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EFFECTIVE, AFFORDABLE, AND SUSTAINABLE SOLUTIONS FOR LAND & WATER ENVIRONMENT

March 8, 2024

To: Mr. Richard S. Novak, Chair
Sherborn Zoning Board of Appeals
19 Washington Street
Sherborn, MA 01770

Re: Farm Road Homes 40B – Compendium of BoH Determinations, Comments, and Recommendations Regarding Public Health Requirements

Dear Mr. Chair and Board Members:

Creative Land & Water Engineering, LLC (CLAWE) has received and reviewed the comment from Sherborn BoH dated February 26, 2024. This letter provides our responses. To facilitate the review, we will quote the Reviewer's comments first in *italics* and follow-up with our response in red. This response is mainly to address the comments on septic system issues.

Introduction

Conditional decisions, identified outstanding needs, recommendations based on the information available are organized as follows:

- *Public versus Private Water Supply Issues*
- *Private Water Supply Compliance Determinations and Recommendations*
- *Septic System Issues*
    - *Room/Bedroom Review*
    - *Incomplete Information*
    - *Current Status of Compliance Determinations*
        - *Title 5, including mounding analyses and nitrogen loading analyses*
        - *BoH Regulation I*
- *Other BoH Regulations*

WATER SUPPLY ISSUES

Public Versus Private Water Supply

While the Board of Health (BoH) recognizes that the private wells as presented to the Massachusetts Department of Environmental Protection (MassDEP) do not meet the thresholds or characteristics that would *mandate* categorization and regulation as public water supplies (PWS), the BoH recommends that a PWS be established for this project. Reasons for this recommendation include:

- This project represents an atypical density of both water withdrawal and septic discharges on a *relatively* small property.

- The total potential population of 152 persons served by on-site wells is significantly above the 25-person threshold for a PWS.

- The residential nature of the project means that constant and reliable water supply is critical. Should there be problems with the water supply (whether for all or part of the project), residents do not have the secondary option of a municipal supply and the density of development on the site complicates the addition of future replacement wells.

- In the setting of private wells with multiple owners, residents lack a formal process to collectively identify, troubleshoot, and remediate problems as they arise. A PWS would provide residents the oversight, information, and fiscal mechanism needed to ensure a safe and reliable water supply. None of these safeguards exist in the setting of private wells, typically owned and maintained by one party, and would need to be created by future Farm Road Homes residents, which is particularly burdensome.

The Applicant's reasoning for a private well approach, with multiple wells each serving from 18 to 24 persons, includes that this approach is:

- environmentally preferable as the project's wells can be farther from: (i) the septic effluent discharge and (ii) existing neighboring wells;
- less costly than a PWS; and
- not as difficult to locate on the property as would be a PWS.

BoH assessments of those points are summarized in this document.

Advantages of a PWS

- ***Resiliency*** -- A network of wells offers:
  - redundancy of resource access;
  - operational adjustment options during maintenance work, repair efforts, or other issues for individual wells in the network (e.g., temporary off-lining of an individual well, preferential use of certain wells according to high and low water seasons); and

    - the ability to consider well yields in the aggregate, rather than each individual private well needing to always fulfill the demands of the homes to which it is assigned.[1]

- ***Economies of Scale***:
    - Sampling is most often performed at a single distribution point rather than every well, as would be the case for separate private wells. Periodically, raw water samples from individual wells are drawn, which can be informative about which wells in the network are optimal for use at any given time. Certain sampling is done at multiple points in the distribution system (e.g., for lead and copper, see Attachment A).
    - PWS shared operation and maintenance responsibilities under MassDEP's guidance/requirements for establishing funding mechanisms for such.
    - If ever required, a PWS offers the option of consolidated treatment systems rather than duplicates on individual wells.
    - A local PWS offers frequent groundwater quality information that can be of value to nearby residents (i.e., PWS analytical results for quality parameters are readily available at www.mass.gov).

- ***Efficiency of Oversight:***
    - The existing systems of MassDEP create efficiency throughout the process.
    - Requiring similar oversight through a Homeowner's Association is not logistically practical, and no mechanisms exist through the BoH.

Technical Feasibility for a PWS

Being a PWS does not mean that a single well must be the source of the water. MassDEP permits the combining of multiple wells' outputs into one PWS. Furthermore, a collection of wells providing water to a PWS need not all feed into the supply at the same time, but MassDEP looks for at least 3 wells to be operating at any one time. Wells not routinely needed to meet demand can serve to meet the requirements for back-up or alternative supply. [2]

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[1] Constant fulfillment of that need may be complicated when nearby wells share bedrock fractures and exhibit preferential draw by one well over another.

[2] 310 CMR 22.21(3)(a): Any person who obtains Department approval for a community public water system that relies entirely upon groundwater sources shall provide additional wells, wellfield, or springs and pumping equipment, or the equivalent, capable of producing the same volumes and quality of water as the system's primary well, wellfield, or spring at all times, or shall provide the storage capacity equivalent to the demand of at least two average days if approved by the Department, unless an interconnection with another public water system has been provided which can adequately provide the quantity and quality of water needed.

A network of smaller wells (sometimes referred to as a well-field) may offer the following advantages:

- Locating wells can be less complicated (and offer more potential to optimize technical aspects) than associating specific residences to ownership and control of the well's access route.

- Instead of the uncertainty of variable yield rates from each individual private well, in a PWS network the high producers can supplement lower producers, reducing uncertainty at the overall project level.

- Since PWS criteria are met by combining the individual wells into a single point for distribution, one main line from a PWS is possible rather than crisscrossing distribution lines from multiple wells. As a result, site infrastructure layout can be more flexible and likely simplified. This will help with the required separation distances from water supply features to various other aspects of the project's structures and utilities. It will also help with future system maintenance activities.

- "*Zone Is of wells, whether bedrock or overburden, are allowed to overlap.*" [per MassDEP Drinking Water Program, Northeast Regional Office, 1-8-2024]

- PWSs do not necessarily require one large Zone I radius.[3]

A rough illustration of a multiple-well PWS layout at the Farm Road site is presented below. It is not proposed as a required or even recommended layout. Instead, it merely demonstrates that alternative layouts may be possible.

Note that no attempt was made to alter currently proposed site plan features and thus the layout example works around them. At this stage of the project there is the ability to vary site plans significantly to accommodate alternative options, given that there is no new infrastructure yet.

Also note that having the Zone I's (the protective circles around each well) extend onto adjacent Town conservation land would require a formal agreement with the Town for compliance with MassDEP requirements for protection of PWS integrity.

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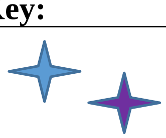
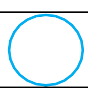
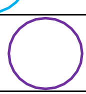
[3] "For wells going through the Source Approval process, if two or more wells are located within 50 feet of one another, then the Zone I radii will be based upon the combined approved yield of the wells and will be assigned to each well in the group. If one or more of the sources going through the Source Approval process are located at a distance greater than 50 feet from any of the other sources, then MassDEP will determine which wells, if any, are to be assigned combined yields. Wells that are not assigned a combined yield will be assigned a Zone I radius based upon the approved yield for each individual well." [per MassDEP Drinking Water Program, Northeast Regional Office, 1-8-2024]

Multi-Well PWS Layout
(for purposes of concept illustration only)

Key:

	**Wellheads (roughly 60 to 80 feet apart between adjacent wells; the adjacent blue and purple wellheads are intended to show mutually exclusive options)**
	**Zone I that can support supply volume that aligns with the minimum 125-foot protective radius**
	**Zone I with a 180-foot protective radius (i.e., can support a pumping rate in gpd equal to approximately 225% that of the 125' protective radius)**
Solar	**Location of a possible solar array**
not to scale; based on an excerpt from a CLAWE plan, with only the elements noted above added; extensive site reconfiguration is not a BoH duty – this is a concept illustration	

Financial Feasibility of a PWS

Examples of Existing Viability for VSS PWSs

The following are examples (by no means exhaustive) of existing, Community (i.e., residential) PWSs in Massachusetts. Since they all serve populations of 500 or less, they are classified as very small systems (VSS).

Given that certain costs are somewhat fixed regardless of VSS size, such as those for permitting, operator services, and laboratory analyses for quality, the costs are apparently not prohibitive for populations as little as 20% of the size of Farm Road Homes.

Very Small System PWSs in Massachusetts		
Town	**Population**	**Name**
Colrain	28	Foundry Brook Association
Mendon	31	Mendon Housing Authority
Hubbardston	40	Silverleaf Hollow Condominiums
Hubbardston	40	Briarwood Townhomes
Hubbardston	40	Hubbardston House Apartments
Berlin	48	Northbrook Village Ret.
Brimfield	60	Brimfield Housing Authority
Granby	61	Granby Housing Authority
Grafton	64	Laurel Hill Condominiums
Berlin	80	Northbrook Village II
Boxborough	80	Liberty House Condominium
Sunderland	88	Pond Ridge Condo Assn
Belchertown	107	Sports Haven Mobil Home Park
Mashpee	112	Beechwood Point Condos
Upton	118	Cobblers Creek Condominiums
Carver	120	Meadow Woods Mobile Home Park
Lancaster	120	Lancaster Woods Condominiums
Brookfield	123	Nanatomqua Mobile Home Park
Stow	132	Arbor Glen Condominiums
Brimfield	137	Meadowbrook Acres Mobile Home Park
Tyngsborough	150	River Crossing Condominium
Granby	152	Granby Heights Condominiums
Hancock	160	Beaver Pond Meadows
Cheshire	180	Berkshire Estates
Mashpee	222	Sea Oaks Condominiums
Source: www.mass.gov website, database of PWSs, January 2024		

Existing examples of PWS financial viability in Sherborn include:

- Woodhaven – 24 units, senior rentals, reasonable rents;
- Leland Farms – over 50% of the units are affordable; and
- The Fields at Sherborn - another 32-unit 40B.

According to residents of The Fields at Sherborn, an average monthly fee for *both water and septic system management* is approximately $100. Fees are assessed from metered water usage volume per residence. The collection of fees is intended to cover on-going operation and maintenance expenses and to build up funds to cover periodic repairs or other special future needs of the systems.

The financial viability of the Woodhaven and Leland Farms PWS situations was questioned, given the on-going efforts to modify the systems there. According to Sherborn's DPW Director and a representative from WhiteWater (the firm responsible for operating these PWSs), the circumstances of current expenditures are unique to their situations and largely result from:

- the age of Woodhaven's plumbing, which was installed prior to regulations restricting the use of leaded solder;
- the downtown location and associated groundwater conditions;
- pH adjustment equipment to manage lead and copper leaching; and
- significant efforts for combining systems that had not been combined originally.

The last circumstance carries a cautionary message regarding cost challenges to future residents at Farm Road Homes if individual private wells must later be merged into a PWS to address some of the resiliency, preferential draw, or other technical issues noted under "Advantages of a PWS".

Installation Costs

Given that the wells currently proposed could be readily used for a PWS, the installation costs are not necessarily different, other than as any one well's costs could differ from another's depending on the conditions encountered.

Pump Testing Costs

For PWSs, MassDEP requires extended pump testing and monitoring of nearby existing wells for assessing broader impacts of the proposed withdrawals. For recent larger projects with shared wells, the BoH has implemented similar requirements. Thus, the costs would be similar.

Permitting Costs

According to current MassDEP's current fee structure for the permitting process, and assuming that the total volume of the residential development's water supply is under 70 GPM, the listed permitting fees for New Source Approvals are $1,380 for permit WS13 and $1,585 for permit WS15. MassDEP has indicated that it generally allows multiple wells to be permitted within a single approval process, as it did for The Fields at Sherborn. Just as well plans would need to be developed by a professional and provided to the BoH for review, a comparable effort would be needed for preparing submissions to MassDEP.

Management Costs

PWSs must be overseen by a MA-certified water supply operator:

- Most VSSs contract with a firm that can provide certified water system operators who periodically check on the system to ensure proper functioning.

- At a minimum, certified water supply operators shall conduct monthly on-site inspections unless specifically exempted in writing by MassDEP.

- MassDEP estimates that a minimum of 6-hours of documented on-site operation per year and a minimum of 12 hours of documented total operation per year are necessary to perform the typical certified water supply operator duties. Operator demands for VSSs are generally less than for larger systems.

The operators perform sample collection and submittal to a certified laboratory for analyses according to a schedule established by MassDEP (see attachments for a sample schedule):

- An appropriate list of quality parameters is identified by MassDEP for the specific PWS' circumstances.

- Certified laboratories are able to automatically upload the data to MassDEP, where it is checked for compliance and, when applicable, outreach about non-compliance is made. Laboratories alert the PWS owners and operators about any quality parameters that do not meet drinking water standards.

Annual reporting about the PWS must be made to MassDEP:

- Reporting can be done via an on-line system.

- Once initial information is entered (such as details about system ownership, contacts, location, size, design, features, risks), subsequent years require updating of information for the reporting year, such as withdrawal volumes for each well, changes to the system, etc.

- Selected information is also provided to all residences associated with the water supply via a Consumer Confidence Report, which is usually prepared by the contracted certified operators according to templates provided by MassDEP.

Private Water Supply: Compliance Determination

The Board reviewed the well information presented on the Septic plans relative to Sherborn well location regulations. All seven proposed wells meet the required setbacks from the SAS, property line, and distance from abutting wells.

Wells #1, 6, and 7 do not meet local setbacks of 55 feet from the edge of a traveled way or 50 feet from the edge of a right of way (II.6.0). These wells are not adequately protected from traffic or snow plowing, and should be relocated farther from the traveled way. Alternatively, but less optimal, plans for the protection of each of these wells shall be provided for review and approval.

Wells #2, #5, and #7 serve 24 people each, which is the maximum allowed to comply as private well. Any additional bedrooms in the units the respective wells serve would trigger the need for a PWS.

In the event the water supply is determined to be private, the Board recommends that all the Sherborn Board of Health Water Supply Regulations be followed, including well location, construction, quantity and quality performance standards.

Private Water Supply: Recommendations

Relocation of Well #7

Flooding in January 2024 rose to the location of Well #7 at 217-foot elevation. Submerged well heads risk contamination from surface water. The well shall be relocated above the 100-year flood plan.

PFAS6 Testing

If the projects water is supplied by private wells, all wells shall be tested for per- and polyfluoroalkyl substances (PFAS) at the time of well establishment to maintain the same stringent water quality standards of a PWS. Given the project is intended for families, and the greatest risks from PFAS chemicals is cumulative exposure over time, future owners should have knowledge of their potential health risks and be given the same protections as members of a PWS or other new construction in town.

PFAS6 testing should be done in accordance with Sherborn Board of Health Regulation II, Section 17.3. This includes a deed recording in the event levels are detected above the Massachusetts Maximum Contaminant Level (MMCL) of 20 ppt and subsequent treatment system installed for each unit the affected well serves.

The Board recognizes a site-specific risk for PFAS contamination at 65 Farm Road. In August 2015 a large barn fire occurred at the site, where the Sherborn Fire Department received mutual aid from four abutting communities. Given the high prevalence of per- and polyfluoroalkyl substances in firefighting foam, there is a real risk that groundwater was contaminated at this site as a result of the fire. As such, PFAS testing upon project initiation is highly recommended for the protection of future project residents.

Pump Testing

Private water supply wells shall be installed prior to any building construction to ensure sufficient water quantity. Well installation shall not be phased, as it affects the accurate determination of both quantity and quality. All on-site wells shall be pumped simultaneously for a minimum of 48 hours and possibly longer, subject to dynamics observed during the first 48 hours. The BoH agent shall be permitted to witness the testing.

The Applicant shall contact abutters and offer to monitor their wells during the pump test, at the Applicant's expense. It is the choice of the neighbors to grant or not grant permission.

Prior to performing the extended pump-test, the applicant must provide to the Town a *Pump Test Plan* for review that includes:

1. Measurement method for determining pumping rate
2. Location the pumped water will be discharged and methods to maximize reinfiltration in a manner that does not interfere with the pump testing
3. How water levels in the pumped wells will be monitored
4. Identify neighbors participating in monitoring
5. Plan to assure that bacteria and other contaminants are not introduced into the neighbors wells during monitoring
6. How long water levels will be measured before and after pumping
7. Method for analyzing the water level data
8. Contingency plan if any of the on-site wells interfere with each other OR with neighboring wells

Response: The Farm Road Homes has addressed the water supply issues in meetings and in writing:

1. The private water supply is chosen based on the overall land ownership and the best setting to avoid direct impact between water supply wells and the common septic system.
2. The applicant has obtained a DEP confirmation that the private water supply layout.
3. The water supply wells as in diversified location will have less impact for their relatively smaller drawdown zone.
4. The local aquifer showed consistent productivity based on the near wells at 49, 53, 55, which showed consistent 10 gpm yield.
5. The private water supply well can be monitored and tested in more flexible and effective ways through consistent approval condition and ownership oriented interest based approach.

SEPTIC SYSTEM ISSUES

Room/Bedroom Review

The Board reviewed the floor plans presented in "Architectural Design Plans" dated 7/6/23 for the four proposed unit configurations. All floor plans comply with both Title 5 and Sherborn regulations regarding room count and bedroom count. The floor plans for each unit lack a depiction of the basement and attic space, and are assumed unfinished, but this has not been confirmed by the Applicant. Basement and attic spaces have not been included in the room count review. In order to comply with bedroom count under Sherborn regulations, unfinished spaces in each of the units shall not be finished into bedrooms and any finishing of the spaces, now or in the future, must first receive Board review and approval.

If floor plans change, the Board reserves the right for additional review.

Specific comments for each of the unit floor plans follow below:

3- Bedroom Front-Loaded Unit

The 2nd floor office space is less than 70 sqft, which is the minimum square footage for a Title 5 bedroom. To not be considered a bedroom, the square footage of this space shall not be made greater than 70 sqft.

Response: It is confirmed that this place will not more than 70 sf ft.

3- Bedroom Rear-Loaded Unit

Plans depict a 2nd floor loft, which appears to have a half-wall at the stairwell. This should remain a half-wall, to prevent future conversion of the loft space to a bedroom.

Response: It can be conditioned in addition to agreed deed restriction on total bedroom numbers to be recorded.

The 2nd floor office space is less than 70 sqft, which is the minimum square footage for a Title 5 bedroom. To not be considered a bedroom, the square footage of this space shall not be made greater than 70 sqft.

Response: It is confirmed that this place will not more than 70 sf ft.

External elevation renderings show a space above the garage, which is presumed unfinished, and therefore not considered in the Board's room count review. Confirmation the space is unfinished would be appreciated.

Response: It is to confirm that this place will not be finished as qualified as a bedroom.

2- Bedroom Duplex Units

External elevation renderings show a space above the garage, which is presumed unfinished, and therefore not considered in the Board's room count review. Confirmation the space is unfinished would be appreciated.

Response: It is to confirm that this place will not be finished as qualified as a bedroom.

2- Bedroom Cottage Units

No additional comments.

Septic Plan Review

As of the morning of February 26, 2014, a response has not yet been received for the February 16, 2024 letter sent by the BoH to the Applicant regarding the status of the Farm Road Homes' septic plans. The letter identifies:

- Information deficiencies remain for the plans, including but not limited to:
  - data not appropriately and/or accurately presented (e.g., refusal encountered in deep observation holes, clarification of details about application of the Frimpter method to groundwater adjustments for historic high elevation determination); and
  - vertical profiles that are missing for groundwater and for system components.
- Several septic design features are not in compliance with Title 5, including but not limited to:
  - the maximum allowed soil covers over the septic tanks, pump chamber, and the soil absorption system have been exceeded; and
  - issues that might be resolved once information deficiencies are addressed.

Further details can be found in Attachment C's copy of the Agent's Deficiency Letter.

Response: See our responses to the BOH agent February 16, 2024 letter. Our data in groundwater and soil texture were confirmed to be consistent with our field notes and independent laboratory soil sieve analysis. This was fully discussed at the March 6, 2024 hearing.

Groundwater Mounding Analyses

The Board has not yet had the benefit of the Peer Reviewer's input regarding groundwater mounding analyses. Current concerns arise from:

- possible misapplication of data;
- the lack of transparency around methodologies and inputs; and
- insufficient information for the Peer Reviewer to perform a thorough evaluation.

A key example of ***data misapplication*** involves percolation test and sieve analysis results being used in place of saturated hydraulic conductivity investigation. The purpose of percolation testing (or sieve analyses) is to determine whether septic effluent entering the soil absorption system will be able to infiltrate the soils immediately around and below that system readily, without causing back-up into the pipes, distribution chambers, beds, etc.

Groundwater mounding analyses, whether for septic systems or stormwater infiltration methods, seek to predict how the discharge of a large amount of fluid onto/into the ground will move downward to the overburden's groundwater surface (aka, water table - the upper surface of the zone of saturation) and cause a localized mound on the water table. The mounding results from a combination of the discharge rate, saturated condition of soils below the water table, and the types of soils encountered along the way and the speed with which fluid can move through them.

MassDEP's Stormwater Handbook notes that "***A Title 5 percolation test is not an acceptable test for saturated hydraulic conductivity. Title 5 percolation tests overestimate the saturated.***

Response: 1. We had a meeting with the peer reviewer and the BOH agent regarding how to approach the groundwater mounding analysis, specifically, discussion on mounding computer model, how to determine the aquafer depth and hydraulic conductivity as we discussed in our response to BOH agent 2/2/2024 letter in the supplementary part. The BOH "possible misapplication of data" was a total misunderstanding of our study for the following reasons:

a. Regarding percolation rate, for the same soil condition, many researchers have demonstrated that hydraulic conductivity is closely correlated with percolation rate. [1]
b. The agent has witnessed all the soil testing and monitoring related to septic design in deep hole soil evaluation, water table monitoring, and soil sampling for soil texture determination. The groundwater table in the southwest part of the site is deep and consistent. Surficial geology showed overall in this area soils are fairly clean loamy sand to sand condition that was confirmed with six (6) soil samples throughout the site not just the SAS area that was tested by a third party DEP certified laboratory. See testing report for details attached to our Feb 2, 2024 letter to address BoH Agent comments. It is updated and attached to this letter for easy reference based on the hearing on March 6, 2024.
c. The hydraulic conductivity data presented in our supplement are honest reporting of what we agreed to do per the peer review meeting consensus. The highly variable is expected from academic and reality perspectives:
    1) Soil conditions in reality can be very complex and a scientific based judgement call have to be conservatively made for all parameters related to the design by the design engineer with review peer's consensus.
    2) The design uses percolation rate and soil texture for effluent application rate. The soil samples were taken as shown in our field note at the depth of 5-6 ft which will determine the unsaturated treatment before reaching groundwater zone. This depth is in full compliance with Title 4 ft as well as the town 5 ft groundwater separation zone with 1 ft conservative safety board.
    3) Through our soil testing and monitoring, we know in the SAS area the groundwater is deep down at an elevation of 1 or 2 ft above the downgradient wetland more than 100 ft away, so the slope of the groundwater is mild with the land rises 15-20 ft. As all soil scientists and hydrogeologists can tell by training and groundwater hydraulic principle, for the milder of groundwater slope the more permeable the soil would be per Darcy's Law that governing the groundwater flow.
    4) Soil has different vertical and horizontal hydraulic conductivities in most non-homogeneous or heterogeneous soil. horizontal permeability (Kh) normally is significantly (10 times) higher than the vertical permeability (Kv). The percolation tested rate may count for 1/3 of vertical and 2/3 of horizontal value due to its test setting. If assume Kh = 5Kv, the percolation test result may be only 70% of the horizontal Kh. So it is conservatively used to estimate hydraulic conductivity.

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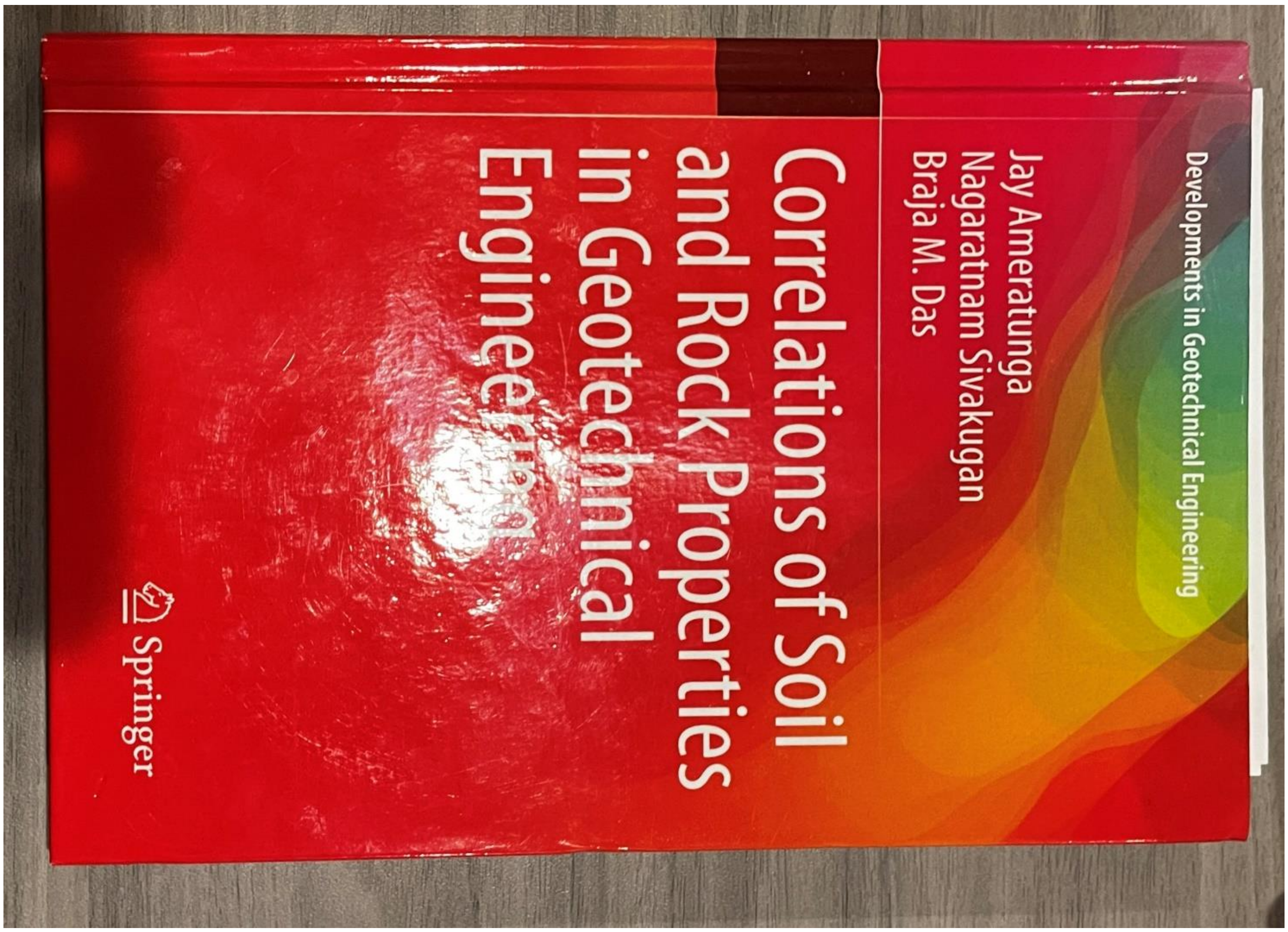
[1] Wang, D.S. (1999) "A simple mathematical model for infiltration BMP design," presented at the 4th USA/CIS Joint Conference on Environmental Hydrology and Hydrogeology, November 7-11, 1999, and published in *Hydrological Science and Technology*, American Institute of Hydrology, Vol. 15, No. 1-4

5) When we chose the Kh for our groundwater mounding analysis, we referenced the average typical value for the soil type we found in the field based on a industry standard not the percolation test. However, the percolation test result is a good confirmation and showed more or less the Kh we used is in line with the lowest percolation rate of 5 mpi (24 ft/day). The typical silty sand Kh would be 28 ft/day. The groundwater mounding is determined by the overall average Kh not the slowest Kh. So, we are very conservatively applying the Kh value in our analysis. As we have percolation rate tested at 3 mpi (2 tests) and 4 mpi (2 tests) and only one at 5 mpi. We also had a percolation test done close to the weathered ledge in DTP 65-10D showed percolation rate less than 2 mpi.
6) When we talking about the saturated aquifer depth here, we included the SBOH required correction on the observed high groundwater table during high groundwater season, which is another safety factor that had been inlcuded in our design. We used actual observed groundwater in the SAS area and applied the correction as agreed by the BOH earlier and practiced in our agreement and in consistent with BOH review for other projects. We also checked our analysis with the assumption that any dry test pits has a high groundwater at the bottom of the test pits plus the groundwater correction on top of the bottom of the dry pits. This would make the groundwater a few feet higher but also make the saturated aquifer depth a few feet higher. In our analysis, we kept the same depth of the aquifer depth while used higher groundwater using the dry test pit depth for groundwater, which is another safety factor in our design.
7) The Groundwater mounding is calculated with Hantush model, which assumes that the groundwater is level and can extend infinite. Therefore, the groundwater aquifer condition (initial depth Ho, Kh) impacting the mounding is not only determined by the underneath of the SAS field but also by the Ho and Kh further away. As we showed using three well drilling logs at 49, 53, and 55 that the aquifer depth become thicker towards the west where the groundwater is flowing. By using the value at 53 Farm Road that is in line with the SAS physical location and geological setting is a relatively conservative approach.
8) Another reality fact is that, groundwater will not stay in ground forever and stay the same height as in high groundwater season. When groundwater travels downstream, it will break out in streams or wetlands, then groundwater merge to surface water, under normal groundwater mounding simulation, the downstream breakout will be the control boundary condition and groundwater will not get any higher at that point. This is just a simple principle of groundwater hydraulics. During growing season, when vegetation takes more water than the rain, groundwater table will start drop to supply the plant growth need until the end of the growing season. Things can vary a little year to year due to the rain and temperatures. Given this condition, it is almost impossible to really test the full "saturated" aquifer Kh on top of the changes in space and in depth. A limited well testing will hard to test the right Kh and Ho. Some safety factor in picking the Ho and Kh is added in the engineering design practice as we discussed above.
9) At our site, it is understandable that the groundwater flowing downstream towards the wetland and the aquifer in that direction would be more relevant in our engineering judgement. Therefore, we find out the aquifer depth in the well drill logs for 49 and 53 Farm Road, which was drilled in October 2005 and November 2021, respectively. The similar elevation and conservative depth of the aquifer at 53 Farm Road was used with 2 ft correction given in relative low groundwater season to come to the 14.5 ft Ho in the model. It could be more if large correction used. It is

agreed by the peer reviewer to use 2 ft and we believe it is a conservative approach.

10) While we tested the soil texture, at the downgradient, the soil was tested medium sand. The average Kh could be 153 ft/day for average sand condition. As the soil in the upper limit turned out fine medium loamy sand, we stick to the 24 ft/day for our mounding analysis, which again is conservative.
11) As we explained above, there will be no method can fully capture the exact Kh for the maximum Ho as it will be impossible to do the well testing at the historic high groundwater the BOH is requesting for design. The Kh and Ho used is more than reasonably and conservative for the site condition based on our two years of over 47 soil testing and ground water monitoring with the testing in SAS area witnessed by the BoH agent. The data is coming out very consistent with the well drilling logs in this area.



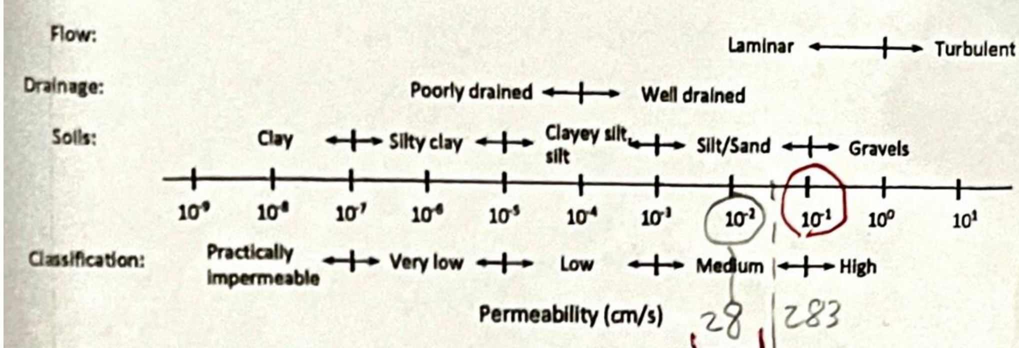


Fig. 2.8 Typical values of permeability

2.6.3 *Reynold's Number and Laminar Flow*

Figure 2.8 can be used as a rough guide for the flow (laminar or turbulen drainage (well or poorly drained) characteristics of the major soil groups, a ranges of their permeability values. A simple classification based on permeabi suggested by Terzaghi and Peck (1967) is also shown. Reynold's number R flow through soils can be defined as

$$R = \frac{vD\rho_w}{\mu_w}$$

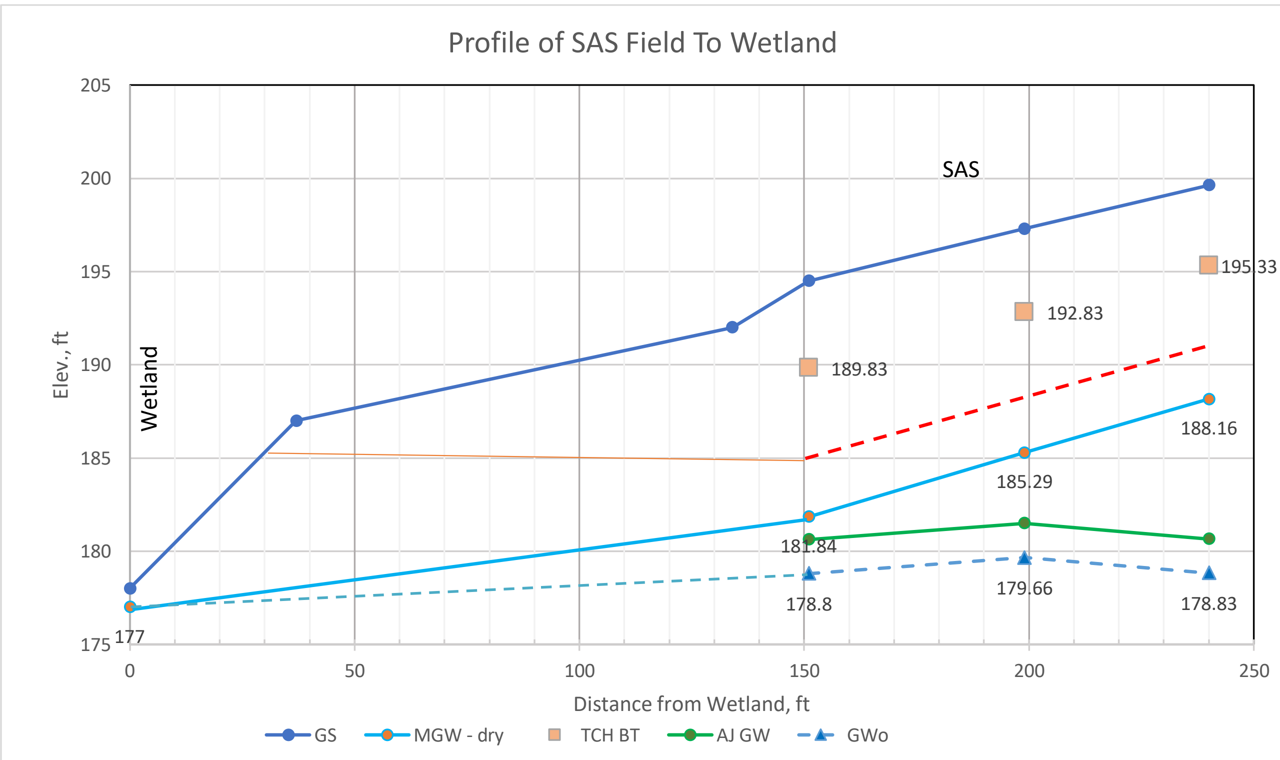
where v = discharge velocity, D = average diameter of the pores, ρ_w = den water (1000 kg/m^3), and μ_w = dynamic viscosity of water (1.002×10^{-3} N which is also known as the *absolute viscosity*. The ratio μ_w/ρ_w is the kin viscosity of water. Muskat (1946) and Scheidegger (1957) discussed the experimental work that has been carried by several researchers out to dete the limiting value of R beyond which the flow will not be laminar and D'Arc becomes invalid. It appears that $R = 1$ can be taken as a conservative estimate through coarse sands and gravels is generally turbulent. In computing Re number from Eq. (2.30), D is sometimes taken as D_{10} or the average grain dia

2.6.4 *Anisotropy*

The permeability of cohesive soils can be *anisotropic*, where it is generally la the horizontal direction than in the vertical direction. In special case o deposits, the vertical permeability can be larger than the horizontal perme (Harr 1962). The ratio k_h/k_v reported in the literature is generally less thai most soils. Fukushima and Ishii (1986) showed that for a weathered g compacted at different water contents, this ratio to be quite high, som exceeding 10. In varved clays and stratified fluvial deposits, this ratio can exceed 10 (Casagrande and Poulos 1969; Tavenas and Leroueil 198 et al. 1978). Some anisotropic behavior of natural clays reported by Taven

***hydraulic conductivity rate.*"** Using CLAWE's method, the actual mound will most likely be higher than predicted by that method. A problem with this could be that if, for example, the mound rises to the bottom of the soil absorption system, surface breakout of minimally treated septic effluent and/or compromised bacteria and virus reduction due to the lack of a drying out period (which promotes die-off) are more likely.

Response: As we explained above, there will be no possibility that the groundwater mounding will be breakout between the SAS and the wetlands, which is located at 108 ft away and far exceed the DEP Title 5 50 ft wetland setback requirement. Given that we have so much more ground water separation here in addition to our conservative approach in choosing calculation parameters, if the groundwater mounding height is 3 or 4 times higher than we calculated, we do not see the mounding can get to the bottom of the trench to cause breakout as demonstrated in the following chart which present a profile drawing from the wetland to the SAS area.



The bottom line is the observed high groundwater table based on observable water in some wells in the area. Adding Frimpter adjusted of 1.83 ft will get us to the second line from the bottom in the SAS area. Third line from the bottom is the water table using the bottom of the dry pits plus the groundwater mounding height (0.91 ft) and adjusted water table of 1.83 ft, which is still more than 7 ft below the bottom of the trenches as show as orange square. The top line is the ground surface profile. As a wild testing if we add another 3 ft mounding height (about 4 times of the calculated value) to the mounding height, we will still have 4 ft of groundwater separation. Then the water will have to flow level for over 100 ft to break out. As we mentioned that DEP only requires 50 ft setback to wetland, it means that the septic is allowed to break out into wetland after 50 ft treatment. This just will not happened here. In addition to the treatment of the I/A as we described above, there will be more than 7 ft of good soil under that leaching field with moderate infiltration rate for good treatment before reaching the underlaying groundwater, which will be filtered out more than 99.99% pathogens if not 100%. The only left will be minor soluble like nitrate to reach ground water before the water will travel laterally downstream. Emerging personal care and pharmaceutical product is not regulated and is a challenging to all the residences that will need to be managed in education and waste handling as the Town is doing well in managing some of those wastes to stop them from entering the wastewater flow. As we agreed, a good education program can be considered for this community with the help of the BOH.

In the photographs below, taken by the BoH Agent during observation of subsurface exploratory activities and sample collection in the vicinity of the proposed soil absorption system with CLAWE (December 2023), the lighter-color upper layer consists of sandy soils. The deeper, darker layers exhibit the characteristics of glacial till, which is less hydraulically conductive than sandy soils. A proper mounding analysis must take into account the soil layers within the vertical profile. There are a variety of acceptable methods for doing so, as indicated by MassDEP's Stormwater Handbook.

Response: The photo took by the BoH Agent can be misleading and was definitely misinterpreted for the following reasons: a) the soil was taken from the bottom of testing hole at 5-6 ft depth not the upper layer as we shown in our filed note, b) the soil was taken out and shown under the sun which changes the color significantly as people can see of the color of leaves on the ground, c) a photo of trees in the light of sun turned dark gray into bright orange similar to the soil photo taken by the BoH Agent, d) soil in our sampling bucket shows gray brown color, d) as shown in all our soil logs, the upper orange color B soil in all test pits were sandy loam, which would not make sense for us to take sample of the sandy loam soil and by miracle turned into loamy sand or even sand. The soil samples were taken in front of the BoH Agent and delivered to Yankee Lab by CLAWE staff and not by myself. The Agent also confirmed that he felt that the sample was taken from about 5 ft which is consistent with our measurement record of 5-6 ft.

In conclusion, it is not to the design engineer's interest or professional calling to take a risky approach for designing the onsite wastewater treatment system like this project. In our 30 years of professional career, we have designed many types and sizes of onsite wastewater treatment system up to 80,000 gpd. We also had experience continuously monitoring groundwater for a 15600 gpd system with similar soil but much shallower groundwater condition. We could not even detect groundwater mounding height more than the groundwater fluctuation noise which used the same groundwater mounding analysis method. In addition to the safety factors in the Title 5 design code like larger groundwater separation than almost all other states, we have done very thorough holistic investigation of the site to address the comments and concerns from the Board and neighbors and factored in even more safety buffer in the design as we discussed above and in our hydrological report and supplementary documents.

Soil samle from the same hole shown above

Soil collected for grain size analysis (sieve analysis). Corresponds to the upper layer in the photo to the right (note color). Sand, loamy sand, and/or sandy loam.

Tree color changes under sun and in shade

Test pit exhibiting a profile with 2 general categories of soil: sandier material (brown hue) near the surface and glacial till (grey hue) deeper.

If the issue of ***methodology transparency*** cannot be resolved with CLAWE, the BoH recommends that all necessary raw data be provided to the Peer Reviewer, who can then use vetted software and/or methods for the septic system's groundwater mounding analyses.

Response: We have shared our field notes as requested. The computer model is also vetted software that the peer reviewer is very familiar with. Some discrepancy in soil texture judgements and large boulders or bedrock were fully discussed at the meeting on 3/6/2024. We addressed the soil texture discrepancy using sieve analysis. The agent also agreed at the meeting that, given the deep soil, even some weather rock present at the bottom of some of the test pits will not impact the design as overall the soil depth is far more than Title 5 and the BoH required. The Frimpter groundwater adjustment had been supplied to SBOH long before the design and will transfer to the plan. The sewer and water crossing will be identified, and construction details will be added to the septic plan. The Notes for water line from well to tank and tank to each unit shut off mechanism will be added to the sewer and well plan. The details have been already added to the Comprehensive plan as we informed the Board at the 3/6/2024 meeting.

Another source of uncertainty for the BoH is that the CLAWE reports contain conflicting information within them, making it all the more difficult to follow the path of assessment. For mounding analyses in particular, sieve (grain size) analyses were performed on a limited set of soil samples and the laboratory results are presented. However, it is unclear how the information was or was not used for assessing hydraulic conductivity and why. There are a range of K-values shown but it seems only one was used – why?

Response: Taking two soil samples were agreed at our work meeting with SBOH agent and the peer reviewer, Peter Delin. The soil samples are taken in consistent with the soil evaluation standard per Title 5 at depth 5 ft to 6 ft. The sieve analysis by a DEP certified laboratory confirmed the conservative end of the soil texture is loamy sand not sandy loam. The analysis using sieving analysis size is just a way to confirm the hydraulic conductivity and was not the only way we used to determine the hydraulic conductivity as we explained above. Therefore, we only see differences in all data aspects not conflicts, it is the job of a designer to take the proper and safe approach to chose the design data in all the different aspects by their training and experience as we explained in detail above to make a complicated issue understandable as we can.

Nitrogen Loading Analyses

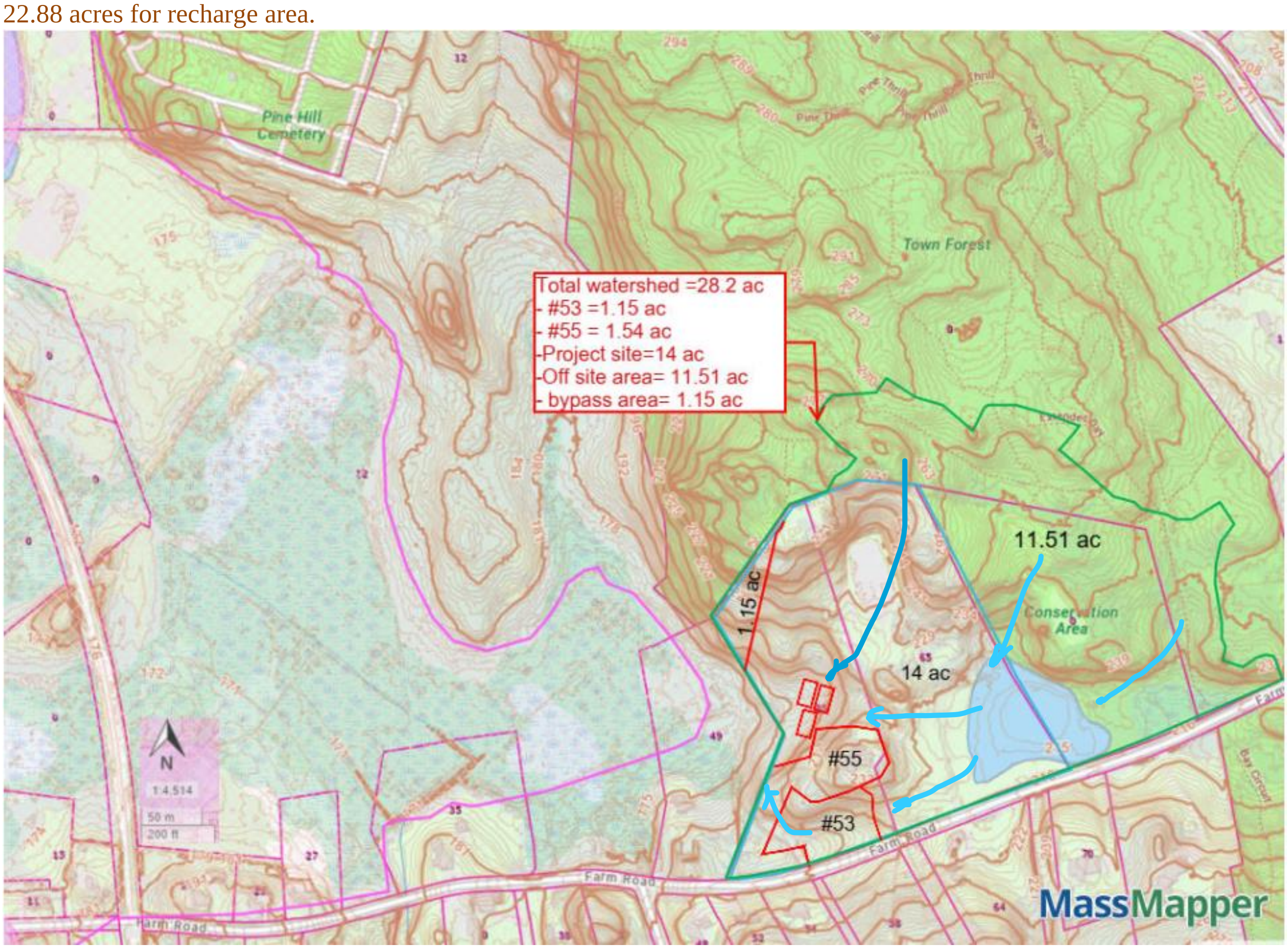
Similar concerns exist for this topic as for the groundwater mounding analyses. There is significant overlap in data types and uses between these analyses.

Significant concerns about the analyses to date make it difficult to draw conclusions about a predicted nitrogen loading situation at this time. This is primarily due to the lack of methodology transparency and the apparent use of use of atypical assumptions about site dynamics. Peer Reviewer evaluation has not yet been received.

Outstanding questions and requests for information include, but are not limited to:

- Has overburden groundwater flow direction been determined by appropriate and sufficient monitoring well readings? A minimum of 3 triangulated points are needed to establish water table slope. Wet and dry season slopes may vary, as found by CLAWE during its testing at The Fields of Sherborn.

Response: As a common phenomenon, groundwater flow is mostly in line with surface water flow, especially in an open valley topography condition as we have in the project site SAS area. See the following drainage map showing a total drainage area with overall flow direction from north and northeast to southwest. The SAS is located in a broad valley with a sandy ground moraine in the middle which hosts 53 and 55 Farm Road. We also have done 39 soil test pits throughout the site See Comprehensive Permit Plan sheets 15 and 16 in addition to the 8 soil testing in the SAA area. With 7 monitoring wells installed per BoH requirement. Using the soil test result and conservative assumption using top of ledge as the highwater if no water is encountered, we generated a high groundwater flow map and attached to this letter for reference. The groundwater flow direction as mapped is in agreement with the surface topography, which is found recharging groundwater towards west. The advantage of the project site is that there is additional 11.51 acres of off site conservation land upstream which provides additonal recharge to dilute the nitrogen concentration with a total of 24.36 acres of watershed to the AOI area. This confirmed that the nitrogen analysis was conservative as it used only 22.88 acres for recharge area.



Updated total water shed map to show groundwater recharge area to the reception boundary of the project site

- Once the stormwater and septic effluent mounding analyses are resolved, the BoH would like to have a project level assessment performed to capture any cumulative mounding impacts of stormwater and septic effluent systems.

  Response: It is our professional opinion that the groundwater mounding has been properly updated to incorporate the peer review inputs and as we explained above the design will provide a large groundwater separation (over 7 ft) with a conservative groundwater mounding height calculated.

- How does the method used for Farm Road Homes compare with those applied by CLAWE, Hydrogeocycle/Beta Groups, and Nobis for The Fields at Sherborn project? Given similarities in septic system size, soils, and climate, what accounts for the significant differences in ***projected nitrogen levels*** at identified receptors? Note the following site-specific distances from the downgradient edge of the soil absorption systems to the primary/nearest identified receptor of effluent plumes:
  - for The Fields at Sherborn, approximately 600 feet to the northern edge of Dirty Meadow Swamp, reached by predicted nitrogen concentrations of 23 to 26 mg/l; and
  - for Farm Road Homes, approximately 150 feet to the property line to the west[4], reached by predicted nitrogen concentrations of 4 to 7 mg/l.

Rsponse: The same engineer used the same method to calculate both The Field and Farm Road Homes site. The major difference between the two is the total recharge watershed size, leaching field width cross the contours, and the distance to the groundwater downgradient boundary at the sensitive receptor with groundwater breakout. For The fields the recharge watershed was about 15 acres and the field was only 80 ft wide across the groundwater flow, and the groundwater breakout at the wetland is 600 ft while the Farm Road Homes has 24 acres of recharge area and the SAS is 170 ft across the groundwater flow, the distance to wetland breakout is less than 150 ft. There are drinking water wells right at the downgradient of the AOI at Fields at that time of study while all drinking water wells are located upgradient of the SAS AOI. In addition, the stormwater recharge at the Fields is located cross groundwater gradient from SAS while The Farm Road Homes has groundwater recharge more uniformly distributed in the upper recharge area to the SAS and funneling down to the receptor (Property line. It is much more environmentally friendly here as no well is located between the SAS and downgradient property line) and a large wetland treatment buffer further down for more treatment. The larger recharge area and the wide spread out across the groundwater flow made the nitrogen concentration lower here at Farm Road Homes.

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[4] The location of the downgradient receptor is not clear; for now it is assumed to be the property line to the west of the soil absorption system.

Making sure that the nitrogen loading analysis is done well for this large source of potential contamination is important. Although nitrogen and nitrogen compounds are not the only contaminants of concern for septic effluent plume impacts to sensitive receptors and down-gradient properties, they are closely affiliated with septic system wastewaters and have been extensively studied. Once appropriate nitrogen loading analyses are performed, nitrogen can be used as a reference point for understanding the transport of other septic contaminants to receptors.

Response: As we explained above, the nitrogen loading to downgradient receptor (property line and wetland) is well considered by careful study of the overall geological setting so that the nitrogen from SAS can be mitigated by as big recharge area as possible with the proper layout across the groundwater flow and uniformly distributed groundwater recharge design. In addition, the I/A used will treated the effluent significantly lower Nitrogen concentration (19 mg/l) than DEP required 25 mg/l for TN. As a result, we expected that the nitrogen level reaching the downgradient receptor will be far less than DEP drinking water standard 10 mg/l. See our response to BoH agent comment dated February 2, 2024 attachment, which is updated with some minor corrections in abutting well logs and septic design flow and attached here for easier reference.

Note that the ***nitrogen reduction*** innovative-alternative (I/A) technology proposed for the septic system at Farm Road Homes does not treat many of the other contaminants found in septic effluent. Thus, while the I/A technology allows for additional density of development due to its potential to meet nitrogen discharge targets, other contaminants are likely to be higher in groundwater with the additional 25% loading allowance granted to users of the nitrogen-reducing

I/A systems.

Response: As required by DEP approval for I/A secondary treatment standard, the I/A will reduce TSS and BOD to 30 mg/l and TN and N-nitrate to 19 mg/l. As many other pollutants are biding to TSS, like TP, the I/A will also remove many other pollutants including TP. Nitrogen removal is just a practical concern reference marker used by DEP to regulate the treatment.

OTHER PUBLIC HEALTH ISSUES

III.3.1 Environmental Health Impact Report
III.14.0 Environmental Health Impact Report – Scope and General Submittal Requirements

These regulations require projects of ten or more dwelling units or a design flows of >2,000 gpd to submit an Environmental Health Impact Report (EHIR). An EHIR shall include the following analyses:

- Geologic stratigraphy
- Determination of groundwater flow directions
- Determination of maximum groundwater elevation
- Evaluation of water table mounding
- Prediction of down-gradient water quality impacts

The Applicant submitted a "Hydrogeologic Evaluations Report" on December 11, 2023, which includes the above analyses. Verification of the input data and evaluation of the methodologies applied is currently under review by the Peer Reviewer and the Board. The Board will consider this requirement fulfilled following receipt and review of the Peer Reviewer's final report.

Response: No response needed. We agree with the BOH on this issue that our hydrogeological study provided the required study by EHIR of SBOH.

III.12.0 Drainage

This regulatory section addresses stormwater management topics. The Applicant submitted an updated version of a "Stormwater Management Report" on February 23, 2024. Further review by the Peer Reviewer is anticipated. The Board considers this stormwater process as a reasonable substitute for its regulations with the exception that it would like the cumulative groundwater mounding effects from stormwater retention/infiltration basins and the soil absorption system SAS to be evaluated, primarily for reasons of predicting septic system performance issues and impacts.

Response: The SAS and the stormwater basin A are located at quite different terrain. Given the short during of the stormwater basin impoundment less than 3 days. The groundwater mounding was checked and will not affect the SAS area.

III.13.0 Earth Removal Standards

On February 23, 2024, the Applicant submitted a letter regarding “2nd Comprehensive Permit Plan Changes”. It contains a “cut and fill analysis” for the septic construction area, multiple stormwater basins, and the well access area, with a net of 10,667 cubic yards being removed. This is noted as potentially impacting the abutting properties and resources. Per 13.1, the threshold for applicability is 350 cubic yards of material per lot or 1,000 cubic yards per project. Existing site documents provide much of the information required by the Earth Removal Restoration Plan and the Board does not recommend duplication of information.

Standards specified by 13.2 are important for public health and groundwater protection and are recommended for this project.

Response: Per BOH regulations III 3.2, the proponent team has provided required hydrogeological study of the site for the proposed onsite wastewater treatment soil absorption system (SAS) design. The soil removal is due to the need of construction of septic and stormwater management and all associated infrastructure with adequate soil testing according to the current applied Title 5 and DEP stormwater management regulations and handbook. It applied the state-of-the-art technology and design approach not to impact the groundwater resources.

Feel free to contact us if you have any questions.

Sincerely,

Creative Land & Water Engineering, LLC

By

Desheng Wang, Ph.D., P.E., CWS, CSE

Francis Alves, E.I.T., CSE
Civil/Environmental Engineer

Cc: Bob Murchison
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Subject: Estimate Hi-WT by USGS (Frimpter) Method
65 Farm Road, SAS
Sherborn, MA
Location:

By: DSW **Date:** 29-Nov-21
Chkd: **Date:**
Job No.: J269-10 **Sheet:** 1

Update 3/7/2024

Formulation

Sc-Sh/OWc-OWmax = Sr /OWr
Sh = Sc - Sr/OWr(OWc - OWmax)

in which, Sc = measured depth to water at the site;
Sh = estimated depth to probable high water level at the site;
OWc = measured depth to water in the observation well;
OWmax = depth to recorded maximum water table at the observation well;
Sr = range of water where the site is located;
OWr = recorded upper limit of annual range of water level at the observation well.

Input Report **USGS observation well** WINCHENDON (XNW) 13

Date	MW	Soil Type	Sc	Sr	OWc	OWmax	OWr	Ground Elev.	Reference Well used
11/24/2021			ft	ft	ft	ft	ft	ft	
	DHTP 5-1	Till/LS	**12.92**	10	4.43	1.86	10.82	195.04	WINCHENDON (XNW) 13
SAS #3	DHTP 5-2	Till/LS	**15.24**	10	4.43	1.86	10.82	200.77	WINCHENDON (XNW) 13
	DHTP 5-3	Till/LS	**15.91**	10	4.43	1.86	10.82	198.04	WINCHENDON (XNW) 13
Tank Area	SL TP-2	Till/LS	9.00	10	4.43	1.86	10.82	218.30	WINCHENDON (XNW) 13
4/27/2021	55-10	Till/LS	11.25	10	3.84	1.86	10.82	196.92	WINCHENDON (XNW) 13
	55-10An	Till/LS	13.00	10	3.84	1.86	10.82	192.10	WINCHENDON (XNW) 13
SAS #1, #2	55-11	Till/LS	15.58	10	3.84	1.86	10.82	201.00	WINCHENDON (XNW) 13
	55-11An	Till/LS	16.25	10	3.84	1.86	10.82	193.92	WINCHENDON (XNW) 13

Output Report

Date	MW	Depth to HW, Sh, ft	Correction, ft	assumed High Water Table Elev. (ft)	Note
11/24/2021	DHTP 5-1	10.54	2.38	184.50	dry
	DHTP 5-2	12.86	2.38	**187.91**	dry
	DHTP 5-3	13.53	2.38	184.51	dry
	SL TP-2	6.62	2.38	211.68	
	55-10	9.42	1.83	**187.50**	dry
4/27/2021	55-10An	11.17	1.83	**180.93**	
	55-11	13.75	1.83	**187.25**	
	55-11An	14.42	1.83	**179.50**	

Notes:

SAS #3
1. Groundwater level in XNW 13 Winchendon was measured on 11/24/2021.
2. Onsite ground water was meaured with Mr. Mark Oram on 11/24/2021 by Desheng Wang
3. Ten (10) ft of water level range for till slope (Sr) as required by Mr. Mark Oram.
4. Test pits SL TP-2, 5-1, 5-2, 5-3 were found dry and did not reflect the true water table rather for reference.

SAS #1, #2
1. Groundwater level in XNW 13 Winchendon was measured on 4/27/2021.
2. Onsite ground water was meaured with Mr. Mark Oram on 4/27/2021 by Desheng Wang
3. Ten (10) ft of water level range for till slope (Sr) as required by Mr. Mark Oram.
4. Test pits 55-10, 55-10An, 55-11, 55-11An were found dry and did not reflect the true water table rather for reference.