Sewerage Treatment System in Seoul

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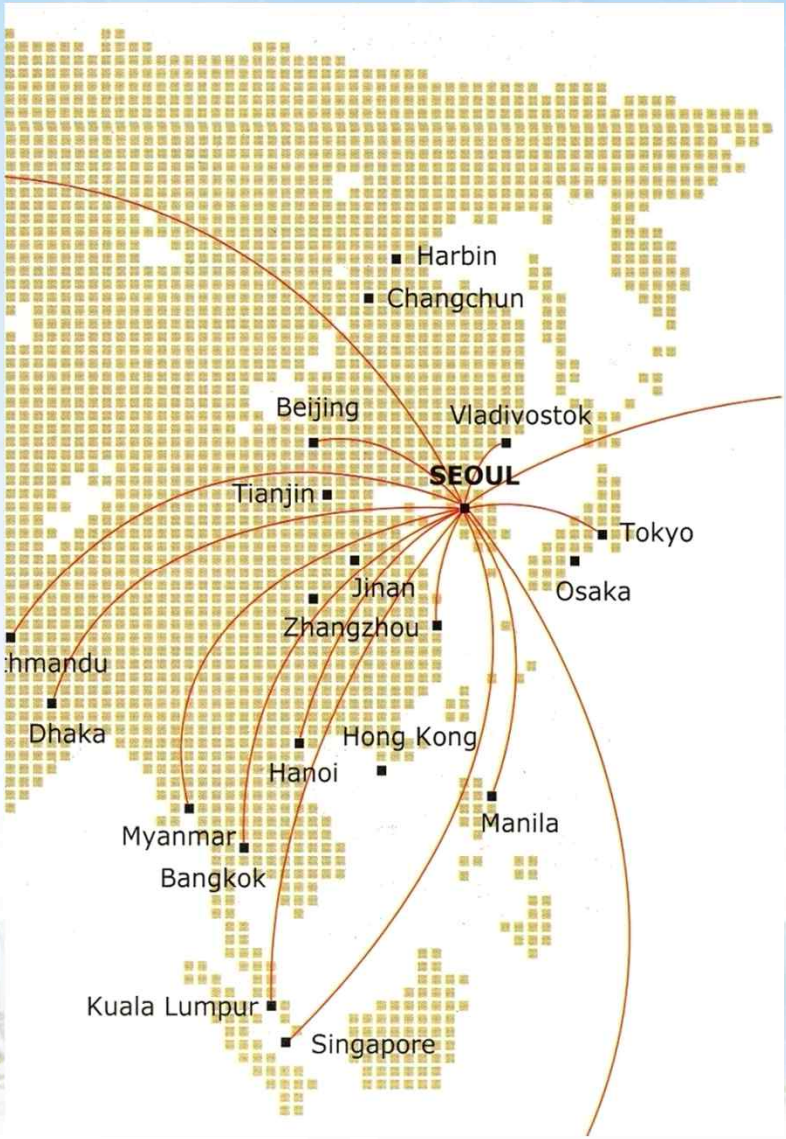
Location of Seoul

Seoul in Asia



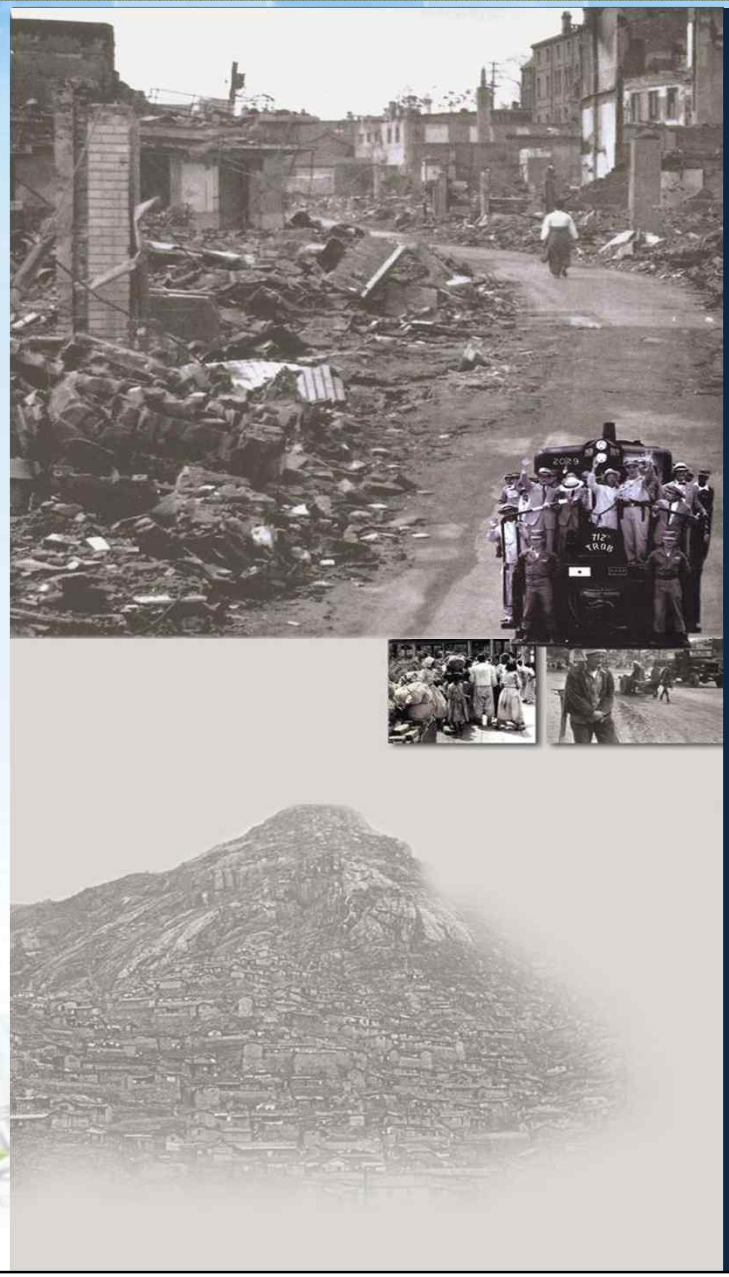
Seoul in South Korea

Seoul in Capital Region

Seoul, the capital city of Korea,
is located in the middle of
the Korean Peninsula linking China and
Japan, the largest consumer markets of
Asia.

Natural Environment

The Era of Destruction : the 1950s

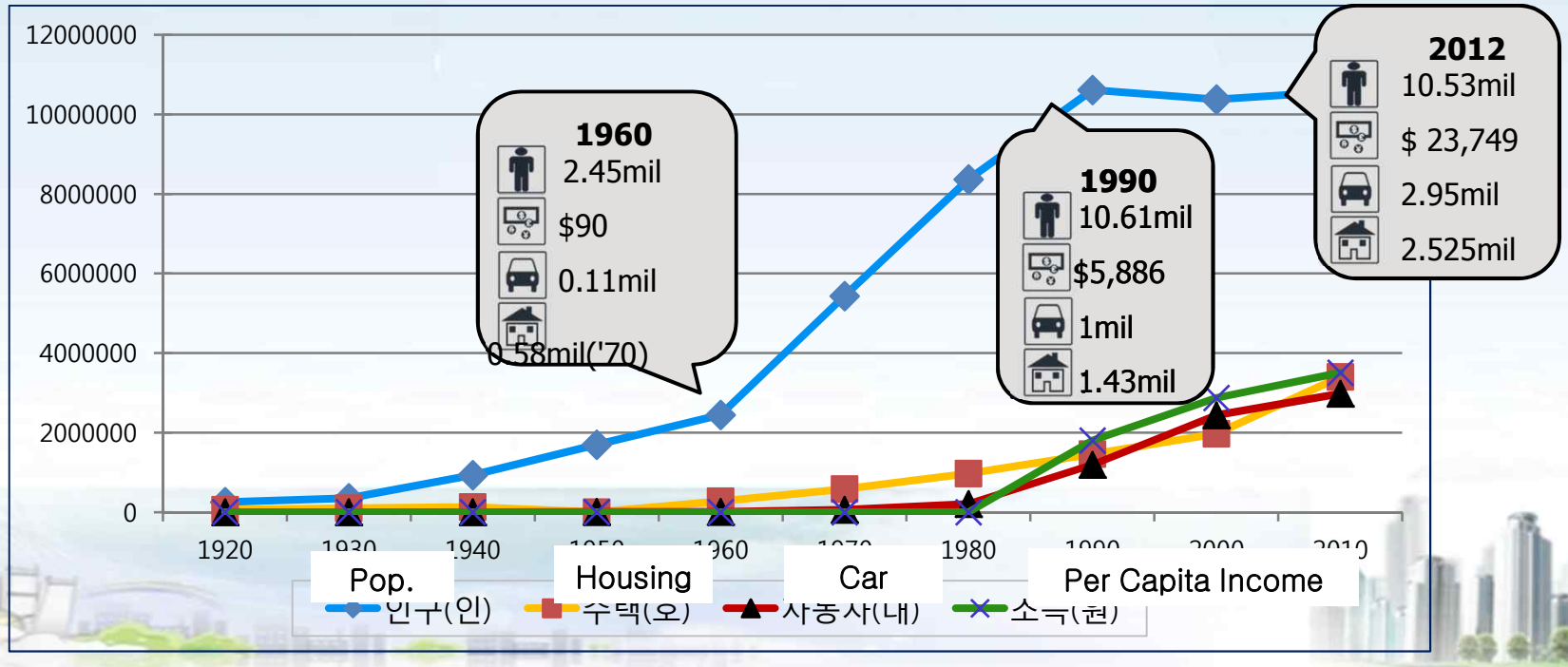


- Reconstruction and Demographic Concentration after the Korean War (1950-1953)
- Urban problems such as poverty, housing shortages, and waste management and so on.

“Miraculous growth over half a century”

- Population rose exponentially after the Korean War, stabilized after the 90s.
- Income level: with the national economic development (1960s~), also rose after 1980s.
- From being a receiver of ODA, to an ODA donor country (1.17billlion, in 2010)
- 2012 Global Power City Index : World's 6th in Ranking

※ Mori Memorial Foundation Institute for Urban Strategies



Sewerage System in Seoul

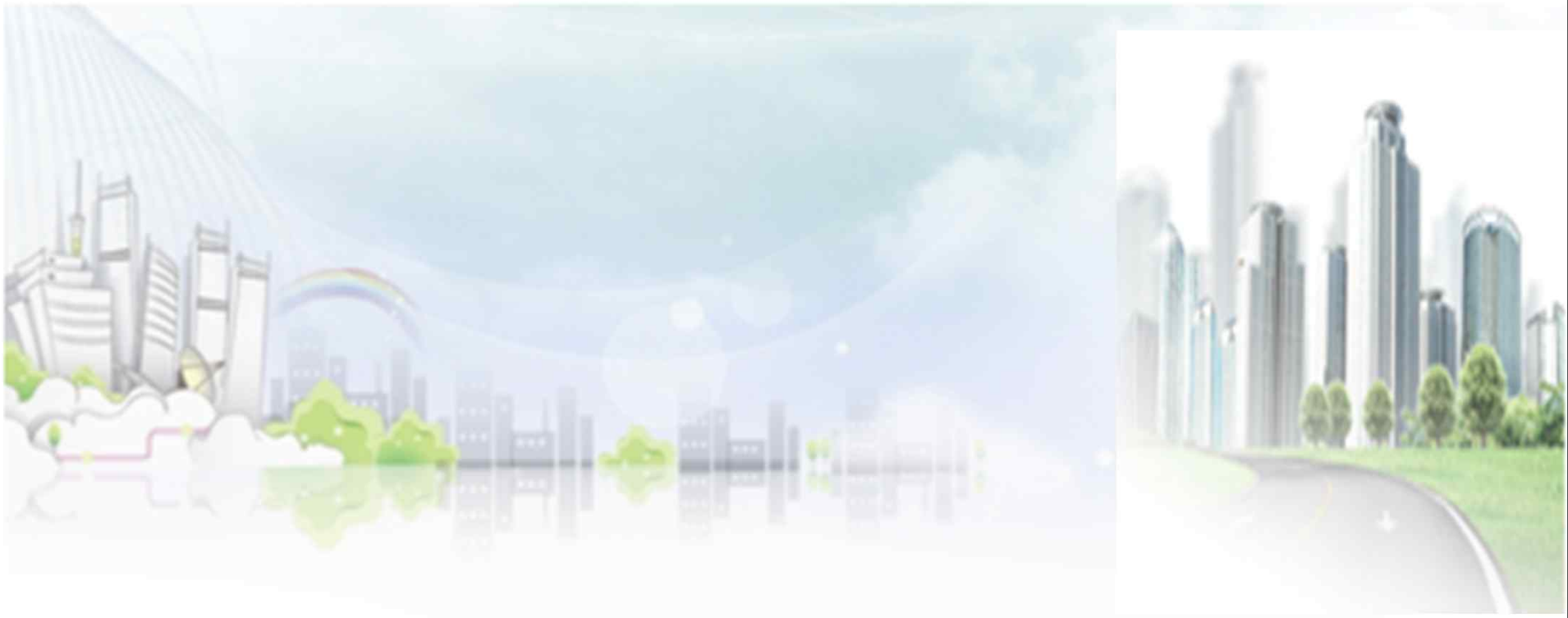
Present Status of Sewerage System

History of Sewage treatment in Seoul

Development Plans

Future Policy Direction

Present Status of Sewerage System

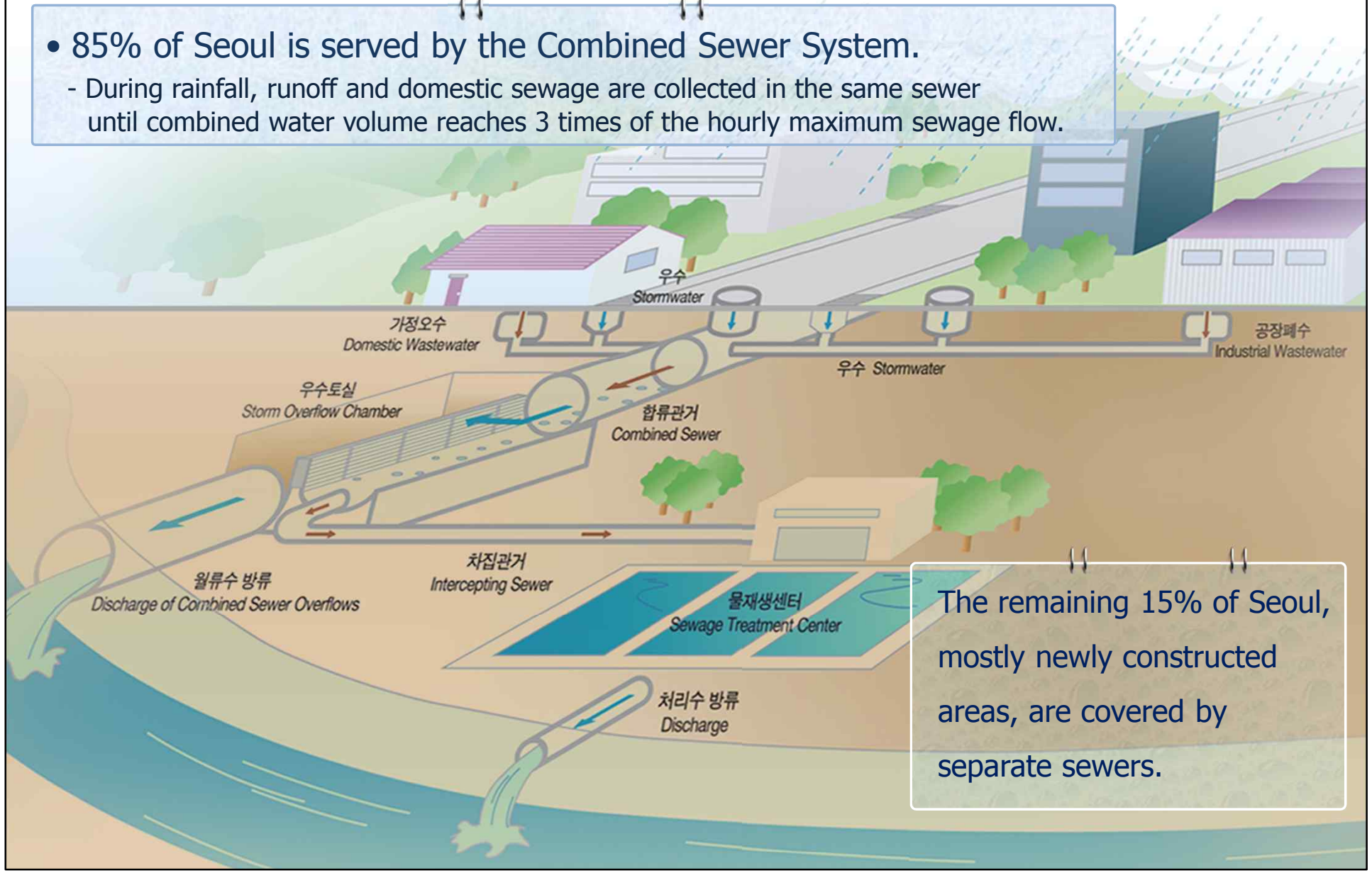


Overview of the Sewerage System

- Area Served : 605.33 ㎢
- Population : 10.44 million
- Drainage area : 4 big areas
- Sewer length : 10,297km
- Treatment Centers : 4
- Served ratio : 100%

Overview of the Sewerage System

- 85% of Seoul is served by the Combined Sewer System.
  - During rainfall, runoff and domestic sewage are collected in the same sewer until combined water volume reaches 3 times of the hourly maximum sewage flow.



The remaining 15% of Seoul, mostly newly constructed areas, are covered by separate sewers.

Overview of the Sewer in Seoul

- Length by Type

(Km)

Total Length	Circular	Rectangular	Open channel	U-shape gutter
10,297	8,704	1,198	115	280

- Length by Function

(Km)

Total Length	Combined sewer system	Separate sewer system			Interceptor
		Total	Storm sewer	Sanitary sewer	
10,297	8,819(86%)	1,022(10%)	575	447	456(4%)

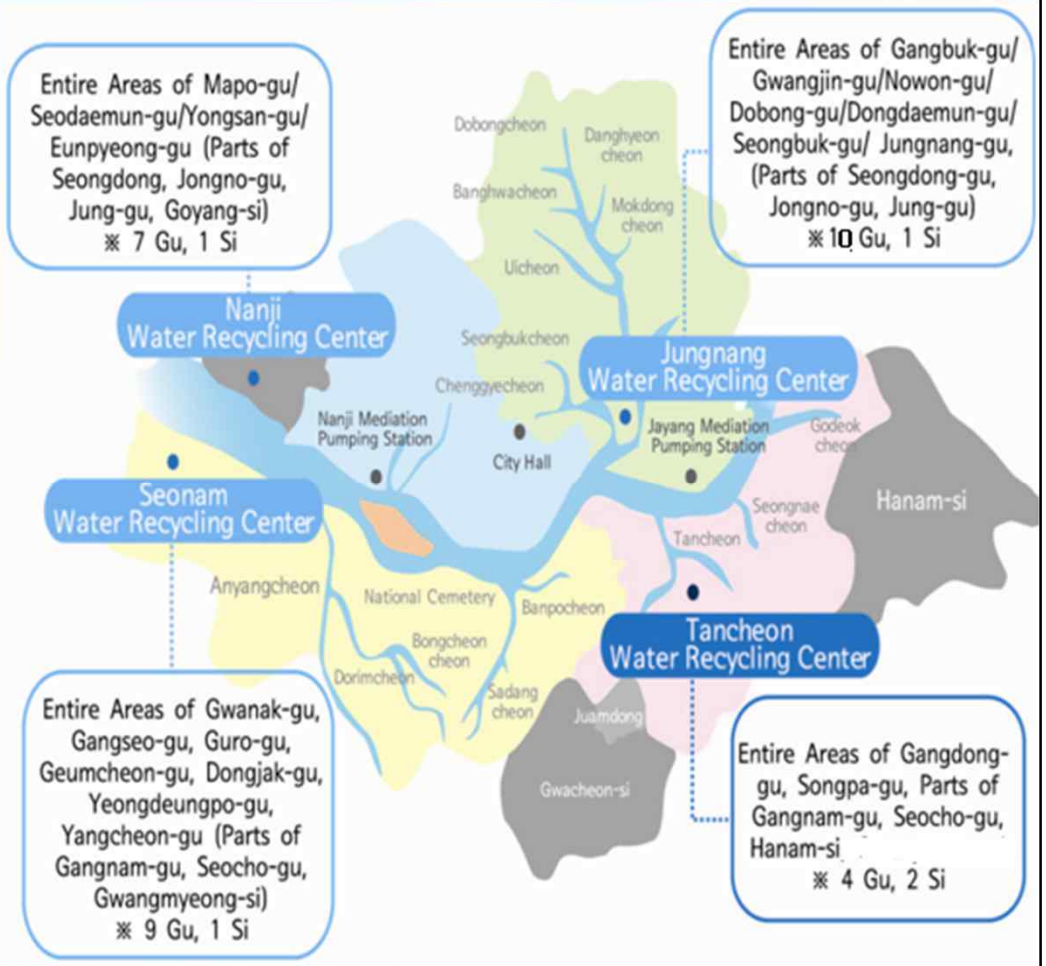
- Subsidiary Facilities

(EA)

Manhole	Storm water inlet	Grit chamber	Storm water overflow chamber
206,092	486,767	918	1,340

Present Status of Sewage Treatment Plants

- Capacity : 5,810,000㎥/d
  - Night soil & Septic : 10,500 ㎘/d
- Sludge Treatment : 1,700 t/d
  - In Site : Sludge Drying 400, Incineration 300
  - Other Site (Sudokwon Landfill Area) : 1000t/d
- Process
  - Before Jan, 2012 : Standard Activated Sludge
  - After Jan, 2012 : MLE + Chemical Treatment
- Total Man Power : 547 Persons



Jungnang Water Reclamation Center

- Site : Chajangteo 5-gil 10, Seongdong-gu
- Area : 791,000㎡
- Construction Period : 1970 ~ 1997
- Construction Cost : USD 370 million
- Sewage Treatment Capacity : 1,710,000㎥/d
- Night Soil & Septic : 4,000㎘/d
- Sludge Drying Furnace : 200t/d
- Manpower : 137 persons
- 2011 Budget : USD 52.9 million

Nanji Water Reclamation Center

- Site : Jayu-ro 116, Goyang-si, Kyeongki-Do
- Area : 929,000㎡
- Construction Period : 1984 ~ 1997
- Construction Cost : USD 214 million
- Sewage Treatment Capacity : 1,000,000㎥/d
- Night Soil & Septic : 4,500㎘/d
- Sludge Incinerator : 150t/d
- Manpower : 116 persons
- 2011 Budget : USD 37.8 million

Tancheon Water Reclamation Center

- Site : Nambusunhwan-ro 6610, Kangnamgu
- Area : 385,000㎡
- Construction Period : 1983 ~ 1998
- Construction Cost : USD 332 million
- Sewage Treatment Capacity : 1,100,000㎥/d
- Sludge Drying Furnace : 200t/d
- Manpower : 122 persons (Private Sector Operation)
- 2011 Budget : USD 33.5 million

Seonam Water Reclamation Center

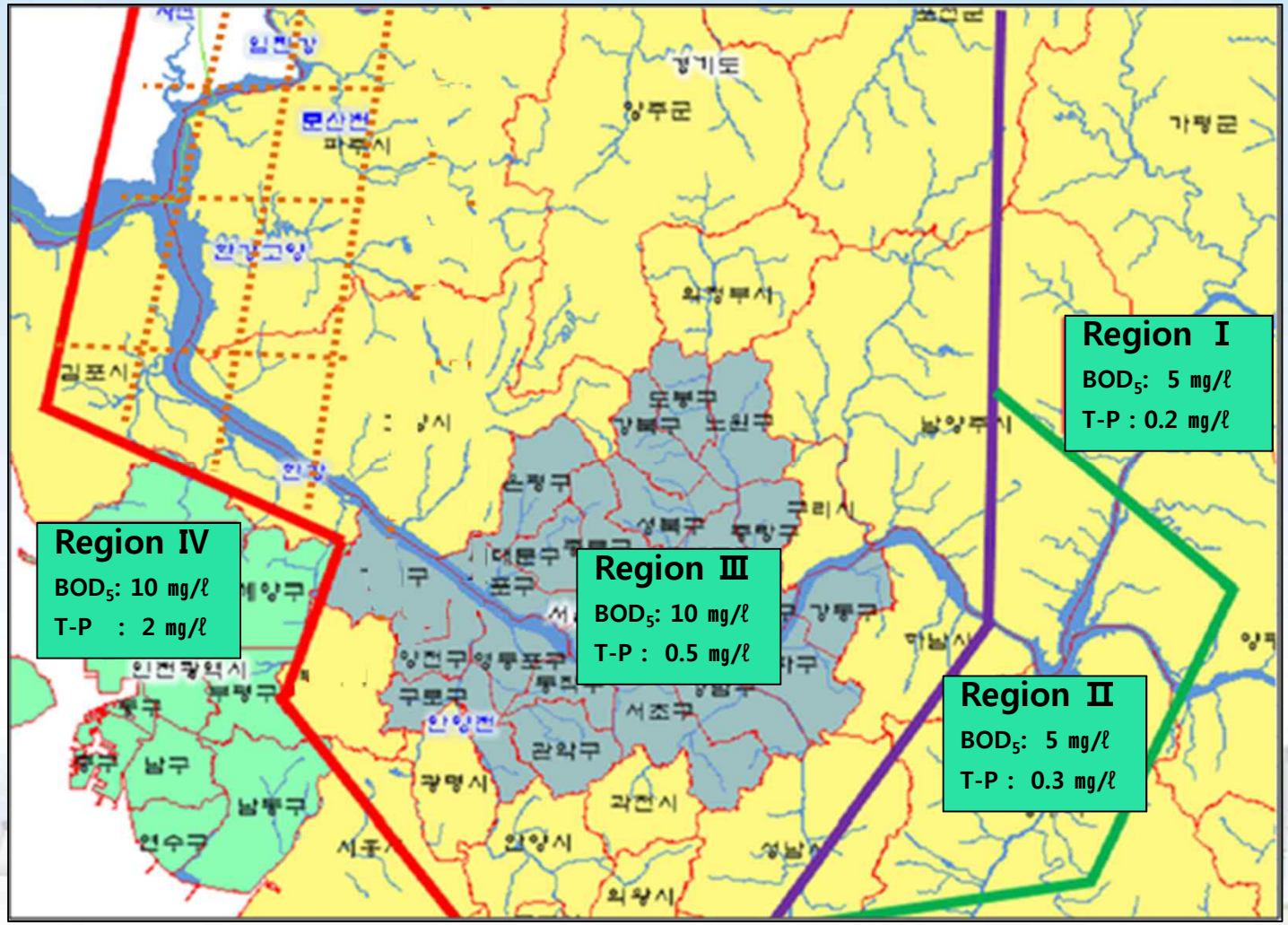
- Site : Yangcheon-gil 546, Kangseo-gu
- Area : 1,091,000㎡
- Construction Period : 1984 ~ 1999
- Construction Cost : USD 429 million
- Sewage Treatment Capacity : 2,000,000㎥/d
- Night Soil & Septic : 2,000㎘/d (increase capacity to 4,000㎘/d by 2015)
- Sludge Incinerator : 150t/d
- Manpower : 176 persons (Private Sector Operation)
- 2011 Budget : USD 49.8 milion

Present Status of Sewage Treatment (Average, 2012)

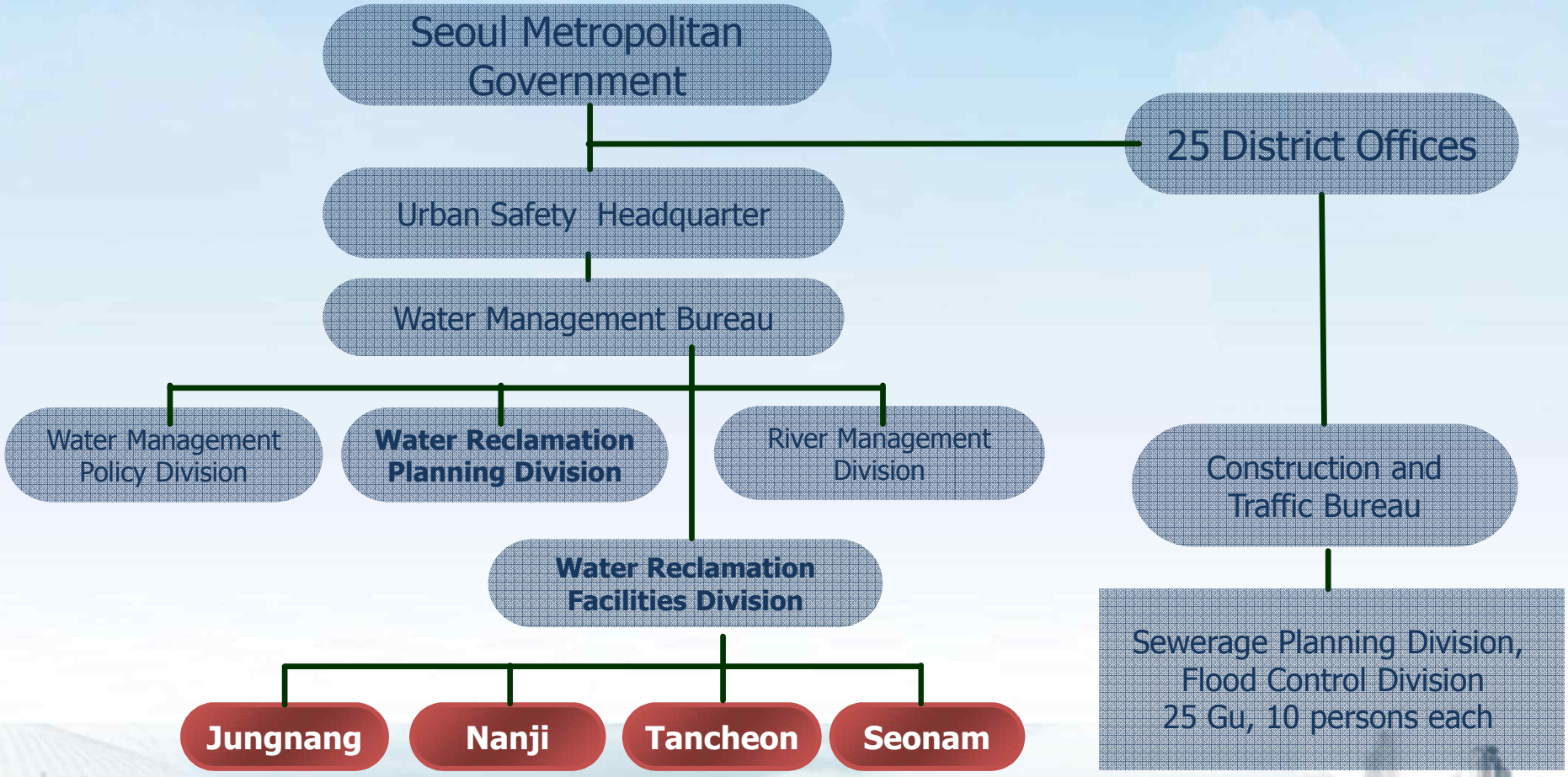
Description		Total	Jungnang	Nanji	Tancheon	Seonam	Remarks
Sewage Plant Capacity	Total(㎥/day)	5,810,000	1,710,000	1,000,000	1,100,000	2,000,000	Activated sludge process
	Operation	4,420,000	1,340,000	620,000	790,000	1,660,000	
BOD	Inflow	(㎎/ℓ)	160	125	128	122	
	Effluent	＜10(㎎/ℓ)	7.2	6.8	4.3	7.1	
Sludge Treatment Capacity (ton/day)	Total	1,496	467	259	296	475	
	Solidification	820	263	115	116	327	
	Incineration	262	-	133	-	128	
	Drying	359	189	-	170	-	
	Others	53	15	11	10	20	Recycling&Others
Night Soil & Septic	Total	10,500(㎘/day)	4,000	4,500	-	2,000(4000)	
	Operation	10,882(㎘/day)	3,639	4,412	-	2,831	
Digestion Gas Generation		201,934(㎥/d)	81,307	35,801	17,028	67,798	
Food Leachate treatment		707(㎥/day)	177	396	-	134	2013.2 data

Present Status of Sewage Treatment (Average, 2012)

- Regional Classification by Effluent Quality Standard (Han River Area)

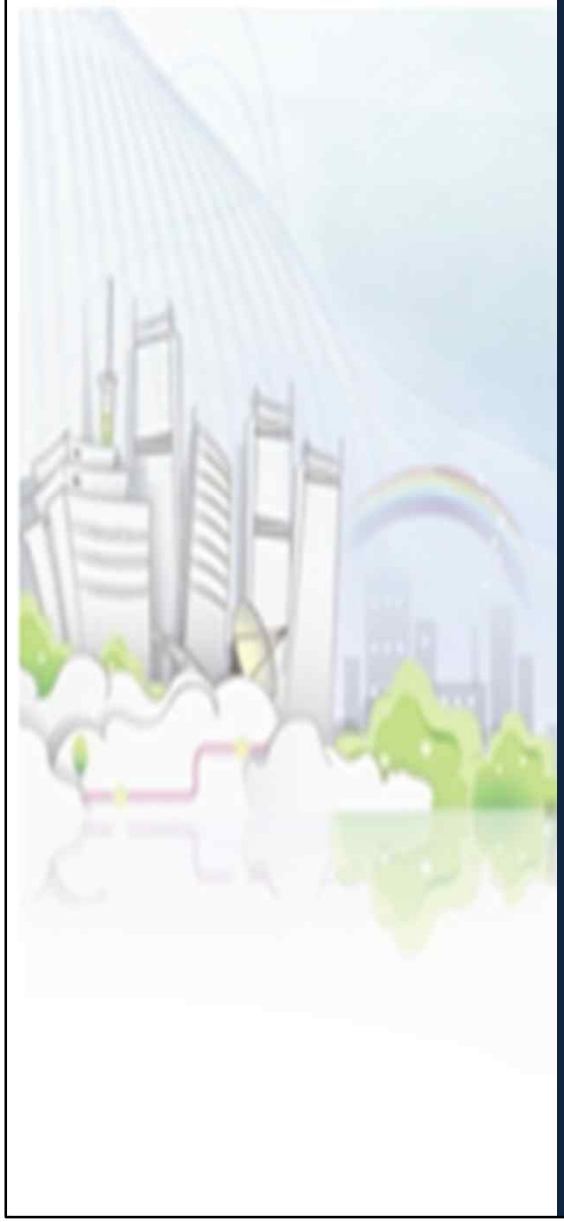


Organization of Sewerage Management System



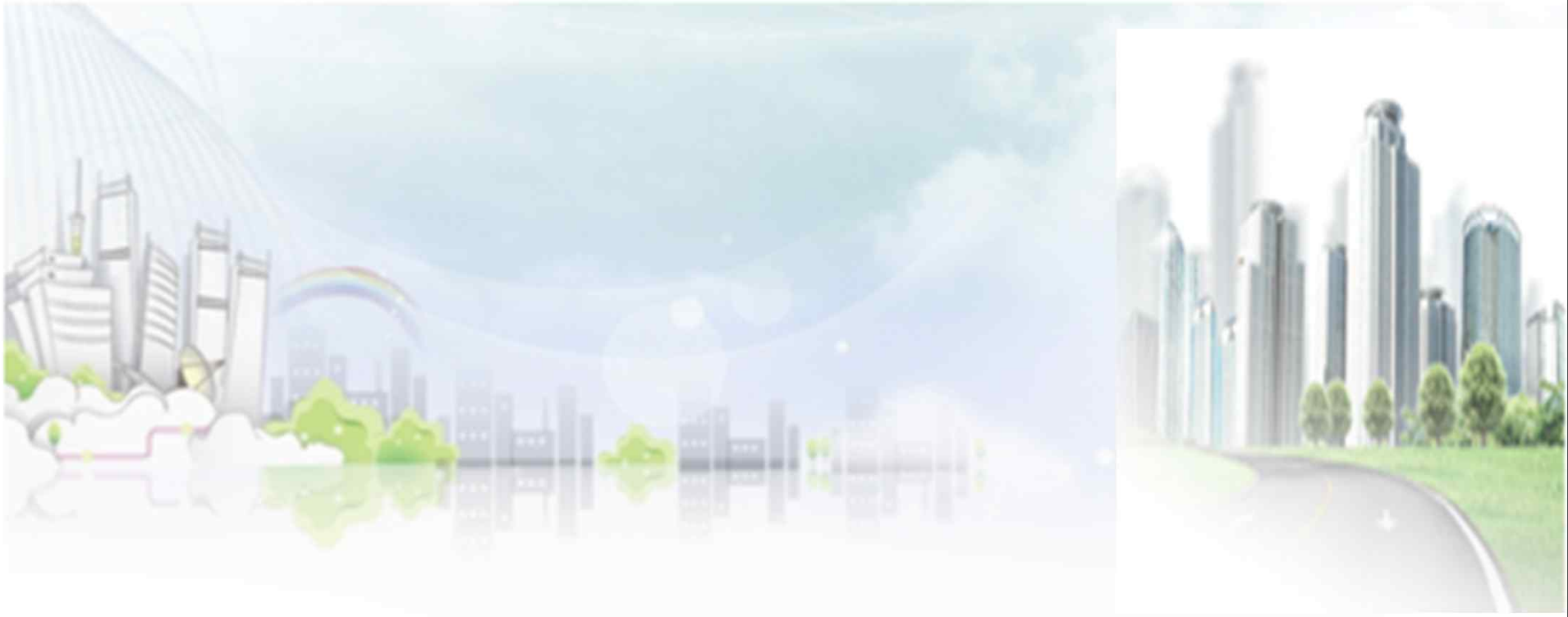
4 Sewage Treatment Centers, 547 persons

Budget for Sewerage System



- Special accounting scheme for sewerage works
- Budget (2013)
  - Revenue : 603 billion won (USD 541 mil)
    - Tariff : 496 billion won (82.3%)
    - Others : 107 billion won (17.7%)
  - Expenditure : 603 billion won (USD 541mil)
    - Sewer Maintenance : 306 billion won (50.8%)
    - Operation and Maintenance of Sewage Treatment Centers(STC) : 198 billion won (32.8%)
    - Facility Modernization and Others : 99 billion won (16.4%)

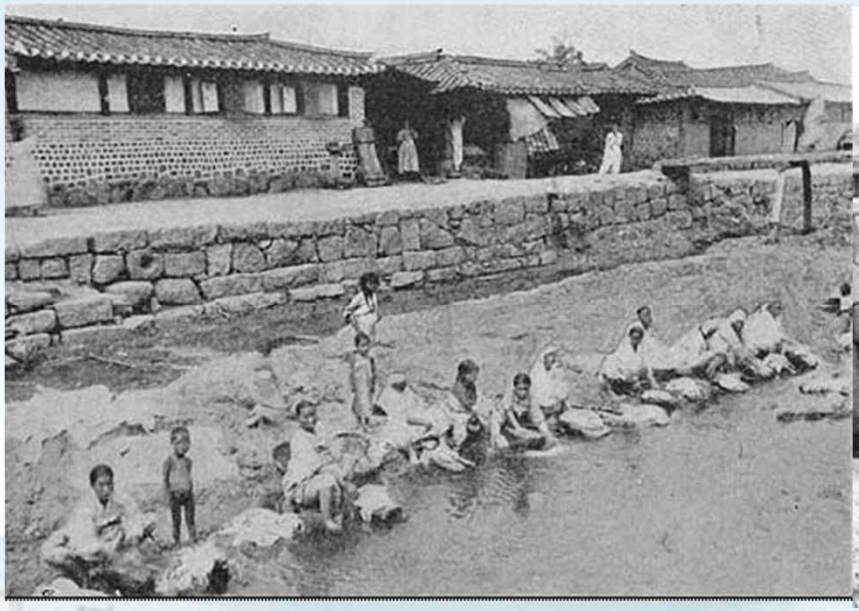
History of Sewage Treatment in Seoul



Development of Sewerage Management in Seoul

Before 1960s

- National Income : Below USD 80/capita in GNI
- Area : 268㎢, Population : 2.4million
- Reconstruction and extension of sewers (225km) built before Korean War (1950~1953)
- No treatment plants. Sewage and night soil were discharged into streams and Han River



Flooded Downtown Area (‘57)

Shabby Houses along the Cheonggye Stream (‘50s)

Dye Works along the Stream(‘50s)

Han River in the Winter

Han River in the Summer(‘68)

Development of Sewerage Management in Seoul

1960s ~ 1970s : Background

- National Income : USD 82 → 1,645 in GNI
- Seoul's administrative district expanded twofold
  - Area : 268㎢ ⇒ extended to 605㎢(1973)
  - Population : 2.5million → 8.3million
- **Sewage conditions**
  - Increased wastewater due to rapid population growth,
    More industrial wastewater resulting from economic growth
  ⇒ Pollution of the Han river and its tributaries began from the 1960s
  ⇒ Necessary to establish a division which oversees the sewage treatment policies, build sewage treatment facilities, and improve sewage pipes

❖ During the two decades, streams in Seoul were severely contaminated.
All 36 streams were regarded as dangerous and 24 streams were covered up.

Development of Sewerage Management in Seoul

1960s ~ 1970s : Seoul's Policy

1. Institutional arrangements & Organization reform

- Enactment of the Sewerage Act(1966)
- Change in organizational structure: Sewerage Division originally under the Construction Management Bureau → Elevate to Sewerage Management Bureau (1976) and newly establish Sewerage Administration Division

2. **Improve and expand the coverage of sewer pipelines** (Significant expansion since 1960s)

- Expansion of culvert pipes rather than openly exposed pipes
- Construction of 5,940km sewers in newly constructed areas (840 in 60s, 5,096 in 70s)

※ Service rate 27.9%(1970) → 64.8%(1980) with total 6,588km sewers

3. **Unsanitary, open sewer lines → Covered-up roads**

- From late 1950s to late 1970s, 19 streams including Joonghakcheon and Chunggyecheon (total length 19,207m) were covered up.

* Perception of covered roads : More hygiene, looks betters, addresses traffic problems

Development of Sewerage Management in Seoul

1960s ~ 1970s : Seoul's Policy

4. Construction of Sewage Treatment Facilities

- Lack of funding and technology: Loan from AID, Planning by a foreign company (Cheonggyecheon Sewage treatment plant, etc.)
- Construction of 4 septic soil sanitary disposal plants (2,930t/d) during 1972~1976
- Completion of first sewage treatment plant (Jungnang, 360,000㎥/d) in 1979

※ Sewage treatment rate of 1980 : 15% of total 2,400,000㎥/d sewage

Development of Sewerage Management in Seoul

'Cheonggyecheon Sewage Treatment Plant' - The very first in Korea

◆ Background: Serious contamination of the Han River in the early 1960s

◆ Snapshot of the facilities in 1979 (Upon completion)

- Area: 362,670㎡
- Treatment capacity : 150,000㎥/day

※ To treat the domestic sewage from the Cheonggyecheon basin (5,600ha, 1.30m people)

- Treatment method: Activated sludge method (Advanced treatment)
- Treatment efficiency: BOD average 330ppm -> Below 19ppm
  SS average 330ppm -> Below 30ppm

⇒ Discharge to Han River

◆ Construction process: Utilized loans due to lack of funding and technology,
Received technical service from a foreign company

Devise a plan(1962) → Submit the loan contract plan to the Construction Management Bureau(1964.8) → Apply for government-guaranteed loan to USOM in Korea(1965.10) → Approval by the National Assembly(1966.4) → Conclude loan contract with AID for $3.5m → Conclude technical service agreement with D.M.J.M(1967.9) → Complete the design(1969.9) → Obtain approval for the design from USAID in Korea(1969.11) → Begin construction(1970.6) → Sign a contract for an additional loan of $2.8m(1974.4) → Complete construction(1976.9)

Development of Sewerage Management in Seoul

' Jungnang Sewage Treatment Plant'

◆ Snapshot of the facilities in 1979 (Upon completion)

- Treatment Capacity : 210,000㎥/day
- Treatment method: Activated sludge method (Advanced treatment)
- Treatment efficiency
  - BOD average 250ppm -> below 20ppm
  - SS average 300ppm -> below 30ppm

⇒ Discharge to Han River

※ Note: Digestion gas produced during the treatment process is used to produce 1,400kw of electricity (Account for 60% of the electricity consumption)

◆ Construction process

Loan from the UK Gradley Brant Bank (10.15 billion won)

Construction started in December 1975 and ended in September 1979

※ Established the Office for the Management of Jungnang Sewage Treatment Plant

⇒ Oversee both the Cheonggyecheon plant and the Jungnang plant

Development of Sewerage Management in Seoul

Covering of the Cheonggye Stream ('58~'66)

Development of Sewerage Management in Seoul

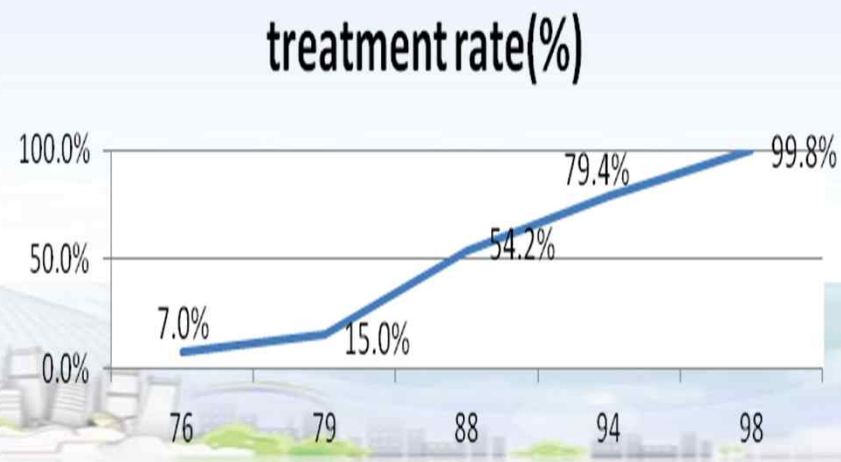
Covered Cheonggye Stream (1968)

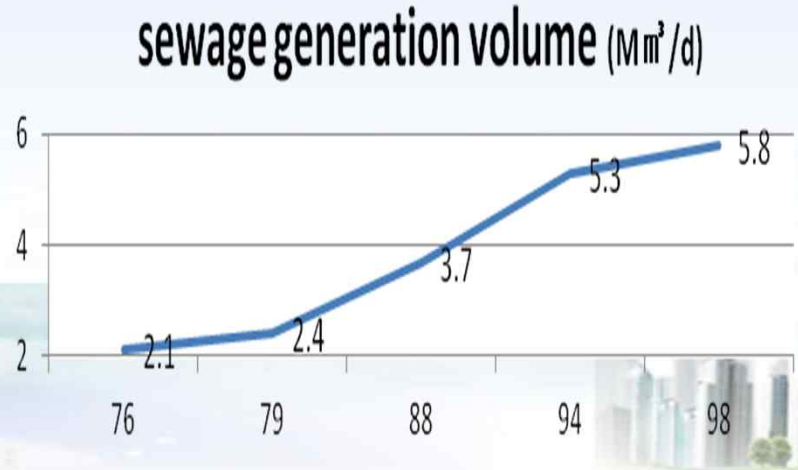
Construction of the Cheonggye Highway
('68~'71)

Development of Sewerage Management in Seoul

1980s ~ 1990s : Background

- National Income : USD 1,800 → 10,841 in GNI
- Population : → 10.3million
- **Sewage conditions**
  - Increase of sewage generation volume, Serious environmental pollution
  - Greater public awareness of the lack of sewage treatment volume and the importance of sewage treatment





Development of Sewerage Management in Seoul

1980s ~ 1990s : Seoul’ s Policy

1. Institutional arrangements

- Drastic revision of the Sewerage Act(1982), Master Plan for Sewage and Drainage in Seoul

※ Revision: Mandate the establishment of a master plan, Charge fees to public sewerage users

- Establish a Master Plan for Sewage and Drainage in Seoul(1983):

  To be devised every 20 years, revised every 5years

- Enact the Ordinance on Sewerage Usage(1983) & Collect public sewerage user fee

⇒ To secure funds to manage the sewerage system

※ Annual tax revenue 49.5 billion (1985) → 132.2 billion (1994)

Development of Sewerage Management in Seoul

Master Plan for Sewage and Drainage in Seoul(1983)

- Target year : 2011
- Estimated population : 1,041,7,000
- Major contents
  - Expand sewage pipes: Add existing pipes 7,059,650m + integrated pipes 1,967,249m, waste water pipes 555,289m
  - Facility Size: Daily sewerage generation volume per capita 235L, Current capacity 36,000㎥/day
    + Increase of 3,191,900㎥/day ⇒ Final Target: 4,551,900㎥/day
  - Build 4 large-scale sewage treatment facilities

Divide Seoul into four areas (Jungnang, Tancheon, Gayang, Nanji) to build sewage treatment facilities

※ Revision to the Master Plan

Flood in 1988 → Revision to incorporate the revised run-off coefficient and rainfall intensity (1992) → Revision to accommodate decreased estimate of population and reclassify the drain areas (1996)

Development of Sewerage Management in Seoul

1980s ~ 1990s : Seoul’ s Policy

2. Expansion of the Sewage Treatment Facilities

- Establish a plan to expand the sewage treatment facilities ahead of the 1986 Asian Games and 1988 Summer Olympics
- Increase the treatment capacity of all four existing sewage treatment plans as part of the ‘Comprehensive Development Plan of the Han River’

※ Construction of 4 sewage treatment plants (total 5,810,000㎥/d)

⇒ 1998. Achieved 99.8% sewage treatment service rate

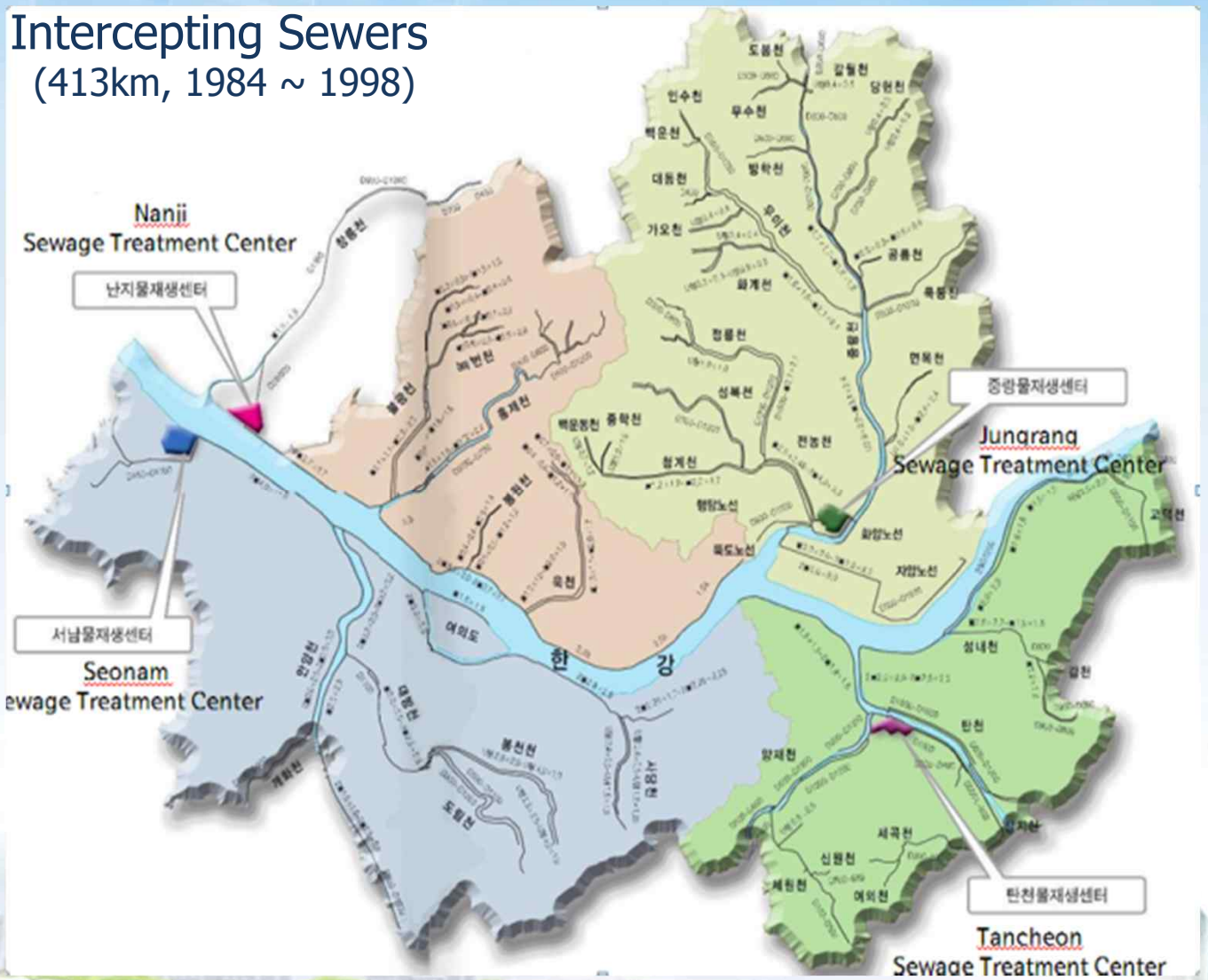
⇒ 1999. Sewage generation volume 5.65mil㎥/day, Treatment capacity 5.81mil㎥/day

3. Introduction of separate pipes(1981) to seperate rain water and waste water

- Introduce separate pipes in new built-up areas
- Start with areas such as Gaepo, Garak, Godeok, Mokdong, Sanggye, Junggye

※ intercepting sewers (413km) during 1984 ~ 1999

Development of Sewerage Management in Seoul



Development of Sewerage Management in Seoul

1980s ~ 1990s : Seoul’ s Policy

4. Rehabilitation of existing pipes: Examine the pipes & Devise a maintenance plan(1992)

- Examine the existing pipes in each drain area
- Devise a systematic plan to repair decrepit or damaged pipes

5. Introduction of Trenchless Pipe Lining in pipe maintenance(1995)

- Problems of excavation: Compromise aesthetic feature of the city, traffic congestion, road wear due to hardening of site, inconvenience for residents , etc.

  ⇒ Introduce CIPP method which does not require excavation to rehabilitate a pipeline

  ※ Cured in place pipes lining (CIPP) : Liner is installed inside the pipes to build new pipes and repair the existing ones (First applied to pipes in Shingye-dong, Yongsan-gu)

Development of Sewerage Management in Seoul

❖ Despite the development of the sewerage system, streams were still left as dead spaces until the late ’90s. The downtown areas near the covered streams became dilapidated with unpleasant conditions like hateful stench coming from the streams below.

Development of Sewerage Management in Seoul

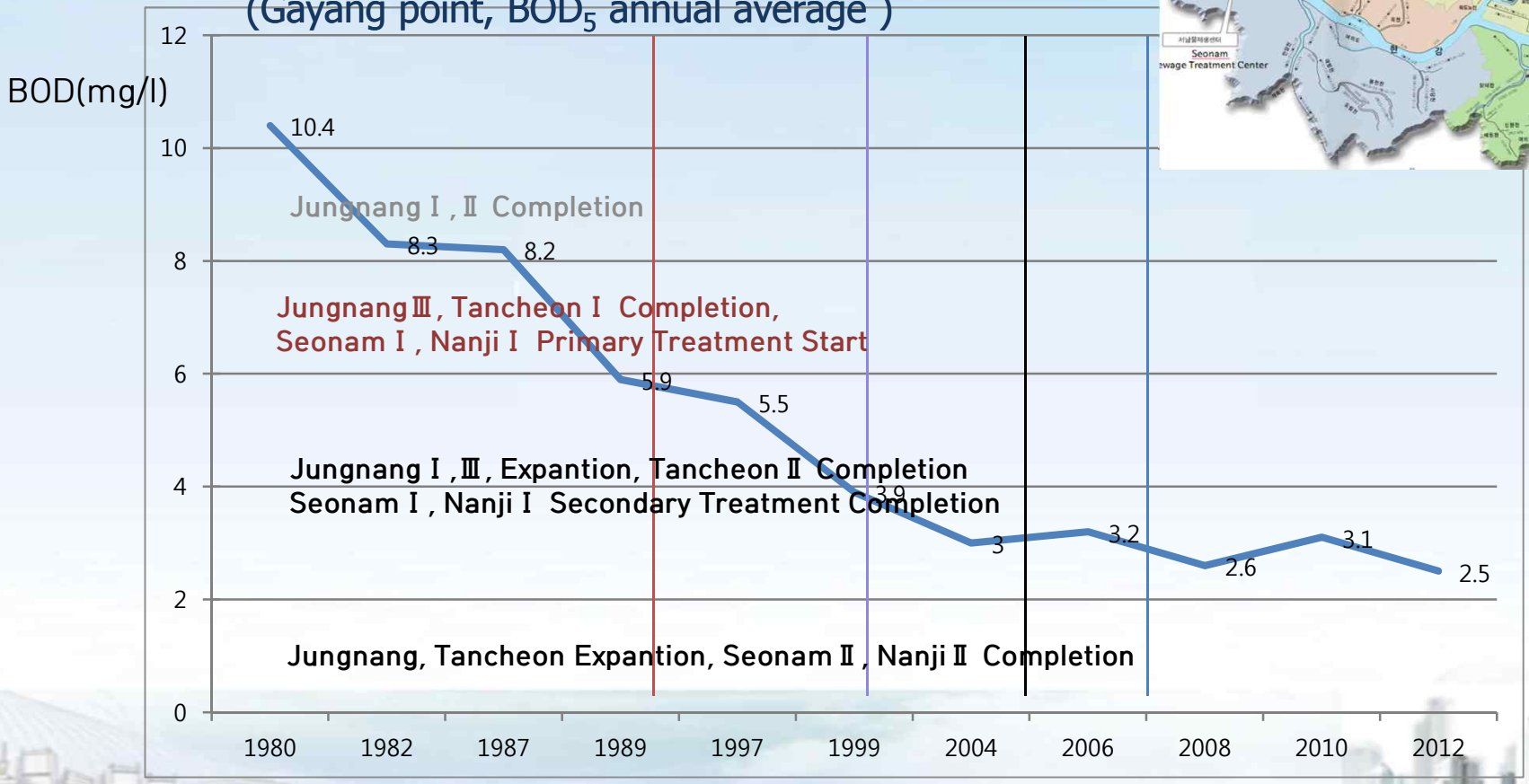
❖ Construction of Sewage Treatment Plants in Seoul

Plants	Year	Volume (100㎥/d)	Construction Cost (Million Won)	Cost(Converted to 2012 price)	Treatment Rate (Primary)	Treatment Rate (Secondary)
Jungnang Ⅰ	1976	150	6,143	32,452	7.0%	7.0%
Jungnang Ⅱ	1979	210	9,632	35,203	15.0%	15.0%
Tancheon Ⅰ	1987	500	129,595	268,304	77.3%	36.8%
Seonam Ⅰ(primary)	1987	1,000	35,456	73,406	77.3%	36.8%
Nanji Ⅰ(primary)	1987	500	23,676	49,017	77.3%	36.8%
Jungnang Ⅲ	1988	750	130,323	262,724	92.8%	54.2%
Tancheon Ⅰ Expantion	1991	100	851	1,549	79.4%	47.3%
Jungnagn Ⅰ,Ⅲ Expantion	1992	350	48,101	85,712	85.1%	53.7%
Tnacheon Ⅱ	1994	150	45,803	78,281	79.4%	79.4%
Seonam Ⅰ (Secondary)	1994	1,000	118,219	202,046	79.4%	79.4%
Nanji Ⅰ (Secondary)	1994	500	57,406	98,112	79.4%	79.4%
Jungnang Ⅲ Expantion	1997	250	65,263	99,440	87.5%	87.5%
Nanji Ⅱ	1997	500	102,368	155,976	87.5%	87.5%
Tancheon Ⅱ Expantion	1998	350	50,349	68,369	99.8%	99.8%
Seonam Ⅱ	1998	1,000	208,096	282,572	99.8%	99.8%

Development of Sewerage Management in Seoul

Han River Water Quality

(Gayang point, BOD_5 annual average)



Development of Sewerage Management in Seoul

2000s ~ Present : Background

- National Income : USD 10,159 → 20,250 in GNI
- Population : 10.37mil(2000) → 10.17million(2013. 8)

- **Sewage conditions**

  - Greater demand for improvement in the surrounding environment (ex. eliminate odor) with the increase of residential buildings in the vicinity

  21,400 households reside within 300m (Tancheon 12,644, Jungnang 1,367, Seonam 7,219, Nanji 177)

  - Mandatory onshore treatment of sludge following the ban on ocean disposal (2005)
  - Strengthened sewage treatment standards (2008, 2010)

  BOD 20 → 10 ㎎/l, T-P 2 → 0.5 ㎎/l

Development of Sewerage Management in Seoul

2000s ~ Present : Seoul' s Policy

1. Construct Sludge treatment facilities (2002)

- Construction of Sludge treatment facilities (700t/d)

2. Introduce Advanced Sewage Treatment Facilities (2007 ~)

- Construct advanced sewage treatment facilities at the Jungnang Sewage Treatment Center (Capacity 46,000 ton/day)
- Improve the existing facilities at the four centers

3. Transform into a facility that produces new and renewable energy

- Install solar panels
- Initiate the project to use congestion gas fuel

4. Ensure transparent management of the sewage treatment facilities & consultation with the residents for community support programs (2012)

- Set up a steering committee for each center (composed of 7~10 members, selected by the administrative district council), Invite residents to participate in consultation and debates

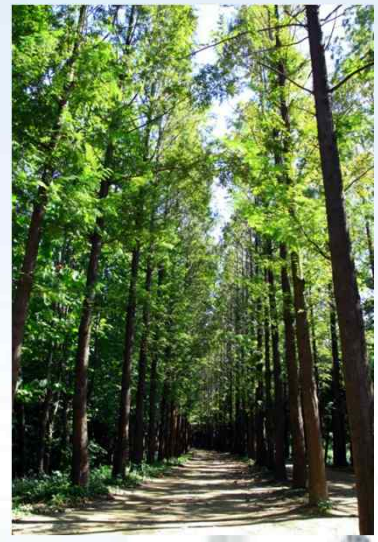
Development of Sewerage Management in Seoul

2000s ~ Present : Seoul’ s Policy

5. Eliminate sewer plant odor and build convenience facilities for the residents

- Construction of offensive odor prevention facilities and creation of parks, sports utilities, play grounds, etc for resident use (308,000㎥ of 4 sewage treatment plants)

Tancheon Park



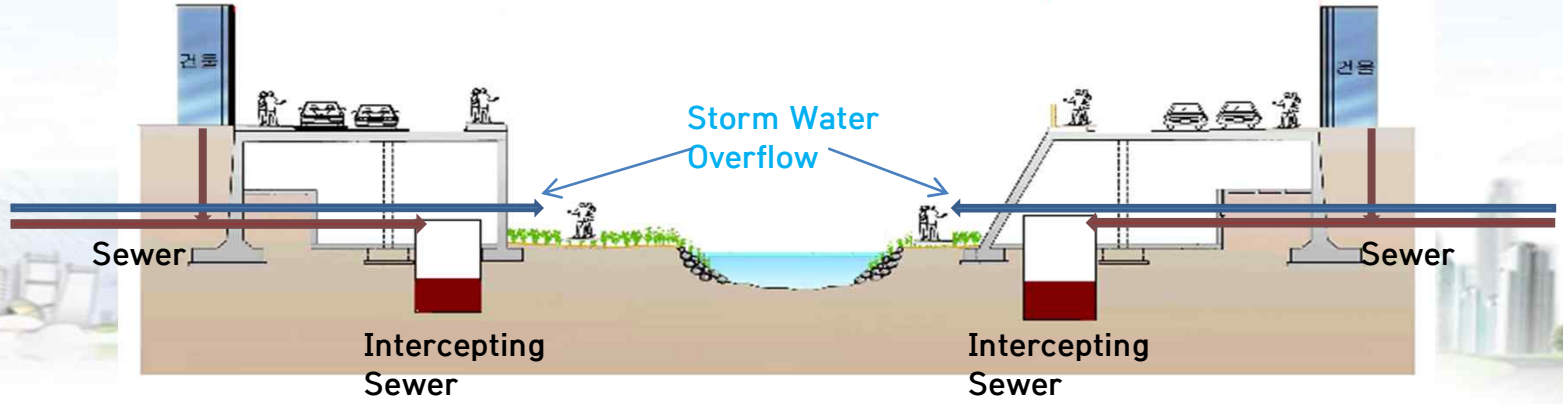
Seonam Environment Park (in Seonam Center)

Development of Sewerage Management in Seoul

Effects of 100% Sewage Treatment

- Transformation of the covered-up roads into eco-friendly spaces

Opening of newly restored Cheonggye Stream (Oct. 1st, 2005)



Development of Sewerage Management in Seoul

Effects of 100% Sewage Treatment

Seongbuk Stream

Danghyeon Stream

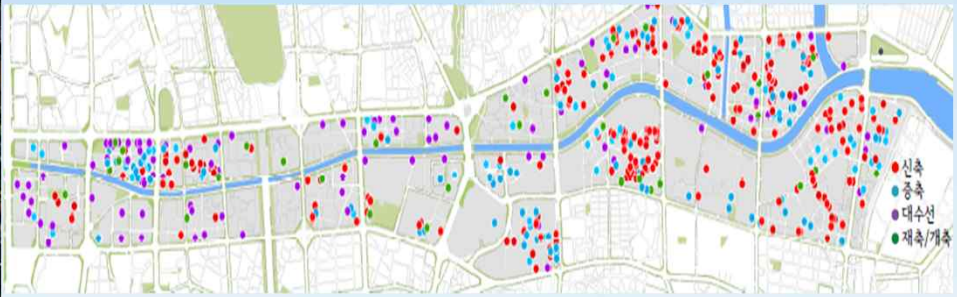
Dorim Stream

- Transformation of the streams into ecological parks

❖ After the completion of 100% sewage treatment service in 1999, over 17 streams have been restored as echo spaces, walking paths and playgrounds.

Development of Sewerage Management in Seoul

Impact of 100% Sewage Treatment



- New construction
- Expansion
- Repair
- Reconstruction

❖ The downtown area near the restored streams in Gangbuk regained a competitive advantage.

❖ Existing markets in the area regained their vitality and a lot of buildings have been repaired or newly constructed, too.

Problems of the Sewerage System in Seoul

- **CSO(Combined Sewer Overflow) Problem**

  - Seoul's sewers were mostly designed to discharge the mixture of sewage and storm water into streams at 1,140 CSO discharge points when the flow volume exceeds 3 times the hourly maximum flow of sewage in the event of heavy rain.

  - The runoff condition and volume of sewage generation in some drainage areas have changed, thus in need of bigger intercepting sewers than the already installed ones.

  - Combined Sewer Overflows from discharge points usually contain a lot of pollutants, thereby threatening public health. Such negative impact of CSOs can be minimized by installing pollutants reduction facilities with storm water detention facilities at discharging points and increasing the capacity of intercepting sewers in some drainage areas.

  - However, these measures require huge expenses (about USD 360 mil) and a long time for planning and execution.

Problems of the Sewerage System in Seoul

- **Sewer Repair & Replacement**

  - 18.8% of sewers in Seoul were constructed 30 years ago and 57.9% were built 20 years ago. Many of them have problems like decrepitude, leakage from bad joints and insufficient discharge capacity. The total forecast expenditure during next 10-year period for sewer repair and replacement purpose is over USD 4.4 billion.

- **Strengthening of Effluent Standards**

  - In an effort to prevent water pollution, the national effluent standards have been continuously strengthened for the last 20 years. BOD limitation was lowered to 10mg/l in 2008 from 20mg/l. Total phosphorus concentration limitation, which was 8, has been strengthened to 2 in 2008 and 0.5 in 2012.

  - In addition, the national environmental law will soon mandate the local governments to implement total water pollution load management system and first flush control system. Therefore, local governments will need to not only secure additional budget but also spaces to build the new facilities.

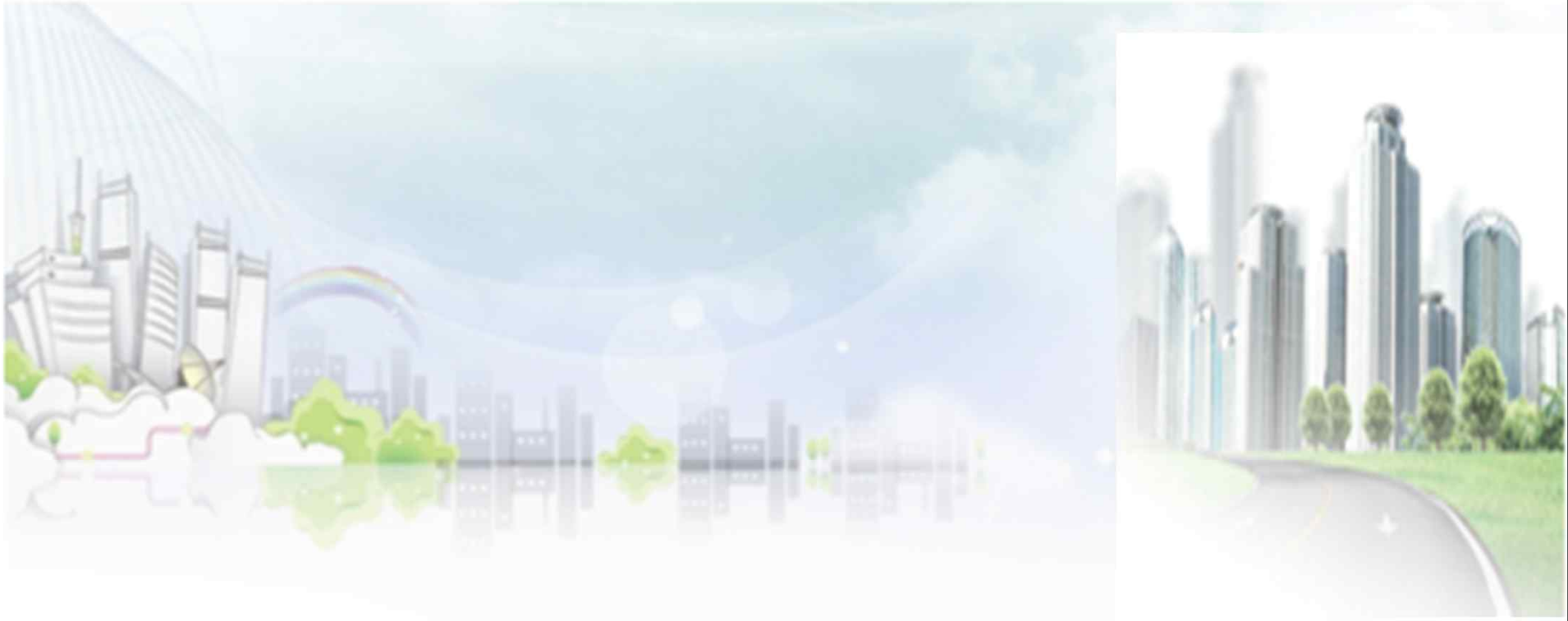
Problems of the Sewerage System in Seoul

- **Public's Complaint about the Sewage Treatment Plants**

- Three sewage treatment plants are located in the residential areas of Seoul and a lot of households are adjacent to the plants. Another plant is located in the suburb of Seoul but several small towns are located near the plant. Therefore, since the beginning of the plant operation, many citizens complained of offensive odor and property value depreciation.

- Seoul Metropolitan Government has achieved great success in eliminating the odor but there are still civil complaints about inconvenience.

Development Plans for Sewerage System



Sewer Reconstruction Plan

Purpose

To Secure Optimal Flow Velocity	To prevent sedimentation and bad smell		
To Secure Discharge Capacity	To ensure civil safety and protect property against flooding		
To Secure Water Tightness	To prevent contamination of soil & stream; To protect sewers from infiltration/inflow		
To Enhance Durability	To extend sewer lifespan; To prevent the occurrence of negligent accident		

Sewer Reconstruction Plan

Overview of the Repair and Replacement Plan

- Construction Period : 2010 ~ 2020
- Budget : USD 4,460 million
- Target : 3,705 ㎞ of decrepit sewers with leakages from bad joints and insufficient discharge capacity

Policy Direction

- Planning by drainage area unit – Starting with lower drainage areas first
- Citizen-friendly construction

- Application of trenchless technology

- Lightweight lining with temporary facility for open-cut

Construction of Advanced Treatment Facilities

Background

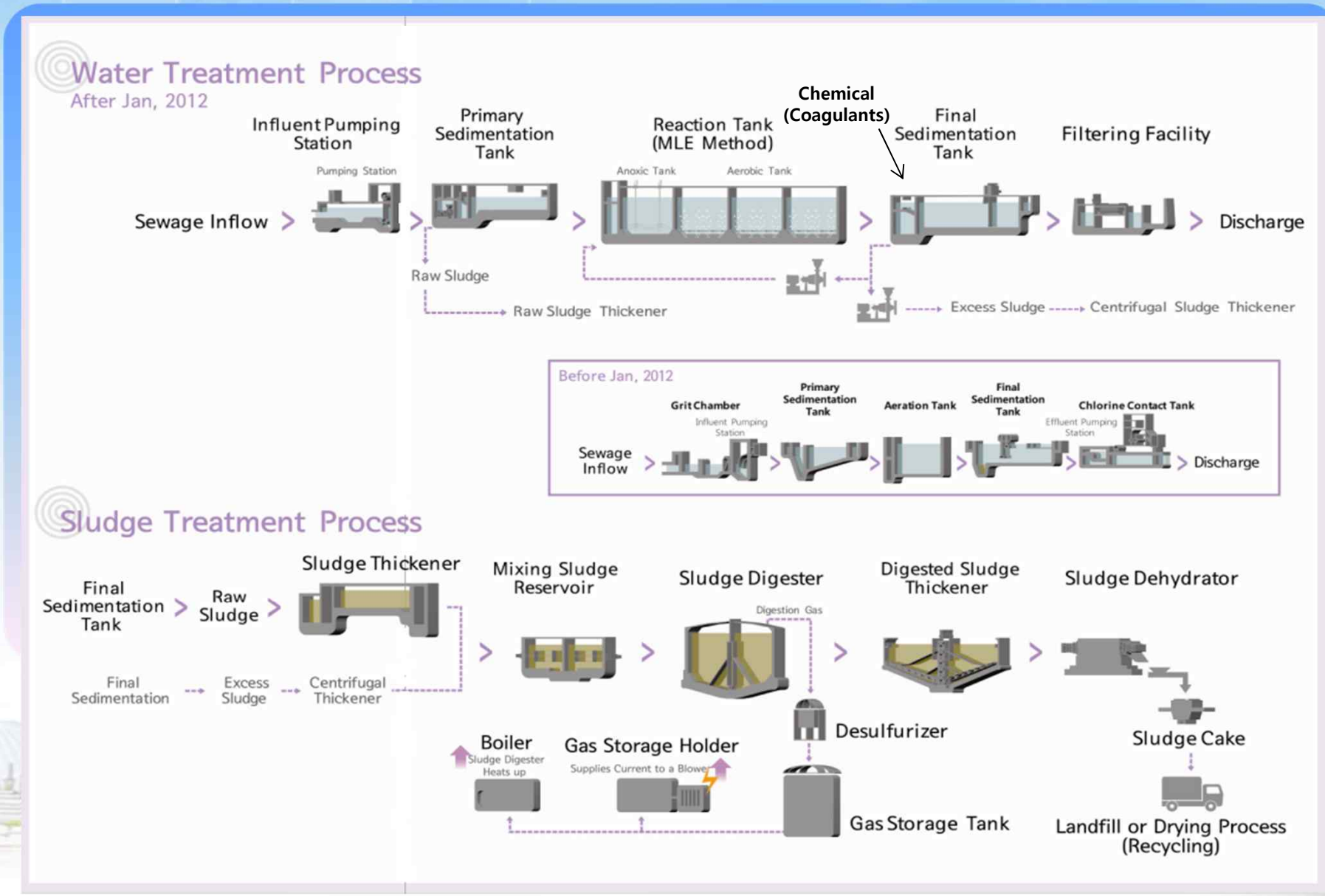
- Necessary to meet the newly strengthened standard of phosphorus: 0.5 ㎎/ℓ in 2012
- Safe treatment of phosphorus to prevent eutrophication

Construction Plan

- Construction Period : 2009 ~ 2013
- Budget : USD 270 million
- Target : 4 Centers
- Stricter standard on treatment process and efficiency

Process	Standard Activated Sludge (Before 2012)	MLE (Modified Ludzack-Ettinger) + Chemical Treatment (After 2012)
Treatment Efficiency	• 93% BOD Removal Rate : 150㎎/ℓ→10㎎/ℓ • 93% SS Removal Rate : 150㎎/ℓ→10㎎/ℓ • Phosphorus (Effluent) : ≤ 2.0 ㎎/ℓ	• 96% BOD Removal Rate : 170㎎/ℓ→ 7㎎/ℓ • 95% SS Removal Rate : 131㎎/ℓ→ 7㎎/ℓ • Phosphorus (Effluent) : ≤ 0.5 ㎎/ℓ

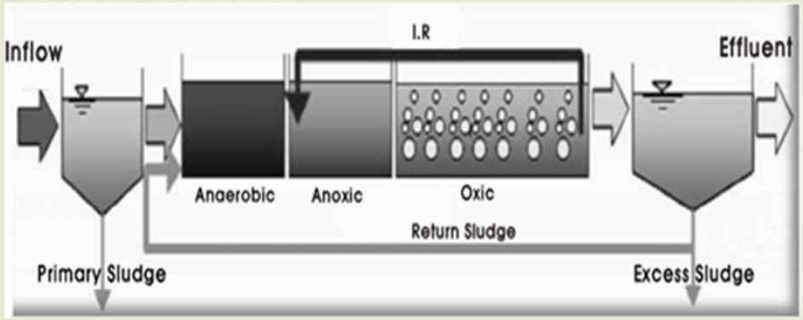
Construction of Advanced Treatment Facilities



Construction of Advanced Treatment Facilities

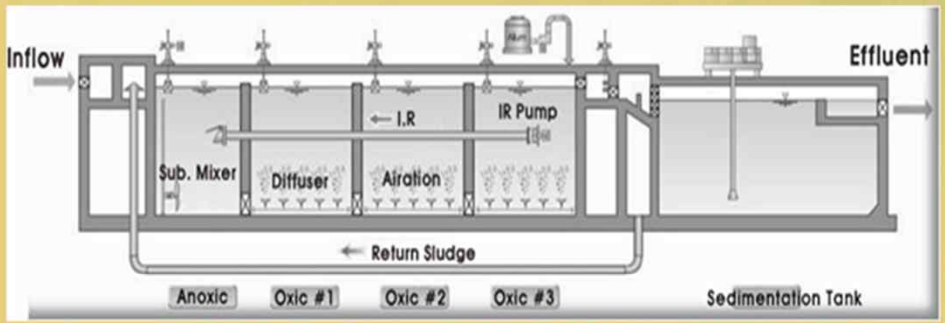
Applied Method

A2O Process



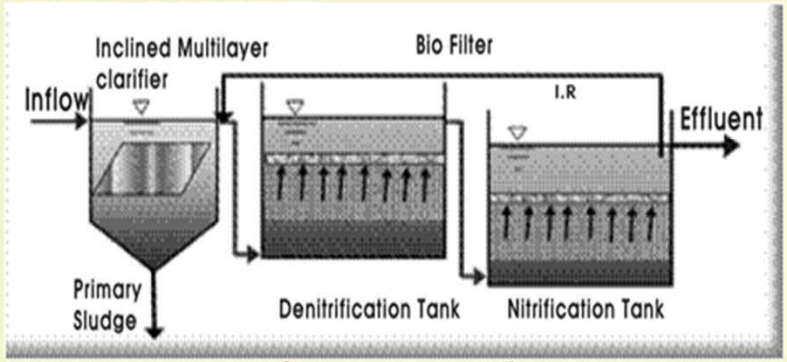
(Jungrang 460,000Ton/Day, In Operation)

MLE Process



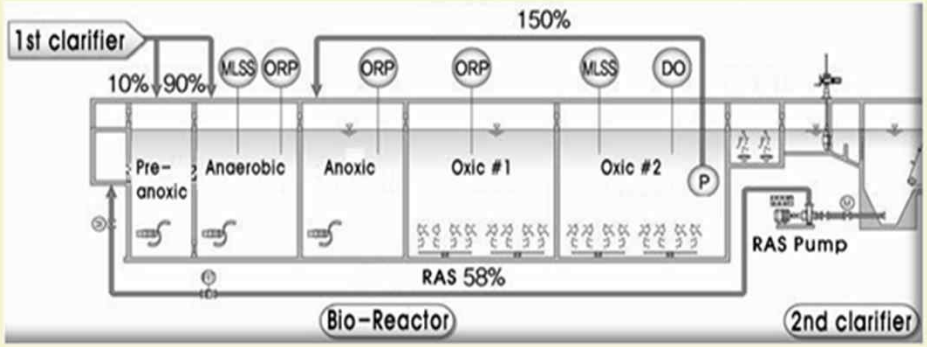
(Jungrang 880,000Ton/Day Seonam 1,270,000Ton/Day, Nanji 860,000Ton/Day, Tancheon 900,000Ton/Day)⇒3,910,000Ton/Day(By 2012.12)

SBAF Process



(Jungrang 250,000Ton/Day, By2014.01)

4-Stage BNR Process



(Seonam 360,000Ton/Day, By 2015.8)

Expansion of Sludge Treatment Facilities

Background

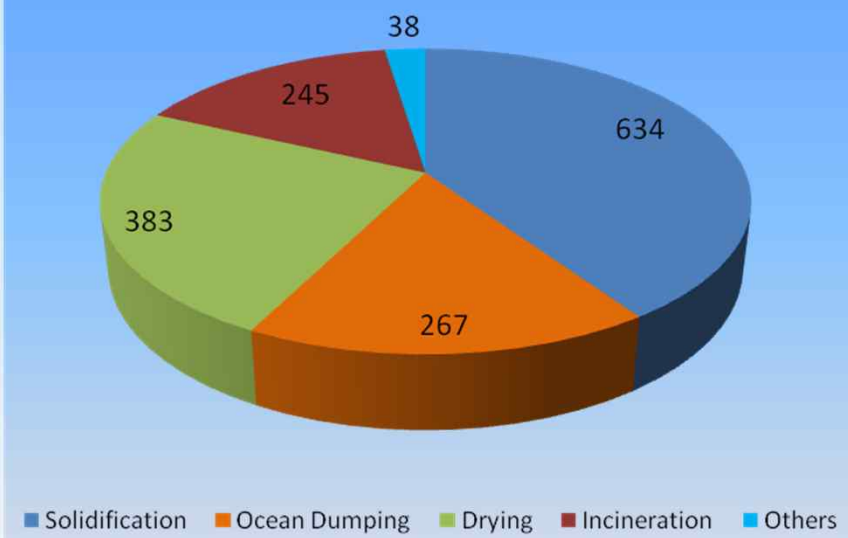
- Prohibition of ocean dumping with the enforcement of the London agreement「96 protocol」 and revision of the Sea Contamination Prevention Law (from Feb. 2012)
- Preparation for increase of sludge from newly adopted phosphorus treatment process

Construction Plan

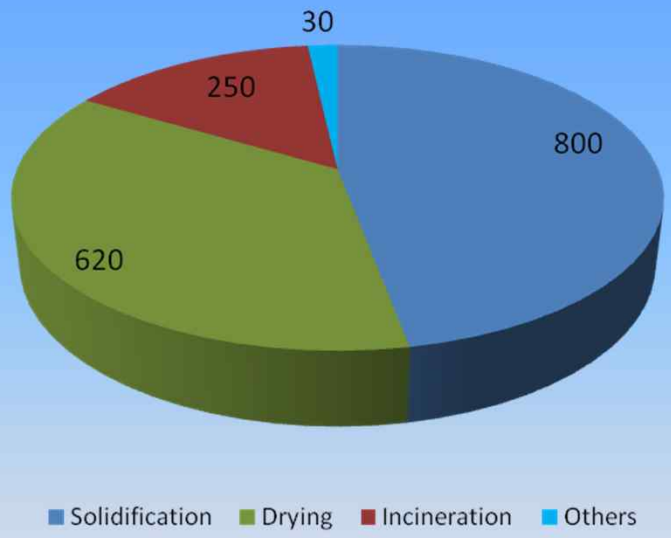
- Construction Period : 2011 ~ 2013
- Budget : USD 40 million
- Newly constructed facilities : 450t/d (present 1,700 → 2,150t/d (after Jan.2014))
  - Jungnang : 100t/d, Drying facility
  - Nanji : 150t/d, Drying facility
  - Sudokwon Landfill Area : 200t/d (part of 1000t/d), Drying facilities

Expansion of Sludge Treatment Facilities

2011 (1567 ton/day)



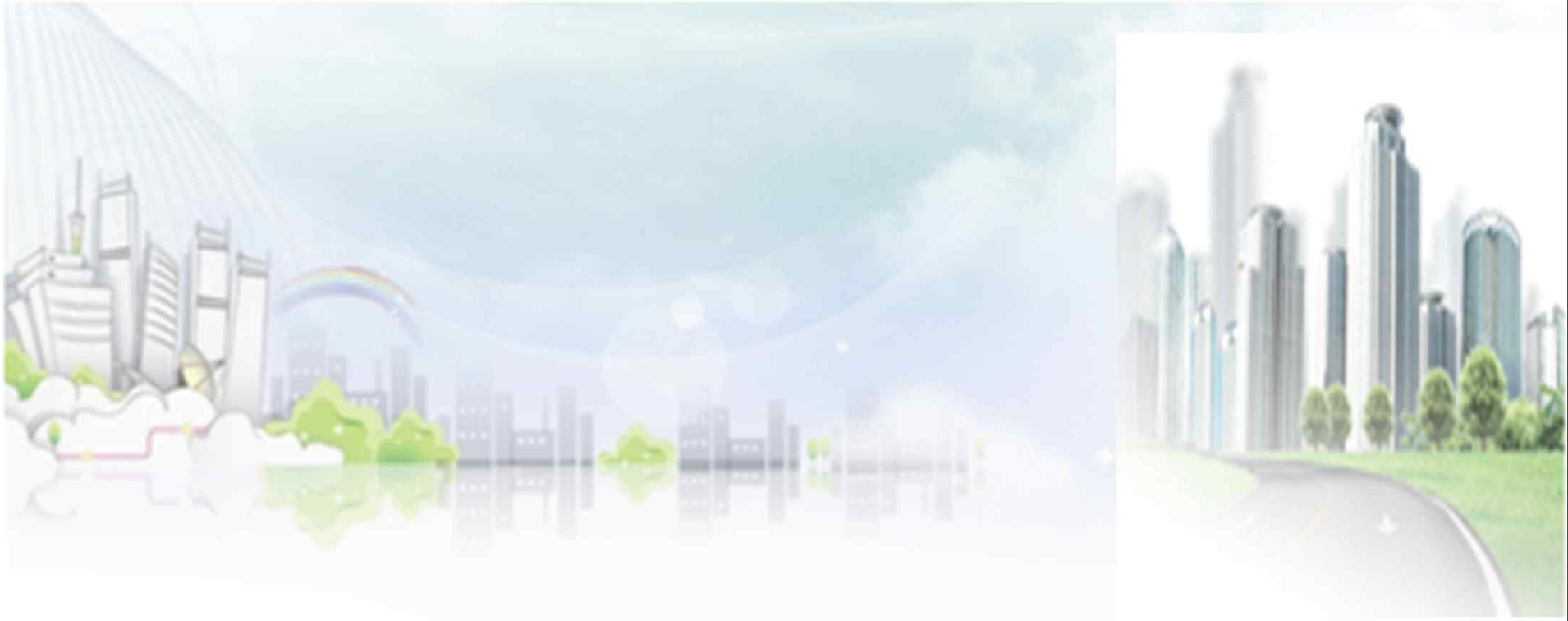
2014 (1700 ton/day)



Drying Facility

Sudokwon Landfill Facility

Future Policy Direction



Modernization Plan for Jungnang & Seonam

- **What is Modernization of Sewage Treatment Plants in Seoul?**
  - Integrating and laying facilities underground
  - Adopting advanced technology for new facilities
  - Creating parks and recreation areas on the ground
- **Target Centers : Jungnang, Seonam**
  - 3-stage construction (2007~2027)

Modernization Plan for Jungnang & Seonam

- Modernization of **Jungnang Center**

  - Scope of modernization : 1,130,000㎥/d (Extra 460,000㎥/day – Previously retrofitted)

  - Period : 2007 ~ 2026 (20years)

  - Budget : USD 853 million

[1st Stage of the Project (250,000 ㎥/d]

  - 2007 ~ 2015, USD 188 million

  - Above-ground structures ***: Sports areas, Water museum, Ponds and***

Modernization Plan for Jungnang & Seonam

- Modernization of **Seonam Center**
  - Scope of modernization : 1,630,000㎥/d
  - Period : 2008 ~ 2027 (20years)
  - Budget : USD 1,210 million

[1st Stage of the Project (360,000 ㎥/d)]

- 2008 ~ 2016, USD 269 million
- Above-ground structures ***: Water science museum, Water garden***

Resident-Friendly Sewage Treatment Center

Purpose : Build "Resident-friendly facilities"

by changing STCs to *"Parks or Eco-friendly space"*

1. Creation of Covered Parks at Tancheon Center

- Site area : 392,671㎡, Covered area : 109,381㎡
- Project Cost : USD 63.3 billion
- Project Period : 1999~2015

  - 1st stage : 1999~2004, 10283㎡, - 2nd : 2005~2007, 15600㎡, - 3rd : 2007~2010, 49700㎡
- Facilities : Park, Forest zone, Sports areas, Children's playground, Parking lot, etc
- Future Plan : 4th Stage 33,798㎡ (2013~2015, about 45 billion won)

Resident-Friendly Sewage Treatment Center

Tancheon Center Area View

Resident-Friendly Sewage Treatment Center

2. Creation of Resident-Friendly Space around Seonam & Nanji

- Forest park and Sports facilities at **Seonam center**
  - Total Area : 188,500㎡
  - Project Cost : USD 8.1 million
  - Project Period : 2008 ~ 2011.6
  - Facilities : Walking trail, Forest, Tennis courts, Golf course, etc.
- Sports Facilities at **Nanji center**
  - Total Area : 10,000㎡
    (Football field, Basketball court, etc)
  - Project Cost : 1,000 million won, 2010~2011.2

3. Future Project

- **Nanji Modernization** Plan
  - Project Cost : USD 49.3 million
  - Project Period : 2013 ~ 2020
  - Facilities : Walking trail, Forest, Sports facilities, etc

Use of New & Renewable Energy

- **New & Renewable Energy**
  - Energy that comes from sources that are continually replenished such as sunlight, wind, tides, waves, and geothermal heat
- **Use of New & Renewable Energy in STCs**
  - Sewage Treatment Systems are basically energy-intensive facilities; however, there is a huge potential to produce new & renewable energy at STCs using digestion-gas, sewage heat recovery, photovoltaic power generation, and etc.

Goal of Energy Self-Sufficiency Rate for 4 STCs in Seoul

Year	2011	2015
Target Energy Self-Sufficiency Rate for STCs	• 25%	• 50%
Energy Consumption of 4 STCs	•129,842 TOE/Year (mostly Electricity)	•140,436 TOE/Year (increase with advanced treatment facilities)
Energy Production at 4 STCs	• 39,079 TOE/Year (mostly digestion gas)	• 80,626 TOE/Year (digestion gas increase, construction of sewage heating pump and photovoltaics)

양버들9 한글이 "소화가스 증가, 열펌프 건설, 태양전지 설치"가 맞는지?
양버들, 2013-11-25

Use of New & Renewable Energy

Photovoltaic power generation

- Construction of solar cells on the treatment tanks and on the ground
  - Plan : 2,000kw (2012, Jungnang 400, Nanji 100, Seonam 1,300)
    → 10,770kw (2 015, Tancheon 2,280, Jungnang 690, Seonam 6,000)
  - Construction Cost : USD 46.6 million (invested by Electricity Generation Enterprisers)

Seonam Photovoltaic Arrays(1,300kw)

Use of New & Renewable Energy

Sewage Heat Recovery

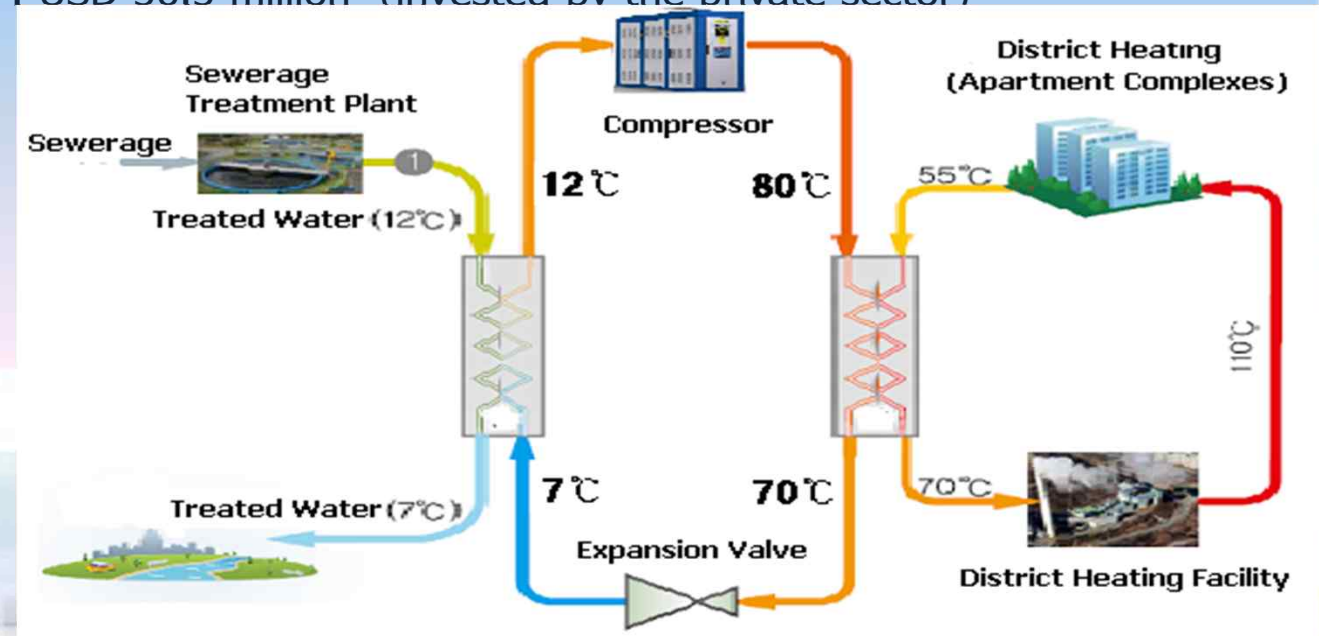
- Recovery of heat from treated water

※ 5℃-Thermal energy recovery can be achieved by heat-pump installation

- Plan : 52 TOE (2010, Jungnang 26, Seonam 26) → 19,000TOE (2014, Tancheon 19,000)

→ 30,000TOE (2015, Seonam 11,000)

- Construction Cost : USD 56.5 million (invested by the private sector)



Use of New & Renewable Energy

Digestion Gas

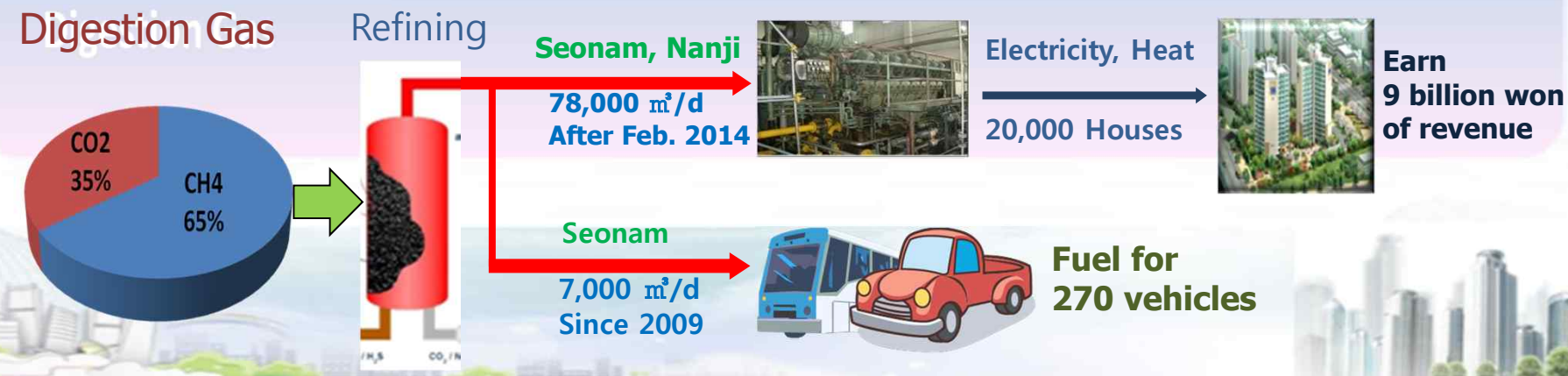
- Increase of gasification rate and enhancement of utility value

  - Plan : 201,900㎥/d(2012) → 260,000 ㎥/d (2015)

    ☞ Cavitation and Ultrasonic Wave Treatment at the inlet line of sludge digester

❖ Present Gas Usage : Digester Heating 49%, Sludge Dry 22%, Generation 5.8%, Fuel for industry 7.7%, Burning 14.5%

⇒ By enhancing digestion gas values through refining and selling gas to cogeneration enterprises, over USD 8 million of revenue can be earned annually



Re-use of Treated Water

Current: 5% (220,000 ㎥/d)

- Road Cleaning and Cooling water
- Subway Train Washing
- Others

Future Goal: 10% of discharge

- Maintenance water for streams
- Water for landscaping
- Cleaning water, etc.

Maintenance water of stream

Water for Landscaping

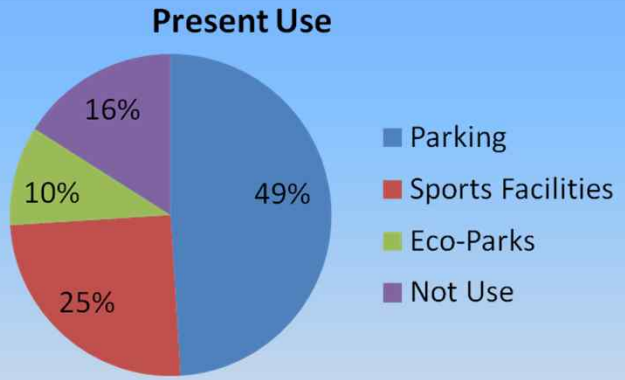
Cleaning water

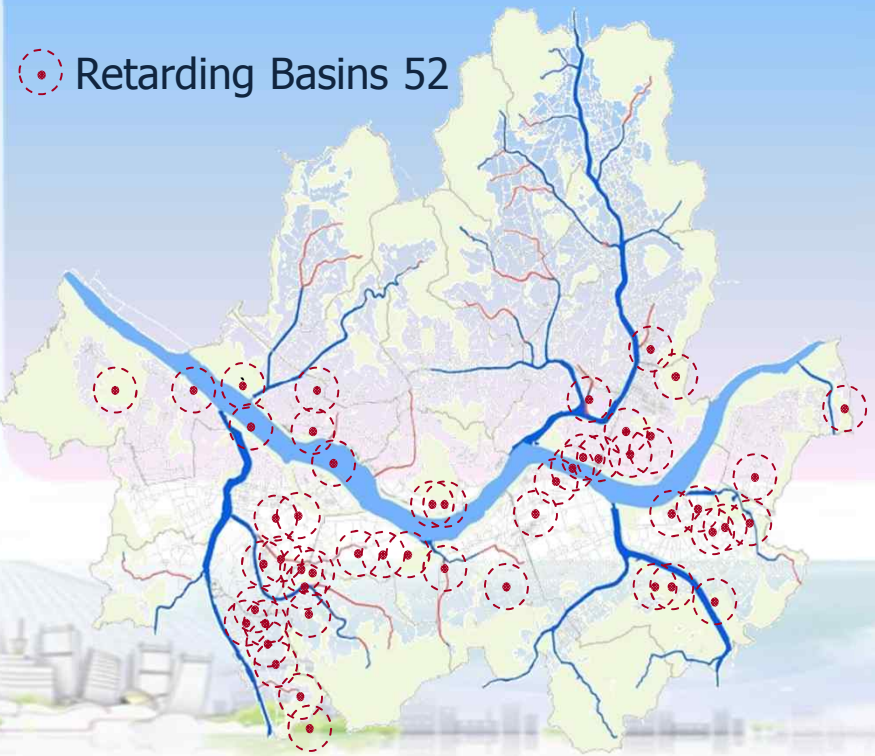
Practical Use of Retarding Basins in Urban Areas

Function of Retarding Basins

Collect the torrents and slow it down to help reduce the impact of floods in built-up areas

Total Area in Seoul : 1,820,000㎡



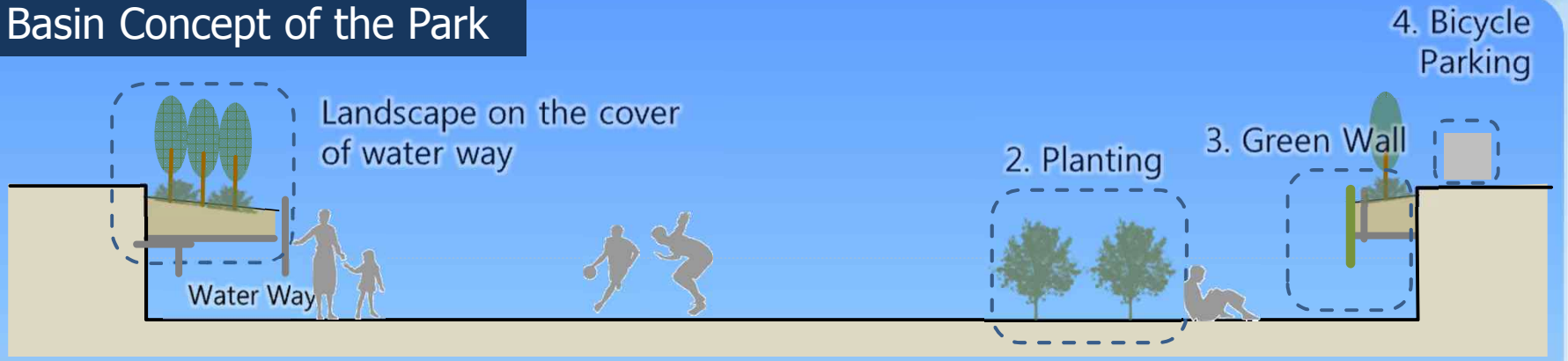


Basic Plan for Practical Use

- Change to ecological space for residents
- Create a Cultural Complex

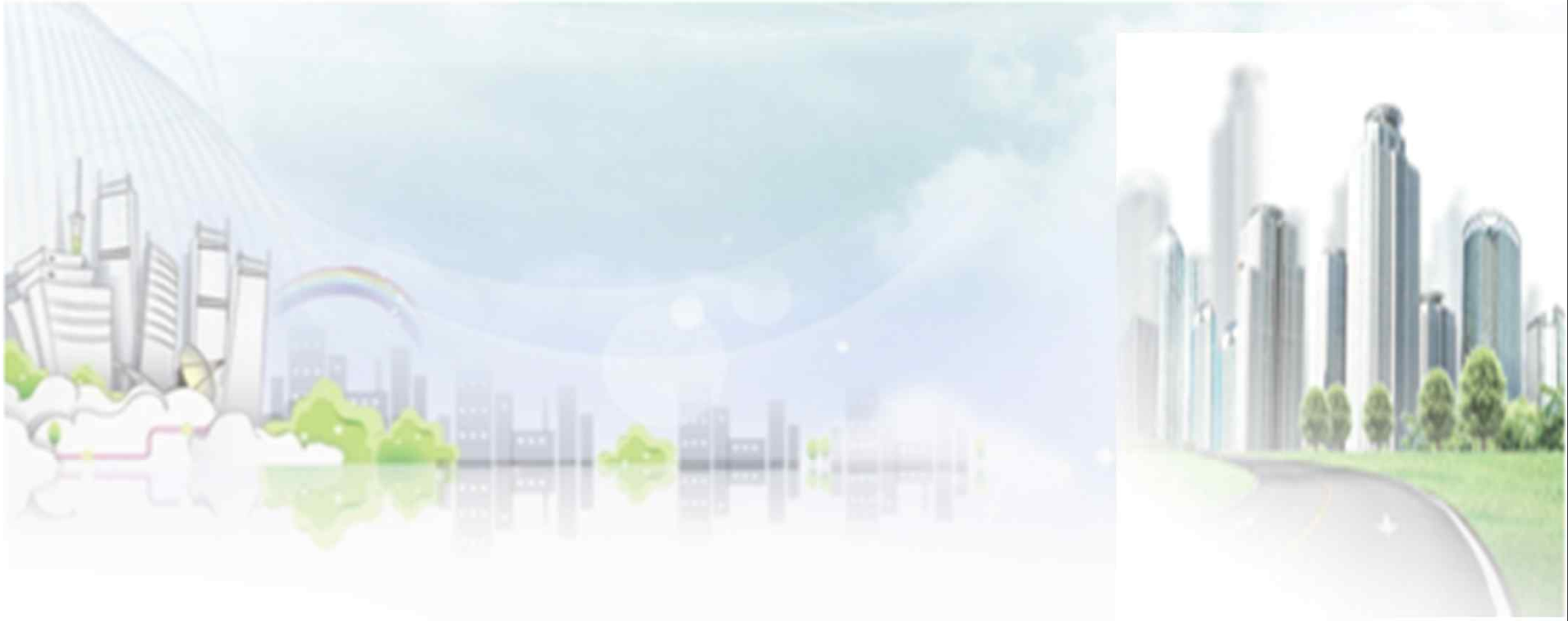
Practical Use of Retarding Basins in Urban Areas

Basin Concept of the Park



Cultural Complex

Recommendations



Why should we treat sewage?

- **To secure pleasant living space**
- **To protect the water environment**
- **To increase the usability of water which is one of most important resources in our society**

Combined sewer vs. Separate sewer

- **Consider existing sewers and condition of planning drain areas.**
  - Urban areas where sewers are already constructed:

    Adopt storm overflow chamber and intercepting sewer in order to create a combined sewer system
  - New town sites : Separate sewer system is recommended
  - Rural areas : Incomplete separate sewer system is recommended
  - Separate sewer system : Be careful not to misconnect sewers

Large scale plants(centralized) vs. Small plants(on-site)

- Advantage of Centralized Treatment

  ➢ Large scale plant is feasible from the construction and operation expense aspect

  - Plant construction cost for 1㎥/d sewage in Korea (1985~2011)

Capacity	Over 300,000 ㎥/d	100,000 ~ 300,000 ㎥/d	10,000 ~ 100,000 ㎥/d	500 ~ 10,000 ㎥/d
Construction Cost (Won/1㎥ sewage)	21 sites USD 314	31 sites USD 762	135 sites USD 1,740	314 sites USD 4,789

❿ Disadvantage of Centralized Treatment

➢ Centralization of sewage makes the sewers larger and additional facilities like pump stations necessary → May incur greater expenses for sewer maintenance

➢Centralization treatment may cause water in adjacent streams to run out

➢ Longer sewers may cause inflow/infiltration problems → Sewage volume may exceed design capacity and lead to decreased efficiency of treatment

❿ **Should consider the distance between urban clusters and the possibility of complaints from residents living in adjacent areas.**

Construction

- **Prepare progressive expansion plans in line with the urban development plans**
  - Decide the construction timing of the Primary, Secondary, Advanced treatment
  - Determine the order of priority of drain areas : upstream, downstream
- **Install the sewer taking into account the future land use of drainage area**
  - Consider the facility capacity, durability, and maintenance procedures
- **Decide the treatment method by analyzing the local circumstances**
  - Find low cost, highly efficient methods under local conditions
  - Consider the relationship with local residents.
  - Consider the disposal method of byproducts such as sludge and bio-gas, etc.

The sewerage system of Seoul shall largely contribute to the safe and comfortable lives of the citizens and the preservation of planet Earth.

Thank you!