YEAR 2010-2011 REPORT

Beaufort County Storm Water Quality Monitoring

Beaufort County, South Carolina

Submitted to:

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Submitted by:

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EXECUTIVE SUMMARY

The Beaufort County Storm Water Quality Monitoring Program was developed to achieve the four primary goals identified in the Storm Water Management Plan (SWMP) and support the county's future implementation of this plan. The four primary goals are: 1) establish baseline water quality; 2) determine and track long-term trends to measure effectiveness of current best management practices (BMPs); 3) conduct bacterial source tracking (BST) and; 4) measure efficiency of selective BMPs. Table 1 shows the recommended tributary sampling as indicated in the SWMP and Table 2 shows the current tributary sampling locations. GEL Engineering, LLC (GEL) was first selected by Beaufort County in 2007 to implement the water quality monitoring program for two years. In 2009, GEL was selected to continue the water quality monitoring program, for the potential of up to five years.

During Year 4, no funds were spent to conduct BST due to the inconclusive nature of data derived during past BST and no further advancements in the technology. Additionally, due to elevated copper concentrations at the Eagles Pointe Golf Club, expanded copper evaluations were conducted to predict toxicity and evaluate the effects of applications of copper sulfate.

Due to the limited duration of sampling, long-term trend analyses cannot yet be conducted, but preliminary observations can be drawn from the data collected thus far:

- The concentrations of fecal coliform exceed the state shellfish harvesting waters standard of 14 CFU/100 mL at all sample stations.
- Three years of consistent water quality data were obtained for multiple stations and Beaufort County elected to discontinue data collection at these sites.
- A sample station, BECY-17A, was added as a new retrofit opportunity was identified. The purpose of the addition was to establish water quality prior to implementing the retrofit.

- Excluding fecal coliform, data collected in Year 4 did not regularly exceed action levels for parameters with “critical exceedance concentrations” as set by Beaufort County and based on the South Carolina Estuarine and Coastal Assessment Program (SCECAP) standards.

- The data obtained from expanded copper evaluations and toxicity modeling at Eagles Pointe Golf Club suggests that discharge from the pond system would not negatively impact the downstream aquatic environment if discharge was prevented from leaving the pond system for 24-hours following an application of copper sulfate.

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1.0 Year 4 Storm water quality monitoring

GEL was retained to continue the storm water quality monitoring program that was initiated in June 2007. During Year 4, GEL:

- Continued monitoring all established stations in response to a qualified storm event rather than on a set schedule;
- Reported sample values exceeding "action levels" to Beaufort County for those parameters with SCECAP-based "critical exceedence concentrations;"
- Routinely met with Beaufort County to review the latest data, and;
- Made adjustments to sample locations, parameters measured, etc., based on the monitoring results, data review, and monitoring program directives supplied by Beaufort County.

Table 2 summarizes the stations monitored during Year 4, including their name, watershed, receiving water body and classification, etc., and most importantly their purpose.

1.1 Sample Locations and Purpose

Since initiation of the storm water quality monitoring program, the selection and identification of appropriate sampling sites for grab sampling and automatic storm event sampling has been based on the water quality sensitivity analysis (modeling), the current level of service for water quality segments, and the existing and future land use classifications. During Year 4, six trending sites and eight existing water quality stations were monitored, copper was evaluated at the outfall at Eagles Pointe Golf Club, as well as an assessment of fecal coliform in the sediments near the May River. Note, sampling from an additional existing water quality site was initiated in Year 4 (refer to Table 2), and its purpose will be further discussed in Section 2 of this report. All sites monitored during Year 4 are displayed on Figure 1.

1.2 Qualifying Storm Events

During Year 4, GEL collected grab samples and conducted field measurements at all stations following a storm event that was greater in magnitude than 0.1 inches in

magnitude per hour and that occurred at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event.

GEL also conducted monthly composite storm event sampling at five discrete auto sampler locations, provided that a storm event greater than 0.1 inches in magnitude per hour had not occurred within 72 hours from a previously measurable (greater than 0.1 inch rainfall) storm event. Samples were collected with an automatic sampler that was established and secured in each of the locations. The automatic sampler collected an aliquot every two minutes for the first 30 minutes following a qualifying storm event for a "grab sample." In past years, the automatic sampler then collected a 15 minute aliquot for the next two and a half hours for a composite sample. However, based on recommendations from the Year 2 Annual Report, the composite auto sample was no longer collected beginning in September 2009. Instead, a second grab sample was collected when GEL personnel collected the grab from the automatic sampler (referred to as "Grab After" in Tables 3 through 26).

1.3 Sampling/Analytical/QA-QC Procedures

All sampling events were conducted following GEL's Standard Operating Procedures, United States Environmental Protection Agency (EPA) and SCDHEC approved sampling and analytical protocols, and appropriate safety measures. The table below identifies each parameter analyzed, the method allowable maximum holding time, sample preservative and the analytical method:

Parameter	Holding Time	Sample Preservative	Analytical Method
Fecal Coliform bacteria (FCB)*	24 Hours	$Na_2S_2O_3$	EPA 200.8
Total suspended solids (TSS)	7 Days	4°C	EPA 160.2
Salinity	28 Days	4°C	EPA 120.1
Biochemical oxygen demand (BOD)	48 Hours	4°C	EPA 405.1
Ammonia nitrogen (NH3-N)	28 Days	4°C, H_2SO_4 (pH<2)	EPA 350.1
Nitrite and nitrate nitrogen (NO_3 + NO_2)	28 Days	4°C, H_2SO_4 (pH<2)	EPA 353.1
Total Kjeldahl nitrogen (TKN)	28 Days	4°C, H_2SO_4 (pH<2)	EPA 351.2

Total phosphorus (TP)	28 Days	4°C, H_2SO_4 (pH<2)	EPA 365.4
Chlorophyll-a (chl-a)	48 Hours	4°C	SM10200H
Total organic carbon (TOC) - quarterly	28 Days	4°C, H_2SO_4 (pH<2), zero headspace	EPA 415.1
Metals (cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc) — quarterly)	6 Months	4°C, HNO_3 (pH<2)	6010B

* *GEL recommended that fecal coliform levels be analyzed using the five-tube dilution method (also known as MPN) since it provides more accurate results for samples containing turbidity and saltwater and is consistent with methods used during the previous monitoring events. Additionally, the standard holding time for fecal coliform is six hours; however, this method allows for a holding time of 24 hours if the sample data is not for potable water and will not be used for compliance purposes.*

Analysis of pH, temperature, dissolved oxygen, turbidity and conductivity was performed in the field using a calibrated Series 4a DataSonde, manufactured by Hydrolab. This allowed parameters with a short holding time to be analyzed in-situ at the time of sampling at each sample location, thus providing more accurate results. Ambient weather conditions noted during each monitoring event included precipitation over the previous 24 hours. In addition, tide levels were noted during the time of sampling at each location. Each of these field parameters was recorded on a Field Data Information Sheet.

While grab samples collected using the auto samplers was described in Section 1.2 of this report, discrete grab samples were collected by lowering a new sampling container directly into the surface water and next transferred to the appropriate laboratory sample containers that have been pre-labeled and containing the appropriate sample preservative. Sampling personnel wore new laboratory-quality, PVC gloves during all sample collection activities, and changed gloves, at a minimum, between each monitoring location. Each sample container was identified with a laboratory label that was completed during collection, and each label included the following information:

- The address and telephone number of GEL;
- A specific client code for the County;
- The parameter to be analyzed from that container;
- The sample identification number/name, and;
- The date and time of sample collection.

A chain of custody form (COC) was completed and maintained throughout sampling and transportation to the laboratory. Samples were transported to GEL

Laboratories, LLC, or the designated subcontracted laboratory for analysis. A sufficient amount of freezer packs and/or ice was maintained in the cooler to ensure that the samples remain at the recommended temperature (4° C). The analytical results were submitted to the County, along with Critical Exceedances, on a monthly basis. (The COC and analytical certificates were not submitted to the County and are not included within this report, but may be supplied upon request.)

2.0 Adjustments Made During Year 4 Monitoring

Several adjustments were made leading into, and during Year 4 of the storm water quality monitoring program. During this time, one existing water quality station was added (BECY-17a). Additionally, sampling was discontinued at 10 sample stations, including one trend station (BECY-14), five existing water quality (BECY-5, BECY-7ra, BECY-12, BECY-13, and Christine Place), two runoff modeling sites (BECY-1a and BECY-4a), the BMP efficiency site (BMP-Out at Eagles Pointe Golf Club), and a copper evaluation site (Pinckney Colony).

2.1 Monitoring Station Changes

In January 2011, sample station BECY-17a was added to the data collection efforts. Samples collected from this automatic sampler station are for the purposes of evaluating the existing water quality in a stormwater pond adjacent to the Beaufort County Office Complex, which captures and stores the runoff from the parking lot prior to discharge. Future plans for the parking lot include a redesign to better handle stormwater runoff. The purpose of station BECY-17a to gather baseline water quality data prior to the parking lot redesign and compare with data collected after the work has been completed.

In April 2011, sampling at trend station BECY-14 was discontinued. Although a long-term trend station, the site continued to experience high concentrations of salinity, thus results were not indicative of stormwater runoff. Alternative areas to relocated BECY-14 were investigated, but no feasible alternative was identified.

In November 2010, sample efforts at the existing water quality stations BECY-5, and Christine Place were discontinued. Sample collection ceased at BECY-5 due to high concentration of salinity, as well as the collection of three years of low-variability data. Sampling at station Christine Place was originally initiated for the purpose of evaluating existing water quality at a pond in the Christine Place neighborhood. It was originally thought the pond would have sub-par water quality due to a large bird population that utilized the pond and would be a good location for a retrofit. However, data from this

sample station revealed relatively good water quality; therefore, the County decided to remove Christine Place from the sampling efforts. In September 2011, sampling was discontinued at stations BECY-7ra, BECY-12, and BECY-13. Sample collection was halted at these stations due to the collection of at least three years of low-variability data.

Sample collection efforts also ceased at stations BECY-1a and BECY-4a in November 2010. BECY-1a and BECY-4a were originally established to gather data for medium- and high-density residential areas for comparison with data originally used by CDM to calibrate the water quality model. The three years of data collected from these sampling stations was found to be considerably lower than the data used by CDM to calibrate the water quality model. Therefore, the Year 3 report advised moving these sample stations to collect data from an industrial/commercial site to determine how it compares with the model data. However, an industrial/commercial location has not yet been identified.

Lastly, in September 2011, sample collection was discontinued at stations BMP-Out and Pinckney Colony, both of which are outfalls from the Eagles Pointe Golf Club. BMP-Out was originally established as the BMP efficiency site (along with BMP-In). However, after collection efforts were discontinued at BMP-In, the main purpose of station BMP-Out was to determine the quality of water discharged from the Eagles Pointe pond system, as well as copper evaluation. Aside from high concentrations of copper, water quality from outfall BMP-Out did not consistently exceed the SCECAP-based action levels. The purpose of the continued collection efforts at Pinckney Colony was for copper concentration evaluation. As is explained in Section 2.2, a detailed copper evaluation was conducted for the Eagles Pointe Golf Club; therefore, sample collections are no longer necessary at either station.

2.2 Eagles Point Copper Evaluation

During Year 3, review of quarterly total copper data for sample station BMP-Out revealed copper concentrations exceeding current regulatory standards. Current regulatory standards range from 3.0 to 6.0 micrograms per liter (µg/L). In one instance, results from the total copper quarterly sampling produced results exceeding 130 µg/L. The analysis of these samples was for total copper, all of which is not biologically available in aquatic systems.

An analysis for dissolved copper could provide more insight into the potential toxicity within the ecosystem, since dissolved copper tends to be more biologically available. It is important to note that not all dissolved copper is biologically available,

but if dissolved copper concentrations were less than the regulatory standards, the measured copper should not be toxic to aquatic organisms. Therefore, in September 2009, monthly sampling at BMP-Out and Pinckney Colony began for both total and dissolved copper to determine if dissolved copper concentrations are greater than existing regulatory standards. Following several months of sampling, the dissolved copper concentrations remained greater than the regulatory standards.

Although the total and dissolved concentrations were greater than the regulatory standards, a large unknown was whether the observed concentrations would be toxic within this aquatic ecosystem. A second unknown was whether the application of copper sulfate in the pond system at Eagles Pointe affected copper concentrations. Copper sulfate is regularly applied to the pond system to control algal growth. Therefore, with the recommendation of a Beaufort County Stormwater Utility Management Board member, GEL completed Biotic Ligand Model (BLM) analyses, consisting of 3 different sampling events. The BLM predicts the metal toxicity and speciation for a particular site based on the ambient water quality. Therefore, by inputting temperature, pH, dissolved organic carbon, cations, anions, alkalinity, and sulfide, the BLM would predict whether measured concentrations of dissolved copper would be toxic in the aquatic ecosystem. Also, separate sampling was conducted prior to and after the application of copper sulfate to determine how its' application affects copper concentrations.

Based on the findings of the copper sulfate sampling and BLM, the following inferences were made:

- Applications of copper sulfate to the Eagles Pointe pond system increases the dissolved copper concentration, which remain elevated for approximately 24-hours after application.
- The results of the BLM indicate that the observed concentrations of dissolved copper (not in conjunction with the application of copper sulfate) do not exceed the Criterion Maximum Concentration (acute concentration) or Criterion Continuous Concentration (chronic concentration) for the pond system. Therefore, the model data suggests that the dissolved copper concentrations are not toxic.

- The data suggests the downstream aquatic environment from the Eagles Pointe Golf Club would not be negatively impacted by the application of copper sulfate (at levels consistent with the application doses deployed during the course of the study period) if discharge was prevented from leaving the pond system for 24-hours following an application of copper sulfate.

Further details of the copper evaluation were provided to Beaufort County in the *Eagles Pointe Copper Sampling Report*, completed by GEL in June 2011.

2.3 Eagles Point Flow Meters

During Year 3, flow-meters were installed at the two Eagles Pointe outfall points – BMP-Out and Pinckney Colony. The Greyline Instruments, Level-Volocity *Stingray* Logger flow-meters continuously measures and stores water temperature, depth, and velocity data at programmed intervals. Using this data and information about the outfall pipe (i.e., pipe diameter) flow estimates from the system can be calculated. During Year 4, GEL routinely downloaded and processed this data. The data was then provided to Mr. Rick Karkowski of Thomas and Hutton. Mr. Karkowski utilizes this data to perform loading predictions from Eagles Pointe. Along with the ceased sampling from the Eagles Pointe outfalls, data collection from the flow meters was discontinued. In October 2011 the flow meters were removed for a future use in the Beaufort County Water Budgets Study.

2.4 Evaluation of Fecal Coliform in Sediments

Additionally during Year 4, efforts were taken to evaluate fecal coliform in sediments, particularly in the areas near the May River. The purpose of this task was to collect and analyze samples in these sediments to determine if they may be a significant source of fecal coliform concentrations for the May River. The samples were collected in the wetlands and waterways in the Palmetto Bluff development in Bluffton, SC.

The first set of samples was collected in four locations. Additionally, at three of the locations, sediments were collected from the surface (0 to 2-inches of sediment) and at the subsurface (approximately 6-inches below surface). The results of these samples indicate that the subsurface samples contained a minimal concentration of fecal coliform. Furthermore, the results did not identify the sediments to contain a large concentration of fecal coliform in the wetlands. The highest observed concentration of fecal coliform was found in the sediments in a tributary of the May River, rather than in the surrounding wetlands.

A second set of sediment samples was collected in conjunction with a flush test conducted by the Beaufort-Jasper Water and Sewer Authority (BJWSA). The BJWSA flush test consisted of the release of a large quantity of aquifer-stored potable water through drainage areas to the May River. The purpose of the sediment sampling was to evaluate fecal coliform concentrations before and after the flush test to determine how fecal coliform populations in the sediments may react to the large quantity of water entering and exiting the system (in a similar manner of a large rain event). Thus, surface sediment samples were collected at six locations, three days before and after the post flush test and analyzed for concentrations of fecal coliform. The results of the sediments samples were inconclusive, with no observed overarching trends. Based on the inconclusive nature of the results, no further samples were collected in conjunction with the remaining BJWSA flush tests.

3.0 Year 4 Data Analysis

As indicated, GEL's monitoring is being performed to achieve four primary goals identified in the SWMP and support the county's future implementation of this plan. The primary goals are:

1. Perform long-term trend analysis to track BMP effectiveness;
2. Evaluate baseline existing water quality;
3. Confirm model inputs for select structural BMPs; and,
4. Confirm model inputs for runoff quality from land use areas.

3.1 Baseline Existing Water Quality

Stations with higher salinity values indicate the collection of tidally influenced samples rather than those of storm water resulting from a wet weather event. Results from sample station BECY-14 (trending) indicate significant salinity and tidal influence of the samples. As a note, due to the elevated salinity concentrations at BECY-14, samples are no longer collected at this sample station. In addition, a small number sampling events at BECY-1, BECY-2 and BECY-3 indicate elevated salinity values. However, these events occur only during a very high tide in the region and are not as pronounced as the salinity concentrations at BECY-14.

As indicated, stations with results above the applicable water quality standards should receive a higher priority for implementing future BMPs. Note that all stations have average fecal coliform concentrations greater than the state standard of 14 CFU/100 ml. Aside from fecal coliform concentrations and typical seasonal fluctuations, sample stations in Year 4 did not experience widespread or routine results exceeding "action

levels" for the parameters with critical exceedance concentrations, as established by Beaufort County, which are based on the SCECAP standards. The parameters internally tracked for exceedances are biochemical oxygen demand, copper, dissolved oxygen, fecal coliform, pH, total phosphorus, and Total Kheldahl Nitrogen.

As previously noted, GEL no longer collects a composite sample from the automatic samplers. Currently, the grab sample from the automatic sampler is collected, along with a second grab sample directly from the water source (at the time of sample pick-up). A preliminary analysis of the fecal coliform concentration results was conducted to identify a correlation between lapsed time between samples and the fecal coliform concentrations at individual stations, as well as an overarching trend across all stations.

However, this analysis did not reveal any trends based on lapsed time between the samples and the fecal coliform concentrations. It is assumed that the fecal coliform concentrations are affected by a number of station-specific variables that may overshadow the time between sample collections. These variables may include soil types and infiltration rates for the different stations, as well as the land use and waterbody from which a sample is collected (i.e., pond adjacent to a parking lot versus a high-flow drainage creek). Results may also be influenced by the duration, intensity, and overall amount of rainfall that triggers a sample collection.

4.0 Year 4 Conclusions

GEL was retained to continue the storm water quality monitoring during year 2010-2011, while integrating improvements over the existing sampling and analysis program. Again during Year 4, no additional BST efforts were undertaken. This decision was based on limitations with the current BST technologies. In addition to summarizing the Year 2010-2011 storm water quality monitoring program within this annual report, and, as requested by the Beaufort County Storm Water Utility Board, GEL has listed observations made during year 2010-2011 which we believe are worthy of further consideration with regard to changes in future storm water quality monitoring in Beaufort County to further achieve the primary goals identified in the SWMP:

- Identify a new high/medium density residential or industrial/heavy commercial site. Since the data collected from past runoff sampling sites was considerably lower than the data originally used by CDM to calibrate the water quality model, it may be advisable to collect data from other sites to determine how it compares with the model data.

- Identify a new BMP site to investigate efficiency. The previous BMP station at Eagles Pointe Golf Club was determined to not be an appropriate location to measure BMP efficiency, as multiple influent locations could not be accurately measured and assessed. Conversations with Beaufort County indicate a new BMP may be located in conjunction with the future Water Budgets Study.

5.0 References

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