Enhancement of Waterworks’ Revenue Water Ratio (RWR)

Abstract

Reducing water losses within a waterworks system, particularly in the face of water shortage problems, is an important issue faced by modern water providers. Since the early 2000s, the government of the Republic of Korea has worked to reduce the water leakage in local waterworks facilities and, as a result, to enhance the portion of water supplied to customers and increase revenue. This case study examines the reasons for Korea’s establishment of a nationwide policy to reduce waterworks leakage and the difficulties confronted while implementing the policy. Due to the weak financial status and technological level of local governments, the policy was implemented through the consignment of local governments’ water facilities to more professional water management organizations. K-water, a government-owned specialized water management organization, undertook most consignment projects. The main challenges were related mistrust about the necessity of the policy, which made it difficult to actualize the consignments. Another barrier that was difficult to overcome was the resistance from local governments’ water sector workers because of concerns related to job security. Through the national effort to reduce water leakage, for eight waterworks facilities that were operated by K-water in the form of consignments and have been operated for over 10 years,
the average revenue water ratio (RWR) was increased from 52.0 percent in each initial stage to 82.3 percent in 2016. The establishment and promotion of a desirable model and the apparent benefits were critical factors contributing to the policy’s success. Part of the policy’s effectiveness was due to the establishment of standard procedure and guidelines and the use of various methods such as subsidies and performance appraisals to motivate local governments to participate.

**Introduction**

The majority of humans rely on waterworks systems to supply the water they need for daily life. A waterworks system intakes raw water from various water sources such as reservoirs or rivers, purifies the water, and then transports treated water to residences. The considerable costs of construction, maintenance, and regular operation are reflected in the water bill to the customer. But what happens if a significant portion of treated water, for example 30 percent or 40 percent of the produced water, is lost through underground pipe leakages and is not billed to the customers? As of 1997, Korea’s national average waterworks’ leakage rate was 19.0 percent, but some local governments experienced much more severe leakage rates. For example, the leakage rate of Hwasun County was 30.8 percent, and that of Masan City was 38.1 percent. The management of waterworks leakages is a growing challenge for most water providers throughout the world. The need for reducing water loss is a global issue even in developed countries considering the fact that most water supply facilities are relatively old and deterioration is indiscriminative—it affects all nations. The average Non-Revenue Water (NRW) ratio, which includes water losses and other unbilled water consumption in pipeline networks varies from country to country: the international average is estimated at about 30 percent while the Netherland’s rate is about 5.4 percent and Venezuela’s rate is about 62.6 percent (GWI 2017).

To make matters worse, while a significant portion of treated water is lost through leakages, many nations are experiencing water shortages. Climate change, rapid urbanization, and population growth are crucial factors that accelerate water shortage. Many governments are pursuing new water resources development projects to address the urgent problem. Water scarcity currently affects more than 40 percent of the global population and by 2030, global demand for water is expected to grow by 50 percent. This dilemma suggests what seems to be a simple solution: minimize the water losses experienced by waterworks facilities.

In reality, for a variety of reasons, waterworks facilities will inevitably experience some amount of leakage. Many factors affect leakage: poor design and installation of the water supply facilities; poor material quality; and damage caused by the traffic load above the pipeline. Moreover, waterworks facilities deteriorate over time. Even though some amount of leakage is unavoidable, the loss of treated water leads to lost revenue for water providers. In communities that experience water shortage, the local governments must develop new water resources and construct new facilities to provide water to residents.

Leakage reductions in a water supply system will have an significant effect—new water resources can be secured while economic loss and energy consumption can be reduced. In addition, water providers can reduce capital cost by eliminating or deferring the need for new facility construction to secure more water resources. This can decrease the burden that is shifted to customers by way of the water rate.

From a safety perspective, a decrease in leakage will also lead to a reduction in pinholes or void underground spaces which can cause such problems as sinkholes on roads and damage to other utilities. As well, the risk of health problems which can arise from the reverse infiltration of sewage and other pollutants into the water pipe can be reduced.

This case study examines the Korean government’s efforts to decrease waterworks leakage, beginning in 2001. In Korea, the RWR, which is the billed water of a specific water supply system, is used as a national index to appraise and compare the status of water facilities. If a waterworks system has a low RWR, then a considerable

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5 RWR, which is the reverse of Non-Revenue Water (NRW) ratio, is calculated by dividing the revenue water volume by the total system input volume of each waterworks facility and is expressed as a percent (%). Revenue water refers to the billed water used by customers. The total system input volume means the water that is produced and provided into a distribution system which is usually metered at an outlet point of a purification plant. RWR is the most widely used performance indicator for leakage management in Korea.
amount of treated water is lost underground during transport to customers. This forces an increase in operation costs since electric power for pumping and chemicals for disinfection are increased to provide the needed amount of treated water supplied to customers. Increased costs are then transferred to the customers, resulting in a higher water rate.

**Context of the Case Study**

**Water Services in Korea and Background of Local Waterworks Consignments**

As of 2016, water services in Korea are implemented by 161 local governments. Korea's domestic tap water supply rate is over 98.9 percent. Total length of pipeline of Korea's national waterworks is 203,859km, more than five times of the equatorial circumference of Earth. Pipelines experience deterioration year after year, causing leakage without timely maintenance or replacement.

According to the laws that govern the regulation of waterworks in the Republic of Korea, only local governments are the legitimate water providers in their respective administrative districts. Each local government also decides the water rate autonomously by revision of its ordinances. Essentially this means that local governments in Korea play a dual role as water producer and regulator. However, local governments can consign their water services partly or in whole to specialized organizations for the purpose of more effective operation and maintenance.6 The law specifically states the specialized organizations which can perform water services on behalf of local governments.

The Korea Water Resources Corporation or K-water7 is one such organization. K-water initially introduced the consignment model and took the lead in the national effort to enhance RWR by improving local waterworks systems. Since its initial RWR enhancement project in 2001, K-water has increased the number of waterworks facilities it operates to 23 local governments as of 2017. Ten years after K-water started its first RWR enhancement project, Korea Environment Corporation (KECO), another government-owned water organization, joined the national project in 2010 and operates four local waterworks facility projects.

**Basic Concept of the RWR Enhancement Project**

Most waterworks facilities around the world are typically comprised of several sub-systems: intake facilities, conveyance systems, purification plants, service reservoirs, transmission main lines, and distribution networks. The water balance of waterworks can be divided into two categories: Revenue Water (RW) and NRW. Through active leakage management activities, the portion of NRW, which is the loss occurred during the service process, will decrease. A decrease in NRW would not only result in cost reductions for water treatment and supply but also a reduction of the water production volume. The following figure (Figure 1.) represents the basic concept of enhancing RWR.

Table 1. below shows the project concept in a simple format. If a local government's current RWR is 50 percent and the total production cost is US$600 million, then US$300 million will be lost, primarily from underground leakage. But when the RWR is raised to 80 percent by improving the water supply system and active leakage control efforts, a total of US$225 million of the total production cost will be saved annually. This reduced cost can be used to collect the initial investment cost for the RWR enhancement project. But the water provider can go even further to generate more profit. For example,

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6 In accordance with the provision of Article 3 and Article 23 of the Water Supply and Waterworks Installation Act of Korea.
7 K-water, a company owned by the government of the Republic of Korea, is responsible for constructing and operating wide area water service facilities.
K-water is a wholesale water provider for more than two local governments.
US$200 million is used to pay off the investment cost and US$25 million is used for other public purposes or for securing some space in their budget to lower the water rate for customers.

Most waterworks systems inevitably have some amount of unavoidable leakage. It may not be an economically practical decision to pursue a policy to remove all water loss of a system. The optimal leakage level can be determined by considering economic level of leakage (ELL). ELL is found by deciding the point of level of losses where the sum of the cost of the leakage control activity and the cost of water loss is at a minimum as shown in the following figure (Figure 2). RWR enhancement investment projects performed by K-water are based on the concept of a moderate ELL.

### Water Balance of Waterworks in Korea

By internationally accepted standards, the water balance components of a waterworks facility is divided into two categories; RW and NRW. These are in turn subdivided into several categories. Table 2 represents the simple annual water balance in Korea as of 2016. NRW comprises several components: operational use, public use, usage adjustment, metering inaccuracy, unauthorized use, and leakage. Because other NRW components are rather minor in Korea, the central government has been concentrating on reducing the leakage volume.

In Korea, as can be seen from Table 2, the total amount of waterworks leakage on the water supply process was estimated at 682 million tons (m³) according to the Statistics of Waterworks 2016 which was published by the Ministry of Environment (ME). If the estimated quantity of water loss were to be converted to lost revenue, which can be calculated by multiplying the average sale price of water to customers with the total volume of annual national water leakage, the total loss would amount to US$436 million. The amount of water resources still being lost underground is significant, even after a considerable amount of national wealth has been invested in the water treatment and transportation process.

The national total leakage volume also means that about 16 dams would need to be built to secure the same amount of water resources, with a cost of approximately KRW 6,550.4 billion (US$5.96 billion).

### Development Challenge: Reducing Water Loss in Local Waterworks

**Lessening the Amount of Wasted Water Resources While Lowering Water Rates**

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If a waterworks system has a low RWR, then a considerable amount of treated water leaks underground during transport to customers. This forces an increase in operation costs to supply the needed volume of water to customers. The local government is the legal water provider in an area. There are limits on water rate increases (so as not to impede public welfare), and therefore only a small portion of budget can be secured for facility improvement, meaning that the provider cannot suitably perform activities needed to lower the leakage rate. This, in turn, means the RWR for the facility decreases, and a downward spiral of RWR shapes a vicious circle.

Table 3 shows the average RWR, production cost, and water rate among the local governments which are classified by scale. In metropolitan cities, such as Seoul or Busan, the average RWR is above 90 percent which is higher than the average national level. The leakage rate of Seoul is only 2.3 percent. In contrast, for small-scale local governments, which are mostly located in remote rural areas, the average RWR is under 70 percent. In addition, production cost and water rate per unit are also closely related to the level of RWR; they increase when the RWR decreases.

Statistical analysis also proves the close relationship between the RWRs of a waterworks and the total production cost for treated water per unit. Figure 4 shows
the linear relation of the two variables of the 161 Korean local governments as of 2016. The correlation between RWR and production cost of treated water per unit is (–0.4852). RWR is a crucial factor that solely explains about 23.54 percent of the production cost change calculated even including some outliers.

Low RWR inevitably leads to an increase in the water rate for customers. Residents in an area with low RWR pay a greater water rate compared to areas where the RWR is higher. In 2016, the highest water rate for a ton of treated water was 1389.55 KRW (US$1.20) in Pyeongchang County, which was more than double the water rate of Seoul which was 572.11 KRW (US$0.49).11

In 2000, the national average RWR was 74.7 percent, but as of 2016, the Korean national average RWR of all waterworks was 84.8 percent. However, for the majority of small-scale water utilities, which were operated by local governments located in remote rural areas, the average RWR was below 50 percent in 2000.12

Due to the large discrepancy in RWR as well as in water rates across municipalities, the reduction of local waterworks facilities’ water losses and consequently the enhancement of RWR became a national priority for the government of Korea. On February 23, 2001, in order to adopt such as a national policy and institute it consistently, the Korean government enacted an order called The Work Procedure of Waterworks Revenue Water Ratio Enhancement. This code marked a starting point for the national planned effort to enhance RWR.13

**Modernizing Local Waterworks Facilities to Provide More Enhanced Public Services**

For more effective management of water facilities, it is essential to replace old infrastructure and apply more advanced technologies that use continuously evolving information and communications technology (ICT). A more developed system for local waterworks accomplishes two goals: 1) the reduction of water losses; and 2) the addition of new positive-value services that did not previously exist for the general public. Newly added services include: the provision of real-time information of water quality for citizens; an alarm system to notify operators and households of abnormal water usage; and preemptive services to address customer complaints in advance.

Typical technologies related to the modernization of a waterworks system are: building of a District Metered Area system by subdividing the distribution network

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13 Order by Ministry of Environment NO.486.
system into manageable discrete areas; leakage detection and restoration technology; pressure management technology of pipeline networks by installing equipment such as a pressure reducing valve and network control system; technology to evaluate facility deterioration for more reliable and objective decision making regarding facility renewal; a GIS (Geographic Information System) based pipeline network; and building of a pipeline network operation system such as tele-metering and control (TM/TC); and real-time data acquisition and transmission technology.

Implementing these technologies requires a certain degree of specialized competency, however the technology level of local water providers, especially small or mid-level local municipalities, was rather low in the initial stages of the project. This fact implied (from the perspective of the central government) the necessity for national involvement in local waterworks systems.

In this context, K-water, a specialized water management organization, participated in the government-led initiative by engaging with local government to operate their water facilities as a consignee. The main goals of these consignments were to enhance RWR by replacing old infrastructure and introducing new technology. Local water providers could reduce water leakages to enhance RWR in their water supply network, which in turn reduced economic losses, allowing K-water to retrieve its investment cost.

**Delivery Challenges**

In the early 2000s, when the Korea government was trying to enforce the RWR enhancement project on a nationwide level, the regulation and legal system to implement the project was not complete. At that time, K-water could legally supply only bulk water for multiple local areas. In 2001, the Water Supply and Waterworks Installation Act, which the ME was in charge of, was revised to create the legal framework for consignment of local government's water services to a more specialized water management organization.

When the legal framework made it possible for K-water to operate local waterworks directly by way of consignment contracts with local governments, the consignments themselves were controversial among stakeholders—local governments, local government employees, and citizens groups related to the contracts—because they were, at that time, unprecedented. All stakeholders were involved in consignment process.

The RWR enhancement project of Korea encountered many challenges, which can be grouped into three primary categories.

**Resistance from Interest Groups**

When K-water proposed a consignment contract to local governments around 2001, it was difficult to reach an agreement on the long-term consignment cost between the parties. Because RWR enhancement projects require considerable investment cost for infrastructure renewal/replacement and introduction of new technologies, it was inevitable that the consignment payment would be increased in the initial stage within the long-term financial parameters of the project. This caused mistrust from the local government and residents in the service area for the project. Local governments were concerned that the contract provision was unfavorable for them. Local government officials felt that they had unduly yielded the financial provision and that eventually they would suffer a loss. There was a perception gap on both sides regarding the monetary value of the discount rate applied to all long-term investments. The local government officials were accustomed to the concept of annual budget management and were generally not familiar with the analysis of long-term finance.

The complaints did not solely arise due to financial reasons, because local governments were swayed by their political circumstances. The chiefs of local governments and local assembly members are elected and are typically affiliated with a political party, and thereby represent the political orientation and stance of the party to which they belong. A successor of a position after an election has the inclination to reverse the decisions of their predecessor, a political opponent, made. Local assembly members belonging to the opposition party often do not favor the policy the chief of local government is pursuing.

This resistance led to two major disputes, including a lawsuit, by local governments during the initial stage of the policy implementation. The issues were ultimately resolved in favor of K-water: K-water could keep the operations based on the same consignment contacts.

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14 The difficulties confronted during implementation are drawn from interviews with a range of stakeholders involved in the project, including experienced professionals who were involved at various part of the project cycle.
In the beginning, there were no established guidelines to proceed with the consignment contact. The standard basic procedure for consignment was established by the central government in 2001. The general consignment process of a local government’s waterworks facility to a specialized water provider is specifically regulated by laws and provisions of the central government, the ME. Since then, more specific procedure was established in accordance with the national guidelines. Usually the whole project period from the start to the conclusion of a consignment contract following the basic procedure takes a relatively long time: three to five years.

The political situation of local water providers was another concern. The decentralization paradigm of Korea since the early 1990s meant that the central government was relinquishing some of its strong control over the local government. Waterworks consignment of local governments was a major political issue for candidates seeking elected offices, such as mayors or local assembly members.

In general, the consignment of a local governments’ waterworks facility to a different water provider involves various parties which may have different or even incompatible interests; a new water provider to run the project, local administrations, local assemblies, the related central government ministries, interest groups of the local government employees, local press and media, and non-governmental organizations (NGO).

NGOs opposed to consignment agreements for waterworks for the same reason they oppose the privatization of public services: companies have a tendency to pursue profit rather than public welfare and will eventually rapidly increase rates. On August 2002, Masan City’s employee union and civic groups, such as the Federation for Environmental Movements, expressed strong opposition to the ongoing negotiation between K-water and the local government authority for the consignment of Chilseo Water Purification Plant. These groups argued that the potential consignment would bring a rapid increase in the water rate. On July 29, 2003, a civic committee was organized and held a rally and a press conference to express their opposition to the consignment of water service of Seoul City’s Amsa Water Purification Plant. On September 21, 2006, 22 civic organizations held a press conference in Seoul to oppose the consignment of public water service.15

These groups and some segments of the public were concerned that waterworks consignments represented part of a privatization process that could ultimately lead to increases in water rates and deterioration of water quality, even though K-water is a government-owned enterprise.

Most local governments have a department, an Office of Waterworks, to run the water supply system and employ workers to operate the facilities. The workers who engage in the operation of the local governments’ water facilities are mostly civil servants, which means that they have secure jobs. The retirement age of a civil servant in Korea is 60, relatively longer than in the private sector where the typical retirement age is in the late 40s or early 50s.

In cases when the water supply systems are handed over to other water providers by consignment contracts for long terms such as 20 or 30 years, the employees must find new jobs within or outside their previous workplace. The basic alternative they can choose will be transferring

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their job to the new organization. But this requires them to experience significant changes to their working conditions and severance from their previously built human network. Understandably, they were strongly negative about, and resisted, potential consignments. In order to defend their current working condition, they had a tendency to take collective actions.

They were unfavorable toward the consignment agreements because of fear of employment instability that might occur when the right to operate the facilities passed over to specialized water management organizations. Even though K-water is a fully government-owned company and its mission is to pursue the public interest of the nation, government employees had a preconception that working in K-water would be less favorable in terms of job security and that they would have to give up previous benefits such as public employee annuities. Furthermore, the opposition of the Government Employee Union was a major concern. They were negative toward the waterworks consignment not only to defend union members’ interests, but also to prevent downsizing of their union membership, because K-water’s employees belong to a different industrial union.

### Weak Local Government Financial Capacities

The weak financial status of the local governments was a primary hindrance in implementation of the RWR enhancement project. Local governments should have financial independence to run their water supply system autonomously and to invest in the renewal of their facilities without aid from the central government. But the financial independence level of most local governments was generally low, except in large-scale metropolitan cities like Seoul. Especially, small local governments’ financial independence so weak that they have less real ability to introduce and implement a large investment project related to infrastructure renewal. Even as of 2015, approximately 58 percent of the 161 local governments are small-scale water providers whose populations are under 100,000 and water production capacity are under 50,000 m³ per day.16 Mostly, they have limited investment capital and lack the ability to apply new technologies to improve their water supply system.

Furthermore, even though most of these local governments could not implement the RWR enhancement project autonomously and needed national aid from the central government, they preferred the status quo and resisted the policy. It was difficult to find any motivation mechanisms for local governments to participate in the nationwide level RWR enhancement projects.

In addition to the weak financial states of local governments, another problem was that the local water systems were precisely separated by the unit of administrative district, irrespective of geographic conditions that are suitable for efficient water supply in the area. The administrative boundaries do not always coincide with the geomorphological ideal condition for water supply services. In some cases, it may be more economically effective for a local government to provide water to residents through other local governments instead of having their own water system and operating it.

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In some other cases, neighboring local entities developed waterworks facilities on their own and it resulted in the duplication of investments while not being able to take advantage of economy of scale.

**Tracing the Implementation Process**

**Development of Success Stories to Counteract Resistances**

At the beginning of the projects, the central government initially focused on a few pilot projects to be promoted as a successful model for the remaining local governments. As such, the central government’s efforts to disseminate apparent visible outcomes of the consignment cases was critical in implementing and spreading the RWR enhancement project to a nationwide level.

In 2001, the first local waterworks target that K-water tried to initiate as a project was in Masan City which at the time showed a seriously low level of RWR, at 51.2 percent. As it was the first project, K-water collaborated with an international water company, Veolia Water, to share technology and information of both sides. However, the joint project was cancelled because the project confronted a few unexpected obstacles such as resistance from the civil servant union.

After the cancellation of the Masan City project, K-water initiated another project with Nonsan City, in the central part of the Korean peninsula. After finally agreeing upon the consignment contract and launching the project in 2004, K-water invested in Nonsan City’s water facilities and introduced new technologies. The first two projects K-water launched, in Nonsan City and then in Jeong-eup County, were successful. The RWR of Nonsan City was 53.4 percent before consignment in 2004; after four years, the RWR rose to 79.9 percent by 2008. The RWR of Jeong-eup County was 49.8 percent before consignment in 2005 and rose to 81.3 percent by 2009. These results were so apparent for the policymakers and local governments that K-water actively promoted the outcomes of these projects to help local governments understand the basic purpose and benefits of the RWR enhancement policy. As a result, new projects were initiated with other local governments. Ten municipalities joined the RWR enhancement project by consignment from 2006 to 2009 after the first two cases proved successful. By 2007, the mainstream media in Korea began to report the positive side of the consignment arrangements, helping to shift public opinion.

Since the success of the two projects with the Nonsan City and Jeong-eup County, K-water has been implementing and promoting other successful consignment cases in order to mitigate resistance to and mistrust of the projects, which was helpful during the transition stage. From a sample of eight waterworks facilities (out of 23 local waterworks in total that K-water operated for over 10 years), the average RWR rose from an average 52.0 percent at the initial stage to 82.3 percent by 2016. Figure 6 represents the change in RWR for the eight local governments that agreed to RWR enhancement projects before 2007. The most successful case was in Sacheon City whose initial RWR was 39.6 percent and then rose to above 81.8 percent.

An RWR enhancement increase of almost 30 percentage points for all eight local water systems will result in an expected annual total of 31,737 thousand tons of treated water saved instead of lost through underground leakage. From a national perspective, the monetary value of this enhancement is equivalent to US$20.3 million annually when calculated using the average water rate.

In 2009, the ministries of the central government established a policy to provide subsidies of up to 50 percent of the investment cost for water supply infrastructure rehabilitation. While providing assistance through subsidies for the projects, the central government induced local governments to consign their waterworks facilities to a more specialized water management institute for more effective operation. The Ministry of the Interior and Safety (MOIS), which is in charge of financial subsidies for local governments, included RWR as a performance appraisal index of local governments’ administrative performance to motivate the policy. This national policy began to motivate local governments to participate in the RWR enhancement project, especially small-scaled local governments which previously were reluctant to participate because of financial weakness. Between 2009 and 2017, K-water took over 15 more local waterworks.

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17 The name was Vivendi Water at the time.
18 See Annex C for more specific details.
Various other specific guidelines have been established by the ME and K-water for conducting consignments and thus the defined procedure has made it possible to facilitate the consignment policy with less trial and error. The guidelines include: standard business process, standard calculation of consignment cost, procedure for RWR enhancement, and various other related matters.

To take advantage of economies of scale and efficient operation, K-water tried to implement combined consignments by joining together several neighboring water systems of local governments. By combining the consignment of adjacent water supply facilities, water providers can save manpower and operation cost. More drastic measures could include even closing surplus purification plants, thereby significantly reducing maintenance cost. Additionally, a pipeline network may be extended to a wider area connecting previously separated and divided systems. This allowed the network to supply water without interruption even in an emergency which would not have been feasible with the previous independent water systems.

The first model of consolidation was achieved in 2012 when four local governments, located in Southern coastal areas, established a Standard Business Process and Developing Customized Models. When the RWR enhancement policy was first implemented, specific standards for implementation did not exist. To move the policy forward and minimize confusion among local governments, it was necessary to establish guidelines which describe the main aspects of the RWR enhancement project: main areas and scope of the projects, technical factors to consider, the procedures for RWR enhancement project. Without having any relevant standards to refer to for the implementation of the RWR enhancement policy, both the ME and K-water made efforts to establish a uniform guideline. In 2001, the ME published The Work Procedure of Waterworks Revenue Water Ratio Enhancement. This standard was created as a result of governmental awareness of the serious implications that future water shortages pose and the necessity for leakage prevention.

After a considerable period of study by experts and technicians, the ME published the Manual for Waterworks Revenue Water Ratio Enhancement in 2007. The manual has six chapters and deals with main technical areas of application. In 2009, K-water published a more specific and technical manual, the Guidebook for Enhancing and Keeping Waterworks Revenue Water Ratio.

Figure 6 RWR Enhancement of Eight Local Water Systems

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area of the Korean Peninsula, agreed to a consignment contract: Tongyeong City and Goseong County participated in the project which finally completed the combined consignment with the previously joined local governments, Sacheon City and Geoje City. Through the realization of the combined consignment model, duplicate investments by separate small water suppliers could be minimized and efficiency was raised to an optimal level.

In addition, a few new consignment models were introduced in which a customized contract can be developed according to the needs of the local governments. In some cases, consigning a whole waterworks facility for a long-term, irrespective of the specific needs of the local government, may be an ineffective method. Both the central government and K-water developed diverse customized business models to overcome the downsides of the consignment contract that intended to operate the facilities in one package for a long period lasting 20 or 30 years. For example, using the customized contract model, K-water would only operate the water distribution networks for water leakage reduction through the application of relevant technologies to the system, while the local government would still operate their purification plants. Or, K-water can provide consultation services to establish a master plan for the local government and carry out construction work to install required equipment for the application of technology suitable to the local water facility. Because the process of consignment of a whole water supply system takes a long time to be agreed on as a final contract, this customized consignment model is a new alternative which can be used more widely.

Around 2005, when the RWR enhancement policy began to be implemented in earnest and performance needed to be validated, it was found that some of the data local governments had reported was incorrect. This was due mostly to carelessness or indifference in record-keeping, but in extreme cases this was due to intentional manipulation. With incorrect statistical data, the performance result cannot be measured and the policy would not be feasible as a result. The ME, the supervisory authority of the national waterworks system, tightened the implementation of the annual water audits of local waterworks. Overall information of annual water audits were organized systematically into national annual waterworks statistics, used to keep track of chronological change of water loss and RWR. This also made it possible for a local government to compare its performance with other local governments stimulating to enhance RWR level.

**Settlement of Initial Conflicts with Local Water Providers**

As mentioned above, the first contract case between K-water and a local government was Nonsan City which began in 2004. After only one year of the consignment agreement, K-water was confronted with an unpredicted difficulty. The local government protested that the contract provision for the cost redemption was unfavorable. The conflict over the consignment cost lasted for about two years and was finally resolved through arbitration by financial and legal experts. Successful resolution of this case was crucial, because if it had not been resolved, it was likely that future projects with other local governments would not have been feasible.

A more intense conflict case with a local government arose in 2011. Yangju City, which agreed to a consignment contract of the facilities with K-water in 2009, abruptly stopped paying the cost for the operation work, arguing that the financial evaluation model of the project had some fatal flaws that were adverse to their side. This case was not solved easily by negotiation because the issue was provoked based on politics. In the end, the local government authority finally notified the cancellation of the contract in 2012. K-water responded with a lawsuit to resolve the case while at the same time attempting continue negotiations with the local government. The dispute went on for nearly two years until it was finally resolved in 2014 in K-water’s favor.

The case of Yangju City was the second critical incident for introducing the RWR enhancement project. Several local governments that had expressed interest in the project at the time delayed their decision as they observed change in the situation surrounding the dispute between K-water and Yangju City. Ultimately, K-water was able to continue operating the local government’s facilities legitimately after winning the lawsuit. Around that time the MOIS began to acknowledge the economic effect of RWR projects and began to provide support through national subsidies. After the dispute was resolved, a series of local governments started participating in the RWR enhancement projects through consignment contracts.

When the RWR enhancement initiative was first launched, local governments showed skepticism. However, the problems they anticipated (such as rapid
increases in rates for water, and the degradation of water quality) did not emerge. On the contrary, the consignment model demonstrated RWR enhancement and offered better customer service from a professional water provider. These factors led to a change in attitudes to the consignment of the water facilities.

**Enhancement of Customer Satisfaction Level**

Usually, customers of a water supply system experience various discomforts and problems with their water services, for example: poor water quality, shut-down of the water flow, low water pressure, and inaccurate billing. K-water introduced a new concept, Smart Water City (SWC), to local water facilities around the 2005. As SWC utilizes ICT, smart sensors and internet technologies were applied to provide better customer service and to add more economic value. Smart sensors acquire and transmit essential data such as flow rate and pipe pressure to central control centers on a real-time basis. Customers in an SWC area are provided water quality information on a regular basis and feel safe drinking tap water directly without more filtration. Water quality information, which includes such items as turbidity, pH, and residual chlorines, is also provided through electronic display boards located in public spaces. These innovative technologies contributed to creating a more favorable general public opinion toward waterworks’ consignment.

K-water also developed a new service standard for the customer service system of regional waterworks by providing differentiated services and, as a result, enhancing customers’ satisfaction. The service standard includes service manuals for local water services and training of staff. In addition, from the early stage of the RWR enhancement projects with Nonsan City and Jeong-eup County, K-water developed an internet based customer service system, called ‘One Touch Home Clinic’ to settle customer complaints systematically and with speed. Previously, customers had to visit a local government office or call by phone to file a complaint which was inconvenient and time consuming. The newly introduced service system contributed to the change in public opinion about the need for special operation by consignment.

The Korean government appraises the performance of all public service providers’ performance every year. One of the key performance indices is the National Customer Satisfaction Index (NCSI). As a result of efforts to realize systematic customer service, the performance of NCSI of the local waterworks whose facilities had been operated by K-water markedly rose from an average 66.3 percent from the initial level to an average 81.0 percent as of 2016.

**Transferring New Technology to Local Water Facilities**

The successful implementation of new policy that is substantially related to adopting new technology depends on the professional competency of the people involved. In 2007, the ME institutionalized a compulsory education standard for the workers engaged in waterworks facility management. By this law, all waterworks facility managers or operators have to complete a 35-hour education program every three years after they took their positions.

K-water is one of the legal institutes to run the educational programs for local governments’ civil servants. Annually, K-water runs about 50-70 education programs for local governments and 900-1,100 local water facility civil servants are trained at K-water Human Resources Development (HRD) Institute. Many of the educational programs teach advanced technologies to control waterworks leakage. In 2017, for more practical education, K-water HRD Institute built and operates the Water Distribution Network Education Center in which trainees can learn the whole process of enhancing waterworks RWR and related technologies through actual hands on practice.

In addition, K-water provides educational programs for international trainees from overseas countries. Every year, about 200 people, mostly from developing countries from South Asia or Africa, are trained at K-water HRD Institute. These efforts made it possible for K-water to accumulate technology to conduct overseas RWR enhancement projects in other countries such as China and Chile.

**Efforts to Provide Job Security for Local Government Employees**

From the initial stage of waterworks consignment project, K-water adopted a policy of hiring local governments’ water department employees in order to provide employment stability. The policy included more favorable conditions for re-employment such as a salary level increase. A few more privileges were also given for the re-employment

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21 In accordance with the provision of Article 36 of the Water Supply and Waterworks Installation Act of Korea.
of workers. For instance, they were exempt from the job rotation system that is applied to all existing K-water staffs. Thus, they can work in the same location depending on their needs. For those civil servants who preferred not to relocate for the opportunities within the consignment water facilities, local governments also made an effort to provide them with an opportunity to transfer to other jobs. The conditions for re-employment changed more favorably as time went on which contributed to the number of workers who transferred to K-water, even though a portion of them still refused to change their organization.

The transfer of local government employees was essential to form a favorable atmosphere for the RWR projects and consignment of the facilities because the negative image of the consignments was a critical barrier for the implementation of the national policy.

The hiring of local government employees was also necessary from a strategic perspective. Even though the workers generally lacked the required knowledge and skill to perform leakage management, they had tacit experience and background information about their facility’s history and current conditions. Because the local water facilities were not equipped with well-organized information systems such as GIS-based pipeline network map, experienced workers initially provided necessary information for the RWR enhancement project.

Lessons Learned from the Case Study

The need for the leakage reduction of waterworks is a global issue. Because the Korean government has implemented a leakage reduction policy, the national leakage volume has dropped steadily over the past 20 years.\(^{22}\) The upward trend of RWR enhancement is remarkable in that without intervention, water leakage would naturally increase as facilities deteriorate with time. The outcome is a result of national planned efforts to realize better conditions while overcoming obstacles.

The Dissemination and Promotion of Successful Cases to Resolve Mistrust

In general, in the context of local policy adoption, policy diffusion involves a determination of whether a policy adopted elsewhere has been successful. If the policy is deemed to be successful, then a city is more likely to adopt it (Shipan & Volden 2008). To resolve conflicts of interest among the parties concerned and to mitigate mistrust for the effectiveness of a policy that should be realized for the betterment of the general public, the dissemination and promotion of successful cases would be requisite. In particular, since the consignment of a local government’s waterworks facility to a different organization involves various groups such as a local assembly, workers, local press and media, and NGOs, successful precedents were important in persuading them to adopt a new policy.

Through the dissemination and promotion of successful cases, K-water was able to clearly inform other municipalities on the apparent effects of the RWR enhancement policy. Since numeric performances such as RWR and customer satisfaction service enhancements are obvious, distrust by local governments and stakeholders over uncertainty of the results as well as political interest differences are easier to overcome at present compared to the initial phase of the RWR enhancement project.

Overcoming Difficulties During the Initial Stage of Policy Implementation

When viewing the phase from a different perspective, focusing on getting over difficulties during the initial stage of policy implementation is a critical step when spreading any type of national policy, especially one that involves sensitive issues among different interest groups. In Korea, there are many cases of governmental policies that were thwarted before full-scale implementation. That’s because national policies inevitably generate various conflicts of interests, leading to pros and cons among the parties concerned, even though all the parties agree on the basic necessity of the policy. So, if central and local governments can settle potential difficulties and conflicts in the early stages, the implementation of a policy would have a higher probability of success.

Since the RWR enhancement policy, driven by both the Korean government and K-water, has been successfully implemented and expected outcomes have been achieved, it became possible to spread the policy on a nationwide level. But, this result could not have been realized if the challenges confronted in the initial stage, especially if those conflicts with Nonsan City and Yangju City, were not resolved properly.

\(^{22}\) See Annex D for national RWR and leakage volume change through 20 years.
Establishment of Standardized Guidelines

While overcoming initial challenges, the establishment of standardized guidelines to apply and prosecute policies are also important. The Manual for Waterworks Revenue Water Ratio Enhancement (2007) published by the ME and the Guidebook for Enhancing and Keeping Waterworks Revenue Water Ratio (2009) published by K-water are representative cases of guidelines which have played an important role. Various other specific guidelines have been established by the ME and K-water for conducting consignments, and the defined procedure has made it possible to implement the projects with less trial and error. In addition, well-arranged Statistics such as Statistics of Waterworks published by the ME enabled local water providers to keep sound track of performance changes of local governments over the long-term and to give relevant feedback.

In general, well-developed standards can minimize trial and error that can negatively affect stakeholders, thereby improving the likelihood of policy effectiveness. In addition, the know-how accumulated in the guidelines could increase the speed of implementation.

Figure 7 National RWR and Leakage Volume Change Over the Past 20 Years

References

K-water. 2015. "Research on the Advancement of Local Waterworks System.”

### Annex B: Simple Concepts of Waterworks Balance

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<tr>
<th>System Input Volume</th>
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<td></td>
<td>4 Other Billed Water</td>
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<td>7 Usage Adjustment</td>
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</tr>
<tr>
<td></td>
<td>8 Metering Inaccuracy</td>
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<td></td>
<td>9 Unauthorized Consumption</td>
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</tr>
<tr>
<td></td>
<td>10 Leakage</td>
<td>Real Losses</td>
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Revenue and NRW each comprise several factors. *The Guideline for Statistics of Waterworks* published by the ME explains the concepts for each of the water balance components. A brief explanation of the concept for each component is provided as follows:

1. Billed & Metered Water: Directly metered and charged
2. Billed & Unmetered Water: Unmetered but billed for use
3. Water Exported: Provided to other water suppliers
4. Other Billed Water: Water for public use (e.g. parks or public toilets) and funded by other budgets
5. Operational Use: Water used in the distribution process by a water provider for system operation such as flushing pipelines
6. Public Use: Used for public purposes with no income (e.g. firefighting)
7. Usage Adjustment: Water used and billed less than regular for water provider’s responsibility (e.g., adjusting for water quality problem)
8. Metering Inaccuracy: Water used by a consumer but unbilled because it was undetected by a meter
9. Unauthorized Consumption: Water used without permission or by illegal manipulation of a meter
10. Leakage: Water loss from the point of transmission to customers’ meters
## Annex C: RWR Enhancement Project Results for 21 Consigned Waterworks (percentage)\(^a\)

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\(^a\) This table does not include two local waterworks system among 23 which K-water operates by consignment; one is a system which does not apply the RWR concept and the other one is excluded because operations commenced recently in 2017 and has no relevant comparative data.
## Annex D: National Water Balance Change over a 20 Year Period

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<th>Year</th>
<th>Total Production</th>
<th>RW</th>
<th>RWR (%)</th>
<th>Leakage Volume</th>
<th>Leakage Rate (%)</th>
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</table>

## Annex E: The Cost to Build Dams in Korea

<table>
<thead>
<tr>
<th>Dam</th>
<th>Duration for Construction</th>
<th>Total Construction Cost in Billion KRW (Billion USD)</th>
<th>Total Storage Capacity (Million m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>Construction Cost</td>
</tr>
<tr>
<td>Average</td>
<td>15.7 years</td>
<td>409.4</td>
<td>192.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.37)</td>
<td>(0.18)</td>
</tr>
<tr>
<td>Gimcheon-Buhang Apr. 1996 – Sept. 2014</td>
<td>555.9</td>
<td>225.1</td>
<td>20.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.51)</td>
<td>(0.20)</td>
</tr>
<tr>
<td>Bohyunsan Dec. 2008 – Dec. 2014</td>
<td>333.4</td>
<td>201.3</td>
<td>16.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.30)</td>
<td>(0.18)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.31)</td>
<td>(0.14)</td>
</tr>
</tbody>
</table>

Note: Calculated using exchange rate of US$1.00 = 1100 KRW.
The Ministry of Economy and Finance is committed to developing a strong economy and building growth engines through the concerted efforts of its offices and bureaus. The Ministry works to ensure macroeconomic and financial stability, effective policy coordination, efficient allocation of national resources, fiscal soundness, rational tax policies, and robust international cooperation.

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