MWE

Consulting Civil Engineers and Land Surveyors

MetroWest Engineering, Inc.

September 25. 2024

Mr. Kevin Lake, Chairperson
Northampton Conservation Commission
210 Main Street
Northampton, MA 01060

RE: Notice of Intent for 8 View Avenue, Sovereign Builders, Inc.
MADEP File Number 246-0785
Second Peer Review

Dear Mr. Lake and Fellow Commission Members:

As you may recall, I provided your Commission with a peer review letter for the above-referenced project, dated August 23, 2024, performed at the request of a group of concerned citizens and abutters. Just prior to September 12, 2024, the applicant submitted a revised drainage report dated September 9, 2024. As this left me with insufficient time to review the revised submittal, the hearing was continued to September 26, 2024. It was my understanding that the continuance was granted to allow me time to review the 9/12/24 report.

Unfortunately, another drainage report and plan set were submitted just this past Friday, on September 20. Moreover, the hydrologic analysis and drainage approach has undergone a major change. Whereas the earlier submittals relied upon infiltration as the major mechanism to control peak flow rates, the revised plan and supporting calculations rely on stormwater detention and controlled flow release to mitigate flooding impacts. These are very significant changes to the stormwater management approach and warrant a thorough review.

This in turn will require another extensive review on my part, one that requires a significant investment of my time. It is frankly unreasonable to expect me to able to complete a thorough review of yet another design approach in a few days. The applicant should have requested another extension when the new plans and analysis were submitted and in not doing so the public confidence in the process has been diminished.

In beginning my review of the September 20 submittal, I quickly observed a major omission as well as a number and both analysis and design issues. I offer the following comments for your consideration.

## Process Issues

The revised drainage plans and supporting analysis have undergone major revisions since my first review and my comments at the previous public hearing. While it is personally rewarding to see that my input has been considered and has resulted in design changes, it frankly should not be the responsibility of the concerned citizens group to fund a peer review of this project. This subject site has major physical limitations including poorly draining soils, extremely high groundwater levels, extensive wetland resource areas and a dense, compact development proposal. The proposed drainage design pushes hard against the boundaries as to what is allowable both under the MADEP Stormwater Regulations and handbook, and the Wetland protection Regulations, 310 CMR 10.00.

It is clear that an in-depth review of the submitted materials was beyond the resources available of town staff to review, as it requires expertise in hydrologic and hydraulic engineering, as well as a time commitment that most municipal employees simply do not have. Projects of such complexity are routinely subjected to an outside, independent peer review by a qualified consultant, paid for by the applicant.

The lack of an independent peer review forced my clients to engage me to review the project. Their expenses will, at the close of this second review, exceed five figures, a cost that should have been borne by the applicant and not the concerned citizens group.

## Submission Omission

The September 20, 2024, Stormwater Report failed to include the HydroCad Analysis for the Existing Conditions model. This model underwent significant changes based on my earlier review, where I pointed out that the engineer used the wrong Hydrologic Soil Group in determining the pre-development runoff curve numbers in the model. While the cover page for Appendix A states it includes both Pre- and Post-Development Hydrologic Calculations, in fact only the Post-Development Calculations were included.

This means that my own peer review is incomplete, as I cannot verify the input data used in the model. Moreover, it means that the submittal fails to comply with MADEP Stormwater Requirements, as well as the requirements of the Northampton Stormwater Regulations. As a result, the Conservation Commission has only two options:

1. Seek a continuance to allow the applicant to provide the omitted material with sufficient time for a review
2. Deny the application for an incomplete submittal

This is frustrating, as it demonstrates:

1. The applicants engineer/representative rushed the submission package without the responsible professionals checking it for completeness.
2. The responsible review authorities in the town did not bother to review the submission.

This is another issue that adds to the expenses incurred by the concerned citizens group through no fault of that group, and further diminishes public confidence in the process.

**Alteration of Bordering Vegetated Wetlands (BVW)**

As I will discuss in subsequent sections of this report, there are several issues with the hydrologic analysis and drainage system design that make the results and conclusions reported in the narrative of the report suspect and unreliable. However, even if the results are assumed to be correct, the results indicate that wetland impacts, and alteration are likely as a result of this project. Referring to Table 1 on Page 5 of the report, the study indicates that the total volume of stormwater discharged into the BVW will increase from between 35 percent for the 2-year storm to 15 percent for the 100-year storm. The actual volumetric increase in stormwater discharged into the wetlands will likely be higher than figures when certain design flaws in the hydrologic model are corrected, as I will discuss later.

I note that the definition of "Alter" is provided in 310 CMR 10.04 as:

*<u>Alter</u> means to change the condition of any Area Subject to Protection Under MGL c. 131, Section 40. Examples of alteration include, but are not limited to, the following:*

*(a) The changing of pre-existing drainage characteristics, flushing characteristics, salinity distribution, sedimentation patterns, flow patterns and flood retention areas.*
*(b) The lowering of the water level or water table*
*(c) The destruction of vegetation*
*(d) The changing of water temperature, biochemical oxygen demand (BOD), and other physical, biological or chemical characteristics of the receiving water*

The increase in water volume delivered to the BVW will make the wetland "wetter", with water standing in the BVW for longer periods of time and at a greater depth. Additionally, since the drainage system has changed from one relying on infiltration to one relying on detention, water quality characteristics of the water will change. In particular, water temperatures will increase due to heat retention within impervious surfaces and chemical properties will change due to dissolvable constituents such as sodium that cannot be removed by the stormwater system. These environmental changes will alter wetland hydrology over time. Species which tolerate wetter conditions, warmer waters and are resistant to chemicals will thrive over species that are less tolerant of such conditions. Invasive species such as Japanese Knotweed are particularly adept at adapting to such conditions.

Beyond the alteration of wetland hydrology, the increase in stormwater volume discharged into the BVW has the potential to increase downstream flooding issues, and to over-tax existing hydraulic conveyance infrastructure. The applicant has not submitted an analysis of whether existing hydraulic conveyance and/or storage systems have the capacity to accept the additional stormwater volumes that the project will generate.

**Stormwater Infiltration System #1 (SIS #1)**

The engineer/modeler takes a curious approach to stormwater modeling in the case of SIS #1; The model assumes that the system is present for the smaller design storm, the 2-year event, but assumes that it is completely absent for the larger storm events, the 10-year and 100-year event. In the real world, the system is there as it is on the design plans and will be constructed. The post-development model should account for its presence across all design storms. The methodology employed, selectively including the infiltration for one design storm but not another, is at odds with accepted engineering practice and the model should be revised accordingly.

SIS #1, which is used to satisfy minimum stormwater recharge volume under Stormwater Management Standard 3, fails to satisfy the minimum offset requirement of two feet between the seasonal high groundwater table and the bottom of the infiltration system. TP-(2), as shown on Sheet LC-130, reports the seasonal high-water table at 134.83-feet. The bottom of stone of SIS #1 is proposed at 136.33-feet, 1.5-feet above the reported seasonal high groundwater table.

The project narrative, on page 4 under paragraph Area P3, states that this sub-watershed catchment drains into Subsurface Detention System #1 (SDS #1), and then into SIS #1. In fact, the area is first discharged into a flow diversion manhole (DIV #1), which first diverts flow into SIS #1, based on the detail of DIV #1 provided on Sheet LC-501. Flow to SDS #1 only occurs after the water level in SIS #1 reaches the top of the manhole weir, at elevation 137.70-feet. The post-development hydrologic model should be revised to reflect this design element accurately.

**Stormwater Detention System #1 (SDS #1)**

As I have previously noted, the current engineering design relies on detention, rather than groundwater recharge, to attenuate peak flood flows. This is accomplished by means of SDS #1, located under the pavement in the northeast corner of the site.

SDS #1 consists of 224 plastic chambers that are assembled together in the field in a Lego-like manner. The chambers are set on a bed of stone and covered with a bed of stone.

In order to provide for flood water storage and detention, these chambers, including the stone above and along the sides of the chambers, must be empty and not holding water before a storm event begins. Thus, the system of chambers and stones must be impermeable to groundwater that may be present under or along the sides of the system.

To prevent groundwater intrusion into the chambers and surrounding stone, the engineer has called for a 30-mil thick poly-vinyl barrier to be wrapped on all four sides and the bottom and top of the system, to create an impermeable barrier to prevent groundwater intrusion.

Creating a water-tight wrap where the top, bottom and all sides of the system are water-tight using a membrane wrap is a formidable construction challenge, one that I have never seen achieved in my 40-plus years of practice. The membrane itself is difficult to work with as it is not very flexible, and establishing watertight seams can be exceedingly difficult. Moreover, it is virtually impossible to field test the system for water-tightness before backfilling, so even if meticulously constructed, the system as-built may not be water-tight.

Complicating this design is a water table that will vary in depth across the system. Based on the soil tests provided, I estimate that the water table at the northwest end of the system will be approximately at 135.6-feet, and roughly 0.7-feet below the stone bedding supporting the system. However, at the southeast end of the system the water table will be at, approximately, 137.1-feet, about 0.8-feet above the bottom of the stone, and above the bottom of the chambers. The system will therefore be subject to a non-uniform hydrostatic pressure from below, pushing the system up. This force is analogous to the hydrostatic force that sometimes can push an in-ground swimming pool out of the ground in the winter).

The issue is that the system will be subject to both non-uniform hydrostatic pressure from below, and vehicle loading pressure from above. These forces will stress the system integrity and over time may result in a breach of the watertightness, as the modules will shift, and lateral strain will be exerted on the impervious liner. Any breach of the liner can fully compromise the detention capacity of the system by allowing groundwater intrusion, which will result in a failure of the detention component. This in turn leads to a failure to comply with Stormwater Standard # 2.

I realize that construction details and standards can be difficult for a lay person to understand, and the issues presented here may seem abstract. However, nearly everyone has seen road settlement, or live in a house with creaks and groans that develop as the structure is subjected to settlement stress. The mechanism that I discuss above is similar and nearly impossible to avoid.

The design as presented is poor as it is nearly impossible to build and even if built well, will eventually fail due to internal stresses. In my opinion, more suitable design choices are available, and I will discuss alternative approaches at the end of this report.

**Subsurface Infiltration System #2 (SIS #2)**

Soil Conditions and Testing

No soil evaluations were conducted within the footprint of SIS #2, and these are required as per the MADEP Stormwater Handbook. A soil evaluation of soil texture and groundwater levels should be provided.

Groundwater Offset to System

SIS #2 is designed with a bottom of stone elevation at 135.7-feet. The design engineer selected this elevation based on the reported groundwater level of 132.67-feet observed in TP-(1). This test pit is, however, located approximately 15-feet away from and vertically down-gradient from SIS #2. Since the water table here has been shown to reflect the surface topography, the actual water table is likely higher at the location of SIS #2. This can be seen by reviewing the water table reported in TP-3, which is located at the same surface elevation as SIS #2, and 18-feet to the southwest. The reported water table in this test hole was 134.6-feet, and within the two-foot required minimum offset between the bottom the system and the high-water table.

To best evaluate the water table elevation at SIS #2, in the absence of an actual soil evaluation, I interpolated the groundwater elevation using the results reported in TP-(1), TP-3, TP-4 and TP-2, which surround the location of SIS #2. Based on that interpolation, the probable elevation of the water table at SIS #2 is at elevation 133.9-feet.

Based on this interpolation, the bottom of SIS #2 is offset only 1.8-feet from the water table and fails to meet even the minimum groundwater offset requirement of 2.0-feet.

Groundwater Mounding Analysis

While a groundwater mounding analysis for SIS #2 has been provided in the most recent submittal, the analysis is based on questionable data assumptions required for the Hantush Spread Sheet used.

The Hantush method requires the following input data:

(a) Recharge Rate (volume of water to be recharged in a specific time period in feet per day)
(b) Specific Yield (a dimensionless value representing available storage in the aquifer)
(c) Horizontal Saturated Hydraulic Conductivity of the aquifer soil
(d) Basin dimensions (1/2 length and ½ width)
(e) Recharge duration period.
(f) Initial thickness of saturated zone

The modeler used the following data for these values:

(a) RR: 0.54 feet per day
(b) SY: 020
(c) K: 5.4 feet per day
(d) One-half basin dimensions: 13.86 ft by 9.9 ft
(e) Recharge duration; 1.7 days
(f) Initial thickness of saturated zone; 5.67-feet

In my opinion, the data input for items (a), (d) and (e) are incorrect for the following reasons.

The Recharge Rate, RR should be based on the total infiltration volume of 823 CF that occurs during the 100-year storm, applied over the footprint of the infiltration area which is 480 SF. This results in a recharge rate of 1.71 feet per day, not the 0.54 feet per day used in the report.

The basin dimensions, even though SIS #2 has an irregular shape, should equate to the actual surface area of the infiltration system, which is 480 SF. The dimensions input in the analysis submitted, 13.86-feet by 9.9-feet equate to an area of 549 SF, overestimating the infiltration footprint by 22 percent. The dimensions should be adjusted to approximately 9.0-feet by 13.3-feet.

Finally, the infiltration duration period should be set to one day, as the model is simulating the response to a 24-hour storm.

Using the parameters discussed above, the Hantush model predicts a groundwater mound at the center of the infiltration system of 3.3 feet. This mound will therefore extend to within the infiltration system.

**Roof Drainage Conveyance System**

Capacity

The revised stormwater submittal includes a Rational Method Analysis to substantiate the diameter and slope of pipes used to convey roof water from downspouts to the infiltration systems. Unfortunately, no map or diagram was provided to identify which pipes, serving which buildings, were analyzed. As such, there is no way to review or confirm the analysis. A diagrammatic sketch should be provided along with the analysis so that the pipe runs, diameters and slopes can be reviewed.

Cover

The cover over the pipes in the rear of the buildings needs to be assessed to confirm that a minimum one one-foot of ground cover over the top of the pipes is provided. Depending on the required pipe diameters and slopes needed to achieve conveyance capacity, several of the conveyance pipes may have insufficient cover. Of particular concern is the 6-inch diameter pipe that runs behind Building #8. Based on the minimum required slopes, the invert at the north end of this pipe will be approximately 138.8-feet and the crown of the pipe will at elevation 139.3-feet. The proposed finish grade at this location is elevation139.5.feet, or only 2.4-inches above the top of the pipe. While this may seem like a minor point, it is indicative of a design plan that has been rushed and does not consider constructability issues.

Maintenance

The submitted Stormwater Operation and Maintenance Plan makes no mention of the roof gutter and piping conveyance network, despite the fact that the entire hydrologic analysis is predicated on the collection and conveyance of roof stormwater to the disposal systems. If the roof water is not collected and conveyed, for all design storm events, then the analysis as presented will not represent the actual site conditions and the downstream flooding will absolutely occur. Maintenance of the gutters, downspouts and sub-surface conveyance conduits is critical to the performance of the stormwater management system.

As it is presently designed, the collection and conveyance system cannot be inspected, cleaned or maintained. The sub-surface piping network calls for numerous tee-connections, bends, and sharp angles. No cleanouts or inspection ports brought to finish grade are called for on the plans.

As anyone who has ever cleaned a gutter knows, roof shingles gradually degrade and discharge aggregate into the gutters. Gutters are also a magnet for leaves, pine needles, acorns and children's toys. All of these deleterious materials will eventually find its way into the conveyance pipes. Clogging is inevitable, especially at bends, junctions and angle points where changes in velocity can result in material deposition. The current plans provide for no mechanism to inspect and clean the pipes, and the O & M does not even require inspection or maintenance of the system. This is a gross oversight that must be corrected.

**Low Impact Development Components**

The Stormwater Management System as submitted offers no Low Impact Development (LID) components. Contrary to the engineer's assertion in the Stormwater Report, infiltration systems, which now have been largely eliminated for this project, are not considered LID components.

**Conclusions and Recommendations**

The Stormwater Management System for this project has been designed on a knife's edge, pushing hard against the regulatory limits for a site with such poorly draining soils and a water table close to the ground surface. If any of the design assumptions prove to be incorrect the system will fail to protect the interests of the Wetlands Protection Act and the downstream residents. If minor irregularities occur during construction, which is the norm, system failure is the likely outcome. If the ground settles over time causing even a minor rupture of the Subsurface detention system, failure will result. Given the physical limitations of this site, there will be no available remedy, and downstream residents will incur property damage.

In my opinion better stormwater management alternatives are available that would allow the project to move forward at a similar density. I specifically recommend that the following alternatives be explored:

(a) A stormwater disposal system, open to the air and above-grade, should be considered in the northwesterly portion of the property. The system could employ rain gardens, an open infiltration basin, or a constructed wetland to manage the site's stormwater runoff. Such a system offers significant benefits on terms of inspection and maintenance, and greatly reduce the possibility of a system failure. This approach would likely require an adjustment in the building design and placement, perhaps combining single family units into attached units to free up real estate for stormwater management purposes.

(b) Porous or pervious pavement should also be considered for the driveways, the main access road, or both. Since the site is being filled in the driveway and road locations, porous pavement can be an effective means to minimize stormwater runoff and reduce the required size of other stormwater management systems.

In any case, given the complexities that this site faces to achieve the proposed density, the Commission is justified to require that an evaluation of alternatives be provided.

Finally, and in closure, given your 3-minute time limitation for input by non-applicant participants, it does not make sense for me to attend the next hearing, as my attendance is another added expense to the citizens group, and I can accomplish very little in three minutes.

Thank you for your consideration.

Sincerely yours,

Robert A. Gemma, PE, PLS
President

Enclosure : Hantush Mounding Analysis

CC : Concerned Citizen Group as listed below:

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This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. M
Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormw

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimen
thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For
For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as th
if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dim
can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output value
blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary it
and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

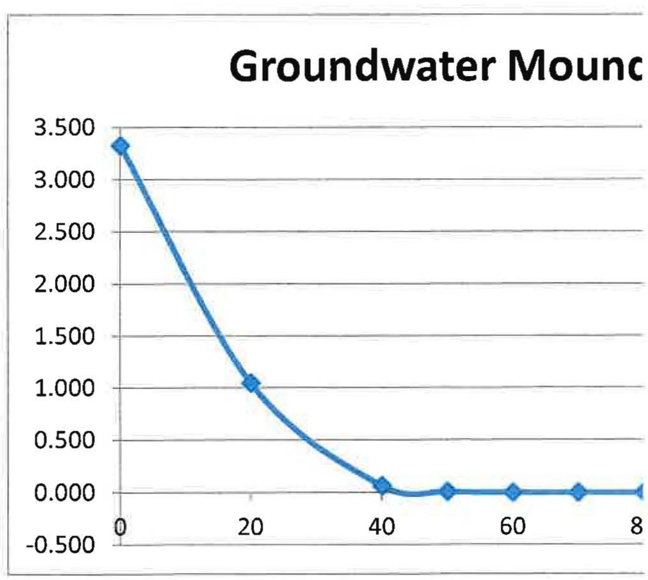
Input Values

| | | |
|---|---|---|
| ***1.7100*** | ***R*** | **Recharge (infiltration) rate (feet/day)** |
| ***0.220*** | **Sy** | **Specific yield, Sy (dimensionless, between 0 and 1)** |
| **5.40** | **K** | **Horizontal hydraulic conductivity, Kh (feet/day)*** |
| **13.300** | **x** | **1/2 length of basin (x direction, in feet)** |
| **9.000** | **y** | **1/2 width of basin (y direction, in feet)** |
| **1.000** | **t** | **duration of infiltration period (days)** |
| **5.670** | **hi(0)** | **initial thickness of saturated zone (feet)** |

| | | |
|---|---|---|
| **9.000** | **h(max)** | **maximum thickness of saturated zone (beneath center of ba** |
| **3.330** | **Δh(max)** | **maximum groundwater mounding (beneath center of basin** |

| Ground-water Mounding, in feet | Distance from center of basin in x direction, in feet |
|---|---|
| 3.330 | **0** |
| 1.050 | **20** |
| 0.067 | **40** |
| 0.014 | **50** |
| 0.004 | **60** |
| 0.003 | **70** |
| 0.003 | **80** |
| 0.003 | **90** |
| 0.003 | **100** |
| 0.003 | **120** |

**Re-Calculate Now**




Mound at center of system = 3.33 feet

**Disclaimer**