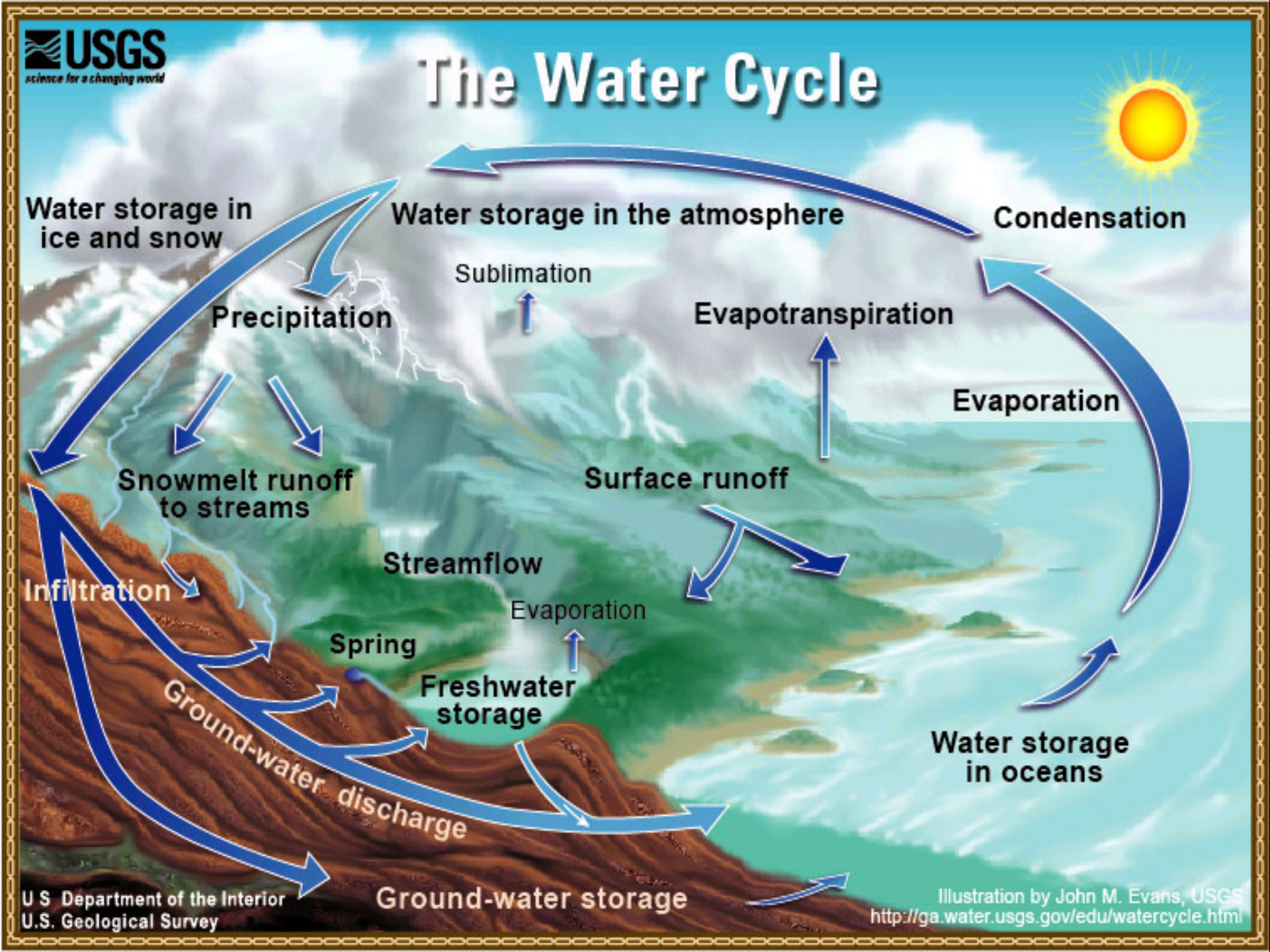
Overview of Watershed and Ecosystem Protection

January 14, 2016

Outline

- Introduction:
  - Importance of Watershed Management
  - Water Quality and Quantity
  - Ecosystems and Human Health
- The Watershed Management Approach
- Pollution of Watersheds
- Drinking Water
  - Thunder Bay
- Water Protection Legislation
- Conclusions


USGS
science for a changing world
The Water Cycle
Water storage in ice and snow
Water storage in the atmosphere
Condensation
Sublimation
Precipitation
Evapotranspiration
Evaporation
Snowmelt runoff to streams
Surface runoff
Streamflow
Infiltration
Evaporation
Spring
Freshwater storage
Ground-water discharge
Water storage in oceans
Ground-water storage
U S Department of the Interior
U.S. Geological Survey
Illustration by John M. Evans, USGS
http://ga.water.usgs.gov/edu/watercycle.html

Water Quality and Quantity

- Quality is based on three components:
  - Physical (temperature, turbidity)
  - Chemical (oxygen, nutrient, acidity)
  - Biological (bacteria, viruses)
- Quality of the water depends on:
  - Local geology
  - Local ecosystems
  - Human uses
- Quality of the water depends on intended use
  - Access to adequate levels of water for human use and environmental systems
  - Water use around the world varies per capita from 20L to 500L/day (Dearden and Mitchell, 2005)
    - Biggest per capita users: Canada, United States, Switzerland

Connections between Ecosystem and Human Health

- Change in water quality can alter an ecosystem by:
  - Changing species composition
  - Introduction of exotic species
  - Alteration of nutrient flow
- Water involved in producing photosynthesis for vegetation
  - Decline in water amount or quality translates into declines in yields and/or quality

Importance for Ecosystem and Human Health

- Loss of 10% of water in humans may cause death
- Min. water requirement for human:
  - temperate regions is 3 litres
  - Tropical or subtropical is 5 l (Dearden & Mitchell 2005)
- Contaminated water can lead to death

Historical Approaches to Water Resource Management

"One who doesn't know the history is unable to plan the future" *An old Chinese proverb*

Ontario after WWII

- Started with Conservation Authorities
- Focused on flood control, erosion and delivering clean water and storm water management
  - As surface water flow increases erosion along water ways also increases

Traditional Approach to Water Resource Management

- Government makes and enforces rules
- Rules are mainly minimal standards
- Emphasis on government sector to solve problems
- Limited public involvement

The Watershed Management Approach

Integrated watershed management, preferably under the direction of a watershed or basin management body, has been prescribed in water policy literature and from other quarters for decades. Few instances may be found where this recommendation has been properly implemented.
(Blomquist and Schlager 2006)

The Watershed Management Approach

Policy has featured two themes:

- The watershed is the appropriate scale for organizing water management, because water sources and uses in a watershed are interrelated.

- The second is that since political boundaries almost never correspond with watersheds and watershed-scale decision making structures do not usually exist

The Watershed Management Approach

Watershed management, although dependent on science and engineering, is first and foremost a social process.

Interactions between scientists and non-scientists require a investment of time and energy

- Develop relationships
- Build trust
- Mutual exchange of information (Rhoads *et al. 1999)*

Biodiversity and Ecosystem Integrity on the Watershed

Past land-use activity, particularly agriculture, may result in long-term modifications to and reductions in aquatic diversity, regardless of reforestation of riparian zones.

Preservation of habitat fragments may not be sufficient to maintain natural diversity in streams, and maintenance of such biodiversity may require conservation of much or all of the watershed (Harding *et al.* 1998)

Biodiversity and Ecosystem Integrity in Watersheds

Riparian corridors typically possess an unusually diverse array of species

Related to:

- Flood regimes
- Geomorphic channel processes
- Altitudinal climate shifts
- Upland influences on the corridor

(Naiman *et al.* 1993)

SuAsCo Watershed Council Committee

Sudbury River
Assabet River
Concord River

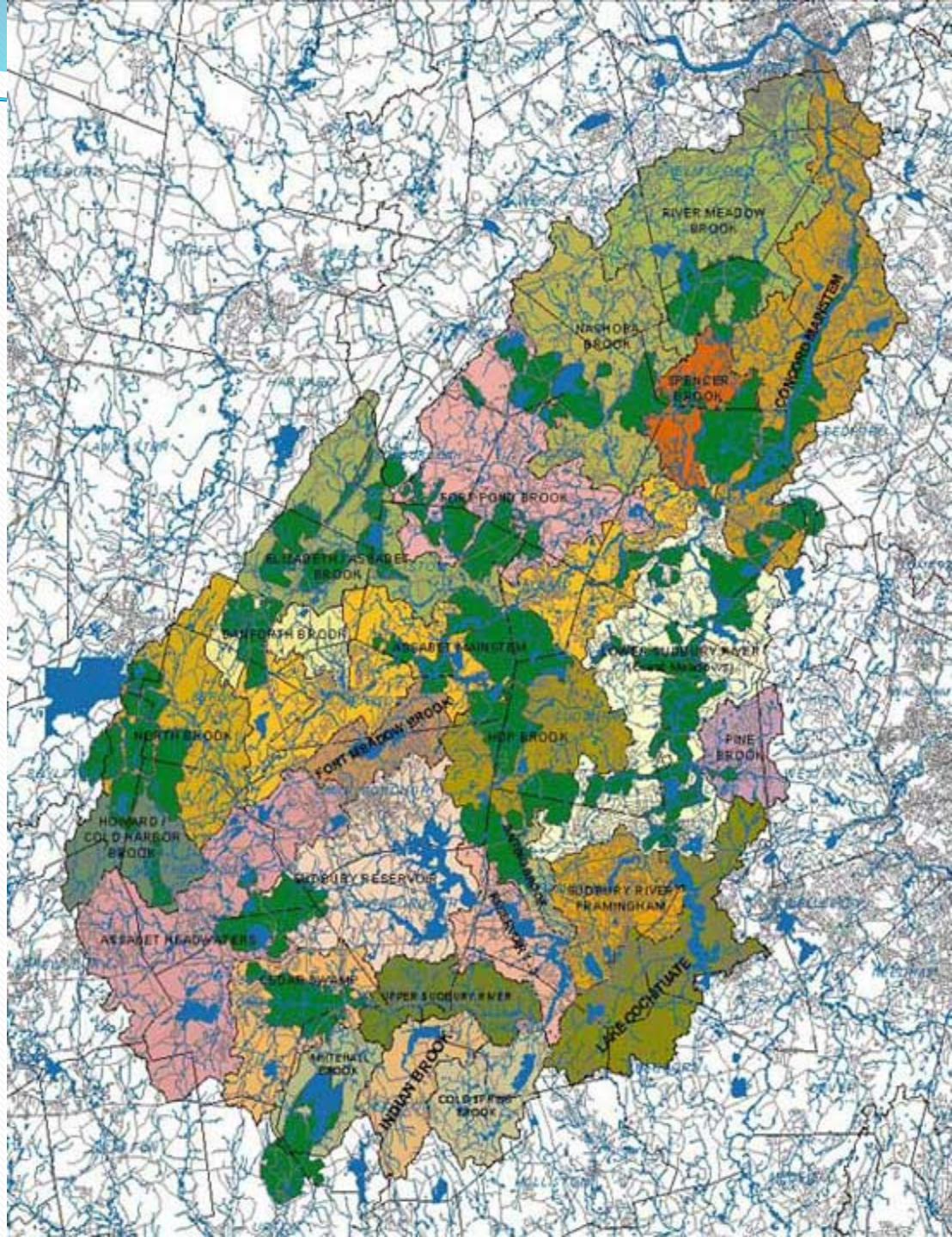
Massachusetts

377 square-mile area

Encompassing partially, or fully by 36 towns

Map showing pockets of biodiversity on the SuAsCo watershed

Green indicates high biodiversity



Biodiversity and Ecosystem Integrity in Watersheds

- Unfortunately, relative to other forms of capital, ecosystems are poorly understood, scarcely monitored, and (in many cases) undergoing rapid degradation and depletion

- Often the importance of ecosystem services is widely appreciated only upon their loss (Daily *et al.* 2000)

Pollution of Watersheds

Point Source Pollution

- Identifiable inputs of waste that are discharged via pipes or drains primarily (but not exclusively) from industrial facilities and municipal treatments plants into rivers, lakes, and ocean (Whipple, 1977)

- Controlled through regulations

Non- Point Source Pollution

- Pollution that occurs when rainfall, snowmelt, or irrigation runs over land or through the ground, picks up pollutants, and deposits them into rivers, lakes, and coastal waters or introduces them into ground water (Whipple, 1977).
- Examples:
  - Agricultural
  - Urban
  - Natural

Point Source Mitigation

- Restrictions/regulations
- Heavy fines
- National Pollution Discharge Elimination System (NPDES) permit program (USGS).

Non- Point Source Mitigation

- Emphasis on biopesticides
- Organic farming
- Storm water discharge permits
- U.S. Environmental Protection Agency

Drinking Water

Drinking water

Municipal drinking water is obtained from a variety of sources

- Lakes, rivers, streams, underground aquifers

All sources are linked in the watershed through the water cycle

Past techniques have focused on treating dirty “raw” water to make it acceptable for drinking

Currently there is a shift toward protecting the water at the source

Protecting Water at the Source

The Clean Water Act 2006 (Ontario)
http://www.sourcewater.ca/swp_cleanwateract/Plain_Language_Guide_July_2007.pdf

- Helps to protect water at the source, as part of an overall objective to safeguard human health
- Help reduce risks by addressing threats to drinking water quantity and quality
- Designed to promote voluntary initiatives

Key principles of the Act are to create source protection plans that are locally developed and implemented

- Source Protection Authority
- Source Protection Committee

Thunder Bay's Source Protection

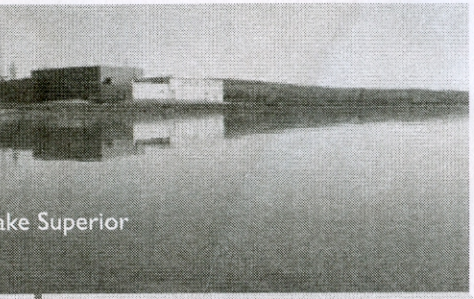
Thunder Bay's source water comes from Lake Superior at the Bare Point Water Treatment Plant

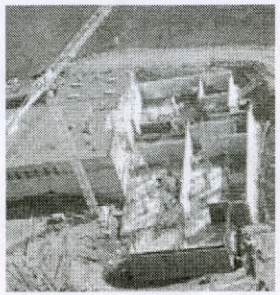
Thunder Bay uses "Watershed-based source protection":

Identifying threats to drinking water and actions to reduce or eliminate threats

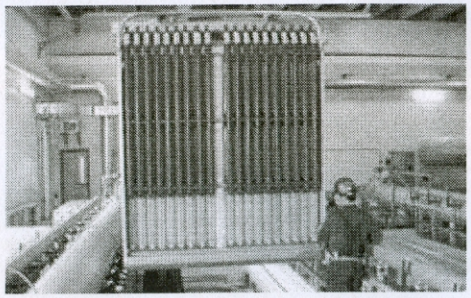
- Managing threats at the level of river systems as a whole
- The approach was chosen because water often flows across community boundaries

Activities in one community may affect drinking water of another community downstream, as well as itself

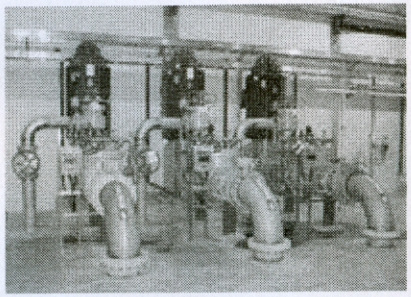




New Reservoirs under construction



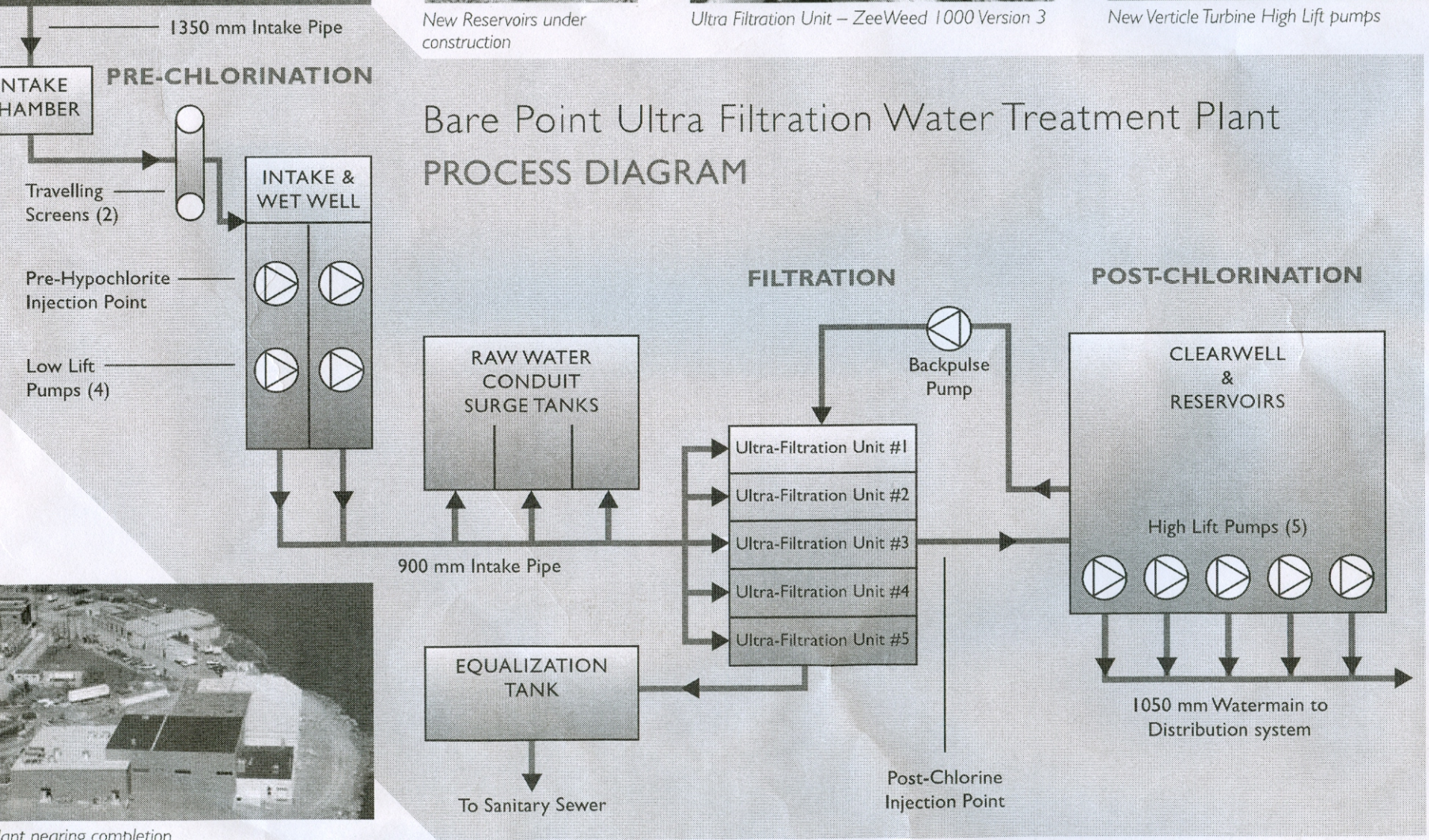
Ultra Filtration Unit – ZeeWeed 1000 Version 3



New Verticle Turbine High Lift pumps

Bare Point Ultra Filtration Water Treatment Plant

PROCESS DIAGRAM



lant nearing completion

Effects of Pollution on the Quality of Drinking Water

Many different contaminants can negatively affect drinking water

Microorganisms (bacteria, viruses)

Chemical contaminants (natural and synthetic chemicals)

Radiological contaminants (naturally-occurring inorganic and radioactive materials)

Water Protection Legislation

Water Protection Act

- A legal instrument for water management
- Funding for municipalities and First Nation communities
- Strategy to protect source water from pollution and shortages
- Mechanisms to strengthen the powers of local, provincial, and federal governments for watershed protection
- Controls bulk water transports
- Provide planning for the future

Some Issues in Canada

Changes in legislation and government amendments

- International Joint Commission and decline of rights
- Great Lakes Compact

Navigable Water Protection Act (NWPA)

NWPA

Originally

- One of oldest pieces of legislation in Canada (1882)
- Protection of all water that is navigable by vessels as small as canoes
- Meant that even very shallow water bodies i.e. streams and rivers, were protected.

Now

- 97 lakes, 62 rivers and three oceans that border Canada.
- Construction of dams, bridges and other projects permitted on most waterways without prior approval under the Act.

NWPA Current Changes

- Amending the definition of “navigable waters” to exclude “minor waters”
- Amending the definition of “work” to explicitly exclude “minor works”
- Deleting the reference to the four “named” works in the Act
  - bridge, boom, dam and causeway
- Adjusting the amount of the current fines in the Act
- The removal of wrecks and derelict vessels
- The definition of inspection powers
- A five year review of the amended *Navigable Waters Protection Act*.

What this means:

- Less protection of sensitive ecosystems
- Less regulation
- Less environmental attention
- More construction time
- More development
- Less of a need for EI Assessors!

Case Study: Australia

LAND CARE AND COMMUNITY-LED WATERSHED MANAGEMENT IN VICTORIA, AUSTRALIA (Ewing 1999)

- Tackle land and water degradation
  - Cropland
- Integrated Catchment (watershed) management
  - Agreement between government levels and communities
- Catchment areas identified
  - Catchment committees created for each area
- Principles
  - Community empowerment
  - Integrated management
  - Targeted investment
  - Accountability
  - Minimization of bureaucracy

Case Study: International Multi-Watershed

- Developing a sustainable watershed management
- Effective governance suggests
  - Water management must focus on a watershed scale, and must integrate all relevant aspects such as, hydrology, ecology, urban water management, agriculture, and watershed management
    - Ex Clean Water Act (Canada), Water Framework Directive (European Union)

Conclusions

Watershed ecosystems encapsulate all living and non living organisms

It is important to protect each component of the watershed

Point and non point pollution sources do affect watersheds

Activities in one community affect local sources, but sources downstream as well

Conclusions (cont.)

- Legislation is essential to maintain governmental input
- Developed and developing countries are making management efforts that see benefits and repercussions
- Watershed management requires a good understanding of ecological and socio-political processes at different social-spatial scales

- Watershed management is necessary for the sustainable protection of natural resources and environmental health

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