DST/TDT/WTI/2k7/06

सत्यमेव जयते

REPORT

ON

Implementation of Cost Effective House Hold Arsenic Remediation Technology in Bihar, West Bengal and UP

BY

PRINCIPAL INVESTIGATOR

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CO-INVESTIGATOR

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March- 2012

SAVE THE ENVIRONMENT
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Index

File No. DST/TDT/WTI/2k7/06
Government of India
Ministry of Science and Technology
Department of Science and Technology

Technology Bhavan
New Mehrauli Road
New Delhi-110 016
Date 29.03.2008

ORDER

Subject: Financial support for " **Systematic studies towards the development of Non-Chlorinated products to purify domestic water supplies on individual and community level"**

Sanction of the President is conveyed for the grant of Rs. 59.36 lakhs (Rupees Fifty nine lakhs thirty six thousand only) and initial release of Rs. 25 lakhs (Rupees Twenty Five lakhs only) to Save the Environment , Kailash Ghosh road, Kolkatta-700008 for implementation of the above project for a duration of 36 months.

2.The items of expenditure for which the total allocation has been approved are given below:-

(Amount in lakhs)

S.no.	Item	Ist Year	IInd Year	IIIrd Year	Total
1	Manpower (3 years) Project officer 1 no.@ Rs.8000 pm,Project assistant 3 Nos. @ Rs. 6000 pm per person Manpower (2 years) Field supervisor 6 Nos @Rs. 2500/- pm per person	4.32	4.32	4.32	12.96
2	Consumables	2.00	2.00	1.00	5.00
3	Contingencies (testing, , data collection and patents)	2.00	2.00	2.00	6.00
4	Travel	1.00	1.00	1.00	3.00
6	Equipments (filters)	14.70	14.70	-	29.40
7	Overhead charges	1.00	1.00	1.00	3.00
	Total	25.02	25.02	9.32	59.36

3. The sanction of the grant is subject to the conditions detailed in Annexure-I. Th acceptance of the grant has been satisfied, and the project would be monitored by monitoring Committee appointed by Department of Science and Technology, Govt. c India.

4. It is also certified that this is the first grant towards the project and as such provisions of GFR 112(1) relating to UCs is not applicable.

5.As per Rule 211(1) of GFRs, the accounts of Grantee Institution shall be open to inspection by the sanctioning authority/ audit whenever the institute is called upon to do so.

6. The expenditure involved is debitable to –
Demand No 81

3425	Other Scientific Research (Major Head)
60	Other (sub major heads)
60.200	Assistance to other scientific bodies (Minor head)
41	Water Technology Initiative
41.01.31	Grant-in-aid (2007-2008) Plan (TSG)

7. The amount of Rs 25 lakhs (Rupees Twenty five lakhs nly) will be drawn by the Drawing and Disbursing Officer, Department of Science and Technology and disbursed to Save the Environment , Kailash Ghosh road, Kolkatta-700008 by Demand Draft. It is also certified that the requisite bond has been obtained from the organisation and accepted by the division.

8.Items of equipment sanctioned under the project should be procured as per provision contained in General financial rules 2005 as per DGS&D rate contract , wherever applicable or by dual bid system ,technical as well as financial.

9. Items of the equipment procured, unless these are declared unserviceable and are contemned in accordance with procedures prescribed in GRFs 2005, will not dispose of without the prior approval of DST.

10. In case if the cheque / DD in reference to the amount sanctioned for disbursement under this sanction is not received by the Principal Investigator with in 14 days of the date of this sanction, Principal Investigator may bring the same, with IFD diary no. & date of sanction etc., to the notice of JS & FA email address fin.adv.dst.dbt@gmail.com for looking into the matter.

11. The organisation will furnish to DST, Utilisation Certificate and Audited Statement of accounts pertaining to the grant immediately at the end of financial year.

12. The organisation will maintain separate audited accounts for the project. If is found expedient to keep apart or whole of the grant in a bank account earning interest , the

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3. IFD, Department of Science & Technology,New Delhi.
4. Director of Audit (CW & M-II), AGCR Building, IP Estate, New Delhi.
5. Save the Environment , Kailash Ghosh road, Kolkatta-700008
6. Dr Pahari Basu, PI , Save the Environment , Kailash Ghosh road, Kolkatta- 0008
7. Sanction folder
8. Master File
9. Office Copy
10. SE (SB)

31/3/08
(Vineet Saini)
Scientist 'C'

File No. DST/TDT/WTI/2k7/06
Government of India
Ministry of Science and Technology
Department of Science and Technology

Technology Bhavan
New Mehrauli Road
New Delhi-110 016
Date 31.03.2008

CORRIGENDUM

Subject :- Financial Assistance for "Implementation of Cost Effective Household Arsenic Remediation Technology in West Bengal"

This is with reference to this Deptt.'s sanction letter of even number dated 29-03-2008 and to say that subject of the sanction order may be read as:

Financial support for **"Implementation of Cost Effective Household Arsenic Remediation Technology in West Bengal"**

instead of

Financial support for "Development of low cost household filter for arsenic and other pollutant-free drinking water using modified laterite"

2. Rest all other terms and condition remain same as mentioned in sanction letter no. DST/TDT/WTI/2k7/06 dated 29-03-2008.

(Vineet Saini) 31/3/08
Scientist 'C

Copy forwarded for information and necessary action to: -

To,

The Pay and Accounts Officer
Department of Science and Technology
New Delhi-110 016

Copy for information and necessary action to:
1. 3 copies of the sanction to the Drawing and Disbursing Officer, DST,Cash Section.
2. Accounts Section, DST, New Delhi.

Contd./-

EXECUTIVE SUMMARY

"It is an uncanny thought that this lurking poison (arsenic) is everywhere around us, ready to gain unsuspected entrance to our bodies from the food we eat, the water we drink and the air we breathe."

Karl Vogel, 1928

AIMS AND OBJECTIVE

(1) To achieve the goal of providing arsenic free water to the villagers of West Bengal suffering from arsenic contaminated water.

(2) To protect the children and recover the health of present and future generation of India from the various diseases caused by drinking arsenic contaminated water and

(3) Rehabilitation of the arsenic patients by providing them arsenic free water.

BACKGROUND

In India, one of the most devastating health crises arising out of arsenic poisoning has quietly unfolded in the lower Gangetic Plains covering some nine districts of West Bengal, and a few districts of Bihar, Chattisgarh, and Uttar Pradesh etc.

Arsenic can cause acute and chronic toxicity in humans. The severity of toxicity depends on age and sex of the individual, the dose and duration of exposure, chemical nature of the compound, route of entry and the amount of arsenic accumulated into the body.

Arsenic concentration in ground water ranges from 50 ppb (parts per billion) to 5 ppm (parts per million). The standard for arsenic in drinking water set by the World Health Organization is .01 mg/l (10 ppb), whereas analysis of water collected by WHO, National Institute of Preventive and Social Medicine (NIPSOM), School of Environmental Science, Jadavpur University, Public Health Engineering Department, West Bengal, Harvard School of Public Health, and several other organizations in Bangladesh have indicated arsenic concentrations ranging from 0.05 mg/l - 5 mg/l, which is far above the permissible level. The domestic and international response to the problem of arsenic poisoning, unfortunately, has been slow and somewhat disappointing.

Considering the rate at which this poison is spreading its web all over the world, there is an urgent need to provide:

1. Immediate relief to those using drinking water with high arsenic concentration.

2. Develop ways and means to mitigate this problem by reducing the level of arsenic in drinking water to at least the permissible and tolerable limits through easy and inexpensive means.

Apart from international organizations, a few research organisations in India such as the All India Institute of Public Health (AIIPH&H), Central Glass and Ceramic Research Institute, School of Environmental Studies, Jadavpur University, and UNICEF, India have been actively involved in the development of indigenous domestic arsenic removal filters. However, these technologies have certain limitations of waste disposal, maintenance and quality of water and are not being effectively utilized by the arsenic affected people of the country.

Keeping the limitations and shortcomings of the aforesaid technologies in mind, a novel domestic arsenic removal filter was developed by defense Research and Development Organization (DRDO). The filter was successfully evaluated in the field in terms of its efficiency for the removal of arsenic, iron and bacteria from ground water. The technology was transferred to the NGO `Save The Environment' to demonstrate and implement the technology in the effected villages. The filter, below is user friendly, cost effective, easy to maintain and does not require any power supply for its operation.

This project was taken up with the aim to demonstrate and implement the technology in the effected rural areas of Bihar, West Bengal and UP which may prove highly beneficial for the villagers who are drinking the arsenic contaminated poisonous water.

KEY FINDINGS

The findings of the project are summarized below.

1. **Installation of 2100 Arsenic Removal Filters (developed by DRDO) in following seven villages of Bihar, U.P. and West Bengal carried out successfully.**

   Names of villages:

   Arbandi (District Nadia, W.B.)

   Chandkuri (District Nadia, W.B.)

   Harinadi (District Nadia, W.B.)

   Nrisingapur (District Nadia, W.B.)

   Sahebdanga (District Nadia, W.B.)

   Tiwaritolla (District Ballia, U.P.)

   Ranuchwak (District Bhagalpur, Bihar)

The first set of filters was installed in June 2008 in Tiwaritola village of Balia district in Uttar Pradesh

1. Awareness programmes for the use of the technology as well as about the persistent problem of arsenic poisoning in water was carried out during this project.
2. People (specially the lady of the family) were trained and filters are being used successfully.
3. Number of beneficiary families **:** 2100

4.	Size of population covered	:	~10,500 (assuming 5 members per family)
5.	Degree of arsenic contamination	:	Arsenic concentration in this water is found To be in the range of 20 to 1500 ppb. Maximum concentration is found in Tewaritola, Balia, UP
6.	Life of filtering media	:	The oldest filters in Balia district have been In use since June 2008 and about 85% of them have still not needed a change of filtering medium. Predicted life of the filter is ~20,000 liters (if As concentration ranges between 20 - 1500 ppb in raw water)
7.	Volume of water filtered	:	The average volume of water filtered per month per family ranges between 525 to 730 liters.
8.	Software development		Generate data structure based on different parameters for statistical data analysis.

IMPLEMENTATION

The project was carried out in two phases (Phase –I and Phase II). The details of the methodology are described below.

DETAILS OF TECHNOLOGY:

Working Principle

The arsenic removal filter, developed by DRDO, works on the simple principle of co-precipitation of arsenic with iron and adsorption of this precipitate on iron oxyhydroxides[13-16], followed by further retention of this precipitate in treated sand. The probable reactions involved in the process are given below:

$$Fe^0 + 2\ H_2O \longrightarrow Fe^{2+} + H_2 + 2\ OH^-$$

$$Fe^{2+} + 2\ OH^- \longrightarrow Fe(OH)_2 \xrightarrow{Fe(II)/Fe(III)} \text{mixed oxides } (\gamma\text{-FeOOH, } Fe_3O_4, \gamma\text{-}Fe_2O_3, \text{ etc.})$$

Sodium salts of arsenite and arsenate get ionized in water medium. The arsenite and arsenate ions are removed further by co-precipitation as $FeAsO_4$ and $FeAsO_3$ and by adsorption of these oxides onto ferric oxyhydroxide solids. The same has been reported by a number of workers earlier also.

Experimental

Materials and Methods

The active material, a processed waste from Steel industry, has been obtained from M/s Tata wires Ltd., Mumbai. Sand used has been obtained from the riverbank of River Yamuna in Delhi, India, and from the riverbank of River Ganga in Kolkata, India. Fine cloth filter has been procured locally.

AR quality reagents and Milli-Q grade water have been used for solution preparation. Solutions of As^{+3} and As^{+5} have been prepared using corresponding salts, $NaAsO_2$ and $Na_2HAsO_4.7H_2O$, respectively. Mixture of As^{+3} and As^{+5} (in the ratio of 1:1) has been prepared by dissolving equimolar amount of corresponding salt in Milli-Q grade water. The reactant material is soaked overnight in water before using in the filter. The sand used is subjected to physical treatment (washing and heat treatment) prior to using it in the arsenic removal filter.

Characterization

The reactant material and sand have been characterized for their surface area and composition using Micromeritics ASAP 2010 Surface Area Analyzer at Centre for Fire, Environment and Explosives Safety (CFEES) , Delhi, and by Phillips X-ray fluorescence (XRF) at Durgapur Steel Plant, Durgapur respectively.

Characteristics of the reactant material and sand, as given in Table 1, clearly indicate that the reactant material is nothing but 99% iron and acts as zero valent iron. Surface area value of sand indicates that its adsorption capacity is low and is basically functioning as a fine filter in this process.

Table 1. Characteristics of Sand and Reactant Material

Adsorbent	**pH (in water)**	**pH (in As solution)**	**Fe (%)**	**Al (%)**	**Mn (%)**	**Si (%)**	**Surface area (BET) m^2/g**
Sand (Yamuna)	10.2 - 0.5	10.2 - 10.5	8.9- 10.5	10.5-11.0	Not detected	79.2-80.0	1
Sand (Ganga)	8.3-8.5	7.5-8.0	4.7-5.0	11.5-12.0	Not detected	79.8-80.0	4
Reactant Material	8.5 - 9.0	8.8 - 9.0	99.2-99.5	Not detected	0.42-0.45	Trace amount	0.5

The variation in the pH of pure water and of arsenic solution when allowed to percolate down through the reactant material and through sand has been determined using a pH meter (Model: Elico LI-120)

Scanning electron micrograph (Fig. 2) of the material as taken on Scanning Electron microscope (Model: Leo 1455) at 500 magnification confirms the fibrous elongated morphology.

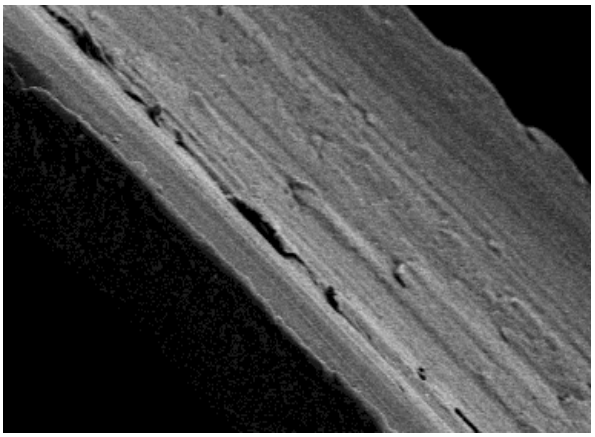

Figure 2. SEM Micrograph of reactant material

Metal analysis

Arsenic concentration in water, prior to and after treatment, has been measured as per ASTM method[17] using Hydride Generator (Model: HG-3000) attached to AAS (Model: GBC 904AA) at Centre for Fire, Environment and Explosives Safety (CFEES), Delhi, India. Iron concentration was determined using AAS. The results were also verified at Department of Environmental Sciences, Jadavpur University, Kolkata.

Design of Arsenic Removal Filter

Arsenic removal filter as shown in Figure 3 has been designed and fabricated both in plastic and in stainless steel.

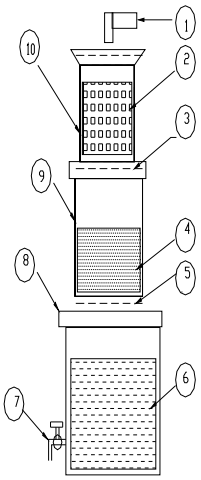

Figure 3. Schematic Diagram of Arsenic Removal Filter

1. Inlet for Arsenic-Contaminated Water
2. Reactant Material

3. Fine Cloth Filter
4. Treated Sand
5. Fine Cloth Filter
6. Arsenic-Free Water
7. Outlet for Arsenic- Free Water
8. Container for Arsenic-Free Water
9. Container for Treated Sand
10. Container for Reactant Material

As shown in the above figure, the filter comprises of three chambers. The first chamber contains the reactant material enclosed in a fine cloth bag. In the second chamber is placed a fine cloth bag containing treated sand. The third chamber simply acts as a collector chamber for treated water. Arsenic-contaminated water is allowed to enter the first chamber of the filter at a predetermined flow rate from where it passes down to the second chamber and finally gets collected in the third chamber. The time it takes for water to flow down from the first chamber to the third chamber is about 2 minutes.

Using the above stated design, optimization studies w.r.t. inlet water flow rate, amount of reactant material and amount of treated sand were carried out.

Optimization of Flow Rate

Keeping the amount of reactant material and treated sand constant at 500 g and 1500 g, respectively (the capacities of first, second and third chambers designed to be 7 L, 7 L and 16 L, respectively, for this purpose), experiments were carried out to study the effect of flow rate of

arsenic (As^{+3} or As^{+5} or 1:1 mixture of As^{+3} and As^{+5}) contaminated water on the arsenic removal efficiency of the filter. The results of these experiments showed that irrespective of the arsenic species present in water, 15 Lph was the maximum allowable flow rate for the inlet water stream (contaminated with arsenic) because the arsenic concentration in filtered water raised beyond prescribed limits once this flow rate value was exceeded. It was also established that if the amount of reactant material and treated sand was raised to 1000 g and 3000 g, respectively (the capacities of first, second and third chambers designed to be 16 L, 25 L and 50 L, respectively, for this purpose), maximum allowable flow rate that could be achieved was 30 Lph. The results are depicted in Figure 4.

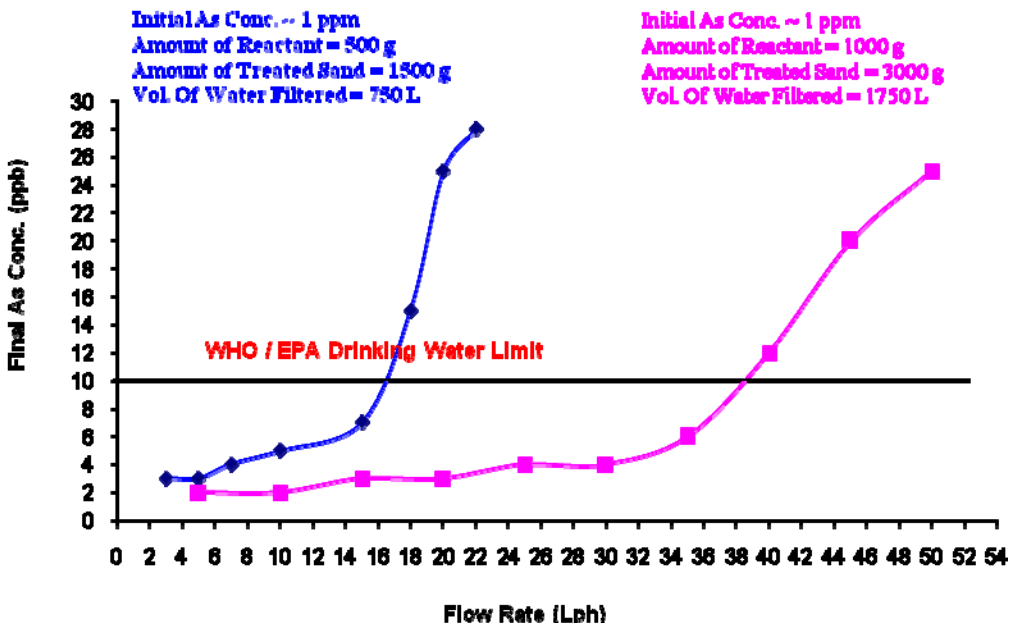

Figure 4. Optimization of Flow Rate

Thus two filter systems were designed based on the above observations. The details of both the systems are given below:

System I

1. Adsorbent (Steel plant waste)	-	500 gms
2. Treated Sand	-	1500 gms
3. Flow rate	-	15 lit / hr (Lph)
4. Initial As conc. range	-	1- 4 ppm
5. Final As Conc.	-	< 3 ppb (Well below EPA / WHO's drinking water limit of 10 ppb)
6. Volume of water treated	-	750 lits.
7. Quality of water	-	Suitable for drinking purpose.
8. Leaching of other metals	-	No leaching

System II

1. Adsorbent (Steel plant waste)	-	1000 gms
2. Treated Sand	-	3000 gms
3. Flow rate	-	30 lit./hr
4. Initial As conc. range	-	1ppm
5. Final As Conc.	-	< 3 ppb (Well below EPA / WHO's drinking water limit of 10 ppb)
6. Volume of water treated	-	1750 lits.
7. Quality of water	-	Suitable for drinking purpose.
8. Leaching of other metals	-	No leaching

Effect of Initial Arsenic Concentration

The effect of initial arsenic (1:1 mixture of As^{+3} and As^{+5}) concentration (varying from 1.0 ppm to 4 ppm) on the arsenic removal efficiency of the filter, in terms of total volume of water filtered (final arsenic concentration in filtered water < 10 ppb), using optimized amounts of reactant material and treated sand for the two flow rate systems was studied and the observations are illustrated in the form of a bar chart (Fig. 5). As expected, an increase in the arsenic concentration in water leads to a decrease in the total volume of water that can be treated using this filter.

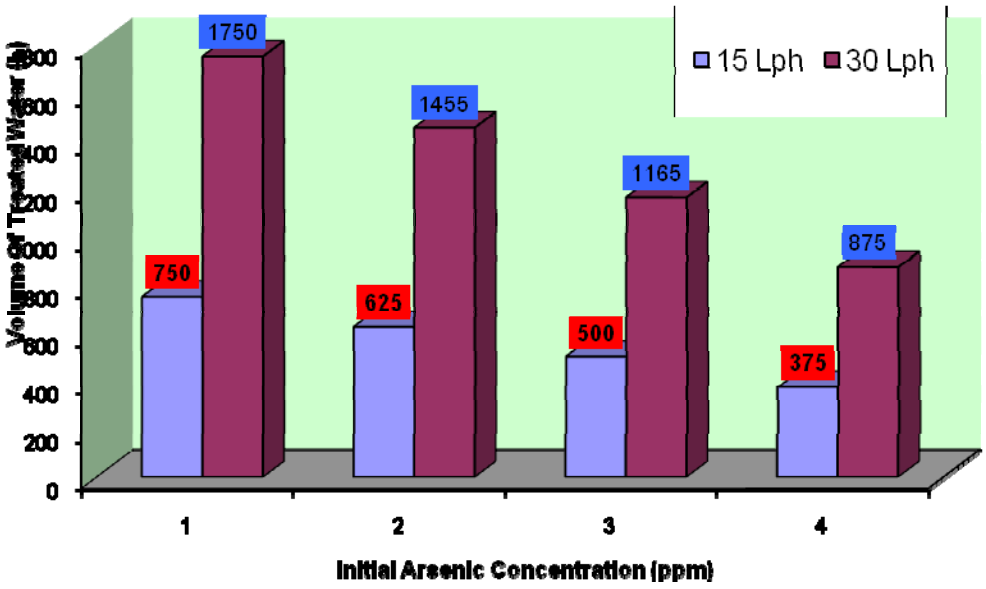

Figure 5. Effect of Initial Arsenic Concentration

Water Quality

The filtered water collected in the third chamber was analyzed for its arsenic concentration, iron (that may leach out from the reactant material during the process) concentration and microbes. The results as enlisted in Table 2 clearly indicate that the quality of

the filtered water conforms to the internationally (WHO and US EPA) set drinking water standards.

Table 2. Results of Water Analysis

S.No.	Arsenic Species Present	Arsenic conc. (mg/L)		Iron conc. (mg/L)		E.Coli (count /100ml) after 48 hrs.	
		Initial	After Treatment (Final potable water)	Initial	After Treatment (Final potable water)	Initial	After treatment (Final potable water)
1	**As(III)**	**1000**	**<.03**	**Not Detected**	**<0.3**	**8**	**0**
2	**As(V)**	**1050**	**<.03**	**Not Detected**	**<0.3**	**8**	**0**
3	**Mixture of As (III) and As (V) in the ratio of 1:1**	**1025**	**<.03**	**Not Detected**	**<0.3**	**8**	**0**

Figure 6. Three Types (Stainless steel, Clay and Plastic) DRDO Water Filters (15 lph Capacity)

Waste Disposal

Although the waste generated during arsenic removal process is not environmentally harmful as such, as reported by earlier workers, yet disposal of arsenic-laden waste is an important aspect under growing environmental regulations. Therefore, precipitate formed during reaction and the used sand is being disposed off in the form of impermeable concrete blocks of M-25 standard grade used in construction industry resulting in no waste generation in the process and making the technology environment-friendly and green.

Leaching tests have been carried out for the waste generated during the process as well as for concrete blocks as per the standard Toxicity Characteristic Leaching Procedure (TCLP) for solid wastes (EPA protocol SW-846-1311), and the results are tabulated in Table 4.

Table 4. Results of Leaching Tests

Type of waste	**Arsenic Concentration in Filtered Water (ppb)**	
	Laboratory Samples	***Field Samples***
Waste	BDL*	BDL
Concrete Blocks	BDL	BDL

- BDL: Below Detection Limit i.e.<3ppb

Figure 9. Waste Conversion in to Cement Brick

Phase-I

In phase one, two thousand one hundred filters made-up of stainless steel , type –I with the flow rate of 15 lph were distributed in following selected seven villages of Bihar, West Bengal and UP.

List of the selected arsenic affected villages:

1. **Arbandi (District Nadia, W.B.)**
2. **Chandkuri (District Nadia, W.B.)**
3. **Harinadi (District Nadia, W.B.)**
4. **Nrisingapur (District Nadia, W.B.)**
5. **Sahebdanga (District Nadia, W.B.)**
6. **Tiwaritolla (District Ballia, U.P.)**
7. **Ranuchwak (District Bhagalpur, Bihar)**

The technology implementation was carried out in following steps.

1. Awareness programme about the water contamination problems were carried out in the selected affected villages of respective states.

2. Training about the operation and maintenance of the filters was given to the family members, specially the lady of the family in the selected houses of the villages

3. Regular monitoring of the water quality was carried out using Merck testing kit for the raw water and the filtered water.

4. Some randomly selected water samples from the source as well as from the water filter were also tested at NABL accredited national laboratory.

Some of the photographs given below give glimpse of the aforesaid implementation programme.

Figure 10. Door To Door Survey and Water Testing

Fig.11a. Distribution of Water Filters in the Villages

Fig.11b. Distribution of Water Filters in the Villages

Figure 12a. Training to the House Holders for the Operation and Maintenance of the Filter

Figure 12b. Training to the House Holders for the Operation and Maintenance of the Filter

Software (SW) Development

A SW in C++ has been developed for the statistical data analysis to derive the life of the filter in each village separately.

Brief description of the execution of the program is as follows:

1) Download Dev C++ - Compiler form the given link :-

http://download.cnet.com/Dev-C/3000-2069_4-12686.html

2) Install it

3) Execute exe file.

Generate data structure based on different parameters for statistical data analysis

Phase-II

PRC held in May 2011 decided to monitor the working of the filters under the close supervision of an expert in a particular village. For this purpose the reactant material of one hundred filters was changed, water quality was regularly monitored and people were trained thoroughly for periodic washing of the filter as well as for the waste disposal procedure. The details are as follows.

Village	:	**Chandkuri (District Nadia, W.B.)**
Date of change of reactant material	:	**July 20, 2011**
No. of Families	:	**One hundred**
Period of monitoring	:	**July 20 –December 31, 2011**

Some of the pictures as given below clearly depict the working of the filters as per the instructions of PRC under phase –II**.**

Figure 13. Change of Reactant Material, Washing and Waste Disposal under Phase-II

Figure 14. Testing of Water by Merck Field Test Kit

RESULTS AND DISCUSSION

Phase –I

The results of the studies carried out in phase one is given in table- 5 below.

Table 5. Summary of the Results of the Implementation of Technology

Village	No. of Families	Date of Installation	Period of Use	Arsenic Conc. in Raw Water (mg/L)	Average volume of water filtered per family per year without change of reactant material (Liters)	No. of family changed reactant materials
Arbandi (W.B.)	301	30.12.2008	21	0.02 - 0.1	**8750**	3
Chandkuri (W.B.)	446	01.01.2010	9	0.02 - 0.5	**7300**	0
Nrisinghapur W.B.)	140	01.01.2010	9	0.02 - 0.5	**6940**	0
Ranuchwak (Bihar)	300	11.08.2008	26	0.02 - 0.5	**6310**	5
Sahebdanga (W.B.)	253	02.01.2010	9	0.02 - 0.4	**7640**	0
Tewaritolla Ram Garh (U.P.)	302	01.07.2008	27	0.02 - 1.5	**8290**	61
Harinadi (W.B.)	358	01.01.2010	9	0.02 - 0.5	**8410**	1

The results as presented in the table above indicate a very high efficiency of the filters. The first sets of filters were installed in Tewaritola village of Balia district, U. P. on 1st July,

2008. So far only sixty one filters required change of reactant material where as others were functional till September, 2011.

The arsenic concentration in these villages ranged from 20 ppb to 1500 ppb as against the required limit of 10ppb (WHO and EPA drinking water limit). Average quantity of water filtered from these filters ranged between 6310 to 8750 liters per family per year indicating average of approximately 21 liters of drinking water per family per day.

The details of the study are very clearly shown in the figures below.

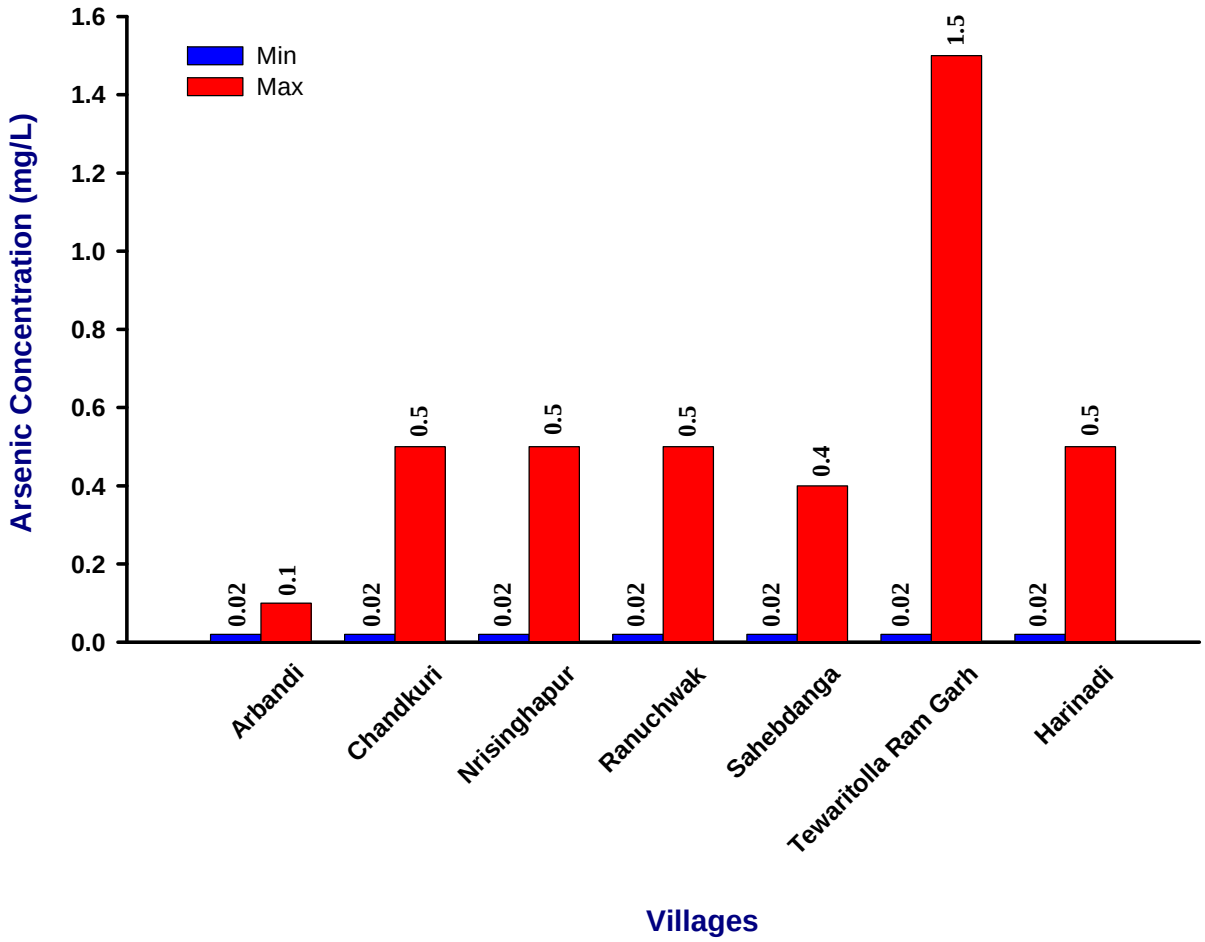

Figure 15. Arsenic Concentration (mg/l) in Water in Villages Under Study

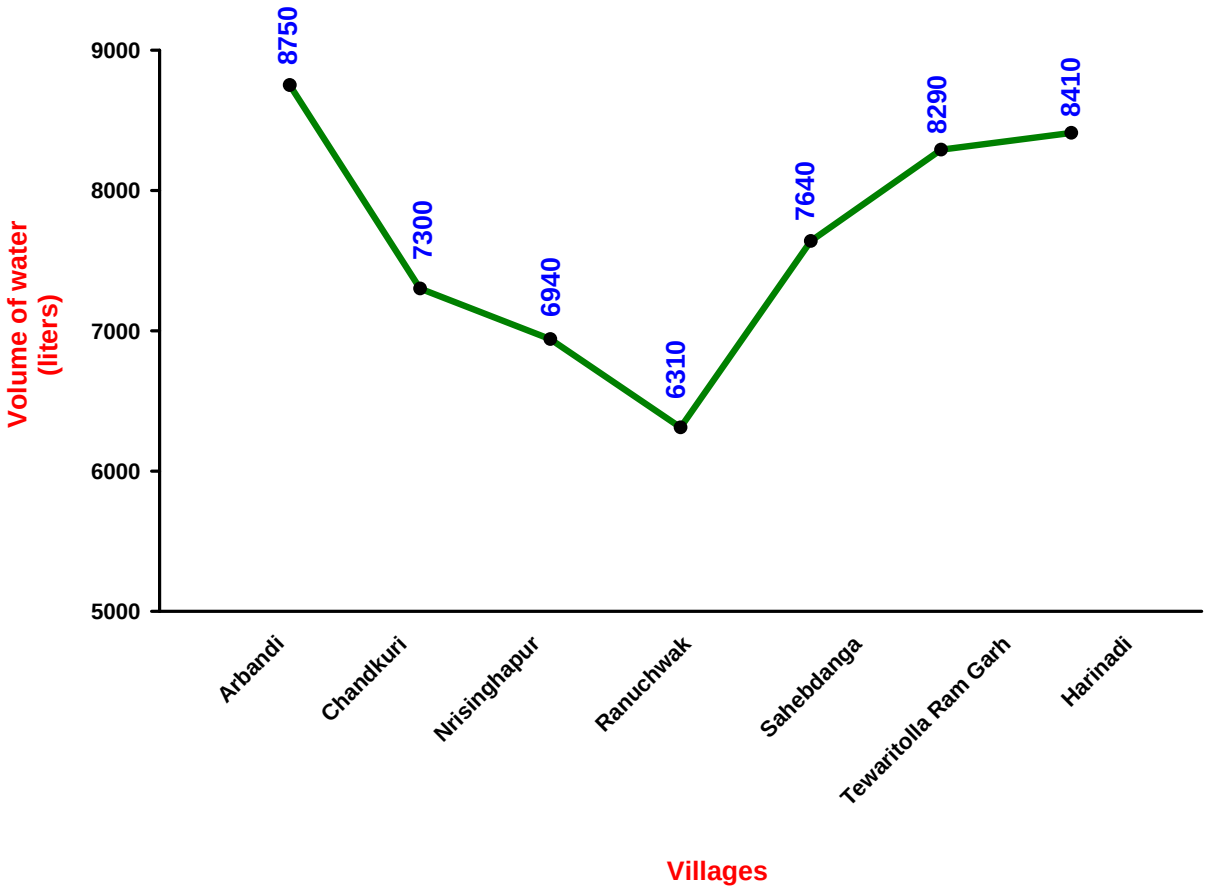

Figure16. Average Volume of Water(Liters) Filtered per Family in One Year Without Any Change of Reactant Material

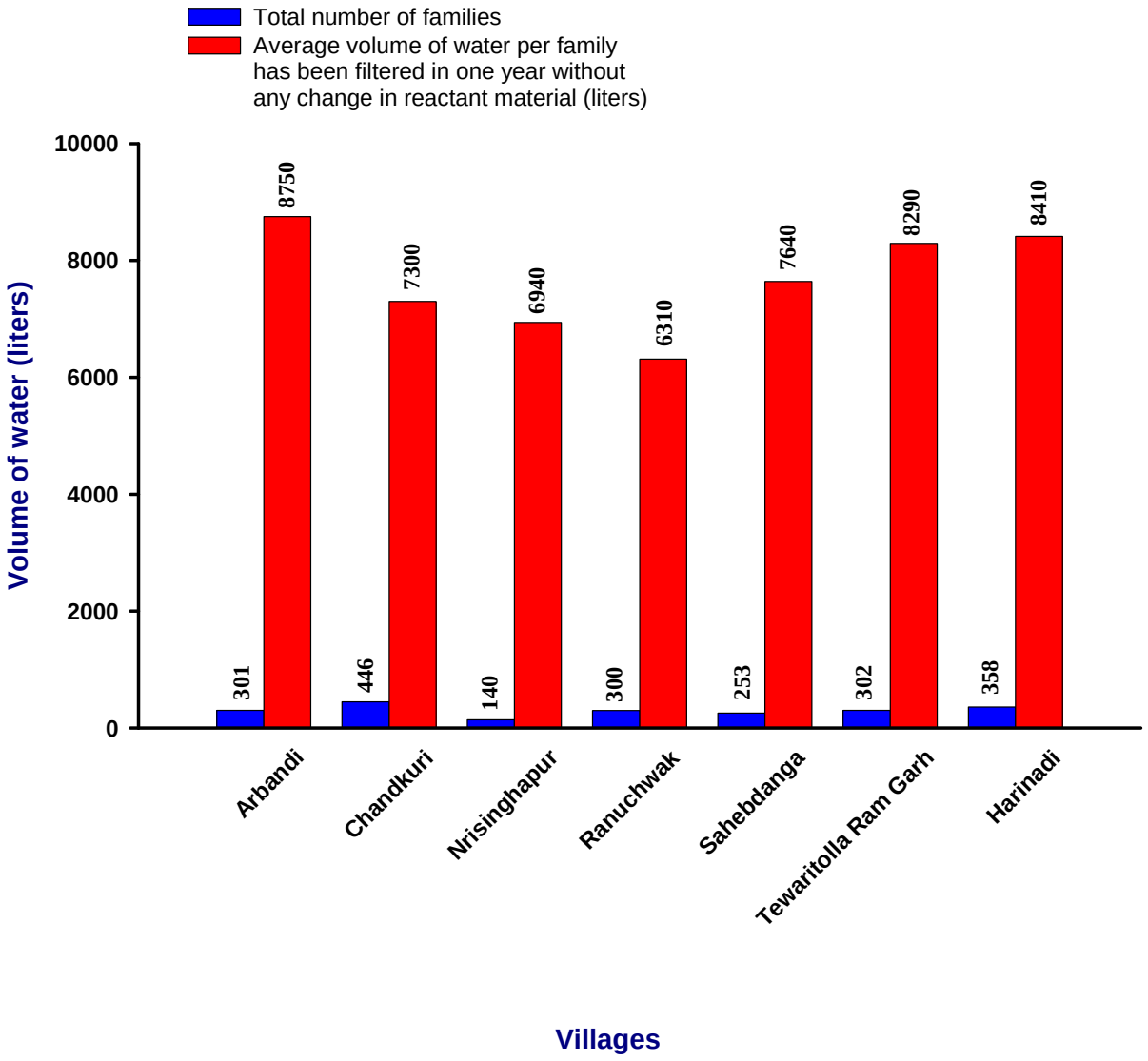

Figure 17. No. of Families and Average Volume of Water (Lit) Used per Family in the Villages Under Study

Phase-II

The reactant material was changed for one hundred filters. The quality of water was constantly monitored very closely. All the water filters performed well in terms of their efficiency and quality of water. The arsenic concentration was found to be below detection limit (BDL) i.e. less than 3 ppb.

Software (SW) Execution

Automated software has been developed which can predict the working life of the reactant material based on the initial concentration of the arsenic in ground water. The software generates DATA structure for Statistical DATA Analysis. The programme is in CD which can be downloaded in computer and any data can be entered in order to get the final analysis. The main characteristics of the SW are as follows.

It generates excel data sheet of 8 parameters for every village

No. of houses	Arsenic concentration level	Used filtered water till 1st wash (f1)	Used filtered water till 1st wash (f2)	Used filtered water till 1st wash (f3)	Used filtered water till 1st wash (f4)	Used filtered water till change the filter CF=sum of fi	Monthly used filtered water

- Generates lots of different parameters data structure

- Developed SW for t –test with level of confidence 95% (Apply T-statistics) to find that whether average filtered life of each village is meeting the expected life (expected

filtered life X=20,000 ltrs---It is taken from lab results and overall parameters affecting the life of the reactant material of the filters –which is independent of field data)

- Developed SW for t –test with level of confidence 95% (Apply T-statistics) to find that whether average filtered life of two villages are close or far apart (T- test apply when sample size is small)

- Finally developed SW generates the following data structure automatically from the RAW Data for the following statistical data analysis

Ars level	No of house	No of house in %	y-no of house whose total use of water 20000	z- no of hs where used water >=x=20000 till filter changed or yet to change	W= z/y.100 i.e. in % the filter life x	

The capacity of the reactant material in this filter has been predicted ~20,000 liters if the concentration of arsenic in raw water ranges between 20- 1500 ppb.

CONCLUSIONS and RECOMMENDATIONS

Based on the successful completion of this project, following conclusions can be drawn:

The water filter for the removal of arsenic developed by DRDO has been successfully validated in the field for the removal of arsenic from ground water and confirms the following characteristic features:

1. Requires no Power (electricity or battery)
2. Easy maintenance
3. Cost-effective
4. Environment-friendly
5. User Friendly
6. Easy waste disposal
7. Very efficient and long lasting

The water filter for arsenic removal as discussed above can provide a reliable solution for the basic problem of arsenic contamination in ground water and is recommended to be used by State Public Health Departments (PHDs) in the arsenic affected areas.

The project is recommended to be replicated in the villages of other states such as Assam, other North East States and Chhattisgarh etc.

A project is also recommended to be carried out in the Indo- Bangladesh and other border areas in order to provide safe drinking water to the BSF and other armed forces.

ACKNOWLEDGEMENTS

The PI and Co-PI place on record their heartfelt gratitude to Dr. Lakshman Prasad, former head TDT division, DST for giving the opportunity to work for this project. We are deeply touched and are grateful to Sri Sanjay Bajpai, Sc. `F' and Sri Vineet Soni, Sc. `C' for their constant support and guidance throughout this work. We are also thankful to the Chairman and the Members of the project review committee for providing their technical support during the course of this work.

We also express our deep sense of appreciation to Dr. Sucheta Chakrabarti, Sc.`E', SAG, DRDO for providing guidance in the development of software, Dr. Rajkumar Tulswani, Sc`C', Dr. Richa, Sc`C' and Ms. Pavitra Gautam, Sc`B', DIPAS for their help in the compilation of the data and report.

Last but not the least, we are indebted to Dr. P.C. Deb and Dr. J. Narayan Das Former Directors of NMRL, Ambernath, Dr. S.C .Sharma, Sc.`G', NMRL (DRDO) for giving us the technology and a special chance for its implementation in the field where more than ten thousand people got relief from the arsenic poisoning.

>>>>>>>>>>>>>

APPENDIX

Core Committee, Arsenic Task Force
Govt. of West Bengal
Bikash Bhawan (South Block) 3RD Floor
Tel: 2334 –2171
e-mail: arstaskforce_corecom@vsnl.net

Chairman: **Prof. K.J Nath**
Convener: **Dr. S. P Sinha Ray**

To
Dr. P.C Deb
Director
Naval Materials Research Laboratory.
Ambernath

Date: 28th May, 2004

Sub: Report on the Arsenic Removal Technology developed by NMRL.

Dear Dr. Deb,
Thank you for visiting our office and submitting the report referred to above. I have gone through the report and would like to take this opportunity to compliment and congratulate you and your colleagues particularly Dr. Kshipra Misra for this commendable effort. The technology developed is efficient in removing Arsenic to the desired limit and it is also found to be very cost effective. Though presently developed only as a domestic treatment unit, I feel that the technology has the potential for scaling up for large community plants.

I would recommend that you enter into MOUs with NGOs and also have dialogue with UNICEF, PHED, Govt. of West Bengal, in the matter of the use of your technology by the community.

With kind regards

Prof. K.J Nath
Chairman, Arsenic Task Force

Core Committee, Arsenic Task Force
Govt. of West Bengal
Bikash Bhawan (South Block) 3RD Floor
Tel: 2334 –2171
e-mail: arstaskforce_corecom@vsnl.net

Chairman: **Prof. K.J Nath**
Convener: **Dr. S. P Sinha Ray**

Date. 07-10-2005

CERTIFICATE

TO WHOM IT MAY CONCERN

This is to certify that the field trials for domestic Arsenic Filter developed by Naval Materials Research Laboratory, Research & Development Organization, Govt. of India, Ministry of Defence, Ambernath, India, were successfully conducted in a number of villages in North 24 Parganas by an NGO (Save The Environment) under the guidance of All India Institute of Hygiene & Public Health team, lead by Sri Diptarup Kahali, Project Manager, ICEF Project. The filters were found to be very efficient in removing arsenic below the desired limit. They are cost effective, user friendly and performed very well in the affected villages in West Bengal.

(Prof. K.J Nath)
Chairman,
Arsenic Task Force.

Ajoy De
Member
West Bengal Legislative Assembly
Chairman
Santipur Municipality

21, Subal Podder Lane,
P.O. - Santipur, Dt. Nadia
S.T.D. : 03472
Office : 278029
Fax : 277170
Resi : 278003
: 278262
Chamber : 278111

Ref. No. .....

Date 21-09-2007

TO WHOM IT MAY CONCERN

This is to certify that SAVE THE ENVIRONMENT CALCUTTA, installed 300 nos. DRDO, NMRL Domestic Arsenic Removal Filter in the several Houses at the village of Lalmath under Nabla Gram Panchayet in Block and P.S. Santipur. The people of the Locality highly satisfied and benefitted for this sort of work done by them on full free of charges.

I wish their success in future.

21.9.07

(AJOY DE)
M.L.A.

श्रीमती शकुन्तला देवी
"ग्राम प्रधान"
ग्राम पंचायत- गंगापुर
क्षेत्र पंचायत- बेलहरी, बलिया

निवासः
ग्राम- गंगापुर
पो०- गंगापुर
जिला- बलिया (उ०प्र०)

पत्रांक.....

दिनांक 4/10/09

To दा सेक्रेटरी सम्पादक
सेवा दा रूरल
अरमर
कलकत्ता —
पं० 700009

महाशय मुझे जानकारी है कि आपके तिवारी टोला गाँव में आप लोगों ने आरसेनिक फीलटर लगाये थे। उसमें से लग-भग 90% फीलटर सही तरह से चल रहा है। मुझे यह भी मालूम है। आपका दिन 3 अक्टू. छोटे यह दौरा चल रहा है कि इस बार २० या २५ फीलटर का भी ईट बन चुका है। आपसे अनुरोध है कि आपसे आगे भी कार्य जारी रहेगी।

शकुन्तला देवी

ग्राम पंचायत - गंगापुर
क्षेत्र पंचायत - बेलहरी

डीआरडीओ फिल्टर का प्रयोग पहली बार

तिवारी टोला में मंगलवार को डीआरडीओ फिल्टर के लिए पीड़ितों की सूची तैयार कर रहे संयुक्त टीम के सदस्य

संवाददाता रामगढ़

- कोलकाता व दिल्ली की संयुक्त टीम कर रही सर्वेक्षण
- सूबे की सरकार पहली बार जून के अंत तक आर्सेनिक पीड़ितों को देगी फिल्टर

केन्द्र सरकार ने इलाके के आर्सेनिक प्रभावित लोगों को शुद्ध पेयजल मुहैया कराने की दिशा में एक और पहल की है। बलिया प्रदेश का पहला ऐसा जनपद होगा, जहां डीआरडीओ फिल्टर के जरिए शुद्ध पेयजल उपलब्ध कराया जायेगा। इसके लिए सर्वाधिक प्रभावित तिवारीटोला गांव को चयनित किया गया है। कलकत्ता व दिल्ली की संयुक्त टीम सर्वेक्षण में जुटी है। सम्भावना जतायी जा रही है कि जून के आखिरी तक गांव के हर घर में यह फिल्टर पहुंच जायेगा।

आर्सेनिक प्रभावित इलाके में लोगों को शुद्ध पेयजल उपलब्ध कराना केन्द्र व प्रदेश सरकार के लिए करीब दो दशक से चुनौती बना हुआ है। क्षेत्र के तिवारीटोला, चौबेछपरा, रामगढ़, रिकिनीछपरा, गंगापुर, सुधरछपरा, बलिहार, केहरपुर, श्रीनगर, गंगौली, शाहपुर समेत कई गांव इस दूषित जल की चपेट में है।

करीब आधा दशक पहले तिवारीटोला के भूगर्भीय जल की जांच के बाद यादवपुर विश्वविद्यालय कोलकत्ता ने सनसनीखेज खुलासा किया था कि यहां से तीन किमी की परिधि का क्षेत्र पूरी तरह आर्सेनिक से प्रभावित है।

क्षेत्रवासियों को शुद्ध पानी उपलब्ध कराने के लिए कई प्रयास किये गये। रामगढ़ व केहरपुर तथा राजपुर एकौना में पानी टंकी के निर्माण को शासन से हरी झण्डी मिली। कर्म शुरु भी हुआ लेकिन अंजाम आर्सेनिक पीड़ितों को कहीं से भी राहत देने वाला नहीं रहा।

इस बीच, आर्सेनिक प्रभावित क्षेत्र में उम्मीद की एक और किरण दिखने लगी है। परीक्षण के तौर पर तिवारीटोला गांव को चुना गया है, जहां डीआरडीओ फ़िल्टर के जरिये आर्सेनिकमुक्त पानी उपलब्ध कराया जायेगा।

जेएनयू, दिल्ली, सेफ दि इन्वायरमेन्ट कोलकत्ता के अलावा डीएसटी व डीआरडीओ की संयुक्त टीम गांव के सर्वेक्षण में जुटी है। टीम में शामिल पारिजात त्रिपाठी, डा. प्रलप बसु, डा. संयज वाजपेयी, डा. छिप्रा मिश्रा, संजीत मिश्रा, गोरंग गुल्दा, सिंधक मैत्री, श्याम रैना का कहना है कि डीआरडीओ वेस्ट टेक्नालॉजी पर आधारित फिल्टर है। यह पानी से आर्सेनिक जैसे खतरनाक तत्वों को अलग कर देता है। दो सप्ताह पहले इसकी तकनीकी को देखते हुए प्रधानमंत्री ने एवार्ड दिया है। अगर प्रदेश में पहली बार इस प्रयोग बेलहरी ब्लाक के तिवारीटोला में होगा।

June, 2008

OFFICE OF THE Phone : (03473) 271092

ARBANDI-I GRAM PANCHAYAT

VILL. & P.O.- ARBANDI ✪ P.S.- SANTIPUR ✪ DIST.- NADIA.

Smt. Durga Munda
Prodhan

ARBANDI-1 GRAM PANCHAYAT
ARBANDI
Santipur Block
P.O.- Arbandi, Nadia

Sri Bibhas Mondal
Upa-Prodhan
Mob.: 9735235328

Ref. No. ৩৫২/(৯)

Date : ২৭.৩.২০১১

প্রতি,

মাননীয় সম্পাদক মহাশয়,
জেড্ দ্য এনভায়রনমেন্ট,
কলকাতা - ৭০০০০৮.

মহাশয়,

নদীয়া জেলার শান্তিপুর ব্লকের আড়বান্দী-১ গ্রাম পঞ্চায়েতের অধীন আড়বান্দী গ্রামে প্রত্যেকটি পরিবারকে পানীয় জলের ফিল্টার প্রদানের জন্য শুভেচ্ছা রইল। আনন্দের সঙ্গে জানাচ্ছি যে এই গ্রামে প্রদত্ত ৩০২ টি আর্সেনিক মুক্ত ডি.আর.ডি.ও. ফিল্টারের মধ্যে প্রায় বেশীরভাগ ফিল্টারই সঠিক ভাবে ব্যবহৃত হচ্ছে। ফিল্টারের জল রান্না ও পানীয়ের কাজে ব্যবহার করে গ্রামবাসী খুবই উপকৃত। এর জন্য আমরা ভারত সরকারের বিজ্ঞান ও প্রযুক্তি বিভাগের কাছে আন্তরিক ভাবে কৃতজ্ঞতা জানাই।

ভবিষ্যতে এই ধরনের প্রকল্প যদি এই গ্রাম পঞ্চায়েত এলাকায় পুনরায় রূপায়িত হয়, তাহলে আরও অনেক ব্যক্তি উপকৃত হবে।

ধন্যবাদসহ,

27/3/11

(Smt. Durga Munda)
Pradhan
Arbandi-I, Gram Panchayet
Vill & P.O.-Arbandi, Nadia

INDIAN INSTITUTE OF TOXICOLOGY RESEARCH
(Formerly: Industrial Toxicology Research Centre)
MAHATMA GANDHI MARG, POST BOX NO. 80,
LUCKNOW-226001 U.P. (INDIA)
(Constituent Laboratory of C.S.I.R.)

IITR

NABL	T	255
NABL	T	256

IITR/RPBD/21/2009
October 28, 2009

Speed Post

Dr. Pralay O Basu
Save The Environment
18/1 Kailash Ghosh Road
Kolkata-700008

Subject: Analysis report of raw water samples

Report No.	TS-1081 (I to X)
Signed by	Dr. R.C. Murthy
Your reference no.	STE/2009/040 dated 7.10.2009
Sample collected by	Save The Environment, Kolkata
Sample plan and procedure	Tube well and Filter*
Date of sampling	6.10.2009*
Environmental condition during sampling	N/A*
Sample delivered on	7.10.2009
Sample condition	Unsealed
Source of sampling	Tiwaritolla, Block Belahari, Ballia*

Dear Sir,

Please find enclosed the analysis report of your sample. Your reference number for each sample is matched with our internal IITR Code No. as follows:

Your sample(s) reference no.	IITR Code No.
Chandra Dip Sharma (Raw water)	TS-1081 (I)
Triloki Choubey (Raw water)	TS-1081 (II)
Sree Ram Prasad Show (Raw water)	TS-1081 (III)
Parwati Tiwari (Raw water)	TS-1081 (IV)
Ashoke Show (Raw water)	TS-1081 (V)
Chandradeep Sharma (Final water)	TS-1081 (VI)
Triloki choubey (Final water)	TS-1081 (VII)
Sree Ram Prasad Show (Final water)	TS-1081 (VIII)
Parwati Tiwari (Final water)	TS-1081 (IX)
Ashoke Show (Final water)	TS-1081 (X)

Kindly acknowledge the receipt of the report.

Encl: As above

Yours faithfully

(B.D. Bhattacharji)
Head, RPBD

*Information provided by the customer

Telephone No. EPABX Main Campus 262017; 2614689; 2627332; 2620207; 0522-2611547;
Fax 0522-2611547; 2628227; E-mail: rpbdiitr@yahoo.com; website: www.iitrindia.org

INDIAN INSTITUTE OF TOXICOLOGY RESEARCH
(Formerly Industrial Toxicology Research Centre)
MAHATMA GANDHI MARG, POST BOX NO. 80
LUCKNOW-226001 U.P. (INDIA)

METAL ANALYSIS REPORT

Date: October 19, 2009

1. Sample Registry No. : TS- 1081 (I to X)
2. Nature of Sample : Raw Water
3. Sealed/Unsealed : Unsealed
4. Date of Receipt : 07.08.2009
5. Method : APHA/AWWA 3110 (21st Edition, 2005)

Sample Code	Arsenic (µg/ml)	Iron (µg/ml)
TS-1081-I	0.767	9.205
TS-1081-II	0.292	5.660
TS-1081-III	0.248	11.825
TS-1081-IV	1.223	11.175
TS-1081-V	0.406	11.430
TS-1081-VI	0.115	0.050
TS-1081-VII	0.012	0.063
TS-1081-VIII	< 0.005	0.067
TS-1081-IX	< 0.005	0.060
TS-1081-X	0.011	0.064

As - Analysis performed on Atomic Absorption Spectrometer (GBC Avanta ∑) with VGA
Fe - Analysis performed on Flame Atomic Absorption Spectrometer (GBC Avanta ∑)

1. The report pertains to the sample tested only.
2. This report shall not be used or produced in fragments.
3. This report shall not be used for any other purpose than declared by the sponsor.
4. ITRC is not regulatory and certifying agency hence no part of this report should be used for legal purposes under any circumstances.

19/10/09

(Dr. R.C. Murthy)
Scientist & Head
Metal Analysis Laboratory
Name, Designation & Signature of the Analyst with Date

PRESIDENCY UNIVERSITY, KOLKATA
Department of Geology & Environmental Systems Management
86/1 College Street, Kolkata 700073, India
□ +91 33 2219 2636, +91 33 2241 1960 (extn.207)

To : Dr. Pralay O. Basu,
Founder Secretary and Director,
C/o M/s Save the Environment,
18/1 Kailash Ghosh Road, Kolkata - 700008

REPORT OF WATER QUALITY ANALYSIS

Nature of Sample : Water of Village Chandkuri, Block Santipur, District Nadia, West Bengal

Collection of Sample : Samples collected and supplied by M/s Save the Environment

Date of Receipt of Sample in Laboratory : 25.10.2011

ANALYSIS REPORT

Sl. No.	Specification of Sample	Result
1	Save/R-1	0.0276 mg/l
2	Save/F-1	BDL
3	Save/R-2	0.026 mg/l
4	Save/F-2	BDL
5	Save/R-3	0.037 mg/l
6	Save/F-3	BDL
7	Save/R-4	0.02 mg/l
8	Save/F-4	BDL
9	Save/R-5	0.053 mg/l
10	Save/F-5	0.002 mg/l
11	Save/R-6	0.032 mg/l
12	Save/F-6	BDL
13	Save/R-7	0.032 mg/l
14	Save/F-7	BDL
15	Save/R-8	0.049 mg/l
16	Save/F-8	0.01 mg/l
17	Save/R-9	0.044 mg/l
18	Save/F-9	BDL
19	Save/R-10	0.045 mg/l
20	Save/F-10	BDL

BDL: Below Detection Limit (below 0.001 mg/l)

11/11/11

Head
Department of Applied Geology &
Environmental System Management

Date : 11.11.2011