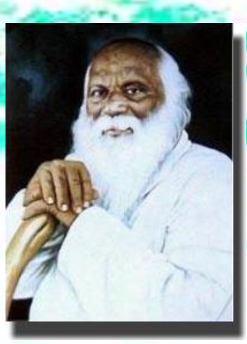
Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE OF ENGINEERING, SATARA



A PROJECT REPORT ON

"IMPROVING THE PERFORMANCE OF RURAL WATER SUPPLY IN MAHARASHTRA"

Submitted by

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UNDER THE GUIDANCE OF

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ACKNOWLEDGEMENT

I take this opportunity to express my profound gratitude and deep regards to my guide Dr. Anand Tapase for is exemplary guidance, monitoring and constant encouragement throughout the course of this thesis. The blessing, help and guidance given by him time to time shall carry me a long way in the journey of life on which I am about to embark.

I am obliged to staff members of ‘Karmaveer Bhaurao Patil College of Engineering’ for the valuable information provided by them in their respective fields. I am grateful for their cooperation during the period of my assignment.

The required document like DPR are provided by Z.P.SATARA, and their cooperation was too good and helpful, special thanks to them. Also Gramsevak of Shelarwadi Gram Panchayat helped us a lot by giving us all details of project and giving us all related documents.

The Avinash Gadhve, who is the engineer from wai. Under him the Shelarwadi Village water supply scheme were constructed. He also explained the scheme in details, explained the work, difficulties during the work, problems occurred and how they managed the problems. So we are thankful to him.

ABSTRACT

Rural water supply is becoming a major considerable topic today. Today many of villages are facing the problem of improper water supply or improper quality of supplied water. As the rural area is mainly depends upon natural sources of water, it is necessary to cure the natural water sources and proper quantity of supply should be provided. Quantity of water with good Quality of water should be reached to each and every person in village. Population is increasing day by day, so increasing the capacity of water storage is also today's requirement. Design of village water supply infrastructure also suffers from several deficiencies, including improper design of source, poor siting of overhead tanks, wrong selection of pump capacity, poor pipe design resulting in high pressure losses, and poor layout of distribution system that does not consider geographic distribution of the population. The operation and maintenance of the scheme is also found lacking on many fronts due to lack of adequate technical knowledge, and human and financial resource at local level.

So that it is necessary to monitoring of the schemes considering only number of hamlets covered, number of households with access to water supply and type of access, and not the actual per capita water supply to individual households, quality of water supplied and frequency and reliability of water supply that are essential for achieving public health outcomes. It will give the overview of the project, that what is necessary to change or adopt new ideas in the water supply scheme so that to improve it. So that is necessary to overlook at the approaches for planning, design, operation and management and performance of rural water supply schemes. So that in this project, we have done an assessment of a village named as 'Shelarwadi' from wai. In assessment various points and aspects are monitored and considered like planning of scheme, design, operation of scheme, management, operation and maintenance of the scheme, scheme's todays condition and other things. This report will helpful to this scheme and also other schemes to understand what actually have to be done.

Accordingly, we have attended two workshops conducted by the IIT, Mumbai, CTARA and IRAP. One on Rajarambapu Institute of Technology, Islampur on 24th September, 2017 to 26th September, 2017. Second workshop on Amrutvahini College of Engineering, Sangamner on 14th January, 2018 to 15th January, 2018. Where we received all the information about project, introduction of project, methodology, what actual case study is and much more. After all these workshop knowledge we assessed a village named 'Shelarwadi' in wai.

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CHAPTER 1: INTRODUCTION

1. INTRODUCTION

Rural water supply is becoming a major considerable topic today. Today many of villages are facing the problem of improper water supply or improper quality of supplied water. As the rural area is mainly depends upon natural sources of water, it is necessary to cure the natural water sources and proper quantity of supply should be provided. Quantity of water with good Quality of water should be reached to each and every person in village. Population is increasing day by day, so increasing the capacity of water storage is also today's requirement. Design of village water supply infrastructure also suffers from several deficiencies, including improper design of source, poor siting of overhead tanks, wrong selection of pump capacity, poor pipe design resulting in high pressure losses, and poor layout of distribution system that does not consider geographic distribution of the population. The operation and maintenance of the scheme is also found lacking on many fronts due to lack of adequate technical knowledge, and human and financial resource at local level.

The criteria for assessment of performance of water supply schemes and overall water supply sector is not comprehensive enough to assess their real contribution to achieving the larger developmental goals of socio-economic advancement. The monitoring of the schemes considers only number of hamlets covered, number of households with access to water supply and types of access, and not the actual per capita water supply to individual households, quality of water supplied and frequency and reliability of water supply that are essential for achieving public health outcomes. Given this scenario, there is a need to relook at the approaches for planning design, operation and management and performance assessment of rural water supply schemes.

One key strategic intervention for reforming rural water supply sector is to have third party evaluation of water supply schemes which would help enhance the accountability of the water supply towards bringing about all round improvement in the management drinking water supply schemes-the process of planning design, operation and maintenance, and water safety and security measures.

The Water Supply and Sanitation Department (WSSD) is the primary agency concerned with rural water supply in Maharashtra. After initiating several reform measures, the department is experimenting with new institutional arrangements aimed at improving sector performance, through Unnat Maharashtra Abhiyan. UMA is an initiative of Ministry of Higher and Technical Education, whose mandate is to build an independent and public knowledge infrastructure for Maharashtra for socio-economic and cultural development of its people, especially those in the bottom of the socio-economic strata. UMA aligns with Unnat Bharat Abhiyan (UBA) of Ministry of Human Resource Development, Government of India, whose vision is to bring about "transformational change in rural development processes by leveraging knowledge institutions to help build the architecture of an inclusive India".

The objectives of UMA are to seek alignment of existing curricula and ongoing research with regional development needs, re-emphasize field work and case studies as an important part of pedagogy, provide formal mechanism for local bodies such as Zilla Parishads, Gram Panchayats, etc. to access a regional engineering college for their knowledge needs, and to obtain funding and data for the same under this programme, WSSD, Maharashtra has aims to engage teachers and students of UMA recognised engineering colleges to help in monitoring and evaluation of rural water supply schemes in collaboration with IIT-Mumbai.

1.1 CTARA: Centre for Technology Alternatives for Rural Areas

In the last two decades, our country has witnessed significant and rapid changes in several spheres and at an increasingly rapid speed. The economic reforms and the policies of liberalization, globalization, and privatization have resulted in momentous changes in perspectives, policies, and practices pertaining to technology, development, and the interrelationship between the two.

The Centre is gearing itself to face the challenges posed by these changes, through research projects as well as new academic and training programs. CTARA now has an M. Tech. Program in Technology and Development (started from July 2007) and Ph.D. Program. Apart from these programs, CTARA also offers Technology and Development Supervised Learning courses to the B.Tech students across the Institute. CTARA has over the years developed relations with various Governmental Departments at the Centre and State; Industrial Houses, Non-governmental Organizations/Community Based Organizations.
(Reference: http://www.ctara.iitb.ac.in/en/about-us)

1.2 UNNAT MAHARASHTRA ABHIYAN (UMA)

Unnat Maharashtra Abhiyan (UMA) is a project of the **Ministry of Higher and Technical Education**. Its mandate is to build an independent and public knowledge infrastructure for the state of Maharashtra which will bring socio-economic and cultural development for its people, especially those in the bottom 80% of the socio-economic strata. UMA aligns closely with the Unnat Bharat Abhiyan (UBA) mechanism of the Ministry of Human Resource Development, Government of India, whose vision is to bring about "transformational change in rural development processes by leveraging knowledge institutions to help build the architecture of an Inclusive India"

UBA is being operationalised through the UMA, since they both share the same objectives:

- To seek some alignment of curricula and research with regional development needs
- Re-emphasize field-work and case-studies as an important pedagogy
- Provide a formal mechanism for local bodies such as Zilla Parishads, Gram Panchayats, etc. to access a regional engineering college, including the IITs, for its knowledge needs, and to obtain funding and data for the same.
- Reform teaching, curricula and research to align with Development Sector Objective
- Train future professionals and align with development objectives
- Make institutions Regional Resources/ Knowledge and Innovation Centres
- Provide mechanism for citizens to approach institutions for service
- Provide mechanism for developing innovative solutions and access to District Innovation Funds
- Engage institute to government

1.3 UBA: Unnat Bharat Abhiyan:

As foreseen by Gandhi Ji in his seminal work, ‘Hind Swaraj’, the western developmental paradigm, based on centralized technologies and urbanization, has given rise to serious problems like increasing inequity (leading to crime and violence), and climate change due to rapid ecological degradation. To ameliorate these problems, it is necessary to promote development of rural areas in tune with Gandhian vision of self-sufficient ‘village republics’, based on local resources and using decentralized, eco-friendly technologies so that the basic needs of food, clothing, shelter, sanitation, health care, energy, livelihood, transportation, and education are locally met. This should be the vision of holistic development of villages. Presently, 70% of the population in India lives in rural areas engaged in agrarian economy with agriculture and allied sector employing 51% of the total work-force but accounting for only 17% of the country's GDP. There are huge developmental disconnects between the rural and urban sectors such as inequity in health, education, incomes and basic amenities as well as employment opportunities - all causing great discontent and large-scale migration to urban areas. The imperatives of sustainable development which are being felt more and more acutely all over the world also demand eco-friendly development of the villages and creation of appropriate employment opportunities locally. Increasing urbanization is neither sustainable nor desirable. So far, our professional higher education institutions have largely been oriented to cater to the mainstream industrial sector and, barring a few exceptions, have hardly contributed directly to the development of the rural sector. Unnat Bharat Abhiyan (UBA) is a much needed and highly challenging initiative in this direction.

1.4 UMA Institutes in Maharashtra:

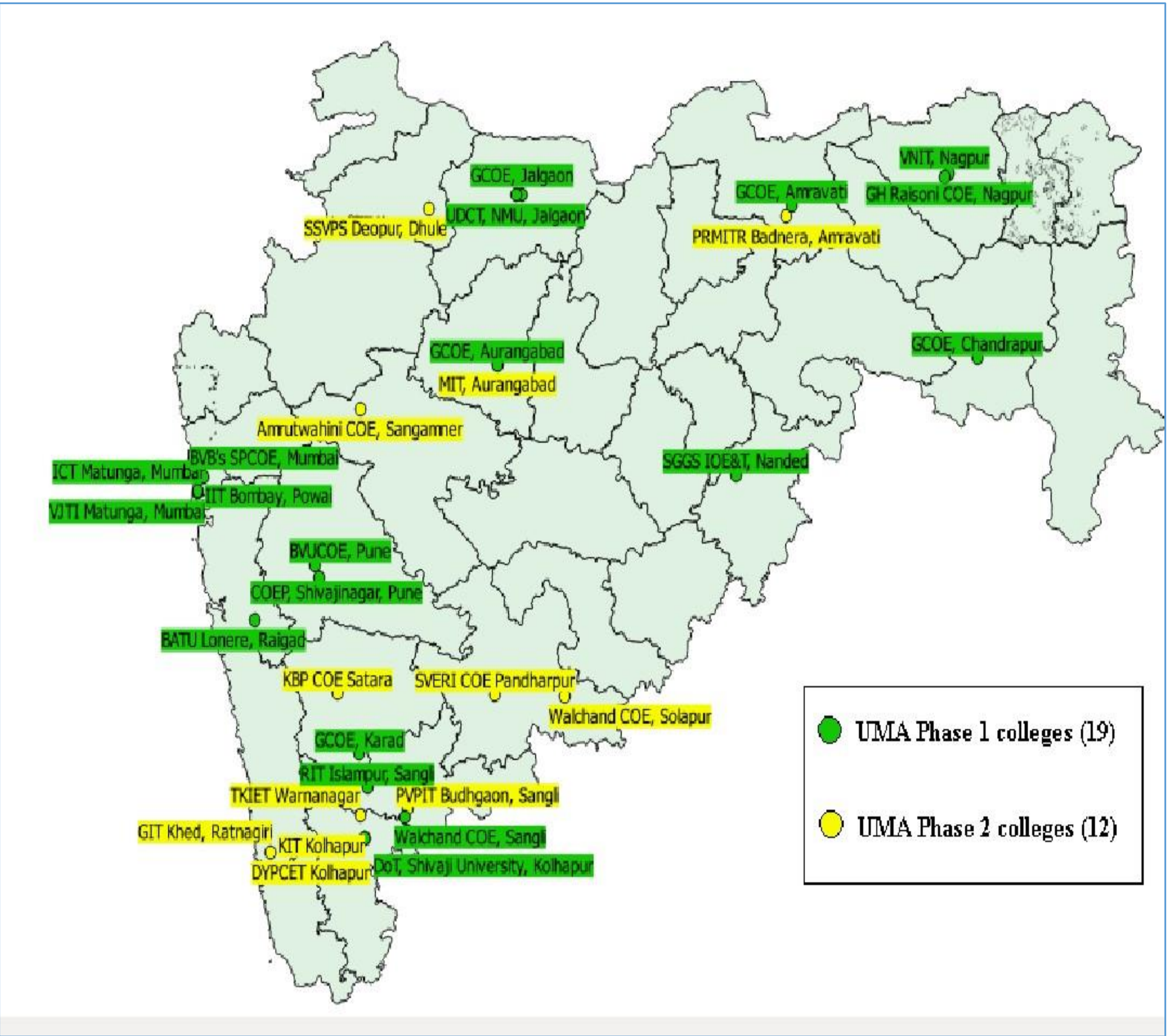

Fig.: 1.4.1 UMA institutes in Maharashtra

1.5 Technology and Development Cell (TDC) in UMA Institutes

1.5.1 An inter-disciplinary cell to-

- Engage with Government Departments, District Administration, Peoples' Representatives and Common People
- Internship, Projects and Fellowships with Case-Studies as key mechanism - water, energy, urban and rural planning, public transport, MSNA, JYS, MGNREGA
- Credits for the studies
- Provision of funds from Government Departments

1.5.2 Responsibilities of TDC

- **Facilitation** between Government bodies, Faculty, and Students
- Building a **knowledge repository** of outputs
- **Fund management** (accounts)

1.6 IRAP: Institute for Resource Analysis and Policy:

IRAP Mission is to cater to the sustainable management of natural resources for improved food security, livelihoods and environment.

1.6.1 **Objectives**:

- Design sound strategies for the management of natural resources and their related services, and interventions that promote enhanced resource based livelihoods, with due consideration to ecological integrity in urban as well as rural areas.
- Work towards appropriate policies for sustainable, equitable and productive use of natural resources, and sustainable natural resources based livelihoods in both cities and rural areas.
- Work towards evolving appropriate institutional arrangements for implementing actions for management of natural resources and their services, which also promote inter-sectorial coordination.
- Undertake policy advocacy for sustainable natural resource management systems that are people centred and based on principles of equity, productivity and resource sustainability.
- Work in partnerships with national and international organizations, wherever called for, in pursuing the organization's mission and goal.

(Reference: http://irapindia.org/mission.html)

1.7 UNICEF: The United Nations Children's Fund

UNICEF is fully committed to working with the Government of India to ensure that each child born in this vast and complex country gets the best start in life, thrives and develops to his or her full potential.

The organization began its work in India in 1949 with three staff members and established an office in Delhi three years later. Currently, it advocates for the rights of India's children in 16 states.

1.8 MERI (Maharashtra Engineering Research Institute)

The Maharashtra Engineering Research Institute (MERI) was established in the year 1959. It is the prime institute of Maharashtra state under Water Resources Department. It is entrusted with the work of applied research in various disciplines of civil engineering like soil mechanics, construction material studies, testing, highway, coastal, remote sensing & GIS, seismology, hydraulic model studies, reservoir sedimentation studies etc. It is largely dealing with field problems of applied research pertaining to various projects. Being the state research institute, its jurisdiction is spread over the entire Maharashtra state covering the water resources and public works.

(Reference: http://www.merinashik.org/ and http://www.merinashik.org/index.php/links/)

1.9 OBJECTIVES OF RURAL WATER SUPPLY SCHEME BY UMA

Overall objective is to build the capacities of Engineering College teachers and students in planning, design and monitoring the evaluation of rural water supply schemes, which is aimed at strengthening the institutional capabilities of Water Supply and Sanitation department (WSSD), Government of Maharashtra for enhanced performance of rural water supply schemes, through a structured training programme. The training focused on the following components:

1. **Extension**: Development of UMA institutes as a public knowledge infrastructure accessible to public e.g. Ability to work as Third Party Audit agency
2. **Teaching**: Enabling effective guidance of student in development sector research-Training the trainer
3. **Research**: Exposure and simulation towards emerging issue in development sector specially WASH sector
4. Reform teaching, curricula and research to align with Development Sector Objectives
5. Train future professionals and align with development objectives
6. Make institutions Regional Resources/ Knowledge and Innovation Centers
7. Provide mechanism for citizens to approach institutions for service
8. Provide mechanism for developing innovative solutions and access to District Innovation Funds

1.10 EXPECTED OUTCOMES BY UMA

- 30 Engineering college professors from 15 engineering colleges across Maharashtra are trained to use advanced concepts and practices to plan, design and carry out monitoring and evaluation of rural water supply and sanitation schemes, using the contents of the modules developed for the purpose.
- Facilitate the trainees to apply learning from the training for performance assessment (evaluation) of two existing water supply schemes in assigned district and identify concrete intervention for improvement.

CHAPTER 2.

Overview of Water Supply and Sanitation Department GR dated 15th June 2015 for Assessment of Rural Water Supply Schemes

2. Overview of Water Supply and Sanitation Department GR dated 15th June 2015 for Assessment of Rural Water Supply Schemes

2.1 Why Third Party Technical Inspection (TPI)

- Large Scale failure of GW based Piped Water Supply Schemes (60 % failure)
    - Design Issues
    - Implementation Issues
    - Social and Financial Issue
- Dysfunctional and Underperforming schemes
    - Technical problems like low pressure and water quality issues (Differential Service)
        - Maintenance and Repair Issues
        - Institutional and Governance Related Issues
    - Extension of Service due to Rapid Urbanization (Villages/Towns > 10,000 population leading to demand for reliable drinking water service)
    - Drinking Water Security in drought affected areas
        - Scarcity affected villages and Source Sustainability
        - Drinking Water Security and Management of conflicting demands
        - Water Quality Issues
    - Service Quality Improvements
        - Efficiency, Equity and Sustainability
        - Reliability of service (adequate supply with sufficient pressure)
        - Round the year guaranteed service
        - Increase no. of domestic pipe water connections

2.2 Important GRs: from official website of Government of Maharashtra (www.maharashtra.gov.in)

- ❖ **Government Resolution Number: 20100317153821001**
- ❖ **Government Resolution Number: GraPaDho-1114/Case No.22/PaPu-07, Date 09 July, 2014**
- **Reference GRs:**

1. Government Resolution Number: GraPaPu-1099/Case No.328/PaPu-07, Date 27 July, 2000
2. Government Resolution Number: GraPaPu-1001/Case No.190/PaPu-07, Date 3 September, 2001
3. Government Circular Number: GraPaPu-1002/Case No.532/PaPu-07, Date 23 March, 2002
4. Government Circular Number: GraPaPu-1006/Case No.343/PaPu-07, Date 24 November, 2006
5. Government White Paper Number: GraPaPu-1006/Case No.343/PaPu-07, Date 25 January, 2007
6. Government Resolution Number: GraPaPu-1007/Case No.243/PaPu-07, Date 4 February, 2008
7. Government Resolution Number: GraPaDho-1109/Case No.104/PaPu-07, Date 1 August, 2009
8. Government Resolution Number: GraPaDho-1109/Case No.115/PaPu-07, Date 9 September, 2009
9. Guidelines by Central Government regarding National Drinking Water Programme
10. Government Resolution Number: GraPaDho-1109/Case No.104(A)/PaPu-07, Date 17 March, 2010
11. Government Resolution Number: GraPaDho-1110/Case No.122/PaPu-07, Date 15 May, 2010
12. Government White Paper Number: GraPaDho-1109/Case No.104(A)/PaPu-07, Date 30 August, 2010
13. Government White Paper Number: GraPaDho-1111/Case No.90/PaPu-07, Date 4 June, 2011
14. Government Resolution Number: GraPaDho-1213/Case No.35/PaPu-07, Date 16 July, 2013
15. Government Resolution Number: GraPaDho-1208/Case No.52/PaPu-07, Date 9 October, 2013
16. Government Resolution Number: GraPaDho-1113/Case No.60/PaPu-07, Date 01 January, 2014
17. Government Resolution Number: GraPaDho-1113/Case No.156/PaPu-07, Date 22 January, 2014

- ❖ **Govt. Resolution No.: Gra.Pa.Dho.- 1114 / Case No.61 / Pa.Pu.-07, Date 15 June, 2015**
- **Reference GRs:**
    1. Govt. Resolution No.: Gra.Pa.Dho.- 1114 / Case No.22 / Pa.Pu.-07, dated 9 July, 2014
    2. Govt. Resolution No.: Gra.Pa.Dho.- 1109 / Case No.104(A) / Pa.Pu.-07, dated 17 March, 2010

2.3 Government Resolution: Figures showing Government Resolutions:

राज्यातील अभियांत्रिकी महाविद्यालये तसेच तंत्रनिकेतने व अन्य शैक्षणिक व संशोधन संस्थामधील विद्यार्थ्यांना राज्याच्या विकासात सहभागी करुन घेण्याची योजना...

महाराष्ट्र शासन
उच्च व तंत्र शिक्षण विभाग
शासन निर्णय क्रमांक : बैठक- ३६११/(५६/१५)/तांशि २
मंत्रालय विस्तार भवन, मुंबई ४०० ०३२.
दिनांक : १३ जानेवारी, २०१६

<u>संदर्भ</u> :- शासन निर्णय क्रमांक : बैठक- ३६११/(५६/१५)/तांशि २, दिनांक २८/४/२०१५

<u>प्रस्तावना :-</u>

राज्यातील विविध सामाजिक व विकासाशी संबंधित प्रश्नांची संशोधनाव्दारे उकल करुन त्यावर अचूक उपाययोजना शोधणे आवश्यक आहे. त्या दृष्टीने विविध शासकीय यंत्रणा व शैक्षणिक संस्था यांच्या दरम्यान विशेषत: सामाजिक व आर्थिक स्वरुपाच्या महत्त्वाच्या गंभीर समस्यांसंदर्भातील संशोधन वृध्दिंगत करण्यासाठी आणि विविध प्रकल्प निहाय निरनिराळया योजनांमध्ये अभियांत्रिकी तसेच अन्य व्यावसायिक अभ्यासक्रमांसाठी शिक्षण घेणाऱ्या विद्यार्थ्यांचा सहभाग वाढविणे आवश्यक आहे.

२. देशातील ग्रामीण क्षेत्रातील विकास कामांमध्ये आय.आय.टी. सारख्या प्रगत शैक्षणिक संस्थांचा सहभाग वाढवून परिवर्तन घडविण्यासाठी केंद्र शासनामार्फत उन्नत भारत अभियान देशातील निवडक, प्रगत शैक्षणिक संस्थांमार्फत राबविण्यात येत आहे. याच धर्तीवर महाराष्ट्र राज्यात देखील अभियांत्रिकी महाविद्यालये, तंत्रनिकेतने आणि अन्य उच्च शिक्षण संस्थांमध्ये सुरु असलेले संशोधन हे अधिकाअधिक राज्यातील विविध सामाजिक व विकासाशी निगडीत दैनंदिन जीवनातील समस्यांची (उदा. ग्रामीण योजनातंर्गत ग्राम स्वच्छता, शौचालये, सांडपाणी व्यवस्थापन, पेयजल, रस्ते विकास, रस्त्याचे मुल्यांकन करुन मजबूतीकरण, जलसंधारण, इंधन व उर्जा, आरोग्य, दुष्काळ आदी) उकल करुन ते लोकाभिमुख करणे गरजेचे आहे. या संस्थांमधील संशोधन तसेच कुशल मनुष्यबळ वापरुन सामाजिक क्षेत्रातील विकासाच्या समस्यांवर उचित तंत्रज्ञानाच्या वापराने तोडगा

योजनांच्या मूल्यमापनासाठी नामांकित बाह्यस्थ संस्थांची नामिका सूची (Empanelment) तयार करणेबाबत.

महाराष्ट्र शासन
नियोजन विभाग
शासन निर्णय क्रमांक : मुमाअ १०१६/प्र.क्र. ७८/का-१४१७
मंत्रालय, मुंबई - ३२
दिनांक : २२ जुलै, २०१६

<u>प्रस्तावना</u> :

राज्याच्या सर्वांगीण विकासासाठी विविध प्रशासकीय विभाग व त्यांच्या क्षेत्रिय कार्यालयांमार्फत सुमारे १८०० योजना राबविल्या जातात. या योजनांचे राज्यस्तरीय व जिल्हास्तरीय असे दोन प्रकारात वर्गीकरण करण्यात आले आहे. राज्याच्या विकासात्मक योजनांची अंमलबजावणी व संनियंत्रण संबंधित विभागामार्फत होत असते. तथापि, विकासात्मक योजनांच्या उद्दिष्टांची पूर्तता व योजना राबविताना येणाऱ्या अडचणी / त्रुटी जाणुन घेण्यासाठी त्रयस्थ संस्थांकडून योजनांचे मूल्यमापन करणे आवश्यक असते. सद्य:स्थितीत नियोजन विभागाच्या अधिपत्याखालील अर्थ व सांख्यिकी संचालनालयामार्फत सिमीत प्रमाणात योजनांचे मूल्यमापन करण्यात येते. मूल्यमापनाची व्याप्ती वाढविण्याच्या दृष्टीने तसेच नमुना पाहणी व सांख्यिकी विषयाबाबत शासनाच्या विभागांना व कार्यालयांना सल्ला देऊ शकेल अशा सक्षम व नामांकित संस्थांची नामिका सूची (Empanelment) तयार करण्याचे शासनाच्या विचाराधीन होते. यास्तव, नामांकित संस्थांची नामिका सूची (Empanelment) तयार करण्यासाठी या क्षेत्रातील तज्ञांची व अधिकाऱ्यांची समिती गठीत करुन, विहीत पध्दतीने निवड प्रक्रिया राबविण्यात आली.

<u>शासन निर्णय</u> :

या शासन निर्णयाच्या परिशिष्ट-१ मध्ये नमूद केलेल्या संस्थांच्या नामिका सूचीस या शासन निर्णयान्वये ५ वर्षासाठी मान्यता देण्यात येत आहे. नामिका सूचीतील संस्थांचे अनुभव व क्षमता यांचा

ग्रामीण पाणी पुरवठा योजनांच्या त्रयस्थ तांत्रिक परिक्षणासाठी मार्गदर्शक सूचना.

महाराष्ट्र शासन
पाणी पुरवठा व स्वच्छता विभाग
शासन निर्णय क्रमांकः ग्रापाधो-१११४/प्र.क्र.६१/पापु-०७
७ वा मजला, गोकुळदास तेजपाल रुग्णालय इमारत संकुल, मंत्रालय,
मुंबई-४०० ००१
तारीख: १५ जून, २०१५

<u>वाचा</u> :

१) **शासन निर्णय क्रमांकः** ग्रापाधो-१११४/प्र.क्र.२२/पापु-०७, दिनांक ९ जुलै,२०१४
२) **शासन निर्णय क्रमांकः** ग्रापाधो-११०९/प्र.क्र.१०४(अ)/पापु-०७, दिनांक १७ मार्च,२०१०

<u>प्रस्तावना</u> :

ग्रामीण पाणी पुरवठा व स्वच्छता क्षेत्रात सुधारणा तसेच विकेंद्रीकरण घडवून आणण्यात महाराष्ट्र राज्य देशात अग्रेसर आहे. राज्याच्या ११२.४ दशलक्ष लोकसंख्येपैकी ६१.८ दशलक्ष (सुमारे ५५%) लोकसंख्या ग्रामीण भागात राहते. राज्याचा लोकसंख्येच्या दृष्टिने देशात दुसरा तर क्षेत्रफळाच्या बाबतीत तिसरा क्रमांक लागतो. राज्यात ३३ जिल्हे असून त्यामध्ये २८,८१३ ग्रामपंचायतींचा व सुमारे ९८,८४२ वस्त्यांचा समावेश होतो.

राज्य शासनाच्या पाणी पुरवठा व स्वच्छता विभागामार्फत पाणी पुरवठा व स्वच्छता विषयक

Guidelines for third party technical inspection of Rural water supply schemes.

Government of Maharashtra
Water Supply and Sanitation Department
Govt. Resolution No.: Gra.Pa.Dho.- 1114 / Case No.61 / Pa.Pu.-07
7th Floor, Gokuldas Tejpal Hospital Building Complex, Mantralaya,
Mumbai - 400 001
Date: 15 June, 2015

<u>**Read:**</u>

1) **Govt. Resolution No.:** Gra.Pa.Dho.- 1114 / Case No.22 / Pa.Pu.-07, dated 9 July, 2014
2) **Govt. Resolution No.:** Gra.Pa.Dho.- 1109 / Case No.104(A) / Pa.Pu.-07, dated 17 March, 2010

<u>**Foreword:**</u>

The state of Maharashtra is leading in the field of improvements and decentralisation of rural water supply and sanitation. Out of the population of 112.4 million in the state, 61.8 million people (approximately 55%) live in rural areas. The state ranks second in terms of population and third in terms of area. There are 33 districts in the state, including 28,813 Gram Panchayats and approximately 98,842 dwellings.

CHAPTER 3:
WORKSHOP ATTENDED ON RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR

3. Workshop was attended on Rajarambapu Institute of Technology, Rajaramnagar, Islampur on 24th September, 2017 to 26th September, 2017.

- **Conducted by: IRAP** (Institute for Resource Analysis and Policy)
  CTARA (Centre for Technology Alternatives for Rural Areas)
  UNICEF, Mumbai

- Workshop in Rajarambapu Institute of Technology, Rajaramnagar, Islampur, Dist.: Sangali
- **Guests**: Abhijeet Raut (Chief Guest)
  Dr.Dinesh Kumar (Institutive Director, IRAP)
  P.D.Kumbhar (IIT Bombay)
  Raj Desai
  Anand Ghodke

Date: 24th September, 2017 to 26th September, 2017

3.1 WORKSHOP IMAGES:

Image 1. DR. Anand Tapase sir discussing with


unicef

CHAPTER 4:
INTRODUCTION TO RURAL WATER SUPPLY IN MAHARASHTRA

4. INTRODUCTION TO RURAL WATER SUPPLY IN MAHARASHTRA:

4.1Rural Water Supply in Maharashtra State

Rural India has more than 700 million people residing in about 1.42 million habitations spread over 15 diverse ecological regions. Meeting the drinking water needs of such a large population can be a daunting task. The non-uniformity in level of awareness, socio-economic development, education, poverty, practices and rituals and water availability add to the complexity of the task. Despite an estimated total of Rs. 1,105 billion spent on providing safe drinking water since the First Five Year Plan was launched in 1951, lack of safe and secure drinking water continues to be a major hurdle and a national economic burden. Around 37.7 million Indians are affected by waterborne diseases annually, 1.5 million children are estimated to die of diarrhoea alone and 73 million working days are lost due to waterborne disease each year. The resulting economic burden is estimated at $600 million a year. While 'traditional diseases' such as diarrhoea continue to take a heavy toll, 66 million Indians are at risk due to excess fluoride and 10 million due to excess arsenic in groundwater. In all, 195813 habitations in the country are affected by poor water quality. It is clear that the large investments have not yielded comparable improvements in health and other socio-economic indicators. Water Resources and Utilisation

- India has 16 per cent of the world's population and four per cent of its fresh water resources.
- Estimates indicate that surface and ground water availability is around 1,869 billion cubic metres (BCM). Of this, 40 per cent is not available for use due to geological and topographical reasons.
- Around 4,000 BCM of fresh water is available due to precipitation in the form of rain and snow, most of which returns to the seas via rivers.
- Ninety two per cent groundwater extracted is used in the agricultural sector, five and three per cent respectively for industrial and domestic sector.
- Eight nine per cent of surface water use is for agricultural sector and two per cent and nine per cent respectively are used by the industrial and domestic sector. While on the one hand the pressures of development are changing the distribution of water in the country, access to adequate water has been cited as the primary factor responsible for limiting development. The average availability of water remains more or less fixed according to the natural hydrological cycle but the per capita availability reduces steadily due to an increasing population.
- In 1955, the per capita availability was 5,300 cubic metres (cu.m) per person per year, which came down to 2,200 cu. m in 1996.
- It is expected that by around 2020, India will be a *'water stressed'* state with per capita availability declining to 1600 cu m/person/year.4 A country is said to be water stressed when the per capita availability of water drops below 1700 cu. m/person/year

4.2RURAL WATER SUPPLY

The provision of clean drinking water has been given priority in the Constitution of India, with Article 47 conferring the duty of providing clean drinking water and improving public health standards to the State. Rural water supply (RWS) programmes in India can be divided into several distinct phases

Early Independence (1947-1969)

1949: The Environment Hygiene Committee (1949) recommends the provision of safe water supply to cover 90 per cent of India's population in a timeframe of 40 years.

1950: The Constitution of India confers ownership of all water resources to the government, specifying it as a state subject, giving citizens the right to potable water.

1969: National Rural Drinking Water Supply programme launched with technical support from UNICEF and Rs.254.90 crore is spent during this phase, with 1.2 million bore wells being dug and 17,000 piped water supply schemes being provided.

Transition from technology to policy (1969-1989)

1972-73: Introduction of the Accelerated Rural Water Supply Programme (ARWSP) by the Government of India to assist states and union territories to accelerate the pace of coverage of drinking water supply.

1981: India as a party to the International Drinking Water Supply and Sanitation Decade (1981-1990) declaration sets up a national level Apex Committee to define policies to achieve the goal of providing safe water to all villages.

1986: The National Drinking Water Mission (NDWM) is formed.

1987: Drafting of the first National Water Policy by the Ministry of Water Resources.

Restructuring phase (1989-1999)

1991: NDWM is renamed the Rajiv Gandhi National Drinking Water Mission (RGNDWM).

1994: The 73rd Constitutional Amendment assigns panchayati raj institutions (PRIs) the responsibility of providing drinking water.

1999: For ensuring sustainability of the systems, steps are initiated to institutionalize community participation in the implementation of rural drinking water supply schemes through sector reform. Sector reform ushers in a paradigm shift from the 'Government-oriented supply-driven approach' to the 'People-oriented demand-responsive approach'. The role of the government is envisaged to change from that of service provider to facilitator. Under reform, 90 per cent of the infrastructure is funded by the government, with the community contributing 10 per cent of the remaining infrastructure cost and 100 per cent of operation and maintenance costs. Sector reforms projects were introduced in 67 districts across the country on pilot basis.

1999: Total Sanitation Campaign (TSC) as a part of reform principles initiated in 1999 to ensure sanitation facilities in rural areas with broader goal to eradicate the practice of open defecation. As part of the programme, a nominal subsidy in the form of incentive is given to rural poor households for construction of toilets. TSC gives strong emphasis on Information, Education and Communication, Capacity Building and Hygiene Education for effective behaviour change with involvement of PRIs, CBOs, and NGOs

Consolidation phase (2000 onwards)

2002: Nationwide scaling up of sector reform in the form of Swajaldhara.

2002: The National Water Policy is revised, according priority to serving villages that did not have adequate sources of safe water and to improve the level of service for villages classified as only partially covered.

2002: India commits to the Millennium Development Goals to halve by 2015, from 1990 levels, the proportion of people without sustainable access to safe drinking water and basic sanitation.

2004: All drinking water programmes are brought under the umbrella of the RGNDWM.

2005: The Government of India launches the Bharat Nirman Programme for overall development of rural areas by strengthening housing, roads, electricity, telephone, irrigation and drinking water infrastructure. The target is to provide drinking water to 55,069 uncovered habitations; those affected by poor water quality and slipped back habitations based on 2003 survey, within five years.

2007: Pattern of funding under the Swajaldhara Scheme changes from the previous 90:10 central-community share to 50:50 centre-state share. Community contribution is now optional. The approach paper for the 11th Five Year Plan calls for a comprehensive approach which encompasses individual health care, public health, sanitation, clean drinking water, access to food and knowledge about hygiene and feeding practice. It also states the need to upscale more schemes related to community management of water reducing the maintenance burden and responsibility of the state. It is envisaged to provide clean drinking water for all by 2009 and ensure that there are no slip-backs by the end of the 11th Plan. (www.wateraid.org)

- NRDWP focus was on ensuring water availability in rural areas (Potability, adequacy, affordability and equitable distribution).
- NRDWP adopted a decentralised approach in planning, implementation and O&M of rural water supply schemes.
- NRDWP adopted following norms:
- 40 Lpcd of safe drinking and domestic water for human beings
- 30 Lpcd additional for cattle in the Desert Development Programme areas
- One hand-pump or stand post for every 250 persons
- Water source to be made available within the habitation or within 1.6 km in the plains and within 100 m elevation in the hilly areas.
- Major difference ARWSP and NRDWP was the later focus on 'household level' for drinking water supply coverage.

4.3Maharashtra State

The State of Maharashtra is one of the most industrialized with strong social and economic growth. The State is divided into 6 administrative divisions, namely Konkan, Pune, Nashik, Aurangabad, Nagpur and Amravati. The State has a total of 36 districts and 353 blocks. Out of these, Mumbai and Mumbai Suburban are two urban districts and the remaining 34 are rural districts.

A basic summary of the State is as follows:

- Capital – Mumbai
- Administrative Divisions - Six
- Districts – 36 (Rural 34, Urban 2)
- Block Panchayats – 353
- Gram Panchayats – 27,918
- No of Habitations – 86881

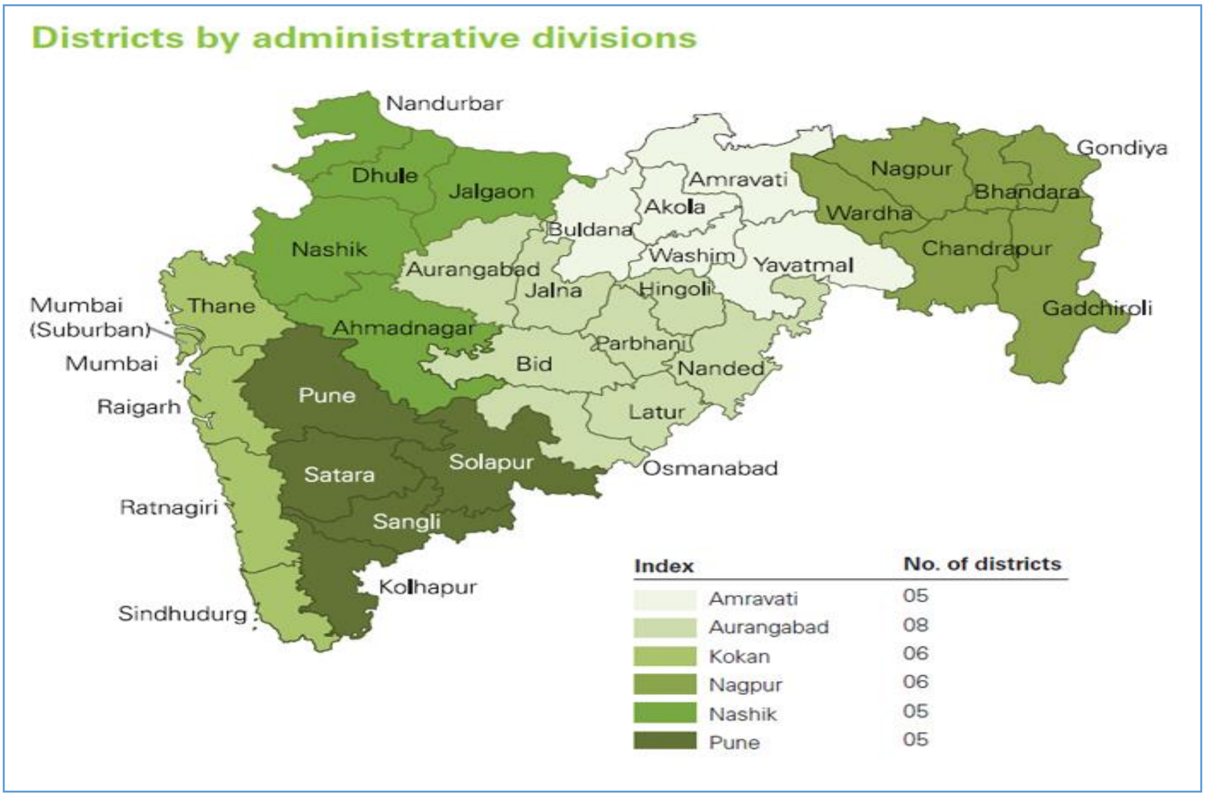

Fig.:4.3.1 Districts of Maharashtra by Administrative divisions

(Source- www.hetv.org/india/mh/map.htm)

As per the Census 2011, the State has total a population of 11.24 crores. It was 9.69 crores in 2001. Between 2001 and 2011, the population growth rate was 15.99%. The population density is 365 persons per sq. km in 2011as against 315 in 2001 in Maharashtra. The share of urban population increased from 42.4% in 2001 has increased to 45.2% during

2011. This indicates to a pattern of urbanization in the State. The key socio-demographic characteristics of the State are summarized below:

- Decadal growth rate of Population (2001-2011)– 15.99%
- Sex ratio (Census 2011)- 929
- Population density (Census 2011) – 365 per sq.km.
- Literacy rate (Census 2011) - 82.3%
- Female literacy – 69.9% & Male literacy – 88.4%
- IMR (SRS 2013) - 24
- MMR (SRS 2010-12) – 87

Maharashtra has faced several droughts in the past from time to time due to failure of monsoon or erratic pattern of rainfall. There are more than 70 talukas in 11 districts facing chronic drought conditions. This has created severe drinking water scarcity in many of these areas due to which villages in these areas have been depending on supply of drinking water by tankers and bullock carts. Besides this, many other areas face drinking water scarcity in spite of good rainfall. A variety of solutions have been explored to mitigate the risks with drinking water security. One such attempt under the present study was focused on piped water schemes for supplying water to tanker fed villages in their vicinity.

4.4 Surface & Ground Water Resources

Rainfall differs widely between various regions of the State. The Western Ghats and coastal districts receive an average annual rainfall of 2000mm, while the large part of the State lying in the rain shadow area receives an average rainfall of 600 to 700mm. The State receives about 85% of its rainfall from the South-West monsoon during June to September. The 75% of drainage of the State's area chiefly occurs through the eastward flowing rivers Godavari and Krishna to the Bay of Bengal and the rest of the area drains into the westward flowing rivers like the Narmada, Tapi and coastal rivers in Konkan rivers to the Arabian Sea. The state is divided into 5 major river basins namely, Godavari, Krishna, Tapi, Narmada and west flowing rivers of Konkan coastal strip. Annual average water available yield for entire the State of Maharashtra drained by above river basins is about 163820 Mm3. The four river basins in the Western Ghats namely Krishna, Godavari, Tapi and Narmada contribute 55% of the dependable yield. These four river basins comprise 92% of the cultivable land and more than 60% of the population in rural areas. The rest of 45% of state's surface water flows through the west flowing rivers emanating from the Ghats and drains into the Arabian Sea, which is not utilized due to geological constraints. Availability of ground water in the State is limited because of the hard rock presence over 92% of its area. Other factors which influence limitations in the availability of ground water are the peculiar physiography of the region and wide variations in the rainfall. The State's estimated rechargeable fresh groundwater resource is about 33.95 BCM and the net available ground water is about 32.15 BCM. The present gross groundwater draft for all purposes is 17.18 BCM. The Stage of groundwater development for the State, as whole, is 53%. This indicates that on an average 53% of yearly replenish able groundwater is being used in the State. Out of 353 Talukas, 325 are categorized as Safe, 16 Semi-Critical, 2 Critical and 10 Over-Exploited (GSDA, 2014).

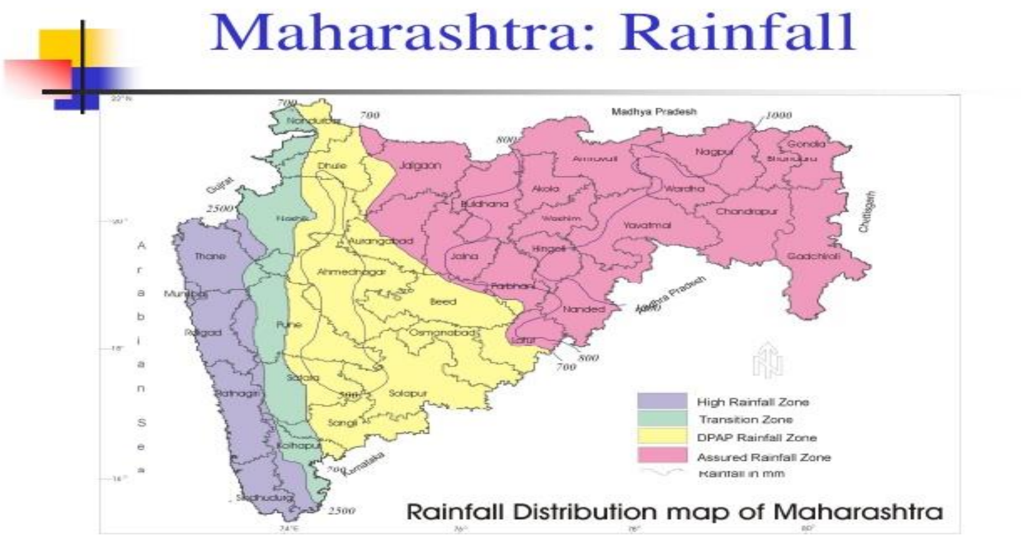

Fig. 4.4.1 Maharashtra: Rainfall Distribution Map

(https://gsda.maharashtra.gov.in/ataglance.html)
(www.h3danieledance.com/index.php?=maharashtra-map)

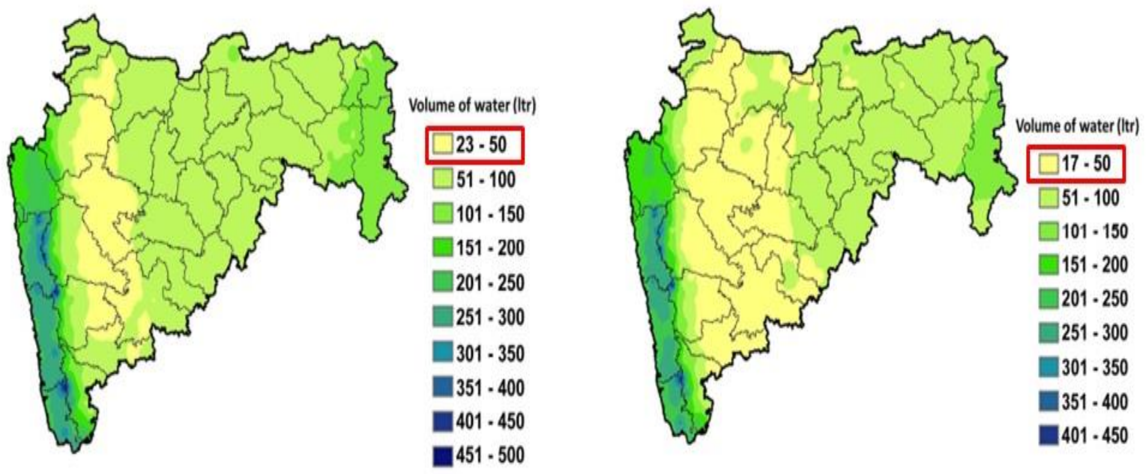

Fig. 3 Rain water potential in litre/sqft map for the southwest monsoon season **Fig. 4** Annual rain water potential in litre/sqft map

Fig. 4.4.2 Rain Water Potential in litre/Sqft map for the southwest monsoon season and Annual rain water potential in litre/sqft map

(https://www.google.co.in/amp/s/sandrp.wordpress.com/2016/12/16/imd-estimates-rainwater-harvesting-potential-of-maharashtra/amp/)

4.5 RIVERS IN MAHARASHTRA:

4.5.1 Krishna River

The Krishna River is the fourth-biggest river in terms of water inflows and river basin area in India, after the Ganga, Godavari and Brahmaputra. The river is almost 1,300 kilometres long. The river is also called Krishnaveni.

Length: 1,400 km

Source: Mahableshwar

Basin: 258,948 km^2 (99,980 sq.me.)

Country: India

Mouths: Hamsaladeevi, Bay of Bengal

Bridges: Penumudi-Puligadda Bridge

4.5.2 Koyna River

Tributary in India

The Koyna River is a tributary of the Krishna River which originates in Mahableshwar, Satara district, western Maharashtra, India. It rises near Mahableshwar, a famous hill station in the Western Ghats.

Length: 130 km

Country: India

Mouth: Krishna River

4.5.3 Nira River

River in India

Nira is a river flowing through the Indian state of Maharashtra. It is a tributary of Bhima river and flows through Pune District, Pune and Solapur districts of Maharashtra. Karha is a tributary of Nira.

Source: shirgaon (bhor)

Country: India

Mouth: Krishna River

District: Pune

4.5.4 Venna River

Tributary

The Venna River rises in Mahableshwar, and is a tributary of the Krishna River in Satara district of western Maharashtra, India. It rises near Mahableshwar, a famous hill station in the Western Ghats.

Length: 130 km (81 mi)

4.6 DAMS IN SATARA DISTRICT:

4.6.1 Dhom Dam:

- Dhom Dam

Dhom Dam

Distance -	44 Km from Satara
Storage - Gross	13.50 TMC
Live	331.05 mm3
Dead	51.27 mm3
Command Area	32925 Hect
Year of completion	1978
Hydro Ele.Proj.	1 Mw , 2 Unit

Fig. 4.6.1 Dhom dam

Dhom Dam, is an earth fill and gravity dam on Krishna-river near Wai in state of Maharashtra in India.

Specifications: The height of the dam above lowest foundation is 50 m (160 ft.) while the length is 2,478 m (8,130 ft.). The volume content is 6,335 km^3 (1,520 cu mi) and gross storage capacity is 13.80 TMC or 382,270.00 km^3 (91,711.45 cu mi).

- **Purpose: Irrigation-** The construction of this dam started at 1976. The major purpose of this dam is the supply of water to the agriculture, to the industries, and for the drinking water supply to the majorly for Wai, Panchgani-Mahableshwar and the surrounding villages on the bank of dam. This dam was supplied the water to agricultural land of the Wai, Koregaon, Satara, Javli and Khandala talukas. The catchment area dams the Krishna River and forms the Dhom Lake which is approximately 20 km (11 mi) in length. Completed in 1982, it is one of the largest civil engineering projects commissioned after Indian independence. The Dhom electricity project is run by the Maharashtra State Electricity Board. Dhom dam made the lake to the storage capacity of 14 T.M.C.
- **Hydroelectricity**: The Dhom generates the electricity of 4 MG from the basement electricity house.

- **Village Accessibility:**

Dhom is a Village in Wai Taluka, Satara District, and Maharashtra State. Dhom is 7.9 km distance from its Taluk Main Town Wai. Dhom is 37.9 km distance from its District Main City Satara. And 155 km distance from its State Main City Mumbai. .

Other villages in Wai Taluk are Wai, Akoshi, Amrutwadi, Anandpur - Chorachiwadi, Anavadi, Anpatwadi,

Nearby villages are Varkhadwadi (1.5 km), (Eksar-1.5 km) Boriv (0.5 km), Abhepuri (1.9 km), Pandewadi (2.5 km), Velang (2.5 km). Nearby towns are Wai (7.9 km), Jawali (18.5 km), Mahableshwar (18.9 km), Khandala (21.9 km).

Dhom Pin Code is 412803 and Post office name is. Other villages in (412803) are Wai, Vasole, Akoshi, Bhogaon, Dhom.

Reference: https://en.wikipedia.org/wiki/Dhom_Dam

4.6.2 KOYANA DAM

1. Irrigation Projects :

- Koyna Dam

Koyna Dam

Distance -	*98 Km from Satara*
Storage - Gross	*98.78 TMC*
Live	*93.65 TMC*
Dead	*5.125 TMC*
Length	*807.22 m*
Height	*85.35 m*
Year of completion	*1963*
Hydro Ele.Proj.	*1920 MW.*

Fig. 4.6.2. Koyana Dam

The **Koyna Dam** is one of the largest dams in Maharashtra, India. It is a rubble-concrete dam constructed on Koyna River which rises in Mahableshwar, a hill station in Sahyadri ranges. It is located in Koyna Nagar, Satara district, nestled in the Western Ghats on the state highway between Chiplun and Karad.

- **DETAILS**:

The main purpose of the dam is hydroelectricity with some irrigation in neighboring areas. Today the Koyna Hydroelectric Project is the largest completed hydroelectric power plant in India having a total installed capacity of 1,920 MW. Due to its electricity generating potential Koyna-river is considered as the 'life line of Maharashtra'.

The spillway of the dam is located at the center. It has 6 radial gates. The dam plays a vital role of flood controlling in monsoon season.

The catchment area dams the Koyna-river and forms the Shivasagar Lake which is approximately 50 km (31 mi) in length. It is one of the largest civil engineering projects commissioned after Indian independence. The Koyna hydro-electric project is run by the Maharashtra State Electricity Board.

The dam has withstood many earthquakes in the recent past, including the devastating 1967 Koynanagar earthquake, resulting in the dam developing some cracks. After the disaster grouting of the cracks was done. Also internal holes were drilled to relieve the hydrostatic pressures in the body of the dam. Indian scientific establishment has formulated an ambitious project to drill a deep borehole in the region and intensely study the earthquake activity. This would help in better understanding and possible forecast of earthquakes. The proposal is to drill up to 7 km and study the physical, geological and chemical processes and properties of the reservoir triggered earthquake zone in real time. It would be an international project to be led by Indian scientists.

In 1973 the non-overflow portion of the dam was strengthened, followed by strengthening the spillway section in 2006. Now the dam is expected to be safe against any future earthquake, including ones with a higher intensity than that of 1967.

REFERENCE: https://en.wikipedia.org/wiki/Koyna_Dam

4.6.3 Mhaswad Dam:

Mhaswad dam, (also called **Rajewadi dam**) is an earth fill dam on Man River near Maan, Satara district in the state of Maharashtra in India.
Specification: The height of the dam above lowest foundation is 24 m (79 ft.) while the length is 2,473 m (8,114 ft.). The gross storage capacity is 47,880.00 km^3 (11,487.02 cu mi)
Purpose: irrigation
Preference: https://en.wikipedia.org/wiki/Mhaswad_Dam

4.6.4 Morana Dam:

Morana (Gureghar) Dam, is an earth fill dam on Morana-river near Patan, Satara district in the state of Maharashtra in India.
Specification: The height of the dam above lowest foundation is 47.02 m (154.3 ft.) while the length is 420 m (1,380 ft.). The gross storage capacity is 39,550.00 km^3 (9,488.55 cu mi)
Purpose: Irrigation

4.6.5 **Morana Gureghar Dam**: **Morna Dam**, also called as **Gureghar dam**, is an earth fill dam on local-river near Patur, Satara district in the state of Maharashtra in India.
Specification: height of the dam above lowest foundation is 28.65 m (94.0 ft.) while the length is 600 m (2,000 ft.). The volume content is 1,109 km^3 (266 cu mi) and gross storage capacity is 44,740.00 km^3 (10,733.70 cu mi)
Purpose: Irrigation

4.6.6 Uttarmand Dam:

Uttarmand Dam, is an earth fill dam on Uttarmand-river near Patan, Satara district in the state of Maharashtra in India.
Specification: The height of the dam above its lowest foundation is 46.45 m (152.4 ft.) while the length is 1,389 m (4,557 ft.). The volume content is 0 km^3 (0 cu mi) and gross storage capacity is 24,925.00 km^3 (5,979.83 cu mi).
Purpose: Irrigation

4.6.7 Veer Dam:

Veer Dam is one of the important dams in Maharashtra, India. It is a rubble-concrete dam constructed on Nira River. It is located in near Shirwal, Satara district. The water is mainly used for irrigation and farming. The dam is located around 70 km from Pune. This place offers a good stretch of 7-8 km along the river Nira. This entire belt along the river is extremely rich with Avifauna.
Details: The main purpose of the dam is hydroelectricity with some irrigation in neighbouring areas. It is at the border of Pune district and Satara district. Veer Dam has now become a key bird-watching spot around Pune. This includes the Bar-headed Geese & Demoiselle Cranes. There are over 170 different species of birds at Veer Dam. Also there are waders, raptors as well as flycatchers in and around Veer Dam.

4.6.8 Yeralwadi Dam:

Yeralwadi Dam, is an earth fill dam on Yerala-river near Khatav, Satara district in the state of Maharashtra in India.
Specification: The height of the dam above its lowest foundation is 19.5 m (64 ft.) while the length is 2,115 m (6,939 ft.). The volume content is 663 km^3 (159 cu mi) and gross storage capacity is 33,020.00 km^3 (7,921.92 cu mi)
Purpose: Irrigation

4.6.9 Kanher Dam:

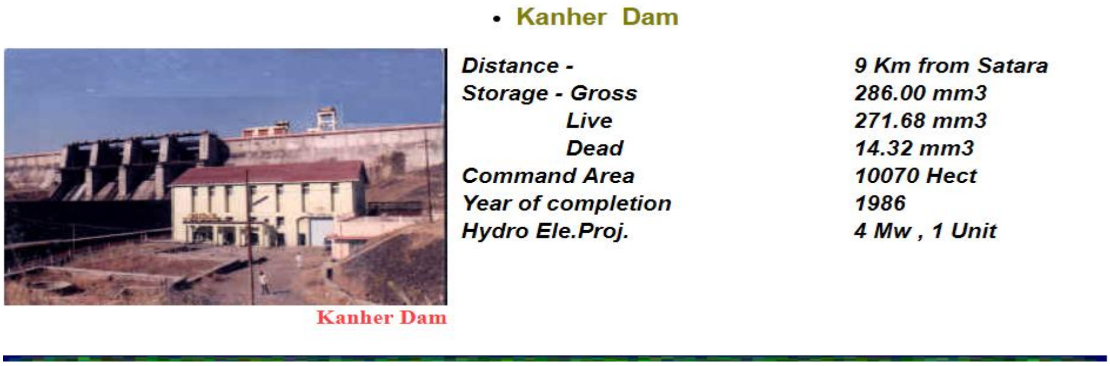

Fig. 4.6.9 Kanher Dam

CHAPTER 5:
POPULATION FORCASTING

5 POPULATION FORECASTING

5.1.1 Introduction

India is the second most populous country in the world. And the rate of increase in population is also high. It indicates the need of precise calculation of the future population. For the successful design of the structures related to public use on a larger scale there is need to consider the most probable future population. Inaccurate or unsuitable methods of the population forecasting when used may result in increased cost of the construction or unable to satisfy the project requirements. There are various methods used for forecasting the population each assuming various factors and assumptions. Each method gives the different value of future population. An attempt is made in this paper to compare the population of Pune district of year 2011 with the calculated population of the same year by five different methods. The populations of year 1971 to year 2001 were taken for calculation purpose. The population of Pune district consisted of populations of the villages and small towns even involved in the district. So no method is perfectly suitable for the conditions.

Design of water supply and sanitation scheme is based on the projected population of a Particular city, estimated for the design period. Any underestimated value will make system inadequate for the purpose intended; similarly overestimated value will make it costly. Changes in the population of the city over the years occur, and the system should be designed taking into account of the population at the end of the design period.

Factors affecting changes in population are:

- increase due to births
- decrease due to deaths
- increase/ decrease due to migration
- Increase due to annexation.

The present and past population record for the city can be obtained from the census population records. After collecting these population figures, the population at the end of design period is predicted using various methods as suitable for that city considering the growth pattern followed by the city.

5.2 METHODS

5.2.1 ARITHMETICAL INCREASE METHOD

This method is suitable for large and old city with considerable development. If it is used for small, average or comparatively new cities, it will give lower population estimate than actual value. In this method the average increase in population per decade is calculated from the past census reports. This increase is added to the present population to find out the population of the next decade. Thus, it is assumed that the population is increasing at constant rate. Hence, dP/dt = C i.e., rate of change of population with respect to time is constant. Therefore, Population after nth decade will be Pn= P + n.C Where, Pn is the population after 'n' decades and 'P' is present population.

Example: Predict the population for the year 2021, 2031, and 2041 from the following population data.

Year	1961	1971	1981	1991	2001	2011
Population	8,58,545	10,15,672	12,01,553	16,91,538	20,77,820	25,85,862

Solution

Year	Population	Increment
1961	858545	-
1971	1015672	157127
1981	1201553	185881
1991	1691538	489985
2001	2077820	386282
2011	2585862	508042

Average increment = **345463**
Population forecast for year 2021 is,
P2021 = 2585862 + 345463 x 1= **2931325**
Similarly, P2031 = 2585862 + 345463 x 2 = **3276788**
P2041 = 2585862 + 345463 x 3= **3622251**

5.2.2 GEOMETRICAL INCREASE METHOD (OR GEOMETRICAL PROGRESSION METHOD)

In this method the percentage increase in population from decade to decade is assumed to remain constant. Geometric mean increase is used to find out the future increment in population. Since this method gives higher values and hence should be applied for a new industrial town at the beginning of development for only few decades. The population at the end of nth decade 'Pn' can be estimated as: Pn = P (1+ IG/100) n (2) Where, IG = geometric mean (%) P = Present population N = no. of decades.

Example

Considering data given in example 1 predict the population for the year 2021, 2031, and 2041 using geometrical progression method.

Solution

Year	Population	Increment	Geometrical increase Rate of growth
1961	858545	-	
1971	1015672	157127	(157127/858545) = 0.18
1981	1201553	185881	(185881/1015672) = 0.18
1991	1691538	489985	(489985/1201553) = 0.40
2001	2077820	386282	(386282/1691538) = 0.23
2011	2585862	508042	(508042/2077820) = 0.24

Geometric mean IG = (0.18 x 0.18 x 0.40 x 0.23 x 0.24)^1/5= 0.235
i.e., 23.5% Population in year 2021 is,
P2021 = 2585862 x (1+ 0.235)1 = 3193540
Similarly for year 2031 and 2041 can be calculated by,
P2031 = 2585862 x (1+ 0.235)2 = 3944021
P2041 = 2585862 x (1+ 0.235)3 = 4870866

5.2.3 INCREMENTAL INCREASE METHOD

This method is modification of arithmetical increase method and it is suitable for an average size town under normal condition where the growth rate is found to be in increasing order. While adopting this method the increase in increment is considered for calculating future population. The incremental increase is determined for each decade from the past population and the average value is added to the present population along with the average rate of increase. Hence, population after nth decade is Pn = P+ n.X + {n (n+1)/2}.Y (3) Where, Pn = Population after nth decade X = Average increase Y = Incremental increase

Example- Considering data given in example 1 predict the population for the year 2021, 2031, and 2041 using incremental increase method.

Year	Population	Increase (X)	Incremental increase (Y)
1961	858545	-	-
1971	1015672	157127	-
1981	1201553	185881	+28754
1991	1691538	489985	+304104
2001	2077820	386282	-103703
2011	2585862	508042	+121760
	Total	1727317	350915
	Average	345463	87729

Solution-

Population in year 2021 is,

P2021 = 2585862 + (345463 x 1) + {(1 (1+1))/2} x 87729 = 3019054

For year 2031 P2031 = 2585862 + (345463 x 2) + {(2 (2+1)/2)} x 87729 = 3539975

P2041 = 2585862 + (345463 x 3) + {(3 (3+1)/2)} x 87729 = 4148625

5.2.4 GRAPHICAL METHOD

In this method, the populations of last few decades are correctly plotted to a suitable scale on graph (Figure). The population curve is smoothly extended for getting future population. This extension should be done carefully and it requires proper experience and judgment. The best way of applying this method is to extend the curve by comparing with population curve of some other similar cities having the similar growth condition.

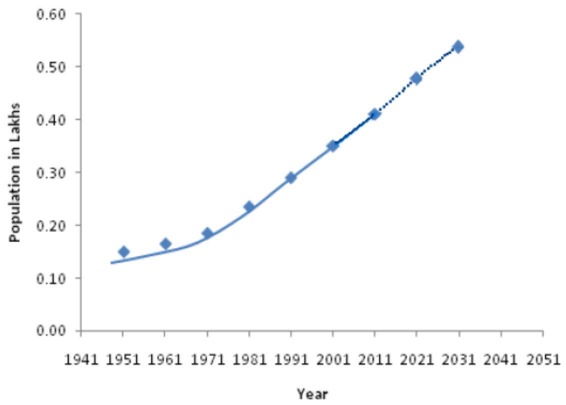

Figure- Graphical method of population forecasting

5.2.4 COMPARATIVE GRAPHICAL METHOD

In this method the census populations of cities already developed under similar conditions are plotted. The curve of past population of the city under consideration is plotted on the same graph. The curve is extended carefully by comparing with the population curve of some similar cities having the similar condition of growth. The advantage of this method is that the future population can be predicted from the present population even in the absence of some of the past census report. The use of this method is explained by a suitable example given below.

Example:-

The populations of a new city X given for decades 1970, 1980, 1990 and 2000 were 32,000; 38,000; 43,000 and 50,000, respectively. The cities A, B, C and D were developed in similar conditions as that of city X. It is required to estimate the population of the city X in the years 2010 and 2020. The population of cities A, B, C and D of different decades were given below:

i. City A: 50,000; 62,000; 72,000 and 87,000 in 1960, 1972, 1980 and 1990, respectively.
ii. City B: 50,000; 58,000; 69,000 and 76,000 in 1962, 1970, 1981 and 1988, respectively.
iii. City C: 50,000; 56,500; 64,000 and 70,000 in 1964, 1970, 1980 and 1988, respectively.
iv. City D: 50,000; 54,000; 58,000 and 62,000 in 1961, 1973, 1982 and 1989, respectively.

Population curves for the cities A, B, C, D and X are plotted (Figure 5.2). Then an average mean curve is also plotted by dotted line as shown in the figure. The population curve X is extended beyond 50,000 matching with the dotted mean curve. From the curve, the populations obtained for city X are 58,000 and 68,000 in year 2010 and 2020.

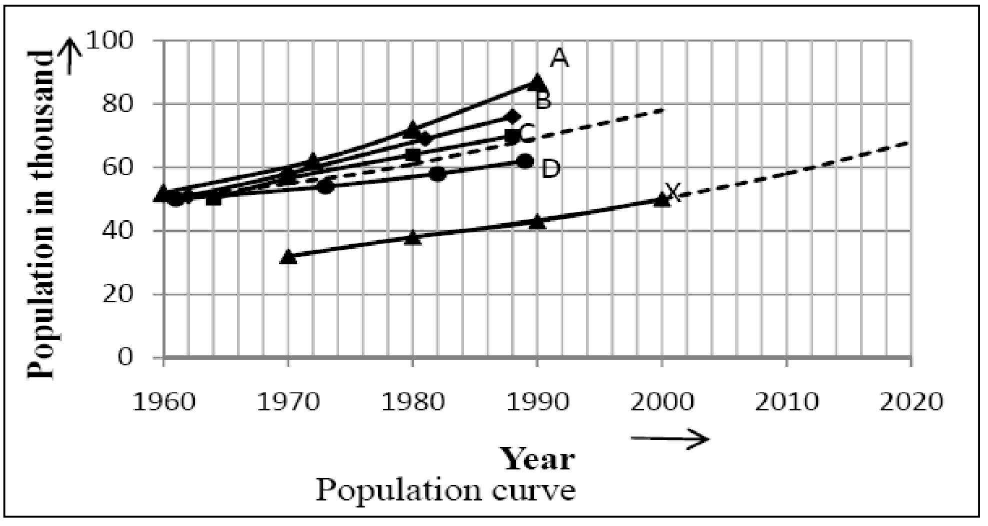

Figure- Comparative graph method.

5.2.5 MASTER PLAN METHOD

The big and metropolitan cities are generally not developed in haphazard manner, but are planned and regulated by local bodies according to master plan. The master plan is prepared for next 25 to 30 years for the city. According to the master plan the city is divided into various zones such as residence, commerce and industry. The population densities are fixed for various zones in the master plan. From this population density total water demand and wastewater generation for that zone can be worked out. By this method it is very easy to access precisely the design population.

5.2.6 LOGISTIC CURVE METHOD

This method is used when the growth rate of population due to births, deaths and migrations takes place under normal situation and it is not subjected to any extraordinary changes like epidemic, war, earth quake or any natural disaster, etc., and the population follows the growth curve characteristics of living things within limited space and economic opportunity. If the population of a city is plotted with respect to time, the curve so obtained under normal condition looks like S-shaped curve and is known as logistic curve.

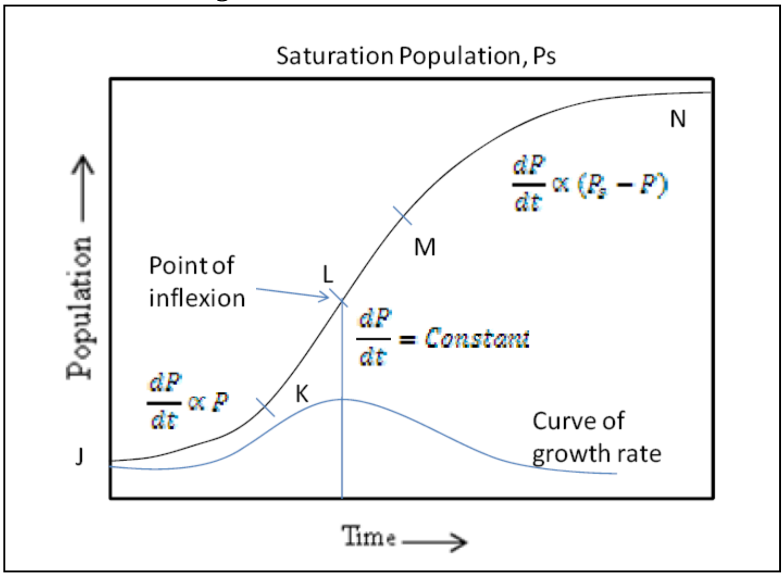

Figure - Logistic curve for population growth.

In Figure , the curve shows an early growth JK at an increasing rate i.e. geometric growth or log growth, dp/dt ∝ P, the transitional middle curve KM follows arithmetic increase i.e. dp/dt = constant. For later growth MN the rate of change of population is proportional to difference between saturation population and existing population, i.e. dp/dt ∝ (Ps - P). A mathematical solution for this logistic curve JN, which can be represented by an autocatalytic first order equation, is given by,

$$\log_e\left(\frac{Ps-P}{P}\right) - \log_e\left(\frac{Ps-P_0}{P_0}\right) = -K.P_s.t$$

where, P = Population at any time t from the origin J

P_s= Saturation population

P_0 = Population of the city at the start point J

K = Constant

t = Time in years

From the above equation we get

$$\log_e\left(\frac{Ps-P}{P}\right)\left(\frac{P_o}{Ps-P_o}\right) = -K.P_s.t$$

After solving we get,

$$P = \frac{P_s}{1+\frac{P_s-P_0}{P_o}log_e^{-1}(-K.P_s.t)}$$

Substituting $\frac{Ps-P_0}{P_0} = m$ (a constant)

and $-K.P_s = n$ (another constant)

we get, $P = \frac{P_s}{1+m\log_e^{-1}(n.t)}$

This is the required equation of the logistic curve, which will be used for predicting population. If only three pairs of characteristic values P0, P1, P2 at times t = t0 = 0, t1 and t2 = 2t1 extending over the past record are chosen, the saturation population Ps and constant m and n can be estimated by the following equation, as follows:

$$P_s = \frac{2P_0P_1P_2 - P_1^2(P_0 + P_2)}{P_0P_2 - P_1^2}$$

$$m = \frac{Ps-P_0}{P_0}$$

$$n = \frac{2.3}{t_1}\log_{10}\left(\frac{P_0(P_s-P_1)}{P_1(P_s-P_0)}\right)$$

CHAPTER 6:
WATER SUPPLY REQUIREMENT

6 WATER SUPPLY REQUIREMENTS (As per IS 1172:1993)

6.1 Water Supply for Residences

A minimum of.10 to 100 litres per head per day may be considered adequate for domestic needs of urban communities, apart from non-domestic needs as flushing requirements. As a general rule the following rates per capita per day may be considered minimum for domestic and non -domestic needs:

1) For communities with population up to 20 000 and without flushing system
   a) Water supply through 40 lphd (Min) stand post
   b) Water supply through 70 to 100 lphd house service connection.
2) For commodities population 20000 to 100 to 150 Lphd 100,000 together with full flushing system
3) For commodities with above 100,000 150 lphd to 200 lphd together with full flushing system.

Purpose Quantity	(LPCD)
Drinking	3
Cooking	5
Bathing	15
Washing Utensils and House	7
Ablution	10
Total	**40**

Table.6.1 40 litres per capita per day (lphd) for humans to meet the following requirements.

CHAPTER 7:
DISTRIBUTION SYSTEM

7 Distribution system

7.1 Introduction:
After treatment, water is to be stored temporarily and supplied to the consumers through the network of pipelines called distribution system. The distribution system also includes pumps, reservoirs, pipe fittings, instruments for measurement of pressures, flow leak detectors etc. The cost of distribution is about 40 to 70% of the total cost of the entire scheme. The efficiency of the system depends upon proper planning, execution and maintenance. Ultimate air is to supply potable water to all the consumers whenever required in sufficient quantity with required pressure with least lost and without any leakage.

7.2 Requirement of a distribution system:
1. The system convey the treated water up to consumers with the same degree of purity.
2. The system should be economical and easy to maintain and operate.
3. The diameter of pipes should be designed to meet the fire demand
4. It should safe against any future pollution. As per as possible should not be laid Below sewer lines.
5. Water should be supplied without interruption even when repairs are undertaken.
6. The system should be so designed that the supply should meet maximum hourly Demand. A peak factor 2.5 is recommended for the towns of population 0.5 to 2 Lakhs. For larger population a factor of 2.0 will be adequate.

7.3 System of distribution:
For efficient distribution it is required that the water should reach to every consumer with required rate of flow. Therefore, some pressure in pipeline is necessary, which should force the water to reach at every place. Depending upon the methods of distribution, the distribution system is classified as the follows:
1. Gravity system
2. Pumping system
3. Dual system or combined gravity and pumping system

7.3.1 Gravity system:
When some ground sufficiently high above the city area is available, this can be best utilized for distribution system in maintaining pressure in water mains . This method is also much suitable when the source of supply such as lake, river or impounding reservoir is at sufficiently higher than city. The water flows in the mains due to gravitational forces. As no pumping is required therefore it is the most reliable system for the distribution of water as shown in fig,

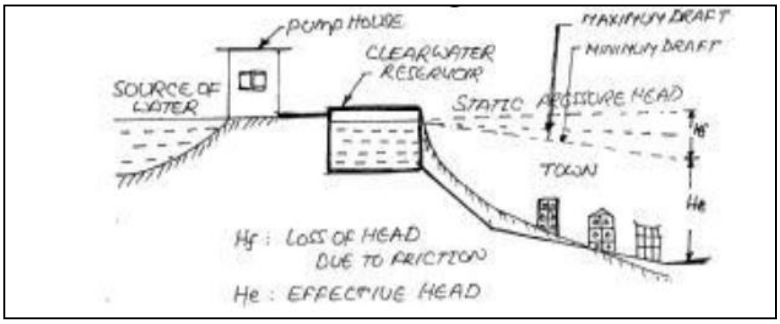

Fig. 7.3.1 Gravity Dam

7.3.2 Pumping system:

Constant pressure can be maintained in the system by direct pumping into mains. Rate of flow cannot be varied easily according to demand unless number of pumps are operated in addition to stand by ones. Supply can be effected during power failure and breakdown of pumps. Hence diesel pumps also in addition to electrical pumps as stand by to be maintained. During fires, the water can be pumped in required quantity by the stand by units.

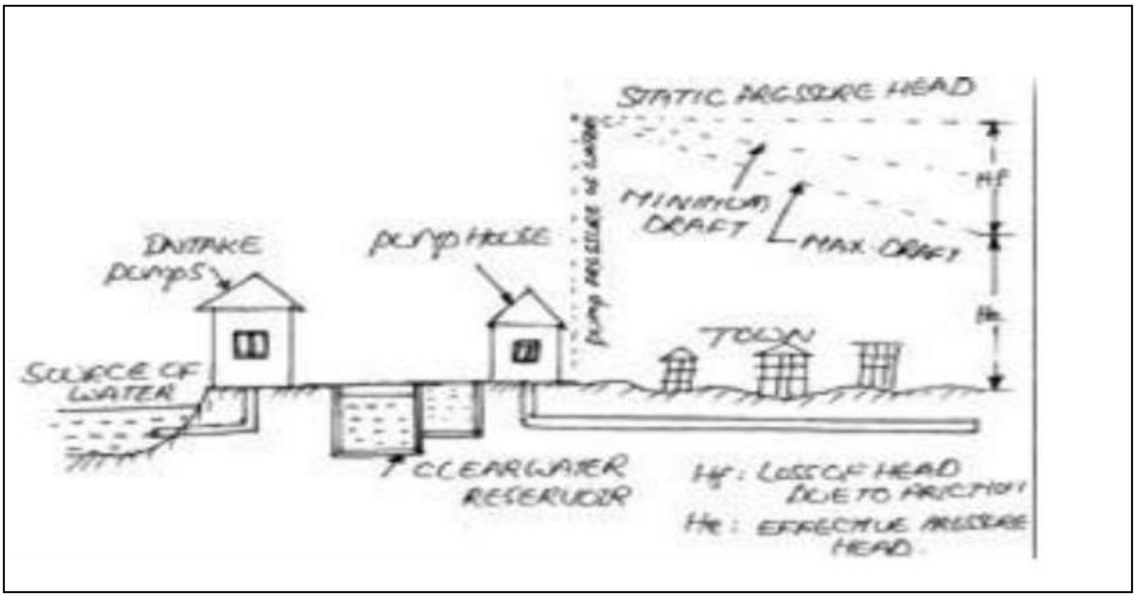

Fig. 7.3.3 Pumping System

7.3.3 Combined pumping and gravity system:

This is also known as dual system. The pump is connected to the mains as well as elevated reservoir. In the beginning when demand is small the water is stored in the elevated reservoir, but when demand increases the rate of pumping, the flow in the distribution system comes from the both the pumping station as well as elevated reservoir. As in this system water comes from two sources one from reservoir and second from pumping station, it is called dual system. This system is more reliable and economical, because it requires uniform rate of pumping but meets low as well as maximum demand. The water stored in the elevated reservoir meets the requirements of demand during breakdown of pumps and for firefighting. The water may be supplied to the consumers by either of the two systems.

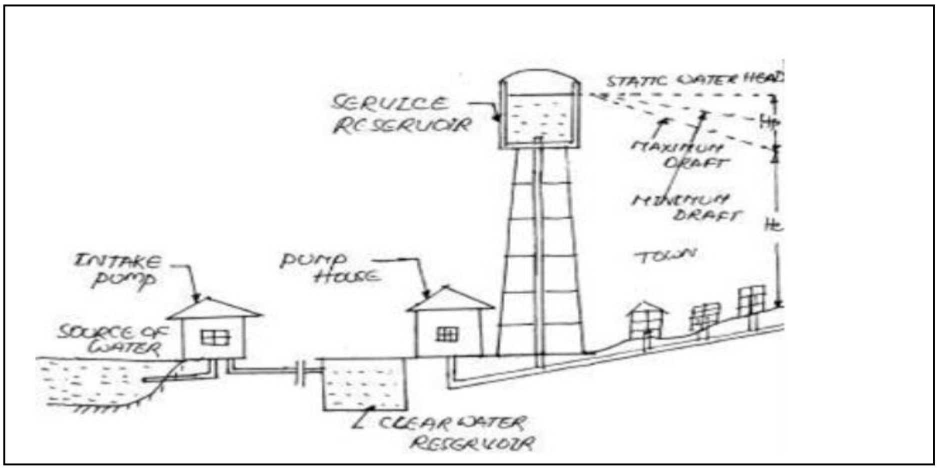

Fig. 7.3.3 Combined Pumping and Gravity Dam System

7.3.4 Continuous system

This is the best system and water is supplied for all 24 hours. This system is possible when there is adequate quantity of water for supply. In this system sample of water is always available for firefighting and due to continuous circulation water always remains fresh. In this system less diameter of pipes are required and rusting of pipes will be less. Losses will be more if there are leakages in the system.

Intermittent system if plenty of water is not available, the supply of water is divided into zones and each zone is supplied with water for fixed hours in a day or on alternate days. As the water is supplied after intervals, it is called intermittent system.

7.4 The system has following disadvantages:

1. Pipelines are likely to rust faster due to alternate wetting and drying. This increases the maintenance cost.
2. There is also pollution of water by ingress of polluted water through leaks during non-flow periods.
3. More wastage of water due to the tendency of the people to store more water than required quantity and to waste the excess to collect fresh water each time. In spite of number of disadvantages, this system is usually adopted in most of the cities and towns of India. In this system water can be supplied in the high level localities with adequate pressure by dividing the city in zones. The repair work can be easily done in the non-supply hours.

7.5 Layouts of distribution system:

Generally in practice there are four different systems of distribution which are used. They are:
1. Dead End or Tree system
2. Grid Iron system
3. Circular or Ring system
4. Radial system

7.5.1 Dead end or tree system:

This system is suitable for irregular developed towns or cities. In this system water flows in one direction only into sub mains and branches. The diameter of pipe decreases at every tree branch.

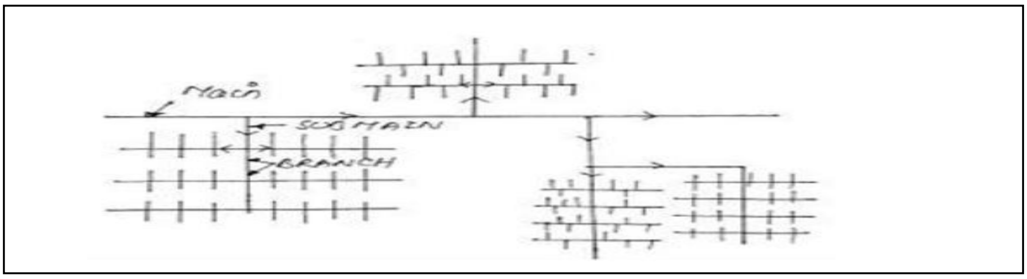

Fig. 7.5.1 Dead end or tree system

- **Advantages:**

1. Discharge and pressure at any point in the distribution system is calculated easily
2. The valves required in this system of layout are comparatively less in number.
3. The diameter of pipes used are smaller and hence the system is cheap and economical
4. The laying of water pipes is used are simple.

- **Disadvantages:**

1. There is stagnant water at dead ends of pipes causing contamination.
2. During repairs of pipes or valves at any point the entire down-stream end are deprived of supply
3. The water available for firefighting will be limited in quantity

7.5.2 Grid iron system

From the mains water enters the branches at all Junctions in either directions into sub mains of equal diameters. At any point in the line the pressure is balanced from two directions because of interconnected network of pipes.

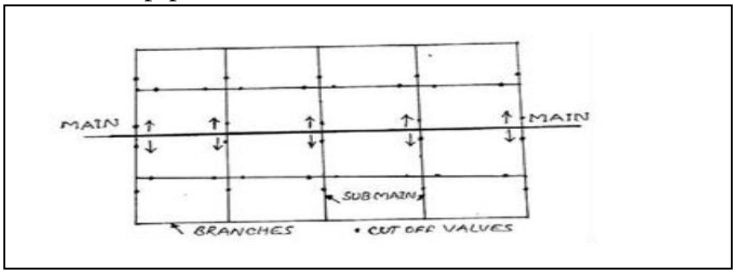

Fig. 7.5.2 Grid iron system

- **Advantages**

1. In the case of repairs a very small portion of distribution are a will be affected
2. Every point receives supply from two directions and with higher pressure
3. Additional water from the other branches are available for fire fighting
4. There is free circulation of water and hence it is not liable for pollution due to stagnation.

- **Disadvantages**

1. More length of pipes and number of valves are needed and hence there is increased cost of construction
2. Calculation of sizes of pipes and working out pressures at various points in the distribution system is laborious, complicated and difficult.

7.5.3 Circular or ring system

Supply to the inner pipes is from the mains around the boundary. It has the same advantages as the grid-Iron system. Smaller diameter pipes are needed. The advantages and disadvantages are same as that of grid-Iron system.

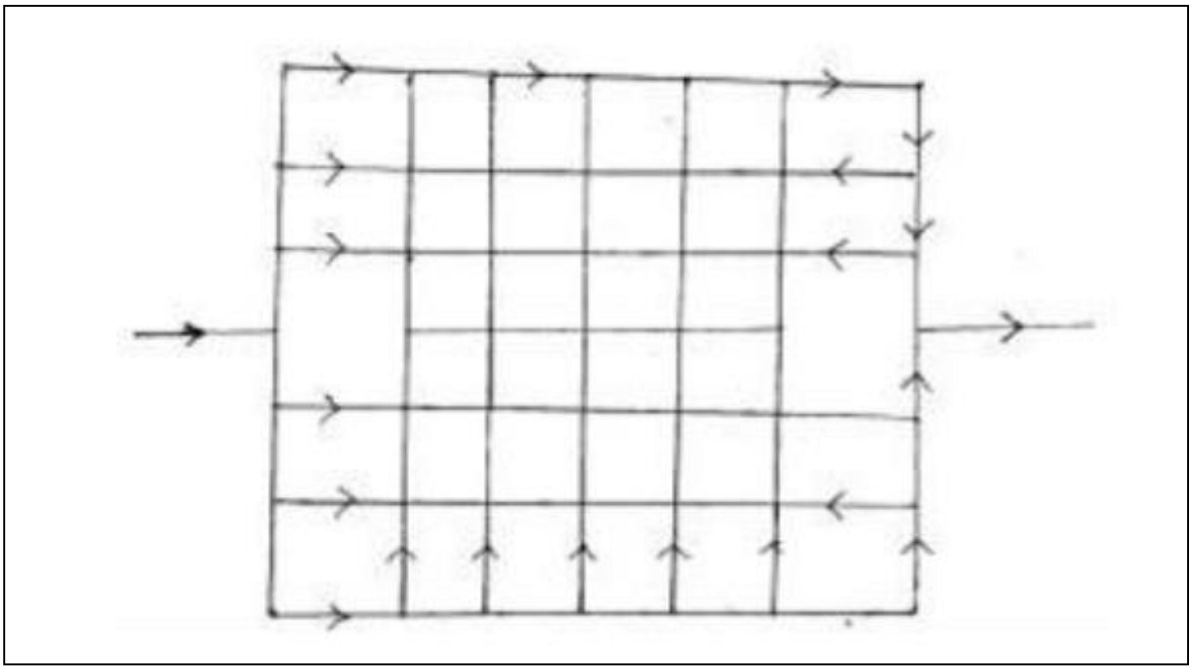

Fig. 7.5.3 Circular or ring system

7.5.4 Radial system:

This is a zoned system. Water is pumped to the distribution reservoirs and from the reservoirs it flows by gravity to the tree system of pipes. The pressure calculations are easy in this system. Layout of roads need to be radial to eliminate loss of head in bends. This is most economical system also if combined pumping and gravity flow is adopted.

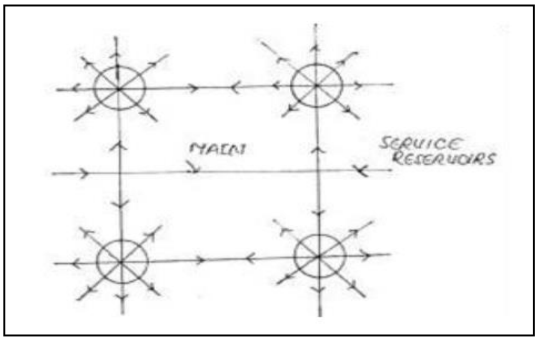

Fig. 7.5.4 Radial System

CHAPTER 8:
INSPECTION AND VISIT REPORT: SHELARWADI

8 An Inspection and Visit Report of RWSS in Satara District

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE OF ENGINEERING, SATARA

An Inspection and Visit Report of RWSS in Satara District

Shelarwadi village Water Supply Scheme (Taluka: Wai, District: Satara)

Submitted by

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Rayat Shikshan Sanstha's Karmaveer Bhaurao Patil College of Engineering, Satara

(2017-2018)

8.1 Executive summary

1. Initial stage of the project was to collect all the important Documents from various authorities like DPR from the Z.P. Satara, which was made available. Remaining all other documents are available from Gram panchayat Shelarwadi.
2. The Field visit was the second and the most important stage. In this stage when we visited the Shelarwadi village it was found that the village is not so much far from the taluka city wai.
3. The supply for village was from a Well which is situated at 1550 M from village, but in actual measurement (from google Maps) it comes to be 1460 m. There is not so much difference in length as per DSR and as per MB.
4. The Well is capable or designed for further 15 year population demand. The demand as per DPR is 40 LPCD.
5. The GSR is situated at the higher elevation near to the village. The New GSR is constructed for 25000 lit. Capacity but actually it stores 27000 lit. Of water, which is a good thing. Also the new scheme is connected to old scheme so that the benefit is more from old scheme also.
6. The old scheme or GSR was not in good condition but at time of implementation of the new GSR old system is also maintained and repaired and joined to new scheme. Which is beneficial for villagers.
7. The main Distribution and distribution network is almost properly designed and as per design properly implemented.
8. The Villagers are happy and satisfies with daily 1 hour water supply. Their opinion was the scheme is very helpful and it completely satisfies the daily water requirement till the last person in the village.
9. Somewhere main distribution pipe was on the ground or open to visit, but not so much issue because it is properly placed and appropriate material is used.
10. The implementation cost is nearly equal to the DPR or estimated cost.
11. The scheme is completely workable and due to combination of old and new scheme villagers are satisfied with the scheme.

8.2 Introduction:

8.2.1 Project Background:

Thane Zilla Parishad empanelled Technology and Development Cell (TDSC) as third-party evaluator in Thane district to improve Rural Water Supply Schemes (RWSS). The broad aim behind this is improving sustainability, efficiency and equitability of these schemes. The technical evaluation is done in two phases: First evaluation after 30% work completion and second after 70% completion. Thane Zilla Parishad has given 23 ongoing schemes under National Rural Drinking Water Program (NRDWP) for third-party evaluation. TDSC is assessing these schemes through design verification, physical asset verification, performance and adherence of scheme to design as per Detailed Project Report (DPR). Shelarwadi (tal.Wai) Rural Water Supply Scheme is a completed scheme. Detailed study of the Shelarwadi RWSS is presented in this report.

Objectives of technical audit

The objectives of the technical audit are as follows:

- Assessment of Detailed Project Report (DPR)to know design details of assets proposed in the scheme and to check whether supporting documents are prepared or not.
- Design verification of key assets of scheme given in DPR is appropriate or not.
- Physical verification of assets to know whether the scheme has been implemented according to design mentioned in the DPR.
- Checking the performance of the scheme for judging the sustainability of the scheme.
- Summarize findings and propose recommendations.

8.2.2 **Assessment Methodology**

The scheme was assessed by following a detailed methodology comprising data collection, necessary field visits and data analysis. These activities include:

1. Assessment of supporting documents and study of design of assist
2. Verification of distribution network design with the help of JalTantra software.
3. Excavation for assist verification at specification level
4. Ensuring Source sustainability and quality of material by checking the yield report and material test report respectively.
5. Tracing of rising main and distribution network for getting actual path and length.
6. Measurement of pump flow rate in order to know the distribution for filling of ESR
7. Collection of house hold data and zone wise distribution of habitation by interviewing the Gram panchayat Officials and Operator.
8. Measuring actual flow rate across the distribution network.
9. Ensuring whether the scheme has cover or household and checking amount of water received by household having individual connections.

8.3Scheme overview

Shelarwadi is a village in Shelarwadi Gram panchayat located in Wai Taluka of Satara District. It is situated 47 km away from district headquarter. Average rainfall of this area is 3000mm. The scheme was sanctioned in 2013-2014.The scheme is designed for 15 years for forecasted population of 1260.

Figure 8.3.1: Google map image showing Shelarwadi village

Details of the scheme taken from the detailed project report (DPR) are mentioned in following table.

Table 8.3: Scheme details

Scheme Name		Shelarwadi(Taluka: Wai) rural water supply scheme	
Taluka and District		Wai and Satara	
Sanction Year		2013- 2014	
Source		Well	
Villages and Habitations covered		Shelarwadi and Mandharwasti	
Scheme capacity		25000 Lit.	
Technical approval date	10/02/2014	Administrative approval date	15/08/2013
Work Order date	03/03/2014	Time limit	17 months
Total Budget estimate	Rs. 34,12,244	Budget spent	
Implementation agency (GP/ Zilla Parishad/ MJP/ VWSC)			Zilla Parishad (DPDC)

8.4 Scheme Description:

Initially, the village was supplied water by Old Scheme having 2 Storage tanks. These tanks were GSR type i.e. Supply was using gravitational system. This scheme was working till 2013 but not sufficient water supply to village. Then new Scheme was constructed and also new scheme connected to old scheme and now both are in working condition.
According to DPR, source of new scheme is new well around 1550 m away from village as suggested by Villagers. Prior to excavation of well, one feeder bore is to be excavated. A pump house of dimension 3m×2.5m×3.0 m and properly fixed control panel board is to be near well. From well, water is to be pumped to GSR at a distance of 1550 m in the village, by using two motor of 5 Hp and 6 HP submersible pump. One motor is for old water system. 65 mm diameter G.I pipe medium class is to be used as rising main And also 90mm dia. PVC Pipe are used in new system. Water is to be supplied to village by gravity from GSR.

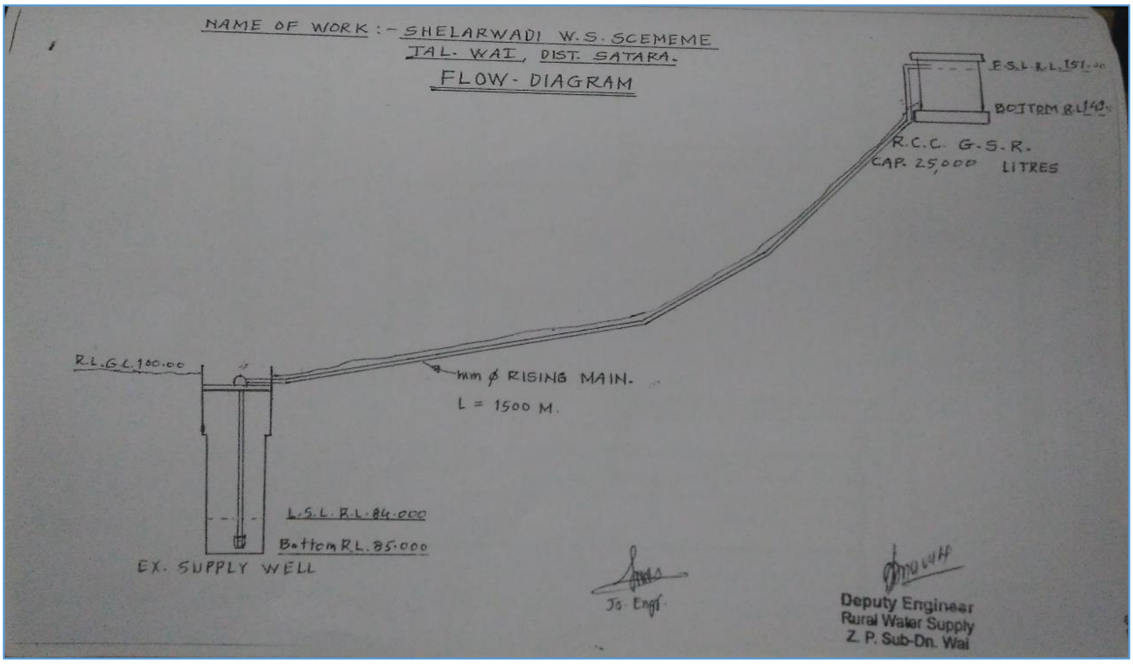


Figure 8.4.1: Schematic layout of the scheme (Ref.: DPR provided by ZP to KBP College of Engineering, Satara)

8.5 Site visit details

Physical verification of all assets of scheme is done by site visit. Activities carried out and purpose of site visits are mentioned in the following table.

Table 8.5: Site visit details

Sr. No.	Visit Dates	Purpose	Findings
1	04/01/2018	Preliminary visit	Assets verification, discussion with VWSC, Gramsevak and villagers

8.6 Planning and Design Evaluation:

It is necessary to make plan and design of any type of project. As we know that the journey from an idea of building the scheme to have it successfully implemented and well-functioning on the ground, it has to pass through various phases. These phases are planning, design, implementation and operation. The mistakes and inconsistency in following norms in any phase may lead to scheme failure, so each phase is important and needs to be verified. Planning and design is the first phase, and is covered in this chapter. Later phases are covered in later chapters.

8.6.1 List of documents in DPR

In order to check official procedure for demanding the scheme, utility of material and source sustainability, the following documents were verified.

Table 8.6.1: Documents assessed

Document	Present in DPR (YES/ NO)	Remarks
Demand letter	YES	OK
GSDA permission/ authorization letter/ report	YES	-
Yield Test	NO	
Material test report	YES	Ultimate stress in steel bar, compressive strength of concrete, GI pipe test and all test results are okay
Water quality test	YES	Potable water
Land acquisition document		
VWSC/ SAC		
Budget Estimate	YES	Detailed estimates
Distribution system Summary/ software program I/O	YES	
Key plan	YES	
Survey map	NO	

8.6.2 Planning Verification:

In order to have proper coverage, sustainability and operation, the first step in designing any scheme is the planning. As per section 0, the necessary planning documents are checked in the assessment of DPR. Although some of these documents are procedural documents (e.g., Gram Sabha resolution, VWSC, etc.), they have a great impact on monitoring and sustainability of the scheme. Following are the findings from the planning document assessment.

- Shelarwadi's habitation was covered in planning, there is proper survey map we could verify planned distribution network against actual laid distribution network.
- Length of rising main considered in design and estimate is 1550 m, whereas actual length measured in audit and length recorded in Measurement Book is 1460 m. It implies that approximately proper survey was carried out or location of well or GSR is approximately accurate.
- For a feeder bore which is near to well, a separate pump house was proposed in planning. Pump house of scheme can be used for feeder bore panel.

8.6.3 Design verification:

The first step of technical audit is design verification of different assets of the scheme. Hydraulic design of various assets is given in the DPR; through design verification it is verified whether the given design details of various assets are correct or not.

Table 8.6.3: Assets design details

Designing component	Dimensions	From DPR	From design verification	Remarks
Population forecasting	Year 2028	1260	1460	Average of incremental increase and geometric method
Demand	MLD	0.068	60 LPCD	Demand is full fill
Raw water Pumping machinery	BHP	5 Hp	5 Hp	Actual length of rising main is approximately equal planned length, so capacity and head Is as per design. And due to combination of old and new scheme, sufficient amount of water is provided to villagers
	Total Head	67 m	65m	
	Pump flow rate	2.36 lps	4.5 lps	
Raw Rising main	Diameter	65 mm	65 mm	Length of rising main 1460 m
Storage tank	Volume	25000 liters	27000 liters	
Distribution main	Diameter Range and respective length	90 mm- 200 m 75 mm-500m 65 mm-400m	90 mm- 200 m 75 mm-500 m 65 mm-700m	Design verification is done through JalTantra

8.6.4 Implementation Evaluation:

This chapter covers physical asset verification done on ground against values given in DPR and estimates.

8.6.5 Physical assets verification:

Physical verification of assets includes checking performance and adherence of scheme to the design as per DPR. Physical assets to be verified are the source, rising main, pumping machinery, pump house, GSRs, and distribution network. The physical assets were verified through on-site inspections.

Table 8.6.5: Physical assets detail

Asset name	Dimensions	From DPR/ Structural design	From Field visit	Remarks
Source (Well)	Diameter	9 m	8.8 m	Okay
	Depth	15 m	15 m	
	Water column		-	
Pumping machinery	BHP	5 Hp	5 Hp	According to DPR , pumps are provided
	Pump type	Submersible	Submersible	
	Standby	1	1	
	Pump flow rate	2.36 lps	4.5 lps	
Pump house	Dimensions	3×2.50×3 M	3.5×3.5×3 M	
	Material	Burnt brick masonry	Burnt brick masonry	
Rising main	Length	1550m	1460m	Length is measured using Google Earth
	Diameter	65 mm	65 mm	
	Material	GI medium class	GI medium class	
Storage tank (GSR)	Diameter	5	5	
	Depth + Free board	1.4	1.4	
	Volume	25000	27000 liters	
	Staging height	12 m	12 m	
Distribution network	Diameter (mm) – Length (m)	90 mm- 400 m 75 mm-1000m 65 mm-800m	90 mm- 400 m 75 mm-1000m 65 mm-850m	Length is measured using Google Earth
	Material	GI medium class	GI medium class	

8.6.6 Assets summary:

a. **Source** – well is constructed on outskirts of village about 1550 m away from village in private land at place suggested by GSDA. Diameter of well and depth is approximately equal to planned, but difference is negligible. Water was available in the well in plenty amount.

b. **Source is sustainable, Water is available in all seasons**. Scheme is functional when we visited the scheme. Water was supplied through this scheme continuously. And daily 1 hour supply is provided as mentioned by villagers.This is a borewell in shelarwadi, which is around 1.5 Km from village. Rising main of old scheme is used as rising main.

Fig.8.6.6A Well

c. **Pumping machinery** – 5 Hp submersible pumps are placed inside well, whereas required pump capacity is also 5 Hp and according to estimate 5 Hp pump was to be installed. Pressure gauge was installed. Two valve are provided as two motors are provided. Also old scheme is working on 6 HP motor pump.

Figure 8.6.6B: Submersible pump and pipe connected to pump and proper support structure

d. **Pump house** – A pump house having dimension 3.5×3.5×3 m was constructed near well. Control panel is not placed properly inside switch room.

Figure 8.6.6C: Outside view of pump house

e. **Rising main** – GI medium class 65 mm diameter pipes are laid in field. In design, 1550 m length of rising main is considered where as in MB record it is measured as 1460 m .Air valve was not placed.

f. **GSR** – Capacity of GSR is 27000 liters, whereas required capacity is 2500 liters. A Circular tank is placed at higher elevation or higher RL from village. So that the water is supplied using gravitational flow system. Sufficient pressure is maintained in GSR.

Fig8.6.6D: Two Ground Storage Reservoirs

Figure 8.6.6E: GSR of Shelarwadi

g. **Distribution main** – Length of distribution network in field is approximately equal to than designed length. Pipes of 90 mm dia. 4KG 200 m ,75mm dia.4KG 1000m, 65mm 850m pipes are provided . Length of designed network matches with length measured in MB records nearly. Length measured in field and MB records is nearly equal. At some place distribution lines are laid on ground.

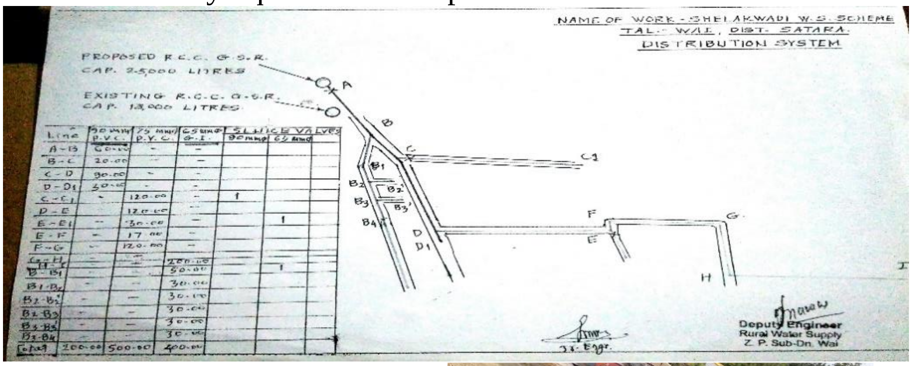


Figure 8.6.6F: Distribution network laid on ground

Figure 8.6.6G: Existing distribution network

8.7 Operation Evaluation:

Data collected on operation and financial status of the scheme is presented in this chapter.

8.8 Operation of Scheme:

Total demand of the scheme is 25000 Lit. This scheme serves the villages Shelarwadi and Mandharwasti.

- To fill the GSR completely it takes 8 hours. Total pumping hours to GSR in one day is 8 hrs.
- There are three zones, and water is efficiently supplied to all three zones and the discharge or pressure of water is plenty enough up to last one in the village.
- Daily one hour supply of water.
- Water is supplied to village between 8.00 am and 9.00 am. Entire village gets water at the same time.
- Three zones are provided sufficient amount of water.
- TCL is added into a well according to operator. No treatment of the alternate source is done.

8.9 Serviceability of scheme:

- ❖ **Coverage** – Distribution network is laid in whole village and Mandharwasti. Every house is supplied enough water and no any complaints against the Water supply.
- ❖ **Villager's opinion:** There was lack of water before these scheme but after implementation of this project the problem of water supply is completely solved as the old system is connected to new scheme and both are in working condition.
- ❖ **Quality** – Quality of water is good, people use it for drinking.
- ❖ **Quantity** – Plenty or enough amount of water is supplied to each and every house in the village. The only reason is combination of old and new scheme of water supply.

❖ **Equity** – As Shelarwadi is near to the GSR and Mandharwasti is somewhat at long distance some difference in pressure happens but last person is also getting plenty amount of water.
The scheme was fully functional and no any delay or barrier in the supply system.

GSR constructed is at sufficient height, as it is constructed on higher RL, naturally by gravity flow is maintained.
The newly constructed GSR is connected with the old GSR (2 No.) so that the GSR satisfies the whole village water demand.

8.10 Financial status of scheme:

Total budget of each asset mentioned in DPR and actual budget spent on each asset recorded in MB is mentioned in following table.

Table 8.10.1: Utilization of budget

Sr. No.	Asset	Total Budget of an Asset (Rs.)	Budget spent (Rs) from MB	Remark
1	Supply Well	11,73,686.00	11,47,883.53	Dimensions are nearly same, A metal mesh should be placed for avoid impurities
2	Pump House	1,14,779.00	1,56,472.36	Size of Pump house is more than design
3	Pumping Machinery	1,53,063.00	¤ 1,50,978.00	-
4	Rising main	7,40,718.00	6,97,708.00	Less length
5	Tanks (GSR)	3,86,183.00	3,86,183.00	No detailing
6	Distribution system	5,28,930.00	5,06,930.00	Less length
7	Misc Work	23,411.00	23,411.00	-
	Total	31,20,931.00	30,69,565.89	(This is only constriction cost)

This scheme was completed and became operational in August 2015. We found MB records which show total budget spent is 69.025% against estimated budget, physical progress of scheme is nearly completed. Only trial run amount will be added in MB records. In above table, in case of few assets there are vast difference in planned budget and executed budget due to no implementation of assets and decrease in dimension.
Financial sustainability of scheme is an important aspect. Following table gives idea about expenditure and cost recovery of the scheme.

Table 8.10.2: Annual charges

Sr. No.	Heads	From DPR (Rs)	
		Present Stage	**Design Stage**
ii	M & R charges	11805.00	23610.00
1	**Total annual burden**	**90847.00**	**145284.00**
i	Population	780	1260
ii	NO. of Houses(6persons per house)	130	210
iii	10% BPL Family	13	21
iv	Taxable houses	117	189
v	No. of private connection 100%	117	189
vi	Water Rates	Rs. 900 per year	900.per year
vii	Connection efficiency	90 %	90%
2	**Total revenue**	**94770**	**153090**

Actual hours of pumping and capacity of pump is considered while calculating actual annual M&R charges as electricity charges is most important expenditure. Number of taxable houses and revenue details are collected from Gram panchayat. Tariff charges are not yet decided by VWSC.

8.11 Scheme Findings:

Document assessment

- Excess saving statement which compares details of work considered in estimate and actual work carried out in field was found in the documents. As many works are not carried out in field like feeder bore pumping machinery, rising main switch house, the total planned cost of scheme was Rs. 34, 12, 244. 00 whereas actual total expenditure on scheme is Rs.3360878.89.
- No survey map is present; verification of distribution network on field against plan is difficult.

8.12 Assets:

❖ **Source**

- **Source is sustainable; it is suitable for drinking purpose. It is also workable in all seasons.** Scheme was functional and in working condition.
- **Source is about 1.**5 km from the village and the GSR is near the village at higher elevation so that there is no any issue of supply of water.

❖ **Pumping machinery**

- 5 Hp and 6 HP submersible pumps were placed inside well, whereas required pump capacity is 5 Hp and according to estimate 5 Hp pump had to place.so that it is as per estimate.

❖ **Rising main**

- **Discrepancy in length** of rising main measurement. In design 1550m length of rising main considered where as in MB record it measured as 1460 m. Air valves are not placed.
- Through design verification 65 mm dia. pipe is sufficient. 5 HP and 6HP motor are sufficient.

❖ Distribution network

- **Approximately** accurate length of distribution network. Length measured in field and MB records is nearly equal. Peoples are satisfied with the supply system of the water.
- At some place distribution lines are laid on ground. But villagers takes care not to harm that portion of the pipe by themselves.
- Some what the line is passing from roads and some where they are open.
- Lengths are same as estimate but some little issues with the household connections.

8.13 Operation

Entire village gets water at the same time. As there are old and new system is interconnected so that no lack of water is there .Water supply is daily 1 hour which enough sufficient for these people.
The supply time is 8.00 am to 9.00 am.

8.14 Service level

- Shelarwadi has good arrangement of the Distribution system.
- Every villagers or every house has water supply.
- Currently operation cost is paid by Grampanchyat.
- **Success Indicator**

Table 8.14: Final Success Indicator score

Sr. No.	Phases	Marks obtained
1	Planning & Design	79.0
2	Implementation	67.1
3	Operation and Maintenance	61.0
4	Exit and Handover	69.1
	Final Score	**69.025**

This success indicator score reflects that the scheme is likely do well if certain improvements are done in completed work and remaining implementation is done properly. The major concerns are highlighted in the next section along with recommendations for improving sustainability of scheme.

8.15 Recommendations:

8.15.1 Scheme specific

- The scheme is nearly ok or acceptable as they used old system combined with new system, but some maintenance to old system and proper arrangement of pipelines are required.
- The distribution pipes which are on the ground should be below ground level.
- Little issues for house hold connections should be solved.
- The mesh on the top of well should be provided to avoid the impurities for environment.

8.15.2 Assets

- The Shelarwadi project is nearly sufficiently supplies the water to the villagers more development is also possible if required.

8.15.3 Design and operation

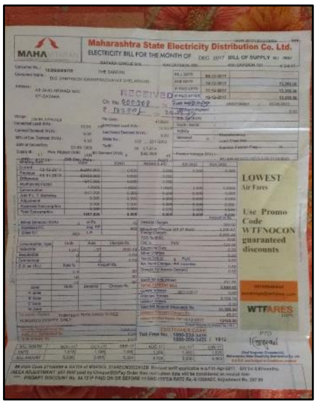
- As the GSR is near the village all house gets enough water and also storage capacity satisfies the demand of the village water.

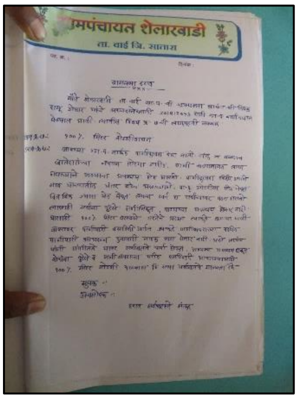
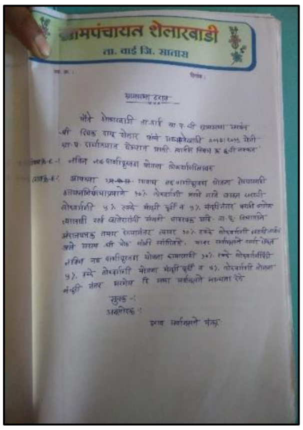
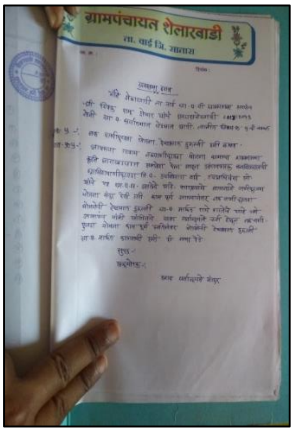
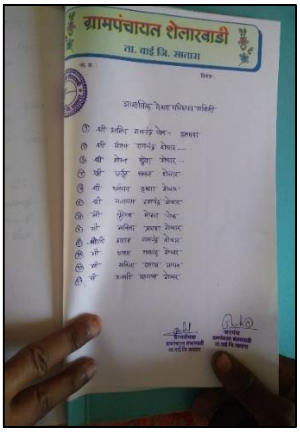
8.15.4 Financial

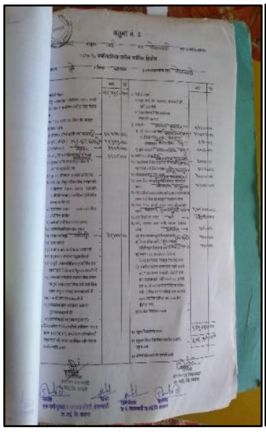
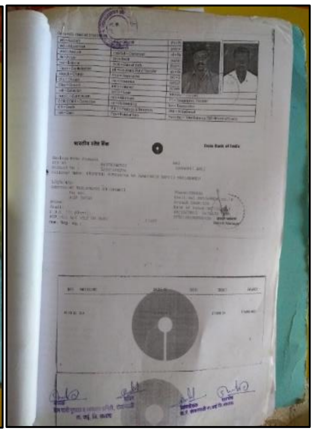
- The scheme is nearly financially equal as per the DPR.

8.15.5 Documents:

Fig.8.15.5 Images of Documents gathered from Grampanchayat Shelarwadi



CHAPTER 9:
RURAL WATER SUPPLY SCHEME UNDER UNNAT MAHARASHTRA ABHIYAN

9. RURAL WATER SUPPLY SCHEME UNDER UNNAT MAHARASHTRA ABHIYAN

9.1DOCUMENTS: SUCCESSFUL WORKSHOP ON RIT, ISLAMPUR

ग्रामीण क्षेत्रों के लिए प्रौद्योगिकी विकल्प केन्द्र
भारतीय प्रौद्योगिकी संस्थान मुंबई
पवई, मुंबई-400 076, भारत
Centre for Technology Alternatives for Rural Areas (CTARA)
Indian Institute of Technology Bombay
Powai, Mumbai-400 076, India

Tel : (+91-22) 2576 7870, 2576 7871
EPABX : (+91-22) 2572 2545, Extn.: 7870, 7871
Fax : (+91-22) 2572 3480

IIT Bombay

To,
Heads of UMA Institutions.

6th October 2017

Dear Heads of UMA Institutions,

Greetings from CTARA, IIT-B.

At the outset, I must congratulate your institution for enthusiastically participating in the UMA-IRAP-UNICEF RWS Assessment Workshop held at Rajarambapu Institute of Technology, Islampur, Sangli from 24th to 26th September 2017. The workshop was a success and a large part of the credit for the same goes to the faculty and student participants for their unwavering support and cooperation.

Our training team has studied the feedback forms submitted by the participants and they will be happy to incorporate some of the suggestions made in their future training sessions. One common feedback is the possibility of availing funding for field-work. You might recall that in the letter dated 3rd August 2017 and the accompanying application form, it was pointed out that the M&E WSSD GR of 15th June 2015 currently applies only to government colleges. Since UMA colleges are not covered under this GR, it was understood that they need to provide for the nominal expenses (around Rs.10, 000 or so) incurred on field-work and data analysis.

I hope that colleges bear in mind that this program is a long-term investment that will help them to establish a long-lasting professional engagement with the district and state administrations. The expected outcome of this project is the generation of quality reports by UMA colleges on their insights, experiences and best practices, which can then be shared with the district administrations and Government of Maharashtra to make a case for their empanelment under the WSSD GR of 15th June 2015. These reports will also be compiled to prepare a training manual and compendium of various schemes audited by colleges across the state, which may be used as a text-book or resource by engineering colleges across the country.

However, if colleges are still not able to commit funds for the same, they should write to me separately, stating the reason. We will try to make some provision for the same.

As mentioned before, TDSC at CTARA will provide the necessary handholding and technical support to the colleges. Please let us know if you have any questions or suggestions.

Thank you.

Regards,

Milind Sohoni
Professor, CTARA and CSE
Chairperson, UMA Advisory Committee

9.2 DOCUMENT: PROJECT CALL

ग्रामीण क्षेत्रों के लिए प्रौद्योगिकी विकल्प केन्द्र
भारतीय प्रौद्योगिकी संस्थान मुंबई
पवई, मुंबई-400 076, भारत

Centre for Technology Alternatives for Rural Areas (CTARA)
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Tel : (+91-22) 2576 7870, 2576 7871
EPABX : (+91-22) 2572 2545, Extn.: 7870, 7871
Fax : (+91-22) 2572 3480

IIT Bombay

3rd November 2017

Dear Heads of UMA Institutions,

Greetings from CTARA, IIT-B.

This is with reference to the UMA-UNICEF-IRAP Rural Water Supply (RWS) Assessment Programme currently underway at your colleges. The CTARA team has been taking weekly updates from all colleges. Most colleges have managed to obtain the DPRs, some have started studying the DPRs and the course material provided by CTARA, and some have visited their designated RWS schemes and begun field-work. We are assuming that all colleges have found internal funding for field visits and data as I have not received any written request for the same so far.

Since our target is to complete this assessment exercise by mid-December, I request all colleges to expedite progress and prepare an action plan for the current month. It is important that participating institutions take this commitment seriously.

Please let us know if you have any queries or require any additional support.

Thank you.

Regards,

Milind Sohoni,

Chairperson, UMA Advisory Committee

CC: UMA Nodal Officers

CC: Prof. Puru Kulkarni, TDSC

9.3 LETTER OF HOLES FROM IIT, MUMBAI

ग्रामीण क्षेत्रों के लिए प्रौद्योगिकी विकल्प केन्द्र
भारतीय प्रौद्योगिकी संस्थान मुंबई
पवई, मुंबई-400 076, भारत

Centre for Technology Alternatives for Rural Areas (CTARA)
Indian Institute of Technology Bombay
Powai, Mumbai-400 076, India

Tel. : (+91-22) 2576 7870
(+91-22) 2576 7871
Fax : (+91-22) 2572 3480

IIT Bombay

22nd January 2018

Dear Heads of UMA Institutions,

Greetings from CTARA, IIT-B.

I must congratulate your institution for enthusiastically participating in and successfully completing the UNICEF-IRAP-CTARA IIT Bombay rural water supply assessment training programme under Unnat Maharashtra Abhiyan (UMA).

The issues raised by participants at the second workshop have been explained below. UMA has taken cognizance of these issues. Please note the actions that we will be taking at our end to solve them.

1. Difficulties in DPR procurement

   Action item: UMA to hold a video-conference session with Zilla Parishad CEOs to brief them about UMA

2. Faculty time accounting, faculty/student credits for project work, floating BTech/MTech projects, special courses on development topics

   Action item: UMA to write to Director, Directorate of Technical Education, requesting him to write to the Vice Chancellors of Universities regarding the above items

Some other suggestions regarding the best times to hold workshops, support for setting up a T&DC, empanelment of colleges for third party assessment of RWS schemes, etc. have been duly noted.

I look forward to your eager participation and steadfast support and cooperation in future events as well.

Please let me know if you have any queries or suggestions.

Thank you.

Regards,

Milind Sohoni

Professor, CSE and CTARA

Chairperson, UMA Advisory Committee

9.4 PRINCIPAL LETTER FOR SUBMISSION OF REPORT

"Education through self-help is our motto" - Karmaveer
Rayat Shikshan Sanstha's

Estd :-1983

Karmaveer Bhaurao Patil
College of Engineering, Satara.

Sadar Bazar, Near RTO Office, Satara, Maharashtra State (INDIA) Pin - 415 001.
Founder : Padmabhushan Dr. Karmaveer Bhaurao Patil (D.Litt.)
[Approved by AICTE, New Delhi, DTE, Maharashtra State - Affiliated to Shivaji University, Kolhapur]

website www.kbpcoes.edu.in
Tele Fax - 02162-235767

Principal

EN 6270

E-Mail : office@kbpcoes.edu.in
Phone : +91 2162 230636 / 235767 / 233005
Ref. No. : KBPCOES/UMA/2021
DATE : 10/01/2018

To,
Dr. Milind Sohoni
Head of Advisory Committee, UMA
CTARA, IIT Bombay

Subject: Submission of inspection and visit report of RWSS scheme from Satara district

Sir,

In respect to the subject mentioned in the caption followed by various references, following students from Civil Engineering Department under the guidance of Dr. Anand Tapase and UMA coordinator of our institute Prof. N.K.Patil have visited the rural water supply scheme which was made available along with its DPR by Z.P.Satara.

1. Mane Pranavkumar Navnath
2. Panke Pratiksha Kakasaheb
3. Sayyad Shahanawaj Sultan
4. Shinde Aishwarya Sunil
5. Pawar Amruta Shivaji

In this connection our institute is entrusted with the assignment of RWSS scheme from Satara district. We approached Z.P.Satara and they provided us DPR of **Shelarwadi Village Water Supply Scheme, Tal. Wai, Dist.: Satara**. Accordingly our students have visited and prepared the inspection report as per the format/template provided by CTARA, IIT, Bombay.

The said report is enclosed here with for your ready references and further procedures.

Thanking you,

Your's faithfully,

I/C Principal,
Karmaveer Bhaurao Patil College of Engineering,
Sadar Bazaar, Satara-415001

K.B.P. College of Engineering EN-6270 Satara

9.5 RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR WORKSHOP CONDUCTED BY CTARA, IIT, MUMBAI AND IRAP

K. E. Society's

Rajarambapu Institute of Technology

NAAC "A' Grade

An Autonomous Institute,

EN 6214, MB 6214

Affiliated to Shivaji University, Kolhapur.

Accredited by NBA, The Institution of Engineers (India) Kolkatta; TEQIP Phase -II Funded,

Approved by AICTE, New Delhi, Govt of Maharashtra.

Ref: RIT/ Civil/766/2017 Date : 26 SEP 2017

RELIVING CERTIFICATE

Consequent upon completion of the program on "**IMPROVING THE PERFORMANCE OF RURAL WATER SUPPLY AND SANITATION SECTOR IN MAHARASHTRA**" jointly organized by UNICEF, IRAP, CTARA IIT Bombay and Rajarambapu Institute of Technology, Rajaramnagar conducted at this institute from **24th September to 26th September 2017.** The following faculty members and students are being relieved in the afternoon of 26th September 2017 as follows;

Sr. No.	Name of Participants	Faculty/Student	Institute / Organization Details
1	Dr. Anand Tapase	Faculty	K.B.P.C.O.E., Satara
2	*Prof. Shitalkumar B. Desai*	Faculty	K.B.P.C.O.E., Satara
3	Mr. Pranavkumar N. Mane	Student	K.B.P.C.O.E., Satara
4	Mr. Ashish H. Patil	Student	K.B.P.C.O.E., Satara

He/she has not been paid Travelling Allowance.

Coordinator
RWS 2017(RIT)

DIRECTOR
K. E. Society's
Rajarambapu Institute of Technology
An Autonomous Institute
Rajaramnagar, Sakharale, (Islampur)

Coordinator
RWS 2017 (IIT Bombay)

9.6 Completion Certificate to A group Member:

IRAP INSTITUTE FOR RESOURCE ANALYSIS AND POLICY

unicef unite for children

CERTIFICATE OF APPRECIATION

TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr. Sayyad Shahanawaj. of K.B.P. College of Engineering, Satara. college have successfully completed the Rural Water Supply Scheme Assessment Training Programme conducted by UNICEF-IRAP-CTARA between September 2017 and January 2018 under the Unnat Maharashtra Abhiyan.

The participant along with his/her team has done field visits and submitted a report.

Mr. Yusuf Kabir
WASH Specialist,
UNICEF – Mumbai

Dr. Dinesh Kumar
Executive Director, IRAP

Dr. Om Damani
IIT Bombay

Dr. Puru Kulkarni
IIT Bombay

Dr. Milind Sohoni
Chairperson,
Advisory Committee, UMA
IIT – Bombay

CHAPTER 10:
SECOND WORKSHOP ON AMRUTWAHINI COLLEGE OF ENGINEERING, SANGAMNER

10.SECOND WORKSHOP ON AMRUTVAHINI COLLEGE OF ENGINEERING, SANGAMNER, MAHARASHTRA

10.1. Field Work Follow-up Workshop:

Improving the Performance of Rural Water Supply and Sanitation Sector in Maharashtra

Organized by:UNICEF Mumbai, IRAP Hyderabad and TDSC of CTARA-IIT Bombay under the Unnat Maharashtra Abhiyan (UMA) Initiative

Venue: 15th-16th January 2018, Amrutvahini College of Engineering (ACE), Sangamner Maharashtra

10.2. ProgrammeAgenda

Day/time	***Session***	***Facilitators***
Day 1	***15th January2018***	
8:45-09:30	Registration	ACE
09:30-10:00	Welcome, context setting and expectations	Shri Yusuf Kabir, Dr M. Dinesh Kumar, Prof Milind Sohoni
10:00-10:30	Overview of the field work component	CTARA
10:30-10:50	Third Party Validation of the Rural Water Supply Scheme: Approach, Findings and Experience Sharing	College 1
10:50-11:10	Third Party Validation of the Rural Water Supply Scheme: Approach, Findings and Experience Sharing	College 2
11:10-11:30	Third Party Validation of the Rural Water Supply Scheme: Approach, Findings and Experience Sharing	College 3
11:30 -11:50	Tea break	
11:50-12:10	Third Party Validation of the Rural Water Supply Scheme: Approach, Findings and Experience Sharing	College 4
12:10-12:30	Third Party Validation of the Rural Water Supply Scheme: Approach, Findings and Experience Sharing	College 5
12:30-12:50	Third Party Validation of the Rural Water Supply Scheme: Approach, Findings and Experience Sharing	College 6
12:50-14:00	Lunch break	
14:00-14:20	Third Party Validation of the Rural Water Supply Scheme: Approach, Findings and Experience Sharing	College 7
14:20-14:40	Third Party Validation of the Rural Water Supply Scheme: Approach, Findings and Experience Sharing	College 8
14:40-15:10	Key observations by resource persons on the field assignments	UNICEF, IRAP and CTARA
15:10-15:30	Tea break	

15:30-16:00	Performance Assessment of Rural Water Supply Schemes: How to make it Comprehensive?	Dr M Dinesh Kumar, IRAP
16:00-17:15	Bottlenecks and opportunities of engaging with government**(with specific reference to latest NRDWP Guidelines)**	UNICEF, CTARA, IRAP and Participants
Day 2	***16th January 2018***	
9:00-11:00	Design tool practice session	CTARA
11:00-11:20	Tea break	
11:20-12:20	Design tool practice session (contd.)	CTARA
12:20-13:00	Way Forward, Feedback and Closing Remarks	UNICEF, IRAP and CTARA
13:30-14:00	Lunch	

10.3. WORKSHOP PHOTOGRAPHS:

15th-16th January 2018


GATE
No.1


AMRUTVAHINI
LEGE OF ENGINEERING, SANGAMNER
Field Work Follow-up Workshop
THE PERFORMANCE OF RURAL WATER SUPPLY AND
SANITATION SECTOR IN MAHARASHTRA
January 15-16, 2018
For Empaneled Institutes Under
Unnat Maharashtra Abhiyan
Role of the institution

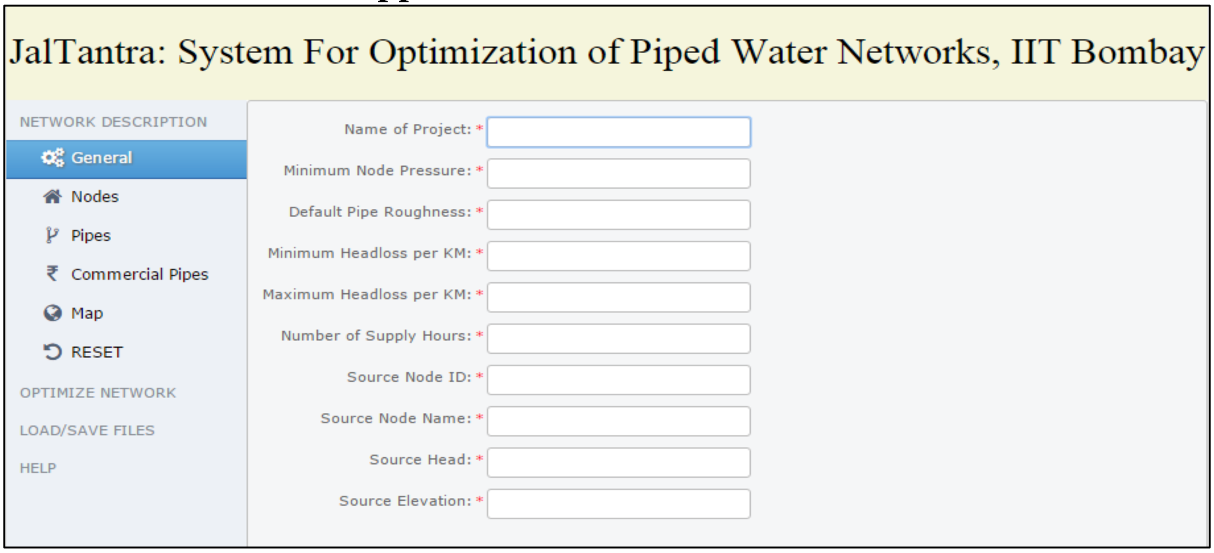
CHAPTER 11:
JALTANTRA SOFTWARE

11. JALTANTRA SOFTWARE:

11.1. JalTantra Features:

- **New Technology: Developed in Java, Platform Independent. Stable and sturdy. Available for free download.**
- **No Network Size Limitation: Capable of handling network having as high as 1000 nodes, solving it in a few seconds.**
- **Best Cost Optimization Capability: Proven optimal algorithm**
- **Extensible and Customizable: Can be easily customized based on feedback from field trials and practical experience.**

11.2. JalTantra Web Application:

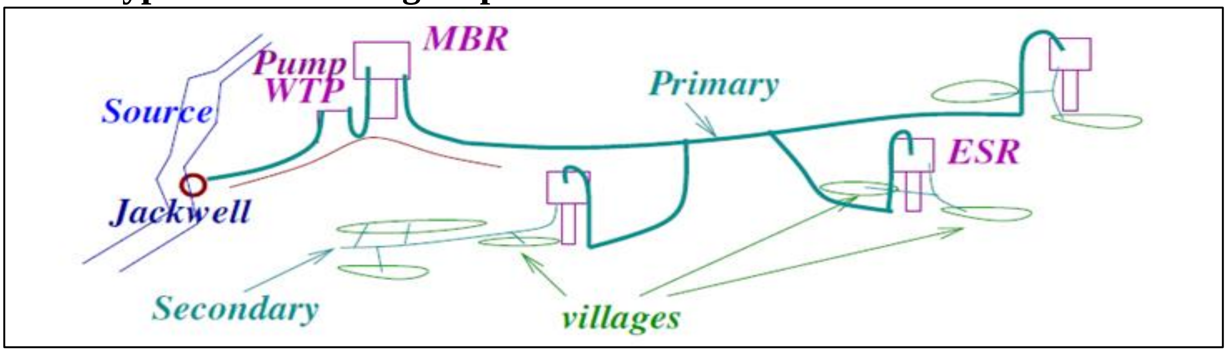


- **http://www.cse.iitb.ac.in/jaltantra/**

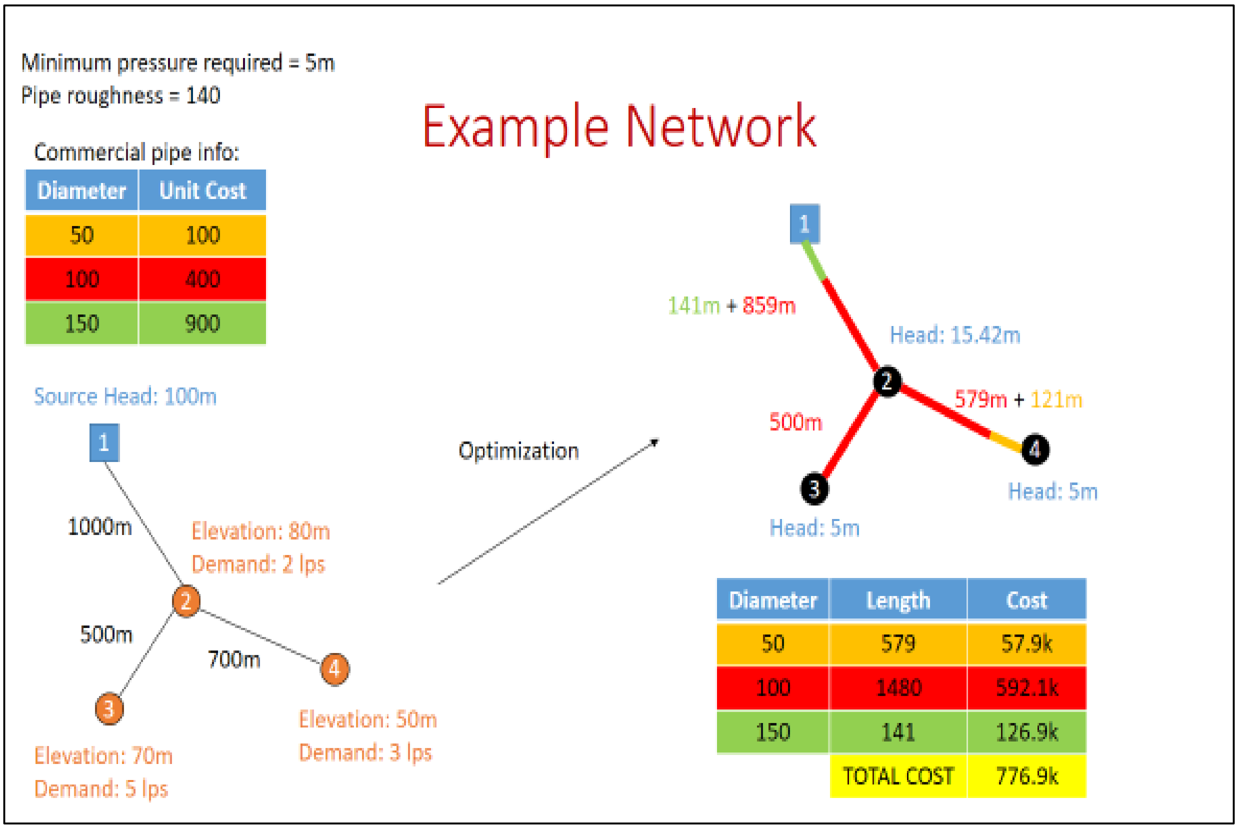
11.3. JalTantra Local Version:

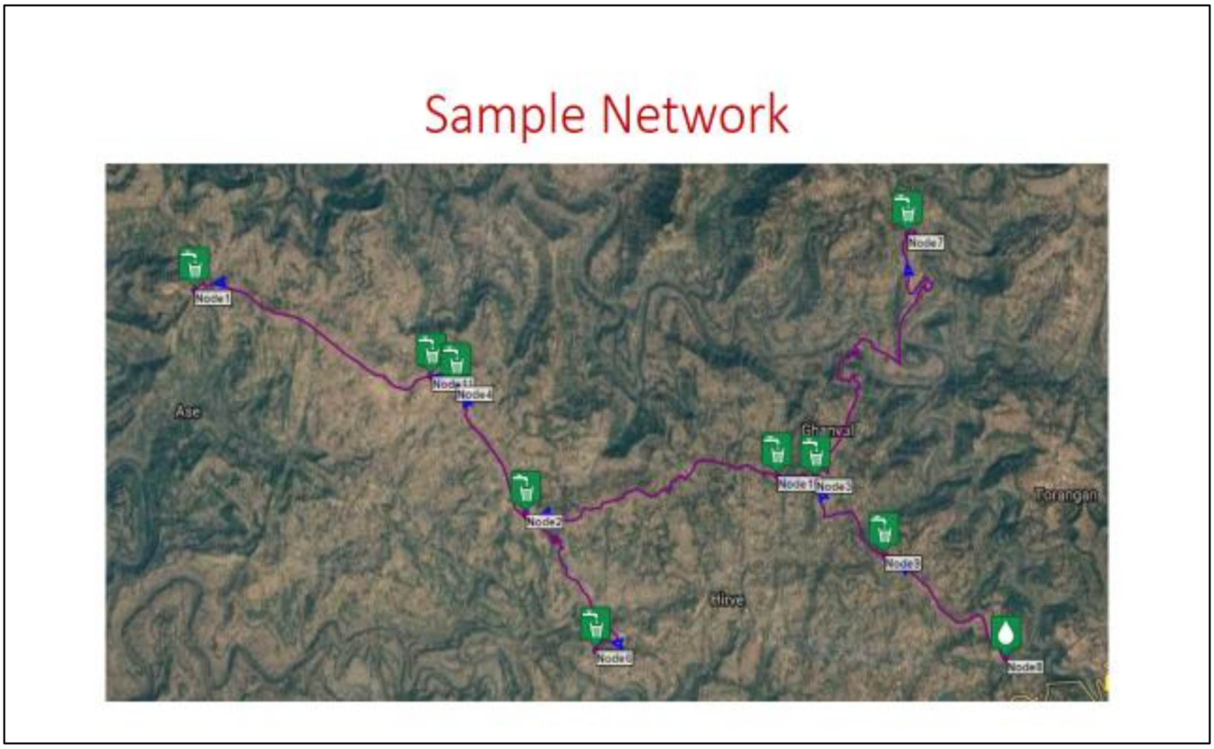
- **Alternatively local version can be installed from http://www.cse.iitb.ac.in/~nikhilh/jaltantra/**
- **Requires java**
- **Map GIS functionality will require internet, everything else can be done offline**

11.4. Typical Multi Village Piped Water Scheme:

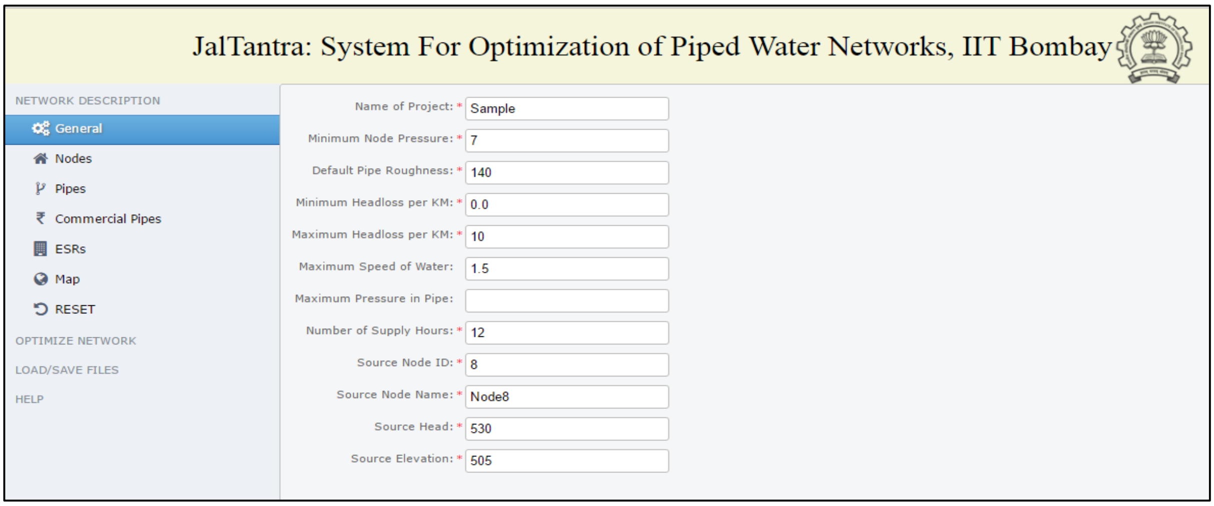


11.5. Example Network:

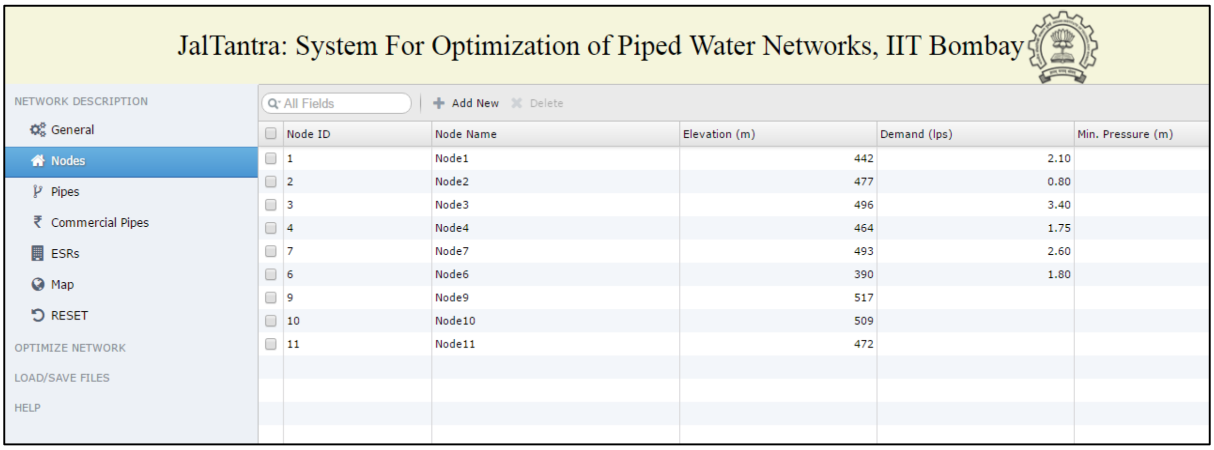




11.6. GENERAL PROPERTES:

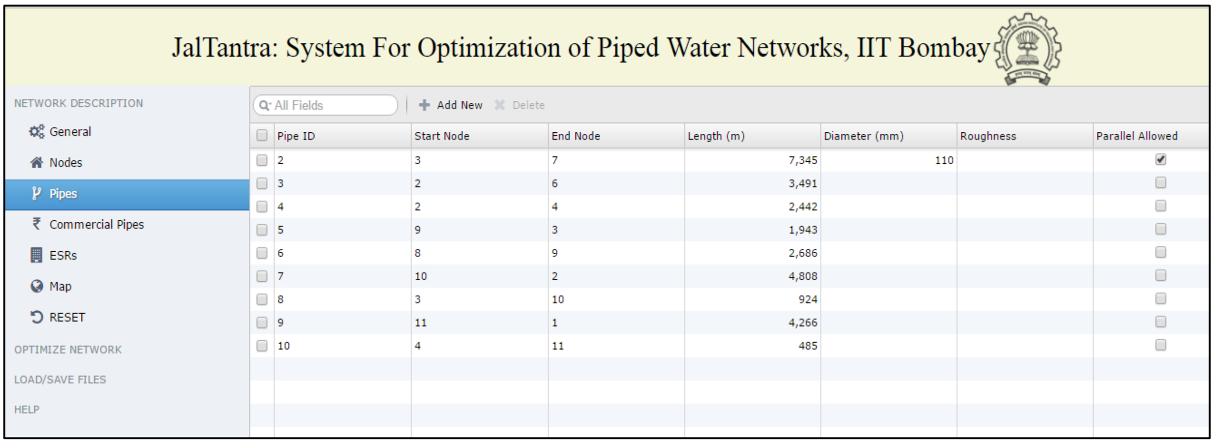


11.7.NODE INFORMATION:



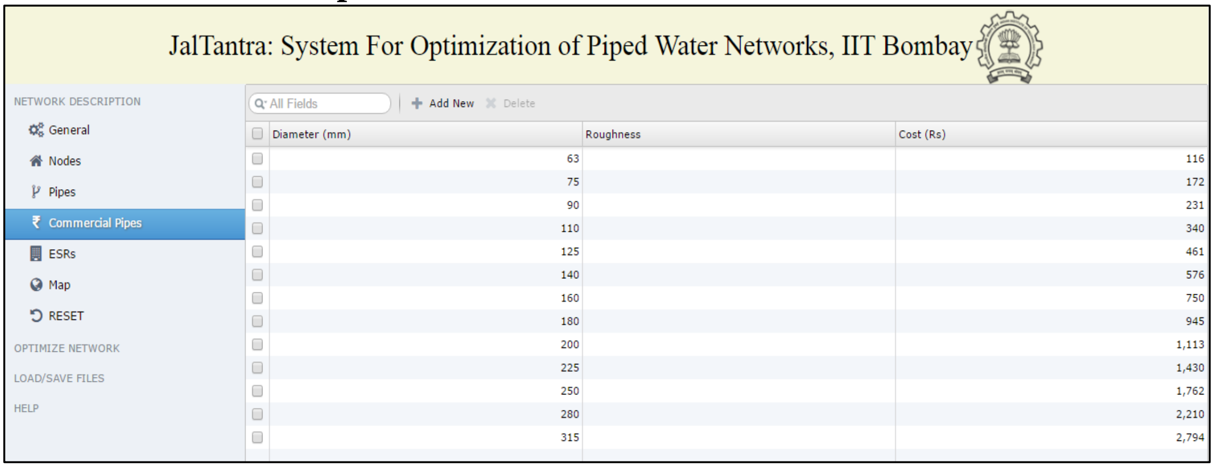
Node ID	Node Name	Elevation (m)	Demand (lps)	Min. Pressure (m)
1	Node1	442	2.10	
2	Node2	477	0.80	
3	Node3	496	3.40	
4	Node4	464	1.75	
7	Node7	493	2.60	
6	Node6	390	1.80	
9	Node9	517		
10	Node10	509		
11	Node11	472		

11.8. PIPE INFORMATION:



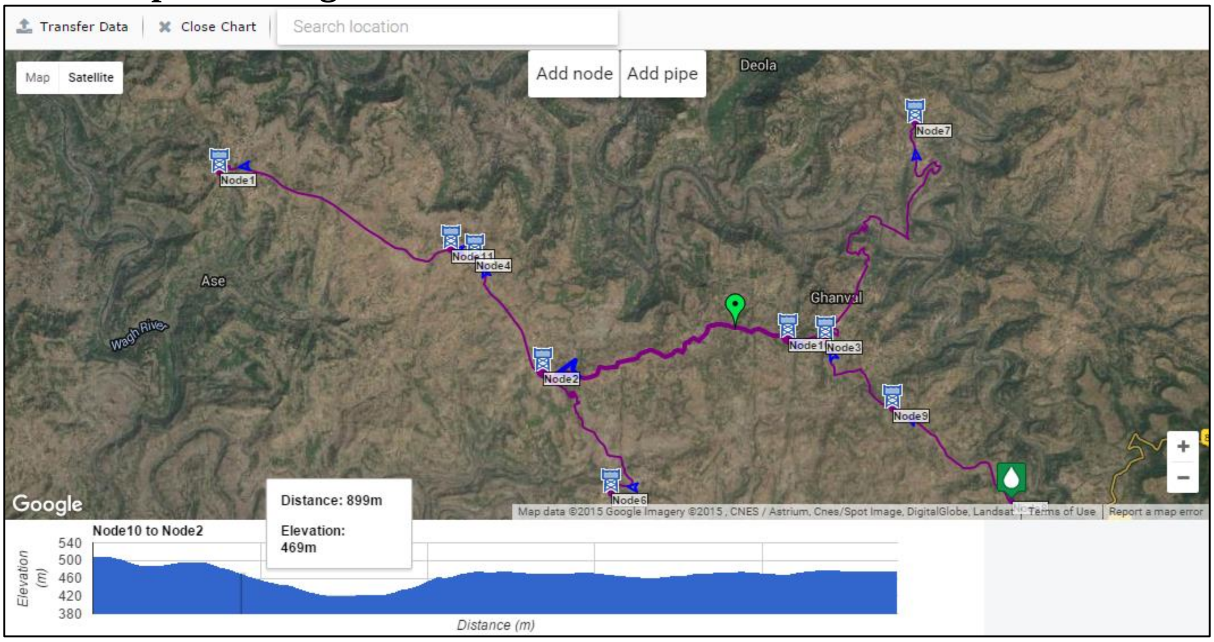
Pipe ID	Start Node	End Node	Length (m)	Diameter (mm)	Roughness	Parallel Allowed
2	3	7	7,345	110		✓
3	2	6	3,491			
4	2	4	2,442			
5	9	3	1,943			
6	8	9	2,686			
7	10	2	4,808			
8	3	10	924			
9	11	1	4,266			
10	4	11	485			

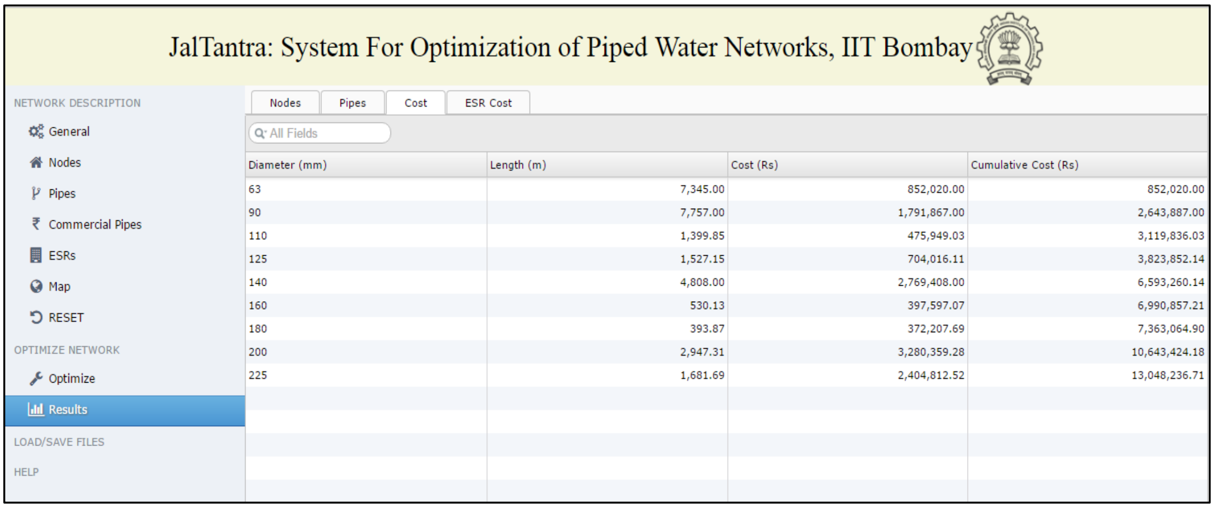
11.9. Commercial Pipe Information:



Diameter (mm)	Roughness	Cost (Rs)
63		116
75		172
90		231
110		340
125		461
140		576
160		750
180		945
200		1,113
225		1,430
250		1,762
280		2,210
315		2,794

11.10. Map GIS Integration:





Diameter (mm)	Length (m)	Cost (Rs)	Cumulative Cost (Rs)
63	7,345.00	852,020.00	852,020.00
90	7,757.00	1,791,867.00	2,643,887.00
110	1,399.85	475,949.03	3,119,836.03
125	1,527.15	704,016.11	3,823,852.14
140	4,808.00	2,769,408.00	6,593,260.14
160	530.13	397,597.07	6,990,857.21
180	393.87	372,207.69	7,363,064.90
200	2,947.31	3,280,359.28	10,643,424.18
225	1,681.69	2,404,812.52	13,048,236.71

11.11. Results:

- Load/Save Files:
- Can load files in three formats: BRANCH, XML or EXCEL
- Can save input files as XML or EXCEL
- Can save output file as EXCEL
- Sample input/output files provided under the HELP section
- Help section also provides details on units, contact info and a YouTube tutorial

11.12. CONCLUSION:

1. Cost optimization
2. Large Network Size: Capable of handling network having as high as 1000 nodes, solving it in a few seconds.
3. Optimized network can be obtained in few seconds
4. Using Pipe diameter, no. of nodes etc. optimized cost can be obtained

CHAPTER 12: CONCLUSION

12. OVERALL PROJECT CONCLUSION:

CHAPTER 13:
REFERENCE

13. REFERANCES:

13.1. Water policy and NRDWP

1. NRDWP Guideline http://mdws.gov.in/sites/default/files/NRDWP_Guidelines_2013.pdf
2. Strategic plan http://mdws.gov.in/sites/default/files/StrategicPlan_2011_22_Water.pdf
3. Background note on NRDWP http://mdws.gov.in/sites/default/files/BackgroundNote.pdf
4. Maharashtra water policy http://www.cseindia.org/userfiles/maharashtraSWP.pdf

13.2.Third party report

1. TISS Kurjapur report http://www.indiaenvironmentportal.org.in/files/file/TISS_KRC_Study_Report_Status_of_Water_Supply_in_Maharashtra.pdf
2. World bank report http://siteresources.worldbank.org/PROJECTS/Resources/40940-1393966271292/IndiaRuralWaterPforRtechassess.pdf

13.3. Complete design guide

1. CPHEEO manual http://moud.gov.in/advisory/manual_ws
2. NCRPB http://ncrpb.nic.in/NCRBP%20ADB-TA%207055/watersupply/index.html
3. Technical book : Published by IWWA,Pune