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| Project Name | Groundwater Elevations | Date | 3/2/2022 |
| To / Contact info | BCWD Managers | | |
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| Regarding | 2022 Groundwater Elevation and Trends | | |

Background

The BCWD's groundwater monitoring program includes an established network of wells for measuring groundwater levels. The network includes residential wells, golf course wells, and DNR observation wells. Water level measurements are collected annually at the residential wells and golf course wells. Water level measurements are recorded hourly at the DNR observation wells using data loggers.

Groundwater level data has been collected for the last 10 years, since 2012. The data has been used to identify trends in groundwater levels and changes to groundwater flow over time. Changes to levels and groundwater flow can have significant effects on Brown's Creek and other groundwater dependent natural resources, flooded areas such as Kimbro Basin, and stormwater infiltration practices (e.g., infiltration basins, infiltration trenches, raingardens).

The well network was established to cover the entire watershed district, and also to monitor each of the major drinking water aquifers in the watershed district. The distribution of wells by aquifer is:

- Quaternary (Glacial) – 6
- St. Peter - 1
- Prairie du Chien – 10
- Jordan/St. Lawrence – 2
- Tunnel City Group – 4
- Multi-Aquifer – 1

See Figure 1 for a Cross-section of aquifers and aquitards in the Twin Cities Metro Area.

Unfortunately, four golf course wells in the network were abandoned in 2022 and can no longer be measured. The wells were located at the Sawmill Golf Club which was sold and is being redeveloped into residential lots. The wells were completed in the Prairie du Chien aquifer. After houses are built in the new development, we will look for new residential wells at approximately the same depths and locations to add to the monitoring network.

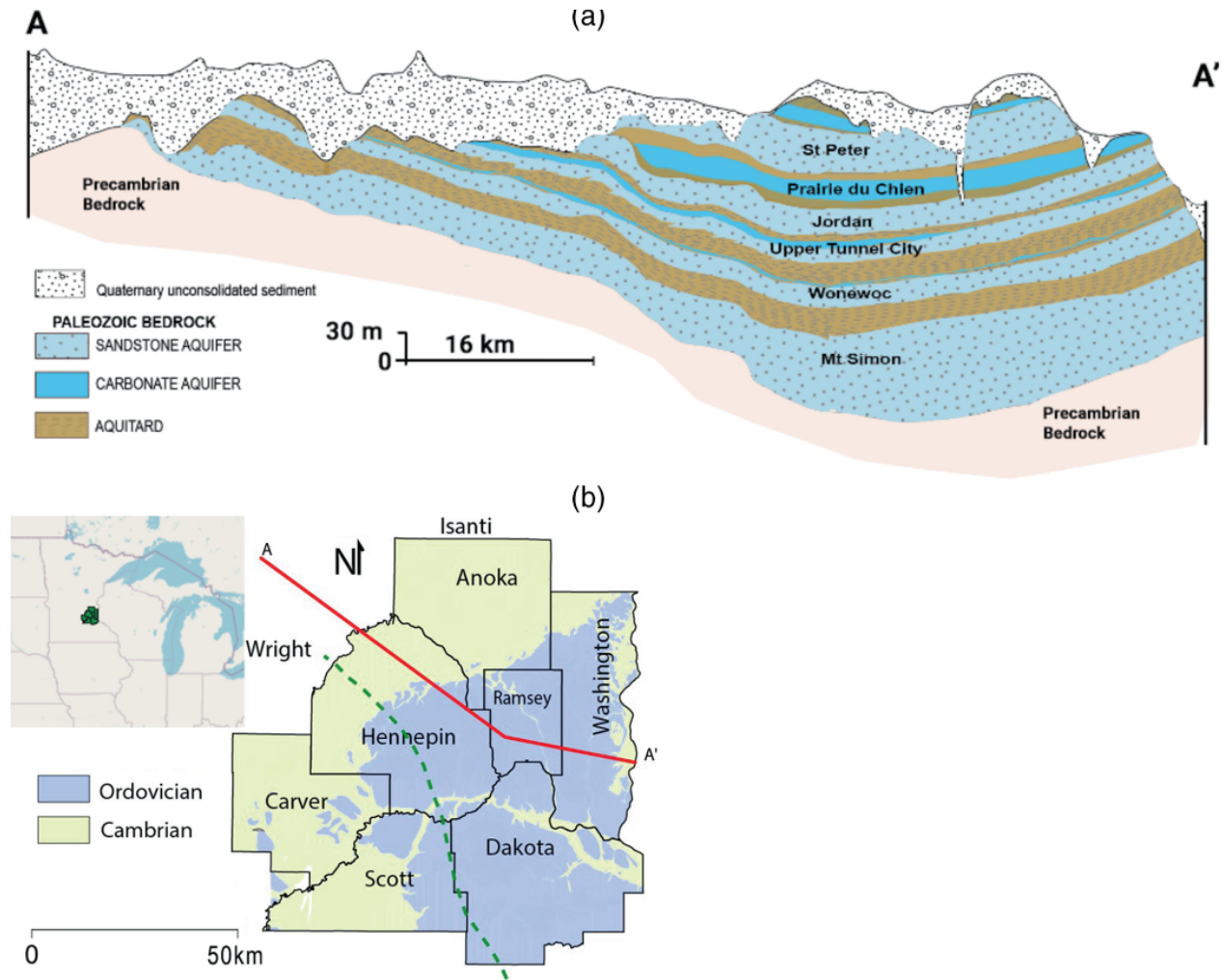


Figure 1 - (a) Cross-section of Aquifers and Aquitards in the Twin Cities Metro Area; (b) Location of Cross-section

Analysis

Residential Wells

Groundwater elevation data from the golf course wells, residential wells, and DNR observation wells are shown in Table 1. Groundwater elevations decreased from 2021 to 2022 with an average decrease of 1.84 feet. The decrease is not surprising considering below average rainfall in 2021 and 2022.

DNR Observation Wells

DNR measures water elevations monthly in four observation wells:

- Brown's Creek Park – Deep well completed in the Tunnel City Group aquifer (2000-present)
- Brown's Creek Park – Shallow well completed in the Quaternary (glacial) aquifer (2001-present)

- Brown's Creek Park – Middle well completed in a confined Quaternary aquifer (2020-present)
- Withrow School – Well completed in the Prairie du Chien aquifer (2000-present)

Groundwater elevation data from the DNR observation wells are shown on Figure 2. The data for the Withrow well shows that the water level has been dropping since reaching a high level of 960.05 feet in June 2020. The groundwater elevation in the Brown's Creek Park – Shallow well does not fluctuate much from year to year (due to its hydraulic connection and influenced by the elevation of Brown's Creek) but has also been dropping since mid-summer 2020. The Brown's Creek Park – Deep well groundwater elevations have also dropped during the recent time period and can fluctuate by as much as six feet over short time periods. This observation is the result of nearby well pumping and will be discussed in more detail in an upcoming technical memorandum. The Brown's Creek Park – Middle well shows dropping groundwater elevations since the beginning of the observation period in October, 2020. Note that the 2022 data is still considered provisional at this time, so DNR may make corrections in the future.

Golf Course Wells

The golf course wells showed similar trends to the other wells. The irrigation well at the Stillwater Country Club is difficult to measure because it is deep and has several obstructions in the well pipe. Similar measurement difficulties were noted in recent years at Stillwater Oaks #1 and one of the irrigation wells at Logger's Trail. We are still looking for reliable ways to measure the water level in these wells.

Change in Water Levels in Each Aquifer

Groundwater levels in each aquifer were compared to identify trends over time. Residential well and DNR observation well levels were used for the analysis. The golf course wells have not been measured for as long, and the water level readings tend to be less reliable due to the large pumping volume.

Quaternary (Glacial) Aquifer

Groundwater levels in the shallow Quaternary aquifer wells are shown on Figure 33. Three of the wells show an increase of about 8 feet since 2012 (although down slightly from 2020). Three of the wells show significantly less increase, about 3 feet. Two wells show very little increase, less than two feet. The well that shows the least increase is located in Brown's Creek Park, near Brown's Creek. The water level in the well is stabilized by the relatively constant water level in the creek and the discharge of groundwater from the aquifer to the creek. The variation in water levels among the wells indicates the importance of having water level readings from several areas across the watershed.

Prairie du Chien Aquifer

Groundwater levels in the Prairie du Chien aquifer are shown in

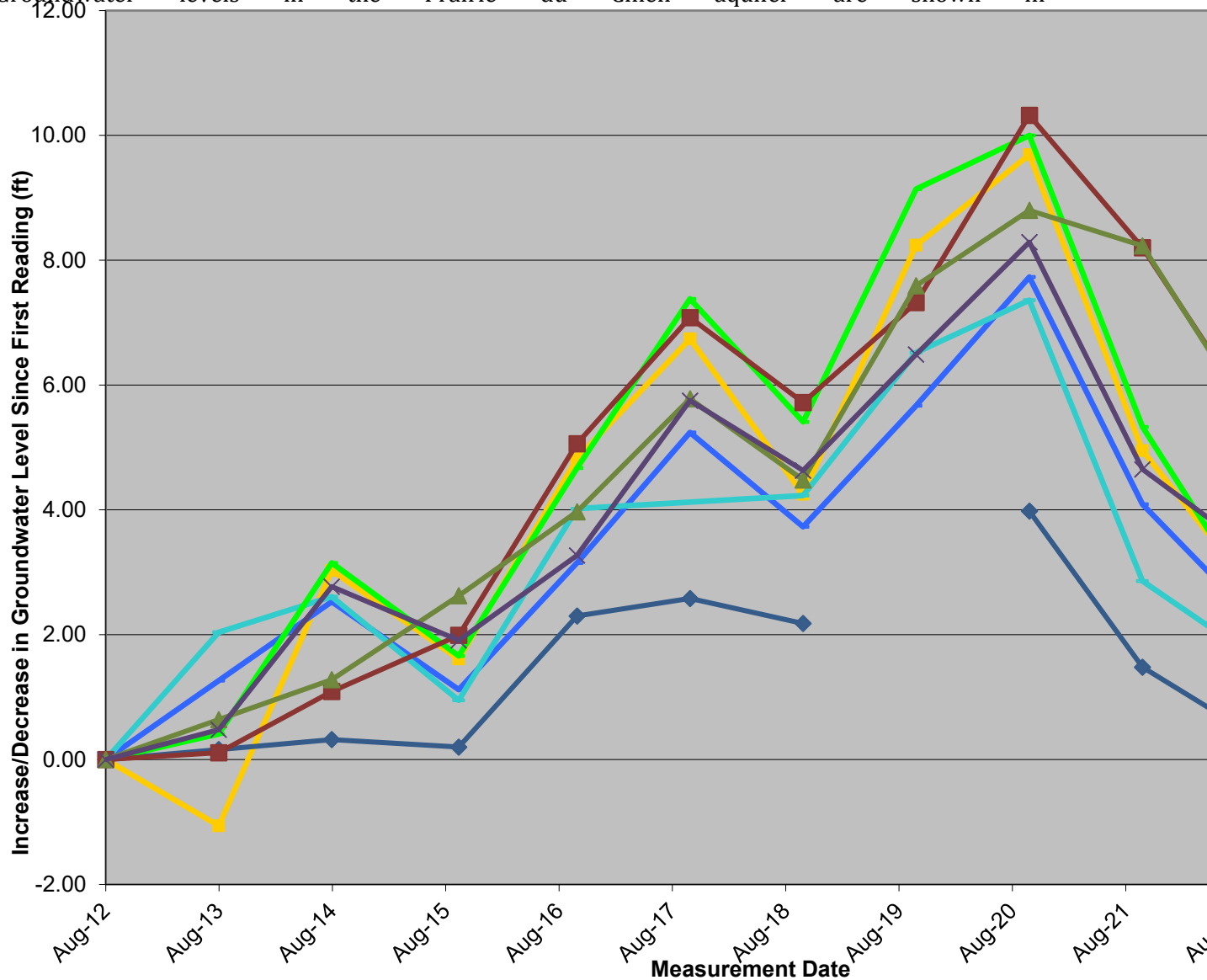


Figure 4. Groundwater Level Change Over Time – Prairie du Chien Aquifer Wells4. Most of the wells showed a consistent increase of 8 to 10 feet from 2012 to 2020 and then a drop during 2021 to 2022. One well, the Wiersma well, shows less of an increase. This well has a shallow depth to water and is located closest to Brown’s Creek (about 300 feet). The relatively stable water level may indicate that this well and this aquifer are influenced by Brown’s Creek.

Other Aquifers

Groundwater levels from the St. Peter, Jordan, and Tunnel City Group aquifers are shown on

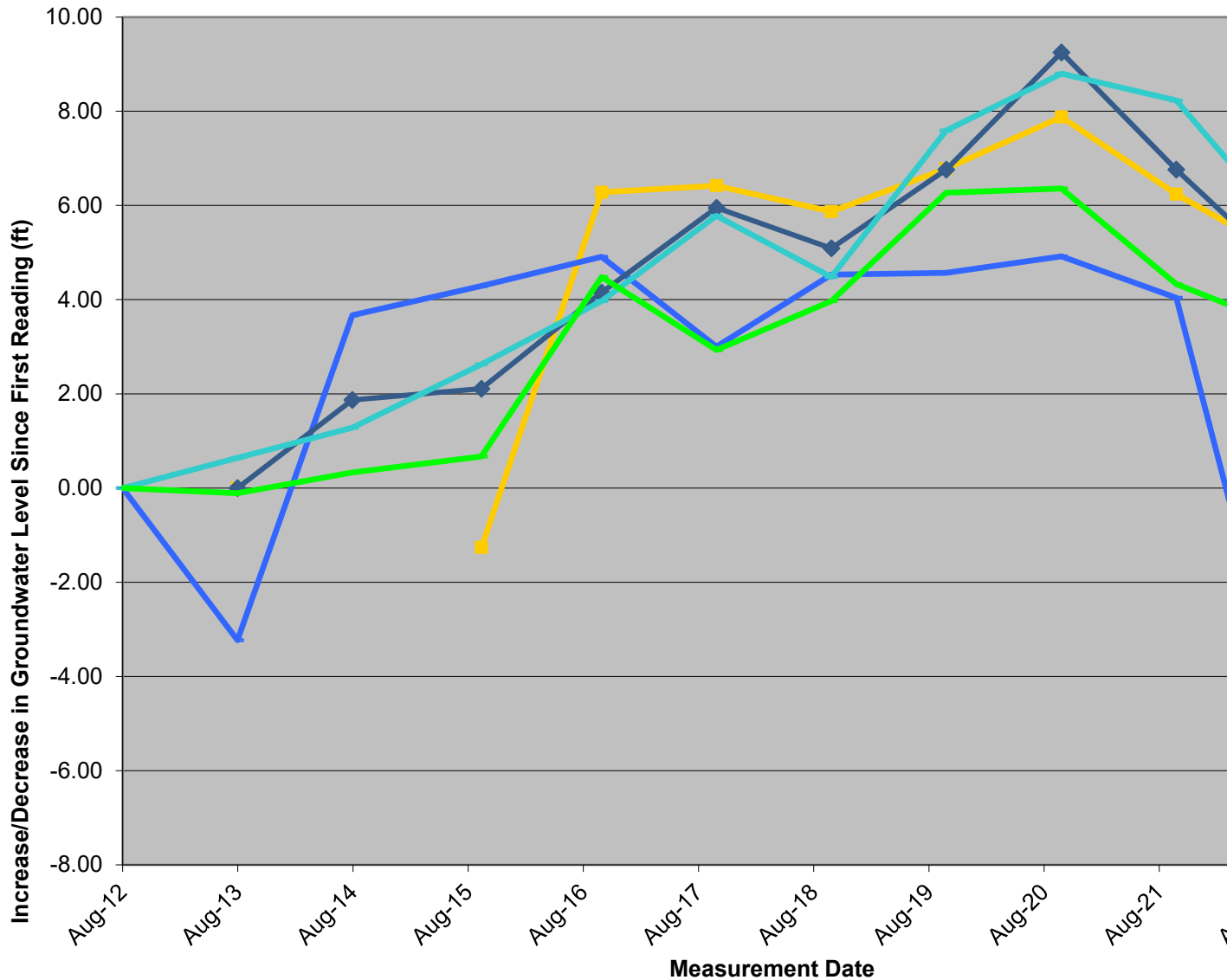


Figure . The wells show similar trends over time, a rise from 2012 to 2020 followed by a drop in 2021. The Olien well water level showed a dramatic decrease from 2021 to 2022, about 10 feet. This is the closest well to the Saint Croix River, and the decrease may show the influence of the 2022 low river level on the Tunnel City Group aquifer in this area.

Recommendations

BCWD should continue to collect groundwater elevation data on an annual basis. The long-term data and analyses are important for understanding groundwater conditions and groundwater/surface water interactions throughout the District.

The data will be particularly useful for understanding the thermal impairment of Brown’s Creek and water level fluctuations in landlocked areas such as the Kimbro Basin. BCWD should expand its

monitoring network to include more wells near landlocked areas. The Managers approved this expansion in 2022, and it will be completed in 2023.

Table 1. Groundwater Elevations

| Unique Number | Name | 2016 Water Elevation | 2017 Water Elevation | 2018 Water Elevation | 2019 Water Elevation | 2020 Water Elevation | 2021 Water Elevation | 2022 Water Elevation | Change since last measure |
|------------------------------|----------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|---------------------------------|
| Approximate Date | | Oct-16 | Oct-17 | Oct-18 | Oct-19 | Oct-20 | Oct-21 | Oct-22 | |
| Golf Course Wells | | | | | | | | | |
| 515171 | Applewood Hills | 891.84 | 895.42 | 894.14 | | 897.65 | 895.58 | 891.45 | -4.13 |
| 151580 | Oak Glen Country Club | 825.50 | 825.88 | 823.56 | 826.12 | 825.63 | 823.00 | | |
| 151581 | Oak Glen Country Club | 829.71 | 830.12 | 828.16 | 828.23 | 828.78 | 829.19 | 827.95 | -1.24 |
| 208038 | Stillwater Country Club | 769.17 | >200 | >200 | >200 | | | | |
| Stillwater Oaks 1 | Stillwater Oaks Golf Club | 910.31 | 913.42 | 910.11 | 912.41 | | | | |
| Stillwater Oaks 2 | Stillwater Oaks Golf Club | 908.89 | 910.27 | 909.05 | 913.60 | 913.72 | 909.95 | | |
| Stillwater Oaks 3 | Stillwater Oaks Golf Club | 910.27 | 911.26 | 910.07 | 911.90 | 912.46 | 911.02 | | |
| Stillwater Oaks 4 | Stillwater Oaks Golf Club | 963.06 | Artesian | 957.69 | 970.29 | 970.16 | 970.81 | | |
| 566145 | Logger's Trail Golf Course | 904.41 | 905.62 | 904.16 | 905.93 | 907.20 | | | |
| 667998 | Logger's Trail Golf Course | 911.29 | 906.28 | 905.10 | 907.34 | 908.40 | 905.30 | 905.08 | -0.22 |
| 761112 | Logger's Trail Golf Course | 900.53 | 901.16 | 900.09 | 901.94 | 903.55 | 900.71 | 899.18 | -1.53 |
| Domestic Wells | | | | | | | | | |
| 428563 | Ed and Laurie Francis | 900.51 | 902.53 | 900.91 | 903.36 | 906.14 | 903.71 | 900.80 | -2.91 |
| 410987 | Dan and Lori Gunderson | 904.96 | 906.98 | 905.62 | 907.22 | 910.22 | 908.10 | 905.35 | -2.75 |
| 196839 | Louis J. Bruno | 862.92 | 867.75 | 866.75 | 866.40 | 870.28 | 868.23 | 931.72 | |
| Leiser | Craig Leiser | 932.63 | 935.11 | 933.99 | 935.85 | 937.65 | 934.01 | 932.67 | -1.34 |
| James | Alan and Molly James | 939.62 | 941.71 | 940.20 | 942.14 | 944.20 | 940.56 | 938.70 | -1.86 |
| 184049 | Kirk and Tracy Hillquist | 942.27 | | 942.48 | 944.77 | 945.61 | 941.11 | 939.87 | -1.24 |
| Thatcher | Jyneen Thatcher | 953.76 | 955.68 | 953.19 | 957.18 | 958.63 | 953.89 | 951.60 | -2.29 |
| 138188 | Rick Vanzwol | 937.89 | 940.02 | 939.36 | 941.45 | 943.96 | 940.84 | 937.81 | -3.03 |
| 479665 | John and Michelle Weaver | 907.27 | 907.41 | 906.86 | 907.77 | 908.87 | 907.23 | 905.85 | -1.38 |
| 493250 | Mark and Sharon Olien | 721.88 | 719.97 | 721.50 | 721.54 | 721.89 | 721.01 | 711.66 | -9.35 |
| 525197 | James and Marilyn Opp | 912.08 | 913.88 | 913.02 | 914.69 | 917.18 | 914.69 | 912.42 | -2.27 |
| 505390 | Larry J and Pamela J Larson | 928.67 | 930.48 | 929.18 | 932.29 | 933.50 | 932.93 | 930.09 | -2.84 |
| 153485 | John P and Carolyn A Rydel | 897.42 | 899.51 | 898.47 | 899.31 | 901.08 | 897.14 | 896.83 | -0.31 |
| 138904 | Duane and Margaret Burmeister | 829.25 | 829.91 | 828.41 | 830.33 | 832.27 | 828.69 | 827.62 | -1.07 |
| 406204 | Michael and Rita Wiersma | 941.10 | 941.38 | 940.98 | | 942.78 | 940.28 | 939.17 | -1.11 |
| Boughten | Larry Boughten | | 953.73 | 951.32 | 954.28 | 956.81 | 949.52 | 948.51 | -1.01 |
| DNR Observation Wells | | | | | | | | | |
| 595649 | Brown's Creek Park - Deep | 866.32 | 864.77 | 865.81 | 868.11 | 868.20 | 866.17 | 865.21 | -0.96 |
| 623066 | Brown's Creek Park - Shallow | 875.53 | 875.77 | 875.05 | 876.84 | 876.88 | 875.30 | 875.01 | -0.29 |
| 551565 | Withrow Elementary School | 954.17 | 956.88 | 954.91 | 958.64 | 959.50 | 954.83 | 951.99 | -2.84 |
| 834170 | Brown's Creek Park - Middle | | | | | 875.59 | 874.15 | 873.43 | -0.72 |
| | | | | | | <i>Average</i> | | | <i>-1.84</i> |

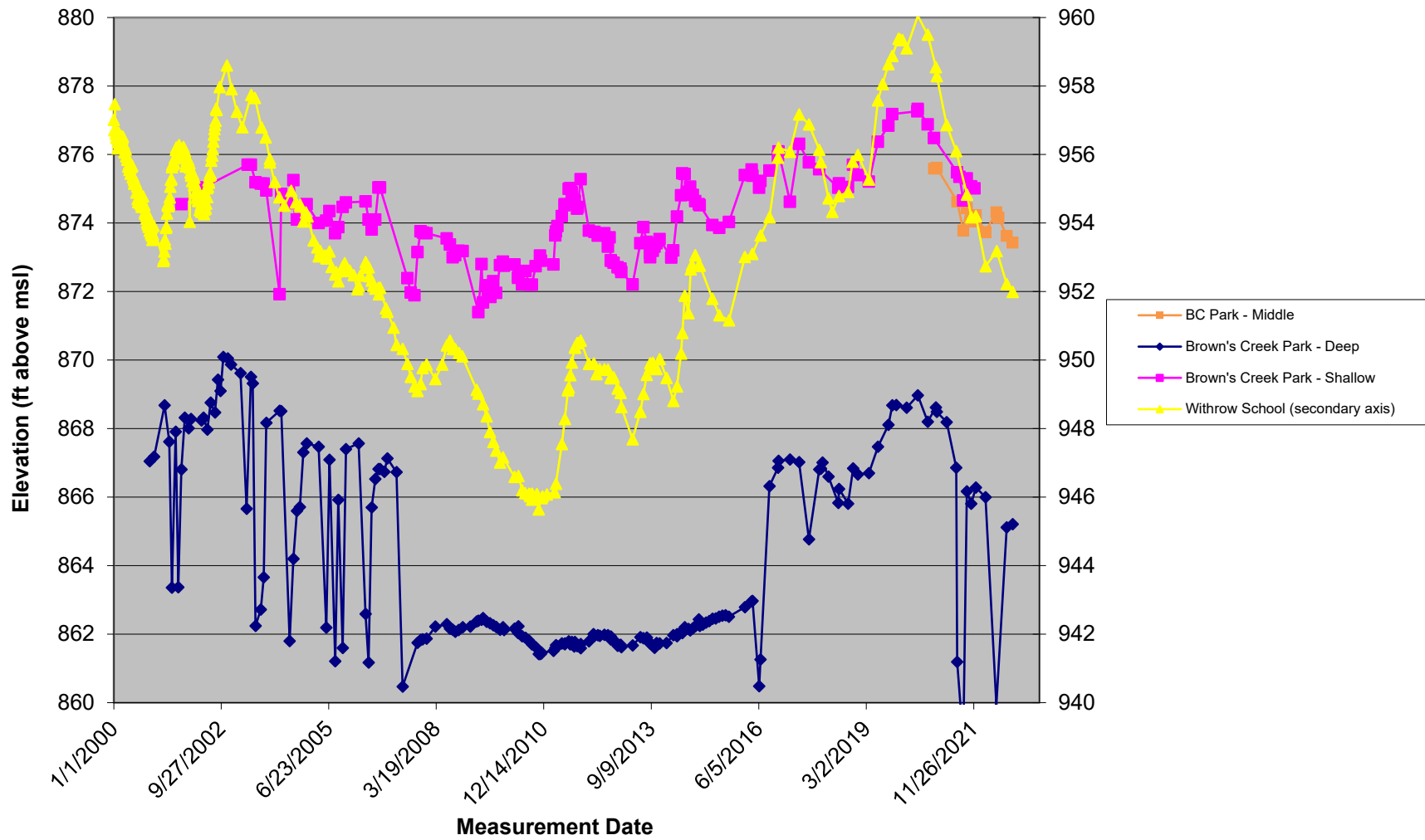


Figure 2. Groundwater Elevations – DNR Observation Wells

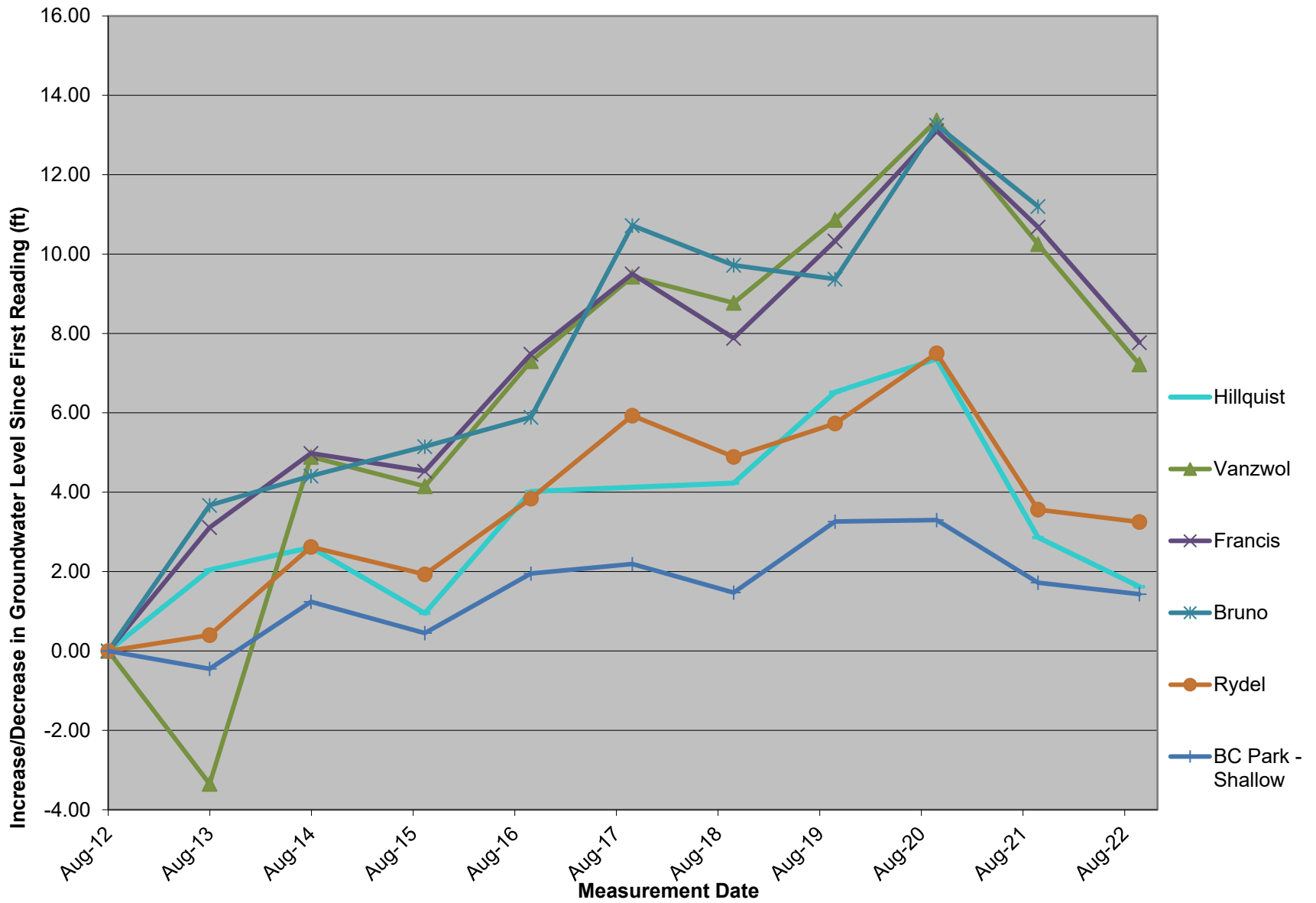


Figure 3. Groundwater Level Change Over Time - Quaternary (Glacial) Aquifer Wells

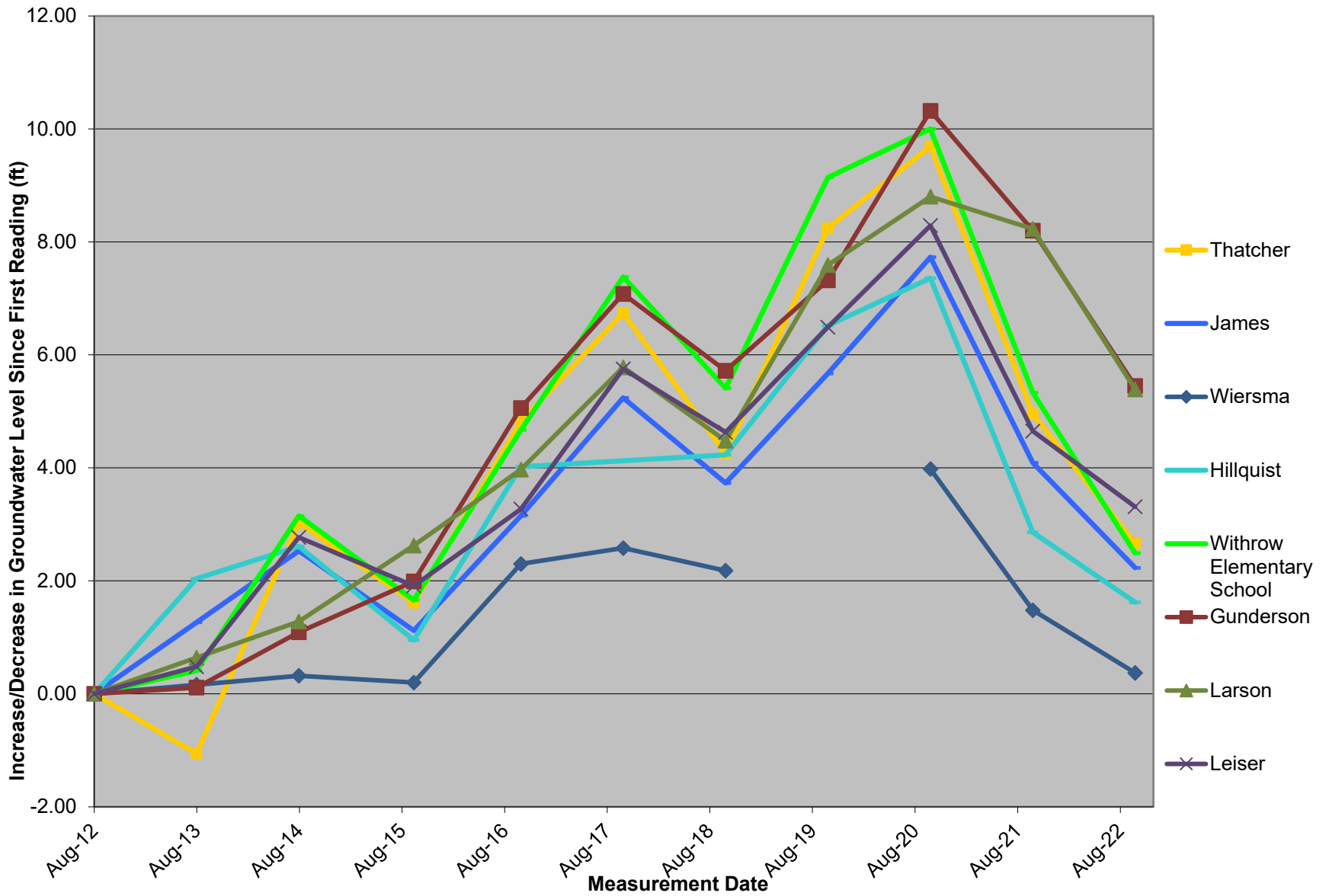


Figure 4. Groundwater Level Change Over Time - Prairie du Chien Aquifer Wells

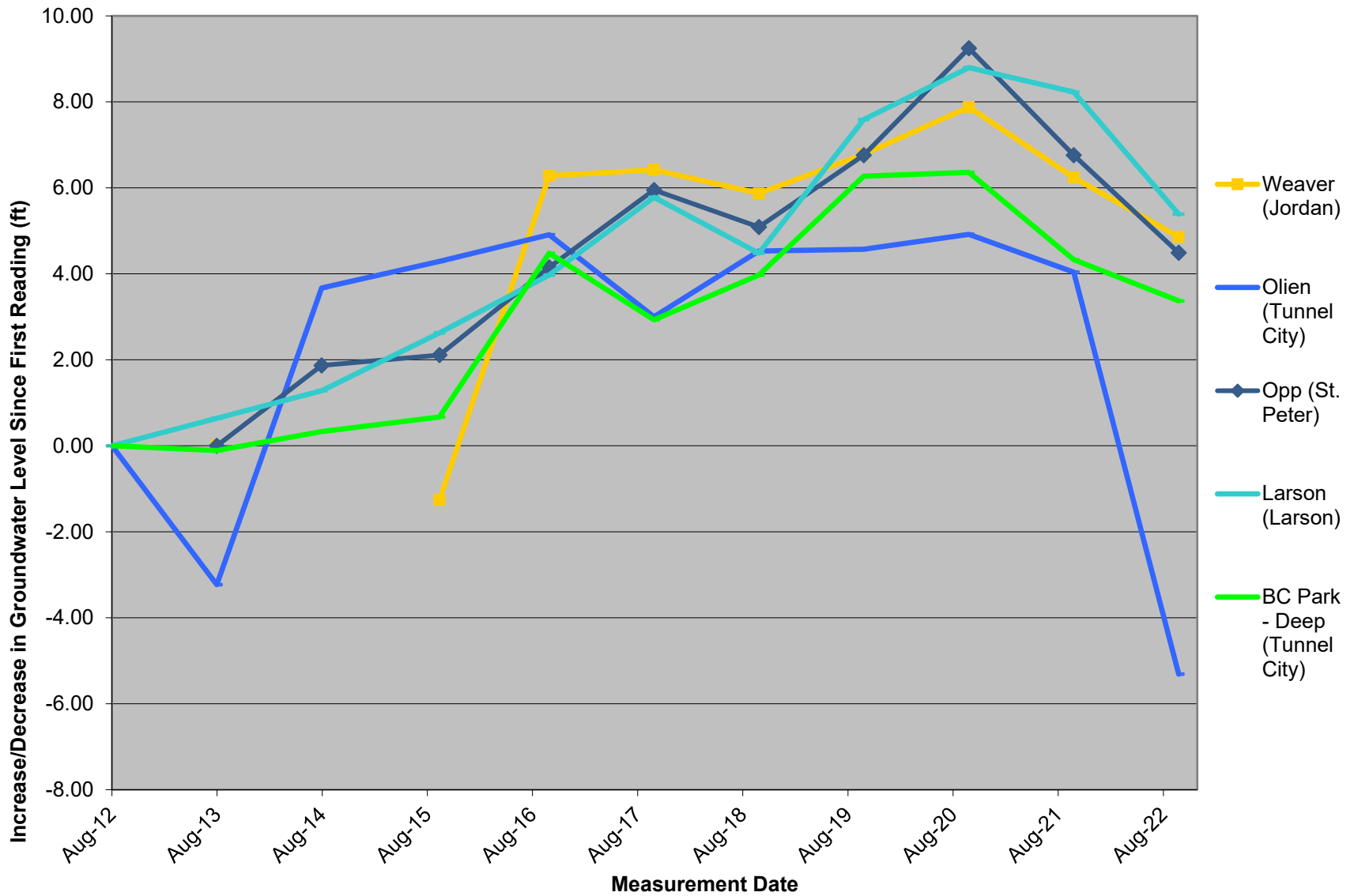


Figure 5. Groundwater Level Change Over Time - Wells in All Other Aquifers