Horsley Witten Group
Sustainable Environmental Solutions
113 R2 Water Street • Exeter, NH • 03833
603-658-1660 • horsleywitten.com

November 8, 2017

VIA EMAIL

Mr. Andrew Port, Director
Office of Planning and Development
60 Pleasant Street
P.O. Box 550
Newburyport, MA 01950

Ms. Julia Godtfredsen, Conservation Administrator
Office of Planning and Development
60 Pleasant Street
P.O. Box 550
Newburyport, MA 01950

Re: Planning Board Peer Review Letter #1/ Conservation Commission Peer Review Letter #2. Peer Review of Hydrologic Concerns.
Proposed Evergreen Commons, 18 Boyd Drive, Newburyport, MA

Dear Mr. Port and Ms. Godtfredsen:

The Horsley Witten Group, Inc. (HW) is pleased to provide the Newburyport Planning Board (PB) and Conservation Commission (CC) with this letter summarizing our peer review of the hydrologic components of the proposed subdivision located at 18 Boyd Drive, also known as Port Place, submitted by Design Consultants Inc. (DCI), Hughes Environmental Consulting (HEC), and Mead, Talerman and Costa, LLC (MTC) on behalf of Evergreen Commons, LLC (Applicant). As you are aware, HW has also provided an initial peer review letter (dated September 26, 2017) about this proposed development to the CC. The hydrologic issues that this letter addresses are the same primary issues under consideration by both the CC and PB that need to be resolved before more detailed review of project design components can be completed. As such, this letter is of specific interest to both the CC and the PB.

We understand that the proposed project is an Open Space Residential Development project on a 36+ acre parcel that is currently occupied by a 9-hole golf course. The entire site is located within the Zone II of a Newburyport public water supply well (Well #2) which supplies untreated water directly to the public water supply distribution system. The proposed development will receive municipal water and sewage services. The proposed stormwater management design includes a combination of deep-sump catch basins, drain manholes, hydrodynamic separators, five bioretention areas, a constructed wetland, and grass conveyance channels. The stormwater management

system discharges to regulated wetland resource areas and is therefore required to meet the Massachusetts Stormwater Standards (MASWS) as described in the Massachusetts Stormwater Handbook (MSH) (February 2008).

HW prepared the following comments based on a review of the materials provided by the City and the Applicant, as well as a site visit with the City and the Applicant's Team on September 8, 2017. The package of materials reviewed by HW was extensive, and a list of these materials is attached for reference (Attachment 1). This letter is organized as follows:

1. Overview;
2. Seasonal High Groundwater (SHGW);
3. Isolated Land Subject to Flooding (ILSF); and
4. Conclusions.

We have numbered our comments according to each section to provide an easy reference for the City and the Applicant's team in discussing and addressing these comments.

1. Overview

As part of our peer review of this project for the CC, we have been working with the Applicant's consulting team to resolve the two most significant hydrologic issues for the proposed development: seasonal high groundwater (SHGW) elevation, and isolated land subject to flooding (ILSF) area and storage volume. Those two issues contribute to many of the design components of the proposed development. As such, during the Conservation Commission (CC) review process, we suggested, and the Applicant agreed, that they would work on further evaluating those two issues to the satisfaction of HW as well as the CC and PB prior to submitting further revised design plans or other project materials.

Following our first peer review letter prepared for the Conservation Commission (dated September 26, 2017), we have since reviewed an updated response package concerning the SHGW and ILSF issues dated Thursday October 26, 2017. This letter details our review and opinions concerning the SHGW and ILSF issues, as well as potential pollutant loading concerns related to the proposed development. Our understanding is that once the PB and CC are satisfied that these key hydrologic issues have been adequately addressed, review can proceed to the full site design, which builds off those key issues.

2. Seasonal High Groundwater (SHGW) Comments

SHGW refers to the long-term average high groundwater level at any specific location, which generally occurs during the early spring in New England. SHGW is critical for project design as it is a regulatory concern for the design of infrastructure such as septic systems (not applicable to this project) and stormwater management systems. It is also good practice to maintain basement floor levels above SHGW to avoid wet basement issues. SHGW should not be confused with record or flood high water levels from any specific historic event. Historic flood events like the Mothers Day storm of 2006, or the period of intense storm activity in March 2010, may potentially produce surface water elevations at specific locations higher than the underlying groundwater, or even groundwater elevations higher than the SHGW.

In our initial review for the CC, we requested that the Applicant augment their previously completed SHGW estimates based upon the observation of soil mottling in test pits by conducting comparisons of site groundwater levels at specific times to nearby, long-term groundwater data from USGS "Index Wells" (a method referred to as the Frimpter Method in Massachusetts). We recommend that both methods be applied and compared whenever possible because multiple lines of evidence pointing to a similar SHGW level lend confidence to the assessment. Conversely, widely differing results reinforces the need for a more thorough investigation of potential errors in observation or calculation.

The Applicant conducted our requested additional analyses and on October 12, 2017 submitted revised materials documenting the SHGW estimates at different locations across the site based upon both test pit indicators and Index Well Frimpter calculations. Following a round of comments from HW, the Applicant submitted revised SHGW materials on October 26, 2017 in which minor calculation and errors were corrected and several additional edits were also made to clarify the presentation of data on the SHGW and ILSF figures. Please note that while the summary SHGW figures from both the October 12th and October 26th, 2017 submittals are dated October 10, 2017 in the title block, the figure contained in the October 26th submittal is actually an updated version that reflects the edits requested by HW.

We offer the following comments related to SHGW:

2.1 The SHGW figure contained in the October 26th, 2017 submittal presents a logical distribution of SHGW across the site with generally good agreement between test pit-based and Index well-based SHGW estimates from two different Index Wells. This agreement lends confidence in the reasonableness of the SHGW estimates. The pattern of SHGW shown on that figure is of higher SHGW

elevations around the southern and eastern perimeter of the site with gradually lower SHGW elevations towards the center and northern end of the site. The largest portion of the site, and the area where most of the stormwater practices and the expanded wetlands area are located, has an estimated SHGW elevation of 52 feet (NAVD 88). The SHGW figure presents a reasonable distribution that presumably reflects a local groundwater flow gradient towards the north (towards the Merrimack River) during the winter/spring high groundwater season.

We do note that the two local groundwater maps that we are aware of both show a groundwater flow direction from the eastern part of the site to the north/northeast, towards the City Well #2 (BSC Group August 22, 1985; NGI, September 2016). Those maps are included herein as Attachments 2 and 3. However, both of those groundwater contour maps reflect summer conditions when City Well #2 is in operation and is creating a cone of depression in the water table that directs groundwater flow towards itself. It is unknown, though it seems reasonable, that during the winter/spring when Well #2 has not been operational for some time the groundwater flow direction would become more northerly and less northeasterly.

2.2 Based on the above-mentioned SHGW revisions, the Applicant revised the design of key project elements; most notably, from a regulatory standpoint, being the various stormwater management practices. All stormwater infiltration facilities have at least the minimum 2 feet of separation above SHGW required by the MSWMS. As discussed further below, ILSF calculations were also revised based upon the revised SHGW estimates. In addition, though not a regulatory requirement, basement floor and road elevations were revised upwards to reflect flood elevations (higher than SHGW) based upon site observations during the so-called Mothers day storm of 2006.

2.3 Please note that the design of the expanded wetlands area is being designed based on average water levels observed from nearby monitoring wells as opposed to SHGW. This makes sense because the concern with wetland construction is ensuring that the wetland stays wet. It is better to have a little more water in the wetland than a little less. We are in agreement with the Applicant on this approach.

2.4 We offer the following input with regard to the higher range of groundwater fluctuation documented in City observation well OB-6 (as reported in the AECOM email correspondence and reported by a project abutter) as compared to what has been observed from the on-site groundwater level measurements.

- An accurate comparison of site groundwater elevations to those in the vicinity of the City Well #2 is complicated by the vastly different lengths of data records and minimal temporal overlap between the two. To our knowledge, site groundwater data consists of an initial round in September 2016, followed by seven additional rounds of varying intervals between early May 2017 and September 2017. Those data are included herein as Attachment 4, a figure created by NGI showing site monitoring well data in comparison with USGS Index well data.

  All, or nearly all, of those site measurement rounds were during time periods when City Well #2 may have been operational (reported to us by NGI and DCI as being primarily during the peak summer water demand period). In contrast, there is a far more extensive data set of water levels from monitoring wells on the City property from 2006 through August 2017. That data set was supplied to us by NGI. Over the two data sets common time period of September 2016 through September 2017, City monitoring wells have exhibited water elevations varying between approximately 40 and 52 feet (NAVD 88). Over that same time period site wells have varied between approximately elevations 45 and 52 (Attachment 5, HW modification of NGI figure). Therefore, at least for the limited data overlap time period, water levels on the City property fall lower than those at the site (likely due to the influence of pumping), and rise to approximately the same high levels during the winter/spring.

  Attachments 6 and 7 illustrate “zoomed in” views of the earlier and later time periods, respectively, of the Attachment 5 data record. Attachments 5, 6, and 7 are all HW modifications of a figure originally created by NGI. HW added additional City monitoring well data records to the figure and highlighted our understanding of the general pumping vs. non-pumping time periods for City Well #2. We interpreted the summer pumping period to be June through September. Close examination of the highlighted pumping periods (reflecting the time frame of City use of Well #2 reported to us by DCI and NGI) on Attachments 6 and 7 reveals that the highlighted June through September times generally coincide with declining water levels in City observation wells, as one would expect. However, it is also evident that the match is not perfect; sometimes the time period of declining water levels is a little longer than the highlighted time frame, sometimes it is a little shorter and, occasionally, it does not match closely. This indicates to us that City use of Well #2 is more variable over time than simply during the high summer water demand season.

- There is an approximately 2.5-foot maximum water level difference between individual site monitoring well water levels over that common time period, and an approximately 5-foot maximum water level difference between individual City wells. Being closer to City Production Well #2, the City wells obviously respond to the influence of pumping to a greater degree than site wells, but site wells likely also feel that influence. Site irrigation well pumping also likely affects site observation well levels.

- In addition to the greater influence from drinking water withdrawals at the City property in comparison to the site, we also note, based on a visit to City well OB-6 during our September 8, 2017 site visit, that OB-6 is located at the edge of an off-site ILSF that appears to receive significant stormwater runoff from adjacent neighborhoods. That ILSF area displays clear wetlands characteristics and we also observed an intermittent runoff channel connecting a stormwater outfall to the ILSF. That outfall appears to discharge stormwater runoff generated off of Briggs Ave.

  At our site visit we also observed a topographic ridge located at the northeastern edge of the site, between the site and OB-6 and the ILSF that receives stormwater runoff from Briggs Ave. According to site boring logs, a boring atop that ridge refused on bedrock at a depth of 12 feet. Based on the Applicant's site survey, that places bedrock at that location at approximately elevation 56 feet (NAVD88); an elevation higher than estimated SHGW for the area (refer to discussion above and Applicant's October 26, 2017 submittal) and the observed historic range of groundwater at the City property. The extent and continuity of that bedrock is unknown but, if extensive, would provide at least some degree of hydrologic separation between the City property and the site.

- Based on the above-discussed common data period, it does not appear justified to simply add some extra factor onto water levels from City wells in order to extrapolate potential high groundwater levels at the site in the past, as has been posited by a project abutter. The relationship between groundwater levels at the site and the City property are complex and variable, both spatially and temporally. No simple offset can be applied to estimate the water elevation at a site well based upon a City well that would be universally true.

- Due to the combination of above-mentioned factors for the City well property compared to the site (greater influence from pumping, additional

stormwater influence, and potential influence of bedrock limiting hydraulic connectivity), it is not surprising that groundwater levels at the City property would exhibit more range than the site wells.

- We note on Attachments 5 that in the time span from 2009 through 2012 all City property observation wells exhibited a downward trend in water levels over and above the regular seasonal fluctuations observed before and after. From 2012 to the present those groundwater levels have continued to fluctuate around an average elevation generally about four feet lower than the average elevation from 2005-2009. The two USGS Index Well data records also shown on Attachment 5 do not exhibit that same pattern, indicating that the effect is not climatically induced but, instead, is caused by something of local origin. This means that either there was some systematic change in how groundwater levels were measured and recorded at the City property over this time period or some local hydraulic factor has changed. Local hydraulic factors might include a systematic increase in average water withdrawals from City Well #2 or a diversion of stormwater recharge away from the City property (changing stormwater management from I-95 is one possibility for a stormwater change, although we do not know if this has occurred). Investigation of the potential cause for this change is beyond the Scope of this peer review.

  Site groundwater level data does not exist for a long enough time period to assess whether or not a similar pattern of declining groundwater levels occurred at the site as has been observed at the City property. With regards to SHGW estimates at the site (presuming that pattern of lowered water levels from the City property also held true for the site), because the Frimpter calculations are based off of current groundwater levels, then the Frimpter SHGW estimates would also be lower if current levels are lower. The SHGW mottling indicators observed from site test pits seem less likely to have been influenced by the approximately 5-8 year time period of reduced average groundwater elevations observed at the City property. The fact that site test pit and Frimpter SHGW estimates are in relatively close agreement gives some confidence that site SHGW estimates are not unduly influenced by some unknown factor influencing City property water levels.

  We mention this lowered water level observation mainly to notify the City in case this is a phenomenon that they wish to further investigate. If it is

determined that the phenomenon has been caused by some anthropogenic factor (e.g. increased pumping) that might change back to the prior condition, reversion to that prior condition might potentially impact site groundwater levels to some unknown degree.

2. Isolated Land Subject to Flooding (ILSF) Comments

The boundary of an ILSF is defined in 310 CMR 10.57(2)(b)(3) as the largest observed or recorded volume of water confined within an area that is not a bordering land subject to flooding (i.e. a flooded area with surface water inlets and outlets). In the event of dispute, calculations regarding the extent of the 100-year flood event are used to determine the probable extent of such water. The lateral boundary of the ILSF is the area that will be inundated during that event. ILSF determination must take groundwater inundation into account in that the available flood storage volume in the ILSF should be calculated only for the volume above SHGW. However, because the definition for an ILSF is based on observed flood conditions, those observed flood conditions are generally higher than SHGW.

In the subject matter, DCI originally provided calculations to estimate the 100-year flood elevation for the site ILSF, and then later correlated photographs of the Mother's Day flood to known survey elevations to estimate the flood condition surface water elevation for the ILSF that peaked at approximately elevation 56.2 (NAVD 88). The photo documentation and site survey reconciliation of flood water elevations associated with the Mother's Day storm, and the correlation of those flood elevations with existing basement floor elevations presented in the August 29, 2017 DCI letter provide a reasonably quantitative estimate of that storm's flood elevations on the site.

We offer the following comments related to ILSF:

2.1 HW recommended that the Applicant use the volume inundated at the golf course above SHGW and beneath the 56.2-foot elevation (NAVD 88) during the Mother's Day storm as the existing conditions flood storage volume that would need to be equaled or exceeded under proposed conditions. HW then recommended that the Applicant conduct a HydroCAD model evaluation for existing conditions to determine the storm event required to fill the ILSF storage volume up to the 56.2-foot peak elevation determined from the Mother's Day storm in order to ensure that the 100-year storm event is contained within the delineated ILSF volume for existing conditions. In their October 26, 2017 submittal, the Applicant completed these calculations using a SHGW elevation of

52 feet for the ILSF area, and modeled that a 7.65–inch, 24-hour rain event was required to fill that ILSF from 52 feet elevation up to the observed 56.2-foot flood elevation with a volume of approximately 452,500 cubic feet (cf). The calculated 7.62 inches of rainfall is less than the 8.3 inches required by the City to simulate the 100-year storm event.

2.3 In order to determine the ILSF area under proposed conditions and ensure that it contains the 100–year storm event and also provides equal or greater storage volume to existing conditions, the Applicant ran the HydroCAD model under proposed conditions grading and land use using the City-required, 100-year storm event value of 8.3 inches. This resulted in a larger calculated required flood storage volume (approximately 617,800 cf) for proposed conditions compared to existing (approximately 452,500 cf). However, due to proposed site grading, that larger flood storage volume is contained above ESHGW (El. 52') and below proposed conditions elevation 55.25 feet, as compared to the existing conditions 56.2 feet elevation observed during the Mother's Day storm. The proposed site grading delineates an ILSF area boundary at 55.25 feet elevation that provides approximately 625,900 cf of flood storage volume, an amount that exceeds the required 100-year storm volume. Therefore, the Applicant has adequately addressed our ILSF comments and concerns.

2.4 In addition, based upon a Special Permit requirement for a maximum site ILSF elevation of 56.5 feet, the current, revised site design maintains road and basement elevations above that higher 56.5-foot elevation. The amount of calculated flood storage beneath the 56.5-foot elevation (approximately 1,100,000 cf) is nearly double the calculated 100-year flood storage volume (approximately 617,800 cf).

3. Pollutant Loading Comments

As the entire site is located within a Zone II contributing area to a Newburyport public water supply well (Well #2), the protection of both surface water and groundwater quality is particularly important with this proposed development. Currently, stormwater runoff from the site, and from the adjacent Briggs Avenue, is conveyed to three wetlands areas connected in series on site. Surface water flow moves generally south to north through two lined water features/detention ponds and terminates at an unlined isolated vegetated wetland (IVW) regulated by the Newburyport CC. All three areas are part of the regulated ILSF area. Any water in the two lined detention ponds that is not withdrawn for golf course irrigation or evapotranspired flows to the IVW where it is either infiltrated to groundwater or evapotranspired.

As observed at our site visit, there is currently minimal vegetated buffer between managed turf areas of the golf course and the wetlands areas. Stormwater runoff from the golf course, therefore, currently receives minimal treatment before entering the wetlands. Similarly, runoff from Boyd Drive was observed to flow towards the ILSF wetlands areas with minimal treatment beyond some settling in the catch basins and some deposition and uptake as runoff travels overland between Boyd Drive and the wetlands.

Under proposed conditions, the site and Boyd drive will both continue to drain to wetlands areas within the ILSF. However, the wetlands area itself, the land use of the contributing watershed area, the means of stormwater conveyance, and the water quality treatment of stormwater runoff are all proposed to be changed as follows:

- A significant portion of golf course land use will be converted into residential housing and open space;
- The three separate wetlands areas will be converted into a single, larger, unlined wetlands area with amended soil and plantings;
- The vegetated buffer to the new wetlands area will be expanded, allowing additional treatment of any direct runoff beyond what currently exists; and
- A stormwater management design compliant with current state regulations will provide significantly enhanced water quality treatment for runoff conveyed to the wetlands resources from both the site and Boyd Drive relative to existing conditions.

We offer the following comments related to pollutant loading:

3.1 With regard to the protection of drinking water quality, the concern, under both existing and proposed conditions, is that the infiltration to groundwater of potential stormwater-derived contaminants infiltrated to groundwater beneath the wetland resource areas might be conveyed to City Well #2. Better water quality entering the resource areas themselves, relative to existing conditions, would translate to better groundwater quality following infiltration of water from the wetlands to groundwater, and therefore lesser pollution risk to the City well. The proposed stormwater management design includes six stormwater wetlands or bioretention systems that will be added to manage stormwater in accordance with the MA Stormwater Standards (MASWS) prior to discharge to the expanded IVW. The improved stormwater management and vegetated buffer under proposed conditions will result in improved water quality entering the wetlands and, ultimately, infiltrating to groundwater.

3.2 The two available groundwater flow maps for the site (both during summer pumping conditions as described above) show flow split on the site by a potential bedrock ridge, with flow from the area of the existing and proposed wetlands heading north towards the Merrimack River and flow from the eastern portion of the site heading northeast towards City Well #2. To our knowledge, the theoretical existence of that bedrock ridge is based on one boring conducted by the BSC Group in the 1980's and another by the Applicant as part of this proposed development application. As discussed above, the one recent boring log that we reviewed does show bedrock at a high enough elevation to represent at least a partial hydraulic barrier between east and west. However, the extent and continuity of that bedrock high are unknown. Even if that bedrock high does not create a continuous hydraulic barrier, our examination of the available water level data from the site and City property indicates that, at least during the wintertime non-pumping season, flow from the wetlands area of the site likely heads north towards the Merrimack River. Flow from this area may head towards City Well #2 during the summertime pumping season.

3.3 We reviewed the stormwater management system for compliance with the MASWS as the measure for potential impacts to, initially, the regulated wetland resources on site and, subsequently, to groundwater and potentially City Well #2. In our review, we found that the general stormwater management approach was suitable for the site and has the potential to meet the MASWS. However, the Applicant is currently revising design plans to respond to our prior comments submitted to the CC. Those plan revisions from the Applicant are awaiting resolution of the big picture hydrology issues discussed in this letter. Assuming the stormwater design is appropriately updated to meet the SWMS, our opinion is that stormwater quality treatment at the site, and by extension its potential influence on groundwater and City Well #2 quality will be in regulatory compliance and constitute an improvement over current conditions.

3.4 In our opinion, the conversion of a site land use from managed golf course turf to open space residential development would also generally be considered an improvement from a pollutant loading standpoint (in particular, nutrients and pesticides). Obviously, there is a wide range of pollutant loading that occurs between different golf courses and amongst different homeowners so that generality does not always hold true but, in our opinion, this is a valid generality. In support of that contention, we offer the following discussion, based on our own project experience with golf course and residential pollutant loading concerns:

- As part of the Total Maximum Daily Load (TMDL) evaluation for Pleasant Bay in Chatham, Brewster, Harwich, and Orleans, MA, the Massachusetts Estuary Program (MEP) reviewed site-specific fertilizer application loads within the watershed, and for the Cape in general. http://www.mass.gov/eea/docs/dep/water/resources/mep/cape/mep-pleasant-lc.pdf

  They determined the following:

  - Based upon approximately 300 interviews and over 2,000 site surveys conducted over the entire upper Cape, the average residential lawn area in the study area is approximately 5000 square feet (sf), half of the residences did not apply lawn fertilizer at all, and the weighted average residential application rate was 1.44 applications per year. Integrating the average residential fertilizer application rate with a leaching rate to groundwater of 20% results in a fertilizer contribution of nitrogen to groundwater of 1.08 pounds (lbs.) of nitrogen per 5000 sf residential lawn. 1.08 lbs. of nitrogen per 5,000 sf residential lawn is equivalent to 0.22 lbs. per 1,000 sf.

  - A smaller survey of 340 homes throughout the Town of Orleans found that the average application rate for residences serviced by professional landscapers (approximately a third of the homes) was 1.76 times per year, while the average rate for home-owner serviced properties (approximately two thirds of the homes) was only 0.85 times per year. Based upon the same 20% leaching factor, the overall weighted average nitrogen loading rate to groundwater was 1.51 lbs. of nitrogen per lawn (equivalent to 0.30 lbs. per 1,000 sf) per year; with the professionally landscaped residences representing 3.29 lbs. of nitrogen per year per lawn (equivalent to 0.66 lbs. per 1,000 sf) and the homeowner landscaped residences 0.64 pounds (equivalent to 0.13 lbs. per 1,000 sf), respectively.

  - The MEP-determined average nitrogen application rates in lbs. per 1,000 square feet per year for four golf courses in the watershed were 4.1 for greens, 3.4 for tees, 3.1 for fairways, and 2.6 for rough. Given that most golf courses have significantly more fairway and rough area than greens and tees, the overall average nitrogen application rate for these golf courses is likely something in the vicinity of 3 lbs. per 1,000 sf per year. Subject to the same 20% leaching rate described above for lawn areas, the MEP-estimated overall nitrogen loading rate to groundwater per year for these golf courses is approximately 0.6 lbs. per 1,000 sf; a number similar to that estimated for the high end of professionally landscaped

residential lawns and approximately double the overall average residential loading rate.

- The Great Bay Nitrogen Non-Point Source Study prepared by the New Hampshire Department of Environmental Services (NHDES) in 2014 also estimated nitrogen application rates for golf courses, residential lawns, and recreational fields. https://www.des.nh.gov/organization/divisions/water/wmb/coastal/documents/gbnnpss-report.pdf

  That study used an overall average annual nitrogen application rate for golf courses of 2.25 lbs. per 1,000 sf of managed turf area. Leaching rate to groundwater is not mentioned but if the same 20% rate used for the Cape MEP study were applied to the Great Bay study, the overall nitrogen loading rate to groundwater for managed turf areas of golf courses would be 0.45 lbs per 1,000 sf. The estimated nitrogen application rate for residential lawn areas is 1.08 lbs per 1,000 sf, based on an estimated fertilizer use of 54% of all homes. Again using the 20% leaching rate to groundwater, that would be equivalent to a nitrogen loading rate to groundwater of 0.22 lbs. per 1,000 sf for residential lawns.

- The Great Bay and Pleasant Bay/Cape Cod studies both indicate generally greater nitrogen application rates and groundwater loading rates per unit area of golf course turf as compared to residential lawns.

- The nitrogen loading comparison between golf and residential lawn areas becomes more conclusive when considering that the percent of any given golf course project area that is occupied by managed turf is generally significantly greater than the percent of a residential development that is managed turf. In the case of the Evergreen site, the existing golf course reportedly consists of approximately 24 acres of managed turf on a 36.4 acre parcel. In contrast that same 36.4 acre parcel is proposed to have approximately 9 acres of lawn under the proposed development proposal (NGI, September 2016).

- We do not have ready data concerning pesticide application rates for residential lawns similar to the fertilizer research discussed above. However, we have conducted numerous water quality monitoring or water quality data review projects for golf courses for which we have reviewed pesticide application data as well as water quality monitoring data. In general we note that golf courses tend to utilize a wide variety of pesticides in significant quantity to maintain a

quality turf surface. We recognize that there is a wide range in both the degree of management and the quality of turf provided by different courses.

3.5 Special conditions regarding lawn maintenance included as Article IX of the August 8, 2017 Draft Homeowners Agreement (HOA) for the development will help to further ensure that pollutant loading under proposed conditions should be less than under existing conditions. The Draft HOA includes requirements for landscaping of all home lots and common areas to be conducted by a single contractor who must submit a landscape management plan to the City each year specifying what fertilizers and pesticides may be used. The City will have the right to limit the allowable products and quantities in recognition of the site's location within a Zone 2 contributory area to City drinking water wells.

3.6 We have reviewed the correspondence from AECOM and NGI regarding potential soil and groundwater contamination on site and concur with both parties that no data supplied to HW for review indicate the potential for any significant, existing, groundwater contamination, and that the low concentrations of pesticides observed in soil samples are consistent with the site's use as a golf course. As stated in the July 30, 2017 letter from NGI, we also concur that numerical modeling of contaminant transport from the site is not warranted due to the lack of a significant source of contamination to model.

4. Conclusions

In summary, we make the following statements regarding our review of hydrologic issues related to the proposed development:

4.1 Our SHGW comments have been adequately addressed with the Applicant's October 26, 2017 submission. The SHGW figure included with that submission portrays a reasonable distribution of SHGW across the site and key site infrastructure are being redesigned based upon those revised SHGW estimates.

4.2 Observed water level fluctuations at City property monitoring wells are greater than those observed on site (for the short common data period in 2016 and 2017). This is likely due to the nearby pumping influence from City Well #2 during pumping seasons, the location of City wells nearby a separate offsite ILSF area that collects significant stormwater runoff, and the potential for a partial groundwater restriction between City property and the site. Due to the

differing hydraulic influences affecting the City property and the site, we recommend not attempting to overly predict groundwater conditions at the project site directly based on the adjacent City well site property.

4.3 The observed decrease in groundwater levels beneath the City property beginning in approximately 2009 may or may not be a real physical event, and its potential causes, natural or anthropogenic, are also unknown. The City may wish to further investigate this phenomenon and also consider potential water level impacts to the proposed development if a human-induced cause for the water level change is determined and that human influence is eliminated, returning water levels to the higher elevation observed prior to 2009.

4.4 Our ILSF comments have been adequately addressed with the Applicant's October 26, 2017 submission. The proposed ILSF delineated area beneath elevation 55.25 feet provides greater storage volume than required to store the simulated 100-year storm under proposed site conditions. In addition, the Applicant is designing roads and basements to be above an even higher Special Permit elevation of 56.5 feet so that a total flood storage volume of nearly double the simulated 100-year storm is available beneath key site infrastructure elevations.

4.5 The proposed MASWS-compliant stormwater management systems, improvements to the vegetated buffers around resource areas, and improvement to site wetlands are expected to improve the quality of water contributed to the site wetlands resource areas. Improved water quality in the wetlands will translate to improved water quality for the groundwater that will receive infiltration from the site wetlands. Improved groundwater quality may subsequently translate potentially to improved water quality at City Well #2, to the extent that it may receive groundwater flow that originated beneath the site wetlands area. In addition, the conversion of land at the site from managed golf course turf to residential development serviced by municipal sewer service is expected to be generally beneficial to water quality, provided that lawn care is properly managed in accordance with the proposed HOA.

4.6 We will work with the City to draft Conditions of Approval for the proposed development that will be beneficial to protecting the City's water quality interests at Well #2.

Thank you for the opportunity to assist the City in reviewing this significant project. Please feel free to contact me, at nprice@horsleywitten.com or 508-833-6600, or Ellie

Baker at ebaker@horsleywitten.com or 603-658-1660 with any questions regarding these comments. We would be happy to attend an upcoming PB Public Hearing to present these comments and respond to questions. Ellie plans to attend the CC hearing this evening to present these comments on my behalf.

Sincerely,

Horsley Witten Group, Inc.

Neal M. Price
Senior Hydrogeologist

cc: Mr. Thomas Hughes, Hughes Environmental Consulting
Mr. Stephen Sawyer, Design Consultants, Inc.
Atty. Lisa Mead, Mead, Talerman and Costa, LLC

Attachments:
1 - List of materials reviewed;
2 - BSC Group 1985 Water Table Map;
3 - NGI 2017 Water Table Map;
4 - Groundwater Levels at site and USGS Index Wells;
5 - Groundwater Levels at City property and USGS Index Wells;
6 - Groundwater Levels at City property and USGS Index Wells 2005-2009; and
7 - Groundwater Levels at City property and USGS Index Wells 2009-2017.

ATTACHMENTS

Attachment A. List of Project Materials Reviewed

The following materials were reviewed for the 18 Boyd Drive Open Space Residential Development:

- BSC Group, Inc., Subsurface Investigation, August 22, 1985.
- Zone 2 Delineation and Source Water Assessment for Newburyport Wells 1 and 2, June, 2001, Talkington Edson Environmental Management, LLC.
- Soil Suitability Reports from January 28, 2016 Deep Observation Holes TP-1 through TP-13 from January 28, 2016, performed by Alexander Parker (no City witness documented).
- City of Newburyport Conservation Commission Findings, DEP File Number 051-0950, issued on June 13, 2016;
- September, 2016 Water Resources Impact Evaluation Report from NGI, Inc.
- October 13, 2016 AECOMM review letter to City Planning Director reviewing Applicant's recent NGI report on potential impacts to the public water supply.
- October 12, 2016 NGI letter to Planning Board.
- October 19, 2016 NGI response letter.
- October 17, 2016 professional opinion letter from Geosphere Environmental Management, Inc. to the Planning Board and Board of Health.
- June 1, 2017 letter from EnviroRisk Solutions to NGI about residual herbicide and pesticide sample data from 3/21/17.
- June 2, 2017 Notice of Intent submitted to Conservation Commission by HEC.
- June 5, 2017 letter from Northeast Geoscience, Inc. (NGI) to Cottage Advisors, LLC discussing soil and groundwater contamination concerns.
- Chart of groundwater elevations from City observation well OB-6 (2001-2017) (submittal date and author not referenced).
- June 26, 2017 memorandum to the Planning Board from Mead, Talerman, and Costa (MTC), LLC, the attorneys representing the Applicant.
- June 26, 2017 Site Plan Review letter prepared by Christiansen & Sergi, Inc. (CSI) in review of June 22 plans;
- June 27, 2017 and July 6, 2017 letters from the Board of Health.
- July 11, 2017 letter from Hughes Environmental Consulting (HEC) to the Conservation Commission addressing June 20, 2017 Conservation hearing comments and MA DEP comments. Referenced two attachments:
    - July 5, 2017 letter from NGI to MTC.

- July 11, 2017 letter from DCI to the CC regarding ILSF calculations and SHGW. Includes Jan 28, 2016 Deep Observation Hole Reports for TP16-5, 6, 7, 8, 9, 10, 11, and 13.

- July 17, 2017 letter from AECOM commenting on the June 5, 2017 soil contamination letter from NGI;
- August 8, 2017 DCI response to June 26, 2017 CSI review letter.
- August 8, 2017 Project Narrative and Stormwater Analysis, prepared by DCI. Updated from May 22, 2017.
- August 9, 2017 letter to the Planning Board from MTC, including attachments:
  - Aug 8, 2017 Draft Homeowners Associations Declaration of Trust
  - Jul 6, 2017 Board of Health comment letter
  - Jul 30, 2017 letter to the Planning Board from NGI opining the lack of appropriateness for modeling of the contaminant transport
- August 10&11, 2017 emails from AECOM to the City Planning Board on behalf of the Water Department.
- August 17, 2017 email comments from abutter Peter Hatcher.
- August 29, 2017 letter from DCI to the Planning Board.
- August 29, 2017 OW-6 Groundwater Evaluation letter (with 4 figures), prepared by DCI.
- Open Space Residential Definitive Subdivision of Land & W.R.P.D. Special Permit, Newburyport, Massachusetts, prepared by Design Consultants Inc., prepared for Evergreen Commons, LLC, original date June 2, 2017, includes:

Cover Sheet	T1	rev. 8/8/17
Existing Conditions Plan of Land	EX1	rev. 8/8/17
Existing Conditions Plan of Land	EX2	rev. 8/8/17
Existing Conditions Plan of Land	EX3	rev. 8/8/17
Existing Conditions Plan of Land	EX4	rev. 8/8/17
Existing Conditions Plan of Land	EX5	rev. 8/8/17
Existing Conditions Plan of Land	EX6	rev. 8/8/17
Lot Layout Key Sheet	S1	rev. 8/8/17
Lot Layout Sheet 1	S2	rev. 8/8/17
Lot Layout Sheet 2	S3	rev. 8/8/17
Lot Layout Sheet 3	S4	rev. 8/8/17
Lot Layout Sheet 4	S5	rev. 8/8/17
Lot Layout Sheet 5	S6	rev. 8/8/17
Civil Key Sheet	C1	rev. 8/8/17
Grading Plan 1	C2	rev. 9/12/17
Grading Plan 2	C3	rev. 9/12/17
Grading Plan 3	C4	rev. 9/12/17
Grading Plan 4	C5	rev. 9/12/17
Drainage & Utility Plan 1	C6	rev. 8/8/17
Drainage & Utility Plan 2	C7	rev. 8/8/17
Drainage & Utility Plan 3	C8	rev. 8/8/17
Drainage & Utility Plan 4	C9	rev. 8/8/17

  - Street Plan & profile Road A & D C10 rev. 8/8/17
  - Street Plan & Profile Road B C11 rev. 8/8/17
  - Street Plan & profile Road C C12 rev. 8/8/17
  - Typical Sections, Details & Notes 1 C13 rev. 8/8/17
  - Typical Sections, Details & Notes 2 C14 rev. 8/8/17
  - Typical Sections, Details & Notes 3 C15 rev. 8/8/17
  - Typical Sections, Details & Notes 4 C16 rev. 8/8/17

- October 2, 2017 email comments from abutter Peter Hatcher with City observation well data attached.
- October 4, 2017 emails (7) from AECOM attaching information otherwise cited here.
- October 13, 2017 DCI response package to September 26, 2017 HW comments on SHGW and ILSF issues.
- October 26, 2017 DCI response package to September 26, 2017 HW comments on SHGW and ILSF issues.

NGI
NORTHEAST GEOSCIENCE INC
Water Supply and Environmental Consulting
97 Walnut Street
Clinton, Massachusetts
978.365.9045
www.ngeo.net

EXISTING PUBLIC WATER SUPPLY
ASSESSORS PARCEL
BEDROCK HIGH
GROUNDWATER FLOW LINE
GROUNDWATER ELEVATION CONTOUR (FT)

NOTE:
GROUNDWATER CONTOURS, BEDROCK HIGH AND GROUNDWATER FLOW LINES FROM BSC GROUP REPORT DATED AUGUST 22, 1985.

N
W E
S
0 50 100 200
Feet

BSC GROUP GROUNDWATER CONTOUR MAP
EVERGREEN COMMONS LLC
18 BOYD DRIVE
NEWBURYPORT, MASSACHUSETTS

NGI REF: BscGwContMap11x17	
Drafted By: JAF	Date: 09/14/2016
Source: MassGIS, ArcGIS, Design Consult., Inc.	

FIGURE 7

B-3
(43.65 ft)

B-5
(40.75 ft)

40

39

42

41

43

B-2
(43.04 ft)

MW-5
(45.51 ft)

44

B-4
(43.36 ft)

SB-4
(NA)

45

B-6
(45.75 ft)

46

SHEET 2

MW-3
(46.52 ft)

MW-6
(46.66 ft)

MW-7
(46.37 ft)

46

47

Old Well
(NA)

IW-1
(NA)

SHEET 4

IW-2
(47.63 ft)

MW-2
(48.2 ft)

MW-8
(47.48 ft)

48

MW-1
(47.9 ft)

Attachment 3 - NGI 2017 Water Table Map

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

NGI
NORTHEAST GEOSCIENCE INC
Water Supply and Environmental Consulting
97 Walnut Street
Clinton, Massachusetts
978.365.9045
www.ngeo.net

EXISTING PUBLIC WATER SUPPLY
EXISTING MONITORING WELL
EXISTING IRRIGATION WELL
SOIL BORING

ASSESSORS PARCELS
GROUNDWATER FLOW LINE
48 GROUNDWATER ELEVATION CONTOUR (FT)
BEDROCK HIGH

N
W E
S

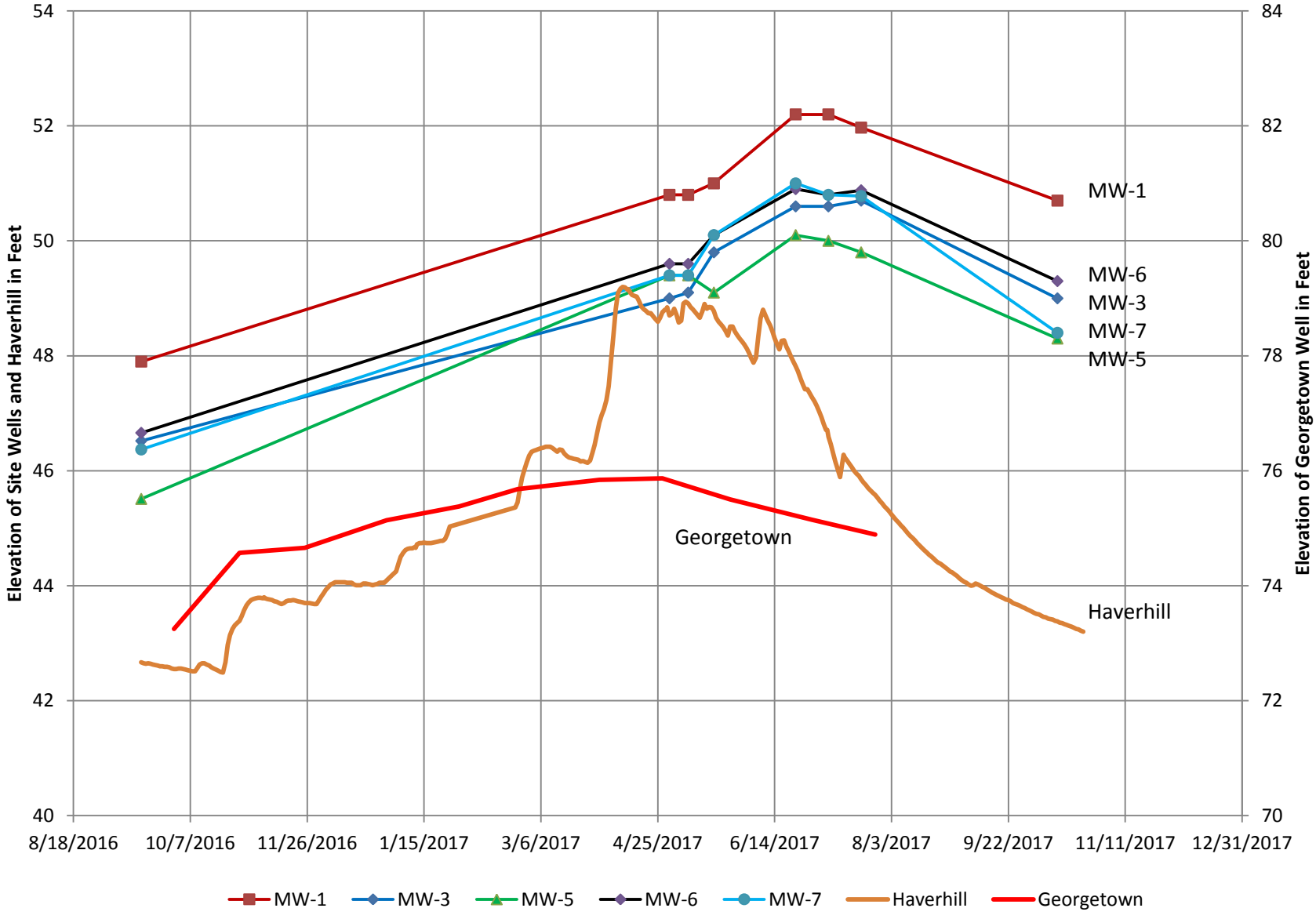
0 50 100 200
Feet

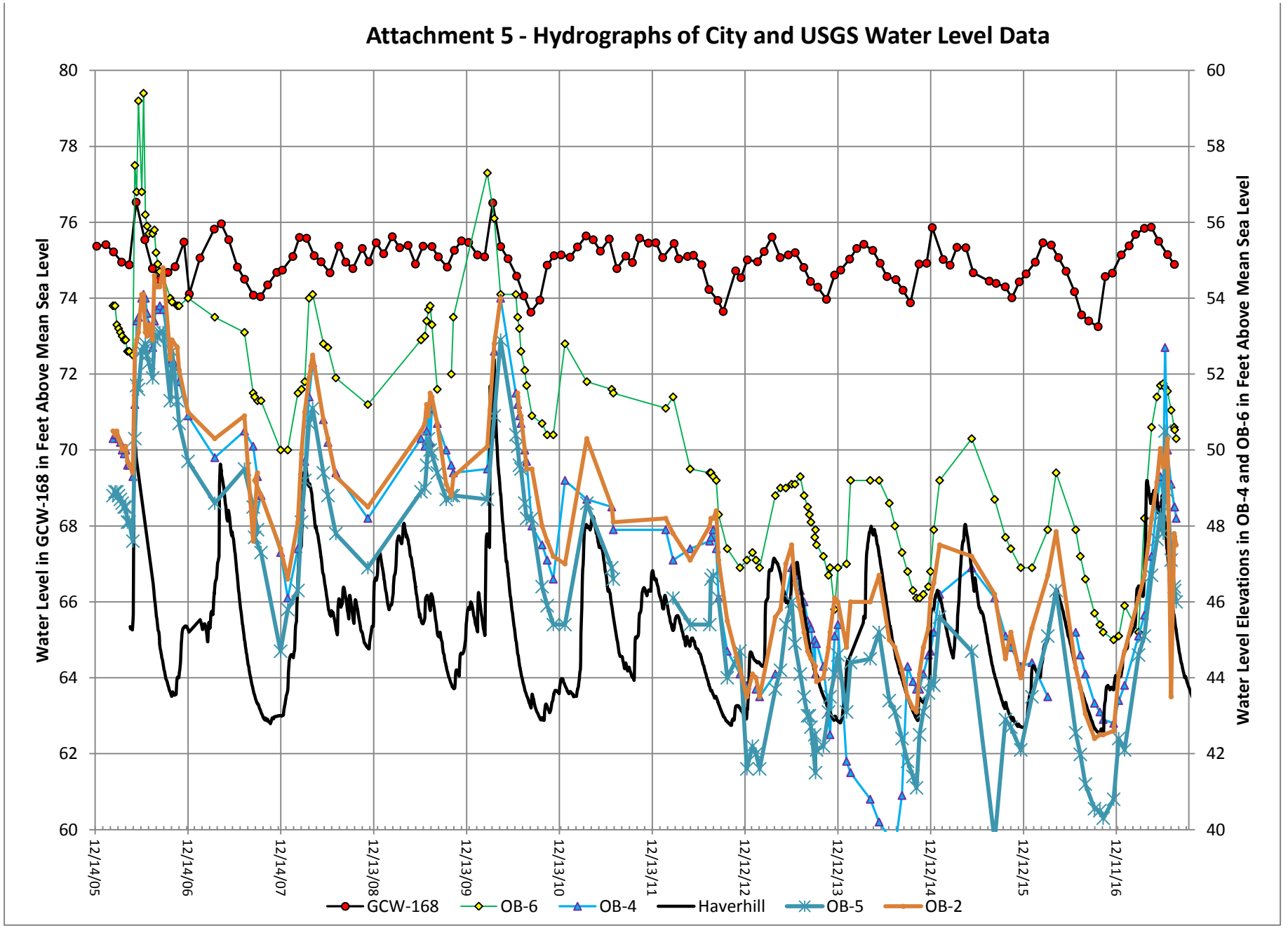
NGI GROUNDWATER MAP 09/16/16
EVERGREEN COMMONS LLC
18 BOYD DRIVE
NEWBURYPORT, MASSACHUSETTS

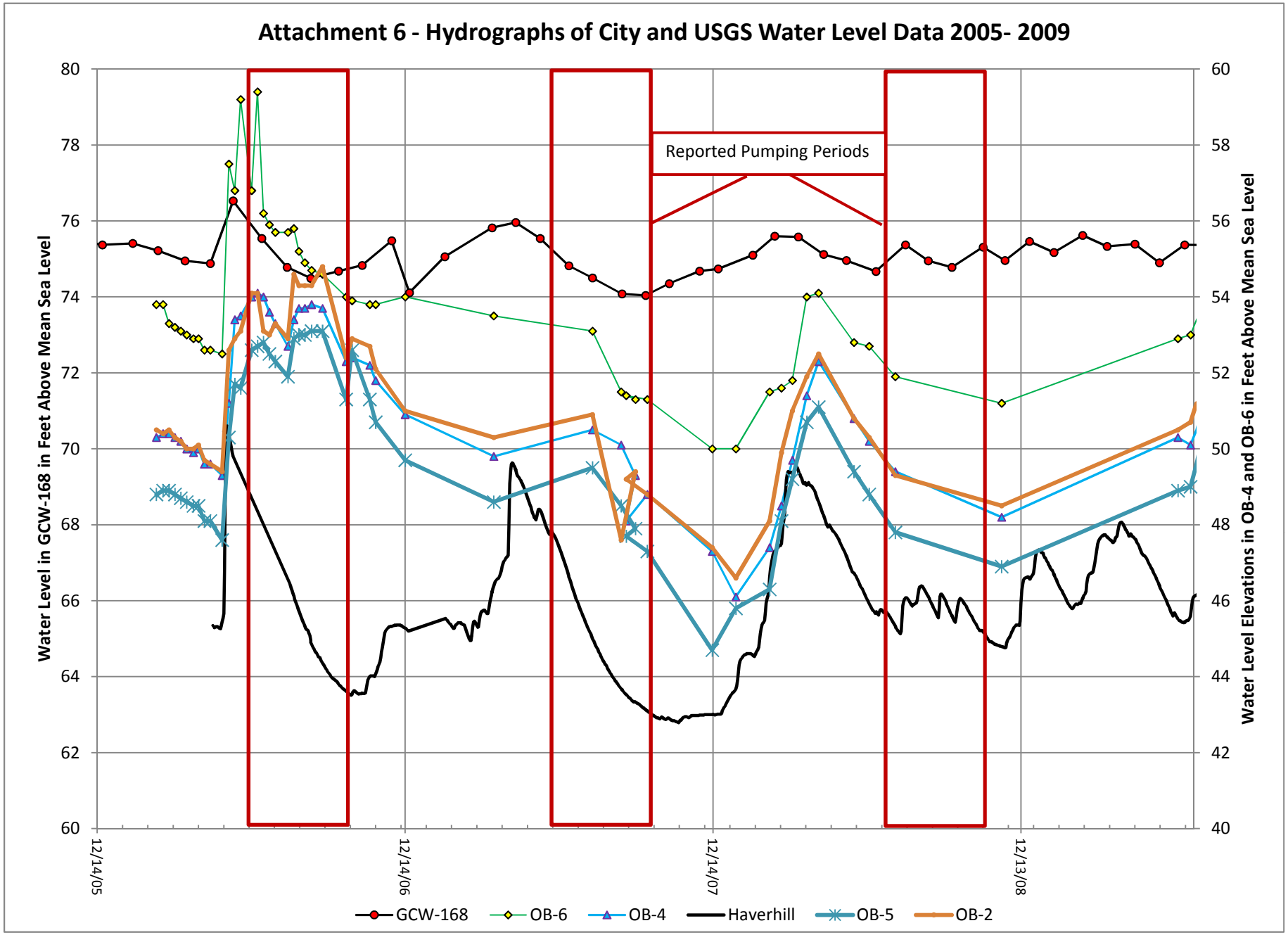
NGI REF: NgiGwContMap11x17
Drafted By: JAF | Date: 09/19/2016
Source: MassGIS, ArcGIS, Design Consult., Inc.

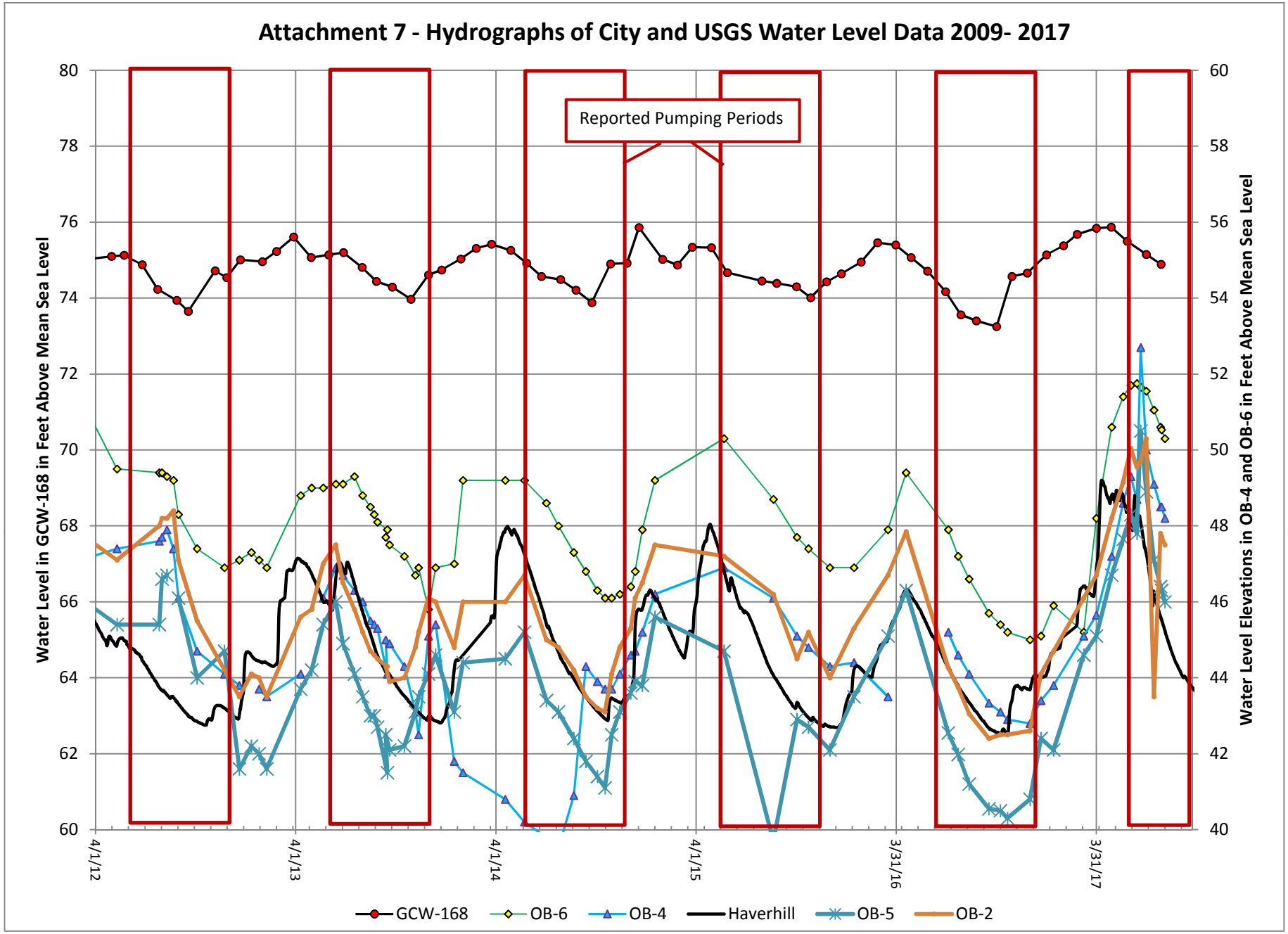
FIGURE 8

Attachment 4 - Evergreen Commons and USGS Groundwater Hydrographs




Attachment 5 - Hydrographs of City and USGS Water Level Data
Water Level in GCW-168 in Feet Above Mean Sea Level
Water Level Elevations in OB-4 and OB-6 in Feet Above Mean Sea Level
80
78
76
74
72
70
68
66
64
62
60
60
58
56
54
52
50
48
46
44
42
40
12/14/05
12/14/06
12/14/07
12/13/08
12/13/09
12/13/10
12/13/11
12/12/12
12/12/13
12/12/14
12/12/15
12/11/16
GCW-168
OB-6
OB-4
Haverhill
OB-5
OB-2


Attachment 6 - Hydrographs of City and USGS Water Level Data 2005- 2009
Reported Pumping Periods
Water Level in GCW-168 in Feet Above Mean Sea Level
Water Level Elevations in OB-4 and OB-6 in Feet Above Mean Sea Level
80
78
76
74
72
70
68
66
64
62
60
60
58
56
54
52
50
48
46
44
42
40
12/14/05
12/14/06
12/14/07
12/13/08
GCW-168
OB-6
OB-4
Haverhill
OB-5
OB-2


Attachment 7 - Hydrographs of City and USGS Water Level Data 2009- 2017
Reported Pumping Periods
Water Level in GCW-168 in Feet Above Mean Sea Level
Water Level Elevations in OB-4 and OB-6 in Feet Above Mean Sea Level
80
78
76
74
72
70
68
66
64
62
60
60
58
56
54
52
50
48
46
44
42
40
4/1/12
4/1/13
4/1/14
4/1/15
3/31/16
3/31/17
GCW-168
OB-6
OB-4
Haverhill
OB-5
OB-2