सत्यमेव जयते

जल वार्षिकी
WATER YEAR BOOK
2013 – 2014

तापी बेसिन
TAPI BASIN

G&D Site Purna at Gopalkheda

केन्द्रीय जल आयोग
नर्मदा व तापी बेसिन संगठन
जल विज्ञानीय प्रेक्षण परिमण्डल.
गाँधीनगर (गुजरात)

Central Water Commission
Narmada & Tapi Basin Organization
Hydrological Observation Circle,
Gandhinagar (Gujarat)

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आमुख

राष्ट्रीय जल नीति में मानकीकृत राष्ट्रीय सूचना प्रणाली डेटा बेस और डेटा बैंकों के एक नेटवर्क के साथ गुणवत्ता के आँकड़े उपलब्ध कराने और प्रसंस्करण क्षमताओं में सुधार के लिए मौजूदा केन्द्रीय और राज्य स्तरीय ऐजेन्सियों के एकीकरण की आवश्यकता पर बल दिया गया है। जल के बहु -उपयोगी स्वरूप एवं उसकी बढ़ती मांग को पूरा करने हेतु संसाधनों के अनुकूलतम नियोजन के संदर्भ में संबंधित आँकड़ो का संकलन अतिमहत्वपूर्ण है।

केन्द्रीय जल आयोग, जल संसाधनों के विकास में संलग्न, भारत सरकार, जल संसाधन मंत्रालय के अन्तर्गत देश की एक शीर्षस्थ तकनीकी संस्था है जो जल विज्ञानीय आँकड़ों के एकत्रीकरण से लेकर परियोजनाओं का मूल्यांकन, अभिकल्पन, प्रबोधन तथा परिचालन करती है।

जल विज्ञानीय प्रेक्षण परिमंडल गाँधीनगर, नर्मदा तापी बेसिन संगठन के अन्तर्गत केन्द्रीय जल आयोग की एक क्षेत्रीय ईकाई है जिसके अन्तर्गत मध्य प्रदेश, महाराष्ट्र, राजस्थान एवं गुजरात से होकर पश्चिम की ओर बहने वाली नदियों पर अधिसूचित महत्वपूर्ण स्थलों पर जल के सतही प्रवाह के आँकड़े एकत्रित किए जाते हैं । तापी मंडल सूरत तापी नदी पर, वर्तमान में **5** स्थलों पर सतही प्रवाह का प्रेक्षण किया जा रहा है। इनके आँकड़े, इस वार्षिकी में संकलित किए गए हैं। इन बेसिन के वार्षिक सतही अपवाह आँकड़ो की प्रवृत्ति का विश्लेषण भी इस वार्षिकी में शामिल किया गया है।

जल वर्ष **2005-06** से जल वार्षिकी का प्रकाशन, केन्द्रीय जल आयोग द्वारा निर्धारित स्वरूप (SWDES) में किया जा रहा है। इस वार्षिकी में सतही प्रवाह के आँकड़ों के साथ - साथ बेसिन से संबंधित सूचनाएँ जैसे कि जलवायु, भूगर्भ विज्ञान, कृषि, भूमि, आदि भी दिये गए हैं।

इस वार्षिकी में दी गयी सूचना एवं संकलित आँकड़े उन सभी के लिये उपयोगी होंगे जो जल संसाधन से संबंधित किसी भी क्षेत्र में रूचि रखते हैं, ऐसी आशा है। इसे और उपयोगी बनाने हेतु सुझाव आमंत्रित हैं।

सूचना के अन्य स्रोत, जिनका उपयोग इस में किया गया है, उनके प्रति अभार प्रकट करता हूँ। वार्षिकी में प्रकाशित आँकड़ों के संकलन, विश्लेषण तथा प्रकाशन हेतु नर्मदा - तापी बेसिन संगठन के अधिकारियों एवं कर्मचारियों ने जिस समर्पण एवं लगन से कार्य संपादित किया है, वह प्रशंसनीय है।

गाँधीनगर (गुजरात) **(धीरेन्द्र कुमार तिवारी)**

मार्च 2015 **अधीक्षण अभियंता**

Preface

The National Water Policy stresses the need for a standardised national information system with a network of data base and data banks, integrating the existing Central and State agencies for providing quality data and improving the processing capabilities. Collection and compilation of data assumes greater importance in the context of optimal resource planning to meet the ever increasing demand for water in its multi-facetted use.

Central Water Commission is an apex organization of the country concerned with planned development and monitoring in water resources sector. CWC has for long been maintaining a Hydrological Observation & Flood forecasting network, which covers almost all the interstate rivers of India.

Hydrological Observation (HO) Circle, Gandhinagar, a field unit in Narmada Tapi Basin Organization of the Central Water Commission, is entrusted with the Hydrological Observation on west flowing rivers draining through the States of Gujarat, Madhya Pradesh, Maharashtra and Rajasthan. The Tapi Division, headquartered at Surat, under HO Circle, is at present, carrying out hydrological observations at 5 sites on river Tapi and its tributaries, which have been compiled in this Water Year Book. It also includes trend analysis of annual surface runoff for these basins.

The publication of Water Year Book in SWDES format has been started since the water year 2005-06 as per guidelines issued by Central Water Commission, New Delhi. This Year Book not only provides the hydrological data but also provides general information about geology, climate, agriculture, soil, cities/towns, major and medium projects in the basin, etc.

It is hoped that the information and data compiled herein will be useful to all those concerned with any field related with water resources of the country. Comments and suggestions, if any, on the Water Year Book are most welcome.

Sources of information compiled in this volume are acknowledged. The efforts put in by all the concerned officers and staff of NTBO, Central Water Commission is acknowledged.

Gandhinagar
March-2015

(Dhirendra Kumar Tiwary)
Superintending Engineer

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Abbreviations and symbols

Av	:	Average
Ann	:	Annual
A.G.R.	:	Automatic Gauge Recorder
C	:	Centigrade
Cum	:	Cubic meter
Cumec	:	Cubic meter per second
c/s	:	Cross section
C.W.C.	:	Central Water Commission
D	:	Days
Dis	:	Discharge
F	:	Float Observation
F.F	:	Flood Forecasting
G	:	Gauge
GD	:	Gauge and Discharge
GDS	:	Gauge, Discharge and Sediment
GDWQ	:	Gauge, Discharge and Water Quality
GDSWQ	:	Gauge, Discharge, Sediment and Water Quality
GTS	:	Great Trigonometrical Survey
hRs.	:	HouRs
IWYB	:	Integrated Water Year Book
WYB	:	Water Year Book
km	:	Kilo meter
M	:	Million
m	:	Meter
mm	:	milli meter
m^3/s	:	Cubic meter per second
Mm3 / MCM	:	Million Cubic meter
Max.	:	Maximum
Min.	:	Minimum
m.s.l.	:	Mean sea level
TDS	:	Tapi Division Surat
Neg	:	Negligible
NNW	:	National Net Work
R.Days	:	Remaining days

R.L.	:	Reduced Level
R.D.	:	Reduced Distance
sq km	:	Square Kilometer
WQ	:	Water Quality
W.L	.:	Water Level
W.Year	:	Water Year
WRI Circle	:	Water Resources Investigation Circle
80 Key	:	80 Key Hydrological Station Scheme
163 Key	:	163 Key Hydrological Station Scheme
0, ‘ . “	:	Degree (30^0) Minutes(56’) Seconds (35”)
*	:	Estimated Discharge
#	:	Discarded and estimated discharge

Chapter -1: Tapi Basin

1.1 Introduction

Tapi Division, Surat under Hydrological Observation Circle, CWC, Gandhinagar is conducting hydrological observations in the catchments of Tapi River and its tributaries at 18 stations, out of which nine (9) are under Flood Forecasting scheme, three (3) under National Network scheme and six (6) are under 80 - Key Hydrological Observation scheme.

Basin Map of Tapi River, showing CWC sites is enclosed as **plate-1**

The gauge & discharge data of five (5) stations, viz. Tapi at Burhanpur, Purna at Gopalkheda, Purna at Yerli, Tapi at Gidhade and Tapi at Sarangkheda are included in this book. From administrative consideration, the basin is divided into three zones viz Upper Tapi Zone, Middle Tapi Zone and Lower Tapi Zone each having one Sub-division viz. Upper Tapi Sub-Division, Bhusawal, Middle Tapi Sub-Division, Dhule and Lower Tapi Sub-Division, Surat respectively under the Tapi Division, Surat. Salient features of existing sites in Tapi basin are given in **Table-1**.

1.2 Geographical setting of Tapi Basin

The Tapi Basin is situated in the northern part of the Deccan Plateau and extends over an area of 65145 sqkm which is nearly 2% of the total geographical area of the country. Nearly 80% of the basin lies in the State of Maharashtra. The basin lies between east longitudes of 72^0 38' to 78^0 17' and north latitudes of 20^0 05' to 22^0 03. it is bound in the north by the Satpura range in the east by the Mahadeo hills, in the south by the Ajanta range and Satmala hills and in the west by the Arabian Sea. The river is bound on the three sides by the hill ranges. The Tapi River along with its tributaries flows over the plains of Vidharbha, Khandesh and Gujarat and over large areas in the state of Maharashtra and a small area in Madhya Pradesh and Gujarat.

The basin has an elongated shape with a maximum length of 587 km from east to west and the maximum width of 210 km from north to south. Perimeter of the basin is about 1840 km. The State wise distribution of the drainage area is given in the **table-2**, There are two well defined physical regions, in the basin, viz hilly region and plains; the hilly regions comprising Satpura, Satmalas, Mahadeo, Ajanta and Gawilgarh hills are well forested. The plain covers the Khandesh areas which are broad and fertile suitable for cultivation primarily. The basin consists of black soils; The coastal plains of Gujarat are composed of alluvial clays with a layer of black soil

above. The culturable area of the basin is about 4.29 Mha which is 2.2% of the total culturable area of the country. The forest cover is about 25% of the area in the asin.

Physiographically, the area is a basaltic landscape with major physiographic units of plateau lands, escarpments, hills, piedmont plains, colluvio-alluvial plains and valley plains.

The entire Tapi basin can be divided in three sub basins: Upper Tapi Basin up to Hathnur (confluence of Purna with the main Tapi (29,430 sq km), Middle Tapi Basin from Hathnur up to the Sarangkheda gauging site (28,970 sqkm), and the Lower Tapi Basin from Sarangkheda up to Sea (6,745 sq km). The annual rainfall for the upper, middle and lower Tapi basins for an average year is 931.90 mm, 713.05 mm and 1407.9 mm respectively.

Table-1: Salient features of CWC sites of River Tapi at a Glance

SL. No.	Name of Site	River	Code No.	Status	Scheme	Catchment area (Km2)	Latitude (N) D M S	Longitude (E) D M S
1	2	3	4	5	6	7	8	9
1	Teska	Tapi	NA	GRF	FF	1486	21^0 49′ 00″	77^0 46′ 05″
2	Burhanpur	Tapi	010217002	GDSQ RF	NNW	8487	21^0 17′ 12″	76 ^{0}13′ 18″
3	Dedtalai	Tapi	010217002	GRF	80K	6660	21^0 31′ 00″	76^0 45′ 24″
4	Hathnur	Tapi	010217006	GRF	FF	29430	21^0 04′ 35″	75^0 56′ 43″
5	Bhusawal	Tapi	010217007	GRF	FF	32478	21^0 03′ 54″	75^0 46′56″
6	Lakhpuri	Purna	010217003	GRF	80K	3560	$20^0$50′ 49′	77^0 21′ 41″
7	Gopalkheda	Purna	010217004	GDSQ RF	80K	9500	20^0 52′ 35″	76^0 59′ 14″
8	Yerli	Purna	010217005	GDSRF	NNW	16517	20^0 56′ 11″	76^0 28′ 27″
9	Chikaldhara	NA	NA	RF	FF	NA	$21^0$24′ 04″	77^0 19′ 46″
10	Girna dam	Girna	010217008	GRF	FF	4729	20^0 28′ 42″	74^0 42′ 55″
11	Dahigaon weir	Girna	010217009	GRF	FF	8599	20^0 50′ 05″	75^0 25′ 26 ″
12	Savkheda	Tapi	010217011	GRF	NNW	48136	21^0 08′ 53″	75^0 30′ 54″
13	Morane	Panjhra	010217013	GRF	80 K	1933	20^0 54′ 32″	74^0 42′ 47″
14	Gidhade	Tapi	010217014	GDRF	FF	54750	21^0 17′ 45″	74^0 48′ 45″
15	Sarangkheda	Tapi	010217015	GDSQ RF	80 K	58400	21^0 25′ 55″	74 ^{0} 31′ 37″
16	Ukai	Tapi	010217016	GRF	FF	62225	21^0 14′ 55″	73^0 35′ 25″
17	Ghala	Tapi	010217018	GRF	80 K	63325	21^0 17′ 53″	73^0 01′ 43″

18	Surat	Tapi	010217019	G	FF	63973	21^0 11′ 49″	72^0 46′ 04″
19	Shegaon	Tapi	Telemetry	RF	--	--	20^0 47′ 46″	76^0 08′ 00″
20	Chiklod	Tapi/ Bokar	Telemetry	RF	--	--	21^0 20′ 06″	76^0 00′ 23″
21	Sagbara	Tapi	Telemetry	RF	--	--	21^0 32′ 35″	73^0 47′ 42″
22	Khetia	Tapi	Telemetry	RF	--	--	21^0 39′ 00″	74^0 42′ 06″
23	Nandurbar	Tapi	Telemetry	RF	--	--	21^0 21′ 37″	74^0 14′ 18″
24	Nizampur	Tapi	Telemetry	RF	--	--	21^0 06′ 49″	74^0 19′ 47″

1.3 The River System

1.3.1 Tapi River

The Tapi River (Hindi ताप्ती , Marathi तापी, Gujarati: તાપ્તી) ancient original name Tapi River (Sanskrit: तापी), is a river in central India. It is one of the major rivers of peninsular India with a length of around 724 km. The Tapi River originates in the Betul district from a place called Multai. It is one of only three rivers in peninsular India that run from east to west - the others being the Narmada River and the Mahi River The Tapi is the second largest westward draining inter-state river basin. It covers a large area in the State of Maharashtra besides areas in the states of Madhya Pradesh and Gujarat.

The Tapi River drains an area of 65145 sq km out of which nearly 80 percent lies in Maharashtra. The State wise distribution of the drainage area is shown in **Table 2**.

Table-2: **State wise distribution of drainage area**

Sl. No	Name of State	Drainage area (sqkm)	Percentage of total
1	Madhya Pradesh	9,804	15.0
2	Maharashtra	51,504	79.1
3	Gujarat	3,837	5.9
	Total	65,145	100.0

For the first 282 Km., the river flows in Madhya Pradesh, out of which 54 Km form the common boundary with Maharashtra State. It flows for 228 Km in Maharashtra before entering Gujarat. Traversing a length of 214 Km in Gujarat, the Tapi joins Arabian sea in Gulf of Cambay after flowing past the Surat city. The river receives

tidal influence for a length of about 20 Km upstream from mouth i.e. up to Singanapore weir.

The Tapi receives several tributaries on both banks. There are 14 major tributaries having a length more than 50 Km. On the right bank 4 tributaries namely, the Vaki, the Gomai, the Arunavati and the Aner join the Tapi. On the left bank, 10 important tributaries namely the Nesu, the Arunavati, the Buray, the Panjhra, the Bori, the Girna, the Vaghur, the Purna, the Mona and the Sipna drain into the main channel. The drainage system on the left bank of the Tapi is therefore, more extensive as compared to the right bank area.

The Purna and the Girna, the two important left bank tributaries together account for nearly 45 percent of the total catchment area of the Tapi. The Purna is one of the principal tributaries of the Tapi, starts in Betul district in Gawilgar hills of the Satpura range and mostly drains through three districts of Vidharbha namely Amravati, Akola and Buldhana. The Girna another Major tributary rises in the Western Ghats and drains Nasik and Jalgaon districts of Maharashtra.

1.3.2 Major Tributaries of the Tapi River System

Purna River

Purna, is one of the tributaries of Tapi, joins from the left. The Purna is the principal affluent of the Tapi. It is the main artery of a network of rivers and streams draining Akola, Amravati and Buldana districts of Maharashtra and Betul district of Madhya Pradesh. It is the only river in the upper Tapi Basin, which has a perennial flow. Rising in the Gawilgarh hills at an elevation of 900 m., North latitude 21^0 38′ 00″ and East longitude 77^0 36′ 00″, the Purna flows first in a South westerly direction for about 60 km through hills and forests before it enters the Purna plains. Flowing in a generally westerly direction for a length of 274 Km, the Purna joins the Tapi north west of Edalabad. The Man is the main left bank tributaries of Purna, and Chandrabhaga and Wan are the principal right bank tributaries. Thus Purna drains a total area of 18, 929 Sq.km.

Girna River

The Girna River is a river in Maharashtra state of southern India. It originates at Kem peak in the Western Ghats range of Nashik District with a latitude of 21° 7' 60 N and a longitude of 75° 19' 0 E, and flows east across Nashik and Jalgaon districts, swinging north in Jalgaon District to join the Tapti River. The dams on the river are Chanakapur and Girana Dam. The name Girna derives from the name of Goddess Giraja (Parvati). A 100 sq km area around Girna River has an approximate population

of 979337 (0.009793 persons per square meter) and an average elevation of 246 meters above the sea. The basin of the Girna lies on the Deccan Plateau, and its valley has fertile soils which are intensively farmed.

Gomai

Gomai River is tributary of Tapti River. It originates in Satpura Mountain Range and merge in Tapi River around 2 km east of Prakasha. Gomai river itself has many small tributary rivers like Susri river (passing by Sultanpur), Tipria river (passing by Mandane), Umri river, Sukhi river

Panzara

The Panzara-Kan or Panjhra is a river in Khandesh region of Maharashtra state of India. It is a tributary of the Tapi River. Panjhra River originates just few kilometers from a small town Pimpalner, Tal-Sakri in Dhule District. One small reservoir named Latipada dam is constructed just after its origin.

Pedhi.

The only important left bank tributary of the Purna is the Pedhi. It rises in the low hills near Rithpur and receives a number of small affluent both from the east and the west, the chief on the west being the Naghira river.

Arna.

The first of the principal right bank affluent of the Purna is the Arna which emerges from the Satpuda hills in Betul district and flows in a south and south-easterly direction passing by Sirasgaon to join the Purna just below Deurwada.

1.3.3. Tapi Basin as per the Watershed Atlas of India

As per the watershed atlas of India, Published by Department of Agriculture and cooperation, Ministry of agriculture, Krishi Bhavan New Delhi (1990),

The sub-catchments from 5C1A to 5C5B pertain to Tapi Basin as shown in **plate-3**.

1.3.3.1 Sub-catchment -5C1A (5C1A1 to 5C1A4)

This catchment is situated in the Surat district of Gujarat drained by lower Tapi River near to its confluence with and some small tributary like Ver and Anjana. The catchment area of this sub catchment is 2140 sq.km.

1.3.3.2 Sub-catchment 5C1B (5C1B1 to 5C1B4)

This Catchment is situated in the plain region of Surat and Bharuch District of Gujarat drained by Kim, Sena, Kini and Ghanta River. The total catchment area of this Catchment is 2580 sq.km

1.3.3.3 Sub-catchment -5C2A (5C2A1 to 5C2A7)

This catchment is situated in the hilly and plane region of Gujarat, Maharashtra State and Madhya Pradesh (MP) drained by small tributaries such as Godada nadi, Dadan khadi, Dudhi, khadi, Kanji nadi, Dehli nadi, Vatkaada nadi, Valhari nadi,Vaki, Gomai, Umri, Lendi-Kordi, covered under Bharuch and Surat districts in Gujarat, Dhulia in Maharashtra and Khargone in MP with the catchment area of 3890 sq.km.

1.3.3.4 Sub-catchment 5C2B (5C2B1 to 5C2B7)

This catchment is situated in the hilly and plain region of Maharashtra State and Madhya Pradesh drained by small tributaries such as Arunavati, Aner, Dhudkheda, Guli Bhaurak, Mor and Suki on the Right Bank of Tapi River. The total catchment area of this catchment is 4890 sq.km.

1.3.3.5 Sub-catchment - 5C3A (5C3A1 to 5C3A5)

This is situated in the plain region of Gujarat and Maharashtra State, drained by Main tributaries such as Rangavali, Nesu, Kordi, Shivnad, Bhad and Amravti in Sub-catchment on the Left Bank of Tapi River. The total catchment area of this Catchment is 3200 sq.km.

1.3.3.6 Sub-catchment- 5C3B (5C3B1 to 5C3B8)

This is situated in the plain region of Maharashtra State, drained by Buray, Sur, Pan, Panjhara, Kanehr, Mokti, Hinasan, Jamkheri Kan, Bori Chikli, Sugran and Kanoli covered under Dhulia, Jalgaon and Nasik district and falls in the Subcatchment on the Left Bank of Tapi River. The total catchment area of this catchment is 6480 sq.km.

1.3.3.7 Sub-catchment- 5C3C (5C3C1 to 5C3C9)

This is situated in the plain region of Maharashtra State, drained by Anjani, Girna, Bahula, Tittut, Nanyad, Panjhari, Sukhi, Masam, Kanjari, Aram and Punand in sub-catchment on the Left Bank of Tapi River covered most of the part of Jalgaon Nasik, Aurangabad and Dhulia. The total catchment area of this catchment is 10100 sq.km

1.3.3.8 Sub-catchment-5C3D (5C3D1 to 5C3D4)

This is situated in the plain region of Maharashtra State, drained by Main tributaries such as Vaghursur, Kag, Khadki, Koka and Bhogavati in the sub-catchment on the Left Bank of Tapi River. The total catchment area of this catchment is 2800 sq.km

1.3.2.9 Sub-catchment -5C4A (5C4A1 to 5C3A6)

This sub catchment is situated in the plain region of Maharashtra State, drained by the Tributaries of Purna River such as Nalganga, Biswa, Ghan nadi, Mas, Nirgana and Mun. Catchment area of this sub-catchment is 5950 sq.km.

1.3.3.10 Sub-catchment -5C4B (5C3B1 to 5C3B6)

This sub-catchment is situated in the plain region of Maharashtra State, drained by the Tributaries of Purna River such as Ban, Shahnur and Bodli km. Catchment area of this sub- catchment is 4020 sq.km

1.3.3.11 Sub-catchment -5C4C (5C4C1 to 5C4C6)

This is situated in the plain region of Maharashtra State, drained by the Tributaries of Purna River such as Murna, Purna, Katapurna, Uma and Pedhi Catchment area of this sub-catchment is 5950 sq.km.

1.3.3.12 Sub-catchment -5C4D (5C4D1 to 5C3D4)

This Sub Catchment area is situated in the plain region of Maharashtra State, drained by the Tributaries of Purna River such as Chanrabhaga, Sapna, and Arna. The total catchment area is 3370 sq.km

1.3.3.13 Sub-catchment -5C5A (5C5A1 to 5C5A8)

This Catchment is situated in the plain and hills region of Maharashtra and Madhya Pradesh State, drained by the Bokad river, Mona river, Utaoli, Tapi and Garg. The total catchment area is 4650 sq.km.

1.3.3.14 Sub-catchment - 5C5B (5C5B1 to 5C1B8)

This Catchment is situated in the plain and hills region of Maharashtra and Madhya Pradesh State, drained by Sipna, Kharpra, Dahsana, Khandu, Baki, Betul and Ambora in Sub-catchment. The total catchment area of this sub-catchment is 5980 sq.km.

***Source**: Watershed Atlas of India, Department of Agriculture and Cooperation, Ministry of agriculture, Krishi Bhavan New Delhi (1990).*

Table–3: **General information of main River/Tributaries of Tapi River Basin**

Sl. No.	Name of River / tributary	Bank	Elevation of source above m.s.l. [m]	Length [km]	Catchment area [km^2]	% of total area
1.	2.	3.	4.	5.	6.	7.
1	Tapi		752	724	22522	34.57
2	Gomai	Right	600	58	1148	1.76
3	Arunavati	Right	450	53	935	1.44
4	Buray	Left	600	64	1419	2.18
5	Panjhra	Left	600	138	3257	5.00
6	Bori	Left	600	130	2580	3.96
7	Aner	Right	600	94	1702	2.61
8	Girna	Left	900	260	10061	15.44
9	Waghur	Left	751	96	2592	3.98
10	Purna	Left	900	274	18929	29.06
				TOTAL	65145	100

1.4 The Climate

The climate of the Tapi Basin is characterized by a hot summer and general dryness throughout the year except during the south-west monsoon season in the upper and middle part of basin but the lower part of the Tapi River Basin shows variation in temperature, rainfall, humidity and other climatic parameters.

The year may be divided into four periods. The winter from December to February, the summer from March to May, the south-west monsoon season from June to September and the post-monsoon period from the October to November

1.4.1 Temperature

Temperature of Tapi basin is like any other part of central India, the temperature is maximum in the month of May and minimum in the month of December to January. In general, upper and middle part of Tapi basin record lower temperature as compared to the lower Tapi basin where the influence of the sea is prominent, and temperature fluctuation is lower than the upper and middle basin.

The temperature profile in the basin is given in the **table-4.**

Table-4:**Temperature profile of Tapi basin (Mean Monthly Maximum Temperature (°C))**

Month	Mean Monthly Maximum Temperature (°C)										
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Lakhpuri	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jun-13	33.3	32.5	27.2	36.4	34.4	34.1	33.7	31.5	29.4	32.4	35.9
Jul-13	29.3	28.9	27.4	30.1	31.4	29.8	30.1	27.2	27.3	28.5	30.9
Aug-13	28.9	28.8	28.5	30.2	28.9	28.6	28.5	26.3	27.1	27.8	31.0
Sep-13	31.5	31.3	26.8	32.3	31.9	33.3	30.2	27.4	28.6	32.0	35.1
Oct-13	30.0	31.4	28.9	31.3	31.5	31.6	30.1	26.6	28.4	31.6	35.9
Nov-13	29.1	30.2	26.4	27.5	30.5	29.8	30.5	24.0	27.9	30.5	35.6
Dec-13	27.0	29.0	24.3	23.3	31.1	28.8	29.8	22.5	27.3	28.5	33.4
Jan-14	26.9	29.2	25.5	22.5	30.5	28.3	27.8	22.6	26.0	26.7	31.4
Feb-14	28.8	30.4	24.6	27.7	32.5	30.1	29.2	22.6	27.5	28.1	33.5
Mar-14	33.2	34.2	33.5	31.2	36.4	33.1	34.3	27.9	31.6	32.9	38.3
Apr-14	39.6	40.4	38.0	37.3	41.2	40.6	39.9	33.6	37.0	36.7	42.3
May-14	40.4	41.5	37.5	40.7	41.5	42.3	40.8	37.7	37.6	40.6	44.0
Annual Mean	31.6	32.3	29.1	30.9	33.5	32.5	32.1	27.5	29.6	31.4	35.6

Table-4: **Temperature profile of Tapi basin (Mean Monthly Minimum Temperature (°C))**

Month	Mean Monthly Minimum Temperature (°C)										
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Lakhpuri	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jun-13	24.8	24.0	22.2	25.5	24.3	26.1	25.1	28.1	24.7	24.1	24.3
Jul-13	24.0	22.7	22.9	24.2	23.4	24.7	24.2	25.6	24.3	23.6	23.9
Aug-13	23.7	22.2	22.0	23.4	22.9	24.1	23.2	24.9	23.1	23.1	23.5
Sep-13	23.0	22.2	21.0	26.0	23.9	24.2	24.0	26.0	23.7	23.9	23.9
Oct-13	22.8	21.7	24.1	25.7	22.2	22.5	22.8	25.3	22.0	22.3	22.4
Nov-13	18.0	14.8	21.2	22.3	16.5	16.3	17.5	22.1	17.0	16.9	17.5
Dec-13	14.7	10.5	17.3	12.7	14.1	13.2	14.5	20.6	14.5	14.6	14.2
Jan-14	16.3	12.0	17.9	11.1	13.5	14.5	15.5	20.3	14.5	14.0	13.7
Feb-14	16.1	13.0	16.5	14.2	12.9	15.1	16.0	20.2	14.8	14.2	14.6
Mar-14	18.7	16.7	23.9	21.5	16.6	26.1	20.1	25.3	19.1	18.2	18.7
Apr-14	23.8	21.7	28.0	21.9	25.7	23.8	23.6	30.9	24.2	22.1	23.7
May-14	28.6	25.8	27.4	23.0	29.8	28.5	27.2	35.6	28.6	26.1	26.5
Annual Mean	21.2	18.9	22.0	21.0	20.5	21.6	21.1	25.4	20.9	20.3	20.6

1.4.2 Rainfall

The south west monsoon sets in the Tapi basin in the middle of June and withdraws by mid October. About 90 percent of total rainfall is received during the monsoon months, of which 50% is received during July and August. The Tapi River basin shows different climatic characteristics due to the variation of topography from upper to lower part of basin.

The average rainfall in the Tapi basin is 888.0 mm. Basin wise variations of rainfall are shown in **table-5** and average rainfall recorded at various sites is given under **table- 6.**

Table-5: 10 years' Average Monsoon rainfall

Sr. No.	Name of Sub Basin	Bank	Length in Km	Catchment Area (sqkm)	% with reference to total area.	10 years average of Monsoon rainfall (mm) from 2004-2013
1.	Upper Tapi up to Hathnur	Main	290	10471	16.1	1004.0
2.	Purna	Left	274	18929	29.1	702.6
3.	Middle Tapi, Hathnur to Ukai excluding Girna.	Main	305	22734	34.9	794.0
4.	Girna	Left	260	10061	15.4	628.3
5.	Lower Tapi-from Ukai to confluence to sea near Surat	Main	129	2920	4.5	1417.6

Table -6: Rainfall at sites in Tapi Basin

Average Annual Rainfall for the period 1980-2013							
Sl No	Name of Site	District	Seasonal Average Rainfall (mm)				Total Annual Average Rainfall
			Winter monsoon	Pre monsoon	South-West monsoon	Post monsoon	
			(Jan-Feb)	(Mar-May)	(June-Sept)	(Oct-Dec)	
1	Teska	Betul (MP)	0.0	0.0	953.8	16.3	970.0
2	Lakhpuri	Akola (MS)	14.8	26.8	624.2	81.2	747.1
3	Chikhaldara	Amarawati (MS)	12.4	29.9	1381.1	117.5	1540.9
4	Gopalkheda	Akola (MS)	14.7	19.7	631.8	55.7	722.0
5	Dedtalai	Burhanpur (MP)	9.9	16.4	796.8	55.0	878.1
6	Burhanpur	Burhanpur (MP)	13.1	23.7	778.9	67.2	882.9
7	Yerli	Buldana (MS)	12.3	18.4	614.4	79.6	724.6
8	Hathnur-Dam	Jalgaon (MS)	10.9	10.5	609.8	64.3	695.5
9	Bhusawal	Jalgaon (MS)	6.4	16.4	626.3	59.2	708.3
10	Girna	Nasik (MS)	3.2	15.1	527.7	79.0	624.9
11	Dahigaon	Jalgaon(MS)	5.5	20.3	665.4	63.9	755.0
12	Savkheda	Jalgaon (MS)	4.1	16.7	582.1	51.5	654.4
13	Morane	Dhule(MS)	2.9	6.6	474.8	60.1	544.5

14	Gidhade	Dhule(MS)	3.5	8.9	536.4	42.3	591.1
15	Sarangkheda	Nandurbar (MS)	2.7	13.2	560.7	47.9	624.5

1.4.3 Wind

Wind speed profile of the basin, based on data collected, is given in **table-7.** The average monthly wind speed in the Tapi basin varies between about 15 km/h and 1.2 km/h. In the pre and post monsoon period, the wind speed is generally higher. The predominant wind direction is NW followed by SW and W. **Table-.7** shows wind data of Tapi basin.

Table-7: **Wind speed profile of Tapi Basin-2013**

Month	**Average wind Speed km/h**									
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jan-13	2.2	4.0	3.0	1.0	2.6	1.8	2.4	2.1	0.8	0.9
Feb-13	2.2	5.4	3.8	2.6	7.0	2.1	3.0	2.9	1.3	1.3
Mar-13	1.8	5.0	3.5	1.1	*	1.6	4.1	3.5	1.3	1.5
Apr-13	2.1	6.0	3.5	1.1	*	1.7	6.2	6.0	3.2	2.4
May-13	2.0	11.9	4.1	1.1	*	3.5	11.2	10.0	7.0	4.6
Jun-13	1.9	8.1	3.9	8.6	*	3.5	5.3	3.5	2.9	0.0
Jul-13	0.2	8.2	4.2	6.2	*	4.8	4.7	1.0	2.3	1.3
Aug-13	2.1	8.2	3.7	6.2	*	3.5	5.0	1.8	3.6	0.9
Sep-13	1.5	3.7	2.2	2.4	*	2.0	3.8	2.2	1.5	1.0
Oct-13	1.4	2.6	3.4	1.4	2.0	1.3	2.5	1.7	0.7	0.8
Nov-13	1.9	2.7	3.8	1.5	1.5	1.2	1.2	1.4	1.0	0.1
Dec-13	1.6	2.8	2.3	2.8	3.0	1.2	1.1	1.2	0.9	0.1
Annual Mean	1.7	3.0	2.0	2.4	0.5	1.5	2.0	1.1	1.1	0.4

* instrument not working

1.4.4 Humidity

The morning relative humidity in the basin varies between 92.4 % to 34.6 % and the evening relative humidity is between 85.8 % to 25.4 % depending upon the season. Humidity is maximum during the monsoon months and is around 80% to 90%. In winter months of December and January, relative humidity comes down to around 30%. Variation in relative humidity between upper, middle and lower section of basin is not very pronounced except in the vicinity of coastal areas. The relative humidity at various stations of CWC in the Tapi basin is given in **Table-8**.

Table-8: **Relative Humidity Data for Tapi basin**

Month	% Morning Humidity										
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Lakhpuri	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jan-13	66.8	75.1	76.8	45.5	66.1	75.2	76.0	71.9	64.6	78.1	74.5
Feb-13	68.2	77.1	72.6	60.6	61.9	67.3	77.9	69.0	68.0	81.0	76.5
Mar-13	47.9	52.3	57.2	56.5	47.4	50.5	59.8	65.7	50.8	72.6	87.4
Apr-13	50.3	36.3	42.7	32.6	41.9	40.0	61.2	68.4	65.9	65.2	91.6
May-13	55.3	32.9	36.2	34.7	44.5	36.9	65.0	83.3	69.2	67.9	92.6
Jun-13	85.3	78.4	76.4	64.8	78.7	78.9	87.1	88.6	83.2	88.5	90.8
Jul-13	86.6	88.4	79.7	71.9	79.6	89.8	91.0	92.0	90.2	93.5	90.7
Aug-13	87.2	87.0	79.8	75.7	89.0	90.6	90.9	82.9	88.7	91.6	90.2
Sep-13	83.6	86.0	77.2	74.0	82.1	90.6	90.9	89.6	87.9	91.7	88.5
Oct-13	81.8	85.3	70.7	71.5	81.2	88.0	91.0	89.7	87.3	91.0	85.8
Nov-13	71.0	80.7	79.3	74.2	72.2	77.4	81.9	81.6	81.3	87.3	72.7
Dec-13	74.6	80.5	76.5	72.0	77.8	79.2	82.7	78.8	82.6	88.4	81.1
Annual Mean	71.6	71.7	68.8	61.2	68.5	72.0	79.6	80.1	76.6	83.1	85.2

Month	% Evening Humidity										
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Lakhpuri	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jan-13	41.6	38.5	80.0	44.9	48.5	46.7	50.0	NA	41.9	NA	NA
Feb-13	38.3	37.3	70.2	55.3	60.7	47.1	52.8	NA	44.3	NA	NA
Mar-13	25.2	35.7	58.6	51.2	39.8	32.8	36.1	NA	33.3	NA	NA
Apr-13	22.3	31.5	34.7	32.1	29.0	30.0	43.4	NA	55.0	NA	NA
May-13	25.6	18.3	40.5	34.0	26.2	26.2	38.9	NA	62.0	NA	NA
Jun-13	70.7	69.4	75.2	68.0	63.4	63.9	76.8	NA	80.3	NA	NA
Jul-13	81.2	79.7	81.1	71.3	75.6	80.4	85.4	NA	83.8	NA	NA
Aug-13	81.7	82.8	75.8	73.9	78.5	83.1	88.2	NA	83.2	NA	NA
Sep-13	74.5	77.7	75.6	70.7	71.0	79.8	85.1	NA	80.0	NA	NA
Oct-13	70.5	77.0	66.8	74.5	73.2	74.3	88.3	NA	75.8	NA	NA
Nov-13	57.1	64.4	77.3	75.2	57.1	63.6	76.8	NA	61.5	NA	NA
Dec-13	55.0	64.7	79.7	68.9	60.0	48.7	85.3	NA	61.5	NA	NA
Annual Mean	53.6	56.4	68.0	60.0	56.9	56.4	67.3	NA	63.6	NA	NA

1.5 Geology

Trap Rocks

Deccan traps cover maximum part of this basin, These trap rocks are the result of outpouring of enormous lava flows which spread over vast areas of Western, Central and Southern India at the end of mesozoic era. They came through long narrow fissures and cracks in the earth crust and spread out as nearly horizontal sheets. They are called 'plateau basalt', because they form a flat-topped plateau. Due to the step-like or terraced appearance on the slope of hills they are also known as 'trap'. These volcanic rocks assume a considerable thickness ranging from a few hundred feet in the south to a couple of thousand feet in the north. The individual thickness of flow varies from a few feet up to a 100 feet or more. A bore-hole at Bhusawal 1211 feet deep, revealed 29 flows, the average being 40 feet In the high hills consisting of several flows, the individual flows can easily be demarcated by their distinct flow lines along which a thin growth of grass is noticed. The lavas are generally horizontal in disposition but at places they dip at very small angles. The traps that are commonly found in the plateau or cliff faces are compact and harder, often characterized by vertical prismatic or columnar jointing. They are dark grey or dark greenish grey to brownish grey in color. The amygdaloidal variety, which is greenish to purplish in color and comparatively softer, generally forms the slopes and valley floors. They contain innumerable cavities which are usually filled with secondary minerals such as quartz, chalcedony, agate, jasper, rock crystal, Zeolites and calcite: The ash or Scoriaceous beds and red bole beds are sometimes noticed. The main minerals constituent in the trap rocks are abundant in Labradorite and Enstatite-augite with varying proportion of interstitial glass which on alteration gives rise to secondary minerals like Palagonite, Chlorophaete Iddingsite, etc. Sometimes Porphyritic basalt is seen showing Phenocrysts of Felspars and glassy matters. Magnetite occurs as minute discreet grains amidst other minerals as well as in the glassy groundmass. In a few cases, olivine is also present.

The other formations found in the basin are Alluvium , lower Gondwana, Cuddapah system Bijwara series and granites gneiss. Most of the area of Tapi basin falling in the Maharashtra state is full of cuts and valleys, land on the right side of the basin lying on southern slopes of Satpura hills consist of black soils the soil cover is deep and rock is found at greater depths. Lands on the left of the basin on northern slopes of Sahyadri consists mainly of dykes and red Murrum soil and are rocky in most parts.

The stratigraphic sequence of Tapi basin is tabulated **table-9**.

Table-9: **Stratigraphic sequence**

Formation	Age
Soil, river alluvia, calcareous Kankar and sands, etc.	Recent.
Conglomerates	Sub-recent.
Trap dykes	Cretaceous Eocene
Deccan basalt flows with inter-trappean Beds, ash beds.	
Erosional Unconformity :	
Upper Gondwana sandstones	Lower cretaceous.

Source : Cultural.maharashtra.gov.in/english/gazetteer

Tectonics and Sedimentation in Tapi Basin

The Late Cenozoic period in the Central Indian Tectonic Zone (CITZ) was marked by several episodes of crustal adjustments which are reflected in terms of various tectonic landforms, repeated adjustments in the drainage systems and sedimentation pattern in the Tapi basin which is a half graben structure. The northern margin of the basin is bound by ENE-WSW trending Tapi Fault Zone (TFZ) while the southern margin gradually merges with the Ajanta-Buldhana plateau.

The Tapi in the initial eastern part runs along a narrow intermontane valley carved into the lower middle level plateau of the south Satpuras. The course of the river is dominantly straight to sinuous with resistant channel boundaries and coarse bed material. Here, majority of the fluvial deposition has been in the form of overbank deposits with restricted flood plain development. The river here flows through a fault controlled valley cut into Deccan Traps and the river terraces on either bank are unpaired. The episode of faulting appears to have been preceded by a high rainfall phase and development of ash associated red paleosol horizon. Post uplift sedimentation in this part of the basin has been in form of buff coloured slack water deposits, dominantly finer grained during uppermost part of Late Pleistocene. Possible inset of transient arid phase (~LGM) had led to preservation of lithified grit beds. The last phase of sedimentation in this part of the basin is in form of grey silt bearing inset terraces of Holocene period derived

from older sediments. This phase appears to have witnessed a major episode of faulting as evident by presence of massive, meter scale bank collapse structures in the sediments. At present the river has set into a denudational phase, engaging into deep incision of its older sediment package and intense undercutting of the exposed sections. Intense vertical erosive activity influenced by slow tectonic uplift is manifest in form of fresh scarp sections, presence of giant pot holes and talus scree and block falls from the sections along the river course. The imprints of ongoing tectonic activity in this part have been in the form of tilting, crushing and brecciation of Deccan Traps and alignment of hot and cold springs along the river course.

The Tapi River after traversing this intermontane valley descends onto the foothills which has a different set up of tectonic landforms and sedimentation history. Here the river course is having dominantly wide and open meander bends with occasional presence of point bars and channel bars. This part represents the deeper part of the basin and sedimentation here has been under the influence of two regional scale faults: Tapi North Fault (TNF) traversing the lower plateau parts of the Satpura ranges and its margin and Tapi River Fault (TRF) which as the name suggests, runs along the course of the Tapi river and has governed the sedimentation pattern in the basin. Several first order transverse tributaries emerge from the Satpura foothills and join the Tapi River course in this stretch. Chronological data supports that the sedimentation in this part of the basin was initiated at least during middle Pleistocene. Episodic uplift of the reactivated segments of old crustal scale discontinuities has provided loci for sedimentation in the basin. The flood plain (red palaeosol) sediments of this part also show signatures of high rainfall phase caused by intensification of monsoon and episodic uplift of the northern footwall block of TNF. Climatic amelioration caused development of multiple bedded calcrete horizons and flash flood deposit. Rejuvenation of the main river and its tributaries has also introduced channel deposits along the river courses at a later phase possibly during upper part of Late Pleistocene. The youngest Holocene deposit occur as inset terraces along the river course. The sedimentary pile in this part is appreciably thick and the base rock/Quaternary contact is not seen along the river course except for the parts which have witnessed contemporary uplift along TRF.

Both TNF and TRF have been active during the deposition of sediments in this part of the basin. The imprints of TNF activity have been in the form of zones of high

geothermal gradient, accelerated denudation even along the juvenile first order streams and deformation of sediments. TRF on the other hand, has preserved the evidences of active tectonic activity in the form of paleoliquefaction features, deformation of sediments, development of coalesced colonies of potholes resulting from intense scouring of the Deccan Trap base rock along the uplifted segments of the TRF and development of alluvial fans. The episodic faulting in the basin created the depocentre for initiation of sedimentation and seismicity in the basin.

(Source: Snigdha Ghatak, Mriganka Ghatak , Tectono-climatic controls on fluvial sedimentation of upper and middle reaches of Tapi River basin, Central India, 2011, Second National Working Group Meeting, Geological Survey Of India)

Purna Basin

Part of the basin is covered by rocks of the Deccan volcanics of Creteceo-Eocene age, and a few alluvium patches of the Purna and Penganga basin, respectively. The trap rocks are usually fine to coarse-grained, dark grey to greenish-black basalts of vesicular and massive types. The hard compact massive flows are generally noticed on the hill tops, *e.g.,* Melghat section whereas comparatively soft and amygdular varieties usually occupy the flanks of the hill or valley floors. Spheroidal exfoliation is a characteristic feature of weathering in the traps. Besides vertical and inclined jointing, columnar jointing is also well seen in more massive types. The vesicular and non-vesicular flows are at places separated by thin beds of ash or scoriae, but typical inter-trappean sedimentary rocks have not been recognised in the area. The amygdular varieties of flows carry secondary minerals like zeolites (mostly heulandite), calcite and chalcedony. No dykes have been found associated with the trap flows in the district where a lava pile of approximately 800 metres is preserved.

Alluvium

The Purna valley alluvium occupies an extensive stretch of low lying ground between Paturda and the confluence of Purna river with that of Tapi in Jalgaon district. In the river valleys and where superficial rain-wash has accumulated, a mixture of black cotton soil associated with sub-recent conglomeratic formation or light brown laterite material is noticeable at places, but otherwise, there is little variation in the nature and extent of soil or any variety of geological interest. The alluvium of the plains is usually of considerable depth. Much on the alluvium produces effervescence of sodium salts. Majority of the wells sunk in the area have brackish water.

Source : Cultural.maharashtra.gov.in/english/gazetteer

1.6 Soil

The soil in the Tapi basin up to Ukai Dam can be broadly classified in to three groups.

1. Coarse shallow soils
2. Medium black soils
3. Deep black soils.

The area covered by these three group of soils in the basin is given in **table-10.**

Table-10: **Types of Soil in Tapi basin**

sl. no.	Type of soil	Districts covered
1	Coarse shallow soils	Betul, Khandwa, Khargon, Amrawati, Akola, Buldhana, Jalgaon, Dhule, Aurangabad and Nasik
2	Medium black soils	Khandwa, Amrawati, Akola, Buldhana, Jalgaon, Dhule, and Nasik
3	Deep black soils.	Amrawati, Akola, Buldhana, Jalgaon, Dhule, Nasik, Surat and Bharuch

Coarse shallow soils

These soils have developed primarily from the basaltic Deccan trap and have been considerably affected by natural processes of weathering and erosion. Their depth is generally between 25cm to 50 cm and seldom more, their texture from surface to sub surface varies from silty loam to clay. Their organic matter content is usually poor and they are moderately drained.

Medium black soils

These soils have developed from Deccan traps and cover the largest area of the basin. Their depth is generally between 50cm to 1m. these soils contain higher lime reserve and are alkaline in reaction. These soils are fair in their contents of phosphates and potash but low in organic matter and nitrogen.

Deep black soils

These soils are found along the Purna river and in the middle and lower reaches of Tapi River. These soils have originated primarily from decomposition of trap rocks of hilly ranges. The depth of this soil varies from 1m to 6m. The soil have very high clay content Montmorillonite predominating and not easily workable during monsoon. The soil reaction varies from neutral to alkaline.

Source: Hydrology and Water Resources of India, Water Science and Technology Library Volume 57, 2007, pp 561-595 Tapi, Sabarmati and Mahi Basins, Sharad K. Jain, Pushpendra K. Agarwal, Vijay P. Singh (http://link.springer.com/chapter/10.1007%2F1-4020-5180-8_12)

1.7 Forest

The Tapi basin exhibits two distinct geographical regions, viz., the plain regions in the east and south-east and the hilly regions of the Satpura ranges in north and north-west. The plain region is extensively cultivated and forests appear only in dotted, scattered patches. The hilly region is an extensive block of compact forests and contains an abundance of rich teak trees. The percentage of the forest area to total area in the Tapi basin is approximately 25% of the total area, and is unevenly distributed.

Tree Forests

These include the forests of producing big-size teak and timber of other type.

Minor Forests

These include the forests in the plain regions, which are capable of producing small-size timber poles of teak, etc. These forests also supply fire-wood, thorns and grass and serve as good pastures for grazing the cattle.

Babul Bans.

These are artificially created forests of Babul (*Acacia arabica*) in the cultivated plain tracts and lie dotted over the area.

Ramnas and Pasture Forests

These include open forests with sparse tree growth and lie mostly in the plain regions, where an intense demand exists for grass and grazing.

Utilization

The forests are managed under regular working plans, the object being the supply of large-size timber for commercial use. The minor forests like Babul Bans and the Ramnas and pasture lands are being maintained to supply the local demand for small-size timber, fuel, grass and grazing.

Forest Produce

The major forest produce is timber. The minor forest produce constitutes various items, such as bamboo, fuel, Rosha grass, fodder grass, minerals, horns and hides, Tendu leaves and gum.

Forest Trees

The most useful trees and plants found in these forests, are given below: -

Teak (*Tectona grandis), Tiwas* (*Ougenia dalbergioides), Shisham* (*Dalbergia latifolia*)., *Bija* (*Pterocarpus marsupium*)., *Haldu* (*Adina cordifolia*), *Saj* (*Terminalia tomenlosa), Dhawda* (*Anogeissus latifolia), Dhaman* (*Grewia tiliaefolia), Semal* (*Bombax malabaricum*; *Silk cotton tree), Siivan* (*Gmelina arborea*), *Kusum* (*Schleichera trijuga*), *Kalam* (*Stephegyne parvifolia), Kahu* (*Terminalia arjuna), Landia* (*Lagerstroemia parviflora*), *Harra* (*Terminalia chebula), Bhormal* (*Hymenodictyon excelsum*), *Salai* (*Boswellia serrata*), *Moyen* (*Odina nodier*), *Kekda* (*Garuga pinnata*), *Maharukh* (*Ailanthus excelsa*), *Moha* (*Madhuca latifolia*),*Tendu* (*Diospyros melanoxylon*

Achar (*Buchanania lanzan), Aonla* (*Emblica officinalis*) *Beheda* (*Terminalia belerica*), *Bhilawa* (*Semecarpus anacardium*) *Amba* (*Mangifera indica*) *Bor* (*Zizyphus jujuba*) *Palas* (*Butea frondosa*) *Babul* (*Acacia arabica*) *Khair* (*Acacia calechu*), *Anjan* (*Hardwickia binata), Jamun* (*Eugenia jambolana), Bhosa* (*Bauhiniarecemosa*), *Rohan* (*Soymida febrifuga*), *Amalatas* (*Cassia fistula*), *Bel* (*Aeglemarmelos*), *Kumbhi* (*Careya arborea*), *Gular* (*Ficus species*), *Dahi-palas* (*Cordias*), *Mokha* (*Schrebera swietenioides*), *Bhirra* (*Chlo-roxylon swietenia*), *Hiwar* (*Acacialeucophloea), Kulu* (*Sterculia urens*), *Gongal* (*Cochlospermum gossypium*) *Dudhi* (*Wrightia tinctoria*), *Arang* (*Kydia calycina*) *Pangra* (*Exythrina Indica*), *Bamboos* (*Dendrocalamus strictus*).

Source: cultural.maharashtra.gov.in/english/gazetteer

1.8 Major/ Medium/Multipurpose/Irrigation projects

At present there are 28 Major and Medium Irrigation schemes completed and 2 projects are in under construction in the form of reservoirs or weirs in the Tapi catchment. List of the name of the completed, under construction and ongoing Projects are given in **Table. 11,12 and 13** respectively.

Table -11: **Major/ Medium/Multipurpose/Irrigation Projects (completed)**

Sl.No	Name of project	River	Status	Capacity (MCM)	
				Gross	Live
1.	Girna Project	Girna	Medium	608.450	523.55
2.	Dahigaon	Girna		-----	-----
3.	Manyad Project	Manyad	Medium	53.95	40.27
4.	Bori Project	Bori	Medium	40.31	25.15
5.	Hathnur	Tapi	Medium	388.000	255.00
6.	Suki	Suki	Medium	50.16	39.85
7.	Abhora	Boked Nalla	Medium	7.440	6.020
8.	Boker Bari	Boker Bari Nala	Medium	7.090	6.54
9.	Agnawati	Agnawati	Medium	3.740	2.76
10.	Titur	Titur	Pick up bandhara.		
11.	Tondapur	Khadki Nalla	Medium	6.304	4.636
12.	Aner Project	Aner	Medium	103.230	56.38
13.	Karwand Proj.	Arunawati	Medium	33.840	31.15

14.	Panjhra Project	Panjhra	Medium	43.410	35.63
15.	Malangaon	Kan	Medium	13.020	11.35
16.	Kanholi	Khanholi	Medium	11.79	8.450
17.	Burai	Burai	Medium	21.330	14.21
18.	Arunawati	Arunawati	Mediu	27.780	14.97
19.	Rangawali	Rangawali	Medium	15.020	12.89
20.	Nagasakya	Panzar	Medium	15.620	11.240
21.	Haran Bari	Mousam	Medium	34.780	--
22.	Ukai	Tapi	Major	8510	7092
23.	Kakrapar	Tapi	Major	51.51	36.57
24.	Lakhigav	Dhakani	Medium	38.80	37.41
25.	Ver	Ver	Medium	4.90	4.61
26.	Sulwada Barrage	Tapi	Medium	65.06	64.642
27.	Sarangkheda Barrage	Tapi	Medium	92.20	91.82
28.	Prakasha Barrage	Tapi	Medium	63.64	62.11
29.	Kate Purna	Kate Purna	Major	97.670	86.350
30.	Nal ganga	Nal ganga	Major	76.200	69.320
31.	Uma	Uma	Medium	14.000	11.680
32.	Nirguna	Nirguna	Medium	32.290	28.850
33.	Morna	Morna	Medium	44.740	41.460
34.	Gyan ganga	Gyan ganga	Medium	36.260	33.930
35.	Mos	Mos	Medium	17.504	15.140
36.	Paltag	Vishvganga	Medium	9.090	7.510
37.	Man	Man	Medium	39.760	36.830
38.	Thoran	Tributary of Purna	Medium	8.480	7.900

Table -12: **Major/ Medium/Multipurpose/Irrigation Projects (Under construction)-Tapi basin**

Under Construction projects					
Sl No	Name of Project	River	Classification	Gross Capacity (MCM)	Live storage (MCM)
1	Shelgaon Barrage	Tapi	Medium	116.37	110.35
2	Padelsa Dam	Tapi	Medium	420.56	407.59

Table -13: **Ongoing Major /Medium Projects- Purna basin**

Sl. No	Name of Project	River	Classification	Gross Capacity (MCM)	Live storage (MCM)
1	Ghungshi Project	Purna	Medium	17.444	17.269
2	Purna Barrage II (Ner Dhamna)	Purna	Medium	8.1743	8.1126
3	Jigaon Project	Purna	Medium	736.579	296.726

1.9 Important Projects in Tapi Basin

The salient features of the important projects, namely Hathnur Dam of Upper Tapi Project, Kakrapar weir and Ukai Dam of Ukai Project, Girna Dam and Dahigaon Weir of Girna Project, are as follows:

1.9.1 Hathnur Dam (Maharashtra)

This is the first stage of Upper Tapi Project. It consists of 717 m long Ogee shaped gated overflow weir in the centre with 1863 m long earthen embankment on either side constructed across the river Tapi near Hathnur village in Jalgaon district of Maharashtra State. It is having a live storage capacity of 255 MCM to irrigate 3, 78, 384 hectares of land in Raver, Yawal and Chopda talukas of Jalgaon district by a right bank canal of 95 km length.

1.9.2 Kakrapar Weir (Gujarat)

The project comprises of an Ogee shaped masonry pick up weir constructed across the Tapi River near Kakrapar in Surat district of Gujarat. The weir was constructed at a cost of Rs.20.61 crores. The weir is 621 m long and 14m high. Two canals take off from either bank to irrigate an area of 2.28 lakh ha. This project was commissioned in the year 1954 as stage -- I of the Ukai project.

1.9.3 Ukai Dam (Gujarat)

This is stage - II of the multipurpose Ukai Project. It consists of 4928 m long and 68.6 m high composite earth - cum - masonry dam across the Tapi River near Ukai village in Surat district of Gujarat State. It includes a spillway with power dam constructed on the left bank. Two canals take off from either bank to irrigate an

area of 1.58 lakh ha. The power house has an installed capacity of 4 units of 75 MW each.

1.9.4 Girna Dam (Maharashtra)

It is constructed across river Girna, a tributary of river Tapi near Panzan village in Nandgaon taluka of Nasik district. This is a multipurpose scheme, main purpose being irrigation and subsidiary power generation (power generation yet to be started). This is a composite dam having total length of 963.17 m, masonry dam with gated spillway for a length of 426.72 m and earthen dam of length of 536.45 m respectively.

1.9.5 Dahigam Weir (Maharashtra)

It is constructed across river Girna near Dahigaon village in Pachora Taluka of Jalgaon district of Maharashtra. It consists of a Ogee shaped Weir having a length of 422.76m and a maximum height of 8.82m. It irrigates an area of 57797 ha land through left bank canal of 45.06 Km. length.

Chapter-2: Stream flow Data

2.1 Methodology

Gauge Measurement

Water level or stage of the river is measured as its elevation above the G.T.S. datum. Water level measurement is conducted by reading non - recording gauges as specified in IS: 4080-1967. Series of vertical staff gauges have been fixed at three sections at every Site. The gauge posts are generally of wood or concrete with cut at water face arrangements and fixed securely in vertical position by anchoring them in M - 150 concrete base of suitable size. Enameled vertical gauge plates with metric markings are fixed on the gauge posts so that gauges can be read to an accuracy of 0.005 m.

Out of three gauge lines the central one is used as Station Gauge line and the readings of other two lines are used for calculation of water surface slope. During non-monsoon season gauges are read thrice daily (0800, 1300 and 1800 hrs.) and during monsoon gauges are read hourly, at the station gauge line.

Discharge Observation

Discharges are observed once a day starting from 0800 hours at all the sites by area - velocity method, except on Sundays and holidays. For non-observation days, the discharges are computed from the stage and discharge relation prepared, from the observed data for that water year.

The stream width is divided into 15 to 25 segments based on the degree of accuracy as outlined in IS: 1192-1981. The width of the river is measured by steel metallic tape or wire/ nylon rope stretched across the river width with markings indicated thereon when the river width and depth permitted wading. For large width and deep flow conditions segmentation is done using simple trigonometric method for which pivot point and segment blocks have been constructed at each site.

The depth is measured by using sounding rod 3 to 6 metres long adopting specifications given in IS: 3912-1966. When the river flow is very deep and swift, lead lines / echo sounders are used. Necessary Air and Wet line corrections are made to the sounding observations as provided in IS: 1192-1981. The velocity is measured as per IS: 3918 - 1966 by using a cup type current meter conforming to specifications given in IS: 3910-1966.

The current meter is lowered at the requisite depth (0.6d) in a vertical at every segment by suspension equipment as specified in IS: 6064-1971.

In high velocities, boats fitted with power engines or motor launches are used. Drift is measured and corrections for the same are made. Where observations by boat or launch are not possible, measurement of velocity is conducted from bridge or cable way. When the above procedures are not possible then velocity is measured by float observations. The observations are recorded in a standard format for calculation of total river flow.

Equipment used for observation

Table-14: List of equipment used in observation

Sl. No	Name of Equipment	By Wading	By Bridge	By Boat	By Float
1	Current Meter	√	√	√	X
2	Pigmy Current Meter	√	X	X	X
3	Stop Watch	√	√	√	√
4	Wading Rod	√	X	X	X
5	Nylon rope & tag	√	X	X	X
6	Measuring Tape	√	X	X	X
7	Protractor	√	√	√	X
8	Ranging Rod	√	X	√	X
9	Sounding Rod	√	X	√	X
10	Automatic Battery Counter	√	√	√	X
11	Thermometer	√	√	√	√
12	Prismatic Compass	X	X	X	√
13	Balloon	X	X	X	√
14	Sounding Cable with fish weight	X	√	√	X
15	Echo Sounder	X	X	√	X

Morphology: No significant morphological changes have been observed at sites.

Narrative description /special information on hydrological conditions is as Under

a) SRRG information for important G and D sites during flood period: - One Self recording rain gauge and one Ordinary rain gauge are available at sites.

b) Flood Hydrograph details enclosed in data part.

c) Extent of flooding:- No unprecedented flood experienced during 2013-14

d) Breaching of embankments and other structures, if any: - There had been no incident of major breaches during 2013-14

e) Substantial changes in river morphology: - Study of river cross sections of last few years indicates that there is no appreciable change in the river morphology at sites.

f) Drought / Water scarcity: - Water scarcity is not experienced and hence no drought in this zone.

2.2 Data Availability of Existing Sites

Table-15: **Data availability of existing sites**

Sl.No	Station Name	River	Station Code No.	Type	Data available	
					From	To
1	Burhanpur	Tapi	010217002	GDSQRF		
				Gauge	16.06.1972	Contd...
				Discharge	14.09.1972	-do-
				Sediment	23.12.1972	-do-
				W Q	01.06.1977	-do-
				RF	15.06.1970	-do-
2	Gopalkheda	Purna	010217004	GDSQ RF		
				G	17.02.1977	-do-
				D	17.02.1977	-do-
				S	30.07.1979	-do-
				WQ	01.08.1979	-do-
				RF	01.01.1980	-do-
3	Yerli	Purna	010217005	GDSRF		
				G	11.11.1971	-do-
				D	01.03.1972	-do-
				S	09.04.1973	-do-
				RF	04.09.1979	-do-
				WQ	01.06.1977	31/05/05
4	Gidhade	Tapi	01 02 17014	GDRF		
				G	15.06.1969	
				D	19.06.1990	-do-
				RF	03.07.1971	-do-
				WQ	01.09.1990	31/05/05
5	Sarangkheda	Tapi	0102 17015	GDSQRF	--	
				G	29.07.1976	Contd..
				D	19.10.1977	-do-
				S	13.07.1984	-do-
				WQ.	01.01.1980	-do-
				RF	15.06.1986	-do-

2.2.1 Availability of Data of closed sites and sites with reduced Status

Table-16: **Availability of data of closed site**

Sl. No	Station Name	River / Tributary	Station Code No.	Type	Data available	
					From	To
1	Dedtalai *	Tapi	0102 17001	GDSRFQ		
				Gauge	06.01.77	Contd..
				Discharge	12.12.77 06.02.14	31.05.05 Contd..
				Sediment	24.01.84	31.05.05
				Water Qly.	01.08.79	31.05.05
				RF	11.08.84	Contd..
2	Lakhpuri	Tapi/Purna	0102 17003	GDRFQ		
				Gauge	16.02.77	Contd..
				Discharge	18.02.77	31.05.05
				Water Qly	03.11.86	31.05.05
				Rainfall	01.09.81	Contd..
3	Savkheda	Tapi	0102 17011	GDSRFQ		
				Gauge	06.04.72	Contd..
				Discharge	10.04.72	31.05.05
				Sediment	01.11.72	31.05.05
				Water Qty.	01.06.77	31.05.05
				RF	01.01.85	Contd..
4	Morane *	Tapi/ Panjhra	0102 17012	GDRFQ		
				Gauge	17.07.76	Contd…
				Discharge	02.11.77 17.03.14	31.05.05 Contd..
				W. Quality	01.09.90	31.05.05
				RF	01.11.91	Contd
5	Dapuri	Tapi/ Girna	0102 17010	GDSRFQ		
				Gauge	21.09.71	31.05.05
				Discharge	21.01.72	31.05.05
				Silt	01.07.73	31.05.05
				WQ	01.06.77	31.05.05
				RF	01.06.85	31.05.05
6	Malkheda	Tapi/ Bori	0102 17012	GDQRF		
				Gauge	17.07.76	31.05.05
				Discharge	02.11.77	31.05.05
				W Qly.	01.09.90	31.05.05
				RF	01.06.87	31.05.05
7	Ghala	Tapi	0102 17 018	GDRFQ		
				Gauge	15.08.77	Contd..
				Discharge	01.06.78 30.01.14	31.05.05 Contd..
				Water Qty.	01.08.83	31.05.05
				RF	01.06.78	Contd..
8	Kakrapar	Tapi	0102 17017	GRF		
				Gauge	01.06.69	15.10.04
				Rainfall	01.06.69	15.10.04

* Ghala, Dedtali and Maorane sites are upgraded from gauge site to gauge and discharge site.

2.3 Explanatory notes

The explanatory notes given here-under are designed to assist in the interpretation of hydrological parameters contained in the data presented. The notes are, therefore, applicable in so far as the data presented in this book.

i] Water year covers the period from June 1st of the one calendar year to May 31st of the next calendar year and includes one complete hydrological cycle.

ii] Discharge is given in cubic metre per second.

iii] Discharges given are observed daily discharges.

iv] Discharges are expressed as 0.000 when river bed is dry and also when there is stagnation of water i.e. velocity is observed as NIL.

v] Discharges indicated with asterisk (*) mark are Estimated discharges as per rating curve equation corresponding to stage at 0800 hours of that day. Discharges indicated with (**#)** marks are estimated discharges of the discarded points.

vi] The Zero of Gauge is a datum level / R. L. fixed for a given site, which is kept1 or 2 m lower than the lowest water level recorded in a perennial stream. In a non- perennial stream, it is kept 1 or 2 m lower than the lowest bed level of the stream.

Vii] Discharges are rounded off to:

a] Nearest full integer when more than 1000.

b] Nearest first decimal figures when between 100 and 1000

c] Nearest two decimal figures when between 10 and 100

d] Nearest three decimal figures when less than 10.

Viii] Maximum and minimum discharges are taken from the observed daily flows.

ix] Runoff in mm is the notional depth of water in millimetres over the catchment area equivalent to annual runoff calculated at the discharge measurement station. It is computed using the relation

$$\text{Runoff (mm)} = \frac{\text{Annual runoff (mm}^3\text{)} \times 1000}{\text{Catchment area (km}^2\text{)}}$$

x] Peak and lowest flow correspond to the highest and lowest water levels recorded during the period of record.

xi] Measuring authority refers to the field division responsible for the operation of the gauging station.

xii] The gauging station code number is a unique NINE digit number, which facilitates storage and retrieval of flow data in data banks. The first two digits are identifier of measuring authority, third and fourth digits represent Basin / Zone and fifth and sixth digit refer to independent river Basins in the zone, seven eight and nine digits indicate site numbers.

xiii] The month and the year from which data available in the data banks is indicated against record available

Plate no-1


TAPI BASIN
ARABIAN SEA
SURAT
GHALA
Tapi River
UKAI DAM
SAGBARA
Gomai River
SARANGKHEDA
Buray River
ANER
JGIDHADE
SAVKHEDA
DHULE
MORANE
Bori River
Punad Proj.
MALEGAON
Girna River
GIRNADAM
BHUSAWAL
JALGAON
DAHIGAON
BURHANPUR
Tapi River
HATHNUR
Van Proj.
Van R.
YERLI
Purna R.
DEDTALAI
CHIKALDARA
Tapi River
TESKA
Purna R.
GOPALKHEDA
DARYAPUR
AMRAVATI
LAKHPURI
AKOLA
BULDANA
Mun R.
Murna R.
Katapurna R.
LEGEND
GAUGE
GAUGE DISCHARGE
GAUGE DISCHARGE SILT
GAUGE DISCHARGE SILT & W. QTY.
GAUGE DISCHARGE & W. QTY.
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RAIN GAUGE STATIONS
FORECASTING STATIONS
COMPLETED PROJECTS
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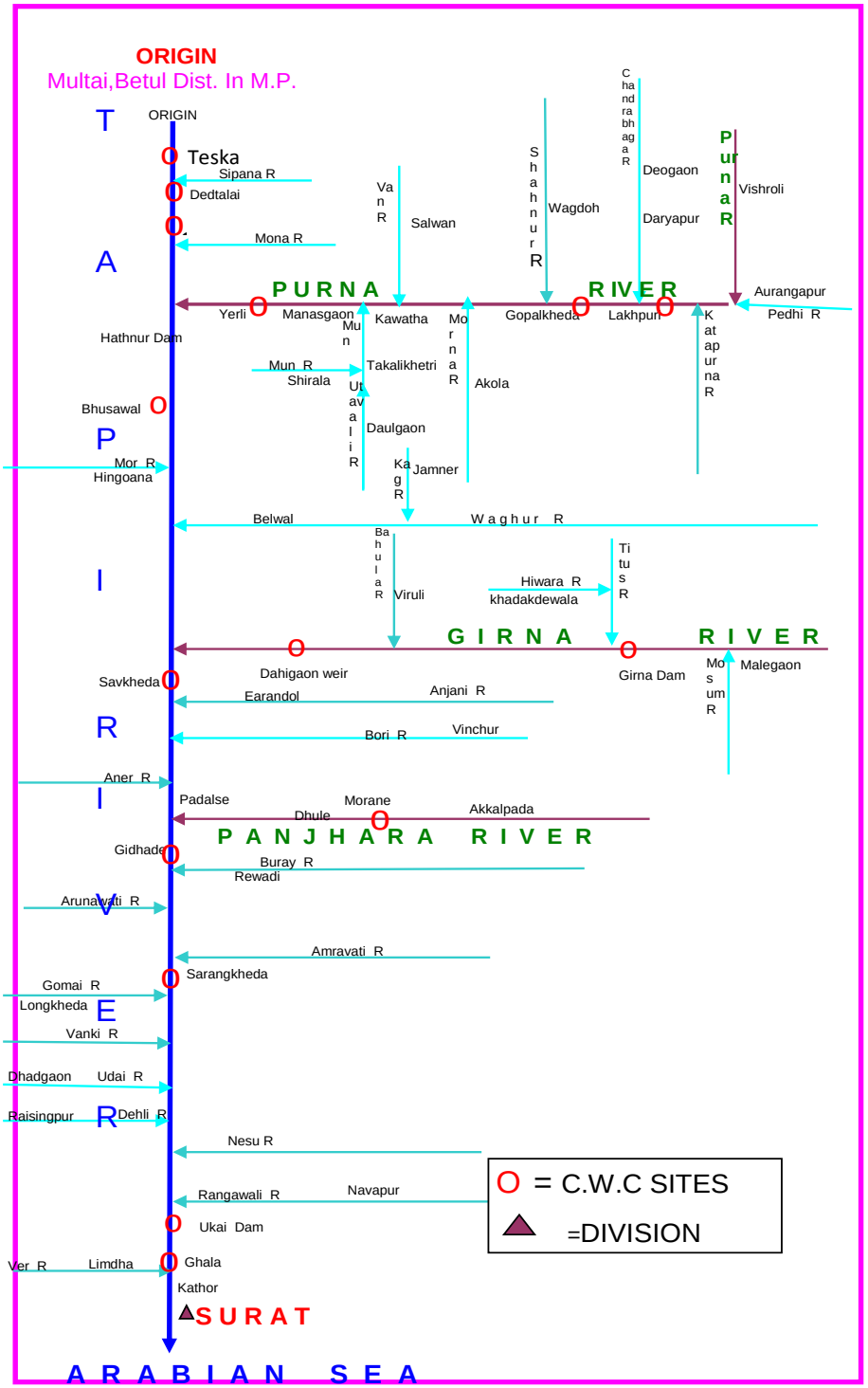
Plate-2


ORIGIN
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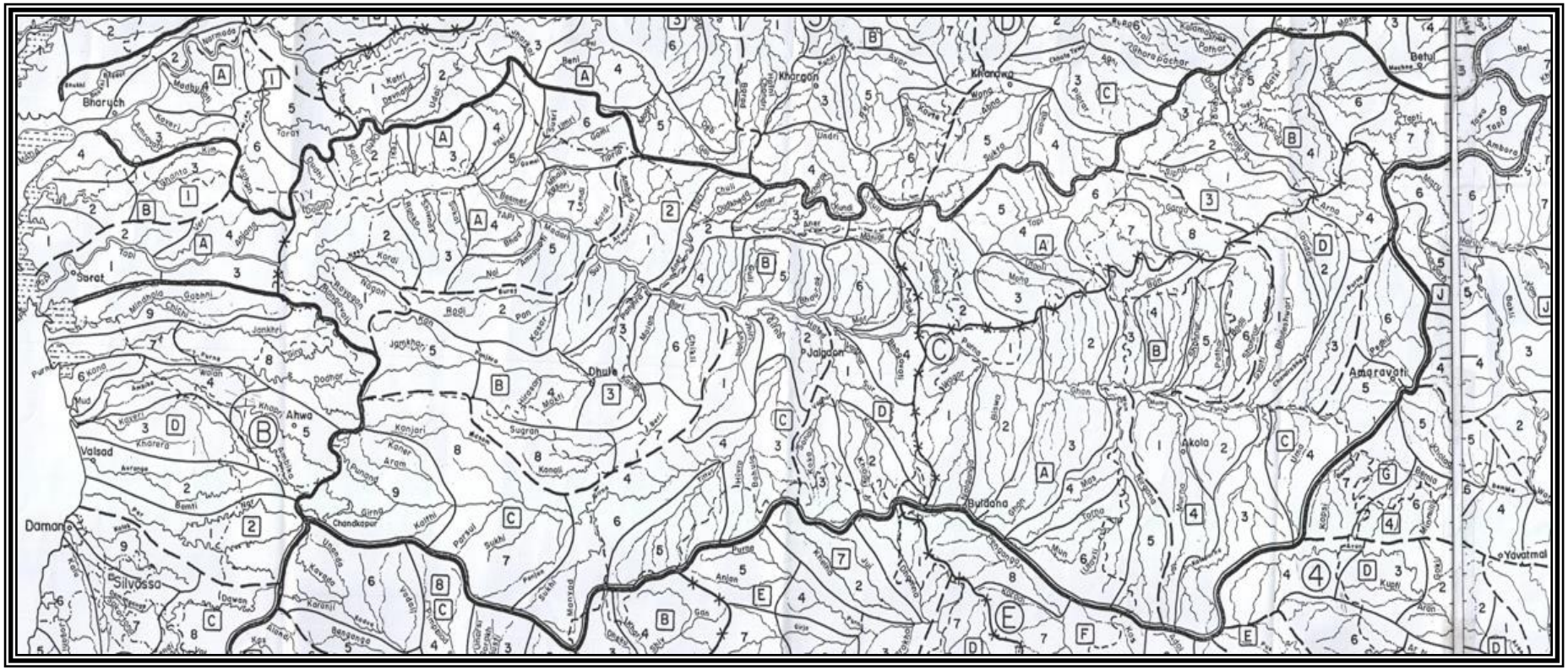
Mona R
Van R
Salwan
Shahnur R
Wagdoh
Chandrabhaga R
Deogaon
Daryapur
Purna R
Vishroli
PURNA RIVER
Aurangapur
Pedhi R
Yerli
Manasgaon
Kawatha
Gopalkheda
Lakhpuri
Katapurna R
Hathnur Dam
Mun
Mun R
Shirala
Takalikhetri
Akola
Morna R
Uttavali R
Daulgaon
Bhusawal
Mor R
Hingoana
Kag R
Jamner
Belwal
Waghur R
Bahula R
Viruli
Hiwara R
khadakdewala
Titus R
GIRNA RIVER
Dahigaon weir
Girna Dam
Malegaon
Mosum R
Savkheda
Earandol
Anjani R
Bori R
Vinchur
Aner R
Padalse
Morane
Dhule
Akkalpada
PANJHARA RIVER
Gidhade
Buray R
Rewadi
Arunavati R
Amravati R
Sarangkheda
Gomai R
Longkheda
Vanki R
Dhadgaon
Udai R
Raisingpur
Dehli R
Nesu R
Rangawali R
Navapur
Ukai Dam
Ver R
Limdha
Ghala
Kathor
SURAT
ARABIAN SEA
O = C.W.C SITES
=DIVISION

Plate no-3

Watershed Map of Tapi River Basin (As per Watershed Atlas of India Published by: Department of Agriculture and Cooperation, Ministry of Agriculture, Krishi Bhavan New Delhi (1990)



Chapter-3 Hydrological data

3.1 Burhanpur

3.1.1 History sheet

Site	**:**	**Tapi at Burhanpur**	**Code**	**:**	**01 02 17 002**
State	:	Madhya Pradesh	District		Khandwa
Basin	:	Tapi	Independent River	:	-
Tributary	:		Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	
Division	:	Tapi Division Surat	Sub-Division	:	Upper Tapi Bhusawal
Drainage Area	:	8487 sq km	Bank	:	Right
Latitude	:	21°17'12"	Longitude	:	76°30'18"
Zero of Gauge (m)	:	213 (msl)	16/06/1972		
		Opening Date	Closing Date		
Gauge	:	16/06/1972			
Discharge	:	14/09/1972			
Sediment	:	23/12/1972			
Water Quality	:	01/06/1977			

Annual Maximum / Minimum observed discharge with corresponding Water Level (m)

Year	Maximum			Minimum		
	Q (cumec)	WL (m)	Date	Q (cumec)	WL (m)	Date
1973-1974	6330	226.112	27/08/1973	1.100	215.120	04/06/1973
1974-1975	2015	220.908	13/08/1974	0.900	214.990	19/05/1975
1975-1976	6117	224.890	12/08/1975	0.800	215.085	22/05/1976
1976-1977	3745	224.435	03/09/1976	0.000	215.085	28/02/1977
1977-1978	3893	223.000	14/09/1977	0.720	214.960	28/05/1978
1978-1979	26683	239.500	29/08/1978	1.000	214.990	01/06/1978
1979-1980	12100	233.950	10/08/1979	0.400	214.970	16/05/1980
1980-1981	5379	224.780	06/08/1980	0.800	214.980	31/05/1981
1981-1982	13259	230.100	10/08/1981	0.800	214.970	16/06/1981
1982-1983	1120	219.190	12/09/1982	0.300	215.030	09/05/1983
1983-1984	3687	222.200	01/09/1983	0.300	215.030	12/06/1983
1984-1985	11305	230.975	19/08/1984	0.100	215.010	10/06/1984
1985-1986	1875	220.500	14/08/1985	0.100	214.890	31/05/1986
1986-1987	4837	223.800	15/08/1986	0.000	214.860	11/05/1987
1987-1988	1160	219.000	18/06/1987	0.200	214.920	31/01/1988
1988-1989	4707	222.825	22/07/1988	0.000	214.780	02/05/1989
1989-1990	3435	221.400	19/08/1989	0.050	214.920	08/03/1990
1990-1991	8959	226.100	23/08/1990	0.000	214.870	15/05/1991
1991-1992	8246	232.450	31/07/1991	0.000	214.700	23/04/1992
1992-1993	4694	224.600	17/08/1992	0.000	214.550	05/05/1993
1993-1994	8268	223.800	16/06/1993	0.000	214.500	12/06/1993
1994-1995	17027	233.600	06/09/1994	0.000	214.800	05/06/1994
1995-1996	6630	226.500	03/09/1995	0.000	214.730	31/05/1996
1996-1997	2742	220.800	28/07/1996	0.136	215.030	16/05/1997
1997-1998	12339	229.350	26/07/1997	0.000	214.700	29/05/1998
1998-1999	25261	238.000	15/09/1998	0.000	214.700	13/06/1998
1999-2000	8649	227.800	10/08/1999	0.111	214.750	30/05/2000
2000-2001	1403	219.000	20/07/2000	0.000	215.620	17/05/2001
2001-2002	6664	225.050	15/08/2001	0.000	215.280	31/05/2002
2002-2003	5300	225.500	06/09/2002	0.000	215.170	25/05/2003
2003-2004	5130	224.600	28/07/2003	0.000	214.950	14/06/2003
2004-2005	5197	225.130	23/08/2004	0.000	215.320	09/05/2005
2005-2006	4098	224.060	15/09/2005	0.000	214.500	13/06/2005
2006-2007	3825	224.075	08/08/2006	0.000	215.900	01/06/2006
2007-2008	32686	236.800	08/07/2007	0.000	214.920	01/06/2007
2008-2009	3797	223.050	05/08/2008	0.000	215.220	01/05/2009
2009-2010	2810	222.500	23/07/2009	0.000	215.320	01/06/2009
2010-2011	2803	223.950	09/09/2010	0.000	216.000	24/01/2011
2011-2012	5965	225.475	27/08/2011	0.000	215.790	12/06/2011
2012-2013	8613	228.250	06/09/2012	0.00	215.290	27/05/2013
2013-2014	8189	228.70	01/08/2013	0.00	215.280	01/06/2013

3.1.2 Annual Maximum flood peak

Year	Highest Flood Level (m)	Date	Hour
1973	227.075	15/07/1973	03:00:00
1974	221.750	13/08/1974	02:00:00
1975	225.850	11/09/1975	20:00:00
1976	224.850	03/09/1976	08:00:00
1977	223.325	14/09/1977	15:00:00
1978	239.500	29/08/1978	18:00:00
1979	233.172	10/08/1979	09:00:00
1980	227.350	06/08/1980	14:00:00
1981	229.800	10/08/1981	00:00:00
1982	218.100	12/09/1982	00:00:00
1983	222.250	02/09/1983	17:00:00
1984	230.600	19/08/1984	02:00:00
1985	219.500	14/08/1985	00:00:00
1986	225.200	15/08/1986	00:00:00
1987	219.600	21/08/1987	06:00:00
1988	223.950	03/10/1988	07:00:00
1989	222.990	23/08/1989	21:00:00
1990	232.150	23/08/1990	17:00:00
1991	233.350	31/07/1991	05:00:00
1992	225.850	16/08/1992	21:00:00
1993	230.200	16/07/1993	22:00:00
1994	236.700	06/09/1994	17:00:00
1995	226.600	03/09/1995	10:00:00
1996	223.600	26/07/1996	19:00:00
1997	229.500	26/07/1997	10:00:00
1998	238.800	15/09/1988	12:00:00
1999	229.800	10/08/1999	03:00:00
2000	223.200	19/07/2000	15:00:00
2001	229.900	15/08/2001	23:00:00
2002	227.800	06/09/2002	01:00:00
2003	228.450	28/07/2003	02:00:00
2004	226.500	23/08/2004	05:00:00
2005	224.400	02/08/2005	13:00:00
2006	225.700	06/08/2006	22:00:00
2007	239.950	08/07/2007	17:00:00
2008	227.000	05/08/2008	21:00:00
2009	225.700	23/07/2009	01:00:00
2010	225.300	30/07/2010	19:00:00
2011	226.100	27/08/2011	09:00:00
2012	238.000	05/09/2012	23:00:00
2013	234.000	01/08/2013	14:00:00

3.1.3 Summary of Data

Stage Discharge data for the period 2013 - 2014

Station Name: Tapi at Burhanpur (01 02 17 002) Division: Tapi Division Surat Local River: Tapi Sub Division: Upper Tapi Bhusawal

Day	Jun		Jul		Aug		Sep		Oct		Nov	
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q
1	215.280	0.000	216.400	117.9	228.700	8189	217.840	485.7 *	217.090	293.9	216.320	90.67
2	215.280	0.000	216.250	89.30	224.750	4745	217.580	429.6	216.900	207.0 *	216.300	89.19
3	215.250	0.000	216.190	71.69	221.200	1940	217.440	391.0	216.880	216.5	216.270	75.37 *
4	215.250	0.000	217.575	424.2	219.880	1362 *	217.340	379.9	217.138	295.0	216.240	83.76
5	215.350	0.000	219.950	1310	219.015	950.5	217.235	343.9	217.380	368.8	216.230	81.39
6	215.350	0.000	218.050	567.9	218.500	747.7	217.275	352.8	217.180	280.5 *	216.190	76.33
7	215.350	0.000	217.450	359.2 *	218.205	620.0	217.085	273.5	217.025	292.4	216.165	74.26
8	215.350	0.000	217.220	306.3	217.950	537.3	216.990	229.7 *	216.820	235.2	216.150	72.99
9	215.350	0.000	217.375	365.1	217.950	524.0 *	216.930	214.4 *	216.795	217.6	216.140	70.41
10	215.350	0.000	216.900	228.3	218.890	910.7	216.840	221.5	216.940	232.7	216.140	54.82 *
11	215.350	0.000	217.100	268.7	218.300	653.0 *	216.885	228.1	218.050	581.0	216.140	69.12
12	215.350	0.000	217.325	351.1	218.040	572.7	216.825	214.2	218.900	897.6	216.130	67.38
13	215.350	0.000	219.625	1207	219.025	968.7	216.810	206.4	218.270	641.5 *	216.120	63.08
14	215.350	0.000	219.430	1140 *	219.065	988.0	216.800	190.5	217.340	326.2 *	216.100	49.01 *
15	217.450	359.2 #	219.320	1094	218.450	711.6 *	216.800	182.8 *	217.070	284.1	216.080	60.86
16	218.650	792.7 *	220.100	1324	218.025	562.9	217.540	441.1	216.850	194.8 *	216.050	46.90
17	218.000	534.5	219.375	1107	217.780	482.9	217.490	415.7	216.795	210.5	216.030	39.45 *
18	216.735	198.4	219.225	1039	217.750	455.2 *	216.920	233.6	216.750	201.1	216.020	56.13
19	216.245	51.53	219.225	1044	217.910	532.0	216.890	204.5 *	216.685	176.1	216.005	50.88
20	216.160	49.59	219.235	1034	217.640	443.3	216.730	193.5	216.610	140.2 *	215.970	33.09
21	216.130	46.08	220.350	1609 *	219.075	1013	217.135	312.6	216.548	154.6	215.950	25.59

22	216.060	43.96	219.070	960.8	221.250	2126 *	223.340	3527 *	216.530	148.8	215.940	30.10
23	215.960	30.72 *	218.975	918.6	225.050	4621	219.240	1044	216.470	126.4	215.930	29.94
24	215.900	26.36	222.350	2680	225.925	5984	218.360	703.3	216.430	122.8	215.925	26.67 *
25	216.035	42.70	219.650	1215	221.450	2248 *	217.890	505.1	216.420	117.7	215.910	25.01 *
26	217.300	316.1	219.715	1220	220.250	1444	217.570	427.5	216.390	106.8	215.900	27.61
27	218.200	607.3	220.165	1395	220.300	1489	217.335	354.2	216.390	96.49 *	215.890	26.24
28	217.715	459.5	219.080	978.2 *	219.200	1033 *	217.190	317.7	216.385	105.8	215.870	25.00
29	217.140	293.3	219.090	987.5	218.815	867.9	217.300	314.5 *	216.370	96.83	215.860	22.39
30	216.760	173.5 *	218.500	759.4	218.325	694.6	217.145	311.4	216.350	95.92	215.850	20.84
31			218.130	578.3	218.045	612.1			216.340	93.22		
Ten-Daily Mean												
I Ten-Daily	215.316	0.000	217.336	384.0	220.504	2053	217.255	332.2	217.015	263.9	216.215	76.92
II Ten-Daily	216.464	198.6	218.996	960.8	218.199	637.0	216.969	251.0	217.332	365.3	216.064	53.59
III Ten-Daily	216.720	203.9	219.552	1209	220.699	2012	218.250	781.8	216.420	115.0	215.903	25.94
Monthly												
Min.	215.250	0.000	216.190	71.69	217.640	443.3	216.730	182.8	216.340	93.22	215.850	20.84
Max.	218.650	792.7	222.350	2680	228.700	8189	223.340	3527	218.900	897.6	216.320	90.67
Mean	216.167	134.2	218.658	862.9	219.829	1582	217.492	455	216.906	243.8	216.061	52.15

Annual Runoff in MCM = 8925 Annual Runoff in mm = 1052

Peak Observed Discharge = 8189 cumecs on 01/08/2013 Corres. Water Level :228.7 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2013 Corres. Water Level :215.28 m

Note: River in pooling condition i.e. negligible flow during 1/6 to 14/06/2013, and from 26-04-14 to 31-05-14

Q: observed/ computed discharge in cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge
#Discarded and estimated

Stage Discharge data for the period 2013 - 2014

Station Name: Tapi at Burhanpur (01 02 17 002) Division: Tapi Division Surat Local River: Tapi Sub Division: Upper Tapi Bhusawal

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	215.845	18.27 *	215.730	4.082	215.670	3.612	215.600	2.596	215.595	2.294	215.400	0.000
2	215.835	18.79	215.725	3.850	215.670	3.101 *	215.600	2.227 *	215.590	2.235	215.400	0.000
3	215.835	18.07	215.720	3.779	215.665	3.633	215.595	2.608	215.580	2.184	215.400	0.000
4	215.830	17.11	215.720	3.699	215.660	3.573	215.595	2.552	215.580	2.154	215.400	0.000
5	215.825	16.36	215.710	7.074 *	215.650	3.514	215.720	4.078	215.575	2.121	215.400	0.000
6	215.820	16.12	215.710	3.696	215.650	3.460	215.690	3.791	215.570	1.927 *	215.400	0.000
7	215.820	15.65	215.710	3.477	215.640	3.258	215.680	3.440	215.565	1.863	215.400	0.000
8	215.820	15.90 *	215.700	3.457	215.640	3.179	215.680	3.417	215.560	1.765	215.400	0.000
9	215.820	15.86	215.700	3.414	215.635	2.750 *	215.680	3.249 *	215.560	1.723	215.390	0.000
10	215.815	15.29	215.695	3.310	215.635	3.284	215.740	4.401	215.555	1.675	215.390	0.000
11	215.815	14.51	215.695	3.293	215.635	3.214	215.720	4.202	215.550	1.633	215.390	0.000
12	215.810	13.97	215.690	3.403 *	215.635	3.213	215.720	4.134	215.550	1.617	215.390	0.000
13	215.805	13.53	215.690	3.189	215.635	3.336	215.710	3.999	215.550	1.749 *	215.390	0.000
14	215.800	13.21	215.685	3.325 *	215.630	3.214	215.710	3.921	215.545	1.706 *	215.390	0.000
15	215.795	13.66 *	215.680	2.974	215.630	3.167	215.710	3.946	215.540	1.529	215.390	0.000
16	215.795	12.48	215.670	3.017	215.630	2.519 *	215.700	3.564 *	215.530	1.492	215.390	0.000
17	215.790	12.33	215.670	3.210	215.620	3.059	215.700	3.564 *	215.520	1.485	215.390	0.000
18	215.785	11.50	215.670	2.922	215.620	2.914	215.680	3.528	215.520	1.509 *	215.390	0.000
19	215.785	11.32	215.680	3.249 *	215.620	2.884	215.670	3.287	215.500	1.407	215.390	0.000
20	215.780	11.09	215.710	3.880	215.610	2.896	215.670	3.216	215.500	1.366 *	215.390	0.000
21	215.780	10.83	215.710	3.905	215.610	2.783	215.660	3.158	215.490	1.343	215.390	0.000

22	215.780	12.38 *	215.700	4.339	215.610	2.676	215.660	3.134	215.480	1.280	215.390	0.000
23	215.770	10.46	215.700	4.056	215.610	2.336 *	215.640	2.694 *	215.470	1.241	215.380	0.000
24	215.760	9.739	215.700	3.735	215.600	2.639	215.640	2.979	215.460	1.117 *	215.380	0.000
25	215.760	10.75 *	215.700	3.489	215.600	2.644	215.640	2.913	215.450	1.073	215.380	0.000
26	215.750	8.879	215.700	3.564 *	215.600	2.690	215.620	2.927	215.450	0.000	215.380	0.000
27	215.750	7.266	215.695	3.306	215.600	2.637	215.610	2.648	215.430	0.000	215.380	0.000
28	215.740	4.924	215.695	3.169	215.600	2.624	215.605	2.554	215.400	0.000	215.360	0.000
29	215.735	8.839 *	215.690	2.971			215.600	2.442	215.400	0.000	215.350	0.000
30	215.730	4.527	215.685	2.819			215.600	2.489	215.400	0.000	215.340	0.000
31	215.730	4.425	215.680	3.991			215.600	2.227 *			215.340	0.000
Ten-Daily Mean												
I Ten-Daily	215.827	16.74	215.712	3.984	215.652	3.336	215.658	3.236	215.573	1.994	215.398	0.000
II Ten-Daily	215.796	12.76	215.684	3.246	215.627	3.042	215.699	3.736	215.531	1.549	215.390	0.000
III Ten-Daily	215.753	8.457	215.696	3.577	215.604	2.629	215.625	2.742	215.443	0.605	215.370	0.000
Monthly												
Min.	215.730	4.425	215.670	2.819	215.600	2.336	215.595	2.227	215.400	0.000	215.340	0.000
Max.	215.845	18.79	215.730	7.074	215.670	3.633	215.740	4.401	215.595	2.294	215.400	0.000
Mean	215.791	12.52	215.697	3.601	215.629	3.029	215.660	3.222	215.516	1.383	215.385	0.000

Peak Computed Discharge = 3527 cumecs on 22/09/2013 Corres. Water Level :223.34 m

Lowest Computed Discharge = 1.117 cumecs on 24/04/2014 Corres. Water Level :215.46 m

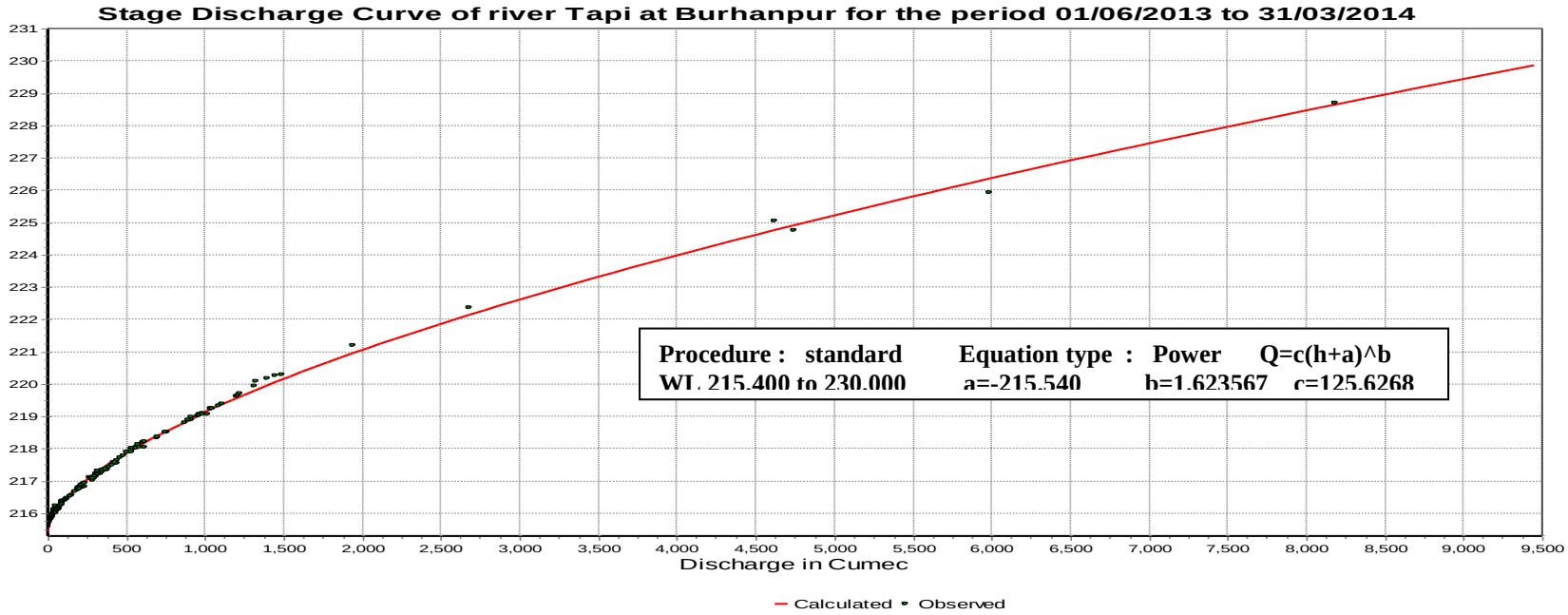
Note: River in pooling condition i.e. negligible flow during 1/6 to 14/06/2013, and from 26-04-14 to 31-05-14

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge

#Discarded and estimated

3.1.4 Stage Discharge Curve

Station Name: Tapi at Burhanpur (01 02 17 002) Division: Tapi Division Surat Local River: Tapi Sub Division: Upper Tapi Bhusawal



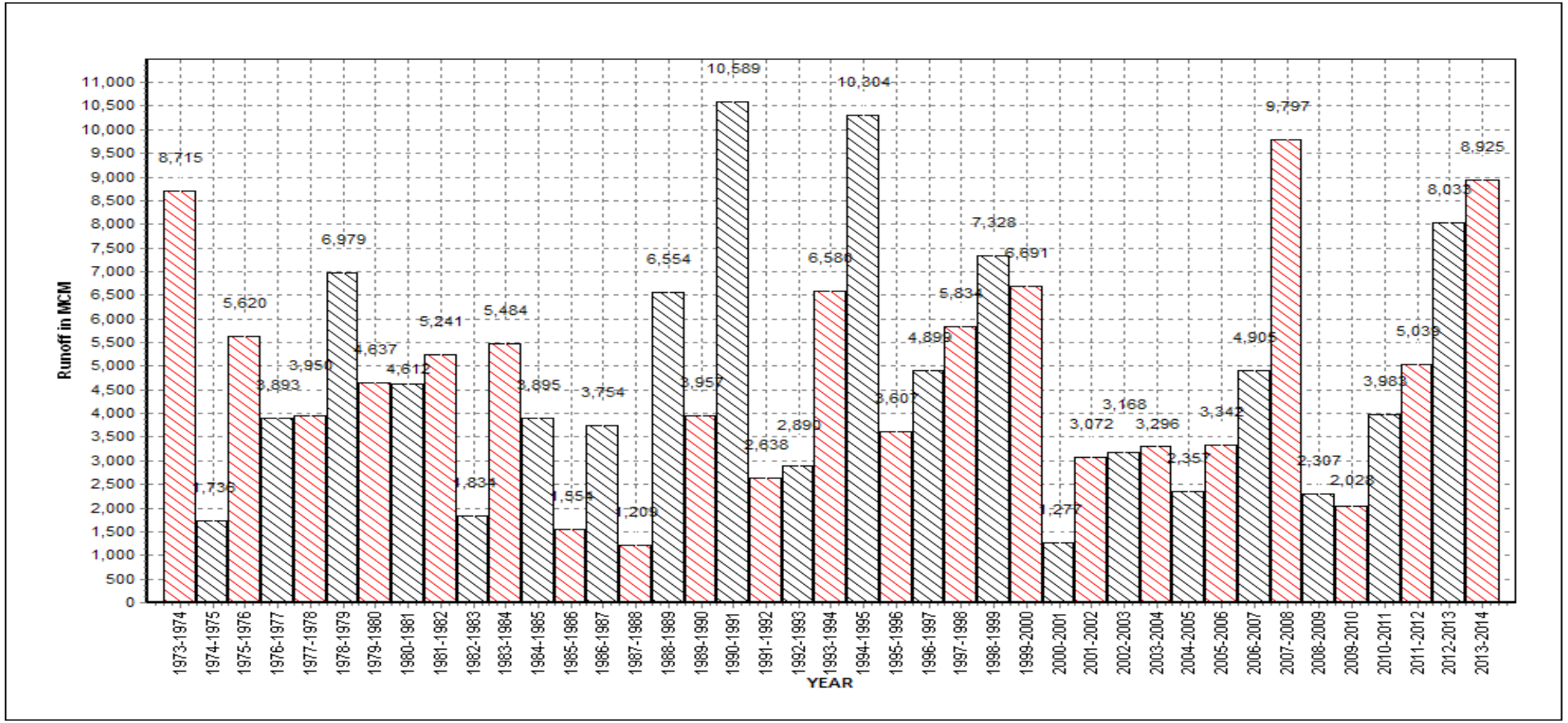
Equation for estimation of discharge for the period 01/04/14 to 31/05/2014 is as following:

Procedure : Standard	Equation type : Power	Q=C(h+a)^b		
LB	UB	a	b	C
215.4	215.70	-213.010	12.41309	11.6498E-05

3.1.5 Annual Runoff

Annual Runoff for the period 1973-2014

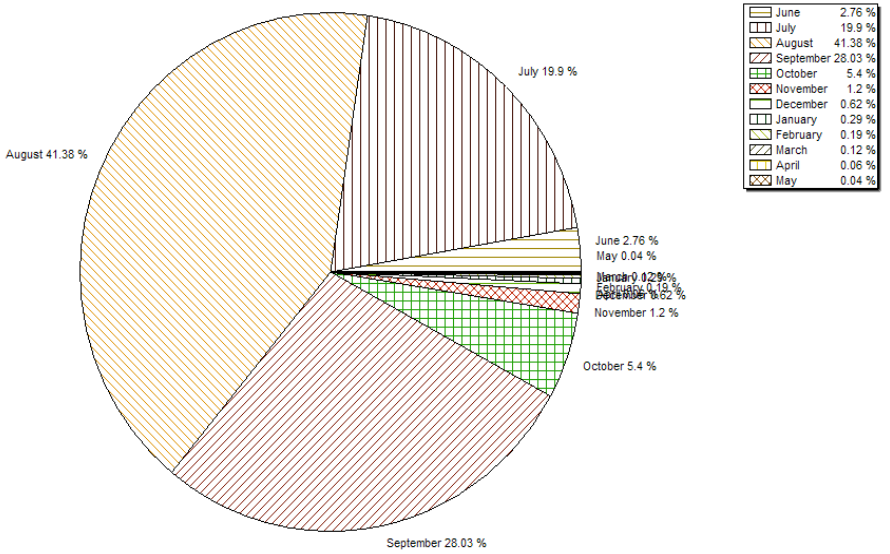
Station Name: Tapi at Burhanpur (01 02 17 002) Division: Tapi Division Surat Local River: Tapi Sub Division: Upper Tapi Bhusawal



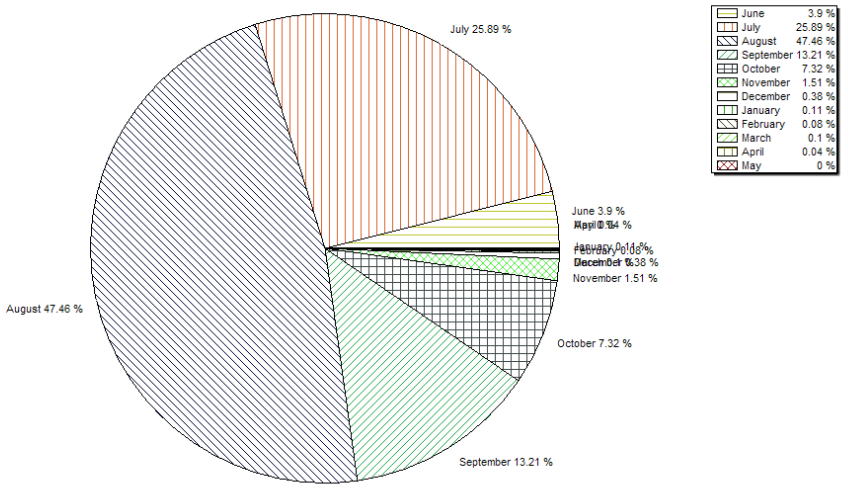
3.1.6 Monthly average Runoff

Station Name: Tapi at Burhanpur (01 02 17 002) Division: Tapi Division Surat Local River: Tapi Sub Division: Upper Tapi Bhusawal

Monthly Average Runoff Based on period 1971-2014



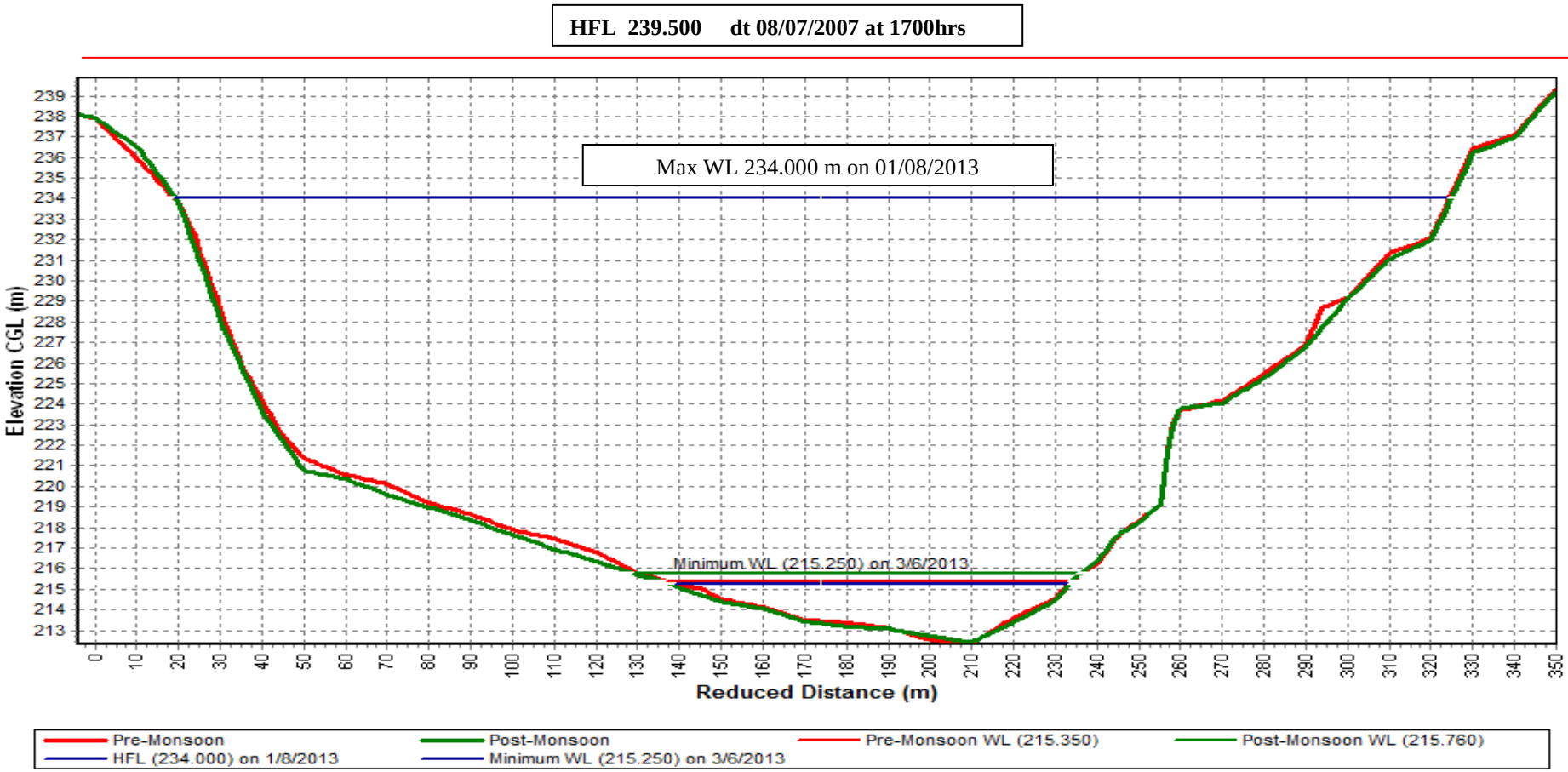
Monthly Runoff Based on period 2013-2014



3.1.7 Superimposed cross section

Station Name: Tapi at Burhanpur (01 02 17 002) Division: Tapi Division Surat Local River: Tapi Sub Division: Upper Tapi Bhusawal

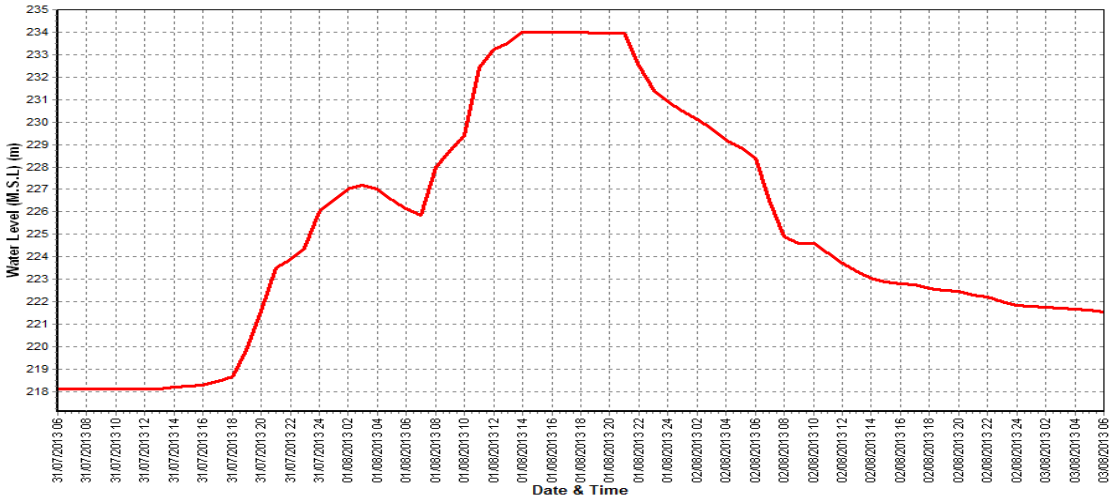
Cross section at SG Line



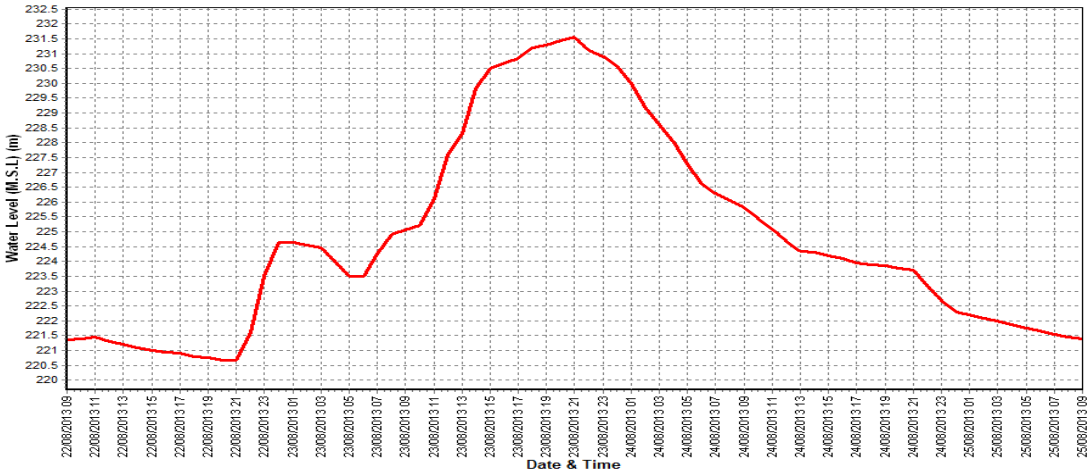
3.1.8 WL vs Time Graph of I, II, III peak

Station Name: Tapi at Burhanpur (01 02 17 002) Division: Tapi Division Surat Local
River: Tapi Sub Division: Upper Tapi Bhusawal

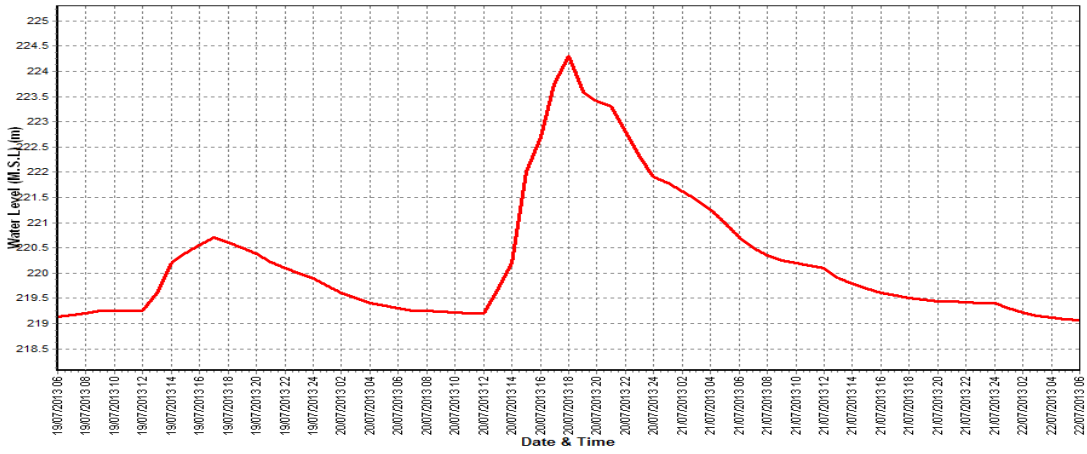
Water level vs Time Graph of Highest (I) flood peak during the water year 2013-14



Water level vs Time Graph of Highest (II) flood peak during the water year 2013-14



Water level vs Time Graph of Highest (I) flood peak during the water year 2013-14



3.2 Gopalkheda

3.2.1 History sheet

Site	**:**	**Purna at Gopalkheda**	**Code**	**:**	**01 02 17 004**
State	:	Maharashtra	District		Akola
Basin	:	Tapi	Independent River	:	Tapi
Tributary	:	Purna	Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	
Division	:	Tapi Division Surat	Sub-Division	:	Upper Tapi Bhusawal
Drainage Area	:	9500 sq km	Bank	:	Left
Latitude	:	20°52'35"	Longitude	:	76°59'14"
Zero of Gauge (m)	:	236 (msl)	17/02/1977		
		Opening Date	Closing Date		
Gauge	:	17/02/1977			
Discharge	:	17/02/1977			
Sediment	:	30/07/1979			
Water Quality	:	01/08/1979			

Annual Maximum / Minimum discharge with corresponding Water Level (above msl)

	Maximum			Minimum		
Year	Q (cumec)	WL (m)	Date	Q (cumec)	WL (m)	Date
1977-1978	133.9	81.532	26/11/1977	0.300	80.420	11/06/1977
1978-1979	2105	250.327	30/08/1978	0.196	237.120	12/05/1979
1979-1980	1872	252.100	10/08/1979	0.000	237.100	18/05/1980
1980-1981	529.3	243.920	17/08/1980	0.200	237.150	01/06/1980
1981-1982	2881	249.680	10/08/1981	0.200	237.020	02/06/1981
1982-1983	358.9	242.240	21/07/1982	0.000	236.860	15/04/1983
1983-1984	1630	248.970	12/08/1983	0.400	236.905	14/06/1983
1984-1985	712.0	245.310	19/08/1984	0.300	237.045	15/02/1985
1985-1986	437.0	242.100	27/06/1985	0.100	237.050	06/01/1986
1986-1987	2192	247.595	15/08/1986	0.200	236.920	14/06/1986
1987-1988	444.1	241.170	21/08/1987	0.000	236.960	21/07/1987
1988-1989	2700	251.450	03/10/1988	0.993	237.170	11/04/1989
1989-1990	565.3	243.800	24/08/1989	0.000	237.170	05/04/1990
1990-1991	1419	248.050	17/08/1990	0.240	236.660	05/03/1991
1991-1992	1341	246.525	31/07/1991	0.000	237.040	26/01/1992
1992-1993	1329	248.650	22/08/1992	0.213	236.470	17/03/1993
1993-1994	189.5	239.090	17/07/1993	0.000	237.300	26/05/1994
1994-1995	2976	250.690	07/09/1994	0.000	237.340	11/05/1995
1995-1996	970.8	245.188	25/07/1995	0.000	237.300	21/04/1996
1996-1997	736.8	243.000	08/09/1996	0.000	236.890	03/05/1997
1997-1998	1313	246.100	01/12/1997	0.000	236.200	24/05/1998
1998-1999	2521	249.955	16/09/1998	0.049	236.410	12/04/1999
1999-2000	1840	249.275	10/08/1999	0.047	236.450	10/04/2000
2000-2001	1020	247.325	20/07/2000	0.000	236.300	10/05/2001
2001-2002	767.7	244.085	15/06/2001	0.087	236.310	24/12/2001
2002-2003	1910	246.700	03/09/2002	0.000	236.300	20/07/2002
2003-2004	200.4	239.500	29/07/2003	0.010	237.600	04/12/2003
2004-2005	292.8	239.700	06/08/2004	0.000	236.220	21/06/2004
2005-2006	1953	247.925	02/08/2005	0.000	236.270	24/06/2005
2006-2007	4124	251.600	07/08/2006	0.430	236.260	18/07/2006
2007-2008	3608	251.100	09/07/2007	0.020	236.110	09/05/2008
2008-2009	256.5	239.740	22/09/2008	0.109	236.150	07/07/2008
2009-2010	286.4	239.675	08/07/2009	0.000	237.160	19/08/2009
2010-2011	1293	245.345	01/08/2010	0.000	237.250	13/05/2011
2011-2012	768.2	243.380	29/08/2011	0.000	237.620	22/01/2011
2012-2013	2515	250.000	07/09/2012	0.000	R-Dry	04/06/2012
2013-2014	2983	249.195	02/08/2013	0.000	237.300	01/06/2013

3.2.2 Annual Maximum flood peak

Year	Highest Flood Level (m)	Date	Hour
1977	241.200	25/11/1977	08:00:00
1978	250.405	30/08/1978	08:00:00
1979	252.100	10/08/1979	08:00:00
1980	247.010	17/08/1980	17:00:00
1981	249.770	10/08/1981	09:00:00
1982	242.940	22/07/1982	16:00:00
1983	249.130	12/08/1983	11:00:00
1984	245.980	19/08/1984	16:00:00
1985	246.000	26/06/1985	18:00:00
1986	247.730	15/08/1986	11:00:00
1987	241.990	21/08/1987	08:00:00
1988	252.000	03/10/1988	14:00:00
1989	244.700	24/08/1989	01:00:00
1990	251.000	25/07/1990	06:00:00
1991	248.350	31/07/1991	15:00:00
1992	248.650	22/08/1992	07:00:00
1993	239.780	16/07/1993	17:00:00
1994	250.750	07/09/1994	10:00:00
1995	245.350	25/07/1995	11:00:00
1996	243.240	08/09/1996	06:00:00
1997	246.250	30/11/1997	18:00:00
1998	250.150	16/09/1998	16:00:00
1999	249.590	10/08/1999	15:00:00
2000	247.400	20/07/2000	09:00:00
2001	244.300	15/06/2001	06:00:00
2002	249.550	03/09/2002	23:00:00
2003	241.900	28/07/2003	18:00:00
2004	242.050	05/08/2004	23:00:00
2005	250.800	01/08/2005	21:00:00
2006	251.600	07/08/2006	06:00:00
2007	251.270	09/07/2007	04:00:00
2008	241.150	21/09/2008	20:00:00
2009	241.880	08/07/2009	15:00:00
2010	246.580	31/07/2010	18:00:00
2011	244.550	06/09/2011	02:00:00
2012	250.160	07/09/2012	05:00:00
2013	249.340	02/08/2013	13:00:00

3.2.3 Summary of Data

Stage Discharge data for the period 2013 - 2014

Station Name: Purna at Gopalkheda (01 02 17 004) Division : Tapi Division Surat Local River: Purna Sub Division: Upper Tapi Bhusawal

Day	Jun		Jul		Aug		Sep		Oct		Nov	
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q
1	237.300	0.000	236.720	8.725	244.725	1271	237.760	62.68 *	237.500	49.49	236.980	15.36
2	237.290	0.000	236.670	6.676	249.190	2490 #	237.695	57.30	237.450	41.61 *	236.960	14.63
3	237.290	0.000	236.650	6.525	247.640	2008 #	237.500	44.45	237.460	41.81	236.940	15.03 *
4	237.300	0.000	236.890	12.77	242.015	613.0	237.345	34.65	240.645	378.0	236.930	15.96
5	237.300	0.000	238.310	101.6	239.310	205.3	237.220	28.58	245.880	1568	236.925	14.40
6	237.300	0.000	237.420	40.57	238.800	170.5	237.320	33.71	242.725	706.4	236.910	14.93
7	237.290	0.000	237.320	33.84 *	238.825	168.3	237.220	28.78	238.125	87.23	236.840	13.76
8	237.180	0.000	236.730	8.586	239.060	176.0	237.150	24.67 *	238.925	178.7	236.830	13.76
9	237.120	0.000	236.690	6.208 *	238.000	81.30 *	237.120	23.18 *	238.480	126.1	236.820	12.95
10	237.100	0.000	236.795	9.014	237.860	68.29	237.260	29.33	239.000	182.0	236.800	12.70
11	237.000	0.000	237.150	19.85	238.640	140.0 *	237.235	29.06	243.385	909.0	236.800	9.706 *
12	236.950	0.000	236.860	12.16	237.690	56.18	237.280	29.58	238.385	112.8	236.790	12.67
13	236.850	0.000	236.780	8.494	238.075	90.93	237.300	31.69	238.460	122.2 *	236.780	12.51
14	236.650	0.000	237.100	22.20 *	241.535	498.3	237.260	29.57	238.180	92.22	236.750	8.038 *
15	243.015	747.0	239.870	261.8	239.390	224.4 *	237.295	32.42 *	238.090	90.88	236.740	12.11
16	240.390	338.2	240.035	297.5	237.835	66.98	237.315	33.55 #	237.780	64.15 *	236.720	11.89
17	239.435	212.8	237.635	51.44	237.690	56.21	237.600	54.83	237.670	58.80	236.710	6.797 *
18	238.375	95.19	238.175	90.48	237.520	46.06 *	237.755	63.77	237.675	59.47	236.710	10.51
19	237.990	73.40	237.915	73.98	237.970	78.46	237.490	44.14	237.480	43.69	236.680	7.888
20	237.370	37.61	237.680	53.85	237.380	36.76	237.515	48.07	237.380	37.35 *	236.670	7.254

21	236.880	12.29	238.400	116.5 *	237.470	42.59	237.440	43.10	237.315	33.12	236.660	6.784
22	236.830	10.69	239.450	225.4	237.800	68.32	246.475	1755	237.290	28.51	236.660	6.526
23	236.760	8.361 *	240.445	354.8	238.915	176.1	244.445	1156	237.240	25.63	236.650	5.744
24	236.700	8.089	242.540	644.0	243.915	1070	238.920	181.9	237.190	24.38	236.645	4.963 *
25	236.750	8.963	240.820	426.7 #	241.070	467.3 *	238.430	119.0	237.275	31.22	236.650	5.306
26	236.805	9.294	240.840	426.8	240.250	324.3	238.190	94.91	237.390	38.16	236.620	5.151
27	237.105	18.23	240.200	306.6	239.010	171.0	237.950	76.77	237.385	37.64 *	236.615	4.196 *
28	237.460	42.88	239.100	189.9 *	238.900	167.5 *	237.720	59.23	237.355	35.36	236.600	4.351
29	237.055	15.92	238.700	161.1	238.370	112.2	237.670	56.21 *	237.215	23.21	236.600	4.320
30	236.800	9.706 *	238.210	97.47	238.390	114.4	237.575	49.66	237.040	18.40	236.585	3.637
31			238.195	93.18	238.000	82.18			237.000	16.91		
Ten-Daily Mean												
I Ten-Daily	237.247	0.000	237.019	23.45	241.543	725.1	237.359	36.73	239.619	336.0	236.894	14.35
II Ten-Daily	238.402	150.4	237.920	89.18	238.373	129.4	237.404	39.67	238.449	159.1	236.735	9.937
III Ten-Daily	236.915	14.44	239.718	276.6	239.281	254.1	239.481	359.1	237.245	28.41	236.628	5.098
Monthly												
Min.	236.650	0.000	236.650	6.208	237.380	36.76	237.120	23.18	237.000	16.91	236.585	3.637
Max.	243.015	747.0	242.540	644.0	249.190	2490	246.475	1755	245.880	1568	236.980	15.96
Mean	237.521	54.95	238.268	134.5	239.717	365.8	238.082	145.2	238.399	169.8	236.752	9.794

Annual Runoff in MCM = 2374 Annual Runoff in mm = 250

Peak Observed Discharge = 2490 cumecs on 02/08/2013 Corres. Water Level :249.195 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2013 Corres. Water Level :249.19 m

Note: 01/06 to 14/06/13 and from 09/4 to 31/056/14 River in polling condition

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge

#Discarded and estimated

Stage Discharge data for the period 2013 - 2014

Station Name: Purna at Gopalkheda (01 02 17 004) Division : Tapi Division Surat Local River: Purna Sub Division: Upper Tapi Bhusawal

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	236.585	3.482 *	236.495	1.973	236.575	3.001	236.530	2.033	236.500	1.483	236.310	0.000
2	236.580	3.570	236.490	1.944	236.570	3.146 *	236.850	14.15	236.490	1.385	236.310	0.000
3	236.575	3.394	236.490	1.932	236.570	2.849	236.850	14.15	236.480	1.231	236.310	0.000
4	236.570	2.984	236.480	1.873	236.610	3.566	236.720	12.43	236.470	1.174	236.300	0.000
5	236.560	2.693	236.470	1.274 *	236.600	3.356	236.680	10.37	236.450	0.883	236.300	0.000
6	236.555	2.600	236.500	2.049	236.600	3.282	236.710	10.46	236.440	0.851 *	236.300	0.000
7	236.550	2.435	236.500	2.032	236.600	3.223	236.670	3.928	236.440	0.495	236.290	0.000
8	236.550	2.719 *	236.495	1.988	236.590	3.065	236.640	3.640	236.420	0.298	236.290	0.000
9	236.540	1.964	236.490	1.972	236.640	4.831 *	236.620	4.320 *	236.410	0.000	236.290	0.000
10	236.520	1.614	236.485	1.894	236.620	3.584	236.610	3.307	236.410	0.000	236.290	0.000
11	236.510	1.603	236.570	3.030	236.600	3.324	236.600	3.328	236.410	0.000	236.280	0.000
12	236.530	2.440	236.580	3.369 *	236.570	2.944	236.580	3.107	236.400	0.000	236.280	0.000
13	236.525	2.421	236.560	2.784	236.560	2.819	236.570	3.002	236.400	0.000	236.280	0.000
14	236.520	2.374	236.550	2.719 *	236.550	2.637	236.565	2.806	236.390	0.000	236.270	0.000
15	236.510	1.942 *	236.540	2.040	236.540	2.149	236.560	2.837	236.380	0.000	236.270	0.000
16	236.500	2.094	236.520	2.034	236.530	2.317 *	236.600	3.833 *	236.370	0.000	236.270	0.000
17	236.570	2.918	236.490	1.972	236.520	1.861	236.640	4.831 *	236.365	0.000	236.270	0.000
18	236.530	2.503	236.480	1.873	236.510	1.771	236.680	10.20	236.360	0.000	236.260	0.000
19	236.525	2.342	236.480	1.431 *	236.500	1.515	236.700	10.12	236.360	0.000	236.260	0.000
20	236.520	2.324	236.500	2.013	236.500	1.501	236.680	10.01	236.350	0.000	236.260	0.000
21	236.510	2.045	236.600	3.302	236.490	1.288	236.670	9.868	236.350	0.000	236.260	0.000

22	236.580	3.369 *	236.630	3.677	236.490	1.275	236.650	3.713	236.345	0.000	236.255	0.000
23	236.570	3.141	236.590	3.298	236.480	1.431 *	236.640	4.831 *	236.340	0.000	236.255	0.000
24	236.560	2.825	236.580	3.042	236.580	3.019	236.620	3.466	236.340	0.000	236.250	0.000
25	236.550	2.719 *	236.570	2.984	236.580	3.084	236.610	3.291	236.340	0.000	236.250	0.000
26	236.540	2.650	236.560	2.929 *	236.560	2.692	236.600	3.224	236.330	0.000	236.250	0.000
27	236.530	2.526	236.580	3.006	236.540	2.059	236.580	3.108	236.330	0.000	236.245	0.000
28	236.510	2.066	236.580	3.034	236.540	2.070	236.560	2.783	236.320	0.000	236.240	0.000
29	236.505	1.853 *	236.580	3.002			236.540	2.006	236.320	0.000	236.240	0.000
30	236.500	2.062	236.575	3.013			236.530	2.317 *	236.320	0.000	236.240	0.000
31	236.500	2.061	236.575	3.003			236.520	1.894			236.230	0.000
Ten-Daily Mean												
I Ten-Daily	236.559	2.746	236.490	1.893	236.598	3.390	236.688	7.878	236.451	0.780	236.299	0.000
II Ten-Daily	236.524	2.296	236.527	2.327	236.538	2.284	236.617	5.408	236.379	0.000	236.270	0.000
III Ten-Daily	236.532	2.483	236.584	3.117	236.533	2.115	236.593	3.682	236.333	0.000	236.247	0.000
Monthly												
Min.	236.500	1.603	236.470	1.274	236.480	1.275	236.520	1.894	236.320	0.000	236.230	0.000
Max.	236.585	3.570	236.630	3.677	236.640	4.831	236.850	14.15	236.500	1.483	236.310	0.000
Mean	236.538	2.508	236.535	2.467	236.558	2.631	236.631	5.592	236.388	0.26	236.271	0.000

Peak Computed Discharge = 467.3 cumecs on 25/08/2013 Corres. Water Level :241.07 m

Lowest Computed Discharge = 0.851 cumecs on 06/04/2014 Corres. Water Level :236.44 m

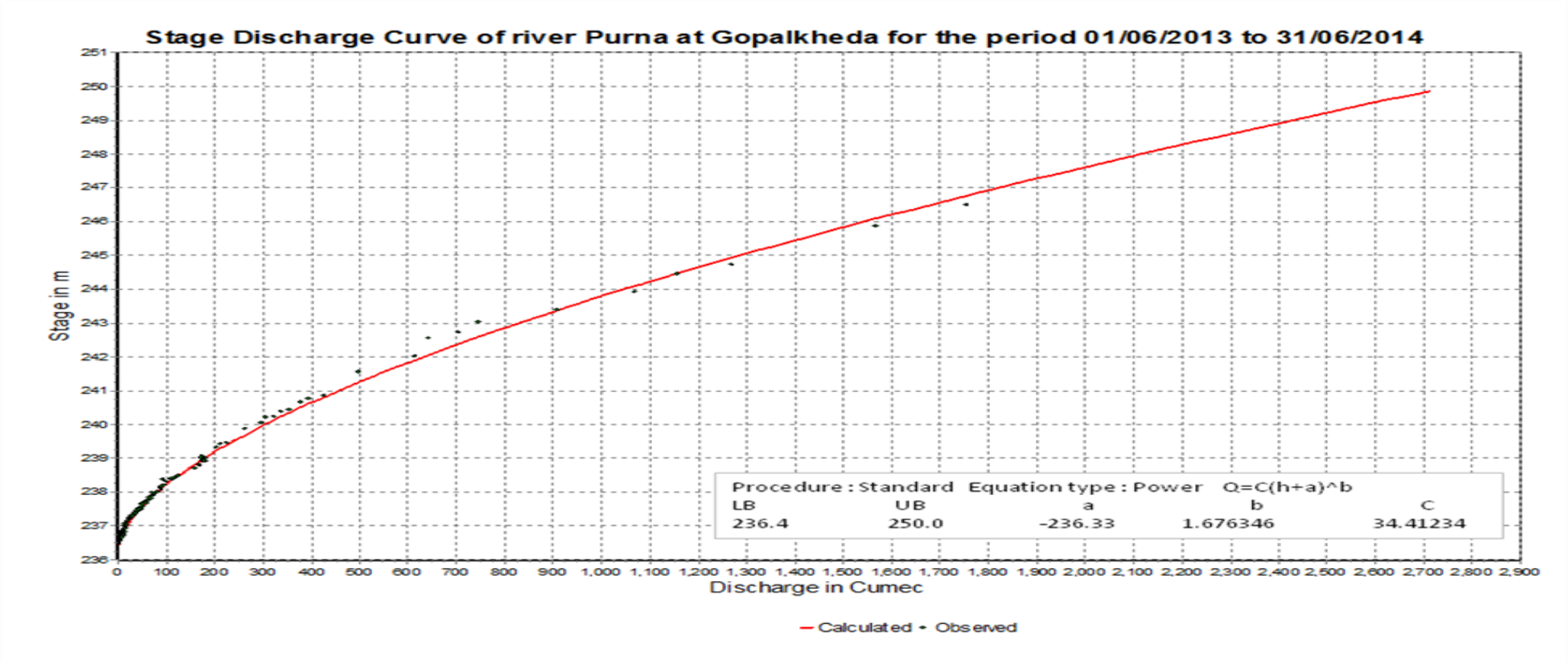
Note: 01/06 to 14/06/13 and from 09/4 to 31/056/14 River in polling condition

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge

#Discarded and estimated

3.2.4 Stage Discharge Curve

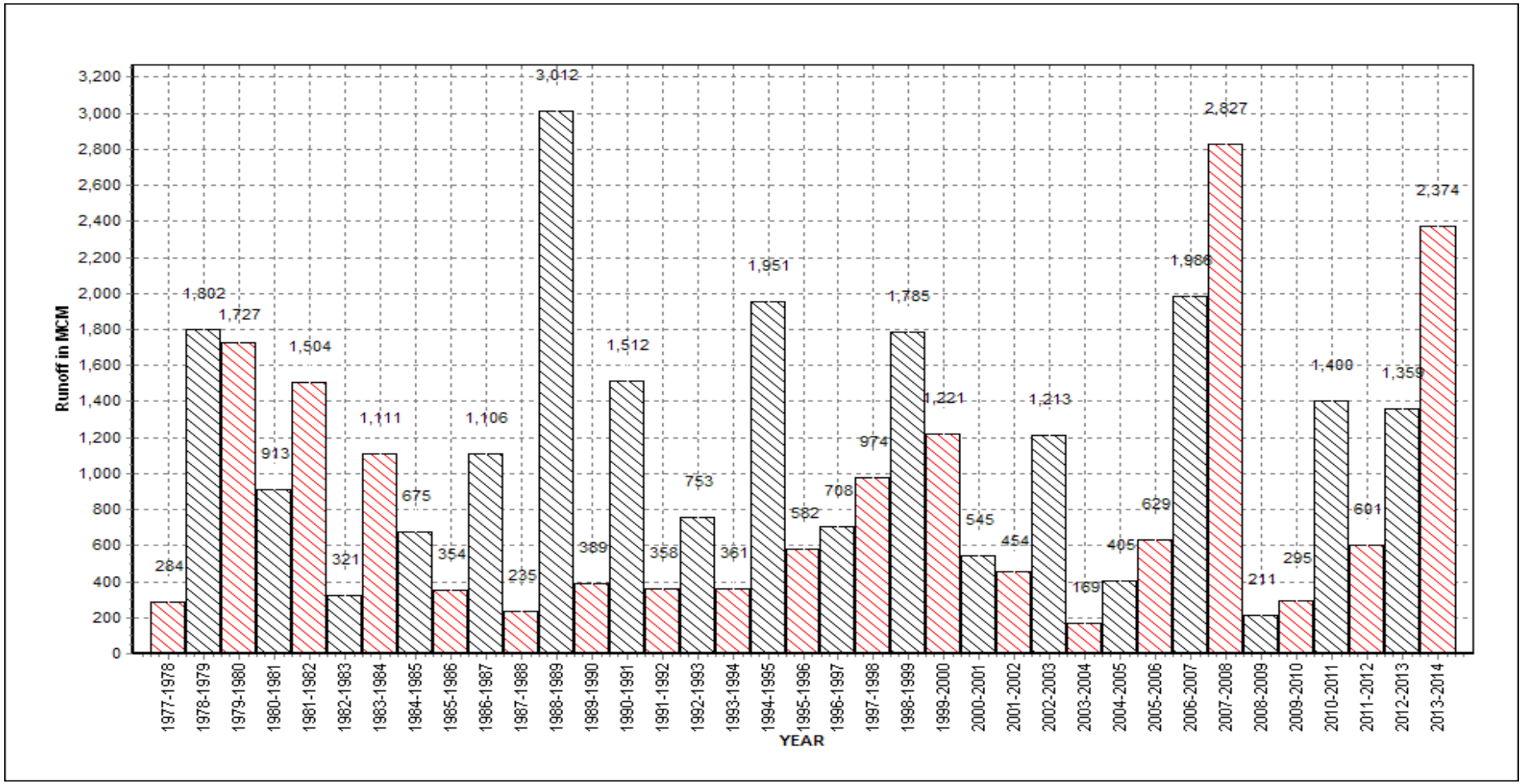
Station Name: Purna at Gopalkheda (01 02 17 004) Division : Tapi Division Surat Local River: Purna Sub Division: Upper Tapi Bhusawal



3.2.5 Annual runoff

Annual Runoff for the period 1977-2014

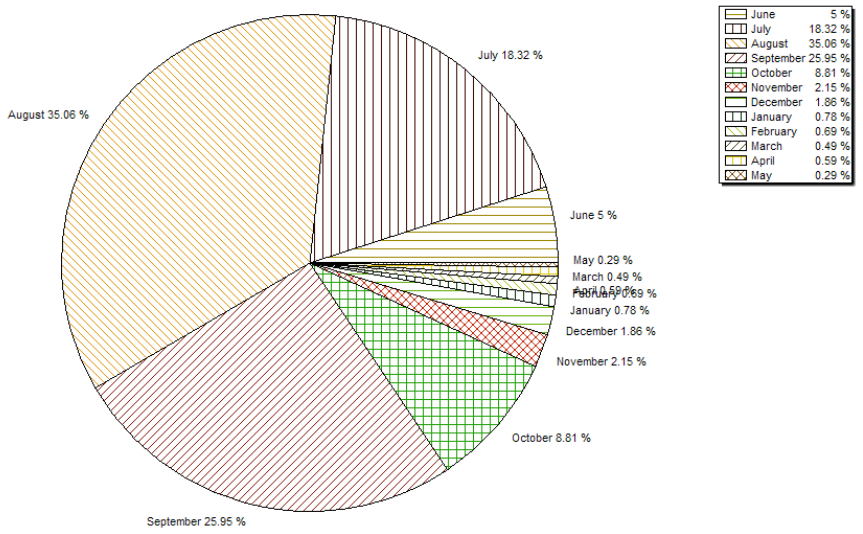
Station Name: Purna at Gopalkheda (01 02 17 004) Division : Tapi Division Surat Local River: Purna Sub Division: Upper Tapi Bhusawal



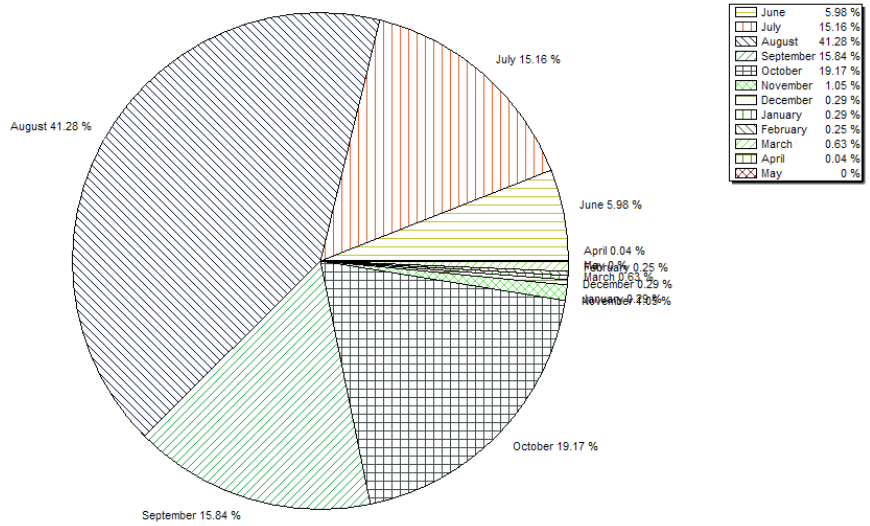
3.2.6 Monthly average Runoff

Station Name: Purna at Gopalkheda (01 02 17 004) Division : Tapi Division Surat Local River: Purna Sub Division: Upper Tapi Bhusawal

Monthly Average Runoff Based on period 1977-2014

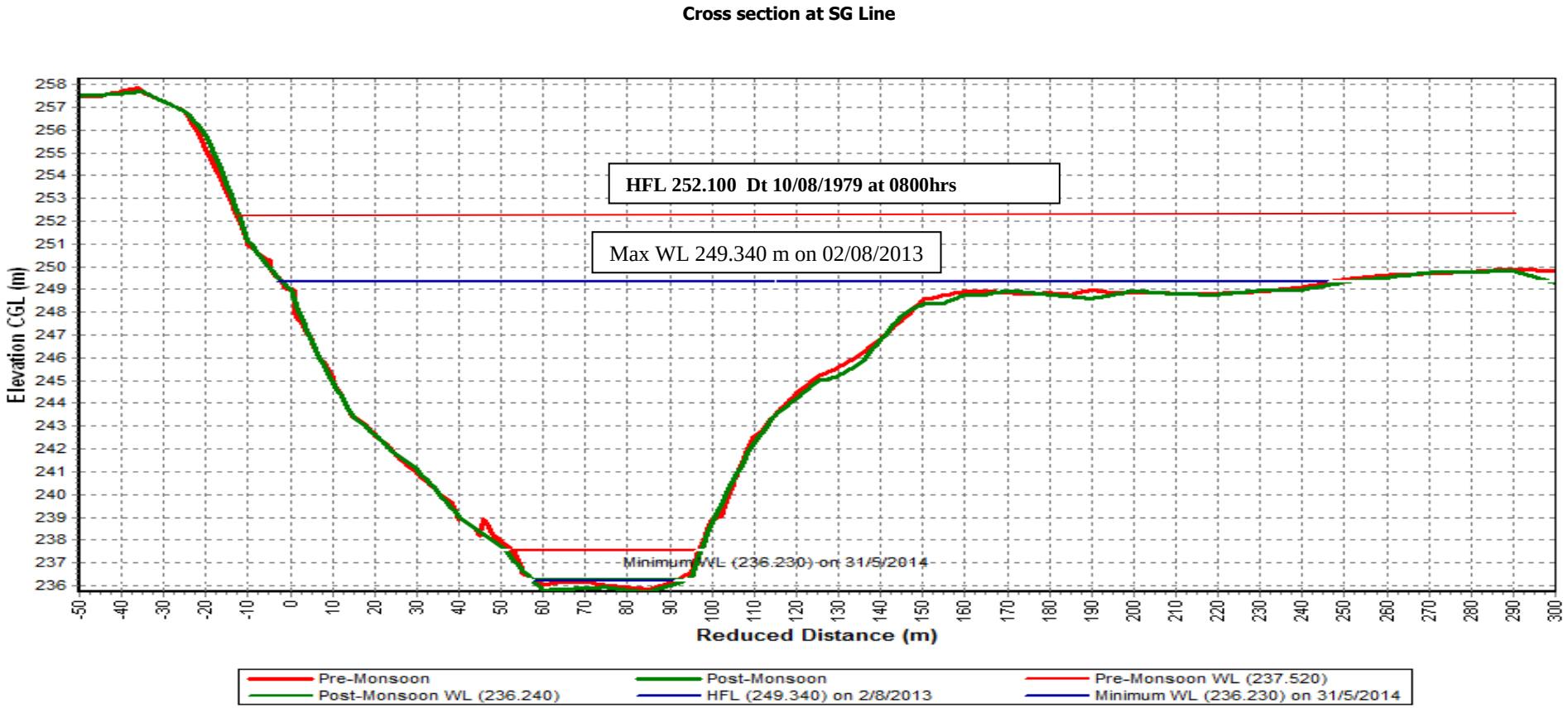


Monthly Runoff Based on period 2013-2014



3.2.7 Superimposed cross section

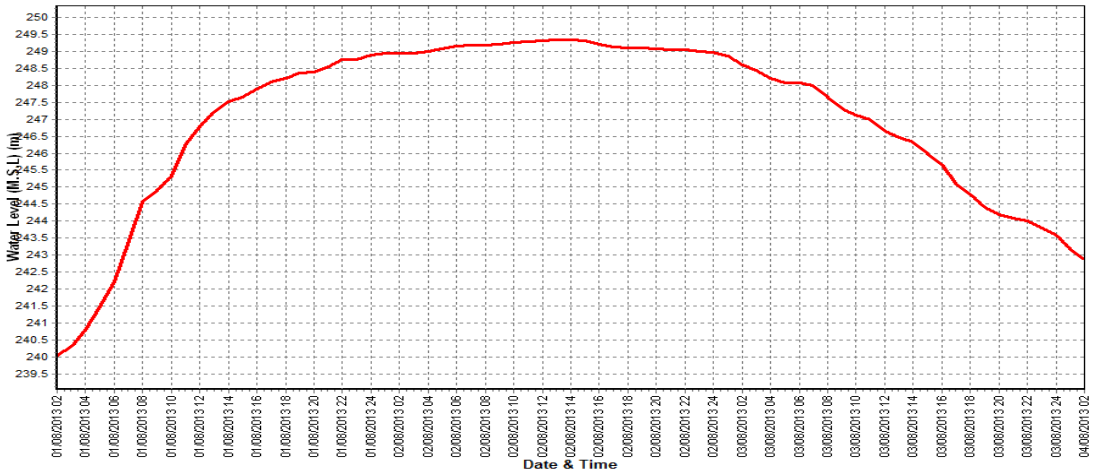
Station Name: Purna at Gopalkheda (01 02 17 004) Division : Tapi Division Surat Local River: Purna Sub Division: Upper Tapi Bhusawal



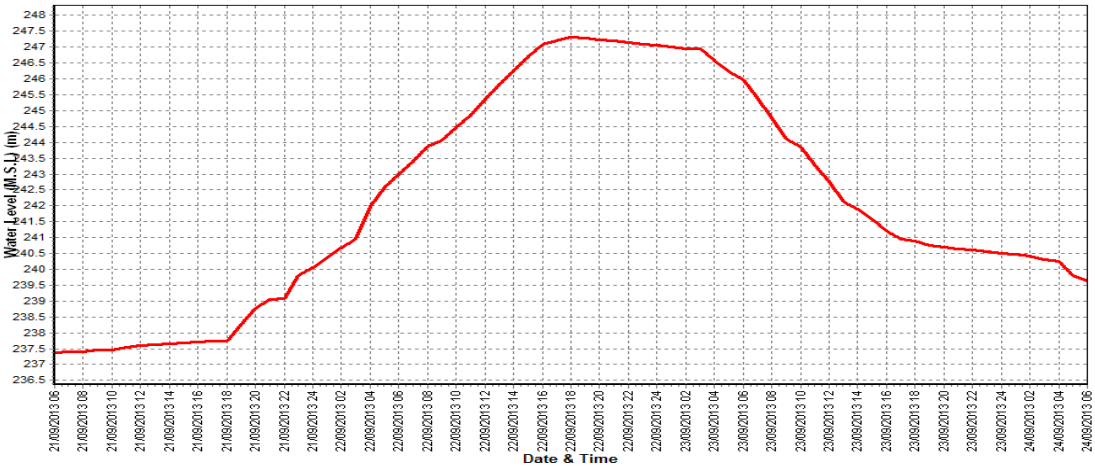
3.2.8 WL vs Time graph of highest I, II, III peak

Station Name: Purna at Gopalkheda (01 02 17 004) Division : Tapi Division Surat
Local River: Purna Sub Division: Upper Tapi Bhusawal

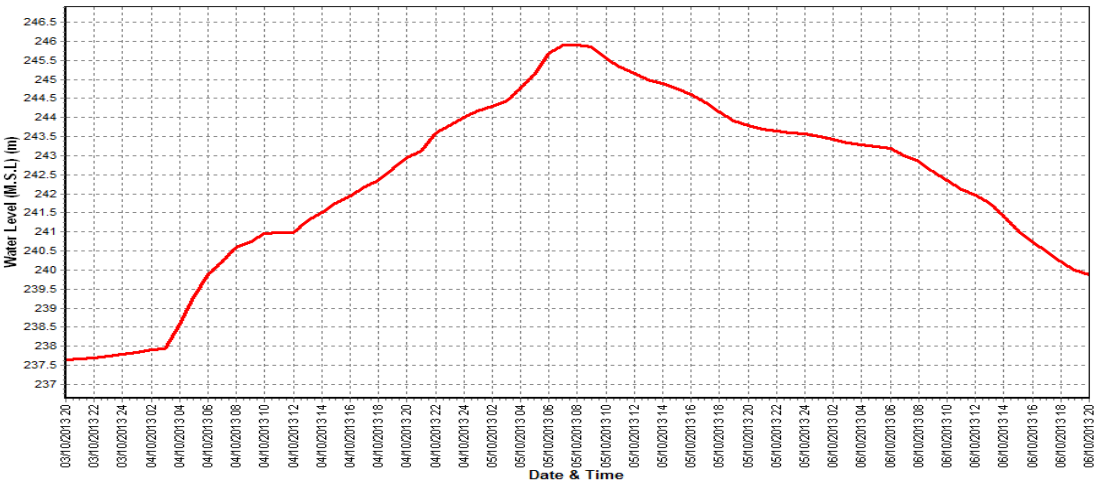
Water level vs Time Graph of Highest (I) flood peak during the water year 2013-14



Water level vs Time Graph of Highest (II) flood peak during the water year 2013-14



Water level vs Time Graph of Highest (III) flood peak during the water year 2013-14



3.3. Yerli

3.3.1 HISTORY SHEET

Site	**:**	**Purna at Yerli**	**Code**	**:**	**01 02 17 005**
State	:	Maharashtra	District		Buldhana
Basin	:	Tapi	Independent River	:	Tapi
Tributary	:	Purna	Sub Tributary	:	-
Sub-Sub Tributary	:		Local River	:	
Division	:	Tapi Division Surat	Sub-Division	:	Upper Tapi Bhusawal
Drainage Area	:	16517 sq km	Bank	:	Left
Latitude	:	20°56'11"	Longitude	:	76°28'27"
Zero of Gauge (m)	:	213 (msl)	11/11/1971		
		Opening Date	Closing Date		
Gauge	:	11/11/1971			
Discharge	:	01/03/1972			
Sediment	:	09/04/1973			
Water Quality	:	01/06/1977	31/05/2005		

Annual Maximum / Minimum discharge with corresponding Water Level (above msl)

Year	Maximum			Minimum		
	Q (cumec)	**WL (m)**	**Date**	**Q (cumec)**	**WL (m)**	**Date**
1973-1974	3060	226.210	28/08/1973	0.000	228.370	27/08/1973
1974-1975	2005	220.882	13/08/1974	0.200	214.400	28/05/1975
1975-1976	2493	222.883	05/09/1975	0.200	214.580	13/05/1976
1976-1977	2580	222.800	04/09/1976	0.200	214.630	02/06/1976
1977-1978	1885	220.965	14/06/1977	0.500	214.553	12/06/1977
1978-1979	4154	225.200	31/08/1978	1.200	214.805	29/05/1979
1979-1980	10380	230.510	11/08/1979	0.916	214.785	14/06/1979
1980-1981	1842	221.532	18/08/1980	1.200	214.815	31/05/1981
1981-1982	3350	224.780	11/08/1981	0.800	214.755	02/06/1981
1982-1983	651.6	219.485	21/07/1982	0.100	214.650	20/04/1983
1983-1984	6055	229.850	12/08/1983	1.243	214.695	31/05/1984
1984-1985	1611	220.595	10/10/1984	0.000	214.475	26/05/1985
1985-1986	3146	223.650	27/06/1985	0.000	214.570	30/05/1986
1986-1987	3073	224.240	07/08/1986	0.100	214.610	01/06/1986
1987-1988	1122	219.825	21/08/1987	0.000	214.620	21/04/1988
1988-1989	6700	228.500	04/10/1988	0.000	214.360	07/06/1988
1989-1990	1298	220.780	24/08/1989	0.000	214.730	17/05/1990
1990-1991	4501	227.150	25/07/1990	0.000	214.880	11/05/1991
1991-1992	1480	221.540	01/08/1991	0.000	214.730	03/03/1992
1992-1993	1974	222.445	22/08/1992	0.000	214.435	17/06/1992
1993-1994	2269	223.820	16/07/1993	0.000	214.650	07/05/1994
1994-1995	3785	225.550	08/09/1994	0.000	214.600	10/06/1994
1995-1996	1538	221.510	03/09/1995	0.000	214.600	16/04/1996
1996-1997	747.2	219.650	24/10/1996	0.000	214.655	23/04/1997
1997-1998	1294	221.350	01/12/1997	0.000	214.600	16/05/1998
1998-1999	3059	224.710	17/09/1998	0.000	214.550	22/05/1999
1999-2000	3020	224.150	11/08/1999	0.000	214.700	30/04/2000
2000-2001	680.0	220.200	20/07/2000	0.000	214.620	27/11/2000
2001-2002	1659	222.260	15/06/2001	0.000	214.600	18/05/2002
2002-2003	2750	225.870	04/09/2002	0.000	214.580	03/02/2003
2003-2004	443.4	218.095	29/09/2003	0.000	214.580	04/06/2003
2004-2005	407.8	217.425	06/08/2004	0.000	214.620	07/03/2005
2005-2006	3046	224.550	02/08/2005	0.000	214.690	07/06/2005
2006-2007	8703	233.540	07/08/2006	0.000	214.600	03/03/2007
2007-2008	3132	225.615	02/07/2007	0.000	214.620	18/05/2008
2008-2009	542.8	218.645	22/09/2008	0.000	214.410	23/04/2009
2009-2010	369.0	217.395	04/09/2009	0.000	River Dry	04/11/2009
2010-2011	1757	223.005	01/08/2010	0.257	214.760	31/12/2010
2011-2012	989.3	219.000	06/09/2012	0.000	214.970	01/06/2011
2012-2013	2348	223.750	08/09/2012	0.000	River Dry	01/06/12
2013-2014	2814	225.430	03/08/2013	0.000	214.300	17/12/13

3.3.2 Annual Maximum flood peak

Year	Highest Flood Level (m)	Date	Hour
1972	224.895	19/08/1972	14:00:00
1973	220.990	13/08/1973	06:00:00
1974	220.990	13/08/1974	06:00:00
1975	222.990	05/09/1975	07:00:00
1976	223.040	04/09/1976	01:00:00
1977	221.250	28/06/1977	20:00:00
1978	225.330	31/08/1978	04:00:00
1979	230.670	11/08/1979	03:00:00
1980	222.200	17/08/1980	15:00:00
1981	224.950	11/08/1981	01:00:00
1982	220.600	20/07/1982	22:00:00
1983	229.870	12/08/1983	09:00:00
1984	220.710	10/10/1984	10:00:00
1985	223.750	27/06/1985	14:00:00
1986	225.200	07/08/1986	00:00:00
1987	219.860	21/08/1987	09:00:00
1988	228.850	04/10/1988	12:00:00
1989	223.340	21/07/1989	21:00:00
1990	228.100	25/07/1990	19:00:00
1991	221.540	01/08/1991	07:00:00
1992	222.655	22/08/1992	19:00:00
1993	223.920	16/07/1993	06:00:00
1994	225.600	08/09/1994	12:00:00
1995	221.520	03/09/1995	09:00:00
1996	219.820	08/09/1996	21:00:00
1997	221.350	01/12/1997	08:00:00
1998	224.730	17/09/1998	11:00:00
1999	224.390	11/08/1999	13:00:00
2000	221.130	20/07/2000	21:00:00
2001	222.530	15/06/2001	10:00:00
2002	226.060	26/08/2002	04:00:00
2003	218.320	09/08/2003	03:00:00
2004	218.120	06/08/2004	14:00:00
2005	225.600	02/08/2005	20:00:00
2006	233.700	07/08/2006	12:00:00
2007	226.930	09/07/2007	23:00:00
2008	218.670	22/09/2008	09:00:00
2009	217.700	04/09/2009	02:00:00
2010	224.000	31/07/2010	22:00:00
2011	220.600	13/07/2011	15:00:00
2012	224.070	07/09/2012	22:00:00
2013	225.440	03/08/2013	12:00:00

3.3.3 Summary of Data

Stage Discharge data for the period 2013 - 2014

Station Name: Purna at Yerli (01 02 17 005) Division: Tapi Division, Surat Local River: Sub Division: Upper Tapi, Bhusawal

Day	Jun		Jul		Aug		Sep		Oct		Nov	
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q
1	River Dry		214.740	16.39	218.050	610.7	215.750	163.9 *	215.560	162.8	214.980	66.78
2			214.670	11.63	224.770	2743	215.540	160.8	215.550	131.4 *	214.970	62.67
3			214.660	10.99	225.430	2814	215.470	144.3	215.355	128.2	214.960	48.53 *
4			215.325	67.42	221.950	1737 *	215.300	104.5	215.900	227.8	214.930	59.93
5			217.350	491.5	217.700	537.4	215.330	106.0	220.825	1387	214.920	57.54
6			216.010	209.4	217.030	440.4	215.180	99.14	219.500	1015 *	214.910	56.68
7			215.500	123.6 *	217.050	454.7	215.250	107.6	216.590	255.4	214.900	51.45
8			215.270	64.12	216.350	260.7	215.040	58.43 *	216.040	274.9	214.880	25.61
9			215.020	52.37	216.300	262.2 *	214.960	48.53 *	216.050	282.1	214.850	24.84
10			214.880	27.60	216.390	270.7	214.930	67.07	216.075	301.3	214.840	34.67 *
11			214.800	26.25	216.200	243.4 *	215.050	87.85	218.900	885.3	214.810	24.05
12			214.790	25.05	216.245	260.4	215.090	105.4	217.200	405.4	214.770	13.98
13			214.955	54.83	215.835	231.5	215.125	111.3	217.000	403.3 *	214.750	13.43
14			215.040	58.43 *	216.650	377.8	215.030	84.29	216.220	275.6	214.740	24.15 *
15	217.650	468.3	215.155	70.18	217.900	606.2 *	215.010	54.66 *	216.000	230.4	214.720	12.91
16	220.810	1360	217.275	520.5	216.135	213.8	215.110	106.4	215.780	168.9 *	214.710	12.33
17	217.440	475.3	216.550	304.5	216.175	256.0	216.660	316.2	215.690	171.1	214.700	20.24 *
18	216.135	218.8	215.830	192.7	215.810	174.0 *	215.670	169.9	215.710	220.0	214.680	11.34
19	216.500	300.1	215.850	193.7	215.460	106.7	215.700	177.2	215.415	108.7	214.660	9.865
20	215.265	76.56	215.800	174.5	215.515	81.36	215.575	165.9	215.430	112.9 *	214.650	8.652

21	214.945	35.86	216.120	228.7 *	215.360	96.29	215.440	139.8	215.300	103.4	214.640	8.412
22	214.650	12.93	216.400	263.2	215.535	111.8	220.150	1196 *	215.100	86.75	214.640	8.376
23	214.690	19.29 *	216.590	326.9	215.715	163.6	222.195	1678	215.080	81.89	214.630	7.762
24	214.680	14.35	220.500	1090	218.675	794.6	218.000	535.0	215.215	125.9	214.610	12.18 *
25	214.660	14.09	218.700	764.5	219.330	969.2 *	216.680	315.0	215.200	98.91	214.580	7.085
26	215.445	94.59	218.200	603.0	217.475	486.7	216.340	291.2	215.330	106.9	214.570	6.768
27	215.900	195.1	218.700	792.5	216.950	395.9	216.050	213.2	215.280	90.82 *	214.560	6.577
28	215.550	99.20	216.700	340.8 *	216.420	285.2 *	215.880	194.9	215.180	93.02	214.550	6.392
29	215.200	62.44	216.400	263.5	216.550	304.1	215.720	158.9 *	215.000	70.29	214.540	6.248
30	214.900	41.45 *	216.075	216.0	215.980	205.0	215.660	170.9	215.000	67.45	214.530	5.969
31			216.135	230.1	215.900	197.8			214.980	64.92		
Ten-Daily Mean												
I Ten-Daily			215.342	107.5	219.102	1013	215.275	106.0	216.745	416.7	214.914	48.87
II Ten-Daily	217.300	483.1	215.604	162.1	216.193	255.1	215.402	137.9	216.335	298.1	214.719	15.09
III Ten-Daily	215.062	58.93	217.320	465.4	216.717	364.6	217.212	489.3	215.151	90.03	214.585	7.577
Monthly												
Min.	214.650	12.93	214.660	10.99	215.360	81.36	214.930	48.53	214.980	64.92	214.530	5.969
Max.	220.810	1360	220.500	1090	225.430	2814	222.195	1678	220.825	1387	214.980	66.78
Mean	215.901	218.0	216.129	252.1	217.317	538.5	215.963	244.4	216.047	262.5	214.739	23.85

Annual Runoff in MCM = 3822 Annual Runoff in mm = 231

Peak Observed Discharge = 2814 cumecs on 03/08/2013 Corres. Water Level :225.43 m

Lowest Observed Discharge = 0.000 cumecs on 17/12/2013 Corres. Water Level :214.30 m

Note: River Dry from 01/06/2013 to 14/06/13, river in pooling condition from 17-12-2013 to 31/05/2014.

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge

#Discarded and estimated

Stage Discharge data for the period 2013 - 2014

Station Name: Purna at Yerli (01 02 17 005) Division: Tapi Division, Surat Local River: Sub Division: Upper Tapi, Bhusawal

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	214.530	6.061 *	214.250	0.000	214.165	0.000	214.160	0.000	214.330	0.000	214.110	0.000
2	214.520	5.754	214.250	0.000	214.165	0.000	214.170	0.000	214.320	0.000	214.110	0.000
3	214.510	4.432	214.250	0.000	214.165	0.000	214.180	0.000	214.320	0.000	214.110	0.000
4	214.500	4.764	214.250	0.000	214.165	0.000	214.190	0.000	214.310	0.000	214.110	0.000
5	214.490	4.396	214.240	0.000	214.165	0.000	214.200	0.000	214.310	0.000	214.100	0.000
6	214.480	4.152	214.240	0.000	214.165	0.000	214.600	0.000	214.310	0.000	214.100	0.000
7	214.470	3.940	214.220	0.000	214.165	0.000	214.600	0.000	214.300	0.000	214.100	0.000
8	214.450	1.351 *	214.200	0.000	214.165	0.000	214.560	0.000	214.300	0.000	214.100	0.000
9	214.430	2.742	214.180	0.000	214.165	0.000	214.560	0.000	214.300	0.000	214.100	0.000
10	214.420	2.624	214.180	0.000	214.160	0.000	214.550	0.000	214.300	0.000	214.100	0.000
11	214.385	2.696	214.180	0.000	214.160	0.000	214.550	0.000	214.300	0.000	214.100	0.000
12	214.370	2.492	214.180	0.000	214.160	0.000	214.600	0.000	214.280	0.000	214.100	0.000
13	214.360	2.381	214.180	0.000	214.160	0.000	214.600	0.000	214.260	0.000	214.100	0.000
14	214.350	2.303	214.180	0.000	214.160	0.000	214.600	0.000	214.250	0.000	214.100	0.000
15	214.350	0.000 *	214.180	0.000	214.160	0.000	214.580	0.000	214.240	0.000	214.100	0.000
16	214.340	2.143	214.180	0.000	214.160	0.000	214.570	0.000	214.220	0.000	214.100	0.000
17	214.300	0.000	214.180	0.000	214.160	0.000	214.560	0.000	214.200	0.000	214.100	0.000
18	214.290	0.000	214.180	0.000	214.160	0.000	214.550	0.000	214.170	0.000	214.100	0.000
19	214.280	0.000	214.180	0.000	214.160	0.000	214.550	0.000	214.130	0.000	214.100	0.000
20	214.280	0.000	214.180	0.000	214.160	0.000	214.530	0.000	214.130	0.000	214.100	0.000
21	214.280	0.000	214.170	0.000	214.160	0.000	214.520	0.000	214.120	0.000	214.100	0.000

22	214.270	0.000	214.170	0.000	214.160	0.000	214.500	0.000	214.120	0.000	214.100	0.000
23	214.270	0.000	214.170	0.000	214.160	0.000	214.480	0.000	214.120	0.000	214.100	0.000
24	214.270	0.000	214.170	0.000	214.160	0.000	214.460	0.000	214.120	0.000	214.100	0.000
25	214.270	0.000	214.170	0.000	214.160	0.000	214.440	0.000	214.120	0.000	214.100	0.000
26	214.260	0.000	214.170	0.000	214.160	0.000	214.420	0.000	214.120	0.000	214.100	0.000
27	214.260	0.000	214.170	0.000	214.160	0.000	214.400	0.000	214.120	0.000	214.090	0.000
28	214.260	0.000	214.170	0.000	214.160	0.000	214.380	0.000	214.110	0.000	214.080	0.000
29	214.260	0.000	214.170	0.000			214.360	0.000	214.110	0.000	214.080	0.000
30	214.250	0.000	214.165	0.000			214.350	0.000	214.110	0.000	214.080	0.000
31	214.250	0.000	214.165	0.000			214.340	0.000			214.080	0.000
Ten-Daily Mean												
I Ten-Daily	214.480	4.022	214.226	0.000	214.165	0.000	214.377	0.000	214.310	0.000	214.104	0.000
II Ten-Daily	214.330	1.201	214.180	0.000	214.160	0.000	214.569	0.000	214.218	0.000	214.100	0.000
III Ten-Daily	214.264	0.000	214.169	0.000	214.160	0.000	214.423	0.000	214.117	0.000	214.092	0.000
Monthly												
Min.	214.250	0.000	214.165	0.000	214.160	0.000	214.160	0.000	214.110	0.000	214.080	0.000
Max.	214.530	6.061	214.250	0.000	214.165	0.000	214.600	0.000	214.330	0.000	214.110	0.000
Mean	214.355	1.685	214.191	0.000	214.162	0.000	214.455	0.000	214.215	0.000	214.098	0.000

Peak Computed Discharge = 1737 cumecs on 04/08/2013 Corres. Water Level :221.95 m

Lowest Computed Discharge = 0.000 cumecs on 15/12/2013 Corres. Water Level :214.35 m

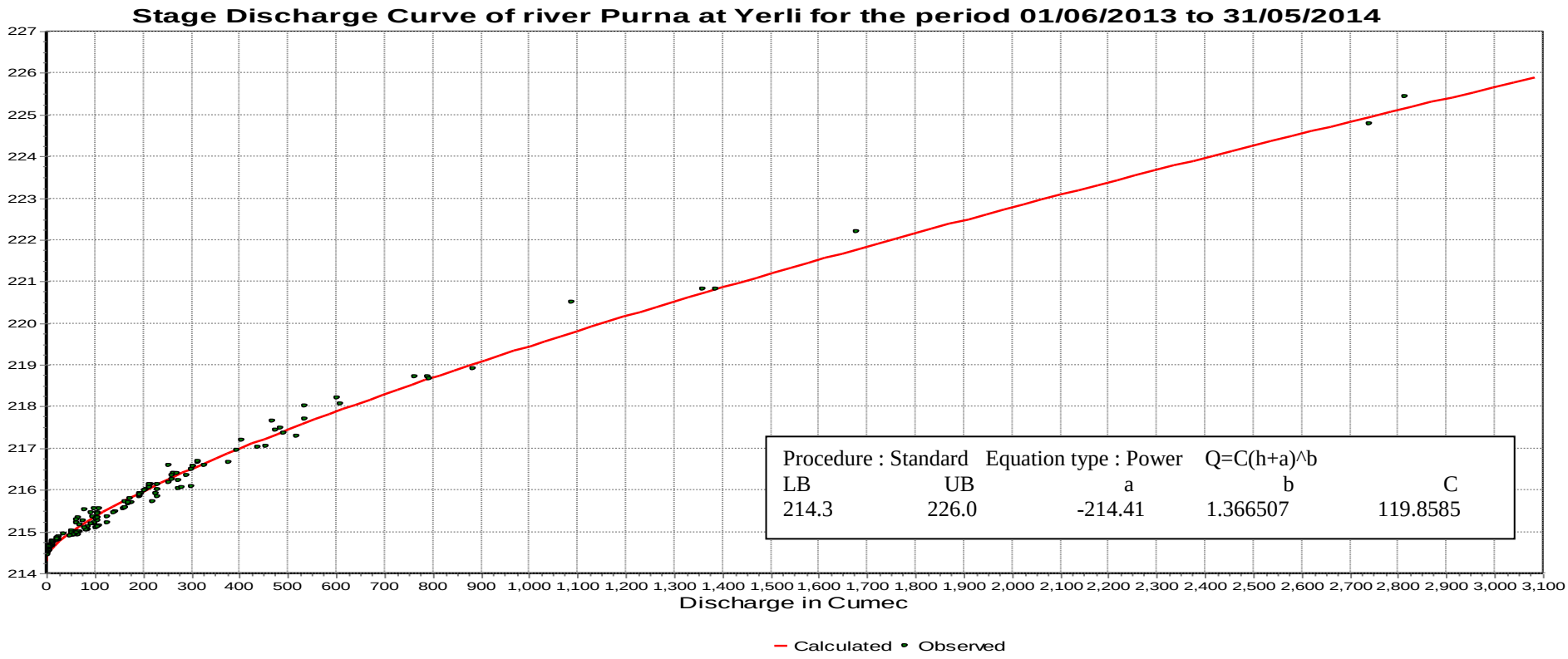
Note: River Dry from 01/06/2013 to 14/06/13, river in pooling condition from 17-12-2013 to 31/05/2014.

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge

#Discarded and estimated

3.3.4 Stage Discharge Curve

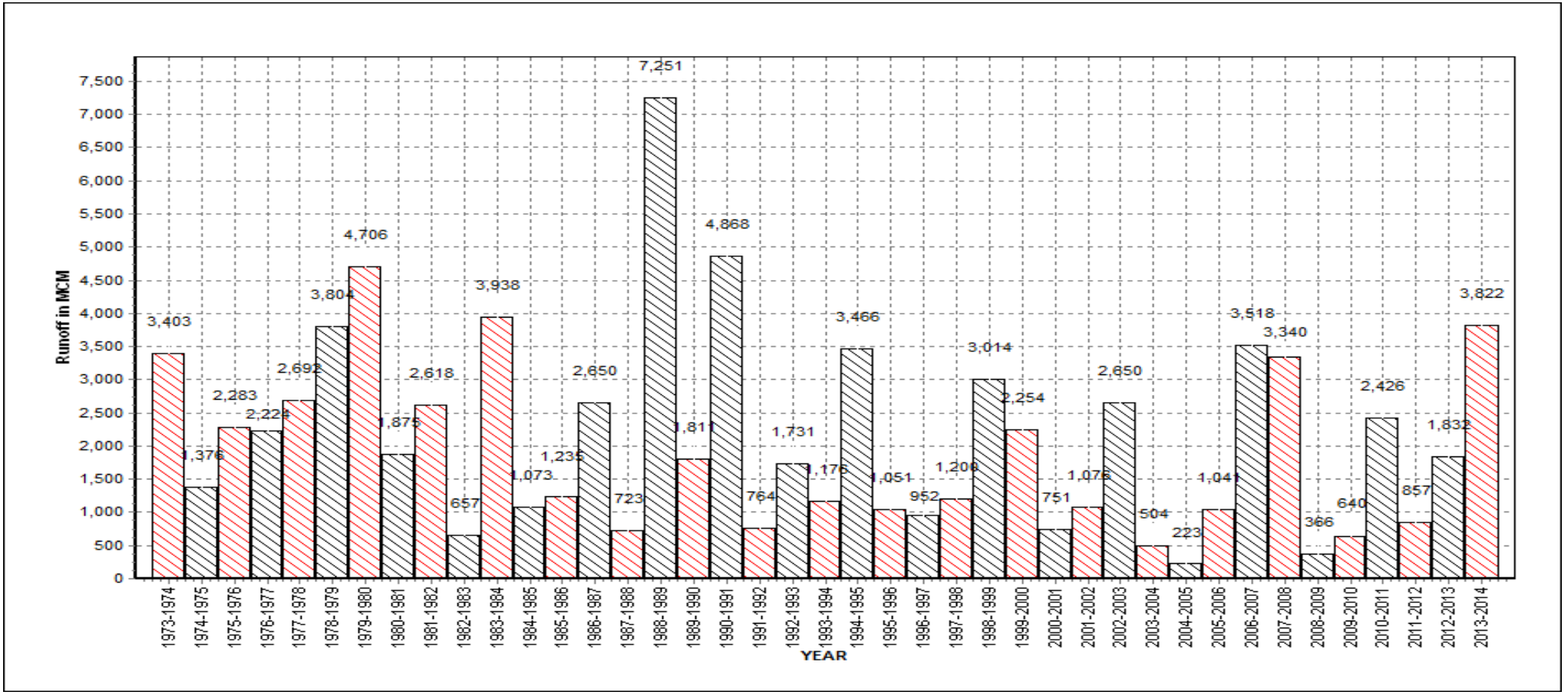
Station Name: Purna at Yerli (01 02 17 005) Division: Tapi Division, Surat Local River:Purna Sub Division: Upper Tapi, Bhusawal



3.3.5 Annual runoff

Annual Runoff for the period 1973-2014

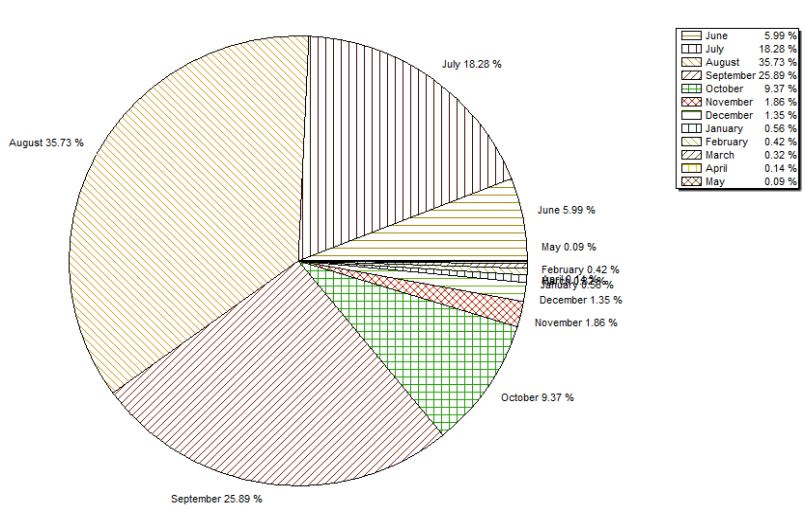
Station Name: Purna at Yerli (01 02 17 005) Division: Tapi Division, Surat Local River:Purna Sub Division: Upper Tapi, Bhusawal



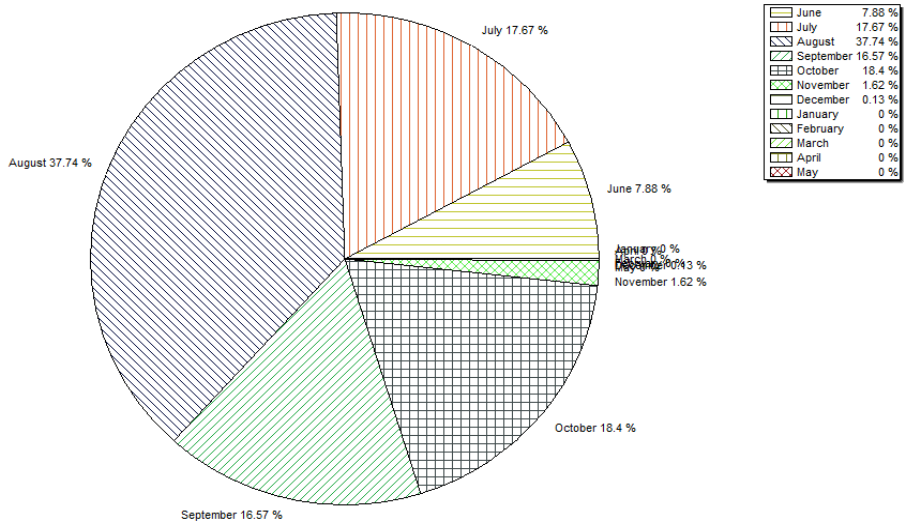
3.3.6 Monthly average Runoff

Station Name: Purna at Yerli (01 02 17 005) Division: Tapi Division, Surat Local River:Purna Sub Division: Upper Tapi, Bhusawal

Monthly Average Runoff Based on period 1973-2014

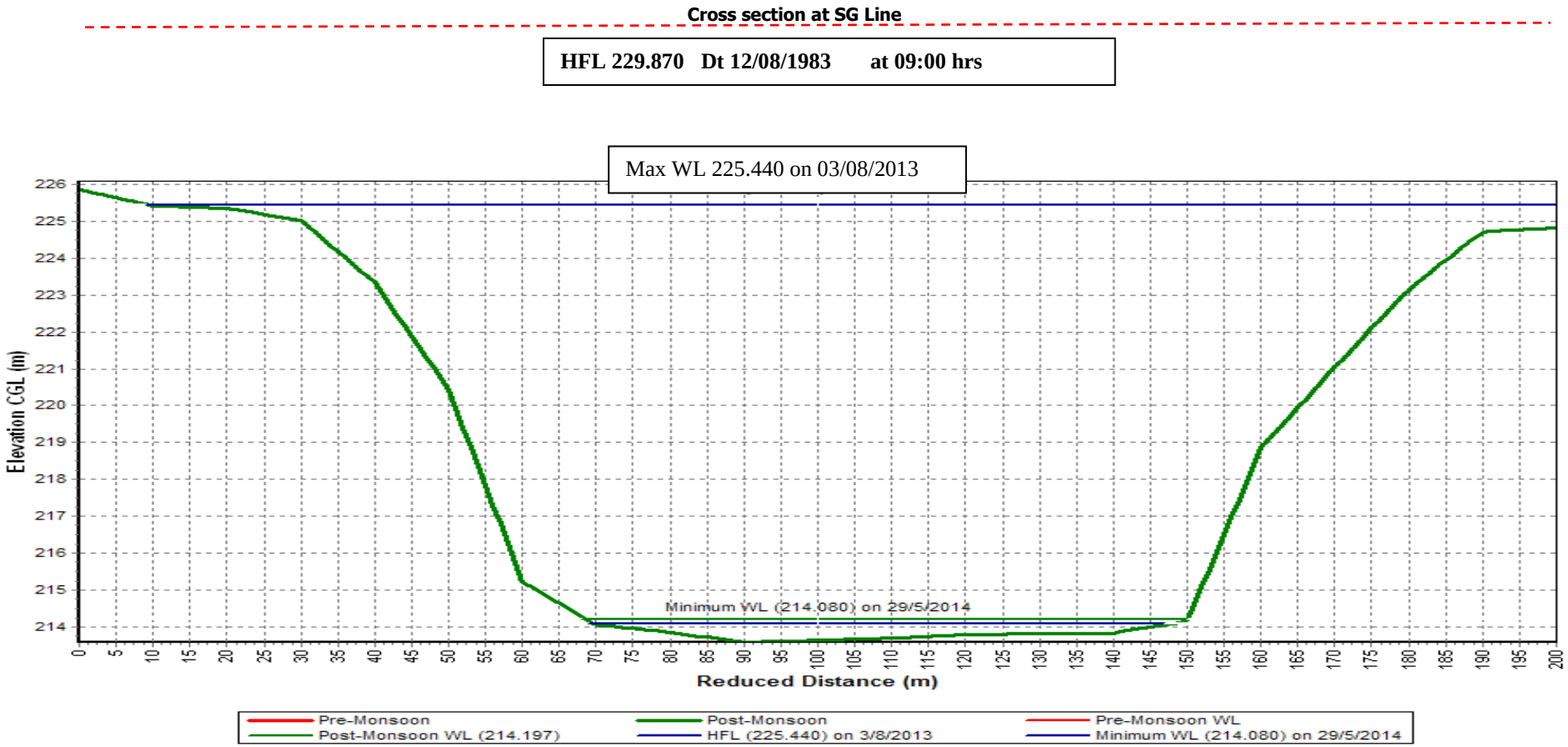


Monthly Runoff Based on period 2013-2014



3.3.7 Superimposed cross section

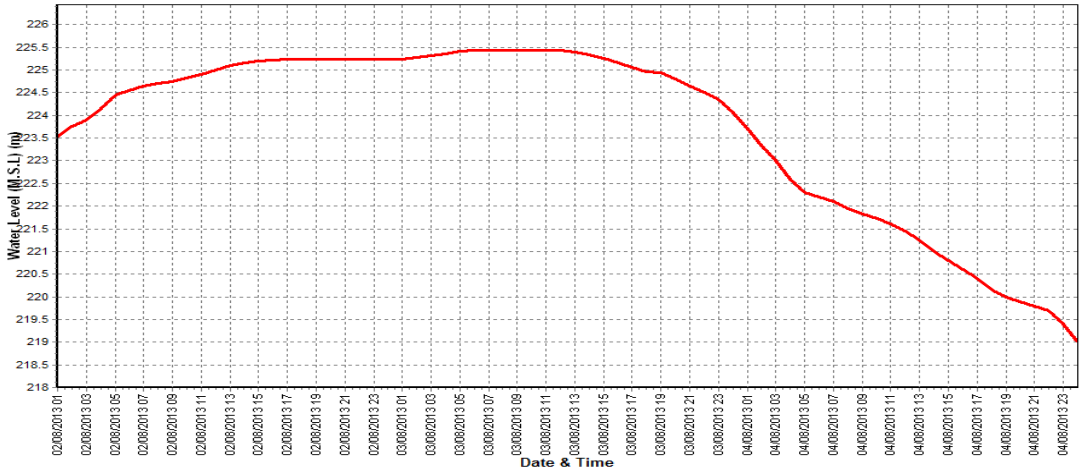
Station Name: Purna at Yerli (01 02 17 005) Division: Tapi Division, Surat Local River:Purna Sub Division: Upper Tapi, Bhusawal



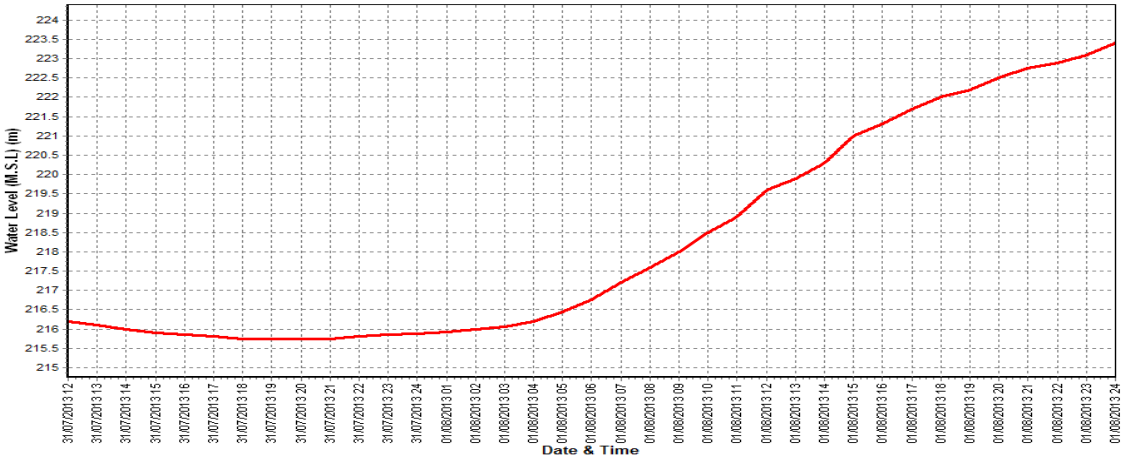
3.3. WL vs Time graph of highest I, II, III peak

Station Name: Purna at Yerli (01 02 17 005) Division: Tapi Division, Surat
Local River: Purna Sub Division: Upper Tapi, Bhusawal

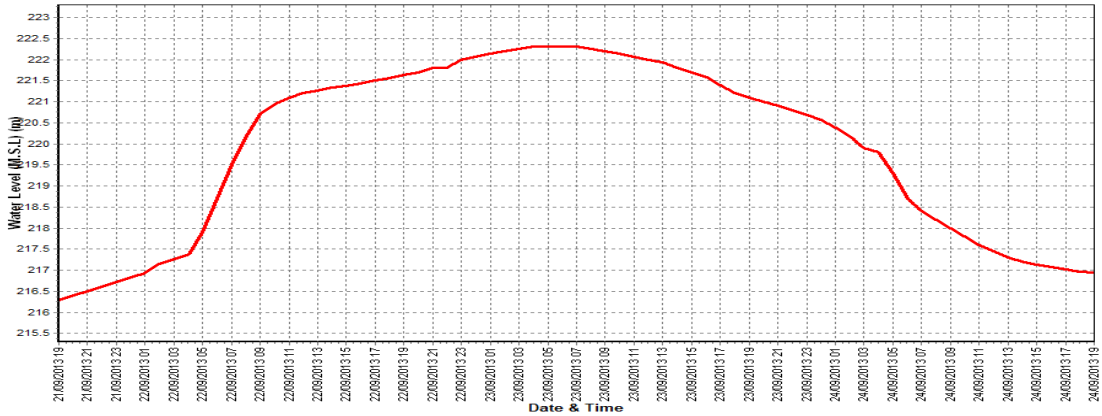
Water level vs Time Graph of Highest (I) flood peak during the water year 2013-14



Water level vs Time Graph of Highest (II) flood peak during the water year 2013-14



Water level vs Time Graph of Highest (III) flood peak during the water year 2013-14



3.4. Gidhade

3.4.1 History Sheet

Site	:	Gidhade	Code	:	01 02 17 014
State	:	Maharashtra	District		Dhule
Basin	:	Tapi	Independent River	:	Tapi
Tributary	:	-	Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	Tapi
Division	:	Tapi Division Surat	Sub-Division	:	Middle Tapi Dhule
Drainage Area	:	54750 sq km	Bank	:	Right
Latitude	:	21°17'45"	Longitude	:	74°48'45"
Zero of Gauge (m)	:	119 (msl)	15/06/1969		
		Opening Date	Closing Date		
Gauge	:	15/06/1969			
Discharge	:	19/06/1990			
Sediment	:				
Water Quality	:	01/09/1990	31/05/2005		

Annual Maximum / Minimum discharge with corresponding Water Level (msl)

	Maximum			Minimum		
Year	**Q (cumec)**	**WL (m)**	**Date**	**Q (cumec)**	**WL (m)**	**Date**
1991-1992	7680	131.300	01/08/1991	0.000	122.100	01/04/1992
1992-1993	4224	129.175	18/08/1992	0.000	River Dry	15/03/1993
1993-1994	8018	132.250	17/07/1993	0.000	River Dry	26/03/1994
1994-1995	15068	136.775	07/09/1994	0.000	River Dry	12/06/1994
1995-1996	4981	130.705	04/09/1995	0.000	River Dry	06/02/1996
1996-1997	2681	127.880	28/07/1996	0.000	River Dry	08/8/1997
1997-1998	4516	130.825	27/07/1997	0.000	River Dry	24/03/1998
1998-1999	17578	137.805	16/09/1998	0.000	River Dry	15/04/1999
1999-2000	6267	131.050	11/08/1999	0.000	River Dry	02/04/2000
2000-2001	2541	126.925	20/07/2000	0.000	River Dry	30/04/2001
2001-2002	5063	130.250	16/08/2001	0.000	River Dry	29/01/2002
2002-2003	7361	132.900	03/09/2002	0.000	River Dry	27/12/2002
2003-2004	4180	129.150	25/08/2003	0.000	River Dry	26/03/2004
2004-2005	3218	129.225	06/08/2004	0.000	River Dry	14/12/2004
2005-2006	3697	128.700	03/08/2005	0.000	River Dry	02/12/2005
2006-2007	20898	141.650	08/08/2006	0.000	River Dry	03/01/2007
2007-2008	10684	135.690	09/07/2007	0.000	121.560	25/06/2007
2008-2009	3670	128.900	06/08/2008	33.270	122.340	26/08/2008
2009-2010	5735	131.190	04/09/2009	0.000	123.350	13/08/2009
2010-2011	4134	129.200	10/09/2010	32.16	122.335	22/07/2010
2011-2012	3639	128.475	30/08/2011	0.000	Pooling effect	NA
2012-2013	8117	133.350	07/09/2012	0.000	129.100	01/06/12
2013-2014	8875	134.425	02/08/2013	0.573	122.700	16/09/13

3.4.2 Annual Maximum flood peak

Station Name: Tapi at Gidhade (01 02 17 014) Division: Tapi division Surat
Local River:Tapi Sub Division: Middle Tapi Sub Division Dhule

Year	Highest Flood Level (m)	Date	Hour
1970	134.650	20/08/1970	11:00:00
1971	128.200	24/07/1971	22:00:00
1972	135.650	19/08/1972	10:00:00
1973	134.300	28/08/1973	02:00:00
1974	128.750	13/08/1974	21:00:00
1975	130.950	05/09/1975	23:00:00
1976	130.300	04/09/1976	23:00:00
1977	129.275	03/09/1977	21:00:00
1978	138.075	30/08/1978	17:00:00
1979	137.650	11/08/1979	07:00:00
1980	130.860	07/08/1980	09:00:00
1981	134.000	11/08/1981	04:00:00
1982	127.140	20/06/1982	19:00:00
1983	131.020	13/08/1983	13:00:00
1984	133.000	19/08/1984	22:00:00
1985	126.650	03/08/1985	16:00:00
1986	130.450	16/08/1986	09:00:00
1987	126.300	22/08/1987	06:00:00
1988	131.740	04/10/1988	05:00:00
1989	131.640	20/08/1989	03:00:00
1990	135.240	17/08/1990	14:00:00
1991	133.500	01/08/1991	01:00:00
1992	129.580	03/09/1992	19:00:00
1993	132.550	17/07/1993	16:00:00
1994	138.820	07/09/1994	23:00:00
1995	131.150	03/09/1995	23:00:00
1996	128.450	28/07/1996	03:00:00
1997	131.850	27/07/1997	04:00:00
1998	137.890	16/09/1998	12:00:00
1999	132.060	11/08/1999	02:00:00
2000	128.620	13/07/2000	18:00:00
2001	131.510	16/08/2001	16:00:00
2002	133.550	26/08/2002	00:00:00
2003	131.900	24/08/2003	21:00:00
2004	129.450	24/08/2004	03:00:00
2005	129.250	02/08/2005	19:00:00
2006	142.950	07/08/2006	15:00:00
2007	136.240	09/07/2007	16:00:00
2008	131.590	16/10/2008	00:00:00
2009	132.760	03/10/2009	09:00:00
2010	130.000	10/09/2010	10:00:00
2011	132.680	08/10/2011	18:00:00
2012	135.600	06/09/2012	22:00:00
2013	135.400	02/08/2013	15:00:00

3.4.3 Summary of Data

Stage Discharge data for the period 2013 - 2014

Station Name: Tapi at Gidhade (01 02 17 014) Division: Tapi Division Surat Local River:Tapi Sub Division: Middle Tapi Sub Division Dhule

Day	Jun		Jul		Aug		Sep		Oct		Nov	
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q
1	128.800	0.000	123.200	232.7	124.750	879.5	123.950	487.3 *	123.760	488.5	127.500	0.000
2	128.780	0.000	122.900	163.2	134.425	8875	124.175	637.0	123.740	408.8 *	128.450	0.000
3	128.780	0.000	123.100	181.5	132.200	6722 #	123.750	516.1	123.740	486.6	129.400	0.000
4	128.780	0.000	122.900	162.8	129.250	4358	123.530	396.0	123.510	424.4	130.350	0.000
5	128.760	0.000	123.350	244.0	127.400	2737	123.350	335.0	124.060	468.5	131.300	0.000
6	128.760	0.000	125.300	999.5	125.500	1339	123.250	305.0	125.150	1031 *	132.000	0.000
7	128.760	0.000	124.300	629.6 *	124.850	927.2	123.190	188.4	124.940	926.5	132.400	0.000
8	128.760	0.000	123.700	393.6	124.700	888.1	123.190	229.5 *	123.800	339.8	132.300	0.000
9	128.760	0.000	123.550	304.6	124.420	681.6 *	123.180	226.6 *	123.560	406.8	132.400	0.000
10	128.960	0.000	123.350	276.0	124.200	611.2	123.180	192.9	123.600	358.3	132.600	0.000
11	128.740	0.000	123.300	274.7	124.850	880.5 *	122.950	170.7	123.900	356.9	132.900	0.000
12	128.720	0.000	123.240	254.4	124.550	702.0	123.750	522.9	125.250	974.5	132.900	0.000
13	128.720	0.000	123.400	288.1	124.340	625.8	123.000	171.7	126.100	1564 *	132.800	0.000
14	128.700	0.000	125.600	1193	126.350	1779	122.900	171.3	125.200	962.9	132.650	0.000
15	128.700	0.000	124.740	771.2	125.450	1190 *	122.700	105.5 *	123.800	542.4	132.780	0.000
16	125.000	0.000	124.860	811.5	125.125	878.4	122.700	105.5 #	123.400	293.2 *	132.780	0.000
17	125.850	1385	125.800	1280	124.350	639.6	125.200	1067	123.200	195.9	132.780	0.000
18	125.050	820.5	125.050	824.9	124.200	587.5 *	125.175	1073	123.325	314.8	132.800	0.000
19	123.700	406.0	125.000	808.8	123.850	411.3	124.350	659.7	123.400	315.7	132.800	0.000
20	123.500	291.8	125.425	1024	124.000	439.0	124.050	466.2	123.350	277.5 *	132.800	0.000

21	123.400	244.6	126.225	1546	124.000	437.8	123.750	511.1	123.300	318.4	132.800	0.000
22	123.200	233.1	125.500	1180	125.050	913.2	128.900	3588 *	123.000	171.2	132.750	0.000
23	122.900	151.7 *	125.000	814.7	126.300	1778	130.100	4934	123.400	0.000	132.650	0.000
24	122.600	65.29	126.200	1488	131.800	6303 #	126.725	2040	124.600	0.000	132.750	0.000
25	122.500	58.54	128.000	2869 #	129.525	4546	125.450	1124	124.300	0.000	132.800	0.000
26	122.450	56.74	126.700	2018	127.400	2954	124.470	776.8	123.650	0.000	132.850	0.000
27	122.400	55.89	126.090	1654	126.150	1638	124.320	602.2	125.800	0.000	132.850	0.000
28	123.900	446.0	126.400	1715	125.850	1729	124.200	555.3	126.500	0.000	132.800	0.000
29	123.900	447.6	125.380	1052	124.900	927.4	123.860	453.0 *	126.800	0.000	132.750	0.000
30	123.450	309.3 *	125.000	858.1	125.050	904.1	123.740	545.9	126.850	0.000	132.700	0.000
31			124.700	874.8	124.450	776.4			126.950	0.000		
Ten-Daily Mean												
I Ten-Daily	128.790	0.000	123.565	358.8	127.169	2802	123.475	351.4	123.986	533.9	130.870	0.000
II Ten-Daily	126.668	290.3	124.642	753.1	124.706	813.3	123.678	451.3	124.093	579.8	132.799	0.000
III Ten-Daily	123.070	206.9	125.918	1461	126.407	2082	125.551	1513	125.014	44.51	132.770	0.000
Monthly												
Min.	122.400	0.000	122.900	162.8	123.850	411.3	122.700	105.5	123.000	0.000	127.500	0.000
Max.	128.960	1385	127.900	2869	134.425	8875	130.100	4934	126.950	1564	132.900	0.000
Mean	126.176	165.7	124.747	0.877	126.104	1905	124.235	771.9	124.385	0.375	132.146	0.000

Annual Runoff in MCM = 10886 Annual Runoff in mm = 199

Peak Observed Discharge = 88757 cumecs on 02/08/2013 Corres. Water Level :134.425 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2013 Corres. Water Level :128.800 m

Note: River remained in pooling condition from 01/06 to 16/06/13 and from 23/10/13 to 31/05/2013 No release or negligible release during this period from existing barrage in D/S of site .

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge
#Discarded and estimated

Stage Discharge data for the period 2013 - 2014

Station Name: Tapi at Gidhade (01 02 17 014) Division: Tapi Division Surat Local River: Tapi Sub Division: Middle Tapi Sub Division Dhule

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	132.750	0.000	132.600	0.000	132.160	0.000	131.650	0.000	131.000	0.000	130.500	0.000
2	132.750	0.000	132.580	0.000	132.120	0.000	131.650	0.000	131.000	0.000	130.450	0.000
3	132.800	0.000	132.560	0.000	132.120	0.000	131.650	0.000	131.000	0.000	130.450	0.000
4	132.800	0.000	132.560	0.000	132.100	0.000	131.630	0.000	130.950	0.000	130.400	0.000
5	132.850	0.000	132.560	0.000	132.050	0.000	131.610	0.000	130.950	0.000	130.400	0.000
6	132.850	0.000	132.520	0.000	132.050	0.000	131.610	0.000	130.950	0.000	130.400	0.000
7	132.870	0.000	132.500	0.000	132.050	0.000	131.560	0.000	130.900	0.000	130.400	0.000
8	132.870	0.000	132.480	0.000	132.050	0.000	131.500	0.000	130.900	0.000	130.380	0.000
9	132.870	0.000	132.480	0.000	132.050	0.000	131.500	0.000	130.900	0.000	130.380	0.000
10	132.870	0.000	132.450	0.000	132.000	0.000	131.450	0.000	130.880	0.000	130.350	0.000
11	132.850	0.000	132.420	0.000	131.950	0.000	131.400	0.000	130.880	0.000	130.350	0.000
12	132.850	0.000	132.420	0.000	131.900	0.000	131.400	0.000	130.850	0.000	130.350	0.000
13	132.820	0.000	132.400	0.000	131.900	0.000	131.380	0.000	130.850	0.000	130.350	0.000
14	132.820	0.000	132.400	0.000	131.900	0.000	131.340	0.000	130.820	0.000	130.300	0.000
15	132.820	0.000	132.400	0.000	131.880	0.000	131.310	0.000	130.800	0.000	130.250	0.000
16	132.820	0.000	132.360	0.000	131.850	0.000	131.300	0.000	130.750	0.000	130.200	0.000
17	132.800	0.000	132.360	0.000	131.850	0.000	131.300	0.000	130.720	0.000	130.200	0.000
18	132.800	0.000	132.360	0.000	131.820	0.000	131.300	0.000	130.700	0.000	130.200	0.000
19	132.780	0.000	132.360	0.000	131.800	0.000	131.300	0.000	130.700	0.000	130.180	0.000
20	132.780	0.000	132.350	0.000	131.800	0.000	131.250	0.000	130.680	0.000	130.180	0.000
21	132.750	0.000	132.300	0.000	131.750	0.000	131.250	0.000	130.680	0.000	130.180	0.000

22	132.750	0.000	132.280	0.000	131.750	0.000	131.200	0.000	130.650	0.000	130.150	0.000
23	132.720	0.000	132.280	0.000	131.700	0.000	131.200	0.000	130.620	0.000	130.100	0.000
24	132.720	0.000	132.250	0.000	131.700	0.000	131.180	0.000	130.580	0.000	130.050	0.000
25	132.700	0.000	132.250	0.000	131.700	0.000	131.150	0.000	130.560	0.000	130.000	0.000
26	132.680	0.000	132.220	0.000	131.680	0.000	131.120	0.000	130.560	0.000	130.000	0.000
27	132.650	0.000	132.200	0.000	131.680	0.000	131.100	0.000	130.540	0.000	130.000	0.000
28	132.650	0.000	132.200	0.000	131.650	0.000	131.080	0.000	130.520	0.000	129.900	0.000
29	132.650	0.000	132.180	0.000			131.080	0.000	130.510	0.000	129.900	0.000
30	132.620	0.000	132.180	0.000			131.050	0.000	130.500	0.000	129.900	0.000
31	132.620	0.000	132.160	0.000			131.000	0.000			129.900	0.000
Ten-Daily Mean												
I Ten-Daily	132.828	0.000	132.529	0.000	132.075	0.000	131.581	0.000	130.943	0.000	130.411	0.000
II Ten-Daily	132.814	0.000	132.383	0.000	131.865	0.000	131.328	0.000	130.775	0.000	130.256	0.000
III Ten-Daily	132.683	0.000	132.227	0.000	131.701	0.000	131.128	0.000	130.572	0.000	130.007	0.000
Monthly												
Min.	132.620	0.000	132.160	0.000	131.650	0.000	131.000	0.000	130.500	0.000	129.900	0.000
Max.	132.870	0.000	132.600	0.000	132.160	0.000	131.650	0.000	131.000	0.000	130.500	0.000
Mean	132.772	0.000	132.375	0.000	131.893	0.000	131.339	0.000	130.763	0.000	130.218	0.000

Peak Computed Discharge = 3588 cumecs on 22/09/2013 Corres. Water Level :128.9 m

Lowest Computed Discharge = 105.5 cumecs on 15/09/2013 Corres. Water Level :122.7 m

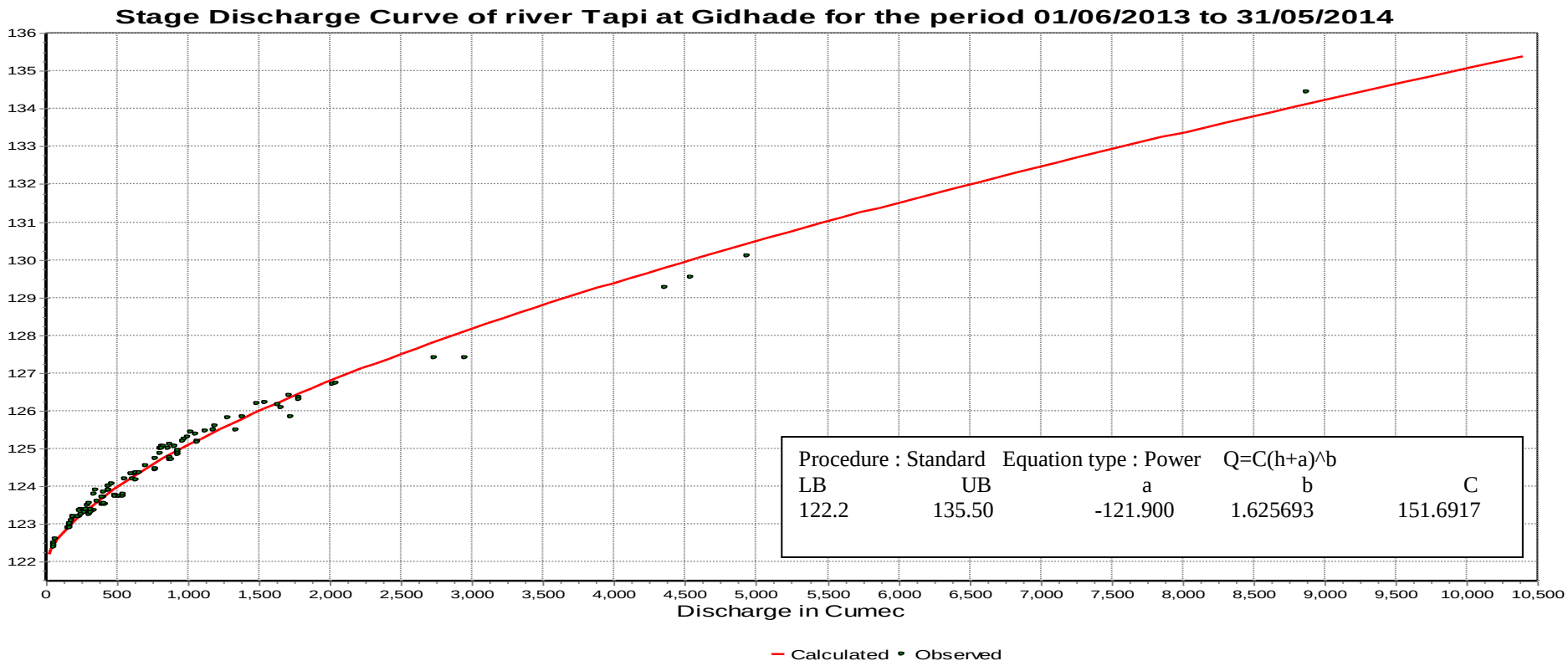
Note: River remained in pooling condition from 01/06 to 16/06/13 and from 23/10/13 to 31/05/2013 No release or negligible release during this period from existing barrage in D/S of site .

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge

#Discarded and estimated

3.4.4 Stage Discharge Curve

Station Name: Tapi at Gidhade (01 02 17 014) Division: Tapi Division Surat Local River:Tapi Sub Division: Middle Tapi Sub Division Dhule



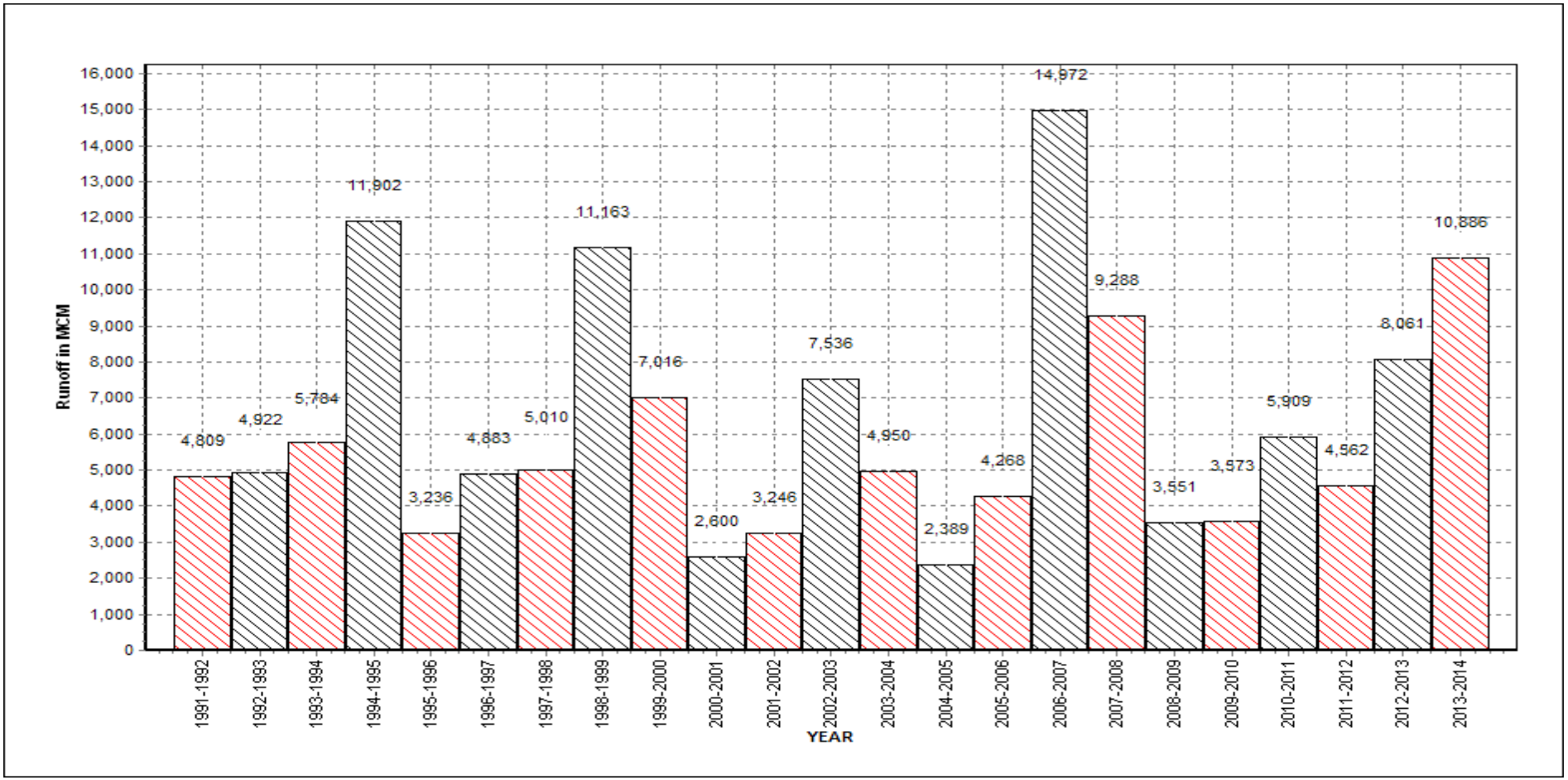
Procedure : Standard Equation type : Power Q=C(h+a)^b

LB	UB	a	b	C
122.2	135.50	-121.900	1.625693	151.6917

3.4.5 Annual Runoff

Annual Runoff for the period 1991 to 2014

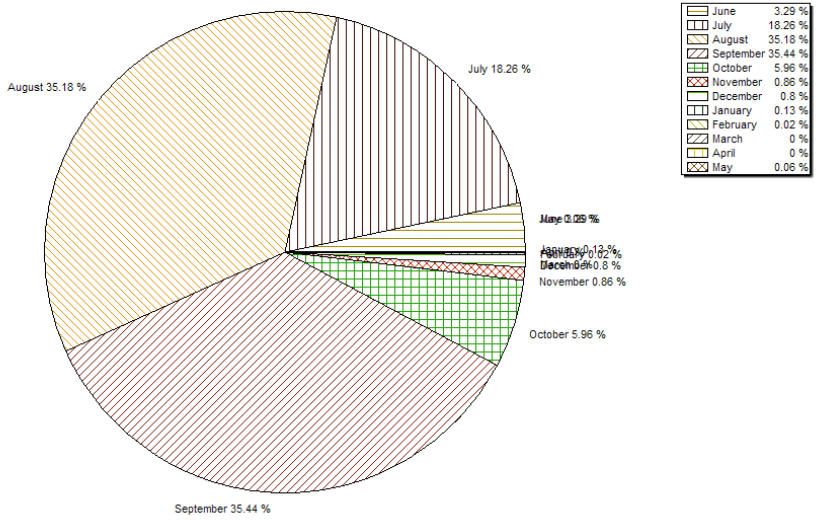
Station Name: Tapi at Gidhade (01 02 17 014) Division: Tapi Division Surat Local River:Tapi Sub Division: Middle Tapi Sub Division Dhule



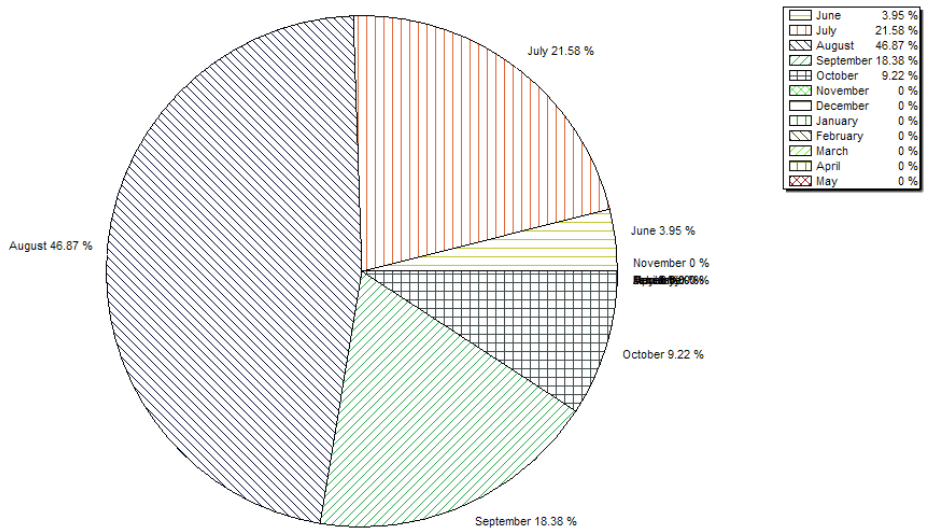
3.4.6 Monthly average Runoff

Station Name: Tapi at Gidhade (01 02 17 014) Division: Tapi Division Surat Local River:Tapi Sub Division: Middle Tapi Sub Division Dhule

Monthly Average Runoff Based on period 1991-2014



Monthly Runoff Based on period 2013-2014

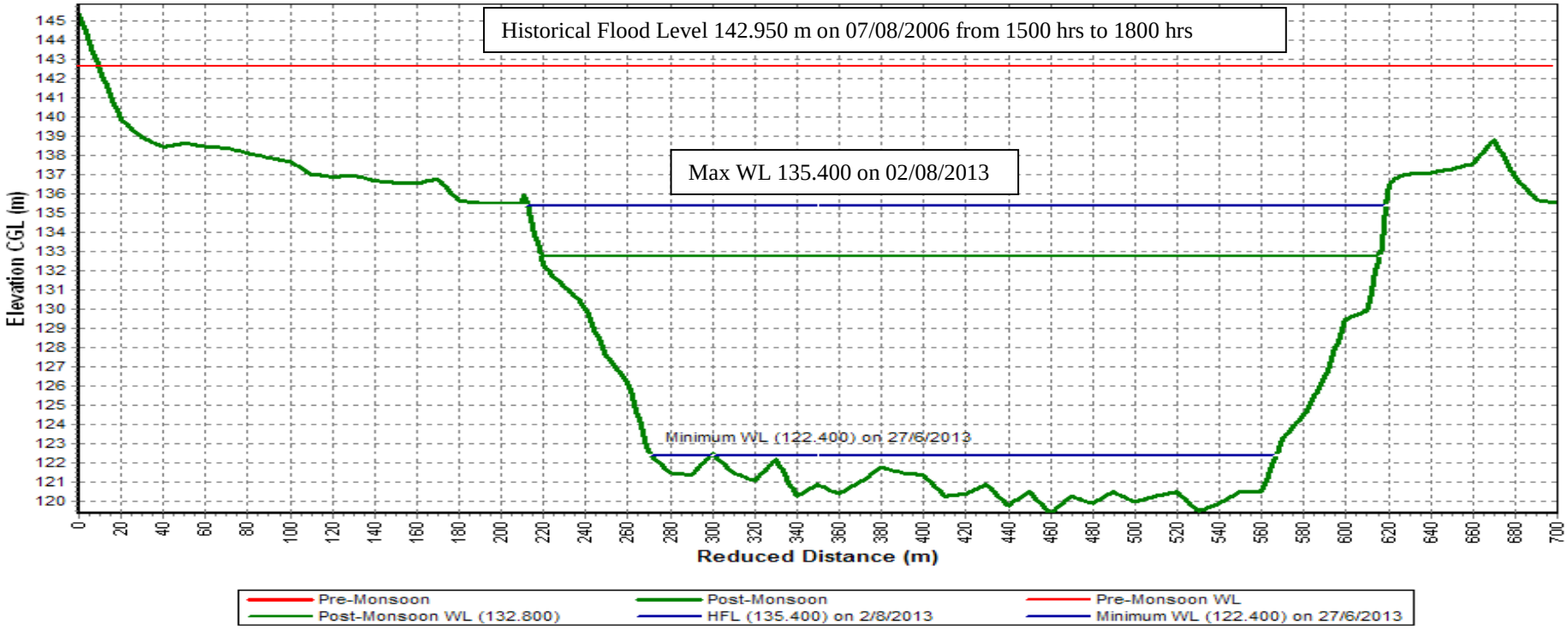


3.4.7 Superimposed cross section

Station Name: Tapi at Gidhade (01 02 17 014) Division: Tapi Division, Surat Local River:Tapi Sub Division: Middle Tapi, Dhule

Cross section at SG Line

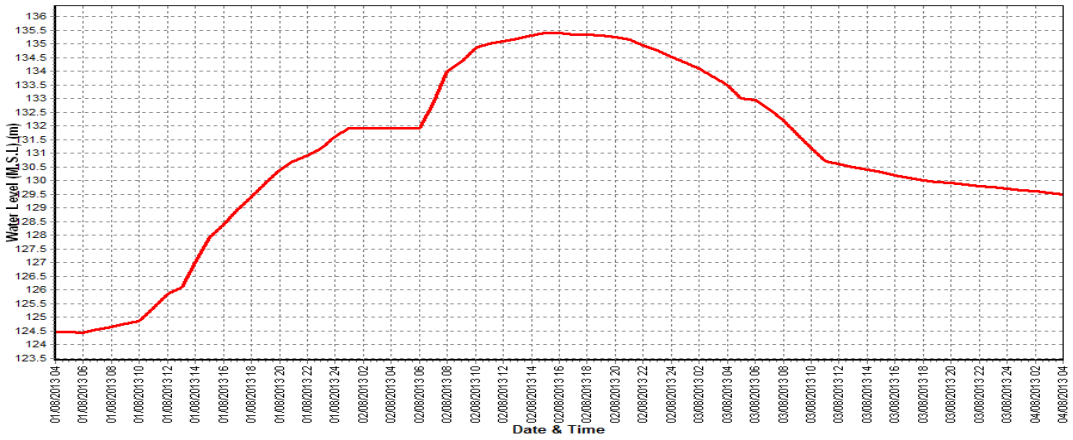
Note:-Pre monsoon cross section at site have not been taken due to submergence of SG line (Due to storage in Sulwada Barrage).



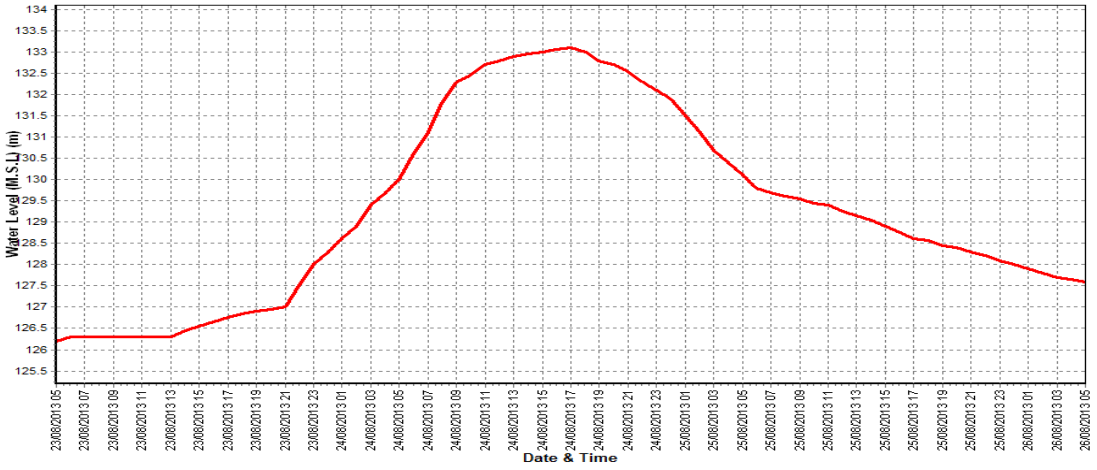
3.4.8 WL vs Time Graph of I,II,III peak

Station Name: Tapi at Gidhade (01 02 17 014) Division: Tapi Division Surat
Local River:Tapi Sub Division: Middle Tapi Sub Division Dhule

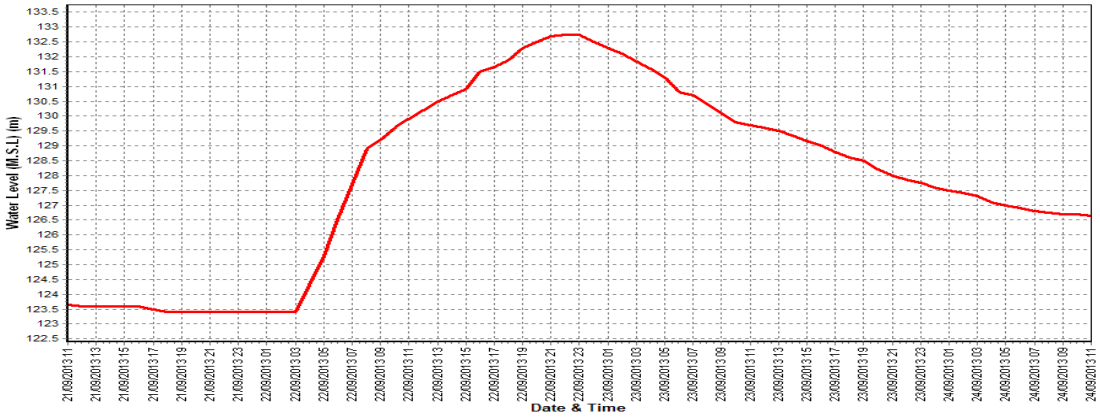
Water level vs Time Graph of Highest (I) flood peak during the water year 2013-14



Water level vs Time Graph of Highest (II) flood peak during the water year 2013-14



Water level vs Time Graph of Highest (III) flood peak during the water year 2013-14



3.5 Sarangkheda

3.5.1 History Sheet

Site	**:**	**SARANGKHEDA**	**Code**	**:**	**01 02 17 015**
State	:	Maharashtra	District		Nandurbar
Basin	:	Tapi	Independent River	:	Tapi
Tributary	:	-	Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	Tapi
Division	:	Tapi Division Surat	Sub-Division	:	Middle Tapi Dhule
Drainage Area	:	58400 sq km	Bank	:	Right
Latitude	:	21°25'55"	Longitude	:	74°31'37"
Zero of Gauge (m)	:	108 (msl)	21/09/1971		
		Opening Date	Closing Date		
Gauge	:	29/07/1976			
Discharge	:	19/10/1977			
Sediment	:	13/07/1984			
Water Quality	:	01/01/1980			

Annual Maximum / Minimum discharge with corresponding Water Level (above msl)

Year	Maximum			Minimum		
	Q (cumec)	**WL (m)**	**Date**	**Q (cumec)**	**WL (m)**	**Date**
1977-1978	600.0	111.610	27/11/1977	0.000	109.400	08/07/1977
1978-1979	13819	121.500	30/08/1978	6.400	109.450	01/06/1978
1979-1980	15000	122.725	11/08/1979	5.000	109.795	03/06/1979
1980-1981	5403	117.010	07/08/1980	5.500	109.730	19/05/1981
1981-1982	11375	119.985	11/08/1981	5.400	109.760	16/06/1981
1982-1983	1714	113.498	21/06/1982	2.500	109.570	22/05/1983
1983-1984	9493	117.135	13/08/1983	2.700	109.570	04/06/1983
1984-1985	13750	118.600	20/08/1984	0.700	109.530	07/10/1984
1985-1986	1820	113.570	04/08/1985	1.400	109.615	24/02/1986
1986-1987	7026	117.395	16/08/1986	0.300	109.480	31/05/1987
1987-1988	1604	113.270	22/08/1987	0.000	109.280	03/05/1988
1988-1989	10521	118.145	04/10/1988	0.000	109.280	11/06/1988
1989-1990	9300	118.055	20/08/1989	0.000	River Dry	24/03/1990
1990-1991	11838	120.060	17/08/1990	0.000	River Dry	23/03/1991
1991-1992	7986	118.485	01/08/1991	0.000	River Dry	29/10/1991
1992-1993	5244	116.000	18/08/1992	0.000	River Dry	10/02/1993
1993-1994	8462	118.060	17/07/1993	0.000	River Dry	05/03/1994
1994-1995	15626	122.575	07/09/1994	0.000	River Dry	01/04/1995
1995-1996	6156	117.530	04/09/1995	0.000	River Dry	26/01/1996
1996-1997	3510	114.810	28/07/1996	0.000	River Dry	29/06/1996
1997-1998	7174	117.970	27/07/1997	0.000	River Dry	24/02/1998
1998-1999	21292	123.030	16/09/1998	0.000	River Dry	22/04/1999
1999-2000	6300	118.100	11/08/1999	0.000	River Dry	05/03/2000
2000-2001	3435	114.900	14/07/2000	0.000	River Dry	01/01/2001
2001-2002	4076	115.800	17/08/2001	0.000	River Dry	23/02/2002
2002-2003	9000	119.000	26/08/2002	0.000	River Dry	13/02/2003
2003-2004	7564	117.400	25/08/2003	0.000	River Dry	30/04/2004
2004-2005	5909	115.970	24/08/2004	0.000	River Dry	24/02/2005
2005-2006	4458	116.050	03/08/2005	0.000	River Dry	30/11/2005
2006-2007	23044	126.000	08/08/2006	0.160	109.330	30/01/2007
2007-2008	11827	121.000	09/07/2007	0.000	109.680	03/01/2008
2008-2009	3406	114.900	06/08/2008	0.000	River Dry	05/09/2008
2009-2010	3942	114.850	24/07/2009	0.000	River Dry	01/06/2009
2010-2011	4876	116.450	10/09/2010	7.400	109.900	22/07/2010
2011-2012	4404	116.100	20/06/2011	123.9	110.650	20/06/2011
2012-2013	10481	120.350	07/09/2012	0.000	110.200	04/07/2012
2013-2014	9027	119.750	02/08/2013	0.000	109.300	01/06/2013

Q: Observed/computed discharge WL: corresponding discharge

3.5.2 Annual Maximum flood peak

Station Name: Tapi at Sarangkheda (01 02 17 015)Division: Tapi division Surat
Local River: Sub Division: Middle Tapi Dhule

Year	Highest Flood Level (m)	Date	Hour
1977	111.910	27/11/1977	18:00:00
1978	123.340	30/08/1978	22:00:00
1979	122.800	11/08/1979	10:00:00
1980	117.420	07/08/1980	16:00:00
1981	120.000	11/08/1981	09:00:00
1982	114.370	21/06/1982	01:00:00
1983	117.370	13/08/1983	17:00:00
1984	119.120	20/08/1984	03:00:00
1985	114.115	28/06/1985	21:00:00
1986	117.830	16/08/1986	13:00:00
1987	113.510	22/08/1987	11:00:00
1988	118.160	04/10/1988	09:00:00
1989	118.340	20/08/1989	06:00:00
1990	120.700	17/08/1990	17:00:00
1991	119.440	01/08/1991	05:00:00
1992	116.200	03/09/1992	22:00:00
1993	118.730	17/07/1993	18:00:00
1994	123.640	08/09/1994	03:00:00
1995	117.800	03/09/1995	23:00:00
1996	115.070	28/07/1996	17:00:00
1997	118.050	27/07/1997	07:00:00
1998	123.640	16/09/1998	18:00:00
1999	118.280	11/08/1999	00:00:00
2000	115.550	13/07/2000	23:00:00
2001	117.700	16/08/2001	22:00:00
2002	119.900	26/08/2002	04:00:00
2003	118.300	25/08/2003	00:00:00
2004	116.350	06/08/2004	15:00:00
2005	116.300	03/08/2005	03:00:00
2006	127.080	08/08/2006	02:00:00
2007	121.800	09/07/2007	19:00:00
2008	115.650	06/08/2008	14:00:00
2009	117.000	06/09/2009	03:00:00
2010	116.800	10/09/2010	05:00:00
2011	116.400	28/08/2011	08:00:00
2012	121.600	07/09/2012	06:00:00
2013	121.400	02/08/2013	24:00:00

3.5.3 Summary of Data

Stage Discharge data for the period 2013 - 2014

Station Name: Tapi at Sarangkheda (01 02 17 015) Division: Tapi Division Surat Local River:Tapi Sub Division: Middle Tapi Dhule

Day	Jun		Jul		Aug		Sep		Oct		Nov	
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q
1	109.300	0.000	110.500	263.5	111.850	821.5	111.400	663.6 *	111.200	599.3	112.250	0.000
2	109.300	0.000	110.275	235.2	119.750	9027	111.500	744.7	111.150	540.1 *	112.250	0.000
3	109.300	0.000	110.400	251.7	118.500	6970	111.200	574.9	111.100	513.8	112.250	0.000
4	109.300	0.000	110.100	173.2	116.000	4275 *	111.000	493.8	111.000	460.8	112.250	0.000
5	109.300	0.000	110.800	431.5	114.700	2814	110.750	379.5	110.950	403.1	112.250	0.000
6	109.300	0.000	112.475	1332	112.950	1499	110.650	299.3	112.600	1376 *	112.250	0.000
7	109.300	0.000	111.750	851.7 *	112.250	1145	110.650	288.9	112.250	1088	112.250	0.000
8	109.300	0.000	111.025	484.4	112.150	1050	110.650	322.6 *	111.250	635.2	112.250	0.000
9	109.300	0.000	110.800	438.3	111.900	937.4 *	110.600	271.0	110.950	434.1	112.250	0.000
10	109.300	0.000	110.550	316.2	111.650	813.7	110.450	234.0	110.950	429.7	112.250	0.000
11	109.300	0.000	110.500	305.8	112.100	1056 *	110.300	196.0	111.250	637.4	112.250	0.000
12	109.300	0.000	110.350	235.8	111.950	1098	111.375	676.4	112.200	1077	112.250	0.000
13	109.300	0.000	110.500	310.1	111.500	760.5	110.500	250.4	113.350	1912 *	112.250	0.000
14	109.300	0.000	110.700	342.5 *	112.400	1253	110.200	86.32	112.550	1381	112.400	0.000
15	109.300	0.000	112.050	1029	113.000	1654 *	110.150	149.6 *	111.350	745.4	112.200	0.000
16	111.200	381.8	112.200	1161	112.450	1317	110.200	85.48	110.950	448.2 *	112.200	0.000
17	113.200	1510	113.000	1774	111.800	994.0	110.500	255.9	110.450	233.0	112.200	0.000
18	112.300	1093	112.375	1231	111.500	715.5 *	112.200	1109	110.450	229.2	112.300	0.000
19	111.250	460.8	112.400	1291	111.200	599.1	111.950	1097	111.350	638.1 #	112.300	0.000
20	110.750	390.5	111.900	981.4	111.200	597.2	111.300	679.9	110.600	0.000	112.300	0.000

21	110.700	347.6	112.250	1149 *	111.200	600.1	111.050	507.1	111.400	0.000	112.400	0.000
22	110.500	282.1	113.000	1591	111.500	751.3	111.050	493.4 *	111.400	0.000	112.400	0.000
23	110.200	164.7 *	112.050	1056	113.200	1734	117.300	5452	111.400	0.000	112.400	0.000
24	109.950	85.55	112.725	1371	117.400	5626	114.300	2410	111.650	0.000	112.400	0.000
25	109.800	67.25	115.000	3216	117.000	5337 *	113.200	1742	112.400	660.7	112.400	0.000
26	109.600	23.72 *	114.000	2429	114.550	2607	112.000	1109	112.200	587.7	112.400	0.000
27	109.600	23.72 *	113.600	2090	113.500	1945	111.800	990.2	112.000	515.0 *	112.400	0.000
28	110.600	374.9	113.600	2105 *	113.450	1988 *	111.700	917.0	112.400	668.6	112.400	0.000
29	111.175	558.4	112.800	1447	112.400	1273	111.250	588.4 *	112.100	0.000	112.400	0.000
30	110.750	362.8 *	112.300	1212	112.400	1272	111.250	585.2	112.100	508.4	112.300	0.000
31			112.050	1052	112.000	1101			112.400	685.4		
Ten-Daily Mean												
I Ten-Daily	109.300	0.000	110.868	477.8	114.170	2935	110.885	427.2	111.340	648.0	112.250	0.000
II Ten-Daily	110.520	383.6	111.597	866.2	111.910	1004	110.868	458.6	111.450	730.1	112.265	0.000
III Ten-Daily	110.287	229.1	113.034	1702	113.509	2203	112.490	1479	111.950	329.6	112.390	0.000
Monthly												
Min.	109.300	0.000	110.100	173.2	111.200	597.2	110.150	85.48	110.450	0.000	112.200	0.000
Max.	113.200	1510	115.000	3216	119.750	9027	117.300	5452	113.350	1912	112.400	0.000
Mean	110.036	204.2	111.872	1037	113.206	2053	111.414	788.4	111.592	561.5	112.302	0.000

Annual Runoff in MCM = 12353 Annual Runoff in mm = 212

Peak Observed Discharge = 9027 cumecs on 02/08/2013 Corres. Water Level :119.75 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2013 Corres. Water Level :109.3 m

All Gates of Sarangkheda Barrage closed river in pooling condition from 01-06-13 to 15-06-13, 20/10/13 to 24/10/13, and from 30/10/14 to31/05/14 Some gates open from 25-10-13 to 28-10-13

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge

#Discarded and estimated

Stage Discharge data for the period 2013 - 2014

Station Name: Tapi at Sarangkheda (01 02 17 015) Division: Tapi Division Surat Local River:Tapi Sub Division: Middle Tapi Dhule

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	112.300	0.000	111.950	0.000	111.650	0.000	111.100	0.000	110.450	0.000	110.200	0.000
2	112.250	0.000	111.950	0.000	111.600	0.000	111.100	0.000	110.450	0.000	110.150	0.000
3	112.250	0.000	111.900	0.000	111.600	0.000	111.100	0.000	110.450	0.000	110.150	0.000
4	112.200	0.000	111.900	0.000	111.550	0.000	111.050	0.000	110.400	0.000	110.150	0.000
5	112.200	0.000	111.900	0.000	111.550	0.000	111.050	0.000	110.400	0.000	110.100	0.000
6	112.200	0.000	111.900	0.000	111.500	0.000	111.000	0.000	110.400	0.000	110.100	0.000
7	112.200	0.000	111.900	0.000	111.450	0.000	110.950	0.000	110.400	0.000	110.100	0.000
8	112.200	0.000	111.850	0.000	111.450	0.000	110.900	0.000	110.400	0.000	110.100	0.000
9	112.200	0.000	111.850	0.000	111.400	0.000	110.900	0.000	110.350	0.000	110.050	0.000
10	112.200	0.000	111.850	0.000	111.400	0.000	110.850	0.000	110.350	0.000	110.050	0.000
11	112.200	0.000	111.850	0.000	111.300	0.000	110.850	0.000	110.350	0.000	110.050	0.000
12	112.200	0.000	111.850	0.000	111.300	0.000	110.800	0.000	110.350	0.000	110.050	0.000
13	112.200	0.000	111.850	0.000	111.250	0.000	110.800	0.000	110.350	0.000	110.050	0.000
14	112.100	0.000	111.850	0.000	111.200	0.000	110.800	0.000	110.350	0.000	110.000	0.000
15	112.100	0.000	111.800	0.000	111.200	0.000	110.750	0.000	110.300	0.000	110.000	0.000
16	112.100	0.000	111.800	0.000	111.200	0.000	110.700	0.000	110.300	0.000	110.000	0.000
17	112.100	0.000	111.800	0.000	111.200	0.000	110.700	0.000	110.300	0.000	110.000	0.000
18	112.100	0.000	111.800	0.000	111.200	0.000	110.650	0.000	110.300	0.000	110.000	0.000
19	112.100	0.000	111.800	0.000	111.150	0.000	110.650	0.000	110.300	0.000	109.950	0.000
20	112.100	0.000	111.800	0.000	111.150	0.000	110.600	0.000	110.300	0.000	109.950	0.000
21	112.100	0.000	111.800	0.000	111.150	0.000	110.600	0.000	110.300	0.000	109.950	0.000
22	112.100	0.000	111.800	0.000	111.150	0.000	110.550	0.000	110.250	0.000	109.900	0.000

23	112.050	0.000	111.750	0.000	111.150	0.000	110.550	0.000	110.250	0.000	109.900	0.000
24	112.050	0.000	111.750	0.000	111.100	0.000	110.500	0.000	110.250	0.000	109.850	0.000
25	112.050	0.000	111.750	0.000	111.100	0.000	110.500	0.000	110.250	0.000	109.800	0.000
26	112.000	0.000	111.750	0.000	111.100	0.000	110.500	0.000	110.250	0.000	109.800	0.000
27	112.000	0.000	111.750	0.000	111.100	0.000	110.500	0.000	110.200	0.000	109.800	0.000
28	111.950	0.000	111.750	0.000	111.100	0.000	110.500	0.000	110.200	0.000	109.750	0.000
29	111.950	0.000	111.700	0.000			110.500	0.000	110.200	0.000	109.750	0.000
30	111.950	0.000	111.700	0.000			110.500	0.000	110.200	0.000	109.700	0.000
31	111.950	0.000	111.650	0.000			110.500	0.000			109.700	0.000
Ten-Daily Mean												
I Ten-Daily	112.220	0.000	111.895	0.000	111.515	0.000	111.000	0.000	110.405	0.000	110.115	0.000
II Ten-Daily	112.130	0.000	111.820	0.000	111.215	0.000	110.730	0.000	110.320	0.000	110.005	0.000
III Ten-Daily	112.014	0.000	111.741	0.000	111.119	0.000	110.518	0.000	110.235	0.000	109.809	0.000
Monthly												
Min.	111.950	0.000	111.650	0.000	111.100	0.000	110.500	0.000	110.200	0.000	109.700	0.000
Max.	112.300	0.000	111.950	0.000	111.650	0.000	111.100	0.000	110.450	0.000	110.200	0.000
Mean	112.118	0.000	111.816	0.000	111.295	0.000	110.742	0.000	110.320	0.000	109.971	0.000

Peak Computed Discharge = 5337 cumecs on 25/08/2013 Corres. Water Level :117.0 m

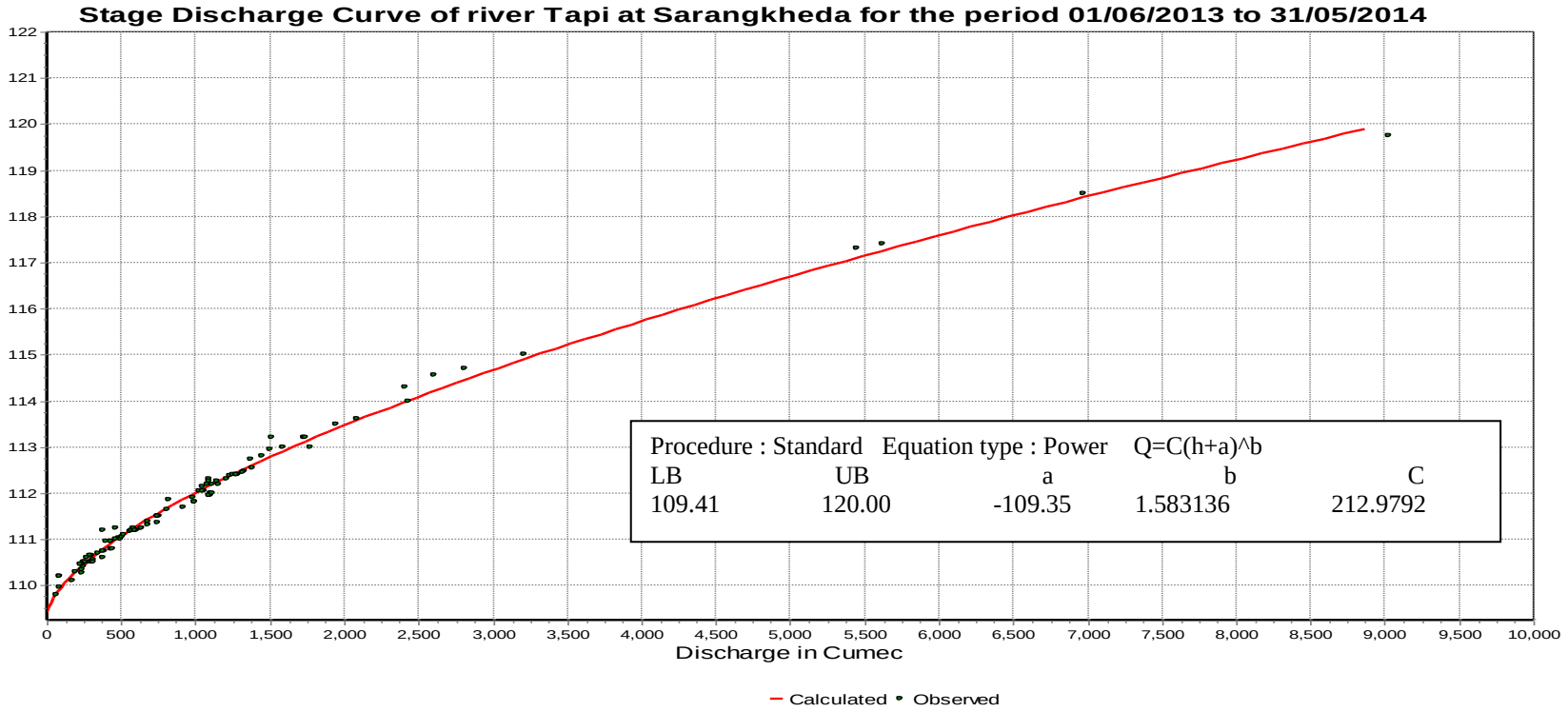
Lowest Computed Discharge = 23.72 cumecs on 26/06/2013 Corres. Water Level :109.6 m

All Gates of Sarangkheda Barrage closed river in pooling condition from 01-06-13 to 15-06-13, 20/10/13 to 24/10/13, and from 30/10/14 to31/05/14 Some gates open from 25-10-13 to 28-10-13

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge
#Discarded and estimated

3.5.4 Stage Discharge Curve

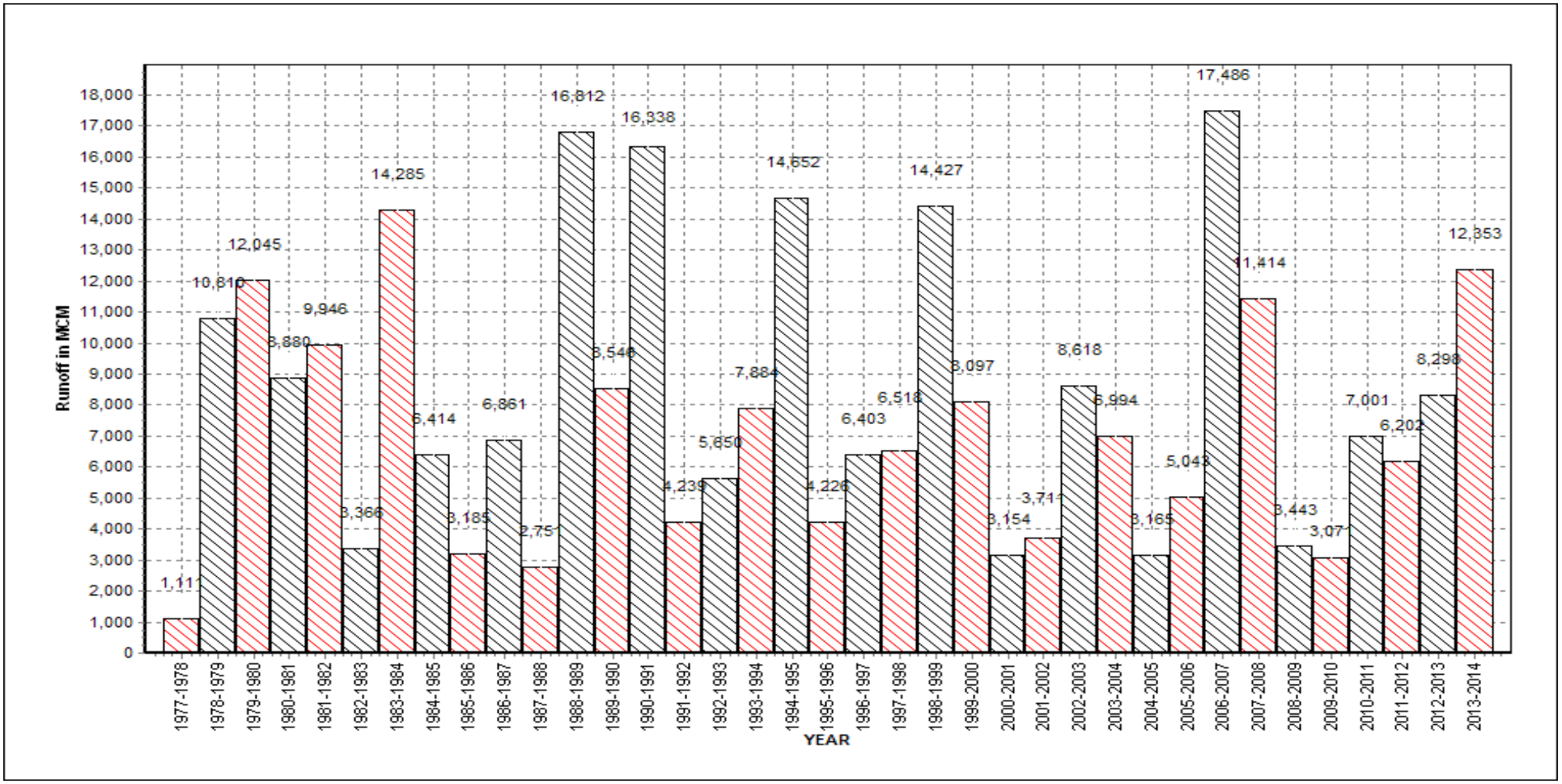
Station Name: Tapi at Sarangkheda (01 02 17 015) Division: Tapi Division Surat Local River: Tapi Sub Division: Middle Tapi Dhule



3.5.5 Annual runoff

Annual Runoff for the period 1977-2014

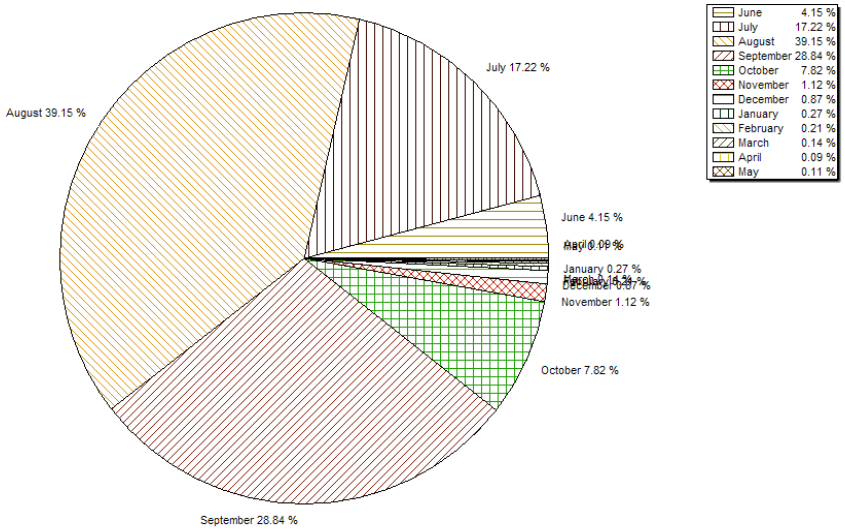
Station Name: Tapi at Sarangkheda (01 02 17 015) Division: Tapi Division Surat Local River:Tapi Sub Division: Middle Tapi Dhule



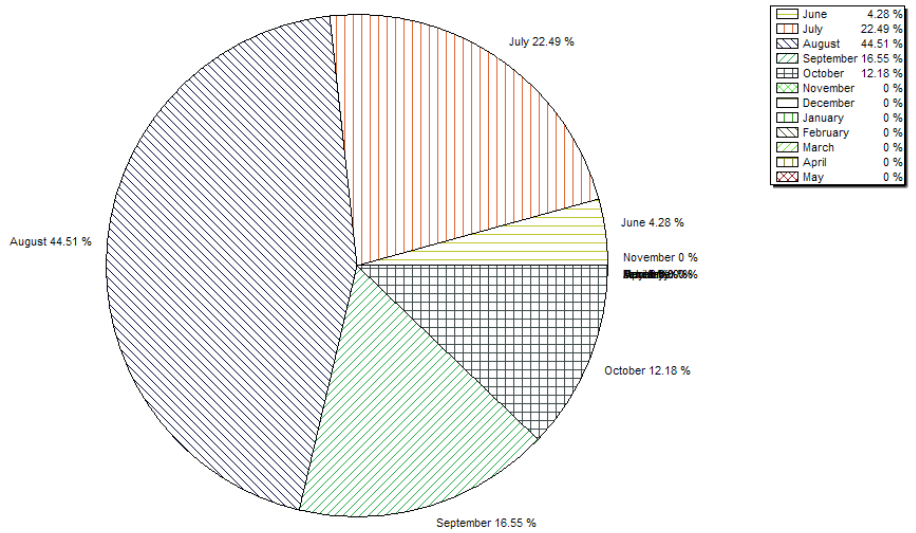
3.5.6 Monthly Average Runoff

Station Name: Tapi at Sarangkheda (01 02 17 015) Division: Tapi Division Surat Local River:Tapi Sub Division: Middle Tapi Dhule

Monthly Average Runoff Based on period 1971-2014



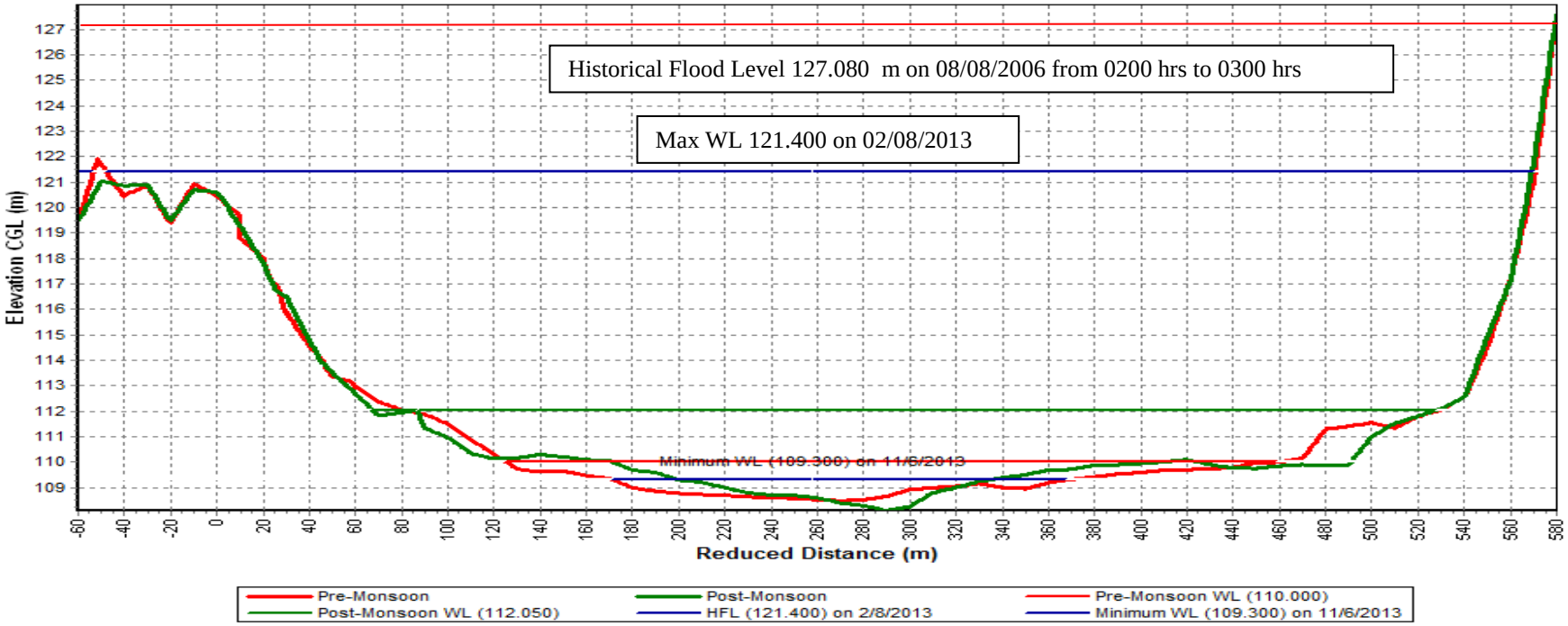
Monthly Runoff Based on period 2013-2014



3.5.7 Superimposed cross section

Station Name: Tapi at Sarangkheda (01 02 17 015) Division: Tapi Division, Surat Local River :Tapi Sub Division: Middle Tapi, Dhule

Cross section at SG Line

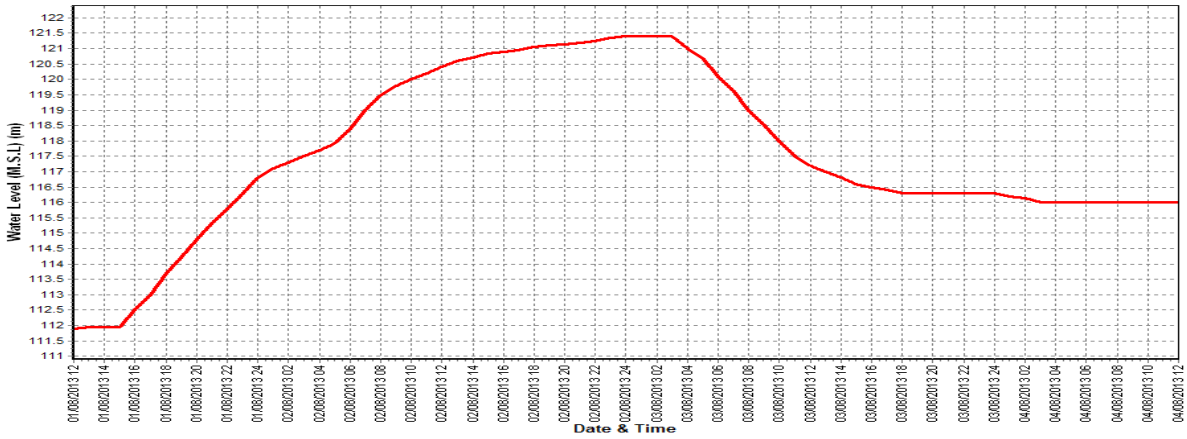


3.5.8 WL vs Time Graph of I,II,III peak

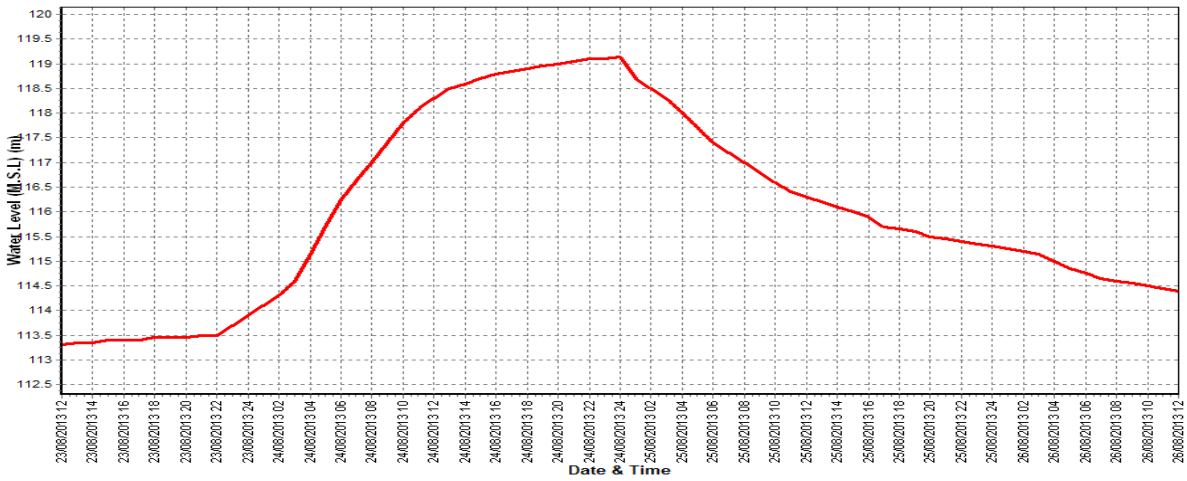
Station Name: Tapi at Sarangkheda (01 02 17 015) Division: Tapi Division Surat

Local River: Sub Division: Middle Tapi Dhule

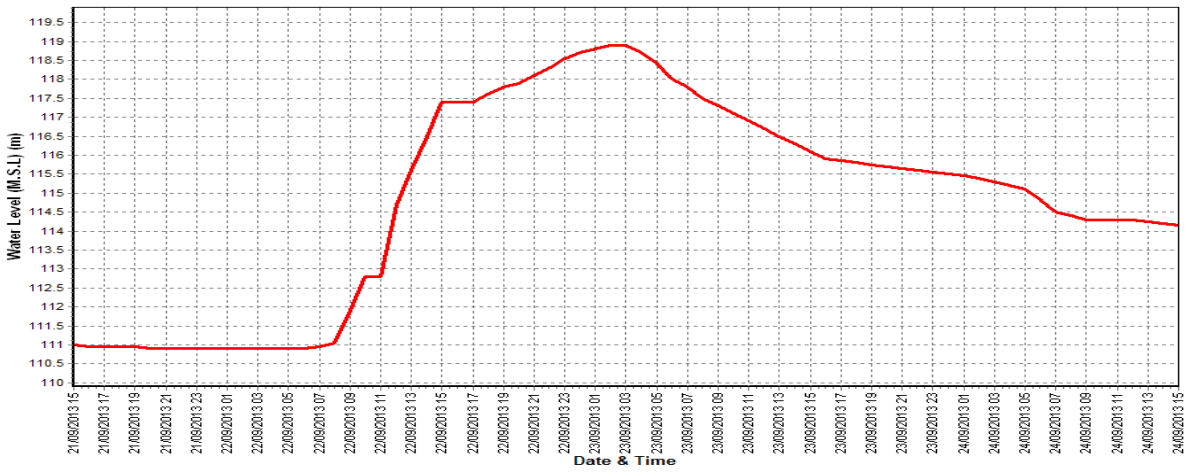
Water Level v/s Time graph of Highest (I) Flood Peak during the water year 2013-14



Water Level v/s Time graph of Highest (II) Flood Peak during the water year 2013-14



Water Level v/s Time graph of Highest (III) Flood Peak during the water year 2013-14



Chapter-4: Trend Analysis

4.1 Introduction

Trends are important indicators of the temporal variability of runoff as computed from observed discharge at site. By analyzing the time sequence of the runoff, we assess the magnitude and significance of the temporal variability. The present surface runoff trend study involves analysis of the temporal variability of data sets on the observed discharges in Tapi basin using available data of existing river gauging stations.

4.2 Methodology

In the analysis of the trends of runoff on Tapi River and its major tributary Purna, annual runoff is computed and analysed. The analysis is carried out for five (5) river gauging stations with sufficiently long and continuous data sets that are fairly representatively distributed across Tapi river Basin.

Overall five stations have been considered in this study. The length of the data sets of river gauging station varies from 23 to 41 years. Subsequently, time series are analysed on various statistical parameters, fitting of mathematical equations, observing moving means for various period so as to find out if there are any trends in the annual runoff data.

4.2.1 Time series analysis

Time series is defined as a sequence of values arrayed in order of their occurrence which can be characterized by statistical properties. Time series analysis may be used to test the variability, homogeneity and trend of a stream flow series or simply to give an upright list the characteristics of the series as graphically displayed. Significant movements of time series are the secular, periodic, cyclic and irregular trends. A time series may display a tendency to increase or decrease, over a specified period. Such a series provides an interesting illustration because if the trend is usually predominant, virtually no other movements are discernible.

Various methods exist for analysis of time series such moving averages, residual series, residual mass curves and balance. Trends may also be revealed by determining if observed stream flow follows some mathematical equation as a function of time.

In this chapter, first statistical parameters have been computed for time series data of annual runoff at different sites in Tapi basin. It is also ascertained if

any mathematical equation can be fitted to the time series to assess predictability. Finally, the data is analysed by the method of moving means for various periods.

4.3 Availability of Data

There are 5 G&D sites in Tapi Basin. Availability of annual runoff data for these sites is summarized in **Table-17.**

Table-17: Availability of Data

S. no.	Site	Period of Availability	Years
1.	Burhanpur on Tapi River	1973-74 to 2013-14	41
2.	Yerli on Purna River	1973-74 to 2013-14	41
3.	Gopalkheda On Purna River	1977-78 to 2013-14	37
4.	Gidhade On Tapi River	1990-91 to 2013-14	23
5.	Sarangkheda on Tapi River	1977-78 to 2013-14	37
The data is placed at **Annexure-1** and shown in line diagram in **Fig- 1.**			

4.4 Analysis

4.4.1 Statistical Analysis

Various statistical parameters of the time series of available data are given below in **Table-18**.

Table-18: Statistical parameters of Annual Runoff series at various sites in Tapi Basin

River Gauging Station	Data length (years)	Mean (MCM)	Median (MCM)	standard deviation (MCM)	Co-efficient of variation
Burhanpur	41	4792.927	3983	2517.836	0.525
Yerli	41	2142.488	1832	1489.71	0.695
Gopalkheda	37	1029.946	753	752.83	0.731
Gidhade	23	6283.304	4950	3338.543	0.531
Sarangkheda	37	7929.027	6994	4435.7	0.559

4.4.2 Fit characteristics

In order to find out if any mathematical equation represents the time series as a function of time, fitting of various types of equations viz. linear, logarithmic, exponential and polynomial have been attempted. Results of such fits are given in the **Table-19** and shown in **Fig 2 through 6**.

Table-19: Fit Characteristics

S. No.	Station name	Standard Deviation σ (MCM)	Coefficient of variation C_v	Mathematical Fit		R^2
1.	Burhan-Pur	2517.836	0.525	Linear	y = 13.24x - 21613	0.004
				Logarithmic	y = 26270ln(x) - 19479	0.003
				Exponential	y = 58.26e0.002x	0.002
				Polynomial	$y = 2.429x^2$ - 9670x + 1E+07	0.018
2.	Yerli	1489.71	0.695	Linear	y = --29.56x + 61061	0.056
				Logarithmic	y = -5896ln(x) + 45012	0.056
				Exponential	y = 1E+20e-0.019x	0.091
				Polynomial	$y = 0.875x^2$ - 3519x + 4E + 06	0.062
3.	Gopal-kheda	752.83	0.731	Linear	y = 5.088x -9121	0.005
				Logarithmic	y = 10096ln(x) -75680	0.005
				Exponential	y = 7.654e0.002x	0.001
				Polynomial	$y = 1.1224x^2$ -4881x+5E+06	0.033
4.	Gidhade	3338.543	0.531	Linear	y = 62.57x - 11899	0.016
				Logarithmic	y = 12509ln(x) -94469	0.016
				Exponential	y = 0.00076e0.00789x	0.011
				Polynomial	$y = 10.14x^2$ - 40543x + 4E + 07	0.031
5.	Sarang-kheda	4452.212	0.560	Linear	y = - 17.04x + 41925	0.001
				Logarithmic	y = -3397ln(x) + 26611	0.001
				Exponential	y = 134.87108e0.00196x	0.0014
				Polynomial	$y = -0.350x^2$ + 1382x -1E+06	0.001

4.4.3 Moving Mean Analysis

In statistics, a moving mean (average), also called rolling average, rolling mean or running average, is a type of finite impulse response filter used to analyze a set of data points by creating a series of averages of different subsets of the full data set.

The first element of the moving average is obtained by taking the average of the initial fixed subset of the number series. Then the subset is modified by "shifting forward", that is excluding the first number of the series and including the next number following the original subset in the series. This creates a new subset of numbers, which is averaged. This process is repeated over the entire data series. The plot line connecting all the (fixed) averages is the moving average. A moving average is a set of numbers, each of which is the average of the corresponding subset of a larger set of data points. A moving average may also use unequal weights for each data value in the subset to emphasize particular values in the subset.

A moving average is commonly used with time series data to smooth out short-term fluctuations and highlight longer-term trends or cycles.

In the present analysis, moving means have been computed for 3, 5 and 7 year periods for various sites of Tapi River Basin and shown in **Fig-7 through 11**.

4.5 Interpretation

4.5.1 Fitting of various statistical/mathematical models viz linear, logarithmic, exponential and polynomial reveals that values of R^2 range from 0.002 to 0.018 for Burhanpur, from 0.056 to 0.091 for Yerli, from 0.001 to 0.033 for Gopalkheda, from 0.011 to 0.031 for Gidhade, and 0.001 to 0.0014 for Sarangkheda. The values of R^2 are quite close to 0 indicating absence of any significant trend.

4.5.2 As regards the Purna, tributary of river Tapi, a decreasing trend is seen at site Yerli from the plot of moving mean averages from about mid-nineties, which again shows signs of rising by 2010, though no trend is visualized on the upstream site Gopalkheda on Purna. On the main stream Tapi, it may be seen from the moving mean analysis that there does not appear any significant trend as observed from 3 year moving mean. But as we prolong the period of mean, cyclicalness or periodicity begins to appear. However, in view of the limited length of data series, it may be premature to conclude that there exists a definite cyclic trend in the annual runoff data.

4.6 Conclusion

Statistically speaking, the annual runoff of river Tapi and its tributary Purna, in general, appears to be a random variable; however elements of cyclicalness cannot be ruled out on the strength of moving mean analysis. A longer set of time series data may help identify trends in annual runoff, if any.

Annexure-I: Annual Runoff data at Various Sites in Tapi Basin

(MCM)

Site / Year	Burhanpur on Tapi	Yerli on Purna	Gopalkheda on Purna	Gidhade on Tapi	Sarangkheda on Tapi
1973-74	8714	3404			
1974-75	1736	1376			
1975-76	5620	2282			
1976-77	3892	2224			
1977-78	3951	2693	284		1111
1978-79	6979	3804	1802		10810
1979-80	4637	4706	1727		12045
1980-81	4612	1875	913		8880
1981-82	5241	2618	1504		9946
1982-83	1834	657	321		3368
1983-84	5484	3938	1111		14258
1984-85	3895	1074	675		6414
1985-86	1555	1235	354		3185
1986-87	3753	2650	1106		6861
1987-88	1209	723	235		2751
1988-89	6553	7250	3012		16812
1989-90	3957	1812	389		8546
1990-91	10589	4869	1512		16338
1991-92	2638	763	358	4809	4239
1992-93	2889	1731	753	4922	5650
1993-94	6580	1176	361	5784	7884
1994-95	10304	3466	1951	11902	14652
1995-96	3607	1051	582	3236	4226
1996-97	4900	952	708	4883	6403
1997-98	5834	1201	974	5010	6518
1998-99	7328	3014	1785	11163	14427
1999-2000	6691	2254	1221	7016	8097
2000-01	1277	751	545	2600	3154
2001-02	3071	1076	454	3246	3711
2002-03	3168	2649	1213	7536	8618
2003-04	3296	504	169	4950	6994
2004-05	2357	223	405	2389	3165
2005-06	3342	1040	629	4268	5043
2006-07	4905	3518	1988	14972	17486
2007-08	9797	3340	2827	9288	11414
2008-09	2307	365	211	3551	3443
2009-10	2028	640	295	3573	3071
2010-11	3983	2427	1400	5909	7001
2011-12	5039	857	601	4562	6202
2012-13	8033	1832	1359	8061	8298
2013-14	8925	3822	2374	10886	12353

Fig 1: Annual Runoff at Various Sites

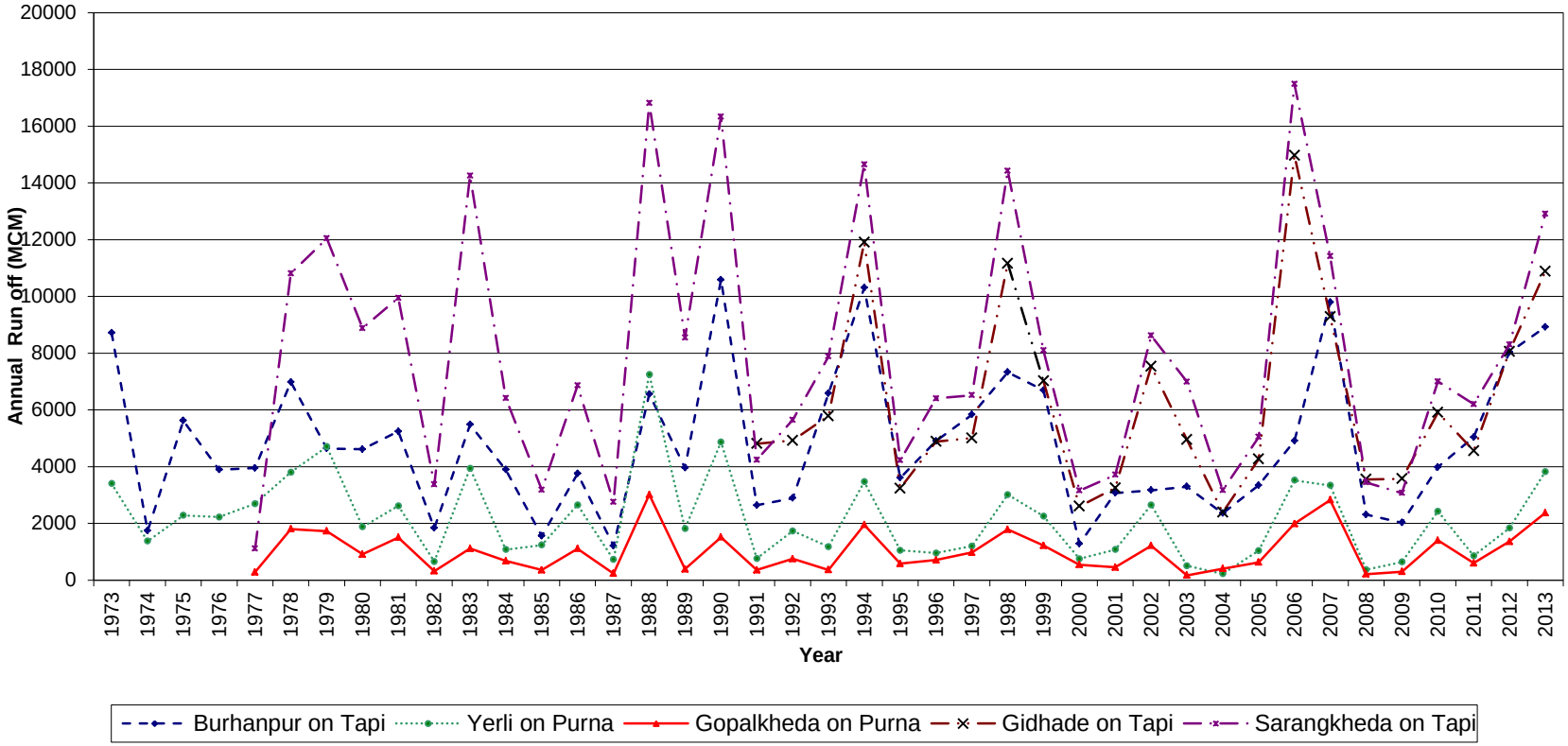


Fig.2: Fit Characteistics at Burhanpur

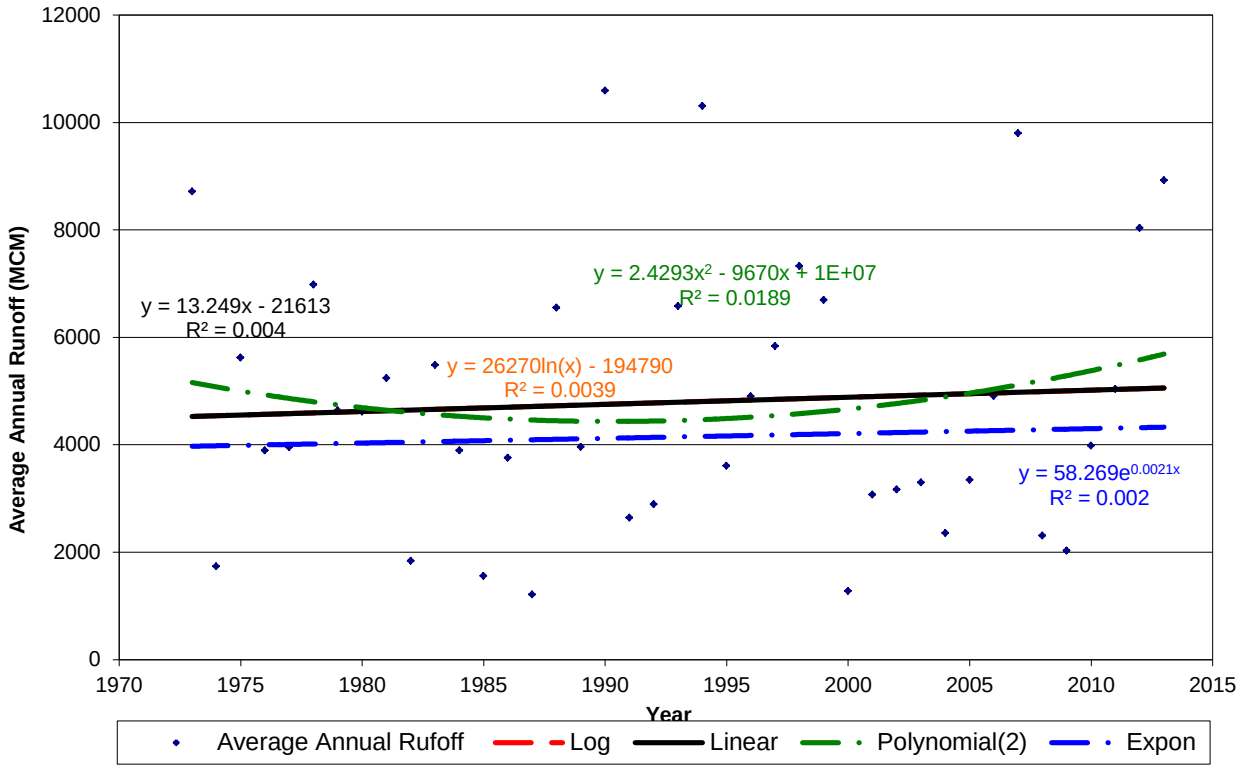


Fig.3: Fit Characteistics at Yerli

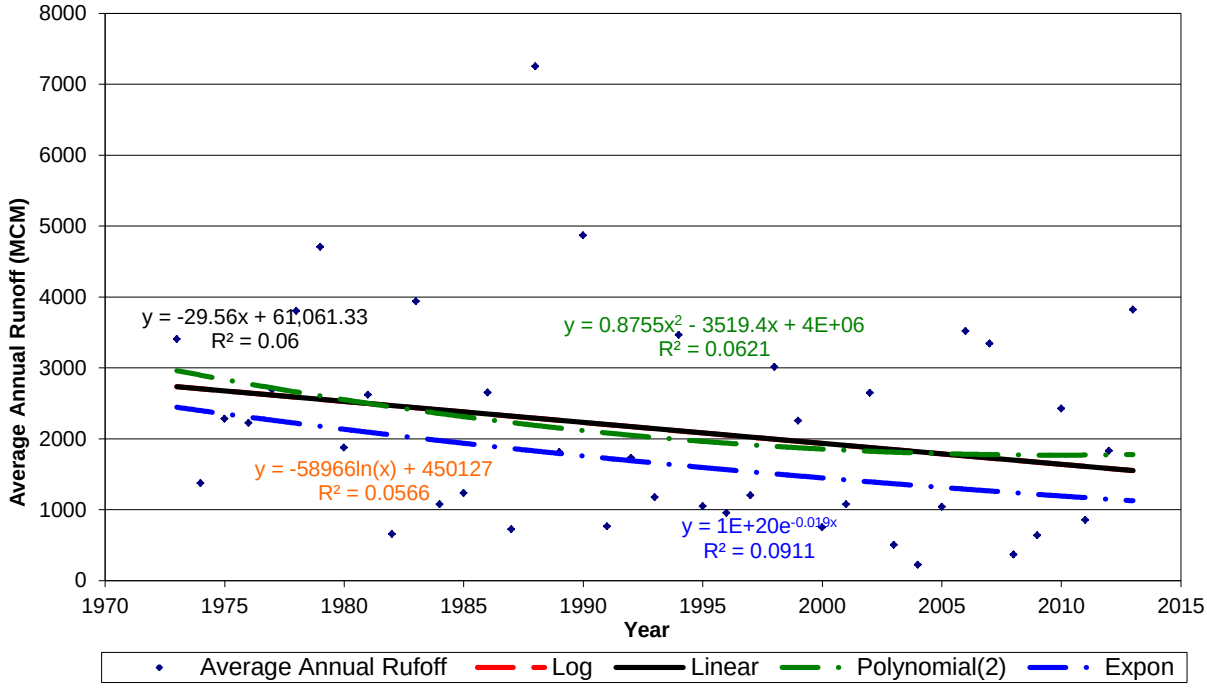


Fig.4: Fit Characteistics at Gopalkheda

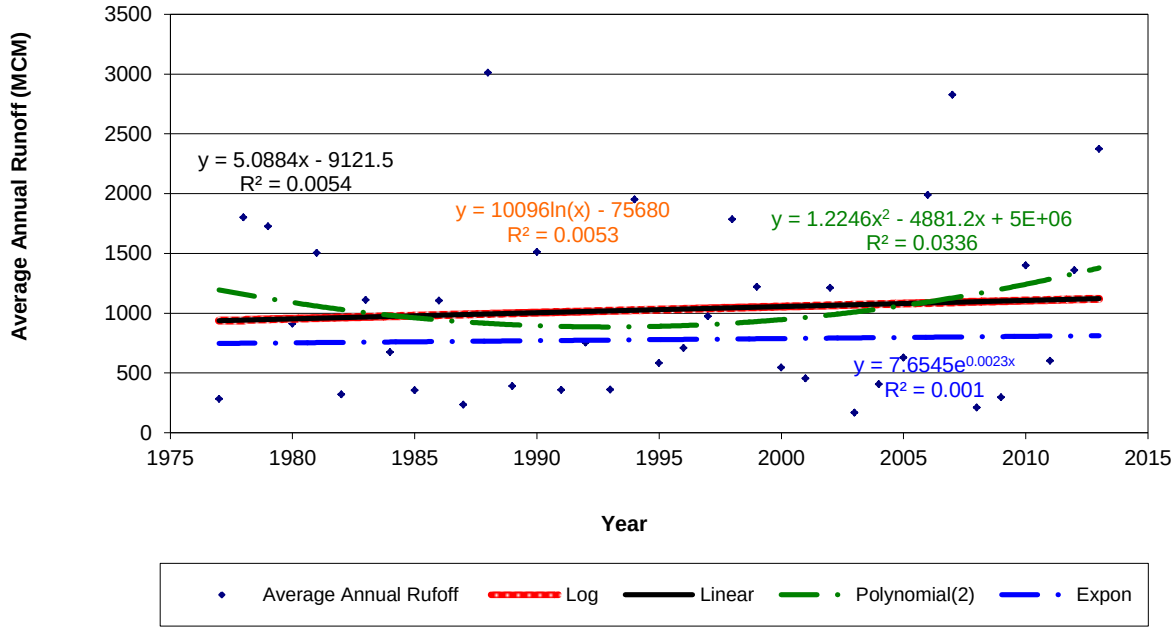


Fig.5: Fit Characteistics at Gidhade

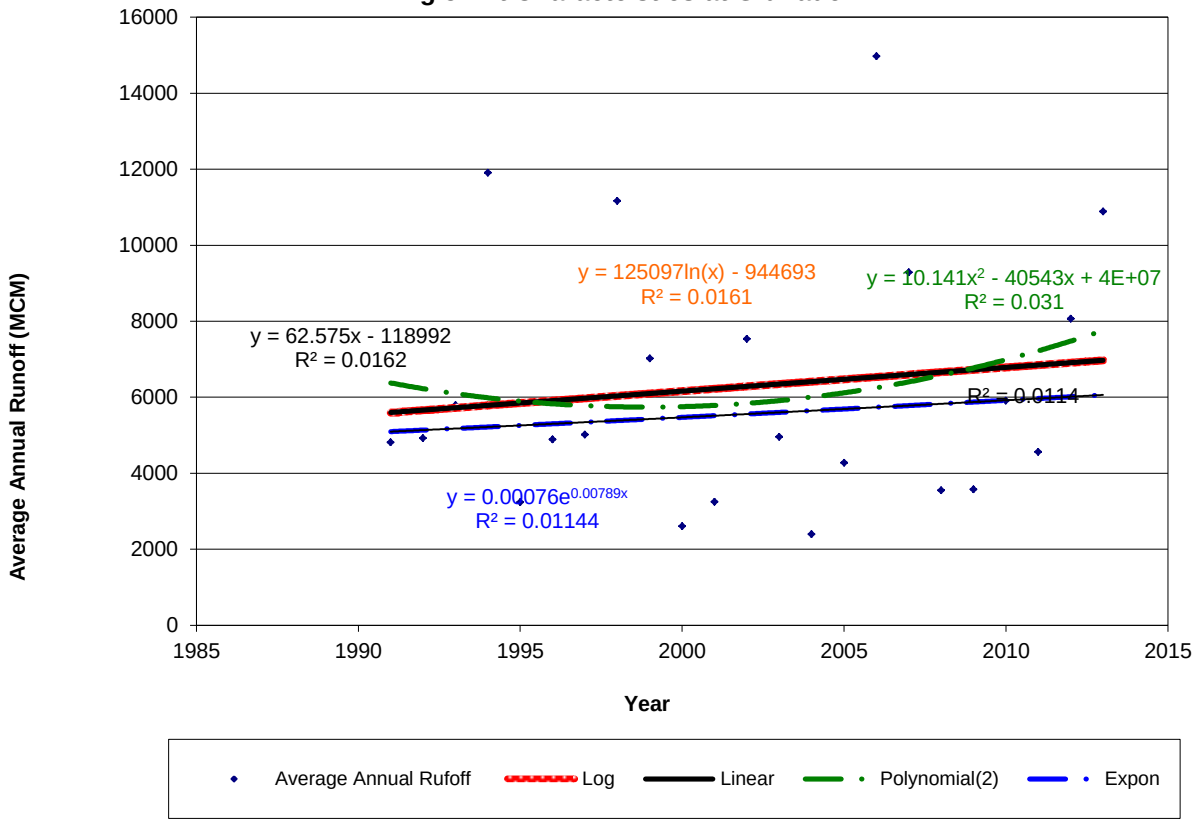


Fig.6: Fit Characteistics at Sarangkheda

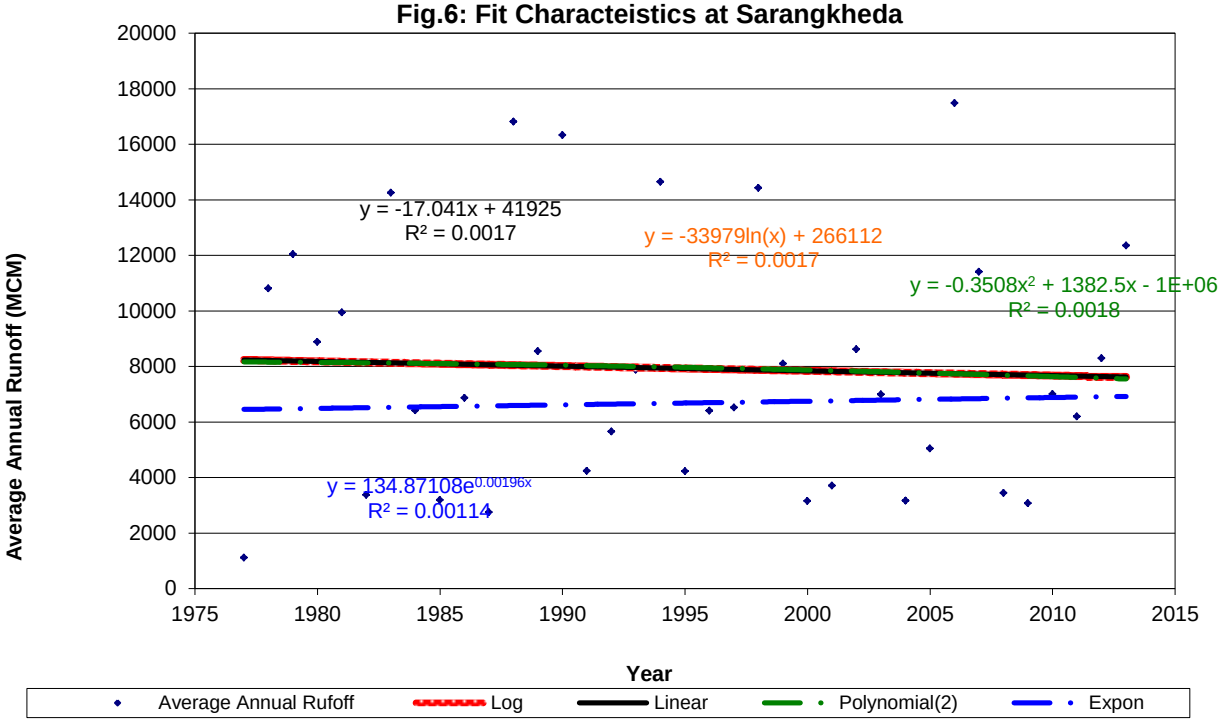


Fig.7: Moving Mean Analysis for Burhanpur

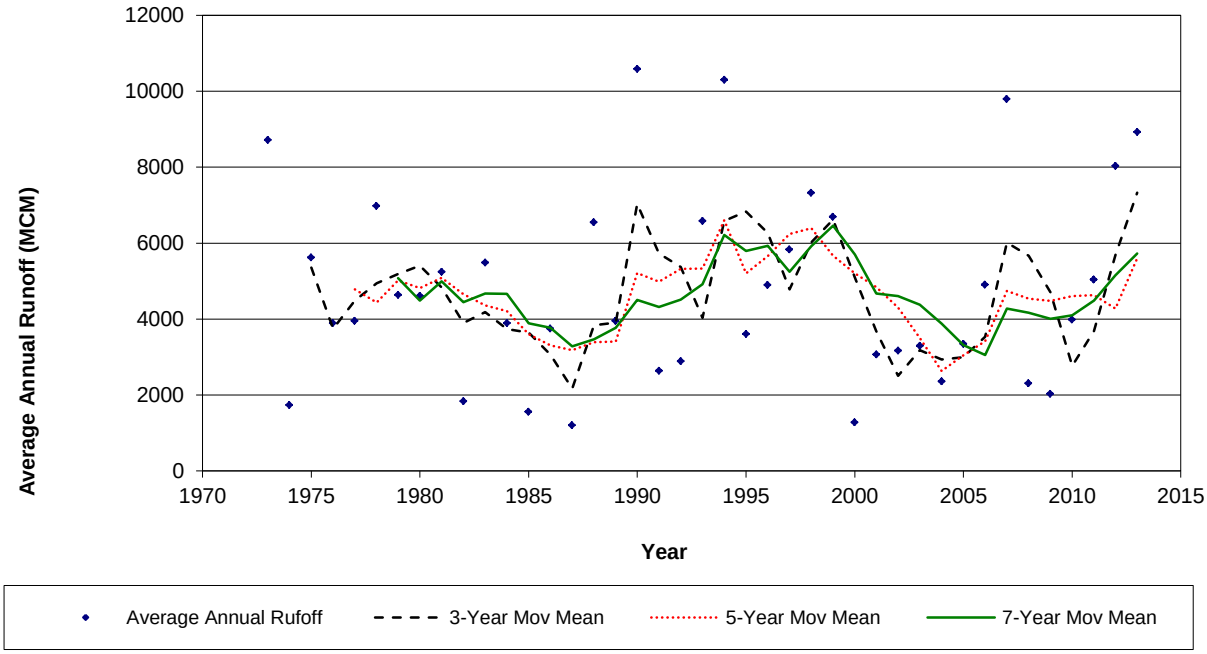


Fig.8: Moving Mean Analysis for Yerli

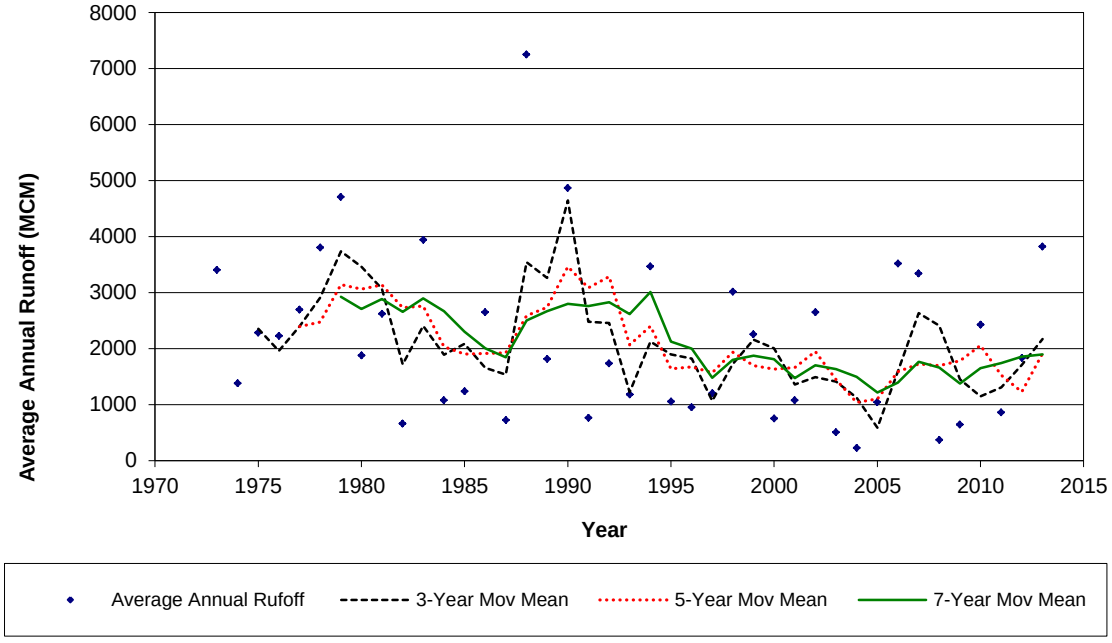


Fig.9: Moving Mean Analysis for Gopalkheda

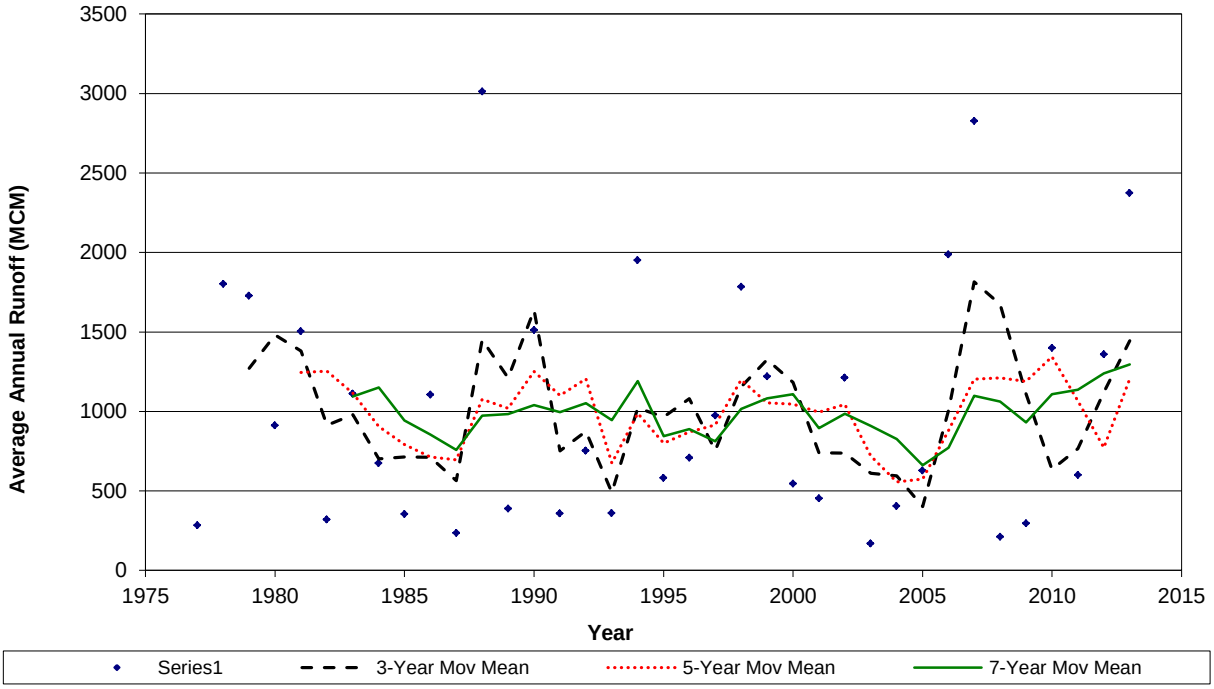


Fig.10: Moving Mean Analysis for Gidhade

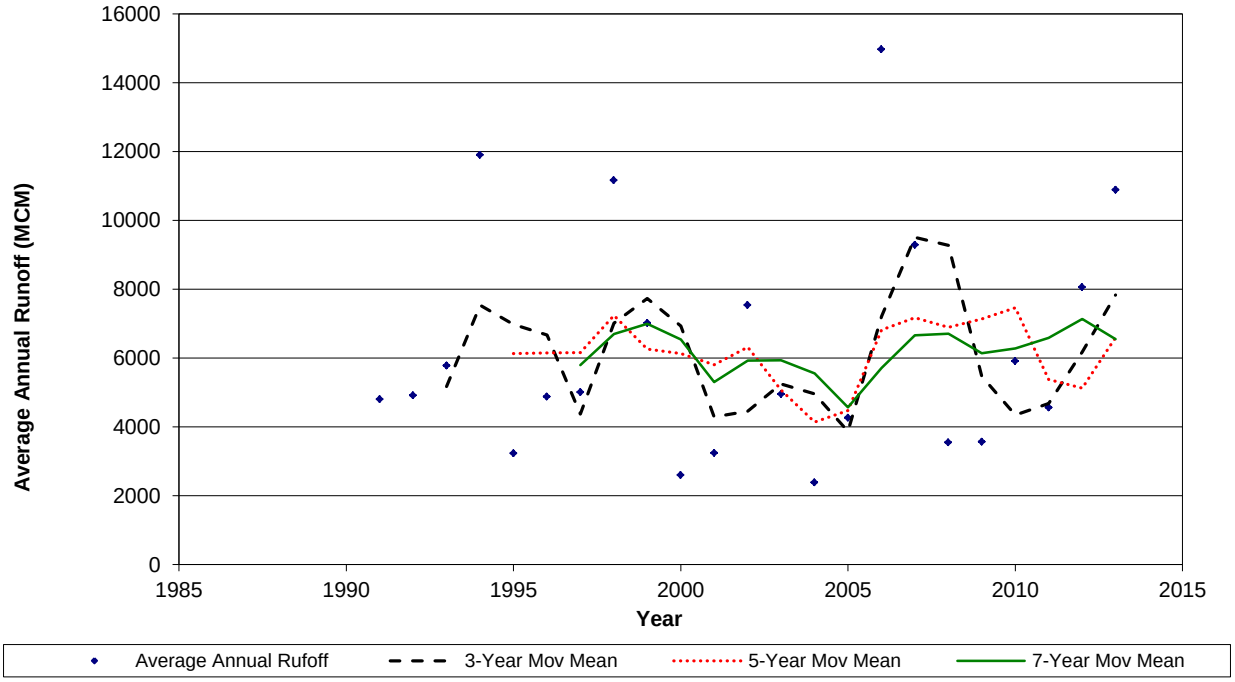


Fig.11: Moving Mean Analysis for Sarangkheda