

2014 Modularization of Korea's Development Experience:
Nanjido Eco Park Restoration
from Waste Dumping Site

2014

2014 Modularization of Korea's Development Experience:
**Nanjido Eco Park Restoration
from Waste Dumping Site**

2014 Modularization of Korea's Development Experience

Nanjido Eco Park Restoration from Waste Dumping Site

Title	Nanjido Eco Park Restoration from Waste Dumping Site
Supervised by	Seoul Metropolitan Government, Republic of Korea
Prepared by	The Seoul Institute
Author	Kee-young Yoo, Senior Research Fellow, The Seoul Institute Won-ju Kim, Research Fellow, The Seoul Institute Kyu-yi Kang, Researcher, The Seoul Institute
Advisory	Jae-young Kim, Professor, Seoul National University College of Engineering Department of Civil and Environmental Engineering Kwang Yim Kim, Former Senior Research Fellow, Korea Environment Institute (KEI)
Research Management	KDI School of Public Policy and Management
Supported by	Ministry of Strategy and Finance (MOSF), Republic of Korea

Government Publications Registration Number 11-1051000-000584-01

ISBN 979-11-5545-132-8 94320

ISBN 979-11-5545-116-8 [SET 19]

Copyright © 2014 by Ministry of Strategy and Finance, Republic of Korea

Knowledge
Sharing
Program



Government Publications
Registration Number

11-1051000-000584-01

Knowledge Sharing Program

2014 Modularization of Korea's Development Experience

Nanjido Eco Park Restoration from Waste Dumping Site



SEOUL METROPOLITAN
GOVERNMENT



서울연구원
The Seoul Institute



Preface

The study of Korea's economic and social transformation offers a unique window of opportunity to better understand the factors that drive development. Within about one generation, Korea transformed itself from an aid-recipient basket-case to a donor country with fast-paced, sustained economic growth. What makes Korea's experience even more remarkable is that the fruits of Korea's rapid growth were relatively widely shared.

In 2004, the Korean Ministry of Strategy and Finance (MOSF) and the Korea Development Institute (KDI) launched the Knowledge Sharing Program (KSP) to assist partner countries in the developing world by sharing Korea's development experience. To provide a rigorous foundation for the knowledge exchange engagements, the KDI School has accumulated case studies through the KSP Modularization Program since 2010. During the first four years, the Modularization Program has amassed 119 case studies, carefully documenting noteworthy innovations in policy and implementation in a wide range of areas including economic policy, administration-ICT, agricultural policy, health and medicine, industrial development, human resources, land development, and environment. Individually, the case studies convey practical knowhow and insights in an easily accessible format; collectively, they illustrate how Korea was able to kick-start and sustain economic growth for shared prosperity.

Building on the success during the past four years, we are pleased to present an additional installment of 19 new case studies completed through the 2014 Modularization Program. As an economy develops, new challenges arise. Technological innovations create a wealth of new opportunities and risks. Environmental degradation and climate change pose serious threats to the global economy, especially to the citizens of the countries most vulnerable to the impacts of climate change. The new case studies continue the tradition in the Modularization Program by illustrating how different agents in the Korean society including the government, the corporations, and the civil society organizations, worked together to find creative solutions to challenges to shared prosperity. The efforts delineated include overcoming barriers between government agencies; taking advantage of new opportunities opened up through ICT; government investment in infrastructure; creative collaboration between the government and civil society; and painstaking efforts to optimize

management of public programs and their operation. A notable innovation this year is the development of two “teaching cases”, optimized for interactive classroom use: Localizing E-Government in Korea and Korea’s Volume-based Waste Fee System.

I would like to express my gratitude to all those involved in the project this year. First and foremost, I would like to thank the Ministry of Strategy and Finance for the continued support for the Modularization Program. Heartfelt appreciation is due to the contributing researchers and their institutions for their dedication in research, to the former public officials and senior practitioners for their keen insight and wisdom they so graciously shared as advisors and reviewers, and also to the KSP Executive Committee for their expert oversight over the program. Last but not least, I am thankful to each and every member of the Development Research Team for the sincere efforts to bring the research to successful fruition, and to Professor Taejong Kim for his stewardship.

As always, the views and opinions expressed by the authors in the body of work presented here do not necessarily represent those of the KDI School of Public Policy and Management.

December 2014

Joon-Kyung Kim

President

KDI School of Public Policy and Management



Contents | LIST OF CHAPTERS

Summary.....	15
--------------	----

Chapter 1

Goals and Achievements Related to Establishing Eco Parks	27
1. Goals and Achievements at the Time of Establishing the Park	28
1.1. Goal at the Time of Establishing the Park.....	28
1.2. Achievement of Park Establishment Compared to Its Goal.....	30
2. Social and Environmental Effects.....	36
2.1. Accommodation of Leisure Activities.....	36
2.2. Increase of Park Resources in Seoul.....	38

Chapter 2

Background and Need for Establishment of Eco Parks.....	41
1. Surrounding Conditions at Establishment of Eco Park.....	42
1.1. Nanjido Waste Dumping Site and Seoul's Waste Management.....	42
1.2. Seoul and Korea's Situation when Establishing the Park.....	46
2. Key Motivation for Establishing an Eco Park	47
2.1. After-Closure Care of the Dump Site.....	47
2.2. Hosting an Environment-friendly World Cup.....	48
2.3. Execution of Core Projects of the Citizens' Elected Mayor	49
2.4. Foreign Cases Referred.....	50

Chapter 3

Strategy and System	53
1. Connection of Regional Development and Preparations for the 2002 World Cup.....	54
1.1. Landfill Stabilization Work	54
1.2. Park Construction	55
2. Project Organization and Decision-Making	57
2.1. Project Organization	57
2.2. Decision-Making.....	57
3. Procurement of Financial Resources.....	58

Chapter 4

Details and Progress	61
1. The Dump Site Stabilization Work	62
1.1. Overview	62
1.2. Leachate Treatment	68
1.3. Landfill Gas Treatment.....	71
1.4. Landfill Surface Levelling and Covering.....	74
1.5. Slope Stabilization	77
1.6. Monitoring Facility	80
1.7. Environmental Plans for Areas Outside of Landfill Stabilization Work	83



Contents | LIST OF CHAPTERS

2. Establishment of the Eco Park	84
2.1. Eco Park Establishment Overview	84
2.2. Pyeonghwa Park	88
2.3. Haneul Park	91
2.4. Noeul Park	93
2.5. Nanjicheon Park	94
2.6. Nanji Han River Park	96

Chapter 5

Success Factor Analysis	99
1. Contributing Factors to Establishment of World Cup Park	100
1.1. Deferment of Commercial Development for Environmental Management of the Waste Dumping Site	100
1.2. Ties with Urban Planning and 2002 World Cup	102
1.3. Self-Recovery of Ecological Functions through Connection to Surrounding Eco-corridors	103
1.4. Continuous Improvements of Wildlife Habitat Environment	105
1.5. Various Traffic Networks Providing Easy Public Access	106
1.6. World Cup Park Management in Partnership with Citizens	107
2. Shortcomings	111
2.1. Disputes Over Establishment of Noeul Park Public Golf Course	111

Chapter 6

Implications for Developing Countries	113
1. Lessons Learned from the Project.....	114
1.1. Landfills: Thorough Care Necessary, Even after Closure.....	114
1.2. Turning Landfills into Parks: Another Opportunity for Urban Restoration	115
1.3. A Park Ecosystem that Grows on Its Own	117
1.4. Communication and Cooperation with the Citizens.....	118
2. Possibility of Applications in Developing Countries.....	120
2.1. Landfills, Future Assets of a City	120
2.2. Appropriate Environmental Management Method for Unsanitary Landfill.....	121
2.3. Provision of new Living Accommodations for Socially Vulnerable People	122
2.4. Use of Landfill Gas for District Heating.....	123
2.5. A Home for Ecology Restoration Education.....	123
2.6. Renewal of Landfill Management System.....	124
References	126

Contents | LIST OF TABLES

Chapter 1

Table 1-1	Change of Animals and Plants at World Cup Park	33
Table 1-2	World Cup Park in SangAm New Millennium Town	36
Table 1-3	Comparison of Users of World Cup Park and Other Facilities	37
Table 1-4	Urban Park Expansion Effect of the World Cup Park	39

Chapter 3

Table 3-1	World Cup Park Construction Expenses and Breakdown	59
-----------	--	----

Chapter 4

Table 4-1	Overview of Stabilization Work Sectional Project	64
Table 4-2	Major Contents on Leachate Treatment	69
Table 4-3	Major Nanjido Gas Treatment Facilities	72
Table 4-4	Amount of Soil Used for Levelling and Final Cover	75
Table 4-5	Rainwater Drainage Measures for Slope Stabilization	79
Table 4-6	Slope Reinforcement Project	79
Table 4-7	Measuring Devices Installation at Nanjido Landfill	81
Table 4-8	Measuring Devices Installed in Nanjido Landfill	82
Table 4-9	Objectives and Concepts per World Cup Park Sector	85

Chapter 5

Table 5-1	Wildlife Habitats Improvement Project	106
Table 5-2	World Cup Park Status	109
Table 5-3	Volunteers and Their Activities at World Cup Park	110

Chapter 6

Table 6-1	Regulations on Municipal Waste Landfill Management Method	125
-----------	---	-----

Contents | LIST OF FIGURES

Chapter 1

Figure 1-1	Changes of Nanjido Seen from the Sky	31
Figure 1-2	Flagship Species of World Cup Park.....	32
Figure 1-3	Major Project Periods of the Nanjido Area	34
Figure 1-4	World Cup Stadium and Surrounding Areas	35
Figure 1-5	SangAm New Millennium Town Plans and Progress	36
Figure 1-6	Visitors to World Cup Park	38

Chapter 2

Figure 2-1	Waste Management Laws and Nanjido Landfill	44
Figure 2-2	Major Waste Management Policies and Nanjido Waste Landfills of Seoul	45
Figure 2-3	Overseas Cases Referred to for the SangAm New Seoul Town	51
Figure 2-4	World Cup Park and Overseas Inspirations	52

Chapter 3

Figure 3-1	Major Project Time Table of Landfill Stabilization Work	55
Figure 3-2	Periods for Construction of the World Cup Park.....	56
Figure 3-3	Project Contents and Time Table in the SangAm New Millennium City Basic Plans ·	56
Figure 3-4	World Cup Park Project Organizations and Decision-Making Structure.....	58

Contents | LIST OF FIGURES

Chapter 4

Figure 4-1	Waste Landfill Stabilization Work Key Map	63
Figure 4-2	Ground Plan of Nanjido Landfill Stabilization Work	67
Figure 4-3	Cross-section of Nanjido Landfill Stabilization Work Plan	67
Figure 4-4	Nanjido dumping site Stabilization Project Leachate Treatment Block Diagram	69
Figure 4-5	Construction of Leachate Impermeable Wall and Collection Wells	70
Figure 4-6	Nanjido dumping site Gas Treatment Method	72
Figure 4-7	Nanjido Gas Extraction Well and Gas Transport Pipe Diagram	73
Figure 4-8	Construction of Landfill Gas Treatment Facilities	73
Figure 4-9	Final Cover Diagram	75
Figure 4-10	Upper Flattening and Final Cover at Nanjido	76
Figure 4-11	Rainwater Drainage Facility for Slope Safety	78
Figure 4-12	Slope Reinforcement Project for Slope Safety	80
Figure 4-13	Landfill Gas Treatment Facilities in Areas Outside of the Landfill Stabilization Work	83
Figure 4-14	World Cup Park Basic Plan Diagram	85
Figure 4-15	World Cup Park Scenery	88
Figure 4-16	Before/After Completion of Pyeonghwa Park	90
Figure 4-17	Basic Plan of Pyeonghwa Park	90
Figure 4-18	Haneul Park Land Usage Diagram	92
Figure 4-19	Noeul Park Construction Process	93
Figure 4-20	Nanjicheon Park Basic Plan	95
Figure 4-21	Photos of Nanjicheon	95
Figure 4-22	Nanji Han River Park Basic Plan	96
Figure 4-23	Photos of Nanji Han River	97

Chapter 5

Figure 5-1	Environmental State at the Time of Nanjido Landfill Closure	102
Figure 5-2	Nearby Greens and Rivers of World Cup Park.....	104
Figure 5-3	Waterways and Grassland around World Cup Park that Act as Eco-corridors.....	104
Figure 5-4	Wildlife Protection Measures Installed at World Cup Park.....	105
Figure 5-5	Transportation System for Access to World Cup Park	107
Figure 5-6	World Cup Management and Operation Organization.....	108
Figure 5-7	Conflict episodes over Noeul Park and Transition to Citizens' Park	112

Chapter 6

Figure 6-1	Before and After Construction of Nanjido Landfill Park	115
Figure 6-2	Residents of Nanjido and Residential Areas	116
Figure 6-3	Animals and Plants Growing Wild in World Cup Park.....	118
Figure 6-4	Public Golf Course of Noeul Park that was Reason for Conflict between the Civic Society and the City of Seoul	120

Contents | LIST OF BOXES

Chapter 2

Box 2-1	After-Closure Care of Household Waste Landfill.....	48
---------	---	----

Summary

Nanjido was a small island where orchids and gromwell grew along with various seasonal flowers. However, in March 1978, Nanjido was changed into a garbage dumping site for the city of Seoul, the capital of Korea. Korea did not employ any modern landfill techniques to treat the gas and leachate generated by landfills during the 1970s. The dump site was used for 15 years without even covering the garbage with soil. Finally, after the trash had built up into two 100m-high garbage heaps, its use as a waste dumping site was discontinued in March 1993. In the meanwhile, the surrounding area became home to the socially vulnerable people living next to the dump.

Korea's first waste management regulation was the Waste Cleaning Act in 1961; the Environmental Preservation Act for industrial waste was enacted in 1977. Household wastes and industrial wastes were dealt with by the same law after enactment of the Waste Management Act in 1987. Six years remained before closure of the Nanjido dump and unfortunately Nanjido still received wastes of the city of Seoul without having proper regulations.

Though late, the Seoul municipality finally began environmental pollution prevention projects to stop the environmental deterioration caused by the dump and established an eco park (called the World Cup Park later) on top of it. The World Cup Park is becoming more and more ecologically healthy as time passes. It has become an attraction of Seoul that many people visit all year round and is also a good example for foreigners of contemporary environmental restoration techniques.

The purpose of this report is to introduce systematically the establishment procedures and management methods of the World Cup Park that was transformed into an eco park

from a waste dumping site, to help policy-makers to understand them easily, and to share experiences of Seoul with foreign countries. It is expected to be especially of help to city governments contemplating the use of suburban areas as waste landfills or securing green spaces for residents.

The report consists of the Goals and Achievements of Establishing Eco Parks (Part 1), Background and Need for Establishment of Eco Parks (Part 2), Implementation Strategy and System (Part 3), Details and Progress (Part 4), Success Factors (Part 5), and Implications for Developing Countries (Part 6).

1. Goals and Achievements of Establishing Eco Parks

The purpose of establishing the World Cup Park was 1) to turn a waste dumping site into an environment-friendly space, 2) to renovate the environment surrounding the stadium for the 2002 World Cup games within a limited amount of time, and 3) to establish the World Cup Park as an open space and park for SangAm City, a “new-town” development in the rapidly expanding city of Seoul.

During the period between 1978 and 1993, a total 92,000,000m³ of garbage was buried in the Nanjido dump. The Seoul city government carried out landfill stabilization work and park establishment construction in consecutive order. Through the stabilization stage, the waste layer was blocked off from outside and facilities were installed to treat landfill gas and leachate generated from waste degradation. During the park construction stage, Haneul Park and Noeul Park were built on top of the garbage mountains, while Pyeonghwa Park and Nanjicheon Park were built on flatland, and the Nanji Han River Park was built on the side of the Han River. One year after cessation of the dumping in 1994, 89 species from 24 families of plants were discovered, but the numbers rapidly increased to as many as 502 species from 95 families of vegetation by 2010 since establishment of the World Cup Park. After Nanjido was transformed into the World Cup Park there was also an increase in animal life, including birds, insects, amphibians, fish and mammals. There were 167 species of animals discovered prior to construction of the World Cup Park, comprising fish, amphibians, insects and mammals. However, eight years after the World Cup Park was completed, researchers counted 731 species in 2010.

It was June 1996 when Korea and Japan were confirmed to co-host the 2002 FIFA World Cup and the decision to build the Seoul World Cup Stadium near Nanjido was made in October 1997 with just four years and eight months before the start of the event. With the 2002 World Cup clock ticking, construction of the stadium was the most urgent issue, but

improvement of environmental factors near the stadium was also an important matter. One unchanging condition was that the Nanjido dump site must be renovated before start of the World Cup game no matter what else happened. The Seoul municipality mobilized all administrative powers and resources, maintained a simple decision-making structure, and finally completed designs and construction for landfill stabilization and an ecological park on schedule before the start of the World Cup games.

The City of Seoul planned to create a new sub-center of the Seoul metropolis at SangAm in which residences, traffic systems, hi-tech industries and ecology could harmonize in the future, calling it the New Millennium Town. With opening of the World Cup Park in 2002 and the reopening of Noeul Park in 2008, the plan to construct Seoul's SangAm New Millennium Town Park was all but complete. In particular, it was possible to secure 43% of total area of the SangAm New Millennium Town as open space and parks. Twelve years after completion of the World Cup Park, residential areas as well as IT companies and high-tech industries have continuously moved into the town, all as originally planned.

The establishment of the World Cup Park led to the creation of a new rest area and green space loved by residents of Seoul. There are 12 million people who visit World Cup Park every year, thus out-numbering total population of Seoul, 10.39 million people. The park has also had the effect of expanding the city's recreational area by 5.3%.

2. Background and Need for Establishment of Eco Parks

Korea fell into a severe economic crisis in 1997, and had to request aid from the International Monetary Fund (IMF). To pay off the debt thus incurred, much of the nation's public capital was privatized and sold overseas, hurting the self-confidence of citizens. It became a period of huge tribulations to persons who were laid off due to the IMF's restructuring requirements. The fact that people voluntarily participated in donating their gold nationwide reflected the wish of people to be freed from such humiliation. The approach of the 21st century was also sufficient motivation for new hope and the 2002 FIFA World Cup was perceived as an opportunity for new public funds to flow into the market. At that time, a total of ten new World Cup soccer stadiums were built nationwide in Korea, in which 1.8 trillion Won was invested. The new millennium and the 2002 World Cup were used as well as opportunities for social change in Korea. At that time, cleanliness of public restrooms, standing in line in public areas, and the public transportation network were greatly improved.

After the closure of the Nanjido dump site in 1993, it became a huge social issue how to use the vast land area of over 2km². Though it was finally decided to establish the World Cup Park, three internal and external factors played important roles in the planning.

First, Korea modernized its waste landfill management system in the late 1990s and after-closure management regulations on closed landfills appeared in the 1996 Waste Management Act. The regulations that require government's inspection on the construction and closure of landfills also appeared at this time. There were, in the past, regulations only on the depth of the waste being buried and the amount of soil required to cover the waste. The after-closure management regulation stipulated that engineering plans and a minimum of 20 years of environmental management were necessary for waste landfills closed after 1998. In 2010, after-closure management regulation was strengthened further and thus the environmental management period was extended to 30 years. This regulation did not apply to the Nanjido dump site since it halted waste-burying operations in 1993. The City of Seoul, however, had already noticed such notions of the central government. It was evident that the area could not be used economically for any purpose other than parks for 20 to 30 years, taking into example cases observed in foreign countries. The city thus concluded that the safest and the most economic utilization of Nanjido was establishment of a park.

The concept of "green" practices became well known at various international events; thus the idea of a Green Olympics and Green World Cup became new icons and a trend. The 1992 Albertville Winter Olympics in France was criticized for the worse-ever environmental pollution and that it destroyed nature. Learning from this, the 1994 Lillehammer Winter Olympics held in Norway became the first in the world to integrate environmental issues into international sports competitions and declared itself as the first iteration of an Environmental Olympics, for which Norway constructed a skating stadium using a natural cave and connected stadiums using trams rather than cars and buses to prevent environmental pollution. The 2000 Sydney Olympics took a step further and used the catch phrase 'Green Olympics' and environmentally restored the Homebush Bay area, which had been a waste landfill, and built the Olympic stadium on top of it. This trend continued on to the 2002 Salt Lake City Winter Olympics in the United States. The Korean government also kept its eye on such trends. The ecological restoration of the Nanjido dump pursued by the City of Seoul was a perfect opportunity to make the 2002 FIFA World Cup an environmental World Cup.

The establishment of the SangAm New Town was a core project of the 31st mayor of Seoul, and the World Cup Park was a sales point intended to underwrite the success of this venture. The 31st mayor, urgently needed a project to overturn the gloomy social

atmosphere resulting from the 1997 economic crisis. In July 1998, before being inaugurated as the mayor, declared the 'establishment of the New Seoul Town'. The New Seoul Town represented SangAm New Town and the World Cup Park would be a park and an open space on the backdrop of the SangAm New Town.

3. Implementation Strategy and System

One of major projects of Mayor, who started his term as the 31st mayor of Seoul from July 1998, was to make the SangAm area into a new sub-center of Seoul metropolis and he officially announced this project right after his inauguration. This project was concretized in the 'SangAm New Millennium New town Basic Plan' that was carried out from August 1998 to May 2000. Over the long term, the plan laid out next 50 years and made establishment of the World Cup Park in Nanjido a core project to transform the SangAm area into an eco-city. The World Cup Park was designed not simply as an ordinary park but within the frame of much more ambitious urban planning and regional development.

The FIFA World Cup in June 2002 served as a stimulus to establishment of the World Cup Park in a short period of time. The waste landfill stabilization work took four years and ten months and was finished in October 2002. To shorten the construction period, building was begun within three months after completion of construction designs. The construction of World Cup Park went from October 2000 to June 2002 and was carried out in tandem with the waste landfill stabilization work.

The total area of the World Cup Park is 2.715km² and the area where the wastes of Seoul were buried was 66.4% of the total park area, 1.803km². The remaining 33.6% of the area was used for automobile entrances, equipment storage, a residential area for socially vulnerable people who picked recyclables, and storage of Seoul municipal construction materials. The large-scale and systematic stabilization work for the Nanjido dump site was concentrated in the 66.4% area where wastes were buried in large amounts.

Establishment of the World Cup Park cost 223.2 billion Won in total, of which 140.5 billion Won was for the stabilization work and 82.7 billion Won was for the park construction. The expenses were paid in full from the ordinary budget of the city though it was a huge investment. The decision to invest general ordinary budget funds was made relatively easily since the investment was related to the international event of the World Cup and it also occurred during a period when the government actively made an effort to mitigate the economic recession by investing public funds. All of Seoul's organizational capacities were utilized for the establishment of the World Cup Park. To complete the project within

a short period of time, tasks were divided into the landfill stabilization work, establishment of Pyeonghwa Park, Haneul Park, Hope Forest, Noeul Park, Nanjicheon Park, and the Nanji Han River Park, along with slope stabilization where necessary. Six departments of the Seoul city government participated in the design and five departments participated in placing orders for construction and supervision. A number of private companies also took part in the project. There were nine companies that participated in design and 23 companies that contributed to the construction. The reason why there were so many construction companies was for the purpose of reducing the construction period through participation of companies with different expertise. Six companies were also employed for construction supervision.

The decision-making structure regarding park construction was also very simple. The Seoul Institute provided the basic framework of the park. Consultation was received from experts in different areas for the construction. The problem was mediating the decisions for projects and for conflicting areas, but two vice-mayors made most of the decisions. Areas that required additional consideration were determined by the mayor. One quite unique point of this project was that several outstanding urban planners participated to draw basic plans and one of them was employed as a vice-mayor, who directly took care of the project's progress from 1998 to 2002.

4. Details and Progress

The Nanjido ecology restoration project included both the stabilization work and the World Cup Park construction. As various wastes were piled up in this site in an unsanitary fashion for 15 years, the rotted wastes generated leachate, odor and harmful gas, thus contaminating the Han River and atmosphere while deteriorating the surrounding ecology. The goal of the stabilization work was to restore the environment and mitigate the pollution, while keeping the huge garbage heaps in place., and perhaps most important, to turn the abandoned land of Nanjido into an environment-friendly park. The stabilization work included installation of an impermeable wall to prevent leakage of leachate from the dump site, the treatment of leachate, the collection and treatment of landfill gas, slope stabilization to manage sides of the waste heaps, and the construction of grassland after covering the top of the landfill with soil.

A shielding wall was installed to prevent leakage of leachate from the sides and bottom parts of the dump site. The leachates were collected and sent to the leachate treatment facility for purification. Sheet pile and slurry walls were installed as measures to prevent leakage of leachate and pollution. Also, 31 leachate collection wells were installed on the

inside of the shielding wall to collect the anticipated amount of leachate (1,860 tons/day). To remove the foul odors and dangers of explosion due to landfill gas, the upper part of the dump site was covered with a blocking layer consisting of soil and a shielding sheet. The 106 landfill gas collection wells were installed on the upper part and sides of the landfill to extract landfill gas from waste heaps, and collected landfill gas was transferred to the treatment facility through a 14,050m-long gas pipe. Landfill gas was used as fuel for a regional heating system and remaining gas was incinerated in the gas stack. The upper part of the landfill had a 4% or greater slope to ensure rainwater runoff. The upper lots of Landfill 1 and Landfill 2 were divided into 10 blocks to help rainwater runoff and site rearrangement was planned accordingly. The upper parts of the landfills were covered with soil to restrict emission of landfill gas and also with a blocking layer (HDPE) to prevent rainwater penetration and later underground water pollution by leachate. On the uppermost part, a vegetation layer (30cm) and surface layer (30cm) were deposited to help vegetation restoration without rainwater permeation. A side-gutter was installed at the slope of the landfill to collect and drain surface water runoff from the upper part. Rainwater pipes (plume pipes, PE pipes, slope waterway, hume pipes, and others) were installed to drain rainwater from the landfill slopes and maintenance roads. Slope collapse and scouring were prevented by installing slope safety devices, such as GEO CELL, slope collection and drainage pipes, and reinforced retaining walls. It was necessary to monitor leachate leaks, landfill gas emissions, contamination levels, stability of landfill slopes, subsidence behavior analysis in the final cover layer of the upper part, and activity destruction. In order to achieve this, 66 surface settlement plates were installed on the upper part of the landfill. Other monitoring equipment was installed as follows: 21 inclinometers on upper parts and sides of the landfill, 17 pore water-pressure gauges, 62 underground water level gauges inside and outside of leachate impermeable wall, 6 underground water contamination monitoring wells outside of the landfill, and 6 landfill gas monitoring wells inside and outside of the leachate impermeable wall. Furthermore, installation of landfill gas collection wells and landfill gas discharge wells was carried out after diagnosis of the environmental status of the ground adjacent to the two waste heaps.

The World Cup Park was designed pursuing ‘mutual coexistence and symbiosis’, coexistence of ‘nature and human culture’, construction of a symbiotic relationship of ‘environmental conservation and human use’, and harmony of ‘artificial structures and natural scenery’. The land usage was divided into four districts, including the activity district, environmental restoration district, natural ecology district and regional facility district, all established according to the site characteristics.

Pyeonghwa Park was designed to express the symbolism of the 2002 World Cup, to endure as a commemorative park and to play a key role in connecting all World Cup Parks organically. Nanji Pond was built in the center of the park and connected to Nanjicheon Park as the source of Nanjicheon Stream. Haneul Park was established as a place for education that expresses the rebirth of land abandoned as a waste dumping site, and then turned back to nature. To express the theme of 'restoration of nature', the entire park was covered with grass, the vegetation that appears first on dry and rough land. Noeul Park incorporates an open-space environment-friendly golf course that minimizes damage to the natural environment. The area of the golf course was limited to 57% of the area of the upper part of Landfill 1, while the remaining 43% was used for natural vegetation and for exercise spaces and walkways for people. Nanjicheon Park features restoration of the natural ecosystem that was damaged by leachates flowing into Nanjicheon Stream, and thus it was established to show the natural river ecology. The land usage plan and spatial structural plan were established with the goal of creating a space for residents, and especially the disabled, senior citizens and youth of SangAm New Millennium Town. Nanji Han River Park is a neighborhood park to be used by residents for recreation and provides exercise, play, picnic and a walking trail. Simultaneously, it was planned as an environment/ecology, World Cup events, and urban park/neighborhood park to accommodate the functions needed for the World Cup games.

5. Success Factors

The City of Seoul's decision not to use the site of the Najido landfill for commercial purposes but instead to create World Cup Park enabled the ecological stabilization of the property. Reborn as a park for the people of Seoul, the project linked regional development with the 2002 World Cup. Various positive forces during the policy decision stage, park establishment construction stage and park management stage combined to provide excellent citizen access, to attract plant and animal life through the nearby ecosystem, and to improve habitats for wildlife.

Plans to use the land of Nanjido Waste Landfill were of high interest not only for the City of Seoul but for the entire country's housing construction industry. Five construction companies formed the Green 21 Forum and reviewed technologies for the early development of Nanjido. However, the initial plan was not adopted because lack of profitability (construction cost of 1.8 trillion Won, land sales cost of 1.5 trillion Won) and secondary contamination due to residuals from landfill waste treatment were expected.

Despite a number of other opinions, the final choice of the City of Seoul for the use of the Nanjido Waste Landfill was “to maintain the current status, while conducting environmental pollution prevention and stabilization work, and deferring usage for the future.” The World Cup Park was thus established here.

Now, just a few years later (2010), there is diverse animal and plant life living throughout the World Cup Park, including 502 plant species, 516 land insects, 62 aquatic invertebrates, 70 wild birds, and various mammals, fish, amphibians and reptiles. Aside from planting some host plants and improving habitats, the City of Seoul is refraining from all human interference. The reason why so many plants and animals live here just eight years since construction of the park in 2002 is because the World Cup Park is ecologically connected with the surrounding area; the Han River, Bulgwancheon Stream, Hongjecheon Stream, and Hyangdongcheon Stream act as eco-corridors for the park.

After the park construction, the City of Seoul planted oak trees, wild pear trees and other plants that could be used as food by animals and built an artificial wetland to promote biodiversity in the Park. Corridors for wild animals such as the narrow-mouth frog, which is a flagship species of the World Cup Park, were also installed. For example, a log ramp was built on the retaining wall and an escape route was also made for animals that fell down into drainage and collecting wells. Nets were installed in the drains to prevent falling.

World Cup Park was not developed just as a neighborhood park for local residents, but as a park for the citizens of Seoul. A major factor that contributed to this was the diverse traffic network. Jayuro that connects Seoul north and east, the Naebu Expressway that connects east and west, Gayang Bridge and Seongsan Bridge that connect the northern and southern part of the Han River, subway line 6 World Cup Stadium Station, and the Hangang walking trail and Bulgwancheon walking trail all help promote access.

World Cup Park is managed by 65 public officials of the City of Seoul. However, due to its huge area that spans more than 2km² and its diverse facilities, it is difficult to manage it properly with this manpower, and thus, volunteers also contribute. Volunteers with expertise are in charge of Nanjido storytelling, carrying out programs, operating the park information center, and providing guidance for the firefly eco-center. In particular, there are 15 people who speak English, Japanese and Chinese; they tell the story of Nanjido to foreigners who visit World Cup Park. Daily volunteers help with picking up garbage, cleaning facilities, administrative support, and other simple tasks. Noeul Park is managed jointly with a civic organization called the ‘Noeul Park People’s Organization’. The World Cup Park monitors changes in animals and plants every year. The monitoring covers seven fields of plant

ecology (flora, mushrooms), animal ecology (wild birds, land insects, aquatic invertebrates, fish), and mineral environment (soil).

However, there were also difficulties in the establishment and management of the World Cup Park. There were conflicts between the civil society organizations and the City of Seoul Green People's Committee over the construction of a public nine-hole golf course in Noeul Park. There was also a legal battle with the Korea Sports Promotion Foundation over the public golf course fee. In result, the nine-hole public golf course is being used as a public park and is being managed jointly with the civil society organization that had argued against it. This was the result of poor communication with the people and an uncomfortable facade of building a park in such a short period of time.

6. Implications for Developing Countries

The Nanjido dumping site was one of the biggest Not-In-My-Backyard (NIMBY) facilities located on the outskirts of Seoul city. Environmentally, it was too barren for people, plant and animal life, and it was used as a residential area for socially vulnerable people. Nanjido was reborn as an eco park by the efforts and vision of City of Seoul. It has become a park of Seoul and an area loved by the people. Valuable lessons were also learned in the policy-making stage for land use, park construction and management stages. Transforming the waste dumping site of Nanjido into an eco park was a very smart decision. While it is important that it became a park, landfill gas and contaminated leachate generated there show why constant after-closure management of waste landfill is necessary. By constructing a park, it was easy to obtain an opportunity for urban restoration. It was possible to create jobs and dwelling places for the socially vulnerable people near the dumping site without much social conflict and thus, it was also possible to transform the surrounding area of the dumping site. It was confirmed that nature could restore itself. In particular, the World Cup Park connected to the surrounding natural environment with various eco-corridors that restored its bio-diversity and health in a short period of time.

Another lesson learned was the importance of communicating with the people. Amidst constraints of having to build a park within very limited time, park construction was achieved with strong support of administrative power and expert groups. In this process, there were conflicts with the civil society of Seoul city and thus, the public golf course of Noeul Park, which was the cause of the conflict, was changed to a citizens' park. With that, all conflicts were resolved. In fact, the 'Noeul Park People's Organization' established by civil society organizations is helping the operation of Noeul Park. The help of volunteers

and civil experts is quite remarkable for the overall operation of the World Cup Park. This shows the power of communication and cooperation.

The case of establishing the World Cup Park in Seoul suggests many implications to cities that experience overcrowding and other environmental problems caused by development during urbanization.

Firstly, idle public land such as waste landfills must be utilized as common assets of the future, rather than for commercial purposes. The fact that the upper part of the dumping site now being used as a park that the citizens of Seoul are proud of is also outstanding. Through this, there was sufficient justification to block off environmental damage resulting from the landfill as well as satisfying the legal conditions of the 20~30 year after-closure management. It acts as a backdrop park for the region and also helps development of the worn and torn area giving the opportunity for people to experience an eco park where they can enjoy nature. If the Nanjido dumping site was used for commercial purposes, this place would have been filled with a bunch of gray concrete skyscrapers.

Secondly, appropriate environmental management is possible for unsanitary landfills as well. The Nanjido dumping site at the time when garbage was buried was the epitome of an unsanitary landfill without any countermeasures for landfill gas, leachate, waste scattering, and pests. Even after the closure of the dump site, massive heaps of garbage that stood 100m high made it difficult to establish an engineering plan for environmental management. The facts that a park would be established in this area, the 2002 FIFA World Cup main stadium would be built here, and that this area would be the home to the New Millennium Town required strict environmental management. However, the City of Seoul achieved stabilization of the waste layer by maximizing nature's healing abilities and blocked pollutants from being exposed to the environment by appropriate engineering measures. The results were highly satisfactory. Many visitors never notice the environmental problems in this site since landfill gas and leachate are being properly collected and treated.

Thirdly, the establishment of a park acted as an opportunity to provide a dwelling place for the socially vulnerable people who lived next to the dumping site. To the people of Nanjido who made a living on picking recyclables from the waste on the site, Nanjido was an important locus for survival (824 households, 3,103 people). The dump was closed in March 1993 but many of the residents did not have resources to leave dwellings, which were shabby and in danger of collapse. Thus, the City of Seoul brokered jobs to over 400 households and created jobs, while helping them to move by giving them rights to move into leased apartments, among other inducements.

Fourthly, collected landfill gas was used as regional heating fuel. At the World Cup Park, a total of 106 landfill gas collection wells – 58 wells in Noeul Park and 48 wells in Haneul Park – were installed to collect the landfill gas generated from the waste layer. From the landfill gas was derived a valuable substance, fuel from methane gas (CH₄). The total amount of landfill gas used as fuel from 2002 to 2013 was 232,572,000m³, which can be monetarily converted to approximately 8.2 billion Won. Landfill gas is used as part of the fuel of the Korea District Heating Corporation that supplies heating to three public buildings, 16,335 apartment households and 36 office buildings. Landfill gas occurs naturally and unless used as such, it leads to exhaust of methane or carbon dioxide, which is known to cause global warming.

Fifthly, the World Cup Park is recognized as a place for international environmental education. Approximately 3,000 domestic and foreign public officials and concerned persons visit the World Cup Park every year. They come to benchmark the landfill that was transformed into a park and to visit the Mapo Resource Recovery Facility (incinerator) and Korea District Heating Corporation (that uses landfill gas and incinerator heat as heat sources for regional heating) located at the World Cup Park. Meanwhile, World Cup Park received the UN Habitat's Special Award in 2010. This award is given to individuals, institutes and businesses recognized for making remarkable contributions by providing housing for humanity and in relation to sustainable urban development.

Lastly, the restoration of the Nanjido as World Cup Park was a turning point for landfill management. During the period of 1978 to 1993 when the Nanjido dumping site was operated, the only regulation on waste landfill in Korea was on how to cover up the landfill. More detailed landfill regulations appeared after enactment of the 1991 waste management act, and this was when the Nanjido dumping site was preparing to finish burial of wastes. Management methods after closing landfill were established in 1998 and this was when the Nanjido was already undergoing its stabilization work. After the Nanjido dumping site was closed, the government made huge revisions to relevant regulations. Landfills now have to be built in an appropriate area and should have a basis to minimize environmental damage in the establishment phase. The government prescribed methods to prevent environmental damage by the facility during burial of wastes. It also specified how to treat and monitor pollutants for a certain period of time after the landfill was closed.

2014 Modularization of Korea's Development Experience
Nanjido Eco Park Restoration from Waste Dumping Site

Chapter 1

Goals and Achievements Related to Establishing Eco Parks

1. Goals and Achievements at the Time of Establishing the Park
2. Social and Environmental Effects

Goals and Achievements Related to Establishing Eco Parks

1. Goals and Achievements at the Time of Establishing the Park

1.1. Goal at the Time of Establishing the Park

1.1.1. Restoration of the Waste Dumping site as an Environment-friendly Space

Nanjido was an island where orchids and gromwells grew, and all kinds of flowers blossomed according to the season. It used to be a treasure chest of nature that attracted migratory birds such as swans and spot-billed ducks in the winter thanks to its clean water and abundant aquatic animal life. In 1978, however, Nanjido was changed into a collection place for garbage generated by Seoul city, the capital of Korea. Not only household wastes, but also construction wastes, sewage sludge and other industrial wastes were buried here. The dumping site did not have modern landfill facilities to collect landfill gas and to treat leachate. Wastes were buried here for 15 years without even using soil to cover wastes. After two mountains of wastes standing 100m high were made, burial of wastes at this dumping site was finished in 1993.

Since then, attention was centered on how to use this land. There were various opinions such as to move the waste somewhere else or to dig it up and treat it, but the conclusion always involved development projects such as apartment construction. However, the City of Seoul made a policy decision to build a park here. Their intent was to restore it into an environment-friendly space since it was an abandoned land due to waste. The City also

wanted that it should contain future-oriented environmental and cultural characteristics for the coming new millennium.

1.1.2. Prompt Environmental Maintenance around the Main Stadium of the 2002 World Cup

In October 1995, Korea made its bid to host the 2002 FIFA World Cup to the Federation Internationale de Football Association (FIFA). In June 1996, it was decided that the 2002 FIFA World Cup would be co-hosted by Korea and Japan. Since then, the search for a place to build Korea's main stadium began. In October 1997, it was decided that Korea's main stadium would be built in the SangAm district of Seoul. The design of the World Cup main stadium was completed in May 1999 so there were exactly three years left until the World Cup games. During construction period, it was necessary to deal with the waste dumping site, as well the prefabricated houses and Nanjicheon River nearby. Ultimately, the restoration of Nanjido also contributed to improvement of the environment surrounding the World Cup Stadium.

1.1.3. The Backdrop Open Space and Park of the SangAm New Millennium Town Contribute to the Construction of an Environment-friendly City

Demand for houses in Seoul city was very high in the 1990s and the City of Seoul attempted to resolve the housing shortage problem through construction of public housing. As part of this, the City of Seoul requested the central government in March 1996 to designate the SangAm-dong area near to Nanjido as a housing site development town that included housing land, communities and farmlands. In addition to hosting the 2002 FIFA World Cup games, a global festival, the City of Seoul devised plans to foster a new secondary central business district of Seoul in this town where residence, transportation, advanced industries and ecology could be combined in the future. They called this area the "SangAm New Millennium Town." According to this plan, Nanjido would take on the role of an open space and park to symbolize an environment-friendly city.

1.2. Achievement of Park Establishment Compared to Its Goal

1.2.1. Restoration of the Waste dumping site to an Environment-friendly Space

Nanjido is an island with an area of 2,720,000m², surrounded by the Han River, Bulgwangcheon River, Hongjecheon River, Nanjicheon River, and Hyangdongcheon River. Before being used as a waste dumping site, Nanjido was filled with grass, farmland, villages and wild animals. It is evident from looking at old maps and photos that Nanjido was also an area where there was harmony between the Han River and the surrounding nature. But during 1978 to 1993 when it was used as a garbage dumping site, a total of 92 million m³ of waste was buried in Nanjido. The waste was mostly from households, construction, sewage sludge, and other urban refuse. The surface of Nanjido that was until then flat rose by about 4m every year and reached 98m at the end of its use.

The City of Seoul first began stabilization construction followed by park construction. During the stabilization construction, the waste layer was blocked off from outside and facilities to collect landfill gas and treat leachate were installed. In the park construction phase, Haneul Park and Noeul Park were built on the mountain of trash, and on the flatland, Pyeonghwa Park and Nanjicheon Park were built, while the Nanji Han River Park was established on the riverside of the Han. The biggest significance was that a waste dumping site was functionally restored to what Nanjido had been in the past. Although Nanjido was formerly a field of grass and rice paddies, it was used as a waste dumping site for 15 years and its land-use category was designated as waste treatment for purposes of urban planning. However, with the establishment of the World Cup Park, the land usage was changed to natural grassland so came under the ownership of the City of Seoul, making it possible to protect the area from for-profit development.

Trees, herbaceous plants and more than one million trees were planted in World Cup Park. However, due to nature's ability to recover, plants began to grow on top of the waste mountain on Nanjido even before construction of World Cup Park began. In exactly one year after closing the of dump site (1994), 89 species from 24 families were reported to be growing and after three years in 1996, grass and trees began to cover the slopes of the waste mountain. The number of plants prior to World Cup Park announced by the World Cup Park management office was 271 species from 60 families, which was a huge increase compared to that of 1994. But the plant count continued to increase even after the completion of the World Cup Park and it reached 502 species from 95 families by 2010. Interestingly, there were about 100 species planted at the time of constructing World Cup Park, while

over 400 species appeared naturally; thus the park attracted a wide distribution of various naturalized plants. Seeds of a variety of plants were brought in with the various wastes and these plants, having a strong adaptability to poor growing environments such as landfill gas, leachate and dry soil, created a unique landfill ecosystem. Approximately 150 naturalized plant species have been recorded since 2003, which accounts for about 50% of the 300 or so naturalized plant species found in Korea (Bae, 2010). But with natural succession, the types of naturalized plants began to decrease and it has recently been reported that there are approximately 100 species (naturalization rate of 22%) growing naturally here.

Figure 1-1 | Changes of Nanjido Seen from the Sky



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

After Nanjido was transformed into the World Cup Park, there was also an increase in animal life, including birds, insects, amphibians, fish and mammals. Prior to the establishment of the World Cup Park, there were 167 animal species including birds, reptiles, insects and

mammals. Ten years after the construction of the World Cup Park, this number increased to 731 species (2010). The huge increase of animal species resulted in more land insects (114 species before 2000, 516 species in 2010), spiders (none before 2000, 54 species in 2010), and birds (33 species before 2000, 70 species in 2010) testimony to the ecological health and balance of the World Cup Park. The increase of birds is due to many summer migratory birds, resident birds, winter migratory birds and passing birds that visit the various habitats such as the Han River, Nanji Pond, Nanjicheon River, grasslands, and forests.

Hundreds of narrow-mouth frogs, a flagship inhabitant of World Cup Park and an endangered species, live along the slopes of the landfill and Noeul Park, while the wrinkled frog and Korean brown frog also lay eggs at Nanji Pond and Ori Pond. Reeve's turtle and the giant water bug, which are also endangered species, have appeared as well. With the change of vegetation, the insect fauna, including butterflies, is becoming more abundant, and traces of the leopard cat, another endangered species, were discovered along the slopes of the landfill in 2007. Breeding of these rare animals has also been confirmed. In 2009, a wild boar was also spotted.

Figure 1-2 | Flagship Species of World Cup Park



Silver Grass



Narrow-mouth Frog

Source: World Cup Park, <http://worldcuppark.seoul.go.kr/>.

Table 1-1 | Change of Animals and Plants at World Cup Park

Section	Before 2000	2003	2004	2005	2006	2007	2008	2009	2010
Plants	60 families 271 species	68 families 438 species	78 families 482 species	90 families 485 species	97 families 451 species	79 families 436 species	77 families 453 species	93 families 519 species	95 families 502 species
Wild Birds	21 families 33 species	29 families 56 species	34 families 69 species	29 families 57 species	29 families 61 species	29 families 62 species	28 families 55 species	32 families 66 species	33 families 70 species
Amphibians / Reptiles	6 families 8 species	9 families 13 species	9 families 12 species	8 families 9 species	7 families 11 species	8 families 11 species	9 families 14 species	9 families 12 species	6 families 9 species
Land Insects	53 families 114 species	51 families 233 species	71 families 279 species	62 families 267 species	63 families 272 species	71 families 229 species	82 families 322 species	79 families 371 species	101 families 516 species
Aquatic Invertebrates	7 families 9 species	-	25 families 27 species	27 families 37 species	31 families 41 species	34 families 44 species	36 families 48 species	33 families 52 species	39 families 62 species
Fish	-	6 families 15 species	5 families 8 species	6 families 10 species	10 families 17 species	8 families 16 species	7 families 14 species	6 families 14 species	6 families 10 species
Mammals	2 families 3 species	9 families 11 species	8 families 10 species	8 families 9 species	7 families 8 species	8 families 11 species	5 families 8 species	9 families 12 species	8 families 10 species

Source: World Cup Park, <http://worldcuppark.seoul.go.kr/>.

1.2.2. Prompt Environmental Maintenance around the Main Stadium of the 2002 World Cup

It was decided that Korea would co-host the 2002 FIFA World Cup in June 1996. The decision to build Korea's main stadium at Nanjido was made in October 1997, thus leaving four years and eight months until the World Cup kickoff. The construction of the World Cup main stadium became urgent. The establishment of the World Cup Park had to be carried out simultaneously with the stabilization work (construction) of the waste mountain even though park construction was possible only after the completion of the stabilization work. Under such conditions, the project timetable was made by retroactively calculating time. In other words, it aimed at completing the World Cup Park within one year and eight months and to complete the design of the World Cup after two years, by November 2001, to meet the goal of completing construction by June 2002. The waste mountain stabilization work was begun in December 1996, with no choice but to overlap with the park construction that would begin in October 2000. To make the park construction possible, construction work that could damage the surface of the garbage mountain was completed during the stabilization construction beforehand. Thus, most of World Cup Park excluding Noeul Park was completed on time before the start of the World Cup in June 2002. With the

establishment of World Cup Park, the environmental maintenance project surrounding World Cup Stadium was for the most part completed, making it possible to complete street renovation and temporary dwelling complex renovation on time.

Stabilization construction, park construction, and the construction of the World Cup Stadium were completed within 7~8 years. Construction of the World Cup Park and World Cup Stadium was concentrated in the last 3~4 years and what made this possible was the City of Seoul's decision-making structure and concentration of administrative capacities. Nevertheless, one of the four parks, Noeul Park, was not opened on time due to the project's short period, and it also had to undergo trial-and-error, being changed into a citizens' park rather than a public golf course as originally planned.

Figure 1-3 | Major Project Periods of the Nanjido Area

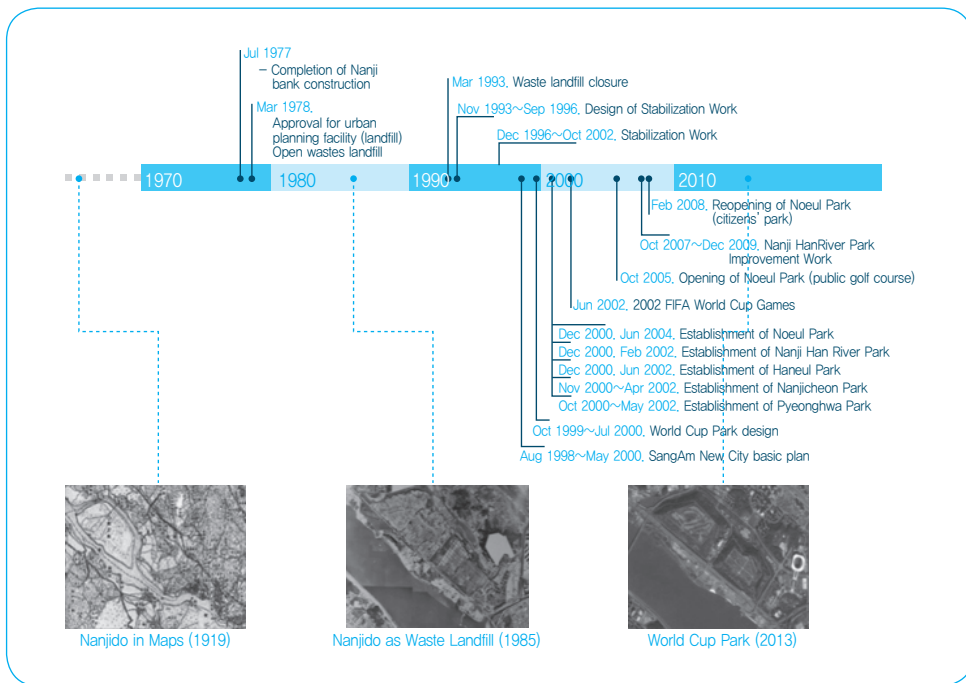
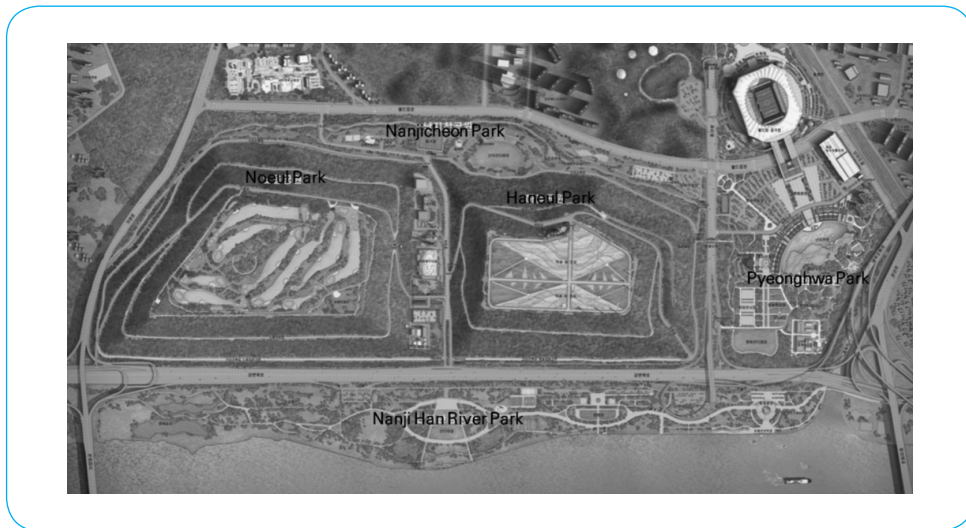


Figure 1-4 | World Cup Stadium and Surrounding Areas



Source: World Cup Park, <http://worldcuppark.seoul.go.kr/>.

1.2.3. Backdrop Open Space and Park of the SangAm New Millennium Town, and How It Contributed to the Construction of an Environment-friendly City

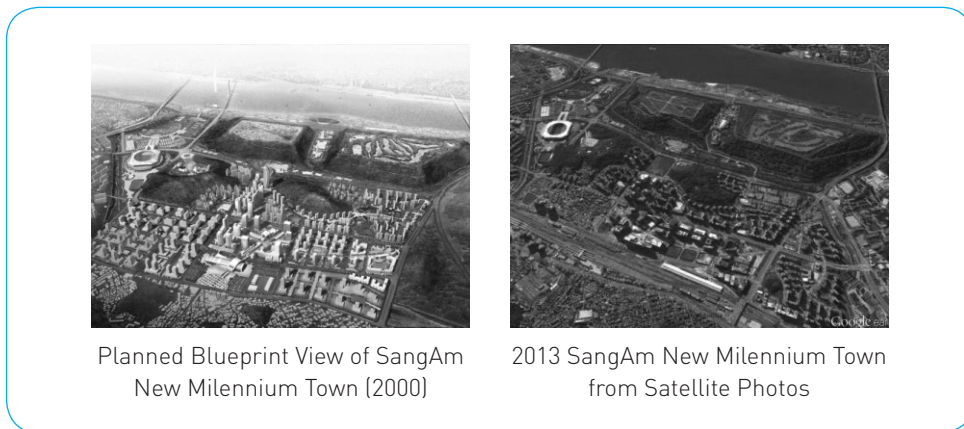
The City of Seoul devised the basic plan to foster a new secondary central business district of Seoul in SangAm town, where residence, transportation, advanced industries and ecology could be harmonized in the future, while for the moment hosting the 2002 FIFA World Cup games successfully. This basic plan included the establishment of the World Cup Park that would symbolize an environment-friendly city in Nanjido. With the opening of the World Cup Park in 2002 and the reopening of Noeul Park in 2008, the establishment of the SangAm New Millennium Town was realized to a considerable degree, and over 43% of the total area of SangAm New Millennium Town was made into open space and parkland. Currently, housing sites are being supplied and IT companies/high-tech industries are being attracted in the vicinity; there are now 870 companies located in the town, over time creating 37,000 new jobs. The fact that the SangAm New Millennium Town is making progress as planned with the World Cup Park can be seen in a satellite photo (Sungkyunkwan University Professor Kim Do-nyeon).

Table 1-2 | World Cup Park in SangAm New Millennium Town

Contents	Area	
	1,000m ²	%
Total	6,330	100
Housing Area	1,606	25.4
World Cup Park (Open Space/Park)	2,715	42.9
Susaek Planned Zone	212	3.4
Nanji Han River Park (Han Riverside)	845	13.3
Residential Environment Improvement District, etc.	952	15.0

Source: Seoul Metropolitan City (2000), SangAm New Millennium City Basic Plan.

Figure 1-5 | SangAm New Millennium Town Plans and Progress



Planned Blueprint View of SangAm New Millennium Town (2000)

2013 SangAm New Millennium Town from Satellite Photos

Source: Seoul Metropolitan City (2000), SangAm New Millennium City Basic Plan.

2. Social and Environmental Effects

2.1. Accommodation of Leisure Activities

The ways that the people of Seoul spend their recreation time is travel and outings (29.4%), watching television or videos (18.1%), watching cultural arts productions (11.6%), exercise (9.2%), rest (7.4%) and religious activities (6.5%) (Seoul Metropolitan City, 2014). Recently, there has been an increasing trend of visitors to World Cup Park during the spring,

summer and fall seasons in comparison to a decrease during the winter time. It is estimated that the park hosts 12 million visitors per year. Compared to the 10.39 million population of Seoul city, everyone in Seoul visits World Cup Park at least once a year, and compared to the 29.4% outing visitors among Seoul citizens (3.06 million), it can be said that each outing visitor visits World Cup Park about four times a year.

The most frequent place for leisure and outings among the residents of Seoul is Han River Park (Han River and riverside), and the Han River Office estimates 66 million visitors annually (Han River Project Office, 2012). When compared to Han River Park, the number of visitors to World Cup Park is only a sixth (1/6). However, the Han River Park passes through the center of Seoul from east to west with a total length of 21km and area of 39.9km² and World Cup Park has a length of 3km and an area of 2.7km², located on the western edge of the city. The two parks show a big difference in size and location. Considering these differences, the number of users of World Cup Park is very high and it in fact has more concentrated usage. In other words, while there are approximately 1.65 million users per 1km² and 3.14 million per 1km of the Han River Park, there are 4.44 million people per 1km² and 4 million users per 1km at World Cup Park. Even compared to the 7.36 million visitors at the five main historical palaces of Seoul, including Deoksugung, Changeokgung, Changgyeonggung, Gyeongbokgung, and Jongmyo Shrine, and six million foreign tourists in Seoul per year, there are more visitors to World Cup Park. World Cup Park is now becoming an attractive place for the residents of Seoul city and an important park for the people that can accommodate leisure demands.

Table 1-3 | Comparison of Users of World Cup Park and Other Facilities

Section	Users (10,000 persons)	Note
Population of Seoul	1,039	- Population of 2014 Q1
World Cup Park	1,200	- Nov~Feb: Weekends/Holidays 20,000, Weekday 1,000 - Mar~Oct: Weekends/Holidays 100,000, Weekday 20,000
Han River Park	6,600	- As of 2011
5 Major Palaces of Seoul	736	- As of 2011 - 5 major palaces: Deoksugung, Changdeokgung, Changgyeonggung, Gyeongbokgung, Jongmyo
Foreigners Visiting Seoul	660	- As of 2011

Source: City of Seoul (stat.seoul.go.kr); World Cup Park (worldcuppark.seoul.go.kr); Han River Office (2012), 2012 Major Work Plan; City of Seoul (2012), 2011 Seoul Survey.

Figure 1-6 | Visitors to World Cup Park



Visitors to Pyeonghwa Park



Visitors to Haneul Park



Visitors Camping at Noeul Park



Visitors Playing at Nanjicheon Park

Source: Google Images (Search word=World Cup Park).

2.2. Increase of Park Resources in Seoul

Seoul's total park area of $16.1\text{m}^2/\text{person}$ is greater in comparison to the total park area of New York City at $14.6\text{m}^2/\text{person}$ and Paris at $14.1\text{m}^2/\text{person}$. However, this measurement of park area can be misleading since mountain parks such as Bukhansan, Dobongsan, Gwanaksan, Suraksan, and Bulamsan that surround Seoul are not as easily accessible as more typical "street-level" parks. Based on the size of neighborhood parks that are more easily accessible such as the city's many pleasure grounds, Han River Park, Olympic Park, World Cup Park, and various sports facilities, after excluding the mountain-type parks mentioned above, Seoul has relatively less park area at $4.8\text{m}^2/\text{person}$ compared to Tokyo at $5.47\text{m}^2/\text{person}$, Paris at $14.1\text{m}^2/\text{person}$, and Berlin at $22.13\text{m}^2/\text{person}$.

The establishment of World Cup Park contributed greatly to supplementing Seoul's insufficient park area. In particular, it had great effects in securing neighborhood parks. The 2.715km^2 size World Cup Park corresponds to a park area of 0.3m^2 per person. This is

1.6% of total park area in the City of Seoul and 5.3% of neighborhood park area and thus the World Cup Park contributed greatly to expanding the city's park area.

Table 1-4 | Urban Park Expansion Effect of the World Cup Park

Section	Total Area (km ²)	Area per Person (m ² /person)	Note
All Parks (A)	169.79	16.1	- All parks: nature parks, neighborhood parks, children's parks, sports parks, other parks - 2011 population of Seoul: 10,575,447
Neighborhood Parks (B)	51.065	4.8	- Neighborhood parks: 8% of nature parks, neighborhood parks, children's parks, sports parks, other parks - 2011 population of Seoul: 10,575,447
World Cup Park (C)	2.715	0.3	- World Cup Park: natural grassland, sports facilities, neighborhood park - 2011 population of Seoul: 10,575,447
C/A (%)	1.6	1.6	- $C/A = 2.715 / 169.79 \times 100$ - $C/A = 0.3 / 16.1 \times 100$
C/B (%)	5.3	5.3	- $C/B = 2.715 / 51.065 \times 100$ - $C/B = 0.3 / 4.8 \times 100$

Source: Seoul Metropolitan City (2012), 2011 Seoul Survey; Seoul Metropolitan City (2000); SangAm New Millennium City Basic Plan, Seoul Homepage, Seoul Statistics, <http://115.84.165.91/jsp/WWS00/>.

2014 Modularization of Korea's Development Experience
Nanjido Eco Park Restoration from Waste Dumping Site

Chapter 2

Background and Need for Establishment of Eco Parks

1. Surrounding Conditions at Establishment of Eco Park
2. Key Motivation for Establishing an Eco Park

Background and Need for Establishment of Eco Parks

1. Surrounding Conditions at Establishment of Eco Park

1.1. Nanjido Waste Dumping Site and Seoul's Waste Management

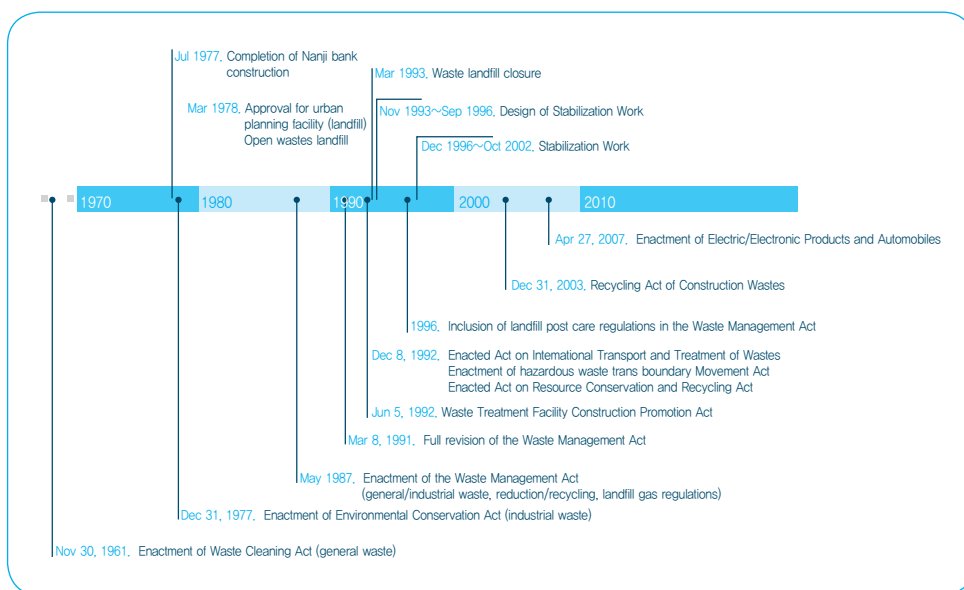
The Nanjido waste dumping site was officially inaugurated in March 1978; approval for its use as a landfill was made at that time. It was used for 15 years as a waste dump, and burial of wastes was officially halted in March 1993. Prior to the opening and closing of the Nanjido landfill, the legal framework of Korea's waste management system was very weak. Regulations on waste management were first created in Korea in 1961 under the Waste Cleaning Act, which dealt with general waste only. Industrial waste that was generated in larger amounts and more harmful was finally addressed in 1977 with the Environmental Preservation Act. In 1987, general waste and industrial waste were dealt with in one single law with the enactment of the Waste Management Act. At that time, about six years were left before the close of the Nanjido dump site. Korea's laws and regulations on waste management evolved quickly from 1992 prior to the close of Nanjido. First, the Act on Resource Saving and Promotion of Recycling (enacted on December 8, 1992) was implemented to promote waste reduction and recycling and this law was later subdivided into the Act on Promotion of Construction Wastes Recycling (enacted on December 31, 2003) and the Act on Resource Circulation of Electric and Electronic Products and Automobiles (enacted on April 27, 2007). To minimize the social conflicts sure to arise with installation of new incinerator and sanitary landfill facilities, the Act on Promotion of Installation of Waste Treatment Facilities and Support for Neighborhood Areas was passed 1995. To enable Korea to participate in international waste management activities, the Act

on International Transfer and Treatment of Wastes (enacted on December 8, 1992) was also enacted. Landfill gas treatment regulation was introduced into the 1987 Waste Management Act and after-closure management regulations were also introduced in 1996, three years after the close of the Nanjido landfill.

In short, the Nanjido site operated at a time when Korea's waste management regulations were just beginning to introduce modern systems and when there were still no regulations on landfills. As shown in the emergence of Korean waste management laws, the waste management of Seoul evolved nearly hand-in-hand with the alignment of the national government's relevant laws.

The waste management status of Seoul was officially documented from 1960. In the early 1960s, there was no waste treatment center designated by the City of Seoul. Household wastes were sent to housing development sites and wetlands. At the time, housing site developers demanded large amounts of materials for covering up land and embankments. The City of Seoul disposed of automobiles at 30 Won per car in 1963 and the quantity disposed at a charge was 57% in 1971, 54% in 1972, 44% in 1973 and 40% in 1974. In 1966, the City of Seoul obtained only-for-dumping sites such as Gunja-dong, Sangweolgok-dong, Eungam-dong and Yeomchang-dong, which were used as landfills. Bangbae-dong, Apgujeong-dong, Jangan-dong Guui-dong, Cheongdam-dong, and Songjeong-dong were used as dump sites from 1976 to 1977. Nanjido was used as a dump site starting in March 1977 and was designated as a waste dumping facility according to urban planning facility classification on March 20, 1978. Nanjido was used as a dump until the City of Seoul proclaimed its close in March 1993. But burial of wastes continued at other dumps thereafter. Guui-dong and Sanggye-dong site were also used as dumps from 1978 to 1980, and there were places that the local government landfilled on a case by case basis. Dobong Landfill and Gonggu Landfill were used together with Nanjido from 1980 to 1985 and it has been assessed that the amount buried was 4,801,595 tons. A large quantity of briquette ashes that were generated during the 1982~1985 were used for piling sand on the riverside of the Han River development project, and the amount of briquette ashes used during this four year period was 6.62 million tons (by car) (Yoo et al., 2000). The location of the Sudokwon Landfill Site (sanitary landfill) was decided in 1988 and foundation construction was begun in 1989; thus the age of bringing in wastes to the Sudokwon Landfill Site began in 1993.

Figure 2-1 | Waste Management Laws and Nanjido Landfill

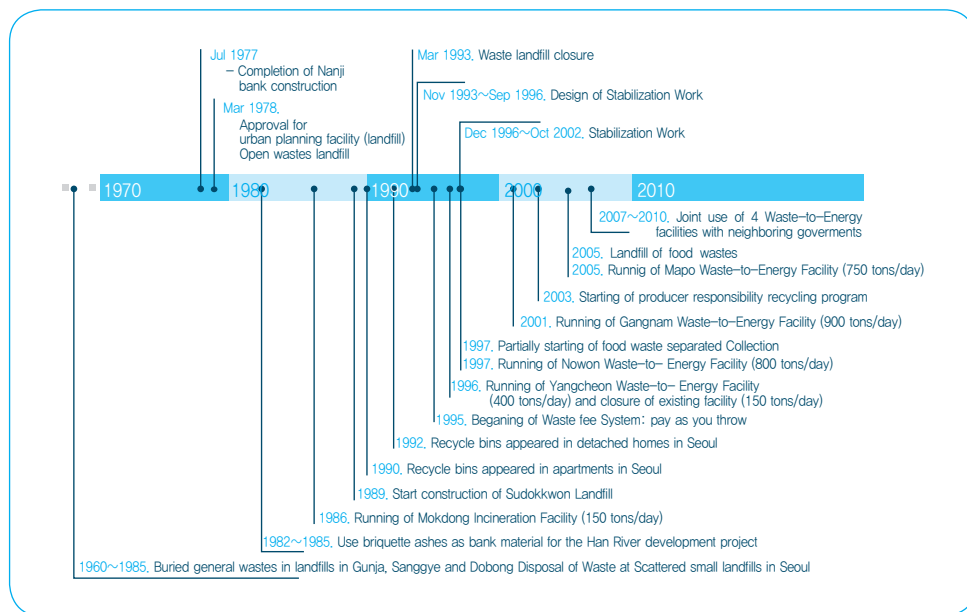


Waste management and landfill management first appeared in Seoul in 1996. The 150 ton/day Mokdong incinerator began operation at this time. Separate collection of paper, scrap metal and plastics was also begun when collecting household wastes. However, reduction, recycling and incineration of wastes began in earnest from 1990. Recycling and separate garbage collection bins began to appear in apartment complexes in 1990. This spread to detached houses in 1992. But performance under these reforms was not satisfactory since half the refuse was trash and half was recyclables. As a solution, the Volume-based Waste Fee System (VBWFS) was introduced in 1995. This system brought big success for the separate collection of recyclables in a short period of time. The extended producer-responsibility (EPR) recycling program that was introduced in 2003 contributed to securing demand for recyclable goods. Food wastes became a headache after the introduction of the Volume-based Waste Fee System (VBWFS) due to odor that arose during the collection procedures and later in the treatment facilities. The City of Seoul partially expanded separate collection of food waste in 1997 to recycle food waste. The city collects food waste separately according to the government prohibition on landfilling of all waste, scheduled to take full effect in 2015. Adequate incineration plants (called resource recovery facilities) first appeared in Seoul three years after the close of Nanjido. In 1996 the Yangcheon Facility (400 tons/day), in 1997 the Nowon Facility (800 tons/day), in 2001 the Gangnam Facility (900 tons/day), and in 2005, the Mapo Facility (750 tons/day) began operation. These four

plants made an important agreement for joint-use incineration with neighborhood local governments from 2007 to 2010.

Thus, well-equipped with procedures for reduction, recycling and incineration, only about 10% of household wastes from Seoul are today being buried in the Sudokwon Landfill Site. This situation is vastly different from the time when waste of all descriptions was buried in Nanjido. The City of Seoul began to study waste treatment methods other than landfill in the mid-1980s and introduced full-fledged policies to lessen the burden on landfills through reduction, recycling and incineration in the mid-1990s. Nanjido received all Seoul's waste without separation or discrimination, and the recyclables mixed with the garbage were picked out by socially vulnerable people who earned a living by recycling. Therefore the Nanjido area naturally became home to socially vulnerable people.

Figure 2-2 | Major Waste Management Policies and Nanjido Waste Landfills of Seoul



1.2. Seoul and Korea's Situation when Establishing the Park

Seoul's growth began to slow down during the 1990s after continuous expansion since the Korean War in the 1950s. The population that was 10.6 million in 1990 dropped to 10.4 million in 2000. Housing construction that was rapidly increasing also began to drop after peaking at 105,000 units in 1996. Fifty-two per cent of Seoul except the surrounding natural green area was developed by 1999 and the growing demand for homes was solved by building tall apartment-type residences.

Naturally, people were sensitive to developments that could affect their property value and actively welcomed convenience facilities such as parks and department stores. Only four household waste incineration plants were constructed out of ten originally planned. The construction of crematories and memorial parks located in the southern part of Seoul was delayed for nearly ten years, and construction only began after a court ruling. Meanwhile, turning the Han Riverside of Seoul and Yeouido Square into parks was supported highly by the people.

Plans for the World Cup Park emerged in 2000, the gateway to the 21st century. However, Korea was in severe economic crisis and had to receive assistance from the International Monetary Fund (IMF) and had to privatize much of the public capital and sell off assets to foreign countries to pay off its debts. To dispel the socially gloomy mood and to give hope to the people, the government devised a commemorative project for the new millennium, which they called the 'SangAm New Millennium Town' and the 'Millennium Park Project'. The 'Millennium Park' was renamed 'World Cup Park' in 2002, and with that, the dark cloud hanging over the people of Korea lifted.

The structural adjustments imposed upon Korea in 1997 by the IMF hurt the pride of the Korean people and caused huge tribulations to those who were subject to layoffs and privatization. The reason why the nation actively took part in the gold donation drive was the people's hopes to overcome the humiliation. The new millennium and the 2002 FIFA World Cup were opportunities for new optimism and for public funds to flow into the market. At the time, ten World Cup stadiums were built, including one in Seoul, and 1.8 trillion Won was invested for this.

The new millennium and the 2002 World Cup games opened the door for social change in Korea. At this time, the cleanliness of public restrooms, standing in line in public areas and the public transportation network were greatly improved.

2. Key Motivation for Establishing an Eco Park

2.1. After-Closure Care of the Dump Site

The concept of sanitary landfill is generally agreed to have begun in Korea with landfill facilities that received installation permits after February 5, 1996 and underwent inspection according to the installation inspection guideline. Prior to this, landfills were simple cutoff-type landfill facilities and had high density polyethylene liners (1.0mm or higher) and clay liners (no permeability coefficient regulations) and did not receive installation inspections, but regular inspections on the operation only. Also, a standard for final cover soil of landfill was applied only on the landfills that were closed after August 9, 1999.

Waste landfill management in Korea was begun in 1963 with the ‘Waste Cleaning Act’ that regulated the height of the first story of landfill at 3m and soil-covering at 60cm regardless of the type of cover-soil used. In 1973, a daily cover-soil standard (5cm) was set and regulations for treating landfill gas were newly enacted in 1987. The year 1999 was an important turning point for landfill management that required the final soil covering to be switched to more comprehensive capping methods to prevent leachate.

After-closure management of landfills came much later and was prescribed for the first time with the revision of the ‘Waste Management Act’ in 1996. Detailed guidelines were established in 2008 and a systematic framework was created after 2010. Its main contents were that after-closure management must be provided for at least 30 years. It also required rainwater drainage, landfill gas collection and treatment, monitoring of surrounding water quality, safety management of landfill structures and drafting of environmental reports.

However, use of the Nanjido site was terminated prior to such systematic management of landfills. But the City of Seoul understood such intention of the government in 1993. It was also evident from foreign cases that other economic uses for former dumps except as parks were not possible for 20 to 30 years after closing of a landfill. The decision was made to transform the Nanjido site to an ecological park as compensation for environmental damage caused to the surrounding area while being used as a landfill from 1978 to 1993 and to pass on the potential value of this area to future generations.

Box 2-1 | After-Closure Care of Household Waste Landfill

After-Closure Care of Household Waste Landfill (Waste Management Act Article 50)

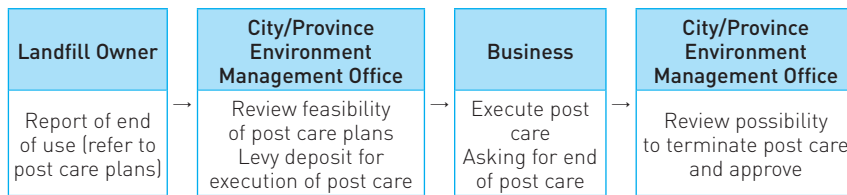
1. Purpose

- ▷ Prevention of damage to the health, property and environment of residents near landfills

2. Post Care Method

- ▷ Care period: 30 years or longer from the end of use or reported closing
- ▷ care personnel
- ▷ care items and methods
 - rainwater drainage
 - leachate management
 - groundwater quality investigation
 - seawater quality investigation
 - emitted gas management
 - maintain stability of structures and ground
 - surrounding environment pollution investigation
 - disease control
- ▷ Draft surrounding environmental impact investigation report

3. Post Care Administrative Procedures



2.2. Hosting an Environment-friendly World Cup

The 1992 Albertville Winter Olympics in France was criticized for the worse-ever environmental pollution generated by such an event and that it destroyed nature. Learning from this, the 1994 Lillehammer Winter Olympics held in Norway became the first in the world to integrate environmental issues into international sports competitions. Lillehammer declared itself the first Environmental Olympics, constructing a skating stadium using a natural cave and connecting stadiums with trams, and otherwise conducting projects that prevented environmental pollution from the beginning.

The Sydney Olympics held in 2000 took a step further and used the catchphrase ‘Green Olympics’ and after the decision to name Sydney as the host in 1993, many relevant projects were carried out. Australians environmentally restored the Homebush Bay area which was a waste landfill, and built the Olympic stadium on top of it. In the Olympic Athletes’ Village contest, the environment-friendly design of Green Peace was adopted and use of harmful

chemical substances was minimized in the construction materials. Builders also avoided use of PVC for chairs, used sand and gravel for the floor of the main stadium, installed rainwater collection storage for each stadium and treated the water for reuse. Furthermore, they employed 100% solar power for stadium lighting, maximized use of natural lighting in the construction designs, the two large hotels constructed within the stadium used 100% solar energy. As well, 500 solar power/electric vehicles were used within the stadium for VIPs, a subway line that circled the Olympic Park was installed and made available free of charge during the Olympics, and organizers employed 3,800 natural-gas buses, and were involved in numerous other environmentally sound projects as well.

Environment, culture and sports were the main values for the Winter Olympics held in Salt Lake City of the US in 2002, which utilized the Wasatch Mountains to enhance environmental values. Games organizers made sure to protect wildlife, and took into consideration energy use, water storage and supply, and protection of forest resources. Thus, the environment was established as the core value for international sports (Kim, 2000).

The Korean government also kept its eye on such trends and established the ‘World Cup D-365 Environmental Management Plan’ that included energy conservation, use of public transportation, avoided use of disposable products, maintained green towns, and participated as stewards of the Environmental World Cup (Ministry of Environment, 2001). However, the ecological restoration of Nanjido pursued by the City of Seoul was the best claim in making the 2002 FIFA World Cup an Environmental World Cup.

2.3. Execution of Core Projects of the Citizens’ Elected Mayor

The 22nd mayor of Seoul from December 1988 to December 1990 was inaugurated again as the 31st mayor of Seoul (July 1998~June 2002). The period of the 22nd mayor, who was appointed by the central government, immediately followed the successful hosting of the 1988 Seoul Olympics so confidence and pride remained high. However, the period of the 31st mayor was completely different. Since the mayor was elected by the people, he was responsible to carry out his campaign pledges. Also a project to overturn the gloomy social atmosphere due to the 1997 foreign exchange crisis was urgently needed.

In July 1998, the 31st mayor vowed the establishment of a ‘New Seoul Town’. This vow was concretized through the ‘SangAm New Millennium City Basic Plan’ that was carried out from August 1998 to May 2000. The plan was to renovate Nanjido and the vicinity to create a new sub-center of Seoul and to assign functions of an information city, eco-city and gateway city to the new town.

The information city was realized through the Digital Media City (DMC), the eco-city as the World Cup Park and environment-friendly residential complexes, and the gateway city through the airport railway and the Gayang Bridge that connected the northern and southern part of the Han River. The function and form of the World Cup Park came to fruition following the start of construction in October 1999. Also, Mayor appointed urban planner Kang Hong-bin, who drew up these two plans as the vice-mayor to pursue actively the establishment of World Cup Park and the new city.

2.4. Foreign Cases Referred

2.4.1. Foreign Cases as Examples for the SangAm New Seoul Town

The people responsible for Seoul's future referred to foreign cases such as Millennium Town in the Greenwich Peninsula of London, England; the Seaside Sub-center of Tokyo in Japan; La Defense of Paris in France; and Potsdamer Platz of Berlin, Germany to help inspire the plans for the SangAm New Town. The Olympic Park of Sydney was also a model case since it was developed from a waste landfill into an Olympic Stadium.

The Greenwich Peninsula of London was once used for steel bar warehousing, fuel recycling facilities and waste dumping. However, this area was developed as a new sub-center by the British government between 1994 and 2005. In particular, its composition and background resemble the SangAm new town as a key project to commemorate the new millennium. Large-scale performance and exhibition facilities (The Dome) and a futuristic residential complex have also been utilized in the design of the new city of SangAm.

Japan Tokyo Waterfront City is a sub-center of Tokyo designed by Japanese government agencies on the occasion of the new millennium, beginning in 1998. It was designed as an international city, a high-tech information city, and a future residential complex ahead of SangAm new city.

Berlin Potsdamerplatz is also worth noting as a model of modern urban development. As La Defense in Paris was planned to include a new Grand Arch resembling the Arc de Triomphe, Seoul also had considered construction of Millennium Gate as a symbolic sculpture in the World Cup Park.

Sydney's Olympic Park was built on a closed landfill called Homebush Bay. The concept of environmental maintenance in the area surrounding World Cup Park is very similar to that of environmental cleanup undertaken around the Australian Olympic Park Stadium.

Figure 2-3 | Overseas Cases Referred to for the SangAm New Seoul Town



Millennium Town, London, England



Seaside Sub-center, Tokyo, Japan



La Défens, Paris, France



Olympic Park, Sydney, Australia

Source: Seoul Metropolitan City (2000), SangAm New Millennium City Basic Plan (in Korean).

2.4.2. Foreign Cases that Inspired the Establishment of World Cup Park

World Cup Park is divided into five zones: Pyeonghwa Park, Haneul Park, Noeul Park, Nanjicheon Park, and Han River Nanji Park.

The design of Pyeonghwa Park includes references to Germany's Munich Airport Center, Costa Mesa Town Center in Southern California, Germany's Regensburg University, La Villette Park of Paris, and Gustav Adolf Square in Gothenburg, Sweden.

Haneul Park was designed to resemble Byxbee Park in California, Olympic Park in Sydney, Australia, and Kiyohara Kita Park in Tochigi, Japan.

Noeul Park, which was originally planned to be built as a public golf course, includes elements inspired by Harborside Golf Course in Chicago that was built on top of a waste landfill and Wakashu Links of Tokyo, Japan with regard to its structure and management methods.

The establishment of Nanjicheon Park utilized cases such as the Twin Island salt wetlands restoration in the U.S., Gase River, Nuka River and Hikizu River of Japan, and the 1998 Expo Site of Lisbon, Portugal. The concept of La Villette Park of France was reflected partially in the Nanji Han River Park.

Figure 2-4 | World Cup Park and Overseas Inspirations



USA-Costa Mesa Town Center
(Pyeonghwa Park)



Sydney, Australia-Olympic Park
(Haneul Park)



USA-Twin Island Salt Wetlands
Restoration (Nanjicheon Park)



Paris, France-La Villette Park
(Nanji Han River Park)

Source: Seoul Metropolitan City (2000), Millennium Park Master Plan (in Korean).

2014 Modularization of Korea's Development Experience
Nanjido Eco Park Restoration from Waste Dumping Site

Chapter 3

Strategy and System

1. Connection of Regional Development and Preparations for the 2002 World Cup
2. Project Organization and Decision-Making
3. Procurement of Financial Resources

Strategy and System

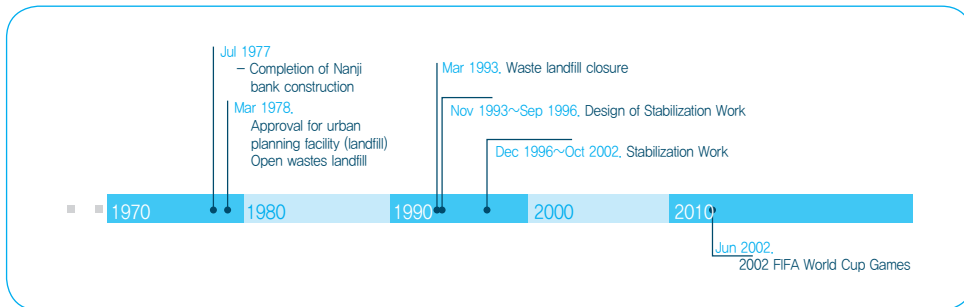
1. Connection of Regional Development and Preparations for the 2002 World Cup

1.1. Landfill Stabilization Work

Waste landfill stabilization work typically includes final covering; blocking and treating leachate; and collection and treatment of landfill gas.

It was decided in June 1996 that Korea and Japan would co-host the FIFA World Cup. The decision to build the Korean main stadium for the World Cup was made in October 1997. It was fixed fact that the World Cup would be held in June 2002. According to time clock of the World Cup Game, the year 1996 was three years after closure of the Nanjido dumpsite. The construction design on the management of the dump site was completed in September 1996. The question was whether the stabilization work could be completed in time for the World Cup or not. Construction lasted for four years and ten months and was completed in October of 2002. To cut down on the construction period, the builders were selected and construction began within three months of completing the construction design. There were concerns about contractors going bankrupt because of the IMF foreign exchange crisis in 1997, but the construction was completed as scheduled.

Figure 3-1 | Major Project Time Table of Landfill Stabilization Work



1.2. Park Construction

One of the major projects of Mayor, who began his term as the 31st mayor of Seoul from July 1998, was to establish the SangAm town as the new sub-center of Seoul, and he announced this project immediately after his inauguration. This project was concretized in the ‘SangAm New Millennium City Basic Plan’ that was carried out from August 1998 to May 2000. This was a long-term plan that looked 50 years into the future and was a core project that would transform SangAm district into an eco-city. However, this was exactly four years prior to the 2002 FIFA World Cup. The waste dumping site stabilization work was in progress and the World Cup Park would have to be completed by the time of the World Cup. The ‘SangAm New Millennium City Basic Plan’, the ‘World Cup Park Basic Plan’ also had to be conducted simultaneously. After completion of the ‘World Cup Basic Plan’, construction of Pyeonghwa Park, Haneul Park, Noeul Park, Nanjicheon Park, and Nanji Han River Park that comprised the World Cup Park began within five months, and they were completed right around the onset of the 2002 World Cup in June. The method that the City of Seoul chose to cut down design time was to allow one person to be in charge of all the plans. The person who was put in charge for this was the urban designer and Seoul University Professor Lee In-seong.

Figure 3-2 | Periods for Construction of the World Cup Park

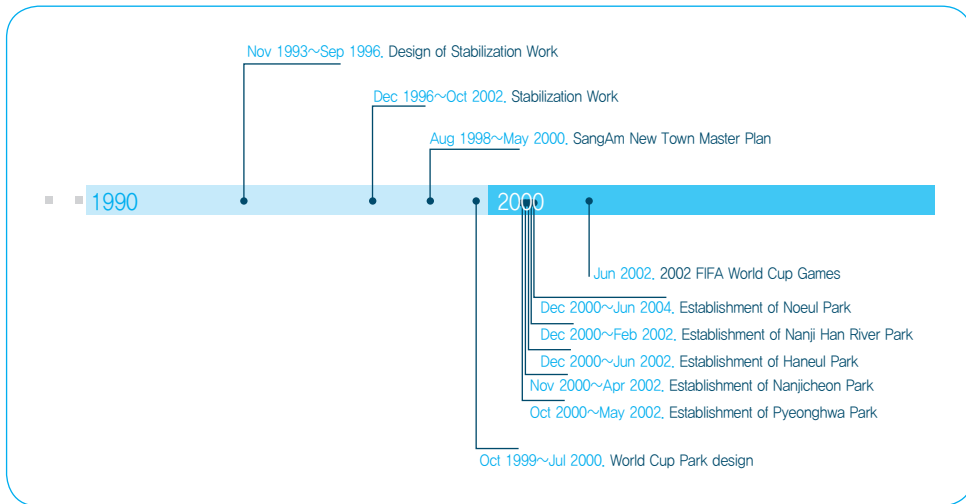
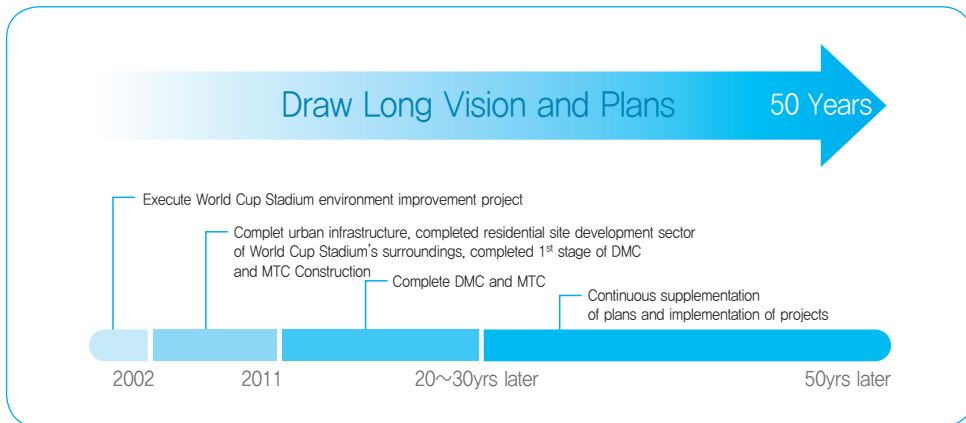


Figure 3-3 | Project Contents and Time Table in the SangAm New Millennium City Basic Plans



Source: Seoul Metropolitan City (2000), SangAm New Millennium City Basic Plan (in Korean).

2. Project Organization and Decision-Making

2.1. Project Organization

Multiple organizational capacities were concentrated on the construction of the World Cup Park. To make it possible to complete the project in a short period of time, landfill stabilization work, the construction of Pyeonghwa Park, Haneul Park, Hope Forest, Noeul Park, Nanjicheon Park, and Nanji Han River Park, as well as slope afforestation, were divided up, and six departments of Seoul's municipal government were involved in design, while five offices were in charge of placing construction orders and supervision.

A number of private and specialized companies also participated. Nine companies took part in the design, and 23 in construction. The reason why there were so many contractors was to reduce the construction time by having builders with different expertise participate in the project. Six companies also joined in the construction supervision.

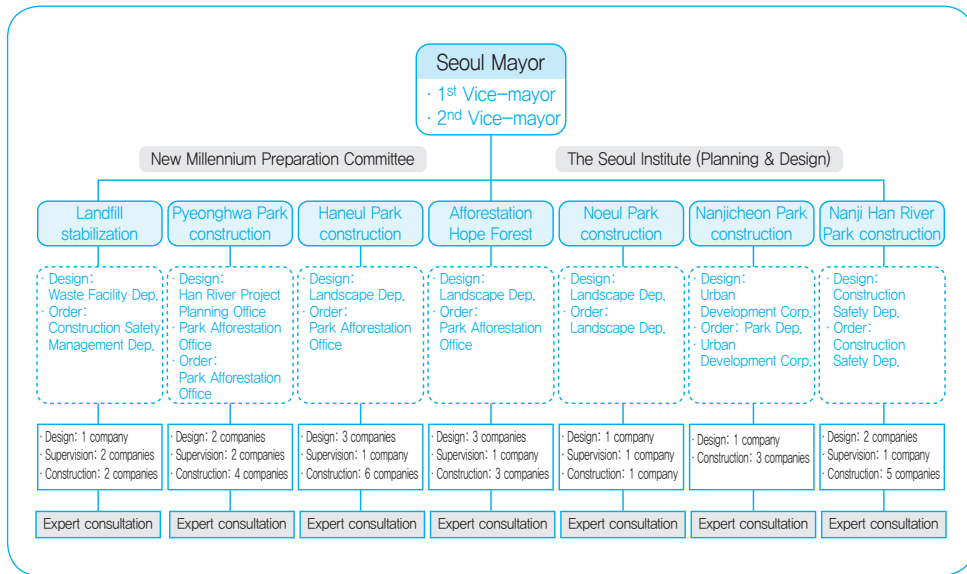
2.2. Decision-Making

The overall decision-making structure was very simple. The main framework was drawn up by the Seoul Institute.¹ Based on this, the relevant departments of the City of Seoul took charge of design and construction. Consultations from experts were sought. The crucial subjects were the decision whether or not to go ahead with the project and mediation of conflicting perspectives; most decisions were made by the two vice-mayors instead of having final approval of the mayor. The mayor made a final decision only when necessary.

The World Cup Park construction project was pursued together with the SangAm New City construction project and the World Cup Park was completed as scheduled. It was explained in Chapter 1 that the surrounding housing regions and DMC construction project were also pursued as planned. However, the reason why it could be completed as planned was because of the participation of outstanding urban planners in developing plans, and it was possible because one of these experts took charge of the process from 1998 to 2002 by serving as the first vice-mayor of administration. In other words, it employed a rare method of using the urban planning designer in the policy-decision line to propel this project.

1. The Seoul Institute was established in 1992. Its mission is to investigate major policy challenges systematically, use professional analysis to solve efficiently the problems of the various cities of Seoul, and through research and academic activities to consider the main challenges to the further development of Seoul.

Figure 3-4 | World Cup Park Project Organizations and Decision-Making Structure



3. Procurement of Financial Resources

The construction of the World Cup Park incorporated a major process of landfill stabilization that proceeded hand-in-hand with building the park. More than 14.05 billion Won was used for the landfill stabilization and 8.27 billion Won was spent on park construction, for a total of 22.32 billion Won.

The expenses were all paid out of the general account of the City of Seoul. At the time, the central government was actively attempting to stimulate the economy by investing public assets and therefore, the decision to invest general financial resources was made quite easily.

Table 3-1 | World Cup Park Construction Expenses and Breakdown

Section	Contents
Total Construction Cost	Total: 223.2 billion Won
Landfill Stabilization Work	Total: 140.5 billion Won - Construction: 134.9 billion Won - Supervision: 3.8 billion Won - Design, etc.: 1.8 billion Won
Park Construction	Total: 82.7 billion Won - Pyeonghwa Park: 31.8 billion Won - Haneul Park: 8.5 billion Won - Noeul Park: 1.3 billion Won - Nanjicheon Park: 15.1 billion Won - Nanji Han River Park: 14.3 billion Won

Source: Seoul Metropolitan City (2003.8), World Cup Park Construction Log.

2014 Modularization of Korea's Development Experience
Nanjido Eco Park Restoration from Waste Dumping Site

Chapter 4

Details and Progress

1. The Dump Site Stabilization Work
2. Establishment of the Eco Park

Details and Progress

1. The Dump Site Stabilization Work

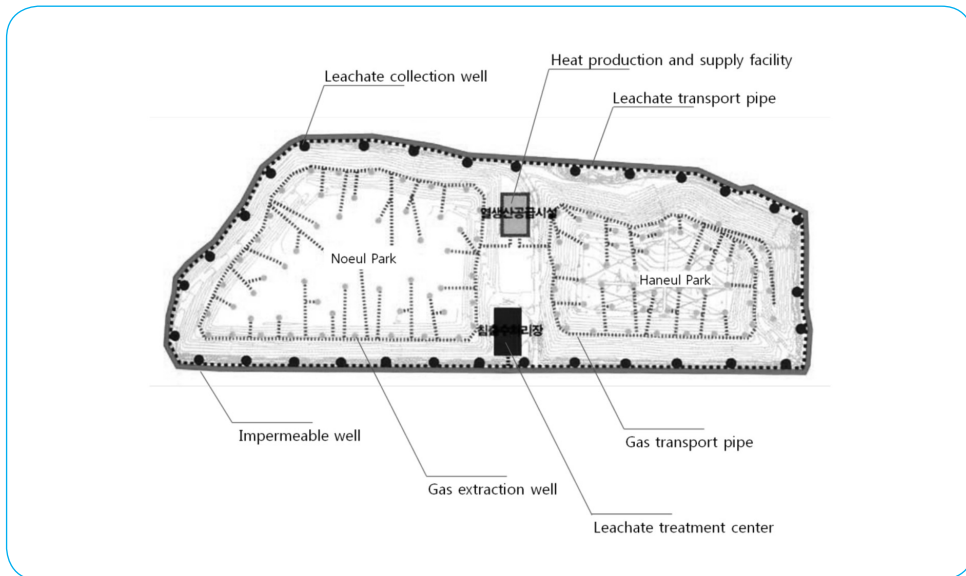
1.1. Overview

After piling up various wastes without any sanitary methods for 15 years at Nanjido, leachate, foul odors and harmful gas were generated as garbage rotted, thus polluting the air and water near the Han River and also destroying the ecosystem of neighboring areas. The goal of the stabilization work was to restore the environment, while leaving the garbage that was completely saturated alone. In other words, it was to find the cause of environmental pollution within the dump site and to make preparations to restore the abandoned land of Nanjido and recreate it as an environment-friendly park.

The total area of World Cup Park is 2.715km²; under 66.4% of that, or 1.803km², lie the remains of the waste dump. The remaining 33.6% was used for vehicle entry, equipment storage, residential areas for the socially vulnerable people who picked up recyclable goods, and for storing construction materials. Construction waste and sewage sludge were also buried during the initial operational period of the landfill. The large-scale and systemized stabilization work for the Nanjido dump site was concentrated in the 66.4% where wastes were buried in large quantities.

The stabilization construction consisted of four main parts: installation of a cutoff collar to prevent leachate from leaking and leachate treatment to purify polluted water; landfill gas collection and treatment; slope safety treatment to manage the environment surrounding the dump site; and the topsoil covering work to blanket the upper part of the dump site with dirt and grow grass on it.

Figure 4-1 | Waste Landfill Stabilization Work Key Map



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

The stabilization work per field was planned according to methods as shown in <Table 4-1>. The main scope of the Nanjido stabilization work was clearing the land of the dump site and covering it up with topsoil, blocking the leakage of leachate, installing treatment facilities, removing harmful landfill gas, securing the safety of landfill slopes, establishing sewage sludge treatment, building rainwater drainage facilities and maintenance roads, and creating other infrastructure for the smooth operation of stabilization facilities.

Table 4-1 | Overview of Stabilization Work Sectional Project

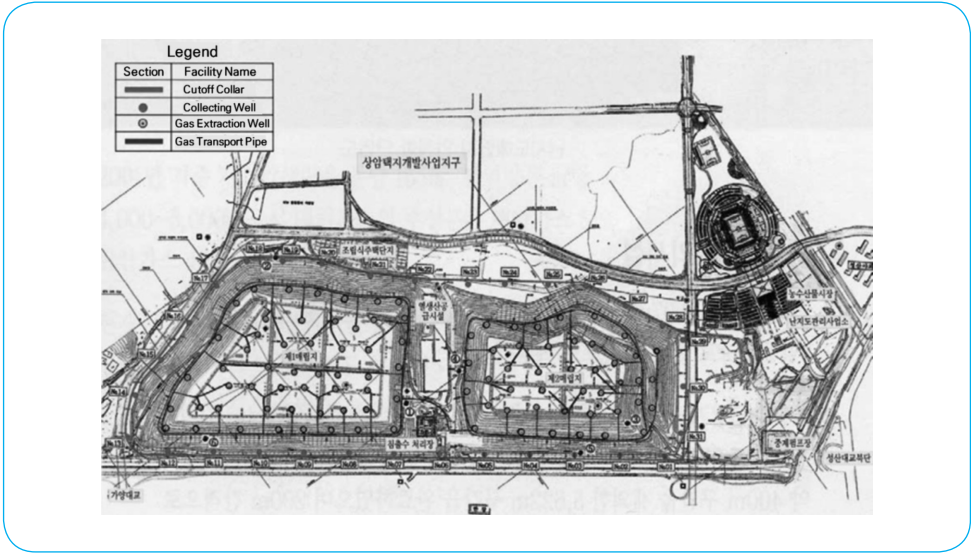
Section	Objective	Contents
Sewage Sludge Treatment	- Danger removal, recycling, and land usage efficiency increase through treatment of landfill sludge (1,144,470m ³)	Covering materials for lower stopper of landfill: 1,144,470m ³ - Landfill 1: 913,208m ³ - Landfill 2: 205,748m ³ - Nanjicheon side drainage: 14,778m ³ - Pond (1, 2, 3): 10,736m ³
Upper Stopper and Cover Soil	- Covering: Minimize permeation of rainwater to minimize leachate, prevent surface gas leaks, vegetation; - Leveling: Maintain existing safety slopes as much as possible, restore vegetation for outer maintenance roads and slope maintenance roads, install protective structure	Around 4% slope of upper stopper for smooth drainage of rainwater - Final covering layer (5.4m): surface layer (30cm), vegetation layer (30cm), drainage layer protection layer (30cm), blocking layer (HDPE1.5mm), support layer (450cm) - Total amount of covering soil: 4,247,665m ³
Block Leachate	- Prevent spread of leachate to nearby areas such as Nanjicheon, Bulgwangcheon and Han Rivers around the landfill	Install cutoff collar with Cement Bentonite Slurry Wall and Steel Sheet Pile on the entire area around the landfill - Installation depth: weathered rock 1m, soft rock 0.5m embedded - Extension: Total 6,017m (sheet pile (S.S.P): 3,345m, Slurry Wall (C.B.S): 2,672m)
Leachate Collection and Treatment	- After collecting slope leaks and base leachate, optimal treatment	<ul style="list-style-type: none"> • Leachate collection device from slope <ul style="list-style-type: none"> - Slope collection pipe: 6,127m - MAT-type multi-channel pipe: 3,500m - Horizontal drain aperture: 667 apertures • Collection facility <ul style="list-style-type: none"> - Collecting wells: 31 units - Vertical Strainer: 9,300m (186 apertures) • Transport facility <ul style="list-style-type: none"> - Natural flow pipe transfer pipe: 5,127m - Pressurized pipe HDPE: 1,547m - Slope collection pipe: 1,360m - Relay pump centers: 2 • Treatment centers <ul style="list-style-type: none"> - Transport and combined disposal to Nanji sewage treatment center after pre-treatment - Treatment process: flux control+ coagulated precipitation+ penton oxidation - Treatment capacity: 1,860 tons/day

Section	Objective	Contents
Landfill Gas Collection and Treatment	- Collection and treatment of landfill (375Nm ³ /min) emitted during waste decomposition	<ul style="list-style-type: none"> • Collection facility <ul style="list-style-type: none"> - Extraction well: 106 • Transport facility <ul style="list-style-type: none"> - Transport pipe (HDPE): 14,050m • Treatment center <ul style="list-style-type: none"> - Exhaust vent: 5 - Incinerators: 2 (FLARE STACK) - Reuse facility: During stabilization construction, after operating, install and operate heat reuse facility by the Korean District Heating Corporation
Slope Stabilization	- Restrict slope collapse and minimization of rainwater permeation	<ul style="list-style-type: none"> • Slope collection draining facility <ul style="list-style-type: none"> - Leachate elution prevention of leachate in slopes • Slope stability <ul style="list-style-type: none"> - Slope grade: stoppage soil cover of 1:1.5 or higher - Step composition: step installation every 5m (width .0m) - Slope reinforcement: Geo-Cell installation 41,560m² • Slope collection drainage facility: 32,300m² (11 units)
Auxiliary Facilities	- Efficient operation and management of landfill stabilization facilities	<ul style="list-style-type: none"> • Rainwater drainage <ul style="list-style-type: none"> - U-type waterway (D600~D1,200): 13,011 - Conduit (D500~D1,500): 6,170 - P.C BOX (1.5×1.5): 176m - Ridge gutter (D300): 3,069m - PE pipe (770~860): 4,978m • Maintenance road <ul style="list-style-type: none"> - Central road (B 19m): 797m - Entry road (B 9.0m): 3,166m - Outer maintenance road (B 7.5m): 5,291m - Slope maintenance road (B 4.5m): 4,983m - Landfill upper road (B 9.0m): 454m - Circulation road(B 7~9m): 440m • Building <ul style="list-style-type: none"> - Management building: 1,152m² - Chemical storage center: 382m² - Relay pump room: 45m² × 2 security offices: 12m² • Eco-corridors for small animals <ul style="list-style-type: none"> - Logs (ø15, L4m ctc 15~18): 430 - Swash plate (ø10, L1.6m ctc 15m): 830 • Street info sign <ul style="list-style-type: none"> - Central road: 13

Section	Objective	Contents
		<ul style="list-style-type: none"> • Stonework <ul style="list-style-type: none"> - Slope road and outer roads (H1.6~2.1m): 7,321m • Fence <ul style="list-style-type: none"> - Inside leachate treatment center (1.8 × 2.0m): aesthetic-type 463m - Slope road entry (1.8 × 2.0m): regular type 180m • Landscape <ul style="list-style-type: none"> - Leachate treatment center: 4,288 trees such as Chinese Juniper and Korean forsythia - Roadside trees: 146 locust trees - Grass area: 16,178 plants such as Korean azalea and rhododendron - Slope greens: 519,219 trees such as wild pear trees - Vegetation greening: 323,072m² such as SS greening • Measurement <ul style="list-style-type: none"> - Water gauge (cutoff collar internal measurement ø30): 31 - Water gauge (cutoff collar external measurement ø100): 31 - Pore water pressure meter (slope road side- depth 45m): 17 - Settlement plate (upper part of landfill- 60×60cm): 66 - Inclinator (top and slopes- depth 0m): 21 - Gas detection well (near Nanjicheon side landfill- ø50): 6 - Groundwater inspection well (near landfill- ø100): 6 • Maintenance <ul style="list-style-type: none"> - Monitoring facility: Leachat and groundwater landfill gas - Operation Management: Settlement and slop safety form 1

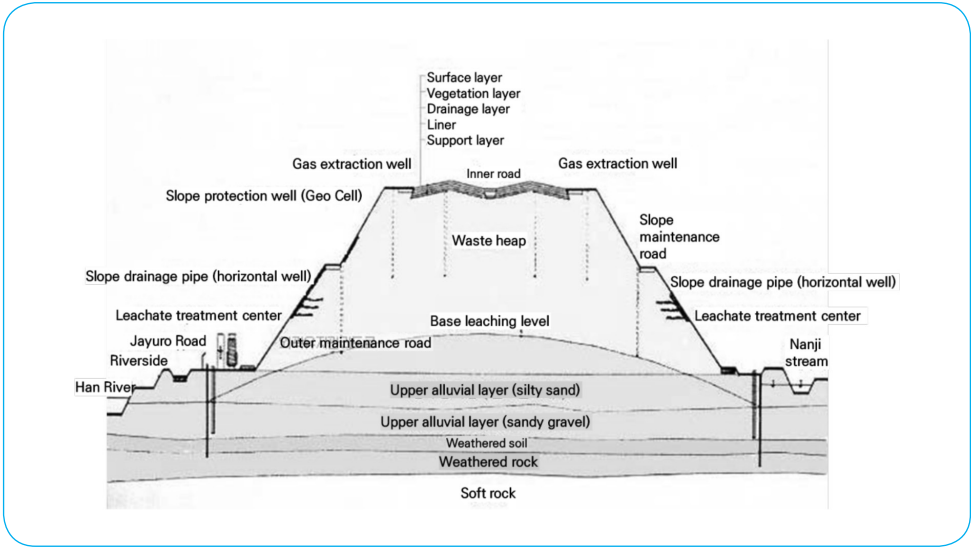
Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Figure 4-2 | Ground Plan of Nanjido Landfill Stabilization Work



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Figure 4-3 | Cross-section of Nanjido Landfill Stabilization Work Plan



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

1.2. Leachate Treatment

1.2.1. Status

The Nanjido dump site was an unsanitary landfill where wastes were buried in the original ground; its structure and covering were highly vulnerable. There were no provisions for a leachate cutoff wall or collection and thus the leachates drained down the slopes to the lower parts of the dump.

1.2.2. Problems

Leachate from wastes generally has high levels of contamination. In the particular case of Nanjido, the lower part was made up of sand and gravel layers making it easy for leachate to move and pollute the Han River and ground-water of surrounding areas, and there were also other problems such as the instability of the slope due to leaks.

1.2.3. Construction Contents

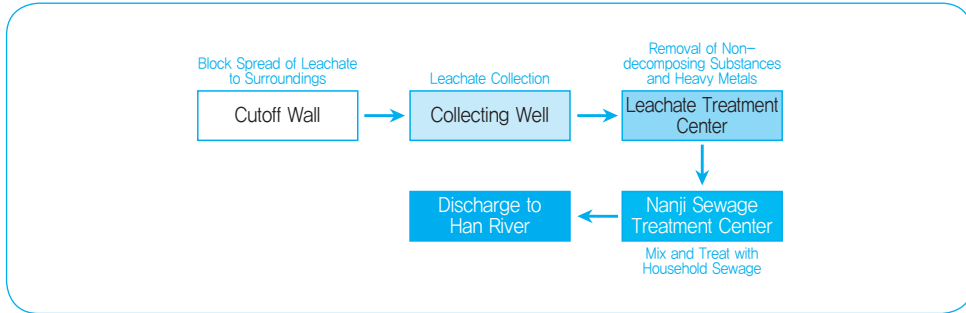
A cutoff collar was installed to prevent the leachate leaking on the slopes and bottom part of the dump and to prevent the base leachate from leaking outside of the dumping site. The leachate is thus collected and sent to the leachate treatment facility, where it is purified to prevent leakage to the outside (Seoul Metropolitan City, 2007).

It was found that the ground-water pollution around the dump further polluted the surrounding water system such as the Han River. Sheet pile and a slurry wall were thus installed to block leaking of leachate and to prevent pollution. With the installation of the cutoff collar, the level of base leachate in the landfill rose and collecting well was installed in the inner part of the cutoff wall to collect a specified amount (1,860 tons/day) and finally the collected leachate was sent to the leachate treatment plant.

The leachate collection well, a permeable concrete structure with a 4.1m diameter casing, was installed in the inner part of the cutoff collar to protect the ground-water by collecting the leachate from the bottom of the accumulation layer.

Leachate collected from 31 leachate collection wells is sent to the pump center via transport pipe (natural flow) and then to the flux control tank in the relay pump center, passing through the pre-treatment process in the leachate treatment plant; it is finally discharged into the collection pipe connected to the Nanji sewage treatment plant.

Figure 4-4 | Nanjido dumping site Stabilization Project
Leachate Treatment Block Diagram



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Table 4-2 | Major Contents on Leachate Treatment

Section	Specifications	Quantity	Note
Impermeable Wall	17~56m	6,017.5m	- S.S.P Wall: 3,345.7m - C.B.S Wall: 2,371.8m
Leachate Collection Well	14~31m	31 units	- 1,860m ³ /day
Leachate Transport Pipe	Ø60~Ø300	8,034m	- Natural flow: 6.487m - Pressurized pipe: 1,547m
Treatment Center	2 stories, 1 roof top	1 type	- Total area: 1,631.26m ²

Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Figure 4-5 | Construction of Leachate Impermeable Wall and Collection Wells



Sheet Pile Transport
for Impermeable Wall Support



Installation of Sheet Pile
for Impermeable Wall Support



Bentonite for Impermeable Wall



Bentonite Upper Covering
for Impermeable Wall



Production of Leachate
Collection Wall



Completion of Leachate
Collection Well

Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

1.3. Landfill Gas Treatment

1.3.1. Status

As the wastes in dump sites rot, the emitted gas has negative impacts on the surrounding environment. In the case of landfill gas from Nanjido, the average emission was 432,000Nm³/day, and its main contents were methane gas (51%), carbon gas (46%) and other gas (3%). Hydrogen sulfide and ammonia, the major substances causing foul odors, are 1.5PPM and 0.3PPM, respectively.

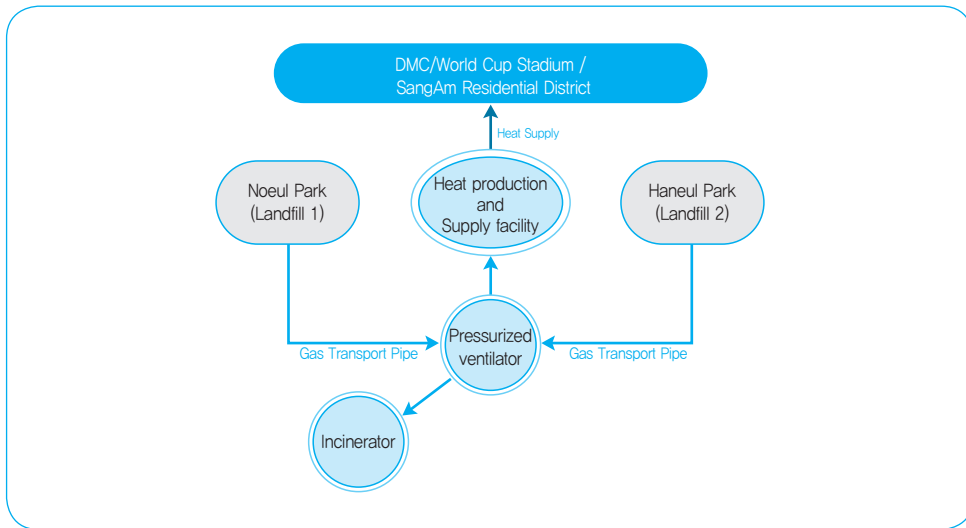
1.3.2. Problems

Methane (CH₄) gas can cause fire and explosion. The hydrogen sulfide and ammonia (NH₃) that account for about 1ppm in landfill gas cause foul odors and are harmful to human health, while they also retard plant growth.

1.3.3. Major Projects

Key issues of landfill gas treatment are removal of foul odors and risk of explosion. For this, the upper part of the landfill was covered with a barrier to block gas emission as fully as possible. One hundred six gas collection wells were installed on the upper part and slopes of the landfill. The collection wells extract landfill gas accumulated in the waste layer, and the gas is then transferred to the landfill treatment plant through a 14,050m long pipe. The gas treatment facilities use most of the landfill gas for district heating, while incinerating the remainder.

Figure 4-6 | Nanjido dumping site Gas Treatment Method



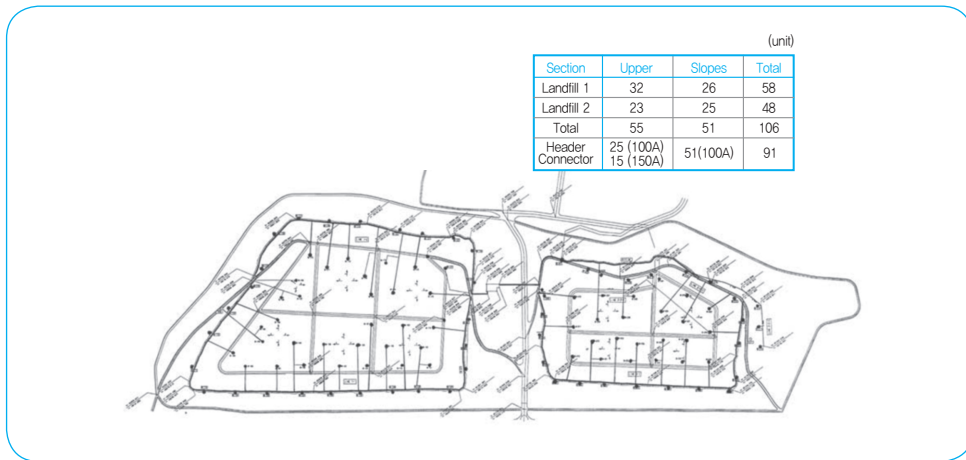
Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Table 4-3 | Major Nanjido Gas Treatment Facilities

Section	Specification	Quantity	Note
Gas Collection Well	Ø 200	106	- Upper part: 55 - Slopes: 51
Gas Transport Pipe	Ø100~450	14,050m	
Gas Incinerator Facility	1 type	1 unit	

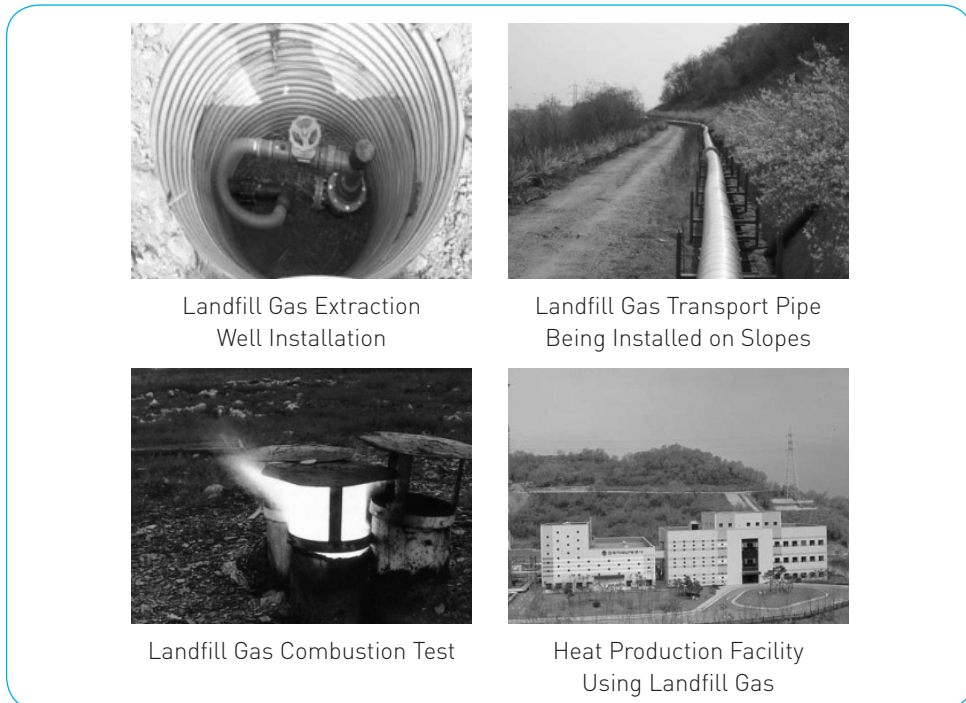
Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Figure 4-7 | Nanjido Gas Extraction Well and Gas Transport Pipe Diagram



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Figure 4-8 | Construction of Landfill Gas Treatment Facilities



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

1.4. Landfill Surface Levelling and Covering

1.4.1. Status

The outer part of the Nanjido Landfill was improved with a sand embankment that was formerly used as the road for garbage transport vehicles and thus, soil compaction of this road was greater compared to the center of the dump site. The upper center part of the dumping site showed ground subsidence (sinking) and thus allowed permeation of rainwater to the interior of the dump site.

1.4.2. Problems

Rainwater that permeated to the upper central settlement point of the dump site passed through the waste layer, changing into leachate that caused destruction and collapse of the slopes.

1.4.3. Construction Direction

The topmost surface of the landfill was covered with soil to secure a minimal slope of 4% so that the rainwater that fell on the upper part of the landfill could be discharged smoothly. To prevent rainwater from permeating the upper part of the landfill, a blocking layer (HDPE) and a drainage layer were also installed. Once the construction was completed, vegetation layers and surface layers were built to support the park on top of it.

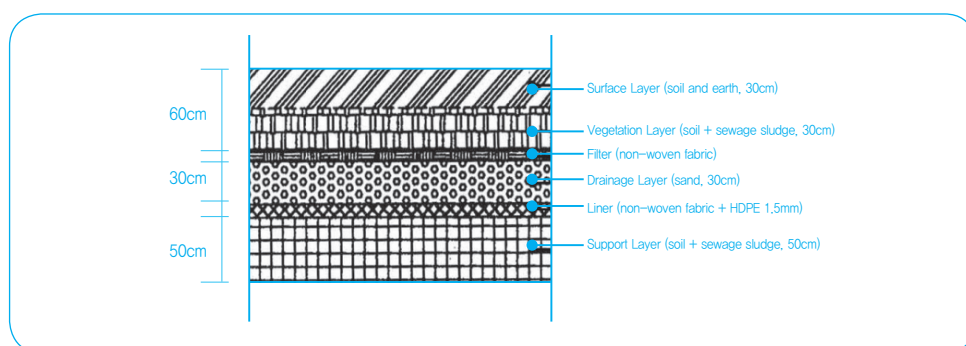
1.4.4. Contents of Construction

The summit of the landfill was graded with at least a 4% incline in comparison to the outer road in consideration of the minimum slant needed for rainwater drainage. The upper sites of landfills 1 and 2 were divided into 10 blocks to establish rainwater treatment and site flattening plans. The top of the landfill, composed of two hills of waste, was covered with soil to suppress gas emissions and was installed with a blocking layer (HDPE) to prevent ground-water pollution from rainwater and leachate.

Soil composed of mixed sand and sludge was used to complete the site leveling of the upper part and later, soil covering was extended to prevent rainwater permeation and to encourage vegetation. The support layer (50cm) the flattening slope and cutoff layer were graded (90% or higher) so that there were no bumps, thus protecting the HDPE sheet from damage; this upper cutoff layer was evenly stretched out so that its thickness would not exceed 25cm.

To increase the cutoff effect, sections of the cutoff sheet were welded together by a heat-welding process. After completion of the HDPE sheet installation, Geo textile was used to prevent damage of the cutoff sheet. Afterward, crushed stone, sand and gravel were used to construct the drainage layer (30cm) for smooth horizontal drainage. After installing the Geo textile to separate layers and to prevent loss of soil from the drainage and vegetation layers, good quality soil for the restoration of vegetation was used to construct the vegetation layer (30cm) and surface layer (30cm).

Figure 4-9 | Final Cover Diagram



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Table 4-4 | Amount of Soil Used for Levelling and Final Cover

Section	Unit	Landfill 1	Landfill 2	Total	Note
Total	m ³	2,936,431	1,467,377	4,403,808	- Earth-volume
Surface	m ³	-	46,126	46,126	- Flattening state - Thickness 30cm
Vegetation	m ³	109,150	46,377	155,527	- Thickness 30cm
Drainage	m ³	109,455	46,988	156,443	- Ø25mm or less - Sand + gravel
Liner	m ³	365,655	178,741	544,396	- HDPE+non-woven fabric
Support	m ³	181,968	79,004	260,972	- Thickness 50cm
Levelling (outside sandy soil filling)	m ³	2,535,858	1,248,882	3,784,740	- Flattening top of waste heaps

Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Figure 4-10 | Upper Flattening and Final Cover at Nanjido



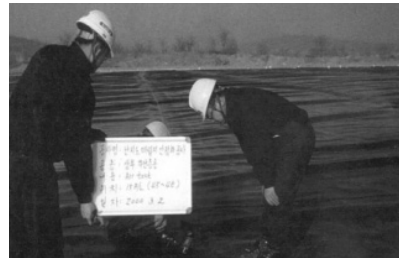
Original Surface of Waste Heap



Flattening Original Surface



Paving the Support Layer



Spreading Liner



Paving Drain Layer



Spreading Non-woven Cloth



Paving Vegetation Layer



Paving Top Layer

Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

1.5. Slope Stabilization

1.5.1. Status

The Nanjido Dump was an unsanitary landfill on hilly land filled with garbage. Due to the sinking and settlement of the central part of the landfill, rainwater permeated the trash and surface drainage could not occur, thus causing high levels of leachate. Rainwater drainage partially occurred along the concrete side-gutter of the lower part of the landfill and a soil gutter formed along with a waterway was formed naturally, but it could not function as drainage due to lack of necessary facilities. Discharge to the outer part of the landfill was made through six discharge pipes directed toward retarding basins and ultimately the Han River, and part of the runoff was discharged to the Nanjicheon River along the surface.

1.5.2. Problems

Because rainwater permeated the upper part of the landfill, leachate was generated in the form of ground-water and slope leaks, weakening the structure and creating danger of slope collapse. When rainwater in the upper part of the landfill and entry road flows out along the surface, the slope can erode and the roads in the landfill could be damaged.

1.5.3. Construction Direction

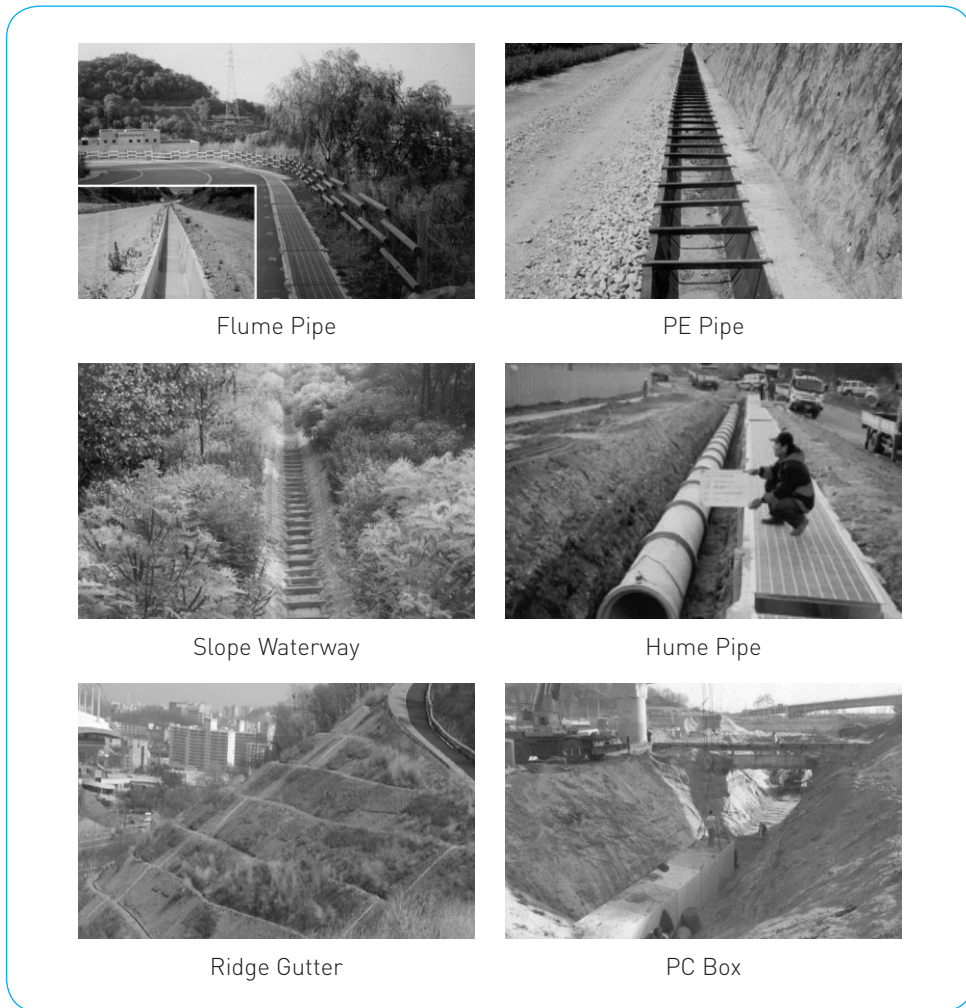
Gutters were installed for the collection and drainage of surface water discharged from the upper part of the landfill. Rainwater drainage pipes (flume pipes, PE pipes, slope waterways, hume pipes, etc.) were installed to drain rainwater from the landfill slopes and maintenance roads. To prevent the risk of slope collapse and scouring, slope safety measures (Geo cell, slope collection and drainage sheets, reinforced earth retaining walls, etc.) were installed.

1.5.4. Construction Contents

Contents for rainwater drainage construction are as follows:

- Approximately 13km of flume pipes were installed along the maintenance road.
- 4.7km of PE pipes were installed along the slope roads.
- 2.5km of slope waterways were installed in 24 points.
- 5.9km of hume pipes were installed near the maintenance road.
- 3.3km of ridge gutters were installed along the slope road and at the landfill gas treatment facility.
- 232 pipe drive wells to discharge rainwater from the Nanjido Landfill to the Han River were buried.

Figure 4-11 | Rainwater Drainage Facility for Slope Safety



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

The following construction was conducted for slope stabilization.

- ① A massive volume of sand was filled in a large sloped area of 42,000m² where the Geo cell was built.
- ② A 6km long collection and drainage conduit facility was installed on the slope so that the rainwater can flow to the drainage facilities, and safety was enhanced using the Geo cell.

- ③ 7.3km stonework and slope face protection blocks were built.
- ④ A reinforced soil retaining wall was installed on the nearby slope of the landfill gas treatment plant.

Table 4-5 | Rainwater Drainage Measures for Slope Stabilization

Section	Specifications	Quantity (m)	Note
Flume Pipe	600B~1,200B	12,918	
PE Installation Pipe	770B~860B	4,728	Slope road
Slope Waterway Installation	600 (B) × 200 (A) × 580 (H)	2,490	24 points
Hume Pipe Installation	D700~D1,500	5,458	
Ridge Gutter	D300	3,278	
Pipe Drive Well	D100~D1,500	232	
PC BOX	1.5×1.5	176	

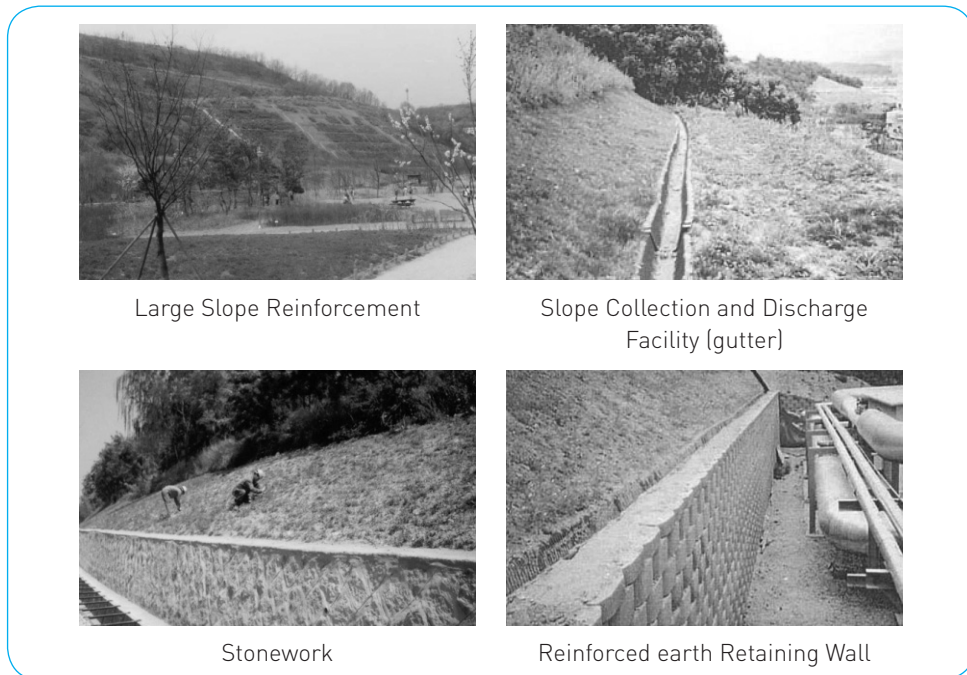
Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Table 4-6 | Slope Reinforcement Project

Section	Quantity	Location	Construction Status
Large Slope Area	41,560m ²	Slope Road	- Bed soil: 226,000m ³ - Geocell: 41,560m ²
Slope Collection Facility	32,296m ²	Landfills 1 and 2 Slopes	- Slope collection sheet: 6,127m - Geocell: 14,543m ²
Stonework and Slope Face Protection Block	7,321m	Maintenance Road	- Stonework installation: 7,321m (h:1.0~2.41m) - Grass planting: 61,063m ² - Geocell: 161,388m ²
Reinforced Earth Retaining Wall and Slope Reinforcement	49.5m	Incinerator Slope	- Geocell: 1,640m ² - Reinforced earth retaining wall installation: 49.5m (H:3.0m)

Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

Figure 4-12 | Slope Reinforcement Project for Slope Safety



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

1.6. Monitoring Facility

1.6.1. Types of Monitoring and Measurement Devices

Monitoring of the Nanjido Landfill includes measuring settlement and stratum movement of waste landfills, checking changes in amounts of ground-water and pollution, and observing the movement of landfill gas. Settlement plates, inclinometers and pore-water pressure meters are used for monitoring waste landfill settlement and stratum movement. The settlement plates were installed on the upper part of the landfill to measure the settlement of the waste layer, making it possible to establish plans to use the upper land. The pore-water pressure meters measure the water pressure between the soil and waste layer pores to identify symptoms of slope destruction.

The ground-water level gauge and ground-water monitor wells are used to measure changes in ground-water level and pollution. The gas monitor well was used to observe the movement of landfill gas and check if the gas is leaking outside the landfill.

Table 4-7 | Measuring Devices Installation at Nanjido Landfill

Item	Measuring Device	Overview	Burying Standards
Settlement	Settlement Plate (upper part of landfill)	<ul style="list-style-type: none"> - Measure settlement of original ground due to waste landfill - Compare settlement measured on site and projected settlement - Present necessary data according to upper land usage plan 	<ul style="list-style-type: none"> - Top of soil filling slope
Displacement	Inclinometer (upper part and slopes)	<ul style="list-style-type: none"> - Measure the horizontal displacement of the ground - Check flank movement of slopes 	<ul style="list-style-type: none"> - Important soil covered slope where horizontal displacement is expected - Lower part of slope with largest expected horizontal displacement - Upper and bottom part of cut slopes
Water Pressure	Pore Water Pressure Meter (on slope road)	<ul style="list-style-type: none"> - Check settlement state due to fluctuation of excess pore water pressure due to soil covering weight and monitor signs of slope destruction 	<ul style="list-style-type: none"> - Areas expecting change in pore water pressure (Measure pore water pressure according to changes of isolated leachate)
Water Level	Ground Water Level Gauge	<ul style="list-style-type: none"> - Identify groundwater level of surface around landfill 	<ul style="list-style-type: none"> - Place not affected by excessive pore water pressure due to sand filling weight and that shows hydrostatic head - Place where it is easy to identify cutoff collar behavior according to changes in water level
	Groundwater Measuring Well	<ul style="list-style-type: none"> - Groundwater level and water quality measuring well around landfill 	
	Groundwater Inspection Well	<ul style="list-style-type: none"> - Measure contamination of groundwater level around landfill 	<ul style="list-style-type: none"> - Areas where groundwater discharge possible around landfill
Landfill Gas	Gas Monitoring Well	<ul style="list-style-type: none"> - To suppress gas from moving outside of the landfill 	<ul style="list-style-type: none"> - Located near structures surrounding the landfill

Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

1.6.2. Installation of Measuring Devices

Efficient operation and future progress of stabilization efforts were identified through regular measurements of leachate leaks, landfill gas emissions and pollution and safety of landfill slopes; settlement behavior analysis of final soil cover layer on the upper part; and destruction caused by future activity. Also, to make it possible to predict the health hazard caused by landfill gas, leakage of contaminated leachate to surrounding areas, slope destruction, and disparate settlement of final soil cover layer of upper part during the early stage, a total of 178 measuring devices were installed around Nanjido. Sixty-six surface settlement plates were installed on the upper part of the landfill, 21 inclinometers on the upper parts and slopes of the landfill, 17 pore water pressure meters, 62 ground-water level gauges inside and outside of the leachate cutoff collar, 6 ground-water pollution monitor wells outside of the landfill, and 6 landfill gas monitoring wells inside and outside of the cutoff collars completed the suite of metering devices.

Table 4-8 | Measuring Devices Installed in Nanjido Landfill

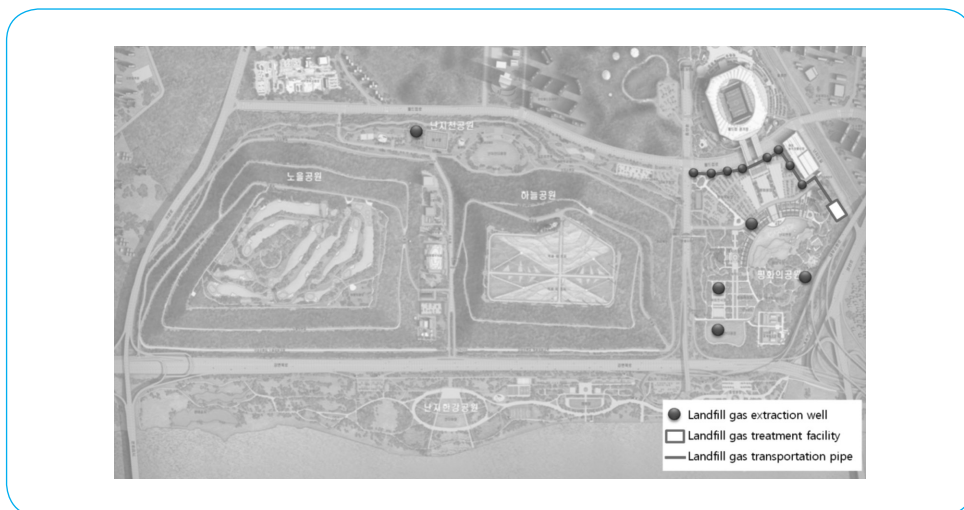
Facility	Specifications	Quantity	Note
Surface Settlement Plate	60cm×60cm	66	Landfill 1: 38, Landfill 2: 28
Inclinometer	Acceleration detector type	21	Landfill 1: 13, Landfill 2: 8
Pore Water Pressure Meter	Vibrating wire type	17	Landfill 1: 9, Landfill 2: 8
Groundwater Level Gauge	Ø30, Ø100	62	Inner and outer part of cutoff collar
Groundwater Pollution Monitoring Well	Ø100	6	Outer part of landfill
Gas Monitoring Well	Ø50	6	Inner and outer part of Nanjicheon Park cutoff collar
Total		178	

Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

1.7. Environmental Plans for Areas Outside of Landfill Stabilization Work

The total area of World Cup Park is 2.715km², and 66.4% or 1.803km² of this area is where the former wastes from Seoul are concentrated. The remaining 33.6% was used for garbage vehicle roads, equipment storage, residential spaces for the socially vulnerable people who picked up recyclable goods from the dump, and storage of construction materials for the city of Seoul. Construction wastes and sewage sludge were also buried at the early stage of landfilling. The area where stabilization work was concentrated was a mound approximately 100m high, and the remaining 33.6% of the area had similar elevation as the surrounding area, so it was called the ‘flat landfill’.

Figure 4-13 | Landfill Gas Treatment Facilities in Areas Outside of the Landfill Stabilization Work



While carrying out the stabilization construction, the City of Seoul diagnosed the flat landfill area. In result, it was found that landfill gas generated as waste bio-decomposed had accumulated in parts of the current Pyeonghwa Park and Nanjicheon Park. The area with the biggest problem was the parking lot stratum on the opposite side of the World Cup Park. There was a possibility that the landfill gas might flow and move along the stratum because the upper part was covered with concrete. Thus, eight landfill gas extraction wells were installed and air pumps that could collect 3.3m³/minute of landfill gas were installed as well. A combustor was also installed to burn off the collected landfill gas. There were

other areas where landfill gas was accumulating in the stratum, and there were four points in Pyeonghwa Park and one point in Nanjicheon Park that required engineering measures. A landfill gas outflow well was installed so that the gas gathered in these five points could disperse naturally in the environment. The outflowing gas passed through an active carbon reaction tower to remove the foul odors and harmful substances (Seoul Metropolitan City, 2002).

2. Establishment of the Eco Park

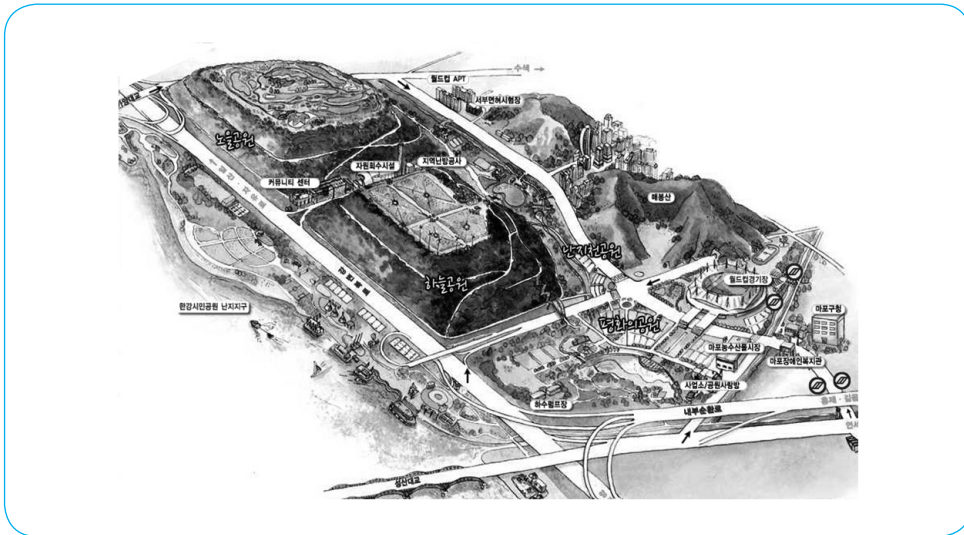
2.1. Eco Park Establishment Overview

To establish Pyeonghwa Park, the ‘Pyeonghwa Park Planning Subcommittee’ was organized to include experts, civic organizations and relevant departments of the City of Seoul; it was convened by the City of Seoul Urban Planning Bureau in May 1995. Its goal was to devise plans for the World Cup Park in conjunction with the ‘Han River Renovation’ project, while maintaining consistency with the ‘New Seoul Town’ project.

The main planning concept of the World Cup Park was set as ‘mutual coexistence and symbiosis’, and aimed at pursuing a healthy mix of ‘nature and human culture’, a symbiotic relationship between ‘environmental conservation and human use’, and harmonious ‘artificial structures and natural scenery’. Land usage was specialized into four activity districts, an environmental restoration district, a natural ecology district, and a regional facility district according to the site characteristics.

It was anticipated that many people would utilize the facilities, so the park was designed to include public golf courses and eco parks on top of the former Nanjido Landfill. The future settlement of each landfill was estimated for suitability and safety of the installed facilities. The settlement prediction results estimated the ground settlement according to park establishment and they were used as basic data for drainage plans and land work plans, as well as standards for establishing supplementary plans such as stabilization work after the establishment of the park.

Figure 4-14 | World Cup Park Basic Plan Diagram



Source: World Cup Park, <http://worldcuppark.seoul.go.kr>.

Table 4-9 | Objectives and Concepts per World Cup Park Sector

Section	Objective	Planning Concept
Pyeonghwa Park (445,500m ²)	Construct image and space to represent all of World Cup Park from a user perspective	<p>The concept of peace, which is the theme of the park, interpreted as “mutual coexistence and symbiosis”</p> <p>Coexistence and symbiosis of nature and human culture: give image of establishing an environment that can heal nature damaged by humans and where nature and humans can coexist</p> <p>Coexistence of artificial structures and natural scenery: Express image of coexistence by diminishing the dominant feeling created by massive structures such as the World Cup Park and millennium gate and pursuing harmony of contrast between artificial elements and natural elements</p>

Section	Objective	Planning Concept
Pyeonghwa Park (445,500m ²)	<p>Create a place to commemorate the new millennium of hope in an age of reunification and the rise of the Korean people and emphasize the symbolism of the 'millennium gate' (installation of the millennium gate was changed during construction)</p> <p>Commemorate the first World Cup of the 21st century joined by people around the globe and establish a modern and high quality open space that enhances the image of Seoul</p>	<p>Harmony and coexistence of hostile forces around the world: utilize the image of peace that heals and reconciles wounds caused by war, national separation, and oppressive forces</p> <p>Harmony of monumental scale and everyday park activities: Harmony of massive space that expresses 'symbols' and 'location', and everyday activities of parks such as walks, rests and playground for children</p>
Haneul Park (191,400m ²)	<p>Establish the park as place for cognitive education that expresses the transformation of waste landfills into places of natural beauty</p> <p>Express landscape allegory containing stories of the past while being consistent with the overall context of Millennium Park to contain the unique personality of the location</p>	<p>Recovery of nature: Symbolize space that shows how nature is reborn in a rough, abandoned space</p> <p>Expression of landscape allegory: Start with the subject of the space that is reborn, or 'start of nature' being closely related to the past history of the waste landfill</p> <p>Implementation of flexible land usage:</p> <ul style="list-style-type: none"> ① The upper usable soil depth of the stabilization construction lining was 60cm and the ground was unstable due to continuous settlement, so building of facilities was restricted ② Space that can flexibly accept future land use (environmental art park)
Noeul Park (339,900m ²)	<p>Originally, it was planned to be an ecological public golf course, but taking into consideration the opinions of the people, it was reopened as a sculpture park in July 2009</p>	<p>Expand and establish small life-form habitat space</p> <p>Operate an eco-program showing the rebirth of a waste landfill into an eco park</p> <p>Manage Noeul Park as an environmental/ecological/cultural park in which nature and people coexist</p>

Section	Objective	Planning Concept
Nanjicheon Park (293,700m ²)	Restore damaged natural ecosystem of Nanjicheon river where waste leachate flowed and make it into a specialized park r that displays the natural river ecology Provide space for the residents of the nearby SangAm New Millennium Town, and especially for the disabled, elderly, and youth	Part of World Cup Park closely linked to Pyeonghwa Park, Haneul Park and Noeul Park Add functions as a neighborhood park for everyday use by residents of the SangAm New Millennium Town Consider conversion into town roads in the future, establish flexible plans
Nanji Han River Park (776,000m ²)	Establish as neighborhood park that the community can use for recreational activities	Neighborhood park that offers exercise, play and picnic facilities, as well as walking trails Planned considering environment / ecology, World Cup, urban park / metropolitan neighborhood park that could also be used during the World Cup games
Landfill Slope (1,419,200m ²)	Greening to stabilize the slopes of the Nanjido Landfill and to act as a habitat for animals and plants	Remediate exposed slopes created during cutting and embankment of landfill slopes to for building roads on top of the 2 massive mountains of waste; treat rainwater, and green the exposed slopes

Source: Seoul Metropolitan City (2003), World Cup Park Construction Site: Green field (in Korean).

Figure 4-15 | World Cup Park Scenery



Pyeonghwa Park



Haneul Park



Noeul Park



Nanjicheon Park

Source: World Cup Park, <http://worldcuppark.seoul.go.kr>.

2.2. Pyeonghwa Park

Pyeonghwa Park had about 10m of wastes buried in the landfill and is now a flat space with elevation of about 15~19m. Within park area are the Mapo Agricultural and Marine Products Market, Nanji Management Office, Mapo-gu Civil Defense Training Center, an electronic waste treatment plant, the Seodaemun-gu and Mapo-gu garbage-truck garage, the Nanji sewage relay pump plant and a taxi-meter inspection center. The Nanji Management Office is also in use on the site since the completion of the park.

The basic plan for the park was designed by the Han River Project Planning Team and the construction design and construction were carried out by the Park Greening Management Office World Cup Park Task Force Team. In the first stage of the basic plan, the Seoul Development Institute (currently Seoul Institute) participated in the oikos and in the second stage, the Seoul Development Institute, Millennium Park Basic Planning Committee and Dongshimwon Company participated. The basic design was carried out by Udae Technician Company and the construction design was made by Sunjin Engineering.

The goal of Pyeonghwa Park from the user perspective was to construct a park whose image would represent all of World Cup Park and be a place to commemorate a new millennium of hope for national reunification and the rise of the Korean people. It also aimed at commemorating the first World Cup of the 21st century joined by people around the world, and to establish a modern and high-quality open space that could improve the image of Korea and Seoul.

For this, Pyeonghwa Park was designed to express the symbolism of the 2002 World Cup and to play a key role to connect all of the elements of the World Cup Park. In the center, the Nanji Pond was built and was linked to Nanjicheon Park as the source of the Nanjicheon River.

The concept of ‘peace’, which was the theme of the park, was interpreted as ‘mutual existence and symbiosis’ such as the harmony and coexistence of nature and human culture, artificial structures and natural scenery, and harmony of the people of the world. The design was intended to stimulate a peaceful feeling for those partaking of the park. Harmony of spaces and discrete user conveniences that do not stand out too much were utilized in the design. It was established on flat land to foster a feeling of openness for visitors to the park; it also has a cozy feeling, as it is surrounded by Haneul Park, formerly a huge mountain of garbage, SangAm World Cup Stadium, and Bukhansan Mountain.

The first thing that catches the eye at the park is a massive arc-shaped Nanji Lake, located in the center of the park and fronted by the Promenade Plaza. It is perpendicular to the axis stretching out from the World Cup Stadium; it was designed to be part of the millennium gate.

The water is about 50cm deep and a wooden deck was built as a waterside trail to raise accessibility to the lake, while a different water-friendly space was established compared to the ecological wetland sector on the opposite side. In the vicinity, zelkova trees were row-planted to create a tunnel-like spatial frame. Orchid-type lighting colonnades were installed on the waterside trail.

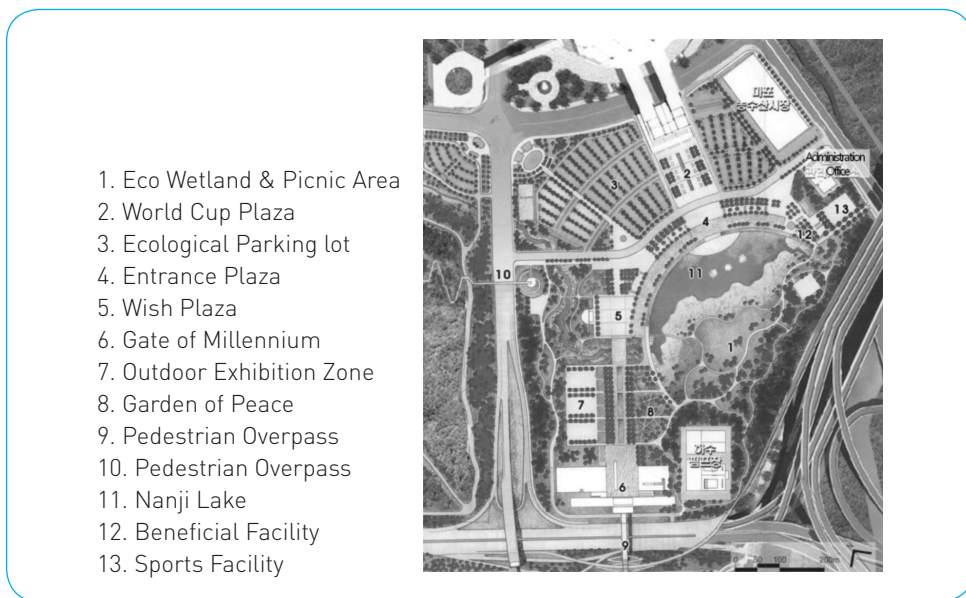
On the opposite side of the Promenade Plaza, a vast humidogene grassland and a space to learn about nature were built. Vegetation from the past such as large willow trees were utilized in the design. On the eastern end of Nanji Pond, the underflow of the Han River (5,000 ton/day) was brought in through torrents directed towards Nanjicheon River to maintain water quality.

Figure 4-16 | Before/After Completion of Pyeonghwa Park



Source: Seoul Metropolitan City (2003), *World Cup Park Construction Site: Green field* (in Korean).

Figure 4-17 | Basic Plan of Pyeonghwa Park



Source: Seoul Metropolitan City (2003), *World Cup Park Construction Site: Green field* (in Korean).

Diagonal as well as straight greens and paths were established to express the conflicts, order and disorders of different classes, nationalities and ideologies of the past, while a small space was set aside for the theme of peace. The millennium gate was planned originally, but that plan was dropped and a grassy area was built in its place.

The Hope Forest was built as part of the ‘Planting 10 million trees of life’ campaign in which the people would participate. Taking into consideration management issues, the picnic area and Hope Forest were not built as one large grassy area, but instead grassy areas of various sizes was built so that they could be used as picnic grounds at different times.

2.3. Haneul Park

The basic plan of Haneul Park was made by the Millennium Park Basic Planning Committee and the basic and construction designs for landscaping were conducted by Yooshin Corporation and Pyeonghwa Engineering. Landscape construction was carried out by Bando Environmental Development, IW Land, and Dongil Construction. The total project cost 25.6 billion Won.

Haneul Park does not have any structures and is just a vast patch of grasses that blow in the wind. It provides an image of restoration and rebirth. This area was made to be a place of education displaying the meaning of the abandoned land as a waste landfill being reborn into nature. To express the theme of ‘recovery of nature’ and that the first vegetation that grows in dry and barren soils is grassy plants, the entire park was made into a grassy park. Also, by expressing a landscape allegory in which the stories of the past are abbreviated, while being consistent with the context of the millennium park, it aimed to convey the unique personality of the location (Seoul Metropolitan City, 2000).

After planting wild grassy species such as silver grass and plantain and naturalized grassy species such as pearl millet, canadensis, daisy fleabane, evening primrose, and clovers, the ecological succession process was left alone without any artificial management to be used for education on grass succession and as an environmental event space. As the barren soil began to recover, the park was established focusing on early grass species (silver grass and grassland: 41,000m²; buckwheat and sunflower grassland: 20,730m²; short grassland: 47,600m²; pure community grassland and stone garden: 3,670m²).

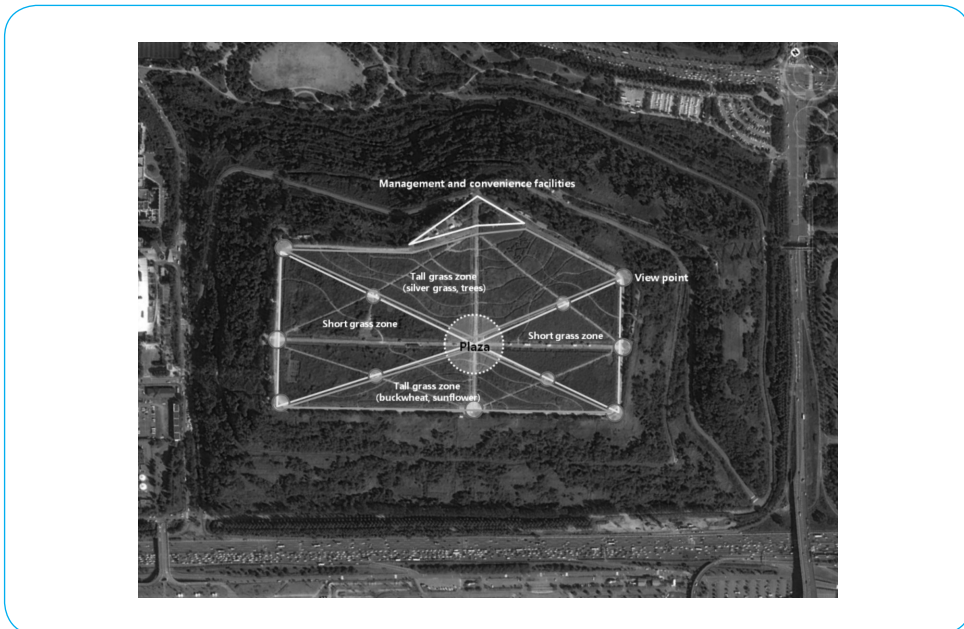
Since the usable soil depth of the upper part after the stabilization work was only 60cm and the ground was unstable, there were restrictions for planting trees and installing structures in the park.

Haneul Park is built on a 100m high landfill of household wastes and it is an unstable land area where 0.19~2.13 meter ground subsidence is expected over the next 20 years. Thus, it is divided into four zones with 4~8% regular drainage slopes separated by cross-type management roads according to the stabilization project, and it is a pyramid-like structure with a high central area and low corner area.

The four zones have different heights and different pyramid types. They have slight slopes for drainage and the topography was used as it was to establish grasslands. In the outer part of the park there are observatories and rest areas. The major walking system is made up of a diamond-shaped walkway connecting the top of the pyramid in addition to the wide cross-type lines, and this is a visualization of flying kites, an activity which is perfect here on windy days. Considering that no trees were planted in the inner parts, trees were concentrated in the outer observatory area to provide shade.

A wooden building with a slanted roof was built as the visitor center at the northeastern entry to the park and considering that it is the highest point in Nanjido, an observatory was installed. Also, a wind power generator was installed in the eastern Han Riverside and the produced electricity supplies the information center and street lights.

Figure 4-18 | Haneul Park Land Usage Diagram

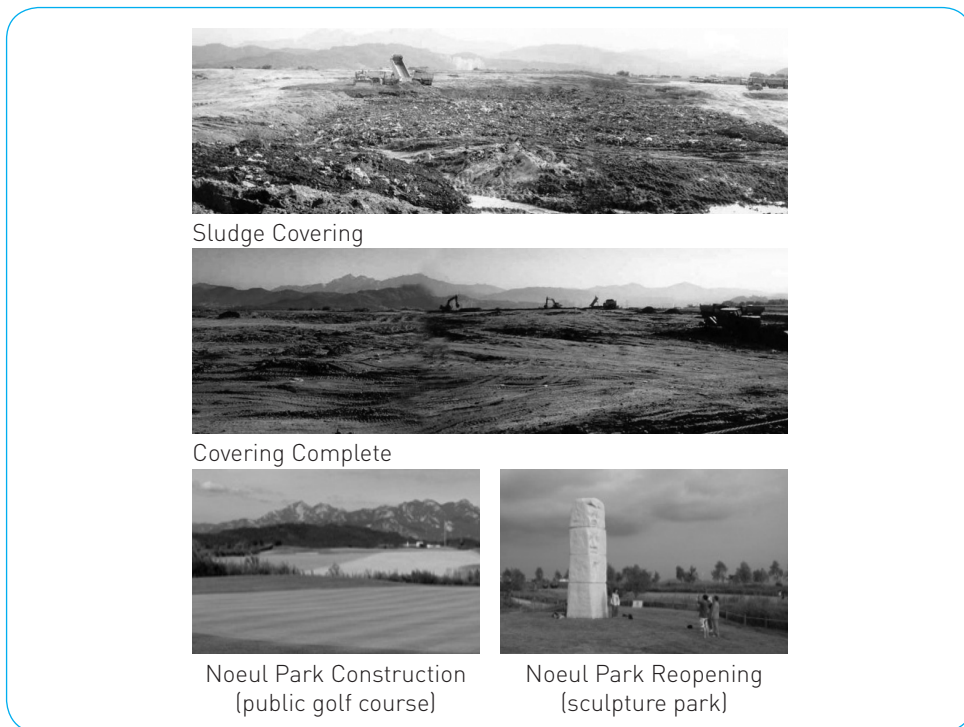


2.4. Noeul Park

The intent of Noeul Park was to expand habitats of small spaces and to operate an ecological program expressing the meaning of rebirth from a waste landfill to an environmental eco park in which nature and people coexist. Reflecting this, to minimize damage to the existing environment and the surrounding natural environment, it was decided to build an environment-friendly golf course, which is an open space that the general public could use.

The area of the golf course was limited to 57% of the area of the upper part of landfill 1, and the remaining 43% was to be set for natural vegetation, exercise facilities and walking paths for the public. However, due to opposition of people against the construction of a golf course, it was refigured as a camping space, children's playground and sculpture park. The golf course construction and reconstruction process of Noeul Park will be dealt with in more detail in Chapter 5, Part 2. The beautiful sunset of Seoul can be viewed from the Wind Plaza and Sunset Plaza, and the ecological pond and ecological garden are environments that improve the stability of the soil; these places have become habitats for wild animals.

Figure 4-19 | Noeul Park Construction Process



Source: Seoul Metropolitan City (2003), *World Cup Park Construction Site: Green field* (in Korean).

2.5. Nanjicheon Park

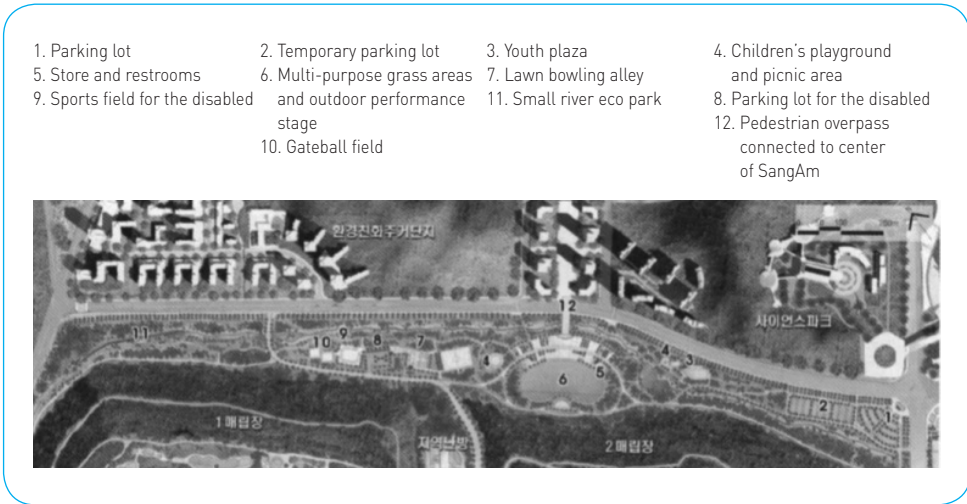
In this site formed in the low area with a width between 70 and 250m between the Nanjido Waste Landfill and SangAm District, there used to be a prefabricated housing complex scheduled for demolition. Despite the river pollution from the Hyangdongcheon River to Gayang Bridge, the natural river area with reeds and willow trees has been maintained relatively well.

Wastes were partially buried in the central part of this site and the river was polluted severely due to runoff from a deep ditch. The restored natural ecology of Nanjicheon River, where waste leachate used to flow, was constructed to show the state of natural rivers. The land use plan and spatial structure plan were established with the goal to be a space for the residents of the nearby SangAm New Millennium Town, and especially the disabled, elderly and youths.

Nanjicheon River is a small river with a narrow river basin area having little risk of flooding damage; it receives 5,000 tons/day of water constantly from the park. Thus, it was made as a water-friendly ecological river where various plants and animal life could live. To be linked with the SangAm New Millennium Town, the rainwater and ground-water of SangAm New Millennium Town were guided towards Nanjicheon River.

A natural purification holding basin was built for healing and remediation of land polluted with waste leachate, and water-purifying plants were planted. River ecology observation trails, wetlands, pond and waterside decks were also introduced. In its vicinity, there are grass areas, children's playgrounds and outdoor performance stages, while it also has facilities for inline skating and bicycling along the river.

Figure 4-20 | Nanjicheon Park Basic Plan



Source: Seoul Metropolitan City (2003), *World Cup Park Construction Site: Green field* (in Korean).

Figure 4-21 | Photos of Nanjicheon



Source: World Cup Park <http://worldcuppark.seoul.go.kr>.

2.6. Nanji Han River Park

Nanji Han River Park is located on a flat waterside with 2~6m elevation difference with Gangbyeonbukno (Jayuro) Expressway. This area was used for a long time to store aggregates after the Han River maintenance project and it has excellent conditions due to the low flooding frequency and slow flow of water even during floods.

Nanji Han River Park is a neighborhood park that can be used for recreation by the community and it offers exercise facilities, play equipment, picnic areas, and walking paths. Also, it was planned to accommodate environmental and ecologic considerations, World Cup events, and serve as an urban/metropolitan and neighborhood park so that it could provide the necessary functions for smooth operation during the World Cup games.

The land use plan reflected spatial characteristics by dividing it up to the pier zone, camping zone, central plaza zone, exercise zone, and waterside eco park zone according to the site conditions.

Figure 4-22 | Nanji Han River Park Basic Plan



Source: Seoul Metropolitan City (2003), *World Cup Park Construction Site: Green field* (in Korean).

Figure 4-23 | Photos of Nanji Han River



Water Park



Water Plaza (mirror fountain)



View of Nanji Han River Park

Source: World Cup Park, <http://worldcuppark.seoul.go.kr>.

2014 Modularization of Korea's Development Experience
Nanjido Eco Park Restoration from Waste Dumping Site

Chapter 5

Success Factor Analysis

1. Contributing Factors to Establishment of World Cup Park
2. Shortcomings

Success Factor Analysis

1. Contributing Factors to Establishment of World Cup Park

1.1. Deferment of Commercial Development for Environmental Management of the Waste Dumping Site

The 150 million tons of household wastes, construction wastes, sewage sludge, and industrial wastes from Seoul city were deposited to such an extent as to create two 100m high mountains in Nanjido between 1978 and 1993. The basic conditions of sanitary landfills such as leachate blockage and treatment, landfill gas collection and treatment, prevention of drifting wastes and emission of foul odors were nowhere to be seen and the landfill was completed without any proper measures.

Prior to closure of the landfill, leachate pools on different parts of the upper level of the waste mountains were constructed. Some areas were swamp-like and unstable, thus dissuading people from approaching them. Landfill gas was emitted from cracks in the surface and there were fires due to the landfill gas in some areas.

Construction of the SudokWon Landfill was begun in Gimpo, Gyeonggi-do in 1988 and it was decided that household wastes of Seoul city would be treated there. From this time on, the City of Seoul made careful consideration on how to manage Nanjido, which was an utterly unsanitary landfill. The City of Seoul began studies for future management measures in 1991. During this process, a wide array of plans were reviewed such as digging out the waste layer to be used as fertilizers, solidification treatment, sorting of recyclables,

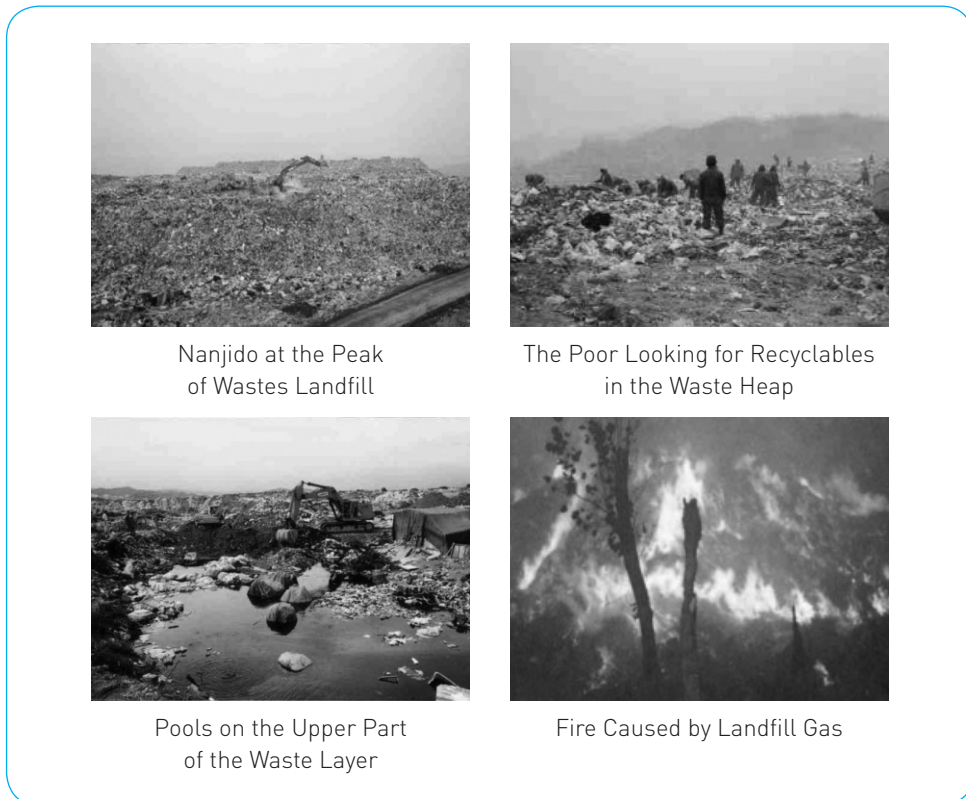
decomposition with lasers, even burial on the west coast. The common trait among all these methods was removal of the waste layer and to use Nanjido for something highly profitable. However, it was concluded that it would be more feasible to ‘maintain the current state, to begin environmental pollution prevention and stabilization work, and to defer its use for the future’. This is because the digging out and removing the waste would require huge expense and it was technologically impractical.

Plans to utilize the Nanjido Dump site were of huge interest to domestic housing contractors as well. Five construction companies organized the Green 21 Forum and reviewed technologies for early development of Nanjido. A method that they proposed was to dig out the waste layer and to separate the waste into combustibles and non-combustibles. Then a rotary kiln could be used to decompose the combustible waste thermally and use the residue as construction fill material for the land (ground foundations). However, due to the lack of profitability (1.8 trillion Won construction cost compared to the 1.5 trillion Won land sales value) and concern regarding secondary pollution, their plans could not be adopted.

Despite various opinions, the final choice of the City of Seoul for the use of Nanjido was to ‘maintain the current state, to begin environmental pollution prevention and stabilization construction, and to defer use for the future’. Immediately after the basic plan, the stabilization work execution design was made from November 1993 to June 1996 and stabilization construction was carried out from November 1996 to October 2002. Following the stabilization construction, the World Cup Park was built.

After the management direction of Nanjido Landfill was decided, there was a big change in the landfill management of Korea as a whole. First, the Waste Management Act stipulated that after-closure management must be carried out for 20 years since 1996 even if the landfills were closed. This regulation was further strengthened later and the after-closure management period was extended to 30 years from 2011. If there had been such regulation before 1993, stabilization construction for Nanjido and deferment of its use for the future would have been decided much more easily. However, it was a time when there were no after-closure measurement regulations for waste landfills, and thus much study was needed on how to use the landfill site. In conclusion, a policy judgment that was ahead of its time was made to build an ecological park.

Figure 5-1 | Environmental State at the Time of Nanjido Landfill Closure



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

1.2. Ties with Urban Planning and 2002 World Cup

With commercial use of the Nanjido Dump site being put off, the ‘SangAm New Millennium City Construction’ and ‘2002 World Cup’ became huge catalysts for the establishment of the World Cup Park. The City of Seoul thought of the World Cup Park as the backdrop green area of the ‘SangAm New Millennium City’ and pursued it together with the development of residential areas and the high-tech city. According to this plan, development of the vicinity would be pursued sequentially with long-term goals of 30 to 40 years, while the World Cup Park would be completed in the short period of 4 to 5 years. The project went as planned and the World Cup Park was completed in 2002 and the SangAm New Millennium City was also built as originally planned. People who settled in the nearby residential areas are very satisfied with the World Cup Park. In fact, the World Cup Park is

the local attraction and pride of the area. It is popular as a new residential area of Seoul and now has relatively higher real estate prices. Not to mention Seoul, but even in any other city in the world, it is rare for a residential area to have such a large-scale park and green area like the World Cup Park in its neighborhood.

One of the biggest duties of Seoul's 31st Mayor (July 1, 1998~June 30, 2002) was to successfully host the World Cup and to meet the new millennium in a meaningful way. The reason why the 'SangAm New Millennium City' was established was because it reflected the demands of the times. With the project period and outline determined, the City of Seoul marshalled an organization to carry out the project effectively. The key was division of the project, reduction of decision-making time, and project command by an urban planner. The foundation was drawn up by the Seoul Institute, and six departments of the City of Seoul participated in the design, while five departments of the City of Seoul were in charge of giving orders for and supervising the construction. There were 32 private companies that participated in the design and construction. For overlapping areas and disputes over the project, the mayor or vice-mayor became directly involved to make decisions. At the time, one of the vice-mayors, Kang Hong-bin, participated in devising the 'SangAm New Millennium Plan' and became a vice-mayor to conduct the project directly.

1.3. Self-Recovery of Ecological Functions through Connection to Surrounding Eco-corridors

The World Cup Park is connected to the Han River and Bulgwangcheon, Hongjecheon and Hyandongcheon Rivers by water. The grasslands of their riversides are connected to the grasslands of World Cup Park. As of 2010, there are 502 plant species, 516 land insect species, 62 aquatic invertebrate species, 70 wild bird species, as well as mammals, fish, amphibians and reptiles living in the World Cup Park. The City of Seoul tries to avoid any artificial interference except for planting host plants and improving the condition of the various habitats. The Han River, Bulgwangcheon River, Hongjecheon River, and Hyandongcheon River act as eco-corridors, and thus are largely responsible for World Cup Park's outstanding biodiversity. World Cup Park only provides nature with a place to live, and nature is gaining its ecological diversity using its own abilities.

Figure 5-2 | Nearby Greens and Rivers of World Cup Park

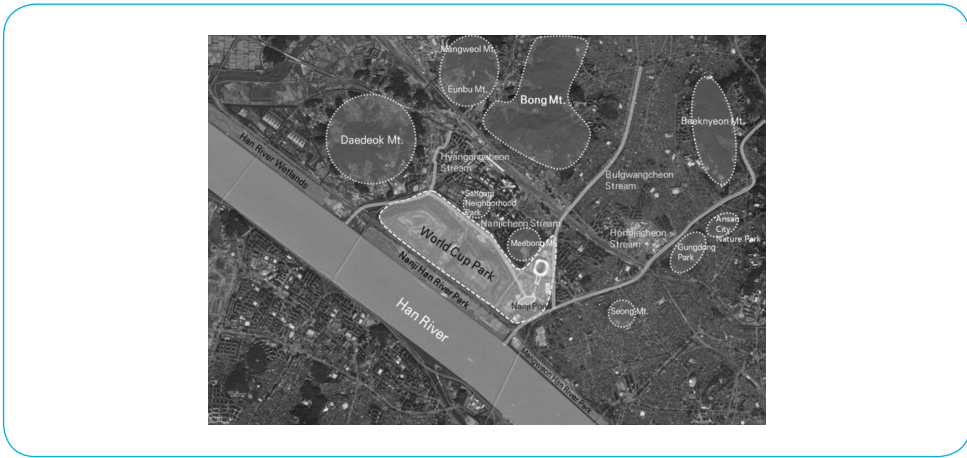
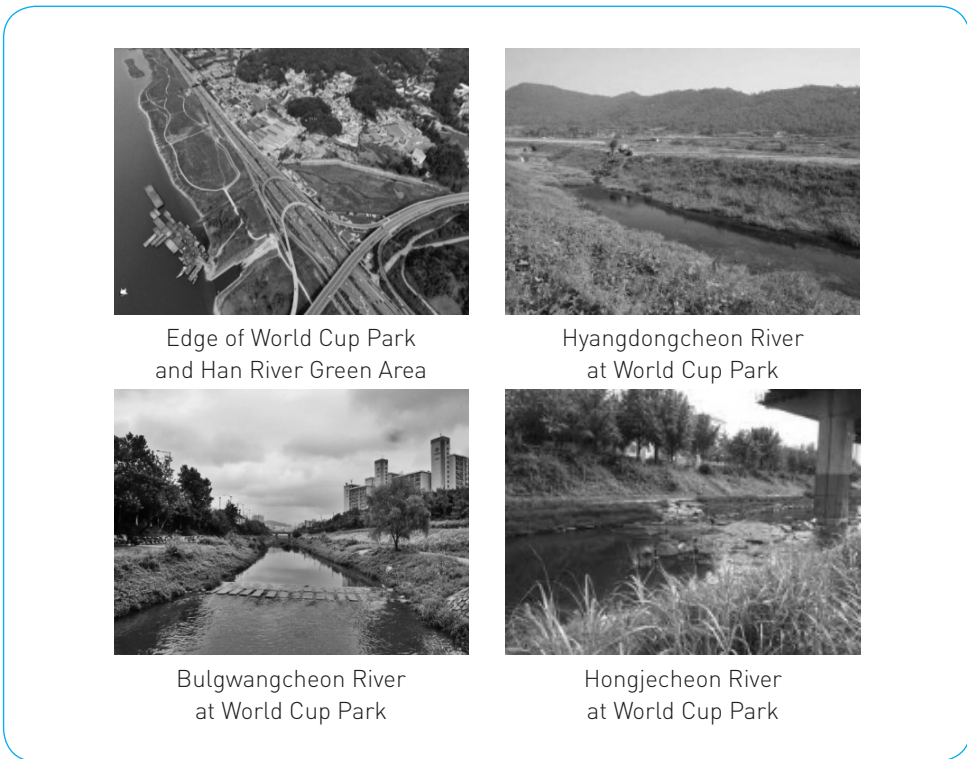


Figure 5-3 | Waterways and Grassland around World Cup Park that Act as Eco-corridors



Edge of World Cup Park and Han River Green Area

Hyangdongcheon River at World Cup Park

Bulgwangcheon River at World Cup Park

Hongjecheon River at World Cup Park

Source: World Cup Park, <http://worldcuppark.seoul.go.kr>.

1.4. Continuous Improvements of Wildlife Habitat Environment

Monitoring of animal and plant life has been conducted every year in Nanjido before and after the construction of World Cup Park. In result, it was found that vegetation on the slopes of the dump included only acacia trees, willow trees, and Eupatorium rugosum, due to the poor quality of the supporting environment. To change such conditions, the City of Seoul planted oak trees and wild pear trees that could be used as food for animals, and built an artificial wetland so that various plants and animals could live there.

First, trees with fruits and seeds that could be eaten by wild animals such as birds and mammals were planted. This project was begun in 2004 and ended in 2008. During this period, 14,903 trees of 18 species were planted in the 20,482m² planting area.

Eco-corridors for wild animals, including the narrow-mouth frog which is a flagship species of World Cup Park were also installed. A log slope path in a retaining wall, and an escape path in drains and collection wells were installed to help animals migrate. Parts of the drainage path were installed with nets to prevent animals from falling into the drains. Also 15 small and large wetlands were installed on the 15 landfill slopes so that animals could drink water and have a rest.

Figure 5-4 | Wildlife Protection Measures Installed at World Cup Park



Source: World Cup Park, <http://worldcuppark.seoul.go.kr>.

Table 5-1 | Wildlife Habitats Improvement Project

Section	Contents
Planting of Host Plants	Trees: 18 species (Mongolian oak, Konara oak, wild cherry tree, wild pear tree, Malus sieboldii Rehder, sumac, date plum, oak tree, Stephanandra incisa, Symplocaceae, bush clover, Viburnum erosum, weigela, baby brier, bridal wreath, pepper tree prickly ash, dichotoma beauty berry, Sorbaria stellipilla) Planted quantity: 14,903 trees, 20,482m ²
Wildlife Pathway	Narrow-mouth frog escape route: 25 Log slope path: 95 Collecting well escape route: 7 Drainage fall prevention net installation: 1,150m Other pathways: 3
Wetlands	Artificial wetlands: 10, 1,178m ² Pot wetlands: 5, 1.8m ²

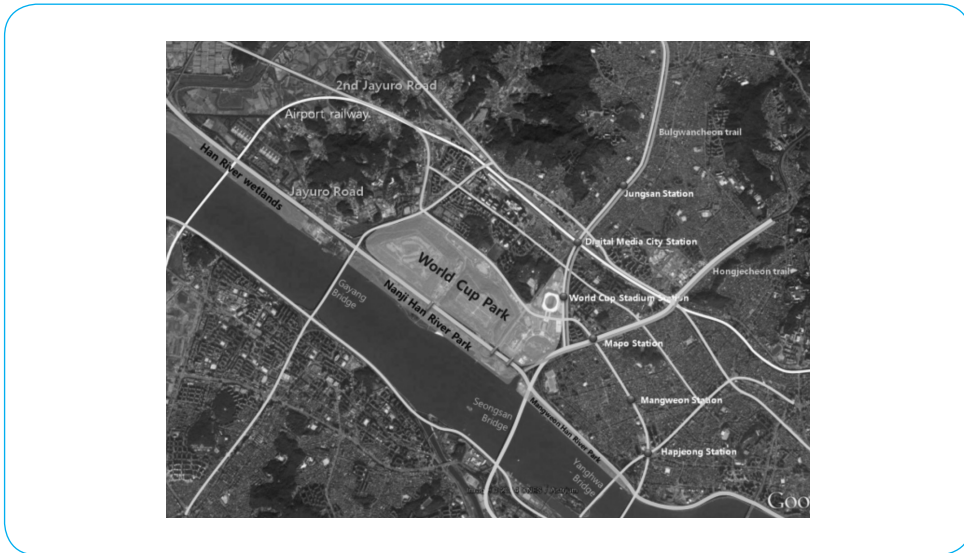
1.5. Various Traffic Networks Providing Easy Public Access

Ten years after building the park, the area has become ecologically healthy. It has also established itself as a public park, visited by 12 million people every year.

World Cup Park is not simply a neighborhood park for residents of the town but a park for all residents of Seoul. The city's diverse transportation network contributed to this.

First, Jayuro that connects the north and the south of Seoul city and Naebu Expressway that connects the east of Seoul to the west, help visitors gain access to this place easily by car or city bus. The northern and southern part of Seoul are connected by Gayang Bridge and Seongsan Bridge. For subway users, World Cup Stadium Station of subway line no. 6 plays a key role. Subway line 6 connects easily to subway lines 2 and 3 and the airport railway and it is also connected even to further away subway lines 1, 3, 4, 5, and 7. The Han River walkway and Bulgwangcheon River walkway help bicycle-riders access this area easily as well.

Figure 5-5 | Transportation System for Access to World Cup Park

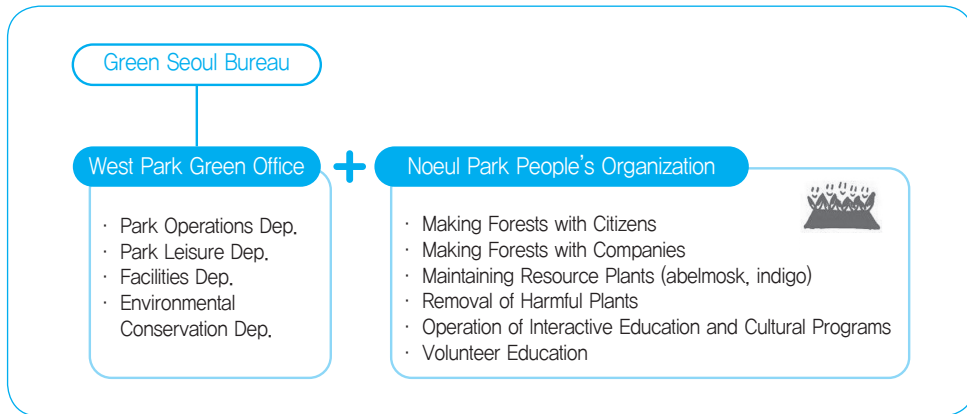


1.6. World Cup Park Management in Partnership with Citizens

World Cup Park is under the direct management of the City of Seoul; its management office was established in March 2002. In January of the next year, it was reorganized as World Cup Park Management Office under the Park Green Management Business Office. In 2005, it was again reorganized into the World Cup Park Management Business Office pursuant to passage of a city ordinance. In 2009 it was reorganized as the West Green City Business Office, and finally in January 2012, it was reorganized into the ‘West Park Green Business Office’ under the Green City Bureau of Seoul. The management office located within Pyeonghwa Park is in charge of the operation and management of World Cup Park, Independence Park, West Seoul Lake Park and Yeouido Park (Kim, 2013).

The non-profit private organization, ‘Noeul Park Citizens’ Organization’, founded in 2011, also plays a leading role in operations together with the City of Seoul. The organization got its start after joint discussions with environmental organizations, organizations of citizens’ solidarity and citizens’ open dialogues. It is operated by volunteers, including experts, environmental activists and community volunteers from various social fields and with the sponsorship of businesses. Its goal is to make Noeul Park become Seoul’s top ecological attraction by monitoring the ecological restoration and by developing and operating the educational, experience and volunteer programs such as planting trees (Kim, 2013).

Figure 5-6 | World Cup Management and Operation Organization



The landscape and major facilities of World Cup Park are managed by the West Park Green Office located inside of the park. The office's Facilities Department is in charge of public works, electricity generation and electricity receiving/distribution facilities, along with the efficient expansion and maintenance plans of other park amenities. The Environmental Conservation Department is in charge of managing landfill gas and leachate as well as general ecosystem management works such as park cleaning, restroom management, supply of water and water purification projects for Nanji Pond and Nanjicheon River, preservation and restoration plans of the landfill ecology, among others.

World Cup Park rents the park facilities to citizens for temporary or exclusive uses such as exhibits, marathons, cultural events, and other large-scale events, essay contests and drawing contests, and for movie, TV or photo filming. Also, the multi-purpose field, tennis court and other sports facilities, as well as the Noeul camping grounds and park golf courses can be used by the citizens through reservations.

Table 5-2 | World Cup Park Status

Section		Contents
Major Facilities	Pyeonghwa Park	UNICEF Plaza, Nanji Pond, Peace Garden, picnic area, Nanjido Story (World Cup Park Exhibit Hall), etc.
	Haneul Park	Stairway to Heaven, Sky-filled Bowl, Observatory, etc.
	Noeul Park	Sculptures, observation deck, grass area, Noeul Camping grounds, etc.
	Nanjicheon Park	Children's playground, multi-purpose sports field, gateball field, soccer field, grass area, etc.
	Nanji Han River Park	Mirror Fountain, Riverside Water Park, Nanji Camping Field, etc.
Tree Management	Trees	15,146 in 53 arbor species, 646,364 in 39 shrub species
	Weeds	940,786 species

The monitoring of the World Cup Park animal and plant life is one of the park management's main projects. Investigation activities have a 50 million Won annual budget that covers observation of the seven fields of plant ecology (flora, mushrooms), animal ecology (wild birds, land insects, aquatic invertebrates, fish), and mineral environment (soil). It began in 2003 and as of 2013, the 11th monitoring session was completed (Seoul West Garden Green Office Manager Park Woong-bin).

Many of the 12 million people visiting the World Cup Park each year enjoy various civic programs, the most famous of which are cultural programs, Nanjido Story Exhibit Hall, Noeul Park Camping Grounds, Park Golf Course and the Seoul Silver Grass Festival. Cultural programs include riverside concerts, summer night family theater and folk games at Lunar New Year and Chuseok. The 'Nanjido Story' exhibit hall is used for environmental education showing the stabilization process of the waste dump site and construction of World Cup Park. Nature-friendly camping can be also experienced amidst a beautiful natural environment at the Noeul Park camping grounds. The Park Golf Course has become a place of entertainment culture for men and women of all ages and the disabled.

World Cup Park is managed by 87 public officials of the Seoul municipal government. However, due to the vast area spanning 2km² and various facilities, it cannot be managed by them alone, so they accept support from many volunteers. Expert volunteers are in charge of telling the Nanjido story, carrying out programs, operating a park information center and guidance at the firefly ecology center. Also 15 people who speak English, Japanese and Chinese tell the Nanjido story to help foreigners visiting the World Cup Park

understand better. One-day volunteers help with simple administration work such as trash pick-up, facility cleaning and event support. Their activities are recognized as a volunteer performance for schools.

Reservations for programs can be applied for at the ‘Seoul Public Service Reservation (<http://yeyak.seoul.go.kr>) homepage that deals with all public services of the City of Seoul. For the sake of fairness all programs are free of charge. There is a charge, however, for renting locations.

Table 5-3 | Volunteers and Their Activities at World Cup Park

Section	Sector	Activity Contents	Personnel
Expert Volunteers	Nanjido Storytelling	Information to domestic/foreign visitors to the exhibit, answering phone calls, distributing PR materials, selling books published by the park, etc.	15 person English 6, Japanese 6, Chinese 3
	Program	Development/operation of eco programs, collection of data related to program operation	19 person
	Park Info Center	Information for park use, lost children care, first-aid, answering phone calls, distributing PR materials, selling park booklets, operating park information program	48 person
	Firefly Ecology Hall	Information for visitors to the firefly ecology hall and larva experience center	16 person
Daily Volunteers	Environmental Management	Picking up garbage, cleaning chairs and fences	Secondary school students, college students, adults, families
	Green Management	Picking weeds, planting flowers, fertilizing, watering, etc.	
	Event Support	Assist program operation, information for foreigners, park event support, etc.	
	Office Assistance	PR material distribution support, cleaning up, etc.	

2. Shortcomings

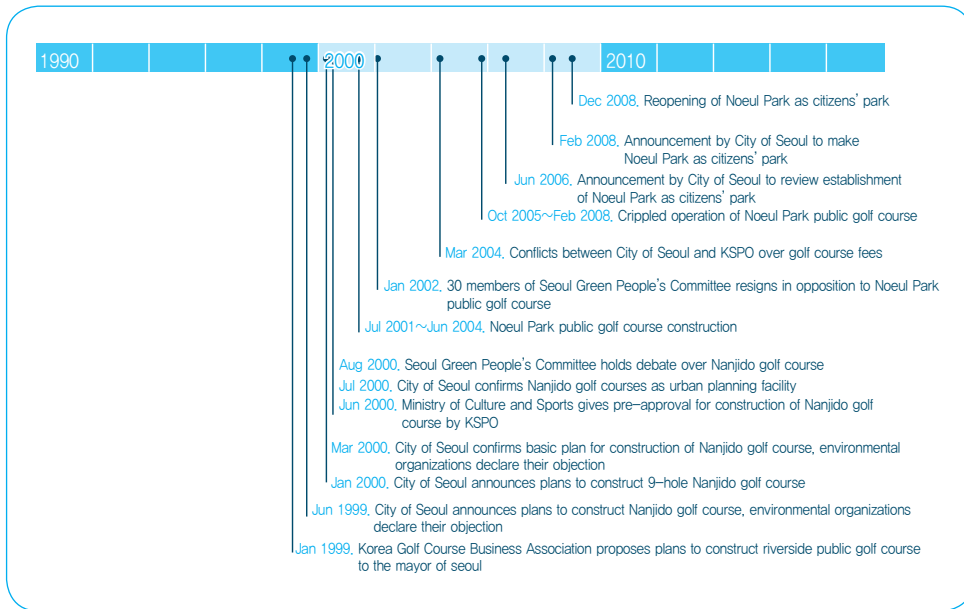
2.1. Disputes Over Establishment of Noeul Park Public Golf Course

While designing the World Cup Park, the City of Seoul decided to construct a nine-hole public golf course in Noeul Park and this was announced to the public in January 2000. In July, the golf course was designated as an urban planning facility and the Korea Sports Promotion Foundation in charge constructed the golf course from July 2001 to June 2004. The decision to make the golf course by the City of Seoul was because when building a golf course on top of a landfill, it does not require structures that burden the landfill layer. It is also easy to find and repair cracks caused by uneven settlement. There are many cases of building golf courses on top of waste landfills in foreign countries and a part of the management expenses of landfills can be recovered from golf course fees.

However, civil organizations in the environmental sector immediately announced their opposition to the City of Seoul's golf course establishment plan in March 2000. In August 2000, the Seoul Green People's Committee and the policy advisor committee in the environmental sector of Seoul, held a debate on this issue. In January 2002, 30 members of the Seoul Green People's Committee opposed the golf course and resigned from their positions; they argued that the citizens' park would attract 1.8 million Seoul residents to Noeul Park each year while only 90,000 people would use the golf course, and thus this would be a project for a specific group, supported by governmental financial resources. There was a wide array of other issues as well such as environmental pollution due to use of agro-chemicals, objections to reckless development of golf courses all around the nation and ignoring the opinions of the Green Seoul People's committee, the policy advisory group in the environmental sector of Seoul.

After the golf course was completed in June 2004, it took another year to prepare for it to open, which occurred in October 2005. Even though City of Seoul opened the golf course, it still was unable to operate it normally until February 2008, when the City announced that it would give up the use of the golf course and transform it into a citizens' park. This was because disputes between the City of Seoul that championed low fees for the public golf course and the Korea Sports Promotion Foundation that claimed high fees in order to reflect high construction costs of golf course.

Figure 5-7 | Conflict episodes over Noeul Park and Transition to Citizens' Park



Interestingly, Noeul Park, which is currently being used as public space for camping areas and park golf courses, is consistent with claims of the civil society organizations that opposed the plan of the City of Seoul. If there was a process of listening to the opinions of citizens in the planning stage for the establishment of the golf course, Noeul Park would have been used from the first as a citizens' park without a six-year gap and conflicts between civic society and the City of Seoul.

2014 Modularization of Korea's Development Experience
Nanjido Eco Park Restoration from Waste Dumping Site

Chapter 6

Implications for Developing Countries

1. Lessons Learned from the Project
2. Possibility of Applications in Developing Countries

Implications for Developing Countries

1. Lessons Learned from the Project

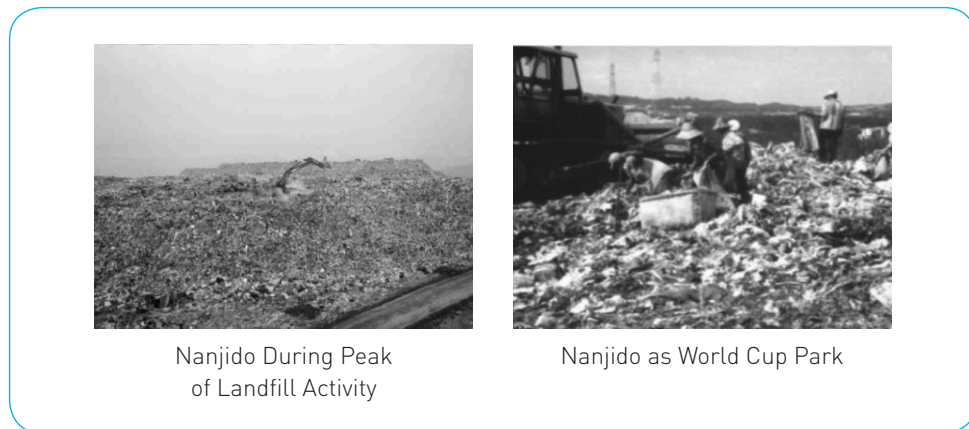
1.1. Landfills: Thorough Care Necessary, Even after Closure

Nanjido was a typical unsanitary waste landfill. All it had was a landfill border and did not meet any conditions of modern sanitary landfills such as leachate treatment, landfill gas treatment and tramping down the waste and covering it with soil. Only after the area's use as a dump site was finished, a concrete wall was installed to prevent leachate from polluting ground-water and the Han River; the landfill gas treatment facility, a thick soil layer to cover the top and a shield to prevent permeation of rainwater were also installed.

Twenty years since the end of burying wastes, the landfill management records show that such construction was absolutely necessary. There is still landfill gas being generated in the waste layer, which is the geological foundation of the World Cup Park. In terms of methane gas (CH₄), the landfill gas that was generated in 2002 at the time of the World Cup Park's construction, was 8,523 tons and 3,601 tons in 2013. Though the quantity dropped by about 58% with the passage of time, this shows that the wastes are still decomposing. For the leachate collected through the cutoff collar for prevention of ground-water pollution built along the landfill layer, based on the chemical oxygen demand (COD_{cr}), there were 164 tons in 2012 and 71 tons in 2013, showing that this is also fulfilling its functions. Another sign that the waste layer is still decomposing is the settlement of the landfill layer. The annual average subsidence was slightly high at 9.8 to 11.5cm for the first five years after completion of the stabilization work, but it gradually decreased and the average settlement for the past six years has been 5.1cm. This is much lower than annual average settlement

of 21cm expected during the stabilization construction in 2002. This shows that the landfill foundation is gradually stabilizing and there are no considerable problems regarding park safety, but it is also a sign that decomposition is continuing. Settlement during 2002 to 2013 was an average of 94cm for Noeul Park (max 327cm, minimum 24cm) and it was 71cm for Haneul Park (maximum 115cm, minimum 39cm).

Figure 6-1 | Before and After Construction of Nanjido Landfill Park



Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

If after-closure management for Nanjido Waste Landfill was not conducted, the landfill gas, leachate and pollutants that occur during the decomposition process of the waste layer would have been discharged into the atmosphere and the Han River. The poor air quality due to odors and the danger of landfill gas would have made it difficult to establish the citizens' park as it exists today, and even if such a park had been built, it would not be as popular as it is today.

1.2. Turning Landfills into Parks: Another Opportunity for Urban Restoration

Nanjido was originally grasslands and parts of it were farmland. Farmers also used to live there. However, after it began to be used as a waste dumping site in 1978, four-to-eight-ton garbage trucks came to the site every day, sometimes as many as 2000 trucks. It became to be called an “island of triple abundance”—dust, foul odors and flies. Some of the residents left but others started to come there in search of recyclables, as many as 2,000 to

3,000 people. They were divided into two groups: the first group would scavenge through the garbage that the trucks dumped on the ground and the second group would follow bulldozers as they plowed through the garbage; they would pick up garbage with some potential economic value. The homes of those living in Nanjido were make-shift houses made with vinyl, erected near the garbage mountains. This scavenger settlement was burned to the ground in 1984 during a big fire. Afterwards, they lived in 950 prefabricated houses built by the City of Seoul around the current Nanjicheon River area. After the landfill was closed in 1993 and construction of the park began, these people left the area. The City of Seoul offered them ownership of newly built apartments or helped them move into permanent-lease apartments as an effort to provide suitable housing for them.

Figure 6-2 | Residents of Nanjido and Residential Areas



Residents of Nanjido Farming Peanuts (before landfill)



People Collecting Recyclable Goods (during landfill)



Fire in the Community (during landfill)



Prefabricated Houses of those Collecting Recyclable Goods (during landfill)

Source: Seoul Metropolitan City Construction Safety Department (2003), Nanjido Landfill Stabilization Construction Site (in Korean).

By turning the Nanjido Waste Dump into the World Cup Park, the City of Seoul was able to achieve several objectives simultaneously. First, the landfill was transformed into a park for the community and citizens of Seoul. Second, the residents of this area were moved to other places without much trouble. The residents easily agreed to move and there was little social opposition owing to benefits such as apartment ownership or moving into permanent-lease apartments provided by the City of Seoul. Last, it was possible to quickly develop the surrounding area into the New Millennium City. If the residents had been opposed, it would have been difficult to carry out such urban planning development projects.

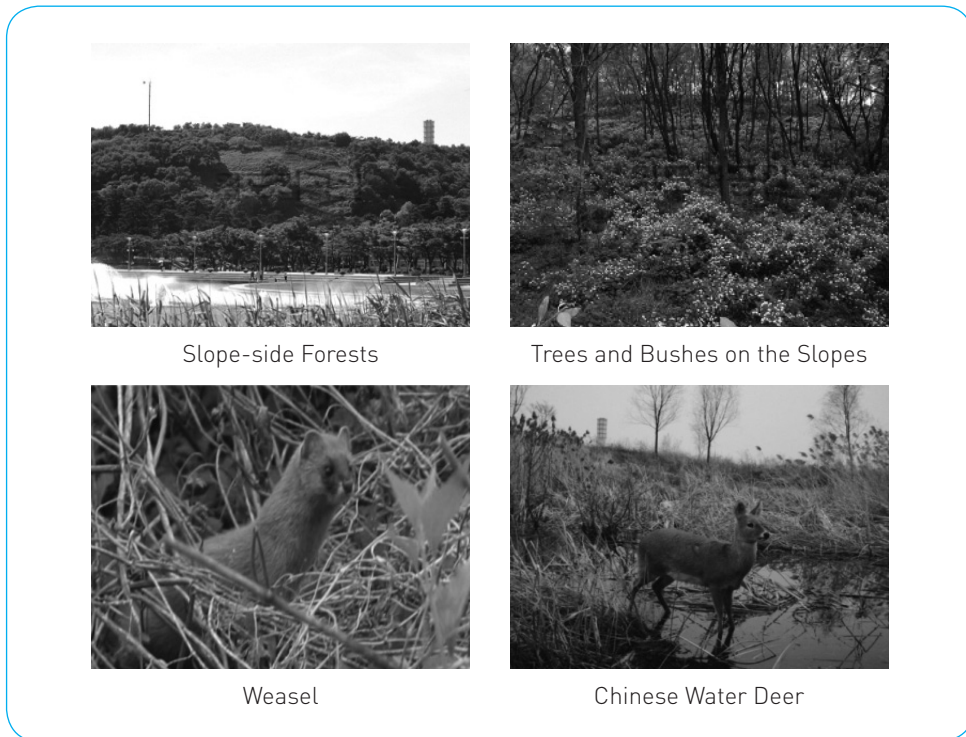
1.3. A Park Ecosystem that Grows on Its Own

The World Cup Park construction was divided into spaces to be used by people through careful planning and suppression of environmental damage resulting from stabilization work and space for nature to be restored. Even though there were artificial works to improve the habitats of animals such as establishment of eco-corridors and wetlands, and planting host plants when constructing the park, there were no other artificial projects during its use as a park, except monitoring the change of animal and plant life. Now, animal and plant life is spreading through the power of nature, and the ecology is recovering its balance. Ultimately, humans provided the space only and now animals and plants are growing on their own.

There are many nonnative plants growing on the slopes of World Cup Park. They seem to have been introduced into this area as seeds and weeds when it was a waste dumping site. No narrow-mouth frogs, Chinese water deer or weasels were found in this site when it was a dump. Now, however, they are being spotted by surveillance cameras. It appears that they have found their way to World Cup Park following the green zones of the Han River, Hyangdongcheon River, Hongjecheon River and Bulgwangcheon River.

The improvement of the ecological health of World Cup Park is objectively proven through the changes of the fauna and flora, as noted by investigations each year since establishment by the City of Seoul. In the 2000 investigation, there were 438 animal and plant species; in 2013, 1,092 species. Total biodiversity has increased to 582 plant species, 84 fungi and 426 animal species.

Figure 6-3 | Animals and Plants Growing Wild in World Cup Park



Source: Seoul Metropolitan City (2003), *World Cup Park Construction Site: Green field* (in Korean).

1.4. Communication and Cooperation with the Citizens

For the waste landfill stabilization construction and the World Cup Park construction, the expertise, technologies and organizational capacities both inside and outside of the City of Seoul were all mobilized. Six departments of the City of Seoul participated in the design, while five departments of the City of Seoul gave orders for and supervised the construction. A total of 32 private companies participated in the design and construction and the designs of all construction units reflected opinions of professors, researchers and technicians. Supervised by the City of Seoul and hosted by the Seoul Institute and Seoul University, the ‘Vision of the Millennium Park - International Symposium on Environment-friendly Planning of Nanjido’ was held on December 2, 1999 to receive consultation of international experts and to collect overseas cases. At the symposium, environment-friendly park design of waste landfills, environment-friendly design programs, cases of environment-friendly restoration and golf course establishment cases were presented and followed up with discussions.

By listening to the opinions of experts as stated above, it became possible to efficiently utilize the short period from October 1999 to May 2002 (32 months) from the design to the completion of the World Cup Park.

The entire project and construction was carried out as planned, but Noeul Park which was part of the World Cup Park, could not be used as a golf course as originally planned. The golf course that was constructed in the 200,000m² area of Noeul Park had a nine-hole course length of 2,750m. Social and civic organizations opposed the construction of a public golf course from the very beginning. The reason why such organizations opposed building of a golf course was that while 1.8 million people of Seoul would visit the Noeul Park when used as a citizens' park, about 90,000 people only would use the golf course. Thus, they viewed this as a project to benefit a specific group only by investing public financial resources. There were other issues as well such as environmental pollution due to use of agro-chemicals, creating a mood for reckless development for golf courses all around the nation and ignoring opinions of the Green Seoul People's committee, which is the policy advisory group in environmental sector of Seoul. The Noeul Park, which is currently being used as space for the citizen such as camping areas and park golf courses, is consistent with the claims of the civil organizations that opposed the plans of the City of Seoul. In fact, Noeul Park is currently being managed under the leadership of the 'Noeul Park Citizen's Organization' organized by civil organizations. If there was a process of listening to opinions of citizens in the planning stage of the golf course, the Noeul park would have been used from the first place as a citizens' park without a six-year gap and conflicts between the civic society and the City.

Figure 6-4 | Public Golf Course of Noeul Park that was Reason for Conflict between the Civic Society and the City of Seoul



Noeul Park Public Golf Course
Shown in the Basic Plan



Protest by Civic Organizations
Opposing the Use of Noeul Park
as a Public Golf Course

Source: Naver Images (Search word=Public Golf Course of Noeul Park).

2. Possibility of Applications in Developing Countries

2.1. Landfills, Future Assets of a City

In most cities, waste landfills are located on the outskirts. When a landfill is used for a long period of time its space to bury waste runs out or the city itself grows around the dump site; in either case, it can no longer be used as a landfill. Even if its use as a waste landfill is terminated, the land cannot be used right away. Landfill gas and leachate are continuously emitted and the soil is polluted and the waste stratum is unstable. Therefore, stages of waste landfill management such as after-closure management are being regulated and expanded.

The Nanjido Landfill followed the procedure detailed above. It did not have any features of modern sanitary landfills and it was a thoroughly backward state-run dump that received no economic or technological support. However, the concept of modern sanitary landfill was accepted in full for management following Nanjido's closure. The final soil covering was compacted very firmly and landfill gas was collected. Leachate from the waste layer was gathered and pre-treated, and only then sent to the sewage treatment center before being discharged into the Han River. The points where the landfill ground subsides are also being monitored.

What stands out most is that the upper part of the dump site is being used as a park, which has become the pride of the citizens of Seoul. Through this, justification to block environmental damage due to the previous landfill practice was gained, while also satisfying the legal condition of 20~30 years of after-closure management. By acting as the backdrop park of the region, it gave citizens the gift of development to an underdeveloped region, the chance to enjoy an ecological park where they can meet nature near their homes. If the Nanjido Dump was developed for commercial purposes, it would have already been filled with gray concrete skyscrapers.

The City of Seoul invested considerable financial resources of 223.2 billion Won in the stabilization of the dump site and construction of the World Cup Park. However, statistically speaking, every citizen of Seoul visits the World Cup Park at least once a year. Thanks to the World Cup Park, neighborhood park area in Seoul city was increased by 5.3%. The SangAm New Millennium Town, which was devised with a long-term perspective of over 50 years, is being developed according to plans. These are the benefits of not using the 2km² landfill for commercial purposes, but instead the citizen's park of World Cup Park that Nanjido Landfill gave to the City of Seoul and the citizens of Seoul.

Cities' growth is increasingly limited due to large-scale waste landfills; thus many urban regions must consider how to utilize landfills after their closure. The answer can be found from the case of Seoul city—Seoul's Nanjido Dump and World Cup Park built on top of it.

2.2. Appropriate Environmental Management Method for Unsanitary Landfill

The Nanjido Dump was a typical case of an unsanitary landfill, lacking in all countermeasures against landfill gas, leachate, waste scattering and insects. Even after closing the dump site which had become two massive garbage mountains 100 meters tall, it was not easy to set up engineering measures for environmental management. The facts that a park would be established in this area, the 2002 FIFA World Cup main stadium would be built in the neighborhood, and that the New Millennium Town would be developed in this site all required strict environmental management. However, the City of Seoul maximized use of nature's ability to heal itself for stabilization of the waste layer and blocked pollutants from being exposed to the environment, which were engineering measures appropriate to the situation.

The engineering measures were divided into soil-covering, blockage of leachate, collection and treatment of landfill gas and slope stabilization construction. The soil-covering

construction was planned to maintain a slope gradient of about 4% for smooth discharge of rainwater, while adding a total 1.4 m of final soil-cover layer with a surface layer of 30cm, a vegetation layer of 30cm, a drainage layer of 30cm, a blockage layer HDPE sheet of 1.5mm and a support layer of 50cm. To prevent leachate pollution from spreading to surrounding waterways such as the Han River, a cement bentonite slurry wall and steel sheet pile were installed around the entire landfill. The installation depth was 1 meter of weathered rock and 0.5m of soft rock with a total length of 6,235m. Collection, transportation and treatment facilities were installed to collect and treat slope and base discharge of leachate. The daily capacity of the leachate treatment facility was 1,860 tons and the pre-treatment was carried out first and was followed by final treatment after transport to the Nanji sewage treatment center. The landfill gas (375Nm³/min) emitted through decomposition of wastes was treated synthetically using 106 extraction wells, a 13,250m long HDPE transportation pipe, vents, an incineration facility, and a reuse facility. Six hundred sixty-seven holes of 9m long horizontal drainage plate were installed to prevent slope destruction and to minimize rainwater permeation.

The Nanjido Landfill contained buried wastes using unsanitary landfill methods. Stringent environmental management was absolutely necessary because the upper part would be used as a park and the surrounding area would be residential. However, the Nanjido Landfill stabilization construction satisfied conditions from engineering perspectives.

2.3. Provision of new Living Accommodations for Socially Vulnerable People

To the people living in Nanjido who made their livings by collecting recyclables from the waste, Nanjido was a very important workplace. However, there were frequent fires caused by landfill gas from the garbage heap, and thus the temporary buildings that residents lived in were all destroyed by a huge fire in 1984. The City of Seoul built 950 12m² prefabricated houses to replace the burned-down dwellings. At the time, there were 3,103 people in 824 households living in the prefabricated houses in Nanjido and 141 people of 57 households were recipients of the livelihood program supported by the government (Seoul Metropolitan City, 2003).

Half of the approximately 800 households left the area when the Nanjido site was closed in March of 1993, but the remaining residents continued to live in the steel-framed prefabricated temporary dwelling places. The roof and walls of these prefabricated houses were severely corroded and there were concerns of massive disasters in the case of heavy rains, but they had no choice but to stay in these make-shift homes. The City of Seoul helped

them find jobs through employment promotion projects, while also providing support for them by giving them rights to move into lease apartments and paying for moving expenses so the prefabricated houses could be demolished. The 61 garbage collection centers and its 400 or so employees were moved to the Sihwa Industrial Complex. The three construction aggregate companies on the backside of Landfill 2 were also moved and thus the relocation of everyone who made a living in the dump site was completed.

2.4. Use of Landfill Gas for District Heating

There are total 106 landfill gas collection wells (58 in Noeul Park and 48 in Haneul Park) at World Cup Park to collect the landfill gas emitted from the waste layer. Methane (CH₄) has value as fuel and the total amount of landfill gas used as fuel from 2002 to 2013 was 232,572,000m³, which is worth of 8.2 billion Won.

Of the 106 collection wells, 14 are A-grade with methane concentration of 45% or higher and 16 are B-grade with methane concentration of 40~45%. The collected landfill gas passes through 14 km-long pipes and is gathered at the landfill gas boiler. The heat from the boiler is supplied to three public buildings, 16,335 nearby apartment households, and 36 office buildings through a regional heating pump. It should be noted that the landfill gas accounts for approximately 3% of the district heating in the area and the main source of fuel is 60% LNG and 30% incineration heat from the Mapo incineration facility. However, landfill gas is generated naturally and unless used as such, it can only be discharged into the atmosphere as methane or carbon dioxide, which are both greenhouse gases. In particular, use of methane gas as a district heat source, simultaneous use of waste heat from incinerators and landfill gas, and cooperation with heat sales companies such as the District Heating Corporation are rare not only in Korea but also throughout the world.

2.5. A Home for Ecology Restoration Education

Approximately 3,000 public officials and interested parties from Korea and abroad visit the World Cup Park every year. They come to benchmark the dump site that was changed into a park and to visit the Mapo Resource Recollection Facility (incinerator) and Korea District Heating Corporation (that uses landfill gas and incineration heat for district heating sources) located within World Cup Park. Furthermore, World Cup Park won the UN Habitat's Special Award. This award is given to individuals, institutes and businesses recognized for making considerable contributions for providing housing for humanity and in relation to sustainable urban development. In conclusion, World Cup Park was recognized as an internationally exemplary case.

World Cup Park was an abandoned terrain where all of the wastes from Seoul were gathered. Garbage, dirt and pests characterized this area best. After its use as a waste landfill, however, reflecting on the past wrong-doings in Nanjido and anticipation for the future came together to recreate Nanjido as an ecological park where nature and humans coexist, and the surrounding area was transformed into a place popular to live in Seoul. Nanjido Landfill now has a new value as a place for international environmental education.

2.6. Renewal of Landfill Management System

During the period of 1978 to 1993 when the Nanjido Landfill was in operation, the only regulation on waste landfills in Korea was on how to cover up the trash. Modern landfill regulations appeared after the enactment of the 1991 Waste Management Act, and this was the moment when the Nanjido Landfill was preparing to close. Management methods for post-landfill use were established in 1998 and this was the time when the city had already completed designs and begun stabilization construction. In result, the City of Seoul made its own judgment for operations and stabilization construction from the operation to after-closure management without any prescribed procedures or methods.

After the Nanjido Landfill was closed, the government made huge revisions to relevant regulations. The landfill management regulations were subdivided into establishment of landfills, operation of landfills, and after-closure management. Landfills now have to be located in appropriate areas and also must prepare methods to minimize environmental damage in the establishment phase. The government has also prescribed methods to prevent environmental damage by the facility during burial of wastes. Landfill operators furthermore must treat and monitor pollutants for a certain period of time after the landfill is closed.

If these regulations had been put into place since the 1970s, the Nanjido Landfill would not have been designated as landfill in the first place. Even if it had been chosen as a landfill, it would not have been allowed to cause such severe environmental damage to the surrounding environment and people. In order to use our valuable land resources efficiently and to reduce damages to the natural environment and people, environmental regulations, including strict landfill regulations, are necessary at all times and places.

Table 6-1 | Regulations on Municipal Waste Landfill Management Method

Section	Landfill Establishment	Landfill Management Method during Landfill Use	Follow-up Management Method after end of Landfill Use
Contents	<ul style="list-style-type: none"> ▷ Site selection ▷ Environmental impact evaluation ▷ Compensation for affected areas ▷ Base construction <ul style="list-style-type: none"> - Groundwork - Cutoff - Leachate transport pipe - Leachate treatment facility - Landfill gas collection ▷ Inspection 	<ul style="list-style-type: none"> ▷ Leachate treatment <ul style="list-style-type: none"> - Blocking leachate - Transporting leachate - Treating leachate ▷ Landfill method <ul style="list-style-type: none"> - Internal entry way - Burying by stage - Covering with soil ▷ Landfill gas treatment <ul style="list-style-type: none"> - Landfill gas collection - Landfill gas transport - Landfill gas treatment and utilization ▷ Disease prevention 	<ul style="list-style-type: none"> ▷ Post-care management period <ul style="list-style-type: none"> - within 30 years ▷ Post-care management personnel: dedicated manpower ▷ Rainwater drainage method <ul style="list-style-type: none"> - Rainwater drainage facility ▷ Leachate management <ul style="list-style-type: none"> - Leachate examination - Leachate treatment ▷ Groundwater and seawater quality examination ▷ Landfill gas management <ul style="list-style-type: none"> - Landfill gas examination - Landfill gas treatment method ▷ Structure and ground stability <ul style="list-style-type: none"> - Investigation point and method ▷ Environmental monitoring <ul style="list-style-type: none"> - Surface water - Soil examination - Disease - Drafting surrounding - Report: every 5 years

- Bae, Du-hyun (2010), "Valuing the biodiversity of ecological park in Seoul: using contingent valuation and contingent choice method," Yonsei University Graduate School master's degree thesis.
- Bae, Sang-pil (2003), "A Study on the Policy-making Procedure of the Environmental Restoration of Nanjido in Seoul," Seoul National University Graduate School master's degree thesis.
- Han River Project Headquarters (2012), *2012 Major Work Plans*.
- Jo, Y. M., Kim, H. S., Sung, W. M., and Yoo, M. J. (2000), *Evaluation of NanJido landfill and environmentally-friendly restoring strategies: Groundwater and leachate management*, The Seoul Institute.
- Jo, Y. H., Lee, J. W., Jo, S. H., and Jo, K. H. (2000), *Evaluation of NanJido landfill and environmentally-friendly restoring strategies: Ecological rehabilitation*, The Seoul Institute.
- Kim, H. J., Min H. J., and Choi, J. H. (2000), *Sydney Environmental Olympics Report*, Seoul Environmental Foundation.
- Kim, G. S., Jung, J. Y., and Jo, G. S. (2000), *Evaluation of NanJido landfill and environmentally-friendly restoring strategies: Odor control and management*, The Seoul Institute.
- Kim, Seong-eun (2013), "Comparative Study on Park Marketing Strategies by Urban City Operator," Seoul National University Graduate School of Environmental Sciences master's degree thesis.
- Kim, W. S., Shin, D. C., Jang, J. H., and Dong, J. I. (2000), *Evaluation of NanJido landfill and environmentally-friendly restoring strategies: Air pollution (VOC Emissions) management*, The Seoul Institute.
- Korea Environment & Resources Corporation (2008), *Study on Plans for Improving Landfill Facility Follow-up Management System* (in Korean).
- Lee, Chang-woo (2012), *World Cup Park Opening Round Table: Landfill Environmental Restoration Project Performance Evaluation and Search for Plans to Construct International Network*, The Seoul Institute.
- Ministry of Environment (2001), *World Cup D-365 Environmental Management Plan* (in Korean).

-
- Monthly Environment and Landscape Editing, Parks of Korea, Jogyeong Publishing, 2006.
- Seoul Metropolitan City (1992), *Nanjido Landfill Environmental Pollution Prevention and Stabilization Plan* (in Korean).
- Seoul Metropolitan City (2000), *SangAm New Millennium City Basic Plan* (in Korean).
- Seoul Metropolitan City (2002), *Improving environmental performance assessment of landfill Nanjido* (in Korean).
- Seoul Metropolitan City (2003), *World Cup Park Construction Site: Green field* (in Korean).
- Seoul Metropolitan City (2007), *Environment of Seoul* (in Korean).
- Seoul Metropolitan City (2012), *2011 Seoul Survey* (in Korean).
- Seoul Metropolitan City Construction Safety Department (2003), *Nanjido Landfill Stabilization Construction Site* (in Korean).
- Seoul Metropolitan City World Cup Park Management Office Environmental Preservation Department (2006), *Nanjido Regains Its Scent: World Cup Park Reborn as Environmental Eco Park* (in Korean).
- Shin, Min-gyu (2000), “Environmentally Friendly Public Golf Course Design on the Nanji-islind Landfill Site, Seoul, Korea,” Seoul National University Environmental Studies Graduate School master’s degree thesis.
- Yoo, K. Y., Lee, S. R., and Lee, J. Y. (2000), *Evaluation of NanJido landfill and environmentally-friendly restoring strategies: Biochemical and geological stabilization*, The Seoul Institute.
- Google Images, <https://www.google.co.kr/search>.
- Google Earth.
- Noeul Park People’s Organization, <http://cafe.daum.net/nanjinoeul>.
- Seoul Han River Project Headquarters Nanji Han River Park, <http://hangang.seoul.go.kr/>.
- Seoul Statistics, <http://stat.seoul.go.kr/>.
- World Cup Park, <http://worldcuppark.seoul.go.kr/>.

www.ksp.go.kr

Ministry of Strategy and Finance, Republic of Korea

339-012, Sejong Government Complex, 477, Galmae-ro, Sejong Special Self-Governing City, Korea Tel. 82-44-215-2114 www.mosf.go.kr

KDI School of Public Policy and Management

339-007, 263 (Bangok-dong, Korea Development Institute), Namsejong-ro, Sejong-si, Korea Tel. 82-44-550-1114 www.kdischool.ac.kr



ISBN 979-11-5545-132-8

**Knowledge Sharing Program
Development Research and Learning Network**

- 339-007, 263 (Bangok-dong, Korea Development Institute), Namsejong-ro, Sejong-si, Korea
- Tel. 82-44-550-1117
- www.kdischool.ac.kr