

WATER SUPPLY AND WATER QUALITY

1. Water Supply Management
2. Water Quality Management
3. Municipal Water Quality
4. Walkerton and related threats
5. Concerns and Threats to Drinking Water

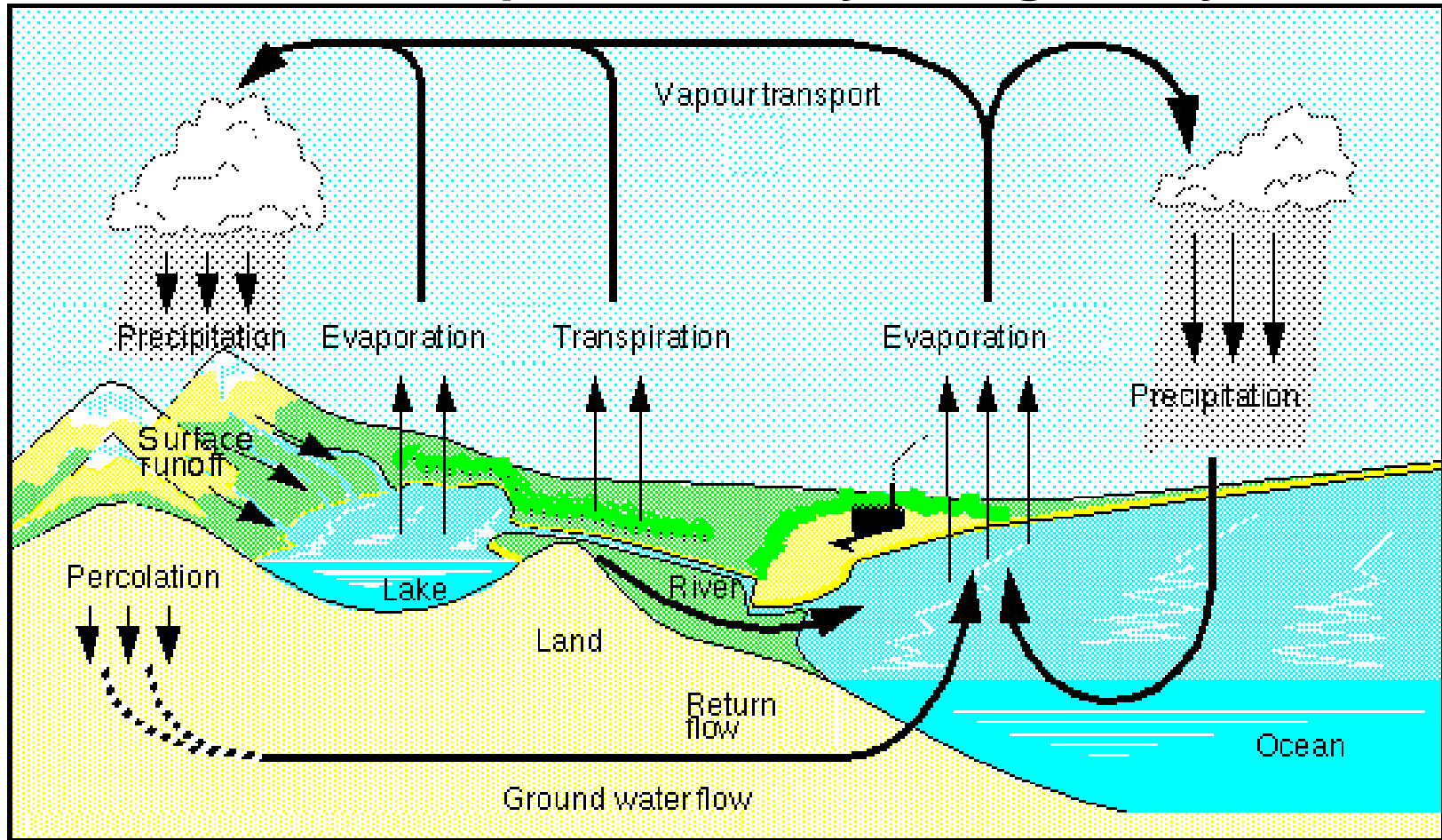
1. WATER SUPPLY MANAGEMENT

Water supply is the provision of water for different types of human use, such as drinking, domestic use, irrigation and urban-industrial supply.

Two basic issues are related to the balance between demand and availability and the quality of water:

- Supply is dependent on the physical principles of the hydrologic cycle
- Demand is related to
 - density of population
 - type of usage.

Basic Principles of the Hydrological Cycle



Courtesy Erich Roeckner, Max Planck Institute for Meteorology

Total amount of runoff = a crude estimate per capita population

2. Water Quality Management

What determines water quality?

The water of even the healthiest rivers and lakes is not absolutely pure. All water (even if distilled) contains many naturally occurring substances:

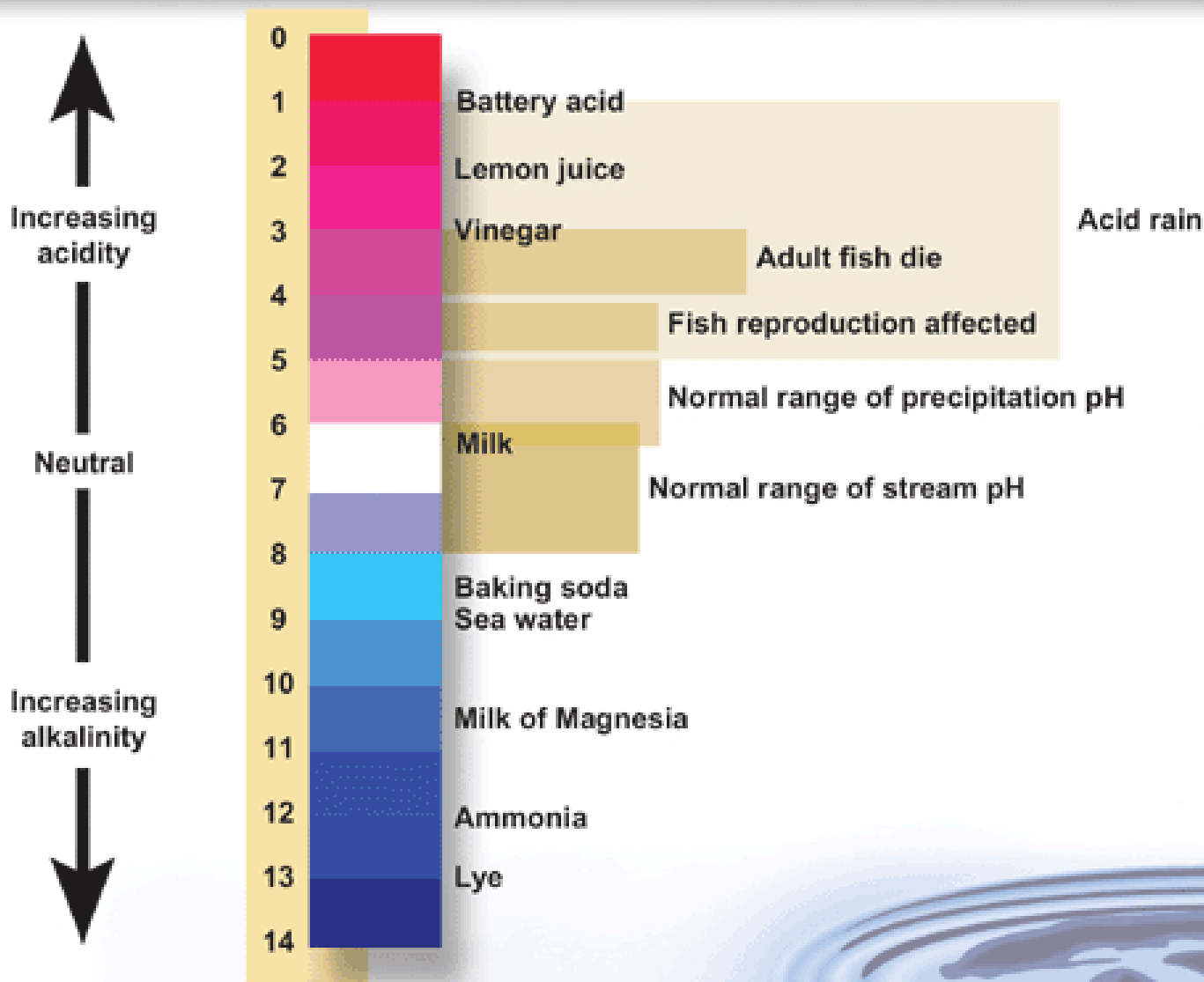
- bicarbonates
- sulphates
- sodium
- chlorides
- calcium
- magnesium
- potassium

How do we measure water quality?

Collect samples of the water, of living organisms, and of suspended and bottom sediments.

- pH
- temperature
- dissolved oxygen
- turbidity
- conductivity

The pH scale



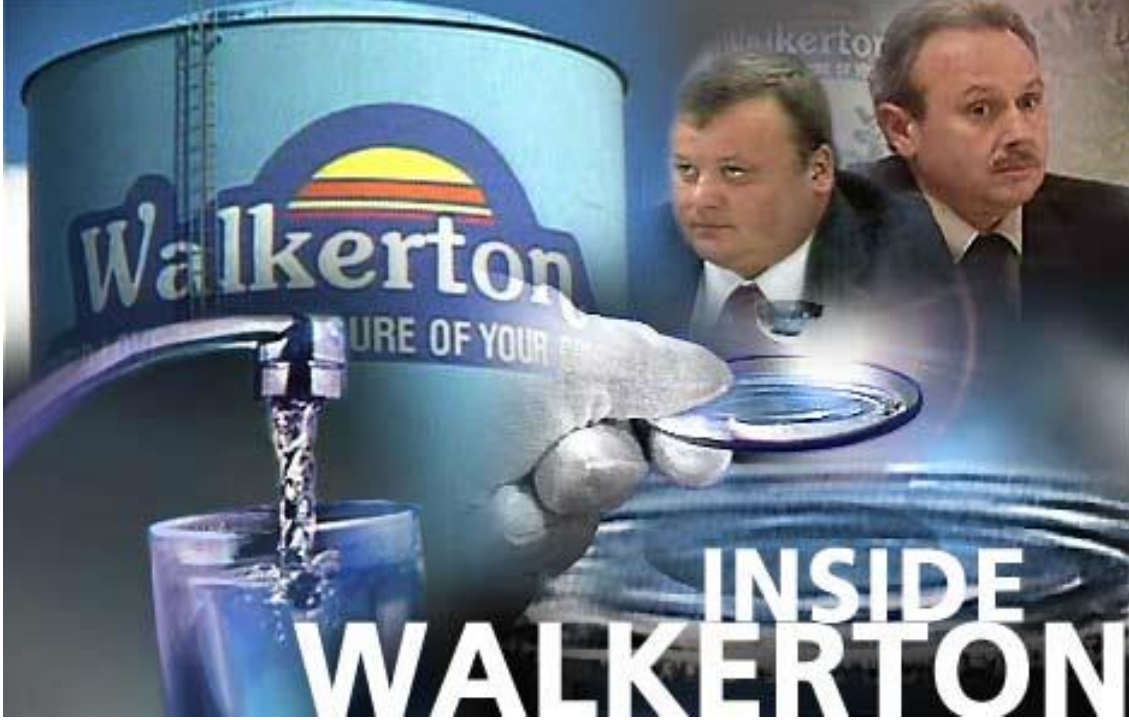
A sampling of water quality information

- Approximately 57% of Canadians are served by wastewater treatment plants, compared with 74% of Americans, 86.5% of Germans, and 99% of Swedes. •
- In developing nations, 80% of diseases are water-related.
- Of all Canadians, 26% rely on groundwater for domestic use.
- One drop of oil can render up to 25 litres of water unfit for drinking
- One gram of 2,4-D (a common household herbicide) can contaminate ten million litres of drinking water.
- One gram of PCBs can make up to one billion litres of water unsuitable for freshwater aquatic life.
- One gram of lead in 20,000 litres of water makes it unfit for drinking. Older homes often contain plumbing made of lead or soldered in lead, which can then leach into water
- The nitrates in fertilizers promote excessive growth of algae and larger aquatic plants, causing offensive algal blooms and driving out sport fish.
- Methane gas can often be seen bubbling up from the bottom of ponds; it is produced by the decomposition of dead plants and animals in the mud.

3. Municipal Water Quality

Three major issues of municipal water supply are:

1. drinking water quality
2. wastewater treatment improve quality
3. water demand management

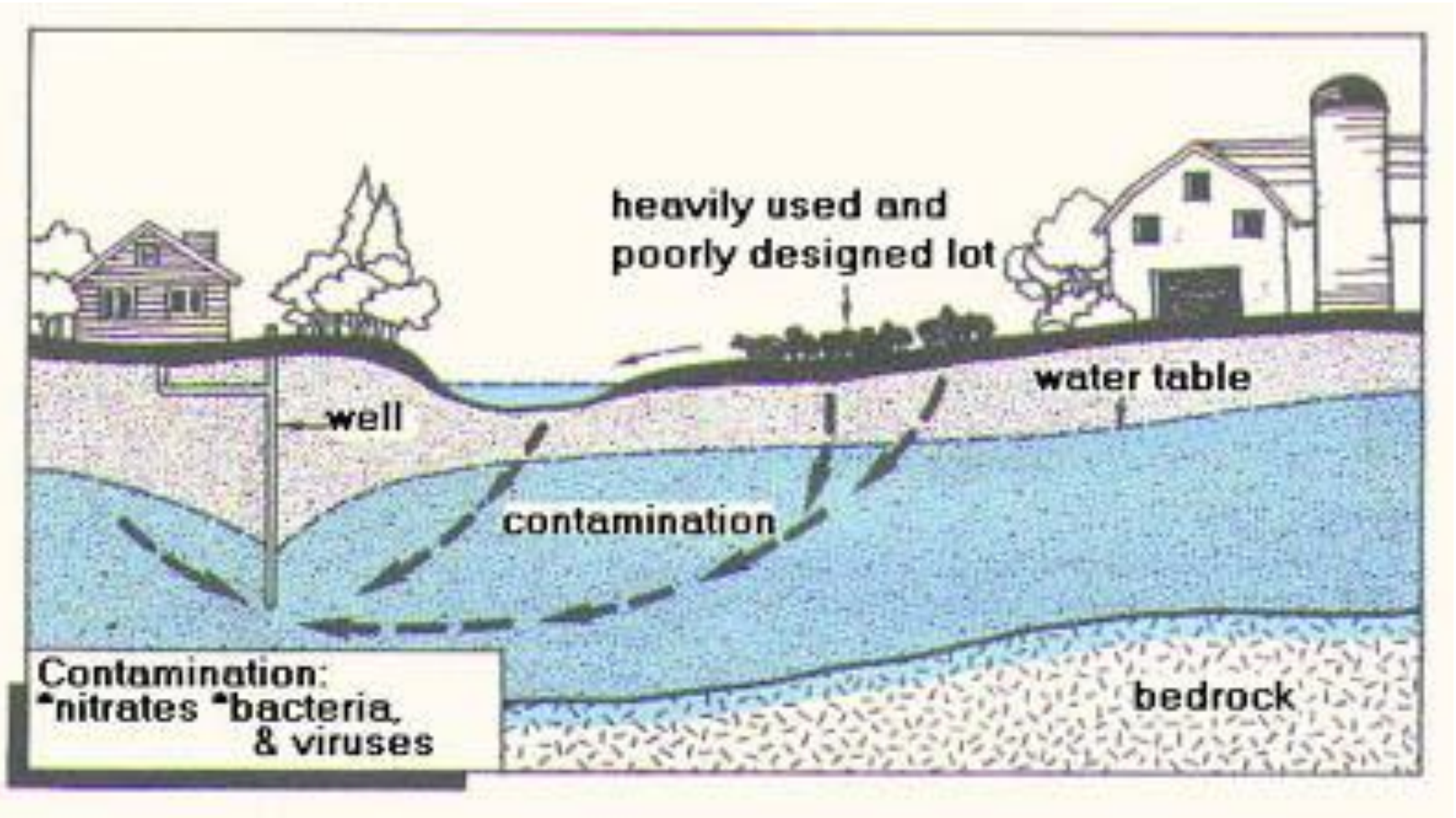


- Improper chlorine treatment
- Equipment being repaired
- Operators had insufficient training
- Private Co. falsified monitoring
- Provincial Monitoring inadequate



- May 2000
- Water supply contamination from E-Coli Bacteria
- 7 died and 2300 became ill
- E-Coli from manure on fields near water supply
- Shallow well and fractured bedrock
- Exacerbated by rainfall
- Farmer followed proper practices

ANIMAL LOTS



Water Quality Programs and the Multi-Barrier Approach

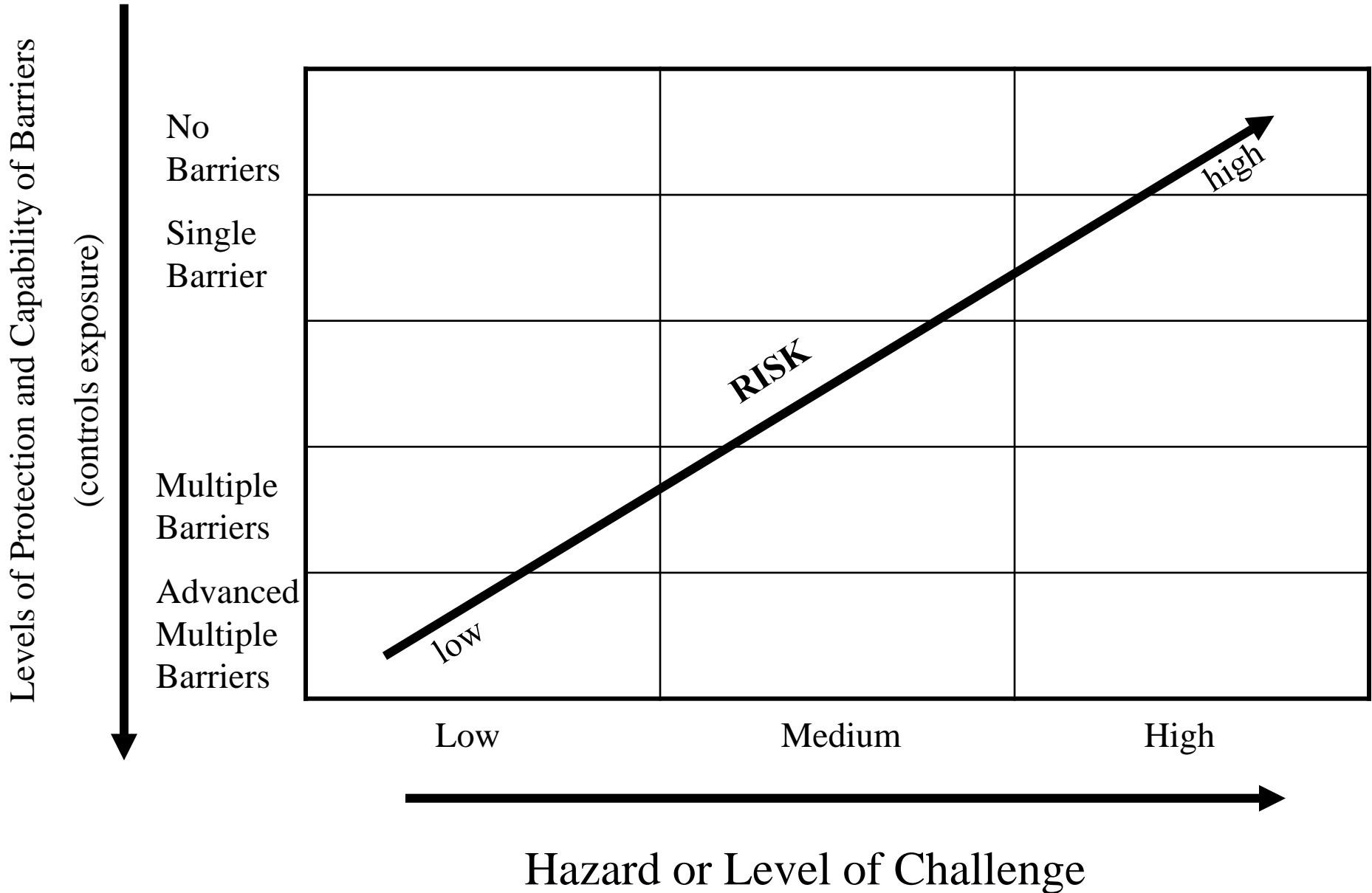
- Provincial governments have the primary responsibility for managing and protecting water quality, including the provision and regulation of drinking water and wastewater services
- The federal government is responsible for ensuring the safety of drinking water within areas of federal jurisdiction, such as national parks and Aboriginal reserves.
- The federal government also protects water quality by regulating toxic substances, conducting water quality research, and promoting pollution prevention.

A water system must be robust and resilient to change.

Multi-barrier Approach

1. Source: the best possible raw water quality should be maintained and protected
2. Treatment: effective treatment should be designed, operated and maintained
3. Distribution: secure storage and distribution of treated water should be provided
4. Monitoring: appropriate and effective monitoring should be performed
5. Response: appropriate and effective response to adverse monitoring or adverse circumstances are needed

Relationship of drinking water risk to water contamination challenge and treatments system resilience



5. Concerns and Threats to Drinking Water



Outline

- Introduction
- Pharmaceuticals and Personal Care Products
- Chlorine Byproducts (THMs)
- Waterborne Diseases
- Water Terrorism
- What Can We Do? / Future Outlook



Introduction

- Although Canadian water treatment and infrastructure is of the highest standards of the developed nations, they are not the only reliable safeguard to water quality.
- Many problems exist *within* and *beyond* the existing water management systems from a local, national and international scale.
- “Business As Usual” is not an option.
- Threats are still poorly addressed because of our common failure to understand the scope of the problem.

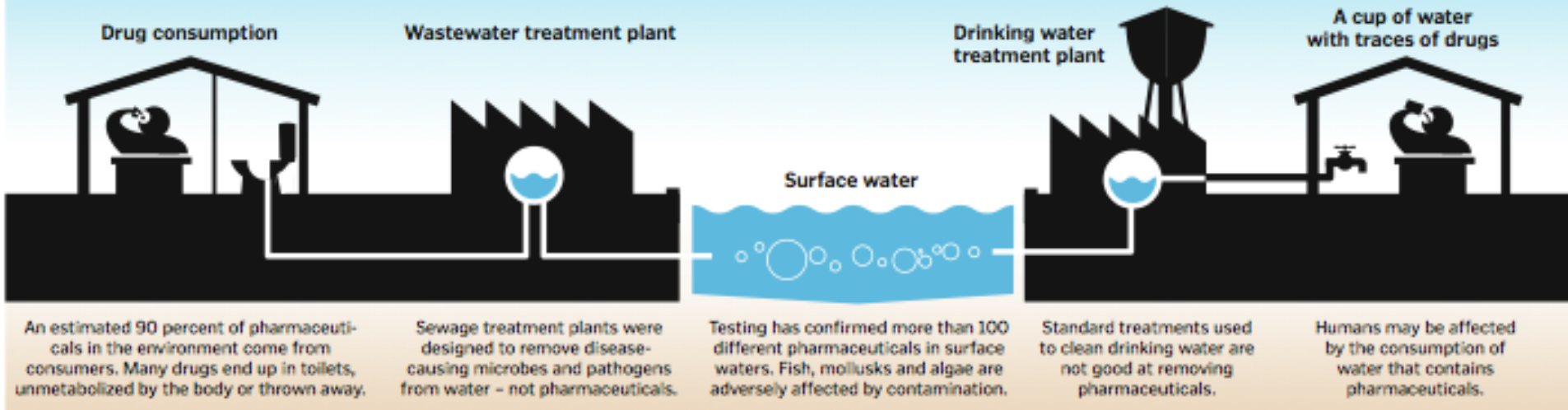


Pharmaceuticals and Personal Care Products in the Water



Pharmaceuticals in drinking water

An investigation by The Associated Press found that drinking water supplied to at least 41 million Americans carried residues of antibiotics, anti-convulsants, mood stabilizers, sex hormones and other pharmaceuticals.

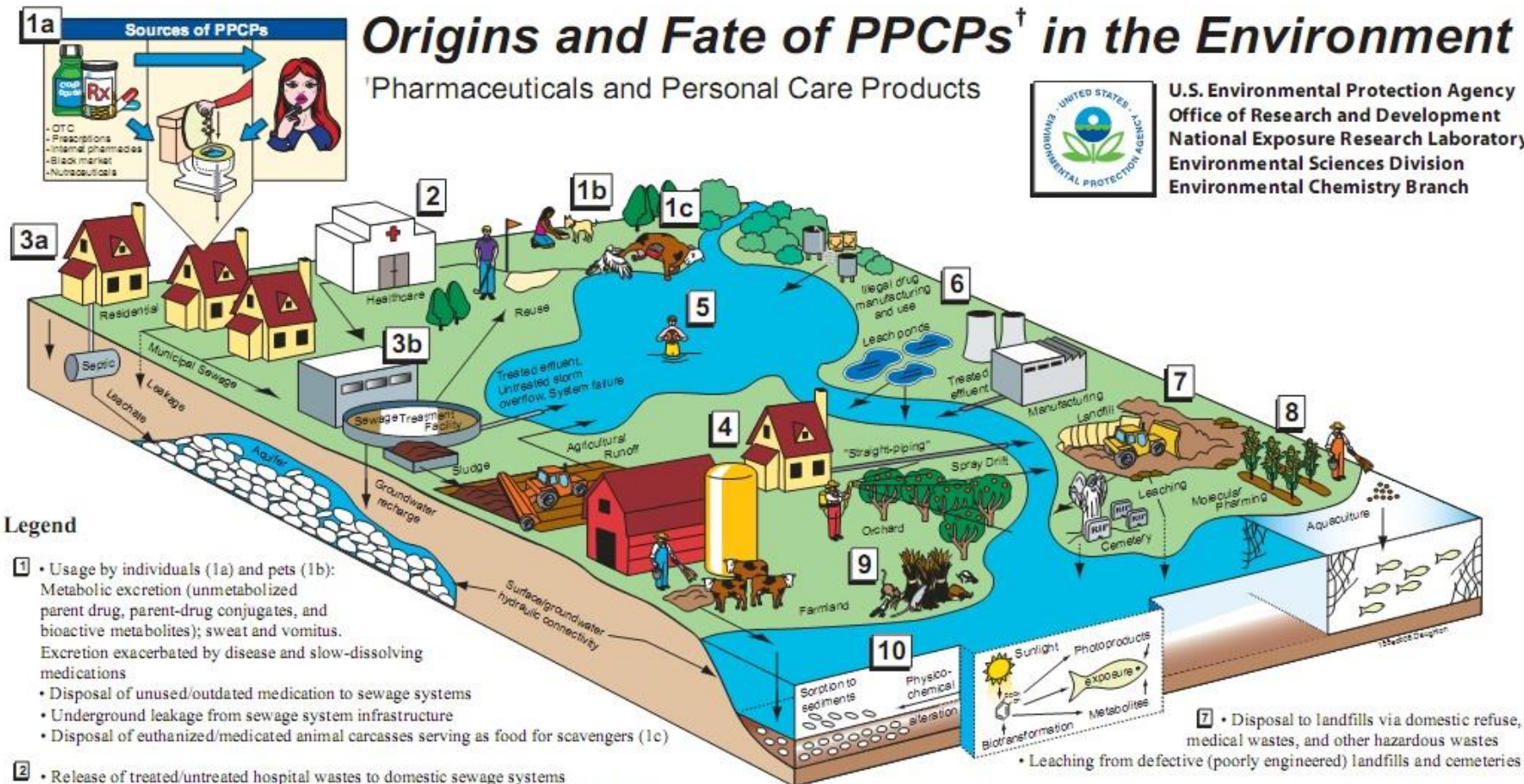


Origins and Fate of PPCPs[†] in the Environment

[†]Pharmaceuticals and Personal Care Products



U.S. Environmental Protection Agency
Office of Research and Development
National Exposure Research Laboratory
Environmental Sciences Division
Environmental Chemistry Branch

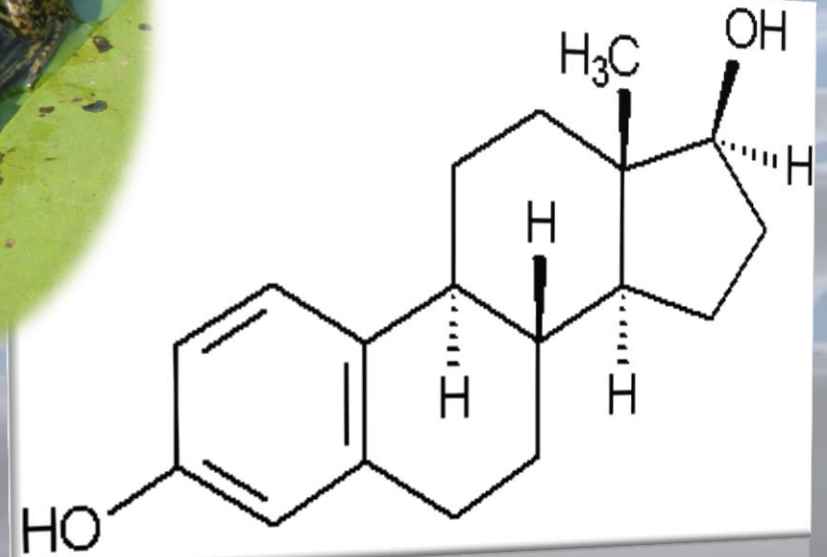


Legend

- 1 • Usage by individuals (1a) and pets (1b): Metabolic excretion (unmetabolized parent drug, parent-drug conjugates, and bioactive metabolites); sweat and vomitus. Excretion exacerbated by disease and slow-dissolving medications
 - Disposal of unused/outdated medication to sewage systems
 - Underground leakage from sewage system infrastructure
 - Disposal of euthanized/medicated animal carcasses serving as food for scavengers (1c)
- 2 • Release of treated/untreated hospital wastes to domestic sewage systems (weighted toward acutely toxic drugs and diagnostic agents, as opposed to long-term medications); also disposal by pharmacies, physicians, humanitarian drug surplus
- 3 • Release to private septic/leach fields (3a)
 - Treated effluent from domestic sewage treatment plants discharged to surface waters, re-injected into aquifers (recharge), recycled/reused (irrigation or domestic uses) (3b)
 - Overflow of untreated sewage from storm events and system failures directly to surface waters (3b)
- 4 • Transfer of sewage solids ("biosolids") to land (e.g., soil amendment/fertilization)
 - "Straight-piping" from homes (untreated sewage discharged directly to surface waters)
 - Release from agriculture: spray drift from tree crops (e.g., antibiotics)
 - Dung from medicated domestic animals (e.g., feed) - CAFOs (confined animal feeding operations)
- 5 • Direct release to open waters via washing/bathing/swimming
- 6 • Discharge of regulated/controlled industrial manufacturing waste streams
 - Disposal/release from clandestine drug labs and illicit drug usage
- 7 • Disposal to landfills via domestic refuse, medical wastes, and other hazardous wastes
 - Leaching from defective (poorly engineered) landfills and cemeteries
- 8 • Release to open waters from aquaculture (medicated feed and resulting excreta)
 - Future potential for release from molecular pharming (production of therapeutics in crops)
- 9 • Release of drugs that serve double duty as pest control agents:
 - examples: 4-aminopyridine, experimental multiple sclerosis drug → used as avicide; warfarin, anticoagulant → rat poison; azacholesterol, antilipidemics → avian/rodent reproductive inhibitors; certain antibiotics → used for orchard pathogens; acetaminophen, analgesic → brown tree snake control; caffeine, stimulant → coqui frog control
- 10 • Ultimate environmental transport/fate:
 - most PPCPs eventually transported from terrestrial domain to aqueous domain
 - phototransformation (both direct and indirect reactions via UV light)
 - physicochemical alteration, degradation, and ultimate mineralization
 - volatilization (mainly certain anesthetics, fragrances)
 - some uptake by plants
 - respirable particulates containing sorbed drugs (e.g., medicated-feed dusts)

17 α -Estradiol

Estra-1,3,5(10)-triene-3,17 β -diol



Thousands of different active molecules belonging to various therapeutic classes, with different physiochemical properties, chemical structures, environmental behavior and **persistence** have lead to the complex issue involving environmental pollution from PPCPs.

**TAKE YOUR MEDICINE...
Back to your pharmacy**



Protect your health and the environment by returning unused or old medicines for safe disposal.

IMPORTANT

DO NOT

- Flush drugs down the toilet
- Throw drugs down the sink
- Dump drugs in the trash
- Give drugs to other people to use

BRING BACK

- All unused or old prescription drugs, including patches
- Non-prescription medicines like analgesics
- Herbal products
- Vitamin and mineral supplements

Check to see what's accepted at your pharmacy.

EcoSuperior
ENVIRONMENTAL PROGRAMS
www.ecosuperior.org

 Environment Canada / Environnement Canada

Canada

Egalement disponible en français

Environmental Working Group's
**shopper's guide to
 safe cosmetics**



INGREDIENTS TO AVOID

DMDM hydantoin and Imidazolidinyl urea
toxic contaminants

Fragrance and dyes
allergies, cancer, nervous system

Methylchloroisothiazolinone and Methylisothiazolinone
allergies, nervous system

Parabens or "-paraben"
hormone effects

"PEG" and "-eth"
toxic contaminants

Sodium lauryl or laureth sulfate
skin damage, toxic contaminants

Triclosan and triclocarban
thyroid and environmental concerns

Triethanolamine (TEA)
allergies, toxic contaminants

For more information on this list, visit cosmeticsdatabase.com

With no required safety testing, cosmetics companies can use almost any chemical they want, regardless of risks. Read labels before you buy.

PRODUCTS TO AVOID

Anti-aging creams with lactic, glycolic, AHA, and BHA acids

Hair dyes with ammonia, peroxide, p-phenylenediamine, diaminobenzene; all dark permanent hair dyes

Liquid hand soaps with triclosan

Nail polish and removers with formaldehyde

Skin lighteners with hydroquinone

Safer shopping tips

- Use fewer, simpler products.
- Don't trust claims like "dermatologist-tested," "natural," or "organic." Read the ingredient label instead.
- Take label warnings seriously. They indicate hazardous chemicals.
- Look up your products' reviews at EWG's cosmeticsdatabase.com.

SUNSCREENS

- Stay in the shade from 10 am to 4 pm
- Wear a hat, sunglasses, & protective clothing
- Use SPF 30 or higher
- Avoid sprays and the ingredient oxybenzone
- Use 7% or higher zinc oxide or titanium dioxide
- Avoid added bug repellent

CHILDREN'S PRODUCTS

- Avoid boric acid and sodium borate in diaper cream
- Avoid 2-bromo-2-nitropropane-1,3-diol in baby wipes
- Avoid toothpaste with fluoride for children under 2
- Avoid play makeup like lipstick, perfume, and nail polish

More tips and product reviews at cosmeticsdatabase.com

- **Subscribe to EWG's newsletter.**
[Sign up at ewg.org/signup](http://ewg.org/signup)
- **Support the Kid-Safe Chemicals Act.**
[Learn more at ewg.org/kidsafe](http://ewg.org/kidsafe)



first cut out guide, then fold here

Make your own cosmetics guide

1. Cut along dotted
2. Fold guide in half along the middle.
3. Fold guide into thirds like an accordion to make it pocket-size



fold guide into thirds at these two points



Ingredients

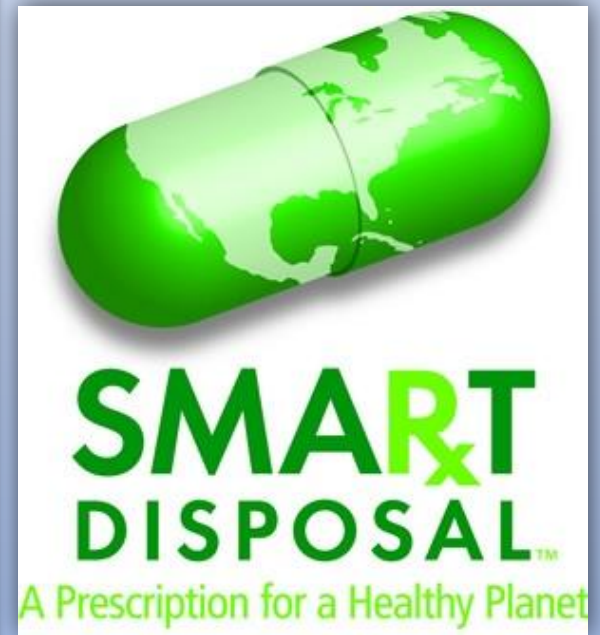
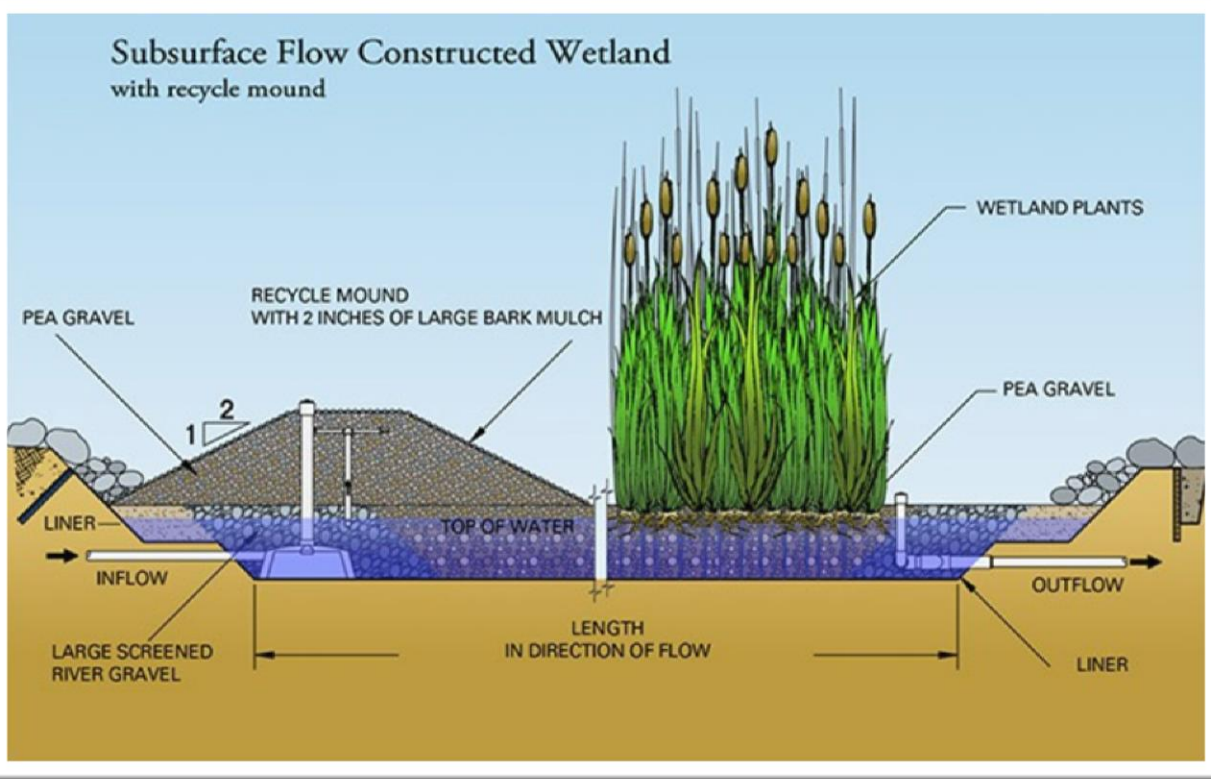
How to Use

Black = Safe Synthetic
 Green = Natural and/or Organic

Sodium Bicarbonate, Citric Acid, Fair Trade Cocoa Butter (Theobroma cacao), Laureth 4, Almond Oil (Prunus dulcis), Water (Aqua), Chamomile Powder (Anthemis nobilis), Marshmallow Powder (Althaea officinalis), Marigold Powder (Tagetes erecta), Synthetic Musk, *Benzyl Benzoate, Perfume, D&C Red No. 33,.

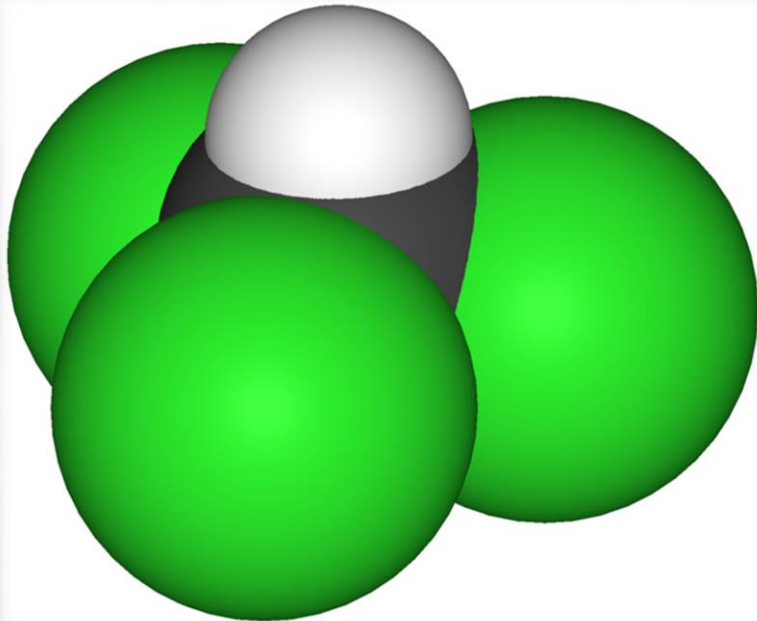
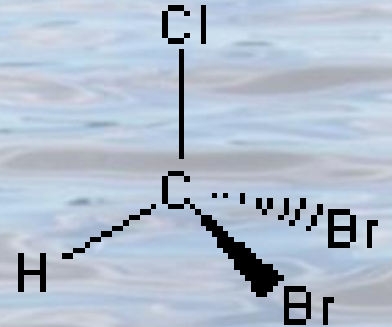
*Naturally occurs in essential oils

There is a need for alternatives from a scale that spans from our daily lives to the international management.



Chlorination Disinfectant Byproducts

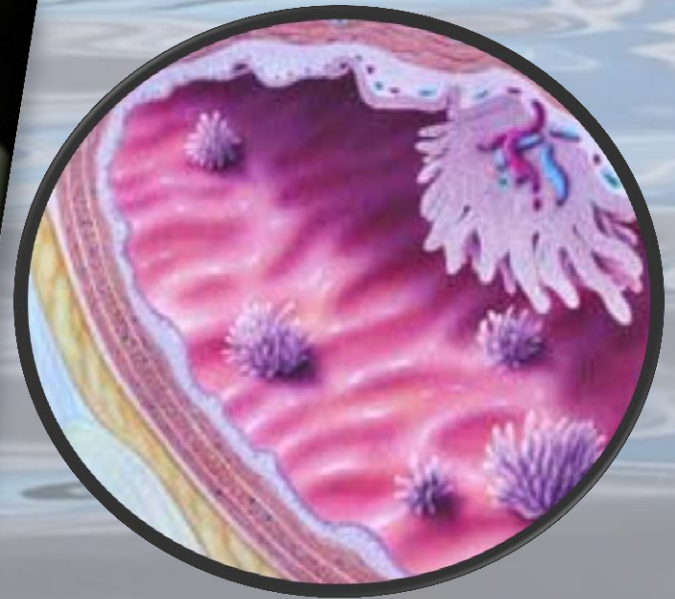
TRIHALOMETHANES
(THMs)



- Chlorine is a disinfectant added to drinking water
- Reduces and eliminates microorganisms such as viruses and bacteria
- CDBPs are chemical compounds that form when water, containing natural organic matter, reacts with chlorine
- THMs are a major subgroup of chlorination by-products

THE PROBLEM?

Evidence of close relationships between bladder cancer and exposure to THMs



Case Studies

- One study in Ontario, Canada examined the relationship between bladder cancer and exposure to chlorination byproducts in public water supplies (King and Marrett, 1996).
- Thunder Bay has also done studies on the rate of bladder cancer in Loch Lomond water supply

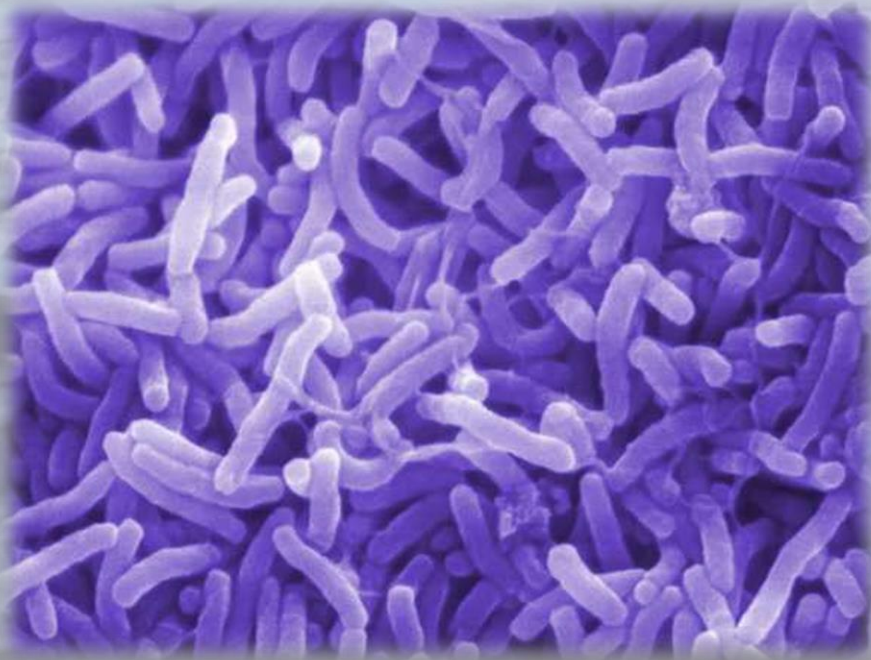


Solutions:

- A carbon filter can remove chlorine and its byproducts
- Alternatives to chlorine disinfectants
 - Ozonation
 - Chloramines
 - Chlorine dioxide
- Better knowledge and application of more precise methods
- Ontario drinking water quality standard (ODWQS)



Waterborne Diseases



Waterborne Diseases

- Types of diseases linked to water
 - Water-based diseases
 - Water-washed diseases
 - Water-related diseases
 - Water-borne diseases
 - typhoid
 - cholera

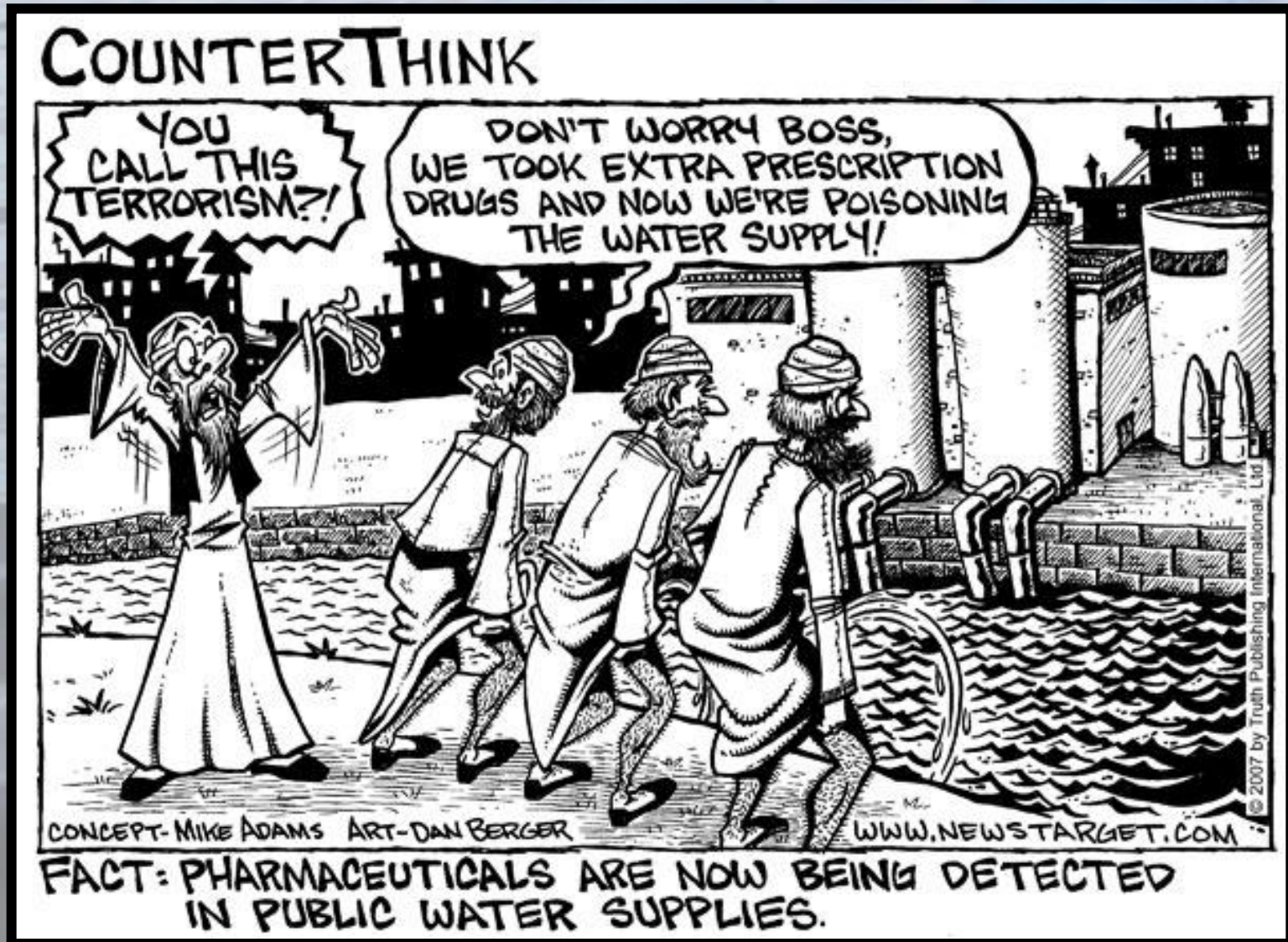


Solutions

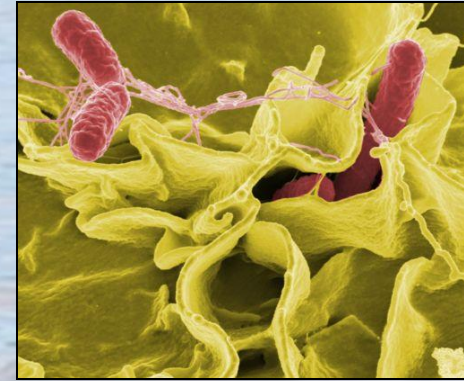
- Vaccinations
- Oral Rehydration Therapy
- Need to be Proactive!
 - Education
 - Water Treatment Facilities (urban)
 - Safe Water System (rural)
 - Wells vs Surface Water



Water Terrorism



Water Terrorism



- Biological, chemical, cyber and physical threats
- Risks to infrastructure, human health, economy
- Biological
 - potential to do the most harm
 - Anthrax, salmonella, Q fever, pneumonic plague, human waste
 - Contaminate reservoirs, bottling plants
- Chemical
 - Pesticides, chlorine, prussic acid (large quantities)
 - Some available in stores, others on the black market

Water Terrorism



- Cyber Threats
 - The use of computer network tools to shut down critical national infrastructure
 - Energy, transportation, dams
 - The most likely form of water terrorism (Lewis 2002)
- Physical Threats
 - Destruction of infrastructure from explosives

Water Terrorism

- Case Studies:
 - Romania 1944 German military polluted a Romanian towns drinking water with human waste (biological)
 - 1985- A cult in the Ozark mountains were planning to poison the water supply of New York, Chicago, Washington D.C., with potassium cyanide (chemical)
 - 2000 Australian man gained control over the waste water system, releasing sewage into parks, rivers, and private properties. Did this using a laptop and radio transmitter (Cyber)
 - U.S. security heightened post 9/11



Future Outlook



Strategies to Increase Public Education and Awareness

- Educate citizens to engage and inspire to permanently change behaviour
 - Websites
 - Newsletters
 - Annual water quality report and fact sheets
- Information should help public understand guidelines, conservation issues, costs of providing services, improvements, further research needs, pollution mitigation



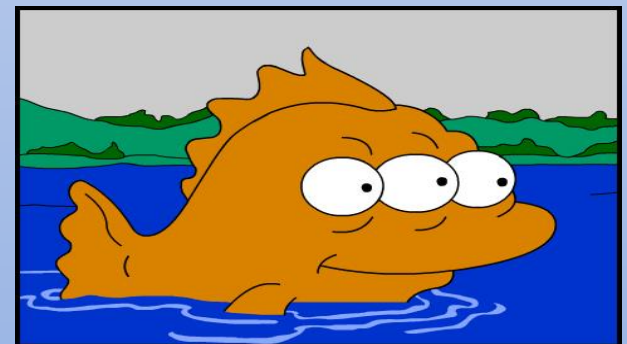
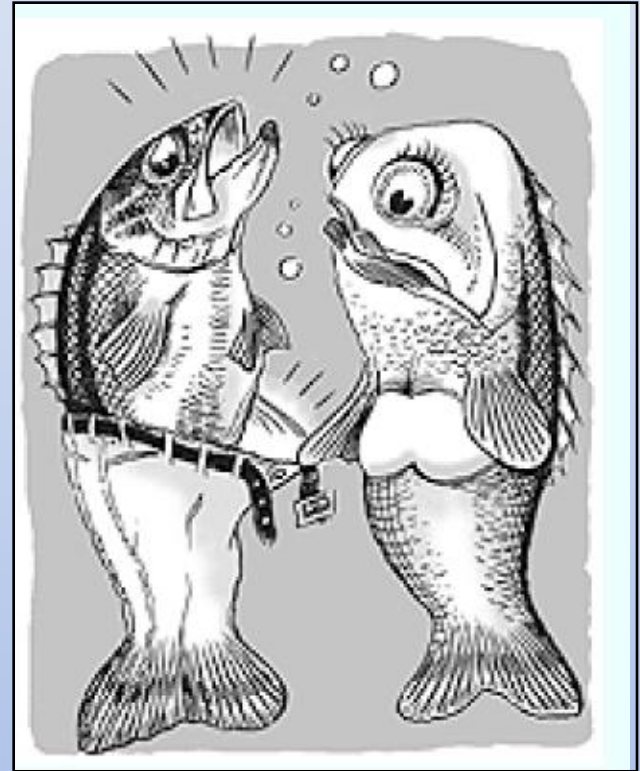
Education

- Educating land owners on regular water testing and well maintenance
- Land owners should be aware of best management practices
 - Stream banks
 - Buffer strips
 - Tree planting
 - Fencing



Research & Science

- Science-based decisions should be made - rather than on policies and assumptions which could result in measures that are overly or under-protective of human and ecological health.
- Research and development must be supported – it is not a cost, it is an investment in the future.
- Science is usually only 10-20% of the solution. The remaining management requires partnerships across jurisdictions, industry, commerce and the community.



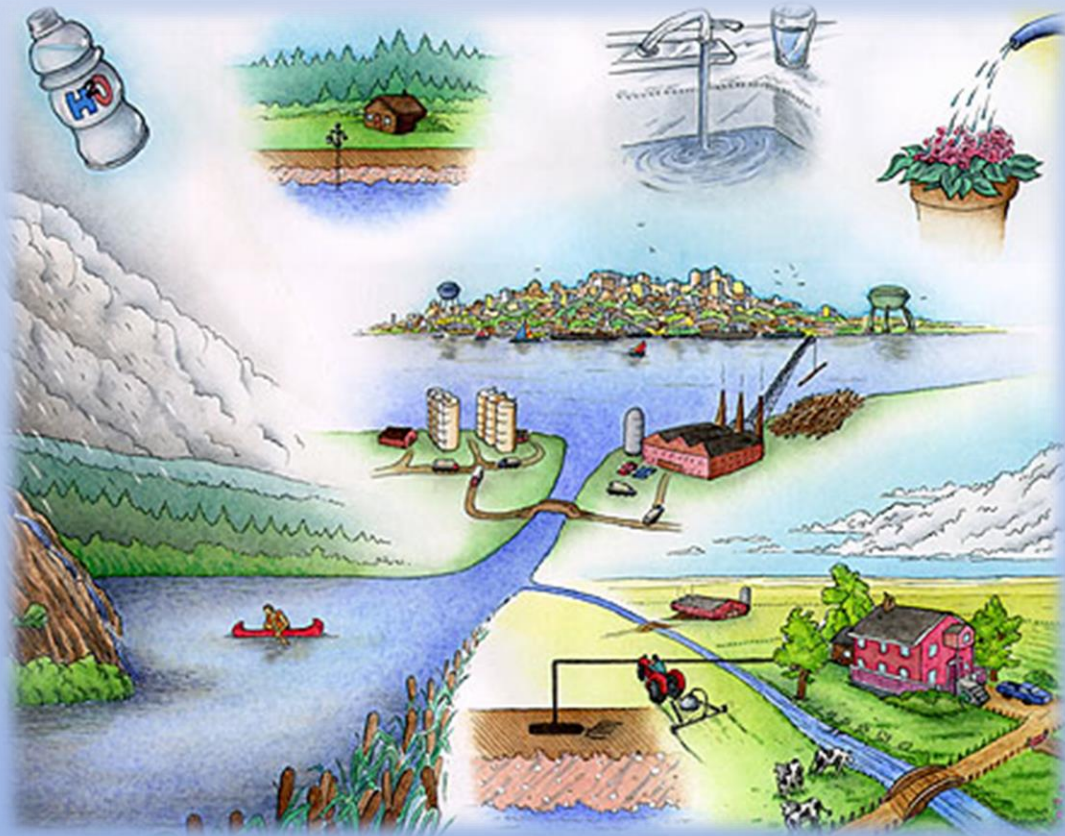
Responsibility and Management

- Political Issues – Up/Downloading of responsibility
- Stewardship of landowners
- Preventive Risk Management Approach
 - Understanding water supply from beginning to end
 - Know the ways it can be contaminated and the required treatments
- Example: The Multi-Barrier Approach
 - Identifies all known and potential hazards
 - Ensures barriers are in place to reduce or eliminate risk of contamination



Closing Remarks

- Better knowledge of who is responsible
- Recognizing tomorrow's threats and finding the solutions today, rather than looking to solve today's problems tomorrow



MINISTRY OF THE ENVIRONMENT
DRINKING WATER ONTARIO

The background of the slide is a close-up photograph of water with numerous small, concentric ripples. The water is a light blue-grey color, and the ripples create a textured, shimmering effect across the entire surface.

What do you think is the best way to manage untapped threats?

What other threats may exist to our drinking water supply?