BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH AT NEW DELHI

ORIGINAL APPLICATION NO 600 /2024

IN THE MATTER OF-:

BHUSHAN LAL PARIMOO & ROBIN RAM KRISHAN **PETITIONERS**

VERSUS

STATE OF JAMMU AND KASHMIR & ORS **RESPONDENTS**

INDEX

Date 30/06/2026

APPLICANT
THROUGH
ADVOCATE
PRAKASH PANDEY
Mo N 7805008055

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REJOINDER TO THE SUPPLEMENTARY AFFIDAVIT FILED ON BEHALF OF RESPONDENT NO. 6

The Applicant respectfully submits the following rejoinder to the Supplementary Affidavit filed by Respondent No. 6:

PRELIMINARY SUBMISSIONS

1. At the outset, the Applicant respectfully submits that the respondents have deliberately attempted to divert the attention of this Hon'ble Tribunal from the real controversy involved in the present Original Application. The core issue before this Hon'ble Tribunal is not the general objectives of the River Front Development Project, flood management, pollution control or other ancillary aspects sought to be highlighted by the respondents. Rather, the principal issue is the proposed destruction and removal of an already established and fully developed Tourism Park comprising mature trees and green cover, which has been serving as a vital ecological and recreational asset for the residents of Jammu.
2. The said park is not merely an open parcel of land but an established urban green space providing invaluable ecological services including air

purification, temperature regulation, biodiversity conservation, carbon sequestration and environmental balance. It also serves as an important public recreational space, regularly used by residents for walking, exercise, leisure and other outdoor activities, thereby contributing significantly to public health and well-being.

3. Significantly, throughout the Supplementary Affidavit, the respondents have failed to disclose any compelling necessity or scientific justification for **dismantling the existing green park and replacing it with commercial or concrete infrastructure**. No material has been placed on record to demonstrate why the existing park cannot be preserved while implementing the remaining components of the project or whether any alternative design or alignment was ever considered.

4. Instead of answering this fundamental issue, the respondents have sought to shift the focus of the present proceedings by referring to matters which are extraneous and not directly relevant to the controversy involved. Such an approach is intended to avoid addressing the Applicant's specific challenge regarding the arbitrary destruction of an existing ecological asset and, therefore, deserves to be rejected by this Hon'ble Tribunal.

5. The Supplementary Affidavit itself acknowledges that the process of obtaining Environmental Clearance is still underway. This admission alone demonstrates that the scientific assessment of environmental consequences has not yet attained finality. Consequently, any irreversible action including acquisition of Tourism Park land, tree felling, alteration of river morphology or permanent land use change prior to grant of Environmental Clearance would defeat the very object of environmental appraisal contemplated under law.

6. It is further submitted that the respondent's own "Conceptual Plan for Real Estate Development of Reclaimed Land of Tawi Riverfront, Jammu" unequivocally reveals that the impugned project is not merely for beautification, environmental restoration or development of green spaces, but is predominantly a large-scale real estate and commercial development project involving construction of Group Housing, Retail Mall, Hotel, Resort, High Street Retail, Public Parking and other permanent built-up structures over the project site. The project

envisages a total built-up area of 2,07,959.75 square metres at an estimated cost of ₹1,000 crores. The said document completely belies the respondent's plea that the proposed activity is intended for environmental protection or creation of green areas. On the contrary, it demonstrates that an existing public green space is proposed to be sacrificed for commercial exploitation and permanent construction, which is contrary to the settled principles of environmental jurisprudence, including the Public Trust Doctrine and the Precautionary Principle. A copy of the said Conceptual Plan is annexed herewith as **ANNEXURE** A13 page 14-85

7. Save and except those averments specifically admitted herein, each and every statement contained in the Supplementary Affidavit is denied.

8. REPLY TO PARAGRAPH NO. 1

(A) The contents of Paragraph No. 1 are denied except to the extent they relate to matters of record.

(B) The respondents merely state that the project aims at development of green spaces, pollution control, flood protection and groundwater recharge. Such objectives are broad policy declarations and do not constitute proof that the proposed River Front Development Project is scientifically capable of achieving the stated objectives.

(C) The averments made by the Respondent in Paragraph No. 1 are self-contradictory, misleading and deserve to be rejected. The Respondent has sought to justify the project on the ground that its objective is the creation and enhancement of green spaces and improvement of the urban environment. However, the Respondent has conspicuously failed to explain how such an objective can be achieved by first destroying an already existing, well-established and fully functional green park comprising hundreds of mature trees and rich vegetation.

(D) It is submitted that the existing Tourism Park itself constitutes a developed green area and is already fulfilling the very objectives now sought to be projected by the Respondent, namely environmental protection, urban cooling, carbon sequestration, biodiversity conservation, pollution mitigation and providing a healthy

recreational space for the public. The Respondent has neither disclosed any scientific study nor furnished any rational justification demonstrating why the existing green park must be destroyed in order to create another so-called “green area”.

(E) . In the absence of any explanation, the plea of “creation of green spaces” is nothing but a misleading justification and an attempt to camouflage the irreversible destruction of an existing ecological asset. Such a stand is arbitrary, irrational and contrary to the principles of sustainable development and the Precautionary Principle recognised under environmental law.In environmental matters, the Precautionary Principle requires scientific certainty before irreversible ecological intervention and not after environmental damage has already occurred.

9. REPLY TO PARAGRAPH NO. 2

(F) The contents of Paragraph No. 2 are specifically denied.

(G) The respondents have attempted to justify acquisition of Tourism Park land merely by asserting that it is required for execution of the project. Such an assertion is wholly insufficient.

(H) The Tourism Park presently performs significant ecological functions including:

Carbon sequestration;

Urban heat mitigation;

Air purification;

Dust filtration;

Biodiversity conservation;

Floodplain buffering;

Storm-water absorption; and

Noise attenuation.

(I) No environmental study has been produced demonstrating that destruction of the existing park is environmentally preferable to its preservation.

(J) The respondents, being public authorities, hold environmental resources in trust for present and future generations. Under the Public Trust Doctrine, existing ecological assets cannot be sacrificed merely because an alternative commercial or infrastructural use is considered administratively convenient.

10.REPLY TO PARAGRAPH NO. 3

(A) The contents of Paragraph No. 3 are emphatically denied.The respondents seek to justify felling of approximately 712 existing trees by proposing plantation of a larger number of saplings and shrubs. Such reasoning is scientifically unsustainable. Ecological value cannot be measured merely by numerical replacement.

(B) mature tree provides substantially greater environmental services than newly planted saplings, including:Carbon sequestration; Temperature regulation; Biodiversity habitat; Air purification, Soil stabilization, Storm-water absorption; and Riverbank protection.

(C) Plantation undertaken at distant locations cannot compensate for the immediate and permanent loss of an established riverine urban forest adjoining River Tawi.

(D) The Applicant respectfully submits that compensatory plantation may be a mitigating measure but it can never constitute complete ecological compensation for destruction of mature green cover.

(E) Accordingly, the proposed tree felling is arbitrary, environmentally unsustainable and contrary to the Precautionary Principle, the Public Trust Doctrine and the constitutional guarantee of a clean and healthy environment under Article 21 of the Constitution of India.

11 REPLY TO PARAGRAPH NO. 4

A. The respondents seek to justify the proposed acquisition of Tourism Park by contending that the reclaimed land shall be utilised for commercial and recreational facilities, road

connectivity and disaster evacuation. However, the said contention, far from assisting the respondents, strengthens the Applicant's case that the project substantially contemplates commercialization of reclaimed riverfront land.

B. The Comprehensive Master Plan itself indicates that substantial portions of the reclaimed area have been earmarked for commercial and concrete infrastructure. The respondents have failed to explain why the existing green belt cannot be preserved while implementing the remaining components of the project.
C. No feasibility report, alternative alignment study or engineering analysis has been produced to establish that demolition of Tourism Park is the only available option.
D. Rather, increased commercial activities along the reclaimed riverfront are likely to result in greater traffic congestion, increased human concentration and enhanced disaster vulnerability.
E. Development cannot be achieved at the cost of eliminating existing ecological assets when reasonable alternatives have neither been considered nor disclosed before this Hon'ble Tribunal.

12. REPLY TO PARAGRAPH NO. 5

A. The respondents have categorically admitted that the Environmental Clearance (EC) has not yet been granted and that the proposal is still under consideration before the competent authority.This admission completely demolishes the respondents' assertion that the project has already been environmentally assessed.
B. The Applicant respectfully submits that Environmental Clearance is not an empty formality or a post facto exercise. It is a mandatory statutory safeguard intended to ensure that the environmental consequences of a project are scientifically evaluated before irreversible activities commence.
C. The respondents cannot simultaneously contend that:

- the project is environmentally safe; and

- the environmental appraisal process is still incomplete.
- Until completion of the Environmental Impact Assessment process and grant of Environmental Clearance, the respondents themselves cannot ascertain:
- the cumulative environmental impacts;

D. Therefore, any acquisition of Tourism Park, alteration of the river course, felling of mature trees or permanent land-use change before completion of the statutory environmental appraisal would be premature, arbitrary and contrary to settled environmental law.

E. The respondents' own affidavit thus establishes that the scientific basis of the project has not yet attained finality.

13. REPLY TO PARAGRAPH NO. 6

A. That the contents of Paragraph No. 6 of the reply are vehemently denied as being false, misleading, and contrary to the official records. The respondent has deliberately attempted to divert the controversy by asserting that the flood risk had been controlled and reduced in the year 2025. The said assertion is demonstrably false and is belied by the information furnished by the Flood Control Division, Jammu under the Right to Information Act, 2005. The RTI records unequivocally reveal that on 26.08.2025, the River Tawi attained a flood level of 34 feet (Highest Flood Level) with a discharge of 5,10,600 cusecs, which is recorded as the highest flood level in more than two decades, even surpassing the flood level recorded in the year 2014. Therefore, the respondent's claim regarding effective flood-risk reduction is not only factually incorrect but is also contrary to its own official records. The respondent has thus failed to approach this Hon'ble Court with true and correct facts, and the averments made in Paragraph No. 6 deserve to be rejected in toto, Copy Of RTI is annexed as **ANNEXURE A14 page** 86-90

B. It is further submitted that an independent scientific study titled "Estimation of MFFPI for Flood Hazards Assessment Using Geospatial Technology in the Tawi Basin, India" authored by Dr. Ajay Kumar Taloor & Ors., published in the journal Geo systems and Geo environment, Vol. 3 (2024), has categorically observed that unplanned and unscientific

development, encroachments, and human interventions in and around the Tawi River, particularly in the Jammu city area, have significantly aggravated flood hazards and caused extensive damage to life, property, and public infrastructure. The said scientific study also cautions that any unprofessional development in the vicinity of Jammu city without proper management mechanisms may prove disastrous. A copy of the said research paper is annexed herewith as **ANNEXURE A 15** 91-101

C. The said photographs clearly establish that substantial damage was caused to public property and infrastructure, resulting in significant financial loss to the public exchequer. Thus, the respondent's assertion that the flood risk had been effectively controlled stands completely falsified by its own official records. The respondent has, therefore, failed to place true and correct facts before this Hon'ble Cour.

14. **REPLY TO PARAGRAPH NO. 7**

A. The contents of Paragraph No. 7 are denied as being misleading and legally unsustainable. The respondents have attempted to justify the proposed project by asserting that interceptor drains and sewage pumping stations have reduced pollution in River Tawi. Even assuming, without admitting, that such measures have improved water quality, the same has no nexus with the destruction of Tourism Park, felling of mature trees or alteration of the river ecology.

B. Pollution control measures and tree felling are two distinct issues. One cannot be used to justify the other.

C. The respondents have failed to produce any scientific material including Water quality monitoring reports; Comparative pre-project and post-project water quality data; Third-party environmental audit reports; or Independent verification of the claimed pollution reduction.

D. On the contrary, the Applicant shall place on record photographs and RTI information demonstrating that during the floods of August 2025, several sewage pumping stations and ancillary pipeline infrastructure constructed within the river bed suffered extensive damage, resulting in failure of the sewage transport system and substantial loss of public funds.

E. The respondents have therefore failed to establish that the alleged pollution control measures justify irreversible ecological destruction.

15. REPLY TO PARAGRAPH NO. 8

A. That the contents of Paragraph No. 8 of the reply are denied to the extent they are contrary to the record. The petitioner has the highest regard for the law laid down by the Hon'ble Supreme Court and does not dispute the proposition of law enunciated therein. However, the reliance placed by the respondent on the said judgment is wholly misconceived and misplaced, as the facts and circumstances of the present case are entirely distinguishable. The judgment relied upon by the respondent does not authorize the destruction of an existing public park or green area for the purpose of establishing a commercial complex under the guise of development. The factual matrix and findings recorded by the Hon'ble Supreme Court are materially different and, therefore, have no application to the present case. Furthermore, the respondent has failed to adhere to the well-settled environmental principles governing sustainable development, including the Precautionary Principle and the Public Trust Doctrine, which mandate protection and preservation of public green spaces and environmental resources. In the absence of compliance with these fundamental principles, the respondent cannot seek shelter under the doctrine of sustainable development. Consequently, the reliance placed on the said judgment is wholly erroneous, misconceived, and liable to be rejected

B. The respondents cannot invoke Sustainable Development while simultaneously admitting that the Environmental Clearance process remains incomplete.

C. True sustainable development balances ecology with development; it does not replace existing ecological assets with commercial infrastructure.

16.REPLY TO PARAGRAPH NO. 9

A. The contents of Paragraph No. 9 are denied. The respondents have sought to justify continuation of the project on the ground that

substantial public funds have already been invested. Such a contention is wholly misconceived.Public expenditure cannot legalize an action that is otherwise environmentally unlawful.

PRAYER

In view of the facts and circumstances stated hereinabove, it is most respectfully prayed that this Hon'ble Tribunal may be pleased to:

(a) Reject the contentions raised in the Supplementary Affidavit filed by Respondent No. 6;

(b) Hold that no irreversible activity including acquisition of Tourism Park land, tree felling, river modification or permanent land-use change shall be undertaken.

© Pass such other and further order(s) as this Hon'ble Tribunal may deem fit and proper in the interest of justice, environmental

Date 30/06/26

APPLICANT
THROUGH
ADVOCATE
PRAKASH PANDEY
Mo N 7805008055

INDIA NON JUDICIAL

Government of Jammu and Kashmir

सत्यमेव जयते

₹10

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Certificate No.	:	**IN-JK33969353590828Y**
Certificate Issued Date	:	30-Jun-2026 11:31 AM
Account Reference	:	NEWIMPACC (SV)/ jk12707004/ NEHRU MARKET/ JK-JM
Unique Doc. Reference	:	SUBIN-JKJK1270700449966933526302Y
Purchased by	:	BHUSHAN LAL PARIMOO
Description of Document	:	Article 4 Affidavit
Property Description	:	Not Applicable
Consideration Price (Rs.)	:	0 (Zero)
First Party	:	BHUSHAN LAL PARIMOO
Second Party	:	Not Applicable
Stamp Duty Paid By	:	BHUSHAN LAL PARIMOO
Stamp Duty Amount(Rs.)	:	10 (Ten only)

Sonia Gupta LRA No. 734 41-Nehru Market Jammu

IN-JK33969353590828Y

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RAM [illegible]SS
Advocate
J&K High Court

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

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IN THE MATTER OF-:

BHUSHAN LAL PARIMOO & ROBIN RAM KRISHAN

PETITIONERS

VERSUS

STATE OF JAMMU AND KASHMIR & ORS.

RESPONDENTS

AFFIDAVIT

I **BHUSHAN LAL PARIMOO S/O MAHESHVER NATH, Aged 80 yrs R/O H No F-521/A,UNO lane ,Talab Tillo, Jammu City, Jammu and Kashmir-180002** do hereby solemnly affirm on oath as under

1. That , I am Petitioners in the instant case and fully conversant with the facts of the case and hence, competent to swear on this affidavit.
2. That , I am filing Rejoinder against the supplementary affidavit filed by Respondent no 6 Along with Annexure before the Hon'ble Tribunal the Contents from Para 1 to last have been drafted on my instruction and the same have been explained to me by my counsel.
3. That ,we had read and understood the contents and based on the documents filed along with the application

B.L. Parimoo

DEPONENT

VERIFICATION

I, The above named deponent do hereby verify that the contents of the paras above are true and correct and no material fact has been concealed.

Signed and verified on this 30th Day of june 2026 at Jammu.

B.L. Parimoo

DEPONENT

Identified by
Mukul Sharma
S/o Jagdish Kumar

Solemnly Affirmed / Sworn before me
Hence Attested

NOTARY PUBLIC
Jammu Distt Jammu
30/06/2026

CONCEPTUAL PLAN

For

Real Estate Development of Reclaimed Land of Tawi Riverfront, Jammu

From

4th Bridge to Bikram Bridge

By

Jammu Smart City Limited (JSCL)

ENVIRONMENT CONSULTANT

OCEAO-ENVIRO Management Solutions (India) Pvt. Ltd.

QCI – NABET Certificate No: NABET/EIA/22-25/SA 0212

Plot - No. 218, Sector-11, Vasundhara, Ghaziabad, Uttar Pradesh– 201012

www.oceaoenviro.com | info@oceaoenviro.com

Environment Expert
Jammu Smart City Ltd.

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OCEAN-ENVIRO MANAGEMENT SOLUTIONS (INDIA) PVT. LTD.

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LIST OF FIGURES

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1.0 QCI – NABET CERTIFICATE

भारतीय गुणवत्ता परिषद
QUALITY COUNCIL OF INDIA

NABET

National Accreditation Board for Education and Training

Certificate of Accreditation

Oceao Enviro Management Solutions (India) Pvt. Ltd., Ghaziabad

Plot - No. 218, Sector-11, Vasundhara, Ghaziabad - 201012, Uttar Pradesh

The organization is accredited as Category-A under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA/EMP reports in the following Sectors:

S. No	Sector Description	Sector (as per) NABET	Sector (as per) MoEFCC	Cat.
1.	Mining of minerals - Open cast only	1	1 (a) (i)	A
2.	Metallurgical industries (ferrous & non ferrous)	8	3 (a)	B
3.	Cement Plants	9	3 (b)	A
4.	Pesticides industry and pesticide specific intermediates (excluding formulations)	17	5 (b)	A
5.	Synthetic organic chemicals industry	21	5 (f)	[illegible]
6.	Highways	34	7 (f)	A
7.	Common Municipal Solid Waste Management Facility (CMSWMF)	37	7 (i)	B
8.	Building and construction projects	38	8 (a)	B
9.	Townships and Area Development projects	39	8 (b)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in SAAC minutes dated October 18, 2023 posted on the QCI-NABET website.

[illegible] *dated Dec. 18, 2023. The accreditation needs to be renewed before the expiry date by Oceao Enviro Management Solutions (India) Pvt. Ltd., Ghaziabad following due process of assessment.*

Issue Date
Dec. 18, 2023

Valid up to
Aug. 05, 2025

Mr. Ajay Kumar Jha
Sr. Director - NABET

Certificate No.
NABET/EIA/22-25/SA 0212

Prof (Dr) Varinder S Kanwar
CEO - NABET

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2.0 INTRODUCTION

The Govt. of Jammu & Kashmir, Housing & Urban Development Department, Civil Secretariat, Jammu has proposed a project "Development of Tawi Riverfront" in Jammu City. The project is part of Jammu Smart City Mission which has been conceived as a measure of flood protection to the adjoining areas in addition to leveraging its benefits for creating a recreational space for the city of Jammu.

Jammu Smart City Ltd. (JSCL) is appointed by Housing & Urban Development Department, Civil Secretariat, Jammu to develop riverfront's land for optimum use with focus on creating vibrant public realm on riverfront while ensuring energy & environment sustainability, propose energy efficiency solutions. The proposed project has been transferred to Jammu Smart City Ltd. (JSCL) vide the letter no: *HUD/PLAN/02/2019/SP/II dated: 22/04/2021*. Copy of Letter is enclosed as ***Annexure-I***.

3.0 ABOUT PROJECT PROPONENT

The Jammu Smart City Limited (JSCL) is a special purpose vehicle (SPV) that aims to transform Jammu into a smart city. Jammu Smart City Limited (JSCL) is implementing the Smart City Proposals (SCP) covering both Area Based Development (ABD) and PAN-city solutions under Smart City Mission. Jammu SCP proposes smart solutions in ABD and PAN-city, providing various smart features/infrastructure.

4.0 ABOUT TAWI RIVER:

The Tawi River is a major tributary of the Chenab River in Jammu and Kashmir. It originates from the Kali Kundi glacier in the Doda district and flows through the city of Jammu.

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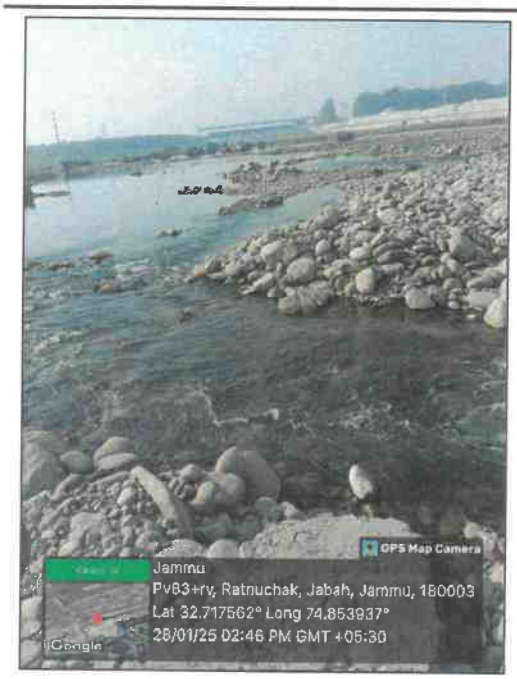

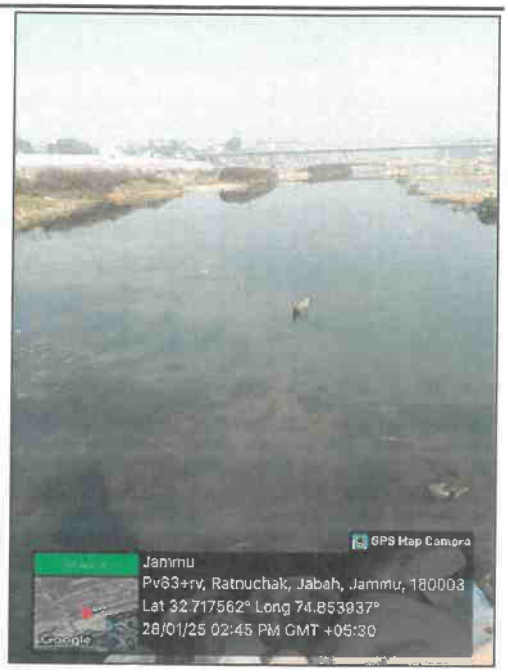

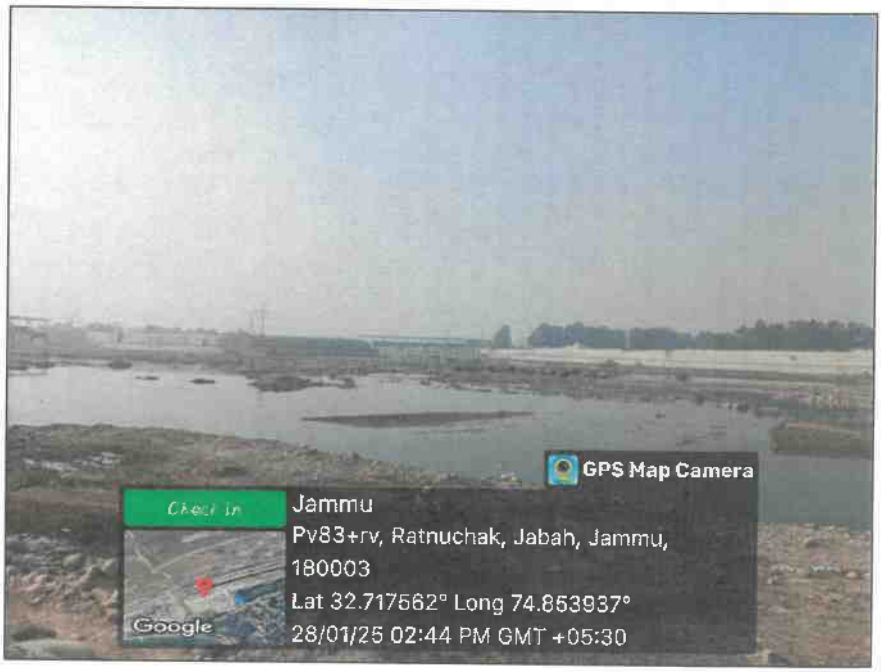

Figure 1: Photographs of Tawi River at project site

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5.0 BRIEF DESCRIPTION OF THE PROPOSED PROJECT

The proposed project **"Real Estate Development of Reclaimed Land of Tawi Riverfront, Jammu"** is being developed by Jammu Smart City Limited (JSCL). The project involves development on land area measuring **1,57,207.57 sq.m. (15.72 Ha or 38.85 Acres)** & built-up area of **2,07,959.75 sq.m.** Since, the built-up area of the project is 2,07,959.75 sq.m. exceeding 1,50,000 sq.m., thus, the project is covered under Schedule-8(b) i.e. Category B1- 'Townships & Area Development Projects' as per the EIA Notification of Ministry of Environment, Forest & Climate Change (MoEF& CC) dated 14th September, 2006 and amendments thereof. **Total cost of the project is 1000 crores.**

The baseline environmental study has been done for the period from 1st January 2025 to 31st March, 2025 by a NABL Accredited Lab.

Table 1: Salient Features of the project

S.No.	Particulars	Details
1.	Project Name	Real Estate Development of Reclaimed Land of Tawi Riverfront, Jammu
2.	Project Location	From 4th Bridge to Bikram Bridge
3.	Total Length of Project Area	Approx. 2.70 Km (including Right Bank (1.07 km), Left Bank (1.1 km) & Central Island (0.45 km))
4.	Size of the project / Total Plot Area	1,57,207.57 sq. m (15.72 Ha or 38.85 Acres)
5.	Total Built-up Area	2,07,959.75 sq.m.

The proposed project is being developed at **Left Bank, Central Island & Right Bank** of Tawi River and further comprise of various components as given in **Table 2.** Site Plan showing development planning on Left Bank, Central Island & Right Bank is shown below in **Figure 2.**

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Table 2: Area Details of Project (For All Components)

LOACTION	Code	COMPONENTS	PLOT AREA (IN SQ.M.)
Left Bank (A)	A1	Public Parking	1,796.42
	A2	Group Housing	26,180.78
	A3	Retail Mall	20,421.80
	A4	Hotel	5,637.34
	A5	Public Parking	3,255.99
	A6	Road	2,263.20
		Total (1)	**59,555.53**
Central Island (B)	B1	Resort	37,150.39
	B2	Public Parking	3,423.90
	B3	Irrigation Plot	1,039.33
	B4	Public Parking	1,560.45
	B5	Road/Drop off area	6,638.24
		Total (2)	**49,812.31**
Right Bank (C)	C1	High Street Retail	6,808.25
	C2	Park 1	5,202.91
	C3	Park 2	4,910.57
	C4	Road	26,097.92
	C5	Masjid & Substation	4,325.29
	C6	Public Parking	494.79
		Total (3)	**47,839.73**
Total (1+2+3)			**1,57,207.57**

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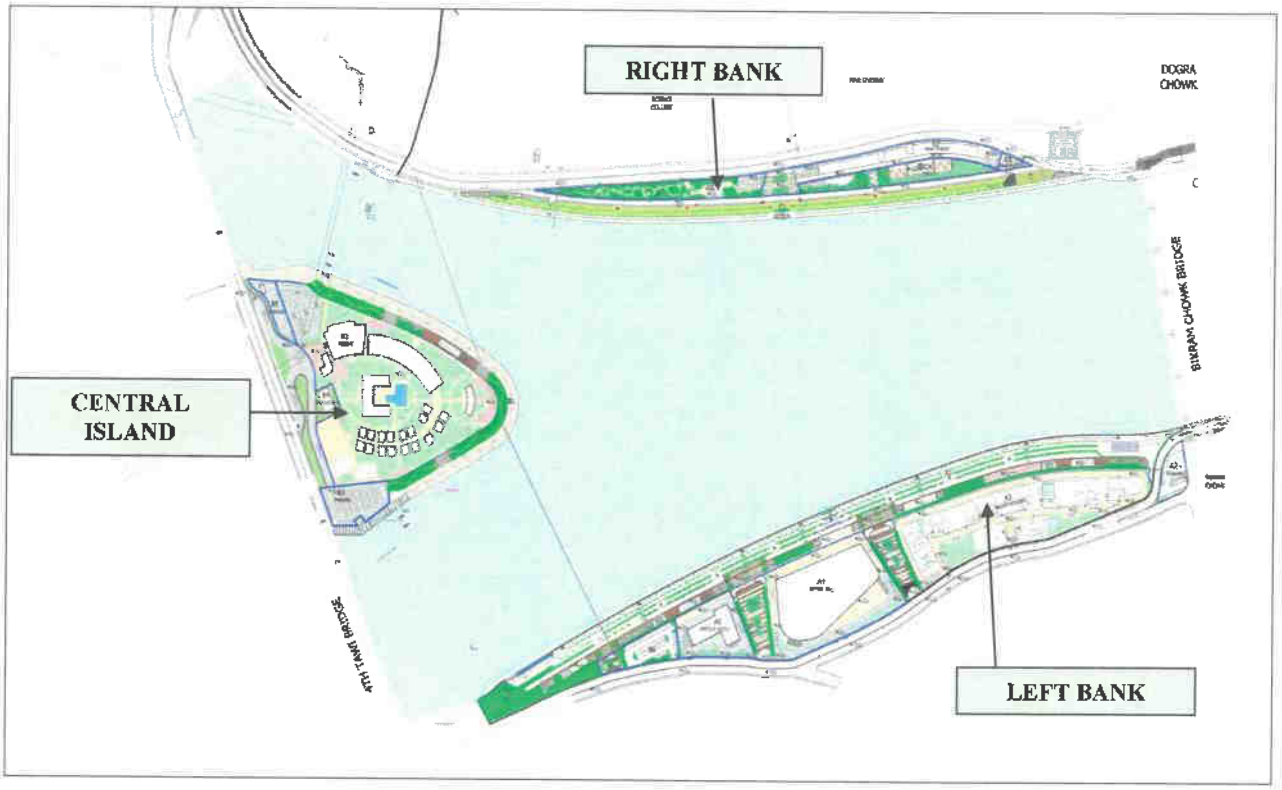

Figure 2: Project Development Plan

6.0 SITE LOCATION AND SURROUNDINGS

The project site is located From 4th Bridge to Bikram Bridge, Jammu. Location map of the project site is shown below **Figure 3**. The proposed project involves development work on the reclaimed land on river edge from Bhagwati Nagar Bridge to Bikram Chowk Bridge which is Approx. 2.70 Km in length (including Right Bank (1.07 km), Left Bank (1.1 km) & Central Island (0.45 km). The Geographical Co-ordinates of the Left Bank, Central Island & Right Bank are given in **Table 3(a), 3(b) & 3(c).** The buffer map on Google Earth Image of 500 m, 2 km, 5 km and 10 km is shown below at **Figure 4, Figure 5, Figure 6, Figure 7 & Figure 8.**

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Table 3(a): Geographical Coordinates for Left Bank

Corner	Latitude	Longitude	Corner	Latitude	Longitude
1	32°42'55.24"N	74°50'57.43"E	23	32°43'7.55"N	74°51'30.49"E
2	32°42'55.56"N	74°51'0.10"E	24	32°43'7.77"N	74°51'31.28"E
3	32°42'56.03"N	74°51'1.13"E	25	32°43'7.93"N	74°51'32.21"E
4	32°42'56.60"N	74°51'2.75"E	26	32°43'8.13"N	74°51'32.14"E
5	32°42'57.18"N	74°51'5.28"E	27	32°43'8.36"N	74°51'33.08"E
6	32°42'57.56"N	74°51'8.01"E	28	32°43'8.83"N	74°51'32.96"E
7	32°42'57.61"N	74°51'10.07"E	29	32°43'7.79"N	74°51'30.46"E
8	32°42'57.76"N	74°51'11.59"E	30	32°43'7.33"N	74°51'28.89"E
9	32°42'57.93"N	74°51'12.15"E	31	32°43'7.19"N	74°51'28.13"E
10	32°42'59.26"N	74°51'15.22"E	32	32°43'6.96"N	74°51'25.83"E
11	32°42'59.95"N	74°51'16.59"E	33	32°43'6.77"N	74°51'24.34"E
12	32°43'0.95"N	74°51'18.37"E	34	32°43'6.49"N	74°51'22.93"E
13	32°43'1.50"N	74°51'18.95"E	35	32°43'6.19"N	74°51'21.59"E
14	32°43'2.21"N	74°51'20.28"E	36	32°43'5.90"N	74°51'20.66"E
15	32°43'3.05"N	74°51'22.52"E	37	32°43'5.46"N	74°51'19.37"E
16	32°43'3.61"N	74°51'24.38"E	38	32°43'4.95"N	74°51'17.86"E
17	32°43'4.16"N	74°51'25.70"E	39	32°43'3.25"N	74°51'13.43"E
18	32°43'4.71"N	74°51'26.83"E	40	32°43'1.92"N	74°51'10.25"E
19	32°43'5.02"N	74°51'26.58"E	41	32°43'0.44"N	74°51'6.98"E
20	32°43'6.72"N	74°51'29.79"E	42	32°42'58.10"N	74°51'2.19"E
21	32°43'7.07"N	74°51'29.64"E	43	32°42'56.87"N	74°50'59.94"E
22	32°43'7.25"N	74°51'30.60"E	44	32°42'55.42"N	74°50'57.31"E

Table 3(b): Geographical Coordinates for Central Island

Corner	Latitude	Longitude	Corner	Latitude	Longitude
1	32°43'1.07"N	74°50'47.25"E	15	32°43'7.32"N	74°50'53.91"E
2	32°43'1.64"N	74°50'50.57"E	16	32°43'7.65"N	74°50'52.99"E
3	32°43'1.48"N	74°50'50.75"E	17	32°43'8.06"N	74°50'51.68"E
4	32°43'2.05"N	74°50'51.76"E	18	32°43'8.38"N	74°50'50.29"E
5	32°43'3.27"N	74°50'53.72"E	19	32°43'8.60"N	74°50'49.10"E
6	32°43'3.89"N	74°50'54.70"E	20	32°43'8.90"N	74°50'47.73"E
7	32°43'4.44"N	74°50'55.31"E	21	32°43'8.86"N	74°50'47.67"E
8	32°43'4.78"N	74°50'55.58"E	22	32°43'9.10"N	74°50'47.41"E
9	32°43'5.19"N	74°50'55.84"E	23	32°43'9.06"N	74°50'47.34"E
10	32°43'5.44"N	74°50'55.94"E	24	32°43'9.43"N	74°50'46.88"E
11	32°43'5.99"N	74°50'55.95"E	25	32°43'9.51"N	74°50'46.25"E
12	32°43'6.29"N	74°50'55.76"E	26	32°43'9.72"N	74°50'44.89"E
13	32°43'6.56"N	74°50'55.52"E	27	32°43'9.22"N	74°50'44.24"E
14	32°43'6.83"N	74°50'55.01"E	28	32°43'9.19"N	74°50'41.84"E

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Table 3(c): Geographical Coordinates for Right Bank

Corner	Latitude	Longitude	Corner	Latitude	Longitude
1	32°43'13.75"N	74°50'47.28"E	25	32°43'17.75"N	74°51'24.58"E
2	32°43'13.47"N	74°50'49.33"E	26	32°43'18.39"N	74°51'24.49"E
3	32°43'13.56"N	74°50'49.62"E	27	32°43'18.38"N	74°51'24.29"E
4	32°43'13.63"N	74°50'49.80"E	28	32°43'18.75"N	74°51'24.32"E
5	32°43'13.43"N	74°50'51.27"E	29	32°43'18.86"N	74°51'24.69"E
6	32°43'13.22"N	74°50'53.65"E	30	32°43'19.04"N	74°51'24.68"E
7	32°43'13.09"N	74°50'55.42"E	31	32°43'18.86"N	74°51'23.68"E
8	32°43'13.05"N	74°50'56.99"E	32	32°43'18.34"N	74°51'19.62"E
9	32°43'13.12"N	74°50'59.64"E	33	32°43'17.94"N	74°51'15.62"E
10	32°43'13.27"N	74°51'2.19"E	34	32°43'16.43"N	74°51'10.21"E
11	32°43'13.56"N	74°51'4.78"E	35	32°43'15.86"N	74°51'5.40"E
12	32°43'13.85"N	74°51'7.23"E	36	32°43'15.38"N	74°51'1.75"E
13	32°43'14.49"N	74°51'11.26"E	37	32°43'14.64"N	74°50'56.85"E
14	32°43'14.92"N	74°51'13.90"E	38	32°43'14.44"N	74°50'55.73"E
15	32°43'15.86"N	74°51'18.90"E	39	32°43'14.21"N	74°50'53.85"E
16	32°43'16.16"N	74°51'20.48"E	40	32°43'14.01"N	74°50'52.06"E
17	32°43'17.75"N	74°51'28.05"E	41	32°43'14.03"N	74°50'50.54"E
18	32°43'18.09"N	74°51'29.59"E	42	32°43'14.24"N	74°50'50.02"E
19	32°43'18.50"N	74°51'29.80"E	43	32°43'14.35"N	74°50'49.94"E
20	32°43'18.75"N	74°51'29.69"E	44	32°43'14.63"N	74°50'50.00"E
21	32°43'18.55"N	74°51'28.82"E	45	32°43'14.67"N	74°50'49.68"E
22	32°43'18.43"N	74°51'28.86"E	46	32°43'14.40"N	74°50'49.59"E
23	32°43'17.83"N	74°51'26.79"E	47	32°43'14.38"N	74°50'49.13"E
24	32°43'17.98"N	74°51'26.75"E	48	32°43'14.64"N	74°50'47.52"E

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Figure 3: Location map of the project site

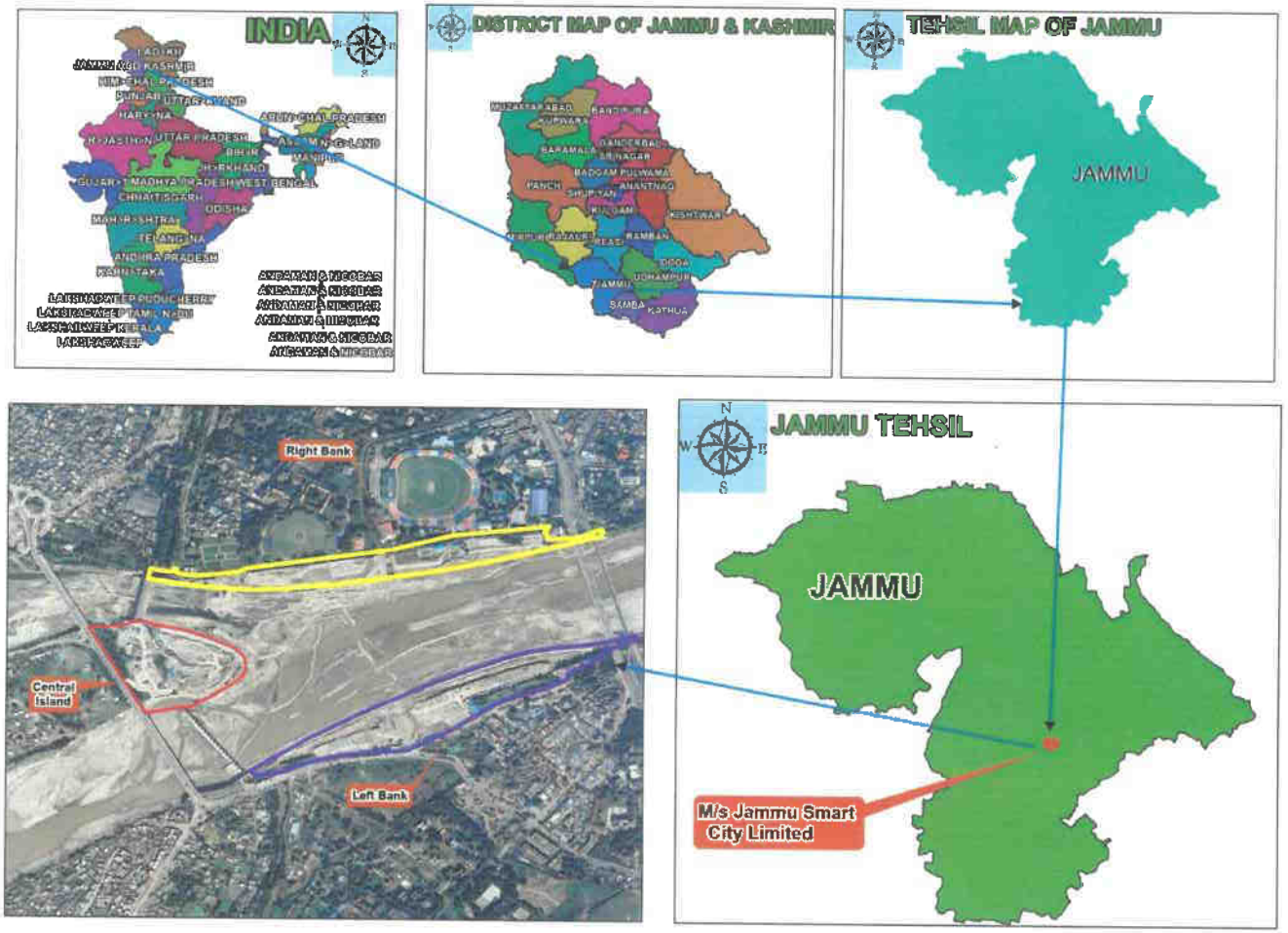

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Figure 4: 500m buffer map of the project site

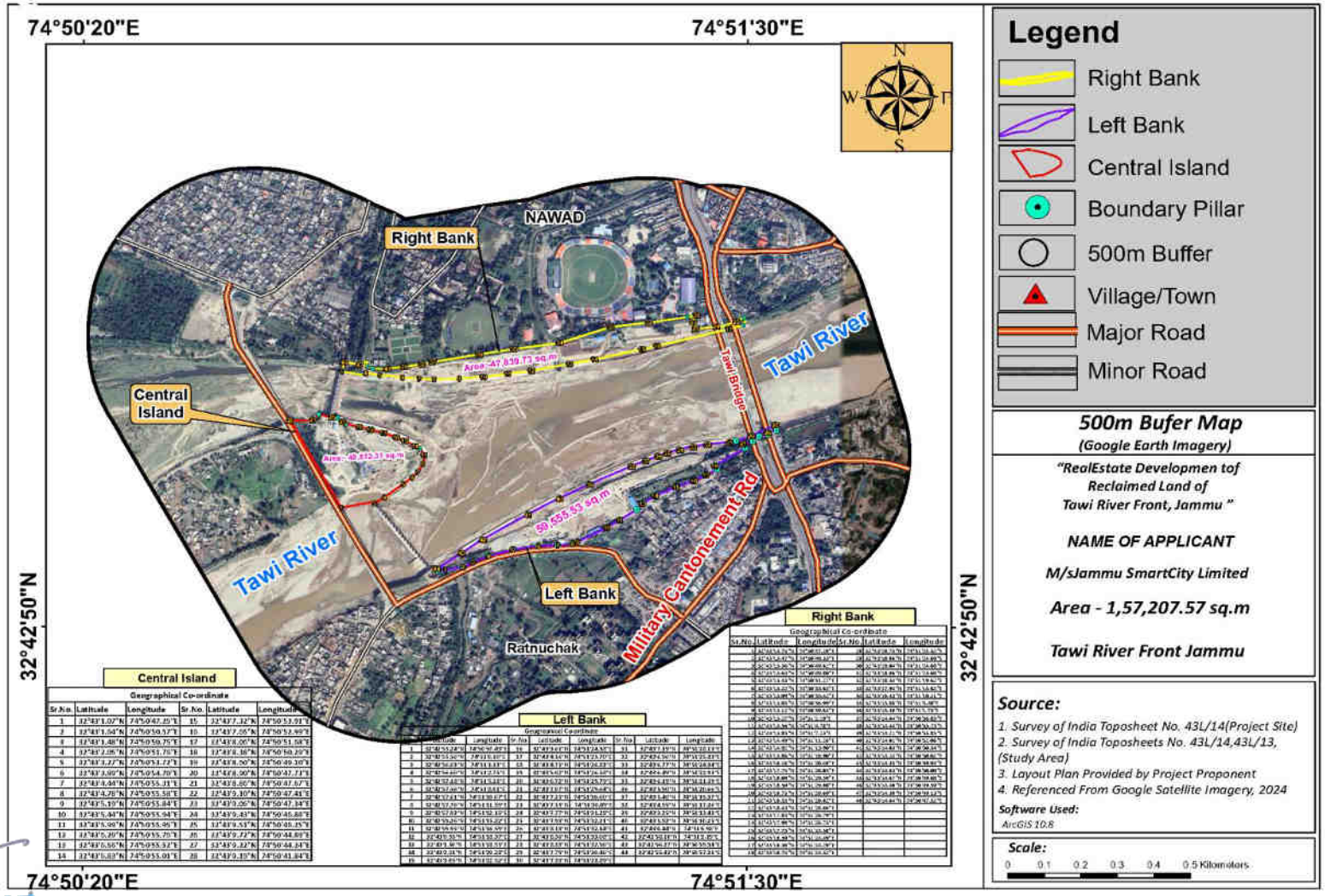

Figure 5: 2km buffer map of the project site

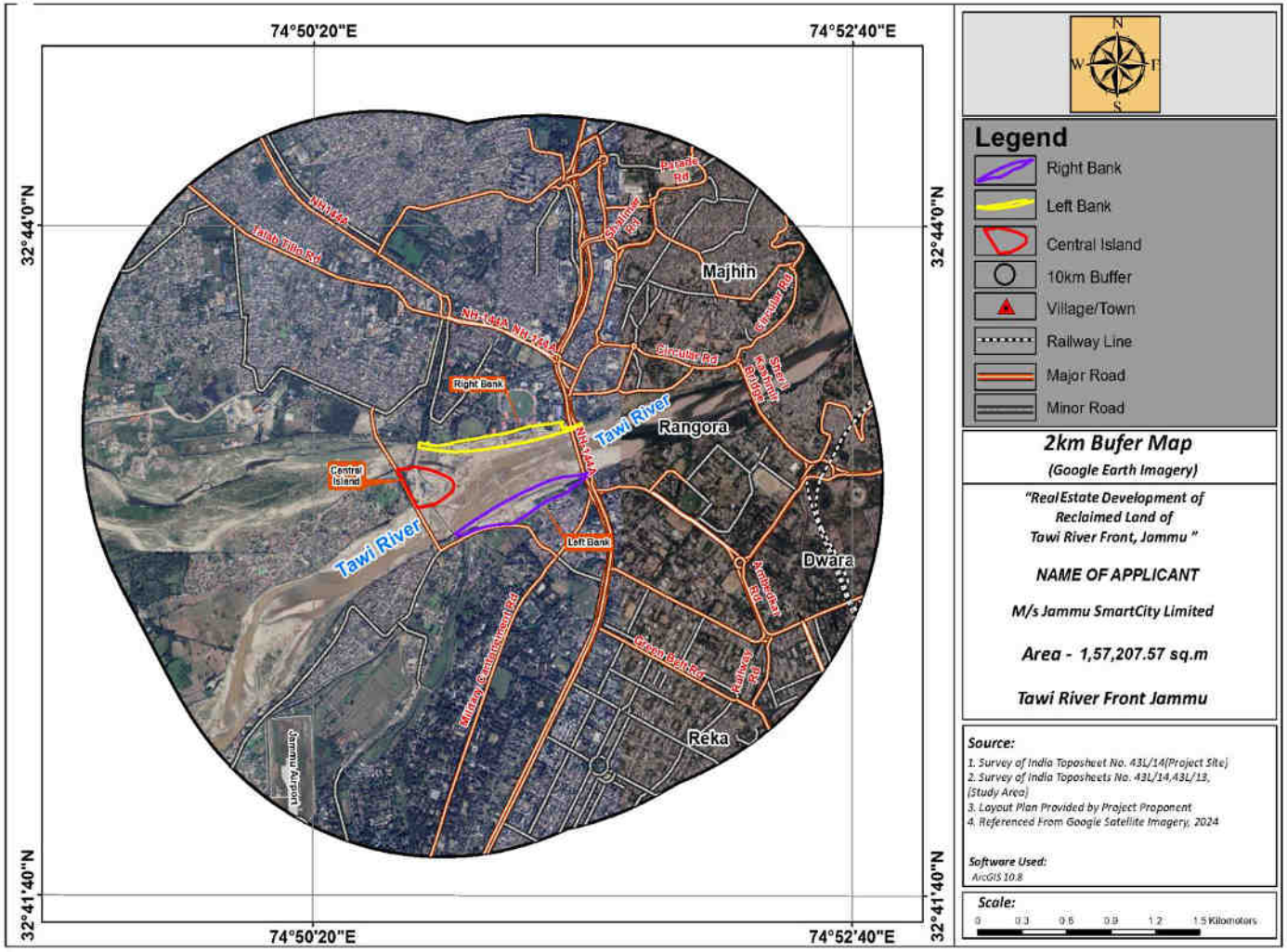

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Figure 6: 5km buffer map of the project site

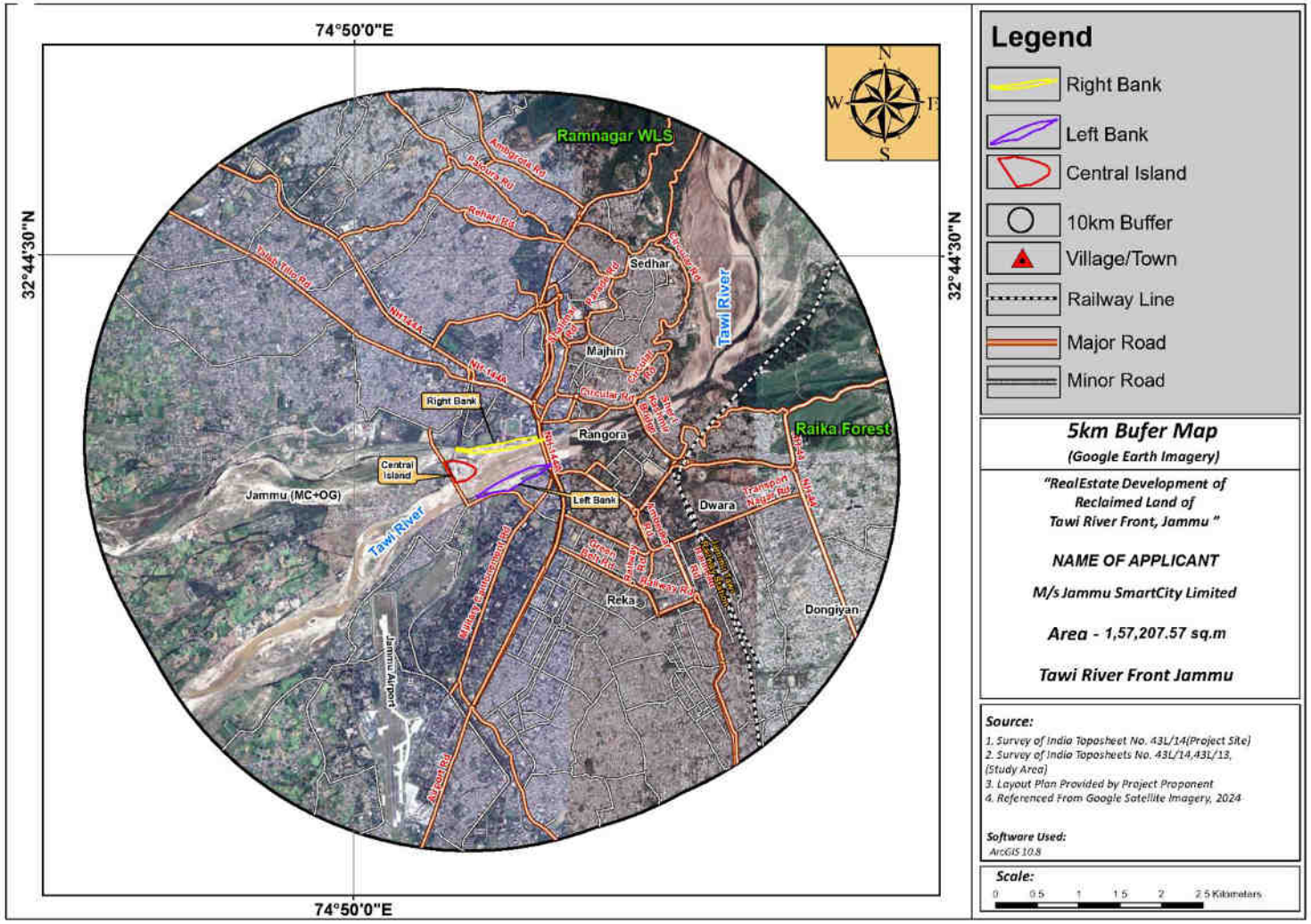

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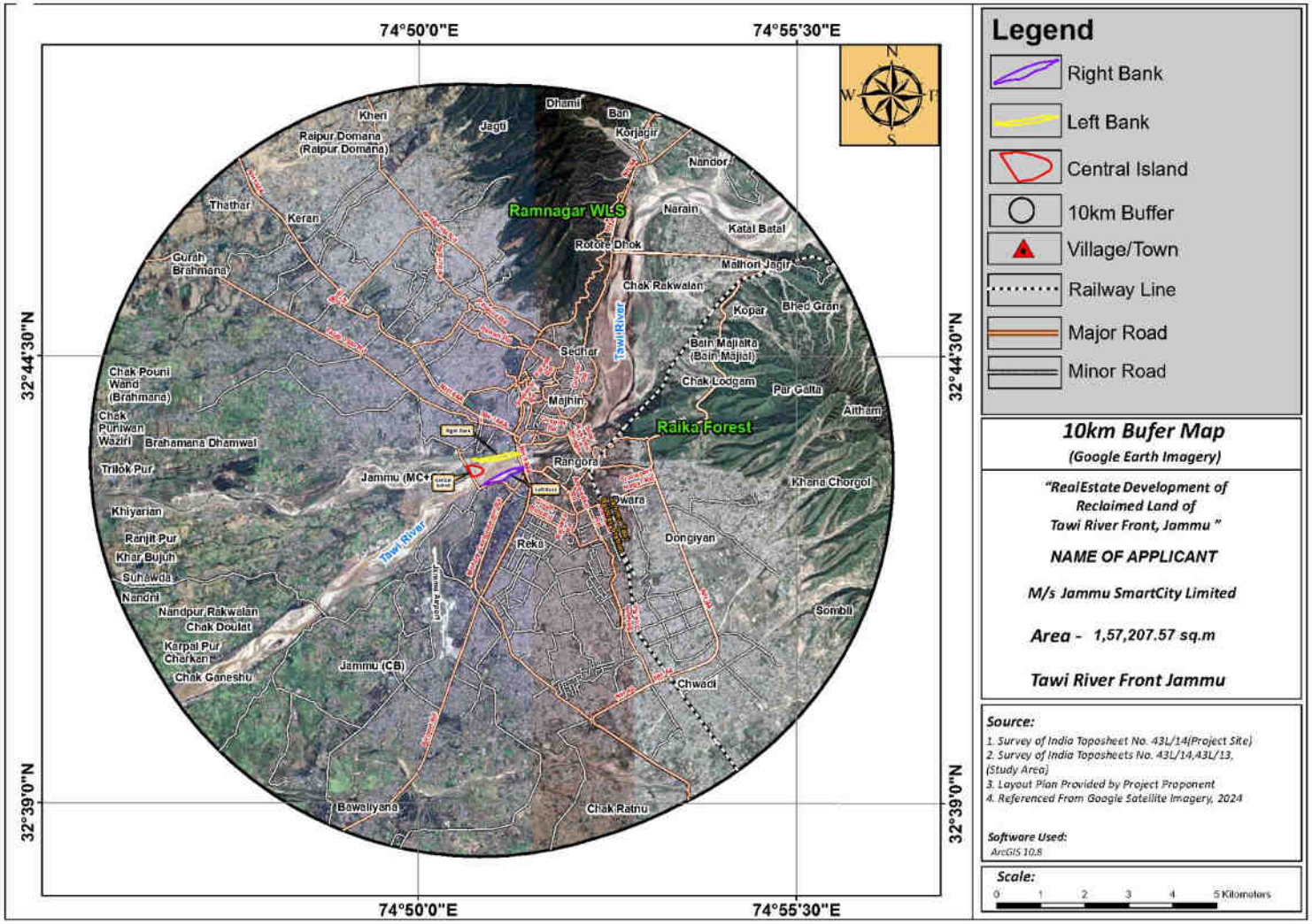
Figure 7: 10 km buffer map of the project site



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7.0 PROJECT SITE CONNECTIVITY

The project site is located From 4th Bridge to Bikram Bridge, Jammu. The site surroundings & Environment Sensitive Area along with distance and direction are given below in **Table 4.**

Table 4: Site Connectivity

S. No.	Particulates	Name of Places	Distance (in Kms)	Direction
1	Nearest Habitat	Jammu City	Proposed Project lies within the Jammu City	
2	Nearest Airport	Jammu Airport	1.75	SW
3	Nearest Railway Station	Jammu Tawi Railway Station	2	SE
4	Nearest Bus Stand	Jammu Tawi Bus Stand	0.25	SES
5	Nearest Road/NH	RS Pura Road	Adjacent to project Site	
		NH-44	2.93	E
6	Nearest School/College	Govt. Gandhi Memorial Science College, Jammu	0.35	N
		University of Jammu	0.65	ESE
		Govt. M.A.M PG College	0.45	SE
		Council of Scientific and Industrial Research–Indian Institute Of Integrative Medicine (CSIR–IIIM)	1.00	N
		Government College for Women	1.75	W
		Air Force School	2.45	S
		Govt Hari Singh Higher Secondary School	0.80	NE
		Maulana Azad Stadium	0.1	N
7	Nearest Worship Place	Maha Maya Temple	3.25	E
		Shri Raghunath Temple	1.05	NEN
		Jamia masjid	0.44	E
8	Nearest Hospital	Government Medical College and Hospital	1.6	N
		Government Hospital Gandhi Nagar, Jammu	1.35	S
9	Nearest Police Station	Nawabad Police Station	0.39	N
		City Police Thana	1.5	NEN
10	Nearest Fire Station	Gandhi Nagar Fire Station	1.32	SE
11	International Border	Indo-Pak Border	15.45	W
12	Nearest Town, City, District Headquarters	Civil Secretariat Jammu	1.6	NEN
13	Nearest River/Nallah/ Canal	Tawi River	Adjacent to project Site	

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		Balol Nalla	6.5	S
14	Village Panchayats, Zila Parishad, Municipal Corporation, Local Body	Jammu Municipal Corporation	0.66	NWN
15	Heritage Sites	Bahu Fort park, Historical Landmark	2.2	E
		Amar Mahal Museum and Library	3.20	NNE
16	Nearest Wildlife Sanctuary	Ramnagar Wildlife Sanctuary	3.30	NE
17	Nearest Factory	Industrial Area	4.65	SES

The project falls on Survey of India Topo sheet no 43L/14. The Study area map within 15 km buffer on Toposheet No. 43L/14, 43L/13, 43L/14 is shown in **Figure 8.**

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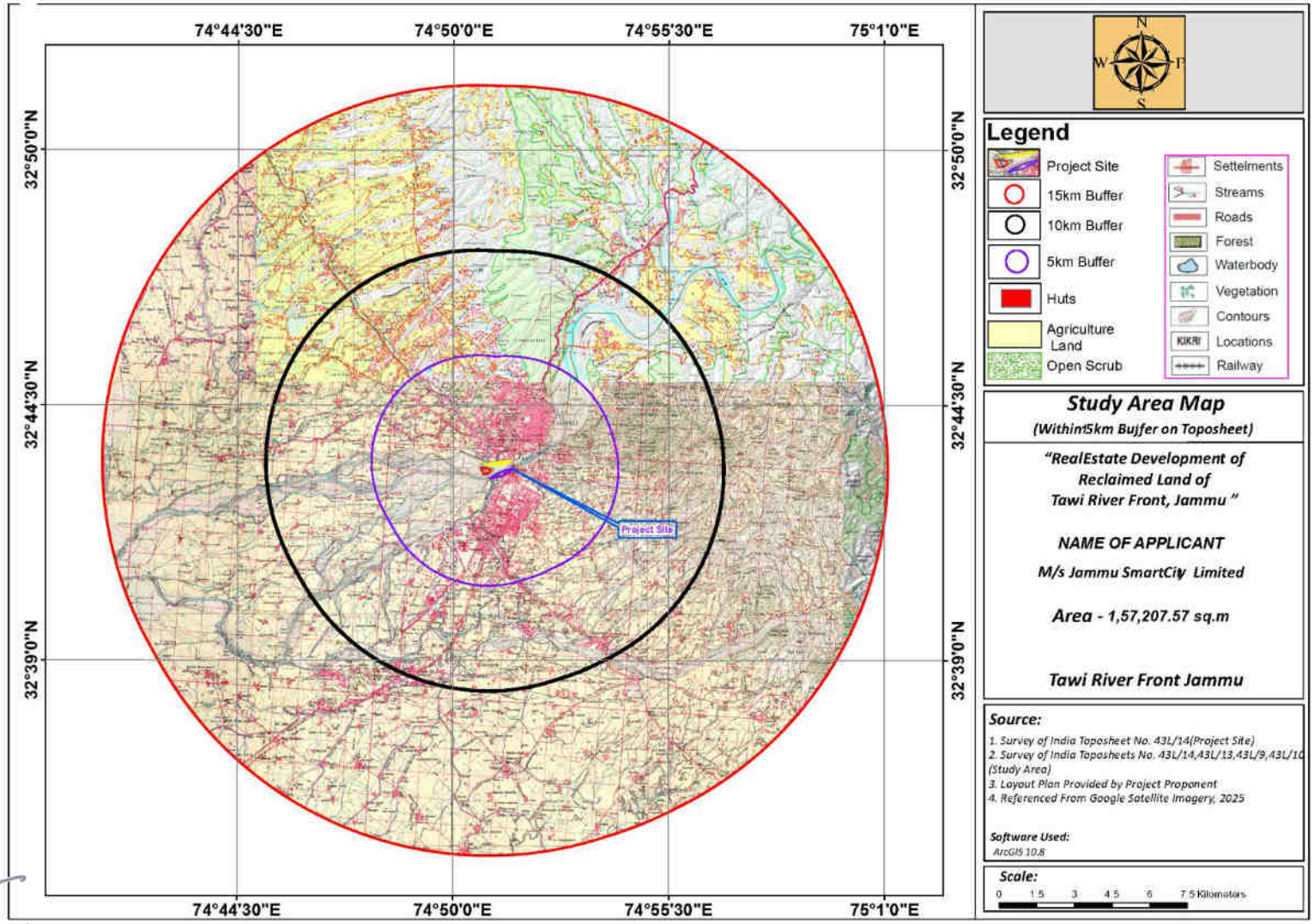
Figure 8: 15 km Study Area Map on Toposheet



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8.0 AREA STATEMENT

The total plot area of the proposed project is 1,57,207.57 square meters (15.72 Ha or 38.85 Acres). The proposed built-up area is 2,07,959.75 square meters. The detailed area statement of the project is given in the following **Table 5.** Project Site Map is shown in **Figure 9.**

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Figure 9: Project Site Area Map

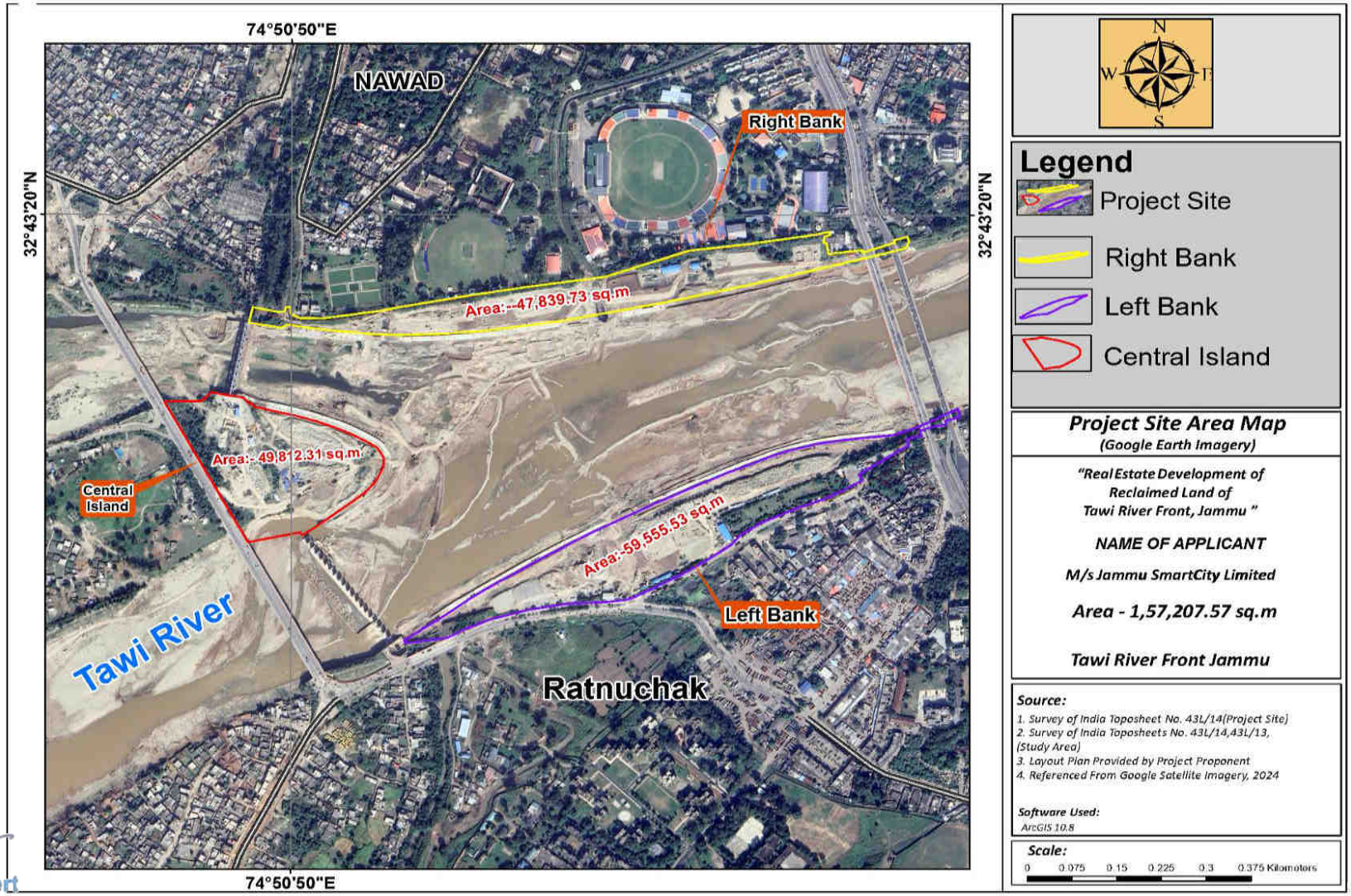

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Table 5: Area Statement of Tawi Riverfront Development Project

Code	Components	Plot Area (in sq.m.)	Permissible Ground Coverage (%)	Achieved Ground Coverage (%)	Achieved Ground Coverage (in sq.m.)	FAR Permissible	FAR Achieved	FAR Achieved (in sq.m.)	Non-FAR (in sq.m.)	Total BUA
A	**Left Bank**									
A1	Public Parking	1,796.42	-							
A2	Group Housing	26,180.78	30	28.6	7,484.25	3	2.68	70,210.92	36,938.47	1,07,149.39
A3	Retail Mall	20,421.80	45	44.20	9,031.50	1.75	1.61	32,815.47	24,711.02	57,526.49
A4	Hotel	5,637.35	30	29.7	1,674.72	2	1.84	10,376.14	9,068.94	19,445.08
A5	Public Parking	3,255.99	-							
A6	Road	2,263.20								
Total Left Bank		**59,555.53**						**1,13,402.53**	**70,718.43**	**1,84,120.96**
B	**Central Island**									
B1	Resort	37,150.39	25	22.3	8,296	0.5	0.4	14,676.15	4,838.77	19,514.92
B2	Public Parking	3,423.90								
B3	Irrigation Plot	1,039.33								
B4	Public Parking	1,560.45	-							
B5	Road/Drop off area	6,638.24								
Total Central Island		**49,812.31**						**14,676.15**	**4,838.77**	**19,514.92**
C	**Right Bank**									
C1	High Street Retail	6,808.25	35	26.3	1,791	0.7	0.53	3585.78	738.09	4323.87
C2	Park 1	5,202.91								

C3	Park 2	4,910.57								
C4	Road	26,097.92								
C5	Masjid & Substation	4,325.29								
C6	Public Parking	494.79								
Total Right Bank		**47,839.73**						**3585.78**	**738.09**	**4323.87**
TOTAL (A+B+C)		**1,57,207.57**			**28277.47**			**1,31,664.46**	**76,295.29**	**2,07,959.75**

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The detailed area statement for Residential Group Housing, Retail Mall, Hotel, Resort & High Street Mall is given in **Table 6, 7, 8, 9 & 10.**

I. GROUP HOUSING AREA DETAILS

The detailed area statement for Residential Group Housing is given in **Table 6(a), 6(b) & 6(c).**

Table 6(a): Area Details of Group Housing

S. No	Description	Area (in sq.m.)
1.	Plot Area	26,180.78
2.	Achieved Ground Coverage (@ 28.59%)	7,484.25
3.	Achieved FAR (@ 2.68)	70,210.92
4.	Non-FAR	36,938.47
5.	**Total Built-up Area (4+5)**	**1,07,149.39**
6.	Landscape Area @26.33%	6894.34

Table 6(b): Built-up Area Details of Group Housing

S. No.	Description	FAR (in sq.m)	Non - FAR (in sq.m)	BUA (in sq.m)
1	7 Towers Residential Area-I	64,250.92	4,037.68	68,288.60
2	Club House Amenities -II	3,708.09	122.07	3,830.15
3	Basement Area-III	2,205.15	32,778.73	34,983.88
4	Site service & Guard room	46.76	0	46.76
TOTAL BUA(I+II+III)		**70,210.92**	**36,938.48**	**1,07,149.39**

Table 6(c): Details of Dwelling Units

Dwelling Unit	TYPE 1	TYPE 2	TYPE 3	TOTAL
2 BHK	102	8	8	118
3 BHK	170	8	8	186
4 BHK	68	32	0	100
Total				**404**

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II. RETAIL MALL AREA DETAILS

The detailed area statement for Retail Mall is given in **Table 7(a) & 7(b).**

Table 7(a): Area Details of Retail Mall

S. No	Description	Area (in sq.m.)
1.	Plot Area	20,421.80
2.	Achieved Ground Coverage (@ 44.20%)	9,031.50
3.	Achieved FAR (@ 1.61)	32,815.47
4.	Non-FAR	24,711.02
5.	**Total Built-up Area (4+5)**	**57,526.49**
6.	Landscape Area @24.65%	5034.45

Table 7(b): Floor wise Area Details of Retail Mall

S.No.	Description	FAR (in sq.m)	Non- FAR (in sq.m)	BUA (in sq.m)
1	Ground floor	8831.23	201	9031.50
2	First floor	7758.95	200	7959.22
3	Second floor	7403.69	555	7959.26
4	Third Floor	7758.96	200	7959.26
5	Basement-1	1062.65	11001.35	12064.06
6	Basement-2	0.00	12553	12553.18
Total		**32,815.47**	**24,711.02**	**57,526.49**

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III. HOTEL AREA DETAILS

The detailed area statement for Hotel is given in **Table 8(a) & 8(b).**

Table 8(a): Area Details of Hotel

S. No	Description	Area (in sq. m.)
1.	Plot Area	5,637.34
2.	Achieved Ground Coverage (@ 29.7%)	1,674.72
3.	Achieved FAR (@ 1.84)	10,376.14
4.	Non-FAR	9,068.94
5.	**Total Built-up Area (4+5)**	**19,445.08**
6.	Landscape Area @ 24.18%	1363.619

Table 8(b): Floor wise Area Details of Hotel

S. No	Description	FAR (in sq.m)	Non FAR (in sq.m)	BUA (in sq.m)
1	Ground floor	1481.39	113.89	1595.28
2	Service floor 1	0.00	1495.05	1495.05
3	First floor	1285.02	209.48	1494.51
4	Second floor	1454.71	177.35	1632.06
5	Third Floor	1454.71	177.35	1632.06
6	Four Floor	1454.71	177.35	1632.06
7	Fifth Floor	1454.71	177.35	1632.06
8	Service floor 2	0.00	1632.06	1632.06
9	Terrace Floor	732.57	99.57	832.15
10	Service + Guard	263.99	0.00	263.99
11	Basement-1	346.67	2455.22	2801.9
12	Basement-2	447.64	2354.26	2801.9
Total		**10,376. 14**	**9,068.94**	**19,445.08**

IV. RESORT AREA DETAILS

The detailed area statement for Resort is given in **Table 9(a) & 9(b)**.

Table 9(a): Area Details of Resort

S. No	Description	Area (in sq.m.)
1.	Plot Area	37,150.39
2.	Achieved Ground Coverage (@ 22.3%)	8,296
3.	Achieved FAR (@ 0.4)	14,676.15
4.	Non-FAR	4,838.77
5.	**Total Built-up Area (4+5)**	**19,514.92**
6.	Landscape Area	15153.42

Table 9(b): Floor-wise Area Details of Resort

S.No.	Description	FAR (in sq.m)	Non-FAR (in sq.m)	BUA (in sq.m)
1.	Arrival Block	269.059	0	269.06
2.	Banquets	2631.4	259.826	2891.23
3.	Restaurant	293.58	0	293.58
4.	Hotel Block	4409.58	571.967	4981.55
5.	Cottage type -1	1503.801	124.749	1628.55
6.	Cottage Type-2	1575.14	112.868	1688.01
7.	Amenities	3262.56	220.947	3483.51
8.	Common Services	385.35	-	385.35
9.	Basement	345.676	3548.417	3894.093
Total		**14676.15**	**4838.77**	**19514.92**

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V. HIGH STREET RETAIL AREA DETAILS

The detailed area statement for Retail Mall is given in **Table 10(a) & 10(b).**

Table 10(a): Area Details of High Street Retail

S. No	Description	Area (in sq.m.)
1.	Plot Area	6,808.25
2.	Achieved Ground Coverage (@ 26.3%)	1,791
3.	Achieved FAR (@ 0.53)	3585.78
4.	Non-FAR	738.09
5.	**Total Built-up Area (4+5)**	**4323.87**
6.	Landscape Area (18.78 % of total Plot Area)	1278.97

Table 10(b): Built-up Area Details of High Street Retail

S.No.	Description	FAR (in sq.m)	Non FAR (in sq.m)	Built-up Area (in sq.m)
1	Ground floor	1520.09	163.03	1683.12
2	First Floor	1958.25	575.05	2533.30
3	Common services	107.45	-	107.45
TOTAL		**3585.78**	**738.09**	**4323.87**

9.0 POPULATION DENSITY

Construction Phase:

During construction phase approx. 400 construction workers will be hired from local areas.

Operation Phase:

During operation phase, the total population for project is envisaged to be **15,892** persons including all components of the project along with expected footfall. Population details along with breakup is given below in **Table 11.**

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Table 11: Population Details

S.No.	LOCATION	FACILITIES	POPULATION (Person)
1.	**Left Bank (A)**	**Residential Group Housing** • Residents • Staff (5%) • Visitor (10%)	**2,767** • 2406 • 120 • 241
		Retail Mall • Staff (10%) • Visitor (90%)	**9,129** • 913 • 8216
		Hotel • Guests • Staff	**684** • 571 • 113
2.	**Central Island (B)**	**Resort** • Guests • Staff	**1,929** • 1803 • 126
3.	**Right Bank (C)**	**High Street Retail** • Staff (10%) • Visitor (90%)	**833** • 83 • 750
4.	**Expected Overall Footfall**		**500**
	JSCL Staff for supervision		**50**
Total (1+2+3+4)			**15,892 Persons**

Reference *– National Building Code, 2016.*

The detailed population calculations for Residential Group Housing, Retail Mall, Hotel, Resort & High Street Mall is given in **Table 12, 13, 14, 15 & 16.**

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I. GROUP HOUSING POPULATION DETAILS

The detailed population calculation is given in **Table 12.**

Table 12: Detailed Population Calculation for Group Housing

S. No.	Particulars	Dwelling Units	Norms	Total Population (Person)
1	**Residential Population**			
a	2 BHK	118	5 Persons Per Unit	590
b	3 BHK	186	6 Persons Per Unit	1116
c	4 BHK	100	7 Persons Per Unit	700
	Total Residents (a + b + c)			**2406**
2	Staff		5% of total residential population	**120**
3	Visitors		10% of total residential population	**241**
	Total Population (Residents + Staff+ Visitors)			**2,767 Persons**

II. RETAIL MALL POPULATION DETAILS

The detailed population calculation is given in **Table 13.**

Table 13: Detailed Population Calculation for Retail Mall

S. No.	Description	Area (in sq.m.)/Rooms/Seats	Norms	Total Population (Person)
1.	**Ground Floor**			
	Retail (A)	**8,831.23**	**3 sq.m. /person**	**2,944**
	❖ Visitor (@ 90%)			2649
	❖ Staff (@ 10%)			294
2.	**1st Floor**			
	Retail (B)	**7758.95**	**6 sq.m. /person**	**1293**
	❖ Visitors (@ 90%)			1164
	❖ Staff (@ 10%)			129
3.	**2nd Floor**			
	Retail	**5232**	**6 sq.m. /person**	**872**
	❖ Visitor (@ 90%)			785

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	❖ Staff (@ 10%)			87
	Restaurant	**766**	**1.8 sq.m. /person**	**426**
	❖ Visitor (90%)			383
	❖ Staff (10%)			43
	Entertainment/Gaming Zone	**1406**	**1.8 sq.m. /person**	**781**
	❖ Visitor (90%)			703
	❖ Staff (10%)			78
	Total (C)	**7758.95**		**2071**
4.	**3rd Floor**			
	Retail	**4076**	6 sq.m. /person	**679**
	❖ Visitor (@ 90%)			611
	❖ Staff (@ 10%)			68
	Food Court	**1695**	1.8 sq.m. /person	**942**
	❖ Visitor (90%)			848
	❖ Staff (10%)			94
	Multiplex 4 nos.	**1000 seats (250 each)**	1000 Seats	1000
	❖ Visitor (90%)			900
	❖ Staff (10%)			100
	Entertainment/Gaming Zone	**346 sq.m.**	1.8 sq.m. /person	192
	❖ Visitor (90%)			173
	❖ Staff (10%)			19
Total (1+2+3+4)				**9,129 Persons**

***Source-** National Building Code of India*

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III. HOTEL POPULATION DETAILS

The detailed population calculation is given in **Table 14.**

Table 14: Detailed Population Calculation for Hotel

S. No.	Description	Area (in sq.m.)/Rooms/Unit	Criteria	Population
1.	Hotel	155	@2 persons per room	310
2.	Staff			100
3.	Banquet	470.04	1.8 sq.m per person	261
4.	Staff		5% of Total Population Banquet	13
Total				**684**

Source- National Building Code of India

IV. RESORT POPULATION DETAILS

The detailed population calculation is given in **Table 15.**

Table 15: Detailed Population Calculation for Resort

S.No.	Description	Area (in sq.m.)/Rooms/Unit	Criteria	Population (Person)
1.	Banquets	2631.4 sq.m	1.8 sq.m per person	1462
2.	Restaurant	293.58 sq.m	1.8 sq.m per person	163
3.	Hotel Block	64 Rooms	2 person per room	128
4.	Cottage type -1	9 Unit	2 persons per unit	18
5.	Cottage Type-2	16 Unit	2 persons per unit	32
Total (A)				**1803**
Staff for Banquet & Restaurant (B)			5% of Total Population Banquet & Restaurant *i.e.* 1625	81
Staff for Hotel & Cottage (C)			25% of Total Population Hotel Block & Cottage *i.e.* 178	45
Total Population (A+B+C)				**1,929 Persons**

Source- National Building Code of India

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V. HIGH STREET MALL POPULATION DETAILS

The detailed population calculation is given in **Table 16.**

Table 16: Detailed Population Calculation for High Street Mall

S.No	Description	FAR (in sq.m)	Criteria	Population (Person)
1	Ground floor	1520	3 persons per sq.m.	507
2	First Floor	1958	6 persons per sq.m.	326
TOTAL (1+2)				**833**
3.	Staff		10% of Total Population	83
4.	Visitors		90% of Total Population	750

10.0 WATER REQUIREMENT & WASTE WATER GENERATION DETAILS

Construction Phase:

During construction phase approx. 400 construction workers will be hired from local areas. Total Water Demand of the project will be 18 KLD @ 45 LPCD.

Source: Private water Tankers

Facility of Bio Toilet/Mobile Toilet will be provided for construction workers at the project site during construction phase.

Further, for construction activities approx. 2953 KLD water will be required.

Source: Tawi River

Operation Phase:

The total water requirement envisaged for project during operational phase is 1264 KLD. Total Fresh water requirement is envisaged to be approx. 522 KLD.

Source: Municipal Corporation, Jammu

Water requirement & waste water generation details for all facilities proposed in the project is given below in **Table 17.** The Water Balance Diagram for Dry Season is shown below in **Figure 10**.

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Table 17: Water requirement, Wastewater generation & Treated Water details for project

S.No.	Location	Facilities/ Area in sq.m.	Fresh Water Demand (in KLD)			Total Treated Water Demand		Total Water Demand (in KLD)	Waste Water Generation (in KLD) (@80% of Fresh Water Demand+100% of Flushing Demand)	Treated Water Generation (in KLD) (@90% of the waste water generation)	Proposed capacity of STP/ETP (in KLD)	
			Residents + Guest + Staff + Visitors	Kitchen	Laundry	Flushing Water Demand (in KLD)	Water Demand for Landscaping & HVAC (in KLD)				STP	ETP
1	Left Bank (A)	Residential Group Housing	221	-	-	113	35	369	290	261	350	-
		Retail Mall	100	-	-	102	108	310	182	160	250	-
		Hotel	85	14	12	23	35	169	112*	100	150	30
2	Central Island (B)	Resort	65	8	7	31	90	201	95**	86	120	20
3	Right Bank (C)	High Street Retail	6	-	-	10	6	22	15	14	25	-
4	Expected Foot Fall	Visitors	3	-	-	5	-	8	6	5	-	-
5	JSCL Staff	Staff	1	-	-	1	-	2	3	2	-	-
6	Landscape Area Water Demand for JSCL (@5 lt/sq.m/day) (A+B+C)	36,638.32 sq.m.	-				183	183	-		-	
Total (in KLD)			522			285	457	1264	703	628	-	

Note: *Wastewater generation is 112 KLD *i.e.* 80% of Fresh Water Demand+100% of Flushing Demand = 21 KLD (90% of treated water from ETP of capacity 30 KLD) to be treated in STP of capacity 120 KLD.

** Wastewater generation is 95 KLD *i.e.* 80% of Fresh Water Demand+100% of Flushing Demand + 12 KLD (90% of treated water from ETP of capacity 20 KLD) to be treated in STP of capacity 120 KLD

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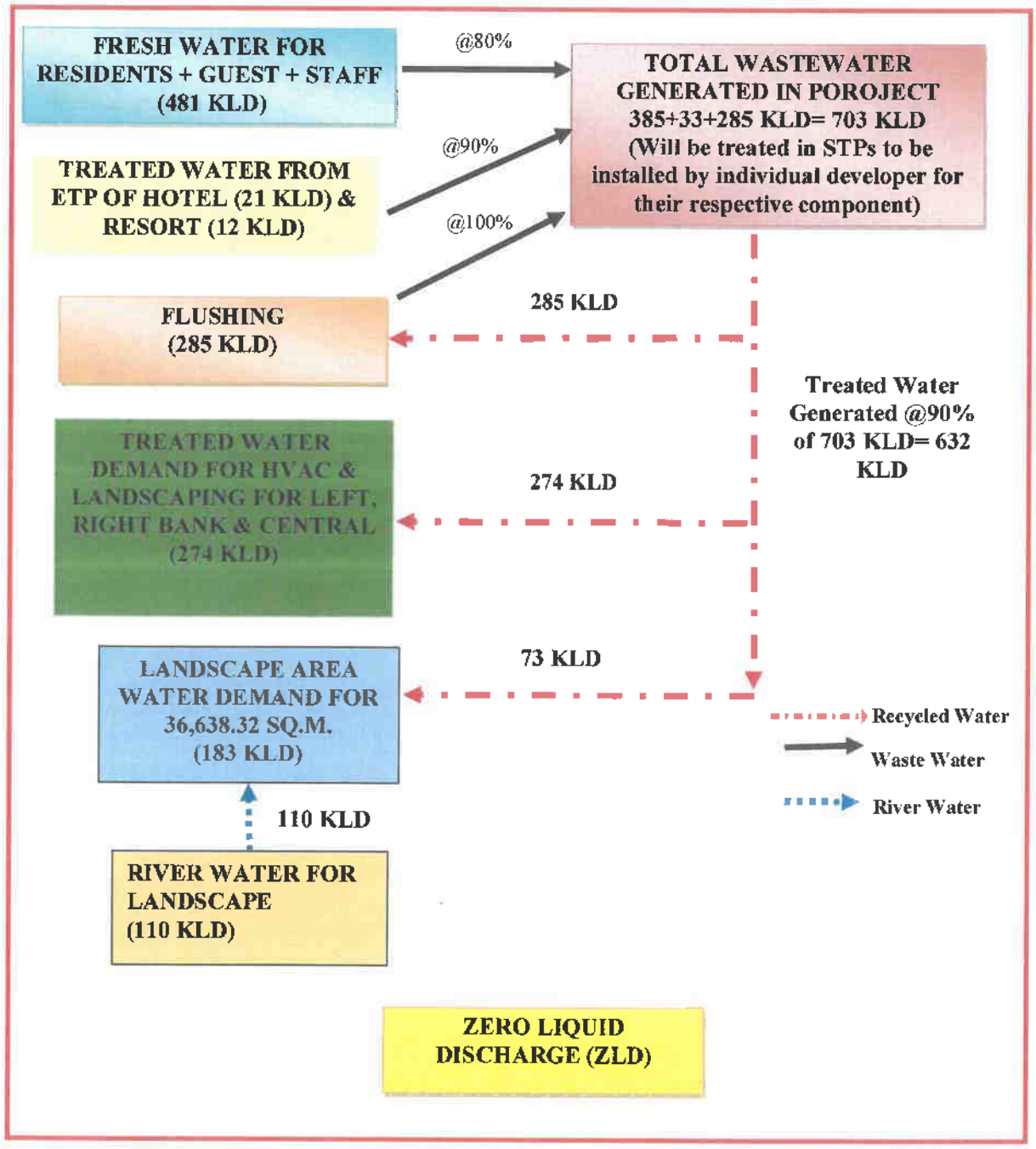

Figure 10: Water Balance Diagram for all Components

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I. GROUP HOUSING WATER REQUIREMENTS & WASTE WATER GENERATION DETAILS

The Water Requirements & Waste Water Generation calculations for Residential Group Housing, Retail Mall, Hotel, Resort & High Street Mall is given in **Table 18, 19, 20, 21 & 22.**

Table 18(a): Calculations of Fresh Water & Treated Water Requirement for Group Housing

S. No.	Particulars	Occupancy/ Area/ No's	Fresh Water Demand		Treated Water Demand		Total (KLD)
			LPCD	Quantity (KLD)	LPCD	Quantity (KLD)	
1	Residents	2406	90	217	45	108	325
2	Staff	120	25	3	20	2	5
3	Visitors	241	5	1	10	3	4
4	Landscape Area	6894.34 sq.m.			@5 lt./sq.m./day	35	35
Total				**221**		**148**	**369**

Source- National Building Code of India

Table 18(b): Summary of Water Demand & Wastewater Generation for Group Housing

S. No.	Particulars	Water Demand (in KLD)
1.	Total Water Demand	369
2.	Fresh Water Demand	221
3.	Flushing Water Demand	113
4.	Treated water Demand	148
5.	Wastewater Generated (@80% of Fresh Water Demand + 100% Treated Water Demand)	290
6.	Treated Water Generation (@90% of Wastewater Generated)	261
7.	STP Capacity (Proposed)	350

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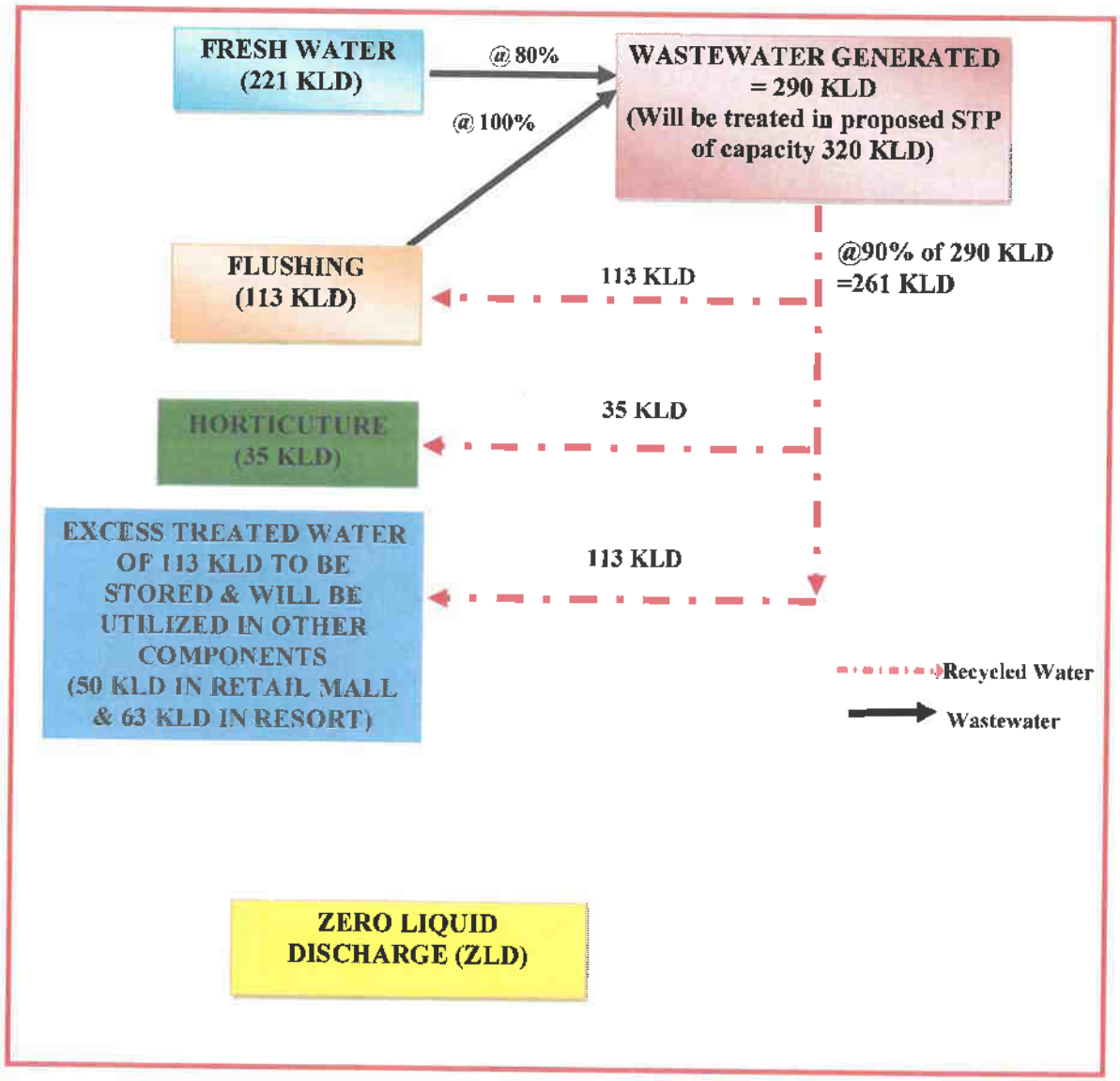

Figure 11: Water Balance Diagram for Group Housing

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II. RETAIL MALL WATER REQUIREMENTS & WASTE WATER GENERATION DETAILS

Table 19(a): Calculations of Fresh Water & Treated Water Requirement for Retail Mall

S.No.	Description	Population	Fresh Water Demand		Treated Water Demand		Total Water Demand (KLD)
			LPCD	Quantity (KLD)	LPCD	Quantity (KLD)	
1	Floors	6985	5	35	10	70	105
2	Restaurant	383	55	21	15	6	27
3	Food Court	848	25	21	10	8	30
4	Staff	913	25	23	20	18	41
5	Landscape Area	5034.45	-		5 lt./sq.m.	25	25
6	HVAC	1032 (TR)			Capacity*10*8*0.0001	83	83
Total			-	**100**		**210**	**310**

Source- National Building Code of India

Table 19(b): Summary of Water Requirement & Wastewater Generation for Retail Mall

S. No.	Particulars	Water Demand (in KLD)
1.	Total Water Demand	310
2.	Fresh Water Demand	100
3.	Flushing Water Demand	102
4.	Treated Water Demand	210
5.	Wastewater Generated (@80% of Fresh Water Demand & 100% of Flushing Water Demand)	182
6.	Treated Waste Water Generation (@90% of Wastewater Generated)	160
7.	Proposed STP Capacity	250

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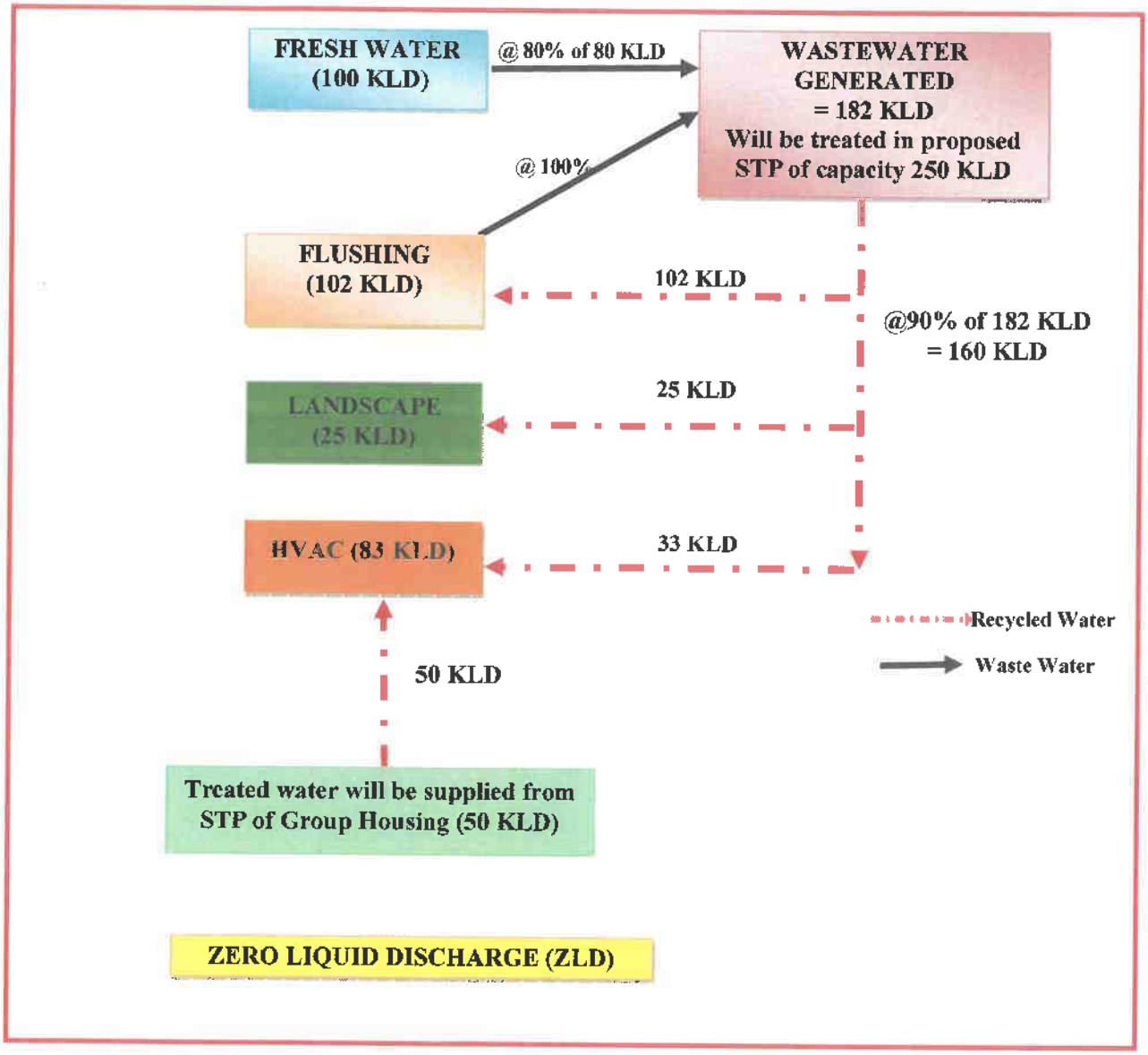

Figure 12: Water Balance Diagram for Retail Mall

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III. HOTEL WATER REQUIREMENT & WASTE WATER GENERATION DETAILS

Table 20(a): Calculations of Fresh Water & Treated Water Requirement for Hotel

S.No	Description	Population	Fresh Water Demand		Treated Water Demand		Total Water Demand Quantity (KLD)
			LPCD	Quantity (KLD)	LPCD	Quantity (KLD)	
1	Hotel Guest	310	260	81	60	19	99
2	Banquet Guest	261	5	1	10	3	4
3	Staff	113	25	3	20	2	5
4	Laundry	4 kg/room	20 lt./kg/day	12	-	-	12
5	Kitchen	930 meals/day	15 lt./meal/day	14	-	-	14
6	Landscape Area	1363.619 sq.m.	-	-	5 lt./sq.m	7	7
7	HVAC	350 TR	-	-	Capacity *10*8*0.001	28	28
Total				**111**		**58**	**169**

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Table 20(b): Summary of Water Requirement & Wastewater Generation for Hotel

S. No.	Particulars	Water Demand (in KLD)
1.	Total Water Demand	169
2.	Fresh Water Demand	111
	• Guest+ Staff	85
	• Laundry	12
	• Kitchen	14
3.	Flushing Water Demand (Staff & Visitors)	23
4.	Total Treated Water Demand (Flushing + Landscape + HVAC)	58
5.	Wastewater Generated (@80% of Fresh water demand for Staff & Guest + 100% of Flushing)	91
6.	Effluent Generated (@80% of Kitchen + 100% of Laundry)	11+12=23
7.	Treated Effluent from ETP (@ 90% of effluent generated)	21
8.	Total Wastewater to be treated in STP (Sewage Generated + (90% of treated effluent from ETP)	112
9.	Treated Waste Water Generation (@90% of Wastewater Generated)	101
10.	Proposed STP Capacity	150
11.	Proposed ETP Capacity	30

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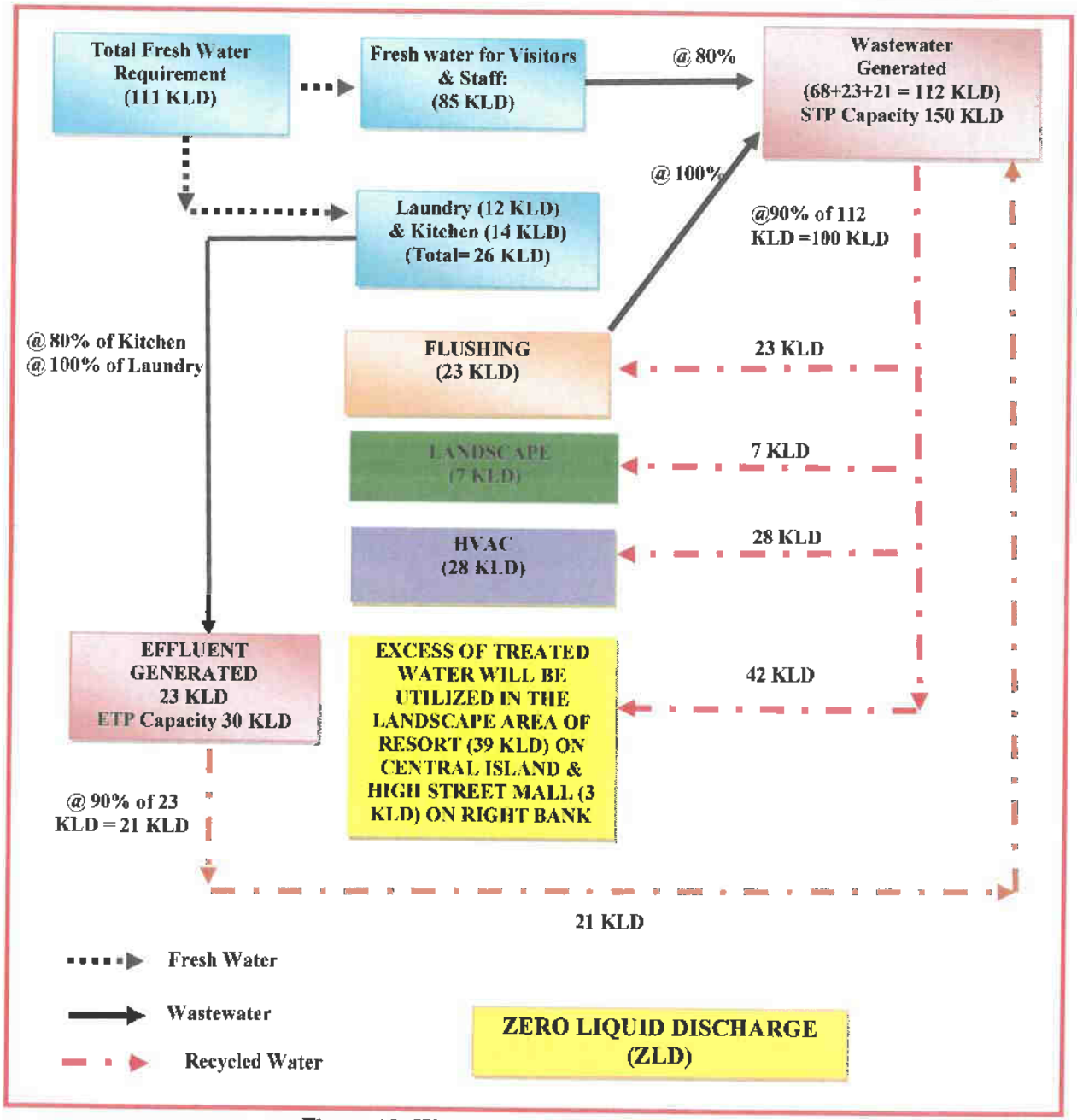

Figure 13: Water Balance Diagram for Hotel

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IV. RESORT WATER REQUIREMENT & WASTE WATER GENERATION DETAILS

Table 21(a): Calculations of Fresh Water & Treated Water Requirement for Resort

S.No	Description	Population/Weight in Kg per day/ Meals per day /Area (in sq.m.)	Fresh Water Demand		Treated Water Demand		Total Water Demand (KLD)
			LPCD	Quantity (KLD)	LPCD (KLD)	Quantity (KLD)	
1.	Banquets Guest	1462	5	7	10	15	22
2.	Restaurant Guest	163	55	9	15	2	11
3.	Hotel Guest	128	260	33	60	8	41
4.	Cottage type -1 Guest	18	260	5	60	1	6
5.	Cottage Type-2 Guest	32	260	8	60	2	10
6.	Staff @5% of Total Population Banquet & Restaurant)	81	25	2	20	2	4
7.	Staff @25% of Total Population Hotel Block & Cottage	45	25	1	20	1	2
8.	Laundry (@ 4 kg/bed)	89 beds*4 = 356 kgs/day	20 lt/kg/day	7	-	-	7
9.	Kitchen (@3 meals/person/day)	178 persons*3 = 534 meals/day	15lt/meal/day	8	-	-	8
10	Landscape	15,153.42	-	-	5lt/sqm	76	76
11.	HVAC (TR)	181 (TR)			Capacity*10*8*0.001	14	14
Total				**80**		**121**	**201**

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Table 21(b): Summary of Water Requirement & Wastewater Generation for Resort

S. No.	Particulars	Water Demand (in KLD)
1.	Total Water Demand	201
2.	Fresh Water Demand • Staff + Guest • Laundry • Kitchen	80 65 7 8
3.	Flushing Water Demand (Staff & Visitors)	30
4.	Total Treated Water Demand (Flushing + Landscape + HVAC)	128
5.	Wastewater Generated (@80% of Fresh water demand for Staff & Guest + 100% of Flushing)	52+30=82
6.	Effluent Generated (@80% of Kitchen + 100% of Laundry)	6+8=14
7.	Treated Effluent from ETP(@ 90% of effluent generated)	13
8.	Total Wastewater to be treated in STP (Sewage Generated + (90% of treated effluent from ETP)	82+13=95
9.	Treated Waste Water Generation (@90% of Wastewater Generated)	86
10.	Proposed STP Capacity	120
11.	Proposed ETP Capacity	20

Source- National Building Code of India

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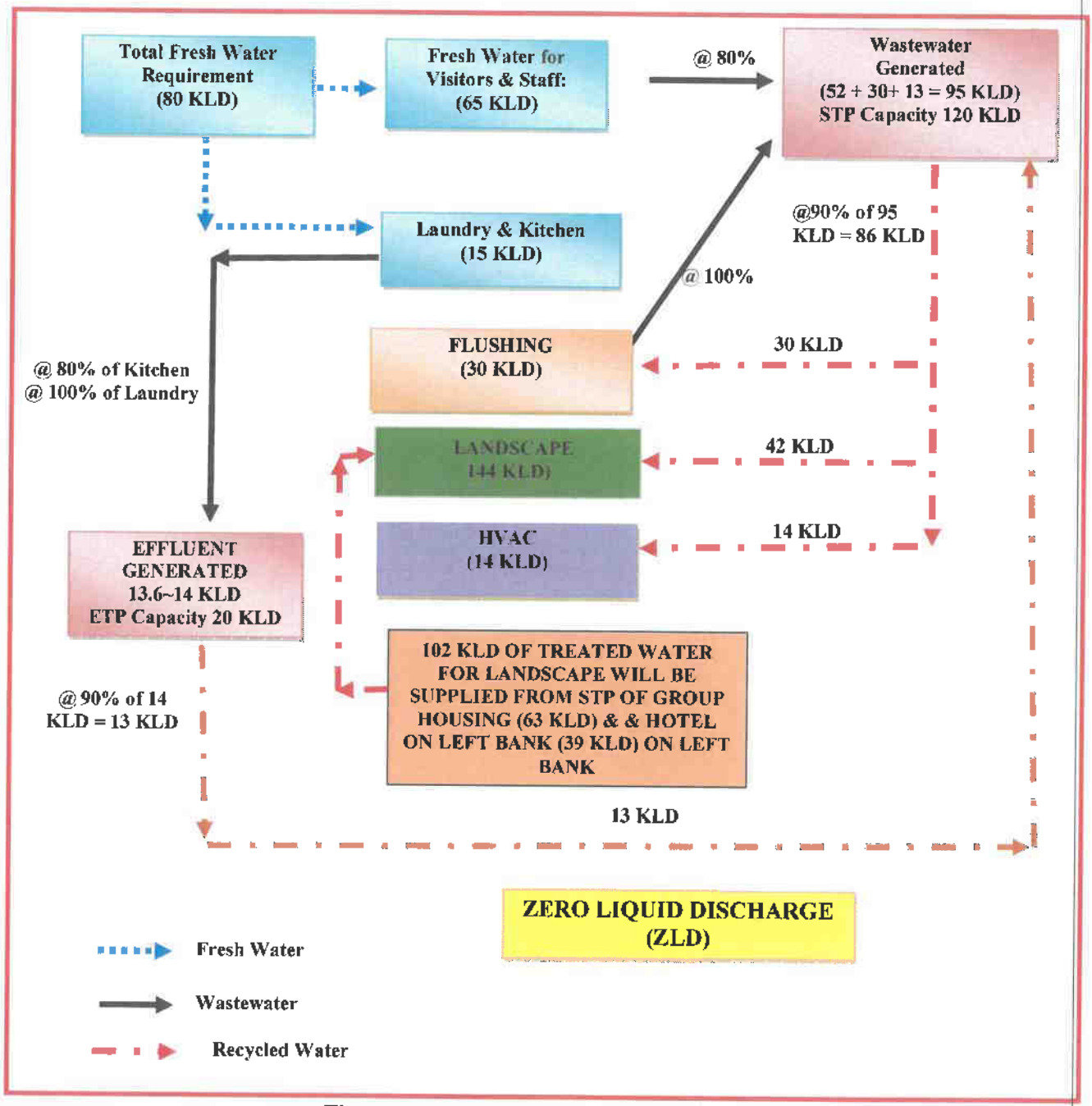

Figure 14: Water Balance Diagram for Resort

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V. HIGH STREET MALL WATER REQUIREMENT & WASTE WATER GENERATION DETAILS

Table 22(a): Calculations of Fresh Water & Treated Water Requirement for High Street Mall

S. No	Description	Population /Area (in sq.m.)	Fresh Water Demand		Treated Water Demand		Total Water Demand (KLD)
			LPCD	Quantity (KLD)	LPCD	Quantity (KLD)	
1.	Staff	83	25	2	20	2	4
2.	Visitors	750	5	4	10	8	11
3.	Landscape	1278.97	-	-	5lt/sq.m.	6	6
Total				**6**		**16**	**21**

Source- National Building Code of India

Table 22(b): Summary of Water Requirement & Wastewater Generation for High Street Mall

S. No.	Particulars	Water Demand (in KLD)
1.	Total Water Demand	21
2.	Fresh Water Demand	6
3.	Flushing Water Demand	10
4.	Treated Water Demand	16
5.	Wastewater Generated (@90% of fresh water + 100% of Flushing)	15
6.	Treated Water Generation (@90% of waste water generated)	13.5
7.	STP Capacity	25

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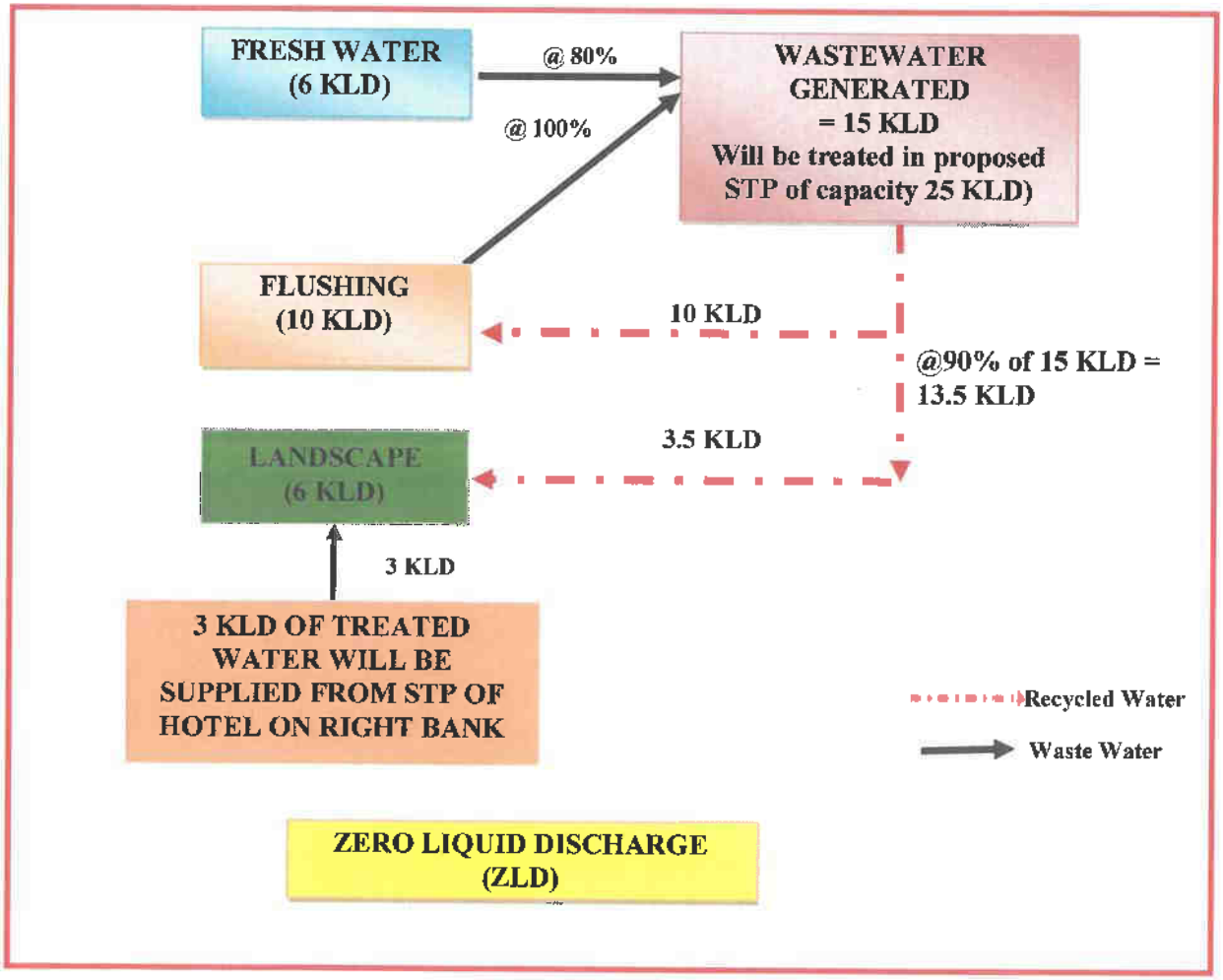

Figure 15: Water Balance Diagram for High Street Mall

- **END USE OF SURPLUS TREATED WATER WITHIN THE COMPONENTS**
- Approximately 113 KLD of surplus treated water generated from the Residential Group Housing component will be reused for landscaping purposes—50 KLD in the Retail Mall located on the Left Bank and 63 KLD in the Resort on the Central Island.
- Additionally, around 42 KLD of surplus treated water generated from the Hotel will be reused-39 KLD for landscaping in the Resort on the Central Island and 3 KLD in the High Street Mall on the Right Bank.
- Through this integrated reuse strategy, the proposed project is designed to achieve Zero Liquid Discharge (ZLD).

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10.1 WASTEWATER GENERATION & ITS TREATMENT

Collectively, approx. 703 KLD of total wastewater will be generated in the project. Wastewater generated from each facility will be treated in the STPs of total capacity 945 KLD (i.e. 350 KLD, 250 KLD, 150 KLD, 120 KLD & 25 KLD) & ETPs of total capacity 50 KLD (*i.e.* 30 KLD & 20 KLD). STPs and ETPs required will be installed by the individual developers for their own facility. Approximately 628 KLD of treated water will be recovered from the STP and reused within the project for flushing, landscaping, and HVAC requirements. This efficient reuse strategy will enable the project to achieve Zero Liquid Discharge (ZLD).

11.0 STORM WATER MANAGEMENT

Storm-water runoff from roof top of Residential Group Housing, Retail Mall, Hotel, Resort & High Street Retail will be collected in Rainwater Harvesting Tanks to be provided within the project premises to collect rain water. Excess storm water will be allowed to drain into the external storm drain. Rain water harvesting has been catered to and designed as per the guideline of CGWA.

The volume of recharge tank shall be 2.5m*2.5m*2m = 12.5 m^3/ hr for storage of the water.

The path ways around the harvesting lines will be graded to facilitate drainage into trenches proposed around the compound.

Table 23: Rainwater Harvesting Calculations

Calculation for Storm Water Load			
S.No.	**Description**	**Total**	**Unit**
1	Total Plot Area	1,57,207.57	Sqm
2	Roof-top area = Ground Coverage	28,277	Sqm
B	**Total Runoff Load**		
1	Roof-top Area (area*rain fall*run off Coefficient)	28,277*0.010*0.85 = 240.35	m^3/ hr
4	Total Runoff Load	240.35	m^3/ hr
C	**Total for all areas - volume of runoff & Calculation for RWH**		
1	Total Volume of runoff generated from the proposed Project, Taking 15 minutes Retention Time (Total Runoff load/4)	240.35/4=60.08	m^3/ hr
2	Volume of Recharge Tank (l*b*h)	2.5*2.5*2=12.5	m^3/ hr
3	**No. of RWH Tanks**	**60.08/12.5 = 4.80 ~ 5 Tanks of 12.5 KLD each has been proposed**	

According to the Rainwater Harvesting calculations for collection of runoff generated from roof top 5 tanks each having capacity of minimum 12.5 KLD~13 KLD has been proposed.

Note: Storm water runoff from green spaces and paved/open areas within the project site will be directed to the nearby storm water drainage system.

12.0 VEHICLE PARKING FACILITIES

Adequate provision will be made for car/vehicle parking at the project site conforming bye laws and MoEF&CC requirement. The project site is well connected to existing roads and highways, ensuring minimal additional load on the surrounding transportation infrastructure.

Total **2,080** number of ECS for parking has been proposed in the project. Details are given in **Table 24.**

Table 24: Proposed Parking Details

LOACTION	COMPONENTS	PARKING REQUIRED (IN ECS)	PARKING PROPOSED (IN ECS)
Left Bank	Public Parking	-	32
	Group Housing	627	905
	Retail Mall	658	592
	Hotel	105	104
	Public Parking	-	82
Central Island	**Total (1)**	**1390**	**1715**
	Resort	152	167
	Public Parking	-	94
	Public Parking	-	
	Total (2)	**152**	**261**
Right Bank	High Street Retail	63	64
	Park 1	-	18
	Park 2	-	-
	Public Parking	-	22
	Total (3)	**63**	**104**
Total Parking Proposed (1+2+3)		**1,605 ECS**	**2080 ECS**

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Detailed parking calculations for Residential Group Housing, Retail Mall, Hotel, Resort & High Street Mall is given in **Table 25, 26, 27, 28 & 29.**

I. GROUP HOUSING PARKING DETAILS

Table 25(a): Details of Parking Required in Group Housing

S.No.	Description	Dwelling Unit	Car/ Unit	Total
1.	2BHK	118	1 ECS per DU	118
2.	3BHK	186	1.5 ECS per DU	279
3.	4BHK	100	2 ECS per DU	200
4.	Visitors car parks			30
	TOTAL CAR PARKING			**627 ECS**

Source- Development Control Regulations

Table 25(b): Details of Parking Proposed Group Housing

S.No.	Description	Parking Proposed (ECS)
1.	Basement-1	449
2.	Basement-2	456
3.	Total	**905 ECS**

II. RETAIL MALL PARKING DETAILS

Table 26(a): Details of Parking Required in Retail Mall

S.No.	Description	Area in sq.m	Parking Norms	Total ECS
1.	Parking Required	32,909.25	2 ECS per 100 sq.m.	658 ECS

Source- Development Control Regulations

Table 26(b): Details of Parking Proposed in Retail Mall

S.No	Description	Parking Proposed (ECS)
1.	Basement	592
2.	**Total**	**592**

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III. HOTEL PARKING DETAILS

Table 27(a): Details of Parking Required in Hotel

S.No	Description	Area in sq.m	Parking Norms	Total ECS
1.	Parking Required	10,483.67	1.5 ECS/100 sq.m.	105 ECS

Source- Development Control Regulations
Note: BUA for ECS calculation exclude common service areas and Basement

Table 27(b): Details of Parking Proposed in Hotel

S.No	Description	Parking Proposed (ECS)
1.	Basement	104
2.	**Total Parking Proposed**	**104 ECS**

Table 27(c): Details of Public Parking in Left bank

S.No	Description	Parking Proposed (ECS)
1.	**Total Parking Proposed**	**82 ECS**

IV. RESORT PARKING DETAILS

Table 28(a): Required Parking in Resort

S. No.	Description	Area	Criteria	No. of ECS
1.	Parking Required	15235.473	1 ECS/100 sq. m. of BUA	152

Source- Development Control Regulations
Note: BUA for ECS calc. exclude common service areas and Basement

Table 28(b): Proposed Parking in Resort

S. No.	Description	Parking Proposed (ECS)
1.	Surface Parking	91
2.	Basement Parking	76
3.	**Total**	**167 ECS**

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Table 28 (c): Details of Public Parking in Central Island

S.No	Description	Parking Proposed (ECS)
1.	**Total Parking Proposed**	**94 ECS**

V. HIGH STREET MALL PARKING DETAILS

Table 29(a): Parking required in High Street

S. No.	Description	Area	Criteria	No. of ECS
1.	Parking Required	4216.42 sq.m.	1.5 ECS/100 sq. m. of BUA*	63

Source- Development Control Regulations
*Note: *BUA for ECS calc. exclude common service areas and Basement*

Table 29(b): Parking Proposed in High Street

S. No.	Description	Parking Proposed (ECS)
1.	Surface Parking	32
2.	Mechanical Parking	32
Total		**64**

Table 29(c): Details of Public Parking in Right bank

S.No	Description	Parking Proposed (ECS)
1.	**Total Parking Proposed**	**18 ECS**

13.0 SOLID WASTE GENERATION

Solid waste would be generated both during the construction as well as during the operation phase. The solid waste expected to be generated during the construction phase will comprise of excavated materials, used bags, bricks, concrete, MS rods, tiles, wood etc. The following steps are proposed to be followed for the management solid waste:

- Construction yards are proposed for storage of construction materials.
- The excavated material such as topsoil and stones will be stacked for reuse during later stages of construction
- Excavated top soil will be stored in temporary constructed soil bank and will be reused for landscaping.
- Remaining soil shall be utilized for refilling / road work / rising of site level at locations/ selling to outside agency for construction of roads etc.

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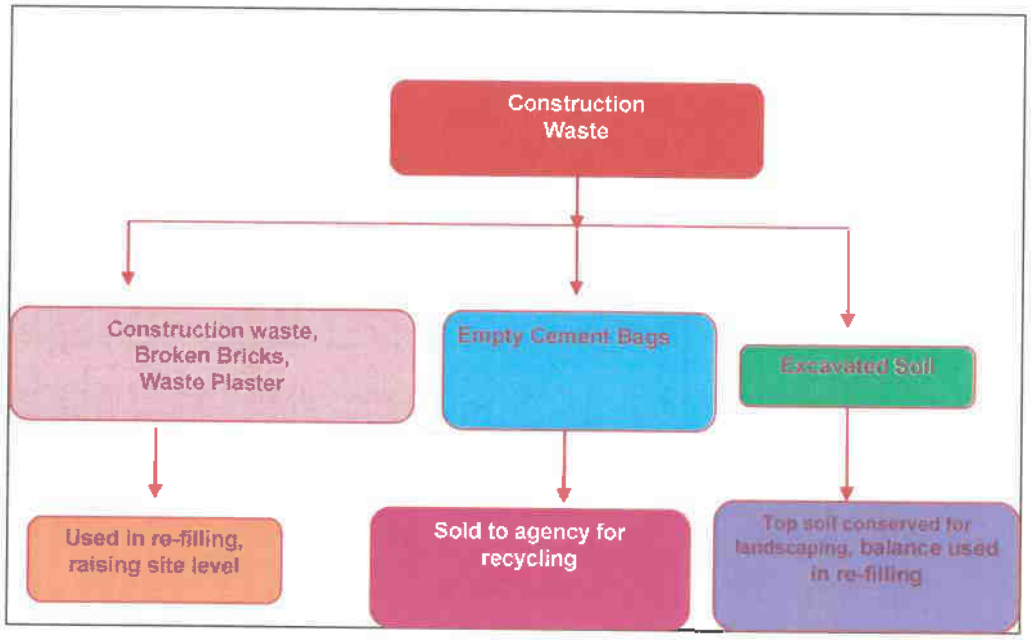

Figure 16: Solid Waste Management during Construction Phase

During the operation phase, the solid waste generated from the project is mainly domestic waste and estimated quantity of the solid waste is approx. **3512 kg/day~3.512 Tonnes/day**. The detailed calculation for solid waste is given below in **Table 30.**

Table 30: Solid Waste Generation Details (For all Components)

LOCATION	COMPONENTS	SOLID WASTE (IN KGS)
Left Bank	Group Housing	1262
	Retail Mall	1461
	Hotel	291
Central Island	Resort	365
Right Bank	High Street Retail	133
Total Solid Waste Generated		**3,512 Kgs/day ~ 3.512 Tonnes/day**

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I. GROUP HOUSING WASTE GENERATION DETAILS

Detailed waste generation calculations for Residential Group Housing, Retail Mall, Hotel, Resort & High Street Mall is given in **Table 31, 32, 33, 34 & 35.**

Table 31(a): Solid Waste Generation Calculations for Residential Group Housing

S. No.	Category	Kg per capita per day	Waste generated (kg/day)
1	Residents	2406 @ 0.5 kg /day	1203.0
2	Staff	120@ 0.25 kg / day	30.0
3	Visitor	241@ 0.15 kg /day	28.2
4	Landscape waste 6894.34 sq.m (1.70 acres)	1.70@0.2 kg/acres	0.34
Total			**1261.54 ~ 1262 kg/day**

Table 31(b): Bifurcation of Municipal Solid Waste & Disposal for Residential Group Housing

S. No.	Description	Quantity of waste generated (Kg/day)	Composition	Disposal
1	Biodegradable waste (50%)	630.65 kg/day	Waste vegetables and foods, etc.	OWC of adequate capacity will be installed within the site to convert biodegradable waste into manure which will be utilized for landscaping.
2	Recyclable waste (40%)	504.8 kg/day	Papers, cartons, thermocol, plastics, glass etc.	Recyclable waste will be handed over to authorized agency for its disposal as per Solid Waste Management Rules,2016 & its amendments thereof
3	Inert waste (9%)	113.58 kg/day	-	Will be handed over to authorized agency
4	E-waste (1%)	12.62 kg/day	Electronics & Electrical equipment	Will be handed over to authorized recyclers & disposed as per E-Waste (Management) Rules,2016 & its amendments thereof

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II. RETAIL MALL WASTE GENERATION DETAILS

Table 32(a): Solid Waste Generation Details for Retail Mall

S. No.	Category	Kg per capita per day	Waste generated (kg/day)
1.	Staff	913@ 0.25 kg / day	228.25
2.	Visitor	8216@ 0.15 kg /day	1232.4
3.	Landscape waste 5034.45 sq. m. (1.244 acres)	1.244 @0.2 kg/acres	0.25
Total			**1460.89~ 1461 kg/day**

Table 32(b): Bifurcation of Municipal Solid Waste & Disposal for Retail Mall

S. No.	Description	Quantity of waste generated (Kg/day)	Composition	Disposal
1	Biodegradable waste (50%)	731 kg/day	Waste vegetables and foods, etc.	OWC of adequate capacity will be installed within the site to convert biodegradable waste into manure which will be utilized for landscaping.
2	Recyclable waste (40%)	584 kg/day	Papers, cartons, thermocol, plastics, glass etc.	Recyclable waste will be handed over to authorized agency for its disposal as per Solid Waste Management Rules,2016 & its amendments thereof
3	Inert waste (9%)	131 kg/day	-	Will be handed over to authorized agency
4	E-waste (1%)	15 kg/day	Electronics & Electrical equipment	Will be handed over to authorized recyclers & disposed as per E-Waste (Management) Rules,2016 & its amendments thereof

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III. HOTEL WASTE GENERATION DETAILS

Table 33(a): Solid Waste Generation Details for Hotel

S. No.	Category	Kg per capita per day	Waste generated (kg/day)
1	Staff of Hotel & Banquet	113@0.25 kg / day	7.75
2	Guests of Banquets	261@ 0.15 kg /day	219.3
3	Guests of Hotel	310@0.5kg / day	64
4	Landscape waste 3,962.59 sq. m. (0.9791 acres)	0.9791 @0.2 kg/acres	0.19
Total			**291**

Table 33(b): Bifurcation of Municipal Solid Waste & Disposal for Hotel

S. No.	Description	Quantity of waste generated (Kg/day)	Composition	Disposal
1	Biodegradable waste (50%)	146 kg/day	Waste vegetables and foods, etc.	Mechanical Composter or OWC of adequate capacity will be installed within the site to convert biodegradable waste into manure which will be utilized for landscaping.
2	Recyclable waste (40%)	116 kg/day	Papers, cartons, thermocol, plastics, glass etc.	Recyclable waste will be handed over to authorized agency for its disposal as per Solid Waste Management Rules,2016 & its amendments thereof
3	Inert waste (9%)	26 kg/day	-	Will be handed over to authorized agency
4	E-waste (1%)	3 kg/day	Electronics & Electrical equipment	Will be handed over to authorized recyclers & disposed as per E-Waste (Management) Rules,2016 & its amendments thereof

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IV. RESORT WASTE GENERATION DETAILS

Table 34(a): Solid Waste Generation Details for Resort

S. No.	Category	Kg per capita per day	Waste Generated (kg/day)
1	Staff of Hotel & Banquet	126@0.25 kg / day	31.5
2	Guests of Restaurant	163@ 0.15 kg /day	24.45
3	Guests of Banquets	1462 @ 0.15 kg /day	219.3
4	Guests of Hotel	128@0.5kg / day	64
5	Guests of Cottage Type 1 & 2	50@0.5 kg / day	25
6	Landscape waste 15,153.42 sq. m. (3.74 acres)	0.748 @0.2 kg/acres	0.75
Total			**365**

Table 34(b): Bifurcation of Municipal Solid Waste & Disposal for Resort

S. No.	Description	Quantity of waste generated (Kg/day)	Composition	Disposal
1	Biodegradable waste (50%)	182 Kg/day	Waste vegetables and foods, etc.	Mechanical Composter or OWC of adequate capacity will be installed within the site to convert biodegradable waste into manure which will be utilized for landscaping.
2	Recyclable waste (40%)	146 kg/day	Papers, cartons, thermocol, plastics, glass etc.	Recyclable waste will be handed over to authorized agency for its disposal as per Solid Waste Management Rules,2016 & its amendments thereof
3	Inert waste (9%)	33 kg/day	-	Will be handed over to authorized agency
4	E-waste (1%)	4 kg/day	Electronics & Electrical equipment	Will be handed over to authorized recyclers & disposed as per E-Waste (Management) Rules,2016 & its amendments thereof

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V. HIGH STREET MALL WASTE GENERATION DETAILS

Table 35(a): Solid Waste Generation Details for High Street Mall

S. No.	Category	Kg per capita per day	Waste generated (kg/day)
1.	Staff	83@0.25 kg / day	20.75
2.	Visitor	750@ 0.15 kg /day	112.5
3.	Landscape waste 1278.97 sq. m. (0.316 acres)	0.316 @0.2 kg/acres	0.06
Total			**133.31 ~ 133 kg/day**

Table 35(b): Bifurcation of Municipal Solid Waste & Disposal for High Street Mall

S. No.	Description	Quantity of waste generated (Kg/day)	Composition	Disposal
1	Biodegradable waste (50%)	67 kg/day	Waste vegetables and foods, etc.	Mechanical Composter or OWC of adequate capacity will be installed within the site to convert biodegradable waste into manure which will be utilized for landscaping.
2	Recyclable waste (40%)	53 kg/day	Papers, cartons, thermocol, plastics, glass etc.	Recyclable waste will be handed over to authorized agency for its disposal as per Solid Waste Management Rules,2016 & its amendments thereof
3	Inert waste (9%)	12 kg/day	-	Will be handed over to authorized agency
4	E-waste (1%)	1 kg/day	Electronics & Electrical equipment	Will be handed over to authorized recyclers & disposed as per E-Waste (Management) Rules,2016 & its amendments thereof

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SOLID WASTE MANAGEMENT

❖ **Collection and Segregation of waste**

2. The Bio degradable waste generated is sold to the local vendors.
3. Adequate number of colored bins (Green and Blue & dark grey bins– separate for Bio-degradable and Non Bio-degradable) will be provided at the strategic locations
4. Litter bin are also provided in open areas like parks etc.

❖ **Treatment of waste**

- **Bio-Degradable wastes**

1. Bio-degradable waste will be subjected to Organic Waste Converter and the compost/resultant will be used as manure.
2. Horticultural Waste is proposed to be composted and will be used for gardening purposes.

- Recyclable wastes

1. ***Grass Recycling*** – The cropped grass will be spread on the green area. It will act as manure after decomposition.
2. Recyclable wastes like paper, plastic, metals etc. will be sold off to recyclables.

- **Non-Recyclable wastes**

Non-Recyclable wastes will be disposed through Govt. approved agency. Hence, the Municipal Solid Waste Management will be conducted as per the guidelines of Municipal Solid Wastes (Management and Handling) Rules, 2000 and amended Rules, 2016.

- **E- waste**

E-waste management will be conducted as per the guidelines of E-waste (Management) Amendment Rules, 2018.

- **Battery Waste**

Battery waste management will be conducted as per the guidelines of Batteries (Management & Handling) Amendment Rules, 2010.

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❖ **Disposal**

Recyclable and non-recyclable wastes are disposed through the sewerage conveyance network of Jammu. Hence, the Municipal Solid Waste Management are conducted as per the guidelines of Municipal Solid Wastes (Management and Handling) Rules, 2016. The hazardous waste will be stored and disposed as per Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2016. E-Waste will be disposed in accordance with the E-waste guidelines, 2016. The Batteries waste will be stored and disposed as per Batteries Waste (Management & Handling) Rules, 2010. The biomedical waste will be stored and disposed as per Biomedical Waste (Management & Handling) Rules, 2016.

A Solid waste management Scheme is depicted in the following figure :

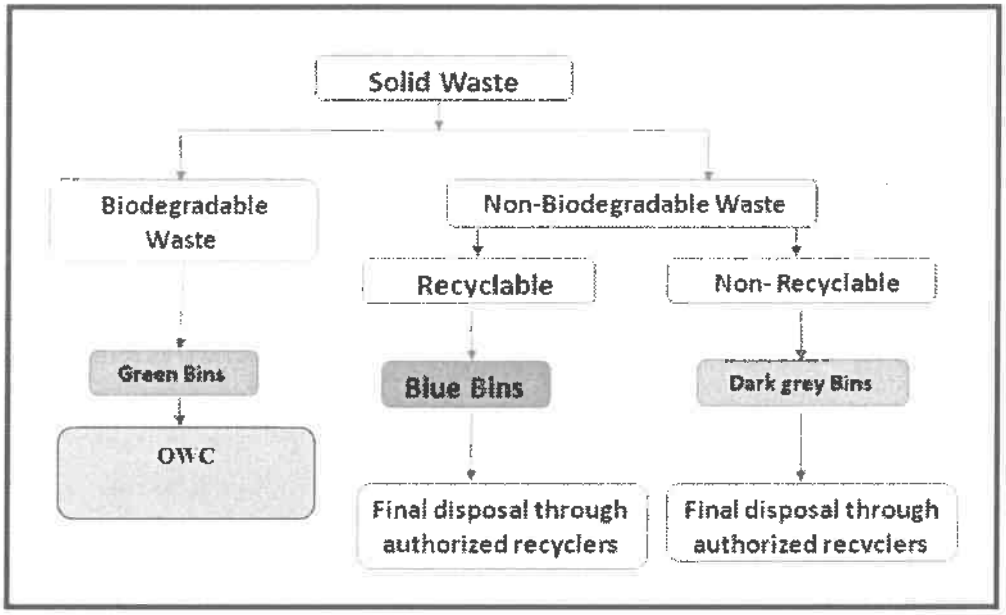

Figure 17: Solid Waste Management Scheme (Operation Phase)

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14.0 POWER REQUIREMENT

Construction phase: During construction phase expected power demand shall be approximately 5 KVA.

Source: Temporary connection (TC) from Jammu Power Distribution Corporation Limited.

For power back up 2 DG sets of capacity 2 x 1500 KVA each will be installed at construction site. The DG sets will be equipped with acoustic enclosure to minimize noise generation and adequate stack height for proper dispersion.

Operation Phase:

During operation phase expected power demand will be 11686 KW.

Source: Jammu Power Distribution Corporation Limited.

For power back up DG set of total capacity 12920 KVA will be provided:

- For Group Housing= 810 x 4 = 3420 KVA
- For Hotel = 2000 x 1= 2000 KVA
- For Malls =1250x 4= 5000 KVA
- For Resort =1250x2= 2500 KVA

The DG sets will be equipped with acoustic enclosure to minimize noise generation and adequate stack height for proper dispersion.

15.0 LANDSCAPE AREA OF PROJECT & PLANTATION DETAILS

Total Green area of 61,471.60 sq.m. has been proposed in the project including for all components i.e. 39.10% of the total plot area i.e. 1,57,207.57 sq.m. Details of proposed landscape area on Left Bank, Right Bank & Central Island is given in **Table 36.**

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Table 36: Detail of Green Areas within Tawi Riverfront Project:

S. No.	LOCATION	Code	FACILITIES	PROPOSED LANDSCPE AREA (in sq.m.)
1.	Left Bank (A)	A1	Residential Group Housing	6894.34
		A2	Retail Mall	5034.45
		A3	Hotel	1363.619
		A4	Public Parking 1	297.388
		A5	Public Parking 2	1103.799
		A6	Green Buffer	12,504.36
2.	Central Island (B)	B1	Resort	15153.42
		B2	Drop Off Area	1952.838
		B3	Green Buffer	5,774.94
3.	Right Bank (C)	C1	High Street Retail	1278.97
		C2	Park 1	5,202.91
		C3	Park 2	4,910.57
Total (1+2+3+4)				**61,471.604**

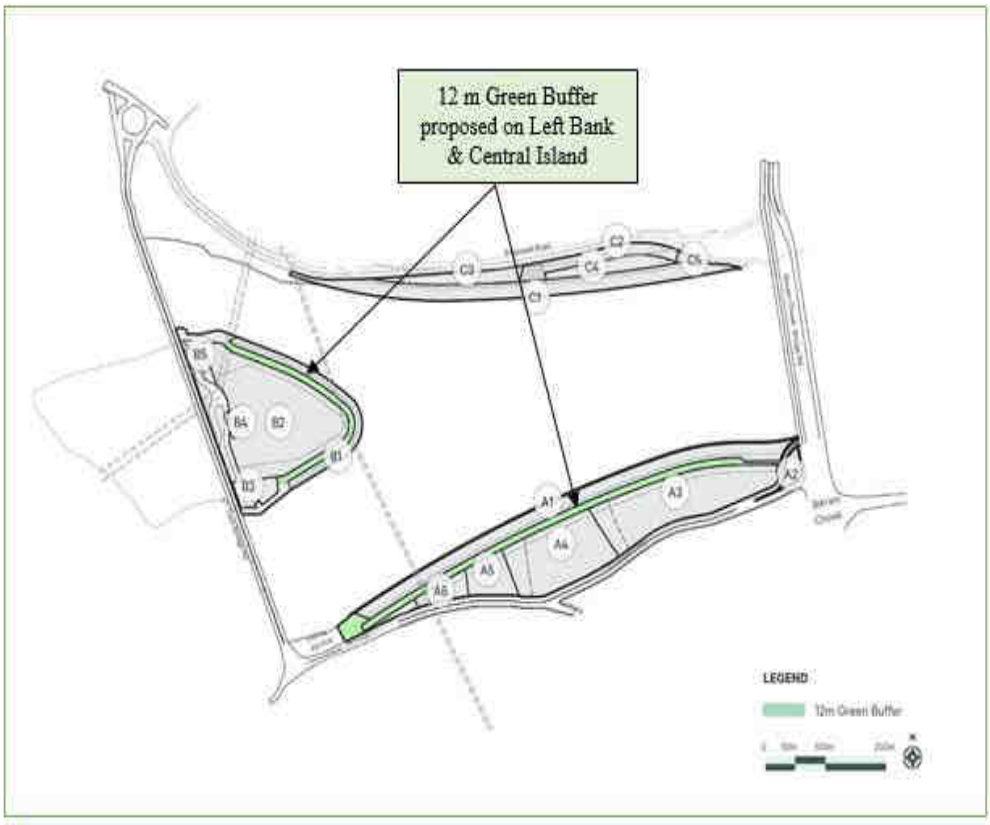

Figure 18: 12m Green Buffer along Left Bank & Central Island

Mandatory 12m Wide green Buffer is reserved on left bank promenade A1 & Central Island Promenade B1 as per **Figure 18.**

Tree Plantation:

Total no. of trees, shrubs and grasses proposed to be planted at Left bank, Right bank and Central Island are as follows:

- Trees-1735 No's
- Shrubs-24277 No's
- Fountain Grass-5000 No's

Details of trees, shrubs and grasses proposed are given in Table 37, 38, 39 & 40 respectively:

Table 37: List of Trees & shrubs Proposed at Left Bank

S. No.	Location	Area	Quantity	Proposed species of plants to be provided
1	12 m strip adjacent to top promenade running throughout its length	12M Green Buffer: 10,732.5 sqm (21.2K)	Tree: 242 Shrubs: 5045 Fountain Grass: 2500	**Trees** 1. *Thespesia populnea* 2. *Neolamarckia cadamba* 3.*Markhamia lutea* 4.*Dalbergia sisso* 5. *Cassia fistula* 6. *Michelia champaca* 7. *Bauhinia purperea* 8. *Pongamia pinnata* 9. *Tabebuia rosea* 10. *Jacaranda mimosaefolia* 11. *Bismarck Palm*
				Grass 1. *Pennisetum setaceum* (Red fountain grass) *2. Pennisetum setaceum* (White fountain grass)
				Shrubs 1.*Gerodendrum inerme* 2.*Bougainvillea* 3. *Hibiscus rosa sinensis* 4. *Murraya paniculata* 5.*Casesalpinia pulcherrima* 6. *Tecoma purperea* 7. *Bauhinia purpere*
2	Planters on 2 No. Intermediate promenades	Total area of planters on 2nd and 3rd	Tree: 30 Shrubs: 5030	**Trees** 1. *Michelia champaca* 2. *Bauhinia purperea*

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		promenade: 1963.3 sqm (3.8K)		**Shrubs** 1. *Quisqualis indica* 2. *Ipomoea cairica* 3. *Vernonia elaeagnifolia* 4. *Crinum latifolium* 5. *Clerodendrum inerme* 6. *Leucophyllum Frutescens* 7. Bougainvillea
				Shrubs 1.*Clerodendrum inerme* 2.Bougainvillea 3. *Hibiscus rosa sinensis* 4. *Murraya paniculata* 5.*Casesalpinia pulcherrima* 6. *Tecoma purperea* 7. *Bauhinia purpere*
3	Top promenade (trees)	6m wide promenade	174 No. of Trees	**Trees** 1. *Thespesia populnea* 2. *Azadirachta indica* 3. *Callistemon lanceolatus* 4. *Butea monosperma* 5. *Michelia champaca* 6. *Bauhinia purperea*
4	Bottom promenade (trees)	8m wide promenade	95 No. of Trees	**Trees** 1. *Pongamia pinnata* 2. *Neolamarckia cadamba* 3. *Cassta siamea* 4. *Lagerstroemia speciosa* 5. *Salix babylonica*
Total plantation on Left Bank: • Trees- 541 • Shrubs-10075 • Fountain Grass-2500				

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Table 38: List of Trees & Shrubs Proposed at Right Bank

S.No.	Location	Area	Quantity	Proposed species of plants to be provided
1	Park 1	5,196 sqm (10.2 K)	Tree: 380 Shrubs: 2940	**Tree** 1. *Jacaranda mimosaefolia* 2. *Cassia fistula* 3. *Tabebuia rosea* 4. *Bauhinia purpurea* 5. *Neolamarckia cadamba* 6. *Thespesia populnea* 7. *Azadirachta indica* 8. *Butea monosperma* 9. *Leucaena leucocephala* 10. *Michelia champaca* 11. *Dalbergia sissoo* 12. *Alstonia scholaris* 13. *Bismarckia nobilis* 14.*Pongamia pinnata* 15. *Grevillea robusta* 16. *Casuarina equisetifolia* 17.*Cinnamomum camphora* 18. *Musa acuminata* 19. *Moringa oleifera* 20.*Tamarindus Indica* 21.*Callistemon citrinus* 22.*Cassia siamea* 23. *Ficus elastica* 24. *Nyctanthes arbor-tristis* 25. *Platanus orientalis* 26. *Syzygium cumini*

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				Shrubs 1. *Tecoma stans* 2. *Bauhinia purpurea* 3. *Hamelia patens* 4. *Caesalpinia pulcherrima* 5. *Crinum latifolium* 6. *Vernonia cinerea* 7. *Ipomoea cairica* 8. *Michelia champaca* 9. *Heliconia* 10. *Duranta erecta* 11. *Ficus microcarpa* 12. *Bougainvillea* 13. *Hibiscus rosa sinensis* 14. *Plumbago auriculata* 15. *Quisqualis indica* 16. *Tecoma gaudichaudi* 17. *Tecoma capensis* 18. *Plumeria alba* 19. *Clerodendrum inerme* 20. *Ficus benjamina* 21. *Cycas revoluta*
2	Park 2	3988.5 sqm (7.8K)	Tree: 170 Shrubs: 1187	**Tree** 1. *Jacaranda mimosifolia* 2. *Callistemon citrinus* 3. *Cassia siamea* 4. *Grevillea robusta* 5. *Alstonia scholaris* 6. *Thespesia populnea* 7. *Bismarckia nobilis* 8. *Markhamia lutea* 9. *Michelia champaca* 10. *Pongamia pinnata* 11. *Cassia fistula* 12. *Tabebuia rosea* 13. *Bauhinia purpurea* 14. *Plumeria alba* **Shrubs** 1. *Plumbago auriculata* 2. *Heliconia spp.* 3. *Murraya paniculata* 4. Dracaena trifasciata 5. *Clerodendrum inerme* 6. Hibiscus rosa-sinensis 7. *Quisqualis indica* 8. *Vernonia cinerea* 9. *Tecoma gaudichaudi* 10. *Tecomaria capensis*

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				11. Bambusa spp. *12. Hamelia patens* *13. Crinum latifolium* *14. Duranta erecta* *15. Ficus microcarpa*
3	Planters on 2 No. intermediate promenades	Total area of planters on 2nd and 3rd promenade: 1826 sqm (3.6 K)	Tree: 30 Shrubs: 5030	**Tree** 1. *Michelia champaca* *2. Bauhinia purpurea* **Shrubs** 1. *Quisqualis indica* *2. Ipomoea cairica* *3. Vernonia cinerea* *4. Crinum latifolium* *5. Clerodendrum inerme* *6. Leucophyllum frutescens* *7. Bougainvillea* *8. Heliconia* *9. Dracaena trifasciata* *10. Plumbago auriculata* *11. Hibiscus rosa-sinensis* *12. Murraya paniculata* *13. Caesalpinia pulcherrima*
4	Top promenade (trees)	6 m wide promenade	130 No. of Trees	**Tree** 1. *Thespesia populnea* *2. Azadirachta indica* *4. Butea monosperma* *3. Melaleuca viminalis* *5. Michelia champaca* *6. Bauhinia purpurea*
5	Bottom promenade (trees)	8 m wide promenade	95 No. of trees	**Tree** 1. *Pongamia pinnata* 2.*Cassia siamea* 3. *Neolamarckia cadamba* 4. *Lagerstroemia speciosa* 5. *Salix babylonica*
Total plantation on Right Bank: • Trees-805 • Shrubs-9157				

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M/s Jammu Smart City Limited (JSCL)

Table 39: List of Trees & shrubs Proposed at Central Island

S.No.	Location	Area	Quantity	Proposed species of plants to be provided
1	12 m strip adjacent to top promenade running throughout its length (see drawing)	5478 sqm (10.8 K)	Tree: 242 Shrubs: 5045 Fountain Grass :2500	**Tree** 1. *Thespesia populnea* 2. *Neolamarckia cadamba* 3. *Markhamia lutea* 4. *Dalbergia sissoo* 5. *Cassia fistula* 6. *Michelia champaca* 7. *Bauhinia purpurea* 8. *Pongamia pinnata* 9. *Tabebuia rosea* 10. *Jacaranda mimosifolia* 11. *Bismarck Palm* **Grass** 1. *Pennisetum setaceum* (Red fountain grass) 2. *Pennisetum setaceum* (White fountain grass)
2	Top promenade (trees)	6 m wide promenade	96 No. of Trees	**Tree** 1. *Thespesia populnea* 2. *Azadirachta indica* 4. *Butea monosperma* 3. *Melaleuca viminalis* 5. *Michelia champaca* 6. *Bauhinia purpurea*
3	Bottom promenade (trees)	8m wide promenade	51 No. of Trees	**Tree** 1. *Pongamia pinnata* 2.*Cassia siamea* 3. *Neolamarckia cadamba* 4. *Lagerstroemia speciosa* 5. *Salix babylonica*
Total plantation on Central Island • Trees-242 • Shrubs-5045 • Fountain Grass-2500				

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Jammu Smart City Ltd.

Table 40: Summary of No. of Trees, Shrubs and Grasses proposed at Left Bank, Right Bank & Central Island

S.No.	Location	No. of Trees (No's)	No. of Shrubs and Fountain grass (No's)
A	**Left Bank**		
1	12 m strip adjacent to top promenade running throughout its length	242	Shrubs- 5045 Fountain Grass- 2500
2	Planters on 2 No. intermediate promenades	30	Shrubs- 5030
3	Top promenade	174	-
4	Bottom promenade	95	-
B	**Right Bank**		
1	Park - 1	380	Shrubs-2940
2	Park - 2	170	Shrubs-1187
3	Planters on 2 No. intermediate promenades	30	Shrubs-5030
4	Top promenade	130	-
5	Bottom promenade	95	-
C	**Central Island**		
1	12 m strip adjacent to top promenade running throughout its length	242	Shrubs-5045 Fountain Grass -2500
2	Top promenade	96	-
3	Bottom promenade	51	-
	TOTAL (A+B+C)	**Trees- 1735**	**Shrubs-24,277** **Fountain Grass – 5,000**

Note: Tree plantation within each component of the Left Bank (*i.e.* Group Housing, Retail Mall & Hotel), Right Bank (*i.e.* High Street Mall), and Central Island (*i.e.* Resort) will be carried out by the respective plot owners.

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UNION TERRITORY OF JAMMU AND KASHMIR
JAL SHAKTI (IRRIGATION AND FLOOD CONTROL) DEPARTMENT, JAMMU
OFFICE OF THE EXECUTIVE ENGINEER, FLOOD CONTROL DIVISION, JAMMU
Email:-xenfcjammu@gmail.com

Parul Gupta
R/O 109B Mast Garh
Jammu
Mob. 9622240739, jktech456@gmail.com

No:- FCD/J/4210-212 **Date:-** 03-12-2025

Sub:- **Application under RTI Act, 2005**
Ref: **Chief Engineer, Jal Shakti (I&FC) Deptt. Jammu's No. IFCJ/PS/19847-49 dated 15/11/2025.**

Dear Sir,

In context of the above cited subject matter, the reply of the information in respect of this Division is given as under:

S.No.	Information sought	Reply
1	Copy of Flood Line Maps for River Tawi within Jammu city limits.	The Flood Control Division Jammu has maintained the gauge on left side of river Tawi on upstream of Bikram Chowk to monitor the water levels on daily basis. The gauge has marked with different flood lines which indicates the level of water and the flood discharge, these reference flood line have been marked with different flood warnings as below:- a) The flood line at 14 feet indicates the ALERT LEVEL. b) The flood line at 17 feet indicates the DANGER LEVEL. c) The flood level at 23 feet indicates the EVACUATION LEVEL (Evacuation process started) and after 23 feet level, the highest flood level starts.
2	Copy of Hydraulic Study conducted to identify flood lines for River Tawi.	Flood Lines are marked as per observed data.
3	Recorded water surface levels for different flood values.	Copy enclosed as Annexure "A"
4	High Flood values recorded in the last 20 years.	The highest flood level recorded from the last more than 20 years is as under: Date of occurrences — Flood Level — Discharge (in Cusecs) 29-09-1988 — 31 feet — 427000 06-09-2014 — 33 feet — 478600 26-08-2025 — 34 feet (HFL) — 510600
5.	Copy of the NOC given by the Irrigation	Does not pertain to this division.

	Department for the River Front Development (RFD) project.	
6	Copy of the Hydraulic Studies conducted for Barrages under the RFD project.	Does not pertain to this division.
7	Details of the Free Catchment Area of River Tawi on the upstream of Jammu City.	River Tawi has catchment area of 2100 sq. km.(approx.) on the upstream of Jammu City.
8	Flood data for Udhampur Monitoring Station and Bikram Chowk Monitoring Station, Jammu.	Does not pertain to this division.

Yours Sincerely

Public Information Officer(PIO)
Executive Engineer
Flood Control Division
Jammu

Copy to the:

1. Chief Engineer, Jal Shakti (I&FC) Department, Jammu for information please.
2. Superintending Engineer, Hydraulic Circle, Jammu for information please.

(Annexure-"A")

GAUGE AND DISCHARGE OF RIVER TAWI AS PER CROSS SECTION TAKEN AT GAUGE SITE OF RIVER TAWI (LEFT BANK UP STREAM JAMMU CITY TAWI BRIDGE

Page-2.

Gauge in Feet	Gauge in Mtrs	Gauge in MSL	Discharge in cusecs	Remarks	Gauge in Feet	Gauge in Mtrs	Gauge in MSL	Discharge in cusecs	Remarks
0'	0.00	290.500	0		17'	5.179	295.68	142000	DANGER LEVEL
0'6"	0.152	290.652	0		17'6"	5.332	295.834	151720	
1'	0.305	290.805	0		18'	5.484	295.986	158200	
1'6"	0.457	290.957	0		18'6"	5.636	296.139	168280	
2'	0.610	291.110	0		19'	5.789	296.291	175000	
2'6"	0.762	291.262	0		19'6"	5.941	296.444	185620	
3'	0.914	291.414	0		20'	6.094	296.596	192700	
3'6"	1.067	291.567	0		20'6"	6.246	296.748	203680	
4'	1.219	291.719	2386		21'	6.398	296.901	211000	
4'6"	1.372	291.872	2797		21'6"	6.551	297.053	222280	
5'	1.524	292.024	3072		22'	6.703	297.206	229800	
5'6"	1.676	292.176	9627		22'6"	6.856	297.358	241500	
6'	1.829	292.329	14000		23'	7.006	297.510	249300	EVACUATION LEVEL
6'6"	1.981	292.481	17840		23'6"	7.158	297.663	261480	
7'	2.134	292.634	20400		24'	7.310	297.815	269600	
7'6"	2.286	292.786	24720		24'6"	7.463	297.968	281840	
8'	2.438	292.938	27600		25'	7.615	298.120	290000	
8'6"	2.591	293.091	32400		25'6"	7.768	298.272	302720	
9'	2.743	293.243	35600		26'	7.920	298.425	311200	
9'6"	2.896	293.396	43640		26'6"	8.072	298.577	324580	
10'	3.048	293.548	49000		27'	8.225	298.730	333500	
10'6"	3.200	293.700	55600		27'6"	8.377	298.882	347000	
11'	3.353	293.853	60000		28'	8.530	299.034	356000	
11'6"	3.505	294.005	67020		28'6"	8.682	299.187	369800	
12'	3.658	294.158	71700		29'	8.834	299.339	379000	
12'6"	3.810	294.310	79200		29'6"	8.987	299.492	393400	
13'	3.962	294.462	84200		30'	9.139	299.644	403000	
13'6"	4.115	294.615	92120		30'6"	9.292	299.796	417400	
14'	4.265	294.767	97400	ALERT LEVEL	31'	9.444	299.949	427000	
14'6"	4.417	294.920	105800		31'6"	9.596	300.101	441400	
15'	4.570	295.072	111400		32'	9.749	300.254	452000	
15'6"	4.722	295.224	120280		32'6"	9.901	300.406	466000	
16'	4.874	295.377	126200		33'	10.054	300.558	478600	~~HFL~~
16'6"	5.027	295.529	135680		34'	10.359	300.863	510600	HFL

J.E/JK

Executive Engineer
Flood Control Division
Jammu

R-1663
17/11/2025

GOVERNMENT OF JAMMU AND KASHMIR
OFFICE OF THE CHIEF ENGINEER IRRIGATION AND FLOOD CONTROL DEPARTMENT
JAMMU

(Tel/Fax- 0191-2582164 , E-mail:- ifcjmu@gmail.com)

Superintending Engineer,
Hydraulic Circle,
Jammu

Executive Engineer
Flood Control Division
Jammu

No ;- IFCJ/PS/19847-49 ***Dated :-*** 15/11/2025

Subject : Request for Information under J&K Right to Information Act 2005.

Sir,

Kindly find enclosed herewith photocopy of RTI received from Sh Parul Gupta R/o 109B Mast Garh Jammu.

In this context I am directed to request you to kindly provide requisite information to the applicant directly within the statutory period under intimation to this office as per section 6(3) of RTI Act 2005.

To provide info under RTI act -

Yours faithfully

Technical Officer to
Chief Engineer,
Irrigation & FC Department
Jammu.

Copy to :-
1. *Sh Parul Gupta R/o 109B Mast Garh Jammu.* for information.

FIO to
AEE-I, AEE-II, AEE-III & AEE-IV
for necessary reply
TO

To,
The Public Information Officer (PIO),
Irrigation & Flood Control Department,
Canal Road, Jammu – 180001

Subject: Request for information under the RTI Act, 2005 regarding flood and hydraulic studies for River Tawi.

Sir/Madam,

Kindly provide the following information under the RTI Act. 2005:

1. Copy of Flood Line Maps for River Tawi within Jammu city limits.
2. Copy of Hydraulic Study conducted to identify flood lines for River Tawi.
3. Recorded Water Surface Levels for different flood values.
4. High Flood Values recorded in the last 20 years.
5. Copy of the NOC given by the Irrigation Department for the River Front Development (RFD) project.
6. Copy of Hydraulic Studies conducted for Barrages under the RFD project.
7. Details of the Free Catchment Area of River Tawi on the upstream of Jammu City.
8. Flood data for Udhampur Monitoring Station and Bikram Chowk Monitoring Station, Jammu.

If any part of the information falls under another department, kindly transfer it as per Section 6(3) of the RTI Act.

Applicant Details:
Name: Parul Gupta
Address: 109B Mast Garh Jammu
Email : jktech456@gmail.com
Contact Number: +91-9622240739
Date: 13-11-2025
Place: Jammu

Office: Chief Engineer Jal Shakti (I&FC) Department
Received: 6/11/25
Date: 14/11/25

Enclosure: Postal order of ₹10 as RTI fee, drawn in favour of "Accounts Officer, Jammu Smart City Limited".

Signature:

Parul Gupta

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Estimation of MFFPI for flood hazards assessment using geospatial technology in the Tawi Basin, India

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ABSTRACT

Flash flood in the Himalayan River has made some catastrophic effects on the life people residing in its river banks mainly associated with extreme rainfall events/cloud bursts/the collapse of moraine-dammed lakes which significantly leads to rapid flooding and subsequently disaster in low laying areas. In the present study, we used different equations to determine the flash flood potential index(FFPI) and further, an improved Modified Flash Flood Potential Index (MFFPI) equation has been used to estimate the area with a predisposition to water accumulation. Various thematic layers prepared in the Geographic Information System (GIS) environment and integrated by providing proper weightage to each thematic layer i.e., slope, profile curvature, soil texture, geology and Land Use Land Cover (LULC), flow accumulation, slope, and profile curvature, etc. The MFFPI equation-derived map of Tawi Basin is classified into five zones such as very high hazard (100.40 km^2), high hazard (971.60 km^2), medium hazard (92.78 km^2), low hazard (634.03 km^2) and the very low hazard (254.61 km^2) areas. Further, the results of the MFFPI were validated with the Analytical Hierarchy Process (AHP) based flood hazard zonation results which shows a very high correlation and similar trends of spatial and areal distribution with the MFFPI. The results of this study are quite useful for the local administration for futuristic planning and management of flood hazards in the Tawi River Basin and many other basins of similar terrain around the world.

1. Introduction

Floods are an overflow of water from the main course of the river occurs whenever there is a very high-intensity rainfall, cloud burst, outburst of glacier lakes, or breaching of dams covering an area from a few inches of water to several meters. They can also come quickly or build gradually. Flooding can also include the sinking of land due to rising groundwater level or overloaded drainage systems mainly due to the encroachment of riverbed (Tincu et al., 2018b). However, a flash flood is a speedy flooding of water over the ground surface due to heavy rain or a sudden release of water from any dammed area, and water acts as surface runoff (Leskens et al., 2014). The runoff phenomenon is mainly due to the interaction between the natural and anthropogenic factors that are specific to a particular area (Patrut and Constantinescu, 2012; Rouillard et al., 2016).

Globally, flood is one of the most frequent types of dangerous natural disaster. In India, the economic and human losses caused by floods are responsible to put more burden on the national economy as compared to other natural disasters. Climate change and global warming lead to continues transgression of sea level which results in the drowning of many areas in the past. Further, due to the rise of global temperature, extreme climate events including heavy precipitation events will be more frequent and severe, and thus flash floods will become a recurrent phenomenon in the near future. India is going to be severely affected by floods and as a

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consequence of this climate change impact, the devastating flash flood events have already created a negative effect on human and natural systems which are likely to be more perilous in near future which will have a detrimental socio-economic, environmental, political, and security implications in the present century (IPCC, 2014, 2021; Bhat et al., 2019, 2019; Ballesteros et al., 2018; Swain et al., 2022; Taloor et al., 2022).

In the last two decades, India is considered a leader in natural disasters management in the world, thus, it has made a high impact on social, economic, and political scenarios (Guhathakurta et al., 2011; Bhatt et al., 2011; Suriya and Mudgal, 2012; Taloor et al., 2019, 2021a; Karunakalage et al., 2021; Kothyari et al., 2022). These flash flood hazards have become quite common, particularly in the Indian subcontinent which has caused great loss to the economy, material damage and death of human lives in these countries (Guptha et al., 2022). In order to know about the causative mechanism of this disaster, a plethora of researchers around the world have made a significant contribution to minimizing flash flood hazard risks through various risk reduction activities like flood hazard mapping, potential flood hazard zonation, flash flood potential index, etc. One of the main activities for mitigating the negative effects of flash flood phenomena consists of the identification and spatial representation of the surfaces prone to surface runoff occurrence (Rahman, and Saha, 2007; Wu et al., 2015; Ballesteros et al., 2018; Rahmati et al., 2016; Rincón et al., 2018; Costache, 2019, 2022).

In general, flood or flash flood analysis can be accomplished either by deterministic modeling or parametric approaches which ultimately aims to generate area prone to flood hazard based on the available information (Balica et al., 2013). The deterministic/hydrodynamic approaches are developed based on the law of conservation and momentum equations to represent behavior. These approaches are dimensionally classified as 1D, 2D and 3D models such as 1D hydrodynamic models (Alho and Aaltonen, 2008; Jung et al., 2013; Teng et al., 2017). Recently, integrated Hydrological Engineering Center- Hydrologic Modeling System (HEC-HMS) and Hydrological Engineering Center-Geospatial River Analysis System (HEC-RAS) models (1D/2D) in the GIS environment have also been used to study different possible solutions for flood control and management around the world in many studies (Bedient et al., 2003). However, the application of the hydrologic and hydraulic models (1D/2D) are data-intensive and computationally expensive (e.g., 2D models) which limits their application to simulate a flood inundation map to assess the involved risk. Therefore, the application of such deterministic/hydrodynamic models is limited mainly to gauged watersheds or river basins (Teng et al., 2017). Further, it can be seen that there are commendable advances in the computational resources and flood inundation mapping tools, but researchers face challenges during the generation of high-quality flood maps, particularly when the study involves a large scale of analysis, short evaluation time, and data scarcity conditions. Therefore, a large number of researchers are engaged in exploring new ways to deal with these challenges and accomplish rapid flood hazard mapping. In the above context, the flood risk can be assessed using the parametric approach which can be developed based on the utilization of open access satellite-based data, other secondary data to generate flood hazard maps and also to evaluate vulnerability to flood hazards. In the last two decades, machine learning techniques, geospatial technologies, and various statistical techniques have been widely used in studies related to potential flood hazard zonation and flash flood potential mapping around the world. The studies on potential flood hazard zonation were conducted using expert knowledge-based models such as analytic hierarchy process (AHP) (Fernández and Lutz, 2010; Kazakis et al., 2015; Das, 2018; Waqas et al., 2021), Bivariate and statistical-based models such as frequency ratio (FR) (Tehrany et al., 2019; Sarkar and Mondal, 2020), logistic regression (LR) (Harries, 2012; Tehrany et al., 2014). Various computer based advance techniques with machine learning models such as artificial neural network (ANN) (Kia et al., 2012; Termeh et al., 2018) hybrid method of Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and machine learning (Rafiei-Sardooi et al., 2021); ensemble machine-learning (Mojaddadi et al., 2017; Hosseini et al., 2020; Costache et al., 2020; Eini et al., 2020); Machine learning based on Genetic Algorithm Rule-Set Production (GARP) and Quick Unbiased Efficient Statistical Tree (QUEST) models (Darabi et al., 2019); Fuzzy logic approach (Costache et al., 2022); Hybrid ensemble modelling for flash flood potential assessment and susceptibility (Singh and Pande, 2021). Besides this, hybrid artificial intelligence approaches coupled with statistical machine learning algorithms based research have also been carried out in recent years to deal with flash flood risk and analysis (Hong et al., 2018; Tien-Bui et al., 2018; Ahmadlou et al., 2018; Bui et al., 2018; Shafizadeh-Moghadam et al., 2018).

Moreover, many researchers have used the Geographic Information System (GIS) based the flash flood potential index based on the terrain characterisation and factors controlling the development of flash floods to assess the degree of susceptibility to flash-floods of a certain surface (Smith, 2003, 2010; Tincu et al., 2018a; Minea, 2013; Shehata and Mizunaga, 2018; Bhat et al., 2019; Shawaqfah et al., 2020). In recent years, with advances in satellite-based spatial and temporal data products, techniques like flash flood potential index mapping have the potential to assess the risk posed due to recurrent flash flood events. Taking into account the all above points, the present study attempts to use the Modified Flash-Flood Potential Index (MFFPI) to identify the areas vulnerable to both floods and flash-floods in the Tawi River Basin of the Northwestern Himalaya. This river basin area is prone to flood hazards and many lives have been lost or affected every year during the monsoon seasons in the recent past.

2. Study area

The Tawi River is a tributary of the Chenab and originates from the Kali Kund Glacier in the Seoj Dhar meadows of the Doda district of Jammu and Kashmir. The river basin covers a total area of 2963.84 km^2 lies at latitude 32°35′ to 33°5′ N and longitude 74°35′ to 75°45′ E and the elevation ranges from 191 m to 4273 m above mean sea level (amsl). The Tawi Basin is characterized by rugged mountainous topography in the northern parts, whereas the southern part of the basin consists of structural and denudation hills and aggradation plains in the southwest portion of the basin. Being a snow-fed start in the Kali Kund Glacier, the Tawi River enters the plains in the Nagrota area of Jammu plains and meets the Chenab River at Marala (Pakistan) in the confluence of the Chenab, the Manawar Tawi and the Tawi River, a southwest point of the basin (Fig. 1). The precipitation pattern is dominated by the summer monsoon; however, winter monsoon is also a fundamental part of the precipitation in the basin. The annual precipitation is 926 mm in the mountainous terrain of Bhaderwah Town (Ashraf and Jamwal., 2022) 1490.33 mm in the hilly terrain of Udhampur (CGWB 2014), and 1116 mm over the Jammu plains (Jasrotia et al., 2019a, 2019b; Taloor et al., 2023).

2.1. Normalized Differential Vegetation Index (NDVI)

The Normalized Difference Vegetation Index (NDVI) is among the oldest index used to estimate the health of the vegetation by using the satellite data with an application in forest ecology, environment, biomass estimation, leaf area index, density of vegetation, amount of food abundance available for plants and animals which ranges from, -1 to 1. The negative correlation implies grass density

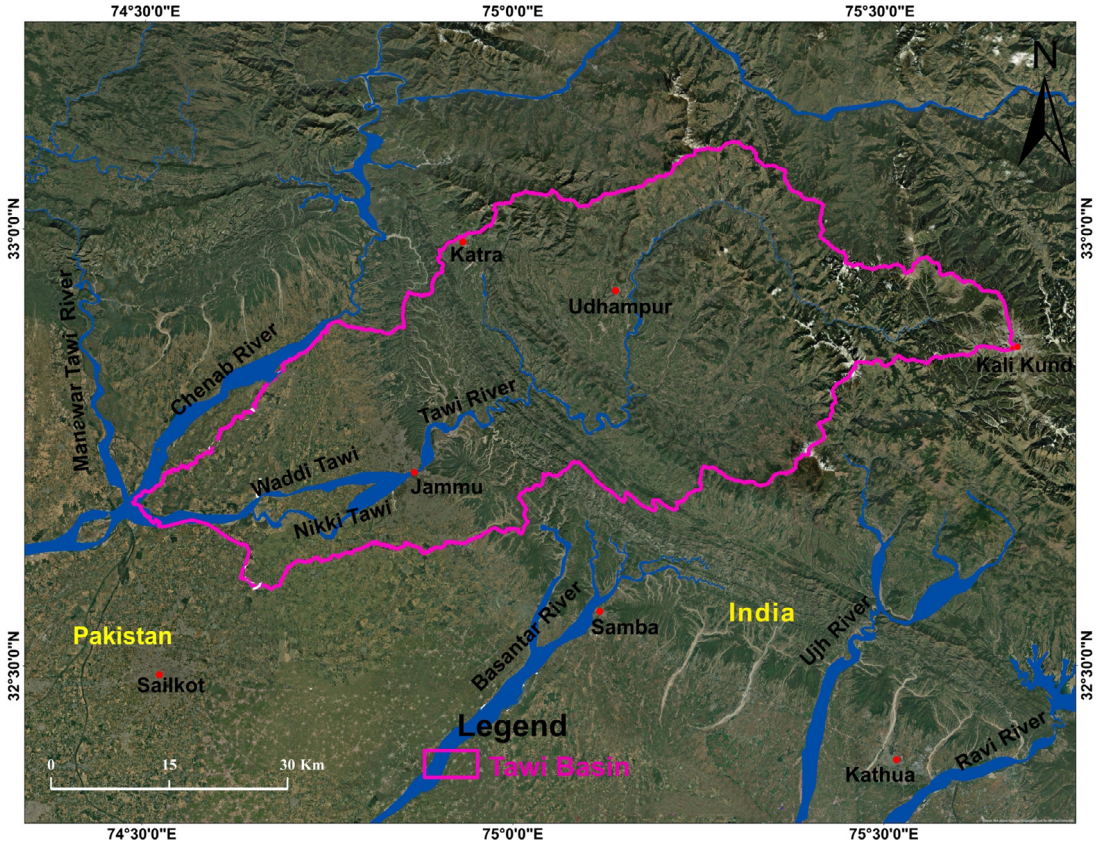

Fig. 1. Google image-based location map of the Tawi Basin, India.

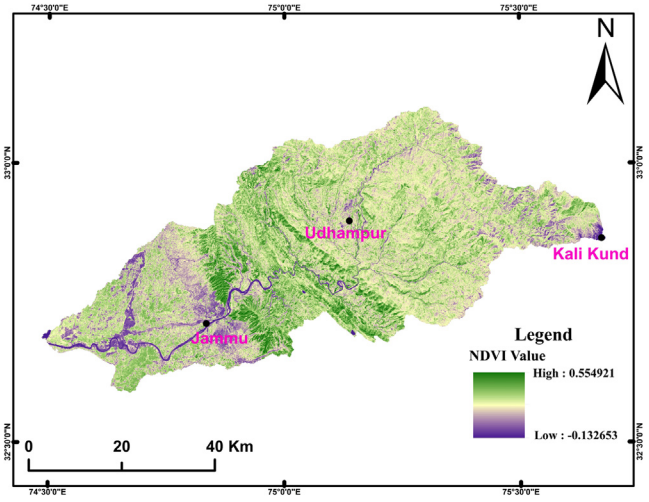

Fig. 2. Normalised Difference Vegetation Index (NDVI) map of the study area.

is low in areas with a high value of NDVI which indicates healthier vegetation (Fig. 2). Generally, the values range between -1 to +1 as it calculates the difference between the red and near-infrared components of light reflected by objects.

$$NDVI = \frac{NIR - R}{NIR + R} \quad (1)$$

Further, it is also helpful in determining the land surface temperature estimation over the surface (Taloor et al., 2021a, 2021b, 2022). The NDVI has a negative relationship with flooding: higher NDVI values indicate the lower probability of flood and lower NDVI values indicate a higher flood probability.

3. Data used

In order to determine the flash flood potential index by using multi-source data which includes satellite data sets of Landsat 8 (30m) Digital Elevation Model (DEM) data of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) with 1 arc resolution was used to delineate the hydrological parameters. The soil texture map was prepared to about the strength of soil resistant to erosion by using the soil map sheet of the National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), India.

4. Methodology

The broad methodology used to demarcate the modified flash flood potential index (MFFPI) is shown in the Fig. 3. In order to determine the MFFPI, the spatial analysis tool of Arc GIS software was used to integrate the various thematic layers. The thematic layers such as LULC, geology, and NDVI have been prepared by using the Landsat-8 for the year 2020. Besides this, ASTER DEM (30 m) of the year 2020 was used to delineate the thematic layers of flow accumulation, slope gradient, and profile curvature in the Arc GIS software. To demarcate the MFFPI, all these above-mentioned thematic layers were integrated into the GIS environment by using the Eq. (2).

$$\mathrm{MFFPI} = 3\mathrm{S} + 2.5\mathrm{Fa} + 2\mathrm{Pc} + \mathrm{St} + \mathrm{G} + 0.5\mathrm{LuLc}/4 \quad (2)$$

where S means the slope map, Pc is the profile curvature map, Sc is surface curvature, St is the soil texture, G is the geology map, and LULC is the land use land cover map of the study area.

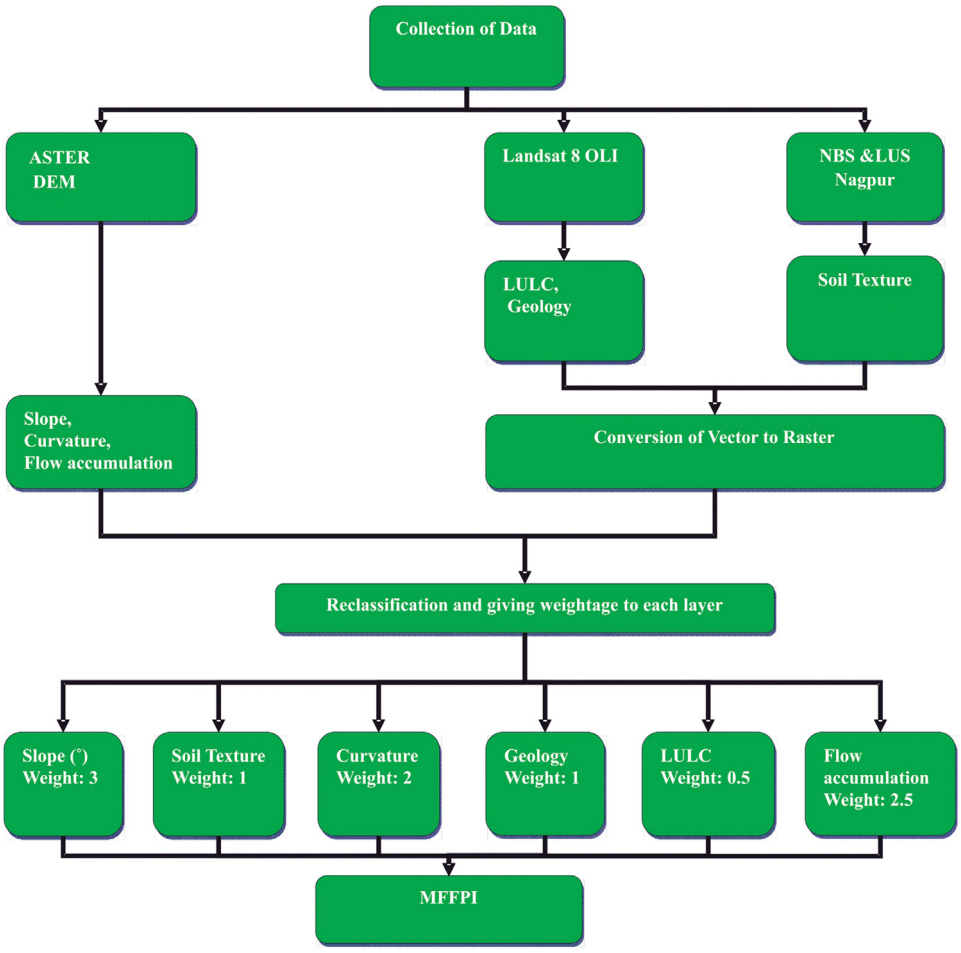

Fig. 3. Methodology used for determining the MFFPI.

The MFFPI equation is the advanced version Flash Flood Potential Index (FFPI), where more thematic layers have been accommodated in order to derive the accurate position of flash floods in the area under investigations proposed by Tinku et al. (2018a) by including the surface curvature and providing the more emphasises to the LULC. The thematic maps of LULC, soil texture, and geology of vector format, are converted into raster. Land cover, soil texture and geology were extracted in vector format, the reason why layers were converted to raster format using conversion tools. Further, all these six thematic layers were reclassified into 5 classes, corresponding to their hydrological response to slope, lithology, LULC and soil texture as well as to the local features, using the reclassify function from Spatial Analyst Tools in ARC GIS software. Class 1 signifies a low contribution to water accumulation, while class 5 corresponds to a high contribution to water accumulation in the same way where class 1 signifies the lowest effect and class 5 signifies the highest effect (Table 1). These thematic layers representing physiographic factors were weighted and further summed in the raster calculator tool in Arc GIS. The resulting index map is the MFFPI map of the study area. To determine the MFFPI, various thematic layers used are described in detail in the following section.

4.1. Land use land cover

A good understanding about study area and assessment techniques is needed for preparing the high-quality LULC map. Such LULC map is quite helpful to determine the changes in watershed hydrology. The LULC of the watershed is needed to generate the flood potential, flood hazard, and flood risk map which plays an important role in flood hazard mitigation and flood risk management (Noori et al., 2016; Taloor et al., 2021b). The LULC map was prepared by using the United Sates of America (USA) satellite Landsat-8, Operational Land Imager (OLI) sensor data in the GIS environment with field information at a scale that is amenable to planning, environmental impact assessment, flood hazard assessment, and development studies. The study area comprises the snow cover, agricultural land, water bodies, urban and built-up land, barren land, and range land. The area is vastly different as each and everything is present from hilly terrain to plains, from dense forest to barren land (Fig. 4). The forest area covers 1051.40 km^2 (35.47%) agricultural area is 1442.82 km^2 (48.69%) with rice, maize, wheat, pulses, fodder, oilseeds, potato, and barley are the main crops of the region. Water bodies cover 111.48 km^2 (3.76%) which includes rivers and stream areas, wetlands, lakes, and ponds whereas the rangeland area accounts for 102.14 km^2 (3.45%) of the total area. The barren land accounts for 44.94 km^2 (1.52%) of the study area, and the urban and built-up land constitutes 203.916 km^2 (6.88%) of the area which includes residential, commercial includes rural and urban settlements. The snow-covered area of 7.12 km^2 (0.25%) is the smallest unit of the LULC found in the northern parts of the study area. In this layer, water bodies and agriculture land classes have given the highest ranking being the most susceptible to flood hazards, whereas forest land has given the least weightage.

Table 1
Thematic layer used in the present study to derive the MFFPI.

S. No	Factors/Theme	Weight for factor	Classes	Weightage for class
1.	Slope	3	0-1°	1
			1 - 5°	2
			5 - 15°	3
			15- 35°	4
			>35°	5
2.	LULC	0.5	Forest Land	1
			Perennial Ice	2
			Range Land	3
			Barren Land	3
			Urban or Built-Up Land	3
			Agricultural Land	4
			Water	5
3.	Soil Texture	1	Lithic Hapludolls	1
			Lithic Udorthents	2
			Dystric Eutrochrepts	3
			Typic Eutrochrepts	3
			Typic Udorthents	3
			Udic Ustochrepts	3
			Fluventic Ustochrepts	4
			Typic Ustifluvents	5
4.	Geology	1	Baila Formation	1
			Sincha Formation	1
			Ramban Formation	1
			Salkhala Rocks	2
			Sauni Volcanic Formation	1
			Gamir Formation	2
			Trikuta Limestone	2
			Lower Murree Formation	2
			Upper Murree Formation	3
			Lower Siwalik	2
			Middle Siwalik	3
			Upper Siwalik	3
			Parmandal Formation	3
			Nagrota Formation	3
			Boulder Conglomerate	3
			Older Alluvium	4
			Younger Alluvium	5
5.	Flow Accumulation	2.5	0–5000	1
			5000–15000	2
			15000–25000	3
			25000–50000	4
			>50000	5
6.	Profile Curvature	2	23.58– -2.52	1
			-2.52– -0.89	2
			-0.89–0.33	3
			0.33–2.17	4
			2.17–28.55	5

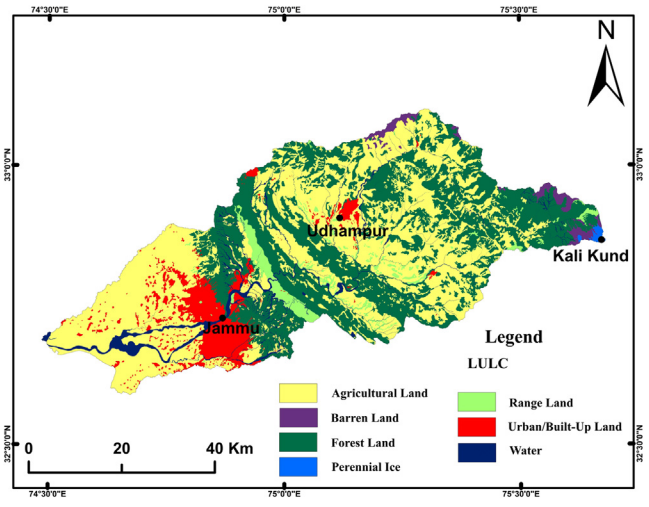

Fig. 4. Land use land cover map of the Tawi Basin.

4.2. Soil texture map

Based on the physical texture of the soil grains soil texture classification was developed in order to distinguish soil properties related to resistance to soil erosion, water holding, and yielding capacity. The soil can be loamy, shallow, arid, or clayey depending on parent material, topography, organisms (including humans), climate, and time. In the study area, eight major classes of soil texture have been determined as shown Fig. 5. Moreover, it is found that soil texture appears to drive the chemical response by controlling porosity and water retention, whereas certain soil textures such as clay, to some extent silt, can be associated with low infiltration rates and result in rapid runoff during intense rainfall (Patel, 2021).

4.3. Geology

Geologically the rocks of the Tawi Basin includes igneous, metamorphic and sedimentary origin and stratigraphically (Ali et al., 2021; Kumar et al., 2022) it covers the rocks from Holocene to

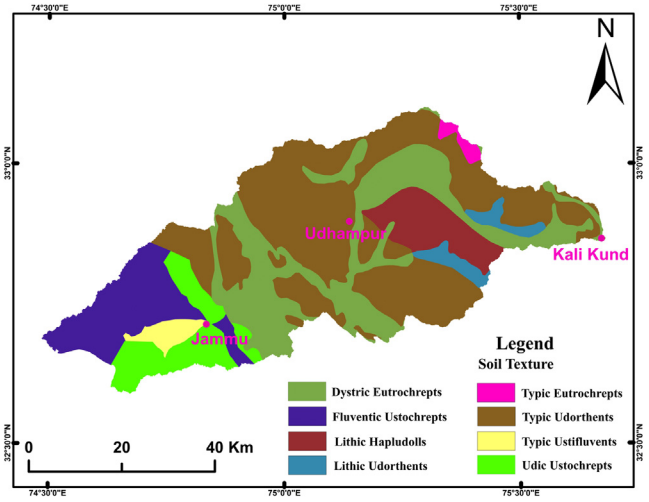

Fig. 5. Soil texture map of the study area.

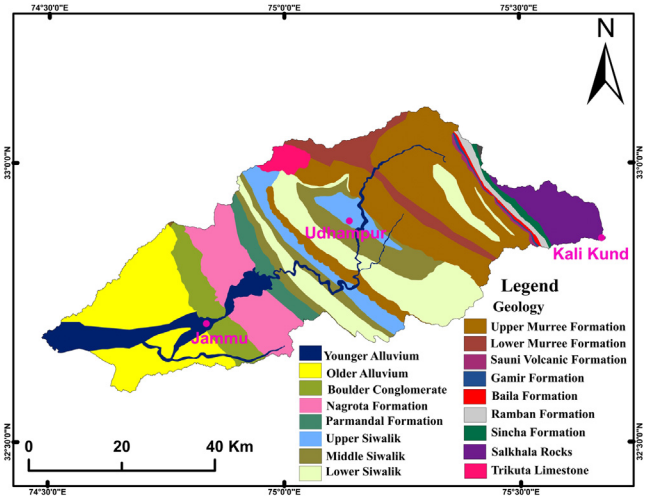

Fig. 6. Geology map of the study area (modified after Karunakaran and Ranga Rao, 1979).

Middle Proterozoic age (Table 1) The major rock formation found in the Tawi Basin (Fig. 6). The Younger and Older Alluvium are part of the river sediments which is unconsolidated and lose, clay and silt-dominated soil of Holocene Age found in the plains of the Jammu city and its adjoining are more prone to the flood hazards. The Siwaliks rocks (Middle Pleistocene to Pliocene Age) are well exposed in the Tawi Basin as composed of a variety of sand and mudstone in the Lower and Middle Siwaliks, whereas the Upper Siwalik is composed of arenaceous sand, and boulder conglomerates refers to coarse-grained rock composed of rounded pebbles and sand (Ranga Rao et al., 1988; Agarwal et al., 1993; Basu et al., 2004; Taloor et al., 2020). The Murree Group (Palaeocene to Eocene Age) as Upper Murree composed of medium to coarse-grained with subordinate grey brown mudstone whereas Lower Murree is dominated by the Red mudstone and fine- medium-grained grey sandstone found in the middle of the Tawi Basin (Karunakaran and Ranga Rao, 1976; Bhatnagar et al., 2022). Further the later Proterozoic crystalline rocks found in the northern part of the Tawi Basin which includes the Baila, Gamir, Ramban, Salkhala, Sincha, Trikuta Limestone Formation and Suni Volcanic of Middle Proterozoic Age (Sharma et al., 2020).

4.4. Slope

The slope is one of the critical parameters which helps to determine the many hydrological and geomorphic parameters and geomorphological features as well as processes. Slope has a direct influence on surface runoff, soil erosion, soil water content, soil formation, erosion potential groundwater flow, and consequently infiltration (Gomez and Kavzoglu, 2005; Jahangir et al., 2019; Kale et al., 2022). The slope layer was prepared after the filling of voids in the DEM and classified into five classes as required as the input layer (Fig. 7a) for the pursuance of MFFPI.

4.5. Flow accumulation and soil curvature

The flow of the water is related to the area of the watershed, the amount of precipitation slope and drainage density. The flow accumulation layer (Fig. 7b) has been generated by using the DEM and, further helps to know about the flow route in order to determine the direction of the flow from each pixel in by computing the number of cells ending in each cell at the foot of the slope and the determined value from each cell is indicative of the total number of pixels flowing into an exclusive cell.

4.6. Slope curvature

The slope curvature defines the convexity and concavity, and of the surface from a function that computes the derivative of height (Fig. 7c). Being considered as a second derivative of elevation, derived by using the DEM data in the Arc GIS software, it is helpful to determine the physical properties of a drainage basin for further understanding related to surface runoff, groundwater flow and its direction (Zevenbergen and Thorne,1987; Moore et al.,1991; Taloor et al., 2017).

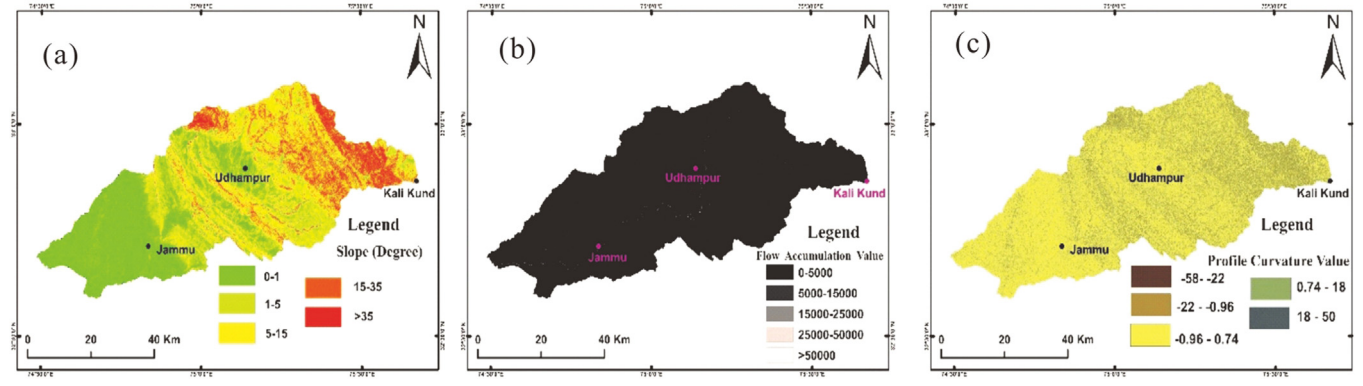

Fig. 7. The Digital Elevation Model (DEM) data based derived (a)slope map, (b)flow accumulation, (c) profile curvature map of the study area.

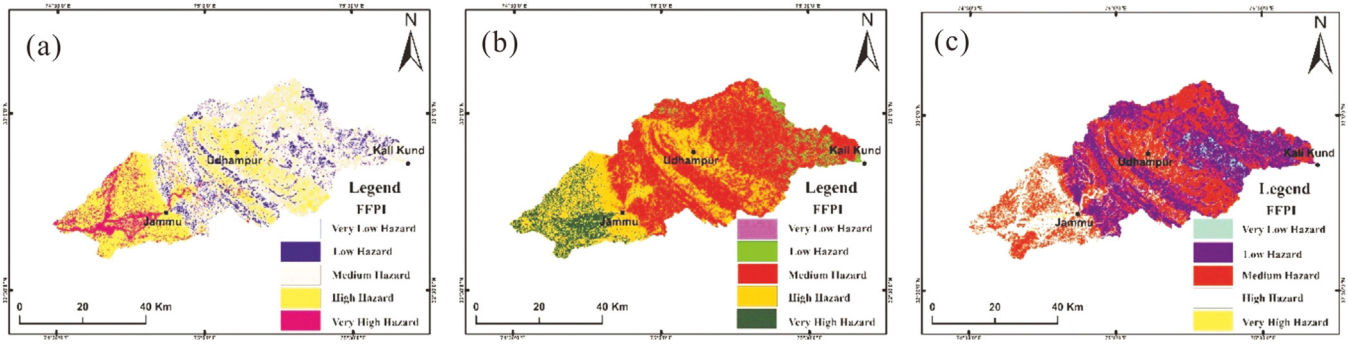

Fig. 8. The flash flood potential index map based derived from the formula used by (a) Smith (2003), (b) Brewster (2010), (c) Kruzdlo (2010). All three formula based derived maps are unable to provide the real scenario of the Tawi River flood potential index map.

5. Results and discussion

There are a variety of methods to predict the flash flood potential map, proposed by Smith (2003), Brewester (2009), Kurdlzo (2010) and all are applied to the present study to determine the best output in the form of flash flood potential map. The method proposed by Smith (2003) as FFPI is based on the calculation of LULC, NDVI, slope, soil texture and flow accumulation where the Eq. (3) is used

$$FFPI = \frac{[n(M) + L + S + V]}{N} \quad (3)$$

where n = weight of slope layer, M = Slope, L = LULC, S= Soil texture, and V= Vegetation cover (NDVI).

However, the result seems to be not satisfactory as there are many polygons in the output beyond the flood zone shown as a flash flood area (Fig. 8a).

In 2009, Brewster (2010) modified the original Smith (2003) version of the Flash Flood Potential Index (FFPI) for implementation in Binghamton, New York, USA. This version of the model gave greater weight to the slope and vegetation cover than the LULC and soil type, effectively prescribing great flash flood potential to areas with greater slope. Based on the Brewester Model approach the modified equation for estimation FFPI is as follows Eq. (4):

$$FFPI = \frac{[1.5(M) + L + S + 0.5(V)]}{4} \quad (4)$$

Although the output of this method is not satisfactory (Fig. 8b) to the study area. Kruzdlo and Ceru (2010) made some modifications and proposed a Flash Flood Potential Index (FFPI) by using the given by Eq. (5)

$$FFPI = \frac{(M + L + S + V)}{4} \quad (5)$$

where M = Slope, L = land use and land cover, S = Soil texture/type, V = Vegetation cover (NDVI). The output of this model is improved up to a certain extent although does not match with the ground realities in the basin (Fig. 8c).

In order to achieve the accuracy, a new developed method known as MFFPI was used to determine the flash flood potential index. Based on the MFFPI model the final output (Table 2) was classified into five classes (Fig. 9). Class 1 signifies the very low hazardous area of 254.61 km^2 (8.68%), class 2 signifies a low hazard area of 634.03 km^2 (21.33%) class 3 signifies the medium hazard area of 992.78 km^2 (33.82), class 4 signifies a high hazard area of 971.60 km^2 (33.11%) and the very high hazardous class of 100.40 km^2 (3.06%) mostly found in the southwest and in the Jammu plains of the Tawi Basin. The results of MFFPI are different from all the previously used equations and quite relevant to

Table 2
Areal distribution of MFFPI and FZH classes in the study area.

Flood hazards	MFFPI		FHZ	
Class	Area (km^2)	(%)	Area (km^2)	(%)
Very Low Hazard(VLH)	254.61	8.62	255.43	8.65
Low Hazard(LH)	634.03	21.47	1119.42	37.9
Medium Hazard(MH)	992.78	33.61	865.8	29.32
High Hazard(HH)	971.60	32.90	611.17	20.69
Very High Hazard(VHH)	100.40	3.40	101.61	3.44
Total	2953.43	100	2953.43	100

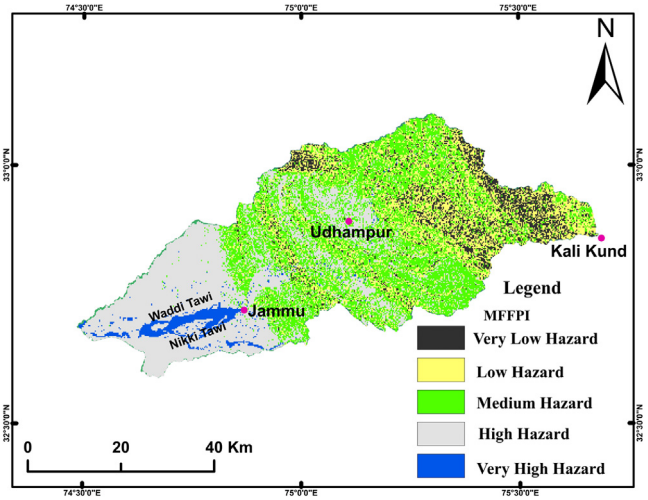

Fig. 9. The modified flash flood potential index map of the study area.

the present flow and flood prone area of the Tawi Basin. However, in the downstream area of the Tawi River, illegal mining of minor minerals has also accelerated the rate of flash flood damage, depletion of aquifers and water table in the area gradually, may cause a water crisis in the coming years in Jammu city and surrounding areas, which are groundwater dependent for domestic uses and groundwater irrigation water. However, there is a complete ban on all kinds of extraction of minor minerals (sand, cobble, pebble, granules and boulders) in the downstream of Tawi basin by the local administration in a quest to save the "Tawi River". Although, the unchecked mining over the years and encroachment of the Tawi River bed have also made devastating effects on the river banks (Fig. 10a-d). Due to massive encroachment in the urban portion of the Tawi River, especially in the Gujjar Nagar area where

Fig. 10. (a-b) Havoc caused by flash flood in the Jammu city area, (c-d) damage caused by the flash flood in the river banks in Jammu city.

flash floods entered into the houses built on the Tawi River bed (Fig. 10a), a temple engulfed in the flash flood opposite to the Gujjar Nagar (Fig. 10b), and the devastating effects of the flash flood in the encroached river land in the adjoining to the Ware House area of Jammu city, are a quite common feature of the Tawi River basin as the houses were wrecked (Fig. 10c) by the flash flood and a portion of the bridge (4th bride on Tawi River in Jammu city) has been washed away(Fig. 10d) due to flash flood in the recent past.

Moreover, based on the topography and morphology of the Tawi River, it is construed that the Tawi River Basin shows significant ecological and morphological diversity beginning from the Kali Kund to its confluence point with Chenab River in the small portion of Tawi River Basin Pakistan. The geomorphology in the upper reaches is dominated by the hills and lofty mountains manifested with cascades, waterfalls, narrow channels, and steep slopes are less prone to flash floods and the area comes under very low to low hazard zone . As the River enters the plains near Nagrota Town of Jammu where it starts widening and depositing sediments in the form of alluvial plains, makes it further wider and more dynamic in Jammu city with significant human interventions, narrowed the path of the Tawi River by making concrete embankments and after passing through the Jammu city it becomes more prone to flood hazards due to its entry into alluvial plains makes it dangerous and threatening to the inhabitants of the border Tehsils of the Ranbir Singh Pura, Gho Manhasa, Suchetgarh, etc are more prone to floods comes under the category of very high to high hazards.

6. Validation

To order to validate the results derived from MFFPI map, an Analytic Hierarchy Process (AHP) model proposed by the Satty (2008) has been used by integrating the different thematic layers to determine the AHP based spatial flood hazard zonation (FHZ) map of the Tawi Basin. The FHZ compared with the MFFPI which shows that similar spatial distribution of the flood hazards zonation (Fig. 11) and the areal comparison of the MFFPI with FHZ are illustrated as bar diagram in Fig. 12 which corroborates the results of flood hazards assessment using the MFFPI method and AHP based FHZ in the Tawi Basin based on geospatial technology.

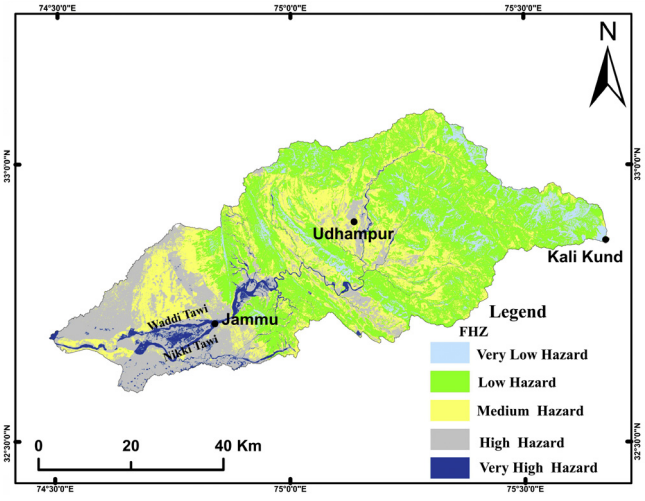

Fig. 11. Analytical Hierarchy Process (AHP) model based flood hazard zonation map of the study area.

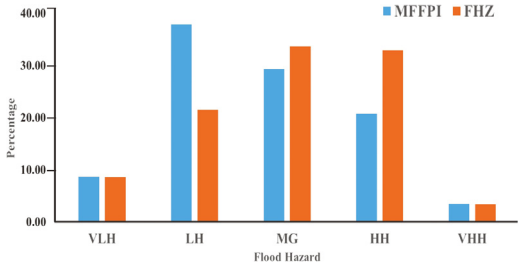

Fig. 12. Bar diagram showing the areal distribution comparison of the of the MFFPI and APH based FHZ in the Tawi Basin.

7. Conclusions

Flash flood is a natural disaster which is frequent in present days as climate change has brought many changes. Flash flood is the disastrous result of climatic and hydrological disturbance and leads to a catastrophic effect on the man and is sustainability. The

MFFPI is a spatial grid based representation of hydrological response characteristics to heavy rainfall which was developed for its application in the flash flood warning decision-making process.

In order to determine the flash flood hazard map in the study area, FFPI's equations given by Smith (2003), Brewster (2010), Kruzdlo (2010) were used to determine the flash flood potential index zones, however, the results seem to unsatisfactory to the study area. The results of the MFFPI are more accurate and relevant based on the past flash flood scenarios in the Tawi River Basin. The MFFPI-generated map seems to provide an accurate flash flood scenario in the Tawi Basin in the absence of other deterministic modeling approaches based on flood hazard map to plan various preparedness and response activities under flash flood situations.

Particularly, the flash flood hazard map using the MFFPI model show that southwest parts of the Tawi Basin which is quite a plain area with vast agriculture and urban built-up land constitutes a very high hazard zone. Further, the flash flood hazard map shows that a very low hazardous area (8.62%) which lies mostly in the northern hilly area, the low hazard area (21.47%), lies in the upper reaches, the medium hazard area (21.47%) covers the central parts, the high hazard area (32.90%) covers the older alluvial plains of Jammu and foot hill zones, whereas the very high hazardous area (3.40%) lies in the southwest parts which covers Jammu plains and area adjoin the river beds of the Tawi basins from Jammu city to the confluence of the Tawi with Chenab River. Further, it can be envisaged that any kind of damming of the Tawi River bed, and unprofessional development in the vicinity of the Jammu city may be disastrous for the people of the Jammu city and low-lying area of Jammu plains downstream of it, without a proper management mechanism.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Ajay Kumar Taloor: Conceptualization, Data curation. **Savati Sharma:** Formal analysis, Funding acquisition. **Divanshu Sharma:** Investigation, Methodology, Project administration. **Rajesh Chib:** Visualization. **Rakesh Jasrotia:** Writing – original draft. **Surbhi Gupta:** Writing – review & editing. **Girish Ch Kothyari:** Writing – review & editing. **Pankaj Mehta:** Resources, Software, Supervision. **Ravindra Vitthal Kale:** Validation.

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