Setting-up a cost recovery system for the largest wastewater treatment plant in south-east Asia

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Abstract A tariff system has been set up for the largest wastewater treatment plant in South-East Asia, the Samut Prakarn Wastewater Treatment Plant south of Bangkok, which is currently under completion. Fully functional the plant will have a design capacity for 500,000 m³ per day and will service a combined residential and industrial area with approximately 600,000 residents and 2,300 factories. The tariff system, which includes a tariff model, is based on water consumption and BOD load. As background for setting the tariffs a comprehensive monitoring system including an industrial permitting system has been developed. The paper presents the background and rationale for setting up the system as well as the objective, scope and content of the tariff system and the industrial permit system. Further, the feasibility of introducing cost recovery systems, which is widely accepted in developing economies on the conceptual level and to some extent implemented at the legal and regulatory level, but has yet to be implemented at large, is discussed.

Keywords Large wastewater treatment plants; Thailand; developing economies; cost recovery systems; industrial permits

Introduction

In August 2000 the Ministry of Science, Technology and Environment in Thailand and the Danish International Development Assistance in co-operation, initiated the technical assistance project the Samut Prakarn Cost Recovery Project in Wastewater Management (abbreviated the SamPraCor Project) based on funding from Denmark. The main aim was to set up a cost recovery system for the Samut Prakarn Wastewater Management Project (SPWMP). It will provide wastewater collection and treatment services for around 2,300 industries and around 600,000 people based on the polluters-pay principle and a cost recovery context in a mixed industrial and residential area in the Samut Prakarn Province south of Bangkok (see Figure 1). The wastewater collection and treatment facilities were almost completed mid-2003 but the inauguration was postponed due to political investigations.

The SamPraCor Project (August 2000 to February 2003) provided technical assistance in relation to: (i) the institutional, legal and regulatory framework; ii) the setting up of a cost recovery system for the Samut Prakarn Wastewater Management Project; iii) the setting up of a routine monitoring system including industrial discharge requirements.

Three-level discharge requirement concept

Discharge requirements for wastewater discharged to a public sewer system are basically formulated by addressing the following four main concerns: (i) protect the workers; (ii) protect the sewerage system; (iii) protect the wastewater treatment plant; and (iii) protect the receiving waters. They can be developed over a wide range. However, simple discharge requirements may have too little flexibility whereas more detailed individual standards may be far too demanding in terms of the resources for monitoring.
and enforcement. On this background a system of discharge requirements has been developed according to a “three-level concept” (see Figure 2) based on the concept that the regulations should be as simple and non-stringent as possible. The major aspect of concern has been to address the above four purposes without risking to disincentive the industries to connect to the collection system.

The basic regulations set the basic standards for discharging wastewater to the sewer system. They are of a descriptive nature, and therefore not sufficiently operative to stand alone for the purpose of regulating industrial effluents. On the other hand the general formulations ensure that all discharge conditions are covered. The main aim is to avoid wastewater that could harm workers or harm the wastewater facilities. The basic regulations consequently state which substances that under no circumstances are allowed to

Figure 1 The location of the SPWMP

Figure 2 The 3-level discharge requirement concept
be discharged. They are independent of the locality, the type of industrial dischargers, the collection system and the treatment plant in question.

The aim of the local standards is to set effluent limit values for parameters that are traditionally of major concern in relation to industrial wastewater. They provide reference, both for the industries and the authorities, so it can be decided if the discharges comply with the requirements. The local standards are mainly related to the design and capacity of the treatment plant and as such the local standards primarily target heavy metals and toxic compounds. However the local standards proposed have been developed to be as simple and non-stringent as possible in order to reflect both the current situation of weak enforcement of existing standards, and the wish to give industries an incentive to connect to the collection system. For instance the proposed local standards includes limit values for compounds such as heavy metals and fat, oil and grease (FOG), but omit limit values for compounds such as BOD, COD and nitrogen. The rationale behind this is that the SPWMP is not designed to handle large concentrations of heavy metals and FOG, which are evidently present in high concentrations in the wastewater from certain industrial and commercial dischargers. On the other hand, the SPWMP is designed to remove BOD, COD and nitrogen, and the estimated load of these compounds is considerably less than the design capacity. At the same time it is important not to impose restrictions on industries which will push them towards a decision of not connecting to the sewer system. This could be the case for industries discharging wastewater with a concentration of BOD, COD or nitrogen above a certain discharge limit. Such industries would have to apply expensive pre-treatment, and might consider if it would be less costly to construct their own plant.

Industries discharging more than 300 m$^3$/d correspond to a little more than 100 industries. However, these industries are responsible for the discharge of 65% of the total flow and up to 90% of the load in terms of other major parameters such as BOD and heavy metals. The individual industrial permits should target these very large and/or problematic industries taking into account individual processes and problems of concern. They should be thoroughly negotiated with the industries and include general discharge conditions, procedures for evaluating compliance, monitoring and reporting requirements, and enforcement procedures. They should have a limited function period. The benefit of introducing an individual permit system for the largest industries would be two-fold. Firstly it would allow for the authorities to take a more flexible approach to the industries of major importance. This could result in either more lax or more stringent terms as compared to the local standards. In addition, and from a more pragmatic point of view, it would allow the responsible authority to focus its limited resources to a rather few but important dischargers. Secondly it could start a constructive dialog with the industries. This would be very important from the point of view of operating the collection and treatment system, since such a dialog would reduce the risk of unexpected changes in the quantity and characteristics of the received pollutants at the wastewater treatment plant. The “dialog approach” would also improve the possibilities of making reliable predictions of future flows and loads from industries, which should be the basis for making decisions on the time schedule for possible extension schemes for the SPWMP.

**Necessary regulatory framework and enforcement**

Basically there are no regulations in Thailand covering specific situations where industrial wastewater is discharged to a public centralised collection and treatment system such as the SPWMP. Consequently, a major prerequisite for introducing the proposed discharge requirements is the preparation and promulgation of the necessary regulatory framework.

A set of industrial effluent standards regulating the discharge of industrial wastewater...
does exist, but these standards basically address wastewater discharged “at the end of the pipe”. Hence an important potential conflict seems to exist between the existing industrial effluent standards and the proposed discharge requirements, since the latter would operate with less stringent standards for wastewater discharged to a public collection system than for wastewater discharged directly to the recipient. This aspect has also been addressed specifically by the SamPraCor Project, and has resulted in a proposal for a notification, to be issued by the central authorities, that clarifies that different rules apply for direct discharge and discharge to a public sewerage system.

Industries in Thailand, as in many other Asian countries, are traditionally rather “closed” towards the outside world. There seems to be a general conception that what goes on “inside the fence” of a private industry is a private matter. To a certain extent this also seems to be a reality when it comes to enforcement by the authorities. Together with the problem of limited resources within the authorities, this results in a sometimes rather sporadic enforcement effort. For a cost recovery system, as that of the SPWMP to be successful it is mandatory that a large fraction of the potential customers are connected. However a very important incentive to connect — or to invest in an expensive own treatment plant at the industry — is that the risk of getting “caught” if failing to comply with the standards is considerable. Therefore, not only the regulatory framework, but also the capacity, and the enforcement tools, of the authorities to conduct effective and efficient enforcement is mandatory for a fully successful cost recovery system.

The tariff system

Over the past 15 years, the government of Thailand has invested about $1.5 billion in the construction of urban wastewater management systems throughout the country. However, the introduction of cost recovery systems for the sector has not kept pace with the very rapid development of new facilities.

Although there are presently about 70 wastewater treatment plants in the country, only two relatively small systems serving high income tourist areas presently apply tariffs. As a result, although the public is keenly aware of the impacts of untreated wastewater in urban areas, awareness of the need for cost recovery in the sector is much less developed. Also, within those government agencies responsible for wastewater management, expertise in the development of tariff systems is still limited. Where proposals for tariff systems have been developed, the primary criteria has often been perceived as political or public acceptability rather than in reference to any specific cost recovery targets.

Within this context, it was very important to begin the tariff design process for SPWMP within the SamPraCor Project by first clearly establishing a set of objectives that the tariffs would be intended to achieve.

These objectives were reviewed with representatives of the key stakeholder groups before being confirmed. Based on these agreed objectives, a transparent methodology for determining the tariffs was then developed and applied.

Objectives

Four key objectives were established as the basis for developing the tariff system for the SPWMP:

- Financial sustainability: Tariffs need to provide for the financial sustainability of the SPWMP. Financial sustainability is defined as the ability of the responsible operating entity to recover the costs of providing services to its customers and, therefore, to ensure the longer-term sustainability of its operations. Furthermore, the tariffs also need to be consistent with any applicable legal requirements or policy objectives regarding cost recovery.
• **Economic efficiency:** Tariffs are to be based on the polluter-pays-principle. This means that tariffs should reflect the costs of the pollution discharged by each customer. To achieve this objective, tariffs are to be set both on the basis of the volume of wastewater discharged by each customer as well as the specific biochemical oxygen demand (BOD) loading of this wastewater. However, to keep the tariff structure relatively simple and the cost of billing and collections low, BOD charges are based on the average BOD concentration for each customer group, with the exception of large industries. Large industrial customers should be billed on the basis of actual BOD discharged.

• **Social equity:** Tariffs are to be consistent with the ability and willingness of customers to pay. Based on internationally accepted criteria, the cost of wastewater management is considered to be affordable if the total combined cost of these services does not exceed 2.5% of household income. To ensure that the tariffs are consistent with willingness to pay, a system of cross-subsidies can be employed between the customer groups.

• **Administrative:** Three key administrative objectives are set out for the SPWMP tariffs. First, in order to maintain tariffs at the lowest levels possible, the tariff structure and associated systems for billings and collections should be low cost. This means keeping the system simple and, therefore, inexpensive to operate and maintain. It also means designing the system so that it is as compatible as possible with the existing tariff and billing system for water supply so that billing and collection could be combined. However, at the same time, the system should also be capable of achieving high rates of collection. Lastly, customers should easily understand the tariff structure, as well as the means by which tariffs are billed and collected. Again, this means keep the system simple and transparent.

Another important factor during the design process was that the organisation to be responsible for the management and operation of SPWMP, including the tariff system, had not yet been confirmed. Since there were no central wastewater management facilities in Samut Prakarn prior to the construction of SPWMP, no existing organisation within the province possessed any experience in the management and operation of such facilities.

Two main options were under consideration by the government. Under the first option, responsibility would be assigned to the existing provincial administrative organisation, while under the second option; a new government organisation would be established to be specifically responsible for SPWMP. However, whichever option was ultimately confirmed, an entirely new management and operating capacity would need to be established. This further reinforced the need to keep the tariff system simple, both to set up and to operate, so that the organisation taking over the system could realistically be expected to successfully do so.

**Methodology**

Based on the objectives set out above, a three-step tariff methodology was developed (see Figure 3):

• **Step 1 – Estimate cost of service:** Estimate the total cost of providing wastewater services that is to be recovered from the wastewater tariff. The cost of service is calculated specifically for each year over the 2002–2015 forecast-period using a computer model developed specifically for the SPWMP. The cost of service consists of three components: (i) operating and maintenance expense; (ii) depreciation expense; and, (iii) bad debts.
Step 2 – Allocate cost of service to collection and treatment: Once the annual cost of service has been determined (Step 1), the second step is to separate this total cost into three components: (i) wastewater collection costs; (ii) wastewater treatment costs; and, (iii) billing and collection costs.

Step 3 – Set tariff for each customer group: Use the allocated cost of service data to set tariffs for each customer group. Normally, the tariff should be set equal to the sum of the three cost of service components developed under Step 2. However, due to concerns regarding different levels of willingness to pay, the cost of service for each customer group is multiplied by an adjustment factor to derive the tariff. This adjustment factor is used to reduce or increase the tariff in accordance with perceived willingness to pay.

Tariff structure
The tariff structure developed incorporates three customer groups, residential, commercial and industrial, which are the same as those employed by the Metropolitan Waterworks Authority (MWA) of Bangkok for the billing and collection of water tariffs. Also, to achieve consistency with the existing MWA system, the wastewater tariff for all three customer groups were expressed on the basis of metered water consumption. MWA has a well established and very effective billing system that achieves collection rates in excess of 96%. Although no agreement with MWA for combined billing and collection had yet been secured, the tariff structure was designed so as enable such an arrangement. Combined billing and collection would not only be much less costly than establishing an entirely new separate system for wastewater, but it would also be capable of achieving higher rates of collection. This would allow wastewater tariffs to be set at lower levels than that required for a separate billing and collection system.
The recommended tariff structure:

- **Residential**: A single residential wastewater tariff would be applied to all customers in the residential customer group. The residential tariff is calculated on the basis of the estimated average BOD concentration for the group. Since there is little variation within this group in terms of BOD, this would provide an appropriate, yet simple approach to cost recovery.

- **Commercial**: Initially, the same approach used in setting the residential tariff would also be applied to the commercial group. A single commercial wastewater tariff would be applied to all commercial customers calculated on the basis of the average BOD concentration for the group. However, since there is considerable variation within this group, this approach is less applicable. However, with 20,000 customers in the commercial group, the logistics of applying tariffs on the basis of the customer-specific BODs would be prohibitively complicated, at least over the shorter term. Instead, it would be preferable to initially keep the tariff structure as simple as possible. However, once this system was up and running successfully, introducing limited variations in the commercial tariff structure could be gradually phased-in. For example, different tariffs could later be applied to larger commercial customers discharging higher BOD wastewater, such as public markets, massage parlors, and large restaurants.

- **Industrial**: The industrial group would be split into two subgroups. The first would consist of those customers generating the largest wastewater flow. This includes approximately 100 large factories that together account for most of the total flow generated by the industrial group. For this subgroup, the tariff would be set on the basis of the actual measured BOD concentration for each customer. The second subgroup would include all other industrial customers. Customers would have the option of paying on the basis of this average BOD concentration or they could apply to have their actual measured BOD concentration used as the basis for the tariff. Customers seeking to apply this second option would have to commission a monitoring program to establish actual BOD concentration.

**Tariff levels**

Based on the tariff structure described above, tariff levels were determined under a range of scenarios including the following two main options:

- **Scenario 1—Meet Asian Development Bank (ADB) financial covenants**: Tariffs are set to achieve in full the cost recovery covenant incorporated into the loan agreement with the ADB, which extended two loans to the government of Thailand to finance a portion of the cost of the SPWMP. The primary covenant relating to tariffs requires that they be sufficient to recover all operating and maintenance costs plus 50% of annual depreciation expense by 2005, 75% of depreciation expense by 2007, and 100% of depreciation expense by 2009.

- **Scenario 2—Cover cash operating and maintenance and capital replacement**: Tariffs are set to fully recover cash operating and maintenance expenses plus a provision to allow for routine capital replacement.

The cost recovery covenant underlying Scenario 1 was developed prior to ADB’s approval of its first loan for the SPWMP in 1995. This covenant was intended to ensure that tariffs would be sufficient to recover all operation and maintenance costs, routine capital replacement, as well as to fund a large portion of the costs of planned second and third phase expansions. However, as a result of subsequent economic developments in Thailand, plans for these expansions were suspended. This meant that the tariff requirements could be significantly reduced from those originally estimated to be necessary and incorporated into the covenant. Scenario 2 was then developed to reflect these lower tariff...
requirements. The estimated tariff levels required under both scenarios are shown in Table 1 for the 2002–2012 period. The tariffs are expressed on terms of Baht per m³ of metered water supply together with the US dollar equivalent of these amounts.

Under both scenarios, the tariffs are well within the range considered to be affordable for residential customers, even for low-income households. Under Scenario 1, the monthly wastewater bill would represent only 0.8% of household income for the low-income group, less than one-third the upper limit of affordability. Under Scenario 2, only 0.3% of monthly income for the low-income household would be required to pay the wastewater bill. Households earning the average income in Samut Prakarn would need to allocate only 0.6% of their monthly income to pay the wastewater bill under Scenario 1 and 0.2% under Scenario 2.

Virtually all industrial customers would find the tariffs, even under those under Scenario 1, to be much less expensive than treating their own wastewater. This conclusion was based on the results of a detailed analysis comparing the tariffs to the cost of onsite treatment. The cost savings are greater for factories discharging lower volumes of higher strength wastewater.

The importance of affordability and willingness-to-pay

Based on the extensive experience of the SamPraCor Team within cost recovery, and lessons learned from other cost recovery projects, paramount importance was put on affordability analysis and willingness-to-pay surveys. A general survey from Bangkok was available at the start of the SamPraCor Project, which revealed that people were willing to pay for wastewater services provided that they could obtain assurances that the money paid was channelled only to that purpose. At the latter part of the SamPraCor Project from December 2002 to February 2003, where the SPWMP was in its last construction and completion phase, a comprehensive marketing survey was conducted which revealed a significant information level amongst both people at large, commercial enterprises and industries about the SPWMP, and a basic willingness to participate economically. Based on this a targeted marked strategy was developed, detailed scheduled, scoped and cost estimated. This marked strategy included a logo for the SPWMP, events and bill boards in order to inform about and involve the stakeholders in the SPWMP. Consequently a lot of focus in the SamPraCor Project has been put on raising awareness and on this background increase the willingness-to-pay, amongst people at large as well as the industrial and commercial sector in terms of connecting to the system.

Table 1 Average tariff requirements (current prices)

<table>
<thead>
<tr>
<th>Customer group</th>
<th>Projected tariffs – Baht/m³ ($/m³ equivalent)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scenario 1: Meet ADB financial covenants</strong></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>5.95 (0.15)</td>
</tr>
<tr>
<td>Commercial</td>
<td>7.65 (0.19)</td>
</tr>
<tr>
<td>Industrial</td>
<td>13.60 (0.34)</td>
</tr>
<tr>
<td>Overall average</td>
<td>11.63 (0.29)</td>
</tr>
<tr>
<td><strong>Scenario 2: Cover cash operating and maintenance and capital replacement</strong></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>2.55 (0.06)</td>
</tr>
<tr>
<td>Commercial</td>
<td>5.95 (0.15)</td>
</tr>
<tr>
<td>Industrial¹</td>
<td>11.90 (0.30)</td>
</tr>
<tr>
<td>Overall average</td>
<td>8.86 (0.22)</td>
</tr>
</tbody>
</table>

¹Tariff for customer with a BOD discharge of 740 mg/l, the estimated overall average for the industrial group
Likewise the affordability aspect has been a major focus for project activities during the whole project period based on the following four cornerstones:

- **Detailed cost estimation** of the fully functioning plant including recurrent costs in connection with the daily operations as well as investment costs in connection with repair and renewal of equipment and facilities.

- **Computerised tariff model** incorporating the detailed cost estimation as well as the prospective users. The tariff model, which was developed with a user friendly interface, would allow economists and engineers as well as decision makers to easily run different tariff scenarios, and take decisions based on the calculated results.

- Based on this propose a comprehensive **tariff system** based on identified political and strategic assumptions and choices.

- **Intensive training** in the use and understanding of the tariff system and the tariff model, including specialist-level training as well as executive level training, with the aim of anchoring the tariff concept and the tool in the Thai organisational environment. In order to ensure maximum transfer of know how all the training was conducted by a Thai professor in economics with expertise within cost recovery.

In connection with the executive-level training, and as part of the marked strategy, pedagogical examples was set up which showed the very low level of burden of the wastewater tariffs for different income groups in relation to “accepted costs” such as cigarettes, liquor and the lottery.

**Feasibility and sustainability of cost recovery systems**

Despite the high awareness in the SamPraCor Project right from the start about the importance of the issues outlined above, and how to transfer the know how, and intensive training and capacity building activities covering specialist level as well as executive level management, the sustainability of the approach including the use of the developed **tariff system** and the **tariff model** is questionable. A major explanation for this is that the SPWMP as such has been under heavy political scrutiny since 2002, and as far as the authors of this paper are informed, the treatment plant has yet to be put into operation. However, it is assessed that it would be questionable, even in a “smooth” political environment, if the concept of the tariff system and the tariff model could survive for long. There are a number of reasons for this which we think are general for developing economies, and which we think will take some time to address:

- **Awareness and social context.** People at large and the industrial sectors needs to be informed comprehensively, and in a long-term comprehensive and extensive process, of the drawbacks of inadequate wastewater management (economic as well as health), the benefits of proper management, the concept of polluter-pays-principle, which is widely acknowledged at the principal political level and embedded in the laws, and the concept of cost recovery including the setting of tariffs. In this connection it is important to address the widely spread notion that wastewater “disappears” and consequently is no problem, and if it is a problem then it must be the government, not the individual person or industry, which will have to solve this problem. Focus should be on the services provided in treating the dirty water of peoples and the industries.

- **Political context.** As indicated above the polluter-pays-principle, and also the setting up of cost recovery system, is to a certain extent embedded in the political, legal and strategy environment. However the concept of the clear cut connection between the long-term financing of the yearly running costs and the investment costs, and the setting of the tariff level needs to be addressed thoroughly in relation to politicians as well as the top executive level. There is a wide tendency to consider the setting of tariffs as a pure political issue with no or little connection to the concept of full cost recovery.
recovery and the polluter-pays-principle. The consequence of this is either non-functioning or poorly functioning treatment plants, which is frequently seen in developing economies all over the world, or subsidising from the state or federal budget, which is not in line with either the polluter-pays-principle or the concept of cost recovery.

- **Institutional capacity.** Part of the above can be explained by inadequate institutional capacity for managing all aspects of a modern wastewater treatment plant including long-term investment plans and tariff setting. However, the first step is to set up transparent, independent and accountable management organisations, which are audited based on international auditing standards. In the mind of the present authors a root to the problem lies in that the organisational structure normally is intertwined with state, regional or federal government organisations, and is consequently liable to not be independent and not transparent. This problem has to be addressed before the problem about inadequate institutional capacity should be addressed.

As can be seen from above the underlying issue is a need for changing the political concept towards the concept of “good governance” and the “civic society”. Before this has been done there is little chance for comprehensive and in-depth application and implementation of full cost recovery for wastewater management in many developing economies in the world. In this connection it is futile to even think about trying to directly transfer modern wastewater management principles and methodologies. What is needed is adapting and applying the concept of good governance and the civic society and in this connection rethinking the institutional framework for setting up professional, transparent and accountable organisations in charge of operations as well as tariff setting and billing and fee collection. When this is in place then developing economies could more comprehensively benefit from technology transfer in terms of technical professionalism as well as economic and institutional professionalism within wastewater management. A special issue, which also needs to be addressed, but which is outside the scope of this paper, is the high political involvement in large construction projects, which in a number of cases invalidates projects. In this connection there is a need to investigate legal, policy and strategic venues for depoliticising major construction projects in developing economies.

**References**

27 Technical Background Reports have been produced as part of the SamPraCor Project covering pure technical issues as setting up a comprehensive routine wastewater monitoring system, institutional issues in relation to assessing the merits and drawbacks of different organisational models, and economic issues in relation to costing and financing the treatment facilities. All reports are with a Thai summary. In addition to this a small booklet of 80 pages has been produced which in layman’s language describes the project and its results. This booklet is available in English as well as in a Thai version. The booklet and the Technical Background Reports are available on request from Pollution Control Department within Ministry of Natural Resources and Environment in Bangkok.