Sewer plan in Kitakyushu city

2015

Sewer System Planning Division, Sewer System Department, Water and Sewer Bureau, Kitakyushu City
Contents

1 Basic policy
   (Planned target year・planning area・ separation system)
2 Planning factors
   (1) Wastewater facility planning
       (estimated population・estimated wastewater flow・
        estimated effluent water quality, etc.)
   (2) Storm–water drainage planning
       (flood possibility, estimated storm–water flow)
3 Current situation
4 Priorities
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Basic Policy
Planned Target Year

- Construction of sewer system in Kitakyushu City: Almost completed by March, 2006
  ⇒ Percentage of sewerage population: 99.8%
  ※全国平均75.8%(2011.3)

- Short-term plan:
  Progress management through a 5-year financial plan
  ⇒ Emphasize sewerage works management

- Medium-to-long term plan: Set a goal for each major project
  - Improvement of storm-water drainage: Fiscal 2014
  - Improvement of combined sewer system: Fiscal 2023
Sewer System Planning Area: 23,736ha

- Area is divided into 5 treatment districts for improvement
  - Excluding mountainous areas and unpopulated areas in the city (48,789ha)

- Excluded areas:
  - Individual wastewater treatment by combined septic tank
  - Emphasize construction efficiency

Storm-water drainage improvement area: 13,858ha

- Area which requires storm-water drainage by sewer system
  - Urban area accounting for about 60% of planning area
集合処理と個別処理

●それぞれの有する特性、水質保全効果、経済性、維持管理等を総合的に勘案し、地域の実情に応じた効率的かつ適正な整備手法の選定を行う。

①コスト比較
集合処理と個別処理の一人当たりのコスト比較

②施設設置の可否
浄化槽を設置しようとしても各戸に設置スペースや排水路を確保できなければ整備が困難 → 集合処理を検討

③放流先の状況
放流先の水質保全を速やかに実施しなければならない場合、下水道（集合処理）による確実な整備を検討
雨水整備対象区域
Removal System

- Adopt separate sewer system as a rule
  ⇒ Combined sewer system: 3, 422 ha
  (Mostly constructed in the 1960s)

【合流式】
○メリット
  - 早急に整備が図れる
  - 事業費が比較的安価

○デメリット
  - 降雨時に汚水の混じった雨水が公共用水域に放流される

【分流式】
○メリット
  - 降雨時においても汚水が公共用水域に放流されない

○デメリット
  - 整備に時間がかかる
  - 事業費が比較的高価
Factors for Planning Wastewater Facility
Estimated Population

- Estimated population: 1,300,000
  - Set in 1991
  - Population density:
    - Urban area: 50~120/ha
    - Suburbs: 5~40/ha
  - Nonresident Population (for tourism, employment, etc.) is taken into consideration in estimated wastewater flow.

※Revision is under study due to the disparity with actual population.
Estimated Wastewater Flow Per Person Per Day

- Set for urban area and suburbs separately

  - Domestic wastewater Flow :
    Set based on water supply estimated in waterworks plan

    Urban area : 480L/person/day
    Suburbs     : 320L/person/day (Mean wastewater flow per person per day)

- Fluctuation ratio
  Daily mean flow : Daily maximum flow
  ⇒ set based on actual inflow into sewage treatment plant
  Daily maximum flow : Hourly maximum flow
  ⇒ estimated based on actual water supply

  Urban area ⇒ Daily mean flow : Daily maximum flow : Hourly maximum flow = 1:1.25:1.875
  Suburbs     ⇒ Daily mean flow : Daily maximum flow : Hourly maximum flow = 0.78:1:1.6
Estimated Wastewater Flow Per Person Per Day

- Underground water flow:
  Estimated at 20% of maximum wastewater flow per person per day.

<table>
<thead>
<tr>
<th></th>
<th>Urban area</th>
<th>Suburbs</th>
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</thead>
<tbody>
<tr>
<td>Estimated mean</td>
<td>600 (=480+120)</td>
<td>400 (=320+80)</td>
</tr>
<tr>
<td>wastewater flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated maximum</td>
<td>720 (=600+120)</td>
<td>500 (=420+80)</td>
</tr>
<tr>
<td>wastewater flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated hourly</td>
<td>1,020 (=900+120)</td>
<td>750 (=670+80)</td>
</tr>
<tr>
<td>maximum wastewater</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Unit: L/person/day)
Estimated Wastewater Flow

- **Estimated wastewater flow** = Domestic wastewater flow + Industrial wastewater flow + wastewater flow from other sources

  - **Domestic wastewater flow**: wastewater flow per person per day × estimated population
  - **Industrial wastewater flow**: set based on notification from industry (estimated when unknown)
  - **Wastewater flow from other sources**: tourism, airport, development project, etc.

- **Estimated wastewater flow during wet weather** in combined sewer system

  - **Interception factor**: Three times the estimated maximum hourly wastewater flow during dry weather

  ⇒ Cost effectiveness is taken into consideration
## Estimated Wastewater Flow (summary)

(Unit: m³/day)

<table>
<thead>
<tr>
<th></th>
<th>Estimated daily mean flow</th>
<th>Estimated daily maximum flow</th>
<th>Estimated hourly maximum flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic wastewater</td>
<td>703,100</td>
<td>851,400</td>
<td>1,222,100</td>
</tr>
<tr>
<td>Industrial and other wastewater</td>
<td>128,680</td>
<td>161,000</td>
<td>242,700</td>
</tr>
<tr>
<td>Total</td>
<td>831,780</td>
<td>1,012,400</td>
<td>1,464,800</td>
</tr>
</tbody>
</table>

Note: Estimated wastewater flow during wet weather: 3,286,800 m³/day
Estimated Water Quality and Treatment Process

Estimated influent water quality
- BOD : 200mg/L
- SS : 250mg/L

Consider industrial wastewater, return flow from sludge treatment facility, etc.

Estimated effluent water quality
- BOD : 15mg/L
- SS : 35mg/L

Consider actual treated effluent water quality and compliance with Environmental Quality Standards.

Treatment process:
Standard activated-sludge process
Factors for Planning
Storm-water Drainage
Flood Probability
Design Storm-water Flow

Flood probability: **Once in 10 years (53.1mm/h)**
(Applied to construction works since 1991)

Design storm-water flow calculation formula:

\[
Q = \frac{1}{360} \times C \times I \times A
\]

- Run-off coefficient \((C)\): 0.4 (mountain) ~ 0.85 (central urban area)
- Rainfall intensity formula \((I)\): \(\frac{440}{(\sqrt{t} + 0.54)}\) (mm/h)
  - Determined based on 40-year rainfall data between 1949 and 1988
  - Reaching time \((t)\): 5 + Time of flow (min)
- Drainage area \((A)\)
Current Situation
Wastewater Facility (End of March, 2014)

- Sewered area: 16,290ha
  (including combined system area: 3,422ha)
- Sewered population: 975,533
- Rate of sewered population: 99.8%
- Rate of flush toilet service: 99.4%
- Total pipe length: sanitary sewer 3,245km
  combined sewer 856km
- Treatment plant: 5
  (treatment capacity: 621,000m3/day)
- Pump station: 28
- 低地ポンプ: 約130箇所
Current treatment capacity: 621,000m³/day
Existing main sanitary sewer and combined sewer lines
Treatment of Wastewater from Kitakyushu Airport (offshore airport)

Kukokitamachi Pump station
Pump capacity: 1.67 m³/min
Number of pump: 2

Sone Sewage Treatment Plant

Sanitary sewer main line (gravity flow)
Diameter: 300–2,000mm
Length: 9,700m

Sanitary sewer main line (pumping)
Diameter: 200mm
Length: 7,100m
Simple manhole pump system ⇒

High operational and economical efficiency has enabled early start of operation.
Improvement of Storm-water Drainage
(End of March, 2014)

- Sewered area: 9,795ha
- Flood control achievement rate: 70.7%
- Total length of storm sewer: 345km
- Exclusive storm-water pump station: 6
- マンホールポンプ: 7箇所（うち、同海ビオパーク送水用1箇所含む）

Kinzangawa pump station
- Operation started in March, 2001
- Harmony with surrounding residential area was taken into consideration.
概算工事費（目安）

●処理場：約300億円（曾根浄化センター）

●ポンプ場：約80億円（藤田ポンプ場）

●管渠（管径や工法、現場状況等によって様々である。）
  ・口径200（開削工事）　90,000円／m
  ・口径2000（推進工事）　820,000円／m

※2014年　本市初任給（大卒程度）　約18万円
（参考：1米ドル＝約105円）
Priorities
Priorities

① Storm-water drainage (flood control)
   Create a secure and safe city

② Improvement of combined sewer system
   Reduce pollution load on public water utilities
   (creation of a better water environment and water cycle)

③ Facility renovation
   Ensure functionality of old facilities

④ Advanced treatment
   Prevent eutrophication of public water utilities
   (removal of nitrogen and phosphorous)
① Improvement of Storm-water Drainage (flood control)

Current problem: flood damage

⇒ Occurrence of Local downpour assumed to be caused by global warming
⇒ Increase in storm-water runoff associated with change in land use

Flood on national road (September, 2004)
Flood on prefectural road (September, 2004)
北九州市の浸水対策の契機

過去の大水害

1953年6月：4日間で650mmの降雨
⇒ 1年間の降水量の約40%にあたる

※紫川の氾濫、土砂災害等の発生

・死者：183人
・家屋倒壊：3,800戸
・総罹災戸数：83,000戸

被害総額：110億円
（現在価格：約600億円）
近年の浸水被害 平成25年7月3日

＜浸水被害＞ 床上：32棟、床下：115棟
◆ 都市化の進展により、雨水流出量が増大

1950年代（開発前）
現在

山や田畑が宅地化

※近年は、浸水リスクが増大
⇒ 気候変動、土地利用の変化による
総合的な浸水対策のメニュー

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<tr>
<th>区分</th>
<th>手法</th>
<th>対象</th>
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</thead>
<tbody>
<tr>
<td>ハード対策</td>
<td>流下能力向上</td>
<td>管渠、ポンプ場</td>
</tr>
<tr>
<td></td>
<td>施設の新設・増設</td>
<td>管渠、ポンプ場</td>
</tr>
<tr>
<td></td>
<td>淌める</td>
<td>調整池、貯留管</td>
</tr>
<tr>
<td></td>
<td>浸透させる</td>
<td>舗装、ます等</td>
</tr>
<tr>
<td></td>
<td>開発指導</td>
<td>宅地開発等</td>
</tr>
<tr>
<td></td>
<td>情報提供</td>
<td>防災情報マップ、Web、防災mail</td>
</tr>
<tr>
<td></td>
<td>自発的な活動</td>
<td>止水板、土のう清掃、迅速な避難</td>
</tr>
<tr>
<td>ソフト対策</td>
<td>住民との協働</td>
<td>無</td>
</tr>
</tbody>
</table>
ポンプ場の整備

藤田ポンプ場

雨水調整池の整備

湯川新町雨水調整池
河川、下水道、道路が一体となって、総合的に推進

河川部局：河川改修

河道拡幅

下水道部門：雨水管・ポンプ場・雨水調整池等の整備

雨水管の整備

ポンプ場の整備

雨水調整池の整備

道路部門：側溝・ますの整備、アンダーパス対策
Storm-water Drainage Improvement Project

Objective: To protect lives and properties of citizens and urban assets, and create a secure and safe city

Activity

- Be prepared for the heaviest rainfall in a decade (53.1mm/h)

Target

- Raise flood control achievement rate by Mar. 2015
  70.7% (March, 2014) → 71% (March, 2015)

⇒ Promote efficient improvement in coordination with river, road and other projects to improve watershed as a whole
災害に対する住民との協働

◆ 浸水被害の軽減

積極的な情報提供
- 防災情報マップ配布（危険箇所、避難所等の周知）
- Web公開（雨量、ライブカメラ、河川水位等）
- 防災mail送信

自発的な活動
- 土のうや止水板の設置
- 側溝や樹の清掃
- 迅速な避難

情報提供（防災情報マップ、Web）
住民の活動（止水板、土のう設置）
Improvement of Combined Sewer System

Current problem

- Outflow of untreated sewage
- Capacity shortage of storm–water drainage
- Old and deteriorated facilities
- Disappearance of local waterside

Outflow of untreated sewage

Combined sewer using waterway

Flood in combined system area
Combined Sewer System Improvement project

● Objective: Reduce pollution load on public water bodies
  ⇒ Ensure a secure and safe civic life
  ⇒ Create a better water environment

● Activity
  • Sewer separation: 1,700ha
  • Construction of storm-water tank: 12 locations

● Target
  • Completed by March, 2024
  Improvement rate 31.8%(March, 2014) → 100%
Schematic diagram of improved combined sewer system

Sewer Separation

Now

Combined sewer

Sewer separation

Combined sewer

Sanitary sewer

Storm sewer

Storm-water tank

Rain

Wastewater

Rain water

Combined outlet

Public water body

Wastewater

Sent to and treated at treatment plant

Public water body

Storm-water tank

Store sewage temporarily

To treatment plant
雨水滞水池設置

<table>
<thead>
<tr>
<th></th>
<th>神嶽P</th>
<th>戸畑P</th>
<th>藤田P</th>
<th>門司港P</th>
</tr>
</thead>
<tbody>
<tr>
<td>貯留容量</td>
<td>4,600m³</td>
<td>4,400m³</td>
<td>2,800m³</td>
<td>760m³</td>
</tr>
<tr>
<td>運転開始</td>
<td>平成10年</td>
<td>平成18年</td>
<td>平成24年</td>
<td>平成25年</td>
</tr>
</tbody>
</table>

神嶽ポンプ場

戸畑ポンプ場
③ Facility Renovation

● Current problem

Increase in the number of old and deteriorated facilities

Total length of old pipe

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</tr>
</thead>
<tbody>
<tr>
<td>Total length of old pipe (km)</td>
<td>7</td>
<td>16</td>
<td>67</td>
<td>134</td>
<td>286</td>
<td>1,810</td>
<td>2,505</td>
<td>3,004</td>
<td>3,334</td>
<td>3,664</td>
<td>4,003</td>
<td></td>
</tr>
</tbody>
</table>

Decay caused by hydrogen Sulfide

Cave-in in the road caused by damaged sewer pipe
Facility Renovation Project

Objective:
Stable operation and enhanced functionality of sewerage

Activity:
Conduct survey and inspection systematically, and renovate as appropriate

- Pipe ⇒ Longer service life by regular maintenance for smoother operation
- Pump, treatment and other facilities ⇒ Upgraded function
  Cost reduction by more efficient maintenance work
Examples of Pipe Renovation
④ Water Treatment

Current situation: Anaerobic–aerobic treatment through well–designed operational control

Receiving waters satisfy Water Quality Standards(T–N, T–P).
Advanced Treatment

Current situation: Wastewater is partly treated further after secondary treatment and effectively used in each sewage treatment plant.

- Sand filtration ⇒ for washing, cooling and other purposes
- Sand filtration + ceramic membrane treatment

⇒ used in adjacent park

※Promote further advanced treatment

Final target

- T−N : 10mg/L
- T−P : 0.3mg/L
Other Projects
Other Projects

● Coordination with river projects
  ⇒ Improve combined sewer system in association with river development to create better water environment

● Contribution to Resource Recycling Society
  ⇒ Make effective use of sewer sludge to help achieve Zero Emission

● Promotion of citizens’ participation
  ⇒ Planning with citizens
Coordination with river projects

- Improve combined system by laying storm sewer in line with river development project

Bachi River: Before

Bachi River: After
Contribution to Resource Recycling Society

- Sludge generation: 186t/day (Fiscal 2013)
  - Cement feedstock: 122t/day
  - Incineration with municipal waste: 64t/day

All used effectively

※今後は、低炭素化社会への移行などに伴い、本市においても污泥の燃料化を計画しており、現在、日明浄化センターで污泥燃料化施設を整備中である。
- Generated electricity is used as power in sewage treatment plant.
- Steam is used as a heat source to dry sludge.
おわりに

北九州市は、「世界の環境首都」及び「アジアの技術首都」を都市ブランドとして構築することを目指しています。

下水道分野においても、市民・行政が協働して取り組みを進め、未来の世代に引き継げる下水道システムを構築し、また、世界の環境首都を目指すべく、低炭素化社会への貢献に努めていきたいと考えている。
Thank you for your kind attention.

For further information:
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