



Introduction to Arsenic Biosand Filter (Kanchan Filter)

**Entrepreneurs Training on the Promotion
of
Arsenic Biosand Filter (Kanchan Filter)
In Nepal**

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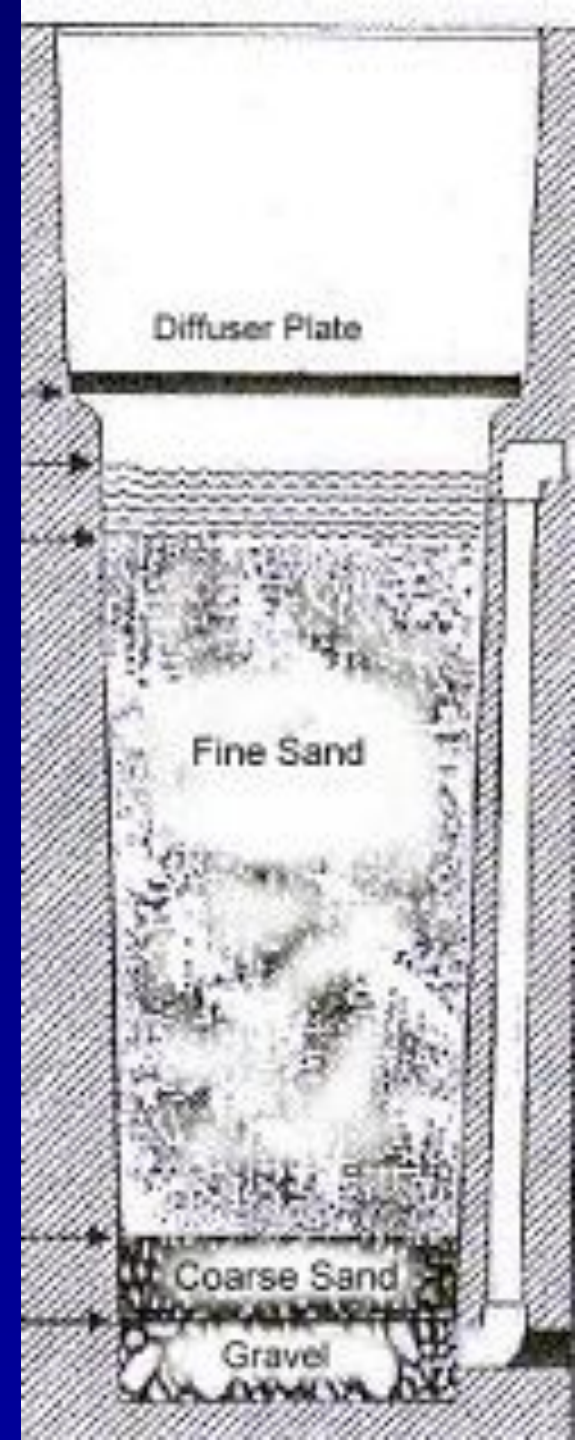
Presentation Outline

1. Introduction to Kanchan Filter (Arsenic Biosand Filter)
2. Arsenic, Iron, & Bacteria Removal Mechanisms
3. Four Different Filter Configurations
4. Filter Operations & Maintenance
5. Technical Performance
6. Implementational Issues
7. Cost
8. Conclusions
9. Questions and Discussions



Biosand Filter

- First developed by a Dr. David Manz of the University of Calgary in Canada
- Based on slow sand filter technology for intermittent use
- Intended for bacteria removal from drinking water
- Made with easily available materials: concrete or plastic container, PVC pipe, sand, gravel, and lid
- Adequate flow rate for a large family
- No chemical additives
- Easy to operate and clean
- Require 2 to 3 weeks to reach optimum removal of bacteria & viruses

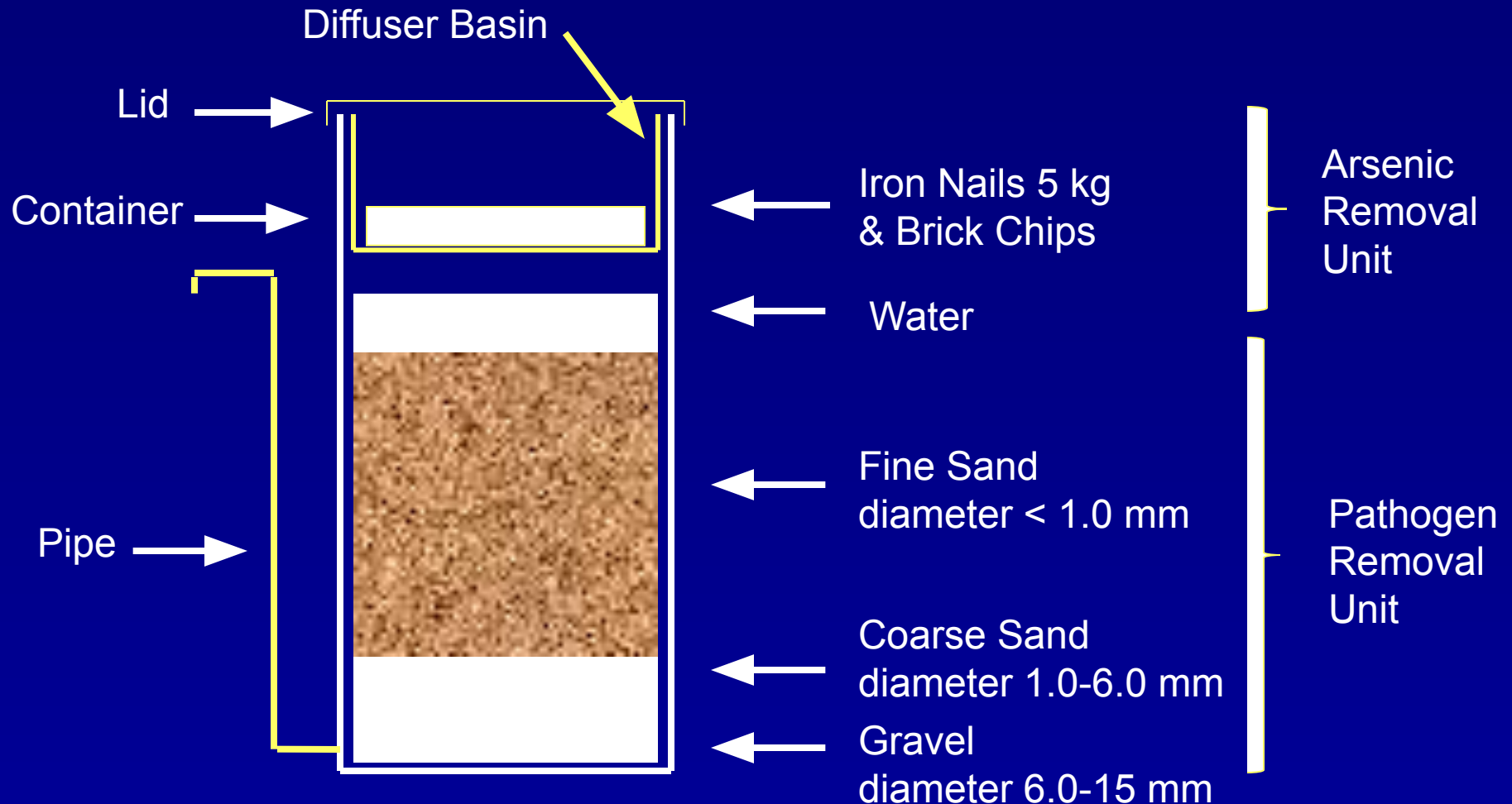


Arsenic Biosand Filter (Kanchan Filter)

- Developed by Massachusetts Institute of Technology (MIT), Environment & Public Health Organization (ENPHO), and Rural Water Supply and Sanitation Support Programme (RWSSSP)
- An improvement on the former Biosand Filter
- Intended for bacteria and arsenic removal
- Made with easily available materials: concrete or plastic container, PVC pipe, sand, gravel, iron nails, and lid
- Adequate flow rate for a large family
- No chemical additives
- Easy to operate and clean
- Require 2 to 3 weeks to reach optimum removal of bacteria & viruses
- Immediate arsenic removal after installation

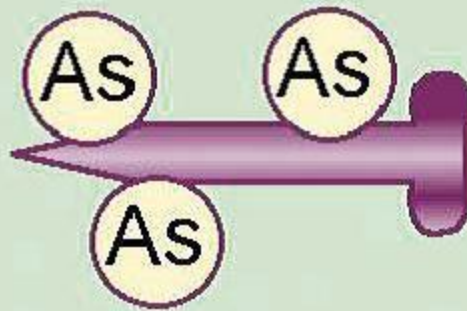


Kanchan Filter Cross Section



Arsenic Removal Mechanism

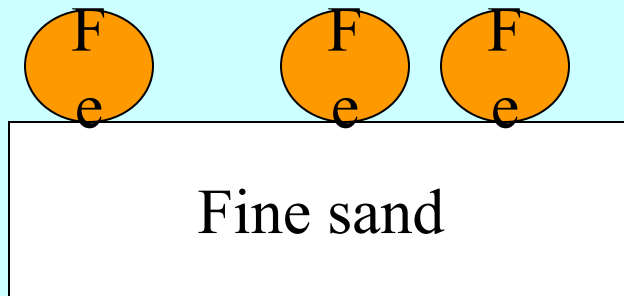
- After contact with water and air, iron nails in the diffuser basin will quickly rust
- Iron rust (ferric hydroxide) is an excellent adsorbent for arsenic



Arsenic (As) particles are effectively adsorbed on the rusted iron nails surface.

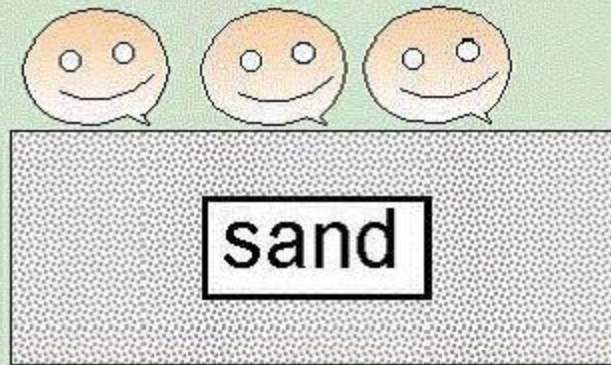
Iron Removal Mechanism

- Soluble iron(II) in raw water is oxidized in the filter to insoluble iron(III)
- Iron is trapped on top of sand layer by physical straining

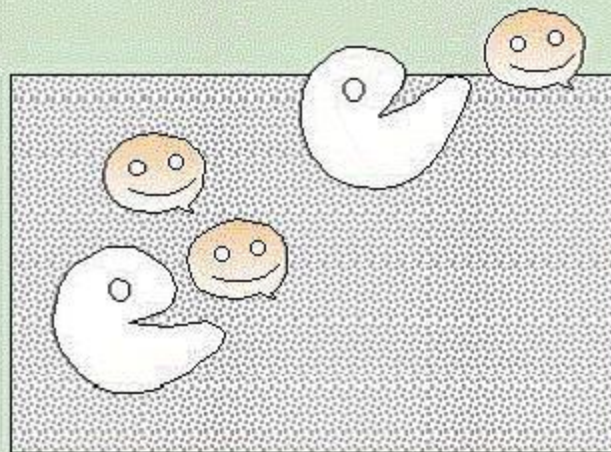


Iron particles are trapped on top of the fine sand layer by physical straining (i.e. too large to pass)

Bacteria Removal Mechanism



Larger pathogens will be trapped on top of the sand layer by physical straining.

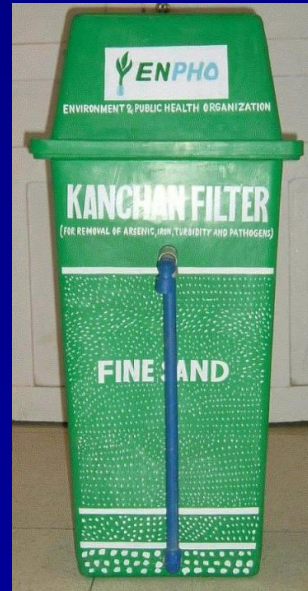


Smaller pathogens are removed by predation by microorganisms residing near the top sand layer.

Filter Design

We have developed 4 configurations for the Kanchan Filter:

1. Concrete Square
2. Concrete Round
3. Plastic Hilltake
4. Plastic Gem505



Concrete Square Filter





Placing iron nails into
diffuser box



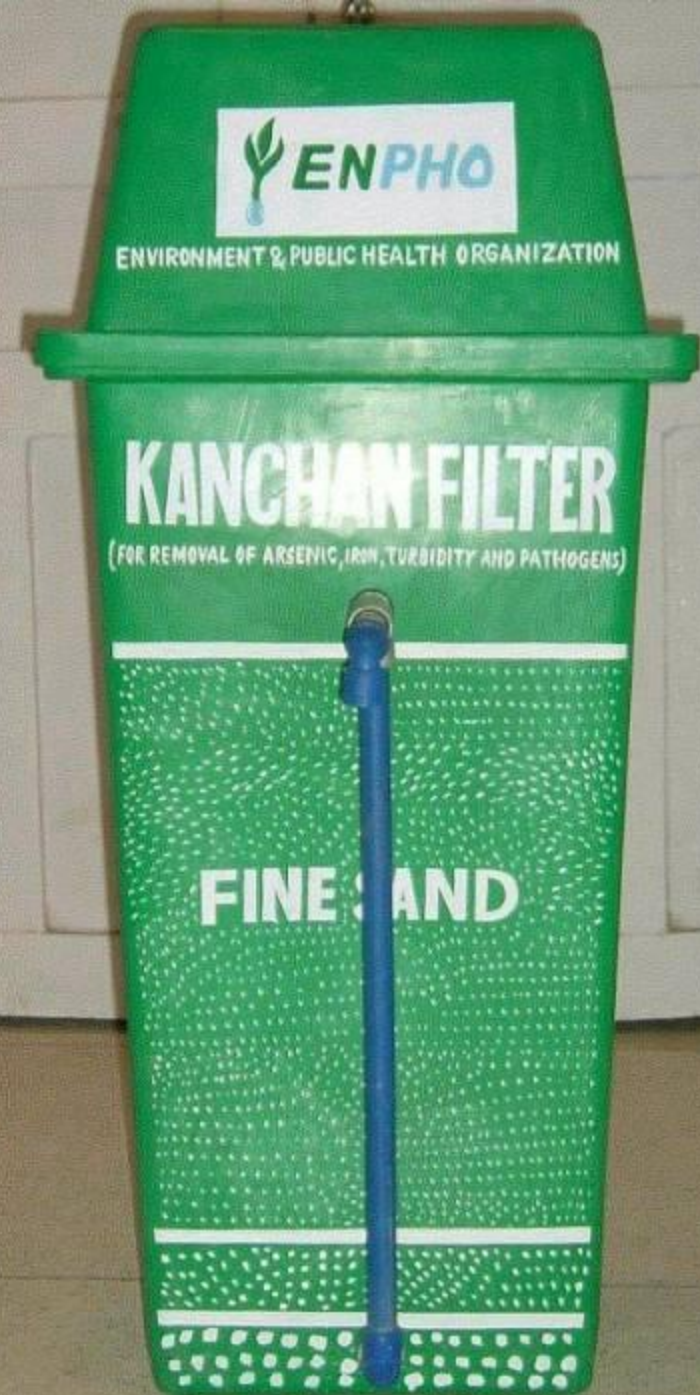
Placing brick chips into
diffuser box

Concrete Round Filter



Metal lid and
diffuser basin

Plastic Hilltake Filter





Top view of filter and basin



Placing brick chips in the
diffuser box

Plastic Gem505 Filter





Top view of filter and basin
with iron nails and brick chips

Top view of filter with
basin removed



Filter Operation

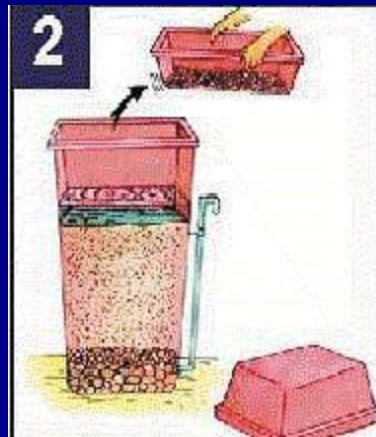


1. Pour water into top basin. Water will pass through filter and flow up the pipe
2. Collect filtered water at the pipe outlet
3. If flow rate is insufficient, then cleaning is required

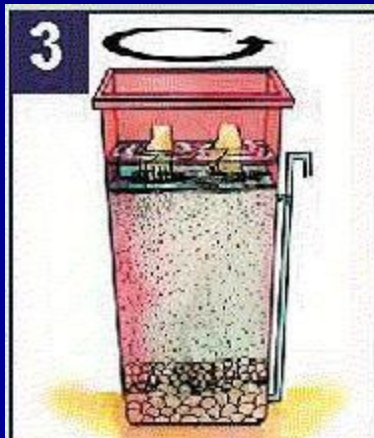
Filter Cleaning/ Maintenance



Wash your hands with soap



Remove diffuser basin

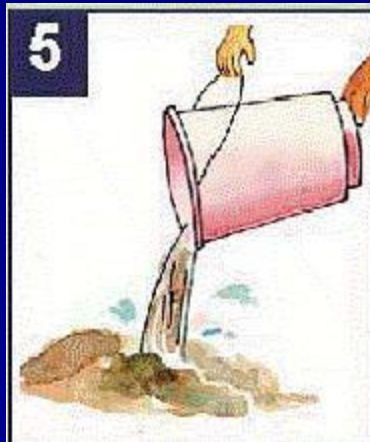


Stir the uppermost $\frac{1}{2}$ inch of sand with your fingers

Filter Cleaning/ Maintenance



Remove turbid water with a cup.
Replace the basin and add more water.
Repeat the stirring process for two additional time.



Discard the turbid water in a dug hole
with some cow dung in it



Now the filter can be used again

Filter Performance

- Currently more than 800 filters are in operation
- More than 500 were distributed by NRCS, about 100 by Fund Board, about 200 by RWSSSP
- Filters were distributed starting from September 2002 until today
- We have monitored more than 300 filters from February – April 2004 on arsenic and iron removal



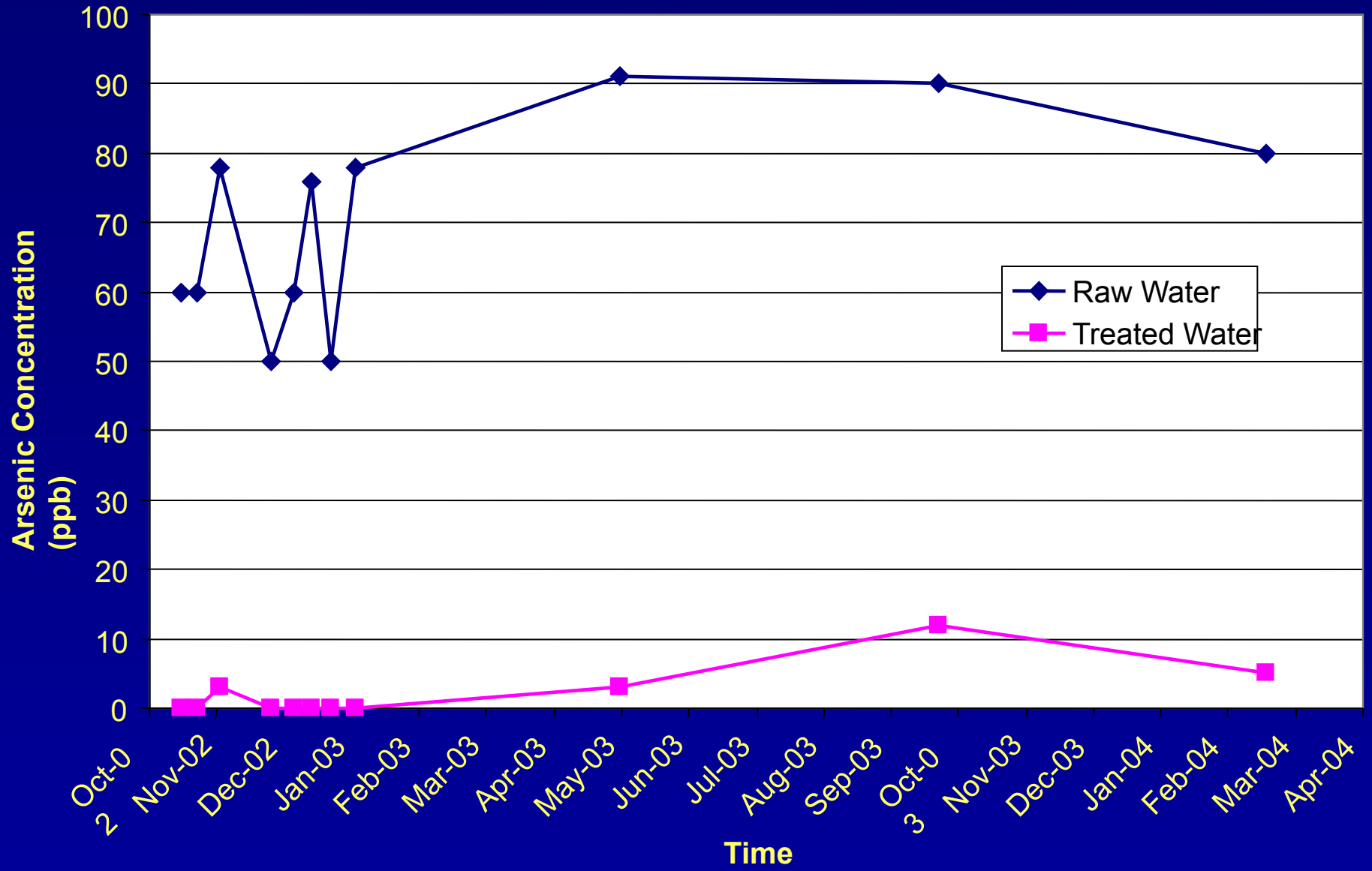
Filter Performance: Arsenic

Number of Samples	323
Average Removal %	94.1%
% of Filtered water:	
0 to 10 ppb	88.6%
11 to 50 ppb	9.5%
50 + ppb	1.9%
Average Raw Water Conc.	129 ppb

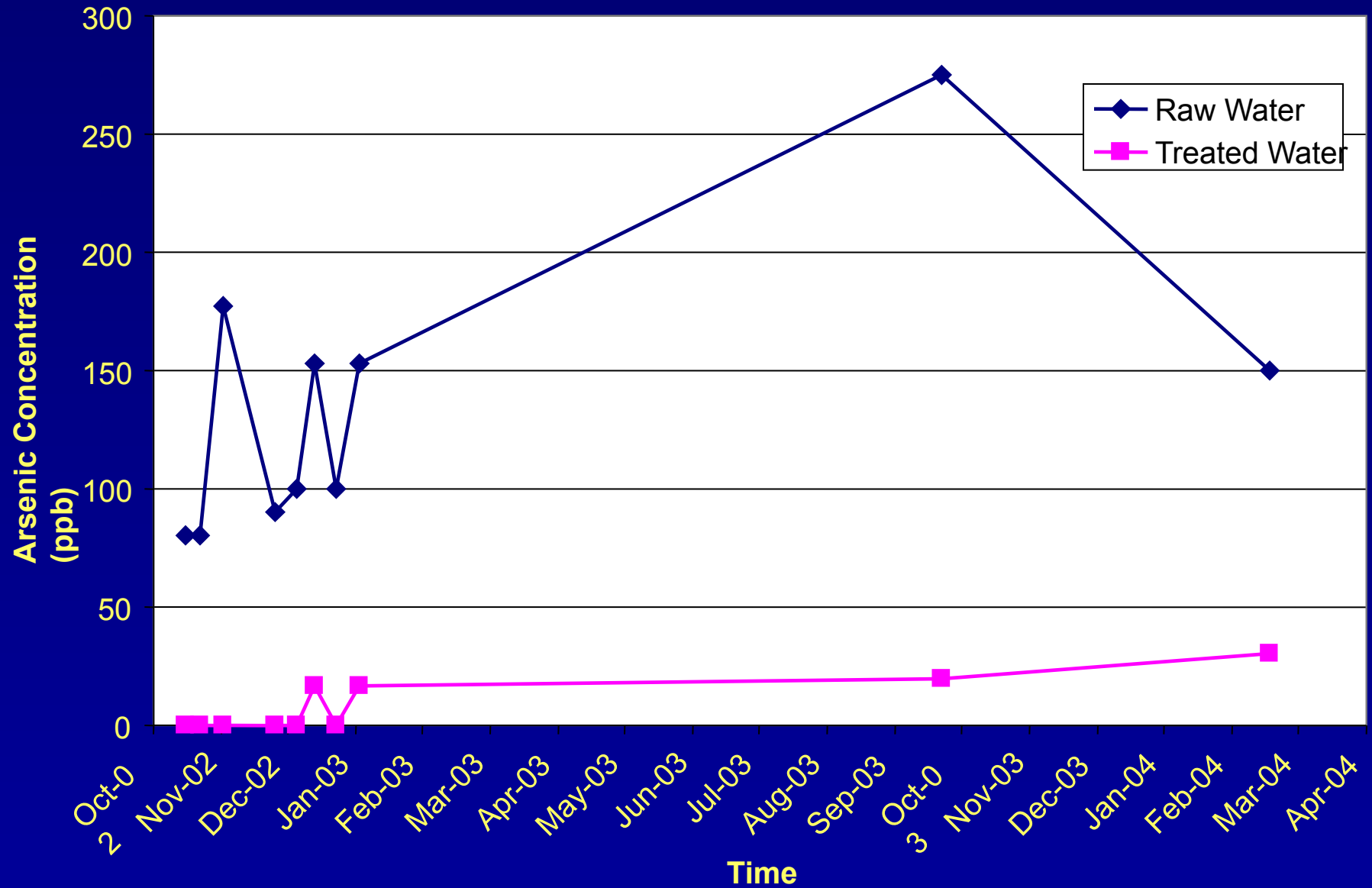
← Improper installation!



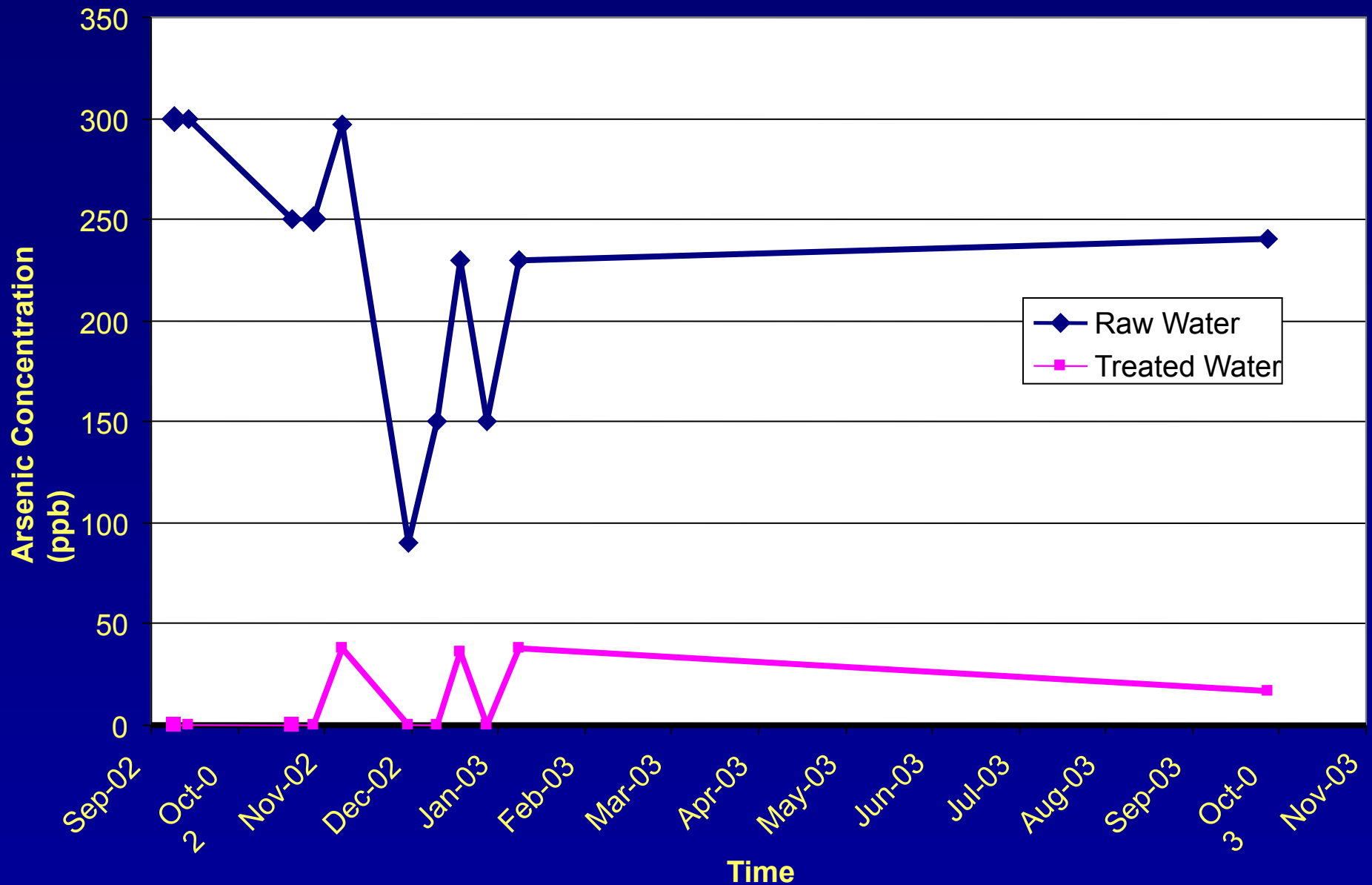
1.5 Years Arsenic Monitoring on Filter A



1.5 Years Arsenic Monitoring on Filter B



One Year Arsenic Monitoring on Filter C



Filter Performance: Iron

Number of Samples	354
Average Removal %	94.2%
% of Filtered water	
0 to 0.3 ppm	80.5%
0.3 to 1 ppm	18.2%
1 + ppm	2.2%
Average Raw Water Conc	4.4 ppm

← Improper installation!



Filter Performance: Bacteria

- Insufficient bacteria removal test on the Kanchan Filter for statistically significant results
- Our study (7 filters) showed bacteria removal of up to 100% after the filter was in operation for about 2 – 3 months
- Previous studies on the Biosand Filter in Canada, Nicaragua, Dominican Republic, and U.S.A. showed 90 to 99+% bacteria removal



Technical Performance of 4 Filter Configurations

	<i>Concrete Square</i>	<i>Concrete Round</i>	<i>Plastic Hilltake</i>	<i>Plastic Gem505</i>
Arsenic Removal	Average 94%			
Iron Removal	Average 94%			
Bacteria Removal	Under investigation			
pH Change	Increase by an average of 0.3 to 0.4 pH units			
Flow Rate (Liters per hour)	17	15	25	15



Implementation Issues Comparison of 4 Filter Configurations

	<i>Concrete Square</i>	<i>Concrete Round</i>	<i>Plastic Hilltake</i>	<i>Plastic Gem505</i>
Operation	Easy	Easy	Easy	Easy
Maintenance	Simple	Simple	Simple	Simple
Labour	Require trained Mistri	Require trained Mistri	Require trained technician	Require trained technician
Production rate	One filter per mold per day	One filter per mold per day	Many filters per day	Many filters per day
Transportation	Very heavy	Very heavy	Somewhat heavy	Light
Aesthetic	Good	Good	Looks like a trash bin	Good



All filters are easy to operate and maintain

Iron mold is required to construct concrete filters



Construction of concrete filters can be time consuming (1 filter per mold per day)



The concrete filter is very heavy (100+ kg) thus transportation can be difficult

The Plastic Hilltake filters may look like a trash bin therefore not attractive





The Plastic Gem505 Filter is widely available and is easy to transport

The Plastic Gem505 Filter is simple to construct



Cost Comparison of 4 Filter Configurations

	<i>Concrete Square</i>	<i>Concrete Round</i>	<i>Plastic Hilltake</i>	<i>Plastic Gem505</i>
Container and Lid	445	395	1300	405
Basin	250	250	75	75
Piping System	98	98	174	133
Sand & Gravel	3	3	5	3
Iron Nails 5 kg	350	350	350	350
Transportation	53	48	91	49
Labour	210	210	68	54
Documentation	25	25	25	25
Tools	223	223	54	54
Total Cost	1657	1607	2142	1149

Comparison Summary

	<i>Concrete Square</i>	<i>Concrete Round</i>	<i>Plastic Hilltake</i>	<i>Plastic Gem505</i>
Technical Performance	Excellent	Excellent	Excellent	Excellent
Easy to Implement	Somewhat difficult	Somewhat difficult	Easy	Easy
Cost	Cheap	Cheap	Relatively expensive	Cheapest
Recommended for Wide-scale Implementation?	Maybe	Maybe	Maybe	YES

Conclusions

- The Kanchan Filter (Arsenic Biosand Filter) is an improvement upon the proven Biosand Filter technology
- The Kanchan Filter can effectively remove arsenic (94%) and iron (94%)
- Of the 4 different configurations, the Gem505 shows the most promise
- The construction, operation, and maintenance of the filter is simple
- The filter cost is estimated to be about 1100-1200 Rs



Acknowledgements

In Nepal:

- Environment and Public Health Organization (ENPHO), Kathmandu
- Rural Water Supply and Sanitation Support Programme (RWSSSP), Butwal
- Nepal Red Cross Society (NRCS)
- Rural Water Supply and Sanitation Fund Development Board (RWSSFDB)
- Department of Education (DOE)
- Department of Water Supply & Sewerage
- UNICEF Nepal

Internationally:

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- Massachusetts Institute of Technology, Department of Civil and Environmental Engineering, Boston, USA
- MIT IDEAS Competition and Lemelson Foundation
- Japanese Red Cross Society (JRCS)
- University of Calgary, Canada

Thank You