जल वार्षिकी
WATER YEAR BOOK
2013 – 14

पश्चिम प्रवाही नदियाँ

(पूर्णा, अम्बिका, वैतरणा, धाधर, दमणगंगा और किम)

WEST FLOWING RIVERS

(Purna, Ambika, Vaitarna, Dhadhar, Damanganga & Kim)

GD Site- Damanganga at Nanipalsan

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)

मार्च -2015

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 आँकड़ो 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 द्वारा पश्चिम प्रवाही नदियों पूर्णा अम्बिका, वैतरणा, धाधर, दमणगंगा और किम पर वर्तमान मे 7 स्थलों पर सतही प्रवाह का प्रेक्षण किया जा रहा है।इनके आँकड़े इस वार्षिकी में संकलित किए गए हैं। ।इन बेसिनों के वार्षिक सतही अपवाह आँकड़ो में 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।

वार्षिकी में प्रकाशित आँकड़ो 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 7 sites on West flowing rivers viz. Purna, Ambica, Vaitarna, Dhadar, Damanganga and Kim 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.

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

C o n t e n t s

List of Plates and Figures

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Abbreviations and symbols

Av	:	Average
Ann	:	Annual
A.G.R.	:	Automatic Gauge Recorder
C	:	Centigrate
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
MD	:	Mahi Division, CWC, Gandhinagar
neg.	:	Negligible
NNW	:	National Net Work
R.Days	:	Remaining days
R.L.	:	Reduced Level
R.D.	:	Reduced Distance
R.C.C.	:	Reinforced Cement Concrete
sq km	:	Square Kilometer
TD	:	Tapi Division, CWC, Surat
WQ	:	Water Quality
W.L.	:	Water Level
W.Year	:	Water Year
WRID	:	Water Resources Investigation Division, Ahmadabad
WRI C	:	Water Resources Investigation Circle, Ahmadabad
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

1.0 Introduction

1.1 General

This water year book presents data of seven hydrological observation stations, alongwith general information about basins and trend analysis for annual runoff, for the water year 2013-14 in Purna, Vaitarna, Ambica, Dhadhar, Kim, Wagh and Damanganga rivers. The data of 06 sites which are included in this book are collected by Tapi division, Central Water Commission, Surat under Hydrological Observation Circle, Gandhinagar. Jurisdiction map of Tapi division, CWC, Surat is enclosed at **Plate-1**. Central Water commission is conducting hydrological observations on major west flowing river basins under various schemes viz national network (NNW), 80-key stations, 163- key stations and flood forecasting (FF). The scheme wise distributions of sites are shown in the **table-1**.

Table-1: Scheme wise distributions of sites

Sl. No.	Name of Site	Station Code	Scheme	Type
1.	Purna at Mahuwa	01 02 19 001	NNW	GDS WQ
2.	Vaitarna At Durvesh	01 02 25 001	NNW	GDS WQ
3.	Ambica at Gadat	01 02 20 001	80 Key stations	GDSWQ
4.	Dhadhar At Pingalwada	01 02 14 001	163 Key stations	GD WQ
5.	Kim at Motinaroli	01 02 16 001	163 Key stations	GDWQ
6.	Wagh at Ozerkheda	01 02 24 002	FF	GD
7.	Damanganga at Nanipalsan	01 02 24 001	FF	GD

2.0 Description of River Basins

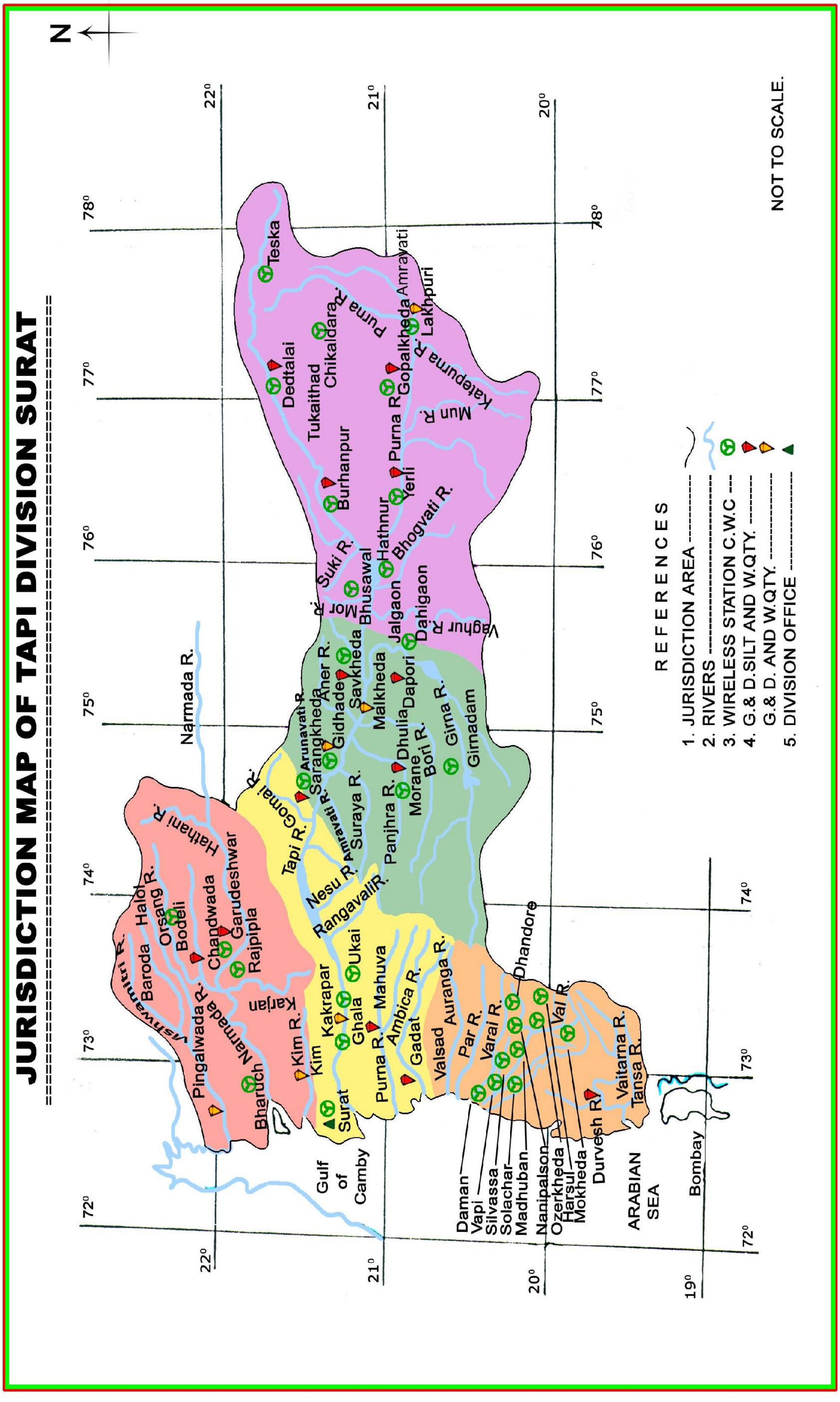
There are 6 independent river basins as given below under the jurisdiction of Tapi Division, Central Water Commission, Surat,

1. Purna Basin
2. Ambica Basin
3. Vaitarna Basin
4. Dhadhar Basin
5. Damanganga Basin
6. Kim Basin

Description of these river basin is given in subsequent sections of this year book.

1.2 Jurisdiction Map of Tapi division, CWC, Surat.

Plate – 1



2.1 Purna Basin

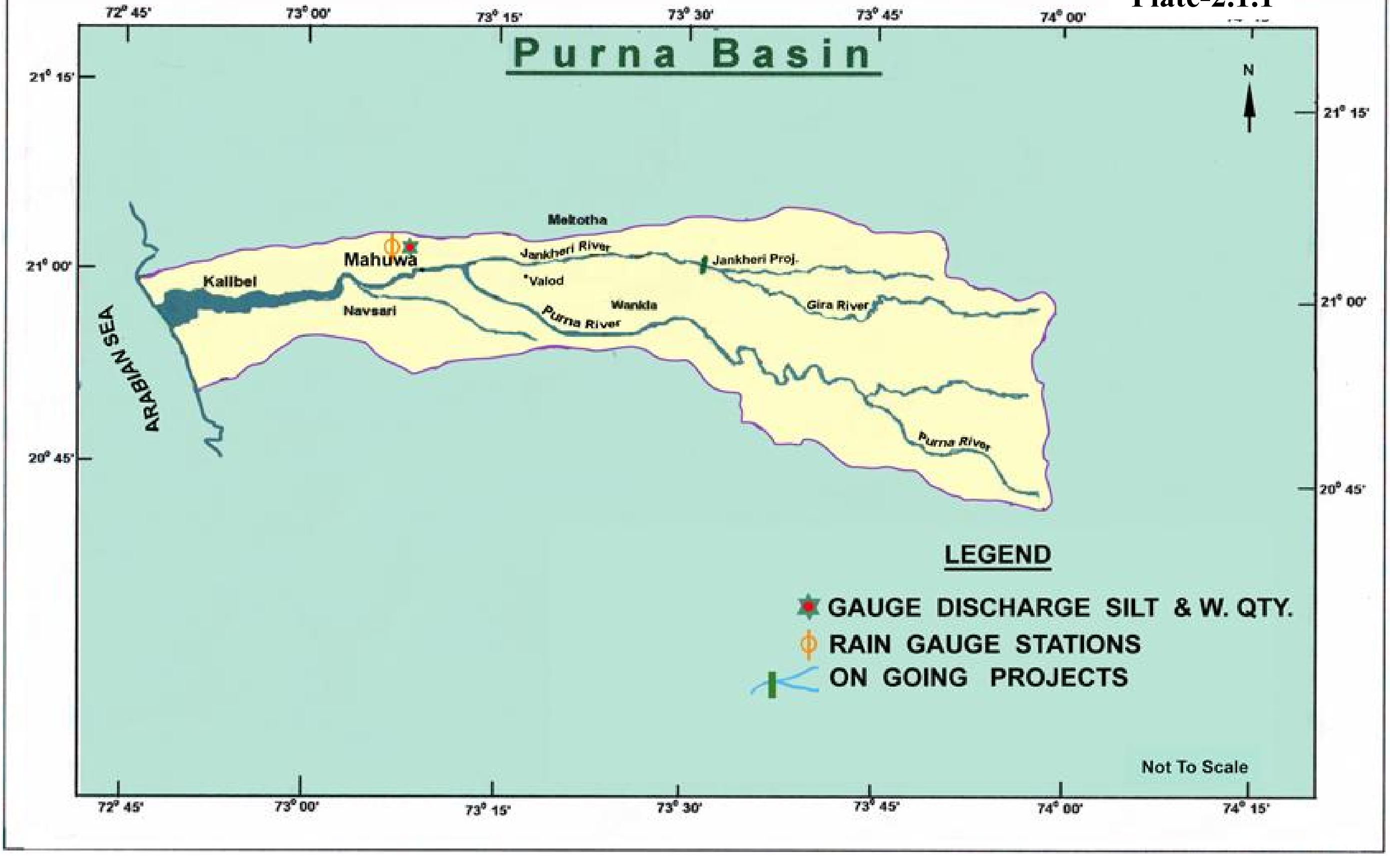
2.1.1 Geographical setting of Purna Bain

Purna River is an important west flowing river with its catchment lying in Ahwaa,Valsad and Navsari districts of Gujarat and in Nasik district of Maharashtra. The Purna basin can be divided into three prominent physiographic regions, i.e.

i) eastern parts, (ii) the middle reaches and (iii) the coastal zones.

The eastern parts of the basin cover a chain of rugged mountain ranges of the Western Ghats running at an elevation of above 1300 m and descending to an elevation of about 100 m at the edges of uplands of the Surat district. The middle reaches of the basin area are marked by high relief zone with ridges and valleys. The hilly zone then merges into the plains through an undulating piedmont coastal zone running parallel to the sea. Basin map of Purna River is shown in **Plate-2.1.1.**

Plate-2.1.1



2.1.2 River System

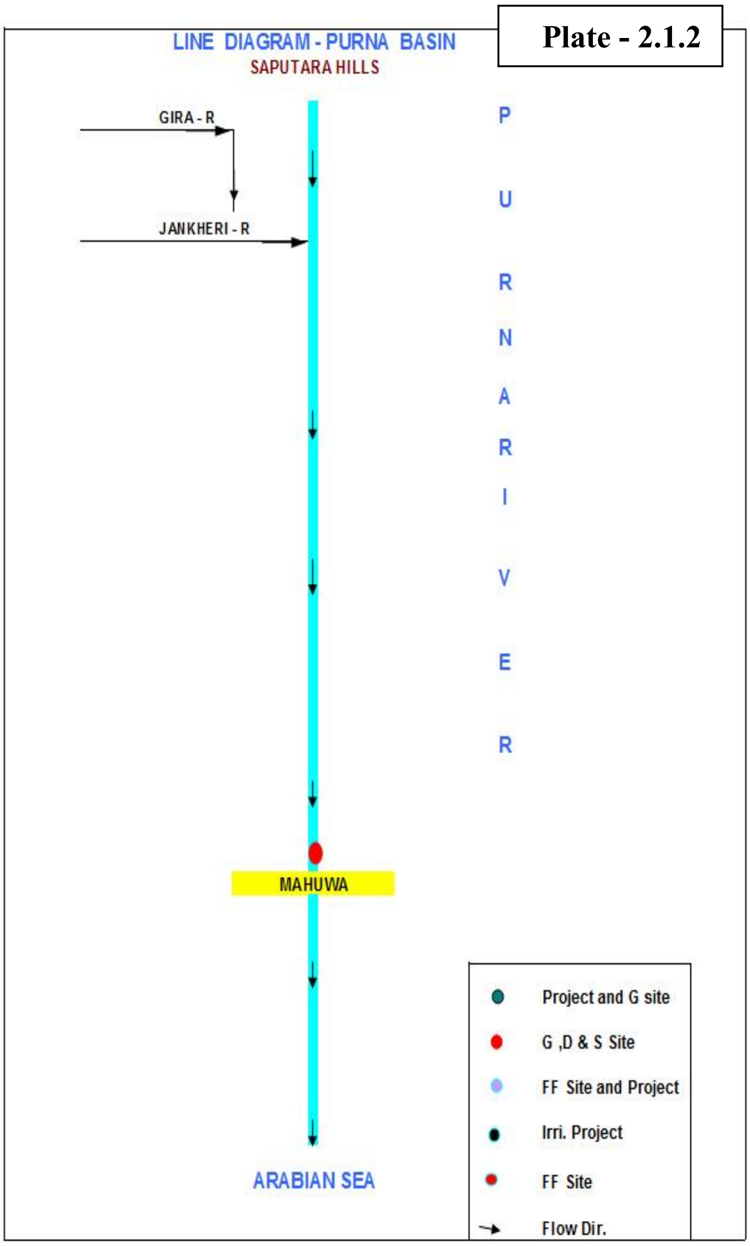
The river Purna rises in the Saputara hills of the Western Ghats near the village Chinchi in Maharashtra. The length of the river from its source to outflow in the Arabian Sea is about 180 km.

The important tributaries of the Purna River are Dhodar nala, Bardanala, Nagihpar nala, Girna River, Zankari River and Dumas khadi. The catchment area of the Purna basin is 2431 Sq. km. The basin lies between 72^0 45' to 74^0 00' East longitude and 20^0 41' to 21^0 05' North latitude. State wise distribution of drainage area is shown in **Table-2.1.1** and line diagram of Purna river system is shown in **Plate - 2.1.2**

Table -2.1.1**:** State wise distribution of catchments area of the Purna basin

Sl.No	State	C.A .in Sq. km.	% Of the total C.A.
1	Maharashtra	58	2.39
2	Gujarat	2373	97.61
	Total	2431	100.00

Plate - 2.1.2



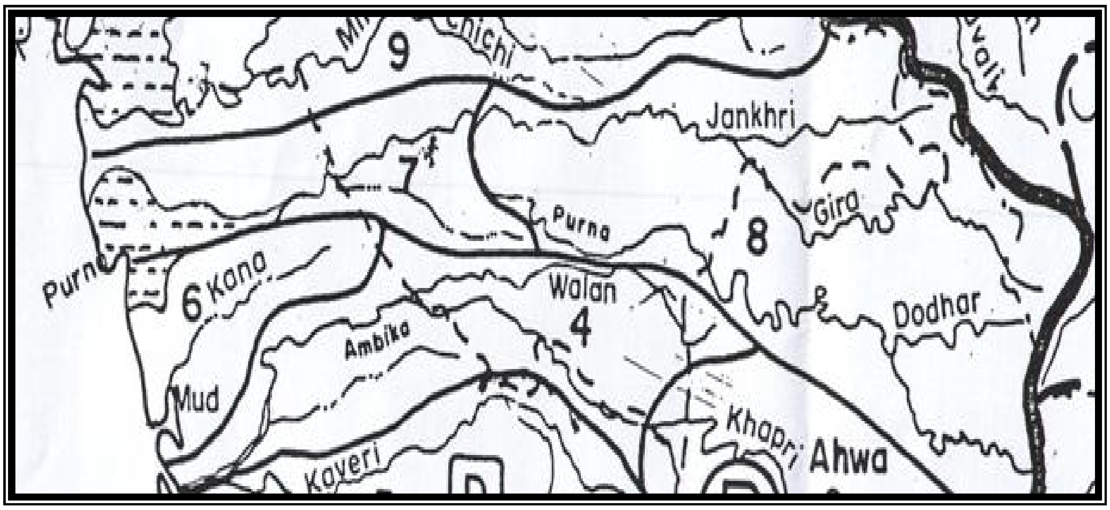
2.1.3 Purna Basin as per Watershed Atlas of India

As per Watershed Atlas of India, Published by Department of Agriculture and Cooperation, Ministry of agriculture, Krishi Bhavan New Delhi (1990), the sub catchments under 5B2D pertain to Purna Basin.

2.1.3.1 Subcatchment -5B2D (5B2D7 & 5B2D8)

This Sub Catchment is situated in the plain and hilly region of Gujarat, and Maharashtra drained by Dhodar nala, Bardanala, Nagihpar nala, Girna River, Zankari River and Dumas khadi. The total area of this Sub-Catchment is 2431 Sqkm. Subcatchment area of Purna Basin is shown in **Fig.-2.1.1**

Fig-2.1.1: Sub catchment area of Purna Basin as per water shed Atlas of India.



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

2.1.4 Climate

Accordingly to Koeppan's Scheme, the climate of the basin is classified as AW-Tropical Savannah as most of the peninsular plateau, south of Tropic of Cancer is classified. In the initial reaches, the climate is influenced by the Western Ghats which becomes continued as the river reaches the coastal plains. The climatic variations are experienced in the patterns of temperature, rainfall & winds, rhythm of seasons and degree of wetness or dryness. These are described as follows:

2.1.4.1 Temperature

The Temperature is maximum in the month of May and Minimum in the month of December to January. The maximum, minimum temperatures observed at site Mahuwa varies from 27^0 C to 46^0 C and 30^0 C to 10^0 C respectively. The temperature profile in the basin is given in the **Table -2.1.2**

Table-2.1.2: Mean monthly Temperature (^{0}C) during water year at site Mahuwa

Month	Mean Monthly Maximum Temperature (^{o}C)	Mean Monthly Minimum Temperature (^{o}C)
Jun-13	30.6	25.4
Jul-13	27.9	24.5
Aug-13	27.3	24.4
Sep-13	28.4	24.5
Oct-13	32.4	23.4
Nov-13	31.9	20.0
Dec-13	30.3	16.3
Jan-14	29.0	16.1
Feb-14	30.8	17.1
Mar-14	34.5	20.1
Apr-14	37.7	23.4
May-14	36.5	26.5
Annual mean	31.4	21.8

2.1.4.2 Rainfall

The basin receives most of the rainfall from the South West monsoon from June to September. Average annual rainfall in the basin is 1596.8 mm. The rainfall at site Mahuwa in Purna Basin shown in **Table - 2.1.3.**

Table -2.1.3 Mean annual rainfall at site Mahuwa in Purna Basin

Sl.No	Name of Site	Data available (No of Years)	Average Annual Rainfall (mm)	Average no of rainy days	Rainfall in the year 2013-14	No of rainy days in 2013-14
1	Mahuwa	28	1596.8	74	1948.8	92

Table-2.1.4: Seasonal Rainfall during Water Year 2013 at Mahuwa in Purna basin

Sl No	Name of Site	Seasonal Rainfall (mm) in 2013				Total Annual Rainfall
		Winter monsoon	Pre monsoon	South-West monsoon	Post monsoon	
		(Jan-Feb)	(Mar-May)	(June-Sept)	(Oct-Dec)	
1	Mahuwa	0	18.4	1603.4	43.6	1948.8

2.1.4.3 Wind

The wind speed and direction profile at site Mahuwa, based on collected data is given in **table -2.1.5**. The average monthly wind speed varies from 2.9 km/h to 0.2 km/h .In the pre and post-monsoon period, the wind speed is generally higher. The pre dominant wind direction is NE followed by SE and W.

Table 2.1.5: Wind Speed at site Mahuwa in Purna basin during Water Year 2013-14

Month	Mean monthly wind Speed (km/h)
June	0.7
July	1.3
August	1.0
September	0.5
October	0.2
November	0.4
December	0.3
January	0.5
February	0.7
March	0.6
April	0.8
May	1.5

2.1.4.4 Humidity

The relative Humidity in Purna basin at site Mahuwa varies between 97.7% and 66.4% depending upon the season. It is naturally maximum in the monsoon period and is around 84.2 to 97.7%. In the winter months of November and December, the relative humidity decreases. The relative humidity profile at station Mahuwa in Purna Basin is given in **table -2.1.6**

Table 2.1.6: Mean monthly Relative Humidity at site Mahuwa in Purna Basin during Water Year 2013-14

Month	Relative Humidity (%)
June	85.7
July	89.5
August	88.3
September	89.0
October	84.5
November	73.4
December	81.8
January	75.2
February	66.4
March	69.9
April	69.9
May	78.6
Annual Mean	78.6

2.1.5 Geology

The whole basin can be divided in to three prominent physiographic zones viz. i) the Eastern zone ii) the middle zone and ii) the coastal zone. The Eastern zone of the basin covers a chain of rugged mountain ranges of the Western Ghats. The middle zone of the basin is marked by high relief zone with ridges and valleys. The hilly region then merges in to the plains through a coastal piedmont coastal zone running parallel to the sea. Deccan traps occupy the most parts of the basin. In the East there are high ridges and deep valleys and towards the west, they merge into the lower reach composed of recent and sub recent alluvium and blown sand. The straight graphical sequences of the rocks found in the basin are Neogene's, Palaeogene and early Palaeogene.

2.1.6 Soil

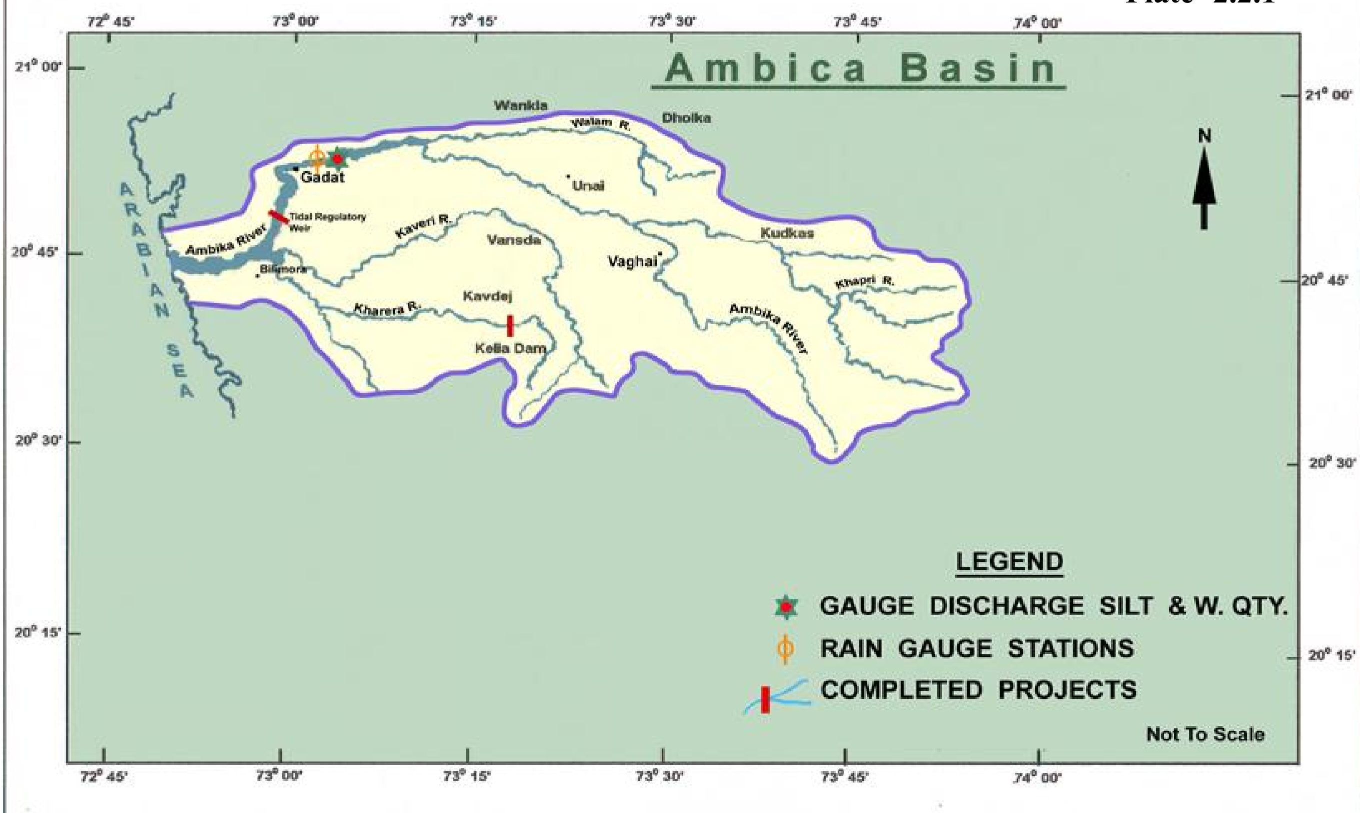
Soils of Purna basin can be classified into three groups viz lateritic soils, deep black soils and coastal alluvial soils.

2.2 Ambica Basin

2.2.1 Geographical setting of Ambica Basin

Ambica River is one of the important west flowing rivers with its catchment in Gujarat and Maharashtra. The Ambica basin which is adjacent to the Auranga basin can be divided in to two prominent physiographic zones. The eastern part comes under a rugged mountain chain of the Sahyadri Western Ghats and descending on the western side to the edge of the uplands of Surat district. This region is situated at general elevation ranging from 1050 m to 100 m. The western part consists of hills and valleys which generally lie below 100 m elevation. Its basin map is shown in **Plate -2.2.1.**

Plate -2.2.1

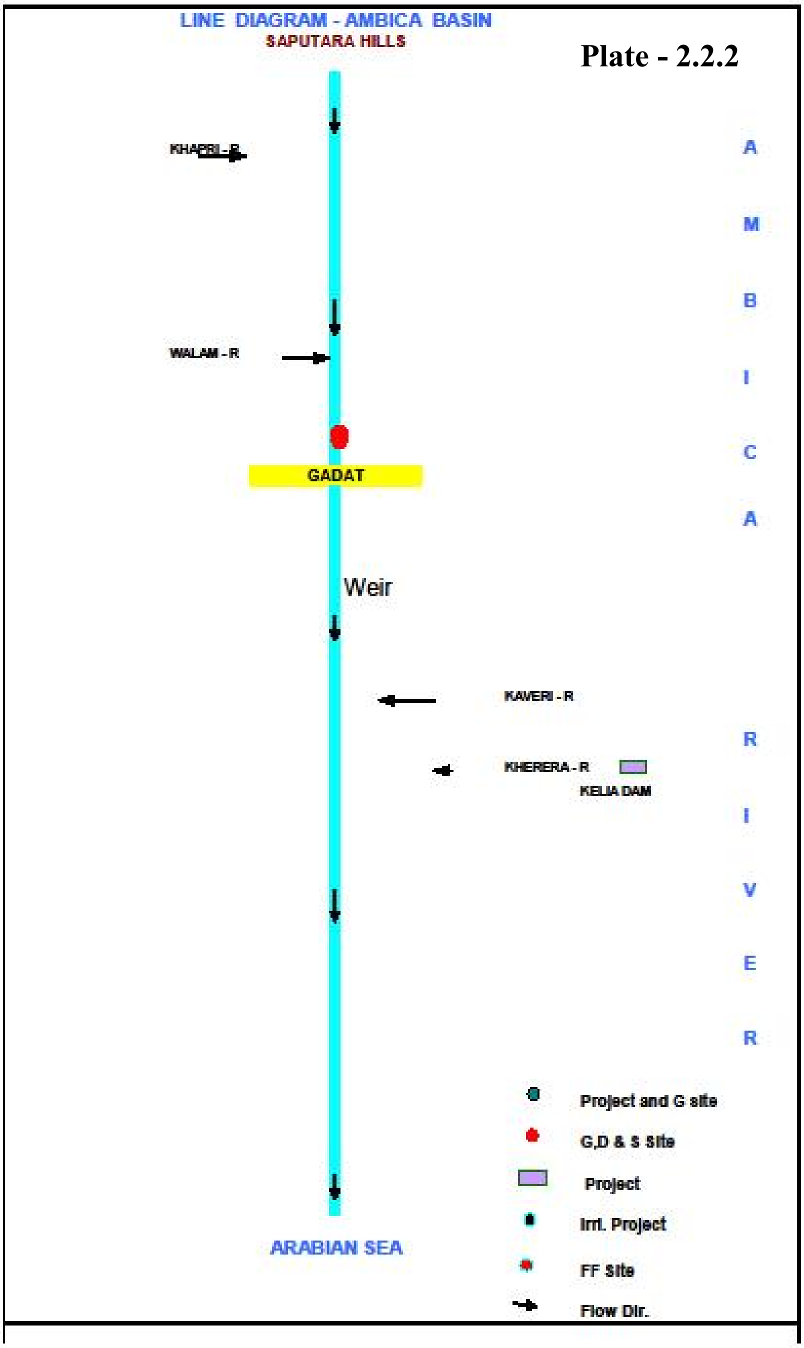


2.2.2 River System

It originates from Saputara Hill ranges near village Kotambi of Surgana taluka in the Nasik district of Maharashtra. After flowing for a length of 136 km it drains in to the Arabian Sea. The important tributaries of the Ambica River are Kapri, Wallan, Kaveri and Kharera. The river Ambica basin lies between 20° 31' and 20° 57' North latitude and 72° 48’ and 73° 52’ East longitude with a drainage area of 2715 Sq.km. The Valsad, Dangs and Surat Districts of Gujarat and a small portion of the Nasik district of Maharashtra falls in the basin, drainage area of Ambica River basin is shown in **Table-2.2.1** and line diagram of Ambica river system is shown in **Plate - 2.2.2.**

Table -2.2.1: State wise distribution of catchments area of the Ambica basin

Sl.No	State	Catchment Area (sq km)	% Of the total C.A.
1	Maharashtra	102	3.76
2	Gujarat	2613	97.24
	Total	2715	100.00



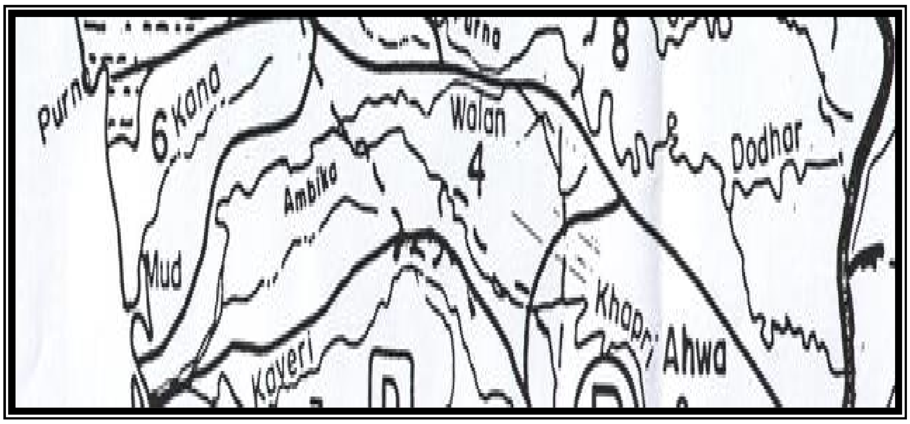
2.2.3 Ambica Basin as per Watershed Atlas of India

As per Watershed Atlas of India, Published by Department of Agriculture and Cooperation, Ministry of agriculture, Krishi Bhavan New Delhi (1990), the sub catchments from **5B2D** pertain to Ambica Basin, as shown in **Fig.-2.2.1.**

2.2.3.1 Sub-catchment -5B2D (5B2D3, 5B2D4 & 5B2D5)

This Sub Catchment is situated in the plain and hilly region of Gujarat, and Maharashtra drained by Kapri, Wallan, Kaveri and Kharera. The total area of this Sub-Catchment is 2715 Sqkm. Subcatchment area of Ambica Basin is shown in **Fig. 2.2.1**

Fig-2.2.1: Sub- catchment area of Ambica Basin as per water shed Atlas of India.



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

2.2.4 Climate

Accordingly to Koeppan's Scheme, the climate of the basin is classified as AW-Tropical Savannah, as most of the peninsular plateau, south of Tropic of Cancer, is classified. In the initial reaches, the climate is influenced by the Western Ghats which gradually changes as the river reaches the coastal plains. The climatic variations are experienced in the patterns of temperature, rainfall & winds, rhythm of seasons and degree of wetness or dryness. These are described as follows.

2.2.4.1 Temperature

The Temperature is maximum in the month of May and Minimum in the month of December to January. The maximum, minimum temperatures observed vary from 27.4^0C to 40^0C and 28.6^0C to 8^0 C respectively. The temperature profile in the basin is given in the **table 2.2.2**

Table-2.2.2: Mean monthly Temperature (^{0}C) during water year at site Gadat

Month	Mean Monthly Maximum Temperature (^{o}C)	Mean Monthly Minimum Temperature (^{o}C)
Jun-13	35.6	28.6
Jul-13	28	24.8
Aug-13	27.4	25.1
Sep-13	28.6	24.8
Oct-13	30.7	23.5
Nov-13	31.7	21.6
Dec-13	30.5	15.9
Jan-14	29.3	13
Feb-14	31.4	12.4
Mar-14	34.5	16.2
Apr-14	37.2	22.4
May-14	38.5	26.4
Annual mean	32.0	21.2

2.2.4.2 Rainfall

The basin receives most of the rainfall from the South West monsoon from June to September. Average annual rainfall in the basin is 1719.1 mm. The rainfall at site in Ambica Basin shown in **Table -2.2.3 & 2.2.4.**

Table -2.2.3: Mean annual rainfall of Ambica Basin at site Gadat

Sl. No	Name of Site	Data available (No of Years)	Average Rainfall (mm)	Average no of rainy days	Rainfall in the year 2013-14	No of rainy days in 2013-14
1	Gadat	31	1806.0	74	2041.3	84

Table-2.2.4: Seasonal Rainfall during Water Year 2013 at site Gadat in Ambica Basin

Sl No	Name of Site	Seasonal Rainfall (mm) in 2013				Total Annual Rainfall
		Winter monsoon	Pre monsoon	South-West monsoon	Post monsoon	
		(Jan-Feb)	(Mar-May)	(June-Sept)	(Oct-Dec)	
1	Gadat	0	0	1995.3	46.0	2041.3

2.2.4.3 Wind

The wind speed and direction profile at site Gadat based on collected data is given in T**able -2.2.5**.The average monthly wind speed varies from 0.3 km/h to 2.5 km/h .In the pre and post-monsoon period, the wind speed is generally higher. The pre dominant wind direction is NE.

Table 2.2.5: Wind Speed at site Gadat in Ambica basin during Water Year 2013-14

Month	Mean monthly wind Speed (km/h)
June	2.5
July	1.5
August	1.1
September	0.9
October	0.5
November	0.1
December	0
January	1.1
February	0.9
March	0.8
April	0.6
May	1.7
Annual Mean	1.0

2.2.4.4 Humidity

The relative Humidity in Ambica basin varies between 93.3 % to 82.0 % depending upon the season the humidity is naturally maximum in the monsoon period and is around 93.3 to 89.9 %. In the winter months of November and December the relative humidity comes down. The relative humidity at station of CWC representative of Purna Basin is given in T**able- 2.2.6**

Table -2.2.6: Mean monthly Relative Humidity at site Gadat in Ambica Basin during Water Year 2013-14

Month	Relative Humidity (%)
June	89.9
July	93.3
August	92.5
September	92.1
October	91.6
November	90.8
December	89.0
January	88.9
February	89.3
March	89.6
April	89.6
May	91.1
Annual Mean	90.6

2.2.5 Geology

The basin can be divided into two prominent physiographic zones. The eastern part comes under rugged mountain chains of the Saputara Hills and descends on the western side to the edge of the uplands of Surat district. This region is placed at a general elevation of 1050 m to 100 m. The western part, barring the coastal plain, is essentially in the sub Sahyadrin zone of hills and valleys generally below 100 m elevation. Deccan traps and intermediate amphitheatres have developed out of the alluvial debris washed from the hills. The lower reaches of the basin upto the coastal margins are mainly alluvial plains

2.2.6 Soil

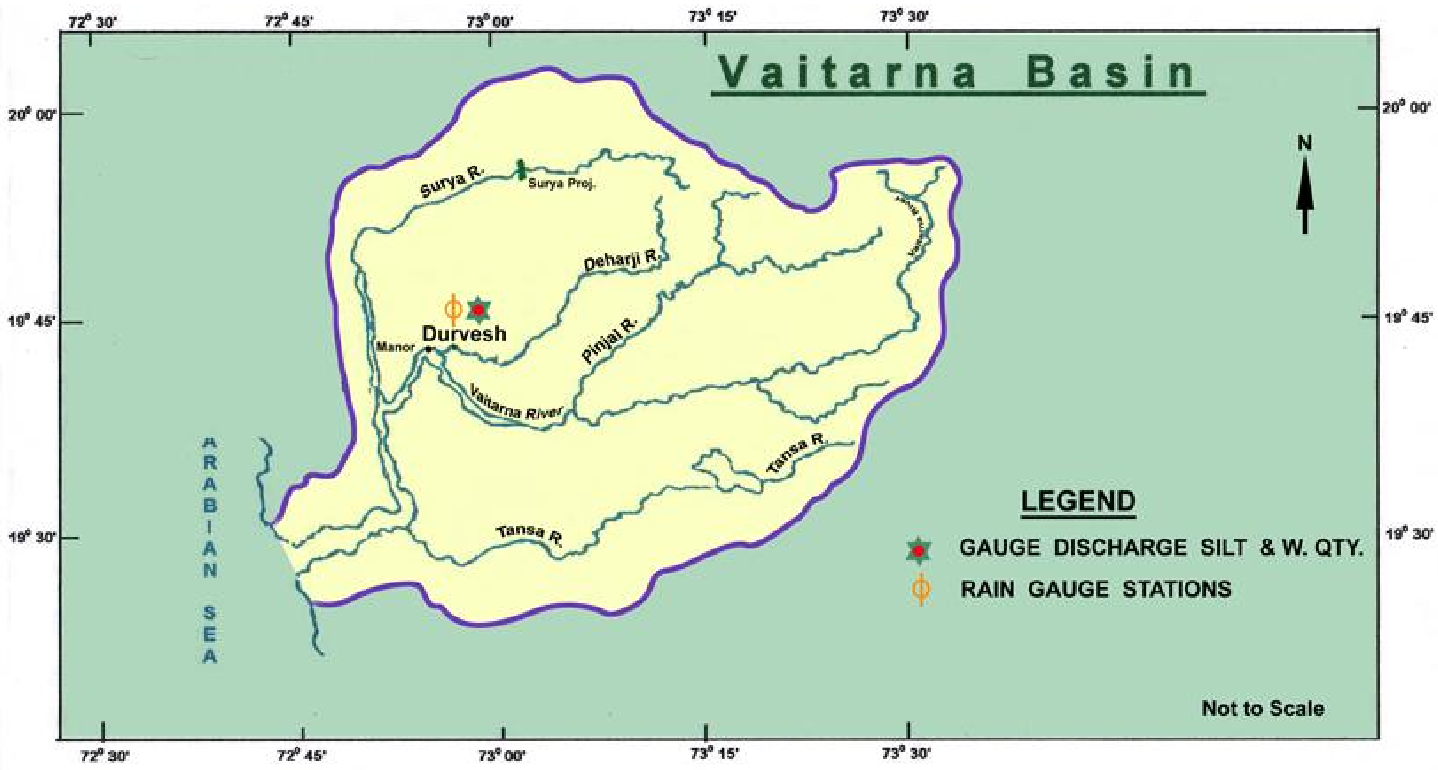
Soil of Ambica basin can be broadly classified into three group viz. Laterite soil, deep black soil and alluvial soil.

2.3 Vaitarna Basin

2.3.1 Geographical setting of Vaitarna Basin

The river Vaitarna is one of the west flowing rivers in the region North of Mumbai and South of the Tapi River. The river rises in the Sahyadri hill range in the Nasik district of Maharashtra State and after traversing a distance of about 120 km in Maharashtra joins the Arabian Sea. Basin map is shown in **Plate -2.3.1**. The Vaitarna basin lies between East longitude of 72^0 45' to 73^0 35' and North latitude of 19^0 25'to 20^0 20'.

Plate -2.3.1



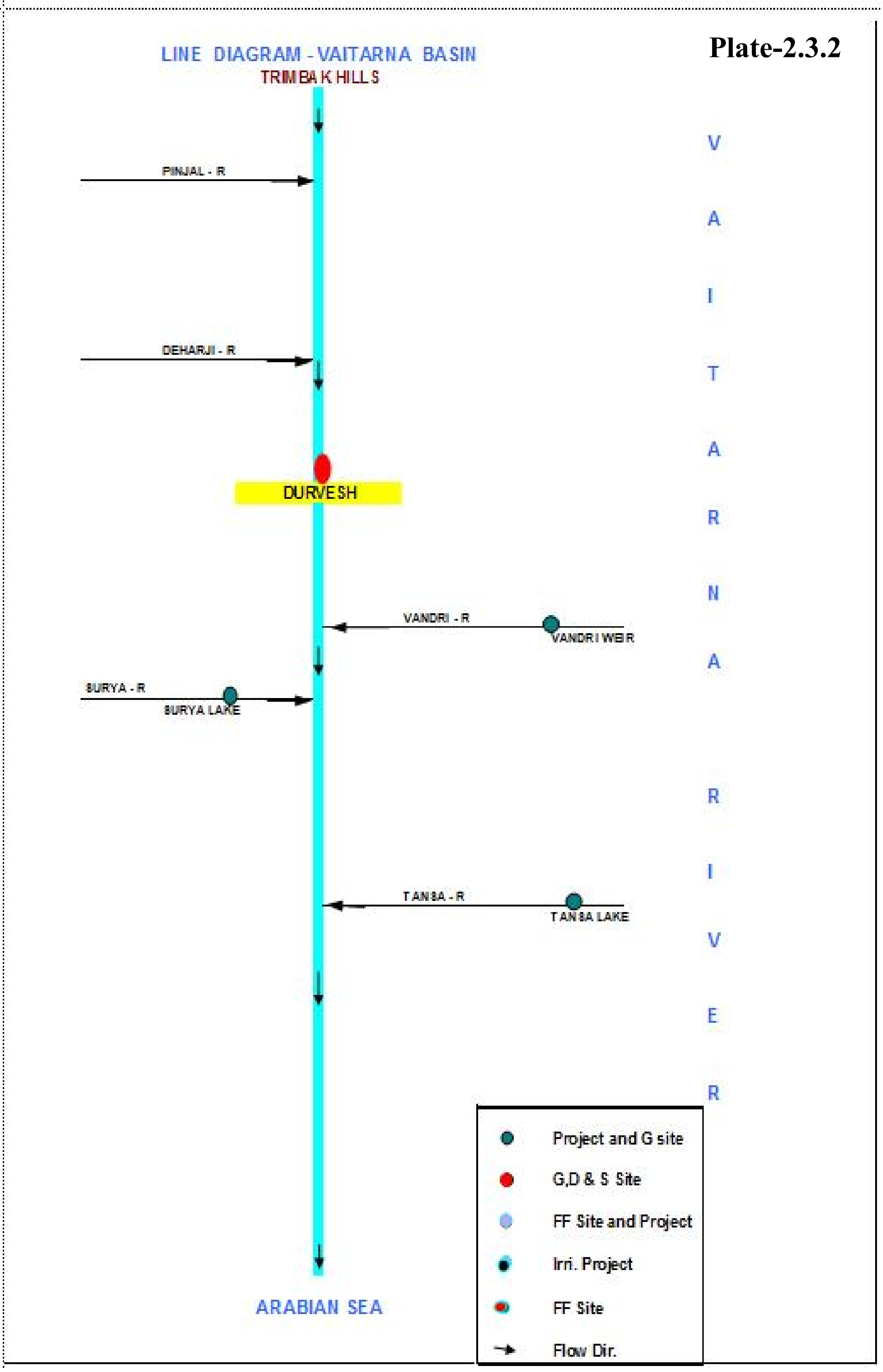
2.3.2 River System

The headstreams of the Vaitarna rise on the southern slopes of the Triambak-Anjaneri range and combine into three southward flowing streams which unite to form the Vaitarna a little north of Dapure. The Vaitarna from here has a very winding course southwards and goes round Zarwad (Jarwar) Budruk.

Due south of it, the river is joined by its tributary Alvand nadi, whose headstreams rise in the same Triambak Anjaneri range on the southern slopes of the Bhaskargad, Phani dongar and Harish dongar, which form the divide between these and those of the Val river flowing northwards. After the confluence with the Alvand river, the Vaitarna turns and flows nearly straight in a south-south-west direction cutting a deep gorge in the scarp of the Sahyadris. A small tributary from the northwest to south-east in a gorge continues the course of the Vaitarna in a remarkably deeply cut valley.

The main tributaries of Vaitarna river are Pinjal, Ganjai, Surya, Daharji, Tansa. The catchment area of Vaitarna basin completely lies in Thane and Nasik districts of Maharashtra. The Vaitarna drains an area of 2019 sq km before it falls in Gulf of Khambhat. A line diagram of Vaitarna river system is shown in **Plate -2.3.2**.

Plate-2.3.2



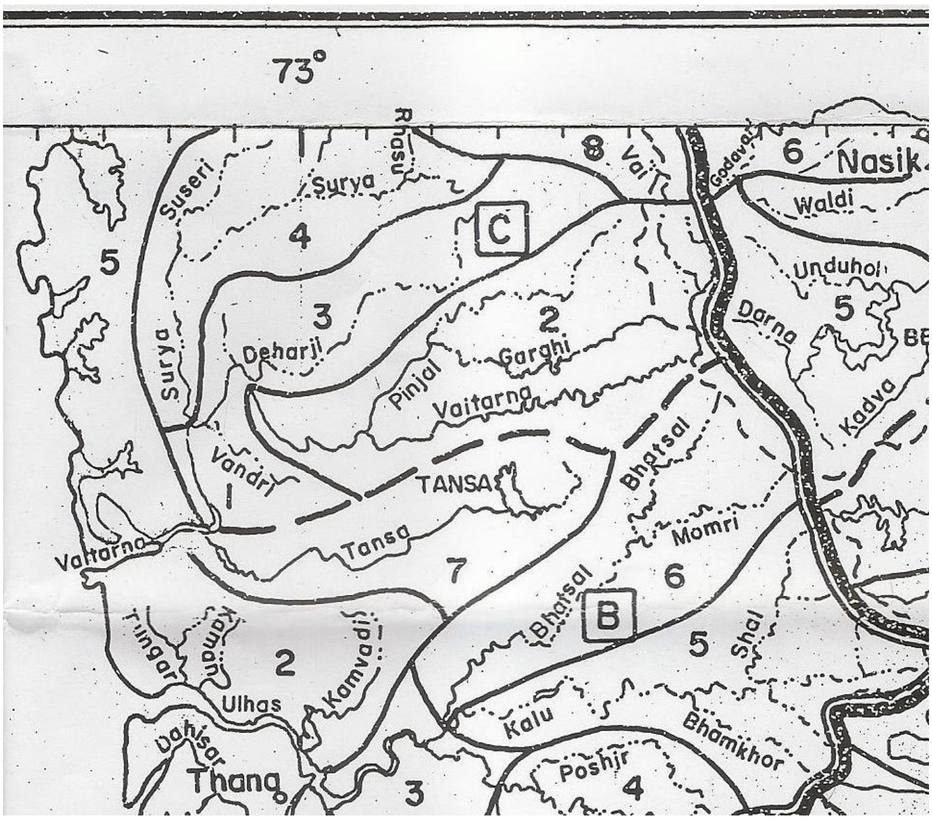
2.3.3 Vaitarna Basin as per Watershed Atlas of India

As per Watershed Atlas of India, Published by Department of Agriculture and Cooperation, Ministry of agriculture, Krishi Bhavan New Delhi (1990), the sub catchments from 5B2C pertain to Vaitarna Basin as shown in **Fig 2.3.1**.

2.3.3.1 Sub-catchment -5B2C (5B2C2 to 5B2C5)

This Sub Catchment is situated in the plain region of Maharashtra. Drained by main tributaries of Vaitarana River , Pinjal, Surya, Daharji, Tansa. The total area of this Sub-Catchment is 2019 sq km.

Fig 2.3.1 **Sub catchment area of Vaitarna Basin as per water shed Atlas of India.**



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

2.3.4 Climate

Accordingly to Koeppan's Scheme, the climate of the basin is classified as AW-Tropical Savannah, as most of the peninsular plateau, south of Tropic of Cancer is classified. In the initial reaches, the climate is influenced by the Western Ghats that becomes coastal as the river reaches coastal plains. The climatic variations are experienced in the patterns of temperature, rainfall & winds, rhythm of seasons and degree of wetness or dryness. These are described as follows.

2.3.4.1 Temperature

The Temperature is maximum in the month of May and Minimum in the month of December to January. The temperature profile in the basin is given in the Table-2.3.1.

Table-2.3.1: Mean monthly Temperature (^{0}C) during water year at site Durvesh

Month	Mean Monthly Maximum Temperature (^{o}C)	Mean Monthly Minimum Temperature (^{o}C)
Jun-13	31.4	25.3
Jul-13	28.8	24.8
Aug-13	29.3	24.9
Sep-13	31.1	24.6
Oct-13	32.1	24.1
Nov-13	33.4	20.1
Dec-13	31.1	16.1
Jan-14	30.9	15.8
Feb-14	32.8	15.8
Mar-14	35.4	20.4
Apr-14	38.7	23.9
May-14	39.9	28.7
Annual mean	32.9	22.0

2.3.4.2 Rainfall

The basin receives most of the rainfall from the South West monsoon during June to October. Almost 98% of the annual rainfall of the basin is received during this period. The rainfall at site in Vaitarna Basin shown in **Table-2.3.2** and **Table-2.3.3**.

Table-2.3.2 Mean annual rainfall of Vaitarna Basin at site Durvesh

Sl. No	Name of Site	Data available (No of Years)	Average Rainfall (mm)	Average no of rainy days	Rainfall in the year 2013-14	No of rainy days in 2013-14
1	Durvesh	32	2595.5	97	3176.2	105

Table-2.3.3: Seasonal Rainfall during Water Year 2013at site Durvesh in Vaitarna basin

Sl No	Name of Site	Seasonal Rainfall (mm) in 2013				Total Annual Rainfall
		Winter monsoon	Pre monsoon	South-West monsoon	Post monsoon	
		(Jan-Feb)	(Mar-May)	(June-Sept)	(Oct-Dec)	
1	Durvesh	0	0	3017	159.2	3176.2

2.3.4.3 Wind

The wind speed and direction profile at site Durvesh based on collected data is given in **Table-2.3.4**. The average wind speed in the Vaitarna basin varies about 1.7 km/h to 6.8 km/h. In the pre and post-monsoon period, the wind speed is generally higher. The predominant wind direction is SW.

Table-2.3.4:Wind Speed at site Durvesh inVaitarna basin during Water Year 2013-14

Month	Mean monthly wind Speed (km/h)
June	4.5
July	5.4
August	4.4
September	3.2
October	2.2
November	2.2
December	2.1
January	2.3
February	2.6
March	2.8
April	3.0
May	3.7
Annual Mean	3.2

2.3.4.4 Humidity

The relative Humidity in Vaitarna basin varies between 92.0 % and 70.0 % depending upon the season. Humidity is maximum in the monsoon period about 92.0 % to 87.9 %. In the winter months of November and December, it decreases. Relative humidity at Durvesh station of CWC is given in **Table-2.3.5**.

Table-2.3.5: Mean monthly Relative Humidity at site Durvesh in Vaitarna Basin during Water Year 2013-14

Month	Relative Humidity (%)
June	87.9
July	91.5
August	90.7
September	91.6
October	89.9
November	86.7
December	85.7
January	86.4
February	85.3
March	82.8
April	82.3
May	81.0
Annual Mean	86.8

2.3.5 Geology

The Great Trap region of the Deccan covers the maximum part of the Basin. It is entirely of volcanic formation. The volcanic portion consists of compact, stratified basalts, and an earthy trap. The basalts are the most conspicuous geological feature. To the west they lie in flat-topped ranges, separated by valleys, trending from west to east. In some flows the- basalt is columnar and then it weathers into the fantastic shapes. The formation at the base of the traps is chiefly amygdaloidal, containing quartz in vertical veins, crystals and zeolitic minerals, especially apophyllite weathering into a gray soil. The absence of laterite, which caps the summits of the hills to the south, is a curious feature in the geology of the area. The basalt is either fine textured or it is coarse and nodular.

2.3.6 Soil

The valleys are filled with disintegrated basalt of various shades from gray to black, washed down by rain. It is of argillaceous nature. This soil is not favorable to the growth of large trees but it is very fertile for cereals and pulses. The black soil contains high alumina and carbonates of calcium and magnesium with variable amounts of potash, low nitrogen and phosphorus. There are broadly two groups of soils: 1) Red coarse soil & 2) Alluvial soil

The red soil is less common and is suitable for cultivation under a heavy and consistent rainfall. Red coarse soil derived from disintegration of basaltic rock fragments under heavy rainfall. The rock fragments have undergone intensive weathering and beaching with the surface weathered and fragmented materials being carried away with the heavy run off in the monsoon period. The residual soil left behind is usually reddish yellow in colour, shallow in depth, coarse sandy loam to sandy loam in texture, rapidly drained and low in fertility. Alluvial soil formed with the deposition of transported materials brought out by heavy run off. This soil is deep to very deep yellowish brown to grayish brown in colour and clay loam to salty loam in texture. This soil is normally free from salinity and alkalinity.

2.3.7 Major / Medium/ multipurpose/ irrigation projects

The major and medium projects completed / ongoing on Vaitarna river basin are as shown in **Table-2.3.6**

Table-2.3.6: List of major and medium projects completed / on going on Vaitarna river basin

Sl. No	Name of the project	River	Status	Capacity in Mcm		Utilisation
				Gross	Live	
1.	Vaitarn Hydro Electric Project. (upper Vaitarna)	Vaitarna	Major	301.60	295.80	Multipurpose
2.	Surya Project.	Surya	Major	285.31	276.35	Multipurpose
3.	Modak Sagar (Lower Vaitarna)	Vaitarna	Medium	N.A.	N.A.	Irrigation
4.	Wandra Project	Wandria	Medium	37.11	35.938	-do-
5.	Deharji River Project	Deharji	Medium	93.120	89.840	-do-
6.	Tansa Dam	Tansa	Medium	N.A.	N.A.	Multipurpose

2.3.7.1 Vaitarna hydropower project

Vaitarna hydropower project is located near Vaitarna and Alwandi masonry and earthen dam on Vaitarna and Alwandi Rivers, 30 km from Ghoti, in Nashik District, Maharashtra. The catchment area at the dam is 160.8 km2. The height and length of the dam is 47 m and 555 m respectively. The reservoir has a live storage capacity of 35 MCM at FRL 603.5 m and the MDDL is at 580 m. The power house has a unit of 60 MW. It has a firm power of 11 MW with mean annual inflow of 635 MCM. MSEB commissioned the project in 1976.

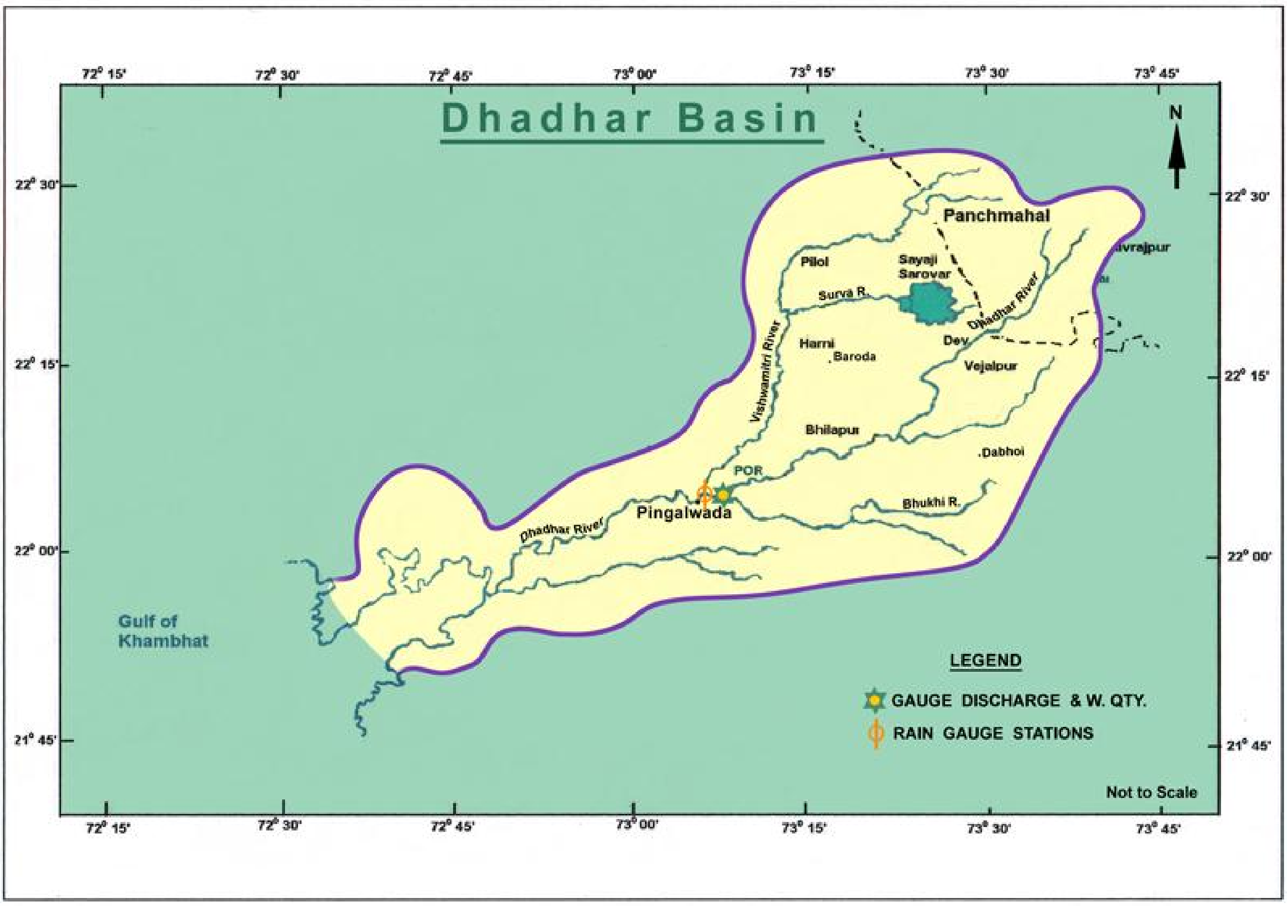
2.4 Dhadhar Basin

2.4.1 Geographical setting of Dhadhar Basin

The Dhadhar River is one of the west flowing rivers in Gujarat state. It originates from the Pavagadh Hills of Gujarat state and flows through Vadodara and Bharuch districts. The river Dhadhar after flowing 87 km receives Vishwamitri tributary from right bank at Pingalwada village 500 m upstream of Gauge and Discharge site. After flowing another 55 km it falls into the Gulf of Khambhat. The total length of the river from its source to outfall in the Gulf of Khambhat is about 142 km.

Basin map is shown in **Plate -2.4.1**.

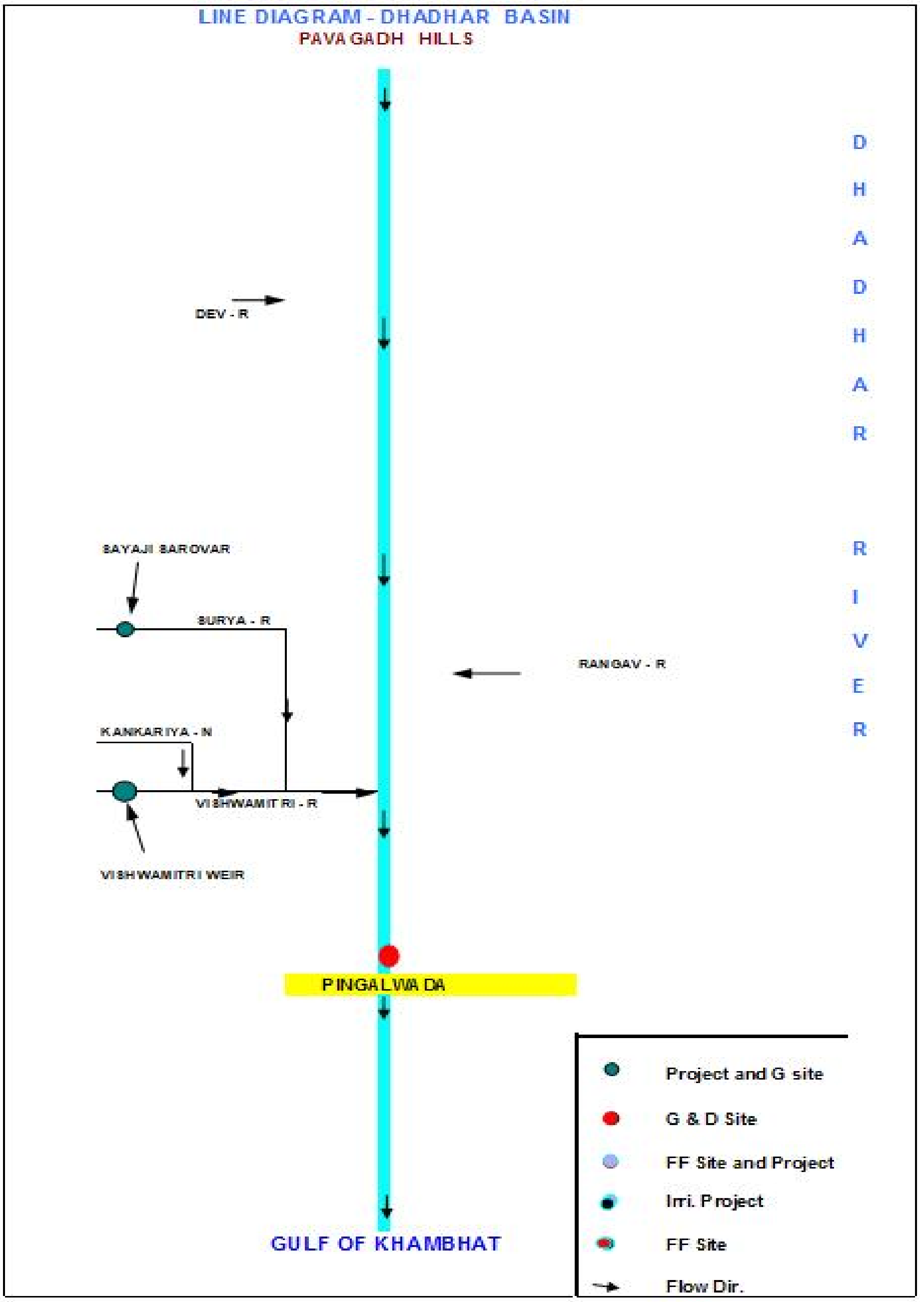
Plate- 2.4.1



2.4.2 River System

The important tributaries of the Dhadhar River are Vishwamitri, Jambuoriver, Dev and Surya River. The catchment area of the Dhadhar basin is 3423 Sq.km. and catchment area up to the site is 2400 Sq.km. It lies between east longitude 72° 30’ and 73° 45’ and North latitude 21° 45’ and 22° 45’. Line diagram of Dhadhar river system is shown in **Plate -2.4.2**.

Plate -2.4.2.



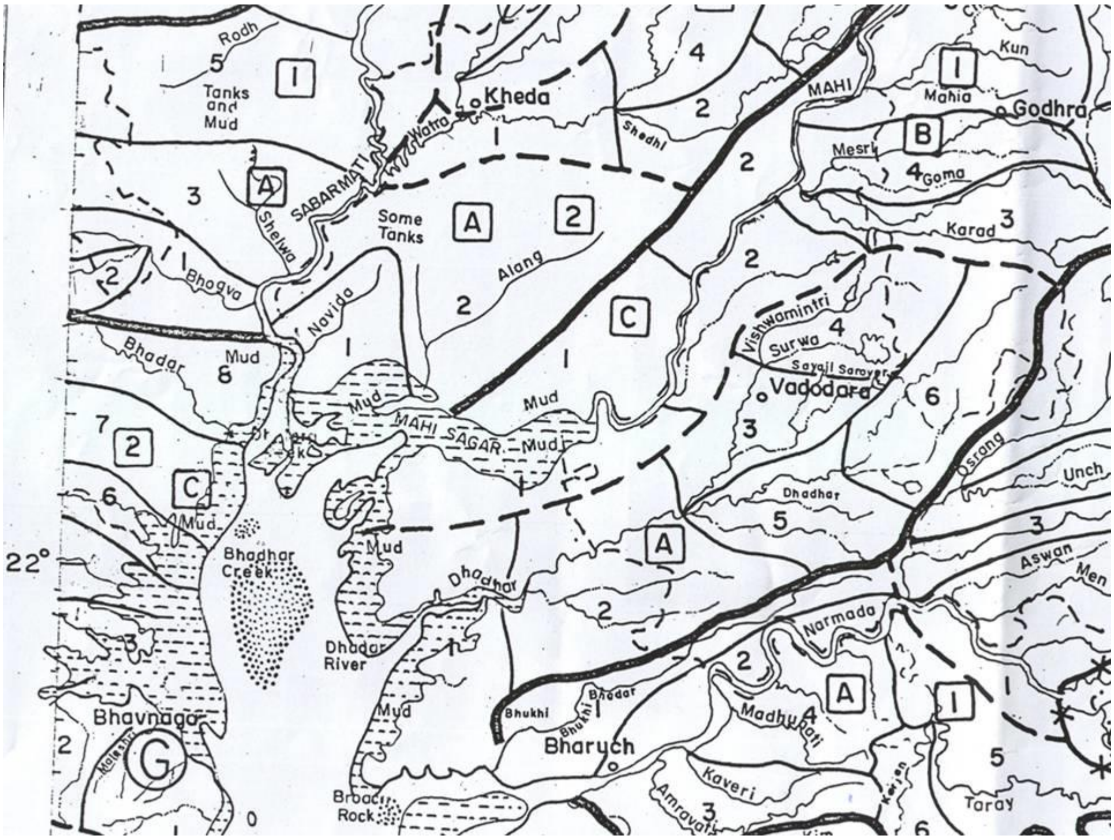
2.4.3 Dhadhar Basin as per Water Shed Atlas of India

As per Watershed Atlas of India, Published by Department of Agriculture and Cooperation, Ministry of agriculture, Krishi Bhavan New Delhi (1990), the sub catchments from 5E1A pertain to Dhadhar Basin as shown in **Fig 2.4.1**.

2.4.3.1 Subcatchment -5E1A (5E1A1 to 5E1A6)

This Sub Catchment is situated in the plain region of Gujarat, The important tributaries of the Dhadhar River are Vishwamitri, Jambuo river, Dev and Surya river. The total area of this Sub-Catchment is 3423 sqkm.

Fig 2.4.1: Sub catchment area of Dhadhar Basin as per water shed Atlas of India.



Source: Watershed Atlas of India, Published by Department of Agriculture and Cooperation, Ministry of Agriculture, Krishi Bhavan New Delhi (1990)

2.4.4 Climate

The Dhadar basin experiences seasons – summer (Mar-May), Monsoon (June-Sep) & winter (Oct-Feb). The major part of basin comprises tropical wet climate, caused mainly due to existence of the Western Ghats. Due to relatively high elevation in forest land, the area of the basin near the origin of the river experiences relatively cooler climate.

Accordingly to Koeppan's Scheme, the climate of the basin is classified as AW-Tropical Savannah as most of the peninsular plates, south of Tropic of Cancer are classified. The climatic variations are experienced in the patterns of temperature, rainfall & winds, whether of seasons and degree of wetness or dryness. These are described as follows.

2.4.4.1 Temperature

The Temperature is maximum in the month of May and Minimum in the month of December to January. The temperature profile in the basin is given in the **table -2.4.1**

Table-2.4.1: Mean monthly Temperature (^{0}C) during water year at site Pingalwada

Month	Mean Monthly Maximum Temperature (^{o}C)	Mean Monthly Minimum Temperature (^{o}C)
Jun-13	32.5	26.3
Jul-13	28.8	24.8
Aug-13	28.9	24.6
Sep-13	30.1	24.4
Oct-13	31.5	23.6
Nov-13	29.7	18.1
Dec-13	27.3	13.8
Jan-14	25.6	12.1
Feb-14	27.7	13.8
Mar-14	32.4	18.8
Apr-14	38.1	22.9
May-14	40.2	27.0
Annual mean	31.1	20.9

2.4.4.2 Rainfall

The basin receives most of the rainfall from the South West monsoon during June to October. Almost 98% of the annual rainfall of the basin is received during this period. The average annual rainfall in the Dhadar basin is 900.1 mm. The South - West monsoon sets in by the middle of June and withdraws by the first week of October. The rainfall is mainly influenced by the southwest monsoon. The effect is most pronounced in Vadodara lying on the windward side of the Western Ghats.

The rainfall at site Pingalwada in Dhadhar Basin is shown in **Table -2.4.2** and **Table-2.4.3.**

Table-2.4.2 Mean annual rainfall of Dhadhar Basin at site Pingalwada

Sl. No	Name of Site	Data available (No of Years)	Average Annual Rainfall (mm)	Average no of rainy days	Rainfall in the year 2013-14	No of rainy days in 2013-14
1	Pingalwada	23	900.1	44	1793.6	61

Table-2.4.3 Seasonal Rainfall during Water Year 2013 at site Pingalwada

Sl No	Name of Site	Seasonal Rainfall (mm) in 2013				Total Annual Rainfall
		Winter monsoon (Jan-Feb)	Pre monsoon (Mar-May)	South-West monsoon (June-Sept)	Post monsoon (Oct-Dec)	
1	Pingalwada	0	0	1700.6	93	1793.6

2.4.4.3 Wind

The wind speed data of the Dhadhar basin is given in table -2.4.4. The monthly average wind speed in the Dhadhar basin varies about 1.7 km/h and 6.8 km/h. in the pre and post monsoon period. During monsoon the monthly average wind speed is generally higher than 4.2 km/h.

In general, wind speed is the lowest in post monsoon period (Oct-Nov) & the highest in June. The pre dominant wind direction is NE/SE. The wind direction remains uniform from post monsoon till early winter i.e. Oct – Feb. Change of direction takes place in March/April. It is observed at site that the dominant wind direction is from North east and east respectively during post monsoon and in winter changes to Westerly and South westerly.

Table-2.4.4: Wind Speed at site Pingalwada in Dhadhar basin during Water Year 2013-14

Month	Mean monthly wind Speed (km/h)
June	*
July	*
August	*
September	*
October	*
November	*
December	*
January	*
February	*
March	1.7
April	1.4
May	1.4
Annual Mean	-

Note: * instrument not working

2.4.4.4 Humidity

The relative Humidity in Dhadhar basin varies between 90.1 % to 66.8 % depending upon the season. Humidity is maximum in the monsoon period and is around 90.1 to 73.8 %. In the winter months of November and December, it decreases. Relative humidity at station Pingalwada in Dhadhar Basin is given in table -2.4.5.

Table-2.4.5: Mean monthly Relative Humidity at site Pingalwada in Dhadhar Basin during Water Year 2013-14

Month	Relative Humidity (%)
June	83.4
July	90.1
August	86.9
September	83.6
October	85.0
November	76.3
December	80.0
January	78.9
February	79.3
March	75.5
April	76.5
May	72.6
Annual Mean	80.7

2.4.5 Geology

The Late Pleistocene fluvial succession is exposed as 18–20 m high incised vertical cliffs all along the Dhadhar River basin in western India. The major fluvial sedimentary facies of the Late Pleistocene deposits in the Dhadhar River basin have preserved evidence of palaeo-drainage and could provide an important link between the sub-humid Narmada basin in the south and the semi-arid Mahi basin in the north. The sedimentary facies documented include overbank fines, which are associated with crevasse splays. Fine grained overbank sediments are interpreted as having formed by sheet flow of sediments over the banks of minor distributary channels during the flood stage. The overlying thinly stratified fluvial sands and silts, at the top of the exposed sediment succession show a thin cap of aeolian sediments suggesting less intense aeolian activity than that observed in Sabarmati, Mahi and Orsang basins, though a significant reduction in fluvial activity is suggested during the arid phase of the LGM.

However, the river may still have been perennial assuming that it retained the larger part of the catchment.

2.4.6 Major/Medium/Multipurpose/Irrigation projects

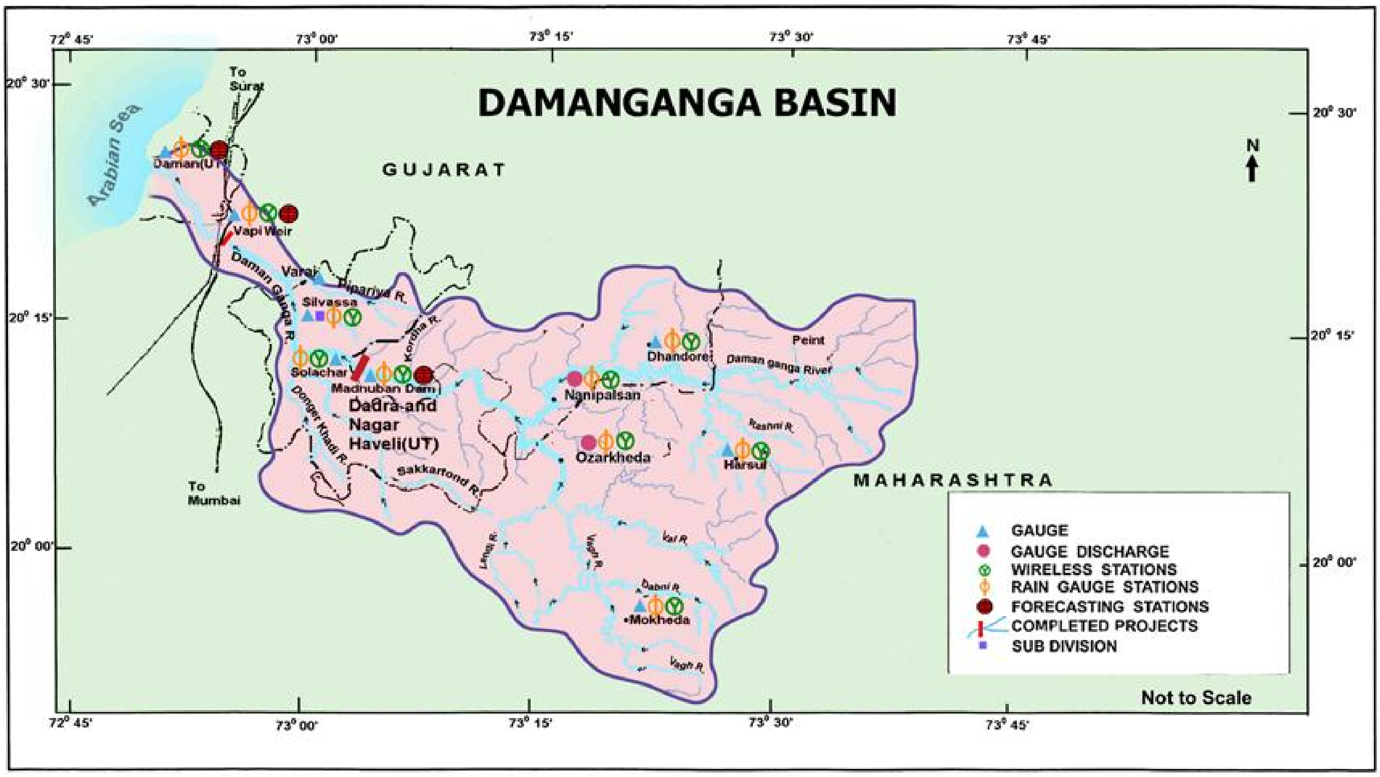
Ajwa tank, Pratap pura, Uma Bhariara, Dhanora, Ghansarva, Haripura, Vadodara, Deo Dam are the medium existing/ongoing projects in the basin.

2.5 Damanganga Basin

2.5.1 Geographical setting of Damanganga Basin

The Damanganga river rises in the Sahyadri hill ranges near village Ambegaon in Dindori taluka of Nasik district of Maharashtra State at an elevation of 950 m above MSL and traverses a total distance of about 131.30 km before it drains into the Arabian Sea at Daman. Damanganga along with its tributaries mainly flows through the hilly areas of Maharashtra, Gujarat and Union Territory Dadra and Nagar Haveli and Daman. Basin map is shown in **Plate-2.5.1**. It drains total area of 2318 sq km in Maharashtra State, Gujarat State and the Union Territories of Dadra, Nagar Haveli (DNH) and Daman & Diu before it drains into the Arabian Sea. The Damanganga River flows through Maharashtra State, Gujarat State and U.Ts. of DNH and Daman & Diu, while Vagh river up to Khargihill dam entirely lies in Maharashtra State.

Plate-2.5.1



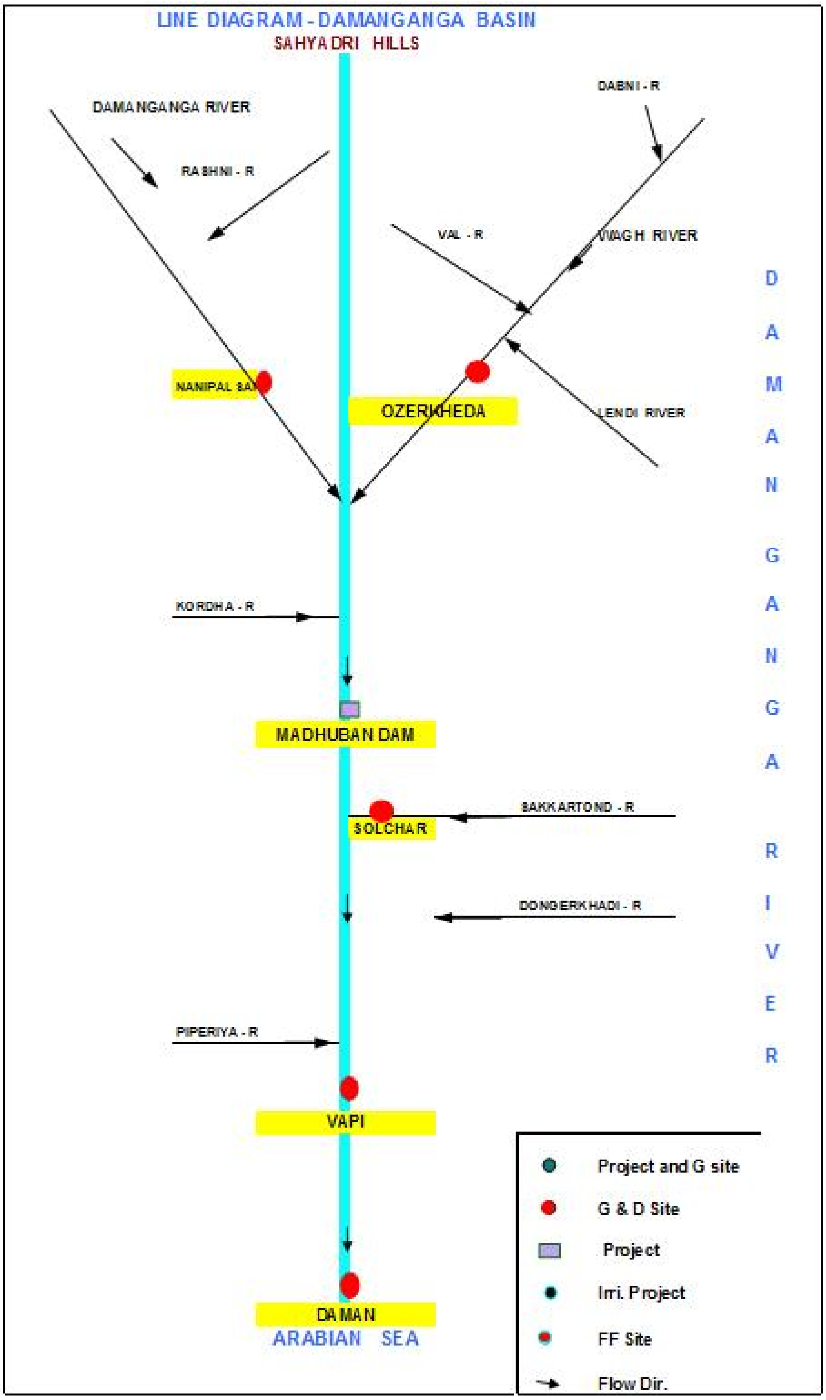
2.5.2 River System

The catchment of the river is fan shaped and the river is prone to severe flashy floods The important tributaries of the Damanganga river are Dawan, Shrimant, Val, Rayte, Lendi, Vagh, Sakartond, Dongarkhadi, Roshni and Dudhni. The Damanganga river drains total 2318 sq km. Drainage area of Damanganga River basin is shown in **Table-2.5.1** and line diagram of Damanganga river system is shown in **Plate-2.5.2**.

Table -2.5.1: State wise Distribution of drainage area of Damanganga River

Sl. No	Name of District / State	Catchment area (Sq km)	% of total catchment area
1	Nasik / Maharashtra	1408	60.74
2	Valsad / Gujarat	495	21.36
3	Dadara & Nagar Havali & Daman U.T.	415	17.90
	Total	2318	100.00

Plate-2.5.2



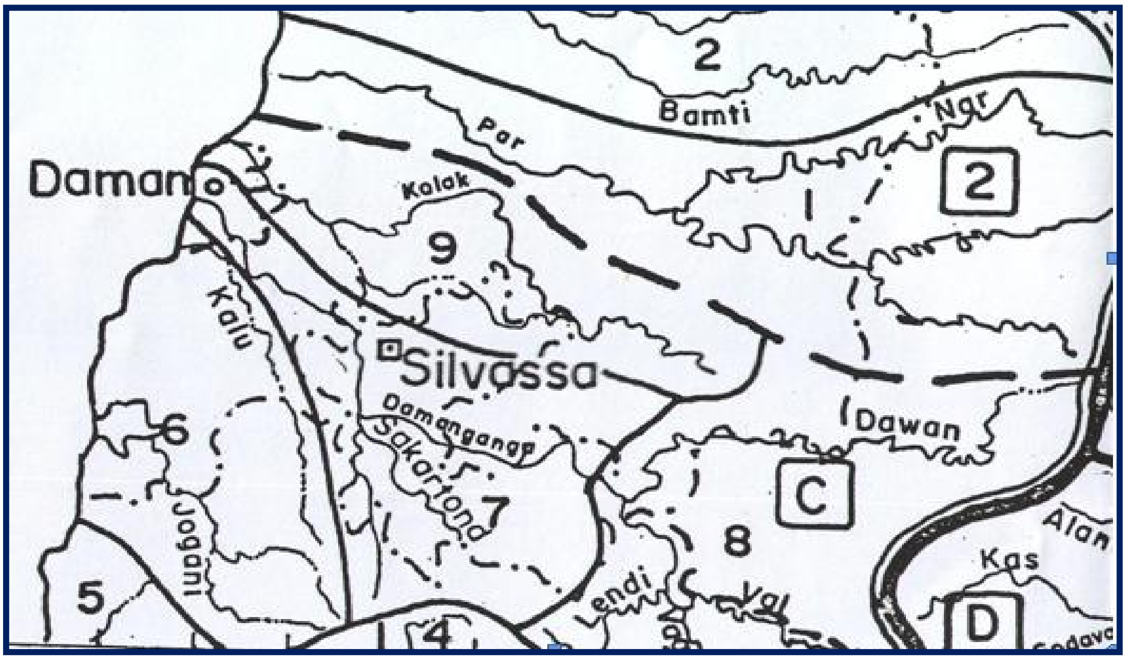
2.5.3 Damanganga Basin as per Watershed Atlas of India

As per Watershed Atlas of India, Published by Department of Agriculture and Cooperation, Ministry of agriculture, Krishi Bhavan New Delhi (1990), the sub catchments from 5B2C pertain to Damanganga Basin. Shown in **Fig-2.5.1**.

2.5.3.1 Sub catchment -5B2C (5B2C7 & 5B2C8)

This Sub Catchment is situated in the plain and hilly region of Gujarat, Maharashtra and Union territory (DNH) drained by Lendi, Sakkartond, Rashni, Val, Vagh, Donger Khadi, Pipariya, and Varai. The total area of this Sub-Catchment is 2318 sq km.

Fig-2.5.1: Sub-catchment area of Damanganga Basin as per watershed Atlas of India.



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

2.5.4 The Climate

The entire Damanganga Basin lies in the Western Ghats region. It is bound on the west by Arabian Sea and on the east by Sahyadri ranges. The climate of the basin is characterised by a hot summer, which is generally dry except the southwest monsoon during June to September.

Accordingly to Koeppan's Scheme, the climate of the basin is classified as AW-Tropical Savannah as most of the peninsular plateau, south of Tropic of Cancer, is classified. The climatic variations are experienced in the patterns of temperature, rainfall & winds, whether of seasons and degree of wetness or dryness. These are described as follows

2.5.4.1 Temperature

The Temperature is maximum in the month of May and Minimum in the month of December to January. The temperature profile in the basin is given in the Table-2.5.2

Table-2.5.2; Mean monthly Temperature (^{0}C) during water year at site Nanipalsan & Ozerkheda in Damanganga Basin

Name of Site	Nanipalsan		Ozerkheda	
Month	Mean Monthly Maximum Temperature (^{o}C)	Mean Monthly Minimum Temperature (^{o}C)	Mean Monthly Maximum Temperature (^{o}C)	Mean Monthly Minimum Temperature (^{o}C)
Jun-13	31.0	24.4	30.8	22.8
Jul-13	27.1	23.7	25.6	22.7
Aug-13	27.5	23.0	26.5	22.7
Sep-13	29.8	23.2	29.1	22.7
Oct-13	32.5	22.0	31.0	22.3
Nov-13	33.3	17.6	33.6	20.0
Dec-13	32.1	13.8	34.8	13.2
Jan-14	30.6	13.3	31.8	13.2
Feb-14	32.4	14.0	32.0	12.9
Mar-14	35.6	17.9	34.7	17.4
Apr-14	38.4	21.6	38.1	21.2
May-14	38.4	24.9	37.0	24.0
Annual mean	32.4	20.0	32.1	19.6

2.5.4.2 Rainfall

The basin receives most of the rainfall from the South West monsoon during June to October. Almost 98% of the annual rainfall of the basin is received during this period. The rainfall at site in Damanganga Basin as shown in Table -**2.5.3**. & table **2.5.4**

Table -2.5.3: Mean annual rainfall of Damanganga Basin

Sl. No	Name of Site	Data available (No of Years)	Average Rainfall (mm)	Average no of rainy days	Rainfall in the year 2013-14	No of rainy days in 2013-14
1	Ozerkheda	Data of this site for year 2013, is under review				
2	Nanipalsan	28	2163.9	91	2667.8	104

Table-2.5.4: Seasonal Rainfall during Water Year 2013 at site Nanipalsan & Ozerkheda in Damanganga Basin

Sl No	Name of Site	Seasonal Rainfall (mm) in 2013				Total Annual Rainfall
		Winter monsoon (Jan-Feb)	Pre monsoon (Mar-May)	South-West monsoon (June-Sept)	Post monsoon (Oct-Dec)	
1	Nanipalsan	0	0	2602.6	65.2	2667.8
2	Ozerkheda	Data of this site for year 2013,is under review				

2.5.4.3 Wind

The wind speed data of the Damanganga basin at two sites viz Ozerkheda and Nanipalsan are given in **Table -2.5.5**. The average wind speed in the Damanganga basin varies about 0.7 km/h to 4.3 km/h. in the pre and post monsoon period.

Table -2.5.5: Wind Speed at site Ozerkheda & Nanipalsan in Damanganga basin basin during Water Year 2013-14

Month	Mean monthly wind Speed (km/h)	
	Ozerkheda	Nanipalsan
June	2.1	2.3
July	1.2	2.2
August	1.1	1.8
September	1.0	1.5
October	0.8	1.2
November	0.7	1.3
December	0.7	1.1
January	1.4	1.7
February	1.9	2.1
March	2.6	3.0
April	2.6	3.3
May	3.3	3.9
Annual Mean	1.6	2.1

2.5.4.4 Humidity

The relative Humidity in Damanganga basin varies between 65.5 % and 91.9 %, depending upon the season. Humidity reaches maximum value during the monsoon period in the range of about 91.9 to 81.8 %. In the winter months of November and

December, it decreases. Relative humidity at Ozerkheda and Nanipalsan stations of CWC in Damanganga Basin is given in **Table-2.5.6**.

Table-2.5.6: Mean monthly Relative Humidity at site Ozerkheda & Nanipalsan in Damanganga Basin during Water Year 2013-14

Month	Relative Humidity (%)	
Name of Site	Ozerkheda	Nanipalsan
June	89.7	89.2
July	91.0	91.6
August	90.5	91.2
September	90.2	91.2
October	91.0	91.4
November	90.3	89.3
December	86.1	88.6
January	81.1	88.5
February	82.0	87.6
March	85.7	78.2
April	83.8	74.8
May	86.6	81.2
Annual Mean	87.3	86.9

2.5.5 Geology

The Great Trap region of the Deccan covers substantial part of the Basin. It is entirely of volcanic formation. The volcanic portion consists of compact, stratified basalts, and an earthy trap. The basalts are the most conspicuous geological feature. To the west they lie in flat-topped ranges, separated by valleys, trending from west to east. In some flows the basalt is columnar and then it weathers into the fantastic shapes. The formation at the base of the traps is chiefly amygdaloidal, containing quartz in vertical veins, crystals and zeolitic minerals, especially apophyllite weathering into a gray soil. The absence of laterite, which caps the summits of the hills to the south, is a curious feature in the geology of the area. The basalt is either fine textured or it is coarse and nodular.

2.5.6 Soil

Soils found in Damanganga basin can broadly be divided in three groups:

1) Red coarse soil
2) Coastal Alluvial soil
3) Black soil

The red soil is less common and is suitable for cultivation under a heavy and consistent rainfall. Red coarse soil is derived from disintegration of basaltic rock fragments under heavy rainfall. It is shallow in depth, coarse sandy loam to sandy loam in texture, rapidly drained and low in fertility. The alluvium is deep to very deep yellowish brown to grayish brown in colour and clay loam to salty loam in texture. This soil is normally free from salinity and alkalinity. The black soil is very fertile for cereals and pulses. The black soil contains high alumina and carbonates of calcium and magnesium with variable amounts of potash, low nitrogen and phosphorus.

2.5.7 Major / Medium/multipurpose/irrigation projects

The important project of this basin is Damanganga project. The salient features of the important components of Madhuban dam of Damanganga projects are as follows.

2.5.7.1 Madhuban Dam

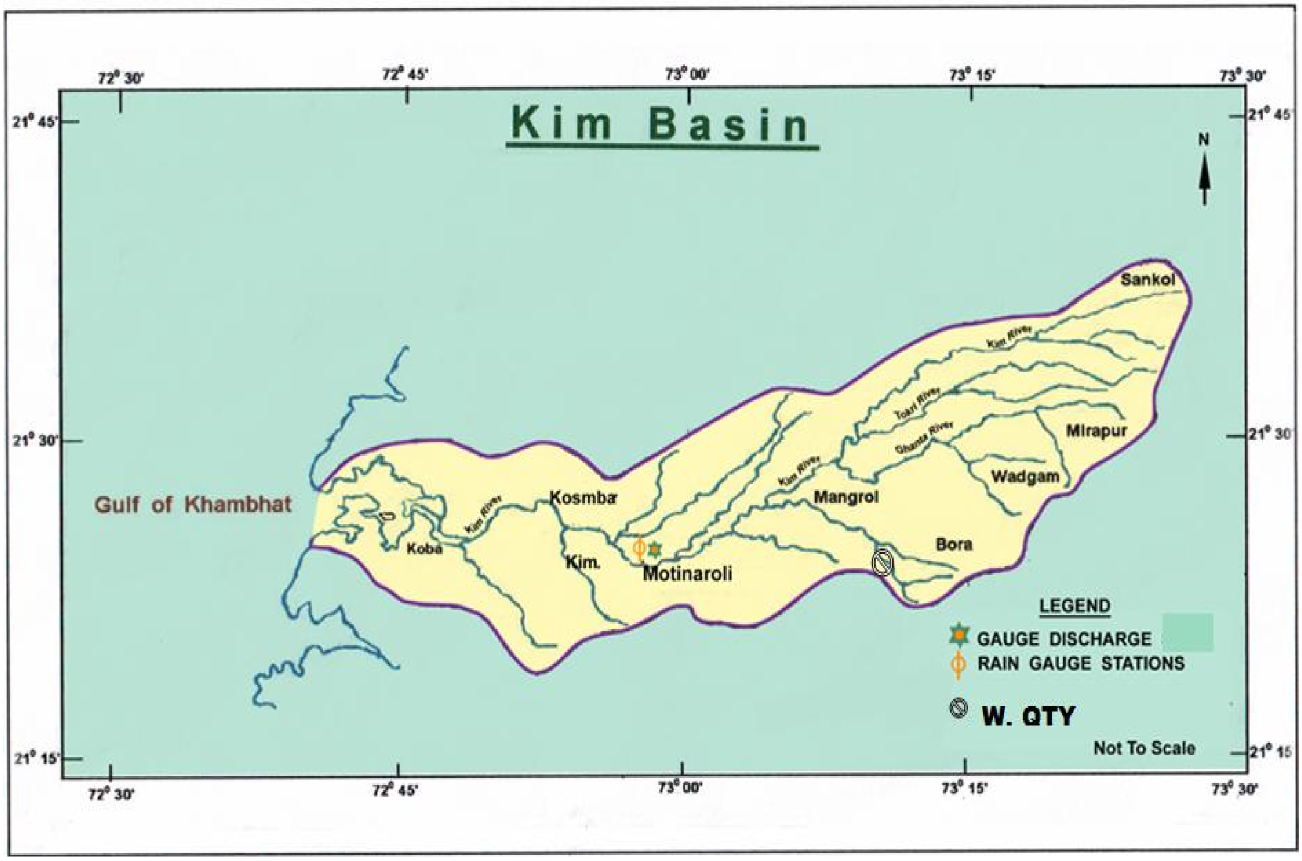
This is a composite dam constructed across the river Damanganga near village Madhuban of Dharampur Taluka, Valsad district of Gujarat state. The main purpose of the project is irrigation, other being water supply for domestic and industrial use and for generation of 2.0 MW of power. The project has a network of canal system on either bank of the river to provide irrigation to an area of 56630-ha of land. The dam has height of 50 m above the deepest foundation to store 567 Mm^3 of water.

2.6 Kim Basin

2.6.1 Geographical setting of Kim Basin

Kim River is one of the west flowing rivers in Gujarat state. It originates from Saputara Hill ranges in Bharuch district and falls in Gulf of Khambhat near village Kantiajal of Hansot taluka of Bharuch district after flowing south west direction for a length of 107 km. The river Kim, for the first 80 km of its course passes through Rajpipala and Valia talukas. For the remaining part, the river flows in a western direction between Ankleshwar and Olpad taluka of Surat District. Basin map is shown in **Plate -2.6.1**.

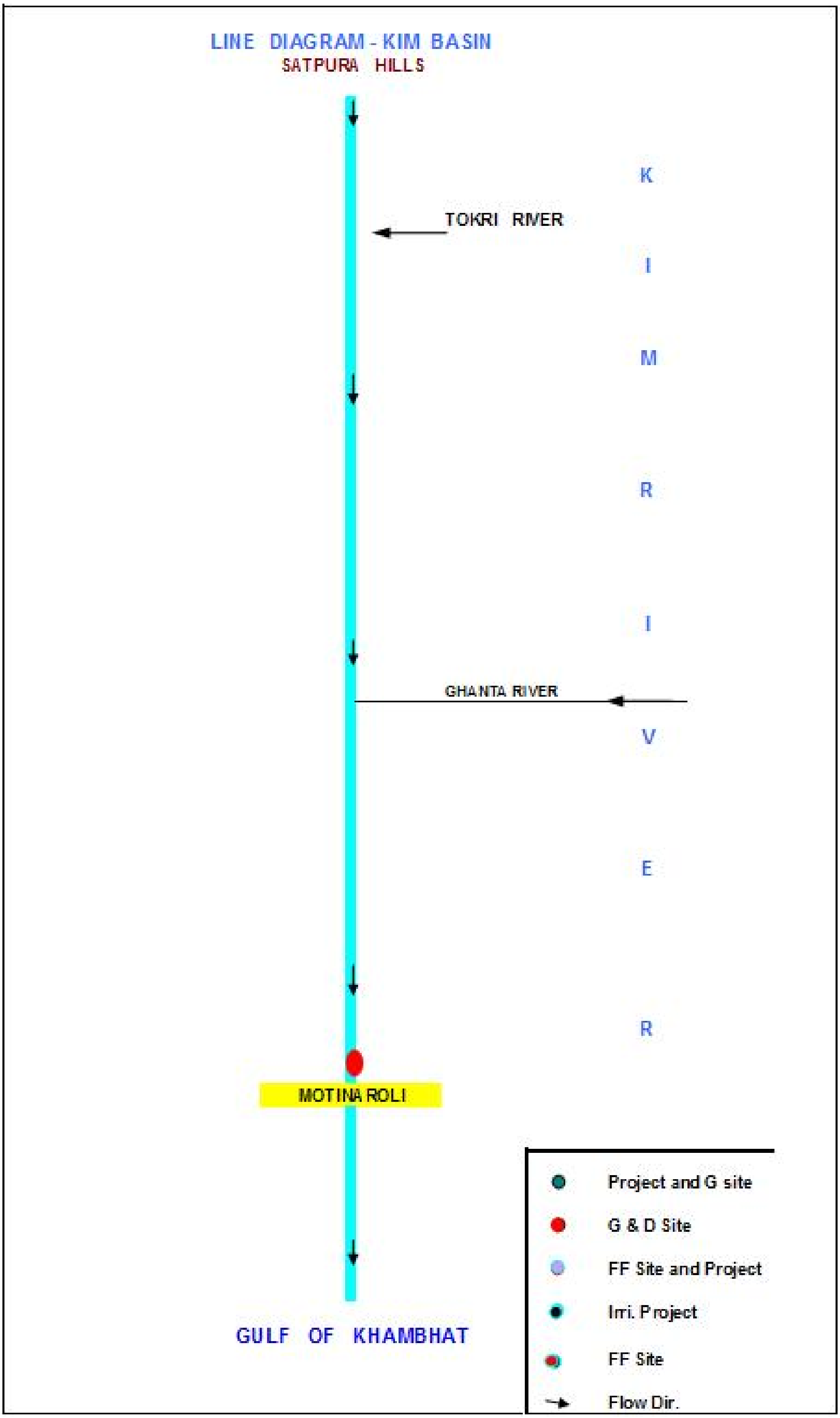
Plate -2.6.1



2.6.2 River System

The main tributaries of Kim river are Ghanta river and Tokri river. The river basin extends over an area of 1286 sq km of which the catchment area up to the site is 804 sq km. The river basin lies between21° 19' to 21° 38' North latitude and 72° 40' to 73° 27' East longitude. A line diagram of Kim basin is shown in **Plate -2.6.2**.

Plate -2.6.2



LINE DIAGRAM - KIM BASIN
SATPURA HILLS
TOKRI RIVER
GHANTA RIVER
KIM RIVER
MOTINA ROLI
GULF OF KHAMBHAT
Project and G site
G & D Site
FF Site and Project
Irri. Project
FF Site
Flow Dir.

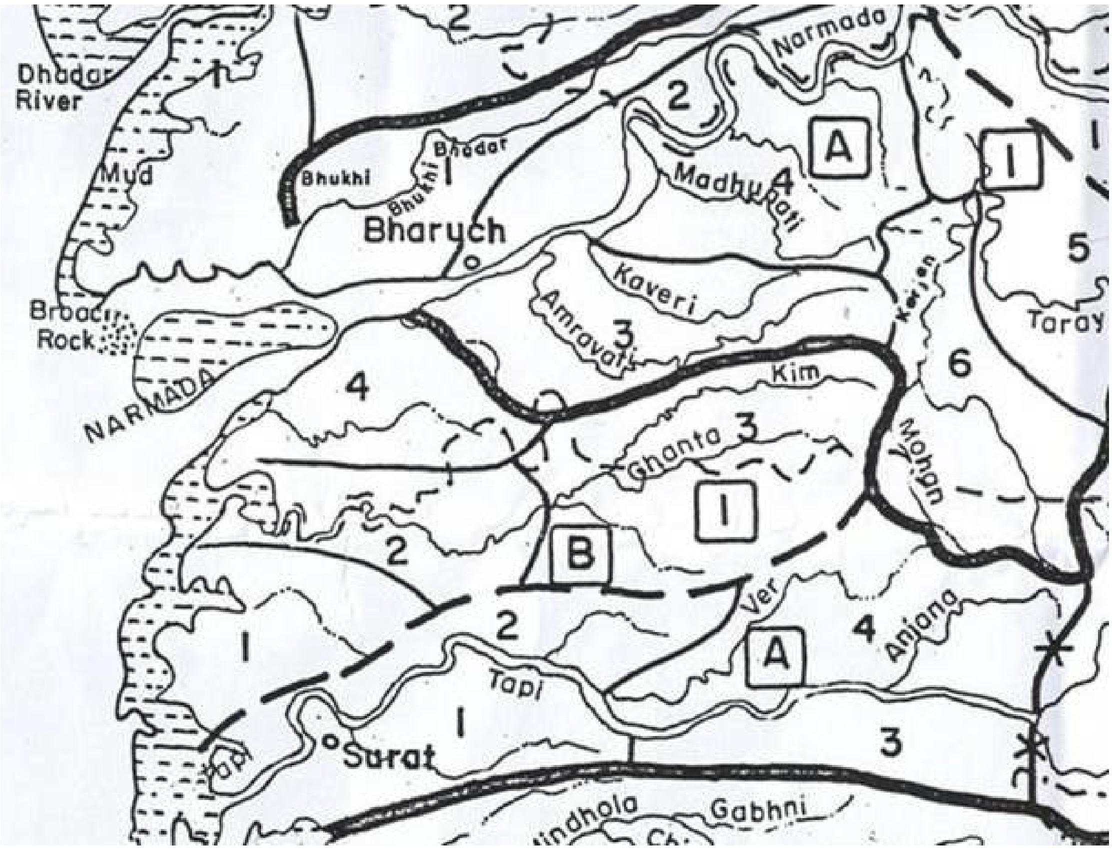
2.6.3 Kim Basin as per Water Shed Atlas of India

As per Watershed Atlas of India, Published by Department of Agriculture and Cooperation, Ministry of agriculture, Krishi Bhavan New Delhi (1990), the sub catchments from 5C1B pertain to Kim Basin as shown in **Fig.-2.6.1**.

2.6.3.1 Subcatchment -5C1B (5C1B2 & 5C1B3)

This Sub Catchment is situated in the plain region of Gujarat, drained by Ghanta and Tokri River. The total area of this Sub-Catchment is 1286 Sqkm.

Fig.-2.6.1: Kim Basin as per water shed Atlas of India.



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

2.6.4 The Climate

Most of the Kim Basin lies in coastal plains near the sea, where the climate is moderate and humid. The month of May is the hottest and January is the generally coldest month of the Basin.

Accordingly to Kocppan's Scheme, the climate of the basin is classified as AW-Tropical Savannah, as most of the peninsular plateau, south of Tropic of Cancer, is classified. The climatic variations are experienced in the patterns of temperature, rainfall & winds, rhythm of seasons and degree of wetness or dryness. These are described as follows

2.6.4.1 Temperature

Temperature is maximum in the month of May and Minimum in the month of December to January. The temperature profile in the basin is given in the **Table-2.6.1**.

Table-2.6.1: Mean monthly Temperature (^{0}C) during water year at site Kim at Motinaroli

Month	Mean Monthly Maximum Temperature	Mean Monthly Minimum Temperature
Jun-13	31.2	25.6
Jul-13	28.1	25.1
Aug-13	28.4	24.3
Sep-13	30.6	23.2
Oct-13	31.9	23.2
Nov-13	34.2	19.3
Dec-13	33.3	14.9
Jan-14	30.4	14.5
Feb-14	31.4	16.0
Mar-14	35.4	19.7
Apr-14	38.8	23.7
May-14	39.4	26.7
Annual mean	32.8	21.4

2.3.4.2 Rainfall

The basin receives most of the rainfall from the South West monsoon during June to October. Almost 98% of the annual rainfall of the basin is received during this period. The rainfall at site in Kim Basin shown in **Table-2.6.2** & **Table-2.6.3**.

Table-2.6.2: Mean annual rainfall of site Kim at Motinaroli

Sl. No	Name of Site	Data available (No of Years)	Average Annual Rainfall (mm)	Average no of rainy days	Rainfall in the year 2013-14	No of rainy days in 2013-14
1	Motinaroli	22	1213.0	54	3736.2	87

Table-2.6.3: Seasonal Rainfall during Water Year 2013 at site Motinaroli

Sl No	Name of Site	Seasonal Rainfall (mm) in 2013				Total Annual Rainfall
		Winter monsoon (Jan-Feb)	Pre monsoon (Mar-May)	South-West monsoon (June-Sept)	Post monsoon (Oct-Dec)	
1	Motinaroli	0	22.0	3656.6	57.6	3736.2

2.6.4.3 Wind

The wind speed data of the Kim basin is given in Table-2.6.4. The average wind speed in the Kim basin varies about 0.3 km/h to 7.9 km/h. The pre dominant wind direction is NE

Table-2.6.4:Wind Speed at site Motinaroli in Kim basin during Water Year 2013-14

Month	Mean monthly wind Speed (km/h)
June	4.6
July	3.7
August	3.3
September	2.8
October	1.0
November	0.4
December	0.3
January	0.7
February	1.3
March	1.1
April	2.0
May	2.8
Annual Mean	2.0

2.6.4.4 Humidity

The relative Humidity in Kim basin varies between 97.1% to 78.7% depending upon the season. It is maximum in the monsoon period and is about 78.7 % to 97.1 %. In the winter months of November and December, relative humidity comes down. Relative humidity at station Motinaroli of CWC in the Kim Basin is given in Table-2.6.5.

Table-2.6.5: Mean monthly Relative Humidity at site Motinaroli in Kim Basin during Water Year 2013-14

Month	Relative Humidity (%)
June	91.6
July	95.1
August	96.4
September	94.8
October	92.1
November	81.3
December	84.6
January	89.1
February	88.8
March	84.3
April	86.0
May	90.3
Annual Mean	89.5

2.6.5 Soil

The soil found in Kim basin can be broadly classified into three groups i.e.Lateritic soils, deep black soils and coastal alluvial soils.

2.6.6 Major / Medium/multipurpose/irrigation projects

The major and medium projects completed / ongoing on Kim river basin are as shown in Table-2.6.6.

Table-2.6.6: Major and medium projects completed / ongoing in Kim basin

Sl.No.	Name of the project	River	Status	Capacity in Mm^3		Utilisation
				Gross	Live	Irrigation
1	Baldeva Irrigation Scheme	Tokri	Medium	8.15	7.84	Domestic
2	Pigut Irrigation S Scheme	Tokri	Medium	7.52	7.27	-do-

Hydrological observations by State government

Source of information

Apart from the sites maintained by central water commission the state government of Gujarat, Madhya Pradesh, Rajasthan and Maharashtra are also conducting gauge and discharge observations in among 14 Basins. The Basin wise list of sites and the authority maintaining the sites are listed in the following para.

Basin wise list of sites

1	Purna Basin	1 Purna 2 Purna 3 Purna 4 Zankhari 5 Zankhari 6 Zankhari	At Wankla At Navsari At Kalibel At Malotha At Ghat At ZanKhari	Sup. Engineer, WRI Circle LD Engg. College campus, near Gujarat university, Ahmedabad & Executive engineer WRI Divn., Bhadra fort, Laldarwaja, Ahmedabad
2	Ambica Basin	1 Ambica 2 Ambica 3 Khapri 4 Kharera 5 Kharera 6 Kaveri 7 Valam 8 Valam	At Unai At Bilimora At Kundkas At Kavdej At Lalia Dam At Vansda At Wankla At Dholka	Sup. Engineer, WRI Circle LD Engg. College campus, near Gujarat university, Ahmedabad & Executive engineer WRI Divn., Bhadra fort, Laldarwaja, Ahmedabad
3 Vaitarna Basin No state govt. Sites in this Basin				
4	Dhadhar Basin	1 Dhadhar 2 Dhadhar 3 Dhadhar 4 Deo 5 Deo 6 Vishwamitri 7 Vishwamitri 8 Surya	At Bhilapur At Por At Pingalwada At Vejalpur At Shivrajpur At Pilol At Harni At Bhaniyara	Sup. Engineer, WRI Circle LD Eengg. College campus, near Gujarat university, Ahmedabad & Executive engineer WRI Divn., Bhadra fort, Laldarwaja, Ahmedabad
5	Damanganga Basin	1 Damanganga 2 Sakertond	At Vapi Bridge At Khanvel	Water resources investigation Sub Division, Navsari
6	Kim Basin	1 Kim	At Vellachha	Water resources investigation Sub Division, Navsari

3.0 Methodology: Stream flow measurement

3.1 Gauge measurement

Water level or stage of the River is measured as its elevation above the g t s datum. Water level measurement was conducted by reading non-recording gauges. A series of vertical staff gauges as per the specifications laid down in is 4080-1977 have been fixed at three sections at each site i.e. Upstream, station gauge and downstream. The gauge posts are of RCC/wooden/ metallic with cut and edge waters and are fixed securely in position by installing them in m-150 concrete blocks of suitable size. Enameled gauge plate with marking in metric unit is fixed on the gauge posts with least count 0.005 m. Out of the three gauge lines the central line is used as station gauge line and readings of the other two lines are used for calculating the surface slope. The gauges were read hourly during Monsoon season and three hourly i.e. 0800, 1300 and 1800 Hrs during non Monsoon season at station gauge line.

3.2 Discharge observation

Discharge observation is conducted once a day at 0800 Hrs, at all the sites by area velocity method except on Sunday and holidays in non Monsoon period. However additional observations were conducted during floods to cover different stages, irrespective of holidays. The River width is generally 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 rope stretched across the River with segment markings indicated thereon, when the River width is quite small and the flow depths permit wading. For larger width and deeper flow conditions and in unmanageable flood conditions segment points vertically are located by measuring the navigation craft with reference to pivot point and segment blocks constructed at sites.the depth measurement is carried out by using sounding rod for depths up to 3 meter and by using long bamboos for depths between 3 meter and 6 meter. For depths exceeding 6 meter sounding reel measurements at segment points are resorted to, and in Some cases, the depths are measured by echo sounder or are computed from the most recent x-sections of the River. The velocity is measured as per is 3918 - 1976 by using a cup type current meter conforming to is 3910 - 1976. The current meter is lowered to the requisite depth i.e. 0.6 of total depth down the vertical at every segment point by suspension equipment as specified in is 6064 - 1981 and where the depth is less than 0.3 meters, the velocity is observed just below the water surface. In medium and high stages with significant flow velocities, boats fitted with power engines are used. Measurements of velocity are sometimes carried out from the bridges when the River flow condition does not permit the boat to be kept stable for velocity observation. When none of the above procedures are possible, the velocity is measured by float observations.

The data observed as above at the site is entered in the prescribed standard format to compute the total River discharge and it is further scrutinised at various levels before finalisation.

The daily observed/estimated discharge data is presented in this book.

Table-3.1.1 : Equipment used for observation

Sl. No	Name of equipment	By wading	By boat	Bridge	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	√
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	X
15	Echo sounder	X	√	√	X
16	Bridge out fit	X	X	√	X
17	Boat out fit	X	√	X	X

3.3 Explanatory notes

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

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

2. Discharge is given in cubic meters per second.

3. Discharges given are daily observed / estimated discharges.

4. The zero of gauge is a datum level / RL Fixed for a given site, which is kept 1 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.

5. Maximum and minimum discharges are taken from the daily observed flows / estimated.

6. Runoff in "mm" is the notional depth of water in millimeters over the catchment area equivalent to annual runoff calculated at the discharge measurement station.

$$\textbf{Runoff (mm)} = \frac{\textbf{Annual runoff (Mm3)}}{\textbf{Catchment area (km}^2\textbf{)}} \times 1000$$

7. Peak and lowest flows correspond to the highest and lowest water levels recorded during the period of record.

8. Measuring authority refers to the field division responsible for the operation of the gauge station. The name of the division is abbreviated by taking first alphabet of the River name followed by alphabets "DN" for division. For example Mahi division is denoted by MDN and Tapi division is denoted as TDN. These abbreviations are given cross-reference in the list of abbreviations and symbols.

9. Gauging station code number is a unique nine-digit reference number, which facilitates retrieval of flow data in data bank. The first two digits denote the

measuring authority. The third and fourth digits are the Basin/zone identifier and fifth and sixth digits are the independent River Basin identifier. The last three digits of the code number indicate gauging site no. which is given from origin to mouth.

11. The month and the year from which data are available in the data bank are indicated against the record available.

3.4 Method of presentation

The data presented in this book is processed discharge data obtained from application of SWDES/HYMOS software.

The station wise hydrological data is presented comprising history sheet, daily flow table and pictorial summary. The sequence of hydrological station arranged from its outfall to origin giving inter-priority to an intermediate tributary station.

4.0 Hydrological data

The hydrological data presented hereby mainly consist of the following

History sheet

Its manly consist of some salient features of particular site as Site name, state, district, River Basin, tributary, catchment area, latitude / longitude, opening / closing date for various types of data& maximum –minimum discharge values.

Data sheet

It consists of stage- discharge data (both observed & estimated from stage discharge curve for the season), for the current year with mean water level during the discharge observation and peak observed and computed discharge with corresponding water level with date during the year, Lowest discharge with corresponding water level with date during the year, Peak discharge with corresponding water level with date since inception, Lowest discharge with corresponding water level with date since inception.

Stage discharge curve

It gives a relationship between the stage of the river and the corresponding discharge.

Annual run-off

It gives the value of Annual run off in MCM for all the years from the opening of the site.

Water level v/s time graph

Hourly observed water level for one to three important highest peak flood events of current Water Year covering the period well before the start and upto well beyond the completion of these flood events.

Charts / Maps

Basin map showing sites / projects

The site-wise pre – Monsoon and post – Monsoon cross sections

The site-wise pie chart

Site-wise bar charts

The site-wise hydrographs (flood events)

Chapter-4: Hydrological data

4.1 Purna Basin

4.1.1 History sheet

HISTORY SHEET

			Water Year	**:**	**2013-14**
Site	**:**	**Purna at Mahuwa**	**Code**	**:**	**01 02 19 001**
State	:	Gujarat	District		Surat
Basin	:	WFR South of Tapi	Independent River	:	Purna
Tributary	:		Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	
Division	:	Tapi Division, Surat	Sub-Division	:	LTSD,CWC,Surat
Drainage Area	:	1995 Sq. Km.	Bank	:	Right
Latitude	:	21°00'52"	Longitude	:	73°08'25"
Zero of Gauge (m)	:	9 (m.s.l)	04/10/1970		
		Opening Date	Closing Date		
Gauge	:	04/10/1970			
Discharge	:	12/11/1970			
Sediment	:	18/06/1973			
Water Quality	:	15/06/1977			

Annual Maximum / Minimum discharge with corresponding water Level (m.s.l)

	Maximum			Minimum		
Year	Q (cumecs)	WL (m)	Date	Q (cumecs)	WL (m)	Date
1971-1972	682.3	13.655	13/08/1971	0.099	10.055	30/04/1972
1972-1973	454.6	12.800	19/08/1972	0.020	9.895	31/05/1973
1973-1974	1550	13.914	25/09/1973	0.026	9.930	09/06/1973
1974-1975	183.0	11.225	01/10/1974	0.071	10.095	31/05/1975
1975-1976	964.3	13.730	13/08/1975	0.030	10.055	12/06/1975
1976-1977	4380	20.550	31/07/1976	0.040	10.150	02/06/1976
1977-1978	4020	19.765	03/09/1977	0.100	10.060	07/06/1977
1978-1979	1692	15.252	09/07/1978	0.200	10.110	10/06/1978
1979-1980	3378	20.100	10/08/1979	0.200	10.110	13/06/1979
1980-1981	775.0	13.667	02/08/1980	0.480	10.190	15/05/1981
1981-1982	1572	16.430	10/07/1981	0.000	10.050	01/04/1982
1982-1983	2815	20.390	25/07/1982	0.100	10.065	09/05/1983
1983-1984	1818	15.666	20/07/1983	0.100	10.010	02/06/1983
1984-1985	846.3	13.955	13/09/1984	0.500	10.310	08/06/1984
1985-1986	3255	20.560	01/08/1985	0.300	10.060	13/04/1986
1986-1987	527.2	12.775	16/08/1986	0.300	10.125	08/03/1987
1987-1988	873.7	15.260	07/07/1987	0.100	10.035	29/01/1988
1988-1989	1526	15.700	27/07/1988	0.200	9.970	18/04/1989
1989-1990	2362	17.920	25/07/1989	0.600	10.020	07/06/1989
1990-1991	1396	17.625	17/08/1990	1.420	9.870	27/03/1991
1991-1992	300.8	10.970	24/07/1991	0.600	9.850	29/05/1992
1992-1993	1386	17.100	03/09/1992	0.280	9.720	30/05/1993
1993-1994	1254	15.250	10/07/1993	0.385	9.635	13/05/1994
1994-1995	3078	20.470	16/06/1994	0.286	9.755	19/04/1995
1995-1996	404.6	11.995	25/07/1995	0.100	9.720	09/06/1995
1996-1997	781.5	13.330	09/09/1996	0.600	9.720	10/06/1996
1997-1998	2174	17.410	25/08/1997	0.430	9.370	27/05/1998
1998-1999	2359	17.720	08/07/1998	0.350	9.355	08/06/1998
1999-2000	695.6	13.030	16/07/1999	0.598	9.320	17/02/2000
2000-2001	782.8	13.250	14/07/2000	0.061	9.160	27/04/2001
2001-2002	1233	14.400	16/08/2001	0.085	9.075	30/04/2002
2002-2003	2517	17.550	25/08/2002	0.089	9.150	05/06/2002
2003-2004	2946	18.365	28/07/2003	0.071	9.075	05/06/2003
2004-2005	8836	23.490	04/08/2004	0.779	9.230	31/01/2005
2005-2006	5437	21.280	29/06/2005	0.500	9.180	16/06/2005
2006-2007	3273	19.050	05/07/2006	0.827	9.140	26/05/2007
2007-2008	3058	18.350	02/07/2007	1.116	9.160	01/06/2007
2008-2009	1853	16.360	19/09/2008	2.163	9.170	06/06/2008
2009-2010	667.2	12.900	07/09/2009	0.000	9.050	01/06/2009
2010-2011	744.5	13.330	09/09/2010	0.007	9.010	27/03/2011
2011-2012	607.5	12.750	29/08/2011	0.000	9.010	10/06/2011
2012-2013	692.4	13.030	13/08/2012	0.000	9.020	01/06/2012
2013-2014	1508	15.500	24/09/2013	0.000	9.000	As per SD Curve

4.1.2 Annual Maximum flood Peaks

Year	Highest Flood Level (m)	Date	Hour
1970	9.780	13/10/1970	08:00:00
1971	13.655	13/08/1971	08:00:00
1972	14.805	06/07/1972	18:00:00
1973	18.215	25/09/1973	16:00:00
1974	12.035	15/07/1974	03:00:00
1975	18.680	12/08/1975	18:00:00
1976	21.200	12/07/1976	19:00:00
1977	20.550	03/09/1977	11:00:00
1978	17.700	29/08/1978	22:00:00
1979	20.210	10/08/1979	19:00:00
1980	15.330	02/08/1980	15:00:00
1981	16.440	10/07/1981	17:00:00
1982	20.710	25/07/1982	15:00:00
1983	17.130	13/08/1983	18:00:00
1984	22.550	18/07/1984	19:00:00
1985	21.050	01/08/1985	04:00:00
1986	13.120	19/07/1986	21:00:00
1987	15.680	07/07/1987	11:00:00
1988	18.185	29/07/1988	01:00:00
1989	19.890	24/07/1989	07:00:00
1990	19.500	17/08/1990	06:00:00
1991	13.670	24/07/1991	18:00:00
1992	17.810	03/09/1992	07:00:00
1993	19.400	14/07/1993	02:00:00
1994	24.800	16/06/1994	17:00:00
1995	13.660	28/07/1995	15:00:00
1996	17.500	23/07/1996	15:00:00
1997	18.000	31/07/1997	21:00:00
1998	17.840	08/07/1998	10:00:00
1999	13.500	19/07/1999	18:00:00
2000	14.640	14/07/2000	02:00:00
2001	19.300	17/06/2001	22:00:00
2002	19.500	26/06/2002	19:00:00
2003	19.880	28/07/2003	06:00:00
2004	23.900	04/08/2004	00:00:00
2005	21.280	29/06/2005	08:00:00
2006	20.300	05/07/2006	12:00:00
2007	20.500	02/07/2007	12:00:00
2008	18.800	19/09/2008	15:00:00
2009	14.740	22/07/2009	21:00:00
2010	14.400	07/08/2010	15:00:00
2011	14.140	14/08/2011	21:00:00
2012	13.800	13/08/2012	05:00:00
2013	19.700	23/09/2013	20:00:00

4.1.3 Summary of Discharge Data

Stage –Discharge data for the period 2013-14

Station Name: Purna at Mahuwa (010219001)   Division : Tapi Division Surat   Local River: Purna   Sub -Division : LTSD, CWC, Surat

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	9.010	0.000	9.260	0.000	10.830	159.5	9.860	37.12 *	10.260	81.49	9.370	6.841
2	9.020	0.000	9.270	0.000	11.440	282.1	9.800	29.86	10.080	57.76 *	9.370	6.830
3	9.020	0.000	9.260	0.000	11.700	349.1	9.700	20.96	10.000	55.41	9.370	6.934 *
4	9.020	0.000	9.290	0.000	10.960	181.4 *	9.680	19.35	10.360	93.43	9.380	6.978
5	9.020	0.000	10.030	57.91	10.780	167.8	9.680	19.61	10.080	70.00	9.380	6.978
6	9.010	0.000	10.020	55.45	10.620	134.4	9.700	20.90	9.860	37.12 *	9.370	6.812
7	9.010	0.000	9.920	42.33 *	10.520	110.6	9.680	19.57	9.760	24.83	9.370	6.807
8	9.040	0.000	9.700	20.77	10.400	97.69	9.680	23.45 *	10.200	75.20	9.360	6.209
9	9.030	0.000	9.620	11.82	10.360	90.07 *	9.640	20.81 *	10.000	55.37	9.360	6.199
10	9.120	0.000	9.620	11.68	10.880	190.3	9.620	11.80	10.520	109.8	9.360	6.555 *
11	9.130	0.000	10.590	134.7	10.960	181.4 *	10.620	134.3	9.920	50.28	9.340	6.003
12	9.130	0.000	10.780	168.3	10.750	159.5	10.360	93.60	9.880	39.60	9.340	5.986
13	9.120	0.000	10.360	94.13	11.240	245.0	10.580	132.6	9.760	29.16 *	9.320	5.441
14	9.110	0.000	10.340	87.54 *	15.440	1493	10.360	93.56	9.720	22.12	9.320	5.141 *
15	9.100	0.000	9.980	47.49	11.820	362.5 *	11.060	199.4 *	9.640	14.89	9.320	5.428
16	9.070	0.000	9.800	30.74	11.200	237.9	10.520	108.9	9.640	20.81 *	9.300	4.909
17	9.100	0.000	10.590	131.6	10.830	163.6	10.480	108.5	9.600	10.73	9.300	4.495 *
18	9.140	0.000	12.040	444.0	10.720	141.3 *	10.780	168.3	9.600	10.96	9.300	4.898
19	9.800	30.51	11.870	396.9	10.580	133.1	10.360	93.49	9.580	9.169	9.310	5.306
20	9.800	30.40	10.980	205.7	10.480	108.8	10.020	56.12	9.540	14.86 *	9.310	5.304

21	9.600	9.618		10.680	135.1	*	10.360	92.87		9.920	50.29		9.480	8.862		9.310	5.270	
22	9.480	8.137		11.710	342.3		10.100	72.59		9.860	37.12	*	9.450	8.106		9.300	4.680	
23	9.430	9.412	*	11.240	248.6		10.360	92.48		13.650	1052		9.440	8.423		9.300	4.874	
24	9.330	4.106		11.860	399.4		10.200	72.72		15.500	1508		9.440	8.402		9.300	4.495	*
25	9.270	0.000		11.000	206.9		10.460	103.2	*	12.610	563.4		9.420	8.151		9.290	4.729	
26	9.230	0.000		12.740	606.8		10.580	131.9		11.440	284.4		9.420	8.187		9.290	4.723	
27	9.230	0.000		11.230	244.6		10.480	108.4		10.940	203.0		9.400	8.129	*	9.290	4.716	
28	9.230	0.000		11.500	288.3	*	10.100	59.84	*	10.620	133.9		9.400	7.307		9.270	4.076	
29	9.250	0.000		11.700	347.2		10.020	56.11		10.660	132.0	*	9.400	7.296		9.270	4.066	
30	9.230	0.000		11.220	243.5		9.980	47.71		10.380	95.18		9.380	6.901		9.250	3.463	
31				11.000	207.1		9.980	47.77					9.380	6.994				
Ten-Daily Mean																		
I Ten-Daily	9.030	0.000		9.599	20.00		10.849	176.3		9.704	22.34		10.112	66.04		9.369	6.714	
II Ten-Daily	9.250	6.091		10.733	174.1		11.402	322.6		10.514	118.9		9.688	22.26		9.316	5.291	
III Ten-Daily	9.328	3.127		11.444	297.3		10.238	80.50		11.558	405.9		9.419	7.887		9.287	4.509	
Monthly																		
Min.	9.010	0.000		9.260	0.000		9.980	47.71		9.620	11.80		9.380	6.901		9.250	3.463	
Max.	9.800	30.51		12.740	606.8		15.440	1493		15.500	1508		10.520	109.8		9.380	6.978	
Mean	9.203	3.073		10.619	168.1		10.811	189.5		10.592	182.4		9.729	31.28		9.324	5.505	

Annual Runoff in MCM = 1547 Annual Runoff in mm = 776

Peak Observed Discharge = 1508 cumecs on 24/09/2013 Corres. Water Level :15.5 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2013 Corres. Water Level :9.01 m

Water Level(m.s.l) in m *:Computed Discharge #:Discarded Discharge (values changed as per rating curve)

Note: River remained in pooling/ no flow condition w.e.f. 01/06/13 to 18/06/13 and from 25/06 to 04/07/13

Stage –Discharge data for the period 2013-14

Station Name: Purna at Mahuwa (010219001) Division: Tapi Division Surat Local River: Purna Sub -Division: LTSD, CWC, Surat

Day	Dec			Jan			Feb		Mar		Apr		May	
	W.L	Q		WL	Q		WL	Q	WL	Q	WL	Q	WL	Q
1	9.250	3.058	*	9.250	3.429		9.070	0.000	9.030	0.000	9.030	0.000	9.010	0.000
2	9.250	3.466		9.250	3.429		9.070	0.000	9.020	0.000	9.030	0.000	9.010	0.000
3	9.260	3.530		9.240	3.103		9.060	0.000	9.020	0.000	9.010	0.000	9.010	0.000
4	9.260	3.513		9.240	3.098		9.060	0.000	9.020	0.000	9.010	0.000	9.020	0.000
5	9.260	3.508		9.240	2.802	*	9.060	0.000	9.010	0.000	9.010	0.000	9.020	0.000
6	9.250	3.474		9.240	3.072		9.050	0.000	9.010	0.000	9.010	0.000	9.020	0.000
7	9.250	3.460		9.240	0.000		9.050	0.000	9.010	0.000	9.020	0.000	9.020	0.000
8	9.240	2.802	*	9.220	0.000		9.050	0.000	9.010	0.000	9.020	0.000	9.010	0.000
9	9.240	3.122		9.220	0.000		9.050	0.000	9.030	0.000	9.020	0.000	9.010	0.000
10	9.240	3.116		9.220	0.000		9.040	0.000	9.030	0.000	9.020	0.000	9.010	0.000
11	9.260	3.542		9.200	0.000		9.040	0.000	9.030	0.000	9.020	0.000	9.010	0.000
12	9.260	3.512		9.180	0.000		9.040	0.000	9.030	0.000	9.010	0.000	9.010	0.000
13	9.260	3.518		9.180	0.000		9.050	0.000	9.040	0.000	9.010	0.000	9.010	0.000
14	9.270	4.062		9.180	0.000		9.050	0.000	9.040	0.000	9.010	0.000	9.020	0.000
15	9.270	3.602	*	9.160	0.000		9.050	0.000	9.040	0.000	9.010	0.000	9.020	0.000
16	9.270	4.058		9.160	0.000		9.050	0.000	9.040	0.000	9.020	0.000	9.020	0.000
17	9.270	4.054		9.160	0.000		9.040	0.000	9.020	0.000	9.020	0.000	9.020	0.000
18	9.260	3.480		9.140	0.000		9.040	0.000	9.020	0.000	9.020	0.000	9.020	0.000
19	9.260	3.479		9.140	0.000		9.040	0.000	9.020	0.000	9.020	0.000	9.010	0.000
20	9.260	3.476		9.120	0.000		9.030	0.000	9.020	0.000	9.030	0.000	9.010	0.000

21	9.250	3.432		9.120	0.000	9.030	0.000	9.010	0.000	9.030	0.000	9.010	0.000
22	9.250	3.058	*	9.120	0.000	9.030	0.000	9.010	0.000	9.030	0.000	9.010	0.000
23	9.250	3.428		9.110	0.000	9.020	0.000	9.010	0.000	9.030	0.000	9.010	0.000
24	9.250	3.424		9.110	0.000	9.020	0.000	9.010	0.000	9.020	0.000	9.020	0.000
25	9.240	2.802	*	9.100	0.000	9.020	0.000	9.010	0.000	9.020	0.000	9.020	0.000
26	9.240	3.099		9.100	0.000	9.030	0.000	9.010	0.000	9.020	0.000	9.020	0.000
27	9.240	3.098		9.100	0.000	9.030	0.000	9.020	0.000	9.020	0.000	9.020	0.000
28	9.240	3.092		9.080	0.000	9.030	0.000	9.020	0.000	9.020	0.000	9.020	0.000
29	9.250	3.058	*	9.080	0.000			9.020	0.000	9.010	0.000	9.010	0.000
30	9.250	3.437		9.080	0.000			9.030	0.000	9.010	0.000	9.010	0.000
31	9.250	3.385		9.070	0.000			9.030	0.000			9.010	0.000
Ten-Daily Mean													
I Ten-Daily	9.250	3.305		9.236	1.893	9.056	0.000	9.019	0.000	9.018	0.000	9.014	0.000
II Ten-Daily	9.264	3.678		9.162	0.000	9.043	0.000	9.030	0.000	9.017	0.000	9.015	0.000
III Ten-Daily	9.246	3.210		9.097	0.000	9.026	0.000	9.016	0.000	9.021	0.000	9.015	0.000
Monthly													
Min.	9.240	2.802		9.070	0.000	9.020	0.000	9.010	0.000	9.010	0.000	9.010	0.000
Max.	9.270	4.062		9.250	3.429	9.070	0.000	9.040	0.000	9.030	0.000	9.020	0.000
Mean	9.253	3.392		9.163	0.611	9.043	0	9.022	0	9.019	0	9.015	0

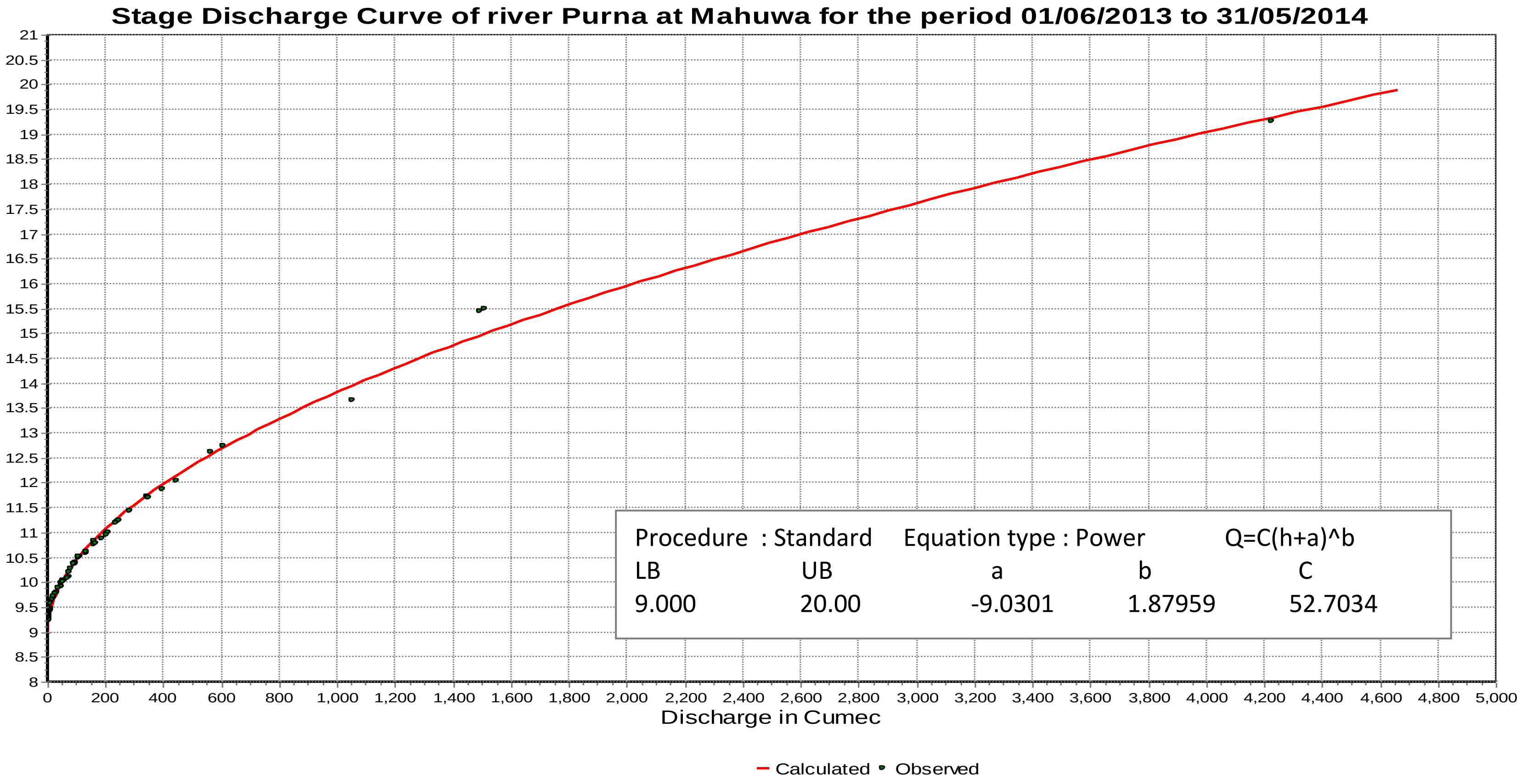
Peak Computed Discharge = 362.5 cumecs on 15/08/2013 Corres. Water Level :11.82 m
Lowest Computed Discharge = 0.000 cumecs on 02/06/2013 Corres. Water Level :9.02 m

Water Level(m.s.l) in m *:Computed Discharge #:Discarded Discharge (values changed as per rating curve)

Note: River remained in pooling/ no flow condition w.e.f. 01/06/13 to 18/06/13 ,25/06 to 04/07/13 and from 07/01 to 31/05/2014

4.1.4 Stage Discharge Curve

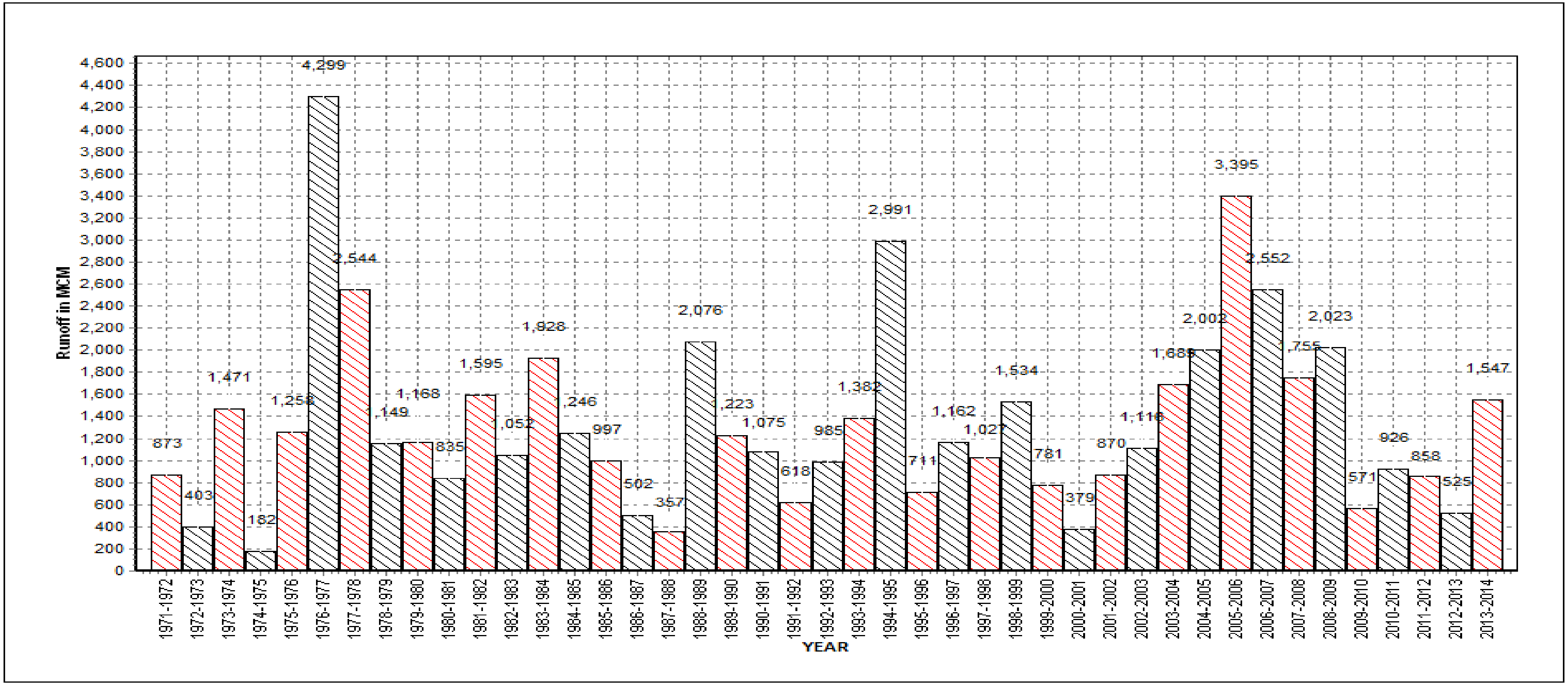
Station Name: Purna at Mahuwa (010219001) Division: Tapi Division Surat Local River: Purna Sub -Division: LTSD, CWC, Surat



4.1.5 Annual runoff

Annual Runoff Values Runoff Based on period 1971 to 2014

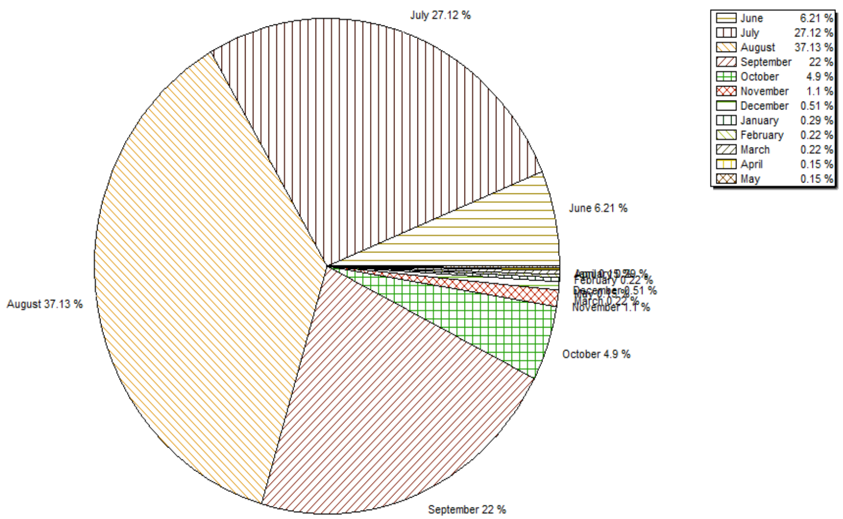
Station Name: Purna at Mahuwa (010219001) Division: Tapi Division Surat Local River: Purna Sub -Division: LTSD, CWC, Surat



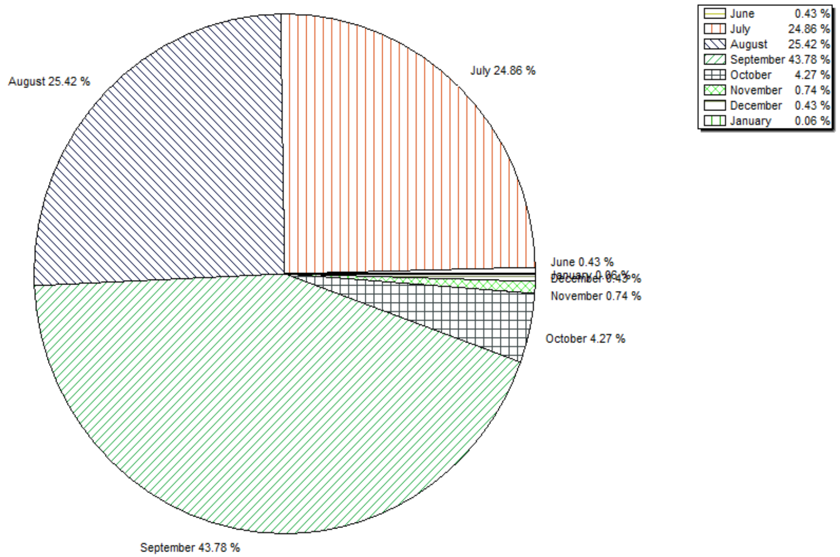
4.1.6 Monthly Average Runoff

Station Name: Purna at Mahuwa (010219001) Division: Tapi Division, Surat Local River: Purna Sub -Division: LTSD, CWC, Surat

Monthly Average Runoff Based on period: 1971 -2013



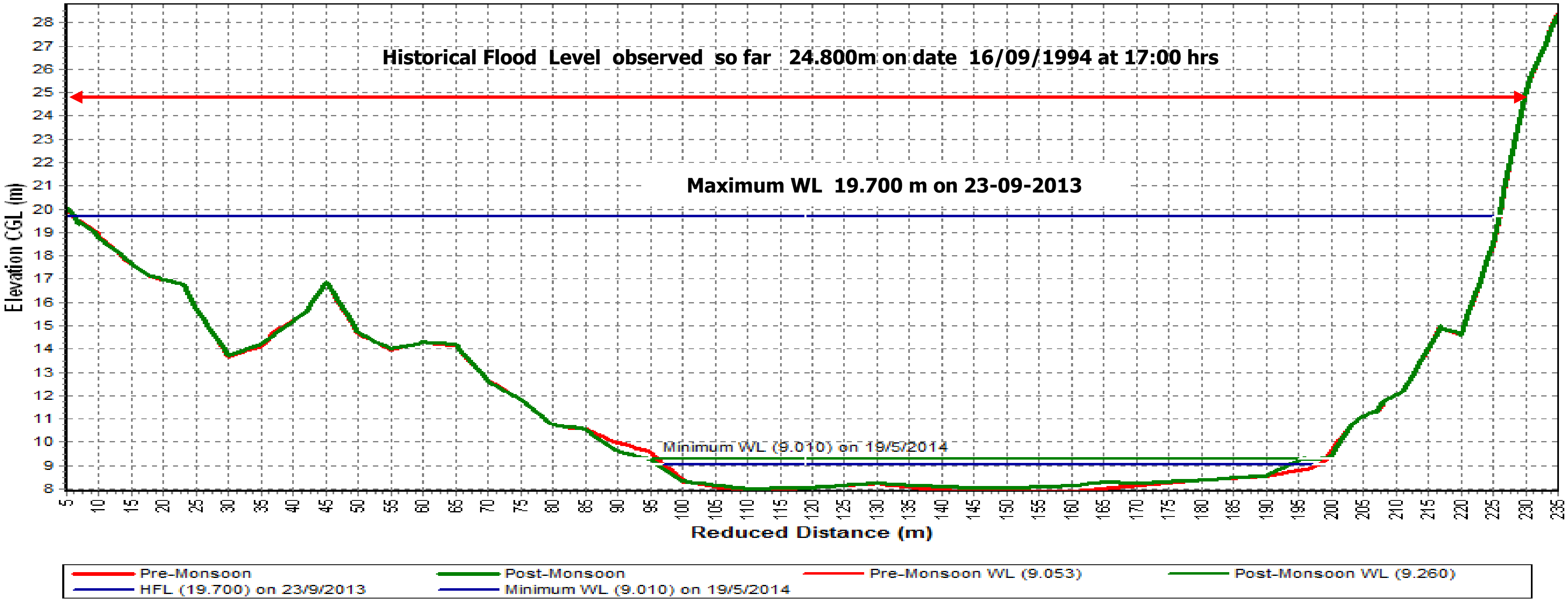
Monthly Average Runoff Based on period: 2013-14



4.1.7 Superimposed cross section

Station Name: Purna at Mahuwa (010219001) Division: Tapi Division Surat Local River:Purna Sub -Division: LTSD, CWC, Surat

Superimposed cross section at SG line

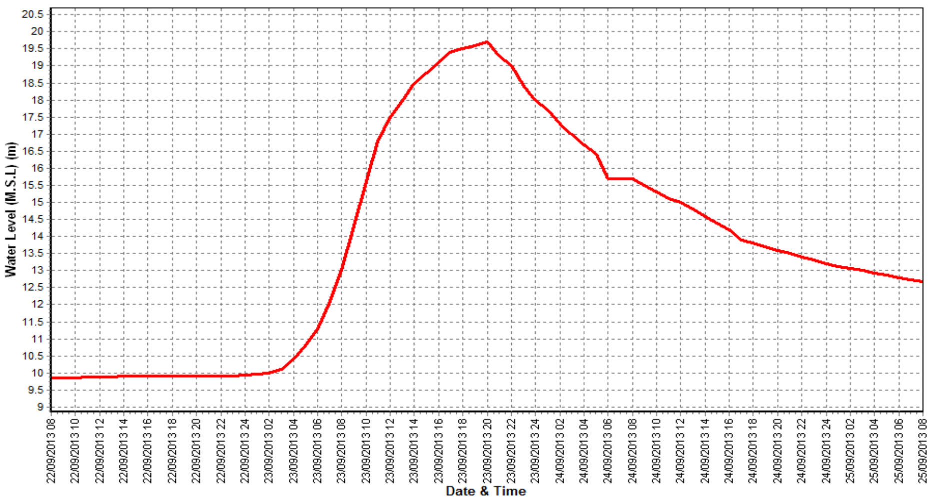


4.1.8 Water Level vs. Time- Graph of Highest Flood Peaks during 2013-14

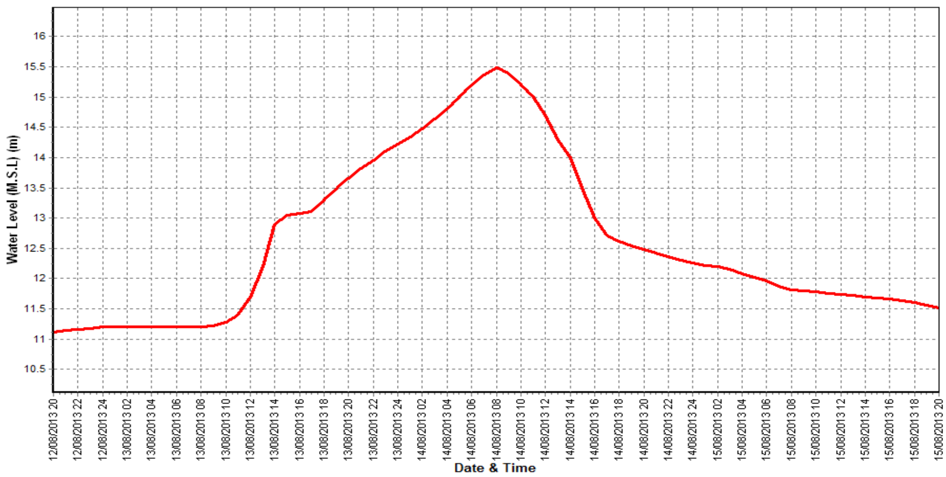
Station Name: Purna at Mahuwa (010219001)
Local River : Purna

Division : Tapi Division Surat
Sub -Division : LTSD, CWC, Surat

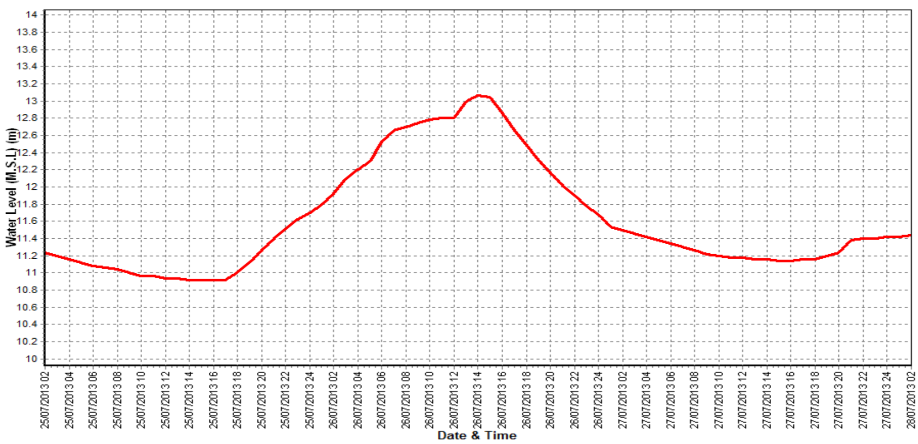
Water Level Vs. Time –Graph of I peak during the year 2013-14



Water Leel Vs. Time –Graph of II peak during the year 2013-14



Water Level Vs. Time –Graph of III peak during the year 2013-14



4.2 Ambica Basin

4.2.1 History sheet

HISTORY SHEET

			Water Year	**:**	**2013-14**
Site	**:**	**Ambica at Gadat**	**Code**	**:**	**01 02 20 001**
State	:	Gujarat	District		Valsad
Basin	:	WFR South of Tapi	Independent River	:	Ambika
Tributary	:		Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	
Division	:	Surat	Sub-Division	:	Surat
Drainage Area	:	1510 Sq. Km.	Bank	:	
Latitude	:	20°51'22"	Longitude	:	72°59'05"
Zero of Gauge (m)	:	1.5 (m.s.l)	14/01/1979		
		Opening Date	Closing Date		
Gauge	:	14/01/1979			
Discharge	:	12/03/1979			
Sediment	:	01/02/1985			
Water Quality	:	01/04/1980			

Annual Maximum / Minimum discharge with corresponding Water Level (m.s.l)

	Maximum			Minimum		
Year	Q (cumecs)	WL (m)	Date	Q (cumecs)	WL (m)	Date
1979-1980	1686	9.900	10/08/1979	0.180	3.350	16/06/1979
1980-1981	1492	9.160	02/08/1980	0.700	3.460	03/06/1980
1981-1982	1449	8.950	02/07/1981	0.000	3.500	13/06/1981
1982-1983	1537	9.400	25/07/1982	0.000	3.410	13/05/1983
1983-1984	1881	10.500	16/08/1983	0.000	1.500	07/06/1983
1984-1985	1551	9.430	06/07/1984	0.390	3.410	13/06/1984
1985-1986	1876	10.255	01/08/1985	0.100	3.315	17/04/1986
1986-1987	658.7	7.005	19/07/1986	0.100	3.315	13/06/1986
1987-1988	825.7	7.955	26/08/1987	0.000	3.200	05/04/1988
1988-1989	2308	10.110	27/07/1988	0.700	3.340	30/04/1989
1989-1990	2508	11.025	24/07/1989	0.456	3.285	08/06/1989
1990-1991	1385	10.220	17/08/1990	1.070	3.240	23/03/1991
1991-1992	450.7	6.440	28/07/1991	0.000	2.940	28/04/1992
1992-1993	1898	11.550	03/09/1992	0.000	3.020	14/06/1992
1993-1994	1245	5.185	25/06/1993	0.433	2.945	09/06/1993
1994-1995	2764	11.500	16/06/1994	0.364	2.940	03/05/1995
1995-1996	750.0	6.900	03/09/1995	0.091	2.810	16/04/1996
1996-1997	1255	8.425	24/07/1996	0.274	2.700	10/06/1996
1997-1998	1350	8.730	25/08/1997	0.465	2.200	30/05/1998
1998-1999	1200	8.800	08/07/1998	0.446	2.190	08/06/1998
1999-2000	2989	11.395	16/07/1999	0.783	2.130	26/04/2000
2000-2001	910.8	8.450	14/07/2000	0.748	2.425	13/01/2001
2001-2002	1873	9.810	20/07/2001	2.385	2.255	06/11/2001
2002-2003	1217	8.605	28/06/2002	2.210	3.955	21/10/2002
2003-2004	3650	10.075	28/07/2003	0.000	3.020	10/06/2003
2004-2005	2700	12.170	04/08/2004	1.812	3.700	30/10/2004
2005-2006	2894	13.010	29/06/2005	0.000	6.465	25/02/2006
2006-2007	1783	9.840	29/07/2006	0.000	6.460	02/03/2007
2007-2008	1601	9.400	02/07/2007	5.400	3.710	29/10/2007
2008-2009	1295	9.640	12/08/2008	40.43	3.840	30/08/2008
2009-2010	599	7.090	21/07/2009	0.000	4.820	01/06/2009
2010-2011	870.2	7.815	09/09/2010	0.000	4.590	01/06/2010
2011-2012	1594	9.67	29/08/2011	0.000	3.550	07/07/2011
2012-2013	548.7	6.930	13/08/2012	0.000	4.930	01/06/2012
2013-2014	1399	8.715	14/08/2013	0.000	3.750	As per SD curve

4.2.2 Annual Maximum Flood Peak

Year	Highest Flood Level (m)	Date	Hour
1979	12.180	11/08/1979	01:00:00
1980	10.690	02/08/1980	16:00:00
1981	9.980	10/07/1981	15:00:00
1982	10.950	25/07/1982	14:00:00
1983	11.070	16/08/1983	06:00:00
1984	13.470	18/07/1984	20:00:00
1985	13.020	01/08/1985	00:00:00
1986	7.780	19/07/1986	00:00:00
1987	9.870	26/08/1987	03:00:00
1988	11.650	27/07/1988	16:00:00
1989	11.490	24/07/1989	13:00:00
1990	10.270	17/08/1990	09:00:00
1991	6.710	28/07/1991	18:00:00
1992	11.950	03/09/1992	12:00:00
1993	11.710	25/06/1993	18:00:00
1994	13.985	16/06/1994	18:00:00
1995	7.970	20/07/1995	12:00:00
1996	10.400	23/07/1996	16:00:00
1997	12.400	31/07/1997	21:00:00
1998	10.760	08/07/1998	11:00:00
1999	12.760	16/07/1999	02:00:00
2000	10.550	14/07/2000	03:00:00
2001	11.570	20/07/2001	15:00:00
2002	12.360	26/06/2002	22:00:00
2003	13.520	28/07/2003	04:00:00
2004	13.980	04/08/2004	02:00:00
2005	13.450	29/06/2005	16:00:00
2006	12.900	05/07/2006	14:00:00
2007	10.200	02/07/2007	13:00:00
2008	11.420	12/08/2008	13:00:00
2009	9.300	21/07/2009	13:00:00
2010	7.980	09/09/2010	04:00:00
2011	11.800	29/08/2011	06:00:00
2012	8.100	10/08/2012	01:00:00
2013	12.460	23/09/2013	20:00:00

4.2.3 Summary of Data

Stage –Discharge data for the period 2013-14

Station Name: Ambica at Gadat (01 02 20 001) Division : Tapi Division Surat Local River: Ambica Sub -Division : LTSD, CWC, Surat

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	4.930	0.000	3.680	0.000	5.045	238.9	4.150	77.56 *	4.385	358.5	4.560	0.000
2	4.930	0.000	3.760	0.000	5.465	290.5	4.100	83.79	4.300	101.9 *	4.900	0.000
3	4.930	0.000	3.760	0.000	5.775	406.7	4.070	54.58	4.245	87.81	4.980	0.000
4	4.930	0.000	3.750	0.000	5.200	288.2 *	4.050	51.86	4.300	120.1	5.050	0.000
5	4.930	0.000	3.760	0.000	5.175	285.4	4.050	51.98	4.235	87.32	5.050	0.000
6	4.930	0.000	4.520	78.26	4.735	207.0	4.060	50.38	4.170	80.68 *	5.050	0.000
7	4.900	0.000	4.250	93.57 *	4.680	169.8	4.110	88.31	4.085	75.67	5.050	0.000
8	4.960	0.000	4.080	35.50	4.470	139.4	4.060	64.03 *	4.065	62.30	5.050	0.000
9	4.960	0.000	4.110	50.43	4.400	119.4 *	4.020	58.30 *	4.163	70.12	5.050	0.000
10	5.070	0.000	3.990	37.09	5.100	271.5	4.995	212.5	4.095	64.81	5.050	0.000
11	5.070	0.000	4.800	60.89	5.260	302.7 *	4.270	105.5	4.155	68.65	5.050	0.000
12	3.900	0.000	5.615	298.7	4.885	222.3	4.260	100.1	4.160	68.98	5.050	0.000
13	3.800	0.000	4.830	226.0	5.370	315.3	4.380	120.0	4.060	64.03 *	5.000	0.000
14	3.770	0.000	5.110	266.9 *	8.715	1399	4.300	110.6	4.010	59.05	5.000	0.000
15	3.770	0.000	4.545	123.4	6.020	506.0 *	4.190	83.84 *	4.033	60.97	5.000	0.000
16	3.740	0.000	4.260	93.88	5.360	381.1	4.450	133.3	4.000	55.50 *	5.000	0.000
17	3.710	0.000	5.970	346.1	5.030	248.4 *	4.440	129.1	4.010	54.59	5.000	0.000
18	4.170	0.000	6.230	702.9	4.900	219.3 *	4.780	203.7	3.990	54.06	5.000	0.000
19	3.970	0.000	5.940	534.5	4.680	172.9 *	4.300	113.4	3.970	50.15	5.000	0.000
20	3.820	0.000	5.275	329.9	4.520	153.2	4.190	102.1	3.950	48.71 *	5.000	0.000
21	3.820	0.000	4.940	228.1 *	4.420	139.4	4.110	96.32	3.910	43.84	5.000	0.000

22	3.840	0.000	5.395	317.5	4.305	106.1	4.080	66.96 *	3.880	39.73	5.000	0.000
23	3.790	0.000	5.500	321.5	4.320	114.3	6.300	788.3	3.870	38.46	5.000	0.000
24	3.770	0.000	6.210	530.1	4.320	112.0	10.650	2328 *	3.870	37.83	5.000	0.000
25	3.760	0.000	5.470	318.3	4.440	126.6 *	6.850	893.0	3.850	36.94	5.000	0.000
26	3.720	0.000	5.460	295.1	4.695	143.5	5.600	665.8	3.840	36.03	5.000	0.000
27	3.710	0.000	5.470	304.9	4.540	136.7	5.160	540.6	3.830	33.68 *	5.000	0.000
28	3.690	0.000	5.580	384.1 *	4.380	115.8 *	4.800	465.3	3.810	33.53	5.000	0.000
29	3.690	0.000	5.500	317.2	4.290	106.6	4.700	176.9 *	3.800	0.000	5.000	0.000
30	3.690	0.000	5.280	282.3	4.240	98.16	4.530	393.0	3.800	0.000	5.000	0.000
31			5.300	296.4	4.200	91.73			4.100	0.000		
Ten-Daily Mean												
I Ten-Daily	4.947	0.000	3.966	29.48	5.005	241.7	4.166	79.33	4.204	110.9	4.979	0.000
II Ten-Daily	3.972	0.000	5.258	298.3	5.474	392.1	4.356	120.2	4.034	58.47	5.010	0.000
III Ten-Daily	3.748	0.000	5.464	326.9	4.377	117.4	5.678	641.4	3.869	27.28	5.000	0.000
Monthly												
Min.	3.690	0.000	3.680	0.000	4.200	91.73	4.020	50.38	3.800	0.000	4.560	0.000
Max.	5.070	0.000	6.230	702.9	8.715	1399	10.650	2328	4.385	358.5	5.050	0.000
Mean	4.222	0.000	4.914	221.7	4.933	246.1	4.734	280.3	4.030	64.32	4.996	0.000

Annual Runoff in MCM = 2152 Annual Runoff in mm = 1425

Peak Observed Discharge = 1399 cumecs on 14/08/2013 Corres. Water Level :8.715 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2013 Corres. Water Level :4.93 m

Q: Observed/Computed discharge in cumecs WL: Corresponding Mean Water Level (m.s.l) in m * : Computed Discharge #:Discarded Discharge (values changed as per rating curve)Note: River remained in pooling/ no flow condition w.e.f. 01/06/13 to 05/07/13 and from 29/10/2013 to 31/05/2014**.**Back water effect form Dewadha Dam exists at site during this period.

Stage –Discharge data for the period 2013-14

Station Name: Ambica at Gadat (01 02 20 001) Division : Tapi Division Surat Local River: Ambica Sub -Division : LTSD, CWC, Surat

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.900	0.000	4.970	0.000
2	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.900	0.000	4.970	0.000
3	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.900	0.000	4.970	0.000
4	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.900	0.000	4.970	0.000
5	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.900	0.000	4.970	0.000
6	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.900	0.000	4.970	0.000
7	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.900	0.000	4.970	0.000
8	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.960	0.000	4.970	0.000
9	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.960	0.000	4.970	0.000
10	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.960	0.000	4.970	0.000
11	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.960	0.000	4.970	0.000
12	5.000	0.000	5.000	0.000	4.990	0.000	4.980	0.000	4.960	0.000	4.970	0.000
13	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.960	0.000	4.970	0.000
14	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.960	0.000	4.970	0.000
15	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.960	0.000	4.970	0.000
16	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.900	0.000	4.970	0.000
17	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.900	0.000	4.970	0.000
18	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.900	0.000	4.970	0.000
19	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.960	0.000	4.970	0.000
20	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.960	0.000	4.970	0.000
21	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.970	0.000	4.970	0.000

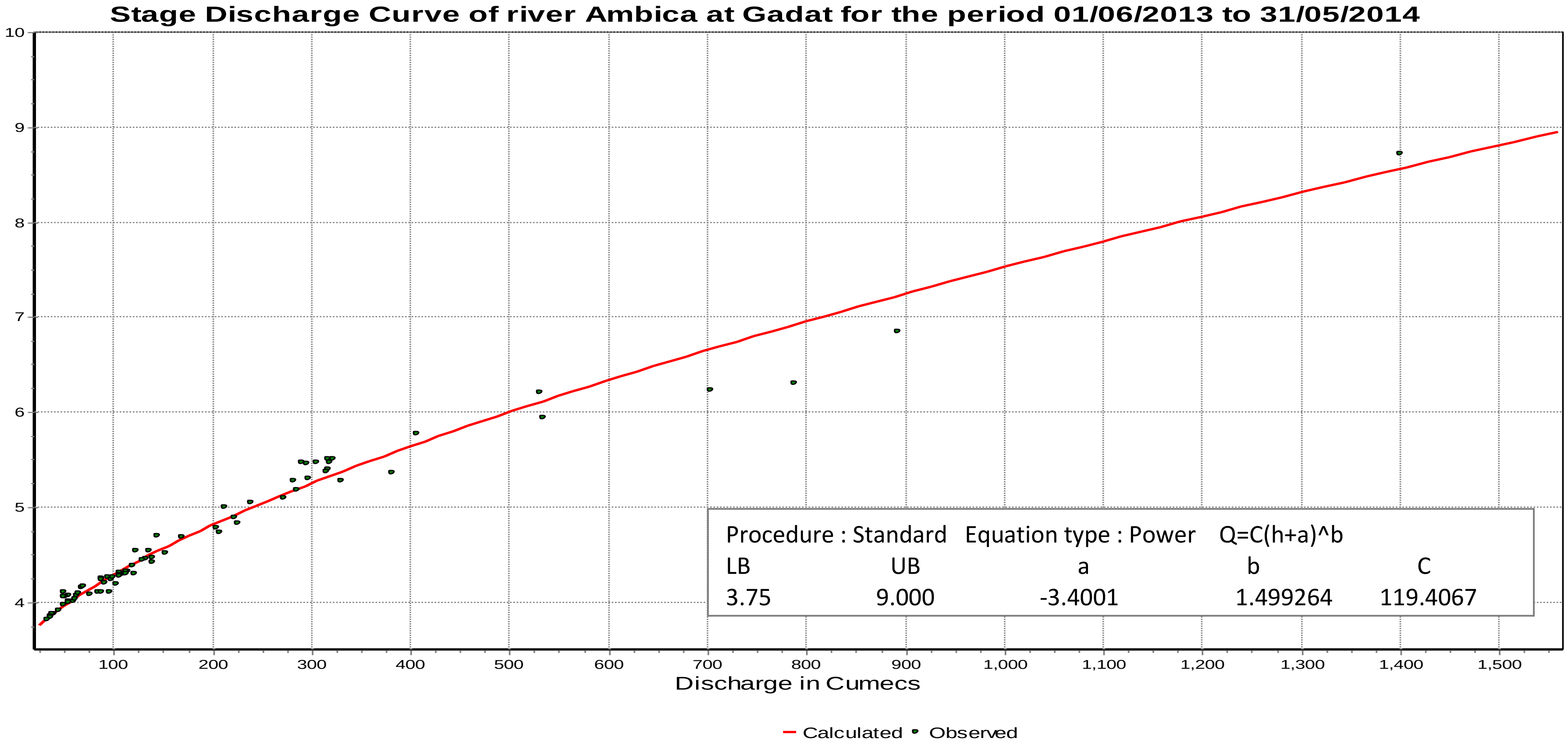
22	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.970	0.000
23	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.970	0.000	4.970	0.000
24	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.970	0.000	4.970	0.000
25	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.970	0.000	4.970	0.000
26	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.970	0.000	4.970	0.000
27	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.970	0.000	4.970	0.000
28	5.000	0.000	5.000	0.000	5.000	0.000	4.940	0.000	4.970	0.000	4.970	0.000
29	5.000	0.000	5.000	0.000			4.930	0.000	4.970	0.000	4.970	0.000
30	5.000	0.000	5.000	0.000			4.930	0.000	4.970	0.000	4.970	0.000
31	5.000	0.000	5.000	0.000			4.900	0.000			4.970	0.000
<u>Ten-Daily Mean</u>												
I Ten-Daily	5.000	0.000	5.000	0.000	5.000	0.000	4.980	0.000	4.918	0.000	4.970	0.000
II Ten-Daily	5.000	0.000	5.000	0.000	4.999	0.000	4.994	0.000	4.942	0.000	4.970	0.000
III Ten-Daily	5.000	0.000	5.000	0.000	5.000	0.000	4.967	0.000	4.973	0.000	4.970	0.000
<u>Monthly</u>												
Min.	5.000	0.000	5.000	0.000	4.990	0.000	4.900	0.000	4.900	0.000	4.970	0.000
Max.	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	5.000	0.000	4.970	0.000
Mean	5.000	0	5.000	0	5.000	0	4.980	0	4.944	0	4.970	0

Peak Computed Discharge = 2328 cumecs on 24/09/2013 Corres. Water Level :10.65 m
Lowest Computed Discharge = 33.68 cumecs on 27/10/2013 Corres. Water Level :3.83 m

Q: Observed/Computed discharge in cumecs WL: Corresponding Mean Water Level (m.s.l) in m * : Computed Discharge #:Discarded Discharge (values changed as per rating curve)Note: River remained in pooling/ no flow condition w.e.f. 01/06/13 to 05/07/13 and from 29/10/2013 to 31/05/2014**.**Back water effect form Dewadha Dam exists at site during this period.

4.2.4 Stage Discharge Curve

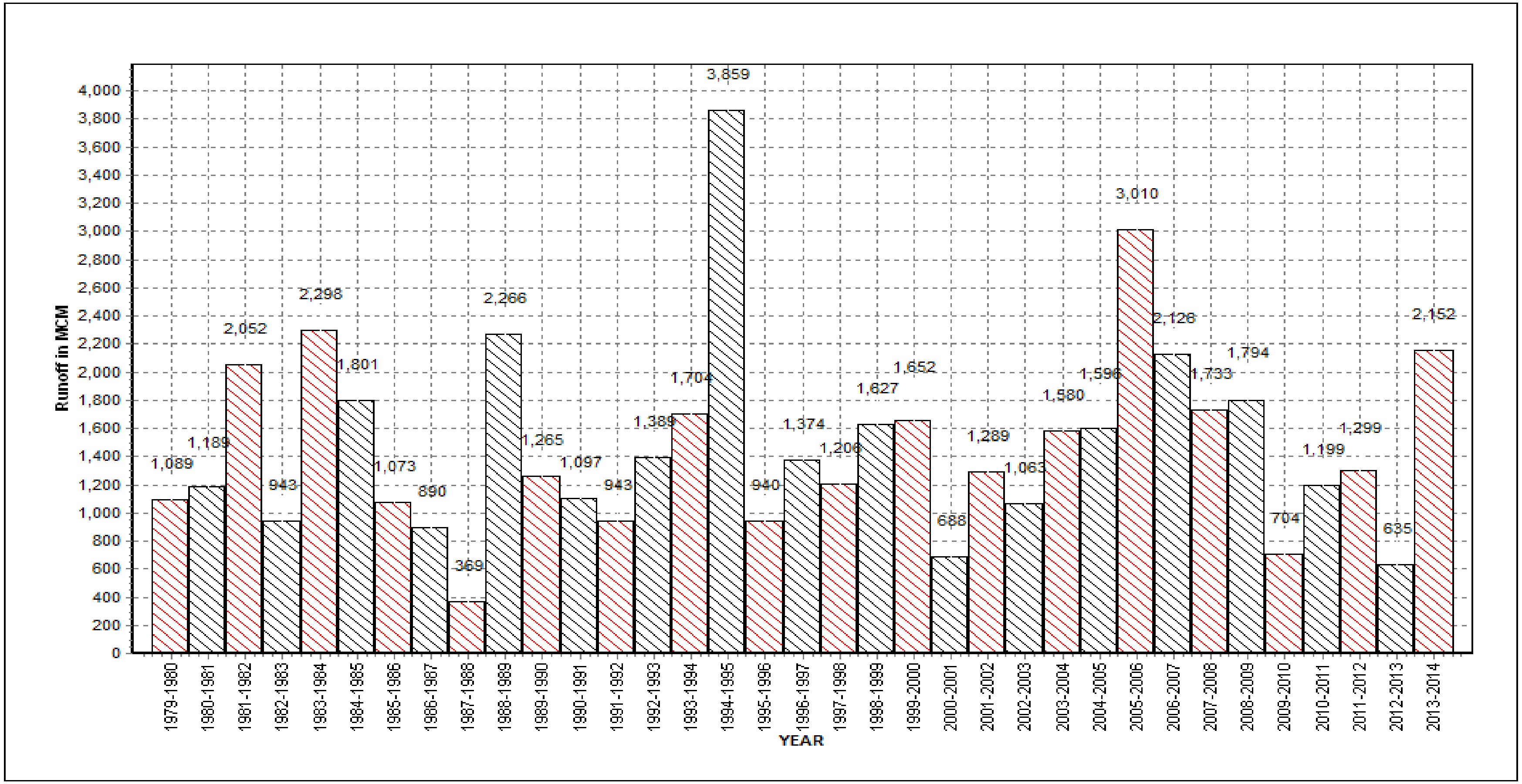
Station Name: Ambica at Gadat (01 02 20 001) Division : Tapi Division Surat Local River: Ambica Sub -Division : LTSD, CWC, Surat



4.2.5 Annual runoff

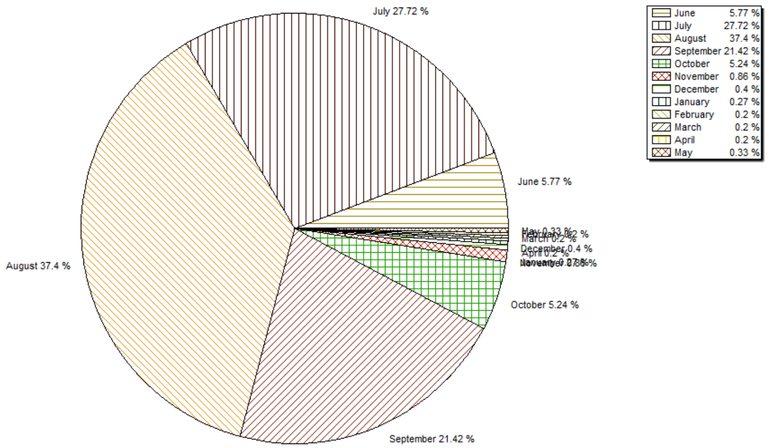
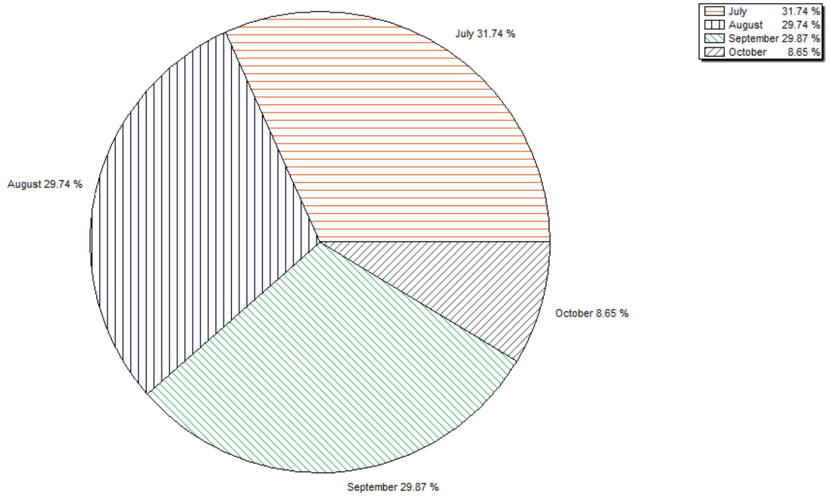
Annual Runoff Values Runoff Based on period 1979 to 2014

Station Name: Ambica at Gadat (01 02 20 001) Division : Tapi Division, Surat Local River: Ambica Sub -Division : LTSD, CWC, Surat



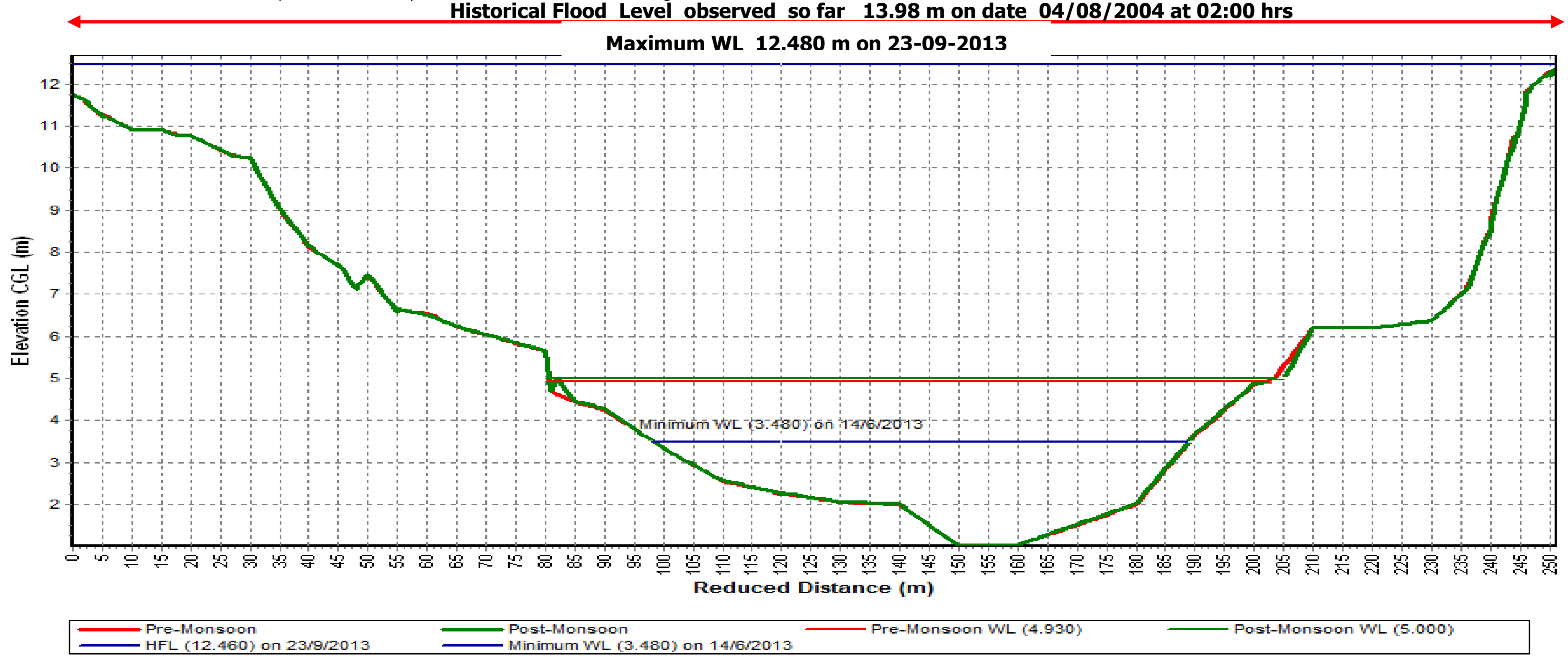
4.2.6 Monthly average Runoff

Station Name: Ambica at Gadat (01 02 20 001) Division : Tapi Division, Surat Local River: Ambica Sub -Division : LTSD, CWC, Surat

Monthly Average Runoff Based on period: 1979 -2013	Monthly Average Runoff Based on period: 2013-14
	

4.2.7 Superimposed Cross section

Station Name: Ambica at Gadat (01 02 20 001) Division: Tapi Division, Surat Local River: Ambica Sub -Division: LTSD, CWC, Surat

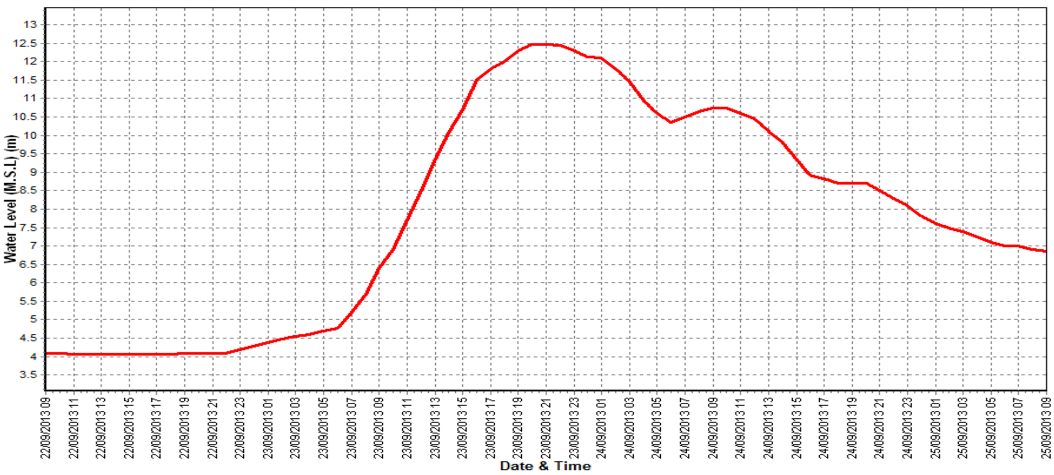


4.2.8 Water Level vs. Time- Graph of Highest Flood Peaks during 2013-14

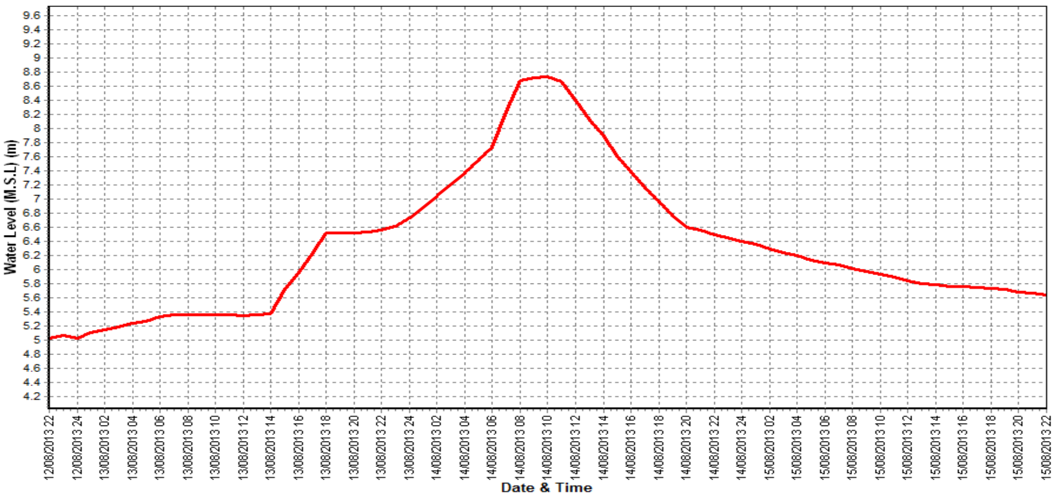
Station Name: Ambica at Gadat (01 02 20 001) Division : Tapi Division Surat

Local River: Ambica Sub -Division : LTSD, CWC, Surat

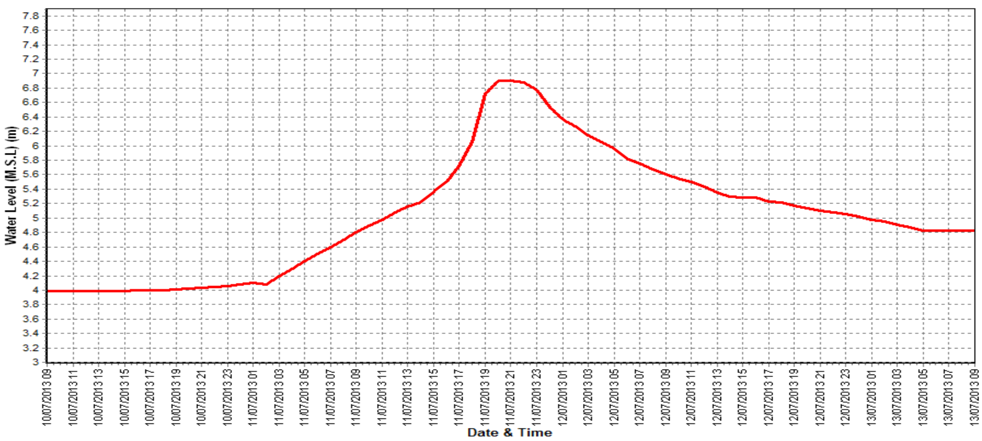
Water level vs. Time graph of 1st flood peak during the year 2013-14



Water level vs. Time graph of 2nd flood peak during the year 2013-14



Water level vs. Time graph of 3rd flood peak during the year 2013-14



4.3 Vaitarna at Durvesh

4.3.1 History sheet

HISTORY SHEET

Water Year : 2013-14

Site	**:**	**Vaitarna at Durvesh**	**Code**	**:**	**01 02 25 001**
State	:	Maharashtra	District		Thane
Basin	:	WFR South of Tapi	Independent River	:	Vaitarna
Tributary	:		Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	
Division	:	Tapi Division, Surat	Sub-Division	:	DGSD,CWC,Silvassa
Drainage Area	:	2019 Sq. Km.	Bank	:	
Latitude	:	19°42'45"	Longitude	:	72°55'50"
Zero of Gauge (m) : 0 (m.s.l)			26/10/1970		
		Opening Date	Closing Date		
Gauge	:	26/10/1970			
Discharge	:	26/01/1971			
Sediment	:	26/01/1971			
Water Quality	:	01/06/1977			

Annual Maximum / Minimum discharge with corresponding Water Level (m.s.l)

	Maximum			Minimum		
Year	Q (cumecs)	WL (m)	Date	Q (cumecs)	WL (m)	Date
1971-1972	4386	11.330	30/09/1971	0.000	1.975	21/06/1971
1972-1973	1543	6.463	02/07/1972	0.000	0.680	03/06/1972
1973-1974	3826	10.950	23/09/1973	0.000	0.890	09/05/1974
1974-1975	1655	6.743	04/07/1974	0.000	0.880	09/05/1975
1975-1976	3303	8.437	11/08/1975	0.000	0.855	29/04/1976
1976-1977	7744	14.250	31/07/1976	0.000	0.975	09/05/1977
1977-1978	4374	11.522	03/09/1977	0.020	0.825	14/06/1977
1978-1979	1796	7.277	21/06/1978	0.000	0.800	03/05/1979
1979-1980	5000	9.060	11/08/1979	0.000	1.045	19/06/1979
1980-1981	2460	9.025	04/08/1980	0.000	1.010	13/02/1981
1981-1982	1748	8.675	10/07/1981	0.000	1.400	17/12/1981
1982-1983	1140	8.900	22/08/1982	2.000	1.620	08/11/1982
1983-1984	2249	9.635	13/08/1983	0.000	0.920	14/06/1983
1984-1985	3180	12.900	19/07/1984	0.100	1.250	15/06/1984
1985-1986	1032	7.155	03/08/1985	0.000	1.440	05/07/1985
1986-1987	1293	7.850	19/07/1986	0.000	1.240	30/10/1986
1987-1988	1287	7.065	07/07/1987	0.000	1.954	02/07/1987
1988-1989	3396	11.000	16/07/1988	0.000	0.000	02/02/1989
1989-1990	1672	9.075	25/07/1989	0.000	1.610	30/06/1989
1990-1991	1761	7.690	18/08/1990	0.000	0.000	03/01/1991
1991-1992	1361	8.800	28/07/1991	0.000	0.000	26/01/1992
1992-1993	1405	8.675	12/08/1992	0.000	0.000	27/01/1993
1993-1994	1497	6.045	16/07/1993	0.000	0.000	15/02/1994
1994-1995	2340	12.550	13/07/1994	0.000	0.000	05/02/1995
1995-1996	1039	7.250	21/07/1995	0.000	0.000	02/02/1996
1996-1997	1611	7.380	23/07/1996	0.900	1.120	10/12/1996
1997-1998	4100	12.330	31/07/1997	0.000	1.200	14/06/1997
1998-1999	8000	15.220	17/09/1998	0.000	1.200	26/04/1999
1999-2000	4536	12.180	16/07/1999	0.000	1.190	14/05/2000
2000-2001	1749	8.440	13/07/2000	0.000	1.140	30/12/2000
2001-2002	1469	7.200	04/07/2001	0.000	1.140	31/12/2001
2002-2003	4400	10.830	27/06/2002	0.000	1.100	24/12/2002
2003-2004	6038	12.350	28/07/2003	0.000	1.090	28/12/2003
2004-2005	5080	12.050	03/08/2004	0.000	1.080	20/04/2005
2005-2006	4997	10.450	28/07/2005	0.000	1.030	13/04/2006
2006-2007	4086	10.680	07/08/2006	0.659	1.060	26/12/2006
2007-2008	2034	7.530	03/07/2007	0.853	1.070	24/12/2007
2008-2009	2941	9.830	20/09/2008	0.470	1.060	22/12/2008
2009-2010	1633	7.750	23/07/2009	0.000	1.000	01/06/2009
2010-2011	1422	7.060	02/08/2010	13.48	0.700	10/06/2010
2011-2012	3408	9.930	29/08/2011	0.000	0.950	03/06/2011
2012-2013	1394	6.460	04/09/2012	0.000	0.840	01/06/2012
2013-2014	2070	7.200	12/07/2013	0.000	0.780	01/06/2013

4.3.2 Annual Maximum Flood Peak

Year	Highest Flood Level (m)	Date	Hour
1974	7.690	04/07/1974	15:00:00
1975	9.860	30/07/1975	03:00:00
1976	14.700	31/07/1976	15:00:00
1977	12.075	03/09/1977	06:00:00
1978	7.720	21/06/1978	10:00:00
1979	9.510	11/08/1979	06:00:00
1980	10.830	04/08/1980	00:00:00
1981	10.500	10/07/1981	20:00:00
1982	9.200	22/08/1982	09:00:00
1983	12.000	15/08/1983	19:00:00
1984	14.460	18/07/1984	18:00:00
1985	8.050	03/08/1985	18:00:00
1986	8.300	15/07/1986	20:00:00
1987	10.800	20/08/1987	15:00:00
1988	13.800	16/07/1988	16:00:00
1989	11.540	25/07/1989	01:00:00
1990	10.250	03/07/1990	20:00:00
1991	10.500	28/07/1991	00:00:00
1992	10.500	03/09/1992	21:00:00
1993	11.900	17/07/1993	00:00:00
1994	12.800	13/07/1994	08:00:00
1995	8.100	21/07/1995	18:00:00
1996	8.220	23/07/1996	18:00:00
1997	12.920	31/07/1997	13:00:00
1998	16.130	17/09/1998	13:00:00
1999	12.500	16/07/1999	09:00:00
2000	8.670	13/07/2000	14:00:00
2001	8.300	09/07/2001	18:00:00
2002	14.500	26/06/2002	18:00:00
2003	12.400	28/07/2003	09:00:00
2004	15.120	02/08/2004	22:00:00
2005	11.340	02/08/2005	14:00:00
2006	11.300	08/08/2006	16:00:00
2007	9.680	05/08/2007	19:00:00
2008	14.220	11/08/2008	20:00:00
2009	9.600	22/07/2009	15:00:00
2010	8.160	31/08/2010	19:00:00
2011	12.720	28/08/2011	19:00:00
2012	7.480	04/09/2012	18:00:00
2013	8.260	02/08/2013	04:00:00

4.3.1 Summary of Data

Stage –Discharge data for the period 2013-2014

Station Name: Vaitarna at Durvesh (01 02 25 001) Division : Tapi Division Surat Sub -Division : DGSD, CWC, Silvasa
Local River: Vaitarna

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	0.780	0.000		2.815	202.4		5.760	869.8		2.370	154.3	*	2.320	172.9		1.630	88.88	
2	0.770	0.000		2.760	191.2		8.000	1372	#	2.160	149.9		2.220	129.5	*	1.620	89.83	
3	0.780	0.000		4.600	445.3		6.120	922.5	#	2.100	142.6		2.120	146.9		1.590	36.17	*
4	0.800	0.000		3.860	362.0		4.000	460.2	*	2.040	100.9	#	2.210	156.5		1.560	8.542	
5	0.830	0.000		3.800	419.9	#	3.510	333.8		2.000	94.71	#	2.620	219.2		1.540	8.086	
6	0.990	0.000		3.170	214.0		3.010	270.5		2.020	97.79	#	2.200	126.3	*	1.540	8.028	
7	1.020	0.000		4.020	464.3	*	2.750	220.0		2.210	156.4		2.290	167.7		1.530	28.55	*
8	1.010	0.000		3.800	419.9	#	3.080	270.8		2.100	110.3	*	2.100	100.3	#	1.520	7.426	
9	0.920	0.000		4.150	491.0	#	3.250	312.4	*	2.040	100.9	*	2.200	155.0		1.510	7.133	
10	1.070	0.000		3.970	454.2	#	4.130	409.2		2.020	97.79	#	2.850	232.8		1.510	26.09	*
11	1.080	0.000		5.970	888.1	#	4.350	532.5	*	2.520	196.7		2.650	215.2		1.500	6.793	
12	1.030	0.000		7.220	1182	#	4.680	475.3		2.600	209.6		2.820	225.3		1.480	5.937	
13	1.160	0.000		6.760	1072	#	3.470	319.7		3.410	316.8		2.460	169.5	*	1.460	5.314	
14	1.260	0.000		4.620	589.4	*	5.280	690.6		3.220	286.0		2.210	161.3		1.450	18.96	*
15	1.130	0.000		3.880	407.5		4.670	600.1	*	2.930	252.7	*	2.220	156.1		1.440	5.494	
16	1.160	0.000		3.880	406.4		3.580	341.7		4.360	404.4		2.130	115.0	*	1.430	4.829	
17	1.230	0.000		4.460	430.5		3.190	284.4		2.700	225.0		2.340	149.3	*	1.420	15.56	*
18	1.300	0.000		5.430	756.5		3.660	392.0	*	2.710	229.2		2.150	118.2	*	1.400	3.567	
19	1.290	0.000		5.750	867.1		3.310	303.6		2.480	189.1		2.030	99.34	*	1.390	3.428	
20	1.300	0.000		5.350	717.8		2.880	243.7		2.630	217.2		1.950	87.09	*	1.380	3.105	

21	1.260	0.000	6.110	920.2 *	2.650	216.3	2.350	178.8	1.890	124.6	1.360	2.828
22	1.280	0.000	5.650	790.9	2.420	183.2	2.120	113.5 *	1.850	119.1	1.350	2.556
23	2.280	139.3 *	4.880	645.2 #	2.260	162.0	2.820	230.5	1.800	64.94 *	1.340	2.456
24	2.740	186.3	6.650	1058	2.300	168.9	5.360	732.9	1.770	60.65 *	1.330	6.120 *
25	2.900	208.0	5.230	673.7	2.960	258.2 *	4.670	600.1 #	1.740	56.42 *	1.320	2.270
26	3.230	240.9	6.470	970.5	2.900	248.3	3.400	279.3	1.710	95.06	1.300	2.009
27	2.810	197.1	4.780	492.7	2.710	226.6	2.900	241.4	1.690	49.50 *	1.280	1.682
28	4.170	359.8	4.170	495.1 *	2.400	159.3 *	2.850	231.1	1.680	97.73	1.260	1.520
29	4.545	413.5	3.840	369.2	2.320	172.3	2.500	176.3 *	1.670	95.70	1.240	0.743
30	3.160	295.4 *	3.420	308.6	2.250	156.0	2.390	184.3	1.660	93.89	1.220	0.319
31			5.300	698.8	2.260	164.9 #			1.640	91.12		
Ten-Daily Mean												
I Ten-Daily	0.897	0.000	3.694	366.4	4.361	544.2	2.106	120.6	2.313	160.7	1.555	30.87
II Ten-Daily	1.194	0.000	5.332	731.7	3.907	418.4	2.956	252.7	2.296	149.6	1.435	7.298
III Ten-Daily	2.837	204.0	5.136	674.8	2.494	192.4	3.136	296.8	1.736	86.24	1.300	2.250
Monthly												
Min.	0.770	0.000	2.760	191.2	2.250	156.0	2.000	94.71	1.640	49.50	1.220	0.319
Max.	4.545	413.5	7.220	1182	8.000	1372	5.360	732.9	2.850	232.8	1.630	89.83
Mean	1.643	68.01	4.734	593.7	3.552	378.7	2.733	223.3	2.103	130.7	1.430	13.47

Annual Runoff in MCM = 3745 Annual Runoff in mm = 1855

Peak Observed Discharge = 1372 cumecs on 02/08/2013 Corres. Water Level :8.0 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2013 Corres. Water Level :0.78 m

Q: Observed/Computed discharge in cumec WL: Corresponding Mean Water Level (m.s.l) in m * : Computed Discharge

#:Discarded Discharge (values changed as per rating curve)

Note: River remained in pooling/ no flow condition w.e.f. 01/06/13 to 22/06/13 & from 01/12/13 to 31/05/14 .

Stage –Discharge data for the period 2013-2014

Station Name: Vaitarna at Durvesh (01 02 25 001) Division : Tapi Division, Surat Sub -Division : DGSD, CWC, Silvassa Local River: Vaitarna

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	1.260	0.000	1.200	0.000	1.280	0.000	1.260	0.000	1.300	0.000	1.270	0.000
2	1.310	0.000	1.300	0.000	1.330	0.000	1.320	0.000	1.360	0.000	1.290	0.000
3	1.350	0.000	1.290	0.000	1.250	0.000	1.310	0.000	1.420	0.000	1.210	0.000
4	1.330	0.000	1.250	0.000	1.180	0.000	1.240	0.000	1.400	0.000	1.180	0.000
5	1.320	0.000	1.230	0.000	1.130	0.000	1.180	0.000	1.280	0.000	1.160	0.000
6	1.280	0.000	1.200	0.000	1.110	0.000	1.120	0.000	1.180	0.000	1.100	0.000
7	1.230	0.000	1.130	0.000	1.090	0.000	1.080	0.000	1.100	0.000	1.020	0.000
8	1.220	0.000	1.110	0.000	1.090	0.000	1.060	0.000	0.970	0.000	1.030	0.000
9	1.210	0.000	1.100	0.000	1.080	0.000	1.050	0.000	0.900	0.000	1.040	0.000
10	1.190	0.000	1.100	0.000	1.080	0.000	1.040	0.000	0.850	0.000	1.020	0.000
11	1.190	0.000	1.110	0.000	1.070	0.000	1.030	0.000	0.820	0.000	1.010	0.000
12	1.180	0.000	1.120	0.000	1.090	0.000	1.020	0.000	0.830	0.000	1.000	0.000
13	1.180	0.000	1.120	0.000	1.140	0.000	1.010	0.000	0.930	0.000	1.030	0.000
14	1.190	0.000	1.150	0.000	1.220	0.000	0.990	0.000	1.010	0.000	1.040	0.000
15	1.250	0.000	1.230	0.000	1.290	0.000	1.010	0.000	1.210	0.000	1.290	0.000
16	1.280	0.000	1.270	0.000	1.330	0.000	1.050	0.000	1.260	0.000	1.220	0.000
17	1.260	0.000	1.340	0.000	1.290	0.000	1.150	0.000	1.300	0.000	1.170	0.000
18	1.300	0.000	1.260	0.000	1.220	0.000	1.240	0.000	1.290	0.000	1.120	0.000
19	1.280	0.000	1.200	0.000	1.160	0.000	1.280	0.000	1.230	0.000	1.070	0.000
20	1.290	0.000	1.180	0.000	1.120	0.000	1.210	0.000	1.170	0.000	1.040	0.000
21	1.270	0.000	1.180	0.000	1.090	0.000	1.150	0.000	1.140	0.000	1.000	0.000

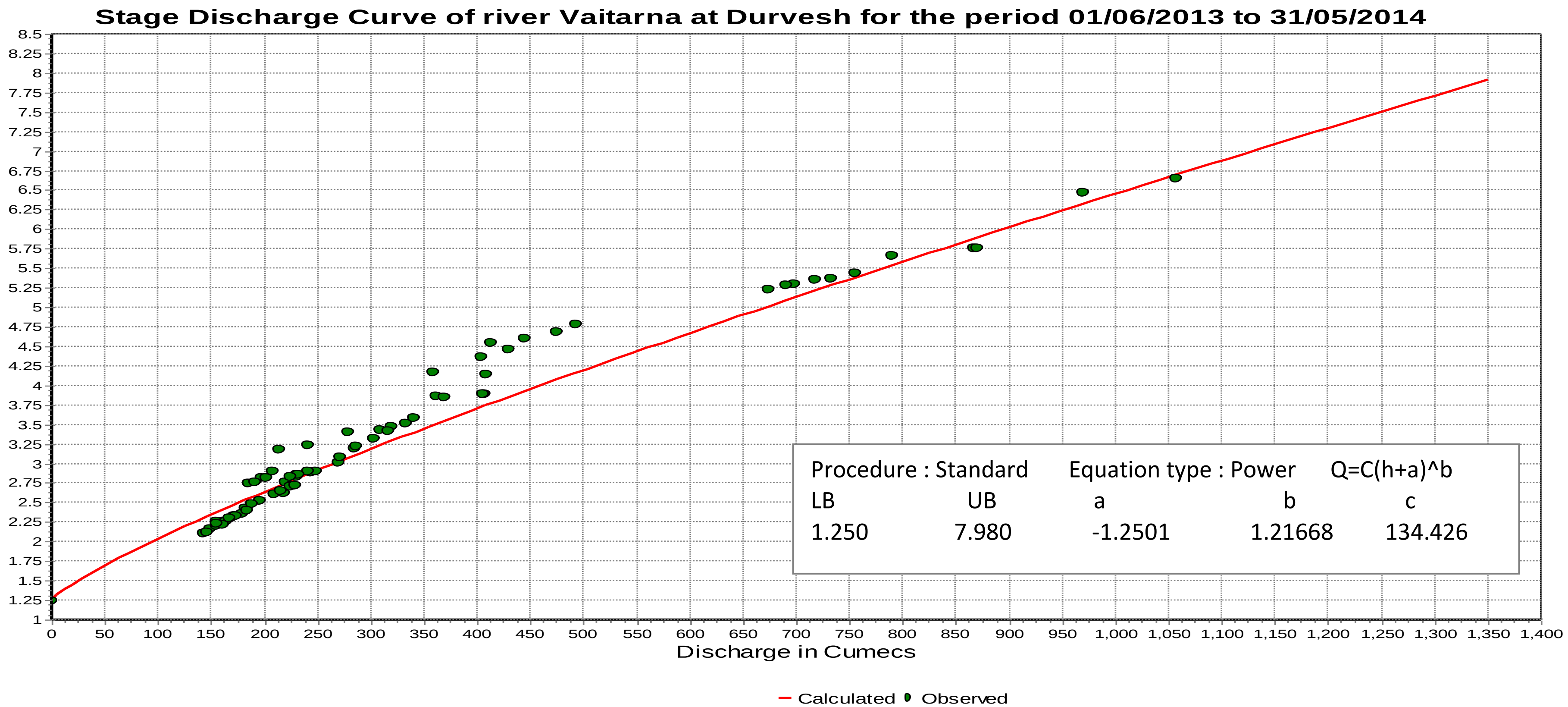
22	1.250	0.000	1.170	0.000	1.080	0.000	1.080	0.000	1.100	0.000	0.950	0.000
23	1.230	0.000	1.150	0.000	1.080	0.000	1.030	0.000	1.040	0.000	0.900	0.000
24	1.220	0.000	1.140	0.000	1.070	0.000	1.000	0.000	1.060	0.000	0.860	0.000
25	1.200	0.000	1.130	0.000	1.070	0.000	0.960	0.000	1.050	0.000	0.900	0.000
26	1.180	0.000	1.130	0.000	1.090	0.000	0.930	0.000	1.070	0.000	0.980	0.000
27	1.180	0.000	1.120	0.000	1.140	0.000	0.920	0.000	1.120	0.000	1.090	0.000
28	1.170	0.000	1.140	0.000	1.200	0.000	0.910	0.000	1.150	0.000	1.200	0.000
29	1.170	0.000	1.180	0.000			0.900	0.000	1.180	0.000	1.180	0.000
30	1.160	0.000	1.200	0.000			1.110	0.000	1.210	0.000	1.160	0.000
31	1.170	0.000	1.230	0.000			1.240	0.000			1.130	0.000
Ten-Daily Mean												
I Ten-Daily	1.270	0.000	1.191	0.000	1.162	0.000	1.166	0.000	1.176	0.000	1.132	0.000
II Ten-Daily	1.240	0.000	1.198	0.000	1.193	0.000	1.099	0.000	1.105	0.000	1.099	0.000
III Ten-Daily	1.200	0.000	1.161	0.000	1.103	0.000	1.021	0.000	1.112	0.000	1.032	0.000
Monthly												
Min.	1.160	0.000	1.100	0.000	1.070	0.000	0.900	0.000	0.820	0.000	0.860	0.000
Max.	1.350	0.000	1.340	0.000	1.330	0.000	1.320	0.000	1.420	0.000	1.290	0.000
Mean	1.235	0.000	1.183	0.000	1.156	0.000	1.093	0.000	1.131	0.000	1.086	0.000

Peak Computed Discharge = 920.2 cumecs on 21/07/2013 **Corres. Water Level :6.11 m**
Lowest Computed Discharge = 6.120 cumecs on 24/11/2013 **Corres. Water Level :1.33 m**

Q: Observed/Computed discharge in cumec WL: Corresponding Mean Water Level (m.s.l) in m * : Computed Discharge
#:Discarded Discharge (values changed as per rating curve)
Note: River remained in pooling/ no flow condition w.e.f. 01/06/13 to 22/06/13 & from 01/12/13 to 31/05/14 .

4.3.4 Stage Discharge Curve

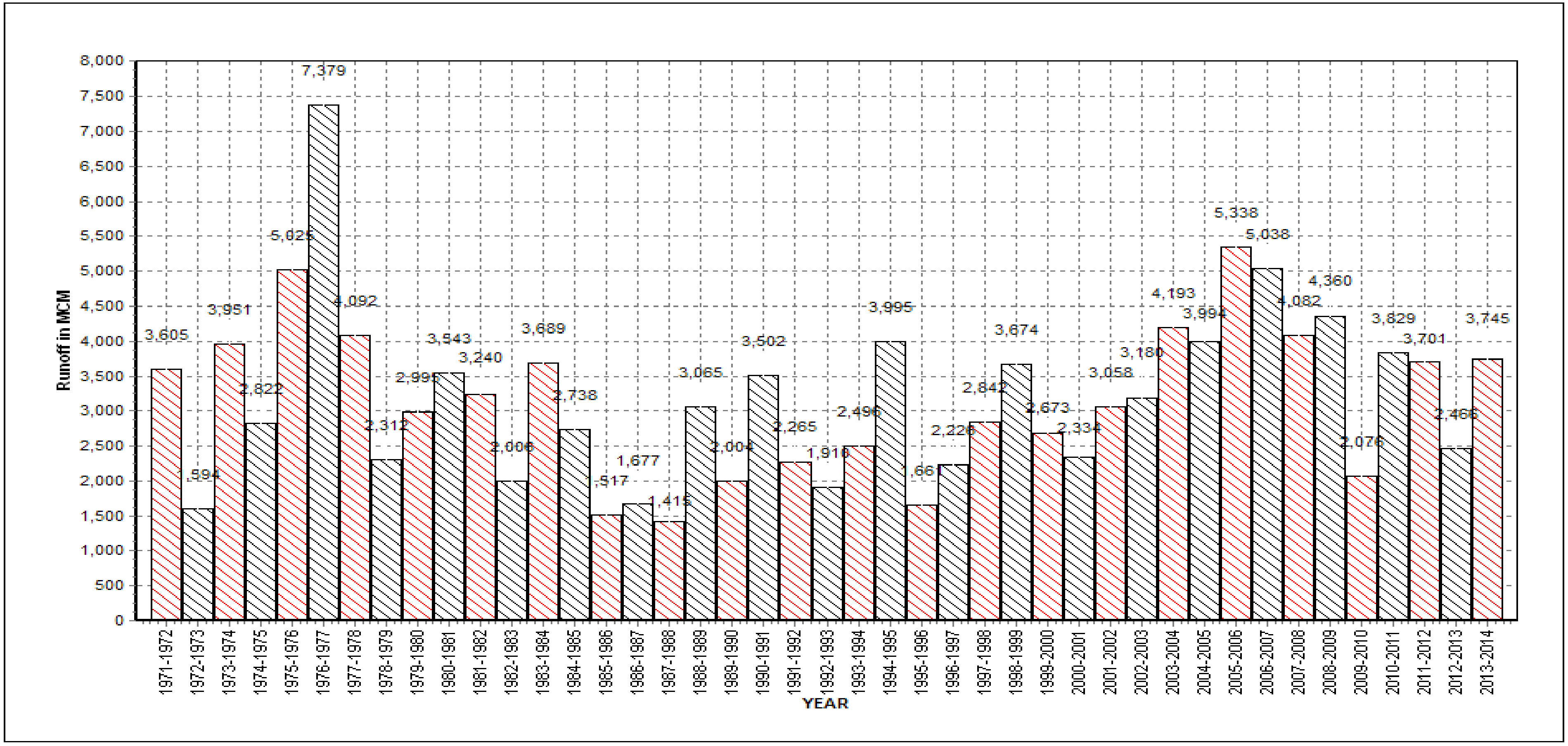
Station Name: Vaitarna at Durvesh (01 02 25 001) Division : Tapi Division Surat Local River: Vaitarna Sub -Division : DGSD, CWC, Silvassa



4.3.5 Annual Runoff

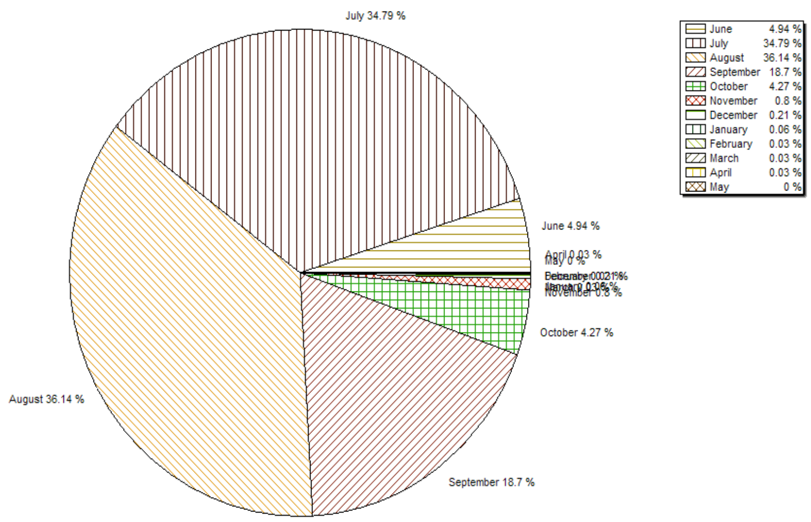
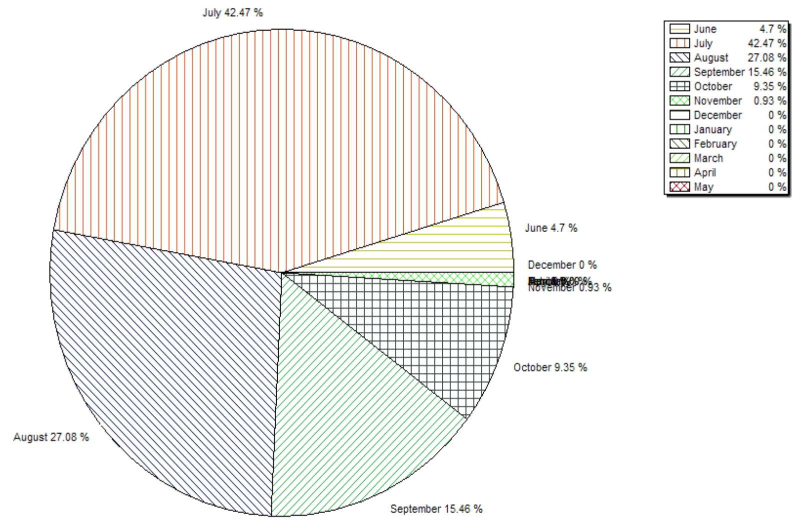
Annual Runoff Values- Runoff Based on period 1971 to 2014

Station Name: Vaitarna at Durvesh (01 02 25 001) Division : Tapi Division Surat Local River: Vaitrana Sub -Division : DGSD, CWC, Silvassa



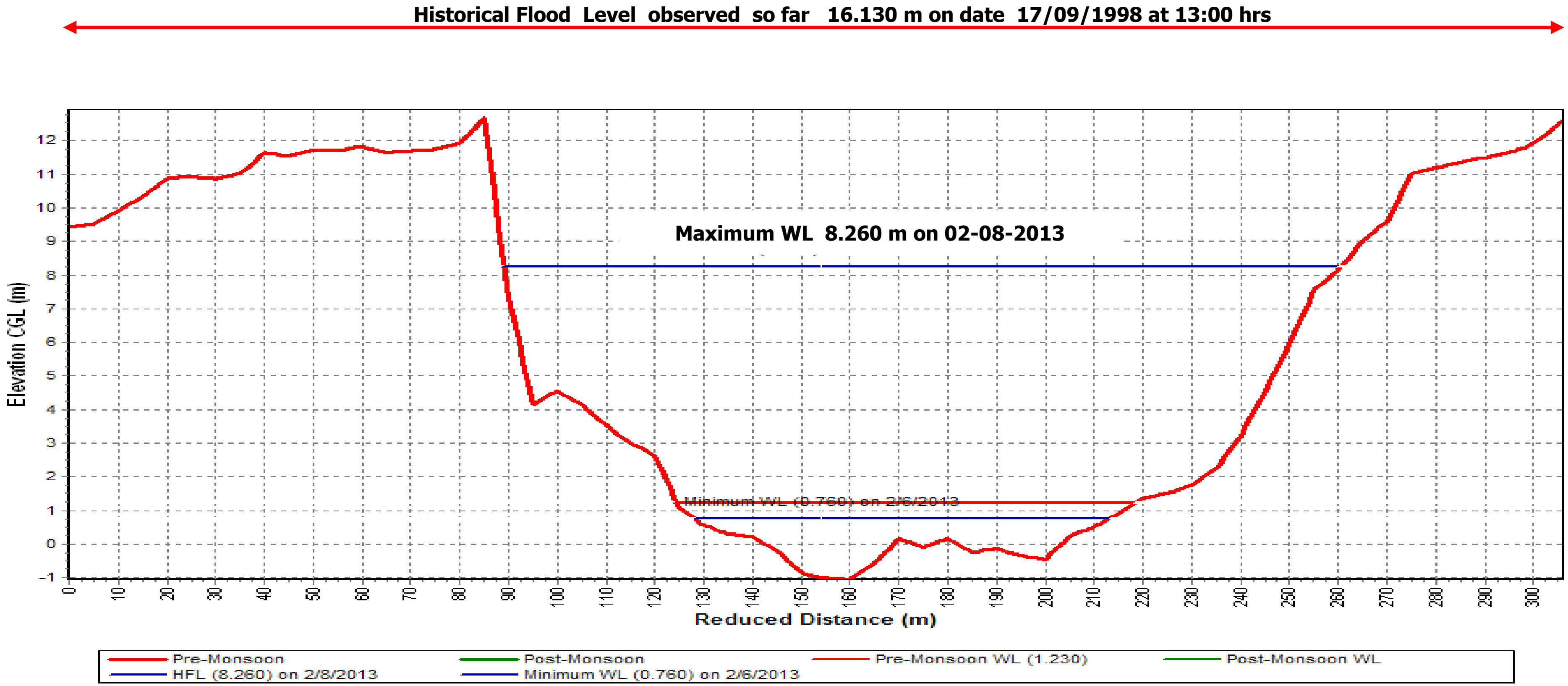
4.3.6 Monthly Average Runoff

Station Name: Vaitarna at Durvesh (01 02 25 001) Division : Tapi Division Surat Local River: Vaitarna Sub -Division : DGSD, CWC, Silvassa

Monthly Average Runoff Based on period: 1971 -2013	Monthly Average Runoff Based on period: 2013-14
	

4.3.7 Superimposed Cross section

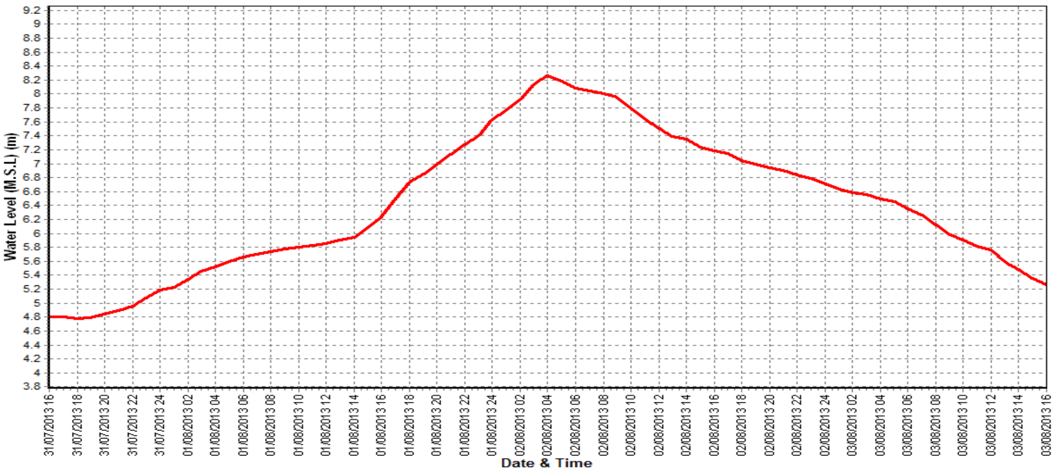
Station Name: Vaitarna at Durvesh (01 02 25 001) Division : Tapi Division Surat Local River: Vaitarna Sub -Division : DGSD, CWC, Silvassa



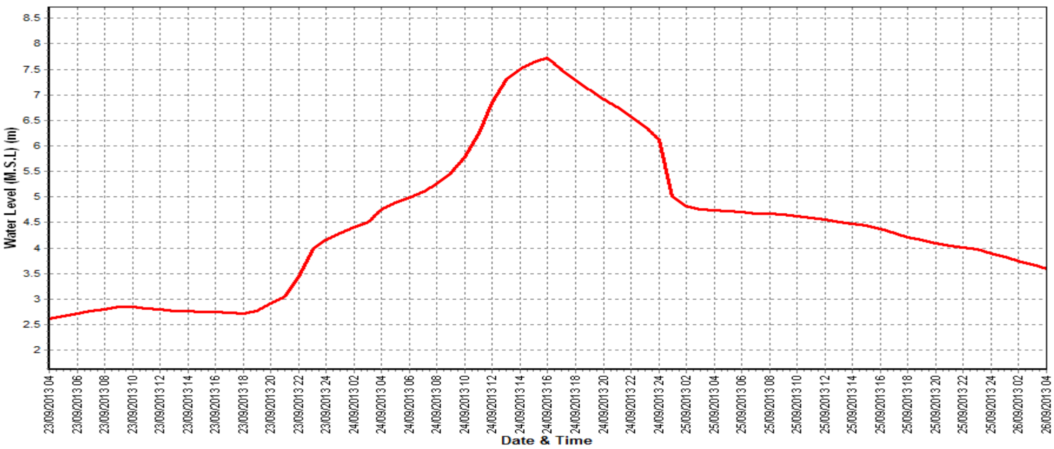
4.3.8 Water Level vs. Time- Graph of Highest Flood Peaks during 2013-14

Station Name: Vaitarna at Durvesh (01 02 25 001) Division : Tapi Division Surat
Local River: Vaitarna Sub -Division : DGSD, CWC, Silvassa

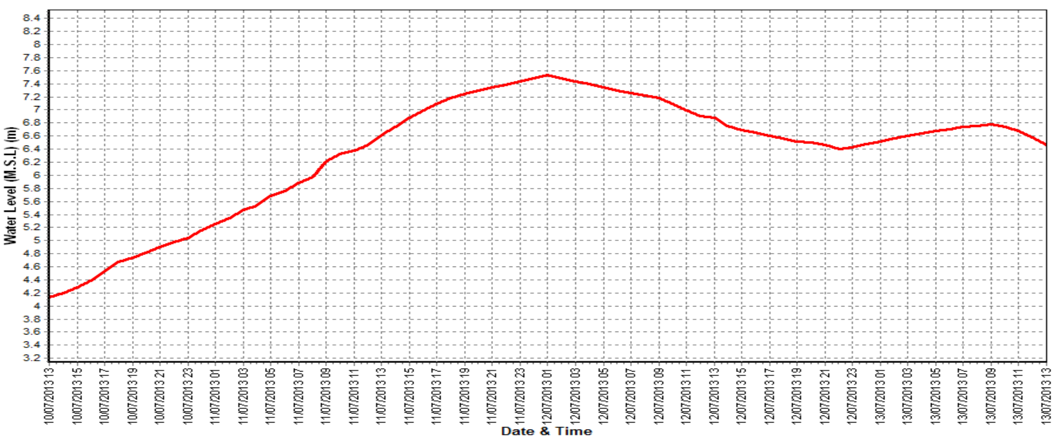
Water level vs. Time graph of I flood peak during the year 2013-14



Water level vs. Time graph of II flood peak during the year 2013-14



Water level vs. Time graph of III flood peak during the year 2013-14



4.4 Dhadhar Basin

4.4.1 History Sheet

HISTORY SHEET

			Water Year	**:**	**2013-14**
Site	**:**	**Pingalwada**	**Code**	**:**	**01 02 14 001**
State	:	Gujarat	District		Vadodara
Basin	:	Narmada	Independent River	:	Dhadhar
Tributary	:	-	Sub Tributary	:	-
Sub-Sub Tributary	:	-	Local River	:	Dhadhar
Division	:	Tapi Dvision, Surat	Sub-Division	:	LNSD Bharuch
Drainage Area	:	2400 Sq. Km.	Bank	:	Right
Latitude	:	22°06'37" N	Longitude	:	73°04'44" E
Zero of Gauge (m)	:	2 (m.s.l)	07/04/1989		
		Opening Date	Closing Date		
Gauge	:	07/04/1989			
Discharge	:	30/06/1989			
Sediment	:				
Water Quality	:	15/03/1990			

Annual Maximum / Minimum discharge with corresponding Water Level (m.s.l)

	Maximum			Minimum		
Year	**Q (cumecs)**	**WL (m)**	**Date**	**Q (cumecs)**	**WL (m)**	**Date**
1989-1990	334.9	10.768	21/08/1989	0.185	4.840	08/05/1990
1990-1991	985.4	18.200	25/08/1990	0.002	5.050	01/04/1991
1991-1992	424.3	13.025	25/07/1991	0.053	5.320	29/05/1992
1992-1993	197.7	10.368	04/09/1992	0.152	5.110	22/01/1993
1993-1994	674.5	15.300	18/07/1993	0.350	5.000	19/03/1994
1994-1995	1056	19.050	09/09/1994	0.280	5.040	12/06/1994
1995-1996	442.0	12.700	23/07/1995	0.650	5.000	30/05/1996
1996-1997	641.7	15.390	30/07/1996	0.500	5.000	25/11/1996
1997-1998	1014	17.400	26/08/1997	0.500	5.120	11/01/1998
1998-1999	602.0	16.835	18/09/1998	0.356	5.120	12/05/1999
1999-2000	23.02	6.500	14/10/1999	0.500	5.040	19/12/1999
2000-2001	503.1	15.425	15/07/2000	0.231	4.980	20/04/2001
2001-2002	418.2	13.500	12/08/2001	0.302	4.990	09/06/2001
2002-2003	427.1	13.700	05/09/2002	0.690	5.050	20/04/2003
2003-2004	839.9	15.710	26/08/2003	0.712	5.060	20/03/2004
2004-2005	681.5	15.260	16/08/2004	0.765	5.070	12/06/2004
2005-2006	807.5	18.450	02/07/2005	0.995	5.180	26/02/2006
2006-2007	759.0	18.245	31/07/2006	0.000	5.000	06/04/2007
2007-2008	586.9	15.250	03/07/2007	2.134	5.050	31/05/2008
2008-2009	682.7	15.750	13/08/2008	1.250	5.110	08/05/2009
2009-2010	21.98	6.745	31/08/2009	0.000	5.090	13/06/2009
2010-2011	655	15.850	09/08/2010	0.000	5.210	01/06/2010
2011-2012	250.1	13.200	14/08/2011	0.000	5.370	27/11/2011
2012-2013	148.2	12.090	12/09/2012	0.000	5.230	01/06/2012
2013-2014	593.6	15.7	24/09/2013	0.000	5.200	01/06/2013

4.4.2 Annual Maximum Flood Peak

Year	Highest Flood Level (m)	Date	Hour
1989	7.860	01/09/1989	08:00:00
1990	18.870	25/08/1990	16:00:00
1991	13.250	25/07/1991	14:00:00
1992	10.500	04/09/1992	23:00:00
1993	15.300	18/07/1993	08:00:00
1994	19.700	08/09/1994	18:00:00
1995	13.300	22/07/1995	23:00:00
1996	15.750	29/07/1996	23:00:00
1997	17.400	26/08/1997	00:00:00
1998	16.950	18/09/1998	02:00:00
1999	7.000	21/07/1999	17:00:00
2000	15.430	15/07/2000	09:00:00
2001	13.500	11/08/2001	21:00:00
2002	13.850	05/09/2002	17:00:00
2003	15.840	26/08/2003	17:00:00
2004	15.260	15/08/2004	22:00:00
2005	18.450	02/07/2005	17:00:00
2006	18.500	31/07/2006	16:00:00
2007	15.350	02/07/2007	21:00:00
2008	17.700	14/08/2008	07:00:00
2009	7.000	29/08/2009	19:00:00
2010	16.300	09/08/2010	19:00:00
2011	13.200	14/08/2011	07:00:00
2012	12.800	12/09/2012	08:00:00
2013	19.300	26/09/2013	05:00:00

4.4.3 Summary of Data

Stage discharge data for the period of 2013-14

Station Name: Dhadar at Pingalwada(01 02 14 001) Division : Tapi Division, Surat Local River: Pingalwada Sub -Division : LNSD, CWC, Bharuch

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	5.200	0.000		5.590	4.557		8.250	45.24		6.000	9.876	*	9.600	72.46	#	6.300	10.52	
2	5.200	0.000		5.570	4.434		7.540	31.17	#	6.200	14.30		7.960	38.49	*	6.250	10.30	
3	5.200	0.000		5.560	4.394		13.000	166.8	#	6.170	13.96		7.775	35.93		6.190	11.99	*
4	5.200	0.000		5.620	5.660		13.900	196.6	#	6.100	13.89		8.600	50.76	#	6.100	9.200	
5	5.200	0.000		6.500	12.37		12.500	151.1	#	6.150	14.02		7.650	33.78		6.000	8.489	
6	5.210	0.000		6.550	12.69		9.100	61.23	#	6.100	13.49		7.450	29.68	*	5.950	8.055	
7	5.200	0.000		6.350	13.89	*	7.525	32.05		6.070	13.05		7.770	35.44		5.900	7.424	
8	5.190	0.000		6.300	11.05		6.350	15.54		6.050	10.42	*	7.685	33.95		5.900	7.379	
9	5.200	0.000		6.100	9.366		6.000	9.876	*	6.050	10.42	*	7.230	26.72		5.880	7.158	
10	5.190	0.000		6.000	8.454		6.650	17.77		6.070	13.01		7.150	25.53		5.780	7.635	*
11	5.200	0.000		6.100	9.045		7.900	37.41	*	6.120	13.69		7.280	26.67		5.750	6.432	
12	5.220	1.585		6.900	16.99		9.000	59.08	#	6.110	13.50		7.120	24.72		5.740	6.208	
13	5.230	1.669		8.300	41.99		7.500	31.90		6.100	13.42		7.000	22.67	*	5.730	6.130	
14	5.230	1.655		6.800	19.79	*	8.250	45.63		6.110	13.46		7.000	22.74		5.600	5.143	
15	5.240	1.719		6.975	17.49		11.000	107.6	*	6.110	11.08	*	6.980	22.19		5.600	5.143	
16	5.260	3.284	*	8.000	39.18		11.100	110.4	#	6.100	13.44		6.980	22.37	*	5.580	5.004	
17	5.340	2.464		7.050	26.14		8.700	52.79	#	5.900	12.27		6.970	21.30		5.570	5.710	*
18	5.900	8.989		7.000	24.90		8.250	43.88	*	5.960	12.71		6.950	20.21		5.560	9.628	
19	5.850	8.331		6.900	23.28		7.490	30.89		5.850	11.66		6.940	19.76		5.550	9.309	
20	5.830	7.844		6.800	22.10		7.300	28.53		5.840	11.14		6.920	21.50	*	5.530	8.986	

21	5.800	7.022		6.600	17.07	*	6.900	23.03		5.830	10.97		6.883	18.91		5.520	8.713	
22	5.800	6.986		6.200	14.24		6.500	17.09		5.840	8.224	*	6.823	17.30		5.500	8.311	
23	5.650	6.418	*	6.300	15.09		6.480	16.80		6.850	22.32		6.800	16.74		5.500	8.449	
24	5.640	5.789		6.500	17.39		6.510	17.20		15.600	257.9	#	6.770	16.05		5.460	4.790	*
25	5.600	5.155		6.400	16.42		8.200	42.93	*	18.950	396.8	*	6.760	15.79		5.450	7.660	
26	5.580	4.599		7.650	35.04		10.450	93.18	#	19.300	412.6	*	6.750	15.23		5.450	7.660	
27	5.580	4.380		9.800	77.15	#	8.800	54.85	#	19.000	399.0	*	6.750	19.09	*	5.430	7.445	
28	5.600	4.609		10.900	105.0	*	6.800	19.79	*	18.720	386.5	*	6.730	14.96		5.430	7.411	
29	5.580	4.450		11.700	127.2	#	6.200	14.33		17.850	348.7	*	6.700	14.36		5.450	7.699	
30	5.600	5.972	*	10.850	103.6	#	6.100	13.55		15.400	250.4	#	6.500	12.22		5.430	7.437	
31				9.650	73.62	#	6.070	13.55					6.300	10.55				
Ten-Daily Mean																		
I Ten-Daily	5.199	0.000		6.014	8.686		9.082	72.73		6.096	12.64		7.887	38.27		6.025	8.814	
II Ten-Daily	5.430	3.754		7.082	24.09		8.649	54.81		6.020	12.64		7.014	22.41		5.621	6.769	
III Ten-Daily	5.643	5.538		8.414	54.71		7.183	29.66		14.334	249.3		6.706	15.56		5.462	7.557	
Monthly																		
Min.	5.190	0.000		5.560	4.394		6.000	9.876		5.830	8.224		6.300	10.55		5.430	4.790	
Max.	5.900	8.989		11.700	127.2		13.900	196.6		19.300	412.6		9.600	72.46		6.300	11.99	
Mean	5.424	3.097		7.210	29.99		8.268	51.67		8.817	91.54		7.186	25.10		5.703	7.714	

Annual Runoff in MCM = 628   Annual Runoff in mm = 262

Peak Observed Discharge = 257.9 cumecs on 24/09/2013   Corres. Water Level :15.6 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2013   Corres. Water Level :5.2 m

Q: Observed/Computed discharge in cumec   WL: Corresponding Mean Water Level (m.s.l) in m   * : Computed Discharge

#:Discarded Discharge (values changed as per rating curve)

Note: River remained in pooling/ no flow condition w.e.f. 01/06/13 to 11/06/13 .

Stage discharge data for the period of 2013-14

Station Name: Dhadar at Pingalwada (01 02 14 001) Division: Tapi Division, Surat Local River: Pingalwada Sub-Division:LNSD, CWC, Bharuch

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	5.440	4.630 *	5.380	6.517	5.860	11.89	5.480	5.136	5.450	3.918	5.410	1.731
2	5.430	7.471	5.410	6.432	5.850	8.323 *	5.480	4.953 *	5.440	3.988	5.390	1.639
3	5.420	6.569	5.420	6.545	5.840	11.14	5.500	5.327	5.450	4.038	5.380	1.596
4	5.420	6.580	5.420	6.538	5.840	11.10	5.490	5.064	5.440	3.826	5.380	4.162 *
5	5.430	7.413	5.420	4.472 *	5.640	6.907	5.480	5.090	5.440	3.815	5.390	1.619
6	5.420	6.558	5.375	6.425	5.540	5.943	5.480	5.042	5.450	4.710 *	5.360	1.512
7	5.420	6.580	5.410	6.008	5.510	5.738	5.490	5.041	5.450	4.033	5.360	1.499
8	5.410	4.393 *	5.400	5.782	5.510	5.697	5.490	5.040	5.440	3.792	5.370	1.520
9	5.400	5.780	5.400	5.766	5.510	5.201 *	5.500	5.117 *	5.440	3.754	5.360	1.493
10	5.420	6.569	5.400	5.766	5.500	5.525	5.500	5.334	5.430	3.637	5.340	1.469
11	5.430	8.024	5.260	5.316	5.500	5.236	5.510	5.599	5.420	2.705	5.350	3.935 *
12	5.420	6.517	5.250	3.215 *	5.510	5.699	5.500	5.265	5.420	2.692	5.360	1.330
13	5.410	6.297	5.250	5.162	5.500	5.482	5.490	4.962	5.410	4.393 *	5.360	1.475
14	5.400	6.346	5.250	4.984	5.500	5.459	5.490	4.941	5.400	4.316 *	5.360	4.010 *
15	5.400	6.329	5.250	5.157	5.510	5.625	5.480	5.038	5.400	2.597	5.340	1.447
16	5.400	4.316 *	5.240	5.019	5.500	5.117 *	5.490	5.035 *	5.380	1.505	5.340	1.432
17	5.400	6.270	5.240	4.982	5.500	5.525	5.480	5.035 *	5.380	2.304	5.320	1.421
18	5.380	6.053	5.240	4.944	5.480	5.170	5.480	4.995	5.390	4.238 *	5.330	3.786 *
19	5.380	6.053	5.250	3.215 *	5.480	5.379	5.470	4.657	5.390	2.597	5.340	1.473

20	5.400	6.346		5.240	4.960		5.510	5.465		5.480	5.030		5.390	4.238	*	5.330	1.462	
21	5.400	6.243		5.250	5.144		5.500	5.444		5.480	4.991		5.380	2.297		5.340	1.473	
22	5.410	4.393	*	5.260	5.346		5.500	5.355		5.470	4.467		5.380	2.290		5.340	1.471	
23	5.410	6.425		5.260	5.263		5.510	5.201	*	5.480	4.953	*	5.400	2.662		5.100	2.240	#
24	5.400	6.243		5.320	5.538		5.500	5.345		5.470	4.473		5.410	1.550		5.080	2.125	#
25	5.400	4.316	*	6.100	15.24		5.520	5.771		5.460	4.311		5.420	2.950		5.080	2.125	*
26	5.410	6.281		6.000	9.876	*	5.520	5.750		5.460	4.351		5.410	2.816		5.100	2.240	#
27	5.400	6.321		5.945	13.29		5.500	5.351		5.450	3.953		5.420	4.472	*	5.090	2.180	#
28	5.420	6.341		5.880	13.05		5.490	5.242		5.470	4.434		5.410	2.815		5.100	2.240	#
29	5.410	4.393	*	5.860	11.95					5.460	4.284		5.400	1.504		5.120	2.370	#
30	5.410	6.362		5.850	11.43					5.470	4.871	*	5.400	4.316	*	5.110	2.300	#
31	5.400	6.229		5.850	11.41					5.450	3.918					5.080	2.130	#
Ten-Daily Mean																		
I Ten-Daily	5.421	6.254		5.404	6.025		5.660	7.747		5.489	5.115		5.443	3.951		5.374	1.824	
II Ten-Daily	5.402	6.255		5.247	4.695		5.499	5.416		5.487	5.056		5.398	3.158		5.343	2.177	
III Ten-Daily	5.406	5.777		5.689	9.777		5.505	5.432		5.465	4.455		5.403	2.767		5.140	2.081	
Monthly																		
Min.	5.380	4.316		5.240	3.215		5.480	5.117		5.450	3.918		5.380	1.504		5.080	1.330	
Max.	5.440	8.024		6.100	15.24		5.860	11.89		5.510	5.599		5.450	4.710		5.410	4.162	
Mean	5.410	6.085		5.454	6.927		5.558	6.253		5.480	4.862		5.415	3.292		5.281	2.029	

Peak Computed Discharge = 412.6 cumecs on 26/09/2013 **Corres. Water Level :19.3 m**

Lowest Computed Discharge = 2.125 cumecs on 25/05/2014 **Corres. Water Level :5.08 m**

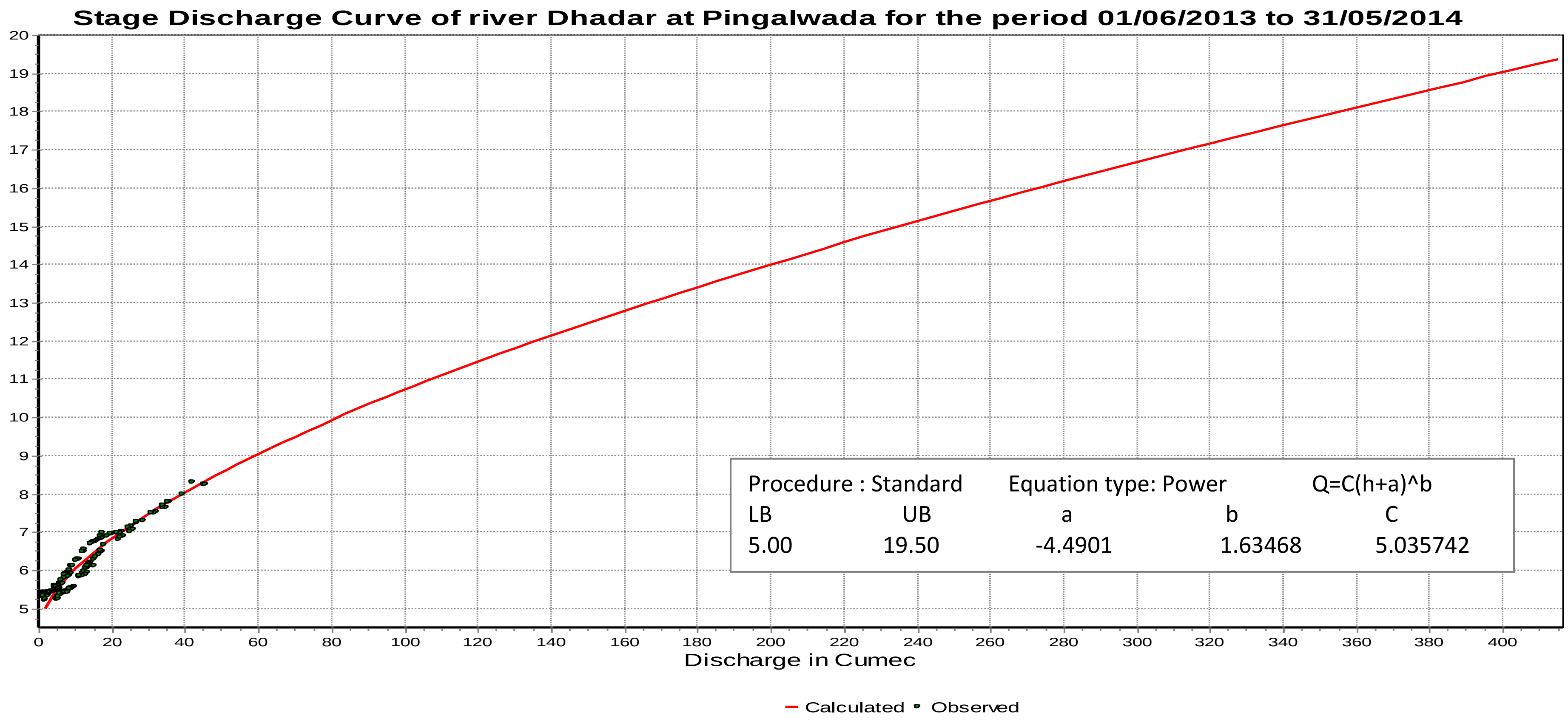
Q: Observed/Computed discharge in cumec WL: Corresponding Mean Water Level (m.s.l) in m * : Computed Discharge

#:Discarded Discharge (values changed as per rating curve)

Note: River remained in pooling/ no flow condition w.e.f. 01/06/13 to 11/06/13 .

4.4.4 Stage Discharge curve

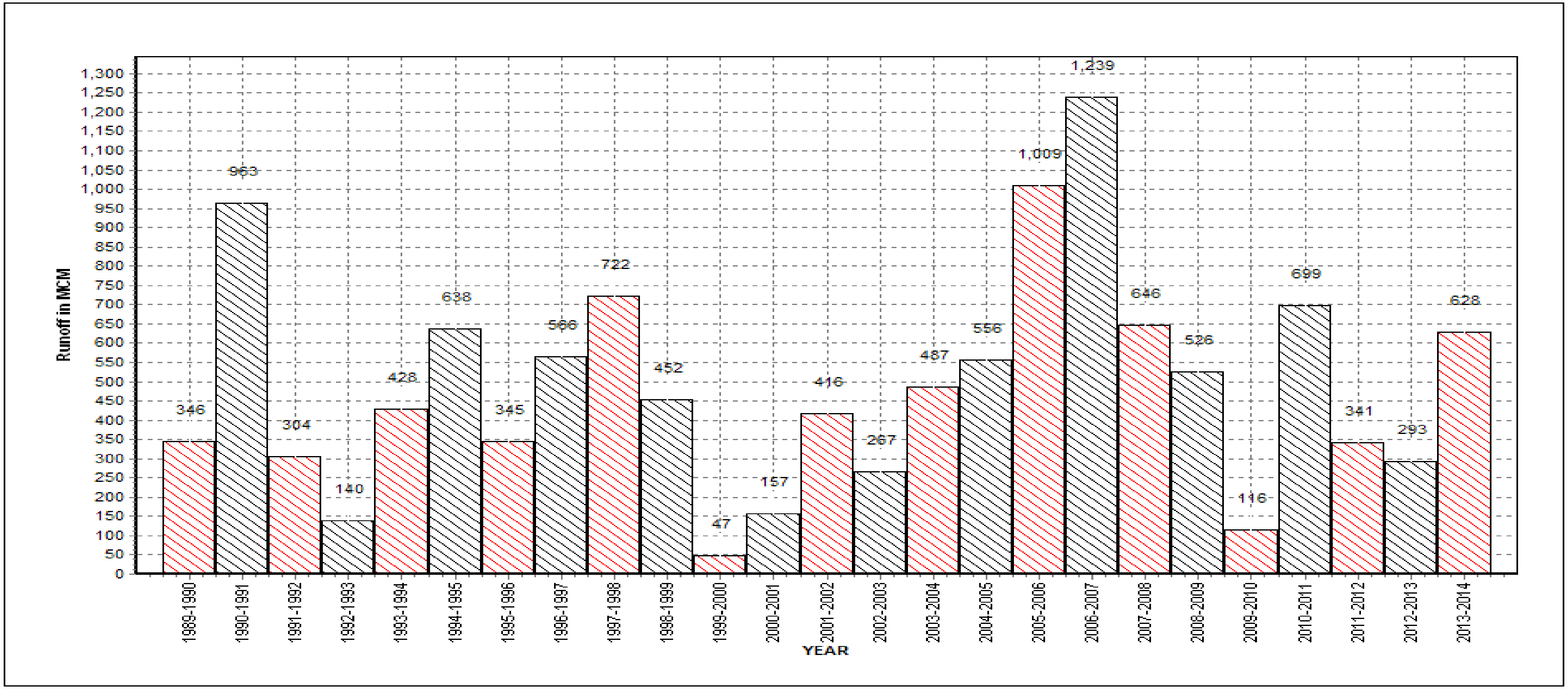
Station Name: Dhadar at Pingalwada(01 02 14 001) Division : Tapi Division, Surat Local River: Pingalwada Sub -Division : LNSD, CWC, Bharuch



4.4.5 Annual Runoff

Annual Runoff Values Runoff Based on period: 1989-2014

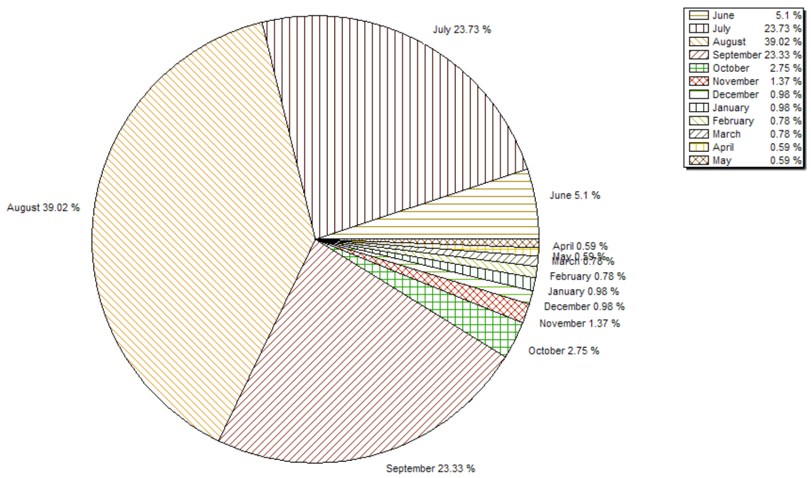
Station Name: Dhadhar at Pingalwada (01 02 14 001) Division : Tapi Division, Surat Local River: Pingalwada Sub -Division : LNSD, CWC, Bharuch



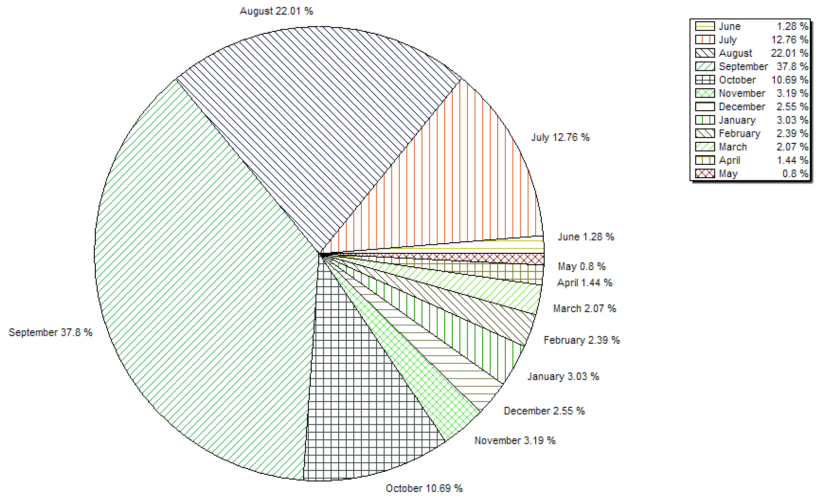
4.4.6 Monthly Average Runoff

Station Name: Dhadar at Pingalwada(01 02 14 001) Division : Tapi Division, Surat Local River: Pingalwada Sub -Division : LNSD, CWC, Bharuch

Monthly Average Runoff Based on period: 1989-2013



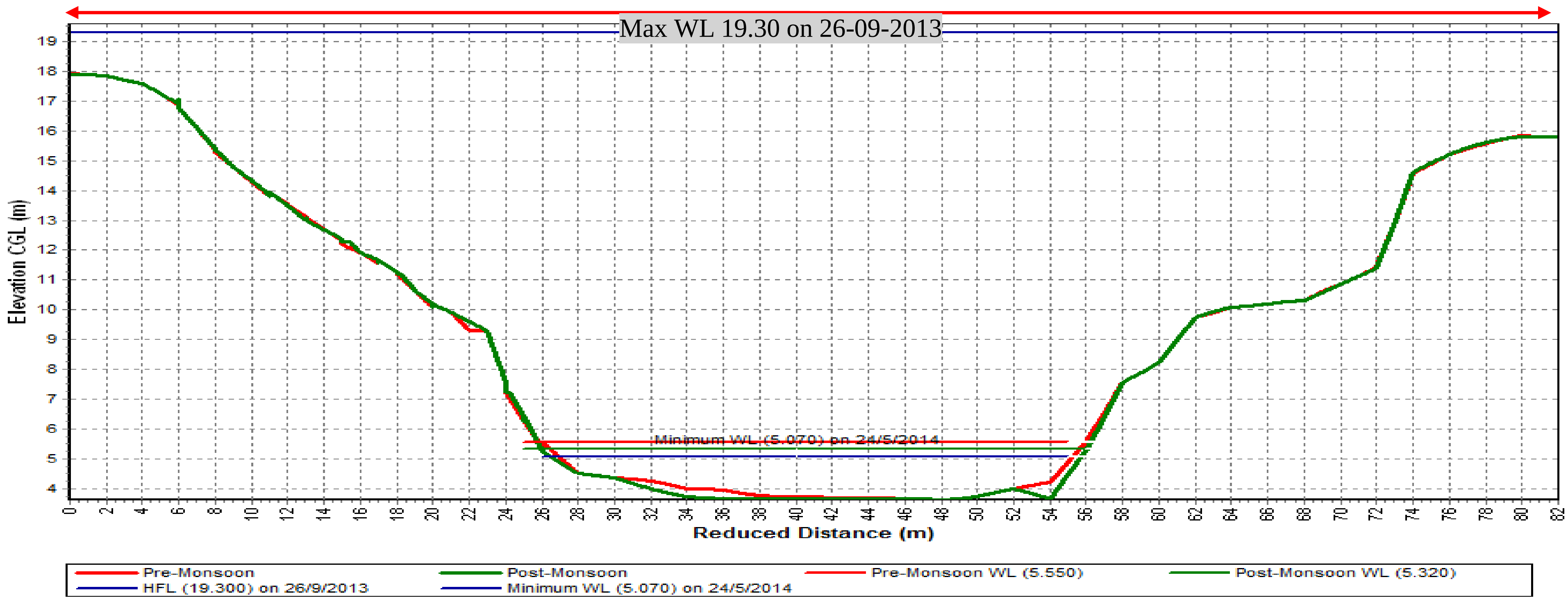
Monthly Average Runoff Based on period: 2013-2014



4.4.7 Superimposed Cross section

Station Name: Dhadar at Pingalwada (01 02 14 001)   Division : Tapi Division, Surat   Local River: Pingalwada   Sub -Division : LNSD, CWC, Bharuch

Highest flood level observed so far 19.70 on dt 08-09-1994 at 1800hrs

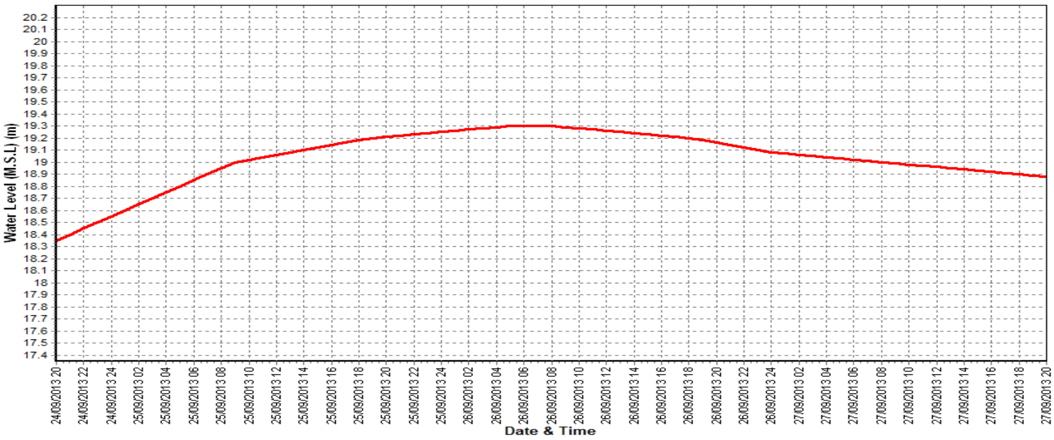


4.4.8 Water Level vs. Time- Graph of Highest Flood Peaks during 2013-14

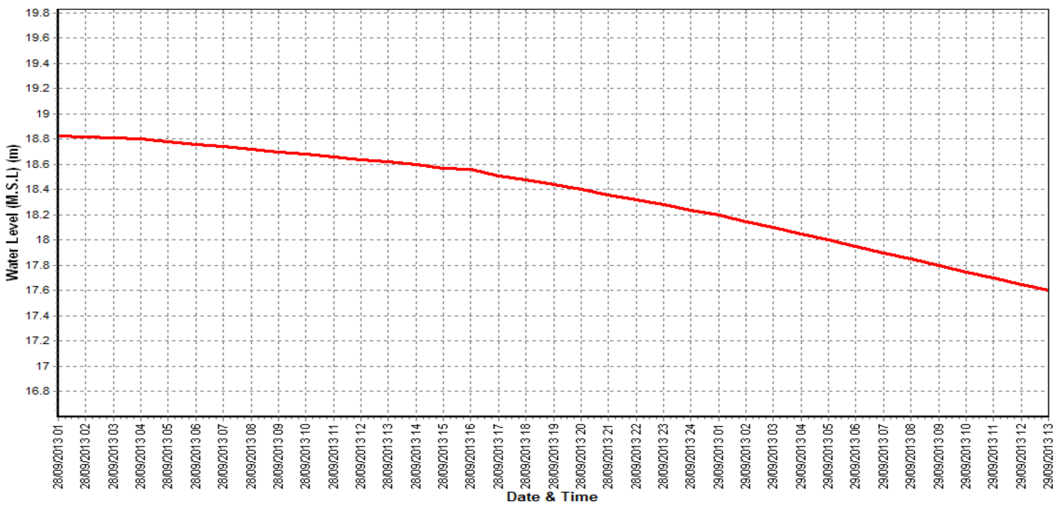
Station Name: Dhadar at Pingalwada
Local River: Pingalwada

Division : Tapi Division, Surat
Sub -Division : LNSD, CWC, Bharuch

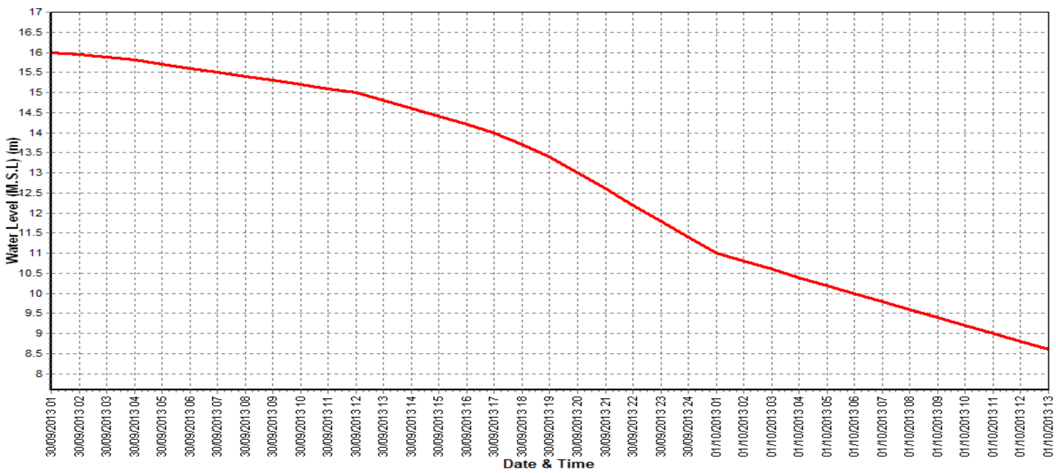
Water level vs. Time graph of I flood peak during the year 2013-14



Water level vs. Time graph of II flood peak during the year 2013-14



Water level vs. Time graph of III flood peak during the year 2013-14



4.5 Wagh Basin

4.5.1.1 History Sheet

HISTORY SHEET

			Water Year	**:**	**2013-14**
Site	**:**	**Wagh at Ozerkheda**	**Code**	**:**	**01 02 24 002**
State	:	Maharashtra	District		Nashik
Basin	:	WFR South of Tapi	Independent River	:	Daman Ganga
Tributary	:	Wagh	Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	
Division	:	Tapi Division, Surat	Sub-Division	:	DGSD,CWC,Silvassa
Drainage Area	:	640 Sq. Km.	Bank	:	
Latitude	:	20°06'01"	Longitude	:	73°16'16"
Zero of Gauge (m)	:	80.1 (m.s.l)	15/06/1983		
		Opening Date	Closing Date		
Gauge	:	28/06/1983			
Discharge	:	01/06/1984 Seasonal 01/06/1991 (Regular)			

Note: Surface runoff data for the water year 2013-14 at this site are under review and will be published after review is completed.

Annual Maximum / Minimum discharge with corresponding Water Level (m.s.l)

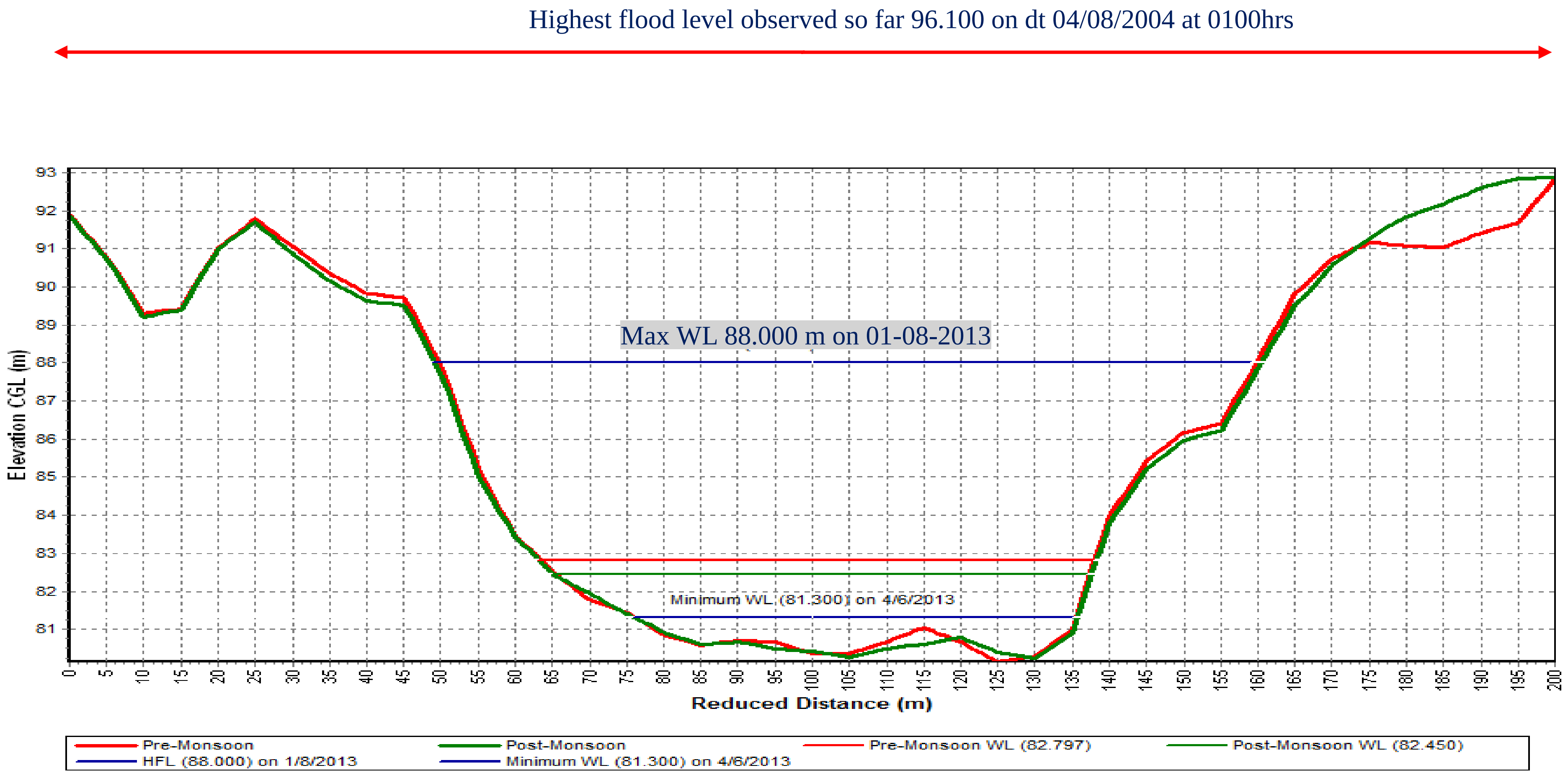
	Maximum			Minimum		
Year	**Q (cumecs)**	**WL (m)**	**Date**	**Q (cumecs)**	**WL (m)**	**Date**
1991-1992	878.8	86.950	27/07/1991	0.000	81.400	17/05/1992
1992-1993	770.9	86.285	12/08/1992	0.000	81.080	22/05/1993
1993-1994	1117	87.100	13/07/1993	0.000	80.980	18/05/1994
1994-1995	1306	88.300	13/07/1994	0.000	81.340	10/02/1995
1995-1996	650.0	85.450	03/09/1995	0.000	80.610	04/03/1996
1996-1997	264.0	84.430	24/07/1996	0.000	80.410	04/02/1997
1997-1998	635.5	86.330	31/07/1997	0.000	80.860	18/03/1998
1998-1999	477.9	85.700	17/09/1998	0.000	80.650	05/05/1999
1999-2000	1144	87.175	16/07/1999	0.000	81.070	14/04/2000
2000-2001	774.8	85.750	13/07/2000	0.000	81.460	22/05/2001
2001-2002	284.0	84.620	16/08/2001	0.000	81.190	05/05/2002
2002-2003	1414	88.050	29/06/2002	0.000	81.110	07/05/2003
2003-2004	1145	87.200	28/07/2003	0.000	81.330	15/02/2004
2004-2005	2700	90.390	03/08/2004	0.000	81.670	20/04/2005
2005-2006	1660	88.550	29/06/2005	0.000	81.140	20/02/2006
2006-2007	1080	86.740	08/08/2006	0.042	81.210	13/01/2007
2007-2008	934.6	86.690	09/08/2007	0.100	81.130	09/01/2008
2008-2009	1421	87.855	12/08/2008	0.072	81.140	15/12/2008
2009-2010	1687	88.595	23/07/2009	0.000	81.090	01/06/2009
2010-2011	578.7	85.320	23/07/2010	0.000	81.080	01/06/2010
2011-2012	1289	87.2	29/08/2011	0.000	81.260	02/12/2011
2012-2013	1365	85.95	11/09/2012	0.000	81.140	01/06/2012

4.5.1.2 Annual Maximum Flood Peak

Year	Highest Flood Level (m)	Date	Hour
1991	87.400	17/07/1991	11:00:00
1992	86.600	12/08/1992	13:00:00
1993	89.700	13/07/1993	16:00:00
1994	88.400	13/07/1994	07:00:00
1995	86.230	02/09/1995	16:00:00
1996	85.720	27/08/1996	19:00:00
1997	89.650	31/07/1997	18:00:00
1998	85.900	17/09/1998	09:00:00
1999	87.350	16/07/1999	07:00:00
2000	85.980	13/07/2000	18:00:00
2001	84.660	16/08/2001	12:00:00
2002	89.200	29/06/2002	13:00:00
2003	87.320	27/07/2003	12:00:00
2004	96.100	04/08/2004	01:00:00
2005	90.000	29/06/2005	05:00:00
2006	87.100	10/08/2006	16:00:00
2007	87.680	08/08/2007	16:00:00
2008	91.000	11/08/2008	17:00:00
2009	88.700	23/07/2009	09:00:00
2010	85.320	23/07/2010	08:00:00
2011	89.500	28/08/2011	16:00:00
2012	86.700	11/09/2012	12:00:00

4.5.1.7 Superimposed cross section

Station Name: Wagh at Ozerkheda (01 02 24 002) Division: Tapi Division, Surat Local River: Wagh Sub -Division: DGSD, CWC, Silvasa



4.5 Damanganga Basin

4.5.2.1 History sheet

History Sheet

			Water Year	**:**	**2013-14**
Site	**:**	**Damanganga at Nanipalsan**	**Code**	**:**	**01 02 24 001**
State	:	Gujarat	District		Valsad
Basin	:	WFR South of Tapi	Independent River	:	Daman Ganga
Tributary	:		Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	
Division	:	Tapi Division, Surat	Sub-Division	:	DGSD,CWC,Silvasa
Drainage Area	:	764 Sq. Km.	Bank	:	
Latitude	:	20°12'00" N	Longitude	:	73°17'00" E
Zero of Gauge (m)	:	95 (m.s.l)	6/15/1982		
		Opening Date	Closing Date		
Gauge	**:**	**15/06/1982**			
Discharge	**:**	**13/10/1983** **Seasonal** **01/06/1991** **regular**			

Annual Maximum / Minimum discharge with corresponding Water Level (m.s.l)

Year	Maximum			Minimum		
	Q (cumecs)	**WL (m)**	**Date**	**Q (cumecs)**	**WL (m)**	**Date**
1991-1992	1018	101.200	28/07/1991	0.000	96.120	26/01/1992
1992-1993	703.1	99.875	12/08/1992	0.000	96.340	22/02/1993
1993-1994	1393	101.485	13/07/1993	0.000	96.100	18/04/1994
1994-1995	1184	102.040	13/07/1994	0.000	96.020	27/04/1995
1995-1996	440.1	99.700	03/09/1995	0.000	96.070	09/03/1996
1996-1997	219.6	99.650	09/08/1996	0.000	96.320	13/03/1997
1997-1998	340.0	100.480	25/08/1997	0.000	96.260	12/03/1998
1998-1999	902.5	102.490	17/09/1998	0.000	96.230	27/06/1998
1999-2000	360.0	100.600	15/07/1999	0.000	96.250	13/06/1999
2000-2001	997.5	102.375	14/07/2000	0.000	96.250	03/03/2001
2001-2002	252.5	99.250	18/06/2001	0.000	96.580	19/02/2002
2002-2003	300.8	99.850	25/08/2002	0.521	96.670	30/11/2002
2003-2004	362.0	100.110	28/07/2003	0.716	96.710	10/12/2003
2004-2005	3173	103.925	03/08/2004	0.290	96.540	31/12/2004
2005-2006	1439	102.050	29/06/2005	0.000	96.420	28/02/2006
2006-2007	2728	103.590	09/08/2006	0.000	96.370	19/02/2007
2007-2008	895.1	100.900	09/08/2007	0.393	96.600	06/01/2008
2008-2009	1304	102.100	11/08/2008	0.000	96.400	25/04/2009
2009-2010	972.5	101.380	05/09/2009	0.000	96.460	19/02/2010
2010-2011	309.9	99.300	02/08/2010	0.000	96.320	01/06/2010
2011-2012	692.8	100.4	29/08/2011	0.000	96.580	24/12/2011
2012-2013	617.7	99.800	11/09/2012	0.000	96.300	01/06/2012
2013-2014	416.8	99.750	24/09/2013	0.000	96.400	01/06/2013

4.5.2.2 Annual Maximum Flood Peak

Year	Highest Flood Level (m)	Date	Hour
1982	100.000	16/08/1982	07:00:00
1983	102.300	15/08/1983	10:00:00
1984	99.700	18/07/1984	13:00:00
1985	99.900	31/07/1985	15:00:00
1986	99.500	19/07/1986	06:00:00
1987	104.000	07/07/1987	13:00:00
1988	100.170	26/07/1988	14:00:00
1989	100.250	24/07/1989	06:00:00
1990	101.000	20/08/1990	03:00:00
1991	101.660	28/07/1991	00:00:00
1992	101.670	12/08/1992	16:00:00
1993	107.890	13/07/1993	13:00:00
1994	103.700	13/07/1994	06:00:00
1995	99.840	21/07/1995	21:00:00
1996	99.980	08/08/1996	19:00:00
1997	104.000	31/07/1997	14:00:00
1998	103.020	17/09/1998	13:00:00
1999	103.200	15/07/1999	13:00:00
2000	103.010	14/07/2000	01:00:00
2001	99.280	18/06/2001	03:00:00
2002	101.850	02/09/2002	18:00:00
2003	100.990	27/07/2003	17:00:00
2004	110.030	03/08/2004	18:00:00
2005	102.200	03/07/2005	15:00:00
2006	104.580	09/08/2006	12:00:00
2007	102.860	08/08/2007	23:00:00
2008	102.100	11/08/2008	08:00:00
2009	101.600	22/07/2009	18:00:00
2010	100.550	24/07/2010	23:00:00
2011	100.580	28/08/2011	01:00:00
2012	101.650	31/07/2012	13:00:00
2013	100.740	23/07/2013	24:00:00

4.5.2.3 Summary of Data

Stage Discharge Data for the period 2013-14

Station Name: Damanganga at Nanipalsan (01 02 24 001) Division : Tapi Division, Surat Local River: Damanganga Sub-Division:DGSD,CWC, Silvasssa

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	96.400	0.000	97.360	69.51		99.300	328.2	#	97.530	64.47	*	97.800	104.2		97.080	20.91	
2	96.390	0.000	97.480	79.06		99.430	351.4	#	97.500	60.09	#	97.760	91.95	*	97.070	20.41	
3	96.400	0.000	97.500	88.70		99.100	301.0		97.490	59.97	#	97.740	89.85		97.070	18.95	*
4	96.390	0.000	99.240	305.6		98.320	168.6	*	97.470	57.76	#	97.720	87.41		97.070	20.32	
5	96.390	0.000	98.000	129.9		98.200	151.0		97.520	63.34	#	97.700	84.57		97.060	19.72	
6	96.390	0.000	97.980	124.9		98.030	134.5		97.560	75.40		97.680	82.09	*	97.040	18.85	
7	96.380	0.000	97.700	84.53	*	97.950	121.7		97.580	76.69		97.650	80.10		97.030	18.50	
8	96.380	0.000	98.160	129.9		97.870	114.3		97.560	67.90	*	97.600	72.21		97.020	17.86	
9	96.380	0.000	97.700	97.13		97.780	94.46	*	97.540	65.61	*	97.560	73.16		97.010	14.25	*
10	96.380	0.000	97.820	111.1		98.000	130.9		97.530	64.47	#	97.520	63.34	#	97.010	14.25	*
11	96.380	0.000	99.400	332.6		98.250	158.3	*	97.500	61.09	#	97.490	42.63		97.000	16.99	
12	96.380	0.000	98.700	219.9		98.270	146.1		97.620	82.26		97.700	91.89		97.000	16.86	
13	96.400	0.000	98.315	160.2		98.120	141.8		97.700	91.46		97.640	77.28	*	96.980	16.34	
14	96.410	0.000	98.230	155.4	*	98.500	199.6		97.630	82.19		97.560	73.36		96.980	12.04	*
15	96.400	0.000	98.050	136.9		98.490	194.1	*	97.620	74.91	*	97.520	63.34	#	96.980	16.28	
16	96.390	0.000	97.900	116.0		98.360	166.3		97.580	78.28		97.520	63.34	*	96.970	15.95	
17	97.550	38.38	98.600	213.9		98.250	147.8		98.000	129.9		97.620	81.15		96.970	11.33	*
18	97.430	35.42	98.650	225.4		98.160	145.4	*	97.820	104.7		97.580	77.24		96.970	15.97	
19	97.290	30.28	98.600	213.9		98.060	138.5		97.700	89.87		97.550	74.99		96.970	15.93	
20	97.520	43.96	98.480	189.3		97.950	121.9		97.560	75.56		97.520	63.34	*	96.970	15.78	
21	97.000	20.14	98.280	162.7	*	97.860	108.7		97.530	64.47	#	97.500	61.09	#	96.960	15.50	

22	97.150	24.77	99.420	327.1	97.790	101.4	97.500	61.09 *	97.480	41.25	96.960	10.63 *
23	97.190	29.36 *	98.950	283.1	97.730	94.40	98.300	153.9	97.450	39.48	96.960	15.50
24	97.170	25.74	99.850	429.2 #	97.780	99.80	99.750	410.3 #	97.270	30.48	96.940	9.259 *
25	97.820	112.4	98.800	233.8	97.780	94.46 *	98.950	270.7	97.200	26.64	96.920	3.164
26	97.490	43.52	99.240	317.6 #	97.800	102.0	98.520	203.1	97.180	25.68	96.870	2.368
27	97.510	43.89	98.580	214.1	97.720	91.79	98.280	150.9	97.150	25.76 *	96.850	2.241
28	97.430	39.58	98.520	198.7 *	97.660	79.68 *	98.000	126.4	97.120	23.14 *	96.830	2.180
29	97.400	37.64	98.430	181.6	97.600	79.73	97.900	109.9 *	97.100	22.29	96.820	2.050
30	97.400	50.19 *	98.330	163.5	97.580	77.90	97.850	107.3	97.100	22.15	96.800	1.931
31			98.500	191.6	97.540	65.61 #			97.080	20.98		
Ten-Daily Mean												
I Ten-Daily	96.388	0.000	97.894	122.0	98.398	189.6	97.528	65.57	97.673	82.88	97.046	18.40
II Ten-Daily	96.815	14.80	98.493	196.4	98.241	156.0	97.673	87.02	97.570	70.86	96.979	15.35
III Ten-Daily	97.356	42.73	98.809	245.7	97.713	90.49	98.258	165.8	97.239	30.81	96.891	6.482
Monthly												
Min.	96.380	0.000	97.360	69.51	97.540	65.61	97.470	57.76	97.080	20.98	96.800	1.931
Max.	97.820	112.4	99.850	429.2	99.430	351.4	99.750	410.3	97.800	104.2	97.080	20.91
Mean	96.853	19.18	98.412	189.9	98.104	143.6	97.820	106.1	97.486	60.53	96.972	13.41

Annual Runoff in MCM = 1417 Annual Runoff in mm = 1855

Peak Observed Discharge = 429.2 cumecs on 24/07/2013 Corres. Water Level :99.85 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2013 Corres. Water Level :96.4 m

Q: Observed/Computed discharge in cumec WL: Corresponding Mean Water Level (m.s.l) in m * : Computed Discharge
#:Discarded Discharge (values changed as per rating curve)

Note: River remained in pooling/ no flow condition w.e.f. 01/06/13 to 16/06/13 & 30/12/2014 to 31/05/2014.

Stage Discharge Data for The period 2012-13

Station Name: Damanganga at Nanipalsan (01 02 24 001) Division : Tapi Division, Surat Local River: Damanganga Sub -Division: DGSD, CWC, Silvasssa

Day	Dec			Jan		Feb		Mar		Apr		May	
	W.L	Q		WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	96.570	0.457	*	96.570	0.000	96.540	0.000	96.520	0.000	96.500	0.000	96.480	0.000
2	96.780	1.804		96.570	0.000	96.540	0.000	96.520	0.000	96.500	0.000	96.480	0.000
3	96.770	1.738		96.570	0.000	96.540	0.000	96.520	0.000	96.500	0.000	96.480	0.000
4	96.750	1.635		96.570	0.000	96.540	0.000	96.520	0.000	96.500	0.000	96.480	0.000
5	96.730	1.581		96.570	0.000	96.540	0.000	96.520	0.000	96.490	0.000	96.480	0.000
6	96.710	1.433		96.570	0.000	96.540	0.000	96.520	0.000	96.490	0.000	96.480	0.000
7	96.700	1.387		96.570	0.000	96.540	0.000	96.520	0.000	96.490	0.000	96.470	0.000
8	96.570	0.457	*	96.570	0.000	96.540	0.000	96.520	0.000	96.490	0.000	96.470	0.000
9	96.690	1.311		96.570	0.000	96.540	0.000	96.520	0.000	96.490	0.000	96.470	0.000
10	96.690	1.311		96.560	0.000	96.540	0.000	96.520	0.000	96.490	0.000	96.470	0.000
11	96.680	1.273		96.560	0.000	96.540	0.000	96.510	0.000	96.490	0.000	96.470	0.000
12	96.680	1.246		96.560	0.000	96.540	0.000	96.510	0.000	96.490	0.000	96.470	0.000
13	96.670	1.224		96.560	0.000	96.540	0.000	96.510	0.000	96.490	0.000	96.470	0.000
14	96.660	1.186		96.560	0.000	96.530	0.000	96.510	0.000	96.490	0.000	96.470	0.000
15	96.560	0.349	*	96.560	0.000	96.530	0.000	96.510	0.000	96.490	0.000	96.470	0.000
16	96.650	1.059		96.560	0.000	96.530	0.000	96.510	0.000	96.490	0.000	96.470	0.000
17	96.640	1.005		96.560	0.000	96.530	0.000	96.510	0.000	96.490	0.000	96.470	0.000
18	96.620	0.857		96.560	0.000	96.530	0.000	96.510	0.000	96.490	0.000	96.470	0.000
19	96.620	0.853		96.550	0.000	96.530	0.000	96.510	0.000	96.490	0.000	96.470	0.000
20	96.610	0.812		96.550	0.000	96.530	0.000	96.510	0.000	96.490	0.000	96.470	0.000
21	96.610	0.779		96.550	0.000	96.530	0.000	96.510	0.000	96.490	0.000	96.470	0.000

22	96.550	0.220 *	96.550	0.000	96.530	0.000	96.510	0.000	96.490	0.000	96.470	0.000
23	96.600	0.771	96.550	0.000	96.530	0.000	96.510	0.000	96.480	0.000	96.470	0.000
24	96.600	0.795	96.550	0.000	96.530	0.000	96.510	0.000	96.480	0.000	96.470	0.000
25	96.550	0.220 *	96.550	0.000	96.520	0.000	96.510	0.000	96.480	0.000	96.470	0.000
26	96.590	0.716	96.550	0.000	96.520	0.000	96.510	0.000	96.480	0.000	96.470	0.000
27	96.580	0.520	96.550	0.000	96.520	0.000	96.510	0.000	96.480	0.000	96.470	0.000
28	96.580	0.490	96.550	0.000	96.520	0.000	96.500	0.000	96.480	0.000	96.470	0.000
29	96.550	0.220 *	96.550	0.000			96.500	0.000	96.480	0.000	96.460	0.000
30	96.550	0.000	96.550	0.000			96.500	0.000	96.480	0.000	96.460	0.000
31	96.550	0.000	96.550	0.000			96.500	0.000			96.460	0.000
Ten-Daily Mean												
I Ten-Daily	96.696	1.311	96.569	0.000	96.540	0.000	96.520	0.000	96.494	0.000	96.476	0.000
II Ten-Daily	96.639	0.986	96.558	0.000	96.533	0.000	96.510	0.000	96.490	0.000	96.470	0.000
III Ten-Daily	96.574	0.430	96.550	0.000	96.525	0.000	96.506	0.000	96.482	0.000	96.467	0.000
Monthly												
Min.	96.550	0.000	96.550	0.000	96.520	0.000	96.500	0.000	96.480	0.000	96.460	0.000
Max.	96.780	1.804	96.570	0.000	96.540	0.000	96.520	0.000	96.500	0.000	96.480	0.000
Mean	96.634	0.894	96.559	0.000	96.533	0.000	96.512	0.000	96.489	0.000	96.471	0.000

Peak Computed Discharge = 198.7 cumecs on 28/07/2013 **Corres. Water Level :98.52 m**

Lowest Computed Discharge = 0.220 cumecs on 22/12/2013 **Corres. Water Level :96.55 m**

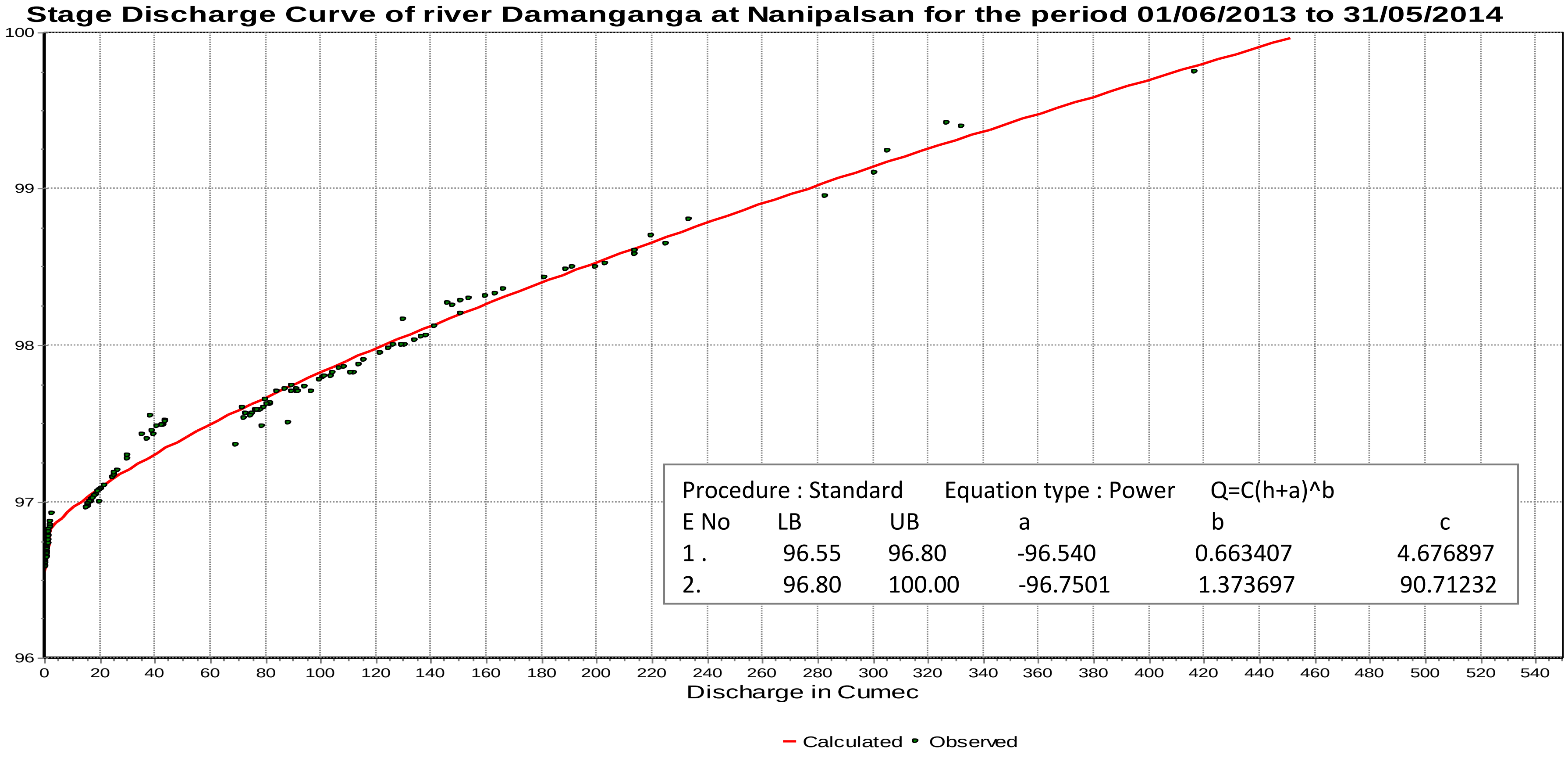
Q: Observed/Computed discharge in cumec WL: Corresponding Mean Water Level (m.s.l) in m * : Computed Discharge

#:Discarded Discharge (values changed as per rating curve)

Note: River remained in pooling/ no flow condition w.e.f. 01/06/13 to 16/06/13 & 30/12/2014 to 31/05/2014.

4.5.2.4 Stage Discharge Curve

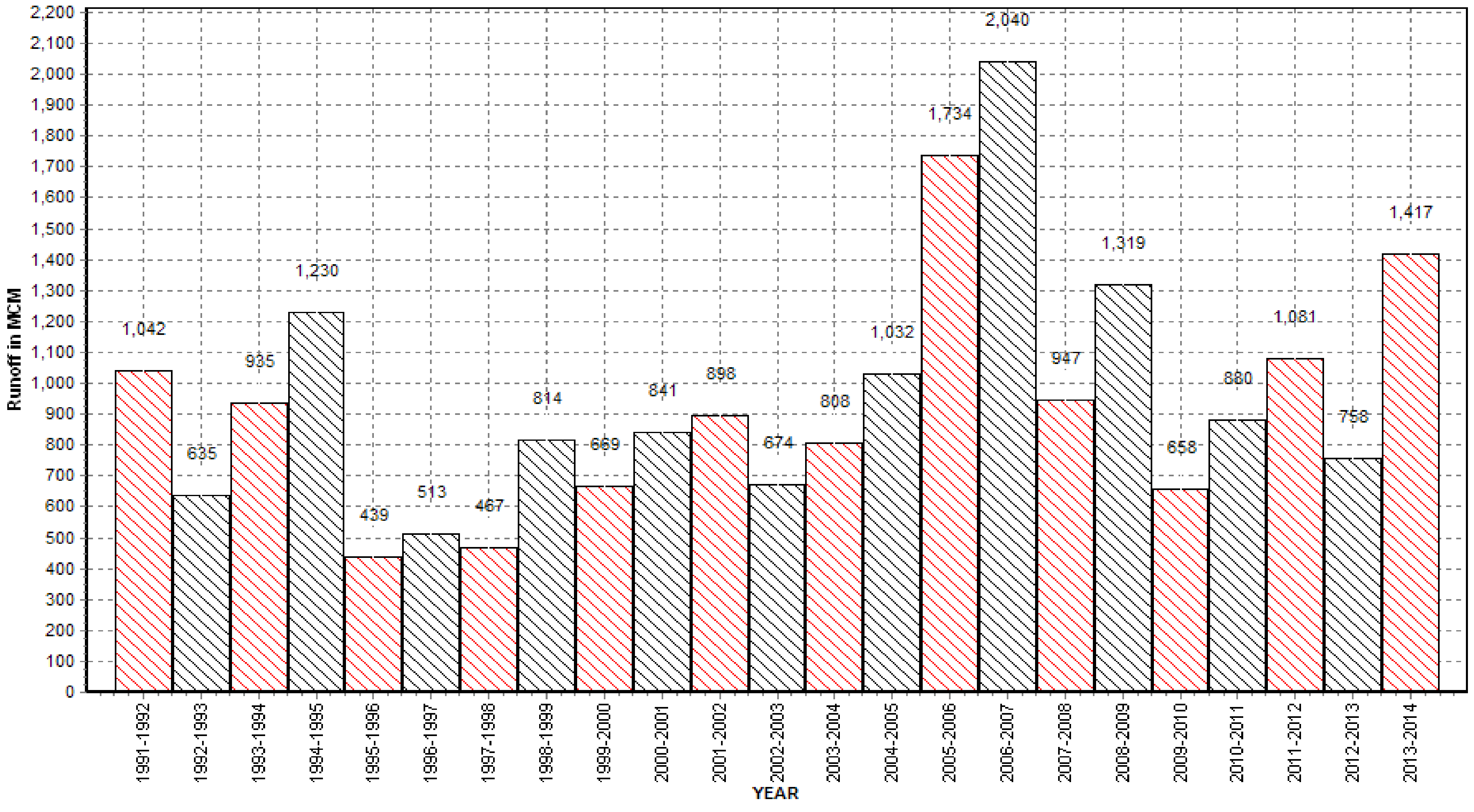
Station Name: Damanganga at Nanipalsan (01 02 24 001) Division : Tapi Division, Surat Local River: Damanganga Sub -Division: DGSD, CWC, Silvassa



4.5.2.5 Annual runoff

Annual Runoff values for the year 1991-2014

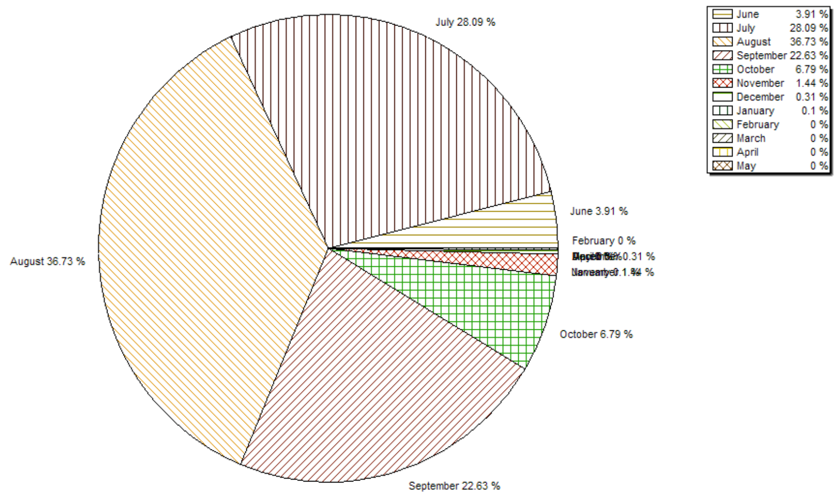
Station Name: Damanganga at Nanipalsan (01 02 24 001) Division : Tapi Division, Surat Local River: Damanganaga Sub -Division : DGSD, CWC, Silvassa



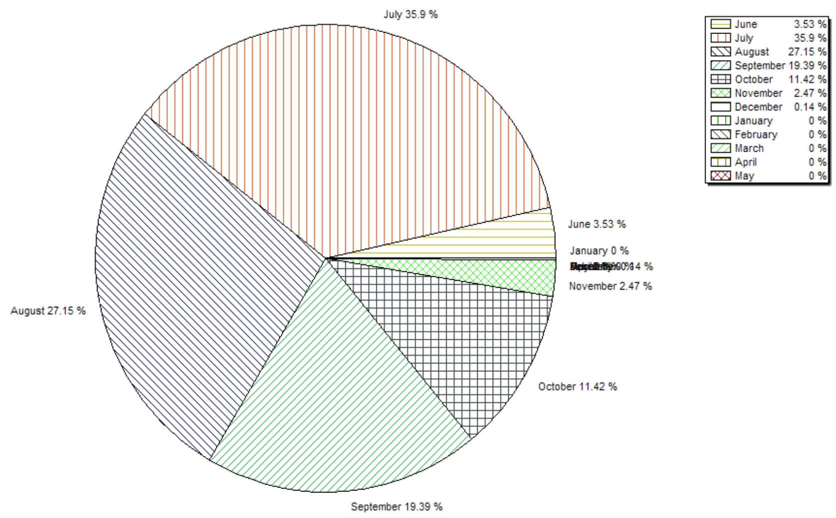
5.2.6 Monthly Average Runoff

Station Name: Damanganga at Nanipalsan (01 02 24 001) Division : Tapi Division, Surat Local River: Damanganga Sub -Division : DGSD, CWC, Silvasa

Monthly Average Runoff Based on period 1991-2013



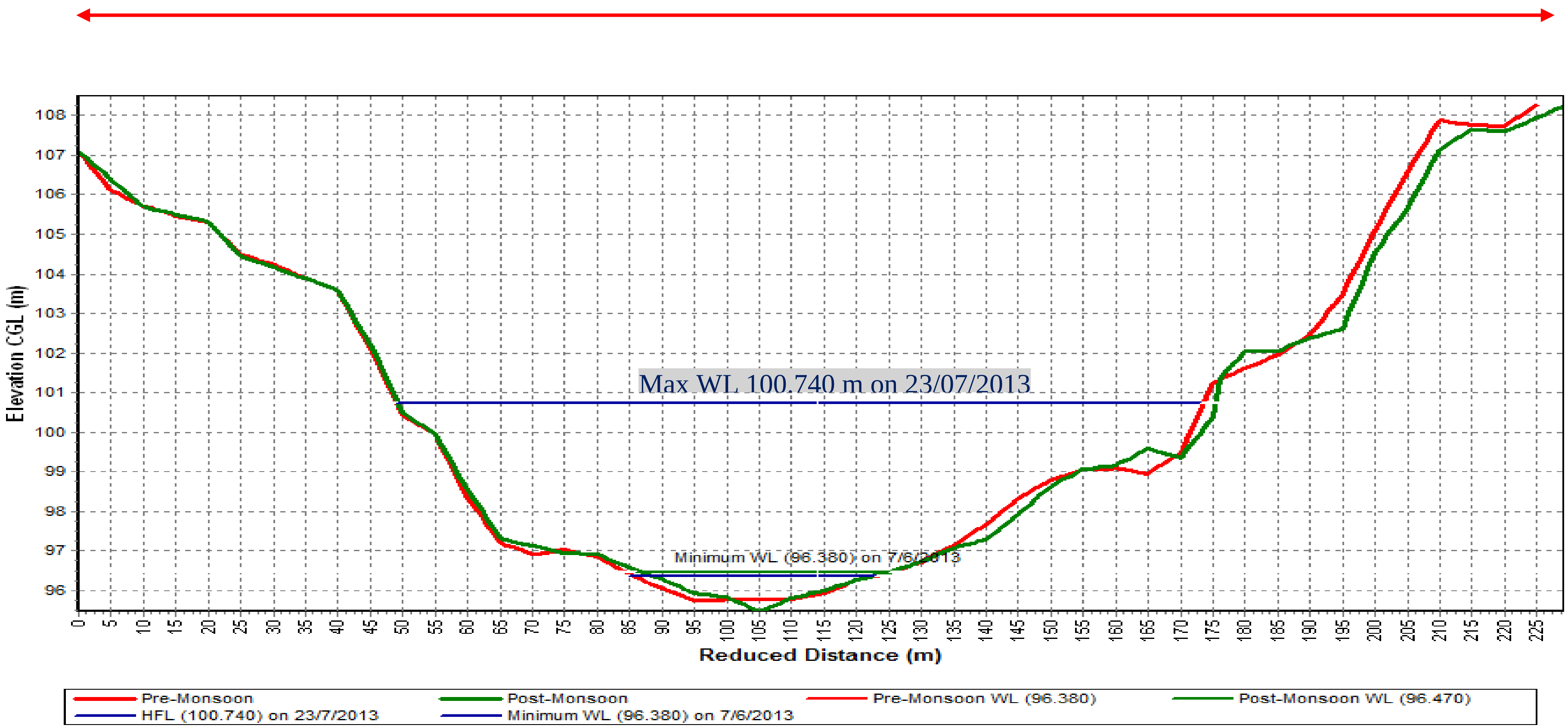
Monthly Average Runoff Based on period 2013-14



4.5.2.7 Superimposed cross section

Station Name: Damanganga at Nanipalsan (01 02 24 001) Division : Tapi Division, Surat Local River: Damanganga Sub-Division:DGSD, CWC, Silvasa

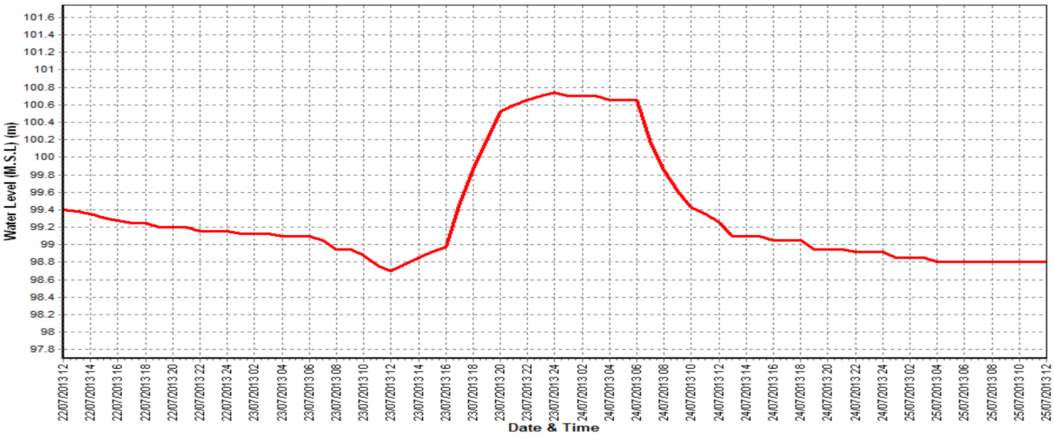
Highest flood level observed so far 110.030 on dt 03/08/2004 at 18 : 00hrs



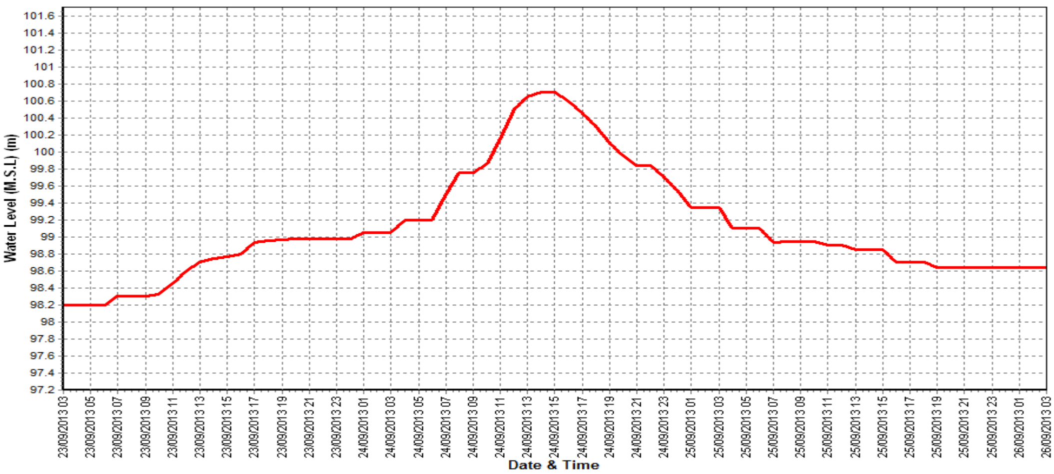
4.5.2.8 Water Level vs. Time- Graph of Highest Flood Peaks during 2013-14

Station Name: Damanganga at Nanipalsan (01 02 24 001) Division: Tapi Division, Surat
Local River: Damanganga Sub -Division: DGSD, CWC, Silvasa

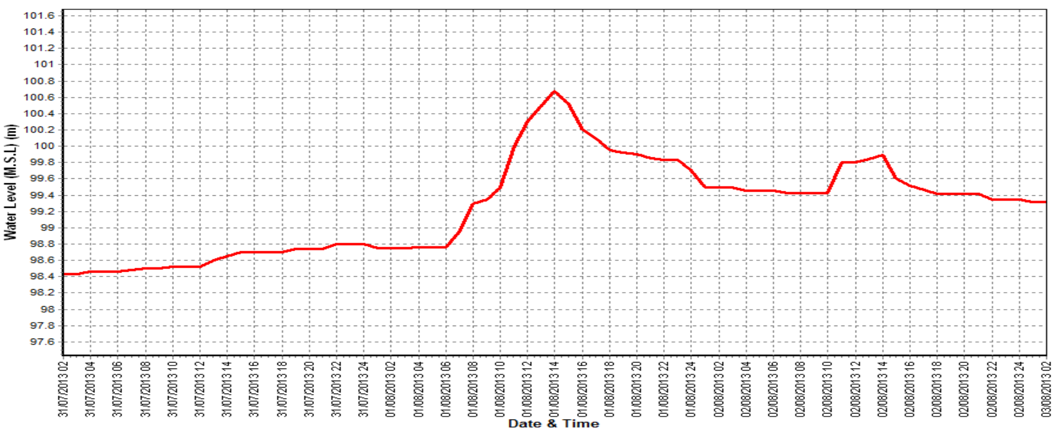
Water level vs. Time graph of I flood peak during the year 2013-14



Water level vs. Time graph of II flood peak during the year 2013-14



Water level vs. Time graph of III flood peak during the year 2013-14



4.6 Kim basin

4.6.1 History sheet

HISTORY SHEET

			Water Year	**:**	**2013-14**
Site	**:**	**Motinaroli**	**Code**	**:**	**01 02 16 001**
State	:	Gujarat	District		Surat
Basin	:	Narmada	Independent River	:	Kim
Tributary	:	-	Sub Tributary	:	-
Sub-Sub Tributary	:	-	Local River	:	Kim
Division	:	Tapi Dvision, Surat	Sub-Division	:	LNSD Bharuch
Drainage Area	:	804 Sq. Km.	Bank	:	Right
Latitude	:	21°24’16”	Longitude	:	72°57’48”
Zero of Gauge **m**	:	5 (m.s.l)	17/10/1990		

		Opening Date	Closing Date
Gauge	:	17/10/1990	
Discharge	:	17/10/1990	
Sediment	:		
Water Quality	:	1/7/1991	

Annual maximum/minimum discharge with corresponding Water level (above m.s.l)

Year	Maximum			Minimum		
	Q (cumecs)	**WL (m)**	**Date**	**Q (cumecs)**	**WL (m)**	**Date**
1991-1992	58.73	10.140	01/08/1991	0.000	6.245	06/05/1992
1992-1993	736.4	17.510	22/06/1992	0.191	7.515	30/03/1993
1993-1994	426.3	13.890	16/07/1993	0.170	7.520	17/05/1994
1994-1995	700.5	13.750	22/07/1994	0.000	7.350	04/04/1995
1995-1996	668.6	15.700	21/07/1995	0.240	7.280	05/04/1996
1996-1997	676.0	16.800	24/07/1996	0.112	7.470	23/04/1997
1997-1998	372.0	16.355	24/08/1997	0.080	7.300	10/03/1998
1998-1999	404.0	15.900	16/09/1998	0.099	7.230	26/03/1999
1999-2000	282.5	13.500	20/07/1999	0.170	7.360	26/03/2000
2000-2001	296.2	13.625	14/07/2000	0.041	7.200	28/05/2001
2001-2002	377.1	14.650	16/08/2001	0.000	7.220	07/05/2002
2002-2003	526.8	14.930	04/09/2002	0.000	7.100	13/04/2003
2003-2004	649.0	14.640	25/07/2003	0.000	7.190	29/05/2004
2004-2005	1288	17.200	04/08/2004	0.000	7.340	14/02/2005
2005-2006	720.2	16.380	30/06/2005	0.000	7.310	22/06/2005
2006-2007	923.2	17.650	29/07/2006	0.956	7.710	27/02/2007
2007-2008	851.7	16.815	02/07/2007	0.280	7.530	08/03/2008
2008-2009	735.6	15.985	12/08/2008	0.500	7.440	25/03/2009
2009-2010	206.8	13.660	07/09/2009	0.000	7.550	25/01/2010
2010-2011	384.2	14.625	10/09/2010	0.770	7.620	04/01/2011
2011-2012	497.8	14.425	26/08/2011	0.000	7.630	19/12/2012
2012-2013	47.640	13.480	04/09/2012	0.000	7.720	07/01/2013
2013-2014	399.3	15.150	23/09/2013	0.000	7.790	09/10/2014

4.6.2 Annual Maximum Flood peak

Year	Highest Flood Level (m)	Date	Hour
1990	7.320	20/11/1990	08:00:00
1991	10.160	01/08/1991	08:00:00
1992	17.660	22/06/1992	11:00:00
1993	15.480	18/07/1993	22:00:00
1994	18.150	16/06/1994	23:00:00
1995	15.850	21/07/1995	15:00:00
1996	16.800	24/07/1996	03:00:00
1997	16.550	24/08/1997	11:00:00
1998	16.600	16/09/1998	13:00:00
1999	16.480	20/07/1999	19:00:00
2000	14.000	14/07/2000	06:00:00
2001	14.800	16/08/2001	08:00:00
2002	15.080	04/09/2002	13:00:00
2003	16.630	25/07/2003	20:00:00
2004	17.400	04/08/2004	12:00:00
2005	17.500	29/06/2005	18:00:00
2006	18.225	29/07/2006	21:00:00
2007	18.090	02/07/2007	20:00:00
2008	16.400	12/08/2008	15:00:00
2009	18.000	19/02/2009	08:00:00
2010	16.130	10/09/2010	05:00:00
2011	14.630	26/08/2011	11:00:00
2012	13.500	04/09/2012	10:00:00
2013	18.710	25/09/2013	22:00:00

4.6.3 Summary of data

Stage Discharge Data for the period 2013-14

Station Name: Kim at Motinaroli (01 02 16 001)   Division : Tapi Division, Surat   Local River:Kim   Sub -Division : LNSD, CWC, Bharuch

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	7.910	0.000	7.840	2.574	9.660	96.97	9.080	56.15 *	9.660	95.70	8.600	34.32
2	7.920	0.000	7.820	2.190	10.620	157.0	9.070	56.77	9.470	75.09 *	8.580	33.99
3	7.940	0.000	7.770	2.151	15.350	369.2	9.020	50.63	9.330	76.76	8.570	32.45 *
4	7.950	0.000	8.800	49.00	10.600	132.7 *	9.000	45.02	9.295	75.08	8.530	33.87
5	7.950	0.000	9.060	54.83	10.390	135.4	9.000	45.11	9.575	92.35	8.580	30.66
6	8.230	17.61 #	8.740	40.01	10.100	113.5	9.325	76.17	9.290	66.27 *	8.600	34.10
7	8.290	20.16 #	8.850	45.29 *	9.680	98.14	9.300	75.74	9.240	68.59	8.620	34.26
8	8.930	50.22	9.000	54.17	9.510	96.19	9.180	60.95 *	9.740	102.0	8.650	35.60
9	8.000	8.283 *	8.850	30.47	9.480	75.58 *	9.070	55.67 *	10.860	166.7	8.520	32.47
10	9.100	76.57	8.780	30.01	9.720	100.7	9.030	50.58	9.315	76.02	8.450	27.11 *
11	9.100	49.10	9.405	62.94	11.300	170.0 *	9.010	46.48	9.400	83.87	8.450	29.68
12	9.180	81.21	10.950	139.0	9.910	106.6	9.330	78.81	9.310	75.56	8.430	29.37
13	8.910	42.98	14.900	260.0	10.200	127.8	9.120	59.38	9.250	64.33 *	8.400	29.11
14	8.565	34.26	12.900	258.3 *	14.535	340.6	9.030	50.66	9.120	59.34	8.380	24.04 *
15	9.635	97.59	9.535	90.80	11.320	171.0 *	9.330	68.22 *	9.130	60.07	8.350	27.87
16	9.020	53.29 *	9.230	65.46	10.150	124.4	9.010	46.75	9.070	55.67 *	8.350	27.88
17	9.375	91.11	10.955	162.0	10.100	121.9	9.000	44.98	9.020	50.65	8.330	21.87 *
18	9.415	95.26	13.055	248.1	9.730	88.02 *	9.070	56.76	8.980	49.75	8.310	26.08
19	9.535	96.89	12.200	176.7	9.620	94.79	9.020	50.71	8.940	45.38	8.300	25.80
20	9.050	70.64	13.150	224.9	9.460	86.25	8.980	49.44	8.900	47.63 *	8.150	4.247
21	8.950	67.58	12.500	235.9 *	9.360	80.35	8.940	45.42	8.900	43.56	8.010	3.729
22	8.950	62.81	10.490	138.5	9.290	73.83	8.900	47.63 *	8.850	41.52	8.000	3.729

23	9.180	60.95 *	11.275	184.3	9.240	68.46	15.150	399.3	8.750	39.09	7.980	3.385
24	8.870	45.03	10.140	114.6	9.250	69.23	17.690	541.1 #	8.720	37.73	7.980	2.625 *
25	8.100	12.25 #	12.425	209.6	9.340	68.71 *	18.160	569.9 #	8.750	39.33	7.960	2.964
26	7.860	2.893	11.915	202.7	9.260	69.28	18.250	575.4 *	8.750	39.24	7.950	2.925
27	7.810	2.004	12.400	209.6	9.210	68.84	12.180	152.5	8.710	38.81 *	7.940	2.858
28	8.200	6.091	10.480	126.4 *	9.170	60.47 *	10.080	121.5	8.690	36.73	7.920	2.451
29	8.150	14.29 #	10.325	134.4	9.140	60.18	9.820	92.55 *	8.660	35.73	7.910	2.273
30	7.900	4.522 *	10.270	130.2	9.100	58.74	10.650	153.8	8.610	34.18	7.890	1.616
31			9.850	104.6	9.090	58.07			8.620	34.19		
Ten-Daily Mean												
I Ten-Daily	8.222	17.29	8.551	31.07	10.511	137.5	9.108	57.28	9.578	89.46	8.570	32.88
II Ten-Daily	9.179	71.23	11.628	168.8	10.632	143.1	9.090	55.22	9.112	59.22	8.345	24.59
III Ten-Daily	8.397	27.84	11.097	162.8	9.223	66.92	12.982	269.9	8.728	38.19	7.954	2.856
Monthly												
Min.	7.810	0.000	7.770	2.151	9.090	58.07	8.900	44.98	8.610	34.18	7.890	1.616
Max.	9.635	97.59	14.900	260.0	15.350	369.2	18.250	575.4	10.860	166.7	8.650	35.60
Mean	8.599	38.79	10.447	122.2	10.093	114.3	10.393	127.5	9.126	61.52	8.290	20.11

Annual Runoff in MCM = 1320 Annual Runoff in mm = 1642

Peak Observed Discharge = 399.3 cumecs on 23/09/2013 Corres. Water Level :15.15 m

Lowest Observed Discharge = 0.000 cumecs on 09/01/2014 Corres. Water Level :7.79 m

Q: Observed/Computed discharge in cumec WL: Corresponding Mean Water Level (m.s.l) in m * : Computed Discharge
#:Discarded Discharge (values changed as per rating curve)

Note: River in pooling or no flow condition w.e.f. 01/06/2013 to 05/06/2013 & 09/01/2014 to 21/01/2014, 4/03/14 to 19/03/14 21/05/2014 to 31/05/2014

Stage Discharge Data for The period 2013-14

Station Name: Kim at Motinaroli (01 02 16 001) Division : Tapi Division, Surat Local River: Kim Sub -Division : LNSD, CWC, Bharuch

Day	Dec			Jan			Feb			Mar			Apr			May		
	W.L	Q		WL	Q		WL	Q		WL	Q		WL	Q		WL	Q	
1	7.880	1.284	*	7.840	0.432		7.910	2.055		7.960	2.370	#	8.160	4.487		8.130	4.768	
2	7.870	1.010		7.830	0.387		7.910	1.701	*	7.850	0.848	*	8.160	4.400		8.130	4.771	
3	7.930	2.509		7.850	0.746		7.890	1.024		7.810	0.268		8.190	4.915		8.140	4.728	
4	7.920	2.293		7.840	0.520		7.900	1.130		7.770	0.000		8.170	4.778		8.150	4.718	*
5	7.930	2.468		7.850	0.848	*	7.930	2.512		7.760	0.000		8.150	4.197		8.160	4.929	
6	7.950	2.870		7.850	0.727		7.970	2.943		7.740	0.000		8.140	4.599	*	8.170	4.990	
7	7.910	2.095		7.830	0.371		7.980	3.062		7.740	0.000		8.140	4.295		8.180	5.206	
8	7.910	1.701	*	7.810	0.121		8.000	3.145		7.740	0.000		8.160	5.242		8.190	5.300	
9	7.910	2.106		7.790	0.000		8.050	3.507	*	7.720	0.000		8.150	4.951		8.170	4.957	
10	7.910	1.223		7.780	0.000		8.130	4.052		7.720	0.000		8.140	4.790		8.170	4.998	
11	7.900	1.169		7.780	0.000		8.130	4.134		7.730	0.000		8.130	4.716		8.160	4.836	*
12	7.890	1.091		7.780	0.000		8.090	4.041		7.730	0.000		8.120	4.258		8.130	4.856	
13	7.870	1.032		7.770	0.000		8.080	3.832		7.730	0.000		8.120	4.359	*	8.120	4.831	
14	7.840	0.999		7.760	0.000		8.100	4.022		7.720	0.000		8.110	4.239	*	8.200	5.320	
15	7.820	0.377	*	7.750	0.000		8.140	4.181		7.720	0.000		8.110	4.543		8.160	4.911	
16	7.810	0.355		7.750	0.000		8.140	4.599	*	7.720	0.000		8.100	4.506		8.220	5.374	
17	7.810	0.357		7.750	0.000		8.190	4.776		7.720	0.000		8.100	4.490		8.150	4.807	
18	7.860	1.017		7.780	0.000		8.230	5.126		7.720	0.000		8.100	4.118	*	8.130	4.479	*
19	7.850	0.997		7.770	0.000		8.200	4.927		7.700	0.000		8.090	4.061		7.960	2.370	#
20	7.880	1.074		7.760	0.000		8.200	4.905		7.940	2.551		8.110	4.239	*	7.820	0.273	
21	7.890	1.078		7.760	0.000		8.220	4.983		7.960	3.084		8.120	4.500		7.800	0.000	

22	7.890	1.425	*	7.850	0.732		8.220	5.041		8.000	3.115		8.120	4.588		7.790	0.000	
23	7.900	1.171		7.880	1.073		8.240	5.772	*	8.000	2.881	*	8.120	4.670		7.760	0.000	
24	7.880	1.062		7.900	1.178		8.210	4.937		8.060	3.553		8.120	4.675		7.750	0.000	
25	7.880	1.284	*	7.910	1.232		8.170	5.016		8.090	4.005		8.130	4.841		7.740	0.000	
26	7.860	1.015		7.920	1.836	*	8.130	4.595		8.170	4.692		8.100	4.319		7.730	0.000	
27	7.860	1.014		7.920	2.287		8.000	3.537		8.180	4.678		8.100	4.118	*	7.720	0.000	
28	7.850	0.996		7.940	2.554		8.040	4.036		8.190	4.762		8.090	4.046		7.710	0.000	
29	7.850	0.848	*	7.930	2.467					8.170	4.600		8.110	4.579		7.700	0.000	
30	7.810	0.241		7.920	2.215					8.170	4.954	*	8.120	4.681		7.690	0.000	
31	7.810	0.241		7.910	2.052					8.160	4.454					7.680	0.000	
Ten-Daily Mean																		
I Ten-Daily	7.912	1.956		7.827	0.415		7.967	2.513		7.781	0.349		8.156	4.666		8.159	4.936	
II Ten-Daily	7.853	0.847		7.765	0.000		8.150	4.454		7.743	0.255		8.109	4.353		8.105	4.206	
III Ten-Daily	7.862	0.943		7.895	1.603		8.154	4.740		8.105	4.071		8.113	4.502		7.734	0.000	
Monthly																		
Min.	7.810	0.241		7.750	0.000		7.890	1.024		7.700	0.000		8.090	4.046		7.680	0.000	
Max.	7.950	2.870		7.940	2.554		8.240	5.772		8.190	4.954		8.190	5.242		8.220	5.374	
Mean	7.875	1.239		7.831	0.703		8.086	3.843		7.884	1.639		8.126	4.507		7.991	2.949	

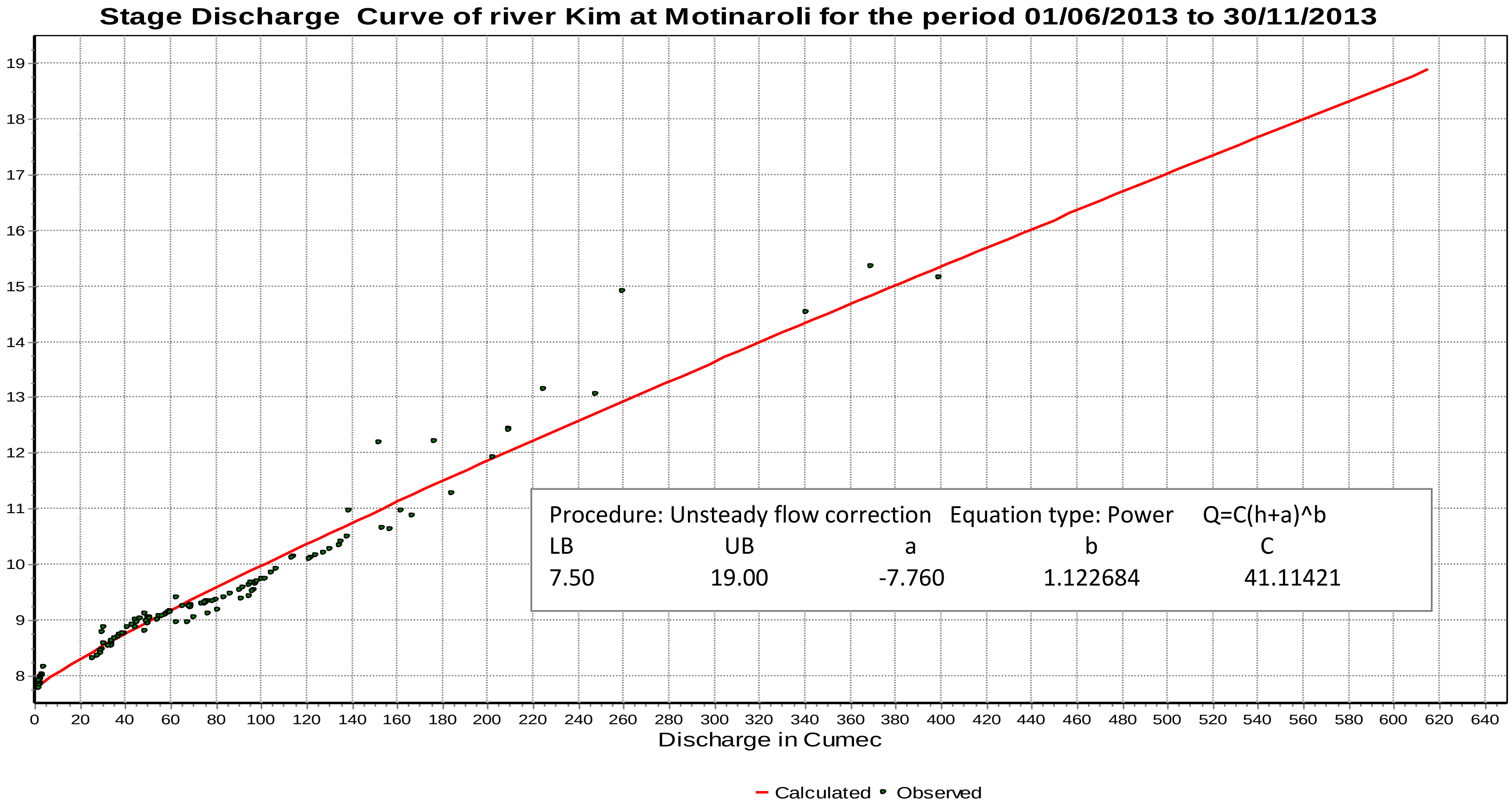
Peak Computed Discharge = 575.4 cumecs on 26/09/2013 **Corres. Water Level :18.25 m**
Lowest Computed Discharge = 0.377 cumecs on 15/12/2013 **Corres. Water Level :7.82 m**

Q: Observed/Computed discharge in cumec WL: Corresponding Mean Water Level (m.s.l) in m * : Computed Discharge
#:Discarded Discharge (values changed as per rating curve)

Note: River in pooling or no flow condition w.e.f. 01/06/2013 to 05/06/2013 & 09/01/2014 to 21/01/2014, 4/03/14 to 19/03/14, 21/05/2014 to 31/05/2014

4.6.4 Stage Discharge Curve

Station Name: Kim at Motinaroli (01 02 16 001) Division : Tapi Division, Surat Local River: Kim Sub -Division : LNSD, CWC, Bharuch



Equation for estimation of discharge for the period 01/12/13 to 31/05/2015 is as following:

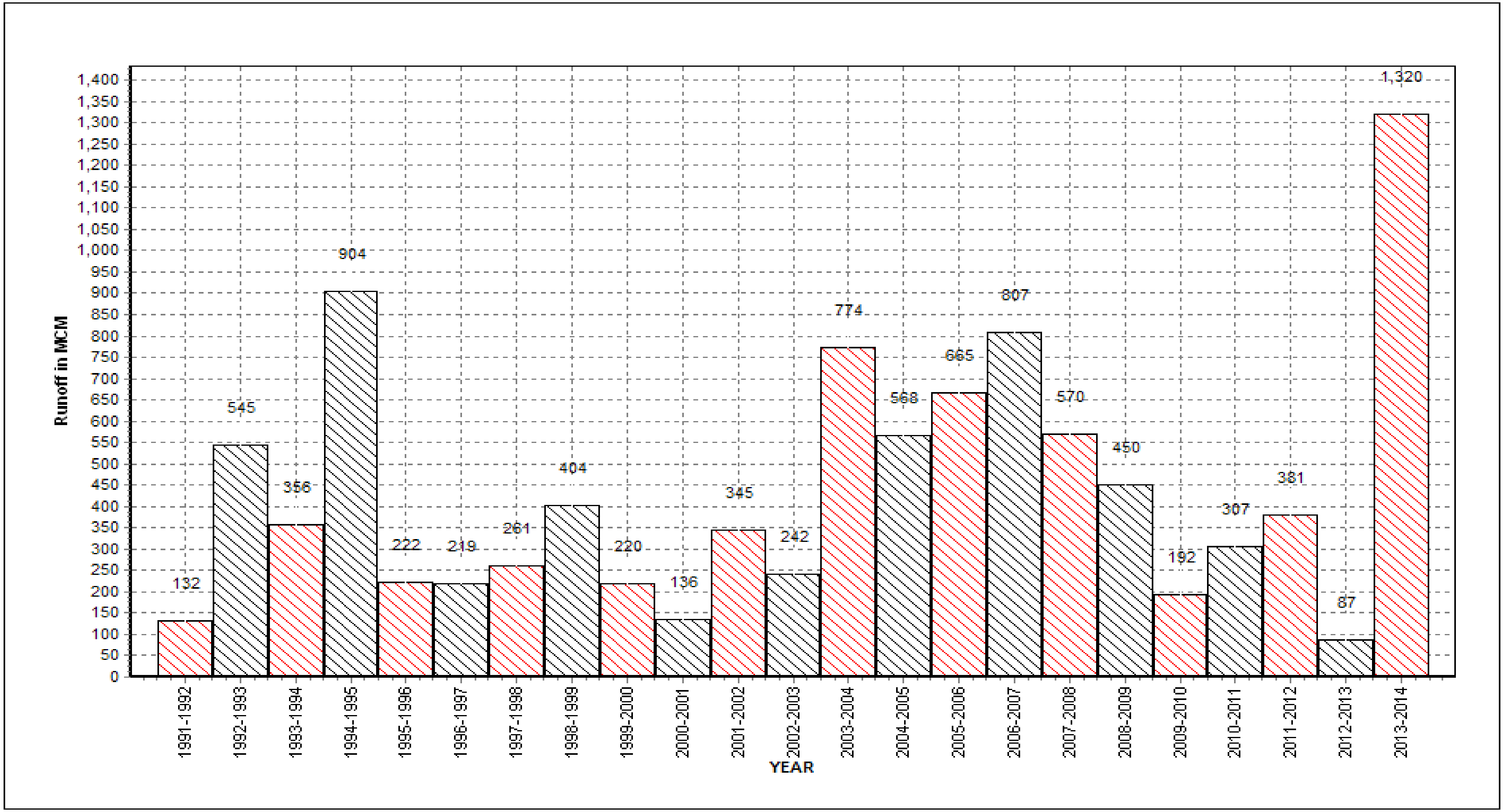
Procedure: Unsteady flow correction		**Equation type: Power**		**Q=C(h+a)^b**
LB	**UB**	**a**	**b**	**C**
7.8	**8.50**	**-7.8001**	**0.880911**	**11.89767**

The equation is under review for period 01/12/2013 to 31/05/2014

4.6.5 Annual runoff

Annual Runoff values for the period 1991-2014

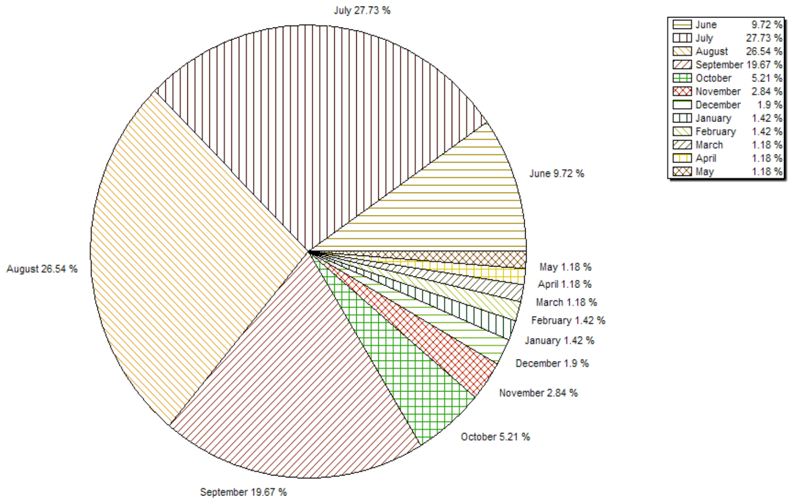
Station Name: Kim at Motinaroli (01 02 16 001) Division: Tapi Division, Surat Local River: Kim Sub -Division: LNSD, CWC, Bharuch



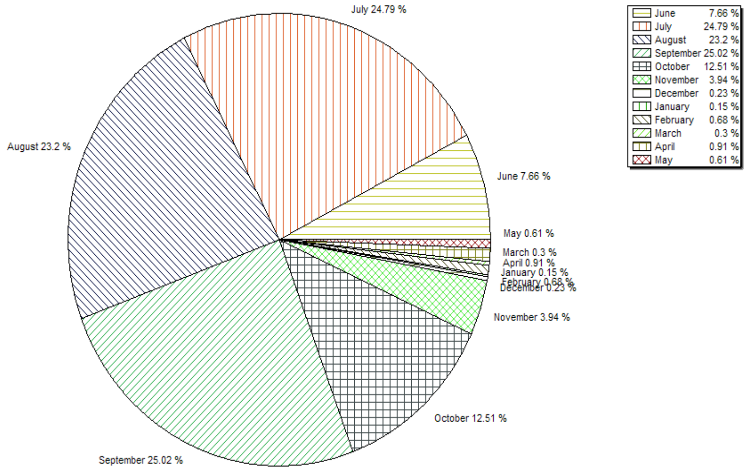
4.6.6 Monthly average Runoff

Station Name: Kim at Motinaroli (01 02 16 001) Division : Tapi Division, Surat Local River: Kim Sub -Division : LNSD, CWC, Bharuch

Monthly Average Runoff on period 1991-2013

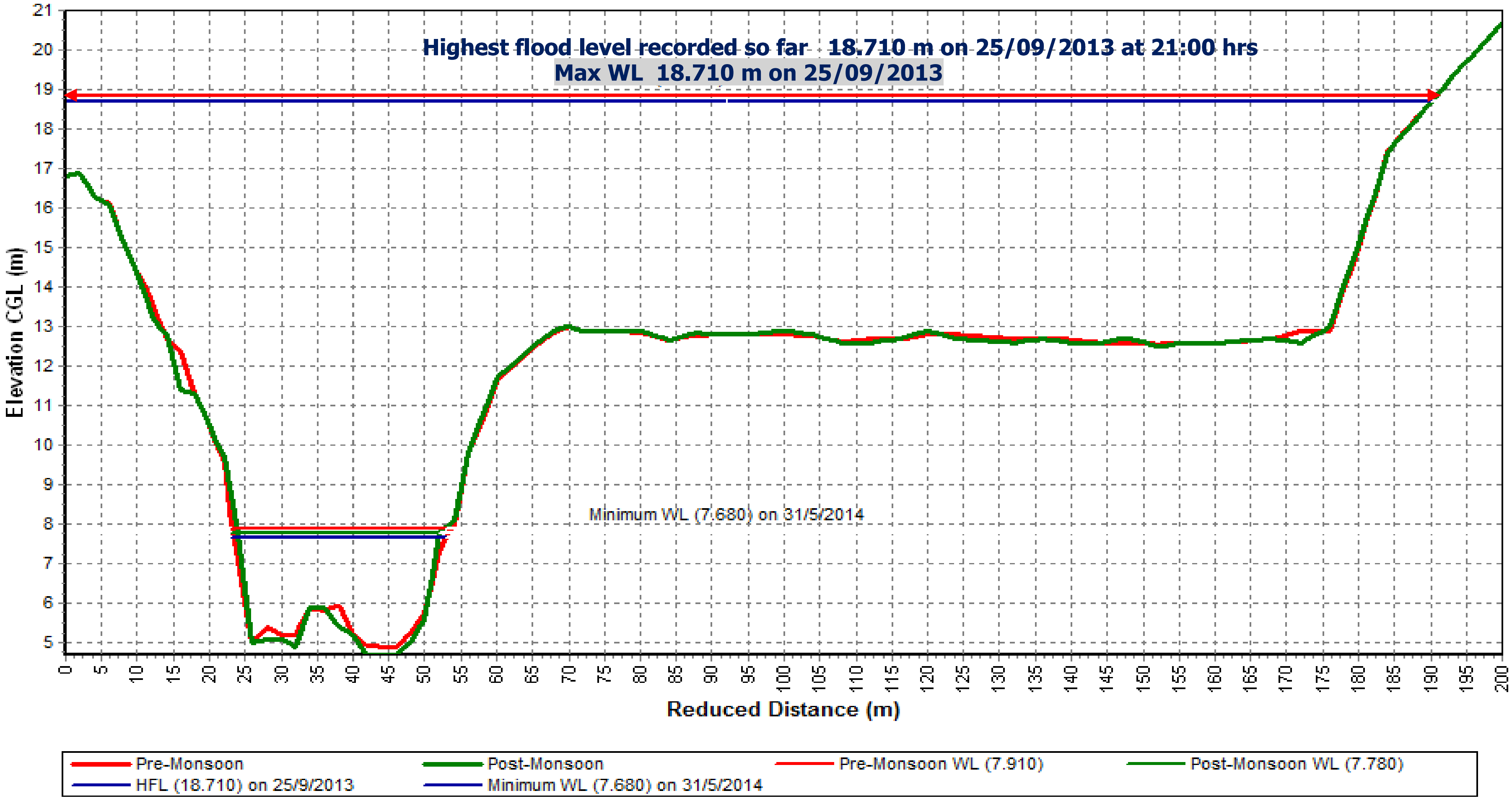


Monthly Average Runoff on period 2013-14



4.6.7 Superimposed cross section

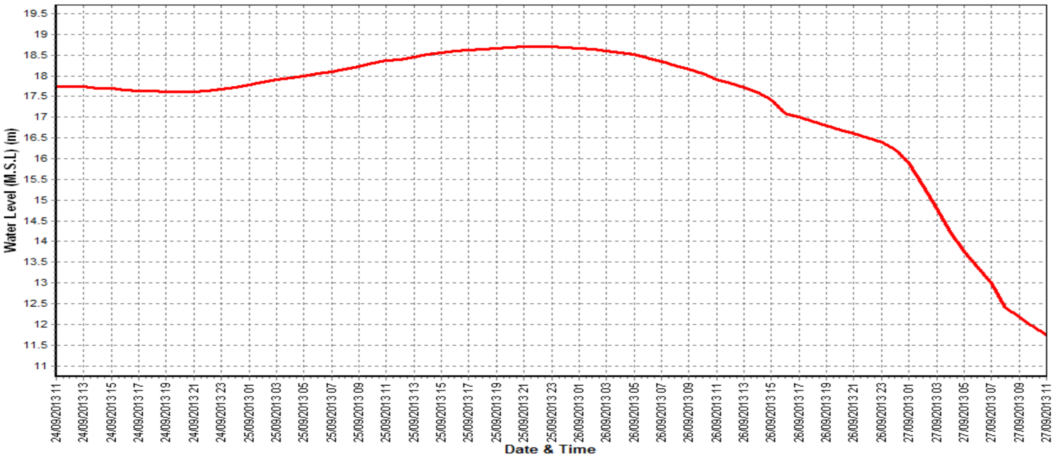
Station Name: Kim at Motinaroli (01 02 16 001) Division : Tapi Division, Surat Local River: Kim Sub -Division : LNSD, CWC, Bharuch



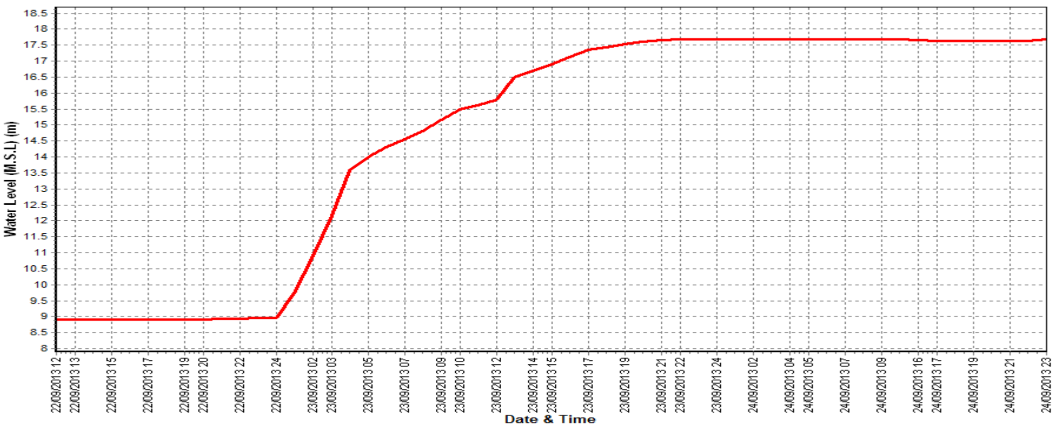
4.6.8 Water Level vs. Time Graph of highest flood peaks during 2013-14

Station Name: Kim at Motinaroli (01 02 16 001) Division : Tapi Division, Surat
Local River: Kim Sub -Division : LNSD, CWC, Bharuch

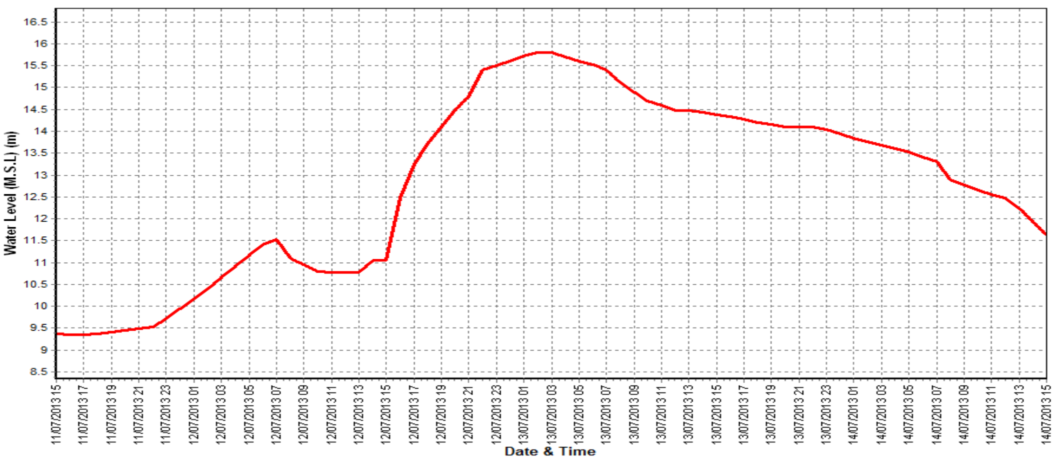
Water level vs. Time graph of 1st flood peak during the year 2013-14



Water level vs. Time graph of 2nd flood peak during the year 2013-14



Water level vs. Time graph of 3rd flood peak during the year 2013-14



5.0 Trend Analysis

5.1 Trend Analysis of Purna Basin

5.1.1 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 Purna basin using available data of existing river gauging stations.

5.1.2 Methodology

In the analysis of the trends of runoff on Purna River at Mahuwa annual runoff is computed and analyzed. The analysis is carried out for one (1) river gauging station with sufficiently long and continuous data sets that are fairly representatively distributed across Purna river Basin.

Overall one station has been considered in this study. The length of the data sets of river gauging station is 43 years. Subsequently, time series are analysed on various statistical parameters, fitting of mathematical equations, observing moving means for various periods so as to find out if there are any trends in the annual runoff data.

5.1.2.1 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 in Purna 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.

5.1.3 Availability of Data

There is a 1 G & D site in Purna Basin. Availability of annual runoff data for this site is summarized in **Table -5.1.1**

Table-5.1.1: Availability of Data

S. No.	Site	Period of Availability	Years
1.	Mahuwa on Purna River	1971-72 to 2013-14	43
The data is placed at Annexure-1 and shown in line diagram in **Fig- 5.1.1.**			

5.1.4 Analysis

5.1.4.1 Statistical Analysis

Various statistical parameters of the time series of available data are given below in **Table-5.1.2**

Table-5.1.2 Statistical parameters of Annual Runoff series at various sites in Purna Basin

River Gauging Station	Data length (years)	Mean (MCM)	Median (MCM)	standard deviation (MCM)	Co-efficient of variation
Mahuwa	43	1340	1149	844.312	0.63

5.1.4.2 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- 5.1.3** and shown in **Fig 5.1.2**

.

Table-5.1.3: Fit Characteristics

S. No.	Station name	Standard Deviation σ (MCM)	Coefficient of variation C_v	Mathematical Fit		R^2
1.	Mahuwa	844.312	0.63	Linear	y =2.0585x -2760.1	0.0009
				Logarithmic	y = 4099.6Ln(x) -29804	0.0009
				Exponential	$y = 0.0342e^{-0.0052x}$	0.0105
				Polynomial	$y = 0.0117x^2 - 44.559x + 43669$	0.0009

5.1.4.3 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 Purna River Basin and shown in **Fig-5.1.3**.

5.1.5 Interpretation

5.1.5.1 Fitting of various statistical/mathematical models viz linear, logarithmic, exponential and polynomial reveals that values of R^2 range from 0.0009 to 0.0105 for Mahuwa. The values of R^2 are quite close to 0 indicating absence of any significant trend.

5.1.5.2 The curve for three year moving mean shows two bell shaled patterns at either end. However, as the period of moving mean is enlarges, smaller variations disappear and no trend is seen.

5.1.6 Conclusion

Statistically speaking, the average annual runoff of river Purna in general, appears to be a random variable A longer set of time series data may help identify trends in annual runoff, if any.

Annexure-I

Annual Runoff data at Site Mahuwa on Purna

Water Year	Annual runoff in MCM
1971-72	873
1972-73	403
1973-74	1471
1974-75	182
1975-76	1258
1976-77	4299
1977-78	2544
1978-79	1149
1979-80	1168
1980-81	835
1981-82	1595
1982-83	1052
1983-84	1928
1984-85	1246
1985-86	997
1986-87	502
1987-88	357
1988-89	2076
1989-90	1223
1990-91	1075
1991-92	618
1992-93	985
1993-94	1382
1994-95	2991
1995-96	711
1996-97	1162
1997-98	1027
1998-99	1534
1999-00	781
2000-01	379
2001-02	870
2002-03	1116
2003-04	1689
2004-05	2002
2005-06	3395
2006-07	2552
2007-08	1755
2008-09	2023
2009-10	571
2010-11	926
2011-12	858
2012-13	525
2013-14	1547

Fig. 5.1.1: Annual Run Off - Purna at Mahuwa Sites

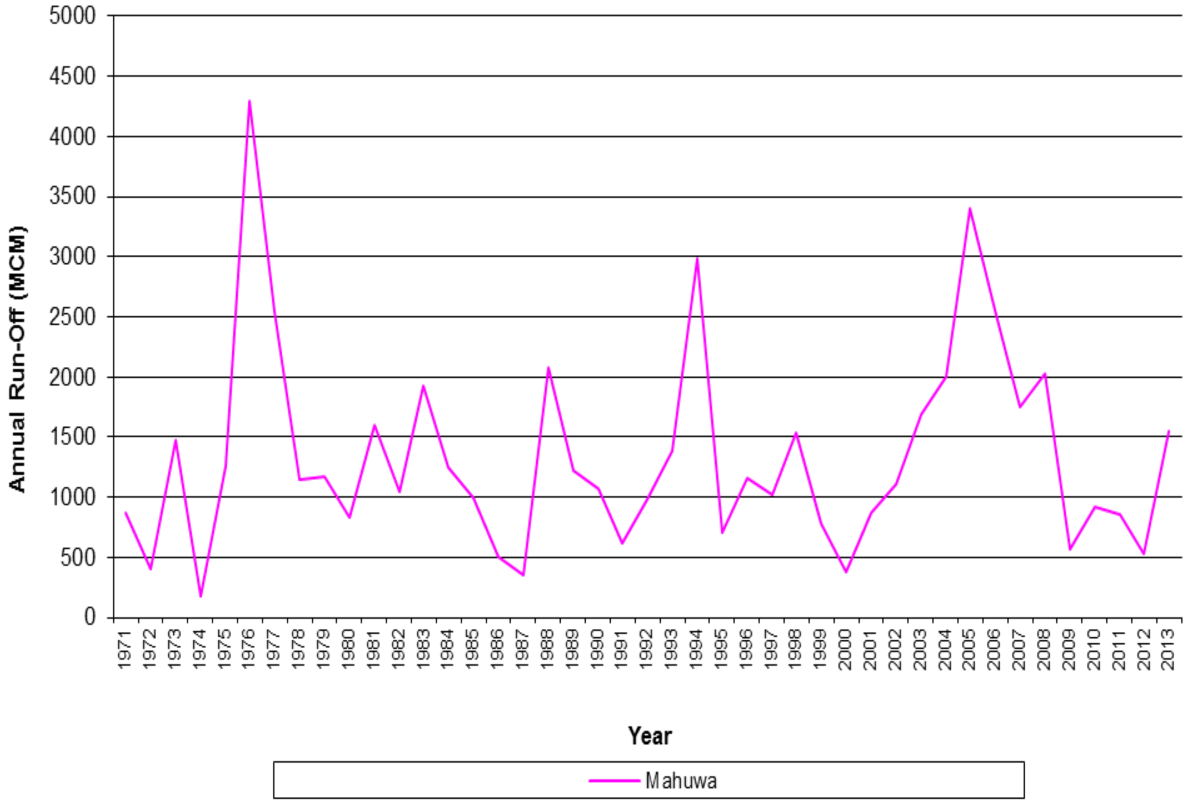


Fig.5.1.2 : Fit Characteistics- annual run off - Purna at Mahuwa

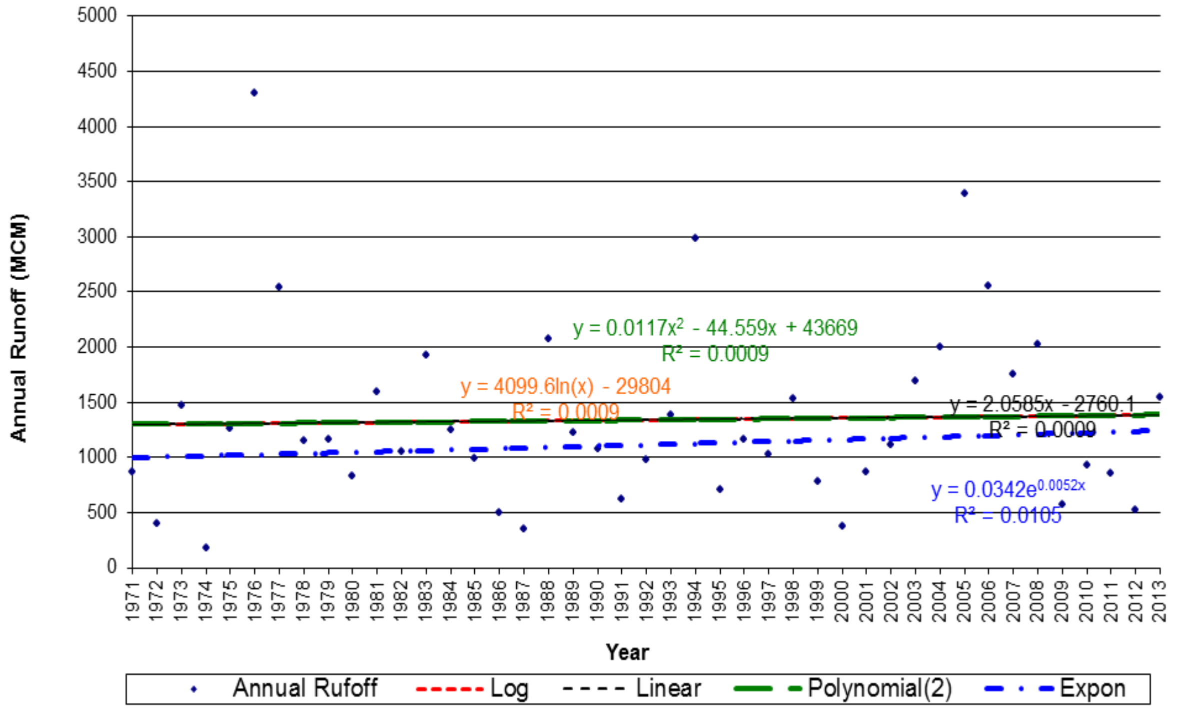
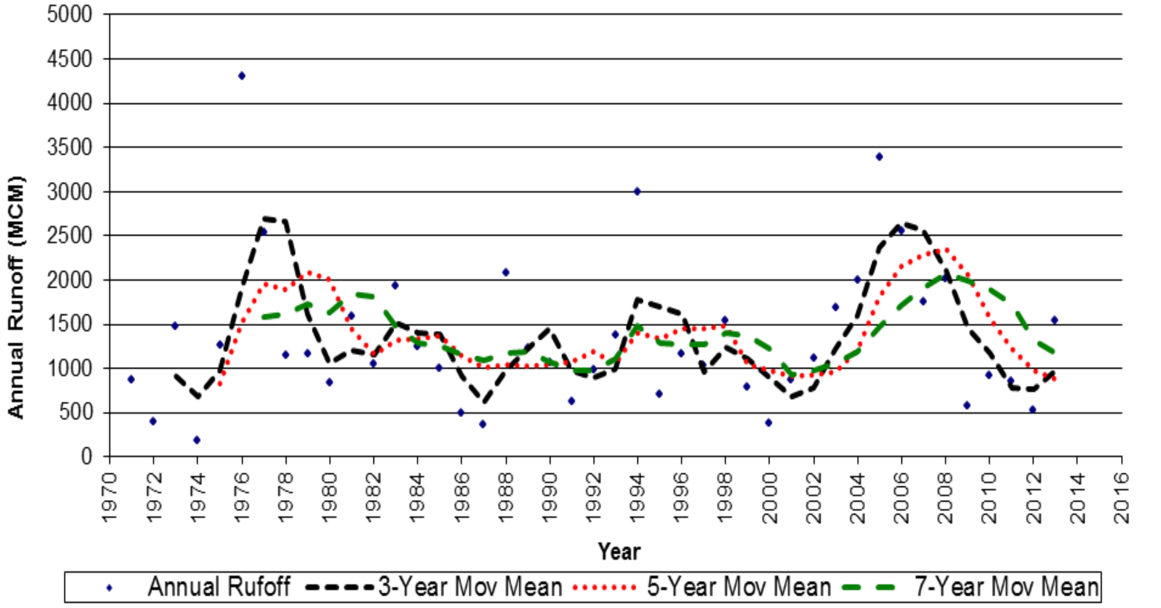


Fig.5.1.3: Moving Mean Analysis for annual run off - Purna at Mahuwa



5.2 Trend analysis of Ambica Basin

5.2.1 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 Ambica basin using available data of existing river gauging stations.

5.2.2 Methodology

In the analysis of the trends of runoff on Ambica River at Gadat, annual runoff is computed and analyzed. The analysis is carried out for one (1) river gauging station with sufficiently long and continuous data sets that are fairly representatively distributed across Ambica river Basin.

Overall one station has been considered in this study. The length of the data sets of river gauging station is 35 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.

5.2.2.1 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 in Ambica 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.

5.2.3 Availability of Data

There is a one G & D site in Ambica Basin. Availability of annual runoff data for this site is summarized in **Table -5.2.1**

Table-5.2.1 Availability of Data

S. no.	Site	Period of Availability	Years
1.	Gadat on Ambica River	1979-80 to 2013-14	35
The data is placed at Annexure-1 and shown in line diagram in **Fig- 5.2.1.**			

5.2.4 Analysis

5.2.4.1 Statistical Analysis

Various statistical parameters of the time series of available data are given below in Table-5.2.2.

Table-5.2.2 Statistical parameters of Annual Runoff series at various sites in Ambica Basin

River Gauging Station	Data length (years)	Mean (MCM)	Median (MCM)	standard deviation (MCM)	Co-efficient of variation
Gadat	35	1483	1299	691.947	0.467

5.2.4.2 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-5.2.3** and in **Fig 5.2 2**.

Table-5.2.3: Fit Characteristics

S. No.	Station name	Standard Deviation σ (MCM)	Coefficient of variation C_v	Mathematical Fit		R^2
1.	Gadat	691.947	0.467	Linear	y = 4.2905x – 7081.1	0.004
				Logarithmic	y = 2241ln(x) - 15571	0.000
				Exponential	$y = 2.4833e^{0.0032x}$	0.0049
				Polynomial	$y = -0.5787x^2 + 2314.4x - 2E+06$	0.01

5.2.4.3 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 Ambica River Basin and shown in **Fig-5.2.3.**

5.2.5 Interpretation

5.2.5.1 Fitting of various statistical/mathematical models viz linear, logarithmic, exponential and polynomial reveals that values of R^2 range from 0.000 to 0.01 for Gadat. The values of R^2 are quite close to 0 indicating absence of any significant trend.

5.2.5.2 Patterns of gradually rising and then falling values of annual run off are seen in moving mean plots of different periods indicating elements of cyclical ness in the data. 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 average annual runoff data.

5.2.6 Conclusion

Statistically speaking, the average annual runoff of river Ambica, 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 of Site Gadat on Ambika

Water Year	Annual runoff in MCM
1979-80	1089
1980-81	1189
1981-82	2052
1982-83	943
1983-84	2298
1984-85	1801
1985-86	1073
1986-87	890
1987-88	369
1988-89	2266
1989-90	1265
1990-91	1097
1991-92	943
1992-93	1389
1993-94	1704
1994-95	3859
1995-96	940
1996-97	1374
1997-98	1206
1998-99	1627
1999-00	1652
2000-01	688
2001-02	1289
2002-03	1063
2003-04	1580
2004-05	1598
2005-06	3010
2006-07	2126
2007-08	1733
2008-09	1794
2009-10	704
2010-11	1199
2011-12	1299
2012-13	635
2013-14	2152

Fig.5.2.1 Annual Run off - Ambika at Gadat

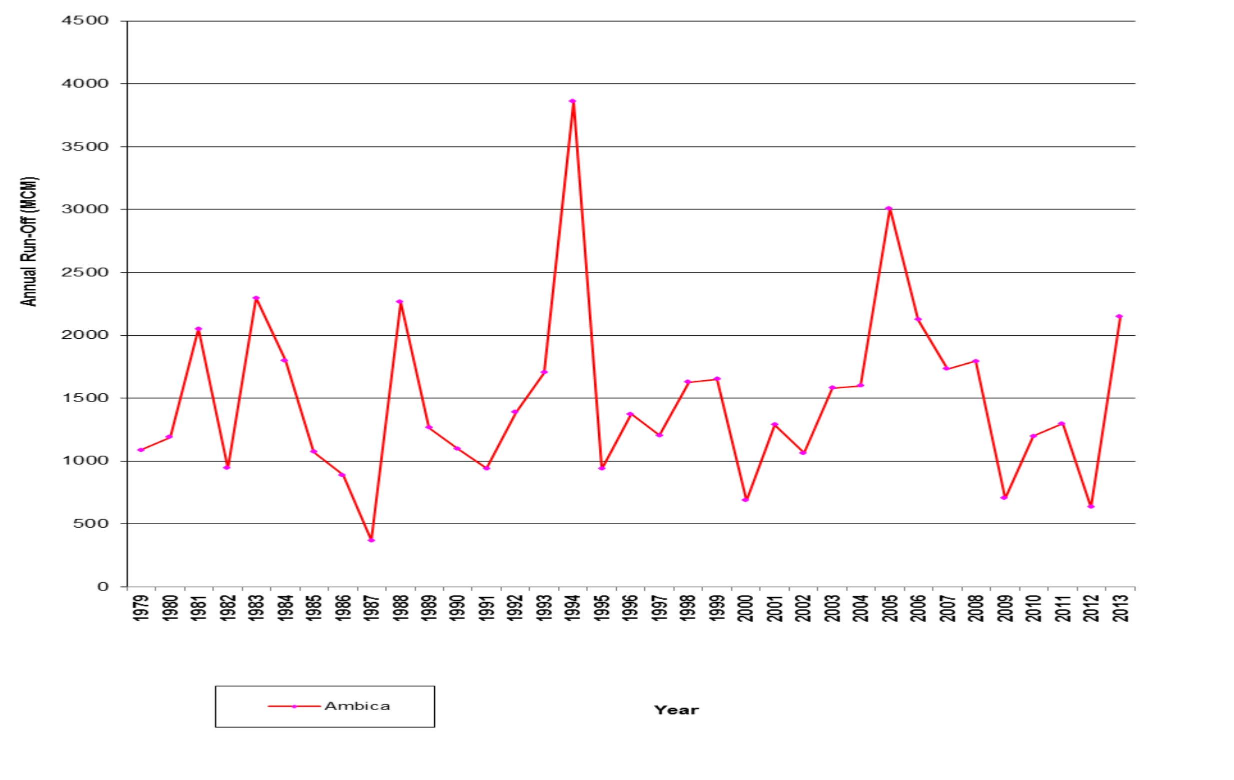


Fig.5.2.2 Fit Characteistics -Annual run off- Ambica at Gadat

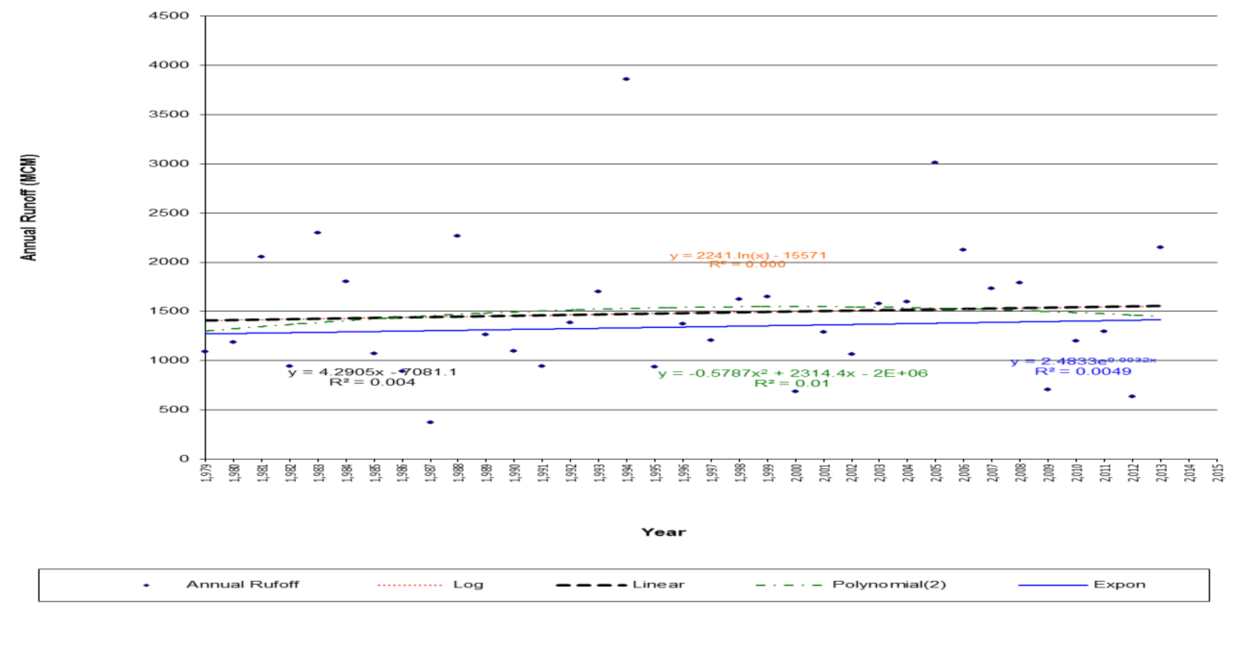
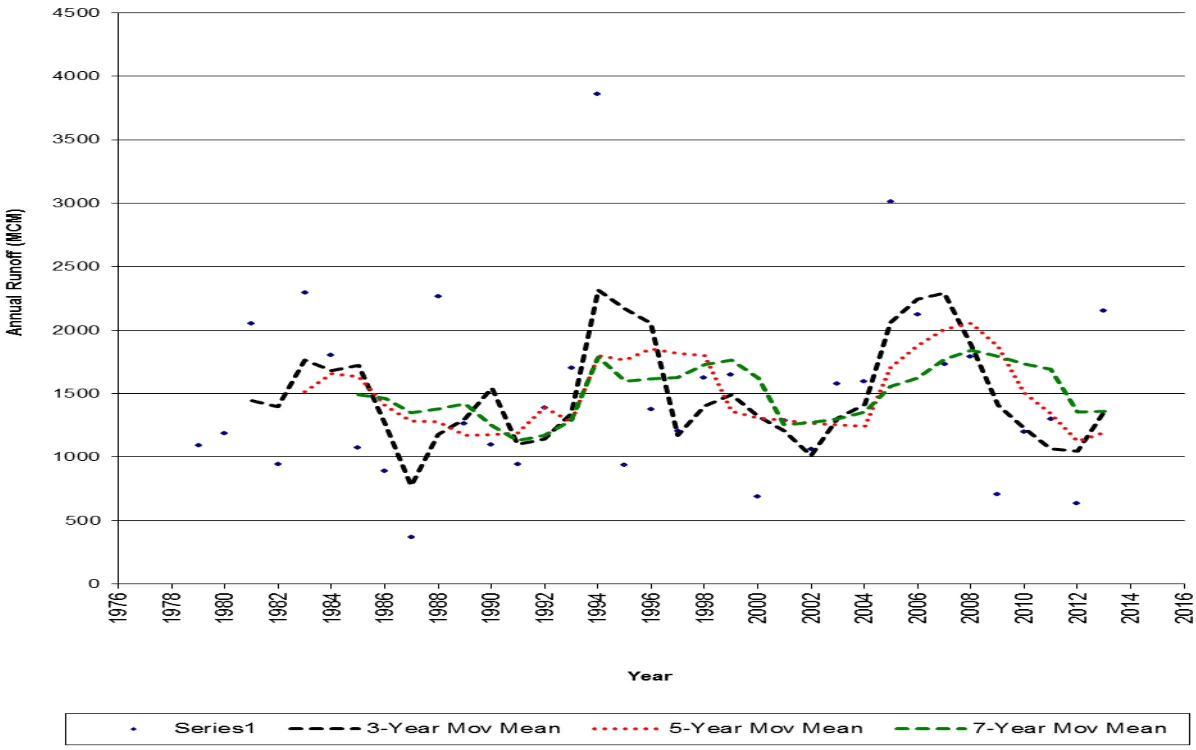


Fig.5.2.3 Moving Mean Analysis for annual run off - Ambica at Gadat



5.3 Trend Analysis of Vaitarna Basin

5.3.1 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 Vaitarna basin using available data of existing river gauging stations.

5.3.2 Methodology

In the analysis of the trends of runoff on Vaitarna River at Durvesh, annual runoff is computed and analyzed. The analysis is carried out for one (1) river gauging station with sufficiently long and continuous data sets that are fairly representatively distributed across Vaitarna river Basin.

Overall one station has been considered in this study. The length of the data sets of river gauging station is 43 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.

5.3.2.1 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 in Vaitarna 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.

5.3.3 Availability of Data

There is a 1 G & D site in Vaitarna Basin. Availability of annual runoff data for this site is summarized in **Table -5.3.1**

Table-5.3.1 Availability of Data

S. no.	Site	Period of Availability	Years
1.	Durvesh on Vaitarna River	1971-72 to 2013-14	43
The data is placed at Annexure-1 and shown in line diagram in **Fig-5.3.1.**			

5.3.4 Analysis

5.3.4.1 Statistical Analysis

Various statistical parameters of the time series of available data are given below in **Table-5.3.2**.

Table-5.3.2 Statistical parameters of Annual Runoff series at various sites in Vaitarna Basin

River Gauging Station	Data length (years)	Mean (MCM)	Median (MCM)	standard deviation (MCM)	Co-efficient of variation
Durvesh	43	3193	3065	1200.826	0.376

5.3.4.2 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-5.3.3** and shown in **Fig 5.3.2**.

Table-5.3.3 Fit Characteristics

S. No	Station name	Standard Deviation σ (MCM)	Coefficient of variation C_v	Mathematical Fit		R^2
1.	Durvesh	1200.83	0.376	Linear	y =7.035x -10821	0.005
				Logarithmic	y = 1383Ln(x) -10188	0.005
				Exponential	$y = 1.469e^{0.003x}$	0.016
				Polynomial	$y= 2.964x^2 – 11803x + 1E+07$	0.123

5.3.4.3 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 Vaitarna River Basin and shown in **Fig-5.3.3**

5.3.5 Interpretation

5.3.5.1 Fitting of various statistical/mathematical models viz linear, logarithmic, exponential and polynomial reveals that values of R^2 range from 0.005 to 0.123 for Durvesh. The values of R^2 are quite close to 0 indicating absence of any significant trend.

5.3.5.2 It is seen at site Durvesh from the plot of moving mean averages that after a period of high annual runoff about mid 1970's ,the annual runoff has gradually reduced and subsequently again shows gradual rise peaking about 2005. It may or may not be part of a larger trend. With the current length of data set, conclusions cannot be drawn regarding cyclical trend.

5.3.6 Conclusion

Statistically speaking, the average annual runoff of river Vaitarna at Durvesh in general, appears to be a random variable. A longer set of time series data may help identify trends in annual runoff, if any.

Annexure-I

Annual Runoff data of Site Durvesh on Vaitarna

Water Year	Annual runoff in MCM
1971-72	3605
1972-73	1594
1973-74	3951
1974-75	2822
1975-76	5025
1976-77	7379
1977-78	4092
1978-79	2312
1979-80	2995
1980-81	3543
1981-82	3240
1982-83	2006
1983-84	3689
1984-85	2738
1985-86	1517
1986-87	1677
1987-88	1415
1988-89	3065
1989-90	2004
1990-91	3502
1991-92	2265
1992-93	1910
1993-94	2496
1994-95	3995
1995-96	1661
1996-97	2226
1997-98	2842
1998-99	3674
1999-00	2673
2000-01	2334
2001-02	3058
2002-03	3180
2003-04	4193
2004-05	3994
2005-06	5338
2006-07	5038
2007-08	4082
2008-09	4360
2009-10	2078
2010-11	3829
2011-12	3701
2012-13	2466
2013-14	3745

Fig.5.3.1 Annual Run off- Vaitarna at Durvesh

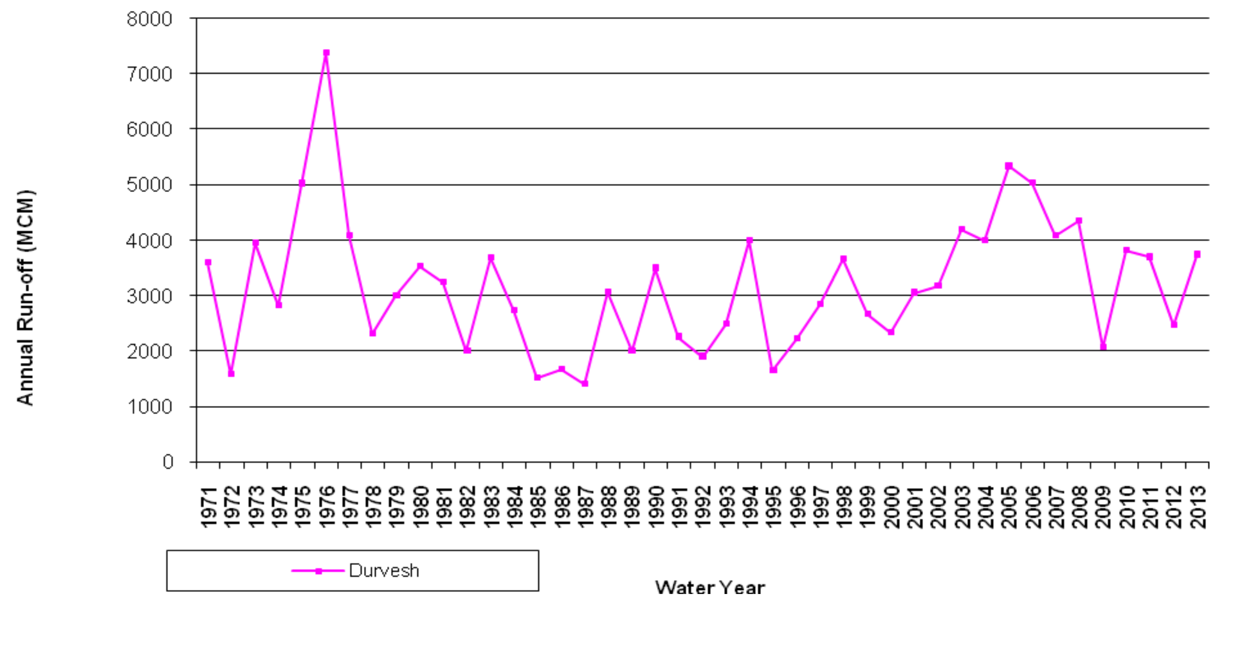
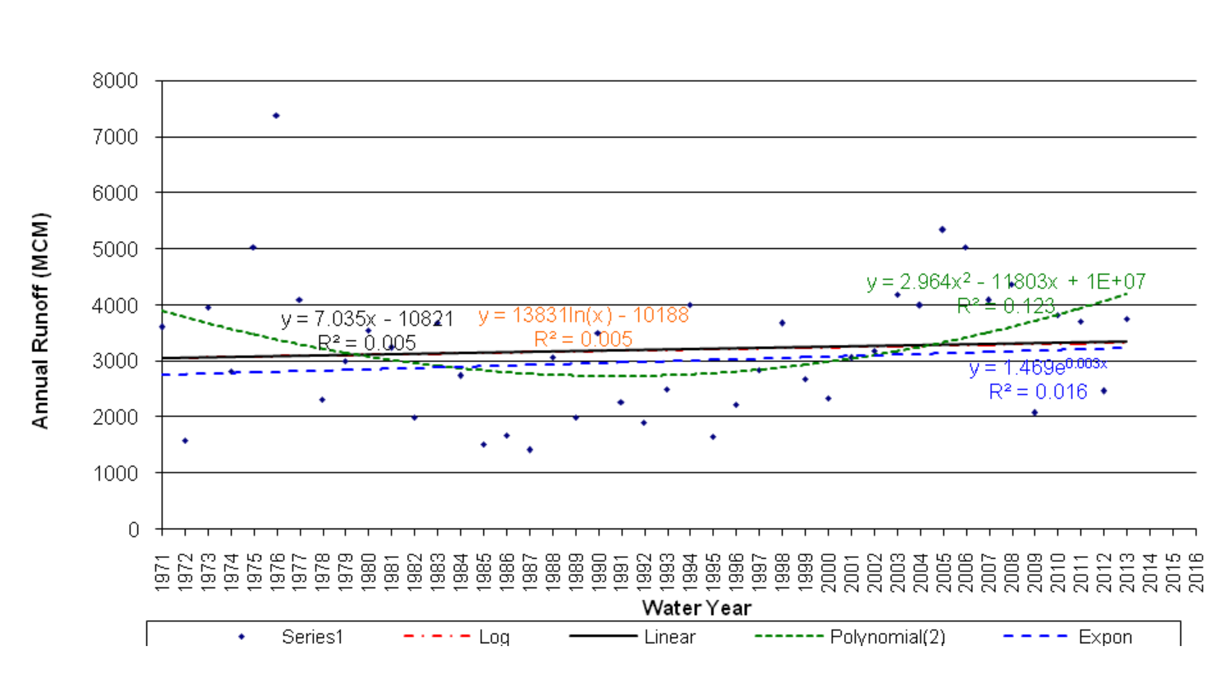


Fig.5.3.2: Fit Characteistics -Annual runoff -Vaitarna at Durvesh



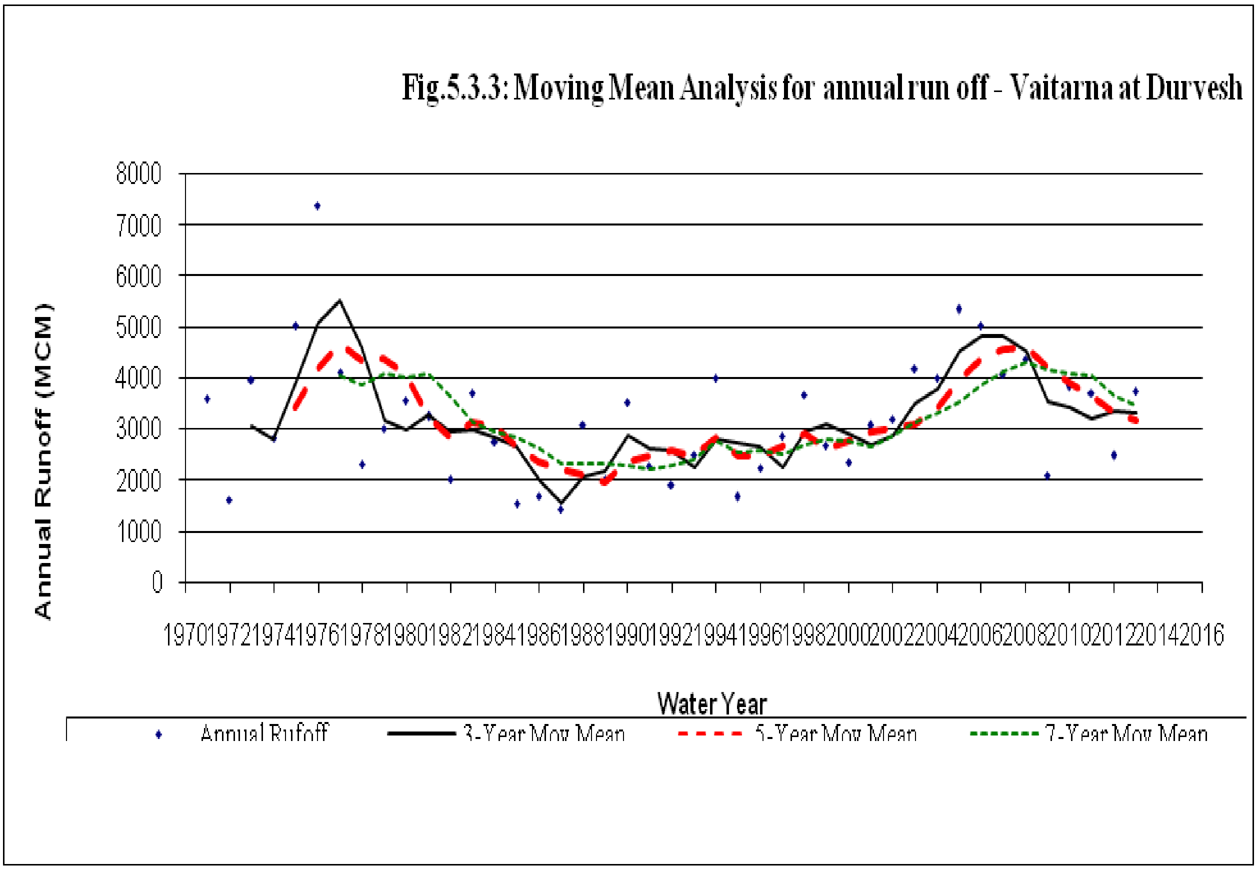


Fig.5.3.3: Moving Mean Analysis for annual run off - Vaitarna at Durvesh
8000
7000
6000
5000
4000
3000
2000
1000
0
Annual Runoff (MCM)
197019721974197619781980198219841986198819901992199419961998200020022004200620082010201220142016
Water Year
Annual Rufoff
3-Year Mov Mean
5-Year Mov Mean
7-Year Mov Mean

5.4 Trend Analysis of Dhadar basin

5.4.1 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 Dhadhar basin using available data of existing river gauging stations.

5.4.2 Methodology

In the analysis of the trends of runoff on Dhadhar River is computed and analyzed. The analysis is carried out for one (1) river gauging station with sufficiently long and continuous data sets that are fairly representatively distributed across Dhadhar river Basin.

Overall one station has been considered in this study. The length of the data sets of river gauging station is 25 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.

5.4.2.1 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 in Dhadhar 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.

5.4.3 Availability of Data

There is a 1 G & D site in Dhadhar Basin. Availability of annual runoff data for this site is summarized in **Table -5.4.1**

Table-5.4.1 Availability of Data

S. no.	Site	Period of Availability	Years
1.	Dhadhar at Pingalwada	1989-90 to 2013-14	25
The data is placed at Annexure-1 and shown in line diagram in **Fig- 5.4.1.**			

5.4.4 Analysis

5.4.4.1 Statistical Analysis

Various statistical parameters of the time series of available data are given below in **Table-5.4.2**.

Table-5.4.2 Statistical parameters of Annual Runoff series at various sites in Dhadhar Basin

River Gauging Station	Data length (years)	Mean (MCM)	Median (MCM)	Standard deviation (MCM)	Co-efficient of variation
Pingalwada	25	493	452	288.368	0.585

5.4.4.2 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 **Table-5.4.3** and in **Fig 5.4.2**.

Table-5.4.3 Fit Characteristics

S. No.	Station name	Standard Deviation σ (MCM)	Coefficient of variation C_v	Mathematical Fit		R^2
1.	Pingalwada	288.368	0.585	Linear	y = 9.357x - 18255	0.050
				Logarithmic	y = 10756ln(x) - 14210	0.050
				Exponential	$y = 2E\text{-}16e^{0.021x}$	0.036
				Polynomial	$y = -1.257x^2 + 5045x - 5E+06$	0.082

5.4.4.3 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 Dhadhar River Basin and shown in **Fig-5.4.3.**

5.4.5 Interpretation

5.4.5.1 Fitting of various statistical/mathematical models viz linear, logarithmic, exponential and polynomial reveals that values of R^2 range from 0.036 to 0.082 for Pingalwada. The values of R^2 are quite close to 0 indicating absence of any significant trend.

5.4.5.2 No significant trend is seen at site Pingalwada from the plot of moving mean averages except that it shows signs of rising by 2005-06 & 2006-07. However, in view of the limited length of data series, it may be premature to conclude that there exists a definite trend in the annual runoff data.

5.4.6 Conclusion

Statistically speaking, the average annual runoff of river Dhadhar at Pingalwada, in general, appears to be a random variable. A longer set of time series data may help identify trends in annual runoff, if any.

<u>Annexure-I</u>

Annual Runoff data at Pingalwada in Dhadhar Basin

Water Year	Annual runoff in MCM
1989-90	346
1990-91	963
1991-92	304
1992-93	140
1993-94	428
1994-95	638
1995-96	345
1996-97	566
1997-98	722
1998-99	452
1999-00	47
2000-01	157
2001-02	416
2002-03	267
2003-04	487
2004-05	556
2005-06	1009
2006-07	1239
2007-08	646
2008-09	526
2009-10	116
2010-11	699
2011-12	341
2012-13	293
2013-14	628

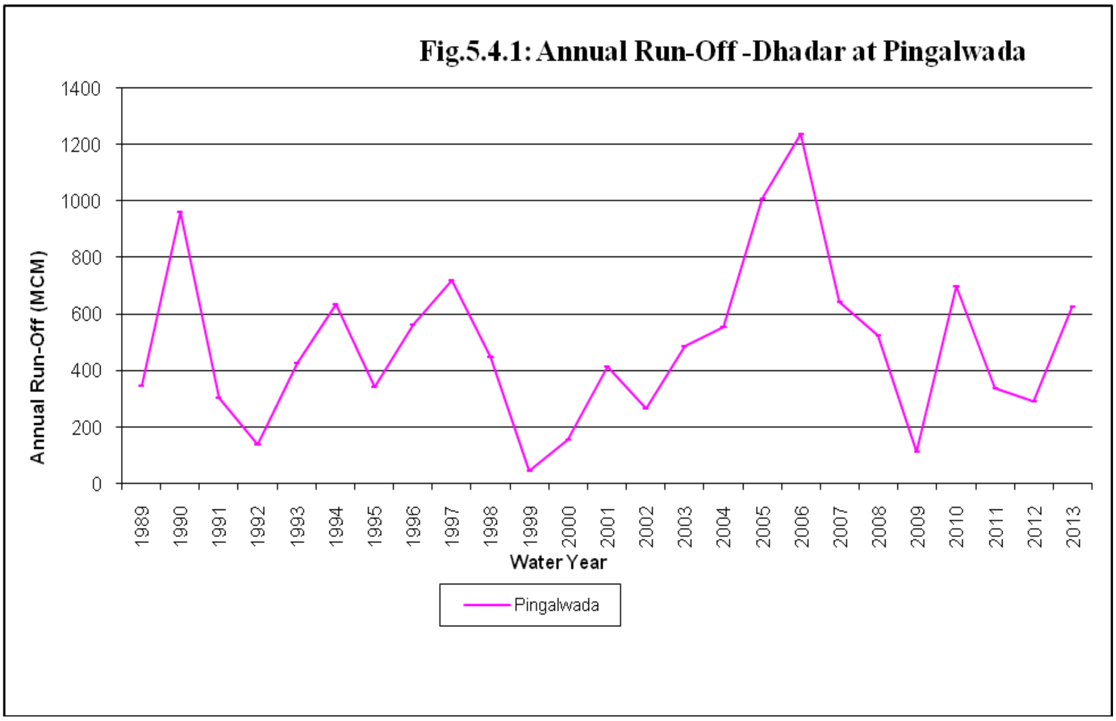


Fig.5.4.1: Annual Run-Off -Dhadar at Pingalwada
Annual Run-Off (MCM)
1400
1200
1000
800
600
400
200
0
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Water Year
Pingalwada

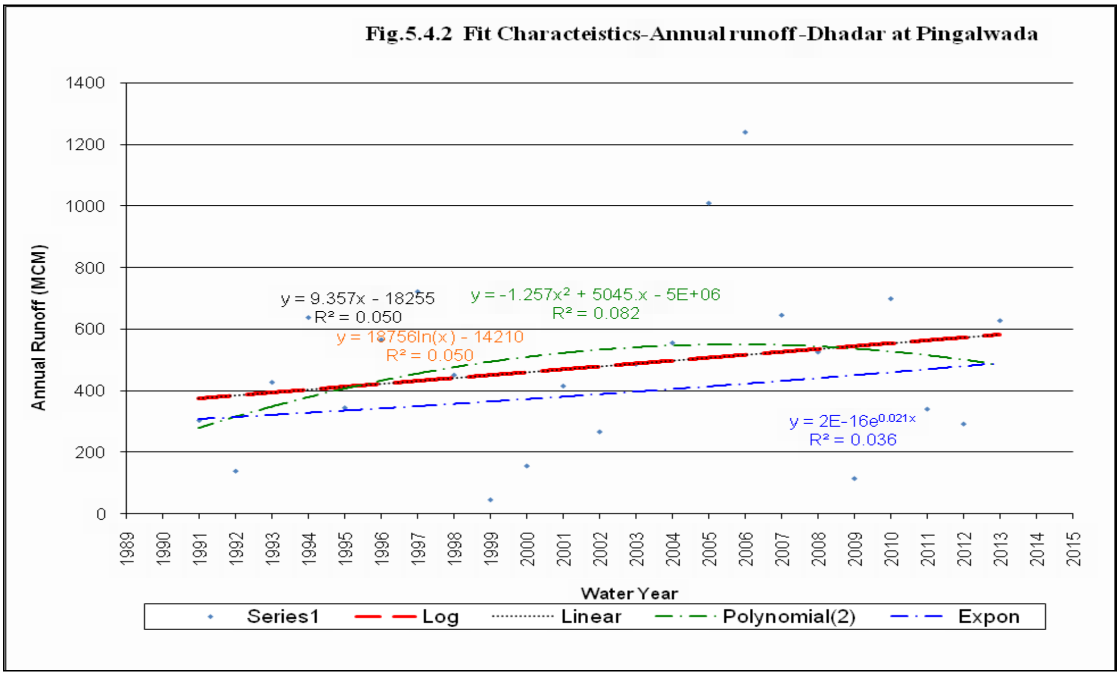


Fig.5.4.2 Fit Characteistics-Annual runoff-Dhadar at Pingalwada
Annual Runoff (MCM)
1400
1200
1000
800
600
400
200
0
y = 9.357x - 18255
R² = 0.050
y = -1.257x² + 5045.x - 5E+06
R² = 0.082
y = 18756ln(x) - 14210
R² = 0.050
y = 2E-16e0.021x
R² = 0.036
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Water Year
Series1
Log
Linear
Polynomial(2)
Expon

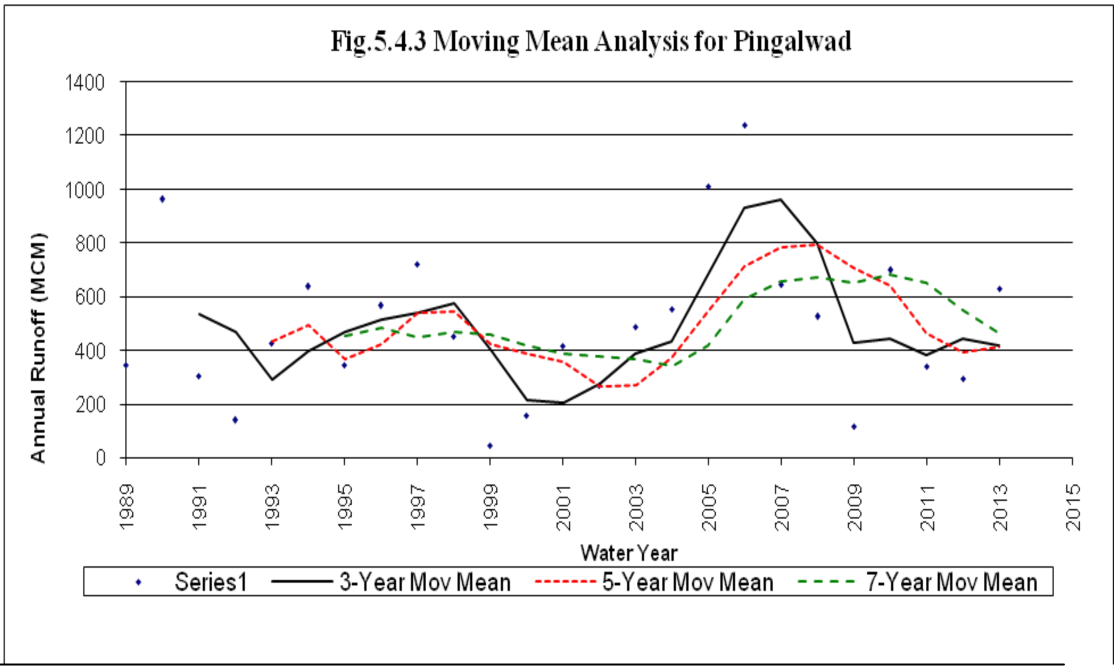


Fig.5.4.3 Moving Mean Analysis for Pingalwad
Annual Runoff (MCM)
Water Year
Series1
3-Year Mov Mean
5-Year Mov Mean
7-Year Mov Mean

5.5 Trend Analysis of Damanganga basin

5.5.1 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 Damanganga basin using available data of existing river gauging stations.

5.5.2 Methodology

In the analysis of the trends of runoff on Damanganga River and its major tributary Wagh, annual runoff is computed and analyzed. The analysis is carried out for two(2) river gauging station with sufficiently long and continuous data sets that are fairly representatively distributed across Damanganga river Basin.

Overall two station has been considered in this study. The length of the data sets of river gauging station is 23 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.

5.5.2.1 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 in Damanganga 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.

5.5.3 Availability of Data

There are 2 G & D sites in Damanganga Basin. Availability of annual runoff data for this site is summarized in **Table -5.5.1.**

Table-5.5.1 Availability of Data

S. no.	Site	Period of Availability	Years
1.	Nanipalsan on Damanganga River	1991-92 to 2013-14	23
2	Ozerkheda on Wagh River	1991-92 to 2012-13	22
The data is placed at Annexure-1 and shown in line diagram in Fig- 5.5.1 & 5.5.2 *The data of Ozerkheda for water year 2013-14 is currently under review, hence not included in the trend analysis.			

5.5.4 Analysis

5.5.4.1 Statistical Analysis

Various statistical parameters of the time series of available data are given below in **Table-5.5.2**.

Table-5.5.2: Statistical parameters of Annual Runoff series at various sites in Damanganga Basin

River Gauging Station	Data length (years)	Mean (MCM)	Median (MCM)	Standard deviation (MCM)	Co-efficient of variation
Nanipalsan	23	910.0	880	392.408	0.431

5.5.4.2 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-5.5. 3 and shown in Fig 5.5.2A & 5.5.2B

Table-5.5.3: Fit Characteristics

S. No.	Station name	Standard Deviation σ (MCM)	Coefficient of variation C_v	Mathematical Fit		R^2
1	Nanipalsan	392.408	0.431	Linear	$y = 20.78x – 40668$	0.129
				Logarithmic	$y = 41614Ln(x) – 31539$	0.129
				Exponential	$y = 3E\text{-}17e^{0.022x}$	0.152
				Polynomial	$y= 0.172 x^2 -670.5x +65137$	0.129
2	Ozerkheda	405.5	0.412	Linear	$y = -2.700 x +6390$	0.001
				Logarithmic	$y = -5373Ln(x) + 41825$	0.001
				Exponential	$y = 2E+17e^{-0.01x}$	0.037
				Polynomial	$y= -2054 x^2 +8219x -8E+06$	0.036

5.5.4.3 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 Damanganga River Basin and shown in **Fig-5.5.3A & 5.5.3B**.

5.5.5. Interpretation

5.5.5.1 Fitting of various statistical/mathematical models viz linear, logarithmic, exponential and polynomial reveals that values of R^2 range from 0.129to 0.152 for Nanipalsan. Similarly, fitting of various statistical/mathematical models viz linear, logarithmic, exponential and polynomial reveals that values of R^2 range from 0.001 to 0.036 for Waugh (a tributary of Damanganga) at Ozerkheda. It is observed that in both the cases, the values of R^2 are quite very small, indicating absence of any significant trend.

5.5.5.2 No significant trend is seen at site Nanipalsan from the plot of moving mean averages except that it shows signs of gradual rise by 2003-04 & 2004-05. Similarly, the moving mean plot for Wagh at Ozerkheda does not indicate any trend except a gradual rise by mid - 2000s. Therefore, in view of the limited length of data series, it may be premature to conclude that there exists a definite cyclic trend in the average annual runoff data

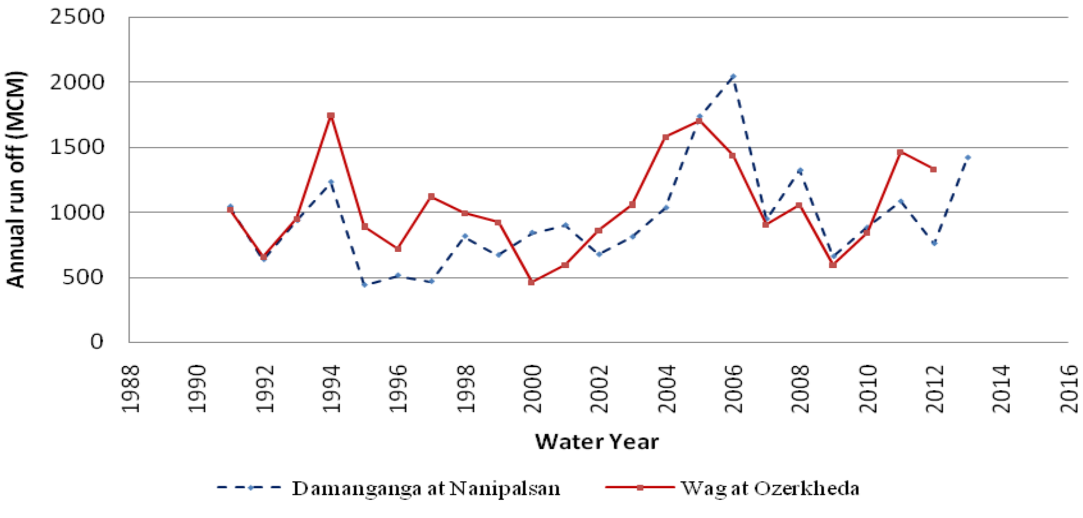
5.5.6 Conclusion

Statistically speaking, the average annual runoff of river Damanganga and its tributary Wagh, , in general, appears to be a random variable. A longer set of time series data may help identify trends in annual runoff, if any.

Annual Runoff data at Sites in Damanganga Basin **Annexure-I**

Site / Water Year	Nanipalsan on Damanganga	Ozerkheda on Wagh
1991-92	1042	1017
1992-93	635	654
1993-94	935	944
1994-95	1230	1746
1995-96	439	889
1996-97	513	719
1997-98	467	1120
1998-99	814	988
1999-00	669	917
2000-01	841	459
2001-02	898	592
2002-03	674	859
2003-04	808	1058
2004-05	1032	1576
2005-06	1734	1701
2006-07	2040	1436
2007-08	947	904
2008-09	1319	1051
2009-10	658	595
2010-11	880	842
2011-12	1081	1466
2012-13	758	1328
2013-14	1417	Under review

Fig.5.5.1 Super imposed Annual Run-Off - Damanganga at Nanipalsan & Waugh at Ozerkheda



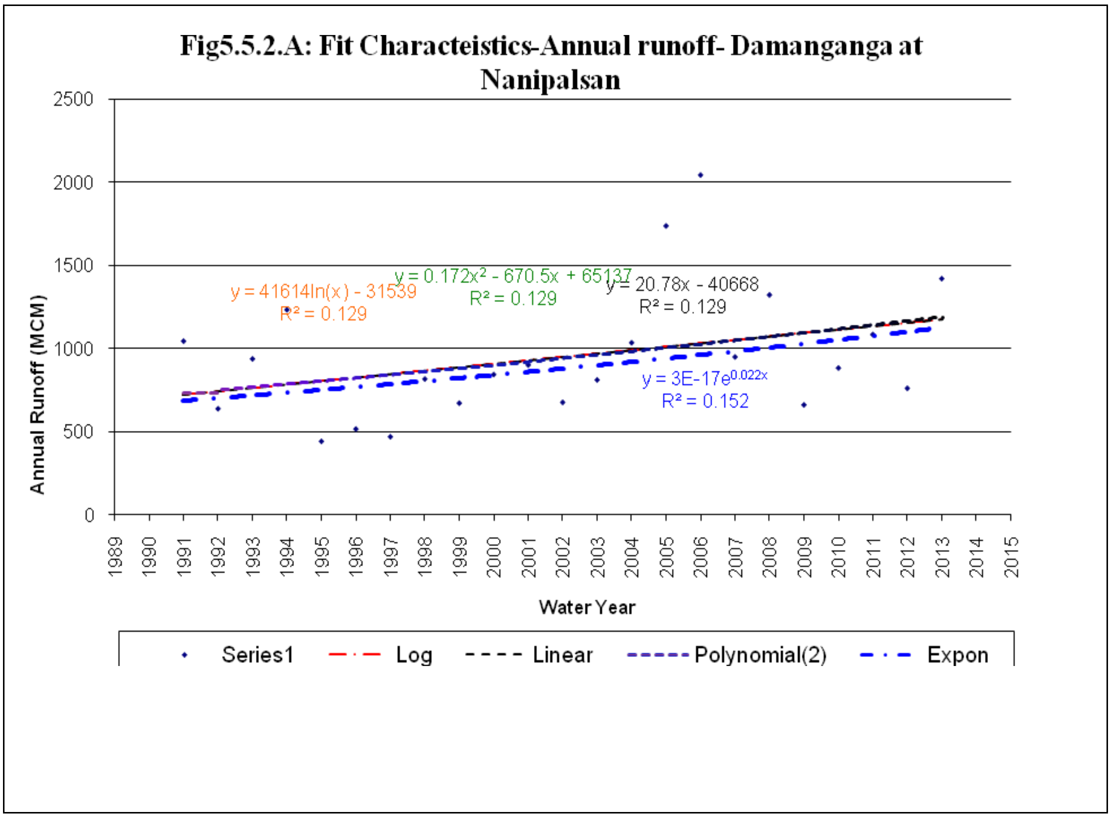


Fig5.5.2.A: Fit Characteistics-Annual runoff- Damanganga at Nanipalsan
y = 41614ln(x) - 31539
R² = 0.129
y = 0.172x² - 670.5x + 65137
R² = 0.129
y = 20.78x - 40668
R² = 0.129
y = 3E-17e0.022x
R² = 0.152
Annual Runoff (MCM)
Water Year
Series1
Log
Linear
Polynomial(2)
Expon

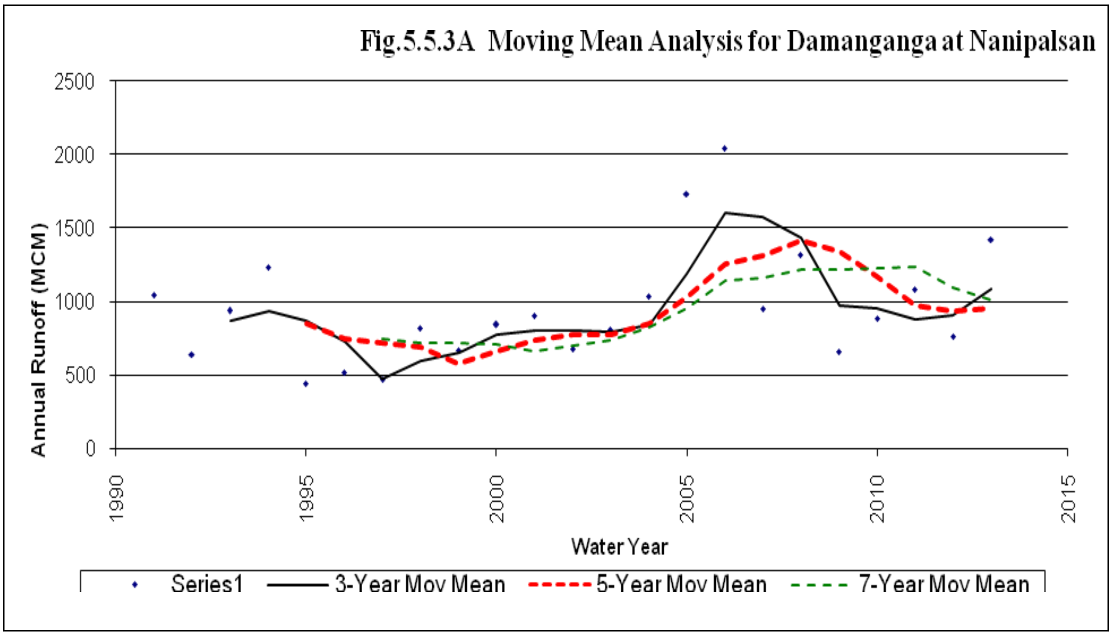


Fig.5.5.3A Moving Mean Analysis for Damanganga at Nanipalsan
Annual Runoff (MCM)
Water Year
Series1
3-Year Mov Mean
5-Year Mov Mean
7-Year Mov Mean

Fig.5.5.2 A Fit Characteistics Wagh at Ozerkheda

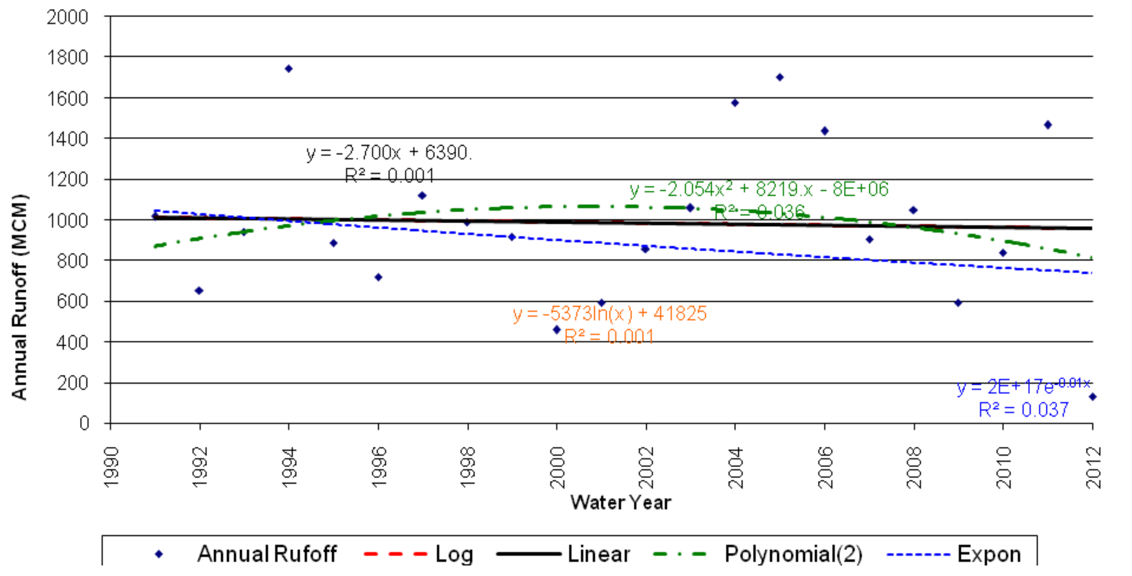
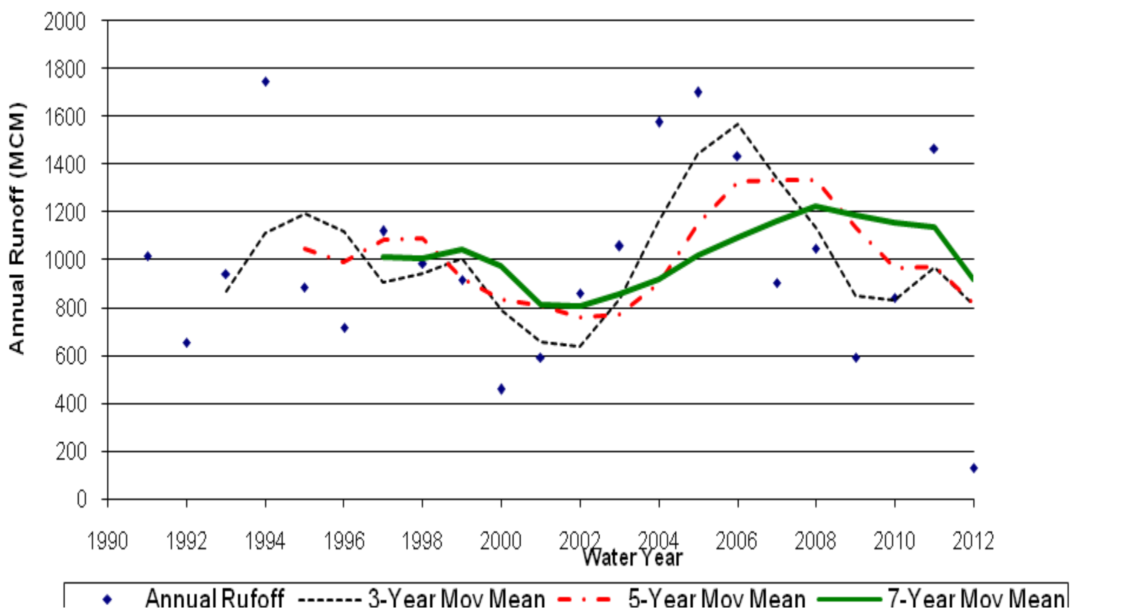


Fig.5.5.3 A Moving Mean Analysis for Annual run off - Wagh at Ozerkheda



5.6 Trend Analysis of Kim Basin

5.6.1 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 Kim basin using available data of existing river gauging stations.

5.6.2 Methodology

In the analysis of the trends of runoff on Kim River , annual runoff is computed and analyzed. The analysis is carried out for one (1) river gauging station with sufficiently long and continuous data sets that are fairly representatively distributed across Kim river Basin.

Overall one station has been considered in this study. The length of the data sets of river gauging station is 23 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.

5.6.2.1 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 in Kim 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.

5.6.3 Availability of Data

There is a 1 G & D site in Kim Basin. Availability of annual runoff data for this site is summarized in **Table -5.6.1**

Table-5.6.1 Availability of Data

S. no.	Site	Period of Availability	Years
1.	Motinaroli on Kim River	1991-92 to 2013-14	23
The data is placed at Annexure-1 and shown in line diagram in **Fig- 5.6.1.**			

5.6.4 Analysis

5.6.4.1 Statistical Analysis

Various statistical parameters of the time series of available data are given below in Table-5.6.2.

Table-5.6.2: Statistical parameters of Annual Runoff series at various sites in Kim Basin.

River Gauging Station	Data length (years)	Mean (MCM)	Median (MCM)	Standard deviation (MCM)	Co-efficient of variation
Motinaroli	23	439	356	298.399	0.679

5.6.4.2 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- 5.6.3** and shown in **Fig 5.6.2.**

Table-5.6.3: Fit Characteristics

S. No.	Station name	Standard Deviation σ (MCM)	Coefficient of variation C_v	Mathematical Fit		R^2
1.	Motinaroli	298.399	0.679	Linear	y =10.77x -21128	0.06
				Logarithmic	y = 2155Ln(x) -16340	0.059
				Exponential	$y = 7E\text{-}12e^{0.015x}$	0.024
				Polynomial	$y = 0.784x^2 - 3131x + 3E\text{+}06$	0.071

5.6.4.3 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 Kim River Basin and shown in **Fig-5.6.3**.

5.6.5 Interpretation

5.6.5.1 Fitting of various statistical/mathematical models viz linear, logarithmic, exponential and polynomial reveals that values of R^2 range from 0.071 to 0.024 for Motinaroli. The values of R^2 are quite close to 0 indicating absence of any significant trend.

5.15.5.2 Gradually decreasing values of annual run off are seen at site Motinaroli beginning from 1997 to about 2001 after which a gradual rise is seen from the moving mean plot of 7 year moving mean. After reaching a peak value in about 2007, elements of decrease in values are again visible from the 7 year moving mean plot. Thus, as we prolong the period of mean, elementary 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 average annual runoff data.

5.6.6 Conclusion

Statistically speaking, the average annual runoff of river Kim 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 of Kim at Motinaroli

Water Year	Annual Runoff in MCM
1991-92	132
1992-93	545
1993-94	356
1994-95	904
1995-96	222
1996-97	219
1997-98	261
1998-99	404
1999-00	220
2000-01	136
2001-02	345
2002-03	242
2003-04	774
2004-05	568
2005-06	665
2006-07	807
2007-08	570
2008-09	450
2009-10	192
2010-11	307
2011-12	381
2012-13	87
2013-14	1320

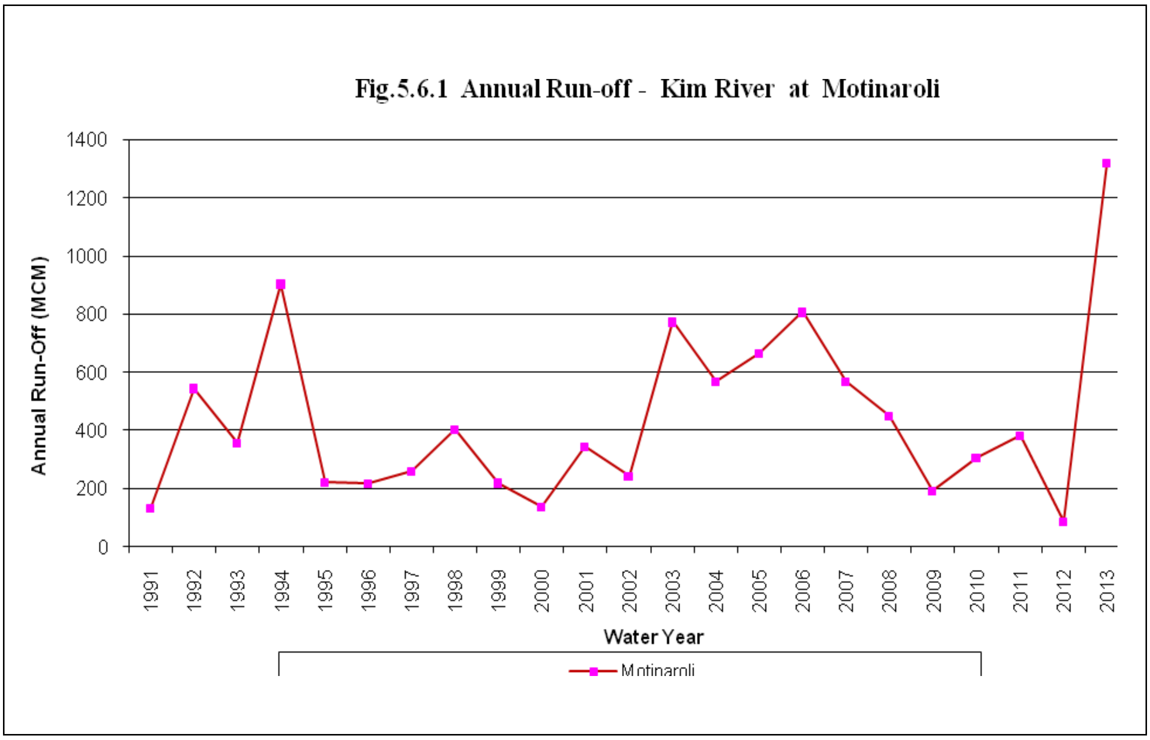


Fig.5.6.1 Annual Run-off - Kim River at Motinaroli
Annual Run-Off (MCM)
Water Year
Motinaroli

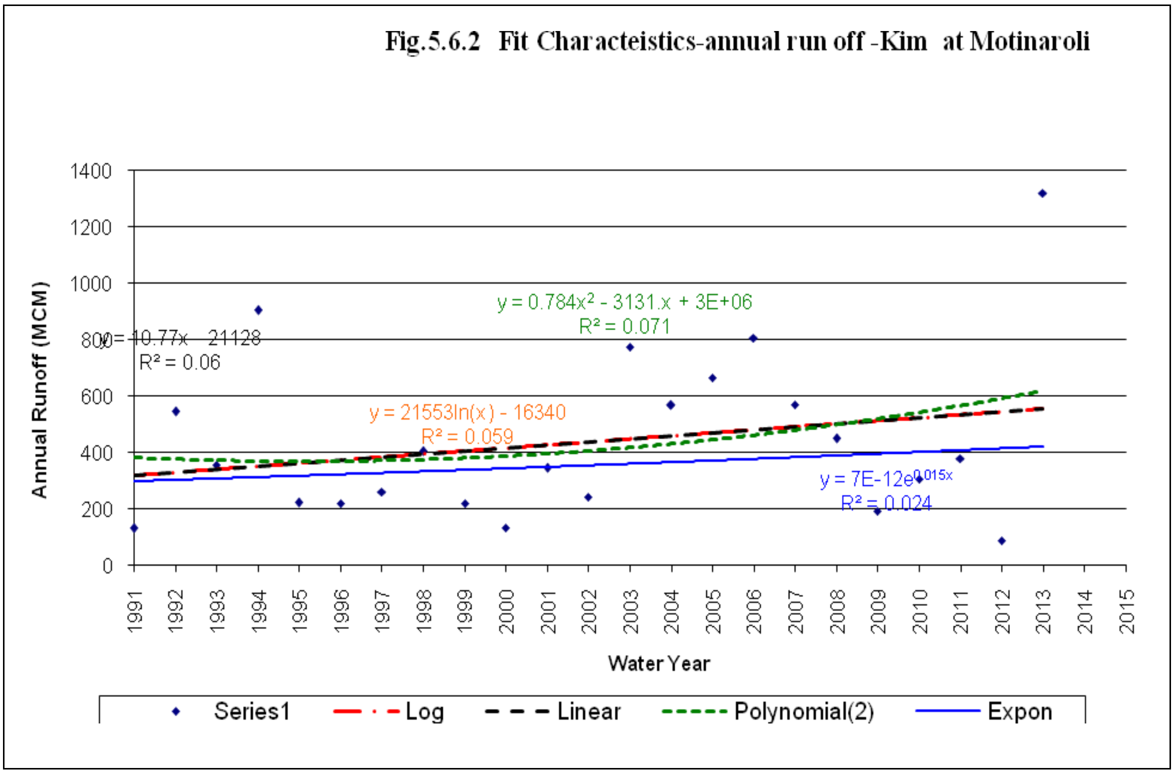


Fig.5.6.2 Fit Characteistics-annual run off -Kim at Motinaroli
Annual Runoff (MCM)
y = 0.784x² - 3131.x + 3E+06
R² = 0.071
y = 10.77x - 21128
R² = 0.06
y = 21553ln(x) - 16340
R² = 0.059
y = 7E-12e0.015x
R² = 0.024
Water Year
Series1
Log
Linear
Polynomial(2)
Expon

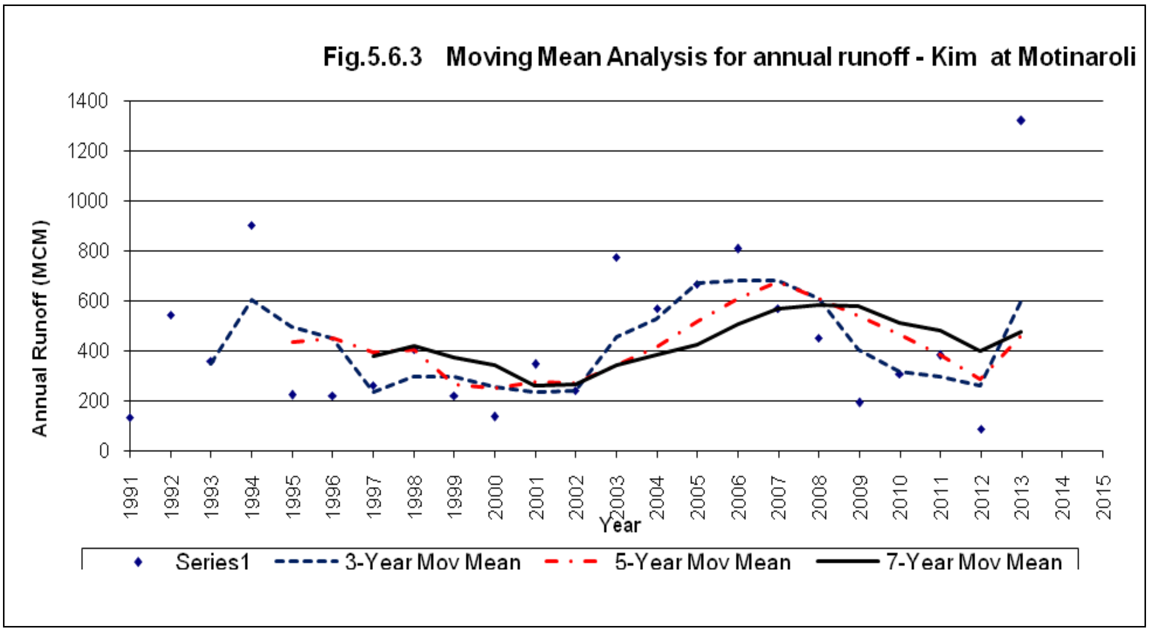


Fig.5.6.3 Moving Mean Analysis for annual runoff - Kim at Motinaroli
Annual Runoff (MCM)
1400
1200
1000
800
600
400
200
0
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Year
Series1
3-Year Mov Mean
5-Year Mov Mean
7-Year Mov Mean