TECHNICAL REVIEW OF TEST RESULTS AND IMPLEMENTATION OF THE GROUNDWATER MONITORING PROTOCOL THE BRIDGE GOLF COURSE Southampton, NY PART 1

And

REVIEW OF PROTOCOL MODIFICATION PROPOSALS AND RECOMMENDATIONS PART 2

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EXCECUTIVE SUMMARY: FINDINGS AND RECOMMENDATIONS

In accordance with the Town Resolution No. 2010-412, the town contracted both Dr. A. Martin Petrovic and Thomas Cambareri on June 15, 2010 to provide a review of the groundwater monitoring program (GWMP) conducted at The Bridge golf course and provide recommendations based upon that review upon which the Town will base any amendment or change to the Groundwater Monitoring Protocol.

This separate section presents the summary findings and recommendations of the review of the GWMP. The Final Technical Review Report, which contains our review of pertinent subject matter, proposed changes to the ground water monitoring protocol (the "Protocol") and the management plan, and recommendations, should be referred to for further explanation of the following summary points and recommendations.

FINDINGS

PROTOCOL DEVIATIONS: Based on our review there have been infrequent, but justifiable deviations that have not affected the overall monitoring program.

GROUNDWATER SAMPLING PROCEDURES: Based upon a review of the available quarterly and annual reports and Independent Review reports, field log books, sample shipments are made according to the Protocol.

QUALITY CONTROL SAMPLES: Based upon a review of the available quarterly and annual reports and Independent Reviewer reports, sampling, handling and testing protocols have been followed very closely over the nine years of the monitoring program.

LABORATORY QUALITY CONTROL: Based upon a review of the available quarterly and annual reports and Independent Reviewer reports, all quality control samples indicate that by 2002 the program gained consistency in all matters and the Underwriters Laboratory is meeting the quality control requirements.

NITRATE IN GROUNDWATER: The background well (BW-1) is not useful to compare to other wells because this well is on the other side of the divide and is impacted by several different land uses and its nitrate concentration is nearly always higher than the downgradient wells. Turf management has not significantly impaired water quality, and nitrate concentrations in groundwater have generally remained below 25% of the agreed upon threshold of 5 ppm. The groundwater monitoring program can be improved and optimized.

PHOSPHORUS IN GROUNDWATER: The concentrations of phosphorus in groundwater are basically below the quantitation limit and it is recommended that phosphorus be removed as an analyte.

PESTICIDES IN GROUNDWATER: Of the 13 wells tested, there were 60 detections of pesticides above the reporting limit, which is 0.1 ppb for most analytes. In all but five cases, the detection was below 0.5 ppb. The concentrations of detections individually and cumulatively for any well are below 5ppb, the lowest of the two general public health thresholds (POCs [5 ppb] and GVs [50 ppb]). Thus, the overall quality of the groundwater has not been significantly affected by the golf course pest management operations at The Bridge golf course.

LYSIMETERS RESULTS:. The goal of the lysimeters is for early warning about the potential mass of nitrogen or pesticides that can potentially leach further through the soil to groundwater. Long term data has shown that where nitrate is being detected, lysimeter concentrations are higher than groundwater as would be expected. Overall the average lysimeter nitrate concentrations are not extremely high and there have only been few exceedences above the 10 ppm action level, which have a reasonable maintenance explanation. The lysimeter results also show a mixed performance of the biofilters in which biofilters at one set of locations appears to work extremely well in contrast to other locations. The lysimeter sampling program can be improved and optimized.

TURF AREA: The total fertilized area is 78.27 acres, which is slightly less than 80.38 acres, the amount allowed.

APPLIED FERTILIZER: Based on the superintendent's annual reports, as contained in the comprehensive annual water quality monitoring reports, and reviewed by the Independent consultant, the fertilizer application amount is below the lowest end of the specified range of 6,386-11,627 pounds N per year. The average over the 9 year period (2001-2009) is 4,539 lbs/yr. This is 71% of the low end range of the allowable amount. The last five years of turf management have only used an average of 2905 lbs/yr or 45% of the lowest end of the allowable amount.

PESTICIDES APPLIED: The reports outline the occurrence, identifies the pest, and the action thresholds for pesticide application. The actions taken are in conformance with the Natural Resource Management Plan. Targeted pesticide application generally corresponds to the pest occurrence as found in the field pest history reports.

GROUNDWATER FLOW MAPS: Quarterly reports contain the water level measurements and the Annual reports contain four quarterly water table maps. The water table flow directions show some variability in flow directions particularly at the top of the groundwater divide and impart a higher degree of variability to the BW-1 and MW-1S nitrogen concentrations.

IRRIGATION: There are four irrigation wells located along the 15 fairway. The four wells have a combined capacity of 1,100 gallons per minute. Irrigation amounts were obtained from the Independent Review reports. Overall the irrigation amount averages 24.3 million gallons per year. The golf course has made recent use of drip irrigation in the perimeter turf to the sand traps with very favorable results in turf growth and health.

CONCLUSION

The Groundwater Monitoring Protocol and its amendments have been effectively implemented over the last nine years and based upon our review can be improved and optimized.

RECOMMENDATIONS

A summary of the recommendations to improve and optimize the Protocol are presented in the Executive Summary below. The basis of each recommendation is the technical review that is contained within Part 1 and 2 of report. The collective recommendations of this report are focused on ensuring the long term goal of groundwater protection

MONITORING WELLS: The original 14 monitoring wells now number 13, which are sampled quarterly (Table ES-1). It is recommended to reduce the number of regularly sampled wells to 7 wells including four (4) that had elevated nitrate levels or frequent pesticides detections (referred to as turf response monitoring wells MW-2D, MW-3S, MW-5 and MW-2S), two (2) monitoring wells not influenced by the golf course operations (referred to as Ambient wells MW-1D and MW-3D) and the perched well PW-1. The seven monitoring wells are recommended to be sampled semi-annually for total Kjeldahl nitrogen (TKN), nitrate, S150 pesticides and field parameters. However, semi-annual monitoring of method S150 pesticides for the two ambient wells will only be triggered if nitrate concentrations are greater than 1 ppm in those wells. If that occurs, they will be sampled in the next sampling event immediately following the > 1ppm detection(s). Every two years, the entire remaining network of 12 monitoring wells will be sampled. Every fourth year will include analysis for a comprehensive list of compounds for the Turf Response Wells and others as indicated on Table ES-2.

	Well	**Category**	Semi	2-yr
1	BW-1	Drop		
2	PW-1	Misc	X	X
3	MW-1S	Misc		X
4	MW-1D	Ambient	X	X
5	MW-2S	Turf Response	X	X
6	MW2D	Turf Response	X	X
7	MW-3S	Turf Response	X	X
8	MW-3D	Ambient	X	X
9	MW-4/4R	Turf		X
10	MW-5	Turf Response	X	X
11	MW-6	Ambient		X
12	MW-7	Turf		X
13	MW-8	Turf		X
14	MW-9	Abandoned		
	Total Wells		7	12

LYSIMETERS: We recommend that two of the current eight sets of lysimeters continue to be monitored for nitrogen and S150 pesticides on a semi-annual basis. These lysimeter sets include two fairway locations, F1-3 and F3-3 that have a consistent response and can be used to reduce turf management impacts. As for green lysimeter testing, we recommend that The Bridge discontinue sampling the current green biofilter lysimeters and install angled lysimeters through the use of a small tracked Geoprobe at 9 to 12 ft below the front end of the green at Holes 4, 7, and 14.

FIVE YEAR REVIEW: The Protocol should be reviewed in five years to evaluate its implementation, cumulative groundwater conditions and consideration of future modifications. The Study Director should initiate this (currently, Stuart Cohen), and the Town and the SCWA should act promptly on the recommendations. We recommend that this review be accomplished within six months to one year of the date the submission is received from the Study Director.

RESPONSE TO DETECTIONS AND OTHER ISSUES:

1. The Town should adopt a new lower limit of nitrogen fertilization where no more than 3000 lbs of nitrogen be applied to the current land area per year which translates to 0.9 lb N/1000 ft2. The annual report should present and discuss the amounts of fertilizer applied in relation to the concentrations of nitrogen found in groundwater.

2. In regards to nitrate in groundwater, we recommend that a new long term average goal (since 2005) shall be 2 ppm average annual for all turf wells and 1 ppm for ambient wells. Based upon the results of the nine years of data, these goals can be achieved by adopting a new lower nitrogen fertilization application of no more than 3000 total pounds per year. This outstanding long term average for nitrogen in groundwater has been achieved by The Bridge due to their diligent turf management. The 2 ppm annual average is well below the 10 ppm state and federal drinking water standard and 5 ppm nitrogen loading standard. This lower nitrogen limit is consistent with the Peconic Estuary nitrogen management challenge to which The Bridge has agreed to meet.

3. An evaluation of the relationship of heavy single rain events/periods (pages 34-36) and nitrate-nitrogen concentrations in groundwater indicated that there was little correlation and therefore should not be used as the basis of a management response. To be more responsive to spikes in nitrate-nitrogen concentrations, we recommend that the Protocol resampling threshold of 5 ppm be lowered to a nitrate-nitrogen concentration of 4 ppm.

4. Based upon the recommendation of the reduction of sampling from quarterly to semi-annually we recommend reducing the trigger to resample in any well (except PW-1) from 5 ppm of nitrate-nitrogen to 4 ppm. The well (s) in question will be immediately resampled within two weeks of receipt of the results. If the concentration is confirmed in the offending well (s), all fertilization will stop in the surface watershed and groundwater area upgradient of the offending well(s).

An evaluation will then be conducted by the Study Director in consultation with the Town to determine the conditions and issues that caused the large increase (fertilizer, rainfall, irrigation, runoff). A report to the Town will be made by the Study Director within one month of receiving the resampling-confirmation results indicating the cause and remediation plans related to the high nitrate-nitrogen level. Fertilization will resume when the concentration of the offending well is less than 2 ppm of nitrate-nitrogen or as outlined in the remediation plan.

5. We agree with the recommendation of ETS that the threshold for re-sampling a well for pesticides can be increased and recommend variable a "Resampling and Management Triggers" These triggers acknowledge the wide disparity of Health references for pesticides, which for those listed on Table 9 range from 0.44 to 50 ppb and reflect the prudent management decisions made by The Bridge over the past nine years relative to pesticide use on the golf course and will reduce the effort of resampling that has given little useful information in the past.

6. If the Management Trigger for pesticides is exceeded in any well then the sampling will revert back to quarterly for all 12 wells (not including the Background BW-1 or abandoned MW-9 well) until the level drops below the Management Trigger.

7. The response triggers for the lysimeters are recommended to be <5 ppm nitrate as a goal and >10 ppm nitrate as a management response. A Resample Trigger for pesticides of greater than 1 ppb is recommended. A Management Trigger of 5 ppb for any pesticide detection is recommended. Pesticide detections for all past lysimeter data and current on-going pesticide detections is recommended to be formatted for presentation in the 2011 monitoring report and all future reports.

8. Phosphorus in groundwater monitoring wells has seldom been above the detection limit and does not appear to be related to turf management at The Bridge. Therefore, it is recommended that phosphorus be dropped from the required analysis.

9. Semi-annual and Annual reports of nitrate in groundwater shall adopt a new comparative structure recommended in this review and compare the results of the Turf and Turf Response wells to the Ambient Wells and not to the background well (BW-1). The reports shall present the data by updating the long term concentration graphs of this report.

10. The four year comprehensive monitoring shall be applied to the four turf response wells, MW-2S, MW-2D, MW-3S, and MW-5. The four year comprehensive testing will be expanded to include the ambient wells (1D and 3D) and all other wells if there is a detection using the methods S150 or 515.3 in any of the previous semi-annual or two year events or if the average annual nitrate-N concentration is above the 2 ppm average annual nitrogen goal.

11. Comprehensive monitoring shall include methods L300, L311, S150 and EPA methods 547 (only if glyphosate has been used above 3 lbs of active ingredient in one year), 200.8 (only if MSMA has been used), and 515.3.

12. The results thus far of the Volatile Organic Compounds analysis by EPA Method 524.2 have been below the detection limit for all but background concentrations of chloroform and MTBE. It is recommended that this suite of compounds be dropped from the four-year comprehensive program in all wells except for MW-1S since it is downgradient of the current operations facility.

13. The management response to nitrate detections at the perched well (PW-1) should be increased to 10 ppm, since it does not sample the principle aquifer (see the Perch Water Well section of the Report for explanation). However, if the well exceeds 5 ppm for more than one year (more than two-semi-annual events) then the well shall be pumped off with the use of a submersible pump (>20gpm) and sampled for nitrate and S150 pesticides. This method of sampling the perched well could be used in place of the low flow pump for future sampling events.

14. The preparation of groundwater flow maps can be reduced from quarterly to once per year which would include annual snap shot measurements of all wells. Long term hydrographs should be presented in the reports for all semi-annual sampled wells.

15. A capture area to the irrigations wells under average annual and monthly peak flow conditions should be prepared using a groundwater model. This has been prepared by Mr. Cambareri and the results included in the Report Attachments.

16. The response to detections in monitoring wells now requires that a delineation of the area affecting the well(s) be used to reduce or stop the use of fertilizers and detected pesticides. Because surface runoff may play more of a role through drainage basins and underlying materials, such as the old Bridgehampton Raceway, a map of surface watersheds to monitoring wells shall be developed including the location of drains and their discharge locations by the Bridge as part of the 2011 annual report.

17. At an October 14, 2010 Town Board work session, Dr. Cohen of ETS (the Study Director), offered that the golf course would consider potential impacts on beneficial insects (pollinators) in future requests for new pesticides, in addition to the ground water contamination risk assessment procedures it established at the time of the 1995 risk assessment. We concur with this recommendation.

OPERATIONAL RECOMMENDATIONS

REPORTING: Pesticide and fertilizer application records, on daily time steps, shall continue to be included in the semi-annual and annual reports as required by the original Protocol with recommendations of this review. This shall be done on a hole-by-hole basis. Also, the procedure to select areas for the reduced amounts of either pesticides or fertilizer in response to detections of pesticides and/or nitrates in wells should be explained in the report(s).

Proposed "new" pesticides shall be requested in advance according to the Natural Resource Management Plan. The request shall contain: the compound name, its proposed use, estimated quantities to be applied and risk assessment.

Two semi-annual reports per year shall be prepared and submitted to the Town and SCWA. The reports shall contain all figures and graphs and attachments of data. These reports shall be submitted in digital form and one paper copy and posted on the Town Website by the Town.

CART PATHS: It was noted that the use of golf cart paths on the wooded areas had been appreciably reduced from the earlier years. The Bridge should continue this practice and prepare a site map for the first annual report that shows their locations. The map shall be updated when ever changes are made to the location of cart path and maintenance vehicle paths/roads.

BIO-FUNGICIDES: The Bridge shall implement a systematic testing program for bio-fungicides that can potentially be used in the golf course disease control program. The systematic approach would include on-site testing of the materials compared to the golf course's traditional fungicide program along with un-treated areas to determine the effectiveness of the bio-fungicides. The Bridge should consider evaluating the risk of several new fungicides introduced since 2000 that are considered to have a much lower risk by USEPA including, but not limited to, boscalid a reduced risk pesticide (Emerald), and a mineral oil (Civatas). Potential impacts to beneficial insects (pollinators) will be considered in the risk assessment, as volunteered by the golf course (see above).

IRRIGATION: The Bridge shall equip all 18 greens with soil moisture sensors to further refine the amount of irrigation applied. The Bridge shall install time domain refractomitry (TDR) soil moisture probes to map greens, tees and fairway soil moisture variation to further refine and make adjustments in the amount of water applied to very specific locations on the golf course. The use of drip irrigation bunker surrounds shall be expanded as practicable. These irrigation improvements shall be accomplished within the five year review period.

FERTILIZATION
If the golf course should require more than the fertilization limit, a request shall be sent to the town six months in advance indicating the reasons (need for more nitrogen) and why such an increase will not lead to an exceedence of the 2 ppm average annual threshold.

Figure ES-1 Aerial Figure of Golf at the Bridge

Table ES-2 Groundwater Monitoring Protocol Frequency and Response

Well	Category	NITRATE (ppm)			PESTICIDES				4 YR+ COMP	WT**
		Semi N^	GOAL	Mgmt Response	Semi Pest^^	2-YEAR	Resampling Trigger	Management Trigger		
BW-1	Drop						5x Quant Limit Or 3x Quant Limit if Ref Pt < 5(ppb) Or upon detection if Ref Pt< 1ppb	10% Ref Pt Or 3x Quant Limit Or upon detection if Ref Pt < 1 ppb	Cond	yes
PW-1	Misc	yes	<5	10*	S150	515.3			Cond	yes
MW-1S	Misc		2	4		N, S150 +VOC			Cond	yes
MW-1D	Ambient	yes	<1	4	S150 if N > 1	S150			Cond	yes
MW-2S	Turf Response	yes	2	4	S150	515.3			Yes	yes
MW2D	Turf Response	yes	2	4	S150	515.3			Yes	yes
MW-3S	Turf Response	yes	2	4	S150	515.3			Yes++	yes
MW-3D	Ambient	yes	<1	4	S150 if N > 1	S150			Cond	yes
MW-4/4R	Turf		2	4		N, S150, 515.3			Cond	yes
MW-5	Turf Response	yes	2	4	S150	515.3			Yes	yes
MW-6	Ambient		<1	4		N S150 + 515.			Cond	yes
MW-7	Turf		2	4		N S150 + 515.3			Cond	yes
MW-8	Turf		2	4		N S150 + 515.3			Cond	yes
MW-9	Abandoned									

* Remedial Action if > 5 ppm.

** WT measured at sampled wells and long term hydrographs updated semi-annual, annual WT snap shot with Water table map. + Includes methods L300, L311, S150 and EPA methods 547, 200.8, and 515.3. Volatile Organic Compounds analysis by 524.2. ^ If any well exceeds 4 ppm, then the well will be immediately sampled and if confirmed, all fertilization will stop in the upgradient area until concentrations drop below 2 ppm. or as indicated in the remedial plan ^^ If the Management Trigger is exceeded in any well then the sampling will be revert back to quarterly for all wells until the level drops below the Management Trigger in all wells. Semi-annual sampling in ambient wells shall include pesticides in the next round of semi-annual sampling if N > 1 ppm. TKN will be included in the semi-annual, 2-Year and 4 Year comprehensive sampling round.

PART 1. TECHNICAL REVIEW OF GROUNDWATER MONITORING PROTOCOL

BACKGROUND AND PURPOSE

In order to comply with the Southampton Town Board conditions of approval for groundwater protection, the property owners Bridgehampton Road Races Corp. retained Environmental & Turf Services, Inc. (ETS) to develop a sophisticated, comprehensive turf management plan and ground water risk assessment to ensure that turf chemicals would not impact ground water quality at The Bridge Golf Course. A significant tool to achieve this end was the Ground Water Monitoring Protocol. The protocol is the agreement, which describes how the groundwater monitoring program will be conducted, the results will be reported, and the responses that will be triggered by detections.

The original 1997 Groundwater Monitoring Protocol that was endorsed by the Suffolk County Water Authority, was amended ten times to address the following topics: 1) Well Locations and Depth; 2) Baseline Analyses; 3) Pesticide Analytes; 4) Construction of New Deep Wells; 5) Protocol Review after Five Years; 6) Low Flow Sampling Procedures; 7) Annual Interpretive Report; 8) Response Triggers; 9) Lysimeter Sampling and 10) add new pesticides to the list in 2002. The Declaration of Covenants and Restrictions was amended in 2009 to abandon well MW-9.

These amendments were written in response to comments received by the Planning Board's peer reviewers (Petrovic and Cambareri) in October 1998 and the State Attorney General's (AGs) office after the protocol was endorsed by the SCWA and the protocol authors.

The Groundwater Monitoring Protocol is subject to a five year review according to Amendment #5. In early 2006, ETS submitted a request with justification to modify the Groundwater Monitoring Protocol. The Town's Independent consultant reviewed and offered recommendations relative to proposed protocol modifications. The monitoring protocol has continued since that time so there are now 9+ years of monitoring under the original protocol as amended.

In accordance with the Town Resolution No. 2010-412, the town contracted both Dr. A. Martin Petrovic and Thomas Cambareri on June 15, 2010 to provide a review of the groundwater monitoring program conducted at The Bridge Golf Course and provide recommendations based upon that review, upon which the Town will base any amendment or change to the Groundwater Monitoring Protocol (GWMP).

This report presents the findings of the review of the GWMP and its quarterly and annual reports and other data that was made available. The report consists of our review of pertinent subject matter followed by a review of the proposed changes to the GWMP.

GROUNDWATER MONITORING PROTOCOL

The rationale of the Groundwater Monitoring Protocol is:

1) "meet the requirements of the Suffolk County Water Authority (SCWA) guidance;
2) help ensure the study will be conducted in a quality manner; and
3) help ensure the management plan and risk assessment have resulted in a golf course operation that will not impact ground water quality."

Prior to the construction of the golf course, the Town Board retained the services of A. Martin Petrovic, PhD. to oversee the work of ETS and provide an independent review of the groundwater monitoring and test results. In addition to being reviewed by ETS and Dr. Petrovic, the groundwater test results are also reviewed by the Suffolk County Water Authority (SCWA).

IMPLEMENTATION OF PROTOCOL

There are 14 monitoring wells and 22 suction lysimeters, in accordance with the 1997 protocol as amended. The lysimeters test leachate water quality from the putting greens and fairways to provide early warning for detection of any contaminants. One background monitoring well, three down-gradient wells and one shallow perched water well were installed prior to golf course construction. The remaining wells were installed in 2000, at the beginning of the construction phase when the well sites could be cleared. Two baseline-sampling rounds were taken prior to golf course clearing. The wells have been sampled quarterly for the last nine years. Results of the groundwater testing are received concurrently by the SCWAand ETS, and submitted to Dr. Martin Petrovic and the Southampton Department of Land Management in the form of quarterly and annual reports. Dr. Petrovic also receives, Superintendent Annual reports containing scouting reports, amounts of applied fertilizers, pesticides, chain of custody and laboratory quality control data, weather station data and irrigation volumes. His review is reported in quarterly and annual reports that include an annual site visit. The body of these reports from ETS and Dr. Petrovic forms the basis of this review. A complete listing of the available digital reports is included in the Attachments to this report.

A brief chronology of the initial implementation years of the Monitoring Protocol is listed below.

1998 – Clearing the Site, August installation of the initial wells BW, PW and MW-1, 2 & 4, Baseline sampling- two rounds.
1999 – Shaping of the course.

2000 – July Grassing the course, First fertilizer and pesticide applications, March-June installation of MW-3 and 8 additional wells, Baseline sampling- two rounds.
2001 – May Lysimeters installed. October EHL becomes the prime laboratory
2002 – Dec – First Annual Report for 2001, May Dedicated sampling pumps installed, new analytical methods with lower detection limits

The Ground Water Monitoring Program contains a multitude of requirements and procedures including the installation of state-of-the-art equipment for monitoring, irrigation and facility operations, reporting, thresholds, and responses. The Ground Water Monitoring Program and Course operations has been implemented according to the Protocol and gained consistency in all matters by the 2002 sampling year. This is a tremendous accomplishment and shows long term capacity for attention to detail.

PROTOCOL DEVIATIONS

Every quarterly and annual report provides an opportunity for the Bridge to identify areas where there have been deviations from the Protocol. Over the course of the nine year period there have been infrequent deviations. A typical deviation might be dependent on not having enough lysimeter water to run the complete analysis or temperature of samples exceeding 4 degrees C.

Based on our review there have been infrequent, but justifiable deviations that have not affected the overall monitoring program.

GROUNDWATER SAMPLING PROCEDURES

This includes a review of sampling procedures to insure that representative samples are taken and delivered to the laboratory. Items that are regularly reviewed include: a copy of the actual field log book with dates and signatures, chain of custody forms and overnight shipping receipts.

Based upon a review of the available quarterly and annual reports and Independent Review reports, field log books, sample shipments are made according to the Protocol.

QUALITY CONTROL SAMPLES

Quality Control Samples are required by the Protocol including one field trip blank, a duplicate for every ten samples, and decontamination rinse water if needed for lysimeter samples.

Based upon a review of the available quarterly and annual reports and Independent review reports, sampling, handling and testing protocols have been followed very closely over the nine years of the monitoring program.

LABORATORY QUALITY CONTROL

Laboratory Quality Control is required to include: method detection limit, practical quantification limit and results of matrix blank, matrix spike and matrix spike duplicate recovery analyses. Early in the groundwater monitoring program the initial laboratory was not meeting all the Quality Control requirements and the Bridge changed labs to Underwriters Laboratory, (formerly EHL). Some of the early results have different detection and reporting limits.

Based upon a review of the available quarterly and annual reports and Independent Reviewer Reports, all quality control samples, by 2002 the groundwater monitoring program gained consistency in all matters. The Environmental Health Laboratory, which subsequently became Underwriters Laboratory is meeting the quality control requirements of the Protocol.

NITROGEN IN GROUNDWATER

A review of nitrogen data indicates that nitrogen concentrations in groundwater beneath the golf course have increased over pre-existing concentrations in some of the monitoring wells. However, the nitrogen concentrations over the last five years appear stable; below the action threshold of 5 ppm and well below the federal and state drinking water standard of 10 ppm. Water quality data indicate that the background well may affected by being both near the groundwater divide and impacted by other land uses, which does not allow a comparison of turf management impacts to ambient conditions.

BACKGROUND CONDITIONS

The U.S. Environmental Protection Agency (1992) states that a background level is "the concentration of a (sic) substance that provides a defensible reference point that can be used to evaluate whether or not a release from the site has occurred." Additionally, "background levels do not necessarily represent pre-release conditions, nor conditions in the absence of influence from source(s) at the site." In the case of the monitoring program at The Bridge, the background monitoring location (BW-1) was chosen based upon 1998 groundwater flow information that showed it was in an upgradient location from the proposed managed turf areas and thus its water quality could be compared to the downgradient monitoring wells.

BW-1 is located on the southern side of the groundwater divide in the vicinity of a fairly intense area of land use consisting of heavy construction, the club house, parking lot and pre-existing land clearing. A review of the nitrate concentrations indicates that there is much variability in its concentration as shown in the graph below. This is due to the variety of land uses in proximity to it and the fact that this particular well is subject to much more variation of groundwater flow paths than the other wells since it is located at the top of the regional groundwater divide.

The water quality impacts from turf management are completely different from the impact resulting from a variety of other land uses as measured at the BW-1 well. Comparing the two, ETS can say that the impact of other land use is higher, lower or the same as the impact of turf management. When comparing the background well to the downgradient wells (except the perched water table well), ETS reports the yearly average nitrate concentration in 6 of 9 years (2001-2009) was higher in the background well relative to the downgradient wells. For the purposes of our review we chose to make the comparison to wells that provide a reference to water quality that is not impacted by turf management conditions.

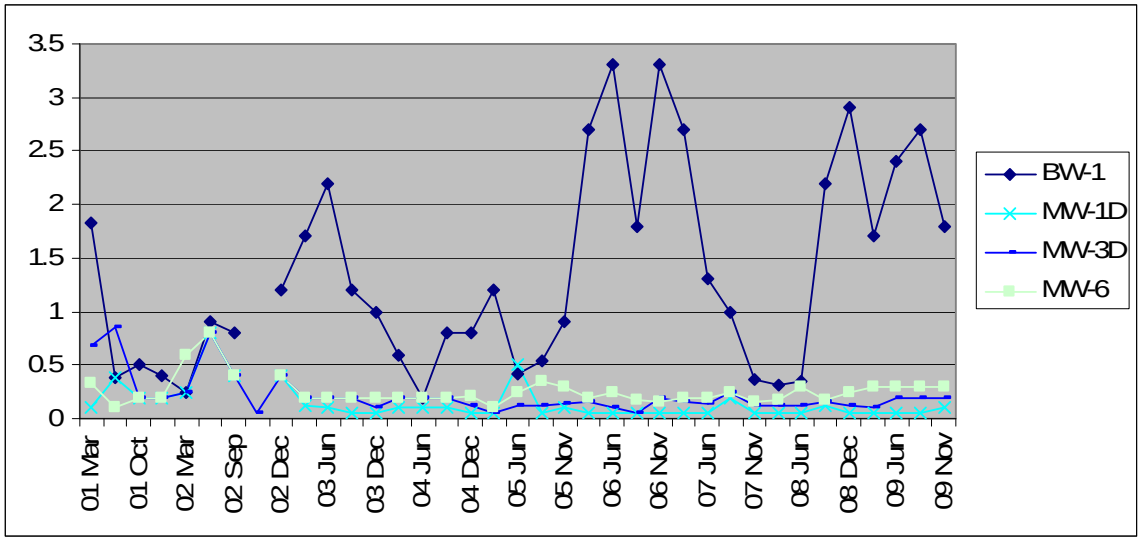


Figure 1. Nitrate-Nitrogen in the Background Well and MW-1D, MW-3D & MW-6

A review of the water quality data suggest several other wells should be considered as indicating ambient conditions. The locations MW-1D, MW-3D and MW-6 have low stable concentrations throughout the entire 9 year period of record as compared to the "background" well BW-1 as shown in the graph above. The combined long term (9 yr) average nitrate concentration of the three ambient wells is 0.21 ppm. Although these three wells are located in the managed area, it is evident that the nitrate concentrations have not appreciably changed after the variability of the initial years of the monitoring program.

The deep wells, including MW-1D and MW-3D were added to the monitoring well network to evaluate the potential of substances subject to a vertical hydraulic gradient. The deep wells typically have their 10 ft screens located 25 ft into the water table whereas the shallow wells have their screen straddle the water table. It is apparent that in these two cases there has been no increase of nitrogen at all and no presence of pesticides. It is not until the groundwater flow paths approach MW-2D at the farthest

downgradient edge do we see evidence of a vertical path with higher nitrogen in the deeper well.

MW-6 is a "shallow" well but has similar consistent low concentration results to the other ambient wells MW-1D and 3D. The well log of MW-6 indicates that it has a 40 ft screen located below a low permeable zone as compared to the other shallow wells that are typically screened at the water table. The fact that wells MW-3D, 1D and MW-6 are located in proximity to other wells that are experiencing statistically significant N increases makes a strong case that they represent the true ambient water quality conditions at The Bridge Golf Course. For the purposes of our review, we have categorized the monitoring wells for making water quality comparisons as miscellaneous (uncertain conditions), Turf Wells (ones influenced by turfgrass management activities) and Ambient Wells (ones not influenced by turfgrass activities) in the Table below.

Table 1. Categories of Monitoring Wells and N Concentrations

Nitrate in Groundwater (mg/L) (2005 to 2009)				
WELL TYPES	**WELL ID**	**AVERAGE**	**MAX**	**MIN**
MISCELLANEOUS	BW-1	1.69	3.30	0.31
MISCELLANEOUS	PW-1	2.87	4.40	0.57
TURF	MW-1S	0.67	1.30	0.05
TURF	MW-2S	1.38	2.60	0.67
TURF	MW-2D	1.51	1.80	1.30
TURF	MW-3S	2.19	3.00	0.44
TURF	MW4/4R	1.94	2.40	1.50
TURF	MW-5	1.80	2.40	0.90
TURF	MW-7	1.34	1.80	0.95
TURF	MW-8	1.02	1.30	0.60
ABANDONED	MW-9	2.26	3.10	0.20
5-YR AVERAGE		1.48*		
* not including MW-9				
AMBIENT WELLS	MW-1D	0.07	0.50	0.05
	MW-3D	0.14	0.24	0.05
	MW-6	0.23	0.34	0.11
5-YR AVERAGE		0.15		

It is noted that the use of the Mann-Kendall test in the 2009 ETS Annual report found that the three recommended ambient wells had decreasing concentrations. ETS has indicated that the variability of nitrogen concentrations in the earlier sampling years might be due to the release of dissolved solids from the initial land clearing as will as the potential for greater nitrogen movement into groundwater during the establishment of the golf course. The variability could account for the anomalous higher nitrate results at the beginning of the monitoring program for the ambient wells, which results in an apparent decreasing trend. However, it appears on the graph (Figure 1) that they are consistently low over the last five or more years.

The Mann-Kendall test also indicated the increases in the nine Turf Wells (eight now that MW-9 is abandoned). The increasing trends of the eight Turf Wells are evident in the graph below (Figure 2). Low nitrate concentrations, generally below 0.5 ppm, are observed in the beginning of the monitoring program, before the course was built and the early years of fertilizer application. The low pre-existing concentrations are followed by an increasing trend, and then a general leveling off. MW-1S is the most variable and like BW-1 its location close to the regional divide results in more variable groundwater flow paths. Over the last three quarters, an increasing trend at the end of the monitoring period is seen in MW-2S. The early outlier of 6.6 ppm nitrate in Well MW-3S, which was not confirmed by resampling, is omitted for this analysis.

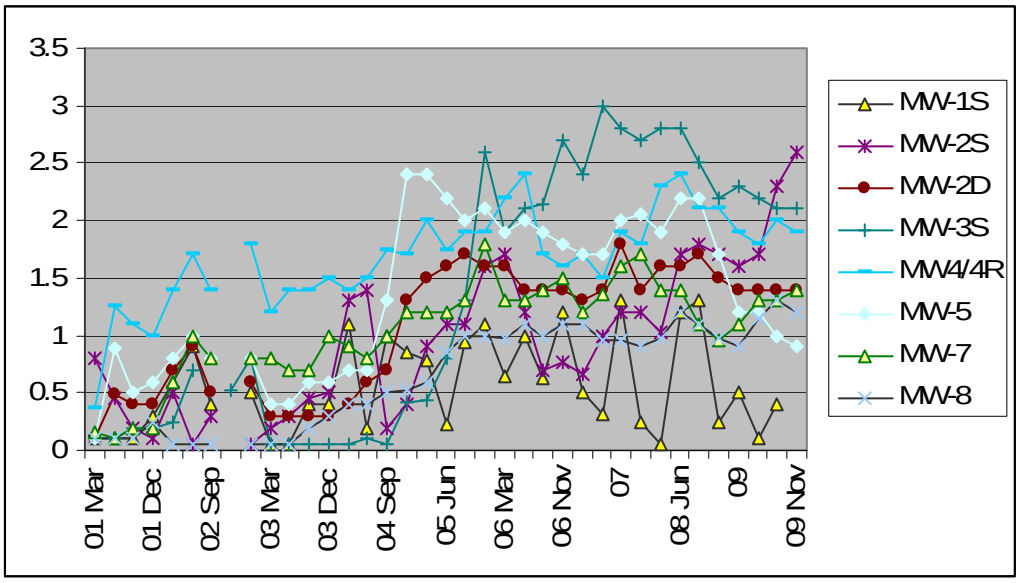


Figure 2 Nitrate-Nitrogen Concentration in Eight Wells Affected by Turf Management

If we omit the BW-1, PW-1 and even MW-9 in the calculations, and identify MW-1D, 3D and MW-6 as ambient wells, we can make better comparisons to the water quality in the eight remaining turf wells to evaluate the impact of turf management at the golf course as shown below.

Nitrate (ppm)	
0.21	Nine Year Average (2001-2009) of the three ambient wells
0.15	Last 5 year (2005-2009) average of the three ambient wells
1.08	Nine Year Average of the 8 turf wells w/o BW-1, PW-1 or MW-9
0.87	Nine Year Average increase of nitrogen over ambient (0.21 ppm)
1.48	Last five year average of 8 turf wells w/o BW-1, PW-1 or MW-9
1.33	Last five year average increase over ambient (.15 ppm)
0.67 to 2.19	Last five year range of average nitrogen of 8 turf wells
2.87	Last five year average in perched groundwater (PW-1)

There has been an overall average N increase of 0.9 ppm observed in the eight turf management wells over the nine year period of record (2001-2009). If we use only the last five years in which the increase appears to flatten-out, as suggested in the 2009 Annual report, then the average nitrate concentration is 1.48 ppm. This is a 1.33 ppm average increase over the ambient concentration of 0.15 ppm. The average ambient nitrate concentration is less because the last five years do not include the higher concentrations from front-end variability in the early years of the data. Conversely, the eight turf management wells have a higher nitrate concentration because the low concentrations of the pre-build and early years are not included.

Individual maximum N concentrations over the last five years (2005-2009) are 3.1 ppm in MW-9 (abandoned) and 3.0 ppm in MW-3S. The maximum nitrate increase over the average ambient concentration of 0.15 ppm is 2.85 ppm.

PERCHED WATER TABLE

The perched monitoring well PW-1 presents an interesting case. The nitrate concentration in PW-1 is nearly a straight line increase from 0.2 to 4.5 ppm as shown in the graph below (Figure 3). The two points below the "straight line" are suspect. The perched water table is only 32 feet below the land surface whereas the average depth to the aquifer's water table is 99 to 219 feet depending on topography. Review of the well log indicates that the thickness of the perched water table is about 10-15 feet. A review of the well logs from other sites on the course indicates that the aquitard does not have an appreciable thickness or extent. However, a USGS study by Schubert (WRI-R98-4181) of groundwater flow paths in the Southfork area indicates a sub-regional perched aquifer in the moraine deposits in this vicinity. In any case, the perched aquifer is shallow, has less water, and is not replenished by the principle aquifer. Therefore, the nitrogen mass that leaches is subject to less dilution than what occurs in the principle aquifer. Groundwater in perched areas typically "leak" through the supporting clay at very slow rates that can change the character of its quality before eventually contributing to the principal aquifer.

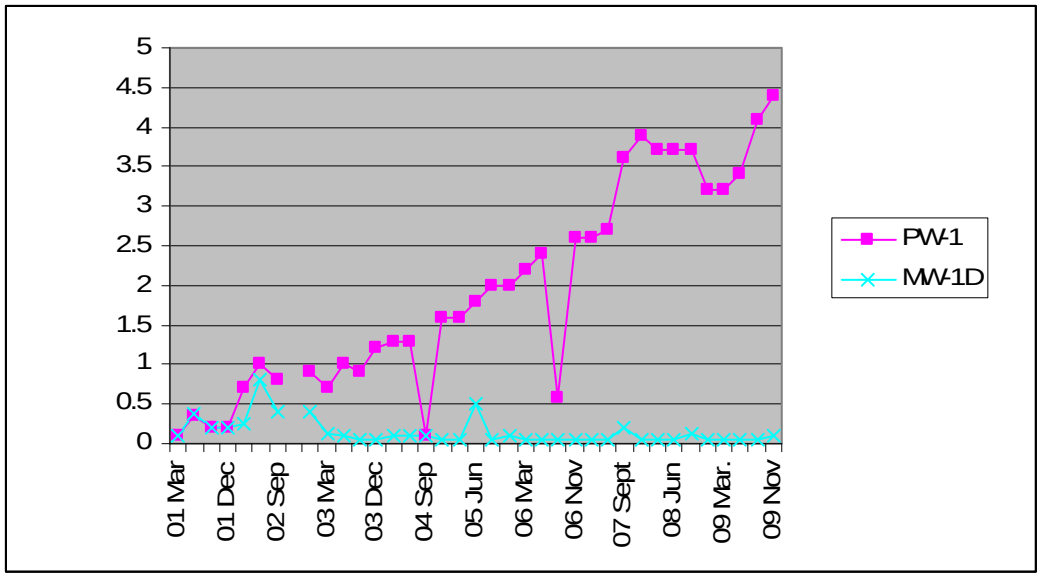


Figure 3 Nitrogen Concentration (ppm) in PW-1 (2001-2009)

There are a host of questions that the water quality increase of the perched water table raises. At what concentration will N level off? The perched well is also located in close proximity to a drainage pond, which receives drainage from at least two drains on Fairway 8 that were observed during the site visit. Does the drainage pond concentrate dissolved nitrogen from surface drainage that subsequently leaches to the perched aquifer? What is the N concentration in the pond? Should the 5 ppm trigger level be applied to the perched aquifer? A long term hydrograph of PW-1 should be prepared and compared to the other wells to evaluate fluctuations and determine if the perched water

table has a net gain due to irrigation. Is the perched zone extensive enough to use as a limited source of enriched irrigation water? A long term pump test and water quality assessment of PW-1 using a high yield submersible pump should be considered in the interim to evaluate its use as a source of recycled nitrogen. Discharge of the water pumped from PW-1 into the pond due to its potential for nitrogen uptake is another potential alternative.

NITRATE SUMMARY

The quarterly and annual reports use the BW-1 well to compare the impacts of turf management. The comparison may not be useful because the well is on the other side of the divide and is impacted by several different land uses and its concentration is nearly always higher than the downgradient wells.

Although turf management has a demonstrated nitrate impact on groundwater quality, the results are low enough below the 5 ppm threshold to conclude that it has not significantly impaired water quality. Thus, the turf management protocols have kept nitrate concentrations in groundwater below 25% of the agreed upon threshold of 5 ppm.

It is apparent that application of fertilizers to turf aided by irrigation can result in the migration of solutes through over 100 feet of the unsaturated zone that results in water quality impacts at the water table.

In regard to the perched water monitored in PW-1, a case can be made that the threshold should not be 5 ppm since it is not part of the principle aquifer; however, if the concentration should exceed 5 ppm, then remedial action should be required (i.e., use it for irrigation). The questions raised above may be useful to evaluate if it appears that the 5 ppm threshold is being approached.

Continued monitoring of a number of the deep wells is important to evaluate long term ambient ground water.

PHOSPHORUS IN GROUNDWATER

Phosphorus is sampled in groundwater monitoring wells and lysimeters. We used the summary table from the 2009 Annual report to comment on its occurrence in groundwater. Overall, the detected amounts of phosphorus are very low. Phosphorus is subject to attenuation by the iron and aluminum particulates in the soil aquifer matrix. A certain amount of phosphorus is natural. The data below (Figure 4) are qualified in the large number of non-detects that are averaged as ½ of the detection limit of 0.05 ppm.

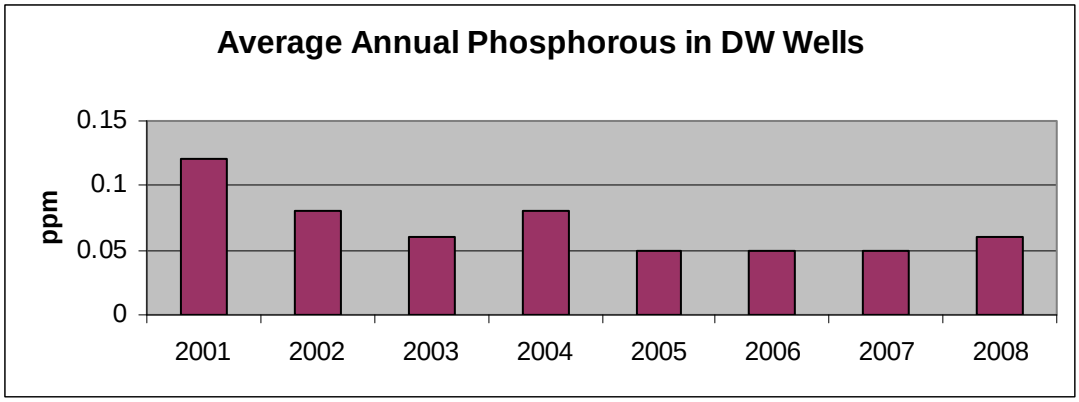


Figure 4 Average Annual Phosphorus in Downgradient Wells (DW) (without BW-1 and PW-1)

The 1998 Independent Review indicated that phosphorus loading would not likely be a problem to downgradient surface water bodies. The monitored groundwater concentrations are basically below detection limit so it is recommended that phosphorus be removed as an analyte in future monitoring events.

PESTICIDES IN GROUNDWATER

Of the 13 wells tested, excluding the background well, there were 60 detections (see Table 2) of pesticides above the reporting limit, which is 0.1 ppb for most analytes. In all but five cases, the detections were below 0.5 ppb. The five detections that were above 1 ppb occurred in the early monitoring years 2001-2002 at the MW-4 site well, which was replaced with well MW-4R. The detections were associated with a surface water sump located in close proximity to MW-4. In addition, the well casing was cracked. Those compounds have not been detected since the well was replaced. The recent number of detections has occurred at the MW-2 well site where myclobutanil, propiconazole isomers, and chlorothalonil have been detected in the years 2007 to 2009. Chlorathalonil has also recently been detected at PW-1, MW-5, 7, 6, and 8. Many of these are first time detections that are just at the reporting limit (0.1 ppb) and should be evaluated in the future if the levels increase and are persistent. Other than MW-4 during 2001-2002, specific pesticide concentrations both individually and cumulatively in any well were below the New York State Principle Organic Compound public health thresholds of 5 ppb, the 50 ppb DEC Guidance Values, or ETS Health Advisory Levels, whichever is lower and appropriate for the particular pesticide.

Table 2. Average Annual Phosphorus in Downgradient Wells (without BW-1 and PW-1)

Well*	Paclobutrazol	Triadimenol	Myclobutanil	Chlorothalonil	Propic a	Propic b	PCNB	Total Detects
MW-4/4R	5	8						
MW-2S			6	1		2		
MW-2D			8	1	10	10		
PW-1				1				
MW-5				1				
MW-6				1				
MW-7				2			2	
MW-8				2				
Total Detects	5	8	14	9	10	12	2	60
Total Analysis	533	533	533	533	533	533	533	533
Percent detects	0.94%	1.50%	2.63%	1.69%	1.88%	2.25%	0.38%	11.26%

* The results from the abandoned well, MW-9, are not included in this table.

The Bridge has taken an aggressive response to the detection of pesticides. They have voluntarily agreed to eliminate the use of paclobutrazol, myclobutanil, and triadimefon. The Protocol indicates that pesticide application shall be reduced to one half the amount over the golf course. An interpretative decision to apply the reductions over specific areas based upon detections is a more recent application to this response and should be evaluated. For instance, the 3rd quarterly report in 2009 indicates that only one-half of certain pesticides (chlorothalonil and propiconazole-a) used in the past will be applied to hole areas 6, 7, 9 and 13. The reduction is also indicated in the 2009 4th quarterly report. Although this type of information is contained in the paper quarterly reports the information needs to be in much greater detail (i.e.a hole by hole analysis including specific location, i.e. greens, tees, fairways or roughs, by date of application for each pesticide should be included in the semi-annual reports to track how these reductions are implemented over time. It is also recommended that, the procedure to select areas for the reduced amounts should be explained and included in any future report.

In the case of pesticides, the overall quality of the groundwater has not been significantly affected by the golf course operations at The Bridge Golf Course.

LYSIMETERS

Lysimeters are used to sample shallow soil water and to serve as an early warning/response method to protect groundwater quality. In sandy soil it is often difficult to obtain enough of a water sample for both pesticide and fertilizer inorganic compounds. The nitrogen threshold for response action at the Lysimeters is 10 ppm. This level was exceeded several times: twice at G4-3 and G4-6 (2004), four times at G7-3 (2007-2008) and nearly exceeded (9.7 ppm) at F10-3 in 2005. The exceedence at G4 was explained as a result of mis-application of fertilizer directly above the lysimeters. The exceedence at G7 was explained as a result of no bio-filter over the lysimeters. The long-term trend analyses of the nitrogen lysimeter data are shown in Table 3 that is derived from the 2009 Annual Report below. Over the period of 2001 to 2009 the annual average nitrate concentration in the lysimeters ranged from a low in 2006 of 0.77 mg/L to a high of 4.14 mg/L in 2008 with no clear pattern.

Table 3. Mean Nitrate-Nitrogen Concentrations in all Lysimeters

Year	Mean N Concentration (ppm)	Standard Deviation (±; ppm)	Number of Data Points	Number of Non-detects (% ND*)
2001	1.1	1.21	10	0 (0)
2002	1.21	1.01	25	3 (12)
2003	1.13	1.37	30	9 (30)
2004	2.61	4.37	34	11 (32)
2005	1.1	2.09	28	11 (39)
2006	0.77	0.79	31	10 (32)
2007	2.40	2.95	32	8 (25)
2008	4.14	10.25	32	8 (25)
2009	1.90	1.88	32	8 (25)

*ND = non-detects

The quarterly occurrence of nitrate in lysimeters was plotted and graphed below (Figure 5). The graph shows that except for the initial sample results, the lysimeters at G14 (at both the 3 and 6 foot depths) had relatively few detections. In fact, the eight non-detects for the 2007 to 2009 years, as indicated in Table 3 above, are from the lysimeters at this location. It is also apparent that the nitrate concentrations at the couplet lysimeters G14-3 & 6 have a similar track to each other**.** The statistics of nitrate at each location are shown in the Table 4. The average nitrate concentration of six of the eight lysimeters is above 2.28 ppm and the maximum concentration was reported at a N concentration greater than 5 ppm. Overall, however, there were only 18 out of 260 lysimeter samples that were greater than 5 ppm. It would be expected that the lysimeters would have higher maximum and average concentrations than the monitoring wells because the lysimeters catch relatively undiluted "runoff" from the course or receive drainage from the greens. It is also evident that the lysimeter data is used to manage turf as when in the 2008 quarterly report, less nitrogen fertilizer was specified in response to a detection of 21 ppm at G7-3.

The lysimeter data indicate a mixed performance of the biofilters. The biofilters at the G14 location appear to work extremely well in contrast to the biofilter at G7 at some of the sampling events, even accounting for the outlier detections from unintentional applications. It is unclear at the moment if there are parameters that can account for the contrast and it is therefore recommended that monitoring the biofilters be dropped from the protocol in favor of actual green infiltration.

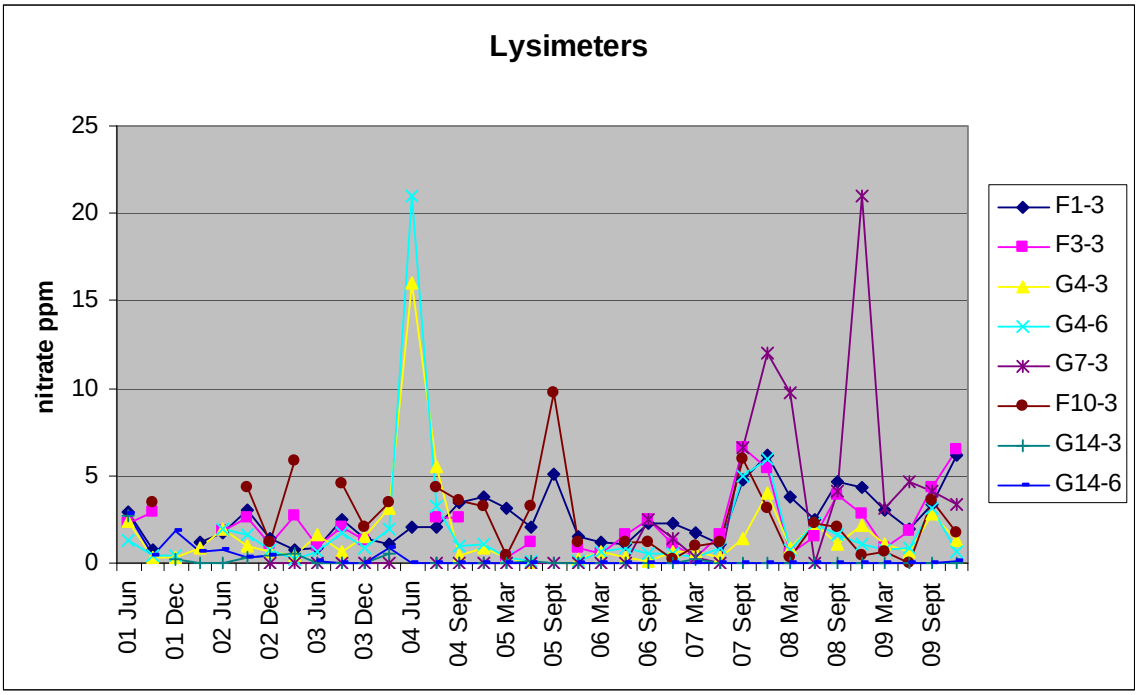


Figure 5 Graph of Nitrate Concentrations in Lysimeters

Table 4. Nitrate Concentrations (ppm) in Lysimeters (2001-2009)

	mean	max	min	n	NDs
F1-3	2.61	6.2	0.8	35	0
F3-3	2.24	6.6	0.34	30	0
G4-3	1.67	16	0.13	35	1
G4-6	1.90	21	0.15	34	0
G7-3	2.63*	21	0.29	28	16
F10-3	2.61	9.7	0.23	29	1
G14-3	0.18	2.68	0.16	34	26
G14-6	0.28	2.77	0.1	34	24

N= number of samples; NDs = number of non-detects
* 56 ppm was not included in this result

Overall, the results of the lysimeters are used as an early warning as to the mass of nitrogen or pesticides that can potentially leach further through the soil to groundwater. Long term data has shown that where nitrate is being detected, lysimeter concentrations are higher than groundwater. The lysimeters also show that the installation of bio-filters to attenuate nitrogen has worked reasonably well to protect groundwater as seen in the

performance between G14 and G7, before G7 was reconstructed. Furthermore, the use of couplet lysimeters appears to produce redundant data.

The detections of pesticides in lysimeters are presented as text in the body of the quarterly and annual reports. The following are some highlighted occurrences. In 2003, there were detections of triadimenol in F3 and F10 at concentrations of 10 to 3.7 ppb and 1.1. to 1.3 ppb, respectively. Also there were detections of triadimenol, fenarimol and propiconazole-a,b in G14 -3 and G14-6. In 2004 there were detections of fenarimol in G14-3 and G14-6 and a detection of myclobutanil in F10. In 2005, there were detections of fenarimol, myclobutanol, propiconazole. In 2006, there were detections of myclobutanil, fenarimol and propicnazole-b, all less than 1 ppb. In 2007, there were no detections of pesticides at all, but in 2008 there were detections of propiconazole, chlorothalonil, myclobutanil, fenarimol, and PNCB. In 2009, there were detections of propiconazole, chlorothalonil, and PNCB all less than 1 ppb. A complicating issue is where there have been detections of triadimenol and myclobutanil where the fungicide Bayleton and Eagle were not applied. However, it is known that these pesticides are used on sod farms in the area, and these parts of the golf course have sod purchased from those farms.

GOLF COURSE OPERATIONS

The Protocol and Natural Resource Management Plan provide for a number of operational requirements. These include Turf Area, applied fertilizer, applied pesticides, irrigations, site visits, and general management. The quarterly and annual reports of both ETS and Dr. Petrovic provide the basis of our review of several key areas.

TURF AREA

The Decision on the Golf at the Bridge Course specified that the 281 acre total project area in the Quasi-Public Service Use District would have approximately 122 aces in managed turf. The decision allowed a breakdown of 80.38 acres in managed turf and 50.18 acres of perimeter turf in which there would be low maintenance with no fertilizer or irrigation.

3.74 Tees
2.72 Greens
33.05 Fairways
40.87 Intermediate Rough
80.38 Total Acres

50.18 Perimeter Rough – Low Maintenance – No fertilizer or Irrigation

We asked for an as-built assessment of the area of turf. The Bridge Superintendent Gregg Stanley provided us with a GPS assessment of the area of managed turf. These were provided as pdf files containing two maps of the front and back nine holes (found in the Attachments) as well as the range area, and a table listing the total acreage.

The total fertilized area as mapped is actually 78.27 acres, which is slightly less than 80.38 acres, the amount allowed.

APPLIED FERTILIZER

Nitrogen

The Protocol requires the reporting of the types and amounts of fertilizers and pesticides applied to the course. The quarterly and annual reports contain the information as required in the Protocol. The Independent review provided by AM Petrovic has verified information contained in the Superintendent's notes and annual reports.

The golf course is allowed to apply the following amount of nitrogen (N) fertilizer:

6.46 acres of greens and tees at 2.5-4 lbs. N/1000 sq. ft.	704 to 1,126 lbs. N/year
30.05 acres of fairways at 3-4 lbs. N/1000 sq. ft.	3,927 to 5,236 lbs. N/year
40.29 acres of roughs at 1-3 lbs. N/1000 sq. ft.	1,755 to 5,265 lbs. N/year
Totals	6,386 to 11,627 lbs. N/year

The following chart shows the annual amount of fertilizers applied to the golf course relative to the recommended low end of the cumulative limit of 6,386 pounds per year.

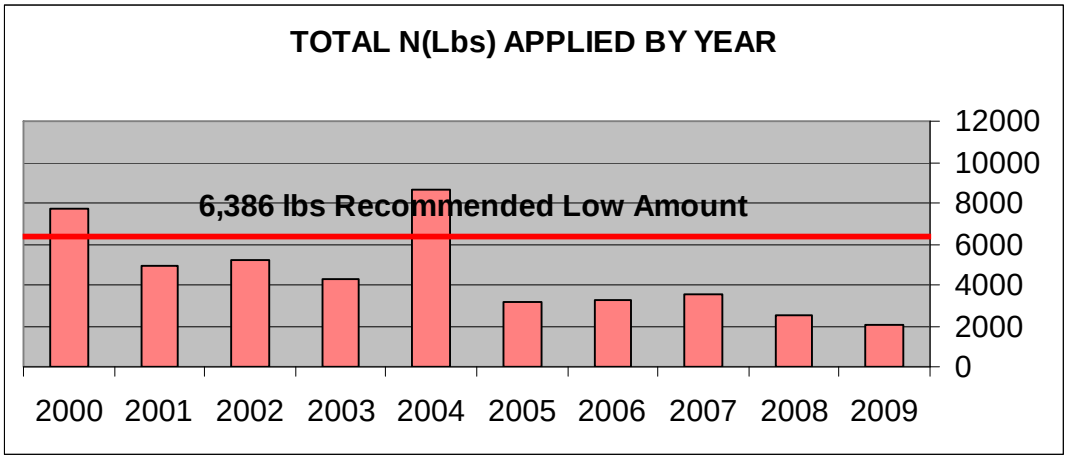


Figure 6. Total Nitrogen Fertilizer Applied

As reported in the superintendent's annual reports and reviewed by the Independent consultant, fertilizer amounts have been below the specified amount of 6,386 pounds N per year since 2004. The average over the 9 year period is 4,539 lbs/yr. This is 71% of the low end range of the allowable amount. During the last five years (2005-2009) of turf management, the Superintendent has only used an average of 2,905 lbs/yr or 45% of the low end of the allowable amount (6,386 lb N/yr). It is noted that the higher amount of fertilizer (8,667 lbs/yr) used in 2004 preceded significant increases of groundwater nitrogen concentrations in several of the 8 turf and turf response wells as shown on the earlier graph; however, the amount used in 2004 was within the range of the total amount allowed.

Water quality data in the eight turf monitoring wells over the five year period of 2005-2009 indicate a "plateau" average N concentration of 1.48 ppm, which is approximately 30% of the 5 ppm threshold. A maximum concentration of 3 ppm or 60% of the 5 ppm threshold was observed in one of those eight wells. The original Protocol allows a doubling of the fertilizer applications beyond that used over the last 5 years. A doubling of the fertilizer amount may result in a doubling of resultant average nitrogen concentrations (assuming it is a linear relationship, which it is not) that approach 3 ppm and maximum concentrations that could exceed 5 ppm.

The 1995 Integrated Golf Course Management Plan and Water Quality Risk Assessment predicted increases of resultant nitrogen concentrations in groundwater of approximately 0.3 ppm above background (a range of 0-0.5 ppm was given). The Independent Review of 1998 used a nitrogen loading model to estimate that nitrogen concentrations from the highest recommended application rates would range from 2.4 to 1.4 ppm depending on leaching rates from 15 to 25%. First order calculations of non-point source loading impacts to groundwater are based on a number of simplifying assumptions.

Now that there is nine years of groundwater water quality data we revisited the calculation of relative nitrogen leaching to groundwater. The 9 years of quarterly sampling allowed for the characterization of distinct turf wells with higher N concentrations than ambient wells. The water quality trend in groundwater from turf wells over the last five years maintains consistent nitrogen concentrations as compared to the initial years, as discussed earlier, which indicates an average increase of 1.33 ppm nitrogen. We calculated a comparative mass of nitrogen in the volume of aquifer consistent with the annual recharge, by incorporating 22.7 inches of recharge (50% of the average long term precipitation) over 80 acres of turf. The calculated annual mass of nitrogen in the aquifer is 19% of the average annual nitrogen application rate over the last five years of 2,900 lbs/yr.

ETS presented an alternative method in which they calculated the nitrogen mass from the 1.33 ppm concentration in a pre-determined volume of aquifer. This was compared to the total amount of nitrogen applied over 5 years. An adjustment of an additional one-half that amount was incorporated to account for groundwater travel time which results in a leaching rate of 12%.

We compared the estimates to nine scientific research studies on golf course turf, of which more than half are greenhouse studies. The studies cover a wide range of factors that influence nitrogen leaching including cultivar and species differences, amendments of sand, nitrogen sources and rates of application, cultivars of bentgrass with different rooting depths, clipping management, soil types, and an actual green on a golf course.

The amount of leaching ranged from none to a high of 71% of the amount of fertilizer nitrogen applied with an average from all studies of 13.34%. Half of all the results (84 values) were below 3% of the amount applied. Field studies are considered a better representation of what actually occurs in the real world and greenhouse studies are good to compare factors and often give higher leaching values. When only considering the four field studies, the percent of fertilizer nitrogen that leached averaged 3.0%, ranging from 0.02% to 13.2%. The golf green turf had the highest amount of fertilizer nitrogen that leached. The factors found to increase fertilizer nitrogen leaching were: applying increasing amount of nitrogen fertilizer especially to pure sand greens compared to ones with peat or other amendments, much more leaching occurred during the establishment phase that in subsequent years (up to 3yrs), bentgrass cultivars with shorter roots than ones with deeper roots had more leaching, the more irrigation was applied more fertilizer nitrogen leaching, the sandier the soil the greater the amount of fertilizer nitrogen that leached, and annual bluegrass had much more leaching than bentgrasses especially annual bluegrass from Canada.

The Bridge has agreed to be a part of the Peconic Challenge to achieve the goal of no more than 2 ppm nitrogen in groundwater. Based on the nitrogen application values and present average nitrogen concentration in groundwater of 1.48 ppm, it is recommended change in the protocol that the town adopt a qualified limit of no more than 3,000 lbs of nitrogen applied per year.

Additional recommendations by Dr. Petrovic to further reduce fertilizer applications and yet maintain a healthy playable surface should continue to be implemented such as use of clippings on rough areas.

As indicated in the Annual and Independent Reviewer reports, the Superintendent continues to use soil test results to guide fertilizer application.

PESTICIDES APPLIED

The application of pesticides follows the requirements of the approved 1998 Natural Resource Management Plan (NRMP) as amended in 2000 with review and recommendations of Dr. Petrovic.

The NRMP allows the use of 32 specific pesticides. Over the course of operations only 14 pesticides have been used. The majority of pesticides used are fungicides followed by herbicides and very infrequent use of insecticides. The following are the types and names of the actual pesticides used on the golf course by year. The amounts of pesticides applied are available in the Superintendent's Annual reports. The Independent Reviewer evaluates the Superintendent's scouting and total pesticide application amounts. Scouting is performed daily and observations of pests are recorded as part of the field history/scouting reports. Those reports outline the occurrence, identify the pests, and the action thresholds for pesticide application. The actions taken are in conformance with the Natural Resource Management Plan. Pesticide application generally corresponds to the pest occurrence as found in the field pest history reports.

Table 5. Number of compounds of each type of pesticide

	Insecticide	Herbicide	Fungicide
2009	0	1	5
2008	0	1	5
2007	0	1	5
2006	0	1	4
2005	0	0	5
2004	1	0	7
2003	1	0	6
2002	1	0	6
2001	0	0	8

Table 6. Pesticides Applied by Year

2009 azoxystrobin, iprodione, chlorothalonil, propiconazole, 2-4D, dicamba, MCPP-H
2008 azoxystrobin, iprodione, chlorothalonil, propiconazole, 2-4D, dicamba, MCPP-H
2007 azoxystrobin, iprodione, chlorothalonil, propiconazole, 2-4D, dicamba, MCPP-H
2006 azoxystrobin, iprodione, chlorothalonil, 2-4D, dicamba, MCPP-H
2005 azoxystrobin, iprodione, myclobutanil, chlorothalonil, PCNB, trinexapac-ethyl
2004 thiophanate methyl, thiram, iprodione, triadimefon, propamocarb, propiconazole, chlorothalonil, chlorpyrifos -turfmate and tea
2003 thiram, iprodione, triadimefon, fenarimol, propamocarb, propiconazole, chlorpyrifos -turfmate and tea
2002 thiram, iprodione, triadimefon, fenarimol, propamocarb, propiconazole, chlorpyrifos

2001 thiram, iprodione, triadimefon, fenarimol, propamocarb, propiconazole, thiophanate methyl -Turfshield & paclobutrazol,-GReg

* 2002 Annual report indicates that triadimefon and paclobutrazol were stopped in June 2003 and Sept 2001, respectively, and fenarimol was stopped in 2003.

The amounts of pesticides applied are contained in the appendices of the quarterly water quality monitoring reports and summarized in the Annual reports. The Independent Reviewer reviews all of The Bridge reports submitted to the Town. The scouting is performed daily and observations of pests are recorded as part of the field history. The reports outline the occurrence, identifies the pest, and the action thresholds for pesticide application. The actions taken are in conformance with the Natural Resource Management Plan. Targeted pesticide application generally corresponds to the pest occurrence as found in the field pest history reports. No insecticides have been applied since last used in 2004.

GROUNDWATER FLOW MAPS

Measurement of static water levels and preparation of water table maps are required by the protocol. Quarterly reports contain the water level measurements and the Annual reports contain four quarterly water table maps. The water table flow maps show some variability in flow directions, particularly at the top of the groundwater divide. Although the difference in flow directions seems to impart a higher degree of variability to wells BW-1 and MW-1S and their nitrogen concentrations, the flow maps do not have a great bearing on the management of the course, except the selection of reduced pesticide area applications as a response to a threshold exceedence, as discussed above.

Water table maps should continue to make use of measurements at the TW-wells and be contoured by hand.

The collection of water table measurements and preparation of water maps should continue. However, long term hydrographs of the wells should be prepared and compared and regularly included in the semi-annual and annual reports. These can be used to supplement irrigation and precipitation reporting and as discussed earlier compare to the perched well.

IRRIGATION

There are four irrigation wells located along the 15thfairway. These four wells have a combined capacity of 1,100 gallons per minute. Irrigation amounts were obtained from the Independent Reviewer's reports. Overall, the irrigation amount averages 24.3 million

gallons per year. The irrigation period is from April to October for 7 months with the highest rates being in the summer. This translates into a daily average pumping rate of 115,700 gallons per day over the seven month period. The annual average amount can be pumped over a period of approximately 105 minutes.

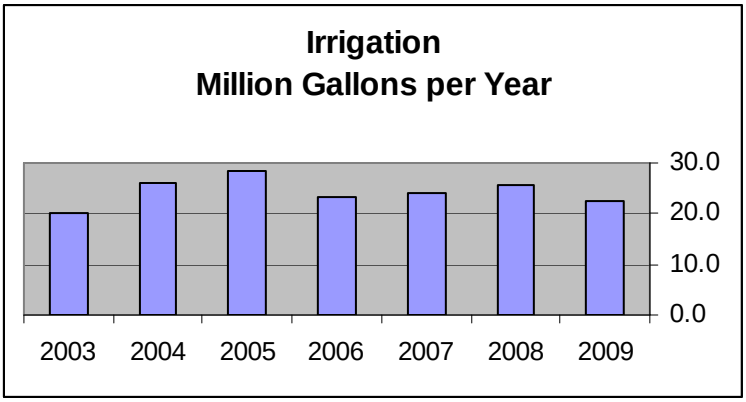


Figure 7. Annual Irrigation Applied

The irrigation amounts are recorded by the Toro weather station. The data are used to evaluate the net amount of annual evapo-transpiration (ET) in inches that would be required by the irrigation system. The inches of ET and the amount applied are fairly equal except for 2004 and 2005. It is assumed that a much higher rate of irrigation was needed during these yearly grow-in years prior to 2001 and a more accurate way to incorporated ET data was implemented following 2005.

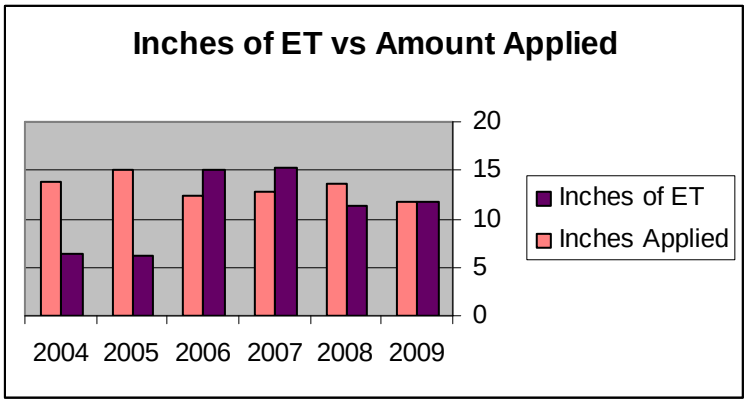


Figure 8. Inches of Evapotranspiration vs. Amount of Irrigation

The pumping of 24 million gallons per year will result in slight variations of groundwater flow near the pumping well, resulting in a potential dilution of substances in groundwater proximal to the wells. The locations of irrigation wells should be shown on the groundwater table map. A groundwater flow capture area for the irrigation wells using

a simple groundwater model was prepared by the Technical Review Team and the results are attached to this report. The golf course has made recent use of drip irrigation in the perimeter turf to the sand traps with very favorable results in turf growth and health. The Independent Review has encouraged a wider application of this technology to promote healthy and more resistant growth and reduction in irrigation amounts and it is recommended to be added to the amended Protocol.

SITE VISIT

On August 11, 2010 Thomas Cambareri and Marty Petrovic conducted a site visit to the Bridge Golf Course. The site visit was attended by Jeff Murphree, the Town's Director of Land Management, Stuart Cohen of Environmental & Turf Services, Inc. (ETS), Gregg Stanley, Golf Course Superintendent, and Filip Sinni and Steve Colabufo of the Suffolk County Water Authority (SCWA). The meeting started at 12:30 PM. After introductions, general discussion, and site description, a site visit was conducted with the use of several golf carts. Mr. Cambareri rode with Gregg Stanley and Mr. Petrovic rode with Stuart Cohen. The party visited well sites MW-3, MW-5, MW-2, LG-7, PW-1, passed by the irrigation wells, MW-4R and the general area of abandoned well MW-9. The party met again at the golf course Superintendent's office to discuss impressions and to hear Mr. Cohen's specific ideas about updating his request for modifications to the monitoring program. It was noted that the use of golf cart paths on the turf areas had been appreciably reduced from the earlier years

TECHNOLOGY ALTERNATIVES

PEST MANAGEMENT

The Bridge should consider a systematic testing program for bio-fungicides that can potentially be used in the golf course disease control program and it is recommended to be added to the amended Protocol. The Bridge has conducted a non-technical evaluation of some of the bio-fungicides (see Table 8, from 2010 Pest Management Guides for Commercial Turfgrass, Cornell University). The reason to consider the use of bio-fungicides is that they are often much less toxic than conventional fungicides. The systematic approach would include on-site testing of the materials below compared to the golf courses traditional fungicide program along with un-treated areas to determine effectiveness of the bio-fungicides.

Except for one occasion, The Bridge has not requested to have any new pesticides added to the list of approved pesticides for use on the golf course. Since most of the pest problems are diseases, The Bridge should consider evaluating the risk of several new fungicides introduced since 2000 that are considered to have a much lower risk by USEPA: boscalid a reduced risk pesticide (Emerald) and a mineral oil (Civatas). Any new pesticides must be approved by the Town. The request for such approval must be accompanied with a ground water quality risk assessment, pursuant to the process suggested by ETS by its 1995 report or with more state of the art methods that were developed since 1995.

Table 7. Biofungicides from 2010 Pest Management Guidelines for Turf Grass

Bio-fungicides.

Common Name	**Sample Trade Name(s)[1]**	**Formulation[2]**	**EPA Reg. No.**
***Bacillus licheniformis* strain SB 3086**	EcoGuard Biofungicide	0.14EC	70127-2
Trichoderma harzianum	Rootshield Granules	1.15G	68539-3
***Bacillus subtillis*, strain QST 713**	Serenade Garden Lawn Disease Control	1.34 F	69592-12
	Rhapsody	1.34F	69592-19
***Pseudomonas aureofaciens* strain TX-1**	Spot-Less Biofungicide	1L	75801-1
Polyoxin D Zinc salt	Endorse	2.5W	66330-41-1001
Mono and di-potassium salts of phosphorus acid	Alude	45.8EC	71962-1-1001
	Vital	54.5EC	42519-24
Phosphorus acid	Magellan	52.6L	228-387

[1] Trade names shown are examples of products available and are not meant to be an exhaustive list. [2]AS = aqueous suspension; DF = dry flowable; EC = emulsifiable concentrate; F = flowable; G = granular; L = liquid; SC = soluble concentrate; W or WP = wettable powder; WDG = water-dispersible granule; WSB = water-soluble bag; WSP = water-soluble packet

WATER MANAGEMENT

Most of the fertilizer and pesticides are applied during the period of the year when irrigation occurs. Over irrigation has been repeatedly shown to cause greater movement of nitrogen and pesticides through soils, likely leading to greater groundwater contamination. Thus, to protect groundwater quality everything possible must be done to ensure that over irrigation doesn't occur. The Bridge has done many things to reduce the likelihood of over irrigation: using an irrigation system with very accurate coverage; using evapotranspiration (ET) to guide the amount of water applied; and using drip irrigation to further reduce the amount of water applied in the greens surrounds. In 2010, The Bridge installed 12 soil moisture sensors in 6 greens to further fine tune the amount of irrigation applied. The Bridge should consider equipping all 18 greens with soil moisture sensors to further refine the amount of irrigation applied. The Bridge should also consider using TDR soil moisture probes to map greens, tees and fairway soil moisture variation to further refine and make adjustments in the amount of water applied to very specific locations on the golf course. These suggestions are part of the recommendations to the amended Protocol.

PART 2 REVIEW OF PROTOCOL MODIFICATION PROPOSALS AND RECOMMENDATIONS

Section III(B) of the 1997 protocol states that there will be quarterly sampling for five years, followed by annual sampling in perpetuity. This section was amended in 1999 (Protocol Amendment #5) to indicate that, following five years of monitoring (early 2006), the Study Director (ETS/Cohen) would submit recommendations for changes to the sampling based on a comprehensive evaluation of all data.

PROTOCOL MODIFICATION PROPOSALS

On February 17 and 24, 2006, ETS submitted a five year review of the Ground Water Monitoring Program with a request for modifications in accordance with Amendment #5 of the 1997 Protocol. The Town's Independent Reviewer responded to the proposal and ETS provided alterations to the initial modifications. Subsequent to the submittal of the 2010 Part 1 Report on the Findings of the monitoring protocol, ETS submitted a revised request for amendments.

ETS PROPOSAL – February, 2006

The requested modifications consist of the following:

Reduce the number of sampling rounds from quarterly for all lysimeters and monitoring wells to semi-annual for 8-wells and Annual for 5 wells and drop the Perched Well as follows.

Table 8. Proposed Sampling Frequency in 2006

Semi-Annual	Annual	Drop
MW-1	MW-1S	PW-1
MW-2S	MW-1D	
MW-3S	MW-2D	
MW-4R	MW-3D	
MW-5	MW-6	
MW-7		
MW-8		
MW-9(abandoned)		

Lysimeters were proposed to be sampled annually. The monitoring wells had a proposed sampling schedule of Semi-Annual during: March-April and October-November.

Annual Sampling during: October-November

Proposed Pesticide Analysis included:
S150 for myclobutanil, fenarimol and propiconazole
515.3 for Dicamba, 2-4 D and MCPP

Proposed inorganic analyses included: Nitrate, phosphorus, and field parameters

A proposed two year window was proposed before it would be reviewed again.

INDEPENDENT REVIEW RESPONSE (Petrovic) – August 1, 2006

The Independent Reviewer made the following comments on the ETS request in a letter on August 1, 2006.

> Using only the S150 analytical method for three compounds was too narrow when it covers more than 20 analytes.
>
> Inorganic methods should also include Total Nitrogen
>
> The number and location of all 14 monitoring well sites are appropriate.
>
> The Fairway lysimeters should continue to be monitored. The green lysimeters in the drainage areas should be abandoned and new angled lysimeters 9 to 12 ft below the greens should be installed.
>
> The frequency should not be reduced drastically because of the lag-time that would occur before a responsive action could be taken.
>
> Any modified program should continue for at least five years before being reviewed.

ETS ALTERATIONS OF INITIAL MODIFICATIONS – September 22, 2006

ETS responded to the recommendations in a letter on September 22, 2006 containing the following alterations.

- Reduce only pesticide sampling to semi-annual.
- Continue Nitrogen and field parameters on a quarterly basis.
- Continue comprehensive 3-Year testing program containing methods L300, L311, S150 and EPA methods 547, 200.8, 515.3 and 524.2

ETS PROTOCOL RECOMMENDATIONS -September 7, 2010

ETS submitted a four page wish list for amendments as summarized below. This request was further refined in the final request September 28, 2010 letter.
Expand analyte list to include all pesticides used within the previous 12 months
Drop wells PW-1, MW-1D, MW-3D, MW-6, MW-7, and MW-8
Delete the Method 515.3 unless dicamba, 2-4D , MCPP have been used in the previous 12 months
Reduce monitoring frequency from quarterly to semi-annually in seven wells: BW-1, MW-1S, MW-2S, MW-2D, MW-3S, MW-4R, and MW-5
Establish new pesticide detection response threshold
Delete lysimeter sampling

ETS REQUEST TO AMEND PROTOCOL - September 28, 2010

The request to amend the Monitoring Protocol consists of the following:

A. Expand list of analytes to all pesticides used in the last 12 months, and analyze all pesticides ever used every 5 years

B. Reduce Monitoring in Lysimeters and Wells
    1. Eliminate all Lysimeters
    2. Delete Perched Well (PW-1) after pump test or switch to semi-annual
    3. Delete Background well (BW-1)
    4. Delete five Wells
        i. MW-1D, MW-3D, MW-6, MW-7 and MW-8
    5. Reduce Monitoring Frequency
        i. Semi-annually for PW-1, MW-2S and MW-7
        ii. Annually for MW-1S, MW-2D, MW-3S, MW-4R and MW-5
        iii. Sampled in June and September (turbidity + field parameters)

C. Reduce Analytes
    1. Eliminate Total Phosphorus (TP)
    2. Semi-Annual Pesticides
       MW-1S, MW-2S, MW-3S, MW-4R and MW-5
    3. Herbicides
       Eliminate 515.3 except for every 5 years
    4. Eliminate triennial sampling and replace with comprehensive annual and five-year sampling
    5. New Response Triggers
       Re-sampling for detect of 0.5 ppb or 10% HAL, MCL or DOH (POC or GV) level, whichever is lower.

RECOMMENDATIONS FOR MONITORING PROTOCOL MODIFICATIONS

The technical review of test results and implementation of the Groundwater Monitoring Program found that it was carried out according to the protocol. Furthermore, the nine years of data allowed a long term perspective of the response of the aquifer to the turf management activities at The Bridge. From this perspective we find that the protocol could be optimized without compromising the protection of groundwater resources of the South Fork. The optimization that we recommend contains some reductions in aspects of the protocol and more specific response actions to the data that will continue to be collected.

MONITORING WELLS

Three categories of monitoring wells are evident from the long term data; miscellaneous wells, which tend to respond to other variables than just turf management, turf wells, turf response wells and ambient wells. Of the turf wells, we find that MW-2S, MW-2D, MW-3S, and MW-5 have a strong response to turf management as indicated in the response to higher irrigation and fertilizer applications in the 2004 to 2005 period as shown in the graph below. We refer to these wells as Turf Response Wells and recommend these wells be sampled semi-annually. Further, we recommend that two of the three ambient wells, MW-1D and MW-3D be monitored on a semi-annual basis. These two ambient wells were chosen because they are located downgradient of managed turf, whereas MW-6, the other ambient well is located in the interior of the course (on the fairway of the 7th hole). Every two years, the entire remaining network of 12 monitoring wells will be sampled. Every fourth year will include analysis for a comprehensive list of compounds for the Turf Response Wells and others as indicated on Table 10.

The fluctuating nitrate concentrations at MW-1S are caused by its proximity to the groundwater divide, which is evident in Figure 2. The graph in Figure 9 shows the uniform response of the turf management wells. Because MW-1 does not have a uniform response, we have recommended that MW-1S be classified as a miscellaneous well and be sampled every two years. We have recommended that sampling for volatile organic compounds every three years as specified in the Protocol, is no longer necessary because of the long term lack of detections. However, due to the proximity of the storage shed and facility maintenance area upgradient of MW-1S, we recommend that MW-1S be sampled for volatile organic compounds as a pre-caution, in addition to the S150 pesticides and nitrogen for the two-year sampling round.

The perched well (PW-1) is another miscellaneous well that serves as an indication of impacted water that can subsequently reach the principle aquifer. We agree that PW-1 should continue to be monitored semi-annually with the turf response wells, and recommend that the management response for N be increased to 10 ppm. However, if the well exceeds a N concentration of 5 ppm, then that well should be pumped off in the next routine sampling round with the use of a submersible pump (>20gpm) and sampled for

nitrogen and S150 pesticides. This method of sampling the perched well could be used in place of the low flow pump for future sampling events.

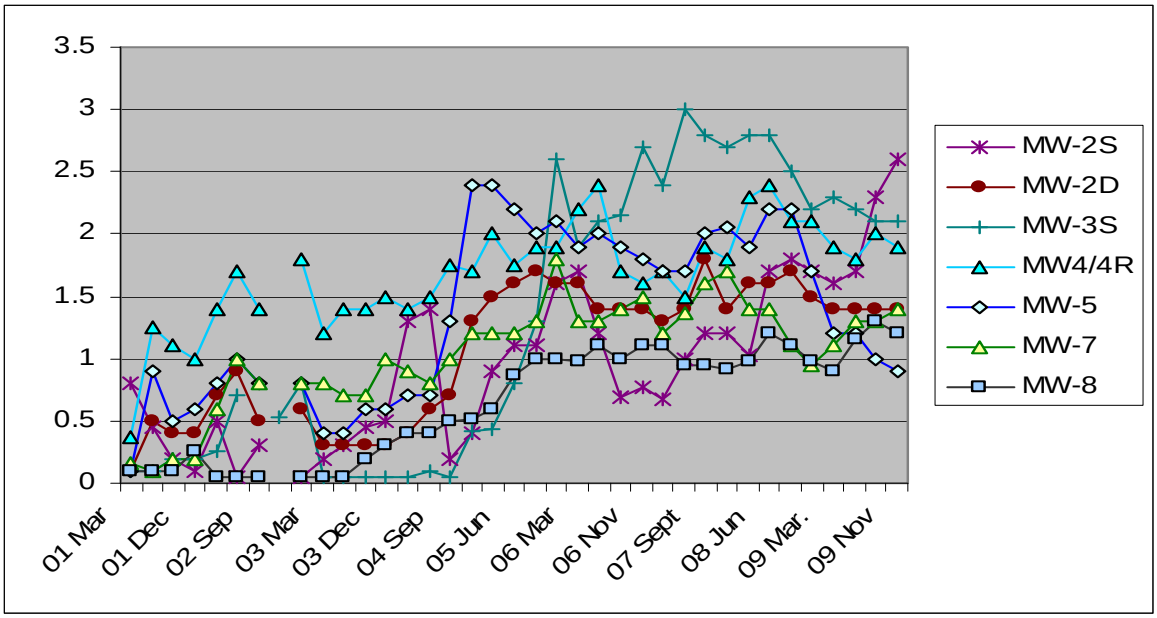


Figure 9. Concentration of nitrate in selected wells over 9 years
Note the elevated nitrate concentration in MW-2D, 3S and 5 in 2004-2005.

In summary, the turf response monitoring wells MW-2D, MW-3S, MW-5, and MW-2S, which has had consistent detections of pesticides, ambient wells MW-1D and MW-3D, and the perched well PW-1 are recommended to be sampled semi-annually for total Kjeldahl nitrogen (TKN), nitrate, S150 pesticides, and field parameters.

LYSIMETERS

Based on further review of the findings of the long term lysimeter data (see graph below), we recommend that some of the lysimeters continue to be monitored for nitrogen and S150 pesticides on a semi-annual basis. These lysimeters include F1-3 and F3-3 that have a consistent response and can be used to reduce turf management impacts. As for green lysimeter testing, we recommend that as an alternative to the green biofilter lysimeters that angled lysimeters be installed through the use of a small tracked Geoprobe at 9 to 12 ft below the greens at the front end of the greens at holes 4, 7, and 14. These lysimeters would measure the overall soil moisture leaching directly from the greens and at a greater depth could avoid low flow soil moisture conditions.

The biofilter on Green 7 was replaced in 2008. Prior to that, this lysimeter was problematic with high concentrations of nitrogen and multiple detections of pesticides. The replacement improved the performance of the new biofilter.

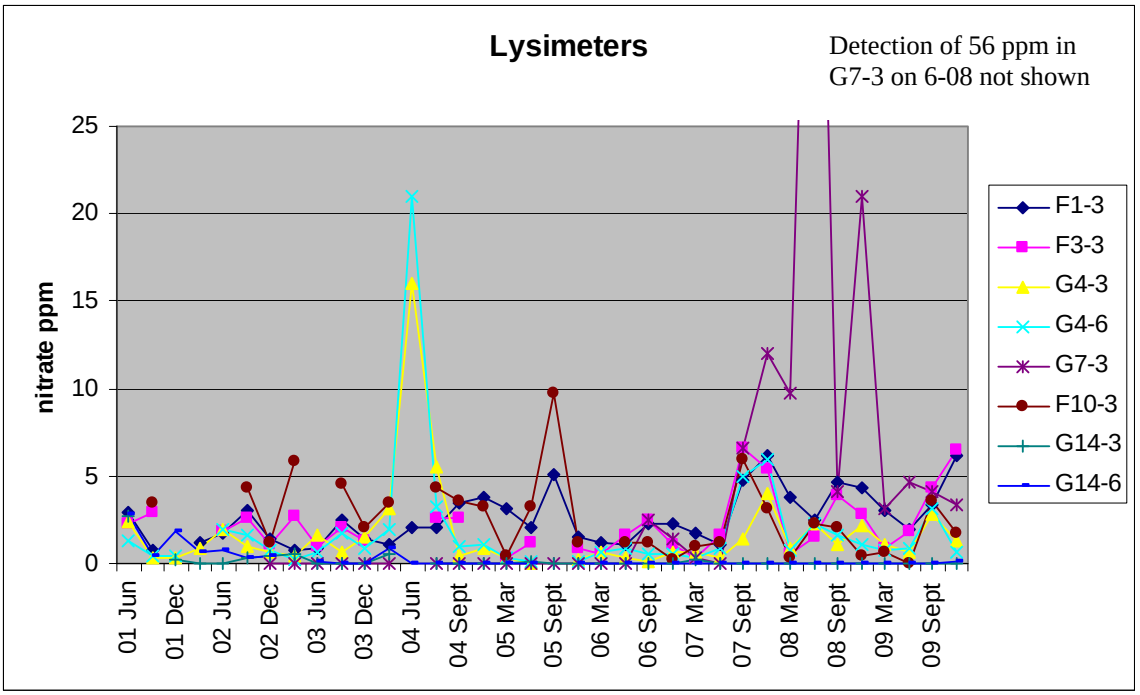


Figure 10 Nitrate concentrations in lysimeters

RESPONSE TO DETECTIONS AND OTHER ISSUES

We recommend that the Town adopt a lower allowable amount of applied nitrogen fertilizer. The average amount of nitrogen fertilizer used over the last five years (2005-2009) is 2,900 lb N/year. The amount of fertilizer used in these last five years is 45% of the current allowable low end amount of 6,386 lb N, and average groundwater concentrations are at 30% of the 5 ppm threshold. Therefore, the Town should adopt a high end limit that no more than 3,000 lb of nitrogen be applied to the current turf area per year, which translates to 0.9 lb N/1,000 ft^2. The annual report should present and discuss the amounts of fertilizer applied with the concentration of nitrogen found in groundwater.

In regards to nitrate in groundwater, the long term annual average goal (since 2005) shall be no more than 2 ppm for all turf and turf response wells (The drinking water MCL is 10 ppm). This goal will be achieved by adopting a nitrogen fertilization application of no more than 3,000 total pounds N per year. This average threshold will allow an individual nitrate detection in any well to exceed 2 ppm; however, if any of the semi-annual turf response wells exceeds 4 ppm N, then that well will be re-sampled within two weeks of receipt of the results for confirmation. If the nitrate concentration is confirmed, then all fertilization will stop in the surface watershed and groundwater area upgradient of that well. An evaluation will then be conducted by the Study Director in consultation with the Town to determine the conditions and issues that caused the large increase (fertilizer, rainfall, irrigation, runoff). A report to the Town will be made by the Study Director within one month of receiving the resampling-confirmation results indicating the cause

and remediation plans related to the high nitrate-nitrogen level. Fertilization will resume when the concentration of the offending well is less than 2 ppm of nitrate-nitrogen or as outlined in the remediation plan.

If the golf course should require more than the fertilization limit, a request shall be sent to the town six months in advance indicating the reasons (need for more nitrogen) and why such an increase will not lead to an exceedence of the 2 ppm average annual threshold.

Currently a detection of a pesticide or metabolite at any level requires a response of resampling. Often the initial sample concentration is just above or at the reporting limit, less than 0.5 ppb. The resampling often results in a similar trace concentration to the first sample. We agree to a method that incorporates the Reference Point (Ref Pt), as defined by either the HAL, MCL or DOH level (whichever is lower) to trigger resampling and reversion to quarterly sampling,. We recommend that the threshold to trigger resampling as 5 times the laboratory method quantitation limit (QL) or 3 times the QL if the Ref Pt is less than or equal to (≤)5 ppb or upon detection if the Ref Pt is < 1 ppb. In addition, given the reduction of sampling from quarterly to semi-annually, we recommend a stringent Management Trigger of 10% of the Ref Pt or 3 times the QL if the Ref Pt is less than 5 ppb or upon detection if the Ref Pt is less than 1 ppb. These variable triggers acknowledge wide disparity of Reference Points (from 0.44 to 50 ppb) and the basis of prudent management decisions made by The Bridge over the last nine years relative to pesticide use on the golf course. If the Management Trigger is exceeded then sampling will revert back to quarterly for all turf wells until the level drops below the Management Trigger. Table 9 that shows the 11 analytes that are/have been typically run including the method, detection limit, Ref Pt, and resampling and management response triggers for reference.

Table 9. Major Pesticides used, laboratory methods, and Response Thresholds

MCPP	515.3	0.5	0.44	RESAMPLING 0.5	MANAGEMENT 0.5
				TRIGGER	TRIGGER
	Lab Method	Quantitation Limit (ppb)	Ref Pt (ppb)	5x Quant Limit Or 3x Quant Limit if Ref Pt < 5(ppb) Or upon detection if Ref Pt< 1ppb	10% Ref Pt Or 3x Quant Limit Or upon detection if Ref Pt < 1 ppb
Paclobutrazol	L300/302	1	50	5	5.0
Triadimifon	L300/302	1	50	5	5.0
Myclobutanil	S150	0.1	50	0.5	5.0
Propiconazole	S150	0.1	50	0.5	5.0
PCNB	S150	0.1	ND	ND	ND
Chlorothalonil	S150	0.1	2	0.3	0.3
Ethofumesate	S150	0.1	50	0.5	5.0
Fenarimol	S150	0.1	50	0.5	5.0
Dicamba	515.3	0.1	0.44	0.1	0.1
2-4 D	515.3	0.1	50	0.5	5.0

The two triggers described in the table and text above are relevant to monitoring – resampling and frequency. The triggers for management responses to detections remain as they were written in the original 1997 Protocol (Section VI).

Phosphorus does not appear to be a concern from turf management at The Bridge. It is recommended that phosphorus be dropped from the required analyses.

The Semi-annual and Annual reports describing nitrate in groundwater should adopt the comparative structure recommended in this review and compare the results of the turf and turf response wells to the ambient Wells. The reports shall present the data by updating the long term concentration graphs.

Comprehensive monitoring shall continue every four years. This includes Underwriters Laboratories' methods L300, L311, S150 and EPA methods 547, 200.8, and 515.3. Method 547 will only be used if the glyphosate herbicide has been used anytime in the past four years if more than 3 lbs of active ingredient was applied. Method 200.8 will only be used if the MSMA herbicide has been used anytime in the past four years or if sod used on the site had MSMA applied to it. The results of the Volatile Organic Compounds analysis by 524.2 have been below the detection limit for all but background concentrations of chloroform and MTBE. It is recommended that this suite of compounds be dropped from the four-year comprehensive program except for MW-1S since it is downgradient of the operations facility. The four year comprehensive monitoring shall apply to the four turf response wells MW-2S, MW-2D, MW-3S, and MW-5. The four year comprehensive testing will be expanded to include all other wells if there is detection greater than the management threshold for the S150 or 515.3 pesticides (Table 10) in any of the previous semi-annual or two year events.

The preparation of groundwater flow maps can be reduced to once per year, which would include annual snap shot measurements of all wells. Long term hydrographs should be presented in the reports for all semi-annual sampled wells. The water table map should still be hand drawn but a more refined presentation graphic should be developed that also shows the location of the irrigation wells. A capture area to the irrigation wells under average annual and monthly peak flow conditions was prepared using a groundwater model by Mr. Cambareri and is included in the Attachments to this report.

The response to detections in monitoring wells has required a delineation of the affected area to be used to reduce or stop the use of fertilizers and detected pesticides. Because surface runoff may play more of a role through drainage basins and underlying materials, such as the compacted area of the Bridgehampton Raceway, a map of surface watersheds to monitoring wells shall be developed including the location of drains and their discharge locations.

We evaluated the relationship of heavy rain events/periods and an increase in the nitrate-nitrogen concentration in both monitoring wells and lysimeters. We observed a large increase in the nitrate-nitrogen concentration in lysimeters in June 2004, September 2005, September/December 2007, and June/December 2008. Figure 11. below shows nitrogen

in the turf wells and the occurrence of exceptional 3 inch or more daily rain events observed in April 2004 (3.9”), July 2004 (3.5”), October 2005 (6.3” and 12.6” in 4 days), April 2007 (2.9”), and in September 2008 (3.0” and 3.1”). The graph indicates that it is difficult to show cause and effect with the mix of daily and quarterly time scales except for the Nov 05 peak of nitrogen in several wells that is concurrent with an extreme rainfall event of greater than 3 inches. However, nitrogen concentrations were on the increase prior to and then decreased after that event. We also prepared a direct comparison of the quarterly nitrogen concentrations to quarterly rain amounts from 2003 to present as shown in Figure 12.

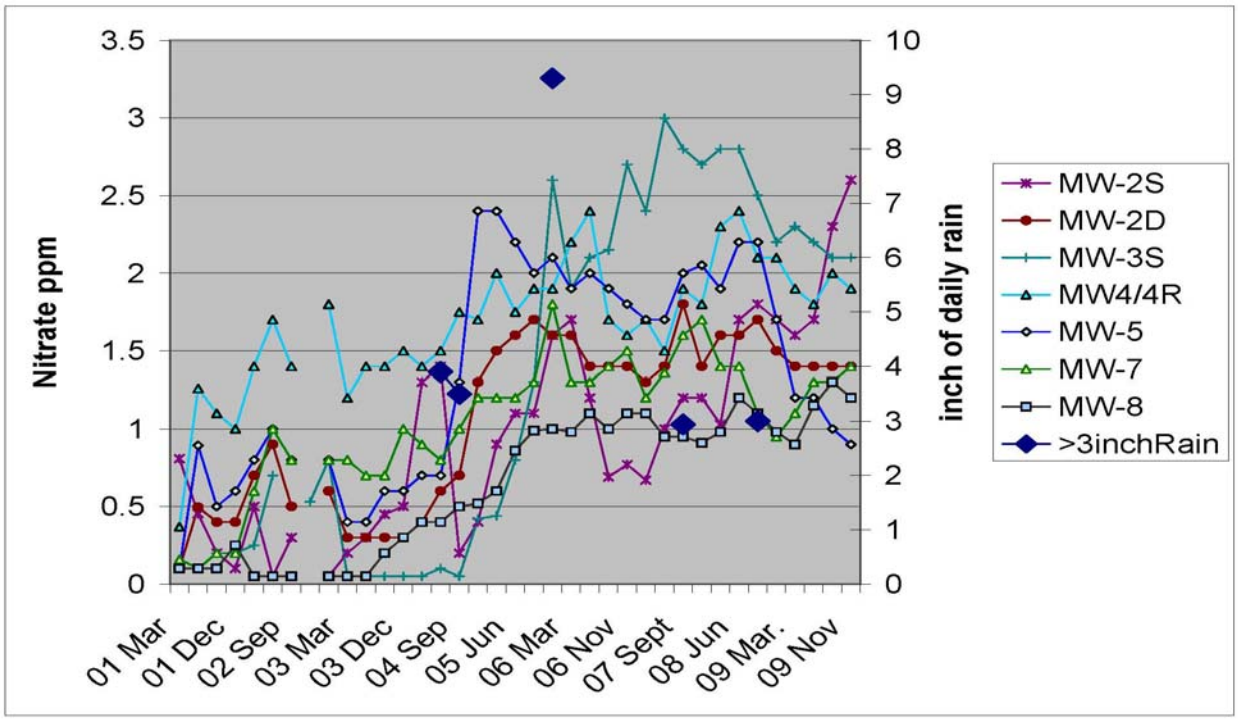


Figure 11. Quarterly nitrate concentrations in relation to episodes of 3 or more inches of rain over 24 hours

While the Figure 12 also shows a good match to the November 2005 event, the comparison does not offer the basis of a rational response to a single episode or even quarterly rain amount. The goal of the monitoring protocol is to ensure the long term protection of the groundwater resource. To be more responsive to higher or spikes in nitrate-nitrogen concentrations, we recommend that the action threshold of 5 ppm be lowered to a nitrate-nitrogen concentration of 4 ppm.

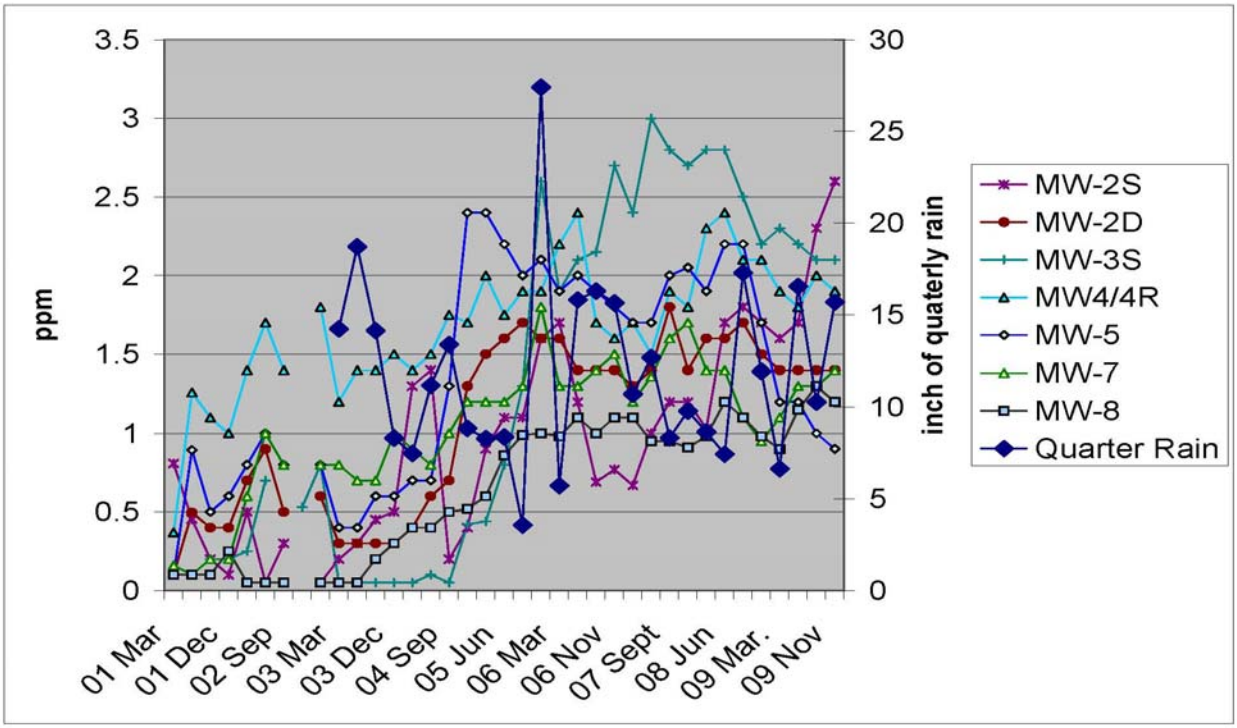


Figure 12. Quarterly nitrogen concentrations in relation to rainfall totals for each quarter.

Our collective recommendations to adopt an average annual nitrate-nitrogen concentration goal of 2 ppm; reduce the nitrogen applications to less than 3,000 lb N/per year; and reduce the threshold management response to a single N concentration of 4 ppm from the original 5 ppm nitrate-nitrogen concentration; are focused on ensuring the long term goal of groundwater protection (Table 10).

The protocol should be reviewed in five years to consider further modifications.

OPERATIONAL REPORTING

Operational reporting shall continue to be included in all reports as required by the original Protocol and with the recommendations of this review.

Table 10. Groundwater Monitoring Protocol Frequency and Response

Well	Category	NITRATE (ppm)			PESTICIDES				4 YR+ COMP	WT**
		Semi N^	GOAL	Mgmt Response	Semi Pest^^	2-YEAR	Resampling Trigger	Management Trigger		
BW-1	Drop						5x Quant Limit Or 3x Quant Limit if Ref Pt < 5(ppb) Or upon detection if Ref Pt< 1ppb	10% Ref Pt Or 3x Quant Limit Or upon detection if Ref Pt < 1 ppb	Cond	yes
PW-1	Misc	yes	<5	10*	S150	515.3			Cond	yes
MW-1S	Misc		2	4		N, S150 +VOC			Cond	yes
MW-1D	Ambient	yes	<1	4	S150 if N > 1	S150			Cond	yes
MW-2S	Turf Response	yes	2	4	S150	515.3			Yes	yes
MW2D	Turf Response	yes	2	4	S150	515.3			Yes	yes
MW-3S	Turf Response	yes	2	4	S150	515.3			Yes++	yes
MW-3D	Ambient	yes	<1	4	S150 if N > 1	S150			Cond	yes
MW-4/4R	Turf		2	4		N, S150, 515.3			Cond	yes
MW-5	Turf Response	yes	2	4	S150	515.3			Yes	yes
MW-6	Ambient		<1	4		N S150 + 515.			Cond	yes
MW-7	Turf		2	4		N S150 + 515.3			Cond	yes
MW-8	Turf		2	4		N S150 + 515.3			Cond	yes
MW-9	Abandoned									

* Remedial Action if > 5 ppm.

** WT measured at sampled wells and long term hydrographs updated semi-annual, annual WT snap shot with Water table map. + Includes methods L300, L311, S150 and EPA methods 547, 200.8, and 515.3. Volatile Organic Compounds analysis by 524.2. ^ If any well exceeds 4 ppm, then the well will be immediately sampled and if confirmed, all fertilization will stop in the upgradient area, and evaluation and remedial plan shall be submitted until concentrations drop below 2 ppm or as specified in the remedial plan ^^ If the Management Trigger is exceeded in any well then the sampling will be revert back to quarterly for all wells until the level drops below the Management Trigger in all wells. Semi-annual sampling in ambient wells shall include pesticides in the next round of semi-annual sampling if N > 1 ppm. TKN will be included in the semi-annual, 2-Year and 4 Year comprehensive sampling round.

Table 11. Lysimeter Protocol Frequency and Response

Lysimeters	NITRATE-NITROGEN (ppm)			PESTICIDES (ppb)			
	Semi N	GOAL	Mgmt Response	Semi Pest	2-YEAR	Resample	Mgmt Response
F1-3	yes	<5	10	S150	515.3	>1	>5
F3-3	yes	<5	10	S150	515.3	>1	>5
G7*	yes	<5	10	S150	515.3	>1	>5
G4*	yes	<5	10	S150	515.3	>1	>5
G14*	yes	<5	10	S150	515.3	>1	>5

* New angled lysimeters installed through the use of a small tracked Geoprobe at 9 to 12 ft below the greens at the front end of the green.

REFERENCES

U.S. Environmental Protection Agency, 1992, Hazard Ranking System Guidance Manual, Office of Solid Waste and Emergency Response Directive 9345.1-07.

Schubert, C.E. 1998., Ground-Water Flow Paths and Travel time to Three Small Embayments within the Peconic Estuary, Eastern Suffolk County, New York, USGS, WRIR 98-4181

ATTACHMENTS INDEX

Available Digital Bridge Monitoring Reports
as of September 12, 2010

	Report		Review	
	Date	Pages	Date	Pages
2001				
Background Report	9/28/2001	101		
Annual	12/30/2002	55		
2002				
1st				
2nd				
3rd				
4th				
Annual	5/1/2003	68		
2003				
1st				
2nd				
3rd				
4th	1/19/2004	19	3/4/2004	5
Annual	4/9/2004	57		
2004				
1st	5/24/2004	4	7/9/2004	5
2nd	11/2/2004	4	10/6/2004	6
3rd	11/19/2004	4	12/8/2004	4
4th	2/11/2005	4	3/15/2005	5
Annual	4/15/2005	68	5/31/2005	18
Site Visit			5/31/2005	18
2005				
1st	5/9/2005	21		**na**
2nd	8/2/2005	21	12/9/2005	5
3rd	11/11/2005	20	12/20/2005	5
4th	1/23/2006	20	5/17/2006	5
Annual	8/31/2006	85	8/1/2006	4
Site Visit			8/1/2006	8
2006				
1st	6/7/2006	20	10/18/2006	5
2nd	8/21/2006	21	10/24/2006	4
3rd	11/1/2006	20	7/12/2007	5
4th	1/23/2007	20	7/12/2007	4
Annual	5/31/2007	68	7/27/2007	17
Site Visit			10/20/2006	4
2007				
1st	5/30/2007	24	11/29/2007	4
2nd	8/23/2007	21	11/30/2007	4
3rd	11/12/2007	20	12/3/2007	4
4th	12/28/2008	20	9/19/2008	4
Annual	6/24/2008	99	9/26/2008	17
Site Visit			9/26/2008	17
2008				
1st	5/8/2008	5	12/29/2008	4
2nd	9/9/2008	23	12/30/2008	4
3rd	12/5/2008	30	1/23/2009	4
4th	2/112009	29	10/19/2009	5
Annual	5/28/2009	124	10/22/2009	19
Site Visit			10/20/2009	3
2009				
1st	6/19/2009	23	2/10/2010	4
2nd	8/12/2009	19	2/11/2010	4
2nd	9/9/2009	21	2/16/2010	4
3rd	11/6/2009	19	2/16/2010	4
4th	2/8/2010	20	3/24/2010	5
Annual	5/28/2010	154	6/30/2010	19
Site Visit			6/30/2010	3

2006 5-Year Review			
ETS		2/17/2006	9
Petrovic Review		8/1/2006	4
Petrovic Response		12/14/2006	5

MAP SHOWING
MONITORING WELLS
AT
THE BRIDGE
SITUATE
NOYACK
TOWN OF SOUTHAMPTON
SUFFOLK COUNTY, NEW YORK

SCALE: 1" = 200

SCALE: 1" = 200

79903	163.199 Ex Spot Elevation, General Elev. GROUND AT MW-1D
79904	162.268 Ex Spot Elevation, General Elev. GROUND AT MW-1
79905	220.640 Ex Test Well, C/L TW-3 TOP PIPE AT MARK
79906	216.222 Ex Spot Elevation, General Elev. GROUND AT TW-3
79907	216.127 Ex Spot Elevation, General Elev. GROUND AT TW-3
79908	241.355 Ex Test Well, C/L BW-1 2IN PVC TOP PIPE
79909	239.927 Ex Spot Elevation, General Elev. GROUND AT BW-1
79910	128.793 Ex C.B. Grate, 2.0 S GREEN
79911	127.908 Ex Test Well, C/L MW-2D 2IN PVC TOP PIPE
79912	128.012 Ex Spot Elevation, General Elev. GROUND AT MW-2D
79913	128.113 Ex Spot Elevation, General Elev. GROUND AT MW-2
79914	128.094 Ex Test Well, C/L MW-2 4IN PVC TOP PIPE
79915	100.947 Ex Test Well, C/L PW-1 4IN PVC TOP PIPE
79916	101.232 Ex Iron MH Cover, 0.7 PW-1
79917	132.403 Ex Iron MH Cover, 0.7 MW-5
79918	132.033 Ex Test Well, C/L MW-5 4IN PVC TOP PIPE
79919	146.882 Ex C.B. Grate, 2.0 6TH DOGLEG
79920	134.076 Ex C.B. Grate, 2.0 6TH FAIRWAY RIGHT
79921	126.342 Ex C.B. Grate, 2.0 AT FRONT 6TH TEE
79922	164.573 Ex Iron MH Cover, 0.7 MW-6
79923	164.231 Ex Test Well, C/L MW-6 4IN PVC TOP PIPE
79924	175.925 Ex Iron MH Cover, 0.7 MW-7
79925	175.476 Ex Test Well, C/L MW-7 4IN PVC TOP PIPE
79926	150.781 Ex Test Well, C/L MW-8 4IN PVC TOP PIPE
79927	151.144 Ex Iron MH Cover, 0.7 MW-8
79928	130.086 Ex C.B. Grate, 2.0 S OF 13TH GREEN
79929	131.555 Ex Iron MH Cover, 0.7 MW-3D
79930	131.579 Ex Iron MH Cover, 0.7 MW-3
79931	131.220 Ex Test Well, C/L MW-3D 2IN PVC TOP PIPE
79932	130.831 Ex Test Well, C/L MW-3 4IN PVC TOP PIPE
79933	147.615 Ex Iron MH Cover, 0.7 MW-9
79934	147.324 Ex Test Well, C/L MW-9 TOP 4IN PVC
79935	138.993 Ex C.B. Grate, 2.0 11TH FAIRWAY
79936	142.442 Ex C.B. Grate, 2.0 11TH FAIRWAY
79937	116.812 Ex Iron MH Cover, 2.0 PUMP PIT
79938	116.769 Ex Iron MH Cover, 2.0 PUMP PIT
79939	116.524 Ex Drain. Struct., C/L 8dia.Pool PUMP PIT
124588	122.750 Ex Test Well, MW-4R TOP PVC PIPE UNDER COVER
79942	120.219 Ex Iron MH Cover, 2.0
79943	120.187 Ex Iron MH Cover, 2.0
79944	119.975 Ex Drain. Struct., C/L 8dia.Pool PIT
79945	113.484 Ex Drain. Struct., C/L 8dia.Pool PIT
79946	113.686 Ex Iron MH Cover, 2.0
79947	113.726 Ex Iron MH Cover, 2.0
79948	116.421 Ex Iron MH Cover, 2.0
79949	116.399 Ex Iron MH Cover, 2.0
79950	116.175 Ex Drain. Struct., C/L 8dia.Pool
79951	111.156 Ex Drain. Struct., C/L 8dia.Pool
79952	111.402 Ex Iron MH Cover, 2.0
79953	111.422 Ex Iron MH Cover, 2.0
79954	128.423 Ex Iron MH Cover, 0.7 MW-2
79955	128.196 Ex Iron MH Cover, 0.7 MW-2D
79956	163.399 Ex Test Well, C/L MW-1D 2IN PVC TOP PIPE
79957	162.351 Ex Test Well, C/L MW-1 4IN PVC TOP PIPE
79958	162.642 Ex Iron MH Cover, 0.7 MW-1
79959	163.685 Ex Iron MH Cover, 0.7 MW-1D
79960	232.670 Ex Test Well, TW-2 MARK CHISELED IN TOP CASING
79961	229.315 Ex Spot Elevation, General Elev. GROUND AT TW-2
79962	214.919 Ex Spot Elevation, General Elev. GROUND AT TW-1
79963	214.875 Ex Spot Elevation, General Elev. GROUND AT TW-1
79964	217.980 Ex Test Well, TW-1 TOP COVER AT ARROW IN CASING

Green L14-3, L14-6

Green L7-3

Green L4-3, L4-6

Fairway L3-3

Fairway L10-3

Fairway L1-3

MW-1
MW-1D
MW-2
MW-2D
MW-3
MW-3D
MW-4R
MW-5
MW-6
MW-7
MW-8
MW-9
PW-1
TW-1
TW-2
TW-3
BW-1

Lysimeter sampling locations for fairways: L1-3 = 3 lysimeters at hole #1, 3 ft depth under fairway

Lysimeter sampling locations for greens: L4-3 = 3 lysimeters at green hole #4 at 3 ft depth drainage from green, L4-6 = two 6 ft depth lysimeters

PREPARED: APRIL 27, 2001
REVISED: NOVEMBER 25, 2002
NOVEMBER 22, 2004

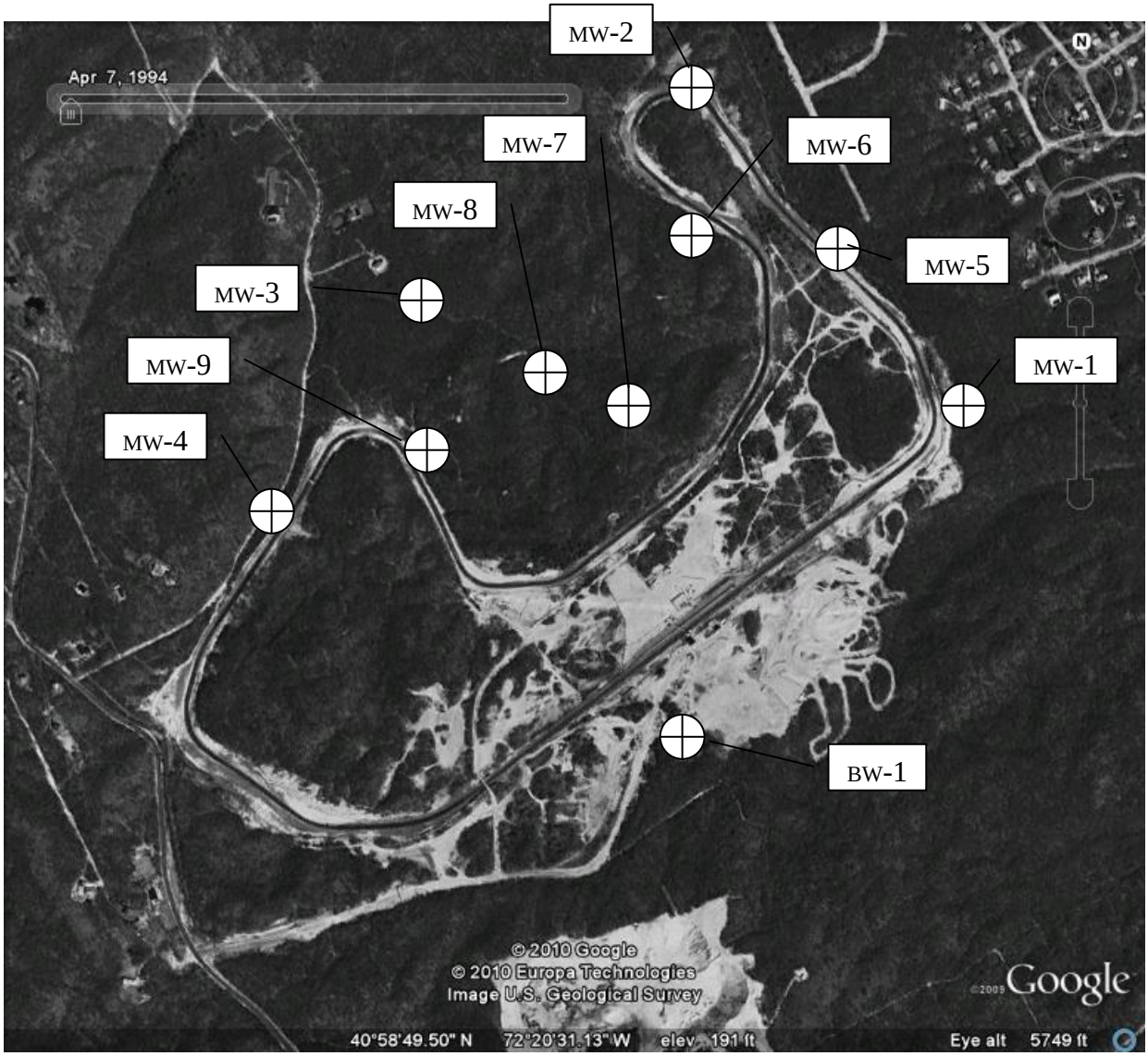
JOHN J. RAYNOR, P.E. & L.S., P.C.
CIVIL ENGINEERS
SURVEYORS SITE PLANNERS
DEERFIELD GREEN P.O. BOX 720
WATER MILL, N.Y. 11976 (631) 726-7600

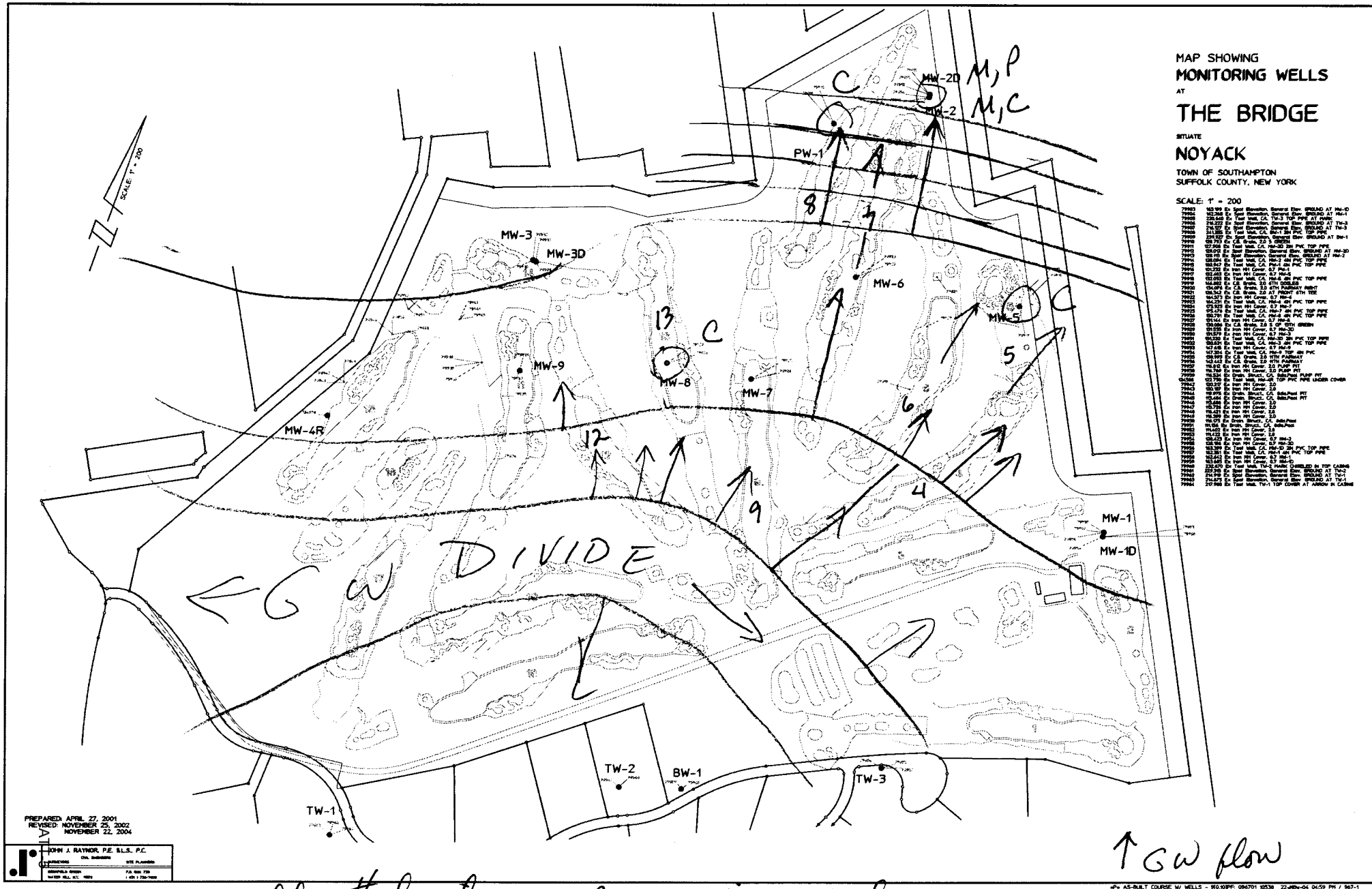
ATT-2

Sept 2009


Sep 5, 2009
MW-2
MW-7
MW-6
MW-8
MW-5
MW-3
MW-9
MW-1
MW-4
BW-1
© 2010 Google
© 2010 Europa Technologies
Image USDA Farm Service Agency
40°58'49.50" N 72°20'31.13" W elev 191 ft
Eye alt 5749 ft
Google

April 1994 – Pre Construction showing future well locations





C = chlorothalonil

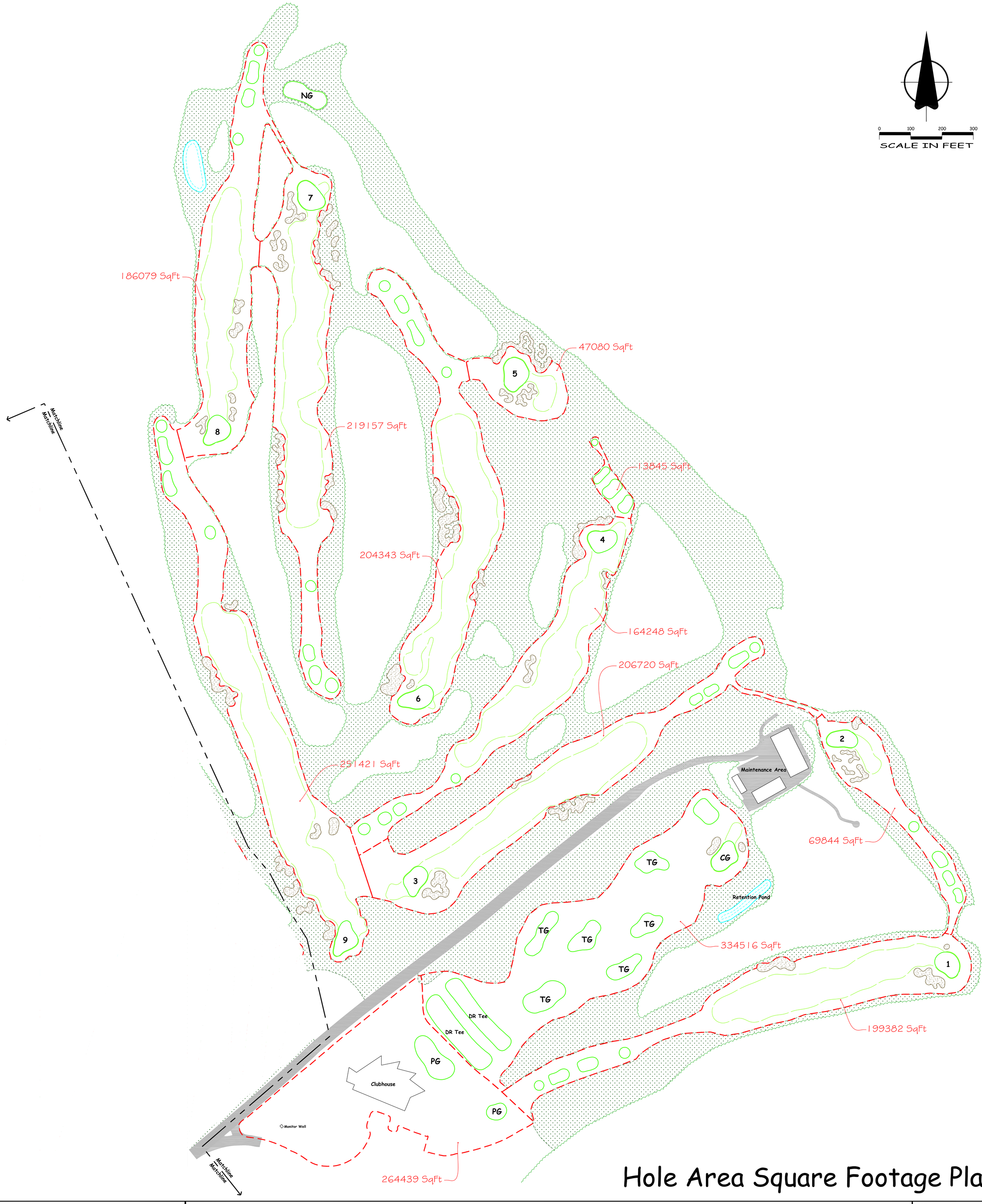
M = myclobutanil

P = propiconazole

↑ GW flow

work map PB

10/20/09



Hole Area Square Footage Plan 1

C-Tech Solutions, Inc.

Ross, Ohio
513-738-3456

Technical Solutions for
GPS * GIS * Irrigation

The Bridge

DATE 07/08/09	SCALE 1" - 100'
SHEET Golf at the Bridge_b20.dwg	
FILE NAME Hole Area Square Footage Plan 1	
DRAWN BY	

0 100 200 300

SCALE IN FEET

Matchline
Matchline

13

54777 SqFt

14

22269 SqFt

194053 SqFt

11

Pump House

Retention Pond

167567 SqFt

155027 SqFt

16

175932 SqFt

12

Retention Pond

218804 SqFt

15

18

139261 SqFt

192657 SqFt

10

Matchline
Matchline

17

229427 SqFt

Hole Area Square Footage Plan 2

C-Tech Solutions, Inc.

Ross, Ohio
513-738-3456

Technical Solutions for
GPS * GIS * Irrigation

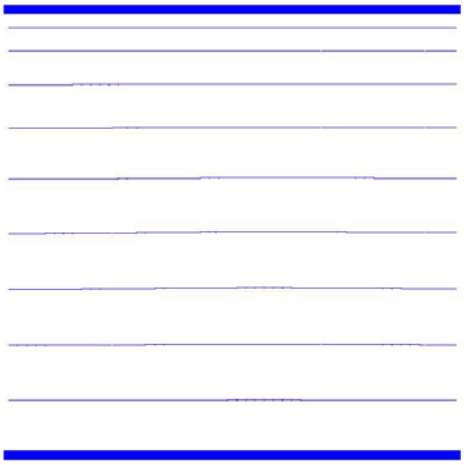
The Bridge

DATE 07/08/09	SCALE 1" - 100'
SHEET Golf at the Bridge_b20.dwg	
FILE NAME Hole Area Square Footage Plan 2	
DRAWN BY	

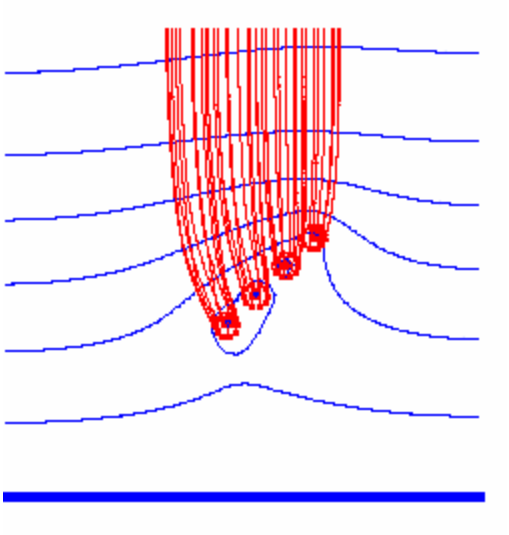
The Bridge Pesticide detections
10.26.09 triennial montoring March 2004 and 2007

MW-4/4R				MW-2S				MW-2D					PW-1	MW-5	MW-6	MW-7			MW-8	
	Paclobut	Myclo	Tri-nol		Myclo	Chloro	Prop (b)		Myclo	Prop (a)	Prop (b)	Chloro	Chloro	Chloro	Chloro	Chloro	Chloro	PCNB		Chloro
Mar-01			1.0	Mar-01				Mar-01					Mar-01	Mar-01	Mar-01	Mar-01			Mar-01	
Jun-01				Jun-01				Jun-01					Jun-01	Jun-01	Jun-01	Jun-01			Jun-01	
Oct-01	4.2			Oct-01	0			Oct-01					Oct-01	Oct-01	Oct-01	Oct-01			Oct-01	
Dec-01	1.3			Dec-01	0		0	Dec-01		0	0		Dec-01	Dec-01	Dec-01	Dec-01			Dec-01	
Jan-02	3.8			Jan-02	0		0	Jan-02		0	0		Jan-02	Jan-02	Jan-02	Feb-02			Feb-02	
Mar-02	1.95			Mar-02	0		0	Mar-02		0	0		Mar-02	Mar-02	Mar-02	Mar-02			Mar-02	
May-02	1.75			May-02	0		0	May-02		0	0		May-02	May-02	May-02	May-02			May-02	
Jun-02	0			Jun-02	0		0	Jun-02		0	0		Jun-02	Jun-02	Jun-02	Jun-02			Jun-02	
Sep-02	0			Sep-02	0		0	Sep-02		0	0		Sep-02	Sep-02	Sep-02	Sep-02			Sep-02	
Dec-02	0			Dec-02	0		0	Dec-02		0	0		Dec-02	Dec-02	Dec-02	Dec-02			Dec-02	
Mar-03	0			Mar-03	0		0	Mar-03		0	0		Mar-03	Mar-03	Mar-03	Mar-03			Mar-03	
Jun-03	0			Jun-03	0		0	Jun-03		0	0		Jun-03	Jun-03	Jun-03	Jun-03			Jun-03	
Sep-03	0	0		Sep-03	0		0	Sep-03	0	0	0		Sep-03	Sep-03	Sep-03	Sep-03			Sep-03	
Dec-03	0	0		Dec-03	0		0	Dec-03	0	0	0		Dec-03	Dec-03	Dec-03	Dec-03			Dec-03	
Mar-04		0		Mar-04	0		0	Mar-04	0	0	0		Mar-04	Mar-04	Mar-04	Mar-04			Mar-04	
Jun-04		0		Jun-04	0		0	Jun-04	0	0	0		Jun-04	Jun-04	Jun-04	Jun-04			Jun-04	
Sep-04		0		Sep-04	0		0	Sep-04	0	0	0		Sep-04	Sep-04	Sep-04	Sep-04			Sep-04	
Dec-04		0		Dec-04	0		0	Dec-04	0	0	0		Dec-04	Dec-04	Dec-04	Dec-04			Dec-04	
Mar-05		0.2		Mar-05	0		0	Mar-05	0	0	0		Mar-05	Mar-05	Mar-05	Mar-05			Mar-05	
May-05		0.2		May-05	0		0	May-05	0	0	0		May-05	May-05	May-05	May-05			May-05	
Jun-05		0.2		Jun-05	0		0	Jun-05	0	0	0		Jun-05	Jun-05	Jun-05	Jun-05			Jun-05	
Sep-05		0.2		Sep-05	0		0	Sep-05	0	0	0		Sep-05	Sep-05	Sep-05	Sep-05			Sep-05	
Nov-05		0.1		Dec-05	0		0	Dec-05	0	0	0		Dec-05	Dec-05	Dec-05	Dec-05			Dec-05	
Mar-06		0		Mar-06	0		0	Mar-06	0	0	0		Mar-06	Mar-06	Mar-06	Mar-06			Mar-06	
Jun-06		0		Jun-06	0		0	Jun-06	0	0	0		Jun-06	Jun-06	Jun-06	Jun-06			Jun-06	
Sep-06		0		Sep-06	0		0	Sep-06	0	0	0		Sep-06	Sep-06	Sep-06	Sep-06			Sep-06	
Nov-06		0		Nov-06	0		0	Nov-06	0	0	0		Nov-06	Nov-06	Nov-06	Dec-06			Dec-06	
Mar-07		0		Mar-07	0		0	Mar-07	0	0	0		Mar-07	Mar-07	Mar-07	Mar-07			Mar-07	
Jun-07		0		Jun-07	0		0	Jun-07	0	0	0		Jun-07	Jun-07	Jun-07	Jun-07			Jun-07	
Sep-07		0		Sep-07	0		0	Sep-07	0	0	0		Sep-07	Sep-07	Sep-07	Sep-07			Sep-07	
Nov-07		0		Nov-07	0		0	Nov-07	0	0.2	0.2		Nov-07	Nov-07	Nov-07	Dec-07			Dec-07	
Mar-08		0.1		Mar-08	0		0	Mar-08	0	0.2	0.2		Mar-08	Mar-08	Mar-08	Mar-08			Mar-08	
Jun-08		0.2		Jun-08	0.2		0	Jun-08	0.2	0.3	0.4		Jun-08	Jun-08	Jun-08	Jun-08			Jun-08	
Sep-08		0		Sep-08	0	0	0	Sep-08	0.1	0.1	0.2	0	Sep-08	0 Sep-08	0 Sep-08	0 Sep-08	0	0	Sep-08	0
Dec-08		0		Dec-08	0	0	0	Dec-08	0.15	0.1	0.15	0	Dec-08	0 Dec-08	0 Dec-08	0 Dec-08	0	0	Dec-08	0
Mar-09		0		Mar-09	0.3	0	0	Mar-09	0.2	0.1	0.2	0.2	Mar-09	0 Mar-09	0 Mar-09	0 Mar-09	0	0	Mar-09	0
				May-09	0.4	0	0.1	May-09	0.25	0.1	0.2	0								
Jun-09		0.1		Jun-09	0.4	0	0.1	Jun-09	0.4	0.15	0.2	0	Jun-09	0 Jun-09	0 Jun-09		0.4	0.1	Jun-09	0
																Jul-09 0.2	Jul-09 0.2	0.1		
Sep-09		0		Sep-09	0.2	0.2	0	Sep-09	0.3	0.1	0.2	0	Sep-09	0.2 Sep-09	0.1 Sep-09	0 Sep-09	0	0	Sep-09	0.5
N = >0	5	8			5	1	2		7	9	9	1		1	1	1		2	2		1

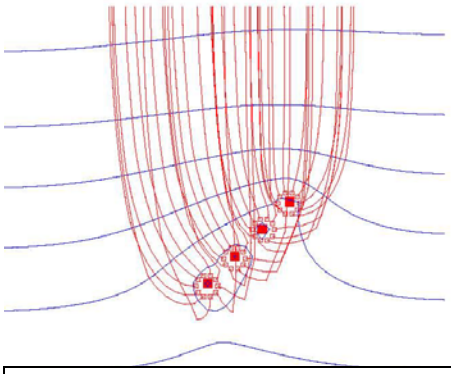
v



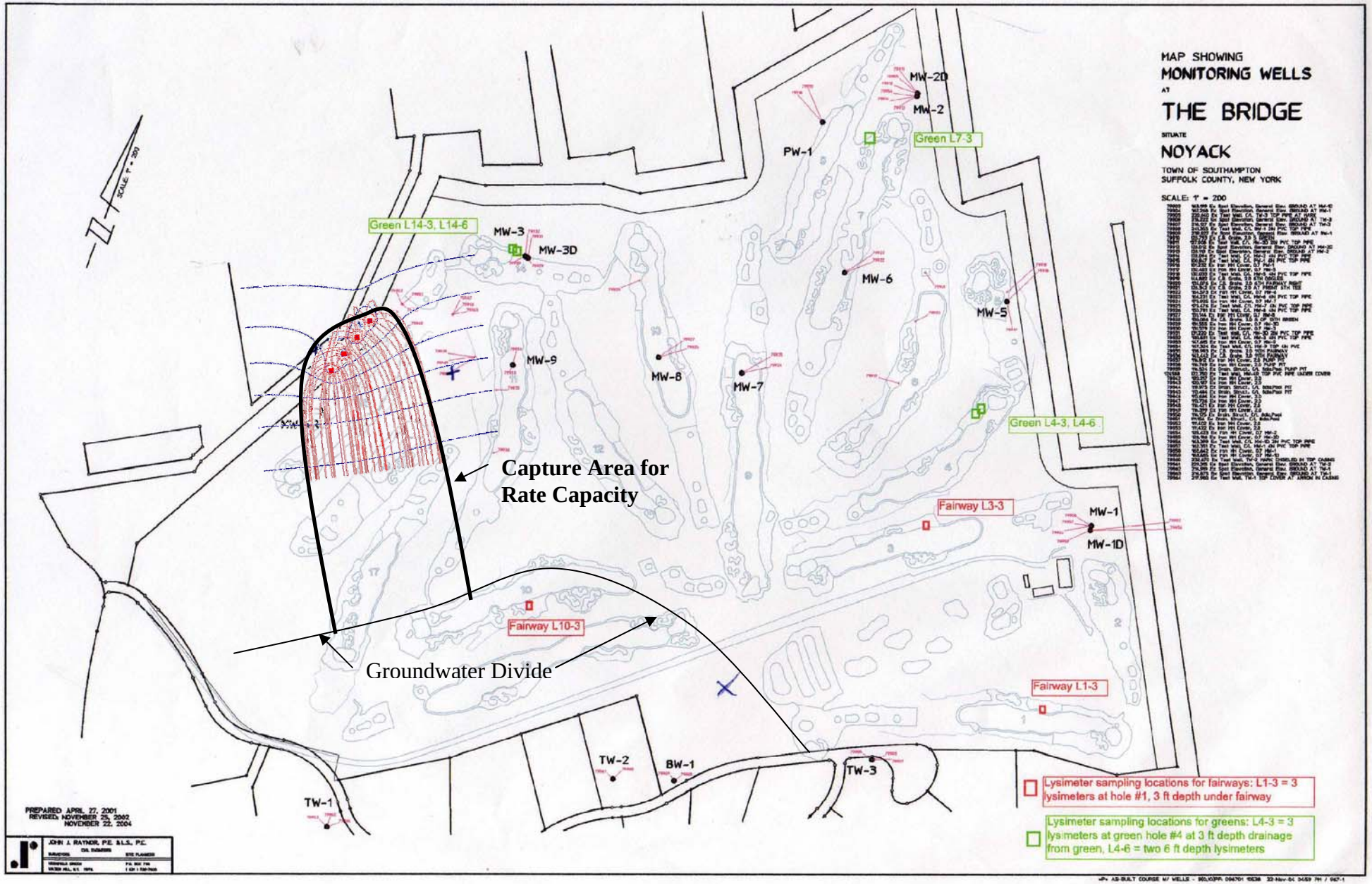
Non- Pumping
Model width 2500 ft



Average Annual Rate
73 gpm each
651 ft wide



Rated Capacity
1080 ft wide
275 gpm each


MAP SHOWING
MONITORING WELLS
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THE BRIDGE
SITUATE
NOYACK
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SUFFOLK COUNTY, NEW YORK
SCALE: 1" = 200
MW-2D
MW-2
PW-1
Green L7-3
Green L14-3, L14-6
MW-3
MW-3D
MW-6
MW-5
MW-9
MW-8
MW-7
Green L4-3, L4-6
Capture Area for
Rate Capacity
Fairway L3-3
MW-1
MW-1D
Fairway L10-3
Groundwater Divide
Fairway L1-3
TW-2
BW-1
TW-3
TW-1
Lysimeter sampling locations for fairways: L1-3 = 3 lysimeters at hole #1, 3 ft depth under fairway
Lysimeter sampling locations for greens: L4-3 = 3 lysimeters at green hole #4 at 3 ft depth drainage from green, L4-6 = two 6 ft depth lysimeters
PREPARED APRIL 27, 2001
REVISED NOVEMBER 25, 2002
NOVEMBER 22, 2004
JOHN J. RAYNOR, P.E. & L.S., P.C.