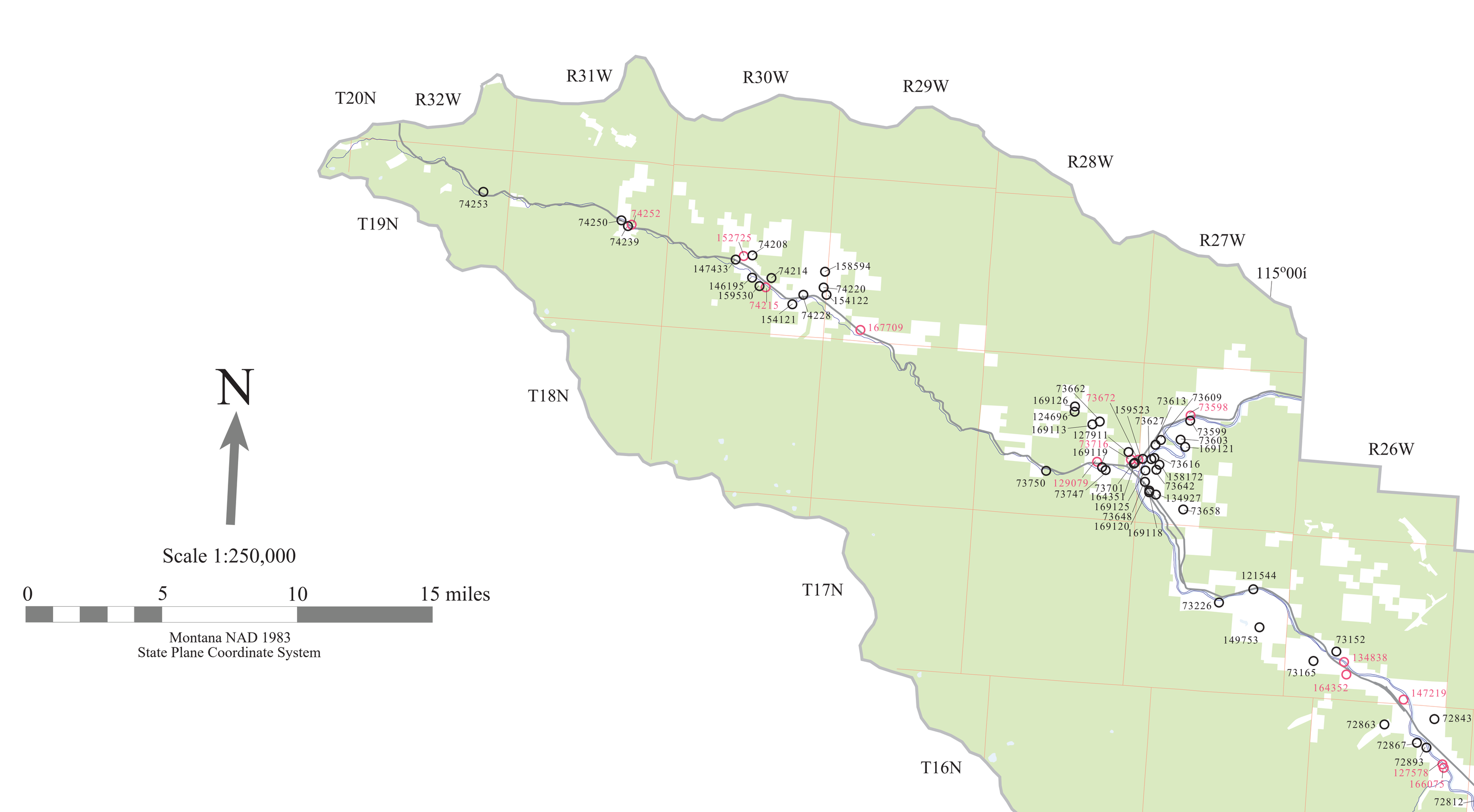

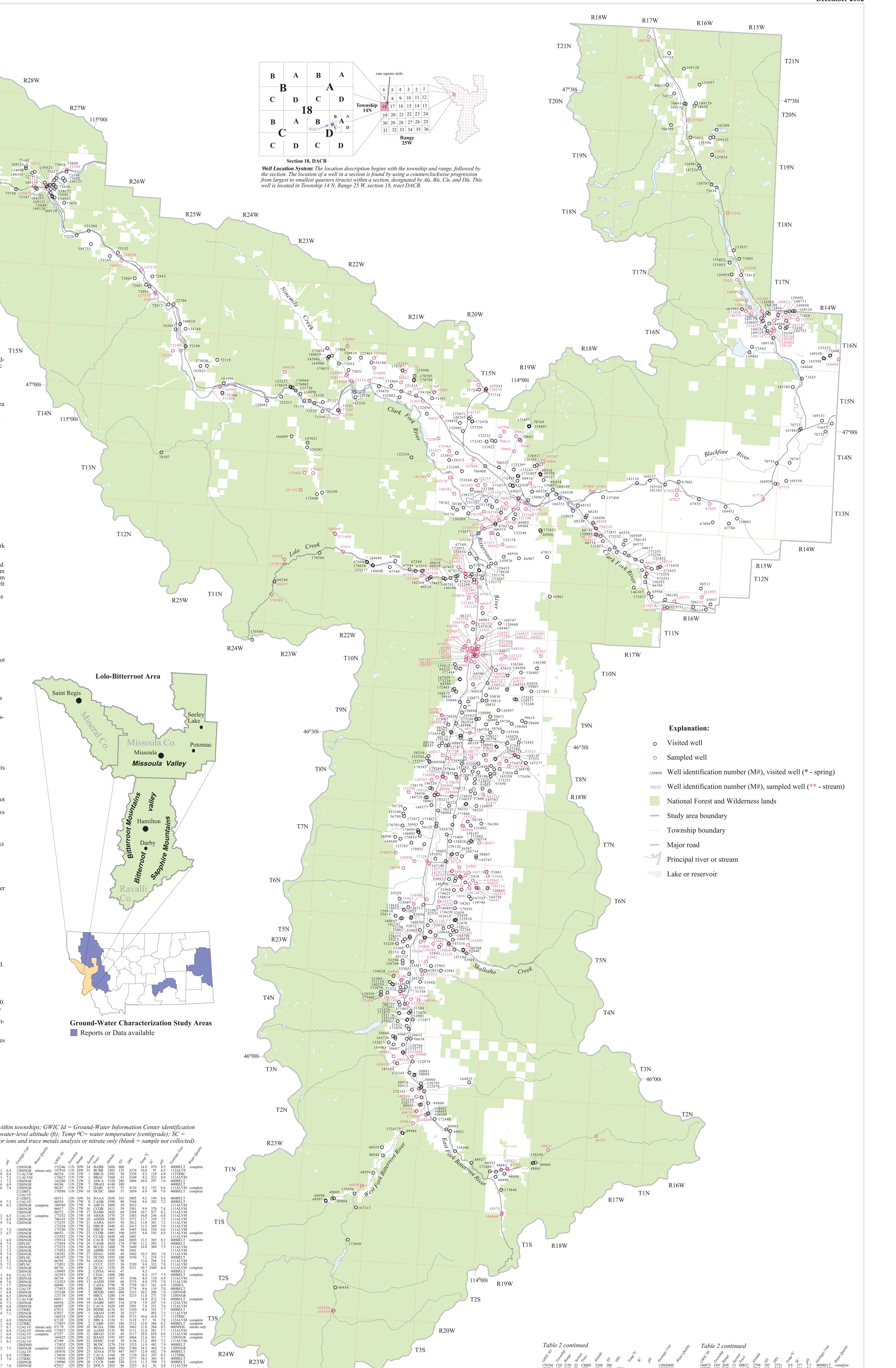

Well Location System: *The location description begins with the township and range, followed by the section. The location of a well in a section is found by using a counterclockwise progression from largest to smallest quarters (tracts) within a section, designated by Aís, Bís, Cís, and Dís. This well is located in Township 14 N, Range 25 W, section 18, tract DACB.*

Data for Water Wells visited during the Lolo-Bitterroot Area Ground-Water Characterization Study: Ravalli, Mineral, and Missoula Counties

by

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Authorís 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 areaís 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 other Part B maps of the Montana Ground-Water Assessment Atlas No. 4.

INTRODUCTION

Visits to 885 water wells were completed as part of the Montana Ground-Water Characterization Program Lolo-Bitterroot Area study. The study area includes Ravalli, Mineral, and parts of Missoula Counties outside of the Flathead Indian Reservation. Most wells were visited between October 1997 and November 1999. Visited wells were chosen from about 25,000 known wells distributed across significant aquifers. Selected wells represent the distribution of significant aquifers throughout the study area but are generally located in areas of development within the intermontane valleys.

Table 1. Summary of geologic distribution of wells.

Geologic Unit	Geologic Unit Codes	Inventoried Wells	Median Depth (ft)
Holocene sand and gravel	111ALVM	163	53
Pleistocene outwash deposits	112OTSH	6	92
Pleistocene terrace deposits	112TRRC	48	47
Pleistocene stratified drift	112DRFT	39	145
Pleistocene till	112TILL	10	170
Pleistocene alluvial fan deposits	112ALVF	90	67
Pleistocene deep alluvium	112ALVM	130	125
Tertiary sedimentary deposits	120SDMS, 120SNGR,120SICL	232	157
Tertiary volcanic and plutonic rocks,	120VLCC, 120PLNC	25	221
Cretaceous intrusive rocks, Idaho Batholith	211DBTL	25	215
Precambrian metasedimentary rocks, Belt Supergroup	400BELT, 400MSSL, 400RVLL, 400MCRB	117	245
Totals		**885**	

GEOLOGIC UNITS

Geologic units for the completion interval of each well (tables 1 and 2) were assigned by comparing the drillerís lithologic log to a geologic framework devised for the area. The geologic framework was based on recent geologic mapping, interpretation of selected well logs, and previous work (Harrison and others, 1986: Lewis, 1998; Lonn and Sears, 1998; Lonn and Berg, 1996; Sears, unpub. data, 1997; Wallace, 1987; Witkind, 1995; and others cited therein).

The study area is varied and consists of several narrow valleys and a few larger intermontane valleys. The rock formations that frame the valleys and the valley-fill deposits vary across the study area. However, the general sequence of geologic units from younger/shallower to older/deeper is: shallow alluvium (112OTSH and 111ALVM), terrace deposits (112TRRC), stratified glacial drift (112DRFT), till (112TILL), alluvial fan deposits (112ALVF), deep alluvium (112ALVM), sedimentary rocks (120SDMS, 120SNGR), volcanic rocks (120VLCC), granitic plutons (120PLNC), and Idaho batholith (211DBTL) and Belt Supergroup rocks (400-series rocks).

In several valleys, alluvial and glacial deposits compose most of the valley-fill material, and represent deposition during one or more glacial advance and retreat cycles and during the postglacial time. In the large intermontane valleys (Missoula and Bitterroot) surficial alluvial deposits are underlain by Tertiary-age deposits that compose most of the basin-fill material (McMurtrey and others, 1965; McMurtrey and others, 1972, Norbeck; 1980). With the exception of some glacial outwash adjacent to the floodplain, exposure of glacially derived deposits are mostly limited to the valley margins.

Holocene sand and gravel (111ALVM) ó
Sandy and gravelly alluvium along most recent river valleys.

Pleistocene outwash (112OTSH) ó
Mostly gravel and some sand at or near the land surface, deposited by glacial meltwater streams.

Pleistocene terrace deposits (112TRRC)ó
Texturally mature sand and gravel deposits that line the major drainages, 15 to 60 feet above the active floodplain. Geologic mapping in the Bitterroot valley (Lonn and Sears, 1998) has defined terraces with respect to relative age, but for the purposes of this study all terraces have been grouped. (112TRRC).

Pleistocene stratified drift (112DRFT) ó
Water-transported and washed sand and gravel derived from glaciers and stratigraphically encased above and below by till.

Pleistocene till (112TILL) ó
Poorly sorted mixture of gravel, sand, silt, and clay deposited directly by glacial ice and in other ice-marginal environments. In the Seeley Lake area this composes a substantial part of the valley-fill material while in the larger valleys these deposits are restricted to the valley margins.

Pleistocene alluvial fan deposits (112ALVF)ó
Alluvial outwash and fan deposits dominated by cobbles and boulders set in a matrix of sand and gravel showing some sorting. These include debris-flow deposits associated with glacial flood events (Lonn and Sears, 1998). These deposits have been mapped primarily in the Bitterroot valley at or above the modern drainages.

Pleistocene deep alluvium (112ALVM) ó
These deposits vary from sandy and gravelly alluvium containing minor silt, mostly buried by confining units of till and glacial lake silt and clay (Seeley Lake), to thick sequences of sand and gravel that grade imperceptibly into Holocene sand and gravel, to thick sequences of alluvium with a substantial clay component (St. Regis).

Tertiary sedimentary deposits (120SDMS, 120SNGR, 120SICL)ó
Clay-rich conglomerates, coal beds, and shales of the Missoula and Ninemile valleys (McMurtrey, and others, 1965), and clay-rich alluvial fan deposits of the Bitterroot valley (McMurtrey and others, 1972). Gravel, sand, silt, and clay deposits of the ancestral Bitterroot River of the Bitterroot valley and southern extent of Missoula Valley (Lonn and Sears, 2001); gravel, sand, and silt deposits of the older Clark Fork River, of the Missoula Valley (Lewis, 1998) and in the St. Regis area (Lonn and McFadden, 1999).

Tertiary volcanic and plutonic rocks (120VLCC, 120PLNC)ó
Rhyolitic flows, volcaniclastic rocks, tuffs, welded tuffs, and shallow intrusive rocks that almost exclusively occur in the southern part of the Bitterroot valley (south of Darby) and locally in the Potomac area. Small granitic plutons are present throughout the Bitterroot valley and form some of the prominent isolated ridges and hills west of the Sapphire Mountains on the eastern side of the valley. Lonn and Sears (2001) lumped the intrusive rocks with the Idaho Batholith and the Belt Supergroup rocks into one general bedrock unit.

Idaho Batholith (211DBTL)ó
Granite and layered gneiss that occurs in the Bitterroot Mountains and the southern part of the Sapphire Mountains.

Belt Supergroup rocks (400BELT, 400MSSL, 400RVLL, 400MCRB, 400PRCH) ó
Metamorphosed limestone, dolomite, siltstone, and sandstone; rocks of the Missoula, Ravalli, Middle Belt Carbonate, and Prichard units; these rocks have been folded, faulted, and fractured.

DATA COLLECTED

Coordinates for visited wells were determined using a hand-held global positioning system receiver and USGS 1:24,000 topographic maps. Where possible, data collected included the static water level, temperature, pH, and specific conductance of the water. Selected data for the inventoried wells are included in table 2; well locations and their Ground-Water Information Center (GWIC) identification numbers are shown on the map. Some wells could either not be pumped to measure water parameters, or not accessed to measure the water level. Selected wells were sampled as indicated in Table 2; results for complete water analyses (major ions and trace metals) and nitrate analyses are available from GWIC.

DATA SOURCES

All data and water-quality analysis results are available from the GWIC database at the MBMG (http://mbmggwic.mtech.edu). Land ownership, hydrography, public land survey, and road data were obtained from the Natural Resources Information System, Helena (http://nris.state.mt.us/).

ACKNOWLEDGMENTS

We thank all property owners who gave permission to inventory their wells. The Bitterroot Water Forum provided special assistance in identifying areas of special interest and concern for the communities of the Bitterroot valley. Reviews of the map by Tom Patton and Wayne Van Voast are appreciated.

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Table 2. Well inventory data. Data are arranged in ascending township, range, and section order. Blank lines separate townships and gray lines separate ranges within townships; GWIC Id = Ground-Water Information Center identification number (- spring; ** - stream); Twn = township; Rng = range; Sec = section; Tr = tract; Alt = land-surface altitude (ft); TD = total depth (ft); SWL alt = static water-level altitude (ft); Temp ^{o}C= water temperature (centigrade); SC = specific conductivity (micro mhos); pH = acidity of water; Geologic Unit = geologic-unit code for well completion; Water Quality = indicates either a complete, major ions and trace metals analysis or nitrate only (blank = sample not collected).*

GWIC ID	Township	Range	Section	Tract	Altitude	TD	SWL	Temp °C	SC	pH	Geologic Unit	Water Quality
48870	01S	19W	4	BAAA	4930	142	4912	9.3	345	8.1	211DBTL	complete
146066	01S	19W	4	ABCC	4890	38	4875	11.4	130	6.4	111ALVM	complete
107213	01S	22W	1	BCCB	4435	37	4430	7.7	49	6.3	111ALVM	
173849	01S	22W	23	CDAC	4590	8	4589	8.2	134	7.2	112ALVM	

GWIC ID	Township	Range	Section	Tract	Altitude	TD	SWL	Temp °C	SC	pH	Geologic Unit	Water Quality
153246	11N	20W	34	BABB	3680	600		14.9	970	8.5	400BELT	complete
147910	11N	20W	35	BCBB	3305	125	3278	10.8	91	6.5	112ALVF	
66224	11N	21W	1	BBCD	3395	50	3354	8.5	129	6.9	112TRRC	
174627	11N	21W	1	BBAC	3360	43	3349	9.2	323	8.0	111ALVM	
142268	11N	21W	2	ADCA	3520	280	3484	10.0	297	7.6	400BELT	
66246	11N	23W	7	DBAD	4140	100					400BELT	
66247	11N	23W	7	DABC	4135	53	4134	8.3	153	6.6	111ALVM	complete
170588	11N	23W	18	DCDC	3860	51	3859	6.9	99	7.6	400BELT	complete
66511	12N	16W	34	DAAA	3850	242	3805	9.2	194	8.6	400BELT	
66554	12N	17W	8	CADB	3590	90	3544	9.8	202	7.2	400BELT	
160369	12N	17W	8	ABCD	3680	54	3652				111ALVM	
66617	12N	17W	16	CCDB	3415	59	3381	9.9	370	7.4	111ALVM	
66572	12N	17W	17	DABB	3420	68	3384	10.7	557	8.2	111ALVM	
173252	12N	17W	18	ABAB	3370	25	3363	10.8	244	6.8	111ALVM	
706143	12N	17W	18	ADDD	3390	55	3371	11.7	339	7.5	111ALVM	
173255	12N	17W	21	AABA	3435	50	3412	11.8	381	7.2	111ALVM	
173254	12N	17W	22	DBCB	3440	43	3413	11.5	369	7.6	111ALVM	