Groundwater Level Trends in the Proposed Harney Basin Critical Groundwater Area – Summary Statistics by Subarea

Informational Report to the Division 512 Rules Advisory Committee

Background

Delineation of the exterior boundary of the proposed Harney Basin Critical Groundwater Area (HBCGWA) was based on the existing administrative boundary of the Greater Harney Valley Groundwater Area of Concern (GHVGAC) as defined in OAR 690-512 Malheur Lake Basin Program adopted 4/13/2016 and effective as of 4/15/2016. The GHVGAC boundary is an established and widely known administrative boundary that includes the lowland areas of the Silvies River, Silver Creek, and the Donner und Blitzen River, as well as the immediately adjacent upland slopes. The vast majority of groundwater use, and all areas of known groundwater level decline within the Harney Basin occur within the GHVGAC boundary.

Groundwater within the proposed HBCGWA boundary is hydraulically connected both laterally and vertically throughout the area, however, groundwater occurs in multiple hydraulically connected hydrostratigraphic units, often follows divergent or convergent flow paths, varies spatially in terms of horizontal and vertical hydraulic gradient, and is sourced from different recharge areas around the Harney Basin. As such, groundwater within the proposed HBCWGA responds variably to proximal and distant pumpage, recharge inputs, and other hydrogeologic parameters. To effectively administer groundwater management within the HBCWGA, fifteen (15) proposed subareas were delineated at the PLSS section-scale (Figure 1).

A Critical Groundwater Area subarea is a portion of a groundwater reservoir that shares similar hydrogeologic properties and similar groundwater conditions including groundwater level elevations, seasonal and annual water level trends, and response to natural and human stresses. The intent of dividing a Critical Groundwater Area into subareas is to group wells that similarly impact the local portion of the groundwater reservoir and where reductions in groundwater pumpage, through voluntary or regulatory action, will have a timely, measurable, efficient, and similar groundwater response within that sub area.

The purpose of this informational report is to provide a summary of groundwater level trends within each of the 15 proposed subareas. Groundwater level trends are variable across the proposed HBCGWA, and variations exists within each of the 15 proposed subareas. Evaluating the relative severity of groundwater level declines within each of the 15 proposed subareas can help facilitate decision-making around prioritization of administrative or voluntary action within the HBCWGA.

Groundwater Level Trends

Groundwater level trends for wells across the 15 proposed subareas can be evaluated to better understand how groundwater level declines vary between subareas as well as the variation that exists within an individual subarea. Two primary groundwater level trend metrics are summarized here:

1. Groundwater level decline magnitude
2. Groundwater level decline rate

For both groundwater level trend metrics there are several possible approaches to making the calculation. The groundwater level trends summarized here represent groundwater level decline magnitude calculated as the total groundwater level change from the highest measured to the most recent annual high, and groundwater level decline rate calculated as the Sen's Slope, which is a robust method of determining the slope via the median of the slopes of all lines that can be drawn through the data points.

Calculating these groundwater level trend metrics requires specifying several parameters that have a significant impact of the overall results of the calculation. For example, calculation of groundwater level decline rate requires specifying the period of time over which the rate of interest will be calculated. As groundwater level decline rates in the basin have changed over time, we are most interested in calculating the decline rate over the most recent period of record, rather than calculating what the decline rate might have been between 1990 and 1995, for example. Additionally, for both groundwater level decline magnitude and groundwater level decline rate it is important to minimize the effects of seasonal variation when pumping impacts cause groundwater levels to be drawn down. To address this, only annual high groundwater level measurements are used in most cases (generally January – April). The parameters specified for the groundwater level trend metrics presented here are described below.

- <u>Groundwater Level Decline Magnitude:</u>
    - Calculated as change in water level from the highest measured to the most recent annual high.
    - The most recent annual high measurement must be in the range 2016 – 2023.
    - The most recent annual high can be measured in any month if it is shallower than the most recent January-April annual high.
    - The highest measured can be measured in any month.
- <u>Groundwater Level Decline Rate:</u>
    - Calculated as Sen's slope.
    - Decline rate only calculated for annual high measurements in the range 2016 – 2023.

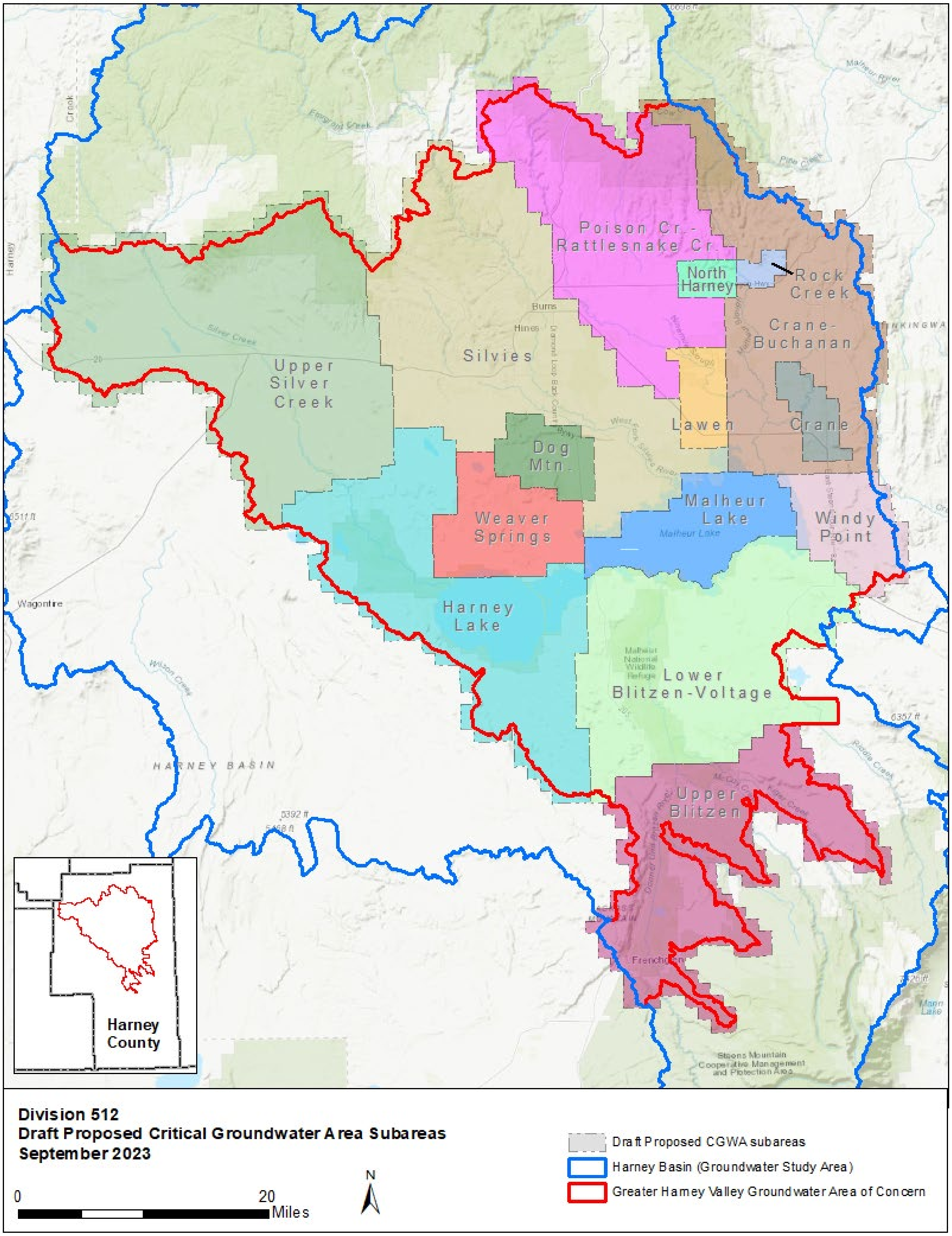

Figure 1: Draft proposed Critical Groundwater Area Subareas.

Summary Statistics of Groundwater Level Trends

Summary statistics for groundwater level trends are one tool that can be used to evaluate the relative severity of groundwater level declines across the 15 proposed subareas. Table 1 provides maximum, minimum, average, and median values for groundwater level decline magnitude for each subarea and Table 2 provides maximum, minimum, average, and median values groundwater level decline rate for each subarea.

Note: negative values presented throughout this document represent declining trends.

Table 1: Summary statistics of groundwater level decline magnitude by subarea. Negative values indicate a declining trend. (n= the number of wells for which decline magnitude could be calculated).

Subarea	Minimum Magnitude (feet)	Maximum Magnitude (feet)	Average Magnitude (feet)	Median Magnitude (feet)
Weaver Springs (n=64)	-116.9	-0.1	-49.0	-49.9
North Harney (n=9)	-83.0	-9.1	-38.7	-33.1
Crane (n=24)	-68.8	-2.7	-25.2	-22.0
Lawen (n=21)	-59.6	-0.1	-21.7	-19.0
Dog Mountain (n=18)	-37.2	-1.5	-17.9	-17.0
Rock Creek (n=16)	-69.8	-4.7	-19.0	-15.0
Windy Point (n=10)	-25.7	0.0	-13.7	-13.9
Crane-Buchanan (n=50)	-52.0	-0.9	-16.5	-12.5
Poison Ck-Rattlesnake Ck (n=25)	-45.3	-0.2	-14.2	-12.1
Lower Blitzen-Voltage (n=42)	-39.8	0.0	-5.9	-4.4
Silvies (n=32)	-29.3	-0.3	-6.9	-4.2
Upper Silver Creek (n=17)	-13.2	-0.7	-5.0	-3.5
Harney Lake (n=16)	-9.0	-0.1	-3.7	-3.2
Upper Blitzen (n=7)	-10.4	-0.1	-2.1	-1.1
Malheur Lake (n=2)	-0.7	-0.5	-0.6	-0.6

Table 2: Summary statistics of groundwater level decline rate by subarea. Negative values indicate a declining trend. (n= the number of wells for which decline rate could be calculated).

Subarea	Minimum Rate (ft/year)	Maximum Rate (ft/year)	Average Rate (ft/year)	Median Rate (ft/year)
Weaver Springs (n=58)	-22.0	8.4	-5.9	-5.4
North Harney (n=9)	-4.8	0.4	-1.7	-1.0
Crane (n=23)	-4.9	2.0	-1.1	-1.0
Lawen (n=21)	-13.7	0.8	-2.5	-2.0
Dog Mountain (n=19)	-5.6	-0.5	-2.2	-1.5
Rock Creek (n=16)	-14.0	-0.1	-4.5	-4.6
Windy Point (n=7)	-1.1	0.0	-0.7	-0.9
Crane-Buchanan (n=49)	-4.0	8.2	-1.0	-1.4
Poison Ck-Rattlesnake Ck (n=26)	-3.2	1.7	-1.0	-0.9
Lower Blitzen-Voltage (n=40)	-1.4	2.0	-0.2	-0.3
Silvies (n=31)	-2.5	1.8	-0.5	-0.5
Upper Silver Creek (n=17)	-1.7	1.5	-0.5	-0.4
Harney Lake (n=16)	-1.1	0.3	-0.5	-0.4
Upper Blitzen (n=8)	-0.9	1.8	-0.1	-0.2
Malheur Lake (n=1)	-1.5	-1.5	-1.5	-1.5

An important consideration when evaluating groundwater level decline magnitude data is the period of record over which the value was calculated, especially in areas where groundwater level declines have been occurring over a long period of time. Table 3 provides summary statistics for the periods of record used to calculate groundwater level decline magnitude by subarea. Again, for this calculation the most recent annual high measurement must be in the range 2016 – 2023. Wells that do not have groundwater level data in the range 2016 – 2023 are not included in the groundwater level decline magnitude dataset.

Table 3: Summary statistics for the periods of record used to calculate decline magnitude by subarea (P.O.R. = period of record).

Subarea	Minimum P.O.R. (years)	Maximum P.O.R. (years)	Average P.O.R. (years)	Median P.O.R. (years)
Silvies (n=32)	1	63	13.6	6.5
Upper Silver Creek (n=17)	1	61	18.5	9.0
Dog Mountain (n=18)	1	60	15.3	9.0
Lower Blitzen-Voltage (n=42)	1	60	20.7	11.5
Poison Ck-Rattlesnake Ck (n=25)	1	58	15.3	10.0
Crane (n=24)	1	55	22.2	15.0
Crane-Buchanan (n=50)	1	49	11.4	7.5
Harney Lake (n=16)	1	48	11.6	5.0
North Harney (n=9)	4	46	21.0	21.0
Lawen (n=21)	1	45	11.9	7.0
Rock Creek (n=16)	1	45	9.6	4.5
Weaver Springs (n=64)	1	44	13.5	9.0
Windy Point (n=10)	1	41	18.0	18.0
Upper Blitzen (n=7)	1	39	10.0	4.0
Malheur Lake (n=2)	1	6	3.5	3.5

The groundwater level trend data can also be evaluated graphically using box and whisker plots. A box and whisker plot is a graphical method of displaying variation in a set of data by showing how the data is distributed and identifying any outliers. The box and whisker plots used here consider any data value that is greater than 1.5 times the interquartile range above the upper quartile or below the lower quartile to be outliers, which is a standard statistical method for determining outliers. Figure 2 provides an explanation of how to interpret a box and whisker plot. Figure 3 is a box and whisker plot showing groundwater level decline magnitude by subarea calculated as change in groundwater level from the highest measured to the most recent annual high measurement. Figure 4 is a box and whisker plot showing groundwater level decline rate by subarea calculated as Sen's Slope. In both Figure 3 and Figure 4, negative values indicate declining trend and subareas are listed from left to right in order of increasing median value.

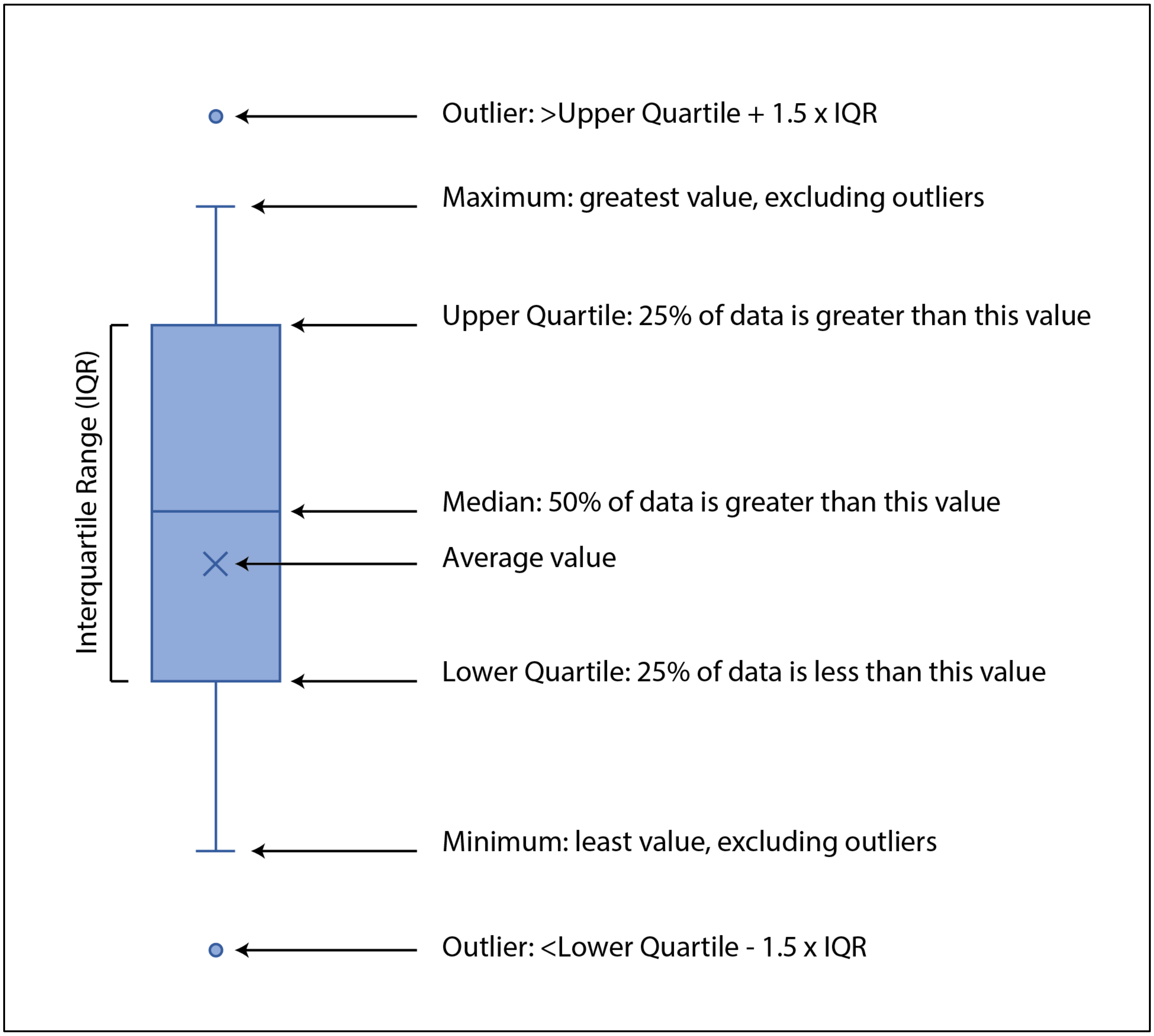

Figure 2: Explanation of box and whisker plots.

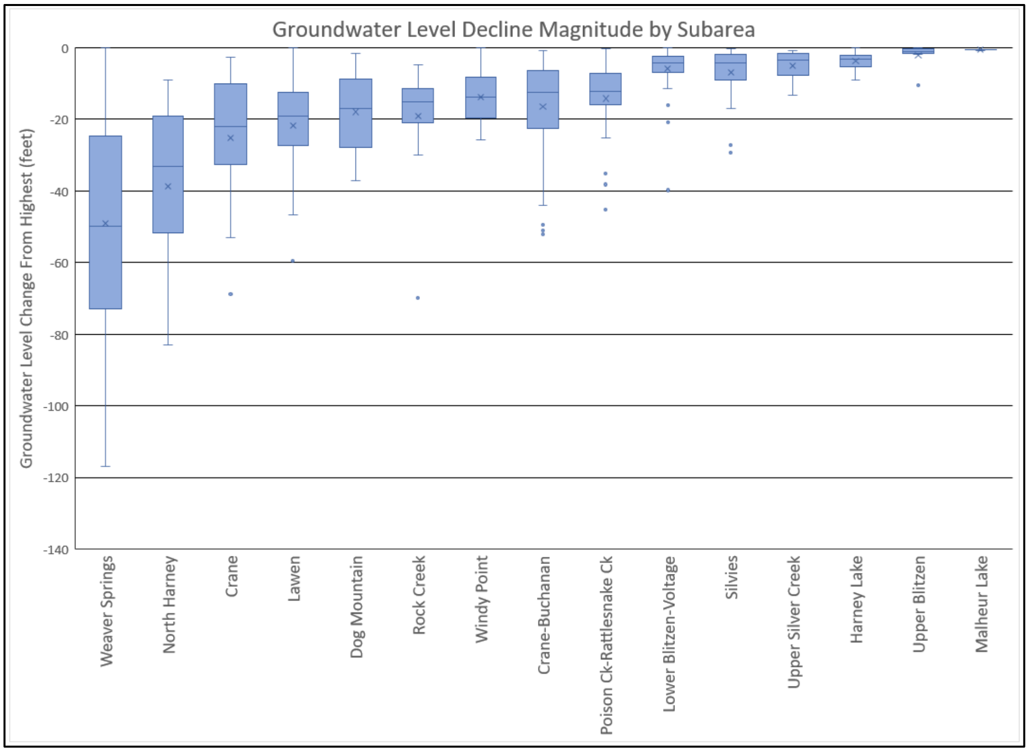

Figure 3: Groundwater level decline magnitude by subarea calculated as change in groundwater level from the highest measured to the most recent annual high measurement. Negative values indicate declining trend. Subareas are listed from left to right in order of increasing median value. Number of wells per subarea noted in Table 1.

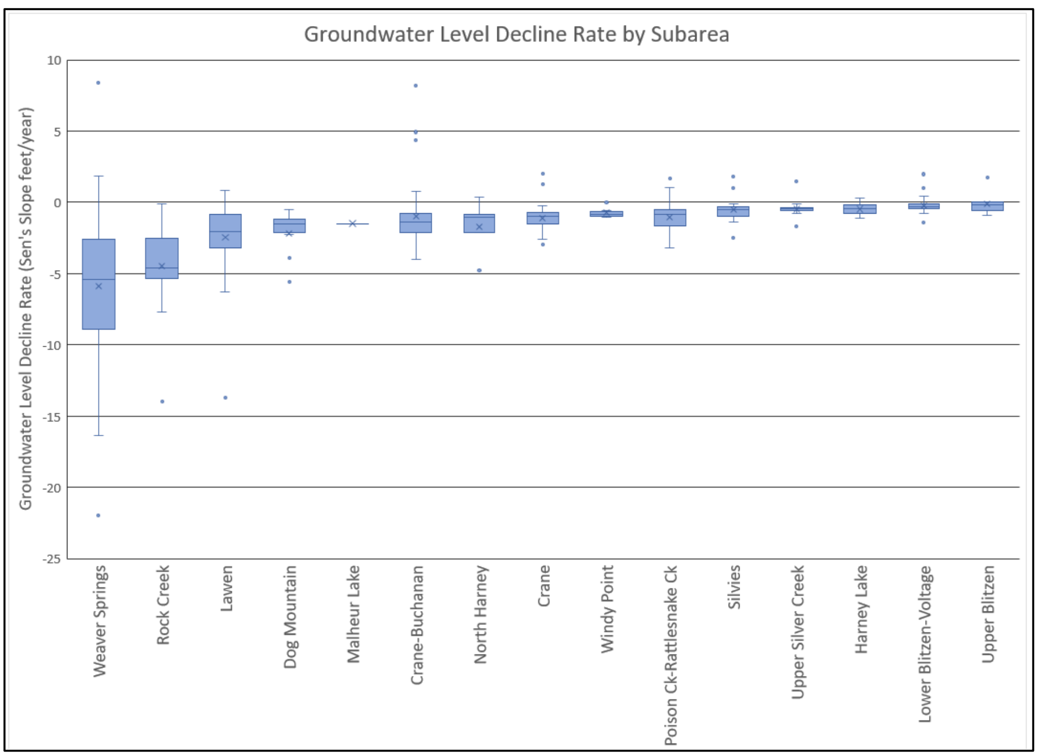

Figure 4: Groundwater level decline rate by subarea calculated as Sen's Slope. Negative values indicate declining trend. Subareas are listed from left to right in order of increasing median value. Number of wells per subarea noted in Table 2.

Other considerations

It is important to recognize that each individual well has a unique groundwater level record in terms of the overall period of record, frequency of measurement, and source of measurement. Additionally, each individual well has a unique well construction and well construction history. Well deepenings in particular can have a significant impact on the groundwater level record, particularly in areas with significant vertical hydraulic gradients. The data summaries provided here are a valuable tool for evaluating groundwater level trends across the basin, however for any individual well it may be important to review the specific groundwater level record and well construction history for that well to fully interpret and understand the calculated groundwater level trend metrics. The summary statistics provided here do not fully capture every unique situation, and in some cases may misrepresent the overall water level record for an individual well simply due to the unique characteristics of each well's measurement and construction history, and the parameters specified for calculating the groundwater level trend metrics.

OWRD groundwater data links

Harney Basin Critical Groundwater Area Process Interactive Map:
https://experience.arcgis.com/experience/2db5f0d5e50142138304801e09b72fb7/

Groundwater Information System (GWIS):
https://apps.wrd.state.or.us/apps/gw/gw_info/gw_info_report/gw_search.aspx

GWIS Mapping Tool:
https://apps.wrd.state.or.us/apps/gw/gw_info/gw_map/Default.aspx

OWRD Groundwater Hydrographs:
https://apps.wrd.state.or.us/apps/gw/gw_info/gw_hydrograph/Hydrograph.aspx

Well Report Database:
https://apps.wrd.state.or.us/apps/gw/well_log/Default.aspx