TOWN OF WOODSTOCK
AQUIFER PROTECTION
WORKING GROUP
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March 20, 2020

Woodstock Town Board
Town of Woodstock
45 Comeau Drive
Woodstock, NY 12498

Report of the Aquifer Protection Working Group Review of Nitrate Concentration

Nitrate concentrations in Woodstock's water supply and aquifer are low and do not warrant corrective action. Nitrate contamination, if it occurs, is very expensive to correct.[1,2] Instead, protection of the wellfields and aquifer to prevent contamination is preferred. The working group is unable to confirm the basis for the Planning Board's recommendation to extend the septic tank effluent collection system.

The Aquifer Protection Working Group met with Larry Allen, Woodstock's Water Superintendent, and Grant Jiang, NYS Department of Health, on March 12, 2020 to review an analysis of Woodstock's water system. In addition to nitrate concentrations, 100 years of rainfall amounts from the Kingston Water Department and 10 years of Woodstock wellhead production were considered.

Planning Board Response to Draft Water Supply Protection Law[3] (WSPL)

The major focus of the working group has been on considering the Planning Board's recommendation in its letter of May 9, 2017 that the town extend the septic tank effluent collection system to the Bearsville Flats. The Planning Board recommended:

> Extension of the Septic Tank Effluent Collection System. The Horsley & Witten Report identifies the most heavily developed portion of the wellhead protection area as having a problematic septic system density as a groundwater contamination issue. As identified in the

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[1] Initial construction costs for nitrate removal systems are expensive, especially for smaller communities. Up front construction costs can range from $350 to $1000 per resident. Annual operating costs are dependent on nitrate concentrations in raw water, the amount of water treated, filter replacement costs, maintenance costs, and chemicals costs. Annual equipment maintenance can cost $0.25-$0.35 per 1000 gallons treated.

[2] Minnesota Department of Agriculture, "Drinking Water Protection Series, Nitrate Contamination – What is the Cost?", Available at http://www.nesc.wvu.edu/ecommerce/products/DW_PublicEducation/DWFSPE347DL.pdf

[3] John LaValle, Chairman, Woodstock Planning Board, "Referral of DRAFT Water Supply Protection Law," Letter to the Town Board, May 9, 2017

> Planning Board's prior TB [Town Board] Referral Responses on the proposed water resource laws, the PB [Planning Board] continues to believe and recommend that extending the sewer system and removing the septic fields in the Flats and vicinity could accomplish the greatest level of water resource protection.
>
> The potential for bacteriological and chemical contamination of our water system from aged septic tanks in the Flats, household practices, past industrial uses, and other potential sources of contamination, known or unknown, must be addressed immediately. Therefore, we consider that any new water resource protective measures such as the proposed WSPL should be taken up simultaneously with initiating an Engineers Map Plan and Report, which will assess the physical and financial feasibility of an Improvement to broaden the area of participation in the Bearsville Flats and vicinity. It is also the PB's recommendation that homeowner hookup costs be financed by project funding on an appropriate pro rata basis as may be feasible.

The working group's analysis failed to identify the nearby septic systems as a significant source of contamination. "When properly sited, designed, constructed, and operated, septic systems pose a relatively minor threat to drinking water sources. On the other hand, improperly used or operated septic systems can be a significant source of ground water contamination that can lead to waterborne disease outbreaks and other adverse health effects." [4] Bacteriological contamination is easily treated. While properly maintained and situated septic systems are effective at treating most contaminants found in effluent, nitrate is one of the few contaminants that is not effectively treated.

The Problem with Nitrates

Nitrate is one of the most common groundwater contaminants in rural areas. It is regulated in drinking water primarily because excess levels can cause methemoglobinemia, or "blue baby" disease, although nitrate levels that affect infants do not pose a direct threat to older children and adults.

Nitrate in groundwater originates primarily from fertilizers, septic systems, and manure storage or spreading operations. Fertilizer nitrogen that is not taken up by plants, volatilized, or carried away by surface runoff, leaches into the groundwater in the form of nitrate. This can elevate the concentration in groundwater above the levels acceptable for drinking water quality. Nitrogen from manure similarly can be lost from fields, barnyards, or storage locations.

Septic systems can elevate groundwater nitrate concentrations because they remove only half of the nitrogen in wastewater, leaving the remaining half to percolate to groundwater. [5]Approximately 80% of dietary nitrates are derived from vegetable consumption; sources of nitrites include vegetables, fruit, and processed meats. Vegetables such as spinach, lettuce, beets and carrots contain significant amounts of nitrate.

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[4] United States Environmental Protection Agency, "Source Water Protection Practices Bulletin, Managing Septic Systems to Prevent Contamination of Drinking Water," July 2001, Available at https://www.epa.gov/sites/production/files/2015-06/documents/2006_08_28_sourcewater_pubs_septic.pdf

[5] Margaret McCasland, et al," Nitrate: Health Effects in Drinking Water," Cornell Cooperative Extension, Available at http://psep.cce.cornell.edu/facts-slides-self/facts/nit-heef-grw85.aspx

Acceptable Levels of Nitrates in Drinking Water

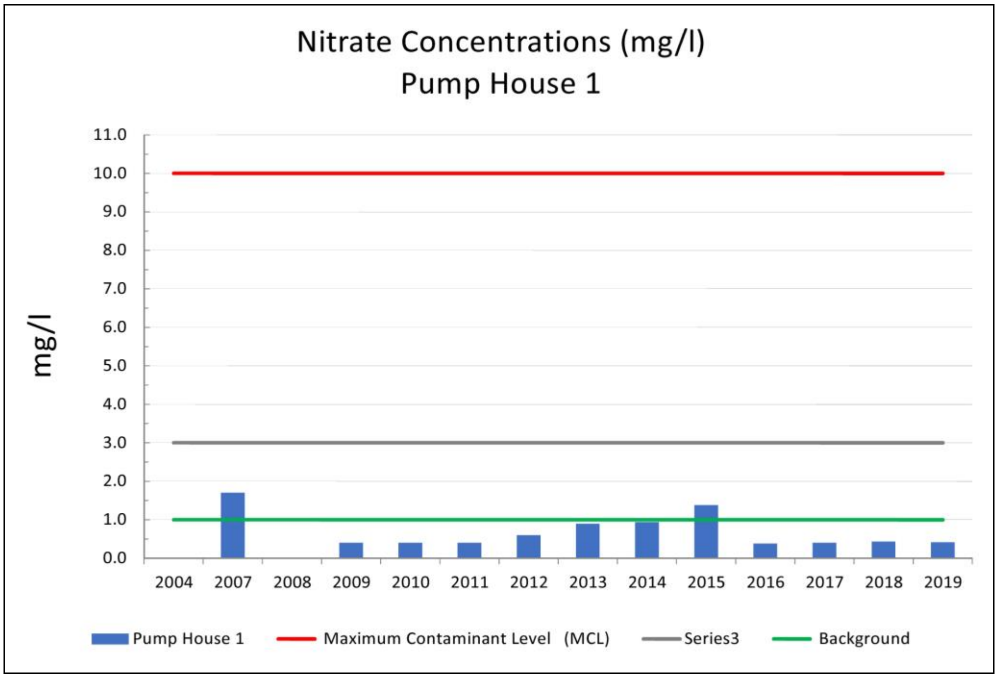
The EPA and New York Department of Health have established guidelines for acceptable levels of nitrates in drinking water.

The EPA states,[6] "While nitrate does occur naturally in groundwater, concentrations greater than 3 mg/L generally indicate contamination (Madison and Brunett, 1985), and a more recent nationwide study found that concentrations over 1 mg/L nitrate indicate human activity (Dubrovsky et al. 2010). EPA's maximum contaminant level (MCL) for nitrate set to protect against blue-baby syndrome is 10 mg/L."

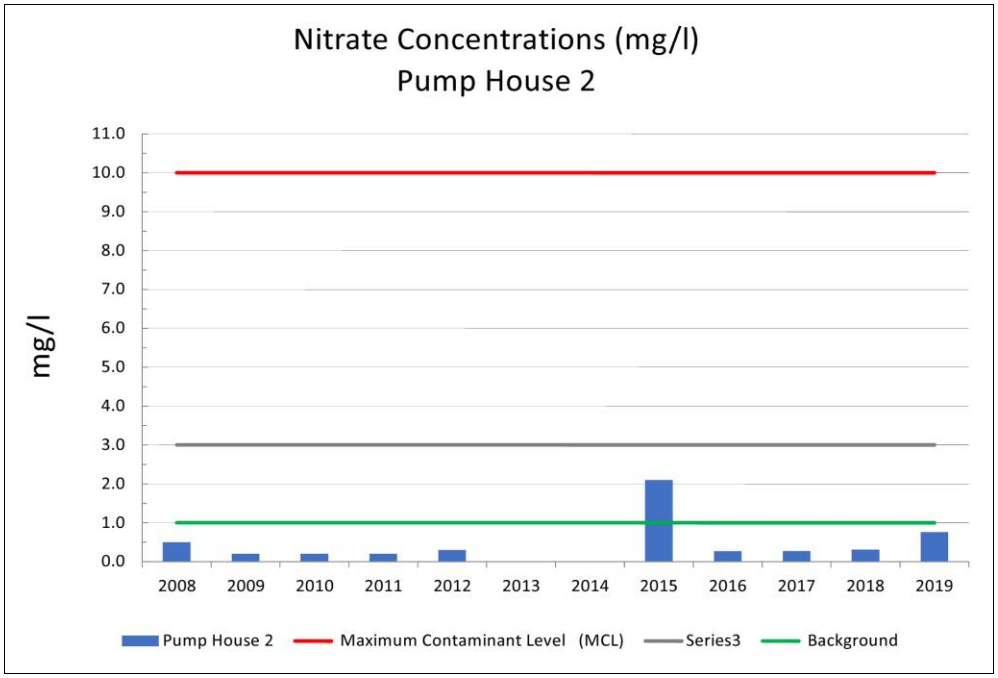
Nitrate Concentration mg/l	
10 mg/l	EPA's maximum contaminant level (MCL) for nitrate to protect against blue-baby syndrome
3 mg/l	Indication of human induced nitrates
1 mg/l	Background level of nitrate concentration

Woodstock Water System Nitrate Levels

Woodstock's water system is required by the Department of Health to periodically test for nitrates in the water supply. The charts below show the nitrate concentrations from the two wellfields during the past several years.



[6] United States Environmental Protection Agency, "Estimated Nitrate Concentrations in Groundwater Used for Drinking," Available at https://www.epa.gov/nutrient-policy-data/estimated-nitrate-concentrations-groundwater-used-drinking



Nnitrate levels are generally below background (1 mg/l) level for both wellfields, and have never exceeded the 3 mg/l level that would suggest contamination.

The working group is continuing to analyze data to understand year to year variations. Nitrate concentrations can vary based on rainfall, the Sawkill's flow, the application of lawn fertilizer, and differences in the pumping rates from the two wellfields.

Next Steps

The Aquifer Protection Working Group is following the protocol suggested by the Department of Health (Appendix). In January 2019, the town board began the roll-out of the recently adopted Comprehensive Plan; making assignments and assigning responsibility for many of the action items in the plan. It was at this time that DOH and DEC announced the Drinking Water Source Protection Program (DWSP2), which was available to support work on the water supply protection law. In June 2019, the Supervisor approved reforming the aquifer protection working group and participating in DWSP2 with the objective of proposing a revised aquifer protection law.

In late September 2019, Grant Jiang, the metropolitan area regional Source Water Protection Coordinator for the NYS Department of Health based out of Monticello, was assigned to provide Woodstock with technical assistance for source water protection activities. Since then, Grant has been assisting us in understanding issues of source water protection.

Respectively submitted,

Kenneth S. Panza, Coordinator
Aquifer Protection Working Group

CC:
Grant Jiang, NYS Department of Health
Aquifer Protection Working Group
Woodstock Planning Board
Woodstock Environmental Commission

Attachment:
Woodstock Notes, Grant Jiang, 3/11/2020

Appendix

Drinking Water Source Protection Program (DWSP2) Framework

- **Form a stakeholder group**
  - To oversee the process and ensure the community is involved.
- **Establish goals and formulate a vision**
  - Designed to be unique to the community and guide their drinking water source protection planning.
- **Develop an overview of the water system**
  - Beginning of the technical portion of the plan. Communities will need to gather basic information about their systems, including analyses of both water quality and water quantity.
- **Update the drinking water source protection map**
  - Inventory potential contaminant sources and create protection areas to help communities identify areas needing protection. The guidance provides a methodology to delineate protection areas for either surface water (lakes, reservoirs, and rivers) or groundwater sources of public drinking water.
- **Prioritize potential contaminants and evaluate risk**
  - The guidance provides communities with information to assess risk of potential contaminant sources to aid in the prioritization process.
- **Identify protection methods**
  - The guidance provides information on both regulatory and non-regulatory protection methods communities can choose to use, such as intermunicipal agreements and encouraging best management practices, to protect their source of drinking water.
- **Develop an implementation timeline**
  - Once protection measures are identified, the next step is for the community to develop a timeline of how they are going to implement the protection measures and make use of the different funding sources that are currently available.
- **Designate a plan management team**
  - This team is responsible for ensuring the community-specific drinking water source protection plan is completed, and the previously identified protection methods are being implemented.
- **Create a revision schedule**
  - To be successful, a community's protection plan needs to be kept up-to-date. The guidance document recommends methods to track changes in the community and ensure the protection plan is updated on a regular basis.

Woodstock Notes
Grant Jiang
3/11/2020

Nitrates are the primary contaminant of concern in Woodstock's source water. The EPA's enforceable Maximum Contaminant Level (MCL) for nitrate was set at 10 mg/L in the 1970s. This MCL was based on acute exposure levels that would be detrimental to human health and not long-term exposure levels. There are some recent studies that suggest that long-term exposure to nitrates below the MCL may have detrimental health effects, but there is not yet scientific consensus on this issue.

Nitrate is naturally occurring and can be expected to be found in almost all water sources at low concentrations (< 1 mg/L; concentrations greater than 3 mg/L generally indicate contamination). Typical sources of elevated nitrate concentrations are from agriculture (livestock or manure-spreading operations in particular), lawn fertilizers, and septic systems. Septic systems have been identified and are the most likely sources of nitrate to the Woodstock aquifer. This was confirmed by an examination of the area around the Woodstock wellfields. While properly maintained and situated septic systems are effective at treating most contaminants found in effluent, nitrate is one of the few contaminants that are not effectively treated.

The aquifer that comprises Woodstock's source water (hereafter the Woodstock aquifer) is a shallow aquifer: the water table is within five (5) feet of the surface in some places. Further, soil surveys and discussions with Woodstock officials indicate that the soils overlying the aquifer are very well drained and aerated. Denitrification, the natural conversion of nitrate to inert nitrogen gas, is a process that almost only occurs in the absence of oxygen. The soil conditions and short vertical distance between existing septic systems and the aquifer suggests that there may not be much in the way of denitrification happening.

Based on an assessment by Steve Winkley (NYRWA), the Woodstock aquifer is not hydrologically connected with other nearby aquifers. Furthermore, a 2011 report by Miller Hydrogeologic indicates that the Woodstock aquifer is not directly influenced by the adjacent Saw Kill in the area of the water supply wells. This is not to say that the Saw Kill does not supply any water to the Woodstock aquifer, but that the wells are not directly receiving water from the Saw Kill when pumping. It may be possible that increasing pumping rates will increase the existing wells' zone of influence to the Saw Kill, thereby establishing a direct connection between the wells and the Saw Kill. There is, however, a confining layer beneath some areas of the aquifer that may preclude a direct connection. During times of drought, however, the Saw Kill has historically run dry: the Saw Kill ran dry during a historic drought in the 1960s, while the Town was still able to pump water from its wells. There are no continuous discharge data available for the Saw Kill, but continuous discharge data are available from the nearby Little Beaver Kill at Beechford, near Mt Tremper (USGS 01362497).

Wellfield 1 generally has higher nitrate concentrations than wellfield 2, concomitant with wellfield 1 being located downgradient of the Bearsville Flats' septic tanks. Wellfield 2 nitrate concentrations were higher than wellfield 1 in 2008, 2015, and 2019. The maximum nitrate concentration at wellfield 1 was 1.7 mg/L on 10/30/2007, and 2.1 mg/L at wellfield 2 on

7/7/2015. Neither of these maximum values are of concern. Because nitrate samples were only collected once per year at each wellfield, it is difficult to determine what exactly is or are the key drivers of nitrate concentrations in Woodstock's wells.

Some likely drivers are:

- **Septic tanks**: this is the most obvious and direct source of nitrate to the Woodstock aquifer. A development known as the Bearsville Flats sits between the two wellfields, and to the best of my knowledge is entirely on septic. Although built in the ~1950s, evidence suggests that the septic tanks are inspected and renovated/replaced as needed during property transactions. It is unclear what the year-round and/or seasonal occupancy of this development is.

- **Precipitation amounts and timing**: Generally, aquifer recharge in this area of the world is higher during the winter/spring months than during the summer and fall months. However, less precipitation during these cooler months may result in lower aquifer recharge. Less aquifer recharge means that there is less dilution of nitrate loadings to the aquifer.

    - Similarly, the Saw Kill is believed to exert an indirect influence on the Woodstock aquifer; that is, the aquifer is likely recharged to some degree by water from the Saw Kill upstream of the Woodstock wellfields. Streamflow in this area of the world is also seasonal, with higher streamflow and concomitantly higher aquifer recharge occurring during the spring months. In years with low winter/spring precipitation, streamflow may be low in spring and thus there may be less recharge of the Woodstock aquifer that spring.

- **Fertilizer application and/or land use loading**: nitrogen is a key component of almost all fertilizers, whether the use be on domestic lawns, commercial landscaping, or in agriculture operations. When applied in excess of plant growth requirements, the excess nitrogen can accumulate in aquifers as nitrate. Similarly, agricultural runoff commonly contains nitrate and is a common source of nitrate loading to aquifers. Aerial imagery does not indicate that there are much or many farms in the area upstream of the Woodstock wells, however, with almost all upstream and upgradient land being forested. However, forested lands

- **Differences in pumping rates between the two wellfields**: groundwater flow in the Woodstock aquifer is roughly from west to east and the most readily identifiable source of nitrate to the aquifer is the Bearsville Flats, located approximately midway between the two wellfields. If one of the wellfields is not pumping as normal, the nitrate inputs, or plume, may migrate towards the wellfield that is now pumping more than usual.

Nitrate concentrations increased at wellfield 1 from 2011/2012 to 2015, before dropping to < 0.5 mg/L in 2016. Nitrate concentrations at wellfield 2 were generally below 0.5 mg/L during this time, except in 2015. Rising nitrate concentrations at wellfield 1 could be attributed to increased pumping from wellfield 1 in 2012/2013 when wellfield 2 was pumping less. However, similar pumping scenarios occurred in 2009/2010 with no associated increase in nitrate concentrations.

Based on the available data (and using the Little Beaver Kill as a proxy for the Saw Kill), one possible explanation for the increasing nitrates from wellfield 1 during 2012 – 2015 may be due to a combination of factors: In 2012, wellfield 2 was not pumping regularly and wellfield 1 carried much of, if not all the water demand in the system. This would have led to the migration of the nitrate plume towards wellfield 1, which was exacerbated by low winter/spring precipitation and streamflow in 2012 and 2013. 2015 was marked by relatively low spring/winter precipitation and extremely low streamflow and thus less aquifer recharge. Nitrate concentrations then returned to < 0.5 mg/L in 2016, most likely due to increased winter/spring precipitation and streamflow, which would contribute to increased aquifer recharge and nitrate dilution. In 2009, a similar reduction in pumping rates from wellfield 2 did not trigger an increase in nitrate concentrations and is likely due to high winter/spring precipitation in 2008 and 2009.

Disclaimer: Please note that this explanation is conjecture based on the information available and further predicated on the assumption that no other major sources of nitrate were involved, and that nitrate loading to the aquifer remained constant over the period of examination. This explanation should thus not be taken or interpreted as the correct and/or only explanation, nor should it be used as the basis for future decisions made by the Town except as an avenue for future investigation. It is also important to note that based on the available information, nitrate concentrations in the aquifer are not of and have never been high enough to be of concern.

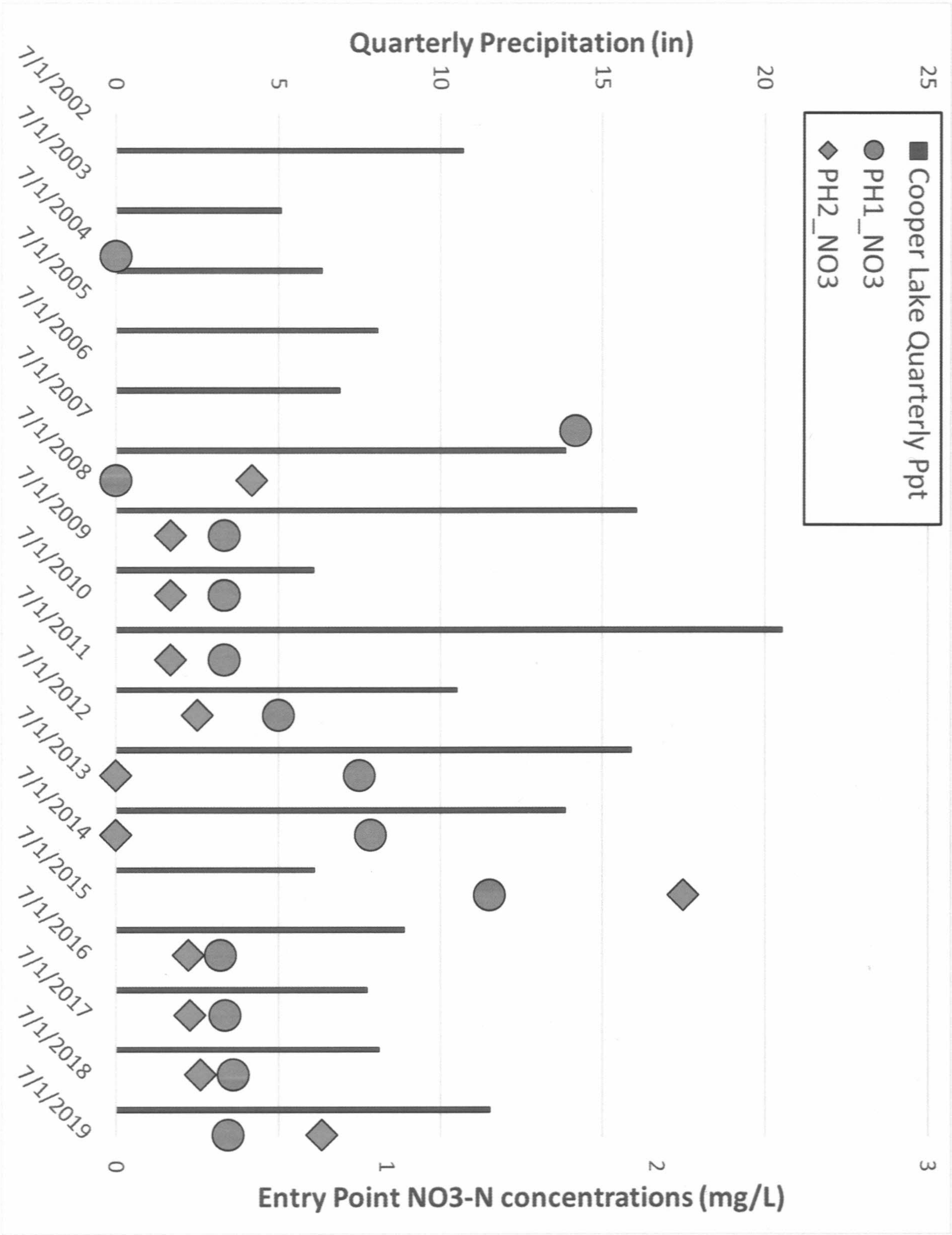


Figure 1. First quarter (Jan, Feb, Mar) precipitation from Cooper Lake. Data courtesy of Kingston water Department. Nitrate is presented in mg/L from wellfield 1 (PH1) and wellfield 2 (PH2).

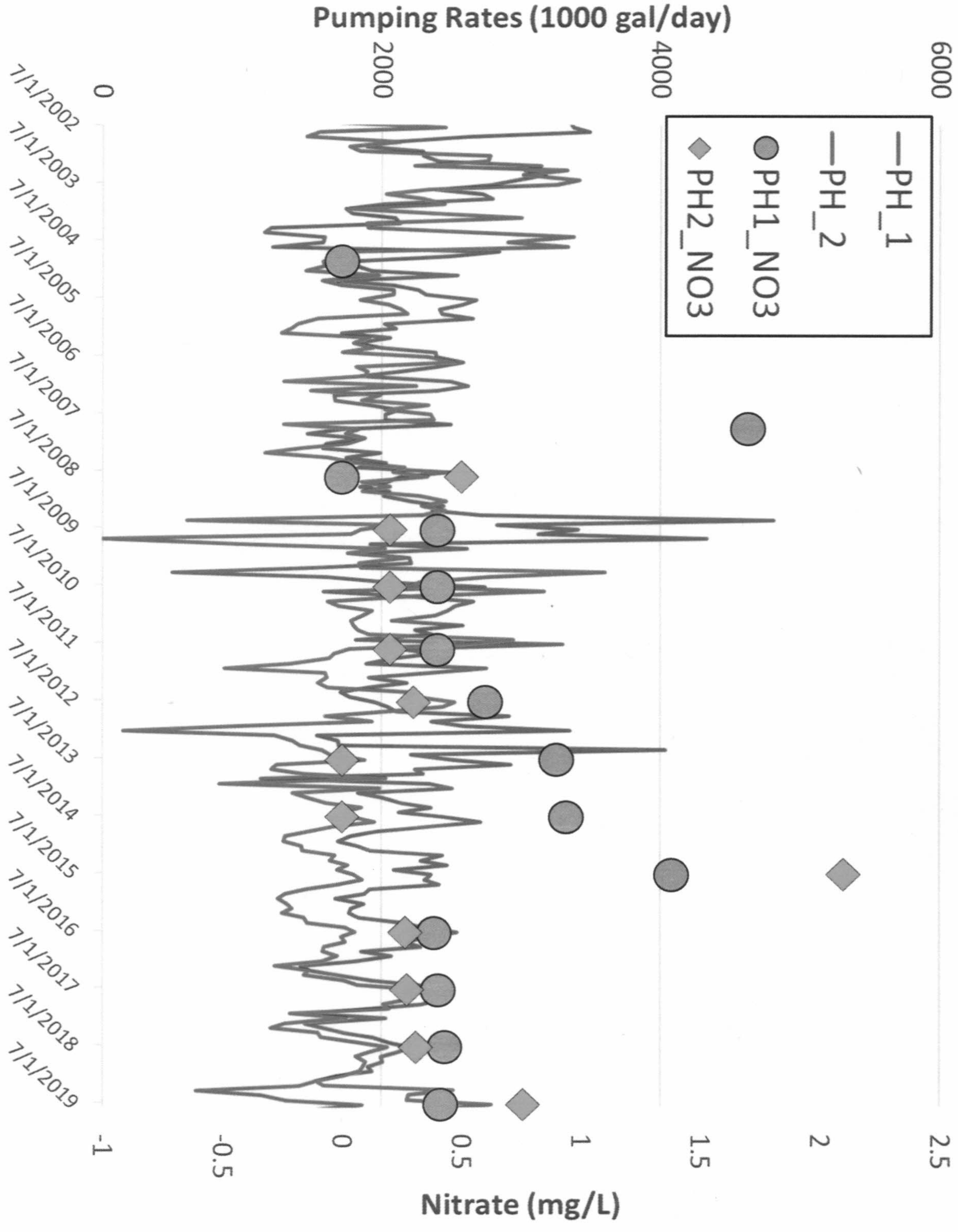


Figure 2. Woodstock water withdrawals from wellfields 1 and 2 (PH_1 and PH_2, respectively) in thousand gallons/day. Nitrate is presented in mg/L from wellfield 1 (PH1) and wellfield 2 (PH2).

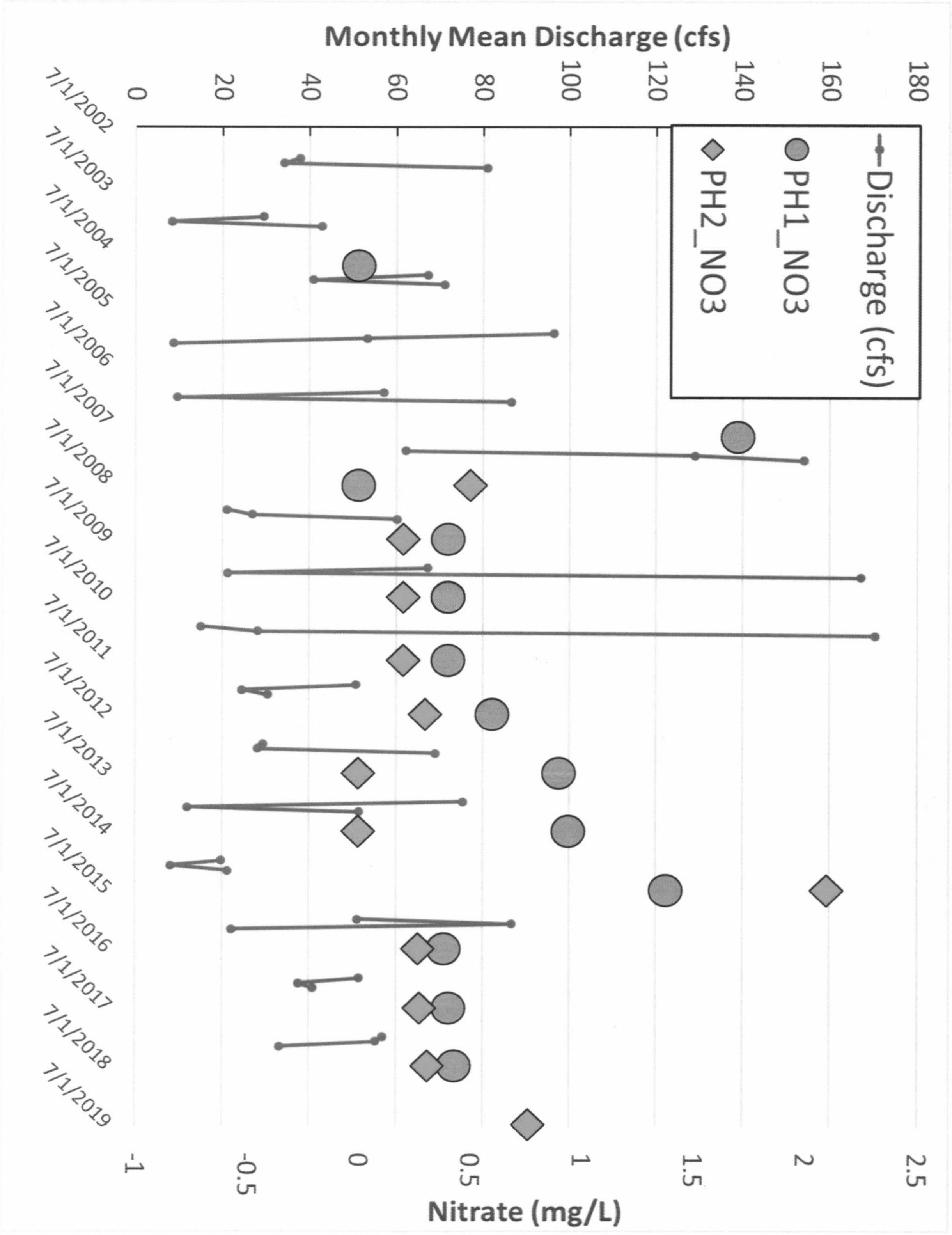


Figure 3. Quarter 1 (Jan, Feb, Mar) streamflow from the Little Beaver Kill at Beechford, near Mt Tremper (USGS 01362497) in cubic feet per second. Nitrate is presented in mg/L from wellfield 1 (PH1) and wellfield 2 (PH2).