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Honolulu Membrane Bioreactor Pilot Study

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Cash Contributors:
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Objectives:
Phase I:

(i) demonstrate the technology for local engineers, operators, owners, and regulators,
(ii) develop operating experience in Hawaii,
(iii) promote the technology for adoption in Hawaii,
(iv) compare different equipment, and
(v) investigate the consistency of water quality, the reliability, and the operability of the technology for three different waste streams.

Phase II:

(i) pilot testing one MBR at an application site to facilitate the full-scale plant design and acquaint the operations staff with the technology,
(ii) pilot testing one MBR at a pump station site to evaluate satellite MBR treatment operation issues,
(iii) pilot testing MBR-based thickening and aerobic digestion of secondary sludge to investigate the potential utility of such operations,
(iv) conducting a comprehensive MBR feasibility study for the island of Oahu, including satellite reclamation, plant expansions, plant upgrades to facilitate recycling, and decentralized treatment for proposed or new developments, and
(v) conducting research on MBR biofouling and aeration mass transfer.

Executive Summary:
The objectives of the study were achieved. MBR technology was introduced and demonstrated effectively for the numerous local engineers, operators, owners, and regulators who observed the pilot units in operation. Approximately 15 licensed wastewater operators gained hands-on experience with the technology, and many more at least viewed the MBRs in operation. Familiarity with MBRs increased such that they have since been proposed for numerous projects statewide and adopted for a 4-million-gallon-per-day retrofit at Schofield Barracks WWTP on Oahu. The six MBRs compared in this study were of very different configurations in terms of membrane materials, membrane pore sizes, membrane shape, aeration rates, bioreactor configurations, and other parameters. In spite of these differences, there were important similarities as follows: (i) Each of the six pilot MBRs produced very similar, very-high-water-quality permeate with reliability, (ii) permeate water quality was excellent—far superior to conventional activated sludge effluent and to media-filtered tertiary effluent in terms of conventional parameters such as 5-day Biochemical Oxygen demand (BOD_5) (<3 mg/L), total suspended solids (TSS) (<2 mg/L), turbidity (mostly <0.1 NTU), indicator organisms (<1 CFU/100 mL), and UV transmittance (>70%), (iii) MBR permeate is suitable for disinfection with UV radiation since it is compact and does not require a chemical supply train or raise associated handling and storage issues, and (iv) MBRs can operate reliably under variable strength conditions due to extended solid retention time (SRT) in a smaller footprint.

Operation and maintenance observations common to all of the six MBR pilot units are as follows: (i) MBR operations are highly automated and controllable but not maintenance free, (ii) MBRs are easy to operate; however, skilled operators who understand activated sludge, membrane filtration, and automation are needed, (iii) periodic recovery cleaning is necessary (and was required in this study after polymer dumps, power outages, equipment failures, and each phase of testing) but easy and effective (chlorine, 2000 ppm; and hydrochloric acid, 1%), (iv) many more screenings were obtained with a 0.5-mm screen than with a 3-mm screen, (v) the MBRs operated at the flux rates advertised (10 or 15 gal/day-ft^2), and (vi) transmembrane pressure (TMP) was a good indicator of the need to recovery clean the membranes.

Pilot testing of the Zenon MBR at Schofield Barracks facilitated the full-scale plant design and acquainted the operations staff with the technology. The piloting of membrane thickening in a nonstandard mode (using a young sludge) demonstrated the importance of adequate aeration for allowing nitrification or denitrification and preventing biofouling and nitrogen poisoning even if solid reduction goals have been achieved. The MBR feasibility study for Oahu found eight potentially feasible sites for MBRs. Bench studies began to

identify biofouling conditions and causes. Pilot aeration testing found that the α factor in oxygen mass transfer was mostly correlated to viscosity (no new relationships were found with other parameters).

This project developed criteria to assist designers and owners in the selection of MBR equipment. Although permeate water quality is essentially the same for all of the six MBRs evaluated, there are differences between the different forms of equipment that can be grouped into cost and noncost factors. Cost issues include membranes and configuration, power and chemical usage, redundancy provisions, pretreatment needs, equipment durability, redundancy, and materials of construction. Noncost factors include ease of operation; control complexity; cleaning frequency, modes, and complexity; and company profiles and experience.