

**Fisherman's Cove and Story Hotel
Bel Ombre, Seychelles
Hydrology & Hydraulic Analysis
Progress & Way Forward**

June 27, 2024

Presentation Outline

1. Introduction
2. Study Breakdown
3. Data Collection
4. Hydrological Assessment & Modeling
5. Existing Conditions Hydraulic Modeling
6. Solutions & Recommendations

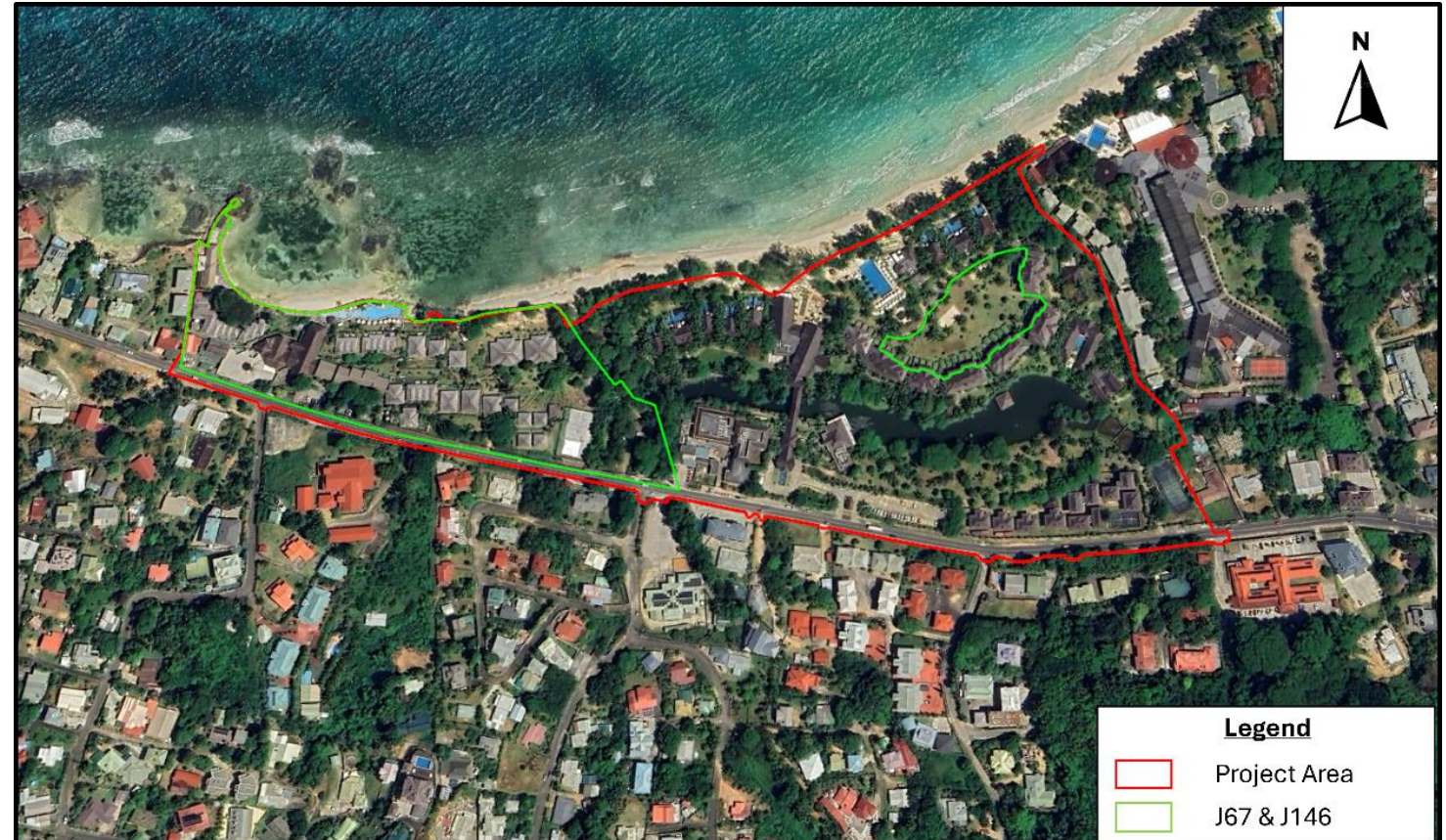
1. Introduction

1. Introduction

As part of the proposed re-development of existing buildings on parcels J67 & J146 of the Fisherman's Cove and Story Hotel Bel Ombre, Seychelles, an environmental impact assessment study is required.

As part of the EIA study, a hydrology and hydraulic analysis of the project area is required, the scope of this presentation is to present the findings of the analysis done and discuss any engineering solutions, if required. A special focus is reserved for the J67 & J146 parcels.

The Fisherman's Cove and Story Hotel project area has an area of 11.27 hectares, while the J67 & J146 parcels have a total area of 3.55 hectares, which is around 31.5 % of the plot area.



2. Study Breakdown

2. Project Methodology

The hydrology and flood mitigation report and study is divided into the following main sections:

- A. Data Collection
- B. Watershed Morphology
- C. Hydrological Modelling
- D. Hydraulic Modelling
- E. Solutions & Recommendation's

3. Data Collection

3. Data Collection

The data collected for the purpose of this study can be divided into three categories and are as follows:

1. Topographic Data
2. Masterplan Data
3. Existing Hydraulic Structures
4. Geological/Land Use Data
5. Rainfall Data

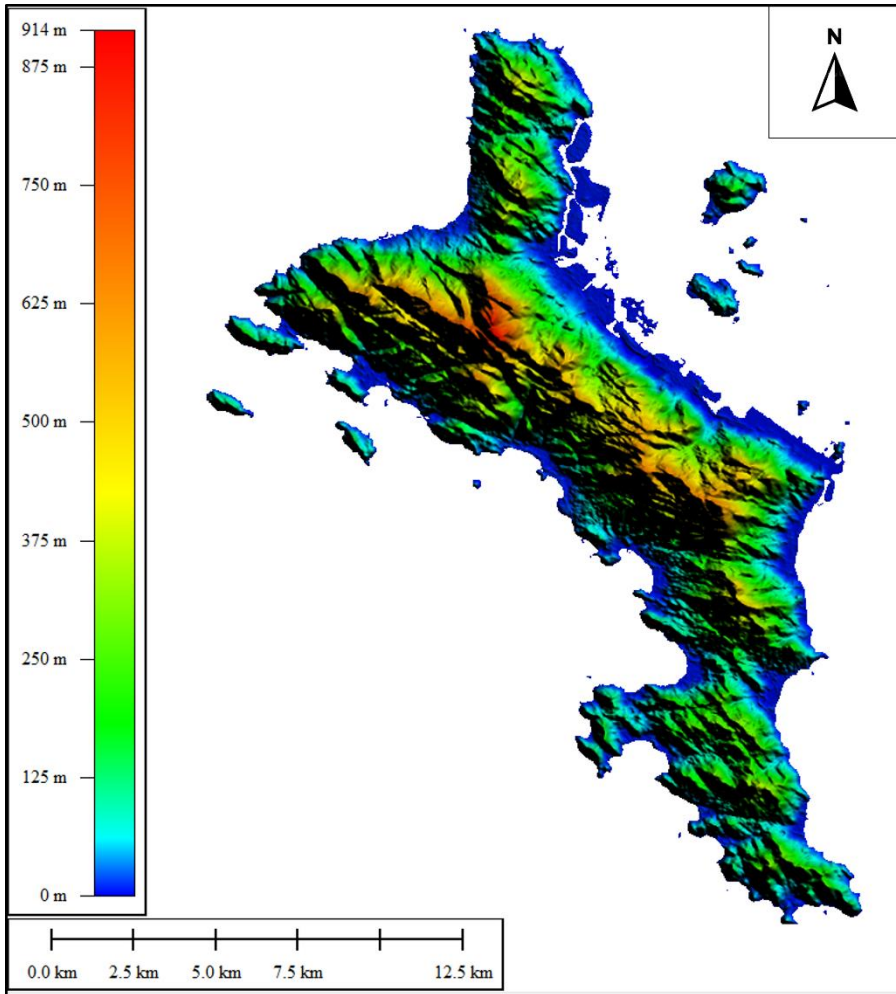
3.1. Topographic Data

Topographic data is needed to identify the location and direction of all of the natural water streams in the surrounding the project area. The data is also required to delineate the borders of the watershed that might have an effect on the hydrological conditions of the project area, as well as identifying the morphological characteristics of the watershed.

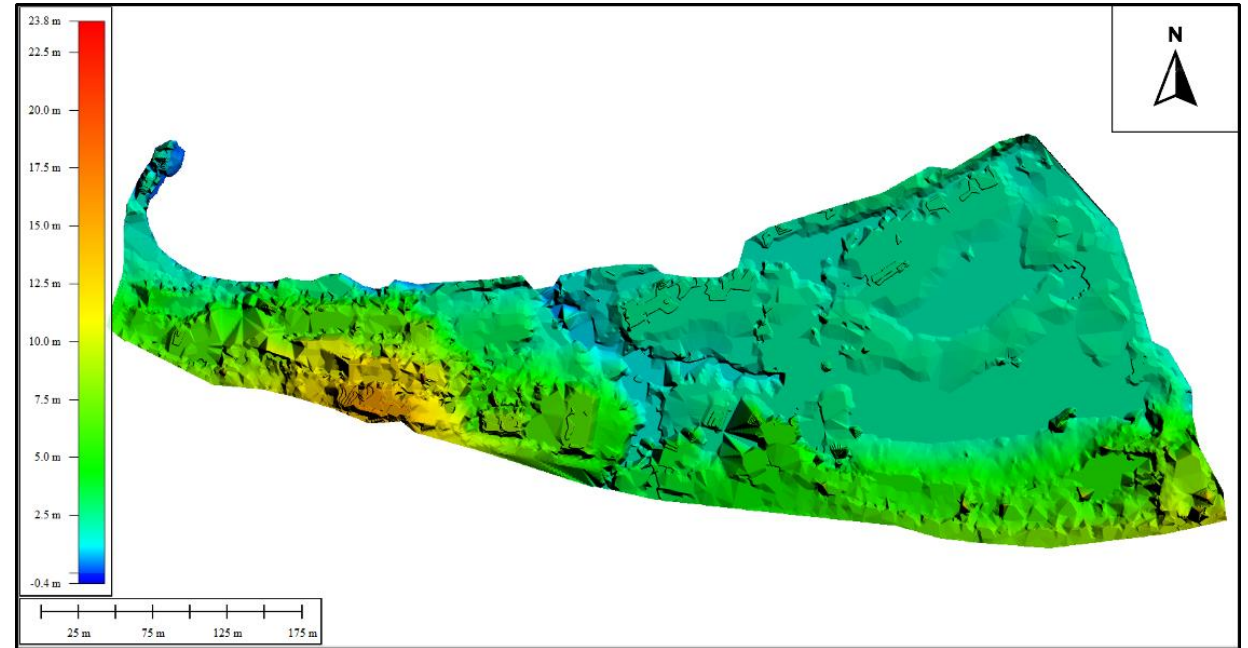
Furthermore, the topographic data will be utilized in the hydraulic modeling and flood plain development of streams that may pass near or through the project area. The collected topographic data can be summarized as follows:

- DEM (Digital Elevation Model) of 30 m accuracy.
- Survey of the Project Area and Surrounding Area

3.1. Topographic Data



DEM (Digital Elevation Model) of 30 m accuracy

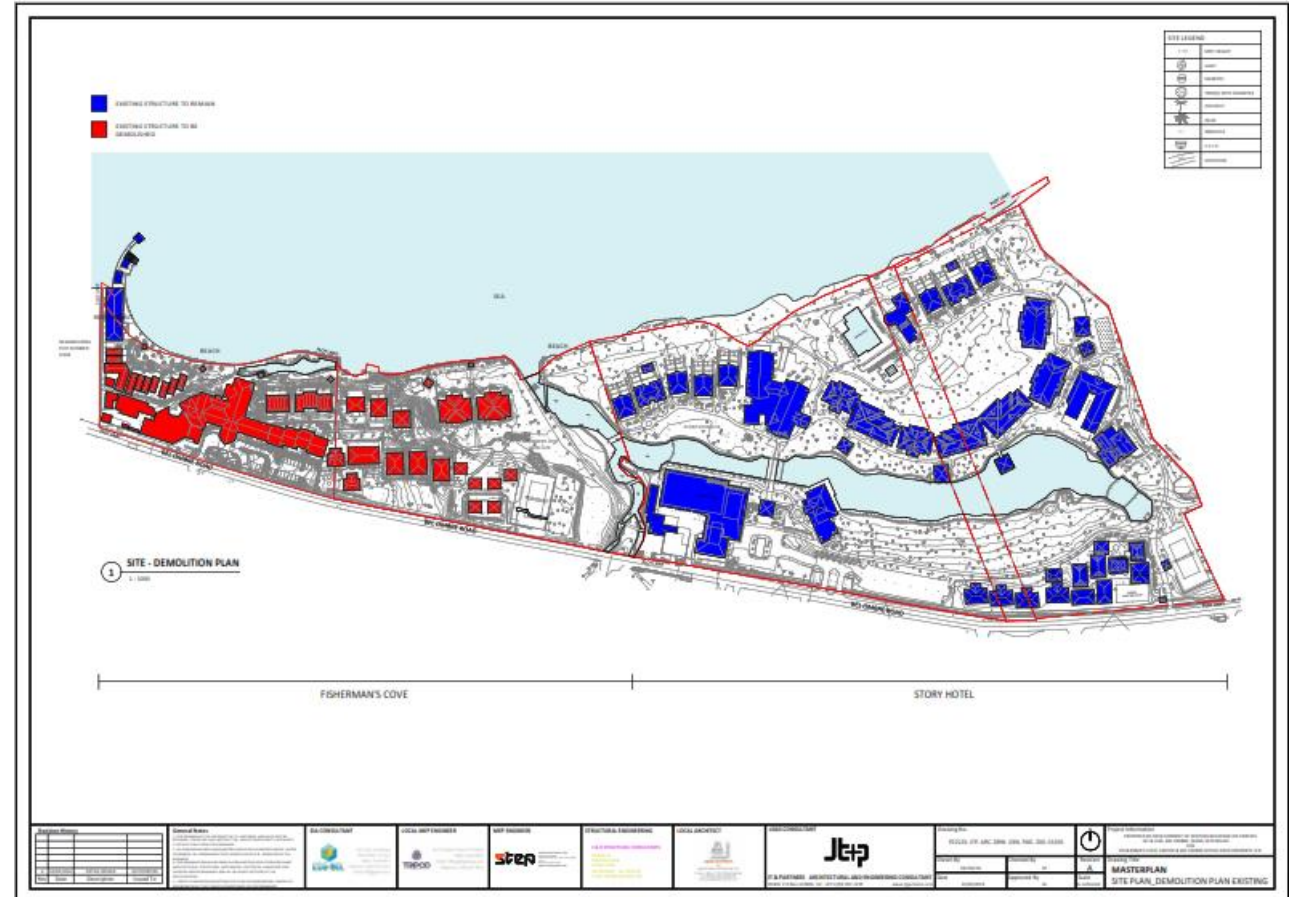


Collected Survey Data

3.2. Masterplan Data

The proposed masterplan of the project area was collected and is required to identify the different land use of the project area and possible affecting watershed.

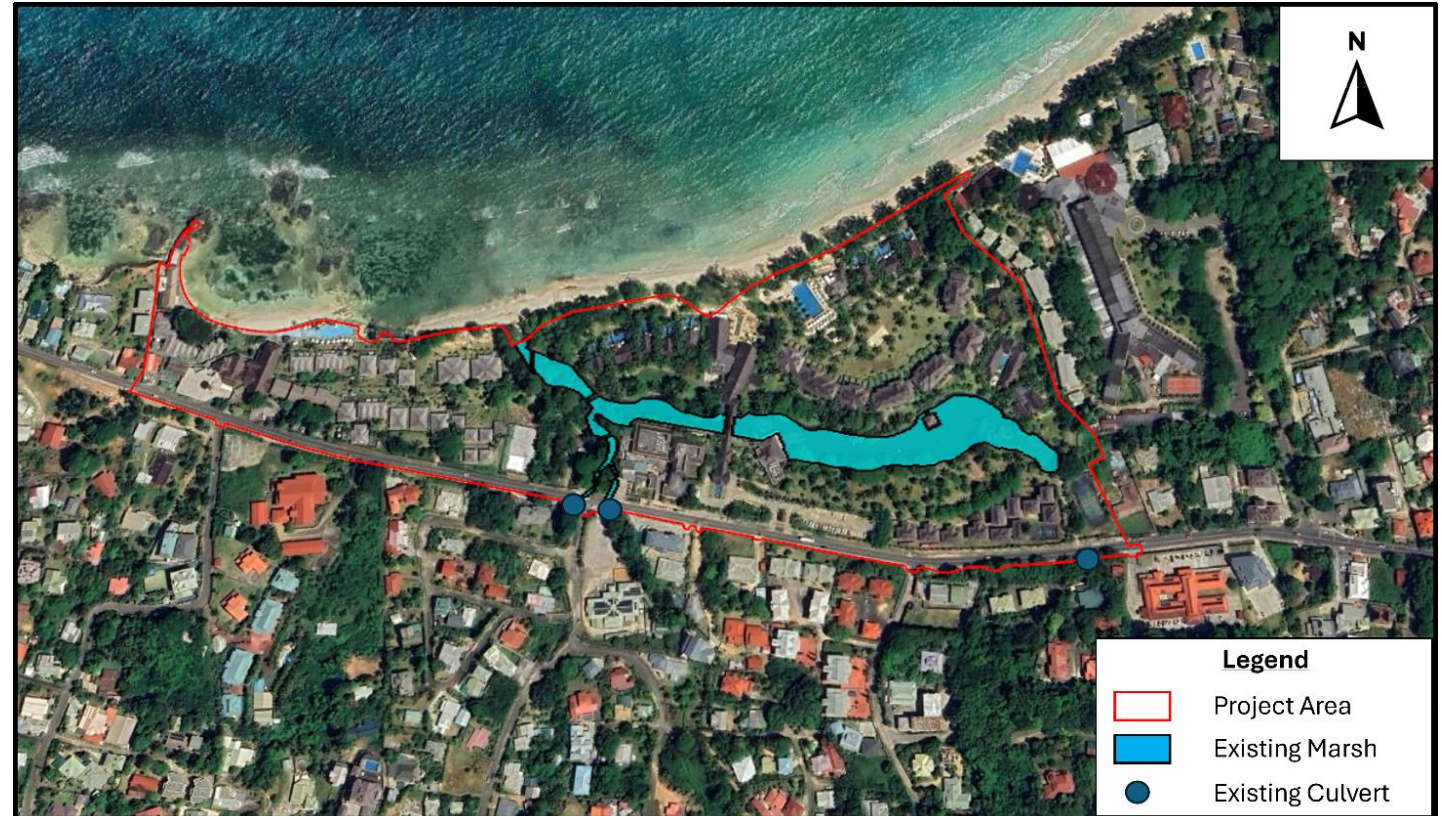
This information is used to identify the hydrological soil groups present inside the watershed in order to estimate the runoff coefficients and curve numbers relative to each watershed.



3.3. Existing Hydraulic Structures

As part of the data collection, the identification of any existing hydraulic structures is paramount to understanding the hydrological and hydraulic parameters of the project site.

In total, 3 culverts were identified as well as an existing marsh, which during rainfall events will act as a naturally occurring channel. The figure shows the location of the identified hydraulic structures.



3.4. Geology/Land Use

The geology and land use of the affecting watershed has a great effect on the peak flow values generated by each watershed.

The geology of the watershed is used to identify the different soils included inside the borders of the watershed, based on the infiltration rates of the identified soils, the hydrological soil group of each can be estimated. Combined with a detailed analysis of the land use included inside the watershed, one can calculate the curve number (CN).

The land use inside of the project area was determined using a mixture of the collected masterplan data and the external watersheds were using the ESRI land use map for Seychelles.

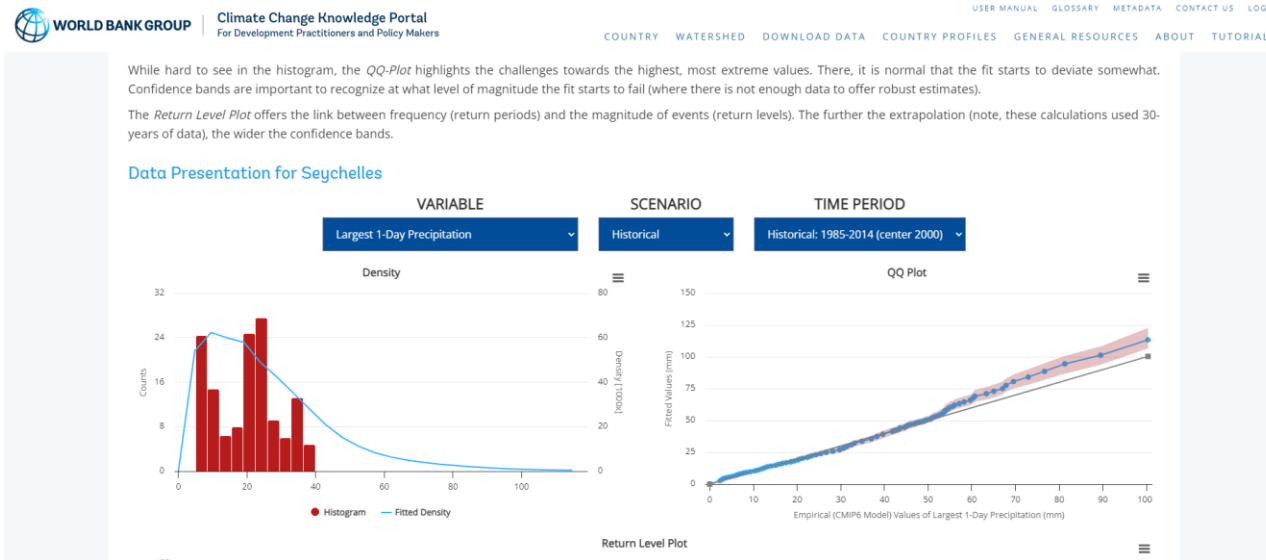


3.5. Rainfall Data

Rainfall data is essential to any flood risk assessment and protections study. The collected data was used to identify the rainfall intensity and rainfall depth for the different design storm return periods.

Rainfall data was collected from multiple sources and not limited to:

- The Ministry of Environment and Energy of The Republic of Seychelles (THE STUDY FOR COASTAL EROSION AND FLOOD CONTROL MANAGEMENT IN THE REPUBLIC OF SEYCHELLES, 2014)
- World Bank Group (Extreme Precipitation Events Analysis, 2022)



Screenshot of World Bank Analysis

Table 2-5-3: Probable Annual Maximum Daily Rainfall

St.No	Name/Return Period	100	50	20	10	5	3	2
1	Seychelles Airport	287	262	229	203	177	156	136
2	Rawinsonde	232	208	177	153	128	108	90
6	Cascade	250	225	193	167	141	120	101
7	La Misere (Fairview)	271	245	210	183	155	133	113
16	Anse Royale PUC	288	262	228	201	174	152	132
17	Anse Royale Police Stn	229	209	182	162	140	123	108
19	Quatre Bomes	170	153	132	115	98	84	72
21	Anse Soleil	202	184	159	140	119	103	89
22	Pointe Au Sel	256	234	204	181	157	138	121
23	Anse Forbans	178	163	142	125	109	95	83
32	Anse Boileau	227	204	175	152	128	109	92
33	Grand Anse Waterworks	281	254	216	187	157	133	112
37	Tea Factory	289	260	221	191	159	134	112
41	Bon Espoir	242	219	188	164	139	120	102
45	La Misere (Mr. Rose)	335	299	252	216	178	147	120
57	Rochon Waterworks	287	258	219	189	158	133	110
58	Hermitage Waterworks	349	318	276	243	210	183	158
61	St Louis	313	282	241	210	177	150	127
74	Le Niol Waterworks	291	265	230	203	175	153	133
76	La Gogue	269	241	202	172	141	117	95
77	Ma Constance(North East)	293	263	223	192	160	134	111
78	Belombre	290	260	221	190	158	133	111

Ministry of Environment and Energy Rainfall Depths

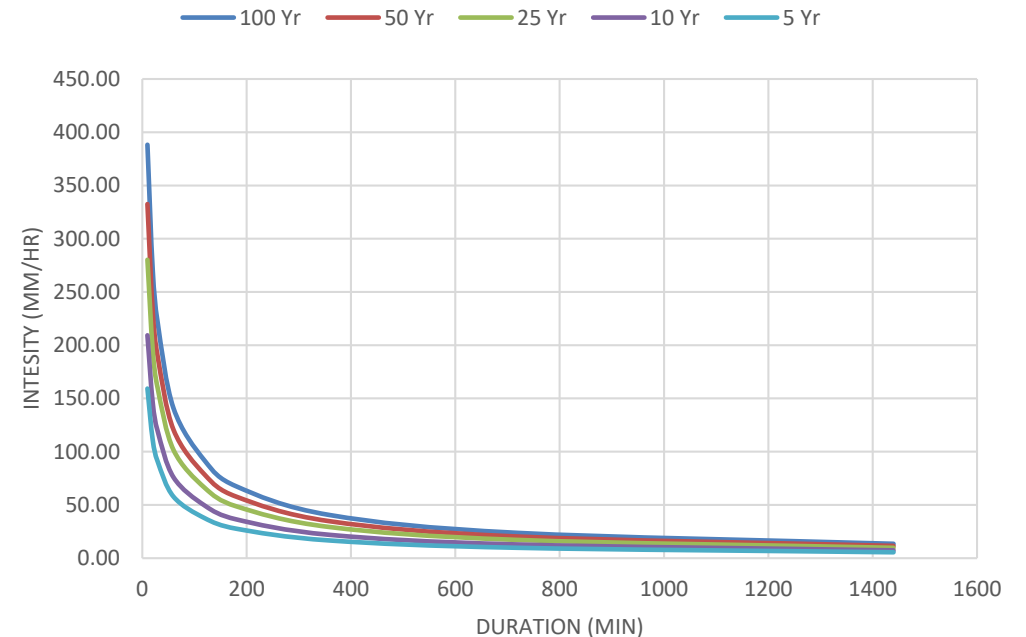
3.5. Rainfall Data

The nearest available stations from the Ministry of Environment and Energy's analysis is the St Louis Station, that has a 100-year rainfall depth of 313 mm, and the World Bank's Adopted Rainfall Depth of 323.58 mm is higher, the adopted rainfall depth is that of the World Bank's analysis which is both more conservative and the world bank's study is more recent it is adopted for the purposes of this study.

Return Period	5	10	20	25	50	100
Depth (mm)	132.64	174.44	220.68	233.47	277.05	323.58

Adopted Rainfall Depths

FISHERMAN'S COVE
 INTENSITY-DURATION-CURVE



4. Hydrological Assessment

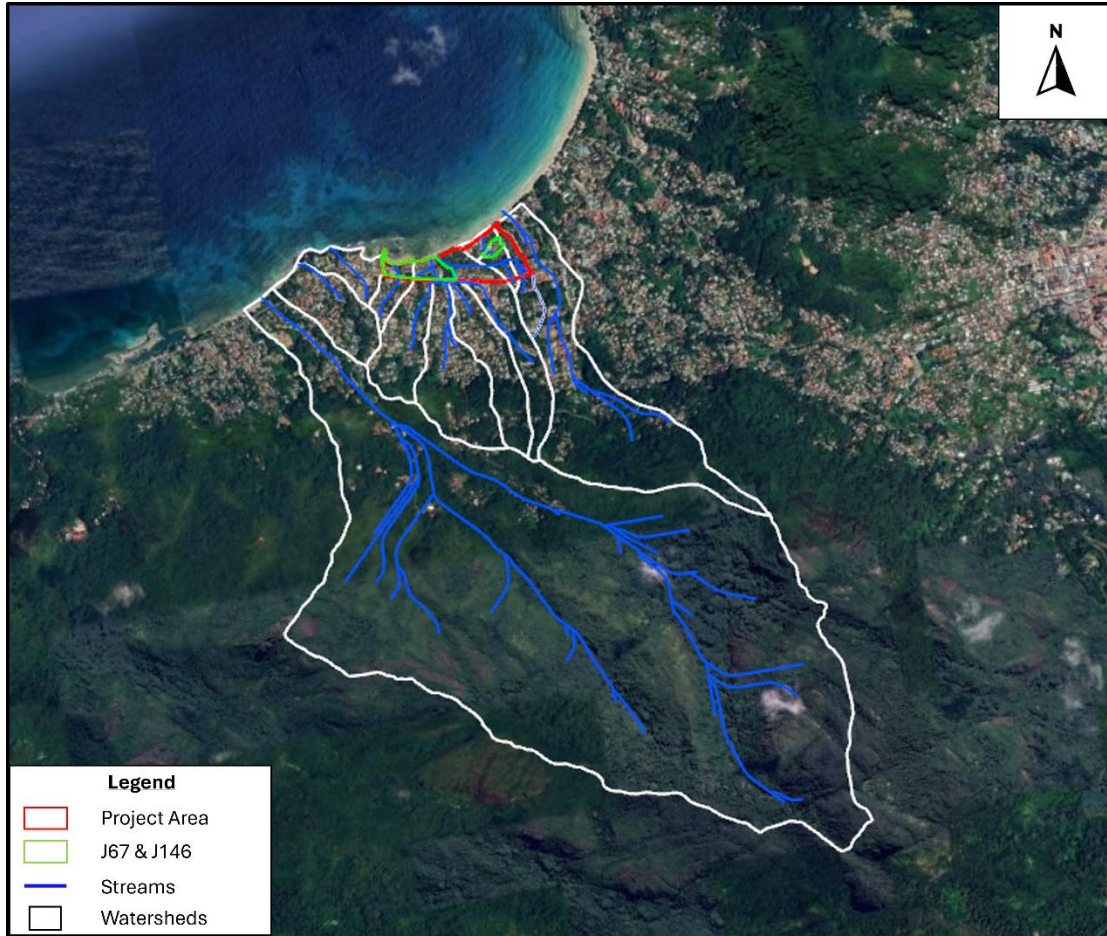
4. Hydrological Assessment

Utilizing the results of the rainfall data analysis in addition to the collected DEM, SAT Imagery, & Site Visit results, a detailed hydrological assessment and model of each of the project areas was developed.

This included the identification of the following key parameters relative to each of the project areas:

- Affecting Watershed Boundaries & Areas
- Watersheds Geological & Morphological Characteristics
- Peak Flow Generated By Each Watershed

4.1. Identified Watersheds



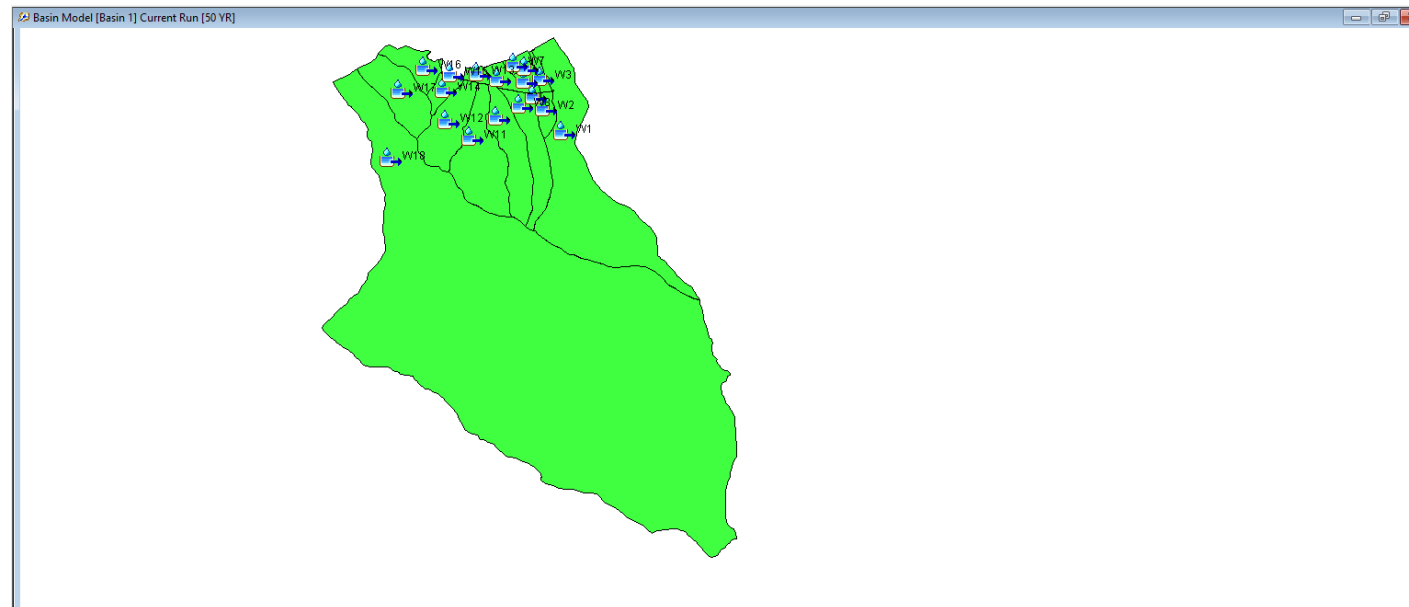
Watershed	Area (m2)	Area (Km2)	Area (Hectare)
W1	553,074.76	0.553	55.307
W2	29,921.08	0.030	2.992
W3	16,011.53	0.016	1.601
W4	2,417.62	0.002	0.242
W5	15,134.66	0.015	1.513
W6	5,551.47	0.006	0.555
W7	15,129.84	0.015	1.513
W8	121,914.74	0.122	12.191
W9	31,649.94	0.032	3.165
W10	145,876.86	0.146	14.588
W11	206,892.05	0.207	20.689
W12	129,558.36	0.130	12.956
W13	17,982.26	0.018	1.798
W14	31,800.52	0.032	3.180
W15	12,107.53	0.012	1.211
W16	65,026.85	0.065	6.503
W17	136,726.77	0.137	13.673
W18	4,015,403.91	4.015	401.540

4.1. Identified Watersheds

Watershed	Critical Stream Length (m)	Slope (%)	CN	c	T lag time (MIN)	Tc (MIN)	Tc Adopted
W1	2,188.49	25.93	64.85	0.51	7.23	12.05	12.05
W2	312.68	12.09	89.00	0.85	6.00	3.61	10.00
W3	298.40	2.01	55.97	0.38	6.00	6.95	10.00
W4	75.46	24.98	89.00	0.85	6.00	0.91	10.00
W5	164.86	4.49	54.70	0.37	6.00	3.23	10.00
W6	75.31	6.69	44.33	0.22	6.00	1.52	10.00
W7	143.79	4.52	51.05	0.31	6.00	2.90	10.00
W8	1,076.33	23.52	75.28	0.66	6.00	7.24	10.00
W9	301.11	2.76	54.03	0.36	6.00	6.20	10.00
W10	1,014.11	24.43	76.32	0.67	6.00	6.82	10.00
W11	983.37	24.45	75.91	0.67	6.00	6.66	10.00
W12	623.13	19.72	83.44	0.77	6.00	5.09	10.00
W13	197.39	3.57	44.26	0.22	6.00	4.05	10.00
W14	303.01	10.46	89.00	0.85	6.00	3.73	10.00
W15	144.00	6.80	49.61	0.29	6.00	2.48	10.00
W16	394.57	5.26	84.98	0.79	6.00	5.95	10.00
W17	655.09	9.14	88.35	0.84	6.00	7.11	10.00
W18	4,389.91	20.37	46.92	0.26	13.56	22.60	22.60

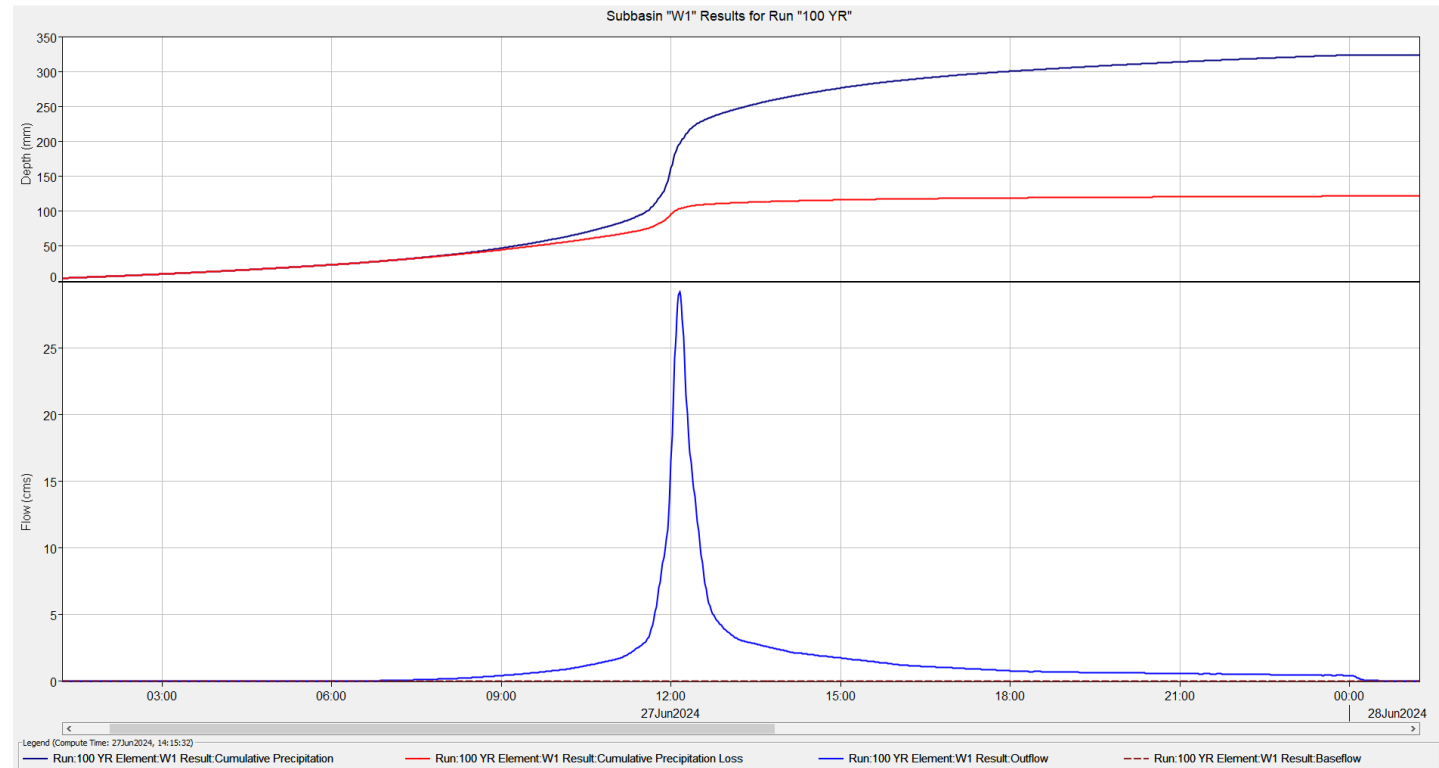
4.2. Peak Flow Calculations

The SCS Unit Hydrograph method is used to estimate the peak flows generated from all catchments intercepted by the project. This method was applied using the hydrologic modeling system HEC-HMS software. The input parameters, the peak discharge, the area of the watershed, and the time to the peak are used to construct a standard unit hydrograph. The SCS type 3 design storm will be adopted for the analysis since it is usually used for tropical areas.

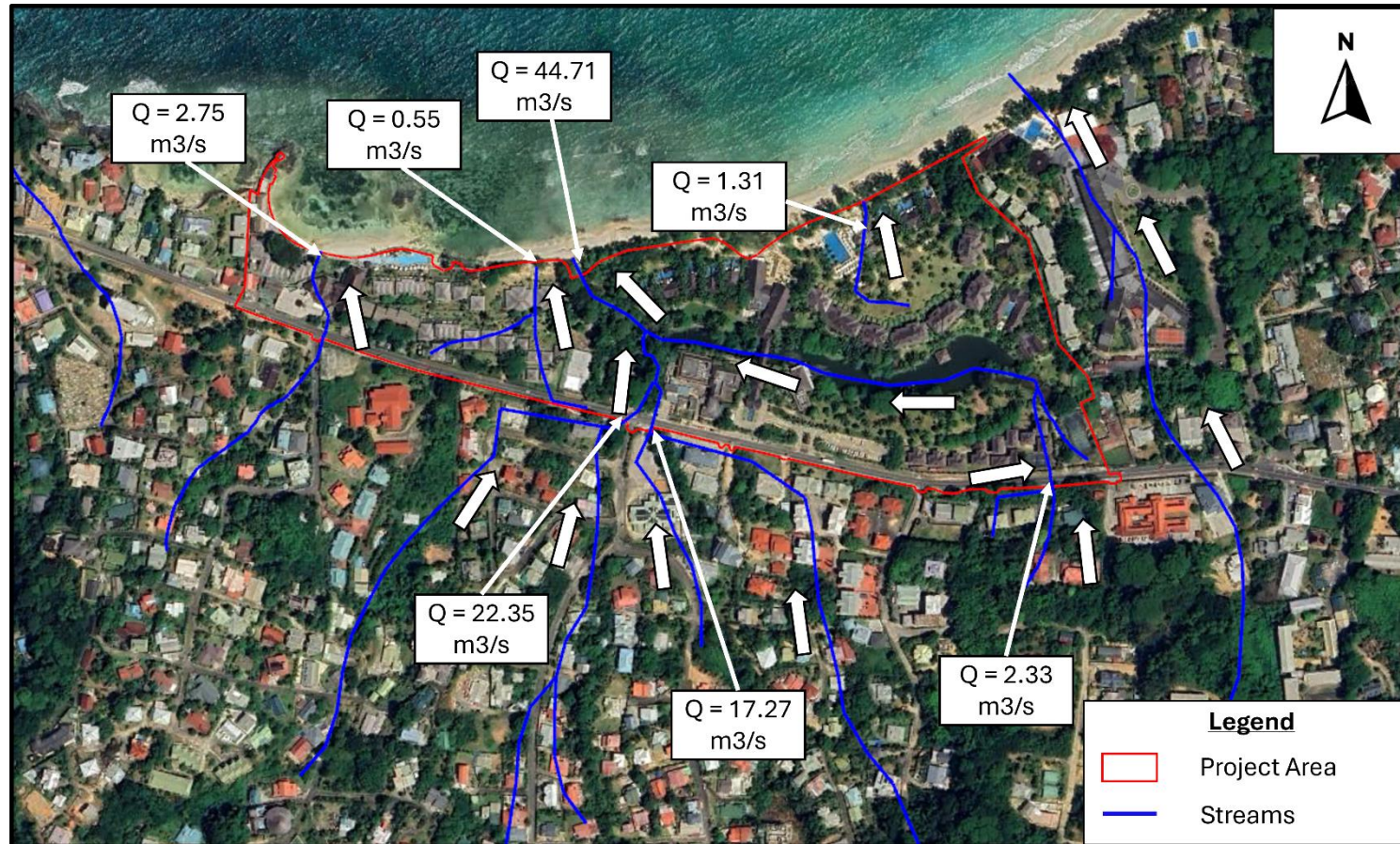


4.2. Peak Flow Calculations

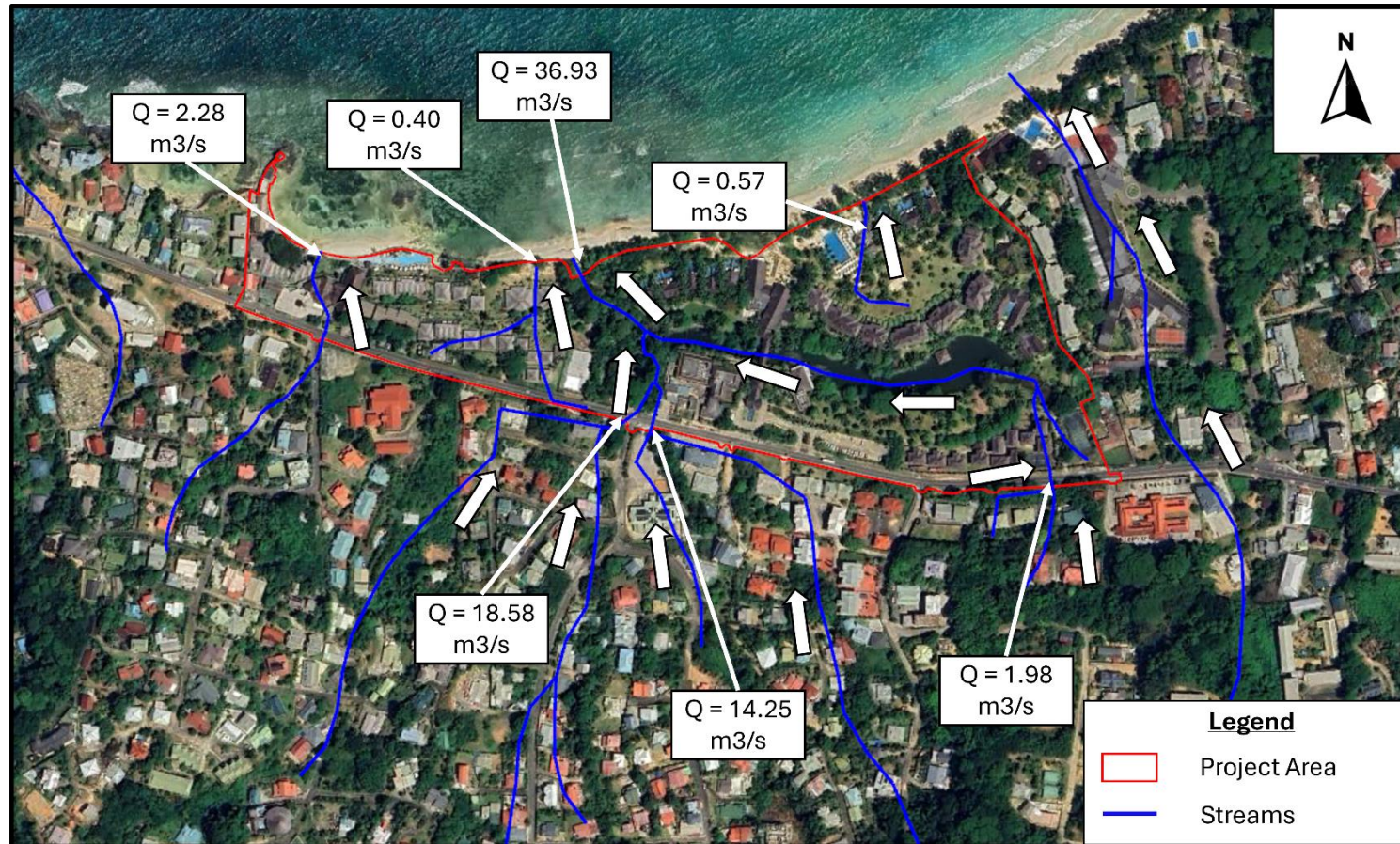
Watershed	Peak Flow (M3/s)			
	10 Year	25 Year	50 Year	100 Year
W1	10.882	17.910	23.325	29.212
W2	1.100	1.520	1.828	2.155
W3	0.224	0.411	0.562	0.729
W4	0.089	0.123	0.148	0.174
W5	0.198	0.370	0.510	0.667
W6	0.032	0.081	0.123	0.172
W7	0.158	0.317	0.450	0.600
W8	3.436	5.156	6.437	7.810
W9	0.399	0.754	1.044	1.369
W10	4.217	6.281	7.817	9.459
W11	5.923	8.848	11.023	13.353
W12	4.354	6.202	7.557	8.995
W13	0.104	0.260	0.396	0.555
W14	1.170	1.616	1.943	2.290
W15	0.114	0.238	0.340	0.458
W16	2.247	3.171	3.848	4.567
W17	4.983	6.907	8.316	9.811
W18	23.107	52.499	77.783	106.958



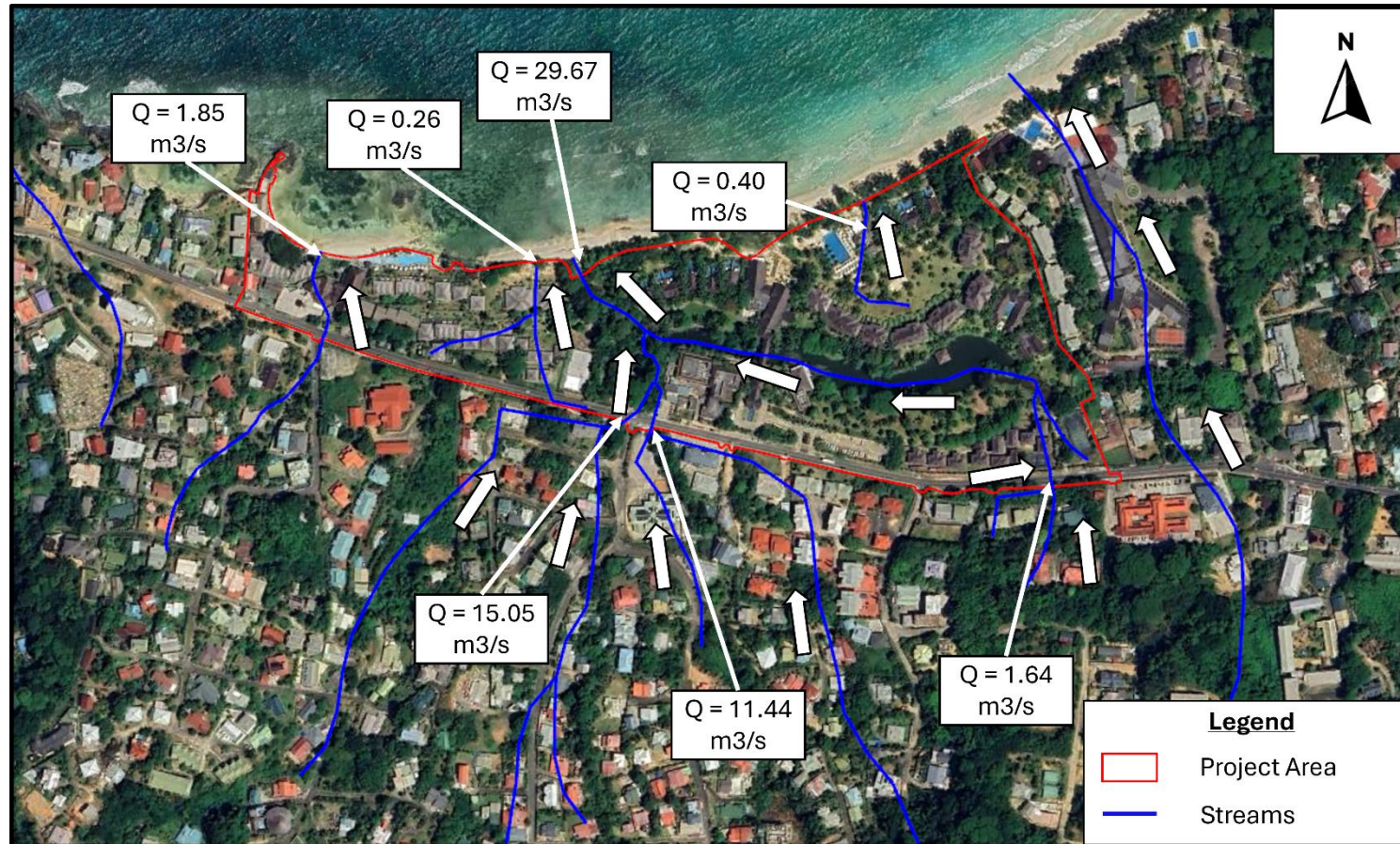
4.2. Peak Flow With Respect to The Project Site – 100 YR



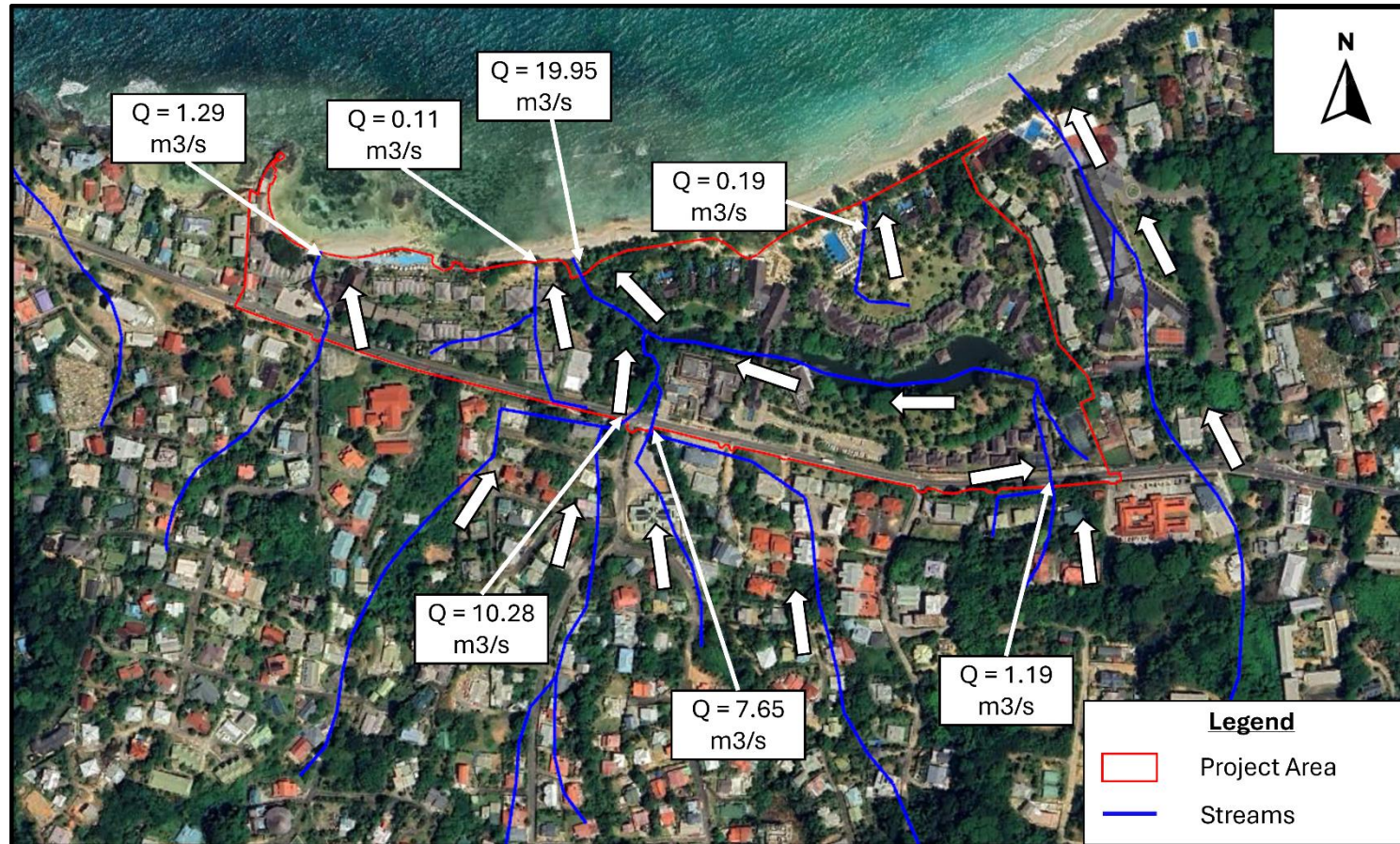
4.2. Peak Flow With Respect to The Project Site – 50 YR



4.2. Peak Flow With Respect to The Project Site – 25 YR



4.2. Peak Flow With Respect to The Project Site – 10 YR



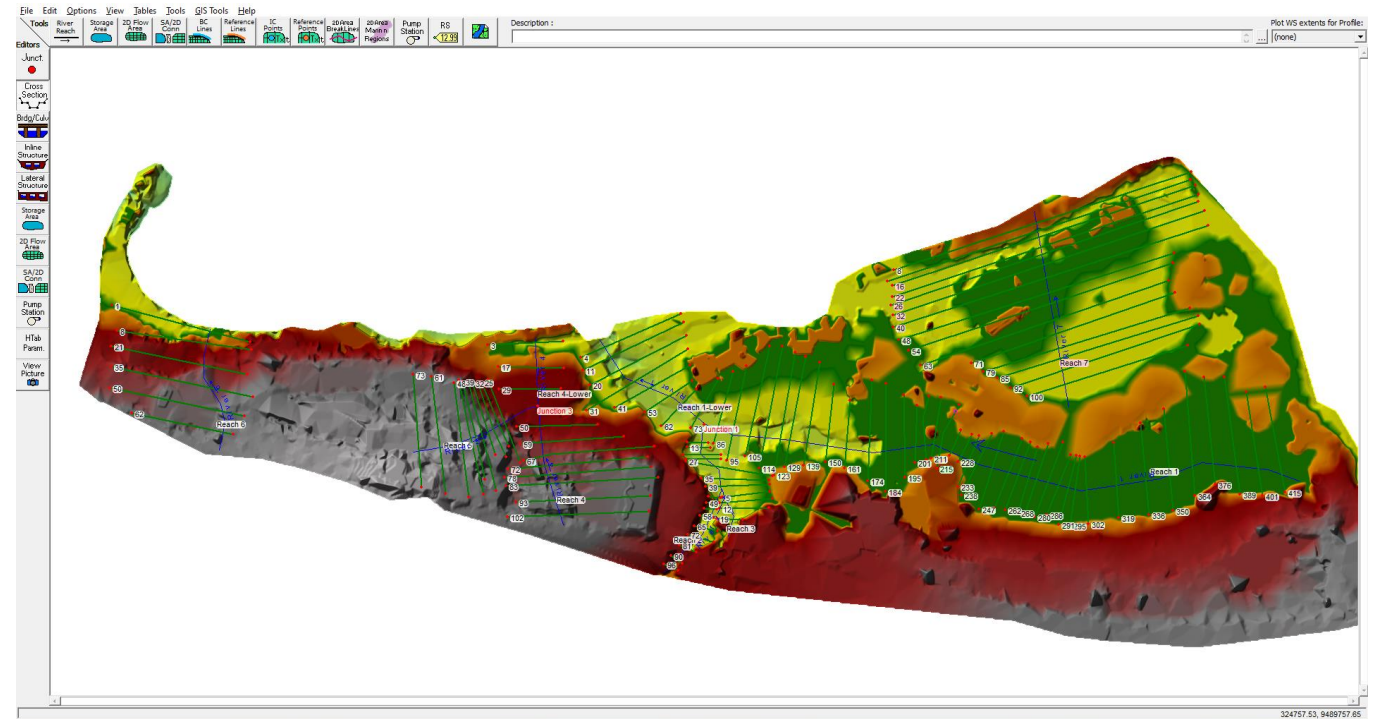
5. Hydraulic Assessment

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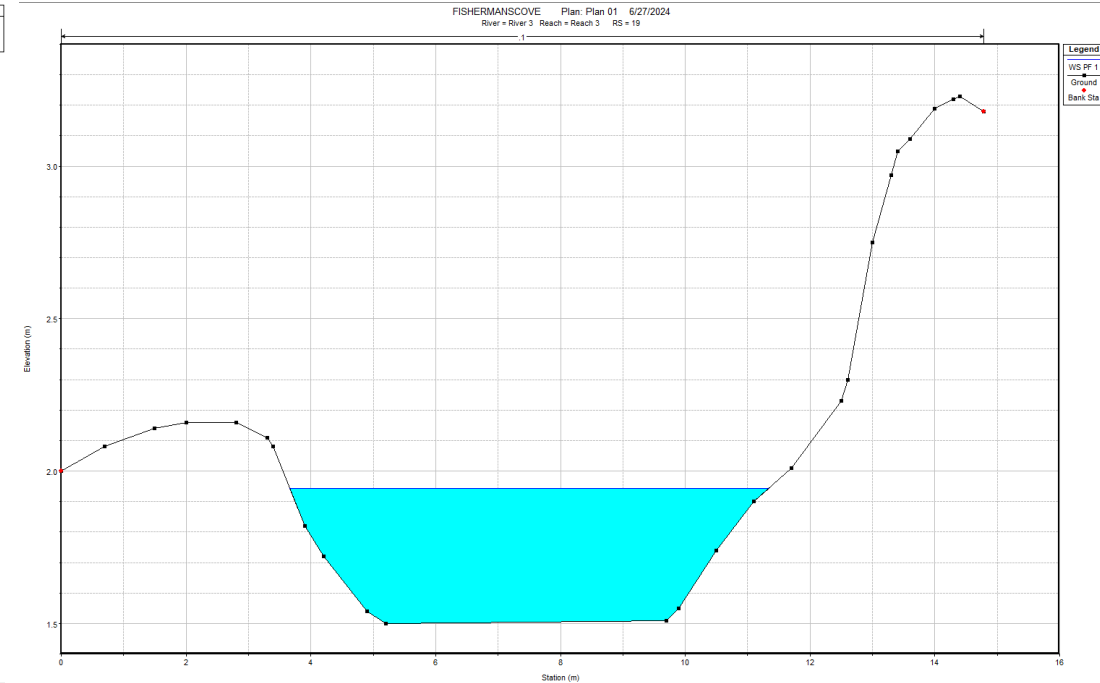
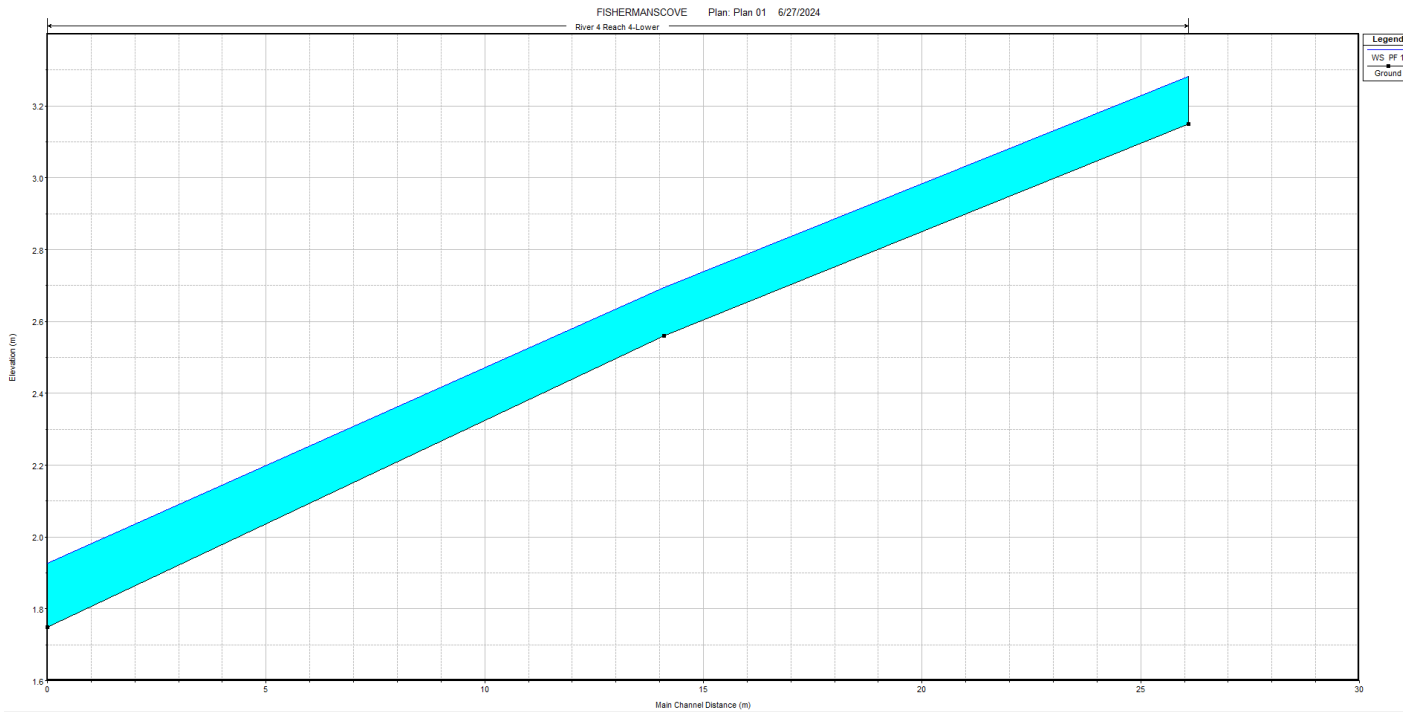
Utilizing the results of the determined peak flow results and collected survey, a comprehensive 2-D model was developed for the project area.

The floodplain and hazard mapping of the streams affecting the project area were determined by applying a two-dimensional computational hydraulic model.

HEC-RAS software which is on the FEMA list of accepted models is utilized for conducting the hydraulic modeling. The one-dimensional modelling was applied for flow behaviors in the internal drainage of the project area at the current layout of the area.

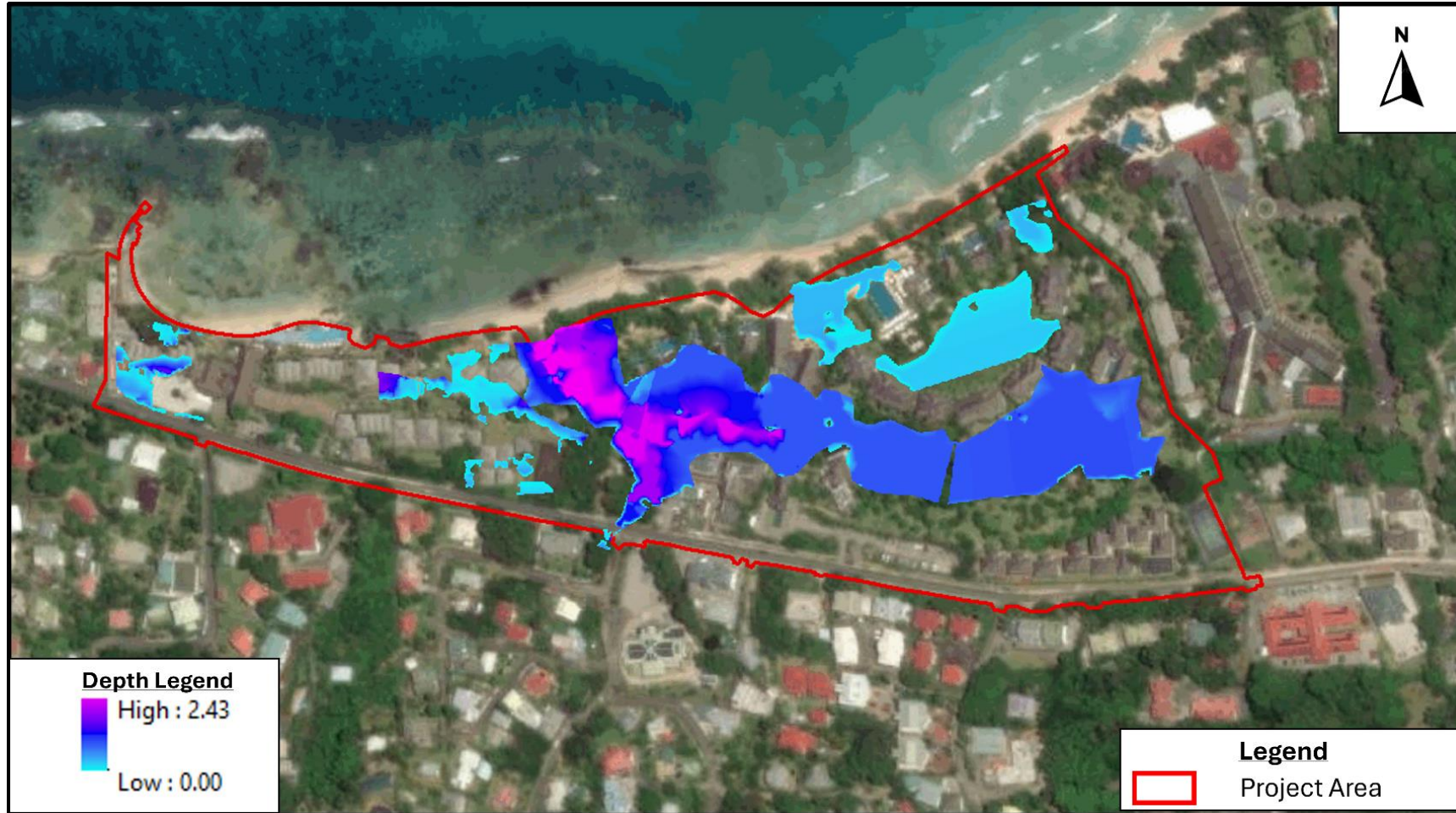


5. Hydraulic Assessment



5. Hydraulic Assessment

The modelling results were used to determine the flood depth, and velocity across the project area.



5. Hydraulic Assessment

The modelling results were used to determine the flood depth, and velocity across the project area. The flood depth along the project area reaches up 2.43 m which is mostly confined in the marsh area.

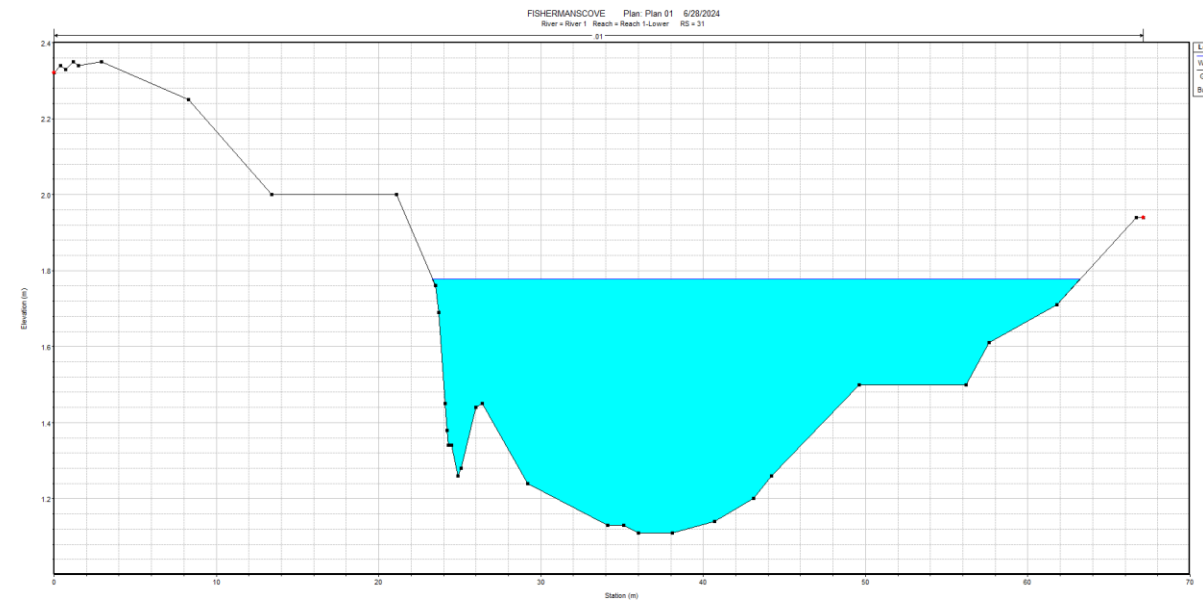
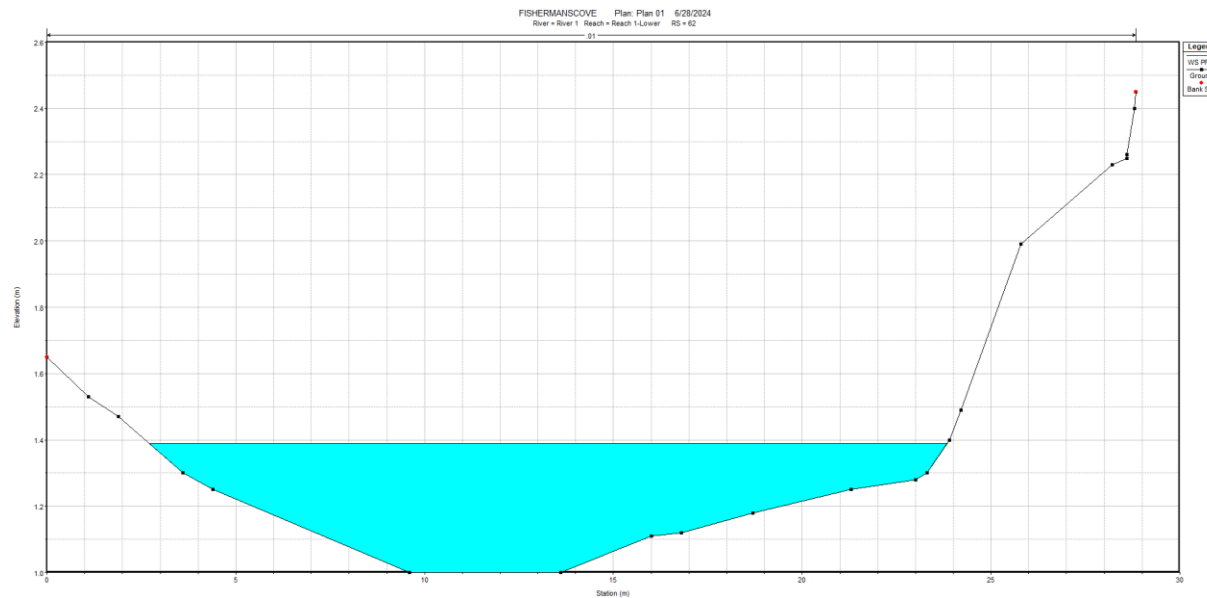
Upon analysis, the modeling results indicate that the major external wadis (are effectively contained within the existing marshland. The marshland discharges towards the sea, minimizing their impact on surrounding areas.

Additionally, the analysis shows that other watersheds have minimal on the project area. Specifically, the J64 and J167 parcels experience little to no external flood risk, with the generated depths contained within these local generated flows, confirming that these areas are less prone to significant flooding.

Overall, the flood depth variation illustrates that the central marshlands play a critical role in managing floodwaters, while the impact on other regions within the project area remains minimal.

5. Hydraulic Assessment

The following cross section is taken along the marsh, showing no overtopping, reinforcing the results of the analysis that the water does not overtop the marsh



6. Recommendations

6. Recommendations

Based on the flood depth analysis, it has been determined that the calculated water depths along the J64 and J167 parcels range between 6 and 33 centimeters. Given that the developmental levels for these parcels range from 28 to 65 centimeters above the natural ground level, it is concluded that no additional flood mitigation solutions are required for these areas. The elevated developmental levels ensure that the parcels remain safe from potential flooding, even during peak water levels.

The flood modeling further indicates that the major external wadis are effectively contained within the existing marshlands. These natural drainage systems channel water towards the sea, thereby reducing the risk of extensive flooding in the surrounding areas. The marshlands serve as a crucial buffer, managing water flow and minimizing the impact of external watersheds on the J64 and J167 parcels.

These findings confirm that the current conditions and natural drainage systems are adequate to protect the J64 and J167 parcels from flooding, ensuring the safety and stability of these developments.

Further assessment of proposed internal drainage network interface with local runoff from both external and internal roads is currently being finalized and will be included as part of the report.



Thank You