საქართველოს გაერთიანებული წყალმომარაგების კომპანია
UNITED WATER SUPPLY COMPANY OF GEORGIA

ADB
Asian Development Bank

WATER SUPPLY AND WASTEWATER SYSTEMS IN WEST GEORGIA: OPERATIONAL ASSESSMENT AND IMPROVEMENT ACTION PLAN

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ABBREVIATIONS

CMMS	Computerized maintenance management system
GEL	Georgian Lari (₾)
GIS	Geographical Information System
HQ	Headquarters
KPI	Key Performance Indicators
NRW	Non-Revenue Water
O&M	Operation and Maintenance
UWSCG	United Water Supply Company of Georgia
HQ	Headquarters of UWSCG located in Tbilisi
PPP	Public Private Partnership
PRV	Pressure Reducing Valve
SCADA	Supervisory Control And Data Acquisition

1 Executive Summary

1. This report presents the results of an operational performance assessment for the water and wastewater services provided in five cities in west Georgia by the United Water Supply Company of Georgia (UWSCG). UWSCG was created by the Government of Georgia in 2010 to improve operations and maintenance performance in the water system and is wholly owned by the Georgian government. This report and the study are not intended to cover other regions served by UWSCG, but in some important ways the situation in west Georgia is also representative of water and wastewater services throughout Georgia. The expert team that carried out the assessment was asked to focus on five cities, make the assessment for each city, and recommend model solutions to the problems identified so that these could be applied nationally. In addition, the team was asked to make assessments of the Customer Services and Asset Management functions in UWSCG and make recommendations that could be widely applied beyond the main study area.

2. The operational performance assessment carried out by the expert team was focused on the following objectives:

a. Maximizing the long-term value of the assets financed by ADB loan

b. Providing continuous water supply (24 hours per day, 7 days per week)

c. Reducing non-revenue water (NRW)

d. Reducing electricity costs

e. Providing a plan for long-term, successful operations of the newly installed water and wastewater systems for UWSCG

3. The five cities selected are Kutaisi (which is Georgia's second city after the capital Tbilisi), Poti (which is a coastal city in the process of developing as a major port), Anaklia and Ureki (which are developing tourist coastal resorts) and Zugdidi, which lies inland. Most of the early assessment work was carried out in Kutaisi, at the request of UWSCG, because it has the most severe water supply problems. Despite heavy investment in renewal of the water supply network, non-revenue water (NRW) is very high in Kutaisi. In addition, the electricity costs and electricity consumption for the water system Kutaisi is exceptionally high. It should be noted that prior to the investment by ADB, what could be described as functional water systems only existed in Kutaisi and Poti and none of the cities had wastewater treatment with only small sections of gravity sewerage systems with direct, untreated discharge. Water supply in the other cities mostly relied on local private and/or public wells with a small distribution system around the wells. Therefore, the assessment of the current operational strategies and practices could only be carried out for the two operational networks (Kutaisi and Poti).

4. As Kutaisi is the largest city within the UWSCG system and since the water system in Kutaisi had been mostly upgraded by the time of this study, a significant amount of the expert team's time was spent understanding the issues within the Kutaisi system, developing theories for reducing NRW and electricity consumption and performing pilot and simulation

testing on the water system to improve the operating conditions. These findings were then applied to the other 4 cities, as applicable.

5. In addition to investigating the operational management issues surrounding Kutaisi's water supply, including building a basic hydraulic model of the city's network, the expert team conducted a specific study of NRW for a small area of the city (Choma), which greatly helped the team to identify the causes of the high NRW. The team also closely examined the pumping arrangements in Kutaisi, enabling a full understanding of the existing energy inefficiencies. Separate reports have been produced following each of the 5 missions in 2017 and 2018.

The main conclusions drawn from the assessments performed during the various missions are:

- UWSCG management and operational teams met during the visits were found extremely dedicated to operate their systems in challenging conditions and improve water services for their customers.

- The substantial investment of US$500 million to date has been an important step that needs to be supported now with operations and maintenance expertise that is still lagging behind. The high NRW in Kutaisi (around 74%, which means that only 26% of the volume of water entering the network is billed to customers) is mainly due to leakage from the network. This is partly due to a failure to decommission old sections of network when installing the new network, and partly due to inadequate leakage control in both the old and new networks. The failure to decommission the old system is most likely the result of poor procedures during commissioning and a lack of operation control procedure after the commissioning operating phases.

- The inadequate leakage control is partly due to lack of training (in overall management and use of modern leakage detection methods) and partly the result of inadequate funding for staff and modern equipment. This problem is not limited to Kutaisi but is one of the key issues to resolve in order to provide continuous (24 hours per day) water supply in other cities across UWSCG.

- Since the high power costs in Kutaisi are closely linked to the high NRW (all water is pumped, so electricity costs for pumping are four times what they would be if there was no leakage), addressing the leakage issues will also greatly reduce the electricity costs. In addition, there are other measures that will reduce the electricity costs in Kutaisi. These include operational changes and installation of SCADA (Supervisory Control And Data Acquisition) managed from a central control centre. Simulation testing was performed on the largest pumping stations in Kutaisi that showed simple operational changes that could reduce electricity consumption significantly. While this issue relates directly to electricity consumption, it is an indication of the poor operational capacity of UWSCG and the minimal understanding of management practices for operating a system that could provide continuous supply at optimized costs. Electricity cost savings of up to 50 percent can be achieved in Kutaisi through proper management, proper billing, proper operations and reduction of NRW.

- All five cities face a significant challenge relating to operations of the newly constructed wastewater systems. UWSCG currently has no expertise in wastewater

management since historically it has only managed water supply systems. Prior to construction of the current wastewater systems, sewerage flows were directed to private septic tanks or discharged untreated into local watercourses. In order to reduce the impacts of untreated wastewater discharges to the environment, UWSCG is currently constructing new sewerage networks and advanced wastewater treatment plants to serve all five cities (and elsewhere in Georgia). The new treatment plants will utilise advanced biological treatment processes to remove both organics and nutrients which are significantly more complex and difficult to operate than the water treatment processes UWSCG is accustomed to (mostly simple chlorination of water supplies). Not only are these systems new to UWSCG, but advanced treatment systems are very new to Georgia, and the expertise to manage and operate such systems is very limited within the country.

- Without proper expertise to manage the sewerage systems and wastewater treatment plants, UWSCG will struggle to implement the intended environmental improvements. The wastewater treatment plants will utilize biological systems, which are sensitive to flow changes, which can be significant in the tourist towns of Ureki and Anaklia, and are highly automated, which will require advanced maintenance knowledge and experience to keep the systems in proper operating condition. Without the proper expertise to manage and operate the wastewater systems, the risk exists that the investment value will not be realized, and the systems will fall into disrepair.

- UWSCG management procedures currently include no formal asset management processes. There is no Master Plan and no Asset Maintenance Plan. Nor is there adequate data to base these plans on, since UWSCG has only recently commissioned the creation of an asset inventory, which is not yet complete. If there is no maintenance plan, then planned maintenance will not happen and asset failure will follow. Again, this creates a risk that the heavy investment in new assets for water supply and wastewater currently taking place will be largely wasted.

- Customer Services in UWSCG appears to be better organised than front line operations management, but nevertheless looks inefficient by international comparisons. Some major changes are needed to bring it up to current international standards.

6. This mission differs from more traditional missions conducted by ADB on water and wastewater projects, which are usually focused on capital investment for the creation of assets. As the assessment team discovered and this document demonstrates, many of the problems in the study area have arisen from (1) insufficient attention to operational needs at design and operating phase and (2) poor construction supervision that did not involve the local operator. **Addressing the operational aspects during the planning and design is strongly recommended for future infrastructure projects and can have significant, positive impacts on the long-term viability of the investment and the long-term operational improvements to the region**.

7. The expert team members all agree that the only feasible way to address the problems identified above, while meeting the stated objectives, is to introduce some form of public private partnership (PPP) arrangement that could attract the interest of an

international operator having the resources and expertise available to tackle the serious issues revealed by the assessment missions. Simply providing a training package will not be enough to ensure the problems are addressed and necessary improvements are achieved in a short timescale. Reorganisation / redeployment of existing staff resources is needed in addition to the import of international experts. A PPP covering the five cities, based on performance criteria and incentives for achievement, is recommended. The detailed design of the PPP is not yet made, but outline costs are presented in this report based on the team's experience of other international PPP arrangements. The total cost over 5 years is estimated to be US$ 50M, around US$ 20M of which would cover new investments needed to correct construction faults and provide modern equipment.

2 Introduction and mission scope of work

8. Georgia and the Asian Development Bank (ADB) signed a framework financing agreement for the Urban Services Improvement Investment program in March 2011. ADB's Board of Directors approved a multi-tranche financing facility for an amount not to exceed $500 million.

9. In parallel to this construction and rehabilitation effort, in 2010 the government of Georgia established the United Water Supply Company of Georgia (UWSCG) as part of the water sector reform to improve the Operation and Maintenance (O&M) of the water and wastewater system in Georgia. UWSCG, which is wholly owned by the State of Georgia, oversees the O&M of 56 cities throughout Georgia.

10. In the last decade major water system infrastructure improvements have been made, including new or renovated networks, using ADB and other multilateral agency loans and a huge improvement in water distribution is foreseen. In addition, major wastewater improvements are ongoing to provide wastewater collection and treatment where there had previously been only localized systems or direct discharge of untreated wastewater.

11. A recent assessment jointly performed by UWSCG and ADB identified several O&M components which could be improved and will require assistance from international experts. Georgia built and is operating a brand-new water system, is constructing new wastewater systems and now needs to increase its effort to upgrade its operating procedures, personnel and equipment. The main O&M components that were identified are: water resource management, treatment operations, distribution network and non-revenue water (NRW) management, customer services and meter management, as well as energy and asset management.

12. Following this assessment, ADB proposed a consultancy mission to define, in collaboration with UWSCG, improved O&M practices, procedures and organisation. This mission would also specify the equipment and training required.

13. UWSCG and ADB selected five cities in the west region of Georgia, Kutaisi, Poti, Anaklia, Zugdidi and Ureki. These cities are home to about 320,000 inhabitants that represent 1/3 of the total inhabitants served by UWSCG. Special focus was given to Kutaisi, which is the largest city served by UWSCG. Pilot studies and simulations were conducted on NRW and energy management in Kutaisi to be used as the basis for implementation of O&M management strategies within the whole of UWSCG.

14. Five specific missions were conducted between November 2017 and September 2018 by a team of five operation experts (see list in Annex 1). The reports of the first four missions are listed in Annex 1 and the report of the last mission is presented in Annex 2. Those missions and related reports provide the basis for the calculations and recommendations provided in this final report. All data collected and calculations during missions are listed in Annex 2.

15. This final report summarises the findings of the five missions and describes the strengths and weaknesses of the current organisation and infrastructure in the west region

based on the facilities that have been constructed or are currently being constructed. It outlines an action plan to improve the operation and maintenance (O&M) organisation in the west region.

3 Water supply and sewerage systems assessment in West Georgia

16. This section reports the team assessment on the current operational organisation, knowledge and efficiency in the five cities. It also includes some comments on the existing and newly-built infrastructure. It is composed of five parts, water supply, customer service, asset management, sewerage, and health and safety.

3.1 Water Supply

17. The first two prerequisites for a sound water supply system are good water resources and good quality supply infrastructure including the pumping stations, network and reservoir.

18. In the five cities visited, both requirements are fulfilled. Indeed, each city has:

- Sufficient quantity and good quality of water resources. The available water supply in the 5 cities are close to or above 500 l/inhabitant/ day as shown Table 1, which is more than adequate if the physical losses through leakage from the network are contained. Only Anaklia could suffer low supply in summer but this could be solved by using private wells which are currently in place

Table 1. Water Supply and NRW in the 5 cities

	Number of inhabitants	Supply			Reservoir size	NRW
	Number	Max m3/h*	l/inhabitant/d	Average number of hours / day	hours of maximum production	%
Kutaisi	196,000	7,083	860	Part of the city 24/7 Part 2*4 hours / day	9 hours **	73.7
Poti	45,000	2,080 Winter 1,000 Summer***	1,000 Winter 530 Summer	24/7 16/day in summer	6 hours	45
Anaklia	3,000 + 10,000 Summer	126	230 Summer	24/07 12/day in Summer	36 hours	nd
Zugdidi	65,000	1300	480	0****	7 hours	-
Ureki	2,000 + 10,000 Summer	306	612 Summer	0****	16 hours	-

*Maximum possible supply volume but not often reached since most of the cities have low total reservoir volumes and therefore, they must stop pumping during the night when the demand is low, and the reservoirs are full.

** The reservoir size is expressed in hour of maximum pumping. The size should be at least 1 day in order to supply during the peak hour (one during morning and one late afternoon) and to be filled during the night.
*** As today only 500 m3/d for the city of Poti during summer but a new well field is expected end of 2018
**** The water network is expected to be operational in 2019. Today people, are supplied by private or municipal local wells (very few data are available on these wells production).

- Most of the water supply infrastructure is less than 10 years old which is considered new as lifetime of a water network is estimated to about 50 years. Fifty percent (50 %) of the Kutaisi network is less than 10 years old as shown in Table 2, and 100 % of Zugdidi, Ureki and Anaklia networks were built in the last 5 years. The weak point for most of these cities is the low storage reservoir volumes which correspond to less than 10 hours of water supply for the biggest cities (see Table 1). This makes the management of the water distribution very difficult. The reservoir capacity should be a minimum of one day's (24 hours) supply.

- Most of the customers are currently or will be soon equipped with a new water meter. The plan is to add meters to every unmetered or new customer by end of 2019.

Table 2. Construction history of the water distribution system in 5 cities (Km)

Cities	Total	2013-2018	2008-2012	> 10 years
Kutaisi	510	87	135	288
Poti	197	137	60	-
Anaklia	67	67	-	-
Zugdidi	250	250	-	-
Ureki	69	69	-	-

19. It should be pointed out that these conditions are very rare throughout Asia where water resources are very often the limiting factor and ageing infrastructure is more typical, with the exception of advanced countries such as Singapore, Hongkong, Korea or Japan.

20. The third condition for a good water system is a good O&M organisation, team expertise, procedures and policies.

21. As today, only two cities out of the five visited have a fully operational water network Kutaisi and Poti. As shown in Table 2, Poti has a brand-new system and Kutaisi network is more older. The other three cities have new water supply infrastructure, which will be operational in the coming months.

22. The operational performance of these two water supply networks currently is characterized by:

- Intermittent water supply in Kutaisi with several areas only supplied 2 times per day for 4 hours each time. Some other areas receive water 24/7. Poti and Anaklia are also in intermittent supply during summer season as shown in Table 1.

- A very high NRW level for Kutaisi and high level for Poti considering that both networks are quite recent as shown in Table 1.
- High energy consumption, especially in Kutaisi.

23. These three characteristics are closely interconnected and reveal major operational deficiencies that require a strong action plan. On the positive side, improving operations is less costly and has a quicker payback compared to looking for new water resources and/or building an entire new water network.

24. It is difficult to assess the causes of the problems with an operations organisation and of a water network in just a few days. To get around this obstacle, it was decided to plan and complete a pilot study in Kutaisi which is the largest city operated by UWSCG. This pilot was done in a small newly-constructed network in Choma area. This approach was extremely useful since it gave the expert team good insight into the operational strengths and shortfalls and the new infrastructure construction weaknesses. The following paragraphs report the main conclusions and propose some corrective actions

3.1.1 NRW

25. The NRW level in a city is a good indicator of the overall performance of the system and is the consequence of many factors. A good understanding of the NRW main origins is key to improving the performance by setting a dedicated action plan. The NRW in Kutaisi and Poti is 74% and 45%, respectively. This mean, in Kutaisi for example, **that every second 1000 litres of water which supply the network are not billed**.

26. NRW is composed of two main types of losses:

(1) Commercial losses quantify the water which is supplied and consumed by the people but not billed and therefore it negatively impacts the revenue of the company. Commercial losses come from either counting or estimating errors, or water stealing (illegal connections or tampered meters)

(2) Technical losses or leakages: Technical losses quantify the volume of water leaking from the network and therefore represent the volume of water which is not supplied to the customers. Decreasing these losses will decrease the volume of water pumped and consequently reduce the consumption of energy

27. In many Asian countries the average NRW is between 30% and 60%, and the split between technical and commercial losses is typically 60 % and 40 %, respectively.

28. The very high NRW of 74% in Kutaisi is surprising because of the large investment that has been performed in new infrastructure but can be explained by specific characteristics, mostly due to poor operational management at commissioning and operating phase.

29. Table 3 reports the volume of water supplied to the network during the first semester of 2018 for the city of **Kutaisi**; 24.4 million m^3 of water coming from the two main well fields and a third smaller one. These numbers are coming from electromagnetic flow meters which are very reliable.

30. Table 4 shows that 6.4 million m^3 were billed for the same period of 6 months, which leads to an average **NRW of 73.7** % during the first semester of 2018 (see Table 4 for NRW).

31. The current production is equivalent to around 700 litres /capita / day (l/c/d), which is very high, and the average billed quantity represents around 180 l/c/d, which is higher than the European standard of 80 to 160 l/c/d. European water prices for drinking water are much higher than in Georgia and therefore people are more conscious of water use.

32. Figure 1 reports the volume of water billed in the last three years. The total volume billed for domestic customers is slightly lower in 2018 compared to 2017. This could be explained by the decrease of the unmetered volumes in 2018 which is compensated by the increase of metered volumes. The trend is due to the installation of meters and it is known that metered customers consume less than unmetered customers. This decrease of billed volumes unfortunately does not have any impact on the NRW because we believe that most of the NRW is due to leakage (see below)

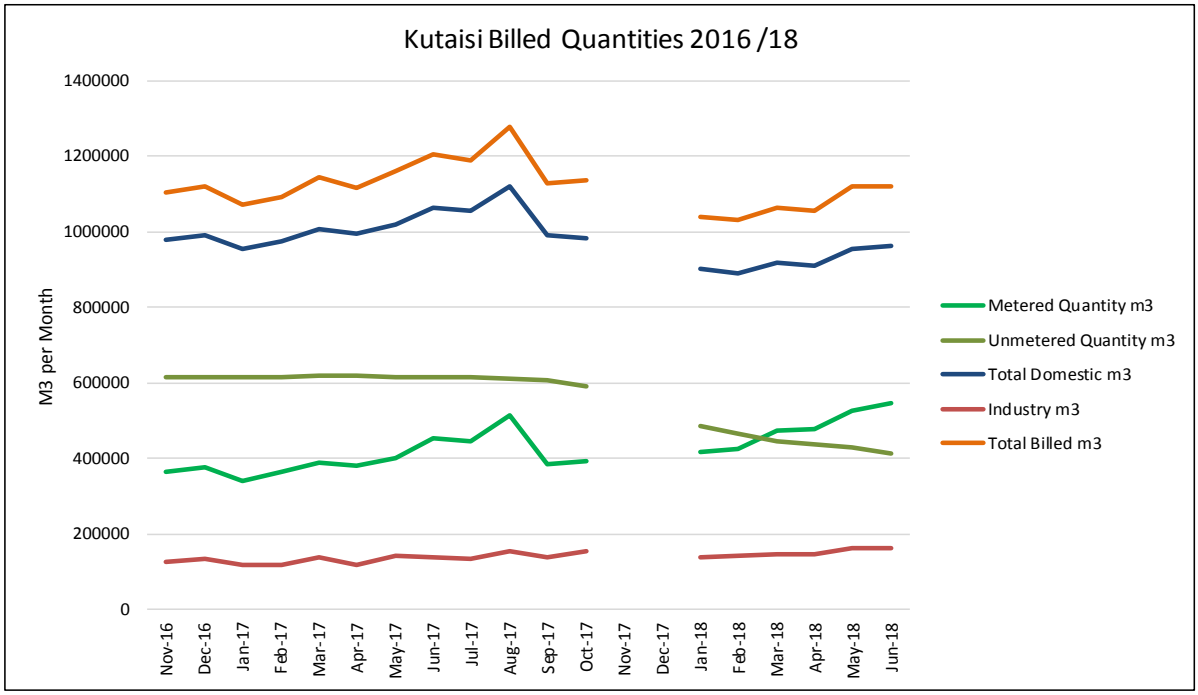


Figure 1. Billed volume in Kutaisi from 2016 to 2018 *(billed volume for Nov and Dec 2017 not available)*

33. For the city of **Poti** the production and billed quantity for the first 6 months of 2018 are 2.24 million m^3 and 1.23 million m^3, respectively. The **NRW is 45 %**.

3.1.2 Analysis of the NRW Breakdown in Kutaisi

34. Figure 2 presents the best estimate of the NRW breakdown for the city of Kutaisi. This figure was constructed in spite of the limited available operational data. For the missing data, the experts used their extensive experience in Asia water operation to estimate a reasonable

range. However, it must be emphasized that the reported high NRW value is calculated using reliable verified data for the volume of water production and billed water consumption.

35. The following breakdown slightly differs from the traditional one from Asia because of two elements that are specific: The underestimation of the unmetered consumption and the connection between old and newly built network as described below.

Table 3. Water production for the city of Kutaisi for the first half of 2018

Month	Amount of water produced m3				Total
	Phartskhanakanebi	Mukhiani	Kopitnari	Gumati	
January 2018	2 600 831	1 354 450	78 640	35 980	**4 069 901**
February 2018	2 570 250	1 325 340	78 350	35 535	**4 009 475**
March 2018	2 610 426	1 355 600	78 640	35 900	**4 080 566**
April 2018	2 608 721	1 363 700	78 700	36 000	**4 087 121**
May 2018	2 608 431	1 345 940	78 350	35 960	**4 068 681**
June 2018	2 600 331	1 381 670	78 800	36 100	**4 096 901**
Total	**15 598 990**	**8 126 700**	**471 480**	**215 475**	**24 412 645**

Table 4. Water Billed in the city of Kutaisi for the first half of 2018

Month	Amount of water billed m3			Total	NRW
	Metered customers	Unmetered customers	Industry		%
January 2018	414 952	485 181	139 336	**1 039 469**	74.5%
February 2018	424 685	464 418	140 873	**1 029 976**	74.3%
March 2018	473 214	446 850	144 511	**1 064 575**	73.9%
April 2018	476 668	435 150	145 055	**1 056 873**	74.1%
May 2018	526 951	428 670	163 115	**1 118 736**	72.5%
June 2018	547 272	414 252	159 617	**1 121 141**	72.6%
Total	**2 863 742**	**2 674 521**	**892 506**	**6 430 770**	73.7%

36. Figure 2 shows that 35 to 40 % of the water produced is consumed but only 26 % is billed. This table also shows that 60 to 65 % of the water produced is leaking from the network. The following paragraphs will discuss in more details the possible reasons for the high losses.

3.1.2.1 *Commercial losses: 9 to 14 % of the production*

37. Table 4 shows that more than 40% of the volume billed is coming from customers without meters. These volumes are estimated and billed on a head count basis (300 l/inhabitant/day). UWSCG Customer Services staff suspect many unmetered customers use

much more than 300[1] l/h/d because they have elevated storage tanks on the premises to cover scheduled periods of non-supply for rationing purposes.

38. The most likely hypothesis for this is that customers allow the tanks to overflow, rather than shut off supply during periods when supply is available, but it is also thought that some customers drain their tanks after each scheduled period before re-filling to refresh the stored water in the tank. This practice is also frequent in other countries such as India with rationing programs.

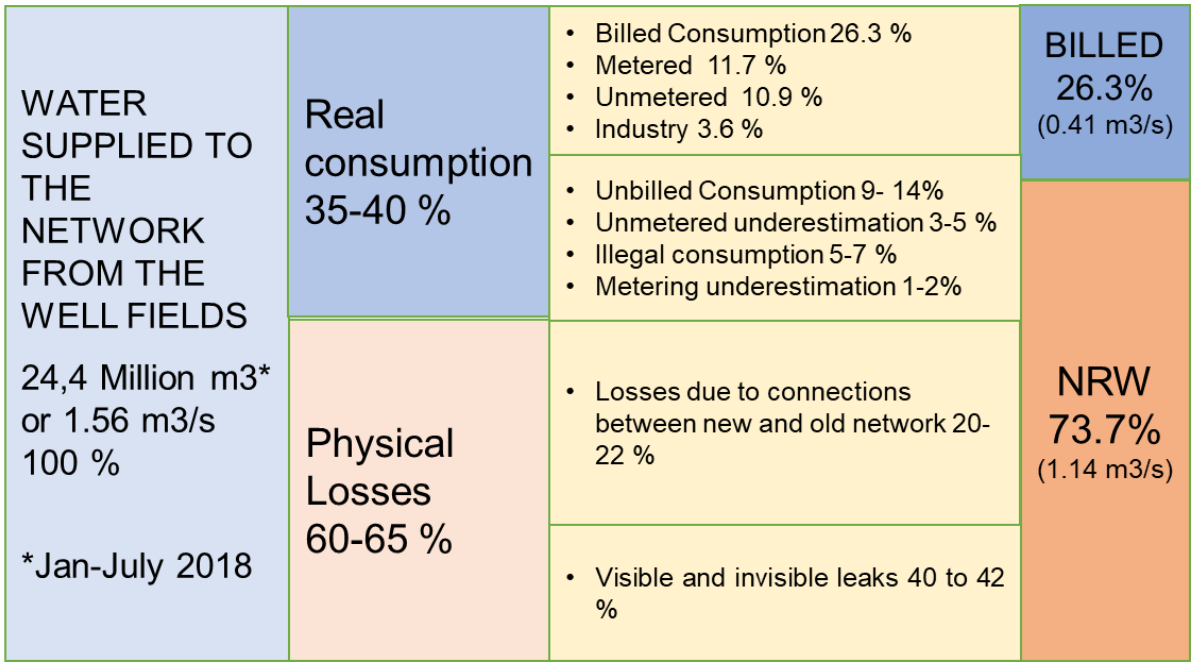


Figure 2. NRW breakdown for the city of Kutaisi during Jan-July 2018

39. Furthermore, it is proven that people without water meters are less careful with their water consumption. The estimate of 300 l/d/person used for the NRW computation probably underestimates the real consumption. Completion of household metering which is expected by the end of 2019 will strongly decrease this source of commercial losses.

40. Since UWSCG did not analyse in detail this underestimation, it is assumed that the real consumption is between 30 to 50 % higher than reported and billed. This will have an impact of 3 to 5 % on the NRW as shown in Figure 2.

41. Several well-known commercial losses are coming from illegal unmetered consumption. Among them we can list, illegal connections, illegal re-connections after disconnection for non-payment and tampered meters. Even though the water is quite cheap in Georgia, it is likely that some illegal activities exist, but it is difficult to estimate it at this stage. UWSCG makes no estimate of these losses and it will take detailed investigation to reduce it. These kinds of commercial losses are the most difficult to find and require a long-term investigation that should focus at the beginning on large customers. The support of the communities is very important.

[1] The volume billed for unmetered customers in Uzbekistan which is similar country in the region is in average 700 l/ inhabitant/ day which is more than 2 times the volume billed in Georgia

The experience in many Asian countries shows that illegal activity is between 5 to 15 % of the water production. Because of the low price of water in Georgia the illegal activity should be in the lower range between 5 to 7 %

3.1.2.2 *Undercounting coming from the meter dysfunction*

42. Finally, the last significant commercial loss is related to meter losses. There are some problems with currently installed meters, mainly concerning meter access and protection. Little care and no consistent design appear to have been applied to metering installation following the installation of new networks. Most of the domestic meters in Georgia are quite new; there were no domestic water meters in use before 2010. Early meters were Class B, but all more recent installations are Class C. Domestic waters are classed as A, B or C, based on their accuracy, with Class A the least accurate and Class C the most accurate (and the most expensive). The accuracy of mechanical meters is determined mainly by their sensitivity to low flows. All meters have a minimum flow rate before they begin to record, so the lower this flow rate the more accurate is the meter. However, meter accuracy also deteriorates with age, due to wear, corrosion and fouling. It is standard practice to replace meters at the end of their assessed useful lives, even those that are still working, based on probable reduced accuracy

43. A programme of meter testing will establish a database of meter accuracy, which can then be used to develop an economic annual meter replacement programme. UWSCG currently only tests meters if customers complain, but since early meter installations are now up to 8 years old, the meters involved could well be displaying inaccuracies.

44. Class B meters underestimate the volume billed between 5 to 10% for meters older than 5 years according to the brand and to the water quality. Since the oldest meters are class B, a meter testing programme should be initiated, using the test bench in Kutaisi that already exists and a replacement program should be started.

45. Since 50 % of the consumption is metered it is assumed that the losses due to meter underestimation is between 1 to 2 % of the production.

46. Other sources of commercial losses are not estimated since those are generally lower than 1% of the water production, e.g. Non-registered customers, whose details are not entered in the customer database (these may be legal connections, but the customers never receive a bill).

3.1.2.3 *Physical losses 60 to 65 % of the production*

47. Figure 2 shows that 60 to 65 % of the water production is leaking within the network. The two main sources of physical losses are the non-disconnected old network and invisible (undetected) leaks.

48. **Non-disconnected old network**. The pilot study done in a newly-constructed network demonstrates that disconnection between the new and the old network was not properly done and therefore the water was leaking through the old network. In the short period of

the pilot (one week), one large connection was quickly found. The cross-connection was located with the assistance of a retired employee. There was no record of the old network position and it was not possible to find it using leak detection equipment. The removal of this connection immediately decreased the NRW by more than 25% from 70% to 45%.

49. Since the network map and institutional knowledge is very weak, the support of retired employees should be institutionalized as it was done in several other countries in Asia. It is very important to capture their knowledge which very often is only in their heads.

50. Since the network is 100 % new in this area it is believed that other connections exist but could not be found in the short one-week pilot. We assume that 40 to 45 % of the production is therefore lost due to failure to decommission the old network pipes following installation of the new network.

51. Further searches for other connections using invisible leaks detection methodology could significantly decrease the NRW in this area and in Kutaisi. Even though it is extremely frequent in Asia to find several parallel networks that could remain for many years or even decades, the case of Kutaisi is more extreme since almost 50 % of the network was redone in the last 10 years (see Table 5). This extensive volume of new works makes the problem much worse in Kutaisi where many connections may exist, and this kind of double network is probably very frequent.

52. A full investigation should be carried out everywhere a new network was laid. This research requires a good organisation and staff with appropriate skills, some equipment and a lot of common sense and some investments. It also needs to collect the basic supply flow meters data for every reservoir and distribution zone and consumption billed data.

53. The existence of these connections between old and newly laid pipe demonstrates the poor quality of construction supervision and operational procedures. As discussed later, local operators should be responsible for their network and therefore should follow up the quality of the construction done and regularly assess the level of water losses.

54. Assuming that 50 % of the Kutaisi network is quite new, volume lost due to the connection between old and new is between 20 and 22 % of the production.

55. **Invisible leaks**. It is well known that invisible leaks are the main source of water losses since they leak continually and for years before being detected, especially with older networks (50% of the network in Kutaisi). The systematic detection of invisible leaks was never done in any cities in Georgia and therefore we could expect high losses in the older network. A strong action plan should be implemented in every city managed by UWSCG

56. The number of visible leaks reported in Kutaisi in 2017 is around 15 leaks / day which means around 10 leaks /km/year, which is quite high. It is very difficult to estimate the exact volume lost in invisible and visible leaks but because of the high pressure in the system we can assume around 40 to 42.5 % of the water is lost.

57. In conclusion, the very high NRW in the city of Kutaisi is mostly due to leakage either in the older network or the more recent network. In the very short term, several actions should be undertaken: (1) quantify NRW by water sector to select the priority sectors and quantify the progress made, (2) look for connections between old and new network which

could significantly decrease rapidly the overall NRW, (3) train and equip several teams to launch an invisible leaks detection program and (4) train and better equip the repair team.

Table 5. Construction or replacement of new network for the city of Kutaisi

Time Period	New Network (m)	% of total
1930-1957	58 211	11.4%
1958-1988	151 918	29.7%
1989-2008	78 462	15.4%
2009	17 397	3.4%
2010	67 156	13.1%
2011	32 316	6.3%
2012	18 148	3.6%
2013	6 518	1.3%
2014	11 387	2.2%
2015	66 245	13.0%
2016	1 022	0.2%
2017	1 148	0.2%
2018	852	0.2%
TOTAL	**510 781**	**100%**

3.1.3 Network pressure management

58. The cities of Kutaisi and Zugdidi are extremely hilly and therefore, water management is more complex. The best way to manage such water networks is to have independent water zones and a number of PRVs (Pressure Reducing Valve) that automatically regulate the pressure at the entrance of each zone. These PRVs are very efficient but require technical expertise to set up and to maintain. The city of Kutaisi is equipped with many such PRVs but those that we could examine were not properly set up or not in use which can also explain the high NRW since high pressures in the network increase the volume of water lost in the leaks.

59. The new water network configuration that was designed and implemented to supply the city of Zugdidi, is not under operation yet and will be extremely dependent upon these PRVs. A high expertise level will be once again required to manage and maintain these PRVs to supply the city on a continuous basis and to control the energy cost that could also be very high in case of mismanagement.

3.1.4 Energy

60. Energy consumption in Kutaisi is extremely high, as documented by the historical energy costs of UWSCG. The annual cost for electricity for the water system in Kutaisi exceeds 6.5 million GEL. The primary reasons for the high energy costs are: 1) inaccurate billing; 2) the physical terrain (significant elevation changes) and design of the system; 3) the high NRW and 4) inadequate attention on operating the system efficiently. During the pilot stage a preliminary energy assessment was performed for the Kutaisi water system. This assessment involved data analysis, physical inspections of energy consuming devices, modelling of the water system energy use and testing of alternative operations strategies through actual full-scale simulations to reduce energy use. Figure 3 shows the breakdown of theoretical energy use by facility for the Kutaisi system.

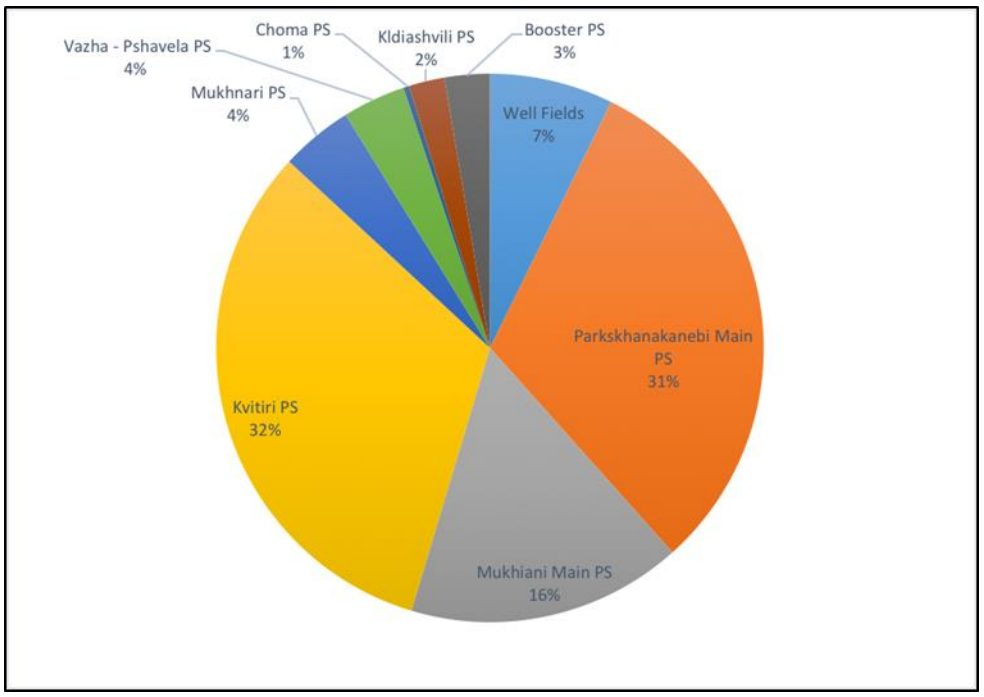


Figure 3.Breakdown of energy use by system in Kutaisi (theoretical kWh use)

61. Based on the data analysis and simulation testing, it was concluded that up to a 50 percent reduction in energy cost could be achieved in Kutaisi. Thirty to thirty-five percent (30 to 35%) energy saving can be achieved with two simple actions. First, installing electrical meters in the main pumping stations/well fields and second, to change the pumping regime in the main pumping stations (as performed in the simulation testing). The two main well fields are currently metered on a shared meter with other facilities. The result is that a calculation must be performed, and the usage is assigned for these facilities. Figure 4 shows that there is significant over billing of electricity use as compared to theoretical use in Kutaisi. Additional savings due to the decrease of water losses, better management of the pressure throughout of the network and of the reservoir level should decrease the energy cost by an additional 20%.

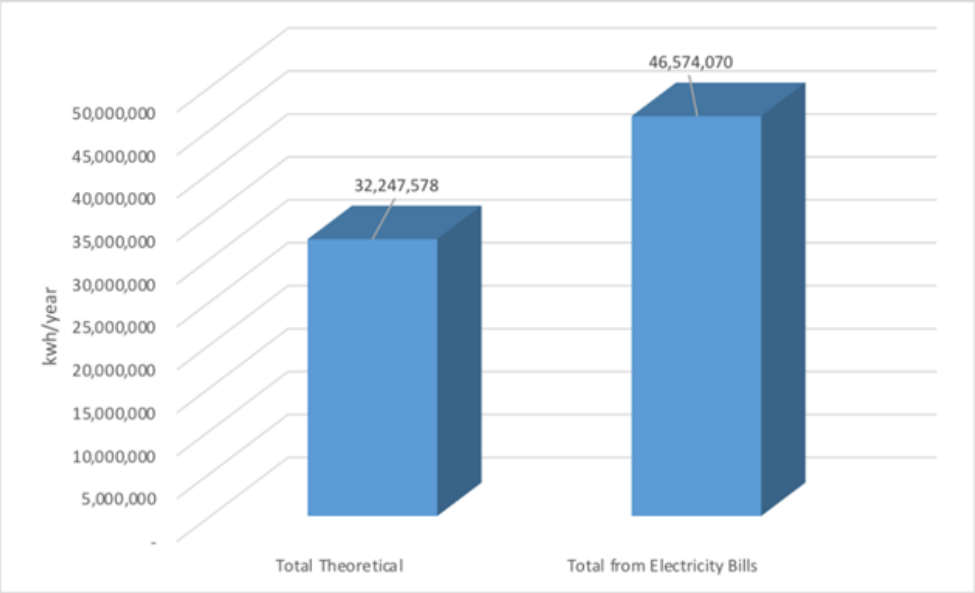


Figure 4. Actual electricity consumption versus theoretical for Kutaisi

62. Based on the evaluations of the other four cities, it does appear that some efficiencies could be achieved by implementing similar operational strategies to those tested in Kutaisi. However, it must be understood that the cities will have new systems, providing greater coverage, which will amount to a net increase in electricity costs. Zugdidi will be the next largest user of electricity (after completion of planned improvements). Currently Zugdidi is supplied by local wells within the water system. The new system will utilize a remote well field for water supply and will require pumping all of the water from a low elevation into the higher elevations of the water system. It will be critical to implement similar operational strategies in Zugdidi to those simulated in Kutaisi to operate the system as efficiently as possible. Two of the other cities (Poti and Anaklia) have relatively flat terrain and electricity consumption cannot be improved significantly. While Ureki has some significant elevation changes, the water supply to the elevated sections of the city is quite small and significant energy savings are not feasible.

3.1.5 Conclusions on water supply

63. The main reason for the poor overall performance in the water supply is the lack of proper organisation, tools, training and equipment available to the current operation teams. These teams who are extremely dedicated have to operate a complex system due to the topography of these cities without any basic equipment and material.

64. In the above paragraphs several main actions are listed. A more detailed action plan for water supply is given in Annex 4 and a cost estimate provided in Chapter 3.

65. This action plan should significantly decrease the energy cost and increase the revenue by decreasing the NRW. It will also allow a 24/7 water supply to every customer.

66. The proposed corrective actions mostly require improved organisation, management, training and some equipment such as SCADA, hydraulic modelling and leak detection

material. It should be done with the support of a small group of well-trained experienced operators.

67. Furthermore, the staff should be incentivized to look for performance improvement and not to be afraid to do the wrong thing. During missions it was noticed that the same procedures continue to exist for more than twenty years and nobody dares to challenge them.

68. Additionally, additional network parts and procedures should be implemented to optimise use of the new infrastructure. Connections between the new network and the old network could be detected by the operation team using new procedures, extended training, and optimised organisation. The number of valves in the new network which is much too low and that will make day-to-day operation more difficult. Indeed, these valves are important to close part of the network when the company has to make some work on the network such as leak repair or new connection. The area to be closed has to be as small as possible for two reasons (1) it has to be empty to start to work and, (2) it means connected customers lose their supply, so the number of affected customers needs to be minimised. Also network restructuring as distribution zones should be implemented with flow meters and remote data monitoring systematically to control flows and operate in real time.

69. Table 6 shows the estimated additional cost to run the action plan for improving water supply. This table was built as follows:

- Current cost: According to UWSCG finance department the current operational cost for the five cities is around GEL 60 million/ for 5 years (Table 6)
- The net additional cost estimated by the expert team is only around GEL 13.5 million (22%). It includes a large energy saving in Kutaisi, some additional material including SCADA and SMART system, and finally some additional manpower for € 4 million; This includes. Additional funding for network restructuring should also be planned as showed in Table 14
    - Energy costs for the normal operation of Zugdidi, Anaklia and Ureki which are not included in the current cost
    - Saving energy in Kutaisi. It is assumed that it will take 5 years to achieve the complete energy savings recommendations. However, this should result in a net savings of € 2.6 million,
    - Additional manpower that is required to implement new tasks and to improve the expertise level is presented in Table 7,
    - The material and software to be bought is listed in Table 8,

Table 6. Expected Water Supply Operating Costs over 5-Year Period (GEL million)

	2019	2020	2021	2022	2023	2024	TOTAL 20-24
Current Cost		**11.0**	**11.4**	**11.9**	**12.4**	**12.9**	**59.6**
Additional cost							
Zugdidi energy		0.7	0.7	0.7	0.7	0.7	3.5
Saving Kutaisi energy		(-0.5)	(-1.2)	(-1.9)	(-2.6)	(-2.6)	(-8.8)
Additional local MP		0.53	0.9	0.9	0.9	0.9	4.0
Material		5.5	4.5	2.4	1.2	1.2	14.8
Total additional cost Water		**6.2**	**4.9**	**2.0**	**0.2**	**0.2**	**13.5**
TOTAL COST		**17.2**	**16.3**	**13.9**	**12.6**	**13.1**	**73.0**

Table 7. Number and cost of additional local employees (GEL million)

	Number of additional people*	cost/ employees /year	2020	2021	2022	2023	2024
TOTAL LEAK DETECTION	24	0.0100	0.080	0.240	0.240	0.240	0.240
HYDRAULIC MODELING	3	0.0150	0.045	0.045	0.045	0.045	0.045
GIS TOTAL 5 TEAM OF 3	15	0.0100	0.090	0.150	0.150	0.150	0.150
SMART ENG. 5 Per SHIFT 3 CITIES	15	0.0150	0.150	0.225	0.225	0.225	0.225
MAINTENANCE SMART KUTAISI	5	0.0125	0.063	0.063	0.063	0.063	0.063
POTI	3	0.0125	0.013	0.038	0.038	0.038	0.038
ZUGDIDI	3	0.0125	0.013	0.038	0.038	0.038	0.038
ADM + Accounting + assistant	6	0.03 & 0.01	0.080	0.080	0.080	0.080	0.080
Total	74		0.533	0.878	0.878	0.878	0.878

Table 8. List of material for water distribution (GEL million)

	2020	2021	2022	2023	2024	TOTAL 20-24
Smart system	1.8	1.3	0.65	0.2	0.2	4.15
SCADA	1.5	1.5	0.4	0.2	0.2	3.8
GIS + Modeling+ Maitenance	0.6	0.3	0.3			1.2
Variable speed pump	0.15	0.15				0.3
leak det & repair	0.8	0.6	0.5	0.3	0.3	2.5
CMMS (Computerized maintenance management system)	0.15	0.15				0.3
Maintenance	0.3	0.3	0.3	0.3	0.3	1.5
Other	0.2	0.2	0.2	0.2	0.2	1
TOTAL	5.5	4.5	2.35	1.2	1.2	14.75

3.2 Customer service

70. The Customer Services department is very involved in the commercial losses component of NRW, as described earlier in section 3.1.2.1. Another important aspect is bill delivery and payment. (see Annex 3 for a detailed analysis for Customer Service)

71. In UWSCG the Customer Services function is partly centralised and partly operated through the Service Centre structure. Service Centres maintain and read meters, using digital tablets that automatically identify the meter number and check the input reading for errors. The readings are transmitted to Tbilisi HQ, where the bills are calculated and transmitted back to the Service Centres for printing. Customer complaints received at Service Centres are forwarded to Tbilisi, but telephone contacts to UWSCG go direct to the Call Centre at Tbilisi, which copies the information back to the relevant Service Centre. Copies of all complaints are forwarded to the regulator, GNERC. However, most telephone contacts are from members of the public reporting visible leaks (referred to as “damage”).

72. 73. UWSCG currently has a very low domestic water tariff by international standards. Revenue has been supplemented in the past by government subsidy, presumably to protect low-income customers. There is also a strong cross-subsidy from commercial customers, whose tariff is around ten times that charged to domestic customers. A tariff review is due to be carried out by GNERC in 2019.”

73. UWSCG uses meter readers / inspectors to deliver bills as well as to read customer meters in line with their scheduled monthly rounds. Some customers have opted for bill delivery by SMS, which of course saves some of the cost of billing. It also means the customer provides a mobile phone number, which could be used to contact the customer to query a missed payment or issue a warning about service problems.

74. UWSCG should mount a publicity campaign to inform customers about the SMS option and explain the advantages over paper billing. SMS messages can also be sent to customers affected by unexpected loss of supply due to bursts, or to issue “boil water” warnings when contamination of the supply has been detected. This is an additional service that puts a more human face on UWSCG, even though the message may be negative. As an incentive, customers could be offered a small discount on their bill if they agree to such contacts by SMS.

75. UWSCG could also pilot a customer portal to provide internet-based billing and payments. Initially it would be limited to a small sample of customers willing to participate in a trial, using the UWSCG website, but then it could be extended by the development of an app for use on a mobile phone. Naturally this will require the agreement and cooperation of UWSCG.

76. It is important to show a more human and caring face towards customers within the five cities, and the pilot could also be used to introduce more flexible payment options, such as budget accounts. Provided they are designed carefully, they will increase UWSCG cashflow, rather than reduce it, whilst providing low-income customers with certainty over their own monthly budgeting.

77. Budget account design involves making an estimate of a customer’s expected consumption over the next 12-month period, based either on previous consumption data or

on household characteristics. A fixed monthly payment is then calculated based on this estimate, which the customer contracts to pay by direct bank transfer on a selected date in the month convenient to the customer. At the end of the 12-month period any excess consumption results in the requirement for a reconciling additional payment, and, conversely, any credit due to under-consumption is repaid to the customer unless the customer opts for the credit to be included in the calculation for the next 12 months.

78. There are several benefits to the utility arising from budget accounts:

a. It is no longer necessary to read customer meters on a regular monthly cycle. Check readings every quarter suffice to track consumption and inform the customer if consumption is on track (or advise a recalculation if it is not). This saves meter reading costs.

b. Similarly, bills are not produced monthly, so bill delivery costs are reduced.

c. The estimated consumption on which the budget payments are made would typically be slightly higher than the probable average consumption over 12 months, so that it is more likely that a credit will result than an account debit. This protects the utility's cashflow.

d. A budget account is an optional payment method that involves a legal contract between the customer and the utility. Debt recovery is strengthened since it is covered by contract law.

79. Developing flexible payment options will obviously require close cooperation between the Operation Partnership and UWSCG, in particular with the call centre in Tbilisi. Call centre agents are the most likely people to be able to identify vulnerable customers, who could benefit from these payment options.

3.3 Asset Management

80. Water and wastewater assets in Georgia suffer from a legacy of low levels of investment during the Soviet Union era. Loans from ADB and other sources are changing this, but formal asset management processes are also absent from UWSCG management arrangements, so simply raising levels of investment is not enough to ensure service improvements occur quickly and efficiently.

81. Asset management is critical for the finance, technical and operation departments. An operation partnership will need to include a strong focus on asset management for the five cities, requiring the development of the business processes described in this section. These will not be exclusive to the five cities and UWSCG may choose to roll out the same processes across other regions.

82. Asset inventory and criticality assessment are the first two main assessments to be done as described below. These analyses will give key information for the Finance Department to measure the asset depreciation and for the Operations and Technical

departments to plan for maintenance programs and renewal rate. This information should also be used for long term investment planning.

3.3.1 Asset Inventory

83. The basic building blocks of any asset management process all involve asset data. UWSCG currently has partial coverage of the dataset needed for asset planning and management; for example, GIS has been implemented, mostly by digitising previous paper records, but there are gaps and errors in the GIS data. Also, information on asset type, age and condition are generally missing, which creates a particular problem for the UWSCG Finance Department, as it means there is not an accurate valuation of the assets available for balance sheet purposes, no information on remaining useful lives of the assets, and hence no accurate measure of depreciation to reflect in the P&L statement.

84. UWSCG commissioned an asset inventory survey in 2017. The first phase of this, undertaken by the Spanish consultants, Eptisa, has been underway throughout most of 2018. The second stage is due to be completed in 2019. Asset valuations and depreciation will be determined by KPMG, using the completed inventory.

85. UWSCG realised from the start that much more information should be collected in the project than the bare minimum required by Finance. In fact, GIS is being used as the primary recording medium for the data. Also, a form of data hierarchy is included, so that it is possible to select an area from the GIS map, display assets within the area, select key assets, such as pumping stations (for which aggregated data can be displayed, such as number of pumps and their capacities), and then to select individual assets within the pumping station and display their details.

86. With the exception of Ureki, which does not yet have its new networks completed, the other cities have either already been surveyed (Kutaisi and Poti) or will be in the next phase (Anaklia and Zugdidi).

87. When completed, the inventory will hold details of 7,888 Km of Water Supply Network, 3,073 Km of Sanitation Network and 82 Km of the Power Supply Network, covering 114 villages and cities in seven different regions of Georgia."

3.3.2 Asset Criticality Assessment

3.3.2.1 *Basic Assessment*

88. With the data being collected for the asset inventory, it should be possible to identify critical assets, or more precisely, the extent to which individual assets should be regarded as critical, i.e. where they lie on the spectrum of criticality, considering their age, condition and function in providing service to customers.

89. Very new assets may not be in the best condition (for example if damage has occurred) and very old assets may still be in good condition and operating reliably. Whether

either type of asset should be replaced, monitored closely as part of a preventive maintenance programme, or left to operate until failure occurs, is part of the criticality assessment. This is largely a matter for experienced engineering judgment, but it is also possible to carry out more sophisticated analysis.

3.3.2.2 *Service Risk Modelling*

90. The purpose of this analysis is to identify the consequences of failure of an asset, taking into account the risk of failure occurring. For example, if a large diameter water supply transmission main were to fracture, perhaps because it is in poor condition, it could take 3 days to repair and the supply to 11,000 customers (based on hydraulic network modelling) could be interrupted for the same period. The service risk could be expressed as the assessed probability that the main will fracture (say 10% per year, perhaps informed by previous occasions when this occurred), multiplied by the population affected, multiplied by the length of service failure (in this case 3 days). The service risk would therefore be 3,300 customer service days per year.

91. More generally, service risk = probability of asset failure x impact of failure. The impact can be simply the number of customers affected multiplied by the length of time service would be interrupted, as in the example above, or it can be expressed as a monetary value if there is information on customers' willingness to pay to avoid the loss of service. In the UK, the economic regulator, Ofwat, has required water and wastewater companies to carry out Cost / Benefit Analysis of capital projects proposed by the companies, using benefit valuations derived from "willingness to pay" research. The principles of Cost / Benefit Analysis (CBA) are well-established in the field of Economics.

92. Whichever it is assessed, the service risk can be used to produce a ranking of possible asset replacements, for example by dividing the cost of replacement by the service risk. If the cost is low and the service risk is high, this indicates a good candidate for early replacement. Economic theory would suggest that all the projects should be ranked in order of lowest cost / service risk and as many of the projects should be approved in rank order as the budget allows.

93. Of course, the budget would need to be determined by other considerations, perhaps as part of a tariff re-calculation performed by the regulator. If willingness to pay information is available, the size of the budget itself can be indicated by the cost / benefit ratio. Projects with a ratio of less than 1 are in theory economically desirable, all other things being equal, so the budget should comprise all of those projects with a cost / benefit ratio less than 1.

3.3.2.3 *Preventive Maintenance*

94. Once the assets selected for early replacement have been confirmed, what remains are assets with a high service risk, but also high replacement cost, plus those assets with a low service risk and low or high replacement cost.

95. Assets with a high service risk are candidates for preventive maintenance. The purpose of preventive maintenance is to reduce the service risk as much as possible[2]. For some assets, the need for regular preventive maintenance is well-known. Manufacturers will often provide warranties that require closely specified maintenance activities to be performed at required intervals. However, older assets may have lapsed warranties and the maintenance requirements for the asset may no longer be available. Replacement parts may be hard to obtain.

96. Where routine maintenance requirements are known, or can be deduced in some way, planned preventive maintenance (PPM) is an obvious requirement. With older assets where it is difficult to define the maintenance requirement, or parts are no longer available, both the risk of failure and the impact of failure may need to be re-assessed. Even though the asset is working perfectly now, it could fail tomorrow. If parts are hard to obtain, the service risk may be greater than previously assumed, because of the time required to bring the asset back into service.

97. In addition, though, some assets, e.g. pumps, can benefit from methods of predictive asset condition monitoring. Pumps often fail from worn or broken bearings, but before actual failure occurs the noise from the bearings begins to change. The heat signature of the pump may also change. It is possible to continuously monitor these variables and pre-empt actual failure by attaching monitors that activate alarms when a characteristic noise is detected, or the temperature of the pump begins to rise out of normal range.

3.3.2.4 *Passive Maintenance*

98. Once assets requiring early replacement have been identified and others have been scheduled for preventive maintenance, what assets remain are either obsolete and no longer required, or else by default are subject to passive maintenance. This means not applying planned preventive maintenance to an asset, and instead accepting that it will eventually fail, at which point repair or replacement will be required. It should not mean that the asset is completely ignored up to that point. Operators visiting installations or working on the network should be trained to carry out visual and audible examination of assets to check that they are functioning correctly. This, of course is easier to do if the assets are above-ground and accessible. Water supply and wastewater networks are underground and therefore more difficult to monitor.

99. In principle, assets placed in the passive maintenance category should only present a low service risk. In practice, the inaccessibility of networks often means that the age and condition of pipes are uncertain. There may be some information about failure rates, but

[2] A good example from another industry is aircraft maintenance. The service risk is very high (passengers' lives at risk if a critical asset fails, even though the probability of catastrophic failure may be low) but the cost of scrapping an aircraft and replacing it with a new one is also very high. Consequently, airlines pay a lot of attention to preventive maintenance and modern aircraft are heavily instrumented to provide early detection of problems in key systems.

probably little or no analysis to determine the true service risk. Passive leakage control (repairing visible leaks only and not trying to find the invisible leaks which may be much larger) is a symptom not only of passive maintenance of the network by default, it also exhibits a lack of concern for service impact.

3.3.3 Asset Maintenance Plan (AMP)

100. Top priority for the PPP is to prepare an Asset Maintenance Plan for the five cities. This should identify any critical assets requiring early replacement, based on their service risk and cost of replacement. It should then identify assets requiring preventive maintenance, either on a planned schedule or relying on predictive asset condition monitoring, as discussed earlier.

101. For the remaining assets, which need not be identified individually, but can be considered in the various asset categories, there should be some allowance for passive maintenance. Passive maintenance, when it becomes necessary due to unexpected failure, can often be more expensive than planned maintenance would have been in the year of failure, so adequate allowance needs to be budgeted for on an aggregate basis, but by definition this category of expenditure is unpredictable.

102. The AMP should identify a budget for maintenance, split between early replacement, planned maintenance and passive, for at least 1 year ahead but with indicative amounts for a further two years. Set against these costs, the service risk removed by the plan should be emphasised.

103. The AMP should serve two key purposes, 1) to provide justification to the regulator for capital investment expenditure on asset maintenance, and 2) to identify in adequate detail which assets need to be maintained in order to protect and improve the levels of service to customers, so that timely investments can be made to those ends. Projects need to be created, options explored, design work carried out and contracts let in accordance with the AMP

3.4 Sewerage systems

104. Georgia launched an ambitious investment program to provide most cities with sewerage systems including a sewage collection system and advanced wastewater treatment plants with nutrient removal capabilities. Previously, no systematic wastewater management was provided for these cities, and the cities were either directly discharging raw sewage or using septic systems for local (individual connections) management. Tables 9 and 10 show the wastewater treatment plants that have been recently constructed or are currently being constructed. It demonstrates that UWSCG is jumping from NO sewerage system to 100 % coverage for the 5 cities in a very short period of time. This major upgrade will improve the health and sanitation of the local population, provide a cleaner environment, and improve economic prospects in the Tourism (cleaner beaches) and Industrial sectors. The construction of the treatment plants for Kutaisi will take more time but are also planned for the next 3 to 5 years.

105. The construction of the advanced wastewater collection and treatment facilities will also provide opportunities to generate additional revenue including reuse of treated wastewater, generation of Biogas and production of soil amendment products. The wastewater treatment systems will include advanced biological treatment for organic contaminant removal, nutrient removal for nitrogen and phosphorus and tertiary treatment. The wastewater produced from these wastewater treatment plants will meet current treatment levels similar to those achieved in Europe or North America.

106. One of the major differences between the water and wastewater systems is that the latter must be able to transport and treat wastewater received from the customers and the receiver does not control either the quality or the quantity of wastewater reaching the treatment plant. The second, major difference is that wastewater treatment processes are mostly based on biological systems and are much more difficult to operate than chemical treatment, which requires highly trained operations teams. These two differences will mean that UWSCG not only has additional systems to operate, but that those systems will be substantially more difficult to operate than the current water systems. This fact cannot be stressed enough. Currently UWSCG does not have staff to operate these systems and finding staff that have the experience within Georgia will be almost impossible as such systems do not exist with few exceptions.

107. Figure 5 shows a site plan for the newly constructed wastewater treatment plant in Ureki. This represents a typical system for those being implemented in the five cities. Most of these systems will be in operation within the new few months, with the exception of Kutaisi which is in the planning stages.

108. UWSCG's experience in operating and maintaining sewerage systems is extremely limited to the management of some old sewage collection pipes. As of today, they do not operate any wastewater treatment plants within the country. The management of the new advanced wastewater treatment plants requires an entirely new team of operators with expertise in biological and chemical processes, electromechanical maintenance, IT and laboratory systems.

109. The design reports by the consultants for the WWTP's reference the following standards:

For Water Treatment, i.e. treatment on the Water Line, requested Effluent quality has to be according to relate EU Directive (*The Urban Wastewater Treatment Directive 91/271/EEC of 21st May 1991* for discharge into sensitive areas, Table 2, Annex I/II.

Table 1-3 Effluent Quality Standards

Parameter	Symbol	Unit	Values for year 2020
Population Equivalents to WWTP	-	PE	14,416
Max. concentrations in Effluent:			
Biochemical Oxygen Demand	BOD_5	mg/l	25
Chemical Oxygen Demand	COD	mg/l	90
Total Suspended Solids	TSS	mg/l	30
Total Nitrogen	TN	mg/l	15
Total Phosphorus	TP	mg/l	2
Dry Solids content in stabilized and dewatered sludge	%DS	%	20

(Source: Tender Dossier, Sec. VI ER, Sub-section 2.2 Design Criteria, page 6-345)

3.4.1 Wastewater treatment plants

110. The team visited the new sewerage system in the city of Ureki, which is a coastal city with large variations in flows between summer and winter. The design and construction of the new wastewater treatment plant (WWTP) is of a very high standard. It is an advanced wastewater treatment with a high standard of equipment and high level of automation (but not total automation). The operators will face several major operation challenges with systems like these.

- nutrient removal systems require highly competent process operators,
- flow variations in resort cities complicate operations,
- high level of automation requires constant maintenance and upkeep of the probes and meters which will require well trained technicians to maintain the fully automated biological process. If these systems are not properly maintained, the systems will not operate efficiently, and the results will be violations of discharge requirements and/or higher operating costs due to overfeeding of chemicals or over-aeration, which will result in additional energy consumption.
- The transition period between low and high flow will be especially difficult to manage since biological systems require a long transition period between two steady state conditions.

Table 9. Wastewater Collection Characteristics in the 5 cities (PS = Pumping Station)

System	Number of PS	System Description	Expected Commissioning
Ureki	30	Gravity and series pumping system	January 2019*
Anaklia	42	Gravity and series pumping system	January 2019*
Poti	28	Gravity and series pumping system (split into two systems for two WWTP)	June 2020*
Zugdidi	23	Gravity system with pumping stations to lift into gravity system (no series pumping to WWTP)	June 2020*
Kutaisi	Unknown	Not yet designed	Unknown

111. A site plan for the Ureki WWTP is shown in Figure 5 along with some pictures of the facility in Figures 6 and 7.

112. Similar designs are used in other plants in the west region and this is a major advantage since the expertise could be shared between the operators in these cities. There are slight differences in the design for the larger WWTPs for Poti and Zugdidi. Those plants will be conventional activated sludge with nutrient removal. Conventional activated sludge plants require even more advanced operating techniques as the reaction time is much shorter. Extended aeration systems (Ureki and Anaklia) have a residence time in the biological process of approximately one day (24-hours) while conventional activated sludge systems have a residence time in the biological process of between 4 and 8 hours.

Table 10. Wastewater treatment plants Characteristics in the 5 Cities

Facility	Design Dry Weather Capacity (m^3/day)	Type of Treatment	Expected Commissioning
Ureki	4,100	Extended Aeration with Nutrient Removal	June 2019
Anaklia	2,400	Extended Aeration with Nutrient Removal	June 2019
Poti 1	12,000	Conventional Activated Sludge with Biological Nutrient Removal	June 2020
Poti 2*	5500	Conventional Activated Sludge with Biological Nutrient Removal	June 2020
Zugdidi	10,500	Conventional Activated Sludge with Biological Nutrient Removal	June 2020
Kutaisi	Unknown	Not yet designed	Unknown

Figure 5. Ureki WWTP Site Plan

Figure 6. Photo Overview of the Ureki Biological system

Figure 7. Photograph of Ureki Grit Removal System

3.4.2 Wastewater collection system

113. In Ureki and in most of the other cities (with the exception of Zugdidi and the planned system in Kutaisi) the wastewater collection system is built with pressure systems using pump stations in series.

114. The collection system in Ureki is also designed for seasonal operation (with dual pressure pipes and high/low operating conditions).

115. From an operational point of view, these systems will be difficult to operate since little or no backup power systems are in place and SCADA is very limited. Therefore, there is almost no reporting (via communication devices) of the operational conditions in the collection system to a centralized control room. The pumping stations will have local alarms, with indicator lights, but the only way to be aware of these alarm conditions is to physically be at the station to see it. In case of electrical or mechanical failure the entire system will stop, and wastewater flooding could happen in the streets. These conditions will not be known until reported by the public or noticed by operators making rounds. It is recommended that changes to the automation and SCADA systems be made so that the systems do not operate in this manner.

116. The pressure system has several operational challenges:

- Many mechanical and electrical devices to monitor, control and maintain (versus a gravity system)
- The lack of SCADA will require constant physical monitoring and slow response during emergency conditions
- Series configuration means one failure can shut down the entire wastewater system
- Each pump station will fail during a power outage and require startup

117. The design of these collection system requires some additional investment to be properly managed. This investment is primarily for monitoring and SCADA systems to report the conditions (level, pump operating status, etc.) to a centralized location (service center, WWTP, etc.).

3.4.3 Sewerage management requirement and cost

118. Since UWSCG does not have any experience nor do they have existing operational staff for these systems, the team of experts estimated the operations cost using standard indicators and ratios.

119. Table 11 shows that the wastewater operations costs for the 5 cities at full operation will be around GEL 6 million / year. Energy and manpower are the two main costs. The energy costs include the pumping in the sewerage system and the cost in the treatment plants which is mainly due to the aeration provided for biological treatment and sludge handling systems. The estimates for energy costs were based on actual motor loads within the sewerage

systems (pumping stations) and for the wastewater treatment plants. These were verified with the actual design reports from the consultants who designed the systems.

120. The estimated manpower for all five cities for wastewater is 175 people including management, operations, maintenance and laboratory personnel for both the WWTPs and the collection systems. Since currently there is no team in UWSCG, a major hiring and training program should be done. The expert team believes that it will be extremely difficult to hire and train new teams without an external support from a water management company experienced in sewerage (sewers and treatment).

121. Table 12 shows the breakdown of manpower needs. It should be noted that this could possibly be reduced by sharing resources and with the implementation of a more robust SCADA system. The manpower needs were based on the experience of the experts and confirmed by the design reports performed by the design consultants for the wastewater systems.

122. Maintenance and chemical costs were based on industry norms and based on the design reports and assumptions for the required reduction in nutrients (primarily phosphorus).

Since the plants will not start simultaneously, the yearly estimated cost for the first 5 years is presented in Figure 8 according to the predicted schedule of the plant operations. The plants in Kutaisi which will be the biggest are not expected to be commissioned for 3 years since the construction has not started. This table should be upgraded every 3 months according to the works progress.

Table 11. Estimate of the Wastewater Operation Costs/year by city at full operation

City	Wastewater			
	Electricity (GEL/yr)	Operations Labor (GEL/yr)	Maintenance (GEL/yr)[1]	Chemicals (GEL/yr)[2]
	Electricity	Labor	Maintenance	Chemicals
Ureki	145 254,86 ₾	280 000,00 ₾	56 250 ₾	23 040,63 ₾
Anaklia	113 840,80 ₾	280 000,00 ₾	32 926,83 ₾	19 162,50 ₾
Poti	487 929,63 ₾	460 000,00 ₾	160 518,29 ₾	90 337,50 ₾
Zugdidi	469 755,00 ₾	340 000,00 ₾	142 682,93 ₾	91 250,00 ₾
Kutaisi	1 409 265,00 ₾	390 000,00 ₾	480 182,93 ₾	273 750,00 ₾
Totals	**2 626 045,29 ₾**	**1 750 000,00 ₾**	**872 560,98 ₾**	**497 540,63 ₾**

1. 0.75% of M&E Costs for first 5 years (after 2% of M&E Costs)

2. $0.01/m3 for ferric addition

Table 12. Preliminary Estimation of the Personnel needed for the new Sewerage system in west Georgia

City	WWTP Personnel	Collection System Personnel	Total Personnel
Ureki	18	10	28
Anaklia	18	10	28
Poti	34*	12	46
Zugdidi	22	12	34
Kutaisi	24	15	39
Total	116	59	175

*Poti has two WWTPs

123. Since UWSCG does not currently have any team and expertise in wastewater biological process, it is highly recommended to build a partnership with an experienced organisation to start operations and train the entire new local team.

124. In addition to the staffing requirements, some equipment and materials will be necessary to properly operate the systems. Table 13 shows the estimated costs for these items. The costs are primarily for two main purposes: 1) backup power and monitoring/SCADA systems for the pumping stations and 2) inspection and cleaning equipment for the sewage collection systems. These items are essential for proper operation and maintenance of the systems.

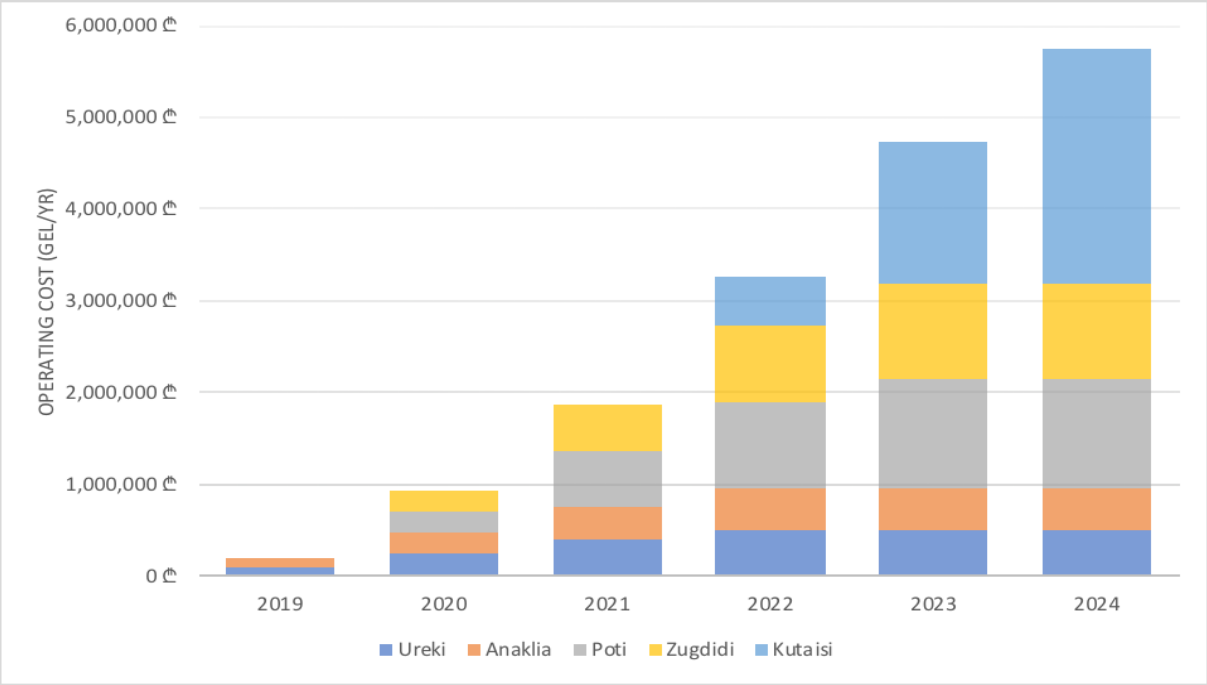


Figure 8. Wastewater expected operating cost over 5-year period

The O&M cost goes up every year because the plants are new and won't receive full wastewater flow initially. The assumed percentages of flow (and also for O&M wastewater costs) for each facility are as follows:

City	2019	2020	2021	2022	2023	2024
Ureki	20%	50%	80%	100%	100%	100%
Anaklia	20%	50%	80%	100%	100%	100%
Poti	0	20%	50%	80%	100%	100%
Zugdidi	0	20%	50%	80%	100%	100%
Kutaisi	0	0	0	20%	60%	100%

Table 13. Estimation of the Capital cost for the Collection system

Item	Number	Cost /UNIT (GEL)	Total Cost (GEL)
Pump Station Smart Monitoring Systems	150	6350	952 500
Computer, Software and Hardware	3	6000	18 000
Vacuum Cleaning Trucks	3	750000	2 250 000
Close-Circuit TV Inspection Equipment	3	50000	150 000
Backup Power Systems for Pump Station	25	50000	1 250 000
Total Capital Cost			**4 620 500**

3.5 Health and Safety procedures and equipment

125. Several water and wastewater equipment and working conditions could cause significant health and safety (H&S) concerns for the operators and also for the general population if procedures are not followed and/or proper equipment is not used and maintained.

126. During the visits, the expert team detected several dangerous situations, such as improper handling and storage of chlorine gas and working in trenches without any protection.

127. The operation of the new sewerage system will add even more dangerous situations such as Hydrogen Sulphide (H_2S) in the sewers and potential risks while working in the treatment plant. H_2S, which is a very toxic gas, is produced in the sewer system by anaerobic biological activity. Every year experienced operators die by inhaling this gas. Proper training for H_2S and confined space entry and proper equipment is absolutely essential prior to starting operations of these systems.

128. H&S requires proper equipment, continuous training, set-up of procedures and more importantly, strong involvement from the top management making H&S a company priority. H&S is first and foremost, a state of mind and the management should not compromise on this. It is strongly recommended that a new H&S system be put in place that includes full-time safety personnel, procedures, training, equipment and other necessary measures.

4 Conclusion and proposed action plan to improve the current infrastructure operation

129. UWSCG is currently building an up-to-date water and wastewater system that should be substantially operational within the coming months.

130. One of the primary goals of UWSCG is to provide excellence in water and wastewater services in an economical and sustainable way and to transition quickly to (1) continuous, and high-quality water supply to all customers in Georgia and (2) improve the environment.

131. The mission of the expert team was to assess the current situation and propose an action plan to improve operations in 5 cities in the west region of Georgia. The main conclusions of this mission are:

- The new infrastructure requires highly skilled operators and advanced management tools, but water supply and wastewater system basic technical and management tools and material are lacking.
- UWSCG lacks the required technical and managerial experience for sewerage systems and wastewater treatment. Furthermore, two of the five cities are coastal cities with extremely high variations in wastewater flows that require strong management and operations experience. An entirely new wastewater organisation should be built with experts who have specific experience in operating highly automated biological, chemical and physical wastewater treatment processes.
- Currently UWSCG is developing an asset register primarily for financial purposes, but the limited database that will result should be further developed to enable asset planning and management. Additional expertise is needed to create a long-term asset requirements master plan and equipment maintenance program.
- Another important conclusion is that apart from the pure technical weaknesses that must be addressed is that an overall management change is key for sustainable improvement in these 5 cities.

132. In addition to the physical and operational improvements recommended, to achieve UWSCG goals, the experts conclude that it is essential to do the following:

- improve the management of the local team to create a professional organisation,
- significantly increase the expertise of the local team through extensive training programs (technical and managerial), and
- implement new smart management systems to improve the reliability. Additional equipment and limited investment will also be mandatory. New management and smart tools that are currently implemented around the world will be a perfect match with the needs in Georgia and should significantly improve the system, if implemented.

133. Newly developed smart systems that are based on Artificial Intelligence software should help the UWSCG team take a giant step toward excellence for water management. This smart system that already includes the experience from many international operators will be key to quickly improve operations and train the employees at the same time.

134. Meeting this huge challenge in a reasonable time frame can only be achieved by entering a partnership with an experienced company specialising in water and wastewater operations with a proven record for similar conditions. This Public / Private Partnership (PPP) could take many forms in concordance to the final objective and priorities of the government for UWSCG.

135. Among the existing PPP formats, a new type of contract called Collaborative Operation & Maintenance contract (COM) promotes an advanced partnership between the parties since both are involved in the planning stage and the financial results. This type of

contract seems well adapted to Georgia. This format, already discussed in the previous report about Kutaisi, could be developed for most of the western region of Georgia.

136. The main goal of this PPP should be to transform the current UWSCG team into a professional organisation to deliver a high performance of service and to empower the local team for a sustainable solution. This partnership should be performance-based and should include the following performance indicators:

- Supply all customers 24/7 and therefore increase customer satisfaction and supply high water quality
- Decrease NRW and save energy to decrease the operational cost
- Increase revenue
- Operate the newly built sewage collection system and wastewater treatment plant to improve the quality of the receiving body (river and beach)
- To introduce a new set of procedures that could be used in other cities managed by UWSCG

137. To implement this new organisation and develop new skills not only requires technical knowhow and training, but also a major change management program which is often organised by the Human Resource and training department. The change management program is the most difficult part and requires a close partnership with UWSCG HQ in Tbilisi.

138. This partnership that will operate the west region of Georgia will also be beneficial to the entire country since the organisation model, the newly developed procedures and the expertise could be implemented by UWSCG in other territories. Such a contract that includes 5 cities in a reasonably small geographic area should draw a lot of attention from the major international operations companies, who are currently trying to develop their business in the region. The selected international company should have an excellent technical track record but also a proven success record in change management. A complete overhaul of the current organisation will a take a minimum of five years.

139. Annex 4 describes a preliminary action plan for water distribution and customer services. This plan should be reviewed and detailed to prepare for the PPP project

The first part describes the action plan for improving the water distribution and includes:

- The first step will be to perform basic review of the existing situation and plan for emergency repairs and quick win.
- In parallel it is important to state as soon as possible the full mapping for the water network.
- The major effort will be to review Operation and Maintenance organisation and to implement new operation procedures. This part will require to hire new employees and train all of them.
- Action to strengthening of the existing distribution system and feasibility study for system extensions

140. Annex 4 also describes an energy management action plan that should rapidly show a sharp energy cost decrease. Action Plans to Improve Customer Services Efficiency and for Improving Asset Management are also outlined.

141. One of the major action for the PPP will be to create from scratch a full wastewater organisation that includes a support team in the HQ and local teams at the plants. This will require to hire and train more than 175 employees over a period of two to three years. A complete set of operational precedures and training should be develpped and implemented. To develop this action plan in a reasonable time frame will requires a careful planning from a well experience operator that could rapidly mobilised several manager, engineers and techniciens for two to three years .

The following budget estimate was developed using the main action plan describes in annex 4 + the estimated cost for wastwater operation as described in section 3.4

Partnership Budget Estimate

142. The financial data provided by UWSCG on the five cities shows a positive EBIDTA of around GEL 2.5 million/year[3] which is sufficient to cover the current operational cost (for water supply) but cannot cover the investment cost and the future wastewater operations.

143. Table 14 summarises the additional cost estimate for the water and wastewater operation in the 5 cities already discussed previously. This additional budget is GEL127 million ($US 49 million) over a 5-year period. This table does not include the current cost of the 5 cities water operation which is reported in Table 6 and which is around 12 million GEL/year.

144. Table 14 includes:

- The additional cost for water
  - Additional local manpower cost as described in Table 7
  - The new material list and cost that should be bought as described in Table 8
  - Energy saving for Kutaisi and additional energy cost for the other cities are described in Table 6
- The additional cost for sewerage. As mentioned before sewerage is a completely new business for UWSCG and therefore the team as to be hired and the material to be purchased.
  - Table 12 provides the estimate of the number of employees needed according to the best international standard and the cost associated.
  - Table 13 summarise the material needed which was not planned in the investment

- The list of experts and their costs are listed in Table 15. The individual cost used in this study are coming from the average price found in PPP international contracts such as O&M, management or lease contracts. A provision for technical assistance in all subjects has been included, the cost is equivalent to two engineers full time for the first three years. It will be used by many experts from different fields for short mission of two week to one month. This cost also include local engineers that will be hired by the international organisation.

[3] The data were shown and discussed during a meeting but no document showing the details are available to the team

- A provision of 26 million GEL for infrastructure to be built and which are not in the current UWSCG plan. This infrastructure could be new reservoirs or new pipes to improve water distribution and the necessary restructuration in distribution zones equipped with flow meters. This provision should be used after the agreement of the three parties: UWSCG, the international company and ADB.
- The cost of 9,5 million GEL for an international consultant company to follow up the performance of the contract.

145. The overall budget for the additional cost is presented Table 14. It summarizes all the cost already discussed and presented in Table 6 (water energy), Table 7 (additional local water employees), Table 8 (additional material for water), Table 11 & Figure 8 (wastewater operation), Table 13 (wastewater material) and Table 15 (the PPP cost)

146. Table 14 includes two parts

- **50% for additional local operation cost including**
  - wastewater cost that are not existing today.
  - additional water supply manpower and energy, smart systems, training and material
  - additional new infrastructure for water and wastewater
  -
- 50% of the overall cost will cover the external experts and the running of the PPP and will stop after 5 years.

147. The detail of expertise cost is reported in Table 15. It shows 5 main experts including the GM, an operator director, a water supply director, a wastewater director, an asset manager and a hydraulic and GIS expert. These experts will stay on for several years to build the organisation. Many short-term expert missions are also planned for improving the expertise in specific fields. The local running cost of the international company is 45 %

148. To summarize, the current wastewater management system has significant gaps in expertise, tools and experience, and these must be addressed to properly operate system. If not addressed, the current situation could lead to inadequate wastewater treatment – leading to environmental issues, disrepair of the newly installed systems and/or health and safety concerns due to the unfamiliarity with sewerage collection and treatment processes. It is imperative that the management systems be strengthened significantly for the wastewater systems.

Table 14. Summary of the additional cost for water supply and wastewater PPP program (All cost in Million GEL)

	2019	2020	2021	2022	2023	2024	TOTAL 20-24
WATER							
Net additional energy	0.35	0.2	-0.5	-1.2	-1.9	-1.9	-5.3
Additional local MP		0.53	0.88	0.88	0.88	0.88	4.04
Material		5.5	4.5	2.35	1.2	1.2	14.75
Total Water	**0.35**	**6.23**	**4.88**	**2.03**	**0.18**	**0.18**	**13.49**
WASTEWATER							
Energy cost	0.05	0.32	0.7	1.3	2.1	2.6	7.02
Manpower + Chemical + Maintenance	0.14	0.6	1.2	1.9	2.7	3.1	9.5
Material and Infrastructure		2.3	2.3				4.6
TOTAL Wastewater	**0.19**	**3.22**	**4.2**	**3.2**	**4.8**	**5.7**	**21.12**
INFRASTRUCUTURE AND MANAGEMENT							
Large infrastrucutre for W and WW		5	8	5	3	5	26
Expertise and Management		14.22	14.22	14.22	8.57	5.52	56.77
Consultant follow-up/Institutional		1.5	2.5	2.5	1.5	1.5	9.5
TOTAL							
		30.18	**33.80**	**26.95**	**18.05**	**17.90**	**126.88**

Table 15. list and estimated cost for the managers and experts for PPP program

Manager and Experts	2020	2021	2022	2023	2024	TOTAL 20-24
WATER						
GM	1.35	1.35	1.35	1.35	1.35	6.75
OPS MANAGER	1.2	1.2	1.2	1.2	1.2	6
WW process	1.05	1.05	1.05	1.05		4.2
WATER PROCESS	1.05	1.05	1.05	1.05		4.2
ASSET MANAGER	1.2	1.2	1.2			3.6
HYDRAULIC + GIS	1.2	1.2	1.2			3.6
SHORT TERM MISSION 1000EUR/D	2.4	2.4	2.4	0.9	0.9	9
LOCAL hr PRIVATE	0.36	0.36	0.36	0.36	0.36	1.8
TOTAL IN GEL	9.81	9.81	9.81	5.91	3.81	39.15
TOTAL IN GEL +45%	14.2245	14.2245	14.2245	8.5695	5.5245	56.7675

149. In the water domain, the weak organisation and expertise must be strongly supported by more contemporary and even advanced tools and know-how. The substantial investment of US$500 million to date has been an important step that needs to be carried through to its end with expertise and participation from experienced international companies that will contribute to making UWSCG a state-of-the-art organisation that will support the current and future development and needs of the Georgian people

150. In conclusion, we would like to extend the team's heartfelt appreciation for the generous collaboration and support from the UWSCG Headquarters and all the operators that have guided this mission. Together we have been able to identify the strengths and areas that need to be developed to transform the organisation into a professional world class entity.

5 Annex 1. List of the experts and of previous reports

DIETMAR JUCH NRW and LEAKS DETECTION EXPERT
SETEC Engineering GmbH & Co. KG,
Feldkirchnerstrasse 50, A-9020 Klagenfurt,
Austria
Tel.: +43 (0) 463 5808 272
Mobile +43 (0) 676 / 84 5808 279
Email: djuch@setec.at
Skype juchdietmar

JOSEF JUST HYDRAULIC MODELING and DMA EXPERT
SETEC Engineering GmbH & Co. KG,
Feldkirchnerstrasse 50, A-9020 Klagenfurt,
Austria
Tel.: +43 463 5808 269
Mobile +43 676 84 5808 269
Email: jjust@setec.at
Skype josefalle

ALAN BLAND CUSTOMER SERVICE AND ASSET MANAGEMENT EXPERT
AB-ility Consultancy Ltd.
Utility Regulation and Business Planning
Email: alanbland@ab-ility.co.uk
Land line: +44(0)1830 540330
Mobile: +44 (0)7776 258278

RODNEY CHAPIN ENERGY EXPERT + WASTEWATER
CEO, Ardurra International PTE LTD (Singapore)
Managing Director, Ardurra International LLC (USA)
p. +65 8453 1656
rchapin@ardurrainternational.com

JACQUES MANEM PROJECT COORDINATOR AND WATER OPERATION MANAGEMENT EXPERT
CEO SOLUTIONS CONSULTING
Tel +33 6 44 81 76 69
Email: j.manem@findsolutions.net

TITLE AND DATE OF THE 4 PREVIOUS REPORTS

WATER SUPPLY AND WASTEWATER SYSTEMS ASSESSMENT
IN 4 CITIES IN WEST GEORGIA, AUG 2018

ASSESSMENT, QUICK WINS
AND PROPOSAL FOR WATER MANAGEMENT
CITY OF KUTAISI, MAY 2018

INCEPTION REPORT
2st MISSION in GEORGIA
(11-17 Dec. 2017) JAN 2018
INCEPTION REPORT

1st MISSION in GEORGIA
(Nov. - Dec. 2017) DEC 2017

6 Annex 2. Report of the last mission of September 2018

This presentation was presented to the client at the end of the mission in September 2018

Preliminary Proposal for 5 Cities Operations

Tbilisi, 27 September 2018

1

TABLE OF CONTENT

- Main data of the 5 cities
- Water supply system
- Operation of the newly built Wastewater infrastructure
- Customer service and Asset Management
- Summary of the additional cost
- Conclusions

2

Main Data for the 5 Cities as of 2017

	Kutaisi	Poti	Zugdidi	Anaklia	Ureki	UWSCG
Nb of inhabitants	196,700	45,000	65,000	3000 + 15000 summer	2000 + 10000 summer	940,000
Nb of customers Water	65,000	17,000	21,000	1140	500	392,000
Nb of employees	290	99	56		-	2690
Total Revenue (million GEL) (% UWSCG)	9.94 (26.5%)	2.14 (5.7%)	0.9 (2.4%)			37.4
Utility (million GEL) (% UWSCG)	5.73 (37.2%)	0.16 (1%)	0.27 (1.7%)			15.4
Manpower (million GEL)	2.33	0.64	0.35			23.7
EBIDTA (million GEL)	1.16	1	0.15			(10)

3

Water Supply System in the 5 Cities

	Kutaisi	Poti	Zugdidi	Anaklia	Ureki	TOTAL
Distributed water (l/s)	1950	222 (summer)	360	35 (summer)	85	7900 (available)
l/inhabit/day	850	420	500	200	600	
NRW (%)	76*	45	-			
Water Resource	Well	Well	Well		well	
Network length, km	520 (200<5y)	197 (<10Y)	250 (new)	67 (2014)	69 New	

* First trimester 2018

5

Proposed Action Plan to Improve Network Management

- Install and run a Smart Network Management System (SNMS) to perform real-time network operation (see next slides). This SNMS should be associated with a new SCADA system.
- Define distribution zones and install flow and pressure loggers.
- Leak detection and repair (new material, training and leak repair kits)
- Implement computerized maintenance management system (CMMS)
- Develop a training program to set and maintain PRV (Pressure Reduction Valve)
- Review and upgrade the current Network hydraulic model
- Updated GIS tool and link it to the customer service database

7

Water Supply strengths and weaknesses

- Most of the network is new, and 100 % of the customers will eventually be metered.
- High quality and large volume of water resource.
- Wells Management should be reviewed to
  - insure long term sustainability of the ground water resource quality and quantity
  - lower energy cost.
- Network management should be much improved to reduce high NRW, provide continuous supply and decrease the energy cost.
- Kutaisi and Zugdidi are very hilly and therefore their networks are very complex to manage efficiently.
- H&S procedure and certification should be reinforced (Chlorine Gas, Work in Trenches, roadworks safety).

6

Benefits of this Action Plan

- Save energy (save at least US $ 1 million per year in Kutaisi)
- Detect invisible leaks more quickly and therefore save additional energy
- Increase revenue by helping located the commercial NRW
- Continuous supply 24/7
  - customer satisfaction and
  - high water quality
- Extent the life time of network

8

Smart Network Management System

Tool which make your network "Smart" for real-time operations

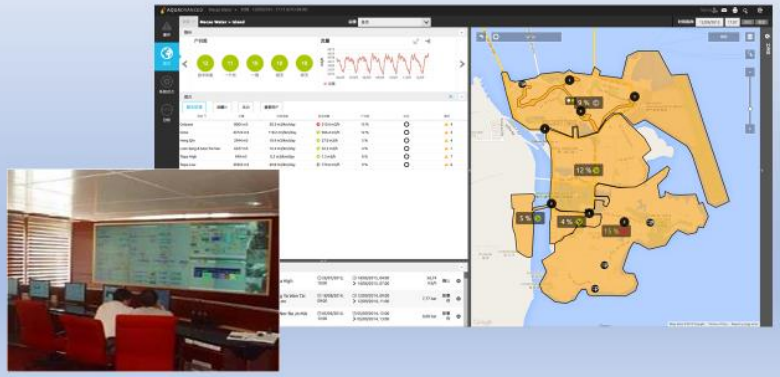
- Define distribution several Zones
- Smart network equipment in each zone (flow and pressure meters in each zone)
- Install tool that monitors and analyse in real time the water network performances
- Several such tools exist today on the market

Two examples in Macau and in Paris Suburb

9

Smart Network Management System : Macau (1)

Macau was divided in several distribution zones. Each zone equipped with flow and pressure loggers. The signals are sent to the control room for analyses by the smart system



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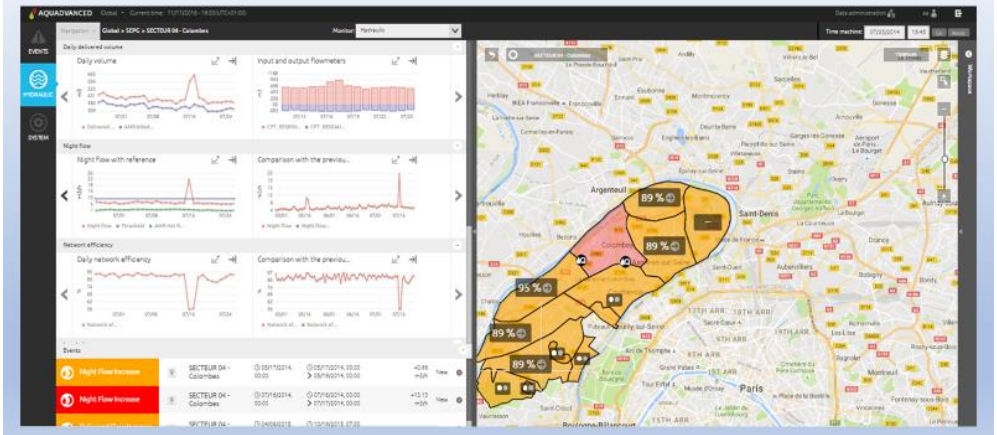
Smart Network Management System : Macau (2)

The central system analyse in continue 24/7 the flow and pressure data and compare them to the "normal range". In case of an anomaly it sends a message to the operator.

11

Smart Network Management System : Paris Suburb



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Smart Network Management System

- Check 24/7 all the data coming from the data loggers (flow, pressure)
- Automatically detect network anomaly (pressure, flow) using historical data, simple rules and the hydraulic model to react quickly to any incident,
- Some existing commercial tools upgrade the rules by themselves using daily data and AI algorithm.
- Operators receive a daily report with all the anomalies and should send crews to intervene on site.
- Easy follow up of parameters such as key costumer consumption, leaks …
- Calculate daily NRW according to historical rules, night flow and other smart meters every day in every zone.
- These tools are very efficient to train the operators since they incorporate the experience of many operators included in the rules.
- These tools are affordable and could be combine with a SCADA system

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Technology Facilitation

A centralized vision for UWSCG asset operations

SMART SYSTEMS TO COLLECT AND ANALYSE DATA

SCADA W, WW
Teams interventions
GIS
Data storage
Smart meters
Customer service
Asset management

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Expected Water Operating Costs over 5-Year Period

(additional revenue coming from the decrease of commercial NRW are not estimated)

Million GEL	2019	2020	2021	2022	2023	2024	TOTAL 20-24
Current Cost		**11,00**	**11,44**	**11,90**	**12,37**	**12,87**	**59,58**
Additional cost							
Zugdidi, Anaklia, Ureki, Poti energy		0,7	0,7	0,7	0,7	0,7	3,50
Saving Kutaisi energy		-0,5	-1,2	-1,9	-2,6	-2,6	-8,80
Additional local MP		0,53	0,88	0,88	0,88	0,88	4,04
Material		5,5	4,5	2,35	1,2	1,2	14,75
Total additional cost Water		**6,23**	**4,88**	**2,03**	**0,18**	**0,18**	**13,49**
TOTAL COST		**17,23**	**16,32**	**13,93**	**12,55**	**13,05**	**73,07**

Operation of the newly built Wastewater infrastructure

- Wastewater Systems – Very Different Than Water Systems
- Wastewater Systems – Advantages & Challenges
- UWSCG 5 Cities - Wastewater Collection
- Pumping Systems in Series – Vulnerabilities
- UWSCG 5 Cities - Wastewater Treatment
- Ureki WWTP
- Wastewater Operating Costs by City at Full Operation
- Wastewater – Suggested Capital Investment

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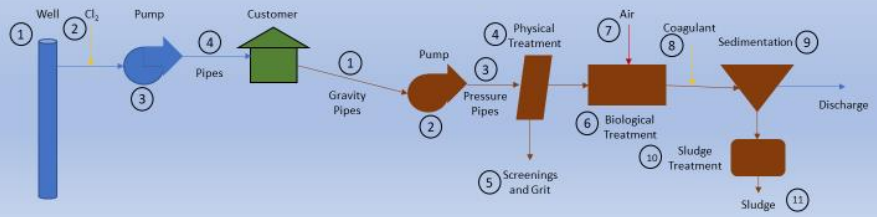
Wastewater Systems – Very Different Than Water Systems

- Water System
  - Must produce what the customer demands
  - Pressure system
  - Physical/chemical treatment
- Wastewater System
  - Must be able to transport and treat what you receive
  - Gravity and pressure system
  - Biological, physical and chemical treatment



Wastewater Systems - Advantages

- Improved Health and Sanitation
- Cleaner Environment
- Improved Economic Prospects
  - Tourism (cleaner beaches)
  - Industry
- Opportunities to Generate Additional Revenues
  - Reuse of Treated Wastewater
  - Biogas
  - Soil Amendment Products

Wastewater Systems – Challenges

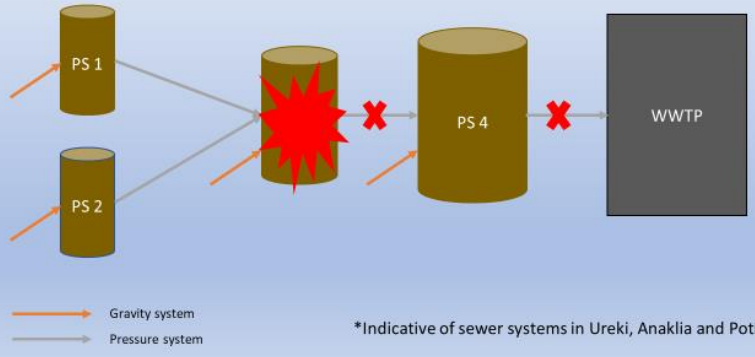
- Operational
  - Pressure and Gravity System cleaning and maintenance
  - Biological treatment systems
  - Sludge handling
- Safety
  - Confined space and hydrogen sulfide gas
  - Pathogens
  - Large mechanical and electrical equipment

UWSCG 5 Cities - Wastewater Collection

System	Number of PS	System Description	Expected Commissioning
Ureki	30	Gravity and series pumping system	January 2019*
Anaklia	42	Gravity and series pumping system	January 2019*
Poti	28	Gravity and series pumping system (split into two systems for two WWTP)	June 2020*
Zugdidi	23	Gravity system with pumping stations to lift into gravity system (no series pumping to WWTP)	June 2020*
Kutaisi	Unknown	Not yet designed	Unknown

* House connections are responsibility of homeowner and may not be connected at this time

Pumping Systems in Series - Vulnerabilities



*Indicative of sewer systems in Ureki, Anaklia and Poti

UWSCG 5 Cities - Wastewater Treatment

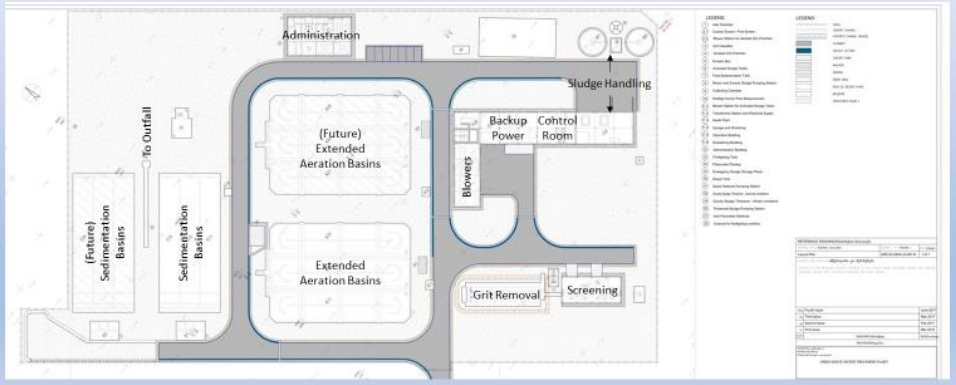
Facility	Design Dry Weather Capacity (m^3/day)	Type of Treatment	Expected Commissioning
Ureki	4,100	Extended Aeration with Nutrient Removal	June 2019
Anaklia	2,400	Extended Aeration with Nutrient Removal	June 2019
Poti 1	12,000	Conventional Activated Sludge with Biological Nutrient Removal	June 2020
Poti 2*	5500	Conventional Activated Sludge with Biological Nutrient Removal	June 2020
Zugdidi	10,500	Conventional Activated Sludge with Biological Nutrient Removal	June 2020
Kutaisi	Unknown	Not yet designed	Unknown

* Plant was constructed in 2012 but has not been operated and may require capital investment before operation

Wastewater Treatment System Operations

- General Conditions
  - Advanced wastewater treatment
  - High standard of equipment
  - High level of automation
- Operational Challenges
  - Nutrient removal requires highly competent process operators
  - Flow variations in resort cities complicate operations
  - High level of automation requires constant maintenance and upkeep

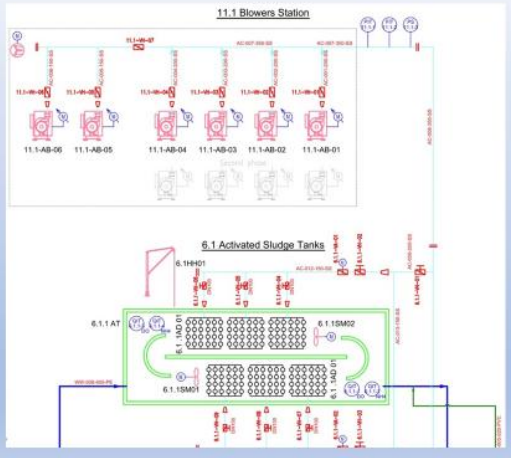
Ureki WWTP



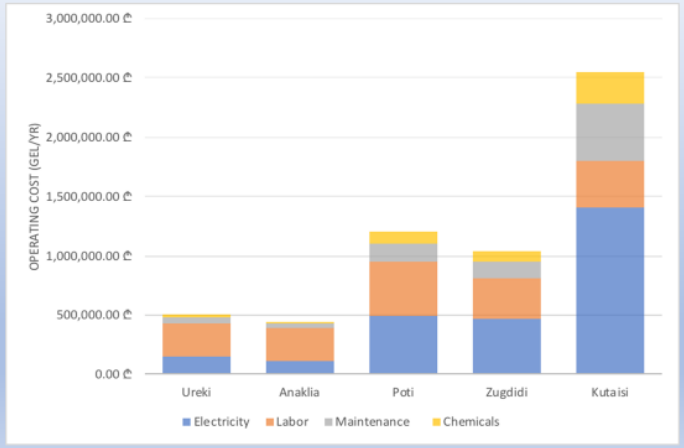
Ureki WWTP

Automation

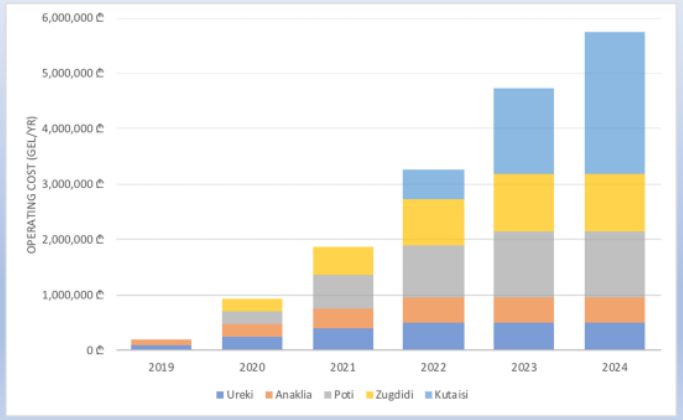
Aeration Control System Process Diagram



Wastewater Operating Costs by City at Full Operation



Wastewater – Expected Operating Costs over 5-Year Period



Wastewater – Suggested Capital Investment

Item	Number	Total Cost (GEL)
Pump Station Smart Monitoring Systems	150	950,000
Computer, Software and Hardware	3	18,000
Vacuum Cleaning Trucks	3	2,250,000
Close-Circuit TV Inspection Equipment	3	150,000
Backup Power Systems for Pump Station	25	1,250,000
	Total Capital Cost	**4,618,000**

Wastewater Collection System Operations

- General Conditions
  - Pressure systems with pump stations in series in most cities
  - Some systems are designed for seasonal operation (with dual pressure pipes and high/low operating conditions)
  - Little or no backup power systems are in place
  - SCADA is limited
- Operational Challenges
  - Many mechanical and electrical devices to monitor, control and maintain (versus a gravity system)
  - Lack of SCADA will require constant physical monitoring and slow response during emergency conditions
  - Series configuration means one failure can shut down the entire wastewater system
  - Each pump station will fail during a power outage and require startup

Customer Services and Asset Management

- Customer Services Current Situation Assessment
- Customer Services Next Steps
- Asset Management Current Situation Assessment
- Asset Management Next Steps

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Customer Services Assessment

Central Functions

- Bespoke billing system and CRM system developed in-house
- Both work well but lack some data links to other systems
- May not be easy to adapt to future requirements, e.g. AMR / AMI

Distributed Functions (Service Centres)

- Meter readers / inspectors perform well with aid of tablet technology
- Good collection ratio for metered customers, probably due to disconnection policy (but this is not very customer-friendly)
- Not so good collection ratio for unmetered, but full metering not too far away
- Commercial losses mainly due to illegal re-connections and broken meters

Current Situation Assessment (2)

Tariffs

- Residential tariffs low by European standards
- Cross – subsidy from commercial / industrial customers to residential
- Previous government subsidies
- Both forms of subsidy not allowed by Water Framework Directive, so if Georgia joins EU, would need to change
- Tariff application due in 2019, but likely outcome unclear presently
- Increased tariffs to support much-needed investment may be offset against required efficiency improvements
- Increased manpower resources needed for meter reading as new meters installed may limit scope for efficiency improvements

Customer Service Next Steps (1)

Tariffs

- Tariff application due in 2019, but likely outcome unclear presently
- Increased tariffs to support investment may be offset against required efficiency improvements
- Engage a discussion on tariff with the regulator:
  - Appoint a project manager
  - Engage an international regulation expert
  - Tariff structure is very important to address affordability

Customer Services Next Steps (2)

Finance want ERP software for financials

- Likely that UWSCG implement a financial ERP
- Further study to be done on implementation and costs
- Recommended to implement it integrating asset management and customer services
- Expensive solutions if only limited to finance
- Assess well the time and engagement needed from company and management

Customer Services Key Issues (3)

3. Customer-Facing Policies
   - Compared to US and European water utilities, UWSCG policies are not very customer-friendly
   - Normal elsewhere to issue at least 2 warnings before disconnection for non-payment
   - Also normal to offer choice of payment options, including budget accounts
   - Banking facilities exist in Georgia to permit monthly fixed or variable payments, but are not used by UWSCG
   - Customers experience customer-friendly companies elsewhere and this raises expectations

Asset Management Current Situation Assessment

Early Stages of Development

- No real history of Asset Management in UWSCG, which is probably the main cause of dereliction evident in operational assets
- But Asset Management as a complete process and discipline has emerged only recently anyway
- In the UK, the main driver has been the regulatory framework, put in place 28 years ago

Asset Management Next Steps

Asset management system to be put in place

- Asset inventory/ register (on going)
- Assets requiring maintenance to be identified (criticality)
- Asset management plan and systems including prioritization criteria
- Link with financial system
- Service ability modeling of the network

Asset Management : Next steps(2)

2. Network Modelling

- Water networks should be routinely modelled, to:
  - Identify areas of low water pressure needing boosting or reinforcement
  - Identify areas of high water pressure needing pressure reduction
  - Enable good design for network extensions or reinforcements to minimize service failures
  - Set up DMAs for leakage control purposes

Summary of the preliminary additional cost estimate for Water and Wastewater Operation in the 5 cities (GEL million)

	2019	2020	2021	2022	2023	2024	TOTAL 20-24
WATER							
Net additional energy	0.35	0,2	-0,5	-1,2	-1,9	-1,9	-5,3
Additional local MP		0,53	0,88	0,88	0,88	0,88	4,04
Material		5,5	6,7	2,75	1,6	1,6	18,15
Total Water	**0.15**	**6,23**	**7,08**	**2,43**	**0,58**	**0,58**	**16,89**
Wastewater							0
Energy cost	0.05	0,32	0,7	1,3	2,1	2.6	4,42
Manpower + Chemical + Maintenance	0.14	0,6	1,2	1.9	2,7	3,1	7,6
Material and Infrastructure		2,3	2,3				4,6
TOTAL Wastewater	**0.19**	**3,22**	**4,2**	**3,2**	**4,8**	**5,7**	**21,12**
Large infrastrucutre for W and WW		5	8	5	3	5	26
Expertise and Management		14,22	14,22	14,22	8,57	5,52	56,77
Consultant follow-up/Institutional		1,5	2,5	2,5	1,5	1,5	9,5
TOTAL		**30,18**	**36,00**	**27,35**	**18,45**	**18,30**	**130,28**

CONCLUSION WASTE WATER (1)

- UWSCG is currently building a entirely new wastewater system that requires additional investment, expertise and management.
- Advanced Wastewater Treatment plants with very variable flow (coastal cities) required advanced level of operational and management expertise. Safety concern are significant and different from water system (H2S, confined space)
- The cost associated to this new infrastructure in the 5 cities was evaluated at around GEL 6 million per year for operation (energy, labour and maintenance and chemical) and an additional investment of GEL 5 million for support system (Truck, back up power, Monitoring system…)

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CONCLUSION WATER (2)

- UWSCG challenges in the water supply system are to
  - Decrease energy level
  - Significantly decrease NRW
  - Increase revenues and
  - Supply all customer 24/7
  - Transform the customer experience
- New infrastructure are available in the 5 cities. Because of significant elevation changes in two of the main cities and high flow variations during the year in the others, day-to-day management required advanced management tools such as SMART and SCADA systems.
- Customers services and Asset Management action plan required a strong collaboration with the HQ (national level process) and may require a new IT system

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CONCLUSION (3)

- UWSCG challenges in the water and wastewater systems provide the opportunities to pilot a new management approach by implementing a PPP for these 5 cities.
- This PPP will bring a internationally experienced operators which has proven track record in similar situations.
- The solutions implemented in these 5 cities could also be used by UWSCG in other part of Georgia

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Proposed project impact, outcome, outputs

Impacts the Project is Aligned with

- Living conditions, health and economy improved in selected cities
  - Government priorities
  - Universal access to safe and affordable drinking water for all by 2030 (Sustainable Development Goal 6)

Outcome:

- Quality, affordable and sustainable WSS services delivered in selected cities

Outputs:

- **Technology facilitated**: Deployed proven, user-friendly ICT-based and energy-efficient solutions
- **Organization developed:** Improved efficiency, management, operation and delivery of services

To be delivered through **enhanced project management support**

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Organization development

- Sustainable and efficient asset management and operation requires "long term investment in capacity development"
  - Government commitment to steer direction (policy, regulation, org restructuring)
  - Organization to lay the ground (adequacy of staff and skills-mix; systems infrastructure and integration) for clear accountability and incentives, and implement
- Public-Private Partnership pilot in select cities (3-4) introduced
  - To demonstrate a sustainable and efficient business model
  - Private operator using a performance-based contract
  - Day to day management including HR decisions
- Institutional/key stakeholder strengthening
  - Enabling environment for tariff adjustments via increased clarity in accountability and authority of GNERC
  - Consumer behavioral change (water conservation, hygiene awareness, etc)

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Project Value Additions

Easy to replicate and scale up

PROMOTING **INNOVATION** THROUGH:

- OPERATIONAL INTERVENTION: Integrated HLT and smart technology solutions
  - Smart and user-friendly
  - Resource-efficient
  - Effective asset monitoring, data analysis (basis for strategies and planning) and management
  - Efficient billing and collection
- ORGANIZATIONAL INTERVENTION: Introduced change management and processes
  - Solicit private sector expertise
  - Performance/results-based
  - Transfer its know-how to support managerial and operational empowerment of UWSCG employees
  - Operational streamlining using ICT technologies

Others:

- Climate change mitigation and adaptation
- Multi-dimensional support (gender, safeguards, poverty)
- Complementing USIIP and other key development partners' infrastructure support

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Modality
Indicative cost, financing, readiness

- Project loan
- ADB loan allocation: $50 million

Source	Amount ($ million)	Share of Total (%)
Asian Development Bank		
Ordinary capital resources	50.0	84.7
Government[a]	9.0	15.3
Total	**59.0**	**100.0**

[a] Government contribution includes taxes and duties.
Source: Asian Development Bank estimates.

- TRTA resources: $750,000

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Likely categorization

Provisional categorization

- Project is likely to be "low risk"
  - Loan amount $50 million
  - Executing agency has implemented externally funded projects including USIIP
- Safeguards
  - Environment – B
  - Involuntary resettlement – B
  - Indigenous peoples – C
- Procurement – A
- Gender – Effective Gender Mainstreaming

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Project Readiness: Targeting "HIGH"

- Early preparation is essential for successful project implementation

Readiness Milestones	Timeline
• Preliminary feasibility studies (financed by CDIA)	ongoing (additional 3-4 cities)
• Feasibility assessment and project preparation	TRTA also includes consultants to help EA/IA prior to mobilization of consulting firm for the ensuing project
• RFP for project management consulting firm	issued prior to SRM
• RFP for PPP (with private operator)	issued before Board date
• IFB (for supply contracts)	launched before Board date

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Indicative Processing Schedule

MILESTONE	TARGET DATE
Clearance of project concept/TRTA paper	September 2018
Mobilization of TRTA consultants	December 2018
Loan fact finding and MOU signing with the government (MRDI)	July 2019
Loan negotiations with the government (MOF)	November 2019
ADB Board consideration	Q1 2020
Loan signing	Q2 2020

➔ **Issue invitation for PPP bids by Q4 2019**

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Key development partners

- EIB – Construction of sanitation network and WWTP in Kutaisi. Loan contract signed – 15 October, 2015. Loan EUR100 million + Grant: EUR4.75 m (NIF) and EUR3.25 m (EPTATF). Total four lots to be tendered under the loan: 3 for sanitation network, 1 for WWTP. In the process of selecting consultant for supervision & design.
- KFW – Construction of WSS Systems and WWTPs in Samtredia, Vani, Baghdati and Stefantsminda under discussion (approx. EUR50 m). Only grant agreement has been signed (EUR1.65 m) to finance feasibility studies. Detailed design preparation and construction works will follow to be financed by loan.
- AFD - Construction of WSS networks and WWTP in Khashuri under discussion (approx. EUR45 m). Ongoing preparation of the detailed design funded by the government.

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7 Annex 3. Detailed analysis of customer service proposed plan.

7.1 Meter Installation

151. There are some problems with currently installed meters, mainly concerning meter access and protection. These need to be corrected and the standards of new meter installations improved. Most of the domestic meters in Georgia are quite new; there were no domestic water meters in use before 2010. Early meters were Class B, but all more recent installations are Class C.

7.2 Meter Protection

152. Little care and no consistent design appear to have been applied to metering installation following the installation of new networks. Some meters have been installed outside the property boundary, in the street, but many others have been installed within the boundary, often adjacent to an external house wall (as in the Figure 9 example below).

153. As is clear from the Figure 9 example, meters are often exposed and vulnerable to damage. In this case, the resident has tried to provide some protection by covering the meter with a piece of scrap aluminium. Even where actual damage is prevented, easy access at ground level allows children to deface the QR code inside the lid of the meter, making it unreadable by the meter reader's tablet (used to record the meter details and consumption index).

154. Many domestic meters are installed at just below ground level inside plastic meter boxes, but, as Figure 10 shows, the boxes allow water ingress following rain, creating condensation that requires the meter window to be wiped clean before reading is possible, or if the dampness has penetrated the meter casing so that condensation is present on the inside, reading becomes impossible (as in this case). Note the paper QR code is also missing, which is not surprising in the damp conditions.

155. The best solution is to relocate the meter by providing a wall-mounting where possible, as in Figure 11. This is actually at the entrance to an apartment block, where a single meter for the whole block is being replaced with individual meters. This has required the internal plumbing of the block to be replaced and replicated for each apartment.

156. If wall-mounting is not possible, a good quality plastic meter box at ground level should be used that is secure and prevents water ingress.

Figure 9. Domestic meter installation in Kutaisi

Figure 10. Poor quality meter boxes

Figure 11. Wall-mounted lockable meter boxes

7.3 Meter Replacement

157. It is standard practice to replace meters at the end of their assessed useful lives, even those that are still working, based on probable reduced accuracy. Meters have usually been initially installed, or replaced, in batches, so it is better to replace an entire batch than to wait for individual meters to run slow or stop (the eventual fate of all mechanical meters).

158. However, different meter types and those from different manufacturers have different useful lives, which also depend on water quality and climatic conditions. Judgment of the best time to replace is aided by statistical sampling from the population of meters. A programme of meter testing will build up a database of meter accuracy which can then be used to develop an economic annual meter replacement programme. UWSCG currently only tests meters if customers complain, but since early meter installations are now up to 8 years old, the meters involved could well be displaying inaccuracies. A meter testing programme should be initiated, using the test bench in Kutaisi that already exists.

7.4 Commercial Losses

7.4.1 Definition

The definition of commercial losses is that element of non-revenue water (NRW) that is not due to physical leakage from the network. The calculation of NRW is based on the difference between the flow delivered into the network and the volume billed to customers, as per the following equation:

NRW (m3) = Sourceworks output (SO) – Total quantity billed to customers (TQB) in a specified period

NRW is normally expressed as a percentage of the source works output, so:

NRW% = (SO – TQB)*100 / SO

159. There are measurement difficulties with this equation, since SO can be inaccurate due to metering inaccuracies at source works. In some of the 5 cities (notably Kutaisi), some source works meters are either malfunctioning or non-existent, in which case output is estimated from pump characteristics and power consumption, but power may also be estimated since there are no electricity meters in some key locations.

160. TQB also contains an element of estimation, since some customers are unmetered. Their bills are based on an assumed consumption of 300 l/h/d, multiplied by the household occupancy rate (where the information is available), or a rate of 2.5 persons per household (average for Georgia) where there is no information.

7.5 Excess Unmetered Consumption

161. If, on average, unmetered customers use more than 300 l/h/d, then the excess unmetered consumption represents one source of commercial losses. Other sources, discussed later, are:

- Illegal connections
- Illegal re-connections after disconnection for non-payment
- Customer meter inaccuracies (already discussed in section 6.3) due to damaged meters or meters running slow
- Billing inaccuracies caused by the impossibility of manually reading all meters simultaneously (but these average out over the course of a year)

- Non-registered customers, whose details are not entered in the customer database (these may be legal connections, but the customers never receive a bill)

162. UWSCG Customer Services staff suspect many unmetered customers use more than 300 l/h/d because they have elevated storage tanks on the premises to cover scheduled periods of non-supply for rationing purposes. A typical installation is shown below in Figure 11.

163. The favourite hypothesis is that customers allow the tanks to overflow, rather than shut off supply during periods when supply is available, but it is also thought that some customers drain their tanks after each scheduled period before re-filling to refresh the stored water in the tank. In Figure 12, the overflow pipe and drainage pipes are clearly visible, as also is the supply pipe and valve. Note that the drainage valve can only be reached by climbing the ladder.

Of course, metered customers also have elevated storage tanks, since their purpose is to cover periods of non-supply. So, when an urban area of unmetered customers subject to rationing is metered for the first time, it would be expected that the excess consumption due to wasted water would be revealed in newly-metered supply data. There is no real evidence of this; the average metered household consumption is 140 l/h/d – less than half of the assumed 300 l/h/d for unmetered customers.

Figure 12. Customers use elevated storage tanks to overcome rationing

164. Elevated storage tanks like these are vulnerable to contamination from birds and rodents. In the interests of public health, they should be removed once they are no longer required when continuous supply is restored. However, this is likely to take some time and may also require legislation.

165. Completion of household metering will eliminate this source of commercial losses, leaving only the other sources, listed earlier, and physical losses, to explain high NRW.

7.6 Illegal Connections

166. In urban areas, illegal connections made above-ground are fairly easy to identify, so they are more likely to be below ground. If the purpose of the illegal connection is to bypass the meter to avoid a normal bill for a metered household, the anomalously low meter reading will attract attention (either by the meter-reader or through the routine consumption analysis carried out by UWSCG HQ). If it is to supply neighbouring properties, then the low metered consumption of those households will attract attention. The most likely properties to have illegal connections are commercial properties, such as hotels, especially those with swimming pools installed. Since it is fairly easy to obtain information on hotel capacity, a check calculation will reveal whether the hotel appears to lack clients during the tourist season.

167. UWSCG Customer Services staff believe illegal connections are more likely in rural areas. Owners of smallholdings and larger farms need irrigation water and / or water for animals, so the temptation in low-income agricultural areas to make illegal connections is great. UWSCG recently identified a farmer who filled his large farm reservoir through an illegal connection.

168. Locating such examples is best achieved by dividing rural areas into districts and inserting bulk meters in the network. Water balance calculations will then highlight either physical leaks or illegal connections, both of which may be present, but illegal connections are less likely to run constantly. If the meters are connected to SCADA, the flows can be monitored remotely.

169. it is also compulsory and should be a routine task to go in the field and check the network. The meter readers should also have an important part in the search for illegal connection. They could be incentivised.

7.6.1 Illegal Reconnections

170. UWSCG currently gives no warning of disconnection. If payment is not made by the due date, disconnection procedures are activated. This is not very customer-friendly and probably gives rise to many complaints directed to GNERC. It also leads to illegal reconnections, since it is fairly easy to remove the seals on the valves that isolate the supply. Customers will not tolerate loss of supply for an extended period if the failure to pay on time was due to an excusable oversight or family crisis.

171. There are actions that could be taken to combat illegal reconnections, such as a heavy fine for interfering with the meter, or a fee for reconnection by UWSCG (which would be a deterrent to non-payment). But a better strategy is to identify those customers who have difficulty in paying (perhaps only temporarily) and distinguish them from those customers who can pay but believe they can avoid paying. Usually the number of customers deliberately avoiding payment is very small, except where it is part of a protest movement.

172. Customers with payment difficulties should be offered assistance, in the form of flexible payment options, for example. This approach would reduce the need for disconnections – and therefore avoid so many illegal reconnections. However, this relies on changes in UWSCG policy in the matter.

173. Finally, it should be remembered that disconnection practices reduce revenue, because they deny access to the company's product, whereas rapid reconnection (even if illegal) restores revenue as long as the meter remains accurate and the customer can be persuaded to make payment. So, there is no overall commercial loss unless it becomes impossible to obtain payment as part of normal debt recovery procedures.

7.7 Non-registered customers

174. These are "invisible customers", because there is no record of them on the customer database. It can occur due to administrative error, when a new customer's details are not added, although the lack of customer detail will be obvious if the meter details are present. More likely is the situation where a new connection is made but a meter is not installed. UWSCG is making new connections in cities where previously the residents relied on private wells, so any invisible customers need to be identified.

175. Meter readers need to be trained to identify residential premises that are not part of their reading schedule, so that the presence or absence of a meter can be checked, but GIS can also be used to highlight possible invisible customers if the customer database addresses and meter numbers are mapped onto GIS. This is a desirable objective anyway.

7.8 Billing

7.8.1 Bill Delivery

176. UWSCG uses meter readers / inspectors to deliver bills as well as reading customer meters in line with their scheduled monthly round. Some customers have opted for bill delivery by SMS, which of course saves some of the cost of billing. It also means the customer provides a mobile phone number, which could be used to contact the customer to query a missed payment or issue a warning about service problems.

177. The PPP should mount a publicity campaign to inform customers about the SMS option and explain the advantages over paper billing. SMS messages can also be sent to customers affected by unexpected loss of supply due to bursts, or to issue “boil water” warnings when contamination of the supply has been detected. This is an additional service that puts a more human face on UWSCG, even though the message may be negative.

178. The PPP could also pilot a customer portal to provide internet-based billing and payments. Initially it would be limited to a small sample of customers willing to participate in a trial, using the UWSCG website, but then it could be extended by the development of an app for use on a mobile phone. Of course, this will require the agreement and cooperation of UWSCG.

7.8.2 Bill Payments

179. If the PPP is to show a more human and caring face towards customers within the five cities, it should try to introduce more flexible payment options, such as budget accounts. Provided they are designed carefully, they will increase UWSCG cashflow, rather than reduce it, but they provide low-income customers with certainty over their own monthly budgeting.

180. This will obviously require close cooperation between the PPP and UWSCG, in particular with the call centre in Tbilisi. Call centre agents are the most likely people to be able to identify vulnerable customers

8 Annex 4. Proposed detailed action plan for the main activities

8.1 Proposed water distribution and supply action plan

181. This section gives more details on the actions plan for each basic function and the overall preliminary budget.

182. It details the basic technical and institutional functions, but it is important to keep in mind that both have to be done in parallel.

183. The following action plan is not exhaustive but gives an overview of the main actions to be done by the partnership.

8.1.1 Basic review of the existing situation and emergency repairs

184. Existing documents and records have to be examined during this phase. The basic review of the existing situation should be a practical diagnostic of the system and not be limited to a theoretical study only.

185. Flow and pressure measurements and pilot area investigations shall provide base data for the planning of any further measures. Emergency repairs will also be done during that phase.

Pressure monitoring program

186. A pressure monitoring program within the transmission and distribution system has to be carried out to record the present supply situation. Pressure will be recorded continuously at different locations for several days. A repetition of these pressure measurements (at the same locations) after introduction of non-revenue water reduction measures will enable the water utility to demonstrate achieved improvements of the supply situation (longer supply times, higher supply pressure).

Flow measurement program

187. In parallel with the pressure monitoring program, flow measurements shall be done at strategic points of the transmission and distribution system such as production facilities, outflow pipes of reservoirs or inflow points to supply zones in order to get a clear picture about water distribution.

Quantification of non-revenue water and its components

188. In addition to the evaluation of the results of flow and pressure measurements of the entire supply system, detailed investigations (inflow and consumption measurements) shall be carried out in at least two representative pilot areas. To establish and to isolate the pilot areas will often require the installation of boundary valves and some house water meters.

Losses on trunk mains shall be assessed separately.

189. A first estimation of non-revenue water components (physical and non-physical losses like leakage, wastage, illegal withdrawal, metering and estimation errors) has to be made. The influence of increased pressure and longer supply times on losses must be assessed.

Review of repair statistics

190. The review of existing repair statistics will give valuable information on the condition of the distribution system. In case no statistics are available, the water utility shall be urged to start immediately with records.

Water quality and water related public health

191. The impact of water borne diseases on public health shall be investigated. It is proposed that the Georgian health authorities should be involved

Intermittent supply

192. The consequence of too low or negative pressure in the distribution system (waste water can penetrate into pipes through leaks) and supply interruptions (consumers are forced to store drinking water in unhygienic private storage tanks) should be investigated.

Insufficient system extension

193. Data about public health of that part of the population which is not served by the public supply system (unsafe drinking water, directly withdrawn from private wells, lakes and rivers or supplied by water tankers is used) should be collected.

Emergency repairs

194. Emergency repairs shall be carried out during that phase whenever necessary but should be limited to punctual interference only. Repair work should be carried out by the water works' maintenance team. The partnership will provide proper repair materials and tools, train the maintenance staff adequately, supervise the repair works and give technical assistance.

8.1.2 Mapping

195. We strongly recommend establishing a GIS Department and the first task will be to check the location, completeness, accuracy and quality of current GIS. A local team shall be established and trained by the operator to work as follows:

-compare the situation on-site with existing GIS documents,

-draw in missing key assets,

-digitization of the situation found on the spot. (constructing the key assets into the GIS plan, in the course of the survey all street names will be included in the plan)

196. Than, the local team should be trained to do the GPS survey (in cm quality, xyz) and terrestrial survey on site à 1 km / day of marked* points for survey.

197. Mapping activities and digitization of map must be done by utility personnel all the time to continuously update the GIS.

198. UWSCG should also provide Satellite images - Digital Elevation Model – cadaster and geo-referenced addresses.

8.1.3 Operation and maintenance

System operation

199. System operation shall include all activities needed to run the water distribution system, such as the operation of pumping stations and reservoirs according to the actual water demand, the control of water pressure in all supply zones as well as emergency measures in case of major bursts, break downs or power failures.

Controlling and monitoring

200. Operational data need to be recorded (for instance running times of pumps, operation of strategic valves), some on a quarterly or monthly basis, some on a weekly or even daily basis.

201. Production metering, district metering, consumption metering (metering and billing department) as well as pressure monitoring shall be carried out continuously and with the maximum use of data logger technology. Performance indicators such as the water balance, the non-revenue water rate or minimum night flows shall be established on a regular basis.

202. A full SCADA system and a smart operation system should be implemented as soon as possible to improve water distribution system and to be used as a main training tool for the local team.

Preventive maintenance

203. In order to keep the utility plant in good condition, systematic routines for inspection, cleaning or lubrication shall be introduced (for instance operation of valves or flushing of fire hydrants at regularly intervals).

204. The minimum night flow into supply zones should be recorded as reference values. In regular intervals (quarterly), measurements shall be repeated, and the inflow observed; significant increase in the minimum night flow shall be the reason to start a leak detection campaign within the respective zone.

205. Defective pipe sections shall be pre-located with step tests. Exact leak location shall be carried out by direct and indirect sounding as well as by leak noise correlation. Detected leaks shall be repaired immediately.

206. In order to maintain the measurement accuracy of water meters, they have to be removed at regular intervals, tested and if necessary repaired and/or calibrated. The establishment of a meter repair shop is recommended. A meter testing facility already exists in Kutaisi but is not used much because of the current policy of only testing customer meters if there is a complaint.

Capacity building

207. All needed materials, tools, instruments, machinery, service vehicles as well as hard and software for operation and maintenance have to be procured. The establishment of a general store and workshops is recommended.

8.1.4 Strengthening of the existing distribution system

Hydraulic Modelling

208. As a minimum the following data of the project area will be required and prepared in previous activities:

- Location, diameter and material of main pipeline digital data from GIS
- Location and capacity of reservoirs, wells and pumping stations
- DEM (Digital Elevation Model) and Geodetic heights of Reservoirs and Pump stations,
- Water production and consumption statistics
- Digital topographic block maps and/or actual satellite images
- Population actual

209. All obtained data will be carefully analysed. The backbone of the model, containing transmission and main distribution lines as well as production and storage facilities will be processed. Nodes and pipes will be defined for the model data base.

210. Flow and pressure measurements will form the basis for reliable figures on the pressure conditions and supply characteristics of the water distribution system. The recorded pressure data will also enable the client to demonstrate improvements of the supply situation caused by the implementation of rehabilitation measures.

211. Once the hydraulic model is established, different hydraulic situations are simulated (min./max demand and special supply conditions if required). Among others, the impact of system improvement measures and network extensions on the supply conditions can be calculated.

212. The results of the network calculations will be presented in form of tables and graphics. Values of importance will be: flow velocity, flow rate, network pressure, absolute pressure and pressure loss.

213. Most important for further evaluations will be the graphical presentation of network pressure in combination with flow velocity.

Transmission mains

The transport capacity of transmission mains and their condition has to be verified. If possible, existing transmission mains should be rehabilitated, otherwise mains have to be replaced or additional ones installed.

Distribution network analysis and optimisation

214. A first rough network analysis shall reveal existing bottlenecks and provide the basis for the design of distribution network strengthening measures.

Network zoning and installation of bulk meters:

215. According to the extent as well as the geographical and geodetic structure, the distribution network may have to be divided into several supply zones. These zones should be separated from each other by permanently closed boundary valves and supplied through well-defined and metered inflow points.

216. This arrangement is necessary to manage pressure at different altitude levels, to provide adequate but not excessive pressure, to control the water distribution and to allow leakage control by waste metering.

217. Repair, replacement or installation of new distribution mains and fittings:

218. Defective distribution mains have to be repaired or replaced. Although large network extensions should be avoided during this phase, it might be necessary to lay some new pipelines in order to increase the transport capacity of the existing distribution network, and to install some first extensions to unserved areas.

219. An adequate number of gate valves, fire hydrants, washouts and air valves has to be installed and/or replaced in order to ensure proper system operation and maintenance.

- Pumping stations

220. Flow and pressure measurements carried through during the basic review of the existing situation (measures of first priority), as well as existing technical documentation about pumps, will give valuable information about the installed pumping capacity.

- Reservoirs

221. The storage capacity of the distribution system and the condition of the reservoirs have to be verified. If possible, existing reservoirs should be rehabilitated, otherwise new reservoirs have to be constructed. Bulk meters have to be installed at all reservoir outlets.

- Service connections

Repair, replacement or installation of new service lines:

222. Defective service lines have to be repaired or replaced. The installation of new service lines during this phase shall only to be taken into consideration, if the available water quantity is sufficient and the supply of already connected so that consumers are not endangered by the increased water demand.

223. The installation of public standpipes might be a reasonable and provisional solution to provide safe drinking water to previously not supplied areas.

Installation of consumer meters and meter calibration:

224. Consumer meters shall be installed at all service lines. For this task close co-operation with the metering and billing department and the mapping department will be necessary

(consumer number, meter number, cross reference to individual zones). Adequate protection for consumer meters has to be foreseen (meter boxes, chambers or indoor installation).

225. Existing working consumer meters have to be removed temporarily for accuracy tests and, if possible calibrated and re-installed or replaced. For this purpose (and also for preventive meter maintenance) a meter test bench has to be procured.

Staff training

226. On-the-job-training and transfer of technology will be achieved by involving the water utility's staff into all planning and construction activities. The maintenance teams will therefore extend their knowledge and know-how on the network. They will also contribute in leading the project to success, by providing their knowledge for design and planning activities.

8.1.5 Feasibility study for system extensions

227. Planning of major system extensions and capacity improvements should not be started before the existing distribution system is strengthened technically and institutionally and before the supply situation has improved substantially.

228. Water losses have to be reduced to the lowest possible level in order to have sufficient resources for the supply of additional consumers.

Establishment of a calibrated hydraulic model

229. A **calibrated** hydraulic model can only be established as one of the last project measures. A prerequisite for this is the availability of adequate digitised network drawings showing all distribution pipes of the sizes DN 80 and bigger; also, the network has to be easily operable (working bulk meters and fire hydrants, tight valves) and its functioning well known.

230. The yearly water consumption (from billing data) is allocated to the supply districts. Calibration measurements will be carried out (only if continuous water supply is assured) in order to adjust the hydraulic model to the real flow and pressure condition.

Design of system extensions

231. System extensions shall be added to the hydraulic model for the optimisation of the complete extended distribution system. The water demand forecast will deliver the consumption figures, necessary for the calculation of future load cases.

232. Once the general concept is established, individual extension measures shall be given priorities. Their scope and time of construction will depend on the available funds.

233. This part of the action plan will require several experts as in.

234. As was identified during the 3rd and 4th missions for the current TA assignment, significant opportunities for energy savings exist. Those are mostly related to the operations of the major pumping stations, but savings can also be gained through hydraulic improvements related to the modelling after the correct mapping done.

8.2 Proposed Energy management action plan

235. As was identified during the 3rd and 4th missions for the current TA assignment, significant opportunities for energy savings exist. Those are mostly related to the operations of the major pumping stations, but savings can also be gained through hydraulic improvements related to the modelling

Action Plan

236. An operations expert and electrical/energy expert should be employed as a part of the larger team to focus on improvements to the pump stations and the overall system. The action items for the team would include:

1) Pumping Stations
    a. Improvements in the operational scheme (pumping cycles, reservoir management, etc.) to reduce energy use
    b. Physical improvements (variable speed drives, pump impeller modification, SCADA controls, etc.) to reduce energy use
2) System Wide Hydraulic
    a. Work with the mapping and modelling team to identify changes to the methodology for moving water in the system to reduce energy use. This may include feeding service areas from different locations or other changes.
3) Electrical Improvements
    a. Improvements to the electrical systems (transmission, sub-stations, switchgear, metering, etc.) to improve the reliability of the system, reduce costs and reduce net use of electricity. This may include switching to higher voltage feed, individual station metering or other improvements.

237. The basis for the action plan and contract will be the Energy Screening Methodology Output and report from the Energy Management Expert from the current TA assignment. The Energy Screening Methodology Output will include estimates of the savings as targets for the action plan.

Needs and Resources

238. This action does not need a full time expert on site but should be managed with long missions with Operational/pumping systems expert and an electrical/Energy systems expert. Some equipment will be required such as SCADA, electrical systems, pump modifications.

8.3 Action Plan to Improve Customer Services Efficiency

239. International benchmarking indicates substantial scope for improved efficiency, both overall and for Customer Services alone. This section deals principally with Customer

Services (CS), but CS organisation at local level is closely tied to the service centre structure at present.

240. One approach could be to reduce the number of service centres. The present structure probably owes more to history than to design and there has already been some consolidation (United Service Centre of Abasha and Senaki; Dusheti, Tianeti and Stepantsminda United Service Centre; Ozurgeti, Chokhatauri and Lanchkhuti United Service Centre). Using the area covered by each regional branch and dividing this by the number of service centres gives the area coverage per service centre in the region. This figure can be converted into a theoretical radius for a circular equivalent service centre, giving an indication of the distance needing to be travelled by staff. Currently the minimum travel distance is 5.1 Km (Kutaisi) and the maximum is 24.3 Km (Shida Kartli and Mtskheta-Mtianeti Regional Branch administered from Gori). It would appear feasible to double the average travel distance of 16.9 Km by redefining regional and / or service centre boundaries, so that the number of centres is halved.

241. Reducing the number of service centres would reduce duplication and allow retirement or re-deployment of staff. One of the problems facing Customer Services is an apparent need for more meter readers as the number of households being metered increases towards 100% coverage. UWSCG sees this problem being solved by installation of AMR meters, or retro-fitting AMR to existing compatible meters. Unfortunately, this solution is ineffective unless investment in IT systems is also made, so that meter readings can be automatically accessed by the billing system. This will take time to develop, especially if it relies on in-house resources, and the number of readable meters will be increasing faster than the system can be developed. Re-deployment of staff from other duties to meter reading could solve the problem.

242. Another approach for CS could be to uncouple itself from the service centre structure and administer all functions directly from Tbilisi. This would mean closing most, or eventually all, of the front office services and developing an internet portal for payments, customer registration and paperless billing. As a long-term development this would be in line with trends elsewhere in the world.

8.3.1 AMR meters

243. AMR meters present many advantages for both the customer and the operator. The customer can understand his true consumption pattern by receiving daily water flow data via the internet. This can help him to detect leakage inside the house or reduce his consumption.

244. The operator can have accurate readings for billing (no more meter readers and also have real time consumption to help him managing its water network. More and more operations in the world are currently using AMR to calculate real time NRW and quickly react to any anomalies.

245. Unfortunately, AMR systems are still more expensive than classic meters (around 120 € /meter) and we do not recommend equipping all connections with AMR at this stage. On the other hand, we strongly recommend equipping the main meters (network and large customers) to help managing the network and keep better track of the large customer

consumption. Around 1000 meters should be installed inside the system for a cost of around €400K.

8.4 Options for Improving Asset Management

246. The proposal for a partnership contract, lasting 5 years, to strengthen UWSCG management by bringing international experts to Georgia, has been mainly characterised as an operational support initiative. However, the fact that it is expected to need 5 years should indicate it is not felt to be simply a matter of technology transfer. In the case of Asset Management, we believe UWSCG is starting from a low base and much institutional strengthening is required.

8.4.1 Collect Asset Information

247. This process is about collecting and collating physical data on assets, including location, type, age and condition of individual assets, and their relationship with other assets (e.g. lengths of pipe network forming a specific supply zone, or equipment within a treatment plant or pumping station).

248. A suitable KPI for this process would be the percentage of coverage for each service area / city. It would inform achievement of the KPI if explanatory data listed coverage of the data elements, so that it could be seen how progress towards the KPI has been made on location, type, GIS updating, age, condition etc.

8.4.2 Analyse Asset Information

249. The key forms of analysis of asset information relate to criticality assessment, serviceability assessment and risk analyses of service failure. In the UK, the economic regulator for water, Ofwat, imposes penalties on water and wastewater companies that demonstrate deteriorating serviceability, so there is an implied KPI of “stable” or “improving” serviceability. Serviceability in the UK is measured by reference to frequencies of failure for various aspects of service, such as hours of interruption to water supplies, failures in drinking water quality tests, population affected by low pressure, sewer flooding incidents, failures against wastewater discharge consents and river pollution events.

250. For UWSCG, given that the focus is on water supply rather than wastewater at this stage, KPIs requiring annual improvements in supply interruptions and low pressure over the five-year period would be appropriate.

8.4.3 Prepare Master Plan

251. The Master Plan is a document that should be updated regularly in the light of actual progress (or obstacles to progress). Even though asset data may be incomplete and analyses of the data subject to uncertainties, it should still be possible to produce an annual revision of the Master Plan, which can then be circulated to stakeholders.

252. To give another example from the UK, water companies are required to produce two separate “master plans”. The first is a Water Resource Management Plan (WRMP), which

must be approved by the environmental regulator (EA in England and Wales and SEPA in Scotland). The second is the company Business Plan, produced every five years and submitted to the economic regulator, Ofwat, for price-setting purposes. Both plans go through several draft stages in each five-year period before finalisation and, for all practical purposes, are continuously updated.

253. In Georgia, there is no separate environmental regulator, so a KPI for production, or revision, of the Master Plan should simply cover timely circulation to stakeholders. This is a "binary" KPI which can be achieved if circulation allowing a consultation period is carried out before a specified date, or else failed if it is late or is not circulated at all. Consultation responses may be positive or negative, but these should be considered in the next revision.

8.4.4 Prepare Asset Maintenance Plan

254. Although the content of the AMP is different in many ways from the Master Plan (5 years instead of 25 years as the plan horizon, planned maintenance of existing assets and replacement of critical assets, instead of new assets required for service development and improvement), it should be prepared and circulated to stakeholders in the same way. As with the Master Plan, an annual revision / update should be provided, subject to the same "binary" KPI.

8.4.5 Manage Capital Programme

255. Since annual updates of the Master Plan and AMP are to be produced, it becomes essential to show that UWSCG's five-year capital programme is consistent, including detail of the investments and expected outcomes for the year ahead.

8.4.6 Manage Projects

256. Whether the expected outcomes, including cost, of the capital programme are achieved or not is very much dependent on how well individual projects are managed so that the best solution to the identified problem is found, the project is advanced through approval stages in time to be designed and constructed as anticipated in the approved capital programme, and the project is commissioned on time to deliver the service expected of it.

Suitable KPIs for this are two-fold:

1. An analysis of the previous year's capital programme should show that overall costs out-turned within a set percentage (plus or minus) of the approved programme.
2. The proportion of projects failing to be completed on or before the completion dates shown in the approved programme should be no more than a given percentage.

257. A good discipline in project management is the conduct of a post-completion appraisal, which compares actual costs with expected costs and actual service outputs with those expected.

8.4.7 Manage AM Performance

258. This process is about tracking performance against KPIs, identifying existing shortfalls and forecasting whether compliance with them is likely to be achieved. To do this requires

regular (i.e. monthly) reporting, so that early corrective action can be taken where non-compliance appears likely. A suitable KPI will therefore relate to the production and appropriate circulation of accurate monthly reports.

8.4.8 ISO 55001 Registration

ISO 55001 is the international standard for asset management. As with other such standards, some organisations may benefit from formal registration, which involves initial audit to qualify, agreement to implement corrective actions where found necessary by the auditor, and regular audits thereafter to maintain the registration. In our view, UWSCG is not ready for registration, but even if it were, its value to UWSCG is in any case questionable."