Implementation of bore-dugwell programs as one of the mitigation options for arsenic-safe water in India
Ground Realities and Opportunities

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WATER IS LIFE!

IS IT TRUE?
GROUND REALITIES
Mr. Nibas Ray, 56, was admitted to the Medical College and Hospital, Kolkata where his right arm was amputated up to the elbow. Mr. Nibash has lost his son, Dhiman Ray, 25, on 31st January 2002 who was also a patient of arsenic poisoning.
PEOPLE AFFECTED BY ARSENIC CONTAMINATION
ARSENIC IN DRINKING WATER

According to Epidemiological studies:

1 in 50 person may die if exposed to arsenic concentration of 100 ppb that is found in most of the tubewells in our target area.
The primary objectives of **Aqua Welfare Society** are:

- provide safe water through modern, modified design dugwells,

- as well as establish and encourage community-based groups - CBGs, to manage these arsenic-free water sources, so that they are sustainable.

- Aqua Welfare Society also regularly educates the community on arsenic and other health issues.
Arsenic belt of India – Ganga, Meghna, Brahmaputra
## Presence of Arsenic in the Aquifer in West Bengal, India

<table>
<thead>
<tr>
<th>Aquifer</th>
<th>Depth Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquifer - 1 <em>(unconfined)</em></td>
<td>&lt;50 feet</td>
</tr>
<tr>
<td>Aquifer - 2</td>
<td>50-500 feet <em>(variable)</em></td>
</tr>
<tr>
<td>Aquifer - 3 <em>(safe)</em></td>
<td>500-2000 feet <em>(variable)</em></td>
</tr>
</tbody>
</table>

*BORE-DUGWELL*
LITHOLOGY OF ROCKS IN WEST BENGAL

Source: Protap Chakraborti
(Geologist)
### Present Groundwater Arsenic Contamination Status of West Bengal, India

<table>
<thead>
<tr>
<th>Physical Parameters</th>
<th>West Bengal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area in sq. km.</td>
<td>88,750</td>
</tr>
<tr>
<td>Total number of districts (no. of district surveyed)</td>
<td>19 (19)</td>
</tr>
<tr>
<td>No. of severely arsenic affected districts *</td>
<td>9</td>
</tr>
<tr>
<td>No. of mildly arsenic affected districts*</td>
<td>5</td>
</tr>
<tr>
<td>Total population of severely arsenic affected 9 districts in million</td>
<td>50.4</td>
</tr>
<tr>
<td>Number of blocks / police station having arsenic &gt;50mgL⁻¹</td>
<td>111</td>
</tr>
<tr>
<td>Number of blocks / police station having arsenic &gt;10mgL⁻¹</td>
<td>148</td>
</tr>
</tbody>
</table>

Source: SOES Jadavpur
There is **NO** arsenic in the surface water
‘Bore-Dugwell as Source of Safe Drinking Water in Areas with Arsenic Contaminated Ground Water in West Bengal’.

Aqua Welfare Society
Five components of our safe water program:

1. Research and Site Selection
2. Construction
3. Maintenance
4. Education
5. Surveillance (self and pwx)
RESEARCH AND SITE SELECTION
On the basis of cartographical maps (source: SOES, Kolkata) blocks of most affected districts were selected as shown below.
NORTH 24 PARGANAS IN 22 BLOCKS
THE GROUND WATER ARSENIC CONTAMINATION
STATUS IN
HAND TUBEWELLS WAS OBSERVED

- <0.01 -0.05 ppm (53.4%)
- >0.05 ppm (29.5%)
- >0.3 ppm (3.4%)

Source: SOES
FEW OF THE SITE SELECTION CRITERIA

- Elevated land in locality close to pond but not too close.

- Maintaining proper distance from sanitary pit.

- Direct sunlight to the dugwells is desirable and trees should be somewhat away from the dugwell.
User friendly GPS device

Geo codes of proposed sites are being recorded during site selection process in Chakdah Block, Dumuria Village in February 2010
The sites are depicted on Earth Google map before consultation with the geologists, Mr. Protap Chakrabortti & Saumendranath Banerjee
There are 217 DUGWELLS as of 2011 in N 24 PARGANAS, WEST BENGAL, INDIA
# Dugwells in Three Districts of West Bengal

<table>
<thead>
<tr>
<th>Districts</th>
<th>Blocks</th>
<th>Constructed</th>
<th>Functional</th>
</tr>
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<tbody>
<tr>
<td>Baduria</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Deganga</td>
<td>35</td>
<td>15</td>
<td></td>
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<tr>
<td>North 24 Parganas</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Habra 1</td>
<td>19</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Swarupnagar</td>
<td>31</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Gaighata</td>
<td>76</td>
<td>54</td>
<td></td>
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<tr>
<td>Nadia</td>
<td>Chakdah</td>
<td>43</td>
<td>42</td>
</tr>
<tr>
<td>Murshidabad</td>
<td>Raninagar II</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>217</strong></td>
<td><strong>162</strong></td>
<td></td>
</tr>
</tbody>
</table>
CONSTRUCTION
PW74GDP1: 12 families, 48 consumers

Constructed on 21st February 2008 in the village, Gawdadhawrpur, Gaighata

photo taken on 4 June 2008
BORE-DUGWELL DESIGN

It is different in many forms from the traditional design

Sketch by Suprio Das
PERFORATED PVC PIPE
DRILLING OF THE PIPE

SAND WHICH ACTS AS A FILTER
CONCRETE RINGS
36” DIAMETER AND 10” LENGTH
PW24/KLS12: The net and the tin cover are used for protection from external debris and tampering.
MAINTENANCE
DREDGING OF DUGWELLS WHENEVER IT IS NECESSARY
**BACTERIA**

Bacteria analysis for Total Coliform and E-Coli is done 30 days after the first application of the disinfectant. During this period people are advised to use water after boiling.

(Theoline contains sodium hypochlorite with 5-10% chlorine in solution. USEPA std: to disinfect 100 gallons, need 24 ounces of bleach).

From each source blind, duplicate samples are collected and taken to the lab within 6 hours of collection.

Analysis is done in a reliable laboratory.

**Article:** “Arsenic Concentrations and Bacterial Contamination in a Pilot Shallow Dugwell Program in West Bengal, India”. Journal of Environmental Science and Health Part A (January 2007, Vol.42, No.1)
# Initial Bacterial counts of 40 functional dugwells in different years

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<tr>
<th>DW ID</th>
<th>Const.Yr</th>
<th>TC</th>
<th>FC</th>
<th>Test_Yr</th>
<th>DW ID</th>
<th>Const.Yr</th>
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<td>0</td>
<td>2006</td>
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<td>13</td>
<td>10</td>
<td>2003</td>
<td>PW45</td>
<td>2005</td>
<td>3250</td>
<td>100</td>
<td>2005</td>
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<td>300</td>
<td>30</td>
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<td>2004</td>
<td>PW48</td>
<td>2006</td>
<td>0</td>
<td>0</td>
<td>2006</td>
</tr>
</tbody>
</table>
Training the users in the use of disinfectant

Measuring the volume of the disinfectant that contains 5% of chlorine in solution

Understanding the theoline chart
In August 2006 introduced weekly health meetings and in November 2006 introduced earthen, ‘mawtka’ filters.
FILTER EVALUATION TO SELECT THE BEST AFFORDABLE TYPE

Steel body

Earthen body

Plastic body
Blind tasting of 20 samples of water collected from dugwells, shallow and deep tubewells using three types of filters: matka, steel and plastic. Matka filter was analyzed to be the best followed by steel that is expensive but matka filter breaks.
PUBLIC AWARENESS
(Health Meetings)
Main concern was and still is how to make the dugwell community based program sustainable.
Exposure to arsenic in drinking water has been established to cause many serious health effects, including lung, kidney, liver, skin, bladder cancers and reports of diabetes, respiratory and cardiovascular diseases and birth defects (NRCReport, 2001 Update).

Every year new studies are being published on deaths due to critical diseases caused when the victim is exposed to arsenic in-utero and early childhood (Vahter, 2008);
VILLAGE MEETINGS

KOLSUR GRAM PANCHAYAT
N 24 PARGANAS

DUMURIA CHAKDA
• Emphasis is given on awareness programs.

• Village meetings followed by health meetings are done in communities and in people’s houses for better impact.
School seminar for the student and teachers.
WILL OUR CHILDREN FACE THE SAME FATE AS THEIR PARENTS?
RESEARCH ON RESPIRATORY LUNG FUNCTION IN CHILDREN
Lung cancer mortality in men according to exposure in childhood

(SMR = standardized mortality ratio = observed/expected deaths)

SOURCE: Allan Smith
SURVEILLANCE
**TRACKING** – to make the program successful

1. Monthly report of status of dugwells

2. Monitoring of arsenic – annually
   Bacteria test after construction.

3. PWX - Uploading reports on Peer
   Water Exchange website
   (peerwater.org).

4. Use of cell phone to upload reports
   right from the village.
Annual water analysis

- analysis for Arsenic level in water (summer)
- Analysis for presence of bacteria in water.
Average arsenic concentrations in ppb of 23 randomly selected wells constructed by AWS measured in March 2012

- <10 ppb: 17%
- <25 ppb: 61%
- <50 ppb: 87%
- >50 ppb: 13%

Source ID Numbers
<table>
<thead>
<tr>
<th>PW40</th>
<th>6</th>
<th>water is fine</th>
</tr>
</thead>
<tbody>
<tr>
<td>PW41</td>
<td>0</td>
<td>ignorance, neighbor feud</td>
</tr>
<tr>
<td>PW42</td>
<td>4</td>
<td>water is fine</td>
</tr>
<tr>
<td>PW43</td>
<td>4</td>
<td>water is fine</td>
</tr>
<tr>
<td>PW44</td>
<td>2</td>
<td>water is fine</td>
</tr>
<tr>
<td>PW45</td>
<td>0</td>
<td>deep tubewell, (arsenic conc. is 253 ppb, 11/8/07)</td>
</tr>
</tbody>
</table>
Change in work culture: team work.
Work whenever they can as long the work is done.
Cross checking of data recorded is essential with the help of the map and dugwell IDs to improve the practice of data collection.
OUR REAL WORK FORCE
CHILDREN DRINKING ALTERNATE SOURCE OF WATER WILL NOT SUFFER FROM DISEASES CAUSED BY ARSENIC
LET'S JOIN OUR HANDS AND MAKE AN EFFORT TO ASSURE OUR CHILDREN A BETTER SOURCE OF ARSENIC SAFE WATER
ARE WE SAFE ???

POISON IN YOUR WATER

Hazard in the Water: First of a Two-Part Series

A Killer at City's Door

Alarmo: Arsenic in groundwater in dangerous proportions in parts of Kolkata is a reality that the government cannot run away from.

Centre comes to the aid of arsenic-affected West Bengal

M. Shanker
The founding members of Project Well

Dr. Meera M Hira-Smith, Geography, Director, Project Well  
(Researcher, University of California, Berkeley, USA)

Dr. Timir Hore, Hydrogeology, advisor, Project well  
(Vice President, C&H consultant, New Jersey, USA)

Mr. Protap Chakraborti, Advisor and Member Project Well  
(ex-director of Geological Survey of India)

Prof. Allan H Smith, Epidemiology, advisor, Project Well  
(Professor, University of California, Berkeley, USA)
**Other members and advisors**

PW members are from multi-discipline

- Jane Liaw, *arsenic study of health research group, University of California, Berkeley, USA.*
- Dr. Xavier Savarimuthu, *Environmental Science*
- Mr. Suprio Das, *Engineer,*
- Mr. Saumendra Nath Banerjee, *Geologist*
- Punurdan Dutta, *social worker, & technical advisor*

**Ex-advisors**

- *Mr. D.K Chakraborty, Civil Engineer, LKP*
- *Dr. DN Guha Mazumder, gastroenterologist, IPGME&R*
- *Dr. Dipankar Chakraborty, Chemistry SOES*
- *Dr. S Banerjee, Chemistry, CSME*

**Other members of Aqua Welfare Society**

- *Mr. Ashok Paul, President*
- *Mr. Uday Mukherjee, Secretary*
- *Mrs. Alpana Hira Davidson, Treasurer*

**Donors:** Private donations, Mosaique of Quebec, Canada, Rotary, Fogarty International and Blue Planet Run Network

*Project Well_MMS_June 2009*