

Amended Appendix I

Amended M.C. Stiles WWTP Foam Study & Outfall Improvements Work Plan

January 2, 2014

Introduction

The draft NPDES permit for the M.C. Stiles Wastewater Treatment Plant (“WWTP”) authorizes discharge of treated wastewater from Outfall 001 with the requirement that “[t]here shall be no distinctly visible floating foam, scum, oil, or other matter contained in the wastewater discharge.” The NPDES permit issued November 30, 2011, for the M.C. Stiles WWTP, effective January 1, 2012, similarly provides that “[t]here shall be no distinctly visible floating scum, oil or other matter contained in the wastewater discharge.” By letter dated December 29, 2011, the City of Memphis (hereinafter “Memphis” or “the City”) appealed, among other things, the above-cited permit condition in the M.C. Stiles WWTP NPDES permit. The appeal is still pending.

The City has voluntarily undertaken steps to reduce foaming in its effluent. The plant staff has used a defoaming agent since the late 1990s; but this approach does not provide a sustainable, long-term solution to address the root causes of foaming at the plant.

Objectives

The underlying state narrative water quality standards (“WQS”) upon which the NPDES permit condition is based does not anticipate that all foam be eliminated from the discharge. For example, where the water quality criterion is for protection of fish and aquatic life, the WQS at 1200-4-3-.03(3)(c) prohibits the discharge of foam “of such size or character that may be detrimental to fish and aquatic life.” Similarly, the water quality for:

- Industrial water supply at 1200-4-3-.03(2)(e) prohibits the discharge of foam of such size and character that “may impair the usefulness of the water as a source of industrial water supply;”
- Recreation at 1200-4-3-.03(4)(c) prohibits the discharge of foam of such size or character that “may be detrimental to recreation;”
- Irrigation at 1200-4-3-.03(5)(d) prohibits the discharge of foam of such size or character that “may impair the usefulness of the water for irrigation purpose;”
- Livestock watering and wildlife at 1200-4-3-.03(6)(d) prohibits the discharge of foam of such size or character “as to interfere with livestock watering and wildlife;” and
- Navigation at 1200-4-3-.03(7)(a) prohibits the discharge of foam of such size or character “as to interfere with navigation.”

The City's objective, under the Consent Decree and under the First Amended Consent Decree, is to assure that any foam that may remain after implementation of the project provided in this work plan is in compliance with the underlying, applicable WQS.

Background Information

Paragraph 12 of the 2012 Consent Decree sets forth the Parties' prior agreement for Memphis to implement the M.C. Stiles WWTP Foam Study and Outfall Improvements Work Plan ("Work Plan"). The Work Plan, set forth in Appendix I to the Consent Decree, discussed, among other things, the sampling program undertaken by Memphis to identify the potential cause(s) of foaming associated with the M.C. Stiles discharge and discussed a number of options. Based upon the desk-top work undertaken at that time, the Work Plan recommended an outfall modification alternative in which the existing outfall drop structure is to be removed and a new sloped outfall pipe constructed from the chlorine contact basin to a new discharge point within the river. The intent of this proposed modification was to reduce the amount of foam entering, and ultimately surfacing, within the Mississippi River.

Since entry of the 2012 Consent Decree, and after extensive analysis and study undertaken by the City, the City has determined that an alternative approach to the outfall design is likely to achieve better results.

As details were developed for the recommended alternative during the preliminary design stage, foam mitigation and other concerns were further analyzed by the City's engineers. Inasmuch as significant issues and uncertainty were encountered during this design, the City felt it prudent to further investigate the effectiveness of the recommended alternative, as well as other alternatives, based upon the new understandings of the system. The design for this project is particularly complicated by two factors:

1. The elevation change (vertical drop) from the chlorine contact basin to the Mississippi River and the associated available horizontal distance between the basin and the River.
2. The required deep excavation and associated dewatering requirements considering the proximity to the Mississippi River.

While the initial work plan approach was based upon desk-top work, the City's engineers found that due to the nuances involved, the amount of reduction cannot easily be quantified through theoretical calculations. As such, the City determined, upon the recommendations of CDM Smith, to take the extra step of engaging Clemson Engineering Hydraulics, Inc. ("CEH") to construct and test a physical model of the outfall to help finalize the design concept. CEH's work included constructing and testing a model of the existing outfall and constructing and testing outfall modification alternatives in order to see real-time results of the effectiveness of modifications on foam mitigation. The City determined that, only by going this extra yard, would the City have the requisite degree of confidence that the foam concerns raised would be adequately addressed.

Essentially this project involved first building and testing a model of the existing outfall to verify and calibrate to current conditions. The existing outfall model was constructed at an approximate 1:6 scale. CEH completed building and testing of the model of the existing outfall, and the testing of this model showed good correlation with the WWTP outfall. Due simply to the air entrainment from the vertical drop structure, foaming can be observed in the model using potable water (no additives to create foam).

Next, a model was constructed to simulate the gradually sloped spillway, similar to the alternative recommended in the work plan. This model was tested to see real time results of the effectiveness of the spillway alternative on foam mitigation. Unfortunately, the model shows limited foam reduction and control with the Work Plan approach. Due to the short distance and slope, there is a hydraulic jump created which is still resulting in a significant amount of air entrainment within the flow.

Amended Option

Based on the initial round of modeling and the new knowledge regarding the site-specific foaming issues, the project team then explored other options. Additional modeling now confirms that a vortex structure and providing venting for air and foam to escape will be the preferred approach for reducing foaming. The constructed model indicates that this approach should decrease the amount of foam beyond that initially anticipated by the Work Plan.

This new approach provides for a new outfall to be constructed utilizing a vortex structure. This structure will be designed to limit the amount of air entrainment and allow venting of air and foam prior to discharge to the river. Testing of a physical model constructed at a 1:6.4 scale demonstrated that a vortex structure will have a significant impact on foam reduction.

The design and construction for the new Stiles WWTP outfall will generally include the following:

- Modifying the effluent weir for the existing chlorine contact basin to switch the primary outlet from the current outfall to the secondary outfall;
- Installing a pipe from the secondary outfall to the new vortex structure;
- Constructing a vortex structure to transition flow vertically while minimizing air entrainment;
- Installing an outlet pipe, constructed at an approximately 0% slope, from the bottom of the vortex structure to the Mississippi River;
- Constructing three vents for air and foam to be continuously vented along the outlet pipe downstream of the vortex structure;
- Setting the outfall discharge at an invert elevation near the historical low level of the Mississippi River (approximately 170 feet); and,

- Installing a crown plate at the end of the outlet pipe to capture any air and foam not previously mitigated by the vortex structure and upstream venting.

During final design and construction, site-specific or other concerns may result in some modifications to the above design, but the basic concept will remain the same.

Amended Schedule

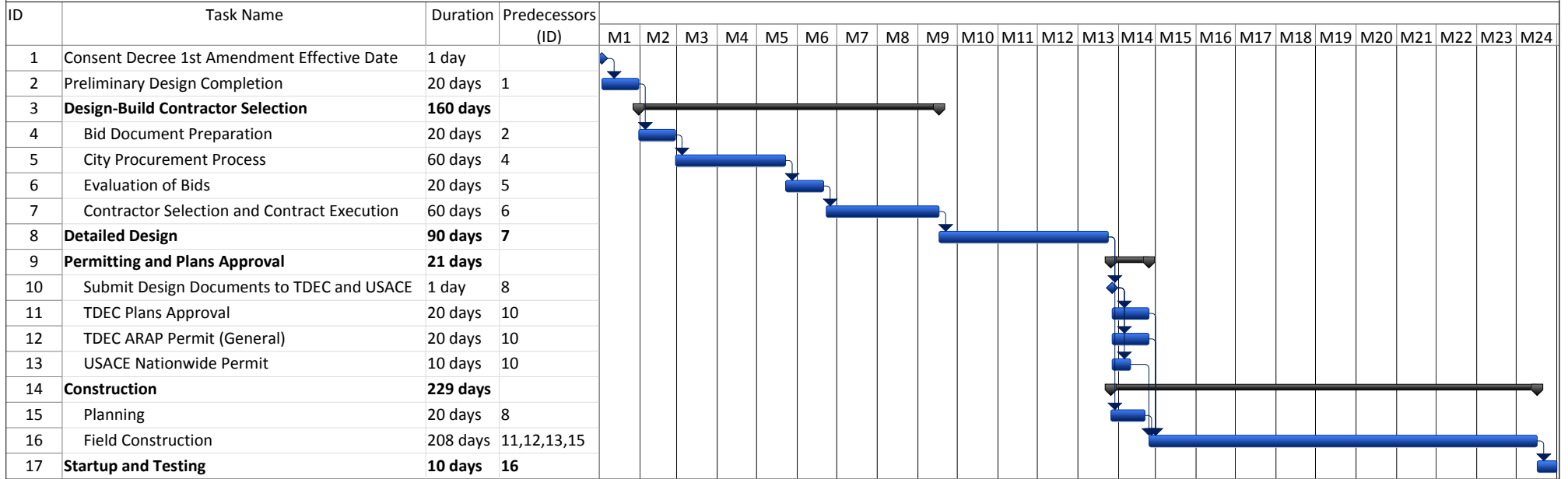
The City notes that the initial work plan schedule was not intended to be a detailed project schedule and was at best an approximation of the total anticipated project length based on its limited theoretical work at that time. The additional work the City has undertaken will help to assure that our mutual objectives of appropriately addressing the foam will be achieved. Accordingly, the following is the schedule for completion of the work.

The new schedule, starting with detailed design, would commence when the First Amendment to the Consent Decree is effective. Due to the fact that it is not known, at this time, when that will occur, subsequent actions are triggered by prior actions. Furthermore, the schedule recognizes that TDEC and USACE review and approval will be occurring.

This schedule (*see* attached gantt chart at p. 5) provides 510 working days (or approximately 24 months) from the effective date of the first amendment to the consent decree for completion of construction, startup and testing. The 510 days are based upon, TDEC and USACE permitting actions and plans approval being undertaken in 21 days (of which 20 of those days coincide with construction planning). In the event that TDEC and/or USACE take more than 21 days for permitting and plans approval, additional time is automatically provided commensurate with the number of additional days that TDEC and/or USACE take as the next step, i.e., construction, is not triggered until the permitting and plan approvals have occurred.

Updated Schedule for Foam Reduction / Outfall Improvement Project

M.C. Stiles Wastewater Treatment Plant



Notes:

- Durations shown are working days. Six holidays (New Year's, Memorial Day, Independence Day, Labor Day, Thanksgiving, and Christmas) are excluded from working days.
- It is assumed that an individual permit will not be required by TDEC or USACE.