University of Minnesota
St. Anthony Falls Hydraulic Laboratory

Project Report No. 300

MODEL STUDY OF MIXING IN THE PROPOSED DECHLORINATION FACILITY OF THE STILLWATER WASTEWATER TREATMENT PLANT IN OAK PARK HEIGHTS, MINNESOTA

by

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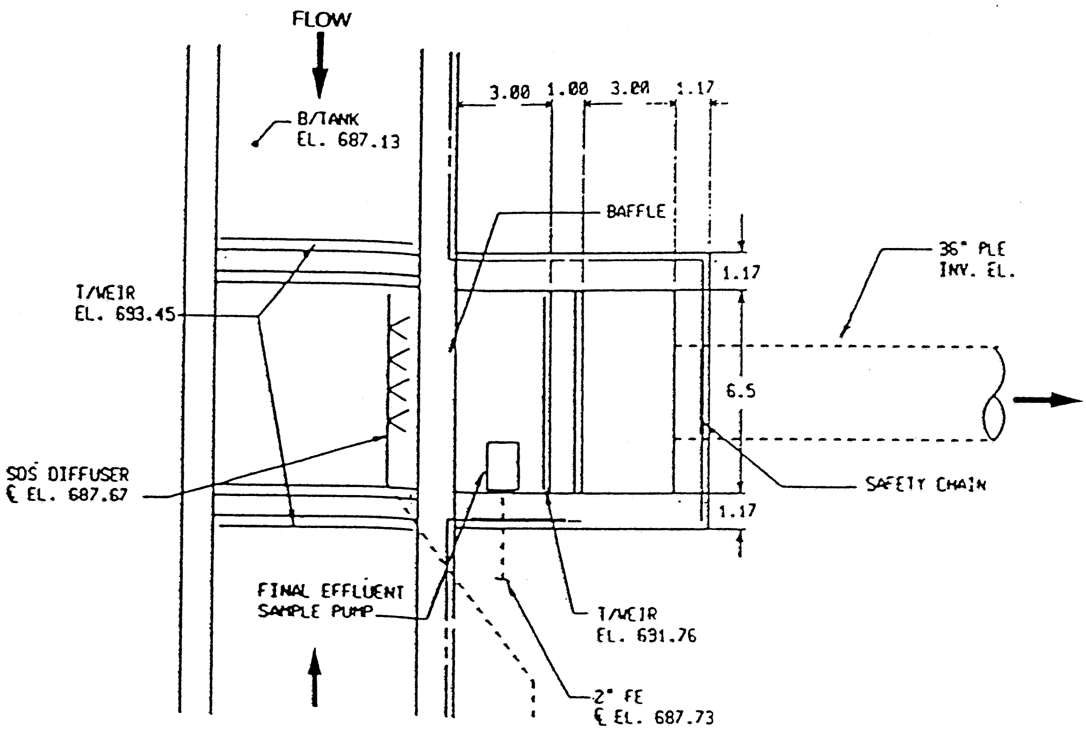
TABLE OF CONTENTS

I. INTRODUCTION

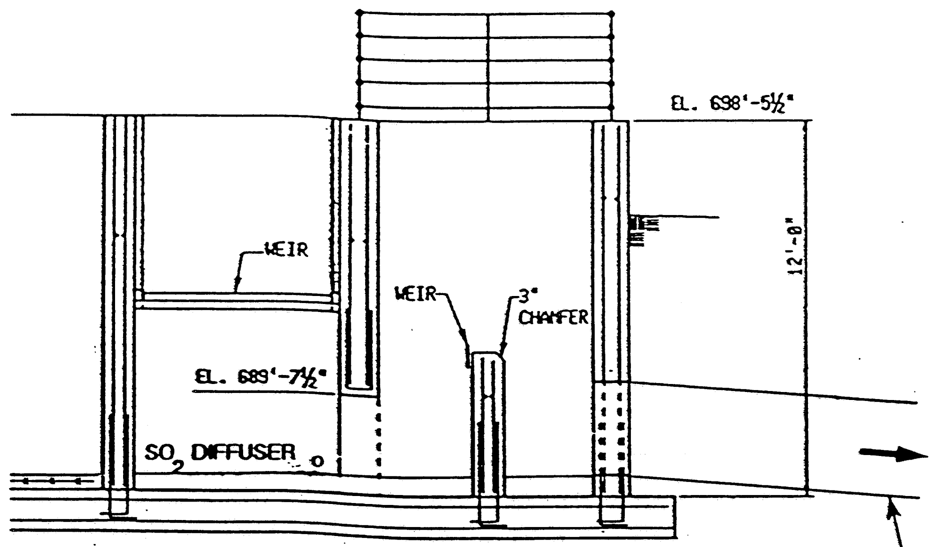
The Stillwater Wastewater Treatment Facility is located in Oak Park Heights, Minnesota. Current plans to modernize the facility include the replacement of the existing disinfection (chlorination) basin and an upgrade to include a dechlorination system and basin. The dechlorination process uses an SO_2 solution that is injected through a multiport diffuser into the dechlorination channel flow. Adequate mixing of the SO_2 solution is necessary for contact and deactivation of the chlorine residue. The dechlorination channel and the SO_2 feed are shown in the plan layout in Fig. I–1.

The Metropolitan Waste Control Commission (MWCC) decided to investigate the mixing of the SO_2 solution (performance) under the specific conditions and geometry of the Stillwater dechlorination basin before finalizing design and construction. The St. Anthony Falls Hydraulic Laboratory (SAFHL), University of Minnesota, in Minneapolis, was contracted to perform the study.

The purpose of the study was to investigate the mixing that occurs in the proposed dechlorination basin, and provide data to support a decision on the acceptability of the proposed design. An additional objective was to provide suggestions for improvement of the design, should problems with mixing in the original design become apparent.



(a) Plan view of prototype



(b) Profile view of protype

Fig. I–1. Proposed new dechlorination basin layout.

V. SUMMARY

1. Model experiments were conducted in a 1:8 geometrical scale model to determine the mixing of the SO_2 solution injected into the wastewater flow through a multiport diffuser. Dye was used to simulate the SO_2.

2. The originally proposed location of the manifold injection system was near the baffle wall. This arrangement does not provide a sufficient amount of mixing. Concentration gradients in the discharge could be seen visually in the outlet pipe. The standard deviation of the measured concentrations was 9 percent of the mean value at the high flow rate (the highest detected).

3. With the operation of just one of the two SO_2 diffusers located near the upstream weirs, the mixing was more complete by the time the flow reached the sampling location in the outlet pipe, compared to the original diffuser location. The standard deviation of the concentration records ranged from 3 (low flow) to 7 (high flow) percent of the mean under the different flow rates tested. Although the mixing was improved over the original diffuser location, it was not ideal, having long period fluctuations in concentration.

4. The case of a flood of the St Croix river producing a backwater effect in the outlet pipe was also studied. The results indicate that this improves mixing over the normal operating condition for all of the flows tested (Table IV–3).

5. Simultaneous operation of both diffusers at the upstream weirs gave the best results for the flow conditions tested (Table IV–3, Figs. IV–3 and IV–4). This provides a more uniform distribution of dye (SO_2) with incoming wastewater and reduced the long period fluctuations characteristic of the single diffuser operation. In the event that an even distribution of dye between the two diffusers could not be maintained, the single diffuser data would represent the worst case scenario.

6. It is concluded that both diffusers in the proposed location and orientation should be operated simultaneously under normal operating conditions. This should provide the best mixing possible and that which is required for efficient mixing operation.