technical memo

OAK GLEN GOLF COURSE PUMPING RECOMMENDATIONS

Date	2/7/2023
To / Contact info	BCWD Board of Managers
From / Contact info	Camilla Correll, PE; Stu Grubb, PG
Regarding	Oak Glen Golf Course Pumping Recommendations

Background

Previous work by EOR has identified reaches of Brown's Creek that lose water to the subsurface during the late summer months. This is an important observation because the stream depends on cold, high-quality groundwater to support the surrounding ecosystem that is sensitive to water temperature and quality.

Irrigation wells at the Oak Glen Golf Course (OGGC) may be contributing to the decrease in groundwater discharge and baseflow in Brown's Creek. EOR recommends continuing our discussions with the OGGC maintenance staff about how to best manage groundwater pumping to reduce impacts to the Brown's Creek ecosystem.

Previous Studies

The lower gorge of Brown's Creek runs along the north side of the OGGC (Figure 1). The Quaternary (glacial) deposits, bedrock formations, and pumping well locations in the area are shown on Figure 2.

EOR observed drawdown events of approximately 6 ft at a DNR observation well at Brown's Creek Park (BC Park – Deep) as shown on Figure 3. These drawdown events commonly occur for 1-3 days and then the groundwater elevation rises back to its original level. This pattern in groundwater elevation is recognizable as the influence of a pumping well.

Oak Glen Golf Course No. 2 well is the nearest pumping well finished in the Tunnel City Group with the pumping capacity (400 gpm) to result in the observed drawdown at BC Park – Deep. Pumping records for this well correlate with periods of drawdown and periods of no drawdown at the BC Park – Deep well, as shown on Figure 4. Oak Glen operates another well, No. 1, that is finished in the Jordan Sandstone aquifer with a capacity of 275 gpm.

Using the observed drawdown and recovery of the groundwater elevation due to pumping, EOR calculated aquifer properties for the Tunnel City Group. Aquifer properties were used to model estimates of drawdown along Brown's Creek. Pumping wells form areas of decreased groundwater head known as cones of depression. Cones of depression are three-dimensional features. The observed drawdown in BC Park – Deep indicates that the cone of depression of one or more pumping wells extends to areas of Brown's Creek.

The most important areas of Brown's Creek in the modeling effort were the areas where the Tunnel City is the uppermost bedrock unit. In these areas, the Tunnel City is potentially connected (hydraulically) to the surficial aquifer. Drawdown in the Tunnel City would reduce the hydraulic pressure in the aquifer and potentially reduce the amount of water contributed to the surficial aquifer. This could result in a reduction of baseflow to Brown's Creek. Modeled drawdown at Brown's Creek where the Tunnel City is the uppermost bedrock unit ranges from 2.7-5.5 ft of hydraulic head, as shown on Figure 5.

Additional modeling was undertaken to determine the effect of Oak Glen Golf Course No. 1 well on the Jordan aquifer and Brown's Creek. The model assumed similar aquifer properties to the Tunnel City in the absence of

drawdown data (because there are no observation wells nearby finished in the Jordan Sandstone). Modeled drawdown on Brown's Creek where the Jordan is the uppermost bedrock unit ranges from 3.7-5.1 ft of hydraulic head, as shown on Figure 6. By the same mechanism explained above, drawdown in the Jordan aquifer could result in reduction of baseflow to Brown's Creek.

As mentioned above, reaches of Brown's Creek have been observed to lose water to the subsurface in the dry summer months. Reduced baseflow to Brown's Creek (and reversal to a losing stream) could result in negative impacts to the ecological resources that depend on the stream. Increased temperature and decreased water quality result from the loss of cold, high-quality groundwater supplying the stream.

In summary:

- Drawdown events of approximately 6 ft has been recorded at the DNR observation well at Brown's Creek Park. These drawdown events commonly occur for 1-3 days and then the groundwater elevation rises back to its original level. This pattern in groundwater elevation is recognizable as the influence of a pumping well.
- EOR used the pumping capacity of the two wells at OGGC and aquifer properties (transmissivity of the aquifer) to estimate the drawdown that occurs in the bedrock aquifers below Brown's Creek.
    - The cone of depression created by pumping from the Tunnel City formation (Well #2) pulls the groundwater away from Brown's Creek by 2.7-5.5 ft (referred to as the hydraulic head). This creates a pressure gradient and causes water in Brown's Creek to flow from the creek into the groundwater system (a losing system).
    - These same calculations were used to evaluate the impact of Well #1 which draws water from the Jordan Aquifer. Results of this analysis indicate that the cone of depression for this well decreases groundwater levels in the lower reaches of Brown's Creek by 3.7-5.1 ft.
- Brown's Creek is impaired for Biota and Lack of Cold-Water Assemblage and one of the main stressors to the system is in-stream temperature. When cold water (baseflow) is pulled out of the stream, it causes instream temperatures to go up which is stressful for cold water fish (i.e., trout) and some macroinvertebrate species.

Recent Court Case Settlements

The 2017 lawsuit White Bear Lake Restoration Association vs. Minnesota Department of Natural Resources found that permitted wells within 5 miles of White Bear Lake had a significant impact in drawing down the water level of the lake. Various remedies were imposed by the court on municipal wells, industrial wells, and golf course wells. Three golf courses near to BCWD (Dellwood Hills, White Bear Yacht Club, and Indian Hills Golf Course) recently signed a stipulation agreement with the court that outlines best management practices to be implemented immediately and measures to be taken when the water level in White Bear Lake falls below different trigger elevations (See Appendix A). Establishing a similar but voluntary arrangement with OGGC could be beneficial for everyone.

Recommendations for Next Steps

To limit the impact of pumping at Oak Glen Golf Course Wells No. 1 and No. 2 on the Tunnel City and Jordan Aquifers underlying Brown's Creek, a set of best management practices for pumping operations should be developed.

The goal of the project is to limit the effect of pumping on the hydraulic head of the aquifers during times when baseflow is critical to sustaining flow in the stream. A review of climate data, groundwater elevations, and piezometer data in stream would be necessary to establish the timing of proposed best management practices.

Since there are two wells at Oak Glen, it would be informative to understand the relative impact of each well on Brown's Creek. To understand if one well has a greater impact on the stream it would be necessary to review modeling results, geology, pumping rates, and stream data.

After reviewing the relevant data, the pumping schedule should be optimized to reduce potential impacts on the aquifers and Brown's Creek. This would include annual timing and pumping durations supported by the analyses performed.

In addition to the optimized pumping schedule, additional best management practices could be explored. The irrigation and water storage methods utilized at the facility are opportunities to reduce the water lost to evaporation. By reducing the evaporative loss, the amount of water withdrawn from the aquifers could be reduced, thereby decreasing the risk to Brown's Creek baseflow.

Requested Action

EOR is requesting approval of the tasks outlined in Table 1. The total time budgeted for the project is 64 hours. The total cost is estimated at $13,312. The funds would come from Budget 942-0011. Depending on the availability of golf course staff, the project can be initiated during the winter, before the spring golf season gets underway.

Table 1. Itemized project description

Task	Description	Estimated Hours	Estimated Cost
1	Discuss objectives with BCWD Administrator. Schedule meetings with OGCC.	8	$1,664
2	Prepare for and attend meetings with OGCC.	16	$3,328
3	Document meetings. Prepare Report.	24	$4,992
4	Follow up meetings with OGCC and BCWD Board	16	$3,328
Totals		**64**	**$13,312**

Figures

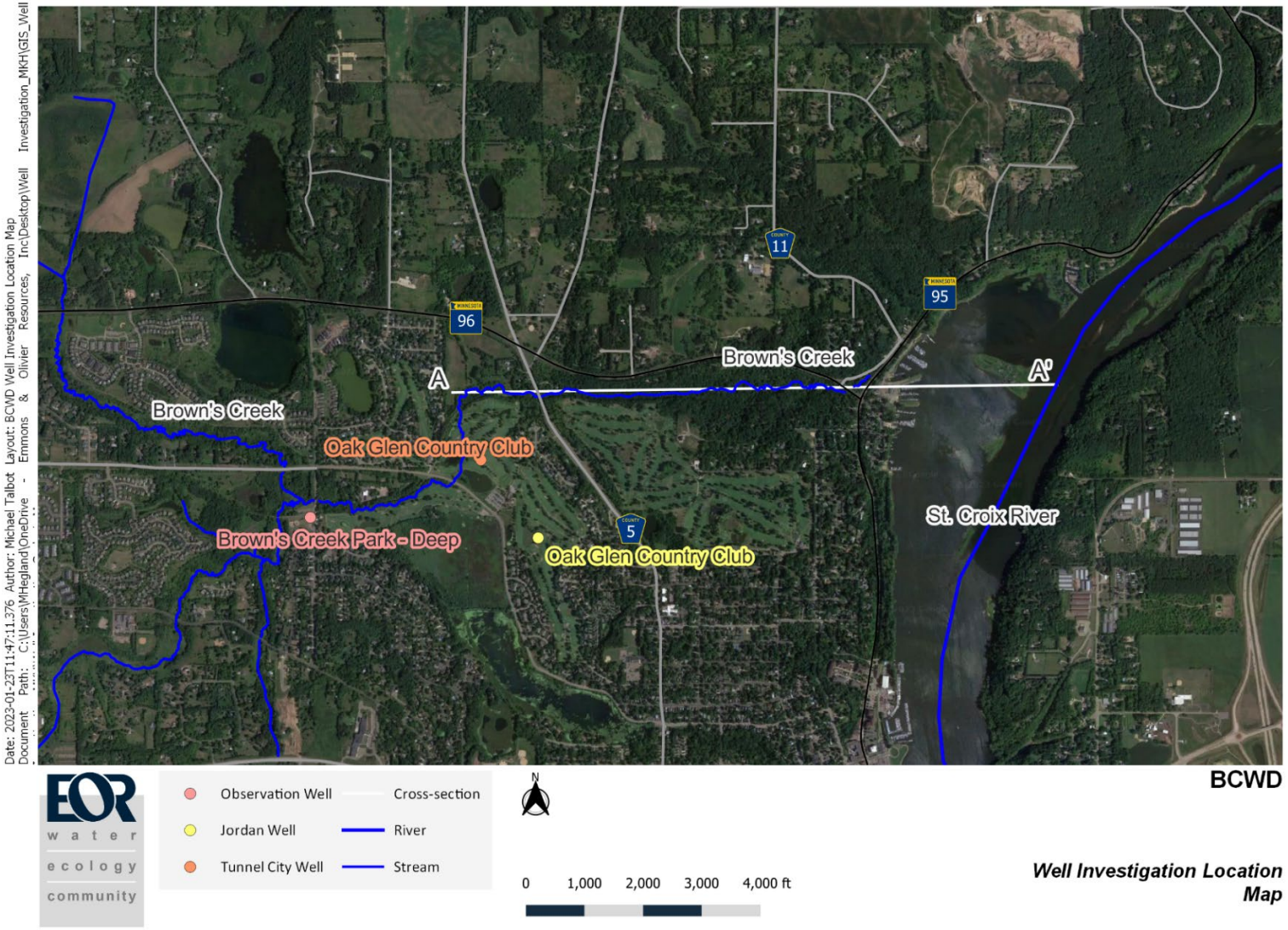

Figure 1. Oak Glen Golf Course, wells, and cross section locations.

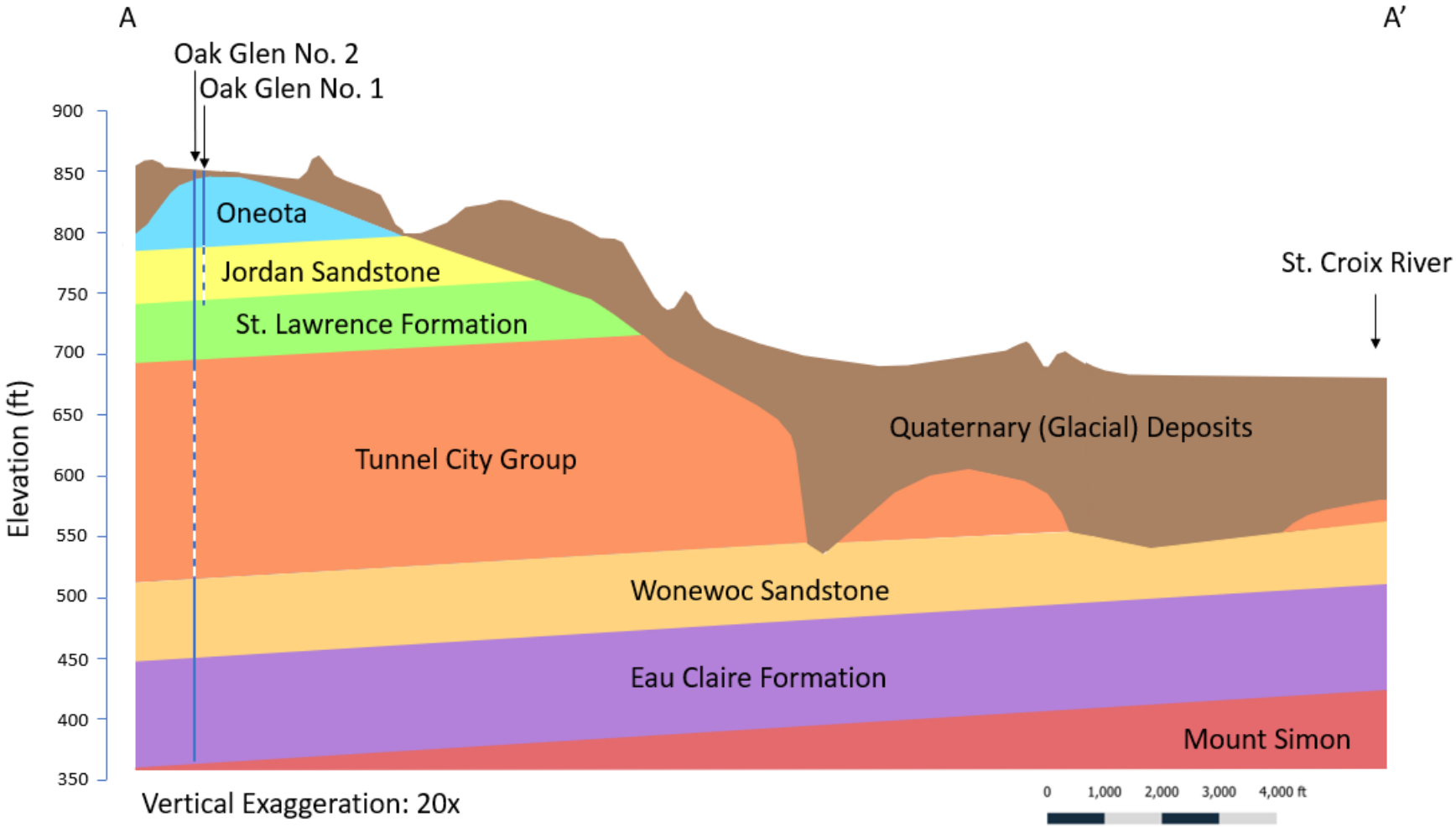

Figure 2. Cross Section A-A'.

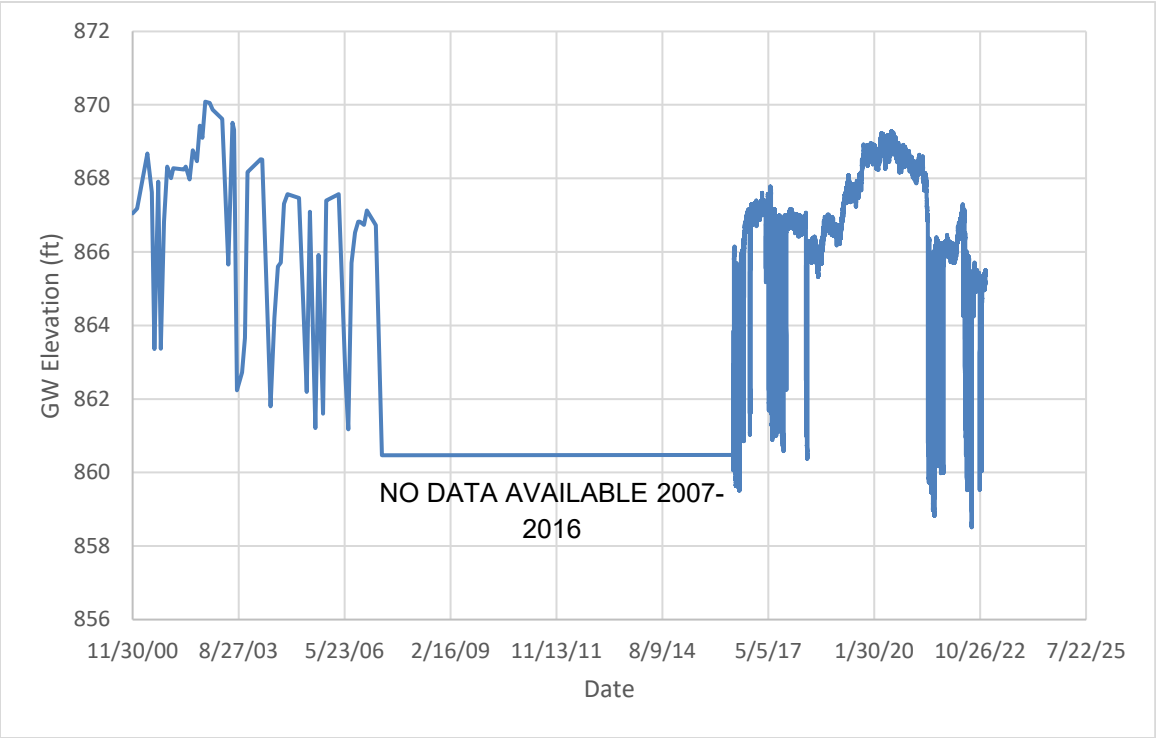

Figure 3. Groundwater elevations at BC Park - Deep monitoring well

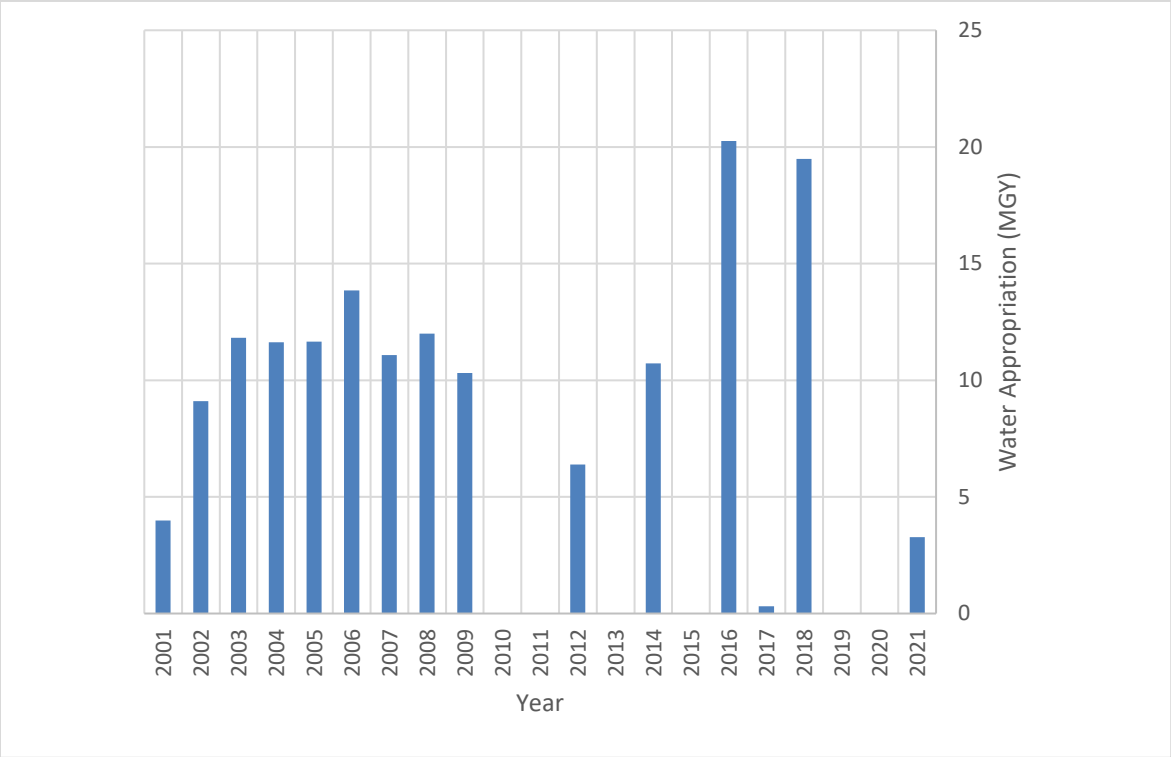

Figure 4. OGGC pumping records.

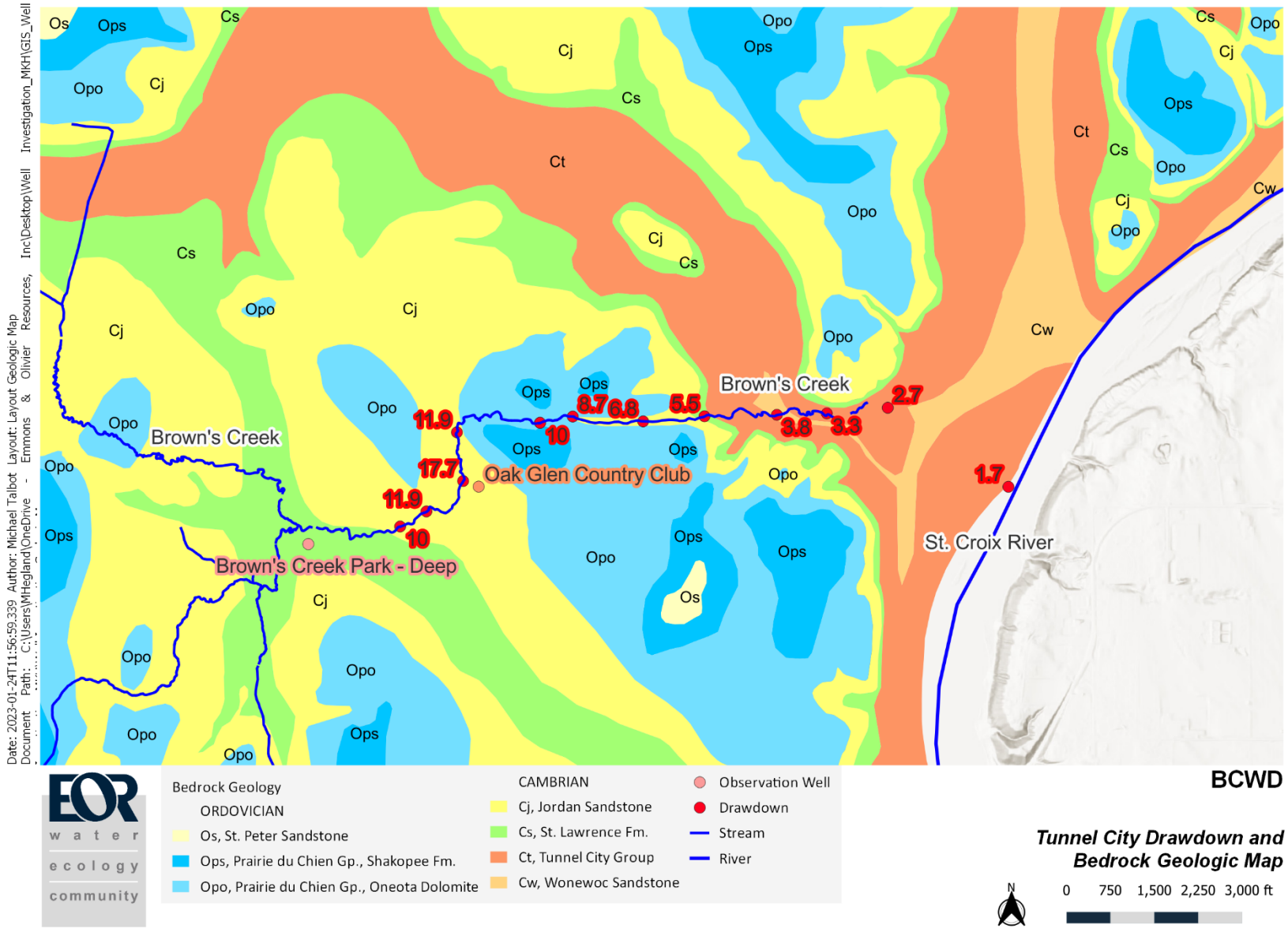

Figure 5. Predicted levels of groundwater drawdown in the Tunnel City Aquifer.

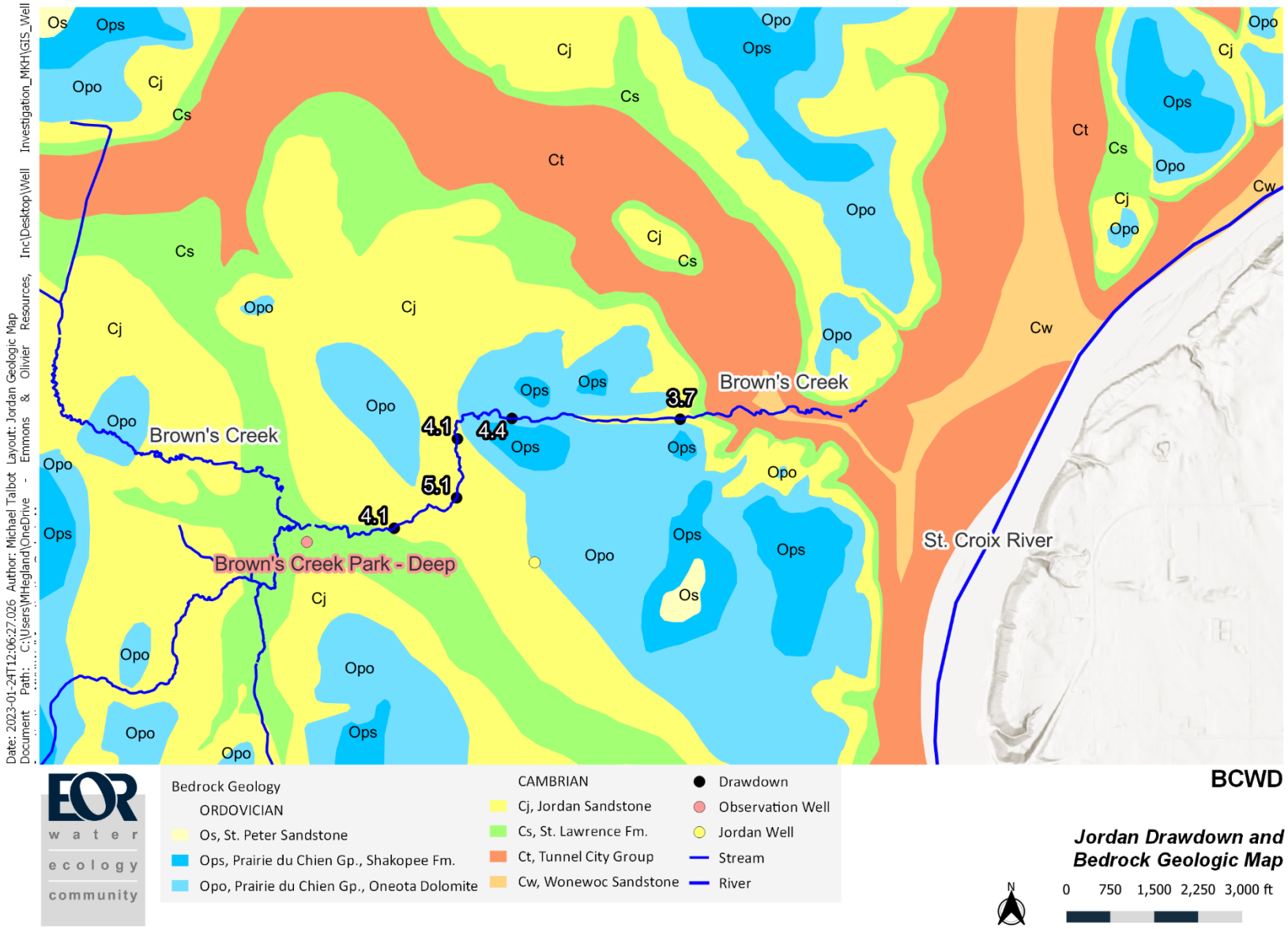

Figure 6. Predicted groundwater drawdown in the Jordan aquifer.

APPENDIX A - STIPULATION AGREEMENT WITH GOLF COURSES

STATE OF MINNESOTA

COUNTY OF RAMSEY

DISTRICT COURT

SECOND JUDICIAL DISTRICT

Case Type: Other Civil

White Bear Lake Restoration Association, *ex rel.* State of Minnesota,

Plaintiff,

and

White Bear Lake Homeowners' Association, Inc., *ex rel.* State of Minnesota,

Intervenor/Plaintiff,

v.

Minnesota Department of Natural Resources and Thomas J. Landwehr, in his capacity as Commissioner of the Minnesota Department of Natural Resources,

Defendants,

and

Town of White Bear Lake,

Intervenor/Defendant.

Case No: 62-CV-13-2414
Hon. Margaret M. Marrinan

STIPULATION

By Order of the Court dated May 11, 2022, the Court granted the parties' request that three business entities that requested a contested case hearing on the Court's DNR water appropriation permit amendments: OAH Nos. 8-2002-35471 (H.B. Fuller), 35559 (Whirlpool), and 35560 (Saputo Dairy) be allowed to enter into settlements with the DNR and not be subject to the Court's Order, which primarily affected municipal permit holders.

The parties now stipulate and agree that the Golf Courses that have also filed for a contest-case hearing: OAH Nos. 8-2002-35473 (White Bear Yacht Club), 8-2002-35470 (Dellwood Country Club), and 8-2002-35472 (Indian Hills Golf Course) not be subject to the Court's Order

and allow them to work directly with the DNR on settlements with them through their own appropriation permits where the permit amendments are, on their face, not relevant to the non-municipal permit holders and neither the non-municipal permit holder(s) nor the plaintiff-intervenors unreasonably object. The parties further agree that only one of two Indian Hills Golf Course permits, namely No. 1987-6206 for golf course irrigation, is subject to this Stipulation.

The Golf Course permit holders are not residential users of water. They are businesses that serve customers, employ hundreds, and contribute to the vitality of the community through the provisioning of recreation and maintaining hundreds of acres of scenery and habitat for wildlife. That said, the permit holders recognize that when the protected elevation is reached on White Bear Lake, certain responses to that situation are appropriate.

Therefore, the Golf Course permit holders stipulate that, as for their part in supporting the conservation of the White Bear Lake protected elevation, they will affirmatively commit to, and memorialize the same in their own DNR Appropriation Permits, the following:

1) Continuing the efficiency measures they have already implemented:

   a. Precision Scheduling of irrigation based on:

      1. Monitoring Current and Future Weather using:

         (a) Evapotranspiration Rates

         (b) Transpiration Rates

         (c) Humidity

         (d) Dewpoint

         (e) Temperature

         (f) Wind

      2. Application of Time Domain Reflectometry (TDR)

3. Monitor Volumetric Moisture Content (VMC)

4. Underground VWC sensors to monitor water levels constantly

5. Utilization of computer based programing for:

   (a) Irrigation Head Run Times % + or -

   (b) Single head control to allow for precision watering

   (c) Utilizing rain sensors to monitor precipitation to automatically turn off irrigation when the threshold is reached

6. Deploy teams of hand-waterers with hoses to supplement irrigation cycles from the system, specializing in high-value turf and localized dry spots

b. Other best practices being utilized:

1. Fertilization rates to assist with plant stress

   (a) Lower nitrogen rates to avoid succulent growth that increases transpiration rates

   (b) Promotion of potassium to increase drought stress to reduce transpiration via osmoregulation

2. Soil cultivation including aeration to promote root depth

3. Increase mowing heights to allow deeper rooting and less stress

4. Low input cultivars selected for new and upcoming projects

5. Irrigation System

   (a) Annual Irrigation Audits to ensure efficient function:

      i. Adjusting irrigation heads to ensure proper function and efficiency

      ii. Choosing correct nozzles to avoid over distribution.

      iii. Drip irrigation installed to increase efficiency in watering landscaped areas

6. Employ the use of wetting agents on high-value turf (greens, tees, fairways) at a certain elevation.

2) Adopt these water conservation practices tied to levels of White Bear Lake:

a. Agree to only apply water to Greens, Tees, Fairways and Driving Ranges when the protected elevation (923.5') is compromised and cease watering any other areas when Court-Ordered conservation measures apply.[1]

b. When the elevation reaches 923,' agree to only apply (via irrigation systems) water to Greens, Tees, and Fairways at night (unless impractical) when it is most effective and not subject to evaporation due to the daytime sun/heat as well as applying advanced chemical wetting agents.

c. If 923' is reached only apply water to Greens Tees and Fairways and system audits are stepped up to bi-monthly readings for maximum efficiency.

d. If 922.5' is reached, agree to maintain no more than 22%[2] soil moisture at 3".

e. If 922' is reached, agree to maintain no more than 21% soil moisture at 3" and raise height-of-cut on fairways 10%.

f. If 921' is reached, agree to maintain no more than 20% soil moisture at 3"[3] and raise height-of-cut on fairways 15% and 10% on tees.

g. Work with the DNR and Watershed District(s) to further identify cost-effective ways to improve efficiencies with practices, equipment and products, particularly with respect to gray-water capture and reclamation and

[1] The elimination of watering rough and other areas may decrease use by 20-25% (roughly 4-5 million gallons per year, depending on the course).

[2] The ideal soil moisture for courses during season for ideal conditions is 30-35%.

[3] Industry standards and basic plant biology agree that soil moisture less than this creates an unsustainable condition for the plants: the plants (grasses) die at less than this percentage.

hybrid turf options that are less water-intensive and partner with conservation agencies to leverage grants and other incentives.

The parties further stipulate that any such settlements would be presented to Administrative Law Judge Lipman, along with an explanation, and assuming they are accepted, the DNR would provide notice to this Court of such settlements as part of the DNR's regular reporting to the Court.

Dated: October 11, 2023

Dellwood Country Club
Indian Hills Golf Course
White Bear Yacht Club

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