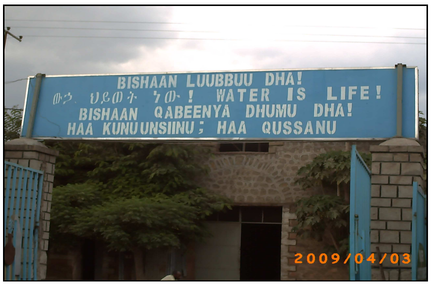
Adama Water Supply and Sewerage Service Enterprise



Augmentation Assessment of the Water Supply service by reconnecting old borehole sources to the existing Surface water supply system as Emergency mitigation Strategy of water shortage in the **Town of Adama**

Assessment made by the OWRB and experts from Addis Ababa Water and Sewerage Authority (AAWSA)

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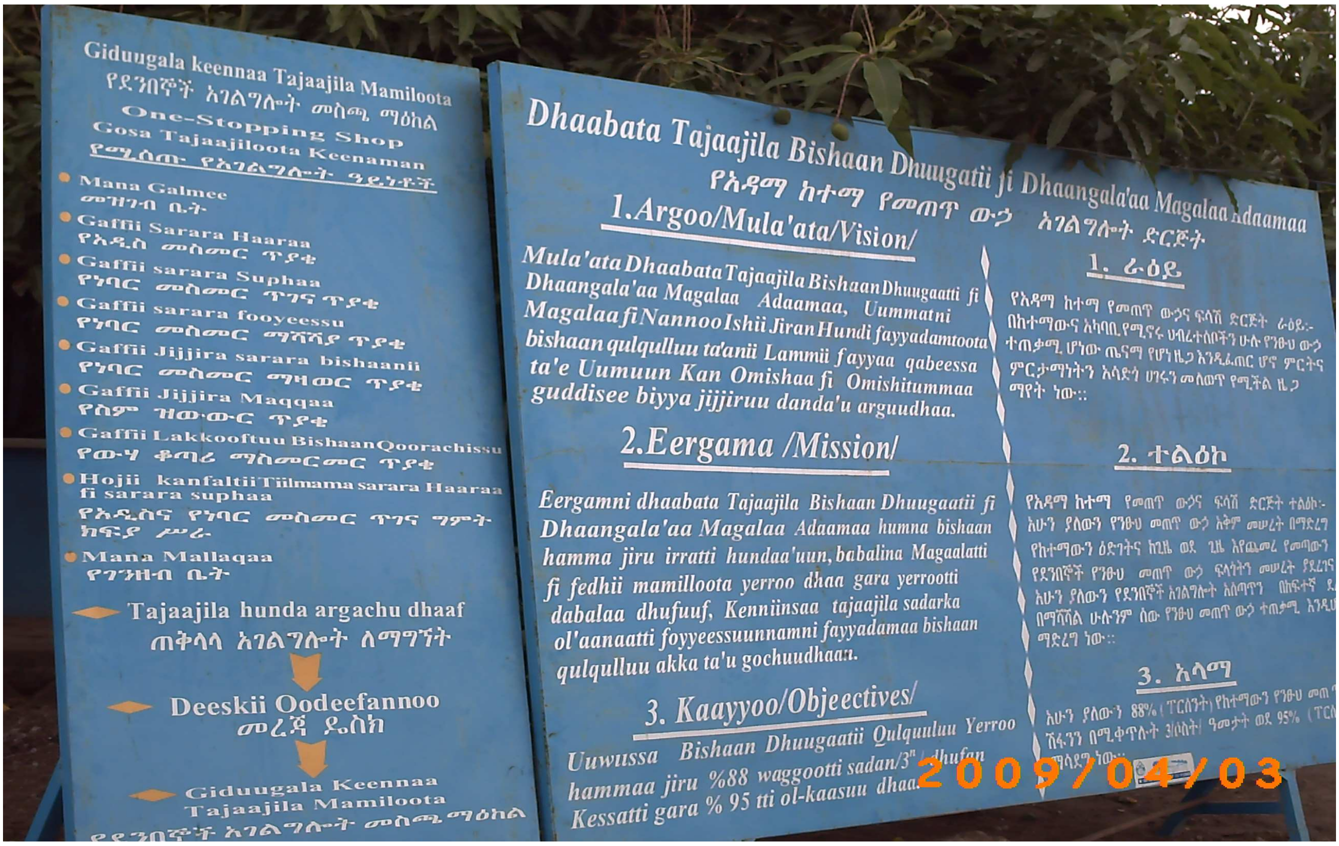

Mission of the Enterprise is …to distribute clean water to all users and its Objective is to aspire for increment of access to clean water from 88 % to 95%. (Dedicative statements created some four years ago)

Brief report of technical supports on emergency assessment for mitigation of water shortage in Adama Water Supply Systems

Technical Assistance Requested- *Adama Water Supply Service Enterprise/Water Board (AWSSE)*

Technical Assistance Offered- *Addis Ababa Water & Sewerage Authority (AAWSA)*

Subject of interest- *Emergency mitigation of water shortage in the town of Adama*

Foreseen strategy- *Augmentation of service by reconnecting old borehole sources to the existing surface water supply system*

Major technical promotions – *technical consultancy and experience sharing on blending of the old wells contents which have excess fluoride compounds with water of the new project (River Hawas) having minimum quantity of fluoride compounds*

Experience of AAWSA- *Blending of borehole water rich in iron with iron-deficient surface water and putting into the city water supply systems for human consumption*

Backgrounds

The town of Adama has been served by groundwater (boreholes) sources for many years before the commencement of service of the new water supply project inaugurated on November 3, 2002. The boreholes drilled at various locations around the town in the radius of 11 km were rich in their fluoride content and children have suffered dental discolorations on top of the water scarcity due to rapid increase in water demand as the number of users frequently rises.

12 wells were located at the place called *Melka Hidda*, on the way down to Wenji Town, some 11 km southwest of the town and have been delivering drinking water at the rate of 80 to 100 l/s depending upon the capacity and type of submersible pump installed. There were also other wells drilled at the various locations in the town such as *Dhaka Adi, RRC, Yilma Dheressa, Beggo Adragot (kebele 02), university (kebele 03), etc.*

The new project which has used river Hawas as a surface source was a relief to users both in quantity and quality and is also with a bester possibility of improvement and expansion activities in the near or far future. The water treatment system of the project is located 17 km east of the town, 3km downstream of the Qoqa Hydropower plant and is operating with 6 hopper-bottomed clarifiers and 6 rapid sand filter units designed at the maximum filtration rate of 330 l/s and optimum rate of 300l/s, about 6.3 years old now.

Due to fluctuation characteristics of the raw water, operation of the treatment system has been quite laborious and chemical consumption was also very high. As a result of close monitoring by the Bureau's experts, it was forceful to change the treatment chemicals and even introducing of new compounds which were not in the design at the beginning.

Having done all the possible jobs, water shortage started to be reported and observation showed that the number of users has increased much only in three years after the commencement of the new service. Quite a lot of residential buildings put in place, modernized lifestyle and personal hygiene optimized, water demanding industrial activities increased, urban farms started to be expanded, large number of big hotel complexes erected, large number of visitors on a daily basis seen, public and private enterprises opened, peri-urban dwellers around the four corners of the town connected to the service, universities and colleges flourished, dormitory town of Wenji lately connected to the system, etc

On top of the dramatic water shortage due to the above cases, power fluctuation from the Qoqa Power Plant has exacerbated the situation adding to the ever increased problems as it usually results in reduction of quantity of product per unit time despite the standby generating set.

In order to mitigate this escalating problems, the Water Supply Service Enterprise of the Adama Town has tried many options including proposal for source expansion works and additional distribution mechanisms but all were found to take too long before coming into action of mitigation.

Therefore, the Enterprise decided to study possibilities of augmenting the service by putting back into service the old ground water sources described above. The intention shows that if some of the wells at Melka Hidda were developed and the systems rehabilitated, there may be a workable possibility of mixing the well water with the water of the surface source coming from the upstream treatment plant.

The challenge

While striving to mitigate the scarcity of water in the town by blending the two opposite sources, it is a challenge as to how the contents may be mixed in a calculated amount giving fluoride concentration of below 1.5 mg/l, international standard set by WHO, after mixing. As a rule there are adverse physiological impacts if fluoride salt is excessively or deficiently consumed in drinking water or food items.

Excessive consumption (8 – 20 ppm, *Ashok Jain, Water Supply Engineering, 2001*) of this salt for an extended time, consumers are most likely to be affected by skeletal or crippling fluorosis, a health condition in which bones will be weak and deformed. Dental fluorosis also results in children consuming water in excess of above 3 mg/t, hence when fluoride concentration is more than 1to 1.5 ppm, removal from drinking water (defluoridation) is recommended. Drinking water containing excessive amounts of fluorides causes tooth enamel to become brittle and to chip off, leaving a stained or mottled effect. The proper proportion of fluorides in drinking water, however, has been found to greatly reduce tooth decay Conversely if water with low or no fluoride salt is consumed, the children teeth will be affected by dental carries, hence addition of fluoride (FLUORIDATION) salt to the recommended standard.

The study of fluoridation began in 1916 when Frederick S. McKay, a Colorado dentist, observed that mottled, or stained, tooth enamel was caused by a substance in some supplies of drinking water. McKay noted that teeth with mottled enamel had a greater resistance to decay. In 1931 the unknown substance was identified as fluoride.

Studies conducted from 1933 to 1942 showed that children experienced up to 70 percent less tooth decay in communities with water supplies containing naturally occurring fluorides at levels of at least 1 part fluoride to 1 part per million (ppm) of water, compared with children in communities with little or no naturally fluoridated water. Subsequent research based on population studies by the United States Public Health Service established 1 ppm of fluoride as the optimal concentration in water. Fluorosis (tooth staining) was found to occur at levels above 1.5 or 2.0 ppm, while only 10 percent of the children studied showed minimal changes in tooth coloring enamel at 1 ppm.

As a result of these early studies, in 1945 Grand Rapids, Michigan, became the first community in the world to add a fluoride compound to the municipal drinking water supply.

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The other challenge is that there is a recommended value of fluoride concentration with respect to the annual average of the maximum daily air temperature. On the assumption that people drink more water in a warmer climate, fluoride levels in water supplies are often adjusted in accordance with an ambient temperature. Mean maximum temperature and corresponding recommended fluoride concentrations that have been used as a guide are given in the table below. Source: *Waterworks Engineering; Planning, Design & Operation, by Edward M. Motley, New Delhi, 2004*

Mean maximum temperature, ^{o}c	***Recommended optimum fluoride concentration, mg/l***	***Remarks***
10.0 to 12.1	1.2	Annual average of the maximum daily air temperature of Adama must be established by the respective office
12.2 to 14.6	1.1	
14.7 to 17.7	1.0	
17.8 to 21.4	0.9	
21.5 to 26.2	0.8	
26.3 to 32.5	0.7	

Temperature boundary for fluoride concentration management

The Adama Water Supply Service Enterprise has therefore intended to share its burden with the Addis Ababa Water and Sewerage Authority (AAWSA)in seek for the technical assistance to bring a qualitative and quantitative solution to the water scarce water supply problem. It is the due consideration of these two parameters (*temperature and recommended concentration of Fluoride*) which gave rise to the request for the AAWSA expertise as to assist in establishing the maximum concentration of fluoride and the optimum quantity of water from the old fluoride boreholes to be mixed with fluoride-free surface water source as to increase the service.

As a result the AAWSA has deployed three senior experts to the site for prompt investigation and recommendation of the foreseen assignment.

The delegated experts were 1) Ato Zeleke Teferi, Water Quality Management ***(0911 86 86 27)***

2) Ato Solomon WaltaNegus, Hydrogeologist

3) Ato Asnake Berhane, Water Supply Engineer and the experts have visited all necessary areas and sources as guided by the Water Supply Service. The onsite assessment work was done and valuable concerns were paid to the need for augmentation needs, the experts finalizing their suggestions by giving certain assignments that the Office of the Adama Water Supply Service should organize data on the boreholes and their actual locations which could assist in implementing the work of revitalizing the boreholes and include them into the system.

Checklist assigned for preparation of well history (to be produced by the WSSE and the Zonal Water Resources Office), required by the AAWSA Experts for design and implementation of the work;

- Static water level
- Well log
- Casing diameter
- Casing type
- Pump position
- Well yield
- Well location (X,Y,Z)
- Locations of all reservoirs

Some available data on the water wells

Wells at Melka Hidda

Well No.	*Yield, l/s*	*Depth, mt*	*[F^-], mg/l*	*Remarks*
1	20	26	2.4-2.9	Dug and brick lined well. Water of this well while it was operational some 10 yrs ago was characterized by its slight brown color indicating leaching of the brick wall
2	6	30	Na	
3	10	68	Na	
4	5	80	Na	
5	8	80	Na	
6	8	80	5.3	
7	8	80	5.5	
8	7	80	Na	
9	-	-	-	Isolated due to dark colored water
10	-	-	7.75	Blocked intentionally by other people
11	10	56	4	
12	-	-	4.78	Tested while it was functional
13	-	-	-	Abandoned due to high fluoride

Other wells in the vicinity of the town

Well No.	Yield, l/s	Depth, mt	[F^-], mg/l	remarks
Old RRC wells	4	180	Na	Hot water, 35 ^{0}c
"	5	180	na	As above
"	-	-	-	Abandoned due to high temperature and no availability of hot water pump
Yilma Dheressa well	4	134	na	Dedicated to urban farms
Kebele 02, Beggo Adragot well	4	180	na	
Dhaka Adii (Horsisa Lakku)	2	246	Na	
Kebele 03 well	-	-	-	Dedicated to the university community

Priorities suggested by the experts

After having tour around the new river water treatment systems and the major well fields, the experts have forwarded some suggestions for ease of the technical and economic investments.

1) Primary suggestion is that the AWSSE should work toward the expansion and improvement of the existing surface water treatment system in a more automated set up to reduce labor intensive activities which usually end up system breakage. The AWSSE should Have as much pumps and spare parts as possible, for sustainable service, install relevant standby power supplies, equip with well trained and well paid staff, equip the laboratory with appropriate equipment and in town water quality monitoring purpose, etc. This also is suggested on the basis of the would be investment and outcomes as may be compared to the rehabilitation and reviving of the old water supply systems.

   It is also highly recommended that the AWSSE should continue with the idea of sludge return system that the raw water will be mixed with the normal sludge that is put back to operation along the incoming raw water in a calculated amount. This would also minimize a daily chemical consumption and improve water quality as the Adama Water Treatment System lacks direct sludge contact which should have been implemented during the design and construction period.

2) Secondly, if the foreseen mitigation strategy is found compulsory and economical, the WSSE should work on how to put Well No.1, yield of 20 l/s, depth of less than 30 mt. pump test and water quality assurance are the prerequisite for all works. If equipped appropriately, this well can yield 72 m^3/hr or 1,728 m^3/day which may suffice the need of about 18,000 more people

3) As a third option, refer to the checklist provided and prepare well identification histories and produce the network of risers and mains, all reservoirs and another important ancillaries where blending and its management would be managed well. The AWSSE is highly advised to refer to the Zonal Water Resources Office for locating of the borehole sources as well as their pump and water quality tests as to give a reliable picture of the intention to facilitate for a workable and productive decision-making activities.

4) Prepare pumps, power source both for operation and standby, riser mains, valves and ancillaries, operating personnel, mixing chambers as would be identified and designed if blending works of all wells are found the last options. If decided, it may be possible to mix discharge of 80 l/s from the wells (5 ppm of fluoride) with 250 l/s to 300 l/s of the river water (fluoride-free) treatment plant output to produce standardized fluoride concentration in the distributed water. The WSSE should be aware that the blending will be in a calculated amount per unit time and both operators of the two systems (Borehole and Hawas river treatment plant) must always read and communicate with each other in that the treatment plant operators need to notify the other part if there is a decrease in quantity of treated water so that the well water injection should be controlled concurrently.

Current demand Vs Supply imbalances

By the time of visit quantity of treated water pumped to the Lugo Reservoirs was 600 m^3/h using the four high lift surface pumps. Operators tolled that this quantity is never sufficient for the needy users of the Adama Town as compared to the previous operations when more than 900m^3/hr could be sent out. It was learnt that at normal condition the plant receives output of 6 raw water pumps at the rate of 174 m^3/hr each, giving the total amount of 174 x 6 = 1,044m^3/hr or 290 l/s. Design shows that the plant can receive upto 330 l/s but 300 l/s was the maximum due to several technical problems.

Per capita satisfaction of the existing operation can be calculated as follows;

Observation shows that the plant, at the pick time, can operate at 170 m3/hr x 6 pump units = 1,020m^3/h

UAFW of 15% will be 1020 x 0.15= 153 m3/hr

Net product will be 1020 – 153 = 867 m^3/hr

867 m^3/hr is equal to 20,808 m^3/day, which shall be consumed by all the town population, including hotels, gusts, passengers, industries, farms, etc as described earlier

Estimated number of users including all types is 350,000 that will depend on the daily product alone. Since the area is within the hot climatic zone, per capita water demand of the town is slightly above other towns and may be calculated as that of demand factor of Addis Ababa which is average of 80 l/c/d.

Therefore, 350,000 people will need 350,000 x 80 = 28,000 m^3/day which can be called *actual daily demand*

The estimated daily product of the system is 20,808 m^3/day

Therefore, percentage satisfaction of the town by the plant can be computed as;

$$\%\ \text{daily access} = \frac{estimated\ daily\ product}{actual\ daily\ demand}\ x\ 100$$

$$= \frac{20{,}808}{28{,}000}\ x\ 100$$

$$= 0.74\ x\ 100$$

$$= \mathbf{74}\ \%$$

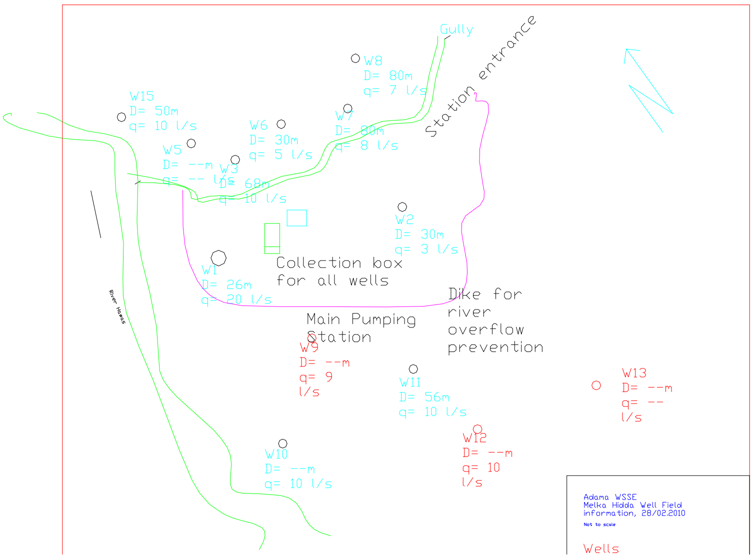
This shows that 74 % of the town is served by the water supply system and the remaining 26% still needs some mechanisms of getting served by the system. The number of people that is served or unserved by this system can also be established.

If we have 20,808 m^3/d of clean water and need to distribute to all users at the rate of 80 l/c/d, then the number of people benefited will be;

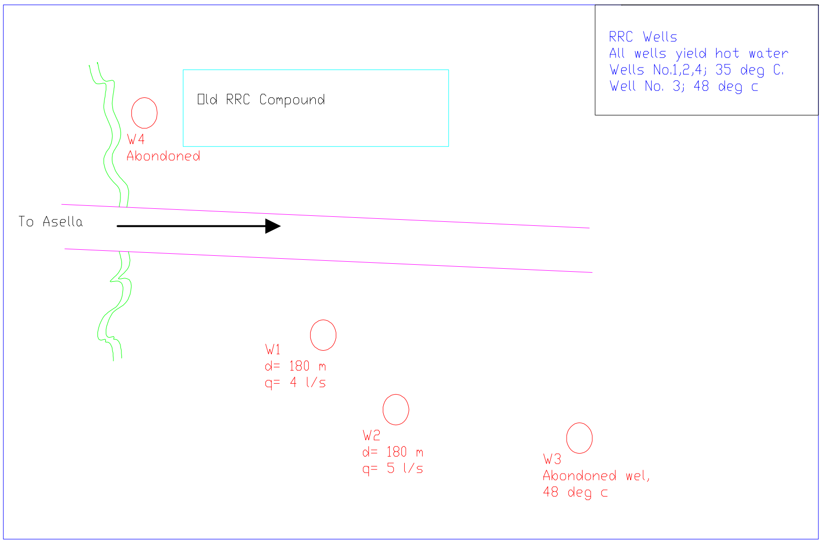
$$n = \frac{20,808}{80}$$

$$n = 260,100$$

This tells us that only 260,100 people were served and the number of people unserved can be established simply as 350,000 minus 260,000 = 89,900 or say 90,000 because 26% of 350,000 will be 91,000. Therefore, we can conclude that about 90,000 people in the town are not getting drinking water service at normal condition and this has shown high scarcity of clean water distribution which requires a timely mitigation action.



<u>Melka Hiddaa old well fields ;</u> The Adama WSSE intends to revive these wells and combine their calculated contents with the treated water coming from the Hawas Conventional Plant



<u>RRC oold well fields in the town ;</u> The Adama WSSE also intentions of combining a calculated amount of water from these wells as an emergency intervention to water shortage problem of the city