Kenya National Highways Authority (KeNHA)

Tender No. KeNHA/2247/2019
CONSULTING SERVICES FOR DESIGN REVIEW, TENDER DOCUMENTATION, CONSTRUCTION SUPERVISION AND CONTRACT ADMINISTRATION FOR REGIONAL MOMBASA PORT ACCESS PROJECT: MOMBASA -MARIKANI (A109) HIGHWAY PROJECT: LOT 2 KWA JOMVU – MARIKANI SECTION (30.4 KM)

Financed by:
The Government of Germany through KfW Development Bank
The European Union through the European Union Africa Infrastructure Trust Fund
The European Investment Bank
The Government of Kenya

FACTUAL MATERIALS REPORT
Nairobi, October 2019
For Information Only
CONSULTING SERVICES FOR DESIGN REVIEW, TENDER DOCUMENTATION, CONSTRUCTION SUPERVISION AND CONTRACT ADMINISTRATION FOR REGIONAL MOMBASA PORT ACCESS PROJECT: MOMBASA -MARIAKANI (A109) HIGHWAY PROJECT: LOT 2 KWA JOMVU – MARIAKANI SECTION (30.4 KM)

DESIGN REVIEW AND ENGINEERING REPORT

FACTUAL MATERIALS REPORT

FOR INFORMATION ONLY

Revision: 2

Date of Submission:

Author: Various Contributors
1 INTRODUCTION ........................................................................................................................................... 2
  1.1 THE INVESTIGATIONS .......................................................................................................................... 2
2 THE PROJECT ROAD .................................................................................................................................... 3
  2.1 THE PROJECT ROAD .............................................................................................................................. 3
  2.2 EXISTING ROAD CONDITIONS .............................................................................................................. 3
  2.3 GEOLOGICAL SETTING OF THE PROJECT ROAD .................................................................................. 3
3 CONSTRUCTION MATERIAL INVESTIGATIONS ....................................................................................... 5
  3.1 INTRODUCTION ........................................................................................................................................ 5
  3.2 FIELD INVESTIGATIONS .......................................................................................................................... 5
  3.3 LABORATORY TESTING ............................................................................................................................ 6
4 BORROW PIT DESCRIPTIONS .................................................................................................................... 7
  4.1 BP1 (1+900 RHS) BWANARI: OFFSET 22KM .......................................................................................... 7
  4.2 BP2 (17+200 RHS) KWABONJE: ADJACENT TO THE ROAD .............................................................. 7
  4.3 BP3 AND BP4 (18+900 LHS) MWACHE: OFFSET 3.5 KM AND 4.3 KM ................................................. 7
  4.4 BP5 (22+900 LHS) MWACHE: OFFSET 4 KM ....................................................................................... 8
  4.5 BP6 (20+500 RHS) TIMBONI: OFFSET 21KM ......................................................................................... 8
  4.6 BP7 (20+500 RHS) LWANDANI: OFFSET 24 KM ..................................................................................... 8
  4.7 BP8 (20+500 RHS) MWAZAI: OFFSET 27 KM ....................................................................................... 8
  4.8 BP9 (26+650 RHS) KAYDEE AT KOKOTONI: OFFSET 3 KM ................................................................. 8
  4.9 BP10 (26+900 RHS) KAVEE AT KOKOTONI: OFFSET 1.1 KM .............................................................. 9
  4.10 BP11 A&B (26+900 RHS) KOKOTONI INVESTMENT AT KOKOTONI: Offset 2 KM ......................... 9
  4.11 BP12 (35+200 RHS) MWACHIPAWA: OFFSET 34.2 KM ................................................................. 9
  4.12 BP13 (35+200 RHS) MWACHIPAWA: OFFSET 33.8KMS .............................................................. 9
5 HARD STONE SOURCES ............................................................................................................................. 10
  5.1 QUARRIES AT MWACHE: KM 18+900 (OFFSET FROM 3.5 KM - 6KM LHS) ...................................... 10
  5.2 QUARRIES AT JARIBUNI: KM 20+500 (OFFSET FROM 45KM TO 50KM RHS) ................................. 10
  5.3 QUARRIES AT KOKOTONI: KM 26.5 TO KM 27 (OFFSET FROM 1.1 KM TO 3 KM RHS) ................. 10
  5.4 QUARRIES AT TARU: 35KM FROM THE END OF THE PROJECT TOWARDS NAIROBI ..................... 11
6 WATER FOR CONSTRUCTION .................................................................................................................. 12
  6.1 WS1 (20+500 RHS): KOMBENI RIVER OFFSET 7.3 KM ...................................................................... 12
  6.2 WS2 (22+900 LHS): MWACHE RIVER OFFSET 4KMS ...................................................................... 12
  6.3 WS3 (23+700 RHS): WANJA WANDEGE POND OFFSET 0.5KMS ...................................................... 12
7 SAND ............................................................................................................................................................ 13

APPENDIX – TEST RESULTS .......................................................................................................................... 14
1 Introduction

This report presents the results of the materials testing carried out during the design review process. The report is for information purposes only and does not discuss or interpret the results and findings.

1.1 The Investigations

The Consultant's investigations identified fifteen potential gravel sources for fill and selected layers and 14 quarry sites (mostly private commercial sources). The Consultant sampled every site for subsequent testing.

The potential hard stone sources located to the LHS of the road near Mazeras are composed of limestone. The potential sources to the RHS of the road around Kokotoni and Taru are composed of sandstone. The quarries in the Jaribuni area are composed of limestone.

In addition, the following may be done to tackle the possible shortage of material in the project area and to reduce the haulage distance of material for pavement and selected subgrade layers:

- Many private quarries around Mazeras and Kokotoni have stockpiles of crusher reject materials that could be used for selected layers. The only issue with this material is a lack of uniformity in quality.

- Possibly the virgin material from the hard stone sources around Kokotoni can be crushed easily and might be used for sub-base, GCS and concrete works. The Contractor may establish a crusher plant in one of these potential sources.

- Rock boulders for stone for bituminous layers may be transported from around Jaribuni and/or from the quarry at Mwarakaya Shopping Centre (km 20+500, 28km RHS) and crushed at this crusher.
2 The Project Road

2.1 The Project Road

The Kwa Jomvu – Mariakani section of the main Mombasa to Nairobi road runs north westward from the coast and is some 30.4 km in length. It begins just after the interchange at km 11+900 currently under construction and ends approximately 1 kilometre after the existing weighbridge at Mariakani.

2.2 Existing Road Conditions

The project road has been in service for many years and now exhibits distress despite the fact that its life has been somewhat prolonged by the application of asphalt overlays and other interventions. The first 2 km of the road is in a very poor condition; full of potholes and, at some locations, the surfacing has disappeared completely.

The block paving section on the rise into Mazeras between km 17+500 and km 18+500 is in reasonable condition as is the majority of the rest of the road after receiving an overlay several years ago.

2.3 Geological Setting of the Project Road

The geology of the south coast of Kenya is characterized by largely of sedimentary origin and range in age from Permian (or possibly Upper Carboniferous) to recent. In general, the geological history of the coastal region has gone through the following succession and creation of geological formations:

1. Archean Basement System: – Gneisses and Schists
3. Mesozoic (Triassic, Jurassic & Cretaceous):- Maji ya Chumvi beds, Mariakani &, Mazeras sandstones, Shimba grits, Kambe limestone, Kibionioni beds, Miritini Shale, Coroa Mombasa limestone, Changamwe shale and Freretown limestone.
4. Cainozoic (Tertiary & Quaternary):- composed of Magarini sands, Lagoonal Deposits, Coral Reefs and River Deposits.
Figure 2-1. Geological Map of Mombasa Area

GEOLOGICAL MAP OF THE MOMBASA--KWALE AREA

[Map of the geological map of the Mombasa-- Kwale area with various geological features and labels.]
3 Construction Material Investigations

3.1 Introduction

The Consultant commenced his tasks with a desk-top review of the Soils and Materials Report and the Final Engineering Report prepared by the original design consultant in June 2015. Thereafter, the Consultant’s field investigations commenced with the initial task of verifying the five potential gravel sources and five potential hard stone sources identified in those reports.

The Consultant noted that there are many projects on going in and around Mombasa and, consequently, most of the potential sources identified in the June 2015 report are exhausted whilst those that were not yet exhausted are being exploited for current projects and are expected to be largely exhausted by the time the Kwa Jomvu – Mariakani projects starts on site. Therefore, new sources of materials need to be found.

3.2 Field Investigations

The Consultant’s Materials Engineer conducted an exhaustive investigation of the project area in an effort to identify new material sources. The investigations included searching for:

- Natural granular material for sub-base layer;
- Borrow material for embankments and improved subgrade;
- Rocks and quarry stones for asphalt concrete, chippings, base course and concrete aggregate and masonry works;
- Sand for mortar and concrete structures;
- Water for compaction and structural works;

The investigations identified several potential sources of selected subgrade material in the form of private quarries within a distance of 1.2 km and 60 km either side of the project road. Potential sources of sub-base material were harder to find. The lateritic gravel that may be used (after being stabilized) is also relatively far away from the project road (21 km to 34 km on the Kaloleni and Kilifi roads). There are also several private quarries even further away (about 50 - 60km) towards Kilifi.

The Consultant sampled all potential sources for subsequent laboratory testing and recorded the locations of the sources using hand held GPS equipment.

The Consultant examined all of the sites with regard to of material type, need for new or improved access road and estimated recoverable quantities based on the visible size of the outcrop and by estimating the depth of the exploitable material from the site geology. Shale, which is abundant around Miritini, weathered limestone (as overburden at Mwache quarries) and weathered sandstone that is common between Miritini to Kokotoni.
3.3 Laboratory Testing

The laboratory tests conducted for the potential sources of construction materials include:

**Gravels for Subbase Layer**
- AASHTO soil classification, Liquid Limits (AASHTO T89), Plastic Limits and Plasticity Index (AASHTO T90);
- 3 point CBR (AASHTO T193) at modified compaction (AASHTO T180), 4 days soaked;
- Gradation, AASHTO T27;
- L.S. AASHTO T 90;

**Quarry Rocks**
- LAA, ASTM C131;
- Sodium Sulphate Soundness (SSS), ASTM C88;
- Aggregate crushing value (ACV), BS- 812 part 110:1990;
- 10% Fines Value (TFV), BS – 812 part 110-1990;
- Specific Gravity and Water Absorption, BS-EN 1097-6:2000;

**Sand**
- Organic Impurity, AASHTO T-21
- Gradation, AASHTO T-27
- Sodium Sulphate Soundness (SSS), AASHTO T-104
- Clay Content

**Water**
- Chloride content
- Sulfate content
- PH value
- TDS

A summary of the laboratory test results are included as an Appendix.
4 Borrow Pit Descriptions

The following describes the potential gravel sources sampled and tested:

4.1 BP1 (1+900 RHS) Bwanari: Offset 22km

This is the borrow pit identified in the June 2015 report as Material site MS 1. Its location is behind Mtwapa off the Mombasa to Kilifi road branching from Majengo Trading Centre (18.2 km from Sabasaba) then 2.8 km on RHS along a track road. This site is composed of coral gravel of about 8 m average depth.

The material's CBR value after 4 days soaking is 67% at 95% MDD, with a plasticity index of 12%. The material falls under unbound material class G-45.

4.2 BP2 (17+200 RHS) Kwabonje: Adjacent to the road

This borrow pit is located on the side of the road at Kwabonje, just after the interchange with the southern bypass. The borrow pit is composed of shale gravel which is abundant in the area.

A material sample was taken from the faces of existing excavations and the results showed that the material’s CBR value after 4 days soaking is 30% and 15.4% at 95% MDD, with a plasticity index of 12% and 13.6%. The material falls under unbound material class G-15.

4.3 BP3 and BP4 (18+900 LHS) Mwache: Offset 3.5 km and 4.3 km

The material sources in these borrow pits consist of quarry overburden and crusher reject material from the private quarries at Mwache. There are four active quarries with very high quantities of overburden. Samples were collected from two of the quarries at 3.5km (Beric Mining) and 4.3kms (Surya) off a gravel road. The overburden material is composed of Yellowish Gray Weathered Limestone. The Crusher reject material (grizzly) is a mixture of gravel, weathered material and cobbles.

The Consultant collected two crusher reject and one-overburden sample from the selected quarries.

The CBR value of the overburden material sampled from Beric Mining after 4 days soaking is 35% at 95% MDD, with a plasticity index of 16%. The CBR values of the reject materials from Beric Mining and Surya quarries are 20 and 15 with PI values of 9 and 12 respectively.

The overburden material from Beric Mining falls under unbound material class G-25.
4.4 BP5 (22+900 LHS) Mwache: Offset 4 km
This borrow pit is located on the RHS before crossing the Mwache River on the Kinango road.

The borrow pit is composed of yellowish weathered sandstone and shale and covers a large area.

A test sample of material from this site was taken by digging pits. The material’s CBR value after 4 days soaking is 10% at 95% MDD, with a plasticity index of 2% (NP).

4.5 BP6 (20+500 RHS) Timboni: Offset 21km
This borrow pit is located just behind Timboni School, after driving some 17 km along the Mazeras to Kaloleni road and branching to RHS 4km to the RHS on a gravel road. The borrow pit is composed of reddish and whitish weathered sandstone with lateritic gravel.

A test sample was taken from faces of existing excavations. The material’s CBR value after 4 days soaking is 20% at 95% MDD, with a plasticity index of 8%. The material falls in unbound material class G-15.

4.6 BP7 (20+500 RHS) Lwandani: Offset 24 km
This borrow pit is located at Lwandani 7 km along a gravel road on RHS after driving 17 km on the Mazeras – Kaloleni road. It is composed of reddish and whitish weathered sandstone with lateritic gravel.

A test sample was taken from the faces of existing excavations. The material’s CBR value after 4 days soaking is 10% and 15% at 95% MDD, with a plasticity index of 24% and 25%. The material falls under unbound material class G-7.

4.7 BP8 (20+500 RHS) Mwazai: Offset 27 km
This borrow pit is located at Mwazai behind Jebana Subcounty Hospital some 10 km on a gravel road after turning right some 17km along the Mazeras – Kaloleni road. It is an active source of reddish and whitish weathered sandstone with lateritic gravel.

A test sample was taken from the faces of existing excavations. The material’s CBR value after 4 days soaking is 25% at 95% MDD, with a plasticity index of 14%. The material falls under unbound material class G-25.

4.8 BP9 (26+650 RHS) Kaydee at Kokotoni: Offset 3 km
This potential source consists of overburden material located at the Kaydee quarry at Kokotoni. It is an active source of fill material used by the contractor of Lot I and is composed of yellowish sandy gravel.
A test sample was taken from the faces of existing excavations. The material's CBR value after 4 days soaking was 20% at 95% MDD, with a plasticity index of 6%. The material falls under unbound material class G-15.

4.9 BP10 (26+900 RHS) Kavee at Kokotoni: Offset 1.1 km
This potential source consists of crusher reject material located at the Kavee quarry at Kokotoni.

A test sample was taken from one of the stockpiles at the Kavee quarry. The material's CBR value after 4 days soaking is 26% and 33% at 95% MDD; it is non-plastic. The material falls under unbound material class G-25.

4.10 BP11 A&B (26+900 RHS) Kokotoni Investment at Kokotoni: Offset 2 km
The material here comprises overburden and crusher reject material. The overburden is composed of yellowish sandy gravel. The crusher reject material is composed of yellowish grey crushed gravel with fine overburden.

The CBR value at 95% MDD, after 4 days' soaking, is 22% for the overburden material. For the crusher reject material, the values are 10% (first time sampling) and 44% (after resampling) at 95% MDD and 4 days' soaking. The overburden has a plasticity index of 23% whilst the crusher reject material is non-plastic.

Both materials are material class G15.

4.11 BP12 (35+200 RHS) Mwachipawa: Offset 34.2 km
This borrow pit is located some 1 km to the LHS of the Mariakani to Kilifi road approximately 33.2 km from Mariakani. It is an active source composed of reddish brown lateritic gravel.

A test sample was taken from the faces of existing excavations. The material's CBR value after 4 days soaking is 55% at 95% MDD, with a plasticity index of 8%. The material falls under unbound material class G-45.

4.12 BP13 (35+200 RHS) Mwachipawa: Offset 33.8kms
This borrow pit is located on the LHS of the Mariakani to Kilifi road approximately 33.8 km from Mariakani. It is an active source composed of reddish and whitish weathered sandstone with lateritic gravel.

A test sample was taken from the faces of existing excavations. The material's CBR value after 4 days soaking is 15% at 95% MDD, with a plasticity index of 8%. The material falls under unbound material class G-15.
5 Hard Stone Sources

The potential hard stone sources can be classified into four groups based on their location and material type.

5.1 Quarries at Mwache: km 18+900 (Offset from 3.5 km - 6km LHS)

There are some six commercial quarries in this area all situated within a reasonable distance from the project road corridor. The sources are composed of Kambe limestone rock.

Sampling was done from the stockpiles at four quarries which were all active during the site visit. These are: Beric Mining, Kwale Investments, Surya and Alington. The test results (presented in Appendix) show that the material has slightly high Los Angeles Abrasion Values (37-42%).

5.2 Quarries at Jaribuni: km 20+500 (Offset from 45km to 50km RHS)

There are several commercial quarries at Jaribuni area off to the left of the road between Kaloleni and the junction with the Mombasa to Kilifi road. These sources contain Kambe limestone and are currently being used for several construction projects in and around Mombasa.

Sampling was done from the stockpiles of the following four commerical sources: Surya, Karsam Ramji, SSVE and Jaribuni Investments.

The other potential source in this area, which is also composed of Kambe limestone, is located at Mwarakaya Trading Centre. It is about 31 km from Mazeras and accessible via the Mazeras –Kaloleni road by travelling 17 km towards Kaloleni, then turning right and driving some 15 km on a gravel road towards Mwarakaya.

5.3 Quarries at Kokotoni: km 26.5 to km 27 (Offset from 1.1 km to 3 km RHS)

There are several commercial quarries in the Kokotoni area. The material in these quarries is sandstone of the Lower Mariakani beds and all are currently being exploited.

Sampling was done from the stockpiles of four sources: Kaydee, Kokotoni Investments, Karsam Ramji and Kavee.

The test results carried out on samples show that the material has a slightly high water absorption rate (1.7 to 2.6%).
5.4 Quarries at Taru: 35km from the end of the project towards Nairobi

There are two quarries, one on each side of the Mombasa - Nairobi road at Taru, neither of which were active at the time of the Consultant’s visit although they have previously been utilized by several projects, including the Standard Gauge Railway section between Mombasa and Voi. The material in these quarries is Taru grit sandstone.

Sampling was done from the leftover stockpile of the Mapinga family quarry, located on the RHS of the Mombasa to Nairobi road. The test results show that the material has water absorption of about 2%.
6 Water for Construction

Most rivers and streams in the project area flow strongly during the rainy seasons only, although there are some perennial watercourses. There are natural ponds and dams on many of these watercourses with the opportunity to create more as may be required. Therefore, depending upon abstraction permits etc., the main water sources in the project area would be these rivers, streams, and water that has collected at the bottom of the quarries in the Mwache and Kokotoni areas.

6.1 WS1 (20+500 RHS): Kombeni River Offset 7.3 km
The Komboni River is located 7.3km from Mazeras along the Mazeras – Kaloleni road. Water ponds in this location and is available throughout the year.

6.2 WS2 (22+900 LHS): Mwache River Offset 4 kms
The Mwache River is located 4 kms from Mazeras on the Kinango road. The river is seasonal but there is a point where the river dams naturally and water is available throughout the year.

6.3 WS3 (23+700 RHS): Wania Wandege Pond Offset 0.5kms
Wania Wandege pond is located 0.5 km off the RHS of the main road at Wania Wandege Trading Centre. The pond has water throughout the year.

The results of the tests carried out on the collected water samples are presented in the table below.

Table 6-1: Potential Water Sources

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Station (km)</th>
<th>Name of Stream/River</th>
<th>Laboratory Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Specification BS3148</td>
<td>PH</td>
<td>Cl (ppm)</td>
</tr>
<tr>
<td>1</td>
<td>20+500, 7.3km RHS</td>
<td>Kombeni River</td>
<td>7.31</td>
</tr>
<tr>
<td>2</td>
<td>22+900, 4km LHS</td>
<td>Mwache River</td>
<td>7.37</td>
</tr>
<tr>
<td>3</td>
<td>23+700, 0.5km RHS</td>
<td>Wania Wandege Pond</td>
<td>7.6</td>
</tr>
</tbody>
</table>
7 Sand

There is very little or no natural sand suitable for construction purposes within the project area. Most of the sand in the area is sea sand.

Some projects around Mombasa use crushed sand and, when using natural sand is required, they haul it from Malindi, about 150 km along the north coast from Mombasa.

The Consultant collected two samples of sand from crushed sand stockpiles at the commercial quarries at Mazeras and Kokotoni and one sample of natural sand from the source at Malindi. The results of the tests are shown in the table below.

Table 7-1: Potential Sand Sources

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Station (km)</th>
<th>Name of Source</th>
<th>% Pass 0.075mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20+800 3.5km LHS</td>
<td>Beric Mining</td>
<td>6.22</td>
</tr>
<tr>
<td>2</td>
<td>25+900, 1.5km RHS</td>
<td>Kaydee Quarry</td>
<td>7.1</td>
</tr>
<tr>
<td>3</td>
<td>35.5,141km RHS</td>
<td>Mjanahari Timboni</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Appendix

Test Results
<table>
<thead>
<tr>
<th>TP NO.</th>
<th>Chainage, KM</th>
<th>Slde</th>
<th>Located at</th>
<th>Quarry Source</th>
<th>Field Material Description</th>
<th>Date Sampled</th>
<th>Date Reported</th>
<th>Specific Gravity and Water Absorption (BS, EN 1097-6: 2000)</th>
<th>LAA %</th>
<th>TEN PER CENT FINES VALUE (TFV) (BS 612: 1990)</th>
<th>Aggregate Crushing Value (BS 612: 1990)</th>
<th>ACV %</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>18+900</td>
<td>3.5km LHS</td>
<td>Mwache</td>
<td>Baren Mining</td>
<td>Crushed Limestone</td>
<td>14-Aug-18</td>
<td>29-Aug-18</td>
<td>2.640</td>
<td>2.660</td>
<td>2.700</td>
<td>0.7</td>
<td>40</td>
<td>160</td>
</tr>
<tr>
<td>Q2</td>
<td>18+900</td>
<td>3.8km LHS</td>
<td>Mwache</td>
<td>Kwaale Invest.</td>
<td>Crushed Limestone</td>
<td>14-Aug-18</td>
<td>29-Aug-18</td>
<td>2.660</td>
<td>2.660</td>
<td>2.710</td>
<td>0.6</td>
<td>42</td>
<td>160</td>
</tr>
<tr>
<td>Q3</td>
<td>18+900</td>
<td>4.3km LHS</td>
<td>Mwache</td>
<td>SURYA</td>
<td>Crushed Limestone</td>
<td>14-Aug-18</td>
<td>29-Aug-18</td>
<td>2.670</td>
<td>2.670</td>
<td>2.700</td>
<td>0.5</td>
<td>41.5</td>
<td>170</td>
</tr>
<tr>
<td>Q4</td>
<td>18+900</td>
<td>5.5km LHS</td>
<td>Mwache</td>
<td>ALONGTON</td>
<td>Crushed Limestone</td>
<td>14-Aug-18</td>
<td>29-Aug-18</td>
<td>2.650</td>
<td>2.670</td>
<td>2.700</td>
<td>0.6</td>
<td>37</td>
<td>180</td>
</tr>
<tr>
<td>Q5</td>
<td>20+500</td>
<td>45.5km RHS</td>
<td>Jaribuni</td>
<td>SURYA</td>
<td>Crushed Limestone</td>
<td>13-Aug-18</td>
<td>29-Aug-18</td>
<td>2.660</td>
<td>2.670</td>
<td>2.730</td>
<td>0.9</td>
<td>29</td>
<td>220</td>
</tr>
<tr>
<td>Q6</td>
<td>20+500</td>
<td>48.5km RHS</td>
<td>Jaribuni</td>
<td>Karsam Ramji</td>
<td>Crushed Limestone</td>
<td>13-Aug-18</td>
<td>29-Aug-18</td>
<td>2.570</td>
<td>2.610</td>
<td>2.630</td>
<td>1.5</td>
<td>33</td>
<td>240</td>
</tr>
<tr>
<td>Q7</td>
<td>20+500</td>
<td>48.5km RHS</td>
<td>Jaribuni</td>
<td>SSVE</td>
<td>Crushed Limestone</td>
<td>13-Aug-18</td>
<td>29-Aug-18</td>
<td>2.670</td>
<td>2.690</td>
<td>2.710</td>
<td>0.6</td>
<td>28</td>
<td>210</td>
</tr>
<tr>
<td>Q8</td>
<td>20+500</td>
<td>49.5km RHS</td>
<td>Jaribuni</td>
<td>Jaribuni</td>
<td>Crushed Limestone</td>
<td>13-Aug-18</td>
<td>29-Aug-18</td>
<td>2.690</td>
<td>2.700</td>
<td>2.720</td>
<td>0.4</td>
<td>28</td>
<td>240</td>
</tr>
<tr>
<td>Q9</td>
<td>20+500</td>
<td>51km RHS</td>
<td>Marakaya</td>
<td>Potential Limestone</td>
<td>Crushed Limestone</td>
<td>15-Aug-18</td>
<td>29-Aug-18</td>
<td>2.680</td>
<td>2.690</td>
<td>2.710</td>
<td>0.4</td>
<td>26</td>
<td>240</td>
</tr>
<tr>
<td>Q10</td>
<td>26+650</td>
<td>1.5km RHS</td>
<td>Kokotoni</td>
<td>Kaydon</td>
<td>Crushed Sandstone</td>
<td>10-Aug-18</td>
<td>29-Aug-18</td>
<td>2.510</td>
<td>2.550</td>
<td>2.520</td>
<td>1.7</td>
<td>29</td>
<td>240</td>
</tr>
<tr>
<td>Q11</td>
<td>26+900</td>
<td>1.1km RHS</td>
<td>Kokotoni</td>
<td>Kavee</td>
<td>Crushed Sandstone</td>
<td>10-Aug-18</td>
<td>29-Aug-18</td>
<td>2.450</td>
<td>2.540</td>
<td>2.600</td>
<td>2.6</td>
<td>26</td>
<td>270</td>
</tr>
<tr>
<td>Q12</td>
<td>26+900</td>
<td>1.2km RHS</td>
<td>Kokotoni</td>
<td>Karsam Ramji</td>
<td>Crushed Sandstone</td>
<td>10-Aug-18</td>
<td>29-Aug-18</td>
<td>2.500</td>
<td>2.550</td>
<td>2.540</td>
<td>2.1</td>
<td>27</td>
<td>310</td>
</tr>
<tr>
<td>Q13</td>
<td>26+900</td>
<td>1.8km RHS</td>
<td>Kokotoni</td>
<td>Kokotoni Inv.</td>
<td>Crushed Sandstone</td>
<td>10-Aug-18</td>
<td>29-Aug-18</td>
<td>2.470</td>
<td>2.530</td>
<td>2.530</td>
<td>2.4</td>
<td>28</td>
<td>280</td>
</tr>
<tr>
<td>TP NO.</td>
<td>Chainage, KM</td>
<td>Side</td>
<td>Located at</td>
<td>Quarry Source</td>
<td>Field Material Description</td>
<td>Date Sampled</td>
<td>Date Tested</td>
<td>Specific Gravity (SSD)</td>
<td>Water Absorption (%)</td>
<td>LAA %</td>
<td>Aggregate Crushing Value (BS 812 : 1996)</td>
<td>ACV %</td>
<td>SSS ASTM C88</td>
</tr>
<tr>
<td>--------</td>
<td>--------------</td>
<td>--------</td>
<td>------------</td>
<td>---------------</td>
<td>---------------------------</td>
<td>--------------</td>
<td>-------------</td>
<td>------------------------</td>
<td>---------------------</td>
<td>-------</td>
<td>------------------------------------------</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>Q1</td>
<td>18+900</td>
<td>3.5km LHS</td>
<td>Mwache</td>
<td>Beric Mining</td>
<td>Crushed Limestone</td>
<td>14-Aug-18</td>
<td>01-Oct-18</td>
<td>2.860</td>
<td>1.2</td>
<td>27</td>
<td>22</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>18+900</td>
<td>3.8km LHS</td>
<td>Mwache</td>
<td>Kwale Invest.</td>
<td>Crushed Limestone</td>
<td>14-Aug-18</td>
<td>01-Oct-18</td>
<td>2.610</td>
<td>1.5</td>
<td>29</td>
<td>21</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>Q3</td>
<td>18+900</td>
<td>4.3km LHS</td>
<td>Mwache</td>
<td>SURYA</td>
<td>Crushed Limestone</td>
<td>14-Aug-18</td>
<td>01-Oct-18</td>
<td>2.710</td>
<td>1.0</td>
<td>27</td>
<td>23</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>Q4</td>
<td>18+900</td>
<td>5.5km LHS</td>
<td>Mwache</td>
<td>ALINGTON</td>
<td>Crushed Limestone</td>
<td>14-Aug-18</td>
<td>01-Oct-18</td>
<td>2.652</td>
<td>1.1</td>
<td>27</td>
<td>23</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>Q5</td>
<td>20+500</td>
<td>45.5km RHS</td>
<td>Jaribuni</td>
<td>SURYA</td>
<td>Crushed Limestone</td>
<td>13-Aug-18</td>
<td>01-Oct-18</td>
<td>2.730</td>
<td>0.7</td>
<td>24</td>
<td>19</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>Q6</td>
<td>20+500</td>
<td>48.5km RHS</td>
<td>Jaribuni</td>
<td>Karsam Ramji</td>
<td>Crushed Limestone</td>
<td>13-Aug-18</td>
<td>01-Oct-18</td>
<td>2.710</td>
<td>0.8</td>
<td>24</td>
<td>18</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Q7</td>
<td>20+500</td>
<td>48.5km RHS</td>
<td>Jaribuni</td>
<td>SSVE</td>
<td>Crushed Limestone</td>
<td>13-Aug-18</td>
<td>01-Oct-18</td>
<td>2.690</td>
<td>0.9</td>
<td>26</td>
<td>19</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>Q8</td>
<td>20+500</td>
<td>49km RHS</td>
<td>Jaribuni</td>
<td>Jaribuni</td>
<td>Crushed Limestone</td>
<td>13-Aug-18</td>
<td>01-Oct-18</td>
<td>2.720</td>
<td>0.9</td>
<td>24</td>
<td>19</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>Q9</td>
<td>26+650</td>
<td>1.5km RHS</td>
<td>Kokotoni</td>
<td>Kayode</td>
<td>Crushed Sandstone</td>
<td>10-Aug-18</td>
<td>01-Oct-18</td>
<td>2.520</td>
<td>3.5</td>
<td>35</td>
<td>31</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>Q10</td>
<td>26+900</td>
<td>1.1km RHS</td>
<td>Kokotoni</td>
<td>Kavso</td>
<td>Crushed Sandstone</td>
<td>10-Aug-18</td>
<td>01-Oct-18</td>
<td>2.490</td>
<td>2.7</td>
<td>28</td>
<td>24</td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>Q11</td>
<td>26+900</td>
<td>1.2km RHS</td>
<td>Kokotoni</td>
<td>Karsam Ramji</td>
<td>Crushed Sandstone</td>
<td>10-Aug-18</td>
<td>01-Oct-18</td>
<td>2.570</td>
<td>2.9</td>
<td>38</td>
<td>31</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>Q12</td>
<td>26+900</td>
<td>1.3km RHS</td>
<td>Kokotoni</td>
<td>Kokotoni Inv</td>
<td>Crushed Sandstone</td>
<td>10-Aug-18</td>
<td>01-Oct-18</td>
<td>2.550</td>
<td>3.0</td>
<td>32</td>
<td>29</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>Q13</td>
<td>41+700</td>
<td>35km (Towards Nairobi)</td>
<td>Taru</td>
<td>Mapinga Family</td>
<td>Crushed Green Siltstone</td>
<td>22-Aug-18</td>
<td>01-Oct-18</td>
<td>2.580</td>
<td>1.9</td>
<td>34</td>
<td>30</td>
<td>6.9</td>
<td></td>
</tr>
</tbody>
</table>
### Borrow Pit Test Results

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>BP</th>
<th>Churnage, Km</th>
<th>Location Source Name</th>
<th>Material Description</th>
<th>Date Sampled</th>
<th>Date Reported</th>
<th>Atterberg Limit</th>
<th>Plasticity Index</th>
<th>SL</th>
<th>SP</th>
<th>GI</th>
<th>Pass (mm)</th>
<th>GM</th>
<th>AASHTO Classification</th>
<th>MGO, TIS</th>
<th>CMC</th>
<th>CBR</th>
<th>Swell</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BP1</td>
<td>1+900</td>
<td>Shanzani</td>
<td>Brownish Gray Coral Reef</td>
<td>21-Aug-18</td>
<td>02-Oct-18</td>
<td></td>
<td></td>
<td>20</td>
<td>12</td>
<td>172</td>
<td>42</td>
<td>29</td>
<td>16.9</td>
<td>2.12</td>
<td>A-2-6 (O)</td>
<td>2096</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>BP2</td>
<td>17+200</td>
<td>Kivumboni</td>
<td>Yellowish and Dark Gray SHALE</td>
<td>16-Aug-18</td>
<td>02-Oct-18</td>
<td></td>
<td></td>
<td>33</td>
<td>12</td>
<td>175</td>
<td>40</td>
<td>15</td>
<td>9.9</td>
<td>2.45</td>
<td>A-2-6 (O)</td>
<td>2020</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>BP3A</td>
<td>18+700</td>
<td>Karic H(C)</td>
<td>Yellowish Gray SHALE with GRAVEL, quarry overburden</td>
<td>16-Aug-18</td>
<td>02-Oct-18</td>
<td></td>
<td></td>
<td>36</td>
<td>16</td>
<td>121</td>
<td>50</td>
<td>36</td>
<td>27.6</td>
<td>1.83</td>
<td>A-2-4 (O)</td>
<td>2160</td>
<td>12.8</td>
</tr>
<tr>
<td>4</td>
<td>BP7B</td>
<td>18+600</td>
<td>Karic H(C)</td>
<td>Brownish Gray Crushed reject</td>
<td>16-Aug-18</td>
<td>02-Oct-18</td>
<td></td>
<td></td>
<td>19</td>
<td>9</td>
<td>374</td>
<td>4</td>
<td>106</td>
<td>26.3</td>
<td>1.77</td>
<td>A-2-4 (O)</td>
<td>2142</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>BP4</td>
<td>18+500</td>
<td>Surya, Mawene</td>
<td>Brownish Gray Crushed reject</td>
<td>14-Aug-18</td>
<td>02-Oct-18</td>
<td></td>
<td></td>
<td>29</td>
<td>12</td>
<td>671</td>
<td>6</td>
<td>305</td>
<td>16.4</td>
<td>1.28</td>
<td>A-6 (O)</td>
<td>2060</td>
<td>8.1</td>
</tr>
<tr>
<td>6</td>
<td>BP5</td>
<td>22+600</td>
<td>Mawene River</td>
<td>Yellowish Weathered GRAVEL</td>
<td>17-Aug-18</td>
<td>02-Oct-18</td>
<td></td>
<td></td>
<td>29</td>
<td>2</td>
<td>64</td>
<td>1</td>
<td>32</td>
<td>12.8</td>
<td>2.13</td>
<td>A-1 (O)</td>
<td>1835</td>
<td>10.9</td>
</tr>
<tr>
<td>7</td>
<td>BP6</td>
<td>20+500</td>
<td>Timboni</td>
<td>Reddish Weathered Sandstone with Latexite</td>
<td>15-Aug-18</td>
<td>02-Oct-18</td>
<td></td>
<td></td>
<td>23</td>
<td>6</td>
<td>413</td>
<td>4</td>
<td>206</td>
<td>18.0</td>
<td>1.48</td>
<td>A-2-4 (O)</td>
<td>2070</td>
<td>9.9</td>
</tr>
<tr>
<td>8</td>
<td>BP7</td>
<td>20+500</td>
<td>Lwamudia</td>
<td>Reddish Weathered Sandstone with Latexite</td>
<td>14-Feb-19</td>
<td>22-Feb-19</td>
<td>50.3</td>
<td>23.8</td>
<td>904</td>
<td>19.7</td>
<td>40.7</td>
<td>48</td>
<td>38</td>
<td>23.0</td>
<td>1.91</td>
<td>A-2-7 (O)</td>
<td>2002</td>
<td>10.6</td>
</tr>
<tr>
<td>9</td>
<td>BP8</td>
<td>20+500</td>
<td>Mwanzia</td>
<td>Reddish Weathered Sandstone with Latexite</td>
<td>15-Aug-18</td>
<td>02-Oct-18</td>
<td>48.2</td>
<td>24.7</td>
<td>1207</td>
<td>11.0</td>
<td>272</td>
<td>82</td>
<td>52</td>
<td>42.0</td>
<td>1.44</td>
<td>A-6-7 (O)</td>
<td>1960</td>
<td>18.0</td>
</tr>
<tr>
<td>10</td>
<td>BP9</td>
<td>25+600</td>
<td>Kayambwe, Kotokoni</td>
<td>Yellowish SHALE with GRAVEL, quarry overburden</td>
<td>14-Feb-19</td>
<td>22-Feb-19</td>
<td>27.2</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
<td>44</td>
<td>2</td>
<td>23</td>
<td>18.0</td>
<td>1.27</td>
<td>A-2-4 (O)</td>
<td>2016</td>
<td>10.8</td>
</tr>
<tr>
<td>11</td>
<td>BP10</td>
<td>25+900</td>
<td>Kotokoni</td>
<td>Brownish Gray Crushed reject</td>
<td>14-Feb-19</td>
<td>22-Feb-19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17.0</td>
<td>2.17</td>
<td>A-5-6-3 (O)</td>
<td>2159</td>
<td>7.8</td>
</tr>
<tr>
<td>12</td>
<td>BP11A</td>
<td>25+500</td>
<td>Kotokoni Inv.</td>
<td>Yellowish SHALE with GRAVEL, quarry overburden</td>
<td>16-Aug-18</td>
<td>02-Oct-18</td>
<td>26.5</td>
<td>0</td>
<td>0</td>
<td>2.1</td>
<td>63</td>
<td>-3</td>
<td>36</td>
<td>17.0</td>
<td>2.17</td>
<td>A-5-6-3 (O)</td>
<td>2159</td>
<td>7.8</td>
</tr>
<tr>
<td>13</td>
<td>BP11B</td>
<td>25+900</td>
<td>Kotokoni Inv.</td>
<td>Brownish Gray Crushed reject</td>
<td>14-Feb-19</td>
<td>22-Feb-19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17.0</td>
<td>2.17</td>
<td>A-5-6-3 (O)</td>
<td>2159</td>
<td>7.8</td>
</tr>
<tr>
<td>14</td>
<td>BP12</td>
<td>35+200</td>
<td>Mwanzhiwana</td>
<td>Reddish Brown Latexite GRAVEL</td>
<td>15-Aug-18</td>
<td>02-Oct-18</td>
<td>24</td>
<td>8</td>
<td>350</td>
<td>4</td>
<td>175</td>
<td>-2</td>
<td>2</td>
<td>21.1</td>
<td>1.75</td>
<td>A-2-4 (O)</td>
<td>2151</td>
<td>10.4</td>
</tr>
<tr>
<td>15</td>
<td>BP13</td>
<td>35+400</td>
<td>Mwanzhiwana</td>
<td>Reddish Brown Sandy GRAVEL</td>
<td>13-Aug-18</td>
<td>02-Oct-18</td>
<td>27</td>
<td>10</td>
<td>328</td>
<td>5</td>
<td>164</td>
<td>-3</td>
<td>4</td>
<td>33</td>
<td>2.10</td>
<td>A-2-4 (O)</td>
<td>2060</td>
<td>8.2</td>
</tr>
</tbody>
</table>