Innovative Secure systems for 24X7 supply of potable water to the people of Indore City

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*Abstract*—The concept of 24x7 water supply to the city is not new thing but was in practice in late seventies but limited to some confined area. It deals with the fact that if the pipeline supplying water to the consumer is full for nearly 24 hrs., the tendency of the consumer to store the water more than their requirement is curbed. It further helps the maintenance engineer to detect leakages in the system and there by measure the quantity of water put into the system. The details like actual quantity of water consumed, water billed and the losses in the system can be ascertained easily.

*Keywords—potable, supply, system, innovative, District Metered Areas, Zones*

1. INTRODUCTION

Indore is the largest city of Madhya Pradesh in terms of its population. Indore has been selected as one of the 100 Indian cities to be developed as a [smart city](https://en.wikipedia.org/wiki/Smart_city) under the [Smart Cities Mission](https://en.wikipedia.org/wiki/Smart_Cities_Mission). It also qualified the first round of Smart Cities Mission and was selected as one of the first twenty cities to be developed as Smart Cities. Unplanned and rapid growth of urban areas poses a major challenge to provide basic water service in any country. Indore being a water stressed city, severe water crisis, will not only risk urban growth and national economy but also, negatively impact the live ability of city and quality of life for urban citizens.

The decreasing availability of water supplies is one of the most important environmental issues taken by various countries. In many urban areas, intermittent service, wherein water is provided to residents for a limited number of hours per day. The term continuous water supply – refer to the supply of potable water to end users through a system of pipes-covering interlinked bulk transmission and/or distribution system which are continuously full and under positive pressure throughout their whole length, such that the end user may draw off water at any time of the day or night, 24x7 throughout the year. This is by itself an important aim for any water supply system. Continuous supply has two main advantages. One is that people can draw water when they need. The second advantage is not holding contamination. When pipes are empty most of time, contamination can seep in through cracks and gaps. A pipe carrying hours a day, on the other hand, will not allow this as the water pressure is acting centrifugally.

It is internationally acknowledged that the best way to keeping water safer during distribution is to ensure that it keeps 36 flowing through the pipes on a regular (24x7) basis. Due to irregular or intermittent water may get contaminated due to pressure 37 difference in pipe or stagnation of water which ultimately leads to health hazard. An intermittent water supply is common to most 38 of the Indian cities. The consumers are forced to collect as much water as possible during the limited supply hours, which leads to 39 excessive usage of pumps.

Continuous water supply is one of the important norms for smart cities. Recently the Government of India has decided to 41 convert 100 cities into smart cities. Intermittent water supply is one of the impediments that get in the way of not only improving 42 service delivery but also for conversion of a city to a smart city. There have been many attempts to achieve this most challenging 43 task. Unplanned distribution system and laxity in water loss management makes 24x7 water supply a difficult task.

"The Manual of Water Supply & Treatment” 3rd Edition CPHEEO, Ministry of Urban Development, New Delhi: stats that,

“The intermittent system suffers disadvantages, wherever possible, intermittent supply should be discouraged or convert it into the continuous supply system for better health and wealth of the citizens”

The objective of this paper is to make a successful project design for the 24x7 water supply system in the Cleanest city of India.

1. Review of Literature
2. PRESENT SYSTEM

The water may be supplied to the consumers by either- (1) continuous system or (2) intermittent system. In the continuous system, the water will be available to the consumers for all 24 hours a day. Whereas the intermittent system will supply water only during peak water demand period fixed hours in the morning and evening. The exact period of supply of water to the consumers will depend on the availability of water from the source/ water treatment plant, pumping rate, available storage of water, availability of electric power supply during the day, water demand, seasons etc.

The intermittent system creates problems like contamination of water in the pipes during non-supply hours, unhygienic as well as insanitation problems due to inadequate use of water by certain group of people by utilizing minimum quantity of water. Besides, at majority of places, the intermittent supplies may not provide much savings of water because of the following reasons:

• In intermittent supply system, water is generally stored by the consumers in tanks, drums, and utensils etc. for use during non-supply hours. They, if unutilized, as soon as the fresh supply is restored, usually throw this stored water away. This increases the wastage and losses of water considerably.

• The consumers have a general tendency to keep the water taps open during no supply hours; so that they may come to know the restoration of the supply. However, in majority of cases, water goes on flowing to waste, unattended even after the supply is restored, thus resulting into wastage of precious treated and potable water.

Besides, this intermittent supply system causes great inconvenience to consumers, keeping them on their toes for receiving and collecting water as soon as the supply is restored.

Further, in this system, when the supply of water stops and the water from the pipe is withdrawn off, a partial vacuum may be created in the pipeline. This induces suction through leaky joints and if dirt or parts of sullage or even sewage and other waste waters on the ground surround the pipes, the same may get entries into the pipes. This contaminates the 30 existing water available in pipes as well as incoming water in the pipelines, when the supply is restored.

Number of sluice valves and control valves are required to be installed in the network of water distribution system. All these valves are operated many times daily, while starting or closing supply. This requires additional operating staff along with high operating and maintenance cost.

Intermittent system should not be continued on long term policy due to the following disadvantages :-

The consumers have to store water for use during non-supply hours; which is likely to be contaminated. Some consumers may not have sufficient storage facilities; which may lead to insanitary conditions ultimately.

It has been observed that the consumers leave their water taps open every time ; which causes much wastage of water.

If more storage of water is kept for the use during non-supply hours, it is thrown away, causing wastage of water.

If any incidents of fire-fighting occur during non-supply hours, no water is available; which may subsequently cause huge damages before the supply could be turned on.

In spite of all these limitations / disadvantages, the intermittent supply system is being mostly adopted in our towns and cities. For improving the pressures in intermittent system, the entire city area is divided into number of zones and different zones are supplied with water during different hours of the day, thus obtaining pressures. Most of network of pipe distribution system of water supply of towns and cities are usually designed as continuous supply system", but after implementation operated as an “intermittent" one. In view of above, the water is to be supplied through continuous system. This is the best system and the water is supplied for all the 24 hours a day. In this system, ample water is always available for firefighting, or any break-down or emergencies, even by closing the supply of certain localities. Besides, due to continuous circulation, water always remains fresh, in the pipelines. Considering these, continuous supply of water around 24 hours a day is proposed for the project area under this.

1. Research Gap

GAP ASSESSMENT OF THE PRESENT SYSTEM: -

Following are the critical issues prevailing with existing water supply & Sewerage system and hence resulting into gap between water management and citizen services.

1. In current scenario, the bulk water supplied into the system has too many direct tapings for distribution of water resulting into pressure drop and non-filling of ESR and leading to un-equitable distribution.
2. The city does not have any metered water connections. Hence, the quantity of water consumption and the physical losses in the city is difficult to be estimated.
3. Serving area/ zone served by each elevated service reservoir (ESR) was not designed as per their capacity. Moreover, distribution pipelines laid in haphazard manner
4. There is substantial loss of water due to old and worn out pipelines leading to leakage.
5. In addition there are more chances of having unauthorised / illegal connections in the distribution system.
6. There are too many deep bore wells within the distribution network.
7. Integrated map / drawings of distribution network are not available for proper demand supply management.
8. In absence of proper instrumentation system there is no accountability for water supplied and distributed. This is leading to un-efficient operation of the system.
9. There is proper complaint registration and redressal mechanism for repairs & maintenance leading to poor services and dissatisfaction among consumers.
10. There is no metering policy and tariff policy in place. Consumers are being charged on monthly basis on flat rate irrespective of their consumption.
11. The Sewerage system is very old and dilipiated condition i.e. laid during the Holkar’s state in 1936.
12. Households are not fully covered and connected with sewerage network.
13. Through the project area has network of Primary and Secondary sewer lines but the linking between these two is missing at few places and sewage is not being carried upto STP fully, resulting sewage disposal into natural drain / river.
14. The treated sewerage is not being reused or recycled. The Treated Sewage is being discharged in Kanh River which is used for agricultural irrigation purpose in the downstream hinterland.
15. RESEARCH DESIGN/METHODOLOGY

Text, timeline

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([https://dwes.copernicus.org/](https://dwes.copernicus.org/preprints/dwes-2018-14/dwes-2018-14.pdf))

Diagram

Description automatically generated

([https://mohua.gov.in/](https://mohua.gov.in/pdf/624eb498862a7Guidelines-for-Planning-Design-and-Implementation-of-24x7-Water-Supply-Systems.pdf))

1. PROPOSED METHOD
2. IMPLEMENTATION
3. RESULTS/DISCUSSIONS
4. The water supply schemes for 24x7 continuous or even intermittent ones should have detailed project reports prepared with equal importance for hydrology, hydraulics, environment, socio-economics, IoT, Cloud computing, telecommunications, and other ICT technologies.
5. All India based standardisations in the sustainable management of water supply schemes and its governance should happen both for villages and towns.
6. The hackathons should be encouraged for all regions of India to develop sustainable water supply schemes be it 24x7 or intermittent type using spatial data available in India / other country websites depicting Indian land regions.
7. There should be 30 percent different disciplines of engineering / science practicing people [ Computer science , geology, hydro-geology, electronics, telecommunication , mechanical , mathematics, water resources engineering , environment/ ecology , social anthropologists ] should be engaged with existing civil engineers.
8. The water availability / water scarcity should be assessed with high reliability by using remote sensing and GIS and related hydrology / hydraulics for 24x7 continuous or intermittent water supply schemes. Integrated water resources management principles (by using surface water, ground water , conjunctive use, water quality aspects, power, indigenous availability of pumps / valves / smart meters as much as possible be included) should be applied while ensuring 24x7 water supply schemes
9. LIMITATIONS

A combination of several institutional, financial and technical reasons do not allow, water service providers in most parts of India to provide continuous supply today.

The principal institutional and financial shortcomings are common to most water service providers in the country:

1. The terms of employment of water service managers and staff are those of the civil service – or related to them. Advancement in the water service organization owes more to length of service than to performance in the post. There is, therefore, limited incentive to achieve high performance in their posts and, as a result, most water service providers operate inefficiently and ineffectively, and service quality is very poor;
2. While water charges are low, the poor, who are largely unconnected or nominally connected, are not benefiting from them. Consequent budgetary subventions to shore up service provider finances are supporting regressive (pro-rich/middle class) tariff structures and the overall inefficiency of the service provider, and largely benefiting the connected middle and rich classes. These governmental subventions, mainly for capital works, result in insufficient revenue (and even less organizational emphasis) to effectively operate and maintain the system or restructure it so that it can be made manageable. The inadequacy of revenue is compounded by the high incidence of non-payment by customers due, mostly, to the poor quality of the water service provided. Low tariffs are thus a reflection of the adverse institutional incentives inherent in the financing arrangements and accountability structures applicable to the sector, rather than a reasoned policy stance on social and equity considerations;
3. Partly due to lack of available funds, or lack of knowledge of modern management systems, most water service organizations lack systems, technology, and computer hardware and software to operate the service efficiently and effectively;
4. Even if funds were available, managers and staff of operational areas have no time to plan and implement the restructuring of their system to render it manageable. They are fully employed operating valves needed to schedule supplies and “fire-fighting” the numerous problems that occur on the distribution network every day due to its generally poor state of repair. There is no time to restructure their system to render it manageable; and
5. In the main, managers and “owners” of water service providers do not feel the need to convert from intermittent to 24-7 supply. They do not understand the limitations that this places on their operational efficiency, nor the magnitude of the risk to health of the practice.

The following are the principal technical reasons for the inability, at present, to achieve 24-7 supply:

1. In most cities, reliable data on distribution networks and customers do not exist. Knowledge of pipelines, their diameter, material, location and state of repair depends heavily upon the experience and memories of line inspectors;
2. Most – in many cases, all – pipelines comprising the distribution system are totally interlinked. This means that water pumped into the system at any point affects the dynamic balance of the entire network to a greater or lesser extent. As water enters the network at a number of points and is consumed with an irregular pattern, the direction and volume of the flow of water at any point in the system are virtually unpredictable. Clearly, this renders the management of the water distribution system impossible. In some cities, transmission pipelines, the sole 32 purpose of which should be to transmit bulk water to Operational Zones (OZs) for distribution, are themselves used as part of the distribution network;
3. There is virtually no metering of bulk water produced and distributed within the operational areas; neither is it metered at any point in its transmission to operational areas for distribution to customers. Without metering, the main operational parameter of a water service provider, it is impossible to effectively manage the system;
4. Without reliable plans or knowledge of pipelines or valves – combined with the totally interlinked nature of systems – control of leakage on a routine, planned basis is virtually impossible. It is rendered even more difficult under intermittent supply conditions as modern, efficient detection methods work effectively only when the system is pressurized. Without the possibility of the repair of the multitude of “hidden” leaks that occur in every distribution system in the world, a water supply system must inevitably be in a continuous state of deterioration;
5. It is unusual for a water utility to measure pressure within its distribution system. An ability to control system pressure is essential to the management and reduction of leakage from systems. In general, pressures are higher under intermittent supply systems – at least at entry to the points of distribution and in their immediate surroundings – as it is necessary to “push” a large amount of water into and through the system in a short space of time. These pressures also often peter out to nothing at the ends of the system supplied; and
6. It is a little recognized point – but a major one from the point of view of system management – that customer meters do not function with any predictable accuracy under intermittent supply conditions. This is in part due to the sand and grit that enters the system but also in great part due to the fact that the meters measure the flow of air – in both directions – at each period of intermittency and this, in turn, also leads to a rapid burn-out of meter bearings.

Labouring under these conditions, urban water service providers throughout the country find it impossible to achieve 24-7 supply.

1. FUTURE ENHANCEMENT
2. Preparation of water pipe network in Bentley Water GEMS from GIS files
3. Preparation of hydraulic model and extended period simulation of the same.
4. Load elevations to the hydraulic model from the 3D contour data.
5. Check the design of all the zones of the town for its adequacy.
6. Creation of the District Metering Areas (DMA) s for transformation to the 24/7 water supply system.
7. Creation of scenarios as required.
8. Preparation of final output of hydraulic design with AutoCAD drawing and report, etc. complete.
9. ACKNOWLEDGEMENT
10. REFERENCES