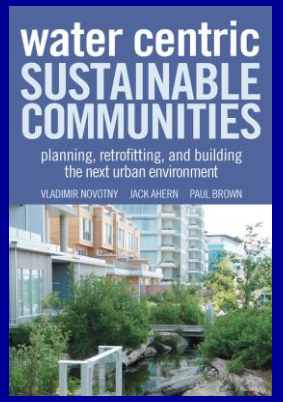
EFFLUENT DOMINATED WATER BODIES, THEIR RECLAMATION AND REUSE TO ACHIEVE SUSTAINABILITY

Chapter 9



DEFINITION

- Effluent dominated water body
  - Predominantly contains waste water effluents during a part of a year
- Effluent dependent water body
  - An ephemeral or low flow stream whose aquatic life can be sustained by treated effluents creating perennial flow

Water – Sewage-Water Cycle (WSW)

- Almost all effluents discharged into continental streams or even groundwater will be reused for potable and other uses, in some cases many times
  - Notable reuses
    - Chicago – Lake Michigan in 1900s
    - Ruhr – Emscher in the first part of 20th century
    - London (well contamination)
    - Morava River in Czech Republic
    - Illinois/Ohio/Mississippi Rivers
- The task of engineers is make WSW Cycle safe and maximize the time between the discharge and reuse

CAN WE DESIGNATE A USE FOR WASTE WATER DISPOSAL?

In early 1900's the Emscher River in Germany was designated and channelized solely for wastewater effluent conveyance.

Answer is No.

Today the Emscher River and its watershed is being "renaturalized" by one of the most ambitious rehabilitation and landscape restoration project

What is required?

- Typically put on the TMDL action list
- Use Attainability Analysis is required to change the designated use (balanced aquatic life and primary recreation)
  - One of the six reasons allowing the change of the use specifically states that treated effluents can be used to compensate a lack of flow without violating the state standard
  - This implies that where an effluent discharge creates a perennial flow or dominates the flow, the resulting aquatic community is to be fully protected
  - The regulations also require that full protection shall be given to accidental swimmers

Large interbasin transfers

Flow deficient water bodies downstream from the point of withdrawal

Effluent dominated water bodies downstream from the point of effluent discharge

Water Deficient Cities -> Effluent Dominated Rivers

Denver (South Platte River)

Flow deficient upstream and in the city, effluent dominated downstream from WWTP

Los Angeles River?

Heavily modified flood conveyance without base flow

The Lower des Plaines River (IL) in Joliet

This river is the larges effluent dominated stream carrying on average 100 m^3/s of flow which is 80 – >90% treated effluent and CSOs (during high flows) from the Chicago Metropolitan Area

Trinity River in Dallas.

After almost all flow is withdrawn for water supply of 6 million people the river becomes effluent dominated downstream. The flow is reused for water supply of Houston.

Gila River in Phoenix (AZ)

Upstream Flow Deprived (ephemeral) river
Downstream almost 100% Effluent Dominated

Note: Disinfection by chlorine downgrades integrity of effluent dominated streams

Potential for rehabilitation

DOOMSDAY ARGUMENTS

- Effluent dominated streams are irreversibly modified.
- Most agree that that the ecology will not fully return to the predevelopment pristine status
- People are psychologically afraid of effluent dominated water bodies
- Long history of abuse and problems

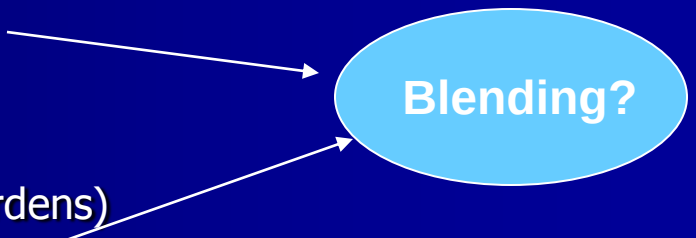
Driving Forces towards Sustainability

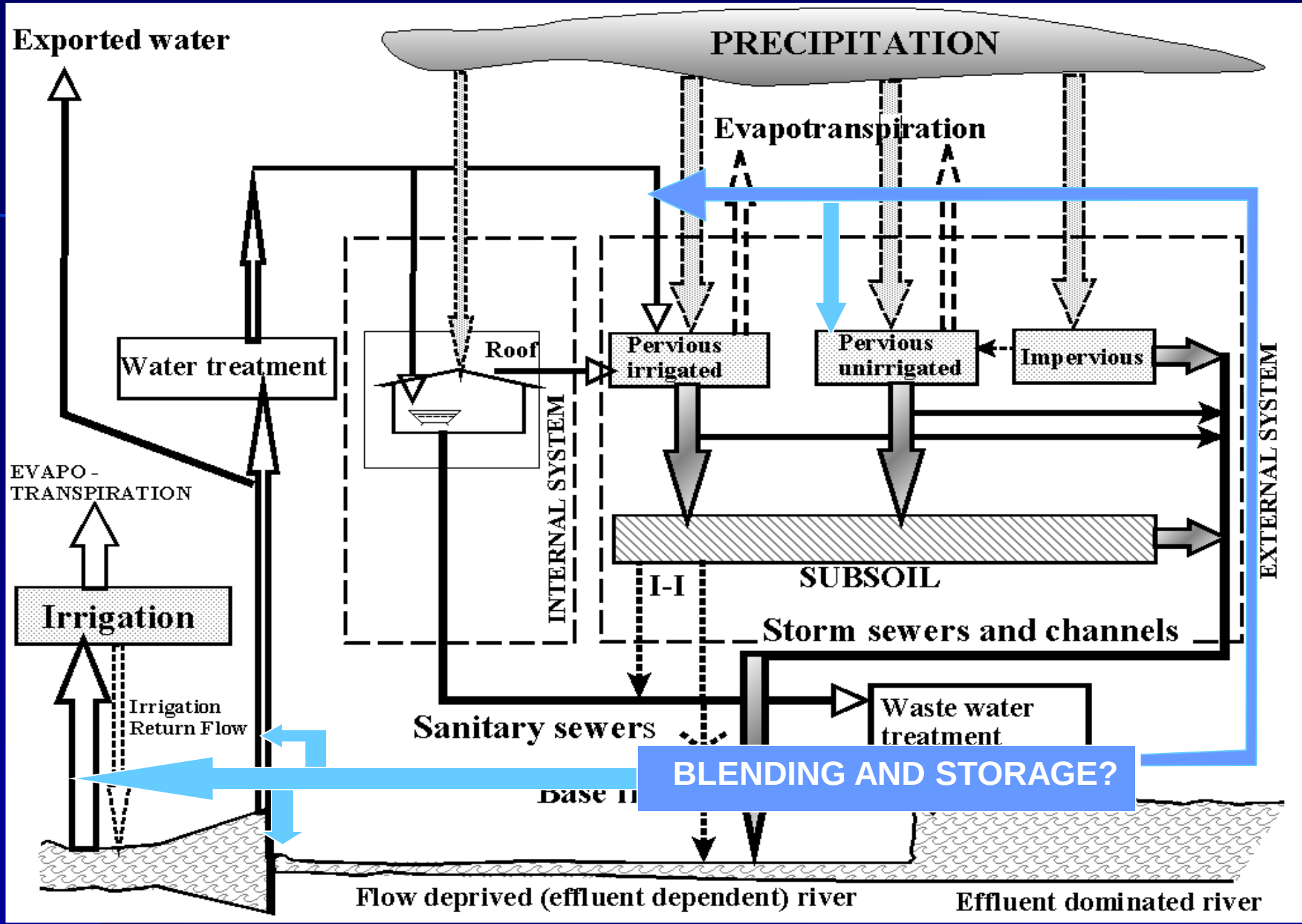
- Increasing water scarcity and conversion into effluent dominated waters will require management of the total urban water hydrological cycle and decentralization of the urban sewerage
- Mandated by Section 101 of CWA and desired by public goals of achieving good ecological status and integrity
- Limits have been reached and something has to be done

- Wastewater treatment technologies are reaching levels that may enable full or partial effluent reclamation and reuse for
  - Irrigation (keep the nutrients in)
  - Flow augmentation to sustain aquatic life with or without blending with reclaimed storm water (remove nutrients)
  - Water – sewage – water cycle today is mostly safe in the US and some other countries

Total Hydrologic Balance

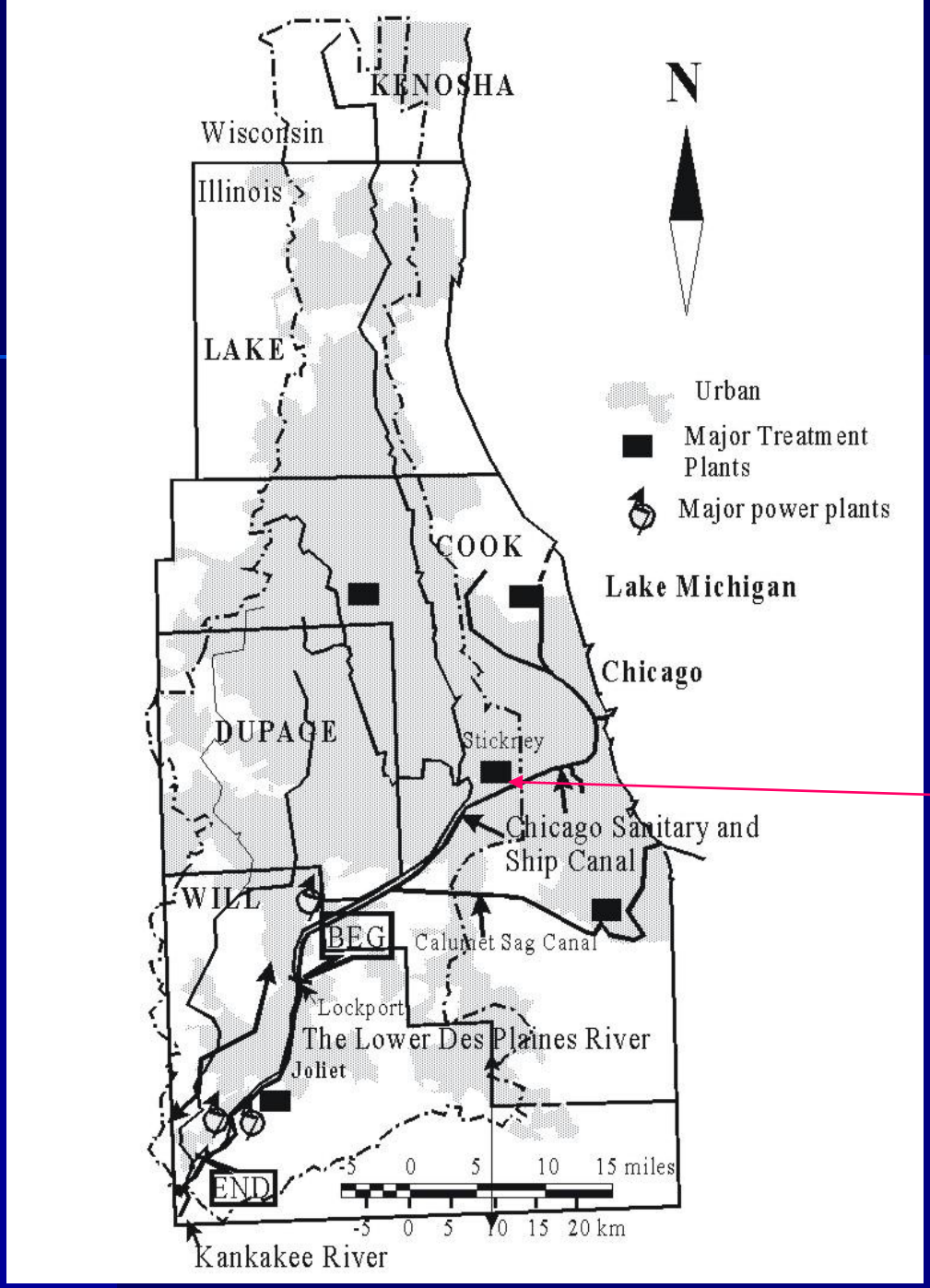
- Water supply, stormwater management, waste water disposal, groundwater levels and stream flow are components of the same system and should be harmoniously managed with ecological goals in focus
- Tools of management:
  - Water conservation
  - Capture and reuse of rainwater
    - Groundwater recharge
    - Low flow augmentation
    - Local (house) irrigation (rain gardens)
  - Effluent reclamation and reuse
    - Irrigation
    - Flow enhancement for aquatic life
    - Aesthetic enhancement of urban streams
    - Groundwater recharge
  - Decentralization and de-regionalization
  - Flow and pollutant load trading




Exported water
PRECIPITATION
Evapotranspiration
Water treatment
Roof
Pervious irrigated
Pervious unirrigated
Impervious
INTERNAL SYSTEM
EXTERNAL SYSTEM
EVAPO - TRANSPIRATION
Irrigation
SUBSOIL
I-I
Storm sewers and channels
Irrigation Return Flow
Sanitary sewers
Waste water treatment
BLENDING AND STORAGE?
Flow deprived (effluent dependent) river
Effluent dominated river

The Lower Des Plaines River Use Attainability

The largest effluent dominated river draining the Greater Metropolitan Chicago Area



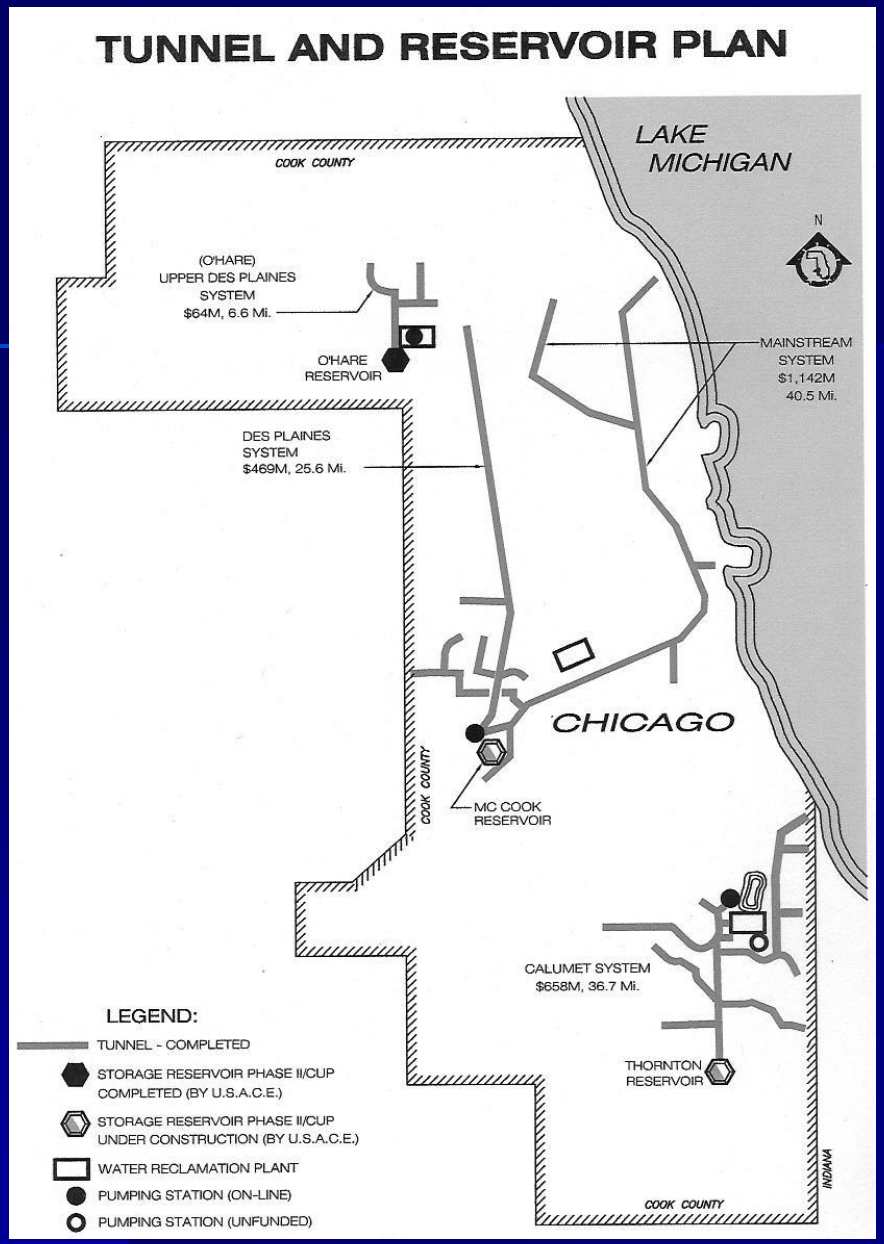
Des Plaines River Basin

Stickney wastewater treatment plant is one of the largest in the world

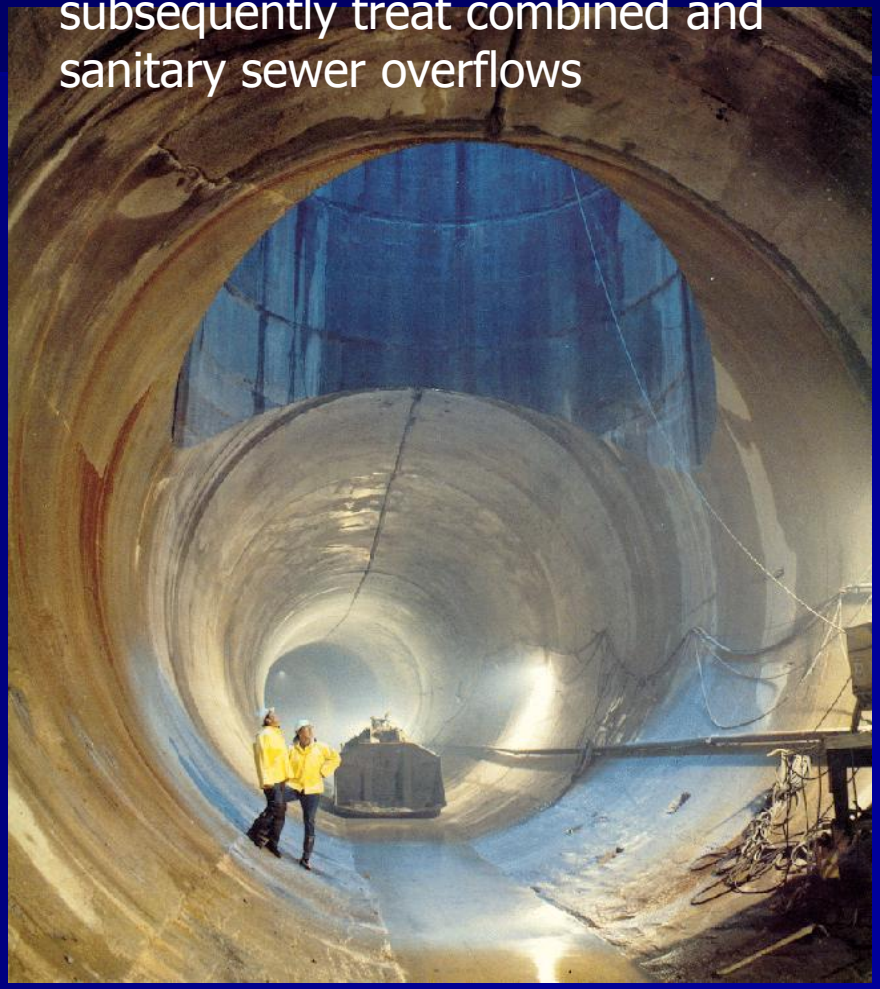
Capacity 40 m^3/sec

Mandatory treatment of point sources must be implemented

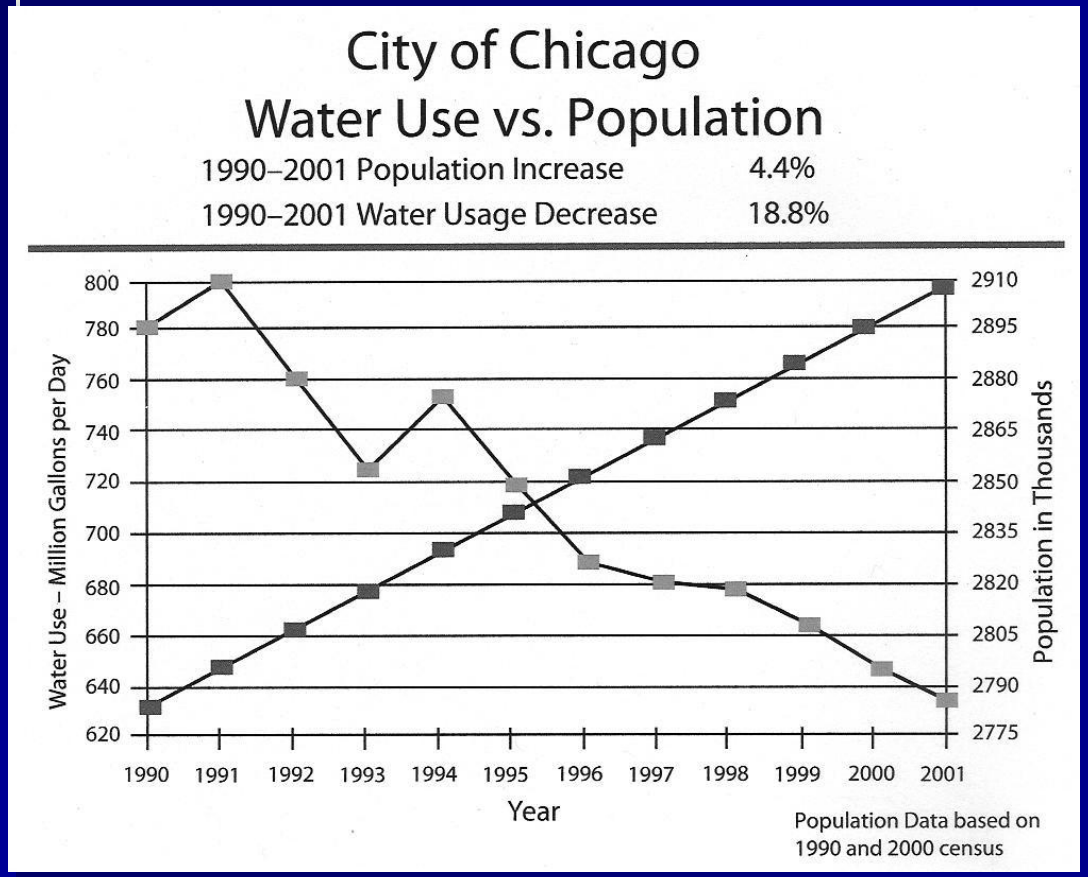
In the US effluent quality is regulated by effluent standards that are uniform. For effluent dominated streams, controls have to go beyond the mandatory point source controls.



More than 150 km of 12 meter diameter underground tunnels were built (drilled) to store and subsequently treat combined and sanitary sewer overflows

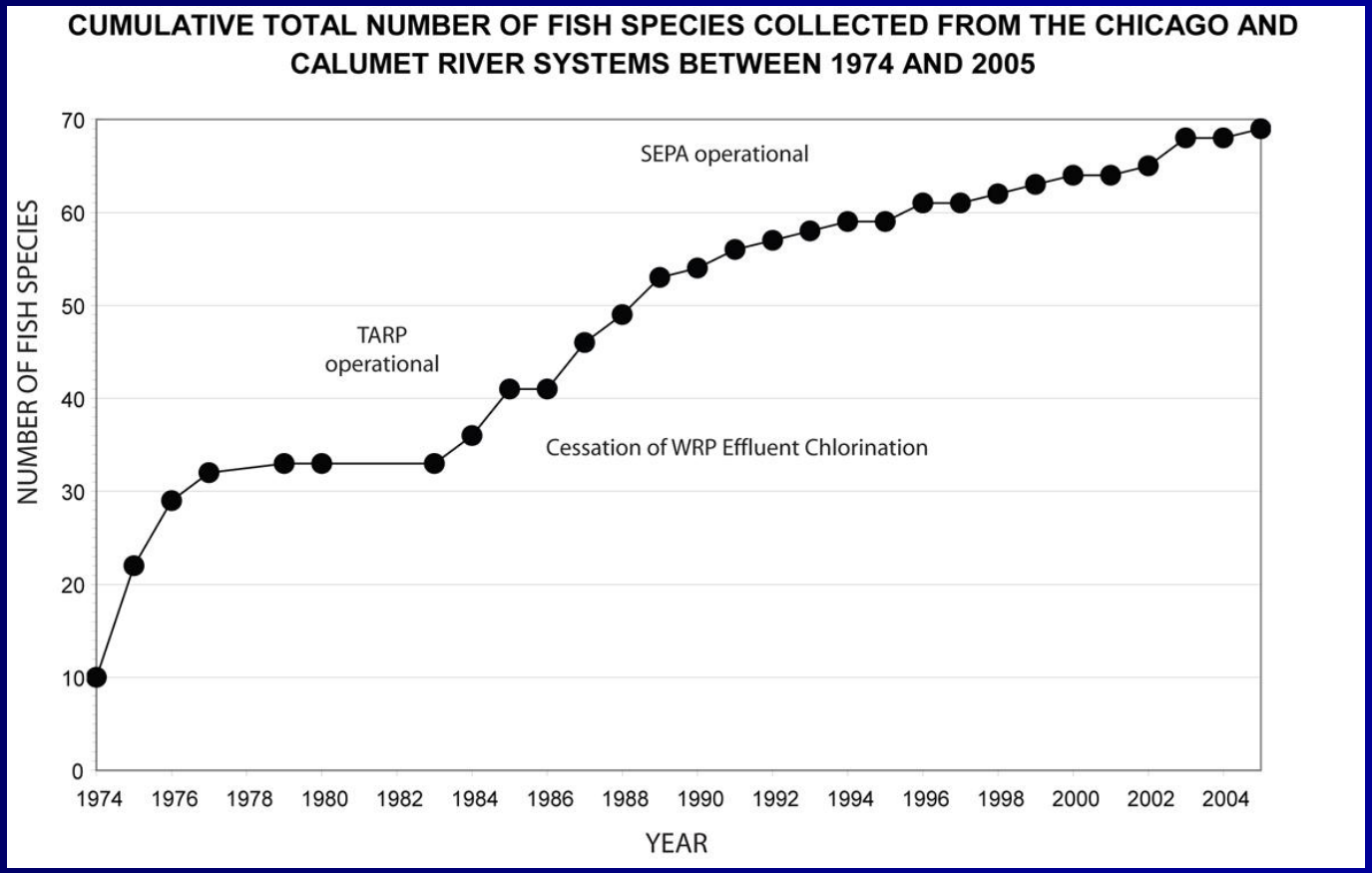


Chicago has implemented water conservation and water pipes sealing



Courtesy MWRDGC

Fish population has improved



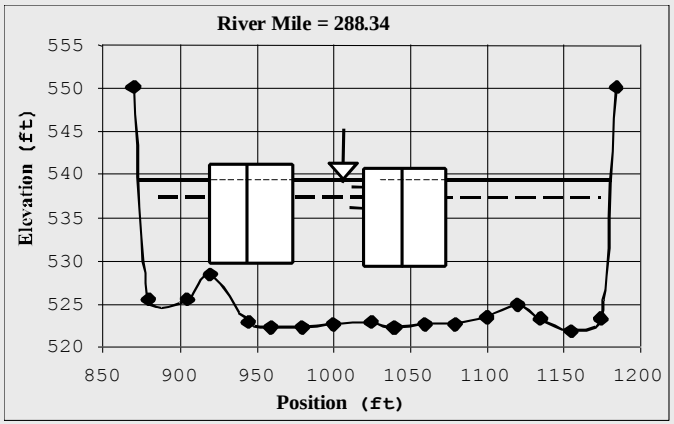
Courtesy MWRDGC

Physical Limitations Brandon Pool

The Des Plain River is one of the major US inland navigation routes connecting Great Lakes with the Mississippi. River.

City of Joliet developed a 4 hectare Bicentennial Park for picnicking, cultural events and visual observation of the river.

Entire Brandon Pool is not suitable for primary contact recreation



The pool is very narrow (105 m) with vertical concrete or sheet pile embankments and fencing.

Dresden Island Pool

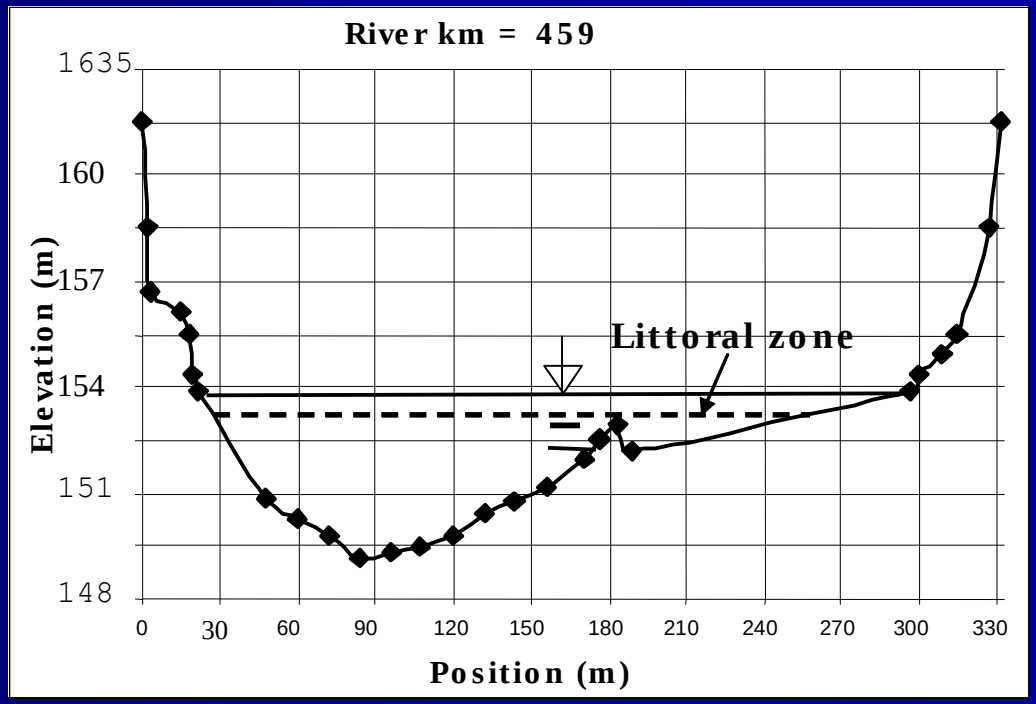
Near Empress Casino

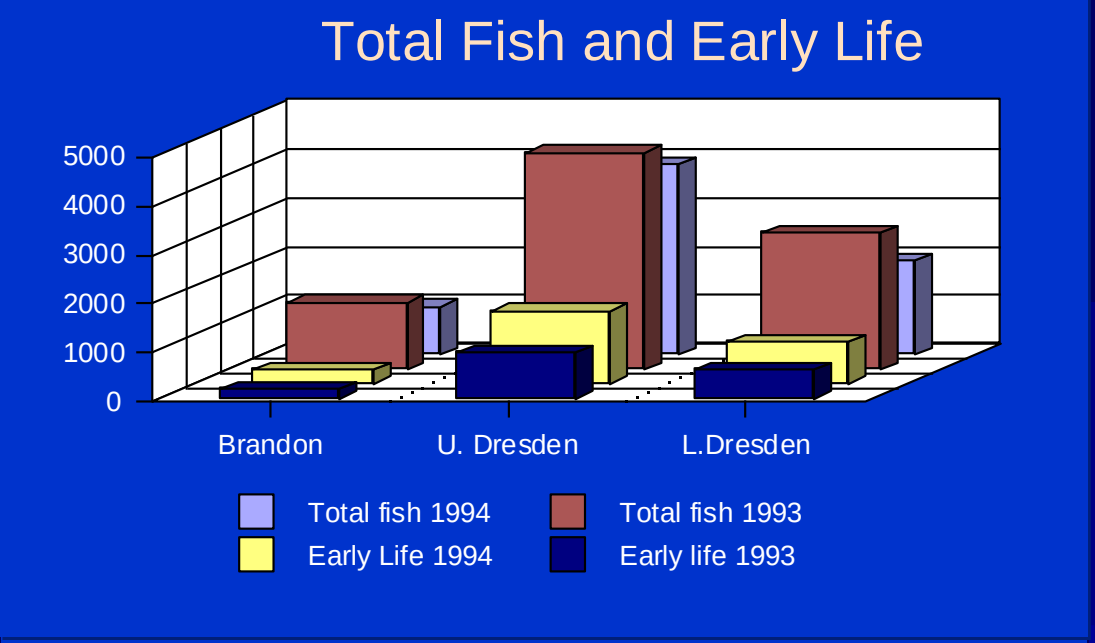
I-55 Bridge

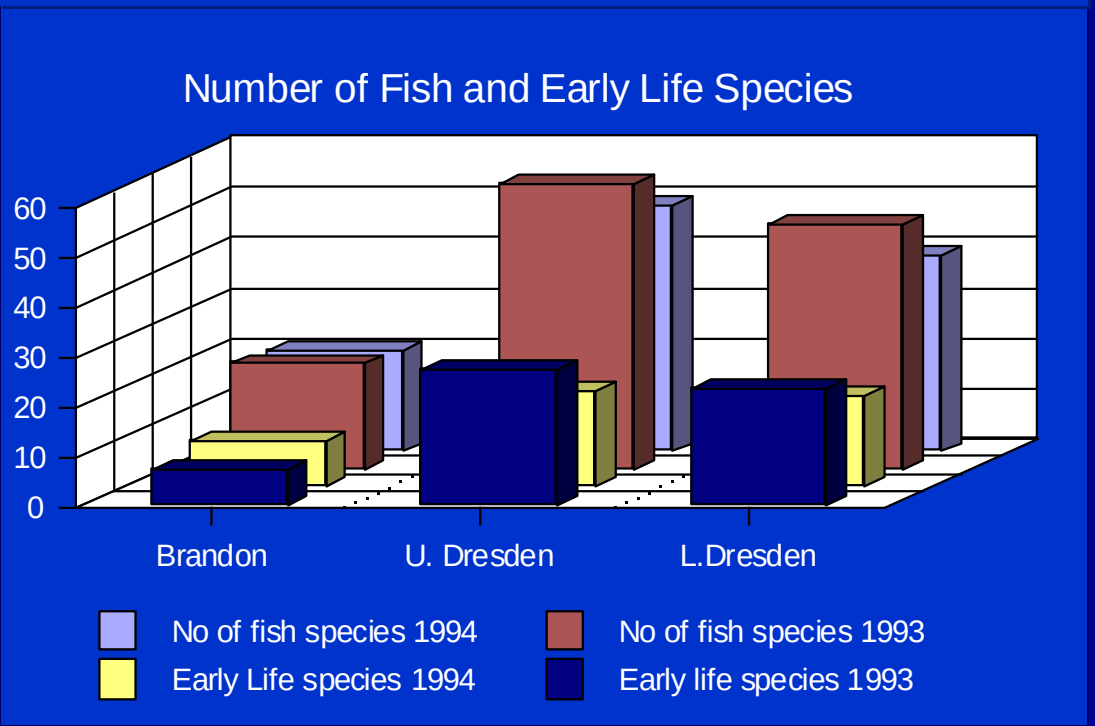
HABITAT IN THE DRESDEN POOL IS FAR MORE SUITABLE TO SUPPORT AQUATIC LIFE

Cross-section

Dresden Island Pool





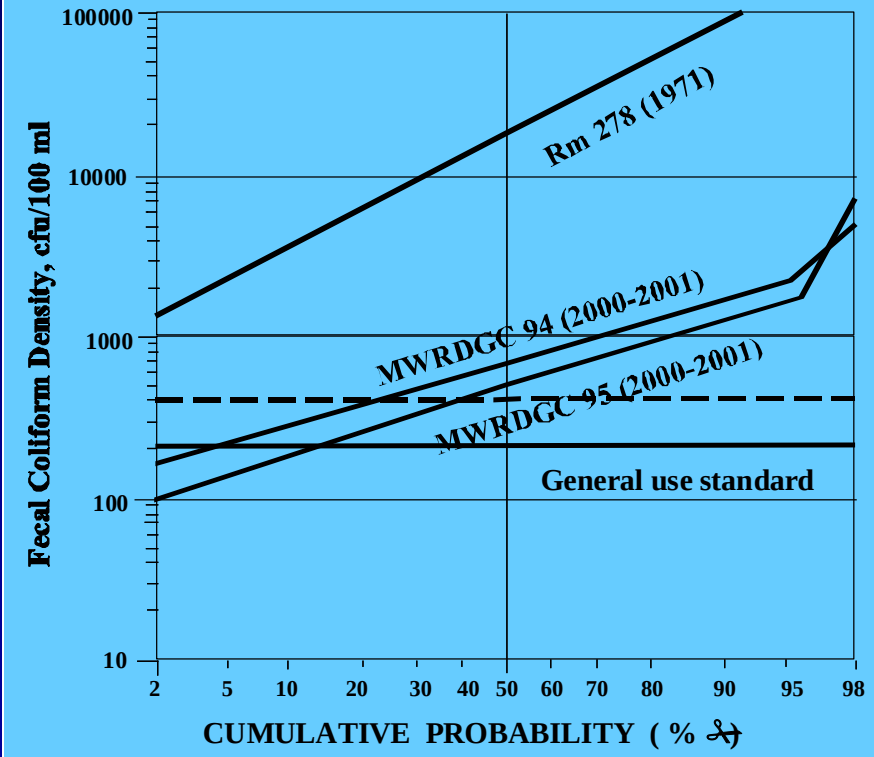


Absence or great reduction of early life forms in the Brandon pool is a consequence of the irreversible habitat modifications. The US Water quality regulation allow less stringent standards for dissolved oxygen and ammonia.

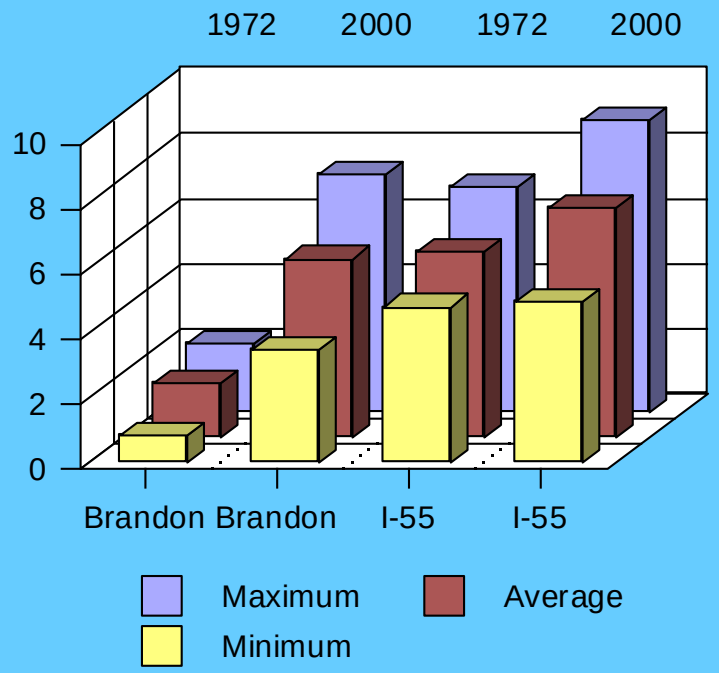
Such variance cannot be applied to the Dresden pool.

IMPROVEMENTS

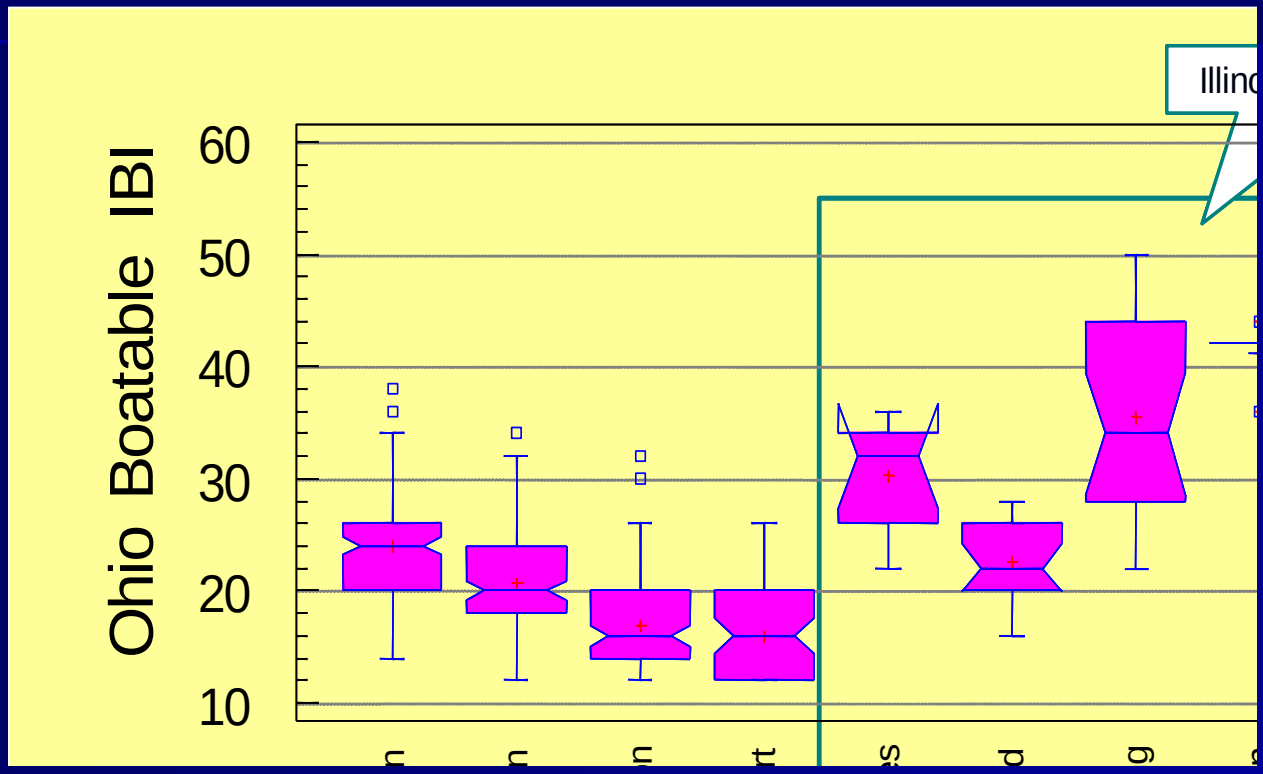
Fecal coliforms
#/100 mL



Historic DO
Concentrations,
mg/L



Ecologic potential



Reference water bodies

Recommendations and findings of the Use Attainability Analysis

- The river can be safe for secondary recreation and accidental primary contact
- The river is being reclassified as a "modified general use" water body that can support a propagation (early life forms) of a balanced aquatic life in one section a and protect aquatic life in the other section
- Additional "common sense" actions should be undertaken by the dischargers into the river and agencies) to attain the goals
  - Temperature, dissolved oxygen improvements in the Brandon pool, disinfection of effluents, considering sediment clean-up in two limited sections

General Conclusions

- Currently impaired urban waters most likely will not return to their pre-development status
  - Irreversible modifications and withdrawals
  - Conflict between increased water scarcity and demand
  - Irreparable legacy pollution in sediments
  - Effluent dominance/dependence
- Ecological potential (integrity) of urban waters is less that that of unimpacted reference streams
- Ecologic potential should be determined by Use Attainability Analysis. In most cases conditions for balanced aquatic biota and primary (contact) recreation and resiliency are achievable

- Achieving the ecologic potential of the receiving waters and aquifers is the moving goal, approached by adaptive management.
- Sustainability and resilience of the new ecologic potential can be maintained by management of the total hydrologic cycle with the ecologic potential as a target. This will require real time monitoring and control.
- The concepts of urban landscape ecology and water body integrity should be unified. Identifying the most efficient landscape surface, green areas, and drainage that would enhance riparian zones and maintain the water body integrity.

- Elimination of socio-economic and legal barriers must be researched, tested on pilot watersheds and potentially successful remedies included into the legal instruments and public education by schools and mass media.
- Continuing and enhancing development of wastewater treatment technologies. The treatment should be tailored also to the safe and beneficial reclamation and reuse that will be increasing in future cities.
- There is a need to research the potential for using blended and treated urban stormwater and treated effluents for landscape irrigation and flow augmentation.