In-Building Sewer Mining System

HONG KONG PRODUCTIVITY COUNCIL
TechDive Apr2020

Environmental Technology
Water Management and Urbanisation

What is the Problem?

Due to urbanisation and population growth:

- Increasing demand of water resources
- Great demand of uninterrupted supply of good quality water
- Higher per capita consumption of water compared to rural areas

Tokyo: 38 million people
Shanghai: 22 million people
New York: 8.4 million people
Hong Kong: 7.4 million people
Hong Kong at a Glance

- Expected annual housing supply: ~43,000 unit
- HK’s annual water consumption: 1,012 million m³
- HK’s annual sewage discharge: 1,007 million m³
- Water consumption & sewage discharge: ~1-2% every year
- Pressure on sewerage infrastructure
Sewer Mining in Urban Cities

Sydney Olympic Park
- A large scale sewer mining unit has been installed for using recycled water for toilet flushing, irrigation and ornamental fountain.
- Under the entire Water Reclamation and Management Scheme (WRAMS).
- Substitutes more than 50% of potable water.

Athens’s Demonstration Plant

Harvesting Wastewater from Sewers

**Challenge:** Ongoing drought challenged availability of water for golf course

**Solution:** Sewer mining water reuse plant provides irrigation water.

Pennant Hills Golf Club - Australia’s first commercial sewer mining water reuse plant.
- Conserves 25 million gallons of Australia’s fresh water a year.
- Advanced MBR produces 172,000 gallons of high quality water per day which is used to irrigate 55 acres.
- “We are proud to be the first to embrace this innovative approach. It is bringing as a drought-proof supply of water that minimizes impact on Australia’s fresh water reserves.” — Steve Walker, president, Pennant Hills Golf Club.

Technology: ZeeWeed MBR with UV Disinfection.

Sewer Mining / Agricultural Reuse.
In-Building Sewer Mining System

A novel concept extracts clean water from domestic sewage or greywater generated from multi-storey residential buildings for on-site reuse.
Concept of Sewer Mining

**Approach 1**

- Decentralised Sewer Mining
- Greywater
  - From shower, laundry, washing basin, kitchen and bath
- Blackwater
  - Toilet
- Residual wastes
- Main Sewer

**Approach 2**

- Decentralised Sewer Mining
- Greywater
  - From shower, laundry, washing basin, kitchen and bath
- Blackwater
  - Toilet
- Residual wastes
- Combined Sewage
- Main Sewer
Potential Applications of Reclaimed Water

- Toilet Flushing
- Irrigation (excluding irrigation sprinklers)
- Fire Water Tank
- General Washing (excluding high pressure jet washing and general washing at markets and food establishments)
- Water Feature
- Makeup Water for Cooling Tower
Our Sewer Mining Technology

Greywater or Combined sewage

Attached growth bioreactor & Membrane Filtration

Reclaimed water applications
## Reclaimed Water Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Typical Grey water</th>
<th>Reclaimed water</th>
<th>Recommended water quality standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6 – 9</td>
<td>6.4 – 8.2</td>
<td>6 – 9</td>
</tr>
<tr>
<td>Colour (Hazen unit)</td>
<td>--</td>
<td>&lt;5</td>
<td>≤20</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>30 – 400</td>
<td>&lt;0.3</td>
<td>≤5</td>
</tr>
<tr>
<td>Biochemical oxygen demand ( \text{BOD}_5 )/mg/L</td>
<td>50 – 500</td>
<td>&lt;8</td>
<td>≤10</td>
</tr>
<tr>
<td>Chemical oxygen demand (mg/L)</td>
<td>100 – 700</td>
<td>&lt;29</td>
<td>--</td>
</tr>
<tr>
<td>Ammonia nitrogen (mg/L)</td>
<td>2 – 15</td>
<td>&lt;0.2</td>
<td>≤1</td>
</tr>
<tr>
<td>Total Suspended solids (mg/L)</td>
<td>30 – 200</td>
<td>&lt;5</td>
<td>≤5</td>
</tr>
<tr>
<td>E. Coli (cfu/100 mL)</td>
<td>(10^4) - (10^8)</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Total residual chlorine (mg/L)</td>
<td>--</td>
<td>System outlet 1.0 – 1.8</td>
<td>≥1 existing treatment system; ≥0.2 at user end</td>
</tr>
</tbody>
</table>

Our Solution

Compact, Unmanned in-building system

➤ Reclamation of sewage or greywater while disposing by-products back to sewer networks

➤ Small footprint system at the basement of multi-storey building to directly purify sewage and segregated greywater from building
Merits of Sewer Mining System

**Merits**

- Very compact and flexible
- Fully automatic system with unmanned operation
- Superior reclaimed water quality meeting the most stringent reuse water quality standards
- Low treatment cost resulting in saving of >HK$4 per m³ recycled water
Cost Saving of Sewer Mining System

- For 50 m³/d capacity system

<table>
<thead>
<tr>
<th>Cost Saving from In-Building Sewer Mining in Hong Kong</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Treatment Cost</td>
<td>$2.2/m³ (~US$0.28/m³)</td>
</tr>
<tr>
<td>• From electricity supply, chemical consumption,</td>
<td></td>
</tr>
<tr>
<td>membrane replacement &amp; media replacement</td>
<td></td>
</tr>
<tr>
<td>Annual saving of fresh water for irrigation</td>
<td>12,045 m³ (100% saving)</td>
</tr>
<tr>
<td>Annual saving from water tariff and sewage tariff</td>
<td>$58,780 (~US$7,536)</td>
</tr>
</tbody>
</table>
In-Building Sewer Mining

Fresh water supply: 660m³/d → 386m³/d

Reclaimed water for toilet flushing: 264m³/d

Reclaimed water for irrigation: 10m³/d

Greywater
From shower, laundry, washing basin, kitchen and bath
274m³/d

Black Water

274m³/d

From shower, laundry, washing basin, kitchen and bath

Residual wastes

Underground tank ~270m³

Plant Room Area ~50m²

Sewer Mining System

660m³/d

Main Sewer

386m³/d
Modular In-building Sewer Mining System

1 m³/day
AIA Building, Central

1 m³/day
Yuet Wah Street URA Project
Customization of In-building Sewer Mining System

70 m³/day
City University of Hong Kong
(Our first installation in HK, 2009)

50 m³/day
Yan Tin Estate, Tuen Mun
(The first installation in PRH Development in HK)
Demonstration of Water Reclamation from Combined Sewage Application in Redevelopment Project in Shanghai, PRC

30 m³/day
Innovative green building features in redevelopment of an old piano factory into a commercial complex
KEY TAKE-HOME MESSAGE

- Using advanced treatment technologies, sewer mining systems can be very compact and unmanned operation.

- For a residential building with 1,000 households with 3 members per household, the total water consumption and sewage discharge was estimated to be 660 m$^3$/d. If the novel in-building sewer mining system is installed for recycling of domestic sewage or greywater for toilet flushing and irrigation, the overall water consumption and sewage discharge can be reduced by around 40%.

- The system operation cost including electricity supply, chemical consumption, membrane replacement is HK$2.2/m$^3$, resulting in a cost saving of HK$4.9/m$^3$ from freshwater supply and sewage discharge tariff.
KEY TAKE-HOME MESSAGE

- For a residential building with 1,000 households, the in-building sewer mining system only occupy 50m² of plant room area and 270 m³ of underground storage tank. The system can be installed at the basement of a multi-storey residential building to directly purify domestic sewage or segregated greywater from the building.

- In-building sewer mining system are proved to be technically and economically feasible to be installed in high-density residential buildings.