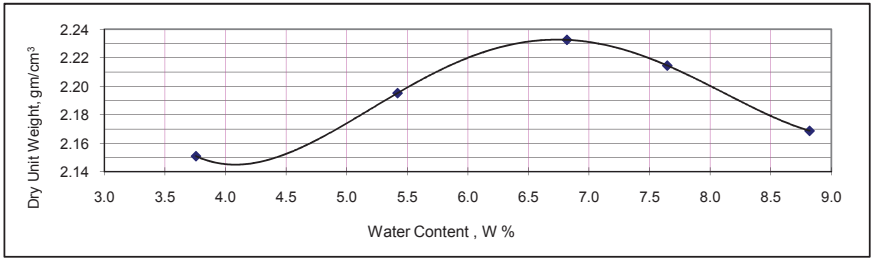
Description of Soil	Base Course Material 4R, 2nd Layer from st. (2+340)			
Test Method	AASHTO T180-10		AASHTO T99-10	
	5 Layers	4.54 Kg Rammer	3 Layers	2.5Kg Rammer
	Method D		Mold Volume cm^3	2183.0
Test Date	28/04/2012			

Water Content Determination

Mass of can + wet soil	1	2	3	4	5		
Mass of can , g	55.6	56	54.8	56.2	56.4		
Mass of can + wet soil	232.4	246.6	233.4	251.9	227.9		
Mass of can + dry soil	226.0	236.8	222.0	238.0	214.0		
Mass of water	6	10	11	14	14		
Mass of dry soil , g	170	181	167	182	158		
Water content , *w%*	3.76	5.42	6.82	7.65	8.82		

Density and unit Weight : $p=M_{ws}/vol$ gm/cm^3 ;

Mass of soil + mold , g	14652	14832	14986	14984	14932		
Mass of mold , g	9780	9780	9780	9780	9780		
Mass of soil in mold , M_{ws}	4872	5052	5206	5204	5152		
Wet unit weight, gm/cm^3	2.23	2.31	2.38	2.38	2.36		
Water content , *w%*	3.76	5.42	6.82	7.65	8.82		
Dry unit weight ,gm/cm^3	2.15	2.20	2.23	2.21	2.17		



Optimum moisture % = 6.8 Maximum dry unit weight, Y_{d} = 2.23 gm/cm^3

Test Report for Compaction Test

Report No.	Proc /05/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

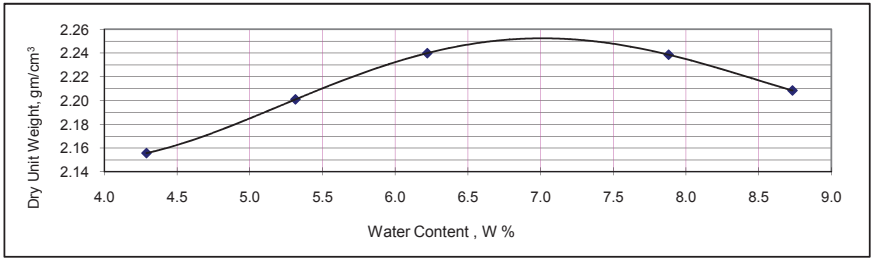
Description of Soil	Base Course Material 5L, 2nd Layer from st. (2+430)			
Test Method	AASHTO T180-10		AASHTO T99-10	
	5 Layers	4.54 Kg Rammer	3 Layers	2.5Kg Rammer
	Method D		Mold Volume cm^3	2183.0
Test Date	28/04/2012			

Water Content Determination

Mass of can + wet soil	1	2	3	4	5		
Mass of can , g	53.8	56.4	55.6	56.4	55.8		
Mass of can + wet soil	236.1	216.9	245.1	223.4	218.9		
Mass of can + dry soil	228.6	208.8	234.0	211.2	205.8		
Mass of water	8	8	11	12	13		
Mass of dry soil , g	175	152	178	155	150		
Water content , *w%*	4.29	5.31	6.22	7.88	8.73		

Density and unit Weight : $p=M_{ws}/vol$ gm/cm^3 ;

Mass of soil + mold , g	14688	14840	14974	15052	15022		
Mass of mold , g	9780	9780	9780	9780	9780		
Mass of soil in mold , M_{ws}	4908	5060	5194	5272	5242		
Wet unit weight, gm/cm^3	2.25	2.32	2.38	2.42	2.40		
Water content , *w%*	4.29	5.31	6.22	7.88	8.73		
Dry unit weight ,gm/cm^3	2.16	2.20	2.24	2.24	2.21		



Optimum moisture % = 7.0 Maximum dry unit weight, Y_{d} = 2.25 gm/cm^3

Test Report for Compaction Test

Report No.	Proc /06/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

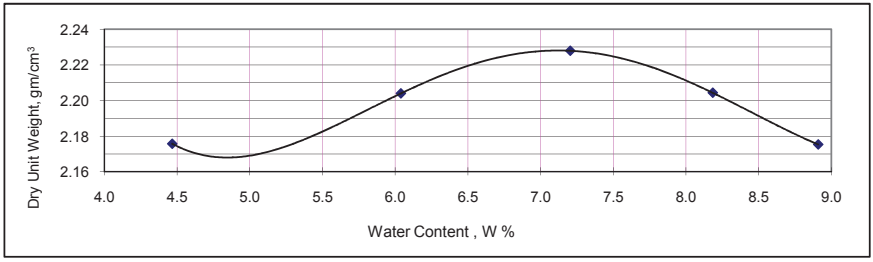
Description of Soil	Base Course Material 7L, 1st Layer from st. (2+700)			
Test Method	AASHTO T180-10		AASHTO T99-10	
	5 Layers	4.54 Kg Rammer	3 Layers	2.5Kg Rammer
	Method D		Mold Volume cm^3	2183.0
Test Date	28/04/2012			

Water Content Determination

Mass of can + wet soil	1	2	3	4	5		
Mass of can , g	61.6	55.2	53.4	54.5	56		
Mass of can + wet soil	232.3	209.7	215.6	242.2	230.8		
Mass of can + dry soil	225.0	200.9	204.7	228.0	216.5		
Mass of water	7	9	11	14	14		
Mass of dry soil , g	163	146	151	174	161		
Water content , *w%*	4.47	6.04	7.20	8.18	8.91		

Density and unit Weight : $p=M_{ws}/vol$ gm/cm^3 ;

Mass of soil + mold , g	14742	14882	14994	14986	14952		
Mass of mold , g	9780	9780	9780	9780	9780		
Mass of soil in mold , M_{ws}	4962	5102	5214	5206	5172		
Wet unit weight, gm/cm^3	2.27	2.34	2.39	2.38	2.37		
Water content , *w%*	4.47	6.04	7.20	8.18	8.91		
Dry unit weight ,gm/cm^3	2.18	2.20	2.23	2.20	2.18		



Optimum moisture % = 7.2 Maximum dry unit weight, Y_{d} = 2.23 gm/cm^3

Test Report for Compaction Test

Report No.	Proc /07/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

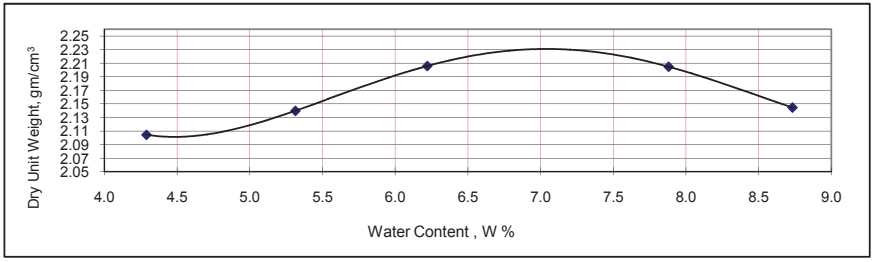
Description of Soil	Base Course Material 10L, 2nd Layer from st. (3+113)			
Test Method	AASHTO T180-10		AASHTO T99-10	
	5 Layers	4.54 Kg Rammer	3 Layers	2.5Kg Rammer
	Method D		Mold Volume cm^3	2183.0
Test Date	24/04/2012			

Water Content Determination

Mass of can + wet soil	1	2	3	4	5		
Mass of can , g	55.0	55.4	56.0	56.0	56.2		
Mass of can + wet soil	238.0	210.0	229.1	224.0	226.0		
Mass of can + dry soil	232.0	204.0	220.4	213.0	213.0		
Mass of water	6	6	9	11	13		
Mass of dry soil , g	177	149	164	157	157		
Water content , *w%*	3.39	4.04	5.29	7.01	8.29		

Density and unit Weight : $p=M_{ws}/vol$ gm/cm^3 ;

Mass of soil + mold , g	14530	14640	14850	14930	14850		
Mass of mold , g	9780	9780	9780	9780	9780		
Mass of soil in mold , M_{ws}	4750	4860	5070	5150	5070		
Wet unit weight, gm/cm^3	2.18	2.23	2.32	2.36	2.32		
Water content , *w%*	3.39	4.04	5.29	7.01	8.29		
Dry unit weight ,gm/cm^3	2.10	2.14	2.21	2.20	2.14		



Optimum moisture % = 7.0 Maximum dry unit weight, Y_d = 2.23 gm/cm^3

Test Report for Compaction Test

Report No.	Proc /08/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

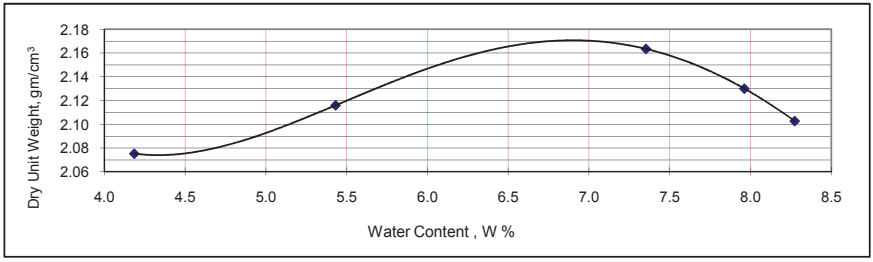
Description of Soil	Base Course Material 12R, 2nd Layer from st. (3+290)			
Test Method	AASHTO T180-10		AASHTO T99-10	
	5 Layers	4.54 Kg Rammer	3 Layers	2.5Kg Rammer
	Method D		Mold Volume cm^3	2183.0
Test Date	18/04/2012			

Water Content Determination

Mass of can + wet soil	1	2	3	4	5		
Mass of can , g	56	56.5	56.2	61.6	55.5		
Mass of can + wet soil	280	270	253.3	243.3	266.2		
Mass of can + dry soil	271	259	239.8	229.9	250.1		
Mass of water	9	11	14	13	16		
Mass of dry soil , g	215	203	184	168	195		
Water content , *w%*	4.19	5.43	7.35	7.96	8.27		

Density and unit Weight : $p=M_{ws}/vol$ gm/cm^3 ;

Mass of soil + mold , g	14500	14650	14850	14800	14750		
Mass of mold , g	9780	9780	9780	9780	9780		
Mass of soil in mold , M_{ws}	4720	4870	5070	5020	4970		
Wet unit weight, gm/cm^3	2.16	2.23	2.32	2.30	2.28		
Water content , *w%*	4.19	5.43	7.35	7.96	8.27		
Dry unit weight ,gm/cm^3	2.08	2.12	2.16	2.13	2.10		



Optimum moisture % = 7.0 Maximum dry unit weight, Y_{d} = 2.17 gm/cm^3

Test Report for Atterberg Limits

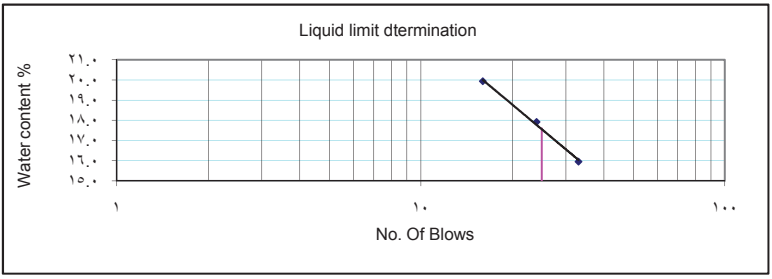
Report No.	Att.: 01/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 1R, 1st Layer from st. (0+280)
Source of Sample	Project Site
Sampling Date	17/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	80.1	78.6	70.3	55.6			
Mass of Dry Soil + Can	72.6	70.5	64.2	52.6			
Mass of Can	25.6	25.3	33.6	33.6			
Mass of Dry Soil	47	45.2	30.6	19.0			
Mass of Moisture	7.5	8.1	6.1	3.0			
Water Content %	16.0	17.9	19.9	15.8			
No. of Blows N	33	24	16				
Log(N)	1.52	1.38	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	17.6	15.8	**1.8**



Test Report for Atterberg Limits

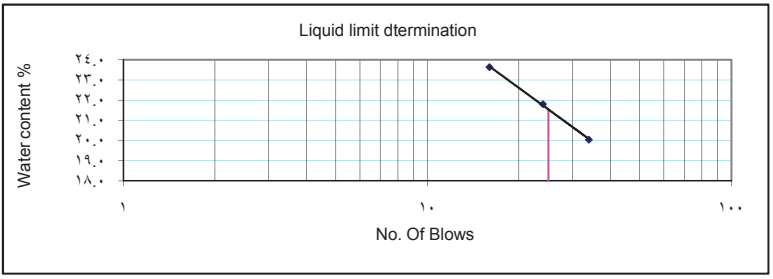
Report No.	Att.: 02/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 1R, 2nd Layer from st. (0+280)
Source of Sample	Project Site
Sampling Date	17/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	82.6	93.2	66.3	51.2			
Mass of Dry Soil + Can	73.0	82.3	59.8	48.4			
Mass of Can	25.1	32.3	32.3	32.2			
Mass of Dry Soil	47.9	50	27.5	16.2			
Mass of Moisture	9.6	10.9	6.5	2.8			
Water Content %	20.0	21.8	23.6	17.3			
No. of Blows N	34	24	16				
Log(N)	1.53	1.38	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	21.5	17.3	**4.3**



Test Report for Atterberg Limits

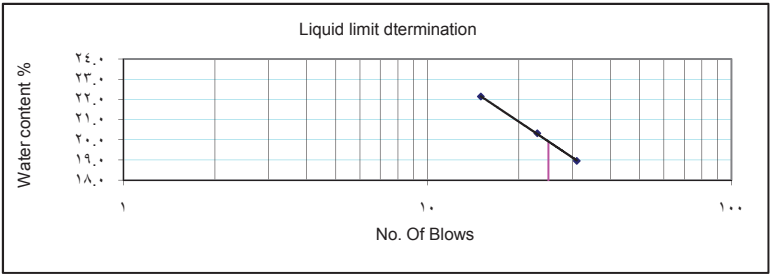
Report No.	Att.: 03/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 1L, 1st Layer from st. (0+280)
Source of Sample	Project Site
Sampling Date	17/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	69.5	71.6	66.1	61.7			
Mass of Dry Soil + Can	62.6	63.9	60.1	57.8			
Mass of Can	26.2	26.0	33.0	33.5			
Mass of Dry Soil	36.4	37.9	27.1	24.3			
Mass of Moisture	6.9	7.7	6.0	3.9			
Water Content %	19.0	20.3	22.1	16.0			
No. of Blows N	31	23	15				
Log(N)	1.49	1.36	1.18				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	19.9	16.0	**3.9**



Test Report for Atterberg Limits

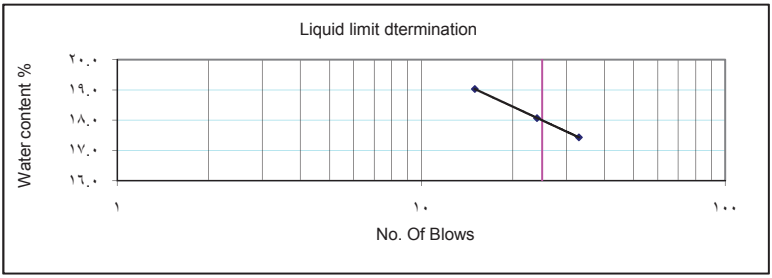
Report No.	Att.: 04/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 1L, 2nd Layer from st. (0+280)
Source of Sample	Project Site
Sampling Date	17/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	88.9	85.2	66.5	58.4			
Mass of Dry Soil + Can	80.6	76.2	59.8	54.0			
Mass of Can	33.0	26.4	24.6	26.6			
Mass of Dry Soil	47.6	49.8	35.2	27.4			
Mass of Moisture	8.3	9.0	6.7	4.4			
Water Content %	**17.4**	**18.1**	**19.0**	**16.1**			
No. of Blows N	33	24	15				
Log(N)	1.52	1.38	1.18				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	18.0	16.1	**1.9**



Test Report for Atterberg Limits

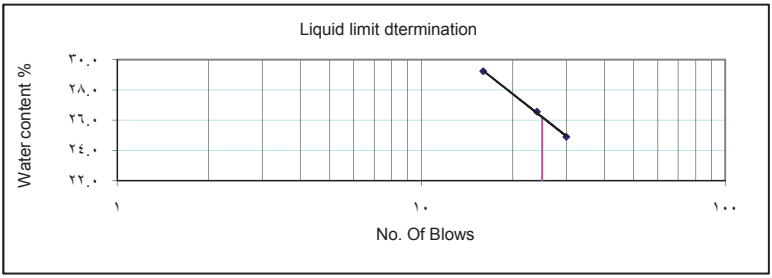
Report No.	Att.: 05/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 2R, 2nd Layer from st. (0+360)
Source of Sample	Project Site
Sampling Date	12/04/2012

Liquid Limit Determination AASHTO T89-10				Plastic Limit Determination AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	126.9	104.8	116.3	89.3			
Mass of Dry Soil + Can	112.8	94.6	102.7	84.6			
Mass of Can	56.2	56.2	56.2	56.2			
Mass of Dry Soil	56.6	38.4	46.5	28.4			
Mass of Moisture	14.1	10.2	13.6	4.7			
Water Content %	24.9	26.6	29.2	16.5			
No. of Blows N	30	24	16				
Log(N)	1.48	1.38	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	26.2	16.5	**9.7**



Test Report for Atterberg Limits

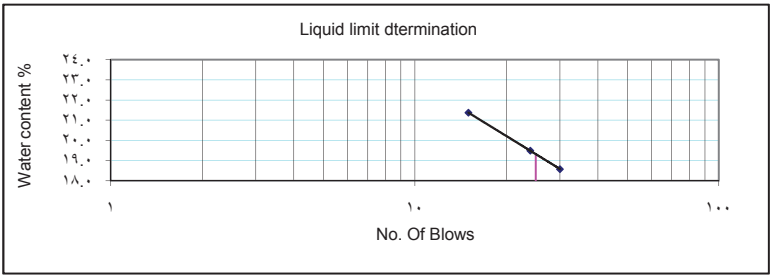
Report No.	Att.: 06/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 4R, 1st Layer from st. (2+340)
Source of Sample	Project Site
Sampling Date	12/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	102.3	84.8	91.6	61.2			
Mass of Dry Soil + Can	91.3	75.6	80.4	57.3			
Mass of Can	32.1	28.4	28.0	32.2			
Mass of Dry Soil	59.2	47.2	52.4	25.1			
Mass of Moisture	11.0	9.2	11.2	3.9			
Water Content %	18.6	19.5	21.4	15.5			
No. of Blows N	30	24	15				
Log(N)	1.48	1.38	1.18				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	19.3	15.5	**3.8**



Test Report for Atterberg Limits

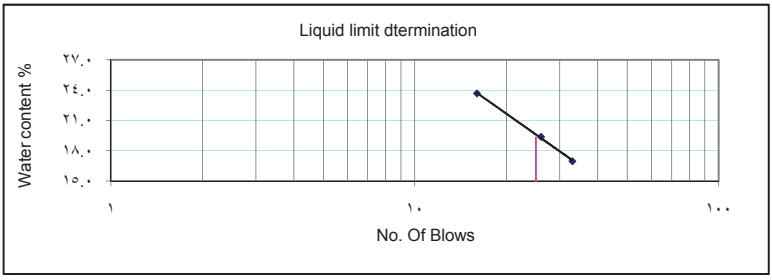
Report No.	Att.: 07/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 4R, 2nd Layer from st. (2+340)
Source of Sample	Project Site
Sampling Date	17/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	90.1	87.4	70.6	56.8			
Mass of Dry Soil + Can	80.8	77.3	63.4	53.6			
Mass of Can	26.0	25.2	33.0	33.2			
Mass of Dry Soil	54.8	52.1	30.4	20.4			
Mass of Moisture	9.3	10.1	7.2	3.2			
Water Content %	17.0	19.4	23.7	15.7			
No. of Blows N	33	26	16				
Log(N)	1.52	1.41	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	19.6	15.7	**3.9**



Test Report for Atterberg Limits

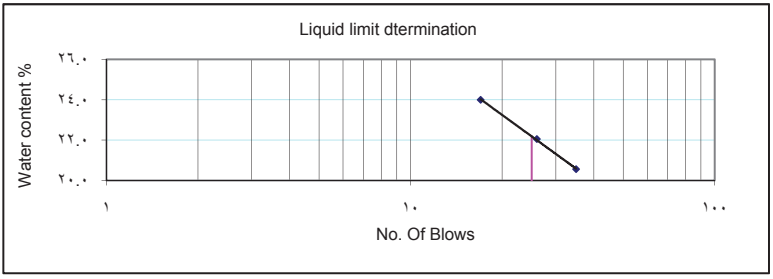
Report No.	Att.: 08/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 5L, 1st Layer from st. (2+430)
Source of Sample	Project Site
Sampling Date	18/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	90.7	86.8	110.3	51.2			
Mass of Dry Soil + Can	79.6	76.9	94.1	47.9			
Mass of Can	25.6	32.0	26.6	28.4			
Mass of Dry Soil	54	44.9	67.5	19.5			
Mass of Moisture	11.1	9.9	16.2	3.3			
Water Content %	20.6	22.0	24.0	16.9			
No. of Blows N	35	26	17				
Log(N)	1.54	1.41	1.23				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	22.2	16.9	**5.3**



Test Report for Atterberg Limits

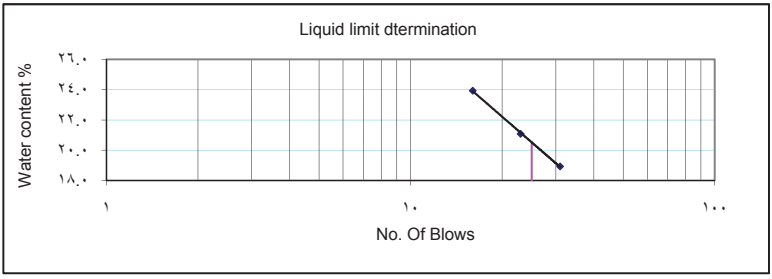
Report No.	Att.: 09/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 5L, 2nd Layer from st. (2+430)
Source of Sample	Project Site
Sampling Date	18/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	77.8	89.6	120.3	64.6			
Mass of Dry Soil + Can	70.0	79.4	103.6	60.4			
Mass of Can	28.8	31.0	33.8	33.5			
Mass of Dry Soil	41.2	48.4	69.8	26.9			
Mass of Moisture	7.8	10.2	16.7	4.2			
Water Content %	18.9	21.1	23.9	15.6			
No. of Blows N	31	23	16				
Log(N)	1.49	1.36	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	20.5	15.6	**4.9**



Test Report for Atterberg Limits

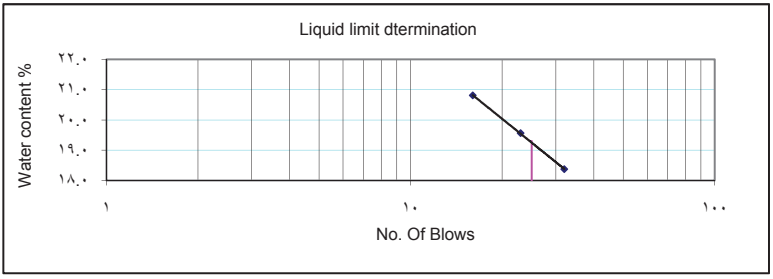
Report No.	Att.: 10/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 6R, 1st Layer from st. (2+610)
Source of Sample	Project Site
Sampling Date	18/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	93.7	89.8	80.6	60.7			
Mass of Dry Soil + Can	83.3	79.9	72.4	57.0			
Mass of Can	26.7	29.3	33.0	32.1			
Mass of Dry Soil	56.6	50.6	39.4	24.9			
Mass of Moisture	10.4	9.9	8.2	3.7			
Water Content %	18.4	19.6	20.8	14.9			
No. of Blows N	32	23	16				
Log(N)	1.51	1.36	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	19.3	14.9	**4.4**



Test Report for Atterberg Limits

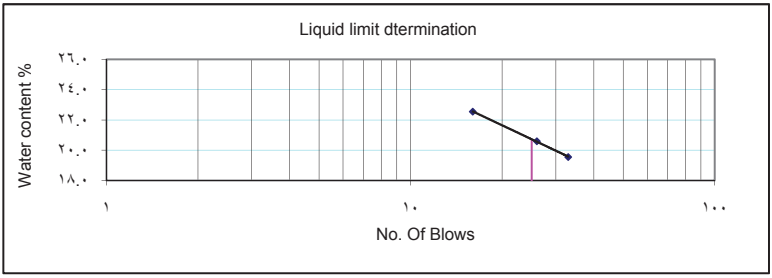
Report No.	Att.: 11/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 6R, 2nd Layer from st. (2+610)
Source of Sample	Project Site
Sampling Date	18/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	88.7	78.7	98.6	56.0			
Mass of Dry Soil + Can	78.3	69.6	85.3	52.7			
Mass of Can	25.1	25.4	26.3	31.3			
Mass of Dry Soil	53.2	44.2	59	21.4			
Mass of Moisture	10.4	9.1	13.3	3.3			
Water Content %	19.5	20.6	22.5	15.4			
No. of Blows N	33	26	16				
Log(N)	1.52	1.41	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	20.7	15.4	**5.3**



Test Report for Atterberg Limits

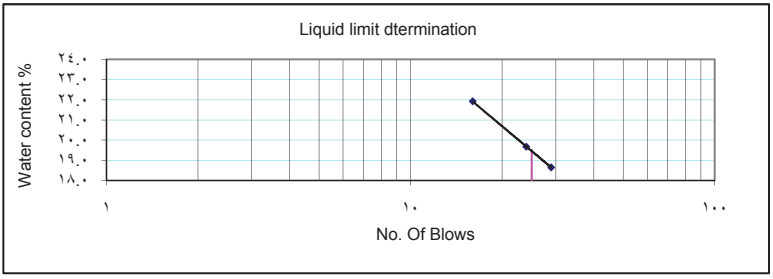
Report No.	Att.: 12/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 7L, 1st Layer from st. (2+700)
Source of Sample	Project Site
Sampling Date	18/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	96.5	82.7	70.8	62.1			
Mass of Dry Soil + Can	86.6	73.0	62.8	58.1			
Mass of Can	33.5	23.7	26.3	33.5			
Mass of Dry Soil	53.1	49.3	36.5	24.6			
Mass of Moisture	9.9	9.7	8.0	4.0			
Water Content %	18.6	19.7	21.9	16.3			
No. of Blows N	29	24	16				
Log(N)	1.46	1.38	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	19.5	16.3	**3.2**



Test Report for Atterberg Limits

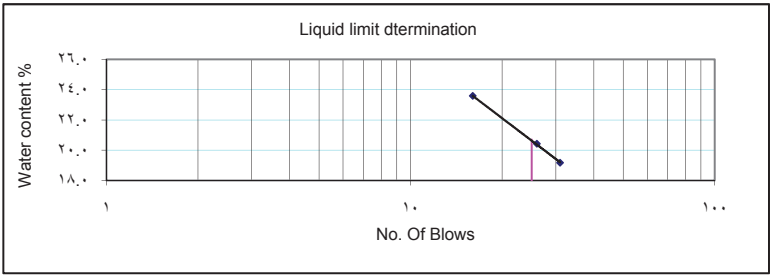
Report No.	Att.: 13/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 7L, 2nd Layer from st. (2+700)
Source of Sample	Project Site
Sampling Date	18/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	96.7	89.4	88.6	52.2			
Mass of Dry Soil + Can	85.2	79.7	77.8	48.5			
Mass of Can	25.2	32.2	32.0	23.7			
Mass of Dry Soil	60	47.5	45.8	24.8			
Mass of Moisture	11.5	9.7	10.8	3.7			
Water Content %	19.2	20.4	23.6	14.9			
No. of Blows N	31	26	16				
Log(N)	1.49	1.41	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	20.6	14.9	**5.7**



Test Report for Atterberg Limits

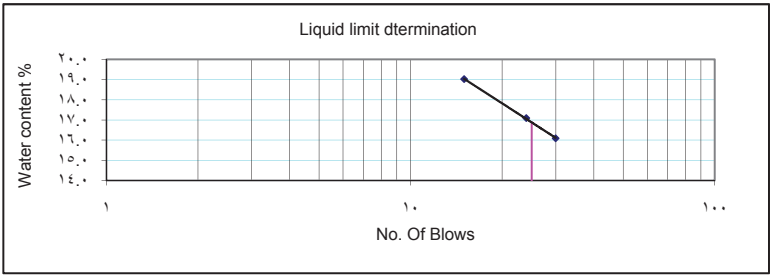
Report No.	Att.: 14/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 10L, 1st Layer from st. (3+113)
Source of Sample	Project Site
Sampling Date	18/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	98.6	111.9	64.8	61.0			
Mass of Dry Soil + Can	89.4	100.4	58.6	57.9			
Mass of Can	32.2	33.1	26.0	37.2			
Mass of Dry Soil	57.2	67.3	32.6	20.7			
Mass of Moisture	9.2	11.5	6.2	3.1			
Water Content %	16.1	17.1	19.0	15.0			
No. of Blows N	30	24	15				
Log(N)	1.48	1.38	1.18				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	16.9	15.0	**1.9**



Test Report for Atterberg Limits

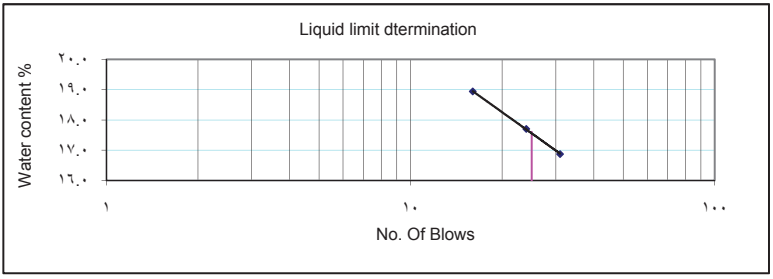
Report No.	Att.: 15/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 10L, 2nd Layer from st. (3+113)
Source of Sample	Project Site
Sampling Date	18/04/2012

Liquid Limit Determination AASHTO T89-10				Plastic Limit Determination AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	90.3	77.8	80.6	49.4			
Mass of Dry Soil + Can	82.1	70.1	72.0	46.5			
Mass of Can	33.5	26.6	26.6	28.1			
Mass of Dry Soil	48.6	43.5	45.4	18.4			
Mass of Moisture	8.2	7.7	8.6	2.9			
Water Content %	16.9	17.7	18.9	15.8			
No. of Blows N	31	24	16				
Log(N)	1.49	1.38	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	17.6	15.8	**1.8**



Test Report for Atterberg Limits

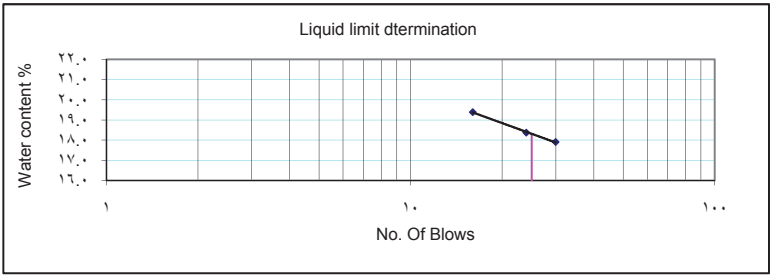
Report No.	Att.: 16/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 12R, 1st Layer from st. (3+290)
Source of Sample	Project Site
Sampling Date	12/04/2012

Liquid Limit Determination AASHTO T89-10				Plastic Limit Determination AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	102.5	97.8	76.8	60.9			
Mass of Dry Soil + Can	92.6	86.3	68.6	56.9			
Mass of Can	37.3	23.7	26.3	32.2			
Mass of Dry Soil	55.3	62.6	42.3	24.7			
Mass of Moisture	9.9	11.5	8.2	4.0			
Water Content %	17.9	18.4	19.4	16.2			
No. of Blows N	30	24	16				
Log(N)	1.48	1.38	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	18.3	16.2	**2.1**



Test Report for Atterberg Limits

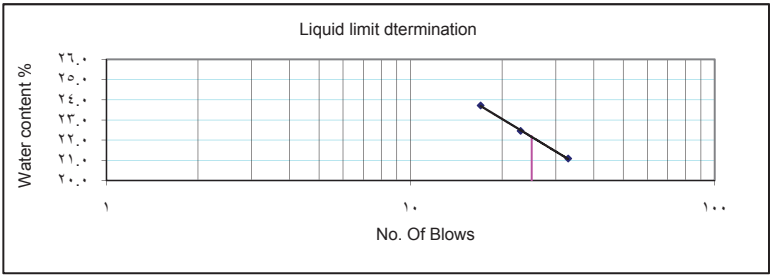
Report No.	Att.: 17/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 12R, 2nd Layer from st. (3+290)
Source of Sample	Project Site
Sampling Date	12/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	91.5	87.2	76.8	54.1			
Mass of Dry Soil + Can	81.4	77.3	67.1	51.2			
Mass of Can	33.5	33.2	26.2	33.5			
Mass of Dry Soil	47.9	44.1	40.9	17.7			
Mass of Moisture	10.1	9.9	9.7	2.9			
Water Content %	21.1	22.4	23.7	16.4			
No. of Blows N	33	23	17				
Log(N)	1.52	1.36	1.23				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	22.2	16.4	**5.8**



California Bearing Ratio
Test Report

Report No	CBR/01/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 1R, 2nd Layer from st. (0+280) same as 6R, 2nd layer	Source of Sample	Project Site

Sampling Date	17/04/2012	Testing Method	**ASTM D1883**

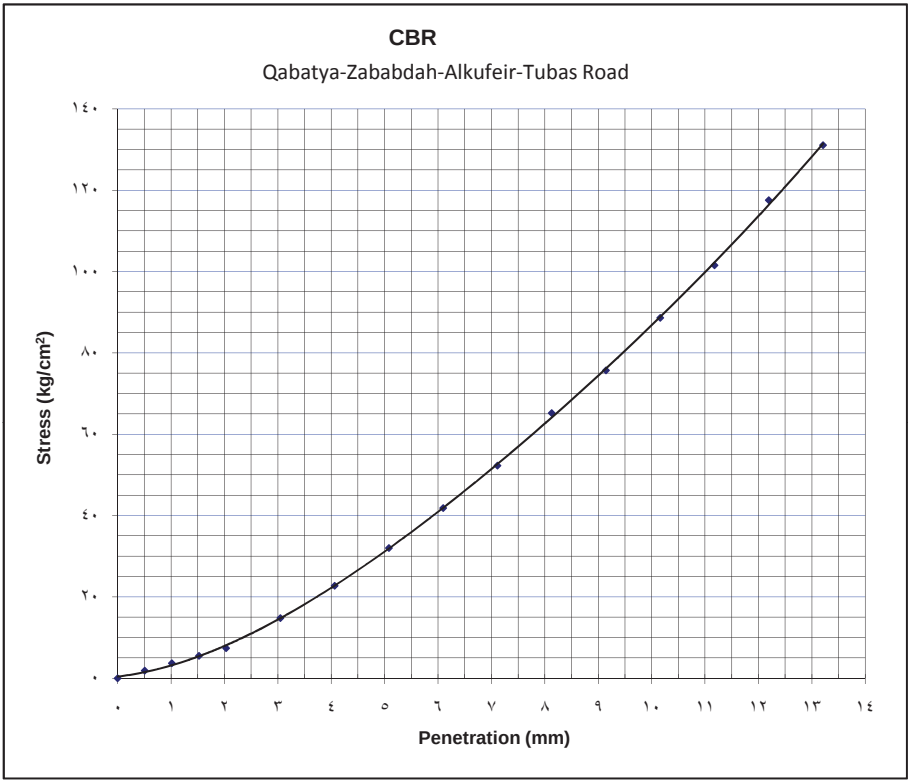
Starting Date	Starting Time	Elapsed Time Hour	Mold no.	1	Mold no.		Mold no.	
			Blows No.	56	Blows No.		Blows No.	
			Surch. gm	5028	Surch. gm		Surch. gm	
			Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %
23/04/2012	15:00	0.00	0.00	0.00				
24/04/2012	15:00	24.00	8.00	0.67				
25/04/2012	15:00	48.00	8.00	0.67				
26/04/2012	15:00	72.00	8.00	0.67				
27/04/2012	15:00	96.00	8.00	0.67				

Mold No	1		
Surcharge, gm	5028		
Initial mass of wet soil+ mold+base plate	12000		
Final mass of wet soil+mold+base plate	12030		
Mass of mold+base plate	6792		
Initial mass of wet soil, M_i	5208		
Initial wet density, r_i	2.39		
Mass of water absorbed, M_w	30.0		
% water absorbed $=M_W/M_s$ x100	0.58		
Diameter (cm)	15.2		
Height (cm)	12.0		
Volume (cm^3)	2183		

Penetration mm	Mold No.	1	Mold No.		Mold No.		
	Blows No.	56	Blows No.		Blows No.		
	Surch.gm	4554	Surch.gm		Surch.gm		
	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	
0.0	0	0.0					
0.5	3	1.8					
1.0	6	3.7					
1.5	9	5.5					
2.0	12	7.4					
3.0	24	14.8					
4	37	22.8					
5	52	32.0					
6	68	41.8					
7	85	52.3					
8	106	65.2					
9	123	75.7					
10	144	88.6					
11	165	101.5					
12	191	117.5					
13	213	131.1					

Water content %	8.1			
Wet Density r_{wet} Kg/cm^3	2.39			
Dry Density r_d Kg/cm^3	2.21			

	56 blows			
Corr. Stress at 2.5mm	32			
Corr. Stress at 5mm	88			
Corr. CBR at 2.5mm	46			
Corr. CBR at 5mm	85			
CBR	85			
Dry Density	2.21			


CBR
Qabatya-Zababdah-Alkufeir-Tubas Road
Stress (kg/cm²)
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Penetration (mm)

California Bearing Ratio
Test Report

Report No	CBR/02/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 1L, 2nd Layer from st. (0+280)	Source of Sample	Project Site

Sampling Date	17/04/2012	Testing Method	**ASTM D1883**

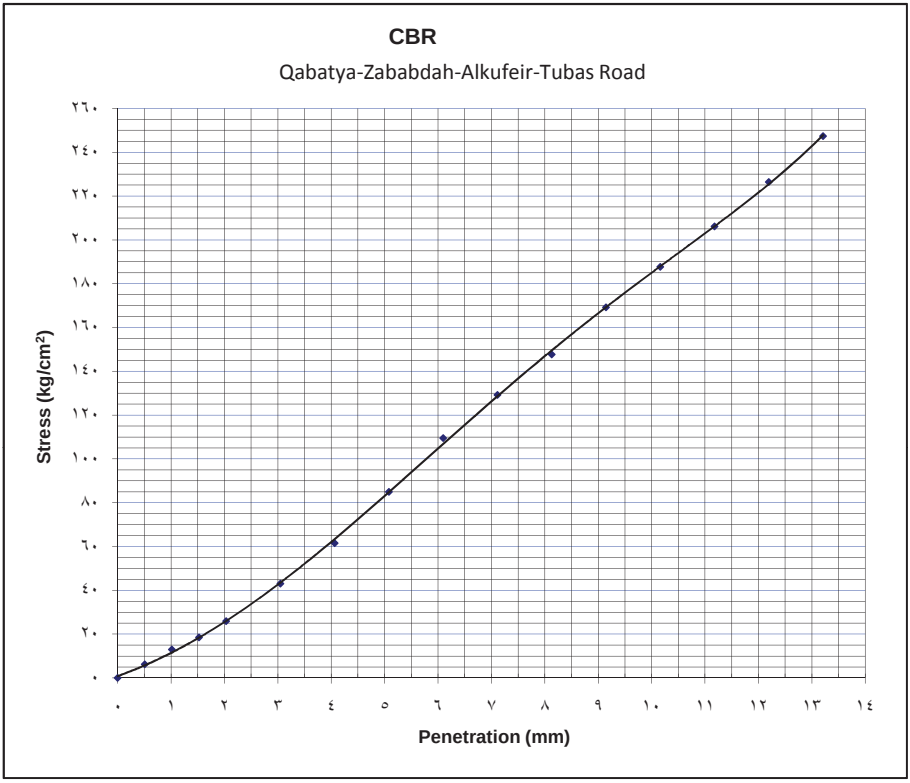
Starting Date	Starting Time	Elapsed Time Hour	Mold no. / Blows No. / Surch. gm / Dial reading (x_0.01)	1 / 56 / 5480 / Shrinkage =100*S/H %	Mold no. / Blows No. / Surch. gm / Dial reading (x_0.01)	Shrinkage =100*S/H %	Mold no. / Blows No. / Surch. gm / Dial reading (x_0.01)	Shrinkage =100*S/H %
23/04/2012	15:30	0.00	0.00					
24/04/2012	15:30	24.00	0.00					
25/04/2012	15:30	48.00	0.00					
26/04/2012	15:30	72.00	0.00					
27/04/2012	15:30	96.00	0.00					

Mold No	1		
Surcharge, gm	5480		
Initial mass of wet soil+ mold+base plate	12010		
Final mass of wet soil+mold+base plate	12025		
Mass of mold+base plate	6792		
Initial mass of wet soil, M_i	5218		
Initial wet density, r_i	2.39		
Mass of water absorbed, M_w	15.0		
% water absorbed $=M_W/M_s$ x100	0.29		
Diameter (cm)	15.2		
Height (cm)	12.0		
Volume (cm^3)	2183		

Penetration mm	Mold No.	1	Mold No.		Mold No.		
	Blows No.	56	Blows No.		Blows No.		
	Surch.gm	5012	Surch.gm		Surch.gm		
	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	
0.0	0	0.0					
0.5	10	6.2					
1.0	21	12.9					
1.5	30	18.5					
2.0	42	25.8					
3.0	70	43.1					
4	100	61.5					
5	138	84.9					
6	178	109.5					
7	210	129.2					
8	240	147.7					
9	275	169.2					
10	305	187.7					
11	335	206.2					
12	368	226.5					
13	402	247.4					

Water content %	6.3			
Wet Density r_{wet} Kg/cm^3	2.39			
Dry Density r_d Kg/cm^3	2.25			

	56 blows			
Corr. Stress at 2.5mm	45			
Corr. Stress at 5mm	95			
Corr. CBR at 2.5mm	65			
Corr. CBR at 5mm	92			
CBR	92			
Dry Density	2.25			


CBR
Qabatya-Zababdah-Alkufeir-Tubas Road
Stress (kg/cm2)
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Penetration (mm)

California Bearing Ratio Test Report

Report No	CBR/03/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 2R, 2nd Layer from st. (0+360)	Source of Sample	Project Site

Sampling Date	12/04/2012	Testing Method	**ASTM D1883**

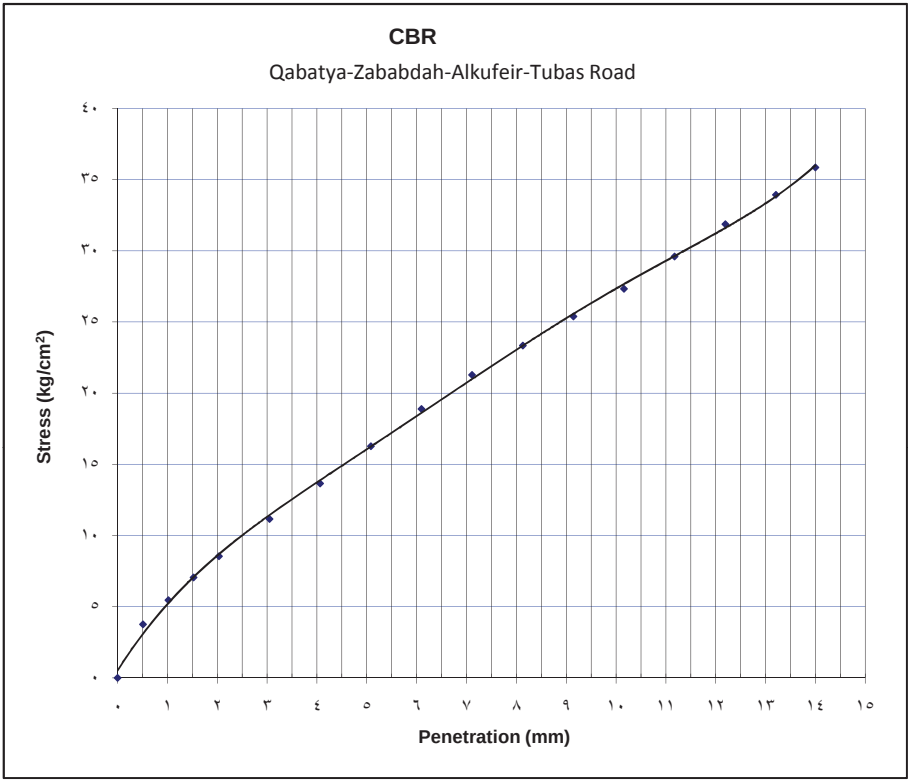
Starting Date	Starting Time	Elapsed Time Hour	Mold no.	1	Mold no.		Mold no.	
			Blows No.	56	Blows No.		Blows No.	
			Surch. gm	5490	Surch. gm		Surch. gm	
			Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %
28/04/2012	15:00	0.00	0.00	0.00				
29/04/2012	15:00	24.00	3.50	0.29				
30/04/2012	15:00	48.00	8.00	0.67				
01/05/2012	15:00	72.00	16.00	1.33				

Mold No	1		
Surcharge, gm	5490		
Initial mass of wet soil+ mold+base plate	11960		
Final mass of wet soil+mold+base plate	12010		
Mass of mold+base plate	6848		
Initial mass of wet soil, M_i	5112		
Initial wet density, r_i	2.35		
Mass of water absorbed, M_w	50.0		
% water absorbed $=M_W/M_s$ x100	0.98		
Diameter (cm)	15.2		
Height (cm)	12.0		
Volume (cm^3)	2178		

Penetration mm	Mold No.	1	Mold No.		Mold No.		
	Blows No.	56	Blows No.		Blows No.		
	Surch.gm	5020	Surch.gm		Surch.gm		
	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	
0.0	0	0.0					
0.5	33	3.8					
1.0	48	5.5					
1.5	62	7.1					
2.0	75	8.5					
3.0	98	11.2					
4	120	13.7					
5	143	16.3					
6	166	18.9					
7	187	21.3					
8	205	23.3					
9	223	25.4					
10	240	27.3					
11	260	29.6					
12	280	31.9					
13	298	33.9					
14	315	35.9					

Water content %	9.2			
Wet Density r_{wet} Kg/cm^3	2.35			
Dry Density r_d Kg/cm^3	2.15			

	56 blows			
Corr. Stress at 2.5mm	10			
Corr. Stress at 5mm	16			
Corr. CBR at 2.5mm	14			
Corr. CBR at 5mm	16			
CBR	16			
Dry Density	2.15			


CBR
Qabatya-Zababdah-Alkufeir-Tubas Road
Stress (kg/cm2)
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Penetration (mm)

California Bearing Ratio
Test Report

Report No	CBR/04/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 4R, 2nd Layer from st. (2+340) same as 4R, 1st Layer	Source of Sample	Project Site

Sampling Date	17/04/2012	Testing Method	**ASTM D1883**

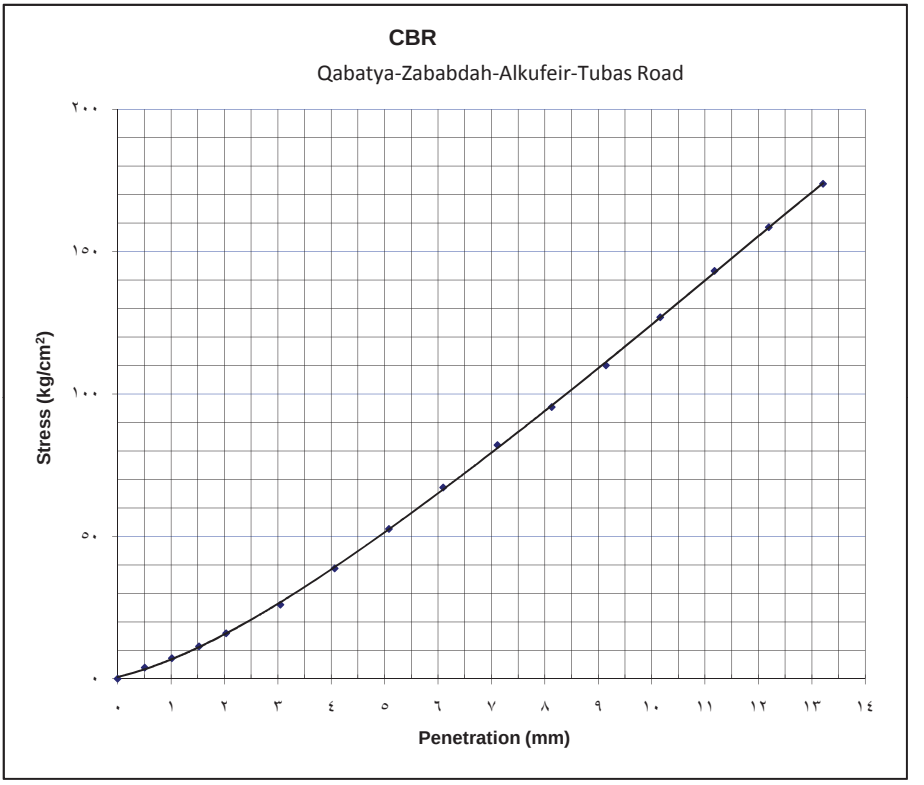
Starting Date	Starting Time	Elapsed Time Hour	Mold no.	1	Mold no.		Mold no.	
			Blows No.	56	Blows No.		Blows No.	
			Surch. gm	5028	Surch. gm		Surch. gm	
			Dial reading (x_0.01)	swelling =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %
28/04/2012	12:00	0.00	0.00	0.00				
29/04/2012	12:00	24.00	8.00	0.67				
30/04/2012	12:00	48.00	8.00	0.67				
01/05/2012	12:00	72.00	8.00	0.67				

Mold No	1		
Surcharge, gm	5028		
Initial mass of wet soil+ mold+base plate	11940		
Final mass of wet soil+mold+base plate	11960		
Mass of mold+base plate	6766		
Initial mass of wet soil, M_i	5174		
Initial wet density, r_i	2.37		
Mass of water absorbed, M_w	20.0		
% water absorbed $=M_W/M_s$ x100	0.39		
Diameter (cm)	15.2		
Height (cm)	12.0		
Volume (cm^3)	2183		

Penetration mm	Mold No.	1	Mold No.		Mold No.		
	Blows No.	56	Blows No.		Blows No.		
	Surch.gm	4318	Surch.gm		Surch.gm		
	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	
0.0	0	0.0					
0.5	34	3.9					
1.0	63	7.2					
1.5	100	11.4					
2.0	140	15.9					
3.0	228	26.0					
4	340	38.7					
5	462	52.6					
6	590	67.2					
7	721	82.1					
8	838	95.4					
9	967	110.1					
10	1115	126.9					
11	1258	143.2					
12	1393	158.6					
13	1527	173.8					

Water content %	6.9			
Wet Density r_{wet} Kg/cm^3	2.37			
Dry Density r_d Kg/cm^3	2.22			

	56 blows			
Corr. Stress at 2.5mm	39			
Corr. Stress at 5mm	75			
Corr. CBR at 2.5mm	57			
Corr. CBR at 5mm	73			
CBR	73			
Dry Density	2.22			


CBR
Qabatya-Zababdah-Alkufeir-Tubas Road
Stress (kg/cm²)
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٠ ١ ٢ ٣ ٤ ٥ ٦ ٧ ٨ ٩ ١٠ ١١ ١٢ ١٣ ١٤
Penetration (mm)

California Bearing Ratio Test Report

Report No	CBR/05/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 5L, 2nd Layer from st. (2+430)	Source of Sample	Project Site

Sampling Date	18/04/2012	Testing Method	**ASTM D1883**

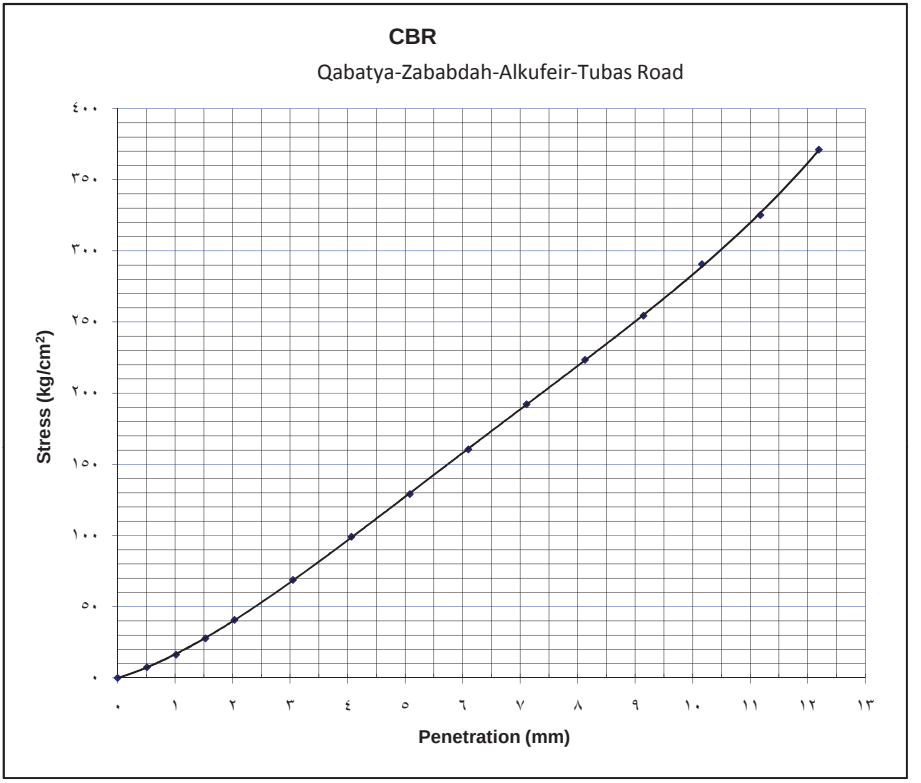
Starting Date	Starting Time	Elapsed Time Hour	Mold no.	1	Mold no.		Mold no.	
			Blows No.	56	Blows No.		Blows No.	
			Surch. gm	5300	Surch. gm		Surch. gm	
			Dial reading (x_0.01)	swelling =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %
28/04/2012	12:30	0.00	0.00	0.00				
29/04/2012	12:30	24.00	3.00	0.25				
30/04/2012	12:30	48.00	3.00	0.25				
01/05/2012	12:30	72.00	3.00	0.25				

Mold No	1		
Surcharge, gm	5300		
Initial mass of wet soil+ mold+base plate	12038		
Final mass of wet soil+mold+base plate	13076		
Mass of mold+base plate	6806		
Initial mass of wet soil, M_i	5232		
Initial wet density, r_i	2.40		
Mass of water absorbed, M_w	1038.0		
% water absorbed $=M_W/M_s$ x100	19.84		
Diameter (cm)	15.2		
Height (cm)	12.0		
Volume (cm^3)	2183		

Penetration mm	Mold No.	1	Mold No.		Mold No.		
	Blows No.	56	Blows No.		Blows No.		
	Surch.gm	4318	Surch.gm		Surch.gm		
	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	
0.0	0	0.0					
0.5	65	7.4					
1.0	143	16.3					
1.5	244	27.8					
2.0	357	40.6					
3.0	605	68.9					
4	870	99.0					
5	1134	129.1					
6	1410	160.5					
7	1688	192.2					
8	1962	223.4					
9	2234	254.3					
10	2553	290.6					
11	2856	325.1					
12	3260	371.1					

Water content %	7.2			
Wet Density r_{wet} Kg/cm^3	2.40			
Dry Density r_d Kg/cm^3	2.24			

	56 blows			
Corr. Stress at 2.5mm	50			
Corr. Stress at 5mm	129			
Corr. CBR at 2.5mm	72			
Corr. CBR at 5mm	125			
CBR	125			
Dry Density	2.24			


CBR
Qabatya-Zababdah-Alkufeir-Tubas Road
Stress (kg/cm2)
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Penetration (mm)

California Bearing Ratio
Test Report

Report No	CBR/06/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 7L, 1st Layer from st. (2+700) same as 1R, 1st Layer, 1L, 1st Layer, 5L, 1st Layer, 6R, 1st Layer, 10L, 1st Layer & 12R,1st Layer	Source of Sample	Project Site

Sampling Date	18/04/2012	Testing Method	**ASTM D1883**

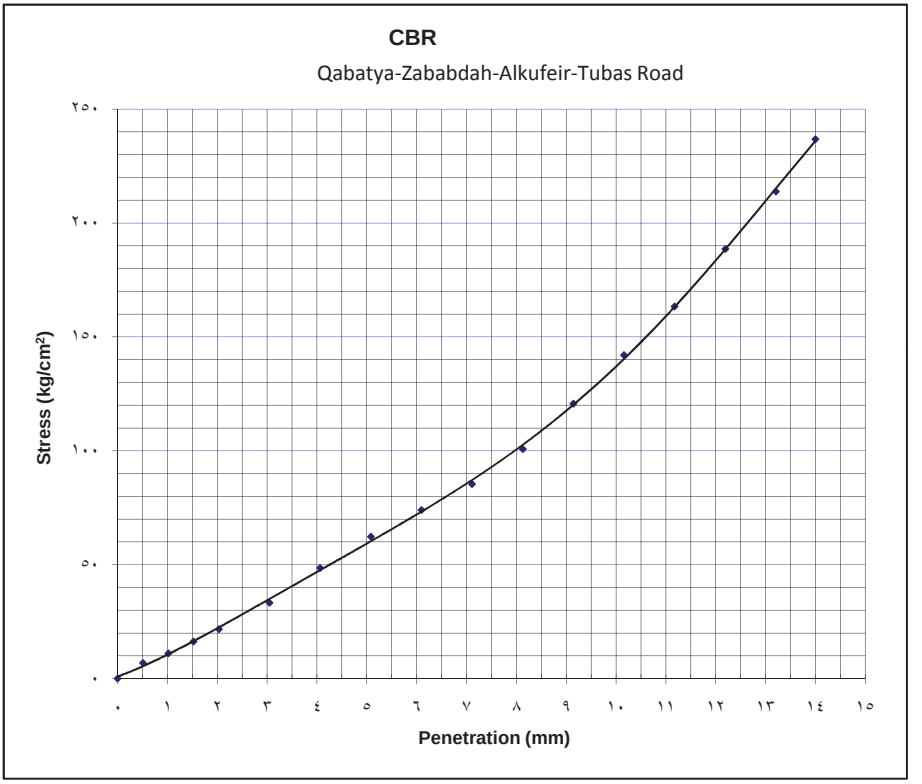
Starting Date	Starting Time	Elapsed Time Hour	Mold no.	1	Mold no.		Mold no.	
			Blows No.	56	Blows No.		Blows No.	
			Surch. gm	5486	Surch. gm		Surch. gm	
			Dial reading (x_0.01)	swelling =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %
28/04/2012	14:30	0.00	0.00	0.00				
29/04/2012	14:30	24.00	4.00	0.33				
30/04/2012	14:30	48.00	10.00	0.83				
01/05/2012	14:30	72.00	14.00	1.16				

Mold No	1		
Surcharge, gm	5486		
Initial mass of wet soil+ mold+base plate	12118		
Final mass of wet soil+mold+base plate	12132		
Mass of mold+base plate	6938		
Initial mass of wet soil,M_i	5180		
Initial wet density, r_i	2.37		
Mass of water absorbed,M_w	14.0		
% water absorbed =M_W/M_s x100	0.27		
Diameter (cm)	15.2		
Height (cm)	12.0		
Volume (cm^3)	2183		

Penetration mm	Mold No.	1	Mold No.		Mold No.		
	Blows No.	56	Blows No.		Blows No.		
	Surch.gm	5000	Surch.gm		Surch.gm		
	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	
0.0	0	0.0					
0.5	60	6.8					
1.0	97	11.0					
1.5	143	16.3					
2.0	190	21.6					
3.0	292	33.2					
4	426	48.5					
5	547	62.3					
6	650	74.0					
7	750	85.4					
8	885	100.8					
9	1060	120.7					
10	1247	142.0					
11	1435	163.4					
12	1656	188.5					
13	1878	213.8					
14	2080	236.8					

Water content %	7.3			
Wet Density r_{wet} Kg/cm^3	2.37			
Dry Density r_d Kg/cm^3	2.21			

	56 blows			
Corr. Stress at 2.5mm	62			
Corr. Stress at 5mm	96			
Corr. CBR at 2.5mm	90			
Corr. CBR at 5mm	93			
CBR	93			
Dry Density	2.21			


CBR
Qabatya-Zababdah-Alkufeir-Tubas Road
Stress (kg/cm²)
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Penetration (mm)

California Bearing Ratio
Test Report

Report No	CBR/07/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 10L, 2nd Layer from st. (3+113)	Source of Sample	Project Site

Sampling Date	18/04/2012	Testing Method	**ASTM D1883**

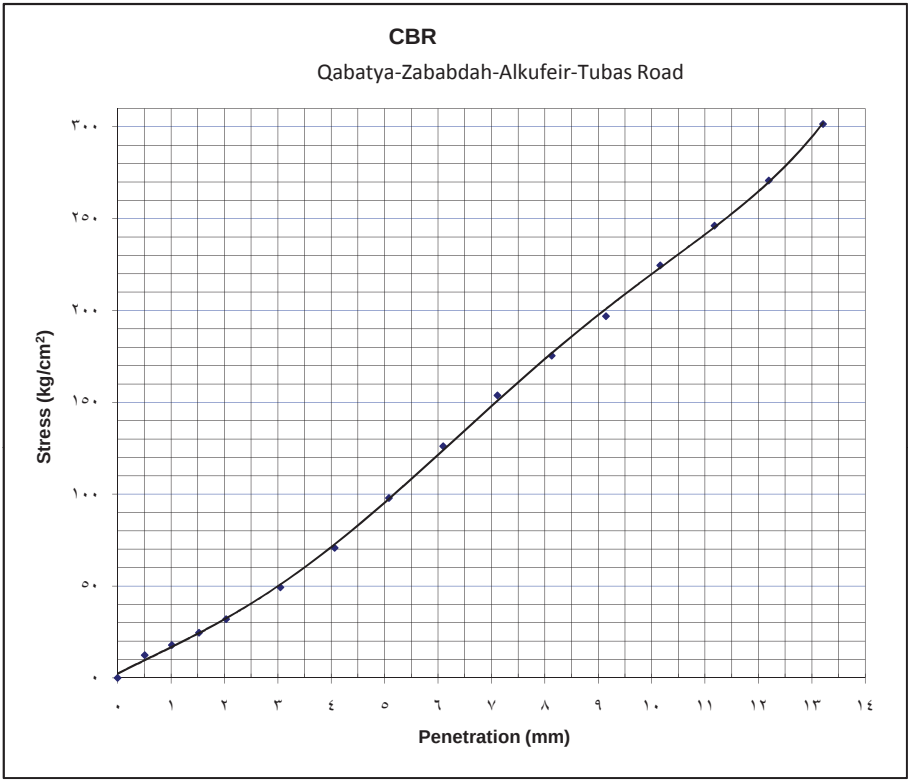
Starting Date	Starting Time	Elapsed Time Hour	Mold no.	1	Mold no.		Mold no.	
			Blows No.	56	Blows No.		Blows No.	
			Surch. gm	5746	Surch. gm		Surch. gm	
			Dial reading (x_0.01)	shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %
24/04/2012	09:00	0.00	0.00	0.00				
25/04/2012	10:00	24.00	6.00	0.51				
26/04/2012	11:00	48.00	16.00	1.37				
27/04/2012	12:00	72.00	20.00	1.71				
28/04/2012	13:00	96.00	23.00	0.01				

Mold No	1		
Surcharge, gm	5746		
Initial mass of wet soil+ mold+base plate	11966		
Final mass of wet soil+mold+base plate	11996		
Mass of mold+base plate	6940		
Initial mass of wet soil, M_i	5026		
Initial wet density, r_i	2.37		
Mass of water absorbed, M_w	30.0		
% water absorbed $=M_W/M_s$ x100	0.60		
Diameter (cm)	15.2		
Height (cm)	11.7		
Volume (cm^3)	2123		

Penetration mm	Mold No.	1	Mold No.		Mold No.		
	Blows No.	56	Blows No.		Blows No.		
	Surch.gm	4998	Surch.gm		Surch.gm		
	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	
0.0	0	0.0					
0.5	20	12.3					
1.0	29	17.8					
1.5	40	24.6					
2.0	52	32.0					
3.0	80	49.2					
4	115	70.8					
5	159	97.8					
6	205	126.2					
7	250	153.8					
8	285	175.4					
9	320	196.9					
10	365	224.6					
11	400	246.2					
12	440	270.8					
13	490	301.5					

Water content %	7.1			
Wet Density r_{wet} Kg/cm^3	2.37			
Dry Density r_d Kg/cm^3	2.21			

	56 blows			
Corr. Stress at 2.5mm	40			
Corr. Stress at 5mm	98			
Corr. CBR at 2.5mm	58			
Corr. CBR at 5mm	95			
CBR	95			
Dry Density	2.21			


CBR
Qabatya-Zababdah-Alkufeir-Tubas Road
Stress (kg/cm2)
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Penetration (mm)

California Bearing Ratio Test Report

Report No	CBR/08/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 12R, 2nd Layer from st. (3+290)	Source of Sample	Project Site

Sampling Date	12/04/2012	Testing Method	**ASTM D1883**

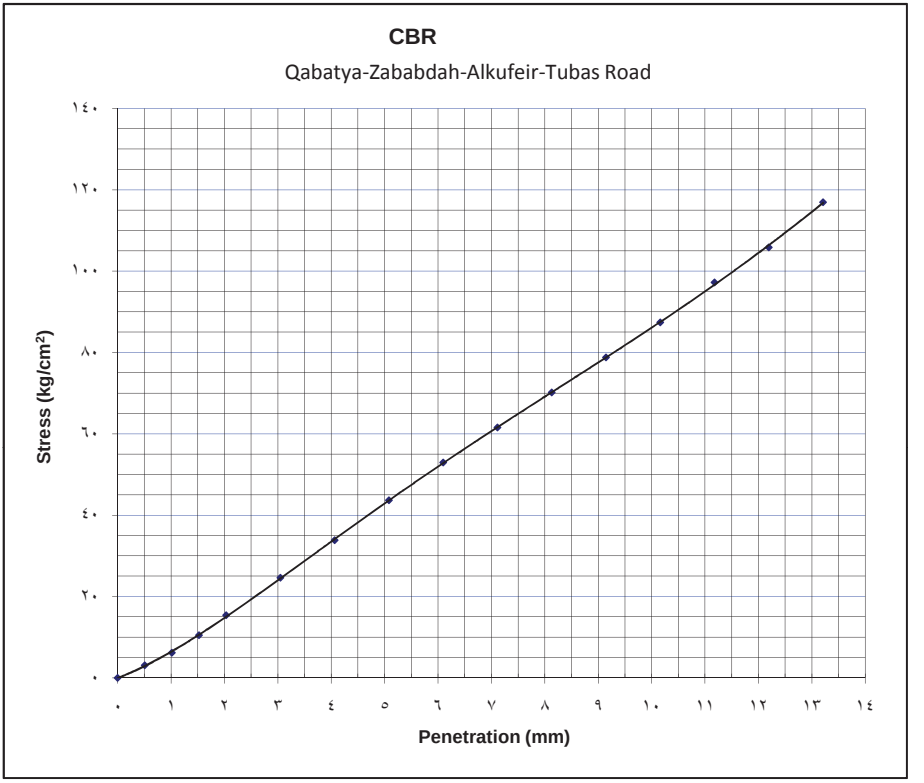
Starting Date	Starting Time	Elapsed Time Hour	Mold no.	1	Mold no.		Mold no.	
			Blows No.	56	Blows No.		Blows No.	
			Surch. gm	5026	Surch. gm		Surch. gm	
			Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %
18/04/2012	09:00	0.00	0.00	0.00				
19/04/2012	09:00	24.00	3.00	0.25				
20/04/2012	09:00	48.00	5.00	0.42				
21/04/2012	09:00	72.00	6.00	0.50				
22/04/2012	09:00	96.00	7.00	0.58				

Mold No	1		
Surcharge, gm	5026		
Initial mass of wet soil+ mold+base plate	11900		
Final mass of wet soil+mold+base plate	11976		
Mass of mold+base plate	6792		
Initial mass of wet soil, M_i	5108		
Initial wet density, r_i	2.34		
Mass of water absorbed, M_w	76.0		
% water absorbed $=M_W/M_s$ x100	1.49		
Diameter (cm)	15.2		
Height (cm)	12.0		
Volume (cm^3)	2183		

Penetration mm	Mold No.	1	Mold No.		Mold No.		
	Blows No.	56	Blows No.		Blows No.		
	Surch.gm	4554	Surch.gm		Surch.gm		
	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	
0.0	0	0.0					
0.5	5	3.1					
1.0	10	6.2					
1.5	17	10.5					
2.0	25	15.4					
3.0	40	24.6					
4	55	33.8					
5	71	43.7					
6	86	52.9					
7	100	61.5					
8	114	70.2					
9	128	78.8					
10	142	87.4					
11	158	97.2					
12	172	105.8					
13	190	116.9					

Water content %	8.0			
Wet Density r_{wet} Kg/cm^3	2.34			
Dry Density r_d Kg/cm^3	2.17			

	56 blows			
Corr. Stress at 2.5mm	20			
Corr. Stress at 5mm	44			
Corr. CBR at 2.5mm	29			
Corr. CBR at 5mm	43			
CBR	43			
Dry Density	2.17			


CBR
Qabatya-Zababdah-Alkufeir-Tubas Road
Stress (kg/cm2)
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Penetration (mm)

Field Density of Soil Test Report [Sand Cone Method]

Report No.:	FD: 01/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material, 2nd Layer			
Sampled by	Lab. Engineers			
Test Method	**ASTM D 1556-07**			
Type of Sand	Standard sand 600 /300 μ m C fraction	Unit Weight of Sand	1.49	gm/cm^3
Testing Date :	21/04/2012			

TEST RESULTS

Point		1	2	3	4	5
Location		1R	2R	3R	4R	6R
Station		0+280	0+360	0+450	2+340	2+610
Weight of sand in the jar (gm)		5000	5000	5000	5000	5000
Weight of sand remaining in the jar (gm)		742	576	780	408	1218
Weight of sand filling the cone (gm)		1750	1622	1750	1622	1750
Net Wt. Of Sample Obtained from Hole	(gm)	3750	4146	3772	4464	3238
Moisture Content	%	3.60	5.20	4.00	3.60	6.40
Wt of sand Filled the Hole	(gm)	2508	2802	2470	2970	2032
Volume of the Hole	cm^3	1683	1881	1658	1993	1364
Net wt. of Dry Sample	(gm)	3620	3941	3627	4309	3043
Wet Density	(gm/cm^3)	2.23	2.20	2.28	2.24	2.37
Dry Density	(gm/cm^3)	2.15	2.10	2.19	2.16	2.23
Layer thickness	(cm)	24	15	22	27	21

SOIL DEGREE OF COMPACTION

Dry Density Obtained in Field	gm/cm^3	2.15	2.10	2.19	2.16	2.23
Max.Dry Density From Lab.Compaction Test gm/cm^3		2.23	2.16	2.23	2.23	2.23
Degree of Soil Compaction	%	96	97	98	97	100

Point		6	7	8		
Location		8R	10R	12R		
Station		2+780	3+118	3+290		
Weight of sand in the jar (gm)		5000	5000	5000		
Weight of sand remaining in the jar (gm)		828	1356	912		
Weight of sand filling the cone (gm)		1750	1750	1622		
Net Wt. Of Sample Obtained from Hole	(gm)	3852	2934	3714		
Moisture Content	%	5.40	5.60	6.40		
Wt of sand Filled the Hole	(gm)	2422	1894	2466		
Volume of the Hole	cm^3	1626	1271	1655		
Net wt. of Dry Sample	(gm)	3655	2778	3491		
Wet Density	(gm/cm^3)	2.37	2.31	2.24		
Dry Density	(gm/cm^3)	2.25	2.19	2.11		
Layer thickness	(cm)	24	21	10		

SOIL DEGREE OF COMPACTION

Dry Density Obtained in Field	gm/cm^3	2.25	2.19	2.11		
Max.Dry Density From Lab.Compaction Test gm/cm^3		2.23	2.23	2.17		
Degree of Soil Compaction	%	101	98	97		

REMARKS:	

Field Density of Soil Test Report [Sand Cone Method]

Report No.:	FD: 02/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material, 1st Layer			
Sampled by	Lab. Engineers			
Test Method	**ASTM D 1556-07**			
Type of Sand	Standard sand 600 /300 μ m C fraction	Unit Weight of Sand	1.49	gm/cm^3
Testing Date :	21/04/2012			

TEST RESULTS

Point		1	2	3	4	5
Location		1R	2R	3R	4R	6R
Station		0+280	0+360	0+450	2+340	2+610
Weight of sand in the jar (gm)		5000	5000	5000	5000	5000
Weight of sand remaining in the jar (gm)		682	102	250	398	1214
Weight of sand filling the cone (gm)		1750	1622	1750	1750	1750
Net Wt. Of Sample Obtained from Hole	(gm)	3904	4864	4470	4226	3138
Moisture Content	%	3.90	3.60	4.50	4.50	5.90
Wt of sand Filled the Hole	(gm)	2568	3276	3000	2852	2036
Volume of the Hole	cm^3	1723	2199	2013	1914	1366
Net wt. of Dry Sample	(gm)	3757	4695	4278	4044	2963
Wet Density	(gm/cm^3)	2.27	2.21	2.22	2.21	2.30
Dry Density	(gm/cm^3)	2.18	2.14	2.12	2.11	2.17
Layer thickness	(cm)	23	30	20	32	18

SOIL DEGREE OF COMPACTION

Dry Density Obtained in Field	gm/cm^3	2.18	2.14	2.12	2.11	2.17
Max.Dry Density From Lab.Compaction Test gm/cm^3		2.25	2.23	2.23	2.23	2.23
Degree of Soil Compaction	%	97	96	95	95	97

Point		6	7	8		
Location		8R	10R	12R		
Station		2+780	3+118	3+290		
Weight of sand in the jar (gm)		5000	5000	5000		
Weight of sand remaining in the jar (gm)		752	1300	644		
Weight of sand filling the cone (gm)		1750	1750	1622		
Net Wt. Of Sample Obtained from Hole	(gm)	3854	3026	4030		
Moisture Content	%	2.70	4.80	6.40		
Wt of sand Filled the Hole	(gm)	2498	1950	2734		
Volume of the Hole	cm^3	1677	1309	1835		
Net wt. of Dry Sample	(gm)	3753	2887	3788		
Wet Density	(gm/cm^3)	2.30	2.31	2.20		
Dry Density	(gm/cm^3)	2.24	2.21	2.06		
Layer thickness	(cm)	30	20	35		

SOIL DEGREE OF COMPACTION

Dry Density Obtained in Field	gm/cm^3	2.24	2.21	2.06		
Max.Dry Density From Lab.Compaction Test gm/cm^3		2.23	2.17	2.17		
Degree of Soil Compaction	%	100	102	95		

REMARKS:	

Field Density of Soil Test Report [Sand Cone Method]

Report No.:	FD: 03/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material, 2nd Layer			
Sampled by	Lab. Engineers			
Test Method	**ASTM D 1556-07**			
Type of Sand	Standard sand 600 /300 μ m C fraction	Unit Weight of Sand	1.49	gm/cm^3
Testing Date :	21/04/2012			

TEST RESULTS

Point		1	2	3	4	5
Location		1L	2L	3L	5L	7L
Station		0+280	0+360	0+450	2+430	2+700
Weight of sand in the jar (gm)		5000	5000	5000	5000	5000
Weight of sand remaining in the jar (gm)		704	724	660	682	798
Weight of sand filling the cone (gm)		1750	1750	1750	1750	1750
Net Wt. Of Sample Obtained from Hole	(gm)	3862	3710	3784	4006	3624
Moisture Content	%	4.00	4.50	3.60	3.10	4.20
Wt of sand Filled the Hole	(gm)	2546	2526	2590	2568	2452
Volume of the Hole	cm^3	1709	1695	1738	1723	1646
Net wt. of Dry Sample	(gm)	3713	3550	3653	3886	3478
Wet Density	(gm/cm^3)	2.26	2.19	2.18	2.32	2.20
Dry Density	(gm/cm^3)	2.17	2.09	2.10	2.25	2.11
Layer thickness	(cm)	17	13	16	16	23

SOIL DEGREE OF COMPACTION

Dry Density Obtained in Field	gm/cm^3	2.17	2.09	2.10	2.25	2.11
Max.Dry Density From Lab.Compaction Test gm/cm^3		2.25	2.18	2.18	2.25	2.23
Degree of Soil Compaction	%	97	96	96	100	95

Point		6	7	8		
Location		9L	10L	11L		
Station		2+870	3+113	3+210		
Weight of sand in the jar (gm)		5000	5000	5000		
Weight of sand remaining in the jar (gm)		1062	1288	967		
Weight of sand filling the cone (gm)		1750	1750	1750		
Net Wt. Of Sample Obtained from Hole	(gm)	3232	3056	3388		
Moisture Content	%	3.60	2.70	4.10		
Wt of sand Filled the Hole	(gm)	2188	1962	2283		
Volume of the Hole	cm^3	1468	1317	1532		
Net wt. of Dry Sample	(gm)	3120	2976	3255		
Wet Density	(gm/cm^3)	2.20	2.32	2.21		
Dry Density	(gm/cm^3)	2.12	2.26	2.12		
Layer thickness	(cm)	18	20	23		

SOIL DEGREE OF COMPACTION

Dry Density Obtained in Field	gm/cm^3	2.12	2.26	2.12		
Max.Dry Density From Lab.Compaction Test gm/cm^3		2.23	2.23	2.17		
Degree of Soil Compaction	%	95	101	98		

REMARKS:	

Field Density of Soil Test Report [Sand Cone Method]

Report No.:	FD: 04/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material,1st Layer			
Sampled by	Lab. Engineers			
Test Method	**ASTM D 1556-07**			
Type of Sand	Standard sand 600 /300 μ m C fraction	Unit Weight of Sand	1.49	gm/cm^3
Testing Date :	21/04/2012			

TEST RESULTS

Point		1	2	3	4	5
Location		1L	2L	3L	5L	7L
Station		0+280	0+360	0+450	2+430	2+700
Weight of sand in the jar (gm)		5000	5000	5000	5000	5000
Weight of sand remaining in the jar (gm)		792	372	840	1138	974
Weight of sand filling the cone (gm)		1750	1750	1750	1750	1750
Net Wt. Of Sample Obtained from Hole	(gm)	3816	4170	3516	3216	3564
Moisture Content	%	3.90	4.70	5.00	4.80	4.10
Wt of sand Filled the Hole	(gm)	2458	2878	2410	2112	2276
Volume of the Hole	cm^3	1650	1932	1617	1417	1528
Net wt. of Dry Sample	(gm)	3673	3983	3349	3069	3424
Wet Density	(gm/cm^3)	2.31	2.16	2.17	2.27	2.33
Dry Density	(gm/cm^3)	2.23	2.06	2.07	2.16	2.24
Layer thickness	(cm)	23	28	26	27	24

SOIL DEGREE OF COMPACTION

Dry Density Obtained in Field	gm/cm^3	2.23	2.06	2.07	2.16	2.24
Max.Dry Density From Lab.Compaction Test gm/cm^3		2.18	2.18	2.18	2.25	2.23
Degree of Soil Compaction	%	102	95	95	96	101

Point		6	7	8		
Location		9L	10L	11L		
Station		2+870	3+113	3+210		
Weight of sand in the jar (gm)		5000	5000	5000		
Weight of sand remaining in the jar (gm)		750	1154	1096		
Weight of sand filling the cone (gm)		1750	1750	1750		
Net Wt. Of Sample Obtained from Hole	(gm)	3798	3120	3308		
Moisture Content	%	4.30	5.10	5.50		
Wt of sand Filled the Hole	(gm)	2500	2096	2154		
Volume of the Hole	cm^3	1678	1407	1446		
Net wt. of Dry Sample	(gm)	3641	2969	3136		
Wet Density	(gm/cm^3)	2.26	2.22	2.29		
Dry Density	(gm/cm^3)	2.17	2.11	2.17		
Layer thickness	(cm)	21	22	18		

SOIL DEGREE OF COMPACTION

Dry Density Obtained in Field	gm/cm^3	2.17	2.11	2.17		
Max.Dry Density From Lab.Compaction Test gm/cm^3		2.23	2.23	2.23		
Degree of Soil Compaction	%	97	95	97		

REMARKS:	

Sieve Analysis Of Base Course

Report No.	BC: 01/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 1R, 1st Layer from st.(0+280)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	17/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3584
Oven Dry wt. of Sample (gm)	3450	Wash Oven Dry wt.(gm)	3146

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	182	5.3	5.3	95	100	70 - 100	
1	25	548	15.9	21.2	79	75 - 100	55 - 85	
3/4	19	350	10.1	31.3	69	60 - 90	50 - 80	
1/2	12.7	504	14.6	45.9	54	45 - 80	-	
3/8	9.5	290	8.4	54.3	46	40 - 70	40 - 70	
#4	4.75	448	13.0	67.3	33	30 - 65	30 - 60	
#10	2.0	368	10.7	78.0	22	20 - 40	20 - 50	
#40	0.425	304	8.8	86.8	13	8 - 20	10 - 30	
#200	0.075	152	4.4	91.2	9	5 - 13	5 - 15	
Pan		304	8.8	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 02/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 1R, 2nd Layer from st.(0+280)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	17/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3636
Oven Dry wt. of Sample (gm)	3510	Wash Oven Dry wt.(gm)	2882

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	214	6.1	6.1	94	100	70 - 100	
1	25	120	3.4	9.5	90	75 - 100	55 - 85	
3/4	19	314	8.9	18.5	82	60 - 90	50 - 80	
1/2	12.7	432	12.3	30.8	69	45 - 80	-	
3/8	9.5	238	6.8	37.5	62	40 - 70	40 - 70	
#4	4.75	456	13.0	50.5	49	30 - 65	30 - 60	
#10	2.0	418	11.9	62.5	38	20 - 40	20 - 50	
#40	0.425	450	12.8	75.3	25	8 - 20	10 - 30	
#200	0.075	240	6.8	82.1	18	5 - 13	5 - 15	
Pan		628	17.9	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 03/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 1L, 1st Layer from st.(0+280)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	17/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3708
Oven Dry wt. of Sample (gm)	3569	Wash Oven Dry wt.(gm)	3140

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	386	10.8	10.8	89	100	70 - 100	
1	25	374	10.5	21.3	79	75 - 100	55 - 85	
3/4	19	242	6.8	28.1	72	60 - 90	50 - 80	
1/2	12.7	488	13.7	41.7	58	45 - 80	-	
3/8	9.5	284	8.0	49.7	50	40 - 70	40 - 70	
#4	4.75	458	12.8	62.5	37	30 - 65	30 - 60	
#10	2.0	388	10.9	73.4	27	20 - 40	20 - 50	
#40	0.425	340	9.5	82.9	17	8 - 20	10 - 30	
#200	0.075	180	5.0	88.0	12	5 - 13	5 - 15	
Pan		429	12.0	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 04/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 1L,2nd Layer from st.(0+280)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	17/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3696
Oven Dry wt. of Sample (gm)	3554	Wash Oven Dry wt.(gm)	3220

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	698	17.6	17.6	82	100	70 - 100	
1	25	310	7.8	25.4	75	75 - 100	55 - 85	
3/4	19	514	12.9	38.3	62	60 - 90	50 - 80	
1/2	12.7	316	8.0	46.3	54	45 - 80	-	
3/8	9.5	484	12.2	58.4	42	40 - 70	40 - 70	
#4	4.75	420	10.6	69.0	31	30 - 65	30 - 60	
#10	2.0	398	10.0	79.0	21	20 - 40	20 - 50	
#40	0.425	346	8.7	87.7	12	8 - 20	10 - 30	
#200	0.075	154	3.9	91.6	8	5 - 13	5 - 15	
Pan		334	8.4	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 05/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 2R, 2nd Layer from st.(0+360)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	12/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	4020
Oven Dry wt. of Sample (gm)	3821	Wash Oven Dry wt.(gm)	2766

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	82	2.1	2.1	98	100	70 - 100	
1	25	302	7.9	10.0	90	75 - 100	55 - 85	
3/4	19	296	7.7	17.8	82	60 - 90	50 - 80	
1/2	12.7	270	7.1	24.9	75	45 - 80	-	
3/8	9.5	168	4.4	29.3	71	40 - 70	40 - 70	
#4	4.75	420	11.0	40.3	60	30 - 65	30 - 60	
#10	2.0	402	10.5	50.8	49	20 - 40	20 - 50	
#40	0.425	500	13.1	63.9	36	8 - 20	10 - 30	
#200	0.075	326	8.5	72.4	28	5 - 13	5 - 15	
Pan		1055	27.6	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 06/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 4R, 1st Layer from st.(2+340)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	12/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3646
Oven Dry wt. of Sample (gm)	3488	Wash Oven Dry wt.(gm)	3066

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	192	5.5	5.5	94	100	70 - 100	
1	25	292	8.4	13.9	86	75 - 100	55 - 85	
3/4	19	370	10.6	24.5	76	60 - 90	50 - 80	
1/2	12.7	524	15.0	39.5	60	45 - 80	-	
3/8	9.5	274	7.9	47.4	53	40 - 70	40 - 70	
#4	4.75	472	13.5	60.9	39	30 - 65	30 - 60	
#10	2.0	398	11.4	72.3	28	20 - 40	20 - 50	
#40	0.425	364	10.4	82.7	17	8 - 20	10 - 30	
#200	0.075	180	5.2	87.9	12	5 - 13	5 - 15	
Pan		422	12.1	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 07/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 4R, 2nd Layer from st.(2+340)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	17/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	4338
Oven Dry wt. of Sample (gm)	4187	Wash Oven Dry wt.(gm)	3624

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	0	0.0	0.0	100	100	70 - 100	
1	25	596	14.2	14.2	86	75 - 100	55 - 85	
3/4	19	494	11.8	26.0	74	60 - 90	50 - 80	
1/2	12.7	610	14.6	40.6	59	45 - 80	-	
3/8	9.5	340	8.1	48.7	51	40 - 70	40 - 70	
#4	4.75	490	11.7	60.4	40	30 - 65	30 - 60	
#10	2.0	390	9.3	69.7	30	20 - 40	20 - 50	
#40	0.425	414	9.9	79.6	20	8 - 20	10 - 30	
#200	0.075	290	6.9	86.6	13	5 - 13	5 - 15	
Pan		563	13.4	100.0	0.0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 08/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 5L. 1st Layer from st.(2+430)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	18/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3104
Oven Dry wt. of Sample (gm)	2961	Wash Oven Dry wt.(gm)	2668

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	196	6.6	6.6	93	100	70 - 100	
1	25	136	4.6	11.2	89	75 - 100	55 - 85	
3/4	19	230	7.8	19.0	81	60 - 90	50 - 80	
1/2	12.7	466	15.7	34.7	65	45 - 80	-	
3/8	9.5	232	7.8	42.6	57	40 - 70	40 - 70	
#4	4.75	480	16.2	58.8	41	30 - 65	30 - 60	
#10	2.0	408	13.8	72.5	27	20 - 40	20 - 50	
#40	0.425	360	12.2	84.7	15	8 - 20	10 - 30	
#200	0.075	160	5.4	90.1	10	5 - 13	5 - 15	
Pan		293	9.9	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 09/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 5L, 2nd Layer from st.(2+430)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	18/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3882
Oven Dry wt. of Sample (gm)	3765	Wash Oven Dry wt.(gm)	3372

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	66	1.8	1.8	98	100	70 - 100	
1	25	798	21.2	22.9	77	75 - 100	55 - 85	
3/4	19	480	12.7	35.7	64	60 - 90	50 - 80	
1/2	12.7	570	15.1	50.8	49	45 - 80	-	
3/8	9.5	280	7.4	58.3	42	40 - 70	40 - 70	
#4	4.75	438	11.6	69.9	30	30 - 65	30 - 60	
#10	2.0	294	7.8	77.7	22	20 - 40	20 - 50	
#40	0.425	252	6.7	84.4	16	8 - 20	10 - 30	
#200	0.075	194	5.2	89.6	10	5 - 13	5 - 15	
Pan		393	10.4	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 10/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 6R, 1st Layer from st.(2+610)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	18/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	2912
Oven Dry wt. of Sample (gm)	2750	Wash Oven Dry wt.(gm)	2360

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	152	5.5	5.5	94	100	70 - 100	
1	25	220	8.0	13.5	86	75 - 100	55 - 85	
3/4	19	282	10.3	23.8	76	60 - 90	50 - 80	
1/2	12.7	362	13.2	36.9	63	45 - 80	-	
3/8	9.5	180	6.5	43.5	57	40 - 70	40 - 70	
#4	4.75	382	13.9	57.4	43	30 - 65	30 - 60	
#10	2.0	326	11.9	69.2	31	20 - 40	20 - 50	
#40	0.425	306	11.1	80.4	20	8 - 20	10 - 30	
#200	0.075	150	5.5	85.8	14	5 - 13	5 - 15	
Pan		390	14.2	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 11/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 6R, 2nd Layer from st.(2+610)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	18/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3144
Oven Dry wt. of Sample (gm)	2969	Wash Oven Dry wt.(gm)	2434

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	0	0.0	0.0	100	100	70 - 100	
1	25	198	6.7	6.7	93	75 - 100	55 - 85	
3/4	19	252	8.5	15.2	85	60 - 90	50 - 80	
1/2	12.7	398	13.4	28.6	71	45 - 80	-	
3/8	9.5	244	8.2	36.8	63	40 - 70	40 - 70	
#4	4.75	424	14.3	51.1	49	30 - 65	30 - 60	
#10	2.0	376	12.7	63.7	36	20 - 40	20 - 50	
#40	0.425	342	11.5	75.2	25	8 - 20	10 - 30	
#200	0.075	200	6.7	82.0	18	5 - 13	5 - 15	
Pan		535	18.0	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 12/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 7L, 1st Layer from st.(2+700)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	18/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3358
Oven Dry wt. of Sample (gm)	3326	Wash Oven Dry wt.(gm)	2928

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	78	2.4	2.4	98	100	70 - 100	
1	25	298	9.1	11.5	89	75 - 100	55 - 85	
3/4	19	310	9.5	20.9	79	60 - 90	50 - 80	
1/2	12.7	482	14.7	35.7	64	45 - 80	-	
3/8	9.5	330	10.1	45.7	54	40 - 70	40 - 70	
#4	4.75	440	13.4	59.2	41	30 - 65	30 - 60	
#10	2.0	428	13.1	72.2	28	20 - 40	20 - 50	
#40	0.425	338	10.3	82.5	17	8 - 20	10 - 30	
#200	0.075	174	5.3	87.9	12	5 - 13	5 - 15	
Pan		398	12.1	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 13/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 7L, 2nd Layer from st.(2+700)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	18/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3524
Oven Dry wt. of Sample (gm)	3378	Wash Oven Dry wt.(gm)	2908

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	0	0.0	0.0	100	100	70 - 100	
1	25	328	9.7	9.7	90	75 - 100	55 - 85	
3/4	19	318	9.4	19.1	81	60 - 90	50 - 80	
1/2	12.7	446	13.2	32.3	68	45 - 80	-	
3/8	9.5	316	9.4	41.7	58	40 - 70	40 - 70	
#4	4.75	530	15.7	57.4	43	30 - 65	30 - 60	
#10	2.0	442	13.1	70.5	30	20 - 40	20 - 50	
#40	0.425	358	10.6	81.1	19	8 - 20	10 - 30	
#200	0.075	170	5.0	86.1	14	5 - 13	5 - 15	
Pan		470	13.9	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of
Base Course

Report No.	BC: 14/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 10L,1st Layer from st.(3+113)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	18/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	2932
Oven Dry wt. of Sample (gm)	2788	Wash Oven Dry wt.(gm)	2528

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	134	4.8	4.8	95	100	70 - 100	
1	25	210	7.5	12.3	88	75 - 100	55 - 85	
3/4	19	280	10.0	22.4	78	60 - 90	50 - 80	
1/2	12.7	374	13.4	35.8	64	45 - 80	-	
3/8	9.5	284	10.2	46.0	54	40 - 70	40 - 70	
#4	4.75	428	15.4	61.3	39	30 - 65	30 - 60	
#10	2.0	342	12.3	73.6	26	20 - 40	20 - 50	
#40	0.425	292	10.5	84.1	16	8 - 20	10 - 30	
#200	0.075	184	6.6	90.7	9	5 - 13	5 - 15	
Pan		260	9.3	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 15/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 10L, 2nd Layer from st.(3+113)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	18/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	2390
Oven Dry wt. of Sample (gm)	2852	Wash Oven Dry wt.(gm)	2384

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	160	5.6	5.6	94	100	70 - 100	
1	25	670	23.5	29.1	71	75 - 100	55 - 85	
3/4	19	254	8.9	38.0	62	60 - 90	50 - 80	
1/2	12.7	472	16.5	54.6	45	45 - 80	-	
3/8	9.5	136	4.8	59.3	41	40 - 70	40 - 70	
#4	4.75	246	8.6	68.0	32	30 - 65	30 - 60	
#10	2.0	170	6.0	73.9	26	20 - 40	20 - 50	
#40	0.425	168	5.9	79.8	20	8 - 20	10 - 30	
#200	0.075	108	3.8	83.6	16	5 - 13	5 - 15	
Pan		468	16.4	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of
Base Course

Report No.	BC: 16/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 12R, 1st Layer from st.(3+290)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	12/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3818
Oven Dry wt. of Sample (gm)	3588	Wash Oven Dry wt.(gm)	3166

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	0	0.0	0.0	100	100	70 - 100	
1	25	616	17.2	17.2	83	75 - 100	55 - 85	
3/4	19	412	11.5	28.7	71	60 - 90	50 - 80	
1/2	12.7	436	12.2	40.8	59	45 - 80	-	
3/8	9.5	268	7.5	48.3	52	40 - 70	40 - 70	
#4	4.75	460	12.8	61.1	39	30 - 65	30 - 60	
#10	2.0	406	11.3	72.4	28	20 - 40	20 - 50	
#40	0.425	380	10.6	83.0	17	8 - 20	10 - 30	
#200	0.075	188	5.2	88.2	12	5 - 13	5 - 15	
Pan		422	11.8	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Sieve Analysis Of Base Course

Report No.	BC: 17/2012

Client	Black & Veatch	Adress	Ramallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Base Course Material 12R, 2nd Layer from st.(3+290)		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab. Engineers**	Sampling Date	12/04/2012
Source of Sample	Project Site	QTY of Sample(gm)	3580
Oven Dry wt. of Sample (gm)	3364	Wash Oven Dry wt.(gm)	2872

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Class B	
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	%	
3	75	0	0.0	0.0	100	100	100	
2 1/2	63	0	0.0	0.0	100	100	100	
2	50	0	0.0	0.0	100	100	100	
1 1/2	37.5	134	4.0	4.0	96	100	70 - 100	
1	25	308	9.2	13.1	87	75 - 100	55 - 85	
3/4	19	246	7.3	20.5	80	60 - 90	50 - 80	
1/2	12.7	426	12.7	33.1	67	45 - 80	-	
3/8	9.5	234	7.0	40.1	60	40 - 70	40 - 70	
#4	4.75	472	14.0	54.1	46	30 - 65	30 - 60	
#10	2.0	448	13.3	67.4	33	20 - 40	20 - 50	
#40	0.425	406	12.1	79.5	21	8 - 20	10 - 30	
#200	0.075	198	5.9	85.4	15	5 - 13	5 - 15	
Pan		492	14.6	100.0	0			

REMARKS:	If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

APPENDIX C
TEST RESULTS FOR THE FILL & SUBGRADE

Moisture Content Report
ASTM C566

Order No.:	Soil 11/2012	Report No.	Soil 11/2012	Date	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Borholes No.	Depth (m)	Can Weight (gm)	Can & Specimen Wet Weight (gm)	Can & Specimen Dry Weight (gm)	Moisture Content %
1L	0-0.08	***	***	***	***
	0.08-0.48	32.2	103.2	99.1	6.1
	0.48-1	***	***	***	***
	1-2.0	32.2	96.9	92.2	7.8
	2-3.5	28.1	93.4	89.4	6.5
	3.5-5	31.4	80.9	76.1	10.7
2L	0-0.06	***	***	***	***
	0.06-0.47	30.5	104.0	102.1	2.7
	0.47-1	***	***	***	***
	1-2.5	32.4	106.7	99.9	10.1
	2.5-3	33.5	105.7	102.0	5.4
	3-3.40	28.4	103.6	101.4	3.0
	3.40-5	25.5	108.7	101.8	9.0
3L	0-0.06	***	***	***	***
	0.06-0.48	28.5	106.2	102.6	4.9
	0.48-1	***	***	***	***
	1-2.0	25.2	103.6	94.1	13.8
	2-2.5	32.9	120.6	112.5	10.2
	2.5-4	23.7	83.9	75.5	16.2
	4-5.0	32.6	104.5	93.5	18.1
4L	0-0.06	***	***	***	***
	0.06-0.50	28.5	114.4	108.6	7.2
	0.50-1	***	***	***	***
	1-2.0	28.4	102.8	97.4	7.8
	2-3.0	36.2	122.8	117.3	6.8
	3-5.0	37.3	109.3	102.3	10.8

Borholes No.	Depth (m)	Can Weight (gm)	Can & Specimen Wet Weight (gm)	Can & Specimen Dry Weight (gm)	Moisture Content %
5L	0-0.06	***	***	***	***
	0.06-0.49	33.5	98.6	96.6	3.2
	0.49-1	***	***	***	***
	0-0.5	26.5	105.0	102.6	3.2
	0.5-2	17.1	56.7	52.9	10.6
	2-3.5	17.3	58.6	54.4	11.3
	3.5-5	17.3	70.8	65.7	10.5
6L	0-0.12	***	***	***	***
	0.12-0.50	32.6	97.3	94.9	3.9
	0.50-1	***	***	***	***
	1-2.0	27.1	80.8	77.5	6.5
	2-2.5	21.8	154.7	147.5	5.7
	2.5-5	***	***	***	***
7L	0-0.13	***	***	***	***
	0.13-0.60	19.6	126.2	123.0	3.1
	0.60-1	***	***	***	***
	1-1.5	61.9	201.2	191.0	7.9
	1.5-2.5	56.4	188.7	175.4	11.2
	2.5-4	55.1	109.3	98.4	25.2
	4-5.0	55.1	138.7	122.3	24.4
8L	0-0.13	***	***	***	***
	0.13-0.55	56.1	257.8	249.8	4.1
	0.55-1	***	***	***	***
	1-3.0	55.2	206.7	192.9	10.0
	3-4.0	55.8	167.9	157.2	10.6
	4-5.0	56.2	203.0	189.1	10.5
9L	0-0.14	***	***	***	***
	0.14-0.53	97.5	347.8	338.4	3.9
	0.53-1	***	***	***	***
	0.40-2	102.1	343.0	328.6	6.4
	2-3.5	108.1	325.1	303.7	10.9
	3.5-5	291.2	464.1	429.8	24.7
10L	0-0.06	***	***	***	***
	0.06-0.46	32.8	109.5	107.4	2.8
	0.46-1	***	***	***	***
	1-2.0	29.4	98.6	91.4	11.6
	2-4.0	26.6	85.0	79.4	10.6

Borholes No.	Depth (m)	Can Weight (gm)	Can & Specimen Wet Weight (gm)	Can & Specimen Dry Weight (gm)	Moisture Content %
11L	0-0.07	***	***	***	***
	0.07-0.48	56.1	258.0	250.0	4.1
	0.48-1	***	***	***	***
	1-3.0	32.2	93.8	88.6	9.2
	3-4.0	32.9	88.5	84.2	8.4
	4-5.0	28.1	77.4	65.3	32.5
12L	0-0.08	***	***	***	***
	0.08-0.50	56.0	257.1	249.0	4.2
	0.50-1	***	***	***	***
	1-1.5	36.2	112.9	105.4	10.8
	1.5-3	26.5	68.7	58.0	34.0
	3-5.0	25.2	69.6	57.4	37.9
1R	0-0.05	28.9	105.9	102.4	4.8
	0.05-0.35	28.9	83.6	76.8	14.2
	0.35-0.42	29.7	101.8	94.8	10.8
	0.42-5	***	***	***	***
	5-5.5	28.9	131.3	129.9	1.4
2R	0-0.45	28.0	114.0	109.5	5.5
	0.45-1	***	***	***	***
	1-2.0	25.4	94.9	91.1	5.8
	2-3.5	43.5	160.6	159.8	0.7
	3.5-5.8	47.2	133.3	126.2	9.0
	5.8-7.0	44.3	153.1	152.0	1.0
3R	0-0.42	30.5	110.0	107.7	3.0
	0.42-1	***	***	***	***
	1-2.5	53.3	141.9	139.8	2.4
	2.5-3.8	49.1	140.8	139.8	1.1
	3.8-5	53.3	138.4	135.0	4.2
4R	0-0.06	**	***	***	***
	0.06-0.65	32.0	160.0	154.8	4.2
	0.65-1	***	***	***	***
	1-2.5	49.5	143.6	130.3	16.5
	2.5-5	44.6	121.6	110.6	16.7

Borholes No.	Depth (m)	Can Weight (gm)	Can & Specimen Wet Weight (gm)	Can & Specimen Dry Weight (gm)	Moisture Content %
5R	0-0.07	**	***	***	***
	0.07-0.50	32.4	155.4	151.0	3.7
	0.50-1	***	***	***	***
	1-2.0	17.3	58.5	57.4	2.7
	2-3.5	17.1	55.0	52.1	8.3
	3.5-5	***	***	***	***
6R	0-0.08	**	***	***	***
	0.08-0.47	19.6	192.9	186.4	3.9
	0.47-5	***	***	***	***
7R	0-0.08	**	***	***	***
	0.08-0.53	21.9	174.6	172.2	1.6
	0.53-1	***	***	***	***
	1-3.0	56.1	207.1	198.7	5.9
	3-5.0	55.7	182.6	175.6	5.8
8R	0-0.07	**	***	***	***
	0.07-0.51	55.1	223.4	218.3	3.1
	0.51-1	***	***	***	***
	1-1.5	55.4	215.3	202.1	9.0
	1.5-2	56.0	225.6	208.2	11.4
	2-2.5	55.1	176.8	161.5	14.4
	2.5-3.5	***	***	***	***
	3.5-5	55.0	152.6	147.8	5.2
9R	0-0.08	**	***	***	***
	0.08-0.48	56.3	237.5	233.9	2.0
	0.48-1	***	***	***	***
	1-2.5	56.0	138.8	130.6	11.0
	2.5-5	97.4	239.5	216.9	18.9
10R	0-0.07	**	***	***	***
	0.07-0.50	102.0	367.1	352.4	5.9
	0.50-1	***	***	***	***
	1-2.0	108.6	331.7	313.4	8.9
	2-2.5	27.0	79.5	73.8	12.2
	2.5-4	290.8	542.6	519.5	10.1
	4-5.0	28.3	81.6	69.0	31.0

Borholes No.	Depth (m)	Can Weight (gm)	Can & Specimen Wet Weight (gm)	Can & Specimen Dry Weight (gm)	Moisture Content %
11R	0-0.07	**	***	***	***
	0.07-0.47	54.7	221.1	214.6	4.1
	0.47-1	***	***	***	***
	1-2.5	62.1	157.5	151.0	7.3
	2.5-4	55.5	139.7	131.6	10.6
	4-5.0	52.4	96.9	85.3	35.3
12R	0-0.07	**	***	***	***
	0.07-0.52	32.3	106.8	103.8	4.2
	0.52-1	***	***	***	***
	1-1.80	***	***	***	***
	1.80-2.80	28.4	73.3	61.5	35.6
	2.80-4	28.4	73.9	62.4	33.8
	4-5.0	33.5	88.8	76.5	28.6

Unconfined Compression Test
ASTM D2166

Order No.:	11/2012	Report No.: UNCON/11/2012		Date :	07/05/2012

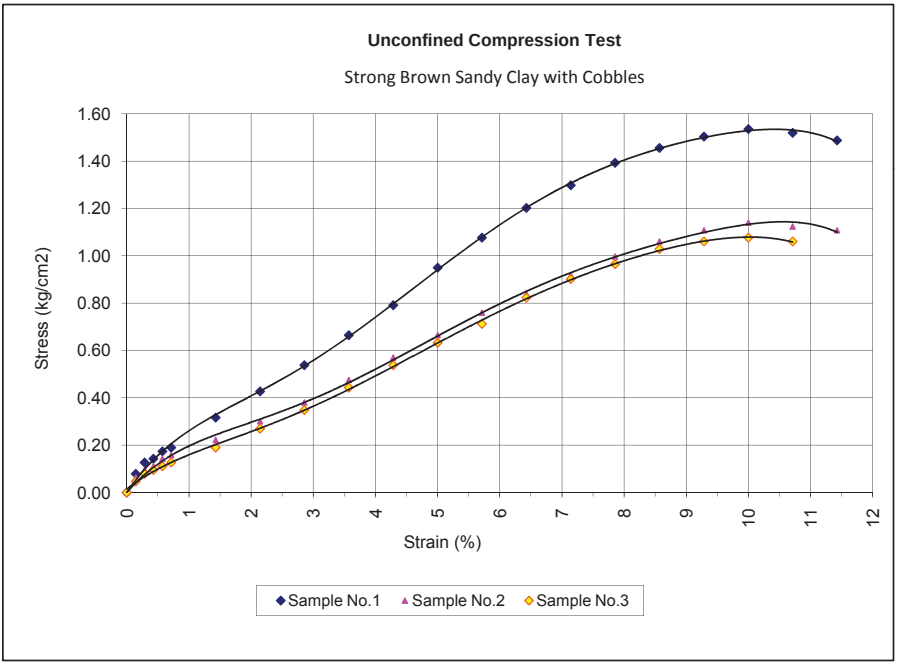
Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Soil Description	Strong Brown Sandy Clay with Cobbles	Boring No.	***
Sample No.	Group 1	Test Date	17/04/2012

Water Content Calculations	No. 1	No. 2	No. 3	Specimen dimensions				
Mass Test Specimen (gm)	136.1	136.2	136.7	Ht.	Dam..	Area	Vol.	
Mass Of Container+wet Soil (gm)	106	106.2	106	cm.	cm.	cm^2	cm^3	
Mass Of Container (gm)	46.2	46.2	46.2	7	3.33	8.7	60.96	Specimen 1
Mass Of Container+dry Soil (gm)	98.7	98.7	98.6	7	3.33	8.7	60.96	Specimen 2
Water Content percent (%)	13.9	14.3	14.1	7	3.33	8.7	60.96	Specimen 3

	Specimen No. 1	Specimen No. 2	Specimen No. 3
Wet Density(kg/cm^3)	2.232	2.234	2.242
Dry Density(kg/cm^3)	1.960	1.955	1.965
Specific gravity	2.534	2.534	2.534
Void Ratio	0.29	0.30	0.29
Degree of Saturation	120.29	122.18	123.53

Sample No.1				Sample No.2				Sample No.3			
Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress
div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2
0	0.0	0	0.00	0	0.0	0	0.00	0	0.0	0	0.00
10	0.1	5	0.08	10	0.1	4	0.06	10	0.1	3	0.05
20	0.3	8	0.13	20	0.3	6	0.09	20	0.3	5	0.08
30	0.4	9	0.14	30	0.4	7	0.11	30	0.4	6	0.09
40	0.6	11	0.17	40	0.6	9	0.14	40	0.6	7	0.11
50	0.7	12	0.19	50	0.7	10	0.16	50	0.7	8	0.13
100	1.4	20	0.32	100	1.4	14	0.22	100	1.4	12	0.19
150	2.1	27	0.43	150	2.1	19	0.30	150	2.1	17	0.27
200	2.9	34	0.54	200	2.9	24	0.38	200	2.9	22	0.35
250	3.6	42	0.66	250	3.6	30	0.47	250	3.6	28	0.44
300	4.3	50	0.79	300	4.3	36	0.57	300	4.3	34	0.54
350	5.0	60	0.95	350	5.0	42	0.66	350	5.0	40	0.63
400	5.7	68	1.08	400	5.7	48	0.76	400	5.7	45	0.71
450	6.4	76	1.20	450	6.4	53	0.84	450	6.4	52	0.82
500	7.1	82	1.30	500	7.1	58	0.92	500	7.1	57	0.90
550	7.9	88	1.39	550	7.9	63	1.00	550	7.9	61	0.97
600	8.6	92	1.46	600	8.6	67	1.06	600	8.6	65	1.03
650	9.3	95	1.50	650	9.3	70	1.11	650	9.3	67	1.06
700	10.0	97	1.53	700	10.0	72	1.14	700	10.0	68	1.08
750	10.7	96	1.52	750	10.7	71	1.12	750	10.7	67	1.06
800	11.4	94	1.49	800	11.4	70	1.11	800	11.4	66	1.04


Unconfined Compression Test
Strong Brown Sandy Clay with Cobbles
Stress (kg/cm2)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
1
2
3
4
5
6
7
8
9
10
11
12
Strain (%)
Sample No.1
Sample No.2
Sample No.3

Unconfined Compression Test
ASTM D2166

Order No.:	11/2012	Report No.: UNCON/11/2012		Date :	07/05/2012

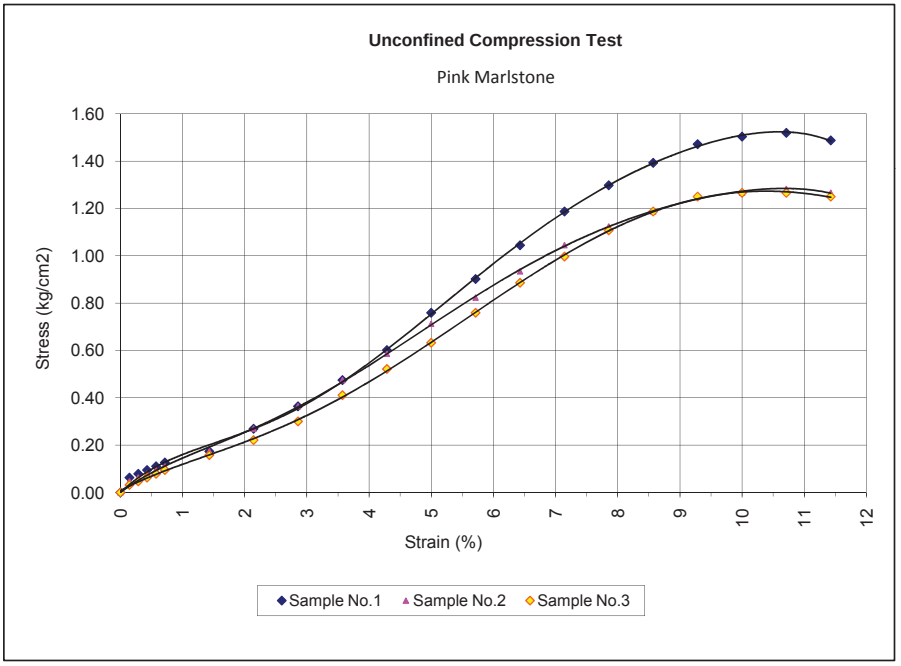
Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Soil Description	Pink Marlstone	Boring No.	***
Sample No.	Group 2	Test Date	17/04/2012

Water Content Calculations	No. 1	No. 2	No. 3	Specimen dimensions				
Mass Test Specimen (gm)	135.2	134.8	135.2	Ht.	Dam..	Area	Vol.	
Mass Of Container+wet Soil (gm)	106	106	106	cm.	cm.	cm^2	cm^3	
Mass Of Container (gm)	46.2	46.2	46.2	7	3.33	8.7	60.96	Specimen 1
Mass Of Container+dry Soil (gm)	98.6	98.8	98.7	7	3.33	8.7	60.96	Specimen 2
Water Content percent (%)	14.1	13.7	13.9	7	3.33	8.7	60.96	Specimen 3

	Specimen No. 1	Specimen No. 2	Specimen No. 3
Wet Density(kg/cm^3)	2.218	2.211	2.218
Dry Density(kg/cm^3)	1.943	1.945	1.947
Specific gravity	2.644	2.644	2.644
Void Ratio	0.36	0.36	0.36
Degree of Saturation	103.55	100.69	102.69

Sample No.1				Sample No.2				Sample No.3			
Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress
div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2
0	0.0	0	0.00	0	0.0	0	0.00	0	0.0	0	0.00
10	0.1	4	0.06	10	0.1	3	0.05	10	0.1	2	0.03
20	0.3	5	0.08	20	0.3	4	0.06	20	0.3	3	0.05
30	0.4	6	0.09	30	0.4	5	0.08	30	0.4	4	0.06
40	0.6	7	0.11	40	0.6	6	0.09	40	0.6	5	0.08
50	0.7	8	0.13	50	0.7	7	0.11	50	0.7	6	0.09
100	1.4	11	0.17	100	1.4	11	0.17	100	1.4	10	0.16
150	2.1	17	0.27	150	2.1	17	0.27	150	2.1	14	0.22
200	2.9	23	0.36	200	2.9	23	0.36	200	2.9	19	0.30
250	3.6	30	0.47	250	3.6	30	0.47	250	3.6	26	0.41
300	4.3	38	0.60	300	4.3	37	0.59	300	4.3	33	0.52
350	5.0	48	0.76	350	5.0	45	0.71	350	5.0	40	0.63
400	5.7	57	0.90	400	5.7	52	0.82	400	5.7	48	0.76
450	6.4	66	1.04	450	6.4	59	0.93	450	6.4	56	0.89
500	7.1	75	1.19	500	7.1	66	1.04	500	7.1	63	1.00
550	7.9	82	1.30	550	7.9	71	1.12	550	7.9	70	1.11
600	8.6	88	1.39	600	8.6	75	1.19	600	8.6	75	1.19
650	9.3	93	1.47	650	9.3	79	1.25	650	9.3	79	1.25
700	10.0	95	1.50	700	10.0	80	1.27	700	10.0	80	1.27
750	10.7	96	1.52	750	10.7	81	1.28	750	10.7	80	1.27
800	11.4	94	1.49	800	11.4	80	1.27	800	11.4	79	1.25


Unconfined Compression Test
Pink Marlstone
Stress (kg/cm2)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
1
2
3
4
5
6
7
8
9
10
11
12
Strain (%)
Sample No.1
Sample No.2
Sample No.3

Unconfined Compression Test
ASTM D2166

Order No.:	11/2012	Report No.: UNCON/11/2012	Date :	07/05/2012

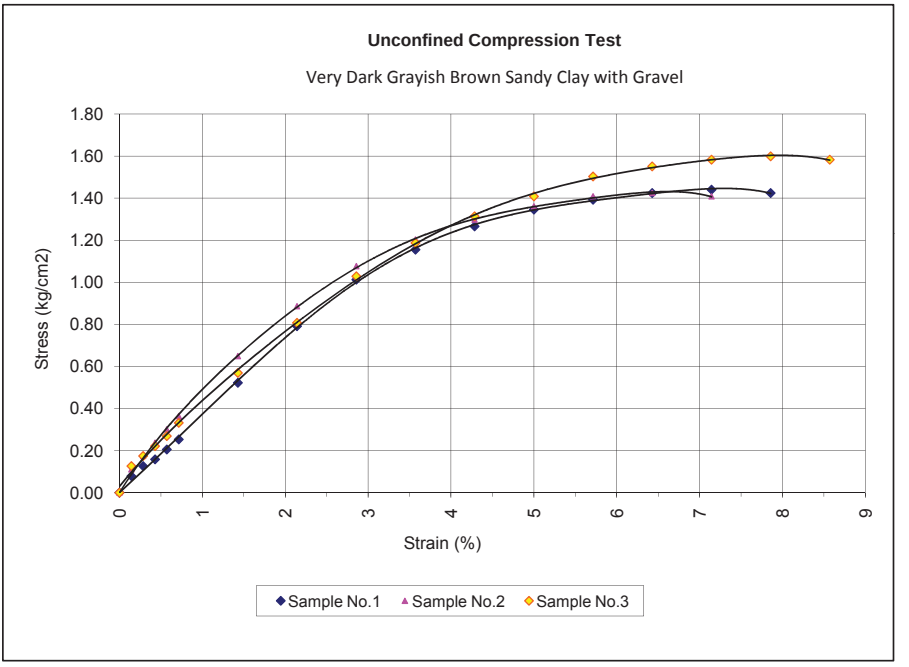
Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Soil Description	Very Dark Grayish Brown Sandy Clay with Gravel	Boring No.	***
Sample No.	Group 6	Test Date	17/04/2012

Water Content Calculations	No. 1	No. 2	No. 3	Specimen dimensions				
Mass Test Specimen (gm)	134.2	135.1	134.1	Ht.	Dam..	Area	Vol.	
Mass Of Container+wet Soil (gm)	106	106	106	cm.	cm.	cm^2	cm^3	
Mass Of Container (gm)	46.2	46.2	46.2	7	3.33	8.7	60.96	Specimen 1
Mass Of Container+dry Soil (gm)	97.6	97.7	97.6	7	3.33	8.7	60.96	Specimen 2
Water Content percent (%)	16.3	16.1	16.3	7	3.33	8.7	60.96	Specimen 3

	Specimen No. 1	Specimen No. 2	Specimen No. 3
Wet Density(kg/cm^3)	2.201	2.216	2.200
Dry Density(kg/cm^3)	1.892	1.908	1.891
Specific gravity	2.552	2.552	2.552
Void Ratio	0.35	0.34	0.35
Degree of Saturation	119.57	121.97	119.23

Sample No.1				Sample No.2				Sample No.3			
Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress
div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2
0	0.0	0	0.00	0	0.0	0	0.00	0	0.0	0	0.00
10	0.1	5	0.08	10	0.1	7	0.11	10	0.1	8	0.13
20	0.3	8	0.13	20	0.3	11	0.17	20	0.3	11	0.17
30	0.4	10	0.16	30	0.4	15	0.24	30	0.4	14	0.22
40	0.6	13	0.21	40	0.6	19	0.30	40	0.6	17	0.27
50	0.7	16	0.25	50	0.7	23	0.36	50	0.7	21	0.33
100	1.4	33	0.52	100	1.4	41	0.65	100	1.4	36	0.57
150	2.1	50	0.79	150	2.1	56	0.89	150	2.1	51	0.81
200	2.9	64	1.01	200	2.9	68	1.08	200	2.9	65	1.03
250	3.6	73	1.16	250	3.6	76	1.20	250	3.6	75	1.19
300	4.3	80	1.27	300	4.3	82	1.30	300	4.3	83	1.31
350	5.0	85	1.34	350	5.0	86	1.36	350	5.0	89	1.41
400	5.7	88	1.39	400	5.7	89	1.41	400	5.7	95	1.50
450	6.4	90	1.42	450	6.4	90	1.42	450	6.4	98	1.55
500	7.1	91	1.44	500	7.1	89	1.41	500	7.1	100	1.58
550	7.9	90	1.42					550	7.9	101	1.60
								600	8.6	100	1.58


Unconfined Compression Test
Very Dark Grayish Brown Sandy Clay with Gravel
Stress (kg/cm2)
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
1
2
3
4
5
6
7
8
9
Strain (%)
Sample No.1
Sample No.2
Sample No.3

Unconfined Compression Test
ASTM D2166

Order No.:	11/2012	Report No.: UNCON/11/2012		Date :	07/05/2012

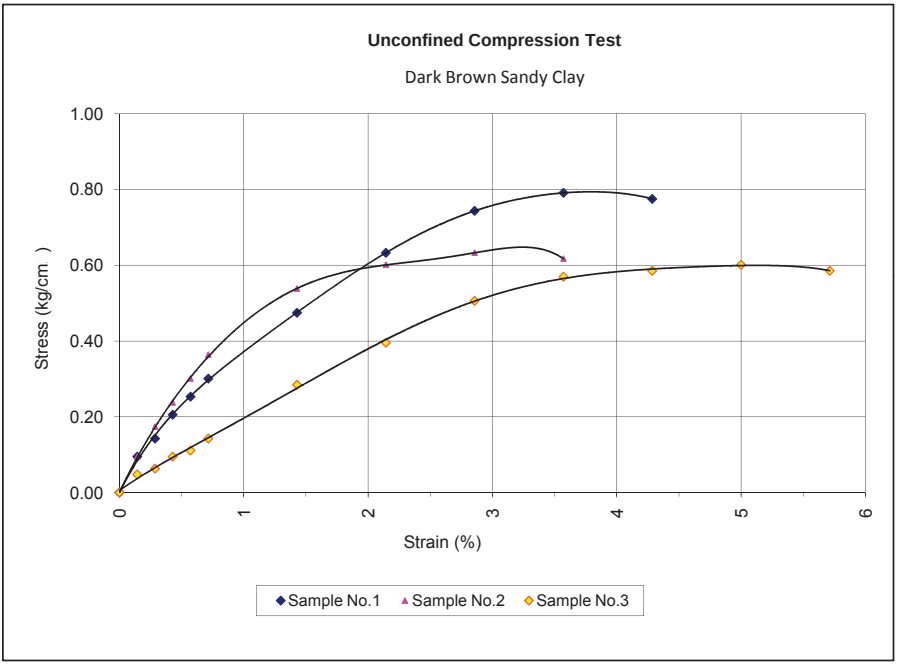
Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Soil Description	Dark Brown Sandy Clay	Boring No.	***
Sample No.	Group 7	Test Date	17/04/2012

Water Content Calculations	No. 1	No. 2	No. 3	Specimen dimensions				
Mass Test Specimen (gm)	105.5	106.4	105.0	Ht.	Dam..	Area	Vol.	
Mass Of Container+wet Soil (gm)	106	106	106	cm.	cm.	cm^2	cm^3	
Mass Of Container (gm)	46.2	46.2	46.2	7	3.33	8.7	60.96	Specimen 1
Mass Of Container+dry Soil (gm)	87.3	88.5	87.1	7	3.33	8.7	60.96	Specimen 2
Water Content percent (%)	45.5	41.4	46.2	7	3.33	8.7	60.96	Specimen 3

	Specimen No. 1	Specimen No. 2	Specimen No. 3
Wet Density(kg/cm^3)	1.731	1.745	1.722
Dry Density(kg/cm^3)	1.189	1.235	1.178
Specific gravity	2.545	2.545	2.545
Void Ratio	1.14	1.06	1.16
Degree of Saturation	101.59	99.19	101.34

Sample No.1				Sample No.2				Sample No.3			
Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress
div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2
0	0.0	0	0.00	0	0.0	0	0.00	0	0.0	0	0.00
10	0.1	6	0.09	10	0.1	6	0.09	10	0.1	3	0.05
20	0.3	9	0.14	20	0.3	11	0.17	20	0.3	4	0.06
30	0.4	13	0.21	30	0.4	15	0.24	30	0.4	6	0.09
40	0.6	16	0.25	40	0.6	19	0.30	40	0.6	7	0.11
50	0.7	19	0.30	50	0.7	23	0.36	50	0.7	9	0.14
100	1.4	30	0.47	100	1.4	34	0.54	100	1.4	18	0.28
150	2.1	40	0.63	150	2.1	38	0.60	150	2.1	25	0.40
200	2.9	47	0.74	200	2.9	40	0.63	200	2.9	32	0.51
250	3.6	50	0.79	250	3.6	39	0.62	250	3.6	36	0.57
300	4.3	49	0.78					300	4.3	37	0.59
								350	5.0	38	0.60
								400	5.7	37	0.59


Unconfined Compression Test
Dark Brown Sandy Clay
1.00
0.80
0.60
0.40
0.20
0.00
Stress (kg/cm)
0
1
2
3
4
5
6
Strain (%)
Sample No.1
Sample No.2
Sample No.3

Direct Shear Test

Order No.:	Soil 11/2012	Report No.: DSH/11/2012		Date :	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

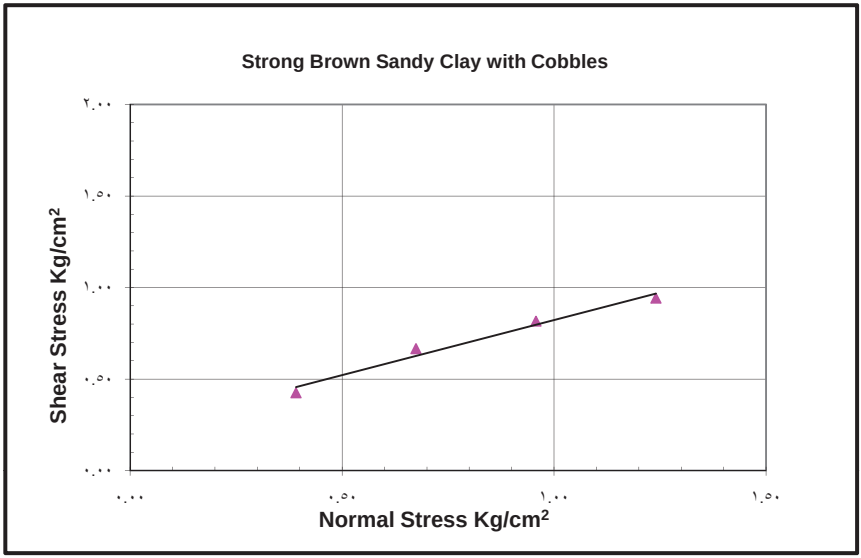
Soil Description	Strong Brown Sandy Clay with Cobbles		
Sample No.	Group 1	Test Date	16/04/2012

For Undisturbed Samples	
Mass Of Container (gm)	4234
Mass Of Container + Soil (gm)	4416
Mass Of Soil Used (gm)	182

Shear Box Dimensions			
Ht. cm.	Dam.. cm.	Area cm^2	Vol. cm^3
4.5	6	28.27	127.23

Wet Density(kg/cm^3)	Water Content %	Dry Density(kg/cm^3)	Normal Load Kg	Normal Stress (Kg/cm^2)
1.43	9.0	1.31	***	***

DEPTH m	Description	Normal Load Kg	Normal Load Kg	Normal Load Kg	Normal Load Kg	Soil Parameters	
		11.064	19.064	27.064	35.064	Φ°	C Kg/cm2
***	Load Dial reading	230	360	510	680	31.03	0.22
	Shear stress Kg/cm^2	0.42	0.67	0.82	0.94		
	Normal stress Kg/cm^2	0.39	0.67	0.96	1.24		



Direct Shear Test

Order No.:	Soil 11/2012	Report No.: DSH/11/2012		Date :	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

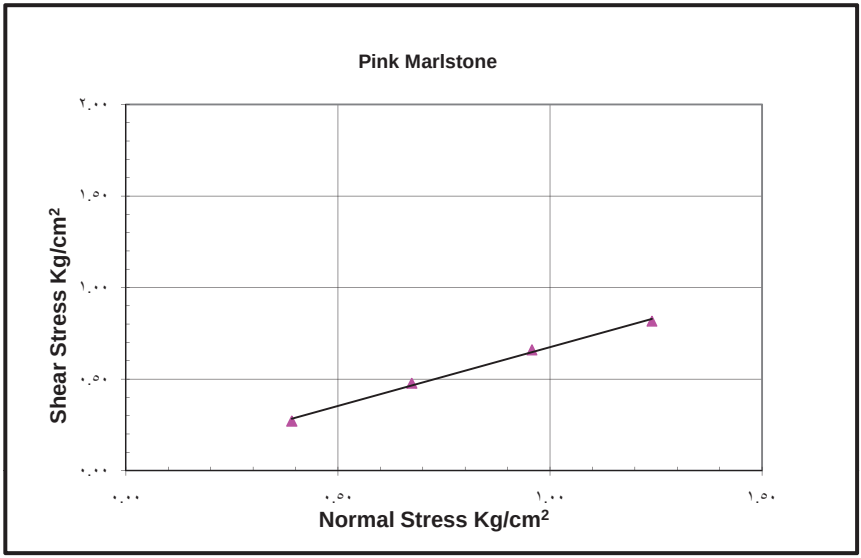
Soil Description	Pink Marlstone		
Sample No.	Group 2	Test Date	16/04/2012

For Undisturbed Samples	
Mass Of Container (gm)	4234
Mass Of Container + Soil (gm)	4412
Mass Of Soil Used (gm)	178

Shear Box Dimensions			
Ht. cm.	Dam.. cm.	Area cm^2	Vol. cm^3
4.5	6	28.27	127.23

Wet Density(kg/cm^3)	Water Content %	Dry Density(kg/cm^3)	Normal Load Kg	Normal Stress (Kg/cm^2)
1.40	7.6	1.30	***	***

DEPTH m	Description	Normal Load Kg	Normal Load Kg	Normal Load Kg	Normal Load Kg	Soil Parameters	
		11.064	19.064	27.064	35.064	Φ°	C Kg/cm2
***	Load Dial reading	180	300	460	640	32.73	0.03
	Shear stress Kg/cm^2	0.27	0.48	0.66	0.82		
	Normal stress Kg/cm^2	0.39	0.67	0.96	1.24		



Direct Shear Test

Order No.:	Soil 11/2012	Report No.: DSH/11/2012		Date :	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

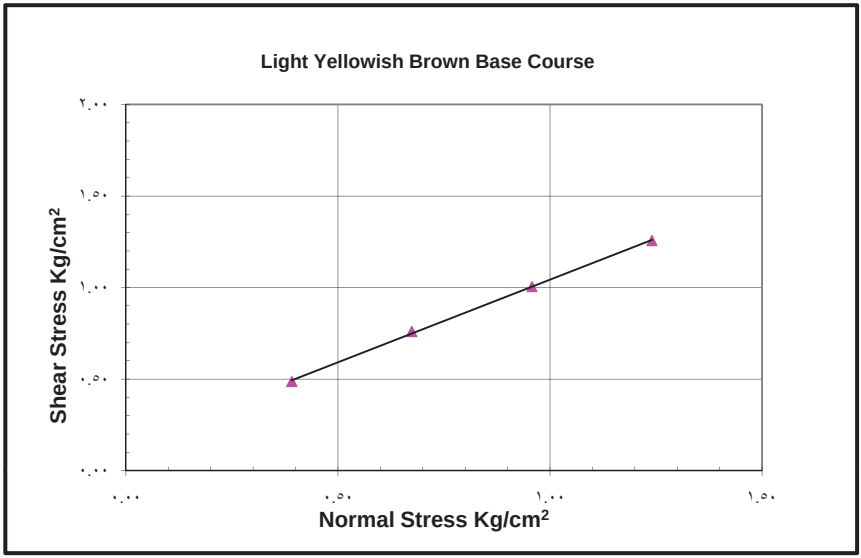
Soil Description	Light Yellowish Brown Base Course		
Sample No.	Group 3	Test Date	16/04/2012

For Undisturbed Samples	
Mass Of Container (gm)	4234
Mass Of Container + Soil (gm)	4428
Mass Of Soil Used (gm)	194

Shear Box Dimensions			
Ht. cm.	Dam.. cm.	Area cm^2	Vol. cm^3
4.5	6	28.27	127.23

Wet Density(kg/cm^3)	Water Content %	Dry Density(kg/cm^3)	Normal Load Kg	Normal Stress (Kg/cm^2)
1.52	3.1	1.48	***	***

DEPTH m	Description	Normal Load Kg	Normal Load Kg	Normal Load Kg	Normal Load Kg	Soil Parameters	
		11.064	19.064	27.064	35.064	Φ°	C Kg/cm2
***	Load Dial reading	250	390	570	780	42.07	0.14
	Shear stress Kg/cm^2	0.49	0.76	1.00	1.26		
	Normal stress Kg/cm^2	0.39	0.67	0.96	1.24		



Direct Shear Test

Order No.:	Soil 11/2012	Report No.: DSH/11/2012		Date :	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

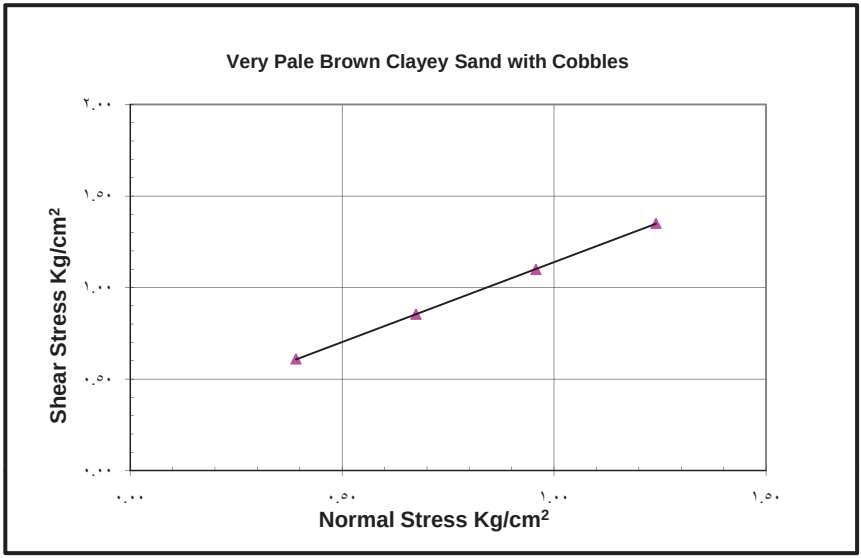
Soil Description	Very Pale Brown Clayey Sand with Cobbles		
Sample No.	Group 4	Test Date	16/04/2012

For Undisturbed Samples	
Mass Of Container (gm)	4234
Mass Of Container + Soil (gm)	4430
Mass Of Soil Used (gm)	196

Shear Box Dimensions			
Ht. cm.	Dam.. cm.	Area cm^2	Vol. cm^3
4.5	6	28.27	127.23

Wet Density(kg/cm^3)	Water Content %	Dry Density(kg/cm^3)	Normal Load Kg	Normal Stress (Kg/cm^2)
1.54	3.0	1.50	***	***

DEPTH m	Description	Normal Load Kg	Normal Load Kg	Normal Load Kg	Normal Load Kg	Soil Parameters	
		11.064	19.064	27.064	35.064	Φ°	C Kg/cm2
***	Load Dial reading	290	420	600	810	41.09	0.27
	Shear stress Kg/cm^2	0.61	0.85	1.10	1.35		
	Normal stress Kg/cm^2	0.39	0.67	0.96	1.24		



Direct Shear Test

Order No.:	Soil 11/2012	Report No.: DSH/11/2012		Date :	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

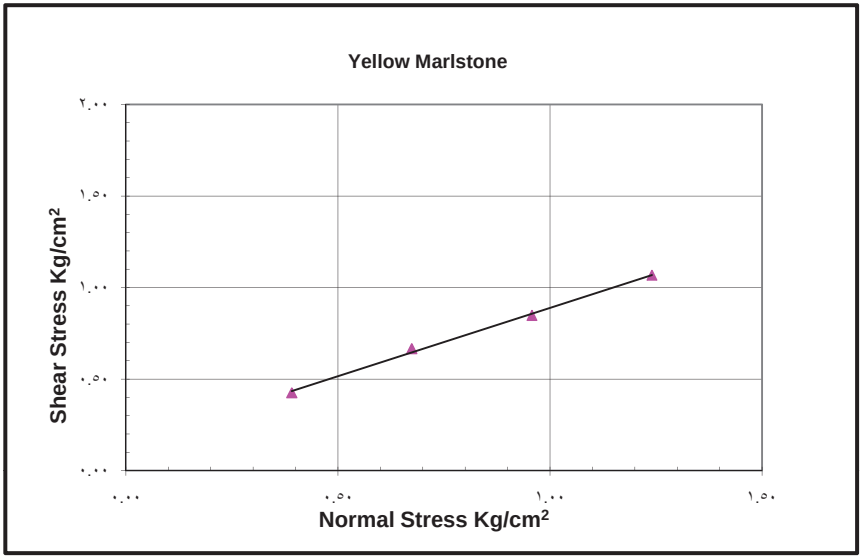
Soil Description	Yellow Marlstone		
Sample No.	Group 5	Test Date	16/04/2012

For Undisturbed Samples	
Mass Of Container (gm)	4234
Mass Of Container + Soil (gm)	4420
Mass Of Soil Used (gm)	186

Shear Box Dimensions			
Ht. cm.	Dam.. cm.	Area cm^2	Vol. cm^3
4.5	6	28.27	127.23

Wet Density(kg/cm^3)	Water Content %	Dry Density(kg/cm^3)	Normal Load Kg	Normal Stress (Kg/cm^2)
1.46	14.6	1.28	***	***

DEPTH m	Description	Normal Load Kg	Normal Load Kg	Normal Load Kg	Normal Load Kg	Soil Parameters	
		11.064	19.064	27.064	35.064	Φ°	C Kg/cm2
***	Load Dial reading	230	360	520	720	36.72	0.14
	Shear stress Kg/cm^2	0.42	0.67	0.85	1.07		
	Normal stress Kg/cm^2	0.39	0.67	0.96	1.24		



Test Report for Atterberg Limits

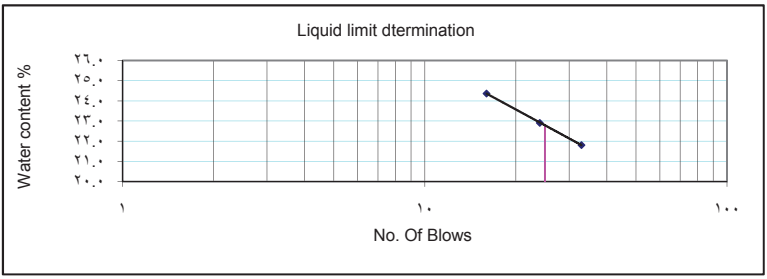
Order No.:	Soil 11/2012	Report No.	Soil 11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Strong Brown Sandy Clay with Cobbles
Source of Sample	Group 1
Samlpling Date	15/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	86.3	113.5	120.3	77.0			
Mass of Dry Soil + Can	81.0	102.8	107.8	73.6			
Mass of Can	56.7	56.1	56.5	55.4			
Mass of Dry Soil	24.3	46.7	51.3	18.2			
Mass of Moisture	5.3	10.7	12.5	3.4			
Water Content %	21.8	22.9	24.4	18.7			
No. of Blows N	33	24	16				
Log(N)	1.52	1.38	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	22.8	18.7	**4.1**



Test Report for Atterberg Limits

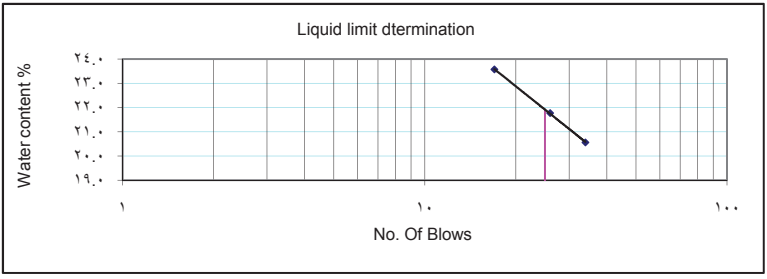
Order No.:	Soil 11/2012	Report No.	Soil 11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Pink Marlstone
Source of Sample	Group 2
Samlpling Date	15/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	77.8	119.5	102.8	82.4			
Mass of Dry Soil + Can	74.1	108.2	93.7	78.4			
Mass of Can	56.1	56.3	55.1	55.1			
Mass of Dry Soil	18.0	51.9	38.6	23.3			
Mass of Moisture	3.7	11.3	9.1	4.0			
Water Content %	20.6	21.8	23.6	17.2			
No. of Blows N	34	26	17				
Log(N)	1.53	1.41	1.23				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	21.9	17.2	**4.7**



Test Report for Atterberg Limits

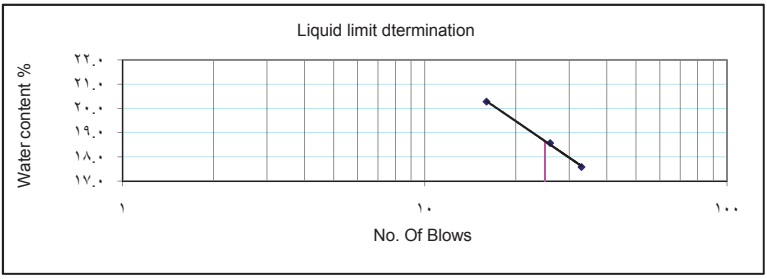
Order No.:	Soil 11/2012	Report No.	Soil 11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Light Yellowish Brown Base Course
Source of Sample	Group 3
Samlpling Date	15/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	66.8	123.1	90.6	85.2			
Mass of Dry Soil + Can	65.2	112.5	84.8	81.1			
Mass of Can	56.1	55.4	56.2	55.8			
Mass of Dry Soil	9.1	57.1	28.6	25.3			
Mass of Moisture	1.6	10.6	5.8	4.1			
Water Content %	17.6	18.6	20.3	16.2			
No. of Blows N	33	26	16				
Log(N)	1.52	1.41	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	18.6	16.2	**2.4**



Test Report for Atterberg Limits

Order No.:	Soil 11/2012	Report No.	Soil 11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Very Pale Brown Clayey Sand with Cobbles
Source of Sample	Group 4
Samlpling Date	15/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can							
Mass of Dry Soil + Can							
Mass of Can							
Mass of Dry Soil							
Mass of Moisture							
Water Content %	NP	NP	NP	NP			
No. of Blows N							
Log(N)							

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	***	NP	***

Test Report for Atterberg Limits

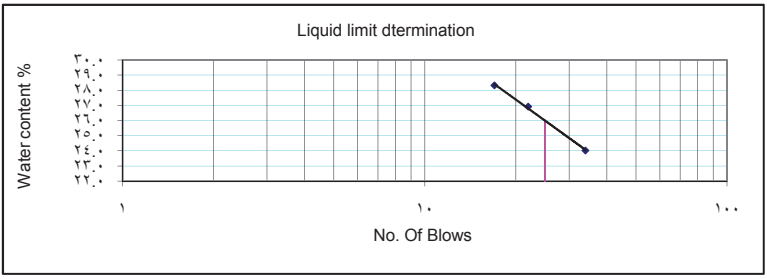
Order No.:	Soil 11/2012	Report No.	Soil 11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Yellow Marlstone
Source of Sample	Group 5
Samlpling Date	15/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	110.3	124.4	98.6	92.4			
Mass of Dry Soil + Can	99.8	109.7	89.0	85.7			
Mass of Can	56.1	55.1	55.1	54.6			
Mass of Dry Soil	43.7	54.6	33.9	31.1			
Mass of Moisture	10.5	14.7	9.6	6.7			
Water Content %	24.0	26.9	28.3	21.5			
No. of Blows N	34	22	17				
Log(N)	1.53	1.34	1.23				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	26.0	21.5	**4.5**



Test Report for Atterberg Limits

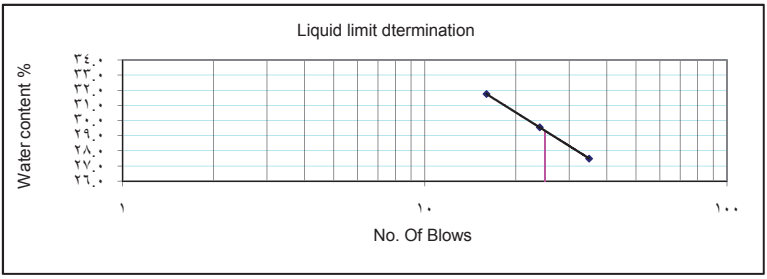
Order No.:	Soil 11/2012	Report No.	Soil 11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Very Dark Grayish Brown Sandy Clay with Gravel
Source of Sample	Group 6
Samlpling Date	15/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	77.2	98.6	104.6	74.2			
Mass of Dry Soil + Can	72.5	88.7	92.6	71.2			
Mass of Can	55.4	55.2	54.8	54.7			
Mass of Dry Soil	17.1	33.5	37.8	16.5			
Mass of Moisture	4.7	9.9	12.0	3.0			
Water Content %	27.5	29.6	31.7	18.2			
No. of Blows N	35	24	16				
Log(N)	1.54	1.38	1.20				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	29.3	18.2	**11.1**



Test Report for Atterberg Limits

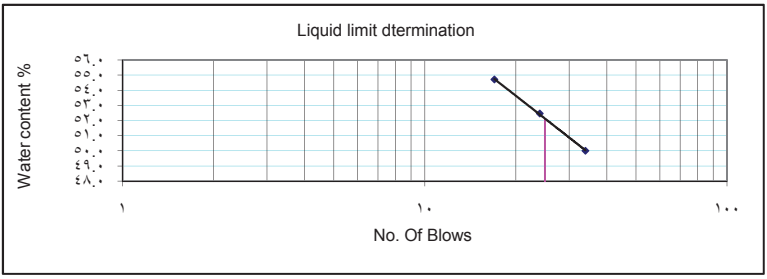
Order No.:	Soil 11/2012	Report No.	Soil 11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of Soil	Dark Brown Sandy Clay
Source of Sample	Group 7
Samlpling Date	15/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-10				AASHTO T90-10			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	99.4	92.6	88.4	80.8			
Mass of Dry Soil + Can	84.8	79.8	76.8	73.9			
Mass of Can	55.6	55.4	55.6	56.1			
Mass of Dry Soil	29.2	24.4	21.2	17.8			
Mass of Moisture	14.6	12.8	11.6	6.9			
Water Content %	50.0	52.5	54.7	38.8			
No. of Blows N	34	24	17				
Log(N)	1.53	1.38	1.23				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	52.1	38.8	**13.4**



Test Report for
Soil Classification

Order No.	Soil 11/2012	Report No.	Soil/11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of soil	Strong Brown Sandy Clay with Cobbles	Testing Date	15/04/2012
Original Source Sample	Group 1	QTY of Sample(gm)	**536**
Oven Dry wt. Of Sample (gm)	**492**	Wash Oven Dry wt.(gm)	**276**

Sieve Size		WT. retained (gm)	Retained %	Accum. Retained %	Passing %	Specification %		Remarks
Nomincla-ture (in.)	Aperture mm	gm	%	%	%			
3	75	0	0.0	0.0	100.0			
2 1/2	63	0	0.0	0.0	100.0			
2	50	0	0.0	0.0	100.0			
1 1/2	37.5	0	0.0	0.0	100.0			
1	25	0	0.0	0.0	100.0			
3/4	19	0	0.0	0.0	100.0			
1/2	12.7	0	0.0	0.0	100.0			
3/8	9.5	0	0.0	0.0	100.0			
#4	4.75	62.0	12.6	12.6	87.4			
#10	2	82.0	16.7	29.3	70.7			
#40	0.452	88.0	17.9	47.2	52.8			
#200	0.075	44.0	8.9	56.1	43.9			
Pan		216	43.9	100.0	0.0			

Atterberg Limits Results

Liquid limit (LL) (%)	22.8	***
Plastic limit (PL) (%)	18.7	***
Plasticity Index (PI) (%)	4.1	***

Test Report for
Soil Classification

Order No.	Soil 11/2012	Report No.	Soil/11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of soil	Pink Marlstone	Testing Date	15/04/2012
Original Source Sample	Group 2	QTY of Sample(gm)	**383.5**
Oven Dry wt. Of Sample (gm)	**356.4**	Wash Oven Dry wt.(gm)	**225.7**

Sieve Size		WT. retained (gm)	Retained %	Accum. Retained %	Passing %	Specification %		Remarks
Nomincla-ture (in.)	Aperture mm	gm	%	%	%			
3	75	0	0.0	0.0	100.0			
2 1/2	63	0	0.0	0.0	100.0			
2	50	0	0.0	0.0	100.0			
1 1/2	37.5	0	0.0	0.0	100.0			
1	25	0	0.0	0.0	100.0			
3/4	19	0	0.0	0.0	100.0			
1/2	12.7	0	0.0	0.0	100.0			
3/8	9.5	0	0.0	0.0	100.0			
#4	4.75	16.7	4.7	4.7	95.3			
#10	2	50.1	14.1	18.7	81.3			
#40	0.452	105.6	29.6	48.4	51.6			
#200	0.075	53.3	15.0	63.3	36.7			
Pan		130.7	36.7	100.0	0.0			

Atterberg Limits Results

Liquid limit (LL) (%)	21.9	***
Plastic limit (PL) (%)	17.2	***
Plasticity Index (PI) (%)	4.7	***

Test Report for
Soil Classification

Order No.	Soil 11/2012	Report No.	Soil/11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of soil	Light Yellowish Brown Base Course	Testing Date	15/04/2012
Original Source Sample	Group 3	QTY of Sample(gm)	**636**
Oven Dry wt. Of Sample (gm)	**617**	Wash Oven Dry wt.(gm)	**516**

Sieve Size		WT. retained (gm)	Retained %	Accum. Retained %	Passing %	Specification %		Remarks
Nomincla-ture (in.)	Aperture mm	gm	%	%	%			
3	75	0	0.0	0.0	100.0			
2 1/2	63	0	0.0	0.0	100.0			
2	50	0	0.0	0.0	100.0			
1 1/2	37.5	0	0.0	0.0	100.0			
1	25	0	0.0	0.0	100.0			
3/4	19	0	0.0	0.0	100.0			
1/2	12.7	0	0.0	0.0	100.0			
3/8	9.5	48	7.8	7.8	92.2			
#4	4.75	172.0	27.9	35.7	64.3			
#10	2	152.0	24.6	60.3	39.7			
#40	0.452	108.0	17.5	77.8	22.2			
#200	0.075	36.0	5.8	83.6	16.4			
Pan		101.0	16.4	100.0	0.0			

Atterberg Limits Results

Liquid limit (LL) (%)	18.6	***
Plastic limit (PL) (%)	16.2	***
Plasticity Index (PI) (%)	2.4	***

Test Report for
Soil Classification

Order No.	Soil 11/2012	Report No.	Soil/11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of soil	Very Pale Brown Clayey Sand with Cobbles	Testing Date	15/04/2012
Original Source Sample	Group 4	QTY of Sample(gm)	**246**
Oven Dry wt. Of Sample (gm)	**239**	Wash Oven Dry wt.(gm)	**158**

Sieve Size		WT. retained (gm)	Retained %	Accum. Retained %	Passing %	Specification %		Remarks
Nomincla-ture (in.)	Aperture mm	gm	%	%	%			
3	75	0	0.0	0.0	100.0			
2 1/2	63	0	0.0	0.0	100.0			
2	50	0	0.0	0.0	100.0			
1 1/2	37.5	0	0.0	0.0	100.0			
1	25	0	0.0	0.0	100.0			
3/4	19	0	0.0	0.0	100.0			
1/2	12.7	0	0.0	0.0	100.0			
3/8	9.5	0	0.0	0.0	100.0			
#4	4.75	8.0	3.3	3.3	96.7			
#10	2	32.0	13.4	16.7	83.3			
#40	0.452	70.0	29.3	46.0	54.0			
#200	0.075	48.0	20.1	66.1	33.9			
Pan		81.0	33.9	100.0	0.0			

Atterberg Limits Results

Liquid limit (LL) (%)	***	***
Plastic limit (PL) (%)	NP	***
Plasticity Index (PI) (%)	***	***

Test Report for
Soil Classification

Order No.	Soil 11/2012	Report No.	Soil/11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of soil	Very Dark Grayish Brown Sandy Clay with Gravel	Testing Date	18/04/2012
Original Source Sample	Group 6	QTY of Sample(gm)	**580**
Oven Dry wt. Of Sample (gm)	**534**	Wash Oven Dry wt.(gm)	**278**

Sieve Size		WT. retained (gm)	Retained %	Accum. Retained %	Passing %	Specification %		Remarks
Nomincla-ture (in.)	Aperture mm	gm	%	%	%			
3	75	0	0.0	0.0	100.0			
2 1/2	63	0	0.0	0.0	100.0			
2	50	0	0.0	0.0	100.0			
1 1/2	37.5	0	0.0	0.0	100.0			
1	25	0	0.0	0.0	100.0			
3/4	19	0	0.0	0.0	100.0			
1/2	12.7	0	0.0	0.0	100.0			
3/8	9.5	0	0.0	0.0	100.0			
#4	4.75	42.0	7.9	7.9	92.1			
#10	2	104.0	19.5	27.3	72.7			
#40	0.452	102.0	19.1	46.4	53.6			
#200	0.075	30.0	5.6	52.1	47.9			
Pan		256.0	47.9	100.0	0.0			

Atterberg Limits Results

Liquid limit (LL) (%)	29.3	***
Plastic limit (PL) (%)	18.2	***
Plasticity Index (PI) (%)	11.1	***

Test Report for
Soil Classification

Order No.	Soil 11/2012	Report No.	Soil/11/2012	Date:	07/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Qabatya-Zababdah-Alkufeir-Tubas Road	Location	Jenin

Description of soil	Dark Brown Sandy Clay	Testing Date	15/04/2012
Original Source Sample	Group 7	QTY of Sample(gm)	**266**
Oven Dry wt. Of Sample (gm)	**200**	Wash Oven Dry wt.(gm)	**26**

Sieve Size		WT. retained (gm)	Retained %	Accum. Retained %	Passing %	Specification %		Remarks
Nomincla-ture (in.)	Aperture mm	gm	%	%	%			
3	75	0	0.0	0.0	100.0			
2 1/2	63	0	0.0	0.0	100.0			
2	50	0	0.0	0.0	100.0			
1 1/2	37.5	0	0.0	0.0	100.0			
1	25	0	0.0	0.0	100.0			
3/4	19	0	0.0	0.0	100.0			
1/2	12.7	0	0.0	0.0	100.0			
3/8	9.5	0	0.0	0.0	100.0			
#4	4.75	0.0	0.0	0.0	100.0			
#10	2	4.0	2.0	2.0	98.0			
#40	0.452	12.0	6.0	8.0	92.0			
#200	0.075	10.0	5.0	13.0	87.0			
Pan		174.0	87.0	100.0	0.0			

Atterberg Limits Results

Liquid limit (LL) (%)	52.1	***
Plastic limit (PL) (%)	38.8	***
Plasticity Index (PI) (%)	13.4	***

8.0 Appendix E: Geotechnical & Structural Evaluation for Wadi Al Nar

The attached report from the ICGES documents the geotechnical and structural evaluation for slope stability of the embankment for the Wadi Al Nar roadway.

GEOTECHNICAL & STRUCTURAL EVALUATION
For
Wadi Al-Nar Road
Submitted to
BLACK & VEATCH

Date: May 7th, 2012
No. 071/2012

To:
Black & Veatch, Ramallah
Attn:
Eng. Robert Mendoza
Eng. Adnan Azazmah

SUBJECT: Testing results of Wadi AlNar Road Stability

Dear Sirs:

You can find with this letter the results of testing and analysis performed for Wadi Al Nar Road to check the stability of the valley side of the road.

Two boreholes were drilled at the site and the material was tested in the laboratory for physical and mechanical properties. The results of testing are included with this report. The results of the investigation were used to analyze the stability of the slope.

Since the design was not available during our analysis stage, the original ground surface elevation was assumed approximately based on our know knowledge of the specific site before, during and after construction.

The analysis of the slope was conducted using a geotechnical software package (PROKON), results showed unstable road and slope.

In the event that additional information or clarifications are needed, please don't hesitate to contact us at your earliest convenience.

I would like to thank you for your confidence and look forward to further cooperation in the near future.

Respectfully Submitted,

Dr. Mohammad Alsayyed, PhD, PE

INTRODUCTION

Wadi Al Nar road project was constructed by ApcoArCon in 2011. The subject section was constructed by cutting from the mountain side and filling into the valley side. Filling was made using trucks hauling the fill from one side to the other till the desired levels were reached. Regardless of the method of compaction adopted, if any, there is a fact that this part of the road and culvert have failed under the applied loads within a short period of time, (less than a year). Black & Veatch consultants who took over after MWH, contracted the International Center for Geotechnical & Engineering Studies (ICGES) to investigate the case and recommend the solution for the problem in order to have a safe road for use.

METHODOLOGY:

Slope stability analysis was made by applying Bishop Method, Janbu Method and Spencer Method in the analysis of slopes. A computer software named *PROKON* based on Limit Equilibrium Method was used for this purpose. The analysis was made by applying line load as well as distributed load. Very low values for safety factor were obtained. Analysis was made using three cases; no load, line load and uniformly distributed load.

Lab Testing:

The following tests and standards were carried out on the obtained samples:

Test no	Tests carried out	Standards
1	Dry Preparation of Disturbed Soil & Soil Aggregate Samples for Test	AASHTO T 87
2	Particle-Size Analysis of Soils	ASTM D 422-63(98)
3	Determination of Atterberg limits of soil	ASTM D 4318-00
4	Unconfined Compressive Strength of Cohesive Soils	ASTM D 2166
5	Specific Gravity of Soils	AASHTO T 100
6	Classification of Soils for Engineering Purposes	ASTM D 2487 - 98
7	Standard Test Method for Direct Shear of Soils Under Consolidated Drained Conditions	ASTM D 3080
8	Unified Soil Classification System	
9	Unconfined Compressive Strength of Cohesive Soils	ASTM D 2166
10	Determination of Water Content of Soils	ASTM C 566

The test results are attached at the end of the report.

Conclusions:

Several cases were investigated, the factor of safety was as shown in the printout attached with this report. The analysis shows that the embankment is not in stable condition.

Recommendations:

Stabilizing the embankment can be done using any of the following techniques:

1. Installing a series of secant piles in the form of curtain wall that goes down to intersect the failure surface. Analysis using this option is done using the same program. It is clear that the safety factor was increased and become more than 1.5.
2. Using jet grouting method in soil stabilization or fixation under the road as well as the slope. The jet grouting columns are to go down below the failure surface.
3. Building a retaining wall at the toe of the slope on stable ground and design it to prevent the slope movement and be enough to have the side slope more flat and at the same time to carry the loads. This wall can take the form of gravity wall or reinforced wall.
4. Dismantling of the pavement and build it again using the appropriate methods of construction as well as the appropriate material to the depth that is recommended by the designer. If soil to be used from the site, it should be modified by mixing with stabizing material such as cement or lime before compaction, trial mixes can be done to determine the appropriate cement or lime to soil ratio.
5. Dismantling the pavement and perform deep compaction on two stages each of about 4 meters.
6. In all cases of backfilling, the backfill should be done in layers 25 cms before compaction and tested to a minimum of 98% degree of compaction on modified proctor and within +- 2% of optimum moisture content.

The design of the approach that you select can be made available for you within 10 days. No additional charge will be added for the design.

Moisture Content Report
ASTM C566

Order No.:	Soil 13/2012	Report No.	Soil 13/2012	Date	09/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Wadi Al Nar

Borholes No.	Depth (m)	Can Weight (gm)	Can & Specimen Wet Weight (gm)	Can & Specimen Dry Weight (gm)	Moisture Content %
BH1	(0-2)	33.3	127.1	116.6	12.6
	(2-3)	35.7	119.0	109.3	13.2
	(3-6)	***	***	***	No Sample
	(6-8)	27.2	97.5	89.0	13.8
	(8-10.5)	32.5	125.5	113.0	15.5
BH2	(0-0.4)	***	***	***	***
	(0.4-1.5)	35.7	124.6	116.3	10.3
	(1.5-2.5)	27.2	101.6	100.1	2.1
	(2.5-3.5)	32.5	101.9	95.3	10.5
	(3.5-5.5)	36.5	124.4	116.5	9.9
	(5.5-7)	33.3	91.2	84.6	12.9
	(7-9)	32.4	105.5	95.2	16.4
	(9-11)	33.8	104.0	93.9	16.8
	(11-14)	45.7	121.1	110.2	16.9

Unconfined Compression Test
ASTM D2166

Order No.:	13/2012	Report No.: UNCON/13/2012		Date :	09/05/2012

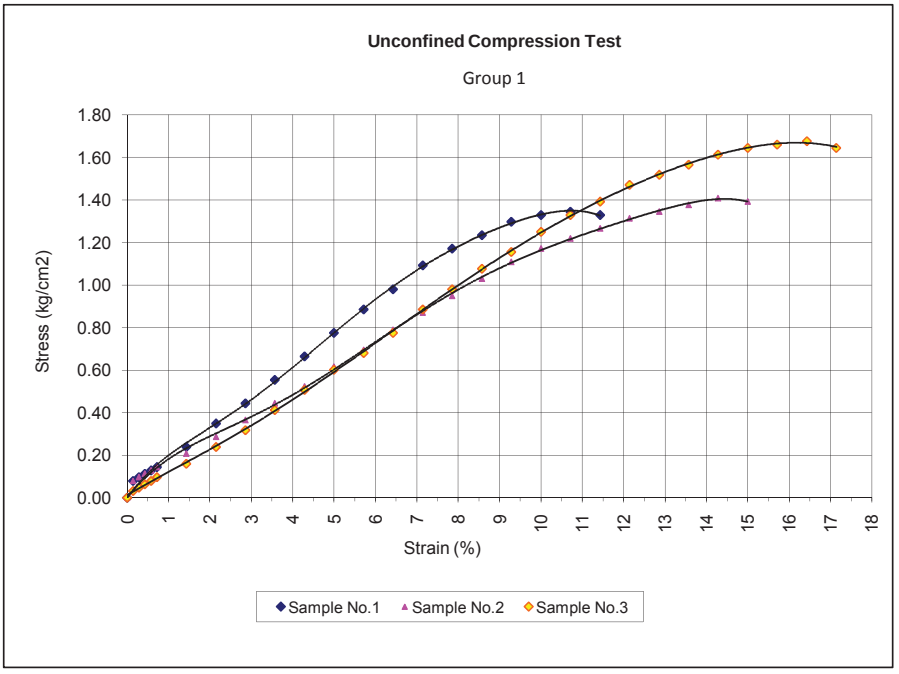
Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Jenin

Soil Description	Very Soft Rock (Dark Yellowish Orange 10YR 6/6)	Boring No.	***
Sample No.	Group 1	Test Date	21/04/2012

Water Content Calculations	No. 1	No. 2	No. 3	Specimen dimensions				
Mass Test Specimen (gm)	127.1	127.7	129.0	Ht.	Dam..	Area	Vol.	
Mass Of Container+wet Soil (gm)	111.5	111.5	111.5	cm.	cm.	cm^2	cm^3	
Mass Of Container (gm)	45.8	45.8	45.8	7	3.33	8.7	60.96	Specimen 1
Mass Of Container+dry Soil (gm)	101	100.7	100.8	7	3.33	8.7	60.96	Specimen 2
Water Content percent (%)	19.0	19.7	19.5	7	3.33	8.7	60.96	Specimen 3

	Specimen No. 1	Specimen No. 2	Specimen No. 3
Wet Density(kg/cm^3)	2.085	2.095	2.116
Dry Density(kg/cm^3)	1.752	1.750	1.771
Specific gravity	2.606	2.606	2.606
Void Ratio	0.49	0.49	0.47
Degree of Saturation	101.63	104.87	107.60

Sample No.1				Sample No.2				Sample No.3			
Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress
div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2
0	0.0	0	0.00	0	0.0	0	0.00	0	0.0	0	0.00
10	0.1	5	0.08	10	0.1	5	0.08	10	0.1	2	0.03
20	0.3	6	0.09	20	0.3	6	0.09	20	0.3	3	0.05
30	0.4	7	0.11	30	0.4	7	0.11	30	0.4	4	0.06
40	0.6	8	0.13	40	0.6	8	0.13	40	0.6	5	0.08
50	0.7	9	0.14	50	0.7	9	0.14	50	0.7	6	0.09
100	1.4	15	0.24	100	1.4	13	0.21	100	1.4	10	0.16
150	2.1	22	0.35	150	2.1	18	0.28	150	2.1	15	0.24
200	2.9	28	0.44	200	2.9	23	0.36	200	2.9	20	0.32
250	3.6	35	0.55	250	3.6	28	0.44	250	3.6	26	0.41
300	4.3	42	0.66	300	4.3	33	0.52	300	4.3	32	0.51
350	5.0	49	0.78	350	5.0	39	0.62	350	5.0	38	0.60
400	5.7	56	0.89	400	5.7	44	0.70	400	5.7	43	0.68
450	6.4	62	0.98	450	6.4	50	0.79	450	6.4	49	0.78
500	7.1	69	1.09	500	7.1	55	0.87	500	7.1	56	0.89
550	7.9	74	1.17	550	7.9	60	0.95	550	7.9	62	0.98
600	8.6	78	1.23	600	8.6	65	1.03	600	8.6	68	1.08
650	9.3	82	1.30	650	9.3	70	1.11	650	9.3	73	1.16
700	10.0	84	1.33	700	10.0	74	1.17	700	10.0	79	1.25
750	10.7	85	1.34	750	10.7	77	1.22	750	10.7	84	1.33
800	11.4	84	1.33	800	11.4	80	1.27	800	11.4	88	1.39
				850	12.1	83	1.31	850	12.1	93	1.47
				900	12.9	85	1.34	900	12.9	96	1.52
				950	13.6	87	1.38	950	13.6	99	1.57
				1000	14.3	89	1.41	1000	14.3	102	1.61
				1050	15.0	88	1.39	1050	15.0	104	1.65
								1100	15.7	105	1.66
								1150	16.4	106	1.68
								1200	17.1	104	1.65


Unconfined Compression Test
Group 1
Stress (kg/cm2)
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Strain (%)
Sample No.1
Sample No.2
Sample No.3

Unconfined Compression Test
ASTM D2166

Order No.:	13/2012	Report No.: UNCON/13/2012		Date :	09/05/2012

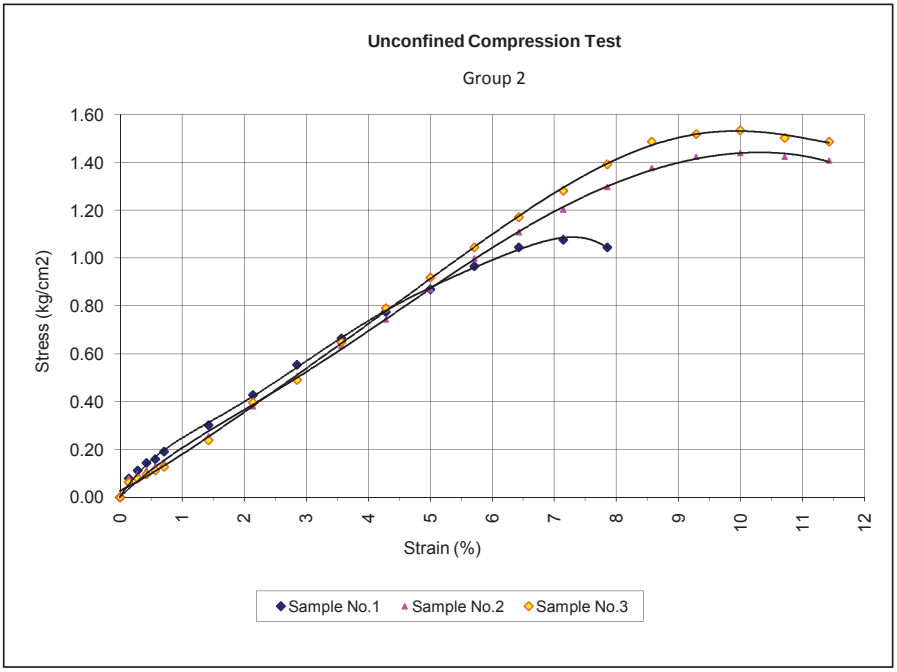
Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Jenin

Soil Description	Very Soft Rock (Grayish Orange 10YR 7/4)	Boring No.	***
Sample No.	Group 2	Test Date	21/04/2012

Water Content Calculations	No. 1	No. 2	No. 3	Specimen dimensions				
Mass Test Specimen (gm)	128.5	129.8	128.4	Ht.	Dam..	Area	Vol.	
Mass Of Container+wet Soil (gm)	103.4	103.4	103.4	cm.	cm.	cm^2	cm^3	
Mass Of Container (gm)	45.8	46.3	45.8	7	3.33	8.7	60.96	Specimen 1
Mass Of Container+dry Soil (gm)	94.7	94.7	94.8	7	3.33	8.7	60.96	Specimen 2
Water Content percent (%)	17.8	18.0	17.6	7	3.33	8.7	60.96	Specimen 3

	Specimen No. 1	Specimen No. 2	Specimen No. 3
Wet Density(kg/cm^3)	2.108	2.129	2.106
Dry Density(kg/cm^3)	1.789	1.805	1.792
Specific gravity	2.624	2.624	2.624
Void Ratio	0.47	0.45	0.46
Degree of Saturation	100.10	103.90	99.14

Sample No.1				Sample No.2				Sample No.3			
Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress	Displacement dial Reading	e %	Load Dial Reading	Stress
div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2	div	mm/div	div	Kg /cm2
0	0.0	0	0.00	0	0.0	0	0.00	0	0.0	0	0.00
10	0.1	5	0.08	10	0.1	5	0.08	10	0.1	4	0.06
20	0.3	7	0.11	20	0.3	6	0.09	20	0.3	5	0.08
30	0.4	9	0.14	30	0.4	7	0.11	30	0.4	6	0.09
40	0.6	10	0.16	40	0.6	8	0.13	40	0.6	7	0.11
50	0.7	12	0.19	50	0.7	9	0.14	50	0.7	8	0.13
100	1.4	19	0.30	100	1.4	16	0.25	100	1.4	15	0.24
150	2.1	27	0.43	150	2.1	24	0.38	150	2.1	25	0.40
200	2.9	35	0.55	200	2.9	32	0.51	200	2.9	31	0.49
250	3.6	42	0.66	250	3.6	40	0.63	250	3.6	41	0.65
300	4.3	49	0.78	300	4.3	47	0.74	300	4.3	50	0.79
350	5.0	55	0.87	350	5.0	55	0.87	350	5.0	58	0.92
400	5.7	61	0.97	400	5.7	63	1.00	400	5.7	66	1.04
450	6.4	66	1.04	450	6.4	70	1.11	450	6.4	74	1.17
500	7.1	68	1.08	500	7.1	76	1.20	500	7.1	81	1.28
550	7.9	66	1.04	550	7.9	82	1.30	550	7.9	88	1.39
				600	8.6	87	1.38	600	8.6	94	1.49
				650	9.3	90	1.42	650	9.3	96	1.52
				700	10.0	91	1.44	700	10.0	97	1.53
				750	10.7	90	1.42	750	10.7	95	1.50
				800	11.4	89	1.41	800	11.4	94	1.49


Unconfined Compression Test
Group 2
Stress (kg/cm2)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
1
2
3
4
5
6
7
8
9
10
11
12
Strain (%)
Sample No.1
Sample No.2
Sample No.3

Direct Shear Test

Order No.:	Soil 13/2012	Report No.: DSH/13/2012		Date :	09/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Wadi Al Nar

Soil Description	Very Soft Rock (Grayish Orange 10YR 7/4)		
Sample No.	Group 2	Test Date	29/04/2012

For Undisturbed Samples	
Mass Of Container (gm)	4234
Mass Of Container + Soil (gm)	4394
Mass Of Soil Used (gm)	160

Shear Box Dimensions			
Ht. cm.	Dam.. cm.	Area cm^2	Vol. cm^3
4.5	6	28.27	127.23

Wet Density(kg/cm^3)	Water Content %	Dry Density(kg/cm^3)	Normal Load Kg	Normal Stress (Kg/cm^2)
1.26	10.5	1.14	***	***

DEPTH m	Description	Normal Load Kg	Normal Load Kg	Normal Load Kg	Normal Load Kg	Soil Parameters	
		11.064	19.064	27.064	35.064	Φ°	C Kg/cm2
***	Load Dial reading	260	370	520	680	26.74	0.34
	Shear stress Kg/cm^2	0.52	0.70	0.85	0.94		
	Normal stress Kg/cm^2	0.39	0.67	0.96	1.24		

Direct Shear Test

Order No.:	Soil 13/2012	Report No.: DSH/13/2012		Date :	09/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Wadi Al Nar

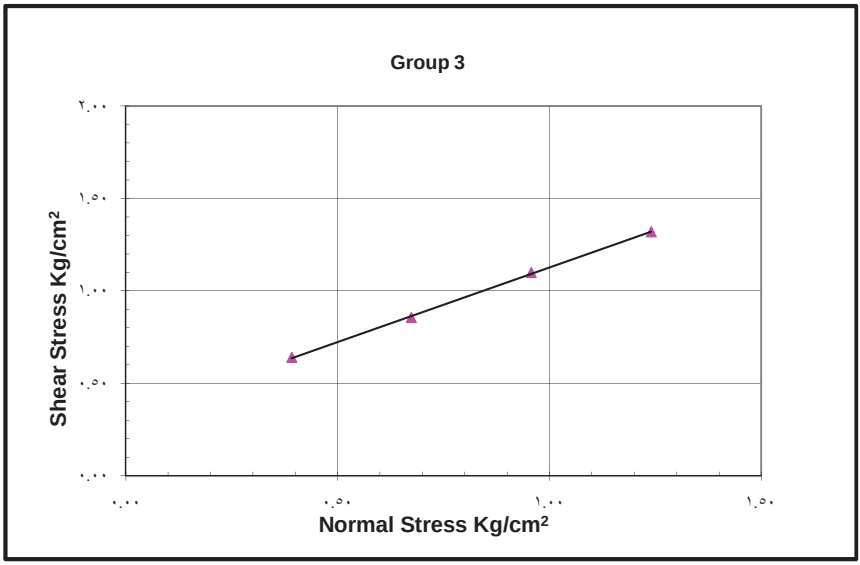
Soil Description	Soft Rock (Pale Yellowish Brown 10YR 6/2)		
Sample No.	Group 3	Test Date	29/04/2012

For Undisturbed Samples	
Mass Of Container (gm)	4234
Mass Of Container + Soil (gm)	4412
Mass Of Soil Used (gm)	178

Shear Box Dimensions			
Ht. cm.	Dam.. cm.	Area cm^2	Vol. cm^3
4.5	6	28.27	127.23

Wet Density(kg/cm^3)	Water Content %	Dry Density(kg/cm^3)	Normal Load Kg	Normal Stress (Kg/cm^2)
1.40	2.06	1.37	***	***

DEPTH m	Description	Normal Load Kg	Normal Load Kg	Normal Load Kg	Normal Load Kg	Soil Parameters	
		11.064	19.064	27.064	35.064	Φ°	C Kg/cm2
***	Load Dial reading	300	420	600	800	38.87	0.32
	Shear stress Kg/cm^2	0.64	0.85	1.10	1.32		
	Normal stress Kg/cm^2	0.39	0.67	0.96	1.24		



Test Report for Atterberg Limits

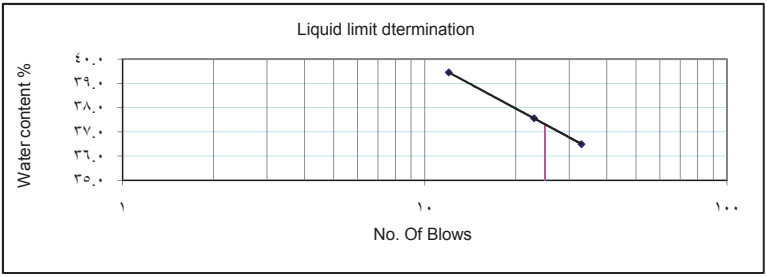
Order No.:	Soil 13/2012	Report No.	Soil 13/2012	Date:	09/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Wadi Al Nar

Description of Soil	Very Soft Rock (Dark Yellowish Orange 10YR 6/6)
Source of Sample	Group 1
Samlpling Date	21/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-96				AASHTO T90-96			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	106.4	102.2	101.8	88.9			
Mass of Dry Soil + Can	90.2	86.8	86.1	79.9			
Mass of Can	45.8	45.8	46.3	46.3			
Mass of Dry Soil	44.4	41.0	39.8	33.6			
Mass of Moisture	16.2	15.4	15.7	9.0			
Water Content %	36.5	37.6	39.4	26.8			
No. of Blows N	33	23	12				
Log(N)	1.52	1.36	1.08				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	37.3	26.8	**10.5**



Test Report for Atterberg Limits

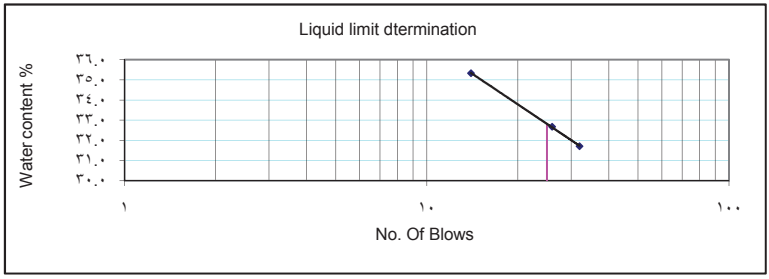
Order No.:	Soil 13/2012	Report No.	Soil 13/2012	Date:	09/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Wadi Al Nar

Description of Soil	Very Soft Rock (Grayish Orange 10YR 7/4)
Source of Sample	Group 2
Samlpling Date	21/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-96				AASHTO T90-96			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	103.1	105.9	104.4	102.2			
Mass of Dry Soil + Can	89.4	91.1	89.1	91.5			
Mass of Can	46.2	45.8	45.8	46.2			
Mass of Dry Soil	43.2	45.3	43.3	45.3			
Mass of Moisture	13.7	14.8	15.3	10.7			
Water Content %	31.7	32.7	35.3	23.6			
No. of Blows N	32	26	14				
Log(N)	1.51	1.41	1.15				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	32.8	23.6	**9.2**



Test Report for Atterberg Limits

Order No.:	Soil 13/2012	Report No.	Soil 13/2012	Date:	09/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Wadi Al Nar

Description of Soil	Soft Rock (Pale Yellowish Brown 10YR 6/2)
Source of Sample	Group 3
Samlpling Date	21/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-96				AASHTO T90-96			
Can No.	1	2	3	1			
Mass of Wet Soil + Can							
Mass of Dry Soil + Can							
Mass of Can							
Mass of Dry Soil							
Mass of Moisture							
Water Content %	NP	NP	NP	NP			
No. of Blows N							
Log(N)							

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	***	NP	***

Specific Gravity
of Soils
AASHTO T100

Order No.:	Soil 13/2012	Report No.: SG/13/2012		Date.:	09/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Wadi Al Nar

Description of sample	Very Soft Rock (Dark Yellowish Orange 10YR 6/6)		
Sample No.	Group 1	Test Date	29/04/2012

Test Result

Mass of oven dry sample In Air (g)	602
Mass of container filled with water at 25o (g)	6662
Mass of container filled with sample and water at 25o (g)	7033
Specific Gravity	2.606

Specific Gravity
of Soils
AASHTO T100

Order No.:	Soil 13/2012	Report No.: SG/13/2012		Date.:	09/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Wadi Al Nar

Description of sample	Very Soft Rock (Grayish Orange 10YR 7/4)		
Sample No.	Group 2	Test Date	29/04/2012

Test Result

Mass of oven dry sample In Air (g)	580
Mass of container filled with water at 25o (g)	6662
Mass of container filled with sample and water at 25o (g)	7021
Specific Gravity	2.624

Specific Gravity
of Soils
AASHTO T100

Order No.:	Soil 13/2012	Report No.: SG/13/2012		Date.:	09/05/2012

Client	Black & Veatch	Address	Rammallah
Project	Wadi Al-Nar Road	Location	Wadi Al Nar

Description of sample	Soft Rock (Pale Yellowish Brown 10YR 6/2)		
Sample No.	Group 3	Test Date	29/04/2012

Test Result

Mass of oven dry sample In Air (g)	720
Mass of container filled with water at 25o (g)	6662
Mass of container filled with sample and water at 25o (g)	7112
Specific Gravity	2.667

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LOG OF BORING NO. BH1

Project Name: Wadi Al-Nar Road | **Project #: 13/2012**
Location: Wadi Al-Nar | **Sheet 1 of 1**
Client: Black & Veatch

Depth, meter	Lithologic Symbol	Material Description	Elevation	Number of Samples	Sample Symbol	Water Content , %	Grain Size Destribution: % Gravel	Grain Size Destribution: % Sand	Grain Size Destribution: % Fines	Atterberg Limits: Liquid Limit (LL)	Atterberg Limits: Plastic Limit (PL)	Atterberg Limits: Plasticity Index (PI)	Cohesion (C) , (Kg/cm2)	Friction Angel , (deg)	Unconfined Compressive Strength , (Kg/cm2)
1		**VERY SOFT ROCK** **Dark Yellowish Orange** **Very Soft Rock**		1		12.6	***	***	***	37.3	26.8	10.5	***	***	1.34
2				1		13.2									
3			477.00												
		NO SAMPLE **No Sample**	3.00												
4				1		***	***	***	***	***	***	***	***	***	***
5															
			474.00												
6		**VERY SOFT ROCK** **Dark Yellowish Orange** **Very Soft Rock**	6.00												
7				1		13.8									
8							***	***	***	37.3	26.8	10.5	***	**	1.34
9				1		15.5									
10			469.50												
			10.50												

Completion Depth: 10.5
Date Started: 18/4/2012
Date Completed: 19/4/2012
Drilled By: Adnan Karajeh
Logged By: Muna Abu Rayyan

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LOG OF BORING NO. BH2

Project Name: Wadi Al-NAr Road | **Project #: 13/2012**
Location: Wadi Al-Nar | **Sheet 1 of 2**
Client: Black & Veatch

Depth, meter	Lithologic Symbol	Material Description	Elevation	Number of Samples	Sample Symbol	Water Content , %	Grain Size Destribution: % Gravel	% Sand	% Fines	Atterberg Limits: Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Cohesion (C) , (Kg/cm2)	Friction Angel , (deg)	Unconfined Compressive Strength , (Kg/cm2)
		BASE COURSE MATERIAL **Base Course Material**	479.60	1		***	***	***	***	***	***	***	***	***	***
1		**VERY SOFT ROCK** **Dark Yellowish Orange** **Very Soft Rock**	0.40 478.50	1		10.3	***	***	***	37.3	26.8	10.5	***	***	1.34
2		**SOFT ROCK** **Pale Yellowish Brown** **Soft Rock**	1.50 477.50	1		2.1	***	***	***	***	NP	***	0.32	38.87	***
3		**VERY SOFT ROCK** **Grayish Orange** **Very Soft Rock**	2.50 476.50	1		10.5	***	***	***	32.8	23.6	9.2	0.34	26.74	1.08
4		**VERY SOFT ROCK** **Dark Yellowish Orange** **Very Soft Rock**	3.50	1		9.9									
5															
6				1		12.9									
7															
8				1		16.4									
							***	***	***	37.3	26.8	10.5	***	***	1.34
9															
10				1		16.8									

Completion Depth: 14
Date Started: 18/4/2012
Date Completed: 19/4/2012
Drilled By: Adnan Karajeh
Logged By: Muna Abu Rayyan

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LOG OF BORING NO. BH2

Project Name: Wadi Al-NAr Road **Project #: 13/2012**
Location: Wadi Al-Nar **Sheet 2 of 2**
Client: Black & Veatch

Depth, meter	Lithologic Symbol	Material Description	Elevation	Number of Samples	Sample Symbol	Water Content , %	Grain Size Destribution			Atterberg Limits			Cohesion (C) , (Kg/cm2)	Friction Angel , (deg)	Unconfined Compressive Strength , (Kg/cm2)
							% Gravel	% Sand	% Fines	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)			
11															
12				1		16.9									
13															
14			466.00 14.00												
15															
16															
17															
18															
19															
20															

Completion Depth: 14
Date Started: 18/4/2012
Date Completed: 19/4/2012
Drilled By: Adnan Karajeh
Logged By: Muna Abu Rayyan

9.0 Appendix F: Material Testing Report for Rawabi

The attached report from the ICGES documents the material sampling and testing performed for the asphalt and the base course materials for the Rawabi roadway.

MATERIAL TESTING
For
Rawabi Internal Road
Submitted to
BLACK & VEATCH

Date: May 7th, 2012

No. 092/2012

To:
Black & Veatch
Ramallah, Palestine

Attn:
Eng. Robert Mendoza
Eng. Adnan Azazmah

SUBJECT: Testing results of Rawabi Internal Road Materials

Dear Sirs:

You can find with this letter the results of testing that was done by our Labs in Bethlehem and Hebron as per your kind request.

In this task the asphalt and the base course materials were samples and tested to verify their compliance with the specifications requirements. No further investigation was done in this assignment.

The results showed some poor quality material as well as workmanship. However, there was no design available for our review regarding the subgrade material or the loading criteria.

In the event that additional information or clarifications are needed, please don't hesitate to contact us at your earliest convenience.

I would like to thank you for your confidence and look forward to further cooperation in the near future.

Respectfully Submitted,

Mohammad Alsayyed, PhD, PE

Lab Testing:

The following tests and standards were carried out on the obtained samples:

Type of Tests	Standards
1.Natural Moisutre Content	ASTM 2216
2.Grain Size Analysis	ASTM C136-2006
3.Atterberg Limits	ASTM 4318
4.Modified proctor	AASHTO 180-2010
5.California Bearing Ratio CBR	ASTM D 1883
6.Soil Classification	AASHTO M 145
7.Field Density	ASTM D 1556-2007
8.Obtain Core Samples	ASTM 3549-93
9.Bulk Specific Gravity	AASHTO T166-10
10.Asphalt Extraction	ASTM 2172-93
11.Gradation of Asphalt Mixture	AASHTO T 30
12.Maximum Theoretical Specific Gravity of Asphalt Mixture	AASHTO T209
13.Marshall Tests for Samples	AASHTO 245-08

Conclusions:

The following conclusions can be drawn from the conducted tests:

1. The base course material gradation is not in compliance with the specifications requirements especially on the fines part.
2. The base course CBR value is less than the Jordanian Specs. Requirements،
3. The degree of compaction and thickness of the base course is accepted،
4. The bitumin content is within the range stated in the Job Mix Formula (JMF).
5. The degree of compaction of the asphalt cores are low.
6. Several cracks exist in the asphalt even the batches that were recently constructed.

Sieve Analysis Of
Base Course

Order No.	130/2012	Report No.	BC: 05/2012	Date:	24/04/2012

Client	Black & Veatch	Adress	Ramallah
Project	Internal Roads/Rwabi	Location	Rwabi

Description of Soil	Base Course Material		
Test Method	**ASTM C136-2006**		
Sampled by	**Lab.Technician /Akram Aqel**	Sampling Date	24/04/2012
Source of Sample	***	QTY of Sample(gm)	5550
Oven Dry wt. of Sample (gm)	5201	Wash Oven Dry wt.(gm)	3998

Sieve Size		WT. Retained (gm)	Retained %	Accum. Retained %	Passing %	Class A	Remarks
Nomincla-ture (in.)	Aperture mm	gm	%	%	%	%	
3	75	0	0.0	0.0	100.0	100	OK
2 1/2	63	0	0.0	0.0	100.0	100	OK
2	50	0	0.0	0.0	100.0	100	OK
1 1/2	37.5	220	4.2	4.2	95.8	100	not Ok
1	25	628	12.1	16.3	83.7	75 - 100	OK
3/4	19	490	9.4	25.7	74.3	60 - 90	OK
1/2	12.7	580	11.2	36.9	63.1	45 - 80	OK
3/8	9.5	270	5.2	42.1	57.9	40 - 70	OK
#4	4.75	626	12.0	54.1	45.9	30 - 65	OK
#10	2.0	410	7.9	62.0	38.0	20 - 40	OK
#40	0.425	492	9.5	71.4	28.6	8 - 20	not Ok
#200	0.075	282	5.4	76.9	23.1	5 - 10	not Ok
Pan		1203	23.1	100.0	0.0		

REMARKS:	

Test Report for Compaction Test

Order No.	130/2012	Report No.	Proc: 13/2012	Date:	24/04/2012

Client	Black & Veatch	Adress	Ramallah
Project	Internal Roads/Rwabi	Location	Rwabi

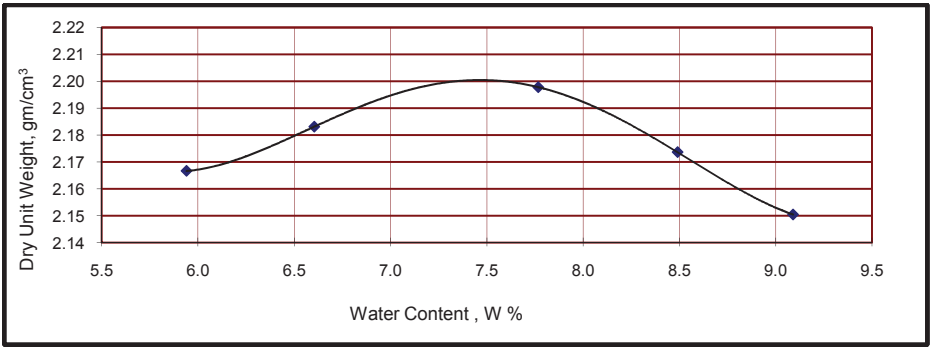
Description of Soil	Base Course Material			
Test Method		AASHTO T180-2010		AASHTO T99-2010
	5 Layers	4.54 Kg Rammer	3 Layers	2.5Kg Rammer
	Method D		Mold Volume cm^3	2133.0
Test Date	21/04/2012			

Water Content Determination

Trial No.	1	2	3	4	5		
Mass of can , g	46	46	46	46	46		
Mass of can + wet soil	260	272	268	276	274		
Mass of can + dry soil	248	258	252	258	255		
Mass of water	12	14	16	18	19		
Mass of dry soil , g	202	212	206	212	209		
Water content , *w%*	5.94	6.60	7.77	8.49	9.09		

Density and unit Weight : $p=M_{ws}/vol$ gm/cm^3 ;

Mass of soil + mold , g	11404	11472	11560	11538	11512		
Mass of mold , g	6508	6508	6508	6508	6508		
Mass of soil in mold , M_{ws}	4896	4964	5052	5030	5004		
Wet unit weight, gm/cm^3	2.30	2.33	2.37	2.36	2.35		
Water content , *w%*	5.94	6.60	7.77	8.49	9.09		
Dry unit weight ,gm/cm^3	2.17	2.18	2.20	2.17	2.15		



Optimum moisture % = 7.5 Maximum dry unit weight, Y_{d} = 2.20 gm/cm^3

California Bearing Ratio
Test Report

Order No :	130/2012	Report No	CBR: 01/2012	Date.:	25/04/2012

Client	Black & Veatch	Address	Ramallah
Project	Internal Roads/Rwabi	Location	Rawabi

Description of Soil	Base Course Material	Source of Sample	Project Site

Sampling Date	19/04/2012	Testing Method	**ASTM D1883**

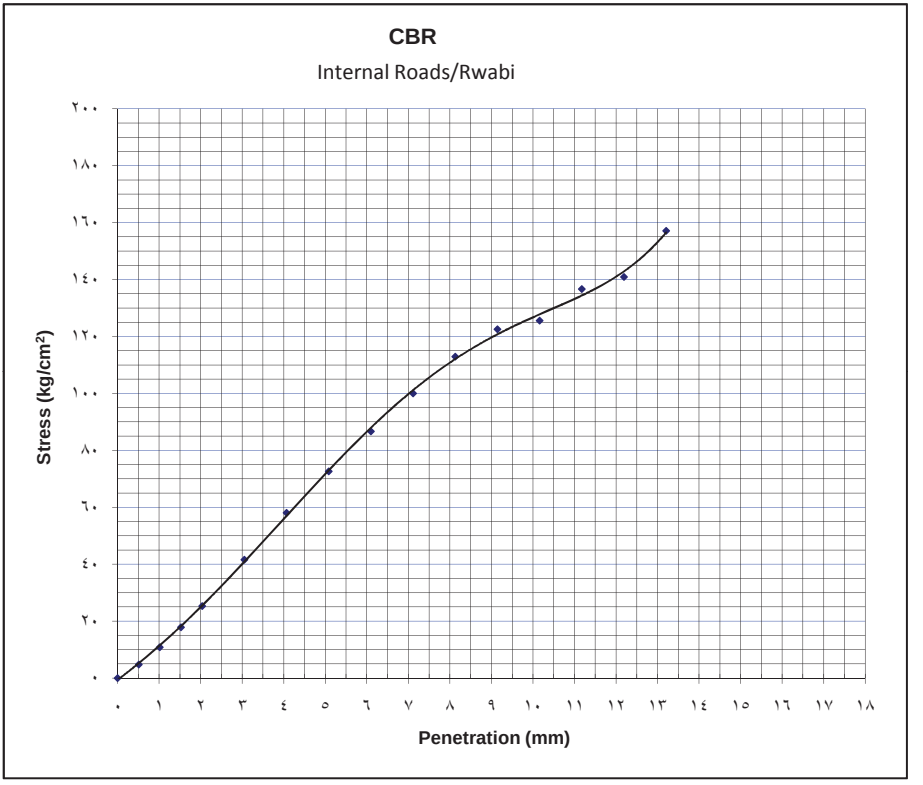
Starting Date	Starting Time	Elapsed Time Hour	Mold no.	1	Mold no.		Mold no.	
			Blows No.	56	Blows No.		Blows No.	
			Surch. gm	4780	Surch. gm		Surch. gm	
			Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %	Dial reading (x_0.01)	Shrinkage =100*S/H %
21/04/2012	10:15	0.00	0.00					
22/04/2012	10:15	24.00	0.00					
23/04/2012	10:15	48.00	0.00					
24/04/2012	22:15	72.50	0.00					
25/04/2012	10:15	96.00	0.00					

Mold No	1		
Surcharge, gm	4780		
Initial mass of wet soil+ mold+base plate	12356		
Final mass of wet soil+mold+base plate	12422		
Mass of mold+base plate	6848		
Initial mass of wet soil, M_i	5508		
Initial wet density, r_i	2.37		
Mass of water absorbed, M_w	66.0		
% water absorbed $=M_W/M_s$ x100	1.20		
Diameter (cm)	15.2		
Height (cm)	12.8		
Volume (cm^3)	2323		

Penetration mm	Mold No.	1	Mold No.		Mold No.		
	Blows No.	56	Blows No.		Blows No.		
	Surch.gm	4316	Surch.gm		Surch.gm		
	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	Piston dial reading (DIV)	Stress, kg/cm^2	
0.0	0	0.0					
0.5	42	4.8					
1.0	95	10.8					
1.5	157	17.9					
2.0	222	25.3					
3.0	365	41.6					
4	510	58.1					
5	638	72.6					
6	761	86.6					
7	878	100.0					
8	992	112.9					
9	1076	122.5					
10	1103	125.6					
11	1200	136.6					
12	1238	140.9					
13	1380	157.1					
14	1475	167.9					
15	1576	179.4					

Water content %	8.3			
Wet Density r_{wet} Kg/cm^3	2.37			
Dry Density r_d Kg/cm^3	2.19			

	65 blows			
Corr. Stress at 2.5mm	33			
Corr. Stress at 5mm	73			
Corr. CBR at 2.5mm	48			
Corr. CBR at 5mm	71			
CBR	71			
Dry Density	2.19			


CBR
Internal Roads/Rwabi
Stress (kg/cm²)
٢٠٠
١٨٠
١٦٠
١٤٠
١٢٠
١٠٠
٨٠
٦٠
٤٠
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٠
٠ ١ ٢ ٣ ٤ ٥ ٦ ٧ ٨ ٩ ١٠ ١١ ١٢ ١٣ ١٤ ١٥ ١٦ ١٧ ١٨
Penetration (mm)

Field Density of Soil Test Report
[Sand Cone Method]

Order No.:	130/2012	Report No.:	FD: 16/2012	Date:	24/04/2012

Client	Black & Veatch	Adress	Ramallah
Project	Internal Roads/Rwabi	Location	Rwabi

Description of Soil	Base Course Material			
Sampled by	**Lab.Technician /Akram Aqel**			
Test Method	**ASTM D 1556-2007**			
Type of Sand	Standard sand 600 /300 μ m C fraction	Unit Weight of Sand	1.48	gm/cm^3
Testing Date :	20/04/2012			

TEST RESULTS

Point		1	2	3	4	
Location (Station)		***	***	***	***	
Weight of sand in the jar (gm)		7000	7000	7000	7000	
Weight of sand remaining in the jar (gm)		3588	3178	3246	3238	
Weight of sand filling the cone (gm)		1682	1682	1682	1682	
Net Wt. Of Sample Obtained from Hole	(gm)	2832	3406	3308	3384	
Moisture Content	%	8.62	6.11	6.00	9.15	
Wt of sand Filled the Hole	(gm)	1730	2140	2072	2080	
Volume of the Hole	cm^3	1169	1446	1400.0	1405.41	
Net wt. of Dry Sample	(gm)	2607	3210	3120.8	3100.32	
Wet Density	(gm/cm^3)	2.42	2.36	2.36	2.41	
Dry Density	(gm/cm^3)	2.23	2.22	2.23	2.21	
Layer Thickness	(cm)	23	22	22	23	

SOIL DEGREE OF COMPACTION

Dry Density Obtained in Field	gm/cm^3	2.23	2.22	2.23	2.21	
Max.Dry Density From Lab.Compaction Test	gm/cm^3	2.20	2.20	2.20	2.20	
Degree of Soil Compaction	%	101	101	101	100	

REMARKS:	

Test Report for Atterberg Limits

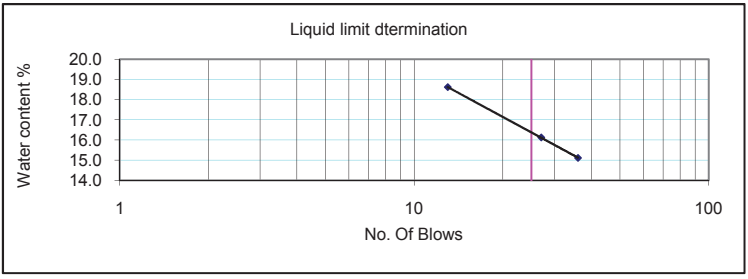
Order No.:	130/2012	Report No.	Att.L: 03/2012	Date:	21/04/2012

Client	Black & Veatch	Adress	Ramallah
Project	Internal Roads/Rwabi	Location	Rwabi

Description of Soil	Base Course Material
Source of Sample	***
Samlpling Date	21/04/2012

Liquid Limit Determination				Plastic Limit Determination			
AASHTO T89-96				AASHTO T90-96			
Can No.	1	2	3	1			
Mass of Wet Soil + Can	104.2	107.0	102.5	106.3			
Mass of Dry Soil + Can	96.6	98.5	93.6	98.8			
Mass of Can	46.3	45.8	45.8	46.3			
Mass of Dry Soil	50.3	52.7	47.8	52.5			
Mass of Moisture	7.6	8.5	8.9	7.5			
Water Content %	15.1	16.1	18.6	14.3			
No. of Blows N	36	27	13				
Log(N)	1.56	1.43	1.11				

Atterberg Limits			
Flow Index	Liquid Limit	Plastic Limit	Plast. Index
	16.4	14.3	**2.1**



Testing Bituminous Paving Mixture Report

Order No:	130/2012	Report No:ASPH/01/2012		Date:	27/04/2012

Client	Black & Veatch	Address	Ramallah
Project	Internal Roads/Rwabi	Location	Rwabi

Sample Source	Project Site	Sampling Date	19/4/2012
Description of Sample	Asphalt	Sampled By:	Lab.Tech./ Akram Aqel

Tested Samples:

1- Analysis test and determination of theoretical maximum density GMM were ,carried out on selected sample reduced from received field bulk sample.
2- Six standard Marshall specimens from received bulk sample were prepared, remolded and compacted 75 blows on each face of each specimen in the lab. using manual compactor after reheating the delivered sample to 135+5C.
3- Prepared standard Marshall specimens in the lab. were used to determine bulk specific gravity, stability and flow of asphaltic mixture sample.
4- Three specimens of six prepared standard Marshall specimens were tested for the purpose of determination of stability and flow soaked in water @ 60 C for 30 minutes whereas the remaining specimens soaked for 24 hrs. in order to determine the loss of stability.
5- (4)Pavement samples were cored and obtained from paved yards using electrical core drill with 4 in diameter bit.

Tests Carried out:

The following tests were carried out according to AASHTO and ASTM standards

1- AASHTO T 166-10 "Bulk specific gravity of compacted bituminous mixtures using paving saturated surface dry specimens.(method A)
2- ASTM D 3549-97 "Test method for thickness or height of compacted bituminous paving mixture specimens."
3- AASHTO T 245-08 "Resistance to plastic flow of bituminous mixture using Marshall apparatus".
4- AASHTO T209-10 "Theoritical maximum specific Gravity (GMM).

This Sheet Contains Three Pages Only

Tests Results

A- Analysis of asphaltic mixture sample

1-Extraction & GMM	
Weight of Asphalt Mix Sample (gm)	1200
Weight of Extracted Aggregate Sample (gm)	1142
Theoritical Maximum Specific Gravity(GMM) of asphalt Sample gm/cm3	2.462
Specific Gravity of Extracted Aggregate gm/cm^3	2.65
Weight of asphalt in Mix Sample (gm)	58.00
Percent of Bitumen by Weight of Total Mix %	4.83
Percent of Bitumen by Weight of Aggregate %	5.08
Specific weight of asphalt in Mix gm/cm3	1.02

2- Extracted aggregate gradation

Sieve size		Passing %	Specifications limits according to Job Mix		Tolerance
in.	mm		Lower Limit	Upper Limit	
1"	37.5	100	100	100	± 5%
3/4"	19	100	94.2	100	± 5%
1/2"	12.5	85.3	82.2	90	± 5%
3/8"	9.5	71.7	66.5	76.5	± 5%
#4	4.75	48.3	44.8	52.8	± 4%
#8	2.36	42.6	31.8	38	± 4%
#20	0.85	17.7	15.8	23.8	± 4%
#50	0.300	9.8	6.8	14.8	± 4%
#80	0.18	8.2	4	11.7	± 4%
#200	0.075	6.1	4.3	7.3	± 1.5%

B- Analysis of Marshall Specimens.

Sample No.	Dry Weight (gm)	SSD (gm)	Wt. In Water (gm)	S.G SSD (gm/cm^3)	Bulk Density (gm/cm^3)	Air Voids %	VMA %
1	1202.0	1210.0	694.0	2.345	2.329	5.4	16.4
2	1207.0	1214.0	695.5	2.341	2.328	5.4	16.5
3	1212.0	1220.0	700.0	2.346	2.331	5.3	16.4
4	1218.5	1228.0	702.0	2.335	2.317	5.9	16.9
5	1217.0	1224.0	703.0	2.349	2.336	5.1	16.2
6	1220.5	1230.0	706.0	2.347	2.329	5.4	16.4
		Average		2.344	2.328	5.4	16.5

C -Stability and Flow

	Soaked in water Bath @ 60C^o			Average
	for 30 minutes			
Specimen No.	1	2	3	
Corrected Marshall stability Kg	1783	1765	1829	1792.3
Flow mm	3.35	3.00	2.71	3.02
Stiffness kg/mm	593.5			

		Soaked in water Bath @ 60C for 24 hours			Average
Specimen No.		1	2	3	
Corrected Marshall stability Kg		1507	1549	1653	1569.7
Flow	mm	3.41	3.37	2.94	3.24
Loss of stability = %			<25 %		12.4

* **Standard Marshall Specimens Specs.**

	Limits as per Job Mix	Jordinian Specifications limits
Void Ratio	4.8	4-7
Stability	1501.63	900
Flow	2.6	2-3.5
VMA	15.2	13
Loss of Stability	14.1	max.25 %
Stiffness	578	min .500% Kg/mm

D- Analysis of Core Specimens.

Specimen No.	1	2	3	4	
Layer	Wearing	Wearing	Wearing	Wearing	
Thickness cm	5.2	5.1	5.2	5.0	
Dry Weight gm	844.0	832.0	834.0	818.5	
SSD Dry Weight gm	850.0	840.0	842.0	826.0	
Weight in Water	468.0	464.0	467.5	454.0	
SSD Bulk Specific Gravity	2.225	2.234	2.248	2.220	
Degree of Compaction %	94.9	95.0	95.6	94.5	
Dry Bulk Density gm/cm^3	2.209	2.213	2.227	2.200	
Bulk Specific Gravity of Standard Marshall Specimens used for the degree of compaction was					2.328
This value represents the average values of specific Gravity of Marshall Specimens obtained by our technicians and tested in the lab.					

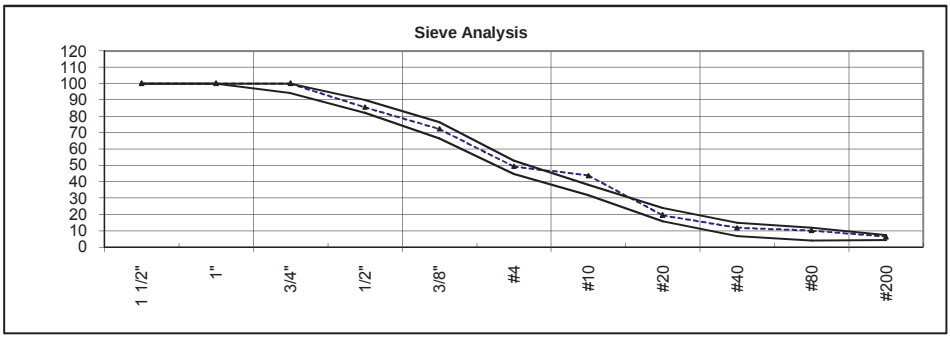
Sieve Analysis
for Bituminous Mix Aggregate

Order No.	130/2012	Report No.:	Asphalt /02/2012	Date:	24/04/2012

Client	Black & Veatch	Address	Ramallah
Project	Internal Roads/Rwabi	Location	Rwabi

Description of Soil	Asphalt		
Test Method	**AASHTO T30-93**		
Sampled by	Lab.Tech./ Akram Aqel	Testing Date	13/03/2011
Source of Sample	Project Site	QTY of Sample(gm)	1200
Oven Dry wt. of Sample (gm)	1142	Wash Oven Dry wt.(gm)	1070

Sieve Size		WT. retained (gm)	Retained %	Accum. Retained %	Passing %	Specification %		Remarks
mm	in.	gm	%	%	%	Lower Bound	Upper Bound	
37.5	1 1/2"	0	0.0	0.0	100.0	100	100	O.K
25	1"	0	0.0	0.0	100.0	100	100	O.K
19	3/4"	0	0.0	0.0	100.0	94.2	100	O.K
12.5	1/2"	164	14.4	14.4	85.6	82.2	90	O.K
9.5	3/8"	152	13.3	27.7	72.3	66.5	76.5	O.K
4.75	#4	262	22.9	50.6	49.4	44.8	52.8	O.K
2.36	#10	64	5.6	56.2	43.8	31.8	38	not O.K
0.85	#20	278	24.3	80.6	19.4	15.8	23.8	O.K
0.425	#40	88	7.7	88.3	11.7	6.8	14.8	O.K
0.18	#80	18	1.6	89.8	10.2	4	11.7	O.K
0.075	#200	44	3.9	93.7	6.3	4.3	7.3	O.K
Pan		72	6.3	100.0	0.0			
		1142.0						



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Theoretical Maximum
Specific Gravity (GMM)
ASSHTO 209-10

Order No.:	130/2012	Report No.:GMM/ 01/2012		Date.:	24/04/2012

Client	Black & Veatch	Address	Ramallah
Project	Internal Roads/Rwabi	Location	Rawabi

Description of sample	Asphalt	Test Date	24/04/2012

Test Result

Mass of oven dry sample In Air (g)	1600
Mass of container filled with water at 25° (g)	6662
Mass of container filled with sample and water at 25° (g)	7612
Maximum Specific Gravity	2.462