Al Ansab Advanced Wastewater Treatment Facility

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ABSTRACT

Wastewater treatment in the Middle East has come a long way in a relatively short period of time. This is driven by a number of factors, both environmental and economic. Partly due to environmental concerns and partly due to water scarcity, treatment must meet very high standards. Treated sewage effluent (TSE) is often the only source of irrigation water available in these burgeoning communities. As more of the area becomes landscaped, reliable irrigation supply has become a critical driving force toward advanced treatment.

Oman Wastewater Services Company developed the Muscat Wastewater Scheme, or master plan, to address its long-term wastewater collection and treatment needs. Further, the master plan developed a program for a network of TSE pipelines to distribute irrigation water from the treatment facilities throughout the Muscat area. The Wastewater Scheme involves consolidating many small treatment facilities which had been constructed for local treatment around smaller developments. In the long-range plan, they will be replaced by 7 central treatment plants, most developed at existing treatment sites. The plan will involve construction of 24 primary pumping stations and a large collection and TSE network in a program of 190 projects, to be completed in 2015.

The premier facility in the Wastewater Scheme is the Al Ansab Sewage Treatment Plant. This facility will initially serve a connected population of 160,000 and an ultimate population of 350,000 in the Muscat catchment

area. The Muscat Wastewater Master Plan recommended the construction of a major treatment facility at the site of the existing Al Ansab tankered wastewater STP.

The Al Ansab STP facility will treat wastewater mostly from the Bawshar Wilayat located in Muscat Municipality. The facility under construction is the first phase (53,000 m^3/d annual average treatment capacity) of an 84,000 m^3/d facility. Phase 1 of the STP is sized to treat flow generated through year 2014. Phase 2 is planned, and will have capacity to treat flows through year 2025.

The project includes a regional laboratory and central administration facility for the OWSC labor force.

MEMBRANE SELECTION

The decision to go to membrane bioreactors for this facility was driven by several key factors:

- Limited available site
- Higher quality treatment required
- Control of odors
- Reliability of treatment under a range of conditions

Treatment standards for full public access irrigation require the removal of BOD and suspended solids, total nitrogen removal, and virus control. The treated effluent standards set for this plant are 5:5:1:9 BOD_5, TSS, NH_3 and TN.

The selected process train was pre-aeration, screening, grit and grease removal, activated sludge biological nitrogen removal, membrane filtering and chlorine residual addition. Sludge is not fully stabilized on site but is dewatered and will be hauled to a centralized compost facility for final processing.

The membrane facility will be the largest flat plate membrane bioreactor facility by Kubota membranes, working through ACWA MBR of Dubai. The flat plate membrane was selected over hollow fiber membranes after extensive evaluation of their applicability for this facility. The membrane supplier was evaluated in an extensive prepurchase process. Evaluation criteria were compiled into seven categories:

- Complexity, Operability and Reliability
- Performance
- Cleaning Requirements
- Company Strength and Experience
- Technology, Process Design and Facilities Design
- Warranty
- Time for Completion

PLANT FACILITIES

The treatment plant is being constructed within a hill above the existing facility, and as such had to be constructed in two separate complexes: a preliminary treatment and solids handling complex, and a biological treatment and effluent pumping complex. Odor control is being constructed for the entire preliminary treatment/solids handling complex.

Preliminary Treatment Complex

Pre-aeration Pre-aeration is used to freshen septic sewage and to strip hydrogen sulfide from the wastewater. Pre-aeration is by coarse bubble aeration in two (2) plug flow tanks. These tanks will be covered for odor control.

Screening Screening is accomplished by three (3) rotary drum screens with 3 mm perforated plate openings. This high level of screening is required ahead of membrane filtration. All channels in this area will be covered and odor controlled.

Grit and Grease Removal Diffused aeration in three (3) plug flow tanks is used to float grease and settle grit. Grit is washed and dewatered in vortex classifiers. This area will be odor controlled.

Odor Control Two separate Odor Control units will be provided using 3-stage horizontal cross-flow Scrubbers. In the first stage, the air stream is washed with Sulfuric Acid for the removal of ammonia. In the second and third stages, the air stream is washed with Caustic Soda and Hydrogen Peroxide for the removal of Hydrogen Sulfide gas as well as other odorous compounds.

Biological Treatment Complex

Activated Sludge Process Biological treatment and nitrogen removal is by a mechanically mixed anoxic zone followed by an aerobic zone equipped with fine bubble aeration system. Centrifugal blowers in the biological complex deliver the aeration air. Four anoxic tanks and associated aeration tanks are under construction. Mixed liquor concentration is high, starting at 8,000 mg/L initially and ultimately to more than 15,000 mg/L. Due to high temperatures, the higher mixed liquor concentration comes at a price of lower oxygen transfer efficiency. Additional blowers are provided for the highest concentrations planned at the extreme high temperatures of summer in Oman.

Membrane Filtration Additional biological treatment, solids separation and bacteria removal is accomplished with membrane filtration in eight (8) membrane cassette tanks. Forward flow to these tanks is provided by pumps at the end of the aerobic zone. Flow is distributed from splitter structures by

pipe to 8 membrane cassette tanks, and return flow flows over broad-crested weirs at each tank. Recirculation flows are combined in a common channel, which returns mixed liquor back to the anoxic tank.

The membrane cassettes are Kubota EK400 units. Each cassette tank has 38 double stacked units. A total of 304 cassettes will be used in the first phase of plant development, with over 120,000 flat plate panels.

Permeation of effluent is by gravity through dedicated pipes for top and bottom cassettes, to a common wetwell. Each cassette tank can be isolated, and initial flows may not require that all cassettes be in service.

Permeate Pumping and Storage Effluent pumps transfer the treated water to Treated Effluent storage with a capacity of over 40,000 m^3 (Phase 1 will include only one TSE storage tank with capacity of 13,000 m^3). A TSE pumping station pumps effluent to the irrigation network which serves Muscat.

Chlorine Residual Addition Sodium hypochlorite solution is used to provide chlorine residual ahead of treated water storage and again in the effluent delivered to customers.

CONSTRUCTION

The project is currently under construction, and should be completed by the end of 2007. The collection network and rising mains are also expected to be completed by that time. In the interim operation, tankered wastewater will continue to be delivered to the old treatment plant. After pretreatment and equalization at the old plant, these flows will be pumped to the new plant for advanced treatment.

ACKNOWLEDGEMENTS

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