AMORY ENGINEERS, P.C.

WATER WORKS • WATER RESOURCES • CIVIL WORKS

25 DEPOT STREET, P.O. BOX 1768
DUXBURY, MASSACHUSETTS 02331-1768

TEL.: 781-934-0178 • FAX: 781-934-6499
WWW.AMORYENGINEERS.COM

March 30, 2017

Mr. Joseph W. Freeman, Chairman
Hingham Zoning Board of Appeals
210 Central Street
Hingham, MA 02043

Subject: **Broadstone Bare Cove – Comprehensive Permit**

Dear Mr. Freeman:

This is to advise that we have reviewed the following documents related to the subject Comprehensive Permit Application:

- Beal's Cove Existing Sewer Infrastructure Assessment, revised October 10, 2016, prepared by Allen & Major Associates, Inc.
- Sewer & Water Usage Summary Spreadsheet (Proposed Conditions), dated November 2, 2016, prepared by Allen & Major Associates, Inc.
- Letter to the Board from Carlton Quinn. P.E. of Allen & Major Associates, Inc., dated October 11, 2016
- Letter to the Board from Attorney Allcock of Marcus, Errico, Emmer & Brooks, P.C., dated March 20, 2017
- Letter to the Board from Attorney Dougherty of Nutter McClennen & Fish LLP, dated March 21, 2017

It is our understanding that the Beal's Cove Condominium Trust is concerned that the proposed Broadstone Bare Cove project will have adverse impacts on an existing sewer line and associated infrastructure that serves the Beal's Cove Condominiums. Based on our review of the documents we offer the following summary of existing and proposed sewer flows tributary to the Beal's Cove Pumping Station (BCPS):

Flow Description	MGD[1]	GPM[2]
Existing Average Daily Flow to BCPS:	0.045	31.3
Proposed Average Daily Flow from Broadstone Bare Cove:	0.058	40.3
Proposed Total Average Daily Flow to BCPS:	**0.103**	**71.5**
Existing Design Peak Flow to BCPS:	0.252	175.0
Proposed Design Peak Flow from Broadstone Bare Cove:	0.325	225.6
Proposed Design Peak Flow to BCPS:	**0.577**	**400.6**

[1] MGD – Million gallons per day.
[2] GPM – Gallons per minute.

The existing 12-inch pipe that discharges into the Beal's Cove Pumping Station has a capacity of 612.6 GPM and proposed peak flow through this pipe is estimated at 400.6 GPM. Therefore, the pipe has sufficient capacity to accommodate projected peak flows. The Beal's Cove Pumping Station has a reported design capacity of 500 GPM and again, peak flow to the station is estimated at 400.6 GPM. Therefore, the pumping station also has sufficient capacity to accommodate projected peak flows.

We note that there is an existing twenty-foot wide sewer easement through which sewage is conveyed from the Beal's Cove Condominiums and the existing building on the 230 Beal Street property (Broadstone Bare Cove property) to the Beal's Cove Pumping Station. In his letter, Attorney Allcock states that the existing twenty-foot wide sewer easement bisects the 230 Beal Street property and occupies 28,610 square feet of the project site. This is not the case as the easement is on property west of the proposed development owned by the Commonwealth of Massachusetts. Attorney Allcock's letter also states that the Beal's Cove Condominium Trust is "informed and believes that the proximity of construction of the apartment complex will impact the integrity of the sewer line." We believe that the existing sewer line is sufficiently far enough away from the project site that construction activity on the site should not adversely impact the integrity of the sewer line.

The Grant of Easement document referenced in the attorneys' letters states that there is "an annual operating and maintenance charge equal to the reasonable cost of operation and maintenance of the pumps and incidental facilities times a fraction, the numerator of which is the number of gallons of sewage contributed by Salah and his successors and assigns[3] and the denominator of which is the total number of gallons of sewage flowing through the sewer line." Based on this requirement Broadstone Bare Cove would be responsible for approximately fifty-six percent (56%) of the costs associated with operation and maintenance of the Beal's Cove Pumping Station and appurtenances. Therefore, it is in Broadstone Bare Cove's interest to protect the existing infrastructure during and after construction.

We understand that there have been questions raised about the capacity of various sizes of sewer pipes. There are three variables that factor into the capacity of a pipe, the size, the slope, and the friction factor, which is based on pipe material (PVC, clay, metal, concrete, etc.). Putting aside the slope and material, a rough comparison of the capacity of various size pipes is to calculate the cross-section area of the pipe. The area of a circle is the constant Pi times the radius squared ($\Pi \times r^2$). For example, the cross section area of a six-inch pipe is 0.20 square feet (s.f.), an eight-inch pipe is 0.35 s.f. and a twelve-inch pipe is 0.79 s.f. However, as mentioned above, slope and friction also affect pipe capacity and the Manning equation takes these variables into account. The attached worksheet demonstrates that two six-inch PVC pipes have less capacity (1.33 cfs) than a single eight-inch PVC pipe (1.43 cfs) laid at the same slope (see yellow highlighted cells).

[3] Broadstone Bare Cove in this case.

Please give us a call should you have any question.

Very truly yours,

AMORY ENGINEERS, P.C.

By:

Patrick G. Brennan, P.E.

PGB
enc.

Manning Equation Worksheet

Equation: $Q = (1.49/n) \times (AR)^{2/3} \times S^{1/2}$

Where Q is the flow (capacity) in cubic feet per second (cfs)
n is the Manning's roughness coefficient (0.011 of PVC pipe)
A is the cross section area (s.f.)
R is the hydraulic radius of the pipe
and S is the slope of the pipe (ft./ft.)

Size (inches)	Manning's n	Slope (ft/ft)	Area (sf)	Hydraulic Radius	Full Flow (cfs)		
6	0.011	0.010	0.20	0.125	0.66	x 2 =	1.33
8	0.011	0.010	0.35	0.167	1.43		
12	0.011	0.010	0.79	0.250	4.22		
18	0.011	0.010	1.77	0.375	12.45		
24	0.011	0.010	3.14	0.500	26.81		
30	0.011	0.010	4.91	0.625	48.61		
36	0.011	0.010	7.07	0.750	79.04		