The Egawa and Shibukawa stormwater storage pipes in Kawasaki City have been operating since 2001 and 2004, respectively. The two stormwater storage pipes were installed to:

- Expand the capacity of stormwater drainage facilities (quantity control)
- Reduce overflow from combined sewers (quality control)
- Augment the sewerage system storage capacity in low lying areas (protection against 1:30 to 1:40 year rainfall event)

All stormwater stored in both storage pipes is generally returned to the Kase Wastewater Treatment Plant after wet weather. The return water is discharged to public water bodies after costly secondary treatment, so it is necessary to monitor the water quality of stored water and investigate how to reduce the high cost of treatment.

Problems with the operation and maintenance of the Egawa storage pipe have occurred because of the inflow of sediment and screenings.

Based on above situation, water quality tests of stored water, functional assessment of the storage facility, and investigation of methods for improvement were conducted in this study with the following aims:

- To decrease the cost of treating stored water
- To devise a method of washing/removing sediment
- To establish an appropriate method for operation and maintenance

### Study on Improved Design of Shibukawa and Egawa Stormwater Storage Pipes

<table>
<thead>
<tr>
<th>Whole term</th>
<th>2004.10 ~ 2006.3</th>
</tr>
</thead>
</table>

(Purpose)

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(Results)

1. Water quality testing of stored water

Water quality tests were carried out separately on water that had been stored for quantity control and quality control. The results of the tests are shown in **Table-1**.

<table>
<thead>
<tr>
<th>Item</th>
<th>Effluent Standards(^*1)</th>
<th>Unit</th>
<th>Quantity Control</th>
<th>Quality Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stored Water(^*2)</td>
<td>Return Water(^*3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stored Water(^*2)</td>
<td>Return Water(^*3)</td>
</tr>
<tr>
<td>BOD</td>
<td>20</td>
<td>mg/ℓ</td>
<td>2 ~ 22</td>
<td>2 ~ 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14 ~ 36</td>
<td>2 ~ 20</td>
</tr>
<tr>
<td>SS</td>
<td>40</td>
<td>mg/ℓ</td>
<td>0 ~ 51</td>
<td>4 ~ 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 ~ 100</td>
<td>0 ~ 20</td>
</tr>
<tr>
<td>T-N</td>
<td>40</td>
<td>mg/ℓ</td>
<td>1.1 ~ 6.4</td>
<td>1.4 ~ 2.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.2 ~ 9.6</td>
<td>4.2 ~ 7.9</td>
</tr>
<tr>
<td>T-P</td>
<td>5</td>
<td>mg/ℓ</td>
<td>0.0 ~ 0.6</td>
<td>0.0 ~ 0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.3 ~ 1.1</td>
<td>0.3 ~ 0.5</td>
</tr>
<tr>
<td>Coliform</td>
<td>3,000</td>
<td>No/ml</td>
<td>71 ~ 830</td>
<td>0 ~ 600</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>640 ~ 28,000</td>
<td>640 ~ 67,000</td>
</tr>
</tbody>
</table>

\(^*1\) Effluent Standards for BOD, SS, and Coliform are from the Sewerage Law, Japan.

\(^*2\) The Standards for T-N and T-P are based on standards of the Water Pollution Control Law, Japan.

\(^*3\) Time of Return Water sampling was follows:

- Start: 1 hour after return started
- End: 2 hours before return completed

It was confirmed that untreated water stored for quantity control would pass the effluent standards and, therefore, could be discharged directly.

2. Direct discharge of stored water

   (1) Possibility investigation using field turbidity meter

   The relationship between the results of the water quality tests and the readings from a field turbidity meter showed that stored water could be discharged directly if the field turbidity meter showed less than 40 NTU.

   (2) Cost comparison with present treatment method
The costs of the following three treatment alternatives were compared:
- Flocculator clarifier + chlorine dioxide disinfection in pump station (water stored for quality control)
- Chlorine dioxide disinfection in pump station (water stored for quantity control)
- Present treatment method + chlorine disinfection in Kase Wastewater Treatment Plant

The cost of the present treatment method (in Kase Water Treatment Plant) was the cheapest of the three. This situation is expected to change with the introduction of advanced wastewater treatment in the future.

3. Countermeasure for sediments in storage pipe

Silt and clay were found to make up over 70% of the bottom sediment deposited in the storage pipes. Therefore, instead of looking at methods for preventing sediment flowing into the storage pipe, we examined and proposed improved sediment removal methods.

Inadequate method: returning and sediment clearing operation done simultaneously
  (sediments are not flushed to the end of the pipe because of inadequate tractive force in the return flow)

Improved method: Perform sediment clearing after the returning operation
  (sediments in the trench are flushed appropriately with adequate tractive force)

4. Measure to prevent clogging of the return pump by debris

A case study of another city was undertaken and as a result it was proposed that a grating could be set on the return flow pump pit to prevent debris inflow. A secondary measure was proposed if the grate method is ineffective, i.e., to install a low water level pump to drain the stored water including a lot of screenings.

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key words: Stormwater, Storage Pipe, Combined Sewer Overflow (CSO) Control, Flood Control