Supply naturally treated waste water for irrigation by building highway landscapes.

- Darshan Shah.
We all know this...!!!

Source: World Business council for sustainable construction
But do we understand?

(Diameter 1500 km)
Oceans
97% Water

(Diameter 250 km)
3% Fresh Water

(Diameter 56 km)
Fresh Water Accessible to sustain us !!!

One out of every 9 individuals is in search of water daily.

Source: U.S. geological survey

Source: water.org
India accounts for 2.45% of land area and 4% of water resources of the world but represents 17% of the world population.

But do we understand?

Source: CGWB, India.
But do we understand?

Water usage pattern

Water demand – Current and Projected.

Source: CPCB
KILLING FIELDS

Suicide by farmers due to agrarian distress in 2014

<table>
<thead>
<tr>
<th>State</th>
<th>Suicides (up to)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maharashtra</td>
<td>204 (up to Apr)</td>
</tr>
<tr>
<td>Telangana</td>
<td>69 (up to Oct)</td>
</tr>
<tr>
<td>Karnataka</td>
<td>19 (up to mid-Nov)</td>
</tr>
<tr>
<td>Gujarat</td>
<td>3 (up to Oct)</td>
</tr>
<tr>
<td>Kerala</td>
<td>3 (up to Oct)</td>
</tr>
<tr>
<td>Andhra</td>
<td>3 (up to Jun)</td>
</tr>
</tbody>
</table>

Previous years' figures for Maharashtra:

- 2011: 608
- 2012: 642
- 2013: 407

200 Vidarbha farmers kill self since Jar.

NO RESPITE  Six cases reported in the last 48 hours; suicides on the rise as new crop season nears

VIDARBHA: MAHARASHTRA’S COTTON BELT

Indian Farmers in Trouble: Cotton Crisis, Economic Strain

But

Condition of Farmers in India and Maharashtra
World uses about **25 billion cubic meters of water per day**

&

generates **20 billion cubic meters of waste water per day**.

Source: The world counts.
Supply naturally treated waste water for irrigation by building highway landscapes.
Aim:
To evaluate the suitability of a natural wastewater treatment system using roads to provide treated waste water for irrigation.

Objectives:
• To study feasibility of road standards with area required for treatment.
• To evaluate the potential of the proposal as a prototype for all existing and proposed highways in water stressed areas of India.
• To supply treated wastewater for irrigation.
• To develop minimum standards for design of the proposed wastewater treatment system.
• To design the system on the basis of sustainability indicators:
  i. Environmental indicators.
  ii. Economic indicators.
  iii. Functional indicators.
• Study shall concentrate only on Municipal gray and black water.

• Study shall not concentrate on Rainwater.

• Study shall be restricted to the existing network of pipelines for water supply and drainage.

• 2 MLD of waste water to be considered for the prototype.
Considering the environmental, economic and functional indicators treating waste water naturally is a sustainable solution. But, natural treatment is land intensive.

In India, almost all areas including the backward regions are connected via roads.

A vast parcel of agricultural land adjoined both sides of the road.

Backward regions have a Class I or Class II town/city nearby.

Waste water from city/town

Naturally treated via channels on highway sides or medians

Supplied to fields adjoining highways
Step 1: Questions

Step 2: Precedent Study

Step 3: Research

Step 4: Critical Analysis

Step 5: Design

Waste water treatment system
Design of the study: Action Research

Physical Geography

Economic Geography

Human Geography
National Highways

Total Road length of India: 79116 Kms.

Road Study

India

Major Roads in India

National Highways

- Golden Quadrilateral
- North South Corridor
- East West Corridor
- NHDP Phase III
- Other National Highways

Intermediary roads

State Highways

Expressways
Total Road length of Maharashtra: 4498 Kms

NAMEH - Nagpur Aurangabad Mumbai express highway.

NH6 – National Highway 6
Nagpur Aurangabad Mumbai express highway – NAMEH (700 km) is a Maharashtra State Highway. It passes through 12 districts of the state. The length passes through backward regions of Vidarbha & Marathwada.

<table>
<thead>
<tr>
<th>Name of Region</th>
<th>Approx Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vidarbha</td>
<td>400 km</td>
</tr>
<tr>
<td>Marathwada</td>
<td>160 km</td>
</tr>
<tr>
<td>Rest of Maharashtra</td>
<td>140 km</td>
</tr>
</tbody>
</table>

It will boost employment through development of Industries in backward regions.
Side Open drains for Rain water on NAMEH.
Site Visit

NAMEH & NH6

Typical Section of NH - 6

2.5 m wide Road  |  2 m to 5 m wide Median (Depressed)  |  7 m wide Road  |  Carriage Way

- Rain water drain to other side
- 0.45m to 0.6 m Central Drain

Side Rain water channels on median
Junction to transport rainwater to the sides
Centre Rain water channels on median
A typical section of a multilane Expressway. Example- NH6
Site Selection - Highway

Kopargaon

KOPARGAON
Kopargaon Town is a headquarter of Kopargaon Tehsil in Ahmednagar district. Area: 10.52 sq.kms. including the part portion of Kopargaon Village. Kopargaon Town is settled on a plane plateau having a gentle slope from North to South and West to East towards the river. It is at an altitude of 496 m.
### WASTE WATER GENERATION

Assuming 80% of supply water as waste water, Kopargaon town generates 10 MLD of waste water.

<table>
<thead>
<tr>
<th>Source</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taluka</td>
<td>Kopargaon</td>
</tr>
<tr>
<td>District</td>
<td>Ahmednagar</td>
</tr>
<tr>
<td>Source of Supply</td>
<td>Godavari Left Bank Canal</td>
</tr>
<tr>
<td>Population in person as per 2001Census</td>
<td>59970 Souls</td>
</tr>
<tr>
<td>Rate of Water Supply</td>
<td>135 LPCD</td>
</tr>
<tr>
<td>Daily Water Supply at designed Stage (Net)</td>
<td>22.227 MLD</td>
</tr>
<tr>
<td>Daily gross demand with losses</td>
<td>25.978 MLD</td>
</tr>
<tr>
<td>Existing Water Supply</td>
<td>12.500 MLD</td>
</tr>
<tr>
<td>Required Daily Demand</td>
<td>13.478 MLD</td>
</tr>
<tr>
<td>No. of Rainy days</td>
<td>34 days</td>
</tr>
<tr>
<td>Average Annual rainfall</td>
<td>57 mm</td>
</tr>
</tbody>
</table>

Source: KOPARGAON MUNICIPAL COUNCIL
The potential waste water to be treated of Kopargaon is 10 MLD per day.

For the prototype 2 MLD of waste water is considered.

Waste water treatment system

Proposed system: Three Stage Treatment

- Primary Treatment
  - Baffled Septic Tank

- Intermediary Oxidation
  - Venturi effect

- Secondary Treatment
  - Horizontal Sub Surface Treatment

Sludge dewatering Reed bed Treatment. (optional)
Waste water treatment system

Proposed system: Three Stage Treatment

BAFFLED SETTLING TANK

INTERMEDIARY OXIDATION i.e. VENTURI EFFECT

HSSF TREATMENT SYSTEM
Proposed System

Stage 1

By rule of thumb, 350 liters of methane can be produced from 1kg of COD removed, which amounts to 350cum/day.

Source: BORDA.

Design diagram for Baffled Septic Tank (2 MLD), derived through calculation.
Proposed System

Stage 2

Schematic pipe section showing Venturi effect, Pipe Dia 10” (Calculation).
To treat the huge volume of waste water efficiently over 5.5 km, the HSSF bed is designed into a module of 2 m x 10 m (w x l) and placed in a series along the highway on both sides.

Each of these modules will be fed with Primary treated Wastewater via a VCP pipe running parallel to it.

**HSSF:**
Plan and Section of the module on entire width of the highway
According to the **calculation** for HSSF (Horizontal sub surface flow), 1 m$^3$ of wastewater, requires an area of approximately 11 m$^2$. Thus for 2,000 m$^3$, area required = 22,000 m$^2$.

Acc. to the road parameters, the width of HSSF shall not exceed 2 m.

Considering two sides of a highway, the final size requirement of each reed bed shall be 5500 m (length) x 2m (width)
HSSF: View of the proposed module.
Proposed View Nagpur Aurangabad Mumbai Express Highway (NAMEH)
Proposed View Nagpur Aurangabad Mumbai Express Highway (NAMEH)
Proposed System

Stage 3

Phragmites karka

Discharge to fields
Perforated pipe
Sewage effluent

Gravel

Sewage effluent VCP - Dia 10"
Rain water drain

2.0 HSSF
1.5 Carriage way

Perforated pipe with swivel arm to control hydraulic head
Roots and Rhizomes
Impervious liner
Discharge to fields
Phragmites karka
Sewage effluent
Rain water drain

Detail Cross Section

Detail Plan of an HSSF module
• Total Supply of treated waste water (75% of 2 MLD): 1.5 MLD per day: 548 MLD per annum: 548000 m$^3$/yr.

• Sugarcane being the major water intensive crop in Kopargaon requires 2500 - 2800 mm/ha/yr. i.e. 2500 m$^3$/ha/yr.

• Area supplied with treated waste water for irrigation: 220 ha annually.
HSSF: Plan and Section of the module on entire width of the NH6
Proposed System
Stage 3

Detail Section of HSSF module for NH6
Proposed View National Highway 6 (NH6)
Proposed View National Highway 6 (NH6)
Cost benefit analysis of proposed system (Graph)

Net Benefit = Rs. 1772/- per day.
Cost benefit analysis of proposed system (Excluding Biogas)

Additional Cost = Rs. 5164/- per day.

Calculation

Rs. 3300/- per acre annually.
Secondary treatment Cost Comparison with Various Technologies


Calculation
## Performance Comparison with Various Technologies (after secondary treatment)

<table>
<thead>
<tr>
<th></th>
<th>ASP</th>
<th>MBBR</th>
<th>SBR</th>
<th>USAB + EA</th>
<th>MBR</th>
<th>WSP</th>
<th>Proposed System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effluent BOD (mg/l)</strong></td>
<td>&lt;20</td>
<td>&lt;30</td>
<td>&lt;10</td>
<td>&lt;20</td>
<td>&lt;5</td>
<td>&lt;40</td>
<td>&lt;10</td>
</tr>
<tr>
<td><strong>Effluent SS (mg/l)</strong></td>
<td>&lt;30</td>
<td>&lt;30</td>
<td>&lt;10</td>
<td>&lt;30</td>
<td>&lt;5</td>
<td>&lt;100</td>
<td>&lt;40</td>
</tr>
<tr>
<td><strong>Fecal coliform removal, Log unit</strong></td>
<td>upto 2&lt;3</td>
<td>upto 2&lt;3</td>
<td>upto 3&lt;4</td>
<td>upto 2&lt;3</td>
<td>upto 5&lt;6</td>
<td>upto 2&lt;3</td>
<td>upto 2&lt;3</td>
</tr>
<tr>
<td><strong>T - N removal Efficiency, %</strong></td>
<td>10 to 20</td>
<td>10 to 20</td>
<td>70 to 80</td>
<td>10 to 20</td>
<td>70 to 80</td>
<td>10 to 20</td>
<td>30 to 40</td>
</tr>
</tbody>
</table>

Proposed Waste water treatment system

Environment Benefits
- Treated waste water shall be discharged to the river, thus not polluting it.
- The proposed system shall reduce the heat island effect on the highways.

Social Benefits
- The system shall help the water to reach hungry fields without any hassle.
- It will in turn reduce the farmer suicides as the field output increases.

Economical Benefits
- This treatment shall save the hassles and the money to be spent on Vegetation buffers on highway, thus adding to the safety of highways.
- This will also improve the aesthetics of the highway.
- Considering the biogas output from the treatment plant, the system is a profitable one.
Highway sides and medians are appropriate locations to treat waste water naturally, creating vegetation buffers.

The proposed treatment system can be a prototype for all the highways w.r.t. its topography.

Treated waste water can be considered as a perennial source of water for agricultural sector which has the highest water consumption.

Economic gains of increased agricultural output with a non-rain dependent farming are immeasurable benefits for a farmer.

This kind of a system can prove beneficial to all such areas where water is unavailable for farming, which can help to overcome the problem of drought.
Thank You...!!!

- Darshan Shah.