Routine Bacteriological Water Sampling
What does it mean?

Presented by
Lynne Magee
30 Jan 2020
WPWG

Excellent health and care for everyone, everywhere, every time.

Without monitoring you really never know what the water is…

- Identify hazards to reduce risk
- Detect trends
- Establish historical reliability
- Evaluate system performance
- Requirement under the Drinking Water Protection Act

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Types of Monitoring

- Microbiological
- Chemical and Physical
- Operational and Process

Pathogens: 3 Distinct Groups

Protozoa	Bacteria	Viruses
		
800 nm- 400X	500 nm – 25X	20 – 90 nm

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Pathogenic Bacteria

- E. coli 0157 and Salmonella
- Single cell, size 500nm

- Destroyed by chlorination and UV disinfection

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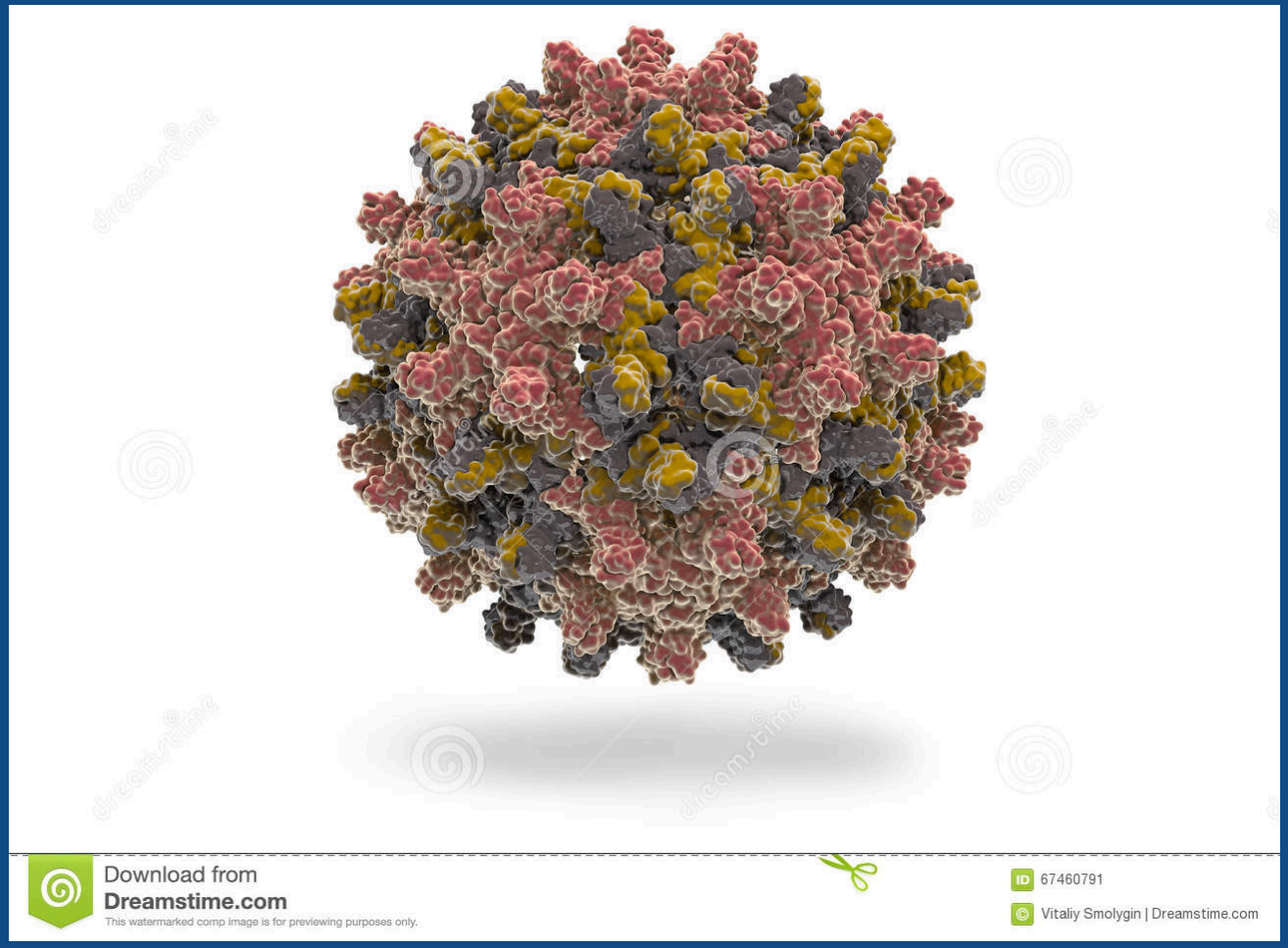
Pathogenic Viruses

- Norovirus



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Pathogen Survivability

Microorganism	Surface water	Groundwater
Viruses	11 – 304 days	11 days – 1 year
Salmonella	1 day – 2 months	
Vibrio Cholera	5 days – 25 months	10 days – 35 days
Protozoan cysts	176 days, 18 + months	2 – 6 months
E. coli indicator group	30 days – 90 days	40 days

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Should We Test for Individual Pathogens?

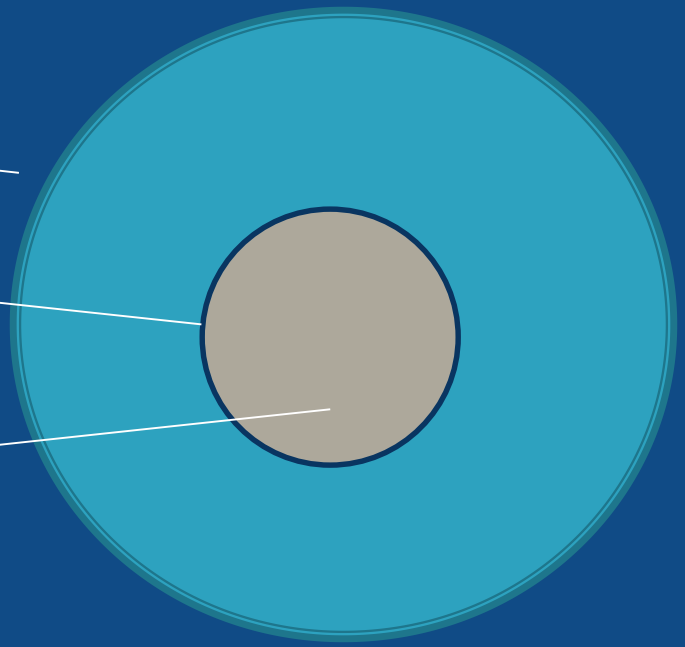
Generally…No

- Cost prohibitive, time consuming, and overly specific
- We use indicator organisms instead

During an outbreak… Yes

Indicator Organisms

- Total coliform bacteria
- *E. coli* bacteria



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Coliform Guidelines For DWQ

- **Standard**: no total coliforms and no *E. coli* detectable per 100 mL, reported as **L1/L1**
- **No sample should contain Escherichia coli (*E. coli*).**
- **No consecutive samples from same site, or not more than 10% of samples in a given month with total coliform bacteria.**

Total coliform bacteria

- Live in the environment (surface water and soil)
- Can reproduce in many places in the environment
- Easily destroyed by simple disinfection
- Fast and inexpensive test $25

What does a positive Total Coliform test result tell us?

Lake

– Their presence is expected

Well

– Secure ground water is not their ‘home’

Drinking water

– Disinfection process not effective

E. coli Bacteria

- Live in the intestinal tract of animals and humans
- Indicator of recent fecal contamination
- Do not survive long in the environment
- Destroyed by chlorination and UV disinfection
- Fast and inexpensive test $25

What does a positive *E. coli* test result tell us?

- Surface water
  - From fecal material so some sample results will be positive
- Ground water
  - Should be absent in a secure ground water supply
  - Fecal material is entering the well
  - Well security or unsecure ground water
- Treated drinking water
  - Treatment system failure
  - Distribution system failure
  - Contaminated water unsafe to drink

What does a negative bacteria result tell us?

- Sample is an indication of no recent fecal contamination
- Some pathogens can survive longer in the environment than *E. coli* bacteria.
- In treated water, clue to the effectiveness of treatment for the targeted pathogens

Sample Volume Vs Water Used

- Water utility serving 36 homes
- Uses 24,500 liters per day (150 gpd/home)
- x 30 days/month = 735,000 litres/month
- 2 samples per month = 200 ml
- 0.200 litres/735,000 litres

= 0.000003% of the water used is being sampled

Plus there's usually two weeks between each sample

Other Monitoring – Process Indicators

- Chlorine demand and residual
- Turbidity
- Conductivity
- pH
- Treatment/Disinfection system performance
- Consumer complaints (taste, odour, appearance)

What to do with the Test Result

- Share them with Island Health DWO
- Compare results over time
- Compare results between sample sites
- Share them with the consumers (annual report

Summary

- Total Coliform - abundant in environment,

  are not fecal in origin
- *E. coli* - indicative of recent fecal contamination

  (pathogens are likely to be present)
- Both are bacteria (as opposed to viruses or protozoa)
- Both are destroyed by UV and chlorination

- Total coliform and *E. coli* tests do not show presence of protozoa or viruses
- Absence of coliform is not a guarantee that pathogens are absent
- Operational monitoring is valuable i.e. chlorine residual
- Decisions must err on the side of caution
- Apply the precautionary principle

Questions?

- Lynne Magee, BSc., CPHIC(C)
- Island Health, Regional Drinking Water Coordinator

3rd Floor

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Nanaimo, BC V9T 2L9

250-755-3339

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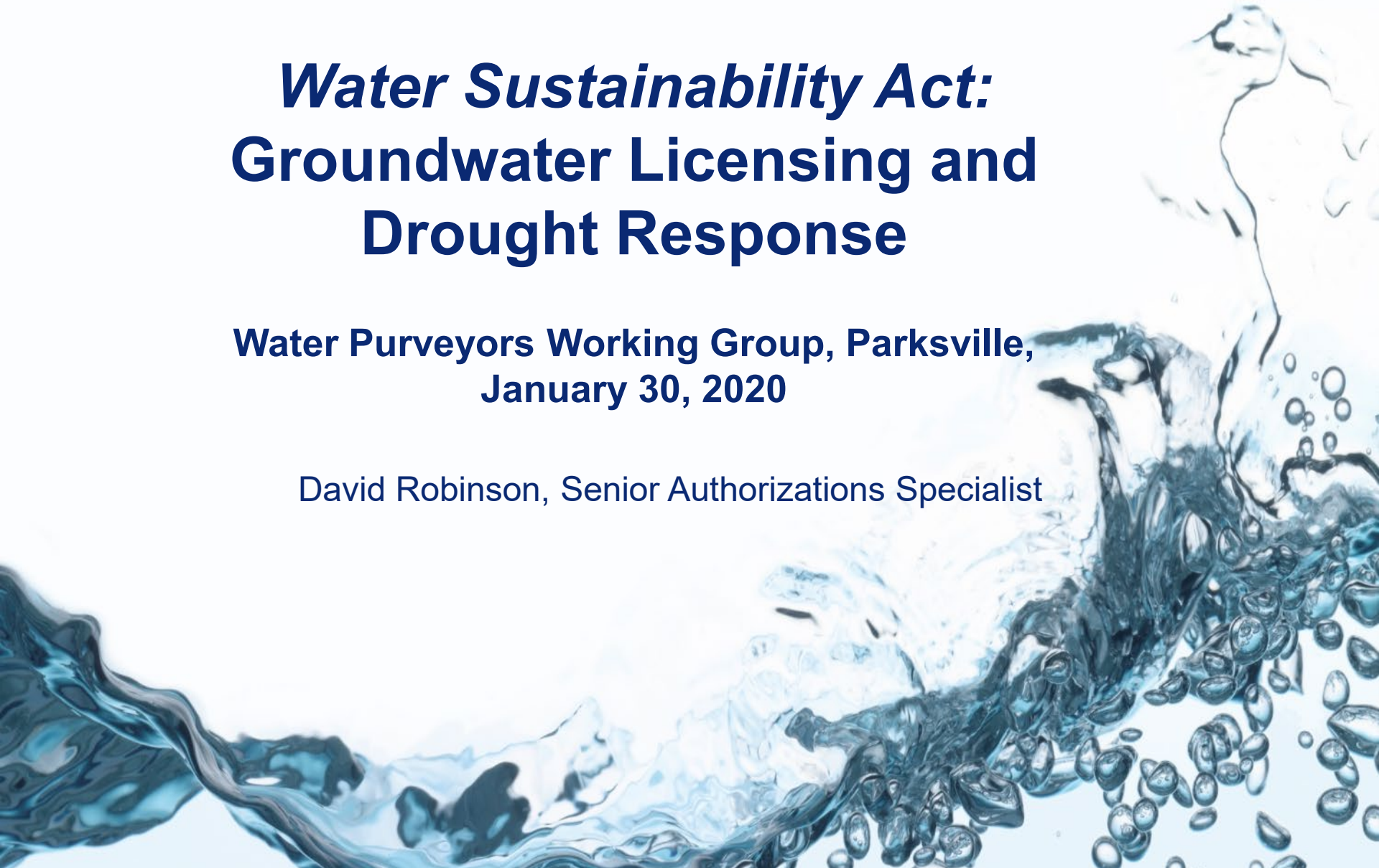
Ministry of **Forests, Lands, Natural Resource Operations and Rural Development**

Water Sustainability Act: Groundwater Licensing and Drought Response

Water Purveyors Working Group, Parksville, January 30, 2020

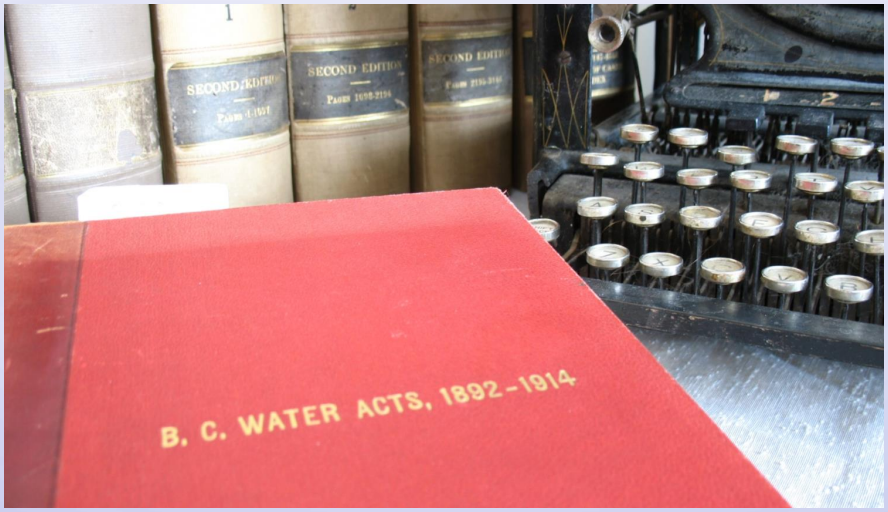
David Robinson, Senior Authorizations Specialist



Legislative Background

BC has been licensing surface water for over a century (previously under the *Water Act*)

Groundwater use followed Common Law principles: divert and use under owner's land for normal uses on their land. The ***right of capture*** with no right of prior appropriation – i.e. the biggest pump wins



Water Sustainability Act – enacted Feb 29, 2016

- Large portion of *Water Act* moved to *Water Sustainability Act*
- Water allocation system based on the principle of **First-in-time First-in-right** (FITFIR)
- Established provisions and procedures to apply for an authorization, decision maker discretion for applications and the right to notice and objection for affected parties
- 11 Water Use purposes
- Water rights are tied to land and pass with conveyance

Water Sustainability Act – enacted Feb 29, 2016

- NEW Diversion and use of **groundwater** and water in a stream requires an authorization unless otherwise exempted – domestic groundwater users, extinguish a fire etc.

- NEW Mandatory consideration of **environmental flow needs** unless exempted (domestic and existing groundwater users).

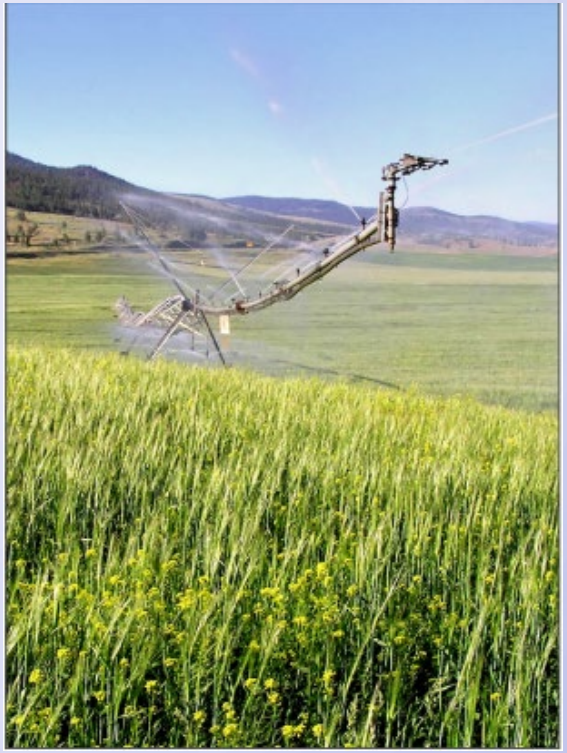
- NEW Groundwater users who were beneficially using water on or before Feb 29, 2016 have until **March 1, 2022 to apply** for a water licence as transition users (excluding domestic users).

Basic Considerations for a Water Authorization Decision

All water licence applications follow a basic process: application submission – review – recommendations – decision.

1. Beneficial Use
2. Water availability
3. Impacts to other parties (notice and objection)
4. Impacts to the environment
5. Impacts to Aboriginal Interests
6. Other approvals/authorizations etc.

These are often all interconnected.



1. Beneficial use

Means using the water:

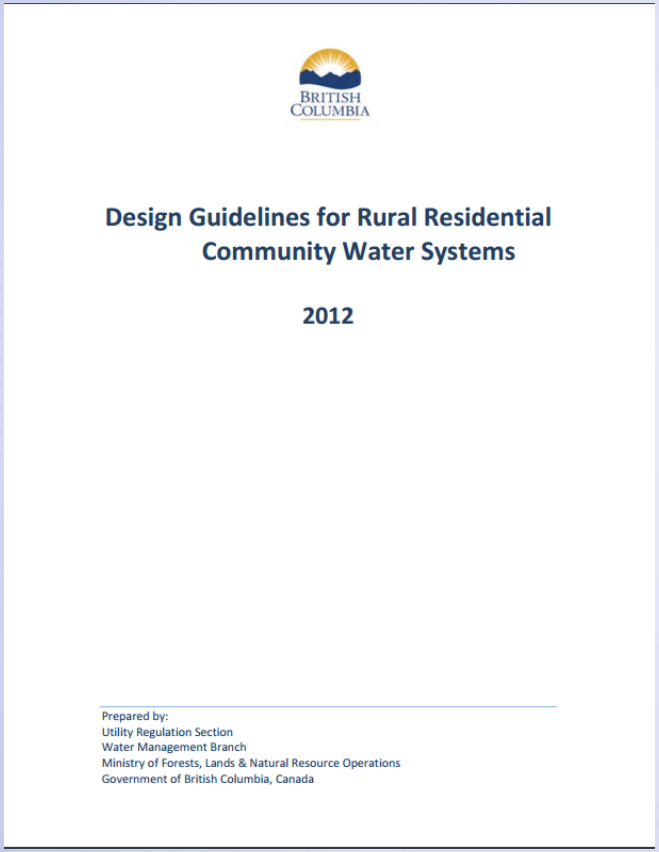
- Efficiently
- In accordance with regulations
- For the purposes, manner and time as authorized

When reviewing an application:

- What are the water use purposes?
- How much water is being used?
- Are there reasonable plans in place for future use?

Most licence holders have three years to make beneficial use of the water (longer for waterworks)

Guidance tools for water use calculations


BRITISH COLUMBIA

Design Guidelines for Rural Residential Community Water Systems

2012

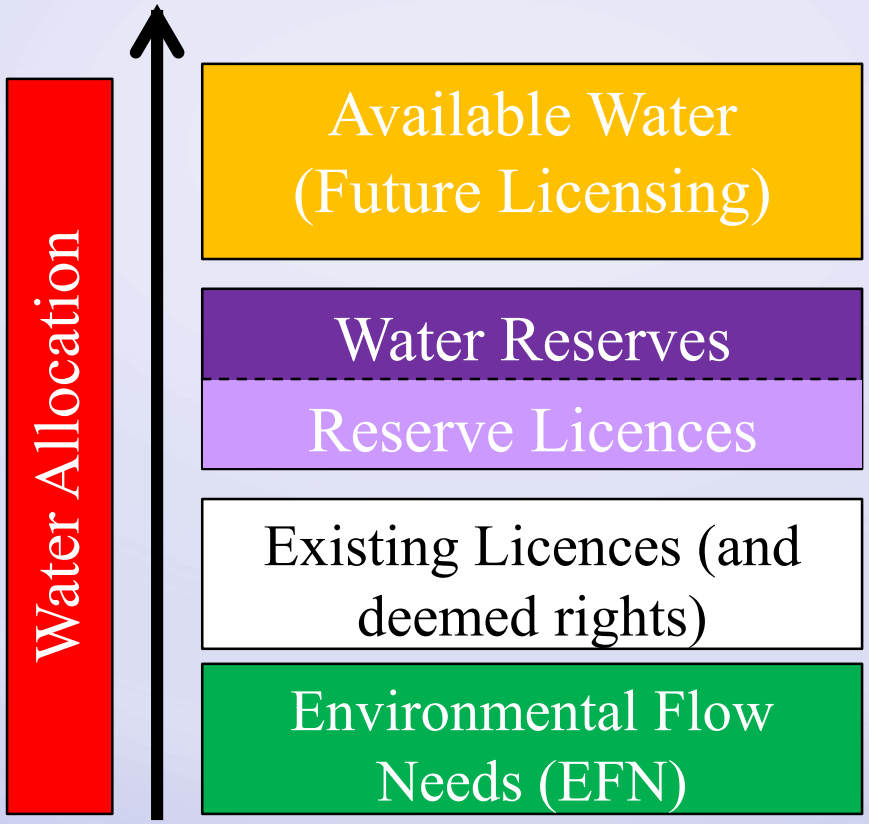
Prepared by:
Utility Regulation Section
Water Management Branch
Ministry of Forests, Lands & Natural Resource Operations
Government of British Columbia, Canada

1. Demand calculations
   - Average day demand, peak hour demand, fire flow demands
2. Design of water system components
3. Wells
4. Transmission and distribution pipes
5. Pump stations
6. Electrical design

http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-rights/water-utilities/design_guidelines_rural_residential_water_mar2012.pdf

2. Water availability – is there water available?

- Net of existing demand and environmental flow needs
- Data sources: observation wells; aquifer studies; water budgets (local/broad)

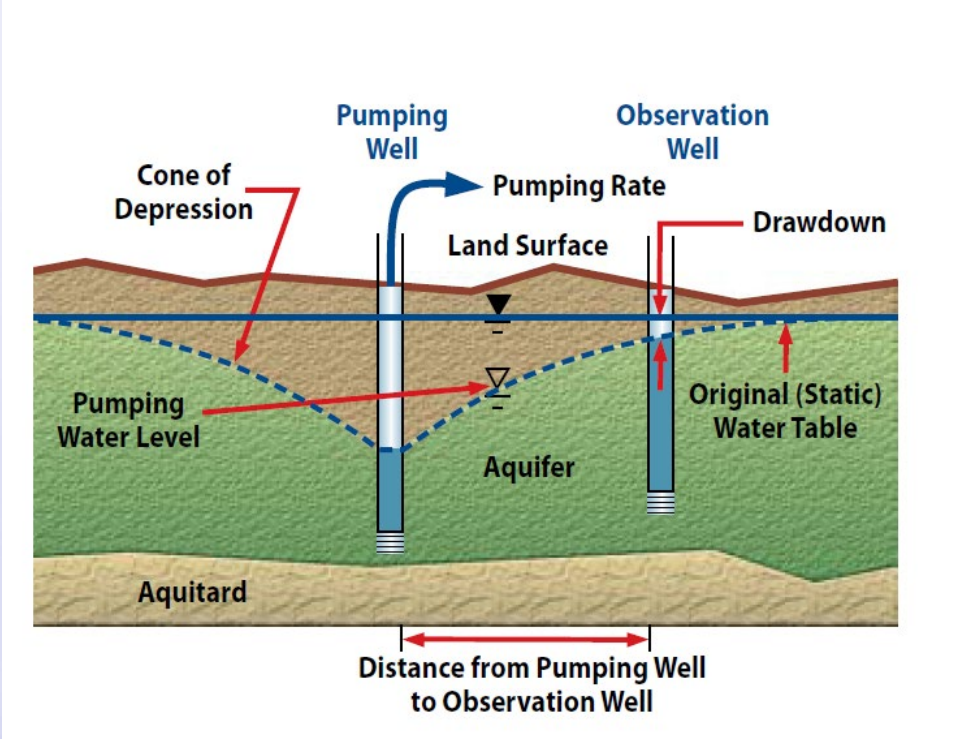


3. Impacts to other parties

Assess impacts to other authorization holders, applicants, riparian owners and land owners who may be affected. Domestic users do not have objector status, but can be notified if likely to be detrimentally impacted.

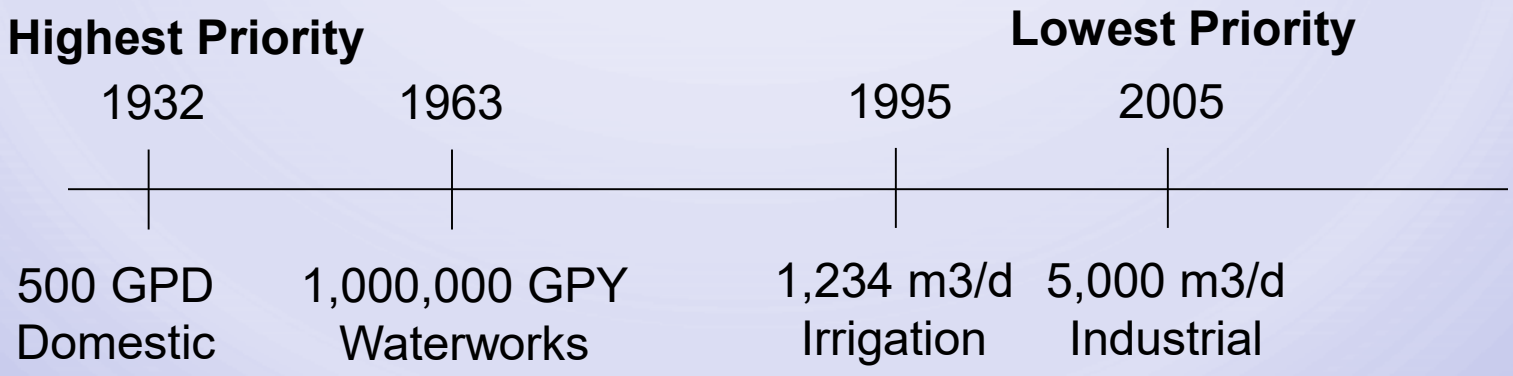
Impacts to other wells

- Need to consider drawdown/interference
- Need for a pumping test depends on a number of factors, including how well aquifer is characterized, volume and sensitivity of the aquifer to drawdown.



FITFIR Explained

- FITFIR = First in Time, First in Right – a transparent way to resolve water rights disputes between users.
- The earlier priority date or “date of precedence” attached to the water right has priority over all others.

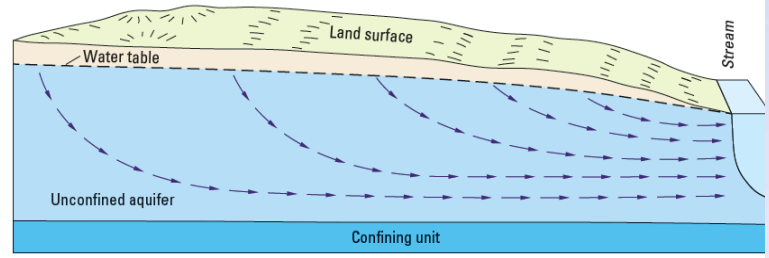


WSA - Section 22 FITFIR continued…

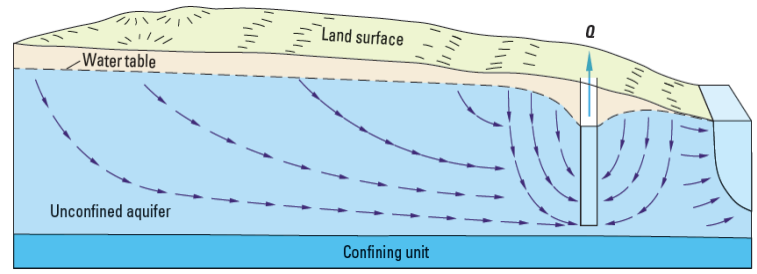
- Groundwater used for domestic purposes has deemed rights = 2,000 L per day per dwelling.
- Date of precedence is date of first use.
- During drought, if FITFIR is being enforced, essential household use permits 250 L per day.

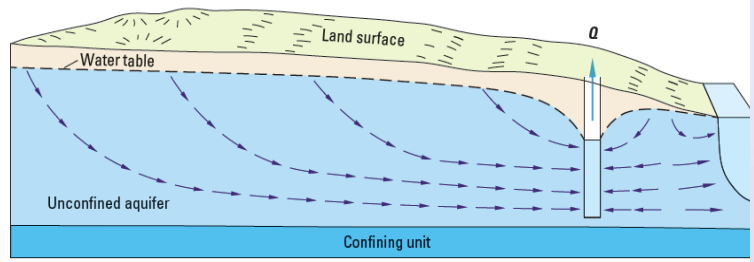
4. Impacts to the Environment

(Hydraulic Connectivity)

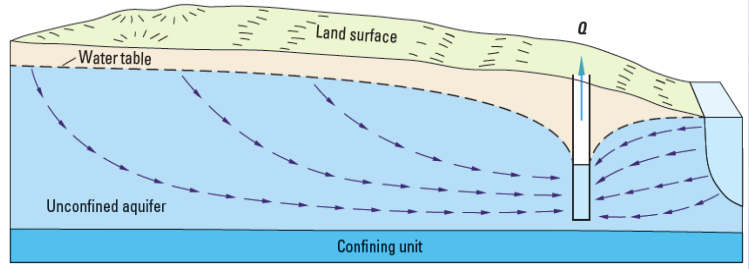


Natural conditions – gaining stream





Well pumping – can deplete stream by intercepting flow



Well pumping – depletes stream by intercepting flow and infiltration of stream water

Source: Barlow and Leake (2012)

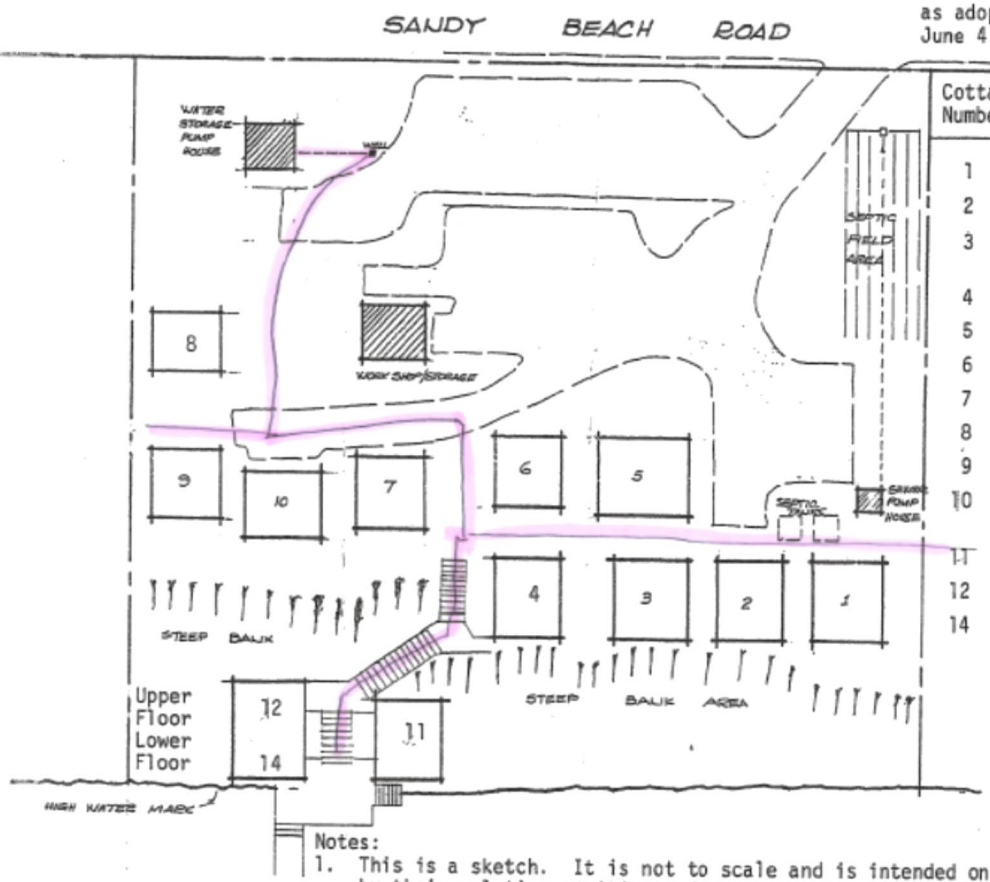
5. Impacts to Aboriginal Interests

- Crown has a duty to consult on all decisions that may adversely impact an Aboriginal Right or Title
  - Constitutional right, further affirmed through UNDRIP
  - Right to fish, hunt, gather, cultural, ceremonial, economic…
    - EFN is a useful mitigation measure in most cases
  - Impacts to aboriginal title as a result of water allocations
  - Treaty process and water allocations (water reserve)

SCHEDULE "A" TO RESOLUTIONS PASSED BY THE DIRECTORS OF SANDY BEACH HOLDINGS LTD. ON JUNE 4, 1995.

PLAN OF PROPERTY OF SANDY B
HOLDINGS LTD.

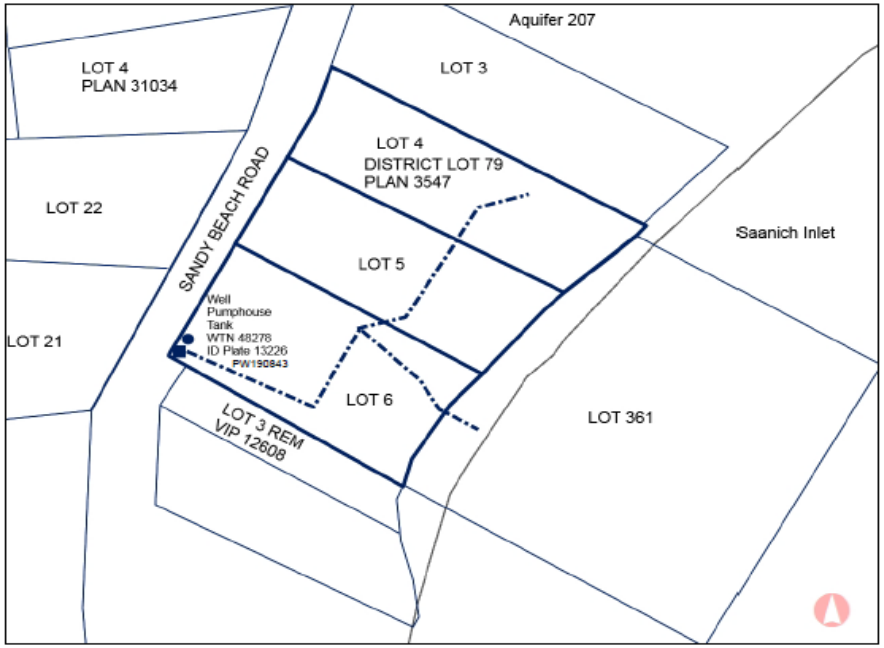
as adopted at Annual Genera
June 4, 1995



Cottage Number	Right of Occu at June 4, 19
1	C. GRANT
2	D. POWELL
3	R. & H. CAMPI M. & N. MAWSO
4	G. & R. FRY
5	R. STOKES
6	D. MURPHY
7	A. YATES
8	R. CARTWRIGHT
9	W. & R. CARTW
10	E. & M. BLANN F. & N. CORNB
11	K. JAMIESON
12	E. THOMPSON
14	F. THOMPSON

Notes:
1. This is a sketch. It is not to scale and is intended only to identify cotta by their relative position and to assign identifying numbers as indicated.
2. Number 13 has been deliberately omitted.

BRITISH COLUMBIA



WATER DISTRICT: Victoria
PRECINCT: Shawnigan
LAND DISTRICT: Malahat

Signature:
Date: April 27, 2017

LEGEND:

Scale: 1: 1,000
Point of Diversion: ●
Pumphouse: ■
Map Number: 92B.063
Pipe: — • — • —
Appurtenant Lands: ▬▬

C.L.: 500124
File: 20003536

Province of British Columbia
Water Sustainability Act

CONDITIONAL WATER LICENCE

The owner of the land to which this licence is appurtenant is hereby authorized to divert and use water as follows:

a) The aquifer on which the rights are granted is 207.

b) The point of well diversion is located as shown on the attached plan.

c) The date from which this licence shall have precedence is June 15, 1982.

d) The purpose for which this licence is issued is waterworks (other than local provider).

e) The maximum quantity of water which may be diverted for waterworks (other than local provider) purpose is 12.5 cubic metres per day.

f) The period of the year during which the water may be used is the whole year.

g) The land upon which the water is to be used and to which this licence is appurtenant is Lots 4, 5, and 6, District Lot 79, Malahat District, Plan 3547.

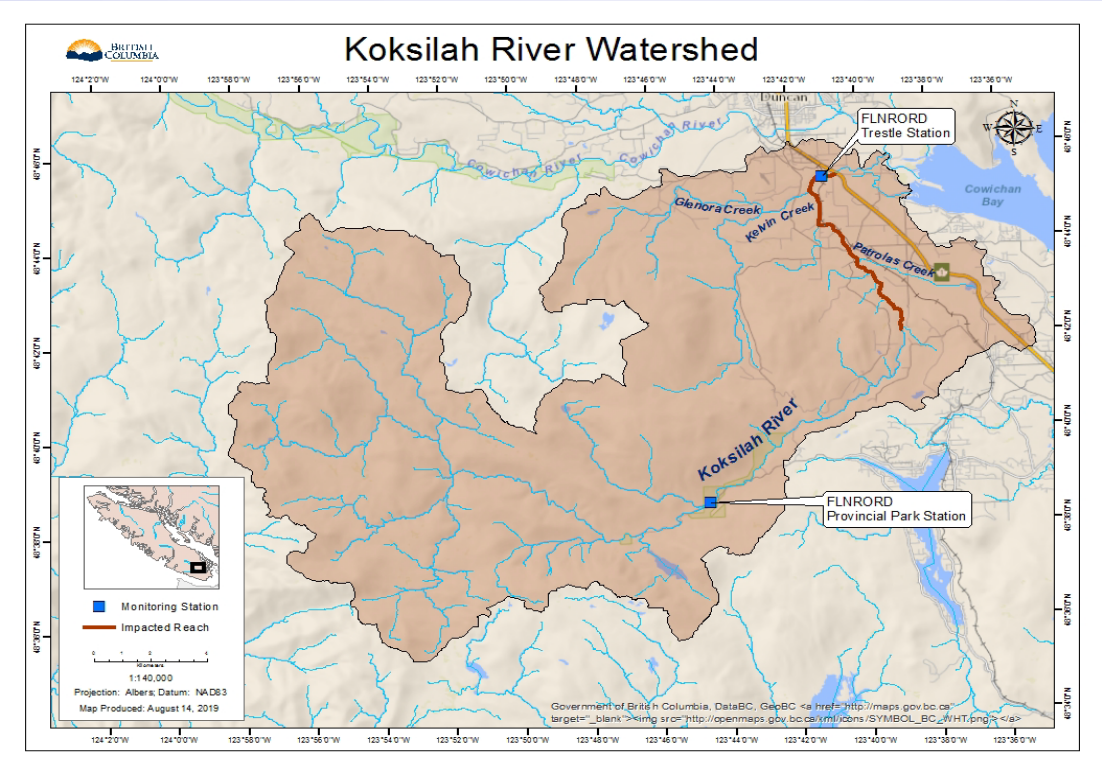
h) The authorized works are well, pipe, pumphouse, and tank which shall be located approximately as shown on the attached plan.

i) The construction of the said works has been completed and the water is being beneficially used. The licensee shall continue to make regular beneficial use of the water in a manner authorized herein.

David Robinson
Assistant Water Manager

2019 Drought Response

- Koksilah: Temporary Protection Order Aug 17 – Sep 18
- Included 37 groundwater wells with inferred use for irrigation of forage crops



Thank You

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Wells and Groundwater Protection

Water Purveyors Working Group
January 30, 2020
Parksville, BC

Nicole Fulcher, MSc.
Groundwater Protection Officer
West Coast Region, Nanaimo

BRITISH COLUMBIA
Ministry of Forests, Lands, Natural Resource Operations and Rural Development



Outline

1. Understanding groundwater
2. Understanding your well
3. Available resources
4. Well protection

Why is Well Protection Important?

- Reliable, safe and clean water
- Longer well life; lower costs
- Maintain property value
- Environmental stewardship and compliance with requirements
- Water protection for your supply system and others who use the same source
- Proper well maintenance helps support good water quality

Photo credit: FLNRORD

Aquifers & Groundwater

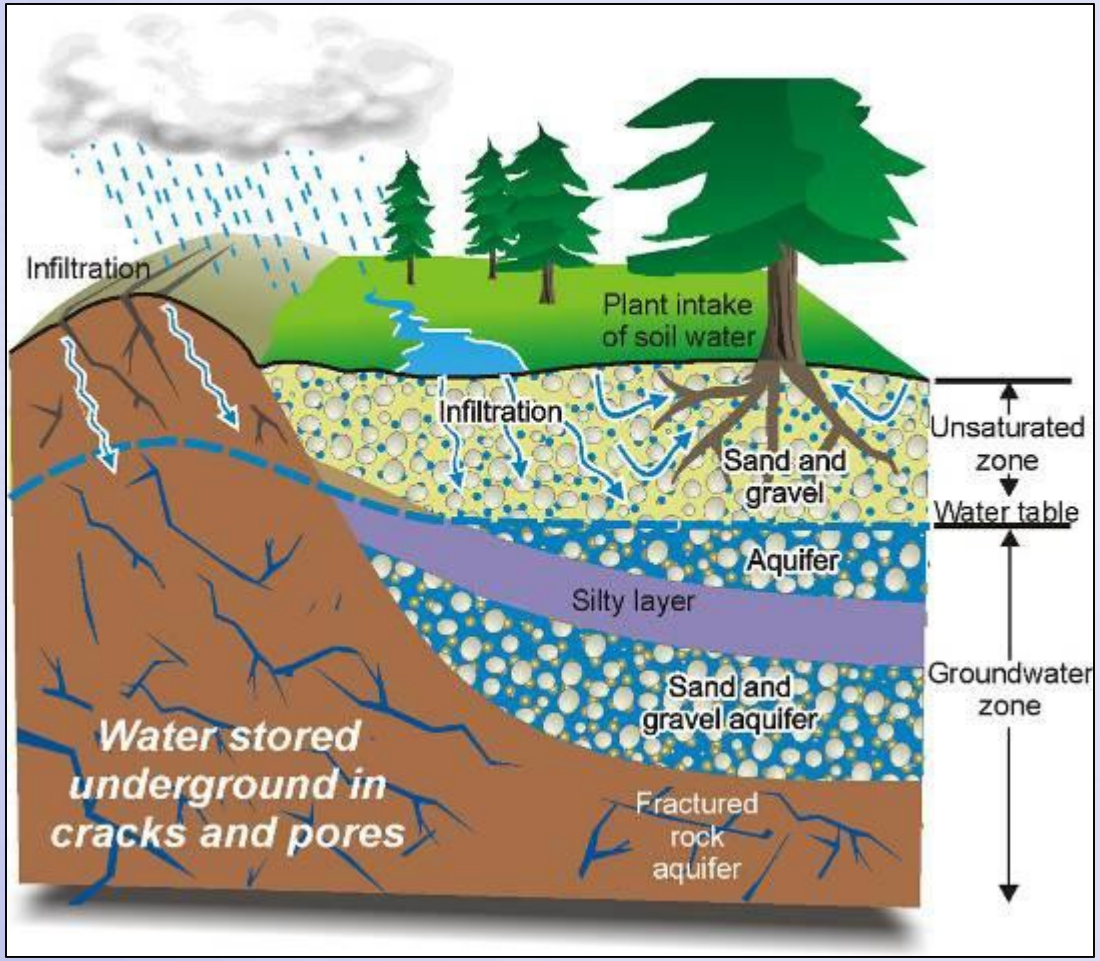
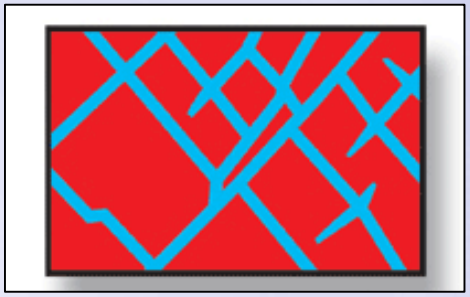
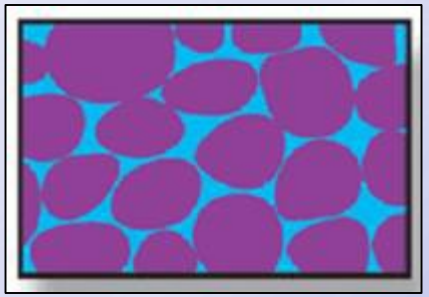


Photo credit: Natural Resources Canada



Water in rock fractures



Water between grains of sand

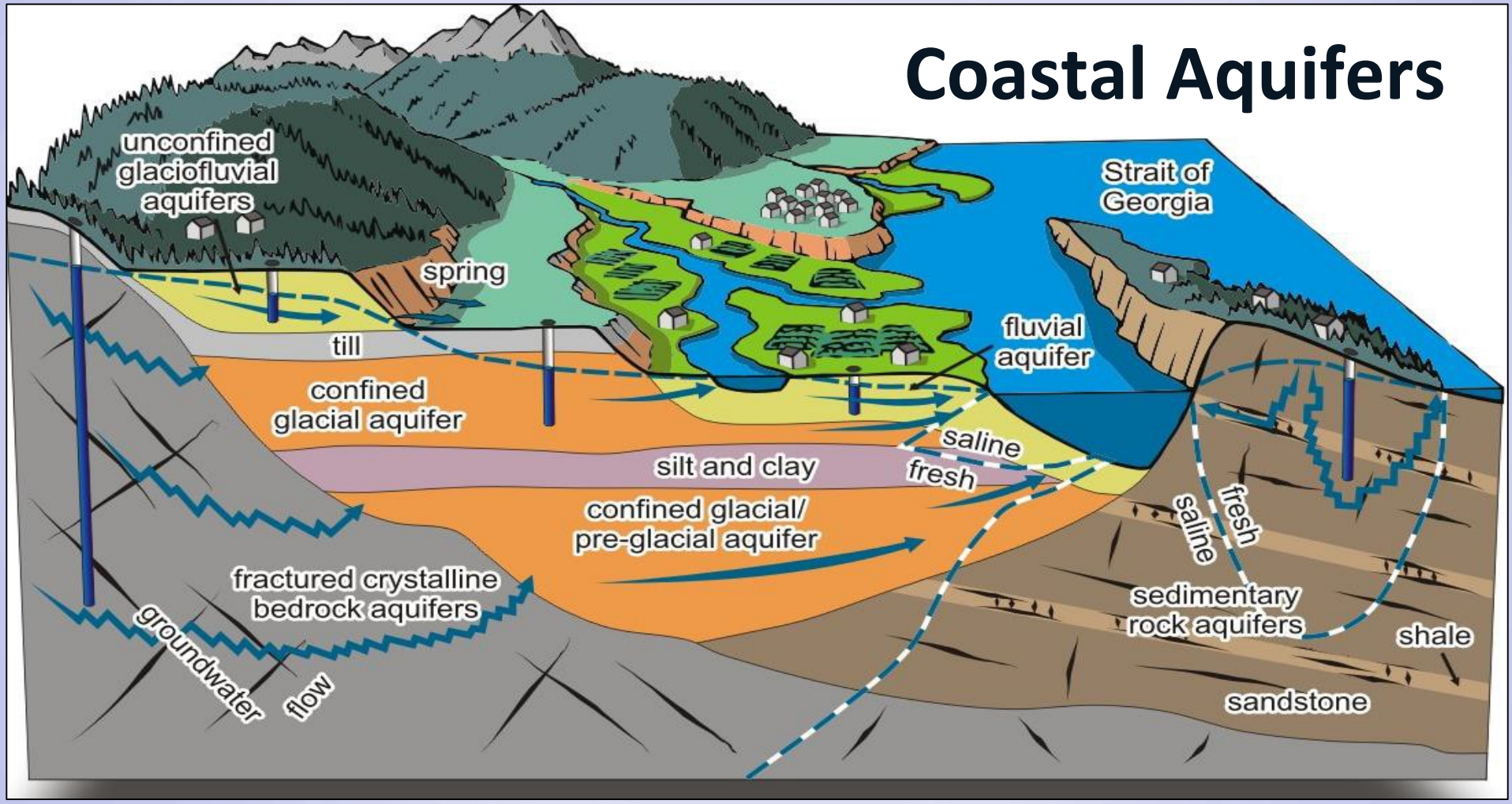
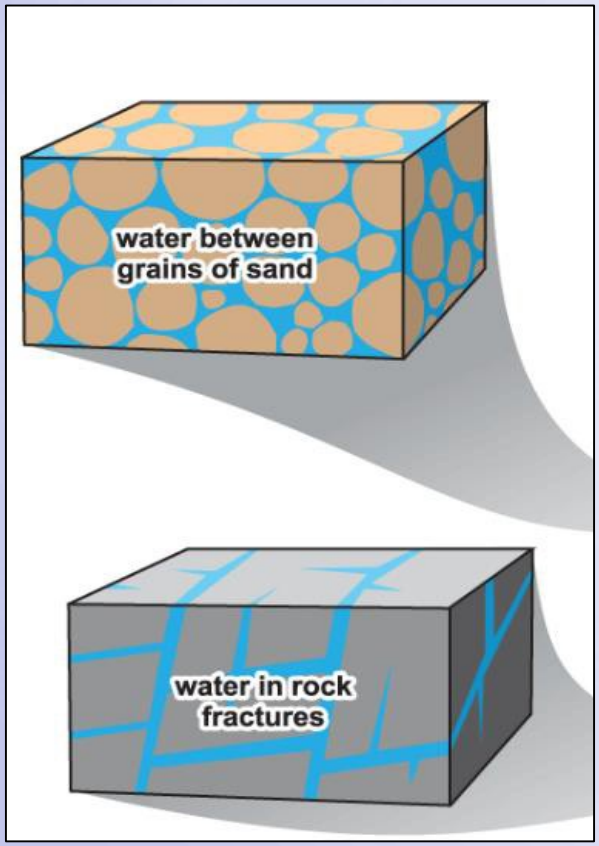
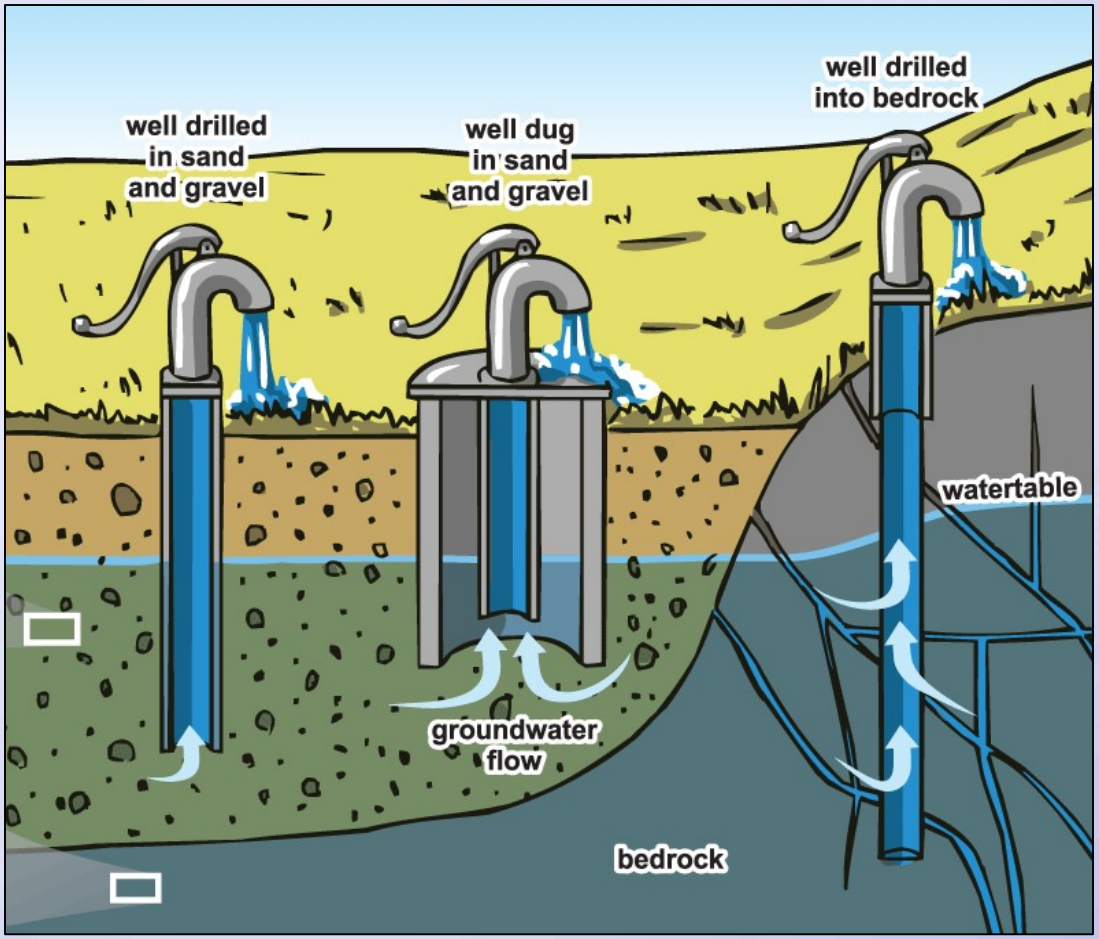


Image credit: Natural Resources Canada

How a Well Works





What kind of well do I have?

There are 3 common well types:

Dug Wells

Drilled Wells

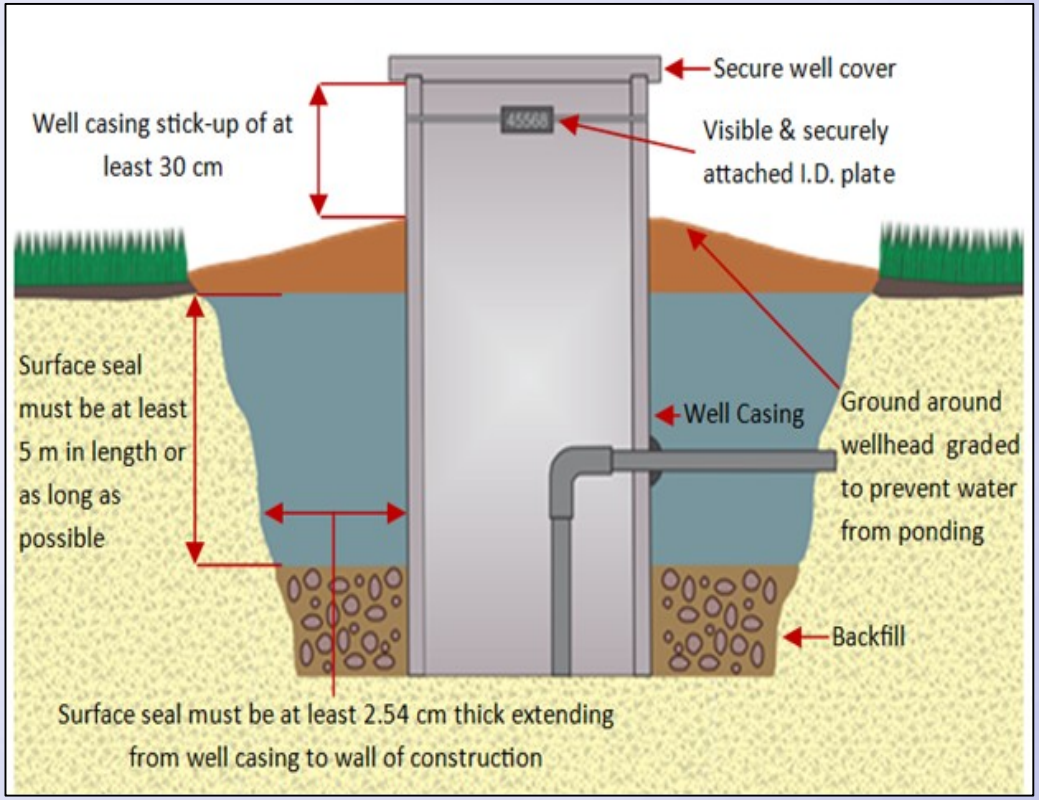
Drilled Wells in Pits

Photo credits: BC FLNRORD, Island Health

Well Types: Dug Well

Large diameter/ shallow

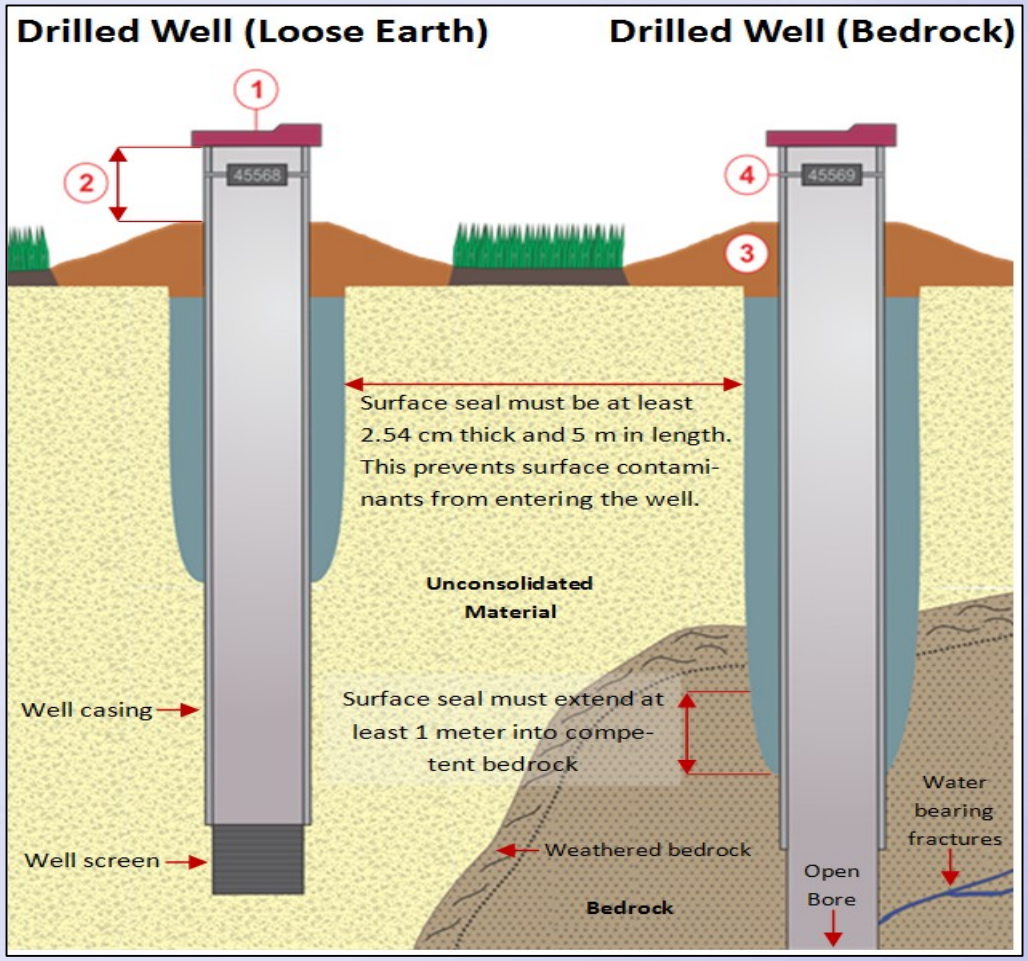
Photo credit: BC FLNRORD, Ontario Ministry of Agriculture, Food and Rural Affairs/ Agriculture (OMAFRA)



Well Types: Drilled Well

Small diameter/ deep

Photo credit: Island Health, OMAFRA



Well Types: Drilled Wells in Pits

- An excavation lined with wood, stone or metal cribbing
- Protects wellhead from freezing
- Prone to flooding and vulnerable to contamination
- Pits are dangerous to enter (low oxygen and hazardous gases)

Photo credits: Ministry of Environment (MoE)

Shallow dug wells may be higher risk than drilled wells

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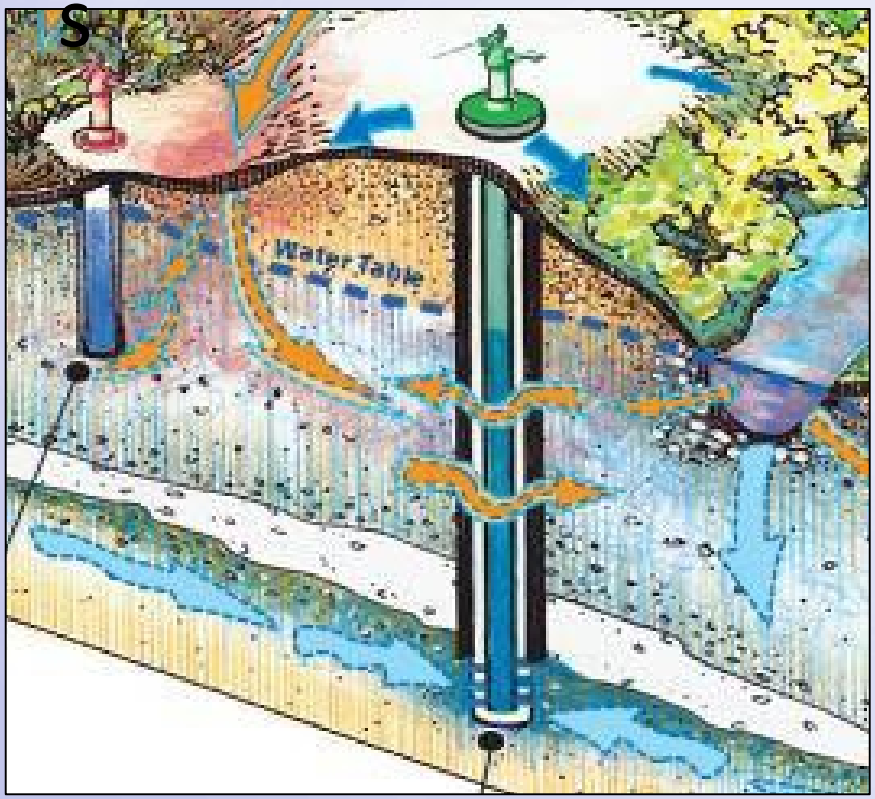


Image credit: BC Ground Water Association

<u>The safest water source:</u>

Generally, a **drilled well** into a confined aquifer at a minimum depth of **15 metres** (49 feet)

Groundwater Resources

- GWELLS – Groundwater well database and well search

https://apps.nrs.gov.bc.ca/gwells/

- Driller and Pump Installer Registry – Lookup drillers and pump installers registered to work in BC

https://apps.nrs.gov.bc.ca/gwells/registries/

- Provincial Observation Well Network

https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/groundwater-wells-aquifers/groundwater-observation-well-network

- Provincial Groundwater Wells and Aquifer Page

https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/groundwater-wells-aquifers/groundwater-wells

- iMapBC – Provincial mapping page with various layers including wells and aquifers

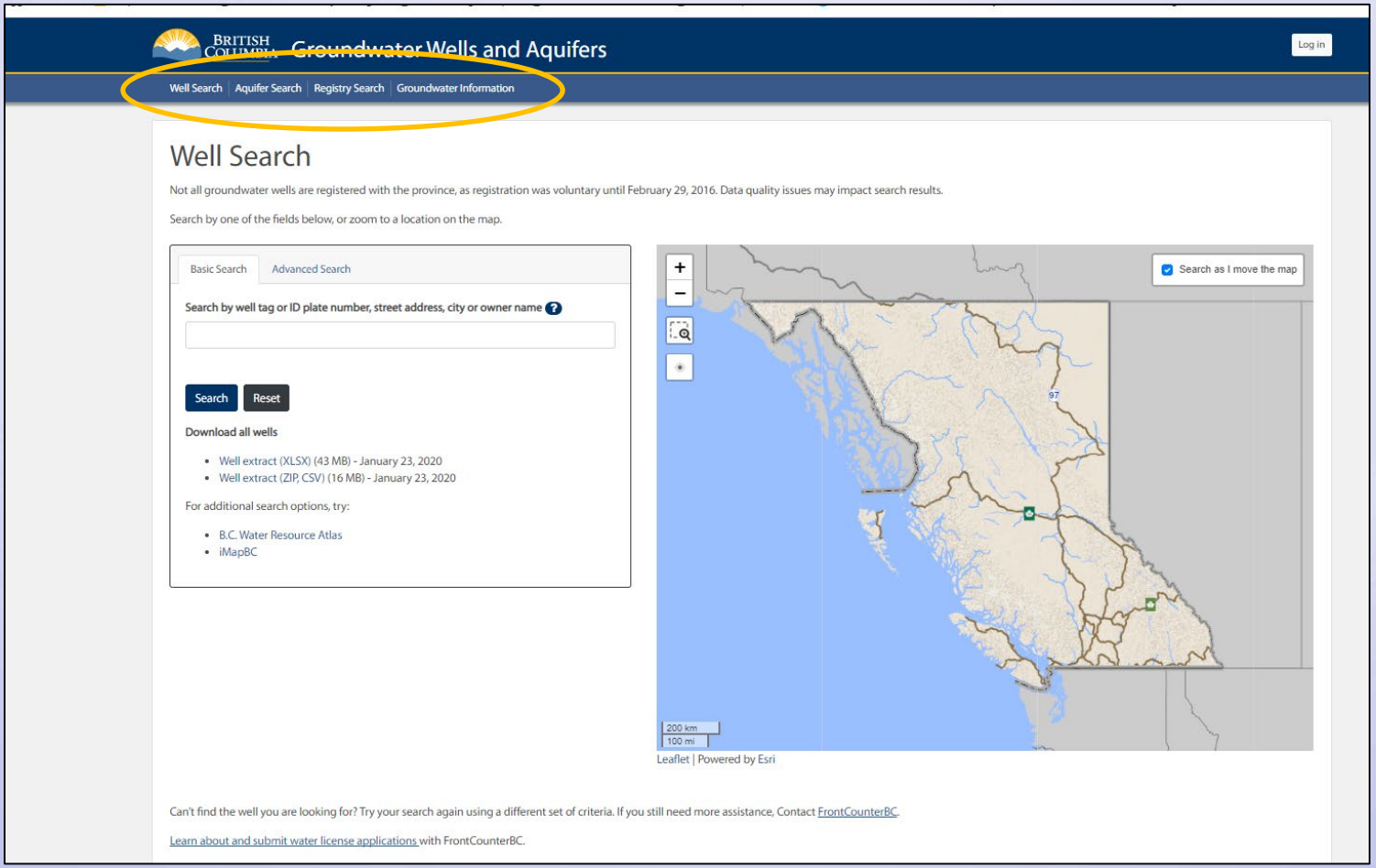
https://www2.gov.bc.ca/gov/content/data/geographic-data-services/web-based-mapping/imapbc

- Ecological Report Catalogue – find groundwater reports for an area

https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/libraries-publication-catalogues/ecocat

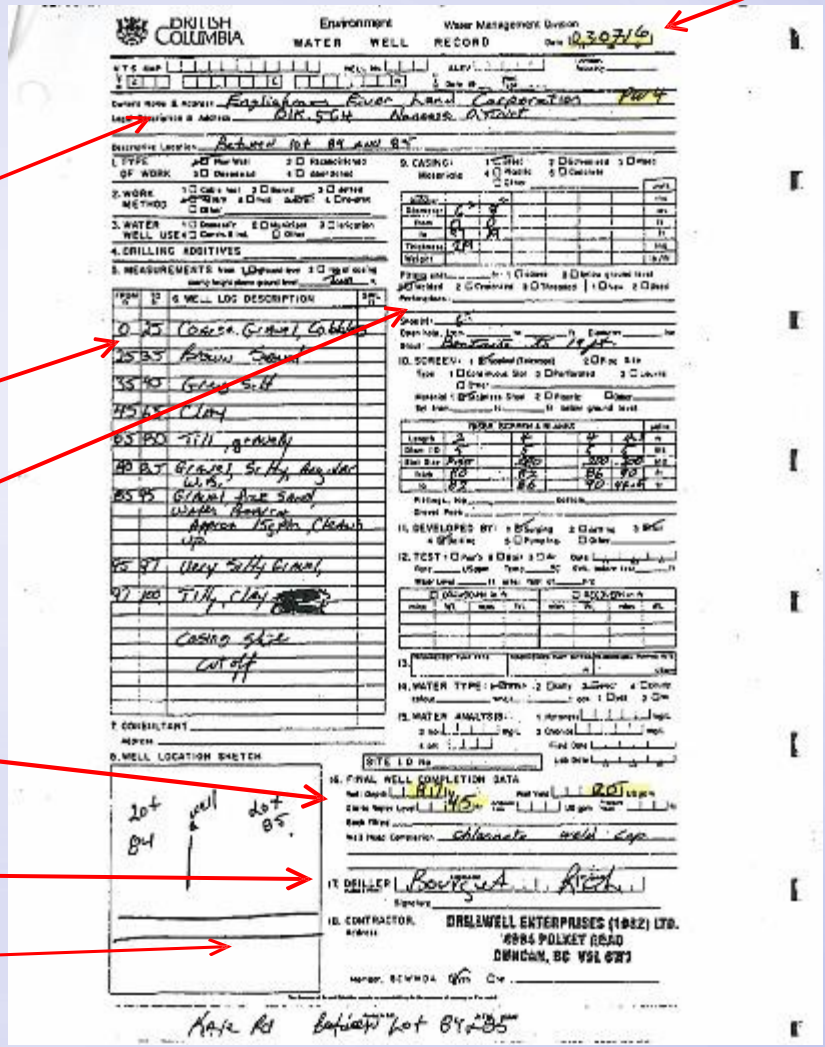
GWELLS – Wells Database

https://apps.nrs.gov.bc.ca/gwells/



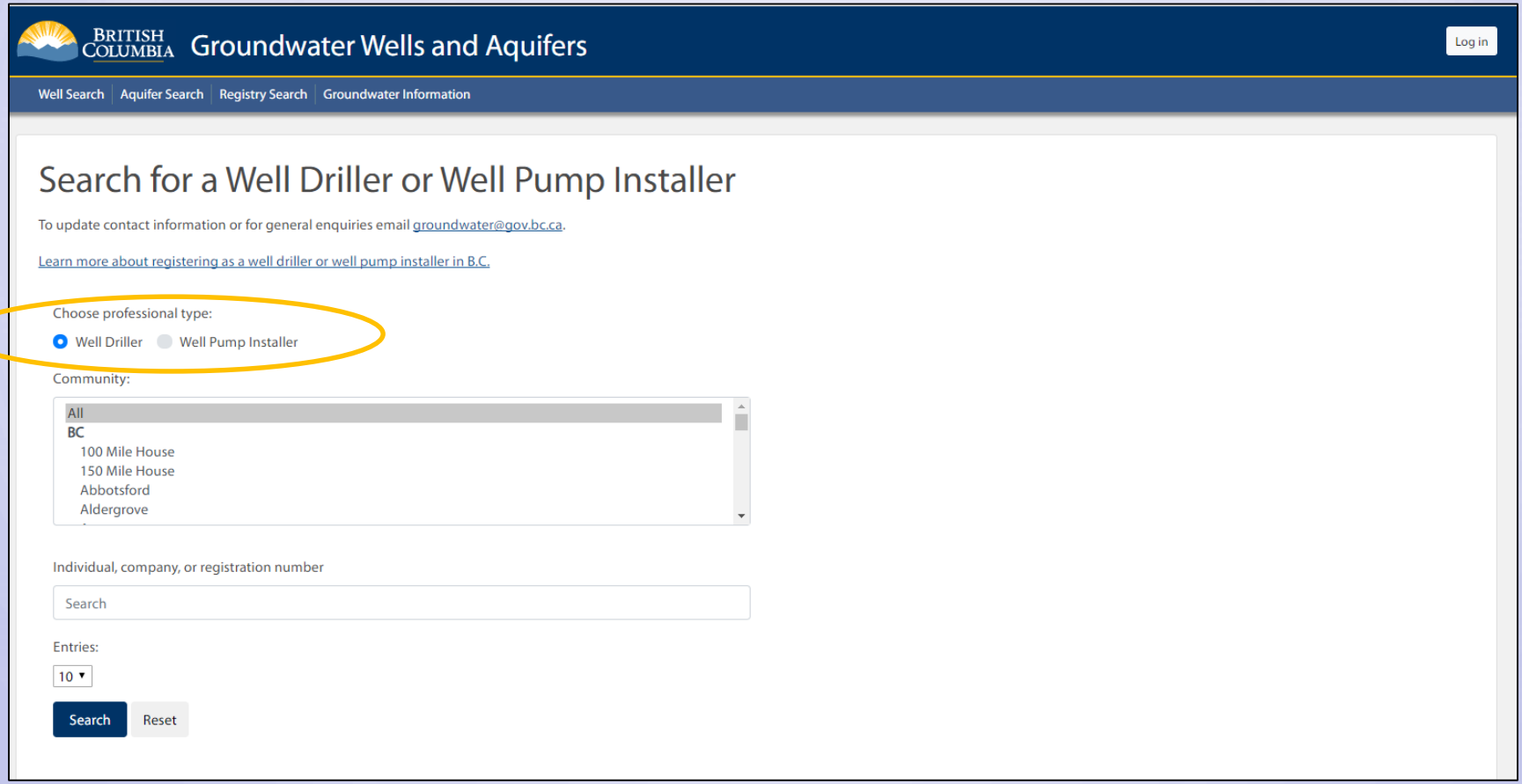
Well Records

- Address and Owners
  - Geology
  - Construction
- Depth, Water Level, Yield
  - Driller
  - Location



Well Driller and Pump Installer Registry

https://apps.nrs.gov.bc.ca/gwells/registries/



Factors Influencing Groundwater Quality:

1. Groundwater Laws
2. Aquifer properties
3. Location
4. Construction & set-up
5. Maintenance
6. Operation
7. Proper closure

Photo credit: FLNRORD

Groundwater Laws in BC

Water Sustainability Act, Groundwater Protection Regulation	Protects groundwater supplies by requiring all wells to be properly constructed, maintained, and closed at end of service (BC FLNRORD)
Environmental Management Act	Prohibits disposal of waste without a permit (MoE)
Drinking Water Protection Act	Protects water supplies by prohibiting contamination of a water source (Island Health)
Public Health Act	Protects water supplies by requiring well setbacks of 30m from potential source of contaminants

Aquifer Properties

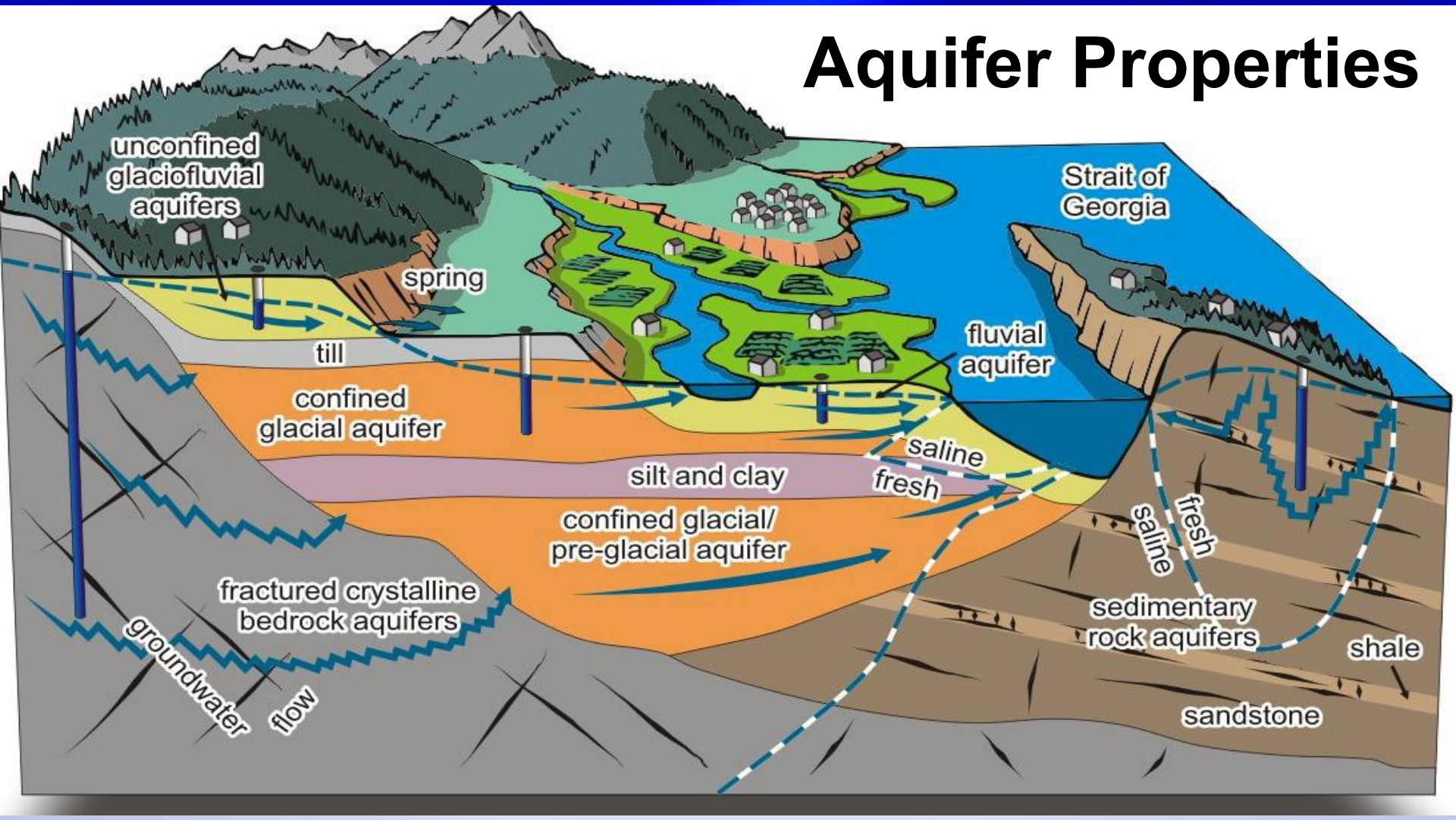
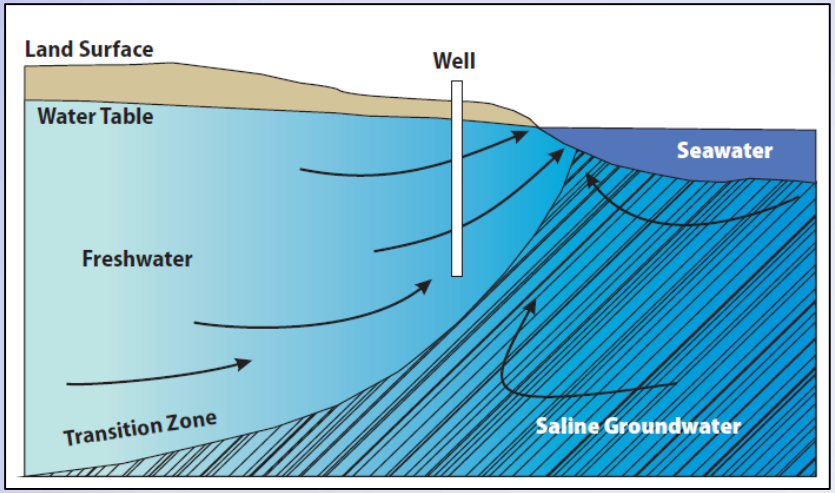
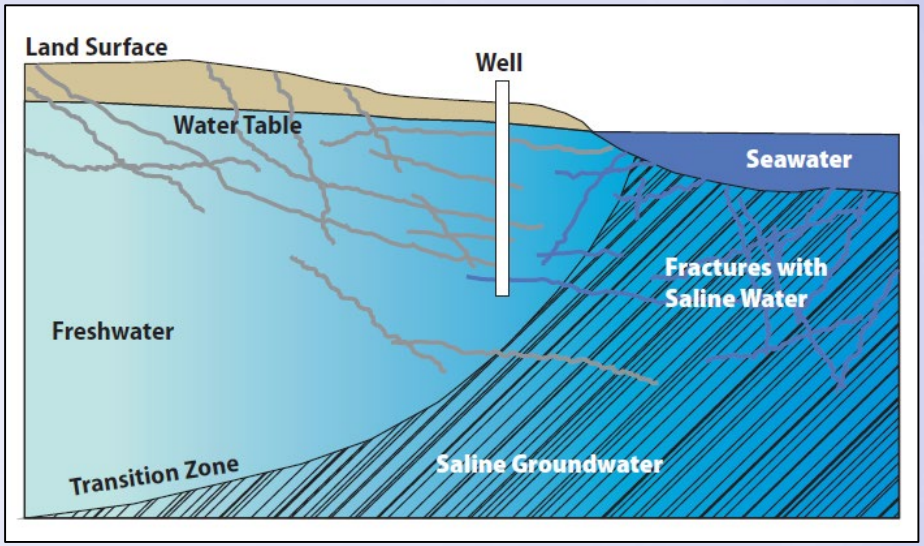


Image credit: Natural Resources Canada

Coastal Aquifers & Saltwater Intrusion

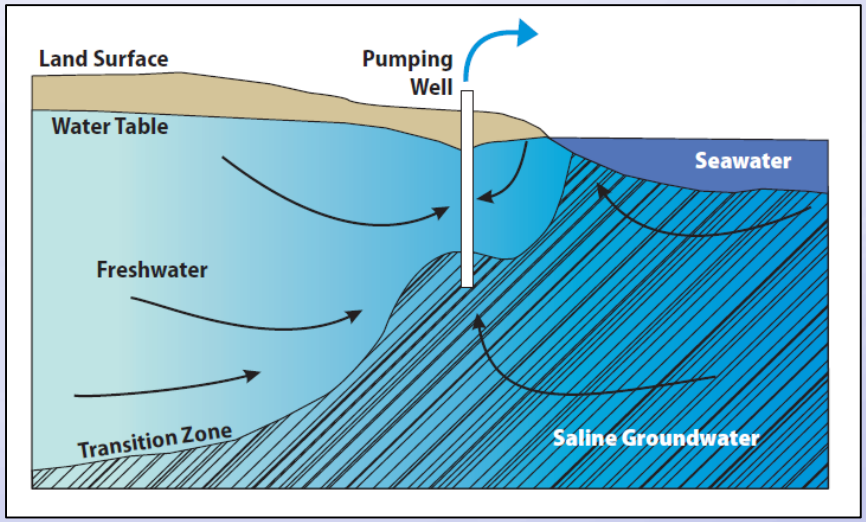




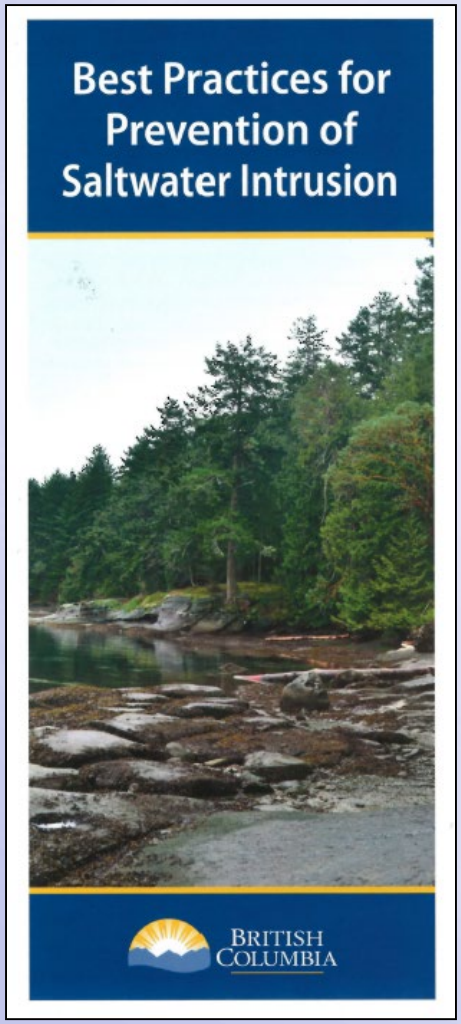
Causes

- Drilling into saline groundwater
- Pumping

The impact can be long-term and permanent but there are possible measures to mitigate the risk



Saltwater Intrusion Best Management Practices



- Proper well siting and drilling for new wells
- Water conservation
- Reduce depth of pump
- Low-volume, high-frequency pumping
- Pump timing
- Increase storage
- Prevent leaks
- Monitoring of water quality
- Water quality testing
- Pump shut-off at certain depth
- Water metering
- Stop using if necessary to give the well time to recover

Ideal Well Location

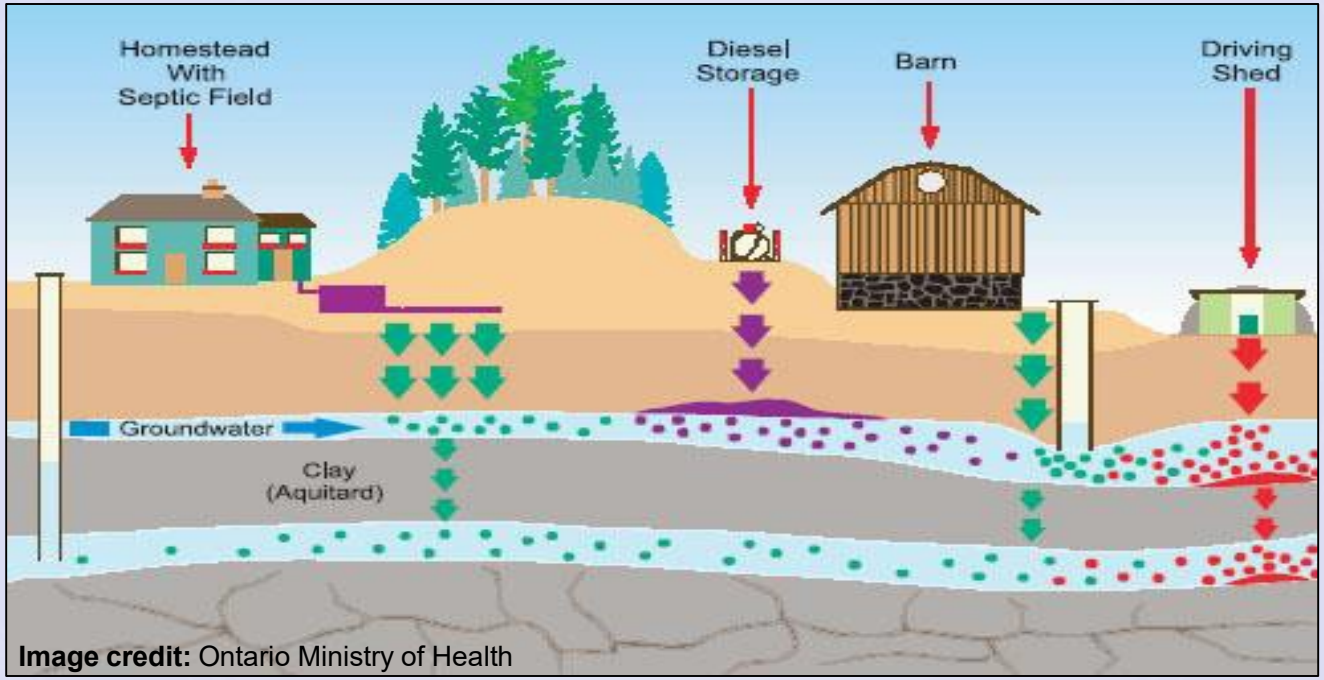


Image credit: Ontario Ministry of Health

- High elevation
- Secure, dry area
- Avoid wells in pits

- 30m / 100’ away from potential contaminant sources
- Not in basement or surrounded by concrete

Possible Contaminant Sources

30 metres or 100 feet from potential contaminant sources including:

Pesticides	Septic Fields
Vehicles	Storage Tanks
Fertilizer	Contaminated Runoff
Fuel	Waste
Animals	Etc.

Proper Well Construction

- Regulated under the Groundwater Protection Regulation
- Standards for well construction protect the health of water users and the aquifer.
- All drilled wells, and dug wells more than 15m deep, must be constructed by a provincially registered well driller
- All pumps must be installed by a provincially registered pump installer

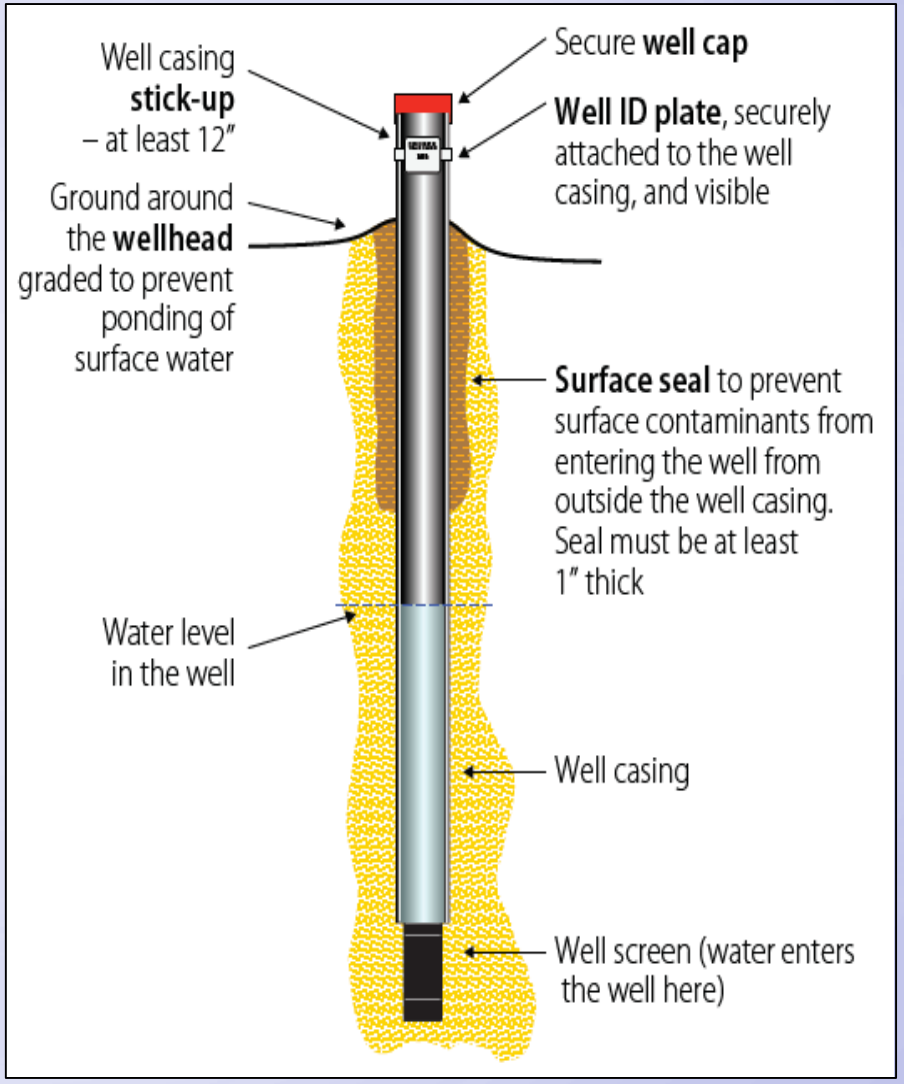


Image credit: BC FLNRORD

Well Identification Plates

- Different from the Well Tag Number
- Required for water systems
- Available from well driller or assigned with license
- For a Supply System, a **Well Identification Report** must be submitted to comptroller within 90 days of ID Plate attachment (groundwater@gov.bc.ca or mailed)
  - Specific requirements under the Groundwater Protection Regulation

Photo credit: BC FLNRORD

Construction & Set-up: Well Caps

Wells must have a securely attached, vermin-proof cap

Photo credits: BC FLNRORD

Construction & Set-up: Well Caps

Different types of well caps…

- Dug well
- Drilled wells

Construction & Set-up: Surface Seal

A surface seal prevents contaminants from entering a well along the outside of the casing

An improper surface seal allows contaminants into the well

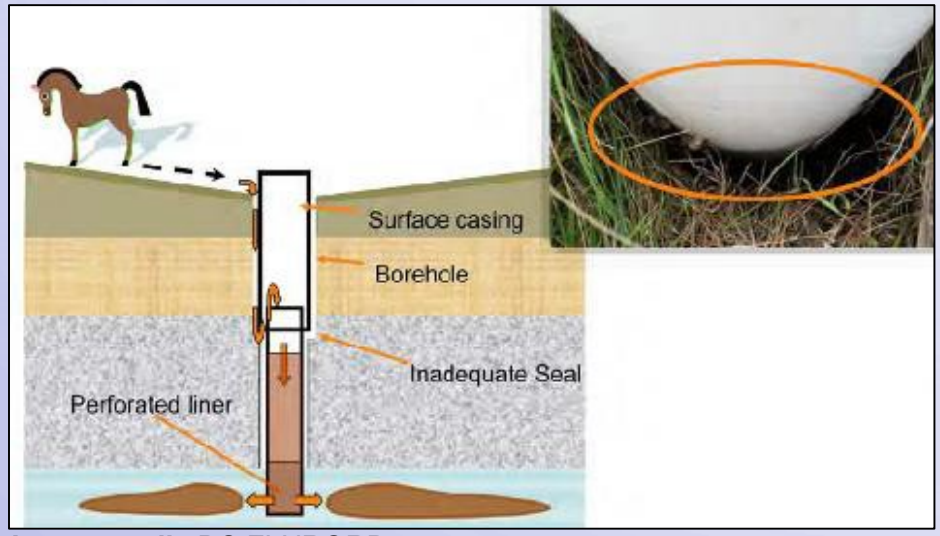


Image credit: BC FLNRORD

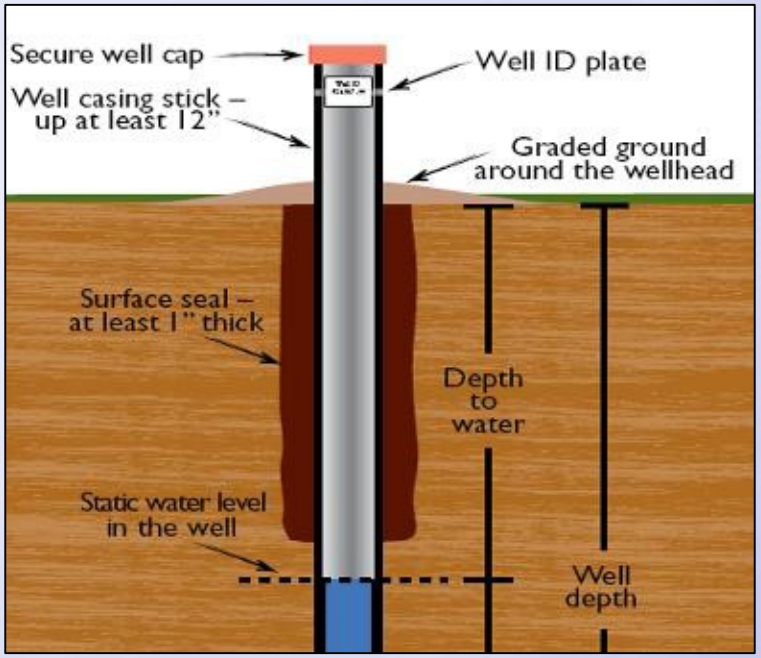


Image credit: Alberta Working Well Program

Construction & Set-up: Surface Seal

Photo credit: MoE

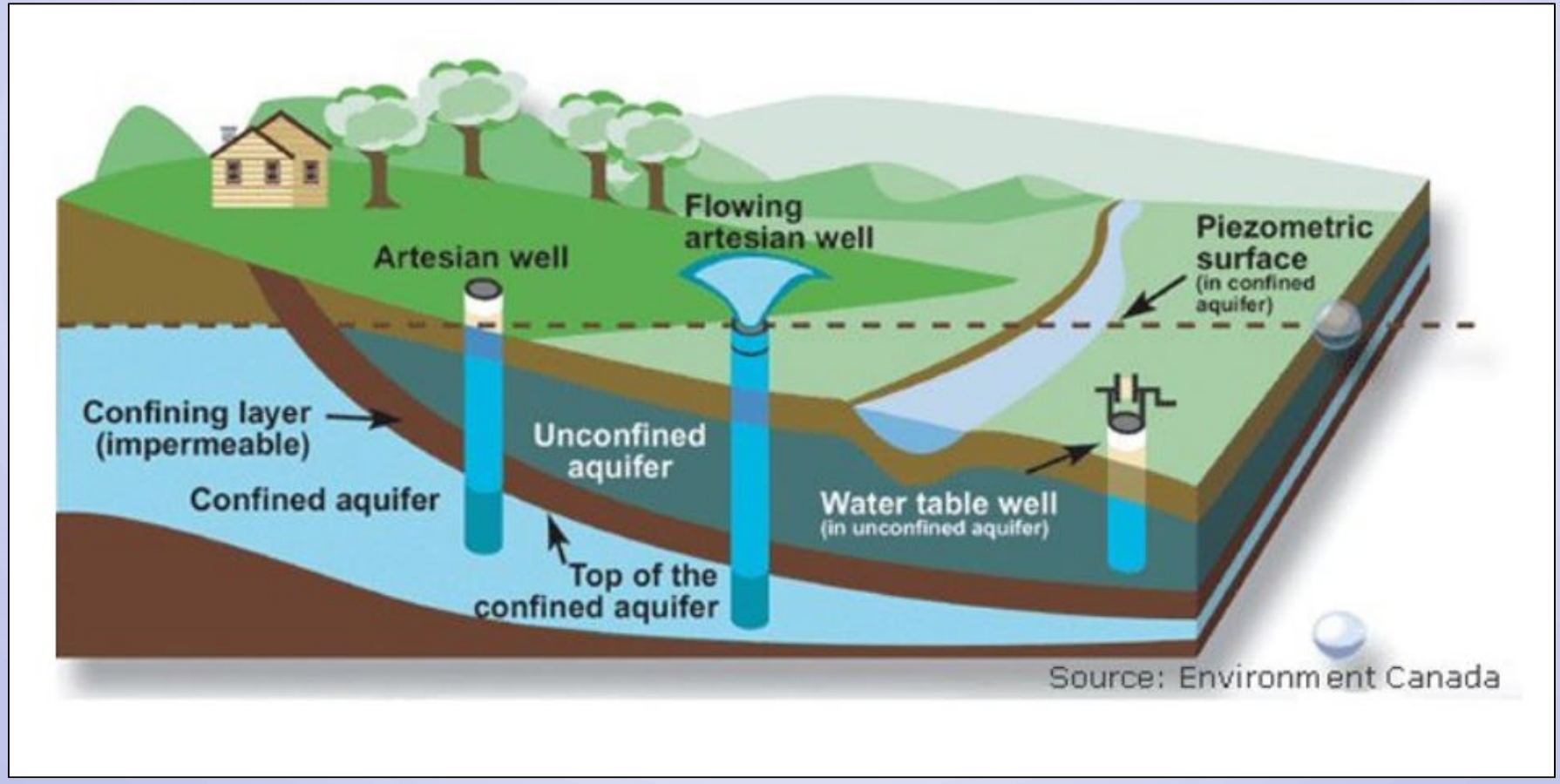
Photo credit: Alberta Working Well Program

Construction & Set-up: Pumphouse

- Keep the pumphouse clean and free of stored chemicals.
- Ideally, don't construct concrete a floor around the wellhead.

Construction & Set-up: Artesian Flow

Artesian flow must be stopped or brought "under control"



Construction & Set-up: Artesian Flow

Artesian flow must be stopped or brought "under control"

Responsible parties:

- Driller at time of construction
- Well owner or land owner for existing well

"Under control" means:

- Clear of sediment
- Entirely conveyed through casing (if applicable)
- Can be turned off indefinitely
- Does not pose a threat to property, public safety or the environment

Prevent Foreign Matter from Entering a Well

- Refuse, carcasses, rodents, contaminated standing water, flood debris, fuel, fertilizer, chemicals, etc.
- Keep a proper cap on
- Maintain a stickup of at least 30 m above ground
- Keep casing in good condition
- Keep surface seal intact

Well Maintenance Requirements

Store contaminants >3m away and prevent from travelling within 3m of wellhead

Maintain 0.3m stick up and protect from damage

Keep ground sloped so water does not pond and is conveyed away from wellhead

Maintain access to wellhead for inspections

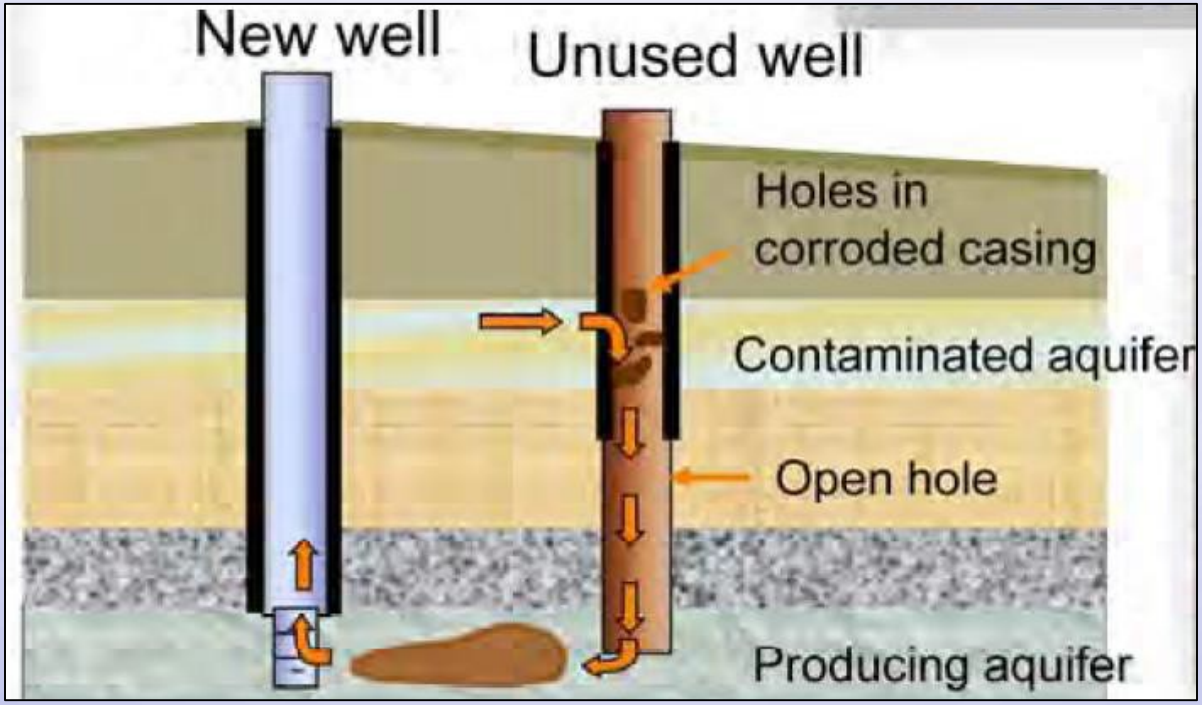
Keep area clear of obstructions and vegetation

Replace ID plate if lost or damaged

Maintain surface seal and fill any visible annular space with sealant

Decommission Abandoned Wells

- Open and inactive or improperly closed wells create a direct pathway for groundwater contamination
- Wells not used for 5 years must be deactivated
- Wells deactivated for 5 years must be decommissioned



Decommissioning

Photo credits: BC MoE

- Anyone can decommission a drilled well <5 m or dug well <15 m Deep. Must follow GWPR standards.
- All other wells require a registered and qualified well driller or pump installer. Artesian well can only be decommissioned by a registered well driller (not a pump installer).

What Can you Do as a Water Manager?

- Know and follow the applicable regulations and requirements
- Inspect the wellhead and the well area regularly
- Properly maintain septic system
- Test water quality regularly and keep records (follow Island Health requirements)
- Keep wellhead and pump house in good repair and free of contaminants
- Ask for help if needed or unsure about your well protection (FLNRORD, Island Health)
- Conserve water resources (metering)
- Plan for climate change (storage, monitoring)

Ministry of Forests, Lands and Natural Resource Operations and Rural Development (FLNRORD)

Information on legislation, regulations, local groundwater resources and your well

Front Counter BC
Phone: 1-877-855-3222
Email: FrontCounterBC@gov.bc.ca

Ministry of Environment (MOE)

Information on legislation, regulations and your well

Email: Groundwater@gov.bc.ca

Report any Natural Resource Violations at 1-877-952-7277 or online at https://www.for.gov.bc.ca/hen/nrv/report.htm

An OVERVIEW of
Rainwater Harvesting

RDN – Water Purveyors Working Group
'Resources for Water Purveyors'
Parksville, January 30, 2020

Ken Nentwig
CANARM Lead Trainer
ASSE Certified
Educator and Consultant

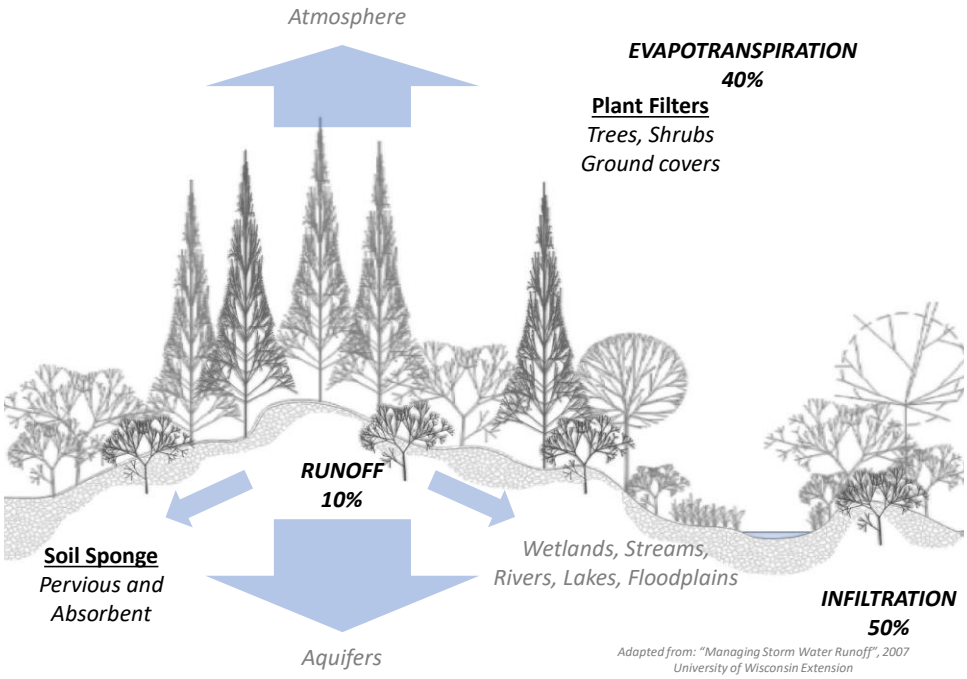
1

Ken Nentwig BLA MLA CLM CLD

CANARM Lead Trainer
CANARM Governor, BC Jurisdiction
ARCSA/ASSE Approved Trainer
ASSE RWH Certified (Design/Install/Inspect)
CSA/ICC Rainwater Standard Joint Technical Committee

Gaia College: 'Rainwater Harvesting/Management'
\+ 'SketchUp Pro for Landscape Design'
CANARM: National Certification Program for RWH Practitioners
KDA: RWH Feasibility Studies/System Design

2


Atmosphere
EVAPOTRANSPIRATION
40%
Plant Filters
Trees, Shrubs
Ground covers
RUNOFF
10%
Soil Sponge
Pervious and
Absorbent
Wetlands, Streams,
Rivers, Lakes, Floodplains
INFILTRATION
50%
Aquifers
Adapted from: "Managing Storm Water Runoff", 2007
University of Wisconsin Extension
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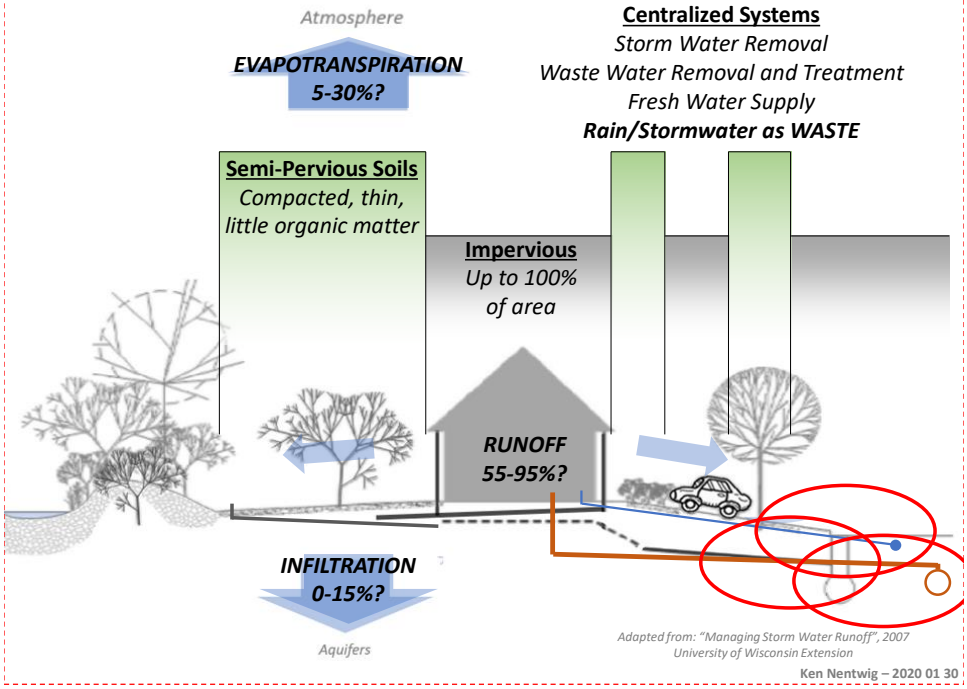
3


Atmosphere
EVAPOTRANSPIRATION
5-30%?
Centralized Systems
Storm Water Removal
Waste Water Removal and Treatment
Fresh Water Supply
Rain/Stormwater as WASTE
Semi-Pervious Soils
Compacted, thin,
little organic matter
Impervious
Up to 100%
of area
RUNOFF
55-95%?
INFILTRATION
0-15%?
Aquifers
Adapted from: "Managing Storm Water Runoff", 2007
University of Wisconsin Extension
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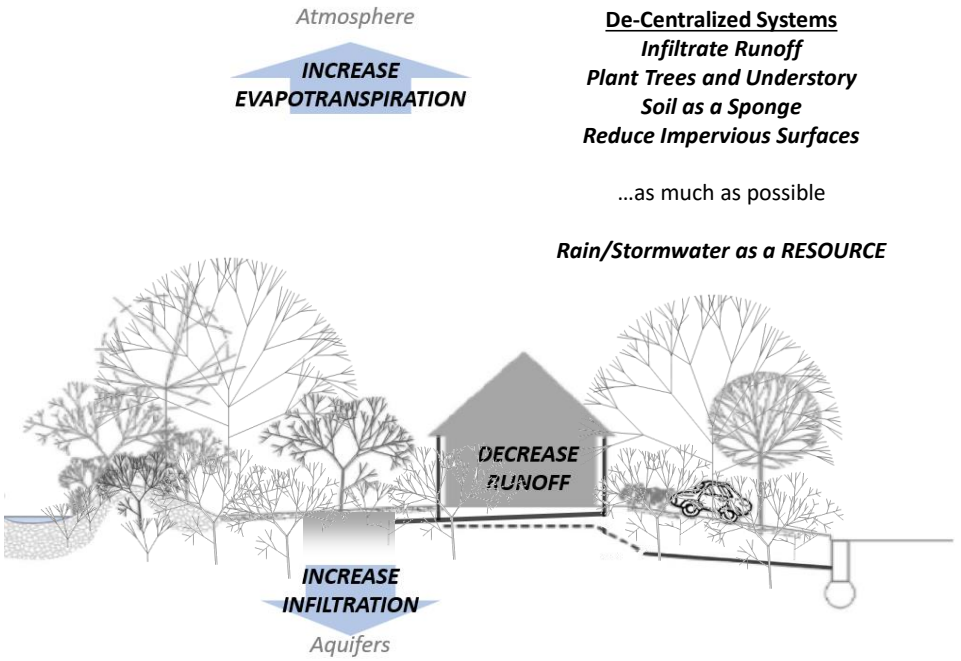
4



De-Centralized Systems
Infiltrate Runoff
Plant Trees and Understory
Soil as a Sponge
Reduce Impervious Surfaces

…as much as possible

Rain/Stormwater as a RESOURCE

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PARADIGM SHIFT

Stockholm, Sweden, September 14, 1959, 5:00 PM

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'Rainwater as a resource'

Flood and storm management
Drought period mitigation
Habitat protection
Fire Protection
Aquifer recharge
Alternate source…..

POTABLE USES
- drinking
- bathing/showering
- food preparation
- oral care
- pools/hot tubs
- emergency supply

NON-POTABLE USES
- irrigation
- flushing
- laundry
- fire suppression
- infiltration
- trap priming
- evaporative/thermal cooling
- pressure washing
- vehicle and street washing
- decorative fountains
- ice rinks

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7

'Rainwater as a resource'

"Great, now we can have enough water to do what we want to do!"

"Cost of 'city' water is too high, let's use this free supply!"

"Rainwater is better for my plants and animals."

"We have so much rainfall, and it all goes to waste!"

"Rainwater is polluted, contaminated, and unsafe!"

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8

"Great, now we can have enough water to do what we want to do!"

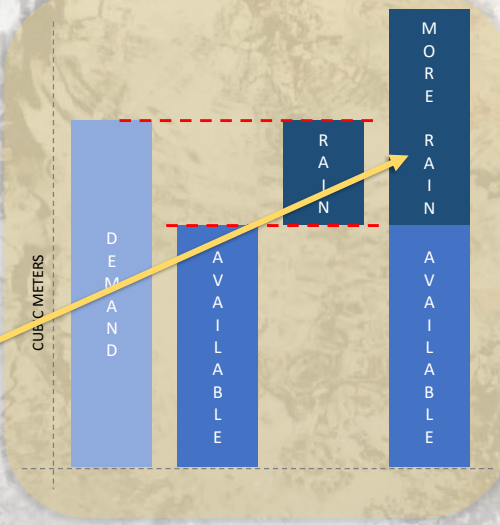
Water restrictions in summer

Aquifer depletion

Poor water quality from wells and surface water

Drought conditions increasing

This could lead to increased demand and use of water overall, taking advantage of the 'new resource' to fulfill our dreams and supposed needs



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9

"Great, now we can have enough water to do what we want to do!"

Water restrictions in summer

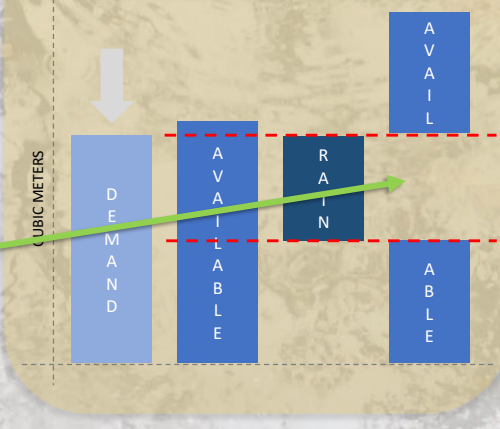
Aquifer depletion

Poor water quality from wells and surface water

Drought conditions increasing

Harvested rainwater can 'fill a gap' in many non-potable uses as an alternate resource, extending the availability of treated water

FLUSHING:	***25% to 30%***
LAUNDRY:	***20% to 30%***
IRRIGATION:	***20% to 30%***
INDUSTRIAL:	***?***



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10

"Cost of 'city' water is too high, let's use this free supply!"

"More holistic and cost-effective rainwater management calls for all lands in Vancouver to do their part to help manage rainwater close to where it lands. Today, private properties depend largely on public infrastructure to manage onsite rainwater. In the future, as part of more cost effectively managing citywide rainfall, private properties and infrastructure will play an important role in reducing discharge to the pipe system through onsite actions."

'Rain City Strategy', City of Vancouver, Nov. 2019, pg 4

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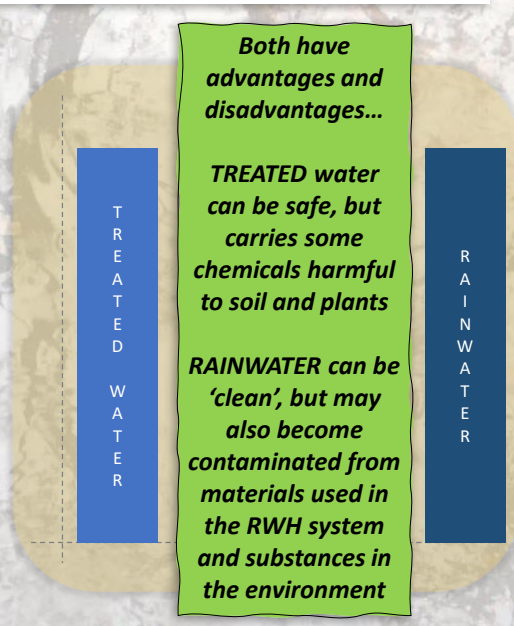
11

"Rainwater is better for my plants and animals."

Pure rainwater is mainly chemical-free, and does not carry minerals, so it is able to better absorb minerals from the soil and transfer them to the plants.

Sanitation of water uses chemicals that can kill soil bacteria, adversely affecting the essential soil organisms.

Water is essential for all plant, animal and human existence, and for soil organisms – use the best water possible.



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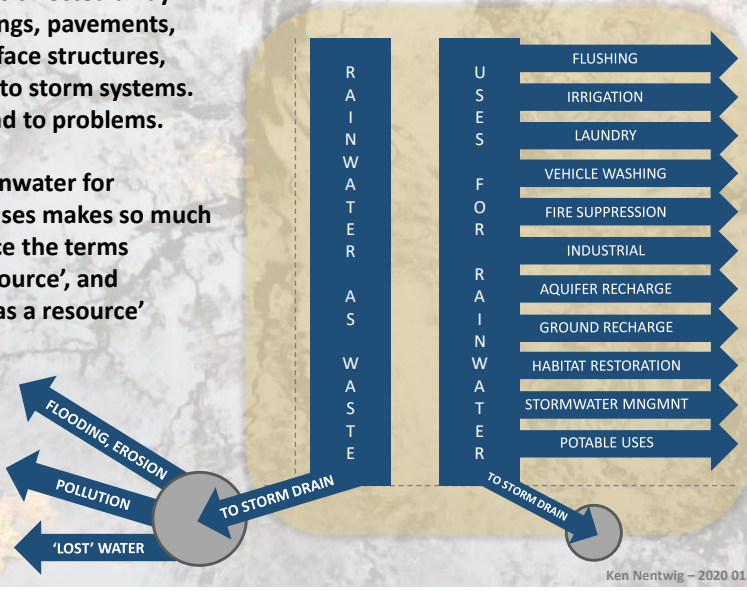
12

"We have so much rainfall, and it all goes to waste!"

Rainwater is directed away from buildings, pavements, and subsurface structures, normally into storm systems. This can lead to problems.

Utilizing rainwater for beneficial uses makes so much sense, hence the terms 'alternate source', and 'rainwater as a resource'



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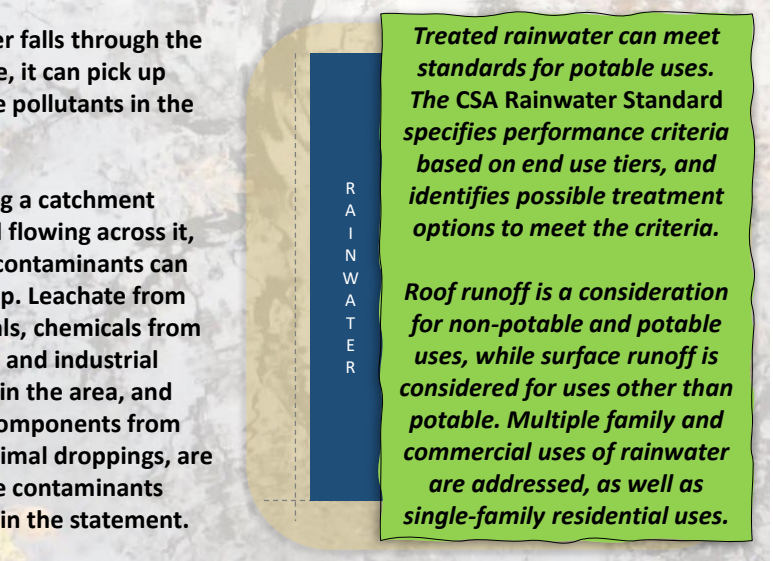
"Rainwater is polluted, contaminated, and unsafe!"

As rainwater falls through the atmosphere, it can pick up some of the pollutants in the air.

Upon hitting a catchment surface and flowing across it, additional contaminants can be picked up. Leachate from the materials, chemicals from agricultural and industrial operations in the area, and dissolved components from bird and animal droppings, are some of the contaminants referred to in the statement.



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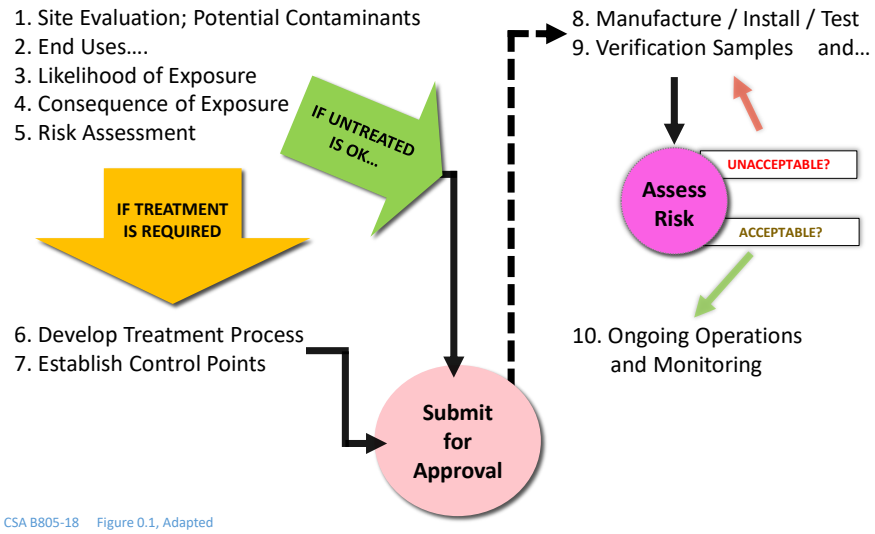
14

Water Safety Plan



CSA B805-18 Figure 0.1, Adapted

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15

Water Safety Plan – CANARM Certification Program

Documentation, categorized according to system type and scope.

	Large RWH Systems	Single Family Residential
Form 1 (Overview)	X	X
Form 2 (Source Water Quality)	X	X
Form 3 (Site Details)	X	X
Form 4 (Hazard Identification)	X	X
Form 5 (Risk Mitigation)	X	X
Form 6 (Risk Management)	X	X
Form 7 (Operations Mgmnt)	X	X
Form 8 (a,b,c) (Technical)	X	X
Form 9 (a,b) (Maintenance)	X	X
Form 10 (Audits/Reports)	X	X

CSA B805-18 Annex 'D', Adapted

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16

Water Safety Plan – *END USE TIERS and COLLECTION SURFACES*

End Use Tiers

1. Non-Potable
Traps; Irrigation;
Ice rink; Fire protection

2. Non-Potable
Flushing; Laundry;
HVAC, Thermal Cooling;

3. Non-Potable
Hose Bibbs; Pressure wash;
Vehicles; Spray Irrigation;
Decorative Fountains

4. Potable
Human contact; Food preparation; Dishwashing;
Misting; Swamp coolers

Collection surface		End use tier
Roofing material		
Asphalt, Ceramic, Clay, Fiberglass, Glass		1, 2, 3, 4
Concrete, Polyethylene membrane		1, 2, 3, 4
Steel, coated or stainless		1, 2, 3, 4
Tin	*corrugated metal; galvanized*	1, 2, 3, 4
PVC	*polyvinyl chloride*	1, 2, 3, 4
TPO	*thermoplastic polyolefin*	1, 2, 3, 4
Asphalt felt and bituminous and tar membranes		1, 2, 3
Copper, Polymer and acrylic		1, 2, 3
Rubber/Butyl /EPDM membrane		1, 2, 3
Vegetated roofs		1, 2*, 3
Wood, untreated and/or treated		1, 2, 3
Asbestos cement		‡
Pedestrian and parking surfaces		1, 2*, 3
(e.g., sidewalks, courtyard, driveways, parking areas, pervious surfaces)		
Public pedestrian accessible roofs		1, 2, 3
Subsurface collection†		1, 2, 3
Landscaped runoff		1, 2*, 3
Street, freeway, shoulder areas		‡
Surface waters and stormwater detention ponds		‡

** HVAC evaporative cooling applications not included.*
† Subsurface water shall not be collected from sites which contain contaminated soils.
‡ Not in the scope of this Standard.

CSA B805-18 Table 5.1, Adapted

CSA B805-18 Table 7.1, Adapted

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17

Water Safety Plan – *Likelihood of Exposure / Risk*

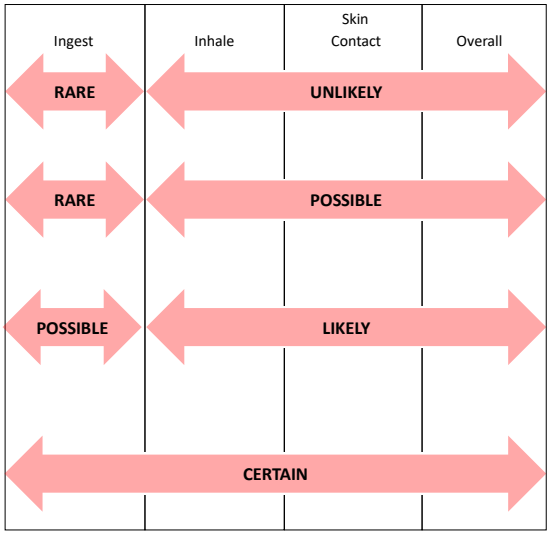
End Use Tiers

1. Non-Potable
Traps; Irrigation;
Ice rink; Fire protection

2. Non-Potable
Flushing; Laundry;
HVAC, Thermal Cooling;

3. Non-Potable
Hose Bibbs; Pressure wash;
Vehicles; Spray Irrigation;
Decorative Fountains

4. Potable
Human contact; Food preparation; Dishwashing;
Misting; Swamp coolers



CSA B805-18 Table 5.1, Adapted

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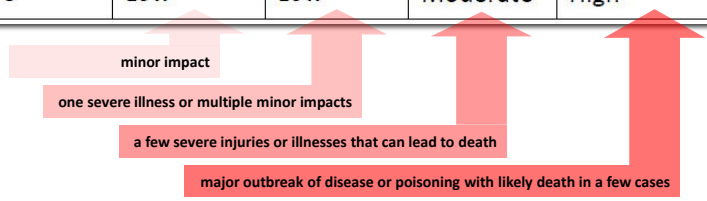
18

Water Safety Plan – *Consequence and Risk Management*

Likelihood	Consequence			
	Negligible	Marginal	Critical	Catastrophic
Certain	High	High	Extreme	Extreme
Likely	Moderate	High	High	Extreme
Possible	Low	Moderate	High	Extreme
Unlikely	Low	Low	Moderate	Extreme
Rare	Low	Low	Moderate	High



CSA B805-18 Annex 'D', and Table D.1, Adapted

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Water Safety Plan – *Performance and Prescriptive Requirements*

Tables 8.1 to 8.4, pp 46-59 – Treatment

Tier	Viruses	Bacteria	Protozoa	pH	OPTION 1 Ultra Violet: Filtration	OPTION 1 Ultra Violet: Disinfection	OPTION 2 Chemical-based: Filtration	OPTION 2 Chemical-based: Disinfection	OPTION 3: Micro - Macro Filtration
PERFORMANCE					PRESCRIPTIVE				

Tables 8.5 and 8.6, pp 61-62 – Output Water Quality

Tier	Parameter	Turbidity (NTU)	HCP CFU / 100 mL	Enterococci CFU / 100 mL	pH	Chlorine: CMF (mg / 100 mL)	Chlorine: SFR (mg / 100 mL)
PRESCRIPTIVE							

CSA B805-18 Tables 8.1 to 8.6, Adapted

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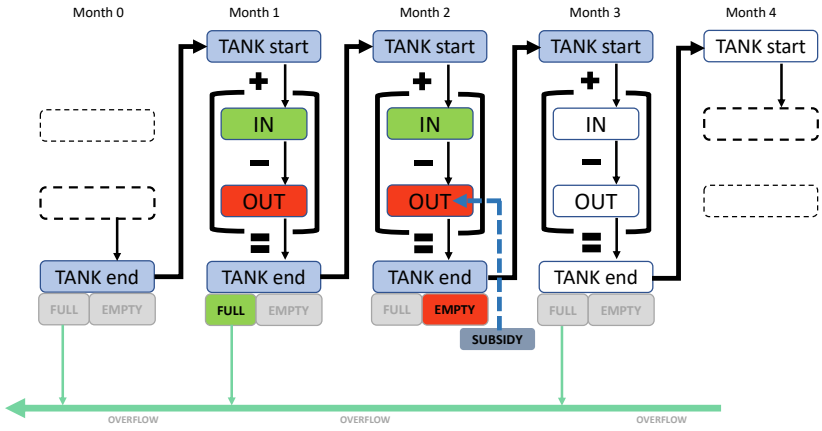
Design Calculations



CSA B805-18 Annex 'C', Adapted

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Certification Program – *CANARM* *(Canadian Association for Rainwater Management)*

Online Webinar Series	**#hr**
Based on CSA B805-18 / ICC 805-2018 Rainwater Harvesting Systems	
• **RWH System Components**	**1**
• **RWH Design and Installation**	**2**
• **RWH Water Quality**	**1**
• **RWH Regulations, Standards, and Guidelines**	**1**
• **Water Safety Plan**	**2**
• **RWH Detailed Design – Case Studies 1**	**2**
• **RWH Detailed Design – Case Studies 2**	**1**
• **RWH for Irrigation Applications**	**2**
• **RWH for Stormwater Applications**	**2**
• **RWH System Management**	**1**

www.canarm.org

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Certification Program – *CANARM* *(Canadian Association for Rainwater Management)*

Information and Awareness to the public

Education for the public and for practitioners

Training and Certification for practitioners, design professionals, decision-makers, approvers

CSA B805-18 Rainwater Standard for Canada

Sets a benchmark for best practices in RWH/M

www.canarm.org

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An OVERVIEW of Rainwater Harvesting

RDN – Water Purveyors Working Group
'Resources for Water Purveyors'
Parksville, January 30, 2020

Ken Nentwig

ken@canarm.org
ken.nentwig@gmail.com
1 250 999 2472

www.canarm.org
info@canarm.org
1 855 300 7778

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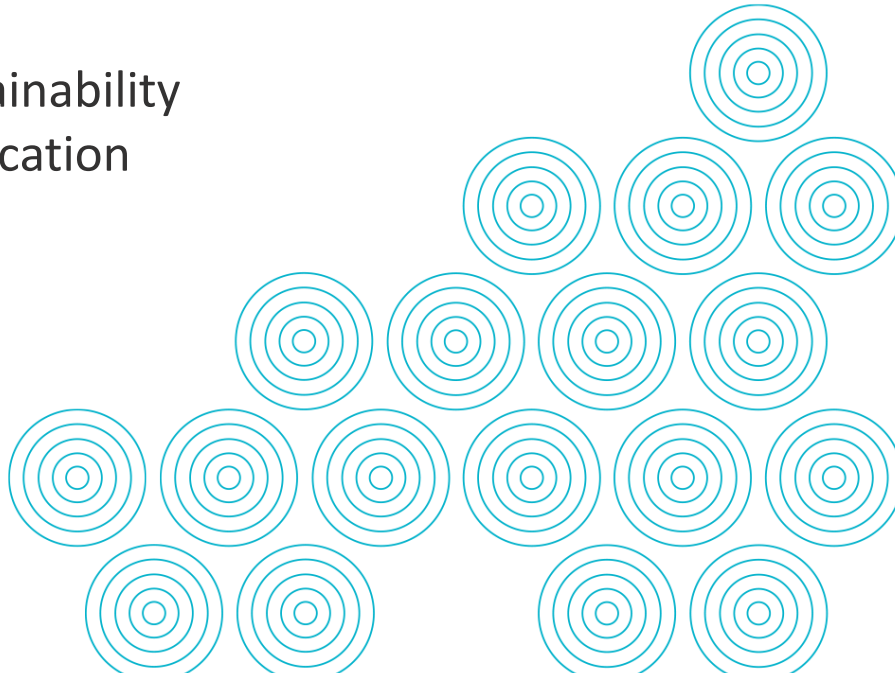
WATERWORTH™

Financial Sustainability & Communication



Agenda

- Asset replacement planning
  - What infrastructure needs to be replaced
- Long term financial model
  - When you will have to replace it
- Communications
  - How to tell your customers

WATERWORTH™

You're providing a service

Objective:
Financial Sustainability

Having sufficient funding to maintain assets in such a manner that meets present infrastructure needs without compromising the ability of future generations to meet their infrastructure needs.

-Gro Harlem Brundtland

Asset Replacement Planning (ARP)

Do You Know What Your Capital Cost Are?

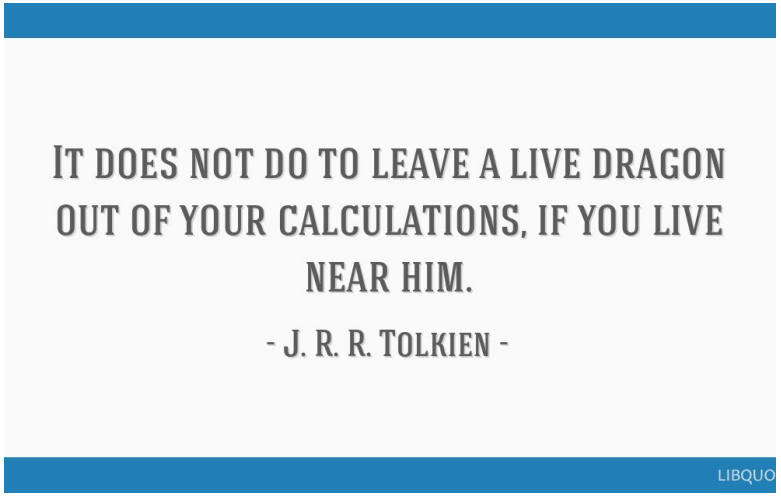
Over the next…

1 year?

5 years?

10 years?

…20 years?



It’s easy to predict operating expenses… but it’s more difficult to predict capital expenses.

Luckily, there is a system.

Building an Asset Replacement Plan

1. Inventory your system
2. Determine age of assets
3. Estimated service life of each asset
4. Cost of replacement

1. Inventory Your System

Item ID	Asset Category	Asset Description	Location	Units
1	Supply	Concrete Dam Intake Works		
2	Treatment	WTP Chlorination		
3	Treatment	Backup genset Generac 8000		
5	Storage	Reservoir 272 m3		
9	Valve	Gate valve		1
11	Valve	Blow off		1
12	Valve	Pressure Reducing Valve (PRV)		1
14	Pumping	Barney Creek Booster Stn		
30	Service	3/4" services 1.5 meters		80
31	Service	Standpipes		5
32	Hydrant	6" Hydrants		8
Total				

2. Determine Age of Assets

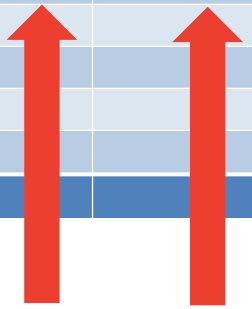
Item ID	Asset Category	Asset Description	Location	Units	In Service Year
1	Supply	Concrete Dam Intake Works			2003
2	Treatment	WTP Chlorination			2001
3	Treatment	Backup genset Generac 8000			2007
5	Storage	Reservoir 272 m3			1975
9	Valve	Gate valve		1	2006
11	Valve	Blow off		1	2011
12	Valve	Pressure Reducing Valve (PRV)		1	2016
14	Pumping	Barney Creek Booster Stn			2006
30	Service	3/4" services 1.5 meters		80	1983
31	Service	Standpipes		5	2012
32	Hydrant	6" Hydrants		8	1995
Total					

3. Estimated Service Life

Useful Lives of Water Infrastructure		
Asset	Useful Life in Years	Comments
Supply Infrastructures		
Dams-Earthen	40	Still under review, may need to use engineering estimate
Dams-Concrete	60	Still under review, may need to use engineering estimate
Manmade Lakes/Waterways	100	
Reservoirs-Concrete	50	Includes both above ground and in-ground reservoirs
Reservoirs-Other	35	Includes lined earth, wood stave and steel reservoirs
Water Towers and Tanks	35	
Wells	60	This includes the well casing
Wells-Screen for wells	25	
Treatment Infrastructure		
Aggregated Approach		
Aggregated Approach-Treatment Plant	25	This may include all components of the plant (listed in detail below) excluding the building itself

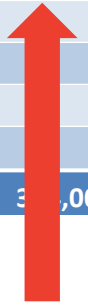
3. Estimated Service Life

Item ID	Asset Category	Asset Description	Location	Units	In Service Year	ESL	Next Replacement Year
1	Supply	Concrete Dam Intake Works			2003	20	2023
2	Treatment	WTP Chlorination			2001	10	2011
3	Treatment	Backup genset Generac 8000			2007	5	2012
5	Storage	Reservoir 272 m3			1975	50	2025
9	Valve	Gate valve		1	2006	40	2046
11	Valve	Blow off		1	2011	10	2021
12	Valve	Pressure Reducing Valve (PRV)		1	2016	10	2026
14	Pumping	Barney Creek Booster Stn			2006	10	2016
30	Service	3/4" services 1.5 meters		80	1983	20	2003
31	Service	Standpipes		5	2012	25	2037
32	Hydrant	6" Hydrants		8	1995	15	2010
Total							



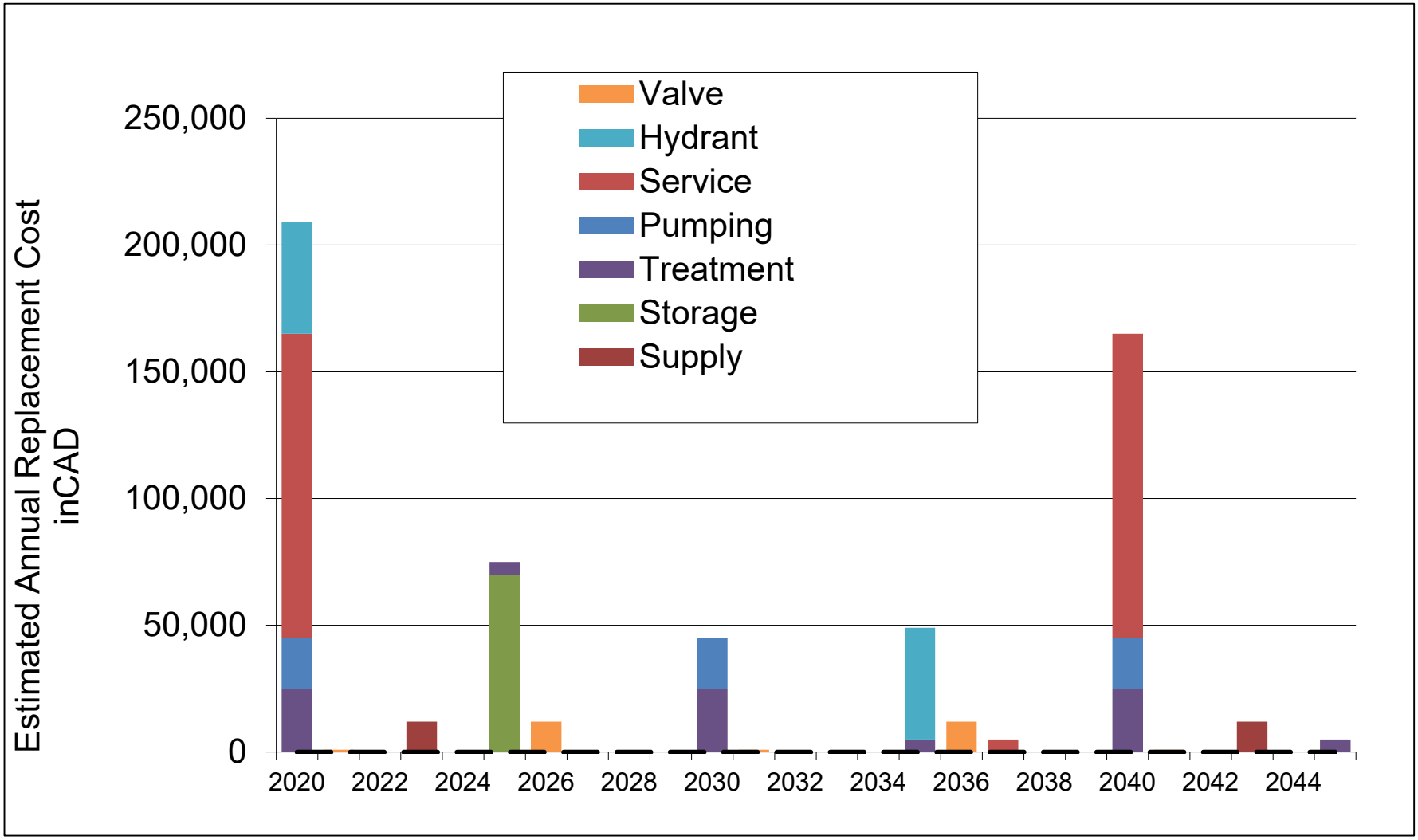
4. Cost of Replacement

Item ID	Asset Category	Asset Description	Location	Units	In Service Year	ESL	Next Replacement Year	Present Replacement Value
1	Supply	Concrete Dam Intake Works			2003	20	2023	12,000
2	Treatment	WTP Chlorination			2001	10	2011	20,000
3	Treatment	Backup genset Generac 8000			2007	5	2012	5,000
5	Storage	Reservoir 272 m3			1975	50	2025	70,000
9	Valve	Gate valve		1	2006	40	2046	15,000
11	Valve	Blow off		1	2011	10	2021	1,000
12	Valve	Pressure Reducing Valve (PRV)		1	2016	10	2026	12,000
14	Pumping	Barney Creek Booster Stn			2006	10	2016	20,000
30	Service	3/4" services 1.5 meters		80	1983	20	2003	120,000
31	Service	Standpipes		5	2012	25	2037	5,000
32	Hydrant	6" Hydrants		8	1995	15	2010	44,000
Total								3 ,000



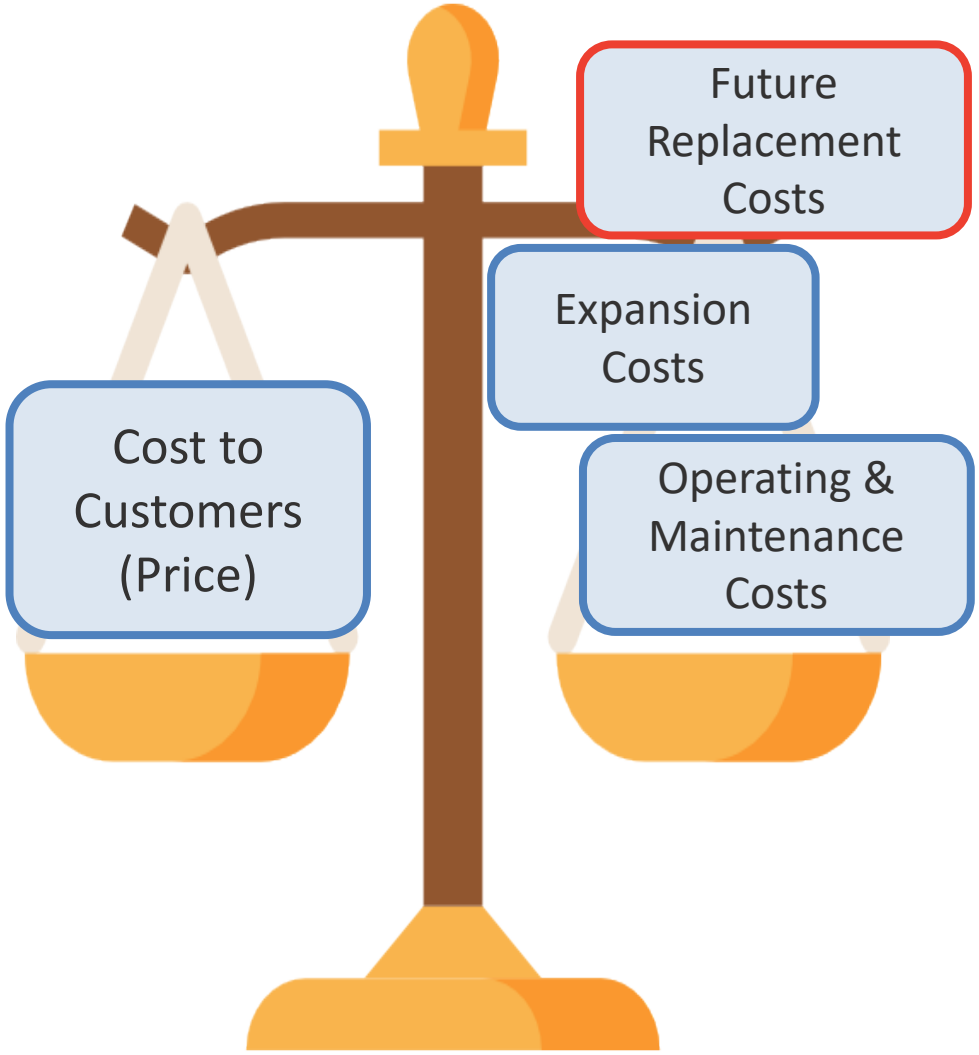
WATER INFRASTRUCTURE - 25 Year Annual Replacements

Projected Annual Replacement Cost by Asset Category
(not adjusted for inflation)



Full Cost Pricing

Full cost pricing fully recovers the cost of providing drinking and wastewater services, including explicitly recognizing the level of reinvestment needed to maintain, replace or upgrade existing assets over the long term.



BCWWA's Position Statement on Infrastructure Funding

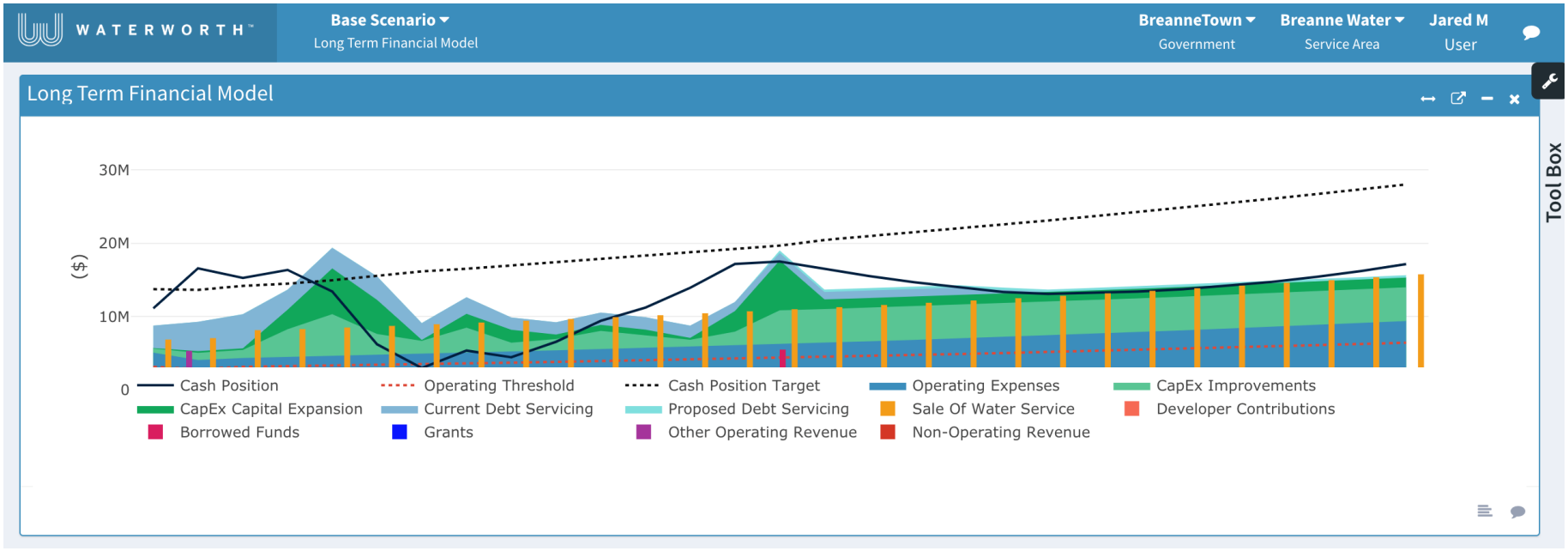
Water and wastewater service providers "should formally develop plans and implement funding strategies" to:

- to deliver services
- that meet community needs
- in a reasonable and affordable way
- for the foreseeable future.

ie. Financial Sustainability

Long-Term Financial Model (LTFM)

Long-Term Financial Model



An LTFM summarizes expenses and revenues and can be used to calculate the impact of a future event or decision.

Communicating Your ARP & LTFM

Why Is This Important for Small Systems?

- Displays forethought and preparedness
- Rate payers are involved in the water system's future health and reliability
- Generates support for your capital plan and corresponding rate increases

What Constitutes “Good” Communication?

AWWA's 10 Principles of Authentic Communication

1. Timely
2. Relevant
3. Truthful
4. Fundamental
5. Comprehensive
6. Clear
7. Accessible
8. Responsive
9. Caring
10. Consistent

Components of a Communications Plan

1. Community attitudes
2. Stakeholder identification
3. Interests analysis
4. Risk analysis
5. Key messages
6. Supporting messages
7. Proofs
8. Channel selection
9. Prepare collateral
10. Implementation schedule
11. Monitor and evaluate

What are Key Messages?

- Key messages are the integral points everyone needs to know about the pending changes and the reasons for them.
- Not the content of the communications (rather, they guide the development).
- 3-5 are ideal.

Key Message: These shoes are for people who love and care for their feet.

Key Message: These shoes are light, breathable, barely there

Example Key Message

Sustainable and reliable water service delivery

"The new water rates ensure that our community can provide continuous services and safe water, today and into the future."

Example Key Message

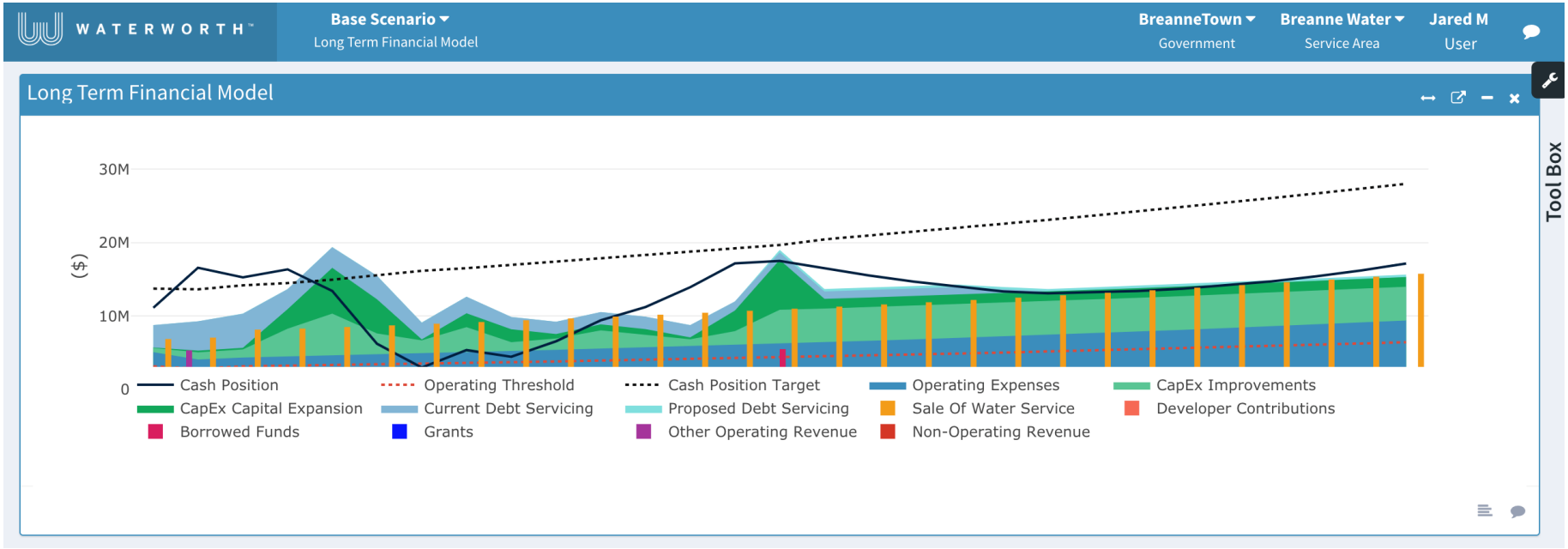
Metering will allow residents to take control of their own water costs

"Charging a portion of the water bill based on the amount of water used will allow you to control how much you pay"

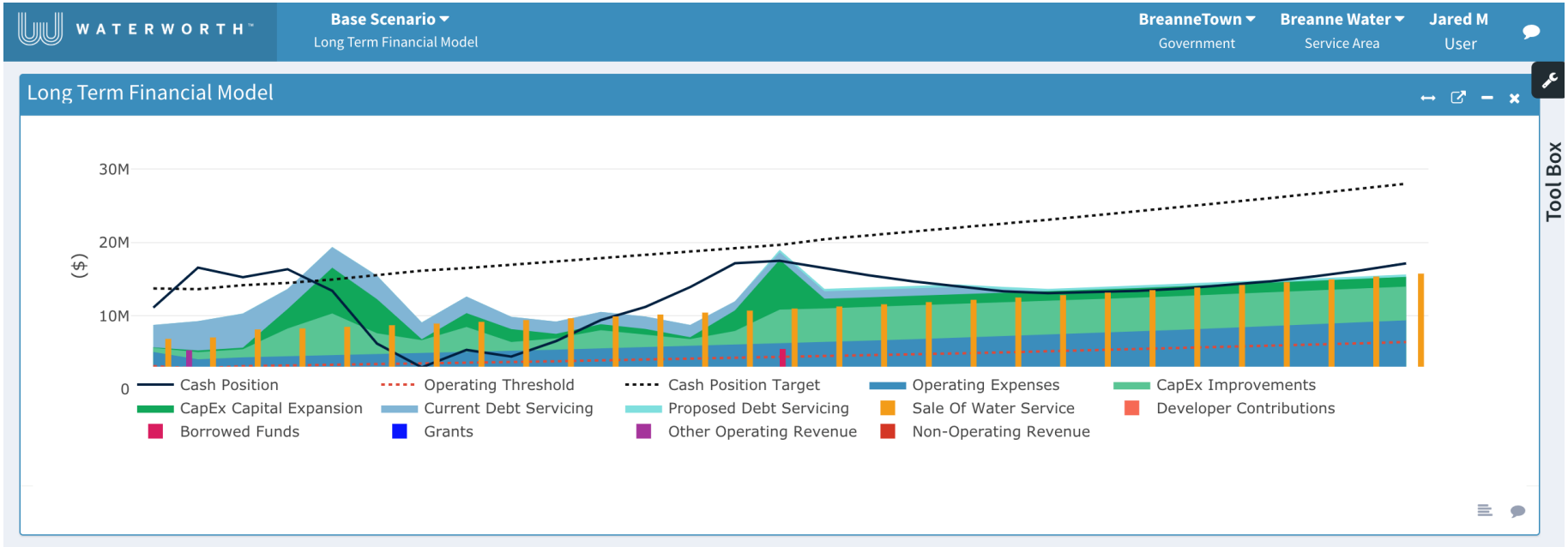
Example Key Message

Water conservation is good for our whole community

"When we use less water, we can delay the need to build new infrastructure, like pipes and well, by years, and sometimes forever. This lower water use saves our community millions of dollars which gets passed on to you through more affordable rates."

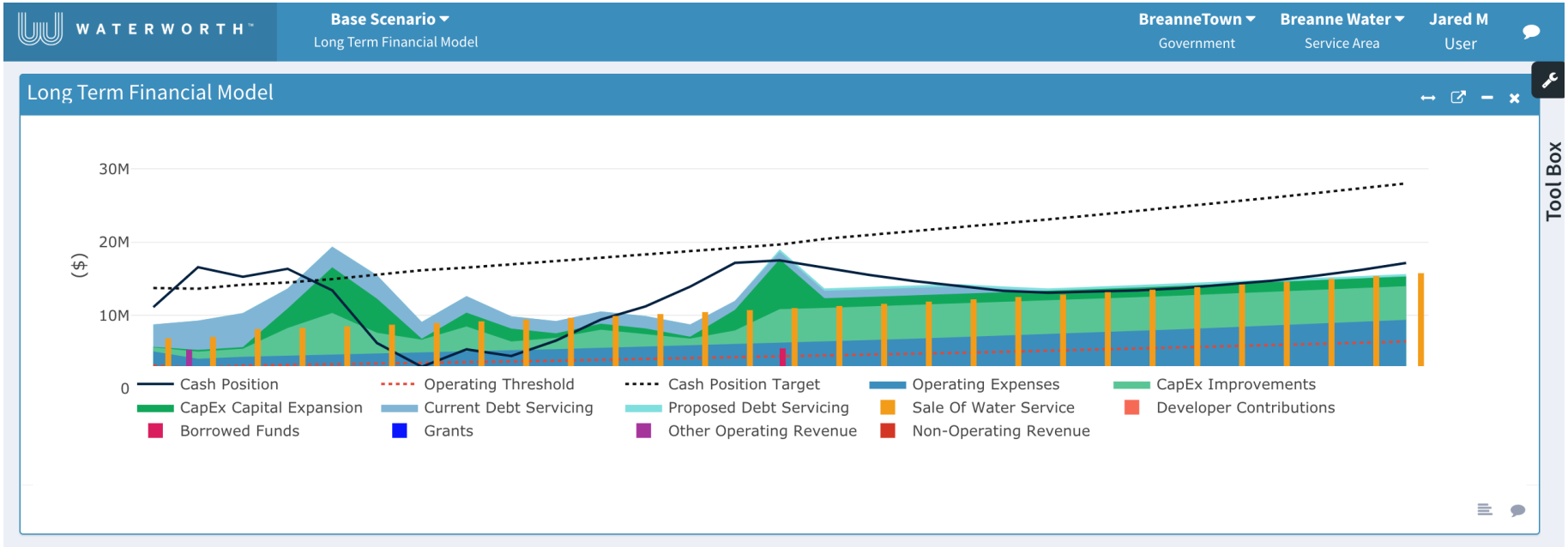


Your LTFM informs your key messages.



Key Message: Sustainable and reliable water service delivery

“The new water rates ensure that our community can provide continuous services and safe water, today and into the future.”



- Displays forethought and preparedness
- Rate payers are involved in the water system's future health and reliability
- Generates support for your capital plan and corresponding rate increases

WATERWORTH™

Take Aways

- Delivery service, not water commodity
- Goals:
  - Full cost pricing
  - Financial sustainability
- Just get started!
- Prudent financial stewards are aware of their long-term capital needs
- Your LTFM informs your key messages
- Effectively communications generate support

WATERWORTH™

Contact us

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1 844 34 WATER

@getwaterworth

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AWWA M36

Water Audits and Loss Control Programs

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Water Audit and Water Balance

- Audit
  - Top down – annual, quick
    - Desk study
    - Free M36 software
  - Bottom up – ongoing, incremental
    - Field testing
    - Repairs and calibration
- Balance
  - Water in = water out

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Water Balance

<table>
<tr><td rowspan="11">Volume From Own Sources (corrected for known errors)</td><td rowspan="12">System Input Volume</td><td>Water Exported (corrected for known errors)</td><td colspan="3">Billed Water Exported</td><td>Revenue Water</td></tr>
<tr><td rowspan="11">Water Supplied</td><td rowspan="2">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
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</table>

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Water Balance- Water In

<table>
<tr><td rowspan="2">Volume From Own Sources (corrected for known errors)</td><td rowspan="2">System Input Volume</td><td>Water Exported (corrected for known errors)</td><td colspan="3">Billed Water Exported</td><td>Revenue Water</td></tr>
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Water Balance – Exported Water

Volume From Own Sources (corrected for known errors)	System Input Volume	Water Exported (corrected for known errors)	Billed Water Exported			Revenue Water
		Water Supplied	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption	Revenue Water
					Billed Unmetered Consumption	
				Unbilled Authorized Consumption	Unbilled Metered Consumption	Non-Revenue Water
					Unbilled Unmetered Consumption	
			Water Losses	Apparent Losses	Customer Metering Inaccuracies	
					Unauthorized Consumption	
					Systematic Data Handling Errors	
				Real Losses	Leakage on Transmission and Distribution Mains	
Water Imported (corrected for known errors)					Leakage and Overflows at Utility's Storage Tanks	
					Leakage on Service Connections up to the Point of Customer Metering	

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Water Balance- Authorized Use

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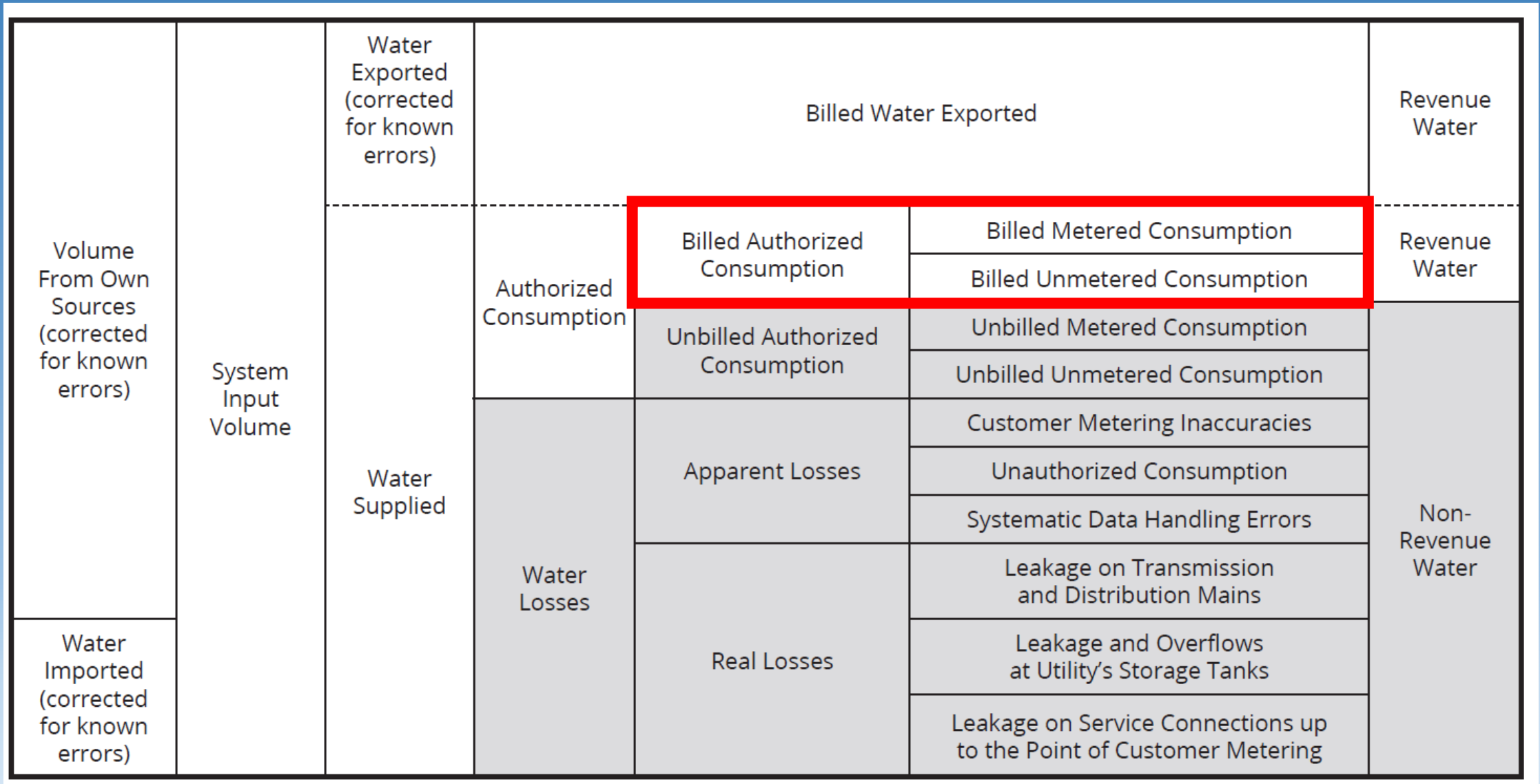

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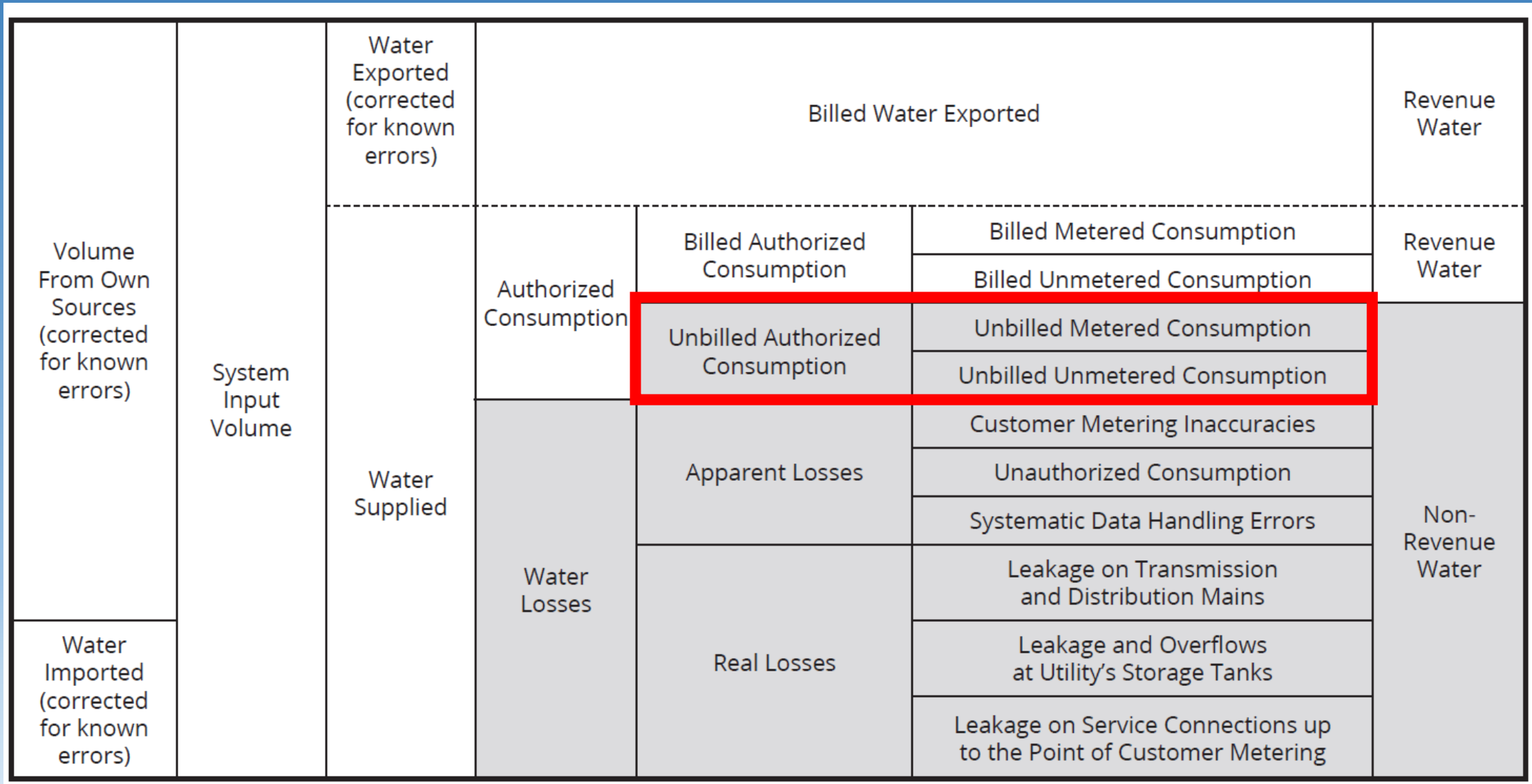
Water Balance- Authorized Use



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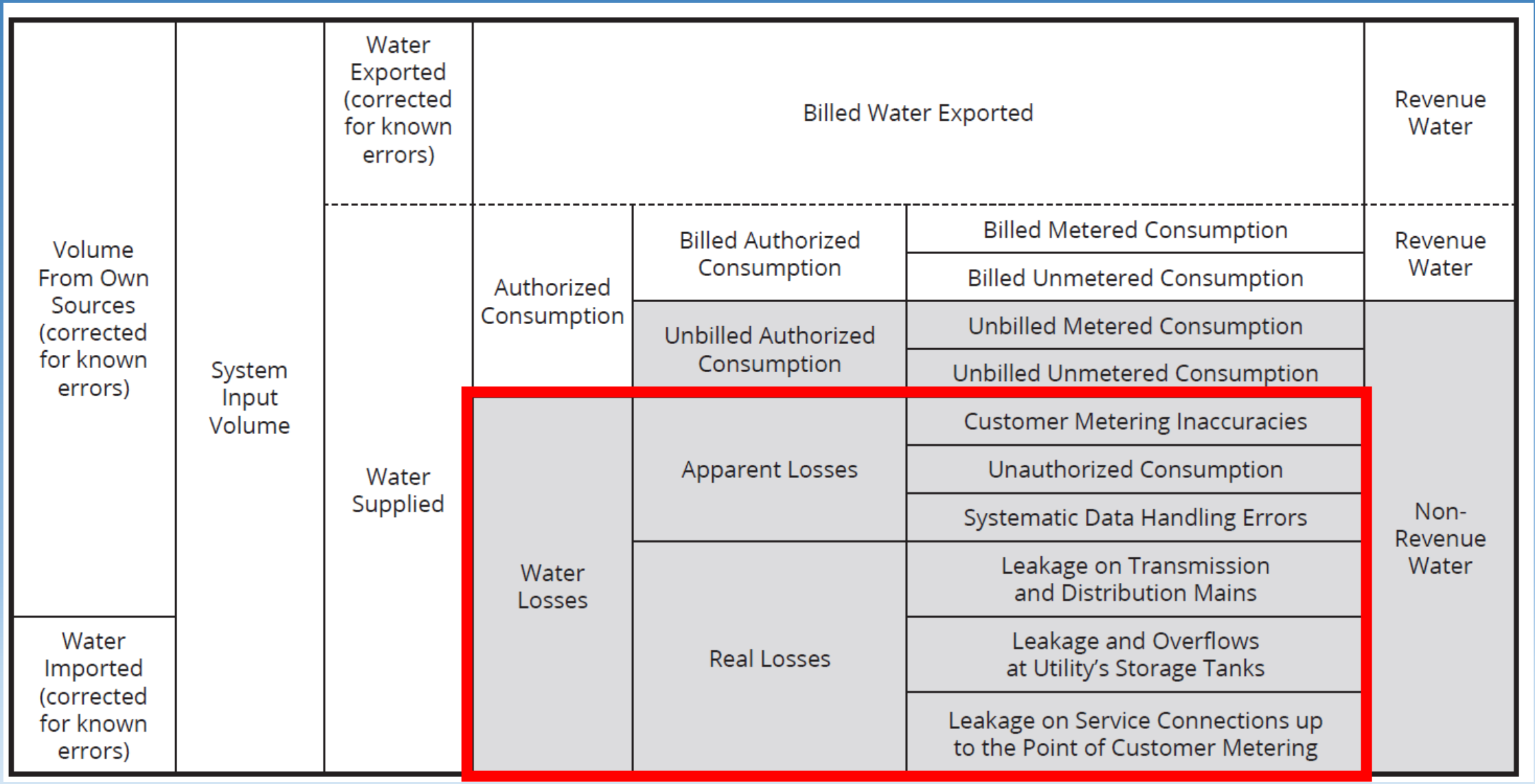
Water Balance – Water Losses



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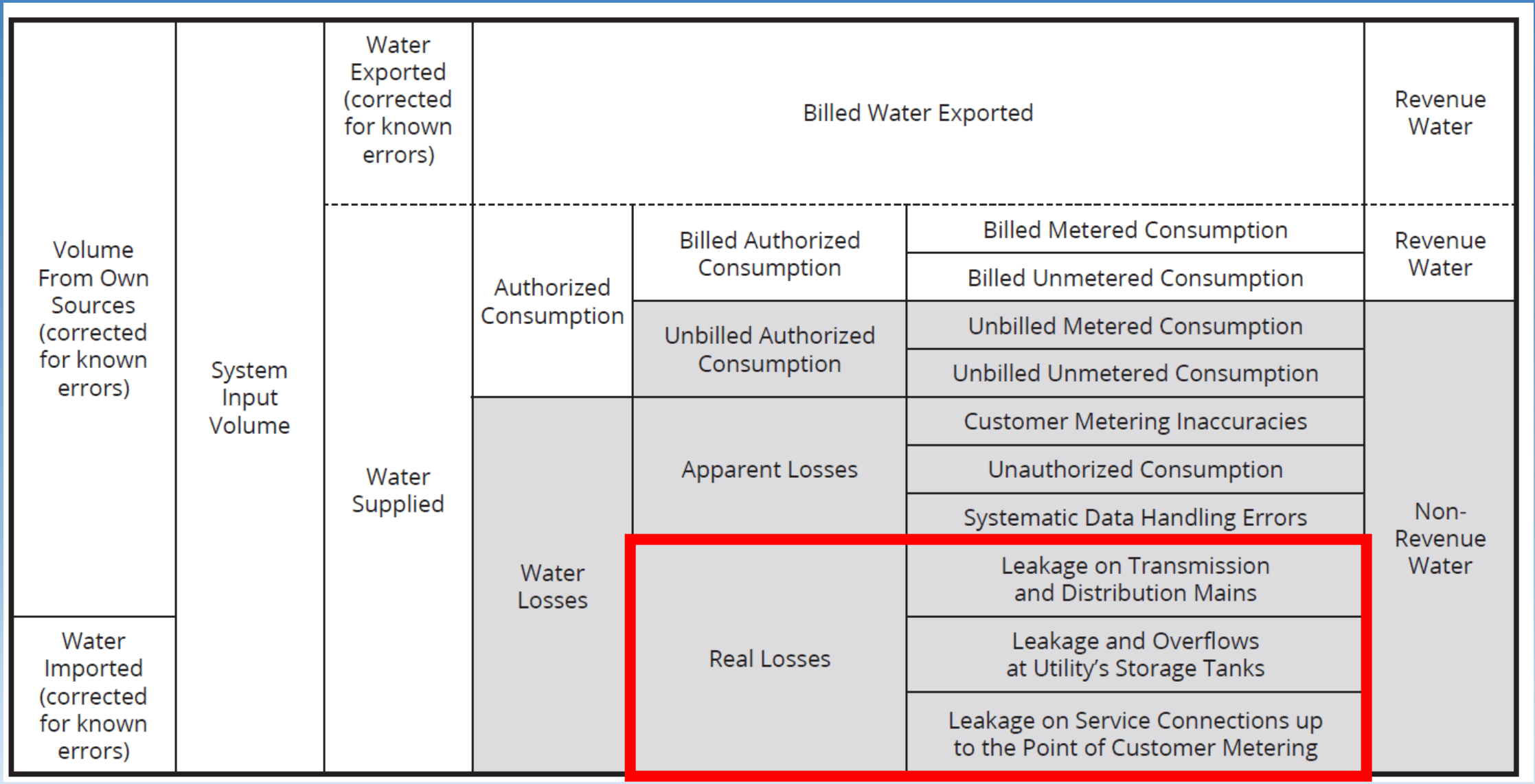

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M36 Software Demonstration

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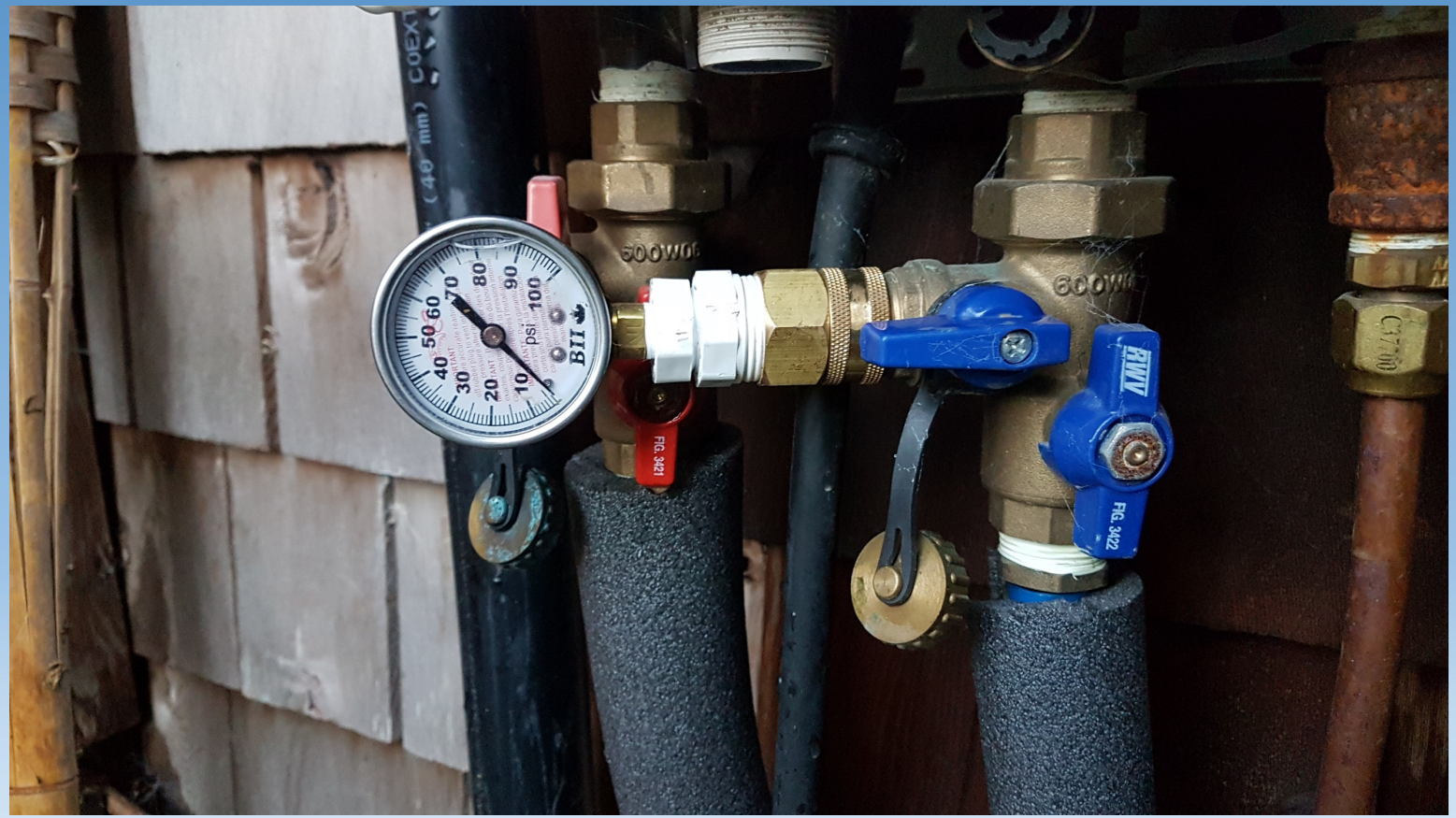
Bottom-up Approach

- Validating the top-down approach with field measurements



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Bottom-up Approach - Apparent Losses

- Flow verification tests for production meters
- Accuracy testing of customer meters
  - Representative sample
- Field investigation
  - Inactive accounts
  - Low-flow accounts
  - Suspicious parcels e.g. connected to sewer but not to water
- Temporary metering of fire hydrants

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Bottom-up Approach - Real Losses

- Leak detection
  - Sonic detection
  - Step testing (a.k.a. zone analysis)
  - Physical observation (e.g. wet areas)
- Overflows from Reservoirs
  - Operator protocols
  - Retrofit solutions
- Real Loss Component Analysis
  - Free spreadsheet available from Water Research Foundation (WRF)

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Case Study – Resort in BC

- Top-down Approach
  - Limited information available
  - Quantified rate of leakage, but not locations
- Bottom-up Approach
  - Zone analysis
  - Physical observations

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Summary

Top-down audit

- Yearly desktop study

Bottom-up audit

- Ongoing field verification and repairs

Real losses

- Leaks and spills

Apparent losses

- Data inaccuracy

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Questions?

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Karl Williaume, P.Eng. Karl@msrsolutions.ca