



Island Park Bacteria Investigation 2020 – 2021; Distinguishing Sources and Drivers

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Henry's Fork Watershed Council

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IDEQ Island Park Bacteria Investigation

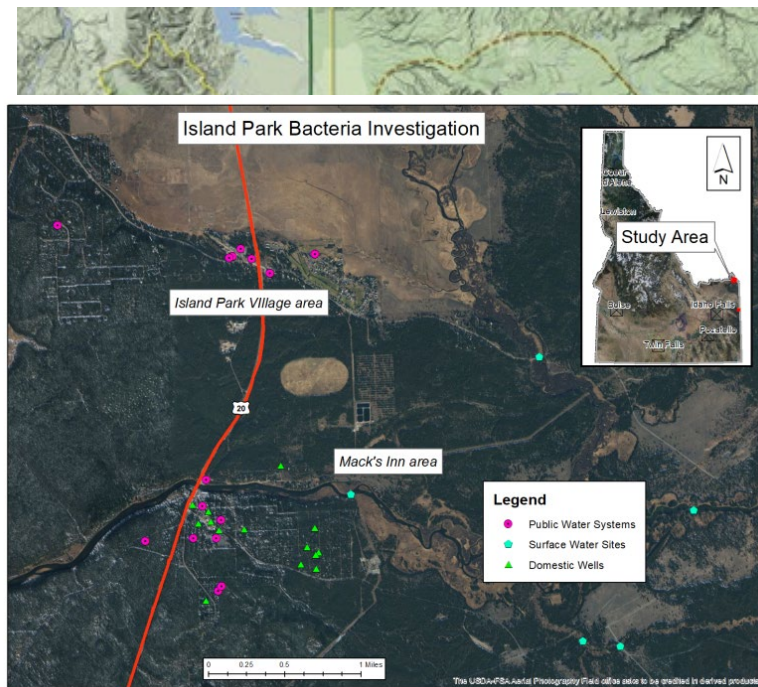
Sources and factors behind seasonal bacteria detections in drinking water wells in the Mack's Inn, and Island Park Village areas, east Idaho

Flint Hall, IDEQ Idaho Falls Regional Office, Michael J. Ferraro, ISU Department of Geosciences
June 3, 2022

<https://storymaps.arcgis.com/stories/6897a2392cea45f49e9272a44da7f513>

Background:

- Heavy use during summer and winter recreation seasons
- Lots of lovin'
 - vacation homes, VRBO
 - RV, camping
 - Outdoor recreation
 - Yellowstone
- Shallow soils and alluvium, fractured rock
(high GW vulnerability)
- Historical seasonal bacteria issues
 - Some areas are on PWS, community wastewater systems (1982)
- Shigella outbreak – 1995
(<https://www.cdc.gov/mmwr/preview/mmwrhtml/00040669.htm>)
 - Island Park Village area – suspected to correlate to unregulated pit toilets used by construction laborers
 - Issues with the wastewater system
- 2020 – increased detections, PWS and domestic wells
 - DEQ DW, EIPHD, County – prompted investigation



Distinguishing Anthropogenic sources:

Identifying N Inputs:

- Natural
- Ambient/baseline
- Anthropogenic

Characterize Distinguishing Factors:

- Defining groups/sources
- Modifying processes

Relate to Context:

- Subsurface
- Land use/BMP Context

Process Flow:

- Know the context
Natural, ambient, anthropogenic sources
- Sample
Bacterial, Major ions, Nutrients, COCs, Tracers, isotopes
- Characterize Factors
– (Multivariate analysis – PCA, HCA, K-Means)
What distinguishes different sources?
What controls timing and occurrence
What processes modify the signature
- Relate to sources
Land use conditions, practices

Forensic N Monitoring Analytes:

Major ion Chemistry, Nutrients, COCs

Field parameters – temp, SpC, pH, DO

Ca, Mg, Na, K, Cl, SO₄, Total Alkalinity

NO₂+NO₃, NH₄

Bacteria (T. coliform, E. Coli)

Stable isotopes, Tracers

¹⁵N, ¹⁵N_{NO3}, ¹⁸O_{NO3}, ¹⁸O_{H2O}, ²H_{H2O}

B, Br



Questions, Sites and sampling:

Questions:

What are the primary sources/drivers?

- Surface water, Sanitary waste leaks/septics, WLAP?

What are the drivers for seasonality and locations?

- Snowmelt?

What factors control the sites impacted?

- Proximity to waste-water, WLAP?

Sites sampled:

Fall '20 – 16 PWS, 15 domestic, 5 SW sites

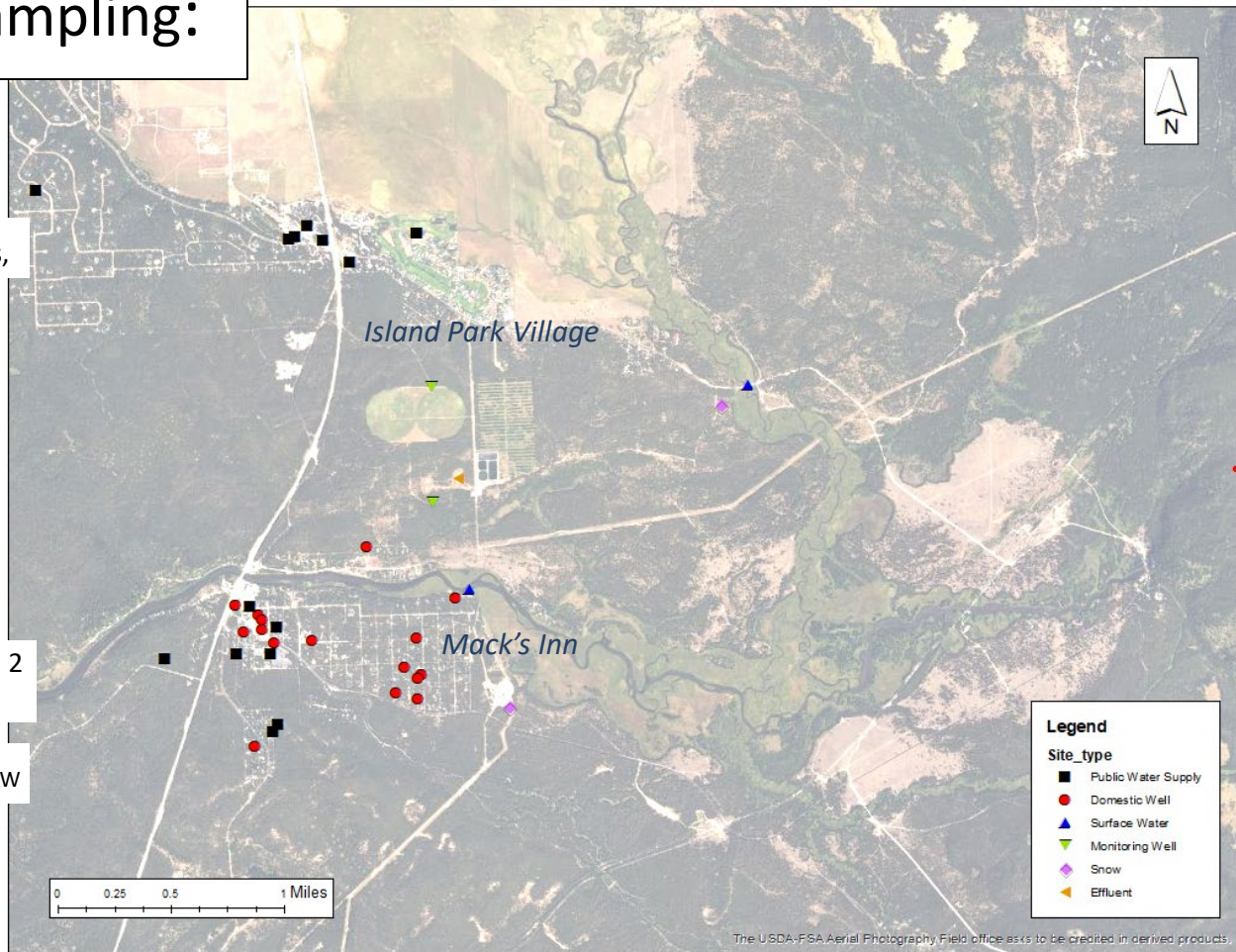
- Bacteria, General chemistry, $^{18}\text{O}/^2\text{H}$
- PCPP with ISU

Spring '21 – 15 PWS, 16 domestic, 2 SW, 2 WLAP, 2 snow, 1 winter effluent

- Bacteria, General chemistry, $^{18}\text{O}/^2\text{H}$
- B, Br, $^{15}\text{N}/^{18}\text{O}$ -nitrate, total ^{15}N
- SpC, temp loggers in monitoring wells and SW

Field parameter monitoring

- Selected PWS





Characterizing factors – Multivariate analysis

The inputs that include the COC include variations/combinations of ambient conditions

Allows a quantitative correlation with multiple factors (focus – 2021 results)

- Characterize Factors

- PCA – end members, sources of variability - optimized analytes

- HCA – similar sites, similar conditions/land uses, similar processes

- K-means – identify factors that distinguish groups, source/process context.

- Data utilized (optimized dataset)

- Proportional milliequivalents for major ions: (Ca, Mg, Na, K, total alkalinity (as CaCO_3), Cl, SO_4), trace elements (B, Br) and $\text{NO}_2 + \text{NO}_3$.

- Not detects replaced by $\frac{1}{2}$ the reporting level -- $\text{NO}_2 + \text{NO}_3$ (5), Br (3), B (1)

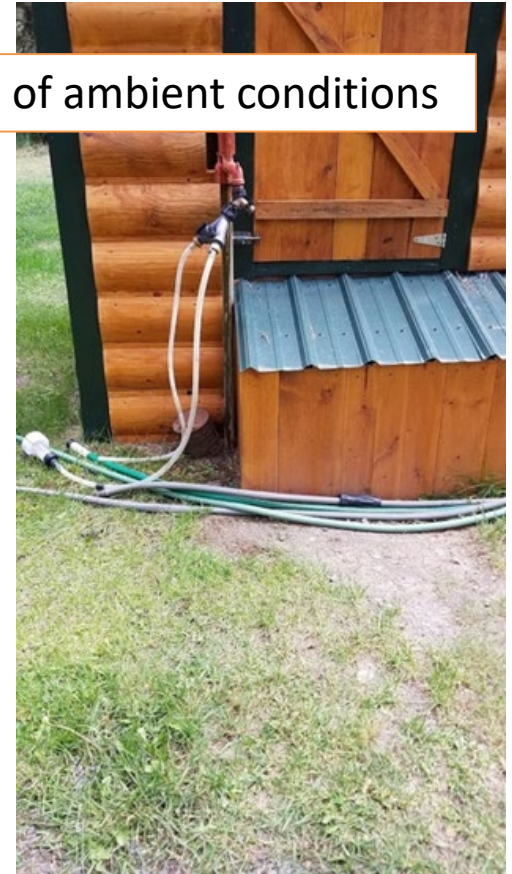
Interpretive plots – in terms of K-means cluster assignments

- Pipers - mixing of sources

- Cl/Br (with context for bacteria) – Cl source distinction, atmospheric/soil/waste

- LMWL – timing of water, impacts from winter/summer precipitation/evaporation

- ^{15}N , $^{18}\text{O}_{\text{NO}_3}$ - nitrogen sources and processes

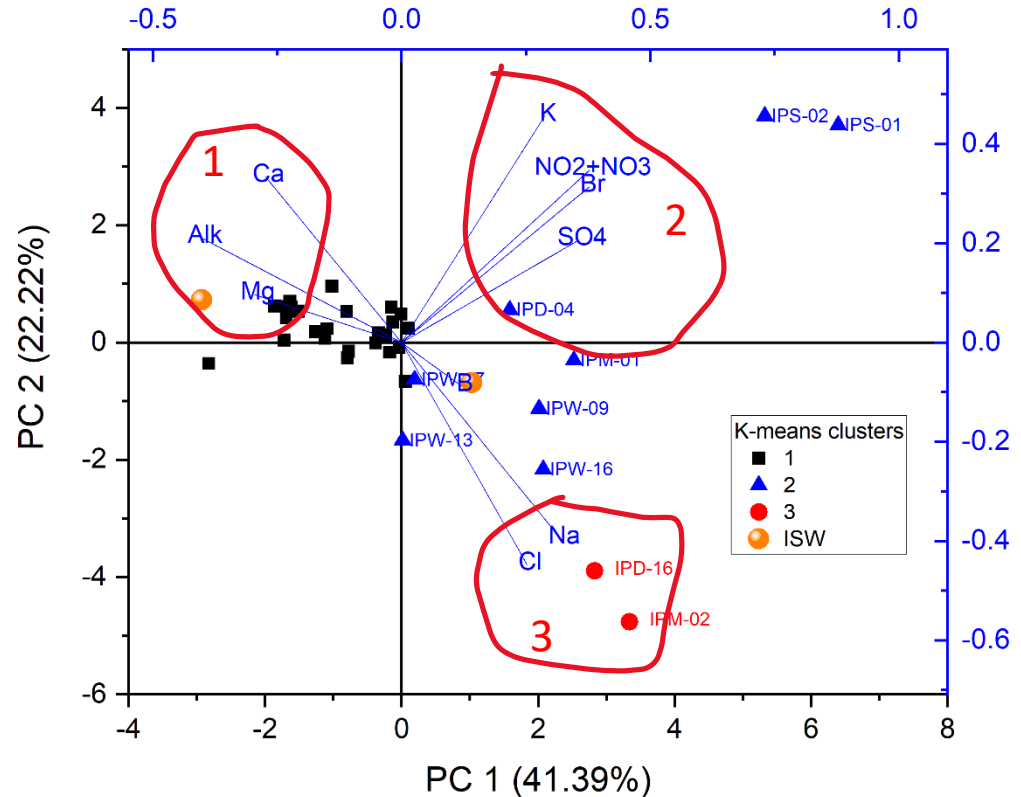


Characterizing factors: Variability/end members (PCA)

- 2021 sampling - 36 GW sites, 2 SW, 2 snow and 1 Effluent
- Three or Four significant components:
 - (1) , NO₂+ NO₃, Br, SO₄, Na, (2) K,NO₂+ NO₃,Ca, Br (3) B, Ca, Cl, Mg (4) B, Mg

Most group 2 sites returned bacteria detections

	Coefficients			
Ca	-0.2741	0.3339	0.3452	-0.4659
Mg	-0.2961	0.0967	0.3032	0.3331
Na	0.3202	-0.3955	-0.4121	0.1876
K	0.2876	0.4564	-0.1044	0.2161
Cl	0.2517	-0.4479	0.3394	-0.3516
SO ₄	0.3565	0.2063	0.2058	0.1263
HCO ₃	-0.4019	0.2104	-0.3817	0.2249
NO ₂ + NO ₃	0.3781	0.3477	0.0550	-0.0920
B	0.1203	-0.0881	0.5329	0.6080
Br	0.3775	0.3137	-0.1344	-0.1480

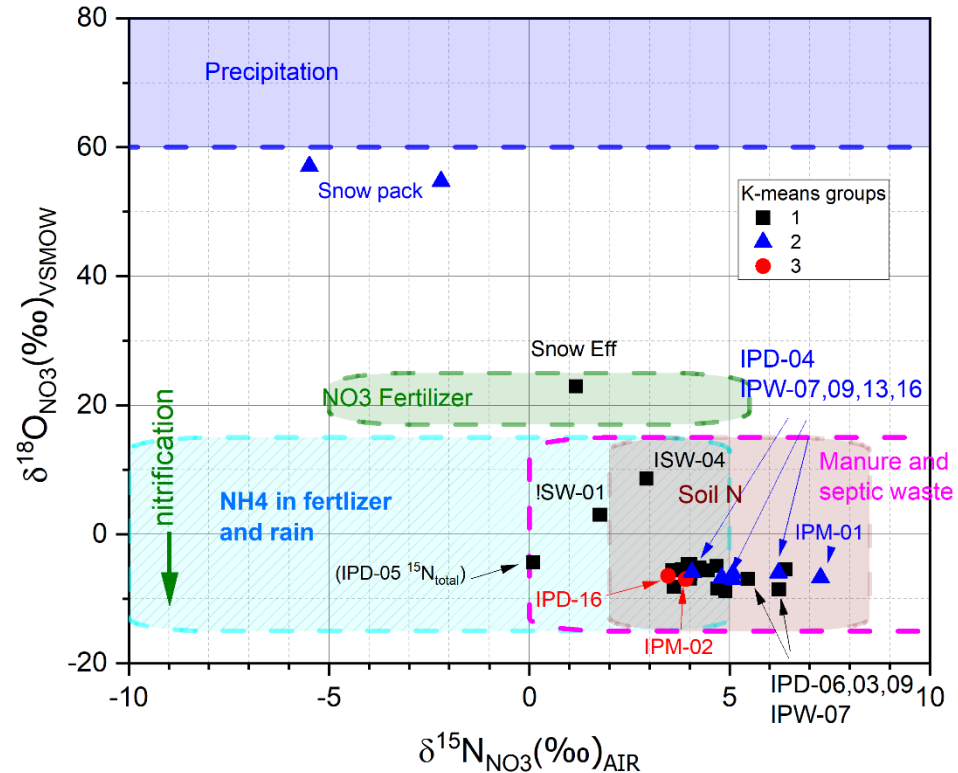




Distinctions (K-Means)

K-means outcomes:

- K means – Piper – cluster 2 – increase in Cl, cluster 3, increased Na
- Cl/Br cluster 2 plot mostly in the waste range, cluster 3 similar
- Most TC,EC detections are cluster 2 and waste range
- IPD-16 could be explained by mix of effluent and SW1
- Dual Isotope plot ($\delta^{15}\text{N}/^{18}\text{O}_{\text{NO}_3}$) indicates enriched $\delta^{15}\text{N}$ for some of these impacted sites (cluster 2) – supporting waste influence





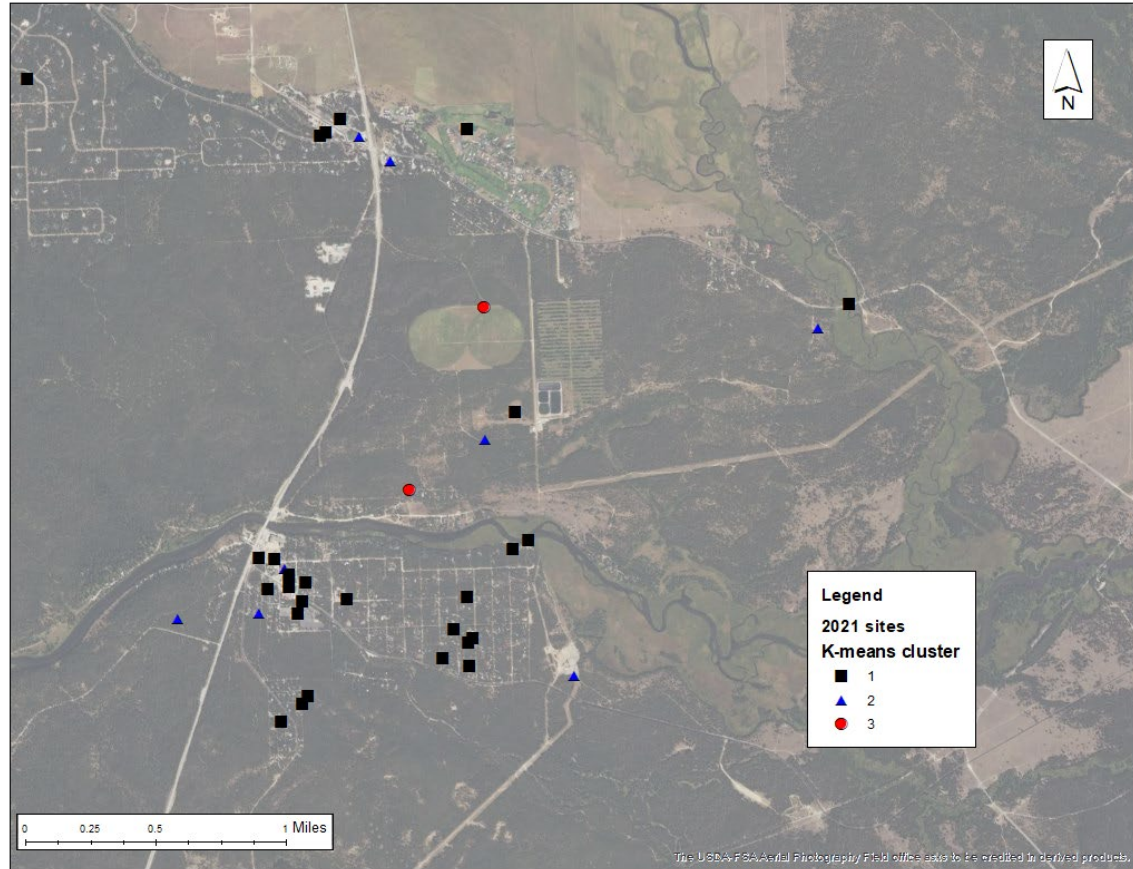
Natural groupings (HCA)

2021 sampling HCA outcomes:

- Groups A – ISW-01 and IPS-03 (snow eff), Group B – ISW-04, Group C – snow sites, Group D – IPM-02 (land app site?)
- TC detections across all groups, E. Coli groups B,C

Spatial plot with K-means

- Group C, cluster 2 share common factors
- Group D, Cluster 3 are distinct



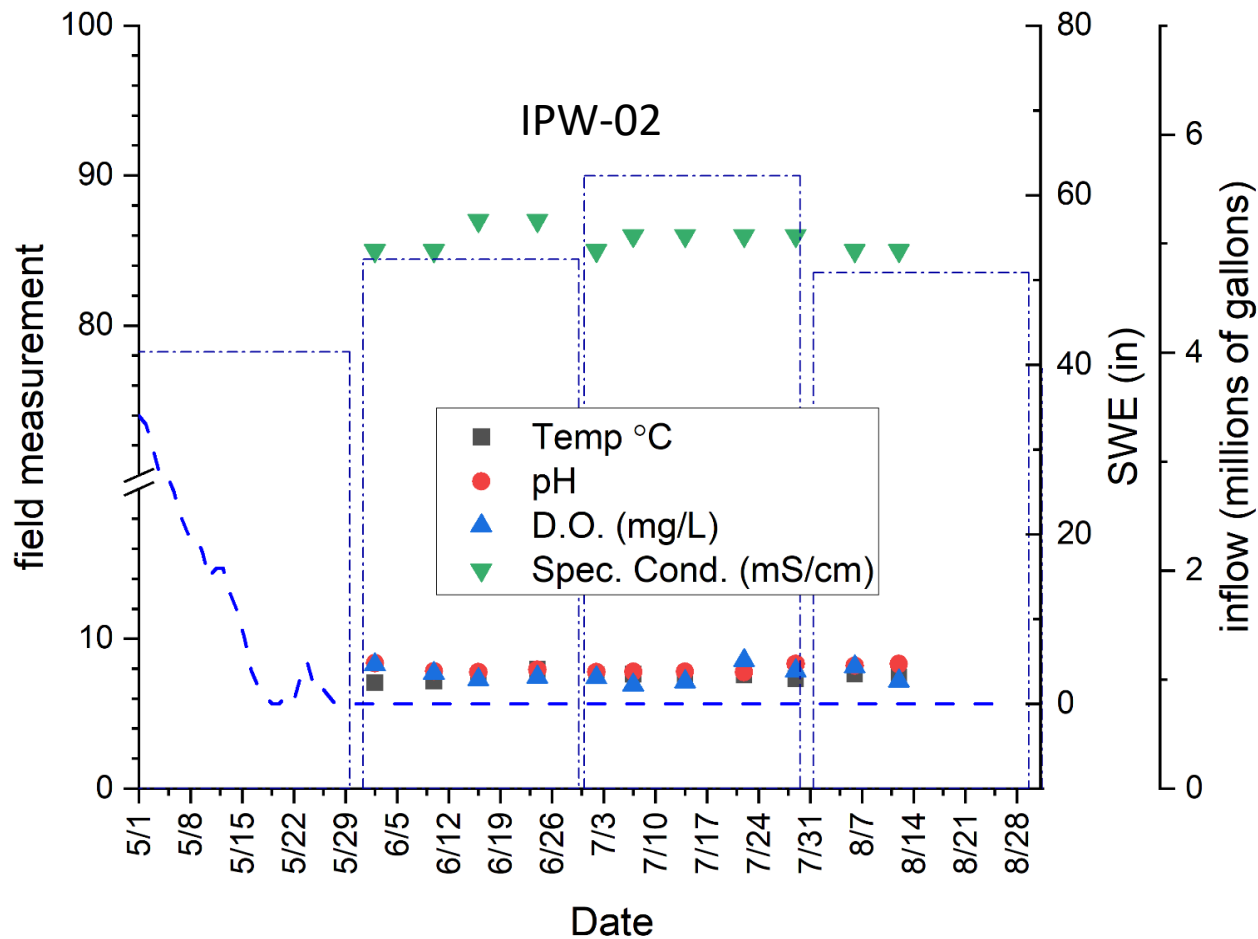


Field Parameters:

- 6/2-8/19

TC, EC detections

- IPW-16 – 7/6/21
- IPW-13 – 5/26/21
- IPW-09 – 9/7/21
- IPW-03 – 8/26/21
- IPW-02 – no detections

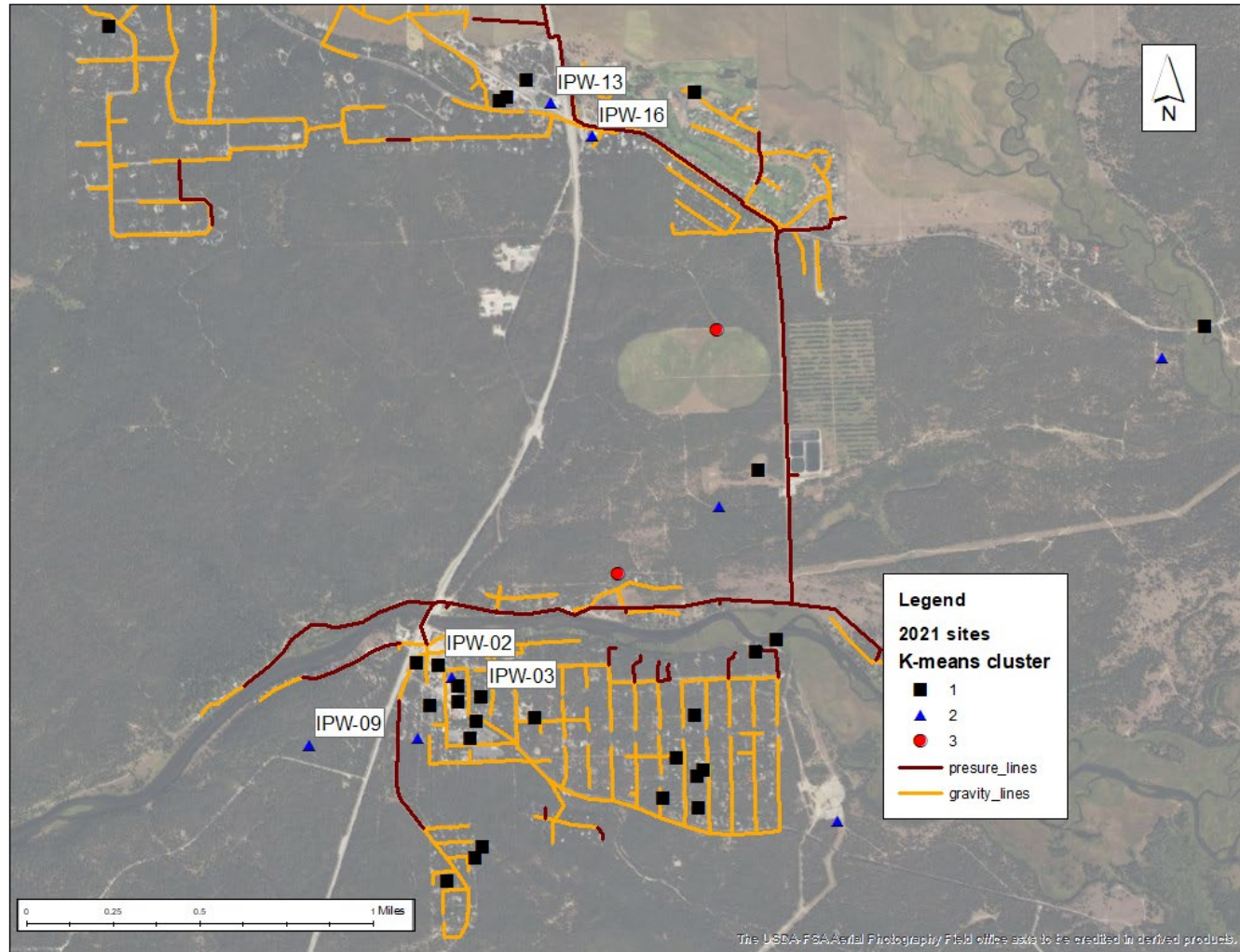


Field Parameters:

- 6/2-8/19

Correlations to drivers

- IPW-16, 13 – close to WW lines
- IPW-09
- IPW-03 – early season – melt related?
- IPW-02 – no trend



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Conclusions:

- Wastewater is a contributing factor – from possible sewer/septics
- Melting snows are likely a factor in driving existing bacteria to ground water
- Surface water from Henry's Lake outlet and the Henry's Fork in the Mack's Inn area is less likely to be a significant influence on bacteria occurrence.
- WLAP does not appear to be a contributing source of bacteria to ground water.
- Impacted sites more frequently included older wells completed to older and less-stringent construction standards.
- Some impacted sites were close to sanitary sewer collection lines and showed impacts correlating to peak flow in the wastewater system, suggesting possible leaks in the sewer collection system.



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Proposed Paths Forward:

PWS operators

- Talk to DEQ about Source Water Protection and options.
 - new well that seals out shallow sources of contamination,
 - consolidating with another PWS

Domestic users

- Contact DEQ, EIPHD, or IDWR about options.
 - onsite treatment, new well-construction, or connection to a public water supply.
 - Follow recommendations for regular monitoring.

County-city Jurisdictions

- Investigate potential contamination sources
 - identify leaks and active septic systems - work to connect to the central wastewater
- Develop and enforce protective ordinances:
 - New construction connecting to community water/sewer
 - Increase monitoring requirements for rental properties.



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Proposed Paths Forward:

DEQ/EIPHD (& other partners)

- Provide Education and training
 - Well/septic maintenance and protection
 - Sponsor local sampling events

(sample to understand the context – not just the Contaminant Of Concern)

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