Montana Bureau of Mines and Geology
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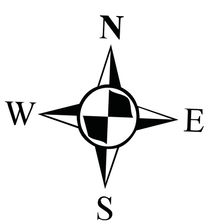
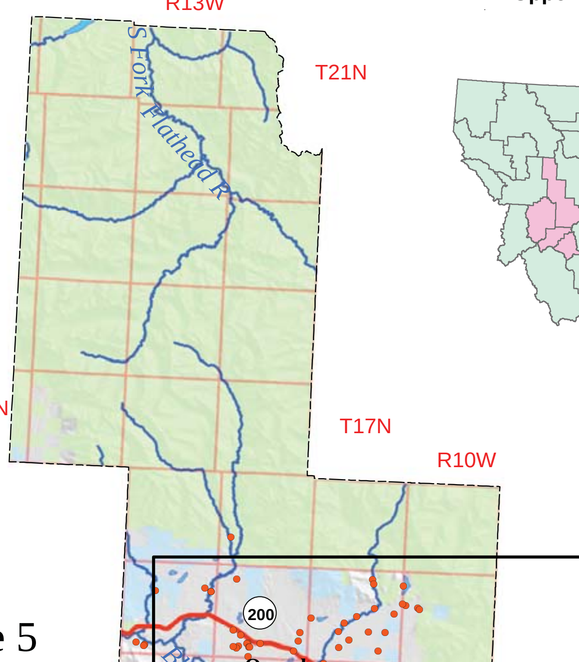




Upper Clark Fork River Ground Water Characterization Area

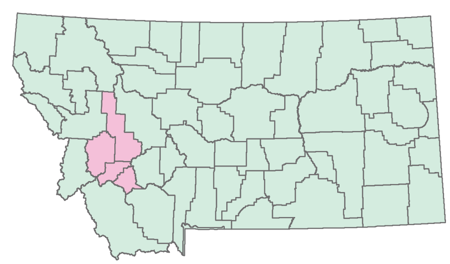


Figure 5

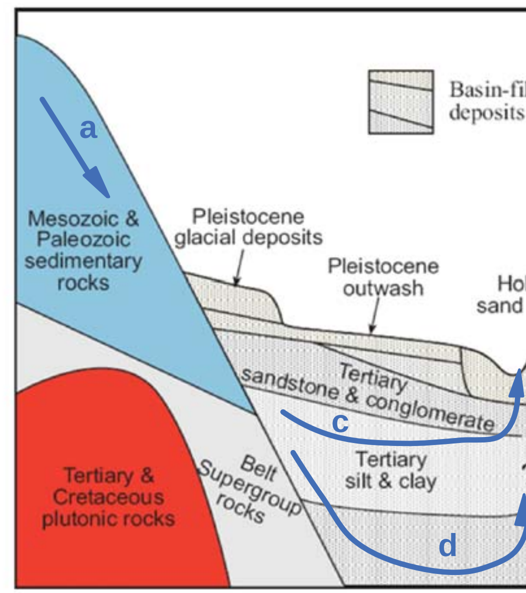
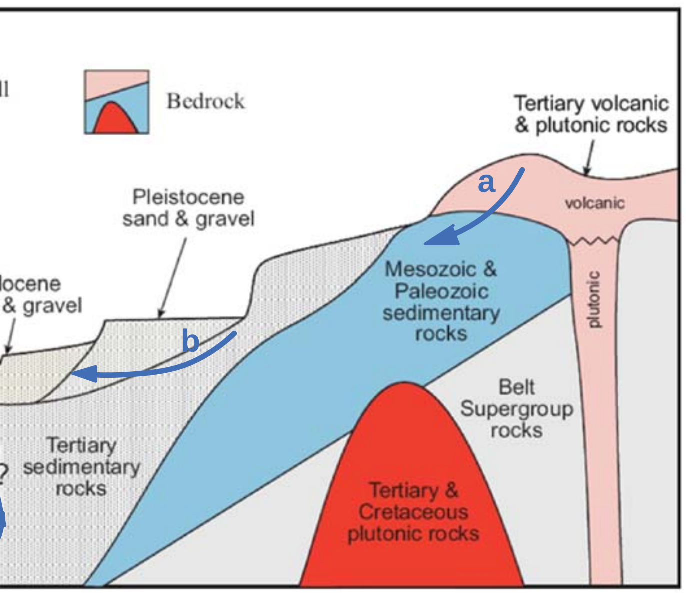
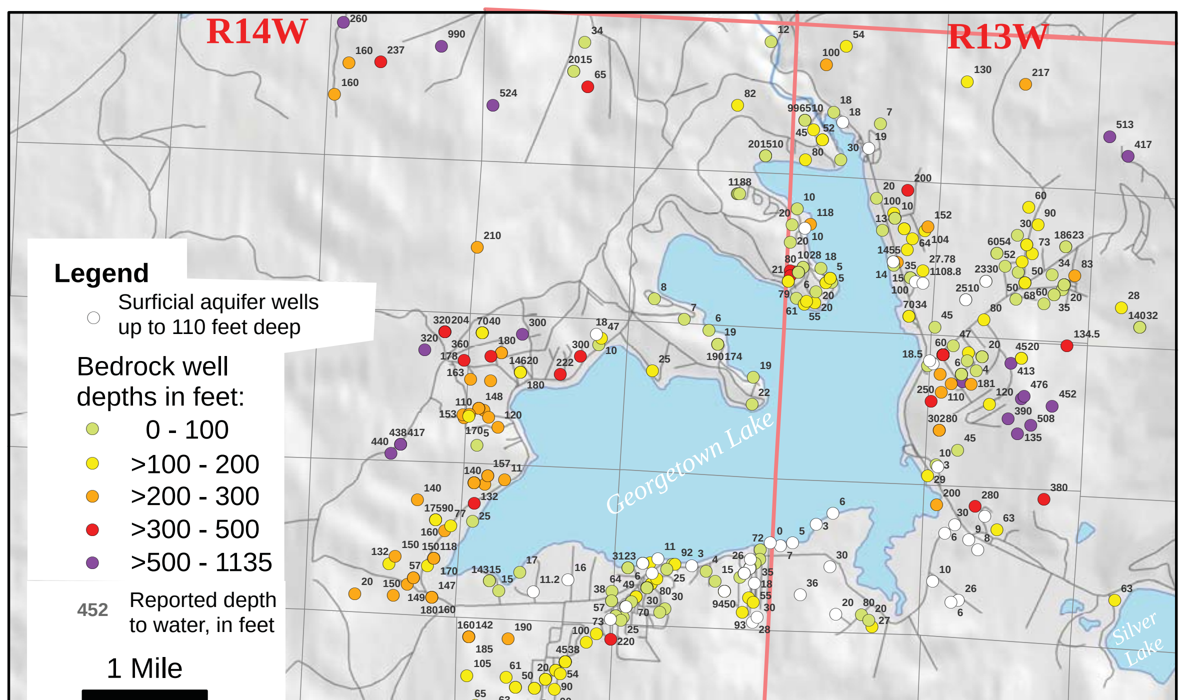
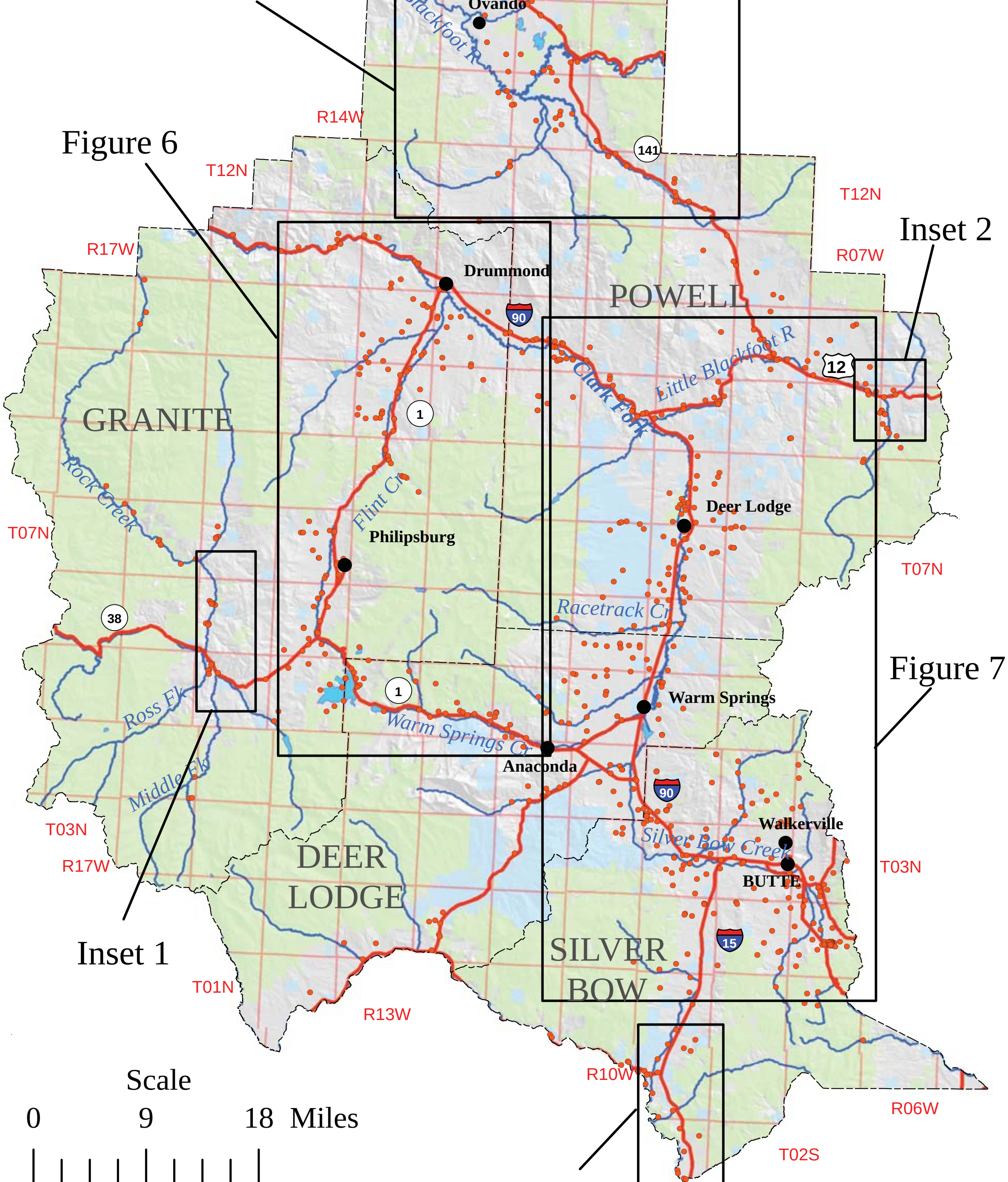


Figure 2. Diagrammatic cross sectio
bedrock and basin fill (from Carstarph





on illustrating stratigraphic relationships between
hen and others, 2004). The groundwater-flow paths



Legend

Public lands

County boundaries

(blue arrows) added here illustrate exa
materials and (b) shallow, (c) intermed

Each intermontane basin is a somewhat
1996). Depending on thickness and layeri
and deep groundwater flow components (
flow infiltration, direct precipitation, and
stratigraphy may create numerous stacked

On a basin scale, the layered sedimen
exceeding vertical permeability, and the
single hydrogeologic unit. Typically, inter
areas at their downstream ends where less
be manifested as springs, marshes, and gai

Unconsolidated surficial sediments associ
generally coarse-grained and, where suffic
are generally recharged from direct precipi

Groundwater levels fluctuate in response t
occurring at annual, diurnal, seasonal, or m
level changes in any particular well depen
pumping), and the aquifer's hydrologic pro
seasonal and surficial water-level influence

Within the study area, many wells displa
irrigation activity beginning in about mid
irrigation ditches and canals and applied i
source of groundwater recharge. In these a
the irrigation season, stay elevated with s
after the irrigation season; at some sites the

Methods

The maps on this plate were constructed l
level measurements and estimated water le
guide the contouring, as were potentiome
Philipsburg valleys (Voeller and Waren,
Lake (Roberts and Waren, 2001), the De
several areas along the Big Hole River (
measurements were collected between
Assessment Program (GWAP); the data s
and 19 spring altitudes (Carstarphen an
determined with hand-held or survey-gra

mples of how groundwater flows through (a) bedrock
liate, and (d) deep paths through basin-fill aquifers.

isolated groundwater flow system (Kendy and Tresch, ng of the basin fill, there may be shallow, intermediate, fig. 2). Recharge occurs from irrigation practices, stream adjacent bedrock units. The layered Tertiary basin-fill water-bearing zones at any particular location.

ts generally result in horizontal permeability greatly entire basin fill and surrounding bedrock often act as a rmontane basins have discernible groundwater discharge permeable bedrock forces water upward to the surface to ning-stream reaches.

iated with either modern streams or glacial features are ciently thick and saturated, make excellent aquifers. They tation, irrigation practices, and surface water.

o a wide variety of natural and anthropogenic influences nulti-year frequencies (Freeze and Cherry, 1979). Water-d on sources and types of recharge, discharge (including operties. Deep wells, somewhat removed from short-term es, tend to best reflect long-term climate.

ay water-level changes clearly associated with seasonal -April and lasting through the end of September. Leaky rrigation water not utilized by crops can be a significant areas, water levels tend to rise dramatically at the start of some irregularities during summer months, and decline e decline continues until the next irrigation cycle begins.

by hand-contouring a combination of inventoried water-evels from driller's logs. Topographic maps were used to etric maps from previous studies in the Drummond and 1997), the Kleinschmidt Flat northeast of Kleinschmidt eer Lodge Valley (Konizeski and others, 1968), and in Marvin and Voeller, 2000). The inventoried water-level February 2000 and July 2002 by the Ground Water set included 779 measured water-level altitudes in wells nd others, 2004). Locations of inventoried sites were de GPS units and are accurate to within 50 ft (15 m).

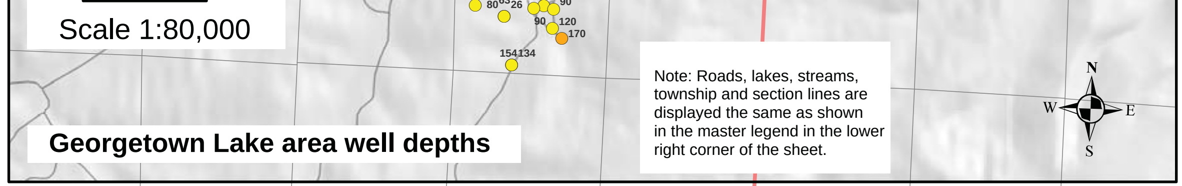


Figure 4. Georgetown Lake area well depths in Township 5 North, Ranges 13 and 14 West.

Descriptions of selected areas

Georgetown Lake

The Georgetown Lake area is shown in figure 4 and in the lower-left part of figure 6. This area contains more than 400 well records, about 67 percent of which have been drilled since 1990. Figure 4 displays the locations of wells reportedly completed in surficial unconsolidated aquifers, generally sand and gravel materials (white circles), and the depth ranges of bedrock wells by color. Static water-level depths are labeled throughout the figure. There are many surficial aquifer and shallow bedrock wells along certain edges of the lake. Deep wells are prevalent along the west shore and east of the lake. The lake altitude on the USGS 1:24,000 topographic map is 6,378 ft, nearly the same as the 6,383-ft mean groundwater-level altitude reported for bedrock wells within about 1.25 miles of the lake (all altitudes are reported as feet above mean sea level). Groundwater-level altitudes in this area range from 6,095 to more than 6,700 ft. About half of the bedrock wells have water-level altitudes within about 50 ft of the lake level, in the range of 6,330 to 6,430 ft. The configuration of the potentiometric surface (fig. 6) indicates that on the northeast and southeast sides regional groundwater flow is toward the lake. The median reported well yield is 18 gpm, with the majority of reported yields ranging from 5 to 40 gpm.

Blackfoot River and Nevada Creek area

The Blackfoot River and Nevada Creek area is shown in figure 5. Much of the valley floor is covered with unconsolidated glacial till. The till typically consists of clay with varying amounts of sand, gravel, and boulders. Till often contains many somewhat separate and disjointed water-bearing zones rather than acting as a single, unified aquifer. Consequently, water levels and well depths are more variable than those observed in coarse, more homogeneous materials.

Kleinschmidt Flat, northeast of Kleinschmidt Lake (fig. 5), is a coarse-grained outwash plain of thick sand, gravel, and conglomerate; the deposits are reportedly cemented at many localities. The outwash aquifer is bounded by relatively impermeable bedrock or till on all sides. Water enters the aquifer as direct losses from the North Fork Blackfoot River and its tributaries at the upper end of the flat, as well as from irrigation losses and direct infiltration of precipitation and snowmelt (Roberts and Waren, 2001). Groundwater levels at the upper, northeast end of Kleinschmidt Flat fluctuate seasonally as much as 45 ft. These fluctuations diminish downgradient toward the discharge area marked by many springs and spring creeks. In the discharge zone, groundwater levels are relatively stable, changing only a few feet annually.

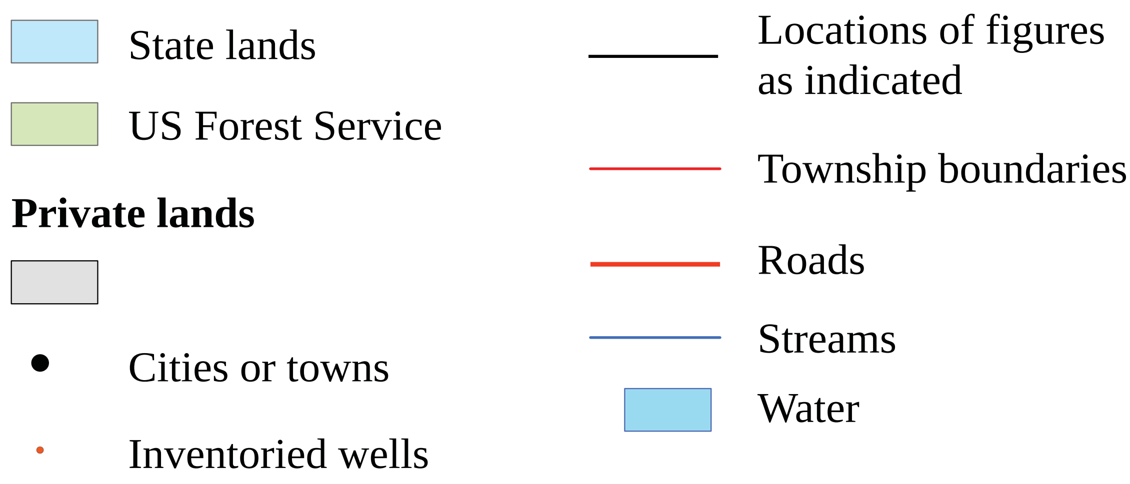


Figure 1. Study area map with land ownership information and key to the locations of selected figures.

Potentiometric Surface Map of Basin Fill and Selected Bedrock Aquifers: Deer Lodge, Granite, Powell, and Silver Bow Counties, Montana

By

Kirk B. Waren and John I. LaFave

Author's Note: This map is part of the Montana Bureau of Mines and Geology (MBMG) Ground Water Assessment Atlas for the Upper Clark Fork River Area. It is intended to stand alone and describe a single hydrogeologic aspect of the study area, although many of the area's hydrogeologic features are interrelated. For an integrated view of the hydrogeology of the Upper Clark Fork River Area, the reader is referred to other maps and reports of Montana Ground Water Assessment Atlas 5.

Introduction

This map portrays potentiometric surfaces for surficial unconsolidated, basin-fill, and bedrock aquifers at selected locations within the Upper Clark Fork River Ground Water Characterization Area. Figure 1 shows the study area, principal geographic and cultural features, and the extents of maps in figures 5, 6 and 7, and insets 1, 2, and 3.

A potentiometric surface represents the altitude to which water levels will rise in wells completed in an aquifer. In the study area, most wells are completed within the surficial unconsolidated alluvial and Tertiary basin-fill deposits or in fractured rock on the valley margins. The potentiometric surfaces depicted here are based on water levels in wells of the most common

Land-surface altitudes at inventoried well
1:24,000 topographic maps and are gene
contour intervals). These inventoried d
potentiometric contours. The well locatio
larger symbols on the maps: yellow circl
Tertiary basin-fill wells, and green squares

The inventoried data set was supplement
driller's logs at 5,810 sites. The estimate
measured data were sparse, and helped co
of better primary data coverage. A geogr
model (DEM) was used to determine the
levels. The reported water level was sub
groundwater altitude. Because of uncertain
the accuracy of the estimated groundwat
Wells with estimated groundwater levels a

Between 2000 and 2003, monthly water
provide insight regarding seasonal fluctuat
a star on the maps. Selected hydrographs
7, with the border color of the hydrograph
well is completed: yellow for surficial unc
bedrock. The hydrographs depict the va
seasonal groundwater fluctuations across th

Geologic maps including the state geo
Assessment Atlas 5, Map 2 (Smith, 2009)
(Berg and Hargrave, 2004) were used to a
area, most of the wells (46%) are con
completed in fractured-bedrock aquifers, a

Reported information on driller's logs w
surficial unconsolidated, Tertiary basin-fil
variety of different methods (pumping, air
time periods (less than one to several h
measurements but give a general indicatio
reported well yield for the surficial uncons
minute (gpm); however, there is a greater r
aquifers (fig. 3a). The median well yield i
Of the 2,169 surficial aquifer wells with
Tertiary aquifer wells exceeded 500 gpm,
gpm. Median reported well depths for the
ft; Tertiary basin-fill aquifers, 105 ft; and b

locations were interpreted from U.S. Geological Survey
rally accurate to +/- 5 to 10 ft (based on 10 and 20 ft
ata were the primary data set used to compile the
ons with measured water levels are represented by the
es for surficial unconsolidated wells, orange circles for
for bedrock wells.

ed by estimated groundwater altitudes determined from
ed groundwater altitudes were used in areas where the
nfirm the shape of the potentiometric surface(s) in areas
aphic information system (GIS) with a digital elevation
land-surface altitude at sites with driller-reported water
tracted from the land-surface altitude to determine the
nties associated with locations and driller's measurements
er-altitude data is much less than the primary data set.
re represented on the maps by the smaller symbols.

r-level measurements were obtained from 86 wells to
tions of groundwater levels. These sites are indicated by
from some of these wells are shown in figures 5 through
n matching the legend color for the aquifer in which the
consolidated, orange for Tertiary basin fill, and green for
ariability with regard to the timing and magnitude of
he study area and between aquifers.

ologic map (Vuke and others, 2007), Ground-Water
, and detailed geologic maps for the Deer Lodge Valley
ssign source-aquifer codes to the wells. Within the study
mpleted in surficial unconsolidated aquifers, 29% are
nd 25% are completed in Tertiary basin-fill aquifers.

as evaluated to summarize well depth and yields from
ll, and fractured-bedrock aquifers (fig. 3). Drillers use a
r-lift, bailing, etc.) to determine well yields over varying
hours). The reported yields are not considered precise
on of the well, hence aquifer, productivity. The median
solidated and Tertiary basin-fill aquifers is 20 gallons per
range in reported yields from the surficial unconsolidated
s about 15 gpm for wells completed in bedrock aquifers.
n reported yields, 35 exceeded 500 gpm; 21 of 1,265
and only 8 of 1,620 bedrock-aquifer wells exceeded 500
three aquifers are: surficial unconsolidated aquifers, 43
edrock aquifers, 160 ft. The distribution of reported well

Flint Creek Basin: Drummond and Philipsburg Valleys

The Flint Creek basin is shown in figure 6, with the Drummond Valley shown in the top center and the Philipsburg Valley in the lower left. Predominant aquifers include sand and gravel deposits capping the Tertiary deposits northwest of Hall, alluvial sediments in the floodplains of Flint and Willow creeks, and Tertiary deposits. Logs for deep wells completed in Tertiary sediments typically report siltstone or shale at depth. In many of these wells, groundwater is encountered in either thin sand and gravel layers or fractures in semi-consolidated rock.

The Drummond and Philipsburg Valleys were the subject of a detailed irrigation return flow study in the mid-1990s (Voeller and Waren, 1997). The hydrology of both valleys is highly influenced by irrigation activity and the importation of water from the East Fork Rock Creek reservoir. Groundwater levels in many areas fluctuate seasonally, largely in response to irrigation practices; the hydrograph for well 63339 in the upper-middle part of figure 6 is a good example. Voeller and Waren (1997) provide detailed discussions of the water budget, including irrigation return flows calculated from four separate sub-basins. Irrigation return flow from excess irrigation water in the Flint Creek basin, much of it stored and released from basin-fill aquifers, approaches 100 cubic ft per second after irrigation stops at the end of the summer. This return flow diminishes over a period of months as groundwater levels decline. Hydrographs from a shallow—deep nested well pair located on the valley margin southwest of Drummond (wells 15483 depth water enters [DWE] = 127 ft and 15484 DWE = 40 ft) demonstrate a downward vertical gradient. Downward gradients are common in recharge areas along valley margins. Away from the recharge areas vertical gradients diminish as flow becomes lateral toward the topographically lower discharge areas.

Deer Lodge Valley

The Deer Lodge Valley (fig. 7) is characteristic of the intermontane basins of southwestern Montana. It is approximately thirty miles in length between where Silver Bow Creek enters at its upper end and where the Clark Fork River exits north of Deer Lodge. It is generally less than 15 miles wide. Konizeski and others (1968) provide an overview of the hydrogeology of the valley. Surficial unconsolidated sediments are found in the floodplain of the Clark Fork River and numerous tributary valleys as shown in figure 7. Tertiary basin-fill underlies the surficial deposits and is thousands of feet thick (Smith, 2009). In many parts of the valley, especially high on benches underlain by Tertiary sediments, deep wells tend to have lower altitude water levels, demonstrating downward vertical gradients.

Summit Valley – Butte Area

The Summit Valley in the southeast part of the study area (fig. 7) is surrounded by granitic rock (quartz monzonite). As much as 800 ft of basin-fill sediments overlie bedrock near the valley center. Additional potentiometric-surface contours with a 20 ft contour interval are available for some areas within the gray rectangle shown in figure 7. The rectangle represents the extent of MBMG Ground-Water Open-File Report 22 (LaFave, 2008), which focused on nitrate in groundwater and surface water in the Summit Valley. Unconsolidated surficial sediments in the depths at any particular location. In general, the potentiometric surface is a subdued representation of the regional topography; the highest groundwater altitudes coincide with the regional topographic highs and the lowest altitudes with the regional topographic lows. Lateral groundwater movement will be in a direction perpendicular to potentiometric contours from higher to lower altitudes.

The maps are based on about 800 measured water-level and spring altitudes gathered during site visits between February 2000 and July 2002. In addition, data from previous groundwater investigations and reports were used where they provided additional detail; reported water levels from driller's well logs and water rights applications were used where measured data were sparse. All the water-level data used to compile this map are available from the MBMG's Ground Water Information Center (GWIC).

Geologic setting

The geologic setting of the Upper Clark Fork River Ground Water Characterization Area is described in detail in Montana Ground Water Assessment Atlas 5, Map 2 (Smith, 2009). The area consists of bedrock-cored mountains that separate large valleys. The valleys are connected by distinct canyons along major streams. Smith (2009) defines three principal categories of geologic materials: surficial unconsolidated sediments, Tertiary sedimentary rocks, and bedrock.

On this plate, areas indicated as bedrock combine many types of consolidated rock. See Smith (2009) for a more complete discussion of the geologic setting and detail on bedrock geology. Bedrock forms most of the mountainous parts of the study area and is also present beneath the basin fill. Within the mountainous areas, there are mapped and unmapped surficial unconsolidated, glacial, and stream-deposited sediments of limited extent.

During the Tertiary period (about 65 to 2.6 million years ago), large, wide valleys in western Montana, such as the Deer Lodge Valley, were structurally down dropped relative to surrounding mountains, and filled with hundreds to thousands of feet of Tertiary and younger sediments (Smith, 2009). Tertiary sediments are typically layered, poorly consolidated deposits that include clay, silt, sand, gravel, conglomerate, shale, sandstone, and volcanic ash; they may include minor amounts of limestone, coal, and volcanic rock. Typically the materials are more consolidated at depth, and if consolidated, are often fractured.

Unconsolidated surficial sediments in the floodplains and under terraces along modern streams typically include sand, gravel, silt, and lesser amounts of clay; in some areas the deposits are glacially deposited till (gravelly clay, silt, sand, and boulders) and outwash (sand and gravel). These surficial deposits are typically less than 70 ft thick, but in a few places, notably in the Blackfoot River and Nevada Creek valleys (fig. 5), the till and outwash may be more than 200 ft thick.

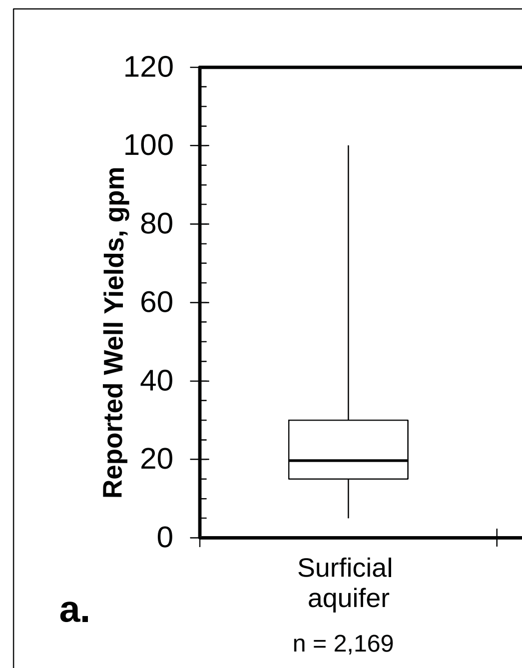
Within the intermontane basins, basin-fill aquifers are saturated Tertiary sedimentary rocks and unconsolidated surficial sediments that can deliver water to wells. Basin-fill aquifers are bounded along the valley margins by fractured bedrock aquifers. Figure 2 is a diagrammatic cross section

depths is illustrated in figure 3b. The lowe
wells reflect variable fracture densities and

Map use

Contours on potentiometric surface maps p
of groundwater flow. Groundwater genera
lower altitudes. An estimate of the de
potentiometric-surface altitude from the l
noting the depths to water reported on nea
records for any area can be obtained from
contoured potentiometric surface is expec
any given point, or +/- the contour interva
contoured potentiometric surface is 100 ft,

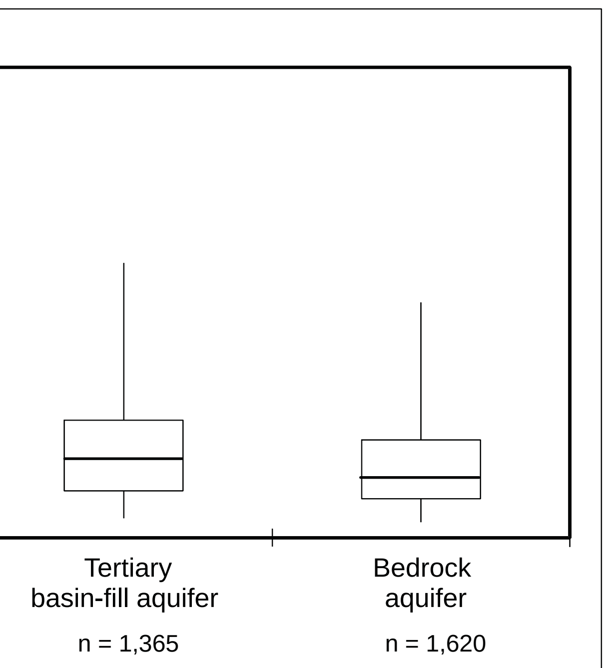
Map accuracy is affected by data distributi
and errors in interpretation. Points at wh
unevenly and map accuracy is greater n
groundwater fluctuations approach or ex
magnitudes of observed water-level fluctu
result in localized, seasonal variations in
seasonal water-level changes in areas wit
others (1968), Voeller and Waren (1997),
and LaFave (2008).



er well yields and wide range in well depths for bedrock
l permeabilities in bedrock aquifers.

provide estimated directions of the horizontal component ally moves perpendicular to the contours, from higher to epth to groundwater can be made by subtracting a and-surface altitude at a desired location, or by simply arby existing well records. For more information, well n the GWIC website (http://mbmggwic.mtech.edu/). The ted to be accurate to +/- one-half the contour interval at l where the contours are dashed. For example, where the accuracy is expected to be +/- 50 ft at any given point.

on, field measurement errors, accuracy of well locations, hich water levels have been measured are distributed near points of measurement. In some areas, seasonal xceed 20 ft (see hydrographs for selected wells for ations). Large seasonal fluctuations in water levels may n groundwater flow direction. Additional details about th supplemental contours is provided in Konizeski and Marvin and Voeller (2000), Roberts and Waren (2001),



Summit Valley are sandy with poor soil development due to their granitic source material, so mobile ions like nitrate readily move through the sediment and into the groundwater (LaFave, 2008). The lack of irrigation development in the Summit Valley is reflected by small seasonal fluctuations in local hydrographs. Apparent downward water-level trends shown in Summit Valley hydrographs are related to dry climate during the study period.

Geothermal features

Warm and hot springs are present in the Deer Lodge Valley, to the northwest along the Clark Fork River, and also near Avon (Sonderegger and Bergantino, 1981). The warm springs have temperatures in the range of about 70 to 80 degrees Fahrenheit, while hot springs at Gregson, about 5 miles south of Opportunity and at Warm Springs are 158 and 172 degrees Fahrenheit, respectively. Wells between 300 and 600 ft deep at Gregson provide hot water to Fairmont Hot Springs resort. The Deer Lodge Valley, the Clark Fork Valley in Granite and Powell Counties, and the valley of the Little Blackfoot River are all mapped as areas expected to contain geothermal resources suitable for direct heat applications (Sonderegger and Bergantino, 1981).

Data sources

Base layers of physiography, hydrology, and cultural features were derived from Geographic Information System coverages available at the Montana State Library Natural Resource Information System, Helena, Montana (http://nris.mt.gov/).

Acknowledgments

This work was supported by the Ground Water Characterization Program at the Montana Bureau of Mines and Geology. Information extracted from the Ground Water Information Center database by the database manager, Luke Buckley. The map and text were improved by reviewers Thomas Patton, John Metesh, Jake Kandelin, and Jim Stimson. Edited by Susan Barth.

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along the valley margins by fractured-bedrock aquifers. Figure 2 is a diagrammatic cross section showing general relationships between bedrock aquifers and basin-fill materials, and general groundwater flow paths.

Hydrogeologic setting

Precipitation is more abundant in the surrounding mountainous areas than in the inset valleys. Water, seasonally stored and released from mountain snowpack, contributes substantially to spring and summer stream flow. The greatest water use in the Upper Clark Fork River Area is irrigated agriculture. Most of the irrigated acreage is located in the valley bottoms where precipitation is less than in the mountains, but where the growing season is longer.

Mountainous areas surrounding the valleys are typically underlain by consolidated bedrock, such as granite, basalt, meta-sedimentary quartzites, and argillites (Smith, 2009). Permeability in these rocks is through interconnected fractures that typically become less connected with depth (Freeze and Cherry, 1979). Bayuk (1989) noted that specific yields in Belt Supergroup bedrock southwest of Missoula, Montana, decreased by a factor of four at depths greater than 250 ft.

Water that infiltrates into the fractured bedrock in the mountains percolates downward and then moves laterally outward from the mountains to the valleys as permeability allows. The lateral movement of water from the mountains to the valleys is a source of recharge to basin-fill aquifers, and can provide baseflow to streams or appear as springs.

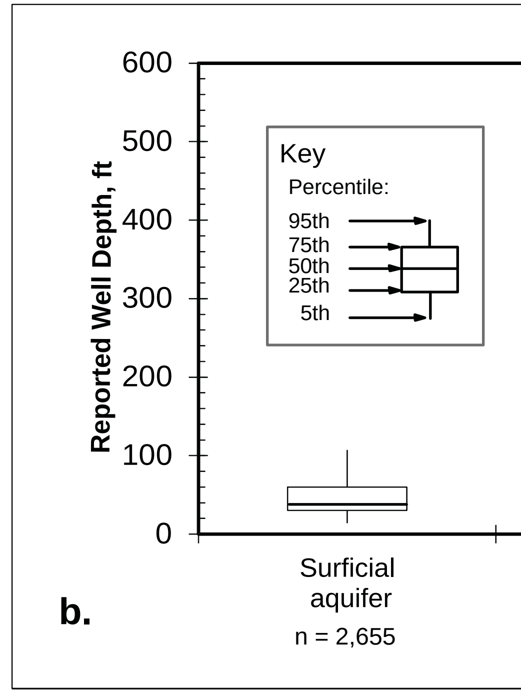
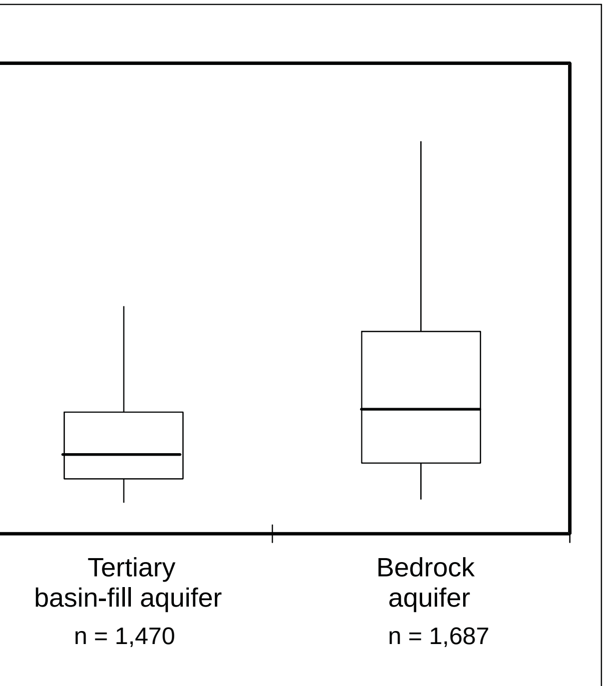


Figure 3. Distribution of (a) well yields
unconsolidated, Tertiary basin-fill, and



s, and (b) well depths: among surficial bedrock aquifers.

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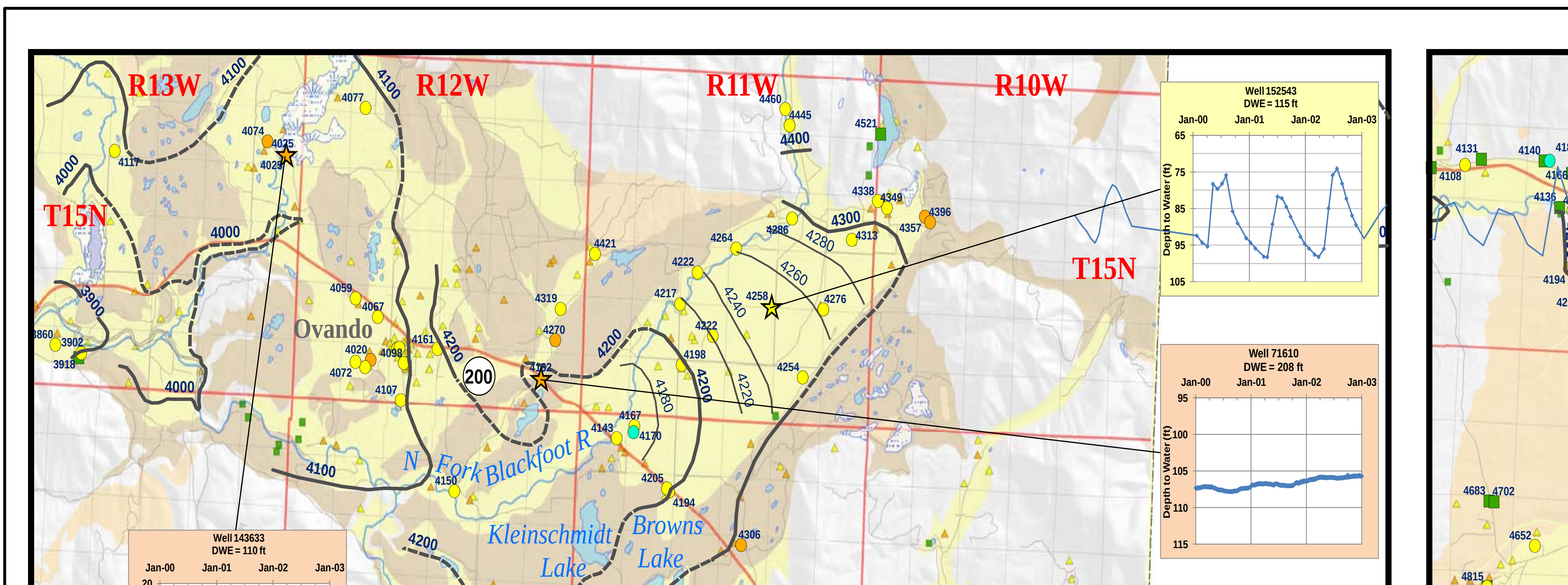
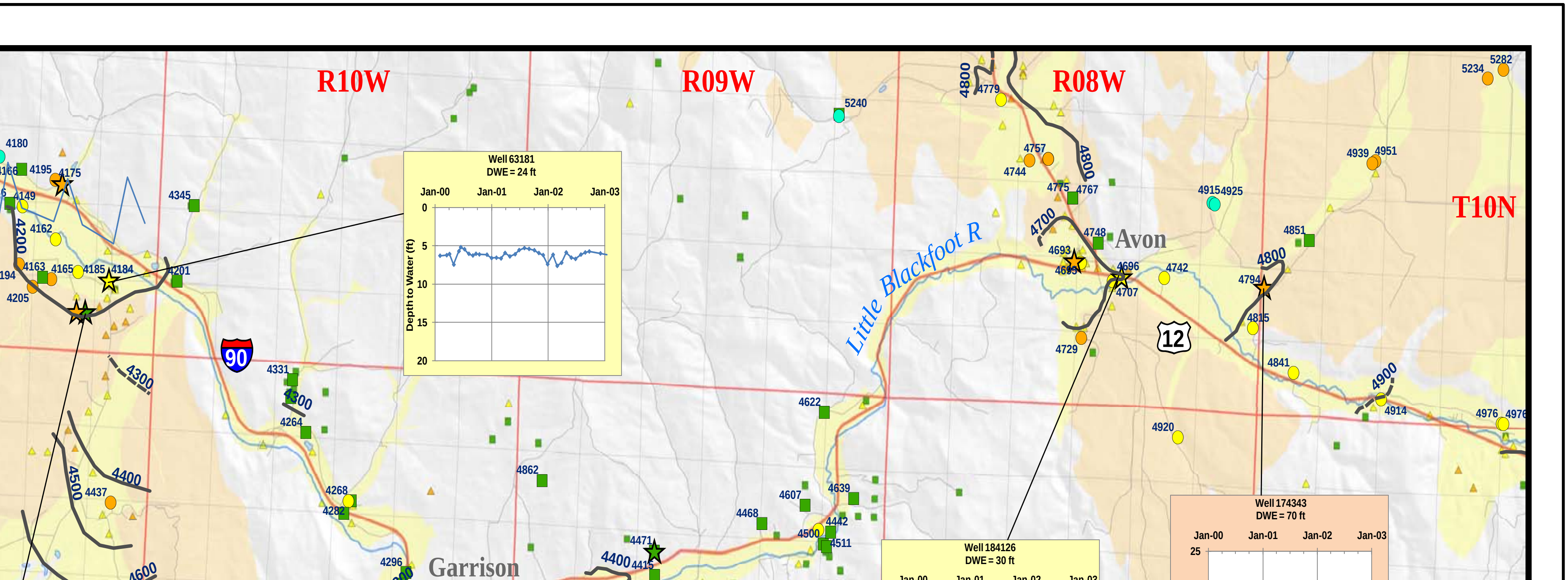

R13W
R12W
R11W
R10W
T15N
T15N
Ovando
N Fork Blackfoot R
Kleinschmidt Lake
Browns Lake
200
4000
4100
4200
4300
4400
3900
4180
4220
4240
4260
4280
Well 152543
DWE = 115 ft
Jan-00
Jan-01
Jan-02
Jan-03
Depth to Water (ft)
65
75
85
95
105
Well 71610
DWE = 208 ft
Jan-00
Jan-01
Jan-02
Jan-03
Depth to Water (ft)
95
100
105
110
115
Well 143633
DWE = 110 ft
Jan-00
Jan-01
Jan-02
Jan-03

Montana Ground Water Assessment Atlas 5, Map 3
July 2011



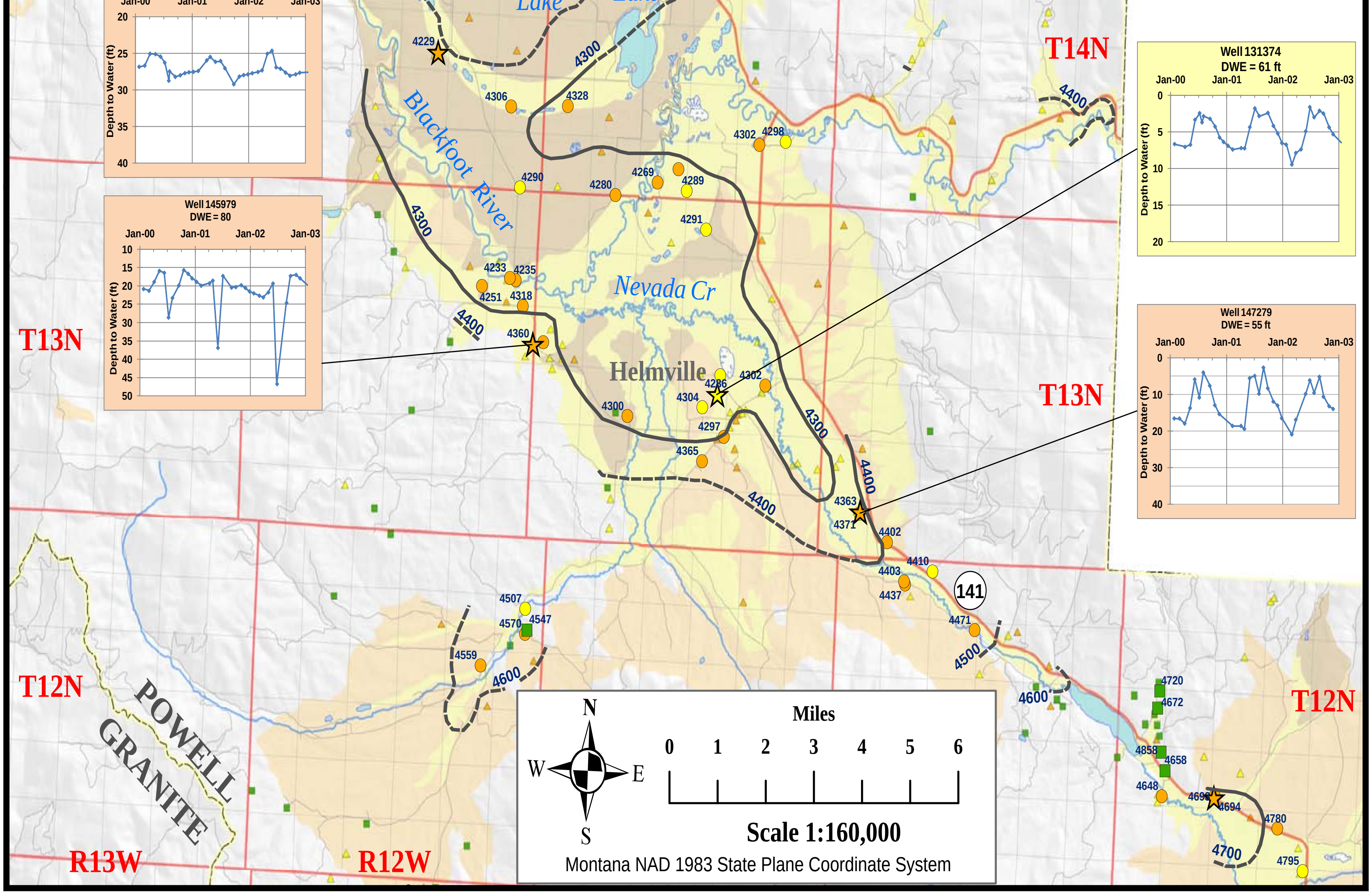
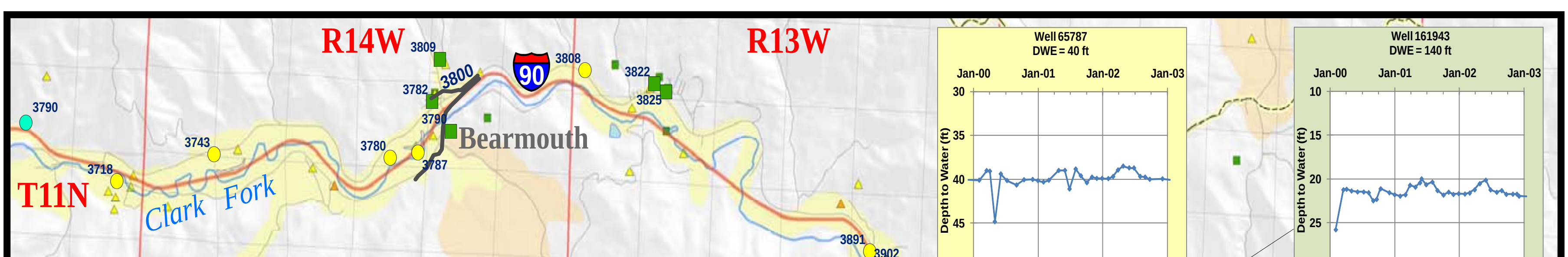
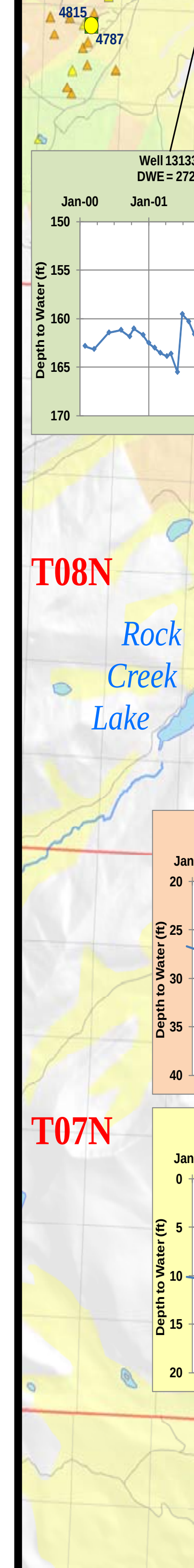
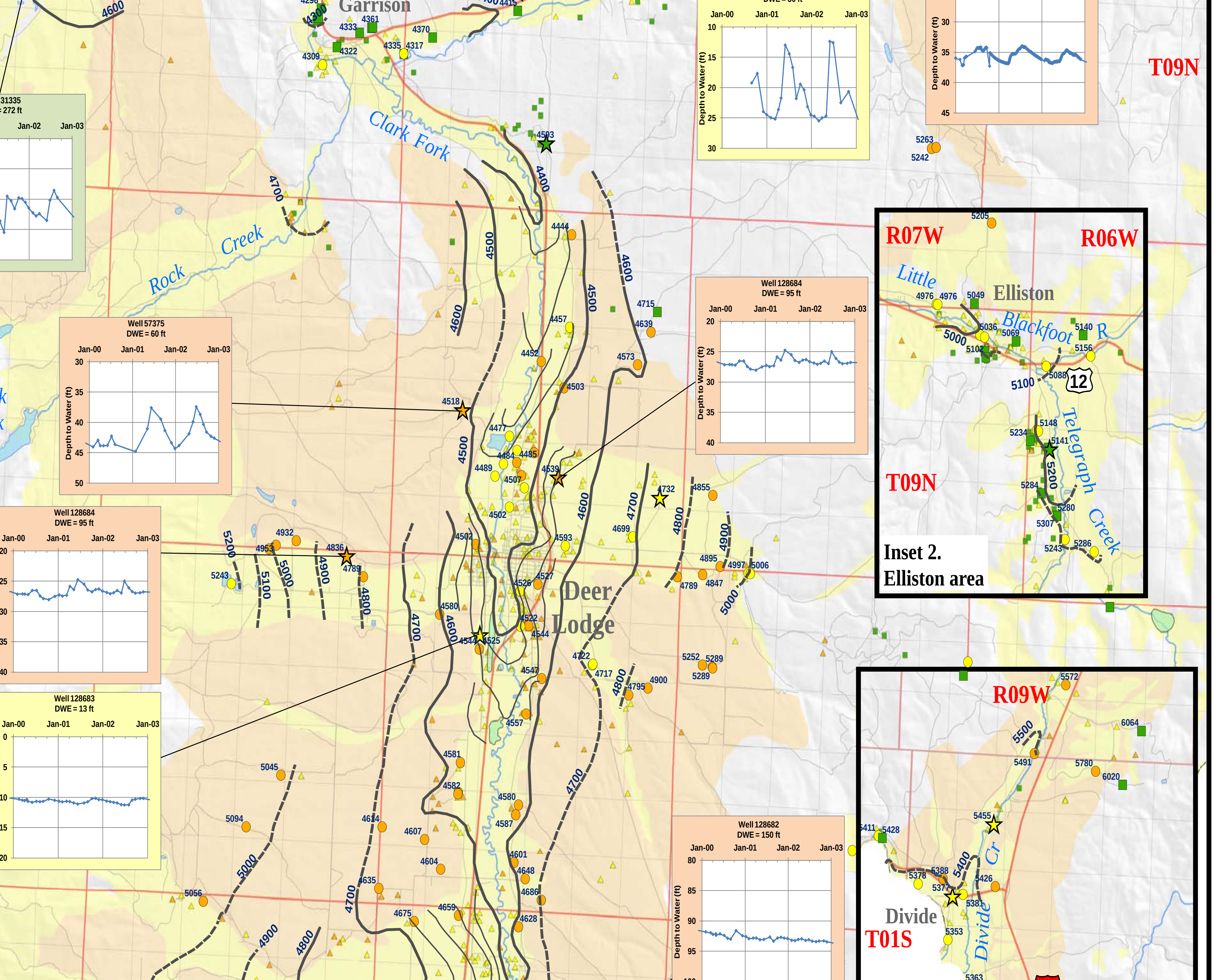


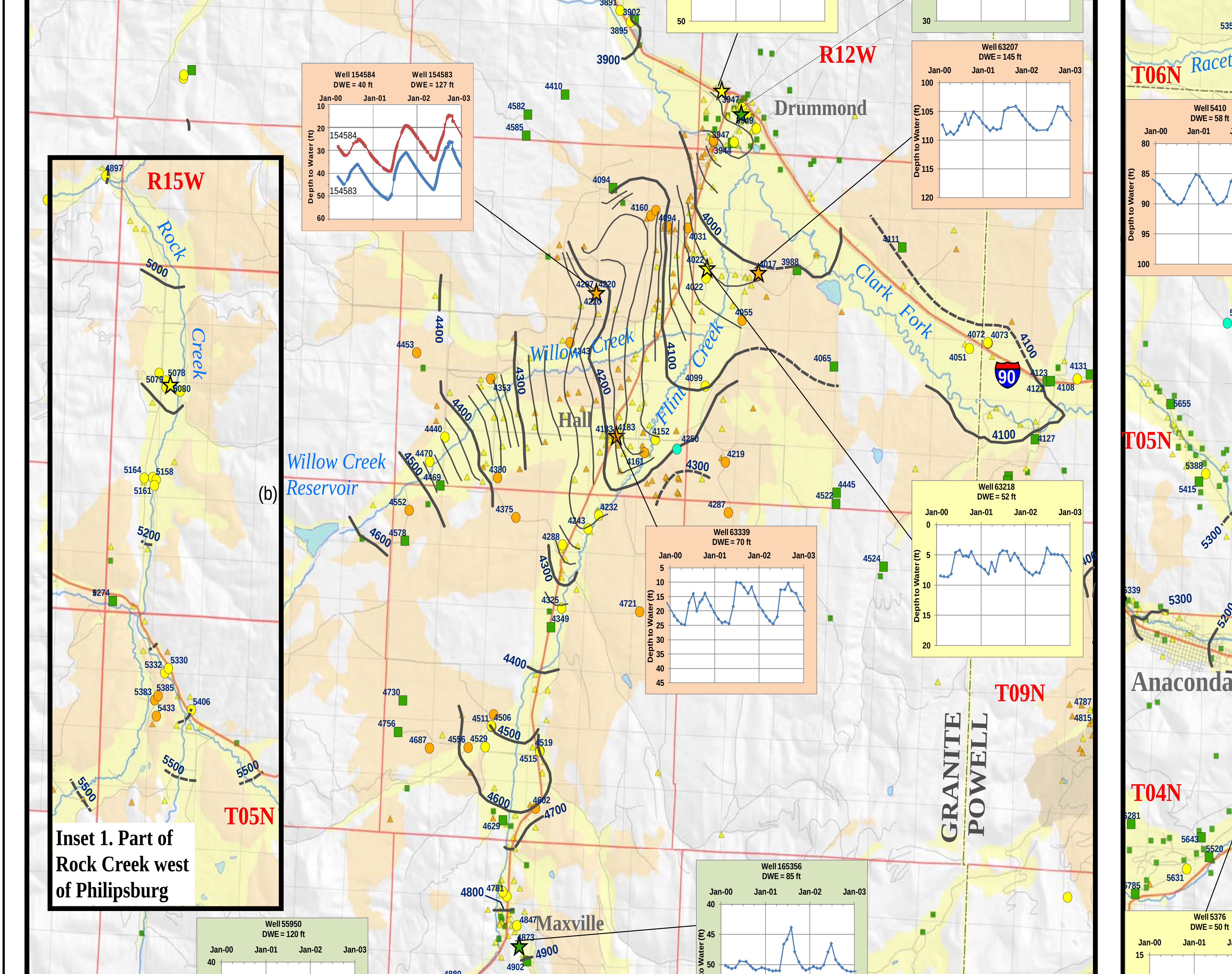
Figure 5. Blackfoot River and Nevada Creek area.



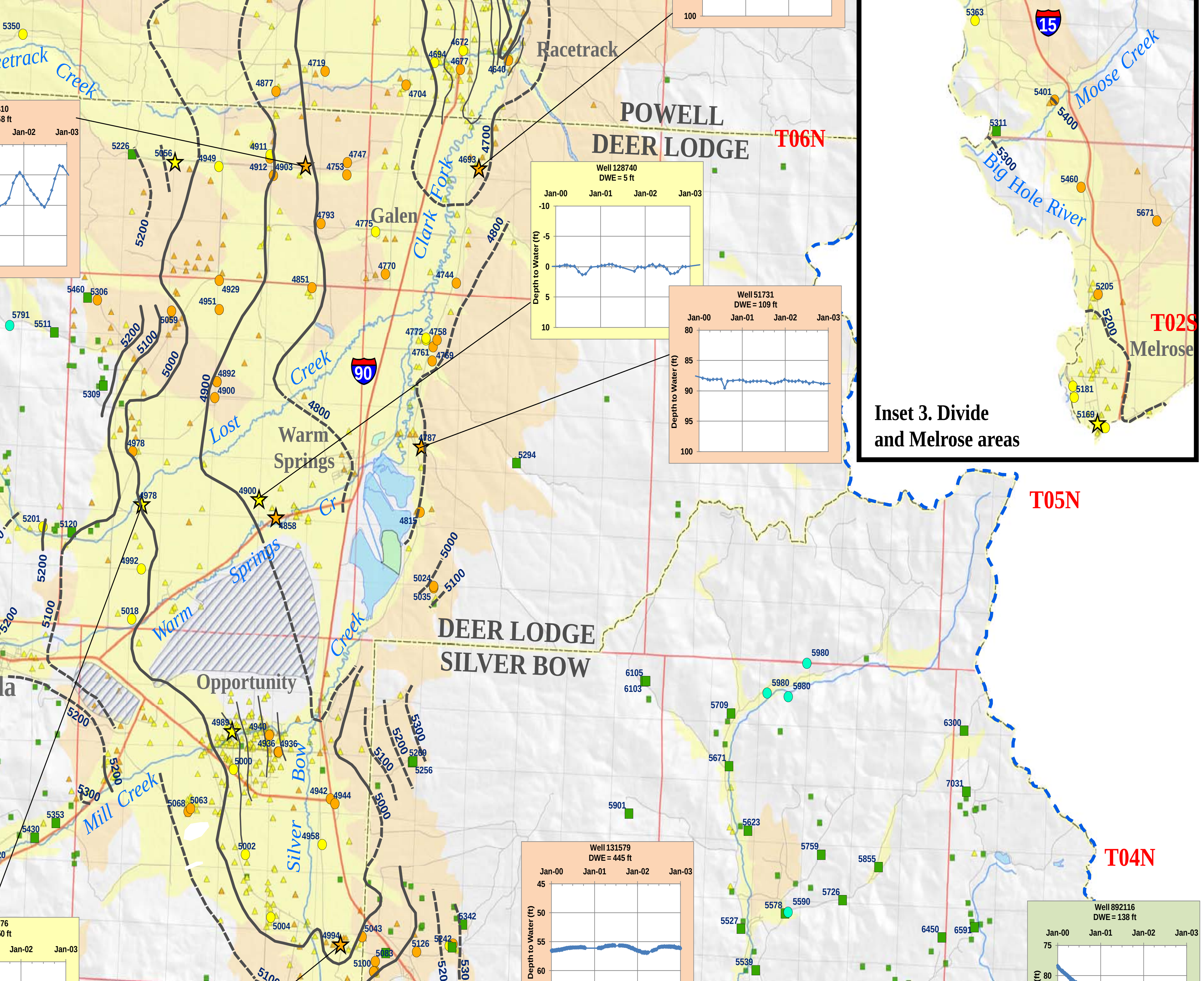


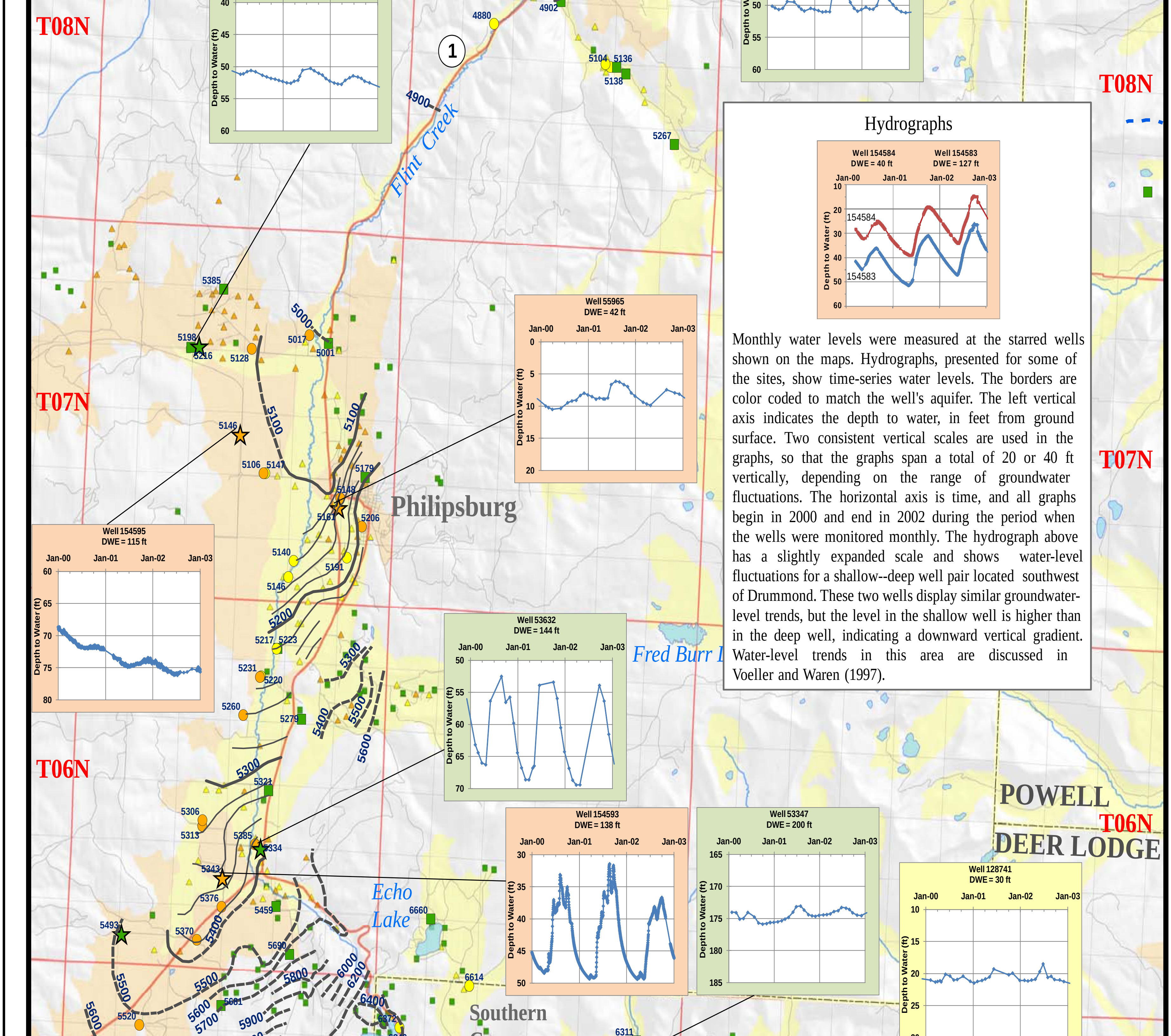


Garrison
Clark Fork
Rock Creek
Deer Lodge
T09N
Well 57375
DWE = 60 ft
Well 128684
DWE = 95 ft
Well 128683
DWE = 13 ft
Well 128682
DWE = 150 ft
Jan-00
Jan-01
Jan-02
Jan-03
Depth to Water (ft)
Inset 2.
Elliston area
R07W
R06W
Little
Elliston
Blackfoot R
Telegraph Creek
12
R09W
Divide
T01S
Divide Cr



R12W
Drummond
R15W
Rock
Creek
Inset 1. Part of Rock Creek west of Philipsburg
T05N
(b)
Willow Creek
Willow Creek Reservoir
Flint Creek
Clark Fork
Hall
Maxville
T09N
GRANITE
POWELL
T06N
T05N
T04N
Anaconda
Well 154584 DWE = 40 ft
Well 154583 DWE = 127 ft
Well 63207 DWE = 145 ft
Well 5410 DWE = 58 ft
Well 63339 DWE = 70 ft
Well 63218 DWE = 52 ft
Well 165356 DWE = 85 ft
Well 55950 DWE = 120 ft
Well 5376 DWE = 50 ft
Depth to Water (ft)
Jan-00
Jan-01
Jan-02
Jan-03
3900
4000
4100
4200
4300
4400
4500
4600
4700
4800
4900
5000
5200
5300
5500
90


Racetrack
POWELL
DEER LODGE
T06N
Galen
Clark Fork
Warm Springs
Lost Creek
Warm Springs Cr
Warm Springs Creek
Opportunity
Mill Creek
Silver Bow Creek
DEER LODGE
SILVER BOW
T05N
T04N
Well 128740
DWE = 5 ft
Jan-00 Jan-01 Jan-02 Jan-03
Depth to Water (ft)
Well 51731
DWE = 109 ft
Well 131579
DWE = 445 ft
Well 892116
DWE = 138 ft
Inset 3. Divide and Melrose areas
Moose Creek
Big Hole River
T02S
Melrose



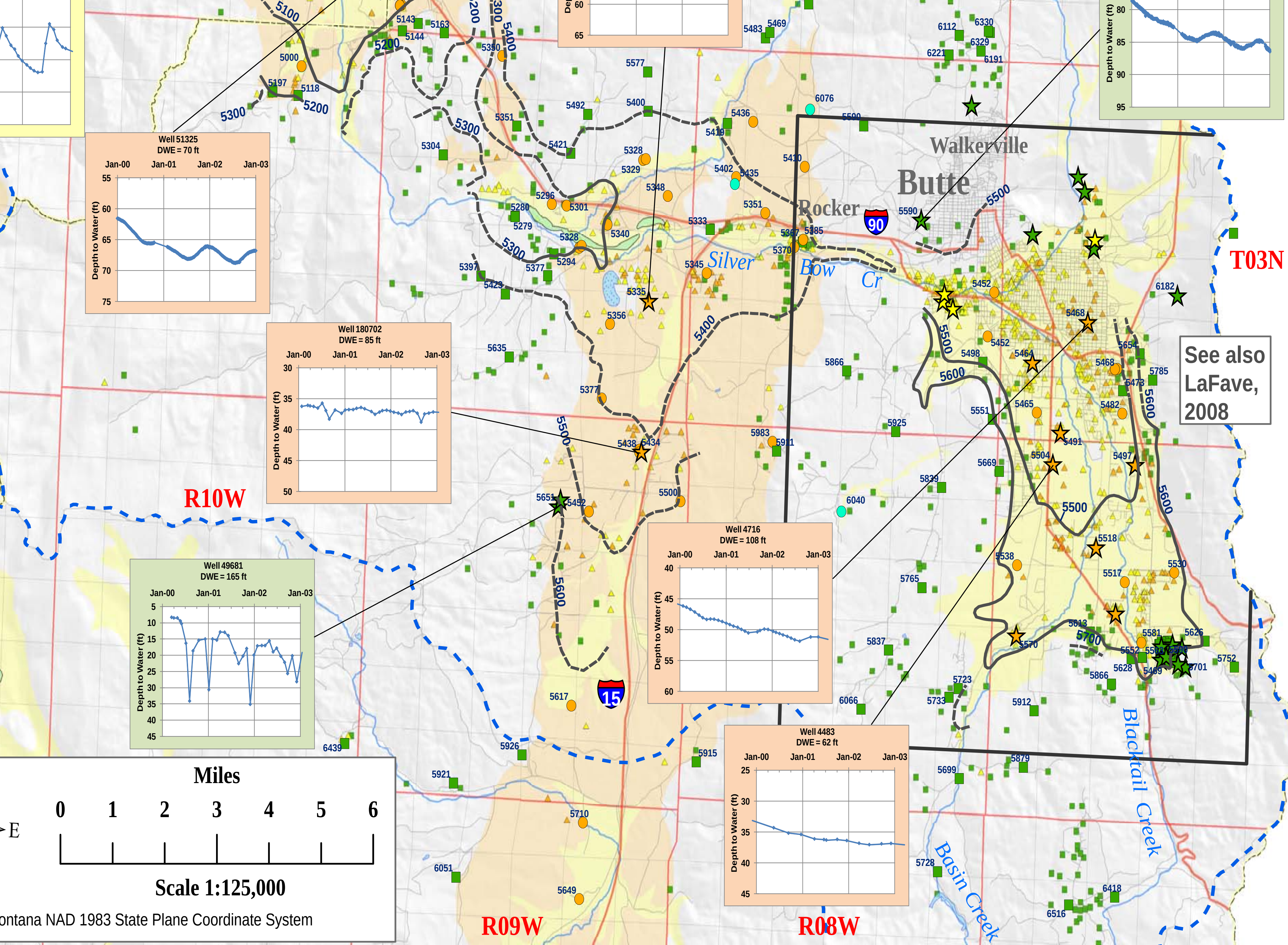
Hydrographs

Well 154584 DWE = 40 ft; Well 154583 DWE = 127 ft

Monthly water levels were measured at the starred wells shown on the maps. Hydrographs, presented for some of the sites, show time-series water levels. The borders are color coded to match the well's aquifer. The left vertical axis indicates the depth to water, in feet from ground surface. Two consistent vertical scales are used in the graphs, so that the graphs span a total of 20 or 40 ft vertically, depending on the range of groundwater fluctuations. The horizontal axis is time, and all graphs begin in 2000 and end in 2002 during the period when the wells were monitored monthly. The hydrograph above has a slightly expanded scale and shows water-level fluctuations for a shallow--deep well pair located southwest of Drummond. These two wells display similar groundwater-level trends, but the level in the shallow well is higher than in the deep well, indicating a downward vertical gradient. Water-level trends in this area are discussed in Voeller and Waren (1997).

Figure 7. Deer Lo

Legend



Lodge and Summit Valleys.

Spring sites

Inventoried spring locations

Water

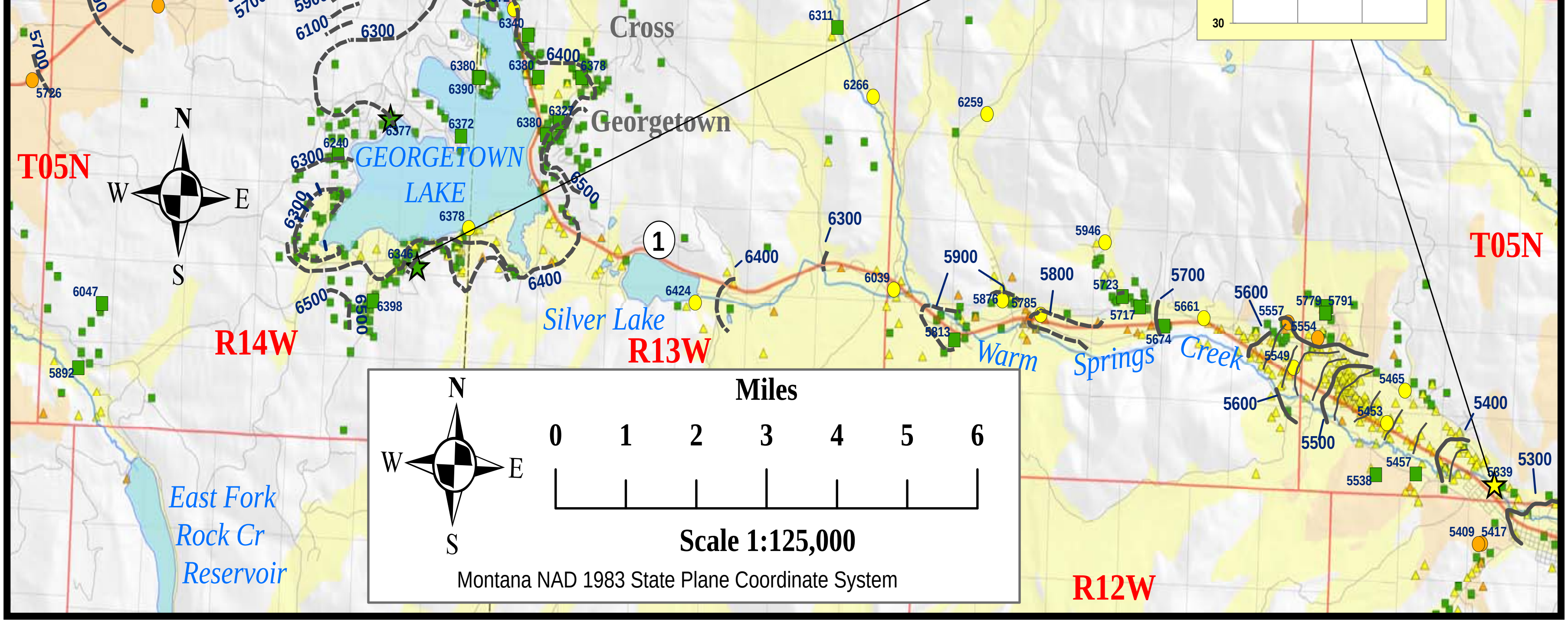


Figure 6. Drummond and Philipsburg Valleys and Georgetown Lake.

Legend

Water well si

Inventoried sites with measured static water-level altitudes, in feet above mean sea level

5421

5421

5421

sites

th
er-
et
el

Sites with monthly water-level measurements. Hydrographs are shown for a selected number of sites.

Water well with estimated water-level altitude

5421 — Surficial aquifer well

5421 — Tertiary aquifer well

5421 — Bedrock aquifer well

5421 Inventoried spring locations with altitude in feet above mean sea level

Geology

- Surficial unconsolidated sediments, coarse-grained (sand, gravel, boulders)
- Surficial unconsolidated sediments, fine-grained (silt, clay, glacial till)
- Tertiary sedimentary rocks (siltstone, sandstone claystone, conglomerate, coal, volcanic ash, etc.)
- Bedrock (granite, volcanic rock, limestone, sandstone, shale, quartzite, etc.)

- Water
- Water intermittent
- Mine tailings
- Wetlands
- Potentiometric contour. Contour interval 100 feet, dashed where inferred
- Supplemental potentiometric contour. Contour interval 20 feet
- Streams
- County boundaries
- Major highways
- Roads
- Township boundaries
- Section boundaries
- Summit Valley Study Area
- Continental Divide