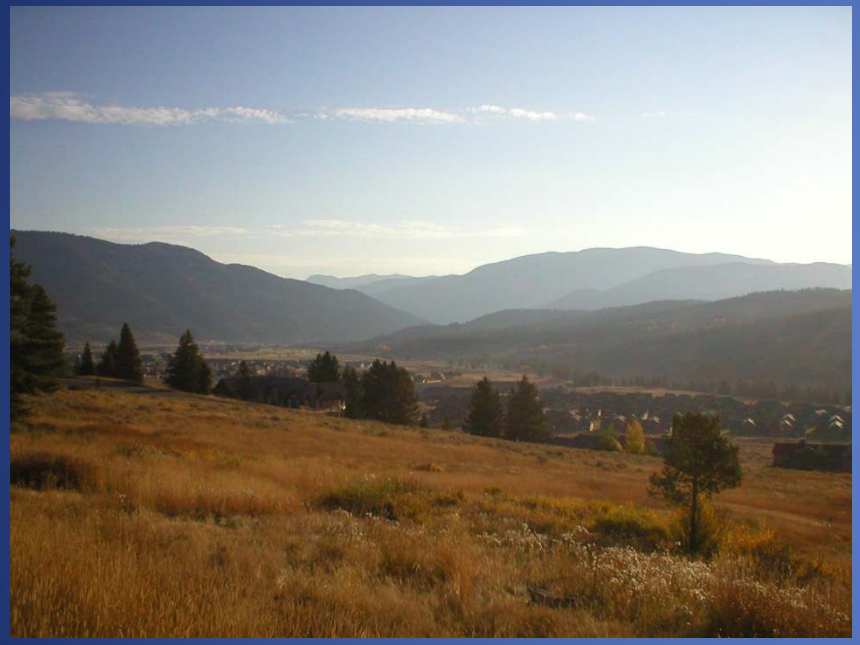
Big Sky Groundwater Investigation

Update to the BSWSD Board, May 24, 2016



Purposes

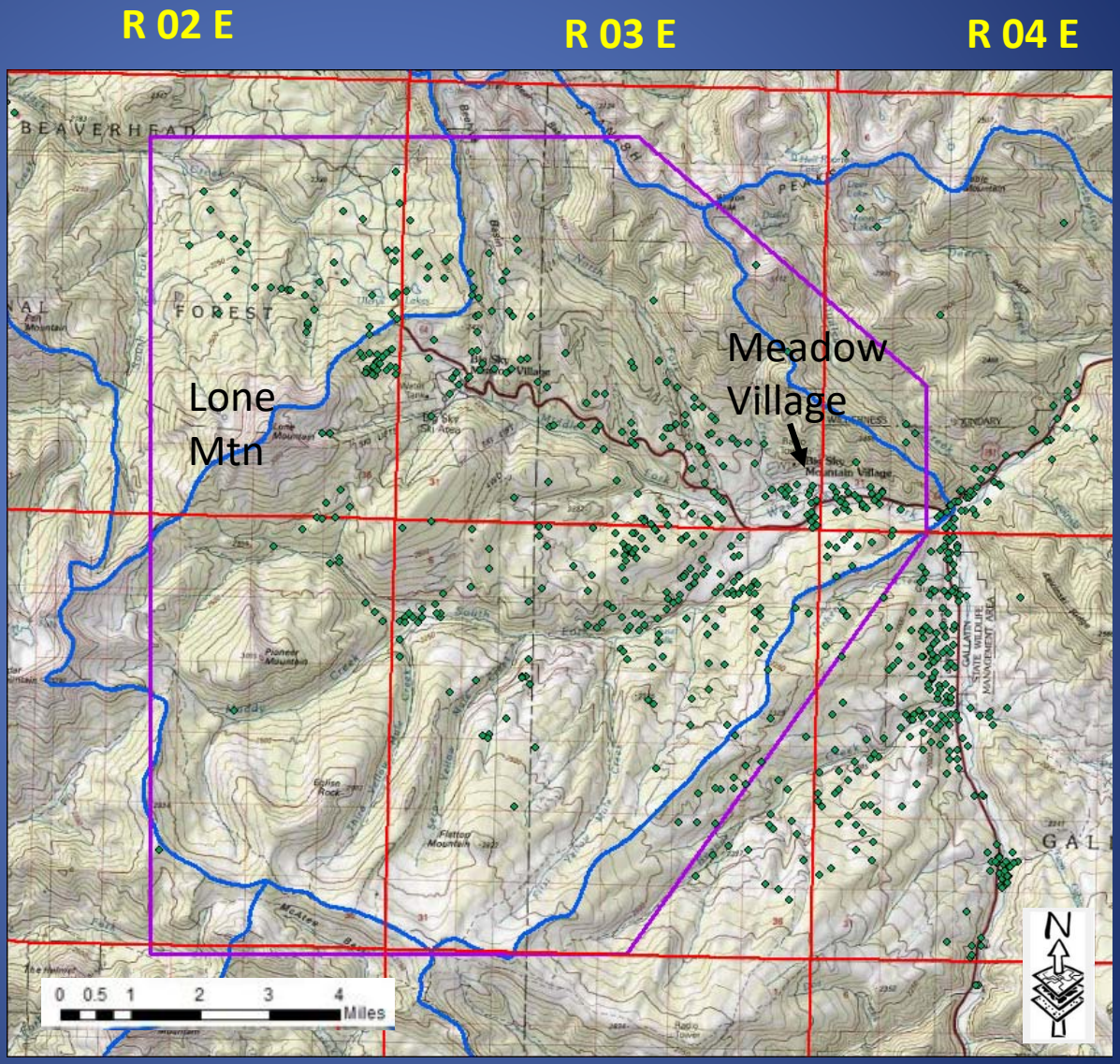
- Develop a conceptual model of the bedrock aquifers in the Big Sky area
- Investigate the Meadow Village alluvial aquifer
- Develop a groundwater model for the Meadow Village alluvial aquifer
- Provide a report and model products

Kirk Waren
James Rose
Connie Thomson
Allison Brown

MBMG
Montana Bureau of Mines and Geology

2013

Big Sky Groundwater Investigation Study Area



- Approximate study area
- Watershed divides
- Townships
- Ground Water Information Center water well locations

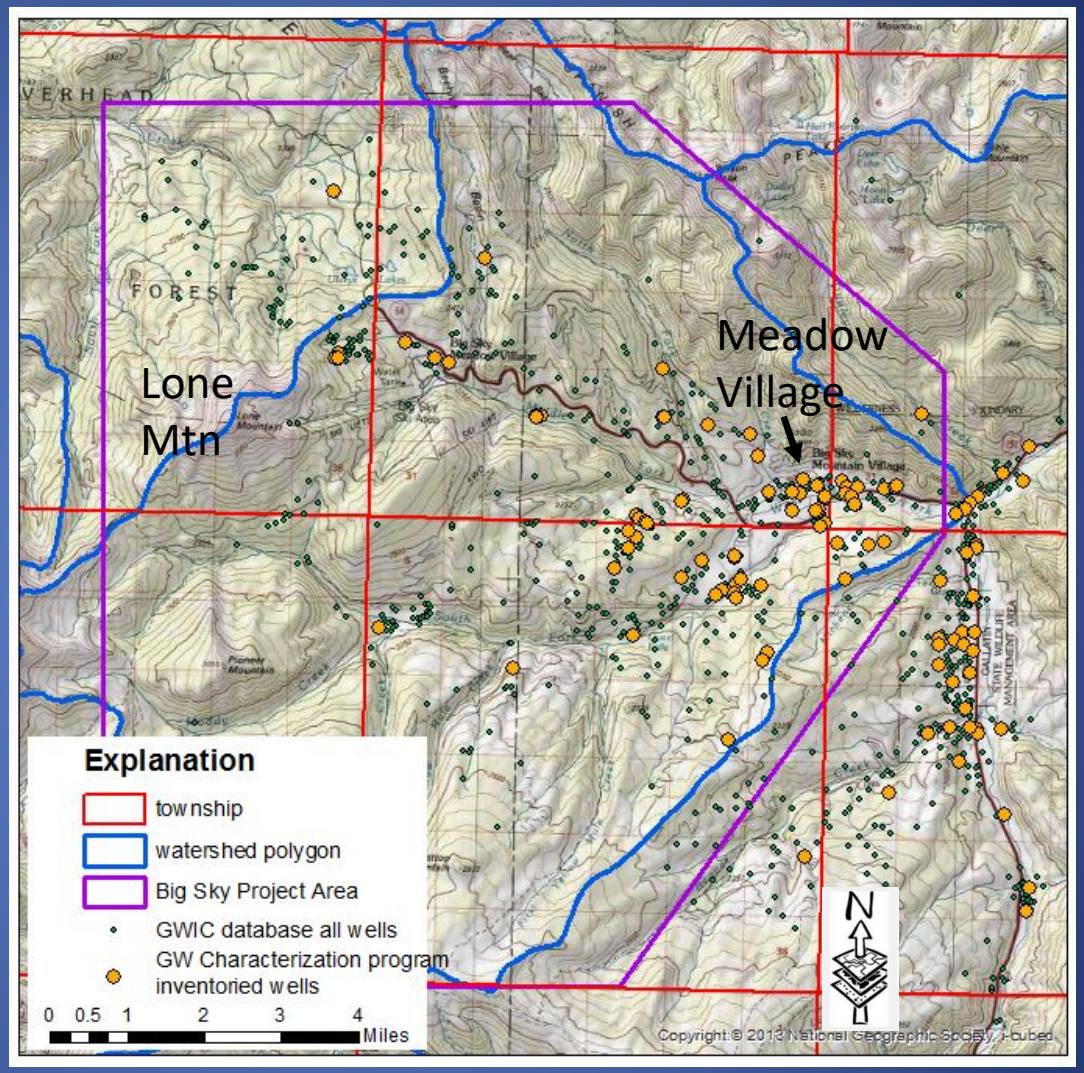
COOPERATORS:

- Gallatin River Task Force
- Big Sky Water and Sewer District No. 363
- Gallatin Local Water Quality District
- Big Sky Resort including Moonlight Basin
- Meadow Village Homeowners Assn.
- Private landowners throughout Big Sky
- Montana Dept. of Natural Resources
  - Water Management Bureau
  - Bozeman Water Resources Regional Office
- Steve Custer, MSU
- Yellowstone Club – access and permissions

Thanks to all for your interest, permissions, and assistance!

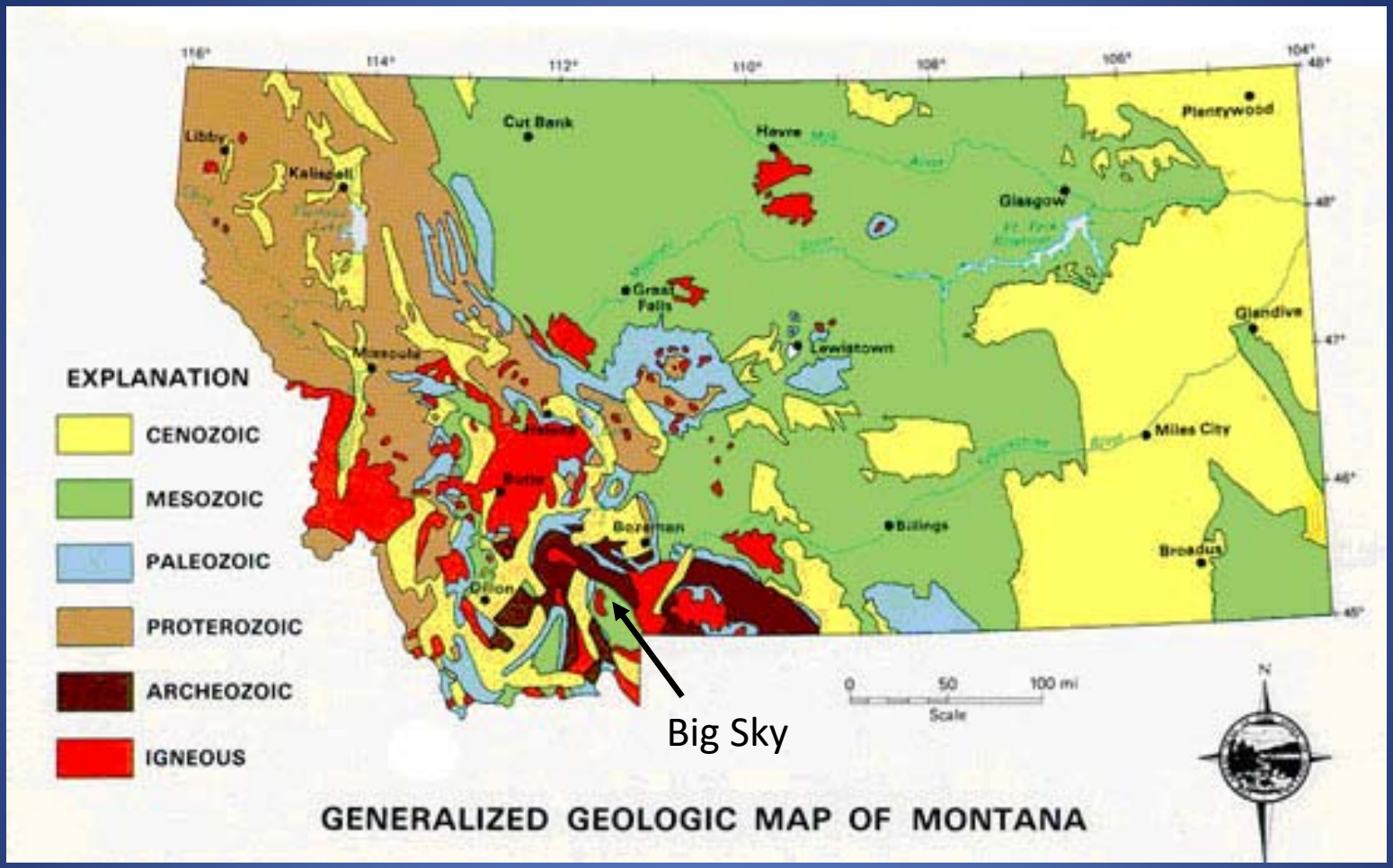
Groundwater Characterization Program

July, 2013

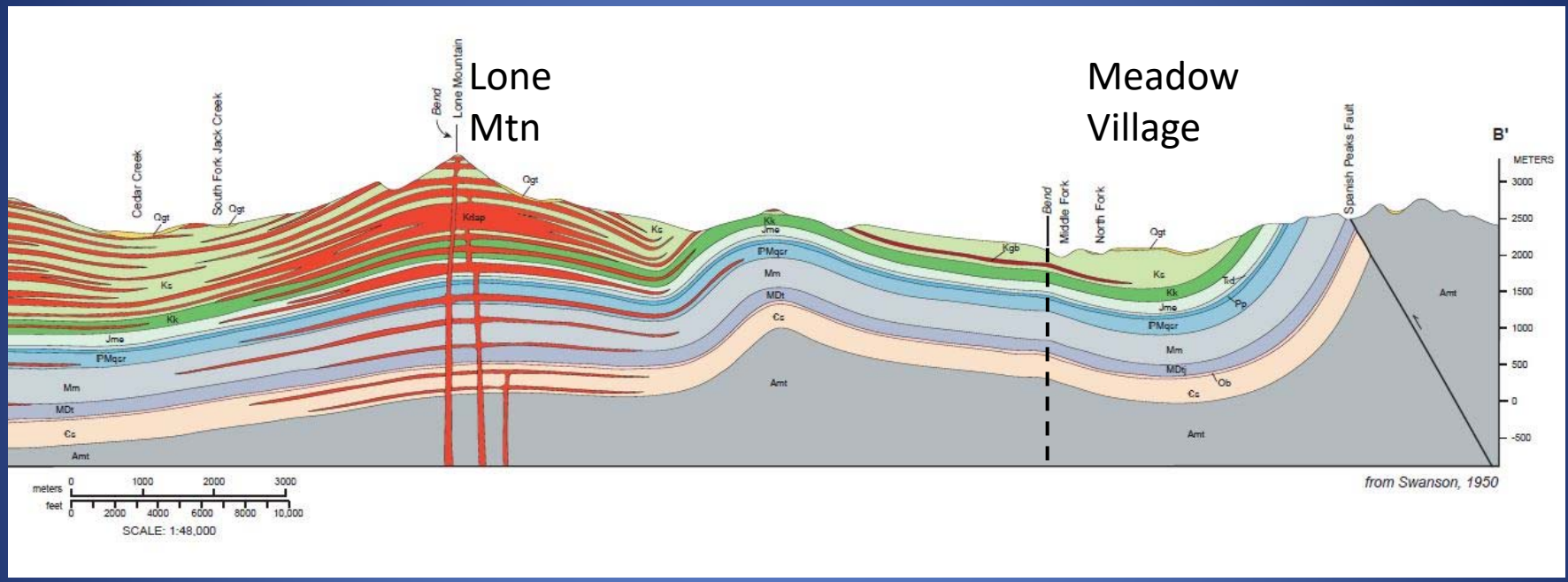


Groundwater Characterization Program inventoried well sites

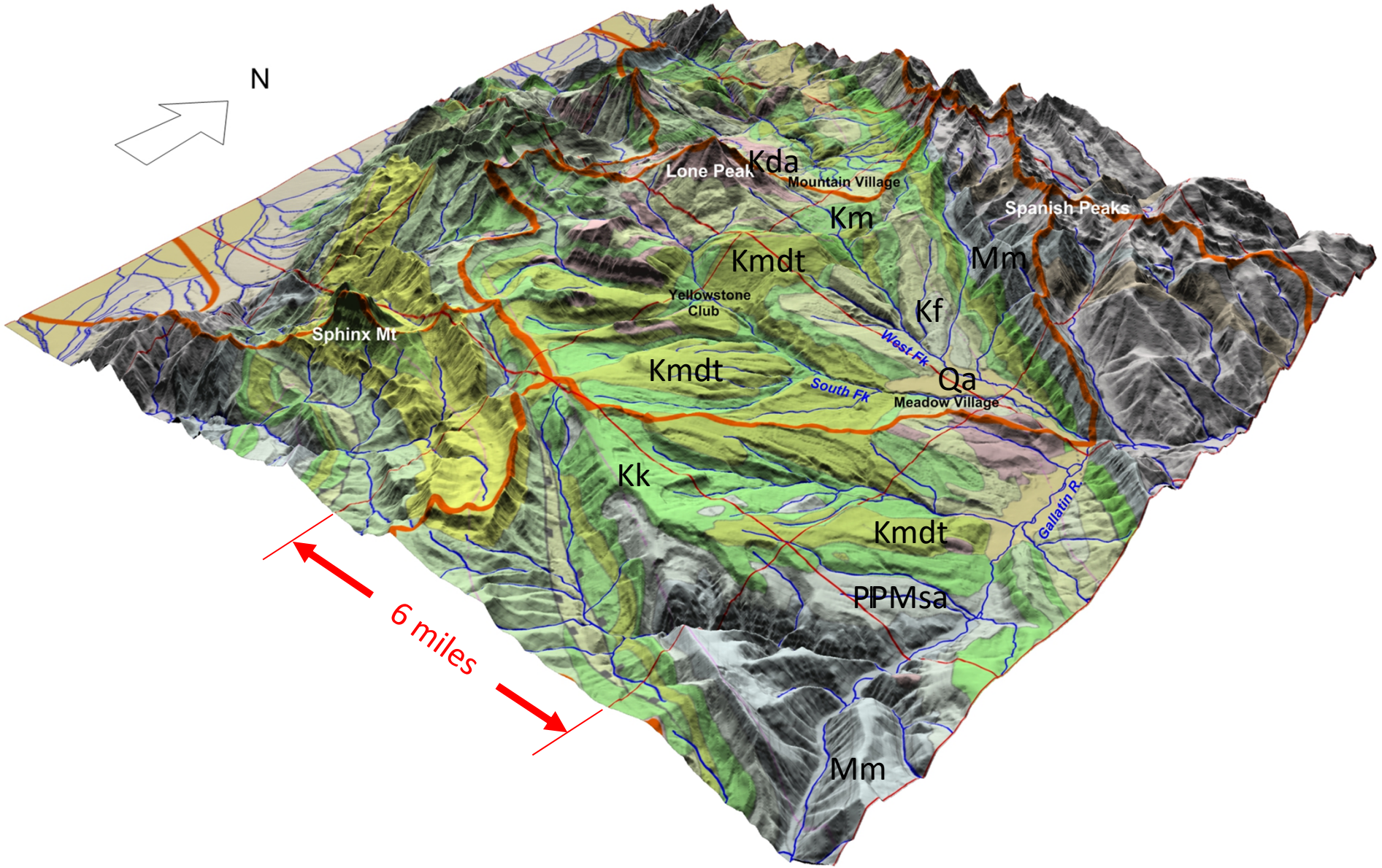

All currently monitored surface water sites
Big Sky
Mountain Village
Meadow Village
Feet
0
2,375
4,750
9,500


EXPLANATION
CENOZOIC
MESOZOIC
PALEOZOIC
PROTEROZOIC
ARCHEOZOIC
IGNEOUS
Libby
Kalispell
Cut Bank
Havre
Glasgow
Plentywood
Great Falls
Lewistown
Glendive
Missoula
Butte
Bozeman
Billings
Miles City
Broadus
Dillon
0 50 100 mi
Scale
N
Big Sky
GENERALIZED GEOLOGIC MAP OF MONTANA

Geologic Cross Section from Vuke, 2013

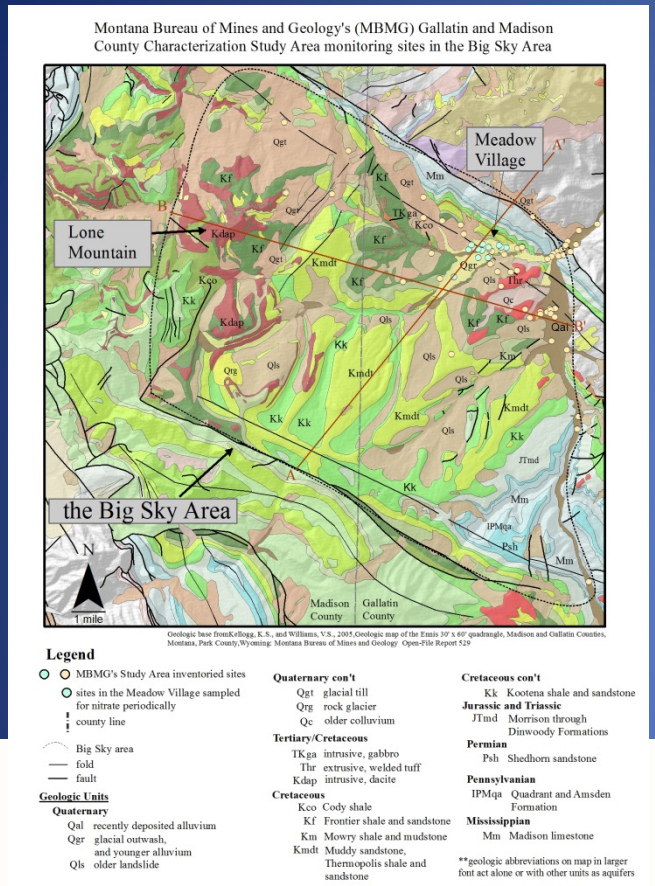


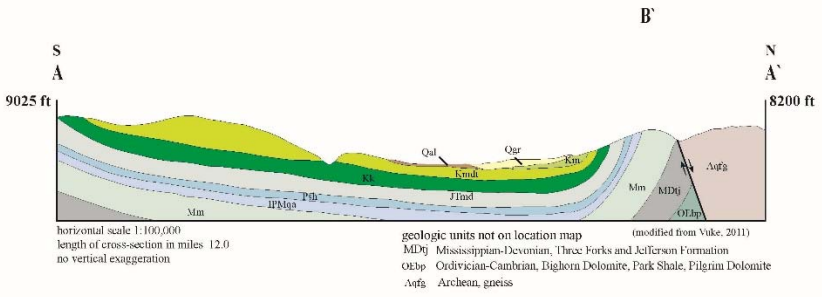
Vuke, S.M., 2013, Geologic map of the Fan Mountain, Lone Mountain, and Gallatin Peak 7.5' quadrangles, Madison Range, Madison and Gallatin Counties, Montana: Montana Bureau of Mines and Geology Open-File Report 633, 27 p., 1 sheet, scale 1:24,000.


N
Lone Peak
Kda
Mountain Village
Km
Spanish Peaks
Mm
Kmdt
Yellowstone Club
Kf
Sphinx Mt
West Fk
Kmdt
South Fk
Qa
Meadow Village
Kk
Kmdt
Gallatin R.
PPMsa
6 miles
Mm

2014

Previous works gathered from the Big sky Water and Sewer District's Library






AQUIFER VULNERABILITY ASSESSMENT
OF THE
BIG SKY AREA, MONTANA

by

David O. Baldwin

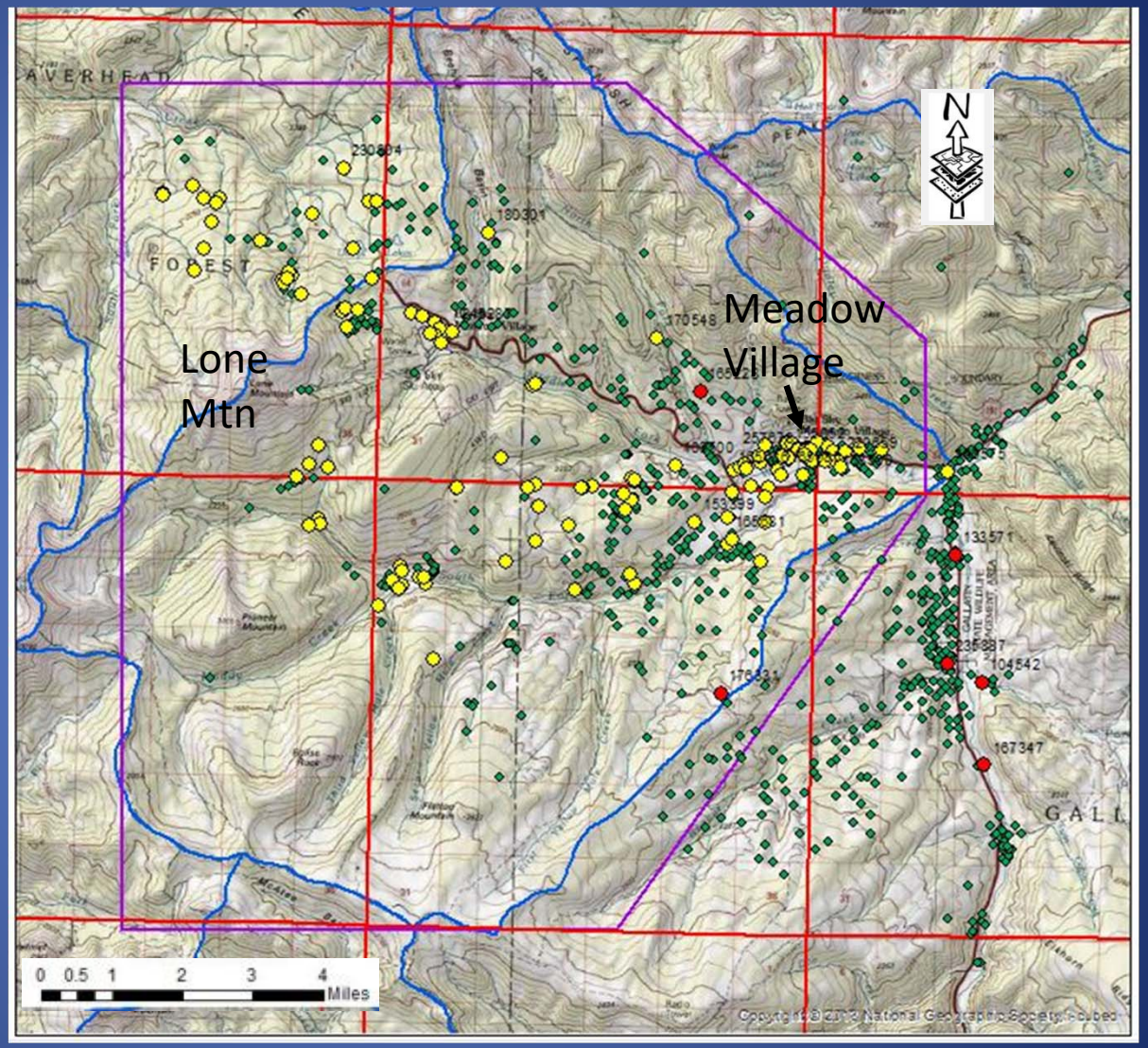
A thesis submitted to the
Department of Geological Engineering
Montana Tech of The University of Montana
for the degree of
Master of Science in Geological Sciences
Hydrogeology Option

Montana Tech of The University of Montana
Butte, Montana
May 1997

Groundwater level monitoring

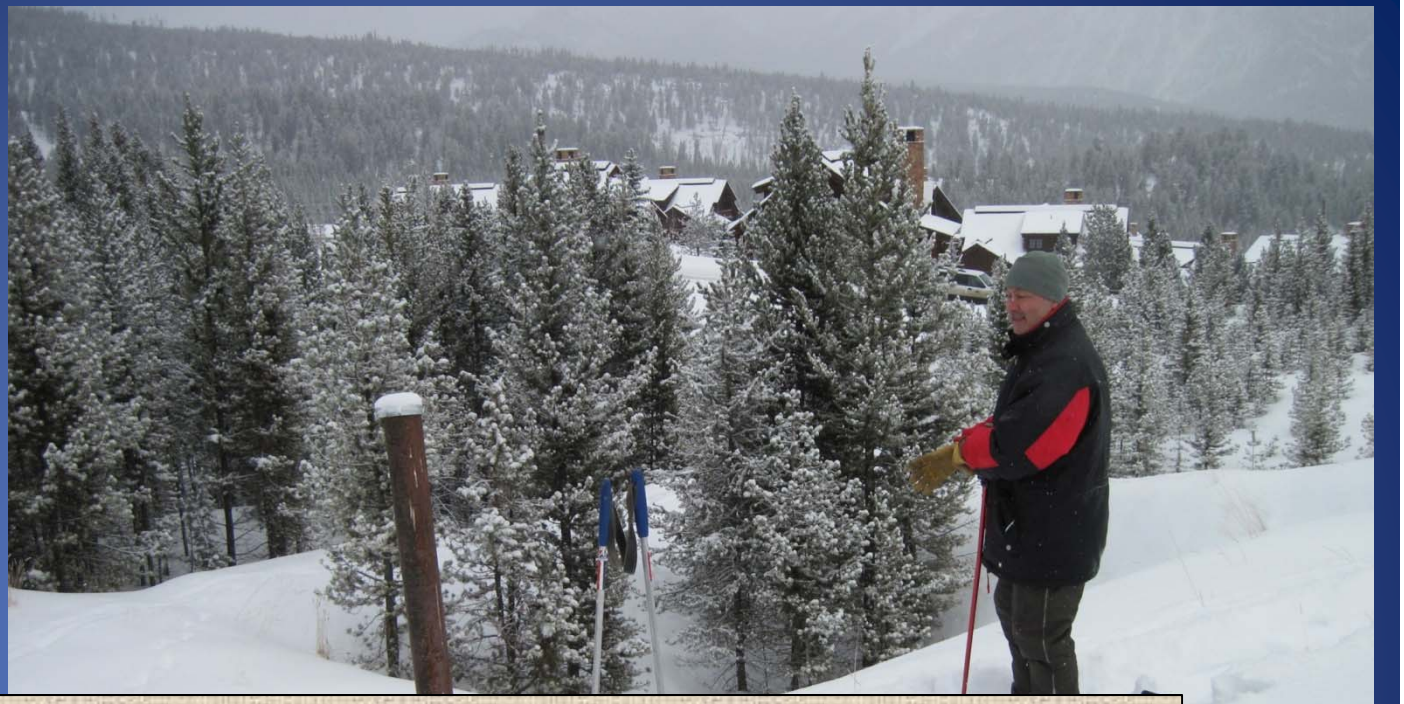
Monitoring expended Into Jack Cr. Basin and the Yellowstone Club area

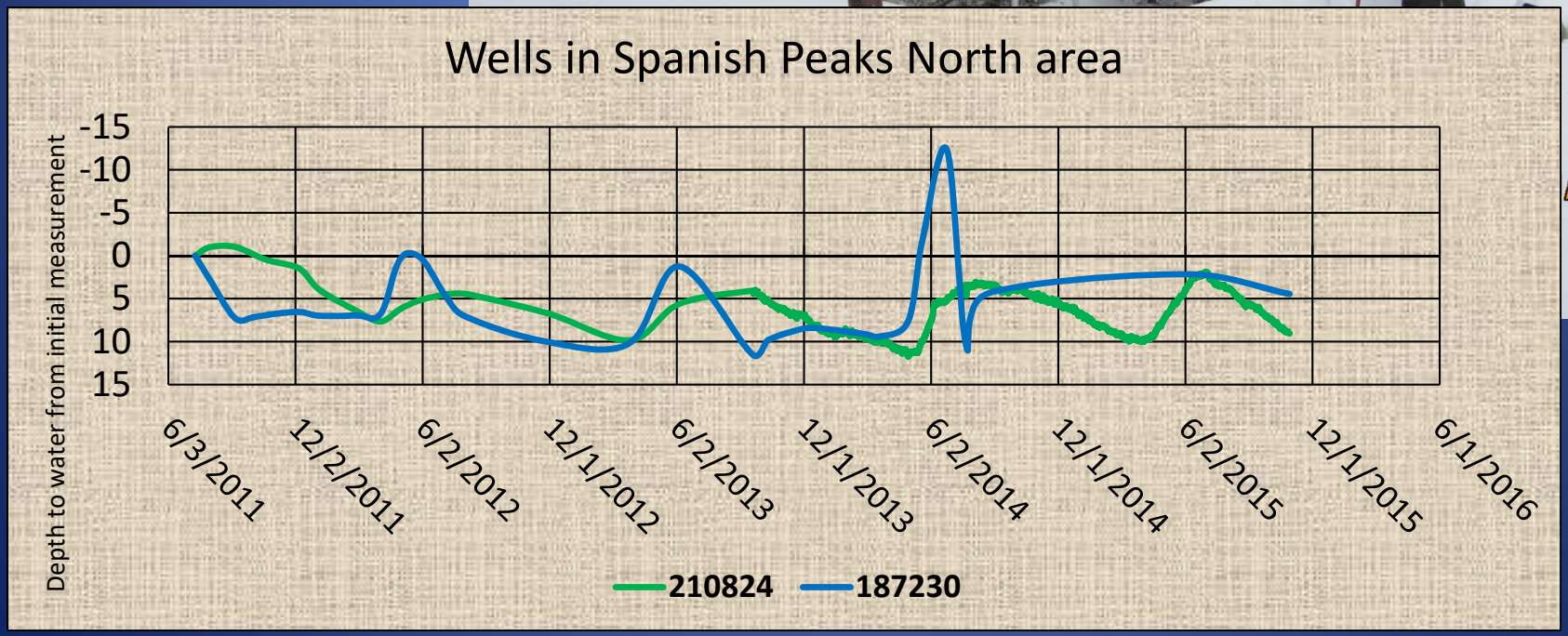
Many wells Instrumented with water level and temperature data loggers



Groundwater Investigation Program monitored well sites

Spanish Peaks Area

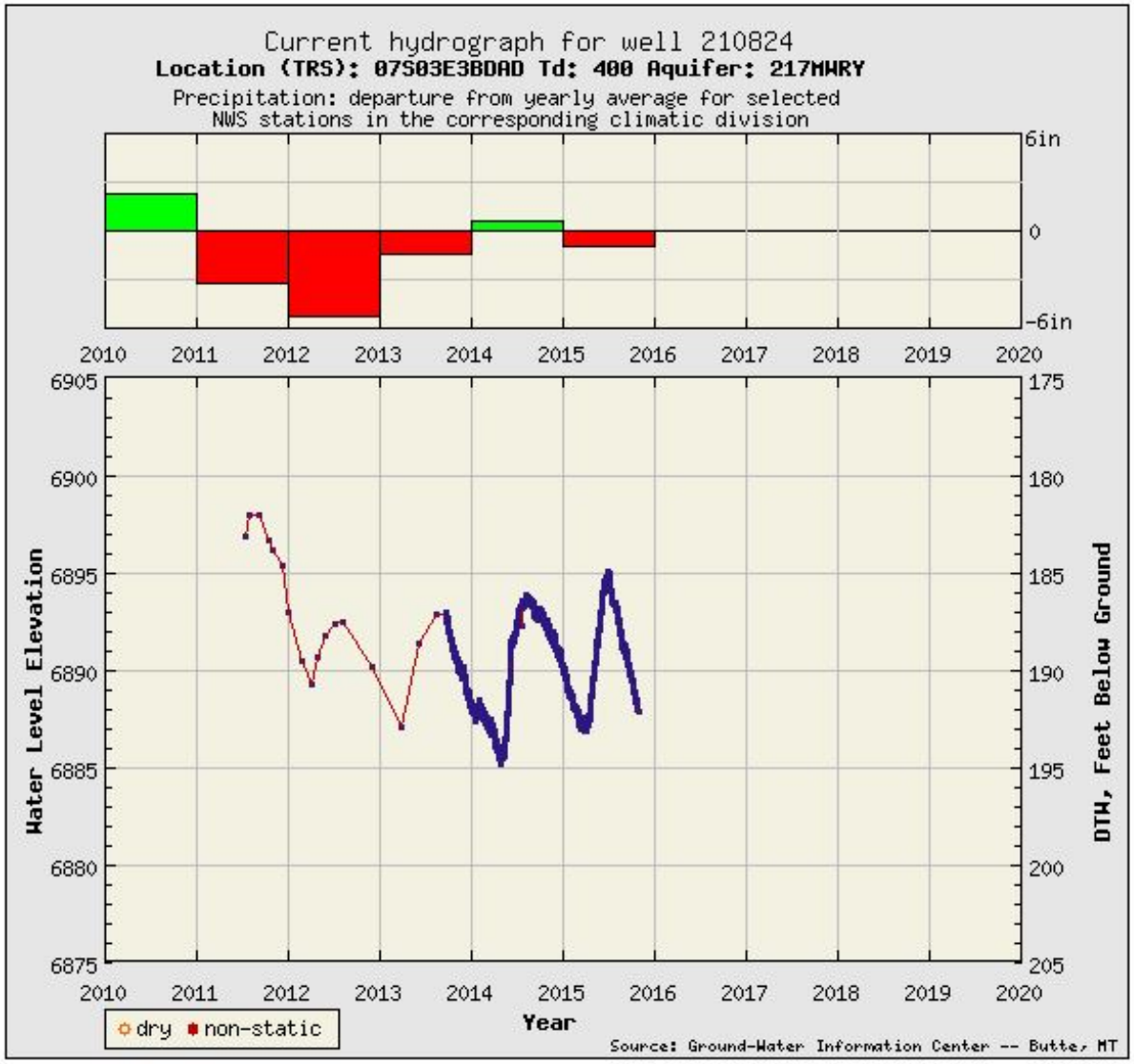




/2013

Groundwater Information Center Well Hydrograph

The following chart represents the current hydrograph for this well. Data reported are in feet



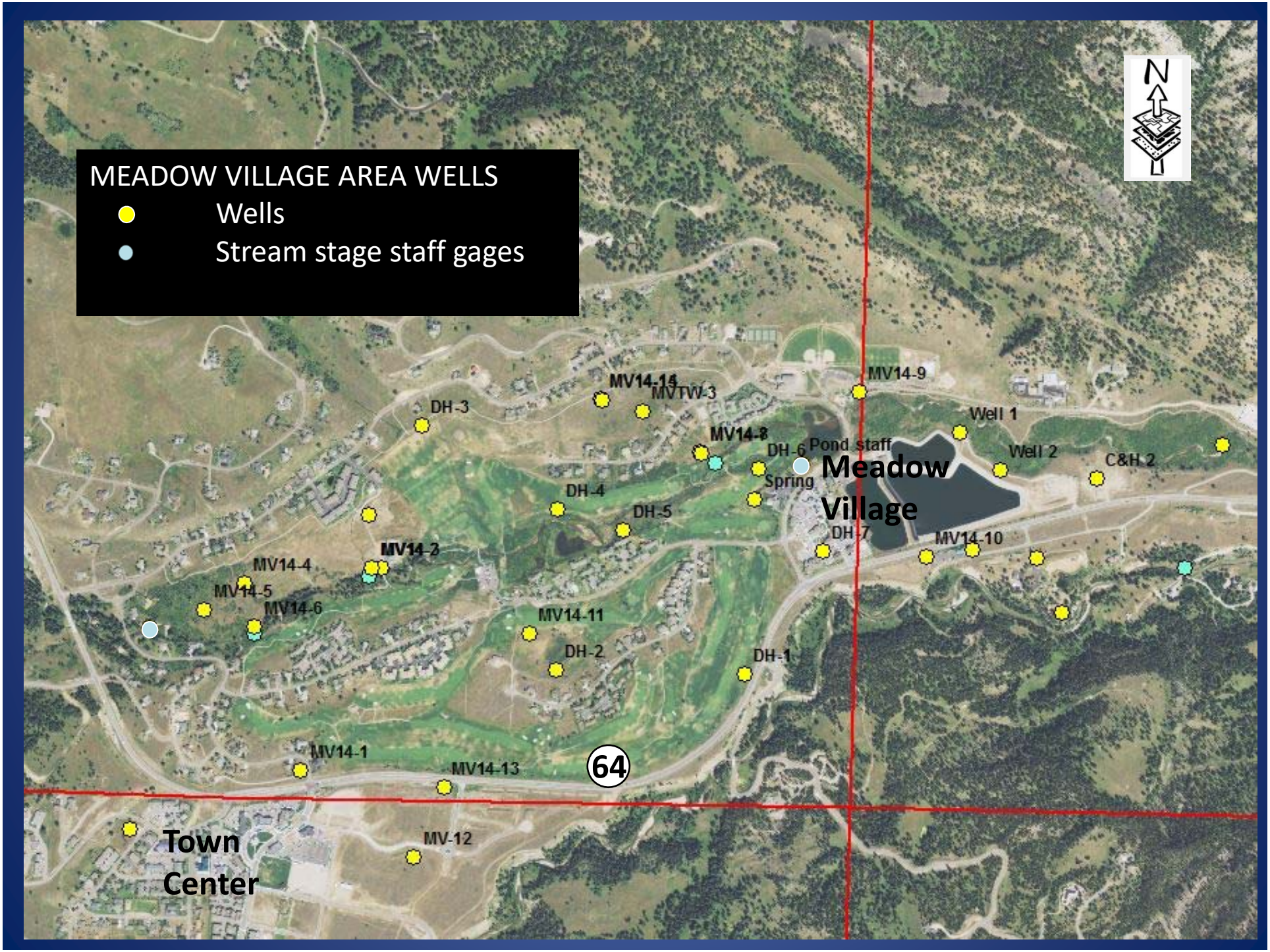
GWIC Id: 210824

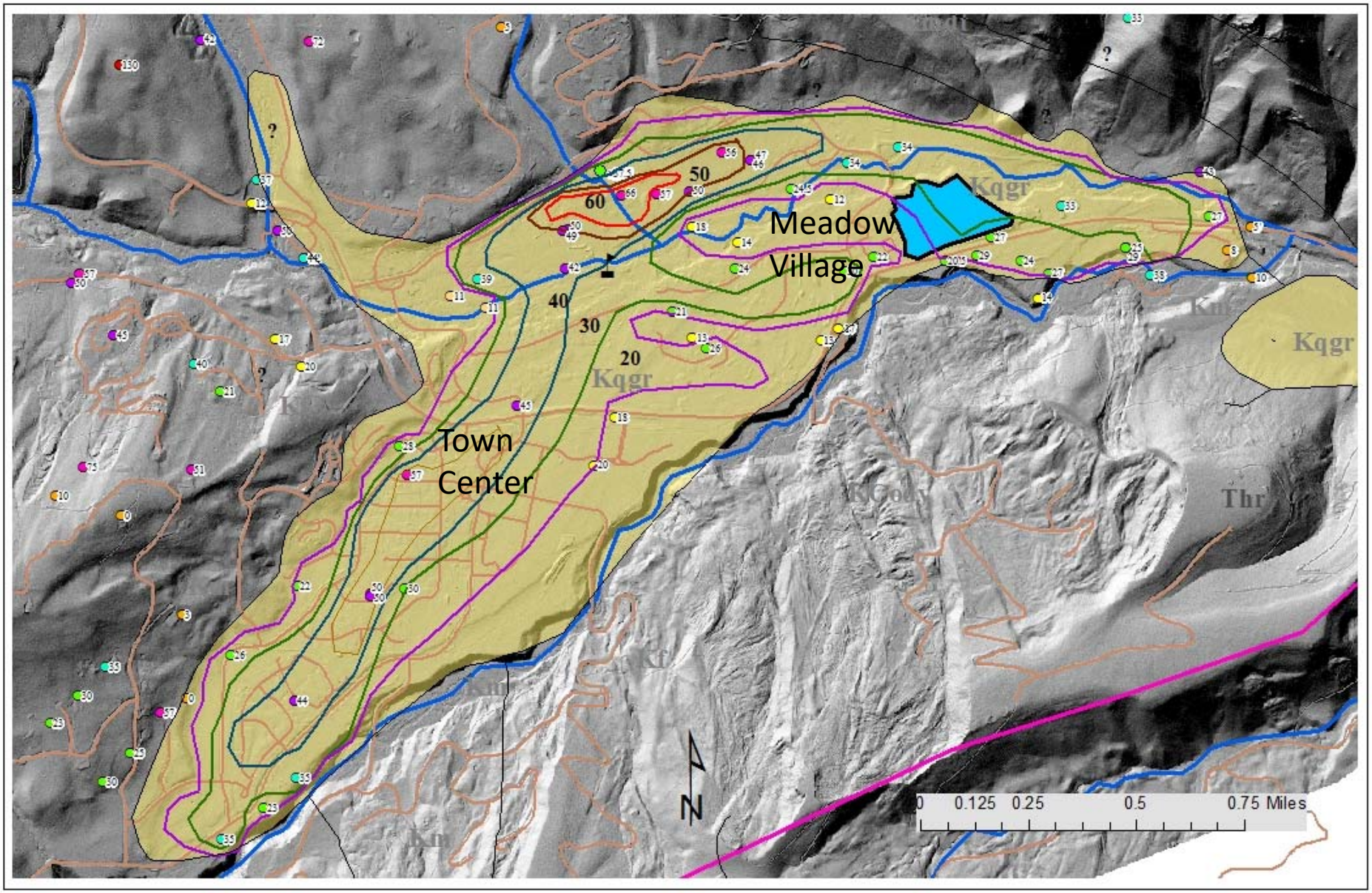
Monitored and sampled GW and SW sites

Sampling of snowpack water chemistry

Additional stream flow measurements and stream water chemistry sampling

Installation of new monitoring wells


MEADOW VILLAGE AREA WELLS
Wells
Stream stage staff gages
N
MV14-14
MVTW-3
MV14-9
DH-3
Well 1
MV14-8
DH-6
Pond staff
Well 2
C&H 2
Spring
Meadow Village
DH-4
DH-5
DH-7
MV14-10
MV14-3
MV14-4
MV14-5
MV14-6
MV14-11
DH-2
DH-1
MV14-1
MV14-13
64
MV-12
Town Center

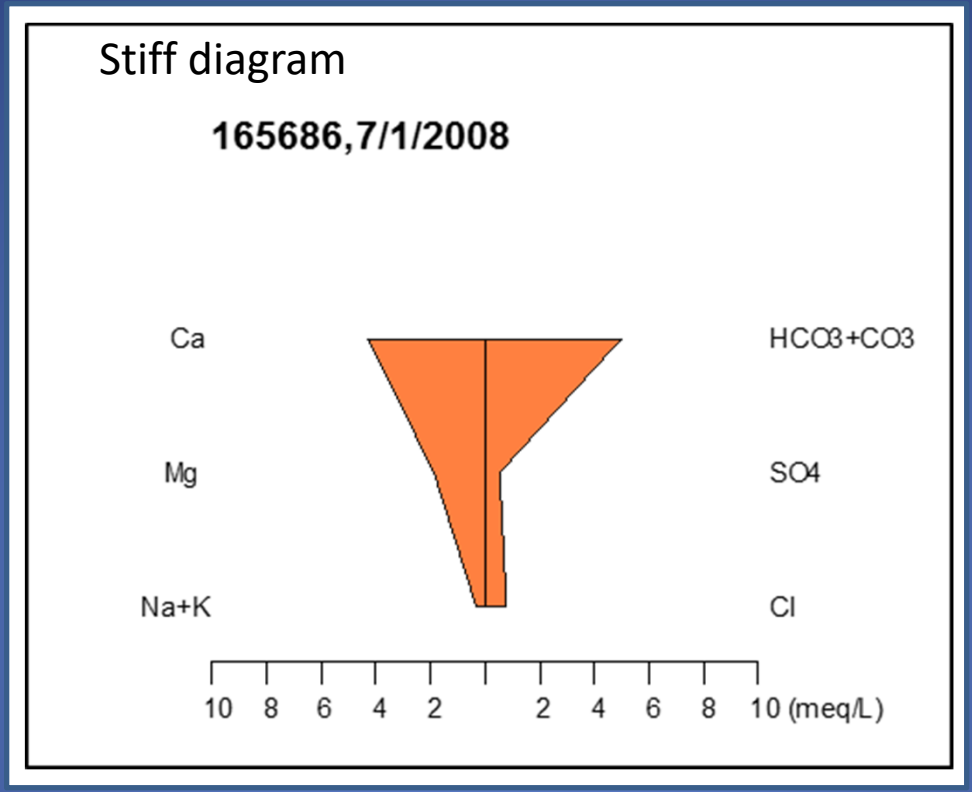

Meadow
Village
Town
Center
60
50
40
30
20
Kqgr
Thr
N
0 0.125 0.25 0.5 0.75 Miles

2015

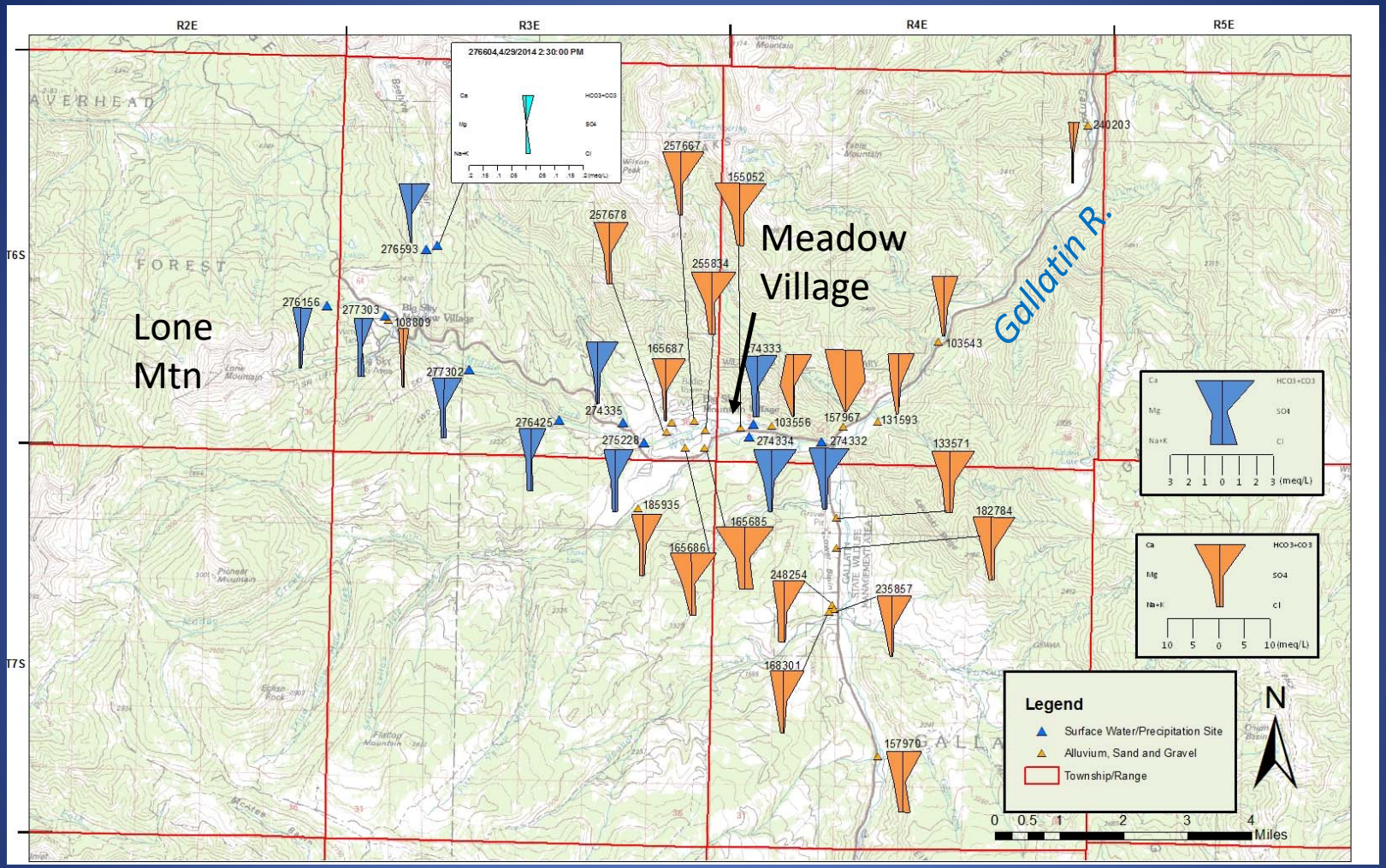
Water quality sampling: 38 wells, 7 springs, selected stream sites, rain and sewage plant effluent

– Samples tested for:

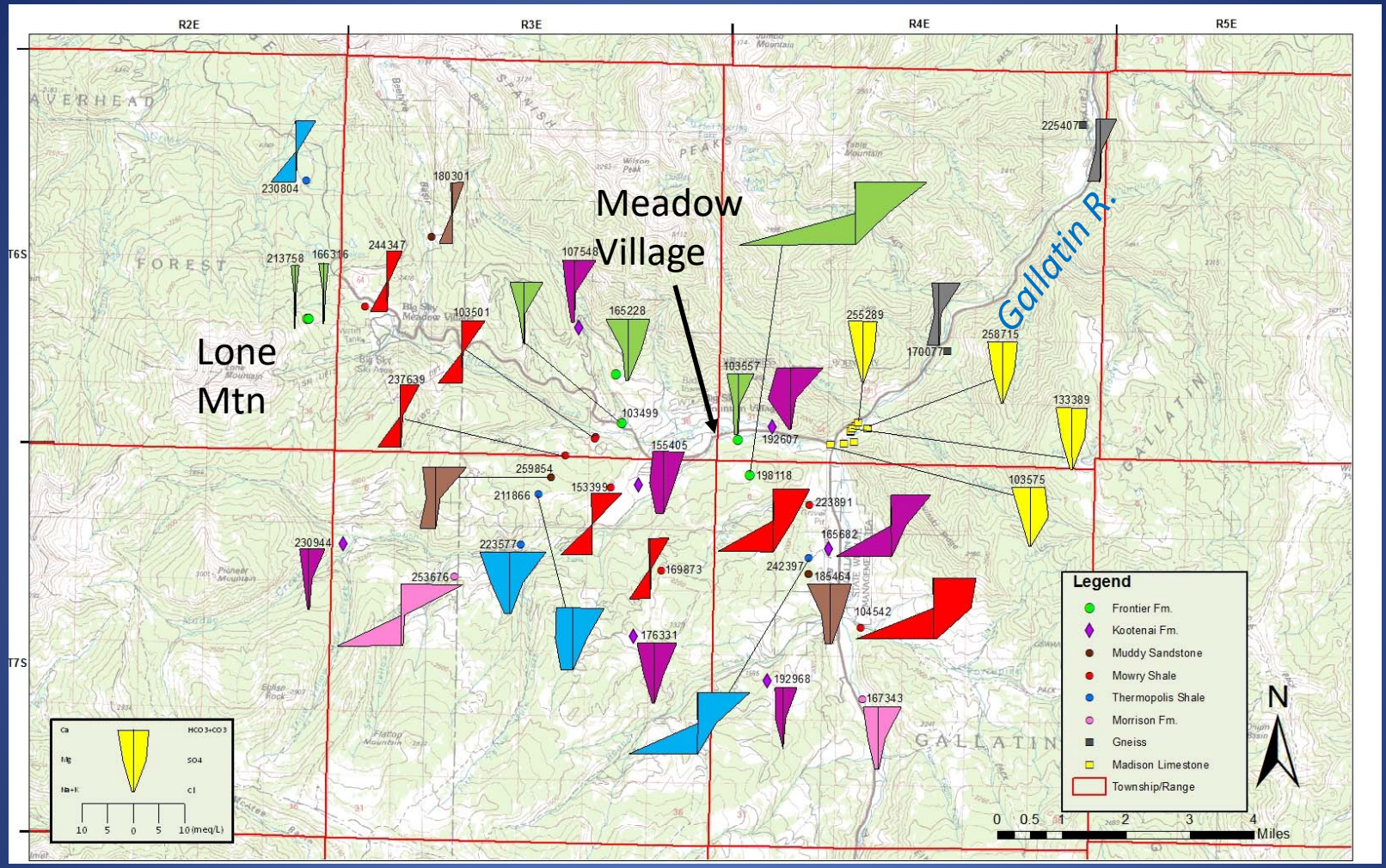
- Full suite water chemistry
- Isotopes of water molecules
- Isotopes of some other elements



A Stiff diagram is a small graph showing the concentrations of major dissolved constituents in water



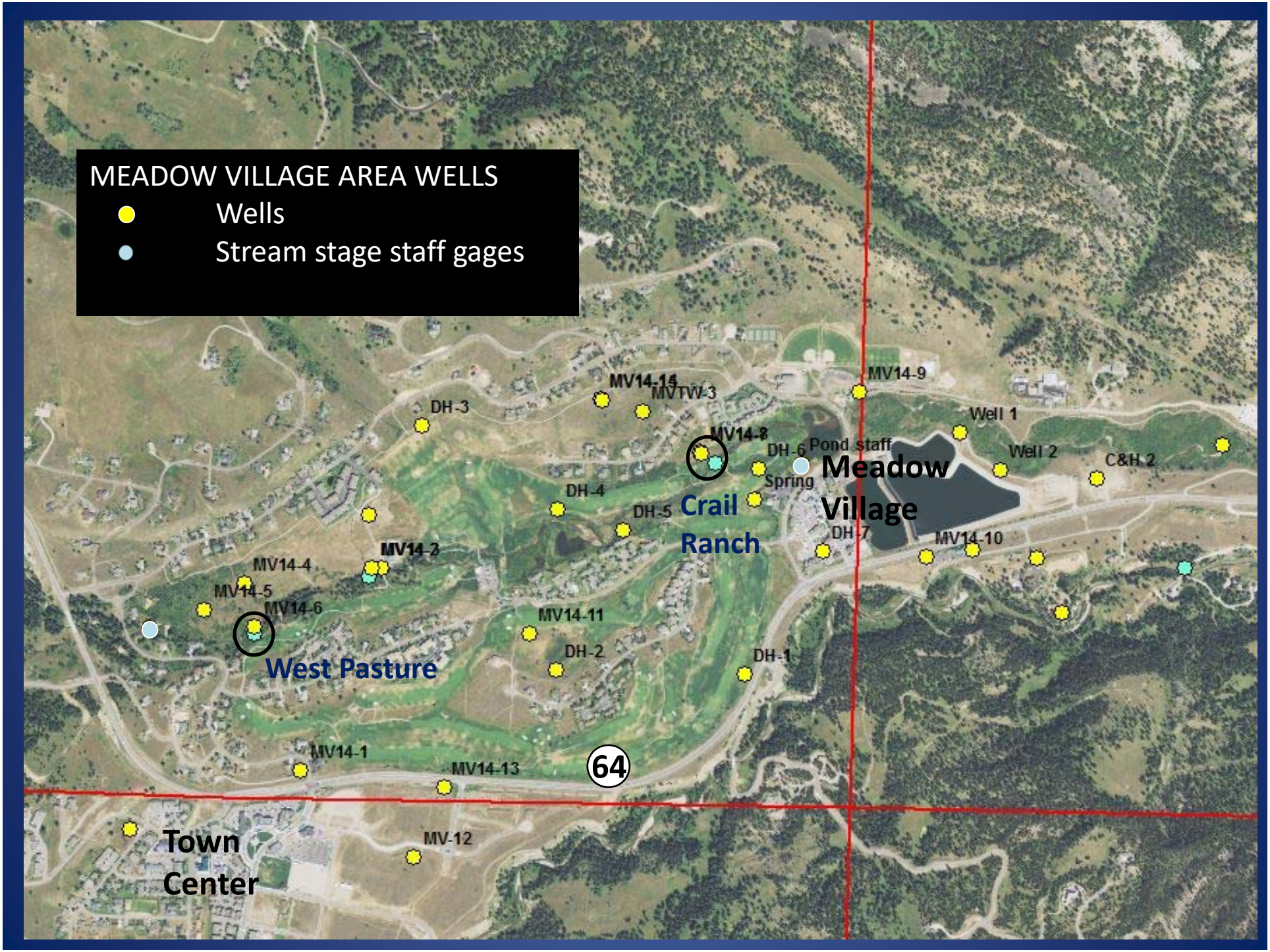
Surface water (blue) and alluvial groundwater (orange) stiff diagrams

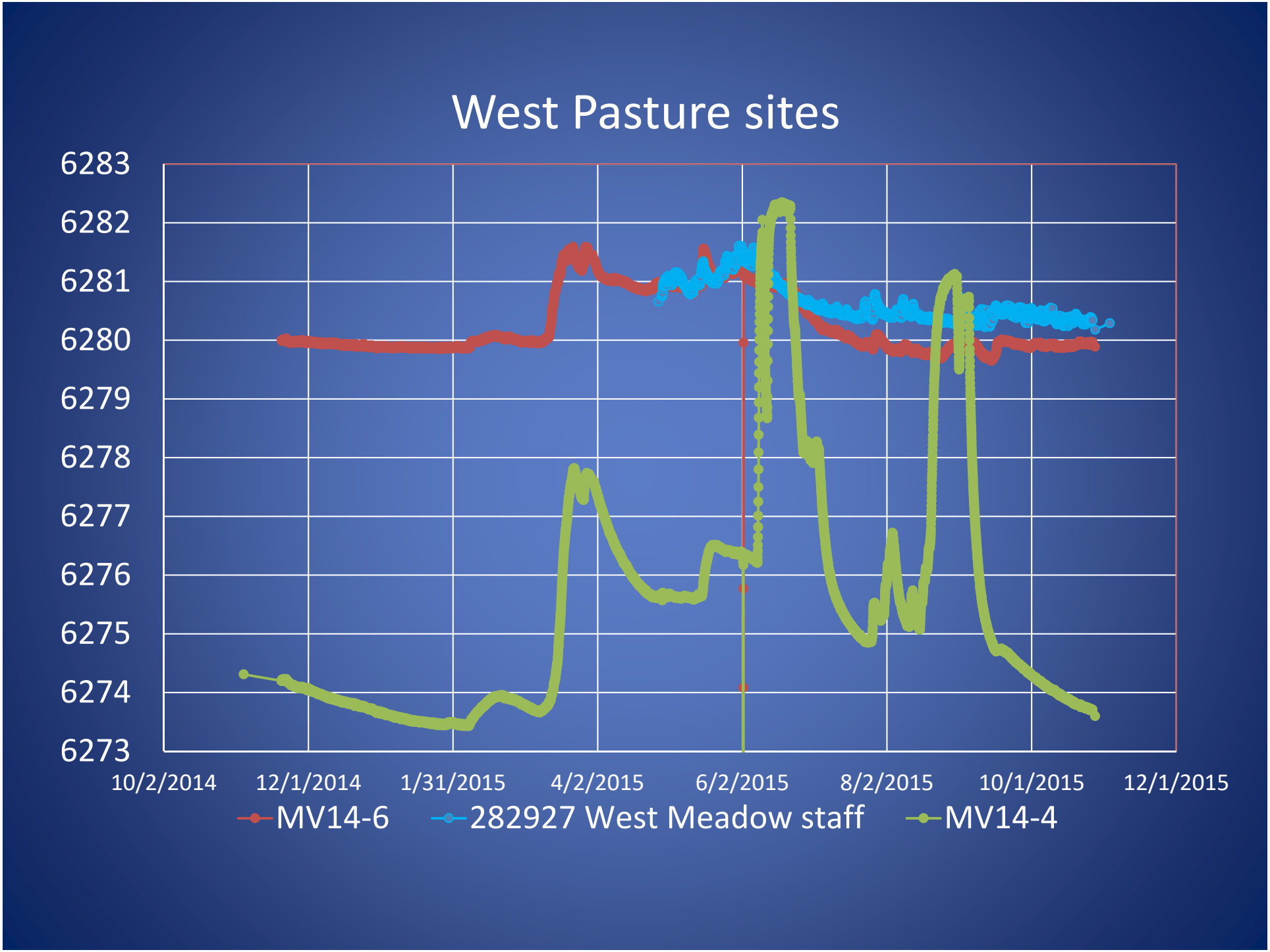


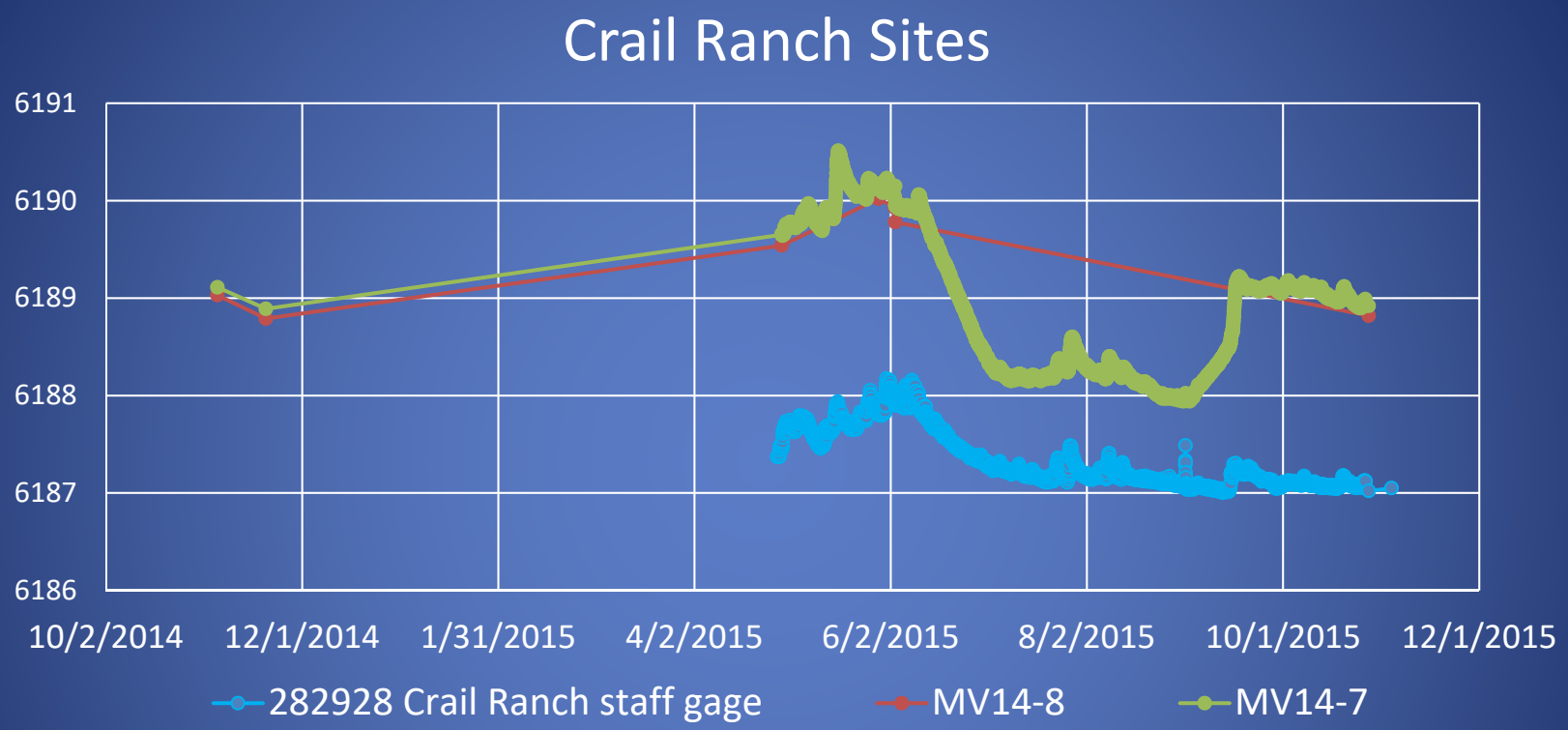
Bedrock aquifer stiff diagrams - the colors indicate various mapped bedrock formations.

Meadow Village
area wells and
Stream sites surveyed

Meadow Village
area staff gages and
wells instrumented

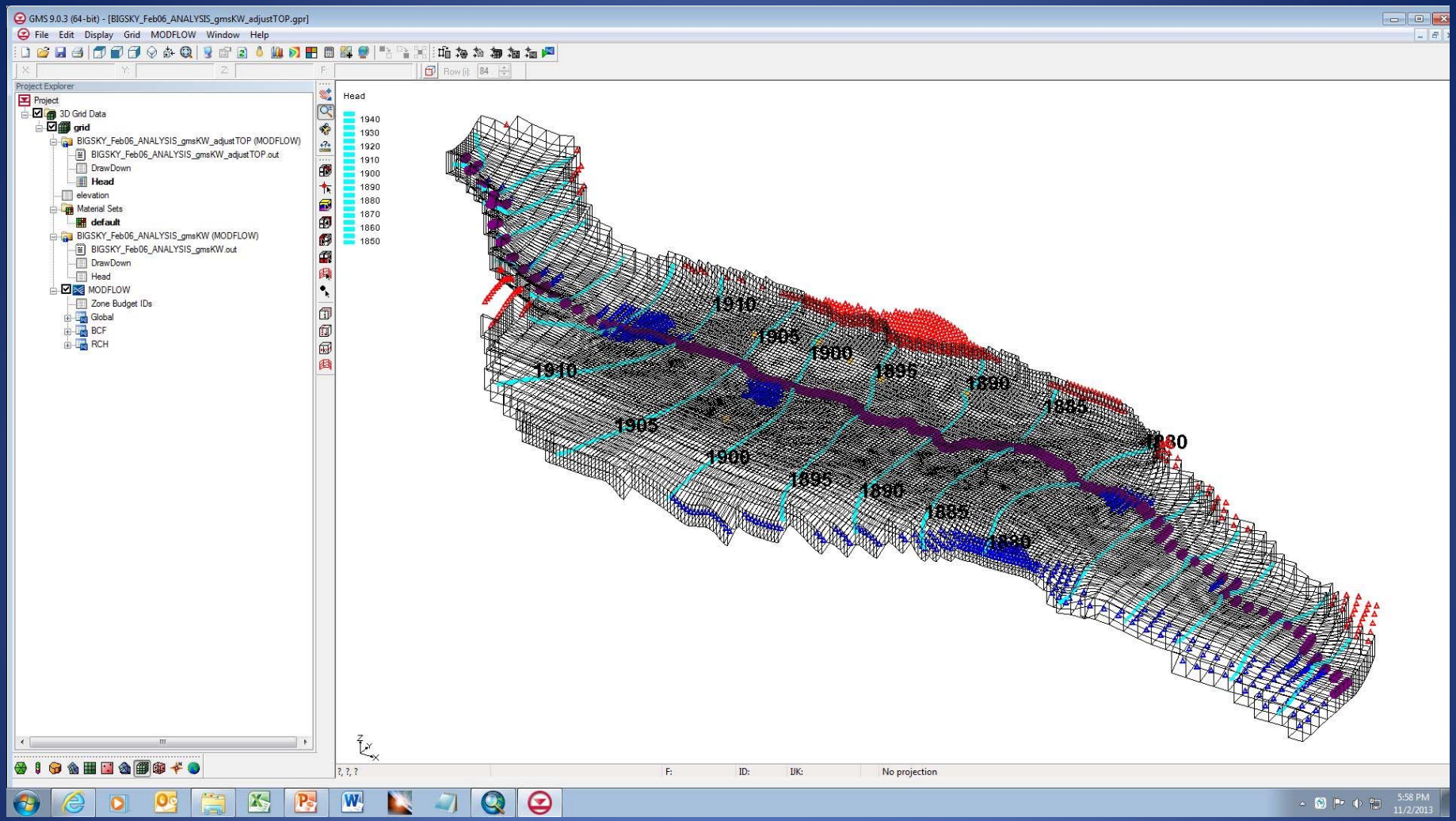

MEADOW VILLAGE AREA WELLS
Wells
Stream stage staff gages
MV14-14
MVTW-3
MV14-9
DH-3
Well 1
MV14-8
DH-6
Pond staff
Well 2
C&H 2
Spring
Meadow Village
DH-4
DH-5
Crail Ranch
DH-7
MV14-10
MV14-3
MV14-4
MV14-5
MV14-6
MV14-11
DH-2
DH-1
West Pasture
MV14-1
MV14-13
64
MV-12
Town Center


West Pasture sites
6283
6282
6281
6280
6279
6278
6277
6276
6275
6274
6273
10/2/2014
12/1/2014
1/31/2015
4/2/2015
6/2/2015
8/2/2015
10/1/2015
12/1/2015
MV14-6
282927 West Meadow staff
MV14-4


Crail Ranch Sites
6191
6190
6189
6188
6187
6186
10/2/2014
12/1/2014
1/31/2015
4/2/2015
6/2/2015
8/2/2015
10/1/2015
12/1/2015
282928 Crail Ranch staff gage
MV14-8
MV14-7

Groundwater use data

Sewage effluent / treated water



Groundwater Modeling System (GMS) software –
Meadow Village area model provided by
Mark Cunnane - Western Groundwater Services

2016

West Fork
Gallatin R.

- Gather and analyze recorded data from well and stream sites
- Seek measurable losses and gains in the West Fork during June and July
- Analyze water chemistry data
- Evaluate area geologic maps and well logs
- Develop a water budget for the Meadow Village aquifer
- Develop a groundwater model for the Meadow Village area
- Refine the project report scope and outline
- Write and assemble draft report
- Develop the first draft of an educational pamphlet