Design of Drinking Water Solution for Tanker fed villages in Mokhada Taluka, Thane

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Background: Tanker fed villages in Thane District and Regional Piped Water Schemes

- Severe drinking water shortage in 27 districts and 136 talukas of Maharashtra state (in 2014)
- 190 tanker fed villages in Thane

- Majority of tanker fed villages in Mokhada and Shahapur taluka
  - dependent on single village, groundwater based schemes
  - absence of surface water based Multi-Village Schemes
Problem Statement

• Given the failure of Groundwater based schemes, explore Surface Water based Multi Village Schemes

• Focus on
  • Source sustainability
  • Operational/Financial sustainability

• Solution Approach
  • Development and extensive use of GIS, and modeling and simulation tools
  • Preferably Gravity Based schemes to minimize operational costs (energy costs)
Ideal Research focus: Multi-criteria constrained optimization of multi-village schemes

- Variables: Water Source, Storage Reservoir locations, Pipe Diameters
- Constraints: Per capita Capital cost government norms
- Optimization: Operation cost

Schematic of infrastructure currently used for seasonal supply
Current MJP Focus

• Instead of minimizing Operational costs
  – minimizes capital costs

• Research Stage I
  – Develop tools and solutions for minimizing capital costs for a given source
  – explore different sources

• Research Stage II
  – Develop tools and solutions for minimizing operational costs
Project Area: A cluster of tanker fed villages in Mokhada Taluka

• Home for three reservoirs supplying water to Mumbai
• 92% Adivasi Population
• About 70 habitations depend on tanker water
• Trend shows Increasing no. of tanker fed villages and habitations in spite of huge spending( 3.5 cr for current year) on drinking water security measures.
Karegaon Scheme and tanker-fed Villages

• Source for Karegaon scheme getting submerged due to Middle Vaitarna Dam Project

• RWSS department redesigned Karegaon keeping geographical scope unchanged

• 13 tanker fed villages in the vicinity of the scheme

• Explore adding these villages to the proposed scheme
Our Solution

- Higher Elevation of tanker fed villages (avg elevation 363 m) makes Middle Vaitarna infeasible

- A new scheme based on upper Vaitarna can serve all beneficiaries of Karegaon scheme, as well as 13 tanker fed villages of Mokhada

- Gravity Flow helps in bringing down both capital and energy cost.

<table>
<thead>
<tr>
<th>Description</th>
<th>MJP Scheme</th>
<th>Proposed Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Capita Cost (Rs.)</td>
<td>5083</td>
<td>2890</td>
</tr>
<tr>
<td>Rural Norm for per capita cost (Rs.)</td>
<td>3495</td>
<td>3495</td>
</tr>
<tr>
<td>Cost per 1000L (Rs)</td>
<td>24.18</td>
<td>6.35</td>
</tr>
</tbody>
</table>
Process

• Gather Information
  – Possible Water Sources
  – Village Location/Population
  – Cost of various infrastructure components
  – Norms for water demand and operational/capital cost
• Explore different sources
• MBR and WTP Layout and Sizing
• ESR Location and Sizing
• Pipe Layout and Sizing
Sources of Information

• MJP
  – Cost of Infrastructure like WTP, ESRs, Pipes
  – Norm of Water Demand
  – Norms for Capital/Operational Cost
  – Guidelines for Sizing of MBR, WTP and ESRs
  – Guidelines for Scheduling
Tools

• Reservoir location and Network design: GIS
• Pipe Sizing – JalTantra (tool developed at IITB)
• Supply Schedule - EPANET

• Research goal: eventually do all of the above with one program
Use of Tools : GIS

Locate water sources, villages, and assets
Deciding where to break the pipes
Calculating distances
JalTantra: A System for Design and Optimization of Water Distribution Networks
JalTantra: ILP Formulation

- Boolean Variables $i_{j} = 1$ if pipe $i$ uses the commercial pipe $j$, 0 otherwise

- Pipe Constraint (for each pipe $i$): $\sum_{j=1}^{m} i_{j} = 1$

- HeadLoss Constraint (at each node $n$):
  \[\sum_{j=1}^{m} \left( \sum_{i,j} \text{loss}(i,j) \times i_{j} \right) \leq H_{REF} - \text{Elev}(n) - P_{min}(n)\]

  Summation over all pipes in the path from source to node $n$

  $H_{REF}$: Head at Reference Node
  $\text{Elev}(n)$: Elevation of Node $n$
  $P_{min}(n)$: Minimum Pressure required at node $n$

  $\text{loss}(i,j) = \text{Headloss}(\text{length}(i), \text{flow}(i), \text{diameter}(j), \text{roughness}(j))$

  We use the Hazen-Williams Equation for calculating Headloss:

  \[10.68 \times \text{length} \times \left( \frac{\text{flow}}{\text{roughness}} \right)^{1.852} \div \text{diameter}^{4.87}\]
JalTantra User Interface
Use of Tools: EPANET Verification for extended period operation
Way Forward: Having designed the solution ..

- Water Conference in Khodala on May 31st, 2014
- Local people involved in taking the initiative forward
- Local MP and MLA were also present
- Secretary, Tribal Development Department, GoM also interested
Conclusions

• Use of tools such as Google Earth, JalTantra/EPANET simulations using GIS data to do the scheme costing/verification

• Potential for making entire Mokhada Taluka tanker free

• Our task does not end with scheme design

• Who should receive our output is important to consider
~ THANK YOU ~