City and County of San Francisco
2030 Sewer System Master Plan

TASK 500
TECHNICAL MEMORANDUM NO. 510
DISINFECTION OF COMBINED SEWER OVERFLOWS

FINAL DRAFT
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1.0 INTRODUCTION

San Francisco currently operates three wastewater treatment facilities to process all dry weather and a large percentage of wet weather flows collected by its combined sewer system. Treated flows discharged to the Bay are disinfected using common chlorination-dechlorination processes. Similar disinfection capabilities are installed in the Oceanside treatment plant but not presently utilized due to the remoteness from public access of the discharge site (approximately 4 miles offshore).

Rare peak wet weather flows which exceed the system's storage-treatment capacity are discharged through one or more of the 36 remaining system relief points as combined sewer overflows (CSOs). In San Francisco the CSOs receive "flow through" treatment in the transport-storage boxes where some settleable solids and floatables are removed prior to discharge.

On an average annual basis, approximately 6 percent of the City's combined wet and dry weather flow currently is discharged as CSOs through the near shore relief points. [Note – SOFT Report, page 11, says 3 percent; 1979 estimate for anticipated performance for a system designed for an average of eight overflows City-wide was 4.1 percent and 32 total hours per year (ave) (ave hours per event, 4 hours)].

Operations required for the treatment and overflow facilities are regulated under NPDES permits issued by the Regional Water Quality Control Board.

2.0 OVERALL APPROACH

In this Technical Memorandum the challenges of large scale, wet weather disinfection practice are reviewed including disinfectant options; pilot and full scale experience; outfall consolidation opportunities; and potential public health and environmental benefits and associated risks.

2.1 Current City Disinfection Practices

Health risks associated with bacteria-laden water may result through dermal (body) contact with the discharge, or through the ingestion of contaminated water or shellfish. Disinfection typically utilizes oxidizing chemicals or ultraviolet radiation to reduce bacterial concentrations to acceptable limits for the prescribed beneficial uses of the receiving waters.

San Francisco uses liquid sodium hypochlorite (concentrated bleach) as its oxidizing chemical with a minimum contact period of minutes at peak flow. Sodium bisulfite, a reducing agent, is applied for dechlorination prior to discharge. The North Point Facility operates intermittently (approximately 30-40 times per year) on wet weather flows, only, treating an average of 700 million gallons per year (SFPUC, 2003). The Southeast Treatment Plant operates continuously treating both dry and wet weather flows.

2.2 Receiving Water Impacts

Receiving water impacts of urban wet weather discharges are complex and highly variable. They are dependent upon the intensity, duration and frequency of events and conditions at the point(s) of discharge. Some generalized conclusions can be drawn however.

San Francisco has made major strides in controlling its combined sewer overflows over the past two decades. Frequency of overflows have been reduced from an average of 40 to 80 per year to 1 to 10 per year (prioritized by location) and the CSO volume has been reduced by more than 85 percent. Dry weather overflows have been eliminated and all flows receive treatment varying from sedimentation and floatables removal (~9 percent) to primary treatment (~9 percent) through full secondary treatment (~82 percent).

"Shoreline bacteriological levels have been monitored for the past 15 years at 45 locations around the City at a frequency of 8 to 12 times per month at each site; visual observations of overflow debris and recreational uses in the vicinity of the overflow structures are also reported. Monitoring results show that coliform bacteria levels are elevated at shoreline stations near CSO structures during and shortly after CSO events, *but generally return to background levels within one or two tidal cycles following the cessation of the overflow*" [emphasis added] (CA Regional Water Quality Control Board, San Francisco Bay Region, 2002).

3.0 EMERGING CSO DISINFECTION TECHNOLOGIES

As recently as 1998 there were fewer than 1000 facilities treating CSOs in the United States with less than 20 percent providing disinfection (WERF, 2005). Of those disinfecting, over half used gaseous chlorine and approximately 10 percent supplemented disinfection with dechlorination to minimize harmful residuals in the receiving waters. Concerns over the safety aspects of transporting, storing and applying gaseous chlorine have led to the increased use of liquid chlorine (sodium hypochlorite) in recent years and the investigation of alternative disinfection technologies. Alternative technologies include ultraviolet radiation (UV), ozonation, and chlorine dioxide (USEPA, 2001).

While the technologies are evolving rapidly, especially UV, the requirements of CSO disinfection are highly site and storm specific and piloting is advised prior to large capital investments. Such piloting would assess, for example, pretreatment requirements, application rates, contact time and controls (including remote activation/monitoring), adaptability for intermittent service, effectiveness, and the potential for generating and controlling harmful byproducts.

4.0 CASE STUDIES

Columbus, GA. Columbus began implementing its Long Term Control Plan (LTCP) in 1995 following two years of pilot testing. It has two CSO treatment facilities and 16 CSO outfalls discharging to the Chattahoochee river system. One treatment plant is a national demonstration facility used to evaluate alternative technologies to remove CSO contaminants and provide environmentally sensitive disinfection. Disinfection methods evaluated included UV, sodium hypochlorite, paracetic acid and chlorine dioxide. Sodium bisulfite was evaluated for dechlorination. *UV disinfection at the two plants was selected based on the demonstration approach of the CSO Control Policy. Demonstration requires that remaining CSOs after implementation of controls must not preclude the achievement of water quality standards or contribute to water quality impairment* [emphasis added] (USEPA, 2001). Disinfection at individual CSO outfalls was not provided or required.

Spring Creek CSO Facility, NY. A four-month pilot test program to evaluate alternative CSO disinfection options was performed for a large existing detention/chlorination facility in New York City. Chlorination/dechlorination was found to be significantly less costly than either UV or ozone. The study findings showed that *"…due to the intermittent nature of CSOs, disinfection technologies like chlorination and chlorine dioxide, which are less capital intensive with higher O&M costs are favored over high capital cost technologies with lower O&M"* [emphasis added] (USEPA, 2003). Variable solids concentration and particle size were shown to significantly affect UV disinfection performance (medium pressure, high intensity lamps). Conceptual level annualized present worth costs for a 5,000cfs peak design flow facility were $379,000 for chlorination/dechlorination vs $10,584,000 for UV radiation (year 2000 dollars) for this existing facility. Note that since this was an existing facility, the costs include only the disinfection add-on.

Syracuse, NY. Four disinfectants, deemed most appropriate for disinfection of wet weather flows, were evaluated in large bench-scale pilot tests for nine storm events between July 2001 and June 2002. Samples were collected at the Metropolitan Sewage Treatment Plant in Syracuse, NY, on combined sewage following screening and degritting. Selected disinfection processes were chlorination, chlorine dioxide, ozonation and UV radiation. High rate contact times were simulated: 5 minutes for chlorination and chlorine dioxide; 3 minutes for ozonation and 5 seconds for UV.

Potentially harmful disinfection residuals or byproducts were produced in the chlorine and chlorine dioxide flow streams which were controlled by sodium bisulfite and ferrous sulfate, respectively. No harmful residuals or byproducts were produced from the ozonation and UV flow streams.

At the targeted doses, chlorination (18 mg/l), chlorine dioxide (7 mg/l), ozonation (23 mg/l), and UV (100 mWsec/cm^2) all achieved USEPA guideline criteria for bacteria. *Chlorination and chlorine dioxide were found to be most cost effective over the full range of flows up to 100 mgd when compared to UV disinfection and ozonation. UV disinfection using medium* *pressure, high intensity lamps were found to be cost effective up to 10 mgd. Ozonation was cost effective only up to 1 mgd* (WERF, 2005). Ozonation was found to be the most expensive technology due to operational complexity in combination with high concentration-time product values.

5.0 COST-BENEFIT ANALYSIS

The City's 36 CSO relief points provide a necessary protection against flooding under extreme, but historically infrequent, storm events. The relief points are widely dispersed around the City perimeter (7 on the Westside, 6 in the North Basin, 17 in the Central Basin, and 6 in the South Basin), with exception of clusters at Channel (7) and Islais Creek(5). Relief disinfection facilities would be sized for the peak flow for each relief point (taking into consideration opportunities for consolidation) as determined by the collection system model for the selected design storm or design conditions.

6.0 SUMMARY

Disinfection of discharges at each of the City's 36 CSO relief points would be very costly and technically challenging. The City's present system of chlorination/dechlorination is a proven system for intermittent operation on the scale of 30-40 activations per year (at the North Point Facility). However, the use of this disinfection process at the CSO relief points would require multiple chemical storage facilities around the City's perimeter and structural improvements to provide minimum contact time for the chemicals to react.

UV disinfection would not require chemical storage, needs only seconds to react, and produces no harmful residuals. However, it lacks full scale application experience in this service (large number of widely distributed application points and very infrequent operations) and would be more expensive to construct and maintain.

The benefits from disinfecting the current 1 to 10 CSO events per year (average *total* duration of 30-40 hours) would be unlikely to justify the high cost.

REFERENCES

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