TECHNICAL MEMORANDUM

To: Steve Hinton, Carlisle ZBA; Chris Heep, Miyares-Harrington

From: Jim Vernon, Nobis Engineering, Inc.

Subject: Alternate nitrate mass balance calculation, proposed SDA 2, 100 Long Ridge Road

Date: October 25, 2016

Background

In Nobis Engineering's "Phase 4 Report, Independent Hydrogeologic Study, 100 Long Ridge Road, Carlisle, MA", dated September 30, 2016, we presented a series of nitrate mass balance calculations, using a method prescribed by the Massachusetts Department of Environmental Protection (MassDEP) in its "Guidelines for Title 5 Aggregation of flows and Nitrogen Loading, 310 CMR 15.216." One set of calculations (Scenarios 7 – 12 in our Phase 4 report), were based on an assumption that groundwater and septic discharge would travel eastward from proposed Septic Disposal Area 2 (SDA2); see Figure 3 Alternative, attached.

At the ZBA Hearing on October 4, it was pointed out that topography in the area suggests a potential local groundwater divide and that groundwater flow directions in this area are not known for sure. This derives from the lack of water level data in the vicinity of SDA2 and the gentle topography in the area. At the hearing, it was also pointed out that groundwater might flow southward from SDA2. Based on this possibility, Nobis performed new, alternative mass balance calculations (Scenarios 17 – 20), associated with SDA2, based on this possibility.

Alternative Nitrate Mass Balance Calculations

For discussion of the assumptions and limitations of the mass balance calculations, see Nobis' Phase 4 report. We delineated an alternate Area of Impact (AOI) that extends southward from SDA2 (Figure 3 Alternative). The AOI delineation depends on the estimated groundwater potentiometric flow contours, which are admittedly uncertain due to lack of water level data, and on topography. The AOI extends southward to the closest known sensitive receptors, homeowner wells at 68 Garnet Rock Drive and 200 Long Ridge Road. The method for AOI delineation is presented in the MassDEP Guidelines and in Nobis' Phase 4 (2016) and Phase 2 (2015) reports.

Noting that this alternative AOI for SDA2 includes SDA1 (Figure 3 Alternative), we subdivided the AOI into two areas, AOI-2A Alt1, which terminates at the northern (upgradient) corner of SDA1, and AOI-2B Alt1, which includes the entire area. (AOI-2A Alt1 is included within AOI-2B Alt1.) For each of these AOIs, we estimated the total area, impervious area, area to be fertilized, and unfertilized areas, by the method described in our Phase 4 Report. See attached Figure D2 Alt1.

We performed nitrate mass balance calculations for the following new scenarios:

- Scenario 17 – AOI-2A Alt1, for the Applicant's rate of 110 gallons per day (gpd) per bedroom;

- Scenario 18 – AOI-2A, Alt1, for the Town's rate of 165 gpd per bedroom;
- Scenario 19 – AOI-2B, Alt1, for the Applicant's rate of 110 gpd per bedroom; and
- Scenario 20 – AOI-2B, Alt1, for the Town's rate of 165 gpm per bedroom.

Results are shown on the attached Table 4Alt. Note that despite the much larger area available to provide dilution for Scenarios 19 and 20, predicted nitrate concentrations are nearly as high as for Scenarios 17 and 18. This is because of the additional nitrate load provided by proposed SDA1.

Discussion

As discussed in Nobis' Phase 4 report, these results are relative results and subject to significant uncertainties. The uncertainties derive from two sources: the major simplifying assumptions in the MassDEP method and the lack of site-specific data in the vicinity of SDA2. These relative results are useful in comparison to other results that used the same method, but should not be directly compared to results obtained by dispersion analyses, which model different physical processes and are also based on simplifying assumptions. Finally, the results presented in this Memorandum are average results predicted over an area (not at a point location) and pertain to overburden groundwater, not to bedrock groundwater, which is tapped by all existing and proposed wells in the area.

Also, it is possible that groundwater impacted by SDA2 would flow both to the east and to the south. However, in this case, the nitrates would be spread out over a larger area, and the resulting concentrations would not be simple additions of the results presented here and in the Phase 4 report.

TABLE 4 Alt

MASS-BALANCE NITRATE LOADING ANALYSES - MULTIPLE SCENARIOS

100 Long Ridge Road
Carlisle, Massachusetts

	Scenario	Defined Area	Wastewater Daily Volume Value Applied	Nitrate Concentration (mg/L)
Proposed Septic Disposal Area 1	1	AOI	Applicant	16.3
	2	AOI	Town	17.1
	3	Alt 1	Applicant	14.3
	4	Alt 1	Town	15.6
	5	Alt 2	Applicant	13.7
	6	Alt 2	Town	15.1

	Scenario	Defined Area	Wastewater Daily Volume Value Applied	Nitrate Concentration (mg/L)
Proposed Septic Disposal Area 2	7	AOI 2A	Applicant	17.0
	8	AOI 2A	Town	17.6
	9	AOI 2B	Applicant	17.9
	10	AOI 2B	Town	19.0
	11	AOI 2C	Applicant	15.4
	12	AOI 2C	Town	17.1

	Scenario	Defined Area	Wastewater Daily Volume Value Applied	Nitrate Concentration (mg/L)
Proposed Septic Disposal Area 2	17	AOI 2A Alt 1	Applicant	15.3
	18	AOI 2A Alt 1	Town	16.3
includes input from Proposed SPA 1	19	AOI 2B Alt 1	Applicant	12.7
includes input from Proposed SPA 1	20	AOI 2B Alt 1	Town	14.3

	Scenario	Defined Area	Wastewater Daily Volume Value Applied	Nitrate Concentration (mg/L)
Proposed Septic Disposal Area 3	13	AOI 3A	Applicant	11.5
	14	AOI 3A	Town	13.2
	15	AOI 3B	Applicant	7.5
	16	AOI 3B	Town	9.4

Assumptions

Applicant wastewater volume value = 2735708.58 L/yr, existing 4-bedroom house wastewater volume value = 607935.24 L/yr
Town wastewater volume value = 4103562.87 L/yr, existing 4-bedroom house wastewater volume value = 911902.86 L/yr
Recharge from precipitation = 1.5 ft./yr
Nitrate load from fertilizer = 933 mg/1000 ft.^{2}

Potential IWPA

Septic Disposal Area #3

Septic Disposal Area #2

Existing Septic System

Septic Disposal Area #1

Suffolk Lane Extension

Suffolk Lane

Garnet Rock Lane

Long Ridge Road

#55 #132 #100 #29 #200 #68 #90 #50

Legend

- Proposed Public Supply Well
- Existing Septic
- Proposed Septic
- SDA 2 Alt 1 AOI (See Tech Memo)
- All other AOIs
- Composite 100 foot Well Buffer (Zone I)
- Potential Interim Wellhead Protection Area
- Existing Water Supply Well
- Groundwater Contour based on Water Levels Observed 1/23/15 by NGI
- Inferred Groundwater Contour (1/23/15)
- Preliminary Groundwater Flow Estimate
- Groundwater Contour with Mounding (see text)
- Drainage Divide
- LGH Project Site
- Streams
- *103.82* Predicted Mound Elevation (see text)

Notes:

1. See text for explanation of Interim Wellhead Protection Area.

2. Proposed well and septic locations from a plan titled 'Plan P - Public Water Supply' by Meisner Brem Corp., February 2, 2016.

3. Assessor's parcels are from the Town of Carlisle. Aerial photography provided by ESRI. Lot line for #90 Long Ridge Road is Approximate.

4. All elevations are based on a relative datum, not sea level.

5. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

0 75 150 300

Feet

1 inch = 150 feet

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FIGURE 3 ALTERNATIVE

AREAS OF IMPACT
PROPOSED SEPTIC DISPOSAL
AREAS AND WELLS
100 LONG RIDGE ROAD
CARLISLE, MASSACHUSETTS

PREPARED BY: JH	CHECKED BY: JV
PROJECT NO. 89220.00	DATE: OCTOBER 2016

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Septic Disposal Area #2

AOI-2B Alt1

AOI-2A Alt1

Existing Septic System

Septic Disposal Area #1

#200

#90

#68

#50

Garnet Rock Lane

Long Ridge Road

LONG RIDGE ROAD

Legend

Surface Type

- Impervious
- Pervious Fertilized
- Pervious Unfertilized
- 100 foot Well Buffer (Zone I)
- Existing Water Supply Well

AOI Areas - Septic #2 Alt 1 (sqft)		
A	Impervious	3,186
	Pervious Fertilized	12,867
	Pervious Non-Fertilized	2,826
	Total	18,879
B	Impervious	17,400
	Pervious Fertilized	13,375
	Pervious Non-Fertilized	49,969
	Total	80,744

Notes:

1. Source: 'Plan P - Public Water Supply' by Meisner Brem Corp., February 2, 2016.

2. Proposed Septic Disposal Area #2 is included in all area calculations.

3. It is assumed that all pervious areas outside the Site boundary are non-fertilized.

4. Assessor's parcels are from the Town of Carlisle. Aerial photography from MassGIS map service, 2013.

5. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

0 30 60 120

Feet

1 inch = 60 feet

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FIGURE D2 ALT 1

SURFACE CHARACTERISTICS
PROPOSED SEPTIC #2 AOI
100 LONG RIDGE ROAD
CARLISLE, MASSACHUSETTS

PREPARED BY: JH	CHECKED BY: JV
PROJECT NO. 89220.00	DATE: OCTOBER 2016

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