ALLAMAGAN CONSTRUCTION COMPANY

Drainage Design for Flood Control on Daalo road in Mogadishu, Somalia .

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1.0 INTRODUCTION

Drainage design for flood control is an important part of urban infrastructure development, especially in rapidly growing cities such as Banaadir Region. Flooding has become one of the major environmental and engineering challenges affecting roads, settlements, businesses, and public services in the region. During the rainy seasons, many roads in Mogadishu experience severe water accumulation due to inadequate drainage systems, poor stormwater management, rapid urbanization, and blocked drainage channels. As a result, transportation is disrupted, road pavements are damaged, and nearby communities face risks to health, safety, and property.

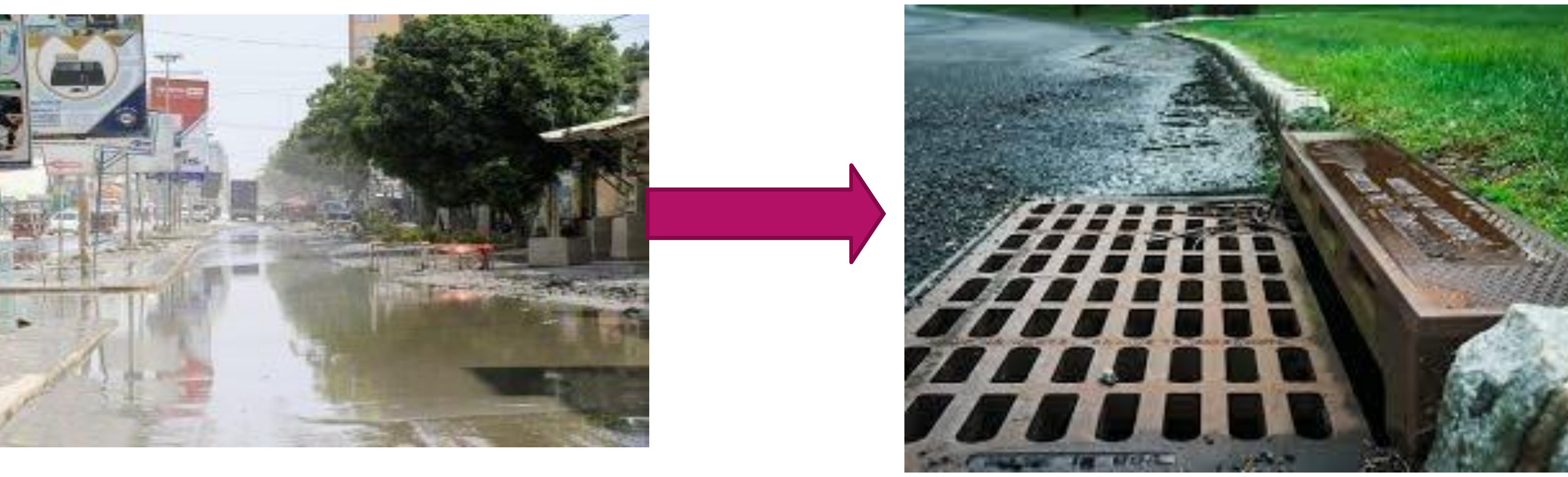
Flooding is a major problem affecting Daalo Road in Banaadir Region, Somalia, due to poor drainage and heavy rainfall. Proper drainage design is important to control storm water, reduce road damage, improve safety, and prevent traffic disruption. This study focuses on designing an effective drainage system to minimize flood risks and improve the durability of the road.

1.1 Definition of

Drainage design for flood control refers to the engineering planning and development of systems that collect, convey, manage, and safely discharge storm water and surface runoff to prevent flooding.

► In **Daalo** area of Mogadishu, drainage design involves the analysis of rainfall patterns, topography, soil conditions, and existing infrastructure to create channels, culverts, storm sewers, retention basins, and other hydraulic structures that reduce flood risks and protect lives, property, and roads.

► Flood control drainage systems are especially important in Mogadishu due to seasonal heavy rainfall and inadequate existing drainage infrastructure.



1.2. Title of the Project

Design of an Integrated Drainage System for Flood Control in Daalo Area, Mogadishu, Somalia."

1.3. Statement of the Problem

▶ Daalo area in Mogadishu experiences frequent flooding during the rainy seasons. The main problems include:

▶ Lack of properly designed storm water drainage systems

▶ Blocked or undersized drainage channels

▶ Poor waste management causing drain blockage

▶ Low-lying topography in some sections

▶ These issues lead to:

▶ Road damage and transportation disruption

▶ Property destruction

▶ Health risks due to stagnant water

▶ Economic losses to residents and businesses

Therefore, a proper drainage design is required to control and manage floodwater effectively.

1.4. Justification of the Drainage Design (Flood Control) The project is justified for the following reasons:

▶ Protection of Lives and Property – Reduces flood-related accidents and structural damage.

▶ Infrastructure Protection – Prevents deterioration of roads and buildings.

▶ Public Health Improvement – Minimizes water-borne diseases caused by stagnant water.

▶ Economic Stability – Reduces business interruptions and repair costs.

▶ Urban Development Support – Supports sustainable planning and

organized expansion of Daalo area.

▶ Given the growing population of Mogadishu, proper drainage infrastructure is essential for long-term development

1.5. Objectives of the Drainage Design (Flood Control)

A. General Objective

▶ To design an effective and sustainable drainage system that controls flooding in Daalo area, Mogadishu.

▶ **B. Specific Objectives**

1. To analyze rainfall intensity and runoff characteristics in Daalo area.
2. To determine peak discharge using hydrological methods.
3. To design appropriate drainage structures (channels, culverts, storm drains).
4. To ensure safe disposal of storm water to natural water bodies or designated outlets.

5. To reduce flood risk and improve road accessibility during rainy seasons.

To propose maintenance guidelines for long-term system performance

1.6. Scope of the Drainage Design (Flood Control)

- ***The scope of this project includes***:

  - ❖ Site survey and topographic analysis of Daalo area
  - ❖ Rainfall data collection and hydrological analysis
  - ❖ Hydraulic design of open and closed drainage systems
  - ❖ Design of culverts, manholes, and discharge outlets
  - ❖ Preparation of 2D drawings and design calculations
  - ❖ Cost estimation of the drainage system
  - ❖ Environmental and social impact considerations

- **The project focuses on designing a complete drainage system to control flooding in Daalo area, Mogadishu.**

1.7. Type & Users of the Drainage Design (Flood Control)

- **Type of Drainage System**

  - ❖ Surface drainage system (open channels)
  - ❖ Subsurface drainage system (storm water pipes)
  - ❖ Combined drainage structures (culverts, retention basins)

- **Users of the Drainage System**

  - ❖ Residents of Daalo area

- ❖ Business owners
- ❖ Road users and transport operators
- ❖ Local government authorities
- ❖ Urban planners and engineers
- ❖ Emergency services

▶ The drainage design will serve both residential and commercial areas and improve overall urban resilience in Mogadishu.

Summery

▶ **Expected Outcomes**

▶ ✓ Reduced flooding

▶ ✓ Improved road durability

▶ ✓ Safer transportation

▶ ✓ Better urban infrastructure

2.0 INTRODUCTION

Over all Topography information

Today we will explain the work we carried out, which was surveying For road.

Through this survey, we identified the differences in ground elevation, the areas where water accumulates the most, the causes of the problem, and the possible solutions.

The total length of the stations we covered was 220 meters on each side, making it 440 meters intotal.

Therefore, we took measurements at 20-meter intervals

for each station.

Topography information

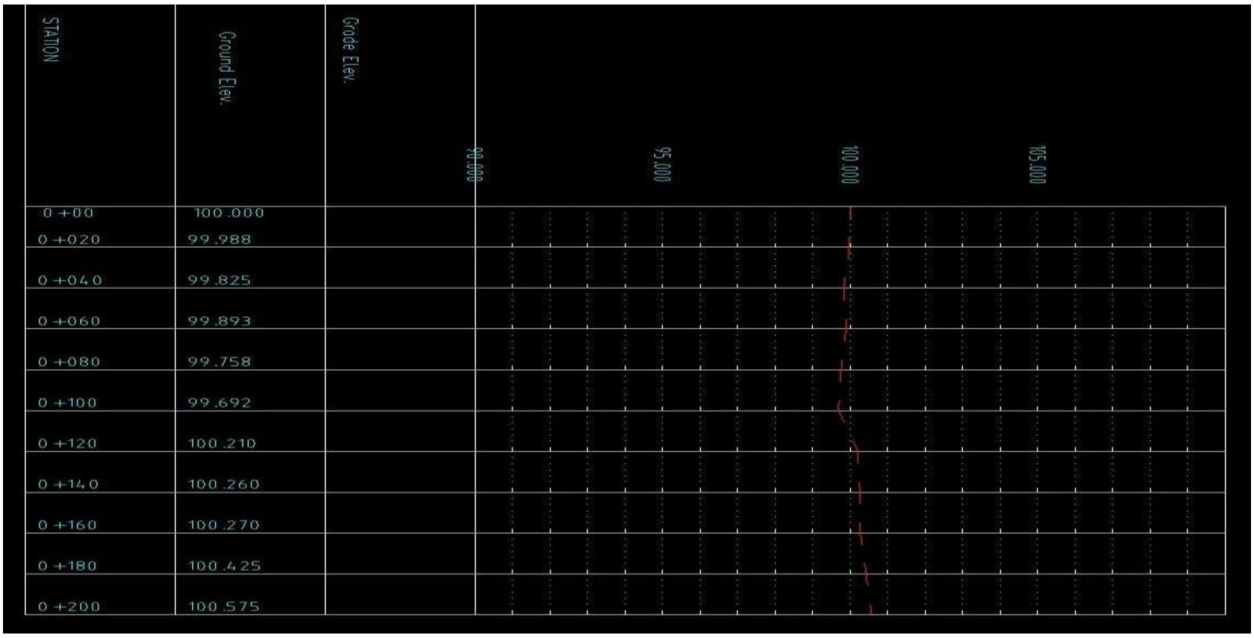
We started the survey from the Bar Ubax Side and concluded at the Balagsii area.

Topography information

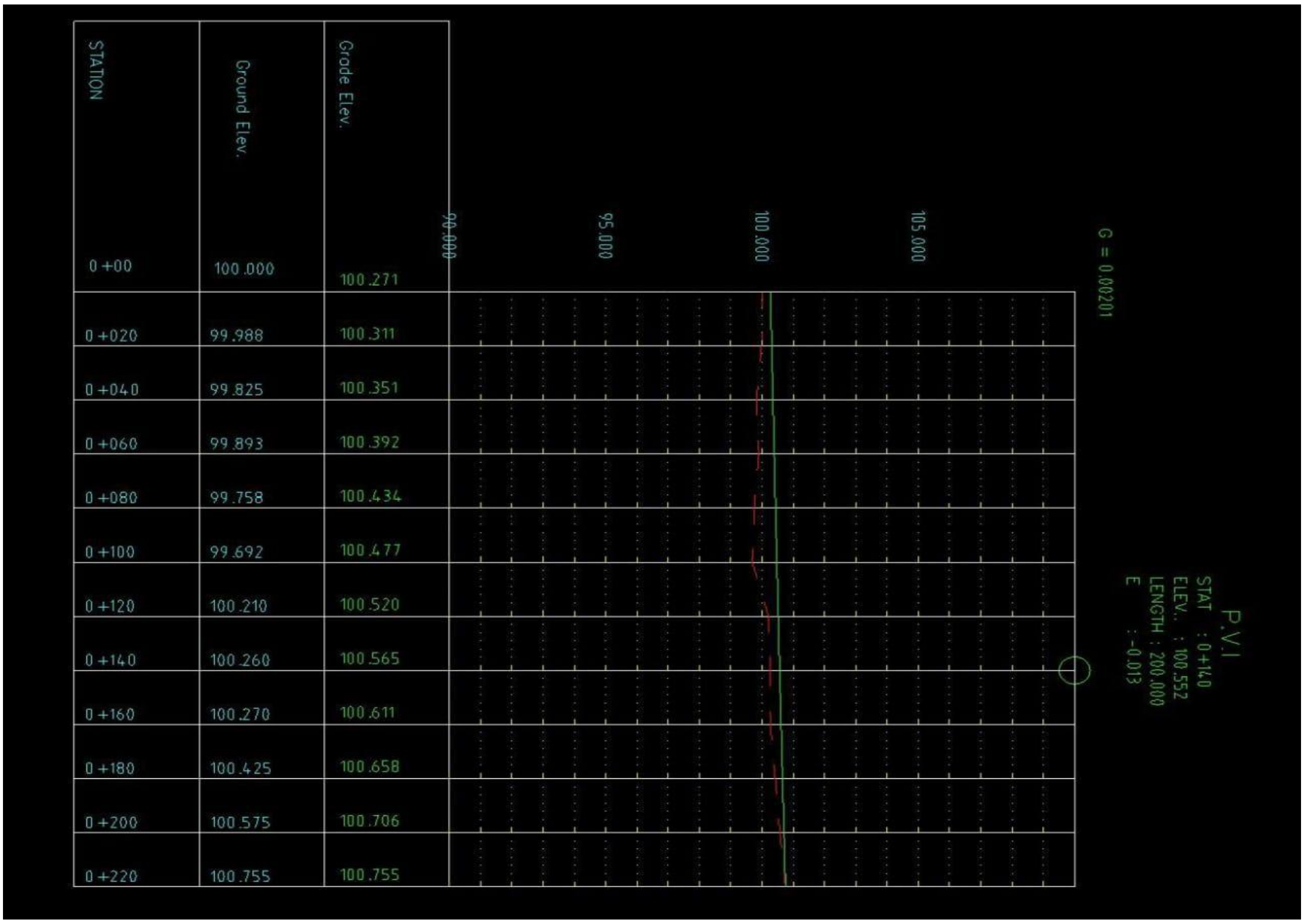
- From the topographic survey, we found that the main problem was variation in ground elevation, which caused water to collect in low lying areas. This indicates that the natural slope of the land is not sufficient for proper surface runoff.

The recommended solution is to design a drainage system that follows the natural slope direction to allow water to flow away from the road area and prevent stagnation.

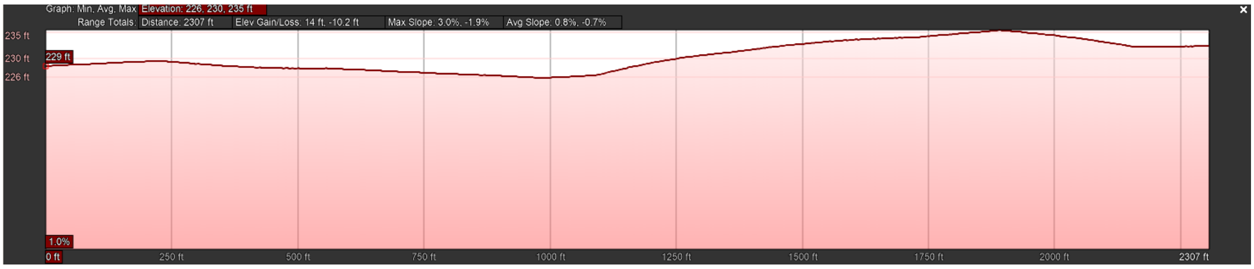
The problem We Found



The solution



The Solution2.1 CUT AND FILL



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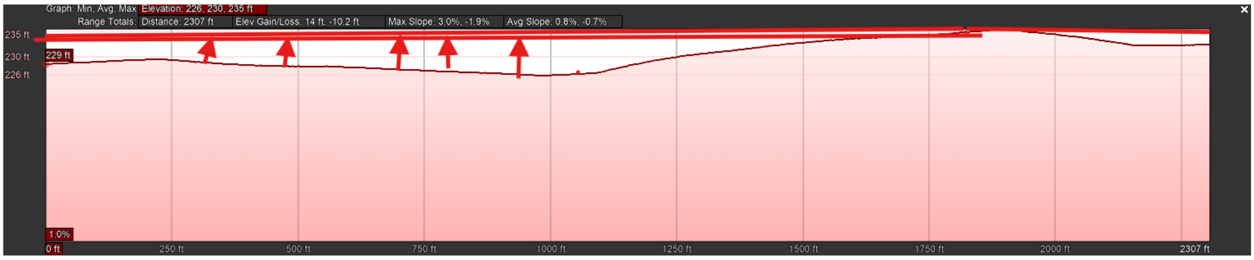
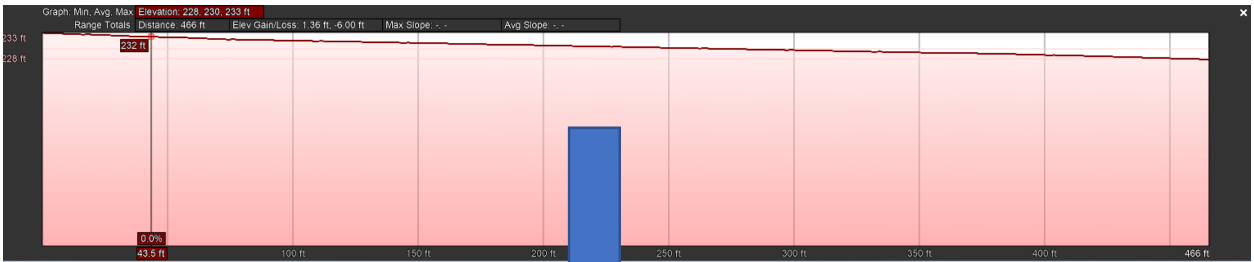


Street 1 Balagsi to Bar uwax

South



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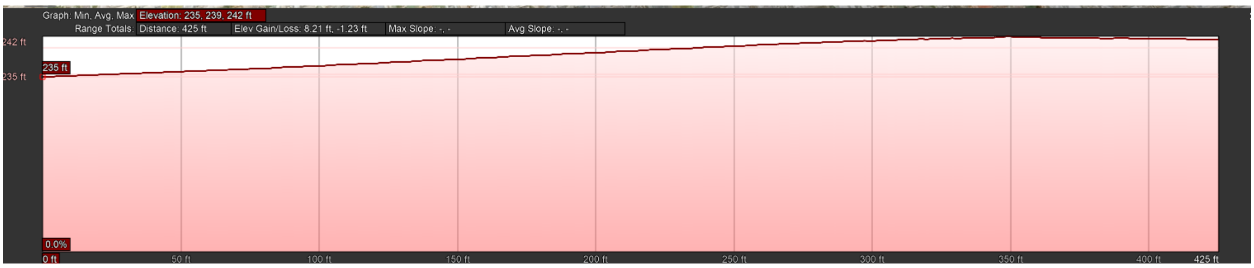

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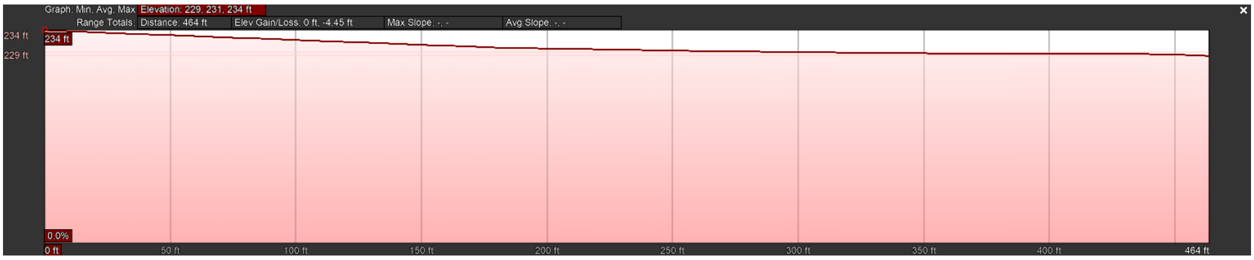

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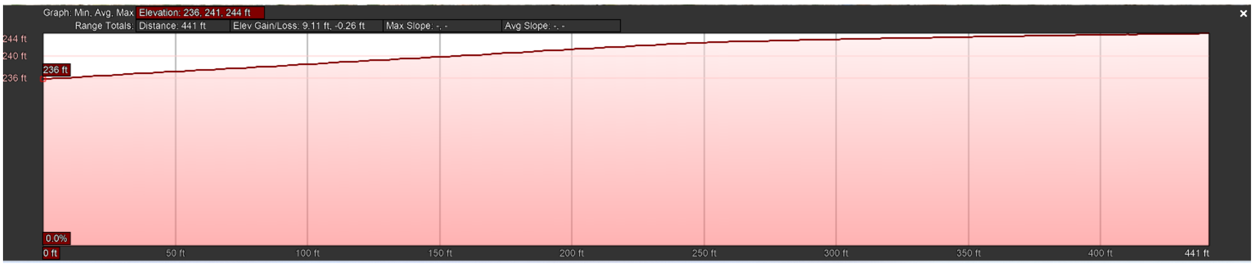

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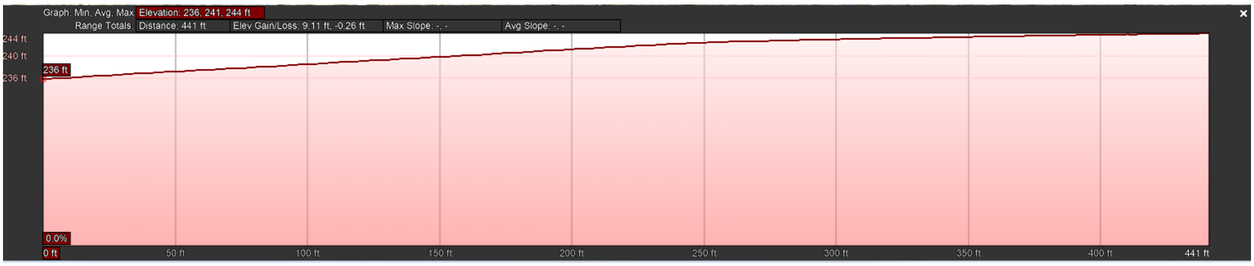

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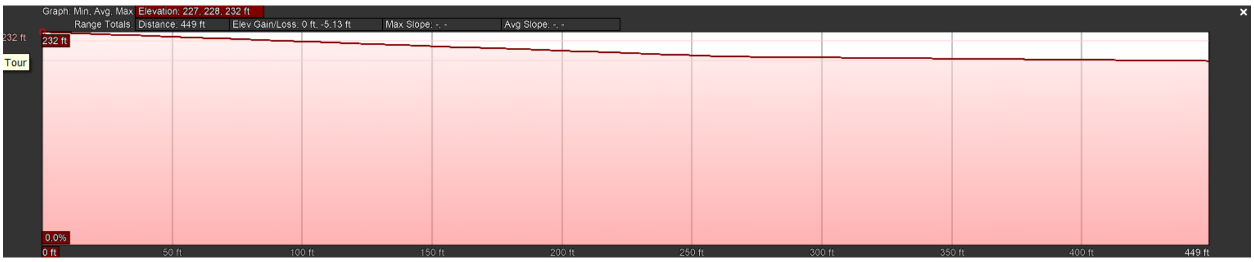

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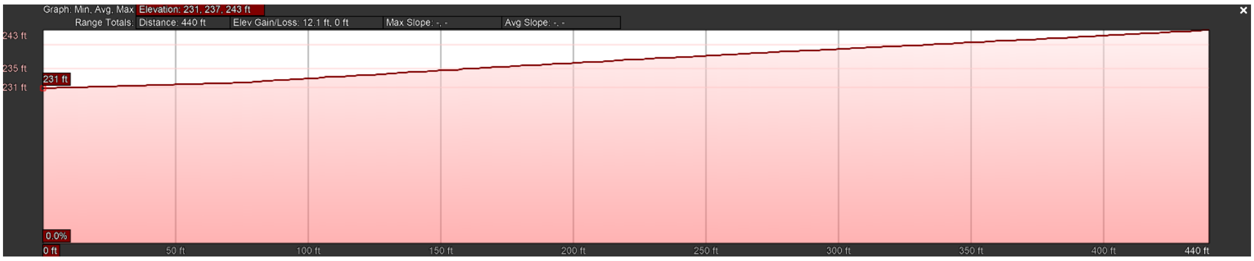

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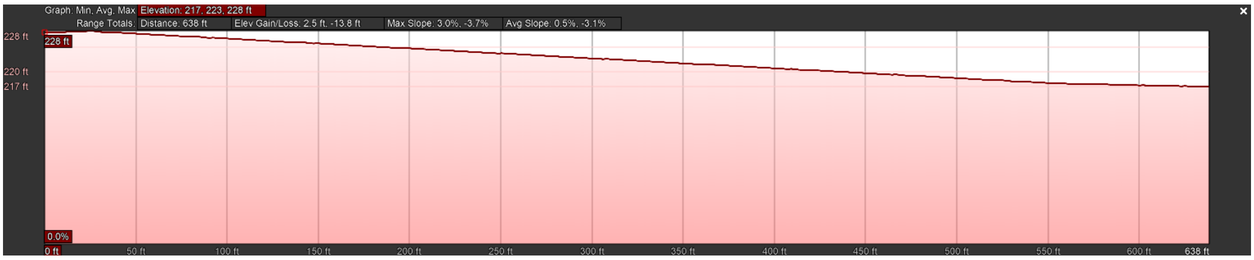
Range Totals:
Distance: 440 ft
Elev Gain/Loss: 12.1 ft, 0 ft
Max Slope: -, -
Avg Slope: -, -
243 ft
235 ft
231 ft
231 ft
0.0%
0 ft
50 ft
100 ft
150 ft
200 ft
250 ft
300 ft
350 ft
400 ft
440 ft



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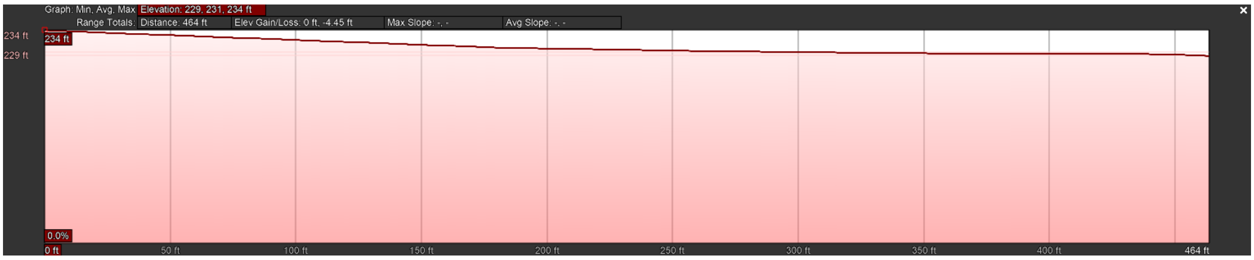
Distance: 638 ft
Elev Gain/Loss: 2.5 ft, -13.8 ft
Max Slope: 3.0%, -3.7%
Avg Slope: 0.5%, -3.1%
228 ft
228 ft
220 ft
217 ft
0.0%
0 ft
50 ft
100 ft
150 ft
200 ft
250 ft
300 ft
350 ft
400 ft
450 ft
500 ft
550 ft
600 ft
638 ft



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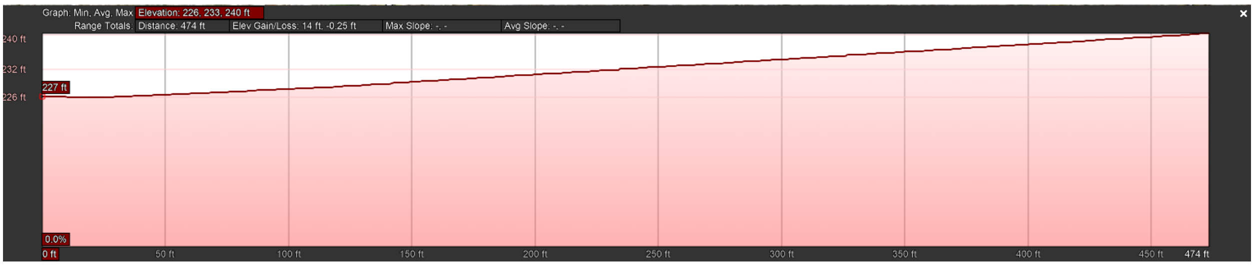
Avg Slope: -, -
234 ft
234 ft
229 ft
0.0%
0 ft
50 ft
100 ft
150 ft
200 ft
250 ft
300 ft
350 ft
400 ft
464 ft



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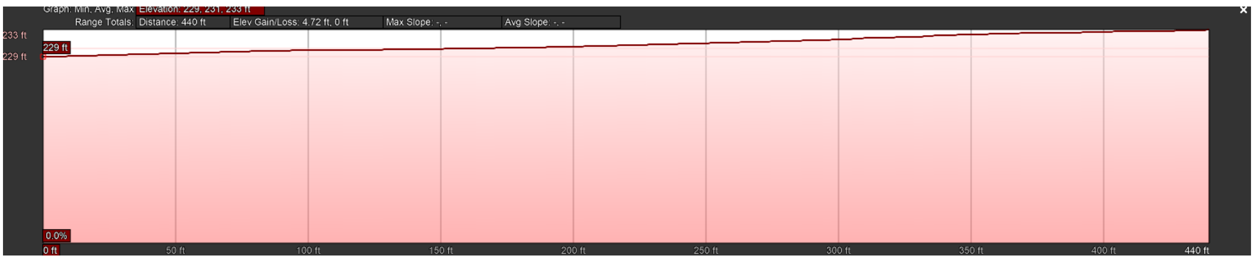
Avg Slope: -, -
240 ft
232 ft
227 ft
226 ft
0.0%
0 ft
50 ft
100 ft
150 ft
200 ft
250 ft
300 ft
350 ft
400 ft
450 ft
474 ft



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Elevation: 229, 231, 233 ft
Range Totals:
Distance: 440 ft
Elev Gain/Loss: 4.72 ft, 0 ft
Max Slope: -, -
Avg Slope: -, -
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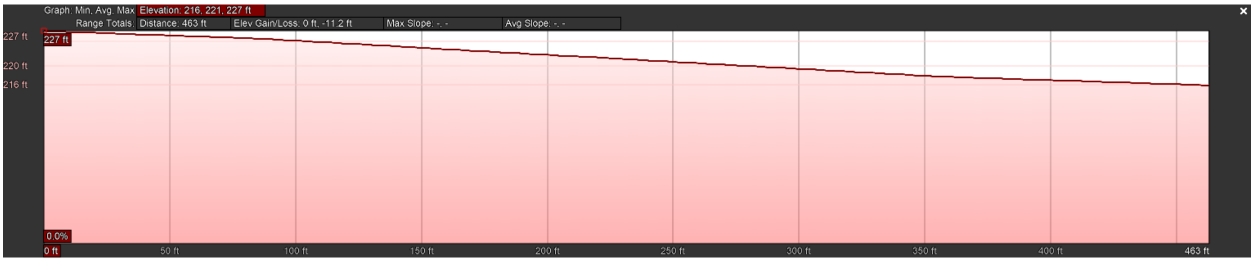
229 ft
229 ft
0.0%
0 ft
50 ft
100 ft
150 ft
200 ft
250 ft
300 ft
350 ft
400 ft
440 ft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Range Totals:
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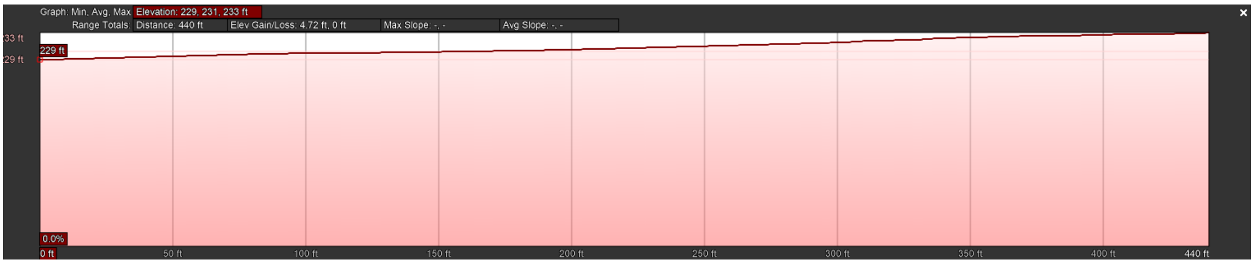
Avg Slope: -, -
227 ft
220 ft
216 ft
0.0%
0 ft
50 ft
100 ft
150 ft
200 ft
250 ft
300 ft
350 ft
400 ft
463 ft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Elevation: 229, 231, 233 ft
Range Totals:
Distance: 440 ft
Elev Gain/Loss: 4.72 ft, 0 ft
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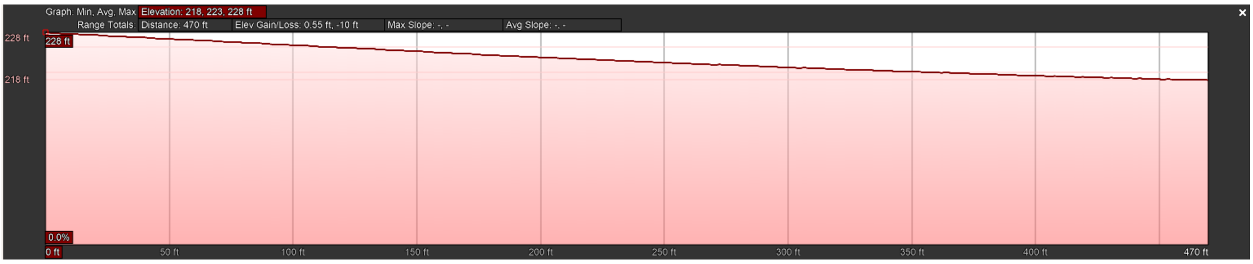
Avg Slope: -, -
229 ft
0.0%
0 ft
50 ft
100 ft
150 ft
200 ft
250 ft
300 ft
350 ft
400 ft
440 ft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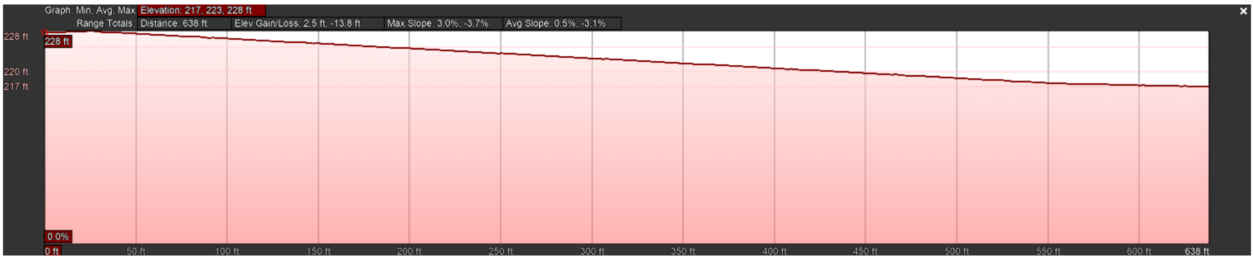
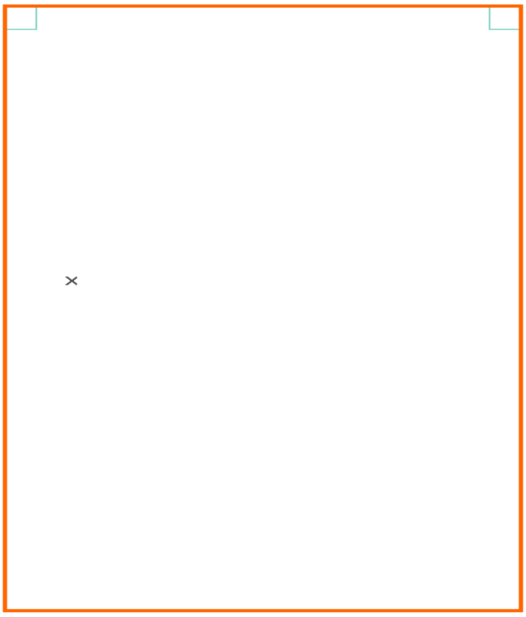
Range Totals:
Distance: 470 ft
Elev Gain/Loss: 0.55 ft, -10 ft
Max Slope: -, -
Avg Slope: -, -
228 ft
218 ft
0.0%
0 ft
50 ft
100 ft
150 ft
200 ft
250 ft
300 ft
350 ft
400 ft
470 ft

Street of drainage system



- **Drainage system designDrainage**



- **Area : 35X55 = 1925m2**

- **The Following is the Formula we Used:**

$$S_{\%} = \frac{\text{Rise}}{\text{Run}} \times 100$$

$$S_{\%} = \frac{\text{Highest Elevation} - \text{Lowest Elevation}}{\text{Distance}} \times 100$$

$$\frac{100.755 - 100}{220} \times 100$$

$$= 0.343\overline{18}$$

Conclusion

- The Highest Point H is 100.755 and the
- Lowest Point L is 100

And the Drainage Follow direction is East Side or Bar Ubah side   due to the topography of the land.

3.0 -ROAD RECONSTRUCTION LAYOUT SKETCH

Total Width: 30m (15m from the centerline to each side)

Carriageway: Two lanes, each approximately 3.5m wide.

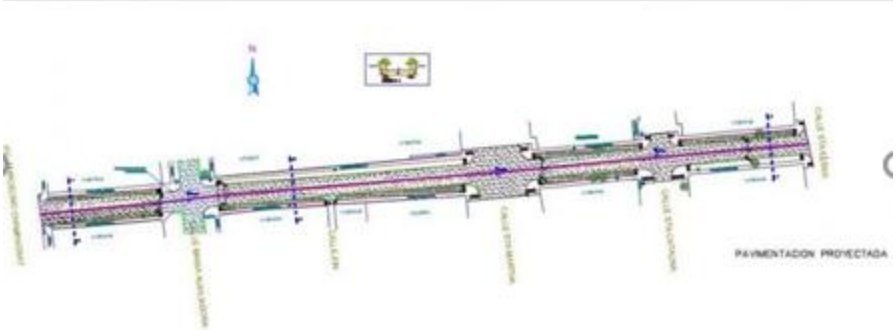
Road Shoulders: Providing lateral support and safety.

Side Drains: Positioned along the edges to collect runoff.

Outlet Points: Connected to low-lying discharge areas. Flood Prevention Mechanism:

The road features a slight slope (cross-fall) of 2–3%, ensuring water flows from the center toward the edges.

Runoff is channeled directly into the drainage network to prevent accumulation.



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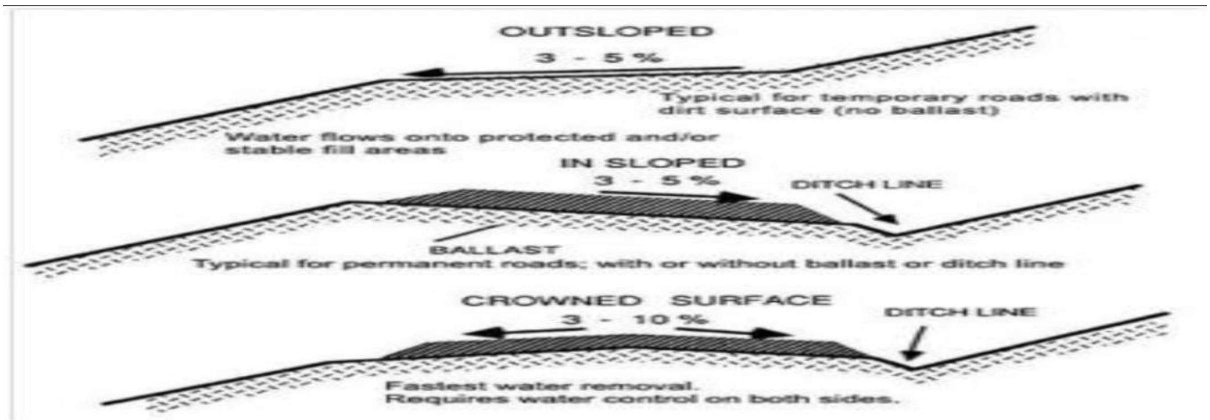


3.1 - **Drainage system concept diagram**

Side Drains: Open channels for surface water.

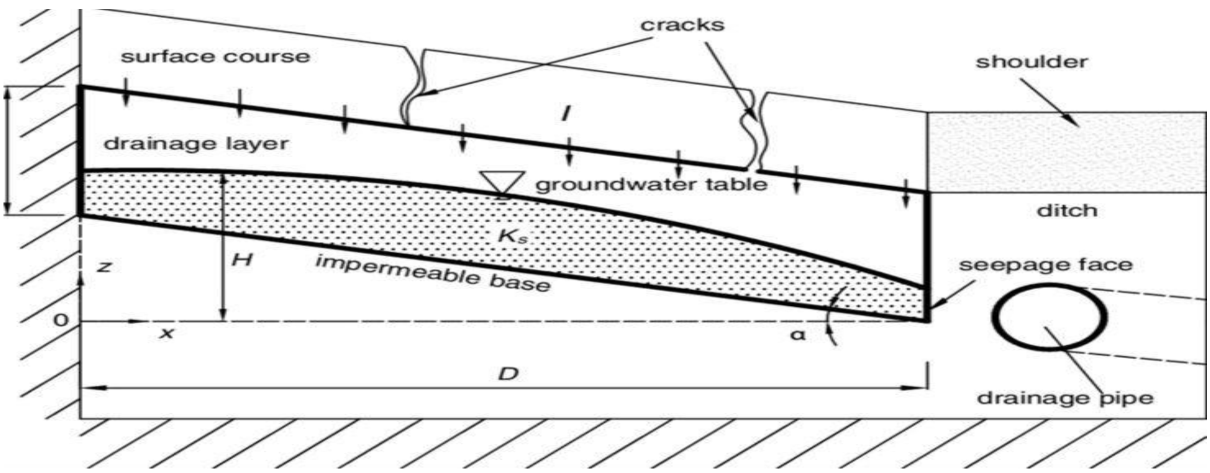
Culverts: Transverse pipes allowing water to cross under the road.

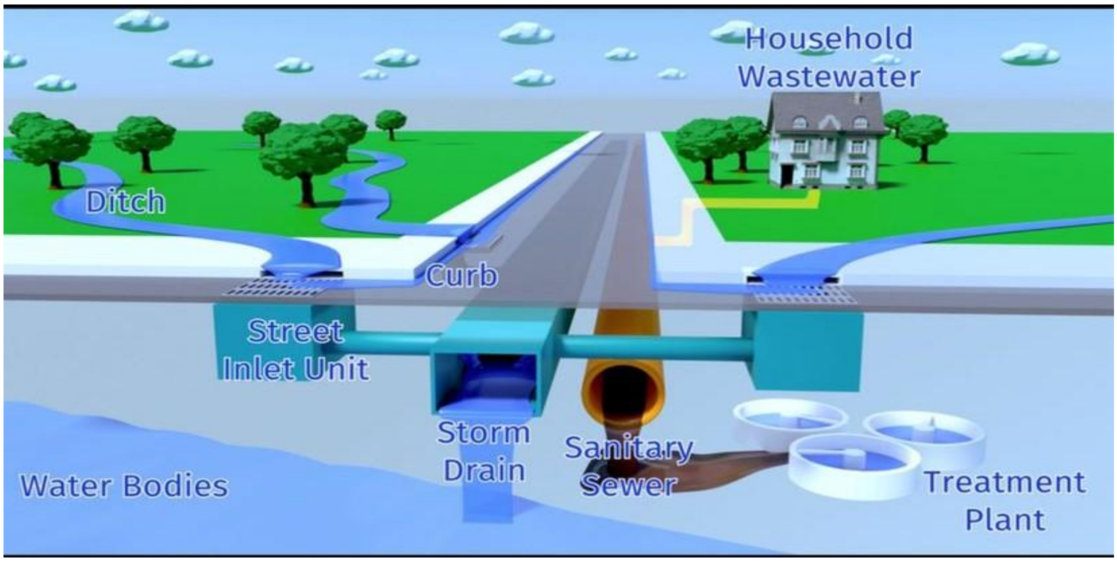
Underground Perforated Pipes: For subsurface drainage and groundwater control.

Outlet Channel: The final discharge point.

Operational Flow:

Rainfall → Road Surface → Side Drains → Culverts → Discharge into low-lying areas or reservoirs.

❖ 



3.2 Road cross-section drawing

Asphalt Layer: The durable wearing course.

Base Course: The primary structural layer.

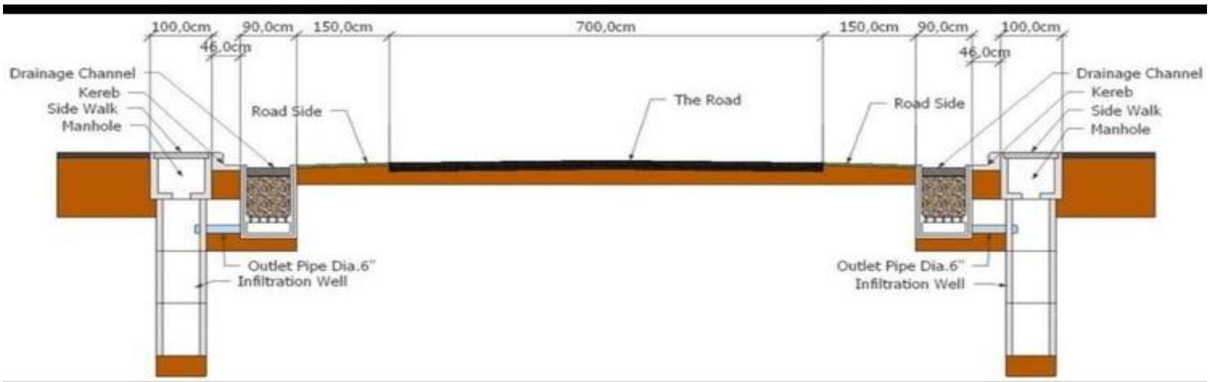
Subgrade: The prepared natural soil foundation.

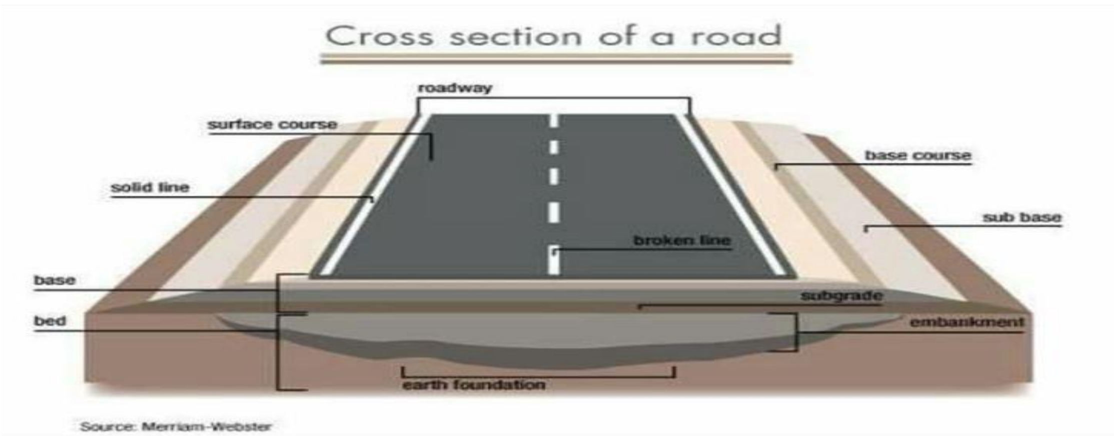
Camber: The subtle convex curvature of the road surface.

Side Drains: Situated at the base of the embankment.

Benefit:

The Camber forces water away from the center of the road, while the side channels capture and transport it, protecting the road's structural integrity.





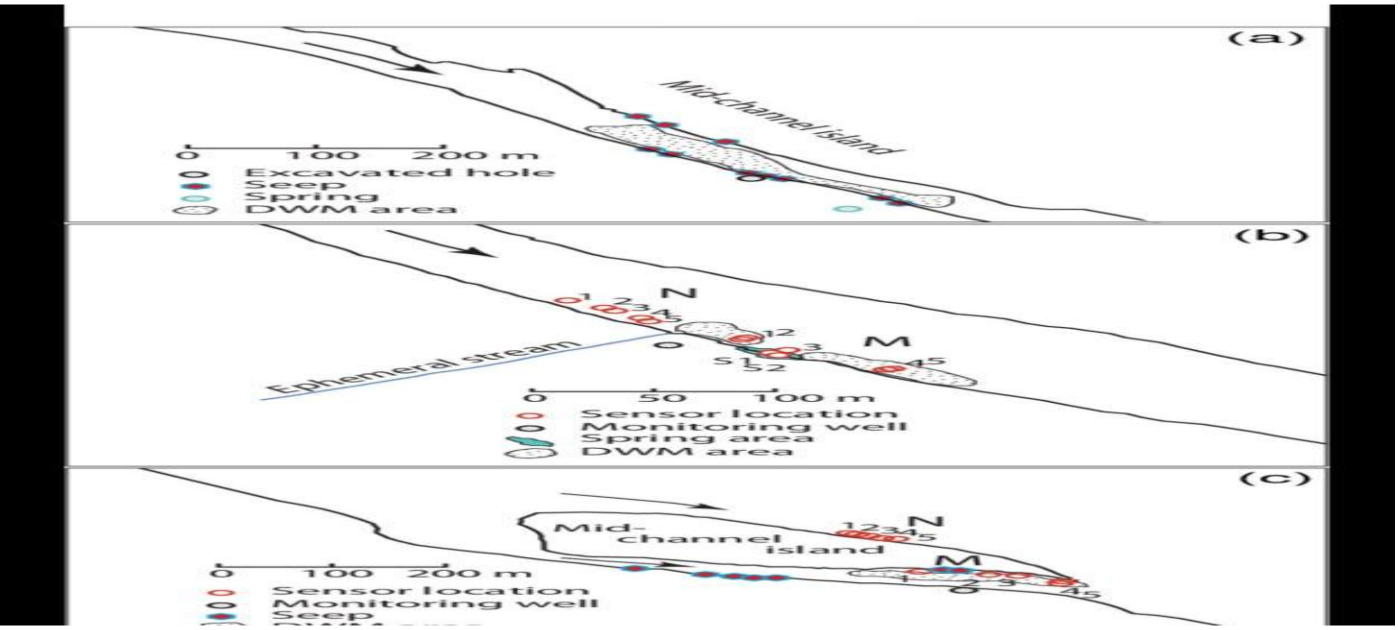
3.3 Water Flow Direction SketchDescription:

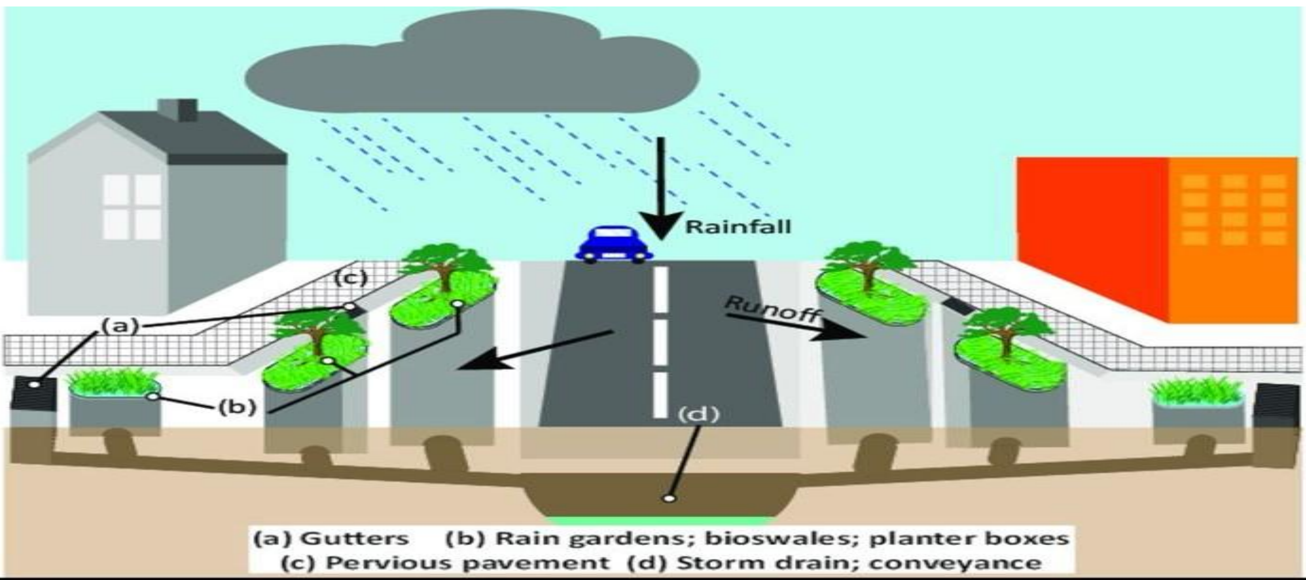
Flow Arrows: Visual indicators showing the path of runoff.

Gradient: A slope moving from high-elevation points to lower discharge zones.

Final Outlet: The designated end-point for all collected water.

Objective: To ensure "positive drainage" and eliminate ponding (standing water) on the road surface.





3.4 - Sustainable Drainage Features (SUDS)Sustainability Elements:

Bioswales: Vegetated channels that naturally filter and slow down runoff.

Permeable Pavement: Pedestrian areas designed to allow water to infiltrate the ground.

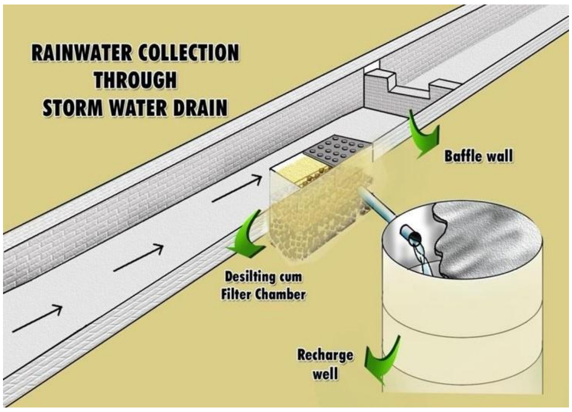
Rainwater Harvesting: Systems to capture and store rain for reuse.

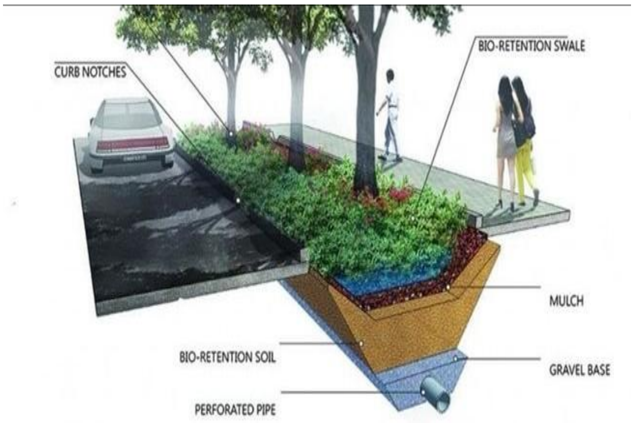
Roadside Trees: Strategic planting to absorb water and stabilize soil.

Benefits: Reduced flood risk and peak flow.

Improved water quality through natural filtration.

Enhanced environmental protection and urban aesthetics.





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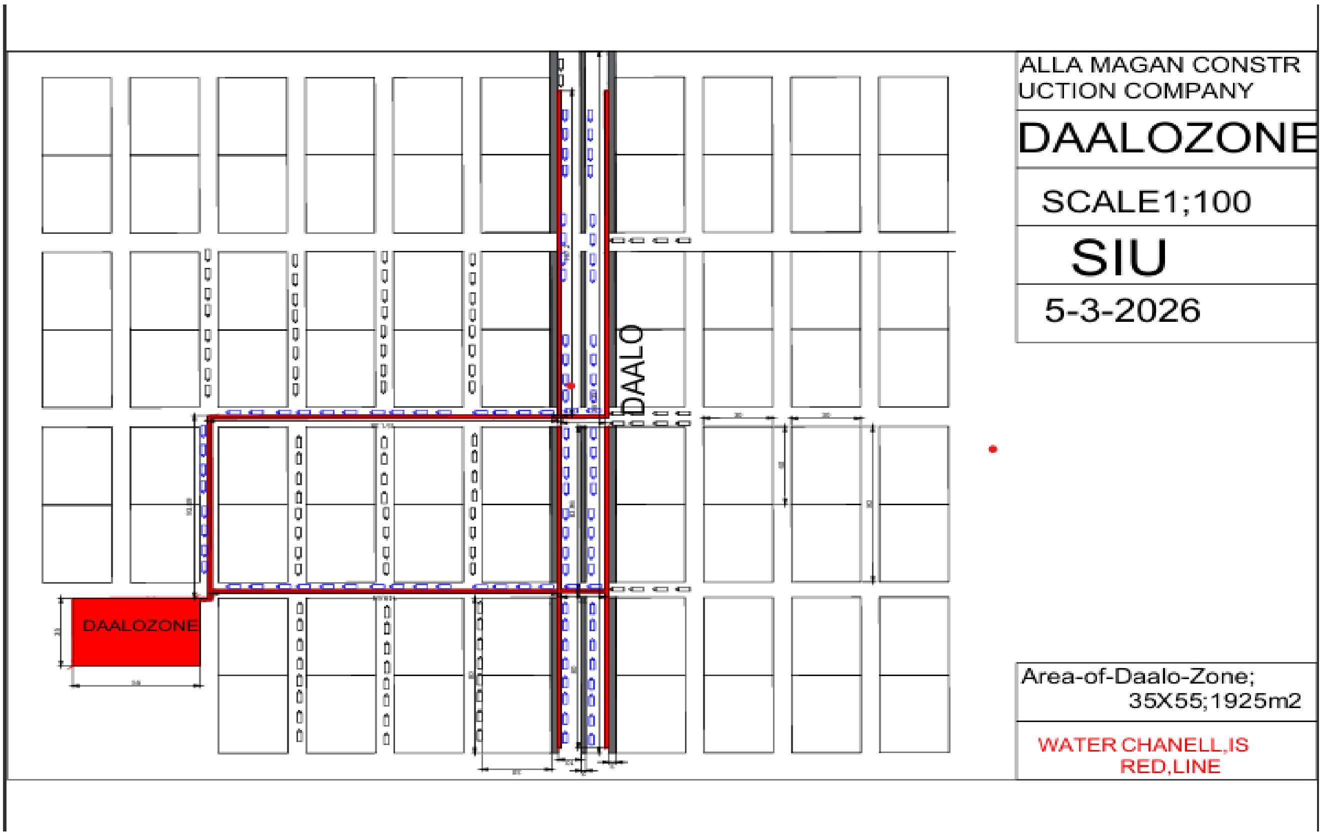
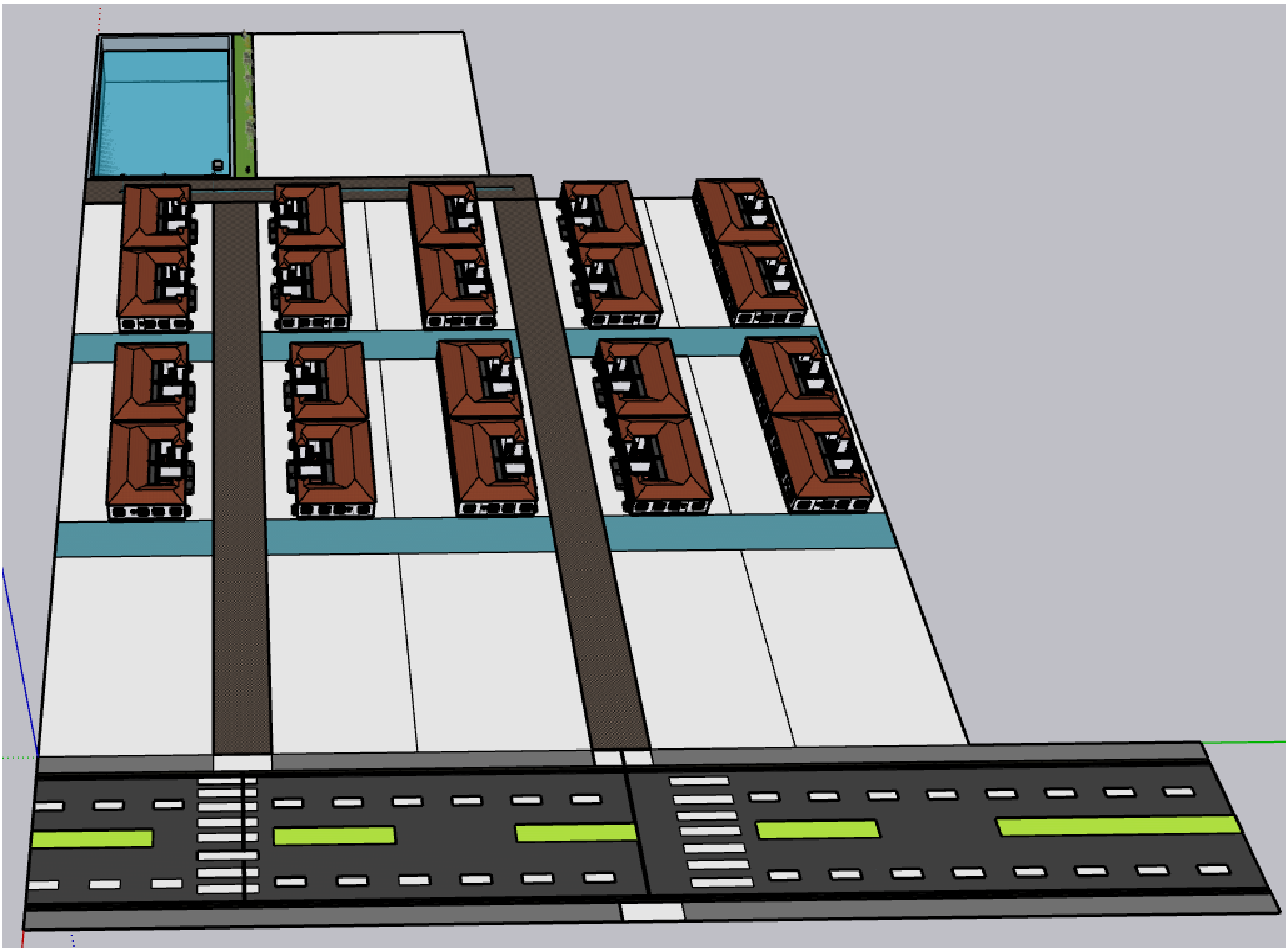
4.0- 2D Plan Road

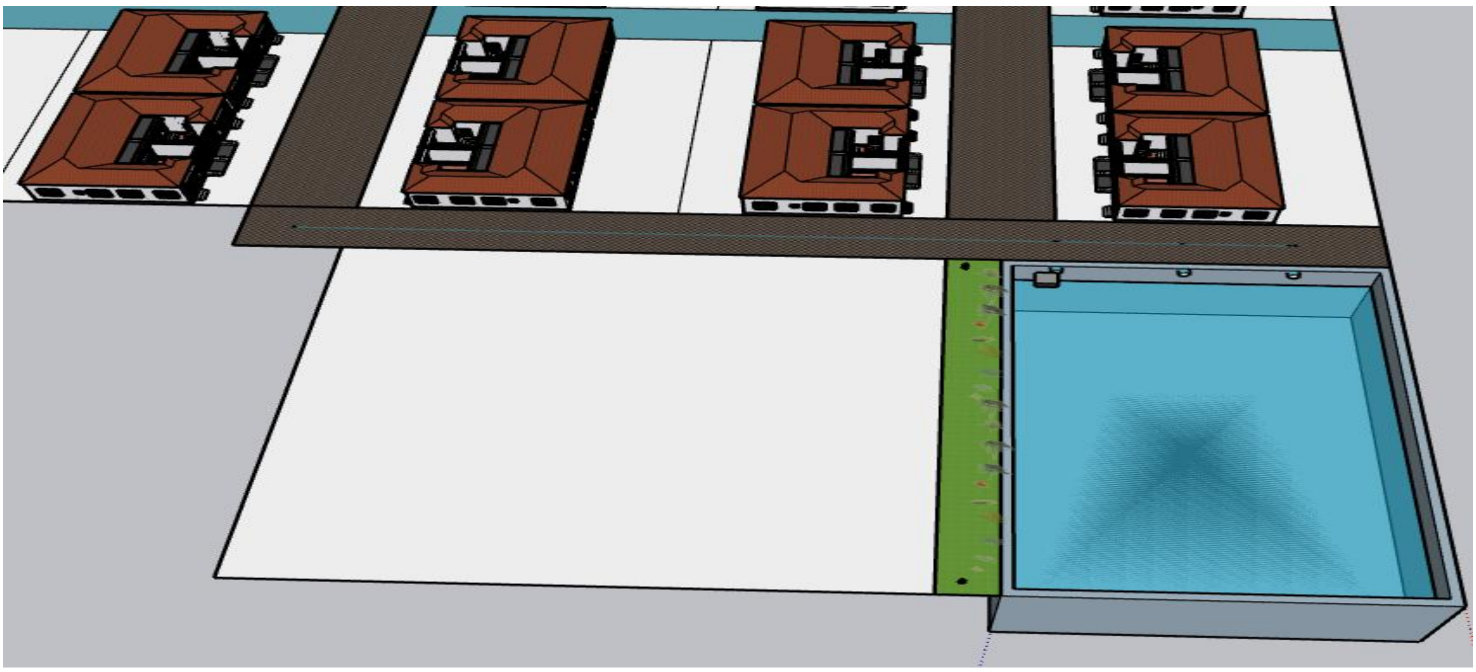


4.1-ELEVATION OF DRAINAGE SYSTEM

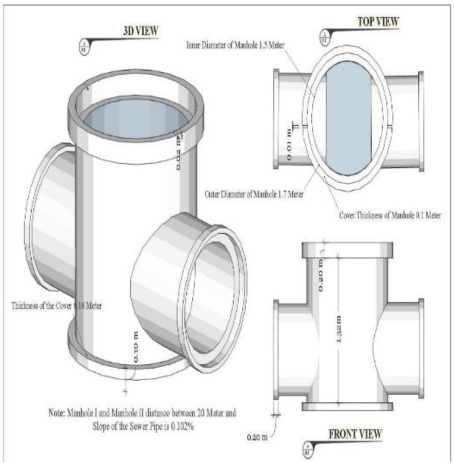
4.2- 3D Road

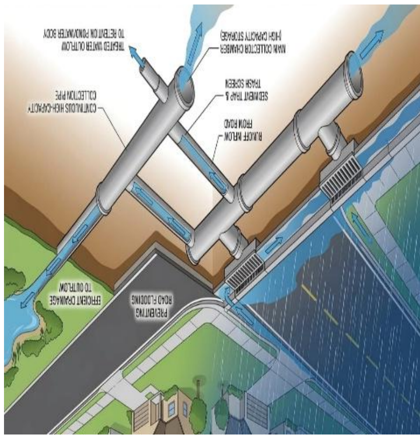


4.3- 3D Storage Water ARea



5.0 PLANNING , DESIGN OF ROAD SIDE DRAINAGE SYSTEM





5.1 Somalia Precipitation Average

Somalia: Precipitation

Somalia	Precipitation, mm per year
Latest value	282
Year	2022
Measure	mm per year
Data availability	1961 - 2022
Average	282
Min - Max	282 - 282
Source	FAO

Specially Banadir Region

- The Banaadir region, which includes the capital city of Mogadishu, receives an average of approximately 399 mm (15.7 in) of rainfall per year. This is significantly higher than the national Somalia average of 282 mm.
- Somalia Precipitation - data, chart | TheGlobalEconomy.com https://share.google/vMfKAtN7E1sW9T2fN

5.2 Storm water Storage Tanks

Reliable Water Tanks in Ethiopia: Rainbow Reservoirs' Sustainable Storage Solutions

Summery

- This integrated design provides a comprehensive solution that:

❖ Prevents water stagnation on the carriageway.

❖ Optimizes storm water runoff management.

❖ Extends the lifespan of the road infrastructure.

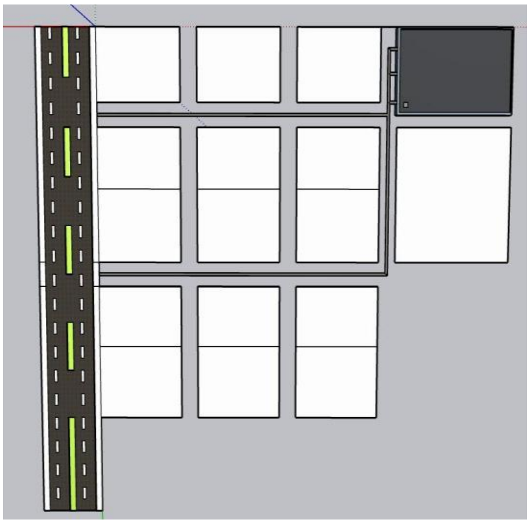
❖ Minimizes flood-related damages and maintenance costs.

5.3 Water Storage & Road Design

Rectangle Storage Calculation and Pavement Layout

5.4.0 Pavement Layout

- Total Width = 30 m
- Two lanes Each Side
- Median (waist) = 3 m
- Other section = 10 m



5.4.1 Road Dimensions

- Total Width = 30 m
- Left Walkway = 3.5 m
- Left Carriageway = 10 m
- Median = 3 m
- Right Carriageway = 10 m
- Right Walkway = 3.5 m

5.4.2 Drainage Pipe System Calculations

Drainage Pipe System Calculations

✅ **Given:**

- Diameter $D = 1, m$
- Radius $r = D/2 = 0.5, m$

📐 Step 1: Cross-Sectional Area of Tube

$$\text{Area} = \pi r^2$$

$$\text{Area} = 3.1416 \times (0.5)^2$$

$$\text{Area} = 3.1416 \times 0.25 = 0.7854\, m^2$$

📦 Step 2: Volume per meter of tube

$$\text{Volume} = \text{Area} \times \text{Length}$$

$$\text{Volume} = 0.7854 \times 1 = 0.7854\, m^3$$

💧 Step 3: Convert to liters

$$0.7854 \times 1000 = 785.4 \text{ liters per meter of tube}$$

✅ Summary:

- **Tube diameter:** 1 m
- **Cross-sectional area:** 0.785 m^2
- **Volume per meter of tube:** 0.785 m^3
- **Liters per meter of tube:** 785.4 L

5.4.3 Water Storage Calculation

Rectangle

- Width = 34 m
- Length = 54 m
- Depth=2m

Step 1: Area

- Area = 34 × 54 = 1836 m²

Step 2: Volume

- Volume =1836 ×2= 3672 MC
- 
- Storage Examples
- 100 mm = 367,200 liters
- 1000 mm (1 m) = 3,672,000 liters
- 2000 mm (2 m) = 7,344,000 liters

6.0 GEOTECHNICAL INVESTIGATION

A. Drainage & Flood Risk

1.Site drainage at Daalo Road, Bakaro Market, Mogadishu is moderate to poor.

Some signs of water accumulation are observed during rainfall due to limited drainage systems.

The area appears potentially prone to flooding, especially during rainy seasons.

2. General Geotechnical Interpretation

B.0 Preliminary Subsurface Interpretation

Based on visual assessment of Daalo Road (Bakaro Market area):

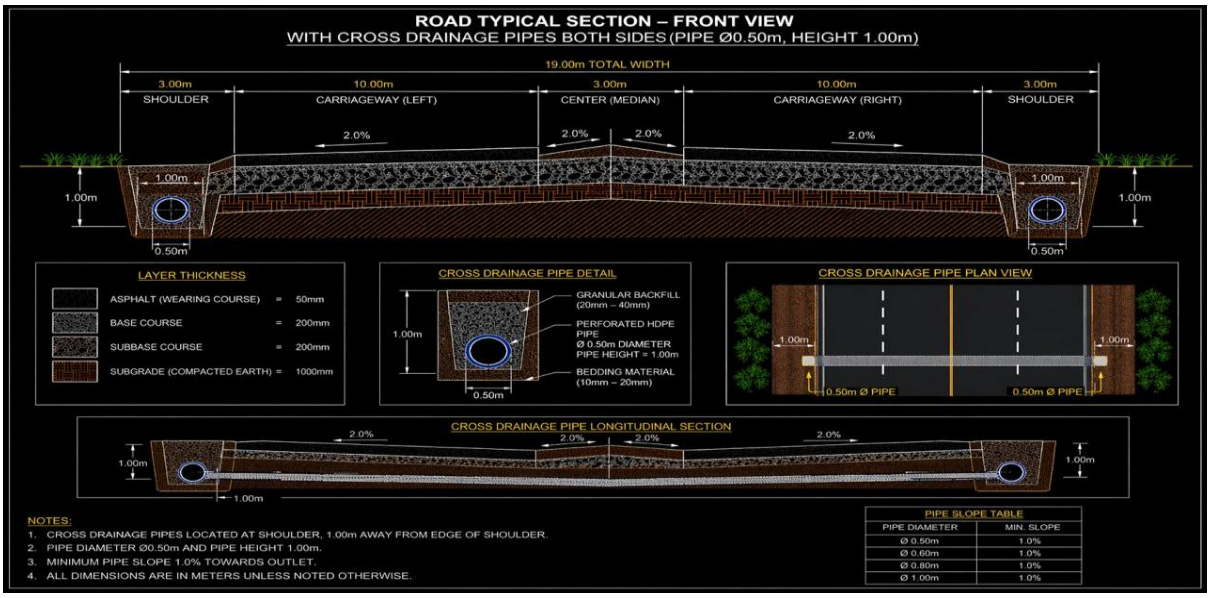
Subsoil is likely composed of:

- Silty sand with sandy clay layers
- Soil conditions suggest:
- Moderate bearing capacity
- **Settlement risk: low to medium**
- The subsurface conditions are preliminarily interpreted as cohesive to semi-cohesive soils, suitable for light to medium structures with proper design.
- **3. Preliminary Engineering Assessment**
- **C.0 Foundation Considerations**
- Based on assumed soil conditions:
- Shallow foundations (strip or pad footings) are likely suitable
- Ground compaction may be required in weaker zones
- Estimated allowable bearing capacity:
- **100 – 200 kPa** (ASSUMED)
- These values are indicative and based on typical soil behavior observed at the site.

D. Limitations & Disclaimer

- **E.0 Limitations of Study**
- This assessment is based only on visual inspection of Daalo Road.
- No boreholes, in-situ testing, or laboratory analysis were conducted.
- Therefore, subsurface conditions may vary and cannot be fully confirmed.
- A detailed geotechnical investigation is recommended before construction**.**

6.1 Structure of Pavement



5.3 Cost Estimation

	Daalo Road Drainage System Estimation				
No	DESCRIPTION OF WORKS	Unit	Quantity	Rate	Amount
1	Site Clearing & Excavation	MC	1000	2	2,000
2	Subgrade Preparation	Msq	5000	3	15,000 $
3	Gravel Base Layer	MC	750	8	$6,000
4	Concrete Pavement	MC	1000	140	$140,000
5	Drainage Pipes	M	881	40	$35,240
6	Culvert & Outlets	M	881	40	$35,240
7	Equipment & Machinery				
	Labor Cost	L.S	20	$15	$9,000
	Bulldoser	L.S	3	$300	$900
	Excavator	L.S	10	$300	$3,000
	Dump Truck	L.S	10	$150	$1,500
	Roller Compactor	L.S	6	$250	$1,500
	Concrete Mixer	L.S	10	$150	$1,500
	Water Tanker	L.S	8	$150	$1,200
	Vibrator	L.S	10	$50	$500
	Survying Equipment	L.S	1	$80	$80
8	Shear wall Underground				
	Cement		3905	$8.50	33192$
	Sand		1018	$200	203,600$
	Aggregate		1629	$500	814,500
9	Road Layers				
	Wearing	Mq	250 Mq	$560	$140,00
	Binder	Mq	400 Mq	&560	$224,000
	Sub-base	Mq	1000 Mq	4200	$200,000
	Sub-grade	Mq	1001 Mq	$200	$200,000
10	Supervision & Testing	L.S	1	$8,000	$8,000
				Total Am	1,684,160