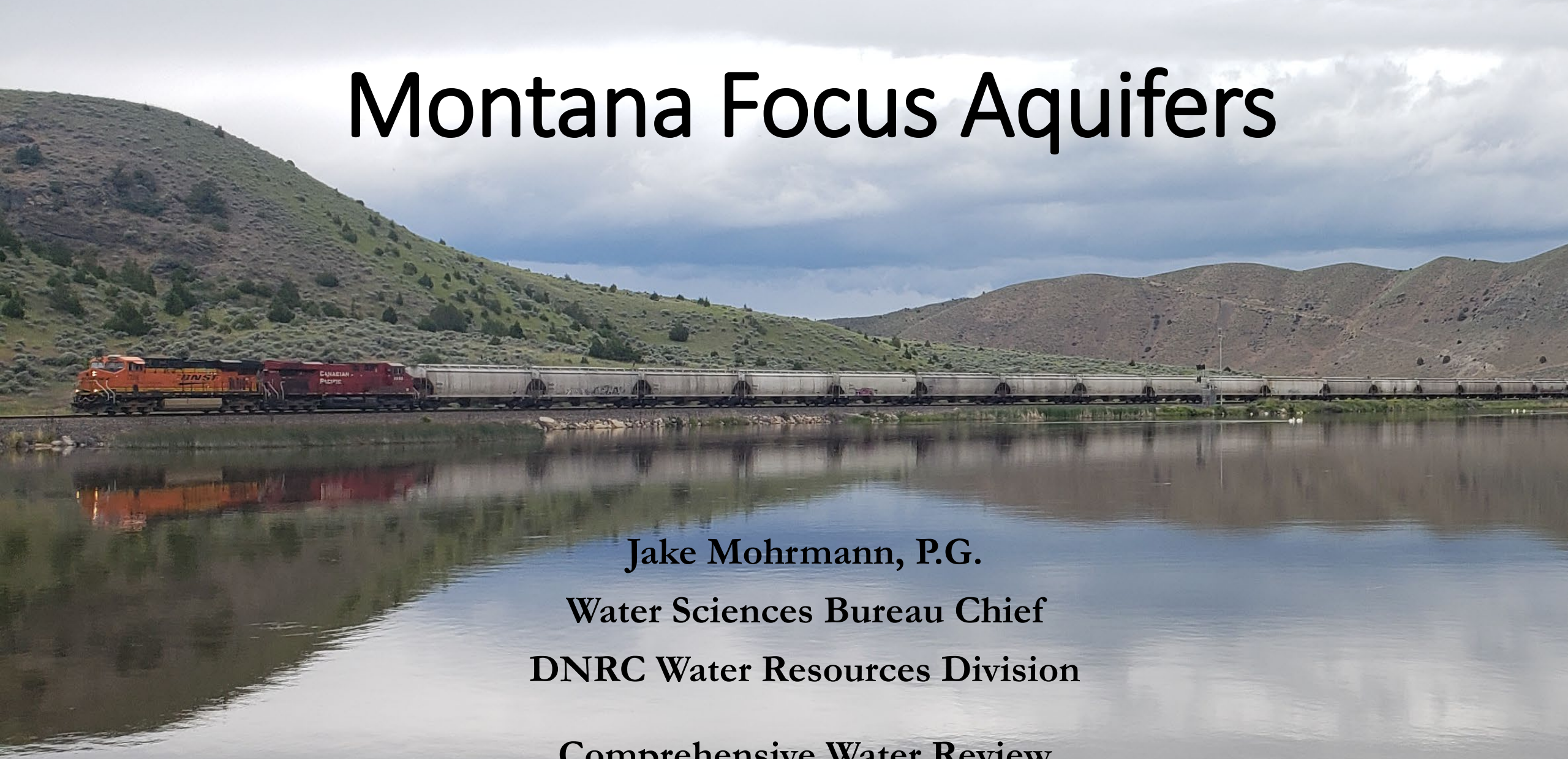
Montana Focus Aquifers



Jake Mohrmann, P.G.

Water Sciences Bureau Chief

DNRC Water Resources Division

Comprehensive Water Review

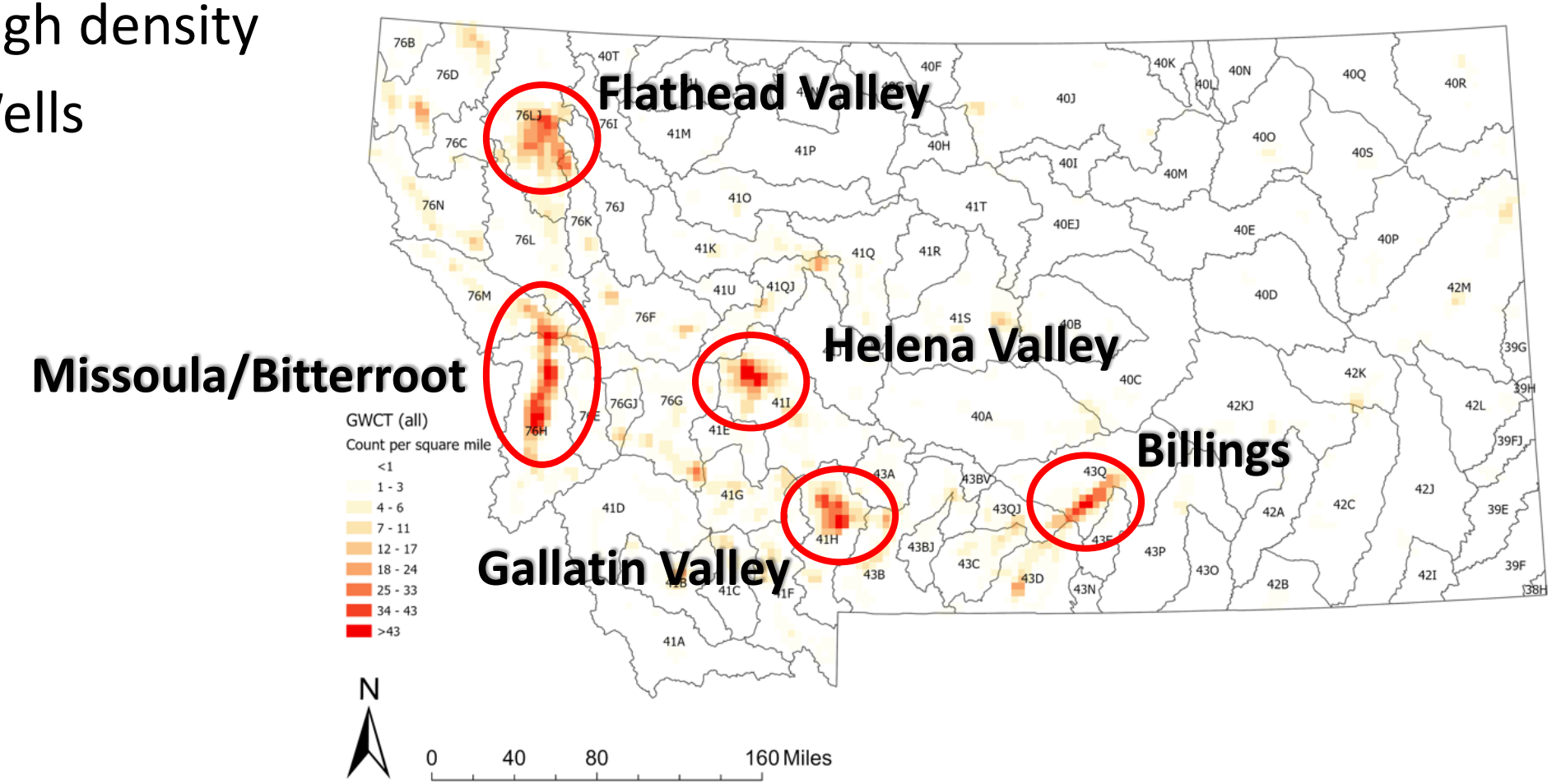
Stakeholder Working Group Meeting 11.15.2023

Overview of Each Aquifer

- Area Statistics
- Geographic and Hydrogeologic Setting
- Land Use Changes over Time
- Aquifer Concerns and Known Issues
- Opportunities

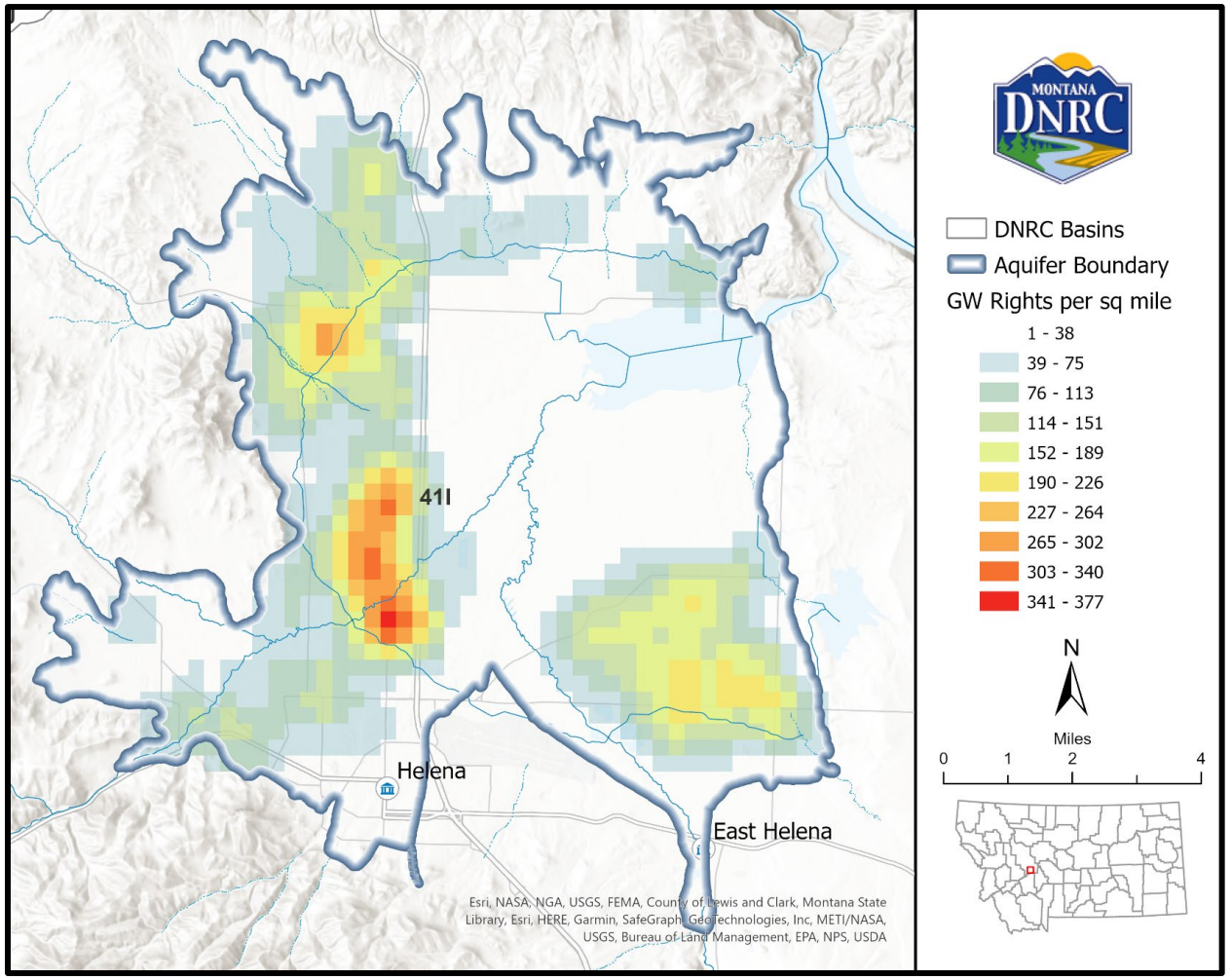
Common Themes

- All 5 are alluvial aquifers with connection to nearby surface water
- All 5 are located in urban areas with increased population growth
- All 5 host a high density of Exempt Wells



Helena Valley

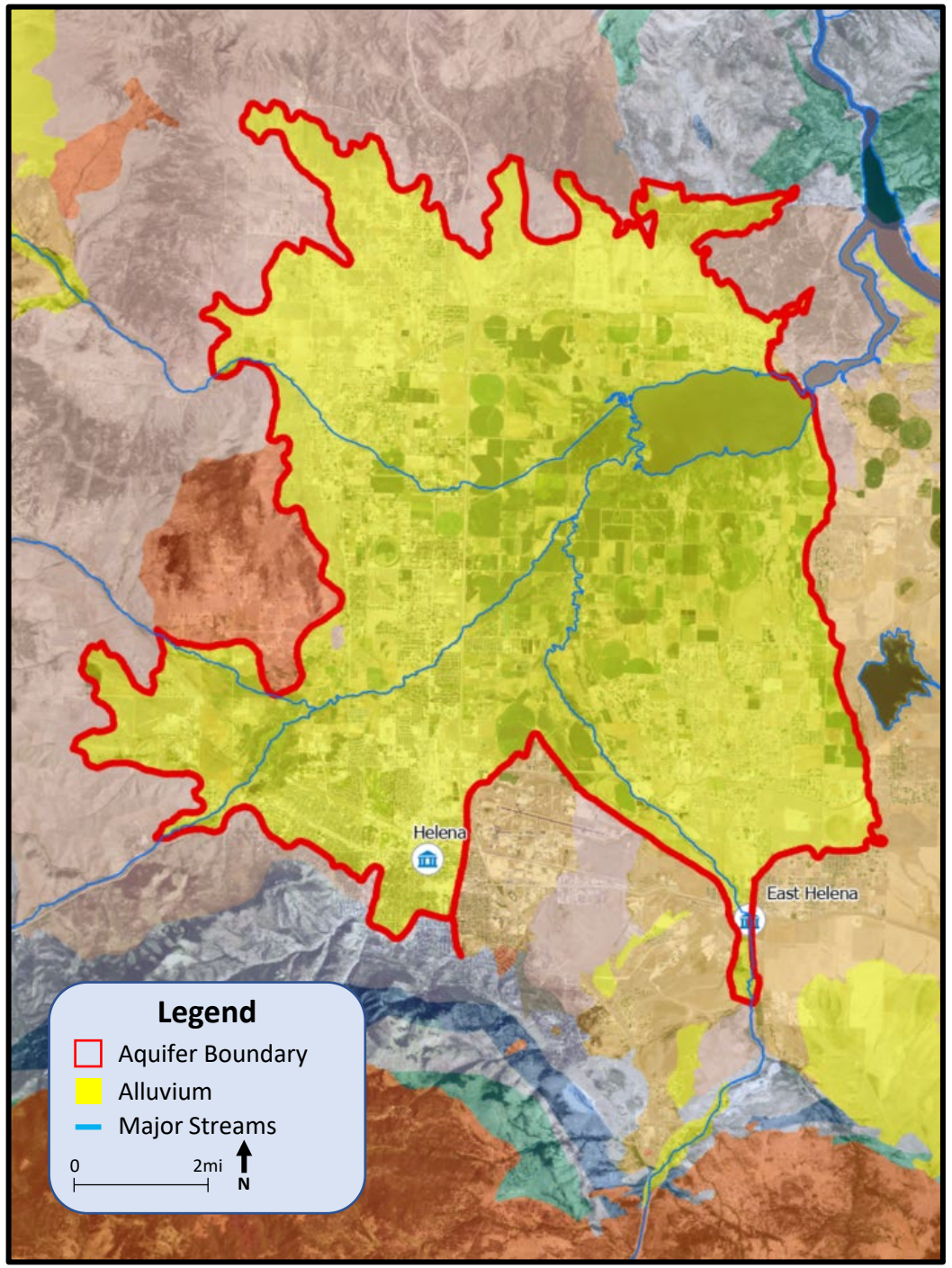
- Population: 73,832[1]
- Change from 2010: +16%
- Population Overlying the Aquifer: 73,115[2]
- Land Area: 87 sq. mi.
- Number of Permits: 273
- (5% of groundwater rights within aquifer boundary)
- Number of Exempt Wells: 4,586
- (83% of groundwater rights within aquifer boundary)



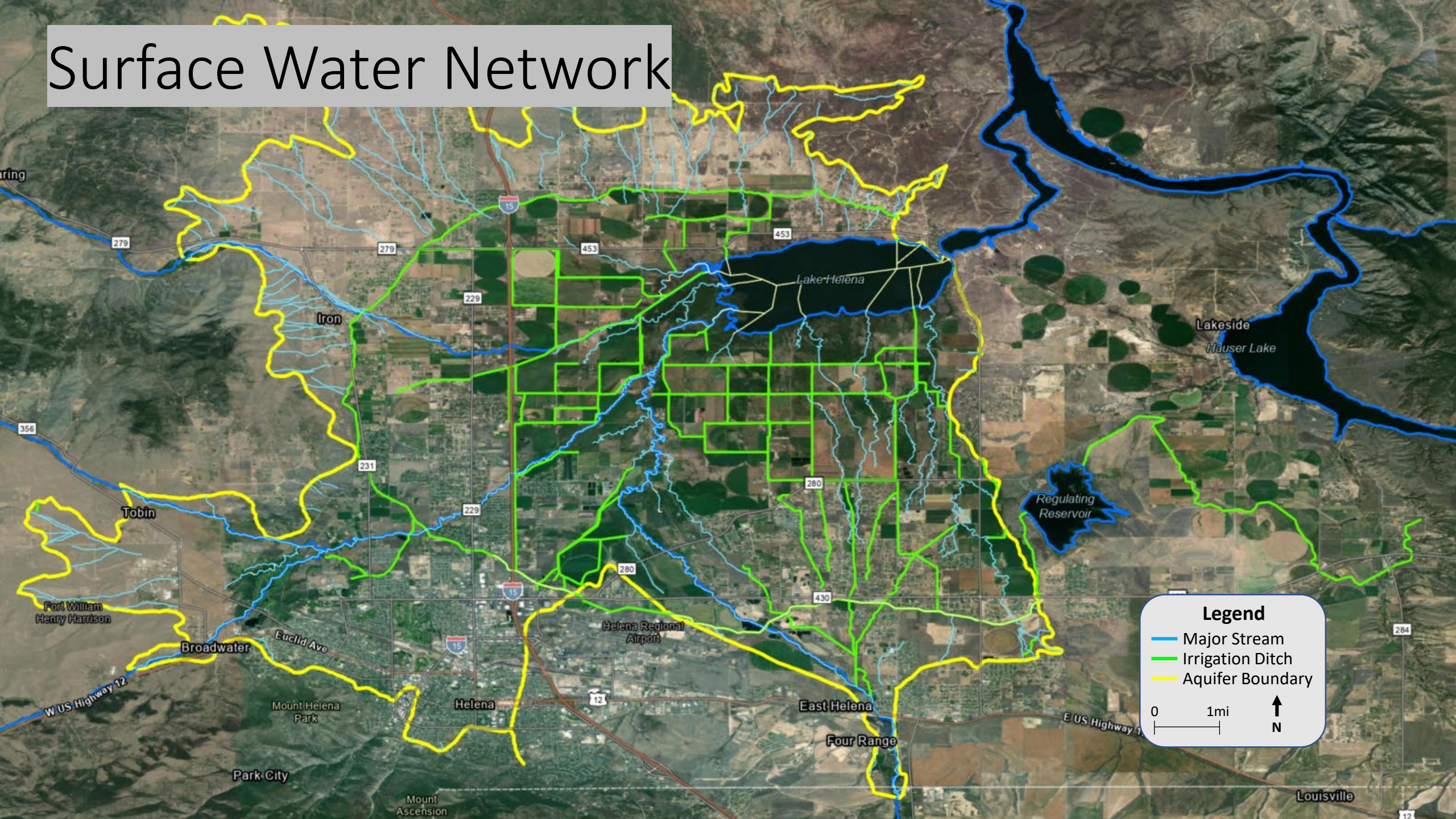
1. County total, estimate from July 1, 2022 (US Census Bureau, 2023)
2. Population calculated in GIS using 2020 Census Tracts that intersect aquifer boundaries. Selected census tracts extended beyond the boundaries of the aquifer and are presented for comparison only.

Hydrogeology

- Large valley-fill aquifer with areas of high transmissivity
- Typical well depths ~40-100 feet deep, yet basin fill is up to 6,000 feet deep
- Well yields of 50-100 gpm are common, high-capacity wells of over 500 gpm are possible

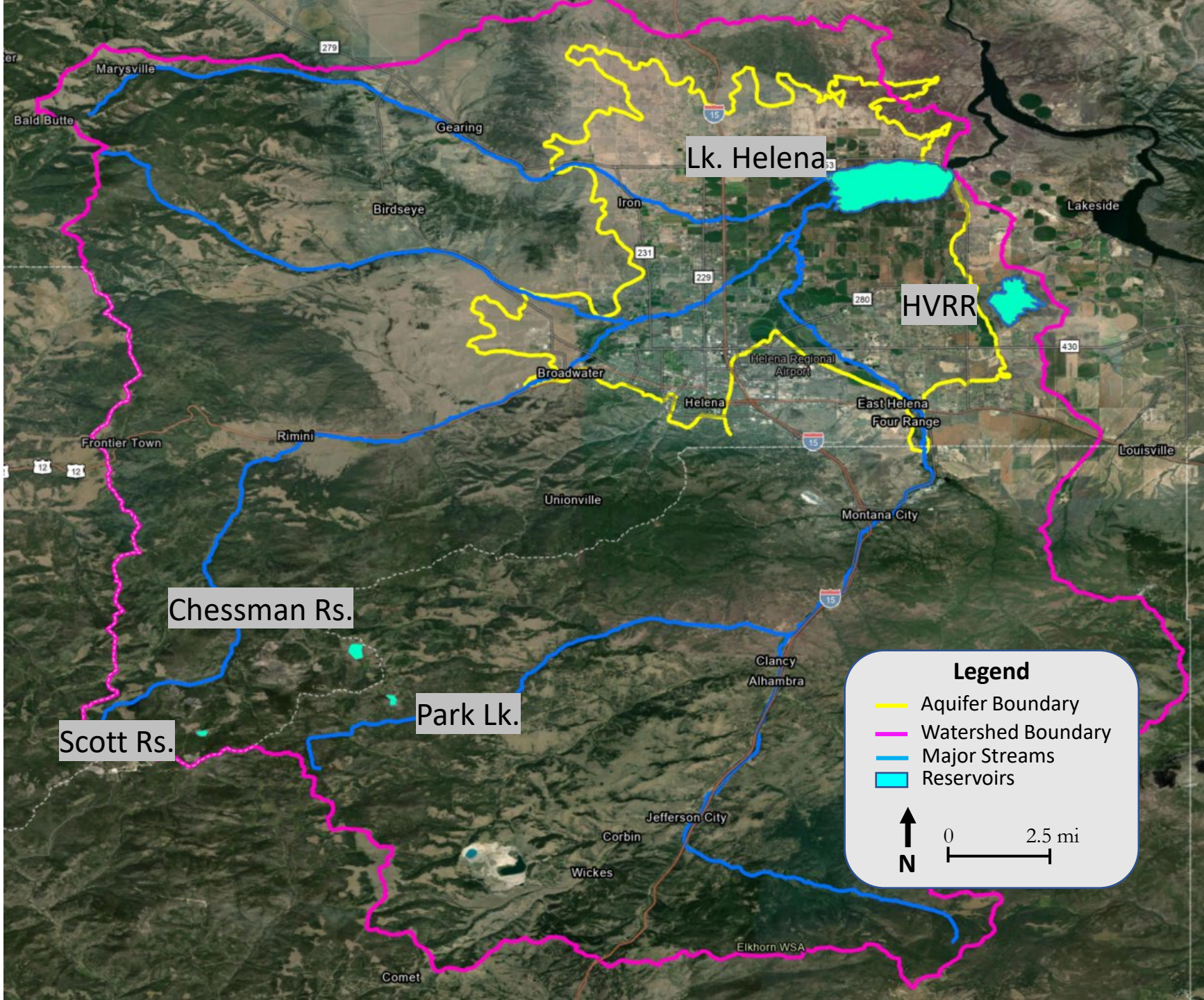


Surface Water Network

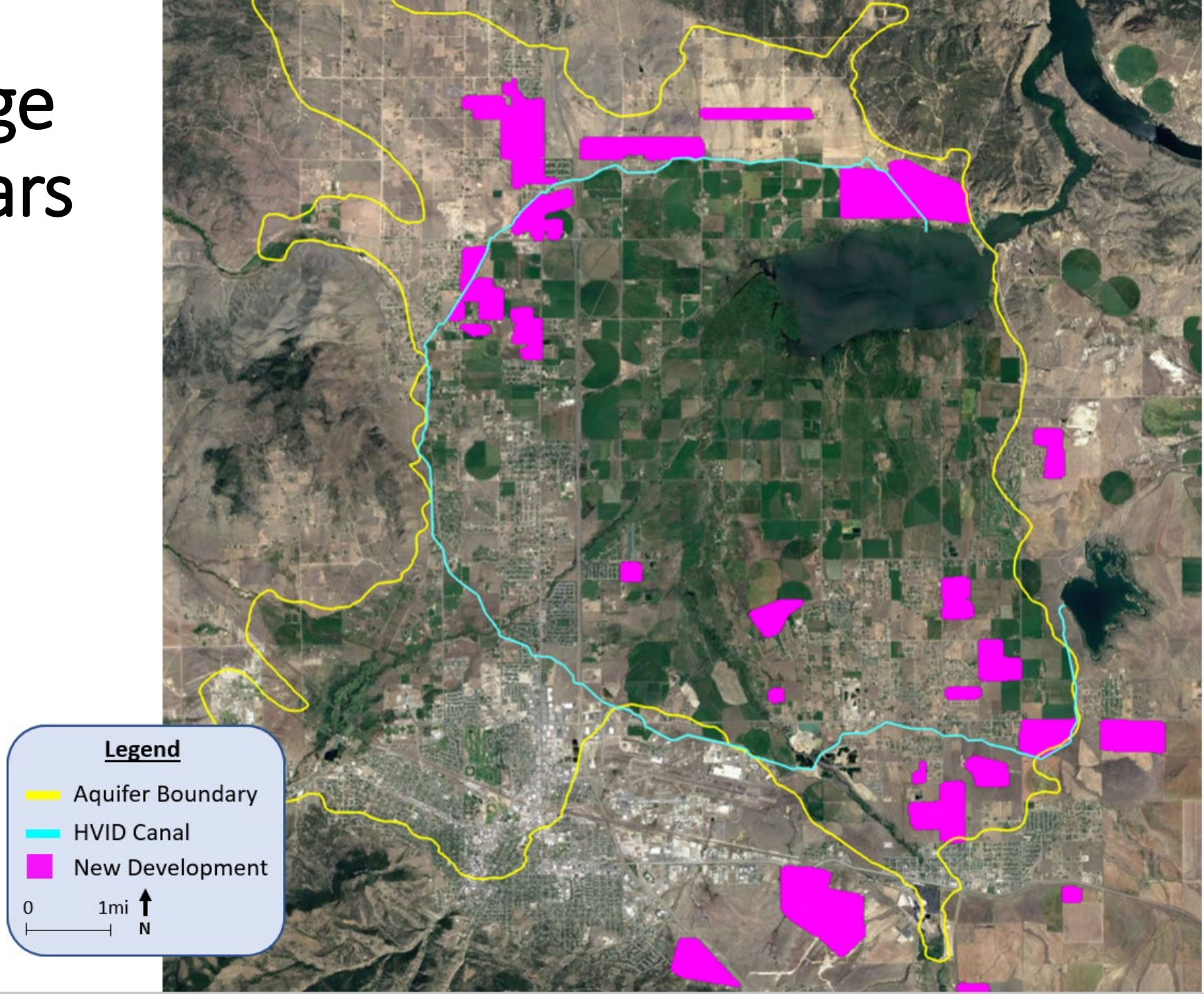


Contributing Watershed

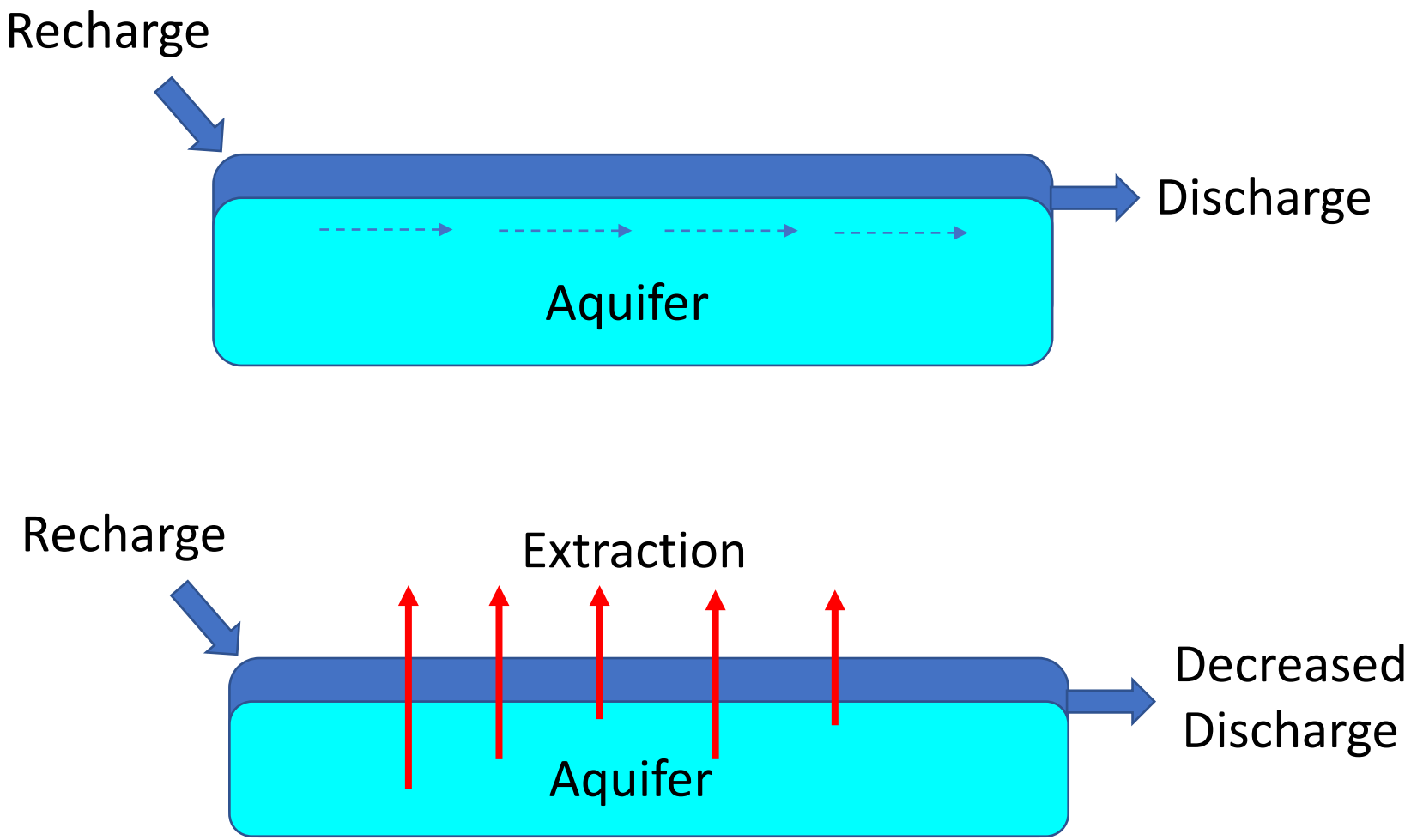
- 618 Square Miles
- 5 surface reservoirs over 20 acres in size



Land Use Change Over Past 15 Years



Groundwater Budget



Helena Valley GW Budget

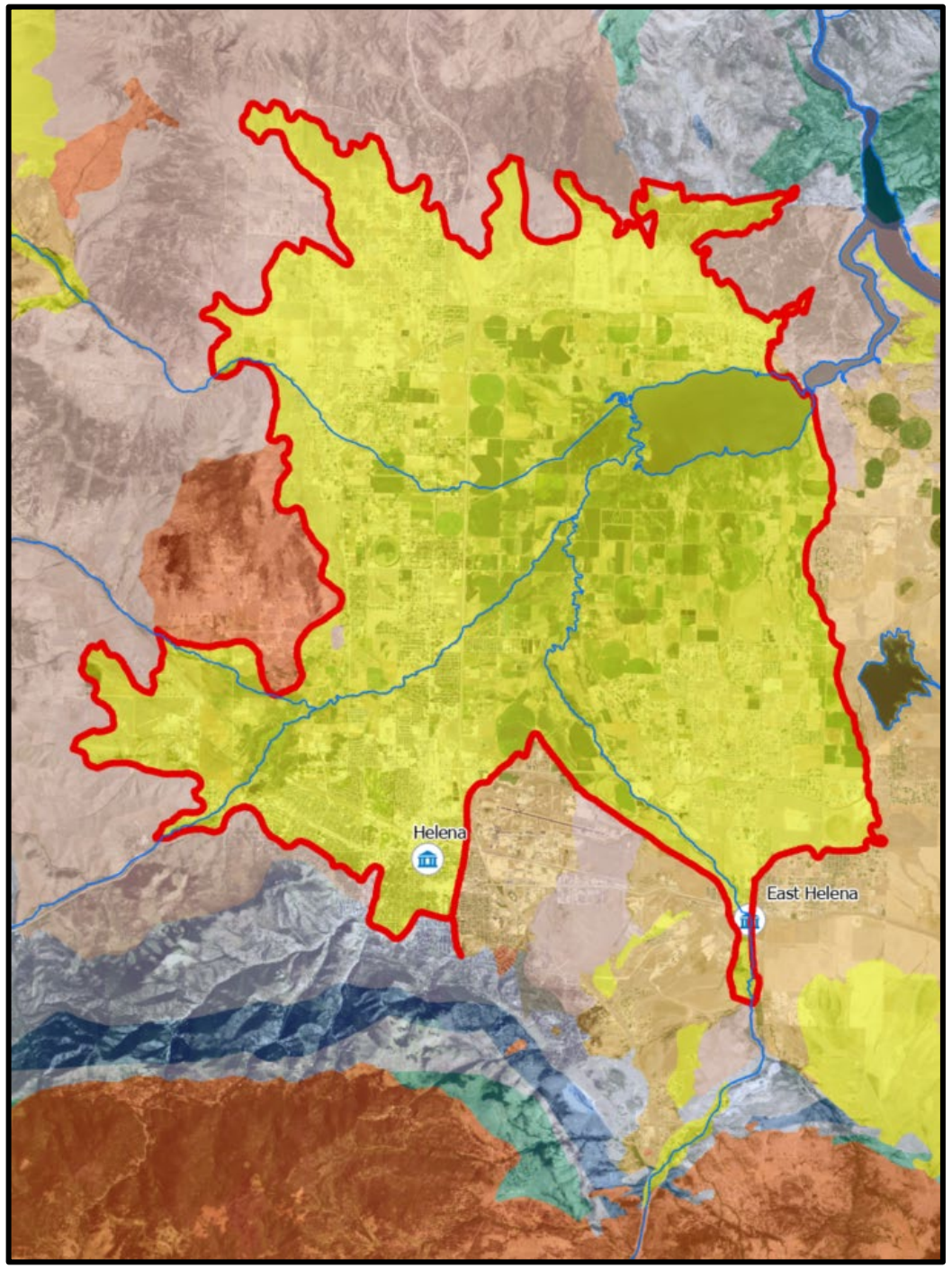
1993 USGS Study

Recharge

- Streams +15%
- Irrigation Canal Losses +8%
- Irrigation Infiltration +31%
- Inflow from Bedrock +46%

Discharge

- Springs, Streams, Drains -41%
- Lake Helena -57%
- Wells -2%

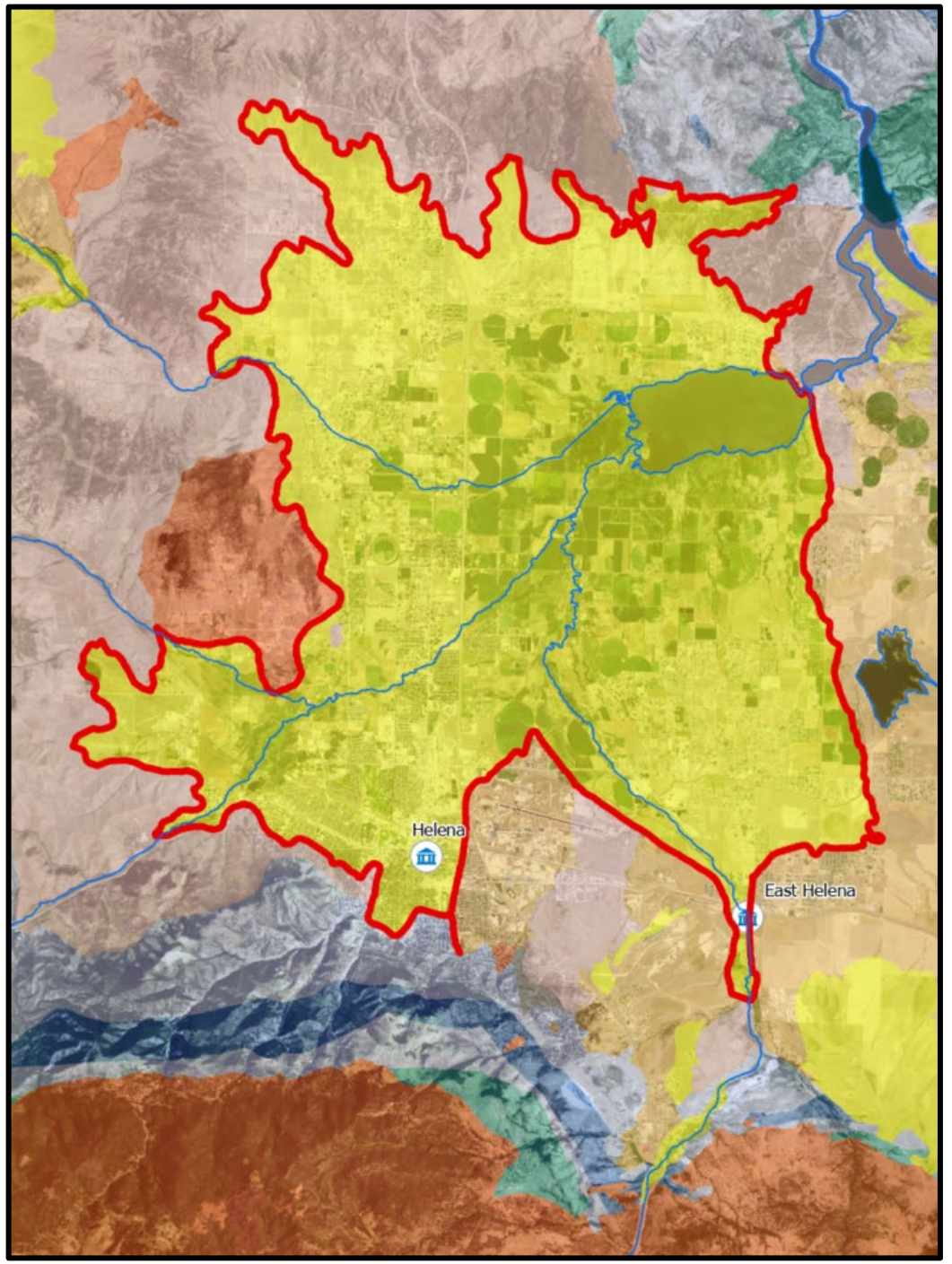


Helena Valley GW Budget

1993 USGS Study

Of the available 86,760 acre-feet per year, 2% is extracted for use. The remaining 98% discharges to the Missouri River System and is appropriated mainly for power generation.

Any new groundwater permit requires mitigation



Helena Valley Aquifer: Concerns and Challenges

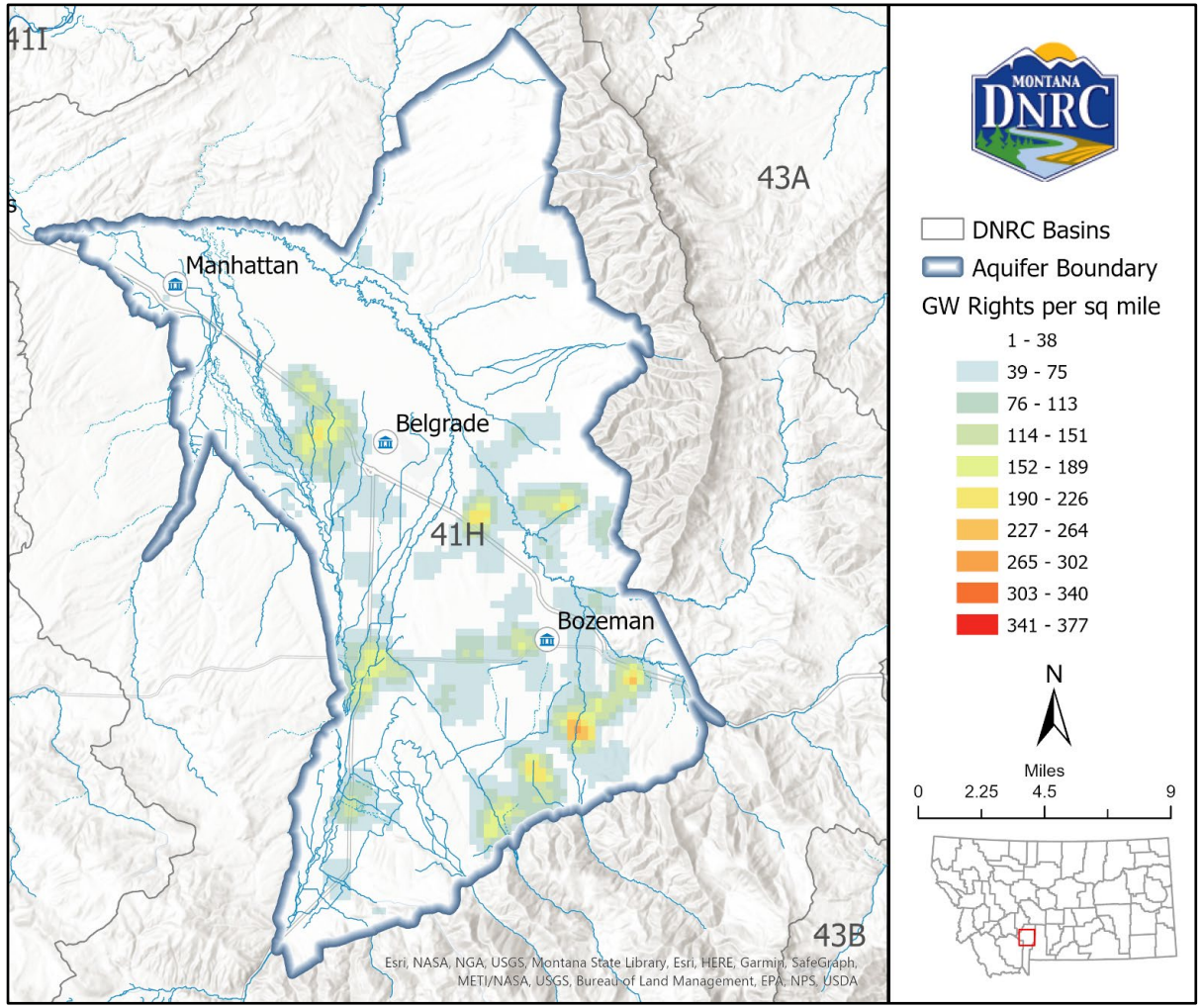
- Aquifer is fairly extensive with abundant recharge; However, any new GW permit requires mitigation
- Much of the recent population growth is located near perimeter of the aquifer, where the aquifer is the thinnest and most vulnerable
- USGS identified ditch loss and irrigation return as major contributors to recharge (39%), Land use changes will reduce this contribution of recharge
- High density of septic systems may cause local water quality issues

Helena Valley Aquifer: Opportunities

- Future studies are needed to better identify water use and availability
- Groundwater modeling can help predict impacts from changes in climate, changes in land use, changes to individual water rights, and viability of mitigation bank schemes
- Helena has yet to perfect 6,950 acre-feet of groundwater reservation
  - Expanding municipal services can tie into high growth areas
- Any additional groundwater use necessitates mitigation in this basin. Increasing surface water or groundwater storage that can be used for mitigation can help facilitate additional groundwater development

Bozeman/Gallatin Valley

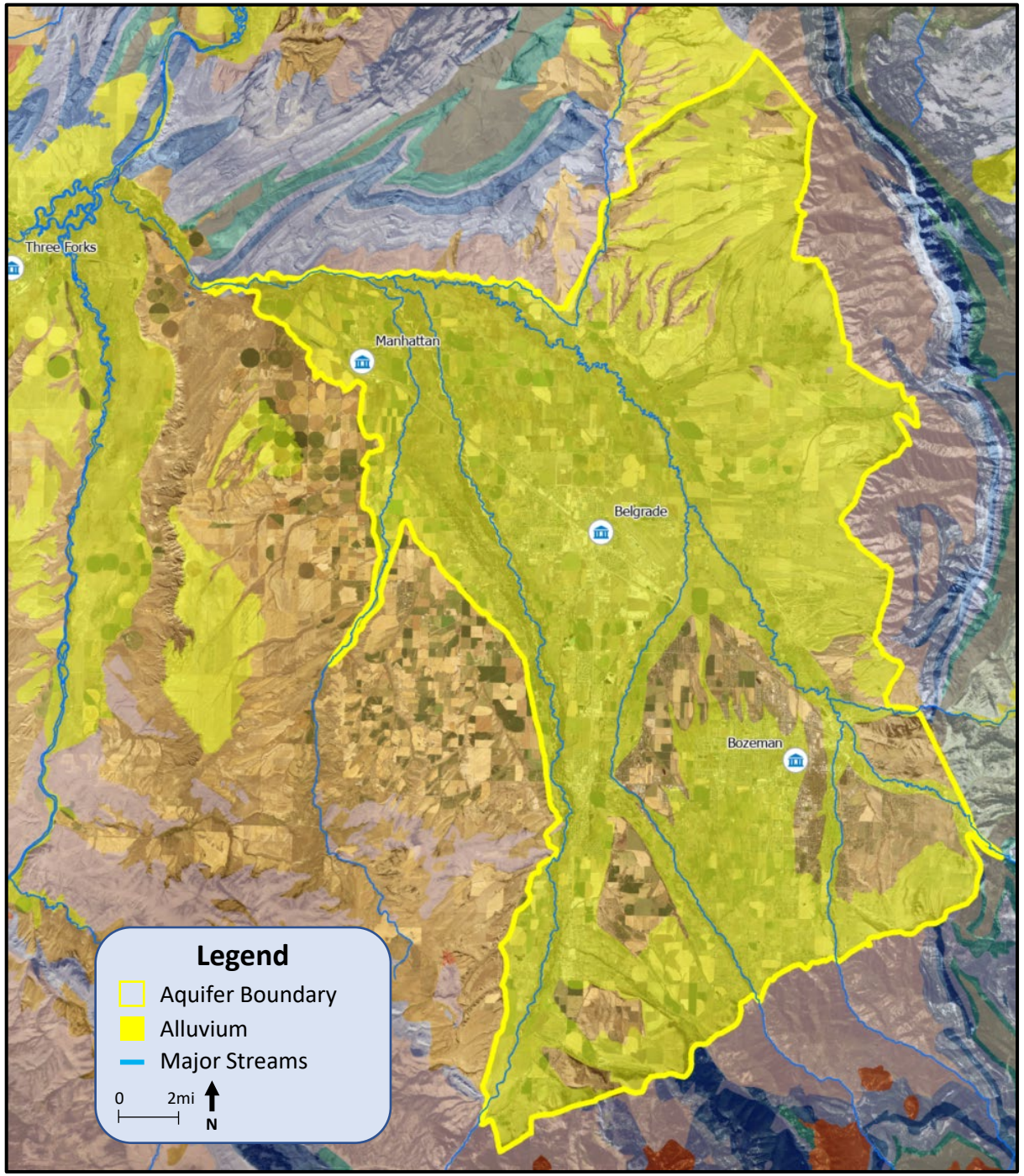
- Population: 124,857[1]
- Change from 2010: +39%
- Population Overlying the Aquifer: 113,608[2]
- Land Area: 352 sq. mi.
- Number of Permits: 192
- (2% of groundwater rights within aquifer boundary)
- Number of Exempt Wells: 8,498
- (82% of groundwater rights within aquifer boundary)



1. County total, estimate from July 1, 2022 (US Census Bureau, 2023)
2. Population calculated in GIS using 2020 Census Tracts that intersect aquifer boundaries. Selected census tracts extended beyond the boundaries of the aquifer and are presented for comparison only.

Hydrogeology

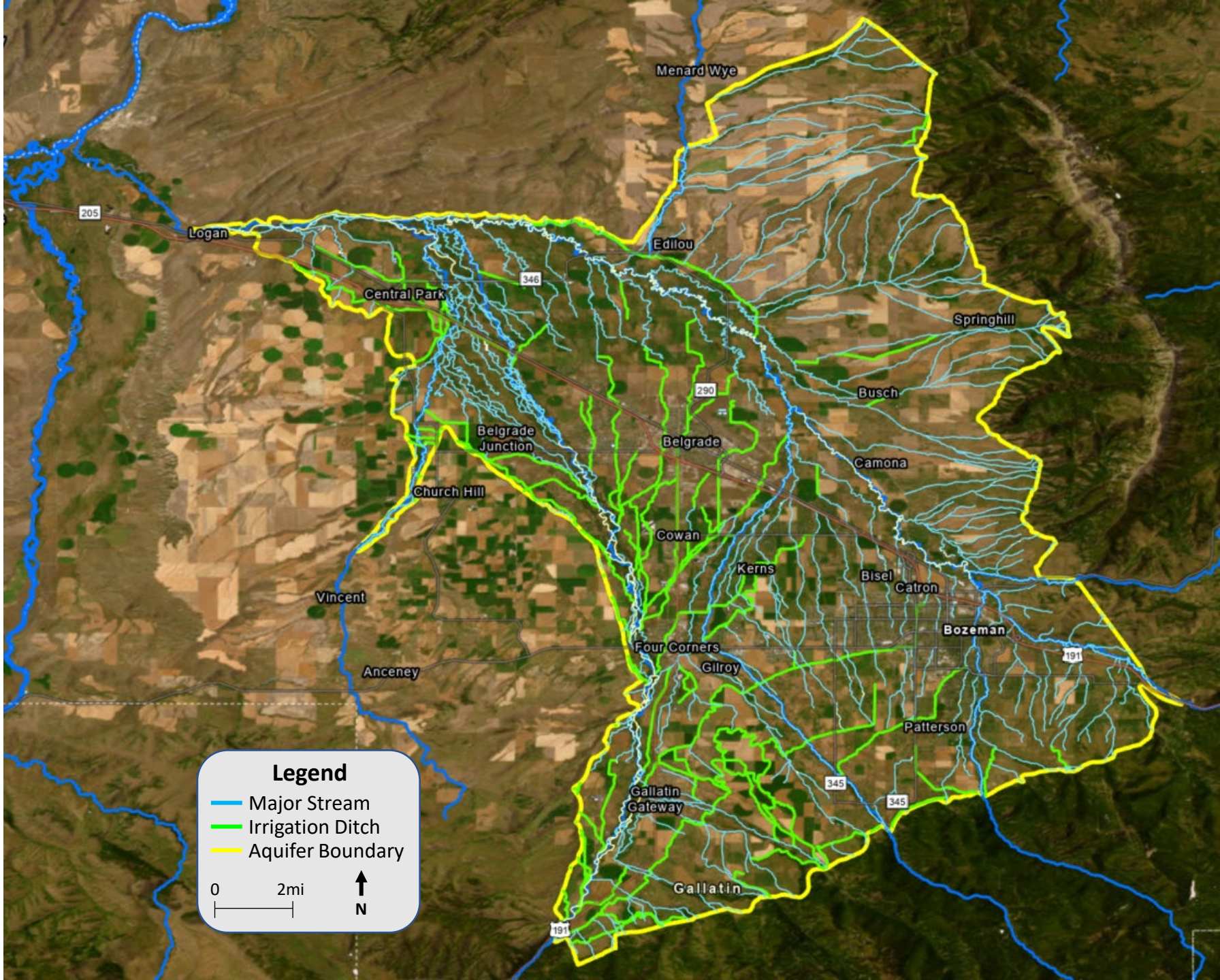
- Large regional Aquifer with unconfined, confined and perched conditions
- Localized conditions, yet aquifer acts as one system
- Typical well depths ~20-120 feet deep, yet basin fill is up to 4,000 feet deep
- Well yields of 50-100 gpm are common



Surface Water Network

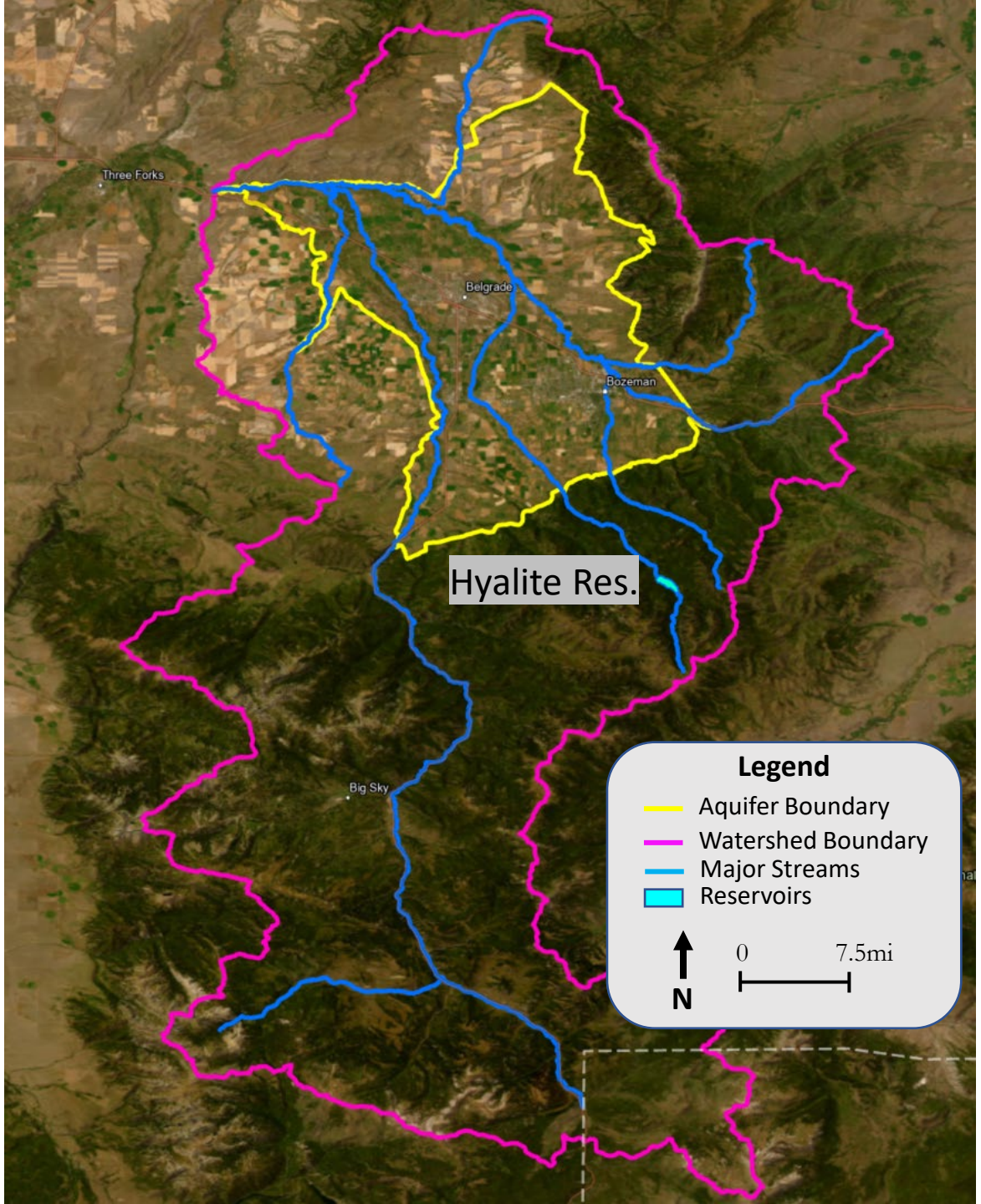
Aquifer Recharge Occurs Primary from Ditch Loss and also from natural surface water losses

Discharge generally returns to the Gallatin River.

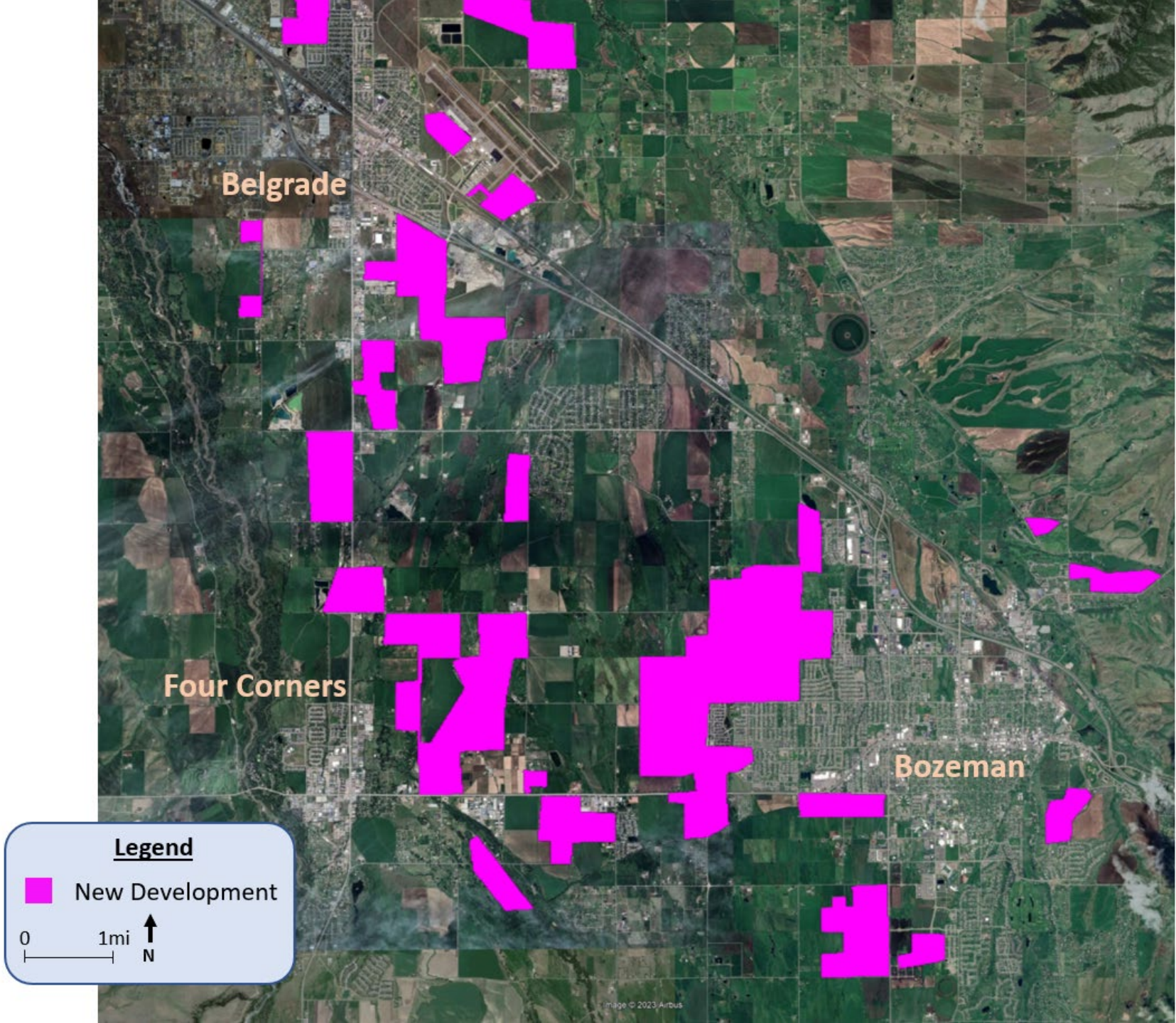


Contributing Watershed

- 1,787 Square Miles
- 1 surface reservoirs over 20 acres in size



Land Use Change Over Past 15 Years



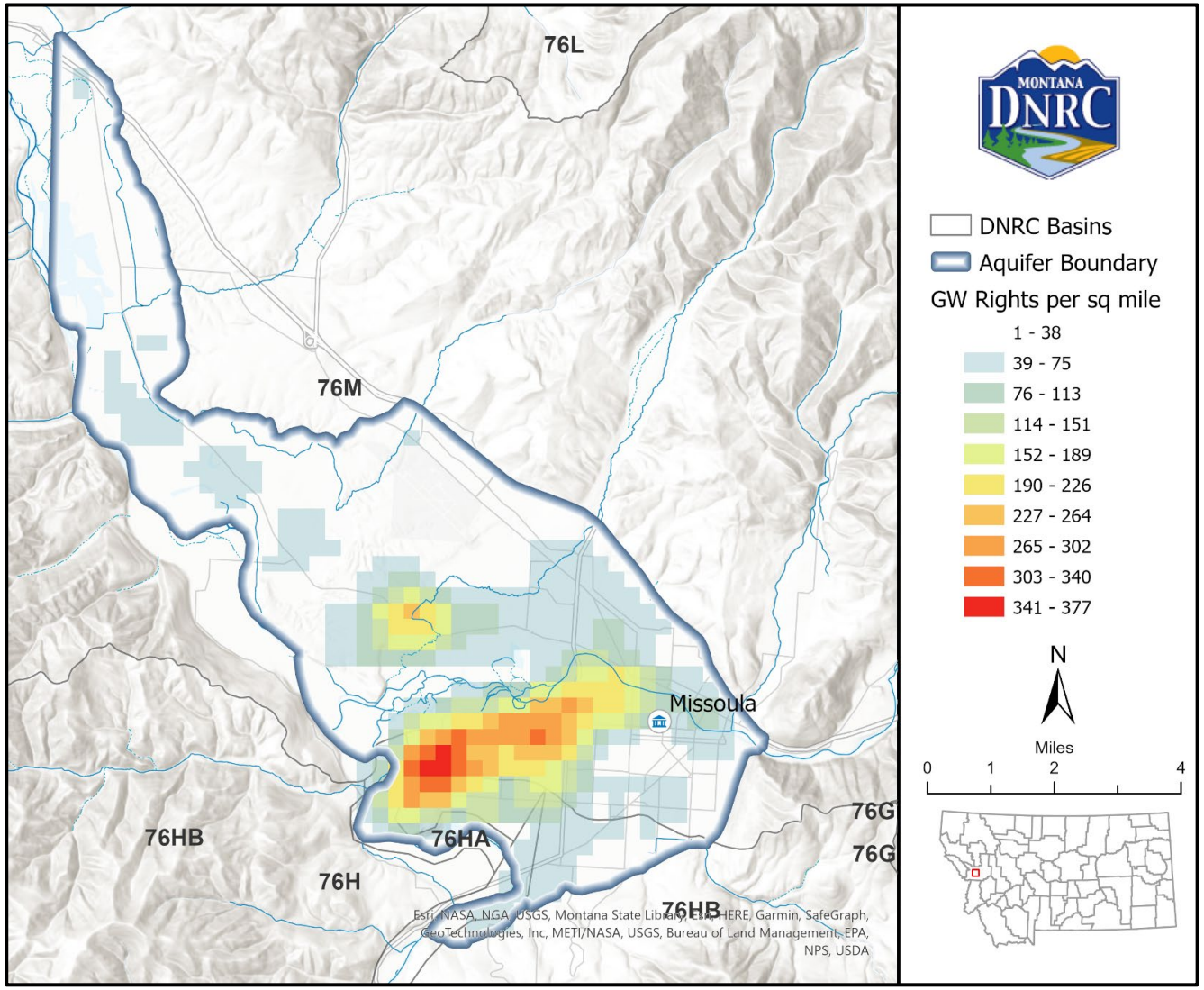
Gallatin Valley Aquifer: Concerns and Challenges

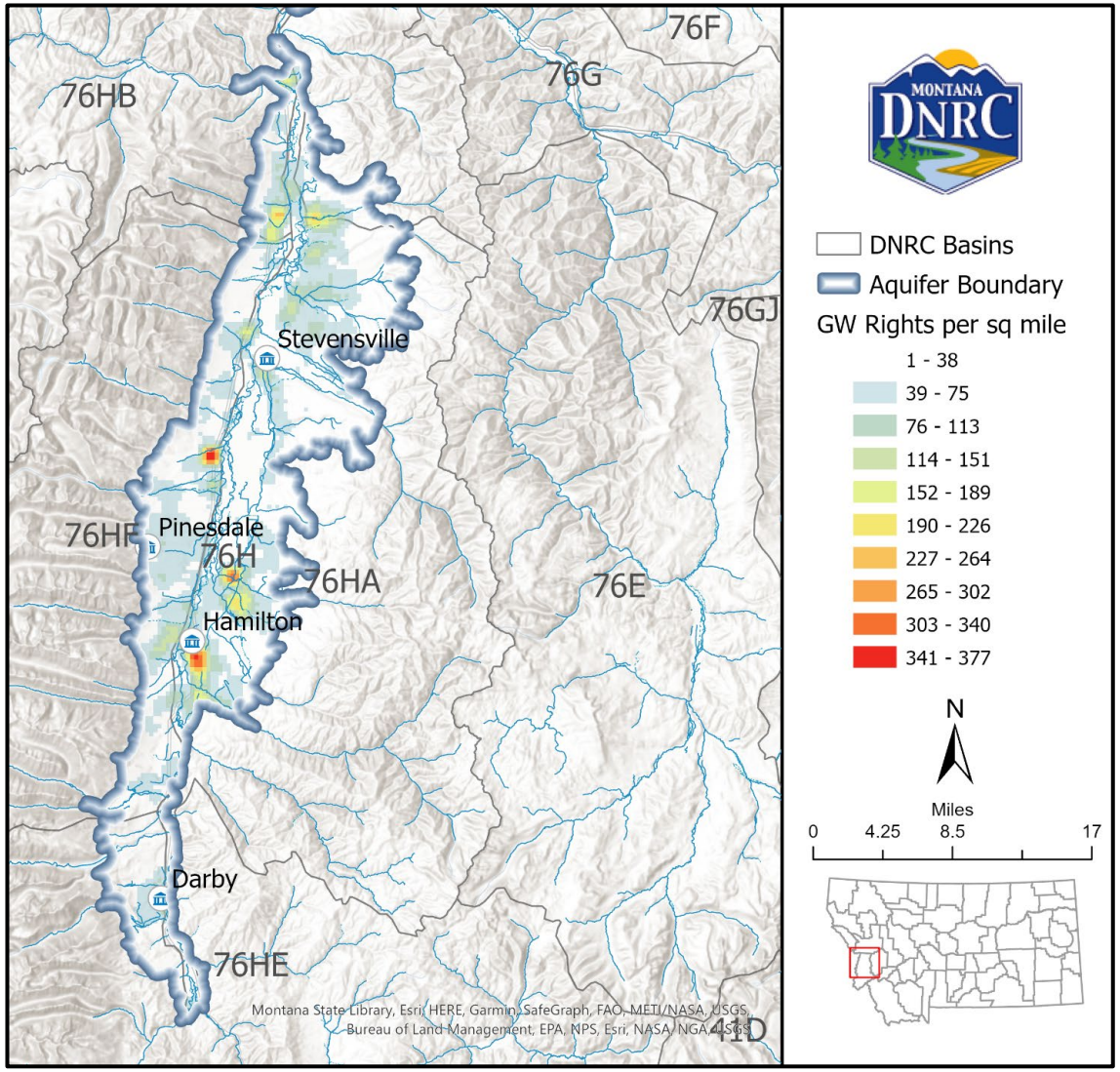
- Aquifer is fairly extensive; however, locally variable and complex
- 2020 MBMG study identified irrigation returns as a major component of recharge
- Modeling suggests aquifer is much more responsive to changes in ditch management vs groundwater pumping
- Closed Basin – any new GW permit requires mitigation

Gallatin Valley Aquifer: Opportunities

- Recent studies helped identify areas with potential for high yield wells
- Several strong local community efforts are working to address growth challenges
- Groundwater modeling can help predict impacts from changes in climate, changes in land use, changes to individual water rights, and viability of mitigation bank schemes
- Any additional groundwater use necessitates mitigation in this basin. Increasing surface water or groundwater storage that can be used for mitigation can help facilitate additional groundwater development

Missoula and Bitterroot Valley





Missoula

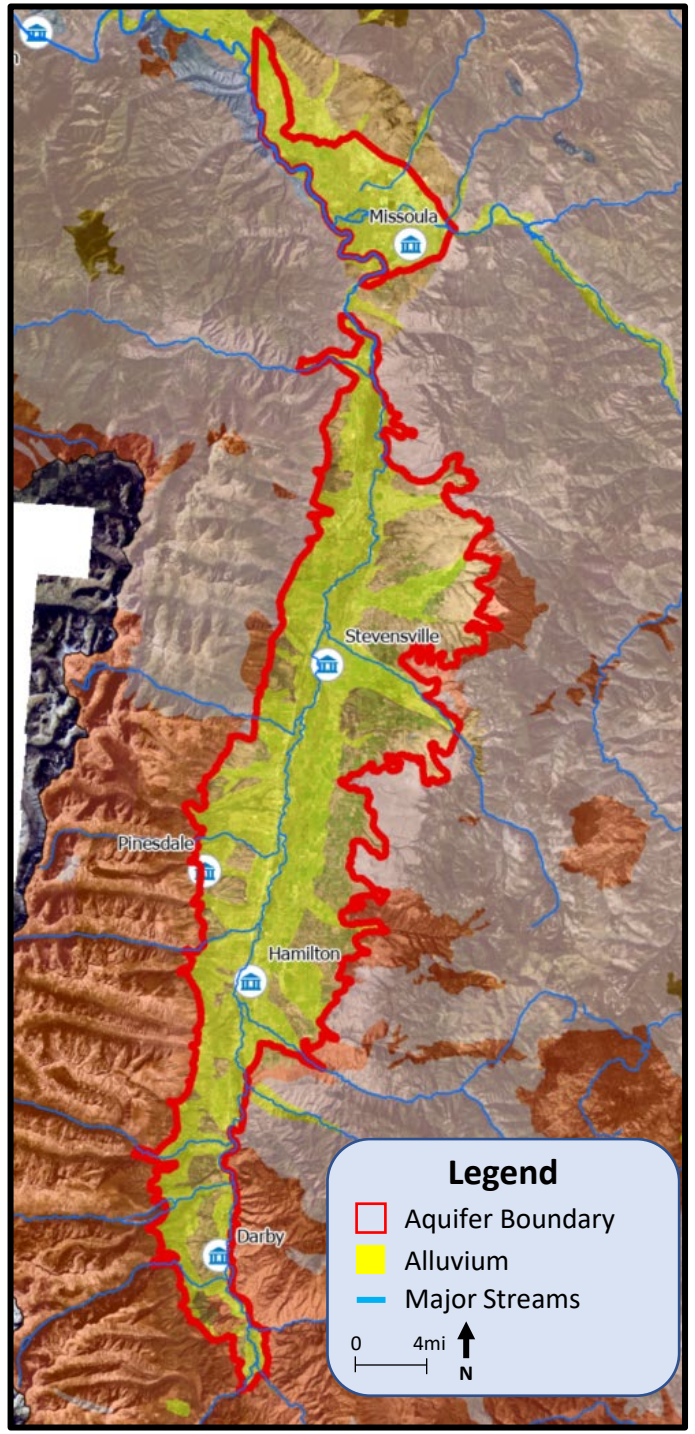
- Population: 121,041[1]
- Change from 2010: +11%
- Population Overlying the Aquifer: 99,158[2]
- Land Area: 51 sq. mi.
- Number of Permits: 133
- (4% of groundwater rights within aquifer boundary)
- Number of Exempt Wells: 2,312
- (74% of groundwater rights within aquifer boundary)

Bitterroot

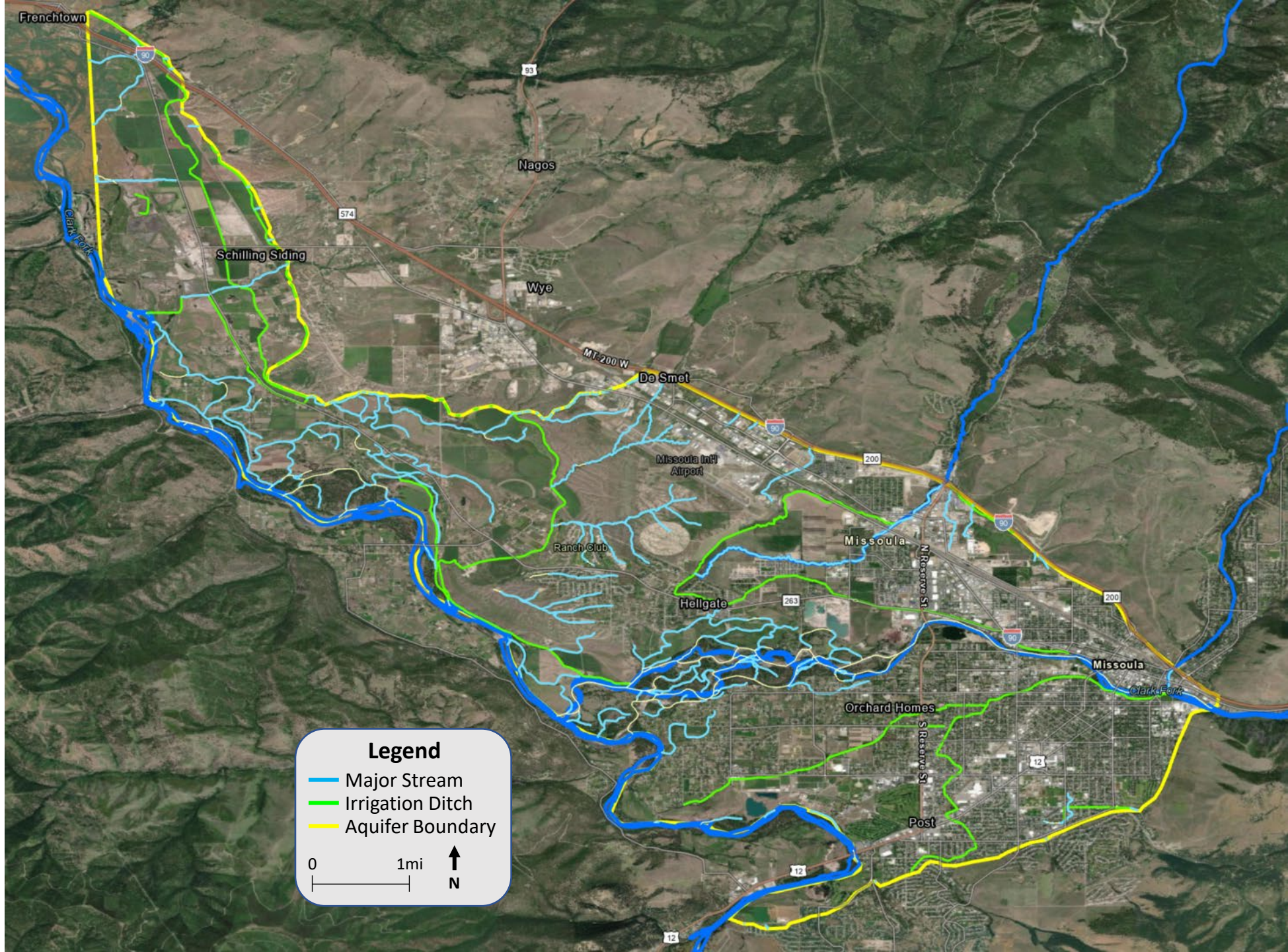
- Population: 47,298[1] (Ravalli Co.)
- Change from 2010: +18%
- Population Overlying the Aquifer: 62,202[2]
- Land Area: 391 sq. mi.
- Number of Permits: 176
- (1% of groundwater rights within aquifer boundary)
- Number of Exempt Wells: 13,434
- (89% of groundwater rights within aquifer boundary)

Hydrogeology

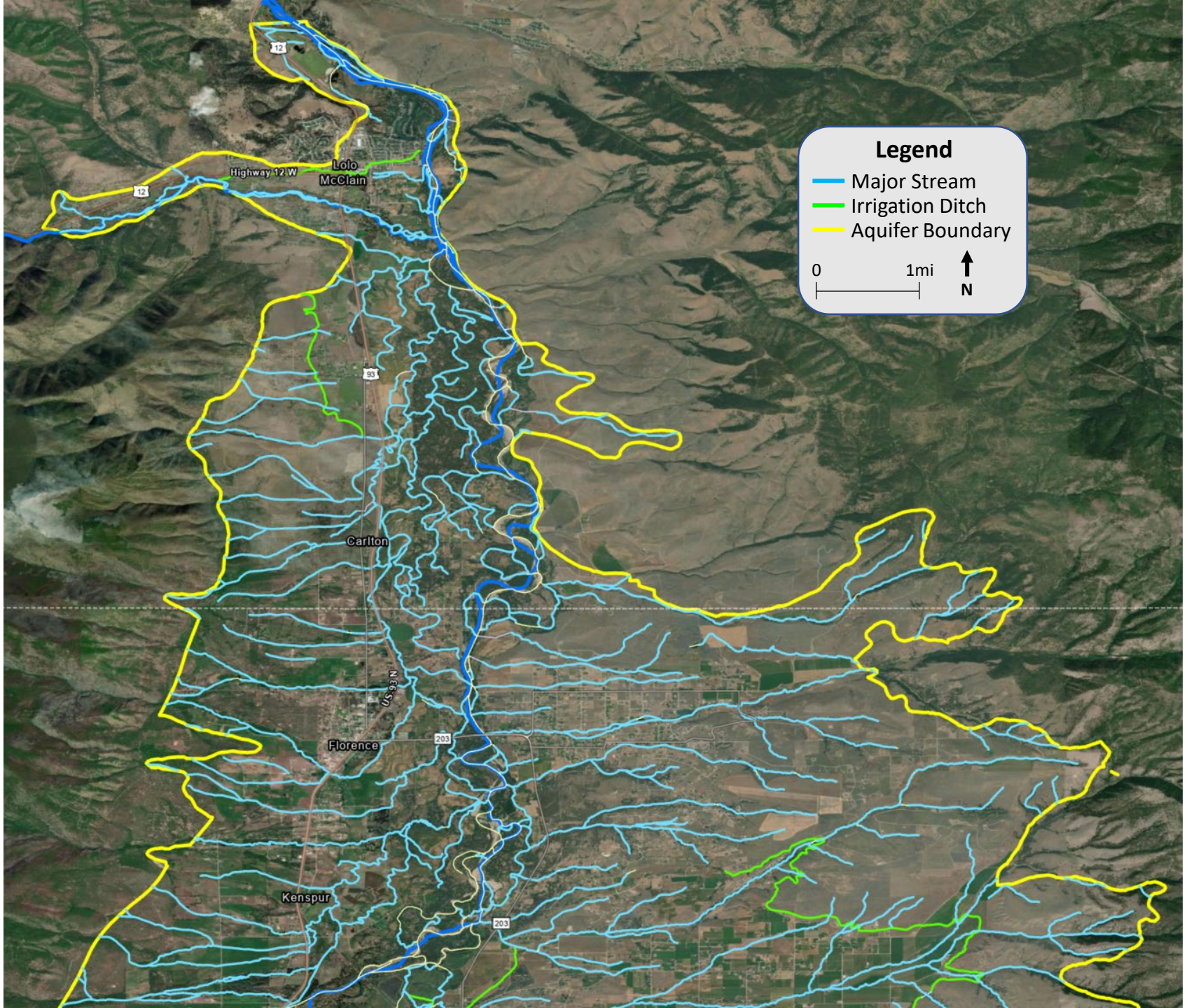
- Multiple aquifer system – Bedrock, Deep Alluvial, Shallow Alluvial
- Typical wells are less than 100 ft deep
- Well yields generally meet the needs of the use and can be over 1,000 gpm
- Primary recharge is from natural surface water loss and also from irrigation ditch loss



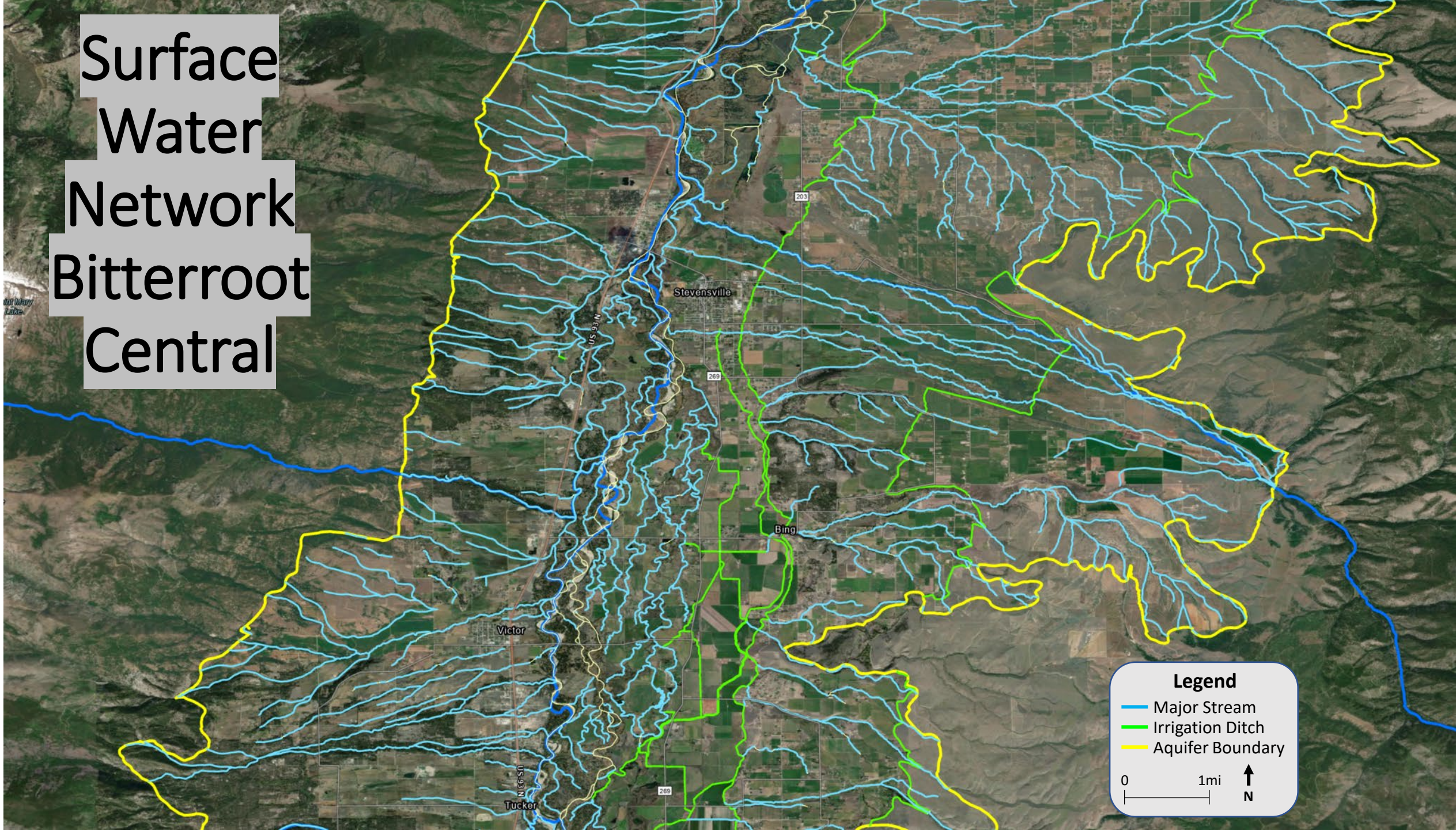
Surface Water Network Missoula



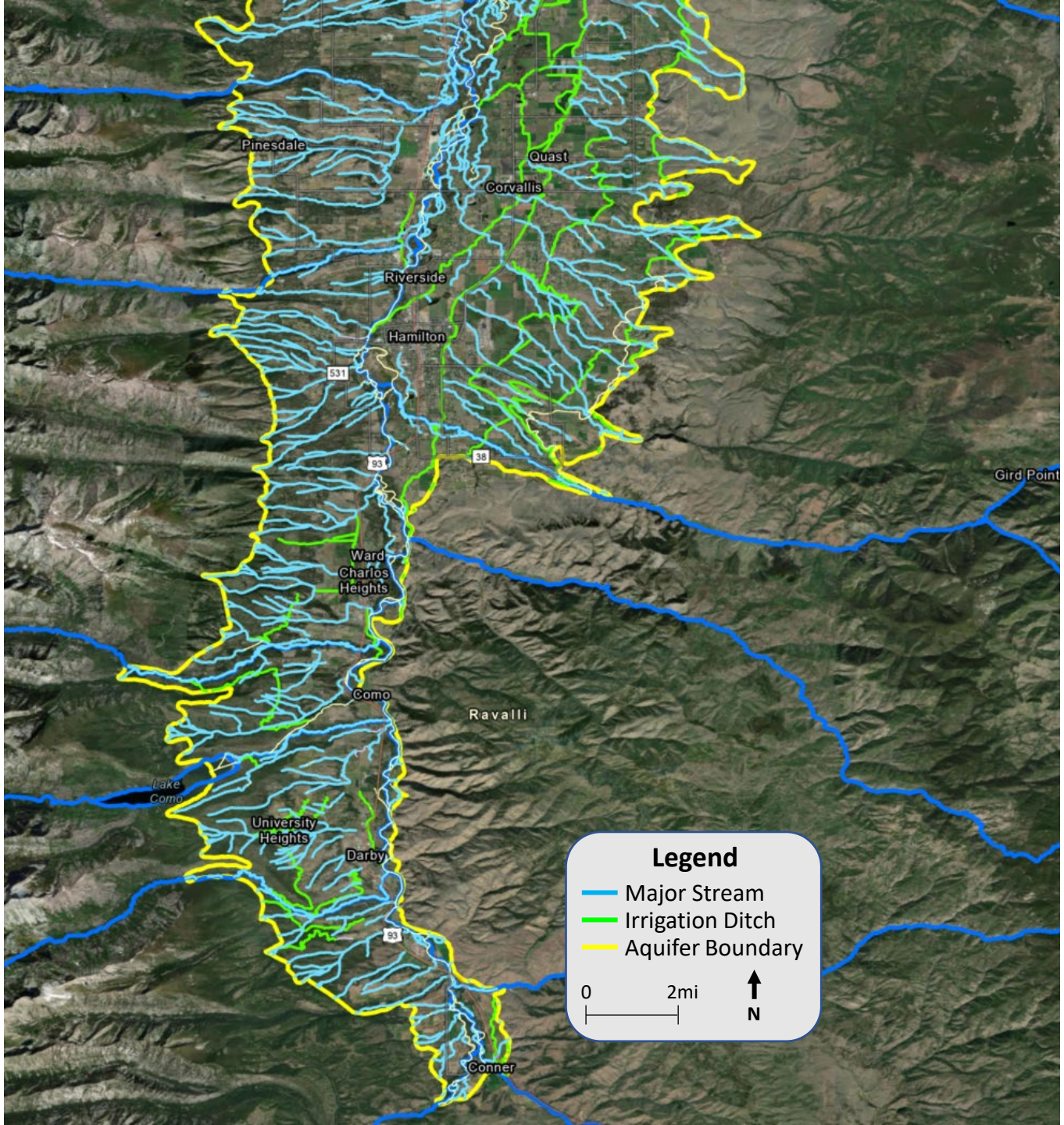
Surface Water Network Bitterroot North



Surface Water Network Bitterroot Central

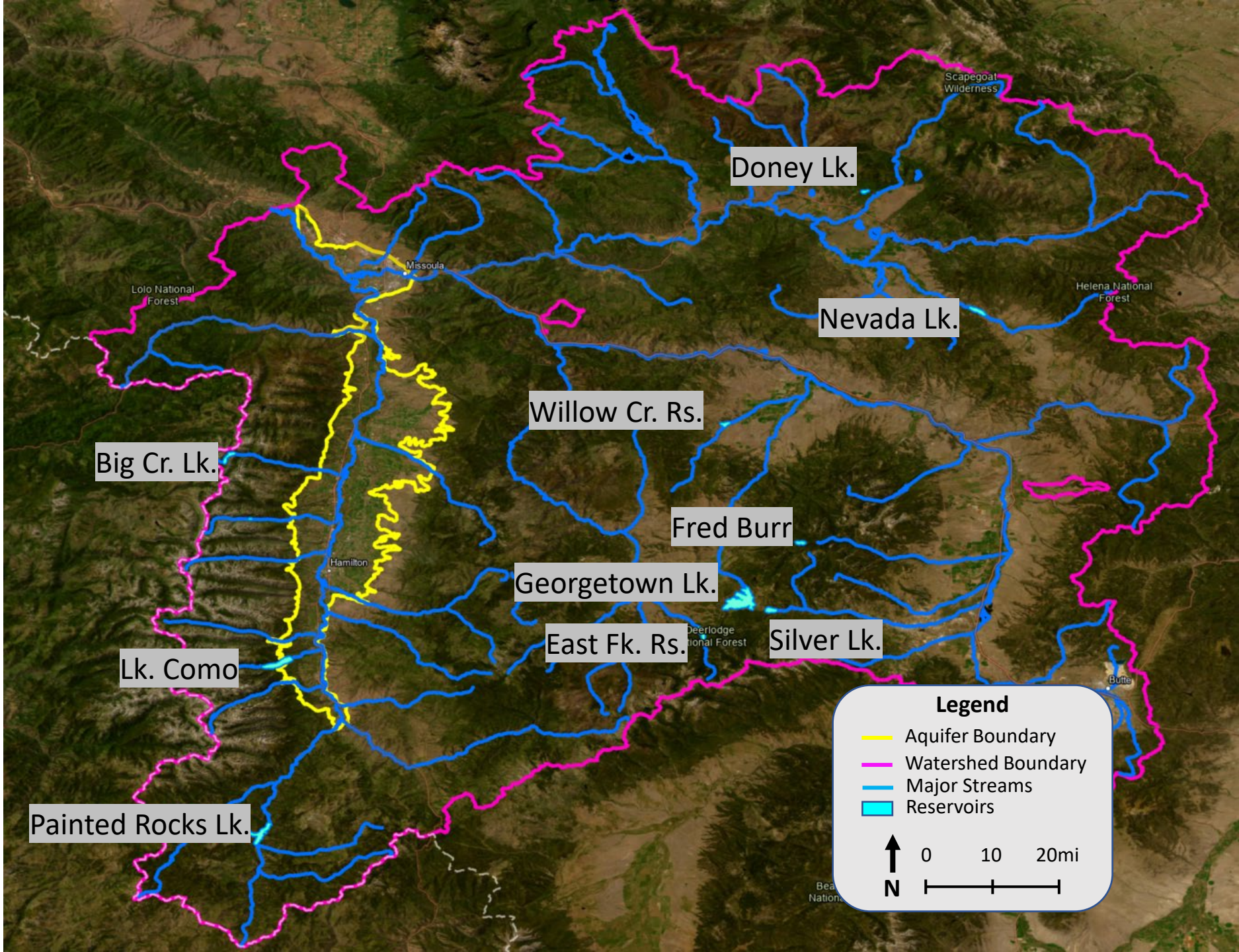


Surface Water Network Bitterroot South

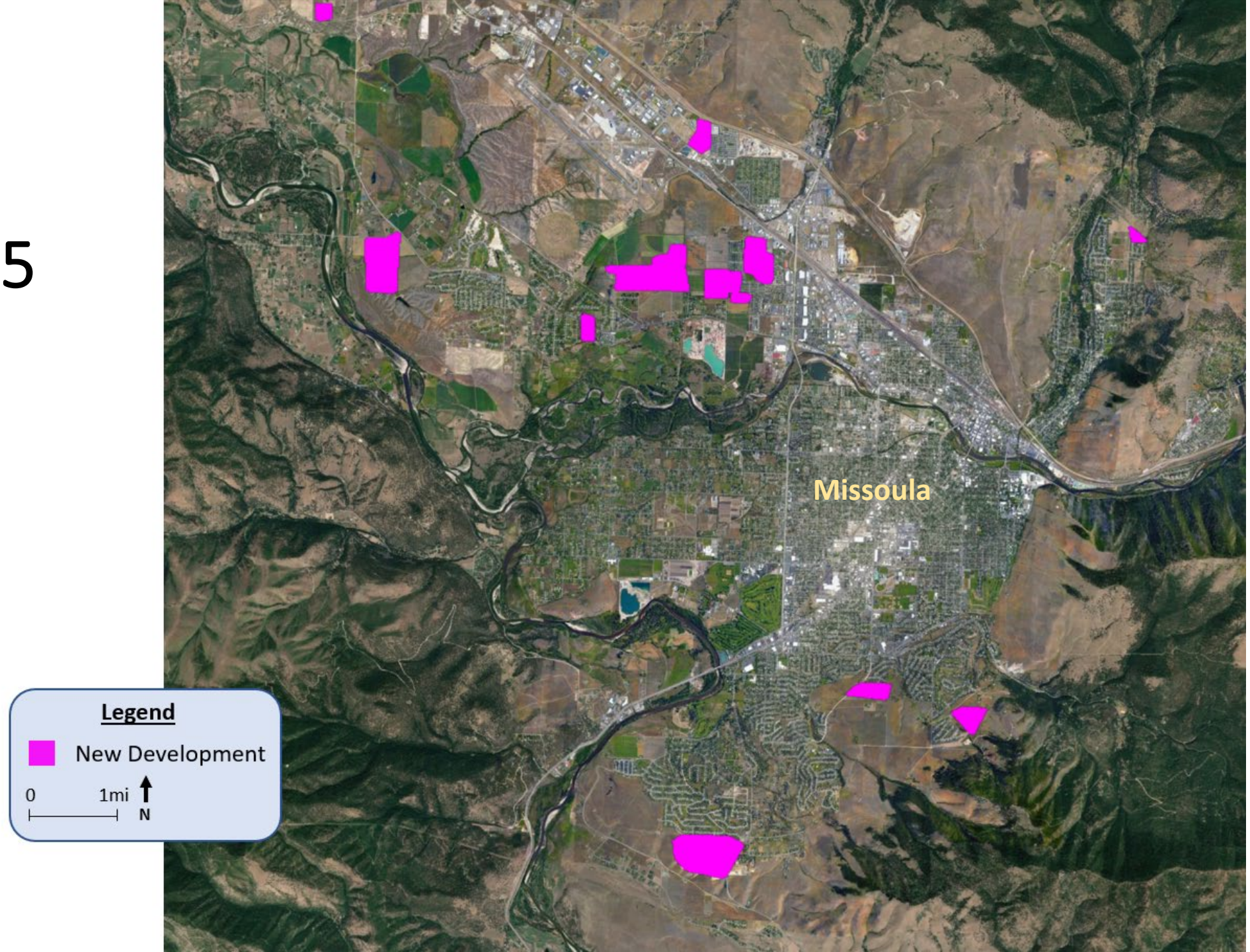


Contributing Watershed

- 9,195 Square Miles
- 10 surface reservoirs over 20 acres in size



Land Use Change Over Past 15 Years



Missoula/Bitterroot Aquifer: Concerns and Challenges

- Some well users likely depend on recharge from ditch loss
- Some Municipalities do not have the water needed to accommodate projected growth (Hamilton by 2044)
- Aquifer is very productive; however, permitting is complicated with proximity to Bitterroot River
- Any depletion to Bitterroot River must be mitigated for a new permit

Missoula/Bitterroot Aquifer: Opportunities

- Future studies will continue to better describe the connection between aquifer layers and the land surface and will better quantify water use and availability
- Groundwater modeling can help predict impacts from changes in climate, changes in land use, changes to individual water rights
- Use of groundwater connected to the Bitterroot River necessitates mitigation. Increasing surface water or groundwater storage that can be used for mitigation can help facilitate additional groundwater development

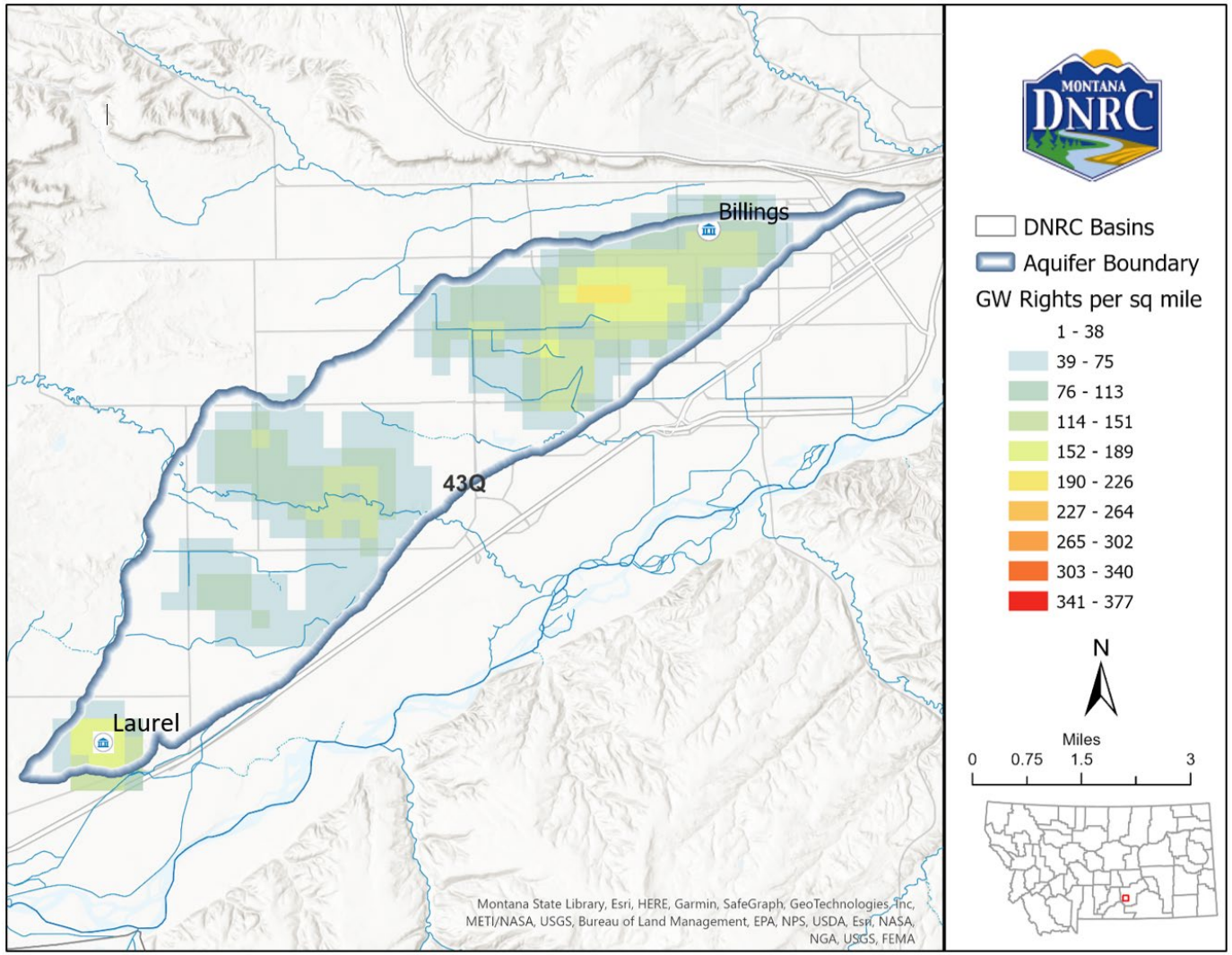
Billings Aquifer

Population: 169,852[1]
Change from 2010: +15%
Population Overlying the Aquifer: 76,872[2]

Land Area: 27 sq. mi.

Number of Permits: 27
(1% of groundwater rights within aquifer boundary)

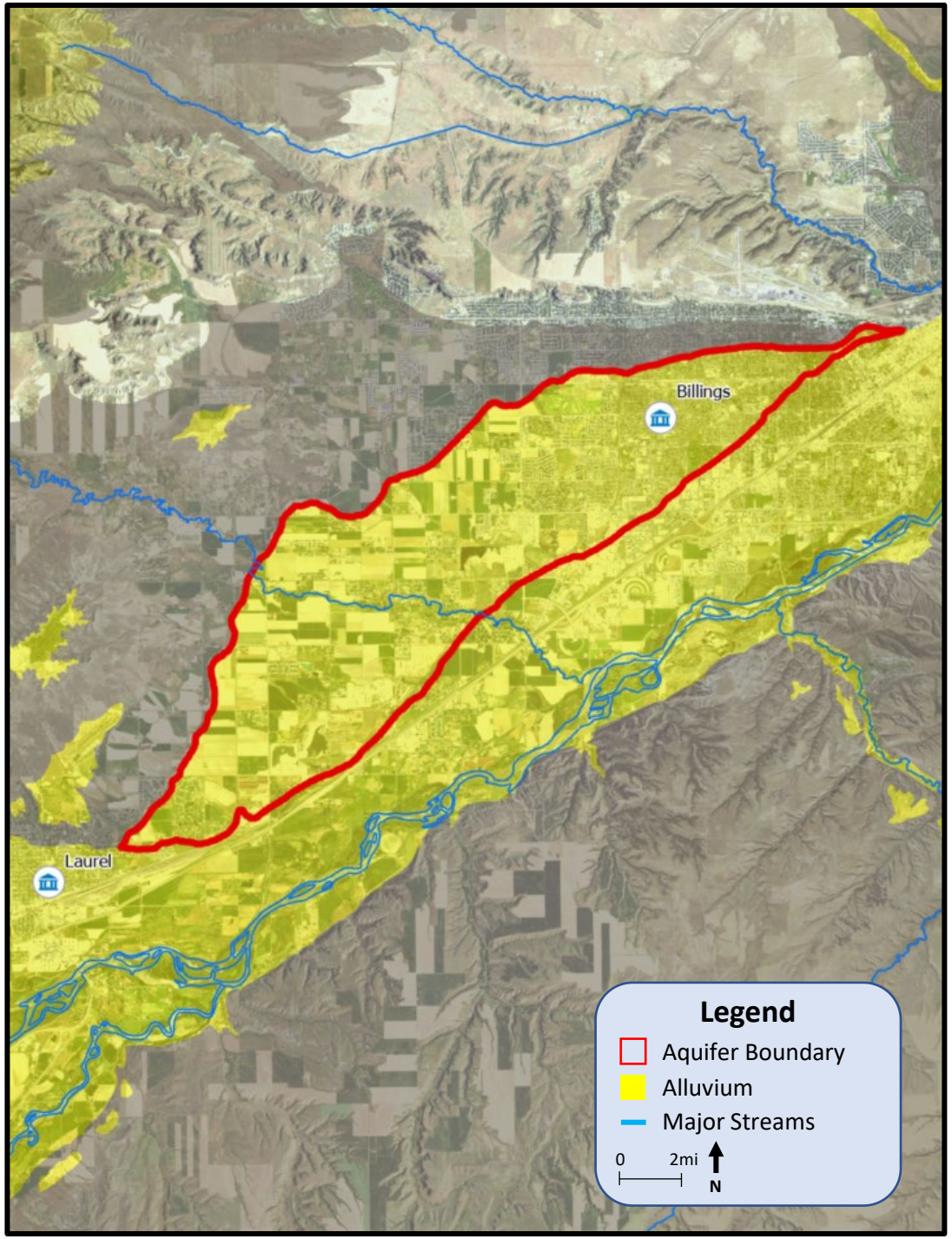
Number of Exempt Wells: 1,767
(94% of groundwater rights within aquifer boundary)



1. County total, estimate from July 1, 2022 (US Census Bureau, 2023)
2. Population calculated in GIS using 2020 Census Tracts that intersect aquifer boundaries. Selected census tracts extended beyond the boundaries of the aquifer and are presented for comparison only.

Hydrogeology

- Unconsolidated sediments, on an ancestral terrace of the Yellowstone River
- Sediments are around 40-50 feet thick
- Water table is around 20-30 feet deep, leaving about 20-30 feet of aquifer thickness
- Typical well yields are between 10-50 gpm with minimal drawdown
- 2002 study identified that approximately 2/3 of the aquifer recharge comes from irrigation ditch loss, and 1/3 comes from precipitation

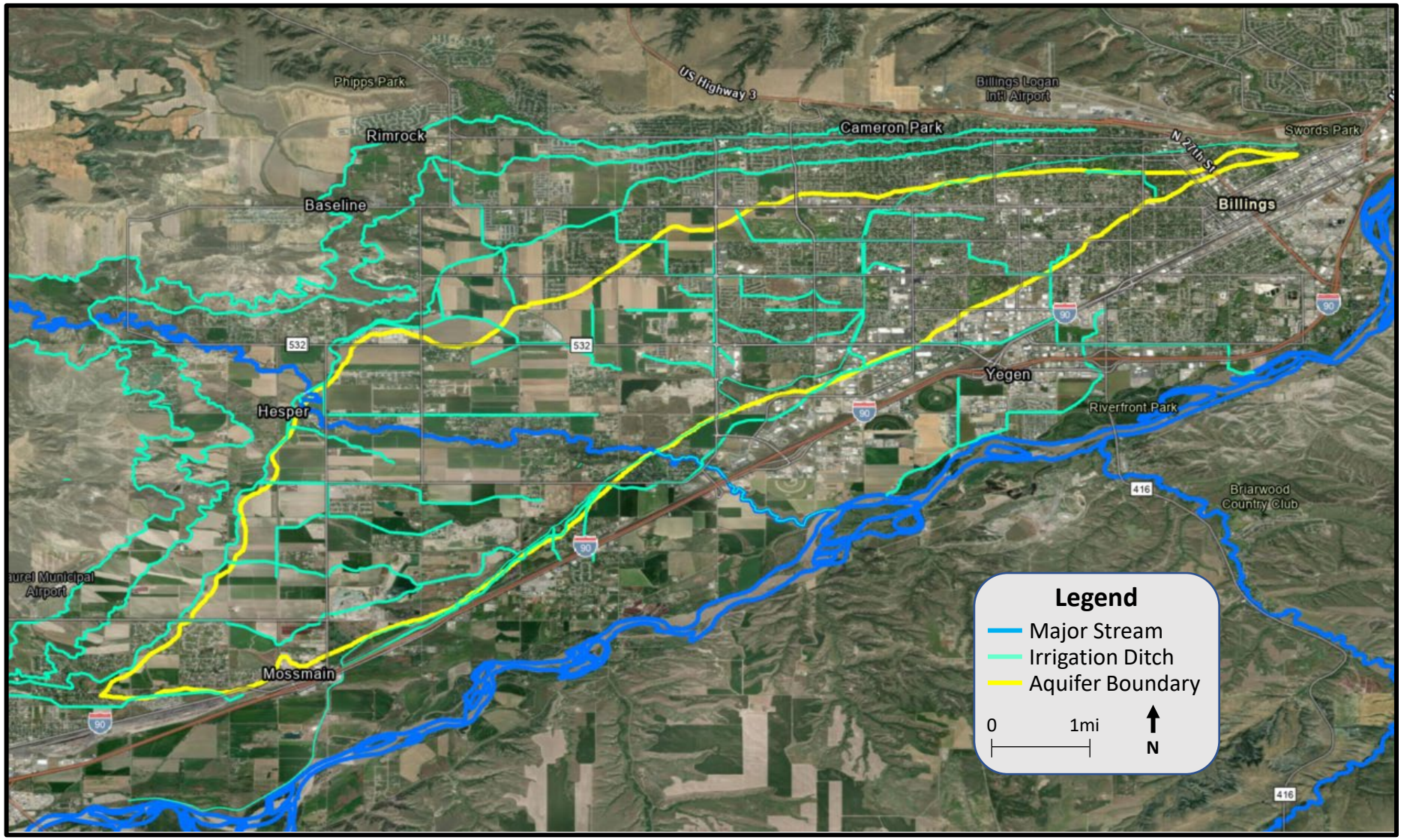


Surface Water Network

Aquifer Recharge Occurs Primary from Ditch Loss

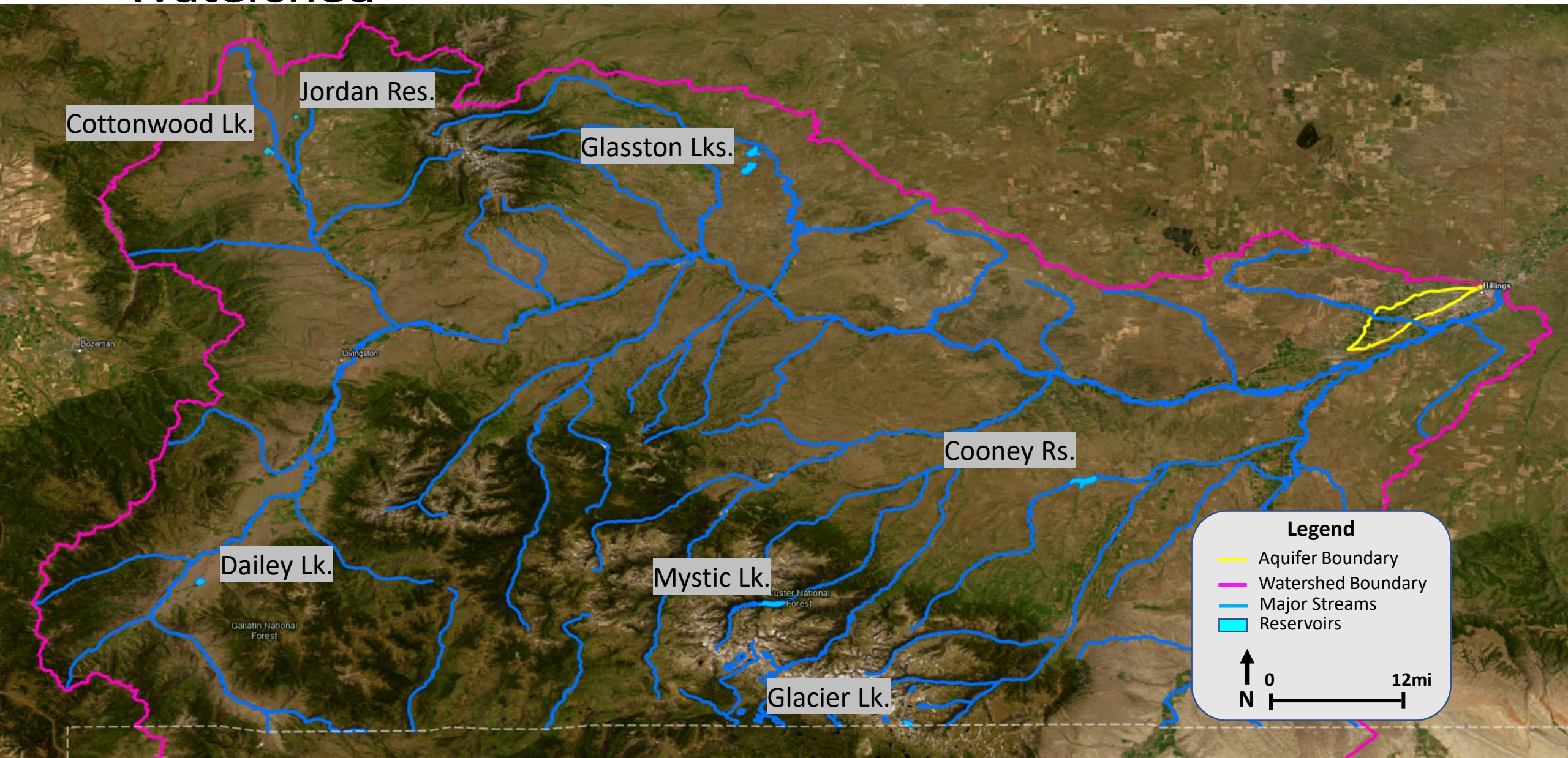
Movement is generally from Northwest to Southeast towards Yellowstone River

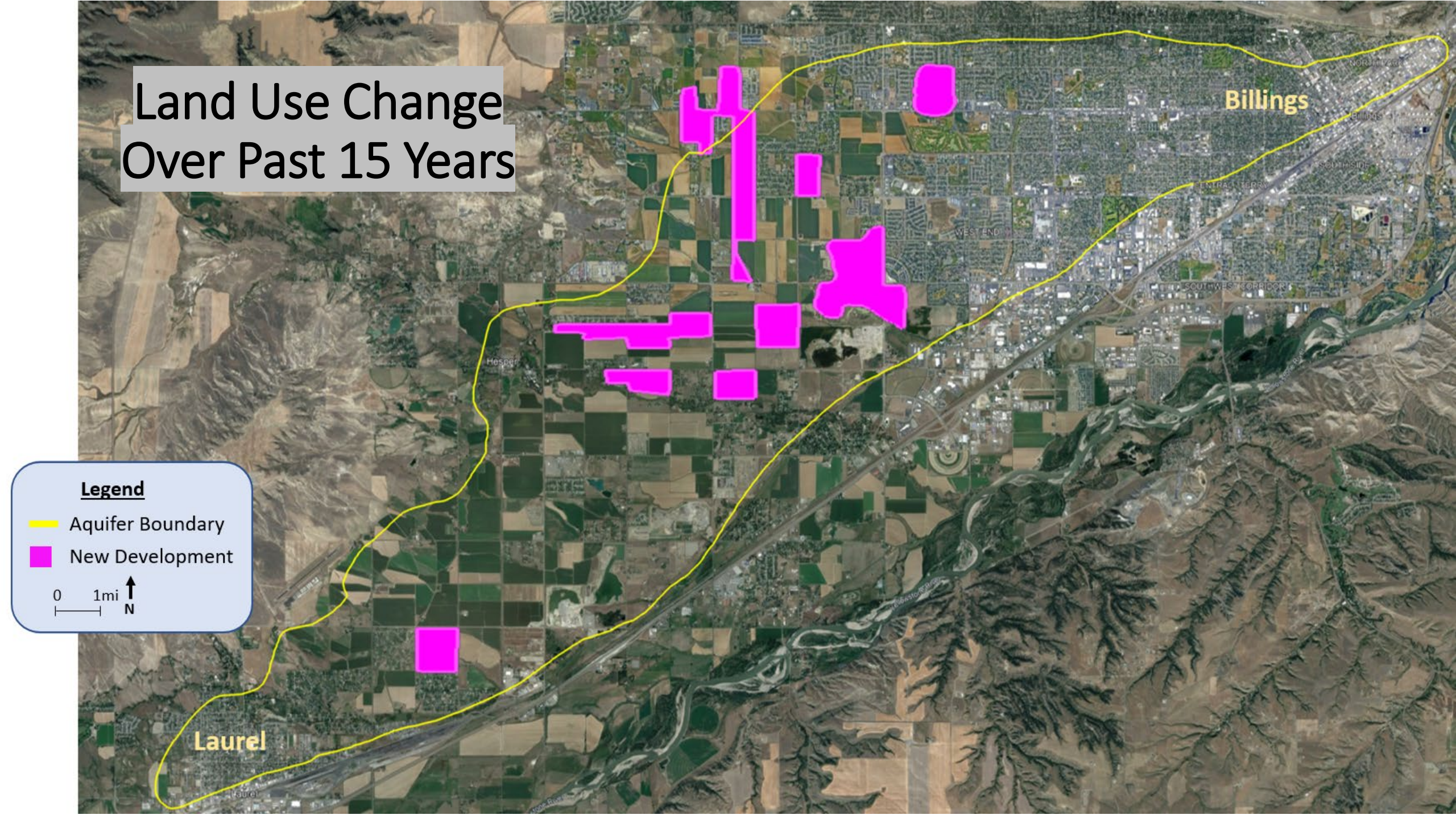
Discharge zone is generally the lower terrace aquifer and the Yellowstone River



Contributing Watershed

- 11,414 Square Miles
- 8 surface reservoirs over 20 acres in size




Land Use Change
Over Past 15 Years
Billings
Laurel
Legend
Aquifer Boundary
New Development
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Billings Aquifer: Concerns and Challenges

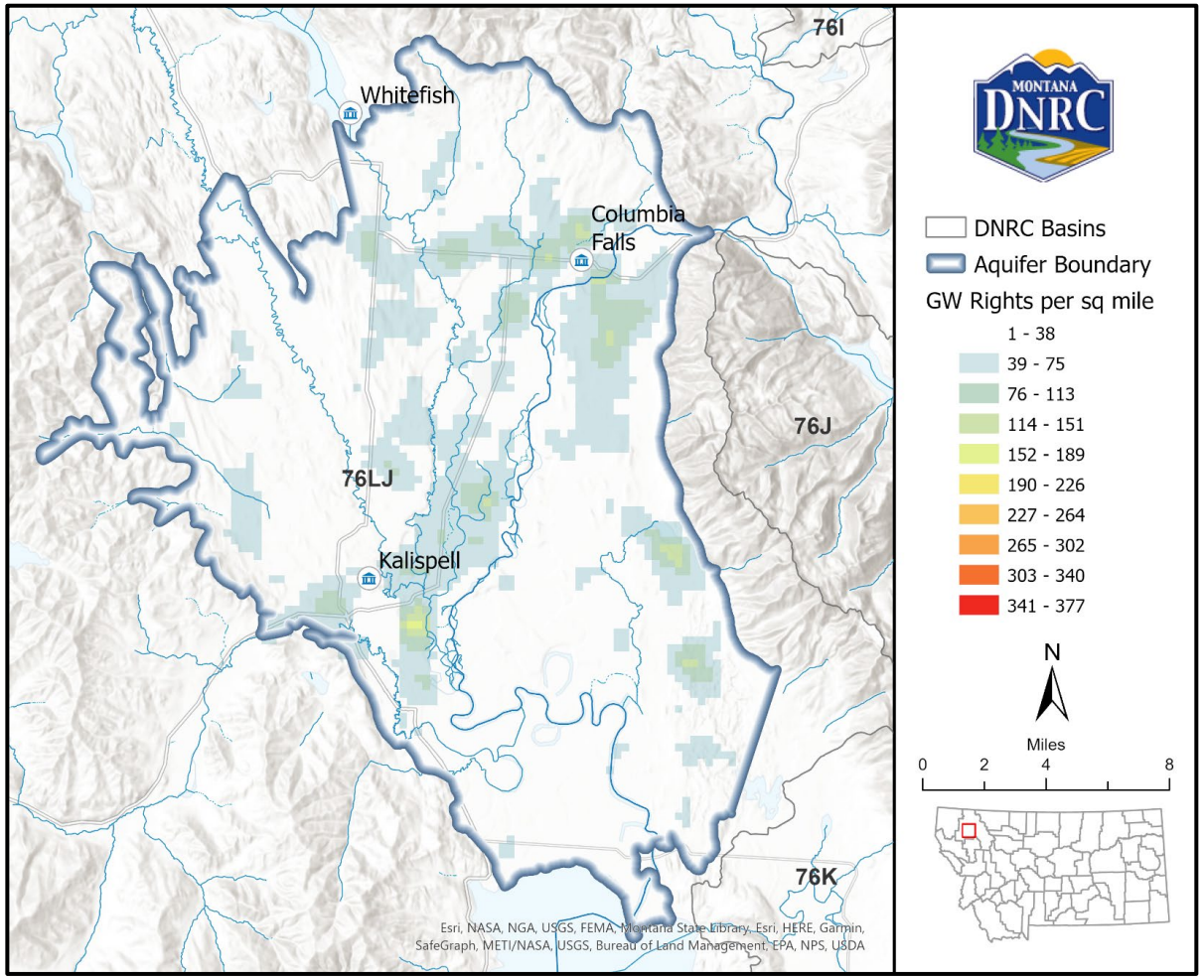
- Aquifer extent is fairly shallow and fairly limited, with only 20-30 feet of aquifer thickness
- MBMG is currently further investigating the link between irrigation ditches, flood irrigation, and aquifer recharge
  - 2002 Study suggest 2/3 of recharge comes from ditch and irrigation loss
- 2019 MBMG model suggested there is a tipping point between lawn/garden irrigation use and aquifer recharge rates, suggesting that additional use of groundwater for irrigation could outpace aquifer recharge leading to unsustainable use of the aquifer.

Billings Aquifer: Opportunities

- Current and Future Studies will better identify water availability and legal demands.
- Groundwater modeling can help establish aquifer sustainable use limits and predict impacts from changes in climate, land use, and also changes to individual water rights
- Billings has 53,550 acre-feet of surface water available through a reservation on the Yellowstone River.
  - Expanding municipal services can tie into high growth areas
- Depending on location, surface water is not legally available on some sources, and new GW right with connection would require mitigation

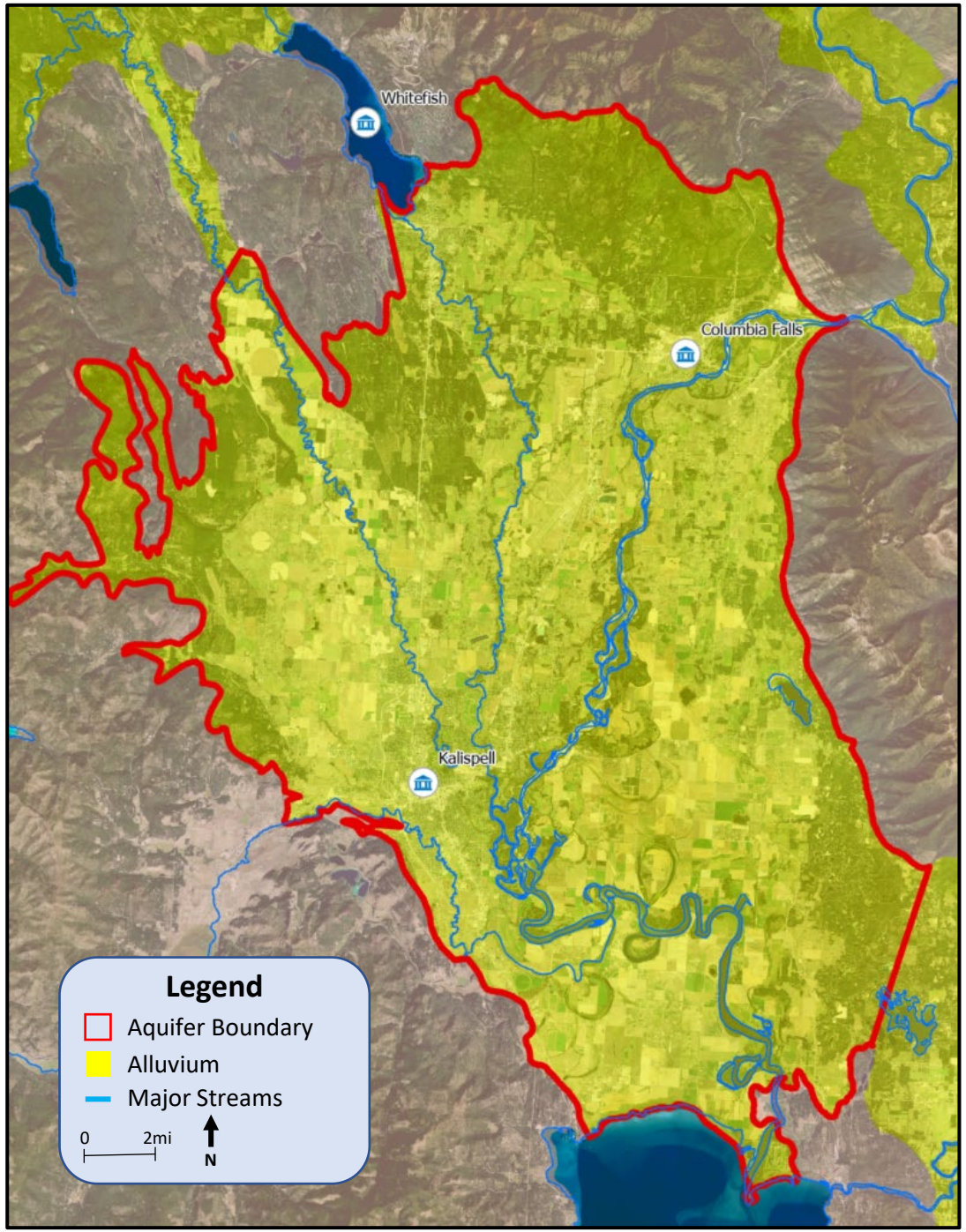
Flathead Valley

- Population: 111,814[1]
- Change from 2010: +23%
- Population Overlying the Aquifer: 97,750[2]
- Land Area: 344 sq. mi.
- Number of Permits: 305
- (3% of groundwater rights within aquifer boundary)
- Number of Exempt Wells: 7,584
- (83% of groundwater rights within aquifer boundary)

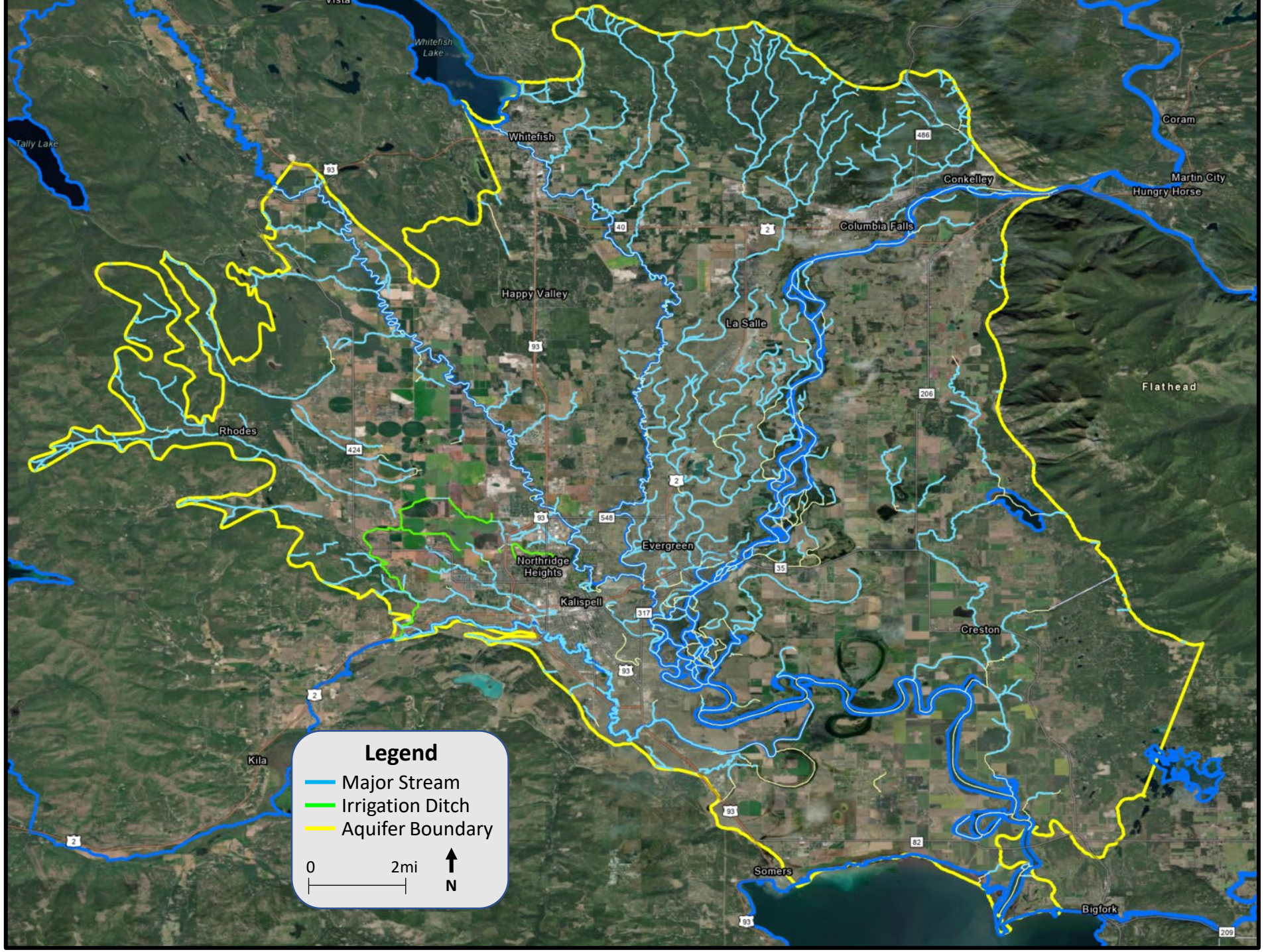


Hydrogeology

- Large regional Aquifer with unconfined, confined and perched conditions
- Localized conditions throughout the valley
- Typical well depths in the “deep” aquifer ~100-200 feet deep, yet aquifer is estimated up to 1,500 feet deep
- Well yields generally meet the needs of the use and can produce over 1,000 gpm
- Primary recharge is from “natural” sources

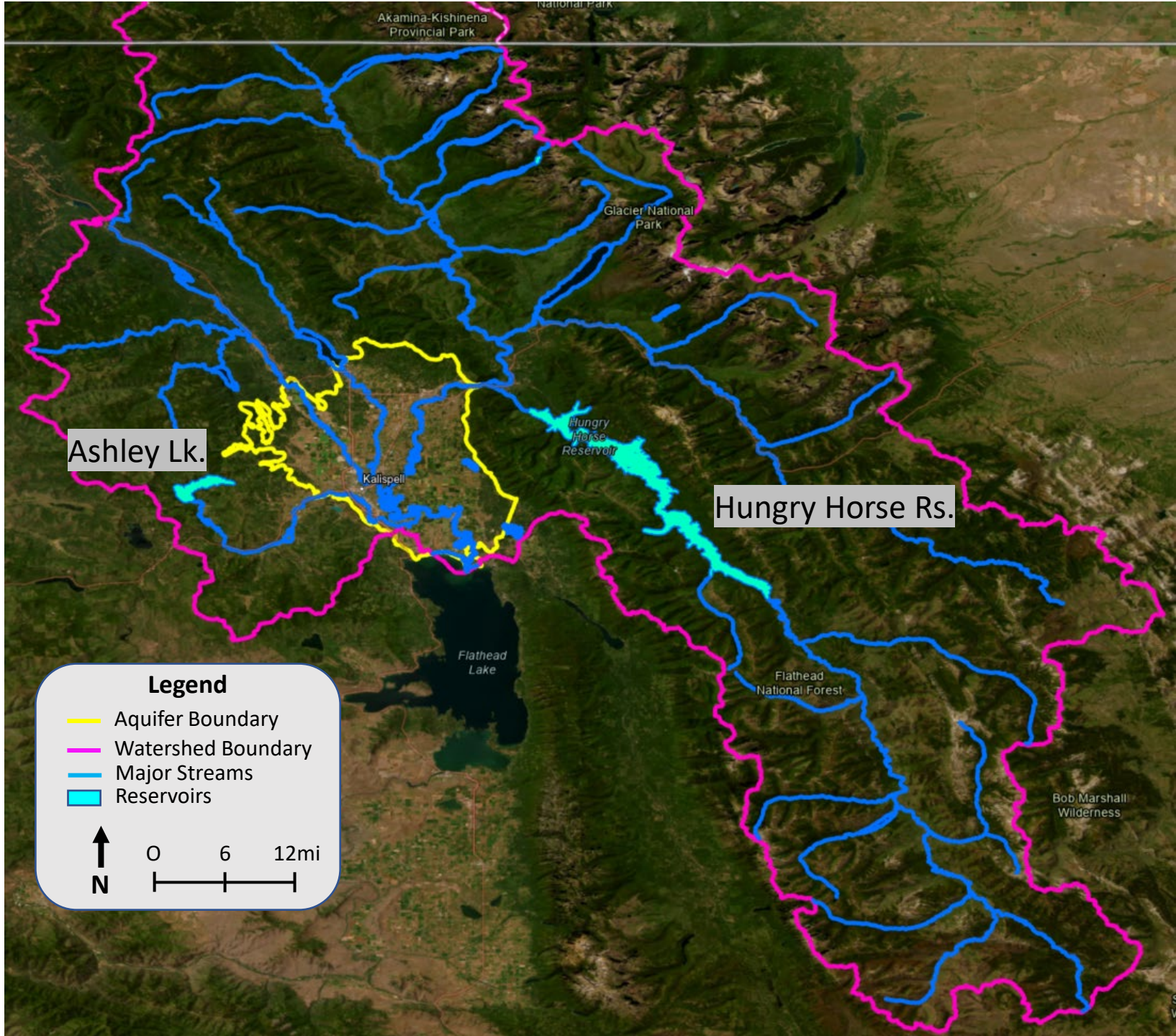


Surface Water Network

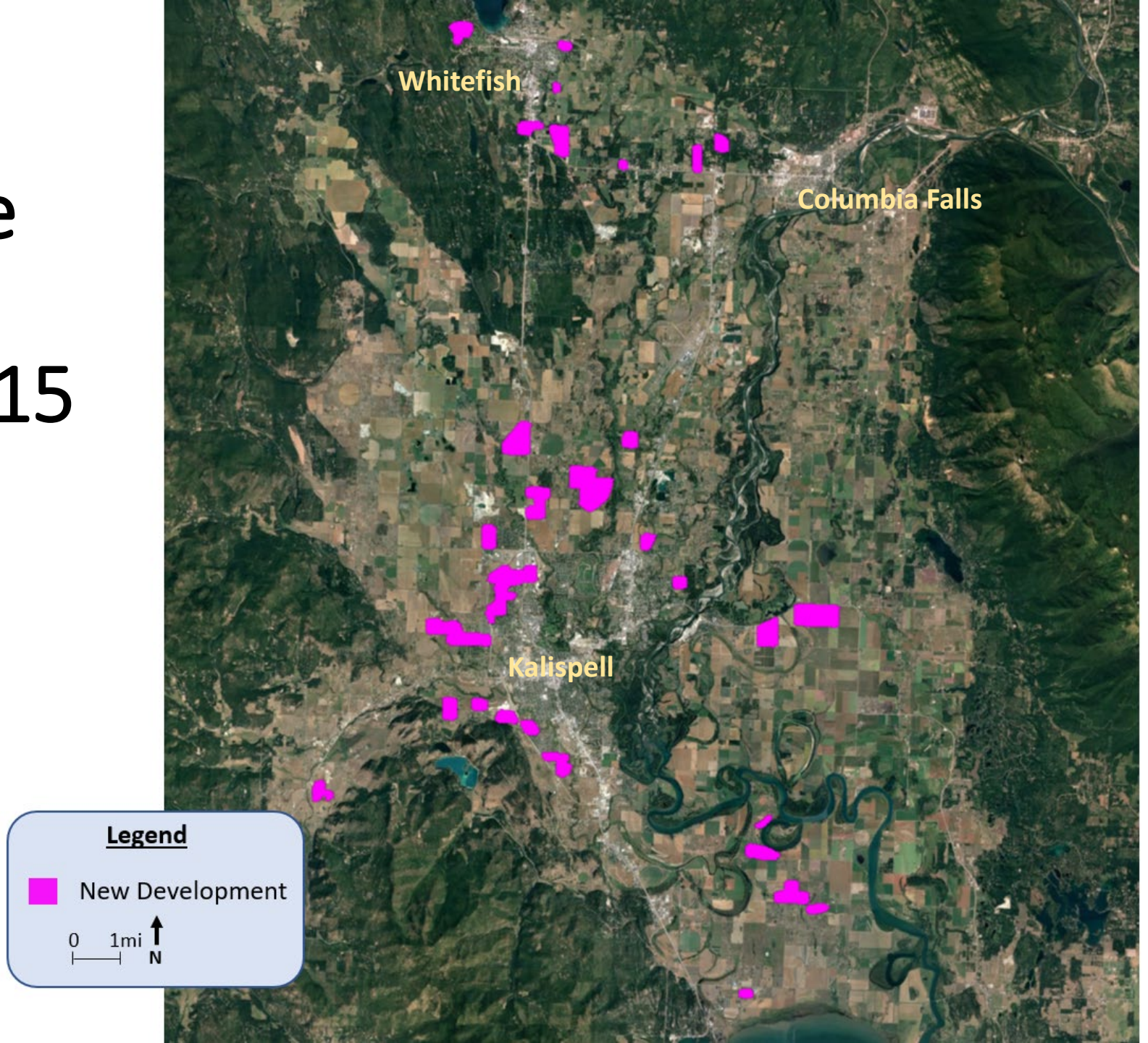


Contributing Watershed

- 5,807 Square Miles
- 2 surface reservoirs over 20 acres in size



Land Use Change Over Past 15 Years



Flathead Valley Aquifer: Concerns and Challenges

- Aquifer is fairly extensive; however, highly variable and difficult to model
- Most new wells are completed in the “deep aquifer” with complex discontinuous leaky confining layer
- Aquifer is dependent on natural recharge, which is currently abundant, but has not been quantified
- Depending on location, surface water is not legally available on some sources, and new GW right with connection would require mitigation

Flathead Valley Aquifer: Opportunities

- Future studies will continue to better describe the connection between aquifer layers and the land surface and will better quantify water use and availability
- Groundwater modeling can help predict impacts from changes in climate, changes in land use, and changes to individual water rights
- Use of groundwater connected to some surface sources in the West & North Valley area necessitates mitigation. Increasing surface water or groundwater storage that can be used for mitigation can help facilitate additional groundwater development

Summary Statistics

	Billings	Gallatin	Helena	Flathead	Missoula	Bitterroot
Population	169,852	124,857	73,832	111,814	121,041	47,298
10 yr Population Change	+15%	+39%	+16%	+23%	+11%	+18%
# of GW Permits	27	192	273	305	133	176
# of Exempt Wells	1,767	8,498	4,586	7,584	2,312	13,434
Aquifer Surface Size	27 mi^2	352 mi^2	87 mi^2	344 mi^2	51 mi^2	391 mi^2
Watershed Size	11,414 mi^2	1,787 mi^2	618 mi^2	5,807 mi^2	9,195 mi^2	9,195 mi^2

Summary of Issues

	Closed Basin	Mitigation Required	Potential Localized WQ Issues	Dependent on Irrigation Returns & Ditch Loss	High Density of Wells	Complex Aquifer
Billings		Potentially	Yes	Yes	Yes	
Gallatin	Yes	Yes	Yes	Yes	Yes	Yes
Helena	Yes	Yes	Yes	Yes	Yes	Yes
Missoula	Partial	Potentially	Yes		Yes	
Bitterroot	Yes	Yes	Yes	Yes	Yes	Yes
Flathead		Potentially	Yes		Yes	Yes

Summary of Opportunities

	Would benefit from detailed modeling	May Need Artificial Recharge to Maintain Existing GW Level	Potential for Mitigation Banking Benefits	Growth Areas May be able to use Municipal Services
Billings	Yes	Yes		Yes
Gallatin	Yes	Yes	Yes	Yes
Helena	Yes	Yes	Yes	Yes
Missoula	Yes			
Bitterroot	Yes	Yes	Yes	
Flathead	Yes		Yes	

Questions