2015 Montana Water Supply Initiative Inventory of Groundwater Resources in the Lower Missouri Basin

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Lower Missouri BAC

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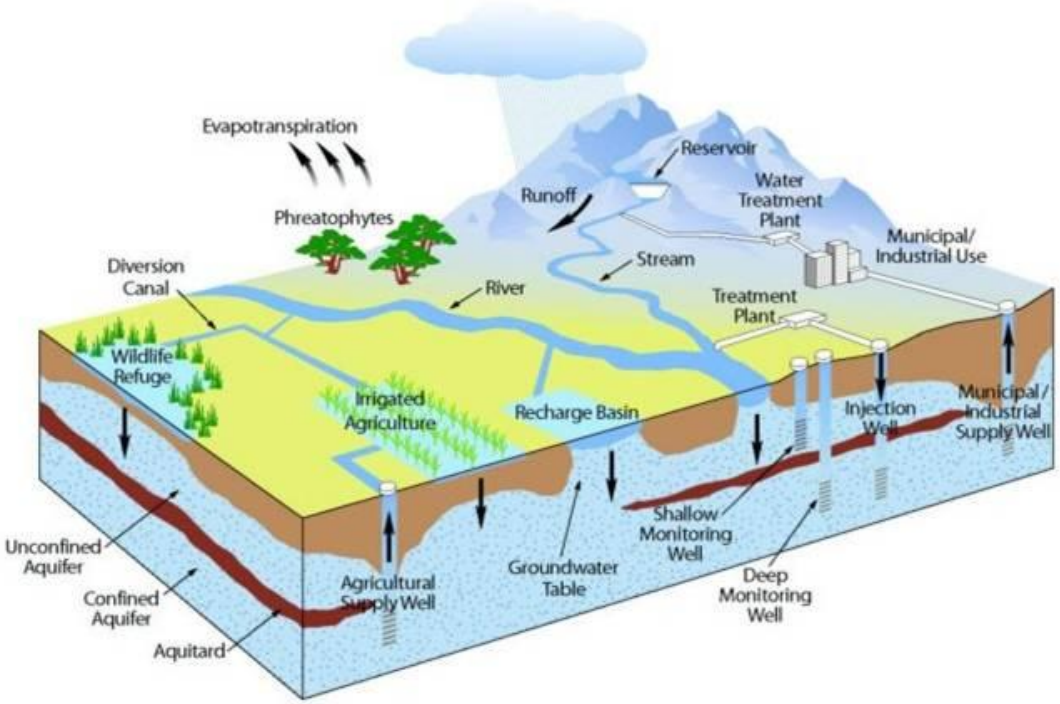
Objectives

- Inventory of aquifers, groundwater levels, and their properties
- Groundwater/surface water interaction
- Past, current, and future groundwater research



Productive Aquifers

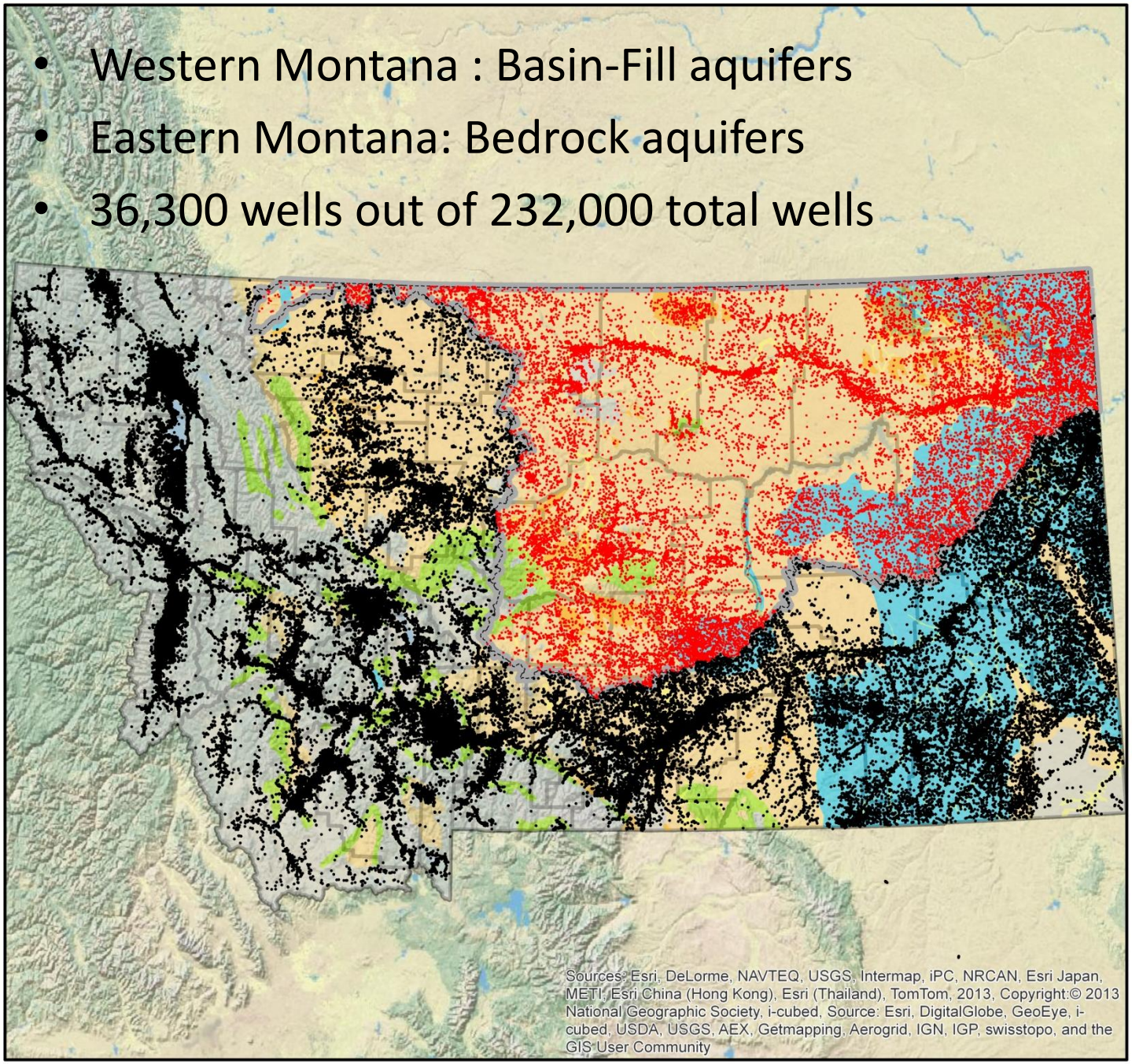
Lower Missouri River Stratigraphy			
Era	*Period*	*Groups and Formations*	
Cenozoic	*Qua.*	Alluvium and Colluvium	
	Neo.	Glacial Outwash	
	Tertiary	Fort Union	Tongue River Member
			Lebo Shale Member
			Tullock Member
Mesozoic	*Cretaceous*	Hell Creek	
		Fox Hills	
		Bearpaw	
		Judith River	
		Claggett	
		Eagle Sandstone (Virgelle)	
		Telegraph Creek	
		Colorado Group	
		Kootenai	
		Morrison	
		Swift	
Paleozoic	*Mississippian*	Amesden	
		Heath	
		Otter	
		Kibbey	
		Madison Limestone	

Location of aquifers shown in shaded boxes

Note: Not to Scale

Lower Missouri Basin Aquifers

- Western Montana : Basin-Fill aquifers
- Eastern Montana: Bedrock aquifers
- 36,300 wells out of 232,000 total wells



MONTANA DNRC
MT DEPARTMENT OF NATURAL RESOURCES & CONSERVATION

Legend

- Lower Missouri Wells
- Wells
- Lower Missouri Watershed
- City
- Aquifers in Quaternary Alluvium
- Aquifers in Tertiary Sand/Gravel
- Aquifers in Cenozoic rocks
- Aquifers in Mesozoic rocks
- Aquifers in Paleozoic rocks
- Not a Principal Aquifer

30 15 0 30 Miles

N

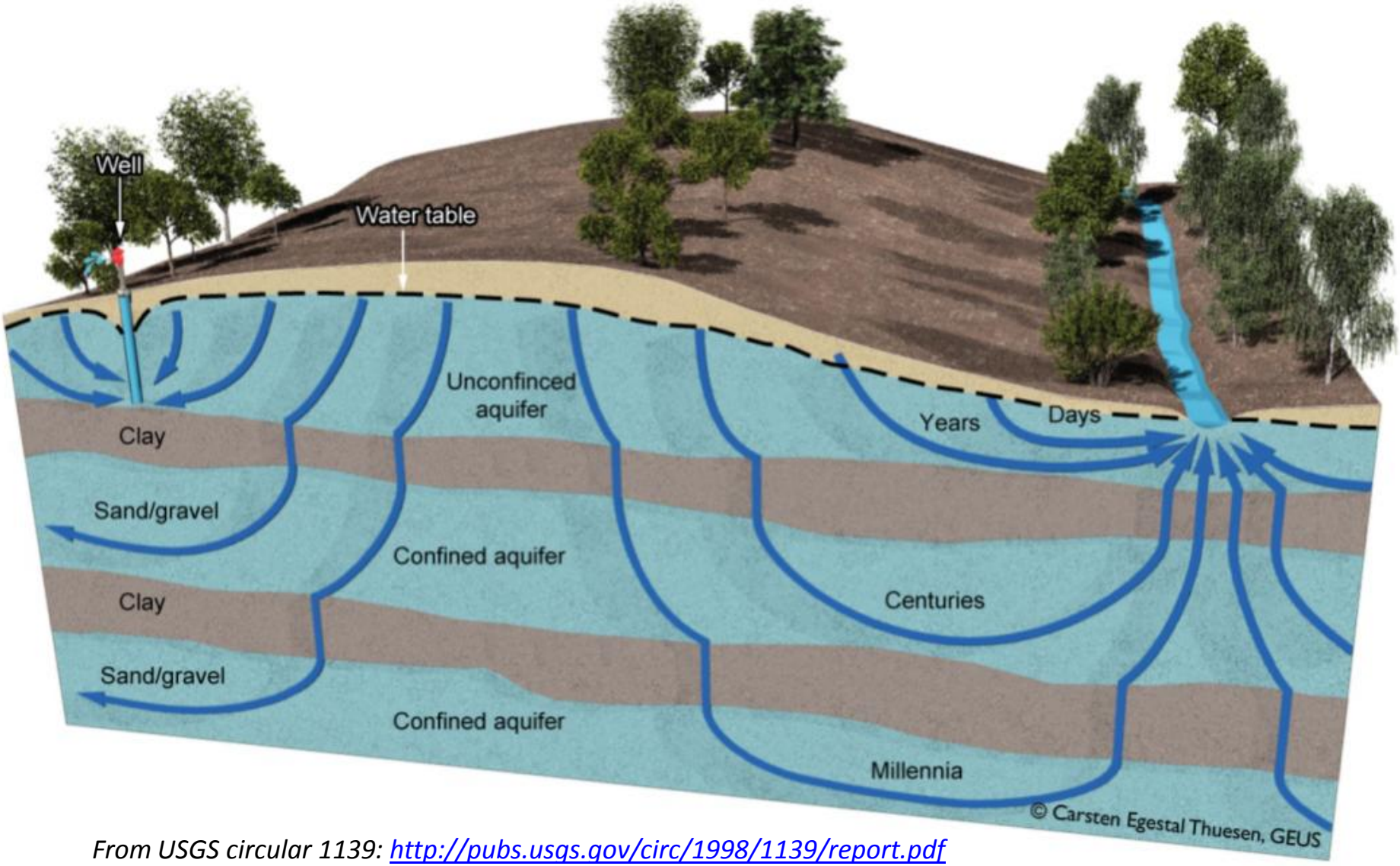
Location Map

Where do people get water in Lo-Mo's 15 Counties?

From USGS-Montana (2000 & 2005) in acre-feet

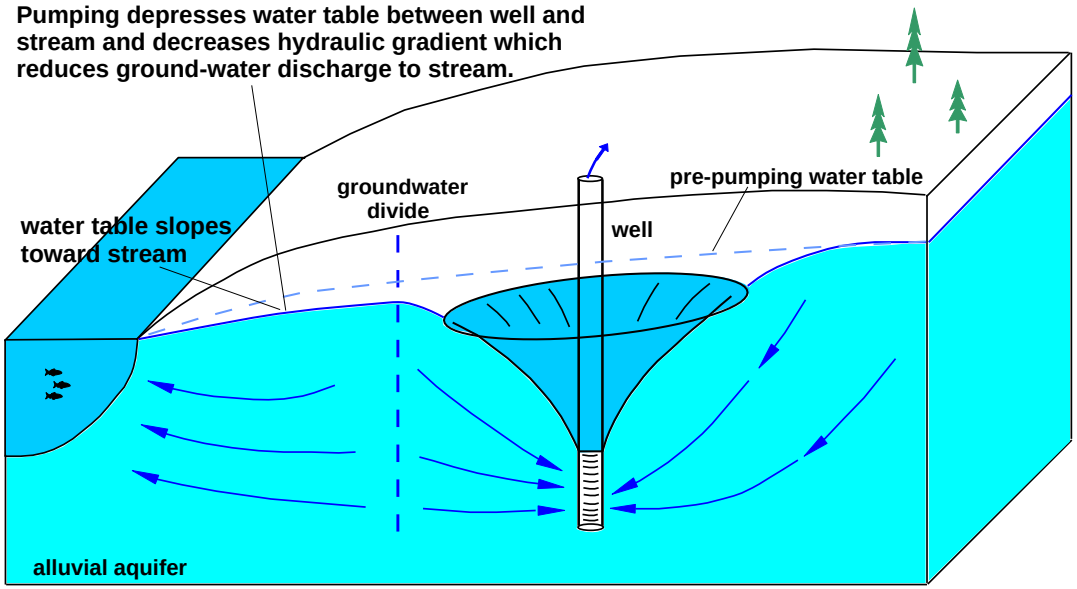
• Total population:	75,055	
• PWS from groundwater	31,070	74 %
• Individual wells:	24,305	
• PWS from surface water	19,680	26 %
• Irrigation (Groundwater)	29,931	2 %
• Stock (Groundwater)	4,195	29 %

Groundwater/Surface Water Connections and Recharge

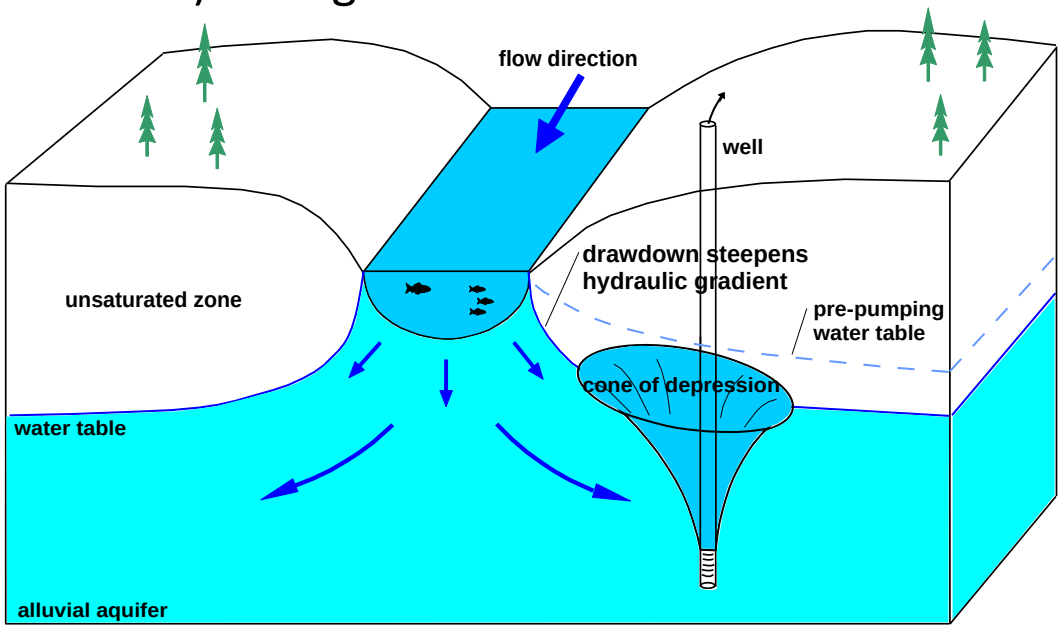


From USGS circular 1139: http://pubs.usgs.gov/circ/1998/1139/report.pdf

1) Gaining Stream - pre-stream capture

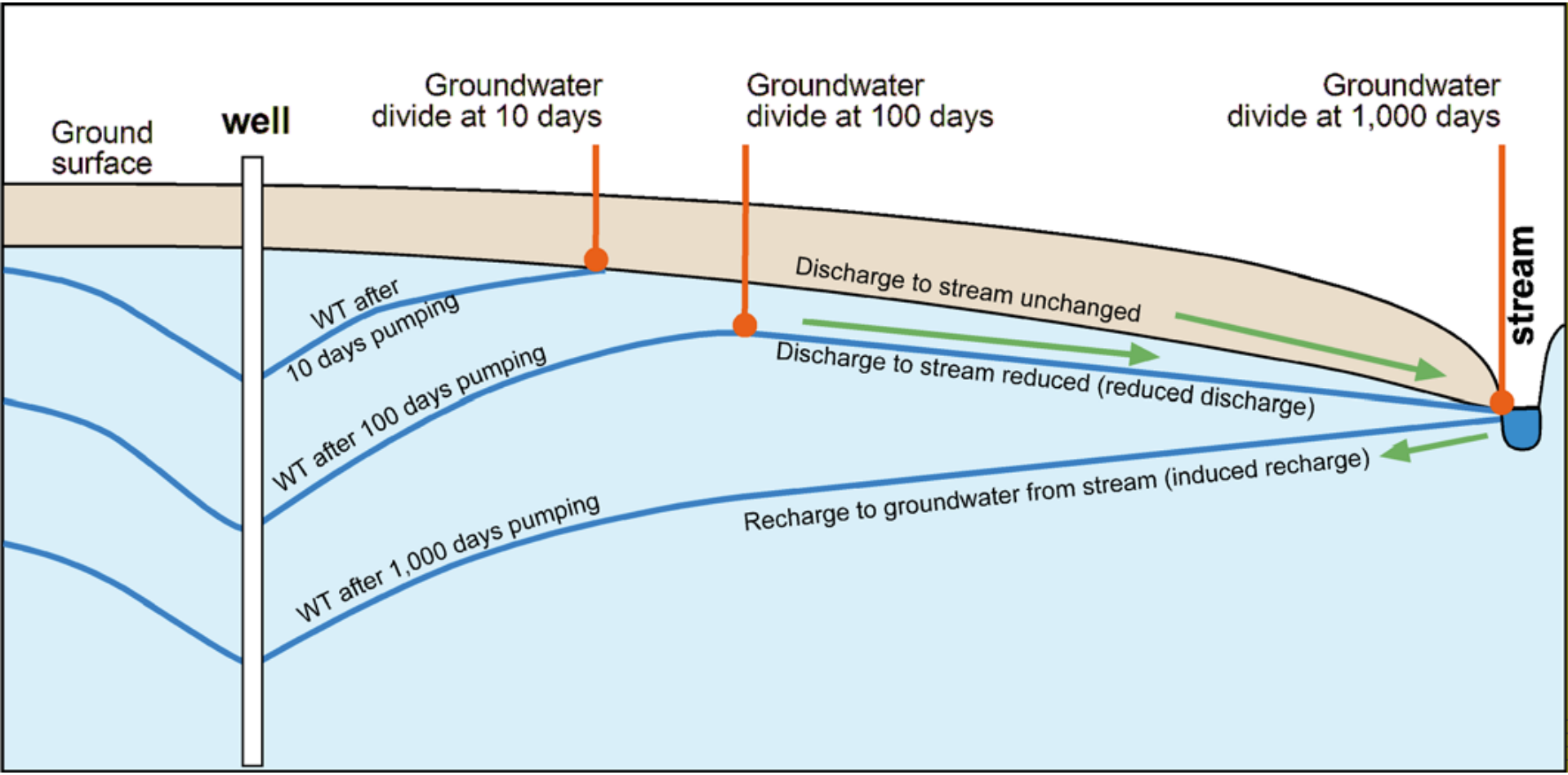


2) Losing Stream - induced infiltration



Induced streambed infiltration is created when pumping draws water directly out of stream, representing increased recharge to aquifer.

Transition from gaining to losing stream

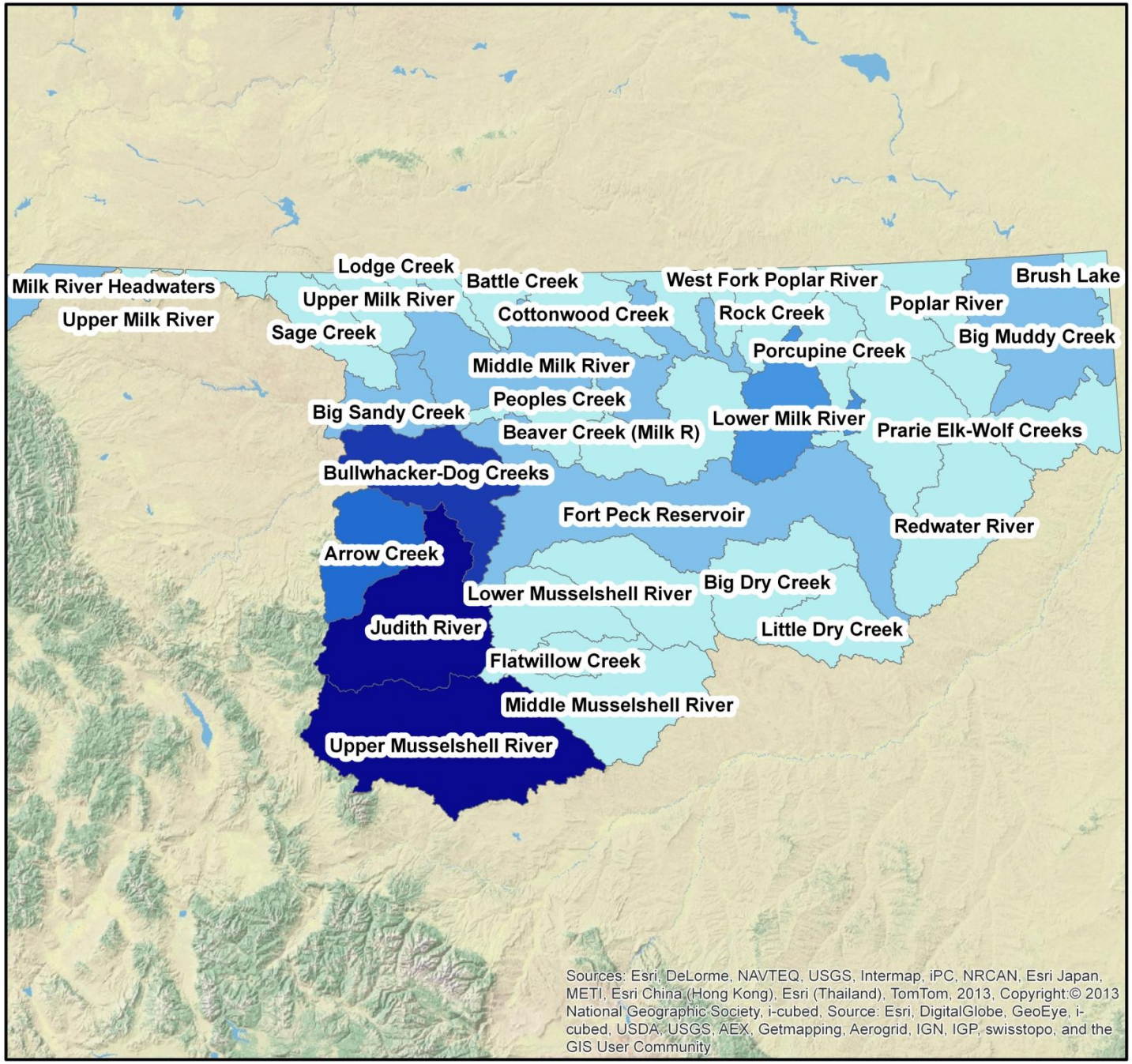


From: http://www.mbmg.mtech.edu/gwip/gwip_pdf/hb831book_appendix.pdf

Groundwater Recharge

- Estimates of recharge are based on base-flow indices (BFI)
- BFI = Surface water baseflow / average flow from USGS gages.
- BFIs estimated/extrapolated from nearby sites- approximately a 1/3 of the sites
- Numerous Assumptions

Lower Missouri Groundwater Recharge



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Lower Missouri Recharge (cfs)

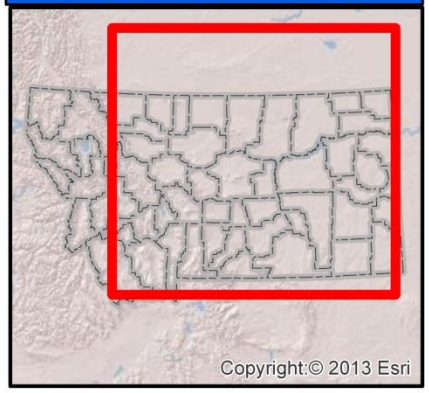
BFI

- 0 - 36
- 37 - 72
- 73 - 108
- 109 - 143
- 144 - 179
- 180 - 215

20 10 0 20 Miles

N

Location Map



Groundwater Research

- USGS Research from ~1924 to Present
  - http://pubs.er.usgs.gov/
- MBMG Research from ~1930 to Present
  - http://www.mbmg.mtech.edu/mbmgcat/catMain.asp

Flood to Center Pivot Conversion (Miller et al., 2002, Teton County)

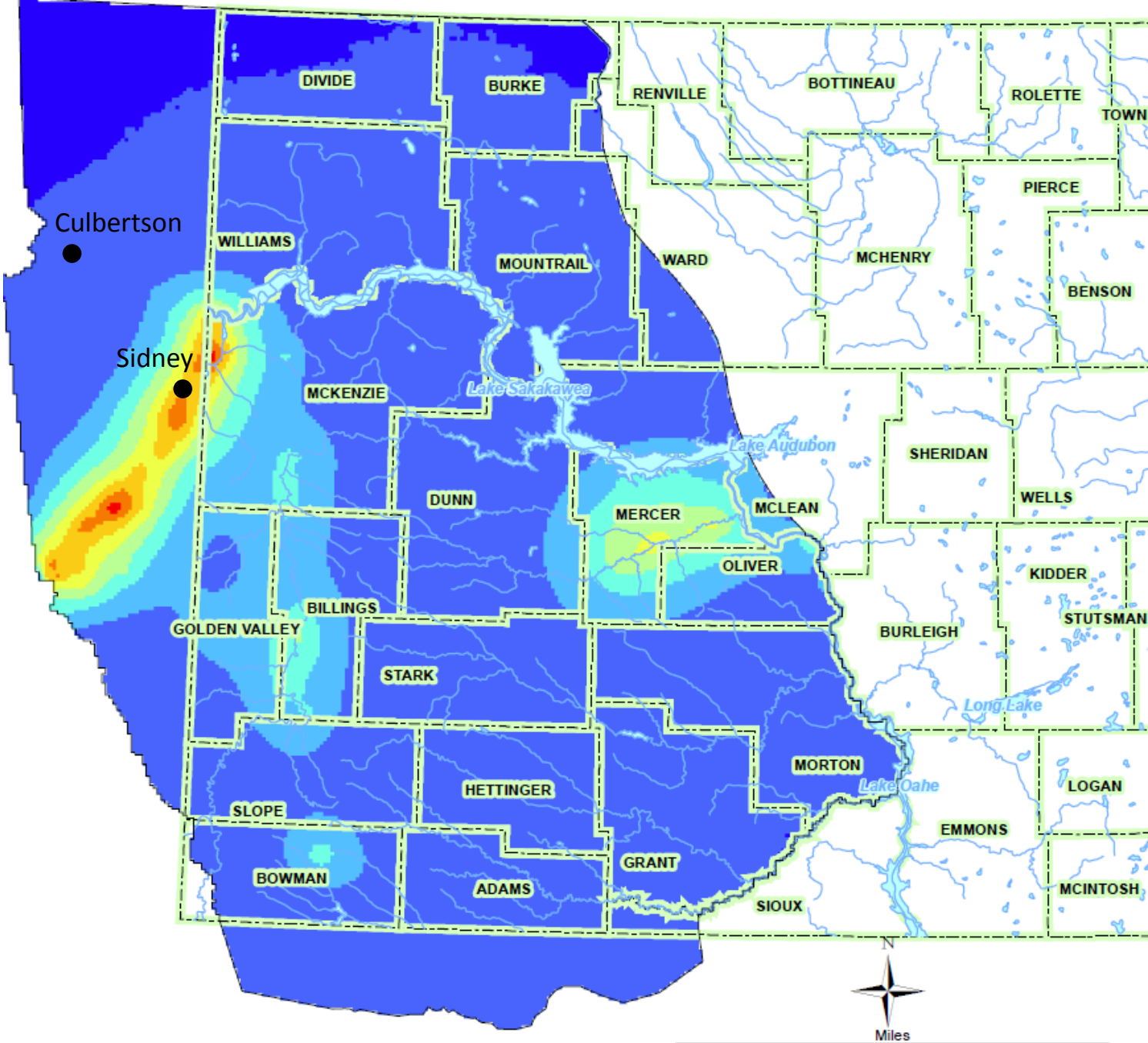
Irrigation method	Recharge (ft) to shallow aquifer	Recharge volume (AF)	Metabolite flux (grams)
Flood (38 acres)	1.0	38.0	22
Wheel line (110 acres)	0.3	31.5	61
Center Pivot (140 acres)	0.1	13.2	0

Controls on Recharge

- Site specific (clay lenses)
- Hydraulic flux
- Groundwater gradients

Project Link: http://www.mbmg.mtech.edu/pdf-open-files/mbmg463.pdf

Fox Hills-Hell Creek Aquifer Model from Fischer (2013)



Legend

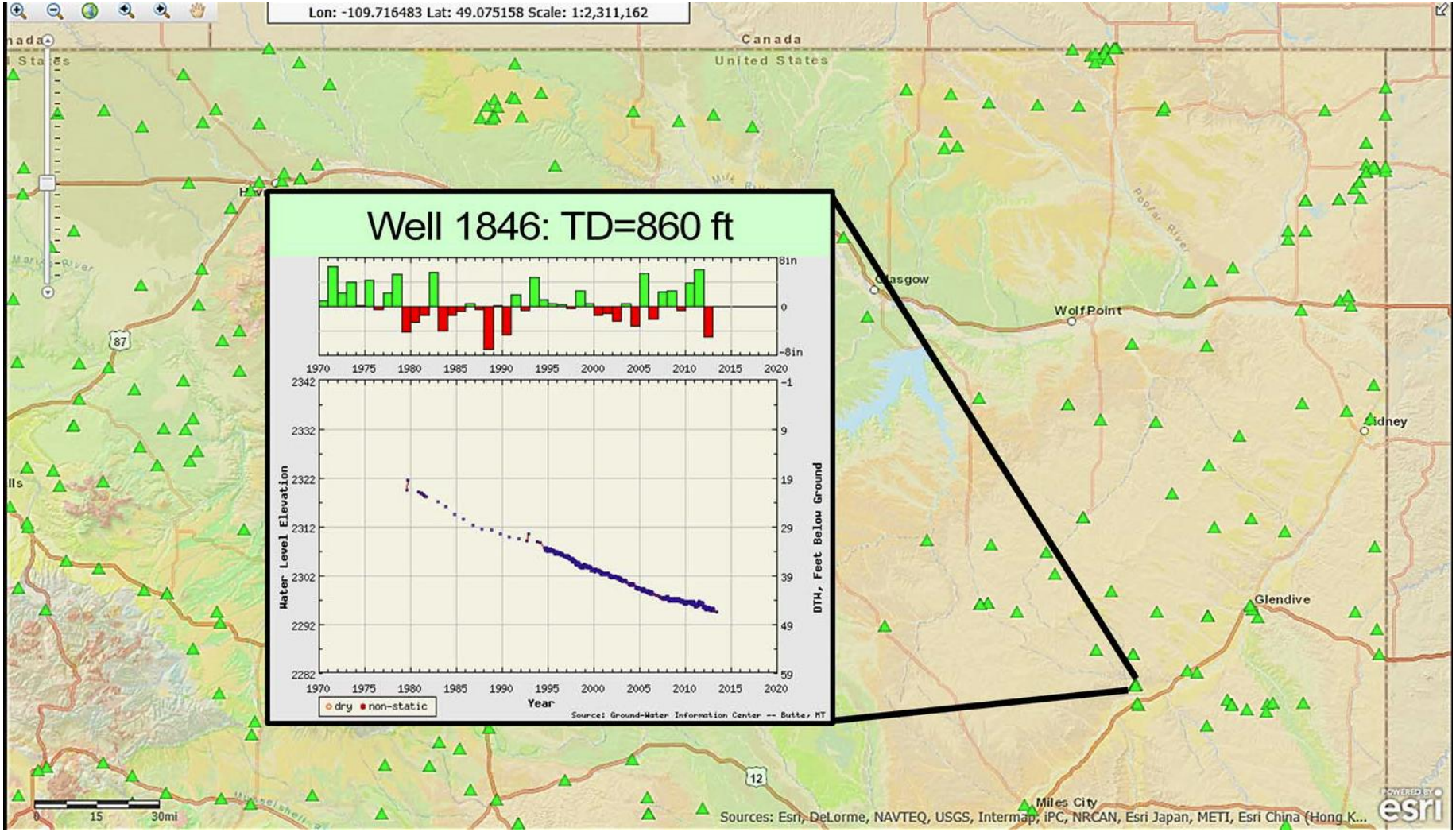
Head Difference

1942 Head - 2009 Head

- 0
- 1 - 25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 175
- 176 - 200

Figure 22. Simulated drawdown in water levels from 1942 to 2009.

Fox Hills Hell Creek aquifer north of Terry, Montana



Future Fox Hills-Hell Creek Aquifer Simulation

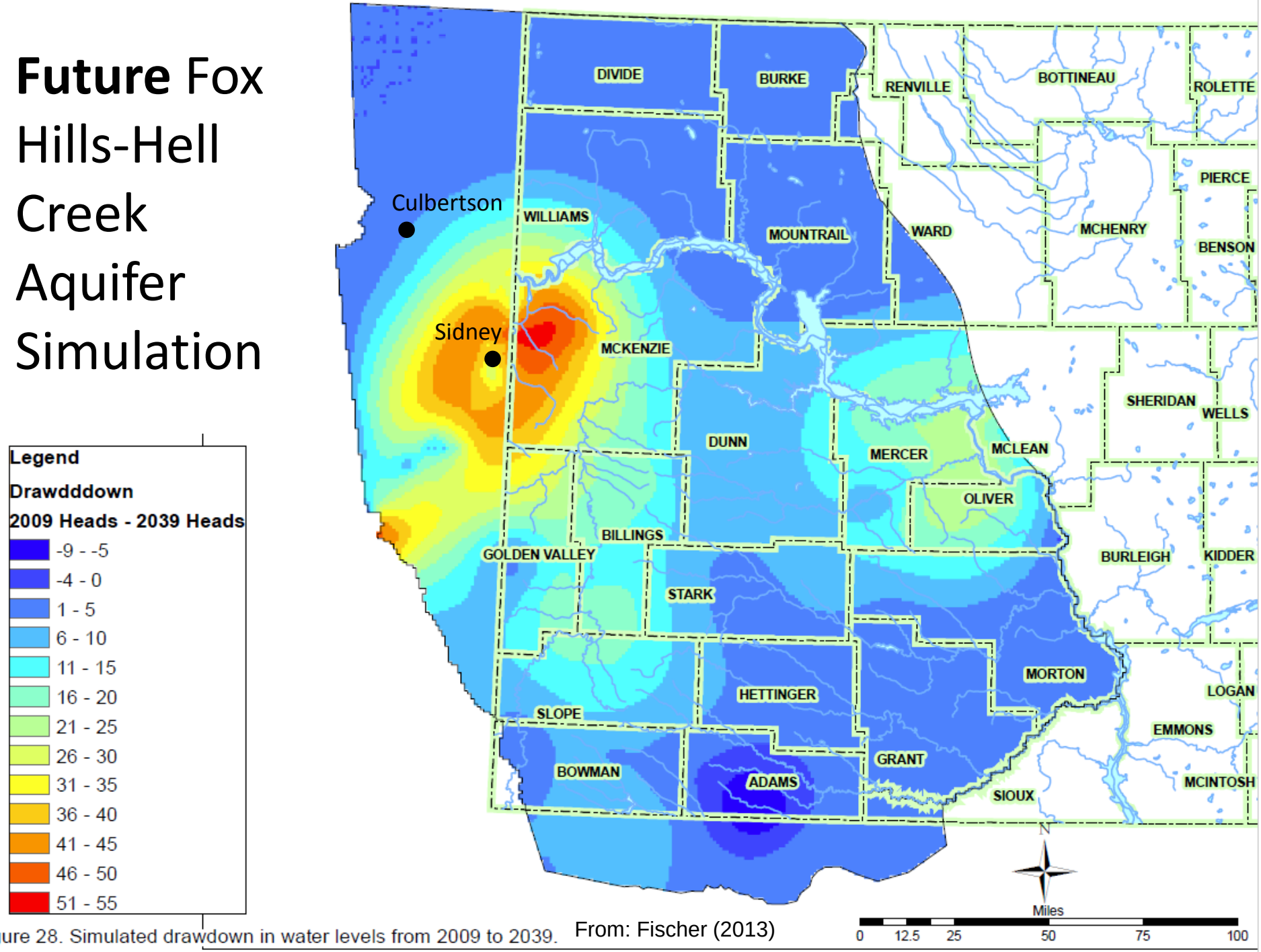
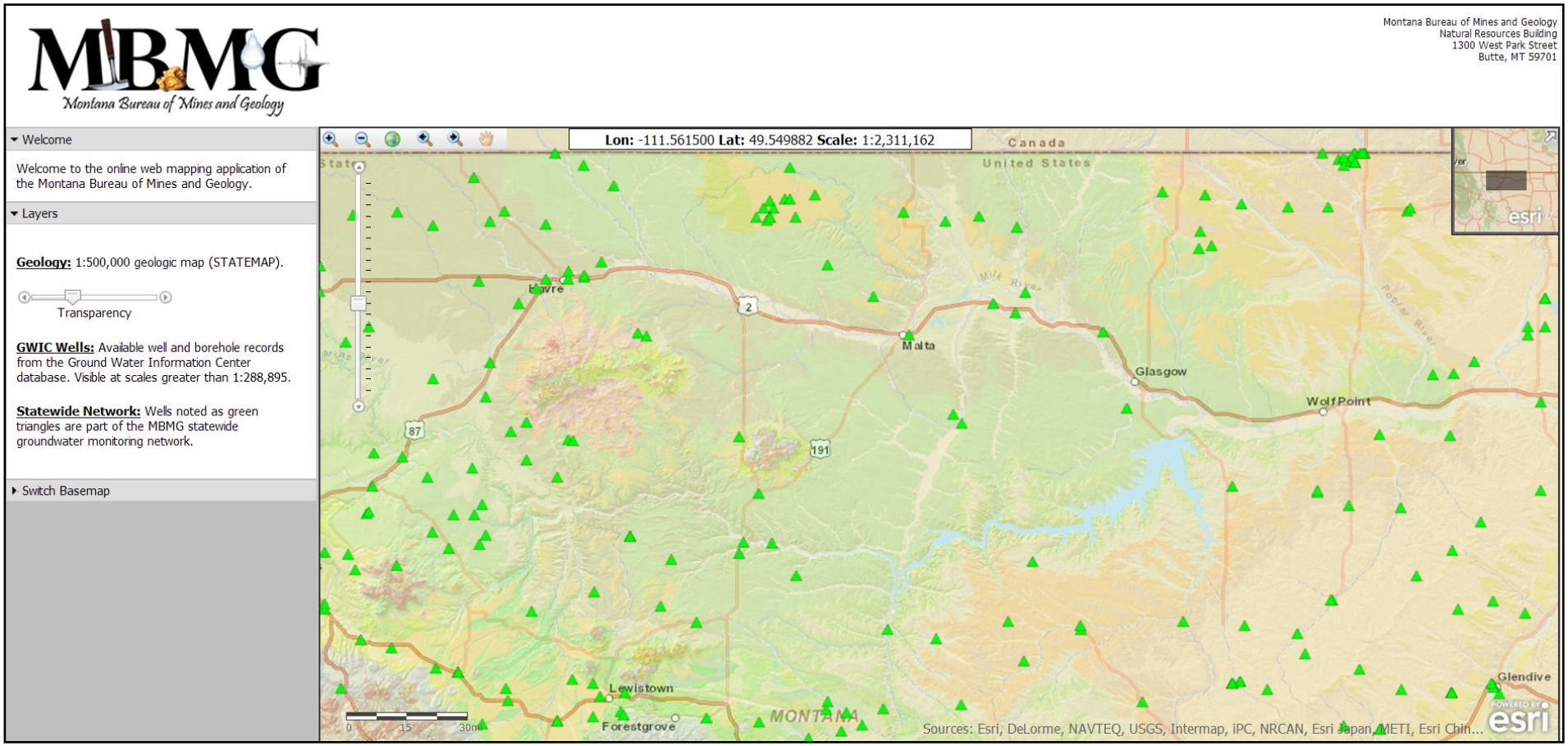


Figure 28. Simulated drawdown in water levels from 2009 to 2039. From: Fischer (2013)

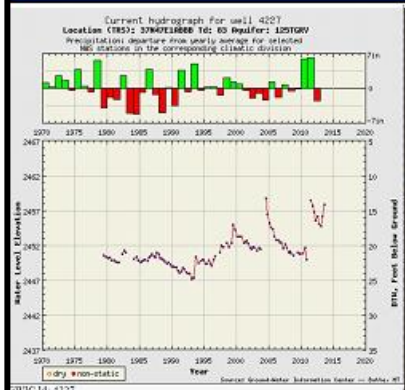
Groundwater Monitoring

- Both USGS (~14 wells) and MBMG (~216 wells) maintain a Monitoring Network.



Project Link: http://mbmggwic.mtech.edu/

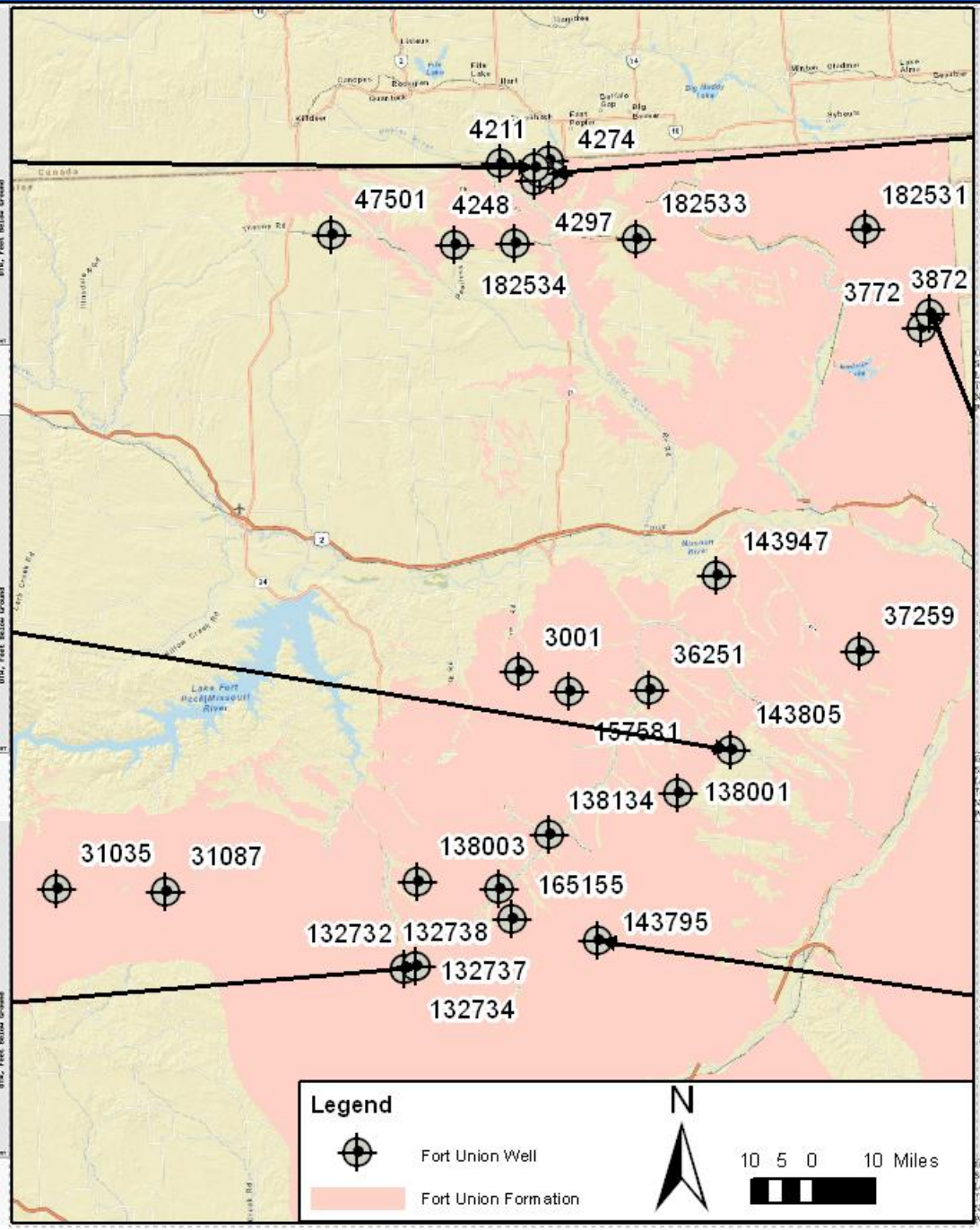
Fort Union Groundwater Levels



GWIC Id: 4227
Site Name: MBMG RESEARCH WELL * GWQQC-06
Location: 37N47E1ABBB
Total Depth: 83 feet
Number of Measurements: 116
Period of Record: 6/29/1979 - 8/7/2013 2:45:00 PM

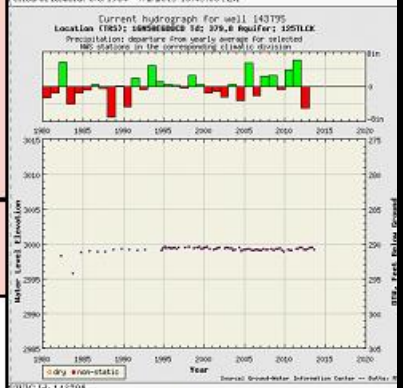
GWIC Id: 143805
Site Name: USGS OBSERVATION WELL SENNER
Location: 21N53E8DABB
Total Depth: 70 feet
Number of Measurements: 81
Period of Record: 10/8/1975 - 8/14/2013 9:24:00 AM

GWIC Id: 132734
Site Name: BURLINGTON NORTHERN * BNTC-403 EAST WELL(USGS RCDR)
Location: 16N44E25BBAC
Total Depth: 103 feet
Number of Measurements: 5243
Period of Record: 9/29/1981 - 7/8/2013



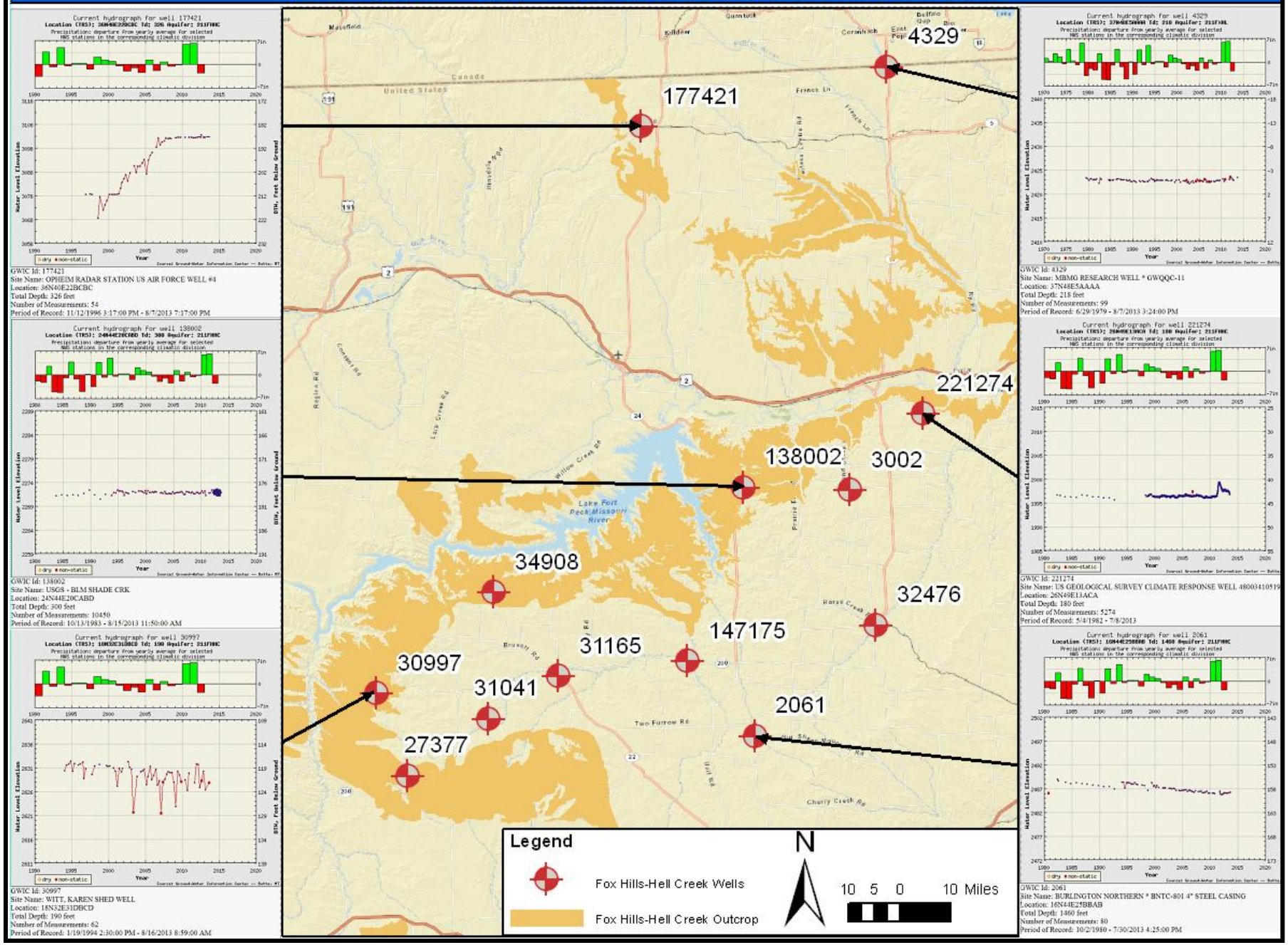
GWIC Id: 4297
Site Name: MBMG RESEARCH WELL * GWQQC-17
Location: 37N47E16DDDD
Total Depth: 288 feet
Number of Measurements: 104
Period of Record: 12/4/1984 - 8/7/2013 1:17:00 PM

GWIC Id: 3872
Site Name: MBMG RESEARCH WELL * 84-18A
Location: 33N58E29ADDB
Total Depth: 330 feet
Number of Measurements: 243
Period of Record: 8/8/1984 - 7/2/2013 10:45:00 AM



GWIC Id: 143795
Site Name: USGS-BLM OBS WELL DEEP SWL
Location: 16N50E6DDCD
Total Depth: 379.8 feet
Number of Measurements: 76
Period of Record: 4/30/1982 - 8/13/2013 11:33:00 AM

Fox Hills - Hell Creek Groundwater Levels



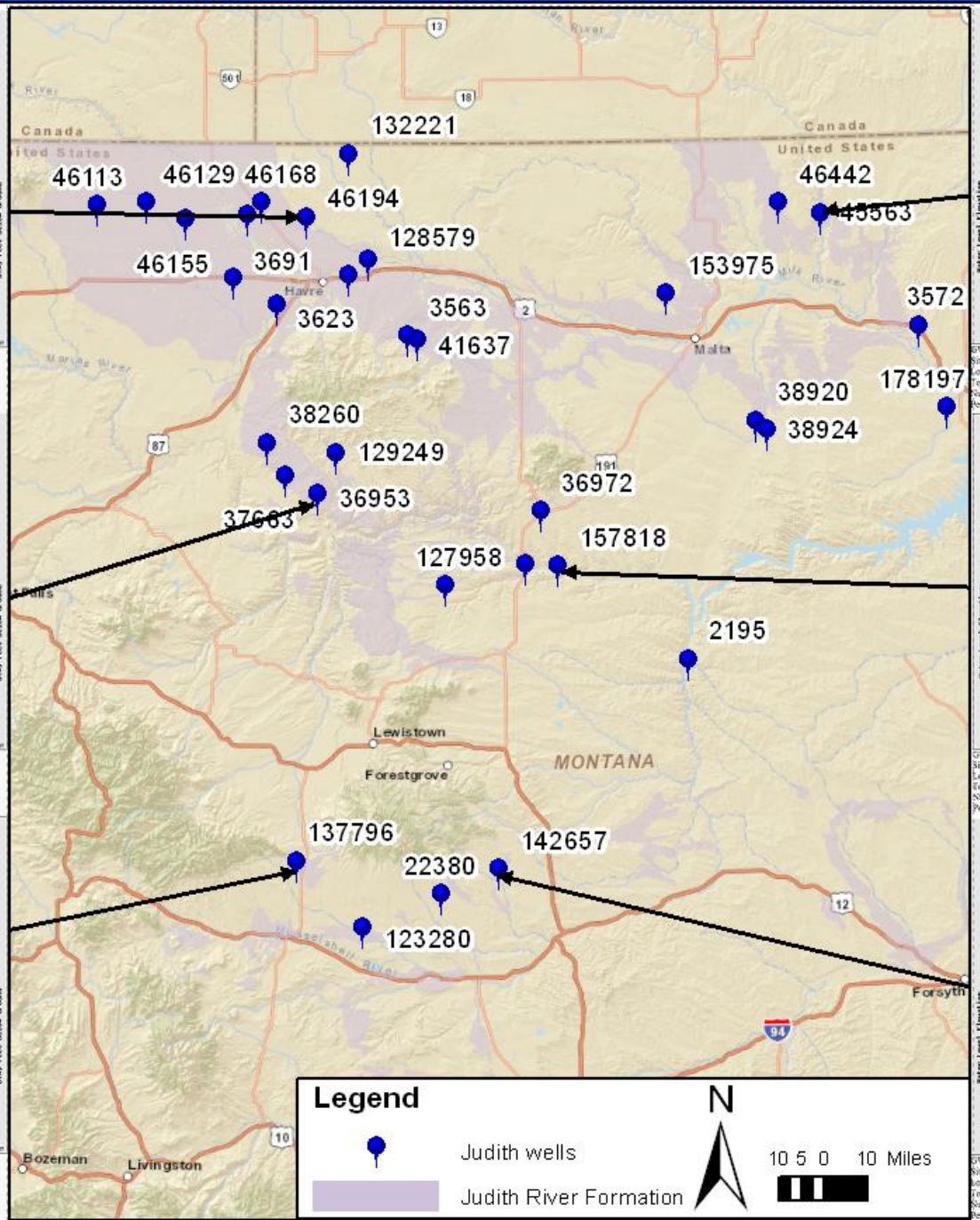
Project Link: http://www.mbmg.mtech.edu/gwip/project-foxHills-Bakken.asp

Judith River Formation Groundwater Levels

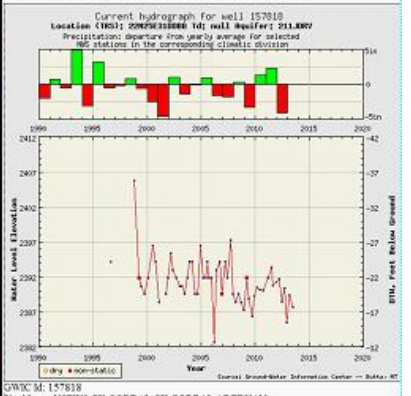
GWIC Id: 46194
Site Name: VERPLOGEN FRANK
Location: 35N15E34ACCB
Total Depth: 258 feet
Number of Measurements: 46
Period of Record: 8/7/1996 9:00:00 AM - 8/10/2013 9:49:00 AM

GWIC Id: 36953
Site Name: BROWN WALTER
Location: 24N16E16BBB
Total Depth: 144 feet
Number of Measurements: 46
Period of Record: 3/21/1996 - 8/13/2013 12:48:00 PM

GWIC Id: 137796
Site Name: SNIDER GEORGE PASTURE WELL
Location: 11N15E35DABA
Total Depth: 100 feet
Number of Measurements: 72
Period of Record: 11/30/1993 4:15:00 PM - 6/26/2013 8:35:00 AM



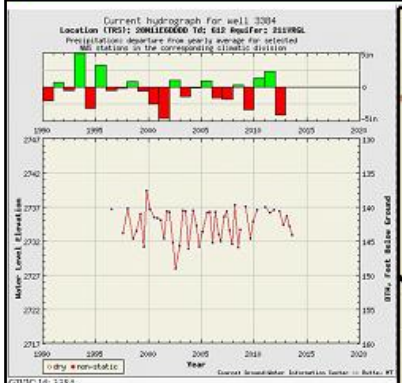
GWIC Id: 45563
Site Name: BARNARD STEVE
Location: 34N34E3AADC
Total Depth: 40 feet
Number of Measurements: 48
Period of Record: 11/13/1996 10:13:00 AM - 8/9/2013 10:35:00 AM



GWIC Id: 157818
Site Name: USFWS CK CORRAL CK CORRAL ARTESIAN
Location: 22N25E31DDBB
Total Depth: feet
Number of Measurements: 57
Period of Record: 8/22/1996 - 6/27/2013 11:14:00 AM

GWIC Id: 142657
Site Name: N BAR RANCH
Location: 10N23E9BCB
Total Depth: 600 feet
Number of Measurements: 67
Period of Record: 4/4/1994 1:45:00 PM - 7/10/2013 10:10:00 AM

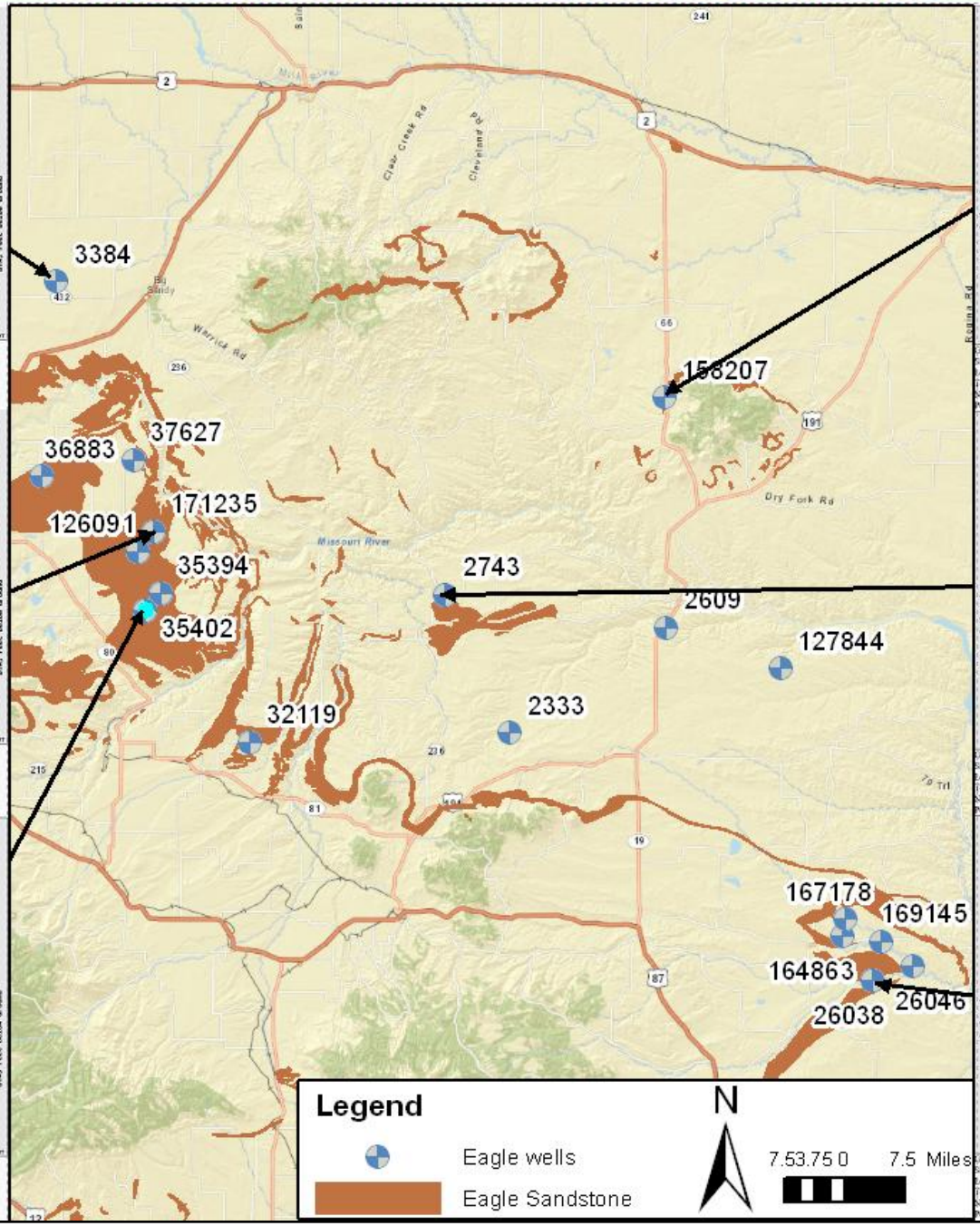
Eagle Sandstone Groundwater Levels



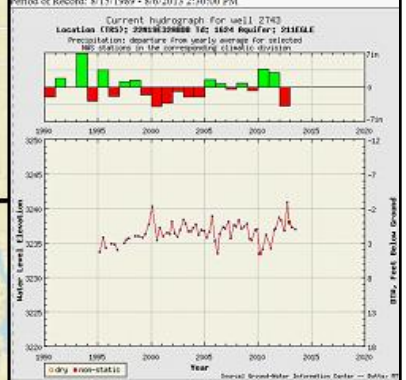
GWIC Id: 3384
Site Name: PEARSON ALLAN
Location: 28N11E6DDDD
Total Depth: 612 feet
Number of Measurements: 50
Period of Record: 6/25/1996 1:00:00 PM - 8/13/2013 10:58:00 AM

GWIC Id: 171235
Site Name: WISHMAN, DENNIS
Location: 23N13E17AAAA
Total Depth: 180 feet
Number of Measurements: 55822
Period of Record: 11/4/1999 2:46:00 PM - 6/6/2013 12:00:00 PM

GWIC Id: 35402
Site Name: BRONSON, WILLIAM
Location: 22N13E32CCC
Total Depth: 89 feet
Number of Measurements: 47
Period of Record: 8/21/1996 1:01:00 PM - 6/6/2013 10:56:00 AM



GWIC Id: 158207
Site Name: BUREAU OF INDIAN AFFAIRS USGS-FT BELKNAP E 15
Location: 26N23E23ACAD
Total Depth: 244 feet
Number of Measurements: 36395
Period of Record: 8/15/1989 - 8/6/2013 2:30:00 PM



GWIC Id: 2743
Site Name: BERGUM RICK AND JANET (FIELD) PASTURE WELL
Location: 22N19E32ABDB
Total Depth: 1624 feet
Number of Measurements: 67
Period of Record: 3/10/1995 9:30:00 AM - 6/26/2013 4:31:00 PM

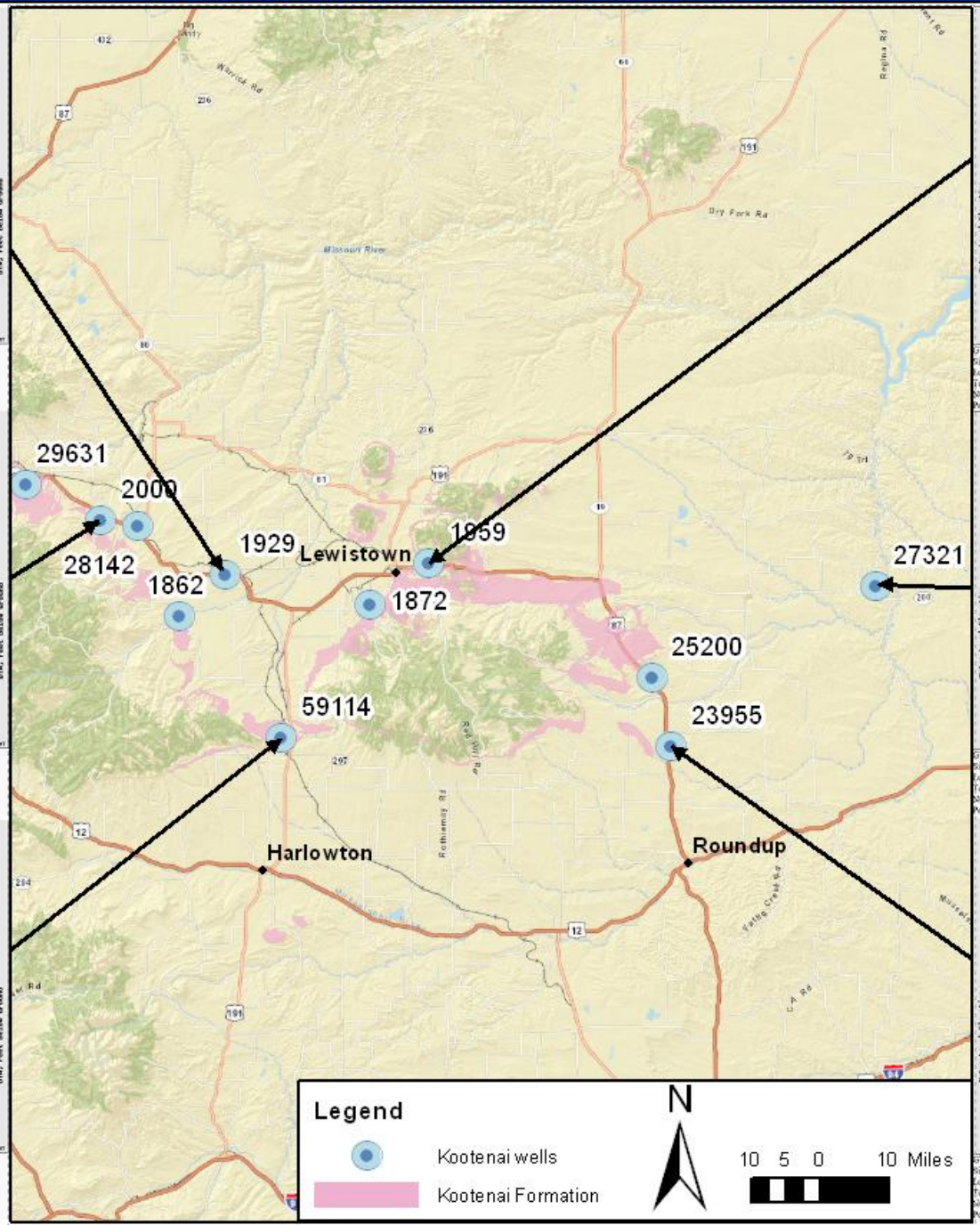
GWIC Id: 164863
Site Name: TRAIL WELL
Location: 15N27E35ACCA
Total Depth: 198 feet
Number of Measurements: 55
Period of Record: 8/7/1997 - 6/17/2013 10:31:00 AM

Kootenai Groundwater Levels

GWIC Id: 1929
Site Name: MSU AG STATION ARTESIAN WELL
Location: 15N14E16DCDD
Total Depth: 1620 feet
Number of Measurements: 76
Period of Record: 11/7/1971 - 6/26/2013 11:11:00 AM

GWIC Id: 2000
Site Name: SURPRISE CREEK COLONY
Location: 16N11E4CDDC
Total Depth: 404 feet
Number of Measurements: 73
Period of Record: 6/24/1980 - 7/9/2013 11:40:00 AM

GWIC Id: 59114
Site Name: MAUWS RANCH MAIN HOUSE
Location: 11N15E13ACCC
Total Depth: 80 feet
Number of Measurements: 62
Period of Record: 11/10/1993 5:30:00 PM - 6/26/2013 8:51:00 AM

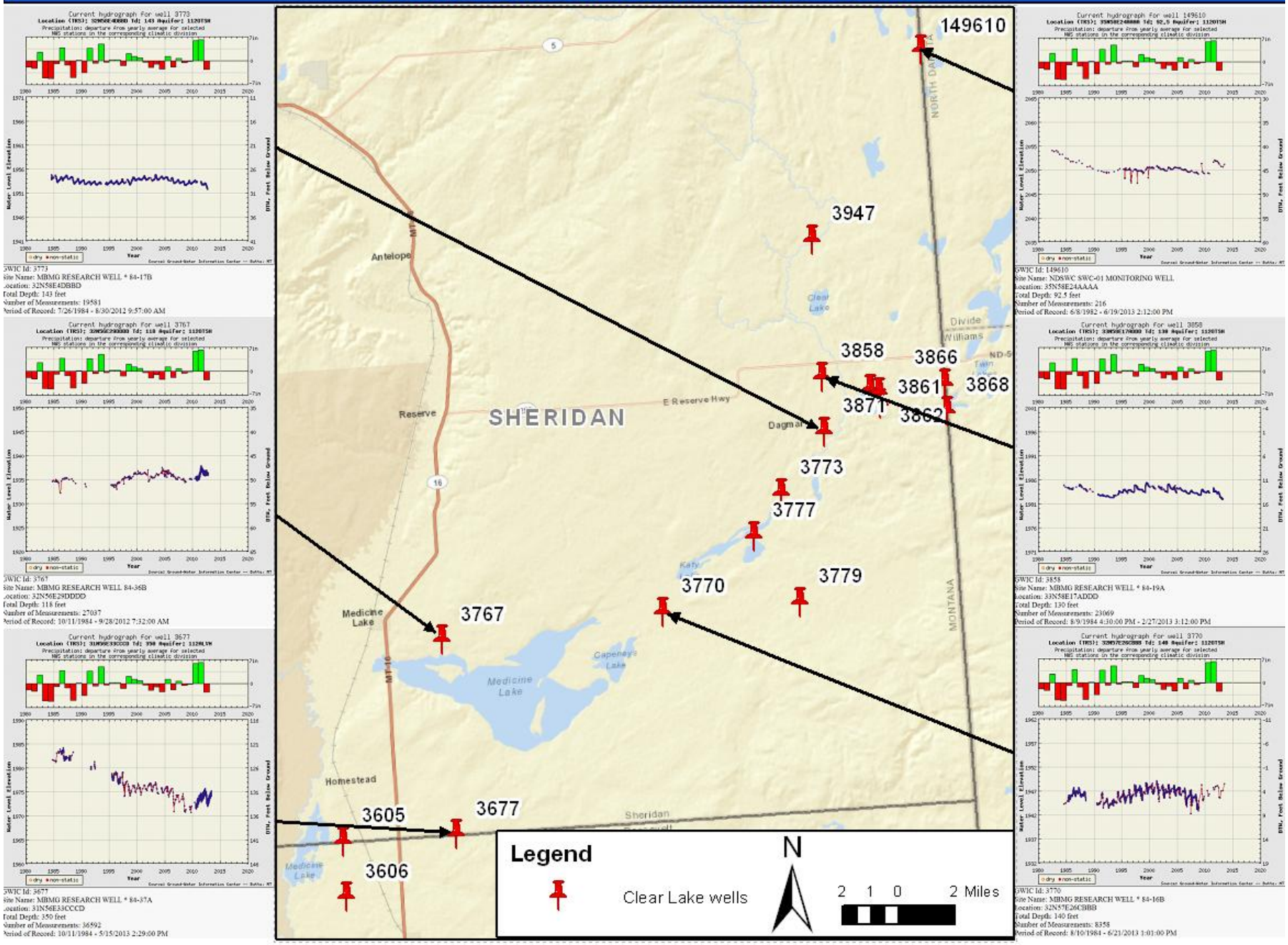


GWIC Id: 1959
Site Name: TURK, HENRY & ARLENE CORRAL WELL
Location: 15N19E9BABC
Total Depth: 90 feet
Number of Measurements: 70
Period of Record: 6/10/1980 1:30:00 PM - 6/26/2013 1:36:00 PM

GWIC Id: 27321
Site Name: AHLGREN LARRY/DIANNE
Location: 15N30E31AAAC
Total Depth: 1500 feet
Number of Measurements: 29903
Period of Record: 12/17/1996 1:05:00 PM - 6/17/2013 11:45:00 AM

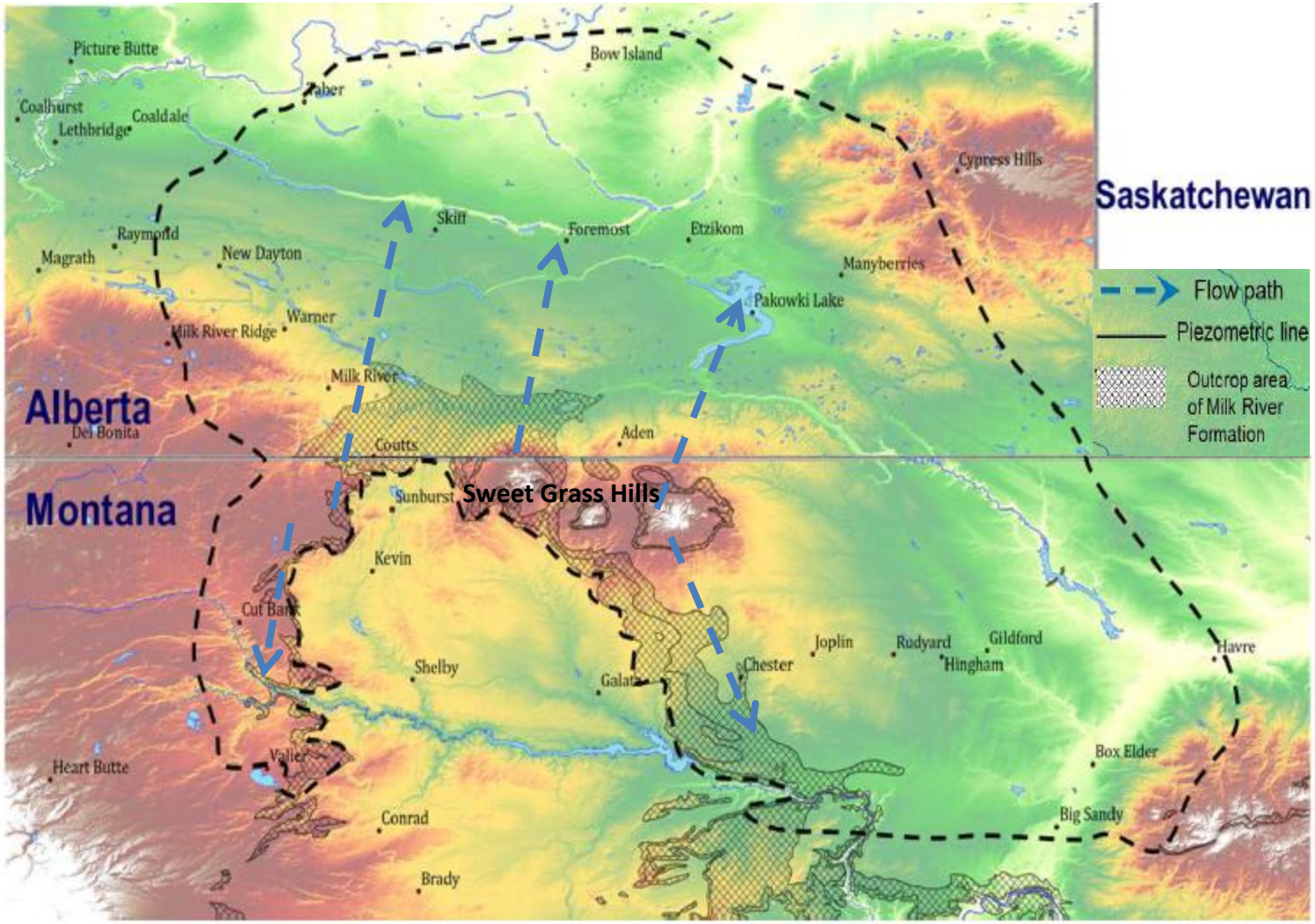
GWIC Id: 23955
Site Name: HILL TOP BLM BLM
Location: 11N25E21CCBD
Total Depth: 1635 feet
Number of Measurements: 76
Period of Record: 1/6/1994 12:49:00 PM - 7/10/2013 9:21:00 AM

Clear Lake Groundwater Levels



Project Link: http://www.mbmg.mtech.edu/gwip/project-clearLake.asp

Milk River Transboundary Aquifer Project



Project Contact: Marie-Amélie Pétré (marie-amelie.petre@ete.inrs.ca)

Questions/Comments/Discussion?

Useful Groundwater Online Resources

- DNRC Water Right Database
  - http://nris.mt.gov/dnrc/waterrights/default.aspx
- MBMG Groundwater Investigation Program
  - http://mbmggwic.mtech.edu/
- DEQ Source Water Protection (Water Quality)
  - http://nris.mt.gov/wis/swap/SwapQuery.asp
- Frac Focus (Chemical Disclosure Registry)
  - http://fracfocus.org/