APPENDIX K

GROUNDWATER MONITORING PROTOCOLS (GMP)

NP&V, LLC

July 8, 2016

Groundwater Monitoring Protocols

The Hills at Southampton

East Quogue, New York

NP&V Job # 05105

July 8, 2016

NELSON, POPE & VOORHIS, LLC
ENVIRONMENTAL • PLANNING • CONSULTING

Groundwater Monitoring Protocols

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The Hills at Southampton

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Groundwater Monitoring Protocols

The Hills at Southampton

East Quogue, New York

1.0 PURPOSE AND ENVIRONMENTAL CONDITIONS

1.1 PURPOSE

The purpose of this document is to present a groundwater monitoring plan for the proposed golf course to be associated with The Hills at Southampton community. The Hills at Southampton golf course will be utilized as a recreational amenity for the 118 unit seasonal residential community located in East Quogue, New York. Results from monitoring events will be reviewed on a quarterly basis to assess groundwater quality in strategic areas of the golf course including up and downgradient monitoring of pre- and post-construction conditions.

The Hills at Southampton golf course will utilize non-traditional turf management practices as outlined in the Integrated Turf Health Management Plan (ITHMP) in order to comply with the golf course management standards established by Suffolk County as well as meet or exceed the Best Management Practices for New York State Golf Courses (NYSBMP). The implementation of the ITHMP will be assisted through several elements related to golf course design and maintenance techniques which will include:

- Development of a healthy soil profile.
- Proper course irrigation and drainage.
- Installation of appropriate disease and pest resistance turf.
- Utilization of native vegetative species where applicable.
- Soil ecology monitoring and management.
- Routine monitoring of the Hills at Southampton golf course for early detection of maintenance needs and detection of problem areas.

The groundwater monitoring plan will be enacted for a period of five years, following which a review will be conducted in order to assess what modifications to the monitoring program may be necessary.

1.2 ENVIRONMENTAL CONDITIONS

1.2.1 Soils

The Soil Survey of Suffolk County, conducted by the U.S. Department of Agriculture in 1975 is a useful source of soils information, which identifies soil types resulting from natural deposition and modification, as well as man-induced alterations associated with land use.

The subject property lies in an area classified as containing Plymouth-Carver association, nearly level and undulating soils. These soils are described as deep, excessively drained coarse textured and coarse textured soils on outwash plains

More specifically, the subject property is comprised of soil types: CpA & CpC - Carver Plymouth Sands, 3-15% & 15-35% slopes, respectively, CuB - Cut and Fill Land, Gp - Gravel Pit, HaA & HaB - Haven Loam, 0-2 and 2-6% slopes, respectively, RdA & RdB - Riverhead Sandy Loam, 0-3 & 3-8% slopes, respectively and Su- Sunbury Sandy Loam. The characteristics of these soil types are- identified as follows **(Warner et al., 1975)**:

Carver and Plymouth sands, 0-3% slopes (CpA) - The Carver series consists of deep, excessively drained coarse-textured soils. This soil type is found mainly on outwash plains; however, they are also found on some flatter hilltops and intervening draws on moraines. The hazard for erosion is slight.

Carver and Plymouth sands, 3-15% slopes (CpC) - The Carver series consists of deep, excessively drained coarse-textured soils. This soil type is found mainly on rolling moraines; however, they are also found on the side slopes of many drainage channels on the outwash plains. The hazard for erosion is slight to moderate.

Carver and Plymouth sands, 15-35% slopes (CpE) - The Carver series consists of deep, excessively drained coarse-textured soils. This soil type is found almost exclusively on moraines except for a few steep areas on side slopes along some of the more deeply cut drainage channels on outwash plains. The hazard for erosion is moderate to severe.

Cut and fill land, gently sloping (CuB) - This series is comprised of areas that have been cut and filled for non-farm uses. The areas generally are large, but some areas are about five (5) acres in size. This soil type is comprised of moderately sloping areas that have been graded for building sites. Slopes range from 1 to 8 percent.

Gravel Pits (Gp) - Open excavations that have been made for the purpose of mining sand and gravel. These pits range in depth from eight (8) or ten (10) feet to more than 100 feet. The sides of the pit are generally left nearly vertical and the bottoms are level.

Haven loam 0-2% slopes (HaA) - This map unit consist of deep, well drained, medium textured soils that formed in a loamy or silty mantle over stratified coarse sand and gravel. Most of these areas are on outwash plains; some are on moraines and generally are on top of low-lying hills. The hazard of erosion is slight and internal drainage is good. Natural fertility is low.

Haven loam 2-6% slopes (HaB) - The Haven series consists of deep, well drained, medium textured soils that formed in a loamy or silty mantle over stratified coarse sand and gravel. This soil is found

on outwash plains and moraines, commonly along shallow drainage channels. The hazard of erosion is moderate to slight.

Plymouth loamy sand, 0-3% slopes (PlA) - Consists of deep, excessively drained, coarse-textured soils that form a mantle of loamy sand or sand over thick layers of stratified coarse sand and gravel. These soils are mainly on outwash plains south of the Ronkonkoma moraine. The areas are generally level, but undulate in some areas. The hazard of erosion is slight.

Plymouth loamy sand, 8-15% slopes (PlC) - This map unit consists of moderately sloping soils on moraines and outwash plains. Where it occurs on moraines, slopes are rolling in many places, and the surface is broken by closed depressions. On outwash plains this soil type is on the short side slopes along intermittent drainageways. The hazard of erosion is moderate to severe because of the slopes and the sandy texture of the soil. Slope and droughtiness are the main limitations on this soil for most nonfarm uses.

Riverhead Sandy Loam, 0-3% slopes (RdA) - Consists of deep, excessively drained, coarse - textured soils that formed in a mantle of sandy loam or fine sandy loam over thick layers of coarse sand and gravel. This soil is generally found on outwash plains, and the areas are large and uniform. Hazardous of erosion is slight.

Riverhead sandy loam, 3-8% slopes (RdB) - The Riverhead series consist of deep, well-drained, moderately course-textured soils. These soils occur primarily on outwash plains. A few small irregular areas are on the moraines. Riverhead soils have moderate to high available moisture capacity. Internal drainage is good, with moderately rapid to very rapid permeability. Natural fertility is low.

Sunbury Sandy Loam (Su) - This is the only Sunbury soil mapped in the county and it is usually found between areas of more poorly drained soils and adjoining well-drained soils of the Riverhead series. Most areas of this soil are small.

1.2.2 Geology

Long Island is located within the Atlantic Coastal Plain, a physiographic province in which substantial sediment deposits overlie the base, or bedrock **(Fuller, 1914).** The surface topography primarily reflects the glacial history of the Island and subsequent human activity.

The Bedrock underlying Long Island slopes south and east at a rate of approximately 70 feet per mile, and the overlying sediments increase in thickness toward the south **(Jensen and Soren, 1974; Smolensky, et al., 1989).**

The primary Cretaceous sediments on Long Island are the Raritan and Magothy Formations, which were deposited atop bedrock during the mid to late Cretaceous period (138 to 65 million years ago) as a result of sediment transport from highlands to the north of the Island **(Koszalka, 1984).** The Raritan Formation consists of two members: the Lloyd Sand and the Raritan Clay. The Lloyd Sand contains the Lloyd aquifer, which is separated from the overlying Magothy aquifer by the low permeability Raritan Clay **(Sutter et al., 1949; Jensen and Soren, 1974).** The Magothy Formation and Matawan Group, which form the Magothy aquifer, were deposited in the late Cretaceous (approximately 75 million years ago) following a period of erosion of the

Raritan clay. The base of the Magothy is composed of coarse sand, gravel and pebbles as large as 2 inches in diameter. These coarse sediments are interbedded with fine to clayey sands and solid clays. Locally thick clay beds have been traced to spans of up to one mile.

During the Tertiary period (65 to 2 million years ago) there was erosion of Cretaceous deposits over much of Long Island due to hydrologic processes such as stream formation. Sea level was low, and a large valley formed north of Long Island in what is now Long Island Sound. Most of the surface sediments evident on Long Island were deposited during the glacial advances of the Pleistocene epoch, Quaternary period (2 million years ago to 10,000 years ago). The Pleistocene was marked by cycles of glacial advance and subsequent retreat producing morainal and glaciofluvial (outwash) sediments on top of the Magothy Formation and Matawan Group. These Quaternary sediments, which consist of clay, silt, sand, gravel, and boulders, include both the Gardiners Clay and the Upper Glacial aquifer. The Ronkonkoma and Harbor Hills Terminal Moraines were deposited as part of this Upper Glacial deposit along the spine and the North Shore of Long Island as the glaciers retreated during the Wisconsin stage of the Late Pleistocene (approximately 25,000 to 10,000 years ago) **(Koszalka, 1984, p. 15).** Low, flat outwash plains formed southward as erosional processes carried sediments away from the moraines, and coastal processes formed barrier beaches along the south shore as sea level rose.

The upper extent of the Upper Glacial Formation corresponds with the topographic elevation of the of the Hills at Southampton property, which ranges from approximately 17 to 255 feet above msl with a thickness ranging from 117 to 355 feet **(Jensen and Soren, 1974)**.

Due to the subject properties location south of the Ronkonkoma terminal moraine, subsurface materials immediately below the surface can be characterized and glacial outwash deposits which generally consist of fine to medium sands and gravels that exhibit excellent groundwater transmitting properties which will be discussed in further detail below. Review of logs prepared for two soil borings installed on the subject property confirmed referenced information that deposited materials underlying the site consist of fine sands with traces of gravel. Copies of the soil boring logs are provided as **Attachment A**.

1.2.3 Hydrogeology

Groundwater on Long Island is derived from precipitation. Precipitation entering the soils in the form of recharge passes through the unsaturated zone to a level below which all strata are saturated. This level is referred to as the water table. In general, the groundwater table coincides with sea level on the north and south shores of Long Island, and rises in elevation toward the center of the Island. The high point of the parabola is referred to as the groundwater divide. Differences in groundwater elevation create a hydraulic gradient which causes groundwater to flow perpendicular to the contours of equal elevation, or generally toward the north and south shores from the middle of the Island **(Freeze and Cherry, 1979)**. Near the shore, water entering the system tends to flow horizontally in a shallow flow system through the Upper Glacial Aquifer to be discharged from subsurface systems into streams or marine surface waters as subsurface outflow. Water that enters the system further inland generally flows vertically to deeper aquifers before flowing toward the shores (**Krulikas, 1986**).

The major water-bearing units beneath the subject site include the Upper Glacial aquifer, the Magothy aquifer, and the Lloyd aquifer **(Jensen and Soren, 1974; Koszalka, 1984)** and corresponds directly with the formation altitudes and thicknesses discussed in **Section 1.2.2**. The aquifer directly underlying the subject property is the Upper Glacial aquifer and is noted to have an average horizontal hydraulic conductivity of 254.6 feet per day (ft/day) (**McClymonds and Franke, 1972)** and an average vertical hydraulic conductivity of 27 ft/day (**Franke and Cohen, 1972**).

Two (2) temporary monitoring wells were installed on the subject property and were situated in the central-northwest and central-southeast parts of the property where access through existing cleared areas could be obtained. Collection of groundwater levels from each revealed that the depth to water was 55 feet below ground surface (bgs) in the central-northwest part of the site and the depth to water was 37 feet bgs in the central-southeast part of the site. The groundwater elevation between each monitoring well was found to range from 15 feet to 13 feet above mean sea level (msl).

The south part of the Hills at Southampton property is located within areas designated as 5 to 10 and 10 to 25 year contributing areas to Weesuck Creek which is located approximately 1,600 feet southeast of the subject property at its nearest location. It is expected that water recharged within these contributing areas would migrate downgradient in the direction of groundwater flow for a period ranging from 5 to 25 years until eventual discharge to Weesuck Creek per the Source Water Assessment Program (SWAP) map prepared by the Suffolk County Water Authority.

2.0 ENGINEERING CONTROLS

The Hills at Southampton golf course will utilize physical and management practice controls to limit the use of traditional application practices normally associated with turf maintenance. The golf course will be state-of-the-art, and will employ the most advanced controls available. Such controls will consist of a liner system installed beneath areas under the more actively managed areas of the course as well as turf management practices which will surpass the golf course management standards accepted by Suffolk County and the Town of Southampton.

2.1 GREEN LINERS AND BIO-SWALES

A green liner system will be employed in order to intercept water recharged through the greens to limit the potential for leaching of nitrates other turf care products from the most actively managed portions of the golf course. The use of a green liner system will be consistent with the overall environmental conservation approach applied throughout the project. The liner will prevent the leaching of nitrogen and other turf care products that may be used on the greens when necessary. As the greens are typically the most intensively managed areas of the course, this approach will enhance the water quality protection efforts for the overall project.

The greens will be lined with impermeable materials consisting of an approved liner material (40 mil HDPE) and excess drainage intercepted beneath the greens will be collected and conveyed to a bio-swales placed in strategic areas of the course, that will ensure the biological uptake and treatment of this water.

It is noted that green liners may not collect all of the drainage water when there are larger storm events, and may not be 100% effective at retaining nitrogen, phosphorus or pesticides. The application of fertilizer nitrogen to greens will not exceed 2.5 lbs/1000 SF per the ITHMP and the use of pesticides will be limited per the ITHMP. The monitoring protocol will include sampling of groundwater downgradient and in proximity to the bio-swales (rain gardens) which are strategically placed near the greens. As a result, these sample locations will determine the effectiveness of the green liner/bio-swale systems in attenuating nitrogen, phosphorus and pesticides and will serve to monitor groundwater proximate to the greens. Nine (9) such wells are proposed, coupled with nine (9) lysimeters in proximate locations to determine the quality of recharge in the vadose zone proximate to the greens, bio-swales and groundwater monitoring wells. All wells and lysimeters will be sampled for nitrogen, phosphorus and pesticides as described in **Section 4.2**. **Figure 1** provides an illustration of the locations of these sampling points.

2.2 PESTICIDE/FERTILIZER MAINTENANCE PROTOCOLS

The Hills at Southampton golf course will institute a management plan which will both be sensitive and sustainable to ensure the health and wellbeing of environmental resources on and in the vicinity of the site. The focus of the plan will be to prevent and control potential problems as well as monitor environmental resources in an effort to evaluate the program and adapt to more efficient and effective strategies when required.

A site specific ITHMP has been prepared for The Hills at Southampton golf course and should be referred to for full control measures to be implemented. Elements of this program will include:

- Utilization of appropriate turf grass species as well as native vegetation to limit the need for supplemental pest and turf management techniques.
- Initiate a soil monitoring and management plan which will include regular testing to assess soil conditions.
- Initiation of a scouting and monitoring program to identify and eliminate problem areas.
- Establish threshold limits for disease and pest problems as well as turf health to identify the point at which supplemental maintenance techniques may be necessary.
- Anticipate response actions that may be necessary for potential action related to pest infestation, disease or turf stress.
  Use environmentally friendly management techniques to eliminate pests, address disease and/or improve turf health when necessary in lieu of commercial products.
- Pesticides and fertilizers will only be used as a last resort and when needed, the least toxic pesticide available should be used. If pesticides are necessary they will be applied in spot treatments only where the pest is found.

The ITHMP should be consulted for detailed information regarding the state-of-the-art management practices that will be implemented in connection with The Hills golf course.

3.0 MONITORING METHODS AND PROTOCOLS

In order to assess the effectiveness of engineering controls and turf management practices, a network of monitoring wells and lysimeters will be installed at critical locations throughout the property and this monitoring system will be sampled for baseline conditions and placed on a routine monitoring schedule. In addition, the irrigation wells to be utilized by the golf course as well as the ponds will also be included within the monitoring schedule. The results of any data generated from the program will be reported to the Town, assessed by the Town and golf course management and used to provide early detection of environmental concerns so that modified management practices can be instituted.

3.1 MONITORING WELL AND LYSIMETER PLACEMENT

A network of three (3) background wells (BW-1, 2 and 3), nine (9) green wells (GW-A through I) and two (2) residential wells (RW-1 and 2) will be installed on the subject site. As noted in Section 1.2.3, groundwater in the vicinity of the Hills at Southampton golf course flows in a southeasterly direction. As a result, three (3) monitoring wells be installed hydraulically upgradient of the Hills at Southampton golf course, along the western property line, and will monitor groundwater quality migrating onto the site. The results from these wells will provide essential information on the quality of groundwater being contributed to groundwater underlying the Hills at Southampton golf course. The effect that golf management practices have on groundwater quality will be assessed through the installation of one monitoring well per every other green (9 total starting with green #2), which will be located downgradient of and in proximity to the green/bio-swale systems. These wells will be placed to monitor green #2, 4, 6, 8, 10, 12, 14, 16 and 18. Two (2) residential wells will be located downgradient of residential use areas. The location of the monitoring wells is depicted on **Figure 1.**

In order to provide an early warning detection of any nitrogen and other turf care products which may leach through the root zone, nine (9) suction lysimeters (L-A through L-I) will be installed in the unsaturated zone at a depth of 6 feet below ground surface in close proximity to the groundwater well (GW) locations. These lysimeters will intercept stormwater and irrigation water migrating through the soil horizon so that it may be collected for analysis before it reaches the underlying groundwater table. Samples will be collected from each lysimeter via a remote access point located outside of the area of play. The location of the lysimeter network corresponds to the GW wells as depicted on **Figure 1.**

At present, the exact locations of irrigation wells has not been determined. Monitoring wells will be situated as far as reasonably possible from irrigation wells in order to decrease any influence of these wells on groundwater flow in proximity to monitoring wells. No irrigation well pumping will occur for a period of 24 hours prior to the quarterly monitoring well sampling events, so as to reduce the influence of irrigation well pumping on groundwater sampling events.

3.2 MONITORING WELL INSTALLATION

A truck mounted drill rig will be utilized to install each two-inch diameter PVC groundwater monitoring wells on the subject property. The boreholes for the two-inch diameter monitoring wells will be drilled utilizing 4¼ inch diameter steel hollow stem augers which will be advance to a depth which will extend to approximately ten feet below the surface of the underlying water table. Once the desired depth has been achieved, the well material consisting of fifteen feet of #20 slot PVC well screen and appropriate length of PVC riser will be placed inside the augers and utilized to dislodge the bottom plug used to prevent the heaving of drill cuttings into the auger. As the augers are removed, a #2 Morie sand gravel pack will be used to fill the annular space around the well to provide a filter medium around the screen zone. The gravel pack will be continually added until it rises to approximately two feet above the screen zone and a two (2) foot bentonite seal will be placed above the filter pack. The remaining annular space of the borehole will be backfilled using drill cuttings or clean sand to a depth of approximately two feet below ground surface and the top of the well will be sealed with an approximately two foot concrete seal which will secure a cast iron, flush mount monitoring well cover at ground surface.

Following installation, each monitoring well will be developed utilizing a submersible pump for the purpose of removing any fine sediment from the wells in order to ensure the infiltration of groundwater representative of the surrounding aquifer. Water will be removed from each well until water clarity achieves fifty NTUs and stabilization (a leveling of approximately 10% for at least three consecutive readings) among several selected groundwater parameters have been achieved. The determining parameters are pH, conductivity, temperature, dissolved oxygen and oxidation-reduction potential. All measurements will be collected using a Horiba multi-parameter groundwater meter.

3.3 LYSIMETER INSTALLATION

Prior to installation, the lysimeter will be tested to ensure tightness and integrity. In order to test for tightness, the units will be submerged in a deionized water bath while a positive pressure of 15 psi is applied. Under pressure, the porous ceramic cup should give off small “champagne” type bubbles over its entire surface if no leaks exist. Large bubbles forming at any joints on the body indicate a leak. If a unit displays signs of leaks the joints will be sealed with Teflon tape, and rechecked.

Following the pressure testing, the lysimeter units will undergo a vacuum test to the units head assembly. A plastic membrane should be first placed over the ceramic cup, and then a vacuum will be applied while carefully monitoring pressure drops. The vacuum test will be conducted with the ceramic cups placed entirely in deionized water. While under a vacuum the units will pull water through the ceramic cup into the vessel. Once the vessel is full with water, if it is found to hold a vacuum it will be considered leak free.

A truck mounted drill rig will be utilized to install each lysimeter on the subject property. The boreholes for each lysimeter will be drilled utilizing 2¼ inch diameter steel hollow stem augers which will be advance to a depth of six feet below ground surface. Once the desired depth has been achieved, the augers will be removed and approximately six inches of silica flour slurry will be poured into the borehole followed by the lysimeter and associated sample tubing. Additional silica slurry will be poured into the borehole until it rises to approximately six-inches above the ceramic cup and a one foot bentonite seal will be placed above the silica slurry. The remaining annular space of the borehole will be backfilled using drill cuttings or clean sand to surface grade. Sample tubing will be lead to a location off of the tee box area so as not to interfere during periods of golf play. The sample ends of the tubes will be accessible through a covered junction box or similar structure.

3.4 GROUNDWATER FLOW MONITORING

Each monitoring well will be surveyed for vertical and horizontal declination so that accurate groundwater elevations may be calculated. During each sampling event a synoptic round of groundwater levels will be collected using an electronic groundwater table indicator. Readings from each well will be used in conjunction with survey elevation data to determine the groundwater elevation at each well location. This information will be transcribed onto a scaled plan and used to determine the pattern and direction of groundwater flow underlying the Hills at Southampton golf course. The data will be used to assess the effectiveness of the monitoring well network in providing accurate data collection points related to groundwater quality.

Once groundwater flow beneath the site is defined using elevation data from the monitoring well network, **Figure 1** will be updated to reflect the upgradient land area that influences each well. In addition, a study to determine if the irrigation well pumping is affecting the monitoring wells will be completed following installation of the irrigation well withdrawal system and the monitoring wells. This would be completed once during an active period of irrigation well usage.

4.0 SAMPLING AND ANALYSIS PROGRAM (SAP)

A Sampling and Analysis Plan (SAP) has been developed to outline the methods, procedure and schedule for groundwater monitoring at the Hills at Southampton golf course. Sampling will include the collection of samples from the underlying water table as well as storm and irrigation water percolating through the unsaturated zone.

4.1 SAMPLING PLAN

The SAP will utilize the network of monitoring wells and lysimeters installed at the Hills at Southampton golf course as well as the irrigation wells to monitor nutrient and pesticide load traveling through unsaturated soils and the underlying groundwater table. This sampling will also include sampling of the on-site pond as well to assess nutrient and chemical load loss due to irrigation.

Background wells will be installed prior to construction and monitored for at last two (2) quarterly sampling events prior to commencement of construction. Golf wells and lysimeters cannot be effectively installed until the golf course construction is complete. Once the golf course grading is complete, the golf wells and lysimeters will be installed. Sampling of background wells (BW), golf wells (GW), Lysimeters (L) and ponds will commence immediately upon installation of wells, and will continue on a quarterly basis as golf course groundcover is planted and maintenance commences. The monitoring wells, lysimeters and pond will be sampled immediately following construction to establish a baseline to which subsequent sampling events can be compared and to set further sampling and management thresholds. Residential wells (RW) will be installed upon completion of residential grading and sampling will commence immediately upon installation of wells and will continue on a quarterly basis as groundcover is planted and maintenance commences. In addition, monitoring of preexisting conditions will allow for an accurate assessment of what, if any, impact the golf course and associated development will have on underlying groundwater conditions. The sample collection will comply with all appropriate regulatory agency protocols and will be conducted by a qualified environmental professional firm with experience in monitoring golf courses who is hired by and under the direction of the Town of Southampton. No pesticide application will occur for a period of 24 hours prior to the quarterly groundwater sampling events, so as to reduce the potential for sample cross contamination.

Sampling will be conducted each year on a quarterly basis for a period of five (5) years. Following several years of sampling data, the frequency/schedule may be evaluated based on a review of the analytical data results. Based on this review, alterations to the monitoring program including the reduction of sampling parameters and frequency or sampling may be considered for future events at the discretion of the Town and their consultant.

It should be noted that only limited sample volumes may be capable of being retrieved from the lysimeters due to inadequate soil moisture. While all attempts will be made to recover an adequate volume for all sample parameters if insufficient sample recovery occurs then lysimeter samples will favor nitrogen series compounds.

Documentation of the sampling for each collection point will be recorded on a site specific sampling form which will record:

- Sample identification
- Date and time sample collected
- Weather
- Field monitoring parameter readings
- Purge volume & sample volume
- Visual observations of water retrieved

Following collection, all samples will be placed immediately in an ice filled cooler to maintain the samples at or below 4 °C. Samples will be shipped overnight to a NYSDEC and USEPA certified analytical laboratory. The laboratory will record the temperature upon arrival and if above 10 ºC, will notify the qualified environmental professional firm doing the sampling and the Town of Southampton that the samples must be retaken since the results might be compromised. For every day of sampling QA/QC samples must collected and analyzed in accordance with applicable regulatory agency protocols.

4.2 SAMPLING ANALYTICAL PARAMETERS

Analytical parameters will include but not be limited to the chemical list of pesticides proposed to be used, when necessary, in accordance with USEPA analytical method protocols. A list of potential pesticides that at a minimum may be used is provided in **Table 1**. In addition, samples will also be analyzed for nutrient series compounds (i.e., total nitrogen, nitrate, nitrite, TKN, phosphate, orthophosphate and total phosphorus) to assess potential impacts related to fertilizer application. Should any additional pesticides be used within the 12 months prior to a monitoring event they will be added to the list of analytical parameters.

Table 1
Pesticides Considered for Use

Cholorthalonil	Fostyl-Al	Paclobutrizol
Propamocarb	Triexapac-Ethyl	Prodiamine
Metaconazole	Boscalid	Penoxsulam
Iprodione	Carefentrazone-Ethyl	Trifloxystrobin
Pendimethalin	Mancozeb	Mefanoxam
Etridiazole	Flutolanil	Deltamethrin
Ethofumesate	Fenarimol	Myclobutanil
Mesotrione	Bispyibac-Sodium	Bifenthrin
Polyoxin	Propoconazole	Spinosad
Azoxystrobin	Thiophanate-methyl	Aluminum tris O-ethyl
Imidacloprid	Thiabendazole	Imidacloprid
Quinclorac	Azoxystrobin	Lambda-cyhalothrin
Carbaryl	Chlorpyrifos	Acibenzolar
Triadimefon + Tridimenol Metabolite	Fluazinam	Penthiopyrad

5.0 SAMPLING METHODOLOGY

5.1 MONITORING WELL SAMPLING

All of the monitoring wells will be sampled using "low-flow" methodology, as described in the scope of work. Under the "low-flow" procedure, each well will be purged with a variable flow rate submersible pump at a rate of 0.4 liter per minute (L/min) until stabilization of selected water quality indicators which will include pH, specific conductance, dissolved oxygen, oxidation-reduction potential, and temperature as well as a turbidity. If turbidity exceeds 50 NTU, samples will be filtered and analyses run on both filtered and unfiltered samples. Once these criteria are met, the sample will be collected directly from the pump, placed in appropriate sample containers and preserved in accordance with the protocols identified in **Section 4.1**. A dedicated sampling hose will be used for each well to ensure sample integrity and eliminate the potential for cross contamination.

5.2 LYSIMETER SAMPLING

The lysimeters will be fitted with a dual line system that can be sampled with a vacuum pump. A vacuum will be applied to the vacuum line to draw water into the ceramic cup followed by pressure being applied to the pressure line to push the sample up the vacuum line and to the surface. Samples will be collected directly from the line, placed in appropriate sample containers and preserved in accordance with the protocols identified in **Section 4.1**.

5.3 POND SAMPLING

Pond samples will be collected by dipping the appropriate sample containers directly into the pond surface waters; samples will be preserved in accordance with the protocols identified in **Section 4.1**. Samples will be consistently collected from a designated sample location which is deemed representative of water contained within the pond.

5.4 IRRIGATION WELL SAMPLING

All on-site irrigation wells will be sampled at a valve head installed at the wellhead. Each irrigation well will be sampled during active irrigation of the golf course or purged of three to five casing volumes to ensure collection of a sample representative of underlying groundwater conditions. Samples will be collected directly from the valve head, placed in appropriate sample containers and preserved in accordance with the protocols identified in **Section 4.1**. The irrigation wells will be monitored frequently during the fertilization season to determine nitrogen content, which will in turn be used to adjust the fertilization program. The irrigation wells will also be tested annually (during the irrigation season) for the same list of pesticides used for the monitoring wells.

6.0 RESPONSE ACTIONS AND MITIGATION MEASURES

Pesticide use may be required to address issues related to turf health and conditions. In order to manage the application of these compounds so that impacts can be minimized, resampling and management thresholds have been established to trigger further action. Management thresholds are based on multipliers applied to established laboratory detection limits as established background level reference points determined by pre-operation sampling results.

6.1 PESTICIDES

Groundwater Resampling Threshold
Any detected compound found to be 5x above the laboratory detection limit or 3x above the laboratory detection limit (to be determined by laboratory) if the established reference point is less than five parts per billion (ppb). If the reference point for a detected compound is less than 1 ppb then resampling will be conducted upon detection.

Groundwater Management Threshold
Any detected compound above 10% of its established reference point or found to be 3x the laboratory detection limit (to be determined by laboratory). If the reference point for a detected compound is less than 1 ppb then resampling will be conducted upon detection.

Pond Management Threshold
The use of pesticide products will be temporarily suspended if the concentration of a detected compound is 100% above the New York State Ambient Water Quality Standards, greater than 50% of the aquatic LC50 of 100% of the USDA-NCRS human toxicity level or 50 ppb, whichever is lower.

6.2 NITROGEN

Resampling Threshold
If any nitrogen compound is found at a concentration of 5 parts per million (ppm) or greater in groundwater or 10 ppm in a lysimeter then the well or lysimeter from which the sample was retrieved will be resampled to confirm the result. Resampling and management will consider background nitrogen concentrations and pre-project nitrogen concentrations in the wells. The Town will be consulted and a strategy developed to address resampling and management options based on increases caused by golf course management practices (should any such increases occur) as opposed to background nitrogen.

Management Threshold
If the result from the affected well or lysimeter is confirmed then all fertilization will stop in the upgradient area and will not be allowed to resume until subsequent sampling events confirm that nitrate concentrations have fallen to below 2 ppm.

Table 2
Resampling and Management Thresholds

Parameter	Resampling Threshold	Management Threshold
Pesticides		
Groundwater	Any detected compound found to be 5x above the laboratory detection limit or 3x above the laboratory detection limit if the established reference point is less than five parts per billion (ppb). If the reference point for a detected compound is less than 1 ppb then resampling will be conducted upon detection.	Any detected compound above 10% of its established reference point or found to be 3x the laboratory detection limit. If the reference point for a detected compound is less than 1 ppb then resampling will be conducted upon detection.
Pond	If the concentration of a detected compound is 100% above the New York State Ambient Water Quality Standards, greater than 50% of the aquatic LC50 of 100% of the USDA-NCRS human toxicity level or 50 ppb, whichever is lower.	Temporary Suspension of Use
Nitrogen (Including nitrate, ammonium and TKN)		
Groundwater [1]	If any nitrogen compound is found at a concentration of 5 parts per million (ppm) or greater in groundwater or 10 ppm in a lysimeter then the well or lysimeter from which the sample was retrieved will be resampled to confirm the result.	If the result from the affected well or lysimeter is confirmed then all fertilization will stop in the upgradient area and will not be allowed to resume until subsequent sampling events confirm that nitrate concentrations have fallen to below 2 ppm.

Note: 1 Resampling and management will consider background nitrogen concentrations and pre-project nitrogen concentrations in the wells. The Town will be consulted and a strategy developed to address resampling and management options based on increases caused by golf course management practices (should any such increases occur) as opposed to background nitrogen.

7.0 QUALITY ASSURANCE/QUALITY CONTROL PLAN (QA/QC)

The QA/QC Plan will be conducted in accordance with USEPA accepted sampling procedures for hazardous waste streams (Municipal Research Laboratory, 1980, Sampling and Sampling Procedures for Hazardous Material Waste Streams, USEPA, Cincinnati, Ohio EPA- 600\280-018) and ASTM Material Sampling Procedures. All samples will be collected by or under the auspices of USEPA trained personnel having completed the course Sampling of Hazardous Materials, offered by the Office of Emergency and Remedial Response.

Separate QA/QC measures will be implemented for each of the instruments used in the Sampling and Analysis Program. Sampling instruments included sampling pumps, lysimeters, monitoring wells, vacuum pumps and sample vessels.

Prior to arrival on the site and between sample locations, sampling equipment will be decontaminated by washing with a detergent (alconox/liquinox) and potable water solution with distilled water rinse. All sample vessels will be "level A" certified decontaminated containers. Samples will be placed into vessels consistent with the analytical parameters. After acquisition, samples will be preserved in the field. All containerized samples will be refrigerated to 4 ^{o}C during transport.

Personnel will be required to wash hands and wear nitrile sampling gloves prior to the collection of all samples. Appropriate precautions will be taken to prevent the potential for cross contamination between sample points or from routine human activity.

QA/QC samples will be collected as part of the sampling protocol and will include the use of trip blanks and field blanks. A laboratory prepared trip blank will accompany samples while in transit on each day of sampling to confirm that sample contamination has not occurred during transit. In order to document whether decontamination procedures are effective at eliminating cross contamination between sample points field blanks will also be collected. Field blank samples will be collected by pouring laboratory supplied deionized water over decontaminated non-dedicated or non-disposable sampling devises into laboratory supplied sample vessels. Field blank samples will only be collected when non-dedicated materials (i.e. lysimeters) devises are used to collect samples. All QA/QC samples will be analyzed for the same suite of parameters outlined for the monitoring program.

A sample represents physical evidence; therefore, an essential part of liability reduction is the proper control of gathered evidence. To establish proper control, the following sample identification and chain-of-custody procedures will be followed.

Sample Identification

Sample identification will be executed by use of a sample tag, logbook and manifest. Documentation provides the following:

1. Project Code
2. Sample Laboratory Number
3. Sample Preservation
4. Instrument Used for Source Soil Grabs
5. Composite Medium Used for Source Soil Grabs
6. Date Sample was Secured from Source Soil
7. Time Sample was Secured from Source Soil
8. Person Who Secured Sample from Source Soil

Chain-of-Custody Procedures

Due to the evidential nature of samples, possession will be traceable from the time the samples were collected until they were received by the testing laboratory. A sample was considered under custody if:

It was in a person's possession, or
It was in a person's view, after being in possession, or
It was in a person's possession and they were to lock it up, or
It is in a designated secure area.

When transferring custody, the individuals relinquishing and receiving will sign, date and note the time on the Chain-of- Custody Form.

Laboratory Custody Procedures

A designated sample custodian will accept custody of the shipped samples and verified that the information on the sample tags match that on the Chain-of-Custody records. Pertinent information as to shipment, pick-up, courier, etc. will be entered in the "remarks" section. The custodian then will enter the sample tag data into a bound logbook which will be arranged by project code and station number.

The laboratory custodian will use the sample tag number or will assign a unique laboratory number to each sample tag and assure that all samples will be transferred to the proper analyst or stored in the appropriate source area. The custodian will distribute samples to the appropriate analysts. Laboratory personnel will be responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the custodian.

All identifying data sheets and laboratory records will be retained as part of the permanent site record. Samples received by the laboratory will be retained until after analysis and quality assurance checks are completed.

Following collection all samples will be placed immediately in ice to maintain the samples at or below 4 °C and shipped overnight to a NYSDEC and USEPA certified analytical laboratory. The laboratory will record the temperature upon arrival and if above 10 °C notify the qualified environmental professional firm doing the sampling and the Town of Southampton that the samples must be retaken since the results might be compromised. For every day of sampling QA/QC samples must collected and analyzed in accordance with applicable regulatory agency protocols.

8.0 REPORTING REQUIREMENTS

Reporting for each quarterly sampling event will be prepared and submitted to the Town of Southampton which will summarize the following:

- A summary of the results for samples collected from the monitoring wells, lysimeters and pond and comparisons with previous quarters.
- A summary of the groundwater elevation data collected and interpretations related to groundwater flow.
- Discussion of any exceedances of any response action thresholds.
- Discussion of actions required/taken to address exceedance of response action thresholds.

Should any exceedances of pesticide or nitrogen thresholds be observed, the Town of Southampton will be immediately advised and the use of the compound will immediately be suspended. The well/lysimeter/pond from which the exceedance was noted will be resampled as soon as practicably possible to confirm the exceedance. If the resampling confirms the initial results, further investigation will be conducted to determine the cause and what action(s) will be required to mitigate further impact. Results of the investigation will be forwarded to the Town of Southampton for review and approval of the mitigation actions to be taken before the application of the suspended compound can again be resumed. Any deviation in any part of the sampling, testing and reporting protocols will be contained in the quarterly/annual report and a justification for deviation in the protocol given.

The quarterly reports will also include documentation of the following:

- Application timing, rates and location for any pesticides and fertilizers.
- Rainfall and irrigation rates during the quarterly period.
- Sampling documentation forms.
- Laboratory reports.

Following the fourth quarter of monitoring an annual report will be compiled to discuss and analyze observations and trends over the previous year. In addition, following the initial five (5) year monitoring period, a report will be provided to discuss previous results, recommendations and action taken. This will be followed with recommendations to modify the monitoring program as necessary.

9.0 OPERATIONAL GOALS

Overall the goal of the Hills at Southampton golf course with regard to turf management is to reduce the application of pesticides and fertilizers through environmentally sensitive golf course design and the use of vegetative species which are native and resistant to drought, pests and disease. The Hills at Southampton golf course will utilize non-traditional turf management practices as outlined in the ITHMP in order to comply with golf course management standards established by Suffolk County and the Town of Southampton, as well as meet or exceed the Best Management Practices for NYSBMP.

The Hills at Southampton golf course will institute a management plan which will both be sensitive and sustainable to ensure the health and wellbeing of environmental resources on and in the vicinity of the facility. The focus of the plan will be to prevent and control potential problems as well as to monitor environmental resources in an effort to evaluate the program and adapt to more efficient and effective strategies when required.

This groundwater monitoring program is a critical component necessary for maintenance of the golf course and has been designed to identify any deficiencies in management practices and alter turf management programs in order to limit impacts to groundwater as well as downgradient receptors.

FIGURE 1
Site Map and Sample Locations

NELSON, POPE & VOORHIS, LLC
ENVIRONMENTAL • PLANNING • CONSULTING

FIGURE
MONITORING WELL & LYSIMETER LOCATION MAP

Source: ESRI wms; USGS SIM 3270, 2010 water table data;
Discovery Land, 9/2014; NP&V data
Scale: 1 inch = 600 feet

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The Hills at Southampton

Groundwater Monitoring Protocols

ATTACHMENT A
Soil Boring Logs

East Coast Geoservices, LLC
P.O. Box 2806
Huntington Station, New York 11746
Phone: (631) 513-8595
www.info@eastcoastgeoservices.com

SOIL BORING LOG

BORING I.D. B-1	**PROJECT NO.** ECG# 05105	**PROJECT NAME** The Hills @ Southampton		
LOGGED BY Eric Arnesen	**APPROVED BY** Eric Arnesen	**LOCATION** Spinney Road		
DRILLING CONTRACTOR East Coast Geoservices, LLC	**DRILLER** Johnathan McGinn	East Quogue, New York		
DRILL BIT DIAMETER/TYPE 2.0 inch/Core Barrel	**BOREHOLE DIAMETER** 2.0 inch	**BORING LOCATION DESCRIPTION** Located approximately 500 feet northwest of the northern end of Spinney Road.		
LAND SURFACE ELEVATION ~70 ft amsl	**COORDINATES** NA	**DRILLING EQUIPMENT/METHOD** Power Probe 9600		**SAMPLING METHOD** Core Barrel
DEPTH OF BORING 25 feet	**DEPTH TO WATER** ~ 55 feet bgs	**START/FINISH DATE** 7/30/14 to 7/30/14		**BACKFILL** Cuttings

Sample Depth (feet)	Sample Interval (feet)	Visual Description	Group Symbol	Blow Counts	PID (ppm)	Remarks
5	0 to 5	All yellowish brown fine sand, trace gravel.	SP	NA	NA	3.0 feet recovered
10	5 to 10	All same as above.	SP	NA	NA	4.0 feet recovered
15	10 to 15	All pink fine sand, trace gravel.	SP	NA	NA	5.0 feet recovered
20	15 to 20	All same as above.	SP	NA	NA	4.0 feet recovered
25	20 to 25	All same as a bove.	SP	NA	NA	3.0 feet recovered Boring Complete
30						DTW determined from piezometer installed at location.
35						
40						
45						
50						

East Coast Geoservices, LLC
P.O. Box 2806
Huntington Station, New York 11746
Phone: (631) 513-8595
www.info@eastcoastgeoservices.com

SOIL BORING LOG

BORING I.D. B-2	**PROJECT NO.** ECG# 05105	**PROJECT NAME** The Hills @ Southampton		
LOGGED BY Eric Arnesen	**APPROVED BY** Eric Arnesen	**LOCATION** Spinney Road		
DRILLING CONTRACTOR East Coast Geoservices, LLC	**DRILLER** Johnathan McGinn	East Quogue, New York		
DRILL BIT DIAMETER/TYPE 2.0 inch/Core Barrel	**BOREHOLE DIAMETER** 2.0 inch	**BORING LOCATION DESCRIPTION** Located approximately 1,000 feet east of the eastern end of Serenity Place.		
LAND SURFACE ELEVATION ~50 ft amsl	**COORDINATES** NA	**DRILLING EQUIPMENT/METHOD** Power Probe 9600		**SAMPLING METHOD** Score Barrel
DEPTH OF BORING 25 feet	**DEPTH TO WATER** ~ 37 feet bgs	**START/FINISH DATE** 7/30/14 to 7/30/14		**BACKFILL** Cuttings

Sample Depth (feet)	Sample Interval (feet)	Visual Description	Group Symbol	Blow Counts	PID (ppm)	Remarks
5	0 to 5	All yellowish brown fine sand, trace gravel.	SP	NA	NA	4.0 feet recovered
10	5 to 10	All same as above.	SP	NA	NA	4.0 feet recovered
15	10 to 15	All pink fine sand, trace gravel.	SP	NA	NA	4.0 feet recovered
20	15 to 20	All same as above.	SP	NA	NA	3.5 feet recovered
25	20 to 25	All same as a bove.	SP	NA	NA	3.0 feet recovered Boring Complete
30						DTW determined from piezometer installed at location.
35						
40						
45						
50						