Fields at Sherborn:
Site Redesign and Nitrogen Loading Issues

Submitted by Neil Kessler December 17, 2015

Given the recent (12/11/2015) submission of a new site design for the Fields at Sherborn project (and information contained in it and in a report to BOH on 11/18/2015 by hydrologist Scott Horsley), I'm writing to raise a few key issues surrounding nitrogen loading to the adjacent wetlands and the possibility that they will require the Commission to revisit the project.

To summarize, I believe that in the old site design, the loading of nitrogen into the adjacent wetlands from the septic system would have an irrefutable, adverse impact on those wetlands. In the new design, it appears that this adverse impact would be *more than doubled*. Given that there is a new design with *significant changes to the septic system*, I suggest that it is imperative that the Commission revisit the project either through gathering new information and amending its order of conditions or requiring a new NOI application for the project.

Below I go into some detail on the nitrogen loading numbers and how the new site design both clarifies their impact and increases the severity of it.

1. Related to the potential for impact of nitrogen and other pollutants on wetlands adjacent to the limit of work, the Commission's 11/17/2015 denial of the Fields at Sherborn NOI states that "though [the septic is] not finalized, the combination of the large relative volume of effluent in the groundwater and its large contaminant loadings raises significant concerns about adverse impacts on the west and then other parts of the wetlands and on their abilities to protect water quality. This effluent may also adversely impact the current wildlife habitat function due to changes in water and vegetation diversity and composition."

   At the time of the Commission's deliberations, there was not sufficient information to speak more fully to this topic, but that information is now more available through hydrologist Scott Horsley's report to the BOH on 11/18/2015 and through the revised site design and plans submitted by the applicant to BOH on 12/11/2015.

2. On 12/11/2015, the applicant provided BOH with a substantially revised site plan, which includes:
   a. elimination of one building (three units)
   b. elimination of a fourth unit from a second building
   c. reorientation of some of the buildings
   d. reconfigured and/or eliminated retaining walls
   e. consolidation of the original three septic leaching fields into two fields (elimination of Leaching Field 1, and consolidation of all septic effluent to Leaching Fields 2 and 3).

3. Based on the limited data submitted to the Commission by the applicant and peer reviewer, and on hydrologist Scott Horsley's report to BOH on 11/18/2015, in the ZBA meeting of 11/23/2015, I noted to the board that the wetland area just south and west of the limit of work (delineated at its northern border by wetland flags A19N to A23N and estimated conservatively by me to be 35,000 square feet in area) was:
   - in the direct path of the septic plume from Leaching Fields 2 and 3.

- going to be loaded with 654.78 kg/hectare/year of nitrogen.

4. <u>"Critical Loading" of Nitrogen</u>

The literature on nitrogen loading in wetlands provides data on "critical loading" levels. Below these levels the wetland can generally function in the way it has been, attenuating nitrogen through vegetative uptake and biological denitrification processes, and providing other ecosystem services such as pollution prevention, flood control, wildlife habitat, etc. (i.e., the "interests" of the WPA). Above those levels the structure and functioning of the wetlands change, often dramatically and permanently, and can no longer provide for these interests/functions.

For freshwater wetlands like those that exist adjacent to the project site, the literature speaks to a range of critical nitrogen loading levels:

- **2.7 - 13** kg/ha/year (Pardo et al., 2011) Aldous 2002; Moore et al., 2004; Rochefort & Vitt, 1990; Vitt et al., 2003 – all referenced in Pardo et al., 2011)
- **6.8 – 14** kg/ha/year (Gotelli and Ellison, 2002, 2006 – referenced in Pardo et al., 2011)
- **10 - 20** kg/ha/year for "poor fens" (Bobbink, Ashmore, Braun, Flückiger & Van den Wyngaert, 2002)
- **15 - 35** kg/ha/year for "base-rich fens" (Bobbink et al., 2002)
- **~25** kg/ha/year **(**Verhoeven et al., 2006)

Therefore, the scientific literature provides a range of critical loading numbers for nitrogen in freshwater wetlands from **2.7** to **35** kg/ha/year.

As can be seen, then, in my calculations based on the original site design, the nitrogen loading is more than 18x the highest critical loading estimate in the literature, which will have severe adverse impacts on that adjacent wetland area, and potentially on the larger Dirty Meadow Swamp wetland beyond it, and with which that area is contiguous.

5. <u>Effects of Critical Loading of Nitrogen</u>

Just a few of the effects of going beyond the critical nitrogen loading levels in wetlands are:

- change in plant community structure
- alteration of microbial processes
- alteration of species diversity and composition
    - losses of nitrogen sensitive species
    - shifts in species dominance
    - losses of native species in favor of exotica and invasive species
- nitrate leaching, which is migration of nitrogen into the surrounding soils and water bodies
- eutrophication

6. <u>Effect of Site Redesign on Nitrogen Loading to Wetland</u>

In site redesign submittals from the applicant on 12/11/2015, three elements are relevant to the Commission's considerations. They are:

a. Daily septic discharge in the leach fields upgradient of the wetland noted above is *increasing from 6,160 gpd to 8,360 gpd*.
b. Concentration of nitrogen in the septic discharge is *increasing from 25 mg/l to 35 mg/l.*
c. The applicant admits that the adjacent wetlands will be impacted by the septic plume, whereas in all previous communication he has denied this.

Related to a., though the overall discharge from the project will be reduced from 9.240 gpd to 8.360 gpd, by eliminating old Leach Field 1 and consolidating its discharge to old Leach Fields 2 and 3, all septic discharge for the site is now being directed into the adjacent wetland. The applicant clearly shows this to be the case in the last page of the site redesign submittal to BOH (see Appendix A) of 12/11/2015. That page shows the path of the septic plume and the "Impacted wetland" area of 27,825 sq ft.

Related to b., I believe it is because the wells that were in the path of the septic plume from Leach Fields 2 and 3 have been relocated, and because old Leach Field 1 has been eliminated, that the applicant appears to no longer see the need to include some of the nitrogen reducing technology in the new septic system. Therefore, the concentration of nitrogen in the septic is rising from 25 mg/l to 35 mg/l.

Both a. and b. mean that, when re-running the calculation (which is admittedly a little less accurate than my previous one because I had to extrapolate from the data available in the old design), the **new nitrogen loading level for the adjacent wetland area is 1,564.00 kg/ha/year**. This is **more than 44x the highest critical loading estimate for nitrogen** in freshwater wetlands.

Any denitrifying that would occur as the septic effluent travels through groundwater level soils will be limited because nitrates, at least, require biological attenuation mechanisms either in the form of microbial denitrification activity which is largely not present in the porous soils on the project site, and interaction with the root zone. Since there are no deep rooted trees in the path of the effluent, and since much of that path is covered by buildings and other structures, interaction with vegetation for uptake is unlikely. In terms of other soluble nitrogen, impervious soils are much better at removing nitrogen, so the pervious soils on the project site will do a generally poor job of reducing nitrogen levels before they reach the wetland.

Related to c., in the past the applicant has claimed that there will be no significant adverse impact to the adjacent wetlands. In the last page of the site plan, he lists the adjacent wetland as an "Impacted wetland" and shows the area of impact at 27,825 sq ft. I don't know if the applicant is arguing that this level of septic effluent will not have a significant adverse impact, but he appears to be concluding this in the last sentence of CLAWE's narrative, where he says that "**The wetland has enough capacity for denitrification of the plume through uptake and biochemical process in the wetland.**" I believe that the calculations I've provided above provide clear and incontrovertible support for concluding that the wetland *does not have enough capacity for this*. Even if the calculation is rerun to cover 8 hectares, a conservative estimate of the size of the entire Dirty Meadow Swamp wetland complex, the loading level is still approximately 50 kg/ha/year, and still above the 35 kg/ha/year number that is the upper limit for critical loading set in the literature.

7. Reconsidering the Project

I suggest that, given the changes detailed above in the site redesign submitted to BOH on 12/11/2015, that there is more than ample basis for the Commission to revisit this project either through gathering new information and amending its order of conditions or requiring a new NOI from the applicant. I urge the Commission to undertake whichever one seems to fit the circumstances the best in order to protect the interests of the Act as they relate to the wetlands adjacent to the project site.

I also suggest that there the Commission would be well served at this juncture to bring in an independent expert to gather clear data on the nitrogen loading and impacts. While my initial analysis of the old site design data was deemed accurate by hydrologist Scott Horsley, I believe a professional hydrologist would provide the kind of clear data the Commission needs to protect the interests of the WPA. Whether that data gathering is achieved through the applicant's peer reviewer, through "piggybacking" on the BOH's Nobis consultant, or whether the Commission seeks town funding for its own expert, I think it is essential to understanding the degree to which this new project design has the potential to adversely affect the interests of the Act.

Lastly, just a few more implications of the adverse impacts from the new design worth considering are:

- If one can conclude that there is an impact to the adjacent wetland, it's relevant to ask whether some portion of those wetlands lie within the Zone II wellhead protection area discussed in previous hearings (see Appendix B).

- If the applicant obtains a Title 5 septic permit, there is a "presumption" in the Act that the interests of the Act in regard to adjacent wetlands will be protected. As peer reviewer Lenore White said, however, the presumption can be overridden when sufficient, rigorous evidence is presented to contradict it. I believe there is the beginnings of this in my analysis

- While the wells have been moved out of the septic plume's direct path, given the potentially dramatic levels of nitrogen loading, wells adjacent to these wetlands may still suffer from nitrogen contamination when the overloaded wetland begins leaching nitrogen that it cannot either uptake vegetatively or denitrify.

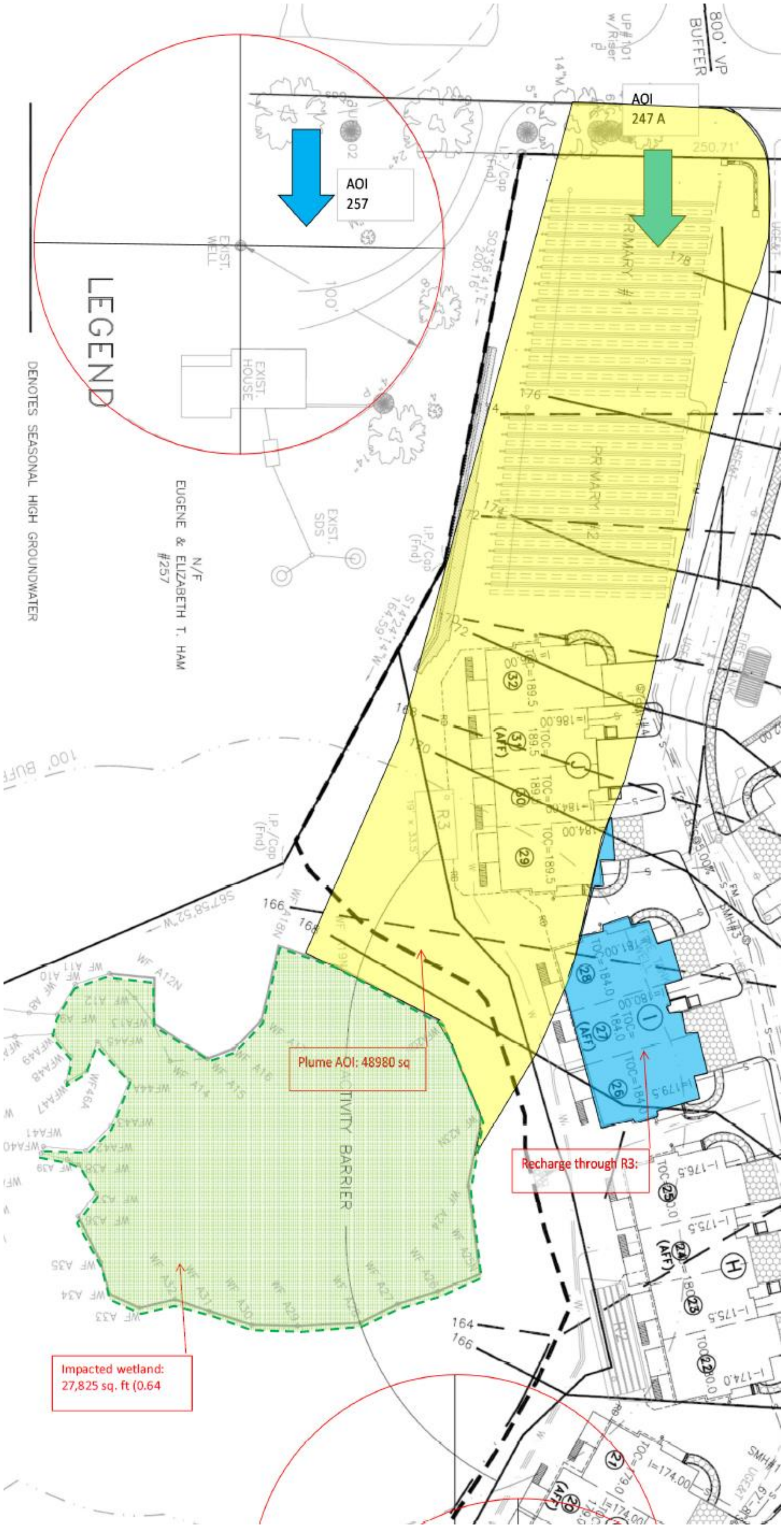
References

Bobbink, R., Ashmore, M., Braun, S., Flückiger, W., & Van den Wyngaert, Isabel JJ. (2003). Empirical nitrogen critical loads for natural and semi-natural ecosystems: 2002 update. *Empirical Critical Loads for Nitrogen,* 43-170.

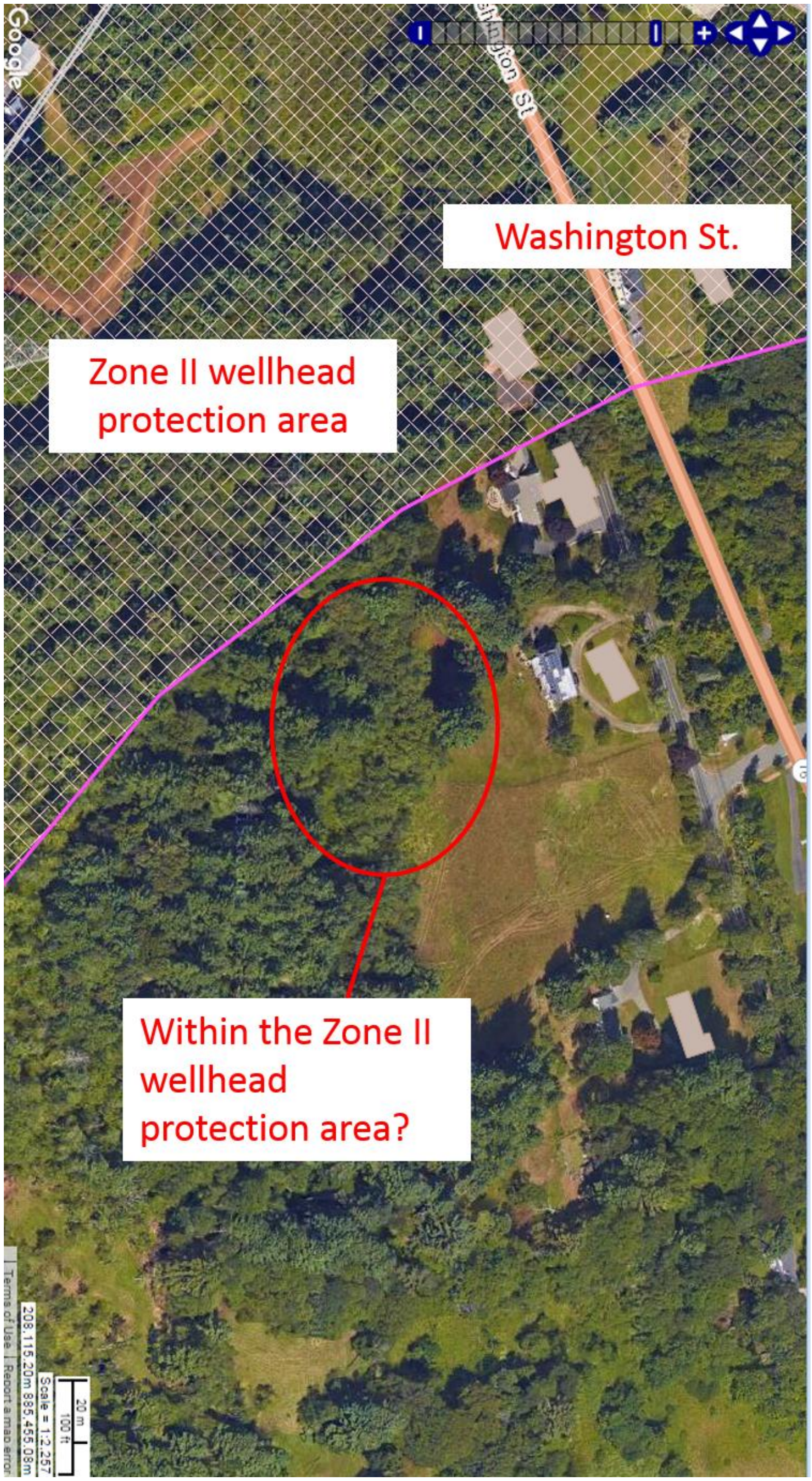
Pardo, L. H., Fenn, M. E., Goodale, C. L., Geiser, L. H., Driscoll, C. T., Allen, E. B., . . . Clark, C. M. (2011). Effects of nitrogen deposition and empirical nitrogen critical loads for ecoregions of the united states. *Ecological Applications*, *21*(8), 3049-3082.

Verhoeven, J. T., Arheimer, B., Yin, C., & Hefting, M. M. (2006). Regional and global concerns over wetlands and water quality. *Trends in Ecology & Evolution*, *21*(2), 96-103.

Appendix A


AOI
247 A
AOI
257
LEGEND
DENOTES SEASONAL HIGH GROUNDWATER
N/F
EUGENE & ELIZABETH T. HAM
#257
EXIST.
HOUSE
EXIST.
WELL
EXIST.
SDS
PRIMARY #1
PRIMARY #2
800' VP
BUFFER
100' BUFF
Plume AOI: 48980 sq
Recharge through R3:
Impacted wetland:
27,825 sq. ft (0.64
ACTIVITY BARRIER

Appendix B


Washington St.
Zone II wellhead
protection area
Within the Zone II
wellhead
protection area?