Montana Bureau of Mines and Geology
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Montana Ground-Water Assessment Atlas 4, Part B, Map 10
July 2006

Patterns of Water-Level Fluctuations, Lolo-Bitterroot Area, Mineral, Missoula, and Ravalli Counties, Montana

by
Larry N. Smith

Author's Note: This map is part of the Montana Bureau of Mines and Geology (MBMG) Ground-Water Assessment Atlas for the Lolo-Bitterroot Area ground-water characterization. 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 Lolo-Bitterroot Area the reader is referred to Part A (descriptive overview) and Part B (maps) of the Montana Ground-Water Assessment Atlas 4.

INTRODUCTION

Water levels have been measured in wells over periods of years to decades to better understand how ground-water levels in wells change with time. Many factors, including pumping (usage), seasonal climate, long-term climate, and irrigation influence the timing and magnitude of water-level changes. During the Lolo-Bitterroot Ground-Water Characterization, water levels were measured on 800 wells; 117 of these wells had more than 10 water-level measurements, 11 wells had hourly measurements using automated water-level recorders, and 62 wells continue to either be measured quarterly or have automatic recorders installed.

METHODS

All water-level records were reviewed but only the 75 records showing seasonal water-level fluctuations are portrayed. The locations of 7 wells that apparently had seasonal water-level fluctuations but were affected by pumping also are included. The 42 wells that showed both seasonal patterns and long-term climatic responses are not included.

At least 3 years of monthly measurements were available for most wells. Some well records with obvious seasonal patterns also included individual pumping or recovering water-level measurements. These individual measurements were deleted from the records before analysis. The water-level fluctuations were averaged by well by month and separated into groups based on the monthly average water-level data.

DISCUSSION

Patterns of water-level fluctuations in wells that do not show multi-year drought or wet-cycle trends can be classified into three types of responses: springtime recharge responses, irrigation responses, and stream recharge responses. Springtime recharge responses are common in floodplains and on some low terraces along rivers, especially near the Bitterroot River, along the Clark Fork River near Hellgate Canyon, in the canyon reach from Huson to the study area boundary, and near other streams in eastern Missoula County. During spring runoff, streamflows and ground-water levels rise concurrently in response to snowmelt and precipitation. The flows and water levels then fall at nearly the same time. Ground water and surface water at these locations are responding to the same hydrologic conditions of springtime runoff.

Water levels in many wells in the area react to the seasonal use of irrigation canals. This water-level response, the irrigation response pattern, shows a rise at the time of spring or early summer meltwater runoff or initiation of irrigation. In this pattern the high water levels are maintained through the summer, and then decline over time, sometimes through the winter into the following spring. Water levels in wells remain high as long as irrigation ditch networks near those wells are in use. The pattern is most convincingly shown in highly productive, shallow aquifers near large irrigation canals, such as well 136694. Except for two wells in the Missoula Valley, irrigation responses were observed only in the Bitterroot Valley. Three well records were classified as having a mix of springtime recharge and irrigation responses. The irrigation hydrograph pattern was recognized by the 1950s and 1960s in the Bitterroot and Missoula Valleys (McMurtrey and others, 1959, 1965).

Stream recharge responses are characterized by an abrupt rise in April and May followed by a steady decline throughout the summer and fall. The response is different from the irrigation response in that the highest levels occur during springtime runoff, and the levels then steadily decrease. The response is different from springtime recharge response because the well water levels remain elevated after the streamflow has returned to low-flow conditions. These responses were seen only in wells completed in unconsolidated materials in the Missoula Valley from Hellgate Canyon to Frenchtown. In this area, potentiometric surface mapping shows that the aquifer is recharged by leakage from the Clark Fork River (LaFave, 2006). Lateral spreading of a springtime pulse of recharge water is thought to be responsible for the steady decline in seasonal water levels.

DATA SOURCES

Current and historic water-level data and hydrographs for all wells can be obtained from the Ground Water Information Center website: http://mbmggwic.mtech.edu. Geologic contacts are simplified from Smith (2006). Base layers of physiography, hydrography, townships, and cultural features were derived from NRIS data sets (http://nris.state.mt.us/).

ACKNOWLEDGMENTS

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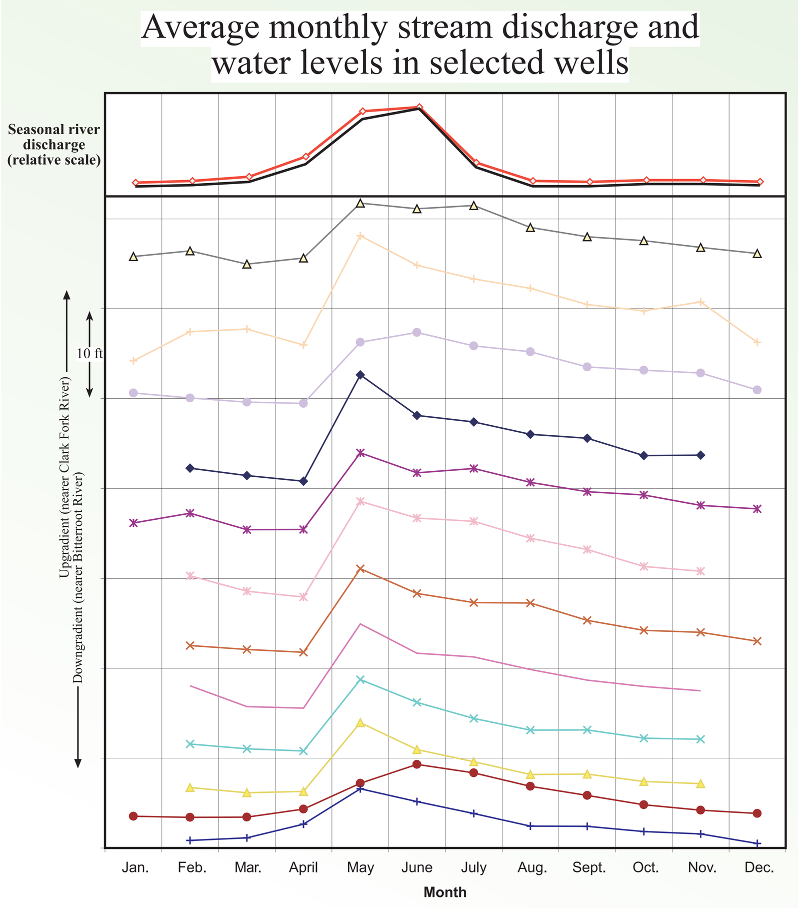
REFERENCES

LaFave, J.I., 2006, Potentiometric surface of the basin-fill and bedrock hydrologic units, Mineral and Missoula Counties, southwest Montana: Montana Bureau of Mines and Geology Ground-Water Assessment Atlas 4B-08, 1 sheet(s), 1:125,000.
McMurtrey, R.G., Konizeski, R.L., and Brietkrietz, A., 1965, Geology and ground-water resources of the Missoula Basin, Montana: Montana Bureau of Mines and Geology Bulletin 47, 36 p.
McMurtrey, R.G., Konizeski, R.L., Stermitz, F., and Swenson, H.A., 1959, Preliminary report on the geology and water resources of the Bitterroot valley: Montana Bureau of Mines and Geology Bulletin 9, 45 p.
Smith, L.N., 2006, Hydrogeologic framework of the Lolo-Bitterroot area, Mineral, Missoula, and Ravalli Counties, Montana (open file version): Montana Bureau of Mines and Geology Ground-Water Assessment Atlas 4B-02, 1 sheet(s), 1:250,000.

Stream recharge response (SR)

Average monthly stream discharge and water levels in selected wells



Discussion

All monitored wells in the Missoula Valley between the Clark Fork and Bitterroot Rivers show a seasonal response to high streamflow followed by a slow decline in water levels throughout the summer and fall. Most of the wells show an abrupt increase in water levels in May, corresponding to spring runoff along the Clark Fork River.

Two monitor wells peak in June, and one as late as October; however, all show a slow decline through the year. The average monthly water-level data do not show significant differences in the time of peak water levels with distance from the river.

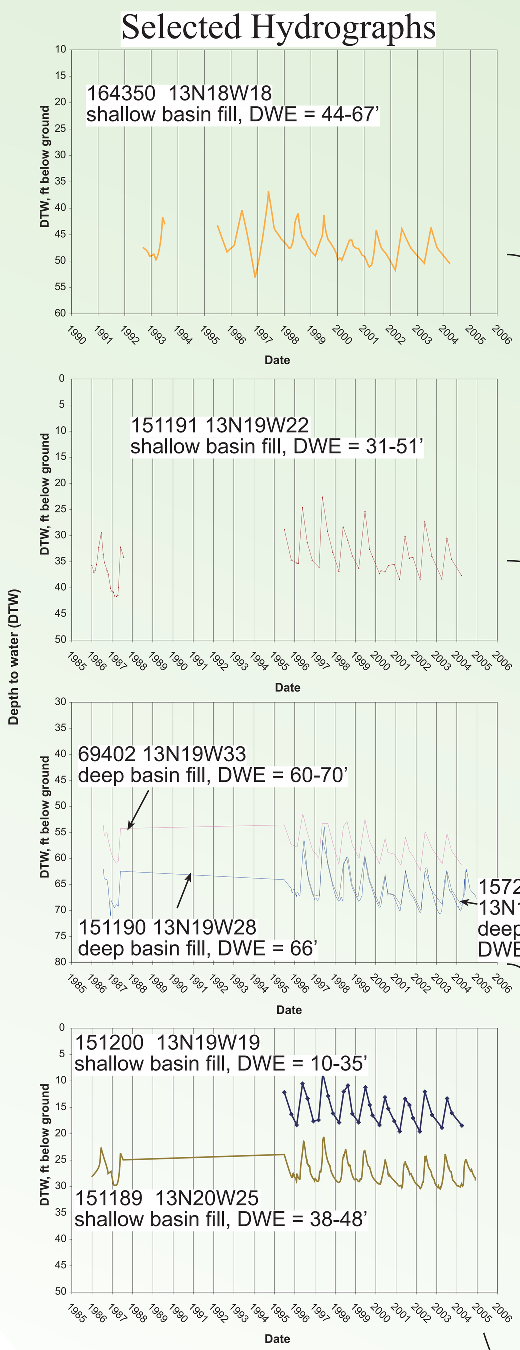
The slow decline in water levels mostly reflects a spreading pulse of recharge water from the losing reach of the Clark Fork River, as it exits Hellgate Canyon. Other factors, such as distribution of irrigation water from canals and suburban and urban irrigation of property, may also locally affect the hydrographs.

USGS 12340500 Clark Fork above Missoula MT 1930-2002
USGS 12353000 Clark Fork below Missoula MT 1929-2002

GWIC Id	TRS	Depth water enters	Dates of measurement	Hydrologic unit
164350	13N18W18	44-67’	1992-2004	shallow basin fill
151191	13N19W22	31-51'	1985-2004	shallow basin fill
69055	13N19W21	28-48'	1996-2004	shallow basin fill
157208	13N19W28	113-118'	1996-2005	deep basin fill
69402	13N19W33	60-70'	1986-2005	shallow basin fill
151143	13N19W20	20-45'	1995-2004	shallow basin fill
151200	13N19W19	10'	1995-2004	shallow basin fill
151161	13N19W30	33-53'	1995-2005	shallow basin fill
157210	13N19W31	87-97'	1996-2005	deep basin fill
151201	13N19W31	31-51'	1995-2005	shallow basin fill
151189	13N20W25	38'	1986-2005	shallow basin fill
151101	13N20W26	5-25'	1995-2005	shallow basin fill

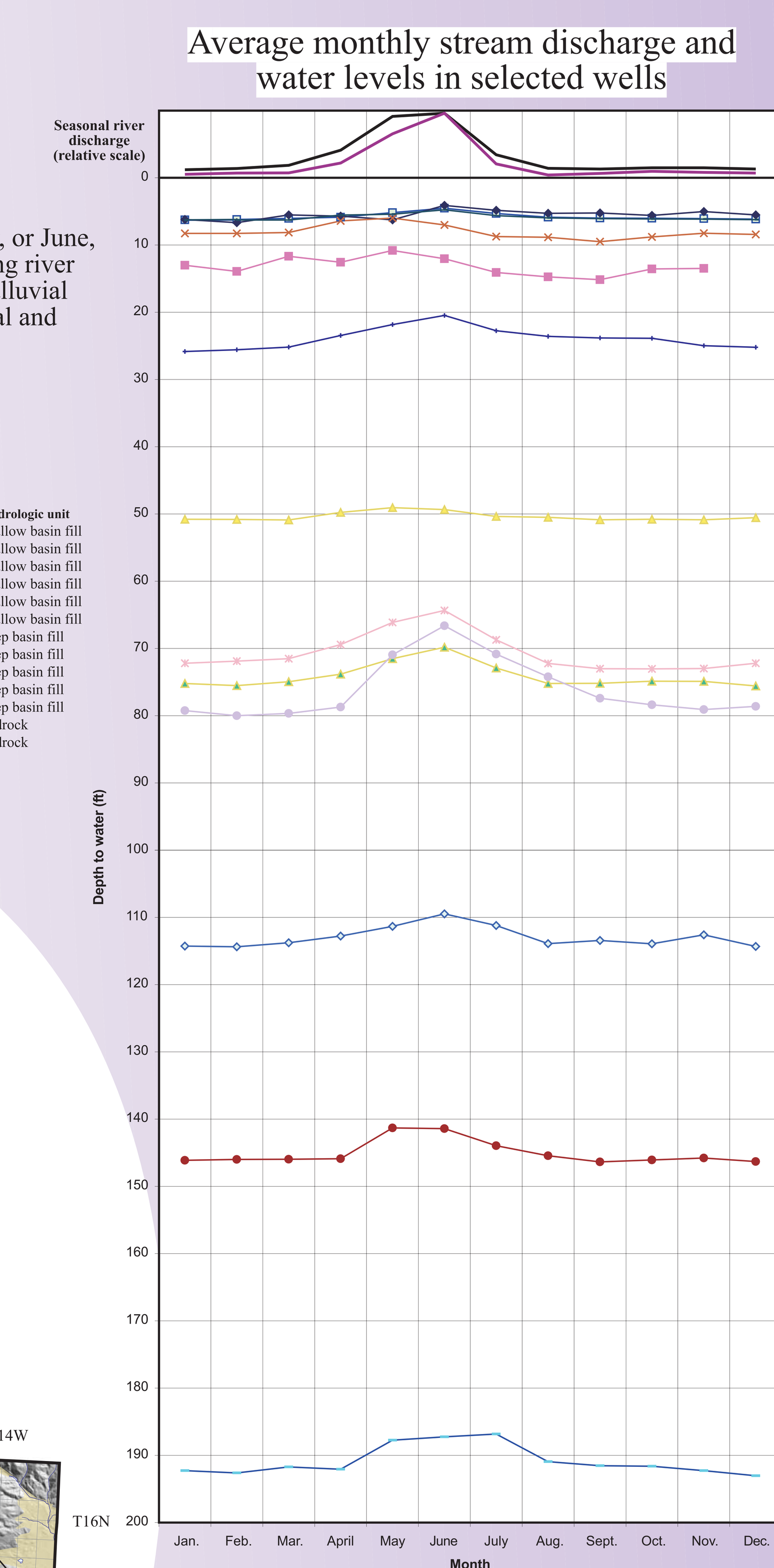
Upgradient (nearer Clark Fork River)
Downgradient (nearer Bitterroot River)

Selected Hydrographs



Springtime recharge (runoff) response (R)

Average monthly stream discharge and water levels in selected wells



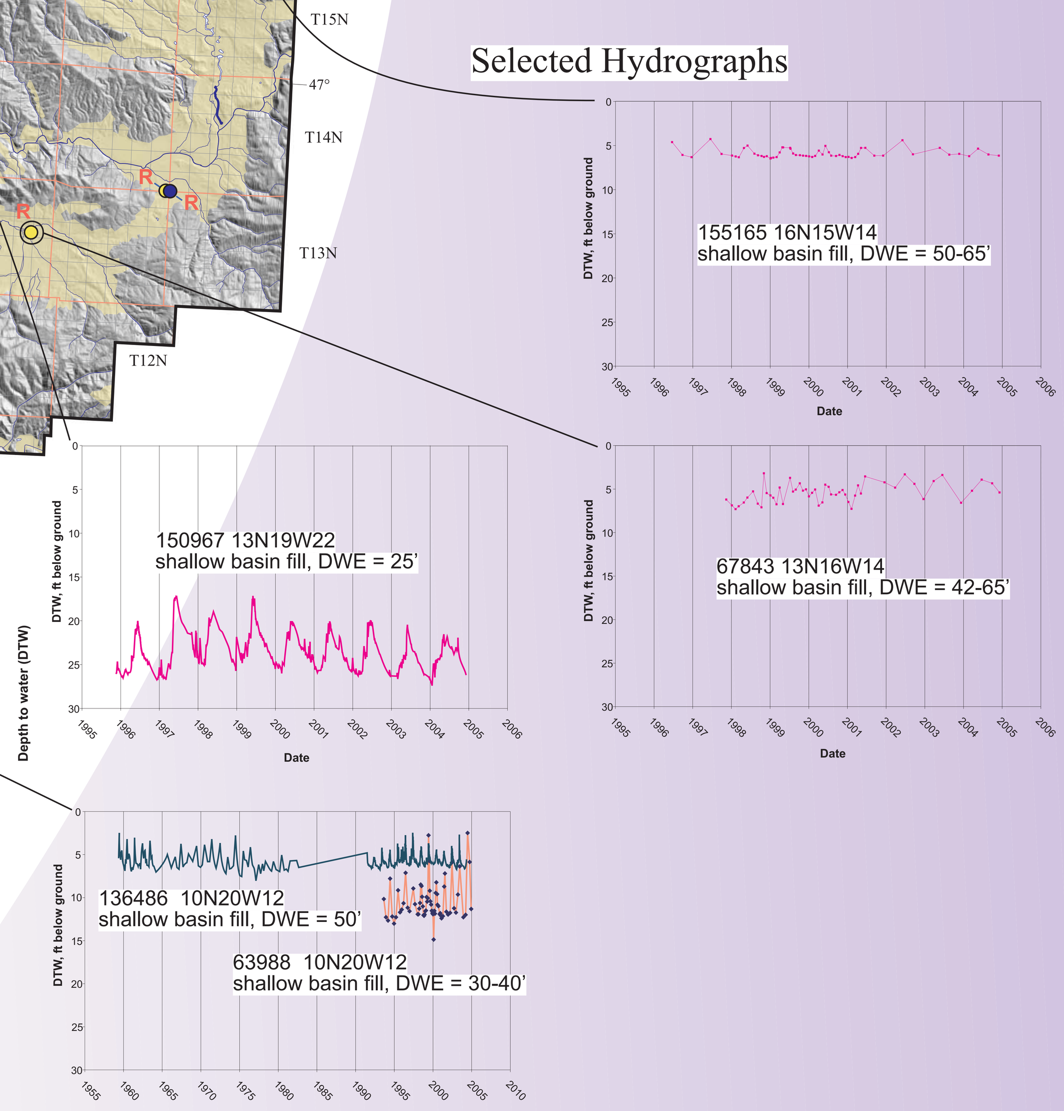
Discussion

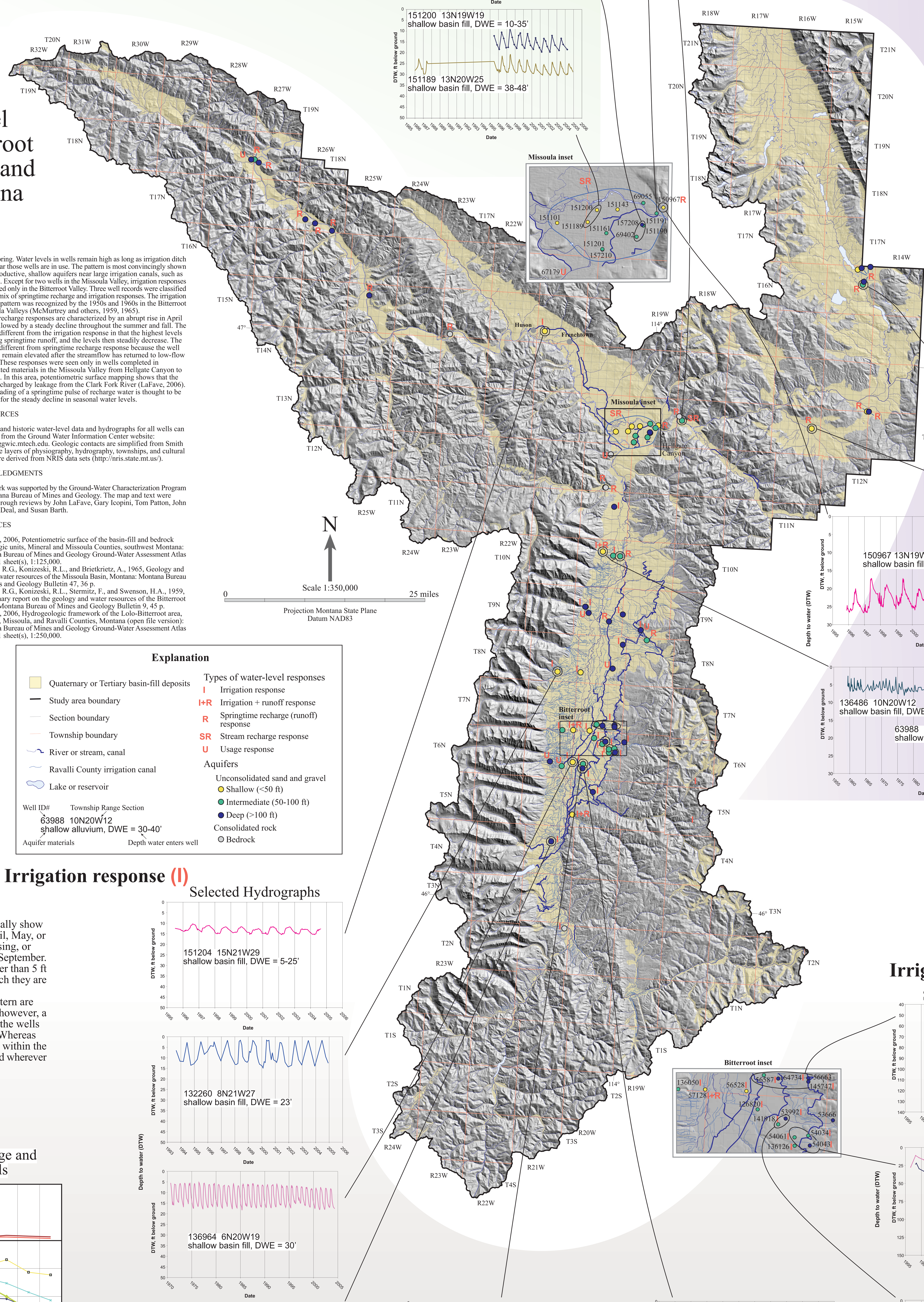
Water levels increase in April, May, or June, but rapidly decrease until July, mimicking river stages. Wells are completed in shallow alluvial aquifers near streams and in deep alluvial and bedrock aquifers in canyon areas.

USGS 12340500 Clark Fork above Missoula MT 1930-2002
USGS 12351200 Bitterroot River near Florence MT 1957-2003

GWIC Id	TRS	Depth water enters	Dates of measurement	Hydrologic unit
150967	13N19W22	25'	1995-2005	shallow basin fill
155165	16N15W14	50'	1996-2005	shallow basin fill
136486	10N20W12	50.5'	1959-1982, 1993-2005	shallow basin fill
67843	13N16W14	42'	1997-2005	shallow basin fill
164958	13N15W01	16'	1998-2001	shallow basin fill
164710	16N15W03	56'	1997-2001	shallow basin fill
73642	18N27W30	192'	1993-2005	deep basin fill
73165	17N26W30	318'	1993-2005	deep basin fill
72196	15N25W09	151'	1998-2001	deep basin fill
147219	17N26W35	180'	1997-2001	deep basin fill
140822	16N15W01	120'	1997-2001	deep basin fill
72178	15N23W32	229'	1993-2002	bedrock
67424	12N20W33	30-270'	1997-2001	bedrock

Selected Hydrographs





Explanation

Quaternary or Tertiary basin-fill deposits
Study area boundary
Section boundary
Township boundary
River or stream, canal
Ravalli County irrigation canal
Lake or reservoir

Well ID# — Township Range Section
63988 10N20W12
shallow alluvium, DWE = 30-40’
Aquifer materials — Depth water enters well

Types of water-level responses
- I — Irrigation response
- I+R — Irrigation + runoff response
- R — Springtime recharge (runoff) response
- SR — Stream recharge response
- U — Usage response

Aquifers
- Unconsolidated sand and gravel
  - Shallow (<50 ft)
  - Intermediate (50-100 ft)
  - Deep (>100 ft)
- Consolidated rock
  - Bedrock

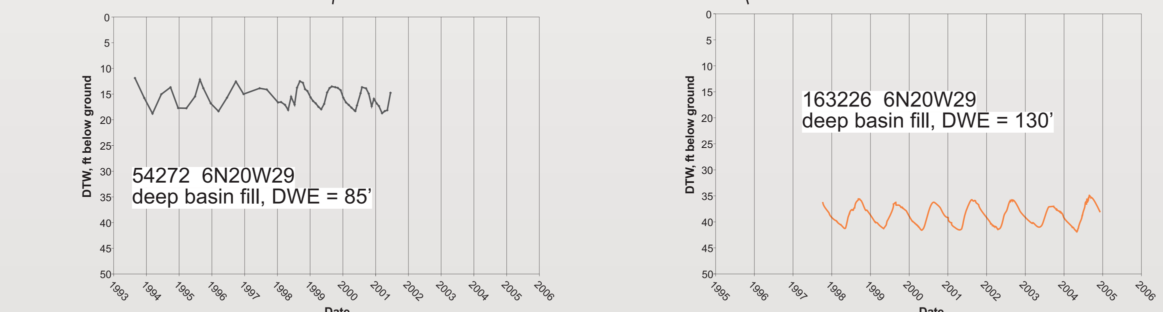
Irrigation response (I)

Discussion

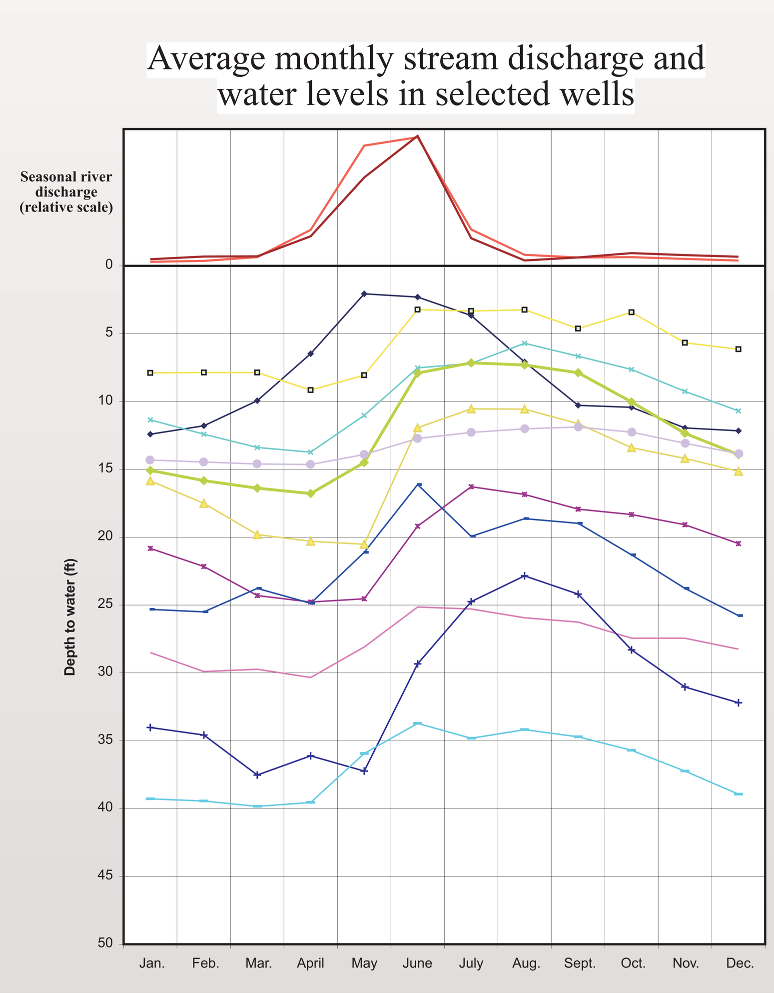
Wells in a variety of aquifers typically show an abrupt increase in water level in April, May, or June, followed by stable, slowly increasing, or slowly decreasing water levels through September. Water-level increases are typically greater than 5 ft and levels rise after a period during which they are stable or steadily decreasing.

Most of the wells showing this pattern are completed within 75 ft of land surface; however, a few are greater than 100 ft deep. All of the wells are near documented irrigation canals. Whereas most wells with irrigation responses are within the Bitterroot valley, this response is expected wherever irrigation canals distribute water.

Selected Hydrographs



Average monthly stream discharge and water levels in selected wells



USGS 12344000 Bitterroot River near Darby MT 1938-2002
USGS 12351200 Bitterroot River near Florence MT 1957-2003

GWIC Id	TRS	Depth water enters	Dates of measurement	Hydrologic unit
151204	15N21W29	5-25'	1995-2005	shallow basin fill
132260	8N21W27	23'	1993-2005	shallow basin fill
56528	7N20W32	40'	1972-1983, 1993-2005	shallow basin fill
58096	8N20W30	34'	1993-2005	shallow basin fill
136964	6N20W19	30'	1971-2005	shallow basin fill
53666	6N19W07	40-140'	1994-2005	deep basin fill
54061	6N20W14	50'	1995-2001, 2004-2005	deep basin fill
54034	6N20W12	84'	1995-2001	deep basin fill
157377	9N20W17	41'	1997-1999	deep basin fill
59980	9N20W17	50-65'	1997-2001	deep basin fill
60099	9N20W24	30-145'	1997-2001	deep basin fill

Irrigation response (I)

Selected Hydrographs