

Wells & Septic Systems

Andrew Lazur

Water Quality, Well and Septic Education

University of Maryland Extension

lazur@umd.edu



AND JUSTICE FOR ALL

In accordance with Federal law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, this institution is prohibited from discriminating on the basis of race, color, national origin, sex, age, disability, and reprisal or retaliation for prior civil rights activity. (Not all prohibited bases apply to all programs.)

Program information may be made available in languages other than English. Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotope, and American Sign Language) should contact the responsible State or local Agency that administers the program or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339.

To file a program discrimination complaint, a complainant should complete a Form AD-3027, USDA Program Discrimination Complaint Form, which can be obtained online, at www.usda.gov/sites/default/files/documents/usda-program-discrimination-complaint-form.pdf, from any USDA office, by calling (866) 632-9992, or by writing a letter addressed to USDA. The letter must contain the complainant's name, address, telephone number, and a written description of the alleged discriminatory action in sufficient detail to inform the Assistant Secretary for Civil Rights (ASCR) about the nature and date of an alleged civil rights violation. The completed AD-3027 form or letter must be submitted to USDA by:

mail:

U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410; or

fax:

(833) 256-1665 or (202) 690-7442;

email:

program.intake@usda.gov.

This institution is an equal opportunity provider.

Conforme a la ley federal y las políticas y regulaciones de derechos civiles del Departamento de Agricultura de los Estados Unidos (USDA), esta institución tiene prohibido discriminar por motivos de raza, color, origen nacional, sexo, edad, discapacidad, venganza o represalia por actividades realizadas en el pasado relacionadas con los derechos civiles (no todos los principios de prohibición aplican a todos los programas).

La información del programa puede estar disponible en otros idiomas además del inglés. Las personas con discapacidades que requieran medios de comunicación alternativos para obtener información sobre el programa (por ejemplo, Braille, letra agrandada, grabación de audio y lenguaje de señas americano) deben comunicarse con la agencia estatal o local responsable que administra el programa o con el TARGET Center del USDA al (202) 720-2600 (voz y TTY) o comunicarse con el USDA a través del Servicio Federal de Transmisión de Información al (800) 877-8339.

Para presentar una queja por discriminación en el programa, el reclamante debe completar un formulario AD-3027, Formulario de queja por discriminación del programa del USDA, que se puede obtener en línea, en www.usda.gov/sites/default/files/documents/usda-program-discrimination-complaint-form.pdf, en cualquier oficina del USDA, llamando al (866) 632-9992, o escribiendo una carta dirigida al USDA. La carta debe contener el nombre, la dirección y el número de teléfono del reclamante, y una descripción escrita de la supuesta acción discriminatoria con suficiente detalle para informar al Subsecretario de Derechos Civiles (ASCR, por sus siglas en inglés) sobre la naturaleza y la fecha de la presunta violación de los derechos civiles. La carta o el formulario AD-3027 completado debe enviarse al USDA por medio de:

correo postal:

U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410; o

fax:

(833) 256-1665 o (202) 690-7442;

correo electrónico:

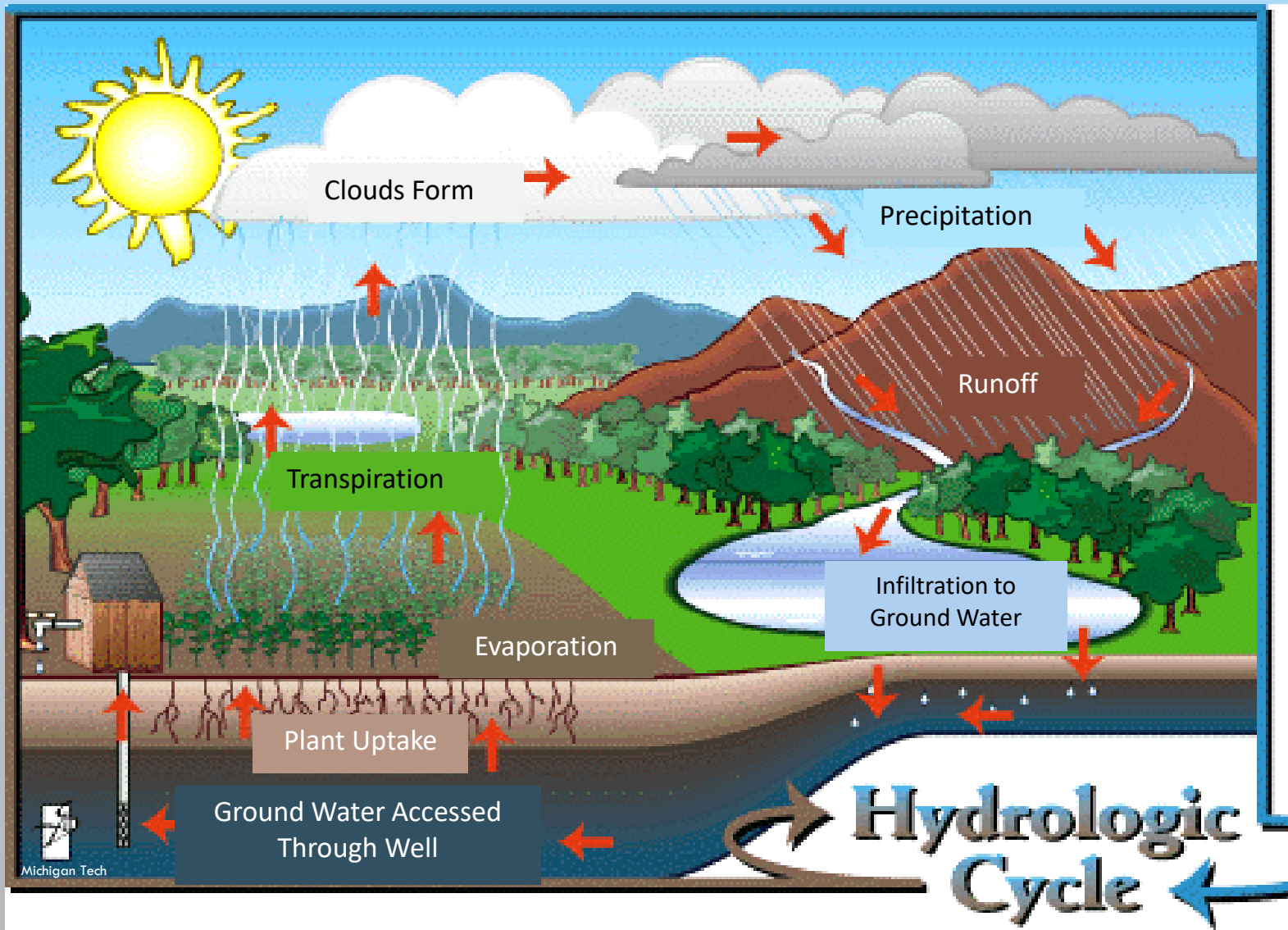
program.intake@usda.gov.

Esta institución ofrece igualdad de oportunidades.

Overview

1. Hydrology, Aquifers and Contamination
 2. Water Wells and Water Quality
 3. Septic Systems and Stewardship
- 

Water Cycle



- 13 million homes in US are on private wells; 44% of population
- ~ 28 % of Marylanders use wells as drinking water

What is an Aquifer?

Sediment or rock
that transmits
water easily

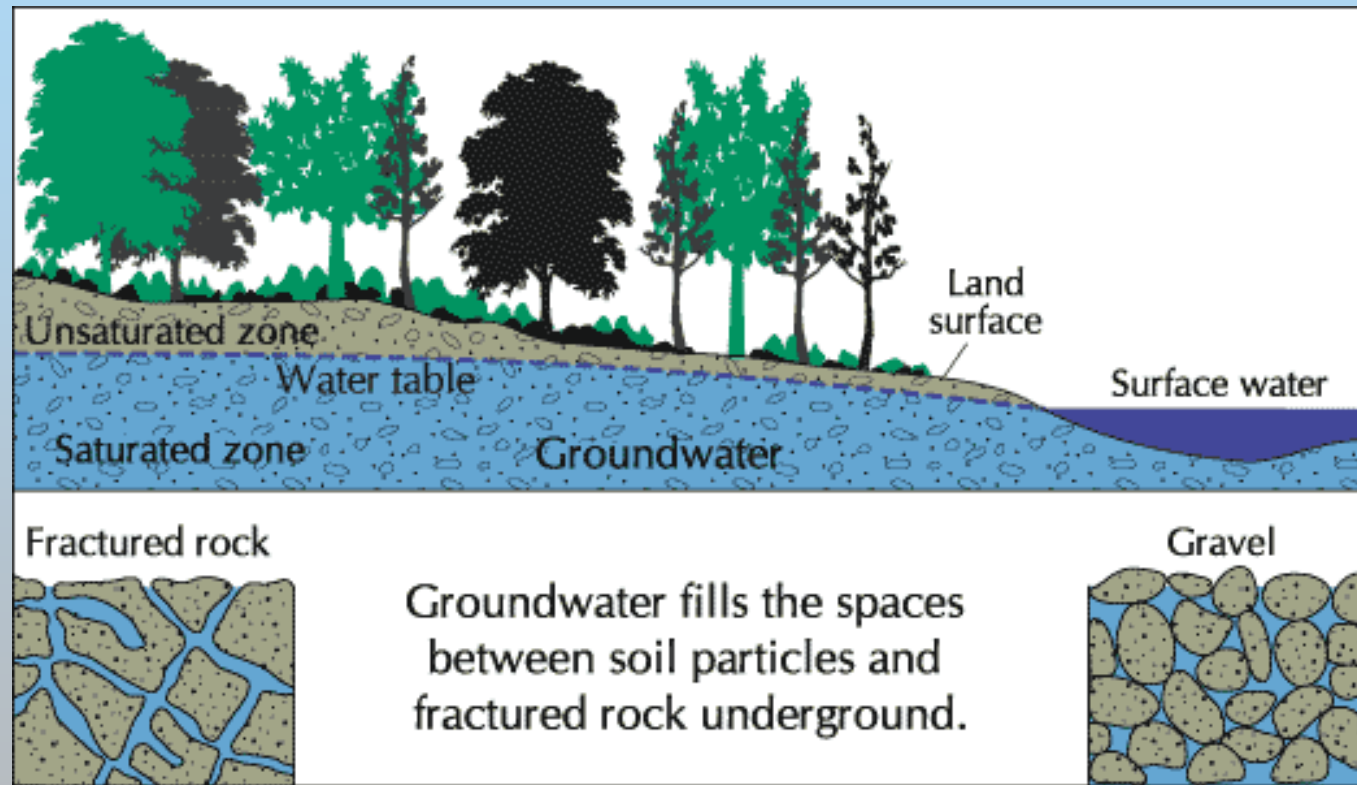


Image compliments of US Geological Survey, adapted by The Groundwater Foundation.

Stream and Groundwater Connectivity

In the MD Piedmont, 48 to 64% of streamflow is baseflow.

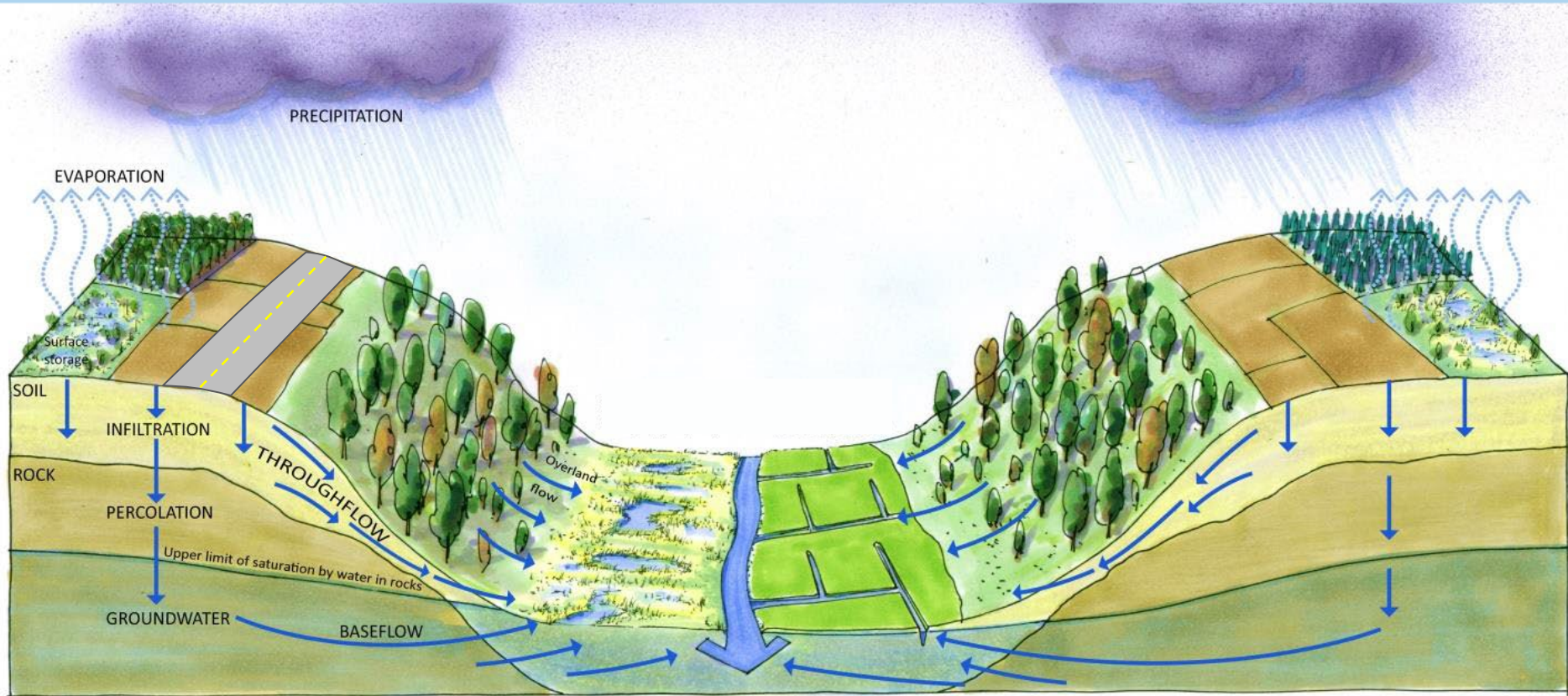
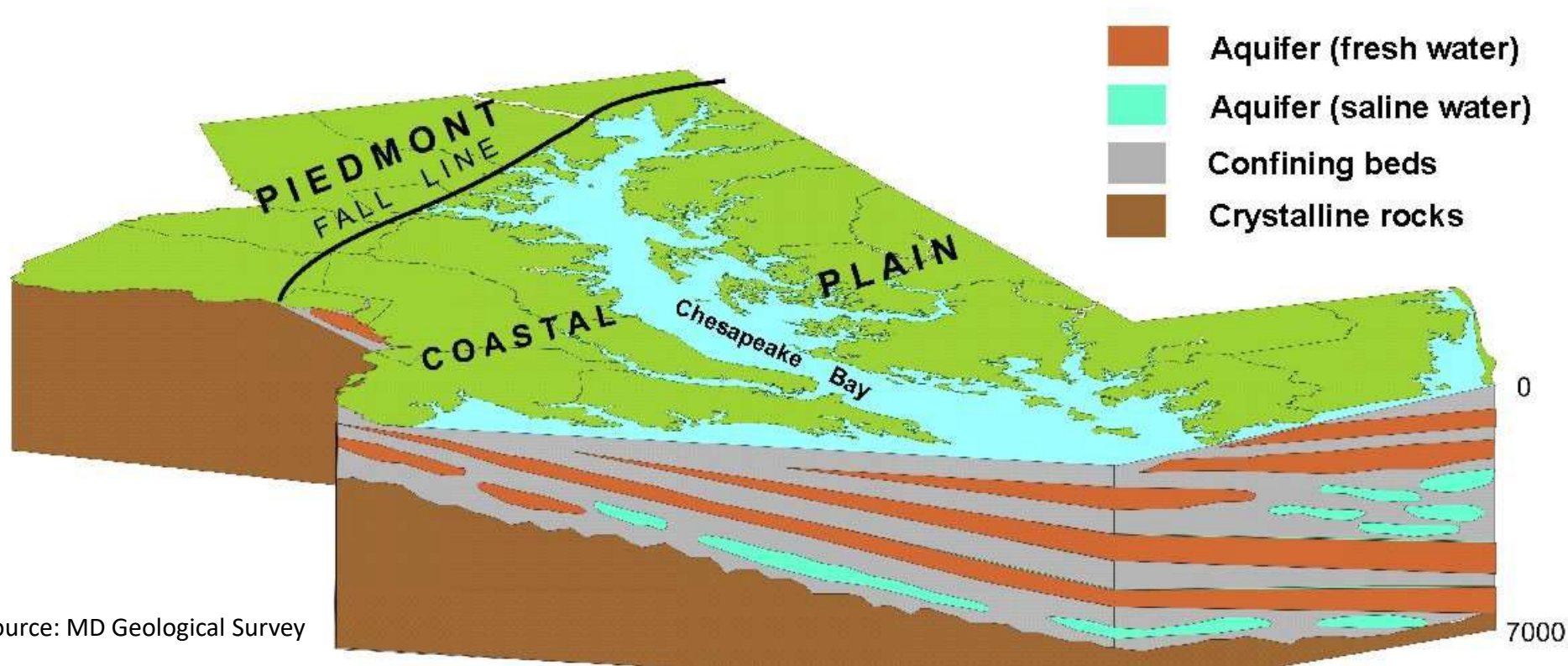


FIGURE: <https://europe.wetlands.org/casestudy/restoration-of-marshes-in-rhine-basin/>

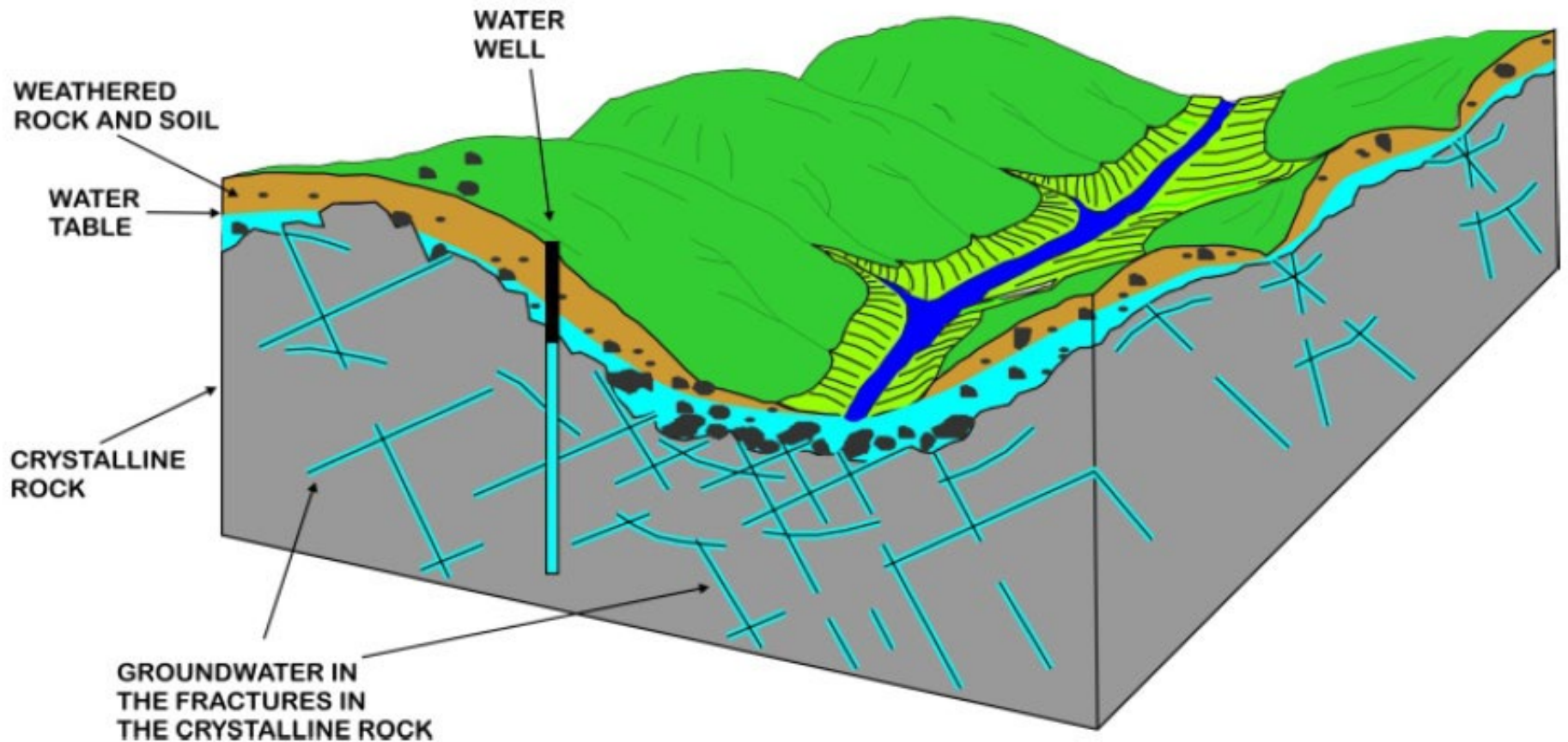
BASEFLOW: Santhi and others, 2008; Duigon and others, 2000

MASS BALANCE: Howard, 1993; Moore and others, 2017

Coastal Plain Aquifers



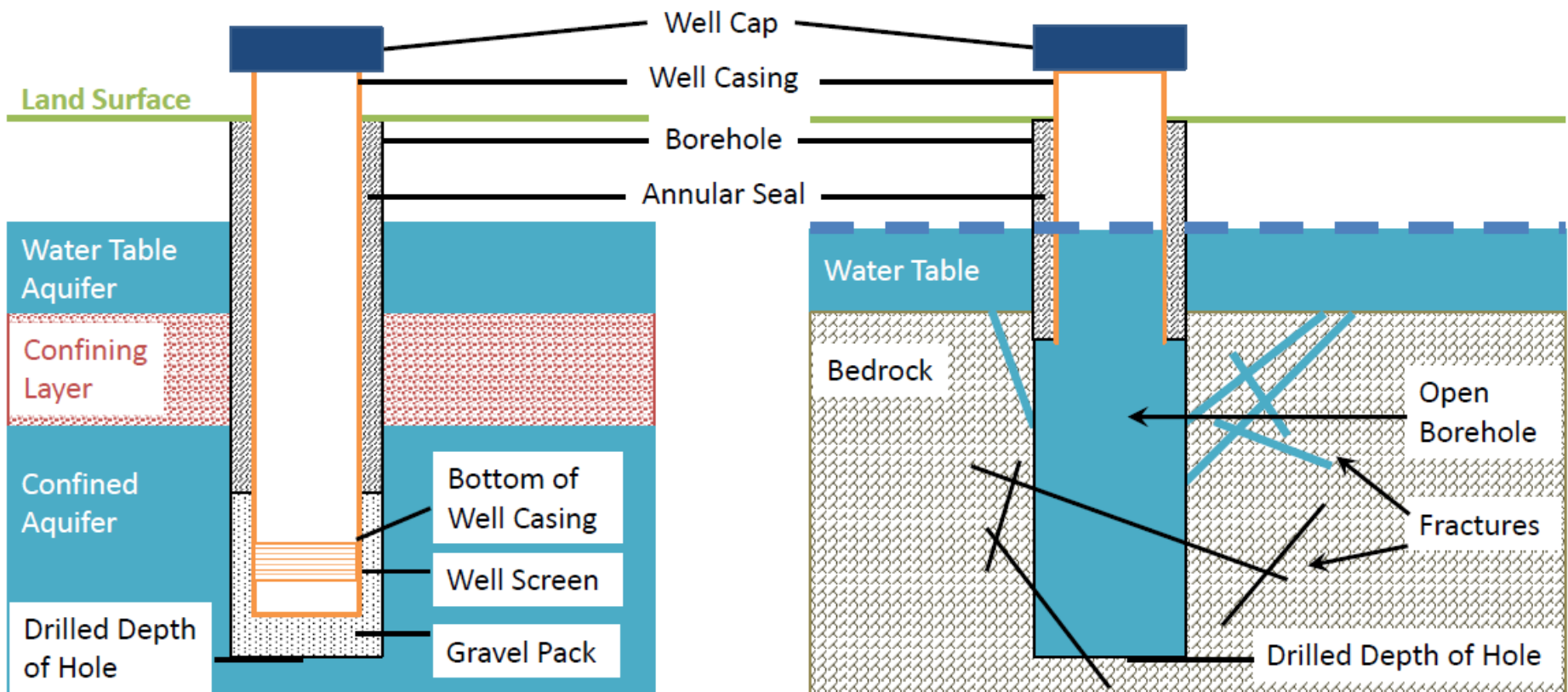
Piedmont Region Aquifers



Wells

Coastal Plain

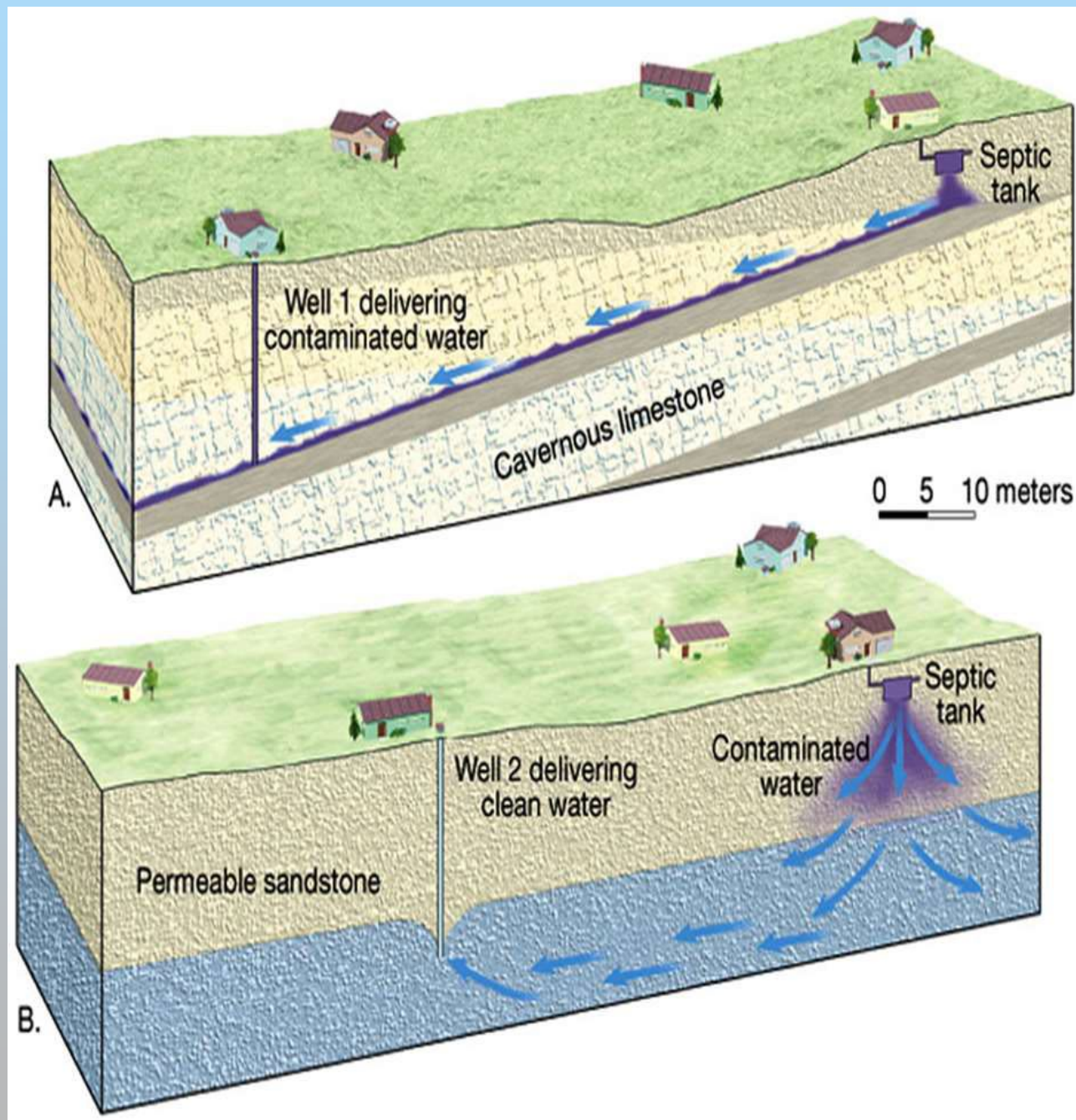
Fractured Rock





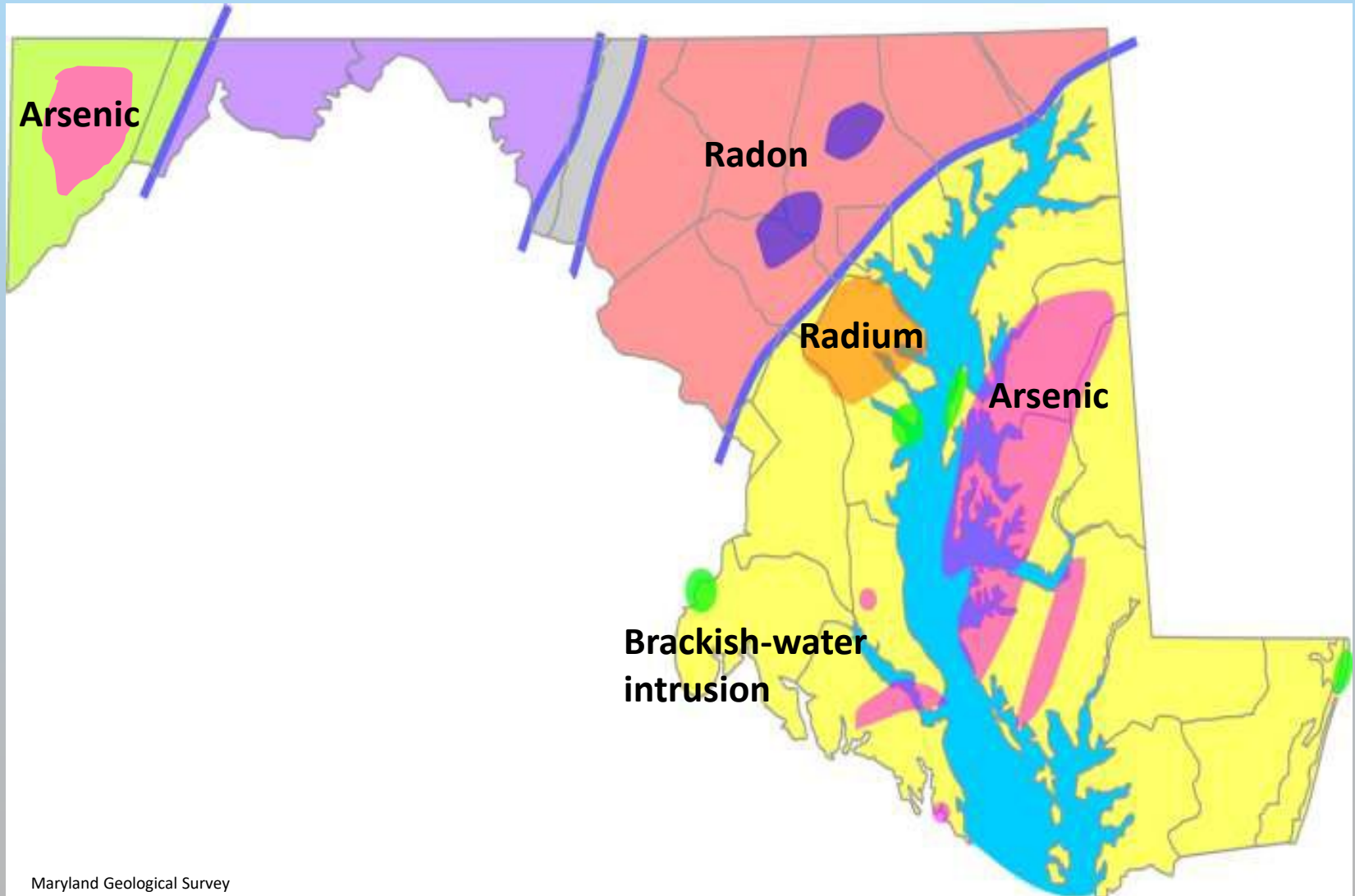
Water Movement and Contamination

- A. The groundwater moves too rapidly through the cavernous limestone to be naturally purified.
- B. Groundwater movement in the permeable sandstone aquifer is slow enough to allow natural purification.



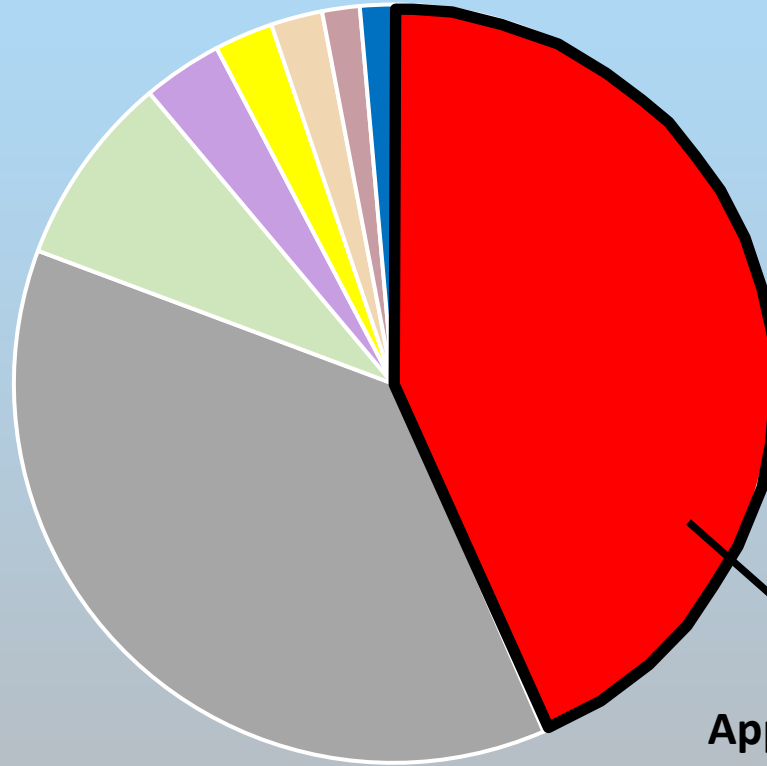


Regional Groundwater Quality Issues





Total Salt Use in the US (2015) is Largely for Road-deicing



Approximately 30 million tons salt applied annually in U.S.

 Road-deicing

 Distributors

 Agriculture

 General Industrial

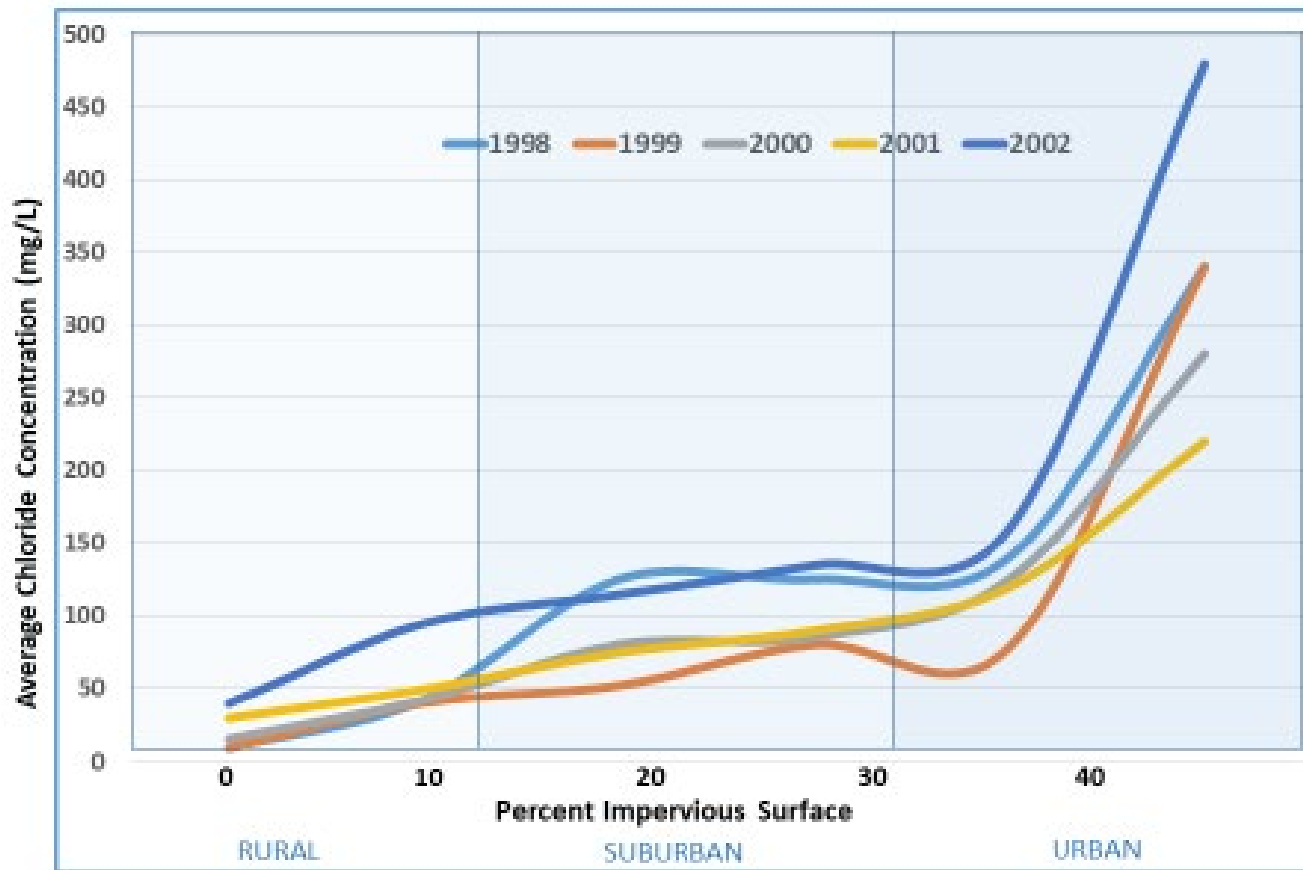
 Chemicals

 Food Processing

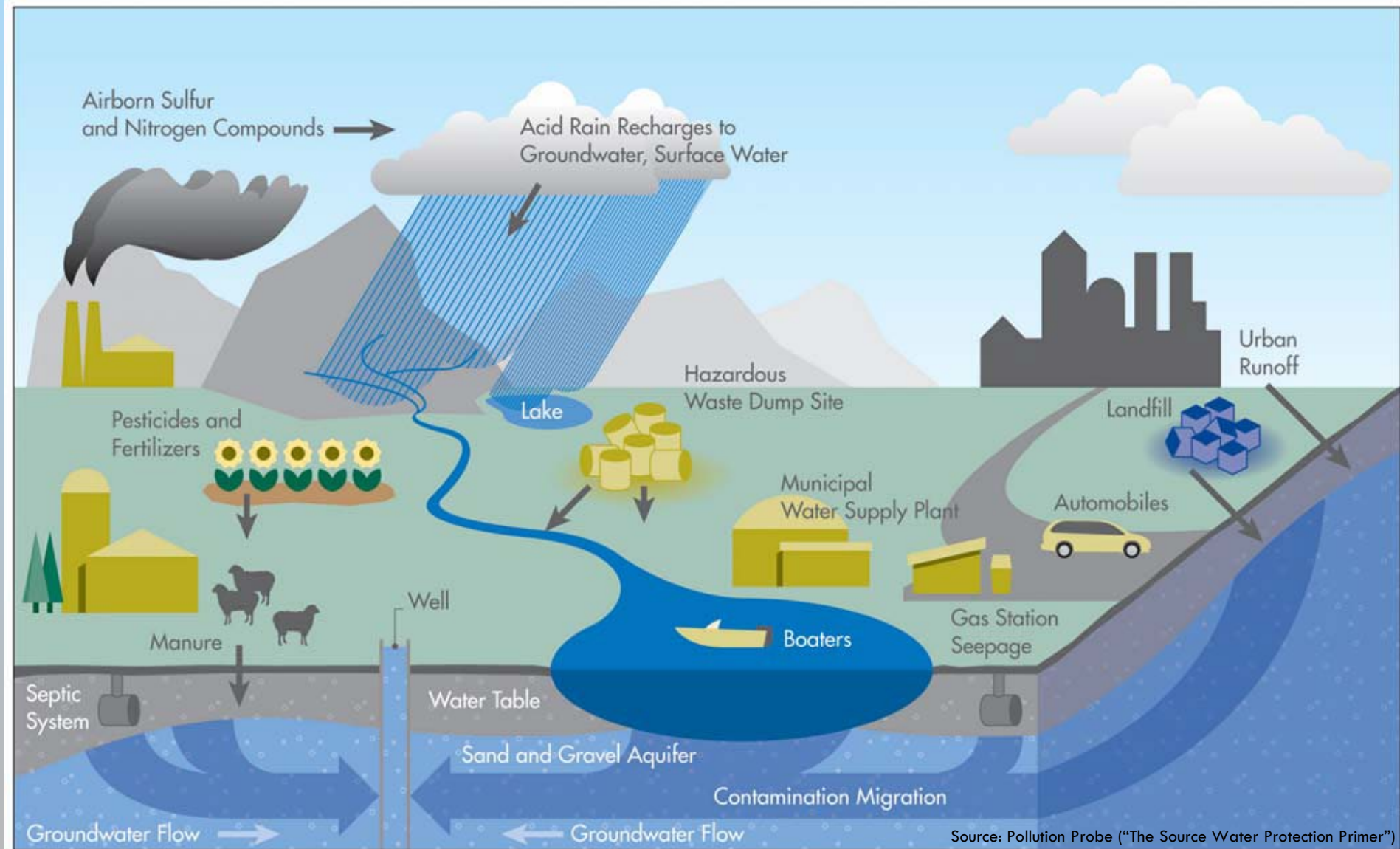
 Other with Exports

 Primary Water Treatment

Stream Chloride Concentrations in MD



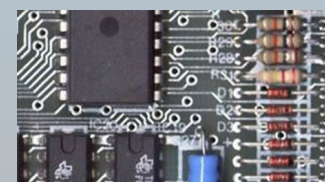
Drinking Water Contamination



Contaminants of Emerging Concern (CEC's)

What/where are they?

- Prescription drugs
- Over-the counter drugs
- Therapeutic drugs
- Veterinary drugs
- Cosmetics
- Sun-screen - UV filters
- Diagnostic agents
- Nutraceuticals (e.g., vitamins)
- Illegal drugs
- Flame retardants
- Food packaging
- Stain repellents
- Oil and mining compounds
- PFAS
- Microplastics



SOURCE: Xia, K. 2018.; EPA, 2018



EPA National Primary Public Drinking Water Regulations *

- Requires all public water utilities to test for 90+ contaminants
 - States may require additional analysis
- Disinfectants
- Disinfection byproducts
- Inorganic chemical
- Microorganisms
- Organic chemicals
- Radionuclides

* Complete list and descriptors available at :
https://www.epa.gov/sites/production/files/2016-06/documents/npwdr_complete_table.pdf

Private Drinking Water Wells



Source: MDWWA

Why Do I Need To Care For My Well Water?

- Homeowners Are Responsible For Drinking Water Quality
- Many Contaminants Do Not Have Obvious Tastes Or Odors
- Depending On The Contaminant, Health Risks Can Include Gastrointestinal Distress, Respiratory Difficulty, Neurological Effects, And Cancer
 - Children, Pregnant Women, And Immunocompromised Individuals Can Be At Particular Risk
- Well Water Testing May Be Required For Home Sales



Image Source: EPA, "Water on Tap"



Top Tips To Protect Your Water

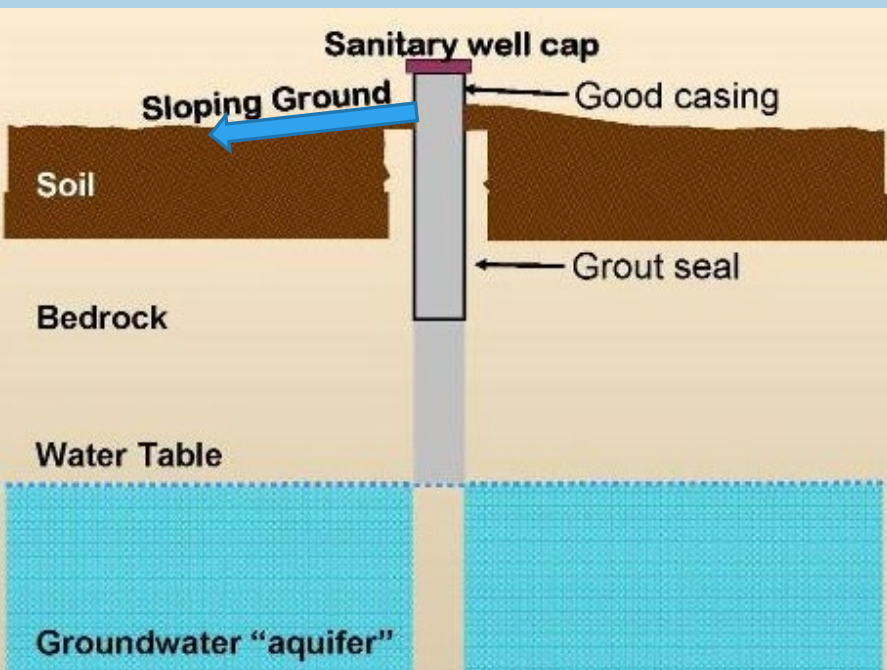
1. Familiarize Yourself With Your Well And Keep It Maintained

- Get A Copy Of Your Well Completion Report (“Well Log”)
- Personally Inspect The Well Every Year
- Have A Licensed Professional Inspect The Well Every 3 Years
- Keep Up-to-date Records Of Well Installation, Repairs, Inspections, And Water Tests

C1	9831	SEQUENCE NO. (MDE USE ONLY)	STATE OF MARYLAND WELL COMPLETION REPORT		THIS REPORT MUST BE SUBMITTED WITHIN 45 DAYS AFTER WELL IS COMPLETED.
			FILL IN THIS FORM COMPLETELY PLEASE TYPE		COUNTY NUMBER
ST/CO USE ONLY DATE Received MM DD YY 8 / 13		DATE WELL COMPLETED MM DD YY 15 / 20		Depth of Well 22 / 26 (TO NEAREST FOOT)	PERMIT NO. FROM "PERMIT TO DRILL WELL" - - - - -
OWNER _____ STREET OR RFD _____ TOWN _____ SUBDIVISION _____ SECTION _____ LOT _____					
WELL LOG Not required for driven wells STATE THE KIND OF FORMATIONS PENETRATED, THEIR COLOR, DEPTH, THICKNESS AND IF WATER BEARING			GROUTING RECORD		
DESCRIPTION (Use additional sheets if needed) 			YES NO ☒ Y ☒ N 44 44 WELL HAS BEEN GROUTED (Circle Appropriate Box)		
			TYPE OF GROUTING MATERIAL (Circle one)		
			CEMENT ☒ CM BENTONITE CLAY ☒ BC 45 48 45 48		
			NO. OF BAGS _____ NO. OF POUNDS _____		
			GALLONS OF WATER _____		
DEPTH OF GROUT SEAL (to nearest foot) from _____ ft. TOP _____ ft. to _____ ft. BOTTOM _____ ft. (enter 0 if from surface)			PUMPING TEST		
FEET FROM TO check if water bearing			HOURS PUMPED (nearest hour) _____ 8 9		
			PUMPING RATE (gal. per min.) _____ 11 15		
			METHOD USED TO MEASURE PUMPING RATE _____		
			WATER LEVEL (distance from land surface)		
			BEFORE PUMPING _____ ft. 17 20		
			WHEN PUMPING _____ ft. 22 25		
			TYPE OF PUMP USED (for test)		
			☒ A air ☒ P piston ☒ T turbine 27 27 27		
			CASING RECORD casing types insert appropriate code below ☒ ST STEEL ☒ CO CONCRETE ☒ PL PLASTIC ☒ OT OTHER MAIN Nominal diameter Total depth		

2. Inspect Wellhead

1. Examine the well cap:
 - In good general condition
 - Securely attached
 - Prevents insects and rodents from entering well
2. Check the casing:
 - In good general condition
 - Measure it to make sure it extends 8" above the ground, or 24" in flood zones
3. Survey the area around the wellhead:
 - Ground is sloping away from the casing
 - Area is clean and accessible



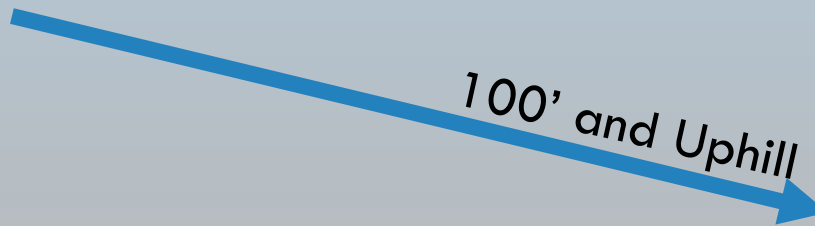
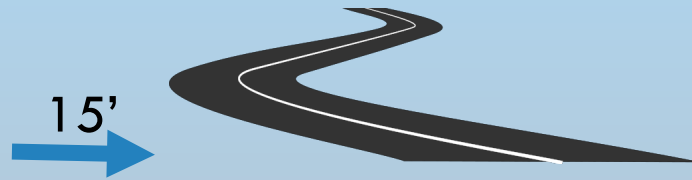


Sanitary Well Cap

- Plastic or metal pieces sealed with nuts and bolts – reduces tampering
- Airtight rubber gasket seal and vented screen prevent insects, small mammals and/or surface water from entering the well – reduces bacterial contamination and debris
- Generally, \$40 - \$50 from local well drillers



Well Regulations - Siting



Not near property lines
or neighbors' wells

Not in areas that
receive runoff



Including
septic system



3. Well Testing Recommendations

If you haven't been testing regularly,
start with a comprehensive test:

- Coliform bacteria*
 - E. coli*
 - Nitrates*
 - Chloride
 - Hardness
 - pH*
 - Lead*
 - Copper*
 - Manganese
 - Total dissolved solids
 - Sulfates
 - Other contaminants based on local land uses and naturally occurring deposits, ex: arsenic, radium
- * TEST Annually
- Important for families with pregnant women, infants, and young children. Use a state certified lab!

LEAD

- Colorless and odorless – indicators are not always present
 - When present, indicators include metallic taste, signs of corrosion, blue-green staining
- There is no safe level of exposure to lead – children under the age of 6 and pregnant women are particularly vulnerable
- **Lead is not in the groundwater, but corrosive groundwater can leach lead from plumbing fixtures and fittings**



Photos: Kelsey Pieper



Tests For Nearby Land Uses Of Concern

Nearby Land Use	Test For
Agricultural operations	Nitrate, coliform bacteria, pesticides
Coal mining	pH, Iron, Manganese
Gas drilling	Sodium, Chloride, Barium
Dump, Landfill, Factory	Metals, VOCs
Heavily salted roadways	Sodium, Chloride, TDS



Tests For Specific Problems

Symptom	Test For
Cloudy/colored water	Detergents
Orange-black stains / Metallic taste	Iron, Manganese
Soap has no lather / White-gray film	Hardness
Salty taste	Chloride, Sodium, TDS
Odor of gas/fuel / Oily sheen	Volatile Organic Compounds (VOCs)
Pin-hole leaks / Blue stains / Metallic taste	pH, Copper, Lead

Other Times To Test Water

- Pregnant Woman or Infant In The Home
- Unexplained or Recurring Gastrointestinal Illness in Family or Guests
- Neighbors Find a Dangerous Contaminant in Their Water
- Sudden Change in Water Taste, Odor, Color, or Clarity
- Chemical or Fuel Spills Into or Near Your Well
- When the Well System has been Repaired or parts have been Replaced



Water Treatments for Contaminants

Contaminant or Substance	Adsorption Media						
	Activated Carbon Filter	Specialty Adsorption Media	Reverse Osmosis (RO)	Distillation	Ion Exchange	Oxidizing Filter	Oxidation Filtration System
Arsenic ¹		✓	✓	✓	✓ (Anion) ⁴	✓	✓
Boron ¹			✓	✓			
Chloride/Sodium ^{1,2}			✓	✓			
Flouride ¹			✓	✓			
Hard Water ²				✓	✓ (Cation)		
Hydrogen Sulfide ¹	✓					✓	✓
Iron/Manganese ²				✓	✓ (Cation)		
Lead ¹			✓	✓			
Nitrate ¹			✓	✓	✓ (Anion) ⁵		
Radon ¹	✓						
Sulfate ¹			✓	✓	✓ (Anion)		
VOC's ¹	✓						

¹ Health related contaminant – use treatment when other options (well repair or replacement not possible)

³ Pretreatments, such as oxidation may be necessary depending on other contaminants

⁵ Use nitrate selective resin

² Aesthetic contaminant

⁴ Use strong base sulfate selective resin

Top Tips To Protect Your Water

(continued)

4. Mind Your Activities Within 100' Of Well:

- Pets
- Plantings
- Mowing

5. Pick Up After Your Pets

6. Pump And Maintain Your Septic Tank



Top Tips To Protect Your Water

7. Use Lower Toxicity Cleaners

8. Minimize Fertilizer And Pesticide Use

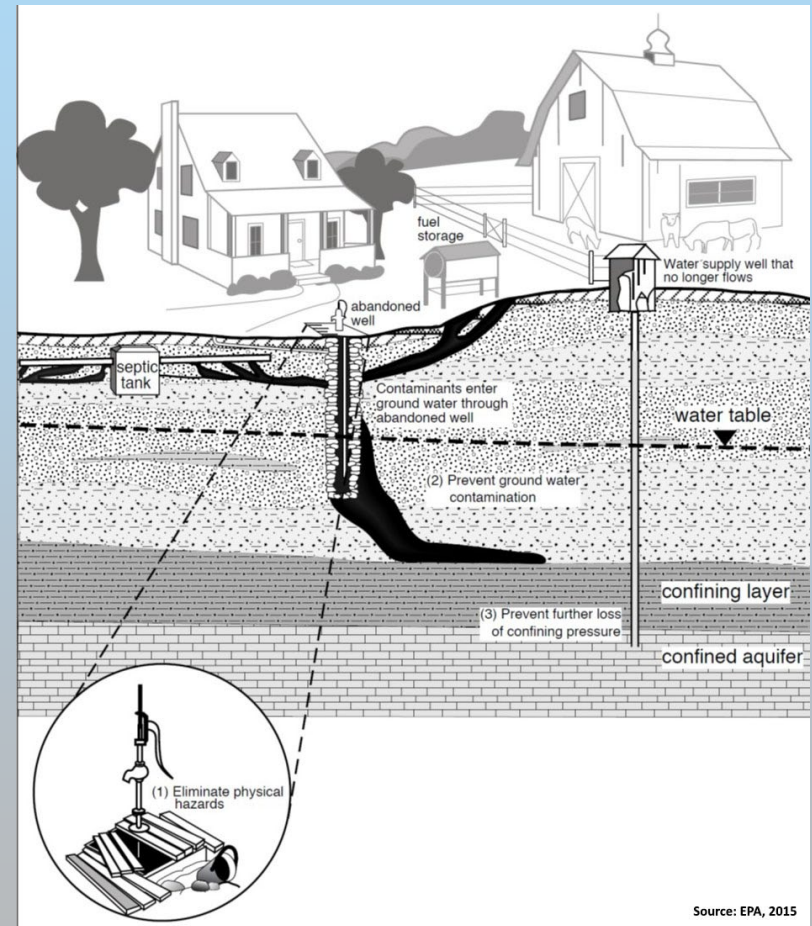
9. Follow Product Guidelines For Storage And Disposal Of Household And Lawn Care Chemicals. Do Not Dump Waste On Ground Or In Water.

10. Regularly Check Underground Storage Tanks That Hold Home Heating Oil, Diesel, Or Gasoline

11. Wash Cars At A Commercial Facility

12. Have abandoned wells properly sealed

Abandoned Wells and Groundwater Contamination



Source: EPA, 2015

Properly Sealing a Well





Overview of Septic Systems

1. What is a Septic System?
2. Standard Septic System Components
3. Best Available Technology (BAT) systems
4. Bay Restoration Fund (BRF) Cost-share Funding
5. Care and Maintenance of Systems
6. Landscaping Tips





Onsite Wastewater Treatment (Septic Systems) In Maryland

- In Maryland, 20% of the population, or 450,000 households are served by septic systems, also known as On-Site Disposal Systems (OSDS)
- Properly functioning OSDS are critical to basic public health and the environment.
 - Contribute 6-7% of total nitrogen loading to the Chesapeake Bay) and can also contaminate ground water (e.g. drinking water for houses on wells)
 - Source of pathogenic bacteria, e.g. E. coli
 - Contribute other harmful contaminants into soils and groundwater – emerging contaminants, e.g. hormones, pharmaceuticals, and household chemicals, etc.

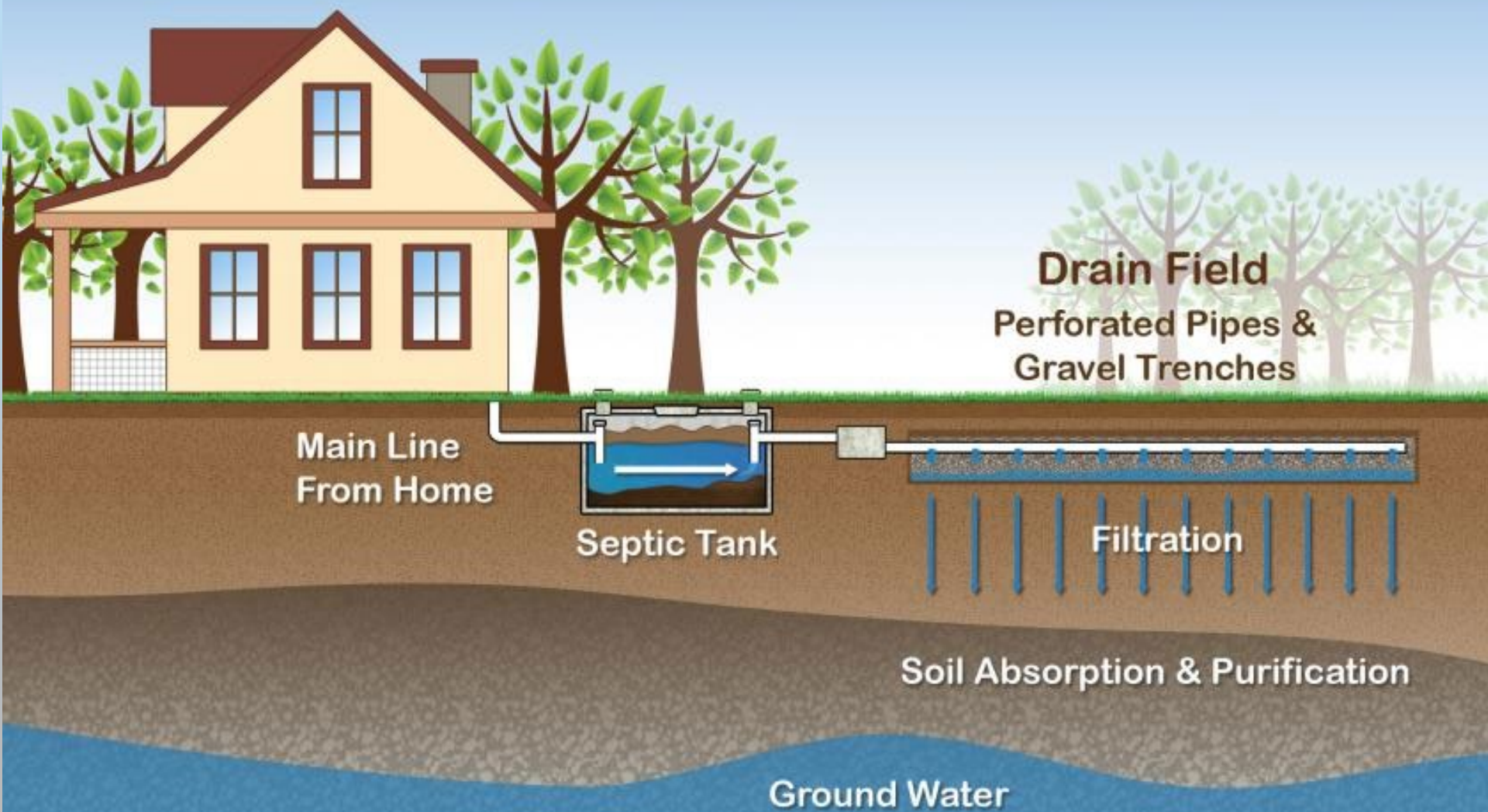


Composition of household sewage

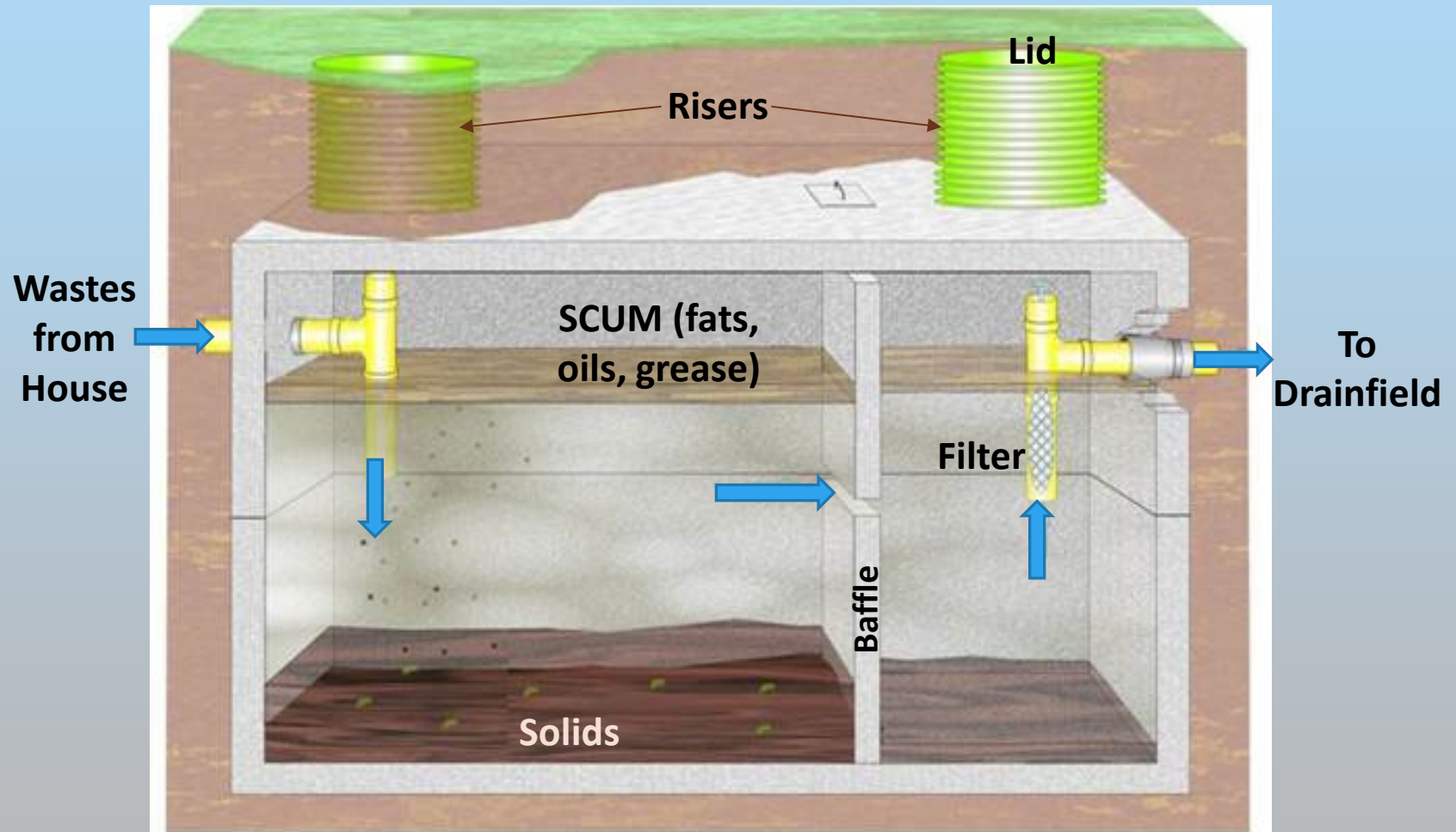
Parameter	Amount (grams/person/day)	Concentration (mg/L)
Total Solids	115 - 200	500 - 880
Total Suspended Solids	35 - 75	155 - 330
Biochemical Oxygen Demand (BOD)	35 - 65	115 - 286
Chemical Oxygen Demand (COD)	115 – 150	500 - 660
Total Nitrogen	6 - 17	26 - 75
Ammonia nitrogen	1 - 3	4 - 13
Total Phosphorus	1 - 2	6 - 12
Fats, oils, and grease	12 - 18	70 - 105
Bacteria	3.78 billion to 378 billion bacteria cells per gallon*	
*Additives contribute only a few billion cells or 0.0053% in tank		
Source: EPA 2002		

Source: EPA 2002

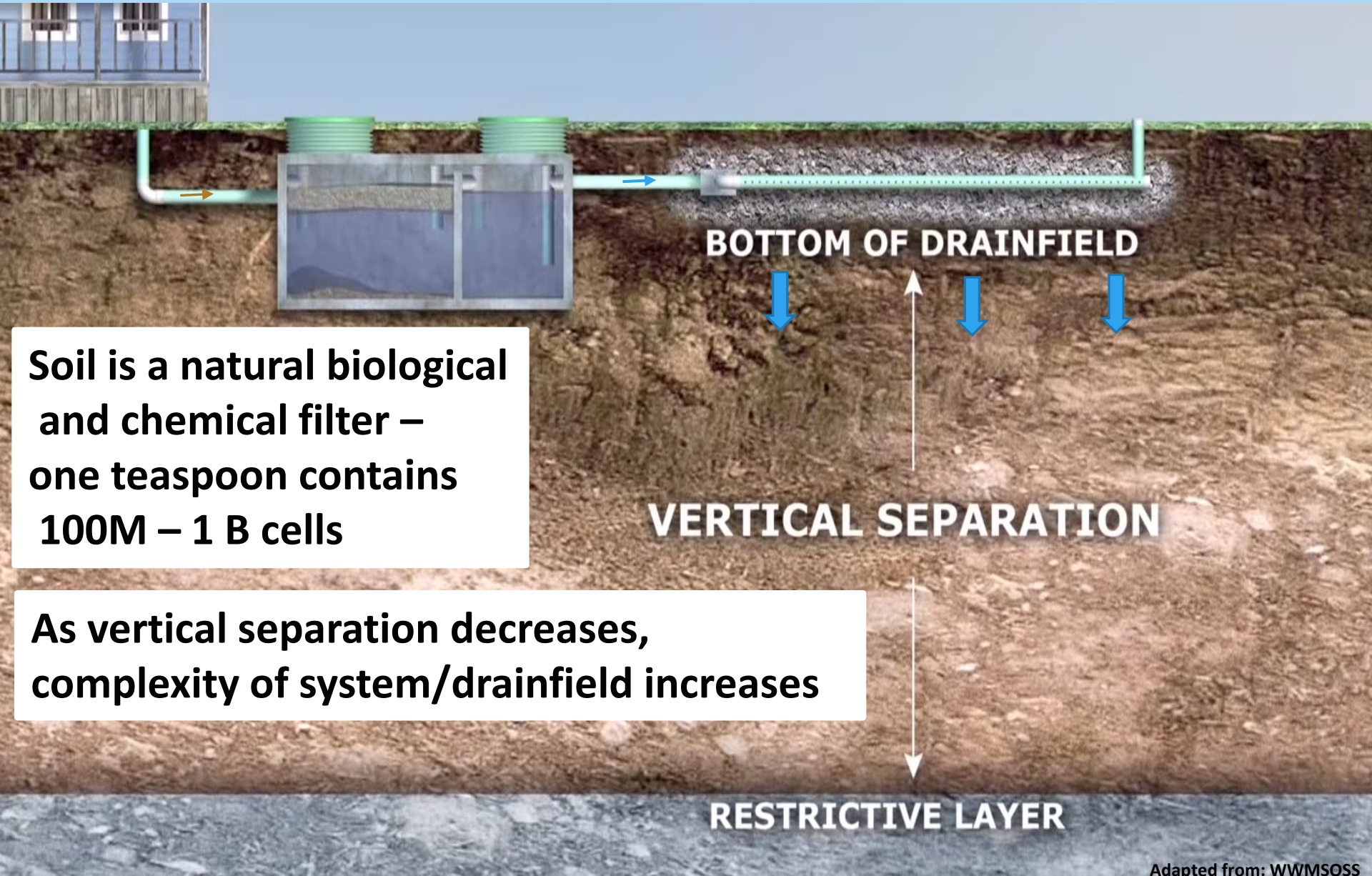
Conventional Septic System



Waste Flow in a Septic Tank



Importance of Soil in a Septic System



Soil is a natural biological and chemical filter – one teaspoon contains 100M – 1 B cells

As vertical separation decreases, complexity of system/drainfield increases



Drainfields - where soil treatment occurs



Conventional gravel trench



EZ Flow media tubes



Drip tube dispersal



Chambers



Sand Mound



Peat filter over gravel



Nitrogen Removal Processes

Above ground

Below ground



Household

Raw waste water

Septic tank

(Primary treatment unit)
(70-90% $\text{NH}_4\text{-N}$, and
10-30% Organic N)

Septic tank effluent



Drainfield
(Unsaturated zone)

$\text{NH}_4^+\text{-N}$

Mineralization

Organic N
(DON+PON)

Tank removes ~5%
of N

MD BAT Units can
remove ~55 - 76%
of N

Drainfield removes
~20-40% of N

BAT Cumulative Removal
~66 - 86.5 %

Ammonifiers

Annamox bacteria

NH_4^+

$+\text{O}_2$

NO_2^-

$+\text{O}_2$

NO_3^-

Nitrifiers

Nitrification

Adsorption

Clay and
organic
colloid fixed

$-\text{O}_2$

Denitrifiers

Leaching

Groundwater
(Saturated/near saturated zone)

Denitrifiers

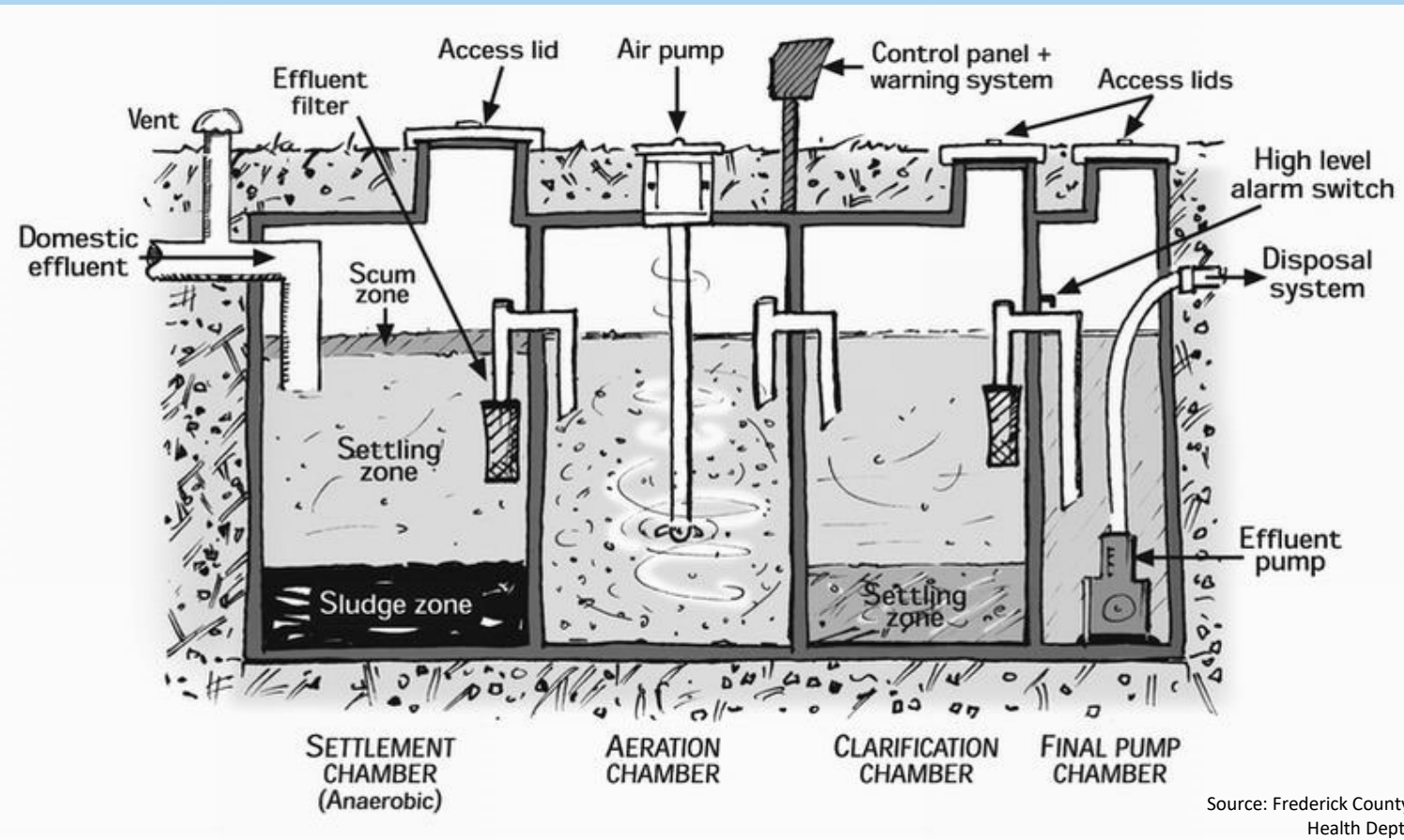
$-\text{O}_2$

N_2O

N_2

Denitrification

Aerobic Treatment System – Best Available Technology (BAT)



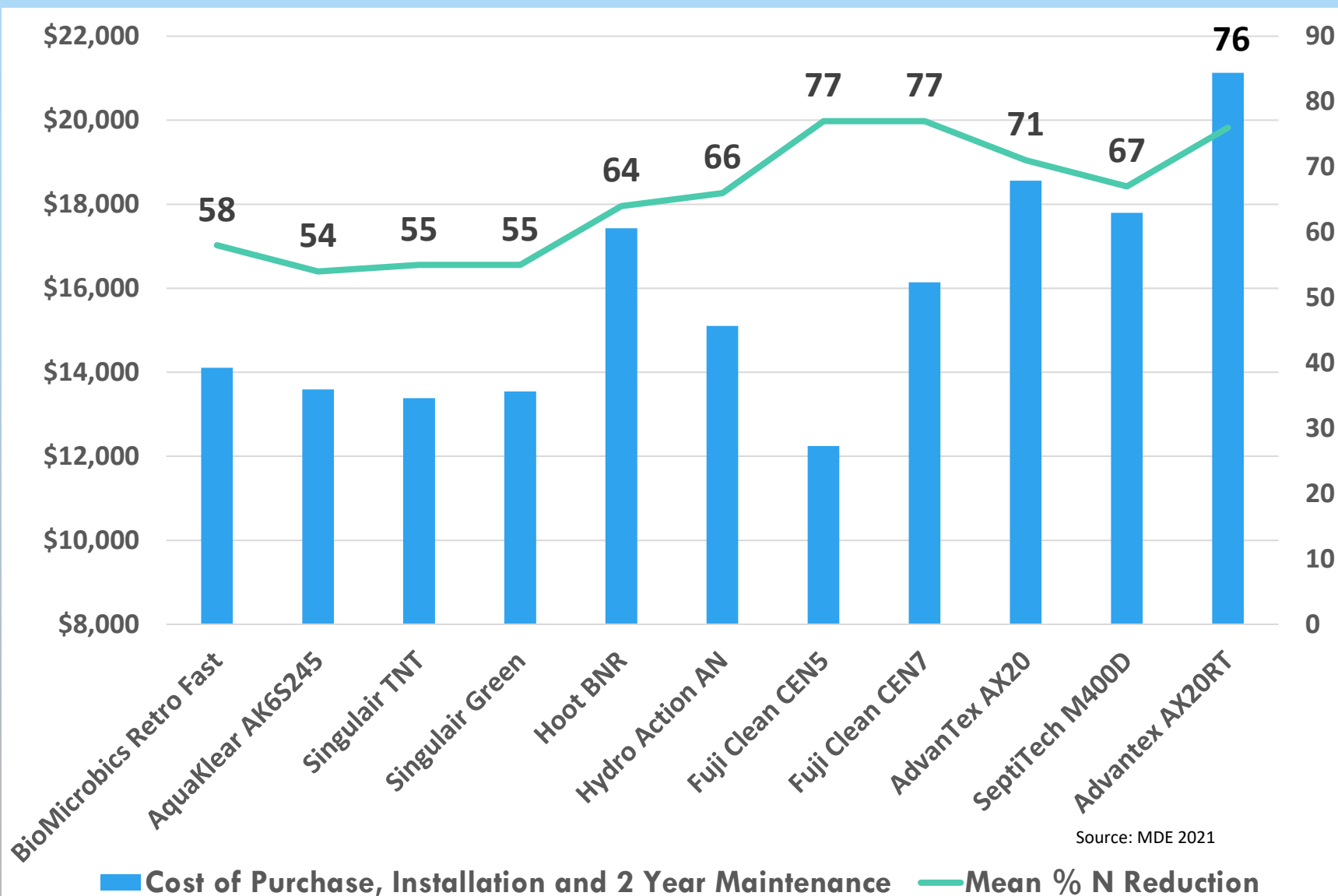
Source: Frederick County
Health Dept.



**Clear,
odorless
effluent**



MD BAT Units – Cost and Nitrogen Reduction





Bay Restoration Fund (BRF)

<http://www.mde.state.md.us/programs/Water/BayRestorationFund/Pages/Index.aspx>

Cost-sharing program for BAT Units

- Established through the Flush Fee

Local counties manage grant funding

- Contact local permitting office for information (e.g. Dept. of Environmental Health)

- Grants awarded on fiscal year of July to June

Limits BAT options to state-certified technologies

- Check MDE website for current list of approved vendors



Trouble Signs of Malfunctioning System

- Wet spots in yard
- Sewage odor in home or yard
- Slow draining toilets/tub
- Backup in house/basement
- Alarm on BAT unit
- Intestinal illnesses





Major Causes of Septic Malfunction

- System not designed or installed properly
 - Site/soils not suitable
- System not maintained
 - Tank pumped, filters cleaned, regular BAT service
- Daily waste flow exceeds design flow
 - Increase in occupancy
- Change in waste stream quality – food business, chemicals
- Root or organic matter clogging pipes
- Improper items flushed – sanitary napkins, grease, chemicals
- Settling of tank, piping, D-box
- Uneven flow to drainfield lines
- Drainfield compaction
 - Automobile traffic, added structure



Homeowner Septic Maintenance Tips

1. Conserve water – fix leaks, use water saving appliances
2. Avoid garbage disposals and draining fats, oils and grease
3. Don't dispose of chemicals down drains
4. Only flush toilet paper – no wipes, etc.
5. Ensure stormwater runs away from tank and drainfield
6. Keep traffic off of drainfield
7. Don't plant trees near tank or drainfield
8. Have tank pumped every 3-5 years
9. Have tank filter (if equipped) cleaned regularly
10. Have system inspected regularly



Septic Tank Pumping Frequency

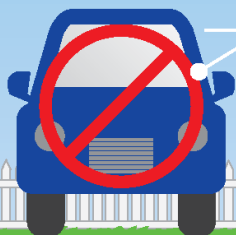
Number of Occupants	750 Gallons	1,000 Gallons	1,250 Gallons	1,500 Gallons	2,000 Gallons
1	4 years	4 years	4 years	5 years	5 years
2	3 years	3 years	3 years	4 years	4 years
3	Annually	2 years	2 years	3 years	3 years
4	Annually	Annually	2 years	2 years	2 years
5+	Annually	Annually	Annually	Annually	Annually

Do Your Part. Be SepticSmart!



Shield Your Field

Divert rain and surface water away and avoid parking vehicles and planting trees on your drainfield.



Don't Overload the Commode

Don't flush diapers, wipes or other items meant for a trashcan down the toilet.



Toilet paper only

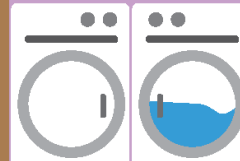
Think at the Sink

Limit use of your garbage disposal and avoid pouring fats, grease, solids and harsh chemicals down the drain.



Don't Strain Your Drain

Use water efficiently and stagger use of water-based appliances, such as your washing machine or dishwasher.



Keep It Clean

If you are on a well, test your drinking water regularly to ensure it remains clean and free of contamination.



Protect It and Inspect It

A typical septic system should be serviced every one to three years by a septic service professional.



Pump Your Tank

Ensure your septic tank is pumped at regular intervals as recommended by a professional.

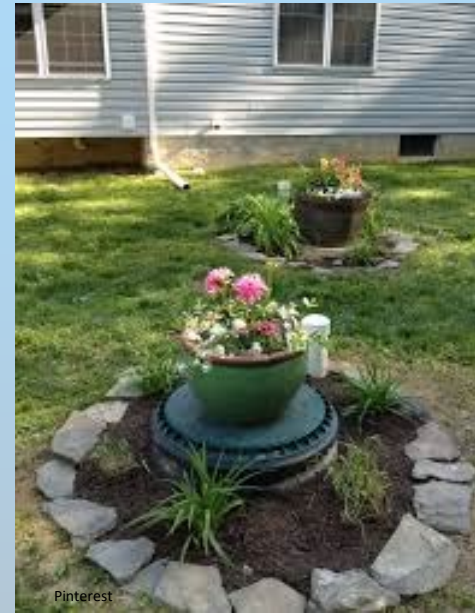
Drainfield

Groundwater Recharge

Aquifer



Landscaping Septic Systems



Desirable Plant Species for Drainfields

Grasses:

Fescue

Lawn

Ornamental grasses -
sideoats grama

(*Bouteloua curtipendula*)

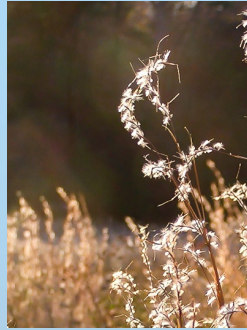
blue grama (*Bouteloua gracilis*)

little bluestem

(*Schizachyrium scoparium*)

prairie dropseed

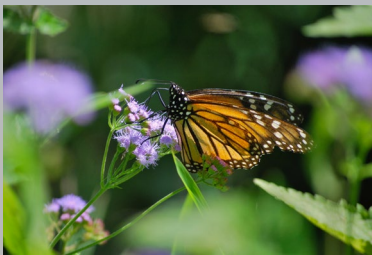
(*Sporobolus heterolepis*)



Grass-like:

Sedges (*Carex* spp.)

Sweet flag (*Acorus gramineus*)



Groundcovers for sun:

Carpet heathers (*Calluna Vulgaris*)

Moss Phlox (*P. subulata*)

Groundcovers for shade:

Ferns, e.g. Christmas fern

Mosses

Pachysandra (not *P. terminalis*)

Wild ginger (*Asarum*)

Wintergreen (*Gaultheria*)

Wildflower meadow mixes



Resources



UME Well and Septic Education Program: <http://extension.umd.edu/well-and-septic>
County Health Dept. Contacts: <http://extension.umd.edu/well-and-septic/county-contacts>

Hydrology/Groundwater

Maryland Geological Survey: <http://www.mgs.md.gov/>

Wells and Water Supply

Maryland Dept. of Environment - Water Supply Division:
http://www.mde.state.md.us/programs/Water/Water_Supply/Pages/Residential_Wells.aspx

Septic Systems

Maryland Dept. of Environment – Onsite Systems Division:
<https://mde.maryland.gov/programs/Water/BayRestorationFund/OnsiteDisposalSystems/Pages/OnsiteSystems.aspx>

Webinar Evaluation:

https://ume.qualtrics.com/jfe/form/SV_a9lbvgWfdsLFpH

