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GW-SW Interactions at Public Water Systems

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Presentation Overview

1. What is surface water influence and why it matters
2. Summary of DEQ's Ground Water Under the Direct Influence of Surface Water (GWUDISW) Evaluation Process
3. Share some examples

Definition of Public Water Supply (75-6-102.15):

a system for the provision of water for human consumption from a community well, water hauler for cisterns, water bottling plant, water dispenser, or other water supply that has at least 15 service connections or that regularly serves at least 25 persons daily for any 60 or more days in a calendar year.

Great Falls - Gore Hill storage tank

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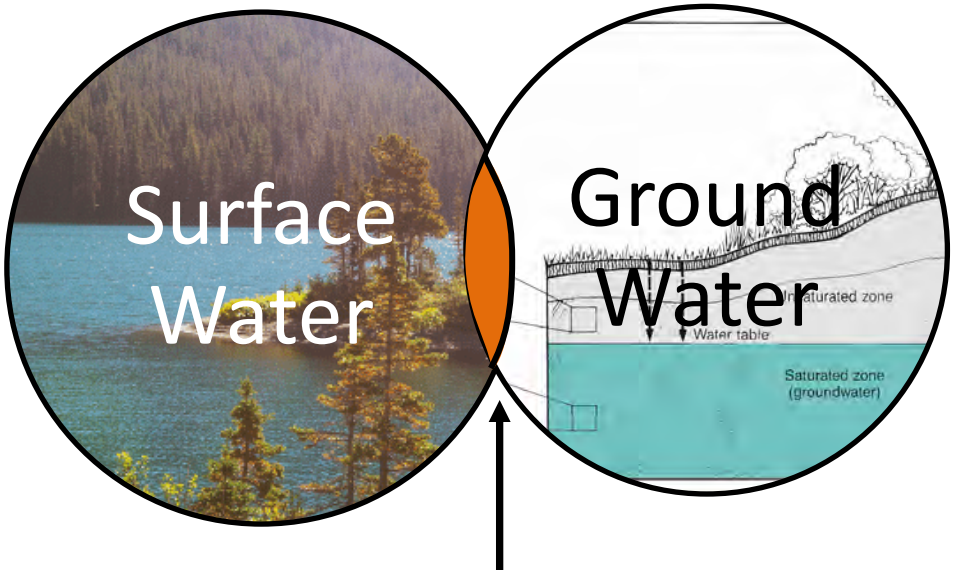
Types of Source Water

Surface Water

- Defined as: Water that is open to the atmosphere and subject to surface runoff
- Assumed to be contaminated
- Treat for a wide range of contaminates
- Treatment:

(1) Filtration, and
(2) Disinfection

- Monitor to ensure treatment is functioning



GWUDISW

1. Subsurface water that has not had sufficient filtration and/or time to kill or inactivate pathogens
2. Groundwater accessed by well or spring box with poor design, construction or in disrepair that allows direct pathway of surface water contamination

Groundwater

- Assumed to NOT be contaminated
- Monitor to test *that* assumption
- Treat for found contaminates
- Filtered by soil, sediment, and rock to remove pathogens
- Sufficient time to inactivate pathogens and cysts

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Two Waterborne Pathogens that are Difficult to Kill

Giardia

- Naturally present in lakes, streams, soil, and surfaces that are feces-contaminated
- Causes infection of the small intestine
- Stomach cramps, watery diarrhea, nausea
- Resistant to chlorine disinfection (> 45 minutes)

Cryptosporidium

- Naturally present in soil, lakes, rivers, and surfaces that are feces-contaminated
- Causes infection of intestines
- Watery diarrhea, vomiting, stomach cramps, fever
- Very Resistant to chlorine disinfection (days)

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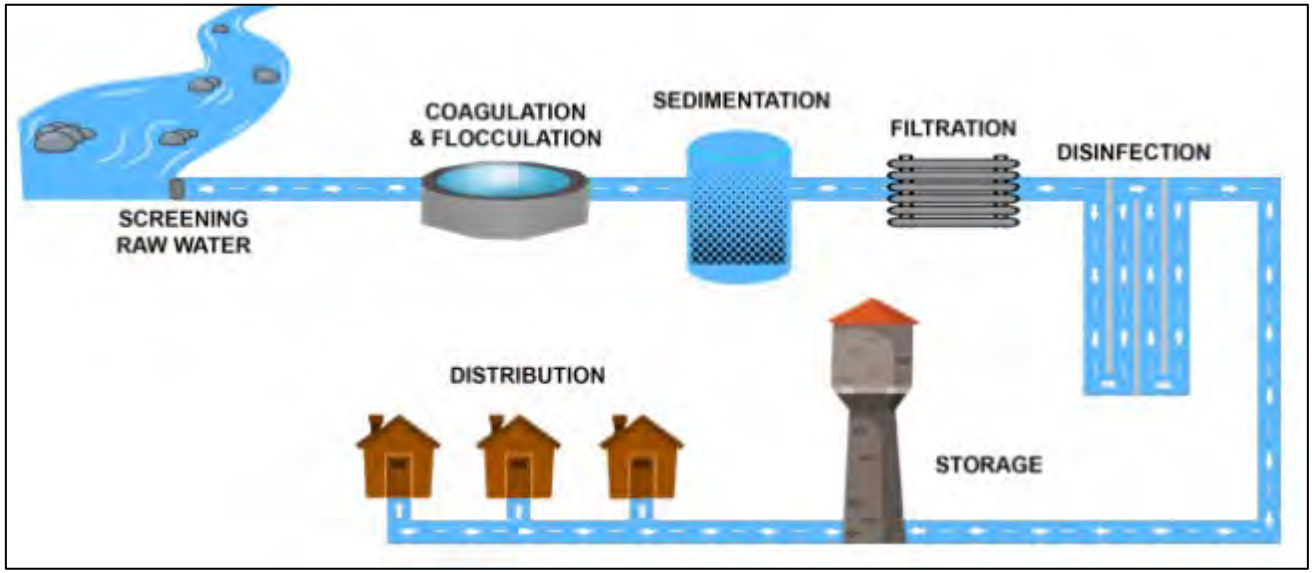
Regulations

- Surface water and GWUDISW sources are subject to the Surface Water Treatment Rules (ARM 17.38.208)
- SWTR require filtration and disinfection
  - Filtration to remove pathogens (e.g., crypto) and turbidity
  - Disinfection to inactivate bacteria, viruses, parasites, etc.



Surface Water Treatment Schematic (Science Direct)

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Montana's GWUDISW Evaluation Process

1. Obvious surface water sources are treated as such
   - Evaluation starts after source is activated
2. For all remaining subsurface sources - Complete Preliminary Assessment (PA) Form
   1. PA form includes distance to surface water, well construction details, and contamination history
3. Classify easily identifiable ground water sources
4. Conduct further review
   - Look at nearby well logs, hydrogeologic assessments and reports, source water reports, aquifer tests, geologic maps, etc.
   - Conduct Microscopic Particulate Analysis tests as needed

- Classify as GW or GWUDISW
  - Issue a Record of Decision letter

- Each water source is evaluated individually

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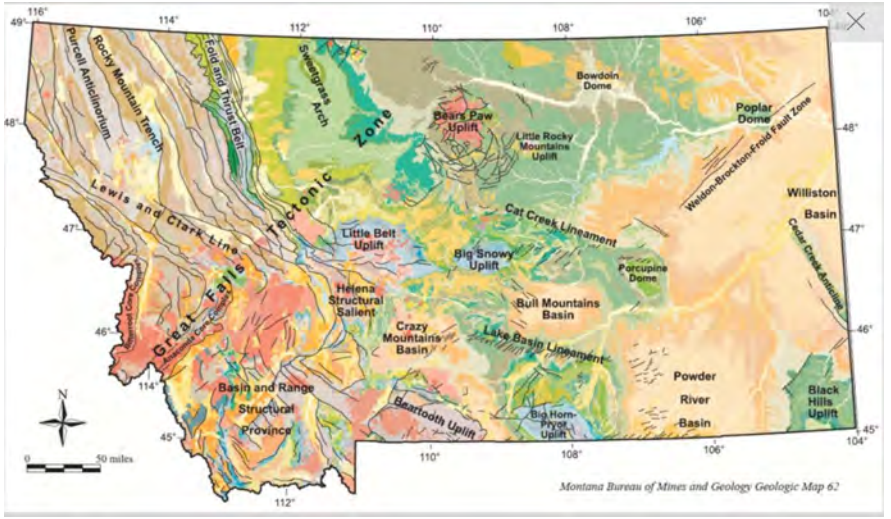
Further Review and MPAs

- Further Review can vary from looking at nearby wells to requiring MPAs
  - Look at nearby well logs,
  - Hydrogeologic assessments and reports,
  - Source water reports,
  - Aquifer tests,
  - Geologic maps,
  - Fractured vs porous media aquifer



- Microscopic Particulate Analysis (MPA) Required
  - Wells <100 ft from surface water
  - Springs
  - Horizontal Wells and Infiltration galleries
  - As required (e.g., fractured aquifer near SW; turbidity event in well)

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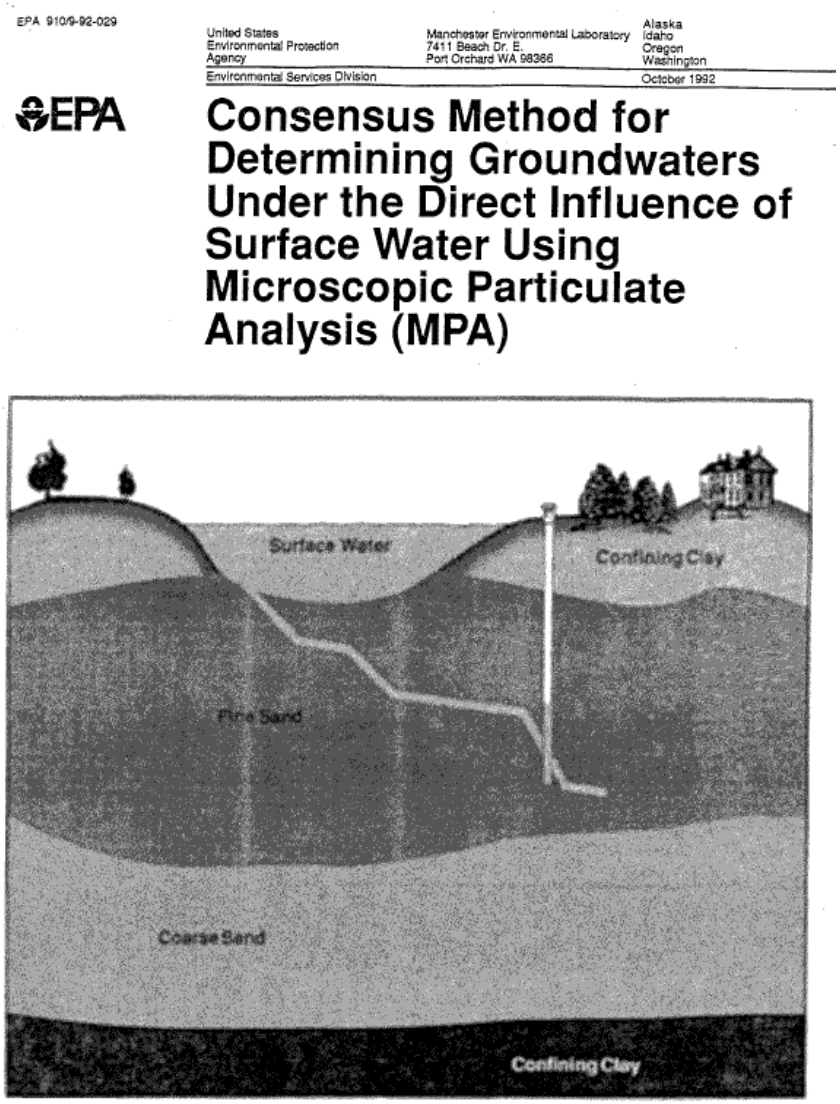
Microscopic Particulate Analysis (MPA)

- EPA consensus method
- Measures the presence of surface water indicating organisms found in subsurface water.
- Primary Surface water indicators
  - Diatoms – considered as conclusive evidence of direct SW influence
  - Coccidia – considered as conclusive evidence of direct SW influence
  - Other Algae – if chlorophyll containing then considered as conclusive evidence of direct SW influence
  - Insect/Larvae – strong evidence, but not conclusive
  - Rotifers – not all require sunlight or rely on food source that relies on sunlight; is supporting evidence
  - Plant debris – broad category and is dependent what was specifically found
- Points convert to Low (≤ 9), Moderate (10-19) or High Risk (≥20)



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MPA Setup

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Implications and Options

GW Classification

- No further action is needed
- Water systems should protect the water source
- Water sources are inspected at each Sanitary Survey
  - Looking for changes to water source or around water source that may affect water quality

GWUDISW Classification

- The Water System has three options
  1. Inactivate the water source (replace with GW source if needed)
  2. Modify the water source, the area around the water source, or the surface water to prevent direct influence (requires additional MPAs to test the modification)
  3. Treat source water to requirements of SWTR
- Temporary measures to protect public health and info customers

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Putting Determinations into Perspective

- ~2,250 Active public water systems
- 250 MPAs conducted at 120 water systems

Total # of Water Sources	3,617
Wells	3,518
Springs	82
Infiltration gallery	16

Total # of Water Sources	3,617	
GW Classification	**3,238**	**89%**
GWUDISW Classification	**42**	**1%**
Inactive and Not Classified	234	6%
Active and Not Classified	103	3%

Data is from spring 2022

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PWS with Recent GWUDISW Sources

- Worden Ballantine Yellowstone MT0000022 (tile drain)
- Wilsall Water District MT0000361 (well)
- Elkhorn Ranch MT0001830 (spring)
- Beartooth Christian Camp MT0004012 (spring)
- **Home 40 MT0004960 (well)**
- **Maverick Mtn Resort MT0002860 (spring)**
- Lewis and Clark Cavern SP Visitor Center MT0002565 (spring)

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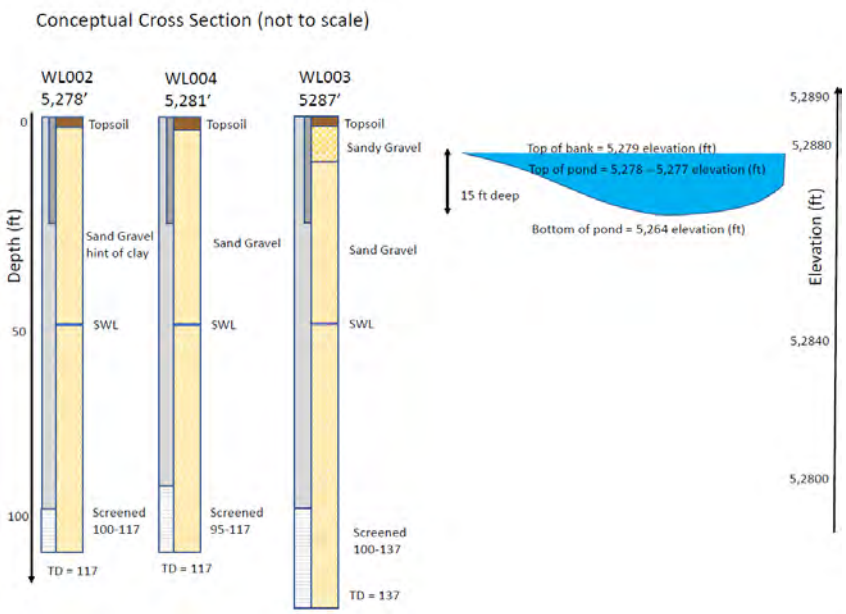
Example 1: Home 40 MT0004960 – Subdivision in Gallatin Valley



WL002 = GW (MPA 4 & 1 pts)
WL003 = GWUDISW (MPA 0 & 10 pts)
WL004 = GW (MPA 4 & 2 pts)

SW source is likely from leaking (lined) pond or leaking irrigation pipe.

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Home 40 WL003 MPA Result

ANALYSIS FOR WATERBORNE PARTICULATES

CH Diagnostic and Consulting Service, Inc.
512 5th Street, Berthoud, CO 80513
P: (970) 532-2078 F: (970) 532-3358

Invoice 20230178

Customer 20221649
Home 40 LLC
529 Clancy Way
Bozeman, MT 59718
PWSID# MT0004960

Laboratory Information
UPS; 6/14/2023; 1000 Hrs; 12.6°C; Wound
Results submitted by:

Sample Identification: Well 2 Raw Water, WL003 RW003

Sample Information: SOURCE: Drilled Well; 137' deep; 110' from surface water; Unchlorinated; pH 6.92 —» pH 7.09; 9°C —» 8.8°C; 0.74 NTU —» 1.24 NTU. TREATMENT: No Treatment

Sample Date & Time: 6/12/2023 01:45 PM —» 6/13/2023 08:07 AM **Sampler:** Scott Patterson

Amount: 4810.735 L (1271 gal) **Filter Color:** Off white **Filter Type:** Polypropylene wound cartridge

Date/Time Eluted: 6/15/2023 01:15 PM **Centrifugate:** <0.001 mL/100 L

RESULTS OF MICROSCOPIC PARTICULATE ANALYSIS

Amount of sample assayed: 480 L

Amorphous Debris	clay (1-2 µm), silt (2-50 µm), sand (50-2000 µm), detritus, aggregates
Algae	4/100 Gal, Oscillatoria
Diatoms	1/100 Gal, Gomphonema
Plant debris	ND
Rotifers	ND
Nematodes	ND
Pollen (pine)	6/100 Gal
Ameba	ND
Ciliates	ND
Colorless Flagellates	2/100 Gal
Crustaceans	ND
Other Arthropods	ND
Other	ND

Giardia and Coccidia are none detected (ND) by MPA unless reported under "Other".
This sample was analyzed for particulates following the Environmental Protection Agency Consensus Method for Determining Groundwaters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA). 1992. USEPA, Port Orchard, WA, EPA 910/9-92-029. All limitations stated in the methods apply. If HV capsule or foam filter was received, method was modified by filtering sample through a Pall Envirochek™ HV capsule or IDEXX Filta-Max™ filter at the sample site. If *Giardia* and *Cryptosporidium* Analysis was also performed, particulate extraction was modified.

COMMENTS: Score: 10-Moderate Risk per EPA Consensus Method referenced above.

Oscillatoria is a genus of filamentous cyanobacteria that is often found in freshwater environments and uses photosynthesis to survive and reproduce.

Gomphomena is a genus of diatoms that is ubiquitous in lakes and streams in North America. Diatoms rely upon photosynthesis for survival.

System is pursuing DEQ engineering approval to inactive GWUDISW well and justify that demand can be met with only two wells.

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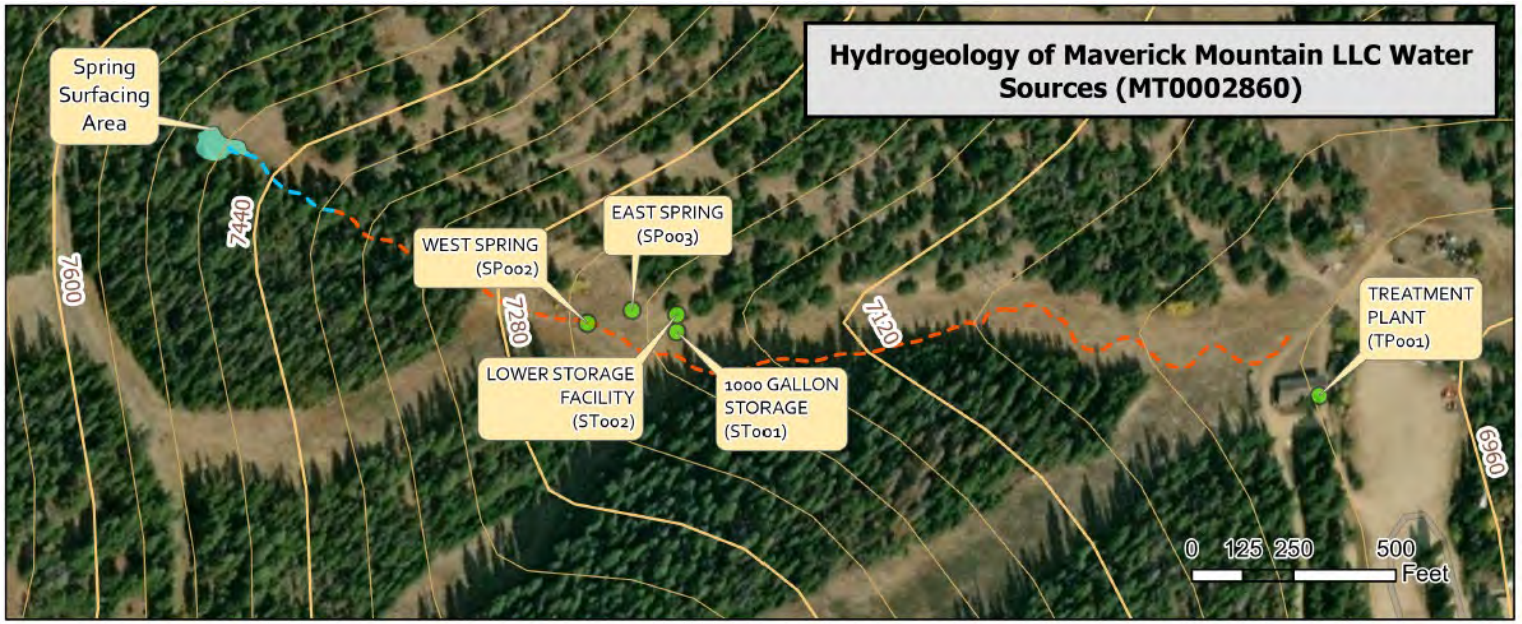
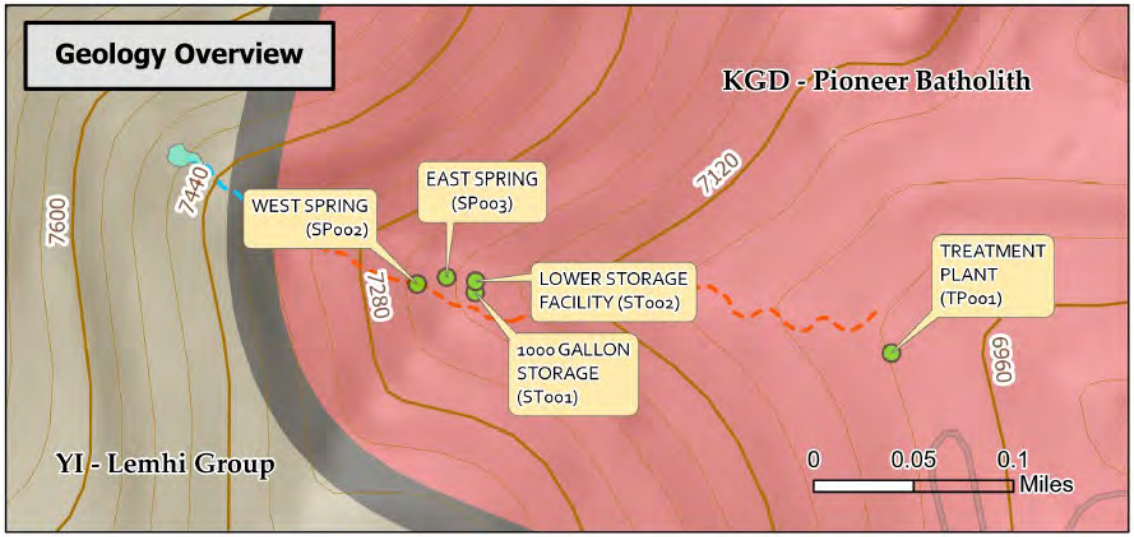
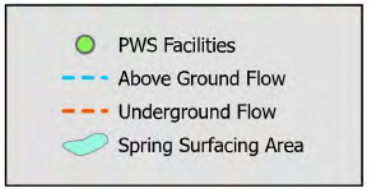
Example 2: Maverick Mountain Resort Spring MT0002860

West Spring Box SP002 = GWUDISW (MPA 16 pts, algae 7/100 gal, diatoms 14/100 gal, rotifers 3/100 gal)

East Spring Box SP003 = GWUDISW (MPA 22 pts, algae 92/100 gal, diatoms 148/100 gal)







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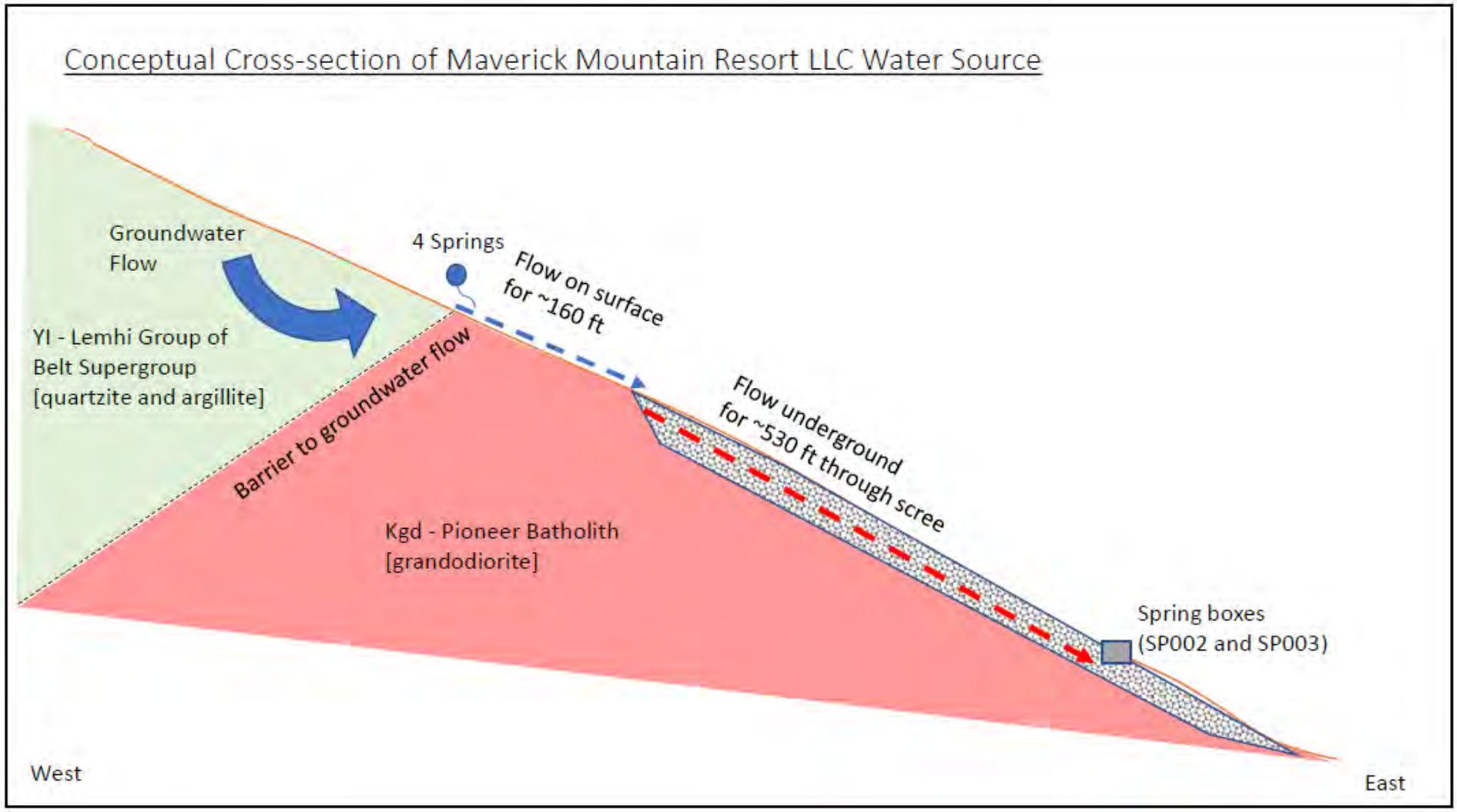
Map created by Montana DEQ Water Quality Division 6/24/2022

Maverick Mountain Resort Spring



Maverick Mountain Resort Spring

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Example 3: Chico Hot Springs

Chico Hot Springs Resort

Spring location

-110.6917, 45.33239

Forest Service property

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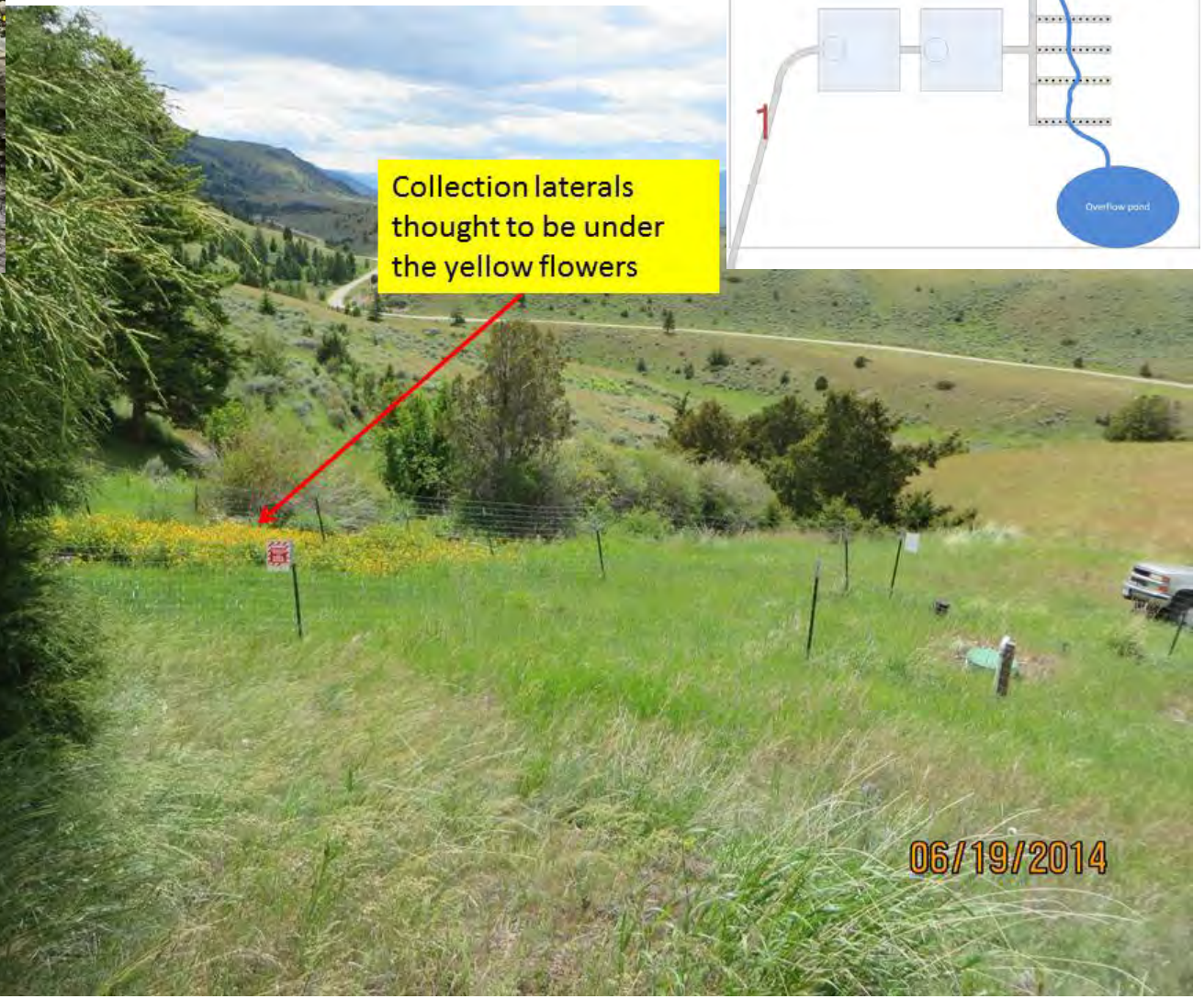
Chico Hot Springs – Drinking Water Spring Source



Yellow flowers enjoying the stream that runs right over the spring collector laterals.

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Chico Hot Springs – MPA result

- MPA sample collected June 2014
- MPA Result – 31 points (High Risk of surface water influence)
  - Algae 3,631/100 Gal
  - Diatoms 6,410/100 Gal
  - Rotifers 6/100 Gal
- Spring source classified as GWUDISW
- Immediately issued Boil Water Advisory
- Provided bottled water and ice
- Modify the pond to prevent infiltration and piped overflow below the spring collector
- Install surface water treatment – Filtration, Ultraviolet and chlorine disinfection
  - Cost $500,000 in 2015

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Chico Hot Springs – Surface Water Treatment

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Rules Coordinator / GWUDISW Rule Manager:
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Rule

- **GWUDISW was introduced as part of Surface Water Treatment Rule**
  - **Determine which water sources and systems are subject to SWTR**
- **ARM 17.39.209 references Circular PWS-5**
- Circular PWS-5 Ground Water Under the Direct Influence of Surface Water
  - Establishes Montana's GWUDISW Evaluation Process
- EPA's Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources
  - Introduces GWUDISW term and general methodology
  - If is up to the States and Primacy Agencies to develop their own GWUDISW evaluation process
  - Because the landscapes, climate and geologic history vary tremendously across the US, it is expected for there to be variability in GWUIDSW approaches.

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PWS-5 Edition Took Effective August 27, 2022

- Transferring assessment and testing requirements from systems to the department
  - DEQ will complete PA and all MPA
  - DEQ Eng will still require PA as part of new source submission
- Modifying the criteria and scores in the preliminary assessment
  - Remove well cap question
  - Distinguish between distribution and source historical sample results and weight source samples more heavily
  - Add annular seal depth and thickness to well construction question; remove reference to confined or unconfined aquifer
- Emphasizing that microparticulate analyses are the determining factor
  - MPA test results will be required instead of Water quality or hydrogeologic assessment
  - If present, MPA test results will be used for classification
- Updating the circular to be consistent with other recently adopted rules
  - Groundwater Rule
  - Annular seal to minimum 25 ft depth as stated in Well Drillers rule and DEQ-1
  - Revised Total Coliform Rule
- Removing extraneous nonregulatory information
  - Scientific explanations, WQ and HA required elements
  - Remove double negative language on PA; clarify PA question

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40 CFR 141.2 Definitions

Ground water under the direct influence of surface water (GWUDI) means any water beneath the surface of the ground with significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium,*

or

significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions.

Direct influence must be determined for individual sources in accordance with criteria established by the State. The State determination of direct influence may be based on site-specific measurements of water quality and/or documentation of well construction characteristics and geology with field evaluation.

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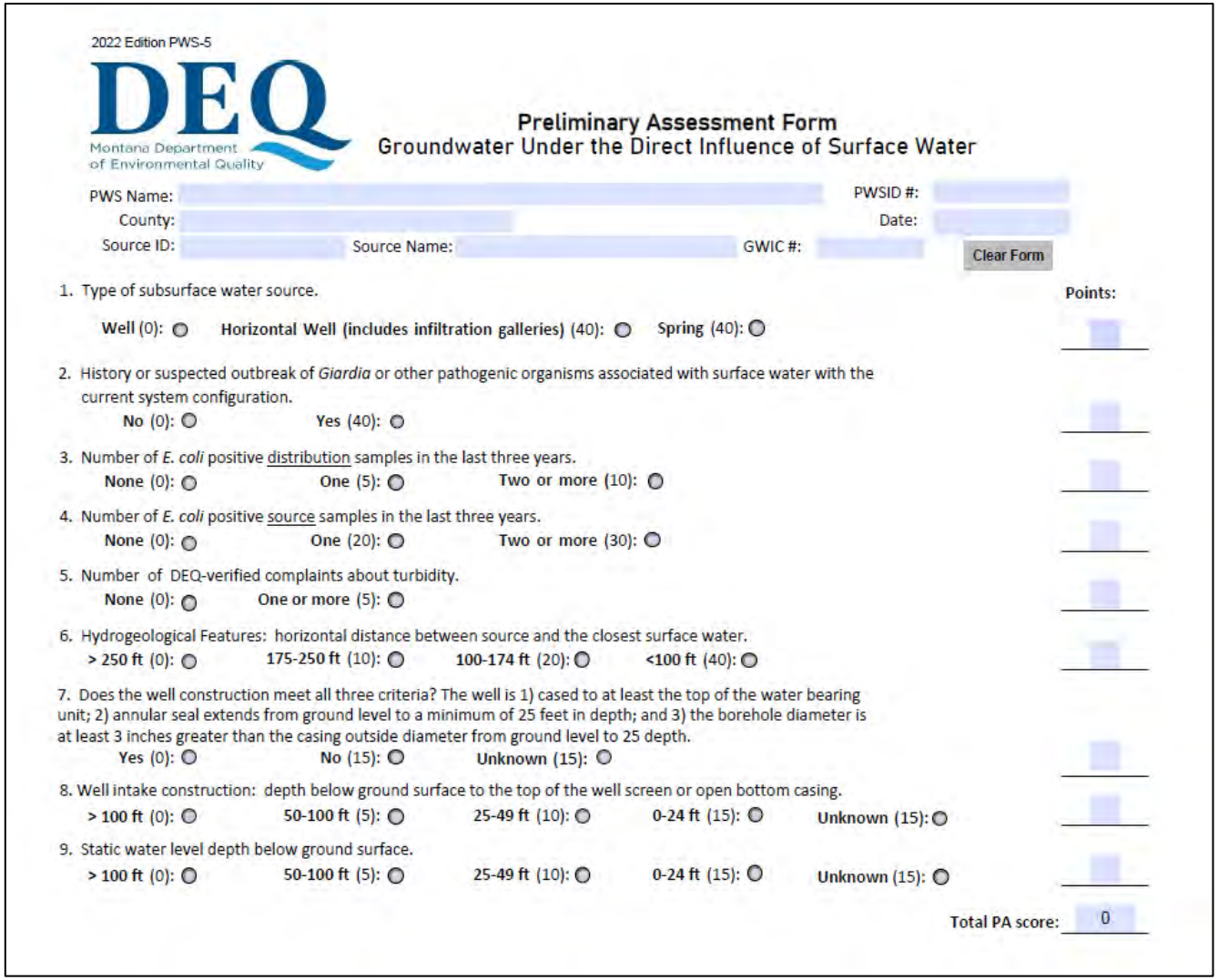
New (as of 2022) Preliminary Assessment (PA)

- PA purpose is to:

1. Highlight obvious GW sources, and

2. Gather pertinent information into one place.

- Worksheet with 9 questions that have weighted scoring answers
- < 40 points = most likely ground water
- ≥ 40 points = further review is warranted
- Score 40 points
  - Spring
  - Horizontal well (infiltration gallery)
  - <100 ft from surface water



2022 Edition PWS-5

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Preliminary Assessment Form
Groundwater Under the Direct Influence of Surface Water

PWS Name: PWSID #:
County: Date:
Source ID: Source Name: GWIC #: Clear Form

1. Type of subsurface water source. Points:
   Well (0): ○ Horizontal Well (includes infiltration galleries) (40): ○ Spring (40): ○
2. History or suspected outbreak of *Giardia* or other pathogenic organisms associated with surface water with the current system configuration.
   No (0): ○ Yes (40): ○
3. Number of *E. coli* positive distribution samples in the last three years.
   None (0): ○ One (5): ○ Two or more (10): ○
4. Number of *E. coli* positive source samples in the last three years.
   None (0): ○ One (20): ○ Two or more (30): ○
5. Number of DEQ-verified complaints about turbidity.
   None (0): ○ One or more (5): ○
6. Hydrogeological Features: horizontal distance between source and the closest surface water.
   > 250 ft (0): ○ 175-250 ft (10): ○ 100-174 ft (20): ○ <100 ft (40): ○
7. Does the well construction meet all three criteria? The well is 1) cased to at least the top of the water bearing unit; 2) annular seal extends from ground level to a minimum of 25 feet in depth; and 3) the borehole diameter is at least 3 inches greater than the casing outside diameter from ground level to 25 depth.
   Yes (0): ○ No (15): ○ Unknown (15): ○
8. Well intake construction: depth below ground surface to the top of the well screen or open bottom casing.
   > 100 ft (0): ○ 50-100 ft (5): ○ 25-49 ft (10): ○ 0-24 ft (15): ○ Unknown (15): ○
9. Static water level depth below ground surface.
   > 100 ft (0): ○ 50-100 ft (5): ○ 25-49 ft (10): ○ 0-24 ft (15): ○ Unknown (15): ○

Total PA score: 0

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PA page 2

- Check box
- Include your name
- Include lat and long
- Please add relevant comments
- Include with PA
  - Well log
  - Map with distance to surface water labeled
  - Photos of source

2022 Edition PWS-5

☐ Score is less than 40 points. Source is likely ground water.

☐ Score is 40 points or greater. Source must undergo further analysis.

Form Completed By:

Affiliation

Source Location:

Latitude: **° (digital degrees)**

Longitude: **° (digital degrees)**

Comments:

When submitting the PA form please also include the (1) well log, (2) a map of source and nearest surface water, and (3) photos showing source construction details and the topography around the source. Please include supporting or relevant documentation.

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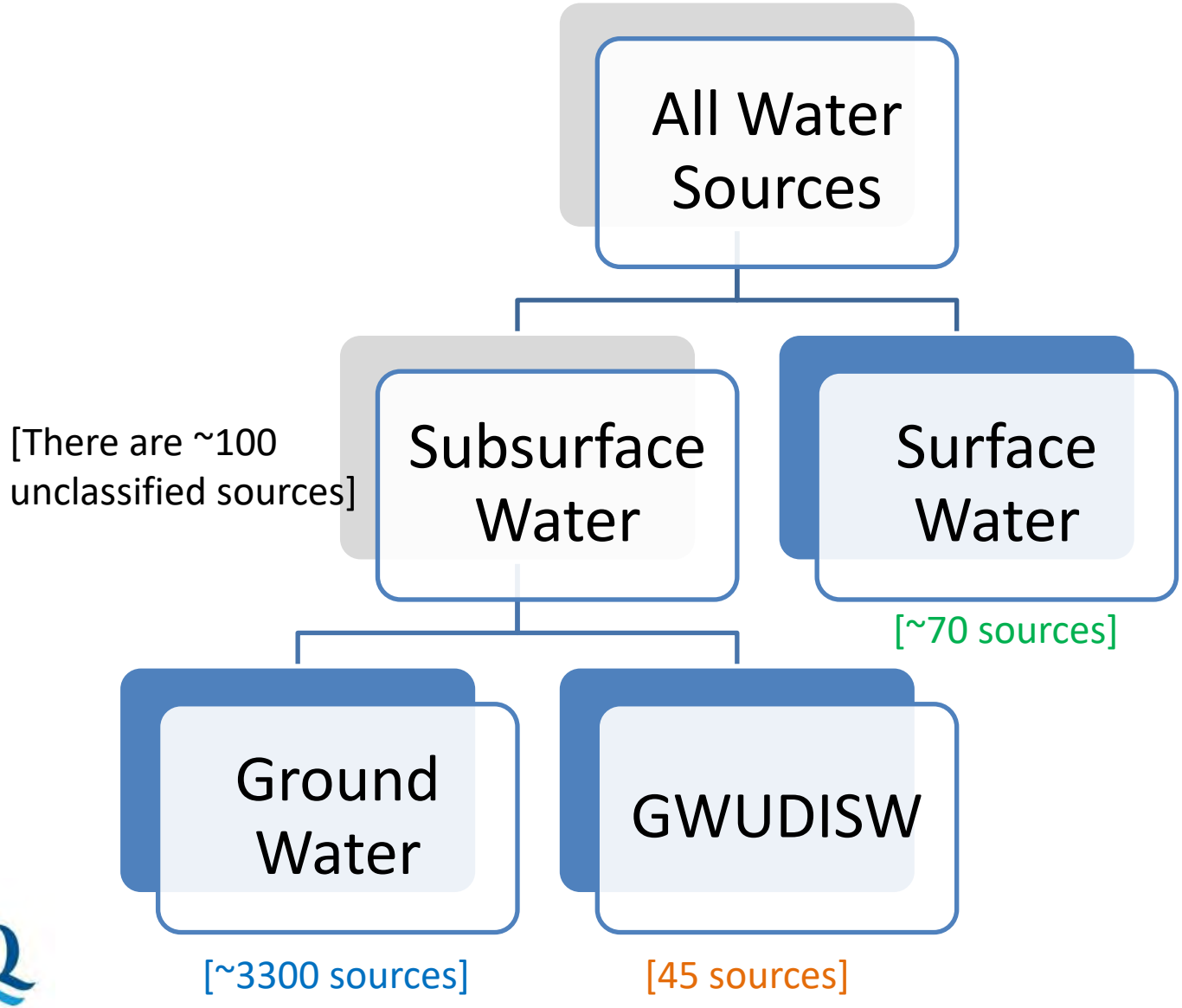
Classifying Source Waters



Five Elements that help me understand a source

1. Aquifer
    1. Porous media or Fractured
    2. Unconfined or confined
    3. Are fines present that can provide filtration?
2. Groundwater Flow direction
    1. Place on map
    2. From surface water to source?
3. Groundwater Recharge
    1. General area
    2. Understand how the aquifer is recharged
4. Well or Spring box construction
    1. Are there protections in place?
    2. Meet standards?
    3. Would improvements prevent SW influence?
5. Nearest Surface Water
    1. Pond, lake, creek, reservoir, canal, etc.
    2. Is the SW gaining or losing water?

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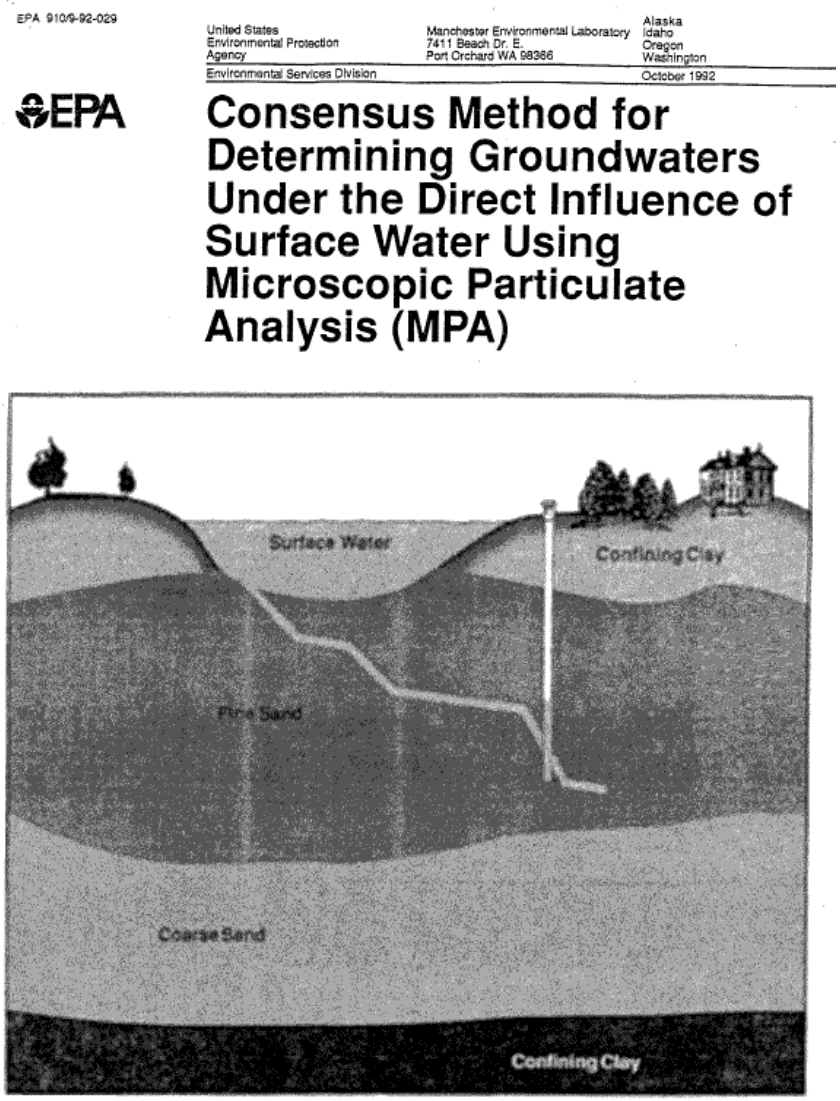
Microscopic Particulate Analysis (MPA)

- EPA consensus method
- Sample Collection:
  - 1 gallon per minute / Maximum 10 psi
  - 1 micron filter
  - 1,000 gallons / 18 hours (1080 minutes)
  - Filter shipped overnight to lab
- Extract particles off filter than identify under microscope
- Points convert to Low (≤ 9), Moderate (10-19) or High Risk (≥20)


EPA 910/9-92-029

United States Environmental Protection Agency
Environmental Services Division

Manchester Environmental Laboratory
7411 Beach Dr. E.
Port Orchard WA 98366

Alaska
Idaho
Oregon
Washington

October 1992

EPA

Consensus Method for Determining Groundwaters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)

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What Happens to GWUDISW Sources?

- Issue GWUDISW ROD based on 1 MPA result > 9 points. [Scott]
- Inform M&R Supervisor, Bureau Chief, Inspector who conducted MPA/completed PA, SWTR RM, FS Supervisor.
- SWTR Letter is sent. [Josh]
  - Explain 3 options to address GWUDISW source
  - Require weekly or biweekly fecal coliform samples
  - Provide copy of PN that is to be distributed quarterly
  - Provide deadline in 18-months to meet one of three options
  - Generally, the source does not meet the filter avoidance criteria
- PWS does not address the GWUDISW source in the provided 18 months,
  - After 18-month deadline has passed and the PWS has not addressed the GWUDISW source satisfactory, a failure to filter violation is issued. [Josh]
  - PWS is referred to ENF based on failure to filter violation. Generally, do not ask for penalties. [Scott]
  - Generally, the PWS needs to hire PE and submit plans and spec to DEQ (e.g., new well, SW treatment, or modify the source, etc.)
  - If PWS chooses to modify the source, the area around the source or the nearby surface water, then MPAs will be required in May-June and August-September to verify that the surface water influence is in fact limited.
  - RTC for failure to filter violation is dependent on which option the PWS chooses to address GWUDISW. Could be drill a new approved well and RTC is when the new well is activated, connected to the system and the GWUDISW source is disconnected from the system. If install SWTR, then need several months of satisfactory monthly reports. If modify the source, 2 MPA with less than 9 points is needed. [Josh]

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MPA Results

Ground Water Risk Factor Table

From: E.P.A. Consensuses Method for Determining Groundwaters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)

Table 1. Numerical range of each primary bio-indicator (Particulate) counted per 100 gallons water.

Indicators of surface water [1]	EH [3]	H	M	R	NS
Giardia [2]	>30	16-30	6-15	1-5	<1
Coccidia [2]	>30	16-30	6-15	1-5	<1
Diatoms [4]	>150	41-149	11-40	1-10	<1
Other Algae [4]	>300	96-299	21-95	1-20	<1
Insects/Larvae	>100	31-99	16-30	1-15	<1
Rotifers	>150	61-149	21-60	1-20	<1
Plant Debris [4]	>200	71-200	26-70	1-25	<1

1. According to EPA "Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources", March, 1991 ed.

2. If Giardia cysts or coccidian are found in any sample, irrespective of volume, score as above.

3. Key= EH – extremely heavy M – moderate NS – not significant
H – heavy R – rare

4. Chlorophyll containing

Table 2. Relative surface water risk factors associated with scoring of primary bio-indicators (particulate) present during MPA of subsurface water sources.

Indicators of surface water [1]	Relative Risk Factor [3]				
	EH [2]	H	M	R	NS
Giardia	40	30	25	20	0
Coccidia	35	30	25	20	0
Diatoms	16	13	11	6	0
Other Algae	14	12	9	4	0
Insects/Larvae	9	7	5	3	0
Rotifers	4	3	2	1	0
Plant Debris	3	2	1	0	0

1. According to EPA "Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources", March, 1991 ed.

2. Refer to Table 1 for range of indicators counted per 100 gallons.
Key= EH – extremely heavy M – moderate NS – not significant
H – heavy R – rare

3. Risk of surface water contamination
≥20 – high risk
10-19 – moderate risk
≤9 – low risk

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