CONTENTS

Volume –I: - (Report & Costing)

Volume –II: - (Designs & Annexures)

DESIGNS ..... ANNEXURES

Volume – III: - (Drawings)

LIST OF ABBREVIATIONS

Abbreviations	Description
AP	Anaerobic Pond
BOD	Biochemical Oxygen Demand
CL	Crown Level
CDP	City Development Plan
CPHEEO	Central Public Health & Environmental Engineering Organization
DFR	Detailed Feasibility Report
DI	Ductile Iron
DPR	Detailed Project Report
DWC	Double Walled Corrugated Pipe
EDC	Energy Dissipation Chamber
ESR	Elevated Service Reservoir
EXL	Excavation Level
FM	Force Main/Pumping Main
GIS	Geographic Information System
GL	Ground Level
GoI	Government of India
GoMP	Government of Madhya Pradesh
GPS	Global Positioning System
GSR	Ground Service Reservoir
GTS	Great Trigometical survey benchmark.
HDPE	High Density Polyethylene
HHs	Households / Household Property
Hp	Horse Power
HRD	Human Resource Development
HRF	High Rate Filter
HT	High Tension
IEC	Information Education & Communication
IL	Invert Level
Km	Kilometre
LCC	Life Cycle Cost
LCCA	Life Cycle Cost Approach
LPD	Litres Per Day
LPS	Litres Per Second
MP	Madhya Pradesh
MHC-1	Manhole Circular Type-1

MHC-2	Manhole Circular Type-2
MHC-3	Manhole Circular Type-3
MHC-4	Manhole Circular Type-4
MHC-5	Manhole Circular Type-5
MHC-6	Manhole Circular Type-6
MHC-7	Manhole Circular Type-7
MH RCC	RCC Special Type Manhole with drop connection & High flood protection System
MHR-1	Manhole Rectangular Type - 1
MHR-2	Manhole Rectangular Type - 2
MJP	Maharashtra Jeevan Pradhikaran
MLD	Million Litre Per Day
MCM	Million Cubic Meter
MoEF	Ministry of Environment and Forest
MPPCB	Madhya Pradesh Pollution Control Board
MSL	Mean Sea Level
NBC	National Building Code of India
NGO	Non-Governmental Organization
NRCD	National River Conservation Directorate
NRCP	National River Conservation Programme
O&M	Operation and Maintenance
OHT	Over Head Tank
PHED	Public Health Engineering Department
RCC	Reinforced Cement Concrete
PWD	Public Work Department
RCC NP	Non-pressure Reinforced Cement Concrete Pipes
SCADA	Supervisory Control and Data Acquisition
SOR	Schedule of Rates
SPS	Sewage Pumping Station
SSF	Slow Sand Filter
STP	Sewerage Treatment Plant
SW	Stone Ware pipe
TMH	Terminal Manhole before STP
TW	Tube Well
UAED	Urban Administration & Environment Department
WTP	Water Treatment Plant
UGSS	Under Ground Sewerage Scheme
UMC	Ujjain Municipal Corporation

LIST OF REFERENCES / DOCUMENTS REVIEWED

1. Manual on Sewerage & Sewage Treatment by Central Public Health Environmental Engineering Organization (CPHEEO) published by the Ministry of Urban Development, New Delhi, Government of India 2013.
2. Guidelines for Preparation of Project Reports under National River Conservation Plan & National Ganga River Basin Authority.
3. Guidelines and Circulars issued by the Govt. of Madhya Pradesh.
4. National Building Code
5. Toposheets, Town Maps
6. City Development Plan of Ujjain Town
7. City Mobility Plan of Ujjain Town
8. SOR's of M.P. UADD – 2012
9. SOR of Maharashtra Jeevan Pradhikaran (Nagpur & Amravati- Dec 2012)
10. SOR for Construction Contracts Employing Trenchless Technology-2014 (ISTT)
11. Census Records.

LIST OF TABLES

CERTIFICATE

Certified that Ujjain Under Ground Sewerage Scheme in total, or any of the components under this scheme, is not funded in any other Central / State Scheme or through any other source..

Certified that land for all the components in this scheme is in possession of Nagar Nigam Ujjain and is encroachment free. There is no hurdle in implementation of this scheme.

Certified that this scheme is in priority sector under AMRUT.

Commissioner
Ujjain Municipal Corporation,
District: Ujjain, M.P.

1. PROJECT AT A GLANCE

Sr. No.	Particulars	Details
1	Name of Project	Ujjain Under Ground Sewerage Scheme
2	Name of Town, District, State	Ujjain, Dist. - Ujjain, Madhya Pradesh
3	Class of Town	Class "C" Municipal Corporation.
4	Town Location	a. Latitude = 23°10′ N
		b. Longitude = 75°46′E
5	Population as per Census	Year 1971 = 208561 Souls
		Year 1981 = 282207 Souls
		Year 1991 = 362633 Souls
		Year 2001 = 430427 Souls
		Year 2011= 515215 Souls
6	Total No of Wards	54 nos.
7	Area of Ujjain Town	100 Sq. Km. (Approx.)
8	Total Nos of Household-2011	103043 nos. of Households
9	Present Water Supply Scenario	Present Water supply to town is being made from two major sources Gambhir Dam and Undasa Tank and tube wells. Around 95% water supply is made through Gambhir dam and rest is covered through tube wells and Undasa tank source.
10	Rate of Water Supply	135 LPCD
11	Present Sewerage Treatment Scenario	Presently Ujjain have no organized sewerage system for treatment of sewerage and waste water. Almost 40% population defects on open area. Rest population are depending on the soak pits and septic tanks. Waste water is flowing through open drains and 13 nallas of town. These 13 nallas are ultimately disposing sewage to Kshipra river. This leads to contamination of river water as well as environment hazards.
12	Population Forecast	Year 2020 = 613830 Souls (Initial Stage)
		Year 2035 = 735840 Souls (Intermediate Stage)
		Year 2050 = 858585 Souls (Ultimate Stage)
13	Sewage Generation	74 MLD (Initial Stage)
		92 MLD (Intermediate Stage)

	(including Infiltration)	110 MLD (Ultimate Stage)				
14	Sewerage Zone / Sewer Districts	Zone – 1 :- Kshipra Zone (Wards Covered - 1, 2, 5(P), 6 (P), 7, 10, 11. 12, 13, 14, 15, 16, 18(P)19, 20, 21, 22, 23, 24,26, 27, 28, 29, 30, 31, 32,33, 34, 35, 36, 37, 38(P),42(P), 44 (P), 45, 46, 47, 48, 49, 50, 51(P), 52 (P), 53(P),8,9)				
		Zone - 2 :- Pilliyakhal Zone (Wards Covered- , 4, 5(P),16(P), 17 , 18(P), 25, 38(P), 39, 40, 41, 42(P), 43, 44(P) & 52(P))				
		Zone - 3 : Triveni Zone (Wards Covered - 52(P), 53(P), 54,				
15	Sewer Network Length in Kms. (DWC-HDPE Pipe-RCC NP3 & RCCNP4)	HDPE-DWC	RCC NP3	RCC NP4	**Total**	
		852 kms	86.57 kms	41.67 kms	980 kms	
16	Property Connections (Initial Stage)	Zone 1			70803	
		Zone 2			36105	
		Zone 3			6858	
		Total			**122766**	
		Sewer Connection Pipes 170/200 DWC – **736 Kms.** No. of HHs Chambers- **40922**				
17	Zone wise Manhole Details	Type	Zone – 1	Zone – 2	Zone – 3	Total
		MHR1	1629	832	379	2839
		MHR2	4887	2495	1136	8518
		MHC1	9774	4990	2272	17036
		MHC2	38	21	20	0
		MHC3	75	41	41	0
		MHC4	115	66	62	7
		MHC5	167	124	102	80
		MHC6	393	248	225	81
		MHC7	23	19	20	62
		RCC-SPMH	42	0	0	42
			17143	8836	4257	30236
18	Sewage Pumping Station (SPS) Dry cum Wet Well			Capacity	Outer Diameter	Depth (He)
		SPS		2298 m^3	32.20	6 m
19	Force Mains /		From To		Size	Length

	Pumping Main (MS Pipe 1200mm dia, thickness 10mm IS 3589 & IS 5504)	FM	SPS to STP		1200 mm	2500 m
20	Pumping Machinery -Configuration of Sewage Pumps at Sewage Pumping Station	For Lean Flow - Q/4 (Peak flow/4) – 2 numbers including 1 standby				
			Discharge (LPS)	Head (m)	Capacity (Hp)	Qty (nos)
		SPS	625	32	360	2
		For Mean Flow - Q/2 (Peak flow/2) – 3 numbers including 1 standby				
			Discharge (LPS)	Head (m)	Capacity (Hp)	Qty (nos)
		SPS	1250	32	715	3
22	Sewerage Treatment Plant	92.0 MLD (Intermediate Stage)				
23	STP Technology	SBR Technology				
24	Land Availability for STP	Yes (Village Surasa)				
25	Land Required for STP	10.0 Hactare (for 2050)				
26	Effluent Disposable Arrangement	It is proposed to dispose of effluent in the Nalla adjacent to STP after due treatment as per CPHEEO & NRCP (National River Conservation Program) Norms. Partial treated sewage/effluent is proposed to be recycled after due polishing and disinfection to recharge Rudra Sagar /Vishnu Sagar and also to be used in Horticulture activities in the town.				
27	Electrical Transformer	SPS & STP		3700 KVA		
28	Electrical Transmission Line	3 Km				
29	Project Cost	Cost of Project- Rs 769.42 Crores				
		Including maintenance of 10 years including defect labiality period of 5 years				
30	Cost per Capita (As per 2020 Population)	Rs 12,335/-				

31	Cost per Capita (As per 2050 Population)	Rs 8,961.49
32	Annual Operation & Maintenance Cost	Rs 20 crores
33	Implementing Agency	Ujjain Municipal Corporation
34	Project Funded Under	Atal Mission for Rejuvenation and Urban Transformation Scheme or any Centre / State Government Funding Scheme
35	Whether Scheme is prepared as per the guidelines of CPHEEO Manual	Yes, as per CPHEEO Manual & NRCP Guidelines 2010
36	Details of General Body Resolution (GBR)	To be annexed
37	Sewerage Sample Test Report	2 Samples from various location of Ujjain Town are tested from State Pollution Control Board (Report is enclosed in Annexures)

2. EXECUTIVE SUMMARY

Water is one of the precious natural resources, which has the finest property of self-replenishment. Ujjain Historic City's Environment is deteriorating because of overall unplanned development, population increase & sewage flowing in open small drains in the town due to absence of organized Sewerage System.

Objectives: The objectives of preparing an Underground Sewerage Scheme for Ujjain are:

- The Proposed Project is Aimed to cover the entire city of Ujjain with Sewerage System with 100% household connectivity.
- Prevention of Pollution of River Kshipra
- To stop Sewage flowing in Open drains, thus creation of most sustainable hygienic & clean Environment.
- Development of a financially sustainable Sewerage System for city of Ujjain

Ujjain Municipal Area is divided in 54 Wards in. Approx.100 Sq Km. (including 36 surrounding villages). Ujjain (also known as Ujjaini, Avanti) is an ancient city of central India, in the Malwa region of Madhya Pradesh. Situated on the eastern bank of the Kshipra River, it is one of the seven sacred cities of the Hindus, and the Kumbh Mela religious festival is held here every twelve years. It is also home to one of the twelve Jyotirlinga shrines to the god Shiva. Great poets like Vedavyasa and Kalidasa have eulogized the city. Vikramaditya, the legendary emperor, ruled the city with his famous Navratnas (nine jewels) including Kalidasa.

To cover entire Ujjain town (including upcoming settlements and slum etc.) with 100% sewage collection, conveyance and treatment facilities for treating the waste water to the desired standard before its disposal to nallas or River Kshipra.

The core objective of the project is to uplift the prevailing environment and create a sustainable environment by providing compatible infrastructure facilities accessible to all the urban and rural community, both residents as also the visitors in project area. For prevention of pollution of River Kshipra and in compliance of Hon. High Court order, it is envisaged to execute underground sewerage scheme for town. After execution of Sewerage Scheme, pollution of River Kshipra will drastically reduce to GOI effluent standards laid down for flowing water bodies.

The alternatives are worked out to the level of detail that enables the comparative evaluation of alternatives and identification of the optimal system. Detailed Project

Report for Under Ground Sewerage Scheme would facilitate to prepare a workable or implementable plan for the Town. It is desired to stop all nallas pouring down waste water from city area in to nearby naturally flowing nalla & ultimately joining holy river Kshipra.

Identification of all point sources & non-point sources of pollution (wastewater) in the area & its eradication by laying sewer network right up to door step of each & every HH and polluting property/unit. Total HH Sewer connections to be done are 1,22,766 by using HHs connection pipe of length 736 km. Total sewer laying work is to be done for length of 980 kms. including Construction of 28666 Manholes.

On all roads & lanes where dominant population exists, sewer laying is proposed. Trunk mains are to be laid as per the suitable connectivity of Mains-Branches & laterals. Sewer lines are to be laid in centre of the road or left/right side of the road as per the suitability, available width of roads and ease of Household/property connectivity.

Underground sewerage scheme is divided into three sewerage zones / districts and 9 Sub Zones based on the detailed topographical survey done and to arrive at techno-economic costing based on concept of no-multi stage pumping.

Sewage from three sewerage zones / districts is proposed to be collected at sump well (SPS) in ward number 1 where all sewage loads from (all 1 to 54 wards) is to be pumped to STP. After treatment of sewage at STP, effluent quality is proposed to be achieved to standards of CPHEEO / NRCP norms & then to discharge into natural nearby nalla and also partial to be used in recharging of Vishnu Sagar & Rudra Sagar.

Sewage sump well is proposed to be constructed for 30 min detention period and average sewage flow for the ultimate year 2050. Pumping units are proposed to be installed for the sewage flow of intermediate design period of 2035 i.e. for 15 years. Sewage treatment plant is proposed on SBR technology. After sewage treatment and reaching the effluent standards to CPHEEO / NRCP guidelines, the treated sewage is proposed to dispose in to natural nearby nalla. For design purpose the BOD value for municipal waste water is considered as 180 mg/lit. The higher value of 250 mg/liters is considered since after commissioning of sewerage scheme, existing septic tanks shall become absolute & then present strength of BOD is likely to increase. While designing STP care has been taken for reaching effluent standards as per the guidelines given in CPHEEO manual and NRCP guideline. For sewerage project, the estimated cost is considered Rs. 76942 Lacs and average annual running and maintenance cost Rs. 2000 Lacs (for 1st Year). The project works are proposed to be constructed in three years' period 2017-2020 and therefore, it is necessary to formulate tender documents and Sanction of this Underground Sewerage Scheme for accordingly on top most priority.

3. INTRODUCTION

3.1 ABOUT THE TOWN :-

Ujjain is the largest town in Ujjain district of the Indian state of Madhya Pradesh. It is the administrative centre of Ujjain district and Ujjain division.

An ancient city situated on the eastern bank of the Kshipra River, Ujjain was the most prominent city on the Malwa plateau of central India for much of its history. It emerged as the political centre of central India around 600 BCE. It was the capital of the ancient Avanti kingdom, one of the sixteen Mahajanpadas. It remained an important political, commercial and cultural centre of central India until early 19th century, when the British administrators decided to develop Indore as an alternative to it. Ujjain continues to be an important place of pilgrimage for Shaivites, Vaishnavites and followers of Shakti.

Ujjain has been selected as one of the hundred Indian cities to be developed as a smart city under PM Narendra Modi's flagship Smart Cities Mission as well as Atal Mission for Rejuvenation and Urban Transformation (AMRUT) Mission, with the focus of the urban renewal projects to establish infrastructure that could ensure adequate robust sewerage networks and water supply for urban transformation.

The assignment for preparation of Concept Report and Detailed Project Report on sewerage and sewage treatment of Ujjain city covering the entire Municipal Corporation extending over an area of approximately 152 km2 (59 sq mi) is being undertaken by WAPCOS Ltd in collaboration with Municipal Corporation of Ujjain.

The scope of operation with the subject matter of the detailed project Report is done:

- Detailed topographical survey.
- Collection of past census population figures for fairly long period.
- Collection of data/information on existing status of water supply and sewerage facilities accessible to the city dwellers.
- Estimation of present and future population of the city and consequent sewage generation, delineation of sewerage zones and sub zones.
- Lay out of trunk, branch and sewer network and constructing hydraulic model
- Detailed design of trunk, branch and sewer network.
- Location of sewage pumping stations, lift stations and sewage Treatment plants.
- Lay out of force/pumping mains and their detailed designs.
- Detailed design of sewage pumping stations, lift stations and sewage treatment plants
- Environmental Impact Assessment and remedial measures

- Formulation of detailed cost estimates of the project.
- Tariff model and economic and financial analysis.
- A team of WAPCOS experts visited the project area along with the client's officials and held meetings with officials of various departments. The site visit is aimed to collect on-site information about the general features of the Study Area as well as specific information about the existing infrastructures such as sewerage and water supply facilities.
- To facilitate the planning and designing of sewerage system of the project area relevant data have been collected from relevant government departments. UMC has carried out several studies for preparation of Ujjain sewerage system. The different Reports were collected from client for analysis of Data and for correlating it with New Sewerage Scheme for the Ujjain city for the year 2050. The reports include Ujjain Development Plan 2021, DPR of Water Supply Distribution, Census Data and CDP of Ujjain, etc.

3.2 LOCATION AND REGIONAL CONNECTIVITY

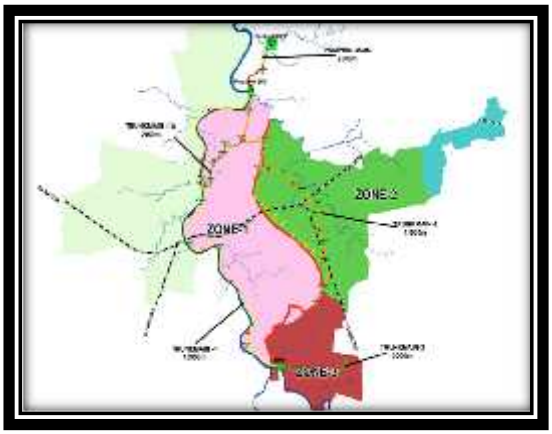
Location: Ujjain's co-ordinates are 23°10′N 75°46′E with average elevation of 494m metres (1620 ft).

Geography: Ujjain is located in the west-central part of India, and is north of the upper limit of the Vindhya mountain ranges. Located on the Malwa plateau, it is higher than the north Indian plains and the land rises towards the Vindhya Range to the south. Region is an extension of the Deccan Traps, formed between 60 and 68 million years ago at the end of the Cretaceous period. The city is on the river bank of Kshipra which falls into nearby flowing Chambal.

Climate:

Summer : The summer season in Ujjain generally lasts from April to June. During this period, the summer spell is experienced in the form of harsh climate. The heat is scorching and the temperature may reach unbearable heights. The maximum temperature during these months may soar to 48°C, occasionally, hot winds called 'Loo' may blow during the afternoon, which aggravates the heat. The summer temperature reaches a minimum of about 24°C during the night.

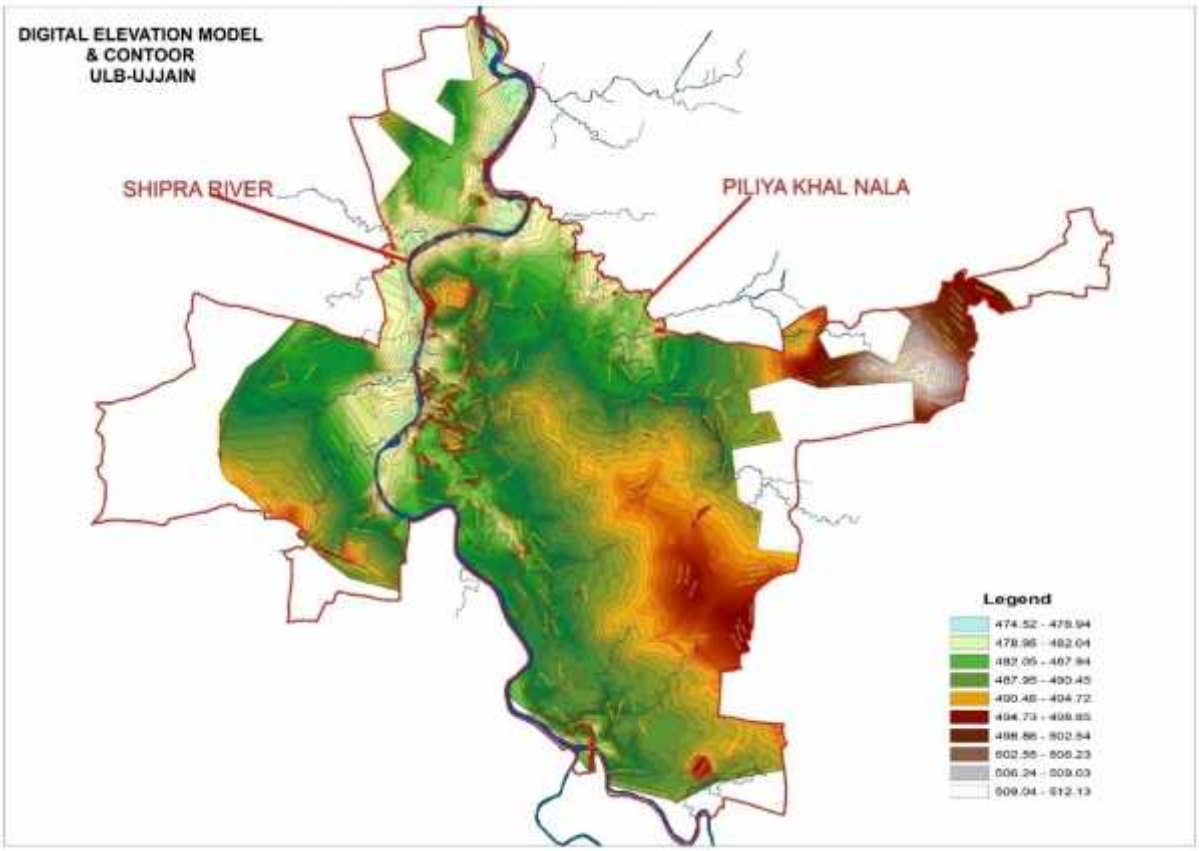
Winter: Winters in Ujjain lasts for four months i.e. November, December, January and February. Though cool, winters are very temperate and pleasant. The maximum daytime temperature generally remains around 24°C and the heat is mild and solacing. Nights are comparatively chillier and the mercury level may drop to a minimum of 9°C. Generally, light woollens are preferable during the day, but heavy woollens become essential during night.



Monsoon: The monsoon season is initiated during the month of June and lasts till the end of September. During this time, the place experiences moderate to heavy rainfall and the average rainfall is recorded at 101 cm. The humidity level slowly mounts and often heavy outpourings are followed by periods of high humidity and bright sunshine. Typical of any other place in Madhya Pradesh, the best time to visit Ujjain is between the months of October and March. Sunny and comfortable, with average daily temperatures around 16 °C (61°F) and little or no rain. The winter peaks in January when temperatures may drop close to freezing on some nights. Lowest temperature ever recorded was 0.3°C. The City has a total annual average rainfall of about 1260 mm. The highest monthly rainfall 227.3 mms in the year 1961. The heaviest fall in 24 hours was 128.4 mms on 06.10.2009.

3.3 TOPOGRAPHY

Detailed topographic survey (by Total Station) is being conducted in the project area adopting State of the art technology. To determine horizontal and vertical control points, DGPS (Trimble 5700 dual frequency) survey, Traverse Survey and Levelling (fly levelling by Auto level Nikon, Sokkia) was carried out, using the Electronic Total Station (ETS) and Auto Level/Digital Level. Topographical features are shown as below.



3.4 MUNICIPAL CORPORATION

UMC was established in 1886 and in 1912, UMC was declared equivalent to first class. In September 1924, the nomination of members of the public representatives was done and Mr. Sohrab G was made the commissioner. Election of members of the electoral system began in 1930. At present the range of Ujjain Municipal Corporation area is 100 square kilometres. The first election of representatives in Ujjain large municipal elections in 1954 and second took place in 1958. In 1965, Ujjain Municipal Corporation has been recognized as the major municipality in 1971 and received the Ujjain Municipal Corporation status.

In 1971, the First Council of Ujjain Municipal Corporation was formed, Second Council in 1979, third in 1994, fourth, Fifth in 2005, Sixth Council Election in 2010,, seventh council was elected in July 2015. The current representatives of the Council will be until 08/12/2020.

Berugd, Shankarpur, Panwasa, Morukedi, Hamukedi, Hriakedi, Skarwasa, Goylakhurd village are included in the municipal limits. Madhya Pradesh Municipal Corporation Act, 1956 and rules framed by the rule / regulations / orders and bye-laws of the corporation is prevalent.

Ujjain city is divided into 54 different wards, and in terms of administrative work, city is divided into 5 Zone-

1. Zone 1, Peeplinaka,
2. Zone 2, the New Fire brigade complex, Agar Road
3. Zone 3, Dudtlai
4. Zone 4, MCSE Road
5. Zone 5, Nanakedha

The administrative work cleaning system in Ujjain Municipal Corporation border area is divided into 7 wards cleaning -

1. Jiwajiganj Ward
2. Jewelry Ward
3. Chris Ward Cheque
4. Maharajvada Ward
5. Dultganj
6. Madhavnagar Ward 1
7. Madhavnagar Ward 2

Temporary bench mark points were provided at existing man-made features on plinth of house, Temple, School etc.

3.5 EXISTING SCENARIO OF WATER SUPPLY: -

Ujjain is situated on the bank of river Kshipra from where the city used to obtain its water. The River is, however, not perennial and the flow significantly reduces from the month of April until arrival of monsoon in July. Thus there was a need to capture new sources for water supply which have merged in the form of Gambhir dam and Undasa tank. The Gambhir dam accounts for nearly 96% of water supply to the city while Undasa tank caters to the rest 4% of the population. Sahebkari tank along with Kshipra River are the other surface resources but these are rain dependent. Another problem with the river Kshipra is that it gets mixed with the river Khan near Triveni (Ujjain) and gets polluted from the industrial waste. However there are water treatment plants installed near the river but still the water gives the problems of bad odour and pale colour. Other than that, the city also depends on surface-subsurface and other sources for water supply. As far as Water Treatment is concerned, a water treatment plant (WTP) was built on the bank of Kshipra River in 1952 for 27 MLD capacity. With increase in population the water supply was augmented in 1967 by a 4.5 MLD capacity WTP with water from the Undasa irrigation tank. This latter facility was mainly used for the industrial area and only a small portion of the city could be served by this scheme. The tank is entirely rain dependent and unreliable.

With the city facing acute water shortages the authority decided to collect water from a dam Constructed on the river Gambhir by PHE department 21 km from the city. Thus a 23 MLD WTP was constructed in 1980 along with a distribution system to cater to unserved areas. Subsequently the authority installed a new WTP of 4.5 MLD with raw water from Sahebkheri Irrigation Tank and augmented the Gambhir WTP to 57 MLD in 1984 and 1992 respectively. The schemes included laying of new distribution lines to new areas. Although the river Gambhir is non-perennial and the flow is dependent on rain, due to its large catchment area and dead storage capacity enough water is stored to fulfil both irrigation and city water supply requirements.

For the commencement of Simhasta festival in 2004 (a special religious feature in Ujjain once in every 12 years), the State government sanctioned a project for Rs.23.93 crores as grant to the municipality to augment the water. Under this project it was proposed to build a 27 MLD capacity WTP by the side of existing Kshipra WTP with raw water drawn from Gambhir dam for both the existing and new plants. Laying of a 21 km long 800 mm dia DI rising main from Gambhir dam to the WTP site was done. Raw water pumps at intake well near Gambhir dam, Clear water pumps at new WTP along with adequate clear water feeder mains to the existing overhead tanks, electric substation at intake well and new water treatment plant were included in this project. The project does not include any new service reservoir or distribution pipelines. The work got completed by March 2004. With the completion of the Simhastha water supply project, the quantity of treated water is reported to be sufficient to serve the

2021 projected city population of 688,000 with more than recommended norm of 135 lcpd and after allowance for losses.

Table-1 Water Supply Sources in Ujjain			
	Surface Source	**Capacity in MLD**	**Percentage coverage**
Source 1	Gambhir Dam	90.00	95.24%
Source 2	Undasa Tank	4.50	4.76%
TOTAL		94.50	**100%**

3.6 EXISTING SCENARIO OF SEWAGE / WASTE WATER: -

- Ujjain Municipal Area divided in 54 Wards in Apprx. 100 SqKm.
- Presently about 60-70 MLD of waste water generated in the city.
- No sewerage system exists in the city.
- Effluent from septic tanks directly goes into road side open drains.
- Waste water trapped at Nalla junctions to sumpwells .
- Collected waste water is pumped to an oxidation pond at Sadawal old STP .
- Risk of overflowing of waste water into Kshripa river due to pump chocking, power failure or any reason.
- Sewage flow into open nalla causes the health hazards and unhygienic environment in terms of odour and mosquito nuisance.

There is no organized sewerage system in the entire town for safe disposal of the sewerage generated in the town. People and Nagar Nigam is depending on soak pit based toilets and septic tanks. It's very expensive system and therefore every one can't afford it, which results in major population defecating in open areas. Soak pit based toilets also possess threat of contemning ground water sources.

The waste water and the effluent from the septic tanks flow through the open gutters. Where facilities are not available, flows in low level areas and get stagnated in open areas thereby creating nuisance. The town does not have a comprehensive system for safe disposal of waste water which results in the environmental pollution, contamination of water and other critical issues related to health of the people of the town. For all kinds of waste water disposal, two types of disposal systems are used in the town. Soak pit / Pit based toilets for soil waste and open drainage for kitchen, bath & Strom water disposal.

Soak pits / Pit based toilets are installed at personal level and Municipal level and maintained by vacuum emptier vehicle. In some areas sewage generated directly flows through open drains and finally gets drained into natural larger drains.

Ujjain is a religious city, which attracts about half a million of pilgrims every year. The River Kshipra flowing through the heart of the city is regarded as a holy river and plays an important role for the religious pilgrims. In view of the potential health risk to bathers the GoI undertook a project to stop the pollution of the River Kshipra under the National River Conservation Programme (NRCP). The GoI provided a grant of Rs.140 million to the PHED for intercepting sewage flow in the major water channels discharging to the river. The intercepted sewage is pumped to a STP, treated and discharged for irrigation. Under this scheme there was no provision for providing sewerage within the city. On completion of the scheme the river is substantially free of pollution but there is little appreciable improvement to the city sanitation. Septic tank is the most common mode of disposal of sanitary waste disposal in Ujjain. The other modes of disposal and household distribution are shown in Table below. It is evident that about 85% of households have an access to Safe mode of sanitary disposal i.e. by the means of Septic tanks, Dug latrines. However, about 15% of households do not have an access to safe mode of sanitation.

Table 2 - Sanitation facilities in Ujjain

Sanitation Facilities	Population Covered	(no. of units)
Septic Tanks	397000	65000
Public Conveniences	21000	850
Low Cost Sanitation units	12000	7554
Dry Latrines	-	0.00
TOTAL	430000	73,404

*source-CDP/CSP Ujjain

Table 3- Major City Level Inventory of drains			
S.no	**Nallah**	**Observed Flow (Mld)**	**Design Flow (Mld)**
		1996	2011
1	Nanakheda	2.75	3.36
2	Alakhadham	3.03	3.71
3	Shastrinagar	3.55	4.34
4	Hanuman naka	7.73	9.45
5	Rajivratna	0.82	1.00
6	Somwaria	8.34	10.20
7	Piplinaka	3.88	6.34
8	Hammalwadi	3.17	3.93
9	Indira nagar	1.93	2.28
10	Siddhawat	1.80	2.20
11	Jaisinghpura	0.08	0.09

*source-CDP/CSP Ujjain

The major cause for overflow and flooding is silting and blockages by solid waste. About 20% of the total drain length is kutccha, which should be lined after proper de-silting.

Ground and surface water contamination occur due to transfer and disposal of the wastewater through unlined canals; Hanuman, Sombaria and Ganda nallah into the River Kshipra. Water logging occurs due to inadequacy and inefficiency of storm water drains at Somwaria, Kartik Chowk, Begampura, Singpuri, Khatriwadi, Sakhipura, Jaisinghpura, Awantipura, Ramghat and Indore Gate.

Existing assets to be used

Inventory of the existing assets available with UMC and its usability has been explored. Team verified the suitability of the existing assets and decided to use 80% of the 200-400 mm DWC pipe stock available with the Ujjain Municipal Corporation for the construction of this sewerage scheme. It is also proposed to use available electrical and mechanical equipment usable and having desired efficiencies are also proposed to be used.

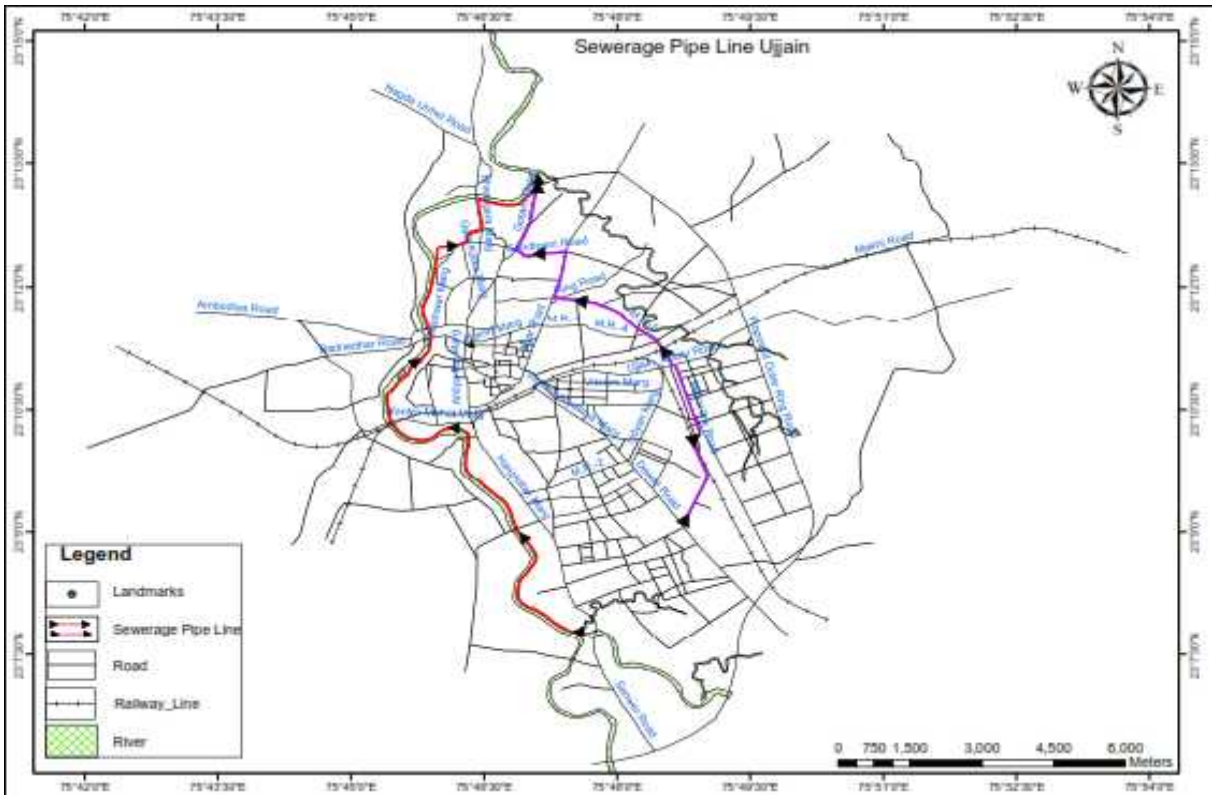
Existing Scenario of Ujjain City in terms of Sewerage System is given in table given below:

Table-4 Existing SPS & STPs- details

LOCATION	Number of Pipes	Dia. Of Incoming Pipes(mm)	Class of RCC Pipes	Ground Level (metre)	Crown Level (metre)	Invert Level
SOMWARIYA	1	750	NP2	497	490.65	489.85
BADNAGAR BRIDGE	1	600	NP2	495	489.5	488.855
MANCHHAMAN	2	300	NP2	464	462.1	461.77
		400	NP2		462.1	461.668
BHERUGARH	1	150	NP2	481	477.05	476.875
GAUGHAT	2	600	NP2	490	485.64	484.995
		600			482.64	481.995
RAMGHAT	2	500	NP2	485	480.92	480.385
		500			480.7	480.165
CHAKRATIRTH	3	1600	NP2	492	485.4	483.72
		900			485.4	484.445
		800			483.4	482.55
INDIRA NAGAR AYURVEDIC COLLEGE	1	600	NP2	481.132	478.702	478.057
RUDRA SAGAR	2	600	NP2	483	479	478.355
		450	NP2		479.55	479.065
STP1	Cap	At Sadawal		Based on Facultative Pond		
STP2	Cap	At Kolukhedi / Abukhana		Based on Facultative Pond		

Existing sewer network which is feasible and workable are proposed to be used with necessary modifications. All old Sewers which are laid in past with the objective of only intersection & diversion of nalla/drains. Once the works of scheme proposed are done and 100% HH sewer connections are done then already laid sewers shall become unserviceable in stages of proportion of Laying completion in respective areas. Accordingly, all old SPS & STP and related Systems shall become idle and ULB preparing inventory for these assets will use as per the need. Presently in Ujjain various Sewer laying works are done in NRCP and other projects.

Sewer laying work done are shown in following map:



Existing, laying of 13 kms of Sewer lines, 19 kms. of Sewage pumping mains & 9 SPS construction is done in past in various Programmes.

In Ujjain, Municipal Corporation/PHED have purchased DWC pipes for requirement of Simhastha-2016. It is proposed to use available good condition pipes around 80% of available stock of DWC 170/200 mm dia. Pipe for household sewer connections and DWC 250/480 mm dia. for Sewer laying works.

Table -5 Inventory of Pipes Available with ULB/Public Health Engineering Project Division Ujjain, District Ujjain(M.P.)

Día of pipe	As per Actual received in tender (m)	Unused Balance (m)	Total Available (m)
100mm/120mm	103424.72	6794.78	110219.5
135mm/150mm	80510.55	4869.53	85380.08
170mm/200mm	33068.5	8438.3	41506.8
250mm/295mm	23032.2	2494	25526.2
400mm/480mm	11525.9	56.8	11582.7
500mm/580mm	2962.65	334.25	3296.9
Grand Total	**254524.52**	**22987.66**	**277512.18**

Available DWC pipes are proposed to be used for house service connecting pipe of DWC – 170/200 mm & for Sewer laying works of DWC – 250/295 mm. The details of pipe to be used are given in table shown below:

Table 6	**Available Use of DWC Pipe Under the Project**			
Dia. Of DWC Pipes to be used	**Used Pipe (Available Length)**	**Unused Pipe (Available length)**	**proposed to be used 80% of usable available pipes**	**Total**
170/200 mm for HH Sewer Connection	33068.5	8438.3	26454.8 (80% of available usable out of used pipe)+ 8438	34893.10
250/295 mm for Laying of Sewer(Laterals)	23032.2	2494	18425.76 (80% of available usable out of used pipe)+ 2494	20919.76
400/480 mm for Laying of Sewer(Laterals)	11525.90	56.8	9220.72 (80%of available usable out of used pipe)+56.8	9277.52
TOTAL				65090.38

4. NEED OF THE PROJECT

There is no regular sewerage system in the entire town for safe disposal of the sewerage generated in the town. People are dependent on soak pit based toilets and septic tanks. It's very expensive system and therefore every one can't afford it, which results in 40% of population defecates in open areas. Soak pit based toilets also possess threat of contemning ground water sources.

The waste water and the effluent from the septic tanks flow through the open gutters. Where facilities are not available, flows in low level areas and get stagnated in open areas thereby creating nuisance. The town does not have a comprehensive system for safe disposal of waste water which results in the environmental pollution, contamination of water and other critical issues related to health of the people of the town. For all kinds of waste water disposal, two types of disposal systems are used in the town. Soak pit / Pit based toilets for soil waste and open drainage for kitchen, bath & Strom water disposal.

Soak pits / Pit based toilets are installed at personal level and Municipal level and maintained by vacuum emptier vehicle. In some areas sewage generated directly flows through open drains and finally gets drained into natural larger drains.

The objectives of preparing an Underground Sewerage Scheme for are:

- For prevention of pollution of River Kshipra and in compliance of Hon. High Court, it is envisaged to execute underground sewerage scheme for the town. After execution of Sewerage Scheme, pollution of River Kshipra will drastically reduce to GOI effluent standards laid down for flowing water bodies like River Kshipra.
- Identification of all point sources & non-point sources of pollution in the area.
- Assessment of pollution in the area affecting the population of the town.
- Details of all feasible alternative systems to address the issue of pollution
- Amongst a number of feasible options, for a project whose implementation will reduce pollution in the area and improve its sustainable quality of living Environment to the desired level and achieve mainly water quality at source of water.

5. APPROACH & METHODOLOGY ADOPTED

5.1. AUTHORITY FOR PREPARATION OF THE PROJECT

The commissioner Municipal corporation Ujjain has authorized WAPCOS for the preparation of DPR for Sewerage scheme and accordingly after various visits with team of wapcos, engineers from UMC, PHED officers. the formulation of DPR has been made. the scheme is to be executed under AMRUT and various available funds for Ujjain.

5.2. APPROACH

An approach has been taken to frame the project to achieve economy in construction. An integrated approach has been taken while studying and designing the new proposal

5.3. METHODOLOGY

The sewage collection system of various sewerage Zones have been identified based on topography, physical boundary and 100% household connectivity by sewer connection & adoptability of stakeholders. Underground Sewerage Scheme is proposed to cover by centralized sewerage system considering the topography of the town by way of dividing it into three sewerage zones. Phasing of sewerage project works is done for intermediate period of design and ultimate period of design and works are to be done accordingly. All civil works construction are to be done for 30 years design period and all E & M components are to be done in two phases: one for 15 years i.e. for year 2035 and other for 30 years i.e. for the year 2050, renewal of equipment of various components proposed.

1) Held discussions with concerned municipal staff and visited with them to various wards, open gutters and water logged areas.
2) Obtained information about town, such as area, population, rainfall, climatic conditions, existing water supply facilities, present water supply through them in different seasons, ward wise information etc.
3) Obtained various maps related to the town area from municipal council and topographical maps of the project area and surrounding area of the town
4) Worked out population projection of the town by various methods as per Manual of CPHEEO and finalized realistic figures.
5) Worked out sewerage to be collected and disposed of for various stages.
6) Collected characteristic of the sewerage and identified the Techno-economical solution for the treatment to be adopted.

7) Carried out detailed survey including taking levels all along the roads speeded over the entire town, fixing bench marks, fixing location of STP, Sump & Pump house etc.
9) Designed various components from the scheme as per guidelines given in the manual on Sewerage and Sewage Treatment by CPHEEO, New Delhi / NRCP Guidelines.
10) Prepared detailed estimates of the project based on Schedule of Rates of UADD MP 2012 and prepared rate analysis for items wherever necessary.

6. POPULATION FORECASTING & SEWAGE GENERATION

6.1 *PRESENT POPULATION & POPULATION FORECASTING :-*

As of 2011 censes, the total population of Town was 515215. Below table 4 shows the population growth trend of town from 1971 – 2011.

Table 6- Population as per Censes

Sr. No.	Year	Population	Increase In Decade	Incremental Increase In Decade	Growth Rate
1	1971	208561			
			73646		35%
2	1981	282207		6780	
			80426		28%
3	1991	362633		-12632	
			67794		19%
4	2001	430427		16994	
			84788		20%
5	2011	515215			
	Total		**306654**	**11142**	
	Average / Geometric Mean		**76664**	**3714**	**25%**
	Rounded		**76664**	**355**	**25%**

Population forecasting has been done by four methods. For each property unit population load is considered as per NBC norms. Institutional needs of population load calculated based on the National Building Code of India (NBC) norms. As per NBC (Part IX-Page7), occupant population load of 5 for each household is considered. Population forecasting has been done by standards methods and tabulated in table 5.

Table 7 Population Forecasting

SN.	Year	Value of "n"	Arithmetic Increase Method	Geometric Progression Method	Incremental Increase Method	Graphical Increase Method	***Designed Population***
1	2020	0.9	584213	628325	584516	9800	***584600***
2	2035	2.4	699209	874670	700657	12800	***700800***
3	2050	3.9	814205	1217598	817597	16000	***817700***

Incremental Increase Method is used for population Projection.

6.2 SEWAGE GENERATION & CAPACITY OF S.T.P.:-

Table 8-SEWAGE GENERATION				
Sr. No.	Particulars	Present Stage Year 2020	Intermediate Stage Year 2035	Ultimate Stage Year 2050
1	Design Population	613830	735840	858585
2	Rate Of Sewage Collection Through House Connection (For 100% Population)	108 lpcd	108 lpcd	108 lpcd
3	Dry Weather Flow (DWF)-Sewage Collection (MLD)	66	80	93
4	Infiltration (250 ltr / day / MH)	8	12	17
5	Average Sewage Collection including Infiltration (MLD)	74	92	110
6	**Capacity of Sewerage Treatment Plant (S.T.P.)**	**74MLD**	**92 MLD**	**110 MLD**

6.3 ZONE WISE POPULATION & SEWAGE GENERATION:-

There are total 54 wards in Town. All these 54 wards are divided into the three (3) Zones depending upon the topography of town. The forecasted pollution was calculation for these 3 zones. Accordingly sewage flow is calculated considering 80% of total water supplied (135 LPCD) to particular zone. Also we have considered 250 Ltr/day infiltrations per manhole per day.

Table 9- *ZONE WISE POPULATION & SEWAGE GENERATION*

Sr. No.	Zone Name	Ward No.	Zonal Population (Inclusive floating Population)				Designed Flow (MLD) 2050
			Year 2011	Year 2020	Year 2035	Year 2050	Year 2050
1	Zone-1	1, 2, 5(P), 6 (P), 7, 10, 11. 12, 13, 14, 15, 16, 18(P)19, 20, 21, 22, 23, 24,26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38(P),42(P), 44 (P), 45, 46, 47, 48, 49, 50, 51(P), 52 (P), 53(P), 8, 9	303697	399012	453150	499364	63
2	Zone-2	3, 4, 5 (P) , 16(P), 17 , 18(P), 25, 38(P), 39, 40, 41, 42(P), 43, 44(P) & 52 (P)	131850	180525	207665	229552	30
3	Zone-3	52 (P), 53(P), 54 , 53 (P) (P)=Partial coverage	8292	34292	75026	129669	17
Total			**515215**	**613830**	**735840**	**858585**	**110**

6.4 SEWERAGE DISTRICTS/ZONAL DETAILS & ZONAL CONNECTIVITY:

As per the topography of Ujjain town, sewer network has been divided into three zones to have techno economic depth of excavation for sewer lines. Zone wise details are given below:

Zonal Map of Ujjain Town

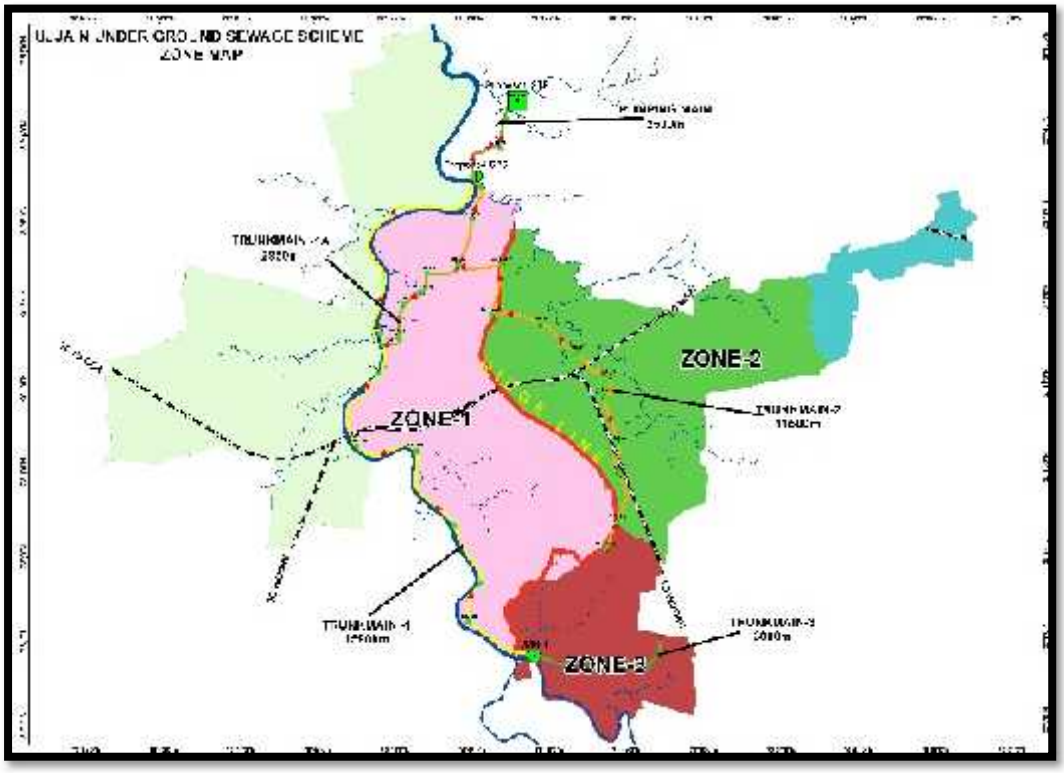


Table 10- Zonal Distribution (Wards Covered)

Zone – 1 - Wards Covered: 1, 2, 5(P), 6 (P), 7, 10, 11. 12, 13, 14, 15, 16, 18(P)19, 20, 21, 22, 23, 24,26, 27, 28, 29, 30, 31, 32,33, 34, 35, 36, 37, 38(P),42(P), 44 (P), 45, 46, 47, 48, 49, 50, 51(P), 52 (P), 53(P),8, 9
Zone – 2 - Wards Covered: 3, 4, 5 (P) , 16(P), 17 , 18(P), 25, 38(P), 39, 40, 41, 42(P), 43, 44(P) & 52 (P)
Zone – 3 - Wards Covered: 52 (P), 53(P), 54 , 53 (P)
Ultimate Stage Population :- Souls
Highest Level :- 521.55 mtr
Lowest Level :- 469.57 mtr
Difference in Level :- 51.98 mtr
Force Main :- 2.5 km

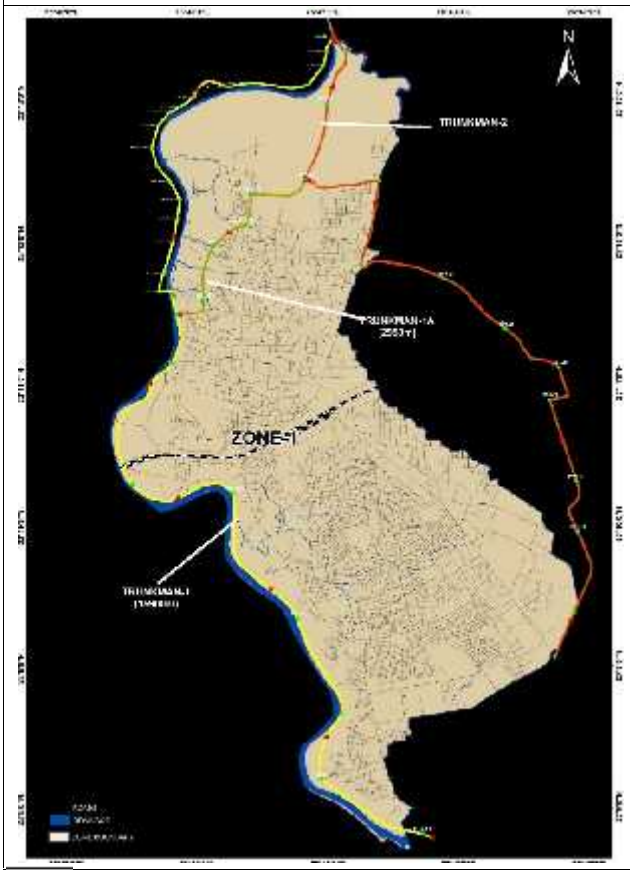
Table 11- Zone – 1 :- Kshipra River Side Area	
	Wards Covered :- 1, 2, 5(P), 6 (P), 7, 10, 11. 12, 13, 14, 15, 16, 18(P)19, 20, 21, 22, 23, 24,26, 27, 28, 29, 30, 31, 32,33, 34, 35, 36, 37, 38(P),42(P), 44 (P), 45, 46, 47, 48, 49, 50, 51(P), 52 (P), 53(P),8, 9
	Ultimate Stage Population :- 499365 Souls
	Highest Level :- 511.64 mtr
	Lowest Level :- 473.41 mtr
	Difference in Level :- 38.22 mtr

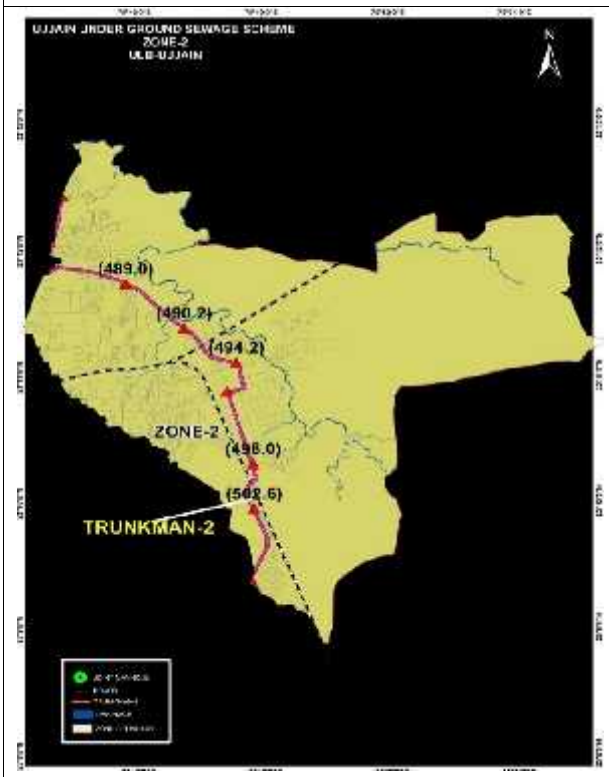
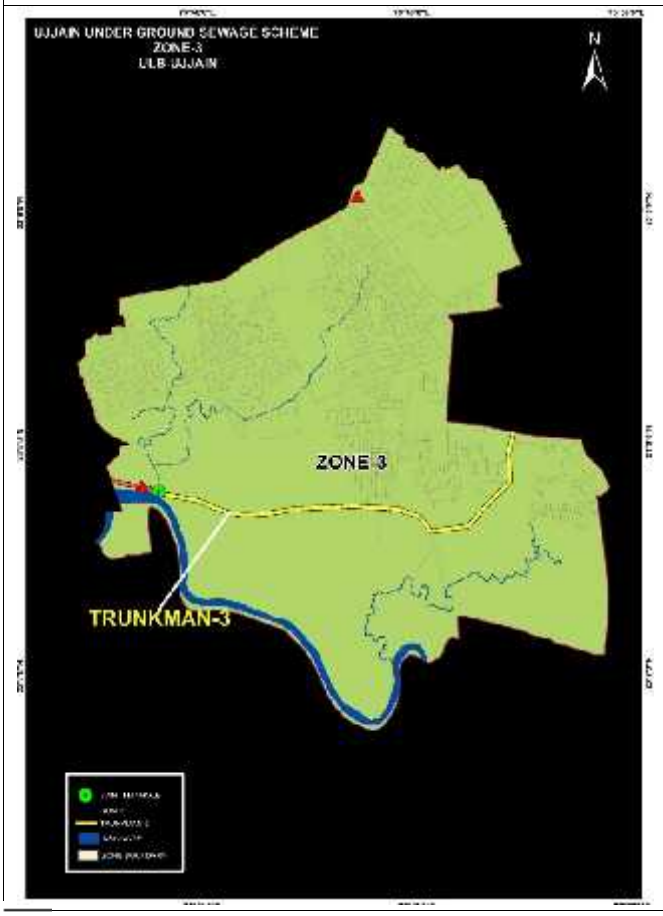
Table 12 – Zone-2 Piliya Khal Nalla Side Area	
	Wards Covered :- 3, 4, 5 (P) , 16(P), 17 , 8(P), 25, 38(P), 39, 40, 41, 42(P), 43, 44(P) & 52 (P)
	Ultimate Stage Population :- 229552 Souls
	Highest Level :- 521.16 mtr
	Lowest Level :- 469.57 mtr
	Difference in Level :- 51.60 mtr

Table 13: Zone – 3 Triveni/Shanti Nagar Side Area	
	Wards Covered :- 52 (P), 53(P), 54 , 53 (P) Ultimate Stage Population :- 129669 Souls Highest Level :- 521.55 mtr Lowest Level :- 480.81 mtr Difference in Level :- 40.74 mtr Force Main :- NA

7. DESIGN PARAMETERS, NORMS ADOPTED & OPTIONS PROPOSED FOR SEWERAGE SCHEME COMPONENT'S

7.1 SEWERAGE SYSTEM DESIGN AS A SEPARATE SYSTEM :-

Sewerage system is an intricate civil Engineering work which is designed for two extreme conditions: minimum flow in the initial range of population and maximum flow for design period loads with conditions of extreme (minimum non-silting and maximum non-scouring) velocities and depth of flow in the conduit. In case, sewer connections are not done for a longer period without any flow, the assets created may become non-functional. Sewerage scheme is designed only for DWF (Dry Weather Flow) i.e. designed as separate system and not as combined system for Techno-economic reasons, as practiced in India following the guidelines of CPHEEO, In case of combined system we shall have to spend 3.5 times more for collection and transmission of sewage and then also due to dilution of sewage, functioning of STP becomes inefficient.

7.2 STAGES OF SEWERAGE SYSTEM :-

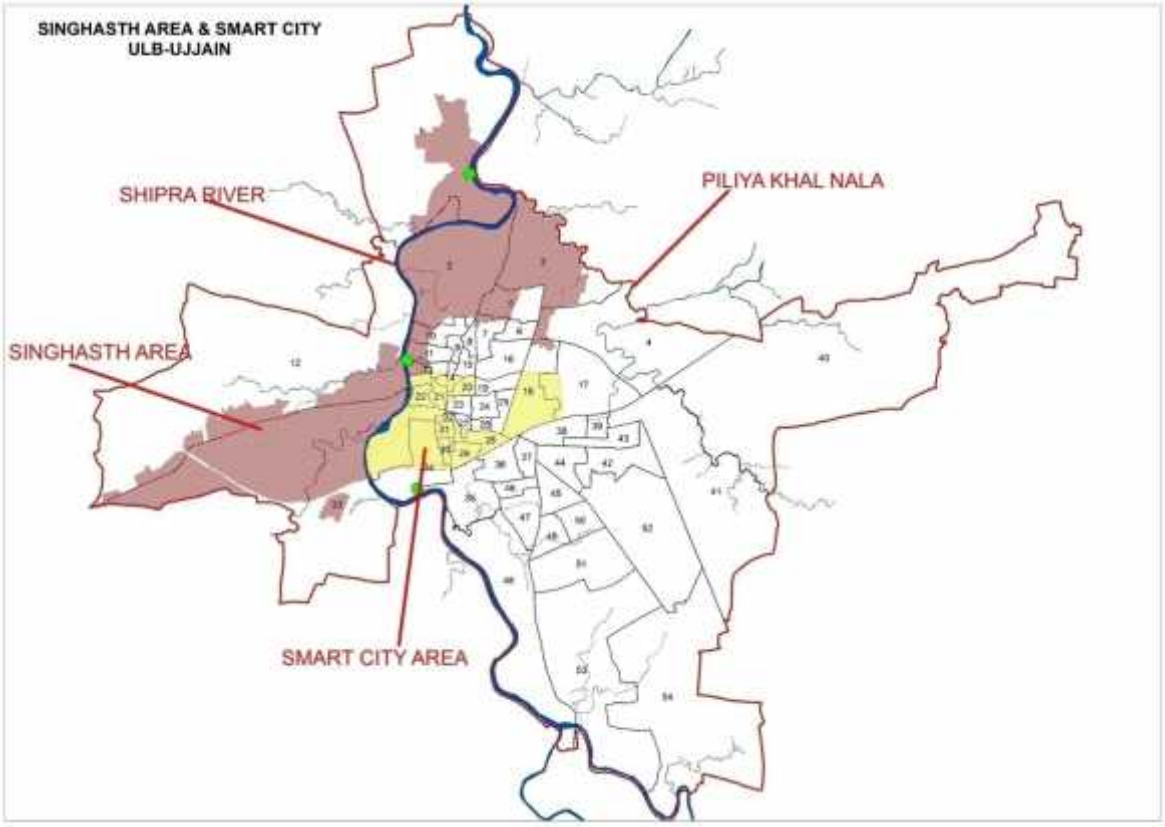
There will be four stages in the entire sewerage system as follows.

1. Collection of Sewage (Sewers & Sewage Pumping Stations)
2. Transportation of Sewage
3. Treatment of Sewage – Sewage Treatment Plant
4. Effluent Disposal System

7.3. FUTURE PROPOSALS FOR SIMHASTHA AREA & SMART CITY AREA :-

Simhasth Mela occurring every 12 years because of which usually temporary water supply and sewerage arrangements are made. The Simhasth Mela Population load is up to a tune of 8 to 10 lacs per day for 1 month mela period, including pre-festival 15 days and post festival 15 days, total of 60 days. Since, Simhasth Mela is area specific (only within Simhasth mela limits) and time specific (only for 60 days), therefore, for Simhasth Mela area proposals are proposed to be financed under Simhasth Area funding.

Smart City Area of Ujjain is shown as below is also covered under this Project and therefore funds available is proposed to be utilized for the Completion of the Project.



7.4 WASTE WATER COMPONENTS: -

CPHEEO Manual stipulates that generally 80% of the water supply may be expected to reach the sewers. However, sewers should be designed to minimum waste water flow of 100 to 135 litres per capita per day for urban, as per the rate of water supply.

7.5 DESIGN PERIOD FOR SEWERAGE COMPONENTS: -

The length of time up to which the capacity of a sewer will be adequate is referred as design period. In the sewer system, the flow is largely a function of population density and water consumption. The design period is different from planning horizon year. Table 1.1. CPHEEO Manual gives design period for different components of sewerage system and sewage treatment. STP should be designed in phases, refer clarification in table 1.1. First phase of STP should be for about 10-15 years but land of STP should be taken for 30 years period.

Table 14 Design Period of Sewerage Scheme Components			
Sr. No.	**Design Component**	**Design Period**	**Remarks**
1	Land Acquisition -STP, SPS, Sewers etc.	30	Generally Land will be required to add later for construction of STP in modules. Accordingly land should be acquired. At STP is proposed to be constructed for Intermediate Stage.
2	Sewerage Network	30	It is designed for 30 years
3	Sewage Pumping Stations Civil Works	30	Cost of civil work is economical for full design period. It is proposed to be designed for 30 years
4	Pumps & Machineries	15	Considering modular approach, it is proposed to be designed for 15 years and provided accordingly.
5	Sewage Treatment Plant	15	The construction shall be usually modular (15 years) in phased manner. In case sewer connections are not done for a longer period without any flow, the assets created for it may become non-functional. For STP capacity is proposed to be constructed for 92 MLD
6	Rising Mains / Force Mains	30	In case of low velocities, dual rising mains are also examined. Only one force main for each SPS is proposed for 30 years' design period.
7	Sewer Connections / Property Connections	30	Most important component of the system is sewer connections, to ensure proper functioning of the total sewerage system. This work takes longer time but with commitments, connections should be done on top most priority.
8	Effluent Disposal & Utilities	30	Provision of design capacities in the initial stages itself is economical & safe disposable of effluent is considered.

7.6 PEAK FACTOR – CARRYING CAPACITY: -

The carrying capacity of the sewers is designed on the basis of prospective population and taking into consideration that 80% of water supply (manual of sewerage) will reach the sewer, multiplied by the peak factor. Peak factor is the ratio of maximum flow at any time to average flow and depends on contributory population. Para 3.2.5 of CPHEEO Manual stipulate peak factor for different contributory population. The minimum flow may vary from 1/2 to 1/3 of average flow. Flow in gravity sewer varies

from hour to hour and seasonally. The recommended peak factor shall be as mentioned below

Table 15 Peak Factor	
Contributory Population	Peak factor
Up to 20,000	3
20,000-50,000	2.5
50,000-7, 50,000	2.25
Above - 7, 50, 000	2

7.7 GROUND WATER INFILTRATION: -

Some quantity of ground water or subsoil water may infiltrate into sewers through defective joints, broken pipes etc. This is significant when water table is high and head of ground water is more than the head of sewage in sewers. Some quantity of sewage may leak out from defective joints and defective pipes when head of sewage is more in sewers than head of ground water outside. Infiltration and leakage mainly depends on quality of construction and water table levels. Infiltration can be considered, vide Para 3.2.7 CPHEEO Manual stipulation (minimum - maximum)

1) 5000 - 50000 liters per day per hectare or
2) 500 - 5000 liters per day per km length of sewers or
3) 250 - 500 liters per day per manhole for sewers laid below ground water level.

7.8 PIPE MATERIAL OPTIONS FOR NETWORK & FORCE MAINS: -

For pumping/Force main MS pipes are considered, for Sewer network DWC/NP3 & NP4 pipes are considered, for mains, laterals, branches & for house/property connections DWC pipes are considered up to Property connection chambers. For Force Main 1200 MS pipe is considered.

7.9 NON-SILTING OR SELF-CLEANSING VELOCITY/MINIMUM VELOCITY :-

Sewage contains organic and inorganic matter. Therefore, if the velocity of flow in sewer is low, this solid matter is likely to settle down and deposited, thus blocking the flow. The minimum velocity required to prevent silting in sewer is called self-cleansing velocity. The velocity should be attained once a day or preferably twice a day to keep the sewer free from trouble of blocking. Sewers have to be designed such that self-cleansing velocity is developed with minimum discharge. A velocity of 0.6 m/s would be required to transport sand particles of 0.09 mm size with a specific gravity of 2.65 vide Para 3.4.3 of CPHEEO Manual recommends a minimum velocity (self-cleansing velocity of 0.6 m/s, for present peak flow and 0.8 m/s at design peak flow for sanitary sewers).

7.10 NON SCORING OR MAXIMUM VELOCITY :-

Erosion of sewer (bottom surface) is caused by sand and other gritty material deposited in the sewer accompanied by excessive Velocity. Velocity in a sewer desirably should not exceed 3 m/sec for RCC pipes and 1.5 m/sec for SW pipes at any time else it will cause erosion of bottom of pipe. Sewerage should not be introduced without ensuring adequate water supply.

7.11 SAFE DISTANCE BETWEEN TWO WATER SUPPLY AND SEWER LINES: -

For roads wider than 25 meters, the water distribution/Sewers pipes should be provided on both sides of the road, by running rider mains suitably linked with trunk mains. (Refer Manual on WS - CPHEEO Govt. of India (1999) Para 6.10.4.2 (p138-139), 10.3.8 (p362), Para 10.11.1 & 10.11.2 (page 388), CPHEEO Manual Govt. of India (1993) ON Sewer & Sewage Treatment- Para 21.3.3.2.

7.12 LAYING AND JOINTING OF SEWERS/PIPES: -

As a rule, trenching should not be carried out too far ahead of pipe laying. The trench should be as narrow as practicable. This may be kept from 0.30 meter over the outside diameter of pipe and depth may be kept at 0.60 - 1.0 meter depending upon traffic conditions. If trucks, Lorries, or other heavy traffic will pass across the pipeline, concrete tiles 600 x 600 mm of suitable thickness and reinforcement should be laid about 2 m above the pipe to distribute the load. If the pipeline crosses a river, the pipe should be buried at least 2m below bed level to protect the pipe.

7.13 BRICK MASONRY AND RCC MANHOLES PROPOSED:-

Brick Masonry Manholes are proposed to be constructed as per the UADD Specifications & given details **in** ***Annexures- D16 &D17***. Special type RCC Drop manholes are proposed with high flood protection arrangements for Trunkmannumber-1 proposed to be laid along Kshipra river. For details refer ***Drawing D-18.***

7.14 HORIZONTAL SEPARATION: -

A Water/Sewer pipe line should be laid such that there is at least 3 meters' separation, horizontally from any existing or proposed drain or Water/sewer line. If local conditions prevent this lateral separation, a water main may be laid closer to a storm or sanitation sewer, provided that the main is laid in a separate trench, or on an undisturbed earth shelf located on one side of sewer at such an elevation that the bottom of the water main is at least 0.5 meters above the top of the sewer.

7.15 VERTICAL SEPARATION: -

In situations where mains have to cross house sewer, storm drain, or sanitary sewer, it should be laid at such an elevation that the bottom of the water main is 0.5 meter above the top of the drain or sewer with the joints as remote from the sewer as possible. This vertical separation should be maintained for a distance of 3 meter on both sides measured normal to the sewer or drain it crosses.

7.16 SEWAGE PUMPING STATION: -

Earlier Pumping stations used to be rectangular with dry and wet wells adjacent to each other or circular with central dry well and peripheral wet well or circular with a dividing wall to separate the dry and wet wells and with centrifugal pumping sets.
It is proposed to construct Dry cum wet well with Provision of flow measurement, adequate ventilation, safety equipment's, pump lifting arrangements shall be made. At places, where depth of sewer becomes too deep and it is difficult to lay sewer at such depths, sewage-pumping station is required to lift the sewage to nearby manhole or to the STP, from where it will flow by gravity.

Screens and Overflow:

Sewage Pumping Station (SPS) are to be provided with coarse screens before the wet well with clear opening of 40-50 mm between the bars for the manually cleaned type and 25 mm for the mechanical type. Drainage facility shall also be provided in the individual screen channels to empty these channels for maintenance purposes.

Wet Well:

The sewer line will discharge the sewage into a wet well. The capacity of wet well/sump should be such that deposition of solids is avoided and sewage does not turn septic. The capacity should not be too low to require frequent on-off of pumping sets. he capacity of the wet well is to be so kept that with any combination of inflow and pumping, the cycle of operation for each pump will not be less than 5 minutes and the maximum detention time in the wet well will not exceed 30 minutes of average flow. The high-water level in sump well will not exceed invert level of lowest incoming pipe.

Table-16 - Details for Dry cum Wet Well /SPS-: Ujjain Underground Sewerage Scheme

Item		**Wet well at Kamed Village**
Top slab of pump house	Top Slab (in mtr)	0.2
Top beam of pump house	Top Beam (in mtr)	0.3
Height of super structure in dry well	Hs in mtr)	4
Clear height of super structure	Hsf (in mtr)	3.80

Cantilever slab	Sb (in mm)	200
Cantilever beam	Bb (in mm)	300
Height of brick masonry inside wet well	Hb (in mtr)	1.2
Free space above inlet pipe	Hfs (in mtr)	0.3
Diameter of inlet pipe	Di (in mm)	2000
Diameter of over flow pipe	Dof (in mm)	2000
Diameter of force main	Dfm (in mm)	1200
Space above free board	Sfb (in mtr)	0.3
Free board	Fb (in mtr)	0.3
Effective height of wet well	He (in mtr)	6
Raft slab /bottom slab	Rs (in mm)	300
PCC in foundation	PCC (in mm)	200
Ground level (RL)	GL(in mtr)	478.0
Excavation level	ExL (in mtr)	469.0
Excavation depth	Dex (in mtr)	11.0
Volume of wet well proposed	Vp (in mtr)	2298
Inside diameter of wet well	Di (in mtr)	22.60
Outside Diameter of Wet well	Do (in mtr)	32.20
Diameter of Force main	Fmd (in mm)	1200

7.17 TYPES OF SEWAGE PUMPS AND CONFIGURATION: -

Non-clog Centrifugal pumps are proposed in Sewage Pumping station (SPS) as per availability in the Indian market. Pumping units are designed to handle suitably peak, average and low-flow from connected sewers. The capacity of pumps shall be adequate to meet the peak rate of flow with 100% standby. Pumps of varying discharge capacity are desirable to handle the variation in flows (lean/average/peak flows). It is generally provided to convey sewage from Sewage Pumping Stations to a higher-level inlet chamber of nearby sewer or Sewage Treatment Plants. Force main should be designed for a minimum velocity of 0.80m/sec for high duty pump in operation. A maximum velocity of 2.5 to 3.0 m/s at ultimate peak flow. Usually economic pipe dia. is obtained at velocity of 1.1 m/sec.

It is proposed to provide configuration sewage pumps at 3 Nos. of pumps each suitable for discharge of peak flow/2 and 2 Nos. of pumps each suitable for discharge of Peak Flow/4 as designed & given as below.

Table17- Configuration of non-clog Centrifugal Sewage Pumping Sets at SPS		
Configuration of Pumps	Peak Flow/ 2	Peak Flow/ 4
Nos.	3	2
Lps for the pumps	1250	625
Head of Pumps in metres	32	32
HP of Pumps	715	360

Pumping Hours:

Find out the actual availability of power in the city and based on it adopt pumping hours. More pumping hours give lower pipe size and hence cost saving. Future expected improvement in power supply may also be considered.

- Hydraulic design is done using Hazen-Williams formula as given below:
- V = 4.567 X 10-3 CD^0.63 * S^0.54 and
- Q = 1.292 X 10-5 CD^2.63 *S^0.54
- Where, Q - Discharge in m3/hr, V - Velocity of flow in m/sec, d - diameter of pipe in mm;
- 'C'Hazen-Williams Co-efficient, S - Slope of Hydraulic Gradient;
- 'C'Hazen-William Coefficients Value adopted used in the hydraulic design is taken 140 for DI pipes with cement mortar lining inside.

7.18 SELECTION OF SEWAGE TREATMENT PROCESS :-

The selection of a particular type of treatment technology will depend upon the techno-economic feasibility of the process selected for treatment. The tech-economic feasibility can be attributed to the following parameters:

Degree of treatment required, Capital cost of the project, Operation & Maintenance cost, Power Requirement, Land Requirement, Ease of construction, Operation & Maintenance, Simplicity of system, Trouble free service, Proven process, Ability to absorb shock loads (Hydraulic / Organic), Need for skilled / unskilled staff O&M, Presence / absence of nuisance potential from mosquito / fly / odour, Ease of access to components of the system for repairs and maintenance, Safety / Hazardous conditions at the plant.

7.19 CLASSIFICATION OF SEWAGE TREATMENT PLANTS: -

When characteristics of raw wastewater, the intended use and quality of receiving waters and their assimilative capacity are known, extent or degree of treatment needed for the wastewaters (sewage) can be determined. Different types of treatment provide different percentage removal of BOD, suspended solids, and total coli forms the general yardstick for evaluating the performance of sewage treatment plants. In general, the treatment plants are classified as: Preliminary treatments, Primary treatments, Intermediate treatments, Secondary treatments & Tertiary treatments.

Table 18- Comparison of Sewage Treatment Processes

Sr. No.	Parameters	Activated Sludge Process (ASP)	Moving Bed Bioreactor (MBBR)	Sequential Batch Reactor Process (SBR)
A	**Inlet Design Parameters**			
1	BOD	250	250	250
2	COD	400	400	400
3	Suspended Solids	300	300	300
4	Total Kjeldhal Nitrogen	45	45	45
5	Total Phosphorus	5	5	5
6	Ammonical Nitrogen	35	35	35
B	**Guaranteed Outlet Parameters**			
1	BOD	<30	<30	< 5
2	COD	<250	<250	< 100
3	Suspended Solids	<100	<100	< 10
4	Total Kjeldal Nitrogen	No Treatment	No Treatment	< 10
5	Total Phosphorus	No Treatment	No Treatment	< 2
6	Ammonical Nitrogen	No Treatment	No Treatment	< 2
C	**Process Operating Features**			
1	Process Type	Aerobic, Continuous	Aerobic, Continuous	Aerobic, Batch

Sr. No.	Parameters	Activated Sludge Process (ASP)	Moving Bed Bioreactor (MBBR)	Sequential Batch Reactor Process (SBR)
2	Automatic control of operating parameters	Not Possible	Not Possible	Inbuilt continuous monitoring (Real Time) of process parameters like rate of change of DO, temperature, inflow and outflow automatically done by computer
3	Optimization of operating parameters while plant operation	Not Possible	Not Possible	All critical operating parameters like cycle time, DO levels Blower operating hours, volume in and volume out can be altered to run the plant at most efficient way
4	Odour and fly problems	Possibility due to Bio-gas generation & handling	No fly problems. Possibility of odour in case the sludge is stored at site for a long time as the sludge is not fully stabilised	Nil, because process produces fully stabilized sludge
5	Capability of Handling Variations	Underperforms during variations in hydraulic as well as organic load	Underperforms during variations in hydraulic as well as organic load	Can handle up to 0-150% flow and BOD variation by adjusting the critical operating parameters as the

Sr. No.	Parameters	Activated Sludge Process (ASP)	Moving Bed Bioreactor (MBBR)	Sequential Batch Reactor Process (SBR)
				treatment process is based on Sequential Batch Reactor
6	Treatment Efficiency of Biological Treatment process	85-90%. Requires Tertiary treatment to achieve < 10 BOD levels. No treatment for nitrogen and Phosphorous removal	85-90%. Requires Tertiary treatment to achieve < 10 BOD levels. No treatment for nitrogen and Phosphorous removal	Excellent Treatment efficiency as high as 98% of BOD removal in single stage
7	Outlet Quality	meets MPCB norms but do not confirm to latest CPHEEO recommended values (BOD<10, SS<10, TN<10, dissolved P<10)	meets MPCB norms but do not confirm to latest CPHEEO recommended values (BOD<10, SS<10, TN<10, dissolved P<10)	Exceeds MPCB Norms and also confirm to latest CPHEEO recommended values (BOD<10, SS<10, TN<10, dissolved P<10). Excellent Quality as good as crystal clear raw water. Fully fit for river/lake conservation and/or reuse.
8	Material of construction of underwater moving parts	MS susceptible to corrosion/wear and tear thus higher maintenance and reduced life cycle of equipment's	MS susceptible to corrosion/wear and tear thus higher maintenance and reduced life cycle of equipment's	Superior Stainless Steel Construction to minimize corrosion / wear and tear thus higher life cycle of equipment's and reduced maintenance costs

Sr. No.	Parameters	Activated Sludge Process (ASP)	Moving Bed Bioreactor (MBBR)	Sequential Batch Reactor Process (SBR)
9	Moving Parts	High	High	Low
10	Maintenance	High	High	Low
11	Level of Automation	No automation. Fully manual operation in most of the existing plants	No automation. Fully manual operation in most of the existing plants	Fully Automatic controlled by PLC and computer with manual override, process is being monitored on real time basis for critical process parameters
12	Ease during shutdown/maintenance	Complete plant to be taken under shutdown while maintenance	Complete plant to be taken under shutdown while maintenance	No need to shut down the plant. Each basin can be taken offline while other basin caters to the treatment requirements
13	Required level of operator attention	High	High	Low
14	Area Requirements	Greater than SBR	Greater than SBR	Less (Less than 50% to that of other conventional treatment schemes)
15	Net Operating Costs	High	High	Low
16	Performance in different climatic areas	Performance is questionable in lower temperatures	Performance is questionable in lower temperatures	Proven performance in both tropical and sub-zero temperatures

Sr. No.	Parameters	Activated Sludge Process (ASP)	Moving Bed Bioreactor (MBBR)	Sequential Batch Reactor Process (SBR)
17	Power generation	Power generation is possible as biogas can be generated by installing primary clarifier, Digester and gas engine. However when the BOD is low, the gas generation is very less. Also, the gas generation is very poor during the winter months and during rainy season when the waste is dilute. So in most cases power generation is not viable option.	Power generation is possible as biogas can be generated by installing primary clarifier, Digester and gas engine. However when the BOD is low, the gas generation is very less. Also, the gas generation is very poor during the winter months and during rainy season when the waste is dilute. So in most cases power generation is not viable option.	Power generation is possible as biogas can be generated by installing primary clarifier, Digester and gas engine. However when the BOD is low, the gas generation is very less. Also, the gas generation is very poor during the winter months and during rainy season when the waste is dilute. So in most cases power generation is not viable option.
D	**Per MLD Requirement Analysis Considering The Outlet Parameters as per latest CPHEEO Recommended Values (Based on IITs Report)**			
(I)	**Area Requirement**			
1	Area requirement Sq M per MLD	900	450	450
(II)	**Operating Costs**			
1	Energy Requirement (KWh/day/MLD)	180	220	150
2	Chemical Cost (Lacs/Annum/MLD)	5.30	5.30	3.30

Sr. No.	Parameters	Activated Sludge Process (ASP)	Moving Bed Bioreactor (MBBR)	Sequential Batch Reactor Process (SBR)
3	Manpower Cost (Lacs/Annum/MLD)	42.12	30.96	25.92
4	Annual Repair Cost (Lacs/Annum/MLD)	2.38	1.94	1.84
(III)	**Average Capital Cost**			
1	Average Capital Cost (Lacs / MLD)	68	68	75
	**Considering 50 MLD Plant*			
(IV)	**Total O&M Cost**			
1	Total O&M Cost (Lacs /Annum / MLD)	353.02	372.11	288.15
(V)	**Treatment Cost (as per year 2010)**			
1	Treatment Cost (Rs./ Cum)	3.20	3.30	2.90

7.20 SBR TECHNOLOGY OF SEWAGE TREATMENT: -

Sequential Batch Reactor (SBR)

The sequencing batch reactor (SBR) is a fill-and-draw activated sludge system for wastewater treatment. In this system, wastewater is added to a single "batch" reactor, treated to remove undesirable components, and then discharged. Equalization, aeration, and clarification can all be achieved using a single batch reactor. To optimize the performance of the system, two or more batch reactors are used in a predetermined sequence of operations. SBR systems have been successfully used to treat both municipal and industrial wastewater.

Operation under SBR Process

Influent wastewater generally passes through screens and grit removal prior to the SBR. The wastewater then enters a partially filled reactor, containing biomass, which is acclimated to the wastewater constituents during preceding cycles. Once the reactor is full, it behaves like a conventional activated sludge system, but without a continuous influent or effluent flow. The aeration and mixing is discontinued after the biological reactions are complete, the biomass settles, and the treated supernatant is removed. Excess biomass is wasted at any time during the cycle. Frequent wasting results in holding the mass ratio of influent substrate to biomass nearly constant from cycle to cycle. Continuous flow systems hold the mass ratio of influent substrate to biomass constant by adjusting return activated sludge flow rates continually as influent flow rates, characteristics, and settling tank underflow concentrations vary. After the SBR, the "batch" of wastewater may flow to an equalization basin where the wastewater flow rate to additional unit processed can be controlled at a determined rate.

Performance of SBR

The performance of SBRs is typically comparable to conventional activated sludge systems and depends on system design and site specific criteria. Depending on their mode of operation, SBRs can achieve good BOD and nutrient removal. For SBRs, the BOD removal efficiency is generally 85 to 95 percent.

SBR manufacturers will typically provide a process guarantee to produce an effluent of less than:

- 10 mg/L BOD
- 10 mg/L TSS
- 5 – 8 mg/L TN
- 1 – 2 mg/L TP

COMPONENTS USED IN SBR STILLING CHAMBER

1. The stilling chamber: Stilling Chamber is a small chamber used with a pumped effluent system and is designed to slow the flow of effluent from the septic tank.

Function of stilling chamber is to reduce Turbulence in the incoming flow
HRT: 45 sec

2. Fine Screen Chamber:

Fine screens are typically used to remove material that may create operation and maintenance problems in downstream processes, particularly in system that lack primary treatment. Typical opening sizes for fine screens are 1.5 to 6mm (0.06 to 0.25 in). Very Fine screens with openings of 0.2 to 1.5 mm (0.01 to 0.06 in) place after coarse or fine screens can reduce suspended solids to levels near those achieved by primary clarification.

3. Screen Dimension:

Bar Thickness: 3mm
Clear Opening between bars: 6mm
Angle of Inclination of Bar: 45 Degree

4. Grit Chamber

Girt chambers are basin to remove the inorganic particles to prevent damage to the pumps, and to prevent their accumulation in sludge digesters.
Surface Overflow Rate: 1555 m3/m2/day
HRT: 60 sec

5. Basin

Aeration Blowers are started for a pre-determined time to aerate the effluent along with the biomass. After the aeration cycle, the biomass settles under perfect settling conditions. Once settled, the supernatant is removed from the top using a DECANTER. Solids are wasted from the tanks during the decanting phase.
F/M ratio: 0.117.

6. Selector Anoxic Zone

The concept of a selector is a small tank or zone at the front end of the aeration basin where influent wastewater and return activated sludge mix prior to entering the main aeration basin. It is called a selector because it is supposed to be anoxic and select for desirable, non-filamentous, bacteria.
HRT: 30 minutes

7. Air Blower & Diffuser

Air blower is operated continuously and stand in dry, well-ventilated place, away from residential premises.

O2 required as per Sewage Manual: 1.200 kg/kg BOD

8. Chlorination Tank

The purpose of chlorination may not always be disinfection and may, in fact, involve odour control or some other objective which will be noted. Proper mixing of incoming effluent with chlorine will be done by providing horizontal or vertical baffle walls or by using a diffuser system in the chlorination tank.

HRT: 10 minutes

9. Chlorinator

It regulates flow of chlorine from chlorine cylinders and mixes it with water to produce a solution of chlorine which can then be dosed into the chlorination tank.

Chlorine Dosage Rate: 2 ppm

10. Sludge Sump

Sludge settled in main basin is transferred either by gravity or pumping to the sludge sump where it is kept in suspension by providing air blowers. The sludge is then fed to centrifuge for further dewatering.

HRT: 4 hours

Sludge Sump Air blower: The sludge is kept in suspension using air blower, otherwise settling of heavy particles takes place and this may cause block in the pump which pumps sludge to the centrifuge. Air Agitation requirement in Sludge Sump: 1 m3/hr/m3

11. Centrifuge

Centrifuge is used for sludge thickening. While prior sludge have the concentration around 0.5-1 % of dry solid, after the thickening process, it will contain up to 5-6% of dry solids.

12. DWPE Dosing System

Function: It adds dewatering Polymer to the sludge prior to being sent to the centrifuge for sludge thickening.

DWPE required: 1.2 Kg/MT of Dry Sludge

HRT: 12 hours

13. Filtrate Sump

Function: The cent rate water from centrifuge will be transferred to the filtrate sump.

HRT: 30 minutes.

Advantages of SBR

- Simple, Flexible and Efficient
- Smaller foot print by eliminating Sedimentation Tanks
- Saves Power due to variable head in tank and OUR control
- Withstands organic and hydraulic shock loads
- Variable design provides consistent treated effluent quality
- Biological Nutrient (N&P) removal by In-built anoxic zone (selector)
- Excellent treated water quality for reuse of water for horticulture, gardening, etc.
- Completely odour free plants
- Modular design - Easy to Augment

Methodology addressing the engineering parameters: Efficient treatment cost:

- Highly efficient and proven technology in India
- Energy efficient devices
- Air requirement is optimized throughout.
- Plant is automatic with PLC based SCADA operation. Hence, minimum manpower.
- Under water parts are in SS, which ensures longer life, lowers wear & tear and results in low equipment maintenance
- SBR technology gives excellent treated sewage quality which reduces chemical consumption i.e. chlorine and poly.
- Built in nutrient removal system, hence no need to go for separate nutrient removal system. Other equipment makes are A class reputed makes which ensures quality and longer life of plant
- Efficient management of odour:
- Aerobic process
- Bio-sludge is fully stabilized in SBR basin itself. Hence bio-sludge is odour free.
- No primary untreated sludge generation, which causes odour**.**

Operations during lower loading rates or variable loads:

- **SBR is true batch reactor can handle load variations effectively.**
- **Water levels and air supplies are adjusted automatically based on actual flow and organic load**
- **SBR basin acts like equalization tank and discharge water at uniform rate even though the feed is variable.**
- **During less inlet flow, the batch treatment turns down to lowest to save energy.**

<u>Efficient utilization of land:</u>

- SBR has compact process design and requires almost 50% less area compare to conventional treatment technologies due to absence of primary & secondary clarifiers, sludge digesters, gas holders, etc.

- Modular design
- Besides, during engineering units will be clubbed together to save land requirement
- SBR has compact process design and requires almost 50% less area compare to conventional treatment technologies due to absence of primary & secondary clarifiers, sludge digesters, gas holders, etc.
- Modular design
- Besides, during engineering units will be clubbed together to save land requirement
- Efficient energy requirement
- VFD is installed for air blower operations
- Air requirement is optimized through OUR control. Feedback will be taken (through PLC/SCADA) from DO meter installed in SBR basins and fed to VFD, which makes the blowers to run efficiently.
- Complete plant operations are controlled and optimized through PLC/SCADA.

Efficient sludge management:

- There is no primary clarifier required in SBR plant, hence no primary untreated sludge
- Bio-sludge generated from the plant is fully stabilized and digested in SBR basin itself. This sludge is completely chemical free, odorless and can be used as soil conditioner.
- Bio-sludge is mechanically dewatered to reduce the quantum to make is tuckable, in case disposal is required.

Easy operations:

- Less number of units as compare to conventional treatment, hence less number of operations. Plant is automatic and controlled by PLC-SCADA based operations.
- Doses not require any special manpower to operate the plant. Minimum manpower required for operation due to automation.
- Plant operating process variables can be changed according to the plant load. Hence, less manual intervention.

Recycling & reuse

The proposed SBR based plant gives excellent outlet, which can be reused for non-potable purpose such as agriculture, washing, flushing and industrial use.

Benefits – implementing the Technology

- Proven Technology in India -Simple, flexible and efficient
- Fully automatic plant

7.21 CHARACTERISTICS OF SEWAGE : -

Table:19 Sampling of Sewage / Waste Water	
Name of Town	Ujjain
Date of Sample Collected	20/01/2017
Date of Report	31/01/2017
Location -1 Name: Begumbagh nalla at Ujjain	Detailed Report received from MP PCB, Ujjain is enclosed in *Annexure-23*
Location -2 Name: Bherugarh nalla at Ujjain	Detailed Report received from MP PCB, Ujjain is enclosed in *Annexure-23*

8. WATER QUALITY STANDARDS PROPOSED AFTER TREATMENT:

After Under Ground Sewerage scheme works are completed & commissioned. Nallas flowing & joining pollution to Kshipra River shall stop. Sewer connectivity to each HH in the town usually takes long time and therefore this arrangement shall be continued till then works of sewerage system are completed and 100% sewer connections to HHs are done. Water Quality Standards for natural nalla /Water body/ as per CPCB classification of Designated Best Use criteria of rivers for bathing are as given below:

Table 20- Water Quality Standards for River / Natural Flowing Water Bodies	
Parameters	**Standards**
pH	6.5 to 8.5
BOD	3 (mg/l) or less
DO	5 mg/l or more
Faecal coliform	
Desirable	500 (MPN/100 ml)
Maximum Permissible	2500 (MPN/100 ml)

Table 21- Recommended Guidelines For Treated Sewage by CPHEEO (vide manual nov. 2013 page 5-4 & page 5-120)	
Parameter	**Recommended Values**
BOD mg/L	Less than 10
SS mg/L	Less than 10
TN mg/L	Less than 10
Dissolved P, mg/L	Less than 2
Faecal Coliforms MPN/100 mL	Less than 230

9. CONSTRUCTION ACTIVITY ISSUES

9.1 STATUS OF STRATA/SOIL, FOR SEWER ALIGNMENTS & PUMPING MAINS, SPS & STP SITES:

Soil & water available in the area of Ujjain are studied & estimates are framed accordingly. Soils of the area are characterized by black grey, red (lateritic), often mixed with red and black alluvium and ferruginous red ravel or lateritic soils. It is necessary for ULB to get prior sanction from State Pollution Control Board for construction of STPs. As per state Govt. it may be ensured that necessary sanctions/clearance from SPCB & line departments are obtained by the authority.

Statutory requirements like sanction from urban local body(if any),sanction required from authorities maintaining roads, Forest Dept. sanctions, Clearance for transfer of land required for the purpose of construction of SPH & STPs may also be processed & obtained NOC before start of works at site.

9.2 STATUS OF WATER TABLE, FOR SEWER ALIGNMENTS & PUMPING MAINS, SPS & STP SITES:

Regarding Water Table in 54 wards of the Town have been studied and details are given in ***Annexure-22***

9.3 ACTIVITY CHART/WORK PROGRAMME FOR EXECUTION OF UNDERGROUND SEWERAGE SCHEME:

Activity chart /Work Programme for planned & time bound execution of work of Ujjain Underground Sewerage Scheme is envisaged for monitoring of execution of works and given in the ***Volume – II Annexure – 18.***

9.4 FLOATING OF BIDS, ITEMS OF CONCERN NEED TO BE INCORPORATED FOR TIME-BOUND COMPLETION OF WORKS.

While floating bids/tenders for work, realistic time period of work be given to contractor and if proportionate completion not done, then contractor should be panelized. Work progress suffering during rains, time lag due to festivals in India like Sankranti, Holi, Ganesh, Durgapuja, Dashera, Diwali, Mohram, Eid and Christmas are also need to be considered. Effect of this time loss should also be reflected in our bid documents as considered for rainy season.

After sewer lying done, the item of roads making good the same, be introduced separately to avoid public criticism. This has been considered in the estimates.

9.5. HINDRANCE AND LIKELY CONSIDERATION FOR INTEGRATION OF SECTORIAL SEWERAGE SYSTEM:

A list of likely considerations is given below:

- Sanctions from Railway & Road Crossings at few places
- Laying of Rider Sewers-Laterals-Sub Mains-Mains in thickly populated areas
- Land acquisition required in alignment of Trunk Mains at some places. Lines likely to cross from Private Lands on shorelines of river Kshipra.
- Heritage areas in Ujjain City i.e Bhukimata Ghat, Ramghat, Narsing Ghat , Chakrateertha
- Smart city core area of the city to be considered in execution
- Simhastha Area Management & integration of various funding slots need to be considered for smooth & efficient execution & completion of the Scheme.

10. SEWERAGE SCHEME COMPONENTS DESIGN

10.1 DESIGN OF SEWER LYING WORKS:

The sewer lines are designed and L-sections are drawn. The detailed designs for sewer lines are given in ***Volume II - D3 to D11***. Drawings are given ***in Volume III, Drawing – D2 to D11***. Details of Excavation & bedding & Construction details of Manhole are provided in ***Volume-III, Drawing No - D14 & D18***

Manning's formula for circular conduits(Sewers) is commonly used for determining the velocity and flow in sewers running full.

V_f	=	3.968	x	$10^{(-)3}$	x	$d^{2/3}$	x 1/n x $s^{1/2}$
Q_f	=	3.118	x	$10^{(-)6}$	x	$d^{8/3}$	x 1/n x $s^{1/2}$

Where

V_f = Velocity in m/sec. While sewer is running full.

Q_f = Discharge in lps. while sewer is running full.

d = Inner diameter of sewer in mm.

n = Manning's coefficient of roughness.

s = Slope of hydraulic gradient.

Values of Manning's Coefficient (n) for Channels and Pipes
Plastic pipe 0.011 – 0.015
Steel/cast iron pipe 0.012 – 0.015
Concrete pipe 0.013 – 0.015
Corrugated metal pipe 0.012 – 0.026

The minimum diameter of Manholes is considered as, the inside diameter of Manhole equivalent to Max. Dia. Of Sewer/pipe plus 0.60 m. However standard depth wise manholes are given in Table in Annexure may be followed.

Minimum Diameter of 250 mm is adopted (Being town of Historic importance and facilities of Metro towns considered) for public sewers and for HH connectivity as 170/200 DWC popes.

10.2 DESIGN OF SEWAGE COLLECTION SYSTEM/ SEWAGE PUMPING STATION (SPS):

Sewage Collection System Sump well/Pumping Stations is designed in Ward No.– 3. Detailed designs are given in Volume II– Annexure 19, land requirement details in Annexure-32. Drawing in Volume – III, Drawing No – D10.

Land Requirement for Dry cum Wet Well/SPS
Total Requirement – 2000 sq m at Village Kamed

10.3 DESIGN OF FORCE MAINS:

Force main is designed considering sewage flows of Ultimate Stage 2050. Detailed Techno economic designs for force mains done & provided in Volume II – Annexure – 20. Plan & L-Section of Force Mains are given in Volume-III, Drawing No – D11.

10.4 DESIGN OF SEWERAGE TREATMENT PLANT:

- STP IS to be constructed in modules one for 2035 (92 MLD) and area for extension is to be secured for 2050 (110 MLD).
- Sequential Batch Reactor (SBR) technology is proposed for Sewerage treatment.
- Location- Village Suhasa near KD Palace (Latitude- 23°14'24.85'' N & Longitude-75°47' 39.68" E)
- Intermediate Demand- 92 MLD (2035)
- Ultimate Demand- 110 MLD (2050)

Sewage Treatment Plant (STP) is envisaged for intermediate design year population of 2035 and its sewage flow of 92 MLD. The land available and remaining area desired for the Ultimate Stage is given in Annexure. Strategical location of STP is decided for the village Surasa after considering three probable options. The location is well suited for the purpose with the presence of nearby natural drain for the outflow from STP.

Type of Sewage Treatment considered for design on SBR Technology. The detailed design sheets are given in ***Volume II – Annexure-16*** & Layout & hydraulic flow diagram for STP is given in ***Volume-III***, ***Drawing No – D-19.***

It is proposed to make the system (STP) automatic for achieving higher efficiency and to minimise cost towards human resources by providing PLC-SCADA. For this purpose, compatible sensor logic for influent and effluent qualities and ensuring quality rotations till then the effluent qualities are achieved as per recommended guidelines for treated sewage by CPHEEO. For this purpose, monitor control and command centre establishment (Centrally placed) is envisaged and provisions are inbuilt accordingly.

Land Requirement for STP

Total Requirement –

For 2035 (93 MLD)- 8 Ha. (20 Acres)

For 2050 (110 MLD)- 10 Ha (25 Acres)

10.5 DESIGN OF TRANSFORMER & TAKING POWER LINE FROM ELECTRIC SUB-STATION :

Design of capacity of transformer has been done and given in ***Annexure-21.*** The rates for transformer of desired capacity are adopted from open market rates. For taking electric power line from substation per km rates from standard SOR has been adopted @ 15,000,000 per km

10.6 DESIGN OF EFFLUENT DISPOSAL ARRANGEMENTS:

It is proposed to use effluent after treatment coming from STP for recharging of Rudra Sagar and remaining let out in to natural nalla flowing nearby STP. Effluent standards are ensured as given in CPHEEO Manual. Pipe from Channel out let to nalla bed is designed & provided. For recharging purpose of Vishnu Sagar & Rudra Sagar, it is proposed to be provided with sump well in STP campus with Pumping Machinery & small pumping main from this effluent sump well to one EDC at Vishnu Sagar. The details of and arrangements are given in ***Drawing D-21.***

11. ABSTRACT OF COST ESTIMATES

TABLE -2 2 ABSTRACT OF COST-UJJAIN UNDER GROUND SEWERAGE SCHEME		
S. NO.	SUB-ESTIMATES	AMOUNT (IN RS LAKHS)
1	Household Sewer - Service Connections	3413
2	Sewers lines including Sewer Appurtenances, Allied Works	19454
3	Restoration & Making of Monolithic Roadways	4273
4	Sewage Collection System, Pumping Machinery & Force Main (Sewage Pumping Main)	1639
5	Sewage Treatment Plant (STP) of Capacity 92 MLD Based on SBR technology inclusive Provision for Automation System of STP (PLC-SCADA)	7820
6	Electric Transformers, Transmission Line and DG Sets at SPS & STP	675
7	Recycling, Reuse of reclaimed water for Horticulture, Road side Irrigation and Recharging of Vishnu sagar and Rudra Sagar	215
Gross Project Cost (Rs. In Lakhs)		37489
RS.375 CRORES		
Rs. Three Hundred Seventy Five Crores only		

12 OPERATION AND MAINTENANCE OF THE SYSTEM:

The efficient operation of sewerage system need flawless construction and getting 100% households connected. It is necessary to have most efficient and financially viable operational system for sustainability of the assets created and its efficient operation and maintenance. It is envisaged to make provision of 10 years' operation and maintenance of the total sewerage system inclusive of 5 years as defect liability period. The maintenance cost is framed and given below considering depreciation of assets created with lapse of time and provision for major breakdowns and repairs, cost towards consumables and energy charges. The maintenance cost includes cost towards human resources and transportation facilities invariably required for operation and maintenance of the system. For making the sewerage system self-sustainable based on basic concepts of civic services considering no profit and no loss in fixing tariff towards giving each household with sewer connection and recurring charges towards operation and maintenance.

Table 23 Annual Operation and Maintenance Cost of Ujjain Sewerage System Scheme

S. No.	Description	Unit	Rate	No.	Rs.	Amount (Rs. In Lakhs)
1	**Civil & Electrical, Mechanical & Instrumentation works**					
1.1	Sewer Network @ 0.25% sewer line works	Per year				110.81
1.2	Sewage Pumping Station(Civil works) @ 1.5% of Civil Works	Per year				4.71
1.3	Sewage Pumping Station(E & M) @ 3% of E&M Works	Per year				28.74
1.4	Force main/ Pumping of Sewage @ 1.5% of FM Works	Per year				11.10
1.5	Sewage treatment Plant @ 1.5% of Civil Works	Per year				131.69
1.6	Effluent Disposal and Utilities @ 1.5% of Civil Works	Per year				3.23
2	**Requirement of officers and Staff for O&M work**		**Rs.**	**No.**	**Per Annum rs. In lakhs**	
2.1	Executive Engineer/Manager	Per year	600000	1	**600000**	6
2.2	AE(Civil) Astt. Engineer	Per year	360000	12	**4320000**	43.2
2.3	AE(E&M) Astt. Engineer	Per year	360000	1	**360000**	3.6
2.4	Sub Engineer	Per year	264000	12	**3168000**	31.68

2.5	Fitter (Mech) cum pump operator	Per year	126000	2	**252000**	2.52
2.6	Electrician	Per year	81000	2	**162000**	1.62
2.7	Gardener/ Sweeper	Per year	20000	58	**1160000**	11.6
2.8	Chemist/ Asst. Chemist/ Lab Attendant.	Per year	180000	2	**360000**	3.6
2.9	UDC, LDC, Peon, Watchman, Driver	Per year	9000	10	**90000**	0.9
3	**Energy Charges (Based on Consumption on Load and tariff)**	Per year				880.00
4	**Equipment / Tools and Plants (3% of E & M on Maintenance) includes Loaders Scrappers, Dozers, Hand cart, Cleaning Agents etc.**	Per Year	65000			721
Section Total						1995.99
5	**Contingent Expenditure (3% of above Cost) including Cost of Consumables**					59.88
Grand Total						2055.87
					Say 20 Crores	
	O & M Cost for 5 years (Adding 33.45%)				**26.69**	**Crores**
	O & M Cost for next 5 years (Adding 40%)				**28**	**Crores**
	Total Cost for O&M for 10 years				**54.69**	**Crores**

13. CASH FLOW PROFILE, REVENUE GENERATION & SELF SUSTAINABILITY OF SCHEME:

For execution of Ujjain Underground Sewerage Scheme, it is necessary to ensure cash flow of funds in proportion to ensured activity wise progress of works to complete & commission works with in 3 years period of construction. For revenue generation Ujjain Municipal Corporation needs to fix sanitation tariff that need to be collected from property owners on monthly basis for O& M of sewerage scheme. In absence of this, non-plan flow of funds sustainability & efficient functioning of sewerage system will become difficult.

Annual internal rate of return for the scheme has been calculated and given in annexure.

13.1 REPAYMENT SCHEDULE :

Repayment Schedule of Loan having as 16.67 % of the Project Cost and Rate of interest as 10.25% is considered. Details worked out are given in ***Annexures-28***.

13.2 CASH FLOW :

Cash flow for Ujjain Under Ground Sewerage Scheme is planned & worked out statement is given in ***Annexure-29***.

13.3 INTERNAL RATE OF RETURN FOR THE SEWERAGE PROJECT OF UJJIAN:

Internal Rate of Return for the Sewerage Project of Ujjain (16.67 % of the cost shall be contributed by ULB) has been calculated. The details worked out are given in ***Annexures-30***.

14. INVESTMENT PLAN/ ACTION PLAN FOR SEWERAGE FACILITIES IN UJJAIN TOWN FOR SHORT TERM, MIDTERM AND LONG TERM:

Table 24- Requirement of Funds and Action Plan			
Sub-Estimate	**Amount (Rs. In Lakhs)**	**Short Term Proposals for year 2020 (Phase-I)**	**Mid Term Proposals for year 2023 (Phase-II)**
Household Sewer - Service Connections	5214	3413	1801
Sewers lines including Sewer Appurtenances, Allied Works	44323	19454	24869
Restoration & Making of Monolithic Roadways	9513	4273	5240
Sewage Collection System and Pumping Machinery &Force Main (Sewage Pumping Main)	1639	1639	-
Sewage Treatment Plant (STP) of Capacity 92 MLD Based on SBR technology inclusive Provision for Automation System of STP(PLC SCADA)	7820	7820	-
Electric Transformers, Transmission Line and DG Sets at SPS & STP	675	675	-
Recycling, Reuse of reclaimed water for Horticulture, Road side Irrigation and Recharging of Vishnu Sagar and provision of mini STP package at Rudra Sagar	215	215	-
Gross Project Cost (Rs. In Lakhs)	**69399**	**37489**	**31910**

15. INSTITUTIONAL REVIEW

The management and public services are organized by different sectorial, officers, workers as per details given below:

Table 25: Management of Ujjain Municipal Corporation
President & Mayor & Council Body
⬇
Commissioner
Assistant Commissioner
⬇
Superintendent Engineer (S.E)
Executive Engineer
Assistant Engineers
Sub Engineers
⬇
Other Field & Office Staff

For execution & maintenance of Water supply & sewerage project works it is necessary to assign exclusive management to an engineer of rank of Assistant engineer & one Sub Engineer. For time bound execution of sewerage project, it is necessary to provide minimum number of engineers / staff as per work load and quality parameters to be adhered to during execution & maintenance works.

Table 26- Requirement of Officers & Staff for O & M		
Designation	No. of Employees: **(For STP, SPS, Sewer lines & Manholes etc.)**	Total
Executive Engineer/Manager	1	1
Assistant Engineer(Civil)	1	1
Assistant Engineer(Mechanical)	1	1
Sub Engineer Civil , E&M	6+6	12
Fitter	1+1	2
Electrician	1+1	2
Pump Operators	4	4
Gardener/ Sweeper	2+2+54	58
Chemist	1	1
Lab Attendant	1	1
UDC, LDC, Peon, Driver, Watchman	1+1+2+2+4	10

16. SAFETY & ENVIRONMENTAL PLAN

As per the notification dated 14th Sept. 2006 of MoEF makes EIA mandatory for Projects involved excavations etc which may create pollution and nuisance to public during execution of work.

The loss of private assets resulting in loss of income and displacement has made social impact assessment an important input into the project design while initiating and implementing developmental interventions. An understanding of the issues related to social, economic and cultural factors of the affected people is critical in the formulation of an appropriate rehabilitation plan. SIA also helps in enhancing the project benefits to poor and vulnerable people while minimizing or mitigating concerns, risks and adverse impacts.

Objectives of SIA and Preparation of SMP

The main objective of Social Impact Assessment and preparation of Social Management Plan is to ensure that the project addresses the adverse impacts on the livelihood of the people and that nobody is left worse-off after project implementation and all local inhabitants, including those affected by the project, have access to project benefits.

Information, Education and Communication Action Plan

Communication Planning is an integral part of planning for sustained development. The success of any program is critically dependent upon the participation of the people, particularly target groups, in the implementation process. To enable people to participate in the development process, it is necessary that people have adequate knowledge about the nature and content of these programs. Information, Education and Communication, therefore assumes added significance in any program. It plays a pivotal role in creating awareness, mobilizing people and making development participatory through advocacy and by transferring knowledge, skills and techniques to the people. It is also critical for bringing about transparency in implementation of the programs at the field level and for promoting the concept of accountability and social audit.

The purpose of the IEC Plan is to provide a framework to the target groups to plan, design, implement and support a strategic communication effort. The Communication strategy would address the social and cultural issues with clearly defined modes and Channels of communication. The IEC Plan is prepared with multiple objectives; to enhance people's understanding of the project; as a communication provider to the community with the aim of soliciting participation of the community in implementing the project, and raising the awareness level of the local community to bring about change in its outlook and behaviour.

As opposed to one time intervention based projects, IEC leaves behind material and more importantly, memories of the messages being conveyed.

Tools of Information, Education and Communication

IEC tools proposed to be used in the project include print and electronic media content, new communication technologies, traditional ways of person to person contact and group events, and any instruments of public visibility. The range is not limiting, and a program can create and design its own tool and content that is best suited to its target audience. Newspapers, Conferences/consultations/workshops, Street Plays, Messages on Loudspeakers, Posters and Banners and any other tool identified through consultation or ideas given by the general public are some of the more effective tools which may be used for effective communication in the project area. A public awareness kit should also be developed for dissemination of information among the public and should ideally be based on the matrix provided below:

Table 27- IEC Tools

Tools	Specifications	Platform
Power point	⦁ Mainly visual ⦁ Design such that it prints well in B&W and does not use much ink ⦁ Keep file size minimal	⦁ Conferences ⦁ Meetings with funding agencies ⦁ Internal presentations to beneficiaries
Media Information Kits	⦁ Press kit primarily to facilitate press whether Newspaper, Radio or TV, with corresponding illustrated material on CD along with print version	⦁ Newspaper ⦁ Radio ⦁ TV
Public Awareness Kits	⦁ Interesting and interactive games, checklists, posters and activity books to enhance awareness	⦁ Distributed in workshops and to students in schools and reach to community through schools

Table 28- Important Acts and Policies		
Sl. No	**Safeguard Policy**	**Applicability to the present project**
1	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Amendment) Act, Second Ordinance, 2015	The Act is applicable in the present project.
2	Scheduled Caste and Scheduled Tribes Orders (Amendment) Act, 2002	The provisions of the Act are not applicable in the present project
3	The Street Vendors (Protection of Livelihood and Regulation of Street Vending) Act, 2014	The Act is applicable in the present project.

SMP Cost and Budgeting: The SMP implementation will involve temporary shifting of mobile vendors and petty/ squatter shopkeepers, cost of residential and commercial structures, if demolished, Livelihood assistance, three public consultation meetings: one each at start, middle and end of the project and monitoring and evaluation of the project by an NGO/independent external agency. SMP Budget has been prepared after the survey; enumeration of the street vendors/hawkers and valuation of private commercial and residential structures likely to be affected by the project. The overall budget will comprise of the following:

Table 29- Budget for Social Management Plan (SMP)			
S. No.	**Description**	**Entitlements/**	**Amount (in Rs)**
1	Shifting of mobile vendors/kiosks	36000 per vendor	1,08,00,000.00
2	Public Consultation Meetings (6 Numbers)	15000 per Meeting	90,000.00
3	IEC		5,00,000.00
4	Monitoring & Evaluation (Contract to NGO)	Contract to NGO/PCB	10,00,000.00
5	Contingency		50,000.00
		Total	**1,24,40,000.00**

Table-30 Cost of Environmental Management Plan(ESMP)						
Item	**Location**	**Season**	**Year**	**Total no. of Samples**	**Unit Cost**	**Total Cost**
Environment Monitoring during Construction Stage						
Air quality Monitoring	10	3	3	90	5,000.00	4,50,000.00
Noise / vibration	10	3	3	90	2,000.00	1,80,000.00
Water analysis	10	3	3	90	6,000.00	5,40,000.00
Soil analysis	10	2	3	60	5,000.00	3,00,000.00
Travel and Transportation of monitoring Team	Lumpsum					2,00,000.00
Sub total						**16,70,000.00**
Environment Monitoring Cost (Operation Stage)						
Air quality Monitoring	10	1	5	50	5,000.00	2,50,000.00
Noise / vibration	10	1	5	50	2,000.00	1,00,000.00
Water analysis	10	1	5	50	6000	3,00,000.00
Soil analysis	10	2	5	100	5,000.00	5,00,000.00
Travel and Transportation of monitoring Team	Lumpsum					2,00,000.00
Plantation lump sum	Lumpsum					2,00,000.00
Awareness program	Lumpsum					1,00,000.00
Sub-Total						16,50,000.00
Total Cost of EMP and Environmental Monitoring						**33,20,000.00**

Table 31 : Safety & Environmental Plan			
Activity	**Environmental Impact**	**Activity / Action Plan**	**Responsibility**
Excavation	Air Pollution / Noise Pollution	Use ear plug & nose masks when necessary for performing task. Excavated soil shall be arranged both side on trench properly at a safe distance.	By Contractor /Agency
Removal of Excavated Stuff	Water (Nali - Nalla)	Ensure that excavated soil shall not be flown in nearby nali & nalla and extra stuff/Soil & be transported to site as per direction of Engineer-in-charge.	By Contractor /Agency
Site Housekeeping		The construction site and surrounding are to be maintained in a clean and presentable condition at all times. Constriction activities shall avoid causing unnecessary disruption & nuisance to adjacent landowners & the public as a whole	By Contractor /Agency
Fire Prevention & Control	Air Pollution	The Contractor shall ensure that there is basic firefighting equipment available on site as per requirement of the local Emergency Services. If any emergency or misshapen then Environmental / Safety shall attend to the requirements immediately.	By Contractor /Agency
Health & Safety		We shall Ensure that First-Aid kit is provided at site Office as per relevant standards	By Contractor /Agency
Tree Safety		Unnecessary tree cutting prohibited shall be adhered to in case progress is affected by any tree. Cutting of tree shall be done as per Provisions of Forest/related dept. norms, plantation of equivalent.	By Contractor /Agency

Power Generator	Air Pollution	Installation of Power generator/DG set as per standard norms shall be ensured at site.	By Contractor /Agency
Material		Material /dumping through truck / trali etc. shall be done carefully & more careful dumping of sand.& packed through thick polythene bag	By Contractor /Agency
Health Safety of Workers		Ensure to arrange medical camp for labours & proper facility like clear water, latrine ,good quality food etc.	By Contractor /Agency
Public Awareness		Before start of any alignment of pipe residents shall be informed line Proper sign boards, display boards, barricading, taps shall be on site to avoid any misshapen during work progress.	By Contractor /Agency
Vehicle / Machine	Air Pollution	We shall Ensure that certification is necessary from concerning respective departments are kept with vehicle.	By Contractor /Agency
Site Clearance		Ensure that after daily progress of work, site is cleaned. No material/Pipe pieces etc. shall be remained on the road.	By Contractor /Agency
Proper Place of Vehicle		Necessary vehicles shall be provided for safety.	By Contractor /Agency
Attention	Water pollution	Work carefully, in the case any damage during the construction like damage occur then proper coordination with concern authorities shall be done & damages are attended to on priority.	By Contractor /Agency