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Strategic Sewage Disposal Scheme
Environmental Impact Assessment Study

Briefing Document on Option Evaluation and Comparison
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Comments by

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on

Technical Issues of Centralized Treatment of Sewage and Deep Sewer Tunnels

Honorable LegCo Panel Members, Ladies and Gentlemen:
In the last EA Panel meeting on 5 October 1998 Prof. Joseph Lee from our Department of Civil Engineering at The University of Hong Kong presented his view on some aspects of the SSDS EIA Study. During the ensuing discussion some technical aspects of the study were questioned, such as the selection of centralized treatment over decentralized treatment, lack of consideration of alternative innovative treatment methods, and technical feasibility of deep sewer tunnels. We would like to offer our views on these important issues. These views are based on a careful analysis of the briefing document as well as on our more than 50 years combined local and international experience in academic research, project management and consulting in environmental and geotechnical engineering.

1. Centralized treatment versus decentralized treatment

There is no universally applicable methodology available which can provide a definite solution to the problem of selecting centralized or decentralized sewage treatment. Important factors influencing this decision are: historical development of existing sewerage and treatment systems; topography, size and location of natural catchment areas for gravity collection of sewage; size requirements of plant and ultimate plant capacity; land availability and compatibility with surrounding land use including buffer zone requirements; total capital and recurrent cost; location and assimilative capacity of receiving waters; potential future requirements for expansion, upgrading or additional treatment; environmental impact of plant (odour, noise, visual impact, etc.).

Commonly accepted advantages of properly selected centralized over decentralized treatment systems are: economy of scale resulting in lower overall design capacity because of lower peak load factors, lower construction and operation cost as well as lower total land requirement; lower manpower requirements and lower degree of equipment redundancy; more efficient control of treatinent processes and higher operational flexibility; central sludge handling and processing; and lower overall environmental impact.

Two or more decentralized plants may cause a higher overall environmental impact on site and through their discharges to receiving waters of various qualities than one centralized plant with one discharge to only one carefully selected site.
If a centralized plant and its discharge system plus the connecting deep underground sewer cost less than the decentralized plants and their discharge systems, centralization generally is the preferred option.

In the case of Hong Kong, decentralized treatment is already a fact as shown by the existence of the major sewage treatment works in Sha Tin, Tai Po, Shek Wu Hui, Yuen Long, Sai Kung and Stanley which correspond to different natural sewage catchment areas of between 10 to 60 km^2 size. The sewage catchment area corresponding to SSDS amounts to about 130 km^2, a somewhat larger, but nevertheless homogenous area consisting of many small individual drainage areas with little flat space available for locating sewage treatment works. Similarly sized catchment areas are reported in cities of comparable population, e.g. Seoul, Sydney, Taipei, Tokyo, etc. Save exceptional cases, catchment areas are generally limited by a conveying sewer length of about 25 km. Due to the much higher population density of 30,000 to 50,000 people per km^2 in Hong Kong catchment areas versus about 20,000 people per km^2 in, say, Tokyo, naturally the corresponding sewage flow per unit catchment area is also higher resulting in treatment works of a larger capacity. Hence the large treatment capacity of Stonecutters Island STW is based on the peculiar urban characteristics of Hong Kong and not due to excessive centralization. Regarding the extent of centralization, Hong Kong's SSDS assumes a wastewater treatment capacity of around 2,090,000 m^3/d for the year 2021, treating about 60% of Hong Kong's wastewater. In contrast, Hong Kong's largest drinking water treatment works in Sha Tin has a capacity of 1,230,000 m^3/d and treats about 50% of Hong Kong's current drinking water supply, exhibiting a similar degree of centralization to which no objections have been raised so far.

To put things in perspective, perhaps it might be helpful to cite a few cases from large cities abroad faced with similar issues of centralization versus decentralization. In all cases, decisions were taken only after completion and evaluation of very detailed studies. The **Boston Harbour** clean-up plan recommended as best solution a single centralized plant with secondary treatment (1,630,000 m^3/d, 55 hectares land requirement for secondary treatment and sludge processing) and a single outfall; as a consequence, a second plant was closed and its sewage conveyed by deep underground tunnel to the centralized plant. In **Singapore**, two centralized treatment works will replace six existing works; two deep underground tunnels of 50 km and 30 km length each will convey sewage to central plants; and 290 ha of valuable land will be freed for residential and other uses. The city of **Zurich** in Switzerland decided to replace extension of the second, smaller sewage treatment plant in favour of constructing a 7 km long sewer tunnel to the first, larger treatment plant despite much higher investment cost, but due to considerable savings on operation cost.

The Hong Kong SSDS scheme with centralized sewage treatment follows accepted international trends whereby large cities increasingly use large, centralized treatment plants and deep underground sewers, often replacing existing decentralized systems.

It is often claimed, fallaciously, that large sewage treatment plants such as centralized plants pose higher operational, safety and environmental risks than smaller, decentralized ones.

In fact, the overall risk of failure of one large plant with its more efficient process control and operational flexibility is smaller than the combined risk of a series of small plants of comparable total cost. A small municipality would not build two sewage treatment plants instead of one to lower the risk of failure. Similarly, a large city does not build two airports or two sewage treatment plants for the sake of lowering the risk of failure.

A large, centralized sewage treatment plant is not inherently more at risk of failure than a series of relatively smaller, but still large-scale, sewage treatment plants of the order of Sha Tin sewage treatment works.

2. Land requirements

Even the most compact or multi-storied space-saving treatment plants which use generally accepted state-of-the-art treatment methods, still require large areas of land as demonstrated by modern treatment plants in densely populated urban areas of Japan. The most compact secondary treatment plants without biological nutrient removal occupy about 20 hectares of land per 1,000,000 m^3/d capacity. Similar area requirements are found in Europe where severe space limitations forced the construction of hypermodern, multi-storied compact treatment plants in city centres near tourist beaches along mountainous shores of the Mediterrancan Sea. Reduction in area requirement, however, results in significantly higher construction and operation cost, increased operational complexity, lack of flexibility, and potential problems in adapting to new requirements in the future.

Assuming a required SSDS treatment capacity of approximately 2,000,000 m^3/d for the year 2020, a centralized treatment facility according to the conventional Sha Tin sewage treatment works design would need 160 hectares of land and a buffer area of about 120 hectares (200 m buffer distance to residential areas). In contrast, a centralized treatment facility using a most compact, multi-storied design would require only one fourth of that area, but this would still amount to 40 hectares plant area plus 68 ha buffer zone, roughly eight times the area of Happy Valley Racecourse. Opting for a decentralized system with five equally sized compact, multi-storied treatment plants in urban areas instead, the total area requirements would amount to about 50 hectares for the plants plus 200 hectares of buffer area, altogether 250 hectares, roughly the size of the old Kai Tak Airport. Even the most experienced engineers and city planners would face insurmountable problems in finding five suitable sites of 50 hectares per plant along the shorelines of Victoria Harbour. For the same reason, the 273 hectares of new strategic landfills were also not sited along Victoria Harbour where most of the waste arises, but at more distant locations.

It is doubtful whether more creative and expensive designs such as building sports stadiums, parking garages or public parks on top of the treatment plants would greatly alleviate the siting problem. Completely enclosed plants with most stringent emission controls might eliminate buffer areas, but at an enormous additional cost. And yet, each such plant of 10 hectares would still require more land than the new wing of the Hong Kong Convention and Exhibition Centre. Additional problems of environmental and visual impact, odour control, sludge management, adequate effluent discharge, and their potential effect on adjacent residents or businesses could be touched upon, but will not be discussed here in more detail.

The SSDS scheme incorporating a centralized system requires much less total land area for sewage treatment plants than a decentralized system. Large-scale space-saving sewage treatment plants, such as enclosed compact plants or multi-storied plants, have been built only in a very limited number under most exceptional circumstances, but they still require large areas and incur significantly higher capital and recurrent costs.

3. Application of alternative, innovative treatment methods

It has been suggested that alternative, innovative treatment methods are available which would greatly reduce land requirements and costs by providing high-rate biological treatment. Methods mentioned are deep shaft technology, sequencing batch reactors, etc.

We have carried out a survey of large sewage treatment plants and found not a single application of these aforementioned methods at a scale applicable to large municipalities like Hong Kong. Hong Kong should not become the international guinea pig testing unproven treatment methods at a cost of billions of dollars to the taxpayer, and involving unacceptably high risks of failure. Demanding application of unproven treatment technology while at the same time demanding low risk treatment plants is contradictory in itself and irresponsible.

For projects of the scale of SSDS, even with decentralized treatment plants, only treatment technologies proven elsewhere should be applied. Application of so-called alternative, innovative treatment methods would need extensive additional pilotscale and large-scale tests resulting in further delays of implementing SSDS.

4. Technical feasibility of constructing deep sewer tunnels

The wisdom of building deep sewer tunnels has been questioned. It has been claimed that the geological conditions of Hong Kong pose an unacceptably high risk for the construction of deep sewer tunnels below the sea because of unpredictable and uncontrollable water intrusion problems.

It is a well known fact that longer and larger tunnels have been built under the sea under geological conditions much worse than those encountered in Hong Kong, be they tunnels for cars, trains, water or sewage. Examples are the 90 km long railroad tunnel connecting the Japanese islands of Honshu and Hokkaido, the 20 km long Northside Sewage Storage Tunnel 104 m below the suburbs and harbour of Sydney, the 15 km long Boston outfall tunnel for treated sewage 122 m below the sea, and numerous cooling water intake and discharge tunnels for electricity generating stations along seashores around the world. With the current state-of-the-art of site investigation, rock excavation and groundwater control methods, it is technically feasible to complete tunnel projects such as those planned for the SSDS.

Using current state-of-the-art technology, the construction of deep sewer tunnels below the sea is technically feasible under the geological conditions of Hong Kong and should not present a serious engineering problem.

SUMMARY:

> **Is a centralized sewage treatment with deep underground sewers too large, too risky, too costly, too difficult to build?**
>
> **All answers to these questions are in the negative.**