Decentral Rainwater Management Policy and Implementations in Case of Seoul and Andong South Koreas

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Abstract

Decentral Rainwater Management Policy and Implementations in Case of Seoul and Andong South Koreas

- As urbanization increases impervious areas and climate change intensifies.
- The importance of urban rainwater management is increasing.
- In the city of Seoul, various policies for decentral Rainwater management have been established to reduce the load on sewage and restore the urban water cycle.
- In addition, rainwater management functions are being granted to existing urban infrastructure through prior consultation policy.
- In the city of Andong, about 7,000 plant-box are being constructed to become an urban green dam.

Content

1. Seoul Water Cycle Recovery Preliminary Consultation System

2. Cases of Seoul Water Cycle Recovery Projects in Seoul

3. Andong City Green Dam

1. Seoul Water Cycle Recovery Preliminary Consultation System

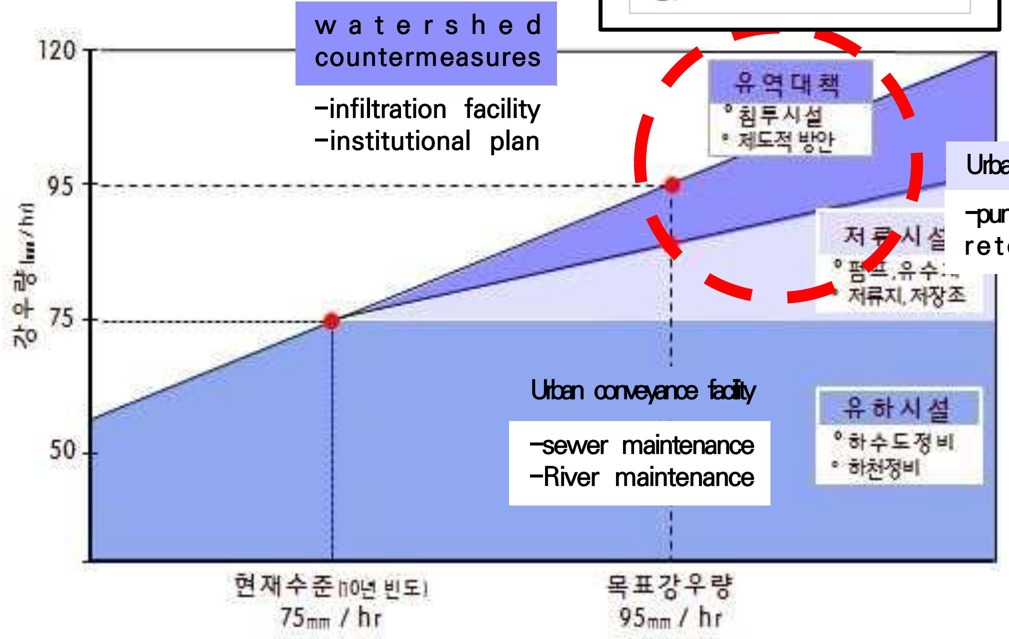
Water Cycle Recovery Preliminary Consultation System

Ministry of Interior and Security (2017): Presenting the Necessity of Watershed Countermeasures

- 미래 기후변화 영향 등을 고려한 -
지역별 방재성능목표 설정 · 운영 기준

2017. 12.

Ministry of the Interior and Safety



Seoul City: The first implementation of water countermeasures the by preliminary of consultation system of low-impact development

www.seoul.go.kr
제 3213호
2014. 1. 16.(목)
서울시보
시보는 공문서의 효력을 갖습니다.

◈ 서울특별시고시 제2014-14호

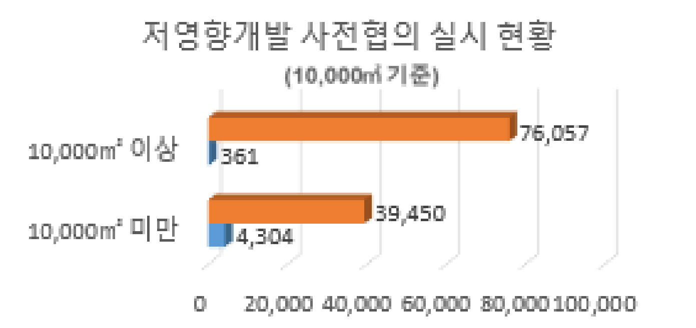
빗물분담량 및 빗물분담량 적용을 위한 평균포화투수계수 고시

서울특별시 물순환 회복 및 저영향개발 기본조례 제6조제1항에 따라 각 발생원에서 빗물 유출을 관리하여야 하는 빗물분담량과 그 적용을 위한 평균포화투수계수를 다음과 같이 고시합니다.

2014년 1월 16일
서 울 특 별 시 장

1. 빗물분담량

water countermeasures (mm/hr)	Public·Education	Parks	Transportation·infrastructure	Large-scale private facil	Small-scale private facil
	6.0	7.5	5.0	5.5	3.5



Consultation number	Amount of imstallaion countermeasure(㎥/h)
4,665	115,507

〈Seoul city: Counsultation statics, 2014~2021〉

1. Seoul Water Cycle Recovery Preliminary Consultation System

Outline of system

■ Base for implementation

– 『Basic Municipal Ordinances of Seoul Water Circulation Recovary and Loew Impact Development』 Article 8 ('14 enact)

– Enforcement of Nonpoint Source Management by Linking Total Water Pollution Load Management System and LID prior consultation

■ Purpose

– An Implementer of a development or authority of approval leads Introduction of Rainwater Management Facilities Using Rainwater Contribution to minimize the outflow of rainwater in the develop area

■ Target and Subject

<table>
<tr><td rowspan="3">Target of prior consultation of LID</td><td rowspan="2">Municipal Ordinances</td><td>Rainwater Management Facilities Required</td><td>· 38 development projects, including buildings with a land area of 2,000㎡ or a total floor area of 3,000㎡ or more</td></tr>
<tr><td>Rainwater Management Facilities Recommend</td><td>· 6 facilities or buildings, such as buildings with a land area of at least 1,000㎡ or a total floor area of at least 1,500㎡
· Other facilities determined by the Mayor as facilities required</td></tr>
<tr><td colspan="2">facilities determined by the Mayor</td><td>· New-build residential use building of 20 households or more</td></tr>
<tr><td rowspan="2">Main agent of Consultation</td><td colspan="2">Seoul city</td><td>Development project with a land area of 10,000㎡ or more</td></tr>
<tr><td colspan="2">Autonomous district</td><td>Development project with a land with area lesser than 10,000㎡</td></tr>
</table>

■ onsultation on LID: Development projects with a land area of 10,000㎡ or more among prior consultations

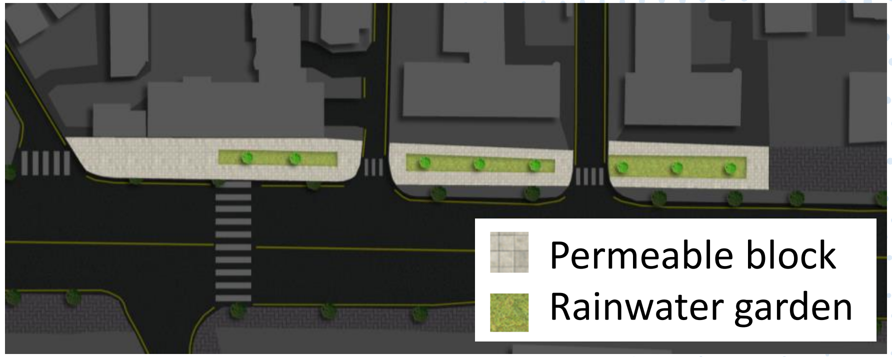
※ in document: Area between 10,000~50,000㎡ / in face: Area more than 50,000㎡, Park area more than 10,000㎡

2. Cases of Seoul Water Cycle Recovery Projects in Seoul

Case Ⅰ : Bangwha-ro 33, Gangseo-gu

■ Rainwater Management Expansion Project

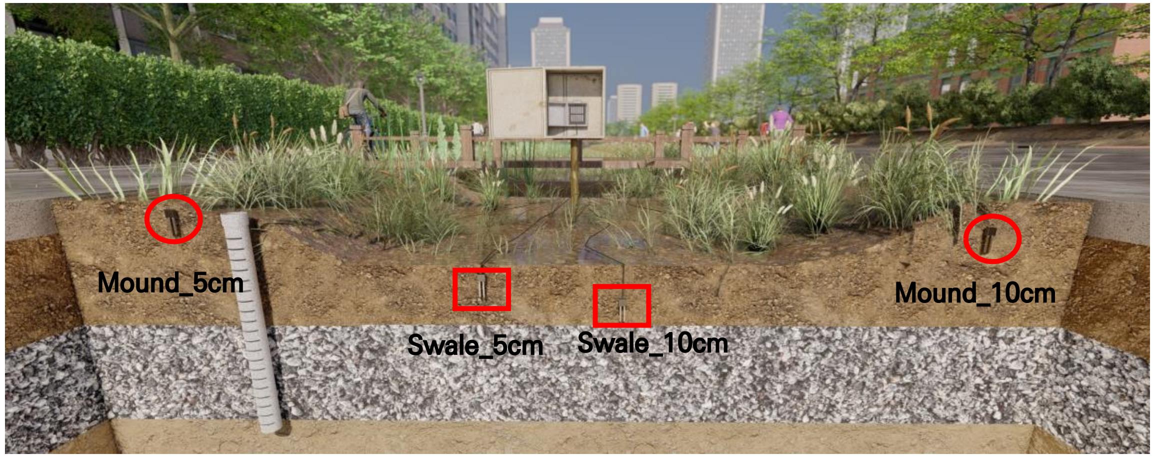
- Construction completed in 2016
- Rainwater garden, permeable block used
- Drainage area : 1,387㎡

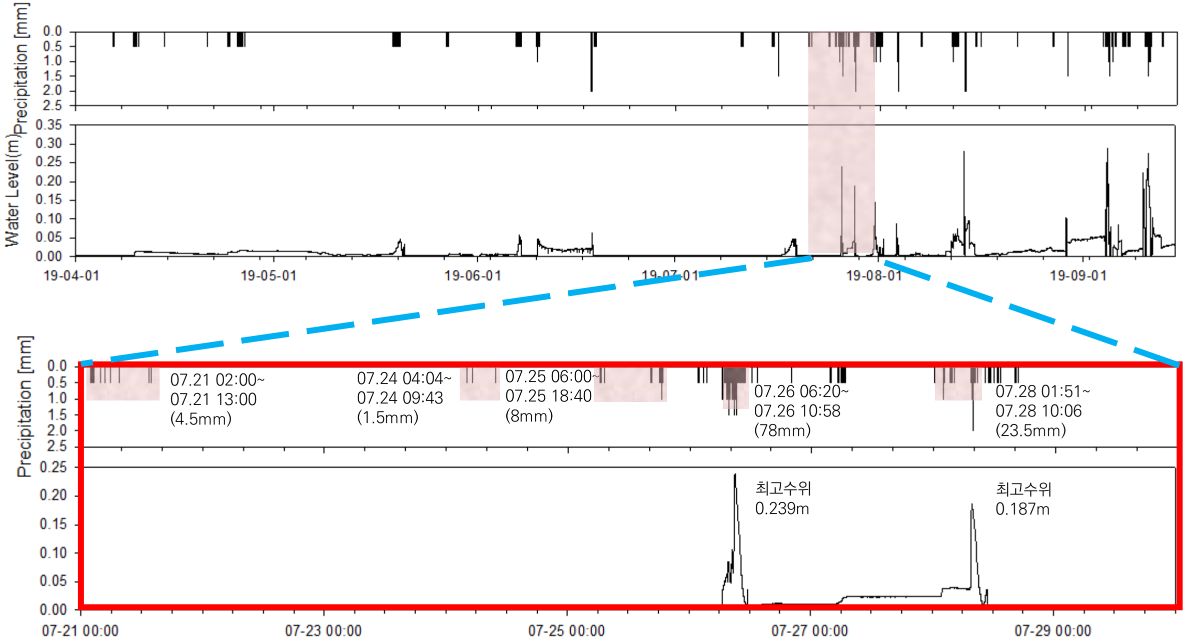


2. Cases of Seoul Water Cycle Recovery Projects in Seoul

Case Ⅰ : Bangwha-ro 33, Gangseo-gu

Facility Type	amout	measurement	Drainage area (m2)	Designed infiltration rate (m3/hr)	Designed infiltration rate (m/hr)	Water treatment Capacity (m3)	Water treatment Capacity (mm)
Permeable pavement1	215	m^2	215	3.66	17	16.51	76.8
Permeable pavement2	249	m^2	249	4.23	17	19.12	76.8
Permeable pavement3	531	m^2	531	9.03	17	40.78	76.8
Rain garden1	167	m^2	167	10.19	61	98.81	591.7
Rain garden2	128	m^2	128	7.81	61	75.74	591.7
Rain garden3	97	m^2	97	5.92	61	57.39	591.7
합계				40.84		308.35	



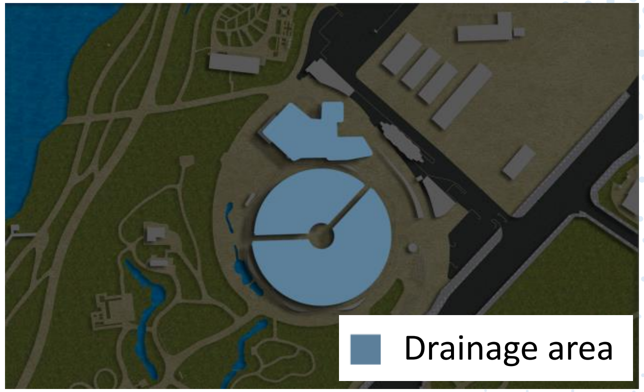


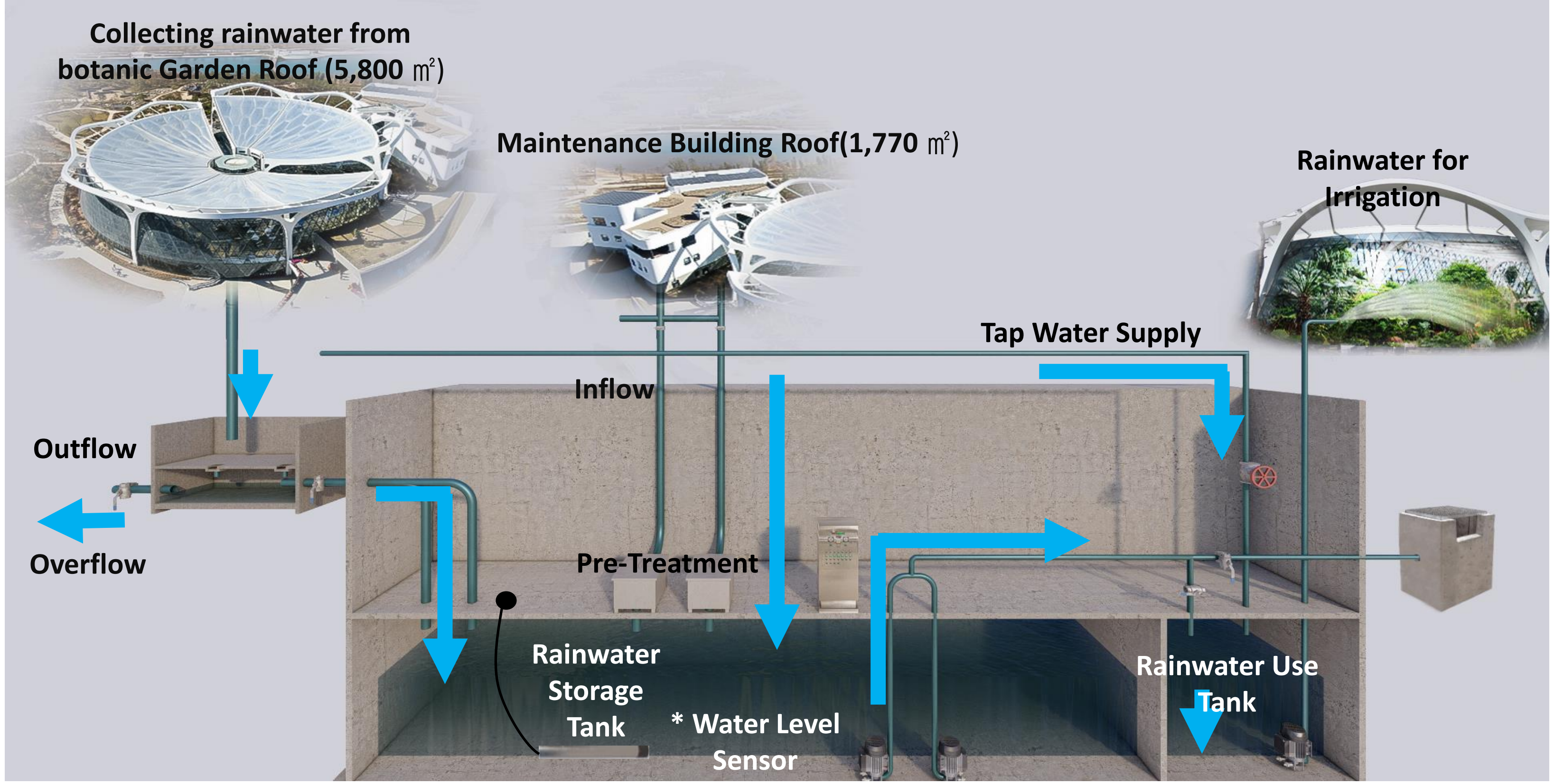
2. Cases of Seoul Water Cycle Recovery Projects in Seoul

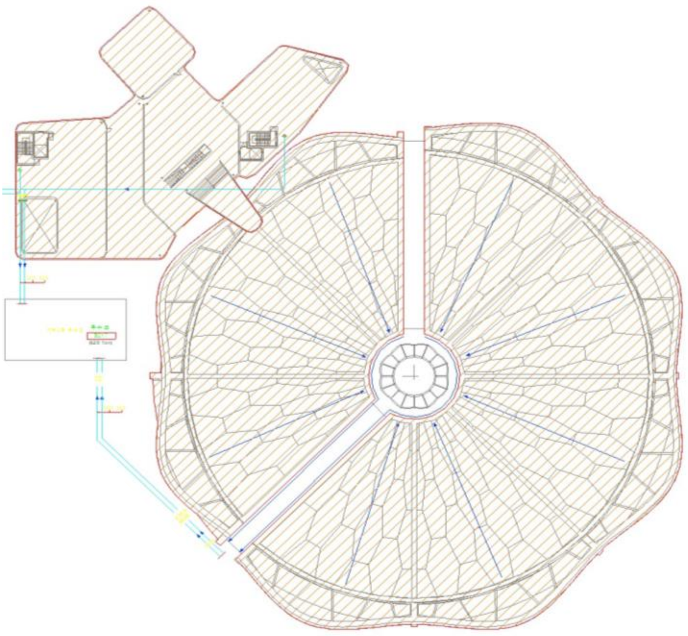
Case Ⅱ : Seoul Botanical Garden

■ Beautiful botanical garden using rainwater for irrigation

- 812 Magok-dong, Gangseo-gu
- Construction completed in 2019
- Rainwater chamber
- Drainage area : 7,570㎡







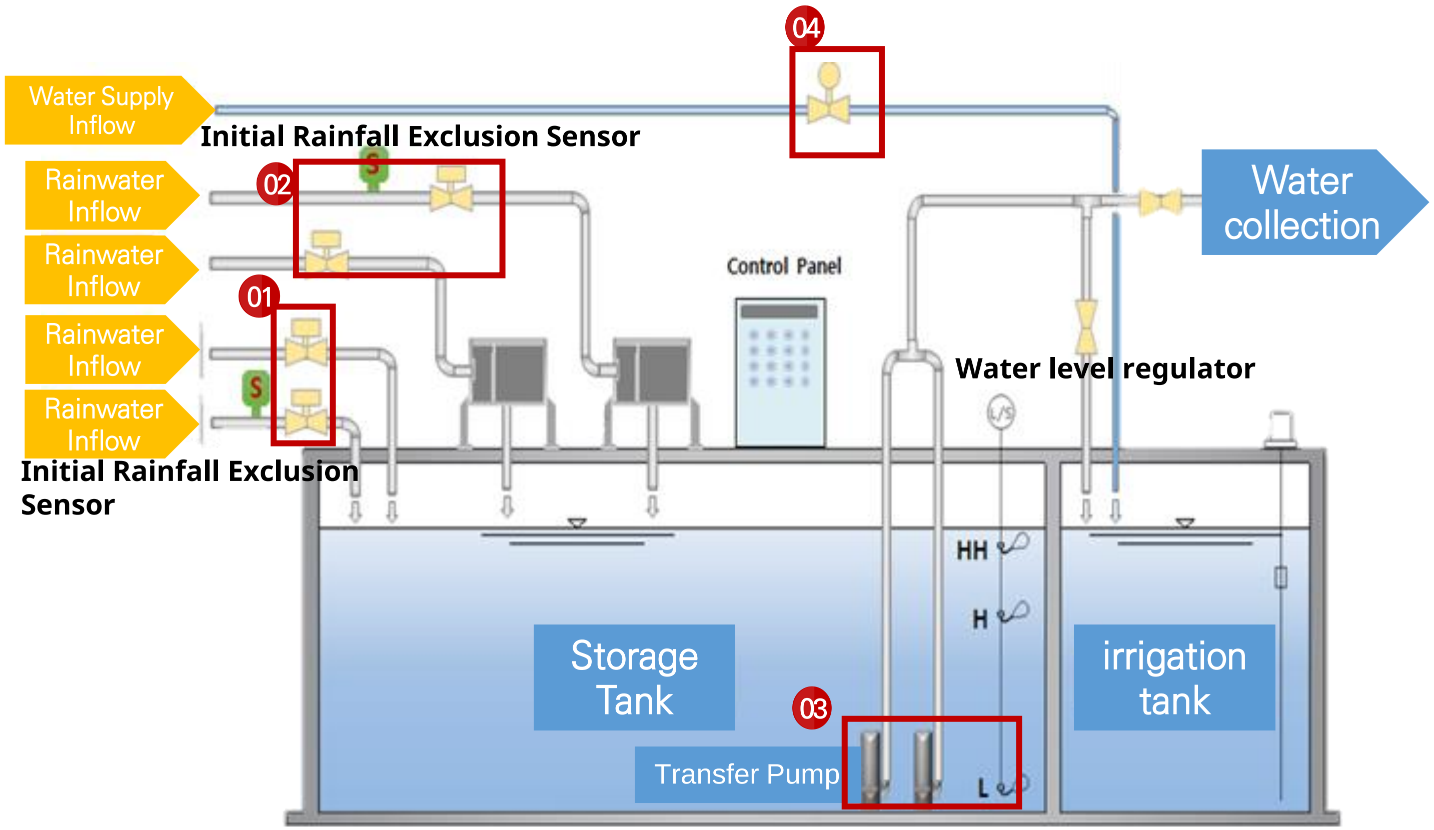
Case Ⅱ : Seoul Botanical Garden

01 Collected rainwater(from the garden roof) inflow control switch

02 Collected rainwater(from maintenance building roof) inflow control switch

03 Water level of pump operation

04 Tap water supply inflow control switch

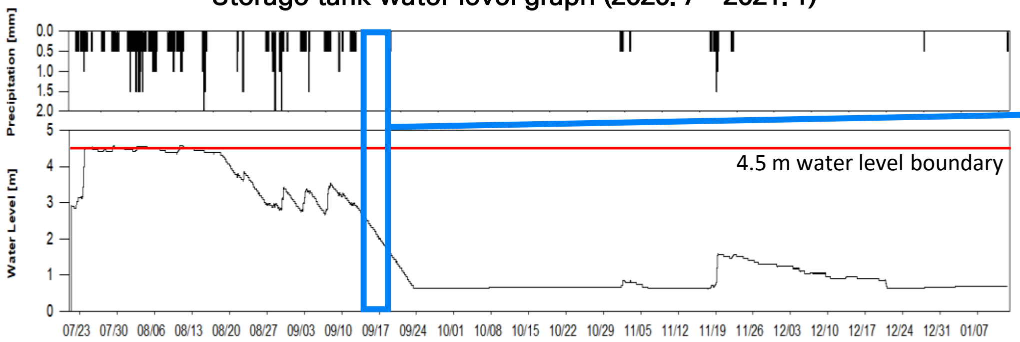


Case Ⅱ : Seoul Botanical Garden

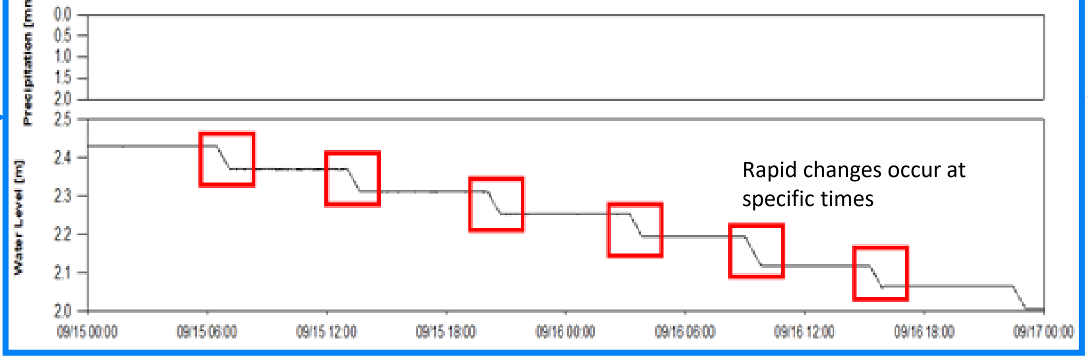
■ The water level of the tank does not rise more than 4.5m

■ Periodically supply water to irrigation tank from storage tank

Storage tank water level graph (2020. 7 ~ 2021. 1)



Storage tank water level graph (2020.09.15 ~ 09.17)

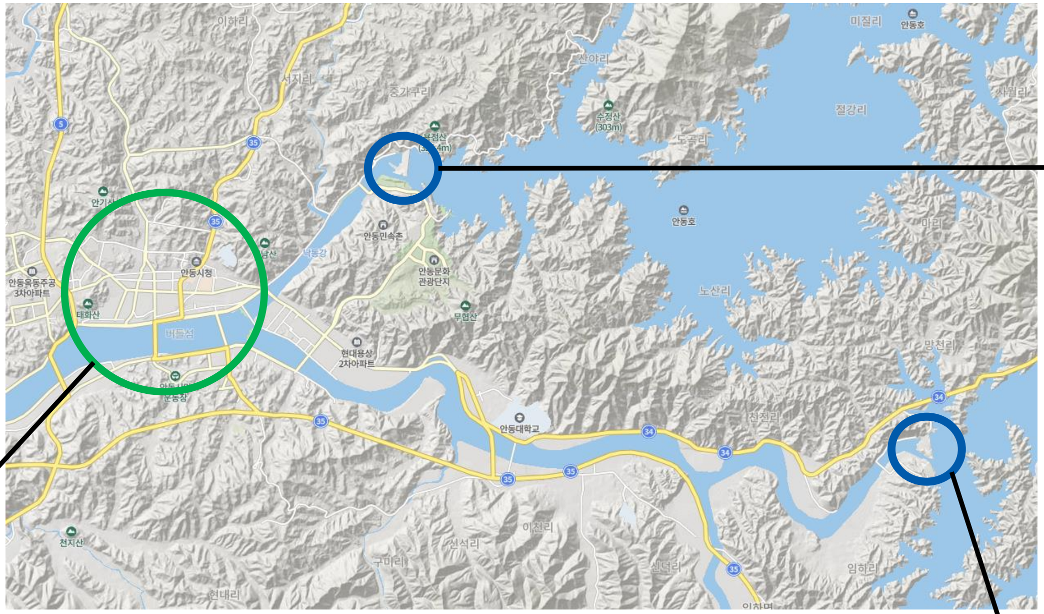


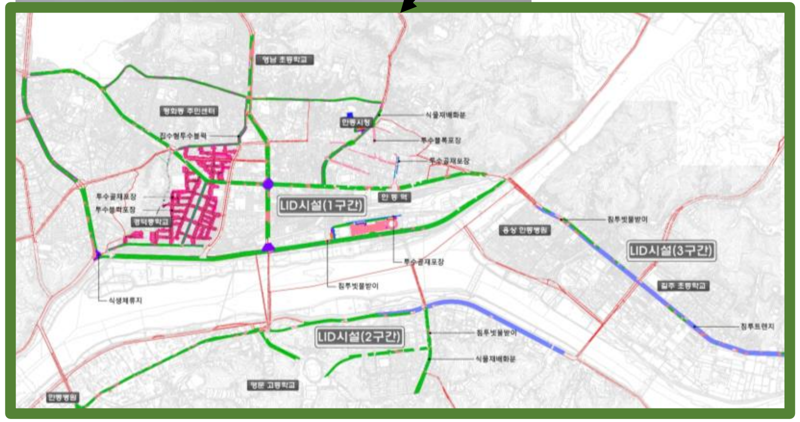
Estimation of storage tank usage (2020.09.15 ~ 09.17)

Period	Time (minute)	Initial water Level(m)	Final water level(m)	Water level gap (m)	Amount of usage(m^3)
9.15 06:30 – 9.15 07:08	38	2.429	2.371	0.058	10.27
9.15 13:03 – 9.15 13:40	37	2.37	2.312	0.058	10.27
9.15 20:06 – 9.15 20:44	38	2.31	2.253	0.057	10.10
9.16 03:13 – 9.16 03:50	37	2.253	2.195	0.058	10.27
9.16 08:59 – 9.16 09:48	49	2.195	2.119	0.076	13.46
9.16 15:15 – 9.16 15:54	39	2.118	2.062	0.056	9.92

3. Andong City Green Dam

Three Dam in Andong City





Green-City Dam

Andong Dam

Limha dam

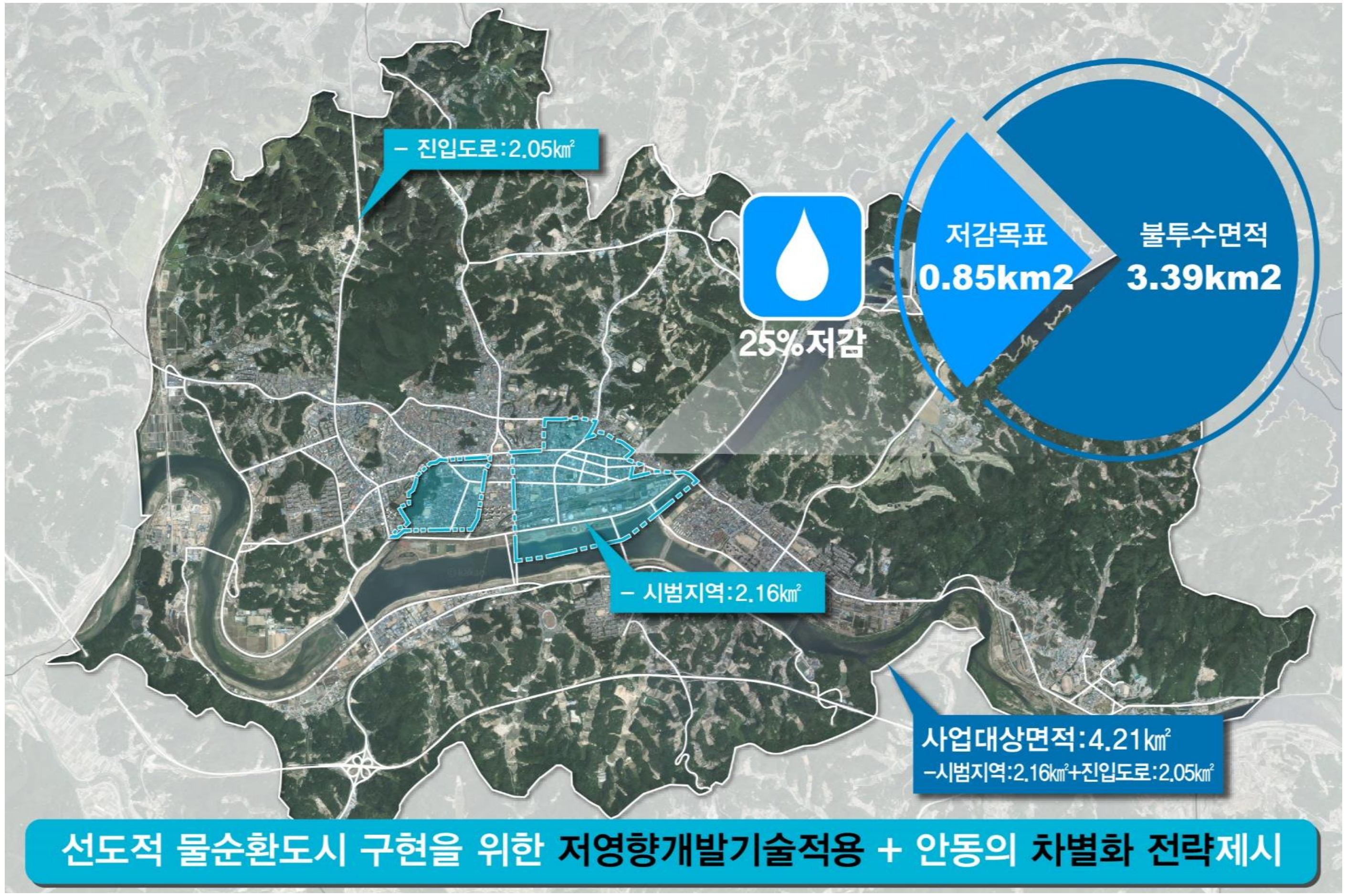
Flood Damages in South Korea

Andong city

Seoul city

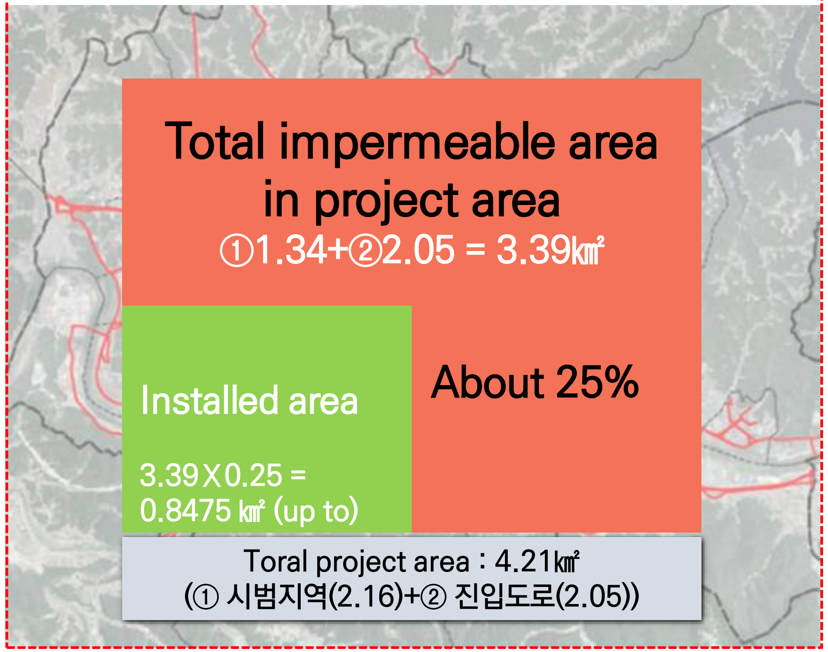
3. Andong City Green Dam

Purpose of Water Circulation Leading City



Purpose of the project

① Manage 25% of impermeable area
② Recover water circulation and reduce non-point pollution sources



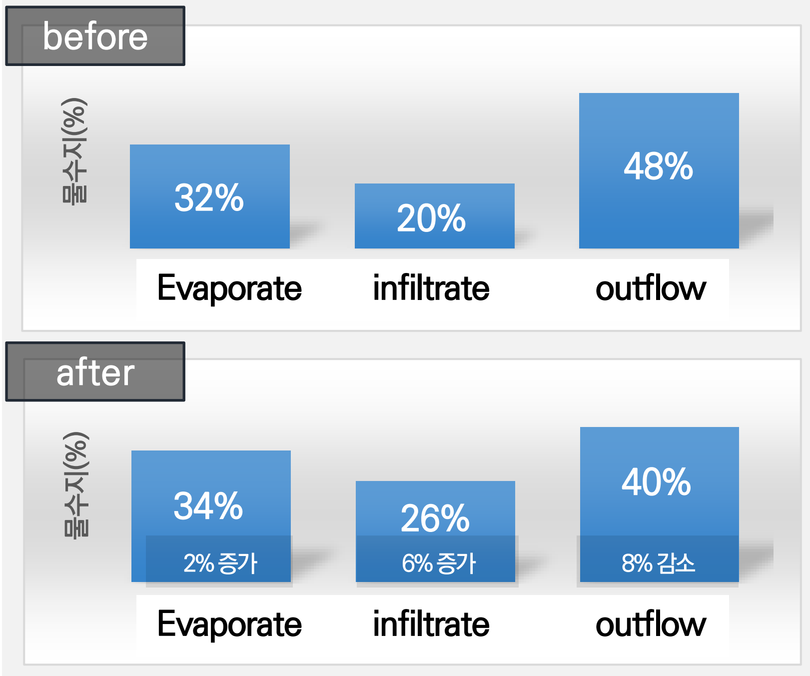
3. Andong City Green Dam

expectation effectiveness of Water Circulation Leading City

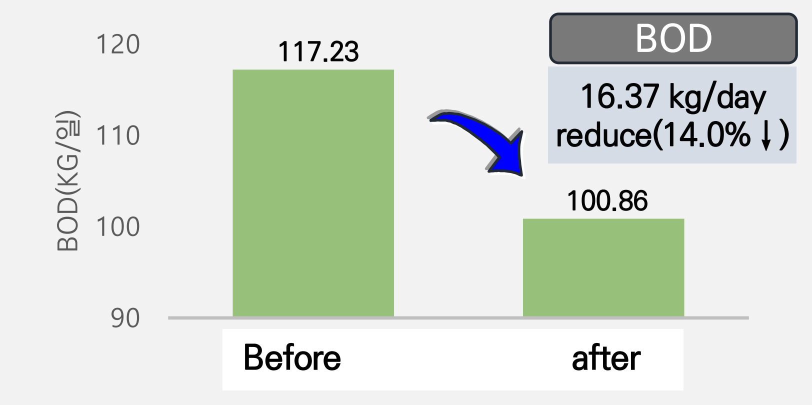
- ■ Water circulation recovery rate increased by 16.01%, and shown decreasing impermeable surface about 12.5%
- ■ Decreasing BOD 16.37/day, T-P 0.39kg/day

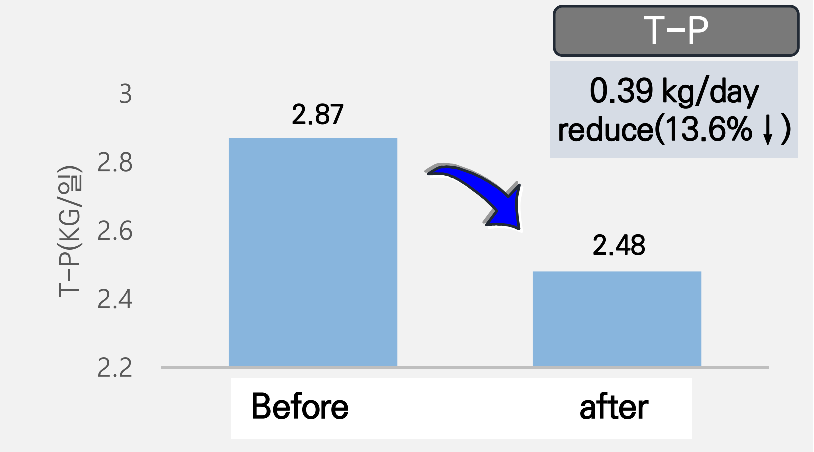
Water circultation recovery rate

구분	① before	② after	② – ①
Water circulation recove	52.43%	68.44%	16.01%(↑)
Impermeable surface	62.15%	49.65%	12.5%(↓)



Decrease non-point pollution rate

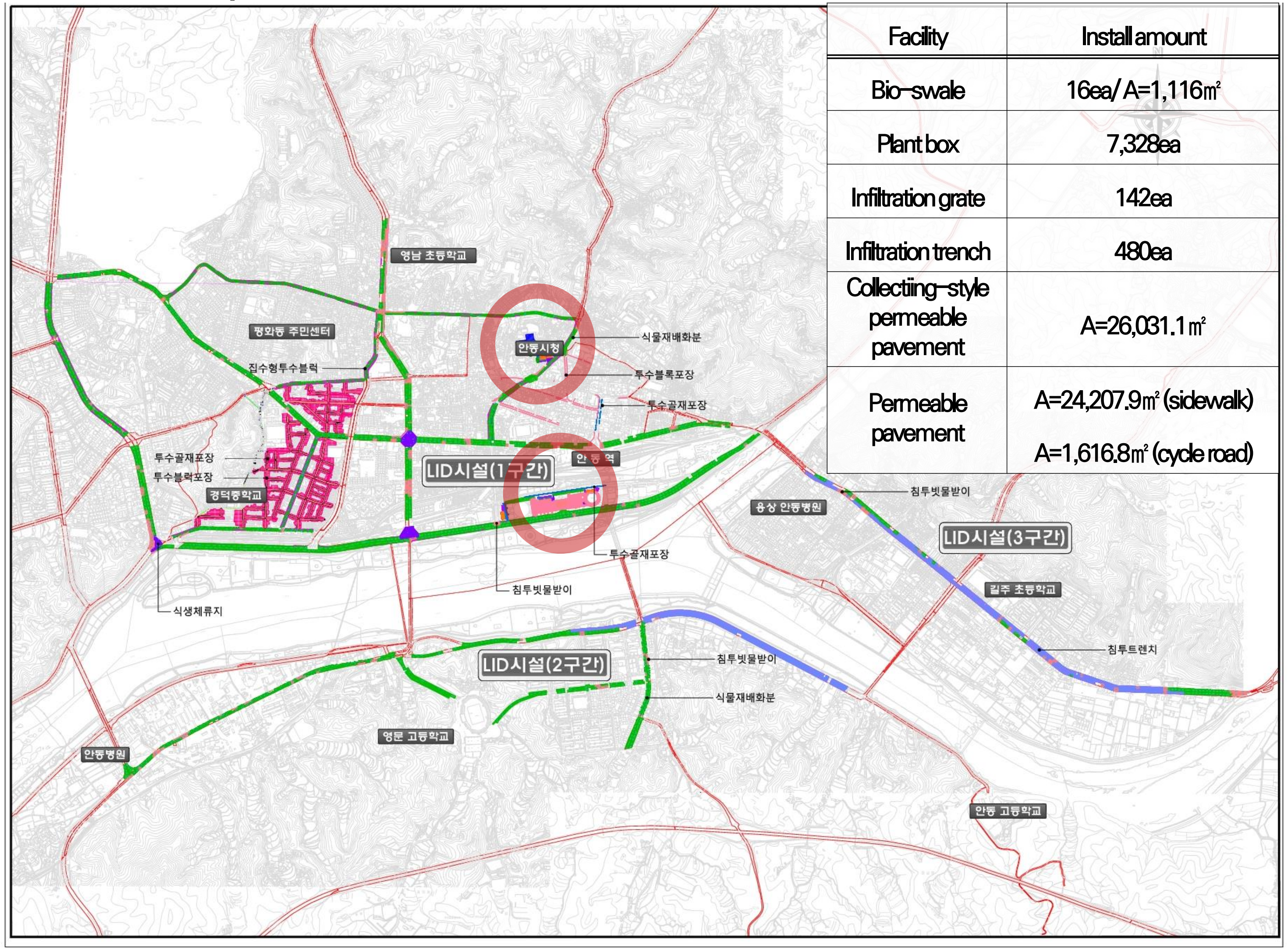




3. Andong City Green Dam

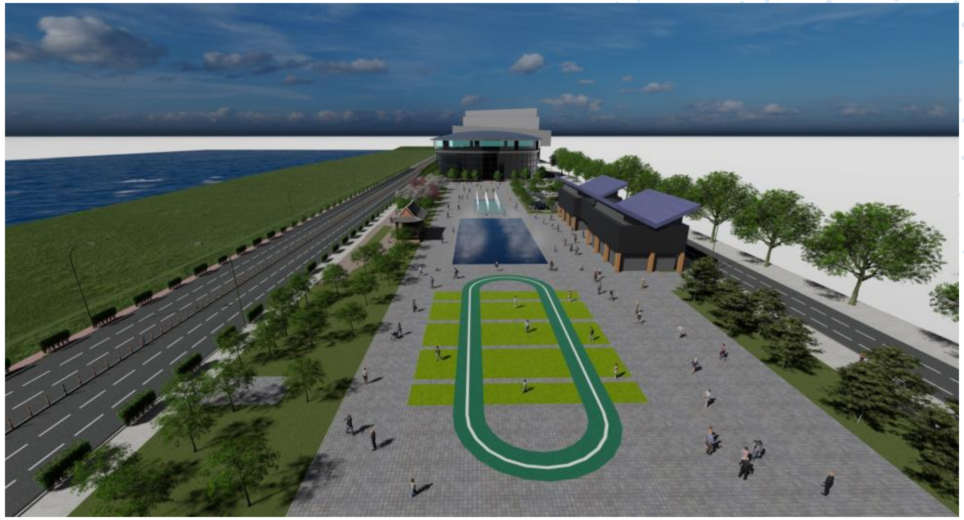
Planning and Size of Application Facilities

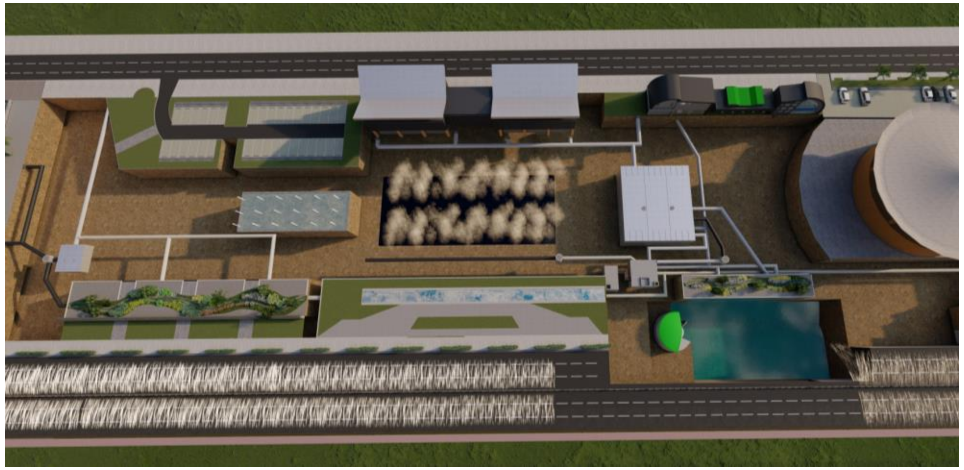
An overall layout



Facility	Install amount
Bio-swale	16ea/ A=1,116㎡
Plant box	7,328ea
Infiltration grate	142ea
Infiltration trench	480ea
Collecting-style permeable pavement	A=26,031.1㎡
Permeable pavement	A=24,207.9㎡ (sidewalk) A=1,616.8㎡ (cycle road)

Spacialized area : 탈춤공원(Tal-dance Park)

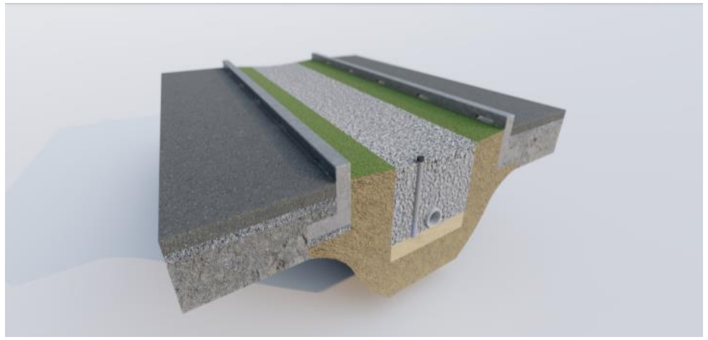




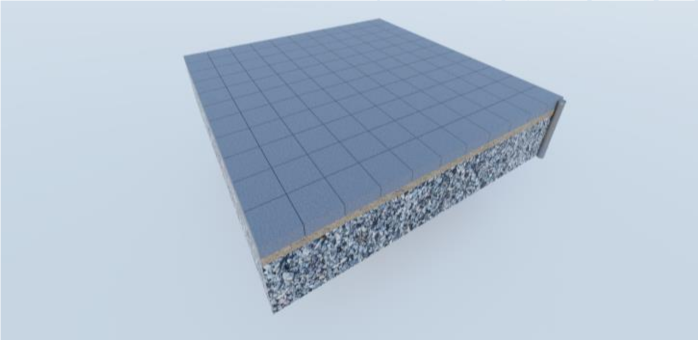
3. Andong City Green Dam

Types of facility

Bio-swale

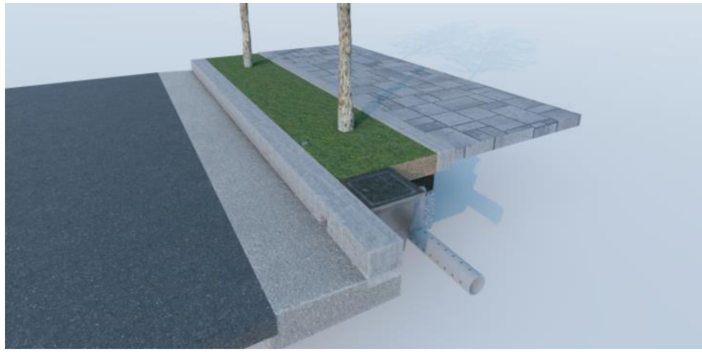


Infiltraion Trench Ditch

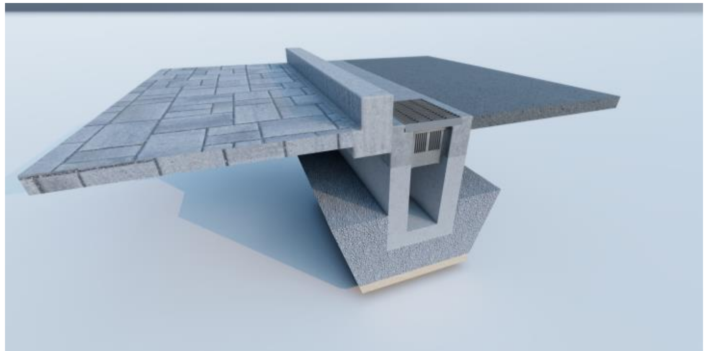


Permeable Pavement Block

Plant box



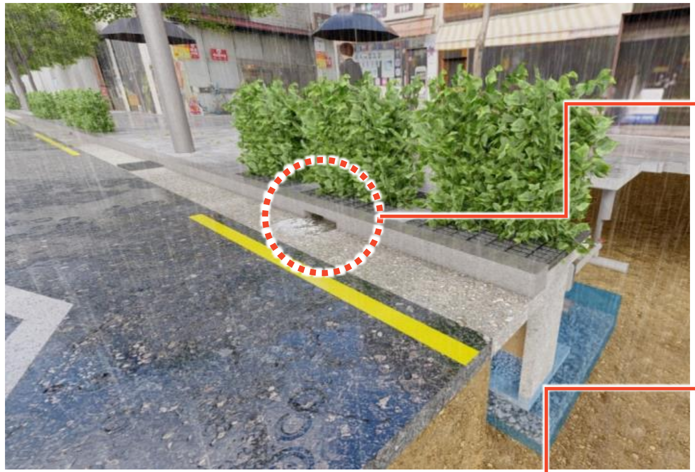
Infiltration Trench

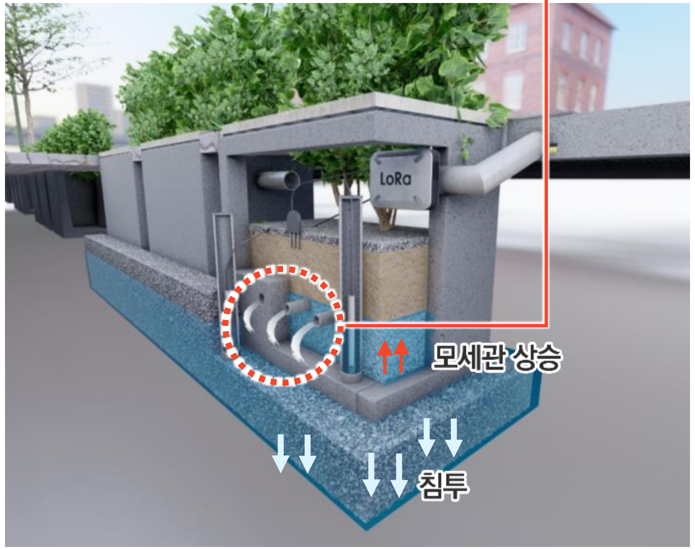


Infiltration Grate

3. Andong City Green Dam

Features of a Small Green Dam





Functional features

1. Removal of non-point pollution on roads in the early stages of rainfall
2. Plant water supply after storing 300mm of rainwater in the lower reservoir (capillary tube rise)
3. Pedestrian safety: planting between upper gratings
4. During concentrated rainfall, overflow water penetrates after a certain amount of storage

Ease of construction and maintenance

1. Can be installed on narrow sidewalk (60 cm wide)
2. Reduce construction time with PC assembly
3. Prevention of plant tests caused by drought and overwet
4. Rainfall to the side of the road(The infiltration occurs in the lower part of the plant cultivation pot, and the sides are blocked by the structure.)
5. vegetation interferes with residents' activities, remove vegetation to functions as a infiltration trench

Features of a Small Green Dam

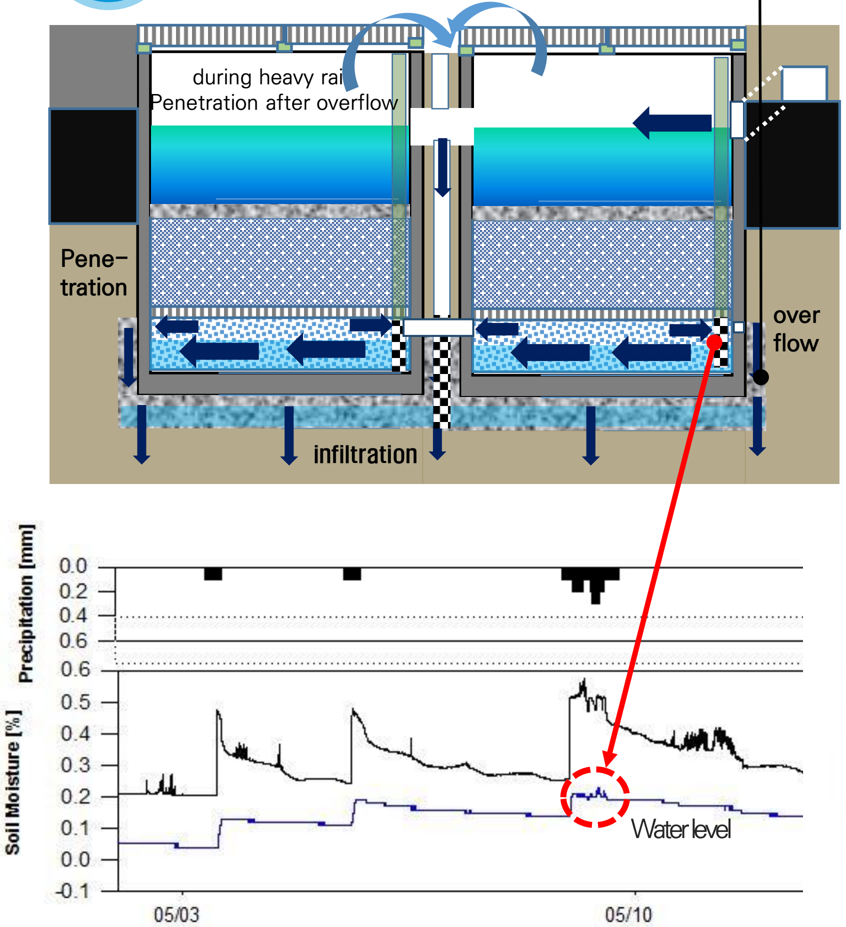
Install a discharge port to prevent wate from being filled above the lower root level, no matter how much inflow is made

→ Preventing the cause of obstruction of root respiration due to poor drainage and ensuring safe growth conditions

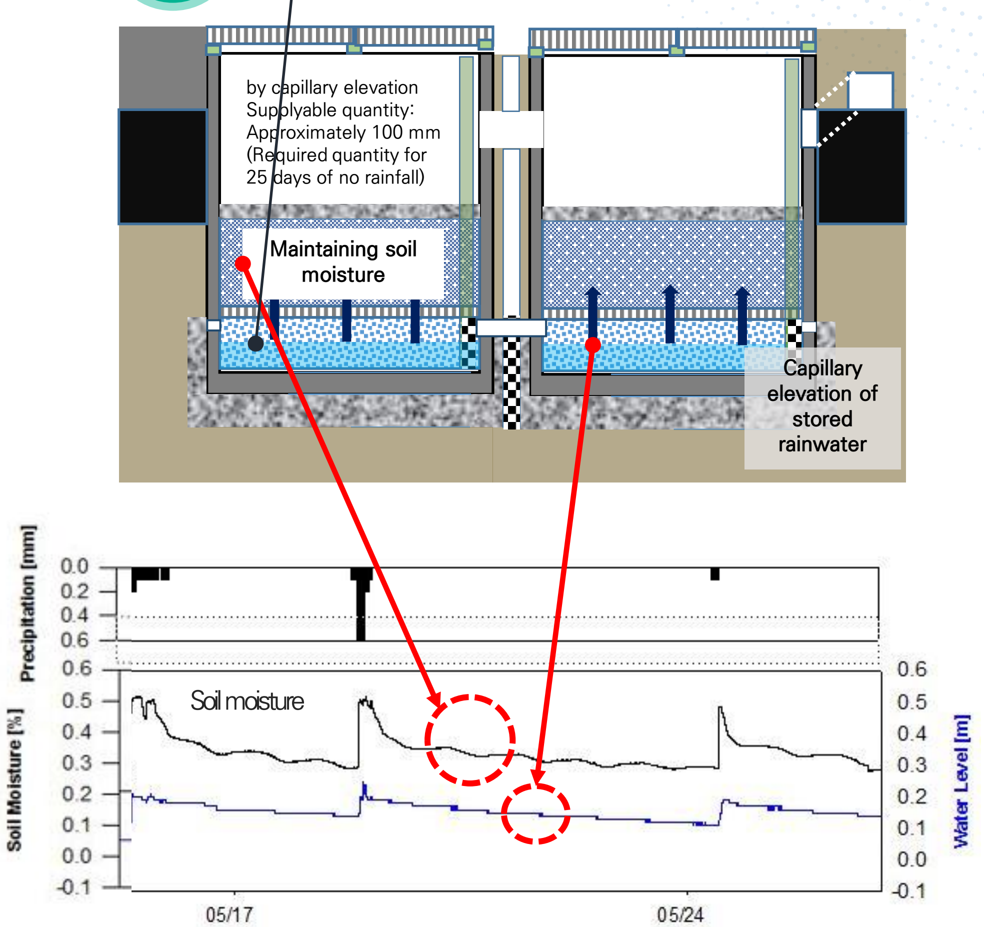
Obtain about 100mm of supplyable quantity due to capillary rise after lower storage

(Average daily yield of 4 mm for 25 days of continuous rainfall)

Wet season



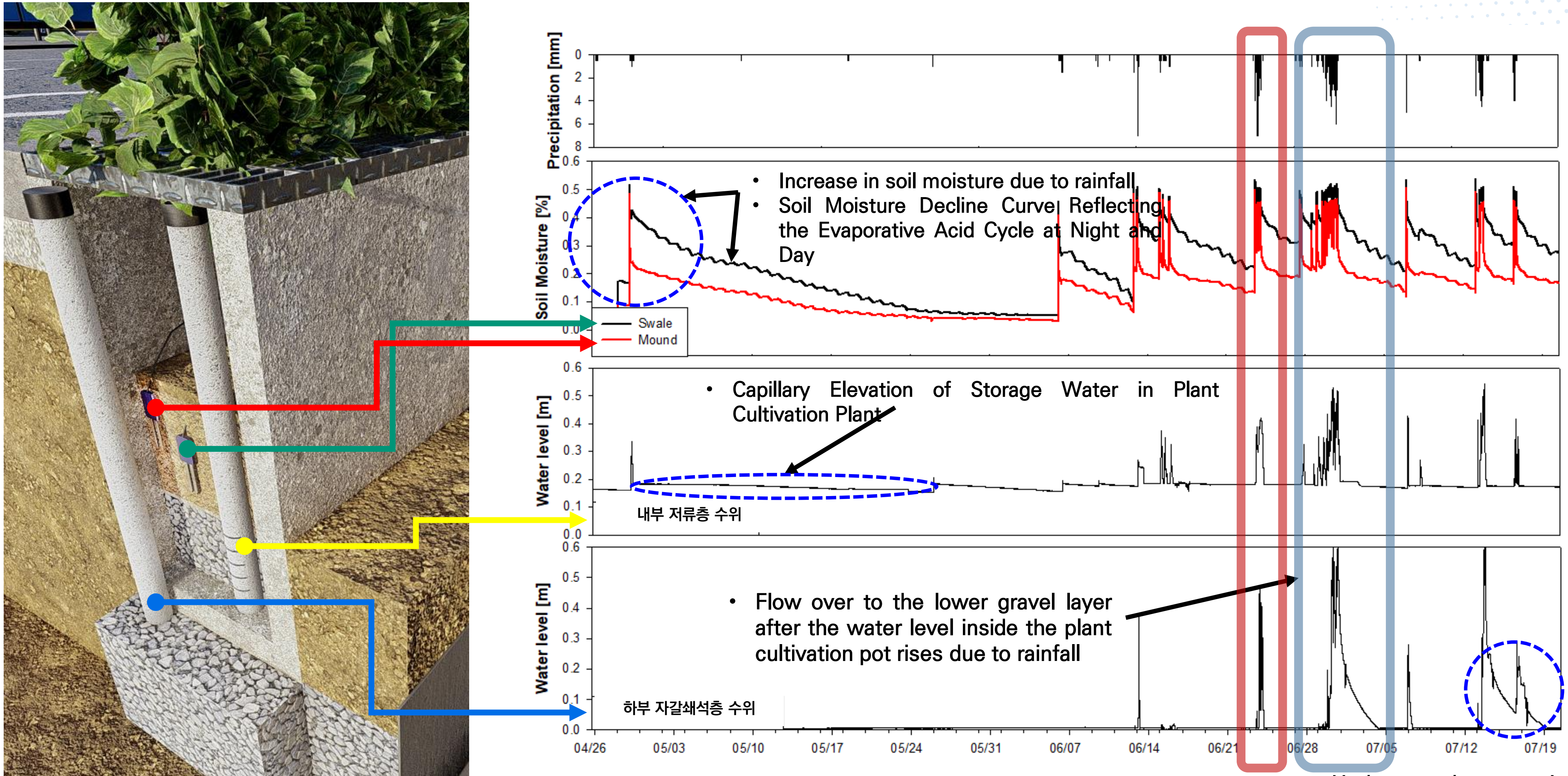
Dry season



2 years after completion ▶

3. Andong City Green Dam

Features of a Small Green Dam



• Underground penetration after rising water level of gravel crushed stone layer due to overflow water during concentrated rainfall

3. Andong City Green Dam

Features of a Small Green Dam

Construction site (actual construction)

Pre-installation section of Andong period (before planting)

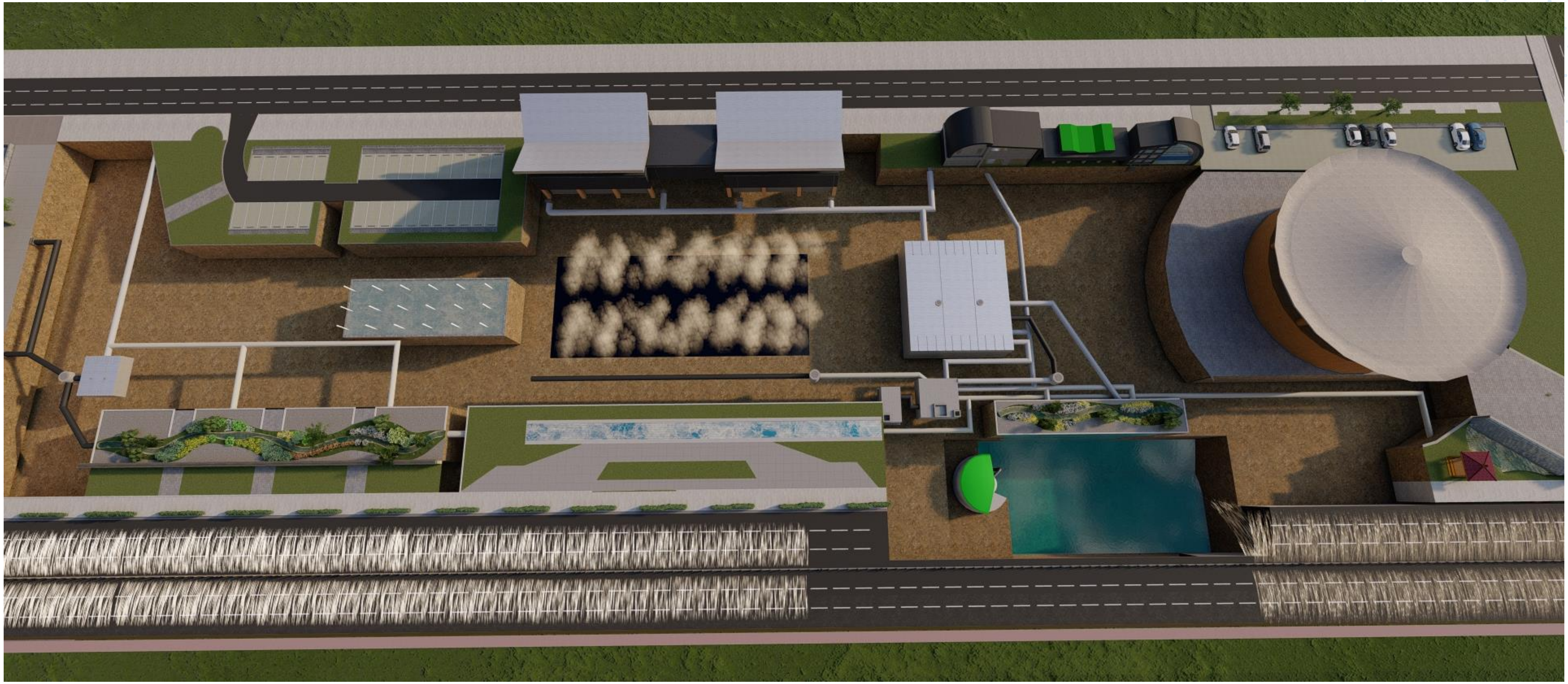
3. Andong City Green Dam

Features of a Small Green Dam

4,500 vehicles of 8ton
Water Bower tank

Yearly infiltration rainwater amount : 35,968 m3

Water circulation system of Tal-dance park



Tal-dance park view and water circulation conceptual map (video)

Support System for Operation and Maintenance of Urban Green Dam

What effect does it have?
Have you achieved your business objectives?

Is the operation and maintenance going well?

ANDONG CITY
안동시

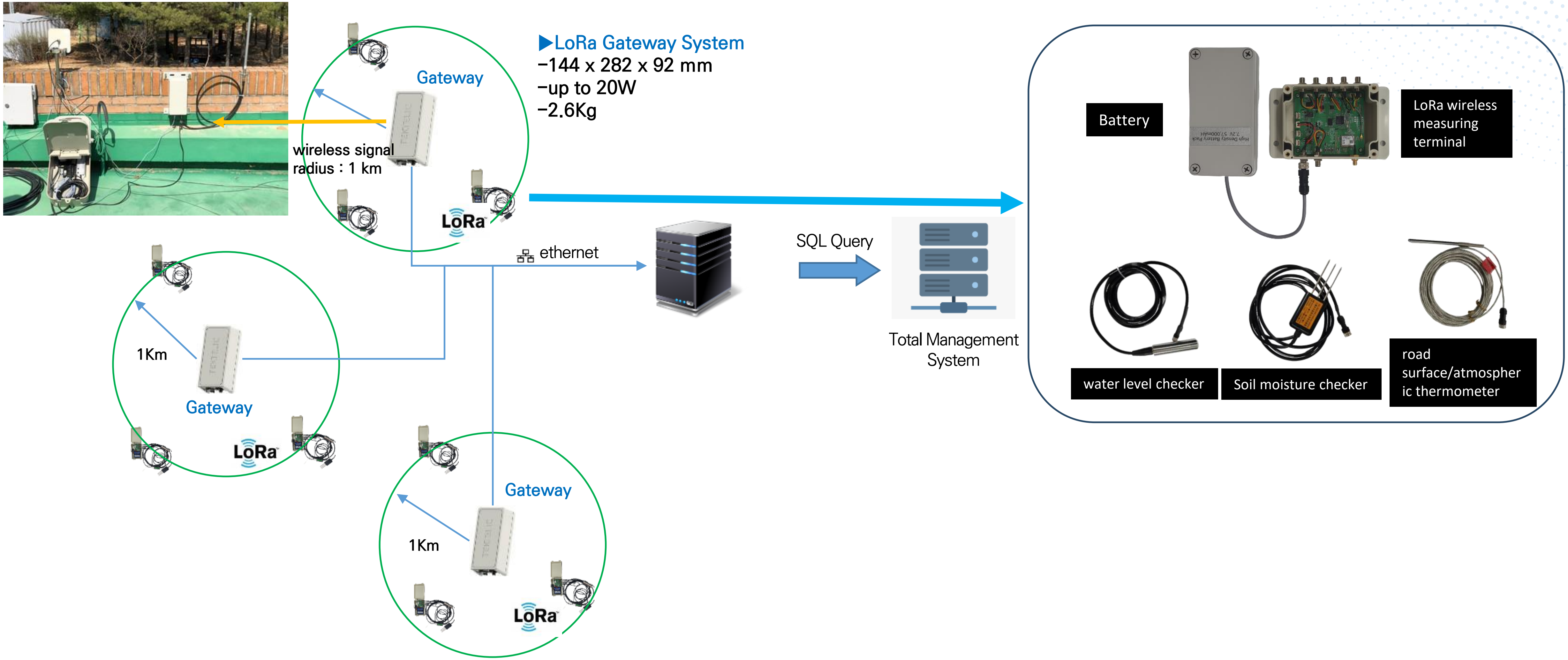
K water

Andong citizens

환경부
Ministry of Environment

3. Andong City Green Dam

Support System for Operation and Maintenance of Urban Green Dam



Measurement and communication system using IoT

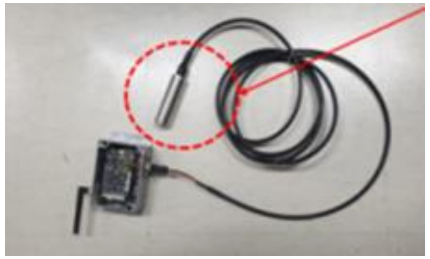
■ Monitoring items and sensor locations by facility type

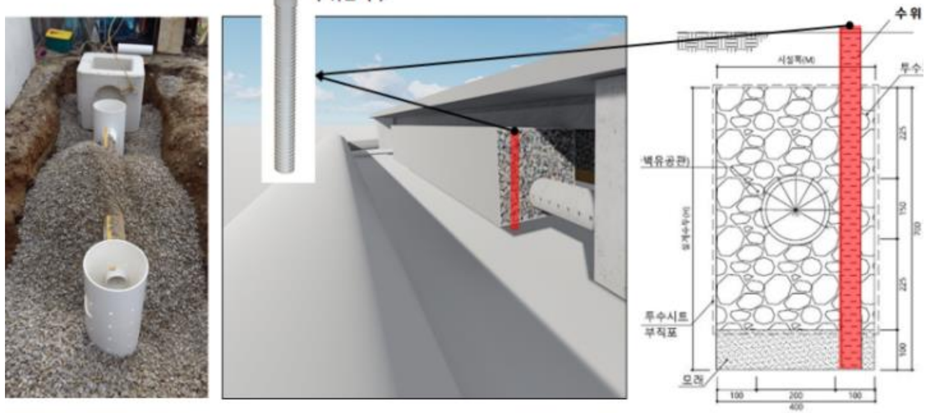
– Penetrating facility (penetrating trench, water permeable block, penetrating side opening, etc): Internal water level

– Vegetation–type facilities (vegetation area, tree filter box, plant cultivation pot, etc): internal water level + soil moisture* + electrical conductivity (optional)

Infiltrating facility

Water level meter connected to node (wireless transmitter)

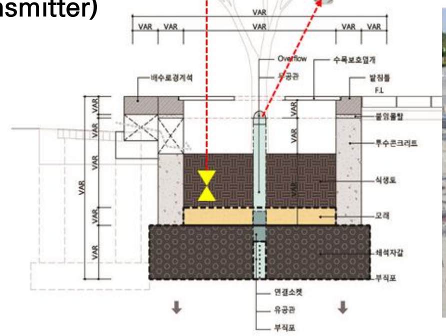




Planting facility

Soil mosture checker connected to node (wireless transmitter)

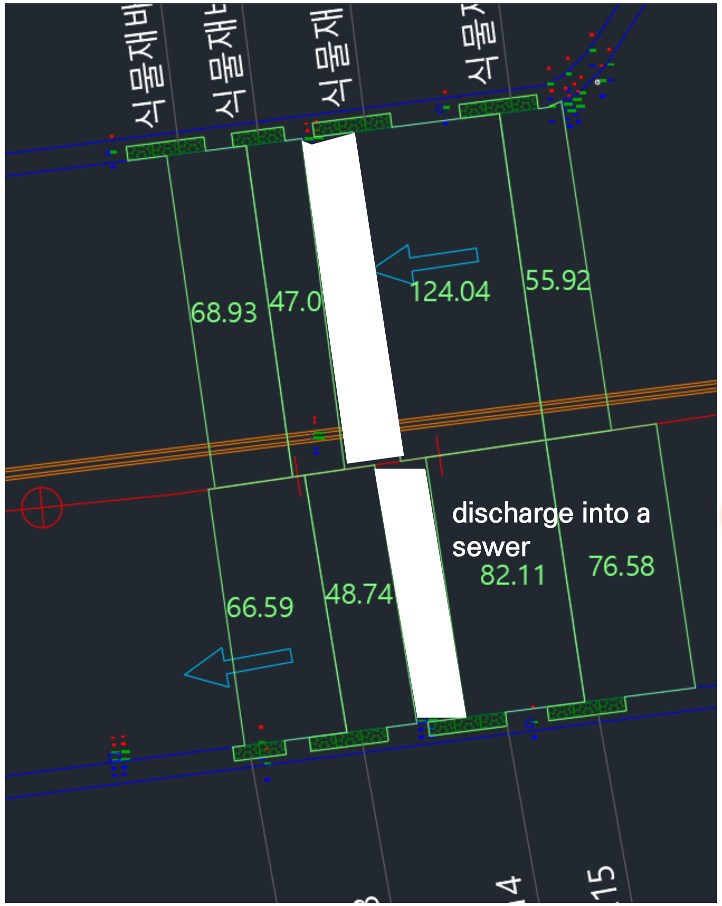
LoRa Node(wireless transmitter)

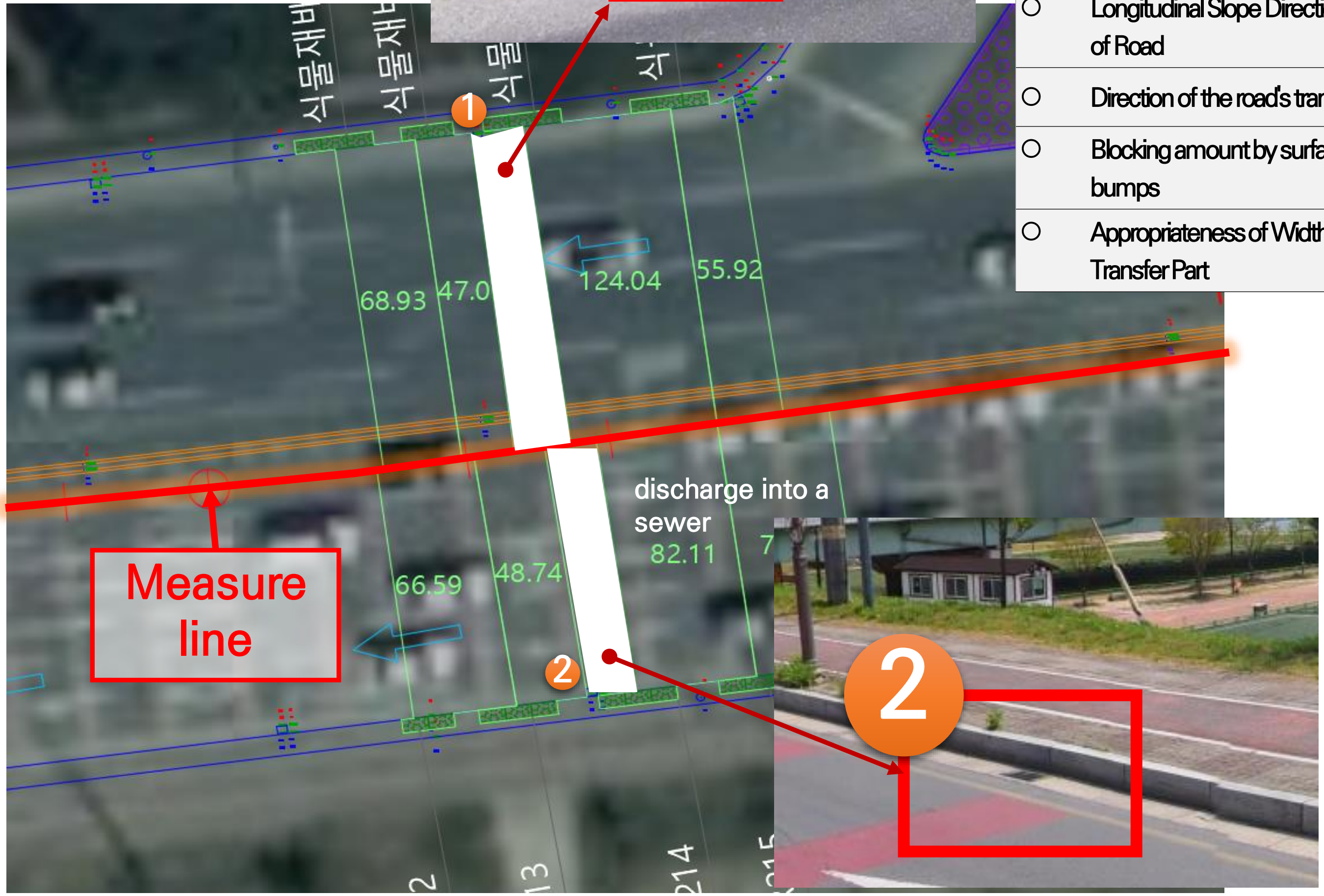


Measurement and communication system using IoT

■ Design Phase: CAD, GIS Drawing Reflects Water Gathering Area

– Drainage area: Actual survey and field survey items





■	Drainage area pre-check list	
○	Location and structure of grate	
○	Location and structure of manhole	
○	Location and connection status of rainwater gutters in buildings	
○	Location of drain trench	
○	Longitudinal Slope Direction and Slope of Road	
○	Direction of the road's transverse slope	
○	Blocking amount by surface flexion and bumps	
○	Appropriateness of Width and Depth of Transfer Part	

Measurement and communication system using IoT

■ Construction stage: Installation of water level bar at the appropriate location of the facility

Construction Process of Andong City

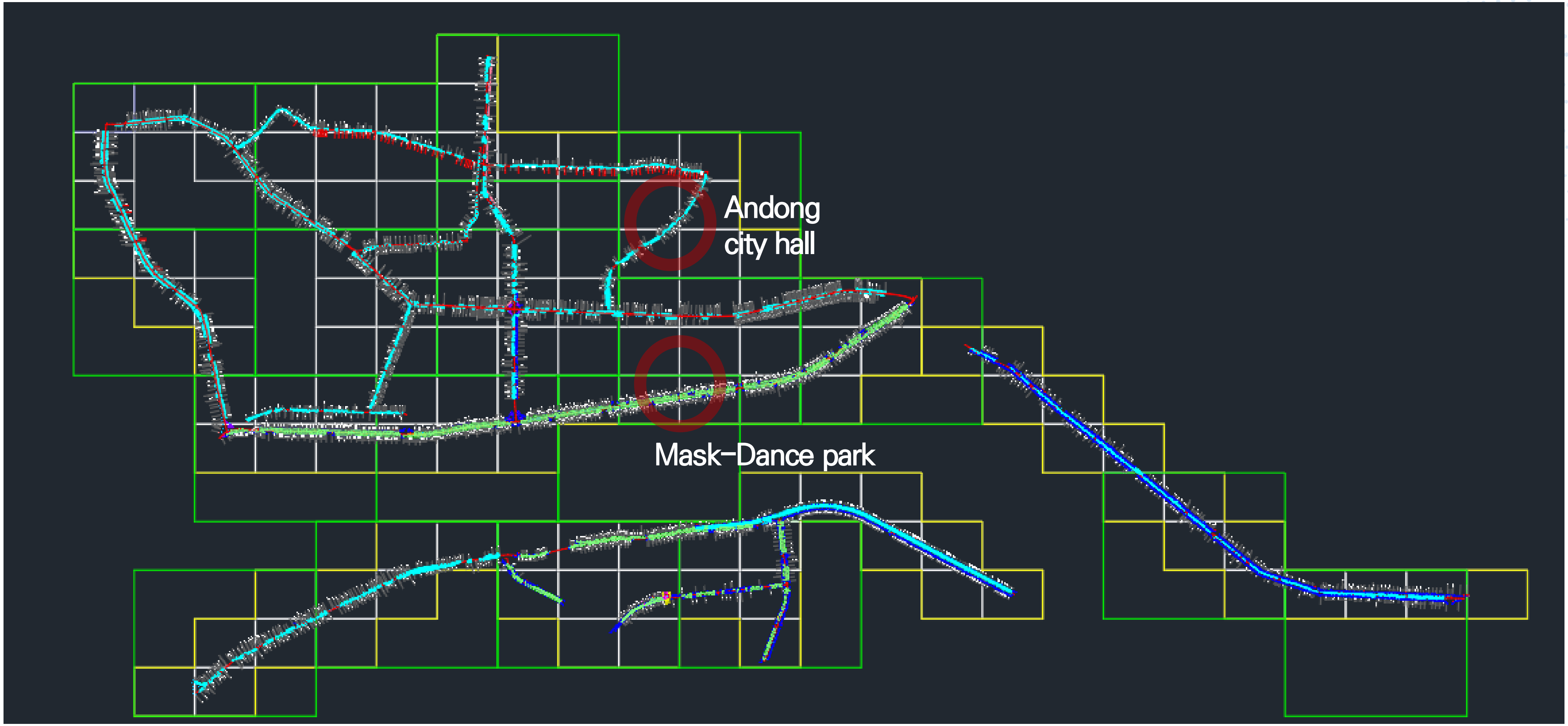
Put a perforated pipe in the facility where the water level meter can be inserted in the future

①Installation of water level observation zones in all facilities throughout Andong City → The supervisory authority can arbitrarily verify facilities at specific points → Improve construction quality

②Monitoring will be carried out after placing the actual sensors evenly at representative points in the future

3. Andong City Green Dam

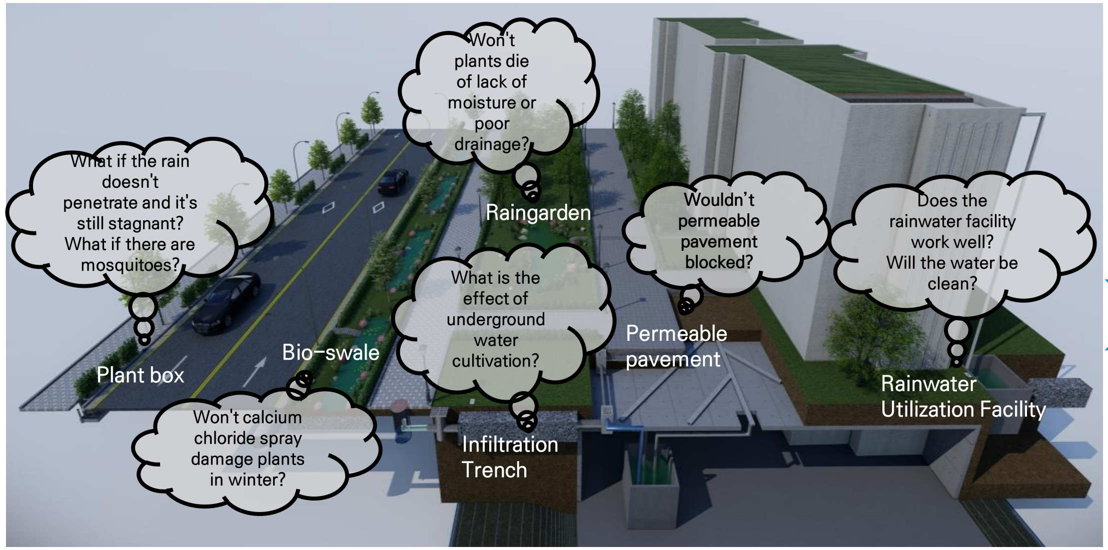
overall layout of Andong City

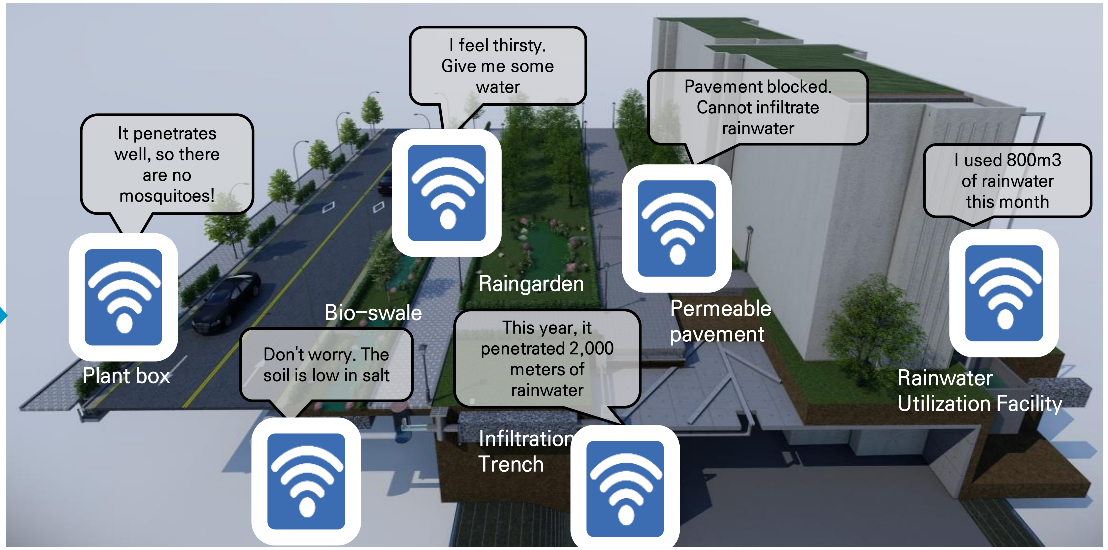


Planning the placement of nodes (sensor+transmitter)
- Quantity: 1,000 IoT sensors on approximately 300 to 400 nodes (quantity can be changed)
- Classification by facility type: Plant cultivation pot, penetration trench, etc
- Categorized by characteristics of target site: Core earthiness, slope, water collection area

Real-time facility diagnosis function

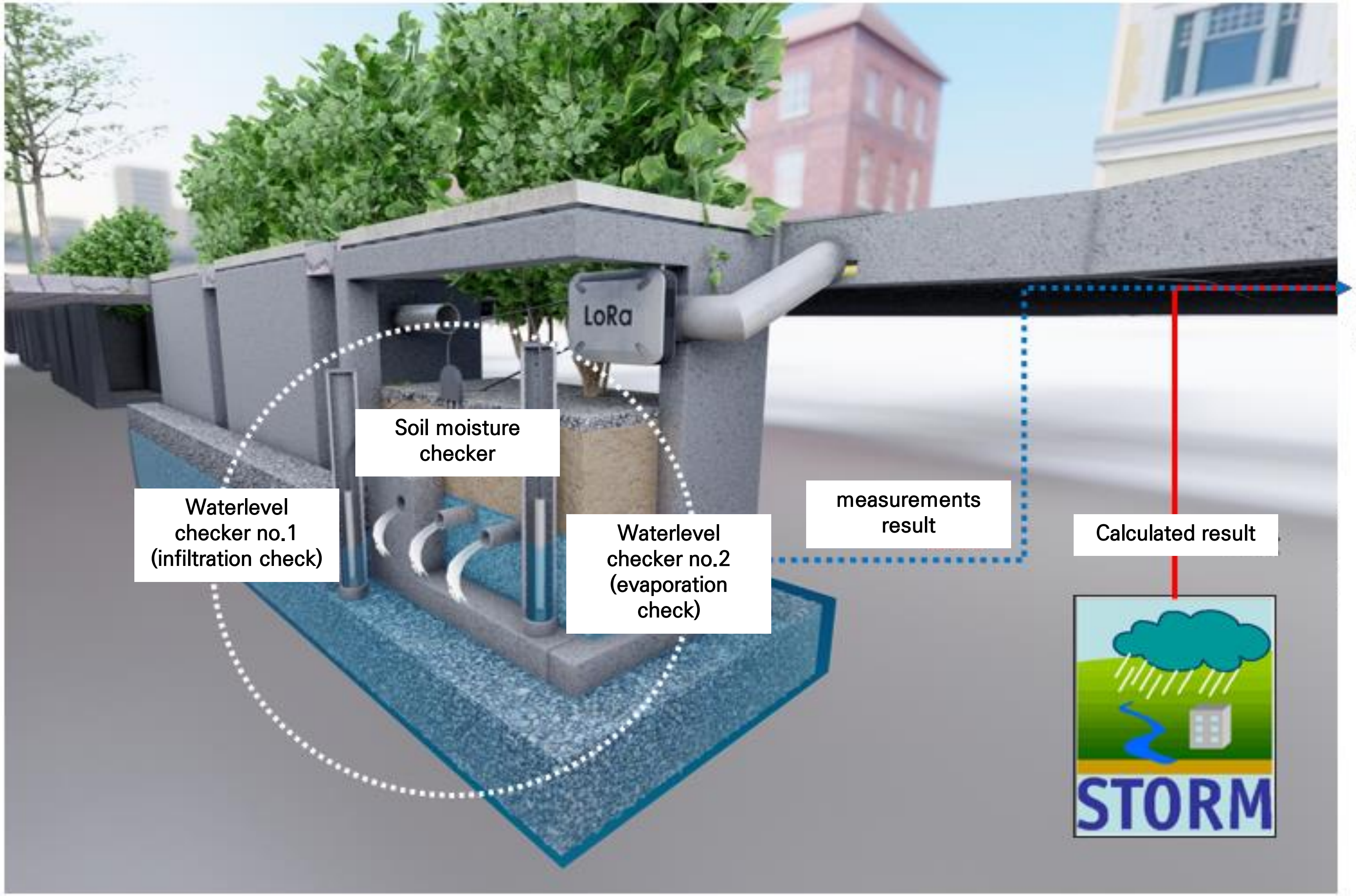
- ■ Inspection of changes in soil permeability, changes in soil moisture, plant growth, test caused by calcium chloride, and poor drainage
- ■ Conditions of water collection facilities, water quality adequacy review, effectiveness verification by facilities, etc
- ■ Construction of an alarm system to prevent plant death due to lack of soil moisture

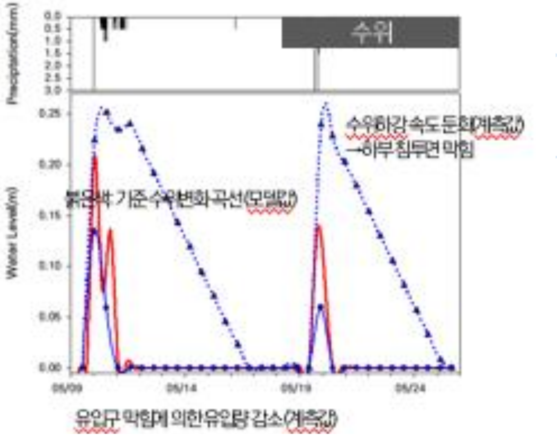




3. Andong City Green Dam

Real-time facility diagnosis function





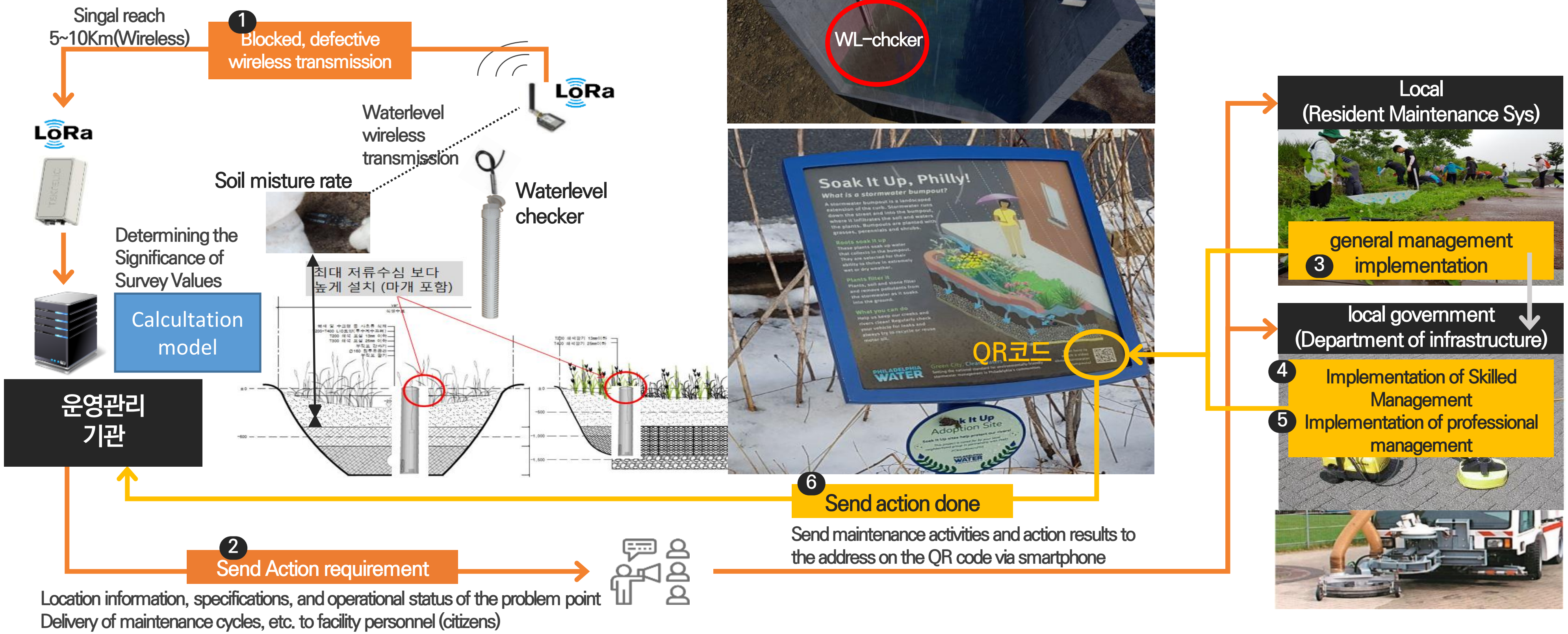
Utilization of measurements and calculations

1. Analysis of the effect of water circulation in individual facilities
2. Support decision making for operation and maintenance

3. Andong City Green Dam

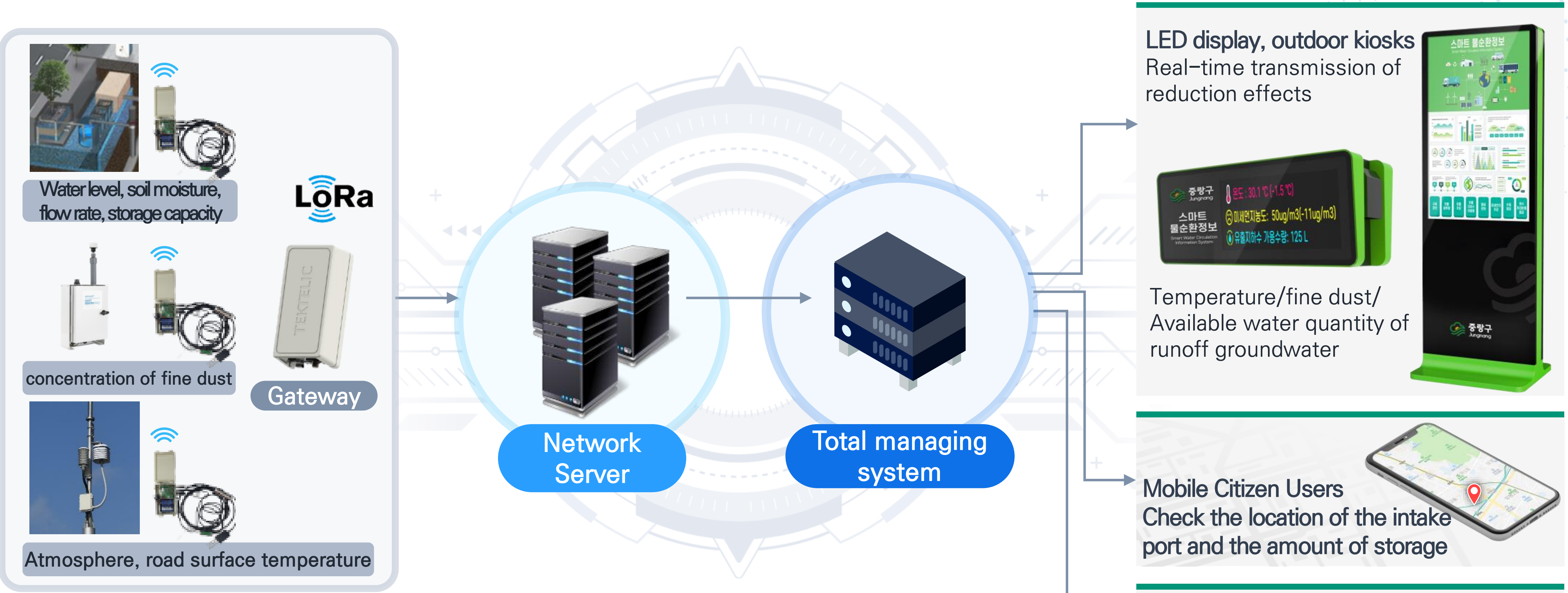
Real-time facility diagnosis function

- ■ Check the operation status of the relevant facilities in real time → Facilities management by the operating institution and supporting citizens' participation in maintenance activities
- ■ Ordinary citizens: Send regular on-site management activities to the operating institution through smartphones and apps along with photo materials



Promote to the public

■ Business performance and public relations through measurement and management of various items



LoRa Smart sensor node

☑ Automatic measurement of water level/soil moisture/temperature/flow/reservation/fine dust

☑ Real-time radio transmission of instrumentation data

LoRa IoT Sensor Network

☑ Free Internet of Things based on self-network without wireless communication costs

Thank you