Environment

Water Community

Solution Exchange for the Water Community
Consolidated Reply

Query: Best Practices in Effective Sewage Disposal - Experiences

Compiled by Pankaj Kumar S., Resource Person and Ramya Gopalan, Research Associate
13 June 2007

From Aniruddhe Mukerjee, Government of Madhya Pradesh, Bhopal
Posted 21 May 2007

Dear Members,

I used to work for the UN-HABITAT on the Water for Asian Cities Programme, which aims to support developing countries in Asia and Pacific to achieve sustainable access to safe drinking water and basic sanitation for the poor, particularly in urban areas. In Madhya Pradesh, the programme is working in four cities of the state, viz. Bhopal, Gwalior, Indore and Jabalpur for improvement and expansion of urban water supply, sewerage and sanitation, water drainage and solid waste management.

Rapid urbanisation has brought with it a substantial increase in sewage wastes, the uncontrolled and unscientific dumping of which has greatly increased the potential hazard to human health through contamination of surface and ground water. It is seen that urban local bodies normally dump untreated sewage in water bodies and low lying areas with no consideration of the impact of this on the environment. Moreover, lack of knowledge of best practices among various municipalities regarding generation, collection and disposal of these wastes leads to continuation of poor practices.

The Ministry of Environment and Forests, Govt. of India has recently legislated the Municipal Waste Management and Handling Rules 2000. However, enforcement of these Rules is far from satisfactory. In the above context, there is a need to understand the following:

- Good practices in implementation of sewage waste management programmes to provide eco-friendly, sustainable, low cost and community based solutions, especially for small and medium settlements, say of a few thousand households. Numerous innovations in this regard by communities, organizations and individuals exist across India.
- Suggested and tried mechanisms for improving the treatment and safe disposal of sewage, such as decentralised treatment through soak-pits, etc. and the potential of such waste to generate energy.
- Institutional framework that should be followed to sustainably manage sewage through community and public-private partnership.

Solution Exchange Community members are requested to please share experiences and best practices in other parts of India on the above issues. Your inputs will help us enhance the design and implementation of the programmes for sewage management in cities, especially for the poor, and will be deeply appreciated.

Responses were received with thanks from

1. **Digbijoy Bhowmik, UNDP assisted project 'National Strategy for Urban Poor', New Delhi**
2. **Ajit Seshadri, The Vigyan Vijay Foundation, New Delhi**
3. **Megha Phansalkar, Water Supply and Sanitation Department, Government of Maharashtra, Navi Mumbai**
4. **R. Srikanth, WaterAid, New Delhi**
5. **Arunabha Majumder, All India Institute of Hygiene & Public Health (AIIH&PH), Kolkata**
6. **Prakasam Tata, Tata Associates International, Naperville, USA**
7. **Salathiel R Nalli, CARE International, Banda Aceh, Indonesia**
8. **Chicu Lokgariwar, Gomukh Environmental Trust, Pune**
9. **Jyotsna Bapat, Consultant, New Delhi**
10. **Mrinalinee Vanarase, IORA for Environmental Solutions, Pune**

Further contributions are welcome!

Summary of Responses

The query asked for best practices on sewage management, especially in the small-habitation context. Respondents outlined various technical options and good practices from different parts of India and gave suggestions for designing institutional interventions for effective sewage management.

Members stressed that most conventional **sewage treatment systems** in India were under-designed, expensive and energy-intensive to run and maintain and were unable to treat a large portion of the sewage. As a result, a large quantity of sewage waste ended up being discharged into water bodies, thus increasing health hazards. They also pointed out that sewage treatment could be looked at in two ways - point source treatment (where water could be recovered) and non-point source treatment (natural processes for self-cleaning of naturally flowing or non-flowing water), and that the emphasis has conventionally been on the former approach.

Respondents outlined that the **selection factors** for sewage treatment technologies were - space available for treatment, time taken, time for transportation of waste and environmental overheads of the treatment methodology. They also gave examples from **Madhya Pradesh**, **Punjab**, **Haryana** and **Delhi**, which had been forced to choose treatment technologies by factors such as a mismatch between the capacity and catchment of the plant, urgency of implementation, sudden increase in land prices, etc.

Discussing **techniques for sewage management**, the group particularly mentioned Waste Stabilization Pond (WSP) as a technology that was cheapest to install and operate and required minimum energy inputs. It also had the potential of giving additional revenue from pisciculture. Members cited successful treatment plants in the **West Bengal** and **Andhra Pradesh** where

WSP had been tried successfully. Other techniques mentioned were the Activated Sludge method and the Up flow anaerobic sludge blanket methods. However, the problem with these conventional techniques is that they required a larger area, took more time and had some environmental overheads, felt members. Improved techniques, which improved on these parameters mentioned by discussants, were fluidized aerobic bioreactor, submerged aerated filter and aerated rock filters.

The discussion also brought out numerous **good practices** in sewage management. The example of Sulabh showed that people would be willing to pay if clean toilets were provided along with bathing, laundry and urinal facilities. Women SHG groups in Pune were designing and managing community toilets successfully and viably. Members also described how wetlands in East Kolkata were used to treat the wastes of Kolkata and to raise fish. Case studies from **Maharashtra** showed how villages had designated certain days in the month for cleaning the entire village, while yet others were successfully using wastewater to grow village gardens. Other suggestions given by members included using wastewater for horticulture and using plants such as Lemna for phyto remediation.

Respondents also discussed the issue of using sewage for producing energy. They shared an example from **Maharashtra** where human excreta had been successfully coupled with animal dung to produce biogas. Respondents also stressed while **China** has been able to effectively couple human waste and pig swill for gas production, the number of such successful experiments in India have not been significant, and mentioned unsuccessful attempts at Bio-methanation in some parts of India in this context.

The group also discussed the **institutional interventions** that would help better sewage management. For example, a project from Tsunami affected areas in **Indonesia** is trying to ensure that no untreated household wastewater would be released into public drains and that all sanitation systems have primary and secondary treatment. Members also cited case studies from **Maharashtra** where Gram Panchayats and Village Water and Sanitation Committees had been empowered to enforce better sanitation conditions and waste treatment methods. Yet another suggestion was to ensure that decentralized management of waste was out in place, especially in new colonies. Members hoped that new Government schemes such as JNNURM would provide space for community institutions to own and manage their sewage systems sustainably.

The discussion brought out a wide variety of experiences of different communities grappling with the issue of managing sewage in their habitations. Many solutions do exist, but members stressed that the issue is linked to unlimited urban growth, and an unsustainable model of sewage. Decentralized treatment of sewage at a habitation level could probably be a long-term solution to the problem, felt members.

Comparative Experiences

From Digbijoy Bhowmik, UNDP assisted project 'National Strategy for Urban Poor', New Delhi

Madhya Pradesh

Two Cell WSP to Handle Small Catchments, Tighra, East Gwalior

The new township selected a two cell WSP (1 anaerobic + 1 aerobic) as land was available and effluent could be discharged in the nearby canal. The design population catchment was 2 lakhs, while the city was planned for 8 lakhs. However, as the population would take time to grow, it was decided to opt for a solution that handles small catchments, and is not very expensive so that it could be replaced with a more heavy-duty solution in the future as the population grew.

Punjab

Up Flow Anaerobic Sludge Blanket (UASB)
Punjab Water Supply and Sewerage Board (PWSSB) selected UASB as the preferred technology as the land made available to the PWSSB could support it in terms of footprint, and new aerated systems were still not proven. The original proposition to attempt a bio-methanation unit was subsequently dropped, as the waste did not contain adequate gas based calorific output.

Haryana

Use of Fluidised Aerobic Bio-Reactor (FAB Reactor), Maham, Rohtak District
The State originally opted for WSP. However, somewhere along the process, State elections held increased the compensation against land acquisition by about four times. The local Public Health Department eventually established that setting up a WSP on acquired land would be more expensive than setting up a few FAB reactors on smaller, but multiple pieces of land. Therefore the latter was opted.

New Delhi

Recycling Drainwater *(from Ajit Seshadri, The Vigyan Vijay Foundation, New Delhi)*
An initiative in Vasant Vihar recycles drain water for horticulture. This plant is in operation for more than 3 years with minimal efforts on Operation and Maintenance and the water and sludge is available for re-use. The scope to reuse recycled water for such lower end uses is appropriate in enabling communities optimize the usage of water

Andhra Pradesh *(from Prakasam Tata, Tata Associates International, Naperville, USA)*

Waste Stabilization Pond System (WSP)
A Waste Stabilization Pond System (series of four ponds, i.e., a deep facultative pond, followed by a high rate algal pond, algae settling pond and a maturation pond) was designed and installed in Vizianagaram by the District authorities about three years ago. After withstanding two heavy monsoon seasons the system continues to work satisfactorily with absolutely no technical persons maintaining it.

From Chicu Lokgariwar, Gomukh Environmental Trust, Pune

Maharashtra

Community Constructed and Managed Toilets, Pune
A spatial mapping of slums using GIS software illustrated the irregularities in toilets constructed by Pune Municipal Corporation. The then Municipal Commissioner and Shelter began the Baandhani initiative **-** women led groups who research, counsel, plan, build, administer and maintain community toilets. Each of the 60 user families pays Rs. 20 per toilet monthly. Baandhinis manage the toilets, paying for the caretaker's services, maintenance and electricity.

West Bengal

Sewage Treatment of East Kolkata Wetland Systems
Kolkata Municipal Corporation generates 600 million litres of sewage/wastewater per day and 2,500 metric tons of garbage, which reaches the outfall channels and is drawn into the fisheries of the wetland where organic compounds biodegrade. A network of channels supplies untreated

sewage and drains out the effluents. The cumulative efficiency of reducing the BOD of the sewage wastewater is above 80% and for coliform bacteria 99.99% on an average. Read more.

Use of Waste Stabilization Pond (WSP) in the Ganga Action Plan (GAP) *(from Arunabha Majumder, All India Institute of Hygiene & Public Health (AIIH&PH), Kolkata)*
GAP Phase I envisaged to intercept, divert and treat 882 mld out of 1340 mld of wastewater. Review found delays in scheme completion, cost escalation, under-performance of completed STPs, inadequate effluent treatment and monitoring, deficient public awareness/participation and fund diversion. Subsequently WSP was installed under GAP as a sewage treatment system and the resulting treated effluent conforms to the quality standards of the EPA 1986.

Maharashtra

Biogas Plant for Sewage Disposal, Saswad *(from Jyotsna Bapat, Consultant, New Delhi)*
In the absence of a centralized sewage system, an individual experience indicates use of biogas plants to ensure effective sewage disposal. A biogas plant was built and connected to two toilets constructed along a wall near the road which passers-by were openly invited to use. Dung of animals belonging to tenants of the 'Wada' courtyard was also used. The plant worked for over 25 years until 1991, when sewage pipes were laid connecting toilets to a central disposal facility.

International

Indonesia

Sustainable Sanitation Systems, Aceh Province *(from Salathiel R Nalli, CARE International, Banda Aceh, Indonesia)*
40% of people living in their own houses have flush toilets with septic tanks acting as soak pits, resulting in its direct percolation into ground water. High water tables along with nearby shallow wells contaminate groundwater posing a great health hazard to 60% of the dependent households. CARE therefore installed sanitation systems, which require treatment, watertight septic tanks, and does not allow release of untreated wastewater into public drains. Read more.

Related Resources

Recommended Documentation

Manual on Sewerage and Sewage Treatment *(from Digbijoy Bhowmik, UNDP assisted project 'National Strategy for Urban Poor', New Delhi)*
CPHEEO Manuals, Central Public Health & Environmental Engineering Organisation (CPHEEO), Ministry of Urban Development (MoUD); http://cpheeo.nic.in/

> *Compiles suggestions on sewage treatment, design of sewer systems emphasizing on reuse and recycling of sewage effluents and operation and maintenance of systems*

Best Practices under Sanitation from Maharashtra *(from Megha Phansalkar, Water Supply and Sanitation Department, Government of Maharashtra, Navi Mumbai)*
Water Supply and Sanitation Department, Government of Maharashtra
Click here to view PDF (Size: 261 KB)

> *Highlights best practices across Maharashtra covering prior conditions that prevailed, the process of change undertaken and the final impact on the sanitation scenario in the State*

From Arunabha Majumder, All India Institute of Hygiene & Public Health (AIIH&PH), Kolkata

Municipal Solid Waste (Management & Handling) Rule 2000
http://www.envfor.nic.in/legis/hsm/mswmhr.html

The Rules lay down the responsibility of management of solid waste disposal and provides various standards for disposal of treated leachate

Environmental Protection Act 1986
http://envfor.nic.in/legis/env/env1.html

Provides quality standards for treated effluents and other processes for safe and effective disposal of sewage across the country

Waste Stabilization Ponds (WSP) for Wastewater Treatment
Cinara, Colombia, FAQ Sheet, IRC International, 11 May 2004
http://www.irc.nl/page/8237

Is a combination of anaerobic, facultative and maturation ponds and the quality of its treated effluent conforms to the standards of the Environmental Protection Act 1986.

From Salathiel R Nalli, CARE International, Banda Aceh, Indonesia

Tsunami Response Program Update
CARE International Indonesia, July, 2006
http://www.tsunamispecialenvoy.org/progressreports/care2.asp

Highlights watsan activities in the region i.e. water quality testing; waste management; reconstruction/rehabilitation of washing stations, latrines, and septic systems; etc

Sustainable Sanitation Systems
Care International
http://www.solutionexchange-un.net.in/environment/cr/res21050701.doc (Size: 28 KB)

Details the sanitation system designed depending on the availability of land, water table, topography, location of shallow wells and the preference of each individual house owner.

East Kolkata Wetland System *(from Chicu Lokgariwar, Gomukh Environmental Trust, Pune)*
Kolkata Environmental Improvement Project
http://www.keiponline.com/east_kolkata_wetland.htm

Details the resource recovery system built by local people, which uses and treats waste water by a network of channels that supply untreated sewage and drains effluents

From Mrinalinee Vanarase, IORA for Environmental Solutions, Pune

Common Aquatic Plants used in Constructed Wetlands and Ponds
Metcalf & Eddy, 1991
http://www.solutionexchange-un.net.in/environment/cr/res21050702.doc (Size: 61 KB)

The figure illustrates how emerging, floating and submerged plants are used for treatment in wetlands and lakes

Biosanitizer – An Eco Resource for Water Conservation
Mr. Uday Bhavalkar, Bhawalkar Ecological Research Institute (BERI); A-1, Padma Park, Behind Padmawati Temple, Pune-Satara Road, Pune- 411009; Tel.: 91-20-2422 6916; bvpl@vsnl.com
http://www.wastetohealth.com/

Controls point source pollution, through a natural catalyst producing need-based amounts of active oxygen that drives eco-logical reactions- cleaning polluted water

Recommended Organizations

Haryana Urban Development Authority (HUDA), Haryana
HUDA Office Complex, C - 3, Sector 6, Panchkula, Haryana; Tel.: 91-0172–2567857/2564048/2560605; huda@hry.nic.in; http://huda.nic.in/about.htm#FUNCTIONS

Selected a FAB reactor at the end of trunk sewer 4, sector 15 due to limited space, and urgency of the situation (load balancing between the sewerage networks for disposal)

Jawaharlal Nehru National Urban Renewal Mission, New Delhi
Ministry of Urban Development (MoUD) and Ministry of Housing and Urban Poverty Alleviation, GoI; http://jnnurm.nic.in/

Promotes the new Area Sabha system, Nagara Raj Bill allowing for community owned and managed sewage treatment systems using part of the local Government budgets

Ganga Action Plan (GAP) *(from Arunabha Majumder, All India Institute of Hygiene & Public Health (AIIH&PH), Kolkata)*
http://www.cag.gov.in/reports/scientific/2000_book2/gangaactionplan.htm

Undertook core schemes i.e. interception & diversion schemes and Sewage Treatment Plants for 'point pollution' and non-core schemes such as low cost sanitation schemes etc

CARE International, UK *(from Salathiel R Nalli, CARE International, Banda Aceh, Indonesia)*
10-13 Rushworth Street, London, SE1 0RB, United Kingdom; Tel.: +44 (0)207 934 9334; Fax: +44 (0)207 934 9335
http://www.careinternational.org.uk/Water+and+sanitation+95.twl

Involved in the Tsunami Recovery Program of Aceh Province, Indonesia with water and sanitation as a priority, working on suitable sewage disposal and safe sanitation systems

From Chicu Lokgariwar, Gomukh Environmental Trust, Pune

Sulabh International Social Service Organization
Sulabh Gram, Mahavir Enclave, Palam Dabri Marg, New Delhi 110 045; Tel.: 91-11-25032617, 25031518, 25031519; Fax: 91-11-25034014, 91-11-25036122; sulabhacademy@vsnl.net

Operates since 1974, nearly 5000 Sulabh Sauchalaya complexes used by about 10 millions daily all over the country.

Shelter Association
Contact: Pratima Joshi, Director; Flat A/17, Sarasnagar Siddhivinayak Society, Opposite Nehru Stadium, Behind Anand Mangal Karyalaya, Shukrawar Peth, Pune 411 002; Tel: 91-020-2444 0363/24482045; info@shelter-associates.org
http://www.shelter-associates.org/

Initiated "Baandhinis" which are women - led local groups in project areas that would research, counsel, plan, build, administer and maintain community toilets

Salina Arts and Humanities Commission, USA *(from Mrinalinee Vanarase, IORA for Environmental Solutions, Pune)*
PO Box 2181, Salina, Kansas 67402-2181; Tel.: (785) 309-5770; Fax: (785) 826-7444; sahc@salina.org; http://www.riverfestival.com

The Smoky Hill River Festival is a project of the Commission, which honors many initiatives across the globe, aimed at restoring self-purification capacities of water bodies.

Related Past Consolidated Replies

Solid Waste Management in Urban Settings, from Nidhi Prabha Tewari, Sanket Information & Research Agency, New Delhi (Advice). Issued 16 August 2005

Highlights successes and failures of recycling and revenue generation potential of solid wastes through case studies

Low Cost and Ecologically Sound Sanitation Practices, from Dinesh Kumar, IWMI, Anand (Experiences). Issued 3 October 2005

Identifies low-cost, ecologically sound sanitation practices for urban and rural areas, and experiences in adopting these methods

Bio Technology Enzymes Process for Wastewater Treatment, from B Hariharasubramanian, TWAD Board, Chennai (Experiences). Issued 10 January 2006

Provides experience in adopting bio-technology enzymes process for waste water treatment

Treatment of Wastewater for Reuse, from K.A.S Mani, APFAMGS, Hyderabad, (Experiences). Issued 14 March 2006

Explores range of approaches in wastewater treatment covering small household level treatment devices, middle range technologies and large intensive solutions

Popularizing Treatment Technologies for Kitchen Wastes, from Gopal Sane, Samruddhi, New Delhi (Experiences). Issued 13 April 2006

Provides range of experiences and lessons learned by trying to promote adoption of ecologically friendly technologies and related innovations into communities

Low-cost Technology for Treating Sullage in Special Soils, from Vijaya Saradhi Atluri, Byrraju Foundation, Hyderabad (Advice). Issued 27 June 2006.

Provides technologies to treat sullage for rural communities & specifically for black cotton soil, highlighting context specifics when selecting an appropriate sullage treatment design

Waste Management at Tourism Sites, from R. K. Anil, Endogenous Tourism, UNDP, New Delhi (Experiences; Referrals). Issued 31 March 2007.

Shares design and implementation of waste management programmes in tourism sites, with application strategies based on the experience of several successful case studies.

Responses in Full

Digbijoy Bhowmik, UNDP assisted project 'National Strategy for Urban Poor', New Delhi

One of the issues that has generally stood out in appropriate technology selection for sewage disposal is the balance between space (footprint or land covered by the unit), carriage length, processing time and environmental overheads. Traditional systems such as activated sludge or up flow anaerobic sludge blanket (UASB) tend to cover considerable footprints, have considerably higher costs (about 30 lakh per Million Litres per day (MLD) in 2002, Punjab rates) and are usually viable for large volumes of sewage emanating from a relatively widespread carriage system. The older (but still one of the most effective) method of waste stabilisation pond covers an even greater area, and sewage takes much longer to process, but is relatively cheaper in terms of technology and requires lower maintenance.

However, land is at a premium in urban areas, and given the low Operation & Maintenance overheads on sewers that departments for Public Health Engineering, Water Supply and Sewerage Boards (WSSBs) or urban local bodies tend to have, a number of solutions have come up that

(a) can work on smaller catchments and collection and shorter conveyance systems,
(b) have a much lesser footprint,
(c) can process waste at a higher rate, and
(d) leave little or no environmental overheads.

Usually, anaerobic systems do not offer these advantages - but some of the newer aerobic technologies do:

I. Fluidised aerobic bio-reactor (FAB reactor): Processes waste in 7 to 10 hours, occupies a fifth of a UASB/ ASP reactor, and the output is non-septic and can be discharged for uses such as arboriculture. Can also work for sizes such as 5 MLD (two square kilometers of medium density township).

II. Submerged aerated filter (SAF): Usually a packaged unit, these can be used in case of large built complexes as well, for population catchments of 1500 persons or so.

III. Aerated rock filters: Used in conjunction with Waste Stabilisation Pond (maturation/ facultative ponds) or as an alternative to aerated maturation ponds as a land saving alternative.

Packaged solutions such as FAB/ SAF reactors do cost quite a bit, though. In 2004, the installed cost per MLD was rated at Rs. 55 lakh on an average, including three years of turnkey maintenance thrown in (this is very common to packaged solutions, and is usually regarded as an incentive by most WATSAN providers in O&M). However, the following examples may shed some light on what affects decisions on appropriate technology selection:

a. Tighra, east of Gwalior, Madhya Pradesh (2005) - also a counter magnet to the National Capital Region: A new township selected a two cell waste stabilisation pond (1 anaerobic + 1 aerobic) as land was available and effluent could be discharged in the nearby canal. (The Central Public Health & Environmental Engineering Organisation benchmarks that a two Cell WSP has the ability to reduce total coliform by 95%). The design population catchment was only 2 lakhs, while the city was planned for 8 lakhs. However, as this population would take time to grow, it was decided to opt for a solution that could handle small catchments, and not a very expensive one so that it could be replaced with a more heavy-duty solution in the future as the population grew.

b. Patiala, Punjab (2002): Punjab WSSB selected UASB as the preferred technology as the land made available to the PWSSB could support it in terms of footprint, and new aerated systems were still not proven. It was also originally proposed to attempt a bio-methanation unit, but the idea was subsequently dropped as the waste was not found to have adequate gas based calorific output.

c. Gurgaon, Haryana (2004): Opted for a FAB reactor at the end of trunk sewer no. 4, sector 15. The Haryana Urban Development Authority (HUDA) selected this on account of very limited space, and urgency of the situation (load balancing between the sewerage networks for disposal).

d. Maham, district Rohtak, Haryana (2006): Had originally opted for WSP. However, somewhere along the process, State elections were held and compensation against land acquisition was increased by about 4 times. The local Public Health Department eventually established that setting up a WSP on acquired land would be more expensive than setting up a few FAB reactors on smaller, but multiple pieces of land. The latter was opted.

e. Municipal Corporation of Delhi (2006 onwards): The still-under-construction Delhi Civic Centre on Jawaharlal Nehru Marg (opposite Ramlila grounds) shall use a SAF reactor to treat the sewage that emanates out of it. The selection of this system has prevented re-ordering of the sewer network around the place.

While the above examples may not provide best practices, they certainly give an insight as to what makes a particular WATSAN provider select a particular technology and how.

As regards the issue of generating energy, China had successfully experimented by generating bio-methane out of human waste coupled with pig-swill, that generates the required calorific value for the gas produced. However, bio-methanation purely from human waste has not been very successful in India, with one of the very few relics being a now-defunct unit at Kathgodam, district Almora, Uttarakhand. Appending other forms of animal waste (cattle/ buffalo etc.) has other logistical issues as most urban local bodies prefer to see dairies out of their areas of jurisdiction. In terms of generating energy from solid waste, some examples have been tried by Dewan Craft Systems (Delhi) and some other agencies, but the rate of success and viability as a commercial service remains low, the moisture content and calorific value of fuel being key issues.

As regards institutional framework, packaged solutions such as FAB/ SAF do hold scope for community owned and managed systems. However, there remain barriers to letting community organisations offload services using local Government revenue expenditure - particularly the limit of 'nominating' an organisation instead of calling for bids. Hopefully, the new Area Sabha system, being promoted under JnNURM as the Nagara Raj Bill would allow for such activities to be taken care of by communities using part of the revenue/ capital budget of the local Government reserved for the purpose.

Hope this helps.

Ajit Seshadri, The Vigyan Vijay Foundation, New Delhi

There are many components of Eco-sanitation. It ranges from open defecation in simple pits with minimal use of water – that is only for self cleaning - up to areas where the community enjoys the luxury of ample amount of water for flushing. Hence best practices would differ in each of these cases.

From our experiences, we cite an initiative at Vasant Vihar in Delhi, where the drain water is recycled for horticulture. This plant is in operation for more than 3 years with minimal efforts on O & M, and the water and sludge is available for re-use. Members would recollect reading about this in an earlier issue of the Community Update. Bio-remediation using natural methods can be resorted to in all the cases.

Where there is scope of reuse of recycled water for lower end-uses, it would be very appropriate as communities can then optimise the usage of water.

It is a very apt step to consolidate successful cases and put these down as sustainable practices. Let us all take time and respond well on these aspects, as rivers, ground water and the over-all environment is to gain from the valuable inputs from members. The mix of best practices that emerge from this discussion could well cleanup a lot of water bodies (such as rivers, canals, ponds, lakes, etc.) in both urban and rural areas.

Megha Phansalkar, Water Supply and Sanitation Department, Government of Maharashtra, Navi Mumbai

Kindly find some good practices on sanitation from Maharashtra on the following URL on the sector website of Maharashtra
http://www.mahawssd.gov.in/Resourcebank/best%20practices%20under%20%20sanitation522200725758pm.pdf (Size: 261 KB)

The Case Studies covered under this document are as follows :

1. Defecate in open and get exposed! (Village Waki Bu. Taluka Deulgaon Raja , District : Buldhana)
2. "Enjoy sanitation!" for children (Village Wadgaon Tejan, Taluka Lonar , District : Buldhana)
3. Safe Water Storage"Village – Malshevga, Taluka - Chalisgaon of Jalgaon District.
4. Open defecation free village campaign" Village: Kherade wangi, Tal: Kadegaon , District : Sangli
5. 'Bhishi' for latrine construction (Village Hingna Kavthal, Taluka Sangrampur , District : Buldhana).
6. Health Protection (Village - Malshevga , Taluka – Chalisgaon , District : Jalgaon.)
7. Clean Mondays (Village - Bhankhed, Taluka – Chikhli , District : Buldhana).
8. Recycling of wastewater: Sunita's household model (Village Wadgaon Tejan, Taluka Lonar , District : Buldhana.)
9. Forestation on wastewater (Village Savangi Tekale, Taluka DeulgaoRaja).
10. Local Co-operative helps latrine construction(Village Rethare Harnaksha, Taluka Walwa , District : Sangli)
11. Anjubai motivated 100 latrines (Village Kankatrewadi, Taluka Atpadi , District : Sangli)
12. Setting up a Rural Sanitary Mart (Village Rethare Harnaksh, Taluka Walwa , District : Sangli)
13. Sanitation Resource center for Tribals . Village Rajura, Taluka Jalgaon-jamod , District : Buldhana

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R. Srikanth, WaterAid, New Delhi

Conventional centralized sewage treatment plant throughout India is grossly under-designed, unsustainable and cannot handle more than 50% of the sewage load. Therefore, the bulk of the sewage flows into major rivers and water bodies contaminating the ground as well as surface water. The conventional sewage model is also energy intensive and has huge O & M components.

Sewage also contains a lot of plant nutrients like nitrates and is therefore best suited for agricultural reuse and for horticultural crops, if uncontaminated by industrial waste and can be used for floriculture. In case it is contaminated with trace metals and industrial effluent, phytoremediation and use of Lemna (Duckweed) can bring down Biological Oxygen Demand as well as nutrients; many are aware of these techniques including municipalities. A combination of Tilapia (Fish) feeding on organic matter and lemna can work miracles in cleansing sewage.

Technology is never a constraint, but the problem is its adoption and implementation, since urban growth has no limits. Municipal Corporations should make necessary legislations so that new colonies and housing complex have self sustaining low cost Sewage Treatment Plants before the housing plan gets approved. This will lead to newer innovation and adoption. Here public - private partnerships can help a great deal.

Arunabha Majumder, All India Institute of Hygiene & Public Health (AIIHPH), Kolkata

Solid Waste (Management &Handling) Rule 2000 relates to solid waste but not liquid waste.

Also, municipal sewage / sullage can be treated in Waste Stabilization Ponds, which is the most appropriate technology in India for sewage treatment and is also low cost. The energy requirement for this is minimum as only the raw sewage needs pumping. No energy is required for operating the Sewage Treatment Plant (STP) as the STP requires solar energy/ radiation and a symbiotic relation is maintained between algae and bacteria in the facultative pond.

The Waste Stabilisation Pond (WSP) is a combination of anaerobic, facultative and maturation ponds. The treated effluent quality conforms to standards as per Environmental Protection Act 1986. In West Bengal, a WSP has been installed under Ganga Action Plan as a sewage treatment system.

If land is available, construction cost of WSP is very less. O&M cost is also very less. Additionally, revenue can be earned from Pisciculture.

Prakasam Tata, Tata Associates International, Naperville, USA

I echo and agree with the answer of Majumder to your query. I designed and had a waste stabilization pond system (series of four ponds, i.e., a deep facultative pond, followed by a high rate algal pond, algae settling pond and a maturation pond) in two parallel trains installed in Vizianagaram, Andhra Pradesh by the District authorities about three years ago. I am pleased to inform that this system is working satisfactorily. The system withstood two heavy monsoon seasons and is still performing satisfactorily with absolutely no technical persons maintaining it.

Salathiel R Nalli, CARE International, Banda Aceh, Indonesia

'**CARE International**' is involved in Tsunami Recovery Program in the worst affected Aceh province in Indonesia. Water and Sanitation is one of their important priorities in this area, where virtually all the existing infrastructure has been destroyed.

In Aceh province, around 40% of the people who are living in their own houses have flush toilet systems. The septic tanks for these houses are primarily soak pits, with the septic water percolating directly into the ground water. Since the ground water levels are very high, the ground water is highly contaminated, which eventually flows into near by shallow wells. 60% of the households residing in their own houses depend entirely on protected dug wells for drinking water. This poses a great public health hazard, which increases the risk of young children being affected by diseases like diarrhea, typhoid and various skin diseases.

To overcome this problem, CARE is installing 'Sustainable Sanitation Systems' for all their newly constructed houses. These sanitation systems are based on three guiding principles:

1. No untreated household waste water may be released into public drains
2. All sanitation systems must have primary and secondary treatment as a minimum
3. Septic tanks must be water tight in service

More details can be found at the following link:

http://www.solutionexchange-un.net.in/environment/cr/res21050701.doc (Size: 28 KB)

Each household sanitation system will be designed independently depending on the availability of land, water table, topography, location of shallow wells and the preference of the house owner.

Chicu Lokgariwar, Gomukh Environmental Trust, Pune

As you have pointed out, efficient sewage management systems tend to be decentralized and community managed. Innovations and technologies are known, and often implemented, but very few of these seem to be sustainable in the long run. Strong institutional frameworks and community ownership may be the key to successful long-term implementation. I have tried to compile information about such (infrastructural and institutional) innovative approaches being implemented in urban areas in India. These have been compiled as per the life cycle of systems from impounding of water to sewage disposal. I am listing a few practices that may be useful to you. Please let me know if you need any details about these processes.

1. Sanitation facilities

1.1. Sulabh Sauchalaya complexes

After studying in detail the behavior and attitude of people for not using community toilets operated by local authorities, Sulabh International Social Service Organization came to the conclusion that if the toilets could be kept clean and if bathing, laundry and urinal facilities could also be provided along with toilets along with reliable availability of water and electricity for lighting, people would have no hesitation in using them and would even pay for the use. Based on these learnings, since 1974, Sulabh has been operating nearly 5000 complexes used by about 10 millions daily all over the country.

Ref: http://www.sulabhinternational.org/

1.2. Community constructed and managed toilets-the *Baandhani* initiative

A spatial mapping of Pune's slums using sophisticated GIS software illustrated the irregularities in toilets constructed by the Pune Municipal Corporation. The then Municipal commissioner and an NGO called Shelters, began by initiating "Baandhinis" [meaning 'the Bond'], which are women - led local groups in project areas that would research, counsel, plan, build, administer and maintain community toilets. The Shelter Association helped in formalising and finalizing their ideas technically. The groups supervised the construction quality, kept a vigil on materials, maintained accounts and rallied their neighbours into active participation. Each of the 60 or so user families per toilet pay Rs. 20 per month. Baandhini pays for the services of a care-taker, for maintenance and the electricity bills. The Baandhinis actively manage the toilets.

So far, Shelter Association has built 13 such toilet units in various Pune slums. In all, 200 new toilet blocks amounting to 3,000 seats have been built by the eight NGOs working under this project.

Ref: http://www.shelter-associates.org/

2. Sewage treatment

2.1. The East Kolkata Wetland Systems

The wetlands to the east of Kolkata (22 ^{0} 27' N 88 ^{0} 27' E) comprise a large number of water bodies spread over 12,500 hectares. Along with the wetlands, are 254 sewage-fed fisheries,

agricultural and solid waste farms and some built up area. The resource recovery system developed by local people over many years uses waste water from the city and is the largest and the only one of its kind in the world. It also helps in water treatment, and is home to waterfowl and a large biodiversity. The Kolkata Municipal Corporation generates roughly 600 million litres of sewage and wastewater everyday and more than 2,500 metric tons of garbage. The wastewater flows through underground sewers to pumping stations in the eastern fringe of the city, and is then pumped into open channels. The responsibility of the Kolkata Municipal Corporation ends when the wastewater reaches the outfall channels. Thereafter, sewage and wastewater is drawn into the fisheries of the East Kolkata Wetland by the owners of the fisheries. Here, after a few days, the organic compounds of the sewage and wastewater biodegrade.

A network of channels is used to supply untreated sewage and to drain out the spent water (effluent). The cumulative efficiency of reducing the BOD of the sewage wastewater is above 80% and for coliform bacteria 99.99% on an average.

Ref: http://www.keiponline.com/east_kolkata_wetland.htm

Jyotsna Bapat, Consultant, New Delhi

I wanted to share what my grand father-in-law living in Saswad [a town in Maharashtra] did as a best practice for sewage disposal.

This was a time when Saswad did not have a centralized sewage system. He built a Bio- gas plant and connected it to the two toilets he had constructed along a wall near the road. Any passer-by was openly invited to use these toilets. Additionally, the dung of animals belonging to tenants who stayed in the 'Wada' [courtyard] was also put into the biogas digester.

In return, to the dung and use of the toilet, all tenants got biogas for heating and cooking. This scheme also ensured effective disposal of sewage disposal. The plant worked for over 25 years. In this sense, my grand father-in-law was a pioneer.

In 1991, when sewage pipes were laid and toilets were connected to a central disposal facility, he disconnected the biogas plant.

Thought you might find this interesting.

Mrinalinee Vanarase, IORA for Environmental Solutions, Pune

I am quite late in replying to the query on effective sewage treatment. However, this is what I would like to share:

There are two approaches in treating wastewater

1. Point source treatment where recovery or reuse of water is expected and
2. Non point source treatment for open systems

1. Point source treatment would include methods like Sulabh Shauchalaya system and eco-sanitation (including rootzone/ constructed wetland). East Kolakata Wetland, mentioned by members, is a good example of biological treatment. However, there are serious concerns about sustaining the capacity of these water bodies in biodegrading waste matter, as sewage also carries hazardous effluents and the effects of these on biodiversity are not all known.

2. Non point source treatment for naturally flowing or non flowing water bodies needs more discussion in this regard.

2.1. Self cleansing capacity- Non point source treatment can start with revitalizing the self cleansing capacity of rivers and streams and it is well known that the purifying action of river-water polluted with sewage is very considerable. A few miles below the outfall or the point of pollution, a river may show little or no sign of pollution at all. To maintain this capacity, it is very important to maintain riparian corridors and hyporheic zones. Maintaining habitats and natural character of the stream like pools, riffles and falls is also very important.

There are many initiatives all over the globe to restore the self purification capacity of water bodies. Visit www.riverfestival.com that honors such initiatives across the globe.

2.2. Wetlands and lakes - In wetlands and lakes, emerging, floating and submerged plants are used for treatment as shown in the figure in the following link:

http://www.solutionexchange-un.net.in/environment/cr/res21050702.doc (Size: 61 KB)

There is a lot of literature available on ecological methods of treating wastewater. A lot depends upon the condition of the water body in reference. It is a complete system of biotic and abiotic elements working together. A check on point source pollution and data on referred water body are essential factors in planning restoration of self purification capacity. We have some data on aquatic plants to be used in management.

Mr. Uday Bhavalkar from Pune has developed one method of controlling point source pollution in biological way. He has developed a product called *BIOSANITIZER* , a naturally produced catalyst that continues to produce need-based amount of active oxygen and drives eco-logical reactions that clean polluted water (surface water, groundwater and wastewater). Ref: http://www.wastetohealth.com/

There is a lot of scope in research and work in mimicking natural ecosystems to establish low cost treatment systems. Public willpower and education would be a crucial requirement for this.

Many thanks to all who contributed to this query!

If you have further information to share on this topic, please send it to the Solution Exchange Water Community at se-wes@solutionexchange-un.net.in with the subject heading "Re: [se-watr] Best Practices in Effective Sewage Disposal - Experiences. Additional Reply."

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