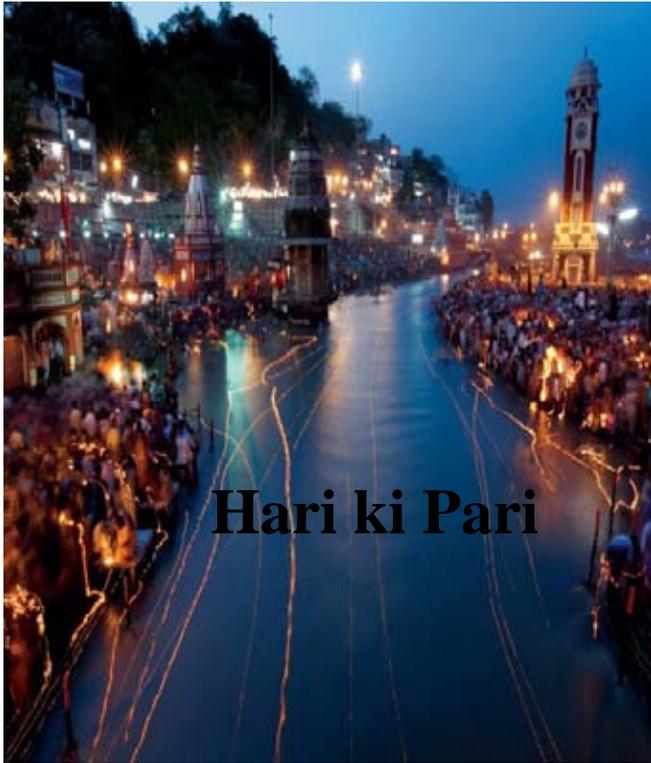


Recycle and Reuse of Wastewater

Acceptable Risk Considerations

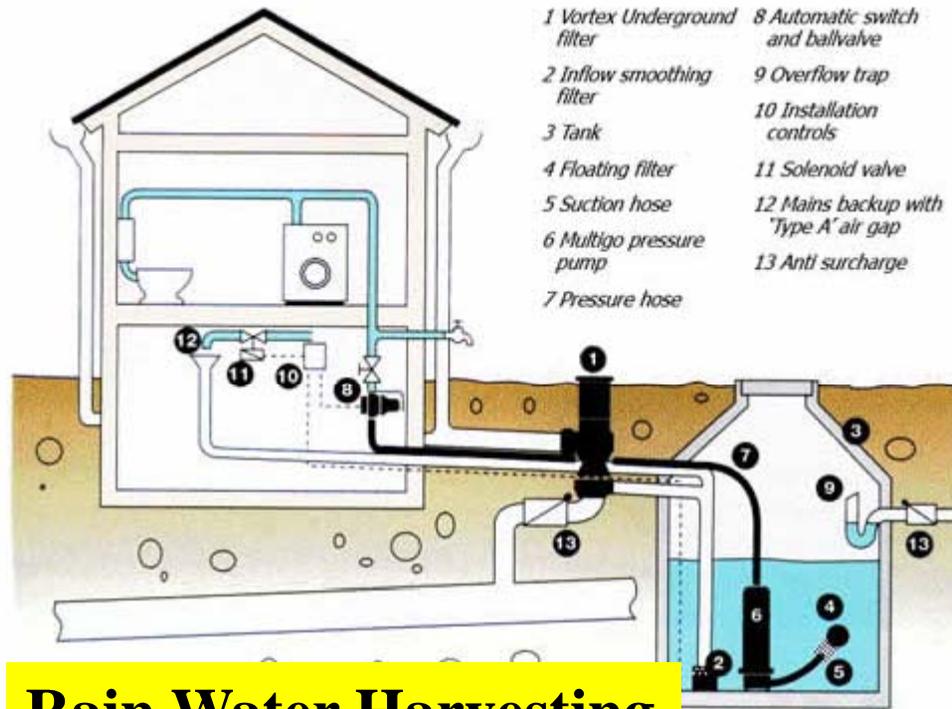


Dr. R. K. Manohar
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Hari ki Pari





Rain Water Harvesting



Drip (trickle) irrigation waters crops efficiently.
Credit: Nova Scotia Agriculture and Fisheries

Gadisar Lake: Tanka 1400AD



©mkgoyal



Acceptable Risk Considerations



Is this risk
acceptable or
unacceptable?

The risks associated with recycled water must be minimized to acceptable levels before recycled water can be used in any specific situation (i.e. the water must be fit for purpose).

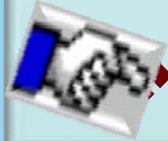
**However, ongoing
monitoring is required to
ensure good risk
management**

Waste Water Asset or Liability?



Recycled Water *Asset or Liability?*

Flow of Presentation



- ◆ **Definitions**
- ◆ **Background**
- ◆ **Need of Reuse and Recycle of water**
- ◆ **Advantages and Disadvantages of Reuse and Recycle of water**
- ◆ **Techniques of Reuse and Recycle of water**
- ◆ **Health Concerns with Reuse of water**

Definitions

Wastewater means any water that is no longer wanted, as no further benefits can be derived out of it.

Reuse of Wastewater: Reutilization of waste water

Reclamation of water: Processes involve to treat wastewater to make it reusable.

Recycling of water: Reuse of wastewater in the same cycle where it is generated

Flow of Presentation

❖ **Definitions**



Background

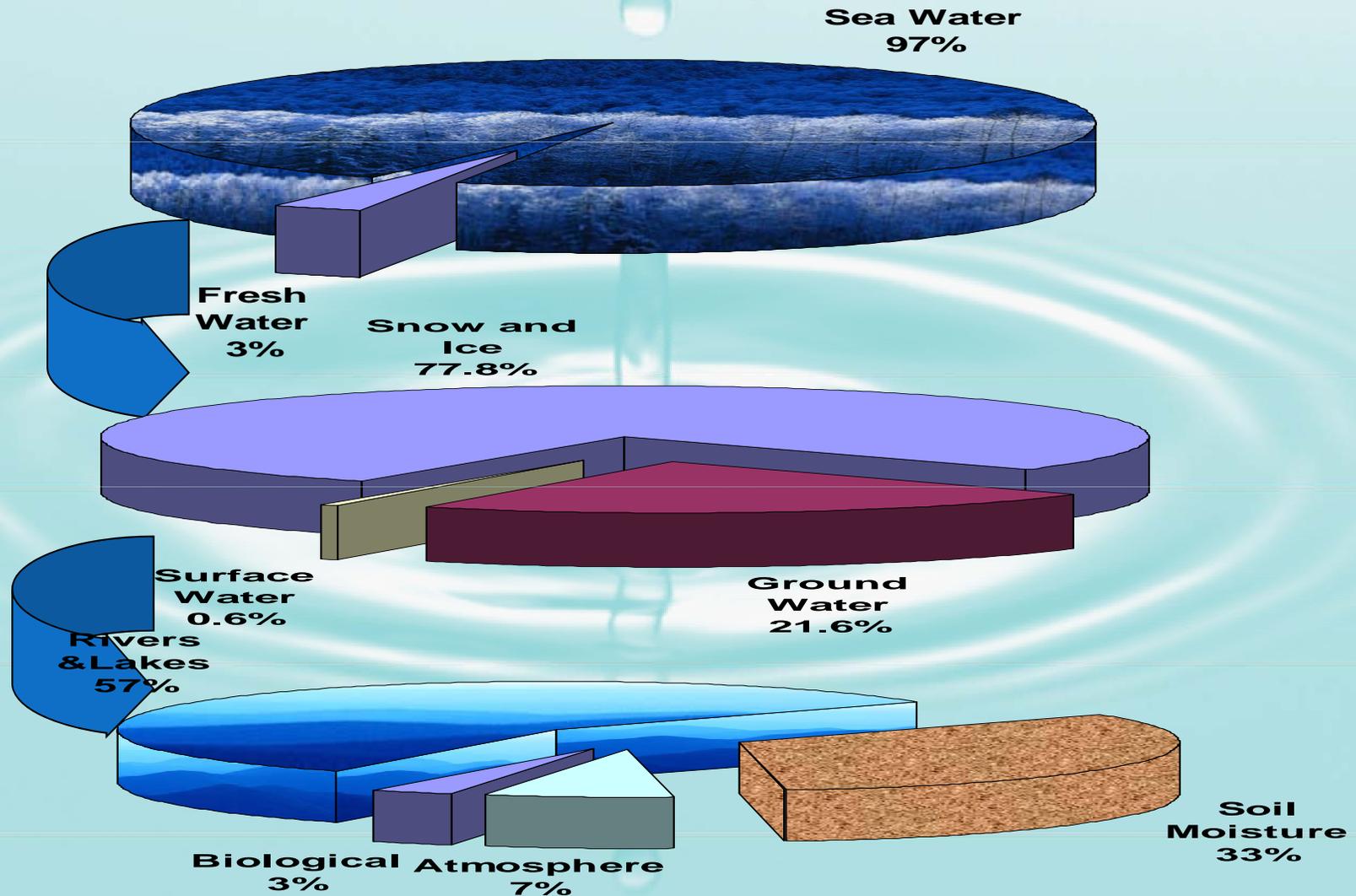
❖ **Need of Reuse and Recycling of water**

❖ **Advantages and Disadvantages of Reuse and Recycling of water**

❖ **Techniques of Reuse and Recycle of water**

❖ **Health Concerns with Reuse of water**

Background: Global Water Budget



Background: India Wastewater and Treatment

- ❖ Fresh water is available only in a small fraction (about 3%) of total water.
- ❖ Although India is wettest country in the world but rainfall is highly uneven with time and space
 - ❖ extremely low in Rajasthan and high in North-East
 - ❖ On an average there are only 40 rainy days
- ❖ Wide gap between demand and supply of water
- ❖ To sustain our growing demand water should be abstract from every possible sources
- ❖ Major amount (70-90%) of wastewater is generated, out of that a very little amount (0-30%) is reused.

Flow of Presentation

❖ Definitions

❖ Background



❖ Need of Reuse and Recycling of water

❖ Advantages and Disadvantages of Reuse and Recycling of water

❖ Techniques of Reuse and Recycle of water

❖ Health Concerns with Reuse of water

Need: Reuse and Recycle of Wastewater

3% of total water
is
Potable Water



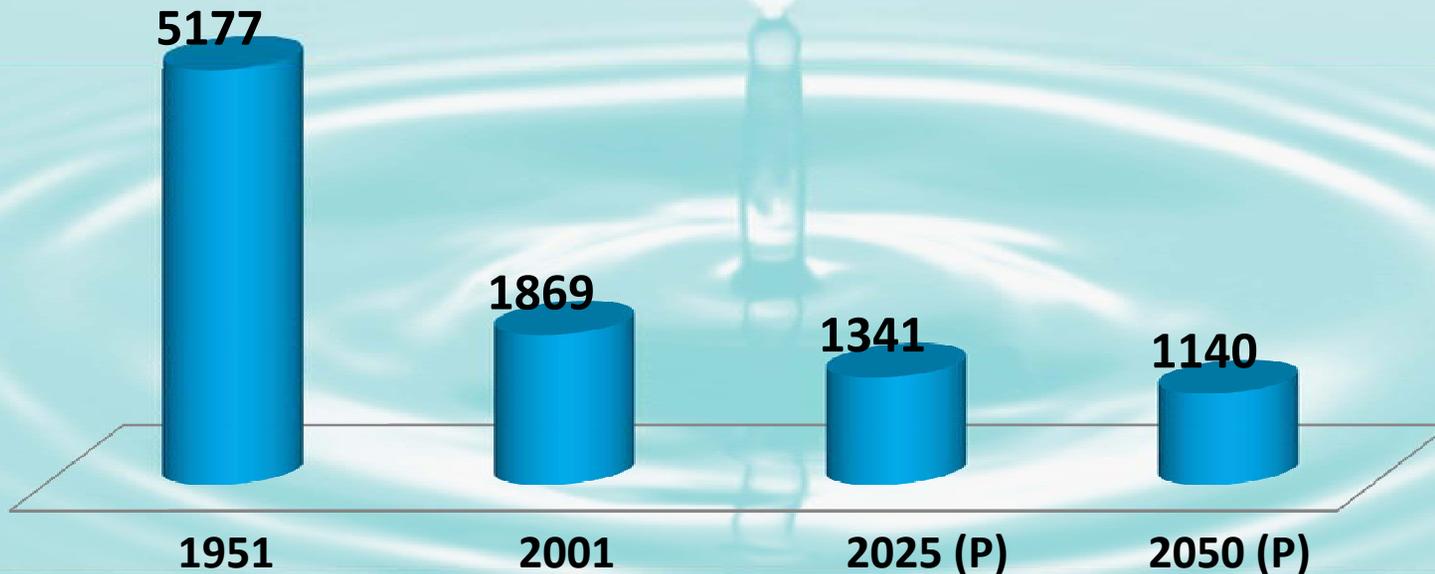
70-90%
Waste water
generated

Around 90% of wastewater produced globally remains untreated, causing widespread water pollution.

Water is Precious and scarce Resource

Indian Scenario: Water

■ Availability of Water (cubic meter per annum)



Water is Precious and scarce Resource

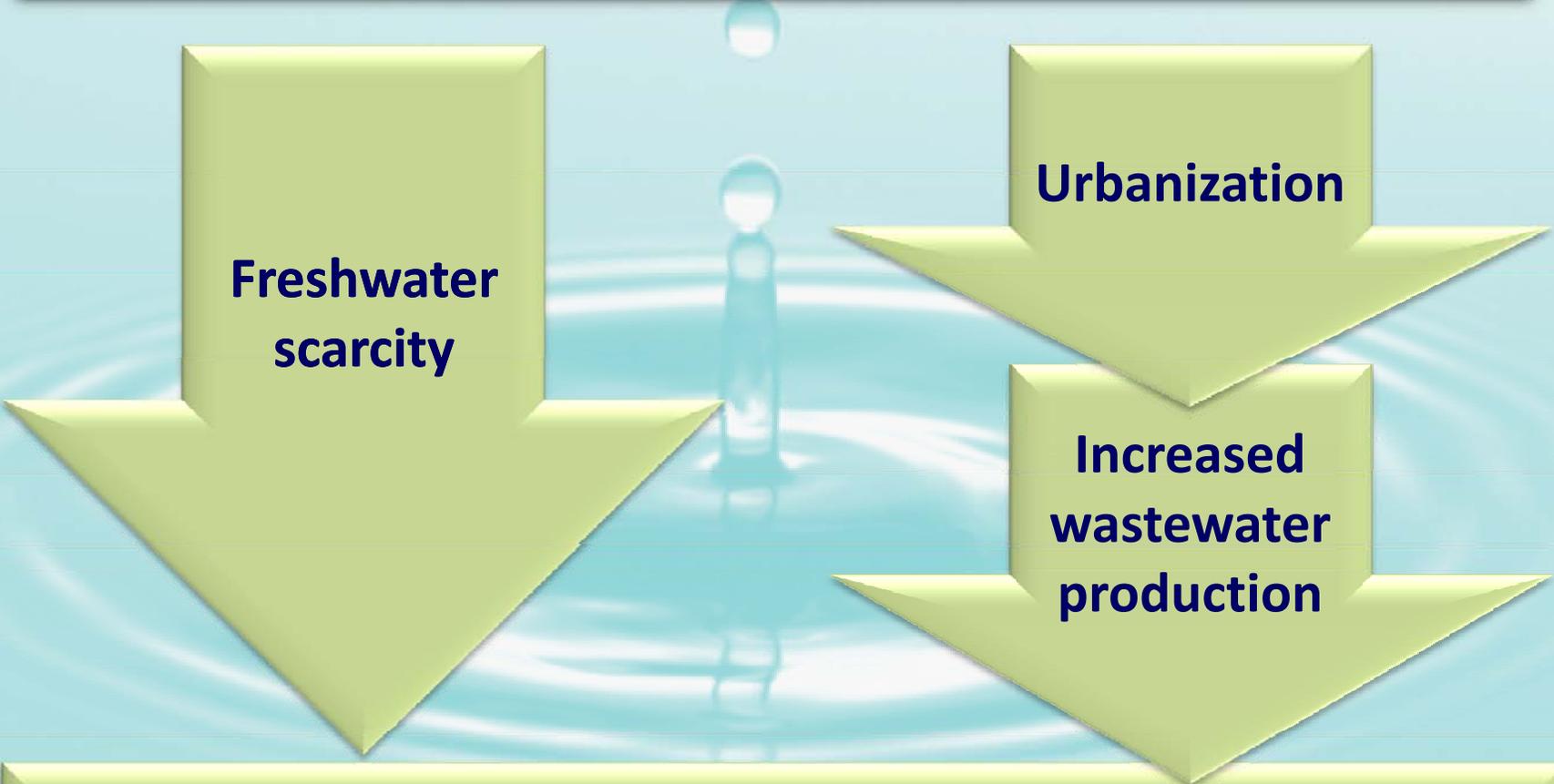
Indian Scenario: The Challenges

- ❖ Rapid increase in demand for water
- ❖ More Water Scarcity in basins
- ❖ Projected situation are alarming
 - ❖ More urbanization (40% + ...?)
 - ❖ Growing population (*1.6 billion..+*)
- ❖ MDG 2015
 - ❖ Food security
 - ❖ **Water Security**
 - ❖ Health Security

Water is Precious and scarce Resource

Need: Reuse and Recycle of Wastewater

**Freshwater
scarcity**



Urbanization

**Increased
wastewater
production**

Increase reliance on wastewater reuse

Flow of Presentation

❖ **Definitions**

❖ **Background**

❖ **Need of Reuse and Recycling of water**

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❖ **Techniques of Reuse and Recycle of water**

❖ **Health Concerns with Reuse of water**

Advantages of Wastewater Reuse and Recycle

- ❖ **Nutrient-rich wastewaters can increase agricultural production**
- ❖ **Reduces the demands on potable sources of freshwater.**
- ❖ **Technology may diminish the volume of wastewater discharged**
- ❖ **Reduce the need for large wastewater treatment systems.**
- ❖ **Pollution of rivers and ground waters may be reduced.**
- ❖ **Tourism can be promoted through better maintenance of resort areas.**

Disadvantages of Wastewater Reuse and Recycle

- ❖ **Revenues to water supply and wastewater utilities**
- ❖ **Reuse of wastewater may be seasonal in nature**
- ❖ **Health problems may occur**
 - ❖ **Direct contact with reused wastewater.**
 - ❖ **During the treatment process**
- ❖ **May result in groundwater contamination.**

Flow of Presentation

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Uses for Waste Water

- **Agricultural Irrigation**
 - Crop irrigation
 - Commercial nurseries
- **Landscape Irrigation**
 - Parks
 - School yards
 - Highway medians
 - Golf courses
 - Cemeteries
 - Residential
- **Industrial Recycling and Reuse**
 - Cooling water
 - Boiler feed
 - Process water
 - Heavy construction
- **Groundwater Recharge**
 - Groundwater replenishment
 - Saltwater intrusion control
 - Subsidence control
- **Recreational / Environmental Uses**
 - Lakes & ponds
 - Marsh enhancement
 - Stream-flow augmentation
 - Fisheries
- **Non-Potable Urban Uses**
 - Fire protection
 - Air conditioning
 - Toilet flushing
- **Potable Reuse**
 - Blending in water supply reservoirs
 - Pipe-to-pipe water supply

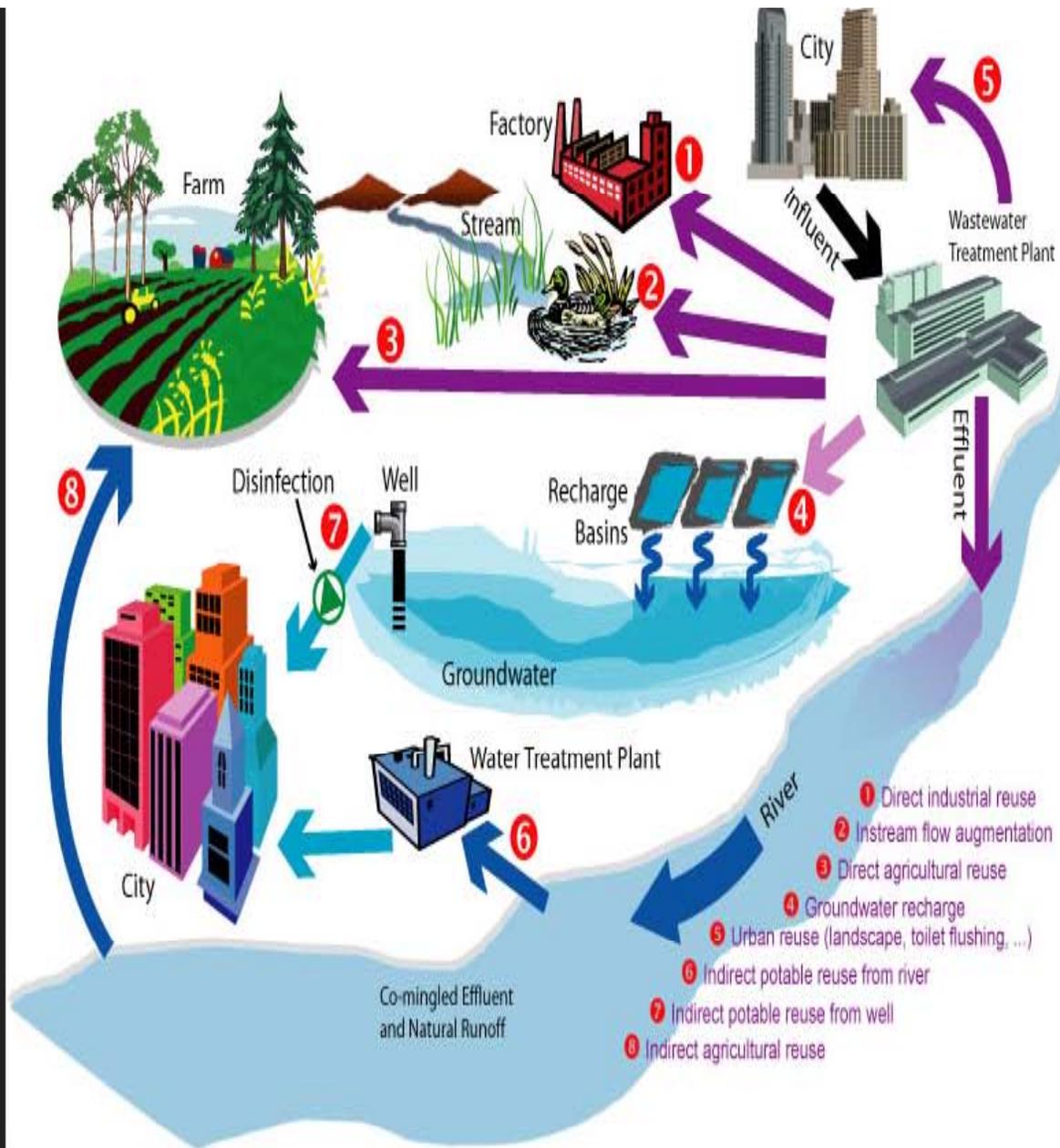
Uses for Waste Water

Direct Use

- Reuse of wastewater directly
- Where health concern is not much cared
- E.g. Industrial use for cleaning, toilet flushing etc.

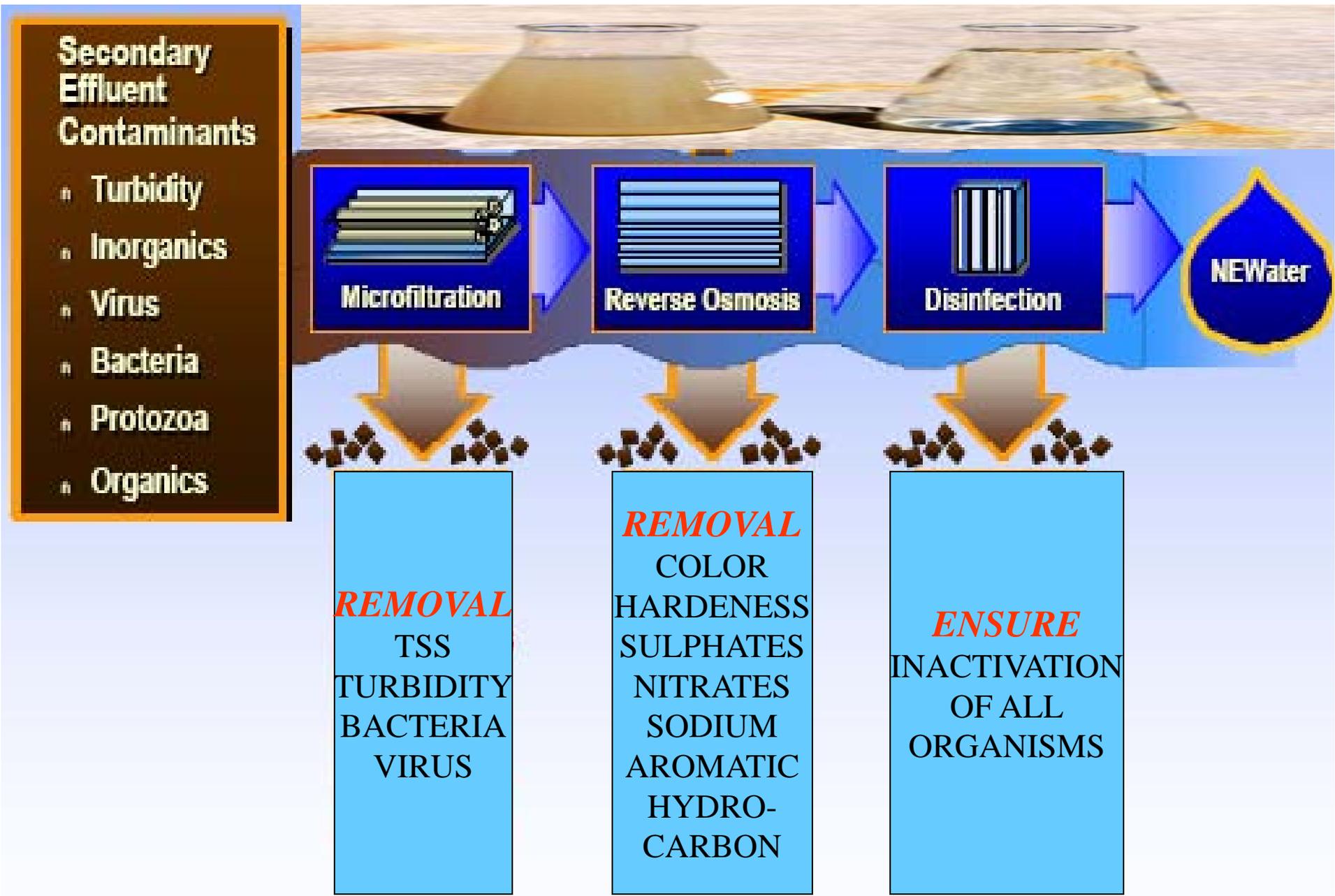
Indirect Use

- Reuse of wastewater after treatment
- Where health concern is there
- E.g. Agriculture use for, drinking etc.



1. Industrial
2. Lakes, Fisheries etc.
3. Agriculture
4. Ground Water Recharge : Pond
5. City : Drinking after Treatment
6. City : Drinking after Treatment
7. City : Drinking after Treatment
8. City : Drinking after Treatment

Uses for Waste Water



Multiple barrier approach for microbial and chemical contaminant removal from secondary effluent

Water Treatment: How Effective?

After secondary Water treatment with

Constituent	Disinfection	Filtration and Disinfection	Microfiltration, RO and disinfection
TSS	5-20	1-4	≤ 1
BOD	5-20	1-5	0-2
TN	2-12	2-12	≤ 1
NO ₃	1-10	1-10	≤ 1
Phosphorus	0.1-0.5	0.1-0.5	≤ 0.5
Turbidity	2-6	≤ 2	0.1 -1
Bacteria	2.2-240	≤ 2.2	≈ 0
Protozoan	5-10	≤ 1	≈ 0
Viruses	100-10000	$\leq .0001$	≈ 0

Uses for Waste Water: Irrigation



5/15/2013

Dr. R. K



Rice farming with treated wastewater

Uses for Waste Water : Irrigation

Winter wheat irrigation in the Negev Desert



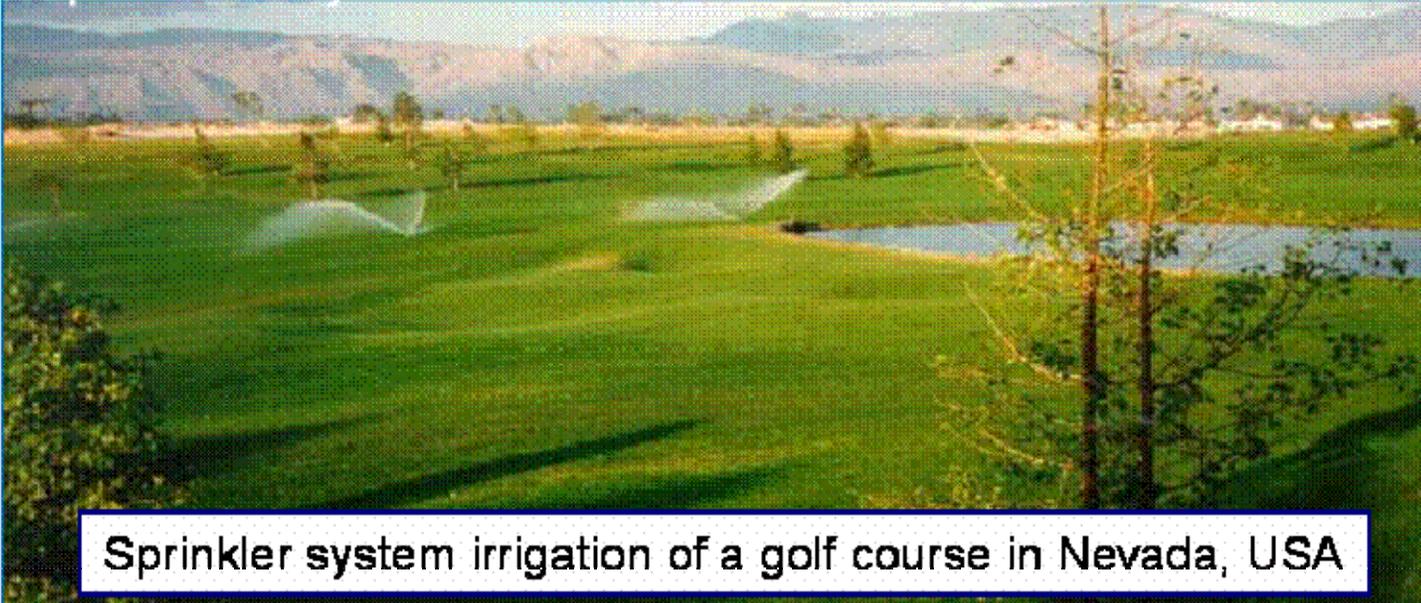
Drip Irrigation of cotton plants



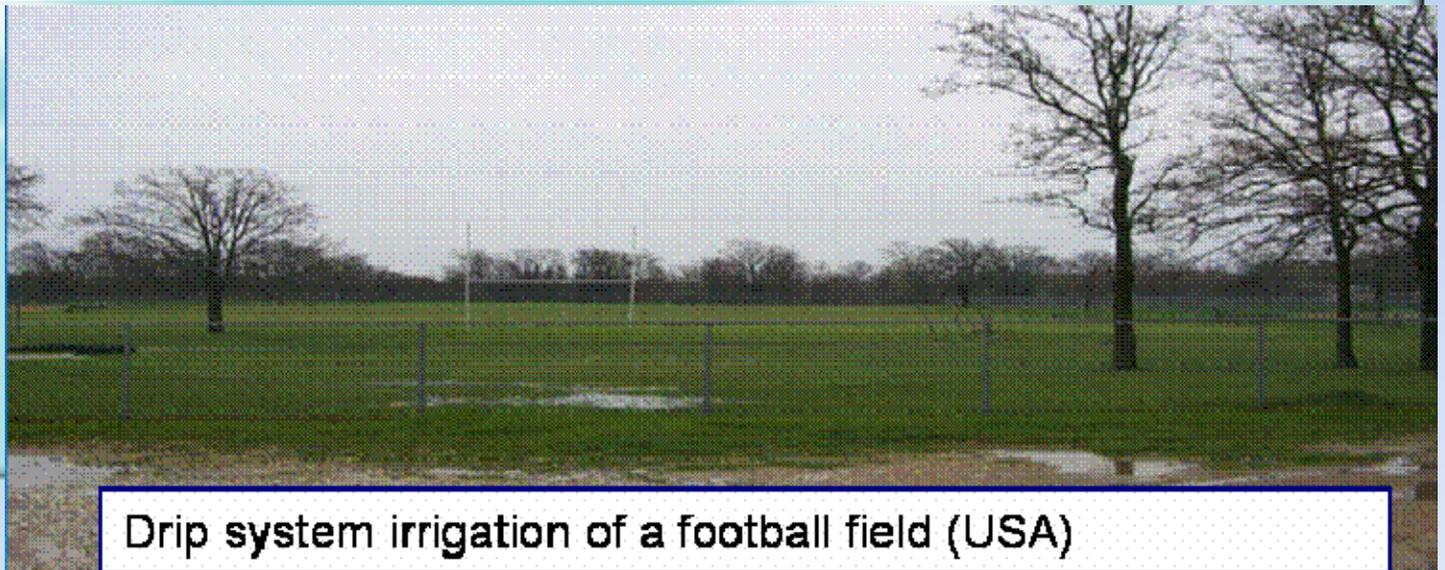
Alfalfa irrigation in the Negev Desert



Uses for Waste Water : Recreation



Sprinkler system irrigation of a golf course in Nevada, USA



Drip system irrigation of a football field (USA)

5/15/2013

Advantages of Agricultural Reuse

- ❖ **High concentrations of nutrients**
- ❖ **May eliminate need for fertilizer**
- ❖ **Long-term soil enrichment**
- ❖ **Decreases demand on potable water supply**
- ❖ **Additional treatment in soil**
- ❖ **Water not discharged to receiving waters**

Disadvantages of Agricultural Reuse

- ❖ **Health risk from associated pathogens**
- ❖ **Health risk from other contaminants (e.g. metals, chemicals, pharmaceuticals)**
- ❖ **Decrease in soil quality from accumulation of metals and acidification**
- ❖ **Infiltration of groundwater**

Uses for Waste Water : Fisheries (Calcutta)India



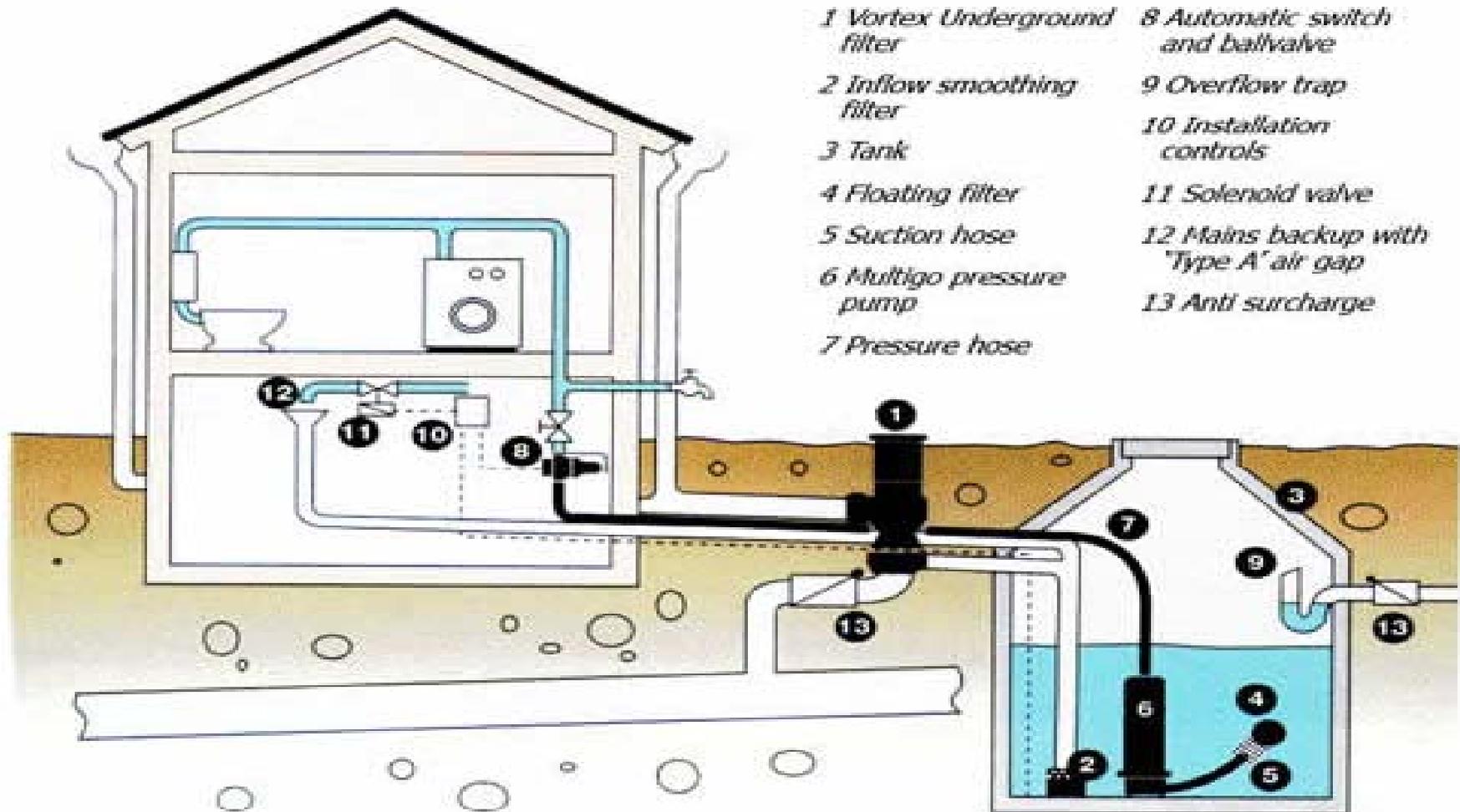
All the city's wastewater (550,000m³/day) is used to fertilize 3000 ha of fishponds, producing some 13,000 tons of fish per year.

Uses for Waste Water

Uses -

- ❖ **Rain water harvesting**
- ❖ **Ponds, Lakes and *Aniket* etc.**
- ❖ **Store surface water including flood or other surplus water for future use**

Uses for Waste Water: Rain water Harvesting



Uses for Waste Water: Lake



Uses for Waste Water: Tanka



5/15/2013

Dr. R. K. Manohar

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Advantages and Disadvantages of Industrial Reuse

Advantages

- ❖ Washing
- ❖ Cooling
- ❖ Boiler
- ❖ Processing

Disadvantages

- ❖ Scaling
- ❖ Corrosion
- ❖ Fouling
- ❖ Health Concern

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Major Water Quality Issues

Common issues of Surface and Ground water

- Pathogenic (Bacteriological) Pollution
- Salinity
- Toxicity (micro-pollutants and other industrial pollutants)

Surface Water

- Oxygen depletion
- Ecological health

Ground Water

- Fluoride
- Nitrate
- Arsenic
- Iron
- Sea water intrusion

Water Related Diseases

Type	Cause	Diseases
Water born Diseases	Ingestion of Contaminated Water	Amoebic and Bacillary Dysentery, Cholera, Typhoid, Viral hepatitis A/E/C, Leptospirosis, Giardiasis, Schistosomiasis, Dracunculosis, Ascariasis etc.
Water based Diseases	Contact of Contaminated Water	Scabies, Dermatitis, trachoma, Conjunctivitis Infestation & diseases transmitted by louse, flea, ticks etc.
	Helping in breeding of diseases transmitting agents	Mosquito born diseases, Fly born diseases, Cyclops born diseases etc.
Lack of Water	Deficiency of Water	Dehydration
	Poor personnel Hygiene	Scabies, Dermatitis, trachoma, Conjunctivitis Infestation & diseases transmitted by louse, flea, ticks etc
Excess of Water	Flood	Accidents due to Flood disaster
	Contamination of water	Diseases due to Ingestion of contaminated water

Infectious Agents: Present in Raw Wastewater

AGENT	DISEASES
BACTERIA	DISEASES
E.Coli	Gastroenteritis
S.Typhi	Typhoid fever
VIRUSES	DISEASES
Polio virus	Polio, Gastroenteritis
Rota Virus	Acute Gastroenteritis
PROTOZOA	DISEASES
E. Histolytica	Amoebiasis
Giardia	Giardiasis
PARASITES	DISEASES
Ascaris	Ascariasis
Taenia	Taeniasis

Prevention of infection: Waste Water

- ❖ **Reduce the pathogen levels**
- ❖ **Avoid direct contact of crops wastewater**
- ❖ **Restrict the type of crops irrigated**
- ❖ **Avoid eating raw salads when not sure of hygiene levels**
- ❖ **Wash thoroughly all vegetables**
- ❖ **Good personal and food hygiene should be maintained.**
- ❖ **Water used for drinking should be of quality standard**

Water Quality Standard

- ❖ **Acceptability Aspects**
- ❖ **Chemical Aspects.**
- ❖ **Microbiological Aspects**
- ❖ **Radiological Aspects**

Water Quality Standard: Acceptability

S. No.	Quality	Maximum permissible Limit
1	Colour	<15 true colour units (TCU)
2	Taste and Odour	Acceptable
3	Turbidity	<5 NTU
4	Total Dissolved Solids (TDS)	<1000mg/L of water
5	PH	6.5 to 8.5
6	Hardness	upto 300 ppm
7	Chlorides	Upto 600 mg/liter of water
8	Iron	up to 0.3 mg/L is acceptable

Water Quality Standard: Chemicals

Inorganic Chemical	Maximum limit permitted (mg/L)	Inorganic Chemical	Maximum limit permitted (mg/L)
Antimony	0.005	Arsenic	0.01
Barium	0.7	Boron	0.03
Cadmium	0.003	Chromium	0.05
Cyanide	0.07	Copper	2
Lead	0.01	Fluoride	1.5
Mercury	0.001	Magnesium	0.5
Molybdenum	0.07	Nickel	0.02
Nitrite	3	Selenium	0.01

Water Quality Standard: Chemicals

Organic Chemical	Maximum limit permitted (mg/L)
Aldrine/Dieldrine	0.03
Hexachlorbenzene	1
Chlordane	0.2
DDT	2

Water Quality Standard: Microbial

Organism	Maximum limit permitted (mg/L)
E. Coli	Zero i.e. Must not be detectable in any 100 ml sample
Total Coliform Bacterias	Zero i.e. Must not be detectable in any 100 ml sample Atleast 95% sample taken throughout the year should be free from coliform bacteria

Water Quality Standard: Radiological

WHO has proposed: Acceptable limits of radioactivity

Gross alpha activity 3 pCi/l (Picocuries per liter).

Gross beta activity 30 pCi/l

Water Purification Methods: Efficiency

S. No.	Physical Method	Efficiency
1	Boiling	High (>95%)
2	Exposed to sunlight	Moderate (90-95%)
3	Plain Sedimentation	Low (<90%)
4	Filtration	High (>95%)
5	Rapid Sand Filter	High (>95%)
6	Slow sand Filter	Moderate (90-95%)
7	Ceramic Filter	Moderate (90-95%)
8	Membrane Filter	High (>95%)

Water Purification Methods: Efficiency

S. No.	Chemical Method	Efficiency
1	Chlorination	High (>95%)
2	Ionization	High (>95%)
3	Ozonation	High (>95%)
4	Coagulation- Flocculation&Precipitation	Moderate (90-95%)

Conclusions

- ❖ Reduce production of waste water
- ❖ Reuse directly as much as one can
- ❖ Recycle the waste water for better use
- ❖ Research promotion in recycling methods
- ❖ Health Concerns should be seen at every step
- ❖ Potential for much greater use in future



Thanks