TRADE AND TRANSPORT FACILITATION STUDY OF THE KAMPALA-JUBA-ADDIS ABABA-DJIBOUTI CORRIDOR

CONTRACT NO. ECSD/IGAD/001/2015

VOLUME 4 of 6: FINAL ARCHITECTURAL AND ENGINEERING DESIGN REPORT AND FINAL FEASIBILITY REPORT- GALAFI ONE STOP BORDER POSTS

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ACRONYMS

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highways and Transportation Officials
AC	Air Conditioning
AfDB	African Development Bank
ATS	Automatic Transfer Switch
BS	British Standards
BM	Bench Mark
BoQ	Bills of Quantities
CBR	California Bearing Ratio
CCZ	Common Control Zone
CGE	Compatible General Equilibrium
COMESA	Common Market for Eastern and Southern Africa
DBST	Double Surface Treatment
DCM	Dynamic Cone Penetration
DLP	Defects Liability Period
DN	Nominal Diameter
DPI	Dynamic Penetration Index
DTM	Digital Terrain Model
EIA	Environmental Impact Assessment
EMA	Ethiopian Mapping Agency
ERA	Ethiopia Roads Authority
ESA	Equivalent Standard Axles
EU	European Union
FIDIC	International Federation of Consulting Engineers
GDP	Gross Domestic Product
GPS	Global Positioning System
HVAC	Heating, Ventilation and Air Conditioning
ICB	International Competitive Bidding
IEE	Institution of Electrical Engineers
ICT	Information Communication Technology
IGAD	Intergovernmental Authority on Development
IP	Internet Protocol
ISO	International Organisation for Standardization
LAN	Local Area Network
LED	Light Emitting Diode
MB	Megabytes
MDD	Medium Dry Density
OD	Outside Diameter
OSBP	One Stop Border Post
PABX	Private Automatic Branch Exchange
PC	Personal Computer
PI	Plasticity Index
PM	Project Manager

PPR	Polypropylene Random
PV	Photovoltaic
PVC	Polyvinyl Chloride
RN	Road Note
SAD	Single Administration Document
SASO	Saudi Arabian Standards Organisation
SGR	Standard Gauge Railway
SIA	Strategic Impact Assessment
SMC	Service Management Centre
TCP	Transmission Control Protocol
TRL	Transport Research Laboratory
TVL	Television Lines
UTM	Universal Transverse Mercator
UPS	Uninterruptible Power Supply
uPVC	Ultra Polyvinyl Chloride
URV	Upper Range Value
VLP	Very Low Profile
VRV	Variable Refrigerant Volume
WAN	Wide Area Network
WC	Water Closet
WHB	Wash Hand Basin
WHO	World Health Organisation

1 INTRODUCTION

1.1 Overview

Kagga & Partners in association with Africon Universal Consulting were awarded the contract for provision of consultancy services for the Trade and Transportation Facilitation Study of the Kampala-Juba-Addis-Ababa–Djibouti Corridor by IGAD. The contract for the assignment was signed by the Employer (IGAD) and the Consultant's Representative on 28th July 2016 at the IGAD Head Quarters in Djibouti. The commencement date of the services was 18th August 2016 and since then the following project deliverables have been submitted in accordance to the Terms of Reference:

- Inception Report submitted on 14th September 2016;
- Progress Report No.1 submitted on 9th November 2016;
- Preliminary Architectural and Engineering Design and Feasibility Study report submitted on 22nd December 2016;
- Draft Legal and Customs Documentation submitted on 1st June 2017.
- Draft Final Architectural and Engineering Design and Feasibility Study Report – Galafi One Stop Border Posts submitted on 30th November 2018following the Joint Technical Committee and Joint Steering Committee Meetings held in Nairobi from 6th to 9th December 2017 as per details in Appendix G and Joint Galafi OSBP Confirmation Visit from 25th to 27th September 2018 as per details in Appendix H.

The Final Architectural and Engineering Design Report and Final Feasibility Report is the 6th project deliverable required by the Terms of Reference for this assignment following a design validation workshop held in Nairobi, Kenya from 19th to 23rd November 2018 as per details in Appendix I.

This report therefore focuses on Galafi OSBPs moving forward and is made of three volumes:

- Volume 4 of 6: Final Detailed Architectural and Engineering Design Report and Final Feasibility Report for Galafi OSBPs;
- Volume 5 of 6: Final Detailed Architectural and Engineering Design Report and Final Feasibility Report – Galafi Ethiopia One Stop Border Posts Drawings;
- Volume 6 of 6: Final Detailed Architectural and Engineering Design Report and Final Feasibility Report – Galafi Djibouti One Stop Border Posts Drawings;

These three volumes are to be read in sequence to meet the 50% of the 6th deliverable as per Terms of Reference. The other 50% of the deliverable concerns Raad OSBPs and is prepared in Volume 1 to Volume 3.

1.2 Background

The Kampala-Juba-Addis Ababa-Djibouti transport corridor is of regional strategic importance. Enhancement of facilities along the corridor will facilitate the easier movement of goods and people within the Eastern Africa region and particularly between the corridor countries of Djibouti, Ethiopia, South Sudan and Uganda. The corridor study, with the aim of regional integration, constitutes the development of

the legal framework, procedures, formats and ICT applications, and design study for 2 One Stop Border Posts (OSBPs) at the borders of 3 bordering countries (Djibouti, Ethiopia, and South Sudan) along the corridor. It is envisaged that the OSBPs will facilitate cross-border movement of goods and people by minimizing delays and congestion and therefore reduce time and cost of transport across borders.

Along the Kampala-Juba-Addis Ababa-Djibouti Corridor, 3 OSBP facilities at the South Sudan-Uganda, South Sudan-Ethiopia and Ethiopia-Djibouti borders are crucially important for reducing transit times and consequently costs and congestions. Trade Mark East Africa undertook an OSBP study at the South Sudan-Uganda (Nimule-Elegu) border. The remaining OSBP facilities at South Sudan-Ethiopia (Raad) and Ethiopia-Djibouti (Galafi) borders have been covered under the Kampala-Juba-Addis Ababa-Djibouti Corridor studies.

The existing border control facilities on either side of each border along the corridor are operating on the basis of respective national legislation. These countries are not currently expected to have common legislation that is supportive of OSBP operations. A legal framework is therefore required to facilitate extra-territorial operations by officials of one country in another to enable OSBP operations.

The procedures, border formalities and IT applications used by countries on the corridor are neither well developed nor compatible. Besides, although there are general agreements at regional and national levels, there is very little collaboration between agencies at least between the neighbouring countries that share border posts as a pre-requisite for operationalizing OSBPs.

The lack of efficient and transparent customs and transportation services is therefore a major impediment to the integration of the corridor countries. Trade and transport between these countries requires efficient door-to-door logistics chains, simple trade formalities, procedures and operations, together with a trade-supporting customs administration.

It implies an overall need for structural changes to facilitate improvements in trade and transport practices, particularly in the use of modern technology and in the field of customs operations and procedures. The efficient operation of transport modes and interface facilities - resulting from reduced physical barriers and institutional interference and simplified legal regimes - is a necessary precondition for effective improvement of trade and transport operations between these corridor countries.

1.3 Objectives of the Study

Objectives of the feasibility study are as follows:

- To review and analyze the current policies and regulatory regimes including operational procedures governing cross border trade in goods, services and movement of persons across borders of the corridor countries;

- To examine the regional level policies and regulatory regimes in the IGAD region that govern cross border trade in goods, services and movement of persons and provide and advise on the potential impact on the proposed OSBPs along the Kampala-Juba-Addis Ababa-Djibouti corridor;

- To undertake (i) feasibility study and preliminary design; (ii) detail engineering design;(iii) cost estimate; and (iv) preparation of bidding documents for the South Sudan/Ethiopia and Ethiopia/Djibouti OSBPs;

- To investigate the requirements for operationalisation of OSBPs and propose a roadmap for implementation; and

- To develop legal framework, procedures, formats, IT applications and provide appropriate recommendations for the operationalisation of one-stop border posts in common areas by border control officers from the countries sharing a border.

1.4 Scope of the Study

The scope of the detailed architectural and engineering design report and final feasibility report is based on the scope extracted from the Project Terms of Reference and comprises of the following:

- Preparation of Detailed Engineering Designs;
- Cost estimates for the proposed Detailed Engineering Designs;
- Economic Cost Benefit Analysis.

1.5 Project Area

1.5.1 Overview

The project area comprises of two border locations namely Galafi on the Ethiopian/Djibouti Border and Raad on the South Sudan/Ethiopia Border as shown in the Kampala-Juba-Addis Ababa-Djibouti Road Corridor as per Figure 1-1.

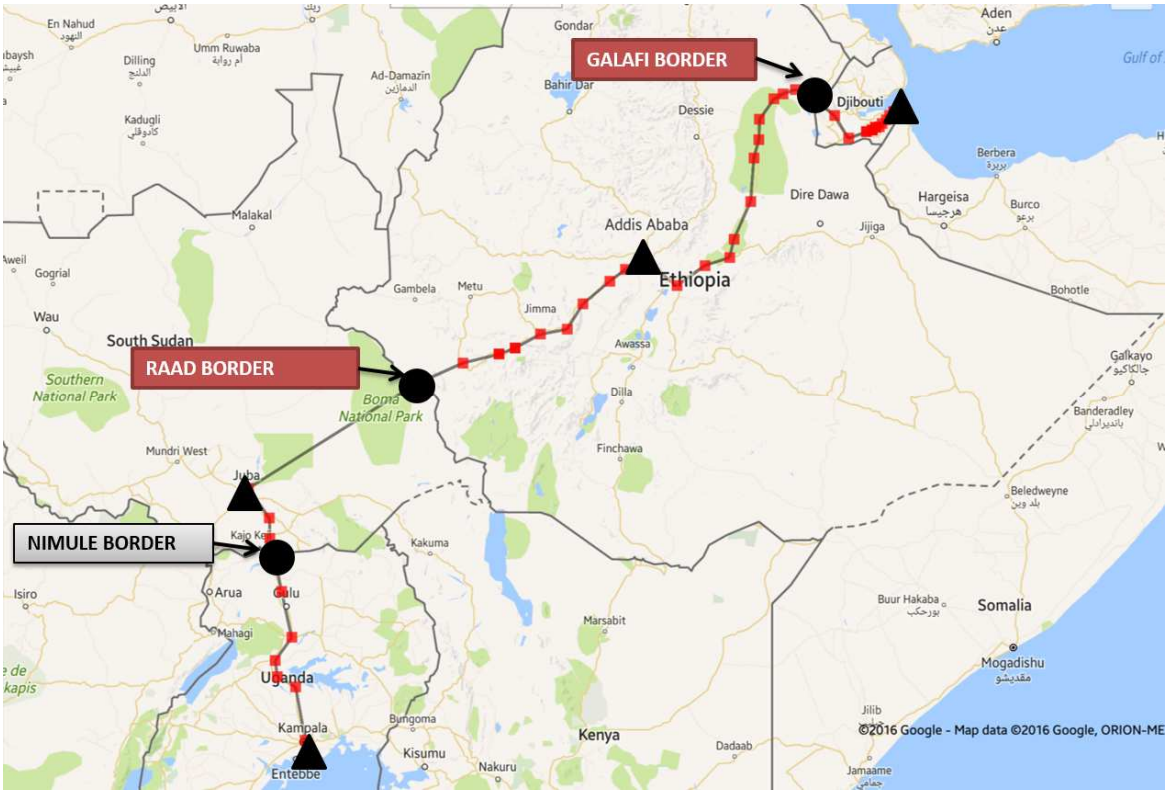


Figure 1-1: Kampala-Juba-Addis Ababa-Djibouti Road Corridor.

1.5.2 Galafi Ethiopia

The Galafi Ethiopia Border post is located 694kilometres from Addis Ababa along the Semera-Mille-Galafi Highway. The border post is located in the Afar Regional State of Ethiopia, which is one of the nine regional states of Ethiopia.

It is the homeland of the Afar people with its capital in Semera, which lies on the paved Awash–Assab highway. The location map and satellite imagery of Galafi Ethiopia border post are illustrated in Figures 1- 2 and 1-3.

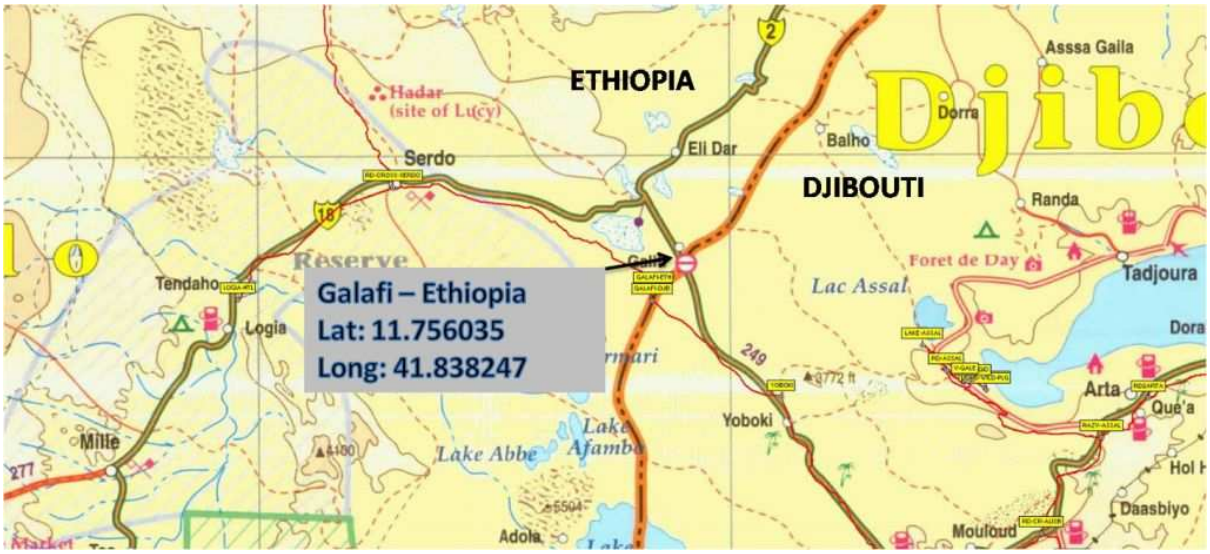


Figure 1-2: Galafi Ethiopia Location

Figure 1-3: Galafi Ethiopia Satellite Imagery

Topography

Galafi Ethiopia is located between mountain ranges that elevate to over 2000 metres above sea level. The land is dry, desolate and marked by sharp cliffs, deep ravines, burning sand and thorny shrubs.

Climate

Galafi Ethiopia experiences the highest average rainfall in August of 37mm with the rest of the year having relatively low rainfall values ranging from 2mm to 25mm. In regards to temperatures, the hottest month is June with an average temperature of 34.9 degrees Celsius. However, at times the temperatures rise up to 50 degrees Celsius. Between the driest and wettest months, the difference in rainfall is 35mm and temperatures vary by 9.7 degrees Celsius.

Cultural and Socio-economics

The inhabitants of Galafi Ethiopia are part of Afar society who are predominantly Muslim and speak the Afar language; a part of the Cushitic branch of the Afro-Asiatic language family. The Afar language is spoken by ethnic Afars in the Afar Region of Ethiopia as well as in southern Eritrea and northern Djibouti. However, since the Afar are traditionally nomadic herders, Afar speakers may be found further afield. Afar is predominantly (89.96%) spoken in the Afar region and is the working language of the state.

According to the 2007 Census 95.3% of the population is Muslim and 4.7% is Christian (3.9% Orthodox Christian, 0.7% Protestants, and 0.1% Catholics).The Afar are traditionally pastoralists, raising goats, sheep, and cattle in the desert. They are organized into clan families and two main classes: the asaimara ('reds') who are the dominant class politically, and the adoimara ('whites') who are a working class and are found in the Mabla Mountains.

1.5.3 Galafi Djibouti

The Galafi Djibouti Border post is located 195 kilometres from Djibouti City along the Dhikil-Yoboki-Galafi Highway. The border post is found in the Dhikil Region of Djibouti which is one of the five regional states of Djibouti. It is the homeland of the Afar people with its capital in Dhikil, which lies on the paved Djibouti–Arta-Dhikil highway. The location map and satellite imagery of Galafi Djibouti border post are illustrated in Figures1-4 and 1-5.

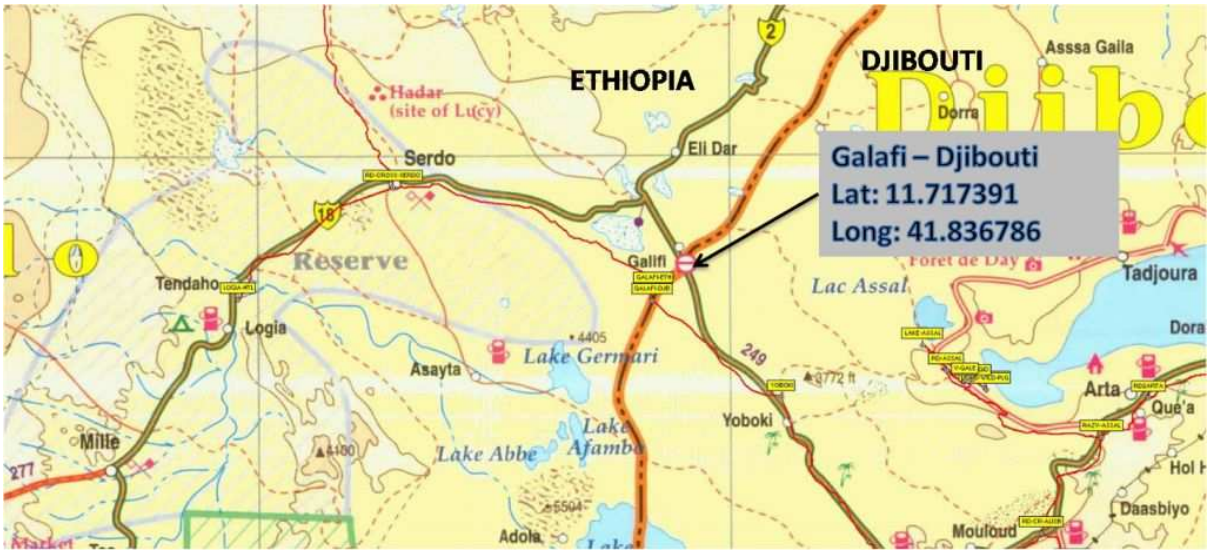


Figure 1-4: Galafi Djibouti Location

Figure 1-5: Galafi Djibouti Satellite Imagery

Topography

Galafi Djibouti is located between mountain ranges that elevate to over 2000 metres above sea level. The land is dry, desolate and marked by sharp cliffs, deep ravines, burning sand and thorny shrub.

Climate

Galafi Djibouti experiences the highest average rainfall in August of 37mm with the rest of the year having relatively low rainfall values ranging from 2mm to 25mm.

In regards to temperatures, the hottest month is June with an average temperature of 34.9 degrees Celsius. However, at times the temperatures rise up to 50 degrees

Celsius. Between the driest and wettest months, the difference in rainfall is 35mm and temperatures vary by 9.7 degrees Celsius.

Cultural and Socio-economics

The inhabitants of Galafi Djibouti are part of Afar society who are predominantly Muslim and speak the Afar language; a part of the Cushitic branch of the Afro-Asiatic language family. The Afar language is spoken by ethnic Afars in the Afar Region of Ethiopia as well as in southern Eritrea and northern Djibouti.

However, since the Afar are traditionally nomadic herders, Afar speakers may be found further afield. Afar is predominantly (89.96%) spoken in the Afar region and is the working language of the state.

1.6 Existing Situation at Galafi Ethiopia and Galafi Djibouti

Galafi Ethiopia

The existing immigration procedures at the Galafi Ethiopia Border are streamlined with good adoption of ICT and efficient operations. The challenges experienced by the Immigration officers include poor quality of the offices and improper housing of ICT equipment.

The existing customs procedures at the Galafi Ethiopia border are cumbersome and inefficient as a result of having an out-dated Customs Management System, poor integration with the Djibouti Customs Management System, poor adoption of automation with predominantly manual processes and records kept. There is need for fast tracking of implementation of the new Ethiopian Customs Management System and streamlining of cargo clearance procedures. There is also need to improve the working environment of the customs staff at Galafi. Security, health and safety measures also need to be improved at Galafi to further improve the working environment.

The Galafi Ethiopia Immigration Department is accommodated in an office block of approximately 45 square metres. The office block is of an open plan layout with only the office of the head immigration having a private office. The office block also entails a server room which houses the ICT server used by the facility. The Office block is in a greatly dilapidated shape and requires construction of a new facility. In terms of Equipment, the building contains air conditioning units which are old and non-functional. There is no communication with immigration officers on Djibouti side.

The Galafi Ethiopia Customs Department has a number of buildings it operates at the border post, these include: 5 office blocks, warehouse with a scanner, verification shades and a weighbridge under construction.

There is no visible water source in the proximity of the border post; however there is water supply within the Galafi border post. Furthermore, there are no visible sewerage facilities at Galafi border post. Electricity and ICT infrastructure are available on site.

Galafi Djibouti

The existing immigration procedures at the Galafi Djibouti border are streamlined with good adoption of ICTs and efficient operations. The challenges experienced by the Immigration officers include poor quality of the offices and improper housing of ICT equipment.

The existing customs procedures at the Djibouti border are well streamlined with good use of ICTs. The operational area is also well suited for quick processing of trucks and cargo clearance. Introduction of the OSBP will further enhance the cargo clearance procedure though better information sharing with the Ethiopian officers and further streamlined procedures.

The existing hard infrastructure is primarily made up of temporary steel shades and buildings that house the bulk of immigration department. The head at customs is housed in an air-conditioned container with the rest of staff in temporary steel buildings. There is a customs clearance booth that does verification of transit documents. There are 3 masonry blocks in proximity to the head of customs that were donated to Customs by the American Government but are yet to be put in use. These masonry blocks exhibited significant cracks implying poor workmanship.

There is electricity coming from the Ethiopian side of the border. It is supplemented by solar power and a standby generator at the Galafi Djibouti border post. There is cellular network at the border post. There is Fibre optic infrastructure coming in from Djibouti as evidenced by man-holes along the access road into Galafi. There are no visible water sources in proximity of the border post. Discussion with the border customs personnel revealed that there is a borehole that serves the community and the water for the border post is trucked in from Ethiopia. There are several pools of water near mountain toes at approximately 20km leading into Galafi border post. There are no visible sewerage facilities at Galafi.

1.7 Proposed Interventions at Galafi Ethiopia and Galafi Djibouti

After carrying out comprehensive feasibility studies and needs assessment captured in the Preliminary Architectural and Engineering Design and Feasibility Report, the Engineer proposed the following space interventions based on the revised immigration and customs procedures, staffing levels and organization structure to turn the current border posts into functional OSBPs as per the project objectives.

1.7.1 Administrative Facilities

i) Administrative offices

The new administrative offices were designed to have immigration and customs officers for both Ethiopia and Djibouti working under the same roof.

Table 1-1: Administrative Office facilities

S/N	Facility	Description
1	Immigration offices	These are housed in the clearance halls located in the main OSBP building and each country will have offices on one side.
2	Customs offices	These are located in the proposed main OSBP building. Other customs officers will be accommodated in the verification area as well as the scanner area.
3	Common work place	A common workspace for officers from Ethiopia and Djibouti was provided in the main OSBP building. Each country was given provision for its own document room, Server room, strong room, search room, holding room, and cold room. Shared facilities include kitchenettes, cafeteria, meeting rooms.
4	Server Room	Two ICT server rooms were provided to serve both the customs and Immigration departments of Ethiopia and Djibouti. Each country was provided its own server rooms.

1.7.2 Passenger Clearance Facilities

Table 1-2: Passenger Clearance Facilities

S/N	Facility	Description
1	Facilities for health and sanitation	Screening counters were provided at the entrance of the clearance halls. Thermographic cameras will be used to detect travellers suspected of having infectious diseases. A quarantine room was provided to isolate such travellers.
2	Facilities for Security and Protection	▪ Body and baggage scanners were provided to detect suspicious objects at the entrance to the clearance halls. ▪ Holding space for suspicious travellers was provided. ▪ Space for persons in need of protection was provided.

3	Passport control	Passport clearance will be done at the immigration offices located in the proposed OSBP main building. Counter space will be arranged so that travellers can proceed from one to the next seamlessly.
4	Washrooms and Rest Space	Washrooms for travellers and immigration officers were provided. These include male, female, staff and persons with disabilities. A rest space was provided for truck drivers as well as private travellers waiting for clearance.

1.7.3 Cargo clearance facilities

Cargo clearance facilities which constitute the biggest percentage of the OSBP are to include the following:

Table 1-3: Cargo Clearance Facilities

S/N	Facility	Description
1	Scanner	One scanner at either side of the OSBP was provided.
2	Vehicle Lanes	Passenger and freight traffic will be separated and distinct parking areas provided.
3	Weighbridge	One weigh bridge was provided to expedite the clearance process.
4	Parking, Fencing, and Security Cameras	▪ Parking was provided for both freight trucks and passenger vehicles in separate areas. ▪ The entire extent of the common control zone (CCZ) was fenced off with a security booth at the entrance to provide security. Closed circuit television (CCTV) will be installed for efficient security observation.
5	Inspection Yards and Warehouses	Inspection yards at different OSBPswere provided in accordance to the proposed clearance process. Warehouses were provided and in addition the storage space will have a strong-room, office space for cargo inspection officers and document room.
6	Processing Counters	The processing counters in the clearance halls have been placed in order of the harmonized clearance process. The two countries will have separate processing counters within the same building.

1.7.4 Support Services and Other Activities

These include staff housing and space for the private sector.

Table 1-4: Support services

S/N	Facility	Description
1	Staff housing	Staff housing were categorized into senior staff, junior staff and support staff.
2	Space for private sector	The private sector will be re-planned in a different location within the proximity of the common control zone (CCZ). There will be provisions to accommodate all the services.

1.8 Design Scope

The Design Scope included the following:

i. Architectural and Engineering Design that involves the following:
   - Designs for new buildings/facilities and renovations in accordance with the standards;
   - Auxiliary facilities according to the assessed needs, site survey findings and required standards;
   - Recommend alternative sources of power supply such as diesel- powered generators and solar power to address power shortages in accordance with the energy guidelines;
   - Provision of staff houses.

ii. Preparation of Site Plans of the OSBPs clearly indicating proposed infrastructure and how they relate to one another with particular emphasis to the flow of both human and vehicular traffic and location of services.

iii. Detailed designs, engineering drawings, cost estimates and for the proposed interventions arising from the studies.

iv. Incorporation of recommendations from the Environmental and Social Impact Assessments (ESIA) in the designs.

1.9 Contents of the report

The report consists of the following chapters:

Table 1-5: Contents of Final report

Chapter 1: Introduction and Background	This chapter sets the scene from which the subsequent chapters are described. It provides a narration of the project introduction, background, objectives and scope of the study as per the terms of reference and the project area.
Chapter 2: Field Surveys and Investigations	This chapter outlines the field surveys and investigations carried out and their subsequent findings used to carry out the detailed designs.
Chapter 3: Detailed Engineering Designs	This chapter lays out the Standards of Practice and Codes of Practice that guided the detailed Architectural and Engineering designs for the project.
Chapter 4: Construction Method	This section discusses the envisaged construction methods to be used during the execution of the works.
Chapter 5: Cost Estimates	Provides a summary of the project cost estimates based on the Detailed Architectural and Engineering Designs as extracted from Bills of Quantities.
Chapter 6: Financial and Economic Analysis	Provides an analysis for the financial and economic viability of the Galafi OSBPs.
Chapter 7: Environmental Impact Assessment and Mitigation	This chapter provides analysis of the implications of the planned OSBPs to the social and biophysical environment in the Galafi OSBPs.
Chapter 8: Risk Assessment and Management	The anticipated risks for implementation of this project have been identified and captured in this Chapter. Mitigation measures are further discussed here.
Chapter 9: Implementation Schedule	Details the activities that will be undertaken to implement the project from procurement to construction and finally defects liability.

2 FIELD SURVEY AND INVESTIGATIONS

2.1 Topographic Surveys

Topographic surveys were carried out at the proposed location for the Ethiopia and Djibouti OSBPs at Galafi.

2.1.1 Activities carried during Topographic survey

The activities carried out under the topographic surveys included:

Data Collection and Planning

i. Collection of relevant survey data/maps for the area of interest at both OSBP locations.
ii. Collection of nearby known Benchmarks that is tied from Ethiopian national grid (EMA nearby Control Points).
iii. Review and desk study of plot area and layout.
iv. Preparation of Concrete Monuments for primary and secondary control points.

The Field Work

i. Boundary confirmation & Flagging
ii. Establishing Control Points
    a. GPS observation for horizontal control (GPS Control Point Establishment).
    b. Benchmark, Secondary Control Point.
    c. Run Traverse from one GPS point and closed on the next GPS (assuring errors in X & Y are within acceptable limit)
    d. Conducted differential levelling on GPS & BM to determine vertical elevation (z) from known (EMA or other nearby Control Points)
iii. Collect x,y,z position (detail survey) using Total Stations survey equipment
    a. Road alignment: with bandwidth of up to 70m (traversal direction) and at interval of 25-30 m in longitudinal direction depending on site prevailing conditions.
    b. OSBP Facility Compound: spot data collection to generate contours to a desired accuracy.
    c. General: of all existing manmade (buildings, roads, fence, ditches, etc) and natural ground features (river/stream courses, gullies, hills, etc) to locate them in survey plan.
iv. Filed Records
    a. Survey raw data.

b. Photo records of
    - All utilities and properties.
    - GPS and MB monograph.

Desk Work

i. Survey Report: this includes report of
    a. Field survey work (with narrations, providing raw and corrected data, accuracy, etc)
    b. GPS and MB monograph

ii. Map Production: this involved plotting of details picked on site using AutoCAD Civil 3D to
    a. Produce the survey plan/map of all existing natural & manmade features.
    b. Show all details and contour lines for the sites.

The Detail topographic surveying work includes the following major tasks:

- Establishment of GPS primary Control points and secondary control points (Bench Marks).
- Traverse survey.
- Differential levelling of the GPS monuments and Secondary control points (Bench Marks).
- Detailed topographic survey using Total Station.

2.1.2 Establishment of Control Points

The observation was carried out with 3 units of Wild Leica dual frequency GPS system 1200 device using static mode with at least 5 satellites tracking per site in order to determine 3D WGS 84 coordinates.

The base line measurement accuracy was 5mm+0.5ppm and 10mm+0.5ppm for Horizontal and vertical angles respectively with a minimum of 30 minutes observation. The GPS point's network is linked to the existing National Triangulation point. In order to transform the WGS 84 coordinates of the GPS observation to UTM coordinates based on Clarke 1880 (modified) Spheroid and Adinadan (30th Arc) datum, a post processing software Leica Geo Office (LGO) Version 3.2 software was used.

Monograph of the whole GPS points with a brief description of the location, photograph and diagram is prepared and included in the report.

2.1.3 Bench Mark Establishment

Using the GPS points established, benchmarks were built at inter visible location, and a traverse was run from one GPS point and closed on the next GPS which was adjusted by the GPS X & Y value in order to avoid propagation of cumulative error.

The elevation of the BM points were determined by spirit levelling using the elevation value of GPS as initial height.

Table 2-1: GPS Coordinate List

GPS ID	Easting	Nothing	Elevation
GPSE01	809468.711	1299398.595	155.388
GPSE01A	809464.026	1299537.609	145.463
GPS-J1	809589.184	1296315.783	149.492
GPS-AJ1	809916.976	1296149.006	143.236

Table 2-2: Bench Mark list

BM-ID	EASTING	NORTHING	ELEVATION
BM-E1	809469.510	1299583.373	145.662
BM-E2	809127.639	1299849.330	143.578
BM-E3	808844.988	1300356.681	144.815
BM-E4	808903.405	1300659.788	146.070
BM-E5	809770.468	1299311.998	151.998
BM-E6	809576.344	1299715.688	144.845
BM-E7	809396.872	1299783.993	143.710
BM-E8	809683.267	1299825.028	142.872
BM-E9	809906.413	1299815.497	142.992
BM-E1A	809776.818	1299168.041	154.364
BM-E1B	808938.014	1299238.823	164.168
BM-E1C	808489.636	1299213.693	174.932
BM-E1D	808829.006	1298917.383	172.542
BM-E1E	809217.093	1298573.531	158.770
BM-E1F	809017.108	1298415.871	159.566
BM-E1G	808988.274	1297943.950	156.719
BM-J1	808853.500	1297580.264	157.790
BM-J2	808900.624	1297325.076	157.098
BM-J3	808887.016	1297207.712	157.006
BM-J4	809007.676	1296992.437	156.703
BM-J5	809199.032	1296704.341	156.196
BM-J6	809424.748	1296547.454	153.654
BM-J7	809681.342	1296459.939	151.288
BM-J8	810071.523	1296438.777	154.456

2.1.4 Detail Survey

The detail ground survey was conducted on the plot of land where the One Stop Border Posts are proposed to be established. Similarly, detail topographical survey was conducted along the alignment of the access road with bandwidth of up to 100m and at average interval of 20 m in longitudinal direction using Total Stations.

5,816 spot surveys were conducted to collect all the physical features and generate the desired topographic information in Galafi.

The spot level survey comprises random elevation points and stringed lined surveys, i.e. edge of pavements, centrelines of existing roads, at every break points or spot heights, minor & major drainages, house, utility lines (if any) and fence etc. These surveys were based on the primary and secondary control points coupled with application of appropriate grid factor during distance measurement by total stations. This data enabled to create DTM and Contour of the surveyed area in Galafi.

The topographic survey was undertaken under the guidance and supervision of a senior surveyor to ensure that all working methods and procedures were in accordance with accepted practices and standards. All field data were recorded in an electronic format.

The Topographic report of the proposed site at Galafi is included in **Appendix A**.

2.2 Geotechnical Investigations

Geotechnical surveys were carried out at the proposed location Galafi for the Ethiopia and Djibouti OSBPs.

2.2.1 Activities carried during Geotechnical Investigations

The activities carried out under the Geotechnical investigations included:

Data Collection and Planning

i. Collection of relevant data, maps and reports for the area of interest at both OSBP locations;
ii. Review and desk study of plot area and layout;
iii. Preparation of preliminary plan for geotechnical investigation.

The Field Work

i. Confirmation desk test plan for DCP & Test Pit;
ii. DCP tests and Test Pits with record of (GPS location, data & photo);
iii. Collection, tag labelling and transportation of samples to material laboratory.

Desk Work

i. Geotechnical Investigation Field Report: this included report of:
   - Interpretation and/or Correlation of DCP records;
   - Visual report of test pits.

Laboratory Test (independent laboratory)

ii. Surveillance of laboratory test procedure and compilation of test results;
iii. Laboratory test results Interpretation and Reporting.

2.2.2 Field Investigations

The Geotechnical Investigations were carried out through in-situ tests (DCP) and trial pits with soil profile logging and sample collection for Laboratory testing. The following were executed on site as part of the geotechnical investigations.

1. Total of Twenty Four (24) trial pits within the area of interest/OSBP Compound (8 on each of the three Compounds) for:
   - Logging of soil profile;
   - Sampling for laboratory tests.
2. Total of Nine (9) Trial Pits along access road (3 along each compound) for
   - Logging of soil profile;

- Sampling for laboratory tests.

3. Total of Thirty Six (36) DCP tests within the area of interest/OSBP Compound (12 on each of the three Compounds)

4. Total of Twelve (18) DCP tests along access road within Ethiopian, across the border and in Djibouti

2.2.3 Laboratory Results

Seismic Information

The project area at Ethio-Djibouti border lies in the Afar Depression. The Afar Depression is an area of lowland plains split by fault blocks and dotted with shield volcanoes. Figure and table below provides information regarding seismic risk and zones of the project area which the designers need to take into account. As such, due considerations for seismic risk has to be given in the foundation and structural design exercise at GALAFI which is located within Zone four (4) of Seismic Zone of Ethiopia.

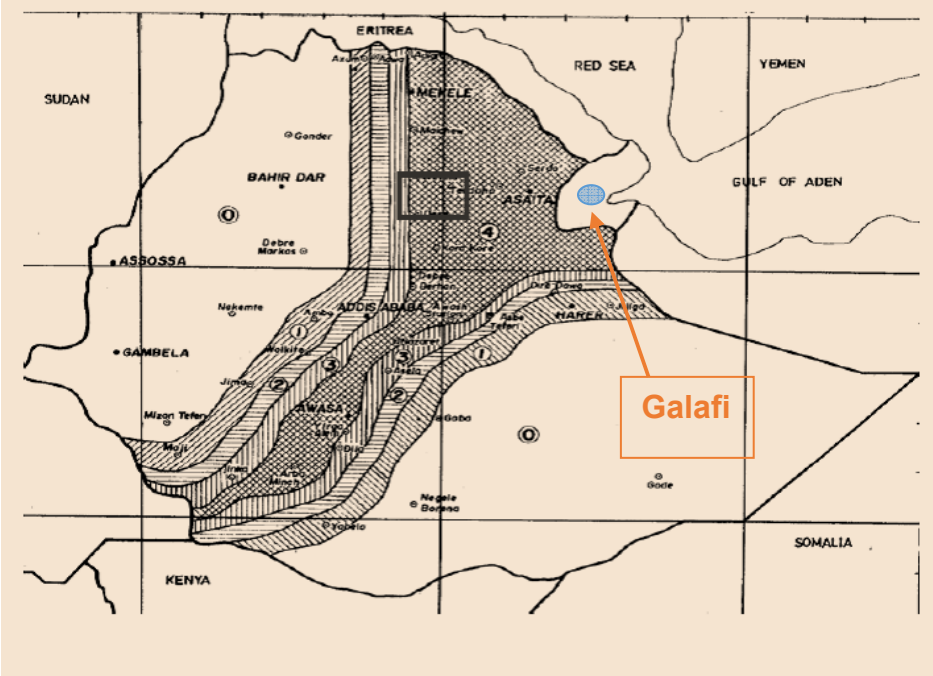


Figure: Seismic Risk and Zones Map of Ethiopia

Table: Ground acceleration Earthquake in each Seismic Zone of Ethiopia

Zone	4	3	2	1
g	0.1	0.07	0.05	0.03

Remarks

The general soil profile in the Galafi project area is made of light grayish sandy soil mixed with silt and clay. The soils are loose on the top 30 cm and become denser with depth. Gravelly materials mixed with pebbles are also observed.

DCP records and DCP correlation results of CBR (as well as visual logging record) revealed loose strata at the top (for almost all test pits and DCP) but the strata become moderately compacted as the increase depth increases. For all the three OSBP compounds as well access road, the maximum CBR obtained from DCP correlation is 26.5 while Laboratory Test results of CBR within the 1st OSBP Compound in Ethiopia (Min. CBR=12.5, Ave. CBR=20.2 & Max CBR= 34), within the "2nd OSBP Compound in Ethiopia" (Min. CBR=1.6, Ave. CBR=2.9 & Max CBR= 5.8) and that of OSBP Compound in Djibouti (Min. CBR=14.0, Ave. CBR=29.4 & Max CBR= 45.0). Laboratory Test results of CBR reveals relatively lower CBR value from "2nd OSBP Compound in Ethiopia" when compared with that of the other two OSBP Compounds.

The best foundation option in sandy soil, generally, depends on the size/load of the structure, the stability the sandy soil itself and the type of structure that is going to be built. In this regards, the Geotechnical Investigation Report coupled with topographic survey and map produced provided comprehensive insight about the nature of the foundation soil and the terrain (and watershed) of Galafi. This enabled building and road designers in the exploration and evaluation of different available foundation design options on the basis of sound engineering judgment.

The Geotechnical report of the proposed site at Galafi is included in **Appendix B**.

3 DETAILED ENGINEERINGDESIGN

3.1 Government Policies

The Governments of Ethiopia and Djibouti are committed to having high standards attained in the building and construction industry, so that the structures constructed are structurally sound and environmentally friendly.

The equal opportunity approach has catered for the people with disabilities being covered under the design considerations including access to public facilities.

In principle, the Governments are interested in having the following areas taken under consideration in design and construction:

i. Proper land use;
ii. Sound structural design for shelter and protection of people and property;
iii. Adequate lighting;
iv. Adequate spacing for the occupants;
v. Environmentally acceptable standards and commitments;
vi. Safe water utilization.

3.2 Architectural Design Criteria

3.2.1 Design Basis

i. The Terms of Reference for the Project (ToR);
ii. Site Survey/Needs Assessment findings;
iii. Standard One stop Border post Designs as laid out by the source book;
iv. The Topographical surveys;
v. Feedback from Joint Project Steering Committee Meeting and Joint Technical Committee Meetings held on 6th to 9th December 2017 in Nairobi, Kenya;
vi. Feedback from Galafi OSBP location confirmation visit held on 25th to 26th September 2018 in Semera, Ethiopia;
vii. The local conditions of climate, geography, geology and local habit;
viii. Geotechnical Investigations Report;
ix. The Standard Design Specifications and Building Regulations in force in the respective countries;
x. Case study Analysis;
xi. Traffic & Trade forecasting;

3.2.1.1 General requirements

The Employer requires a facility with serviced buildings and related operational services that portray the image and function of One Stop Border Posts for countries under the IGAD umbrella. The building style and design representing the following characteristics:

i. A contemporary architectural style that reflects a progressive facility in the 21st century in a tropical country in Africa;

ii. The stature and functions of One Stop Borders under IGAD;

iii. Meets the organizational structure of particular border posts;

iv. Provide for normal OSBP operations and for managing and controlling special border tasks.

The design through the use of contemporary materials and design reflected the characteristics above. The facility achieved excellence through good design based on functional and environmental requirements of the particular border posts. The design also addressed the security requirements of a National Border Post while accommodating requirement for facility to be accessed by members of public.

3.2.1.2 Client's requirements as per the Terms of Reference

Feasibility Study and Engineering Design of One Stop Border Posts (the "Hardware")

A. Review of border clearance process flows including identification of facilities and agencies that operate within and outside the control area and assess one-stop border post layouts, make proposals of suitable border post to ensure smooth flow of traffic;

B. Undertake a feasibility study and propose a suitable layout to Governments for selection of the most suitable layout of OSBP for the South Sudan-Ethiopia and Ethiopia-Djibouti borders;

C. Carry out detail engineering design, cost estimates and preparation of bidding documents for the two one-stop border posts including parking, axle load control, inspection and customs storage facilities, and other essential facilities. The one stop border post facilities are meant to provide among others the following:

(i) Building facilities to accommodate border control officials from both sides of the border for one - stop operation, including but not limited to immigration, customs, police, veterinary services, etc..;

(ii) Weighbridge platform controlled by computer including computer hardware, software with an office and ablution facilities including a control room and a caretaker unit;

(iii) Accommodation facilities where required;

(iv) Warehouse and spaces for cargo handling and equipment;

(v) Road works to accommodate light and heavy vehicle traffic for border control and axle load control;
(vi) On site circulation and separate parking areas for freight and passenger traffic;
(vii) Road and weighbridge signs; and
(viii) Communication facilities and other services.

3.2.2 Design Scope

The scope of design involved the design of facilities as per the terms of reference (ToR) and Needs Assessment findings.

3.2.3 Design Principles and Concepts

3.2.3.1 Key planning principles

A number of key planning principles were established that guided a concept for the design of the One Stop Border posts.

Table 3-1: Key planning principles

The model of OSBP chosen	The designs were based on the Juxtaposed model of One Stop Border Posts arrived at after doing an Options Analysis for the different types of One Stop Border Posts.
Existing Border post Infrastructure	Galafi Ethiopia has several existing infrastructure that accommodates the Post while Galafi Djibouti has a few semi-permanent structures. Some infrastructure at Galafi Ethiopia was retained and remodelled while the rest has been recommended for demolition in a bid to turn the border post into a functional OSBP.
One directional flow of traffic.	All the traffic within the common control zone was designed to move in one direction. Separation of different categories of traffic was also designed.
Connected precincts	Linking the various key departments with clear walkways and driveways for smooth operations and connectivity was designed.
OSBP main building as heart of the Border post	Enforced the OSBP main building as the core of the border post activities.

Zoning	Similar activities were kept in the same zone for smooth transition from one stage to another.
Responsiveness to the Local Climate	Galafi is a very hot area with average temperatures above 45 degrees Celsius. Buildings were designed as a response to this type of climate.
Responsiveness to local practices/ procedures	Strategic interventions to make the Border post more responsive to local Border post practices/ procedures were implemented.
Cost effectiveness in the construction and future operations	The design ensures that there is cost effectiveness during construction and also ensure lower operational costs in the future.

3.2.3.2 Concept Description

Border posts are designed primarily as places of clearance of people and goods as they cross over from one Country to another. A one-stop border post ensures that both people and goods have to be cleared once so as to save on time and promote efficiency. The main pillars of an OSBP are;

- Legal and Institutional Framework;
- Simplification and Harmonization of Procedures;
- ICT and Data Exchange;
- Hard Infrastructure.

The hard infrastructure design was aimed at ensuring that the main pillars of a One Stop Border Post (OSBP) are achieved as well as ensuring that the main functionality of a standard border post is not lost. This design took into account:

i. Accessibility;
ii. Building line;
iii. Parking;
iv. Form;
v. Building height;
vi. Functional relationship of spaces.

3.2.4 Planning & Design Regulations, Standards

3.2.4.1 Planning and design standards

The following planning and design standards were adopted during the design process:

i) Urban Planning and Implementation Manual, for Ethiopia;

ii) Import & Export Data - 1997 To 2015;

iii) Building Regulations for Ethiopia (http://www.mwud.gov.et/web/guest/regulations);

iv) Building Standards (http://www.mwud.gov.et/web/guest/standards);

v) Ethiopian Roads Authority (ERA's) GTP-II Plan for Afar and Gambela;

vi) Public Health Proclamation ETH149135;

vii) Ministry Of Works & Urban Development, Federal Urban Planning Coordinating Bureau (Fupcob), Urban Storm Water Drainage Design Manual;

viii) MP Report of Wind and Solar Energy, GTP II Urban Water Supply Service Standards, GTPII – Growth & Transformation Plan, Ministry of Water, Irrigation and Electricity;

ix) Ethiopia Customs Authority: Customs Proclamation 859-2006;

x) Ethiopian GTPII Urban Water Supply Service Standards;

xi) Architects Data ,third Edition by Ernst & Peter Neufert;

xii) Building Construction Handbook Sixth edition R. Chudley;

xiii) Metric Handbook Planning and Design Data, 2nd Edition, by David Adler;

xiv) British design standards (bsonline.techindex.co.uk).

3.2.4.2 Design Standards

1. Planning

To help ensure that the proposed developments are consistent in terms of aesthetic quality and functional efficiency, a comprehensive plan was used. This allowed successive phases of the development to be carried out by different parties/authorities without losing aesthetic and functional consistency.

Key determining factors for good planning that were considered;

a) Sequence of planning decisions

The starting point of designs was the activity area/the buildings, their shapes, dimensions and orientation to enable them fulfil the required functions. Next in order of precedence were the seating capacity, the general orientation, the zoning of the various activities, parking and planning the overlays.

b) Anticipated capacity

The buildings were designed both for current traffic volumes and for future growth.

c) Orientation

The ideal location for the buildings is to have their longitudinal axis running north to south. With this orientation, the sun will be at the side of the offices during working hours.

d) Zoning

To keep similar activities in the same zone for smooth transition from one stage to another it is important to design for easy, fast and safe transition from zone to zone.

e) Parking

This includes ground floor parking and on-street parking.

f) Overlays (Overflows)

An overlay is an arrangement or emergency provision in case the number of building occupants is beyond what is designed for. The buildings are scalable so as to cater for future growth needs

2. Space Requirements for Activity Areas

The proposed OSBPs are expected to have buildings and services that facilitate its operations. Table 3-2 shows the space requirements and buildings that were provided as per the terms of reference and needs assessment findings.

Table 3-2: Space requirements for Galafi

S/N	Description	Area (m^2)
	GALAFI - ETHIOPIA POST	
A.	**RETAINED BUILDINGS(RE-MODELED)**	
1.	WARE HOUSE	1,850.0
2.	SCANNER BUILDING	1,830.0
3.	SCANNER OPERATIONS BUILDING (2No.)	350.0
4.	STAFF HOUSING(Junior, Senior and Support Staff)	*(Not established)*
B.	**NEW BUILDINGS/FACILITY**	
1.	OSBP MAIN BUILDING	5230
2.	VERIFICATION SHADE	1500
3.	DRIVERS' WASHROOM AND CANTEEN	135.0

4.	POWER/GENERATOR HOUSE	48.0
5.	CLEARANCE BOOTHS	187.0
6.	GATEHOUSES & FENCING	N/A
7.	WEIGH BRIDGE	N/A
8.	DRIVEWAYS, PARKING & WALKWAYS	N/A
C	**DEMOLISHED**	
1.	IMMIGRATION BLOCK	N/A
2.	ISOLATED CUSTOMS OFFICE BLOCKS 1,2 &3	N/A
3.	RELOCATION OF PRIVATE SECTOR	N/A
4.	OLD PERIMETER WALL	

GALAFI – DJIBOUTI POST		
S/N	**DESCRIPTION**	**AREA (M^2)**
1	OSBP MAIN BUILDING	3552.0
2	SCANNER/ WEIGHBRIDGE BUILDING	360.0
3	CONTROL BUILDING(2No)	200.0
4	CLEARANCE BOOTHS (3NO.)	270.0
5	VERIFICATION SHADE	1200.0
6	WAREHOUSE	1390.0
7	MOTORISTS WASHROOMS/ SHED	135.0
8	SENIOR STAFF HOUSING BLOCK (6NO.)	990.0
9	JUNIOR STAFF HOUSING BLOCK (50 UNITS)	3665.0
10	SUPPORT STAFF HOUSING (26 UNITS)	1,040
11	GATEHOUSE & FENCING	N/A
12	DRIVEWAYS, PARKING & WALKWAYS	N/A
13	GENERATOR/ POWER HOUSE	48.0
14	WATCH TOWER (5No)	N/A

The functions, relationships and activities envisaged for occupants and users of the proposed facility consisted of the following:

- **Workstations** for staff to perform their duties with open plan spaces being the preferred mode. Private offices with full height partitions were kept at minimum;
- **Ancillary spaces:** Washrooms, restrooms, pantries- 10% of workstation area;
- **Circulation space** (horizontal and vertical) for workstations: corridors, passengers, staircases, ramps, emergency exits- 15% of workstation area;
- **Technical services** for the entire building, including rooms for: HVAC, electric power, communications, water supply and sanitation, building maintenance;
- **Parking** for different categories of vehicles.

3. Visual aspects

The most important visual attributes that were carefully considered were finishes and colour.

4. Technical aspects

The most common local materials that are available for use in construction are concrete, steel and block work.

Concrete is naturally fireproof, affordable and is a practical material for construction. Concrete may be cast in situ or applied as pre-casts.

Steel is lighter both physically and aesthetically, and offers functional advantages, such as cheaper footings on bad soil, and the possibility of slender, graceful structures. Steel is an obvious choice for roof structures.

Wall finishes; most walls are plastered and painted while steel cladding is used in selected areas.

5. Roof designs

The three basic design considerations for the roof were;

a) The roof provided reasonable degree of enclosure ensuring shading from the sun, wind and rain.

b) The design life is for a minimum of 50 years for the roof structure and a minimum of 20 years for the covering. Design consideration for wind uplift was also made.

6. Details

In all cases, correct detailing was emphasized in order to make correct choice of materials:

- Balustrades were set back from the edges of landings to help reduce the danger of objects being accidentally dropped on people below.
- Floor edges in these positions were upturned to prevent objects rolling over the edge.
- Upper surfaces of rails and balustrades were slopped.
- Corners are to be protected from damage by vehicles by fixing metal guards, or by having rounded profiles.
- All dangerous projections and sharp edges were avoided.

7. Provisions for the Disabled

Increasingly the requirement for equal treatment is being demanded by law, in addition to the social and commercial pressures towards greater inclusiveness. This means that disabled people should be able to utilize the facility without suffering any avoidable disadvantages compared with other people.

In terms of physical infrastructure design, wheel chair users remain the most difficult category to cater for and therefore a crucially important user group. However, in public gatherings such as offices the term “disabled” becomes wide and goes beyond the wheel chair users.

The scope of our site investigations into facilities for the disabled considered the following categories;

- **Impaired Mobility**; This includes wheel chair users, the aged and injured who need support guard rails, walking sticks and clutches, etc.
- **Impaired Vision**; includes those who cannot see properly and may be assisted by clear sound systems.
- **Impaired Hearing**; These depend on clear signage and special facilities such as special ingress and egress routes.
- **Impaired Understanding**; These include the illiterates who are greatly assisted by simple layouts and clear signage.

Therefore accessibility for the disabled was an integral part of the design process. Key considerations included the following;

- Walkway gradients steeper than 1:20 are designed as ramps with hand rails, kerbs and landings.
- Provision of special entrances for the disabled.
- Provision of toilet facilities for the disabled.
- Provision of special viewing areas accessible to the disabled.

8. Sanitary Provisions

Rule of the thumb for toilet provisions for office facilities is summarized in Table 3-3.

Table 3-3: Sanitary Provisions

	Requirements	Urinals	Water Closets	Wash basins
Public toilets-Men	2 toilets for 6 males 1 Disabled toilet with lobby of 4 square meters. 1 wash hand basin	Minimum of 2 for up to 100, plus 1 for every other 80 males or part thereof	Minimum of 1 for up to 250, plus 1 for every other 500 males or part thereof	1 per WC and 1 per 5 urinals or part thereof
Public toilets-Women	2 toilets for 6 females 1 Disabled toilet with lobby of 4 square meters. 1 wash hand basin	No recommendations	Minimum of 2 for up to 50, 3 for 51 to 100, plus 1 for every other 40 females or part thereof	Minimum of 1, plus 1 per 2 WCs

In addition, we provided an appropriate proportion of toilets for the disabled.

9. Infrastructure Services

Lighting System

A good lighting system is essential for ensuring safe entry and exit of building occupants, and lighting the entire facility at night. The lighting design ensured the following;

- Adequate luminance levels;
- Glare control.

CCTV System

CCTV systems are essential for ensuring security and crowd control. The designs have included CCTV systems as a priority.

Fire Detection and Fighting System

The issues noted under design for fire safety are:

- Risks of fire outbreak;
- Risks of spread;
- Detection and control systems;

- Spectator exit system (emergency exits).

The essential minimum provisions that were considered are;

- Fire protection mains and connection points;
- Means of escape (emergency exits).

Water Supply and Drainage System

Water supply installations are required to service the OSBP infrastructure such as the toilet facilities. There was a need for an on-site raised storage tank since the pressure from the mains may not sustain the high volume required for the sanitary facilities.

Table 3-4: Summary Design Performance Standards

	BUILDING ELEMENT	PERFORMANCE STANDARD
	BUILDING FABRIC	
1	External walls	Aesthetically pleasant and to suit particular location and exposure
2	Roof	To suit particular location and exposure i.e semi-arid climate
3	Windows	To suit particular location and exposure. To provide adequate ventilation and lighting
4	Doors	Location and requirement complies with applicable building regulations, codes of practice and good architectural practice.
	FINISHES	
1	General	Chosen in line with current best practice, relating positively to environmental issues and appropriate to particular use
2	Internal finishes	Floor, wall, ceiling finishes, furniture/fittings form part of an integrated design concept
3	External finishes	To provide high performance, durability, and good weathering characteristics and aesthetically pleasing. Good energy efficiency is expected in the design and the use of solar shading would as a minimum be required.
	FIXTURES AND FITTINGS	
1	Filing	Adequate centralized filling provided to reduce personal filling requirements at a work station.
2	Sanitary ware	Separate male and female sanitary ware, toilets to be ventilated to outside, fittings are to be adult height, all fittings vandal resistant, female toilets with sanitary disposal units.
3	Signage	All signage to conform to image of the

		facility
4	Kitchenette	Will have a minimum of a fridge, microwave, means of boiling water, sinks, surfaces, cupboards for storage.
	SERVER ROOMS	
1	Environment	Filtered air, constant temperature/humidity, positive air pressure, protected air vents, anti-static flooring, uninterrupted power supply, connected to generator for standby power.
2	Doors windows, walls, roof	Only one point of entrance, resistant to forcible entry, fire rated doors, no windows or doors to outside of building, monitor window, walls to extend to roof or ceiling, solid roof.
3	Fire protection	To comply with local fire codes
	CIVIL&STRUCTURAL ENGINEERING	
1	Structural works	Designed in such a way to allow reasonable flexibility of room layouts, and future increase of space
2	Infrastructure	Road ways, parking, storm water to be designed according to relevant applicable standards.
3	Ground conditions	Engineer acquainted with geotechnical conditions of the site. Required surveys and detailed studies Carried out.
	BUILDING SERVICES	
1	General	Includes utility service supply, building services documentation, regulations and standards for building services installations
2	Environmental requirements	Considered energy conservation and management, energy targets, acoustic provision, glare and solar gain
3	Mechanical services installations	Considered cooling control, ventilation, water installations, drainage installations
4	Firefighting	Provided as appropriate to comply with codes and regulations and server room specifications
5	Electrical installations	All work conducted to the requirements of the relevant local regulations
6	ICT infrastructure	Software team to design ICT network to carry out all voice/data/television projected traffic.

Service Functions

The project included the provision of hard and soft facility management service functions set out in more detail in Table 3-5.

Table 3-5: Facility Management Service

	SERVICE FUNCTION	DETAILS
	Help desks	To receive queries or any requests for services.
	Cleaning	Domestic cleaning, deep cleaning for windows, architectural fabric etc.
	Hygiene	Ablution facilities, waste collection points, waste disposal points.
	Parking management	Movement and control, external security monitoring.
	Security	Entrance and exit of site, general external.
	Waste management	Waste collection, waste disposal.
	Confidential waste management	Confidential waste collection, confidential waste disposal.
	ICT	All hardware and software used by different border departments, telephone handsets.
	TECHNOLOGY SERVICES	
	Audi visual	Fixed equipment only to boardrooms, meeting rooms, multipurpose halls.
	Connectivity	Wireless networking.
	Backbone	Backbone cabling to connection points.
	Telephony	PABX service.
	Digital projectors	Boardrooms and meeting rooms.
	security	CCTV, access control equipment, access monitoring equipment

3.2.5 Key Functional Layout Principles

The following principles were taken into consideration for an appropriate functional layout.

- Separation of traffic according to different categories;
- Ensuring that all traffic is one directional with minimum points of conflict;
- Proper zoning to ensure that similar activities are grouped together.

3.2.5.1 Traffic Organization

Traffic was categorized into vehicular and pedestrian traffic.

1. Vehicular Traffic

Vehicular traffic has farther been categorized into the following:

- **Express cargo trucks:** these take the express cargo lane and are cleared at the booths after presenting the relevant documents;
- **Fuel trucks:** these are cleared at a separate booth and have a dedicated route since it carries hazardous goods;
- **Freight cargo trucks:** these regular cargo trucks go into a dedicated parking area from where the truck drivers disembark to undergo the clearance process;
- **Staff vehicles:** these have a separate parking and walkway leading to main building;
- **Passenger vehicles** e.g. buses and taxis; these have dedicated parking areas and lanes. The buses have a drop off point and one for picking up the passengers after going through the clearance process;
- **Privately owned small vehicles:** these have been provided with a separate parking space and walkways leading to main building for clearance.

2. Pedestrian Circulation

The pedestrian traffic was subdivided into two categories;

- Those moving within the common control zone(CCZ) including staff ,truck drivers and other individuals seeing clearance;
- Border post communities that cross the border time and again: these have been provided with an exclusive 2m paved passage that is fenced off but patrolled by security.

3. Procedures that guided traffic organization and circulation

- Generally, passenger and freight traffic are separated and separate parking areas provided;
- The CCZs have entry and exit gates;
- Clearance is done in the country of entry; traffic bypasses the post in the country of exit;
- Border controls are carried out in the public (clearance) hall of the facility, exit first and entry second;
- Coaches and buses park in the inspection bays or adjacent parking area, where inspections are conducted as necessary;
- Heavy goods vehicles are inspected in the verification bays, when an inspection is considered necessary;
- Trucks carrying goods that are pre-cleared, transit, hazardous, and/or part of an authorized economic operator (AEO) program are handled by a special fast track unit;

- After completion of border controls, heavy goods vehicles proceed for weighing if deemed necessary;
- Gate passes are signed by the relevant border officers of both countries as processes are completed;
- Commercial drivers whose cargo is not qualified for the fast track proceed to the parking, facility for scanning, processing, and physical inspection, if considered necessary;
- Parking lots can serve as a buffer while trucks wait to be cleared, thereby solving traffic problems;
- Because vehicles, cargo, and persons can be refused entry, return lanes have been planned within the facility;
- All processing takes place in the facility, scanner, and inspection areas. Once all controls are satisfied, the driver exits through the exit gate.

3.2.6 Site Analysis

a) **Sun path**

The sun movement (sun path) during the day and throughout the year was established. A qualitative analysis of the sunlight or shading of the site and parts of the intended buildings was developed.

b) **Prevailing winds**

The Design Team established the approximate speeds and directions of prevailing winds and adapted the design to facilitate natural ventilation.

c) **Building orientation**

The buildings were preferably developed along the East-West axis with main facades facing either North or South to minimize direct exposure to solar radiation.

d) **Building position**

Attention was paid to avoiding hampering of natural light. Adequate spacing was allowed between neighbouring building blocks to allow wind flow between the buildings and assisting natural ventilation.

e) **Drainage**

Existing natural drainage patterns were maintained around existing vegetation to slow down accumulation and flow of water into drainage points.

f) **Physical features on site.**

The site at Galafi is characterised by rocky mountains with hardly any vegetation apart from scanty thorny bushes. This greatly influenced the nature of landscape design adopted for the OSBPs.

g) **Built environment**

Galafi Ethiopia has got several permanent structures while the Djiboutian side has few permanent structures apart from two clearance booths for incoming and exiting traffic. Some of this infrastructure at Galafi Ethiopia is retained while for Djibouti, everything is new.

h) **Land**

The land tenure system was studied to determine issues of ownership, titling, encroachments. Also issues to do with the size, shape, available accesses were influential in the design process.

3.2.7 Proposed Scope of Construction Works

3.2.7.1 Schedules of Accommodation

Table 3-6 shows the detailed space allocations and descriptions for both the Ethiopia and Djibouti posts.

Table 3-6: Space Schedules for Galafi Ethiopia for Administration and shared spaces

SPACE NAME	***SPACES DISCRIPTION***	***CAPACITY***	***AREA/ PERSON***	***UNIT AREA***	***QUANTITY***	***AREA (Sq.M)***
SPACE SCHEDULES FOR GALAFI ETHIOPIA POST						
A.ADMINISTRATION FACILITIES						
IMMIGRATION DEPARTMENT ETHIOPIA POST						
HEAD IMMIGRATION ETHIOPIA	*Office space with meeting Area*	*12*	*5.0*	*5.0*	*1*	*60.0*
IMMIGRATION OFFICERS ETHIOPIA	*Counter space in Clearance Hall*	*5*	*12.0*	*12.0*	*1*	*60.0*
IMMIGRATION OFFICERS DJIBOUTI	*Counter space in Clearance Hall*	*2*	*12.0*	*12.0*	*1*	*24.0*
CUSTOMS DEPARTMENT ETHIOPIA POST						
HEAD CUSTOMS ETHIOPIA	*Office space with area for secretary, visitors Area and meeting area*	*18*	*5.0*	*5.0*	*1*	*90.0*
CUSTOMS DEPUTY MANAGER ETHIOPIA	*Office space with area for secretary, visitors Area and meeting area*	*10*	*5.0*	*5.0*	*1*	*50.0*
Head Verification Officer	*Office space with visitors Area.*	*8*	*5.0*	*5.0*	*1*	*40.0*
CUSTOMS OFFICERS ETHIOPIA 1	*Pool Office space for officers who **grant entry clearance** in Ethiopia Customs Management System*	*10*	*7.0*	*7.0*	*1*	*70.0*
CUSTOMS OFFICERS ETHIOPIA 2	*Pool office space for **scanner** operations*	*10*	*7.0*	*7.0*	*1*	*70.0*
CUSTOMS OFFICERS ETHIOPIA 3	*Pool office for electronic **Cargo Tracking** Team*	*7*	*7.0*	*7.0*	*1*	*49.0*
CUSTOMS OFFICERS ETHIOPIA 4	*Pool office for **ICT Support** Officers (including supervisor)*	*5*	*7.0*	*7.0*	*1*	*35.0*
CUSTOMS OFFICERS DJIBOUTI	*Pool Office space for officers who grant cargo **exit clearance** in Djibouti Customs Management System*	*2*	*10.0*	*10.0*	*1*	*20.0*
Ethiopia and Djibouti Booth officer	*For fast track clearance i.e. for pre-cleared goods e.g. perishable goods and dangerous cargo*	*2 Ethiopia & 1 Djibouti*	*3*	*7.0*	*1*	*21.0*
DOCUMENT STORAGE ROOM	*Documents Storage space with movable storage cabinets*	*n/a*	*n/a*	*n/a*	*n/a*	*38*
SUBTOTAL						***627***
B.SHARED SPACES						
SERVER (ICT) ROOM	A shared room or space for ICT Equipment including racks, Servers, networking and power equipment e.g. UPSs	n/a	n/a	n/a	1	21
CCTV Room	A room with CCTV screens for surveillance purposes	n/a	n/a	n/a	1	28

MULTI PURPOSE MEETING ROOM	For border office meetings. 2 doors with movable middle partition with overhead Projector	105	2	2	1	210
STRONG ROOM	Keeping of crucial documents: one for each country.	n/a	n/a	n/a	1	10
TRAINING ROOM	Training of officers and stakeholders. 2 doors with movable middle partition & catering for PCs. Overhead Projector	65	2	2	1	130
VIDEO CONFERENCING ROOM	For audiovisual telecommunication with headquarters, other border post etc.	19	2	2	1	38
RESOURCE CENTRE	For storage and management of various literally resources (Manuals, Source books, Journals etc.)	19	2	2	1	38
CAFETERIA & KITCHEN	taking meals by staff/officers	63	3	3	1	189
SECURITY ROOMS	To cater for Security personnel office and an Interrogation room	4	20.0	20.0	1	80
KITCHENETTE	Light cooking area	n/a	n/a	n/a	n/a	4
STAFF WASHROOMS	Female and Male on ground floor and 1st floor	n/a	n/a	n/a	n/a	54
PUBLIC WASHROOMS	For the public served at the OSBP main hall.	10 toilets for men & 5 for women	n/a	n/a	n/a	100
CLEANERS STORE		n/a	n/a	n/a	n/a	2
COURTYARD	Open green space to the sky	n/a	n/a	n/a	n/a	430
TOTAL CIRCULATION	Circulation through the building	n/a	n/a	n/a	n/a	1660
TOTAL						**2,592**

Table 3-7: Space Schedules for Galafi Ethiopia for Passenger Clearance facilities

SPACE NAME	SPACES DISCRIPTION	CAPACITY	AREA/ PERSON	UNIT AREA	QUANTITY	AREA (Sq.M)
C.PASSENGER CLEARANCE						
PASSSPORT CONTROL AREA	Part of immigration. Counters separating the clearance hall from officers' workplace.	n/a	n/a	n/a	n/a	n/a
SPACE FOR HEALTH OFFICERS	Health screening counters/desks should be placed at the entrance of the clearance hall	3	n/a	n/a	n/a	n/a
FACILITY FOR HEALTH & SANITATION	Facility to include Reception, Dispensary, Baggage Disinfection room, Diagnosis Laboratory, small shower, Examination room, Isolation room	n/a	n/a	n/a	1	250
POLICE POST	Space for 8 Police officers, 2 holding rooms, 1 Exhibit room and 1 interrogation room.	n/a	n/a	n/a	n/a	168
BODY AND BAGGAGE SCANNERS	Placed at the entrance of the clearance hall.	n/a	n/a	n/a	n/a	n/a
SPACE FOR PERSONS IN NEED OF PROTECTION	Reception facilities at the border for individuals in need of protection. Separate facilities for men and women. Not a physical facility but space where tents can be erected near the parking. To use washrooms in the parking area	n/a	n/a	n/a	n/a	n/a
REST SPACE	Waiting space under a roof for travellers/ long distance drivers with a canteen and washrooms	50	2	2	1	135
TOTAL						**553**

Table 3-8: Space Schedules for Galafi Ethiopia for Cargo Clearance facilities

SPACE NAME	SPACES DISCRIPTION	CAPACITY	AREA/ PERSON	UNIT AREA	QUANTITY	AREA (Sq.M)
D.CARGO CLEARANCE						
PROCESSING COUNTERS	To facilitate receiving and releasing cargo for clearance in clearance hall. Catered for in the clearance hall under Customs above.	n/a	n/a	n/a	n/a	n/a
INSPECTION YARDS	1 All-weather inspection yard to cater for simultaneous inspection of 5 trucks. To include Office Space for inspection officers	n/a	n/a	n/a	n/a	1440
WAREHOUSE	Includes strong room, office space for cargo examination officers and for document storage. To have joint incineration yard.	n/a	n/a	n/a	n/a	1950 note; the ware house is existing and is to be remodelled
LABORATORY	For testing of samples to enhance the verification function. Include workstations for 5 scientists and lab technicians (including head of lab unit) & testing lab	n/a	n/a	n/a	n/a	n/a
SCANNERS	Screening of goods to verify that what has entered the country: includes offices for customs officers.	n/a	n/a	n/a	2	1100 scanner is existing and is to be remodelled
WEIGHBRIDGES	With control room attached	n/a	n/a	n/a	1	60
CLEARANCE BOOTHS	Canopied Booths within the road for clearing fast track vehicles and passengers	n/a	n/a	n/a	1	260
POWER ROOM	Power and standby generator room	n/a	n/a	n/a	n/a	48
PARKING	Separate parking areas for passenger and freight Traffic as well as for staff and visitors. Serves as a buffer while trucks wait to be cleared.	- 10 for Passenger vehicles - 20 for staff & visitors - 50 trucks	n/a	n/a	n/a	n/a
FENCING	Fence to include a gate and an office/booth at the entrance to provide security for operations and freight.	n/a	n/a	n/a	n/a	n/a
VEHICLE LANES	Passenger and freight traffic separated.	n/a	n/a	n/a	n/a	n/a
ANIMAL HOLDING PENS	Recommendation is not to provide animal holding pens for Galafi due to extreme climatic conditions. Clearance of livestock to be fast tracked.	n/a	n/a	n/a	n/a	n/a
TOTAL						**1,808**

Table 3-9: Space Schedules for Galafi Ethiopia for Support Services

BLOCK	SPACES DESCRIPTION	CAPACITY	AREA/ PERSON	UNIT AREA	QUANTITY	AREA (Sq.M)
E.SUPPORT SERVICES						
STAFF HOUSING	Housing existing: to establish nos. & categories.					
SPACE FOR THE PRIVATE SECTOR	Appr.8094sm to include :Restaurants, duty-free shops, and other facilities for the general public. To allocate land outside the OSBP CCZ for private sector to build as per proposed design standards.	n/a	n/a	n/a	n/a	n/a
UTILITIES	Such utility services include power, water, sewerage and communications. Overall site layout to shows connection and distribution points for all utilities.	n/a	n/a	n/a	n/a	n/a
SECURITY CONTROLLED GATEHOUSE	At entrances and exit of the common control zone	n/a	n/a	n/a	4	64
SUBTOTAL						**64**

GRAND TOTAL……6,007sm

NB.This is net area excluding areas of walls and columns

Table 3-10: Space Schedules for Galafi Djibouti for Administration and shared spaces

SPACE NAME	SPACES DESCRIPTION	CAPACITY	UNIT AREA	QUANTITY	AREA (Sq.M)
HEAD IMMIGRATION DJIBOUTI	Office space with visitors Area with secretary and filing space	12	5.0	1	60.0
IMMIGRATION OFFICERS DJIBOUTI	Counter space in Clearance Hall with backroom offices	5	12.0	1	60.0
IMMIGRATION OFFICERS ETHIOPIA	Counter space in Clearance Hall with backroom offices	2	12.0	1	24.0
CUSTOMS DEPARTMENT DJIBOUTI POST					
HEAD CUSTOMS DJIBOUTI	Office space with area for secretary, visitors Area and meeting area	18	5.0	1	90.0
CUSTOMS DEPUTY MANAGER DJIBOUTI	Office space with area for secretary, visitors Area and meeting area	10	5.0	1	50.0
HEAD -VERIFICATION OFFICER	Office space with visitors Area.	8	5.0	1	40.0
CUSTOMS OFFICERS DJIBOUTI 1	Pool Office space for officers who **grant entry clearance** in Ethiopia Customs Management System	5	7.0	1	35.0
CUSTOMS OFFICERS DJIBOUTI 2	Pool office space for **scanner** operations	5	7.0	1	35.0
CUSTOMS OFFICERS DJIBOUTI 3	Pool office for electronic **Cargo Tracking** Team	5	7.0	1	35.0
CUSTOMS OFFICERS DJIBOUTI 4	Pool office for **ICT Support** Officers (including supervisor)	5	7.0	1	35.0
CUSTOMS OFFICERS ETHIOPIA	Pool Office space for officers who grant cargo **exit clearance** in Djibouti Customs Management System	2	10.0	1	20.0
ETHIOPIA AND DJIBOUTI BOOTH OFFICERS	For fast track clearance i.e. for pre-cleared goods e.g. perishable goods and dangerous cargo	1 Ethiopia & 2 Djibouti	7.0	1	21.0
DOCUMENT STORAGE ROOM	Documents Storage space with movable storage cabinets	n/a	n/a	n/a	21
SERVER (ICT) ROOM	A shared room or space for ICT Equipment including racks, Servers, networking and power equipment e.g. UPSs	n/a	n/a	1	21
CCTV ROOM	A room with CCTV screens for surveillance purposes	n/a	n/a	1	22
MULTI PURPOSE MEETING ROOM	For border office meetings. 2 doors with movable middle partition with overhead Projector	100	2	1	200
STRONG ROOM	Keeping of crucial documents: one for each country.	n/a	n/a	1	10
TRAINING ROOM	Training of officers and stakeholders. 2 doors with movable middle partition & catering for PCs. Overhead Projector	40	2	1	80
VIDEO CONFERENCING ROOM	For audiovisual telecommunication with headquarters, other border post etc.	19	2	1	38
RESOURCE CENTRE	For storage and management of various literally resources (Manuals, Source books, Journals etc.)	9	3	1	27
CAFETERIA & KITCHEN	taking meals by staff/officers	60	3	1	180
SECURITY ROOMS	To cater for Security personnel office and an Interrogation room	4	12	2	48
KITCHENETTE	Light cooking area	n/a	n/a	n/a	4
STAFF WASHROOMS	Female and Male on ground floor and 1st floor	n/a	n/a	n/a	54
PUBLIC WASHROOMS	For the public served at the OSBP main hall.	10 toilets for men & 5 for women	n/a	n/a	50
CLEANERS STORE		n/a	n/a	n/a	3
COURTYARD	Open green space to the sky	n/a	n/a	n/a	60
TOTAL CIRCULATION	Circulation through the building	n/a	n/a	n/a	1380
TOTAL					**2,703**

Table 3-11: Space Schedules for Galafi Djibouti for Passenger Clearance

SPACE NAME	SPACES DESCRIPTION	CAPACITY	UNIT AREA	QUANTITY	AREA (Sq.M)
PASSSPORT CONTROL AREA	Part of immigration. Counters separating the clearance hall from officers' workplace.	n/a	n/a	n/a	n/a
SPACE FOR HEALTH OFFICERS	Health screening counters/desks should be placed at the entrance of the clearance hall	3	n/a	n/a	n/a
FACILITY FOR HEALTH & SANITATION	Facility to include Reception, Dispensary, Baggage Disinfection room, Diagnosis Laboratory, small shower, Examination room, Isolation room	n/a	n/a	1	140
POLICE POST	Space for 5 Police officers, 2 holding rooms, 1 Exhibit room and 1 interrogation room.	n/a	n/a	n/a	140
BODY AND BAGGAGE SCANNERS	Placed at the entrance of the clearance hall.	n/a	n/a	n/a	n/a
SPACE FOR PERSONS IN NEED OF PROTECTION	Reception facilities at the border for individuals in need of protection. Separate facilities for men and women. Not a physical facility but space where tents can be erected near the parking. To use washrooms in the parking area	n/a	n/a	n/a	n/a
REST SPACE	Waiting space under a roof for travellers/ long distance drivers with a canteen and washrooms	n/a	n/a	n/a	135
TOTAL					**415**

Table 3-12: Space Schedules for Galafi Djibouti for cargo clearance

SPACE NAME	SPACES DISCRIPTION	CAPACITY	UNIT AREA	QUANTITY	AREA (Sq.M)
PROCESSING COUNTERS	To facilitate receiving and releasing cargo for clearance in clearance hall. Catered for in the clearance hall under Customs above.	n/a	n/a	n/a	n/a
INSPECTION YARDS	1 All-weather inspection yard to cater for simultaneous inspection of 5 trucks. To include Office Space for inspection officers	n/a	n/a	n/a	1340
WAREHOUSE	Includes strong room, office space for cargo examination officers and for document storage. To have joint incineration yard.	n/a	n/a	n/a	1345
LABORATORY	For testing of samples to enhance the verification function. Include workstations for 5 scientists and lab technicians (including head of lab unit) & testing lab. These are part of verification building.	n/a	n/a	n/a	n/a
SCANNERS	Screening of goods to verify that what has entered the country: includes offices for customs officers.	n/a	n/a	2	360
WEIGHBRIDGES	With control room attached	n/a	n/a	1	60
CLEARANCE BOOTHS	Canopied Booths within the road for clearing fast track vehicles and passengers	n/a	n/a	2	360
POWER ROOM	Power and standby generator room	n/a	n/a	n/a	48
PARKING	Separate parking areas for passenger and freight Traffic as well as for staff and visitors. Serves as a buffer while trucks wait to be cleared.	- 15 for Passenger vehicles - 10 for staff & visitors - 40 for trucks	n/a	n/a	n/a
FENCING	Fence to include a gate and an office/booth at the entrance to provide security for operations and freight.	n/a	n/a	n/a	n/a
VEHICLE LANES	Passenger and freight traffic separated.	n/a	n/a	n/a	n/a
ANIMAL HOLDING PENS	Recommendation is not to provide animal holding pens for Galafi due to extreme climatic conditions. Clearance of livestock to be fast tracked.	n/a	n/a	n/a	n/a
TOTAL					**3,513**

Table 3-13: Space Schedules for Galafi Djibouti for Support services

BLOCK	SPACES DESCRIPTION	CAPACITY	UNIT AREA	QUANTITY	AREA (Sq.M)
STAFF HOUSING	Categorized into: 1. Senior staff housing 2. Junior Staff housing 3. Support Staff housing			 5 50 20	 825 3665 800
SPACE FOR THE PRIVATE SECTOR	Appr.8, 090sm Restaurants, duty-free shops, and other facilities for the general public. To allocate land outside the OSBP CCZ for private sector to build as per proposed design standards.	n/a	n/a	n/a	n/a
UTILITIES	Such utility services include power, water, sewerage and communications. Overall site layout to shows connection and distribution points for all utilities.	n/a	n/a	n/a	n/a
SECURITY CONTROLLED GATEHOUSE	At entrances and exit of the common control zone	n/a	n/a	4	64
SUBTOTAL					**13,448**

3.2.7.2 External works

- 1km approach and exit roads;
- One way drive ways/ internal roads with 2 lanes;
- Parking areas for trucks and small vehicles;
- Fencing for the entire facility and an internal fence around the warehouse;
- 2m wide walkways on both sides of internal access roads;
- External exit and entry gates;
- Landscaping;
- Covered storm water drainage channels;
- Mechanical reticulation;
- Electrical reticulation.

3.2.8 Case Study analysis

The following case studies were looked into as an insight into the day to day operations of one stop border posts in the region. The best practices were adopted while the bad ones were avoided.

1. Chirundu OSBP between Zambia and Zimbabwe;
2. Malaba OSBP between Uganda and Kenya;
3. Elegu OSBP between Uganda and South Sudan.

3.2.8.1 Emerging issues from the study of these examples of OSBPs

i. The need for high-level political commitment;
ii. The importance of well-structured committees;
iii. The importance of a well-crafted OSBP legal framework;
iv. The need to refine procedures over time;
v. The importance of training;
vi. The need for a change management process;
vii. Challenges in implementing an OSBP when facilities were designed for traditional two-stop operations;
viii. The incompatibility of / lack of symmetry between hard and soft infrastructure between the two countries;
ix. The importance of ICT;
x. The need for assured disbursement(s);
xi. The need for appropriate signage;
xii. The role of international Development/cooperating partners, and;
xiii. The importance of extended (harmonized) operating hours.

3.2.8.2 Layout of Case Study OSBPs

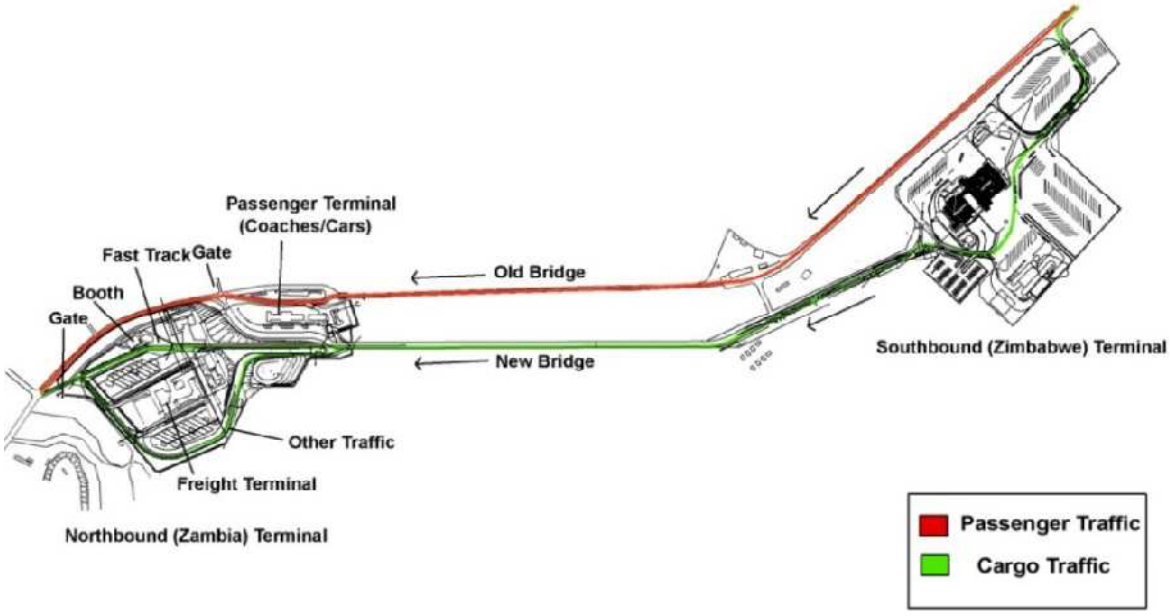


Figure 3-1: Layout of Chirúndu between Zambia and Zimbabwe OSBP

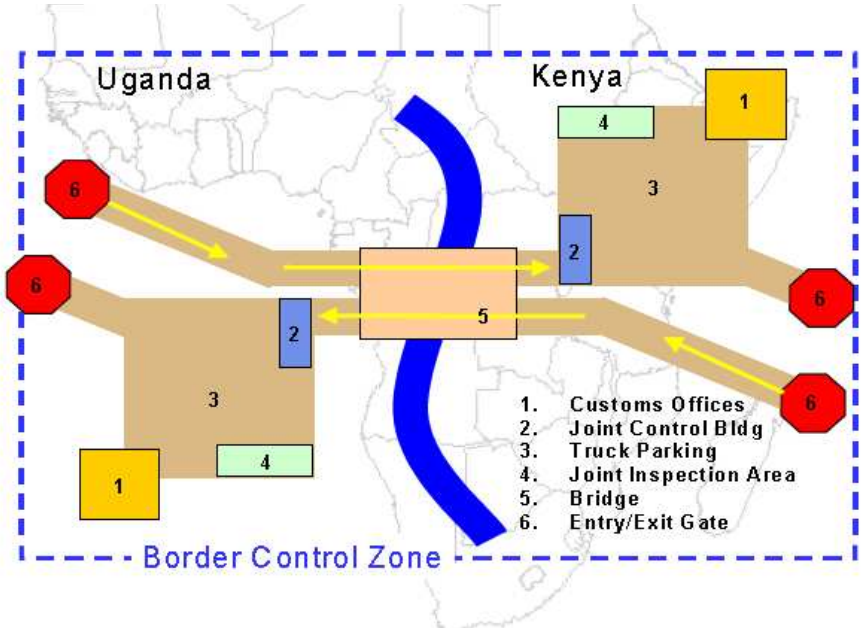


Figure 3-2: Layout of Malaba OSBP between Uganda and Kenya

3.2.9 Stakeholder engagement / Presentations

Comments from workshops/presentations were taken into consideration and thus the designs were modified accordingly.

A summary of the engagements is as follows:

1. Site reconnaissance visits and stakeholder engagements in September 2016
2. Nairobi Validation workshop held in December 2017
3. Galafi Site visit and workshop held in September 2018
4. Several correspondences between Employer and Consultant

3.2.10 Specific Design Considerations for the Hot Arid Climate

The aim of the design for the Galafi OSBPs was to lower both daytime and night-time temperatures in and around the buildings as much as possible to comfort conditions. This was achieved by keeping building envelopes or surface areas of buildings minimally exposed to the sun environment.

Characteristics of Climatic Conditions:

1. Hot dry summer & cold dry winter;
2. Very little rainfall, humidity & vegetation cover;
3. High temperature difference between day & night;
4. Desert area windy & dusty.

Design Strategies employed in the designs:

1. Buildings must remain cool in the extremely hot summers and warm in cold winters;
2. Shade and insulate the buildings against the heat of the day and flush out any stored heat during the cooler nights;
3. Maximize night time cooling with internal windows and high level windows or vents in the centre of the building to let out the hot air and draw in cooler air (windows or vents can be closed in winter and during dust storms);
4. Have very small, well shaded windows on the eastern and western walls;
5. Minimize the length of eastern and western walls;
6. Eastern and western walls are well shaded;
7. Windows are placed to take advantage of any cooling breezes in summer;
8. The roof is insulated with reflective foil & bulk insulation, to reflect heat and retain warmth or coolness;
9. Internal courtyards/atriums provides cross ventilation & natural cooling;
10. Use of lightweight concrete of higher insulation value explored;
11. Roof is to be self-ventilating or cooling and to be constructed of materials that have a higher thermal value;
12. Use light colors for external and internal wall surfaces. White paint has high reflection ratio on sun exposed surfaces;
13. Effective shading of windows and other glazed areas is one of the major requirements for indoor comfort in these regions during hot summer;
14. Thick insulating materials, or radiation screen with ventilation between it and the roof.

3.3 Structural Design Criteria

3.3.1 Introduction

The structural design criteria formed the basis for the structural design of the buildings for the proposed OSBPs. These criteria were compiled from Standards of Practice and Codes of Practice.

The structures were designed and optimized in all design aspects; super structures and substructure elements are all included.

3.3.2 General Principles and Objectives

To full fill the purpose of the structures, they were designed to be safe against collapse and be serviceable in normal use. They must also be able to withstand the effect of accidental damage due to unforeseen events. Calculations alone do not produce safe, serviceable and durable structures calling for a required degree of reliability was achieved by designing in accordance with Euro Codes and adopting appropriate execution and quality control measures.

To fulfil their purpose, the structures were designed to be safe against collapse and be serviceable in normal use as well withstand the effect of accidental damage due to unforeseen events.

The objectives to be achieved by the design included the following:

- **Structural safety** – The structures were designed in accordance to the Euro code standards while employing the UK Nationally determined parameters for concrete and steel structures while ensuring safe load carrying limit conditions.
- **Functionality** – The structures were designed to serve the purpose initially intended such as housing animals, offices, goods and various services
- **Economy** – After considering several options of structural systems, steel portal frames were adopted for the ware house, animal panes, verification shade, drivers shade and canteen due to quick fabrication and construction of the members. A concrete frame was adopted for the main structure with optimized sections.

3.3.3 Design Information

3.3.3.1 Design Standards and References

BS EN I990-2002	: Basis of structural design
BS EN 1991-1-1 : 2002	: Actions on structures
BS EN 1991-1-4 : 2005	: Wind Actions
BS EN 1992-1-1: 2004	: Design of concrete buildings
BS EN 1997-1-1: 2007	: Geotechnical design : General rules
BS EN 1998-I-1: 2004	: Design of structures for earthquake resistance
BS EN 1998-5:2004	: Design of structures for earthquake resistance
BS EN 1993-1-1: 2005	: Design of steel structures – buildings
BS EN 1993-1-5:2006	: Design of steel structures: Plated structural elements
BS EN 1993-1-8:2005	:Design of steel structures: Designs of Joints

Concise Euro code

Design of structural elements;	: Concrete, steelwork, masonry and timber;

Designs to British Standards and Euro codes. 3rd Edition, Chanakya Arya.

Designs and detailed to BS EN 1992

Manual for the seismic design of steel and concrete buildings to Eurocode 8

3.3.3.2 Design Life

The concrete and steel structure materials and design procedures considered the structures to have a design life of 100 years.

3.3.3.3 Exposure conditions

Requirement for durability in BS EN 1992.1.1.2004 were taken into account in order to achieve the required design working life of the structures. Therefore, for design life of 100 years, the exposure class XC2 of concrete was chosen for design. Substructure & external surfaces of super-structure: Moderate to severe, internal surfaces of super-structure: Mild.

From annex E Table E.1N (Fig 3-4), the concrete strength of C25/30 was used for design of the concrete structures, both the sub and super structure.

- The exposure class XC2 of concrete was chosen for design.
- Substructure & external surfaces of super-structure:
- Moderate to severe, internal surfaces of super-structure:
- Mild From annex E Table E.1N (Table 2), the concrete strength of C25/30 was used for design of the concrete structures, both the sub and super structures.

Table 4.3N: Recommended structural classification

Structural Class							
Criterion	**Exposure Class according to Table 4.1**						
	X0	XC1	XC2 / XC3	XC4	XD1	XD2 / XS1	XD3 / XS2 / XS3
Design Working Life of 100 years	increase class by 2	increase class by 2	increase class by 2	increase class by 2	increase class by 2	increase class by 2	increase class by 2
Strength Class [1) 2)]	≥ C30/37 reduce class by 1	≥ C30/37 reduce class by 1	≥ C35/45 reduce class by 1	≥ C40/50 reduce class by 1	≥ C40/50 reduce class by 1	≥ C40/50 reduce class by 1	≥ C45/55 reduce class by 1
Member with slab geometry (position of reinforcement not affected by construction process)	reduce class by 1	reduce class by 1	reduce class by 1	reduce class by 1	reduce class by 1	reduce class by 1	reduce class by 1
Special Quality Control of the concrete production ensured	reduce class by 1	reduce class by 1	reduce class by 1	reduce class by 1	reduce class by 1	reduce class by 1	reduce class by 1

Figure 3-3: Euro Code 2 Structural Classifications

[AC2] Table E.1N: Indicative minimum strength class

	Exposure Classes according to Table 4.1									
Corrosion										
	Carbonation-induced corrosion				Chloride-induced corrosion			Chloride-induced corrosion from sea-water		
	XC1	XC2	XC3	XC4	XD1	XD2	XD3	XS1	XS2	XS3
Indicative minimum strength class	C20/25	C25/30	C30/37		C30/37		C35/45	C30/37	C35/45	
Damage to Concrete										
	No risk	Freeze/Thaw Attack			Chemical Attack					
	X0	XF1	XF2	XF3	XA1	XA2	XA3			
Indicative minimum strength class	C12/15	C30/37	C25/30	C30/37	C30/37		C35/45			

Figure 3-4: Minimum Strength Concrete Steel Structures

3.3.3.4 Cover to main bars

Foundations	50mm
Retaining walls	40mm
Columns	40mm
Beams	30mm
Slabs & Staircases	25mm
Super structure walls	25mm

3.3.3.5 Protection of Structural Steel Surfaces

Protection of structural steelwork comprised of the following:

- Surface preparation by blast cleaning, pickling process or where approved by wire brushing;
- Application of one coat of approved primer after fabrication;
- Two coats of an approved paint system as per Architect's specifications, one applied in the shop and the other applied on site after erection;
- Application of intumescent coating on the surface to increase the fire resistance of steel members.

3.3.3.6 Structural System

Table 3-14: **Structural framing system**

Structure	**System**
Main structure	Steel Moment Resisting Frame
Verification shade	Portal frame and truss system
Ware house	Portal Frame
Weigh Bridge	Portal Frame

The structural framing systems for transfer of vertical and lateral loads to the foundation level for the various structures comprised of the following:-

i. In-situ reinforced concrete pad foundations and reinforced columns;
ii. Structural Steel frames formed by columns, and beams;
iii. Structural steelwork consisting of columns, rafters, bolted connections, haunches.

The vertical load transfer shall be from floor slabs to plinth beams and then to the columns which transfer the loads to the foundation. The main concrete building is braced in both directions and therefore all the lateral loads are taken care of by the column beam connection since the frame is designed to be moment resisting. The steel structures have block work placed in-between the frames plus diagonal bracings that acts as both wind and seismic bracing.

3.3.3.7 Roofing considerations

IT4 Gauge 24 roofing sheets was used with a water proofing membrane to prevent penetration of water.

3.3.4 Materials

3.3.4.1 Concrete

Structural Concrete: Grade C25/30 generally.
Blinding Concrete: C15

(i) Reinforcement

High yield deformed rebar:

f_{yk} = 500 N/mm^2 (type 1 bond characteristics)
f_{cm}= 28 N/mm^2
f_{ctm} = 2.2 N/mm^2

Mild steel rebar:

fy = 250 N/mm^2
fs = 115N/mm^2 for water tanks (Using service stress design approach for crack width limitation)

Specification of rebar shall be in accordance with B.S. 4449

3.3.4.2 Structural Steel

Structural steel shall be grade S235, S275 in accordance to BS EN 10025, BS EN 10210 or BS EN 10219, with yield stresses in the range 235 N/mm2 to 275 N/mm2. Grade S235 and S275 of fy = 235 and 275N/mm2respectively was adopted.

3.3.5 Loads

3.3.5.1 Permanent (Dead) Actions

Concrete unit weight	25.0 kN/m^3
200mm thick wall with plaster	4.80 kN/m^2
150mm thick wall with plaster	3.75 kN/m^2
Services (unless specified otherwise)	0.50 kN/m^2
Ceiling	0.25 kN/m^2
Floor finishes	0.95 kN/m^2
IT-4 roofing sheets	0.15 kN/m^2
Water Unit Weight	10 kN/m^3

3.3.5.2 Variable (Live) Actions

The floor imposed loads are as follows:

Office areas Category B (including 1.0 KN/m2 for light partitions)	3.0 kN/m^2
Cafes and restaurants	2.0 kN/m
Staircase and lobby	3.0 kN/m^2
Plant rooms/ Equipment	7.5 kN/m^2
Roof with IT4 sheets	0.15 kN/m^2

Roof Slab without access except for maintenance	0.5 kN/m^2
Parking floors (vehicles ≤ 30kN)	2.50kN/m^2
Parking floors (vehicles ≥ 30kN)	5.00kN/m^2
Staircase and lobby	3.00kN/m^2
Toilet areas (excluding partitions)	3.00 kN/m^2

3.3.5.3 Wind Loading

Basic wind speed	40 m/s

3.3.5.4 Earthquake loading

As per the code of practice for Earthquake Design: Ethiopian Building Code Standard (EBCS-8)-1995, zone IV (Fig 1.1 Clause 1.4.1), of the seismic Hazard Map of Ethiopia for local hazard. The design ground acceleration shall correspond to a reference return period of 100 years.

The building was subjected to EC8 as it is similar with the EBCS – 8 code for earthquake loading of the following characteristics:

PGA	: 0.05g
Importance Factor	: 1
Spectrum type	: II
Ground type	:B (gradual increase in mechanical properties with depth dense sand, gravel and dark brown silty clay)
Behaviour factor	: 2 (ordinary building, No special requirements)
SLS demand	: drv ≤ 0.005h; v 0.5, h 3.6m, dr ≤ 36mm

3.3.6 Sizing

For the main structure, the final deflection dictated the preliminary sizing of beams which is generally limited to span/250 as per clause 7.4 in BS EN 1992-1 in order to prevent damage to adjacent parts of the structure including finishes, cladding and partitions under quasi-permanent loading conditions.

The maximum crack width was limited to 0.3mm for the exposure class XC3 of concrete obtained from table 7.1N EC2. As for columns, the preliminary size was adopted based on the anticipated loading and assumed rebars.

3.2.6.1 Steel beam profiles

The preliminary depths (top of slab to underside of beam) were 1/35 of the span of the beams especially for the suspended floors. For the portal frames, the length of both the eaves and apex haunch was 1/8 of the span of the portal frame as shown in Figure 3-5.

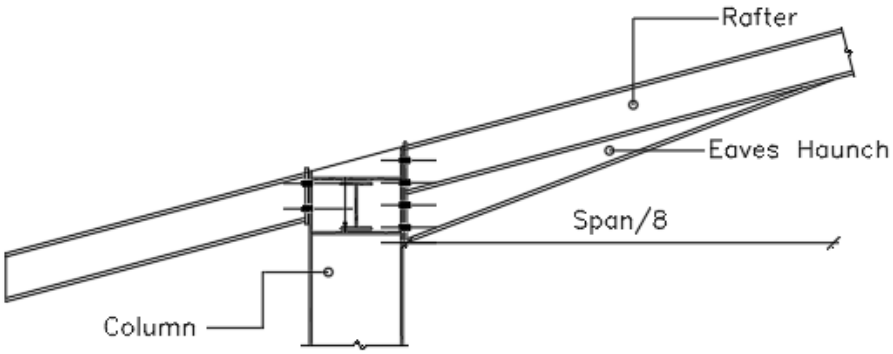


Figure 3-5: Eaves haunch sizing

3.2.6.2 Slabs

The solid slabs were sized based on the basic span/ depth ratios given in table 7.4N of BS EN 1992-1-1 for lightly stressed concrete and the minimum slab thickness for the chosen fire rating in clause 5.7 table 5.8 BS EN 1992-1-2. The same principal is also applied to size the composite slabs used in the steel structures.

Steel decking (profiled sheeting) for composite slabs was obtained from TATA steel ComFlor decking and basing on the average spans of 3.5m, ComFlor 80.Figure 3-6was chosen as the profile sheeting due to its very large corner curvature detail that provides a very efficient profile and ensures unpropped construction to spans of up to 4.2m for simply supported and spans of 5m continuous which saves on construction time and cost.

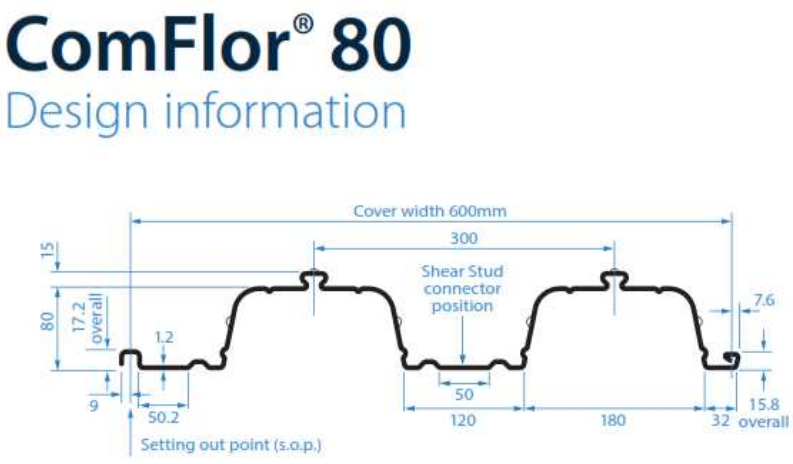


Figure 3-6: ComFlor80 Decking

3.3.7 Foundations

The structures are to be supported on reinforced concrete pad footings with stub columns for steel structures. The selection of shallow foundations followed findings from the geotechnical investigations and analysis that indicated the presence of stable underlying bearing strata to support shallow foundations as anticipated. Results from dynamic cone penetrometer tests revealed clayey soils of bearing capacities of 190kPa average at a depth of 2000mm.

Table 3-15: **Geotechnical Information**

ID	c (Kpa)	Friction ϕ	Width (m)	Unit weight (kNm3)	Depth (m)	Nc	Nq	Ng	A(Kpa)	B(Kpa)	C(Kpa)	Qu=A+B+C (Kpa)
ET1-05	15.4	22.35	2.4	17.8	2.2	9.67	2.73	0.57	280.96	106.91	9.74	397.61
ET1-06	9.6	19.25	2.4	14.8	2.2	8.02	1.94	0.24	200.70	63.17	3.41	267.28
ET1-03	12.1	27.85	2.4	17.7	2.2	8.63	2.22	0.35	312.45	86.45	5.95	404.84
ET1-04	14.5	36.53	2.4	18.5	2.2	9.31	2.55	0.48	442.12	103.79	8.52	554.43
DJ-03	13.34	30.82	2.4	20.6	2.2	8.96	2.38	0.42	358.99	107.86	8.31	475.16
DJ-02	12.36	22.1	2.4	16.9	2.2	8.63	2.22	0.35	247.94	82.54	5.68	336.16
DJ-01	6.08	18.37	2.4	18.3	2.2	6.97	1.49	0.1	166.45	59.99	1.76	228.19
ET2-02	9.7	25.73	2.4	17.75	2.2	8.02	1.94	0.24	268.26	75.76	4.09	348.11
ET2-04	14.4	37.08	2.4	17.16	2.2	9.31	2.55	0.48	448.78	96.27	7.91	552.95
ET2-08	17.2	22.1	2.4	17.75	2.2	10.47	3.13	0.76	300.80	122.23	12.95	435.98
ET2-03	10.76	22.12	2.4	17.46	2.2	8.32	2.08	0.3	239.25	79.90	5.03	324.18
						Average UBC =			393.17	Kpa		
						Allowable BC =			196.59	Kpa		

3.4 Electrical Design Criteria

3.4.1 Design Basis

The design is based on the following documents;

i. The Terms of Reference (ToR), The Technical Proposal and the Contract between the Consultant and IGAD;
ii. The Preliminary Architectural and Engineering Design and Feasibility Study Report approved by IGAD;
iii. British Standard and EU codes for complicity with relevant building services requirements.

3.4.2 Design Scope

The design scope for electrical installations included the following:

- Power Supply from the Utility Company;
- Low voltage power distribution system;
- Lighting system;
- Building lightning protection, earthing system and safety facility;
- Standby Supply.

3.4.3 Energy Conservation and Management

Electrical designs have aimed at ensuring energy conservation and management. This was addressed by use of fluorescent lamps, energy saver lamps, LED lights, emergency lamps, flood lights and automated sensor controls. These creative lighting schemes will enhance environment with natural lighting. Areas with no grid supply system, alternative power source shall be Off Grid hybrid Power Plant (Green Power Solution). The core of the system is the Ascort PO.IN.S Solar Power Injector System which is a four-quadrant inventor that merges the diesel generator with discontinuous solar source (PV plant) and battery storage units with guaranteed stabilised power against odds of Solar Radiation Charges.

3.4.4 Power Source and Distribution

a. Hydroelectric Power as the Main Source of Power
National Distribution Grid Main source through 3-phase oil immersed distribution transformer 50Hz with the highest voltage not exceeding 36kV to BS EN 50464 code.

b. Power Distribution
Central metering where grid power is applicable in the main switch room. Power distribution through loop-in boxes, sub control panels, distribution boards and consumer units as designed in the drawing to specific areas. Individual consumer units will be fixed on specific buildings.

c. Cabling and Wiring

Cabling and wiring for the buildings was designed to allow for full conduit system with ducts/trunking for both internal and external wiring as per IEE wiring regulations BS 7671 code and certified cables to BS EN 525-1,3&4.

3.4.5 Emergency power source

i. **Standby Generator**

Diesel engine generators, turbo charged water-cooled, 3-phase 415/240Volts, 50Hz at 0.8 power factor complete with auto change over panel (ATS) as standby.

ii. **Inverters System**

UPS power backup for ICT installation clean power wired through consumer units, non-standard sockets outlets at working stations in the 3-compartment trunking wired as shown in the drawings.

iii. **PV solar System**

Solar energy through PV modules, invertors, and battery storage system for Green Power Solutions to UNI EN ISO 901 by Ascort Industrial srl.

3.4.6 Lighting System and Fixture

Electrical designs ensured energy conservation and management was addressed by use of fluorescent lamps, energy saver lamps, LED lights, emergency lamps, flood lights and automated sensor controls. These creative lighting schemes will enhance environment with natural lighting.

3.4.7 Electric Installations

Suitable electrical systems were designed and to be conducted to the requirements of relevant local regulations installed in compliance with the following;

i. Mains Distribution

Main switch boards, sectional switch boards and distribution boards have been appropriately provided. They have further been situated to be readily accessible for maintenance activities without undue disturbances to the service delivery.

The switch gears have been designed to provide flexibility for future adaptive/ extension and reasonable increases in connecting, cabling, electrical loads throughout the design life of the premises. Switch boards and distribution boards have been designed with specially provided spaces with due cognizance taken to ensure safe working, maintenance operations and minimization of disruption in respect of access. All the equipment will be provided with durable labels, clearly marked with details of the equipment's' functions and designation. Power factor correction shall be consistent with best practice energy conservation aims throughout the design life of the installations.

ii. Cables

British/ EU certified standard cables with low smoke and fume insulation merits 660/1100- volt grade manufacture shall be used for both internal and underground wiring system. All wiring to lighting, power points, outlets, distribution boards, consumer units through looping boxes, timers and photocells shall be in concealed ducts/ trunkings.

Cables and other electrical services powering through floors, walls, partitions, ceilings, the surrounding hole shall be made good with suitable fire resisting material to the full thickness of the floor or wall as applicable. In addition, suitable internal barriers shall be provided with ducts passing through floor or walls to prevent spread of fire.

iii. Bonding

All non-current carrying metal work associated with the electrical equipment shall be bonded together and this includes enclosures at switchboards and distribution boards, conduits, trunkings, cable armoring. This shall then be connected to appropriate earth continuity conductors as required by the code of practice

iv. Lighting And Small power;

Thermosetting insulated, non-armoured cables for voltages up to and including 450/750V, for electrical power, lighting and internal wiring, having low emission of smoke and corrosive gases when affected by fire shall be used as required by BS EN 50525-1,3 and 4 code of practice and installed to IEE wiring regulations BS 7671.

Socket outlets for clean power, raw power, voice, data and imaging (CCTV) shall be wired in a ring form to RJ 45 outlets on a three-compartment trunking forming a working station point along the walls as indicated in the drawings.

v. Power and Containment

Services were designed to be routed and segregated to avoid any potential interference between power and ICT communication lines. A cable management or other system was adopted to permit flexibility.

vi. Surveillance CCTV and Access control

An IP based surveillance system to monitor activities at the data centre and external perimeter coverage shall be installed. Cameras shall be installed on every door entrance and inside the facility at strategic points to ensure maximum coverage. The cameras shall be ultra-view IP true day/night rugged dome camera 540TVL, H.264 SV.

An enterprise network video recorder for supporting IP cameras storage and play back capable of recording simultaneously up to 24 IP video streams with2-4

Terabytes (TB)storage capacity recording software and hardware to record for a maximum of thirty days shall be installed.

An integrated alarm and access control system shall be installed on all doors to the data centre access and selected offices. The access control shall be fully installed with all accompanying accessories and software for complete operation. All doors shall have finger print biometric readers and PIN card IN and PIN card OUT.

vii. Monitoring System

An environmental monitoring system complete with sensors to operate on a Windows platform, using TCP – IP protocols through gigabit speed connectivity shall be installed. The monitoring system shall report on all of the measureable parameters of the VLP infrastructure and shall provide SMC operators with warning.

3.4.8 Data Centre Network Setup

The data centre design met the following minimum requirements.

i. A **network design:** a hierarchical design broken into logical layers namely; access layer consisting of interfaces with end devices, such as PCs, Access points, printers, and servers. The access layer shall provide access to the rest of the network, and control devices that are allowed to communicate on the network.
ii. **Distribution Layer**; of data that is received from the access layer switches, provide for data separation and forward traffic to the core layer for routing to its final destination. It shall control the flow of traffic, delineate -broadcast domains, resiliency.
iii. **Core layer**; aggregation of data that is received from distribution layer switches and serve as an entry and exit point between the LAN and WAN, centralized services and gateway to the internet. The design factored in redundant hardware components and links to achieve network and device resilience and load balancing.

3.4.9 Lightning Protection and Earthing System

i. **Lightning Protection**

Lightening arrestor pins with copper plates bonded to earth using copper tapes, test clamps and copper electrodes to BS EN 62305 code of practice were designed.

ii. **Earthing and Safety**

Earthing was provided to minimize danger arising from faults between live conductors and non-current-carrying metal-work. The earthing system was designed in such a way that a sufficiently high fault current will flow to cause protective devices to operate within prescribed times as to BS EN 62208 code requirement.

3.4.10 Fire Detection & Suppression System

The system was designed to cover the data centre and entire building comprising of an addressable system. It includes:

i. All mechanical and electrical installation
ii. All detection and control equipment, agent storage containers
iii. Fm-200 agent or equivalent, pipe and fittings
iv. Manual release and abort station
v. Audible and visual alarm devices
vi. Auxiliary devices and controls, shutdowns
vii. Alarm interface
viii. Caution/ advisory signs
ix. Functional checkout and testing and all other operations necessary for a functional, ul listed and /or fm approved fm-200 clean agent suppression system.

3.4.11 Very Early Smoke Detection Apparatus (VESDA) System

An early warning system for smoke will be installed to work in conjunction with the fire detection and suppression system. The VESDA system shall;

i. Continually draw air into a pipe network attached to a detector unit
ii. Pass the air through a dual stage filter to remove dirt
iii. Send the clean air to a laser detection chamber for smoke detection
iv. Measure the light scatter caused by any smoke
v. Process the detector signal and present the smoke level graphically

Communicate the information to a fire alarm control panel through relay/ input module, a software management system or a building management system.

3.5 Water Supply and Drainage Design Criteria

3.5.1 Plumbing pipe work and fittings

Piping with galvanized steel/PPR/PVC pipes was designed for cold water distribution from water tanks to sanitary fixtures and drainage flow fixtures to septic tanks. The plumbing pipe work and fittings were designed to be heavy-duty types with the following diameters and materials:

Service pipe from the main reservoir mains :DN 50mm Galvanized Iron

Distribution pipe work :OD 32 – 12mm uPVC

Waste Water drainage pipework :OD 63 – 150mm uPVC

3.5.2 Storm water Drainage

The roofs were designed to have gutters depth not less than 100mm that will drain the roof storm water catchment into concrete lined drains.

Paved yards were designed to slope at minimum 2%, draining into storm water channels that will lead the storm water into the natural water draining ways.

3.5.3 Water supply

The water supply design for the Galafi OSBPs was based on the table below.

Table 3-16: **Design Criteria for Water Supply**

Water demand	Residential category for staff households with WC – 100 l/ca/d
	Public sanitation (drivers and passengers) – 20/person/d
	Offices (main building, warehouse, verification shade & scanner) – 70 l/ca/d
	Canteen - 1000l/canteen/ day
	Fire fighting flow rate – 30l/s
Water Storage	**Capacity**
	•1.0 day storage
Water source	**Source**
	• Underground water (Boreholes)
Materials	**Pipe work**
	• uPVC pipes
	• Galvanized iron pipes
Design codes	**References**
	• WHO guidelines for drinking water quality • Guide lines for Human Settlement and Planning
Design Flow Velocity	0.6 – 1.5 m/s

3.5.4 Water Source

There is a groundwater source at Galafi Ethiopia which supplies both the Galafi Ethiopia and Galafi Djibouti border posts. The system on the Ethiopian side is a piped network to the border facilities while the Djibouti side is supplied by water trucks collecting water from the Ethiopian system. Additional ground water sources were considered for the two sites.

3.5.5 Water Distribution

All the facilities will receive water from the storage tank by uPVC pipes buried in the ground; exposed pipe sections to be of galvanized iron.

i. Truck drivers and assistants

The projected number of trucks in Year 20 of 2,013 trucks per day was adopted from the Feasibility Study and Preliminary Design Report. Each truck was considered to contain two (2) persons and 50% of the total number was assumed to use the washrooms. A water consumption of rate for public sanitation of 10 liters/person/day was used to calculate the required water demand for the truck drivers and their assistants.

ii. Drivers shed and Canteen

A water consumption of 1000 l/restaurant/day for high class canteen was adopted from the International standards that compared with Uganda Ministry of Water and Environment Water Supply Design Manual 2nd Edition that is in line with the Eastern African countries.

iii. Staff in the OSBP

The total populations of the staff working in the main building, scanner/weighbridge, verification shade and ware house of 477 persons for Galafi Ethiopia and 366 persons for Galafi Djibouti were obtained from the Feasibility Study and Preliminary Design Report. A water consumption rate for administrative offices with WC of 70 l/worker/day was adopted from the International standards; this compared well with Uganda Ministry of Water and Environment Water Supply Design Manual 2nd Edition; that is in line with the Eastern African countries.

iv. Staff Housing

A water consumption rate for medium income household with sewer/septic of 100 l/p/day was adopted from the International standards. The mean household population of 4.7 from the Ethiopia Mini Demographic and Health Survey 2014 was used to arrive at the total population in the staff housing quarters.

3.5.6 Water Storage

The storage tank was sized according to the 20 year design horizon projected population water demand in the OSBPs, the consumption rate and the number of days balancing storage requirement.

The total water supply demand for the OSBPs was thus calculated as per the Table 3-17 and Table 3-18.

Table 3-17: **Water storage tank capacity – Galafi Ethiopia**

Demand Category	Population	Average Daily demand		Total Daily demand (m3)
Truck drivers and assistants	3020	10	persons/day	30.2
Canteen		1000	l/rest/ day	1.0
Staff in OSBP	477	70	persons	33.4
Staff housing	640	100	l/p/day	64.0
Total average water demand				128.6
Un accounted for water losses and cleaning requirements				20%
Total average day supply				154.3
Peak day factor				1.3
Maximum day supply for OSBP Facilities				200.6
r = Fire fighting flow rate (l/s)				30
t=Duration of flow (hrs)				2
Maximum Fire fighting supply, Q=rx60x60xt/1000				216
Water Storage Tank Capacity				417
Water Storage Tank Capacity adopted				**500**

Table 3-18: **Water storage tank capacity – Galafi Djibouti**

Demand Category	Population	Average Daily demand		Total Daily demand (m3)
Truck drivers and assistants	3020	10	l/day	30.2
Canteen		1000	l/rest/ day	1.0
Staff in OSBP	366	70	l/p/day	25.6
Staff housing	300	100	l/p/day	30.0
Total average water demand				86.8
Un accounted for water losses and cleaning requirements				20%
Total average day supply				104.2
Peak day factor				1.3
Maximum day supply for OSBP Facilities				135.4
r = Fire fighting flow rate (l/s)				30
t=Duration of flow (hrs)				2
Maximum Fire fighting supply, Q=rx60x60xt/1000				216
Computed Water Storage Tank Capacity				351.4
Water Storage Tank Capacity adopted				**500**

The designed reservoirs are of galvanized steel section tank elevated 12.0m on section steel support structure.

3.6 Sanitation System Design Criteria

3.6.1 Design Criteria

Table 3-19 shows the design criteria that was adopted for the sanitation design of the OSBPs at Galafi.

Table 3-19: **Design Criteria for sanitation**

Out fall	***State as appropriate:***
	• Connection to septic tank
Materials	**Pipe material:**
	• PVC
	Septic tank
	• Cement plaster finished concrete block wall tank with reinforced concrete slabs. Beams and columns.
Design parameters	**Velocity**
	• Min 0.5m/s
	Depth of flow
	• Min 1/3 full

3.6.2 Treatment of Sanitary Waste

There being no centralized sewer line connecting to a centralized sewage treatment system in Galafi, septic tanks with infiltration trenches were designed as a way of treating the wastewater from the toilets and washrooms.

The sanitation system comprises of:

- Collection sewer pipes;
- Septic tanks;
- Infiltration trenches;
- Sewerage system appurtenances including manholes;
- Solid waste collection bins and storage bunks.

3.6.3 Sanitary Facilities

Normal water closets were designed for use in all the OSBPs toilets. Water borne facilities comprise of WC sets, washing hand basins, heaters and shower units connected to the system.

3.6.4 Collection Sewer Pipes

The collection sewer pipes designed are OD 110mm uPVC to be laid at a minimum slope of 1:100.

3.6.5 Septic Tanks

Four septic tanks were designed to serve:

- Driver's shed
- Main building, verification shade and warehouse,
- Staff housing quarters
- Scanner and weighbridge

Table 3-20 and Table 3-21illustrates the steps used to determine the septic tanks sizes for Galafi Ethiopia and Galafi Djibouti respectively.

3.6.6 Soak away pit / infiltration trenches

The effluent from the respective septic is drained to infiltration trenches. The sizes were determined by taking into consideration the infiltration rate of the soils in Galafi. From the geotechnical investigations carried out on the two sites at Galafi, the soils were found to be sandy gravel thus having an infiltration rate in the ranges of 0.8 – 1.6 inches/hour.

The infiltration rate of 0.8 inches/hour (488l/m2/day) was thus adopted in sizing the infiltration trenches as per Table 3-22 and Table 3-23.

Table 3-20: **Septic tank design – Galafi Ethiopia**

	-	Drivers shed and canteen		Main building	Verification shed	Warehouse	Scanner and weighbridge	Staff housing	
	Water consumption used per person per day, Q	10	1000	70	70	70	70	100	L/P/day
	Population, P	3020		477	63	45	39	640	P/day
	Daily flow	30.2	1	33.4	4.4	3.2	2.7	64.0	m3
	Percentage of sewage flow to the daily flow	100%	100%	80%	80%	80%	80%	80%	m3/P/day
	Volume of liquid entering tank per day, A = P x q	30.2	1	26.7	3.5	2.5	2.2	51.20	m3/day
	Retention	1	1	1.0	1	1	1	1	day
	Volume of liquid stored in tank, A =	30.2	1	26.7	3.5	2.5	2.2	51.2	m3
	Volume of sludge and scum B = P x N x F x S								
	Where;								
	S= sludge and scum accumulation rate	0.06		0.06	0.06	0.06	0.06	0.06	m3/P/year
	N = desludging interval, for N < 5	3		3	3	3	3	3	Years
	F = sizing factor, for temp > 20o	1		1	1	1	1	1	
	Therefore, B =	543.6		85.9	11.3	8.1	7.0	115.2	m3
	Required storage volume, A + B =	574.8		112.6	14.9	10.6	9.2	166.4	m3
	Total storage volume, V =	**574.8**		**138.1**			9.2	166.4	**m3**
	Assume Liquid depth, H =	3.0		2.5			2.0	2.5	m
	W, is the tank width								
	Assume two compartments								
	Tank Width = W								
	Tank Length, L = 2W								
	Area, A = V/H	191.60		55.22			4.60	66.56	**m2**
	Plan Area of tank, A = L x W = 2W x W = $2W^2$								
	Thus $2W^2$ =	191.60		55.22			4.60	66.56	m3
	W =	**9.80**		**5.30**			**1.60**	**5.80**	**m**
	To provide	2 chamber septic tank of		2 chamber septic tank of			1 chamber septic tank of	2 chamber septic tanks of	
	Width of each chamber = Wc	**4.90**		**2.65**			**1.60**	**2.90**	**m**
	Length of tank = L = 2W	**19.60**		**10.60**			**3.20**	**5.80**	**m**
	Depth of tank from floor to soffit of cover slab								
	liquid depth + freeboard								
	Where free board =	500		500			500	500	mm
	Therefore depth of tank from floor to soffit of cover slab	**3.50**		**3.00**			**2.50**	**3.00**	**m**

Table 3-21: **Septic tank design – Galafi Djibouti**

-	Drivers shed and canteen		Main building	Verification shed	Warehouse	Scanner and weighbridge	Staff housing	
Water consumption used per person per day, Q	10	1000	70	70	70	70	100	L/P/day
Population, P	3020		366	63	45	39	300	P/day
Daily flow	30.2	1	25.6	4.4	3.2	2.7	30.0	m3
Percentage of sewage flow to the daily flow	100%	100%	80%	80%	80%	80%	80%	m3/P/day
Volume of liquid entering tank per day, A = P x q	30.2	1	20.5	3.5	2.5	2.2	24.00	m3/day
Retention	1	1	1.0	1	1	1	1	day
Volume of liquid stored in tank, A =	30.2	1	20.5	3.5	2.5	2.2	24	m3
Volume of sludge and scum B = P x N x F x S								
Where;								
S= sludge and scum accumulation rate	0.06		0.06	0.06	0.06	0.06	0.06	m3/P/year
N = desludging interval, for N < 5	3		3	3	3	3	3	Years
F = sizing factor, for temp > 20o	1		1	1	1	1	1	
Therefore, B =	543.6		65.9	11.3	8.1	7.0	54.0	m3
Required storage volume, A + B =	574.8		86.4	14.9	10.6	9.2	78.0	m3
Total storage volume, V =	**574.8**		**111.9**			9.2	78.0	**m3**
Assume Liquid depth, H =	3.0		2.5			2.0	2.0	m
W, is the tank width								
Assume two compartments								
Tank Width = W								
Tank Length, L = 2W								
Area, A = V/H	191.60		44.75			4.60	39.00	**m2**
Plan Area of tank, A = L x W = 2W x W = $2W^2$								
Thus $2W^2$ =	191.60		44.75			4.60	39.00	m3
W =	**9.80**		**4.80**			**1.60**	**4.50**	**m**
To provide	2 chamber septic tank of		2 chamber septic tank of			1 chamber septic tank of	2 chamber septic tanks of	
Width of each chamber = Wc	**4.90**		**2.40**			**1.60**	**2.25**	**m**
Length of tank = L = 2W	**19.60**		**9.60**			**3.20**	**4.50**	**m**
Depth of tank from floor to soffit of cover slab								
liquid depth + freeboard								
Where free board =	500		500			500	500	mm
Therefore depth of tank from floor to soffit of cover slab	**3.50**		**3.00**			**2.50**	**2.50**	**m**

Table 3-22: **Soak away pits/ infiltration trenches design for Galafi Ethiopia**

1	**Drivers shed and canteen Infiltration trenches (2No.)**		
	Soil type : Sandy Gravel		
	Infiltration rate (Hillel, 1982 An introduction to soil physics), f	488	l/m^2/day
	Sewage flow, q	15,600	l/day
	Infiltration wall area required, A = f/q	32	m^2
	Effective depth of the trench (depth from bottom of inlet pipe to bottom of trench)	1.5	m
	Required length of trench = A/2D (both sides of the trench)	10.7	m
2	**Main buildings, Verification shade & Warehouse Infiltration trenches (2No.)**		
	Soil type : Sandy Gravel		
	Infiltration rate (Hillel, 1982 An introduction to soil physics), f	488	l/m^2/day
	Sewage flow, q	16,380	l/day
	Infiltration wall area required, A = f/q	34	m^2
	Effective depth of the trench (depth from bottom of inlet pipe to bottom of trench)	1.5	m
	Required length of trench = A/2D (both sides of the trench)	11.2	m
3	**Scanner and weighbridge Infiltration trenches (1No.)**		
	Soil type : Sandy Gravel		
	Infiltration rate (Hillel, 1982 An introduction to soil physics), f	488	l/m^2/day
	Sewage flow	2,184	l/day
	Infiltration wall area required	4	m^2
	Effective depth of the trench (depth from bottom of inlet pipe to bottom of trench)	1	m
	Required length of trench = A/2D (both sides of the trench)	4.5	m
4	**Staff housing Infiltration trenches (2No.)**		
	Soil type : Sandy Gravel		
	Infiltration rate (Hillel, 1982 An introduction to soil physics), f	488	l/m^2/day
	Sewage flow, q	25,600	l/day
	Infiltration wall area required, A = f/q	52	m^2
	Effective depth of the trench (depth from bottom of inlet pipe to bottom of trench)	1.5	m
	Required length of trench = A/2D (both sides of the trench)	17.5	m

Table 3-23: **Soak away pits/ infiltration trenches design for Galafi Djibouti**

1	Drivers shed and canteen Infiltration trenches (2No.)		
	Soil type : Sandy Gravel		
	Infiltration rate (Hillel, 1982 An introduction to soil physics), f	488	$l/m^2/day$
	Sewage flow, q	15,600	l/day
	Infiltration wall area required, A = f/q	32	m^2
	Effective depth of the trench (depth from bottom of inlet pipe to bottom of trench)	1.5	m
	Required length of trench = A/2D (both sides of the trench)	10.7	m
2	**Main buildings, Verification shade & Warehouse Infiltration trenches (2No.)**		
	Soil type : Sandy Gravel		
	Infiltration rate (Hillel, 1982 An introduction to soil physics), f	488	$l/m^2/day$
	Sewage flow, q	13,272	l/day
	Infiltration wall area required, A = f/q	27	m^2
	Effective depth of the trench (depth from bottom of inlet pipe to bottom of trench)	1.5	m
	Required length of trench = A/2D (both sides of the trench)	9.1	m
3	**Scanner and weighbridge Infiltration trenches (1No.)**		
	Soil type : Sandy Gravel		
	Infiltration rate (Hillel, 1982 An introduction to soil physics), f	488	$l/m^2/day$
	Sewage flow	2,184	l/day
	Infiltration wall area required	4	m^2
	Effective depth of the trench (depth from bottom of inlet pipe to bottom of trench)	1.5	m
	Required length of trench = A/2D (both sides of the trench)	3.0	m
4	**Staff housing Infiltration trenches (2No.)**		
	Soil type : Sandy Gravel		
	Infiltration rate (Hillel, 1982 An introduction to soil physics), f	488	$l/m^2/day$
	Sewage flow, q	12,000	l/day
	Infiltration wall area required, A = f/q	25	m^2
	Effective depth of the trench (depth from bottom of inlet pipe to bottom of trench)	1.5	m
	Required length of trench = A/2D (both sides of the trench)	8.2	m

3.7 Air Conditioning and Ventilation Systems Design Criteria

Air conditioners were designed to provide required room temperatures and relative humidity to selected rooms/offices, server room and reception. Wherever possible, natural ventilation was utilized.

High performance air cooling machines consisting of direct expansion units with air cooled condenser to control temperature and humidity were adopted. Close control down flow air conditioning units (flow discharge) type complete with humidifier/ electric heater modes to be installed in the data center room with 2no.VRV outdoor units installed at the rooftop slab equipped with electronic control mode for duty/standby.

Offices and other halls within the OSBP main building were designed to be supplied by indoor recessed ceiling cassettes with micro process controls compatible to BMS digital/touch pad linked to alert alarms. URV centralized AC system were adopted for each floor controlled by 2 no. outdoor units installed at the rooftop slab with connectivity to allow duty/standby mode function. Installation shall allow for fire alarm interface and water detection alarm as required by BS5839-3 code of practice.

Other buildings like ware house, verification shade and, canteen offices, air conditioner split system shall be used and installed as required by BS EN15265 code of practice. The entire ducting installation system is to be as per schematic design drawing layout and specification.

3.8 Fire Protection Design Criteria

3.8.1 Fire fighting Systems

The system designed comprises use of Hose reels and portable fire Extinguishers with spring headed Inter changeable safety valves to SASO Standards.

The recommended fire fighting flow rate for transportation (Lorry/coach parks, multi-story car parks and service stations) is 25 l/s while that for shops, offices, recreation tourism category is between 20 – 75 l/s from the National guidance document on provision of water for fire fighting, Appendix 5 Water UK May 2002. A flow rate of 30l/s was adopted for the OSBPs.

The required fire fighting pipe diameter was determined as per Table 3-24.

Table 3-24: **Fire-fighting pipe diameter**

Fire fighting flow rate, r	30	l/s	
Duration of flow, t	2	hrs.	
Fire fighting water reservoir capacity, Q =r x 60 x 60 x t/1000	**216**	**m3**	
Minimum residual head at each fire hydrant	20	m	(15 - 60m)
Maximum velocity of flow in water main, V	2	m/s	
Flow in the water main, Q_f = Q (m3)/t /3600(s)	0.03	m^3/s	
Minimum pipe internal diameter (mixed or general industrial area)	100	mm	
Velocity of flow in the fire fighting main, V = Q_f/A	1.2	m/s	(0.6 - 1.5)
Where, A = □$D^2/4$	0.024	m2	
D	175	mm	
Therefore, Pipe diameter of 175mm is sufficient			

3.8.2 Fire Hydrants

The Fire hydrants were placed in the OSBPs such that the distance between two adjacent fire hydrants did not exceed 300m and distance of any building from a fire hydrant is not more than 150m.

3.8.3 Fire fighting pump

The fire fighting pump was sized as per Table 3-25.

Table 3-25: **Fire-fighting pump capacity**

Fire fighting pump/reservoir height	512.0	m	
Elevation of at roof of building (tallest)	514.7	m	
Static head	2.70	m	
Friction head loss in pipe = s x L x v^2 / 2 x D x g			
Where, L - Pipe length =	1726.2	m	
v - velocity of flow =	1.2	m/s	
D - Hydraulic diameter of pipe	0.175	m	
g- acceleration due to gravity	9.81		
s = Darcy friction factor starting at	0.015		
Iterating Colebrook - White Equation, $\frac{1}{\sigma} = -2\log_{10}\left(\frac{k}{3.7D} + \frac{2.51}{Re\sqrt{\sigma}}\right)$	0.0192475		
	0.0190382		
	0.0190470		
	0.0190466		
	0.0190466		
	0.0190466		
Reynold's Number, Re = v x D/m	216,967.83		
m = Kinematic viscosity of water =	1.006E-06		
Roughness (k)	0.1	mm	
Friction head loss in pipe = s x L x v^2 / 2 x D x g	**14.90**	**m**	
Calculated Head Loss in Fittings, Valves, Entrances & Exits			
	K	**Qty**	**Sub Total K**
Angle Valve	5	0	0
Ball Valve, Full Port	0.05	0	0
Butterfly Valve	0.6	0	0
Check Valve, Swing Type	2.3	0	0
Elbow 45 Degrees	0.4	4	1.6
Elbow 90 Degrees, Long Radius	0.6	0	0
Elbow 90 Degrees, Standard	0.9	3	2.7
Flow Meter, Turbine Type	7	1	7
Foot Valve	0.9	0	0
Gate Valve	0.2	2	0.4
Globe Valve	10	0	0

Pipe Entrance, Inward Projected Pipe	1	1	1
Pipe Entrance, Sharp Edge	0.5	1	0.5
Pipe Exit	1	1	1
Tee, Standard, Flow Through Branch	1.8	0	0
Tee, Standard, Flow Through Run	0.6	2	1.2
			15.4
Head Loss - Valves & Fittings (m), = $Kv^2/2g$	**1.22**	**m**	
TOTAL HEAD LOSS, h_f(m)	**16.12**	**m**	
Pump head = Static head + friction head losses + residual head at hydrant	38.82		
To provide pump of capacity	**108**	**m3/hr**	
and head of	**40**	**m**	

3.9 Highways and Roads Design Criteria

3.9.1 Geometric Design

3.9.1.1 Design Standards

The geometric design standards adopted for Galafi OSBP approach and access roads was from the Ethiopian Roads Authority (ERA) Geometric Design Manual – 2013, ERA Geometric Design manual – 2002.

3.9.1.2 Road Functional Class

Volume 1 of the Feasibility and Preliminary Design report section 7.10 forecasts maximum daily traffic of trucks of 2,013 in the year 2036.

Table 3-26 below outlines Geometric Design Criteria used for OSBPs which were considered to be urban/peri-urban areas.

Table 3-26:**DC5 Geometric Design Parameters for Urban/Peri-Urban areas**

Design Element		**Unit**	**Urban/Peri-Urban**
Design Speed		Km/hr	50
Carriageway width		m	7.0
Shoulder width		m	
Minimum Horizontal curve radius	SE = 4%	m	95
	SE = 6%	m	85
	SE = 8%	m	-
Transition curve required			No
Maximum gradient (Desirable)		%	7
Maximum gradient (Absolute)		%	9
Minimum gradient		%	0.5
Maximum Super-elevation		%	4
Minimum crest vertical curve		K	10
Minimum sag vertical curve		K	7
Normal cross-fall		%	2.5
Shoulder cross-fall		%	4

3.9.1.3 Design Speed

A design speed of 50km/hr. was used in design of the OSBP roads as per Urban/Peri-Urban Design parameters for DC5 roads.

3.9.1.4 Horizontal Alignment Design

The horizontal alignment was largely dependent on minimum horizontal curve radii and design speed stated in Table 3-26. Due to the business of the OSBPs, a reduced operating speed of 30km/hr was adopted to enhance safety of the road users.

3.9.1.5 Vertical Alignment Design

The vertical alignment design took into consideration the minimum K-values for the crest and sag, the maximum and minimum gradients presented in Table 3-26.

3.9.1.6 Typical Cross-sections

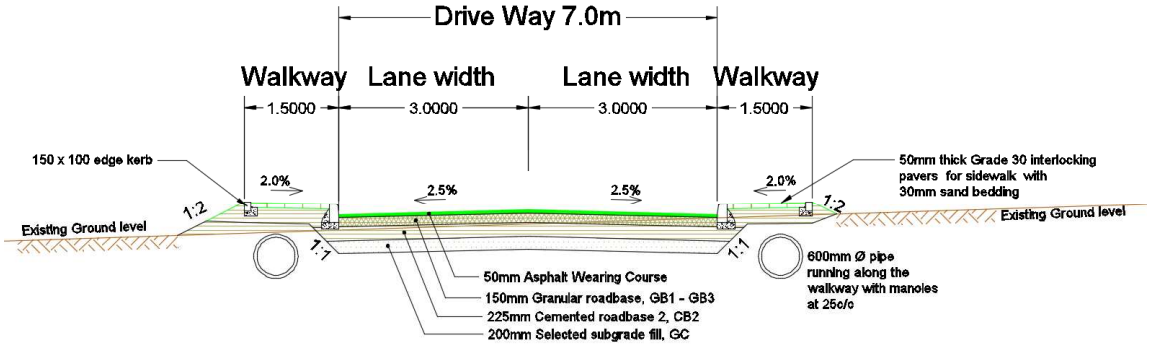
The following typical cross-section elements were adopted for the Galafi OSBP roads:

i. Within the OSBP operation area and the access roads between the two OSBPs
   - 7.0m carriageway (2No. lanes)
   - 2.0m wide raised pedestrian walkways on either sides
   - A closed pipe drain beneath the walkways

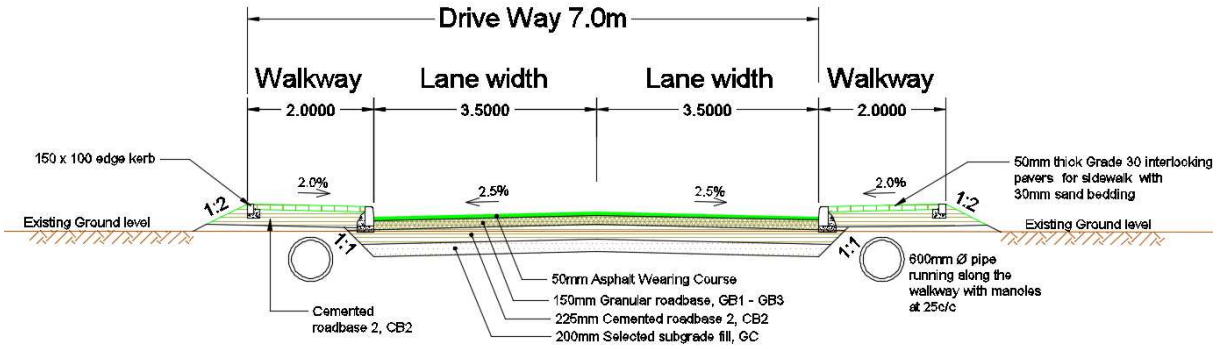
ii. Approach roads to each of the OSBPs from the respective countries
   - 10.5m dual carriageway (3No. lanes each)
   - 2.0m wide raised pedestrian walkways on either sides
   - A closed pipe drain beneath the walkways

iii. The access road to the staff housing area
   - 7.0m carriageway (2No. lanes)
   - 1.5m wide raised pedestrian walkways on either sides
   - A closed pipe drain beneath the walkways

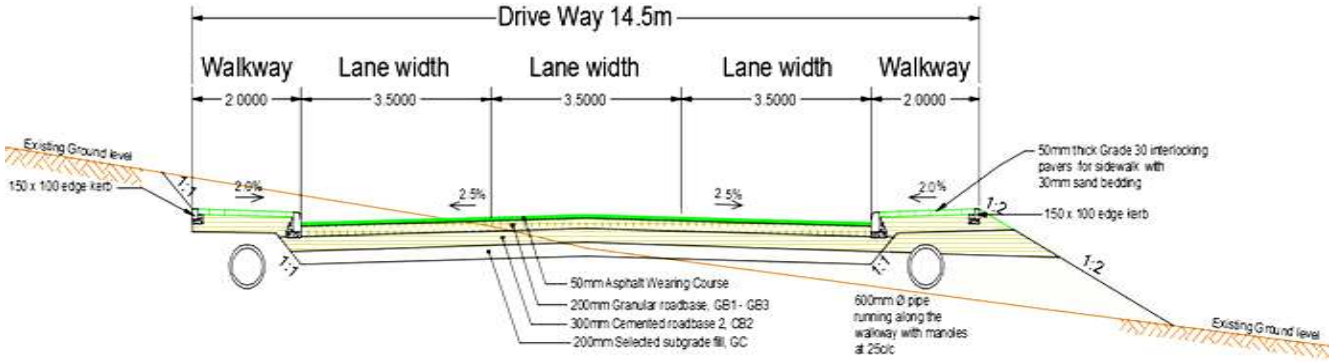
The typical cross-sections are shown in Figure 3-7:



Typical Cross-section for the Staff Housing Access Road



Typical Cross-section for OSBP Loop Roads



Typical Cross-section for Main "Road M1" and Southern Bypass "S.Bypass"

Figure 3-7: Typical Cross-sections

3.9.1.7 Junctions

A minimum turning radii of 15m was considered at junctions in accordance ERA Geometric Design Manual – 2013 to accommodate trucks with trailers. Where space allowed turning radii greater than 15m was used.

Roundabouts were designed to provide opportunities to motorists who would want to turn back before entering the OSBPs. The following roundabout design criteria was adopted from ERA Geometric Design manual – 2013 for traffic volume up to 15,000

- Design vehicle – DV4
- Minimum vehicle turning radius – 15m
- Number of lanes on entry, exit and circulation – 2
- To cater for semi-trailers, the circulatory road width of two lane was increased by 3m.
- Entry radius 20 – 100m, should not be less than 20m to accommodate large vehicles.
- Exit radius 20 – 40m.

3.9.2 Pavement Design

3.9.2.1 Introduction

The pavement design is for two areas; namely the roads and the parking area (Control Zone). The designs were in accordance with the Ethiopian Road Design manual taking into account the available information on latest traffic and soils data.

Roads Section

3.9.2.2 Design Process

The Design process had the following steps:

- Estimating the cumulative traffic loading expected during the design life;
- Defining the strength of the subgrade soil;
- Defining the nominal operating climate;
- Determining any practical aspects which influence the design selection;
- Selecting possible pavement structures.

3.9.2.3 Design Standards

From the information gained, it was concluded that TRL RN 31 design manual is similar with Ethiopian Roads Authority Manual for flexible pavements. The aim of this Chapter is to outline how TRL RN31 guide was used to develop a detailed design.

3.9.2.4 Construction Materials Design Assumptions

The following sub-section outlines the assumptions made of the materials for the design of the pavements.

3.9.2.5 Surfacing

The existing surface roads in the region are surfaced dressed and this is assumed to be adequate for the project road. There are a number of quarries in the region that can provide sealing aggregate of adequate quality and there are no major concerns relating to sourcing this material.

3.9.2.6 Granular materials

The design of roads in the region is based on materials achieving a nominal strength. For all granular materials, the only requirement is a minimum strength since there is usually no disadvantage in attaining higher strengths. The minimum strength requirements for these materials are as follows:

- Granular Base: Soaked CBR>80% at 98% mod. AASHTO density.
- Sub-base: Soaked CBR>30% at 95% mod. AASHTO density.
- Capping/Selected: Soaked CBR>15% at 93% mod. AASHTO density.

3.9.2.7 Granular Base

A wide range of materials can be used for unbound bases, ranging from naturally occurring gravels to crushed rock or stone. There are a number of locations in the region where natural occurring granular materials may be adequate. However, these materials may require stabilisation to achieve the minimum strength requirement (addition of approximately 6% lime).

The potential high cost of producing stabilised natural gravel base (high volumes of lime required) may not be cost effective when compared to the alternative of a crushed rock base. Furthermore, there are a number of sources of crushed rock material within the region. Therefore, this material was adopted as the preferred material for the base layer.

3.9.2.8 Granular Sub-base

The crushed rock material used for the base layer will have more than adequate strength for use as a sub-base. These materials are however considered to be significantly more expensive that lime stabilised. However, this material could be replaced with a blend of natural gravels and crushed rock provided the material achieves the required minimum strength.

3.9.2.9 Selected subgrade fill material

Where the subgrade was identified to be greater than 2% CBR but less that the subgrade design strength of 8% CBR, a selected layer was required to improve the pavements foundation. Selected subgrade fill material (CBR >8%) could be taken from almost all of the borrow pits in the project road.

3.9.2.10 Pioneer layer

Where the natural subgrade is less than 2% CBR a rock fill pioneer layer was provided for. The installation of this layer will require the removal of all soft material and tree roots. The material for the pioneer layer would be sourced from local quarries in the area.

3.9.2.11 Design Traffic

The forecast traffic was based on the regional traffic report. Traffic class T6 ESAs was used for the design. The ESAs determine the load on the pavement. The design is based on the 20-year traffic projection.

Table 3-27indicates the different traffic classes as provided for in RN31.

Table 3-27: **Design Traffic Class**

Traffic Class designation								
Traffic Ranges mESAs	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**
	<0.3	0.3 – 0.7	0.7 – 1.5	1.5 - 3	3 - 6	6 - 10	10 - 17	17 - 30

Ref: RN31 Design Manual,

Referring to RN31 clause 2.3.3 (v), the design traffic loading represents ESAs in one direction.

3.9.2.12 Defining the Strength of Subgrade

The subgrade strength ranges from 1.6% to 45.0% CBR at 95% MDD, four days soaked. The Average CBR for subgrade class designation in those three locations was determined as 3%, which is **S2.**

Table 3-28:**Sub-grade strength ranges**

Classes	**S1**	**S2**	**S3**	**S 5**	**S6**
CBR Range	2	3 – 4	5 – 7	15 – 29	30

Ref: RN31 design manual

3.9.2.13 Climatic conditions

Climate influences the performance of the road. Therefore, the design took into consideration this is a dry region.

Selection of Pavement Structures

Using design catalogues in RN31, the pavement structures that were considered are in Table 3-29 and Table 3-30.

Table 3-29: **Pavement Structure, Option 1**

Layer Thickness	**Material type**
30mm	Double Surface Dressing
225mm	Granular base (GB 1 – GB 3)
300mm	Granular Sub-base (GS)
200mm	Selected Subgrade fill(GC)

Table 3-30: **Pavement Structure, Option 2**

Layer Thickness	**Material type**
50mm	Asphalt
200mm	Granular base (GB 1 – GB 3)
300mm	Granular Sub-base (GS)
200mm	Selected Subgrade fill (GC)

3.9.2.14 The Economical Option

Costs of the pavement options per meter were computed in Table 3-31:

Table 3-31: **Cost comparison for different pavement options**

Option	Pavement Description	Cost/m2			Road width (m)	Cost per LM ($)	Cost /km($)
Option 1	DBST30mm,	16,754	$6.74	$39.47	7.0	$276.29	$276,290
	225mm (Granular Base (Crushed stone) base, GB1	45,000	$13.04				
	300mm Granular sub-base, GS	60,000	$17.37				
	200mm Selected subgrade, GC	8,000	$2.32				
Option 2	Asphalt 50mm	46,000	$13.33	$44.61	7.0	$312.27	$312,270
	200mm (Granular Base (Crushed stone) base, GB1	40,000	$11.59				
	300mm Crushed stone subbase, GS	60,000	$17.37				
	200mm Selected subgrade, GC	8,000	$2.32				

From Table 3-31, Option 1 has the lowest cost/km followed by Option 2. However, in terms of maintenance over the 20 year design horizon there will be need to put an asphalt overlay of 25mm over the DBST in Option 1 after 7 years bringing the final construction costs/km to $322,945 which is comparable to Option 2 cost per km.

Option 2 is adopted as the designed pavement layer. The pavement structure will be applied uniformly to include shoulders except for the surfacing.

3.9.2.15 Controlled Zone/Parking Area

The structural design is similar to the road section except for the surfacing. The surface is 80mm thick precast concrete paving units laid on 30mm thick sand.

4 CONSTRUCTION METHOD

4.1 Introduction

This section discusses the envisaged construction methods to be used during the execution of the works.

4.2 Site clearance

This will involve demolition of existing structures if any, cutting down of all trees, stumps, bushes, vegetation, rubbish and removal of top soil that are in the way of the works to disposal.

Site clearance activities will involve use of earthmoving equipment such light dozing equipment and a grader machine.

4.3 Earthworks

General excavation to formation level shall be done by earthmoving equipment. Excavation of foundation trenches and for column bases shall be done manually. The formation level determination will be dictated by the materials report and the site topography.

4.4 Concrete Works

All concrete for the permanent works shall be batched on site and cast in situ using smaller size concrete mixer. Although with the limited working space on site, a central off-site batching plant would be of added advantage. It also offers better quality control compared to the concrete production using several concrete mixers.

4.4.1 Foundations

The foundations of the structure are mainly comprised of pad footings and combined footings having multiple columns. The construction methodology shall be similar for both.

They are generally constructed as follows:-

i. Excavation to a depth of approximately 2 meters below formation level to suitable founding soil strata as per geotechnical report;

ii. Laying a concrete layer, approximately 50mm thick, at foundation formation level over the full extent of the rectangular foundation to produce a clean, flat plain surface, capable of containing the wet structural foundation concrete. The concrete layer is either transported or cast in-situ;

iii. Fabricating cages of steel reinforcement, which is done on site, with bars protruding vertically to lap column bars for subsequent concrete pours;

iv. Placing formwork for the foundation slab. Formwork will be comprised of wooden or metal sheets supported by wooden stakes and props;

v. Transporting concrete to site from batching plant, pouring and compacting it by vibration to the required level in the formwork;

vi. Leveling the concrete for a period of time to enable it cure before stripping the formwork to form the foundation base;

vii. Placing concrete for columns, including vibration and finish to exposed top of concrete.

viii. Stripping shutters, treating concrete surface and backfilling over excavations with acceptable material and compacting to 95% MDD.

4.4.2 Columns

The concrete columns are constructed as follows:-

i. Fixing a grillage of steel reinforcement for columns to the starter bars;

ii. Erecting vertical formwork for columns with shores and bracing;

iii. Placing and vibrating concrete into formwork for the columns;

iv. Stripping the shutters and curing concrete.

4.4.3 Beams

The concrete beams are constructed as follows:-

i. Fixing a grillage of steel reinforcement for beams to the starter bars;

ii. Erecting horizontal formwork for beams with props and bracing;

iii. Placing and vibrating concrete into formwork for the beams;

iv. Stripping the shutters and curing concrete.

4.4.4 Walls

The concrete walls shall generally be constructed as follows:-

i. Fixing a grillage of steel reinforcement for the walls;

ii. Erecting vertical formwork for the walls;

iii. Placing concrete in wall formwork and compacting by vibration;

iv. Removing shutters, curing concrete, treating exposed surfaces and applying water proofing membrane to faces retaining soil fill, water proofing can typically be a bitumen coating applied by brush or spray;

v. A drain is laid behind the walls comprising a small pipe with granular surround.

4.4.5 Suspended Slabs

The concrete structures shall have slabs cast in-situ and monolithic with beams. The slabs shall be constructed as follows.

i. Erecting formwork on staging to support the wet concrete forming the suspended slab;

ii. Erecting a steel reinforcement cage within the formwork;

iii. Pumping concrete into the formwork and compacting by vibration;

iv. Preparing a finish to the top surface of the wet concrete by smoothing the concrete with a float;

v. Leave the concrete for a period to enable it to cure before stripping off the shuttering.

4.5 Masonry Building Works

Masonry building works only require simple hand tools.

4.6 Steel Structures

4.6.1 Foundations

The foundations of the structures are mainly comprised of pad footings and combined footings having multiple columns. The construction methodology shall be similar to that of concrete foundations as follows:

i. Excavation to a depth of approximately 2 meters below formation level to suitable founding soil strata as per geotechnical report;

ii. Laying a concrete layer, approximately 50mm thick, at foundation formation level over the full extent of the rectangular foundation to produce a clean, flat plain surface, capable of containing the wet structural foundation concrete. The concrete layer is either transported or cast in-situ;

iii. Fabricating cages of steel reinforcement, which is done on site, with bars protruding vertically to lap column bars for subsequent concrete pours;

iv. Placing formwork for the foundation slab. Formwork will be comprised of wooden or metal sheets supported by wooden stakes and props;

v. Transporting concrete to site from batching plant, pouring and compacting it by vibration to the required level in the formwork;

vi. Leveling the concrete for a period of time to enable it cure before stripping the formwork to form the foundation base;

vii. Placing concrete for columns, including vibration and finish to exposed top of concrete;

viii. Stripping shutters, treating concrete surface and backfilling over excavations with acceptable material and compacting to 95% MDD.

4.6.2 Columns

The steel columns are constructed as follows:-

i. Establishing that the foundations have properly set and are suitable for safe erection;

ii. Lifting and placing the columns into position, generally using cranes and securing them in place with bolts, but not tightened fully, bracings may similarly not be fully secured;

iii. Aligning the structure, principally by checking that column bases are lined and columns are plumb;

iv. Bolting up and tightening all joints to secure and impart rigidity to the frame.

4.6.3 Beams

The steel beams are constructed as follows:-

i. Establishing appropriate positions for the steel beams on the columns;
ii. Lifting and placing the beams into position, generally using cranes and securing them in place using bolts tightened to ensure transfer of forces to the columns.

4.6.4 Suspended Slabs

The steel structures shall have composite slabs consisting of steel decking and concrete. The slabs shall be constructed as follows.

i. Lifting the steel sheeting and accurately positioning it on the steel beams with shear studs;
ii. The steel decking shall act as permanent formwork for the slab so propping shall not be necessary;
iii. Laying the layer of BRC mesh with appropriate cover using chairs or spacers;
iv. Pouring the concrete and allowing a period for it to cure and set.

4.7 Roof Structure

The roof structure for the multipurpose hall is comprised of steel trusses with welded joints. This will require welding machines and a lifting crane as the major equipment for the roof construction. A standby generator will also be necessary in case of power outage. The generator capacity should be of sufficient capacity to run the welding machines.

4.8 Construction Method for Earthworks and Pavement layers

4.8.1 Setting out

Areas for excavation will be clearly set out and to ascertain depth of excavation prior to excavations. In the same vain fill areas will be set out and the depth of fill determined before the filling process commences.

4.8.2 Excavations/Fill areas

Excavations of topsoil, borrow material or any other excavations within the pavement layers using equipment; will be done using suitable equipment. Such equipment may be Truck excavator; Bull dozer; Chain loader or a Wheel loader. The material excavated may be stockpiled or carried away. Material will be carried by trucks or any other equipment that the contractor may propose, but suitable for the purpose. In cases where manual excavations will be required; tools such as pick axes, and hoes will be used.

4.8.3 Rock fill

Rock fill material shall be compacted with vibratory rollers to achieve a good mechanical interlock of the rock and the maximum compaction of the finer material in the spaces

between the rocks. The type of vibratory roller used, the operating speed, the number of passes and the layer thicknesses shall be determined after field trials by the contractor

4.8.4 Rock excavation

Excavations in rock will be by appropriate equipment. Blasting will be the last resort on condition that the rock is very strong and cannot be ripped by a 135 HP dozer.

4.8.5 Placing and Compaction of pavement layers

The method of work for laying and compacting the layers will be done using the appropriate equipment for the type of layer and type of material. The type of compaction equipment to be used and the amount of rolling to be done shall be such as to ensure that specified density and finish is obtained without damage being done to adjacent lower layers or structures. Such equipment may include but not limited to, trucks; graders; pavers; steel rollers; sheep foot rollers, water bowser and pneumatic rollers. All the equipment preferably should be self-propelled.

4.8.6 Surfacing

The layer (Asphalt) shall be laid by an appropriate type of self-propelled mechanical spreader. Compaction shall be done by means of approved flat steel wheeled, vibratory or pneumatic-tyre rollers, sufficient in size and numbers to achieve the specified density through the entire depth of the layer.

The minimum for one roller shall be pneumatic tyre with a weight of minimum 2.5 tonnes per wheel and not less than 18 tons total un-ballasted weight. The frequency as well as the amplitude of vibratory rollers shall be adjustable.

Areas where bituminous binders are to be sprayed before laying the asphalt is done, the binder distributors shall be used. The distributor tanks will be fitted with all the necessary instrumentation, i.e. circulatory system, dipstick, heating equipment; thermometers, speed control, pumping system.

Transporting asphalt shall be by vehicles that will be insulated. The delivery trucks shall be fitted with rear spill trays to facilitate transfer of material to the paver without spillage. All vehicles used for transporting asphalt shall be fitted with canvas for transport in excess of 10 km or when weather conditions demand such cover.

4.9 Construction Materials

Table 4-1 shows general description of the proposed construction materials and their source. The selected materials are considered the most affordable yet fulfilling the necessary technical and social conditions. In proposing these materials, the Engineer has considered the need to use materials that would require minimal or no maintenance as a high priority.

Table 4-1: **Proposed OSBP Construction Materials and their sources**

S/N	Facilities Item	Proposed Materials Description	Source of Materials
1.	**Substructure**		
	Foundations	Reinforced Concrete class C25/30	Local Sourcing
	Plinth walls	200mm Thick Blockwork C_u = 3N/mm^2	Local Sourcing
	Ground floor slabs	Reinforced Concrete Class C25/30	Local Sourcing
	Floor finishes	Power floated for industrial floors	Local Sourcing
2.	**Superstructure**		
	Beams and Columns	RC C25/30 and Structural Steel grade S275	Approved supplier / Fabricator
	External walls	200mm thick block work C_u = 3N/mm^2	Local Sourcing
	Internal walls	150mm thick block work C_u = 3N/mm^2	Local Sourcing
	Floor Slabs	150mm thick composite slab with ComFlor 80 decking	Decking by TATA Steel, Concrete by local sourcing
3.	**Window and Doors**		
	Windows	Powder Coated Aluminium Frames And Sections, Steel burglar proofing	Approved supplier / Fabricator
	External doors	Steel casement doors	Approved supplier / Fabricator
	Internal doors	Timber panelled door to fit frame	Approved supplier /Carpenter
4.	**Roofing**		
	Ceiling	Arm-strong boards/Gypsum Board	Architectural
	Roof Structure	Steel struss grade S275	Approved supplier / Fabricator
	Roof Covering	IT4 Gauge 24 iron sheeting	Approved supplier / Fabricator
5.	**Electro-Mechanical**		
	General Lighting	As Thorn	BS UK / Local
	Security lighting	As ShenzYaham	ISO China / Local
	Electrical fittings and fixtures	As Thorn	BS UK / Local
	Water supply pipes	uPVC Pipes / Galvanised Iron	Local Sourcing
	Drainage Fittings and fixtures	Galvanised Iron	Local Sourcing
	Drainage pipes	uPVC/Cast Iron	Local Sourcing
6.	**External works**		
	Landscaping	Shrubs, trees, grass	Local Sourcing/ Approved supplier
	Pedestrian walkways	Pavers	Local Sourcing/ Approved supplier
	Parking	Pavers	Local Sourcing/ Approved supplier
7.	**Roads and Highways**		
	Subgrade	Natural gravels / Crushed rock material	Local Sourcing/ Borrow pits
	Sub-base	Natural gravels / Crushed rock material	Local Sourcing/ Borrow pits
	Granular base	Crushed rock	Local Sourcing/ Borrow pits
	Surface dressing	Asphalt	Local Sourcing/ Approved Plant supplier

5 COST ESTIMATES

5.1 Introduction

The cost estimates for the implementation of the OSBPs at Galafi Ethiopia and Galafi Djibouti are captured in the Tables 5-1 and Table 5-2 respectively. They include costs for architectural, engineering, access roads and all ancillary services required to ensure these facilities function seamlessly.

5.2 Estimated construction cost for Galafi Ethiopia

Table 5-1 shows the estimated construction cost of the proposed Galafi Ethiopia OSBP.

Table 5-1: **Estimated construction cost for the proposed OSBP at Galafi Ethiopia**

BILL NO.	DESCRIPTION	NO	CIVIL WORKS	MECHANICAL INSTALLATION	ELECTRICAL INSTALLATION	AMOUNT (USD)
	GRAND SUMMARY GALAFI ETHIOPIA ONE STOP BORDER POST					
1	PRELIMINARIES		1,360,374			1,360,374
2	MAIN BUILDING GALAFI ETHIOPIA	1	1,962,533	65,524	71,001	2,099,057
3	VERIFICATION SHED	1	473,647	9,350	13,980	496,977
4	WAREHOUSE	1	521,633	10,087	9,927	541,648
5	SCANNER & WEIGH BRIDGE	1	165,055		2,735	167,790
6	POWER HOUSE	1	42,661		1,199	43,860
7	ANIMAL HOLDING HOUSE	1	190,760		1,008	191,768
8	DRIVERS SHED AND CANTEEN	1	113,276	2,828	4,478	120,582
9	MAIN GATE & MONUMENTAL GATEWAY	3	125,065		3,189	128,254
10	INTERNAL GATE AND FENCING	2	26,954		1,442.00	28,396
11	CONTROL BUILDING	2	163,440		INCLUDED	163,440
12	WATCH TOWER	5	117,765		INCLUDED	117,765
13	EXTERNAL WORKS	1	3,259,298			3,259,298
14	ACCESS ROADS	1	5,037,516			5,037,516
15	MECHANICAL RETICULATION AND SITE WORKS			529,001		529,001
16.1	POWER SUPPLY				291,515	291,515
16.2	EXTERNAL LIGHTING (FLOOD LIGHTS)				287,828	287,828
17	AIR CONDITIONING INSTALLATION			380,960		380,960

BILL NO.	DESCRIPTION	NO	CIVIL WORKS	MECHANICAL INSTALLATION	ELECTRICAL INSTALLATION	AMOUNT (USD)
18	ICT SUPPLY AND INSTALLATION				827,862	827,862
	SUB TOTAL-1		**13,559,975**	**997,750**	**1,516,164**	**16,073,889**
	CONTINGENCIES	10%	1,355,998	99,775	151,616	1,607,389
	SUB TOTAL-2		**14,915,973**	**1,097,525**	**1,667,781**	**17,681,278**
	VAT	15%	2,237,396	164,629	250,167	2,652,192
	TOTAL GRAND SUMMARY		**17,153,369**	**1,262,153**	**1,917,948**	**20,333,470**

NOTE: For electrical bills, where it shows "INCLUDED", the respective electrical works are covered in bill 19.3 (External lighting(flood lights)

5.3 Estimated construction cost for Galafi Djibouti

Table 5-2 shows the estimated cost of all the items to be constructed at Galafi Djibouti

Table 5-2: **Estimated construction cost for the proposed OSBP at Galafi Djibouti**

BILL NO.	DESCRIPTION	NO.	CIVIL WORKS	MECHANICAL INSTALLATION	ELECTRICAL INSTALLATION	AMOUNT (USD)
	GRAND SUMMARY GALAFI DJIBOUTI ONE STOP BORDER POST					
1	PRELIMINARIES		1,360,374			1,360,374
2	MAIN BUILDING RAAD	1	1,459,027	65,524	71,001	1,595,551
3	VERIFICATION SHED	1	473,647	9,350	13,980	496,977
4	WAREHOUSE	1	521,633	10,087	9,927	541,648
5	SCANNER & WEIGH BRIDGE	1	165,055		2,736	167,791
6	POWER HOUSE	1	42,661		1,199	43,860
7	ANIMAL HOLDING HOUSE	1	190,760		1,008	191,768
8	SENIOR STAFF HOUSE	6	557,930	15,219	22,770	595,919
9	JUNIOR STAFF HOUSE	25	1,777,962	100,909	43,300	1,922,170
10	SUPPORT STAFF HOUSE	13	796,486	36,760	19,864	853,110
11	DRIVERS SHED AND CANTEEN	1	122,348	2,828	4,478	129,654
12	MAIN GATE & MONUMENTAL GATEWAY	3	125,065		3,189	128,254
13	INTERNAL GATE AND FENCING	2	26,954		1,442	28,396
14	CLEARANCE BOOTH	2	163,440		INCLUDED	163,440
15	WATCH TOWER	6	141,317		INCLUDED	141,317
16	EXTERNAL WORKS	1	3,259,298			3,259,298
17	ACCESS ROADS	1	3,747,125			3,747,125
18	MECHANICAL RETICULATION AND SITE WORKS			529,001		529,001
19.1	POWER SUPPLY STAFF HOUSE				290,590	290,590
19.2	POWER SUPPLY				291,515	291,515
19.3	EXTERNAL LIGHTING (FLOOD LIGHTS)				287,828	287,828
20	AIR CONDITIONING INSTALLATION			380,960		380,960
21	ICT SUPPLY AND INSTALLATION				978,964	978,964
	SUB TOTAL-1		**14,931,081**	**1,150,637**	**2,043,790**	**18,125,509**
	CONTINGENCIES	10%	1,493,108	115,064	204,379	1,812,551

	SUB TOTAL-2		**16,424,189**	**1,265,701**	**2,248,170**	**19,938,059**
	VAT	10%	1,642,419	126,570	224,817	1,993,806
	TOTAL GRAND SUMMARY		**18,066,608**	**1,392,271**	**2,472,986**	**21,931,865**

NOTE: For electrical bills, where it shows "INCLUDED", the respective electrical works are covered in bill 19.3 (External lighting (flood lights).

6 FINANCIAL AND ECONOMIC VIABILITY ANALYSIS

6.1 Introduction

Having established that the project development will be technically feasible, from the architectural and engineering view point, the next step was to determine its financial and economic viabilities through such instruments and procedures as the Cost/Benefit Analysis.

6.2 Overview

In terms of financial and economic viability, it is important to balance the revenues made by Governments through cost savings and losses of taxes and the capital costs for developing the border infrastructure and its operational costs.

These must be discounted over the project life which is 20 years to yield a positive Net Present Value (NPV) and the Internal Rate of Return (IRR) reasonable under public policy, usually 10-12%.

The economic viability is determined by the overall benefits realised by trucking enterprises spilling into the national economies at large.

6.3 Transport Cost-Benefit Analysis

The transport cost-benefit analysis was undertaken for the transport industry to determine the benefits realised by shippers, transporters and the various private operators serving the trade and transport industries.

This was estimated by considering the net savings for shippers and transporters savings over the 20 year project period.

Cost-benefit analysis based on transport performance is applicable to projects to improve infrastructure and operations at the border (including corridor sections connecting with the border).

Cost-benefit analysis involves estimating the cost and time savings of implementing a proposed project (the with-project case); and not implementing it (the without-project case). Cost savings typically include savings associated with operating and maintaining vehicles as well as reductions in the cost of deterioration and loss of goods in transit; and increased transit speeds.

Time savings, which are converted to equivalent cost savings, can include savings related to vehicle operations (e.g., reductions in vehicle transit time) and the inventory costs of goods in transit and kept in storage to cover the risk of delays in transit and uncertainty of delivery times. Unit values of cost and time components need to be assigned by referring to existing data on vehicle operation, cargo values, and the like for each vehicle type. These values are multiplied by traffic volume in the “with” and “without” cases respectively, and the difference between the two cases can be regarded as savings or the gross benefit engendered by the project.

Using the OSBP sourcebook (Busia and Malaba) as a guide, the total savings (and therefore benefits) from the standpoint of trucking enterprise were computed and summarised as below.

Costs stream

a) Total construction costs (CapEx) for the 2 border posts (engineer's estimates – Galafi Ethiopia and Djibouti)) is approx. USD 42.265 million
b) Periodic replacement costs (Galafi) of electrical/mechanical/ICT works occurs in year 10, at USD 2.920million (including 10% increase in the initial costs)
c) Annual maintenance costs for civil works estimated at 0.5% of civil works construction costs.
d) The staffing levels estimated to be total 477 salaried workers at Galafi Ethiopia OSBP and 366 salaried workers at Galafi Djibouti split into the following categories at respective salaries in Table 6-1, giving USD 411.388 million cumulative over 20 years.

Table 6-1: **Staff categories and Salaries**

Category	**No. of Staff at Galafi Ethiopia OSBP**	**No. of Staff at Galafi Djibouti OSBP**	**Monthly Salary**
Senior Managers	2	2	USD 2,000
Managers	5	5	USD 1,000
Support Staff	470	359	USD 750
Total	**477**	**366**	

e) Cumulative Fixed and Variable costs over 20 years is projected at USD468.201million.

Benefit stream

i. AADT (trucks) by the end of 20 year design (planning) horizon is 2,013 trucks.
ii. The transport cost charges for a loaded truck is about USD 3,500 per round trip.
iii. In the "without OSBP project", it takes 24hrs to clear a truck and this will reduce to 4hrs, translating into 20hrs savings in the "with OSBP project". This further translates into 2 additional round trips per month.
iv. It has been assumed that only 60% of the projected AADT remain on the road and take advantage of this opportunity cost; and the other 40% are diverted to the SGR (with some having reached salvage value).
The savings (benefits) are 2 additional round trips per month, for two thirds (8 months) of a year

Interpretation

Total Benefit stream is projected at USD 859.396million

Total Cost (CAPEX + OPEX) stream is projected at USD 468.201million.

Resultant Benefit to cost ratio is 1.84

The detailed computation is presented in Table 6-2.

Table 6-2: **Detailed Cost benefit analysis**

			20 Year Design Horizon					
Nr	**Item**	**2016**	**2017**	**2023**	**2026**	**2033**	**2036**	**TOTAL**
	COST STREAM							
1	**Total Project Construction Cost (USD x 1,000)**	42,265						
2	**Annual Maintenance costs (USD x1,000)**		256	288	306	351	373	
3	**Periodic Replacement costs (USDx1000)**		-	-	2,920	-	3,212	
4	Staff costs (USDx1000)		10,590	15,283	18,468	29,217	35,837	
5	Accommodation Costs (USDx1000)		138	71	82	115	226	
	Subtotal Variable costs USDx1000)		-	-	-	-	-	
	Subtotal Cumulative Variable & Fixed Costs *(From Main Worksheet)*		10,984	15,641	21,776	29,683	39,647	468,201
	BENEFIT STREAM							
a	Transit DWT cargo	7,616	8,530	16,837	23,654	52,292	73,466	
b	Roads share	6,854	7,677	10,102	9,462	20,917	29,386	
c	Average daily number of trucks	1,174	1,052	1,384	648	1,433	2,013	
d	Therefore savings due to OSBP	4,929	4,417	5,812	2,721	6,017	8,453	
e	Assume the truck is 8 months i.e. 2/3 of the year on the road	39,436	35,335	46,497	21,775	48,137	67,629	
	Subtotal Cumulative Benefits *(from Main Worksheet)*							859,396
	Benefit/Cost Ratio							**1.84**

The resultant Benefit /Cost ratio of 1.84 is greater than 1, implying that the project is economically viable from the Cost-Benefit analysis view point. Refer to **Appendix D** for the Main Worksheet.

6.4 Supply Chain Assessment

The effect of the establishment of OSBPs on the efficiency of trade and transport logistics will lead to more efficient transportation by reducing the time spent by trucks at the border from the current 24hrs to slightly about 4 hrs, resulting in an opportunity cost of 20 hours.

Corridor analysis is anchored on value or supply chain assessments. Supply chain analyses provide an opportunity to add some other logistics costs to the transport costs to measure the ordinary cost-benefit analysis. The approach including total costs associated with logistics can be applied on a wider scale rather than to individual components of a corridor project.

These analyses typically analyze a sample of the chains that would benefit from implementation of a corridor project, although they do not provide measures of the benefits that can be easily compared with estimates of the investment costs. In addition to direct transport cost, the analyses include, for example, the cost of unreliability and other logistics costs for assessment of the impact of regulatory facilitation or investment measures.

6.5 Analysis of Trade Impact

As seen from Section 6.3 above, trade will be greatly impacted upon as a result of the OSBP. Trade volumes will increase and transit goods will be processed faster at the OSBPs.

Trade generation and diversion impacts are usually estimated through the use of a gravity model. This modeling approach can be applied to a package of proposed corridor improvements where the expected trade impact is large enough to be estimated. However, individual components of a corridor package are regarded as variables that have only a marginal effect on the level of trade in the model. In addition, a trade gravity model does not by itself provide sufficient information for an economic evaluation since it does not include the costs of investments along the corridor.

The newly launched SGR between Djibouti Port (Djibouti) and Addis Ababa (Ethiopia) will impact heavily on the OSBPs. With electric trains travelling at 120km/hr, it will reduce transit time of cargo to between 10 – 12hrs from between 2 to 3 days by road transport between Djibouti Port and Addis Ababa. This reduces travel time coupled with attractive SGR charges will attract transportation of cargo from the road transport to SGR transport thus reducing and relieving the OSBP of volume of cargo and the customs processes to some extent.

The other SGR route that aims to connect Kenya, Uganda, Rwanda and South Sudan will also impact heavily on the traffic volumes and trade on the proposed OSBPs. The Mombasa-Nairobi section shortened travel time by more than half the time (from ten hours to about four hours), completed in 2017.

6.6 Macroeconomic Modelling

From the macro-economic point of view, the increase in trade volumes will result in more revenues to the partner states of Djibouti, Ethiopia, South Sudan and Uganda, increased economic outlook and the attendant economic integration. The increased trade will therefore lead in an increase in GDP of the respective countries.

Macroeconomic models are suited to the evaluation of improvements along a corridor as a whole. The type of model sometimes used for this purpose is a computable general equilibrium (CGE) model. This type of model is widely used to analyze the aggregate welfare and distribution impacts of policies, the effects of which may be transmitted through multiple markets or contain menus of taxes, subsidies, quotas, and transfer instruments. CGE models can be useful to evaluate packages of corridor improvements that include several policy changes that are not easily included in conventional cost-benefit analysis or trade gravity models.

However, because the use of CGE models depends on national economic and social statistics, they are difficult to apply to trade corridors and program components that involve

more than one country. In tradition cost-benefit analysis, user benefits are measured in the transport market itself. A key question is whether production should be included in the models (what is produced where and with what inputs). Spatial production models can yield useful insights into the linkages between transport and the local economy that would be helpful for policy decision making.

However, these types of models are “data hungry” and require detailed spatial input-output matrices, which are not available in most developing countries. These models are better suited to networks than to individual projects. Hence detailed macro-economic modeling has not been done under this assignment.

A sensitivity analysis was done to find how robust the economic parameters are. For instance, on the construction cost stream side, a 20% increase in the construction costs does not adversely affect the Benefit Cost ratio, meaning that the project is not sensitive to the construction cost. However, the operation and maintenance costs, assumed number of trucks increasing from 60% to 80%, increase in cost per round trip do adversely affect the B/C ratio.

6.7 Conclusion

In this chapter, various aspects of economic modelling have been tackled, including Transport Cost-Benefit Analysis, Supply Chain Assessment, Analysis of Trade Impact and Macroeconomic Modelling.

Based on the detailed cost-benefit analysis results thus far, the project passes the benefit-cost ratio parameter test and implying that it is economically viable.

7 ENVIRONMENTAL IMPACT ASSESSMENT AND MITIGATION

7.1 Introduction

The Social Impact Assessment (SIA) and Environmental Impact Assessment (EIA) studies under this project provide an analysis of the implications of the planned OSBPs to the social and biophysical environment in the project areas. The SIA and EIA address key environmental and social aspects of the proposed OSBPs in relation to other land uses and community life in the project area.

The objective of the ESIA was to analyses and evaluates the anticipated impacts of the proposed project on the physical, biological, socio-cultural and socio-economic environment and thereafter prepare an Environmental and Social Managment and Monitoring Plan (ESMMoP) in accordance to environmental policies, guidelines and procedures of the project Countires as well as in accordance to IGAD and AfDB polices and the International Environmental Convention ratified by the country.

7.2 Legal and Regulatory Framework

The ESIA study for the OSBP was undertaken in accordance to the environmental legal framework of the three project participating Countries namely Government of South Sudan(South Sudan), Federal Democratic Republic of Ethiopia (Ethiopia) and Republic of Djibouti (Djibouti) in addition to the legal framework of IGAD and African Development Bank (AfDB). The Constitution of the Federal Democratic Republic of Ethiopia, Republic of South Sudan and that of the Republic of Djibouti recognises that everyone has a right to a clean and healthy environment which can be achieved by implementing the Environmental Management and Monitoring Plans found in the Environmental and Social Impact Assessment (ESIA) report. The Constitution also makes the ratified regional and international Multilateral Environmental Agreements binding to the Country. The legal documents stipulate the laws governing Environmental Management and, Conservation and states projects that require ESIA study and provide the guidelines for undertaking the study in details.

In Ethiopia, the ESIA study is guided by the Proclamation 299/2002 namely the Environmental Impact Assessment Proclamation and the EIA Guideline Document 2000. The EIA regulations are supported by several policies, plans and pieces of legislations that contribute to environmental management and conservation and these includes Conservation Strategy of Ethiopia and the Region, 1997, The Environmental Policy of Ethiopia, Environmental Pollution Control Proclamation No. 300/2002 and the Solid waste management proclamation No. 513/2007

In Djibouti, the ESIA process is guided by the Environmental Code and the decree establishing the procedure of environmental impact assessment. Other pieces of legislation that supports the Environmental laws includes laws on the establishment of protected areas, biodiversity protection decree, decree on the regulation of the transportation of dangerous products, and a decree on the regulation of substances that deplete the ozone layer.

The AfDB is the project development partners and its safeguard policies and guidelines were incorporated into the study. The AfDB documents consulted during the study are the Bank Group Policy on the Environment namely the Strategic Impact Assessment Guidelines (SIA) and the Integrated Environmental and, Social Assessment Guidelines (IESA), Environmental and, Social Assesments Procedures, Handbook on Stakeholders Consultations, the Involuntary Resettlment Policy and other cross cutting policies on health, gender and population.

7.3 Project Stakeholders

Stakeholder's analysis for the project was undertaken and the key stakeholders identified included: the Ministries related to Environment and Infrastructure, the local communities, truck users, cross border traders, business operators among other service providers. All the key stakeholders were consulted on the proposed project through one to one interviews and stakeholder's forums.

Several stakeholders' meetings were held got the project including IGAD delegates meetings with participation of stakeholders from both countries. The main agenda of the meeting was evaluation of the proposed project which included discussion of project impacts, their mitigations and how to holistically incorporate environmental consideration in the project planning and implementation. The stakeholders meeting indicated that there is need to develop the OSBP as it shall enhance trade in the region.

Stakeholder Consultations and Public Involvement

Simple methods such as networks, literature review and interviews were used in the process of stakeholder identification. The main stakeholders consulted included departmental heads, Local Administrative Officers, and the public. The overall goal of the consultation process was to disseminate Project information and to incorporate the views of stakeholders in the design of the Environmental and Social Impact mitigation measures, Management and Monitoring Plan.

The specific aims of the consultation process are to:

- Improve Project design and, thereby, minimize conflicts and delays in implementation;
- Facilitate the development of appropriate and acceptable entitlement options;
- Increase long term Project sustainability and ownership;
- Reduce problems of institutional coordination and
- Increase the effectiveness and sustainability of income restoration strategies, and improve coping mechanisms.

From the consultations it can be said that the Governments and business communities are very interested to see that the services at the border post enhanced as it shall provide a better environment for the movement of people and goods across the borders thus lead to economic and social growth.

Findings of Stakeholder's Consultations

The several stakeholders consulted at the project level made several comments to the proposed project which were in form of proposals of mitigation measures and as well as appreciation of the project. The main comments made included;

- The economic development of the larger region is being hampered due to the poor functioning of the border post and poor road network thus the plans to improve services at the border post is highly welcomed
- Improved services at the border post will have several secondary benefits as it shall attract businesses and services to the area thus improve the locals access to social services.

7.4 Potential Environmental and Social Impacts

The development of infrastructure can cause a wide range of positive and negative impacts on a number of receptors. The significant environmental and social impacts identified for the proposed project included:

- Destruction of physical environment through quarrying, extraction of construction materials, clearing of scanty vegetation cover and excavation;
- Relocation of traders and settlements found on the project site or its boundaries;
- Air and noise pollution;
- Instances of decreased health and poor sanitation due to increased solid waste and sewage generation;
- Water logging and poor drainage during project implementation;
- Increased water demand in the area;
- Erosion and destruction of soil structure;
- Increased incidences of road accidents due to improved road surface ride ability;
- Conflicts on importation of labourers;
- Increased E-waste.

7.5 Positive Impacts

However, the identified potential negative impacts can be mitigated by implementing the proposed Environmental and Social Management Plan (ESMP) which aims at having a sound environmental project. Recommendations provided in the ESMP included: plant indigenous trees, provide dust screens, develop appropriate drainage structures, coordinate with area planners to develop camp sites at strategic locations, avoid undertaking works in flood prone areas and conducting periodic consultative meetings with community members to discuss issues of concern and their solutions, formation of umbrella bodies with adequate representation from the community members, provision of portable exhaustible toilets to the workers, water palliation to reduce dust evolution and other fugitive emissions, use of hand tools or machines with silencers to reduce noise levels and ambient air pollution, restoration and landscaping of area after construction, provision of employment to community members where applicable, use clean fuels to reduce Green House Gas emission, identifying trading areas for those relocated from the project area, compensate for materials acquisition from private land among other measures.

The project is envisaged to benefit the local community by opening the area to employment, increased economic activities and other associated opportunities arising from

the proposed project. The project will also enhance the national economy through increased flow of goods and services, increased pace of movement, payment of taxes on purchased goods and also by contributing to poverty alleviation through increased food production, acquisition of material goods and services among others.

The stakeholders including the border post users and the local community members are ready to have the project implemented and they considered the negative impacts to be manageable, if appropriate plans are developed simultaneously with the project. The stakeholders understand that the key to enhancing trade and improving the local and, national living standards is by developing the border post. They anticipate this shall reduce the time spent clearing goods at the border post, reduce cost of exports and imports, improve their accessibility to basic services, service providers, goods suppliers and markets for their products.

7.6 Project Alternative Consideration

Project alternatives have been evaluated in terms of site, technology scale and waste management. In regards to project site, the land earmarked for development is already in existence and the development shall be done on the existing land.

The design alternative evaluation took three OSBPs options into consideration namely Common Border One Stop Movement, Straddled One Stop Movement Pattern and Juxtaposed One Stop Movement Pattern. The common OSBPs is where common border post facilities are developed in one of the two bordering countries based on mutual agreements and the border personnel all work in the facilities developed for that purpose in that country. The Straddle OSBP is developed in the middle or centrally between the two neighbouring countries mainly on the no man's land this also requires mutual agreement between the two countries and the personnel also share all facilities. While juxtaposed OSBP is development of facilities in each country but when it comes to personnel a form of exchange takes place and the two offices have personnel from either country working together with their neighbours and they also share information processed at the border. The juxtaposed type of OSBP was found to be viable for the two countries.

Alternatives in terms of technology involves evaluating construction tools in terms of its source of energy, discussing green architectural technology such as incorporating light saving design components, solid waste management technology among others. In this case to ensure the project meets environmental and social sustainability requirements, it is proposed that the project be majorly labour based so as to create employment in the local area especially considering the local communities within the project area have a very high poverty index. Incase of machine use it should use clean fuels to avoid impacting on climate change. Building acoustics and lighting components should be designed to ensure it meets the requirements of green architectural technology.

Alternatives of solid waste management were based on the waste management hierarchy of rethink, reduce, reuse and recycle this shall considerably reduce the amount of waste generated at the project site.

It is recommended that building materials be sourced at the nearest point from the project site as it shall make both economic and environmental sense as this strategy shall reduce transport costs and emissions know to increase impacts of climate change.

7.7 Environmental and Social Management and Mitigation Plan (ESMP)

The options to minimize or prevent the identified adverse social and environmental impacts as well as a monitoring plan have been proposed in Table 7-1. Most of the identified mitigation measures are based on good engineering practices. The ESMP describes the implementation schedule of the proposed mitigation measures as well as planning for long-term monitoring activities. It defines roles and responsibility of different actors of the plan. The financial requirement for undertaking the ESMP is estimated at USD 250,500 for the four main phases of the project namely pre-construction, construction, and operation and decommissioning. Table 7-1 gives an outline of anticipated potential impacts and their proposed mitigation measures.

Table 7-1: Environmental Management Plan

Component	Potential Impacts	Mitigation Measures
Destruction of Physical Environment	• Soil compaction and erosion • Obstruction of natural water channels • Abandoned disused quarries • Contamination with melted bitumen,	• Develop soil erosion control measures which should include silt management structures and construction of run-off management structures especially at drainage outfall; • Limit the circulation of heavy machinery to minimal areas to reduce soil compaction and vegetation clearance; • Locate access roads perpendicularly or diagonally to the slope rather than along steep slopes; • Salvage/reprocess the materials obtained during demolition of the existing structures to reduce need of excavating or sourcing new material; • Rehabilitate material excavated sites; • Avoid melting bitumen on private/productive land; and • Use cleaner and environmental friendly methods in handling bitumen.
Increased Water Demand/Supply & Water Quality	• Increased abstraction of water for construction • Contamination of water bodies through car washing, disposal of solid waste, discharge of effluent, bitumen, oil leaks etc • Decreased water quality and increased incidences of waterborne diseases	• Observe the Water laws and water reserve rights for downstream users; • Develop and implement water management plans to include measures on conservation and controlled usage of the resource such as rain water harvesting and underground water exploration; • Provide alternative sources such as boreholes, ground water abstraction, surface water (rivers, spring and Lake) abstraction; • Obtain water abstraction permit and use metering methods to ensure water is abstracted to recommended limit; • Do not dispose any form of waste in water bodies; • Keep natural water channels free from obstruction; • Consult with community members when identifying water sources to avoid conflicts and abstract water according to conditions of acquired permits taking into consideration the quantified reserve for the water body in question ; • Avoid water contamination and pollution activities at wetlands riparian such as developing on riparian land or marshland/swamps; • Implement appropriate construction site management practices like excavating areas to be worked on only, control flow of excavated materials, cover areas once work is completed.
Destruction of Flora and Fauna & Wildlife-Human Conflict	• Loss of vegetation cover and avian wildlife • Disturbance of terrestrial, aquatic and avian wildlife (competition for food and water resources)	• All trees uprooted to pave way for material excavation, road expansion and access construction should be replanted with indigenous trees; • Use alternative sources of fuel to replace woods fuel and other non-green energy sources; • Promote the development of community tree nurseries; and • Institute Environmental conservation measures as part of the project
Inappropriate Drainage	• Increased erosion and siltation of water bodies	• Install appropriate drainage structures culverts, bridges, mitre drains • Avoid loading storm water pathways with silt and debris

Component	Potential Impacts	Mitigation Measures
	• Flooding of settlement area and work areas • Lack of access to poorly drained areas by the service users	• Rehabilitate water logged areas and provide appropriate drainage structures to reduce incidences of flooding and damage to building structures
Oil Spills and contamination	• Unproductive land • Water contamination • Destruction of ecosystems	• Avoid melting, spilling and burying tar in productive land; • Use cleaner production mechanisms and environmental management systems where appropriate;
Air/Noise	• Degradation of air quality and ambient noise due to excavations operations • Degradation of air quality by vehicles emissions, bitumen burning and dust during excavation operations • Interference with domestic and wildlife due to excessive and destructive noise	• Operate equipments with air pollution control/environmental management systems; • Insulate noisy machines when working near animal habitats and settlements; • Maintain vehicles and machinery in good condition in order to minimize gas emissions and noise; • Avoid bitumen melting activities in open spaces; and • Avoid noisy operations in the night.
Encroachment, Displacement and Resettlement of Project Affected Person	• Loss of property • Destruction of road and reduction of its life span • Increased road maintenance costs • Relocation of market and businesses	• Use of appropriate structures/markings to define the project area and road reserve; • Development of structures to deter encroachment; • Communicate with community members early enough before commencement of works; • Locate areas for relocating PAP to avoid interfering with livelihoods; • Develop and institute the Resettlement Action Plan (RAP)
Occupational, Health and Safety	• Increased incidence of Injuries, road accidents and occupational health hazards to workers and public at large • Increased incidences of STI, HIV/AIDS, school drop outs, unwanted pregnancies, alcoholism, communicable diseases among other • Interference with local culture and values • Increased informal settlement • Increased incidences of water and soil contamination • Decreased level of sanitation • Incidences of suffocation and poisoning	• Provide road safety facilities including road signs, speed breaks, bus stops, footpath, foot bridges among other safety facilities; • Provide workers with Protective Professional Clothing and Equipments (PPC&E); • Conduct social awareness campaign in project areas; • Recruit locals as labourers as much as possible to reduce influx of immigrant's labourers; • Provide housing and appropriate sanitation facilities to workers including mobile toilets at road side sites; • Provide neutralizing and detoxification foods like milk to workers handling chemicals; and • Complying with work place legal requirements; • Employment of competent work force or conduct training and induction courses to workers in order to reduce accidents. • Instituting Safety drills, disaster preparedness and management programmes; and • Implement HIV/AIDS and other communicable diseases programmes in conjunction with relevant ministries
Social Concerns	• Resources competition • Loss of cultural heritage	• Accord local community employment and business opportunity as a priority • Identify areas of cultural importance such as graves and traditional shrine to avoid interference with them

Component	Potential Impacts	Mitigation Measures
	• Gender equity • Alcoholism and drug abuse • Interference with existing local infrastructure such as access roads • Insecurity • Interference with socio-cultural practices such as access or use of local shrine namely *Kayas*	during material excavations; • Establish labour camps at reasonable distance from villages, shopping areas and other local social places; • Where possible offer women equal employment opportunities to men • Contractor in collaboration with proponent should develop corporate social responsibility programmes (CSRP); • Contractor should hold continuous site meetings with workers and community members; • Develop programmes that can promote peace and harmony such as sports, cultural events etc • Rehabilitate infrastructure damaged due project activities; • Compensate PAP appropriately on acquired land, materials and for loss of livelihood; and • Provide security to project workers

7.8 Environmental and Social Monitoring

Monitoring helps determine the effects of the project activities on the environments and enhances understanding of cause effect of impacts and the effective way of mitigating against them. It ensures compliance with regulatory measures and understanding the degree of implementation of ESMP and its effectiveness. A monitoring plan has been developed for the project and is based on the findings of stakeholder's consultations and identified potential impacts. Monitoring shall be done at the various phases of the project as follows;

- *Pre-construction stage*: At this stage monitoring of the parameters is meant to establish the baseline information of the target parameters in the project area. The main baseline indicators parameters to be measures and documented should cover environmental issues such as air quality (noise, emissions and vibration), water quality, sedimentation level, status of land degradation and biodiversity audit. Collection of baseline information including measurements and, laboratory analysis, monitoring of compensation and, resettlement activities is estimated to cost USD 40,000.

- *Construction stage:* At this stage monitoring is meant to establish the pollution levels that arise from the construction activities. The findings are compared to the baseline information documented at the pre-construction phase and action is taken if the measured indicators deviate from the acceptable standards. The estimated monitoring cost at this phase is USD 98,050.

- *Operation stage:* Monitoring at this stage is meant to check on the impacts that might arise as the result of normal use of the infrastructure. The estimated monitoring cost at this phase is USD 30,500.

- *Decommissioning:* Decommissioning is anticipated after the projects life span which is 20 years after completion of construction. In many cases for a building project this phase is associated with demolition of the structures and redeveloping with new structures to suit the needs of the time. It involves removal of the structures and constructing it in some cases sections which are considered stable are maintained and areas which are not stable are redone and materials from such sections should be reused as much as possible.

The main parameters to be measured during monitoring include; air quality, water quality, social issues, vegetation covers, environmental risks and hazards, safety hazards and actual happenings among others. The financial requirements for undertaking monitoring are estimated at USD 72,600 for the four main phases of the project namely pre-construction, construction, operation and decommissioning.

7.9 Environmental Audit

The EIA regulations require that environmental audits be carried out one year after the commencement of the project. The aim of the audit is to unveil the actual performance of EMSP and allow for effective measures to be included in future

projects based on the legislation in force. As per regulations undertaking of the environmental audits would be the responsibility of the Employer.

7.10 Conclusion

The proposed project is economically feasible as it shall reduce business redundancy at the border post and enhance local connectivity to social facilities and markets. It has the potential to open up the area to markets and suppliers in the country; while at the same time boost the development of various industries in the entire region..

On the other hand there are negative environmental and social implications that need to be addressed. While there is a general acceptability of the project by the local community, fear of displacement, loose of livelihood, exposure to cultural interference, preference of foreign skills to local skills, and risks of general safety are among concerns of the local community therefore appropriate mitigation measures should be integrated in the all project implementation phases to ensure its sustainability.

7.11 Recommendations

The proposed project has been found to be feasible and timely for the economic development and growth of the project area and to ensure it meets its objectives holistically it is recommended that: -

- Mitigation measures proposed in the ESMP should form an integral part of decision making during the construction of the OSBPs;
- Continuous monitoring of project impacts, effectiveness of the mitigation measures and consultations with community members should be undertaken and details recorded;
- Institute effective communication, education and awareness towards the project beneficiaries for enhanced acceptability and social harmony; and
- Implement the Resettlement Action Plan (RAP).

8 RISK MANAGEMENT DURING CONSTRUCTION

8.1 Risk Identification

A risk is any event that could prevent the project from progressing as planned. Some risks are inherent to the project itself while others are a result of external influences that are completely outside the control of the Project Team.

The anticipated risks for implementation of this project have been identified and captured in the Project Risk Register in Chapter 8.8 of this report. Updates to the risk register will occur as risk factors change during the course of the project. The Engineer recommends that Risk Management is continuously carried out during regular scheduled project meetings and in the progress reports.

At anytime during the project, any risk factors or events should be brought to the attention of the Project Manager using email or written communication to document the item. The Project Manager shall log the Risk in the Risk Register under the following headings:

- Description of Risk
- Probability
- Impact
- Mitigation Measures

8.2 Risk Responsibilities

The responsibility for managing risk is shared amongst all project team members with the decision authority for selecting mitigation strategies and implementation of contingency plans resting with the Project Manager. The detail below shows the responsibilities envisaged.

- Risk Identification: All Project Members & Stakeholders
- Risk Register: Project Manager
- Risk Mitigation: Project Manager
- Risk Reporting: Project Manager

8.3 Risk Matrix

The Risk Matrix is a product of a risk assessment. Risk Assessment is the act of determining the probability that a risk will occur and the impact that event will have should it occur. Table 8-1: The risk matrix for this project

			Impact				
			Very Low	**Low**	**Moderate**	**High**	**Very High**
			Barely noticeable	Minor areas affected	Major areas affected	Change unacceptable	End item is effectively useless
			1	**2**	**3**	**4**	**5**
Probability	**Very Unlikely** Has not occurred in similar studies or projects, but could. Conceivable in extreme circumstances.	**1**	**Low**	**Low**	**Low**	**Low**	**Low**
	Unlikely Known to happen, but only rarely	**2**	**Low**	**Low**	**Low**	**Medium**	**Medium**
	Possible Incurred in a minority of similar studies or projects	**3**	**Low**	**Low**	**Medium**	**Medium**	**High**
	Likely Could easily be incurred and has generally occurred in similar studies or projects	**4**	**Low**	**Medium**	**Medium**	**High**	**High**
	Very Likely Almost inevitable that event could occur	**5**	**Low**	**Medium**	**High**	**High**	**High**

8.4 Risk Response

The risk response options for this Project falls under the following categories:

- AVOIDANCE – Change course of action to avoid risk
- TRANSFERENCE – Transfer of risk to a third party
- MITIGATION – Take steps to reduce probability and impact hence reducing the risk and taking further steps to manage any residual risk.
- ACCEPTANCE – Simply accept the risk

8.5 Risk Mitigation

Risk Mitigation during project implementation should be documented in the Risk Register and reviewed at regular intervals as set out by the Project Manager.

8.6 Records

Risk records of the projects should be captured under:

- Risk Register
- Risk Assessments for Fieldwork

8.7 Timing of Risk Management Activities

Risk management activities shall be as and when required by the Project Manager.

8.8 Risk Registers

Table 8-2: Project risk register

ID	Risk Description	Probability	Impact	RISK	Trigger Event/ Indicator	Risk Mitigation	Contingency Plan	Owner
1.	Tendering bureaucracy	4	3	MEDIUM	Delays in the tendering process and subsequent project implementation	Ensure institutional capacity to undertake the tendering process.	To put in place a **Procurement Strategy and a resourced Plan** for bid receipt, evaluation, selection of preferred bidders, negotiations with preferred bidder and finalising of agreement within a set period.	Employer
2.	Unstable ground for construction	2	4	MEDIUM	Settlement, Slope Failure	Geo-technical study at Galafi assessed underground soil condition. Foundation designed based on bearing capacity.	Under the scope of works in the tender documentation include a requirement for the Contractor to undertake additional geotechnical tests in the building zones to ascertain ground conditions	Project Manager
3.	Insufficient Construction Period	4	5	HIGH	Delays in completion	Construction methods, material sources and durations of similar OSBP projects have been analysed and an estimated period provided.	**Contractors' Pre-qualification:** for their experience in similar projects **Contract conditions:** The contractual conditions, performance bond, warranty period and retention money etc. are some measures in the contract to assure contractors performance and on time completion.	Project Manager
4.	High Temperatures hindering proper curing of concrete works	5	4	HIGH	High Temperatures	Concrete Works to be scheduled during the coolest part of the day. Plan with the batch plant an acceptable delivery temperature so that materials can be cooled by the supplier as needed.	Use sunshades or windbreaks to reduce possible harsh conditions. Keep an evaporative retarder ready on site in case the temperature gets hotter and water is rapidly evaporating. Use ice as part of the concrete water mix, or use liquid nitrogen to cool the concrete	Project Manager
5.	Volatile security situation at Galafi Border Post during construction	4	5	HIGH	Insecurity	Notifying the respective governments, seeking security clearance and protection during implementation. Advocate for an Intergovernmental security committee to oversee security clearance and safety of project persons and equipment	Hire private security companies for the project	Project Manager
6.	Land Ownership and Acquisition	3	5	HIGH	Land Protests	Undertake and implement a Resettlement Action Plan (RAP)	Engage IGAD's intervention Commence construction only when land has been fully acquired and site handed over to contractor	Project Manager
7.	Delay in project implementation and completion by the contractors: because of its capacity, technical abilities, man power non-availability or	3	5	HIGH	Delayed hand over and commissioning	**Contractors' Pre-qualification:** for their experience in similar projects **Contract conditions:** The contractual conditions, performance bond, warranty period and retention money etc. are some measures in	**Mode of procurement:** Qualified contractors will be selected through ICB **Project implementation** schedule: takes into account time and deliverables **AfDB Standard Bid Documents** will be used	Project Manager

	issues, contractual disputes, financial difficulties, construction material availability					the contract to assure contractors performance and on time completion.	for the procurement of civil works and consultancy services	
8.	**Environment Risk**: The OSBPs construction will invariably impact the natural and socio-economic environment.	3	2	LOW	Environmental degradation	The Engineer has provided a comprehensive Environmental Social Management Plan (ESMP), which covers the pre-construction, construction and operational activities of the Galafi OSBPs.	Contractor to adhere to Environmental Social ManagementPlan (ESMP) during construction of the Galafi OSBPs	Project Manager

9 IMPLEMENTATION SCHEDULE

9.1 Introduction

The implementation of the OSBP project will involve acquisition of contractors through international competitive bidding. This will later translate into physical construction of the various structures on site. Defects liability period is also included to ensure the contractor rectifies all defective works that may arise.

9.2 Preparation of tender documents

Based on the approved Final Design Report, the Consultant has prepared and submit to the Employer, *Bid/Tender Documents* containing bid notice, instructions to bidders, bid data sheet, evaluation methodology and criteria, bidding forms, statement of requirements, conditions of contract (general and special), contract forms, all in accordance with the current AfDB standard bidding document and procedures for works (International Competitive Bidding). The bid/tender documents shall be approved by the Employer.

9.3 Procurement of Works Contract

i. Invitation of Bids

Employer will issue the Bid Notice inviting the contractors to bid and the prospective bidders will pick the approved bidding documents from Employer. A copy of the receipt should be included in the bid document. The bidders will be required to prepare and submit their bids within a specified period.

ii. Pre-bid meeting

A pre-bid meeting shall be organised and thereafter bidders will visit the proposed sites and thereafter to a conference facility at the Employer's premises. The Engineer shall clarify issues and answer questions raised on any matter at the meeting, prepare and distribute a record of the meeting to the stakeholders.

iii. Preparation, submission and opening of bids

The Engineer shall provide responses, through the Employer, to any requests for clarification that are received from bidders prior to the deadline set in the bidding documents. The Engineer shall prepare and issue any addenda required during the period of bidding. The bids will be submitted to and opened publicly at the offices of Employer. The Engineer will attend bid opening and prepare and distribute the record of the bid opening on the AfDB format.

iv. Engineer's estimate

The Engineer's estimate, as is commonly known, will be used in the evaluation and comparison of the bids. However, the Engineer will be expected to have prepared a confidential pre-bid cost estimate and submitted the same to the Employer together with the bidding documents.

v. Evaluation of bids and recommendations

The Engineer will be appointed and shall participate in the membership of the evaluation committee. Evaluation of bids received shall be based on the AfDB procedures. The Engineer will make recommendations for award but only for the consideration of an Evaluation Committee set up by the Employer. The Employer will be responsible for awarding the contract. The Engineer may be instructed to issue notice of the award.

vi. Contract documents

Following award, the Engineer shall prepare the issues for pre-contract discussions and participate in the discussions with the selected Contractor. The Engineer will subsequently prepare the relevant contract documents to be approved by the Employer for signing. The construction contract will be between the successful Contractor and the Employer. The contract will be based on the AfDB format.

vii. Signing of the contract: implementation schedule

Signing the contract with all the contractual provisions in place stipulated in the bidding documents (i.e. guarantee for advances, performance bond, etc) will take place between both parties and thereafter the Contractor will be given possession of the site. The Engineer shall coordinate and assist the parties in signing the contract.

Note: The procurement period is estimated to take **6 months**.

9.4 Construction Period

Upon contract award, the Contractor shall take over the site and this will mark commencement of the construction period and as such supervisory activities shall commence.

i) Checks on Setting out

The Contractor shall be responsible for setting out his works while the Engineer shall ensure that this is carried out accurately so that the geometry is as specified in the drawings.

ii) Regular Inspection of works

All Construction works carried out by the contractor shall be inspected regularly by the Engineer to ensure that the works are carried out according to drawings and specifications, and to the highest acceptable standards of workmanship.

The Engineer shall brief the site inspection staff about their duties and procedures to be followed.

He shall also be responsible for keeping methodical records of all site visits, results of all tests witnessed or reported by the Clerk of Works, schedule of claims, etc.

iii) Clerks of Works

The Engineer shall deploy an experienced Clerk of Works (COW) to be their full time representative on site. The COW shall compile daily reports and ensure that what is instructed by any member of the consultancy team or is indicated in the contract drawings and specifications is followed to detail, including following up variations in accordance with the contract. He shall submit weekly reports to the PM, who shall compile and submit monthly reports to the Client. The COW shall keep record of site delays observed and defective work.

iv) Safety

The Engineer shall also ensure that the contractor adheres to the safety regulations for employees, subcontractors and visitors to the site: safety helmets, boots, guard rails, safety equipment, safety signs, first aid equipment, and compliance with the local safety laws and regulations.

v) Monitor Progress

Progress photographs to be taken during the month backed up by a *monthly Progress Report* to describe the progress achieved in the month.

The progress of works shall be monitored closely regarding quantities and value of work completed, compliance with the time schedules and programmes. In case of any problems, measures will be enforced by any appropriate means available to the Engineers in order to make good of any deficiencies or lost time.

Monthly site meetings to be conducted and all concerned parties shall be represented. Minutes of each site meeting shall be circulated to all concerned parties within seven days.

Complete records concerning the execution of all works will be kept at the Engineer's office, to be submitted to the Employer on completion of the works.

vi) General Technical Assistance

Technical assistance in solving any problems encountered by the Contractor during execution of works shall be provided whenever required to ensure smooth and timely progress of work. The Engineer will advise the Employer on the various alternatives or options available. This includes licenses, permits, right of way.

vii) Advice and direction in Project Implementation

The Engineer shall inform the Employer on program and progress. The Contractor's work programme shall be checked regarding timing, inter-relation between activities, realistic approach with regard to available resources in manpower and equipment. Recommendations shall be made as necessary for the execution of the project in the best manner possible. Wherever any new challenges may arise, all possible alternatives or options shall be explored by the Engineer.

viii) Variations

The Engineer shall issue instructions related to variations which increase the contract value, with prior approval of the Employer.

All necessary designs and documentation of any variations arising from either change of scope, additional works to give solution of any problems during construction shall be prepared and field investigations/ surveys conducted accordingly.

Where the issue of an instruction is related to safety of the work, installations, contractors' staff or any other emergency, the Engineer shall issue the instruction, and then notify the Employer at the earliest opportunity providing full details to substantiate the issue of the instruction.

The Engineer shall issue site instructions and provide recommendations for any variations and necessary changes that may arise during construction. These instructions shall be delivered by the site management team and the Clerk of Works shall see to their implementation.

ix) Cost Control

The Quantity Surveyor shall monitor costs arising from site instructions, including variations. Monthly cost appraisals shall be prepared to give monthly updates on construction cost.

The Engineer shall prepare financial appraisals and cost forecasts, schedules of unit cost for individual work elements and, applying these to measured quantities, check elemental and grand totals against project budget; assist Employer with timely "draw-down" of funds for payments to the contractor during construction, prepare anticipated cash-flow diagrams and tables based on the Contractor's projected and actual progress.

x) Reviewing claims.

Upon receipt of any notice of intention to claim for extension or additional payment by the Contractor, or at any time when the Engineer or the Employer considers that a claim may be made, the Engineer will ensure that appropriate contemporary records are submitted by the Contractor or are in his/her safe custody.

The Engineer will then evaluate any such claims without delay, in accordance with the building contract; and make recommendations to the Employer for appropriate action.

However, since the avoidance of claims is the best solution, maximum effort will be put into coordination of the construction and supply contracts; and also into timely fulfilment of the obligations of the Employer and the Consultants under the contract. This should avoid undue claims from the Contractor.

xi) Measurements.

The Engineer will establish a system by which measurement of works is taken at a regular interval, which could vary for each type of work. This will provide a verification method of measurement of the correctness of the contractors' invoices submitted to the Engineer for certification of payment. The Engineer shall use standard methods of measuring of civil engineering works issued by FIDIC.

xii) Payments (Certify Invoices).

The Engineer shall receive, check, review and certify invoices (interim valuation) including those related to the final completion and retention money. This will involve preparing all accounts and interim payment certificates due to the Contractor, and also detailed quantity surveys including the supply of items and their installation.

The Lead Engineer shall keep a record of the invoices certified for payment; accounts of payments made to the Contractor and the remaining balance of work to be completed under the construction contract as well as approved variation orders.

xiii) Quality Control.

The Engineer shall ensure compliance with drawings and specifications of their respective expertise and ensure quality control of materials and workmanship

The Engineer shall maintain a comprehensive supervisory role to ensure the contractor observes the best building practices possible in terms of quality control management. Suitability of materials to be used for the project shall be determined both on site and through laboratory tests where it is required in accordance with required standards.

The Consultants shall review and monitor certain critical items such as:

- Quality of aggregates, cement, steel, water, concrete blocks, formwork, etc.
- Quality of workmanship
- Concrete batching and placing
- Storage of materials to be incorporated in the works
- Compliance with specified construction tolerances, specifications, drawings, etc.
- Depths of foundations, beams and columns

All materials to be incorporated in works by the Contractor shall first be tested for compliance at an approved laboratory. Material samples shall be approved by the Employer before use. Mechanical and electrical Installations: shall be subjected to the required standard tests as per specifications.

xiv) Inspection of equipment.

All equipment will be inspected by the Engineer prior to installation with regard to damage, proper functioning, compliance and standard specifications.

Supervision of installations

The installation of mechanical, electro-mechanical, electrical equipment, pre-cast components and medical equipment shall be supervised. This is necessary to avoid damage, which could lead to un-necessary delays in commissioning of the completed works, shortened life spans and unpredictable failures. Representative personnel from the Employer should attend the installation of any major plant components.

xv) Commissioning.

The Engineer shall supervise and witness all required tests and performance of plants. Commissioning shall include all tests necessary or specified to ensure a satisfactory operation of the completed project.

xvi) Taking over practically complete works.

The construction stage shall end when the works have been completed in accordance with the contract. The Contractor shall be warned to ensure that the building is ready for inspection before the practical completion date.

The Contractor shall notify the Engineer and Employer in writing, after which the Engineer shall check the progress of building control and other statutory approvals. Also as part of preparations for handover, the Engineer shall compile and send to the Employer for comment, a list of all items to be submitted. As-built drawings, Operation and Maintenance manuals shall be prepared by the Contractor, approved by the Engineer and submitted to client.

A joint site inspection with the Employer shall then follow, organised by the Contractor. The Engineer shall prepare snag lists to notify the contractor of any defects. Defects identified during the joint site inspection shall then be corrected.

When the Employer is satisfied and works are confirmed to be complete, the official handover ceremony shall be organised by the Engineer and Contractor at a date, time and venue agreed with the client.

The Employer shall issue a Letter of Acceptance and Certificate of Practical Completion. After issue of this certificate, half the retention is released and the contractor's liability for liquidated damages ends. This certificate marks the commencement of Defects Liability Period.

Note: The construction period is estimated to take **24 months**.

9.5 Defects Liability Period (DLP)

It is during the defects liability period when the contractor attends to and carries out corrections and remedies to defects in the completed works allowing for normal wear and tear for handling. The defects liability period is usually 6 - 12 months. In the case of the designed OSBP facilities a period **12 months defects liability period** is recommended.

i) Snag Listing

At practical completion and after successful take-over by the Employer, the Defects Liability Period will commence. During this period the Engineer will make interim site visits in order to ensure that any remedial works are attended to, so the site is in full operation. The Engineer will promptly notify the Contractor of any defects detected by issuing a Defects Notice.

Post Construction Supervision focuses on remedial work and defects compiled on practical completion as well as those appearing during the defects liability period.

The Engineer will carry out the following tasks: -

- Ensuring that the Contractor makes good of all defects raised in the snag list prepared on practical completion by carrying out a series of site inspections to check, confirm and approve that defects have been cleared.

- Preparing snag lists for defects appearing within the DLP and carrying out a series of site inspections to ensure that the Engineer lists in detail all the defects according to spaces, looking at building components i.e. floors, walls, ceiling, doors, windows, fittings, electrical and mechanical installations, water and sanitation, external works, etc. When the contractor has made good of the defects, a final site handover shall be arranged.

    - Compiling as-built drawings, maintenance schedules and service manuals.

ii) Project Closure.

The Engineer shall establish and agree with Employer on the criteria to be used for confirming completion of the contract (tasks finished, deliverables finished, testing completed, training requirements finished, equipment installed, tested and operating, document manuals submitted, etc.)

The Engineer shall then convene and hold project close-out meeting attended by Employer, Contractor, end users and stakeholders, at which the project completion report is among other items approved and signed off.

The Employer shall sign the project completion report

iii) Final Certificate.

Before the end of the Defects Liability Period, the Engineer will prepare a detailed schedule of defects, arrange with the contractor to return to site to repair or

replace defective work, before issuing the Final Certificate.

iv) Final Accounts.

Final Account is a summation and a financial statement in settlement of accounts of the project.

The Engineer shall prepare detailed Final Accounts of the project based on full re-measurement of all variations and changes to the contract. All Final Account documentation will be formatted for easy detailed analysis. Preparation and negotiation of all final account costs will be carried out and upon confirmation from the Employer, final accounts will be agreed upon. Full contractual claims related to the services will be available from the Engineer, should they become necessary.

The Final Accounts shall scrutinize and verify the following:

1. The original Contract Sum
2. Amounts paid to the Contractor, Sub-Contractors and Nominated Suppliers under Interim Certificates.
3. Details of Variations to the Contract resulting into adjustments to the original Contract Sum in a form of Omissions and Additions.
4. The release or treatment of the Retention Sum.
5. The final cost of the Project resulting from the above adjustments.
6. The balance of payments due to the Contractor, Sub-Contractors, Suppliers as a final payment
7. A signed statement from the Contractor agreeing that the final account is final settlement for transactions of the project.

v) Final Report.

The Engineer shall carry out a post project evaluation of the project technical work, achievements, the project processes and the management of the project. The Team Leader shall prepare a Final Report at the end of the Defects Liability Period.

In summary the whole implementation schedule until the end of the defects liability period is **42calendar months** as follows:

Table 9-1: **Implementation Schedule**

Item	Activity	Duration
1	Procurement of the works contract	6 months
2	Construction period	24months
3	Defects liability period	12 months
	TOTAL DURATION	**42 months**

10 ROADMAP FOR THE DEVELOPMENT OF RAAD AND GALAFI OSBPS

OBJECTIVE	ACTION	ACTIVITIES	RESPONSIBILITIES	TIME FRAME/REFERENCE DATE January, 2019
1. Coordinate and promote establishment of OSBP	Establish a Project Coordination Unit (PCU) preferably based at the IGAD Secretariat	Coordinate the two neighbouring countries for each of the OSBPs in undertaking bilateral negotiations and building capacity by convening meetings, workshops and other events; Preparing draft work plans and working documents and maintain the records; Conduct awareness and sensitization on OSBP issues and procedures (Public and Private sector), provide benchmarking for best practices and coordinate visits, forums and networking.	-IGAD to establish PCU -IGAD to engage government and key stakeholders including private sector. -IGAD together with relevant government institution to undertake awareness and sensitization.	Short term (Six months)

OBJECTIVE	ACTION	ACTIVITIES	RESPONSIBILITIES	TIME FRAME/REFERENCE DATE January, 2019
2. Coordination of establishment of the OSBPs including creating a platform for a unified commitment at country level.	-A national coordination committee to be set up headed by the office of the President/ Prime Minister(Djibouti, South Sudan/Ethiopia) to monitor and control the implementation of the OSBPs. -IGAD focal point to coordinate with national coordination committees on development of OSBPs	-Development of the OSBPs at Galafi/Galafi(Djibouti/Ethiopia) and Raad/Raad(Ethiopia/South Sudan. -Mobilise resources and provide adequate physical and human resources for the OSBPs.	IGAD to mobilise resources and coordinate with donors and development partners and governments on development of OSBPs	Medium term (One Year)
3. Institutional set up for steering the development of OSBPs	-Identifying the lead ministries in each country and clarifying their roles. -Set up bilateral steering committee of Ministerial Heads. -Set up Technical Task Teams	-Steering the activities of the establishment of the OSBP -Providing regular reporting back as implementation proceeds.	-IGAD to organise and convene governments to set up the necessary institutional framework. -Governments to set up institutional mechanisms to steer and monitor the establishment of OSBPs.	Medium term (One Year)

OBJECTIVE	ACTION	ACTIVITIES	RESPONSIBILITIES	TIME FRAME/REFERENCE DATE January, 2019
4. Harmonise the national policies, procedures and trade regulations for cross border and transit trade between Djibouti and Ethiopia and Ethiopia and South Sudan	-Bilateral agreements negotiated and signed -OSBP Legislative Instruments enacted -Policies and technical standards harmonised. -Transit documents harmonised	Establish national OSBP legislation and conclude Bilateral Agreement and harmonise procedures	-IGAD to coordinate the states in enacting OSBP laws and sign Bilateral Agreements -Border agencies(Joint technical teams) institute reforms and develop capacity -Private sector to create awareness among members.	Medium term (Two years)
5. Develop infrastructure and facilities at Galafi Ethiopia/Galafi Djibouti and Raad Ethiopia/Raad South Sudan border posts.	Develop the structural and civil works, electricity, water and sanitation, communication and human resource capacity building.	Construct the offices, warehouses, public halls, parking lots and provide other ancillary facilities.	-IGAD to lead in resources mobilisation -Djibouti/Ethiopia/South Sudan to provide technical, financial and human resources necessary for the OSBPs. -Private sector to create awareness among members on proper use of the OSBPs	Medium Term/ Long Term (five years)

OBJECTIVE	ACTION	ACTIVITIES	RESPONSIBILITIES	TIME FRAME/REFERENCE DATE January, 2019
6. Monitor and evaluate OSBP at Galafi/Galafi and Raad/Raadborde r posts	Monitoring and Evaluation(M&E) platform developed.	-Data collection systems to be adopted -National and regional forums established to review performance	-IGAD to provide support in terms of training on M&E -Border agencies to collect data and statistics -Private sector to participate in the M&E	Long term (Continuous)
7. Ensure capacity building for the OSBP	Develop OSBP training and sensitisation materials	-Compile the legal documents required -Compile all necessary OSBP documents and materials -Develop the OSBP training curricular and sensitisation materials for Galafi and Raad border posts -Deliver OSBP training and sensitisation to the required stakeholders	-IGAD to coordinate -National training experts -National training experts	Short term(Continuous)