MODULE 1
Introduction to Source Protection

*"Keeping contaminants out of drinking water **sources** is an efficient way of keeping them out of drinking water."*

Justice Dennis R. O'Connor, Associate Chief Justice of the Court of Appeal for Ontario, in Part II of the Walkerton Water Inquiry Report, 2001 (Item 1.4.1)

SECTION ONE

Module Content

Unit 1 – Source Protection (SP) — What We Want and Who We Are

- Why are we here?
- How will we achieve the vision of protecting drinking water at its sources?
- Water Bingo

Unit 2 – We're All About Collaboration

- Working Together

Unit 3 – Drinking Water Source Protection Basics

Sources of Water

- Early Thoughts on Source Protection — What is being done to protect source water?
- Multi-Barrier Approach

Under Your Feet

- Saturated and Unsaturated Zones
- Types of Aquifers
- Recharge and Discharge Areas
- 'Puzzled?' Source Protection Terminology Game

Unit 4 – Wrapping It Up

- Review Questions for this Module
- Self Assessment on Learning Goals
- More Help
- Field Assignment

Field Learning Task to complete for next module:

There is one assignment to complete before the next module:

Review the definitions sheet to re-familiarize yourself with Module 1 source water terminology and their meanings. Scan the newspapers looking for articles that are relevant to water or protection of drinking water at its sources. Read, clip and bring one article with you to the next module.

Learning Expectations:

By the end of this session you should:

- Understand water sources are made up of both groundwater and surface water.
- Understand terms water table, unsaturated zone, saturated zone and Vadose Zone.
- Understand that some water sources come from aquifers.
- Understand the importance of the multi-barrier approach to the protection of drinking water.
- Have met your fellow participants and learned some of the strengths they bring to the group.
- Demonstrate understanding of how mutually-respectful collaboration will work in this group.
- Demonstrate understanding of why water treatment doesn't solve all water quality problems.

Unit 1 – Source Water Protection: What We Want and Who We Are

 **Speaker/Lecture:** Why are we here? A refresher

We are here to bring ideas from, and take ideas back to, our organizations.

We are also here to…

Why are we here?

Speaker/Lecture: How will we achieve the Source Protection vision?

How will I help achieve the Source Protection vision?

We have a much-needed opportunity before us. The provincial government introduced the Clean Water Act on Dec. 5 – the drinking water source protection legislation, upon approval, mandates the development of source protection plans for all of Ontario's watersheds.

Source: Conservation Ontario

Source: Ontario Ministry of the Environment

Group Activity: Water Bingo!

Let's begin to get to know one another...

Instructions: Move from person to person to fill in the bingo spaces learning the names of your new team members, here to support the vision of source protection. Choose a space and ask the person you are meeting if they can answer "yes" to one of the descriptions below. If you get a "yes" response, have that person sign their name in the appropriate box. Each person can only sign your sheet once – unless you have had every person in the group sign your sheet and still do not have a 'water' or 'bingo.' In that case, you can start asking around again. The first person to get TWO STRAIGHT LINES in any direction shouts "Water BINGO" and is declared the winner!

	B	I	N	G	O
W	I drink bottled water.	I believe "sinkholes" are a great thing in golf but a potential contaminant for groundwater.	I live on a farm.	I am curious and need to know "why"?	I enjoy reading a newspaper.
A	I am a strategic thinker.	I love being on a boat.	I am a watershed steward.	I know what "GIS" means. What does it mean? _____	I enjoy watching the television program, 'The Nature of Things'.
T	I live on or near a lake.	I love to solve complicated problems.	My source of water at home is from a well.	I can read and understand a map.	I have the same first or middle name as you.
E	I enjoy learning technical or scientific data.	I am sensitive to the feelings and needs of others.	I love to fish.	I love open spaces.	I attend my local council or watch them on TV.
R	I like walking on trails.	I have a love of nature.	I practice conservation at home.	My home is more than 100 years old.	I drink tap water.

Unit 2 – We're all about Collaboration

 **Group Activity:** Working Together

There are values in having variety of members in a committee, subcommittee or working group. They include…

 **Facilitated Dialogue:** Working Together

Collaboration – working effectively together – begins with a core value to respect the rights and views of all. Synergy ('the whole is greater than the sum of its parts') comes from collaboration, through openly sharing information and resources and freely requesting input, feedback and help.

Collaboration – a definition for our learning and working group:

Collaboration is a principle-based process of working together which builds trust and produces results. What founding principles will allow your group to work effectively together?

Collaboration Principles:

_____

_____

_____

_____

_____

Facilitated Dialogue:

Three Good Questions to Ask and Answer Collaboratively

1. How will we build trust in the group among diverse people who may think differently?

2. What would we see in a group where members' rights, opinions and ideas are respected? What would we hear in a group where mutual respect takes place?

3. What will we do to express appreciation and honest concerns in a way that builds trust and positive working relationships?

What principles of mutual respect will form the basis of our group's approach to working constructively together?

Individual Activity/Personal Reflection

Take a moment to read the sentences below. Complete the sentences, based on your own feelings, having participated in Module 1 collaboration exercises.

What actions will I take to support people working well together (collaboration)?

_____

_____

_____

_____

_____

If I want collaboration, what must I be willing to give up?

_____

_____

_____

_____

_____

"Nothing new that is really interesting comes without collaboration."

- James Watson, Nobel Prize in Physiology or Medicine 1962

Unit 3 – Basics of Protecting Drinking Water at its Sources
What are Our Sources of Water?

 **Facilitated Dialogue:** Where Does Our Water Come From?

In the large group or committee, name as many sources of drinking water as possible:

_____

_____

_____

_____

_____

Early Thoughts on Protecting Drinking Water at its Sources…

 **Group Activity:** What is being done to protect source water?

In groups of three set up by the facilitator, discuss what is already being done to protect the sources of our drinking water. Record your thoughts for presentation to the large group and make individual notes in the space provided for your own reference. Choose one member of your group to present to the larger group or committee your smaller group's shared thoughts. Listen to the reports of other groups and expand your list by capturing their good ideas too:

_____

_____

_____

_____

_____

 **Self Reflection:** What do you do to protect source water?

Firstly, you serve on a committee, subcommittee or working group that is helping plan to protect our source water.

_____

_____

_____

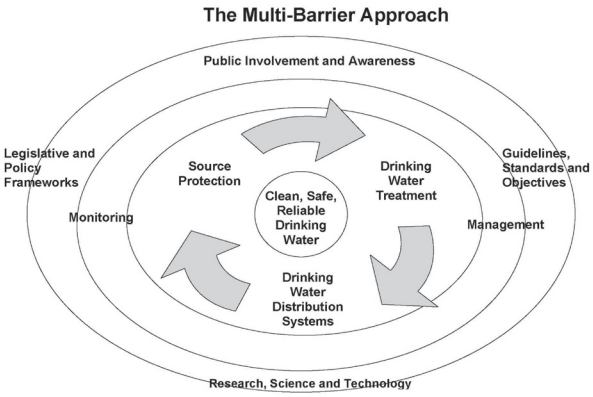
_____

_____

You also contribute your skills, knowledge and abilities in the following ways:

Lecture: Under Your Feet

Your facilitator, or a guest speaker with a technical background, will present a brief overview of source water basics with illustrations to orient you to sub-surface water information (or what is under our feet). The facilitator/speaker hopes you will have questions for them, so please don't hold back with any questions or comments. Questions are great to help us to learn from each other!



Source: Conservation Ontario

Multi-Barrier Approach to Protection of Drinking Water

Group Activity: 'Puzzled?' Source Protection Terminology Game

Instructions:

You will receive from your facilitator two puzzle pieces. On one piece you will find a technical term that has a specific meaning related to protection of drinking water at its sources; on the other puzzle piece you will find a definition of a technical term, also related to source protection. It is unlikely that your two pieces fit together. If this is correct, you are well positioned to play:

***'Puzzled?'* Source Protection Terminology Game!**

Let's collaborate! The perfect fit to your puzzle pieces are in someone else's hands. Seek out the terms and definitions that others have and see if one of their puzzle pieces fits well with yours, and also that the definitions also makes sense. If your definition belongs with a terminology piece, give it to the person who holds the terminology piece so that they have one complete puzzle in their hands. And, keep looking for the perfect fit to complete your own.

When everyone has one complete puzzle, the facilitator will ask you share the technical term as well as its definition with the open group. Your facilitator will draw upon examples to further help draw the connections between the technical terms and their meanings.

Who wins? Everyone wins when we have reached the point where no one is puzzled over the drinking water source protection terminology. Prizes? The real prize is… with a little time and practice, you will develop an extended vocabulary, using groundwater and source water protection terms in meaningful ways.

Reading: Source Water Protection Primer, Pollution Probe, 2004
The Clean Water Act, RSO 2005
Fact sheets on the Clean Water Act

Unit 4 – Summary

Wrapping it up:

Congratulations! Module 1 is almost complete. Already you have mastered quite an impressive amount of material.

Group Activity: Review Questions for this Module

In a small group comprised of three to five individuals, you are to collaborate to present a short summary to the large group answering one of the following review questions, assigned by your facilitator:

a) What is source water?

_____

_____

_____

_____

_____

b) What are the two main kinds of drinking water sources?

_____

_____

_____

_____

_____

c) What is source protection?

_____

_____

_____

_____

_____

d) Why is protecting water sources important?

e) Why can we not just rely on treatment to protect our water supply?

Field Learning Assignment

Between now and the next time we meet please:

1. Familiarize yourself with the technical terms from our definition list and their meanings.

2. Look to the newspapers for any articles which relate to water quality or drinking water source protection. Read and clip the article. Also, take note if the article contains any of the technical words you have learned in module one. If so, are the use and meaning of these technical terms consistent with the meanings we have attached to them? Bring the article with you to the next module for creation of a shared information resource.

Hand-out sheet to be completed independently and returned to the facilitator at next session.

The self-assessment survey is a separate hand-out by the facilitator at the end of Module 1 learning session.

Module One Self-Assessment

Complete a mini-self assessment of your learning thus far.

Place a...
Plus sign [+] (yes, true)
Minus sign [–] (no, not true)
or a Question Mark [?] (uncertain)
...beside your Module One learning take-a-ways.

I have:

- ☐ acquired an understanding of the vision for Drinking Water Source Protection and recognize the important role I have as a member of the Working Group in achieving this vision.
- ☐ developed an appreciation for the uniqueness and diversity of Working Group members. I feel optimistic that my contributions will be valued.
- ☐ developed an understanding of the collaborative framework we will be working within to study the curriculum and help to develop a source water protection plan that can be successfully implemented.
- ☐ developed and/or reinforced my knowledge of technical source protection vocabulary and feel confident to use these terms in ways that other people will understand and find meaningful.
- ☐ covered the basic concepts of groundwater or source water protection.

Do you want more information? Do you feel like you need a little extra learning support? Your facilitator cares about your learning and will be happy to discuss any of these learning points with you in private to help you move to the next module with confidence. Just ask or write down your thoughts here and a facilitator will follow up with you.

SECTION TWO

Priming the Pump

We're all about Collaboration.

You and everyone else comprising the committee, subcommittee or working group, are unique, representing a range of experiences and backgrounds. The complexity and detail required in development of a local Drinking Water Source Protection Plan relies on committees, working groups and subcommittees being comprised of informed local residents, representing a diversity of perspectives and groups.

Committees, subcommittees and working groups are challenged with the task to deal with the specifics of source water protection issues in their watersheds. In so doing, team members will work closely and collaboratively with one another to study difficult problems of global concern and determine the best solutions for local intervention.

You will be given the time and resources needed to sufficiently probe local source-water issues. You will be given access to the most current scientific research and technical data, and technical expertise to help you analyze and draw meaning from this data.

However, the most important ingredient to the group or committee success and achievement of the Source Protection (SP) vision is that you are successfully able to demonstrate the principles of true collaboration.

Collaboration Principles:

✓ People come first

✓ People produce results

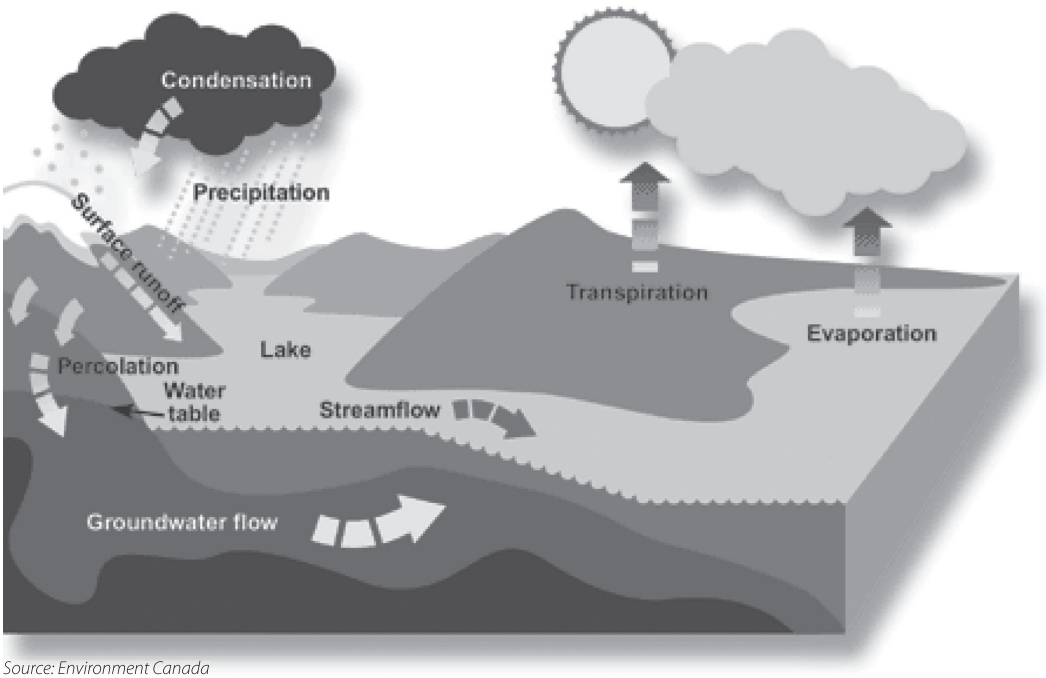
✓ People must be motivated at the heart and spirit level

✓ People are best motivated when their objectives are aligned with a strategic vision

✓ Results are achieved by creating a learning environment grounded in a set of core values, using consensus-based processes to build ownership and alignment.

To continue to achieve collaboration as we work through more complex program study, we will require continued practice, encouraging active participation, listening, openness and personal vulnerability. Please try to be comfortable with a flexible learning program and the adaptability of collaboration that provides the safest atmosphere to encourage creativity, learning and innovative solutions to occur.

Source Protection Basics – The Water Cycle



Source: Environment Canada

What is protection of drinking water at its sources?

In March of 2000, the tragic events in Walkerton forced all Ontarians to begin a journey towards better protection of drinking water sources. Justice Dennis O'Connor led an inquiry and in his report he said "keeping contaminants out of drinking water sources is an efficient way of keeping them out of drinking water."

Keeping source water clean is the first line of defence against unsafe drinking water. It's also much more expensive to clean up polluted water than to protect our water in the first place.

Protection of drinking water at its sources can be described as the voluntary action taken to prevent pollution of our drinking water sources, including groundwater, lakes, rivers, and streams.

Source Protection (SP) planning is development and implementation of a plan to manage land uses and potential contaminants. To be effective, source water protection should be directed at identified major threats to the drinking water source.

The Government of Ontario says it's committed to implementing all 122 recommendations of the O'Connor report, including source water protection plans for every watershed in Ontario.

What is the multi-barrier approach to safe drinking water?

The key to ensuring clean, safe and secure drinking water is to implement multiple barriers throughout the drinking water system from source to tap. No single barrier is 100 per cent effective. Therefore, multiple barriers are required. The common barriers used in the provision of safe drinking water are:

Source Water Protection – keeps raw water as clean as possible and lowers the risk that contaminants will get through and affect the treatment system.

Treatment – there are many unit treatment processes used to remove or inactivate contaminants.

Distribution system – prevents the intrusion of contaminants and ensures appropriate chlorine residual throughout the system.

Monitoring and management – system from source to tap is monitored and managed by trained personnel in accordance with industry legislation, standards, policies and guidelines. Problems are detected early so that corrective action can be taken quickly. Automatic control systems are being incorporated into the water systems.

Emergency Procedures and Plans – responses to emergency and adverse conditions are thorough and effective to prevent health problems.

Why is protecting source water a concern if we can just treat our water later?

We live in a rural area. Half of the people living within the Ausable Bayfield and Maitland Valley watersheds obtain their water from private wells. More than two million people in Ontario get their water directly from surface or groundwater sources.

It has been found that the less polluted the water is before treatment, the less extensive and expensive the efforts are needed to protect the public's health.

Further studies have shown that the cost of dealing with contaminated water can be many times more than preventing their contamination in the first place.

Also, conventional water treatment won't necessarily remove all hazardous chemicals.

Finally, with clean water and healthy ecosystems in the Ausable Bayfield and Maitland Valley watersheds there are unquantifiable benefits in terms of the quality of the public's lives.

We have to solve the problem at the source. This brings us to an important question...

Is there anything that being done to protect source water?
Yes, fortunately there is. Some positive acts of stewardship are happening right now. Conservation Authorities manage watersheds, which are the areas of land drained by rivers, creeks or streams and all tributaries from source to mouth. Water flows across that watershed, crossing forests, farmlands and towns. While the water is traveling across our land different activities affect it. The more ways we limit harmful effects on our water as it travels, the better chance we have that the water coming out of your tap at home or work will be healthy.

What are the sources of our drinking water?
Drinking water could include private and municipal wells, municipal drinking water systems (including treated lake water) and other sources …

Under Your Feet

Water Sources
To understand the importance of protecting water sources, we must begin with a basic understanding of where our drinking water comes from and some of its scientific concepts.

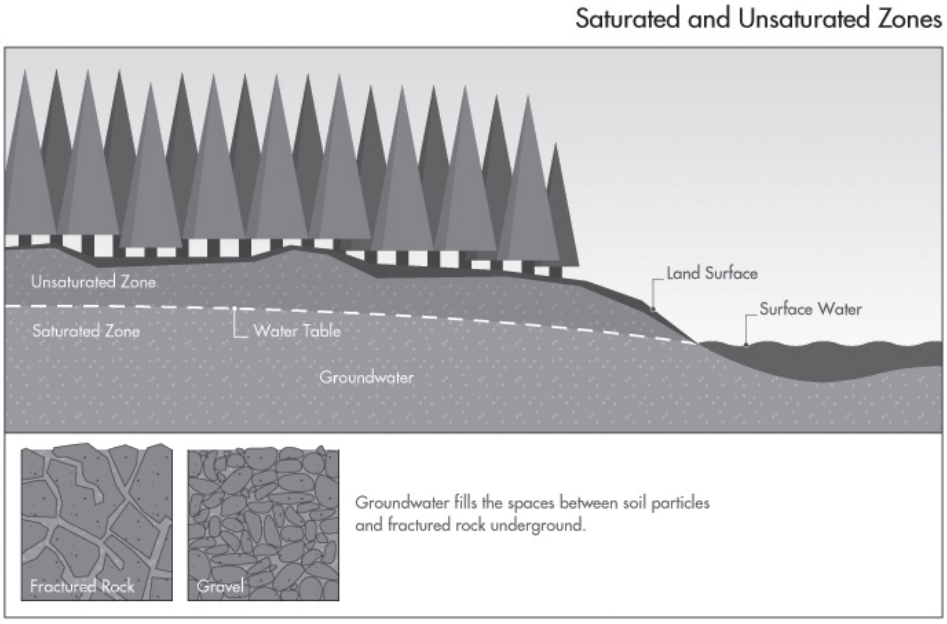
Drinking water is either groundwater or surface water. Drinking water sources are the lakes, rivers, streams and, underground aquifers that serve as the current and future source of a community's drinking water.

Surface water is an open body of water, such as a river, stream, lake, or estuary. All of these receive water from precipitation, runoff from higher elevations, or recharge from groundwater moving below the stream or lake bed.

Groundwater on the other hand, is water that fills the open spaces, or pore spaces, within the rock, sand, gravel or sediment materials lying below the earth's surface. When there are relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity or significant occurrences of microorganisms in any water beneath the surface, this source is known as Groundwater Under the Direct Influence of surface water. 'GUDI' for short! An example of a GUDI would be a shallow dug well on the shore of a lake where the groundwater supply is influenced by the surface supply.

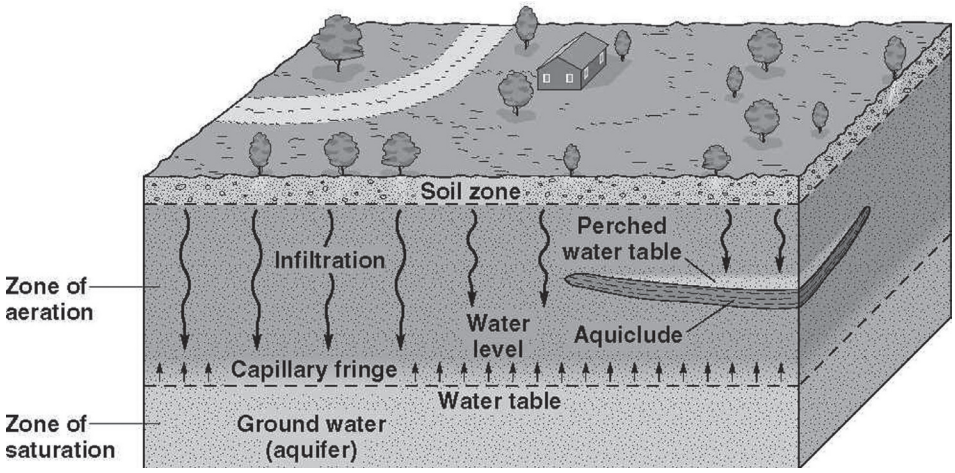
There are many who will argue that there is one other drinking water source today and that is bottled water! But please, be assured this supply originates with one of the sources above.

What Does It Look Like Underground?



Source: Pollution Probe

What are the Subsurface Conditions?



Source: Brooks/Cole – Thomson Learning

As can be seen from the above diagram the subsurface is divided into zones or layers.

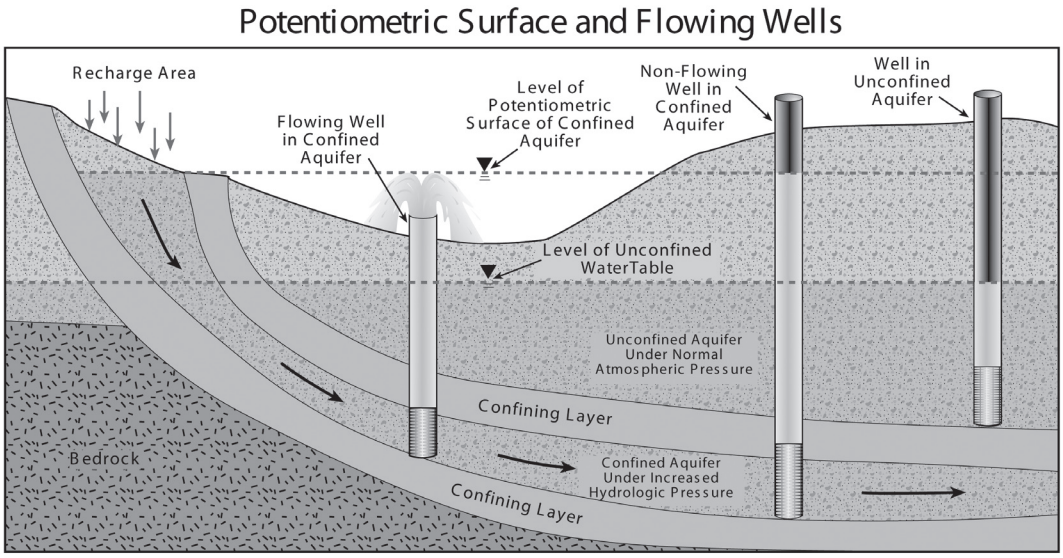
The unsaturated zone is directly below the surface and contains some water. In the unsaturated zone, water and air fill the voids between soil or rock particles. In summary, the area between the land surface and the water table in which the pore spaces are only partially filled with water is the unsaturated zone. It is also called the 'zone of aeration' or 'vadose zone.' Soil pore space also typically contains air or other gases.

Deeper in the ground is the zone of saturation. In the zone of saturation, the subsurface is completely saturated with water.

The point where the unsaturated zone meets the zone of saturation is known as the water table. Water table levels fluctuate naturally throughout the year based on seasonal variations and are the reason why some wells go dry in the summer. In addition, the depth to the water table varies. For example, in (select an area in the watershed or community) the water table is "x" meters below the surface.

The saturated zone may form an aquifer. An aquifer is a geologic formation that contains water in quantities sufficient to support a well or spring.

What are the types of aquifers?

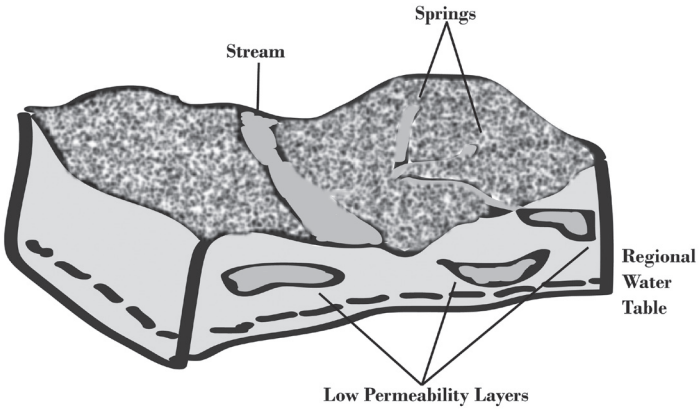


Source: Unknown

Aquifers are generally classified into two types: confined aquifers and unconfined aquifers (see above diagram). There is however a third that does not get mentioned often and that is the perched aquifer.

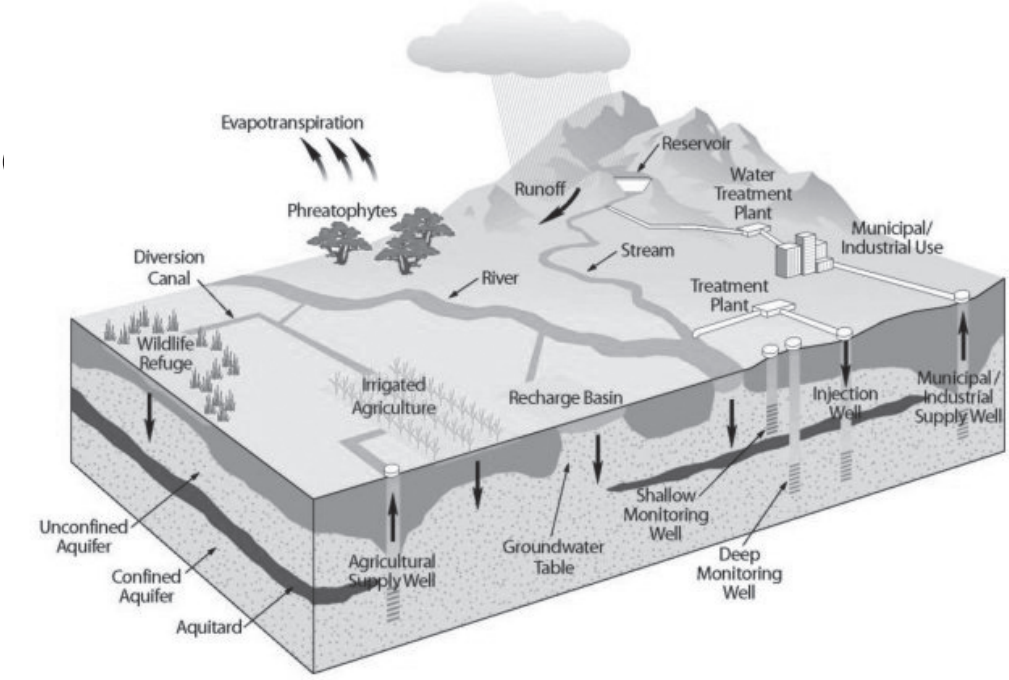
A confined aquifer also commonly called an artesian aquifer. It is the saturated formation between impermeable layers that restrict movement of water vertically into or out of the saturated formation. In this layer, water is confined under pressure, similar to water in a pipeline. Drilling a well into this type of aquifer is similar to puncturing a pressurized pipeline. If the pressure is great enough, the well will flow, and this is called a flowing artesian well.

An unconfined aquifer (water table aquifer) is the saturated formation in which the upper surface fluctuates with the addition or removal of water. The upper surface of an unconfined aquifer is the water table that we talked about previously. Water, contained in an unconfined aquifer is free to move laterally in response to differences in the water table elevations. Unconfined aquifers are also often shallow. Wells constructed into them have a greater potential for contamination than wells constructed into the deeper or confined aquifers.



Source: Source Protection ABCA-MVCA

Perched aquifers occur where groundwater is perched above unsaturated formations as a result of a discontinuous impermeable layer. They also occur in formations where weathered layers or ancient soils have created impermeable zones. Wells drilled into these aquifers have been known to go dry because the water is mined.



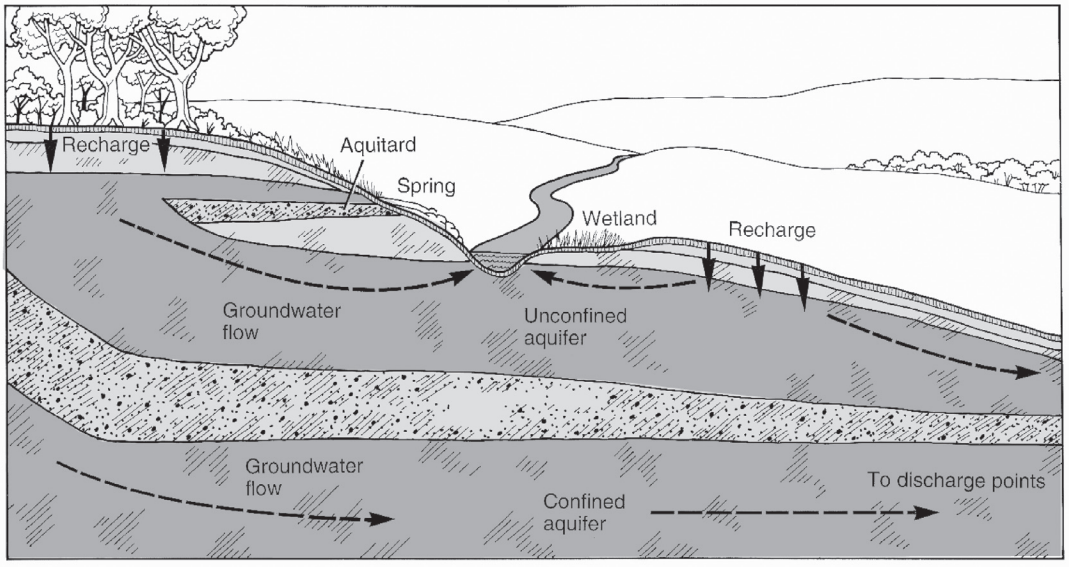
Source: California Department of Water Resources, Groundwater Information Centre

What are recharge and discharge areas?

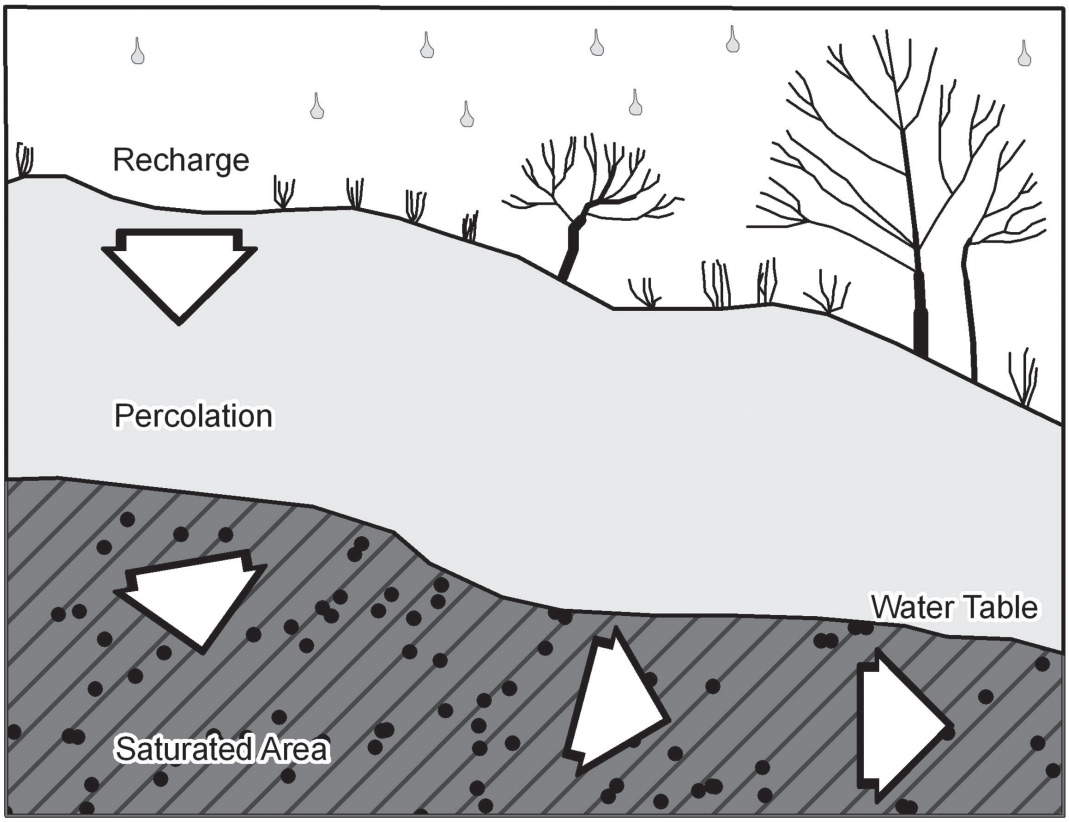
When discussing groundwater basics, the terms recharge and discharge areas always appear.

Replenishment of groundwater is known as recharge. Almost all groundwater originates as surface water and primary sources of natural recharge include precipitation, streams, lakes, etc. Other conditions known as artificial recharge occur from excess irrigation or water purposely applied to augment groundwater supplies. Water within the ground moves downward through the unsaturated zone, under the action of gravity, whereas in the saturated zone, it moves in a direction determined by the surrounding conditions. The zone of contribution is the area of the aquifer that recharges the well.

Discharge of groundwater occurs when the water emerges from the ground. Most natural discharge occurs as flow to surface water bodies such as lakes, streams, and oceans. Pumpage from wells constitutes the major artificial discharge of groundwater.



Source: Unknown



Source: Darrell Innes, GIS Specialist, based on US Geological Survey diagram

It must be noted that streams may lose flow to aquifers (aquifer recharge) during periods of high stream flow (such as spring runoff) but gain flow from aquifers (aquifer discharge) during periods of low stream flow (such as during the summer).

Unconfined aquifers are recharged primarily from precipitation percolating or infiltrating down from the surface, while confined aquifers are generally recharged when the aquifer materials are exposed at the lands surface.

Other Source Protection Key Definitions

The following terms and definitions are not intended to be complete or to have legal force, but rather to help you understand drinking water-related terms in the context of your daily lives and completion of these early training sessions. Comprehensive definitions for some of these terms will be presented in future modules.

Aquifer: A natural underground layer of porous water–bearing materials, often sand or gravel that contains water. (The technical definition of an aquifer describes it as the saturated underground formation that will yield usable amounts of water to a well or spring.) The formation could be sand, gravel, limestone or sandstone. The water in an aquifer is called groundwater. A saturated formation that will not yield water in usable quantities is called an aquiclude.

Groundwater: Water found in the spaces between soil particles and cracks in rocks beneath the earth's surface (usually located in aquifers a natural reservoir below the earth's surface in an aquifer). Groundwater is a natural resource that is used for drinking, recreation, industry, and growing crops.

Raw Water: Water in its natural state, prior to any treatment.

Sinkhole in Tuckersmith
Source: Ausable Bayfield Conservation Authority

Sinkhole: A sinkhole is a depression in the land surface resulting from the dissolution of the underlying soluble bedrock, and the subsequent collapse of overlying soil and rock. Essentially, dissolved bedrock creates a cave which eventually collapses, with soil moving into the bedrock and a large sinkhole depression sometimes forming on the surface. Sinkholes represent conduits where potentially unsafe surface waters have a higher potential to be quickly transmitted to the groundwater system. Sinkholes are circular or elliptical closed depressions. A farmer may view sinkholes as naturally forming holes that occasionally open up in the fields. Some people see sinkholes as sites for dumping trash without thinking of the potential impact on groundwater sources. In urban areas, the sudden appearance of a sinkhole is a hazard that can disrupt utility services, hamper transportation, and cause severe damage to nearby structures. Sinkholes are generally depressions on the surface of the land where water can collect and seep into the groundwater. Sinkholes are typical features of karst regions (Karst topography is the name given to an area underlain by rocks such as limestone and is characterized by caves, sinkholes, and depressions), and provide a direct pathway for surface water to move into the subsurface. The run-off that enters through sinkholes is not filtered as it joins the groundwater system. Sinkholes occur singly, or in groups in close proximity to one another. Sinkholes range from less than a metre to more than thirty metres in depth. Not all topographical depressions are sinkholes.

Source Water Protection: Voluntary action taken to prevent the pollution of drinking water sources, including groundwater, lakes, rivers, and streams. Source water protection is developing and implementing a plan to manage land uses and potential contaminants. To be effective, source water protection should be directed at identified major threats to the drinking water source. See also 'Drinking Water Source Protection' in glossary.

Surface Water Intake: Drinking at least eight glasses of water a day is a fair definition of water intake, but not for students of source water protection! Our definition is: A surface water intake is an important feature of the surface-water collection works employed to withdraw water from a body of water. The raw water collection facilities generally consist of an intake structure located in the water, an intake conduit, and a pumping station to convey the water to a treatment facility. The intake is designed to prevent the access of debris, fish and other objects.

Turbidity: The cloudy appearance of water caused by the presence of tiny particles. High levels of turbidity may interfere with proper water treatment and monitoring.

Water Borne Disease: An infectious illness associated with the ingestion of water from a water system that is deficient in treatment.

Water Budget: The summation of inputs, outputs, and net changes to a particular water resource system over a fixed period.

Water Contaminants: Any physical, chemical, biological, or radiological substance or matter that has an adverse effect on water.

Watershed: The land area from which water drains into a stream, river, or reservoir. There will be a lot more information on watersheds presented in the next session.

Watershed management: is the first and most fundamental step in a multiple-barrier approach to protecting drinking water. Healthy, functioning watersheds naturally filter pollutants and moderate water quantity by slowing surface runoff and increasing the infiltration of water into the soil. The result is less flooding and soil erosion, cleaner water downstream, and greater groundwater reserves. Watershed management is a multifaceted discipline that involves conservation and restoration, land use monitoring, proactive land use regulations, on-site field inspections, education, planning, and emergency spill response.

Watershed Assessment: A watershed assessment is a process for evaluating how well a watershed is working. A watershed-based assessment provides a comprehensive evaluation of conditions and trends in the entire watershed and can be used to:

- Characterize watershed conditions and trends in water quality
- Determine causes of existing and future water quality problems
- Aid in the development, prioritization, and implementation of an overall watershed management program to prevent or correct the identified water quality problems;
- Establish a baseline and assess progress of overall watershed management activities or effectiveness of pollution prevention and control practices;
- Provide data to verify watershed conditions;
- Educate and inform the public.

SECTION 3

Additional Sources

Reading, listening and viewing resources:

Source Water Protection Primer, Pollution Probe, 2004
The Clean Water Act, RSO 2006
Fact Sheets on the Clean Water Act, 2006
Field Learning Assignment