UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4

61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

June 3, 2011

4SD-SSB-TSS

MEMORANDUM

SUBJECT: Potential Stressors Contributing to the late May 2011 Ogeechee River Fisk Kill

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THRU: Glenn Adams, Chief
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I have reviewed the preliminary data the Environmental Protection Agency (EPA) collected for surface water, sediments, and fish tissues from the Ogeechee River, per your request, and have developed hypotheses regarding the causes of stress to the fish population. According to the Georgia Department of Natural Resources (GADNR), the fish ultimately were killed by disease, namely columnaris. The chemical concentrations measured in the samples EPA collected on May 22 and 23 were not high enough to kill fish by themselves. Exposure to a mixture of chemicals in combination with unseasonably warm temperatures and low flows may have been sufficient to weaken the fish. These multiple factors may have weakened the fish enough to make them susceptible to disease. It may be impossible to ever know for certain exactly what happened.

Potential Causes of Fish Kill and Chemicals of Potential Concern

In general, the only chemicals that appear to be of potential concern in the surface water samples were ammonia, formaldehyde, and hydrogen peroxide. Formaldehyde was also detected at levels of potential concern in sediment. Dead mussels were observed downstream of the outfall. Mussels do not contract columnaris. Thus a combination of stressors may have affected the fish causing them to succumb to disease. Elevated temperatures, from unseasonably warm weather, low flows, and chemical stressors could have weakened fish populations. High temperatures near the outfall may have stressed fish in the immediate vicinity of the outfall. However, given that the discharge from the outfall made up only 2 or 3 percent of the total flow of the river, any increase in temperature would be expected to dissipate within a few yards from the outfall.

Ammonia

Ammonia has a recommended water quality criterion for protection of aquatic life that is temperature and pH dependent. Based on the temperature measured at Station 4 of 28 degrees Celsius and the pH of 8.35, ammonia criteria for acute and chronic exposures were calculated as 4.3 and 0.58 mg/L, respectively. The highest concentration of ammonia was measured in surface water at Station 4 at 1.2 mg/L. The ammonia level was greater than the ambient water quality for chronic exposure but was below the criterion for acute exposure. The ammonia criterion for acute exposure is a limit on the 1-hour average and should not be exceeded more than once every 3 years. The chronic criterion is the 30-day average concentration that should not be exceeded more than once every 3 years. Juvenile mussels are sensitive to the effects of ammonia at levels at or below the final acute values used to derive EPA's water quality criteria (Wang et al. 2008).

Hydrogen Peroxide

Hydrogen peroxide was detected by the field crew in Ogeechee River at a maximum concentration of 2 mg/L downstream of the facility. Hydrogen peroxide is a skin, eye, and respiratory irritant. It is capable of liberating large amounts of heat in the process of degrading to oxygen and water. The heat generated can accelerate the decomposition reaction. Hydrogen peroxide is not expected to volatize out of water. Region 4 does not have a screening value for hydrogen peroxide for protection of aquatic life. No screening values were found in other sources. 22 mg/L of hydrogen peroxide was lethal to rainbow trout (LD50) after 4 days of exposure. 26.7 mg/L is toxic to bluegill (LD50). A lowest chronic value of 0.34 mg/L was reported to reduce the growth of *Daphnia magna* (water flea) (Meinertz et al. 2008). The lowest chronic value can be used as a chronic screening value for hydrogen peroxide. Long-term exposure of fish to hydrogen peroxide concentrations at the lowest chronic value may reduce fish growth or hinder their ability to reproduce, but would unlikely kill fish.

Formaldehyde

Formaldehyde is a skin, eye, and respiratory irritant. Formaldehyde exists ubiquitously in the environment. It is associated with textile plants producing permanent press coatings on fabrics. Formaldehyde released to water is not expected to bind to sediment particles or to accumulate to a great degree in sediment beds. Formaldehyde can readily biodegrade in the environment. Formaldehyde released into the water will degrade in 1-3 days. Volatilization from

the water is not expected to be an important process. Bioaccumulation of formaldehyde in fish is not expected to occur to any substantial degree. Region 4 does not have a screening level established for aquatic organisms exposed to formaldehyde. Acute and chronic screening values from the Great Lakes Clearinghouse were used to assess formaldehyde concentrations detected in surface water at the facility outfall. The maximum detected concentration of formaldehyde in the surface water was 400 ug/L compared to the chronic screening value of 74 ug/L and the acute screening value of 660 ug/L. Exceedence of the chronic screening value implies that there is potential risk to sensitive aquatic species if exposed to these levels for extended periods of time.

Formaldehyde was detected in river sediment at the outfall at 310 ug/kg and again at the furthest downstream station at 190 ug/kg relative to a Dutch Intervention value for serious contamination of 100 ug/kg. EPA Region 4 does not have a screening value for formaldehyde in sediments. A screening value of 46 ug/kg can be estimated from the Great Lakes chronic screening value for surface water and an estimate of the partitioning of formaldehyde to organic carbon in sediments based on the method of DiToro and McGrath (2000). The formaldehyde detection at the downstream station indicated surface water contamination at Station 6 may have occurred in the past.

Semivolatile organic compounds benzaldehyde and methylphenol (cresol) were detected in fish tissues. The concentrations of benzaldehyde and methylphenol, which were detected in fish tissues, are below levels associated with mortality or biochemical effects. The single detection of benzaldehyde at 0.061 mg/kg was unlikely to be fatal to the fish given a reported lethal body burden concentration for rainbow trout (*Oncorhynchus mykiss*) of 1,400 mg/kg (McKim and Schmieder, 1991). The single detection of 3- and/or 4- methylphenol at 0.17 mg/kg is lower than a value reported for biochemical effects of 16.3 mg/kg and below the value reported for mortality to fish of 76.5 mg/kg by Kaiser et al. (1984).

Levels of most metals detected in fish are not expected to be harmful to the fish. Arsenic was detected in fish tissues at a maximum of 0.22 mg/kg relative to an average effect level for development of 0.8 mg/kg. The zinc concentration in one fish tissue sample from Station 2 was 59 mg/kg, which was similar to concentrations in fish tissue that were lethal to striped mullet (Zyadah and Abdel-Baky, 2000). A threshold for adverse effect of zinc to fish between 34 to 36 mg/kg was reported by Spehar (1976). The range reported by Spehar (1976) represents the no observable adverse effect level of 34 mg/kg and the lowest observable adverse effects level of 36 mg/kg. The zinc concentration in fish tissue was elevated in one sample. Zinc was not elevated above Region 4 screening levels in sediments.

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