

**A Strategy on the Improvement of Drinking Water Quality Standards in Korea**

By

**KIM, Kyoung Hwa**

**CAPSTONE PROJECT**

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

**MASTER OF PUBLIC MANAGEMENT**

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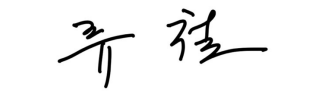
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Approval as of May, 2023

## ABSTRACT

### **A strategy on the Improvement of Drinking Water Quality Standards in Korea**

This paper is to improve the drinking water quality standards in Korea that can be easily understood and experienced by the public by improving the aesthetic items among the drinking water quality standards.

For items that people can easily understand when drinking tap water, such as smell, taste, and turbidity, the standards are set in the drinking water quality standards, and the results are published every month. However, civil complaints increased, such as Incheon tap water overflow accident, tap water larvae, and filter foreign substances detected in tap water at home, and the public demand for clean drinking water increased. However, there is no item for foreign matters in the current drinking water quality standards, and it is replaced by odor and taste items. On the other hand, it is urgent to improve the items and terminology that can be easily perceived by the public in the drinking water quality standards.

In this paper, policy trends in the drinking water field and technical, policy, social, and economic evaluations of aesthetic items for drinking water quality standards are presented, and effective improvement methods are presented.

In the future, from a long-term perspective, it is necessary to regularly review the drinking water quality standards for all items and introduce clear semantic divisions and definitions that are easy for the public to understand through regular monitoring.

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## **1. Introduction**

### **1.1 Background**

Drinking water is the source of all life. In addition, drinking water is an essential public good not only for life but also for various activities such as daily life, industry, and agriculture. If there is a problem with the quality of drinking water, the water cannot be used and, in serious cases, the water supply may be stopped. If that happens, social chaos may be caused, and economic losses will also occur. Therefore, the government should present drinking water quality standards that are demanded by the people and can be easily felt, and strive to restore the reliability of drinking water. Accordingly, water service providers must also make efforts to supply quality drinking water.

The Ministry of Environment and K-water are making great efforts to supply safe drinking water. Various changes have occurred in the quality of raw water due to climate change, and many efforts have been made to improve the quality of raw water and introduce advanced water purification treatment to produce safe drinking water.

In order to supply safe tap water to the public, the Ministry of Environment conducts drinking water inspections by setting a detailed cycle such as daily, weekly, monthly, quarterly, and annually. Drinking water regulations and laws in Korea, such as the Drinking Water Management Act and the Waterworks Act, etc., stipulate the frequency of water quality inspections. In addition, water quality inspections are conducted in accordance with the Water Supply Act and the rules for drinking water quality standards and inspections (Ministry of Environment, 2021). Drinking water quality inspection items are 61 items every month, and the results are announced to each local government. And local governments are notifying the results of water quality tests through their websites.

Despite the government and local governments making great efforts to supply clean and safe drinking water, in May 2019, a major accident occurred with tap water in Korea. Red rust water continued to come out of the tap water, causing great inconvenience to residents who could not drink and use it. In addition, this accident did not occur and end in a short time, but became a bigger problem as it lasted for about 20 days, the supply of drinking water was stopped, and the daily life of the local residents, schools, students, and companies was paralyzed. As a result of this incident, people's distrust of tap water grew even more. It turned out that the cause of this incident was that a large amount of rust water accumulated in the pipes leaked in the process of changing the water route at the water purification plant forcibly. The Ministry of Environment admitted that preparations were poor in all processes of water system conversion and that the initial response was also insufficient. Due to the lack of accurate measurement of turbidity, the water purification plant has become a foreign substance supplier (Ministry of Environment. 2020).

Another water quality accident occurred after the water loss accident in drinking water. Larvae were detected in tap water. Until recently in 2022, larvae were detected in tap water at homes in Changwon, Jinhae , and Incheon, spreading public anxiety. As a result, economic loss occurred as filters had to be installed in each house. Despite the existence of foreign substances such as red water avalanches and larvae, public distrust was rather increased by announcing that it met the current water quality standards. According to the 2021 tap water drinking fact-finding report, only 36% of respondents drank tap water as it was or cut it off in terms of how and how often to drink water. (Tap Water Status Report, 2021). Contrary to Korea, 70% of Europeans drink tap water as it is, even though tap water contains a lot of lime.

In addition, when examining uncomfortable experiences and coping methods when using tap water within the last year, 20.7% of those who had uncomfortable experiences were found.



Inconvenient experiences related to the use of tap water were found to be rust water (5.4%) and foreign matter (2.3%). When experiencing disparagement, the purchase rate of drinking spring water (bottled water) was the highest at 18.2%, followed by using a water purifier (13.2%) and installing a faucet filter (11.2%). (Tap Water Status Report, 2021). The reason for choosing this method seems to be that it is safer to filter or use a water purifier than tap water.

In order to restore trust in tap water, it is natural that water purification plant improvement projects and drinking water safety management measures should be comprehensively implemented to give confidence that safe and clean water is supplied. In addition, such improvement efforts and tap water information should be devised so that the public can easily access them. In the report on drinking tap water (2021), it was found that TV/radio (public service advertisement) was the most effective publicity method for informing the public about tap water and related money at 34.8%. People think that the method of information disclosure using the media is the most effective.

In addition, in order to restore trust in tap water, it will be necessary to add items related to foreign substances that are easy for the public to feel safe and easy to understand to the monthly drinking water quality standards. In many countries around the world, such as Europe, the United States, Korea, and Japan, items such as foreign substances are not included in water quality standards. Foreign matter items should be introduced as water quality management items based on the tap water safety standards that consider the public eye level, such as taste and smell, and the sanitation management standards for water purification plants that water business operators must comply with must also be concreted. Through it, tap water reliability will be able to be restored.

## **1.2 Purpose**

As mentioned earlier, it is necessary not only to add tangible items to the drinking water quality standards, but more importantly, a procedure in which the public can participate in the operation of drinking water quality standards. The public should be able to easily participate in policy decisions related to drinking water, and participate in the process of setting standards as well as water quality. In other words, a plan for citizen participation in tap water policy is also necessary.

In conclusion, this study aims to introduce new items such as foreign substances into drinking water and provide a policy basis for improving the water quality inspection management system that the public can easily feel. To this end, domestic drinking water quality standards and various foreign water quality standards were compared and investigated. In addition, it proposes the introduction of water quality management items that the public can feel, and proposes various strategies to restore trust in drinking water.

## **2. Research Methodology**

To answer the research question on how to introduce water quality management items that the public can easily understand and feel, three research methods were used: literature review, case study, and expert's interview.

In the literature review and case study, the procedures and management systems for setting drinking water quality standards in the United States, Australia, Japan, Canada, and WHO were compared and reviewed with those in Korea.

In addition, through interviews with experts with more than 5~20 years of experience in the field of water quality management and inspection in Korea, in-depth interviews were conducted on the problems of current drinking water quality standards in Korea and how to

improve items that the public can feel.

Expert interviews were conducted on the current drinking water quality standards and operation. In particular, an interview was conducted with 13 focus group members who had professional experience with 5 to 20 years of work experience at a water quality inspection agency. In this paper, interviews were conducted using the Delphi Method. The Delphi Method was evaluated face-to-face with experts, freely expressing their opinions and giving feedback to others.

In this paper, the interviews were conducted in the following order. First, experts were selected, participation was requested, and a questionnaire was developed. Here, the experts consisted of 13 people, specially registered as personnel who can conduct experiments directly at the water quality inspection institution, and consisted of 5 people with 5 to 9 years of experience and 6 people with more than 10 years of experience. In addition, it was composed of two experts with 20 years of experience as planning experts for the operation of drinking water inspection institutions.

### **3. Finding**

#### **3.1 Literature review& case study**

It has been working since 2008 on the improvement of drinking water quality standards and management system. Nonetheless, recent studies have been difficult to find. In addition, it was more difficult to find the improvement of taste, smell, and foreign substances that the public could experience. Therefore, a literature review on smell, taste, and foreign substances among drinking water quality items and data on how to manage and operate such water quality standards were studied.

### **3.1.1 Drinking water quality standards items**

According to WHO (2022), water should not have any unpleasant taste or smell to consumers. This is because consumers mainly rely on their senses when expressing the quality of drinking water. Microorganisms and chemical and physical components in the water can also affect its appearance.

In particular, even if items such as smell and taste do not apply directly to consumers as health hazards, if they have high turbidity, color, or smell, people consider them unsafe and reject the water (WHO, drinking water quality standard, 2022).

However, even in the above literature, guideline values for odor and taste, which have no direct correlation with adverse health effects, have not been established. Hence the turbidity, color, taste. If the smell, etc. changes, we must know that there is a problem with the source of the water or the water treatment process. The public must be informed immediately.

In the US EPA (2009), the taste is 15 (color unit) and the smell is 3 degrees or less. However, this is also expressed as secondary standards (NSDWRS or secondary standards) and there are no mandatory guidelines. Smell and taste are expressed as aesthetic items, and contaminants that can cause such aesthetic effects are not regulated. In the case of New Zealand, there is no standard for odor items, and it is said that the taste should be acceptable to all consumers, and there are no specific standards. (New Zealand Ministry of Health,.2022). Basically, foreign countries do not strictly stipulate standards for smell and taste, and suggest that it should not cause discomfort to citizens. In addition, it makes it possible to select a standard that can be implemented according to the circumstances of the country or region. This is also something to refer to when social issues arise in Korea.

On the other hand, in the case of Japan, there were items of taste and smell, and the standard also stipulated that there would be no abnormalities. In Korea, the water quality

standard for drinking water (2022) determines that it is suitable for drinking water only when it does not smell or taste. If there is a smell, drinking water is stopped. Therefore, when social issues or problems related to water quality occur, it seems necessary to establish guidelines for national safe water quality standards for Korea, especially for smell, taste, larvae, and foreign substances.

Through the previous investigation, in the case of smell and taste, unlike foreign countries, Korea has a limit in that smell and taste regulations are not subdivided, and are simply expressed as 'there is no'. In addition, there were no water quality standards for foreign substances. Therefore, it seems necessary to conduct research on these two in the future.

### **3.1.2 Drinking water quality standards process**

Previous investigations on drinking water quality standard management and operating systems were investigated. The National Institute of Environmental Research (2012) proposed a method to create a system to review the existing drinking water quality criteria items, and also proposed a method to evaluate whether or not regulations should be continued for each item among the existing drinking water quality criteria items.

When developing drinking water quality standards, it is said that standards should be set according to countries or regions, not by any one method. It was proposed that countries should consider conditions that affect exposure, such as climate, environment, social interest, and economy, when setting drinking-water quality standards.

In addition, this report introduced the process of developing guidelines for drinking water quality standards in other countries. In the case of Canada, there is a drinking water subcommittee, and the drinking water subcommittee develops the drinking water guidelines, and in the process of development, all parties to the committee are involved and documented.

For drinking-water monitoring, it involved a process of identification, evaluation, decision, approval, publication, publication and re-evaluation.

Members of the Drinking Water Subcommittee include citizens, central institutions, scholars, water experts, and civic groups to evaluate what items are detected in drinking water and how often. It also evaluates concentrations detected in water treatment plants. Based on these two evaluations, members of the Drinking Water Subcommittee will use their professional experience and knowledge of water quality to make their own judgments. (Canada, Committee on drinking water, CDW,2022)

In the case of the United States, a candidate list of contaminants that are currently unregulated substances and may be hazardous is established, and a review system is established every six years. (Safe Drinking Water Act, SDWA, 2022).

Also, in the case of the United States, citizen participation is active. Decision-making committees, such as the Drinking Water Advisory Committee and the Scientific Advisory Committee, are in place to review and prioritize toxicity assessment and monitoring data. These committees consist of 15 members, including waterworks operators, government agencies, local representatives, social groups and citizens. The procedure for establishing water quality standards considers whether the target contaminant is suitable for inclusion in the water quality standard, and if so, what the water quality standard should be. Above all, it is important to disclose information about the quality of drinking water to citizens (Choi Seung-IL, 2002).

In the case of Australia, the latest information is continuously updated every year and posted on the NHMRC website. Australia also operates a water quality advisory committee, with representatives from jurisdictions participating, and additional experts secured and operated if necessary. WHO revises the guideline values for specific items for drinking water safety every 6 to 7 years, considers new harmful substances, and has a drinking water quality

guideline revision committee to make the final decision.

In the case of Korea, the procedure for establishing drinking water quality standards involves preparing a pollutant candidate list, collecting raw water and purification plant monitoring data, and selecting candidate chemicals. This candidate material utilizes statistics of data measured for three consecutive years. Candidate substances are highly likely to be exposed, and human risk assessment is conducted to select them as the final drinking water monitoring items (Priority chemicals). “Drinking water monitoring items refer to substances for which drinking water quality standards have not been established, but which require monitoring, such as investigation of the content of drinking water in order to secure the safety of drinking water”.

In addition, the monitoring standard refers to the water quality management target value set at a level that does not harm health even if consumed throughout life based on the risk to the human body of the substance set as a monitoring item. In addition, the water quality standards of developed countries such as WHO and the United States for the substance should be included (Ministry of Environment, 2022).

Despite the selection of monitoring items, Korea's drinking water quality standards are in a state of lack of scientific research results for standard setting through periodic review, such as WHO, the United States, and Canada.

Therefore, when social issues related to water quality arise and public interest in water quality is high, water management organizations such as the Ministry of Environment or K-water do not express the water quality condition in a single water quality item or general method, but set water quality standards according to the situation. It must be established, and participation in the Drinking Water Committee must be actively supported.

In the literature review, there were no matters related to improving water quality

standards for odor and taste items that the public could easily experience. In particular, there were no management standards for public anxiety factors such as enemies and larvae. This study aims to study management items and management methods for odor, taste, and foreign matters through participation of experts and citizens.

### **3.2 Experts Interview & Finding**

The title of the interview is a study on ways to improve drinking water quality items experienced by the public. It is a subdivided question for two research questions. Interviews were conducted by dividing the drinking water into quality and process. In the Quality section, interviews were conducted on the areas, items, detailed items and reasons for improvement in the current water quality standards, selection of items that the public can feel, such as the Incheon red tap accident, quality control of inspection results (QC/QC), and evaluation of inspection agencies.

In the Process section, it is about the operation and procedure of drinking water quality inspection. In-depth expert interviews were conducted on water quality standards management procedures and current status, improvement of institutional evaluation methods, selection of K-water inspection institutions as natural institutions, and methods of citizen participation in tap water. The interview results are as follows.

#### **3.2.1 Experts interview findings in the fields of water quality part**

The first section is about the improvement of existing items and the addition of new items among drinking water quality standards, and quality control items and methods for improving the reliability of drinking water quality inspection. First of all, the contents of the interview and findings about drinking water quality standards and quality are as follows.



### **Finding 1. Changes in drinking water quality standard analysis and inspection methods**

- 1) Need to revise the water quality test method itself to comply with water quality standards.
- 2) Need to modify the detection limit. It is correct to eliminate non-detection and express numerical values.
- 3) The government prefers the word non-detection in drinking-water. On the contrary, the word non-detection rather causes distrust among civic groups and the public. It is recommended to indicate the basis for non-detection and the limit of quantification in the test report.
- 4) It can be done with other test methods through the validation of drinking water, but it takes a lot of time, so it is necessary to actualize drinking water quality standards.
- 5) In the current drinking water test method, in the case of smell and taste, the tester directly drinks the water to test it. If the water contains strange substances or contains BETX, it is very dangerous for the tester. Test methods need to be improved. (It is better to express it in the same way as Geosmin, 2-MIB)
- 6) As for the opposite opinion, it is difficult to quantify and express smell and taste. In order to improve the drinking rate of tap water, it is necessary to quantify odor and taste carefully.

### **Finding 2. Items to be improved and new items to be added among drinking water quality standards**

- 1) Detected concentration, frequency, risk. toxicity. In order for items such as social interest to be included in water quality standards, all drinking water inspection agencies must have the capability. This is because standards are compulsory. Even general

companies can enter into standards only when they have the ability to test. So it will take a lot of time. Only when the analysis is properly standardized can it be entered into the standard

- 2) Water quality civil complaints about foreign substances such as foreign substances and larvae are increasing. Water quality analysis methods and standards that can evaluate foreign substances are needed. Civil complaints can be resolved only when government agencies such as the Ministry of Environment and the National Institute of Environmental Research present standards for foreign substances.
- 3) Currently, odor and taste items included in drinking water quality standards should be deleted. Substances with aesthetic influence are those that have odor and taste items to be shared with the public, but are always marked as none. Smell and taste test items must be tasted by the tester himself. The risk to tester safety is also great.
- 4) Microbial items require rearrangement of unnecessary items that are rarely analyzed.
- 5) The Ministry of Environment should make standards and performance evaluation methods for filters. Household filters are marketed without regulation. Rather, lead and cadmium come out of the new filter. It is like drinking bad things again from an unverified filter. It's hard to tell if it's from the tap or from the filter. However, the public may think that it is a foreign substance from tap water. A strict specification policy for the filter itself is required.
- 6) Efforts are needed to select items of recent issues, such as narcotics and pharmaceuticals, as monitoring items for drinking water

**Finding 3. How to improve the reliability of drinking water quality standards**

- 1) The number of items in the proficiency test conducted by the Ministry of

Environment every year to improve reproducibility and accuracy of water quality results is small. (20 items). The drinking water quality standard has 60 items, and the accuracy must be improved by increasing the number of proficiency test items.

- 2) In order to improve the proficiency test method, a third party needs to verify the concentration created by the National Institute of Environmental Research, Ministry of Environment. If it is verified once more by requesting a foreign company to check the concentration, a highly reliable water quality test result will come out. The Ministry of Environment is required to open reliable data on the concentration of the sample itself.

### **3.2.2 Expert interview result findings in the fields of water quality process part**

Next, the contents of expert interviews and findings on the management procedures and operation direction of drinking water quality standards, improvement of inspection agency evaluation methods, and selection of K-water's natural agencies are as follows.

#### **Finding 4. Guidance inspection by inspection agency, proposal to improve the method of on-site evaluation every 3 years by the Ministry of Environment**

- 1) 4 regional watershed offices (Geumgang, Nakdonggang, Hangang, Yeongsangang) and each provincial Health and Environment Research Institute's drinking water inspection agency must undergo an evaluation to be fair.
- 2) It is necessary to form a consultative body composed of civilians to give feedback on the results of tap water quality, and to evaluate each other between the government and public corporations.

**Finding 5. Selected as an official institution for K-water drinking water quality inspection**

- 1) K-water is a place that pursues public interest, not business. Designating as a natural institution as a drinking water inspection institution is an essential part of the long-term roadmap for improving drinking water quality standards in the future. Since K-water has been transferred from the Ministry of Land, Infrastructure and Transport to an agency affiliated with the Ministry of Environment, it is right to designate a drinking water inspection agency as a matter of course as an agency affiliated with the Ministry of Environment, such as the Watershed Office, the Provincial Health and Environment Research Institute, and the Waterworks Office.
- 2) If a K-water inspection agency is selected as an official agency, it has the advantage that there are no budget constraints such as equipment and reagents necessary for water quality testing to create public interest.

**Finding 6. How to restore trust in tap water**

- 1) K-water, as a waterworks business operator, must pay attention to indoor drainage pipes in the blind spot of drinking water quality management and open technology and information.
- 2) Improving drinking water quality standards is itself a task for our research institute, and the public is not interested. It is more important to transmit the water quality results of the drainage pipe network and reservoir to the public via mobile. We propose a method to transmit drinking water quantification to the public via mobile (using K-water My Water data)

Ex) Ministry of Public Administration and Security safety text ozone alarm, fine dust

information, corona information, etc.

- 3) When algae toxin and microplastics become issues in drinking water, people can easily know the information about water and feel relieved if it is transmitted to the public via mobile. K-water water service provider will only need to monitor items that may cause problems while producing tap water and passing through the water supply pipe (pipe quality, etc.)

### **Finding 7. How to engage citizens in tap water policy**

Governments and public institutions tend to recognize that non-detection is normal.

This leads to distrust in civic groups and the public. It is necessary to form a council, discuss with each other, and make efforts and explanations to open the figures as they are.

The issue of opening water quality data also has the following considerations.

- Whether to open water quality data in real time
- How to open water quality data
- How far will the data open trial application go (the village head, the apartment representative, etc.)
- Who will be the standard for maximum disclosure?
- How often is the disclosure?

As for the opposing opinion, if citizens participate in the selection of tap water quality standards, the demand for items will increase endlessly. It is difficult to accept when you see news or issues and ask for that item to be added each time.

Therefore, item importance evaluation and risk evaluation should be considered first. Suggests a way to give options for item selection and make them select. Issued items will be different depending on the type of apartment and consumer, and it is good to be able to select

those items.

Ex1) Our apartment is sensitive to turbidity, so please open the turbidity category every week.

Ex2) In our apartment, foreign substances often come out of old pipes, so please strengthen the foreign substances and heavy metal items and monitor them.

There is a need for a window for citizens to audit whether public officials, K-water, and private companies' drinking water inspection agencies comply with the test law and conduct proper inspections.

#### **4. Problem structure and alternative strategy analysis**

In order to improve the drinking water quality standards management system that the public can feel, the pain points among stakeholders and propose alternatives were suggested.

##### **4.1 Stakeholder pain point analysis**

In order to improve the water quality standards of drinking water, which is the people's drinking water, it is necessary to understand the relationship between various stakeholders who manage drinking water, such as the people, the central government, local governments, waterworks operators, and K-water. The table below analyzes the pain points of stakeholders according to the production process of drinking water (tap water).

Stakeholders were divided into 3 groups. They were divided into citizens and society, K-water water service providers, and policy makers. In order to produce tap water, raw water is taken in, and tap water is produced through a water purification process step, which is then sent to the faucet of each household. Pain points were analyzed at each stage.

First, from the point of view of citizens/society, access to information on water sources, which are raw materials for drinking water, is weak, and it is difficult to find water source information. In addition, they do not know how water treatment is carried out, and there is a lack of interest. Therefore, even if you are curious about the foreign matter, smell, or taste of the faucet, there is no access to information that can be checked in real time. Filters must be installed in each household and checked visually, and filter replacement costs are also borne by citizens. It is necessary to effectively deliver social information to citizens, and to solve the pain points of citizens by preparing a plan to actively participate in tap water evaluation.

Second, K-water is a water service provider or supplier of safe and clean water. In the water intake stage, it is difficult to predict the occurrence of abnormal water quality in the water source due to abnormal climate, and it costs money to respond to algae occurrence. In the purification stage, costs such as the use of chemicals to remove foreign substances and larvae, backwashing costs, and electricity costs increase, and the cost of opening a water purification plant to remove foreign substances also increases.

In the faucet sector, the cost of opening and improving old pipelines to improve foreign substances is also increasing. To solve this problem, it is necessary to strengthen the water treatment process, improve the response to civil complaints related to water quality, develop real-time sharing methods for items that can be experienced by the public, establish a department dedicated to promoting tap water, and thoroughly implement the policies of the Ministry of Environment.

There is a limitation that it takes a long time for policy makers related to drinking water, such as the Ministry of Environment, to create drinking water quality standards that the public can easily understand and trust. The reality is that there are limits to the analysis conditions for black foreign substances in the filter. It is necessary to secure sufficient budget

and support, and the National Institute of Environmental Research needs to present standards for the public's perception of foreign substances, smell, taste, and filter use. A plan to expand the sharing of water quality information by strengthening governance with society and citizens should also be prepared.

The table below shows the difficulties among stakeholders and their solutions.

*Table 1. Stakeholder Pain Point Analysis on 'Improvement of the standard water quality'*

Stakeholder group	Value chain			
	Water tank (Water resource)	Treatment process (Precipitation, filtration)	Purified water	Tap water
Citizen/Society	<ul style="list-style-type: none"> <li>- Weak access to information</li> <li>- communication difficulties</li> <li>- Trouble with policymakers</li> </ul>		<ul style="list-style-type: none"> <li>• lack of interest in water treatment process</li> <li>• lack of information on where to check water quality</li> </ul>	<ul style="list-style-type: none"> <li>• Foreign matters, odor, taste cannot be checked in real time</li> <li>• Filter replacement cost incurred</li> <li>• Difficulty in efficiently delivering society information to citizens</li> <li>• Active participation in tap water evaluation</li> </ul>
Supplier (K-water)	<ul style="list-style-type: none"> <li>• Abnormal weather</li> <li>Difficulty in predicting the occurrence of abnormal water quality in water sources due to (flood, drought)</li> <li>• Increased cost of responding to algae outbreaks</li> </ul>	<ul style="list-style-type: none"> <li>• Cost increase</li> <li>- Chemical use, backwashing cost, electricity cost according to occurrence to remove algae and larvae (Smell, taste disinfection) Proper disinfection process required</li> <li>- Minimization of civil complaints, drug control</li> <li>• (remove foreign matter)</li> <li>Increased cost of water treatment plant facility improvement</li> </ul>	<ul style="list-style-type: none"> <li>• Expenditures for facility construction of old pipelines to improve foreign substances</li> <li>• Restrictions on faucet water quality items (8)</li> <li>• Lack of publicity for tap water</li> </ul>	



	<ul style="list-style-type: none"> <li>• Reinforcing the water treatment process, responding to civil complaints related to water quality</li> <li>• Development of a real-time sharing method for items experienced by the public</li> <li>• Establishment of a department dedicated to publicity for tap water</li> <li>• Thorough implementation of policies of the Ministry of Environment</li> </ul>		
Policy maker (Ministry of Gov.)	<ul style="list-style-type: none"> <li>• Increased cost of algae removal (manpower, time, material cost)</li> </ul>		<ul style="list-style-type: none"> <li>• It takes a long time to set new water quality standards (long term policy)</li> <li>• Filter black foreign matter investigation request increases, but analysis conditions are limited</li> <li>• Improving foreign matter items in drinking water quality standards</li> </ul>
	<ul style="list-style-type: none"> <li>• Policy, law revision <ul style="list-style-type: none"> <li>- Addition of new criteria for drinking water quality</li> <li>- (National Institute of Environmental Research) Suggest criteria for public perception, such as foreign substances, smell, taste, and filter use</li> </ul> </li> <li>• Secure sufficient budget and support</li> <li>• Prepare measures to expand water quality information sharing (strengthen governance, support for technical policies)</li> </ul>		

#### 4.2 Strategy presentation and evaluation analysis

Previously, in Chapter 4.1, problems and improvement plans for the current drinking water quality standards were derived through stakeholder analysis on ways to improve drinking water quality standards that the public can easily feel. In order to improve drinking water quality standards that the public can feel, four actions are needed.

**Strategy 1.** Add new items for foreign substances, larvae, and filter black substances

**Strategy 2.** Security for items that depend on citizens' senses of taste and smell

**Strategy 3.** Prepare measures to expand citizen participation in tap water policy

**Strategy 4.** Tap water awareness survey and feedback, and plan to improve drinking rate

In this chapter, the prioritization of goals and methodology were reviewed through technical, policy, social, and economic evaluation of actions.

Table 2 sets detailed goals for improving drinking water quality standards experienced by the public, and shows the results of technological, policy, social, and economic evaluations to see if the goals are feasible.

The total score for each goal is 20 points. It consists of technical feasibility (5 points), policy acceptability (5 points), social feasibility (5 points), and economic feasibility (5 points). The 5 points were subdivided and scored in the order of very low (0 points) to high (5 points).

Technical feasibility is a method of evaluating whether each goal is technically feasible. Policy acceptability is to examine whether this action is politically possible in the central government, local governments, etc. Social feasibility is to evaluate whether this policy is socially feasible when announced, and economic feasibility is to examine the economic feasibility of this policy.

First, the evaluation result for the action of newly including foreign substances, larvae, and filter black substances in the drinking water quality standard items was evaluated as 17 points out of 20 points. Creating a new item is highly acceptable to the public and society, and it is possible from a policy point of view through the revision of drinking water-related laws. In addition, since there is sufficient national interest and needs for the safety of drinking water, it has sufficient social feasibility. However, when trying to improve drinking water quality standards, it takes a long time to amend the law and in order to meet the new water quality standards, water purification plants incur costs for facility improvement to identify foreign substances at each stage of water treatment. Therefore, economic feasibility was scored rather low.

Second, the action on the security of odor and taste items in drinking water was evaluated with a total score of 14 points. Because smell and taste differ greatly from

person to person, the Ministry of Environment, the policy maker, may show a passive reaction, so the policy possibility is higher than normal. It can be a little passive because it can be done. In addition, the economic feasibility was shown to be low due to the fact that it took a lot of time for basic research, experimental design, and law revision.

Thirdly, there is a plan to expand citizen participation in making tap water policies. This action is considered to have improved civic consciousness and market maturity, and the role of local government and voluntary participation of citizens are essential. In addition, it is possible to confirm and expand the role of the Ministry of Environment, environmental groups, and waterworks operators, but the policy decision maker may be passive, so the technical and policy possibilities are expressed as normal (3 points). In terms of social feasibility, efforts are required for active participation of citizens, and water service providers (k-water), the Ministry of Environment, and a department dedicated to promoting tap water are also needed. It can be said that the social feasibility is rather high through the strengthening of the government-local government-citizen network.

Lastly, it is an action that proposes to improve the drinking rate of tap water through a tap water awareness survey. To this end, it is necessary to improve the function of My water (tap water quality portal service) operated by K-water, and the cost of maintaining the system increases and the time and budget required for the investigation are required, so it showed average (3 points) in the technical and economic evaluation.

In order to implement the actions suggested above, it is essential to enact and amend relevant laws and regulations, such as the Waterworks Act, the Drinking Water Management Act, and standards for drinking water quality standards and rules.

In addition, the evaluation of administrative operability internally for the above

action was all at a high level (5 points), so it was excluded from the total score.

Therefore, as a result of the above evaluation, the highest score among the total 20 points was prioritized, as shown in Table 2.

Table2. Evaluation of technology, policy, society and economy for strategies to improve drinking water quality standards

Strategy	Technical feasibility (5score)		Policy Acceptability (5score)		Social feasibility (5score)		Economic potential (5score)		Total (20)	Priority
	(low 0)←(middle 3)→(high 5)		(low 0)←(middle 3)→(high 5)		(low 0)←(middle 3)→(high 5)		(low 0)←(middle 3)→(high 5)			
foreign matter (Larva, filter black matter) new items added	<ul style="list-style-type: none"> <li>▪ Possibility of reviewing method for identifying larvae by water treatment stage ↑, abundant technology (Kwater)</li> <li>▪ Review of filter black foreign matter, larva identification technology and experimental derivation method</li> <li>▪ Experimental design, conceptual design possible</li> </ul>	5	<ul style="list-style-type: none"> <li>▪ Necessity to amend laws related to drinking water (Subject: Ministry of Environment, government agency)</li> <li>-&gt; Possibility of adding to 60 items↑</li> <li>▪ Security adjustment of rules for drinking water quality standards and investigations (Subject: National Institute of Environmental Research, Ministry of Environment)</li> </ul>	5	<ul style="list-style-type: none"> <li>▪ Sufficient public interest and needs</li> </ul>	5	<ul style="list-style-type: none"> <li>▪ Excessive time required for legislative revision</li> <li>▪ Increased cost of facility improvement to check for foreign substances at each stage of water treatment</li> <li>-&gt; Need to secure budget</li> <li>▪ Material cost, labor cost, etc. required for basic investigation, experiment stage, etc.</li> </ul>	2	17	1

Smell, taste item improvement	<ul style="list-style-type: none"> <li>▪(Existing) As an aesthetic item method, it relies only on people's sense of taste and smell (judged as present or absent) → Specific comments are required.</li> <li>▪ Experimental design, conceptual design possible</li> </ul>	<ul style="list-style-type: none"> <li>▪ Necessity to amend laws related to drinking water (Subject: Ministry of Environment, government agency)</li> <li>-&gt; Possibility of adding to 60 items↑</li> <li>▪ Security adjustment of rules for drinking water quality standards and investigations (Subject: National Institute of Environmental Research, Ministry of Environment)</li> <li>▪ Periodic adjustment of monitoring items for drinking water (Ministry of Environment)</li> </ul>	4*	<ul style="list-style-type: none"> <li>▪ There is a limit to increasing interest only during the algae outbreak period (summer, autumn)</li> </ul>	<ul style="list-style-type: none"> <li>Excessive time required to amend laws</li> <li>▪ Material cost, labor cost, etc. required for basic investigation, experiment stage, etc.</li> </ul>	2	14	2
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Expansion of citizen participation in tap water policy	<ul style="list-style-type: none"> <li>■ Civic awareness and market maturity have improved. increased interest</li> <li>■ The role of local gov. and the voluntary participation of citizens are required</li> </ul>	3	<ul style="list-style-type: none"> <li>■ It is possible to confirm and expand the roles of the Ministry of Environment, environmental groups, and water supply companies, but policy makers may be passive.</li> <li>■ Efforts needed to engage citizens (-1)</li> </ul>	3	<ul style="list-style-type: none"> <li>■ Efforts to devise ways to induce active participation of citizens are needed</li> <li>■ It may be necessary to be in charge of publicity for tap water by water service providers (K-water) and policy makers (Ministry of environment).</li> <li>■ Strengthening government-local government-citizen network</li> </ul>	4	<ul style="list-style-type: none"> <li>■ Expenditures required for PR increase, but deemed acceptable</li> </ul>	4	13	3
Tap water awareness survey (item awareness, drinking rate, proposal)	<ul style="list-style-type: none"> <li>■ Improvement of tap water quality portal service (My water)</li> </ul>	3	<ul style="list-style-type: none"> <li>■ Support for basic survey on tap water drinking rate (By age, by region, etc.)</li> </ul>	3	<ul style="list-style-type: none"> <li>■ Improved portal information usability(Strengthen promotion of existing portal information My water)</li> <li>■ Active participation of schools, local governments, and water service providers</li> </ul>	4	<ul style="list-style-type: none"> <li>■ Expected increase in system cost</li> <li>■ Expected increase in PR and training expenses</li> <li>■ Investigation time and budget required</li> </ul>	2	12	4

## **5. Conclusion**

### **5.1 Major research conclusions**

#### **5.1.1 Problems with the current drinking water quality standards policy**

The current drinking water quality standards were difficult for the people to easily understand for the following reasons. Drinking water quality standards consist of 60 items, and tap water reports are announced every month, but public distrust has increased due to a series of tap water accidents. In the drinking water test report, there was insufficient or no expression about the water quality that the people wanted to know and were curious about. The opinions of stakeholders such as residents and social groups on drinking water quality were not reflected.

#### **5.1.2 Supplementation and improvement direction of drinking water quality standards that can be experienced by the public**

We need to seek re-selection of items that the public can easily understand. smell, taste. It is necessary to express the items that can immediately know the water quality of our house, such as foreign substances, to present standards, and to establish a method for disclosing information. A policy should be established to discuss the quality of drinking water with the central and local governments, water service providers such as K-water, social groups, and citizens.

### **5.2 Additional Suggestions**

In this paper, among drinking water quality standards, a strategic direction was presented for the standard that the public can feel. However, it is necessary to conduct a survey targeting citizens to select specific items. To this end, it is judged that a K-water



tap water drinking rate investigation team can be formed to propose specific improvements in drinking water items.

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## Appendix

### Appendix 1\_ Interview questionnaire

#### (Quality) 먹는 물 수질기준 개선 필요성

1. 먹는 물 관리법, 먹는 물 수질 공정시험 및 규칙에 관한 기준에 따른 현재 먹는 물 수질기준의 개선이 필요하다고 생각하십니까?

1) 매우 낮음 2) 낮음 3) 보통 4) 높음 5) 매우 높음

2. 먹는 물 수질기준 중 개선이 필요한 분야는 무엇이라고 생각하십니까?

(중복가능)

1) 일반항목 2) 무기물 3) 유기물질 4) 중금속 5) 심미적 영향물질

6) 먹는 물 감시항목 7) 일일, 주간 시험항목 8) 상수원수 항목

2.1 위 선택한 분야 중 개선이 필요한 세부항목과 사유는 무엇입니까?

3. 최근 몇 년동안 인천 적수사고, 수돗물 유출발생 등 수돗물 사고가 빈번히 지역적으로 발생하고 있습니다. 사고예방은 당연한 것이지만, 국민들에게 먹는 물의 안정성을 설득하기 위해 현재 먹는 물 수질기준 및 감시항목에 추가할 것이 있다면 무엇이 있습니까? (이물질 항목, 유충관련 항목 등).

(항목)

(사유)

3.1 현행 먹는 물 수질기준 중 냄새, 맛 항목의 개선할 점은 무엇이라고  
생각합니까?

(사유)

4. 먹는 물 수질기준에 따른 각 항목의 정도관리(QA/QC)와 검사소 평가로  
실시하는 숙련도 시험에 대해 관련 방법 및 절차에 개선이 필요하다고  
생각하십니까? 필요하다면 어떤 점이 개선되었으면 좋을지 구체적으로 작성하여  
주시기 바랍니다.

#### (Process) 먹는 물 수질기준 운영 및 관리체계 개선

1. 최근 몇 년 동안 수돗물에서 유충, 이물질 발생으로 수돗물에 대한 국민적  
불신이 증가하였습니다. 정수처리공정을 개선하여 제거가 가능하지만, 여전히  
국민들은 수돗물에 불안감을 가지고 있어, 가정집에 필터를 부착하여 사용중인  
곳이 많습니다. 수돗물에 신뢰회복을 위해 필요한 것은 무엇이라고  
생각하십니까?

- (1) (사유)
- (2) (사유)
- (3) (사유)

2. 통합 물관리를 위한 먹는 물 수질기준 운영 및 관리체계를 개선하고자, 환경부 산하기관인 K-water의 먹는 물 검사기관을 당연기관으로 지정하는 것에 어떻게 생각하십니까?

3. 먹는 물 수질기준 중장기 로드맵 수립을 한다면, 어떤 내용이 포함되어야 한다고 생각하십니까? 단기 및 장기적으로 어떤 방향이 포함되어야 한다고 생각하십니까?

- (1) (사유)
- (2) (사유)
- (3) (사유)

4. 2020, 환경부 수돗물 위생관리 종합대책에 따르면, 수돗물평가위원회에서 시민참여비율을 의무화(30% 이상) 하고 있으며, 자문범위를 수도정책 전반으로 확대 추진하고 있습니다. 총 15명으로 구성되며, 일반시민이 30% 반영되며, 연2회 운영 중입니다. 먹는 물 수질기준 및 운영에 관해 시민참여가 필요하며 어느 분야에 필요하다고 생각하십니까?

(예시) 항목선정, 성적서 공개방식선정(K-water My-water 포털서비스 활용) 등

5. 먹는 물 수질기준 정책 방향과 개선방안에 대해 의견을 자유롭게 적어주십시오.