Preliminary Exempt Well Data for the Comprehensive Water Review Stakeholder Working Group

Last update: 9.29.2023

These data are preliminary for SWG discussion purposes. The Stakeholder Working Group will further refine these data requests with input from the public. This is a working document and information compiled was with time limitations. Data from the Water Rights Information System (WRIS) is often limited by the information provided by water right holders.

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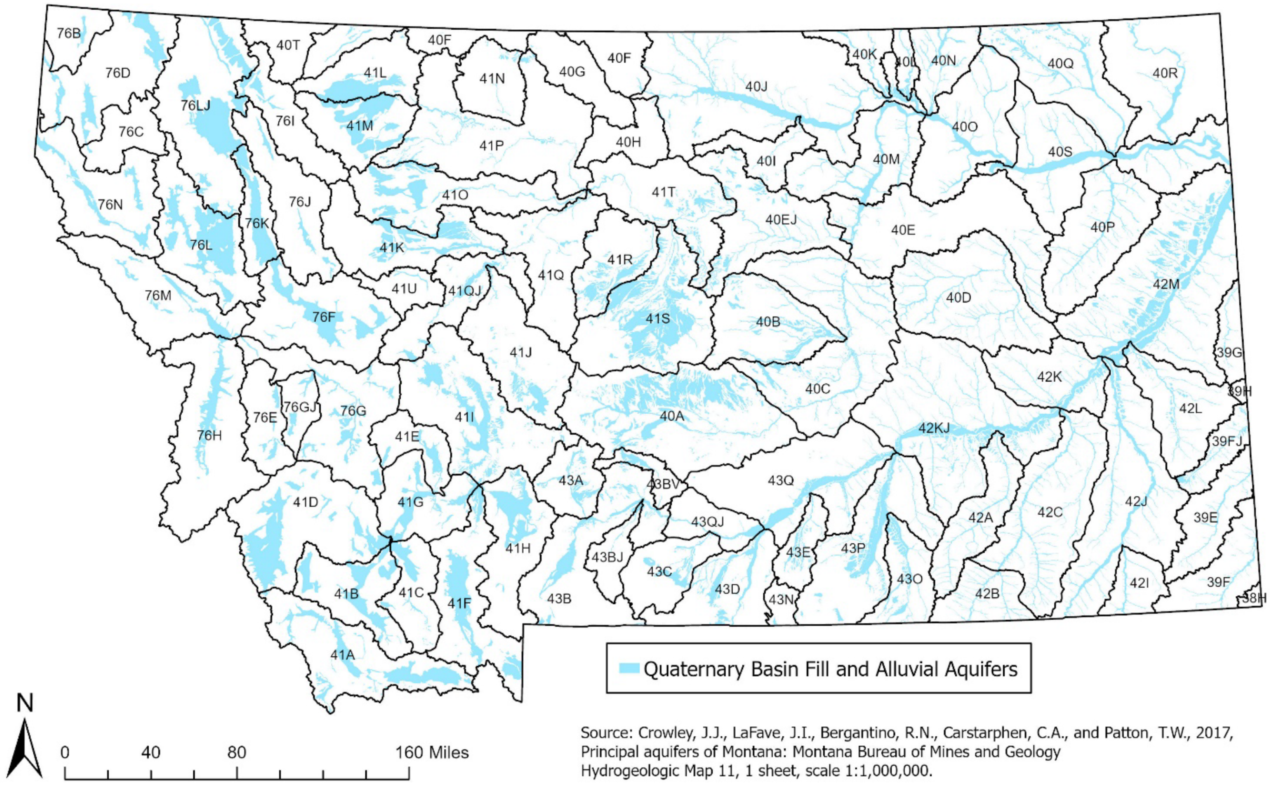
1. Montana Administrative Basins look-up (table)

Basin #	Basin Name	Basin #	Basin Name
38H	Belle Fourche River, Above Cheyene River	39FJ	Little Beaver Creek
39E	Box Elder Creek	39G	Beaver Creek, Tributary of Little Missouri River
39F	Little Missouri River, Above Little Beaver Creek	39H	Little Missouri, Below Little Beaver Creek
40A	Musselshell River, Above Roundup	40J	Milk River, Between Fresno Reservoir and Whitewater Creek
40C	Musselshell River, Below Roundup	40K	Whitewater Creek
40D	Big Dry Creek	40L	Frenchman Creek
40E	Missouri River, Between Musselshell River and Fort Peck Dam	40M	Beaver Creek, Tributary of Milk River
40EJ	Missouri River, Between Bullwhacker Creek and Musselshell Rivers	40N	Rock Creek, Tributary of Milk River
40F	Milk River, Above Fresno Reservoir	40O	Milk River, Below Whitewater Including Porcupine Creek
40G	Sage Creek	40P	Redwater River
40H	Big Sandy Creek	40Q	Poplar River
41A	Red Rock River	40R	Big Muddy Creek
41B	Beaverhead River	41M	Two Medicine River
41C	Ruby River	41N	Willow Creek
41D	Big Hole River	41O	Teton River
41E	Boulder River, Tributary of Jefferson River	41P	Marias River
41F	Madison River	41Q	Missouri River, From Sun to Marias River
41G	Jefferson River	41QJ	Missouri River, From Holter Dam to Sun River
41H	Gallatin River	41R	Arrow Creek
41I	Missouri River, Above Holter Dam	41S	Judith River
41J	Smith River	41T	Missouri River, From Marias River to and Including Bullwhacker Creek
41K	Sun River	41U	Dearborn River
41L	Cut Bank Creek	42J	Powder River, Below Clear Creek
42A	Rosebud Creek	42K	Yellowstone River, Between Tongue and Powder Rivers
42B	Tongue River, Above and Including Hanging Woman Creek	42KJ	Yellowstone River, Between Bighorn and Tongue Rivers
42C	Tongue River, Below Hanging Woman Creek	42L	O'Fallon Creek
42I	Little Powder River	42M	Yellowstone River, Below Powder River
43A	Shields River	43E	Pryor Creek
43B	Yellowstone River, Above and Including Bridger Creek	43N	Shoshone River
43BJ	Boulder River, Tributary of Yellowstone River	43O	Little Bighorn River
43BV	Sweet Grass Creek	43P	Bighorn River, Below Greybull River
43C	Stillwater River	43Q	Yellowstone River, Between Clarks Fork Yellowstone and Bighorn River

43D	Clarks Fork Yellowstone River	43QJ	Yellowstone River, From Bridger Creek to Clarks Fork Yellowstone River
76B	Yaak River	76I	Flathead River, Middle Fork
76C	Fisher River	76J	Flathead River, South Fork
76D	Kootenai River	76K	Swan River
76E	Rock Creek, Tributary of Clark Fork River	76L	Flathead River, Below Flathead Lake
76F	Blackfoot River	76LJ	Flathead River, to and Including Flathead Lake
76G	Clark Fork, Above Blackfoot River	76M	Clark Fork, Between Blackfoot and Flathead Rivers
76GJ	Flint Creek	76N	Clark Fork, Below Flathead River
76H	Bitterroot River		

2. Montana surficial aquifers overlaid with administrative basin- MBMG (map)



Description:

- Date derived from Montana Bureau of Mines & Geology (MBMG) publication
- Surficial aquifers are alluvial aquifers comprised of deposited sediments.
- Generally, alluvial aquifers have a more immediate connection to surface water than bedrock aquifers. Information on bedrock aquifers can be found here.

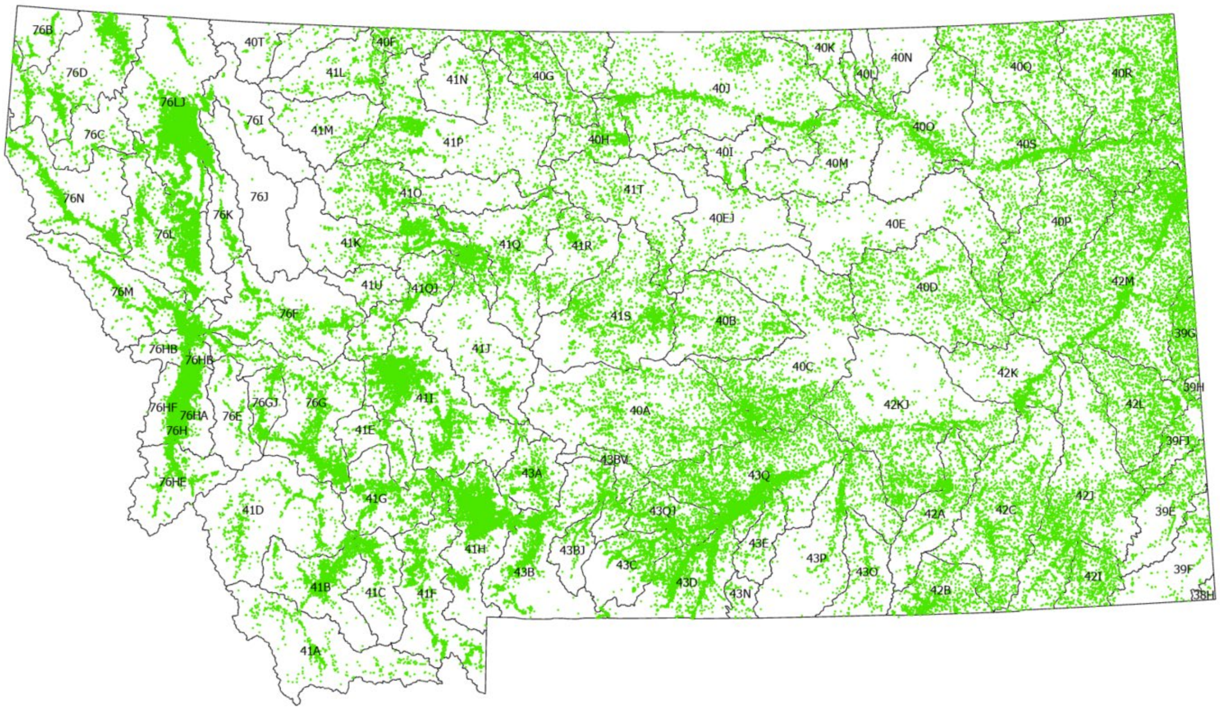
Timeframe: 2017

Summary: n/a

Limitations:

- Not all source aquifers including principal aquifers in Montana are surficial aquifers.
- This data shows the extent of basin-fill and alluvial aquifers but does not consider specific hydraulic connectivity to surface water bodies.
- This data does not show the connection between bedrock aquifers and basin-fill and alluvial aquifers and therefore potential adverse effects to surface water bodies.

3. Location of well logs- MBMG records (map)



Description:

- MBMG Groundwater Information Center
- MBMG Well Logs, 298,467 entries

Timeframe: 1882 – 2023

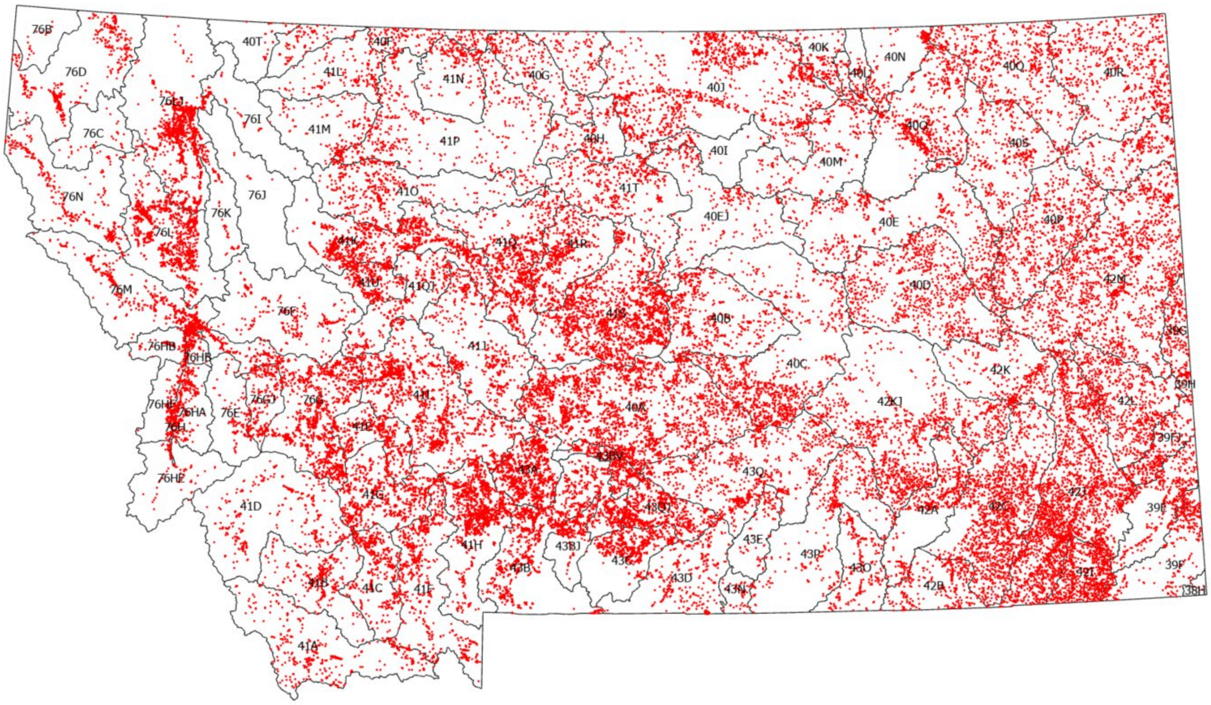
Summary:

- The locations of higher density reflect the same areas as DNRC water right data.

Limitations:

- During 2022, DNRC attempted to match datasets and can confidently match 93,760 records.
- Records will not match because not all drilled wells require water rights, e.g., pre-1973 wells exempt from claim filing, monitoring wells, dry wells, injection wells, wells not put to beneficial use and non-compliant wells etc.

4. Wells with water rights – DNRC records (map)



Description:

- DNRC water right entries for wells, 215,167 water rights
- Water right types include claims, permits & certificates

Timeframe:

- Priority dates range between 1847 and 2022

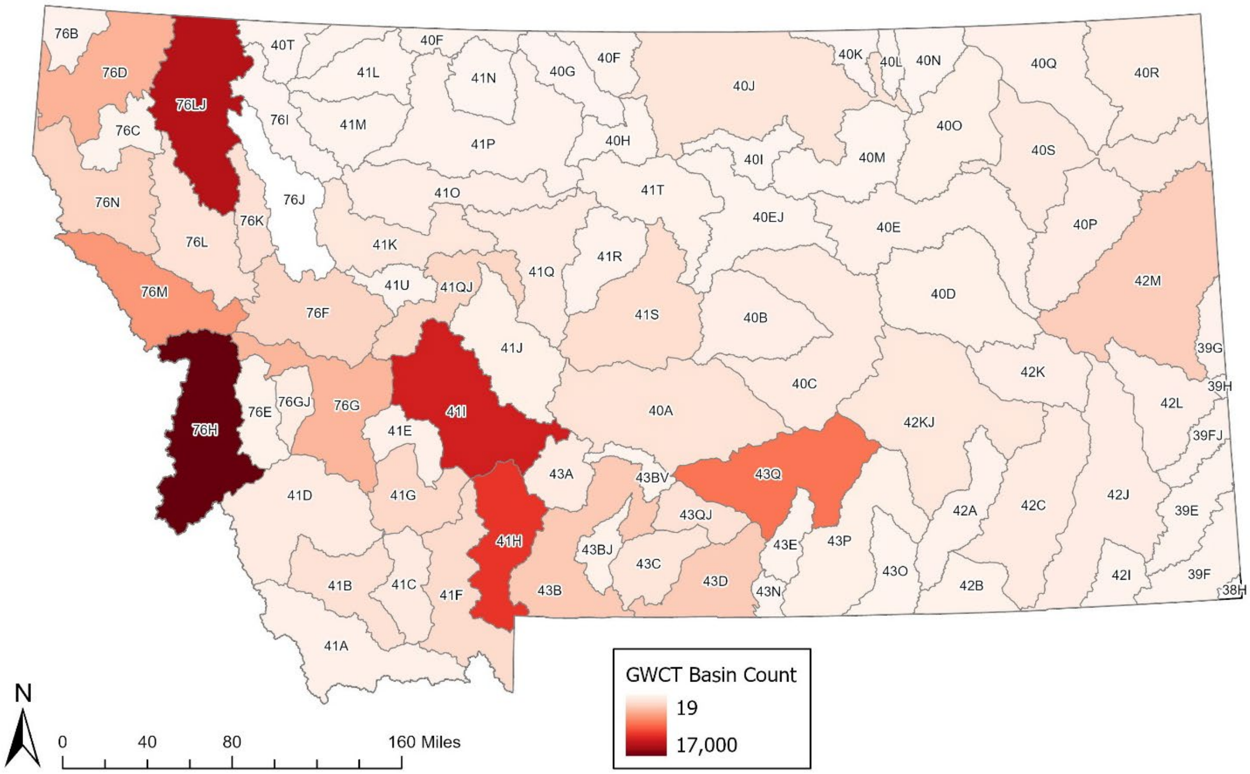
Summary:

- The locations of higher density reflect the same areas as MBMG GWIC data.

Limitations:

- During 2022, DNRC attempted to match MBMG well logs to DNRC water rights and can confidently match 93,760 records.
- Not all drilled wells require water rights, e.g., pre-1973 wells exempt from claim filing, monitoring wells, dry wells, injection wells, wells not put to beneficial use and non-compliant wells etc.
- DNRC has added a database record for the well log number to help further coordinate data between the two databases.

5. Count of exempt wells per administrative basin (map)



Description:

- This list includes all groundwater rights filed under 85-2-306 (includes other exemptions, e.g., geothermal rights, emergency fire protection rights, and other means of diversion, e.g., developed springs).
- This dataset includes other means of diversion, but the majority are wells.
  - 93% wells; 5% developed springs; 1% pit/ponds (not well filled); 1% other

Timeframe: 1973 - 2023

Summary:

- DNRC has received an average of 2,814 filings per year over the past 29 years.
- Since 2014, when the 1987 combined appropriation rule was reinstated, in every year except one (2015), the number of exempt wells received by DNRC has been greater than the number received in 2014, or any of the five years prior (Tabular Listing by Date below).
- There was a 10-year peak in filings in 2019 coinciding with an adjudication program filing deadline and corresponding statewide mailing; the adjudication notice educated water users and motivated many exempt well users to come into compliance with state law.

Limitations:

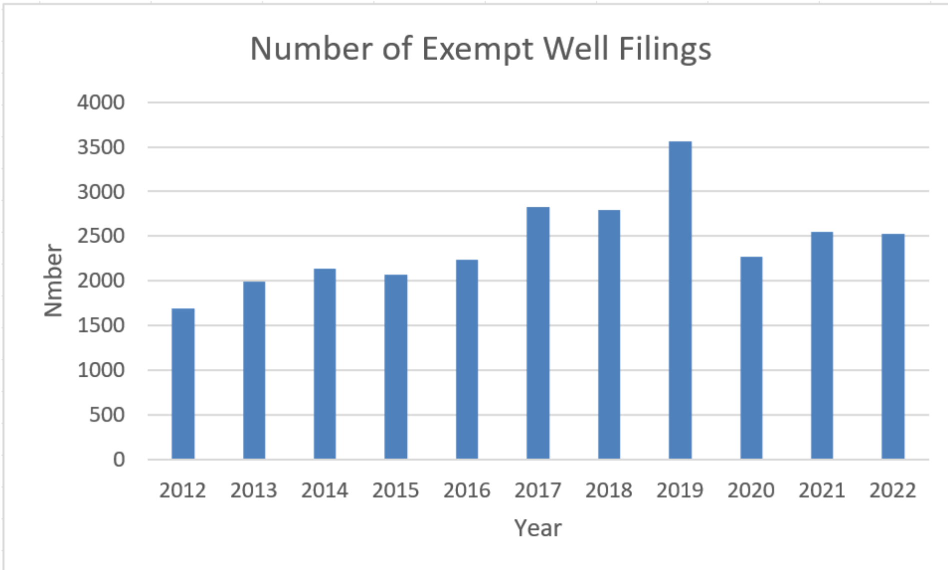
- As mentioned above, this includes other exemptions, such as geothermal heating and cooling and emergency fire protection.
- Not all wells are compliant, so this does not include non-filed wells.
- Dataset does not include pending groundwater Notices of Completion (Form 602).

6. Count of exempt wells per administrative basin (table)

Clark Fork/Kootenai		Upper Missouri		Lower Missouri		Yellowstone		Little Missouri	
Basin	**Count**	**Basin**	**Count**	**Basin**	**Count**	**Basin**	**Count**	**Basin**	**Count**
76B	262	41A	471	40A	1784	42A	276	38H	8
76C	209	41B	1903	40B	704	42B	368	39E	242
76D	4649	41C	1075	40C	992	42C	1000	39F	196
76E	325	41D	1011	40D	573	42I	218	39FJ	252
76F	2740	41E	463	40E	443	42J	890	39G	304
76G	4478	41F	2316	40EJ	237	42K	694	39H	19
76GJ	928	41G	2502	40F	187	42KJ	1244	**Total**	**1,021**
76H	16811	41H	10899	40G	87	42L	623		
76I	102	41I	12265	40H	164	42M	3092		
76J	6	41J	561	40I	45	43A	1000		
76K	1984	41K	1283	40J	1561	43B	3353		
76L	1882	41L	156	40K	70	43BJ	362		
76LJ	13828	41M	238	40L	26	43BV	167		
76M	6074	41N	37	40M	157	43C	1564		
76N	2769	41O	665	40N	49	43D	3224		
Total	**57,047**	41P	302	40O	520	43E	222		
		41Q	986	40P	873	43N	37		
		41QJ	2580	40Q	439	43O	145		
		41U	229	40R	964	43P	539		
		Total	**39,942**	40S	1086	43Q	7870		
				40T	87	43QJ	1926		
				41R	312	**Total**	**28,814**		
				41S	2215				
				41T	367				
				Total	**13,942**				
Total of all filed Groundwater Certificates = 140,766									

(See above for Description, Timeframe, Summary, and Limitations listed below map for this section)

7. Exempt well filings received by DNRC per year (chart)



Description:

- This list includes all Notice of Completion of Groundwater Development rights filed under 85-2-306

Timeframe: 2012 - 2022

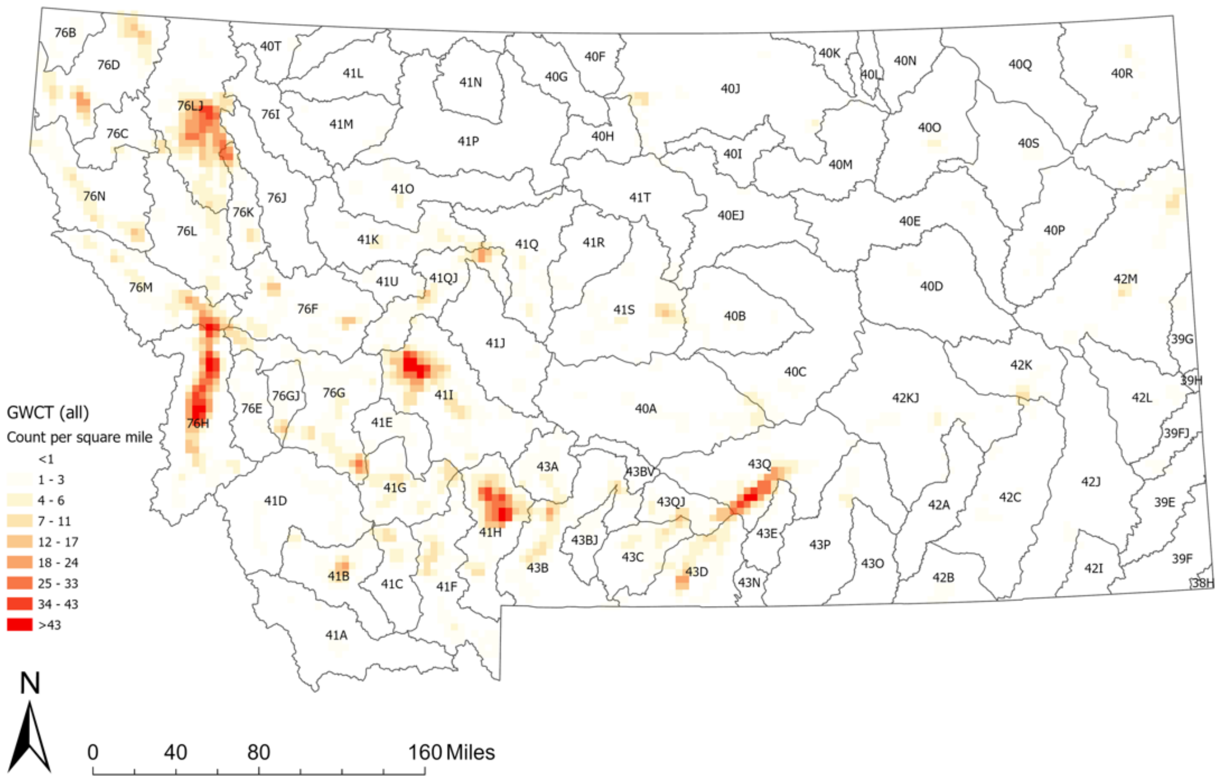
Summary:

- DNRC has received an average of 2,621 filings per year over the past 10 years.
- Since 2014, when the 1987 combined appropriation rule was reinstated, in every year except one (2015), the number of exempt wells received by DNRC has been greater than the number received in 2014, or any of the five years prior.
- A 10-year peak in filings in 2019 coincided with an adjudication program filing deadline and corresponding statewide mailing; the adjudication notice educated water users and motivated many exempt well users to come into compliance with state law.

Limitations:

- Not all wells are compliant, so this does not include non-filed wells.
- Dataset does not include pending groundwater Notices of Completion (Form 602).

8. Count of exempt wells per square mile (map)



Description:

- GIS density analysis count of exempt wells.

Timeframe: 1973-2023

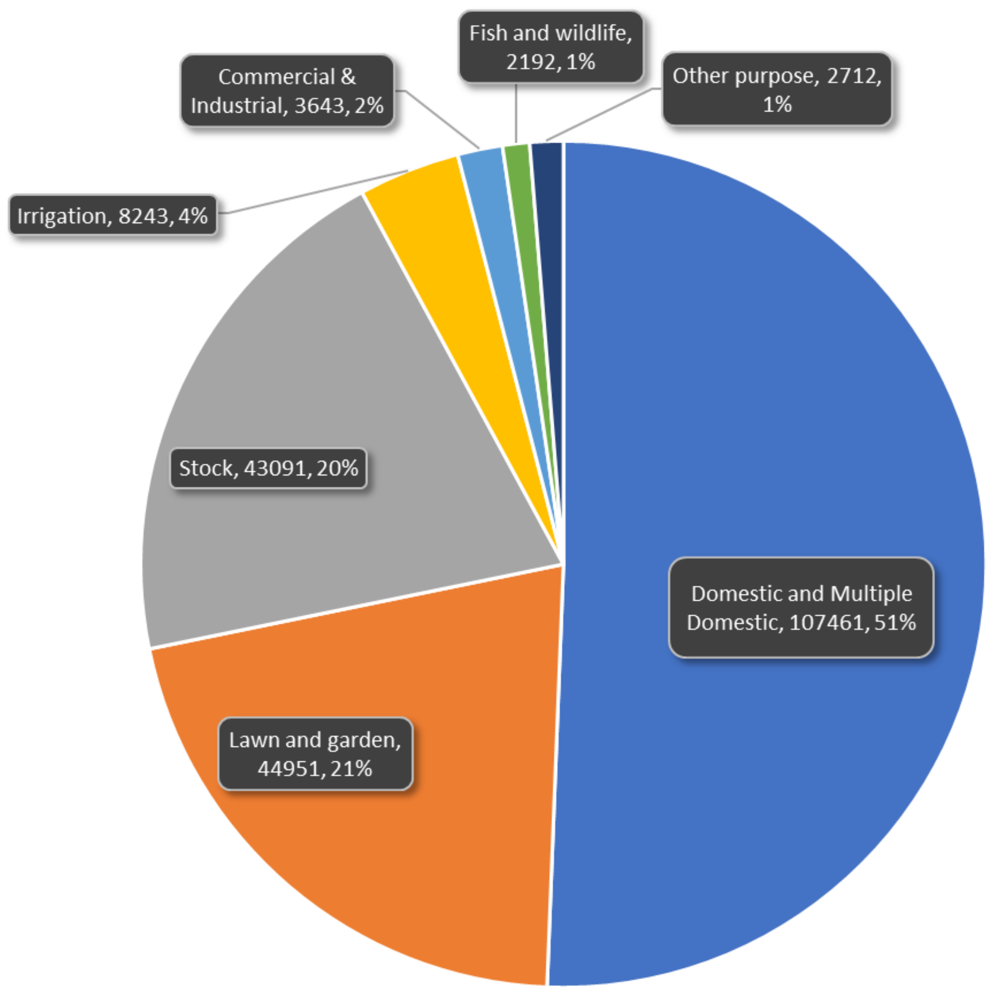
Summary:

- This graphic illustrates that there are five high well density areas across the state. These five areas include the Flathead Valley (76LJ), Missoula/Bitterroot Valleys (76H & 76M), Helena Valley (41I), Gallatin Valley (41H) and Billings area (43Q). Most of these wells are finished in surficial groundwater aquifers with connectivity to surface water.

Limitations:

- This includes other exemptions, such as geothermal heating and cooling and emergency fire protection.
- Not all wells are compliant, so this does not include non-filed wells.
- Dataset does not include pending groundwater Notices of Completion (Form 602).

9. Exempt wells by purposes statewide (chart)



Description:

- A count of unique purpose listings for exempt wells

Timeframe: 1973 – 2023

Summary:

- Domestic purpose is by far the most common, followed by lawn and garden purpose and stock purpose.

Limitations:

- This includes other exemptions, such as geothermal heating and cooling and emergency fire protection.
- Not all wells are compliant, so this does not include non-filed wells.
- Dataset does not include pending groundwater Notices of Completion (Form 602).
- Single water rights can have multiple purposes, so the total number of purposes is much larger than the total number of exempt well water rights.

10. Exempt wells by purposes statewide (table)

Purpose list	Counts by purpose	Purpose list	Counts by purpose
Domestic	104091	Geothermal heating	94
Lawn and garden	44951	Wildlife	91
Stock	43091	Wetland mitigation credit	71
Irrigation	8243	Pollution abatement	35
Multiple domestic	3370	Oil well flooding	29
Commercial	3221	Observation and testing	20
Fish and wildlife	1091	Unknown	13
Other purpose	1004	Power generation	12
Fishery	607	Water marketing	8
Recreation	427	Waterfowl	8
Industrial	422	Wetland	8
Wildlife/waterfowl	403	Erosion control	2
Institutional	245	Mitigation water	2
Fire protection	192	Sale	2
Agricultural spraying	180	Augmentation	1
Mining	139	Fish raceways	1
Municipal	122	Instream fishery	1
Geothermal	95	Storage	1
		Grand total	**212,293**

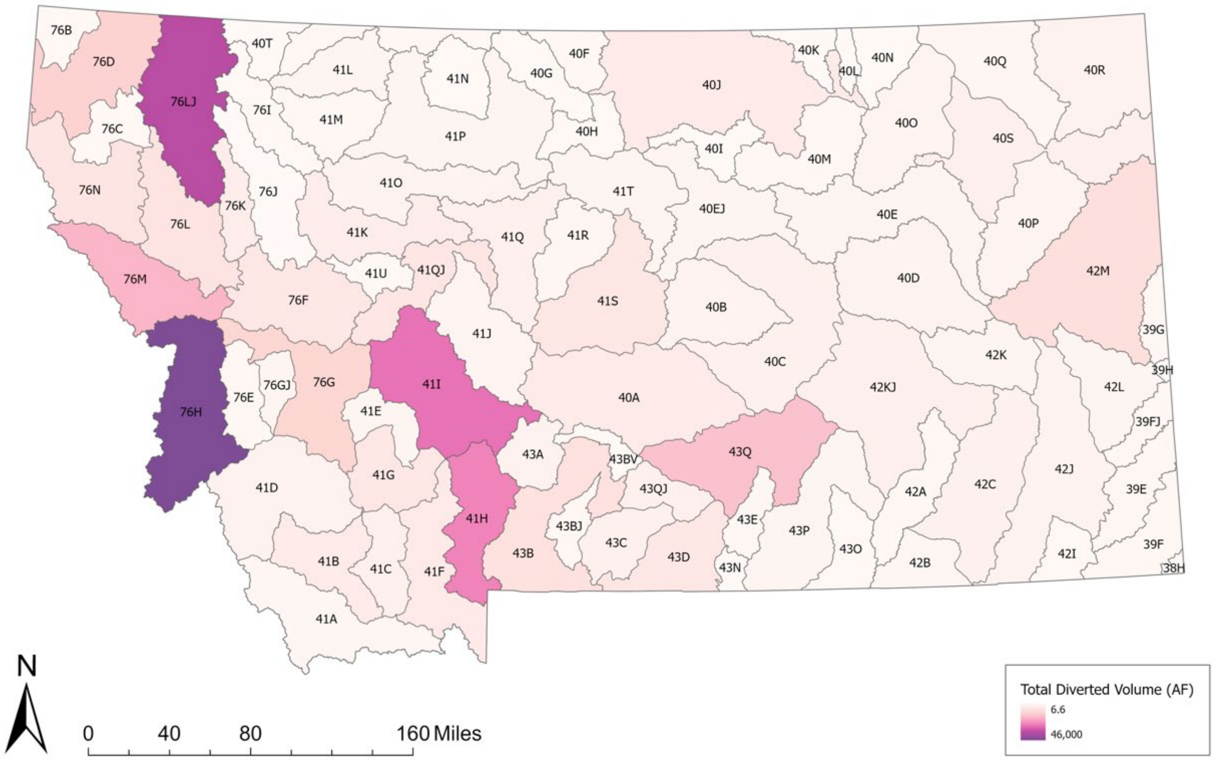
Description:
- A count of unique purpose listings for exempt wells

Timeframe: 1973 – 2023

Summary:
- Domestic purpose is by far the most common, followed by lawn and garden purpose and stock purpose.

Limitations:
- This includes other exemptions, such as geothermal heating and cooling and emergency fire protection.
- Not all wells are compliant, so this does not include non-filed wells.
- Dataset does not include pending groundwater Notices of Completion (Form 602).
- Single water rights can have multiple purposes, so the total number of purposes is much larger than the total number of exempt well water rights.

11. Exempt wells total volume statewide (map)



Description:

- Total diverted volume per basin is based on the total volume listed on each groundwater certificate, when available. Higher diverted volume amounts coincide with higher population areas.

Timeframe: 1973 – 2023

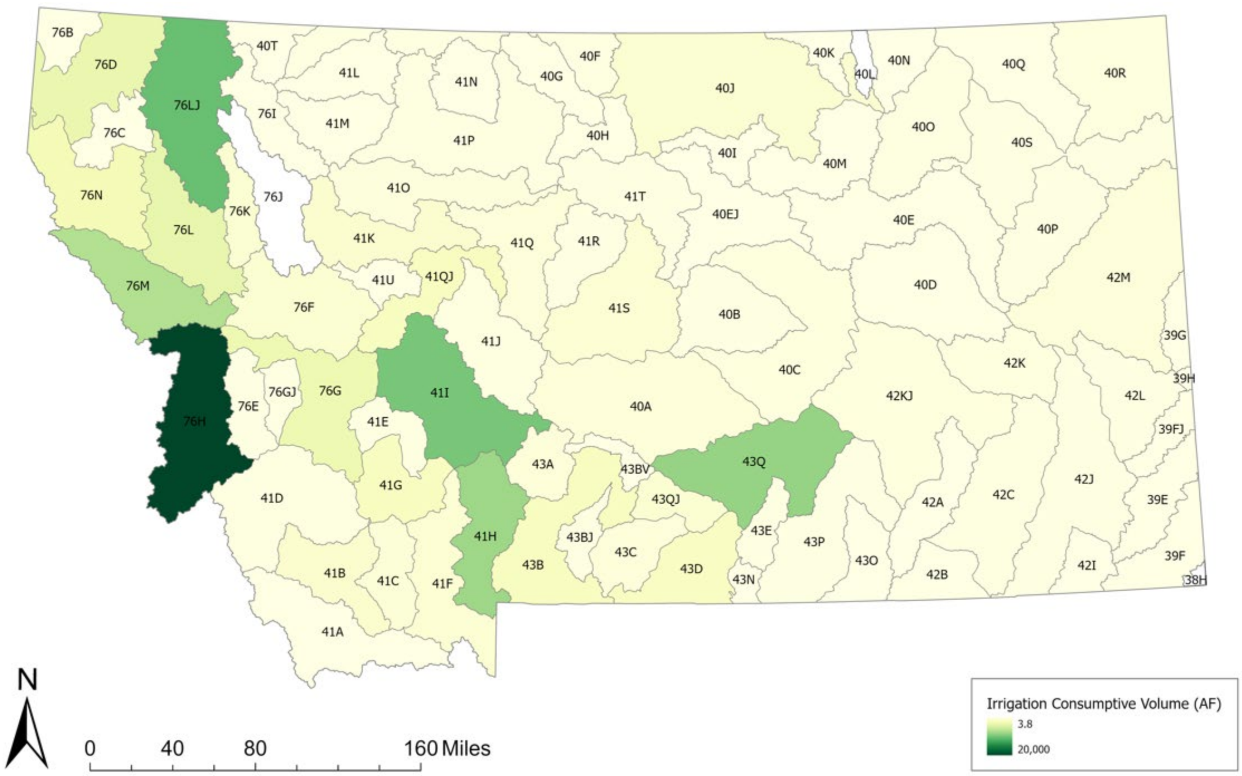
Summary:

- This graphic illustrates that there are high exempt well volumetric use areas across the state.

Limitations:

- This includes other exemptions, such as geothermal heating and cooling and emergency fire protection.
- Not all wells are compliant, so this does not include non-filed wells.
- Dataset does not include pending groundwater Notices of Completion (Form 602).
- Not all exempt well water rights have a listed total volume. Water rights with no volume listed were not included in the analysis.

12. Exempt wells irrigation consumptive volume (map)



Description:

- Irrigation consumption based on maximum acres irrigated when listed on an exempt well water right and totaled within each administrative basin and climatic area where groundwater development is located. Consumed volumes per acre for each climatic area are listed below.
  - Climatic Area 1: 2.1 AF/Acre
  - Climatic Area 2: 1.9 AF/Acre
  - Climatic Area 3: 1.7 AF/Acre
  - Climatic Area 4: 1.4 AF/Acre
  - Climatic Area 5: 1.0 AF/Acre
  - Climatic Area 6: 1.0 AF/Acre

Timeframe: 1973-2023

Summary:

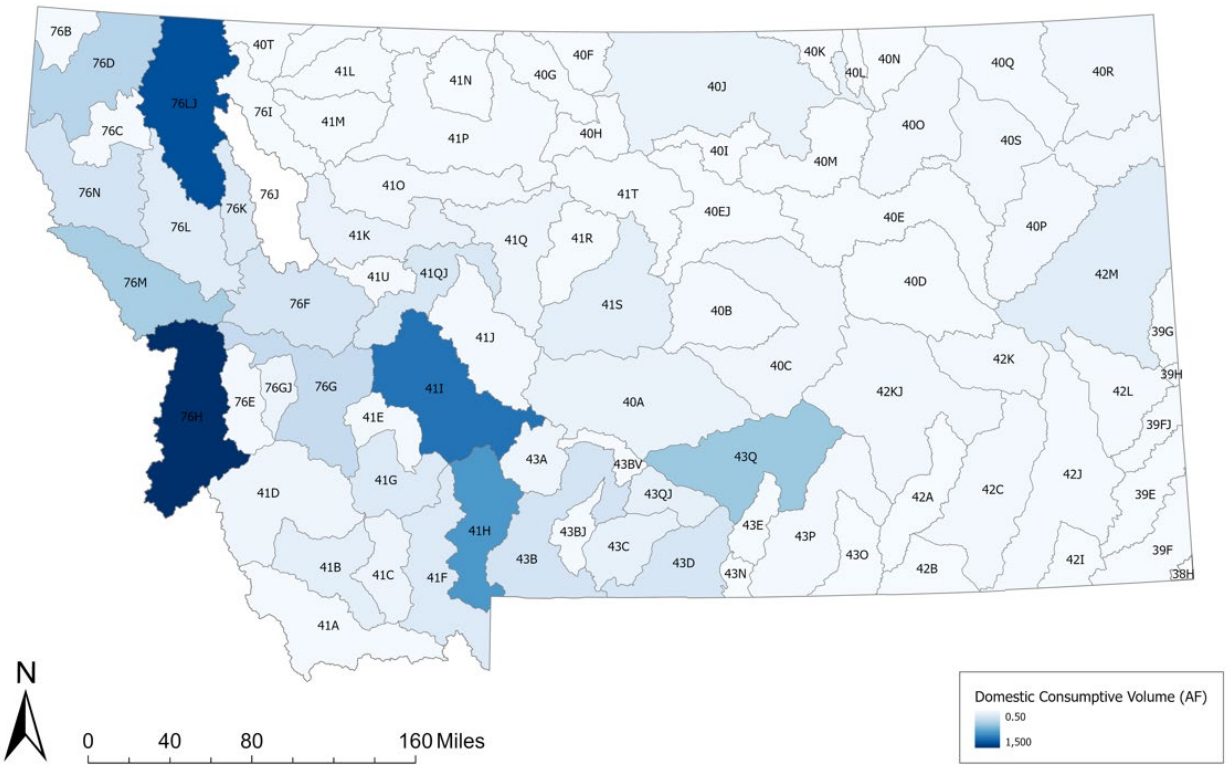
- This graphic also illustrates that the majority of lawn and garden and irrigation purposes are located in the high growth areas.
- The highest number of acres is under the lawn and garden purpose. This data set includes lawn and garden and irrigation purposes.

Limitations:

- Lawn and garden purpose and irrigation purpose have been used interchangeably and also as different types of purposes, so we are assuming the same consumption for both in this exercise.
- Early domestic use included ¼ acre of lawn and garden in the volume, but maximum acres was not listed. Any lawn & garden use for these rights would not be included in this analysis.

- Some exempt well water rights did not list maximum acres for lawn and garden and/or irrigation use. These would not be included in this analysis.
- Prior to 1993, exempt well rights only had a flow rate limitation (100 gpm), so some high acreages and volumes exist in the records for exempt wells.
- Scale of mapped climatic areas is coarse. Application analysis uses a finer dataset for determining consumed volumes.
- Not all wells are compliant, so this does not include non-filed wells.
- Dataset does not include pending groundwater Notices of Completion (Form 602).

13. Consumptive volume based on domestic use (map)



Description:

- Diverted volume for domestic use is assumed to be 1 AF per household (ARM 36.12.115). Consumptive volume for domestic purpose is estimated to be 10% of diverted volume, so equal to 0.1 AF per household.

Timeframe: 1973-2023

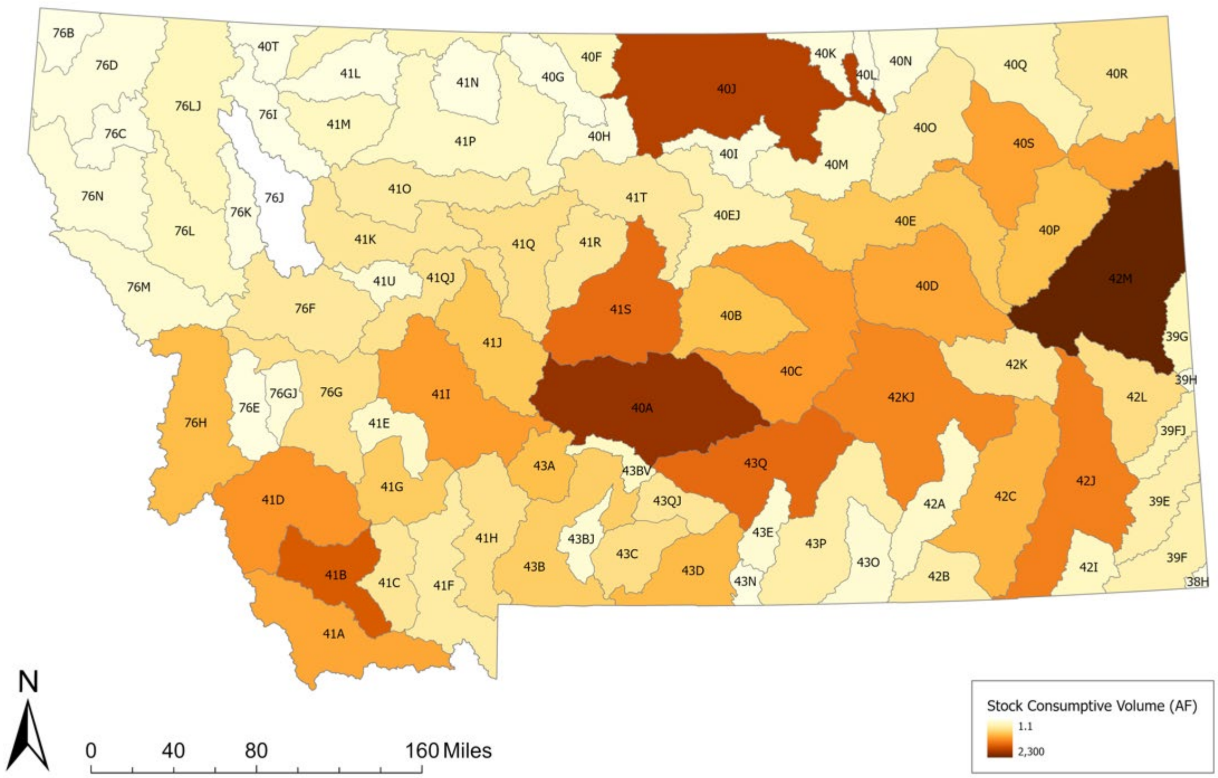
Summary:

- This graphic also illustrates that the majority of domestic and multiple domestic purposes are located in the high growth areas and coincide with areas of highest consumptive use for irrigation using exempt wells.

Limitations:

- 1 AF was used for every exempt filing listing domestic or multiple domestic purposes.
- The MT DNRC standard of 1 AF per household is based on a household of five people using approximately 180 gallons per day (GPD) per person for 365 days per year, and is known to be on the generous side (compared to MT DEQ average household use of 0.28 AF (250 gpd per dwelling for 365 days per year)).
- For purposes of this analysis, 10% consumption was used, but this value can vary based on wastewater treatment type.
- Not all wells are compliant, so this does not include non-filed wells.
- Dataset does not include pending groundwater Notices of Completion (Form 602).

14. Consumptive volume based on stockwater use (map)



Description:

- Stock use per ARM 36.12.115 is 15 gallons per day per animal unit, or 0.17 AF per year per animal unit. Stock watering is considered 100% consumptive.

Timeframe: 1973-2023

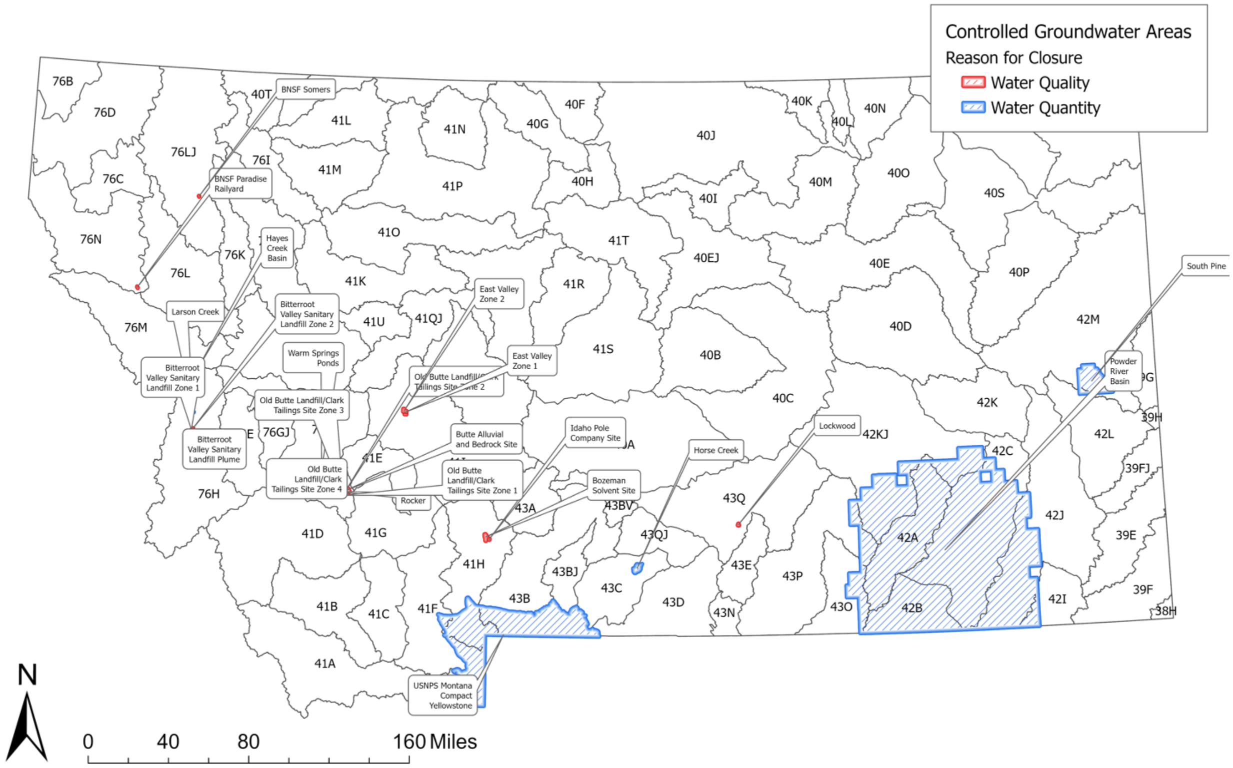
Summary:

- Exempt wells are used for stockwater in rural, less-populated, administrative basins.

Limitations:

- Not all exempt wells have the number of animal units listed.
- Not all wells are compliant, so this does not include non-filed wells.
- Dataset does not include pending groundwater Notices of Completion (Form 602).

15. Controlled Groundwater Areas (map)



Description:

- Per §85-2-506, MCA, the Department may designate permanent or temporary controlled groundwater areas (CGWAs) through the rulemaking process. Broadly speaking, CGWAs are designated to address issues with water quality or water quantity. There are 17 total active CGWAs.

Timeframe: 1967-2023

Summary:

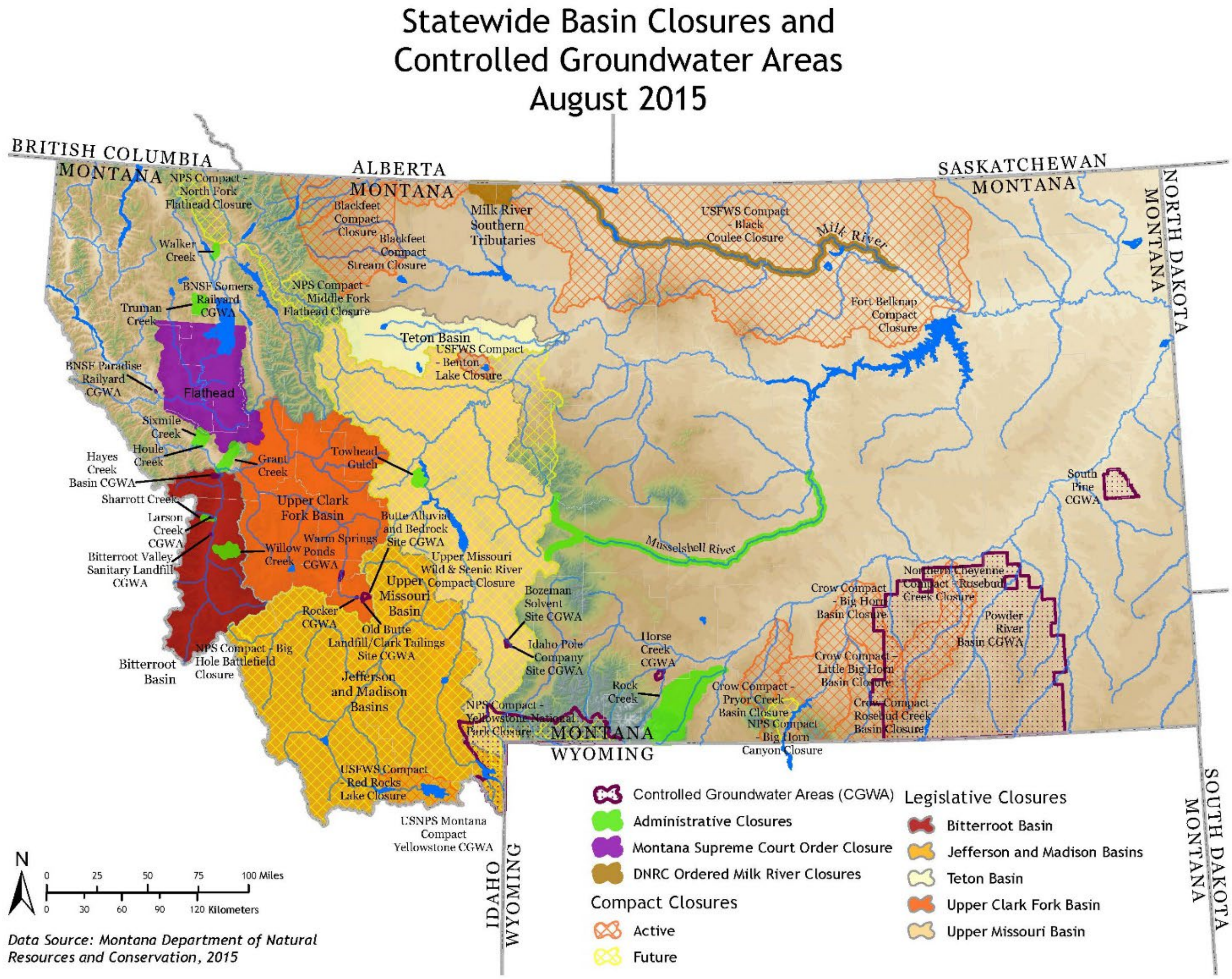
- The rulemaking process can be initiated by the Department or by petitioner (state or local public health agencies, a municipality, county, conservation district, local water quality district, or 1/3 of the water right holders in the proposed CGWA). Petitioners must complete and submit a Form 630 to the Department with analysis prepared by a hydrogeologist, qualified scientist, or qualified professional engineer concluding one or more of the criteria in §85-2-506 (5), MCA have been met, and petitioners must describe the kind of corrective controls they are requesting. To designate a permanent controlled groundwater area, the Department must find that certain criteria have been met and cannot be appropriately mitigated. Prior to the passing of SB 120 in the 2009 Legislative Session, CGWAs were designated by Final Order rather than Administrative Rule.

Limitations:

- Each CGWA is unique, and the full details can be found in the corresponding Final Order or Rule. More information is available on the Department website.

Controlled Groundwater Areas Addressing Water Quantity There are 17 total CGWAs. The table below includes only active CGWAs designated to address water quantity. Full details of each CGWA are in the corresponding Final Order or Rule.	
Hayes Creek Basin Controlled Groundwater Area Missoula County	All new groundwater appropriations require a permit. The Order includes limitations on number of wells per lot and static water level measurements must be submitted annually to the Department. CGWA was designated 11/30/1998 by Final Order.
Horse Creek Controlled Groundwater Area Stillwater County	One Notice of Completion of Groundwater Development (for a maximum of 1 AF/35 GPM) can be filed on each parent tract; all other new groundwater appropriations require a permit. Water use for lawn and garden irrigation may be restricted based on a standard precipitation index (SPI) calculated and posted monthly on the Department website during the irrigation season. Quarterly measurements must be taken and submitted to the Department annually. CGWA was designated 1/3/12 through Administrative Rulemaking (ARM 36.12905).
Larson Creek Controlled Groundwater Area Ravalli County	All new groundwater appropriations require a permit. CGWA was designated 11/14/1988 by Final Order.
Powder River Basin Controlled Groundwater Area Powder River County	Applies only to wells designed and installed for the extraction of coalbed methane (CBM). CBM operators must offer water mitigation agreements to owners of water wells or natural springs within the area that may be impacted by the operation. CGWA was designated 12/15/1999 by Final Order.
South Pine Controlled Groundwater Area Fallon, Prairie, and Wibaux Counties	All new groundwater appropriations require a permit. CGWA was designated 11/1/1967 by Final Order.
Yellowstone Controlled Groundwater Area	All new groundwater appropriations require a permit. Water use must be measured and reported annually. NPS is notified of pending permits and given opportunity to object. CGWA was established on 1/31/94 under the Reserved Water Rights Compact between NPS and State of Montana.

16. Legislative Basin Closures (map)



Description:

- The figure above includes Controlled Groundwater Areas, Administrative Rule Closures, a Montana Supreme Court Order Closure, DNRC-Ordered Milk River Closures, Compact Closures, and Legislative Basin Closures.

Timeframe: 1973-2023

Summary:

- The five Legislative Basin Closures are summarized in the table below. Per §85-2-319, MCA, the Legislature may stop applications for new appropriations and applications for state water reservations in highly appropriated basins.

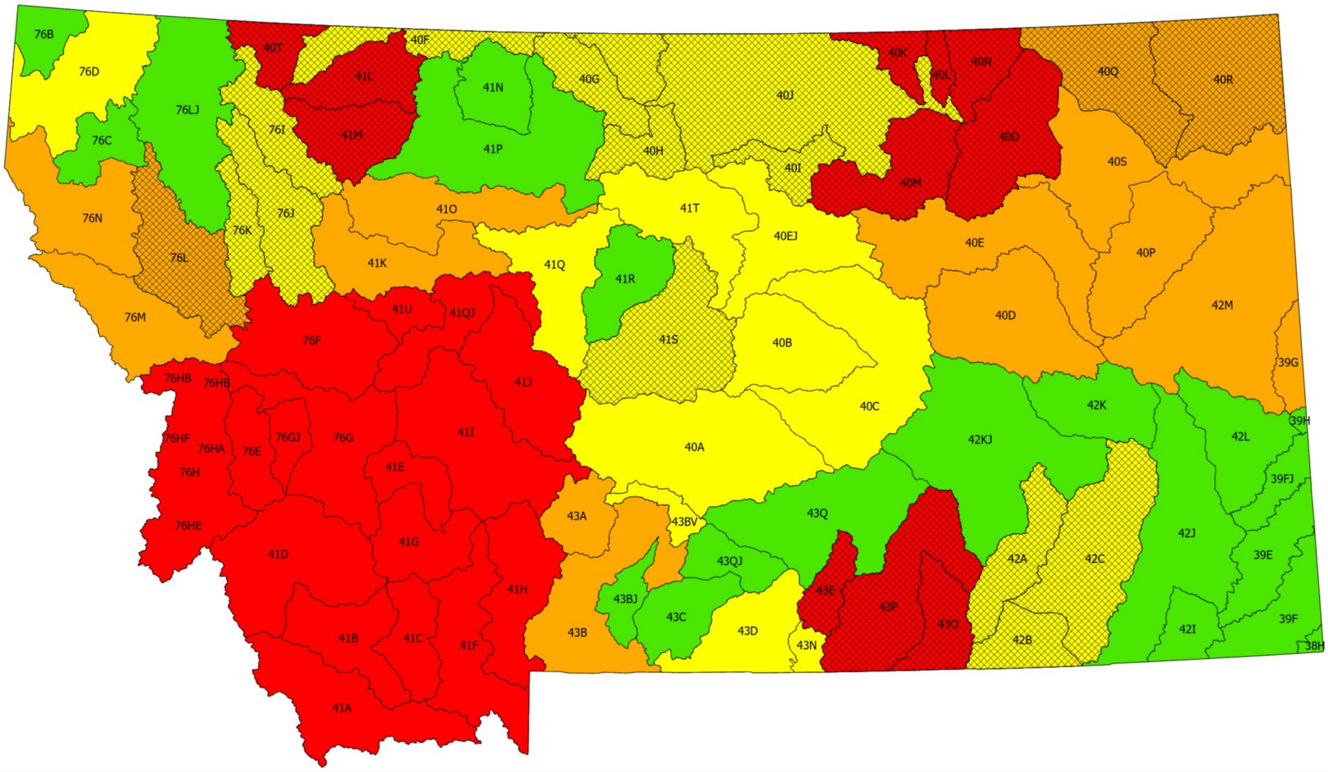
Limitations:

- More information about all types of closures can be found on the Department website.

17. Legislative Basin Closures (table)

Legislative Basin Closures	
Closure	Special Circumstances
Upper Clark Fork River Basin Legislative Closure §85-2-336, MCA	DNRC may not grant a permit unless it meets one of the exceptions. Created a steering committee to report and make recommendations to the Legislature regarding the closure every five years.
Bitterroot River Basin Legislative Closure §85-2-344, MCA	DNRC may not grant a permit until closure terminates* **2 years after all water rights in the subbasin arising under the law of the state are subject to an enforceable and administrable decree as provided in §85-2-406(4), MCA** or if it meets one of the exceptions.
Upper Missouri River Basin Legislative Closure §85-2-343, MCA	DNRC may not grant a permit unless it meets exceptions. This closure **is temporary** until final decrees have been issued for all the subbasins of the Upper Missouri River basin.**
Jefferson-Madison River Basin Legislative Closure §85-2-341, MCA	DNRC may not grant a permit unless it meets one of the exceptions.
Teton River Basin Legislative Closure §85-2-330, MCA	DNRC may not grant a permit unless it meets one of the exceptions.
*Allowing the Bitterroot closure to terminate may allow permits to be granted for a few months of the years when water is legally available. **Pending the adjudication, allowing the closure to terminate DNRC would still not be able to grant permits due to no water being legally available.	

18. Qualitative assessment: ability to permit a new well without mitigation due to legal availability issues and/or adverse effect (map)



Description:

- For a groundwater permit application, legal availability of hydraulically connected surface water must be evaluated. Legal availability of surface water is determined by analyzing physical availability minus legal demands. To find water legally available, the modeled depletions from the proposed groundwater appropriation need to be less than or equal to the amount of water found to be legally available[1]. If water is not legally available, mitigation is required.
- Adverse effect is evaluated based on the applicant's plan for the exercise of the permit. The plan must demonstrate they can adequately control their water use so that prior appropriators' rights may be satisfied. Legal availability of water may influence the ability of a permit applicant to satisfy this requirement.
- These qualitative assessments are based on regional manager expertise from regional application processing, regional specific hydrology expertise from field visits and published scientific studies, and regional public anecdotal information.
- Green basins – a groundwater permit may be obtained without mitigation
- Yellow basins – groundwater permit without mitigation generally possible
- Orange basins – mitigation more likely than not required to obtain a groundwater permit
- Red basins – mitigation required to obtain a groundwater permit
- Crosshatch – permitting without the need for mitigation is complicated by compacts or other major basin closures

[1] Permit Application Manuals (see pages 37-50)

Timeframe: 2023 assessment

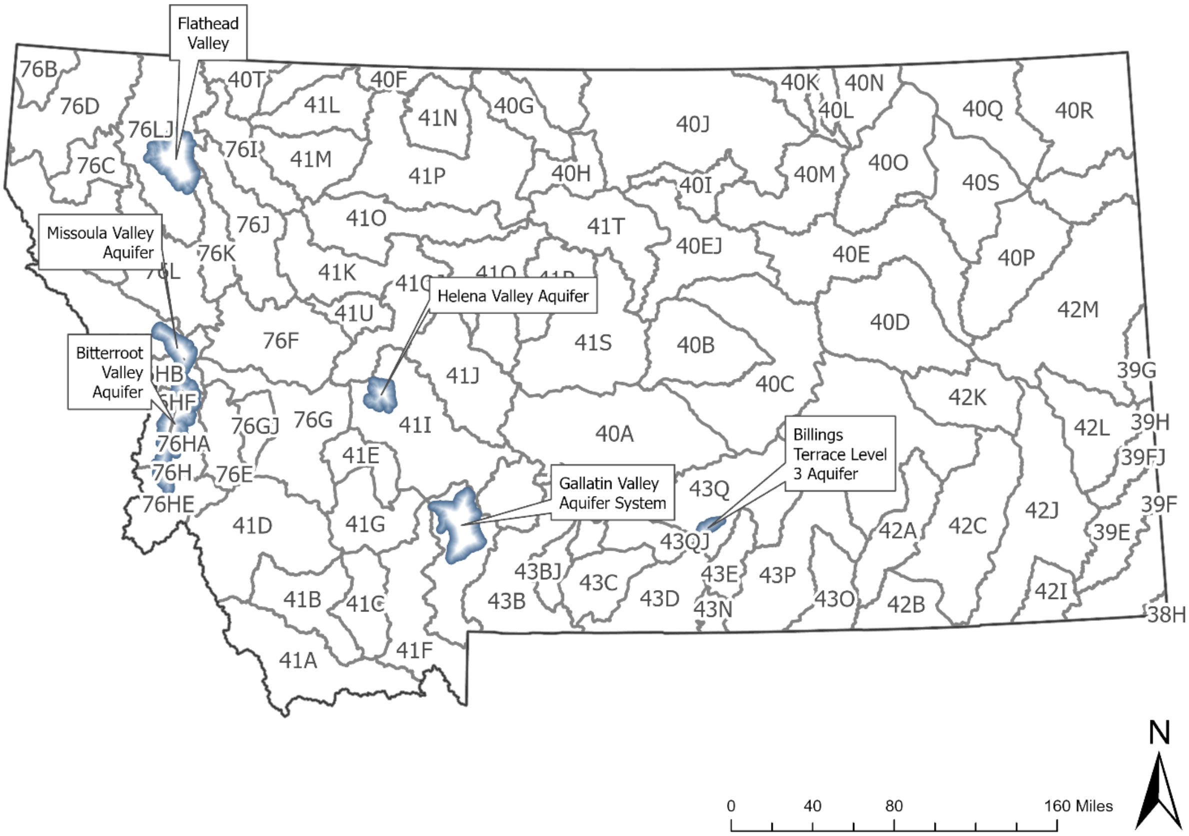
Summary:

- Most basins colored Yellow/Orange/Red are due to groundwater/surface water connection, and no, or limited, remaining surface water legal availability.
- Four basins are noted to have limited groundwater physical availability (43N, 42M, 41T and 40EJ)
- 26 Basins (crosshatch – not including red legislatively closed basins that also have federal and tribal compacts) are noted to have challenges to permit groundwater because of federal or tribal compacts

Limitations:

- Legal Availability and Adverse effect are assessed on an application-by-application basis
- Montana Integrated Hydrologic Model System (MIHMS, coming end of 2024) will have a detailed analysis of physical availability statewide for surface water, with a long-term plan to have legal demands and groundwater analysis, incorporated into the modeling effort.
- Limitations of GW models and errors: groundwater models have uncertainty in four main areas including the conceptual framework, model parameters, calibration, and prediction. In general, model and groundwater model uncertainty should be positively approached to make better decisions including where additional data can be collected and the caveats with model outputs. There are no documented model uncertainty standards, unlike what is recorded for most other published data (i.e., streamflow records/gaging error).

19. DNRC identified focus aquifers that warrant further discussion and investigation.



1.

Description:

- The DNRC took previous data and identified aquifers that warrant further discussion and investigation. This is a preliminary analysis to spur further conversation.
- Appendix A includes an analysis of the five focus aquifers.

Rationale for focus aquifer selection:

1. Aquifers with high concentration of exempt wells (figures 8), where density could have cumulative impacts.
2. Aquifer productivity and long-term flux/decline, which may indicate aquifer capacity limitation (appendix).
3. Aquifers with known hydraulic connection to surface water, which may deplete surface waters (appendix).
4. Surface Water Basin Closures (figure 17), if there is SW/GW connectivity, potential to deplete surface waters.
5. New ground water permitting is likely to require mitigation (figure 17), if there is SW/GW connectivity, potential to deplete surface waters.

Timeframe: 2023

Summary:

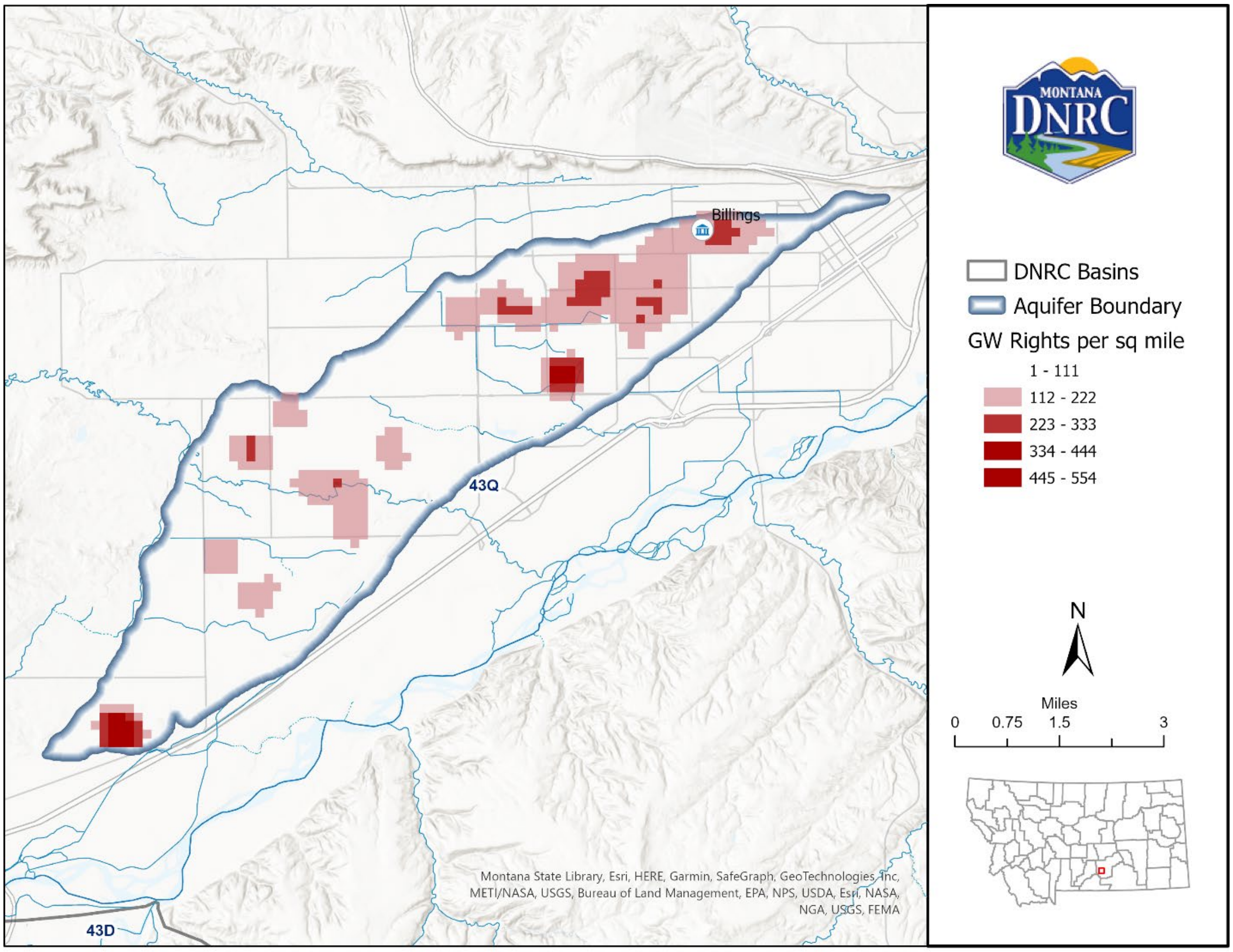
	High density of wells	Potential for aquifer decline	SW connectivity & legal availability concerns	Basin closures with potential to deplete surface waters	New GW permit likely to require mitigation
Billings (43Q)	x	x			
Helena (41I)	x	x	x	Upper Missouri	x
Flathead valley (76LJ)	x				
Missoula & Bitterroot (76H & M)	x	possible	x	Bitterroot	x
Gallatin (41H)	x	x	x	Upper Missouri	x

Limitations:

– Additional aquifers that may warrant additional investigation:
  - Tobacco Valley Aquifer (Eureka area)
  - Lower Yellowstone Buried Channel Aquifer (Sidney area)
  - Ennis Area Aquifer
  - Horse Creek Aquifer (Three Forks area)
  - Seeley Lake Area Aquifer
  - Spokane Creek Area Aquifer (East Helena Area)
  - Virginia City Area Aquifer

Appendix A. State of the science for focus aquifers

1. Billings Terrace Aquifer (43Q)



Type: Alluvial, unconfined

General Description:
Multiple relatively thin terraces of alluvial deposits lie above the floodplain of the Yellowstone River and have groundwater level changes of up to 50 feet, respectively (Olson and Reiten, 2002). The aquifers are thought to be discontinuous and discharge to small springs throughout their extent. Most of the recharge to the aquifers specifically Qat3 as mapped by Lopez (2000), is through agricultural irrigation and approximately a third through precipitation (Olson and Reiten, 2002). Evapotranspiration and runoff, limits precipitation as primary source of aquifer recharge. General groundwater flow direction is from northwest to southeast at a relatively flat gradient of 0.002 ft/ft to 0.006 ft/ft (Olson and Reiten, 2002). A groundwater model by Chandler and Reiten (2019) shows that modeled groundwater level declines is dependent on losses of flood irrigation, density of development, and timing of pumping for lawn irrigation. The model domain created by Chandler and Reiten (2019) shows a tipping point at which lawn irrigation pumping exceeds flood irrigation recharge and therefore creates an unsustainable aquifer yield.

Physical Availability:
The average annual recharge and discharge to a portion of this aquifer is approximately 35,100 acre-feet per and 16,400 acre-feet per year, respectively (Olson and Reiten, 2002). The reported water right volume (permits & gwct) for the entire aquifer is approximately 11,800 acre-feet per year.

Legal Demand: 5,558 AF for all groundwater rights within the Billings Terrace Level 3 aquifer. 16% of water rights did not have a volume assigned.

Legal Availability: Groundwater and surface water are open in the basin. No existing cases of issues with legal demand in basin.

Total Population[1]: 76,887
Area (sq miles): 27
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]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.

DNRC Scientific Memo: Billings Level 3 Terrace Aquifer Memo (DNRC, 2022) establishes a standard transmissivity and storage coefficient for the aquifer.

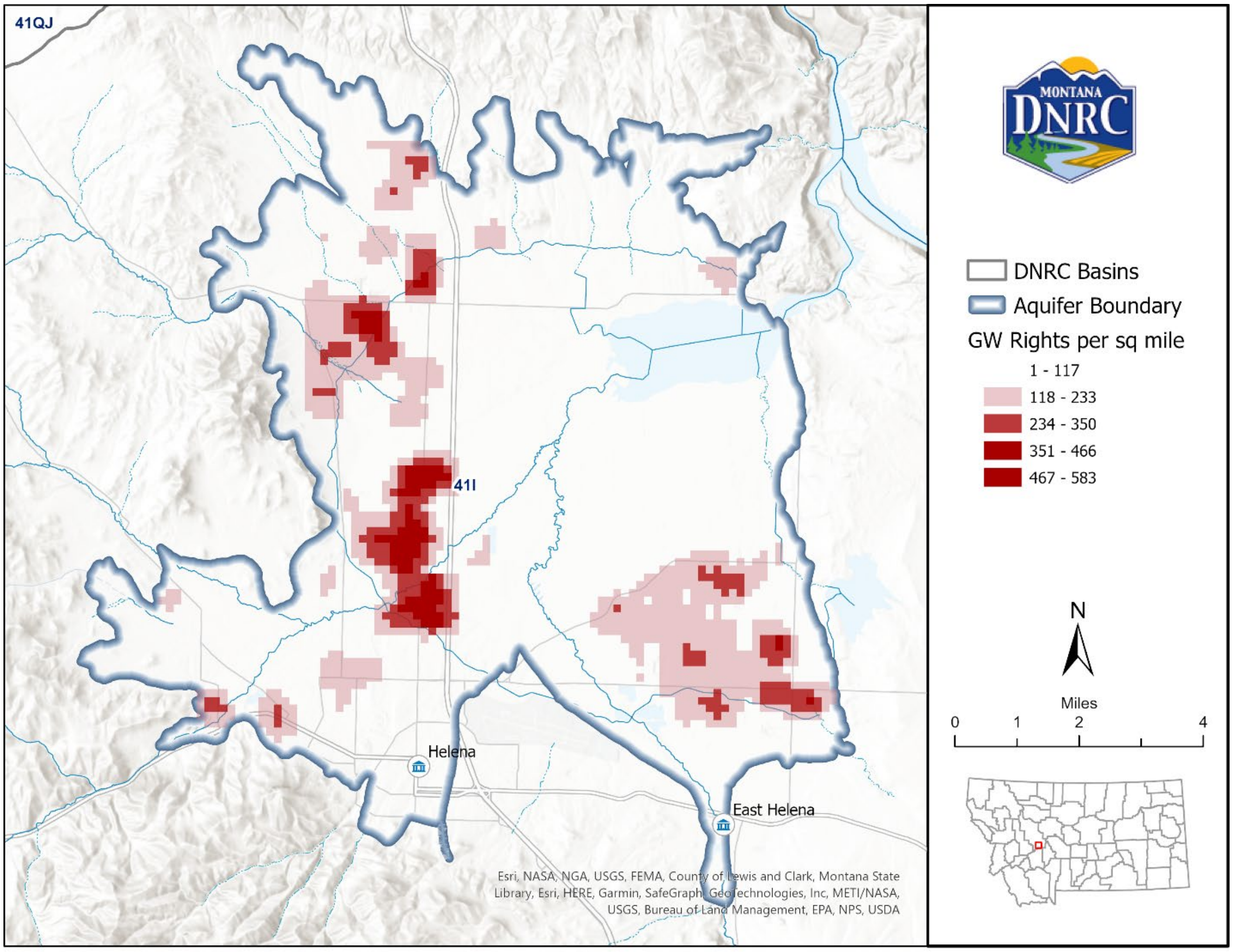
Concerns/Issues/Notes:
An ongoing Montana Bureau of Mines and Geology (MBMG) Groundwater Investigation Program (GWIP) study (approximately 62 mi^2) is investigating the hydraulic connections between the terrace aquifers including potential flow paths and fluxes between terraces and impacts of development and land use changes on the aquifer. The aquifer is likely heavily dependent on recharge from numerous large irrigation ditches and may be vulnerable to major land use changes related to population growth.

Literature:
Chandler, K., and Reiten, J., 2019, West Billings groundwater model: Aquifer response to land-use change in the West Billings area, Montana: Montana Bureau of Mines and Geology Open-File Report 716, 59 p.

Lopez, D.A., 2000, Geologic map of the Billings 30' x 60' quadrangle, Montana: Montana Bureau of Mines and Geology Geologic Map 59, 1 sheet, scale 1:100,000.

Olson, J.L., and Reiten, J.C., 2002, Hydrogeology of the west Billings area: Impacts of land-use changes on water resources: Montana Bureau of Mines and Geology Report of Investigation 10, 32 p., 2 sheets.

2. Helena (41I)



Type: Alluvial, unconsolidated sediments (unconfined, leaky confined)

General Description:
The depth of the unconsolidated alluvium including tertiary sediments in the Helena Valley has been estimated at 6,000 feet. Transmissivity estimates of 10,000 ft2/day represent water bearing zones in the valley fill (Briar, 1992). Water flows from the bedrock boundaries of the valley toward Lake Helena. Recharge is through stream (15%) and irrigation canal losses (8%), infiltration of applied irrigation water (31%), and inflow from fractures in bedrock (46%). The discharge out of the aquifer is leakage to streams and drains (41%), upload flow to Lake Helena (57%), and groundwater withdrawals (2%) (Briar and Madison, 1992). Considering population growth data and increase in groundwater rights, well withdrawals is a large component of the total current discharge from the aquifer.

Physical Availability: New surface and groundwater permit applications are seldom received in this aquifer. Physical availability of groundwater has not been quantified for this aquifer.

Legal Demand: 38,167 AF for all groundwater rights within the Helena Valley aquifer. 20% of water rights did not have a volume assigned. There has been a significant increase in the percent of discharge out of the aquifer due to groundwater developments compared to the modeled data from Briar and Madison (1992), however, an updated water balance has not been calculated.

Legal Availability: Upper Missouri Legislative closure, all new permits or adverse effect to surface water bodies requires mitigation water.

Total Population[1]: 73,115
Area (sq miles): 87
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]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.

DNRC Scientific Memo: No scientific memo exists for this aquifer.

Concerns/Issues/Notes:
Areas of growth around the alluvial fill, specifically in Tertiary sediments and Bedrock in the Scratch gravel area and East Helena/Spokane Bench areas. Controlled groundwater area (52.5 mi2) in the North Hills as part of the MBMG Groundwater Investigation Study limiting exempt wells expired in 2010. Bedrock aquifers and tertiary aged deposits in the Helena Valley area continue to see pressure from subdivision growth, limited recharge, and overall poor well production. Local faults and geologic contacts slow the propagation of flow through sediments and consolidated rock. The Helena Valley aquifer is likely heavily dependent on recharge from large irrigation ditches and may be vulnerable to major land use changes related to population growth. City of Helena is in the process of perfecting its groundwater reservation, to develop a high capacity well field located in the Helena Valley Aquifer.

Literature:
Briar, D.W., and Madison, J.P., 1992. Hydrogeology of the Helena valley-fill aquifer system, west-central Montana: U.S. Geological Survey Water Resources Investigations Report 92-4023, 92 p., https://pubs.usgs.gov/wri/1992/4023/report.pdf.

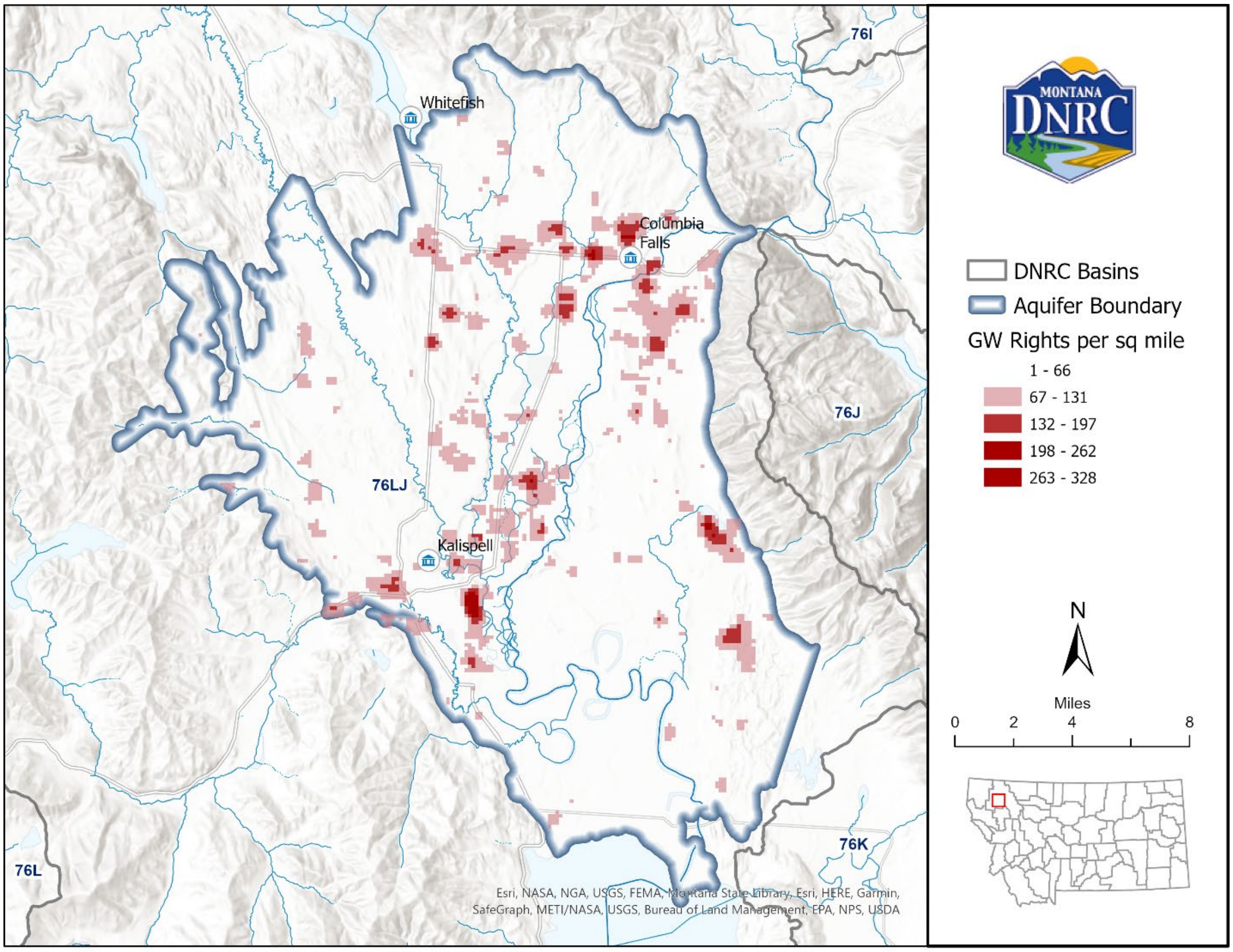
Lorenz, H.W., and Swenson, F.A., 1951, Geology and ground-water resources of the Helena Valley, Montana, with a section on the chemical quality of water, by H.A. Swenson: U.S. Geological Survey Circular 83, 68 p.

Madison, J.P., 2006. Hydrogeology of the North Hills, Helena, Montana: MBMG Open-File Report 544, 36 p., http://www.mbmg.mtech.edu/pdf-open-files/mbmg544-helenavalleyhydrogeology.pdf.

Moreland, J.A. and Leonard, J.B., 1980, Evaluation of shallow aquifers in the Helena Valley, Lewis and Clark County, Montana: U.S. Geological Survey Water-Resources Investigation, Open-File Report 80-1102.

Thamke, J.N., 2000, Hydrology of the Helena area bedrock, west-central Montana, 1993-1998 with a section on Geologic setting and a generalized bedrock geologic map by M.W. Reynolds: U.S. Geological Survey Water-Resources Investigations Report 00-4212, 119 p.

3. Flathead County (76LJ)



Type: Primarily semi-confined deep alluvium aquifer, also unconfined shallow aquifer

General Description:
The Flathead Valley Aquifer System can generally be categorized into six hydro stratigraphic units: the basement Belt bedrock aquifer; Tertiary aquifer; deep alluvial aquifer; silt, clay, gravel zone of the deep alluvial aquifer; discontinuous lacustrine-till aquitard; and the shallow aquifer (Rose, J., 2018). The deep alluvial aquifer is composed of coarse gravels and sand that support high production wells, while the upper portion of the deep aquifer system is composed of fine grain sediments that support smaller yields. The discontinuous lacustrine-till aquitard is composed of silt and clay, water can move vertically through it but extremely slow (0.0007 ft/day) (Rose et al., 2022). The thickness of the aquitard ranges from 4 ft to 790 ft. The thickness of the deep alluvium is interpreted to be in the range of 1,000 ft to 1,500 ft. The thickness of the upper portion of the deep aquifer system is 0 to 100 ft (Rose, J., 2018). The two units within the deep aquifer system may intertongue with each other and with the lacustrine-till aquitard. The shallow unconfined aquifer lies within surficial deposits, which include all sediments emplaced above the lacustrine deposits and includes post-glacial, Holocene deposits of fluvial river and delta sediments, unconsolidated colluvium, mountain-front landslide debris, till on bedrock along the valley margins, glacial drift, debris flows, and eolian sands. Groundwater flow in both the shallow and deep aquifer system generally is towards the center of the Flathead valley and south (Rose et al., 2022 and Smith et al., 2004).

Physical Availability:
Recharge to the unconfined aquifer and semi-confined deep alluvial aquifer occurs primarily along mountain fronts surrounding the valley and is likely augmented by vertical seepage through the aquitard. Approximately 2,800 acre-ft per year recharges in the northern portion of the deep aquifer boundary area through the aquitard (Rose et al., 2022). A published recharge value has not been quantified for any other part of the aquifer system.

Legal Demand: 143,372 AF for all groundwater rights within the Flathead Valley aquifer boundary. 19% of water rights did not have a volume assigned.

Total population[1]: 97,750
Area (sq miles): 344
Number of Permits: 305 (3% of groundwater rights within aquifer boundary)
Number of Exempt Wells: 7,584 (83% of groundwater rights within aquifer boundary)

[1]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.

DNRC Scientific Memo: Legal Availability of Groundwater in the Flathead Deep Aquifer, 2019; Evergreen Aquifer Geothermal/Heat Exchange Wells, 2010

Concerns/Issues/Notes:
Recharge has not been quantified for the deep aquifer as the aquifer system is heterogeneous, complex, and extensive. Connection between the deep aquifer and small surface water sources is unknown or poorly understood in most areas. The Evergreen Aquifer (unconfined, center of valley) is prolific and known to have a direct connection to the Flathead River.

Literature:
Konizeski, R.L., Brietkrietz, A., and McMurtrey, R.G., 1968, Geology and ground water resources of the Kalispell Valley, northwestern Montana: Montana Bureau of Mines and Geology Bulletin 68, 42 p., 5 sheets.

Lafave, J., 2004. Dissolved constituents map of the deep aquifer, Kalispell valley, Flathead County, Montana. Montana Bureau of Mines and Geology

Lafave, J., 2004. Potentiometric surface map of the deep aquifer, Kalispell valley: Flathead County, Montana. Montana Bureau of Mines and Geology

LaFave, J.I., Smith, L.N., Patton, T.W., 2004. Ground-water resources of the Flathead Lake Area: Flathead, Lake, and parts of Missoula and Sanders counties. Part A- Descriptive overview, Montana Bureau of Mines and Geology: Ground-Water Assessment Atlas 2A, 132 p.

McDonald, Catherine, LaFave, J.I., 2004, Groundwater assessment of selected shallow aquifers in the north Flathead Valley and Flathead Lake perimeter, northwest Montana: Montana Bureau of Mines and Geology Open-File Report 492, 40 p.

Myse, T., Bobst, A., Rose, J., 2023. Analyses of Three Constant-Rate Aquifer Tests, East Flathead Valley, Northwest Montana, Montana Bureau of Mines and Geology

Rose, J., 2018. Three-dimensional hydrostratigraphic model of the subsurface geology, Flathead Valley, Kalispell, Montana: Montana Bureau of Mines and Geology Open-File Report 703, 44 p. Plate 1.

Rose, J., Bobst, A., and Gebril, A., 2022a. Hydrogeologic Investigation of the Deep Alluvial Aquifer, Flathead Valley, Montana, Montana Bureau of Mines and Geology.

Rose, J., Bobst, A., Berglund, J.,2022b. An Evaluation of the Unconsolidated Hydrogeologic Units in the South-Central Flathead Valley, Montana, Montana Bureau of Mines and Geology

Smith, L.N., 2004. Altitude of and depth to the bedrock surface: Flathead Lake Area, Flathead and Lake Counties, Montana. Montana Bureau of Mines and Geology

Smith, L.N., 2004. Depth to deep alluvium of the deep aquifer in the Kalispell valley: Flathead County, Montana. Montana Bureau of Mines and Geology

Smith, L.N., 2004. Hydrogeologic framework of the southern part of the Flathead Lake Area, Flathead, Lake, Missoula, and Sanders counties, Montana. Montana Bureau of Mines and Geology

Smith, L.N., 2004. Surficial geologic map of the upper Flathead River valley (Kalispell valley) area, Flathead County, northwestern Montana

Smith, L.N., 2004. Thickness of shallow alluvium, Flathead Lake Area, Flathead, Lake, Missoula, and Sanders counties, Montana. Montana Bureau of Mines and Geology

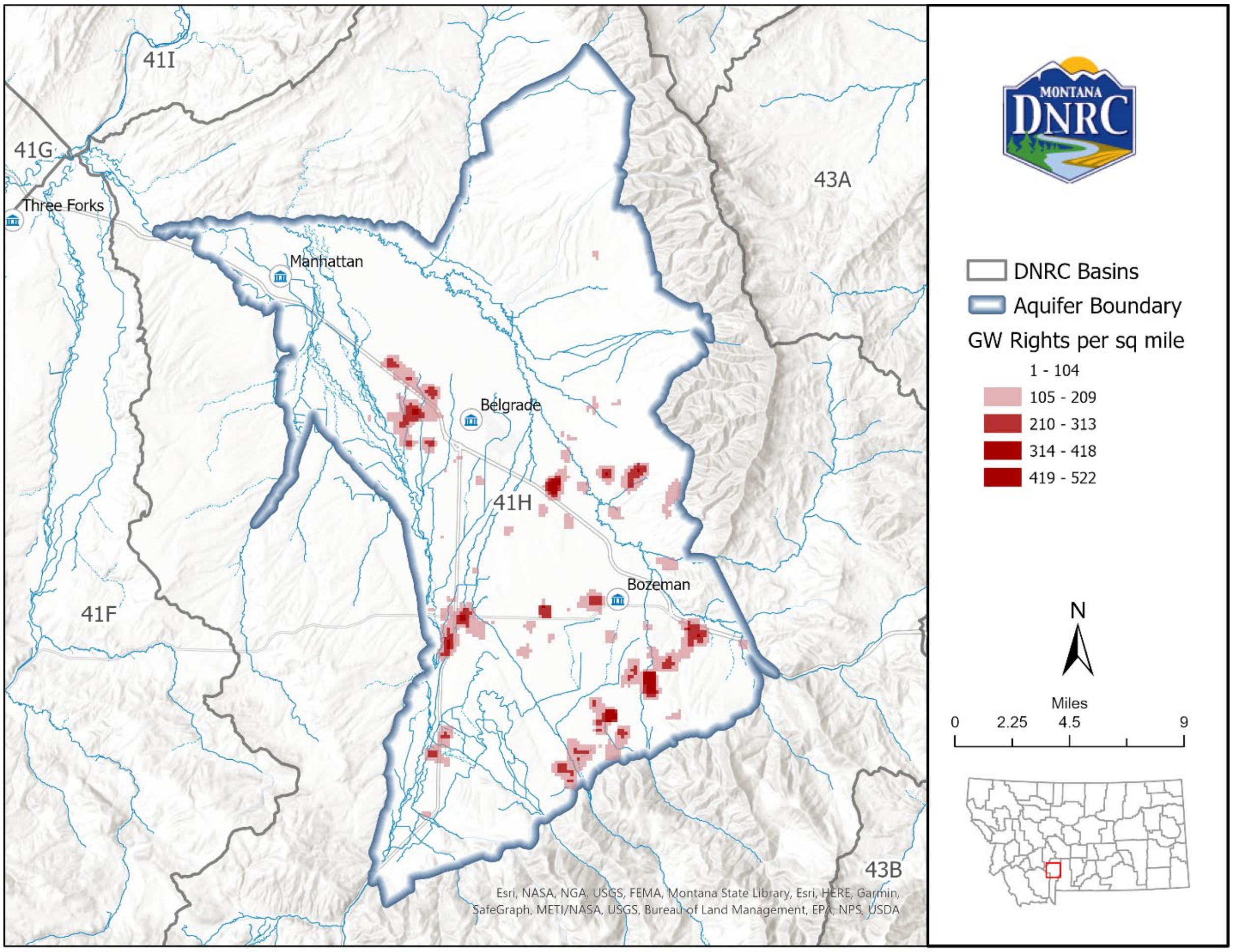
Smith, L.N., 2004. Thickness of the confining unit in the Kalispell valley, Flathead County, Montana. Montana Bureau of Mines and Geology

Smith, L.N., LaFave, J.I., Carstarphen, C.A., Mason, D.C., and Richter, M.G., 2004. Ground-water resources of the Flathead Lake Area: Flathead, Lake, and parts of Missoula and Sanders counties. Part B- Maps, Montana Bureau of Mines and Geology: Ground-Water Assessment Atlas 2A, 132 p.,

Uthman, W., Waren, K., and Corbett, M. 2000. A reconnaisance ground water investigation in the upper Flathead River valley area.

Waren, K.B., and Patton, T.W., 2007, Ground-water resource development in the Flathead Lake ground-water characterization area, Flathead, Lake, Missoula, and Sanders counties, Montana: Montana Bureau of Mines and Geology Ground-Water Open-File Report 19, 2 sheets.

4. Gallatin (41H)



Type: Primarily shallow alluvial/unconfined, also semi-confined, confined, and perched aquifers

General Description:
The Gallatin Valley aquifer has been described as a regional aquifer system due to unconfined, confined, and perched conditions throughout the valley. However, quaternary and tertiary sediments act as one aquifer system on basin scale where local clay layers are discontinuous. The most productive zone is the coarse quaternary fluvial deposits underlying Gallatin Gateway, Belgrade, Central Park, Upper East Gallatin, and Manhattan, which are typically less than 100 ft thick. Tertiary basin-fill sediments may be up to 4,000 ft thick in the vicinity of the Central Park fault zone and the base of the Gallatin Range. MBMG Hydrogeologic Investigation of the Four Corners Area (2020) identified canal leakage as the largest component of groundwater recharge after groundwater inflow to the study area. Water budget simulations were most sensitive to loss of canal leakage than an increase in domestic water use.

Physical Availability: 2010 water budget from MBMG 4 corners study was 169,000 AF/yr +/- 5,000 AF (within study area).

Legal Demand: 74,067 AF for all groundwater rights within the Gallatin Valley aquifer boundary. 23% of water rights did not have a volume assigned.

Total Population[1]**:** 113,608
Area (sq miles): 352
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]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.

DNRC Scientific Memo: No scientific memo exists for this aquifer.

Concerns/Issues/Notes:
Hydrogeologic Investigation of the Four Corners Area (MBMG, 2020) concluded that canal leakage was largest component of groundwater recharge. Water budget simulations were more sensitive to loss of canal leakage than increase in domestic water use. City of Bozeman 2013 Integrated Water Resources Plan projects that city will need to increase its water supply by 6,842-17,752 AF by 2062. Evaluated potential to develop 5,810 AF of groundwater (MBMG, 2018).

Literature:
Evaluation of potential high-yield groundwater development in the Gallatin Valley

Geographic, geologic, and hydrologic summaries of intermontane basins of the northern Rocky Mountains, Montana, USGS Water-Resources Investigations Report 96-4025.

Geology and ground-water resources of the Gallatin Valley, Gallatin County, Montana
Water Supply Paper 1482.

Groundwater potential in the Bozeman Fan Subarea, Gallatin County (to the Water Development Bureau of MT DNRC) 1991

Hydrogeologic investigation of the Belgrade-Manhattan area, Gallatin County, Montana: Superposition groundwater modeling report

Potentiometric surface in Gallatin, Lower Madison, Lower Jefferson, and Upper Missouri River Valleys within parts of Madison and Gallatin Counties, Montana

Hydrogeologic investigation of the Four Corners area, Gallatin County, Montana

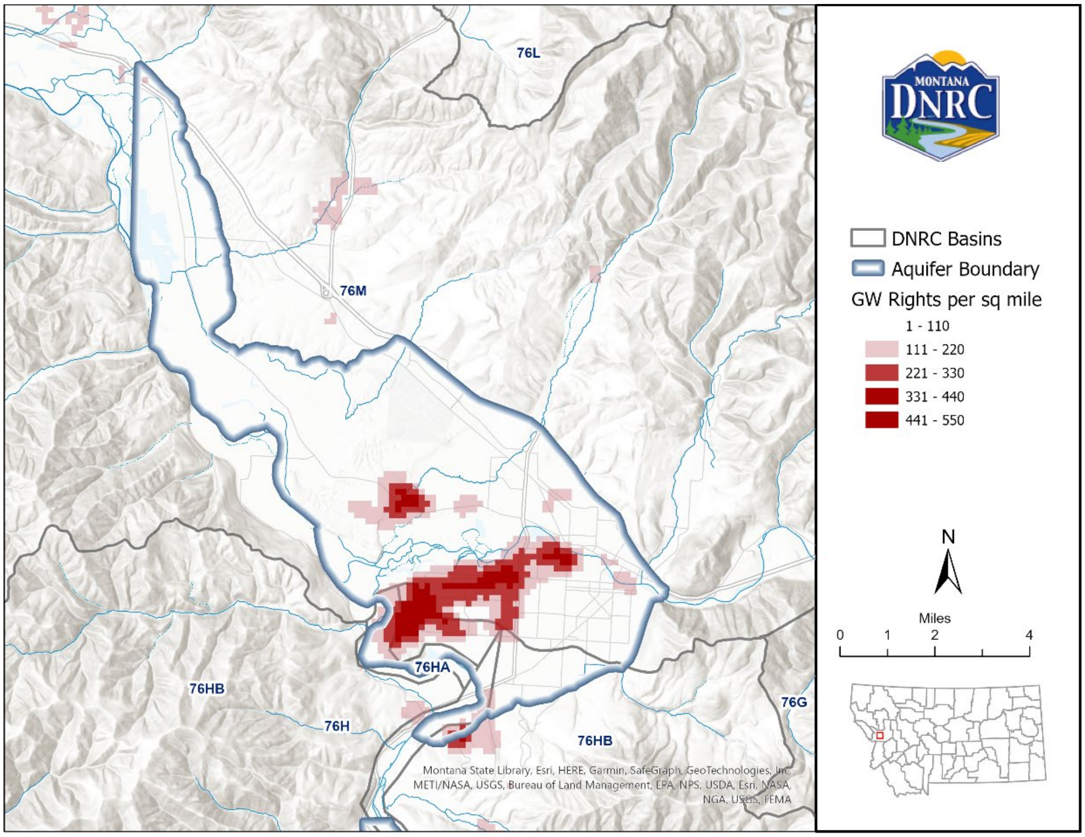
Hydrogeologic investigation of the Four Corners study area, Gallatin County, Montana, Groundwater Modeling Report

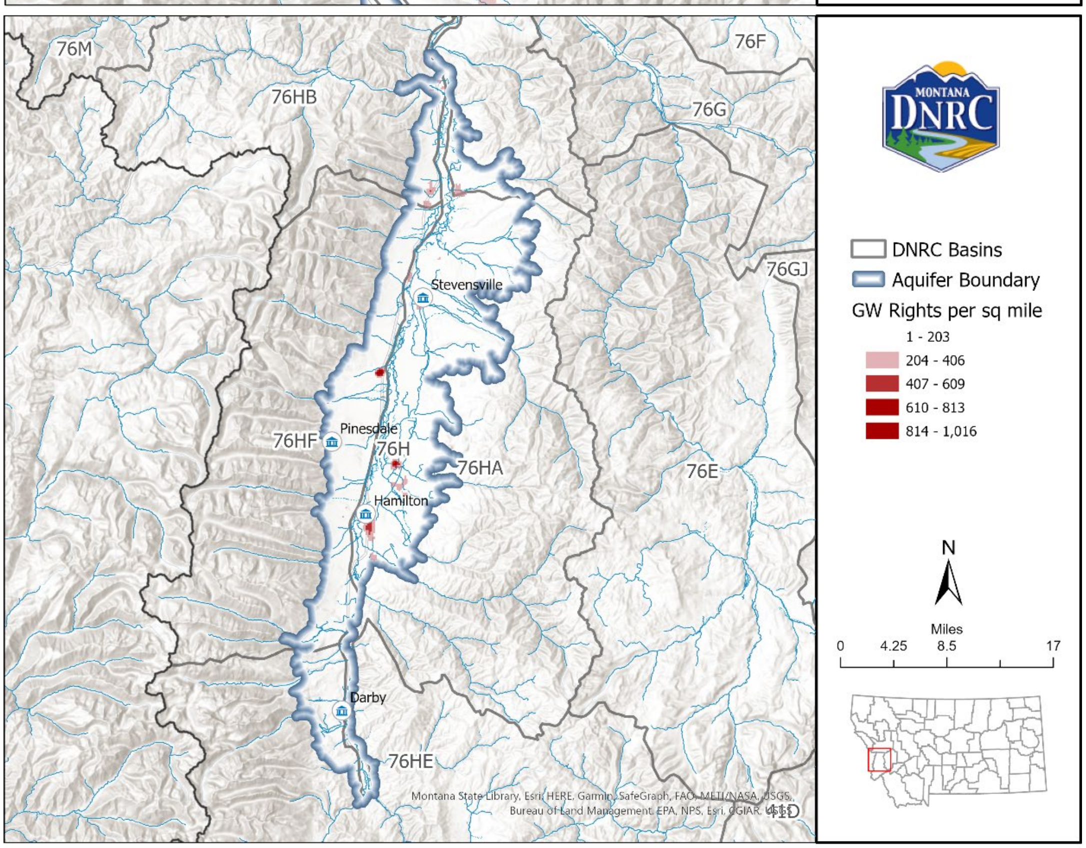
Groundwater quality of Gallatin and Madison Counties, southwest Montana

Data for water wells, springs, and streams visited during the Gallatin-Madison Ground Water Characterization Study

Records of water levels in monitoring wells in the Gallatin Valley, southwestern Montana, 1947-93
Open-File Report 94-536.

5. Missoula and Bitterroot (76H & 76M)





Type:
Bitterroot: System of 3 aquifers: bedrock, deep basin-fill (confined), and shallow basin-fill (unconfined)
Missoula Valley: Unconfined, alluvial, sole-source aquifer

General Description:
Bitterroot: The system is described as 3 regional aquifers: bedrock, deep basin-fill and shallow basin-fill aquifers. The bedrock aquifer is only used by wells on the perimeter of the valley. The deep basin-fill aquifer is semi-confined to confined due to silt and clay-rich layers in primarily tertiary deposits. The shallow basin-fill aquifer is unconfined Quaternary alluvial deposits within 75-80 ft of the ground surface. (LaFave, 2006; Smith and others, 2013; Myse and Hanson, 2023). All three aquifers are interconnected within the valley; recharge to the bedrock aquifer occurs from infiltration and discharge is to streams and to the deep aquifer. The deep aquifer recharge is from the bedrock aquifer and leakage from shallow aquifer or streams along the perimeter of the valley. Discharge is from the upward movement of groundwater from the deep to shallow aquifer.

Missoula Valley: A shallow alluvial aquifer that is bounded by bedrock designated as a sole-source aquifer by the EPA, meaning that this aquifer is the only source of water for Missoula's residents. The unconfined aquifer is comprised of three primary units: unit one (top-most unit) averages 10-30 feet thick and composed of permeable, unconsolidated course sand to boulder-size sediments; unit two (middle unit) averages a thickness of 40 feet and is composed of fine sand and silt with low permeability; unit three (bottom unit) average 50 to 100 feet thick, composed of highly permeable sands and gravels, making this unit highly conductive. The base of the aquifer, below unit three, is not well understood but is assumed to be composed of low-permeability Tertiary sediments. The flow of the aquifer is generally from the northeast to southwest, roughly following the direction of flow of the Clark Fork and Bitterroot rivers.

Physical Availability:
Bitterroot: Estimated groundwater inflow in study area near Hamilton was 84,700 AF (2015 groundwater budget, Myse and Hanson 2023).
Missoula Valley: Modeled hydraulic conductivity estimates range from 4,900 to 36,000 ft/d (Pracht, 2001; M.S. Thesis from University of Montana). No flux or volume calculation found so far.

Legal Demand:
Bitterroot: 72,427 AF for all groundwater rights within Bitterroot Valley aquifer boundary. 19% of water rights did not have a volume assigned.
Missoula Valley: 303,648 AF for all groundwater rights within Missoula Valley aquifer boundary. 14% of water rights did not have a volume assigned.

Total population[1]:
Bitterroot: 62,202
Missoula Valley: 99,158

[1]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.

Area (sq miles):
Bitterroot: 391
Missoula Valley: 51
Number of Permits:
Bitterroot: 176 (1% of groundwater rights within aquifer boundary)
Missoula Valley: 133 (4% of groundwater rights within aquifer boundary)
Number of Exempt Wells:
Bitterroot: 13,434 (89% of groundwater rights within aquifer boundary)

Missoula Valley: 2,312 (74% of groundwater rights within aquifer boundary)
DNRC Scientific Memo:
Bitterroot: No scientific memo exists for this aquifer.
Missoula Valley: Variance – Missoula Valley Geothermal/Heat Exchange Wells, 2010

Concerns/Issues/Notes:
Bitterroot: Groundwater budget in Myse and Hanson 2023 shows largest impact to groundwater system is loss of irrigation with conversion to residential rather than domestic use directly. Estimated up to 75% of groundwater recharge was result of canal leakage and irrigation return flows.
Missoula Valley: There doesn't appear to be any more recent flux estimate or any estimate of total volume of water in the Missoula Aquifer. There is also a gap in our understanding of recharge to the Missoula Valley from both mountain front recharge and recharge from major surface water sources (i.e. Clark Fork River). This presents an area that probably warrants further study and understanding for future water resource management and conservation in the Missoula Valley aquifer.

Literature:
Bitterroot:
Aquifer tests completed in the Bitterroot Valley, Hamilton, Montana
http://mbmg.mtech.edu/mbmgcat/public/ListCitation.asp?pub_id=32351&#gsc.tab=0
Groundwater quantity and quality near Hamilton, Montana
http://mbmg.mtech.edu/mbmgcat/public/ListCitation.asp?pub_id=32556&#gsc.tab=0
Hydrogeologic investigation of the Stevensville study area, Ravalli County, Montana: Interpretive report
http://mbmg.mtech.edu/mbmgcat/public/ListCitation.asp?pub_id=32329&#gsc.tab=0
Groundwater resources of the Lolo-Bitterroot area: Mineral, Missoula, and Ravalli counties, Montana Part A * - Descriptive Overview and Water-Quality Data
http://mbmg.mtech.edu/mbmgcat/public/ListCitation.asp?pub_id=31614&#gsc.tab=0
Potentiometric surface of the shallow basin-fill, deep basin-fill, and bedrock aquifers, Bitterroot Valley, Missoula and Ravalli counties, western Montana
http://mbmg.mtech.edu/mbmgcat/public/ListCitation.asp?pub_id=16118&#gsc.tab=0
Ground-water resource development in the Lolo-Bitterroot ground-water characterization area
http://mbmg.mtech.edu/mbmgcat/public/ListCitation.asp?pub_id=30092&#gsc.tab=0

Missoula Valley:
Potentiometric Surface of the Basin-Fill and Bedrock Aquifers, Mineral and Missoula Counties, Western Montana; https://mbmg.mtech.edu/pdf-publications/GWAA04B-06.pdf

Detecting Regional Groundwater Discharge to nthe Clark Fork River, Melinda Horne, 2017; https://scholarworks.umt.edu/cgi/viewcontent.cgi?article=1193&context=utpp

The Hydrology of the Central and Northwestern Missoula Valley, C.A. Smith, 1992; https://scholarworks.umt.edu/cgi/viewcontent.cgi?article=8379&context=etd

Tracing Ground-Water Flow in the Missoula Valley Aquifer, Southwest Montana, MBMG, 2002; https://mbmg.mtech.edu/pdf/gwof17.pdf

Flow and Aquifer Parameter Evaluation Using Groundwater Age-Dating, Geochemical Tools and Numerical Modeling: Missoula Aquifer, Western Montana, K.A. Pracht, 2001; https://scholarworks.umt.edu/cgi/viewcontent.cgi?article=8380&context=etd