KENYA

JICA Project Briefnote

Project for Strengthening Capacity in NRW Reduction

NRW management based on realistic planning and strengthening nationwide organizational capacity

August 2022

Leak detection on service pipes with listening sticks

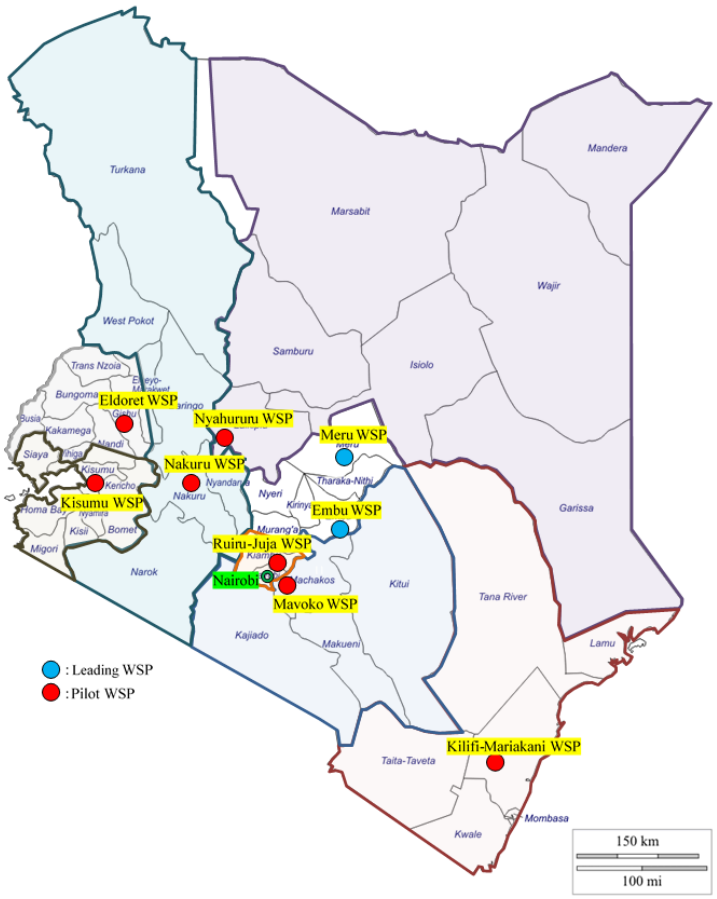


Figure 1 Project Map

1. Project Background and Challenges

1.1 Importance of reducing NRW in Kenya

To effectively utilize limited water resources, the Government of Kenya (GoK) has set the reduction of Non-Revenue Water (NRW) as a policy priority and has a national goal of reducing the national average NRW ratio to 25% by 2030 (Vision 2030). According to the Impact Report issued by the Water Services Regulatory Board (WASREB) under the Ministry of Water, Sanitation & Irrigation (MWS&I), the national average NRW ratio in 2015 was 42%. The ratio was gradually reduced from 60% in 2010, however, further efforts were needed to reach the national target of 25%. Thus, to strengthen the skills and management capacity necessary for implementing NRW reduction activities, and improve the support system for water service providers (WSPs), the Project for Strengthening Capacity in NRW Management (hereinafter referred to as the project) has been implemented for WSPs in Kenya. The project started in October 2016 for five years, and as shown in Table 1, the activities are carried out in three phases. In the 1st and 2nd phases, the activities were carried out as planned. In the 3rd phase due to the spread of the new coronavirus from March 2020, the JICA experts' travels to Kenya were restricted. Therefore, project period was extended by 8 months, and the activity was completed in June 2022.

1.2 Project framework and implementation structure

Figure 2 shows the project framework and counterpart (C/P) organizations. The C/P organizations of the project include the NRW Management Unit (NRW unit) of MWS&I, WASREB, Kenya Water Institute (KEWI) and the Water Service Providers Association (WASPA). These organizations were to support WSPs in their NRW management. The pilot WSPs included two WPSs (Meru and Embu) who received JICA support previously. Additionally seven pilot WPSs were selected based on the results of the baseline survey. Activities for the 9 pilot WPSs were implemented into three phases.

Table1. Starting Phase of Support Activities for Pilot WSPs

Starting Phase	Pilot WSP
Phase 1 （Oct. 2016 ～Sept. 2017）	Meru, Embu
Phase 2 （Oct. 2017 ～Sept. 2019）	Kisumu, Nakuru, Nyahururu, Ruiru-Juja
Phase 3 （Oct. 2019 ～May 2021）	Eldoret, Kilifi-Mariakani, Mavoko

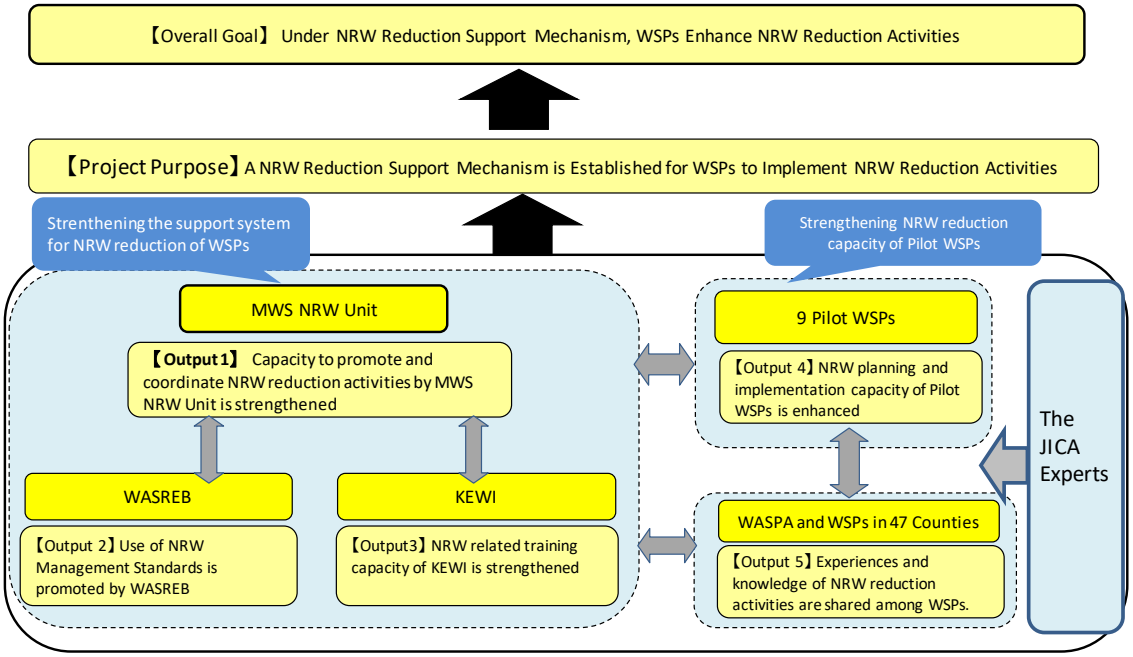


Figure 2 Project framework (Project Purpose and Outputs)

2. Project Approach and Results

The results of the project activities are shown below.

2.1 NRW Unit of the Ministry of Water, Sanitation & Irrigation (Output 1)

The activities of the NRW unit in this project were to prepare NRW management annual reports (hereinafter referred to as the annual reports) for sensitizing about NRW, conduct sensitization activities to the county governments, and support WSPs for their NRW sensitization activities. At the beginning of the project, the number of NRW unit staff was two excluding the project manager. As of May 2022, five staff including the unit chief have been assigned and its organizational standing in the ministry has been improving. In addition, young staff have been assigned at the request of the experts, which has enhanced the sustainability of their activities for the future.

The annual report version 3 (2019/20) was finalised in July 2022 and is in the process of printing now. This version was compiled and edited by the unit staff with little support from the experts. Their capacity to issue the annual reports continuously after the completion of this project has been increasing.

Since the county governments own WSPs, it is essential to enhance the understanding of the county governments on NRW management. Thus, the NRW unit held workshops on NRW management targeting county government officials. Since March 2020, face-to-face activities have been restricted to prevent the

spread of COVID-19. Face-to-face workshops were resumed in January 2022.

Early workshops faced the challenge of having few participants from the counties. The reason for the low attendance was that although daily allowances and accommodation expenses were normally paid to the county officials to attend workshops in Kenya, these workshops hosted by MWS&I could not cater those costs. Therefore, the participation from counties was limited. Initially, the workshops invited top executives of county governments who turned out to have busy schedules and were often not able to participate.

In Phase 3, the range of targeted participants was widened to the directors of WSPs who represented county governments, which resulted in a slight increase in the number of participants. The number of county government representatives, who participated in the workshop and learned about NRW for the first time, was not small. This shows the importance of continuing similar awareness-raising activities for counties.

Regarding NRW reduction activities at WSPs, the face-to-face activities were temporarily suspended to prevent the spread of COVID-19. Nyahururu WSP, which has been conducting its own awareness-raising activities by visiting schools in its service area, resumed their sensitization activities in September 2021.

NRW Unit of the MWS&I also produced a series of videos to encourage learning about water supply systems as part of its awareness campaign. The completed videos have been uploaded to YouTube offering access to everyone.

2.2 WASREB（Output 2）

To revise the NRW Management Standards published in 2014 to suit the current state, WASREB formed an editorial committee consisting of representatives of MWS&I, KEWI, and WASPA. The revised standards consists of two parts: a guideline intends for the NRW managers of WSPs and a handbook intends for their field technicians.

During the revision processes, many WSPs reviewed the revised draft and some of those WSPs participated in the validation workshops to validate the final draft of the revised standards. The standards were finalised in July 2022 and are in the process of printing now. Nevertheless, the contents of the standards have already been introduced by WASREB at the workshops held for the project.

The revised standards includes the list of NRW reduction activities recommended for different levels of NRW ratio shown in Table 2. These activities guide each WSP to work on NRW reduction based on their current conditions regarding NRW. This table was compiled based on the experiences from the activities of the 9 pilot WSPs in Output 4. For example, for the WSPs where the NRW ratio of water supply area is over 40% or the NRW ratio cannot be measured, activities not requiring a large budget, and/or activities easy to start (e.g checking the accuracy of bulk meters, reducing the billing based on estimated consumption, identifying the customers whose meters are not being read, and reducing visible leakage) are recommended. The establishment of distribution zones and district metered areas (DMAs) and the detection of underground leaks are recommended to implement gradually at the WSPs where the NRW ratio is between 40% and 30%. Unlike the previous technical cooperation and some projects carried out by other donors in Kenya, intensive leak detection in a DMA(s) is not necessarily considered to be a priority activity.

WASREB has been considering that the four tools developed through the activities of Output 4 with the pilot WSPs should also be used by the other WSPs as a part of their licensing conditions. These four tools are 1) a series of templates/forms for planning activities based on a detailed capacity assessment to check about 250 aspects and for reviewing the implementation of activities, 2) a monitoring sheet showing monthly trends of key NRW-related indicators in an integrated figure having multiple line graphs, 3) use of the free software called Kobo Toolbox/Collect for data collection and the utilization of the collected data, and 4) detailed analysis of meter reading and billing data using Excel. In April 2022, WASREB staff were trained to understand the above four tools and their effectiveness.

2.3 KEWI（Output 3）

KEWI is the only public vocational school in Kenya to train engineers involved in water supply, sewerage and water resource development. KEWI reviewed the contents of its existing short-term training course for NRW management. Then, with the cooperation of Embu and Meru WSPs, KEWI launched a new practical training course on NRW which consists of lectures (5 days) and on-site training (6 days). In the process of its launch, the instructors became able to understand the day-to-day operation of WSPs for NRW reduction and utilize their knowledge in training.

Table 2 Suggested NRW reduction activities at NRW ratio

Stage	NRW %	Recommended NRW Reduction Measures
1	**Above 40%** (or unknown / unreliable)	◆ Determine the accuracy of production meters by testing and calibrating, and replacing them if faulty or inaccurate. ◆ Eliminate major commercial losses by servicing and testing (and replacing faulty) customer meters and, identifying illegal uses (starting with large and then medium customers). ◆ Install meters for unmetered customers and identify unbilled customers through Customer Identification Survey (CIS) and issue them with bills. ◆ Reduce the time taken to repair bursts, surface leaks and overflows.
2	**Between 40%-30%**	◆ Intensify Stage-1 measures by e.g. establishing routines, etc. ◆ Isolate distribution zones and district metered areas (DMAs) with accurate bulk meters and do NRW monitoring. ◆ Reduce underground leaks by step testing, acoustic survey and pressure reduction in priority areas (this leak reduction can be carried out as a pilot project). ◆ Map bursts and leaks and monitor their recurrences. ◆ Introduce better pipe materials and fittings for new pipelines and service connections (e.g. HDPE or uPVC-D/E). ◆ Minimize commercial losses (including at small customers and data handling errors) by improving meter reading and billing systems, and their uses.
3	**Between 30%-24%**	◆ Intensify Stage-2 measures listed above. ◆ Reduce underground leaks in other areas. ◆ Start replacing pipes which are prone to bursts and leaks.
4	**Between 24%-20%**	◆ Intensify Stage-3 measures listed above. ◆ Accelerate and complete pipe replacement.
5	**Below 20%**	◆ Intensify Stage-4 measures listed above. ◆ Maintain the facilities and skills to sustain the achieved low NRW ratio.

Note: GIS development and NRW monitoring are not included, but are essential to support NRW reduction activities.

In addition, through reviewing the training contents and carrying out the practical training course, the subjects necessary to cover in the training on NRW management for WSPs were identified, and a textbook consisting of 20 lectures and 11 tasks of on-site training was compiled. KEWI has introduced the improved lecture contents not only in its short-term courses but also in the regular courses of KEWI's water supply department, and its students are now learning NRW management as part of the water supply operation. Although the direct activities of the project were completed in Phase 2, KEWI has been continuously carrying out practical training for NRW reduction. A total of 355 trainees have taken this practical training course since 2016 as shown in Table 3.

Further, KEWI has developed a new training course "Innovative Approaches to NRW Management" that introduces the contents of the revised NRW Standards. This training (5 days) is designed for many WSP managers to be able to use the four tools of NRW management developed and used in Output 4. KEWI has conducted a trial of this new training course for three WSPs by the end of May 2022.

Table 3 Summary of the participation in the practical training course for NRW reduction

No.	Data	Location	No of WSP	No of partici pants
1.	Mar-Apr, 2022	KEWI & Embu	4	11
2.	Nov-Dec, 2021	KEWI & Embu	1	34
3.	Oct-Nov, 2021	KEWI & Embu	3	12
4.	Sep-Oct, 2021	Runda	1	10
5.	Jul-Aug, 2021	KEWI & Embu	3	18
6.	Oct, 2019	Mombasa	1	28
7.	May, 2019	Nyahururu	1	43
8.	Jun, 2019	KEWI & Embu	8	20
9.	Mar-Apr, 2019	KEWI & Embu	6	16
10.	Aug-Sep, 2018	KEWI & Embu	3	6
11.	Apr-Jun, 2018	KEWI & Embu	6	37
12.	Feb-Mar 2018	KEWI & Embu	5	14
13.	Aug, 2018	KEWI	8	17

14.	Mar, 2018	KEWI	3	37
15.	Jun, 2017	KEWI & Embu	6	12
16.	Jun, 2017	KEWI	7	40
Total number				**355**

2.4 Pilot WSPs（Output4）

1）Strengthening the planning, implementation and reviewing procedure

At the formulation stage of this project, it was identified that many of the WSPs in Kenya had not developed NRW reduction plans that were suited to their actual situation, and even where plans had been developed, their inadequate implementation in accordance with the plans, which resulted in insufficient NRW reduction, was identified as a challenge. Therefore, in Output 4 targeting the nine pilot WSPs, each WSP was first asked to conduct a self-assessment of its capacity (ability to deal with challenges) and was then continuously supported to develop and implement effective and feasible plans. Specifically, the pilot WSPs assessed their current situation using a checklist of approximately 250 items, the results of which were automatically graphed so that the WSPs could self-assess their capacity (e.g. what activities were not being implemented) in each field related to NRW. Based on this assessment, NRW reduction annual plans (including a mid-term planning bar chart for five years) were prepared annually by each WSP. In addition to these, a series of templates were developed to strengthen the annual PDCA cycle including quarterly progress monitoring and annual activity review (e.g. assessment of the implementation rate of planned activities), and their use has been assisted.

2）Achievement of continuous planning and improved implementation rates

The project aimed at establishing a support mechanism through the activities of Outputs 1 to 3 and Output 5, and more than 6 out of 9 pilot WSPs were expected to implement over 60% of their planned activities in the two consecutive years. NRW reduction annual plans, etc. have been continuously prepared at all the pilot WSPs over the past five years and seven pilot WSPs have achieved the target implementation ratio of planned activities (60%) for two consecutive years as shown in Table 4 although they faced various issues such as lack of funds. This successful result is partly because the support mechanism for WSPs worked during the project. The components of the support mechanism which effectively worked were the self-financed procurement of equipment by the NRW Unit of MWS&I (Output 1), the promotion of NRW officers' capacity building in WSPs by WASREB (Output 2) which considers the capacity building to be a prospective condition for license renewal, the practical training course by KEWI (in charge of Output 3), the facilitation of sharing information on good practices through the network of WASPA (Output 5), etc.

Table 4　Improvement of the implementation ratio of planned activities at each pilot WSPs

Pilot WSP	2016 -17	2017 -18	2018 -19	2019 -20	2020 -21	Evaluation
Meru	68%	70%	75%	43%	98%	3 years continuously + 1 year
Embu	40%	50%	60%	65%	70%	3 years continuously
Kisumu	55%	60%	69%	73%	72%	4 years continuously
Nakuru	82%	85%	90%	70%	80%	5 years continuously
Nyahururu	70%	90%	90%	70%	80%	5 years continuously
Ruiru-Juja	-	30%	20%	68%	74%	2 years continuously
Eldoret	50%	60%	65%	75%	80%	4 years continuously
Mavoko	40%	60%	48%	50%	50%	1 year (partly due to water shortage. but already reached 60% in 2021-22)
Kilifi-Mariakani	35%	60%	50%	40%	70%	1 year + 1 year (delayed org. imp.)
Average	55%	63%	63%	62%	75%	7 WSPs are successful.

The significant improvement in the average implementation ratio of planned activities from 55% to 75% also suggests the success of the project (the decline in 2019-20 is due to the impact of COVID-19).

3) Success in the comprehensive support targeting entire service areas

The project took an approach to avoid overly investing funds and labour into pilot activities in small-scale DMAs while deploying support in the interests of WSPs such as prioritizing measures against commercial water losses at large customers scattered throughout their water supply areas. The project also guided the adjustment of their organizational structure for NRW

reduction and enhanced cooperation between their technical and commercial departments. Although the support for planning NRW reduction activities was provided to all the pilot WSPs from the start of the project, the support for implementing the planned activities was provided through 3 phases and the number of pilot WSPs being supported has gradually increased, as shown in Table 5, due to the limited periods assigned for experts' inputs.

As a result of the comprehensive support targeting the entire water service areas, the NRW ratios at most of the pilot WSPs have significantly decreased in comparison to those at the beginning of supporting their activity implementation (their baseline levels) and their revenues have largely increased (Embu WSP has not been able to obtain a reliable baseline value because it took a long time to prevent air flowing through its largest bulk meter which measures production water volume at the water treatment plant).

The NRW ratio in Meru WSP in 2021-22 is about 17%, which has already reached the Kenyan target of 20% or less. On the other hand, Ruiru-Juja WSP had faced a serious challenge after the start of the project that its top management was dismissed by WASREB because of forging the billed consumption data, and the WSP had to make a fresh start from the difficult situation. However, Ruiru-Juja WSP succeeded in significantly reducing the NRW ratio by 21% as shown in Table 5 by identifying the locations of many customers whose meters had not been read until then, increasing the number of meter readers, replacing its billing system that was used for forging the data with a new system, dividing its water supply areas into 19 DMAs and starting the NRW monitoring of the DMAs.

4） Monthly NRW monitoring and zoning

NRW ratios of many WSPs in Kenya are affected by intermittent water supply, etc., and the NRW ratios often fluctuates seasonally to a large extent. Therefore, it is difficult to assess the effectiveness of NRW reduction activities by only analysing the changes of the NRW ratio over several months. Therefore, in order to distinguish between seasonal fluctuations and the effects of activities, at least three-year worth monthly values of seven key NRW-related indicators were graphed on a single figure and the trends and interrelations of these indicators were analysed. Figure 3 shows an example of Ruiru-Juja WSP which succeeded in reducing the NRW ratio and increasing the billing for water supply continuously and significantly by giving priority to the reduction of commercial water losses. Recently, activities for leak reduction have become active in the WSP and the amount of water supply has begun to decrease. The seven indicators analysed by this method include three types of raw data (1. billed consumption and 2. the amount of billing for water supply, both of which are strongly related to commercial water losses, and 3. volume of water supply, which is strongly related to physical water losses) and four types of calculated values (4. NRW volume, 5. NRW ratio, and 6. average tariff for water supply which responds to the status of dealing with large customers, and 7. potential revenue loss due to NRW).

When preparing a detailed water balance table recommended by the International Water Association (IWA), the WSPs without enough information about their meter errors, frequency of billing on estimation, degree of underestimation, frequency and scale of water thefts, etc. are prone to underestimating commercial water losses. Therefore, they have a high risk of making plans overly biased toward relatively difficult activities such as underground leak detection and the replacement of aged pipes which requires a large sum of budget. Therefore, the method using line graphs on a single figure for monitoring the effects of commercial water loss reduction measures and physical water loss reduction measures separately to some extent as shown in Figure 3 can be an easy alternative monitoring method which can prevent the WSPs from falling into inefficient activities.

The data entry sheet for this NRW monitoring method has been improved to allow the pilot WSPs to update their graphs monthly over 10 years. It is expected that many other WSPs will also use the monitoring sheet continuously in the future. Nyahururu and Kilifi-Mariakani WSPs use the same monitoring sheet for each of their distribution zones. Similarly, other pilot WSPs have been working on strengthening their NRW monitoring for each distribution zone and/or DMA.

Table 5 Trend of NRW ratio and amount of billing at the pilot WSPs

Assisting the Implementation at Each Pilot WSP		Baseline		Approx. Results (2021-22 so far)		
		Year	NRW %*	Current NRW%*	Diff. in NRW%	Revenue↑** (Mill KSh/year)
From Phase 1	Meru	2016-17	24%	Around 17%	7%↓	17 Mill KSh/y
	Embu	2016-17	Not credible	Around 40% (41%→39%→37%→36%)	Gradually decreasing	Cannot estimate due to the lack of reliable baseline.
From Phase 2	Kisumu	2017-18	36%	Around 28%	8%↓	93 Mill KSh/y
	Nakuru	2017-18	35%	Around 31%	4%↓	58 Mill KSh/y
	Nyahururu	2017-18	42%	Around 40%	2%↓	8 Mill KSh/y
	Ruiru-Juja	2018-19	54%	Around 33%	21%↓	187 Mill KSh/y
From Phase 3	Eldoret	2018-19	44%	Around 39%	5%↓	62 Mill KSh/y
	Mavoko	2018-19	41%	Around 35%	6%↓	16 Mill KSh/y
	Kilifi-Mariakani	2019-20	57%	Around 49%	8%↓	78 Mill KSh/y

** Based on the yearly universal NRW ratio calculated in the universal NRW monitoring sheet
* Roughly estimated by "Turnover in 2019-20 / (100 - Current NRW%) x Diff. in NRW%"

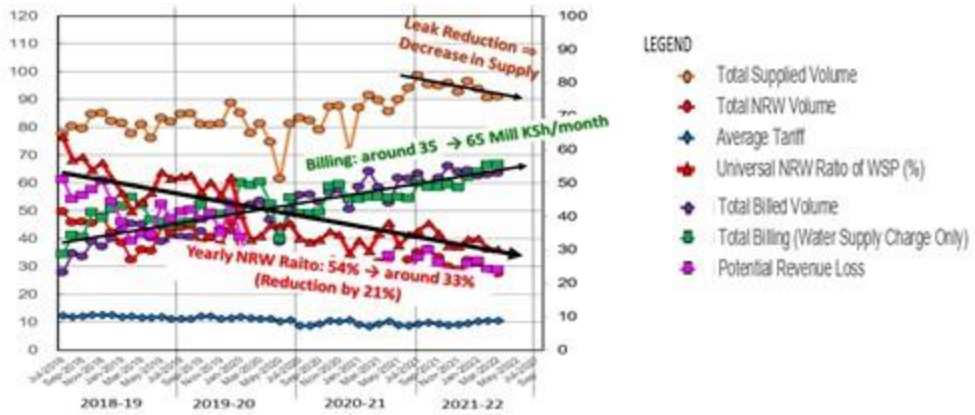


Figure 3 Significant improvement of Ruiru-Juja's NRW ratio and billing amount (2018 - 2022)

Table 6 Significant improvement of Eldred's billing amount in customer category by estimate billing

Baseline Year (2018.7 to 2019.6)	Num. of Customers	Percentage	Num. of Customers	Percentage	Num. of Customers	Percentage	Num. of Customers	Percentage
C1: > 300 m3/month	65	54%	42	35%	14	12%	121	0.2%
C2: 101-300 m3/month	197	54%	128	35%	41	11%	366	0.6%
C3: 51-100 m3/month	584	66%	212	24%	88	10%	884	1.4%
C4: 21-50 m3/month	2,835	63%	1,054	24%	590	13%	4,479	7%
C5: 7-20 m3/month	9,400	57%	4,276	26%	2,736	17%	16,412	26%
C6: 0-6 m3/month	10,215	25%	9,226	22%	21,866	53%	41,307	65%
Total	23,296	37%	14,938	23%	25,335	40%	63,569	100%

HUGE IMROVEMENT OVER THE 3 YEARS

Customer Categories by Consumption Level, and Frequency of Estimation Last 12 Months (2021.4 to 2022.3)	No Estimation		1 or 2 Estimations		3 or More Estimations		Total	
	Num. of Customers	Percentage	Num. of Customers	Percentage	Num. of Customers	Percentage	Num. of Customers	Percentage
C1: > 300 m3/month	115	82%	23	16%	2	1%	140	0.2%
C2: 101-300 m3/month	327	78%	81	19%	13	3%	421	0.7%
C3: 51-100 m3/month	885	87%	112	11%	15	1%	1,012	1.6%
C4: 21-50 m3/month	4,541	90%	427	8%	90	2%	5,058	8%
C5: 7-20 m3/month	15,721	90%	1,535	9%	288	2%	17,544	27%
C6: 0-6 m3/month	34,387	86%	4,566	11%	1,055	3%	40,008	62%
Total	55,976	87%	6,744	11%	1,463	2%	64,183	100%

5) Reduction of Commercial Water Losses

The project supported each pilot WSPs by analysing meter reading and billing data of all customers more than twice to identify various problems related to commercial water losses, and guided them to implement countermeasures suitable for the actual situation at each pilot WSP. Consequently, many of the

pilot WSPs took action to replace or repair defective meters, especially for large customers, and significantly reduced meter errors and the percentage of the billing based on estimated consumption, which resulted in an increase in the amount of billing for water supply as shown in Table 5. At Eldoret WSP, where activities were supported from Phase 3, the entire organization thoroughly implemented countermeasures such as checking meter accuracy and replacing defective meters. As a result, the percentage of the customers not billed on estimated consumption for 12 consecutive months increased from 37% (July 2018-June 2019) to 87% (April 2021-March 2022), as shown in Table 6. Moreover, this resulted in a significant increase in water billing by approximately KSh 62 million/year.

6) Reduction of Physical Water Losses

The measures against physical water losses implemented in this project include 1. reduction of visible leakage in collaboration with meter readers, 2. quick response to pipeline bursts, etc. by monitoring abnormal flow rate using bulk meters, 3. minimum night flow measurement and step test using portable ultrasonic flow meters (UFMs) in hydraulically separated continuous water supply areas, and 4. leakage detection at all customer points using listening sticks in the areas where hydraulic separation is not possible and intermittent water supply areas.

In order to improve the capacity of WSP staff, the project actively adopted step testing that can target a wider area. Efficient and effective leakage reduction was sought to achieved by flexibly selecting, changing and adding target areas of step tests as needed. As a result, the implementation of step tests led to significant leakage reductions in many areas, although less positive results were achieved in areas with poor water supply conditions. In addition, inexpensive and easy-to-use listening sticks proved to be particularly effective in reducing leakage in Kenya. In Embu and Nyahururu, where lowering the NRW ratio of entire water supply area was relatively difficult, wide rural areas having NRW ratios of around 70% due to serious leakage and water theft (i.e. Marmanet Scheme in Nyahururu WSP and Zone 2 of Embu WSP which have around 3,000 and 4,000 connections respectively) were identified as priority target areas for leak detection etc. and intensive supports were provided to deal with these areas.

As a result, the NRW ratios were reduced to about 50% in these areas, but the activities were interrupted due to COVID-19, and the NRW ratios of these areas went up to about 70% again. However, when experts' support was resumed, the NRW ratios in those areas began to decline again, leading to some decline in the NRW ratios of Embu and Nyahururu's entire water supply areas as well.

The project concentrated on commercial water loss reduction measures and, as mentioned above, also focused on leakage reduction measures in selected areas. As a result, a significant or some degree of reduction in NRW ratio was achieved in all the nine pilot WSPs.

Minimum night flow measurement and step-testing

2.5 WASPA & WSPs across the country (Output 5)

The approaches and achievements of Output 4 were repeatedly presented mainly through WASPA's events including its benchmarking workshops having a sub-working group for NRW reduction and bi-monthly meetings for WSP managers. Similarly, the approaches and successful cases of this project were also presented in May 2022 at KEWI's NRW reduction symposium held in Mombasa and JICA's collaboration workshop with African countries held in Nairobi. Output 1 also presented them to other WSPs at its county sensitization workshops.

As part of Output 5, thematic workshops focusing on specific issues, fields and technologies in NRW management and targeting practitioners of WSPs were also held. The first thematic workshop in 2019 was "Countermeasures against illegal water use." The second workshop in 2021 was "Use of smart meters". The third workshop was held on the theme of "Reduction of Commercial Water Losses" in June 2022. The third workshop aimed for introducing the success stories of Output 4 to the commercial

departments of WSPs. The number of participants in this workshop was more than 100, which exceeded our expectations and showed their strong interest in commercial water losses. To prevent the spread of COVID-19, face-to-face activities were restricted from the second workshop, so the thematic workshops have been held online.

3. Nationwide expansion by the support mechanism

1) Increasing the understanding and motivation for NRW management

Figure 4 shows the project's goal of "building a support mechanism for NRW reduction activities." As a result of the activities of Output 4, the NRW ratios of pilot WSPs were reduced and the revenue from water charges increased in almost all the pilot WSPS. These results increased the understanding and motivation for the NRW reduction among the pilot WSPs significantly. At the beginning of the project, management teams of WSPs often showed a short-term view that expensive improvement of infrastructures such as replacement of old pipes must be done in order to reduce their NRW ratio even though active leak detection was rarely performed in these WSPs. Recently, more attention has been paid to easy and cost-effective practical NRW reduction activities. For example, at the county sensitization workshop held in May 2022, the top management of Meru WSP emphasized the importance of reducing commercial water losses by strengthening the monitoring of large customers, which are limited in number but account for a large portion of total water supply.

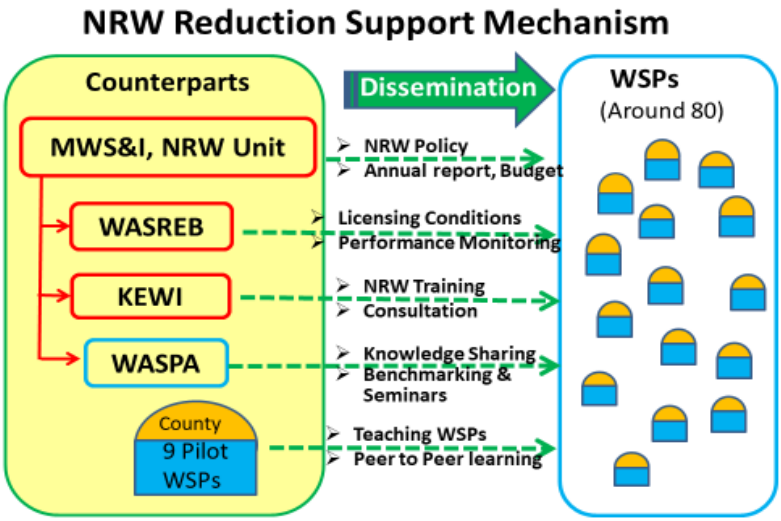


Figure 4: Nationwide expansion by the NRW reduction support mechanism

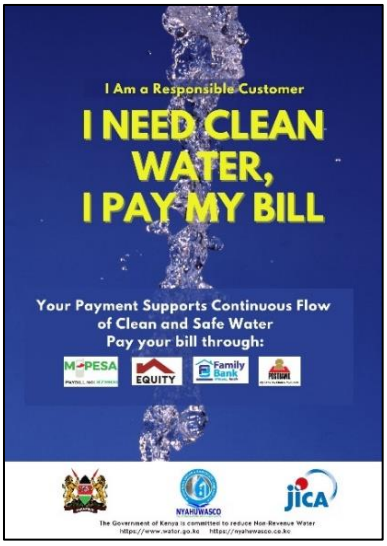
This kind of remark shows that the simplistic idea of "NRW reduction is equal to infrastructure development/improvement" has been successfully abandoned.

On the other hand, the tangible results from Output 4 also helped to improve the understanding and motivation of each organization contributing to the support mechanism for NRW management. In the beneficial situation where the above-mentioned preconceived idea was being dispelled by many WSPs, the organizations holding the support mechanism would be able to assist more WSPs with limited financial and human resources.

Under these circumstances, WASREB has been considering the inclusion of a series of templates for preparing annual NRW reduction plans, activity review sheets and the analysis of meter reading and billing data, etc. as additional conditions for the renewal of WSPs' water service licenses. Moreover, KEWI has also set a new training course, in addition to the practical training course for WSPs, to promote the use of the tools developed in Output 4 and incorporated into the revised NRW standards, and has already conducted its pilot run.

Achievements from the approaches of Output 4 have also been introduced in WASPA's benchmarking

workshops and the county sensitization workshops of Output 1. Through these opportunities, the supporting organizations have enhanced their collaboration and have been actively disseminating the NRW reduction measures established in Output 4 to non-pilot WSPs, which shows that the support mechanism in Kenya as a whole is being strengthened.



Sensitization poster prepared with COVID-19 emergency support to persuade to pay water bills

2) Capacity building of NRW Unit, MWS&I

MWS&I has established its NRW unit to expand NRW management nationwide. At the beginning of the project, its NRW unit had only two staff members and no computer. But as of May 2022, the unit has Unit Chief and five staff members. Although some of the staff have experience in counties and WSPs, they had little experience in sensitization activities which are the mandate of the NRW unit. Through the publication of NRW annual reports, holding county workshops, and participating in events such as World Water Day, the staff gained experiences in sensitization activities. In addition, through the revision of the NRW standards and the participation/review of KEWI's NRW short course, the unit had opportunities to collaborate with WASREB and KEWI and improved their relationship that was considered to be weak previously. Thus, the structure to support NRW reduction nationwide is getting more established.

However, the NRW unit still needs more experience to be able to provide effective, contextual advice to relatively capable WSPs whose NRW ratios are already below 40%. Therefore, the unit must stay actively involved in the NRW reduction activities of many WSPs to gain further experience.

3) Promotion of the revised NRW standards

The revised NRW standards consist of the guidelines targeting the technical manager and the head of NRW unit of each WSP, and the handbook targeting field staff. The standards include the approaches confirmed to be effective through the activities of Output 4. How to implement the approaches and use relevant templates are explained step by step in the standards so that WSPs can adapt them. WASREB has a policy of incorporating the use of the templates shown in the revised standards into the conditions for renewing the licenses of WSPs. Therefore, a training on the use of these templates etc. was conducted for WASREB staff in April 2022.

However, in order for the Standards to be read by the staff of each WSP and for the tools of new approaches such as the templates to be used by many WSPs, WASREB needs to promote the use of the revised standards vigorously and monitor their usage at WSPs continuously. To cover a total of about 90 WSPs in these activities, WASREB should not leave it to their NRW officer alone but should rather tackle it as a whole. WASREB also needs to take advantage of KEWI's new course focusing on the tools included in the revised standards and continue the active cooperation with the NRW unit of MWS&I, etc.

4. Lessons learnt from the Project

1) NRW management as part of water service management

The preceding project, other donors' projects, and JICA projects in other countries, often took an approach starting with technology transfer through pilot activities such as leak detection in small DMAs and gradually expanding similar activities over other areas. However, past experiences have shown that even if the NRW ratio is successfully lowered in a pilot DMA through thorough leak detection, etc., this success does not necessarily lead to the expansion of similar activities to the entire water supply area of a WSP. In case a lot of money, effort and time has been invested in pilot DMAs during the period of such project, it is very difficult for the WSP, after the completion of the project, to increase the number of functioning DMAs by themselves while procuring necessary materials and equipment with their limited resources. Moreover, the skills required for the activities in pilot DMAs are often very different from

the skills needed to expand the activities to other areas (e.g. establishment of a NRW monitoring system for all existing DMAs which can be linked to the billing system or its data, prioritization of DMAs for different activities, etc.), which often make WSPs fail in the stage of expanding their activities over other areas.

The project, therefore, guided the pilot WSPs to prioritize activities that were likely to be effective while taking into account the entire water supply area, and also went through various trial and error processes. As a result, it was empirically learnt that particularly reducing the billing on estimation and improving meter accuracy based on the analysis of meter reading and billing data, with priority given to large customers, is likely to lead to a significant reduction in NRW and a large increase of revenue in a relatively short period. In particular, since increasing tariff revenues is one of the top priorities of WSP, not only for NRW officers but also for the top management of WSPs, starting with measures for large customers is likely to create a virtuous circle for the WSP to work together to reduce NRW.

2) Flexible leak reduction activities and gradual zoning

On the other hand, WSPs that have made progress in reducing commercial water losses or are experiencing a high incidence of pipe bursts and leaks need to conduct proactive leak detection. However, the implementation of efficient leak detection using DMAs is not easy to realize as most WSPs in Kenya have intermittent water supply (their water supply conditions are likely to deteriorate further in the future due to climate change and rapid population growth). In this context, how to reduce leakage in areas that are not hydraulically isolated and areas with intermittent water supply is a major challenge.

In addition, many WSPs in Kenya have inadequate GIS data, and it is highly likely for them that the interconnections of distribution pipes cannot be fully ascertained. As a result, there have been many failed attempts of gradually building out small DMAs (e.g. being unable to separate the network into DMAs, being unable to finish dividing the entire distribution networks anytime soon, and having fallen into over-investment). When WSPs implement the zoning of distribution systems by themselves, they first need to bisect or trisect the entire distribution networks by rivers, geological factors, etc., or divide them into relatively large distribution zones for each water treatment plan, distribution tanks, etc. and then further divide them into DMAs according to their needs and available funds. Therefore, in order to ensure the sustainability of NRW reduction, it is necessary to provide WSPs with some support for such a zoning procedure, with a view to the entire water supply area, during the project period. As a matter of course, an expert having experience in the planning of transmission and distribution systems based on GIS data is essential to provide such support.

Training on mobile GIS using smartphones

3) Strengthening inter-departmental coordination in WSPs

As part of the support to the pilot WSPs, the results of analysing meter reading and billing data were presented to technical and commercial department staff, and they were guided to discuss how the two departments could work together to achieve effective commercial water loss reduction in front of the top management of each WSP. They were also encouraged to review the results of each month's NRW reduction activities based on the NRW monitoring at their monthly inter-departmental meetings and discuss issues, measures and collaboration between the departments. By repeating these efforts, more staff within each pilot WSP were encouraged to get involved in NRW reduction actively. The project also suggests an increase of NRW unit members when necessary. At Mavoko WSP, many staff have been involved in the process of preparing their annual NRW reduction plans, which also helped to empower younger staff. The extent to which GIS and ICT personnel are proactively involved in NRW reduction activities is also considered to have a significant impact on the implementation of efficient and effective activities. Other points to bear in mind are the requirements for

moving from a centralized to a decentralized approach. The centralized approach is easier to build capacity because if the staff working on NRW reduction are decentralized/scattered at their branch offices before their capacity is fully developed, it is likely that the activities in each branch will not be properly implemented and will fail. Furthermore, in some cases, the ranks (job grades) of staff leading NRW activities were too low to make the staff of their commercial departments and branch offices get adequately drawn into NRW reduction activities, which resulted in inadequate outcomes.

Based on the above experience, the revised NRW management standards proposes a NRW management structure within each WSP and presents a suitable grade of the personnel in charge of NRW and required coordination between departments and staff. WASREB will also incorporate the establishment of NRW unit in the licence renewal conditions. Therefore, the establishment of NRW unit consisting of dedicated staff and inter-departmental collaboration would be promoted for the other WSPs by WASRB.

4) Importance of supporting many WSPs

In this project, the nine pilot WSPs were selected from WSPs across Kenya for Output 4 activities in consideration of their regional distribution. Although it was not easy to have sufficient results in all the nine WSPs due to the limited input of experts, there were many merits in targeting the large number of WSPs. One of the merits was that the 9 WSPs and the experts were able to share experiences and ideas among them constantly and continue to search for optimal measures.

There are approximately 90 WSPs in Kenya, and the project's continuous engagement with the nine WSPs, about 10% of the total, helped to change the understanding and awareness of NRW reduction measures across Kenya. The fact that the nine supported WSPs were relatively large and could become leaders in their respective regions was one of the reasons for the positive impact over Kenya.

It is hoped that by further increasing the proportion of the WSPs taking leadership roles actively to 20% and then to 30% in the future, the impact and the sustainability of the project activities are expected to increase across Kenya, and the country's severe water shortages would be mitigated faster. From this experience, deploying support to a large number of WSPs at the same time is considered to be crucial and essential for extending the impact of technical cooperation for NRW reduction to the entire country being supported. It is recommended that future technical cooperation projects in other countries including Africa should also support multiple WSPs at the same time.

5) Support content when targeting a large number of WSPs

When a project directly supports a large number of WSPs, activities in pilot DMAs should not be put at the centre of the project because the activities in pilot DMAs usually require the procurement and installation of pipe materials, bulk meters, pressure reducing valves, etc. by the WSPs. It is also important not to prescribe the activities in detail. Even if the procurement and installation of materials and equipment are supported by a donor agency, it is likely to take several months or in some cases take years, which will have a large negative impact on the progress and outcomes of the project. Moreover, in WSPs with intermittent water supply, it is difficult to efficiently conduct leak detection and maintain facilities, and there is a relatively high likelihood that investment in developing DMAs will be excessive or wasted without generating sufficient results. In addition, in areas under poor water supply conditions where NRW ratios are likely to fluctuate seasonally to a significant extent, long-term monitoring of NRW ratios in pilot DMAs should be carried out without fail. Otherwise, the evaluation of the results from the pilot DMAs and subsequent development of further activities based on the results are likely to be misguided.

When targeting many WSPs in a project, it becomes more difficult to manage the progress of the project and evaluate each activity. Thus, regarding leakage detection, for example, the project should be able to flexibly select, change or add its target areas at any time during the project. It is also important to continuously monitor the impacts of different activities simultaneously over a relatively wide area, such as the entire water supply area or each distribution zone. Moreover, like this project, several activities that can be supported in a few weeks per year for each WSP (e.g. 1. planning, 2. analysis of meter reading and billing data for commercial water loss reduction, 3. GIS development including the identification of customer locations) should be placed at the centre of the project targeting many WSPs. These activities at the centre of the project are expected not to be much affected by delays in procurement and installation of

equipment, etc. Meanwhile, it is also important to deal flexibly with difficult activities such as underground leak detection which is more challenging to get clear results.

Meter accuracy testing by using a scaled bucket

6) Flexible and gradual addition of target WSPs and continuous support

As for the support for the implementation of planned activities at the pilot WSPs in Output 4, target WSPs to be supported were determined for each phase. However, many of the pilot WSPs needed more continuous support. Therefore, the project gradually expanded its support over the pilot WSPs and continuously support them without stopping the support to any pilot WSPs once they are covered until the end of the project.

In addition, as for the support for planning NRW reduction activities using templates, which could be deployed to many WSPs simultaneously to some extent by mobilizing local staff, all the pilot WSPs have been supported continuously from Phase 1 of the project. These efforts of continuous support to each pilot WSP for as long as possible, despite the limited input of experts, is considered to have contributed to the success of the project.

For example, at Ruiru-Juja WSP, where a significant decrease in the NRW ratio was achieved, the head of its NRW unit was replaced three times during the project period, and similar training had to be repeated each time. However, this continuous support has helped the WSP to increase the number of personnel contributing to NRW reduction.

7) Flexible activity planning and expert team composition to encourage ingenuity

In Phase 2 of the project, the project devised ways to spread the use of HDPE pipes, which are effective in preventing water leakage and theft, in Kenya. Specifically, as requested by the project, a Kenyan manufacturer of high-quality HDPE pipes provided training on the installation of HDPE pipes and other equipment to several pilot WSPs, etc. In addition, the project conducted various trials such as installing handmade meter test benches, using a low-cost industrial UFM as a potable UFM, using smartphones for the logging of mechanical bulk meters, and using free data collection and GIS-related software, some of which helped the pilot WSPs improve their operations.

This commitment to various initiatives, including the development of Excel-based tools, was possible because the project had a flexible action plan that was not overly focused on the reduction of NRW in pilot DMAs. It was also possible because the expert in GIS and hydraulic analysis on distribution systems who were also familiar with other IT technologies played a leading role in Output 4. GIS is a very important IT technology and crosscuts all the fields related to NRW reduction such as planning, monitoring of NRW ratio for each area, and implementation of commercial and physical water loss reduction measures. Therefore, it is important to fully consider and ensure at the formulation stage of new projects that GIS experts can play a central role in supporting NRW reduction and that they can also work on IT-related innovations for the project.

Filming of water education video at Nyahururu