Abstract

Manila Water is the private company providing water and sewerage service for the East Zone of Metro Manila. This is being implemented through a 25-year Concession Agreement with the Metropolitan Waterworks and Sewerage System (MWSS). Before privatization, only 3% of the East Zone was covered with adequate sewerage service, prompting various sectors in government to require the acceleration of sewerage coverage expansion.

In response to this, Manila Water pursued solutions that were both effective and efficient, while carefully taking into consideration the customer's ability and willingness to pay. An essential part of these solutions was the targeted use of both separate sewer and combined sewer-drainage systems. This paper aims to discuss the challenges faced and solutions implemented by Manila Water to provide efficient sewerage service, with emphasis on the advantages of utilizing each type of sewer system. To further demonstrate this, also included in this paper is a comparison of two currently operating facilities that are employing these two different types of sewer systems, the East Avenue Sewage Treatment Plant and the Poblacion Sewage Treatment Plant.

Keywords
separate, combined, Manila Water Company, sewerage service, Metro Manila

Introduction

Provision of adequate water and wastewater service was greatly needed at the onset of Manila Water's concession in 1997. A vast majority of the East Zone at the time was experiencing low pressure and poor water quality, and only about 26% of the population had 24-hour access to potable water. Furthermore, massive waterline leaks and illegal connections contributed to a record-high 63% non-revenue water. In terms of sewerage service, there was only one sewage treatment facility providing a total treatment capacity of 40 million liters per day (MLD). In addition, thirty-four Communal Septic Tanks (CSTs) were located in Quezon City. However, these CSTs only provided primary treatment and were under-capacity, prompting urgent need of upgrade. These wastewater facilities served only a total of 40,000 households, or approximately 3% of the total East Zone concession. Moreover, only 1 vacuum tanker was in operation for the desludging of septic tanks and there was no available facility for septage treatment and disposal.

Households not covered by adequate sewerage service at that time relied on individual septic tanks (ISTs) to treat wastewater. Ideally, septic tanks should provide some level of wastewater treatment, however, only few ISTs were properly designed, constructed and maintained, causing untreated septic tank overflow to discharge directly to surface drainage systems and eventually into receiving bodies of water. On the other hand, households without individual septic tanks utilized toilet facilities that directly discharged untreated domestic wastewater to receiving bodies of water.

Such practice in the metropolis, combined with industrial and agricultural discharges, had grossly polluted Metro Manila's major water bodies, thus leading to their deterioration. In terms of total volume, the amount of BOD annually being discharged to the water bodies of Metro Manila has been estimated to be 330,000 tons per year, made up of 192,000 tons domestic and 138,000 tons industrial wastewater.[1] The three major river systems of Metro Manila, namely the

San Juan, Marikina and Pasig Rivers, were declared biologically dead, with reported BOD concentrations of 68, 18.2 and 10.7 mg/L, respectively.[2] The worsening conditions of the three-river system further strengthened the need for improved sewerage services in Metro Manila.

The deteriorating conditions at this time brought about the public-private partnership of the Metropolitan Waterworks and Sewerage System (MWSS), the government agency that provides water and sewerage services for Metro Manila, and Manila Water Company. Through this partnership, 99% of the Metro Manila's East Zone is now able to enjoy clean, potable water that is readily available 24 hours per day. Water pressure has significantly increased; leaks and illegal connections were arrested, consequently reducing non-revenue water to 11%.

On a smaller scale, sewerage services has also improved, with the increase in service area through the addition of new treatment facilities, expansion of sewer lines, and strengthened sanitation programs. However, much has yet to be done to achieve 100% sewerage coverage. In achieving this goal, Manila Water faces several key challenges and as such multiple but targeted solutions have consequently been pursued, among which was the implementation of both separate and combined systems.

Key Challenges

The desire of having immediate positive environmental impact on the polluted water bodies was emphasized by the call to action made by the Department of Environmental and Natural Resources (DENR) and the Office of the President in 2008. The mandate was to accelerate the expansion of sewerage services in Metro Manila. This was further highlighted by the Supreme Court ruling for concerned related government agencies to clean up the Manila Bay. However, it was quickly made apparent that immediate realization of this objective would only be possible through implementation of sewerage infrastructure in the shortest time possible.

Initially, the most logical technical solution was to put up centralized sewerage treatment systems, which was the original proposal in previous sewerage master plans of MWSS. However, it was determined that implementation of these plans would entail massive road excavations and total land area requirement of 47 hectares, all of which would necessitate very high capital costs. Since capital costs are directly recovered from customer tariffs, the realization of these plans had to carefully account for, and was subsequently limited by, the customer's ability to pay.

Apart from tariff implications, issues on land availability and fragmented infrastructure affected the actual physical implementation of sewerage projects. Land, specifically large open areas, which is supposed to be provided by Local Government Units as part of their mandate to clean the environment, is scarce and expensive in the metropolis. Even in the rare instance that these areas are available, informal settlers are frequently encountered and in most cases heavy competition for these properties is encountered via commercial and residential businesses. The fragmented infrastructure of the metro also plays a key role in such that sewer network projects are difficult to execute due to the impact to vehicular traffic and the prioritization of other utility services.[3]

Other challenges encountered in the provision of sewerage service include uncontrolled urban development, customer acceptance and most importantly stakeholder management; all of which affect the goal of providing sewerage service in the most immediate and cost efficient manner.[3]

Strategies

With the identified challenges taken into consideration, Manila Water utilized a strategy that was both technically feasible and affordable to customers, consequently expanding the sewerage and sanitation coverage in the East Zone at a faster pace. Major component of this strategy is the construction of sewage treatment plants employing both separate sewer and combined sewer-drainage when most appropriate and feasible.

For separate sewer systems, sewer lines are directly connected to houses and establishments to convey wastewater to treatment facilities. These networks are operated separately and independently from storm drains and are considered the highest level of wastewater treatment.

In initially pursuing this approach, Manila Water specifically targeted pre-existing CSTs and corresponding dedicated sewer networks. At the onset of privatization, these CSTs did not operate efficiently and were not meeting regulatory standards required for treated effluent. These facilities were oftentimes deteriorated, with access manholes covered and built over with housing infrastructure. Ownership issues also arose between informal settlers and other claimants of the land occupied by the CST. In addition to this, serious health risks were posed to the settlers informally residing on these structures. Consequently, maintenance of these CSTs via desludging was difficult to execute causing sludge and grit to accumulate and eventually rendering these CSTs inefficient and ineffective. With that said, these facilities did have unique advantages specifically for the implementation of separate sewer systems: available land and pre-existing sewer networks.

Hence, the evident strategy to be employed was to upgrade these CSTs into package STPs or, alternatively, lift stations that in turn, would convey wastewater to larger, more centralized sewage treatment plants. As mentioned previously, this strategy eliminated two of the main challenges facing sewerage expansion: first was the inconvenience of laying sewer pipe lines and second was the acquisition of land for the STP. Since there were already existing sewer lines, no excavation was done for areas already served by CSTs – this consequently required very minimal pipe-laying costs and had no impact to pedestrians and vehicular traffic. Also, the locations of the CSTs were simply used as the site for the package treatment plants and lift stations.

Figure 1: Communal Septic Tanks Upgrade to Package Treatment Plants

Consequently, sewerage coverage expansion was hastened with minimal capital cost. By the end of 2005, 28 STPs were already treating wastewater within established DENR effluent compliance standards. Treatment capacity increased to 80 MLD and sewer coverage expanded from 3% to 10%. Furthermore, these package STPs served as "showcase" facilities that demonstrated improvements could be made to health and the environment with minimal impact to surrounding customers, eventually assisting in addressing another main challenge: customer acceptance and stakeholder support.

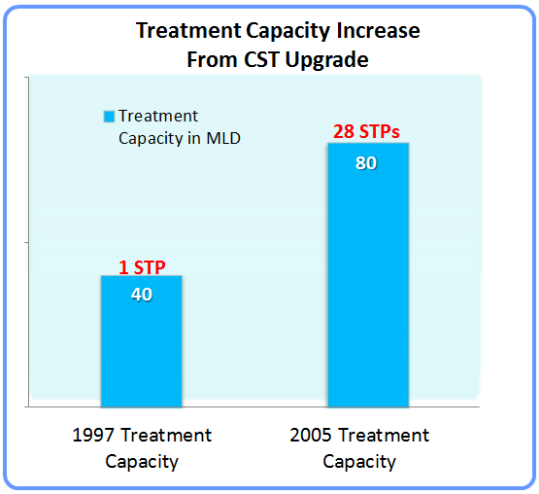

Figure 2: Treatment Capacity Increase from CST Upgrade

In attempting to further accelerate the expansion of sewerage coverage upon completion of these package STPs, it was quickly determined that unique solutions for the employment of separate sewer systems were not readily available. As such, an alternative method for the efficient provision of sewerage service had to be pursued. Manila Water then employed the strategy of combined sewer-drainage system implementation.

For combined sewer-drainage systems, existing drainage infrastructure is utilized to convey wastewater. The main advantage of this system is, again, that the construction of extensive sewer networks is no longer required. Since the individual septic tanks in Metro Manila are currently configured to overflow into existing drainage systems, the immediate means to protect the environment is to intercept these drainage systems before they discharge into receiving bodies of water. Though separate systems still remain the ideal systems for wastewater management, their requirement of massive infrastructure and high capital costs causes their implementation to be disadvantageous as an immediate solution. In effect, since combined systems require neither of the two, they provide a suitable interim solution that actually allows for greater and more rapid pollution reduction.

In the combined sewer-drainage system, a collector pipe or an interceptor pipe is constructed to collect wastewater from drainage for diversion and conveyance to an STP for treatment prior to discharge to the river. These systems are designed to collect dry weather flow and expel storm water flow, the primary consideration being to first collect the most polluted flow (dry weather), and second to allow existing drainage systems to operate properly during flood conditions (wet weather). The treatment of storm flows was not considered due to the sheer volume of rainfall in the country as well as its weak characteristic as a pollutant. Similarly, combined systems also utilize both gravity and force mains, as well as pump and lift stations.

Other advantages offered by combined systems are their effect on project duration and cost. Since extensive sewer networks are no longer an immediate requirement, the combined system approach allows a shorter duration for construction and a significant reduction in costs. Consequently, this approach offers a more practical and equally effective solution in hastening expansion of service coverage and addressing pollution of water bodies. Furthermore, combined systems can be easily integrated into future plans of laying separate sewer pipes; therefore, making no hindrance or obstacle to future plans of having separate sewer systems in Metro Manila. Combined systems can then be seen as an initial step to making separate sewer systems with the fundamental advantage of already treating wastewater earlier on. Essentially, the implementation of combined sewer-drainage systems has a greater net pollution reduction in the short-term than the implementation of separate sewer systems.

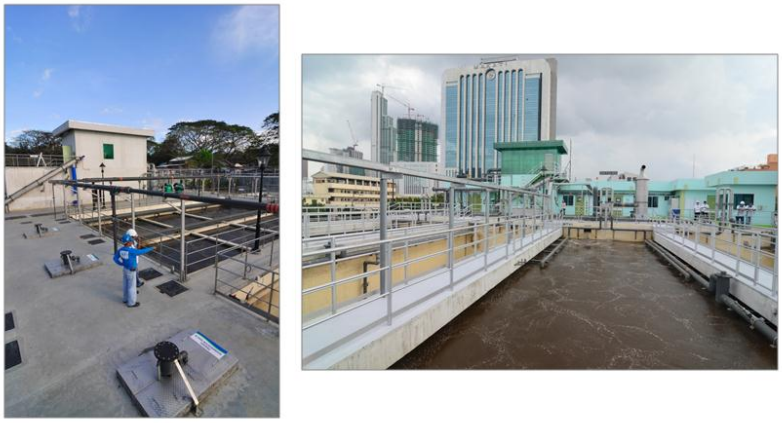

Figure 3: East Avenue STP and Poblacion STP

As of 2012, Manila Water has 3 operational facilities employing the combined sewer-drainage system. These facilities are Pineda, Olandes and Poblacion STP, the first combined system facilities in Metro Manila. All three facilities combined to have a treatment capacity of 25MLD, making the global treatment capacity of Manila Water to 135MLD.

Results and Discussion

Currently, Manila Water has 36 operating Sewage Treatment Facilities with a corresponding 23% sewerage coverage in the entire East Zone. Of these facilities, 2 are septage treatment plants, 3 are STPs with combined systems and 31 are STPs with separate systems.

One of the sewage treatment plants employing a separate system is East Avenue Sewage Treatment Plant. It is a regional treatment facility that has a capacity to treat 16.7MLD of wastewater. It is located in Quezon City and serves a total of 4 barangays. The area covered by East Avenue STP had existing sewer lines and CSTs. However, the condition of the sewer lines necessitated rehabilitation. The close proximity of these CSTs to one another was a factor considered in upgrade of these facilities to lift stations rather than package treatment plants. Wastewater collected from these lift stations is then conveyed to the regional facility for treatment.

The vastness of East Avenue's coverage area plays a crucial role in the construction and capital cost of the facility. The sewer line rehabilitation constitutes 50% of the total cost of East Avenue

STP's system, facility and network. The construction of the STP took almost 2 years while the sewer network rehabilitation required a much longer period of time. The East Avenue STP has been operational since 2010. For purposes of comparison, a metric of capital cost per kilogram BOD removed for one calendar year was considered – this effectively demonstrates how much funding is required per unit of pollution removed, normalizing variables such as influent concentration and total flow. It should be noted however, that this does not take into account the duration of system construction, which in turn is indicative of how immediately pollution is addressed. For East Avenue, the estimated capital cost per kg BOD removed is Php 2,600/kg BOD.

The Poblacion Sewage Treatment Plant was selected for comparison to the East Avenue Sewage Treatment Plant as this has a similar capacity but instead employs a combined sewer-drainage system. This is also a regional treatment facility, having a treatment capacity of 11MLD and serving a total of 3 barangays in Makati City. Due to land unavailability, the facility was built on top of an existing flood control pond raised on thirty five massive columns, making it the only facility in the East Zone to be built over an existing pond. This strategy provided an alternative in addressing challenges in land availability and essentially did not impact existing infrastructure in the highly congested area of Makati City.

It is worthwhile to note that the coverage area of Poblacion STP had no existing sewer lines and the collection of wastewater is solely through existing drainage channels, therefore making the combined system approach the more suitable solution. With that said, the network constructed for Poblacion STP was solely the interceptor pipes, consequently decreasing the total capital cost. For Poblacion, the estimated capital cost per kg BOD removed is Php 1,300/kg BOD. The parameters for the two STPs discussed are summarized below:

	East Avenue STP	**Poblacion STP**
Treatment Capacity	16.7 MLD	11 MLD
Collection System	Separate Sewer System	Combined Sewer-Drainage System
Php / kg BOD Removed	2,600	1,300
Construction Duration	2 years + duration of network construction	2 years

Table 1: Key Features of East Avenue STP and Poblacion STP

As demonstrated, separate systems, though effective, cost relatively twice as much and takes longer to construct as compared to combined sewer-drainage systems. Furthermore, had the two facilities started construction at exactly the same point in time, the combined sewer-drainage system would have removed a greater amount of pollution than the separate system due to its more rapid period of implementation.

Operations

In operating both separate systems and combined systems, different challenges are encountered for each. Since combined sewer-drainage systems capture both septic tank overflow and storm runoff, wastewater quality is more diluted compared to that of separate sewer lines. On the average, wastewater from separate systems is 25% more concentrated in terms of BOD loading. However, comparing changes in influent quality, wastewater from combined systems are more susceptible to fluctuations. This is caused by the sewage received

in combined systems from a vast network of drainage and interceptor lines. Consequently, it is also very hard to trace sources of such fluctuations in terms of organic loading, TSS, oil and grease, color and pH. Unlike for wastewater from separate systems, which have more consistent quality and point sources are easily identified through the existing sewer service connections.

In addition, combined systems frequently experience hydraulic shock loading due to the extensive network of canals and drainages. This sudden increase in flow usually brought about by storm water run-off, causes flooding and other damages. Meanwhile, separate sewer systems are less inclined to experience shock loading since storm runoff is no longer a factor.

Another comparable factor of both systems is the presence of solid waste, a key challenge in operating sewage treatment plants in the Philippines. Improper solid waste disposal of surrounding residents to creeks and drainages causes clogging of the screens and intakes of the lift stations. For combined systems, this prevents wastewater conveyance to the STP. For separate systems, solid wastes that greatly affect its conveyance are the ones disposed in the toilets. Though the volume of solid waste in sewer lines is relevantly smaller compared to solid waste intrusion in combined systems, it still poses risk of sewer line clogging and more frequent sewer maintenance.

Though operations of combined sewer-drainage systems are more difficult in terms of process risk and control, the operational costs for the two systems are relatively of the same magnitude from the treatment perspective. With that said, due to the more extensive network required for separate systems and consequent need for lift stations and maintenance, the overall operational cost of separate systems is slightly higher than that of combined sewer-drainage systems.

Summary

The efficient provision of sewerage service in a heavily urbanized and developing metropolis such as Metro Manila is extremely difficult. Manila Water has utilized two main approaches: separate sewer systems and combined systems. These two systems are each effective for a specific set of conditions, and have combined to help achieve 23% sewerage coverage as of 2012. Though there is great improvement in service, much is still needed to be done. Manila Water continues to thrive for the acceleration of sewerage coverage in the most cost efficient, immediate and comprehensive manner.

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