

Decentralised wastewater treatment including reuse and recycle – role of constructed wetlands



At Center of India: Nagpur

Rajesh B. Biniwale, Ph.D., D.Sc.

**Principal Scientist,
Environmental Materials Division
National Environmental
Engineering Research Institute
Nagpur 440020 India**

rb_biniwale@neeri.res.in

Jaipur, February 7, 2013

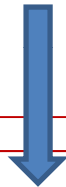
Institute

- CSIR Laboratory
 - HQ Nagpur, 5 Zonal Labs
 - 150 Scientist
 - 300 Project Fellows
 - 300 other technical & supporting staff
 - Annual Budget of Rs. 240 Millions
 - ECF 50 %
- R&D Thrust Areas
 - Environmental Monitoring
 - Environmental Modeling
 - Environmental Materials
 - Environmental Biotechnology & Genomics
 - Environmental System Design and Optimization
 - Environmental Impact & Risk Assessment
 - Environmental Policy
 - Advisory
 - Industries
 - Central Govt. Ministries/Boards
 - State Govt. Ministries/Boards
 - Judiciary

Urban Waste Water Management

Sources

- Municipal/domestic waste water
- Storm water discharges
- Hotel and Offices
- Agricultural runoff
- Landfill leachates
- Industrial wastewater



Impact

- Ground water pollution
- Eutrophication of lakes and other water bodies
- Degradation of river water quality
- Impact on public health



Treatment

- Reuse/recycle
- Avoiding contaminations in water bodies
- Decentralized approach for reducing pressure on civic bodies

Impact on public health

- Odor problems
- Mosquito nuisance and breeding of insects
- E-coli and other pathogenic micro-organisms can contaminate drinking water sources
- Spreading of communicable diseases like cholera, dengue, malaria, etc
- Impact on bathing quality of rivers, beaches etc.

The Mantra:

गंगां पुण्यजलां प्राप्य त्रयोदश विवर्जयेत् । शौचमाचमनं सेकं निर्माल्यं मलघर्षणम् ।
गात्रसंवाहनं क्रीडां प्रतिश्रद्धमथोरतिम् । अन्यतीर्थरतिंचैवः अन्यतीर्थ प्रशंसनम् ।
वस्त्रत्यागमथाघातं सन्तारंच विशेषतः ॥

ब्रह्मानन्दपुराण (८०० ई०)

Thirteen actions are prohibited on approaching the scared waters of the Ganga, namely:

- | | |
|--|---|
| ❖ Defecation | ❖ मलत्याग |
| ❖ Ablutions | ❖ धार्मिक/ पूजन सामग्री धोना |
| ❖ Discharge of wastewater | ❖ अपजल (गन्दा पानी) का विसर्जन |
| ❖ Throwing of used floral offerings | ❖ चढ़ावे के फूल इत्यादि फेंकना |
| ❖ Rubbing of filth | ❖ मैल धोना |
| ❖ Body shampooing | ❖ स्नान में रसायनिक (साबुन इत्यादि) का प्रयोग |
| ❖ Frolicking | ❖ जल क्रीड़ा करना |
| ❖ Acceptance of donations | ❖ दान की मांग करना |
| ❖ Obscenity | ❖ अश्लीलता |
| ❖ Offering of inappropriate praises or even hymns in a incorrect way | ❖ गलत मंत्रों का उच्चारण |
| ❖ Discarding of garments | ❖ वस्त्रों को फेंकना |
| ❖ Beating and | ❖ वस्त्रों को धोना |
| ❖ Swimming across, in particular | ❖ तैर कर पार करना |

Why Decentralized?

- Improve reachability, reduce the need for sewage transportation system
- Allowing use of the treated water in-situ
- Smaller systems technically empowering the smaller LUBs
- Treatment where it is needed

Sewage unexplored resource

- Irony of the situation more than 80% of water converted to sewage
- Out of this sewage more than 90-95 is still water
- No water available in revers and nallahs are perennial

NeWater v/s Drinking water in Indian Cities

- NeWater is result of unit operations and process
- Our drinking water is treated sewage (diluted through natural water bodies, rivers?)

Innovations in Technological Solutions

Command and control approach



Ecosystem- based approach

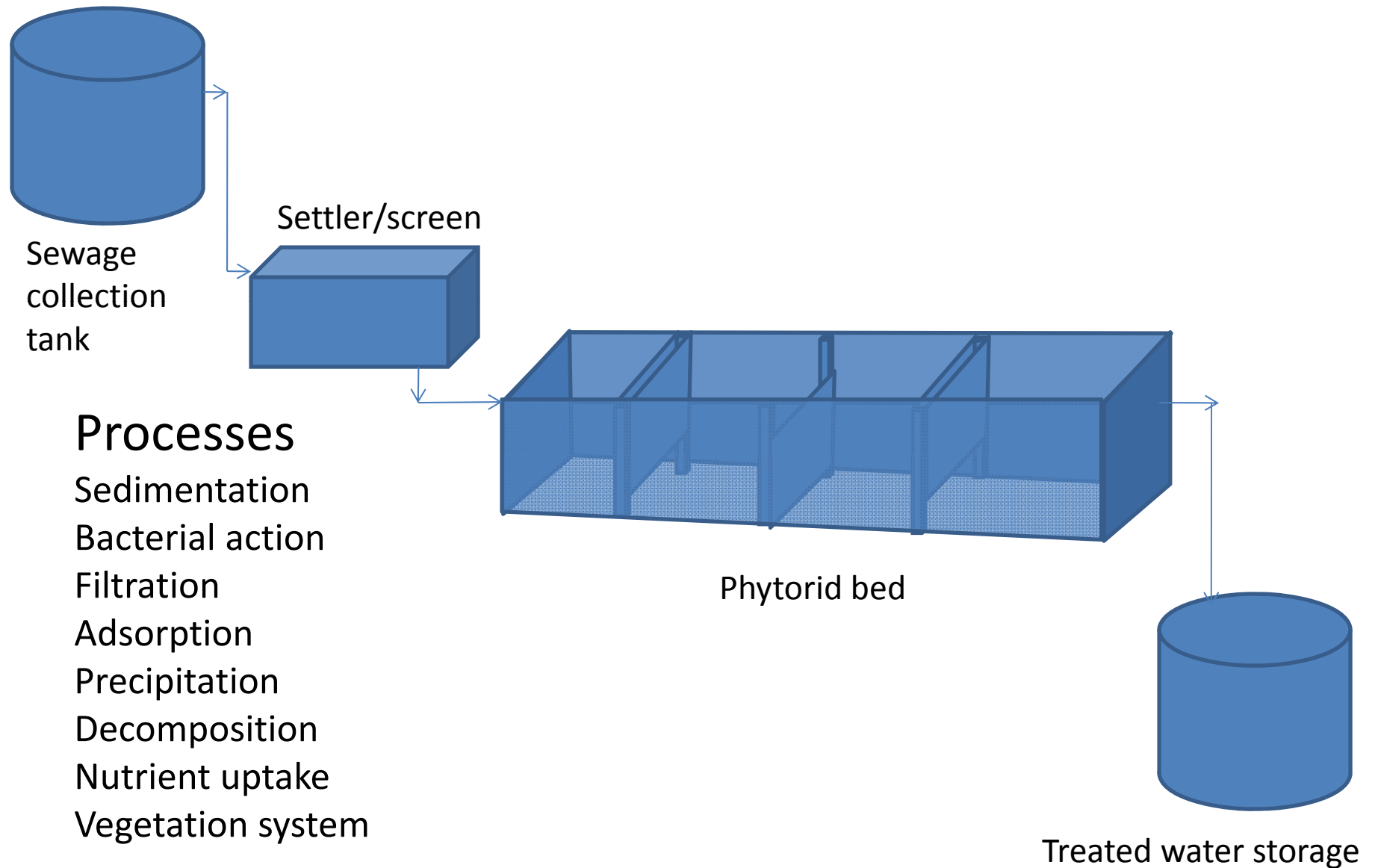


NEERI's PHYTORID

A Constructed Wetland System

- Based on 5 years of intense R&D in lab, pilot
- Now more than 7 years of field experience of plants
- Innovation based on:
 - Our climate
 - Our needs
 - Our cost issues
 - O&M practices
- Given International Patents:
 - Australian Patent
 - European Patent
 - Indian Patent

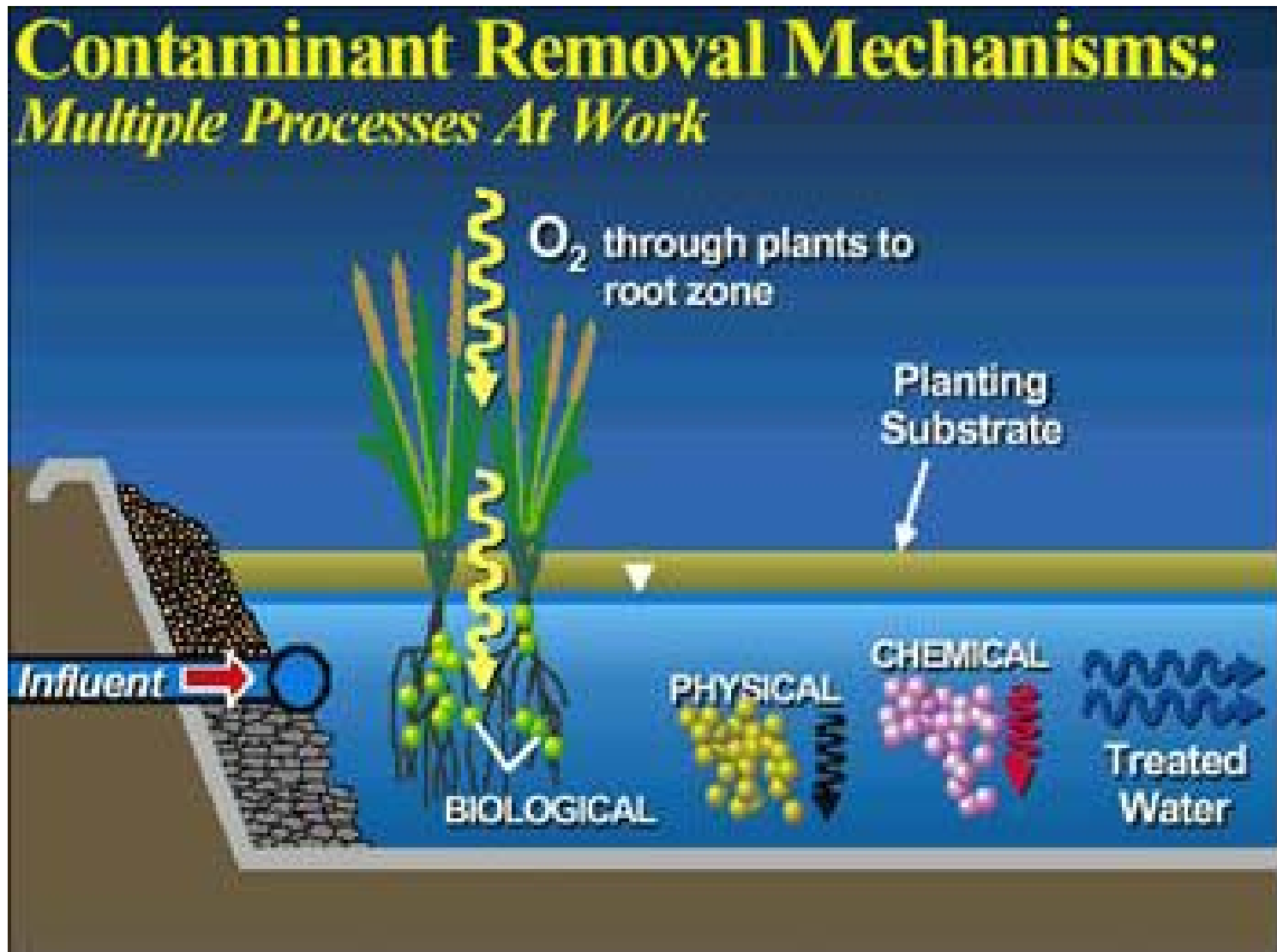
Components of PHYTORID system



WETLAND COMPRISES.....

- ❖ **Primary Settling Cell (PSC)** for the purpose of anaerobic pretreatment of suspended solids.
- ❖ **Secondary Advanced Filter Cell (SAFC)**, that supports a permutation of different sizes of stones and gravel wherein anaerobic digestion occurs.
- ❖ **Tertiary Biological Wetland Cell (TBWC)** made up of different layers of life supporting media such as those used in SAFC and planted with aquatic flora such as Typha, Scirpus, Cyperus, Peltandra and Phragmites.

Phytoremediation Details



Design Approach

- Operating windows for sewage, parameters
- Source based selection of unit operations
- Space availability and levels
- Proximity of end use of treated water
- Quality of water required
- Soil strata
- Design of plant, conceptual, structural and aesthetics

TYPICAL DESIGN FEATURES FOR WETLAND SYSTEM

Design Factor	Surface Water Flow	Sub Surface Water Flow	Phytorid Sewage
Minimum Surface Area	105-523 ac/mld	10.5 –210 ac /mld	3-4 ac/mld
Maximum Water Depth	Relatively shallow	Water level below ground surface	Water below gravel system
Bed depth	Not applicable	>1 m	>2.5 m
Minimum hydraulic residence time	7 days	7 days	1-2 days
Minimum pretreatment	Primary (secondary optional)	Primary	Primary

Typical Performance Characteristics for Various Treatment Methods

Sr.	Items	Conventional activated sludge	UASB	Extended Aeration	Facultative Aerated Lagoons	PhytoRid Technology
1	Performance BOD Removal %	85-92	75-78	95-98	75-85	80-95
2.	Sludge	First digest then dry on beds or use mech devices	Directly dry on beds or use mech devices	No digestion dry on sand beds or use mech devices	Mech. Desludging once in 5-10 years	Negligible
3.	Equipment Requirement (excluding screening and grit removal common to all processes)	Aerators, recycle pumps, scrappers, thickeners, digesters, dryers gas equipment	Nil except gas collection and flaring gas conversion to elect is optional	Aerations, recycle pumps sludge, scrappers for large settlers	Aerators only	None, all flows by gravity
4.	Operational Characteristics	Skilled operation reqd.	Simpler than ASP	Simpler than ASP	Simple	Unskilled operator
5.	Special features	Considerable equipment and skilled operation reqd specially when gas collection and usage considered	Minimal to negligible power reqd. makes it economical at even if gas revenue is neglected	BOD removal highest effluent nitrified high power reqd. Favoured for small and medium plants	Power reqd. similar to ASP operation simpler	Plant species and odour less operations

Various Plant Types



Forage Kochia *Kochia spp*

Poplar Trees *Populus spp*

Willow Trees *Salix spp*

Alfalfa *Medicago sativa*

Cattail *Typha latifolia*

Coontail *Ceratophyllum demersum L*

Bullrush *Scirpus spp*

Reed *Phragmites spp.*

American pondweed *Potamogeton nodosus*

Common Arrowhead *Sagittaria latifolia*



Scirpus



ADVANTAGES

- Cost-effective
- Operation and maintenance expenses are negligible.
- Minimum electricity requirement
- Smaller footprint (Retention time: Typically less than 24 hrs.)
- Facilitates recycle and reuse of water
- No foul odor and No Mosquito Nuisance.
- Tolerates fluctuations in operating conditions such as flow, temperature and pH

APPLICATION

PHYTORID system is useful for treatment of waste water in following applications

- **Domestic wastewater (including decentralized Municipal waste water treatment)**
 - **Colonies, Airports, Commercial complexes, Hotels**
 - **Open drainage**
 - **Cleaning of nallah water**
- **Agricultural wastewater**
- **Dairy waste**
- **Slaughter House Waste**
- **Fish pond discharges**
- **Pre treated industrial wastewater**
- **Municipal Landfill leachates**
- **Several other applications**

Performance of PHYTORID for urban waste

Pollutant	Performance (% removal)
Total suspended solids	85 – 95
Biochemical oxygen demand	80 – 90
Chemical oxygen demand	80 – 95
Total nitrogen	60 – 80
Phosphate	60 – 80
Fecal coliform	>99

Treated water quality will meet the specified norms of CPCB/MPCB for water reuse

PRODUCT WATER QUALITY

- Treated water complies to the regulations laid down by MPCB/CPCB(Table IV fresh water category) to reuse the water for the purpose of discharge, gardening agriculture etc.



GREEN POINTS

- Best Adoptable technology for in-situ treatment and reuse of waste water
- Phytorid Technology carryout on-site treatment and reuse of grey water up to 95%, which would attract total of 5 credits on Indian Green Building Certification (IGBC).

AESTHETICS





**Inaugurated by
Shri Suresh Shetty**

**(Honbl'e State Minister)
Medical Education Higher & Technical Education**

**On
World Environment Day
5th June, 2006
at
Kalina Campus
Mumbai University**



Deatials of PHYTORID facilities case studies

NEERI

Case Studies (Contd..)

MUMBAI UNIVERSITY CAMPUS **(KALINA-MUMBAI)**

- ✿ Design for treatment of mixed (sewage – laboratory) wastewater generated from various department
- ✿ Design to treat the flow of 50 CMD
- ✿ Operation starts from June 2006
- ✿ Treatment system has primary chamber, secondary advance system and Phytoid system
- ✿ Treated water is reuse for gardens and in lake within the campus



KOLIMB AGRICULTURAL COLLEGE **(TITWALA-THANE DIST.)**

- ✚ Design for treat the grey wastewater generated
- ✚ Design to treat the flow of 5 CMD
- ✚ Operation starts from June 2009
- ✚ Treatment system has septic chamber and Phytoid system
- ✚ Treated water is reuse for gardens, vermin-compost plant



Case Studies (Contd..)

MATHERAN HILL STATION (ANAND RIDTGS- ALIBAUG DIST.)

- Design to treat the flow of 20 CMD
- Design for treat the sewage generated from the hotel
- Operation starts from Oct 2010
- Treatment system has septic chamber and Phytorid system
- Treated water is reuse for gardens and lawns



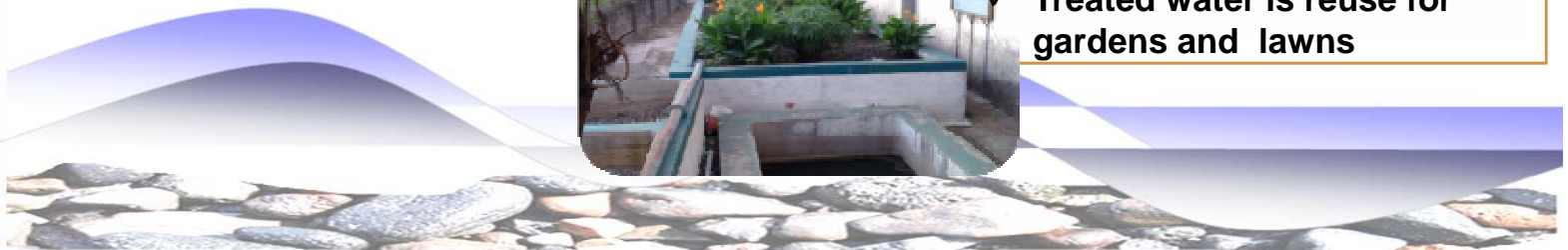
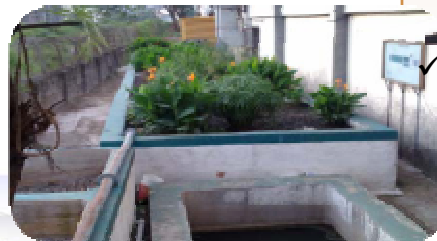
SIEMENS FACTORY (KALWA, THANA)

- ✓ Design for treat the sewage generated from the factory
- ✓ Design to treat the flow of 500 CMD
- ✓ Operation starts from Aug 2007
- ✓ Design of the treatment plant was done to protect existing green cover/ plants
- ✓ Treated water is reuse for gardens and lawn



PREMIER AUTO LTD (PIMPRI CHINCWAD)

- ✓ Design for treat the sewage generated within the factory
- ✓ Design to treat the flow of 150 CMD
- ✓ Operation starts from Jan 2007
- ✓ Treatment system has primary treatment system and Phytorid system
- ✓ Treated water is reuse for gardens and lawns



Case Studies (Contd..)

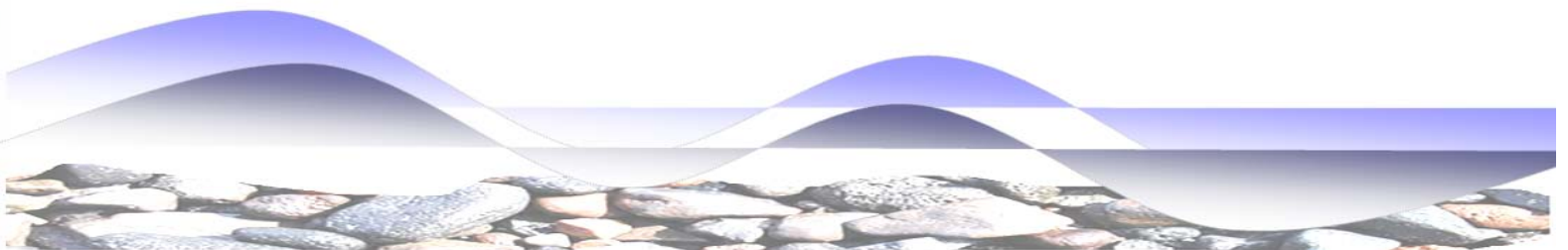
MAHINDRA & MAHINDRA LTD. **(IGATPURI, DIST. NASHIK)**

- ◆ Design for treat the sewage generated from the factory premises
- ◆ Design to treat the flow of 60 CMD (2 STP's)
- ◆ Operation starts from July 2007
- ◆ Treatment system has Primary Treatment System and Phytorid system
- ◆ Treated water is reuse for gardens within the premises



BHARAT FORGE LIMITED (BARAMATI)

- ◆ Design for treat the sewage generated within the premises
- ◆ Design to treat the flow of 100 CMD
- ◆ Operation starts from July 2009
- ◆ Treatment system has septic chamber and Phytorid system
- ◆ Treated water is reuse for gardens and lawns



**Warana Industries Ltd
(Warananagar, Dist: Kolhapur)**

- ✚ Design for treat the sewage generated within the premises
- ✚ Design to treat the flow of 10 CMD
- ✚ Operation starts from Oct 2008
- ✚ Treatment system has primary treatment system and Phytorid system
- ✚ Treated water is reuse for gardens and floor washing



Case Studies (Contd..)

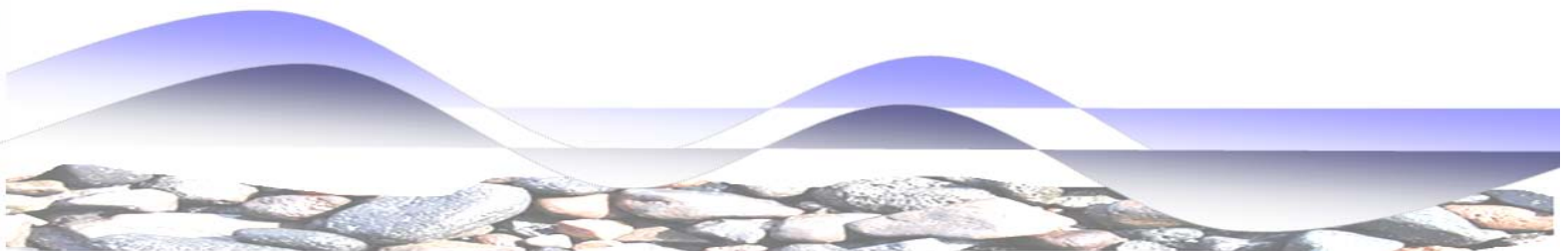
**AJAY METACHEM PVT. LTD.
(WADKI, PUNE)**

- Design for treat the sewage generated from the hotel
- Design to treat the flow of 2 CMD
- Operation starts from Jan 2008
- Treatment system has primary and tertiary treatment with Phytorid system
- Treated water is reuse for gardens



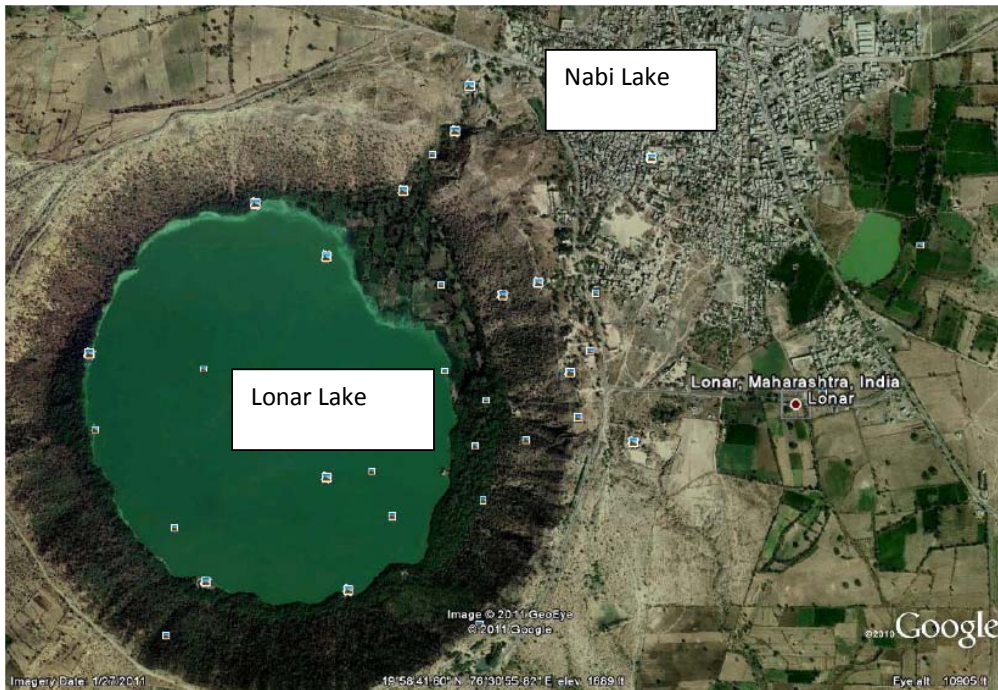
Projects Under Implementation

- ✓ Raj Bhawan, Mumbai
- ✓ Ammunition Factory, Khadki, Pune
- ✓ Greater Noida, Noida
- ✓ Raipur Development Authority, Raipur
- ✓ Bhillai Corporation, Bhillai
- ✓ Maharajbagh Garden, PDKV, Nagpur
- ✓ Slaughter House, Kamptee
- ✓ Phalton Municipal Council, Phalton
- ✓ Teen Murti Bhavan, New Delhi



Telibandha Lake, Raipur

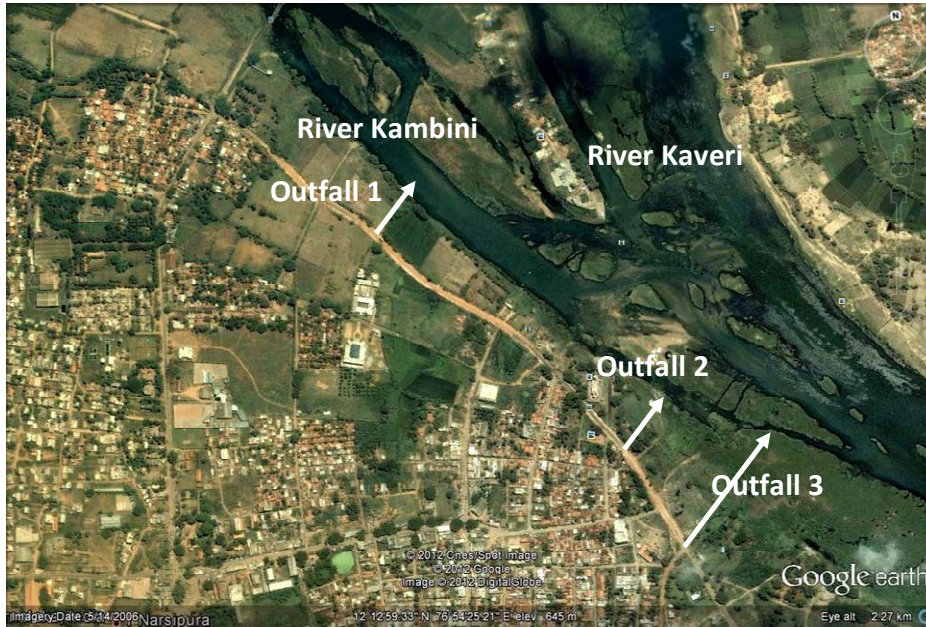




Under Consideration

Lonar Lake, Maharashtra





Under Consideration

T. Nasripura, Mysure



Phytorid for nallah water treatment



Raw sewage
in nallah

Plant at Agricultural
college, PKV Nagpur
Plant Capacity 100
m³/day



Phytorid System

Treated water



Proposed Site for Phytorid



View of Nag Nadi-Naala from
University library road

View of Nag Nadi-
Naala
towards Panchsheel



Nag Nadi- Naala

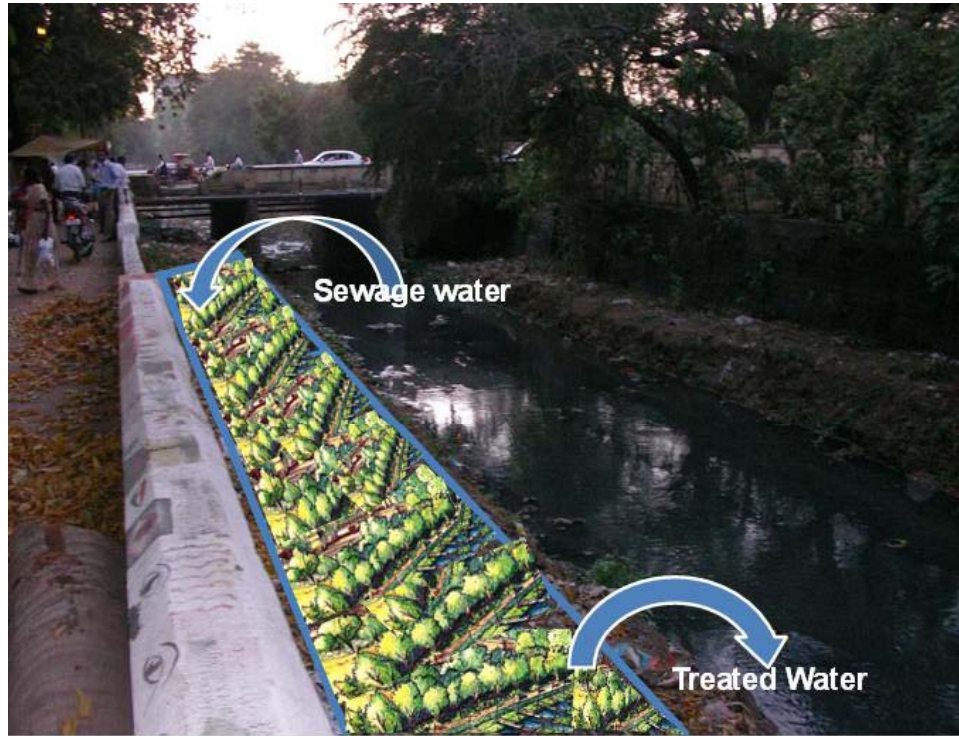
Width: 6.4 meters

Depth: 11 inches (0.2794 meters)

Length: 500 meters (between university road and panchsheel)

Estimate flow : 4 MLD

Proposed design of Phytorid



Estimated land area required: 2563 m²

For a plant capacity of 1000 m³/day

Entire length of the plant: 267m

For a plant capacity of 1000 m³/day

Length of the Phytorid bed: 184 m

Dimension: 1.5m depth X 184m length X 8m width

Project completion period: 12 months

Conclusions

- Constructed wetland is the needed innovative technology
- Better planning for better water availability
- Cost effective in terms of O&M is most important factor

Thank You