AWASH RIVER BASIN WATER QUALITY STRATEGIC PLAN

December, 2016

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LIST OF ABBREVIATIONS AND ACRONYMS

ABA	Abay Basin Authority
AwBA	Awash Basin Authority
AWSSA	Addis Ababa Water and Sewerage Authority
BHC	Basin High Council
BOD	Biological Oxygen Demand
CCA	Causal Chain Analysis
COD	Chemical Oxygen Demand
EC	Electrical Conductivity
EFCCA	Environment, Forest and Climate Change Authority
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
FAO	Food and Agricultural Organization
FDRE	The Federal Democratic Republic of Ethiopia
IWRM	Integrated Water Resource Management
MoANR	Minister of Agriculture and Natural Resources
MoEFCC	Minister of Environment ,Forest and Climate Change
MoH	Minister of Health
MoI	Minister of Industries
MoUD	Minister of Urban Development
MoWIE	Minister of Water Irrigation and Electricity
NGOs	Non Governmental Organizations
pH	Power of Hydrogen
RVLBA	Rift valley Leak Basin Authority
SAR	Sodium Absorption Ratio
TDS	Total Dissolved Solid
TOC	Total Organic Carbon
UN	United Nation
WHO	World Health Organization
WWDSE	Water work Designs Supervision Enterprise

EXECUTIVE SUMMARY

Awash Basin is the most intensively utilized basin due to availability of land suitable for agriculture, industry water resources that can be easily tapped, and its strategic location. However, an increased pollution threat from point and nonpoint sources is creating havoc in the basin. The sustainability of this water resource remains imbalance if appropriate and sustainable water quality monitoring and management measures are not put in place. To ensure efficient a sustainable management of the water resources of the basin, water quality should be considered as a major priority area. Hence, to devise a mechanism for sustainable use of water resources in the basin, this plan was carried out with general objective to make the water quality of the basin suitable for intended purpose.

Since a sound and agreed upon water quality plane prepares the framework for proper organization of the water sector in the entire basin and regulations pertinent to the use of the resource one of the main purposes of the plan.

1. BACKGROUND

1.1. Introduction

Water is life. Every human being, present and future, should have access to safe water. Water is the basis for all living ecosystems and habitats and part of an immutable hydrological cycle. It must be respected if the development of human activity and wellbeing is to be sustainable. These days the pressure on natural water resources in many regions of the world has been increasing dramatically. Two-thirds of water consumption already goes to irrigation and agricultural needs are increasing. Meanwhile, industrialization is also taking a heavy toll on our fragile water supplies, creating both new demands and risks of pollution.

There are different sources of water pollution. Some of the pollutants may expose human beings and other lives to series problem. For instance, different researchers had argued that industries discharge their residuals directly into waterways, which implies that industrialization has positive relationship with increment of organic and inorganic water pollution.

Surface and ground waters can be contaminated by several sources. In urban areas, careless disposal of industrial effluents and domestic wastes contribute greatly to have poor water quality. Agricultural drain waters especially from salty agricultural lands are also creating great environmental concern. The agricultural inputs like pesticides, herbicides, and fertilizers contribute much to introduce pollutants to water bodies.

Most of the rivers in the urban areas of the developing world are the end points of effluents discharged from the industries. Worldwide, it is estimated that industrial sector is responsible for dumping 300-400 million tons of heavy metals, solvents, toxic sludge, and other waste into water sources each year (UNEP, 2010). While significant progress has been made in many developed nations to reduce direct discharges of pollutants into water bodies, more than 70 percent of industrial and domestic wastes in developing countries are dumped untreated into water bodies. It is customary to define water quality by several parameters known as physical, chemical and biological. It is widely accepted that the deterioration of the quality of

surface water, groundwater and coastal water system is mainly controlled by the geological structure and lithology of the watershed, the chemical reactions that takes place within the watershed and the type of land uses and the anthropogenic activities (Alexakis 2008, Loukas 2010, Mlideis et al. 2007, Naseem et al. and Tsakiris et al. 2009). Further, the quality of water resources is vulnerable to a wide range of chemical compounds including organic pollutants (material), salts, nutrients, sediments, heavy metals etc (Gamvroula et al 2012, Kofali and Jurdi 2011, Mosley et al. 2012).

Most of the industries in Ethiopia discharge their waste water into the environment without any form of prior treatment. For instance, a number of studies have indicated that among the industries located in Addis Ababa, 90 percent discharge their waste without treatment into nearby water bodies and open spaces (EPA, 2003). A study on effluents of selected industries in and around Addis Ababa indicated that all the industries studied generate wastes that carry pollutants in excess of the internationally accepted pollutions standard (UNIDO, ESID, 2001).

Water pollution from poor domestic solid and liquid waste management can also be a major problem. According to the recent census data of CSA (2008), about70 % of the generated solid waste in urban areas is in discriminately dumped in rivers, drainage ditches, street sides and vacant lots. Liquid waste management in urban centers of the country is by far inadequate. The 2007 CSA survey indicated that 28.2% of the urban housing units do not have any toilet facility. This fact, together within adequate public toilets, resulted in open air defecation. Major urban centers of the country are not served by a sewerage system (MoUDC, 2012) except the limited coverage in Addis Ababa.

The discharges of strong domestic and industrial wastes definitely pollute fresh water systems of the river and jeopardize their socio-economic and ecological values. For instance, pollution of streams that drain Addis Ababa due to poor waste management practices is considered to be a major problem with adverse public health and ecological impacts (Nigussie, 1999; Gebre and Rooijen, 2009).

The Awash Basin is the most utilized river basin in Ethiopia with a number of small, medium and large scale irrigation schemes ; industries located along the river ; urban and rural water supply schemes (both from surface and groundwater), etc. Many of the big industrial hotspots in the country are found inside the Awash Basin. These include the industrial corridor extending from Addis Ababa to Adama town, Metehara area, kombolcha and Dire Dawa City. For several industries the Awash River is used as source for water consumption and for disposing of their waste. The growing and saline Lake Beseka is also a major threat to the nearby Awash River which is extensively used for irrigation purpose (Elleni, 2009).

The Awash River and its tributaries are sources of drinking water for large and small cities such as Addis Ababa, Adama, Awash and Metehara town. As a matter of fact it is also the main source of domestic water for the majority of the (nomadic) people in the eastern Afar Region. This may further exacerbate the environmental degradation and pollution of the river having negative consequences in terms of both water quantity and quality in the basin.

The Ethiopian Water Resources Management (EWRM) regulation of 2004 is set out boldly as water is natural endowment commonly owned by all the people of Ethiopia, all Ethiopian citizen shall have access to sufficient water of acceptable quality to satisfy basic human needs, water shall be recognized both as economic and social good, shall be under pinned on rural centered, decentralized management, participatory approach as well as integrated frame work, management of water resources shall ensure social equity, economic efficient, system reliability and sustainability. It has often been advocated that the most logical unit for water Resources planning and optimum utilization of available water resources is the river basin. Accordingly, it is desirable that all major river basins in Ethiopia have an integrated development master plan study, and their potential in terms of economic development be known. Therefore, in order to mitigate water quality problem in the basin strategic river basin water quality plan for the basin is prepare with the objective to make the water quality of the basin suitable for intended use.

1.2. Objective of the Plan

The overall objective is to develop Iterative water quality Strategic River Basin plan, to promote and ensure the water quality in the Awash River Basin thereby contribute to the national targeting goal (approaching Middle income countries).

1.3. Vision

To be a model basin in which the surface and ground water shall have acceptable quality for intended purpose.

1.4. Scope of the Plan

To implement the principle of an integrated water resources management, River Basin High Council and Authorities were established under proclamation No. 534/2007. Awash Basin was instituted in accordance with Awash Basin High Council and Authorities establishment Council of Ministers Regulation No. 156/2008. Based on these proclamation and regulation, this plan presents the direction and implementation framework for the basin to achieve the goals for sustainable development. The scope of this plan covers the entire Awash River Basin with a time horizon of 5-10 years.

2. SITUATIONAL ANALYSIS

Policies and institutional frameworks serve as instruments for human cooperation and for reducing uncertainty by establishing a stable structure to human interaction. Accordingly, in the context of river basins, since coordination among various human efforts to use the water available within a basin is at the heart of integrated water resource management (IWRM), policies and institutional frameworks are of paramount significance. Therefore, the fundamental purpose of policy and institutional analysis is to explore this coordinating role of institutions.

2.1. Legal and Institutional Frame work

2.1.1. The federal constitution

The institutional framework for water resources management in a river basin consists of established rules, norms, practices and systems that provide a structure to actions related to water management. Laws, Policies and regulations are the three pillars of the institutional framework for IWRM. Constitution of The Federal Democratic Republic of Ethiopia (FDRE) states that all national policies, laws and institutional arrangements of the country, including those related to the management and administration of water resources must be in line with its provisions. Among these provisions is the utilization of rivers and lakes linking two or more regional states or crossing the boundaries of the national territorial jurisdiction [Article 51(11),]. This provision gives the Federal Government the mandate to manage and administer such rivers and lakes determining of the use, allocation and protection of water resources. The Constitution also provides the Federal Government (or its executive arm, MoIWE) with the right to delegate its powers and functions given to it to Regional States and/or any other water resources management institution [Article 50(50), Article 50 (9)].

2.1.2. The Ethiopian water resources management policy

The Ethiopian Water Resources Management Policy, coined with constitutional provisions and IWRM, is essential instrument to further articulate and elaborate the overall principles and directions the country should follow regarding water resources management. One of such principles is ***as far as condition permit , every Ethiopian citizens shall have access to sufficient water of acceptable quality , to satisfy basic human needs,*** consequently to satisfy these basic needs the policy farmed the following water resources protection principles "***create appropriate mechanism to protect the water resource of the country from pollution and depletion so as maintain sustainable development and utilization of water resource"*** therefore to protect the basin water quality from pollution. The Policy provides basin planning to take the hydrologic basin boundary as the fundamental planning unit and water resources management domain by establishing water quality standards, procedures and mechanisms for all actions that are detrimental ,to water resource including waste discharge ,source development ,catchment management etc.. through concerted efforts of relevant parties by providing the legal basis for active and meaningful participation of all stakeholders.

2.1.3. The Ethiopian water resource management proclamation

The Ethiopian Water Resources Management Policy is backed by the Ethiopian Water Resources Management Proclamation (197/2000) and Regulation (115/2005) for water resources administration, allocation and protection of aquatic ecosystems. The Proclamation ensures that the water resources of the country are protected pollution and deployed for the highest social and economic benefits of the people of Ethiopia. It also lays down fundamental principles that water resources management and administration in the country should be based on the Policy and the Water Resources Laws of the country and that the Supervising Body, defined as the Ministry of Water, Irrigation and Electricity (MoWIE), shall ensure that any water resources related activities in the country are conducted accordingly.

The Council of Ministers established River Basin Authority for the Awash Basin by Proclamation (534/2007) and the MoWIE delegated a substantial portion of its administrative

power in the Awash Basin to the Awash Basin High Council and Awash Basin Authority (AwBA). Accordingly, the central objective of AwBA, as supra-regional organization, is to promote and monitor the integrated water resources management in its jurisdictions for the socio-economic welfare of the people in an equitable and viable manner, without compromising the sustainability of the aquatic ecosystems through building knowledge for informed decisions, networking with stakeholders and regulating and enforcement of water use for sustainable and equitable development in the basin.

2.1.4. Institutional setup

The Basin High Council (BHC) and the Ministry of Water Irrigation and Electricity (MoWIE) are the decision making and advising arms on policy, strategic, technical issues and legal issues for regional water sectors and AwBA. There are large industries and irrigation farms booming in A wash Basin which have significant impact on the water quality if not properly manage the basin, therefore Awash Basin authority is responsible for integrating and coordinating all stake holders and increased pollution threat from point and nonpoint sources is creating havoc in the basin.

The institutional framework of AwBA to comply with the roles and mandates specified in the legal documents (Regulation No. 156/2008) needs the structuring of the basin authority in such a way that core regulatory tasks fall under:

- Basin Study, Research and Information Management
- Basin Planning, Monitoring and Evaluation
- Water Resource Administration and
- Watershed Management and River Training.

Each core process should focus on only two mandates and should start cooperating with other core processes. The focus should be on the following mandates:

1. Water Resources Administration
2. Basin Study and Research and Information Centre
3. River basin policy, plan, monitor and evaluation
4. Finance department and Water Resources Administration

A. Lines of accountability

AwBA and regional water sectors in the entire basin are accountable to the Ministry of Water Irrigation and Electricity on technical issues and to Basin High Council on policy issues. The Basin High council must be operational for both AwBA and water sectors to function well. The Director General is the secretary of the Basin High Council. The main focus is on getting approval for (the execution of) the Basin Plan. The Basin High Council directs the drafting of the Basin Plan and submits it to the council of ministers that will approve the Basin Plan. AwBA prepares the Basin Plan and submits to the Basin High Council. The State Minister of Water is the chair of the council, delegated by the council of ministers. In this way the Basin High Council is the main body to focus on. If approved by the high council, the council of ministers will follow.

2.2. Significant Pressures

The relatively good infrastructures and its proximity for large cities make a wash Basin highly valuable for investment. Accordingly, it is center for the development of industrial, agricultural and other economic activities. These activities have contributed to the increment of population, expansion of urbanization as well as pollution from municipal, industrial, and agricultural sources that impose significant pressure on the water quality of the basin. To understand the challenges and address their significant pressures, the problems are generally categorized as social, economical and environmental pressures.

2.2.1. Social pressure

One of the factors that affect the water quality is over population. In Ethiopia, observations indicate that over the last couple of decades the population carrying capacity of the environment decreased as the number of population increases. A high population growth rate induces increased demand for water and other resources and the rate at which these resources are exploited. Moreover it also causes resources to degrade or deteriorate. In Ethiopia the population is increasing with dramatic rate. According to the Ethiopian 3rd Population and Housing Census of 2007 the growth rate is calculated to be 2.6%. Currently out of the total population in the

country, there is a significant share of 17.1% in Awash Basin which shows an increase of 13.8% in the last seven years. Of the total population, 37.3% and 62.7% resides in rural and urban areas of the basin, respectively. Unless the population awareness regarding the impact of over population is improved the problem may become even worse.

In general the overall understanding regarding the sewage disposal in the country is not satisfactory. In major city including the capital city of Addis Ababa, the sewerage network is not yet completely constructed. As a result it is common to watch city resident when disposing latrine waste in to natural water course. Not only resident but also the industries are disposing their effluent to the natural water course. Tributary rivers flowing in to the Awash River are highly polluted. Because of the aforementioned reasons, not only the rivers but also shallow groundwater schemes are becoming highly polluted.

2.2.2. Economical pressure

The basin is found to be in an increasing pattern in accommodating industries, agricultural activities, and urbanization. A number of large and small scale industries with diverse nature have been established in the basin and also agricultural activities in terms of various irrigation and livestock activities are observed. The expansion of urbanization in the basin has significant impact on the socio-economic feature of the basin. These socioeconomic activities are observed as they have impact on water quality of A wash Basin. Detail descriptions of socioeconomic pressure in the basin are discussed as follows.

A. Industries

It is observed that there are large numbers of industries booming in Awash Basin which have impact on water quality in the basin. Most industrial facilities within the basin do not treat their wastewater before direct discharge into open areas, the river stream, or its tributaries. In the basin along the river flow there are industrial areas, located mainly in Addis Ababa, Alem Gena, Dukem. Bishoftu, Mojo, Diredawa, Kombolcha and Adama. There are nine principal types of industries are indicated in the following table.

Table 1. Types and number of industries in the basin

No.	Industry Type	Total number
1	Brewery Industry	9
2	Chemicals and Construction Inputs Industry	8
3	Food and Beverage Industry	12
4	Leather and Leather Products Industry	15
5	Leather Goods & Garment Producers Industry	7
6	Meat and Milk Industry	13
7	Metal Industry	115
8	Tannery Industry	19
9	Textile and Garment Industry	48

Source: Investment Agency

Industrial facilities produce solid, liquid, and gaseous wastes that are disposed or discharged to the main river or streams. The solid industrial wastes are disposed into municipal dumps or incinerated in open air. The liquid industrial wastes are released to the River, to its tributaries, or into closed valleys. Gaseous waste is released into the air, but can deposit, by absorption and adsorption, into the watershed. In addition to polluting the surface water, these pollutants percolate into the subsurface, thus posing a threat to groundwater as well.

Some of the waste produced by the industries in the basin are toxic or hazardous and should not be released into the environment without pre-treatment. Each industry has its own contaminant characteristics as summarized in Table 2.

Table 2. Summary of industry types with their associated contaminant characteristics

No.	Industry Type	Contaminant Characteristics
1	Textile and Garment Industry	High Suspended Solid & BOD, Alkaline Effluent
2	Leather and Leather Products Industry	High BOD, Total Solids, Hardness, Chlorides, Sulphides, Chromium
3	Tannery Industry	High BOD, Total Solids, Hardness, Chlorides, Sulphides, Chromium
4	Leather Goods & Garment Producers Industry	High BOD, Total Solids, Hardness, Chlorides, Sulphides, Chromium, Alkaline Effluent
5	Chemicals and Construction Inputs Industry	Low pH, High BOD, High TOC, Toxic Benzene Derivatives
6	Meat and Milk Industry	Suspended Solids, BOD, Nitrogen, High faecal coliforms and streptococci
7	Food and Beverage Industry	High BOD, High Suspended Solids, Colloidal and Dissolved Organic Substances, Odors
8	Brewery Industry	Colloidal and Dissolved Organic Substances
9	Metal Industry	Low pH, High content of toxic metals

The distribution of industries in Awash Basin is indicated in Figure 1. According to data obtained (Investment Agency, 2008) the concenration of industries were observed in Addis Ababa, Alem-Gena, Bishoftu and Adama with 69.11, 6.91, 5.69 and 4.07 percent, repectively.

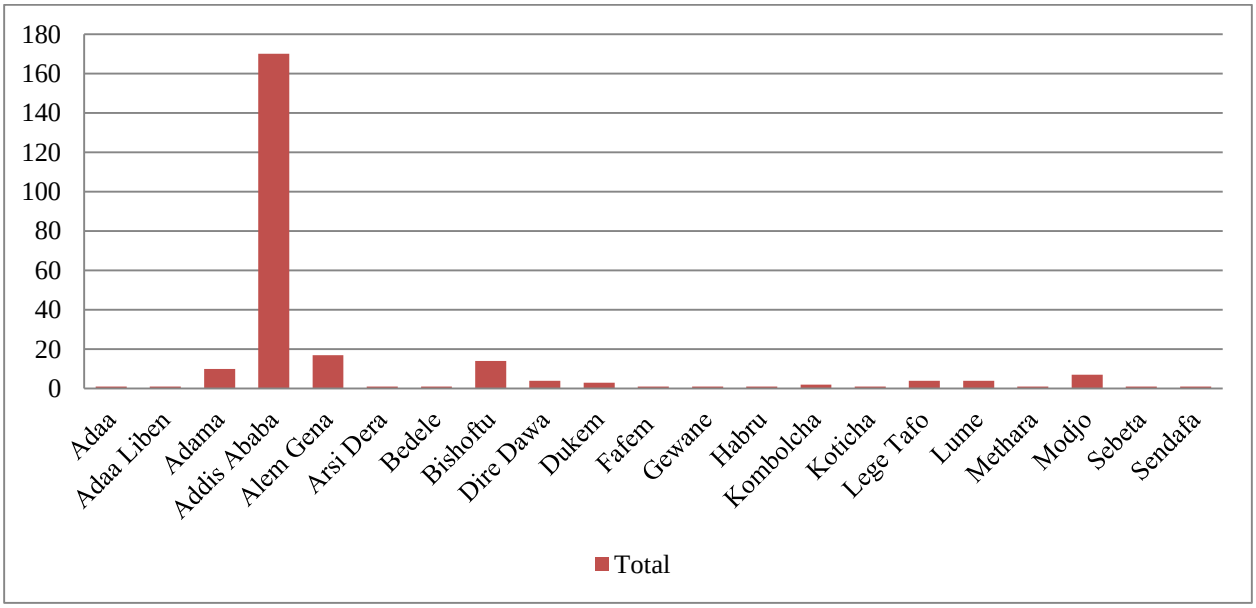


Figure 1. Industry distribution by local name in Awash Basin

B. Agricultural activities

The rapid expansion of agriculture over the past few centuries led to conversion of natural or native vegetation to cultivated agricultural systems. Such changes to land use and agricultural practices have significantly increased leaching of chemicals to surface and ground waters (Carpenter et al. 1998).

Improper irrigation practices, poor water use, and overuse of agrochemicals by farmers in the area results in significant pollution of the River. Most farmers within the basin are not well informed about the appropriate amounts of pesticides and nutrients (e.g., potassium, phosphorous, and nitrogen) to be applied to their lands, considering that these substances – especially nitrogen – dissolve in water and percolate to the groundwater and nearby streams (Nimah, 1998). A rise in the levels of nitrogen in basin water was observed during the period between March and April, corresponding to the time when intense usage of agrochemicals has been reported. The pressures are mainly related to releasing nutrients from agriculture to the river system (Fertilizer or manure runoff from farmland). Due to the stated pressures water quality deterioration is the main impacts in the basin.

C. Urbanization

Marching of Population from rural to cities and towns increase the burden on the land use system of the basin which forced the land to be changed to settlements. The main population centers in the Awash Basin fall within the upstream side of the basin. Raw, untreated wastewater from various municipalities and industries within these areas discharged into tributaries to the River. The existing sewer systems release their untreated effluents into the River or its major tributaries. There are no controlled and regular services for sludge disposal, so tank overflow into streets and public areas is often reported during heavy rains. This brings high impact on water quality of the basin

2.2.3. Environmental pressures

The industrial and agricultural expansion in A wash Basin is high and dynamic for socio economic development. For that reason, emphasis is given to economic growth than to dealing with environmental issues. Though environmental institutions are established and laws are enacted in the basin which seems a commitment from the government still the established institutions suffer from heavy political pressures. Most relevant institutions which deal with environmental issues lack the necessary power to fulfill their duties. Since the existing laws do not have enforcement mechanisms, they are not dynamic; they are feeble and easily circumvented by economically oriented legislations.

Lake Beseka and saline hot springs like Soderea has potential risk as their areal extent and discharge requirement is growing from time to time. This also increases the EC, sodium and sodium absorption ratio (SAR) of the water in the Awash-Awash, Awash-Halidebi and Awash-Terminal sub basins. Water scarcity during dry season is one of the major issues for water quality deterioration. The low flow of the river decreases the dilution power of the river system that leads to increased pollutant concentrations. *Water-logging problem* is a serious issue in Becho plain, Gedabassa and Borkona swamp which can form algal bloom and some water borne diseases in the basin. Flooding hazard in the Awash-Awash, Awash-Halidebi, Awash-Adaitu and Awash-Terminal Sub basins are also the other threatening phenomenon which is critical to the basin that increases the turbidity of the water.

The diverse geological make-up of the basin that comprises basalts, sedimentary rocks, and aluminum silicates minerals are responsible to affect the quality of surface and ground waters. This is evidenced by the high sodium and potassium concentrations in rift valley soda springs, alkaline lakes and deep boreholes which are primarily related to reverse weathering or formation of aluminum silicates minerals. High calcium and magnesium contents characterize wells in the central and northwest plateau drilled in basaltic terrain as well as highland lakes. Leaching of host basalts result in high magnesium content, typical examples of such process exist in the Hayq and Ardibo lakes catchments. The sedimentary rocks with higher sulphate make the waters more sulphate and chloride dominated. This is particularly more common in the northern and central

Afar isolated depressions, where evaporate deposits exist (Ayenew *et al*, 2008). Generally, these phenomena result in increased environmental pressure in the water quality of the basin.

3. WATER QUALITY SCENARIO

Water quality impairment from point and diffuse sources is an issue of concern in the Awash Basin due to the diverse polluting activities and its socio-economic and ecological significances. The major point sources of pollution include discharges from industries and domestic activities and Runoff from urban and agricultural areas is major sources of diffuse pollution.

Most of the industries in the basin discharge their waste water into the environment without any form of prior treatment as a result of this the water quality of the basin is threatened and it is deteriorated from time to time. AwBA, in consultation with all water sectors, has identified water quality issue as one of the major strategic concerns. Therefore, this river basin plan considers water quality as one of the headlines issues.

In order to address this concern, all the water sectors in the entire basin has the mandate to assess, control and monitor the water quality in the basin. Hence, AwBA and all water sectors in the entire basin have compiled and used previous studies output and primary information to develop the current and future water quality scenario in the basin. This relevant information were brought together and used based on the reclassified sub basins.

3.1. Current Scenario of the Water quality of the Basin

The water quality of Awash Basin is deteriorating from time to time both the surface and ground water cases. In the basin there are different types of pollution sources which is a bit different from sub basin to sub basin. Each sub basin is characterized with different pollutant sources. Accordingly, in six sub basins water quality current scenario for surface and ground water is described in the upcoming sub section.

3.1.1. Surface water quality current scenario

Awash Basin has six sub basins which are divided based on hydrologic boundary. The surface water quality current scenarios of each sub basin are presented in the following sections.

A. Awash Upstream Koka Sub basin

The Upstream Koka sub basin is dominantly threatened by wastes from industries and urban areas including Addis Ababa, Special Oromia Zone, Bishoftu and Modjo. Studies by AWSSA (2005, 2010), and EPA (2010) indicated that 80 % of the investigated 70 factories dump their untreated effluent directly to nearby river system. Moreover, only 8% of industries had effluent treatment plant. UN-WATER (2007) reported that people and cattle around Aba Samuel reservoir have been severely affected by contamination resulted from effluent discharge from nearby industries and waste from Addis Ababa city. It is also reported that domestic and septic wastes contribute to a greater amount towards the water pollution of this sub basin. For instance, in Addis Ababa about 14 % of the population has no access to sanitary facilities, while only 6.5% of the population is served by central sewer system which is managed by AWSSA (AWSSA, 2011). About 80.2% of the population mainly use pit latrine and septic tank systems. However, considerable portion of the population living in the vicinity of the natural water systems dump and even connect their septic tank wastes to the river system. The fact that there is no active law enforcing and penalizing mechanism, pollution from the septic origins is being aggravated from time to time.

The river systems also receive pollutants from artificial drainage systems which were meant to collect run-off water. Nevertheless, these drainage systems are being used for disposal of almost all categories of wastes including solid wastes and grit. Water pollution from open solid waste dump sites has become a concern in urban areas. Leachates from these dump sites were investigated to contain heavy metals with ecological and public health risks. These phenomena are witnessed in all major towns of the Awash Basin as shown in Figures (2, 3, 4, and 5).

Figure 2. Addis Ababa solid waste dump site [Source: Tamiru (2005)].

Figure 3. Adama town solid & liquid waste disposal sites [Source: Planet IWRMPLC (2012)].

Figure 4. Waste disposal sites of Bishoftu town [Source: Planet IWRM PLC(2012)].

Figure 5. Sebeta town solid waste disposal site [Source: Planet IWRM PLC (2012)].

B. Awash-Awash Sub basin

Awash River water quality continues to decline in the subsequent sub basins even though source of the pollution varies. Spatial and temporal variability of Awash River at selected sampling points were assessed along the main river courses from the Awash Awash sub basin to the reaches of Awash Terminal sub basin. Based on the primary and secondary data eight years mean annual physicochemical analysis data of 11 surface water samples are analyzed in Table 3. From the table, regarding the physicochemical parameters, spatial variability is observed in the Awash River along the courses due to inflows from other tributaries and natural thermal springs that are hydrologically connected to the Awash River. ***Parameters like fluoride, nitrite and dissolved manganese exceed the lower limits for certain sample sites at Awash-Awash sub basin***. The percentage of samples which exceed the water quality standards for fluoride, nitrite

and dissolved manganese parameters are 43%, 30% and 10%, respectively. But the other parameters (***i.e calcium, magnesium, sodium potassium, chloride, bicarbonate, carbonate, sulphate, nitrate, total hardness and ammonia) fall below the lower limit*** as it is indicated in Figure 6.

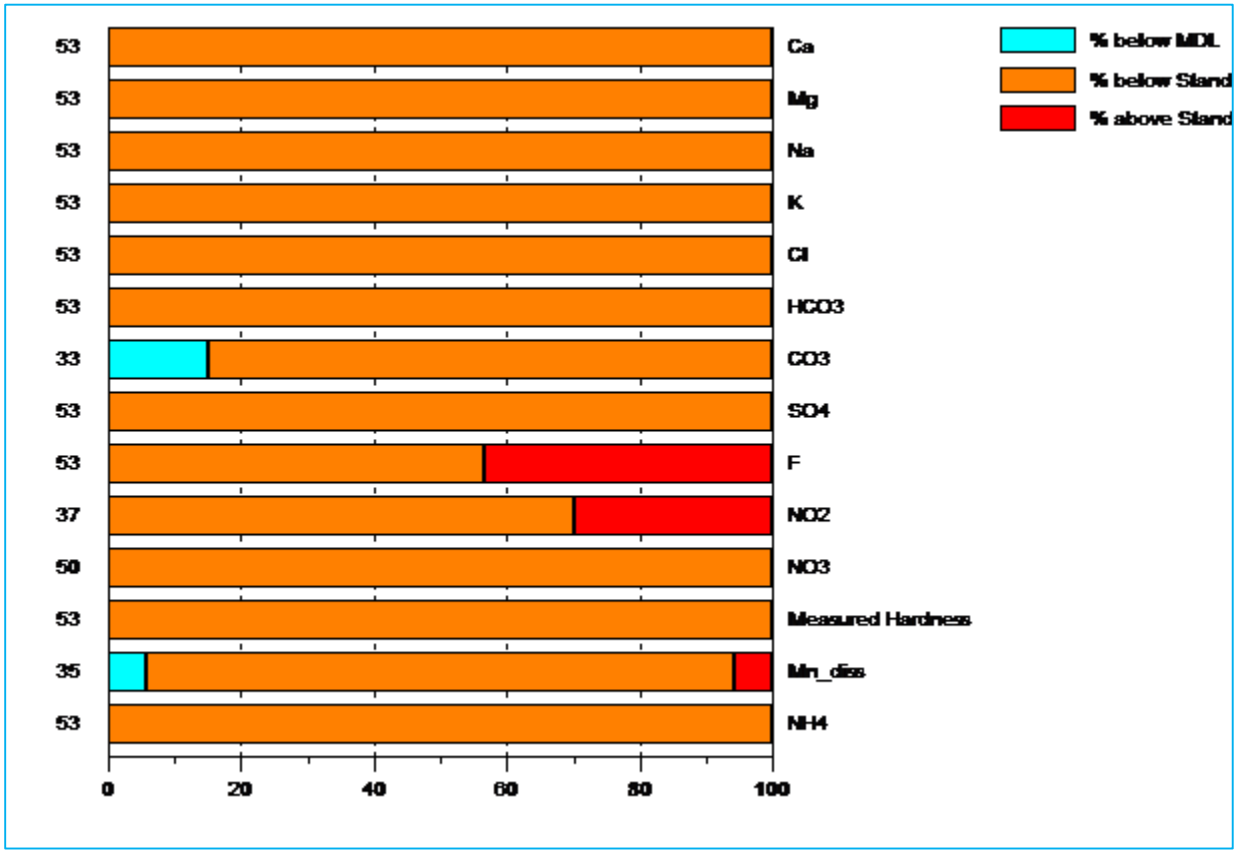


Figure 6. Awash-Awash WHO water quality standard detection summary

The dominant water pollution in Awash Awash sub basin comes from agriculture, saline hot springs and Lake Beseka. Sodium concentration is 1467 mg/L at Beseka station which is beyond the lower limit. Discharge from saline hot springs around Sodere (Kidane Mihret, Abadir, Giyorgis, Mariam) and Doni area, with EC values above 1dS/m, are directly discharged into Awash River deteriorating its quality for domestic and irrigation use. In addition to the thermal springs, discharge from Lake Beseka into Awash River had also contributed to downstream salt load. The return flow from agricultural lands, though not properly quantified, has its own significant effect on quality of the river water. While inflows from Keleta, Werenso and Awash

Arba streams tend to counter balance the effects from the above mentioned sources during the rainy season, the deterioration is aggravated during the dry low flow seasons.

As shown in the figure below the highest concentration of sodium is observed at Awash-Awash sub basin which is from 63.89 to 1448.38 mg/l which may adversely affect the irrigation activity. Furthermore, the value of SAR is also from 16.0936-684.09 which is beyond the lower limit of ***FAO*** Severe irrigation water standard. Therefore in Awash-Awash basin the status of water quality for irrigation purpose can be said unsuitable. As, arecommendation strict drainage mechanism needed to be installed to leach the salt from the agricultural field.

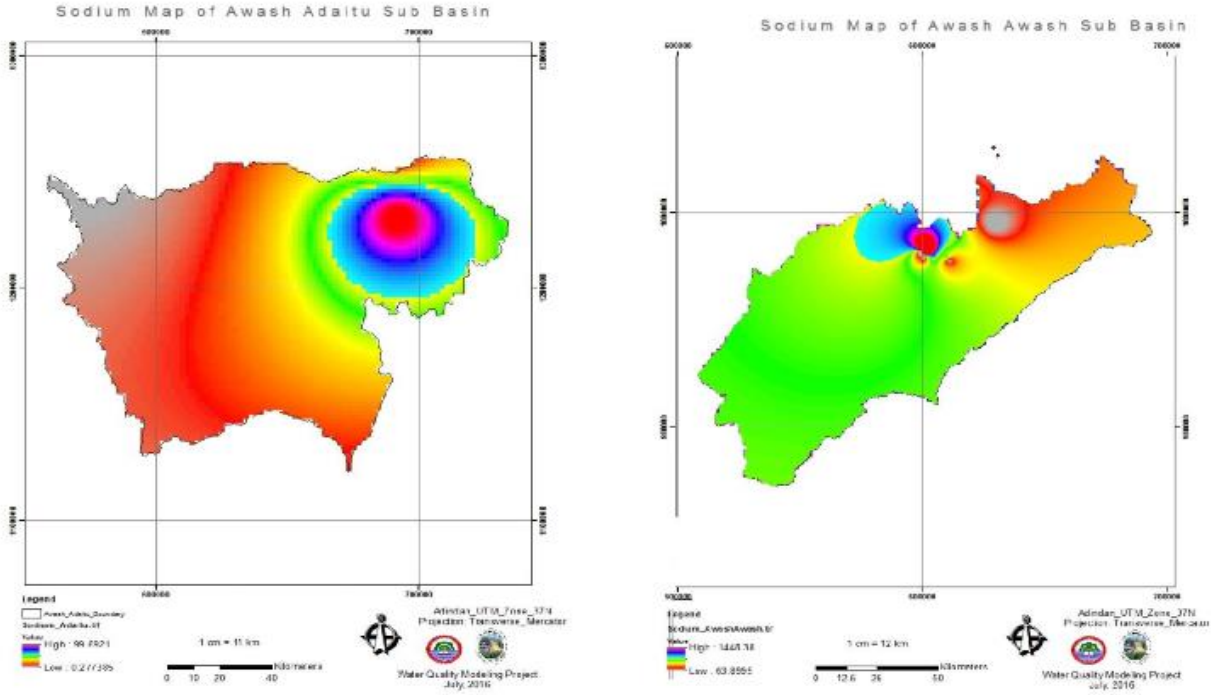


Figure 7. Sodium map of Awash Awash and Awash Adaitu sub basin

C. Awash- Halidebi and Awash-Adaitu sub basins

The low laying three sub basins stretching from Awash Arba to Awash terminal exhibit similar water quality deterioration trend with Awash-Awash sub basin. Furthermore, due to high evaporation, low rainfall and flow rates, the Awash River water quality has declined as a result of brackish water incorporation from other hot springs and Tikurwuha swamp which as well are saline.

In this sub basin, unlike Awash-Awash sub basin, parameters which exceed the lower limit of the standards are only fluoride and nitrite. The percentage of samples with exceeding the fluoride concentration from the lower limits is about 89 % which by far greater than awash-awash sub basin. Whereas the percentage of samples with exceeding nitrate pollutant is about 41 %, which also is a bit greater than Awash-Awash sub basin. But all the other parameters (i.e calcium, magnesium, sodium potassium, chloride, bicarbonate, dissolved manganese, carbonate, sulphate, nitrate, total hardness and ammonia) are below the lower limits of the standard in all observed samples at this sub basin. Figure 8 shows the summary of parameters in comparison with WHO standards.

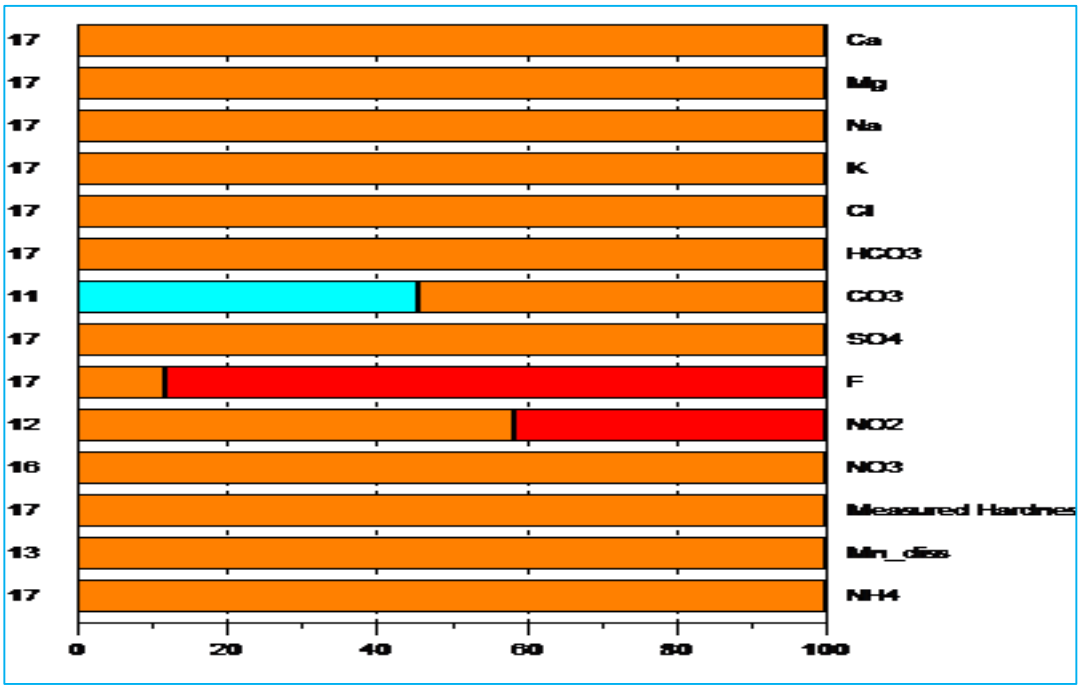


Figure 8. WHO water quality standard detection summary **.**

The mean electrical conductivity of the Awash River was observed to generally increase downstream ranging from 0.347 to 0.636 dS/m. the mean EC value of Lake Beseka is around 5.6 dS/m. Even though the mean EC value increases downstream, the salinity of Awash River varies seasonally signifying that the River could contain significant amount of salt during low flow seasons. Similarly the mean values of most anionic and cationic constituents of Awash River showed increasing trend downstream of the course. The reason for increasing trend of these

constituents were attributed by the impact of Lake Beseka, inflow of different hot springs and inflow of Tikurwuha swamp. On the contrary the river showed decreasing trend in rainy seasons because of the inflows of different tributaries, mainly from the western catchments which are responsible for the dilution effect of the river.

D. Awash-Terminal Sub basin

Awash terminal covers Area downstream of Tendaho up to the farthest lake called Abe. In this sub basin Mile River and Logia River are located and drained into the main Awash River. In this sub basin it is reported that magnesium, sodium, potassium, bicarbonate, carbonate and ammonia exceed the limitation of Ethiopian aquatic species protection water quality standards in the entire samples collected (referee figure 9). Unlike the other two sub basins the percentage of samples which exceed the limitation of the standard for the fluoride concentration is about 82 %. But the other parameters concentration (i.e chloride and dissolved manganese) are observed to be below the lower limit of the standard. The presence of high amount of magnesium and bicarbonate will make the water hard. So the heavy presence of minerals in hard water often leads to pipes becoming clogged. With the clogged pipes, the installed hydraulic machine may run less efficiently. This will lead the water utilities in the sub basin to expend higher energy bills. It also makes the water utilities to spend extra money to repair the damaged water supply components.

Similar to Awash Halidebi Sub basin and unlike Awash-Awash sub basin parameters which exceeding the lower limit of the standards are only fluoride and nitrite (referee figure 10). The percentage of samples with exceeding the fluoride concentration from the lower limits is about 29 % which by far less than Awash Halidebi sub basin. Whereas the percentage of samples with exceeding nitrate pollutant is about 30 % which is similar to **Awash-Awash** sub basin but a bit less than Awash Halidebi Sub basin.

The low laying three sub basins stretching from Awash Arba to Awash terminal exhibit similar water quality deterioration trend with Awash Awash sub basin. Furthermore, due to high evaporation, and low rainfall and flow rates, the Awash River water quality decline as a result of

brackish water incorporation from other hot springs and Tikurwuha swamp which as well were saline.

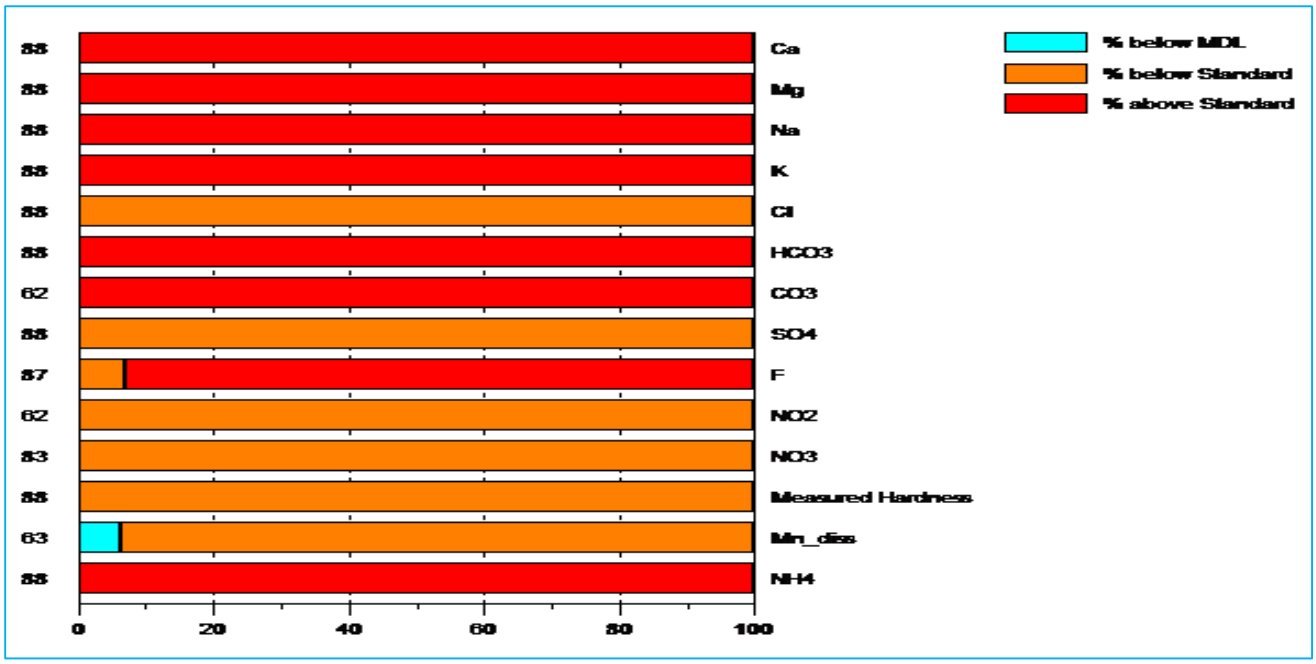


Figure 9. Awash Terminal Sub Basin Ethiopian Aquatic water standard detection summary

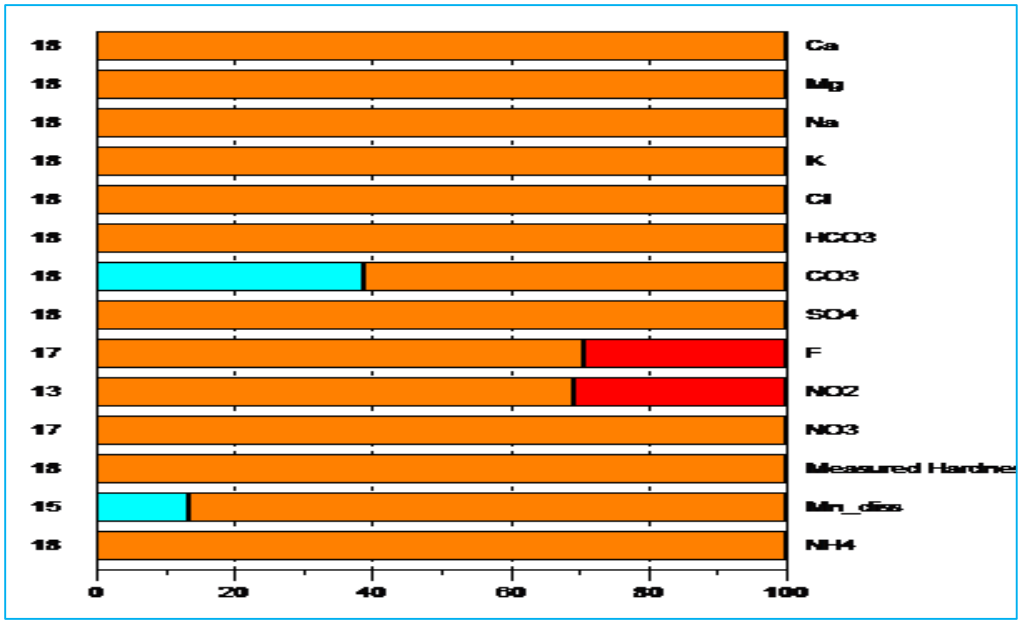


Figure 10. Awash Terminal Sub Basin WHO water quality standard detection summary

E .Eastern catchments

The difference in the topographical and landscape condition in Awash Basin creates an environment like Eastern Catchment with a very less degree of stream network and dominance of groundwater resources. Majorly the water in this sub basin is utilized for drinking purpose. Based on the water quality modeling study done by Adama University it is reported that fecal bacteria are prevailing in eastern sub basin with amount greater than the lower limit set by WHO drinking water standard.

Table 3. Eight Years Mean Annual Physico- Chemical Analysis Result of Awash River Water (2008-2015).

Parameter	Water quality parameter status by sub basin						Water quality standard	
	Upstream koka	Awash_Awash	Eastern catchment	Awash Halidebi	Awash Adaytu	Awash terminal	FAO standard forIrrigation	EPA standad for Aquatic
Ammonia	1.12	0.23	0.18	0.03	0.7	0.25		
Bicarbonate	223.4				266		8.5	
Calcium	37.4	21		58.7	33.1	34.9	200	
Carbonate	42.95			42.5	15.2	214		
Chloride	212.9				46.9		250	
Fluoride	0.48	4.28			1.46	0.54		1
Magnesium	143.7	5.34		7.25	16.9		150	
Nitrate	7.44	0.28	2.31		3	1.41	30	50
Nitrite	0.46	0.07	0.01		0.1	0.06		0.1
PH	8.14	8.5	7.09	6.8		7.37	6.5-9	6.5-9
Phosphate		70.9	15.7	25	0.67	31.4		
Potassium	8.075				7.4			
Sodium		616.41		80.875	99.7		9	
Sulphate		110.67	70.27	49	48.9	31.1		
Total dissolved solid	518.9	1426	710.7	801	416	461	2000	25
Total Hardness		253.33	358.67	42.5	108	214		
Turbidity	573.34	162.53	0.206	0.23	1413.1	42.35		

Source: Awash Basin Authority

3.1.2. Ground water quality current scenario

The quality and characteristics of ground water is predominately depending on the geological formation of the basin i,e the rock and soil types in which water interacts with. Hydro chemical study applied to surface and ground water interactions in Awash Basin revealed that the geology and hydrogeology of the basin is complex. Most of the highlands are covered with early Cenozoic Trap Series volcanics (dominantly basalt, rhyolite and ignimbrite); the rift with acidic volcanics of the Nazreth Group and a relatively younger basic volcanics of the Afar Group (Zanettin *et al*., 1980); and the east is characterized by limited Mesozoic sedimentary rocks which include the Adigrat Sandstone and the Hamanlei Formations consisting of dolomites, limestones, the Amba Aradam sandstones and shale and marl formations. A simplified geological feature of the basin is shown in Figure 11 (Ayenew et al, 2008).

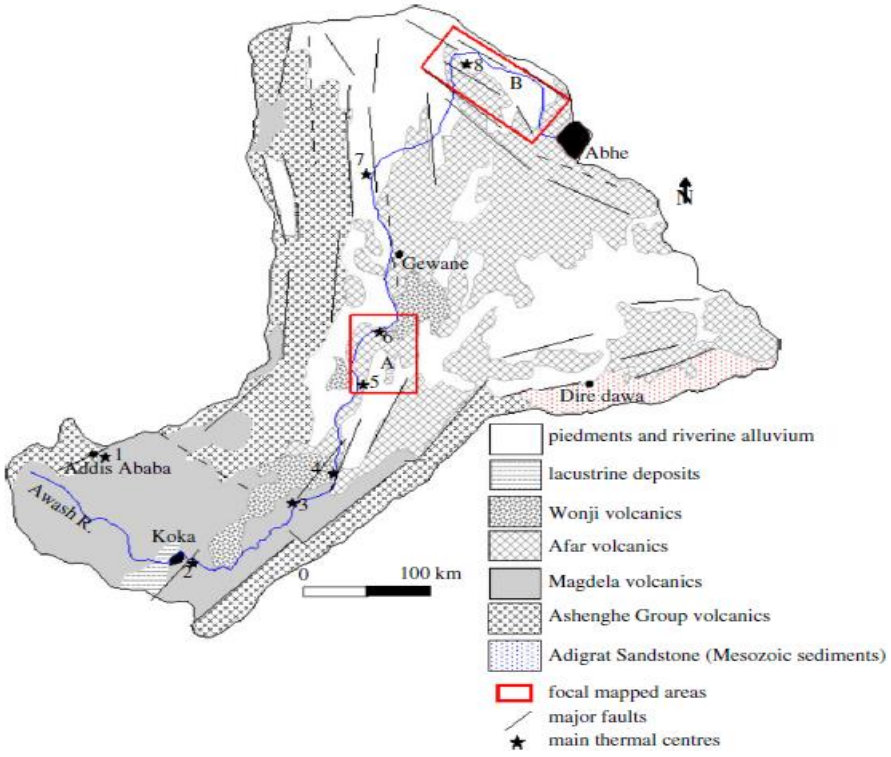


Figure 11. Simplified geological map of the Awash basin (modified from Halcrow, 1989). Thermal manifestation or geothermal centres: 1: Addis Ababa (Filwuha); 2: Sodere–Wonji; 3: Methara-Fantale; 4: Awash–Dofan; 5: Meteka area; 6: Gewane; 7: Theo–Allelobaddo; 8: Tendaho–Abhe. Detailed studied areas: A: Alidghe plain; B:

Tendaho Graben and the surrounding areas [Source: Ayenew *et* al (2008)]. Ayenew et al (2008) identified at least three water groups in Awash River Basin based on total ionic concentration:

1. The rift valley soda, springs, alkaline lakes and deep boreholes tends to ward, the Na^+ K^+ and with low calcium and magnesium. This is related mainly to reverse weathering or formation of Aluminum silicate minerals which is major process incorporating the alkalinity deficit (Wood and Talling 1988) and the dominate of acidic volcanic (in the Afar, Cl^- and SO_4^{-2} play a local role in deep wells far from the alluvial plains.)
2. The water with high Ca and Mg content are localized in the highland basic volcanic area (wells in the central and north west Plato drilled in basaltic terrain and highland lakes. The high Mg content is related to preferential leaching of host basalts. A typical example of such process exists in the Hayq and Ardibo lakes catchment (Semile 2000) In view of the general similarity of rock types drained by streams and rivers in the highland volcanic, the major ion chemistry is not significantly variable. Almost all water are Ca Mg , bicarbonate and type with a TDS of less than 1000mg/L .
3. The transition escarpment has mixed water in terms of the Na, Ca, and Mg cations. However bicarbonate is still the dominant anions expect in the northern and northest part of the basin. Where the sedimentary rocks with higher SO_4^{-2} make the water more So_4^{-2} and Cl^- dominantly. This is particularly more common in northern and central Afar isolated depressions, where evaporate deposit exist.

Generally, three distinct regions with varying ground water circulation and evolution history can be identified in the Awash River Basin (Ayenew *et al*, 2008), these are

i. Shallow fresh water
ii. Intermediate and deep ground water with variable ionic concentration and isotopic signature and
iii. Deep fractionated thermal water with very high salinity and TDS.

Lastly, from the hydro chemical and isotope data, five categories of ground water can be identified in the basin (Ayenew *et al*, 2008). These are

1. The depleted , high TDS, $NaHCO_3$ type thermal water of upper Awash basin
2. The depleted, low TDS, low ^3H waters which occurs in deeper basaltic or ignimbrific aquifer between the head water of Awash and Metehara .

3. The shallow, isotopically enriched high ^{3}H (often> 2 Tu), low TDS (<1000mg/L),Ca, Mg and bicarbonate type water in the highland aquifers.
4. The isotopic ally enriched, high TDS (>1500mg/L) thermal or ground water from deep wells east of lake Beseka and in Asaita area and.
5. The isotopically enriched, intermediate TDS (500-1500mg/L) thermal water in the axial parts of the rift between Addis Ababa and Metehara.

3.2. Future Scenario of the Water Quality of the Basin

As described in sub section 3.1 Awash Basin is divided into six main sub basins for the purpose of efficient management of water quality. To propose water quality management in a sustainable way it is very important to estimate the future scenario of water quality in the basin. Accordingly, the future water quality scenario of each sub basin is presented in the following sub sections**.**

A. Awash Up stream koka Sub basin

The future development trend in the upstream Koka Sub basin will continue to be dominated by urbanization and industrialization as an example the Federal government alone announced his plan to construct 200000 condominium houses let alone the regional's plans and individual housing. With these developments, more domestic and septic wastes and effluents from industries will increase. At the same time demand for water for domestic and industry use will increase reducing the Awash River flow which has a direct impact in losing the dilution potential of the river. Maintaining the water quality of Awash River, considering the future development, entail controlled treated effluent discharge mechanisms and proper water quality monitoring systems to be in place.

B. Awash –Awash Sub basin

The future development trend in the Awash-Awash sub basin will continue to be dominated by irrigation. For instance, the federal and regional governments together with NGOs announce their plan to expand the irrigation of the sub basin to its maximum potential of 79683 hectares. The local communities are engaged in irrigation and water resources development activities mainly in the Awash Valley. Large scale schemes like Fentale and Welenchiti irrigation developments, extension works to the existing state farms and community schemes (Wonji, Metehara, Nura Era, etc) are the current and future development activities which will have significant pressure on the water resources of the basin thereby influencing the availability and quality of the river water.

The irrigation in Awash-Awash sub basin started towards late sixties. The soils at the farm area were generally non-saline and ground water in the area below 10m (Halcrow, 1983). Subsequent long years of surface irrigation and miss-management of irrigation water, in the absence of a well sustained complementary drainage system, will have significant impact on the water qualities of the basin and because of salinity problem in this area most of the lands have low product.

C. Awash-Halidebi and Awash-Adaitu Sub basins

The future development trend in the Awash-Halidebi and Awash-Adaitu sub basin will continue to be dominated by irrigation. For instance, the local communities are engaged in irrigation and water resources development activities mainly in this basin. Large scale schemes like Kesem, Amibara, Bedahmo, Blen, Gewane and Debel irrigation farms are the current and future development activities which will have significant pressure on the water resources of the basin thereby influencing the availability and quality of the river water. However, an increased pollution threat from point sources is creating havoc in this basin. The sustainability of this water resource remains imbalance if appropriate and sustainable water quality monitoring and management measures are not put in place such as proper drainage.

D. Awash Terminal Sub basin

Unlike the other sub basin the water quality in awash terminal sub basin is affected by flooding. It is reported in different literature the flooding frequency at lower awash is high. A number of tributary rivers draining the highlands eastwards will increase the water level of the Awash River in period of short duration of time which will intern cause flooding in this sub basin. Furthermore, Tributaries River in this sub basin like Mille and Logiya Rivers contributed most to the flooding in this sub basin (Yidenkachew, 2008). Flooding has adverse effect on the water quality of the river basin. During floods, water often comes in contact with things it shouldn't, such as dry waste from cities, broken sewer line, and pesticides from agricultural field, allowing a higher pollutant than normal potential for contamination. Drinking water can also be contaminated if floodwater gets into a water main. Due to the contamination of water main and water logging, waterborne diseases expected to occur. In the year 1996 the flooding of the Awash River produced a major disaster at a town called ***Deatbahari***. In the mentioned town after the incidence of the flood waterborne epidemics is reported. Due to climate change, urbanization and deforestation on the upstream of the sub basin the problem associated with flooding in the next 10 years will be expected to be worse. Therefore, due to water quality deterioration, a problem similar to Deatbahari town is expected to occur in the other towns located in this sub basin.

E. Eastern Catchment

Some of the ground water well in eastern catchment is observed to be open. These ground water wells are shallow and utilized for drinking purpose. Some of the observed open ground water wells in eastern catchment mentioned in Adama water quality modeling project include Toni farm 1&2, Adele and Biyodileat Aysha. Toni farm 1&2 are utilized for both irrigation and drinking purpose whereas the other utilized for only drinking purpose. Except the above mentioned well all the other ground water well observed in this sub basin are deep well. The open wells are highly vulnerable for pollution. During 2008 water quality analysis the result of laboratory analysis for the samples obtained from these well reveal the existence of high amount of fecal bacteria. As a result in the next 10 years unless some intervention is done the problem

will be even worse. For the closed deep well the water quality change is not expected in the next 10 years.

4. GOAL, OBJECTIVES AND MEASURES LOGICAL FRAME WORK

4.1. Goal

In order to mitigate water quality problems it requires designing an integrated water resources management strategy. Awash Basin plans to make the water quality of the basin suitable for intended use by 2017 Ethiopian Calendar. With this respect, the water quality in the basin will be improved significantly, with a sharp decline in heavily polluted water areas. In sub basins where the river is utilized for drinking purpose the water safety guarantee level will be raised continuously. Ground water pollution will be strictly controlled. The river water of Awash will be favorable for aquatic life. The water ecological environment in Upper-Awash, Awash-Awash, Awash-Halidebi, Awash-Adaitu and Awash- Terminal sub basins will be considerably improved.

4.2. Objective

The main objective of this plan is to ensure the water quality of the basin as shown in the objective tree (Figure 12) is briefly described as follows.

A. Evaluate the water quality (temporal and spatial)

Assessment of the temporal and spatial water quality of the basin is a crucial activity. This helps to know the status of water in each sub basin in terms of its suitability for the intended purpose of the water use. At first intensive survey will be carried out to detect potential point and non-point sources. Then, representative sampling sites for both the surface and groundwater will be determined in each sub basin and samples will be collected periodically. To distinguish the water in terms of suitability for different uses, preparation of water quality standards will also be required. Therefore, this objective also includes preparation or adaptation of water quality standards.

With the consideration of the above facts, the plan was performed with the following specific objectives.

Specific objectives

- ✓ To test water quality parameters
- ✓ To establish and up grading water quality laboratories
- ✓ To capacitate relevant stake holders

B. Establish permit system for treated waste water

We will optimize the assessment system on water resource protection, enhance supervision and management of water functional areas and evaluate the pollutant carrying capacity of water. We will make plans to regulate waste water disposal of institutions (industries). So basin permit system will be developed to control the effluents discharge to the river. The regulation will include setting appropriate fee to the waste water discharge. The compliant handling mechanism for stakeholder regarding waste water will also develop.

With the consideration of the above facts, the plan was performed with the following specific objectives

Specific objectives

- ✓ To Sett permit system for treated waste water discharge
- ✓ To implement fees for treated waste water discharge
- ✓ To establish Enforcement and complaint handling mechanism

C. Implement waste removal and remediation plan

Strengthening industrial pollution prevention and controlling by applying corrective measures on companies which are not in accordance with the national industrial policy. We will examine small industrial companies with low equipment levels and poor environmentally protective facilities. By 2017 Ethiopian calendar, in line with laws and regulations concerning water pollution control, we will reduce all polluting effluent that go against national rules and pollute

the water environment, which come out of industries such as small paper mills, tanneries, textile printing, colorant, coking, sulfur smelting, arsenic smelting, petroleum refining, electroplating and pesticides.

With the consideration of the above facts, the plan was performed with the following specific objectives

Specific objectives

- ✓ To enable Agricultural farms to have a functional drainage system
- ✓ To transfer new waste treatment technology to industries
- ✓ To ensure cities and big towns to have a sewerage and sewage treatment system
- ✓ To ensure cities, industries and big towns to have a silage and solid waste management system

4.3. Objective Tree

To achieve the aforementioned goal, the following objectives and measures have been set. Figure 12 shows the objective tree in relation to water quality.

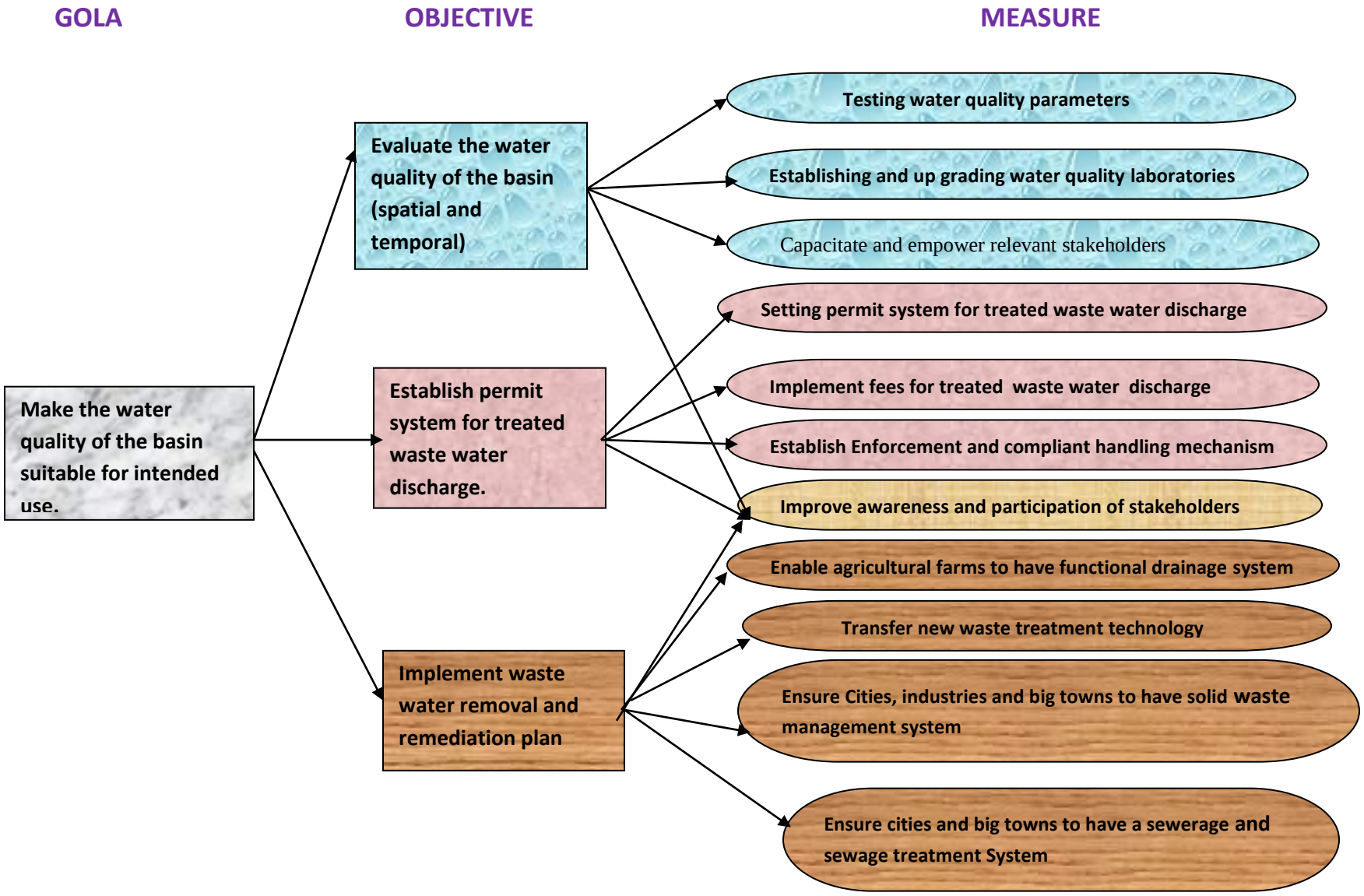


Figure 11. Objective tree for improvement of water quality

4.4. Target and Evaluation Criteria

To achieve the aforementioned general objective, the following target and evaluation criteria have been set. Table 4 shows the evaluation criteria for the desired objectives.

Table 4. Target and evaluation criteria

General objective	Specific objective	Target	Evaluation Criteria
Evaluate the water quality (temporal and spatial)	Testing water quality parameters	Ensuring the water quality as per the standards	produced one water quality states document per-year
	Establishing water quality laboratories	By the end of 2017 establishment of 10 new water quality laboratory	Number of Constructed laboratory per year
	Up grading water quality laboratories	By the end of 2017 Up grading 17 water quality laboratory	Number of up grading laboratory per year
	Capacitate and empower relevant stakeholders	To get qualified experts in water quality	Number of trainees per year
Establish permit system for treated waste water	Setting permit system for treated waste water discharge	To ensure treated waste water discharge as per the standard	produced test report per-year
	Implement fees for treated waste water discharge	To sustain the water quality	Number of polluters per-year
	Establish Enforcement and complaint handling mechanism	Customer satisfaction	feed back from customers in %
Implement waste removal and remediation plan	Enable Agricultural farms to have a functional drainage system	B y the end of 2017 E.C 450 agricultural farms to relies treated waste water	Number of farms with functional drainage system to release waste water per-year
	Transfer new waste treatment technology to industries	B y the end of 2017 all industry to have treatment technology plant	Number of industry received treatment technology per year
	Ensure cities and big towns to have a sewerage and sewage treatment system	B y the end of 2017 E.C 28 big cities and towns to release treated domestic waste water	Number of big cities and towns with sewerage treatment plant per-year
	Ensure cities, industries and big towns to have a silage and solid waste management system	B y the end of 2017 E.C 28 big cities, towns and industries to implement appropriate silage and solid waste management system	Number of big cities, towns and industries with appropriate silage and solid waste management system per year

5. DETAIL ACTION PLAN

To ensure the water quality's of the basin, goal, objective, measures, activities and target have been set as described in the tables bellow.

Table 5. Goal, objective and measures list

Goal	Objective	Measure
Make the water quality of the basin suitable for intended use	Evaluate the water quality (temporal and spatial)	Testing water quality parameters
		Establishing and up grading water quality laboratories
		Capacitate and empower relevant stakeholders
		Improve awareness and participation of stakeholders
	Establish permit system for treated waste water	Setting up permit system for treated waste water discharge
		Implement fees for treated waste water discharge
		Establish enforcement and compliant handling mechanisms
		Improve awareness and participation of stakeholders
	Implement waste removal and remediation plan	Enable agricultural farms to have a functional drainage system
		Transfer new waste treatment technology
		Ensure cities, industries and big towns to have silage and solid waste management system
		Ensure cities and big towns to have a sewerage and sewage treatment system
		Improve awareness and participation of stakeholders

Table 6. 10 years Awash Basin Water quality Plan

Measure	Activity	unit	Target	10 year indicative plane up 2017 E.C						Remark
				Awash up stream koka	Awash Awash	Awash Halidebi	Awash Aditu	Awash Terminal	Eastern Catchment	
Testing water quality parameters	Establish additional surface water quality Monitoring station	No	75	22	17	13	12	11	-	
	Establish additional ground water monitoring station	No	245	22	54	61	32	52	24	A Sum of pizo and bore hole sample site
	Manage water pollution from point and non point sources	%	100	x	x	x	x	x	x	
	Develop/adopt water quality standards	Doc.	1	x	x	x	x	x	x	
	Adopt and implement water quality modeling such as Aqua-chem	%	100	x	x	x	x	x	x	
Establishing and up grading water quality laboratories	Establish water quality laboratory and equip with appropriate facilities	No	17	5	4	1	2	3	2	
Capacitate and empower Relevant Stakeholders	Capacitate Water quality Experts	NO /Trainers	1125	300	250	50	200	150	175	
	Empower Relevant Stakeholders	No of particip ant	5400	900	900	900	900	900	900	Empower Relevant Stakeholders
Setting permit system for treated waste water discharge	Develop treated waste water discharge standards	Doc.	7	x	x	x	x	x	x	
	Set up treated waste water discharge permit system	No	1	x	x	x	x	x	x	
Implement fees for treated waste water discharge	Prepare treated waste water discharge tariffs	Doc.	1	x	x	x	x	x	x	

Establish Enforcement and complaint handling mechanism	Develop and implement guidelines ,directives ,protocols and MoUs	Doc.	1	x	x	x	x	x	x	
	Monitor and evaluate the application of enforcement and compliant handling documents	Doc.	1	x	x	x	x	x	x	
Enable Agricultural farms to have a functional drainage system	Assessment of Agricultural farms	%	100	x	x	x	x	x	x	
	preparation of irrigation design guide line	Doc.	1	x	x	x	x	x	x	
	Construct irrigation drainage system	No	450	80	90	90	80	110		Construct irrigation drainage system
Transfer new waste treatment technology to industries	adopt new waste treatment technology	No	10	x	x	x	x	x	x	
Ensure cities and big towns to have a sewerage and sewage treatment system	Assessment of sewerage and sewage treatment	%	100	x	x	x	x	x	x	
	preparation of sewerage and sewage treatment design guide line	Doc.	1	x	x	x	x	x	x	
Ensure cities, industries and big towns to have a silage and solid waste management system	Assessment of a silage and solid waste management system	%	100	x	x	x	x	x	x	
	preparation of a silage and solid waste management system design guideline	Doc.	1	x	x	x	x	x	x	
	Construct a silage and solid waste disposal system	Doc.	1	x	x	x	x	x	x	

Table 7. Awash Upstream Detail Action Plan

Measure	Activity	Sub activity	unit	target	year				Actors
					2009	2010	2011	2012	
Testing water quality parameters	Establish additional surface water quality Monitoring station.	Identify and decide representative sampling sites.	No	14	4	3	3	4	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions ,EFCCB,ECWDC laboratories &BHC.
		Periodical sampling and Analyses.	No of stat./month	16	6	9	12	16	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
	Establish additional ground water monitoring station.	Identify and decide representative borehole sampling sites.	No	12			7	5	AwBA,MoWIE,Regional Water Bureau,MoEFC,.Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
		Install piezometric sample sites.	No	-	-	-	-	-	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &BHC.
		Rehabilitate piezometric sample sites.	No	-	-	-	-	-	AwBA,MoWIE,MoEFCC.Regional Water Bureau,ECWDC laboratories,Higher institutions
		Periodical sampling and Analyses.	No of stations	12			7	12	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &HBC.
	Manage water pollution from point and non point sources.	Identify point and non-point sources.	%	100	80	20			AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions,MoI& HBC.
		Sampling and analyses of discharge water from major polluters.	No	1000	200	250	250	300	AwBA,MoWIE, MoEFCC,MoI,Textil ,tanery , cotton , flowery cultur instituits,EFCCB & BHC.
		Initiate and enforce to install effluent treatment plant.	%	100	-	25	25	50	MoI,Textil ,tanery , cotton , flowery cultur instituit, AwBA & HBC.
		Monitor and evaluate discharge water from major polluters.	No	1000	200	250	250	300	AwBA,MoFCC,MoI,MoH,Textil ,tanery , cotton , flowery cultur instituit & BHC.
	Develop/adopt water quality standards.	Reviewing existing national and international water quality standard.	Doc.	7	x	x			MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards .	Doc.	6		x	x		MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Presenting the draft standards for stakeholders.	Doc.	6			x		MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Adopting/Implementing the standards documents.	%	100				x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur, instituitHigher institutions & BHC..

	ADopt and implment water quality modeling such as Aqua -chem.	develop data base for water quality.	No	1	x	x			ASTU ,Other staekholders,AwBA & BHC.
		tranings about water quality modeling tools and GIS.	No of traning	16	4	4	4	4	ASTU,Other staekholders,AwBA , Regional water bereau & BHC.
Establishing and up grading water quality laboratories	Establish water quality laboratory and equipement with appropriate facilities.	Construction of laboratory buildings.	No	2		X	X		AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit & BHC.
		Equip. water quality laboratories with appropriate facilities.	No	2		X		X	AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Up grade the level of water quality laboratories in the basin.	No	5	1	2	1	1	AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
Capacitate and empower Relevant Stakeholders	Capacitate Water quality Experts.	Create educational opportunities for water quality Expets (long term).	NO /Trainers	21	3	6	6	6	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
		Organize experience sharing visit for water quality Experts.	NO	16	4	4	4	4	Regiones ,AwBA, MoWIE,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Organize and conduct capacity building trainings (short term).	No of traning	32	8	8	8	8	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
	Empower Relevant Stakeholders .	Awareness creation.	No of participant	500	125	125	125	125	Regiones ,AwBA,community & BHC.
		Organize experience sharing.	NO	4	1	1	1	1	Regiones ,AwBA,community & BHC.
Setting permit system for treated waste water discharge	Develop treated waste water discharge standards.	Identifying polluters.	%	100	80	20			AwBA,MoWIE,Regional Water Bureau,MoEFC,.MoI ,MoAgN,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions and EFCCB & BHC.
		Reviewing existing national and international treated waste water quality standards documents.	Doc.	3	x				MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards.	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		presenting the draft standards for stakeholders.	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		Adopting/Implementing the standards.	Doc.	1			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur instituit ,Higher institutions & BHC.

	Set up treated waste water discharge permit system.	Develop treated waste water discharge permit system.	No	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement waste water discharging permit system (give license for polluters).	No	950	100	200	300	350	AwBA,Regional Water Bureau,Regional irregation bureau & BHC .
		renew license on regular base.	No	604	4	104	304	604	AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Implement fees for treated waste water discharge	Prepare treated waste water discharge tariffs.	Develop treated waste water discharge tariffs.	Doc.	1		x			MoWIE, AwBA ,Regional water bereau ,regional industries bereau & BHC.
		Implement waste water discharge tariffs.	%	100			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC & BHC.
		Collect fees for license and treated waste water discharge.	Birr						AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Establish Enforcement and complaint handling mechanism	Develop and implement guidelines ,directives ,protocols and MoUs.	Asses national/international water quality enforcement and compliant handling mechanisms.	Doc.	3	x				AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Set up enforcement tools , guidelines ,directives and MoUS.	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement enforcement tools , guidelines ,directives and MoUS.	%	100			100		AwBA,MoJ,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions ,EFCCB & BHC.
	Monitor and evaluate the application of enforcement and compliant handling documents.	Develop Monitoring System for enforcement effectiveness.	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Monitor and evaluate the implementation of the documents.	%	100			100		AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Enable Agricultural farms to have a functional drainage system	Assessment of Agricultural farms.	Identification of type of farms.	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
		Identify farms with and without drainage system.	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
	preparation of irrigation design guide line.	Reviewing existing irrigation guideline.	Doc.	4	x				MoAgN,AwBA ,Regional irregation bureau & BHC.
		Setting draft irrigation guideline.	Doc	1		x			MoAgN,AwBA ,Regional irregation bureau & BHC.
		presenting the draft irrigation design guideline to stakeholder.	Doc	1			x		MoAgN,AwBA ,Regional irregation bureau,users& BHC.

		Implementing the irrigation guideline.	%	100			40	60	MoAgN,Investment Agencies,AwBA ,Regional irregation bureau,users& BHC.
	Construct irrigation drainage system.	Construct irrigation drainage system for newly established irrigation farms.	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
		Rehabilitate the existing drainage structure.	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
Transfer new waste treatment technology to industries	adopt new waste treatment technology.	Select exemplary treatment units.	No	5	x				AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions, EFCCB & BHC.
		promote and apply to other industries.	%	100		25	50	25	AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions , EFCCB & BHC.
Ensure cities and big towns to have a sewerage and sewage treatment system	Assessment of sewerage and sewage treatment.	Identify the status of sewerage and sewage treatment system.	%	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
		Identify cities and big towns with and without sewerage and sewage treatment system.	%	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
	preparation of sewerage and sewege treatment design guide line.	Reviewing existing sewerage and sewage treatment guideline.	Doc	1	x				Minister of Urban Development,municipalities,AwBA & BHC.
		Setting draft sewerage and sewage treatment design guideline.	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		presenting the draft sewerage and sewage treatment design guideline to stakeholder.	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		Implementing the sewerage and sewage treatment guideline.	%	100			100		Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.
		Construct sewerage and sewage treatment system for cities and big towns.	No	4	x	x	x	x	Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.
		Rehabilitate the existing sewerage and sewage treatment system.	No	7	1	2	3	1	municipalities ,AwBA & BHC.
Ensure cities, industries and big towns to	Assessment of solid & Sludge waste management system.	Identify the status of solid waste management system.	%	100		50	50		MoEFCC,MoUD,City Administration ,AwBA, RegionalEnvairoment Forest and Climate changeAuthority & BHC.
		Identify cities and big towns with and without solid waste management system.	%	100		50	50		Minister of Urban Development, cities and towns administration,MoEFCC,Municipalities,AwBA & BHC.

have a solid &Sludge waste management system.	preparation of solid & Sludge waste management system design guideline .	Reviewing existing solid waste management guideline.	Doc	1		x			MoEFCC,MoUD,Regional Envairoment Forest and Climate change Authority , AwBA & BHC.
		Setting draft solid waste management system design guideline.	Doc	1		x			MoEFCC,MoUD, AwBA & BHC.
		presenting the draft solid waste management system design guideline to stakeholders.	Doc	1			x		MoEFCC,MoUD,City Administration ,Regional Envairoment Forest and Climate changeAuthority,AwBA,municipalities & BHC.
		Implementing the solid waste management system guideline	%	100			60	40	Minister of Urban Development, cities and towns administration,community, AwBA,Municipalities & BHC.
	Construct solid & Sludge waste disposal system.	Construct solid & Sludge waste management system for cities and big towns	No	4	x	x	x	x	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.
		Rehabilitate the existing solid waste management	No	2	x	x	x	x	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.

Table 8. Awash at Awash Detail Action plan

Measure	Activity	Sub activity	unit	target	year				Actors
					2009	2010	2011	2012	
Testing water quality parameters	Establish additional surface water quality Monitoring station	Identify and decide representative sampling sites	No	12	4	3	3	2	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions ,EFCCB,ECWDC laboratories &BHC.
		Periodical sampling and Analyses	No of stat./mo	22	14	17	20	22	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
	Establish additional ground water monitoring station	Identify and decide representative borehole sampling sites	No	14	-	-	6	8	AwBA,MoWIE,Regional Water Bureau,MoEFC,.Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
		Install piezometric sample sites	No	18	3	3	6	6	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &BHC.
		Rehabilitate piezometric sample sites	No	-	-	-	-	-	AwBA,MoWIE,MoEFCC.Regional Water Bureau,ECWDC laboratories,Higher institutions
		Periodical sampling and Analyses	No of stations	14	-	-	6	14	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &HBC.
	Manage water pollution from point and non point sources	Identify point and non-point sources	%	100	80	20			AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions,MoI& HBC.
		Sampling and analyses of discharge water from major polluters	No	60	5	10	15	30	AwBA,MoWIE, MoEFCC,MoI,Textil ,tanery , cotton , flowery cultur instituits,EFCCB & BHC.
		Initiate and enforce to install effluent treatment plant	%	100		25	25	50	MoI,Textil ,tanery , cotton , flowery cultur instituit,AwBA & HBC.
		Monitor and evaluate discharge water from major polluters	No	60	5	10	15	30	AwBA,MoFCC,MoI,MoH,Textil ,tanery , cotton , flowery cultur instituit & BHC.
	Develop/adopt water quality standards	Reviewing existing national and international water quality standard.	Doc.	7	x	x			MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards .	Doc.	6	-	x	x		MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Presenting the draft standards for stakeholders	Doc.	6			x		MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Adopting/Implementing the standards documents	%	100				x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur, instituitHigher institutions & BHC..
	ADopt and implment water quality modeling such as aqu-chem	develop data base for water quality	No	1	x	x			ASTU ,Other staekholders,AwBA & BHC.
		tranings about water quality modeling and GIS	No of traning	16	4	4	4	4	ASTU,Other staekholders,AwBA , Regional water bereau & BHC.
Establishing and up	Establish water	Construction of laboratory buildings	No	3		X	X		AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit & BHC.

grading water quality laboratories	quality laboratory and equip with appropriate facilities	Equip water quality laboratories with appropriate facilities	No	3		X		X	AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Up grade level of water quality laboratories in the basin	No	-	-	-	-	-	AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
Capacitate and empower Relevant Stakeholders	Capacitate Water quality Experts	Create educational opportunities for water quality Expets (long term)	NO /Trainers	9	1	2	3	3	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
		Organize experience sharing visit for water quality Experts	NO	16	4	4	4	4	Regiones ,AwBA, MoWIE,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Organize and conduct capacity building trainings (short term)	No of traning	32	8	8	8	8	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
	Empower Relevant Stakeholders	Awareness creation	No of participant	500	125	125	125	125	Regiones ,AwBA,community & BHC.
		Organize experience sharing	NO	4	1	1	1	1	Regiones ,AwBA,community & BHC.
Setting permit system for treated waste water discharge	Develop treated waste water discharge standards	Identifying polluters	%	100	80	20			AwBA,MoWIE,Regional Water Bureau,MoEFCC,MoI ,MoAgN,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions and EFCCB & BHC.
		Reviewing existing national and international treated waste water quality standards documents	Doc.	3	x				MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		presenting the draft standards for stakeholders	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		Adopting/Implementing the standards	Doc.	1			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur instituit ,Higher institutions & BHC.
	Set up treated waste water discharge permit system	Develop treated waste water discharge permit system	No	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement waste water discharging permit system (give license for polluters)	No	57	4	10	13	30	AwBA,Regional Water Bureau,Regional irregation bureau & BHC .
		renew license on regular base	No	27		4	14	27	AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Implement fees for treated waste water discharge	Prepare treated waste water discharge tariffs	Develop treated waste water discharge tariffs	Doc.	1		x			MoWIE, AwBA ,Regional water bereau ,regional industries bereau & BHC.
		Implement waste water discharge tariffs	%	100			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC & BHC.
		Collect fees for license and treated waste water discharge	Birr						AwBA,Regional Water Bureau,Regional irregation bureau & BHC.

Establish Enforcement and complaint handling mechanism	Develop and implement guidelines ,directives ,protocols and MoUs	Asses national/international water quality enforcement and compliant handling mechanisms	Doc.	3	x				AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Set up enforcement tools , guidelines ,directives and MoUS	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement enforcement tools , guidelines ,directives and MoUS	%	100			100		AwBA,MoJ,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions ,EFCCB & BHC.
	Monitor and evaluate the application of enforcement and compliant handling documents	Develop Monitoring System for enforcement effectiveness	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Monitor and evaluate the implementation of the documents	%	100			100		AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Enable Agricultural farms to have a functional drainage system	Assessment of Agricultural farms	Identification of type of farms	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
		Identify farms with and without drainage system	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
	preparation of irrigation design guide line	Reviewing existing irrigation guideline	Doc.	4	x				MoAgN,AwBA ,Regional irregation bureau & BHC.
		Setting draft irrigation guideline	Doc	1		x			MoAgN,AwBA ,Regional irregation bureau & BHC.
		presenting the draft irrigation design guideline to stakeholder	Doc	1			x		MoAgN,AwBA ,Regional irregation bureau,users& BHC.
		Implementing the irrigation guideline	%	100			40	60	MoAgN,Investment Agencies,AwBA ,Regional irregation bureau,users& BHC.
	Construct irrigation drainage system	Construct irrigation drainage system for newly established irrigation farms	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
		Rehabilitate the existing drainage structure	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
Transfer new waste treatment technology to industries	adopt new waste treatment technology	Select exemplary treatment units	No	5	x				AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions, EFCCB & BHC.
		promote and apply to other industries	%	100		25	50	25	AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions , EFCCB & BHC.
Ensure cities and big towns to have a sewerage and sewage treatment system	Assessment of sewerage and sewage treatment	Identify the status of sewerage and sewage treatment system	%	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
		Identify cities and big towns with and without sewerage and sewage treatment system	%	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
	preparation of sewerage and sewege treatment	Reviewing existing sewerage and sewage treatment guideline	Doc	1	x				Minister of Urban Development,municipalities,AwBA & BHC.
		Setting draft sewerage and sewage treatment design guideline	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.

	design guide line	presenting the draft sewerage and sewage treatment design guideline to stakeholder	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		Implementing the sewerage and sewage treatment guideline	%	100			100		Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.
		Construct sewerage and sewage treatment system for cities and big towns	No	2			x	x	Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.
		Rehabilitate the existing sewerage and sewage treatment system	No	1	1	-	-	-	municipalities ,AwBA & BHC.
Ensure cities, industries and big towns to have a solid &Sludge waste manageme nt system.	Assessment of solid & Sludge waste management system.	Identify the status of solid waste management system.	%	100		50	50		MoEFCC,MoUD,City Administration ,AwBA, RegionalEnvairoment Forest and Climate changeAuthority & BHC.
		Identify cities and big towns with and without solid waste management system.	%	100		50	50		Minister of Urban Development, cities and towns administration,MoEFCC,Municipalities,AwBA & BHC.
	preparation of solid & Sludge waste management system design guideline .	Reviewing existing solid waste management guideline.	Doc	1		x			MoEFCC,MoUD,Regional Envairoment Forest and Climate change Authority , AwBA & BHC.
		Setting draft solid waste management system design guideline.	Doc	1		x			MoEFCC,MoUD, AwBA & BHC.
		presenting the draft solid waste management system design guideline to stakeholders.	Doc	1			x		MoEFCC,MoUD,City Administration ,Regional Envairoment Forest and Climate changeAuthority,AwBA,municipalities & BHC.
		Implementing the solid waste management system guideline	%	100			60	40	Minister of Urban Development, cities and towns administration,community, AwBA,Municipalities & BHC.
	Construct solid & Sludge waste disposal system.	Construct solid & Sludge waste management system for cities and big towns	No	2			x	x	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.
		Rehabilitate the existing solid waste management	No	-	-	-	-	-	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.

Table 9. Awash Halidebi Detail Action plan

Measure	Activity	Sub activity	unit	target	year				Actors
					2009	2010	2011	2012	
Testing water quality parameters	Establish additional surface water quality Monitoring station	Identify and decide representative sampling sites	No	9	2	2	2	3	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions ,EFCCB,ECWDC laboratories &BHC.
		Periodical sampling and Analyses	No of stations	11	4	6	8	11	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
	Establish additional ground water monitoring station	Identify and decide representative borehole sampling sites	No	12			5	7	AwBA,MoWIE,Regional Water Bureau,MoEFC,.Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
		Install piezometric sample sites	No	-	-	-	-	-	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &BHC.
		Rehabilitate piezometric sample sites	No	22		22			AwBA,MoWIE,MoEFCC.Regional Water Bureau,ECWDC laboratories,Higher institutions
		Periodical sampling and Analyses	No of stations	51	17	39	44	51	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &HBC.
	Manage water pollution from point and non point sources	Identify point and non-point sources	%	100	80	20			AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions,MoI& HBC.
		Sampling and analyses of discharge water from major polluters	No	1	1				AwBA,MoWIE, MoEFCC,MoI,Textil ,tanery , cotton , flowery cultur instituits,EFCCB & BHC.
		Initiate and enforce to install effluent treatment plant	%	100	-	25	25	50	MoI,Textil ,tanery , cotton , flowery cultur instituit,AwBA & HBC.
		Monitor and evaluate discharge water from major polluters	No	1	1				AwBA,MoFCC,MoI,MoH,Textil ,tanery , cotton , flowery cultur instituit & BHC.
	Develop/adopt water quality standards	Reviewing existing national and international water quality standard.	Doc.	7	x	x			MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards .	Doc.	6		x	x		MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Presenting the draft standards for stakeholders	Doc.	6			x		MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Adopting/Implementing the standards documents	%	100				x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur, instituitHigher institutions & BHC..
	ADopt and	develop data base for water quality	No	1	x	x			ASTU ,Other staekholders,AwBA & BHC.

	implment water quality modeling such as aqu-chem	tranings about water quality modeling and GIS	No of traning	16	4	4	4	4	ASTU,Other staekholders,AwBA , Regional water bereau & BHC.
Establishing and up grading water quality laboratories	Establish water quality laboratory and equip with appropriate facilities	Construction of laboratory buildings	No	-	-	-	-	-	AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit & BHC.
		Equip water quality laboratories with appropriate facilities	No	-	-	-	-	-	AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Up grade level of water quality laboratories in the basin	No	1	1				AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
Capacitate and empower Relevant Stakeholders	Capacitate Water quality Experts	Create educational opportunities for water quality Expets (long term)	NO /Trainers	5		1	1	3	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
		Organize experience sharing visit for water quality Experts	NO	16	4	4	4	4	Regiones ,AwBA, MoWIE,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Organize and conduct capacity building trainings (short term)	No of traning	32	8	8	8	8	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
	Empower Relevant Stakeholders	Awareness creation	No of participant	500	125	125	125	125	Regiones ,AwBA,community & BHC.
		Organize experience sharing	NO	4	1	1	1	1	Regiones ,AwBA,community & BHC.
Setting permit system for treated waste water discharge	Develop treated waste water discharge standards	Identifying polluters	%	100	80	20			AwBA,MoWIE,Regional Water Bureau,MoEFCC,MoI ,MoAgN,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions and EFCCB & BHC.
		Reviewing existing national and international treated waste water quality standards documents	Doc.	3	x				MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		presenting the draft standards for stakeholders	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		Adopting/Implementing the standards	Doc.	1			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur instituit ,Higher institutions & BHC.

	Set up treated waste water discharge permit system	Develop treated waste water discharge permit system	No	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement waste water discharging permit system (give license for polluters)	No	1	1				AwBA,Regional Water Bureau,Regional irregation bureau & BHC .
		renew license on regular base	No	1		1			AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Implement fees for treated waste water discharge	Prepare treated waste water discharge tariffs	Develop treated waste water discharge tariffs	Doc.	1		x			MoWIE, AwBA ,Regional water bereau ,regional industries bereau & BHC.
		Implement waste water discharge tariffs	%	100			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC & BHC.
		Collect fees for license and treated waste water discharge	Birr						AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Establish Enforcement and complaint handling mechanism	Develop and implement guidelines ,directives ,protocols and MoUs	Asses national/international water quality enforcement and compliant handling mechanisms	Doc.	3	x				AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Set up enforcement tools , guidelines ,directives and MoUS	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement enforcement tools , guidelines ,directives and MoUS	%	100			100		AwBA,MoJ,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions ,EFCCB & BHC.
	Monitor and evaluate the application of enforcement and compliant handling documents	Develop Monitoring System for enforcement effectiveness	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Monitor and evaluate the implementation of the documents	%	100			100		AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Enable Agricultural farms to have a functional drainage	Assessment of Agricultural farms	Identification of type of farms	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
		Identify farms with and without drainage system	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.

system	preparation of irrigation design guide line	Reviewing existing irrigation guideline	Doc.	4	x				MoAgN,AwBA ,Regional irregation bureau & BHC.
		Setting draft irrigation guideline	Doc	1		x			MoAgN,AwBA ,Regional irregation bureau & BHC.
		presenting the draft irrigation design guideline to stakeholder	Doc	1			x		MoAgN,AwBA ,Regional irregation bureau,users& BHC.
		Implementing the irrigation guideline	%	100			40	60	MoAgN,Investment Agencies,AwBA ,Regional irregation bureau,users& BHC.
	Construct irrigation drainage system	Construct irrigation drainage system for newly established irrigation farms	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
		Rehabilitate the existing drainage structure	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
Transfer new waste treatment technology to industries	adopt new waste treatment technology	Select exemplary treatment units	No	5	x				AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions, EFCCB & BHC.
		promote and apply to other industries	%	100			1		AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions , EFCCB & BHC.
Ensure cities and big towns to have a sewerage and sewage treatment system	Assessment of sewerage and sewage treatment	Identify the status of sewerage and sewage treatment system	%	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
		Identify cities and big towns with and without sewerage and sewage treatment system	No	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
	preparation of sewerage and sewege treatment design guide line	Reviewing existing sewerage and sewage treatment guideline	Doc	1	x				Minister of Urban Development,municipalities,AwBA & BHC.
		Setting draft sewerage and sewage treatment design guideline	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		presenting the draft sewerage and sewage treatment design guideline to stakeholder	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		Implementing the sewerage and sewage treatment guideline	%	100			100		Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.
		Construct sewerage and sewage treatment system for cities and big towns	No	-	-	-	-	-	Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.

		Rehabilitate the existing sewerage and sewage treatment system	No	-	-	-	-	-	municipalities ,AwBA & BHC.
Ensure cities, industries and big towns to have a solid &Sludge waste management system.	Assessment of solid & Sludge waste management system.	Identify the status of solid waste management system.	%	100		50	50		MoEFCC,MoUD,City Administration ,AwBA, RegionalEnvairoment Forest and Climate changeAuthority & BHC.
		Identify cities and big towns with and without solid waste management system.	%	100		50	50		Minister of Urban Development, cities and towns administration,MoEFCC,Municipalities,AwBA & BHC.
	preparation of solid & Sludge waste management system design guideline .	Reviewing existing solid waste management guideline.	Doc	1		x			MoEFCC,MoUD,Regional Envairoment Forest and Climate change Authority , AwBA & BHC.
		Setting draft solid waste management system design guideline.	Doc	1		x			MoEFCC,MoUD, AwBA & BHC.
		presenting the draft solid waste management system design guideline to stakeholders.	Doc	1			x		MoEFCC,MoUD,City Administration ,Regional Envairoment Forest and Climate changeAuthority,AwBA,municipalities & BHC.
		Implementing the solid waste management system guideline	%	100			60	40	Minister of Urban Development, cities and towns administration,community, AwBA,Municipalities & BHC.
	Construct solid & Sludge waste disposal system.	Construct solid & Sludge waste management system for cities and big towns	No	1			X		Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.
		Rehabilitate the existing solid waste management	No	-	-	-	-	-	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.

Table 10. Awash Aditu Detail Action plan

Measure	Activity	Sub activity	unit	target	year				Actors
					2009	2010	2011	2012	
Testing water quality parameters	Establish additional surface water quality Monitoring station	Identify and decide representative sampling sites	No	8	2	2	2	2	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions ,EFCCB,ECWDC laboratories &BHC.
		Periodical sampling and Analyses	No of stations	10	4	6	8	10	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
	Establish additional ground water monitoring station	Identify and decide representative borehole sampling sites	No	12		4	4	4	AwBA,MoWIE,Regional Water Bureau,MoEFC,.Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
		Install piezometric sample sites	No						AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &BHC.
		Rehabilitate piezometric sample sites	No						AwBA,MoWIE,MoEFCC.Regional Water Bureau,ECWDC laboratories,Higher institutions
		Periodical sampling and Analyses	No of stations	12		4	8	12	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &HBC.
	Manage water pollution from point and non point sources	Identify point and non-point sources	%	100	80	20			AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions,MoI& HBC.
		Sampling and analyses of discharge water from major polluters	No	40	5	10	12	13	AwBA,MoWIE, MoEFCC,MoI,Textil ,tanery , cotton , flowery cultur instituits,EFCCB & BHC.
		Initiate and enforce to install effluent treatment plant	%	100		25	25	50	MoI,Textil ,tanery , cotton , flowery cultur instituit,AwBA & HBC.
		Monitor and evaluate discharge water from major polluters	No	40	5	10	12	13	AwBA,MoFCC,MoI,MoH,Textil ,tanery , cotton , flowery cultur instituit & BHC.
	Develop/adopt water quality standards	Reviewing existing national and international water quality standard.	Doc.	7	x	x			MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards .	Doc.	6		x			MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Presenting the draft standards for stakeholders	Doc.	6			x		MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Adopting/Implementing the standards documents	%	100				x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur, instituitHigher institutions & BHC..

	ADopt and implment water quality modeling such as aqu-chem	develop data base for water quality	No	1	x	x			ASTU ,Other staekholders,AwBA & BHC.
		tranings about water quality modeling and GIS	No of traning	16	4	4	4	4	ASTU,Other staekholders,AwBA , Regional water bereau & BHC.
Establishing and up grading water quality laboratories	Establish water quality laboratory and equip with appropriate facilities	Construction of laboratory buildings	No	1		X			AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit & BHC.
		Equip water quality laboratories with appropriate facilities	No	1			x		AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Up grade level of water quality laboratories in the basin	No	-	-	-	-	-	AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
Capacitate and empower Relevant Stakeholders	Capacitate Water quality Experts	Create educational opportunities for water quality Expets (long term)	NO /Trainers	3		1	1	1	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
		Organize experience sharing visit for water quality Experts	NO	16	4	4	4	4	Regiones ,AwBA, MoWIE,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Organize and conduct capacity building trainings (short term)	No of traning	32	8	8	8	8	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
	Empower Relevant Stakeholders	Awareness creation	No of participant	500	125	125	125	125	Regiones ,AwBA,community & BHC.
		Organize experience sharing	NO	4	1	1	1	1	Regiones ,AwBA,community & BHC.
Setting permit system for treated waste water discharge	Develop treated waste water discharge standards	Identifying polluters	%	100	80	20			AwBA,MoWIE,Regional Water Bureau,MoEFCC,MoI ,MoAgN,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions and EFCCB & BHC.
		Reviewing existing national and international treated waste water quality standards documents	Doc.	3	x				MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		presenting the draft standards for stakeholders	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		Adopting/Implementing the standards	Doc.	1			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur instituit ,Higher institutions & BHC.
	Set up treated waste water discharge permit system	Develop treated waste water discharge permit system	No	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement waste water discharging permit system (give license for polluters)	No	37	4	9	11	23	AwBA,Regional Water Bureau,Regional irregation bureau & BHC .
		renew license on regular base	No	24		4	13	24	AwBA,Regional Water Bureau,Regional irregation bureau & BHC.

Implement fees for treated waste water discharge	Prepare treated waste water discharge tariffs	Develop treated waste water discharge tariffs	Doc.	1		x			MoWIE, AwBA ,Regional water bereau ,regional industries bereau & BHC.
		Implement waste water discharge tariffs	%	100			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC & BHC.
		Collect fees for license and treated waste water discharge	Birr						AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Establish Enforcement and complaint handling mechanism	Develop and implement guidelines ,directives ,protocols and MoUs	Asses national/international water quality enforcement and compliant handling mechanisms	Doc.	3	x				AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Set up enforcement tools , guidelines ,directives and MoUS	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement enforcement tools , guidelines ,directives and MoUS	%	100			100		AwBA,MoJ,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions ,EFCCB & BHC.
	Monitor and evaluate the application of enforcement and compliant handling documents	Develop Monitoring System for enforcement effectiveness	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Monitor and evaluate the implementation of the documents	%	100			100		AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Enable Agricultural farms to have a functional drainage system	Assessment of Agricultural farms	Identification of type of farms	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
		Identify farms with and without drainage system	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
	preparation of irrigation design guide line	Reviewing existing irrigation guideline	Doc.	4	x				MoAgN,AwBA ,Regional irregation bureau & BHC.
		Setting draft irrigation guideline	Doc	1		x			MoAgN,AwBA ,Regional irregation bureau & BHC.
		presenting the draft irrigation design guideline to stakeholder	Doc	1			x		MoAgN,AwBA ,Regional irregation bureau,users& BHC.
		Implementing the irrigation guideline	%	100			40	60	MoAgN,Investment Agencies,AwBA ,Regional irregation bureau,users& BHC.
	Construct irrigation drainage system	Construct irrigation drainage system for newly established irrigation farms	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
		Rehabilitate the existing drainage structure	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
Transfer new waste treatment technology to industries	adopt new waste treatment technology	Select exemplary treatment units	No	5	x				AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions, EFCCB & BHC.
		promote and apply to other industries	%	100		25	50	25	AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions , EFCCB & BHC.

Ensure cities and big towns to have a sewerage and sewage treatment system	Assessment of sewerage and sewage treatment	Identify the status of sewerage and sewage treatment system	%	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
		Identify cities and big towns with and without sewerage and sewage treatment system	No	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
	preparation of sewerage and sewege treatment design guide line	Reviewing existing sewerage and sewage treatment guideline	Doc	1	x				Minister of Urban Development,municipalities,AwBA & BHC.
		Setting draft sewerage and sewage treatment design guideline	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		presenting the draft sewerage and sewage treatment design guideline to stakeholder	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		Implementing the sewerage and sewage treatment guideline	%	100			100		Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.
		Construct sewerage and sewage treatment system for cities and big towns	No	3		x	x	x	Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.
		Rehabilitate the existing sewerage and sewage treatment system	No	-	-	-	-	-	municipalities ,AwBA & BHC.
Ensure cities, industries and big towns to have a solid &Sludge waste manageme nt system.	Assessment of solid & Sludge waste managemen t system.	Identify the status of solid waste management system.	%	100		50	50		MoEFCC,MoUD,City Administration ,AwBA, RegionalEnvairoment Forest and Climate changeAuthority & BHC.
		Identify cities and big towns with and without solid waste management system.	%	100		50	50		Minister of Urban Development, cities and towns administration,MoEFCC,Municipalities,AwBA & BHC.
	preparation of solid & Sludge waste managemen t system design guideline .	Reviewing existing solid waste management guideline.	Doc	1		x			MoEFCC,MoUD,Regional Envairoment Forest and Climate change Authority , AwBA & BHC.
		Setting draft solid waste management system design guideline.	Doc	1		x			MoEFCC,MoUD, AwBA & BHC.
		presenting the draft solid waste management system design guideline to stakeholders.	Doc	1			x		MoEFCC,MoUD,City Administration ,Regional Envairoment Forest and Climate changeAuthority,AwBA,municipalities & BHC.
		Implementing the solid waste management system guideline	%	100			60	40	Minister of Urban Development, cities and towns administration,community, AwBA,Municipalities & BHC.
	Construct solid & Sludge waste disposal system.	Construct solid & Sludge waste management system for cities and big towns	No	3		x	x	x	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.
		Rehabilitate the existing solid waste management	No	-	-	-	-	-	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.

Table 11. Awash Terminal Detail Action plan

Measure	Activity	Sub activity	unit	target	year				Actors
					2009	2010	2011	2012	
Testing water quality parameters	Establish additional surface water quality Monitoring station	Identify and decide representative sampling sites	No	8	2	2	2	2	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions ,EFCCB,ECWDC laboratories &BHC.
		Periodical sampling and Analyses	No of stations	9	3	5	7	9	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
	Establish additional ground water monitoring station	Identify and decide representative borehole sampling sites	No	12	2	3	3	4	AwBA,MoWIE,Regional Water Bureau,MoEFC,.Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
		Install piezometric sample sites	No	12		4	4	4	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &BHC.
		Rehabilitate piezometric sample sites	No						AwBA,MoWIE,MoEFCC.Regional Water Bureau,ECWDC laboratories,Higher institutions
		Periodical sampling and Analyses	No of stations	24	2	9	16	24	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &HBC.
	Manage water pollution from point and non point sources	Identify point and non-point sources	%	100	80	20			AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions,MoI& HBC.
		Sampling and analyses of discharge water from major polluters	No	10	2	3	3	2	AwBA,MoWIE, MoEFCC,MoI,Textil ,tanery , cotton , flowery cultur instituits,EFCCB & BHC.
		Initiate and enforce to install effluent treatment plant	%	100	-	25	25	50	MoI,Textil ,tanery , cotton , flowery cultur instituit,AwBA & HBC.
		Monitor and evaluate discharge water from major polluters	No	10	2	3	3	2	AwBA,MoFCC,MoI,MoH,Textil ,tanery , cotton , flowery cultur instituit & BHC.
	Develop/adopt water quality standards	Reviewing existing national and international water quality standard.	Doc.	7	x	x			MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards .	Doc.	6		x	x		MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Presenting the draft standards for stakeholders	Doc.	6			x		MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Adopting/Implementing the standards documents	%	100				x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur, instituitHigher institutions & BHC..
	ADopt and	develop data base for water quality	No	1	x	x			ASTU ,Other staekholders,AwBA & BHC.

	implment water quality modeling such as aqu-chem	tranings about water quality modeling and GIS	No of traning	16	4	4	4	4	ASTU,Other staekholders,AwBA , Regional water bereau & BHC.
Establishing and up grading water quality laboratories	Establish water quality laboratory and equip with appropriate facilities	Construction of laboratory buildings	No	1			X		AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit & BHC.
		Equip water quality laboratories with appropriate facilities	No	1				X	AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Up grade level of water quality laboratories in the basin	No	1		1			AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
Capacitate and empower Relevant Stakeholders	Capacitate Water quality Experts	Create educational opportunities for water quality Expets (long term)	NO /Trainers	6	2	1	1	2	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
		Organize experience sharing visit for water quality Experts	NO	16	4	4	4	4	Regiones ,AwBA, MoWIE,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Organize and conduct capacity building trainings (short term)	No of traning	32	8	8	8	8	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
	Empower Relevant Stakeholders	Awareness creation	No of participa nt	500	125	125	125	125	Regiones ,AwBA,community & BHC.
		Organize experience sharing	NO	4	1	1	1	1	Regiones ,AwBA,community & BHC.
Setting permit system for treated waste water discharge	Develop treated waste water discharge standards	Identifying polluters	%	100	80	20			AwBA,MoWIE,Regional Water Bureau,MoEFCC,MoI ,MoAgN,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions and EFCCB & BHC.
		Reviewing existing national and international treated waste water quality standards documents	Doc.	3	x				MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		presenting the draft standards for stakeholders	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		Adopting/Implementing the standards	Doc.	1			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur instituit ,Higher institutions & BHC.
	Set up treated waste water discharge permit	Develop treated waste water discharge permit system	No	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement waste water discharging permit system (give license for polluters)	No	1		1			AwBA,Regional Water Bureau,Regional irregation bureau & BHC .
		renew license on regular base	No	1			1		AwBA,Regional Water Bureau,Regional irregation bureau

	system								& BHC.
Implement fees for treated waste water discharge	Prepare treated waste water discharge tariffs	Develop treated waste water discharge tariffs	Doc.	1		x			MoWIE, AwBA ,Regional water bereau ,regional industries bereau & BHC.
		Implement waste water discharge tariffs	%	100			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC & BHC.
		Collect fees for license and treated waste water discharge	Birr						AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Establish Enforcement and complaint handling mechanism	Develop and implement guidelines ,directives ,protocols and MoUs	Asses national/international water quality enforcement and compliant handling mechanisms	Doc.	3	x				AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Set up enforcement tools , guidelines ,directives and MoUS	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement enforcement tools , guidelines ,directives and MoUS	%	100			100		AwBA,MoJ,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions ,EFCCB & BHC.
	Monitor and evaluate the application of enforcement and compliant handling documents	Develop Monitoring System for enforcement effectiveness	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Monitor and evaluate the implementation of the documents	%	100			100		AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Enable Agricultural farms to have a functional drainage system	Assessment of Agricultural farms	Identification of type of farms	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
		Identify farms with and without drainage system	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
	preparation of irrigation design guide line	Reviewing existing irrigation guideline	Doc.	4	x				MoAgN,AwBA ,Regional irregation bureau & BHC.
		Setting draft irrigation guideline	Doc	1		x			MoAgN,AwBA ,Regional irregation bureau & BHC.
		presenting the draft irrigation design guideline to stakeholder	Doc	1			x		MoAgN,AwBA ,Regional irregation bureau,users& BHC.
		Implementing the irrigation guideline	%	100			40	60	MoAgN,Investment Agencies,AwBA ,Regional irregation bureau,users& BHC.
	Construct irrigation drainage system	Construct irrigation drainage system for newly established irrigation farms	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
		Rehabilitate the existing drainage structure	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
Transfer new waste treatment technology to	adopt new waste treatment technology	Select exemplary treatment units	No	5	x				AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions, EFCCB & BHC.
		promote and apply to other industries	%	100			100		AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions , EFCCB & BHC.

industries									
Ensure cities and big towns to have a sewerage and sewage treatment system	Assessment of sewerage and sewage treatment	Identify the status of sewerage and sewage treatment system	%	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
		Identify cities and big towns with and without sewerage and sewage treatment system	No	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
	preparation of sewerage and sewege treatment design guide line	Reviewing existing sewerage and sewage treatment guideline	Doc	1	x				Minister of Urban Development,municipalities,AwBA & BHC.
		Setting draft sewerage and sewage treatment design guideline	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		presenting the draft sewerage and sewage treatment design guideline to stakeholder	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		Implementing the sewerage and sewage treatment guideline	%	100			100		Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.
		Construct sewerage and sewage treatment system for cities and big towns	No	1				x	Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.
		Rehabilitate the existing sewerage and sewage treatment system	No	-	-	-	-	-	municipalities ,AwBA & BHC.
Ensure cities, industries and big towns to have a solid &Sludge waste manageme nt system.	Assessment of solid & Sludge waste management system.	Identify the status of solid waste management system.	%	100		50	50		MoEFCC,MoUD,City Administration ,AwBA, RegionalEnvairoment Forest and Climate changeAuthority & BHC.
		Identify cities and big towns with and without solid waste management system.	%	100		50	50		Minister of Urban Development, cities and towns administration,MoEFCC,Municipalities,AwBA & BHC.
	preparation of solid & Sludge waste management system design guideline .	Reviewing existing solid waste management guideline.	Doc	1		x			MoEFCC,MoUD,Regional Envairoment Forest and Climate change Authority , AwBA & BHC.
		Setting draft solid waste management system design guideline.	Doc	1		x			MoEFCC,MoUD, AwBA & BHC.
		presenting the draft solid waste management system design guideline to stakeholders.	Doc	1			x		MoEFCC,MoUD,City Administration ,Regional Envairoment Forest and Climate changeAuthority,AwBA,municipalities & BHC.
		Implementing the solid waste management system guideline	%	100			60	40	Minister of Urban Development, cities and towns administration,community, AwBA,Municipalities & BHC.
	Construct solid & Sludge waste disposal system.	Construct solid & Sludge waste management system for cities and big towns	No	1				x	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.
		Rehabilitate the existing solid waste management	No	-	-	-	-	-	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.

Table 12. Awash Easter Catchment Detail Action plan

Measure	Activity	Sub activity	unit	target	year				Actors
					2009	2010	2011	2012	
Testing water quality parameters	Establish additional surface water quality Monitoring station	Identify and decide representative sampling sites	No	-	-	-	-	-	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions ,EFCCB,ECWDC laboratories &BHC.
		Periodical sampling and Analyses	No of stations	-	-	-	-	-	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
	Establish additional ground water monitoring station	Identify and decide representative borehole sampling sites	No	14	14	-	-	-	AwBA,MoWIE,Regional Water Bureau,MoEFC,.Higher institutions, ,EFCCB,ECWDC laboratories &BHC.
		Install piezometric sample sites	No	-	-	-	-	-	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &BHC.
		Rehabilitate piezometric sample sites	No	-	-	-	-	-	AwBA,MoWIE,MoEFCC.Regional Water Bureau,ECWDC laboratories,Higher institutions
		Periodical sampling and Analyses	No of stations	14	-	14	14	14	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions &HBC.
	Manage water pollution from point and non point sources	Identify point and non-point sources	%	100	80	20	-	-	AwBA,MoWIE,MoEFCC,Regional Water Bureau,ECWDC laboratories,Higher institutions,MoI& HBC.
		Sampling and analyses of discharge water from major polluters	No	17	-	5	5	7	AwBA,MoWIE, MoEFCC,MoI,Textil ,tanery , cotton , flowery cultur instituits,EFCCB & BHC.
		Initiate and enforce to install effluent treatment plant	%	100	-	25	25	50	MoI,Textil ,tanery , cotton , flowery cultur instituit,AwBA & HBC.
		Monitor and evaluate discharge water from major polluters	No	17	-	5	5	7	AwBA,MoFCC,MoI,MoH,Textil ,tanery , cotton , flowery cultur instituit & BHC.
	Develop/adopt water quality standards	Reviewing existing national and international water quality standard.	Doc.	7	x	x	-	-	MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards .	Doc.	6	-	x	x	-	MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Presenting the draft standards for stakeholders	Doc.	6			x		MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE,Higher institutions & BHC.
		Adopting/Implementing the standards documents	%	100				x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur, instituitHigher institutions & BHC..
	ADopt and implment water quality modeling such as aqu-chem	develop data base for water quality	No	1	x	x			ASTU ,Other staekholders,AwBA & BHC.
		tranings about water quality modeling and GIS	No of traning	16	4	4	4	4	ASTU,Other staekholders,AwBA , Regional water bereau & BHC.
Establishing and up	Establish water quality	Construction of laboratory buildings	No	1			X		AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit & BHC.

grading water quality laboratories	laboratory and equip with appropriate facilities	Equip water quality laboratories with appropriate facilities	No	1				X	AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Up grade level of water quality laboratories in the basin	No	1		1			AwBA,MoI,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
Capacitate and empower Relevant Stakeholders	Capacitate Water quality Experts	Create educational opportunities for water quality Expets (long term)	NO /Trainers	6	2	1	1	2	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
		Organize experience sharing visit for water quality Experts	NO	16	4	4	4	4	Regiones ,AwBA, MoWIE,Textil ,tanery , cotton , flowery cultur instituit,Different indestries & BHC.
		Organize and conduct capacity building trainings (short term)	No of traning	32	8	8	8	8	Regiones ,AwBA, MoWIE,Higher institutions & BHC.
	Empower Relevant Stakeholders	Awareness creation	No of participant	500	125	125	125	125	Regiones ,AwBA,community & BHC.
		Organize experience sharing	NO	4	1	1	1	1	Regiones ,AwBA,community & BHC.
Setting permit system for treated waste water discharge	Develop treated waste water discharge standards	Identifying polluters	%	100	80	20			AwBA,MoWIE,Regional Water Bureau,MoEFCC,MoI ,MoAgN,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions and EFCCB & BHC.
		Reviewing existing national and international treated waste water quality standards documents	Doc.	3	x				MoEFCC,AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE & BHC.
		Setting draft standards	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		presenting the draft standards for stakeholders	Doc.	1		x			MoEFCC, AwBA ,ABA ,RVLBA ,MoH,MoAgN,MoWIE& BHC.
		Adopting/Implementing the standards	Doc.	1			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC,Textil ,tanery , cotton , flowery cultur instituit ,Higher institutions & BHC.
	Set up treated waste water discharge permit system	Develop treated waste water discharge permit system	No	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement waste water discharging permit system (give license for polluters)	No	16		4	5	7	AwBA,Regional Water Bureau,Regional irregation bureau & BHC .
		renew license on regular base	No	9			4	9	AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Implement fees for treated waste water discharge	Prepare treated waste water discharge tariffs	Develop treated waste water discharge tariffs	Doc.	1		x			MoWIE, AwBA ,Regional water bereau ,regional industries bereau & BHC.
		Implement waste water discharge tariffs	%	100			x	x	AwBA,MoWIE,Regional Water Bureau,MoEFCC & BHC.
		Collect fees for license and treated waste water discharge	Birr						AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Establish Enforcement and	Develop and implement guidelines	Asses national/international water quality enforcement and compliant handling mechanisms	Doc.	3	x				AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.

complaint handling mechanism	,directives ,protocols and MoUs	Set up enforcement tools , guidelines ,directives and MoUS	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Implement enforcement tools , guidelines ,directives and MoUS	%	100			100		AwBA,MoJ,Higher institutions,Regional Water Bureau,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions ,EFCCB & BHC.
	Monitor and evaluate the application of enforcement and compliant handling documents	Develop Monitoring System for enforcement effectiveness	Doc.	1		x			AwBA,MoJ,Higher institutions,Regional Water Bureau & BHC.
		Monitor and evaluate the implementation of the documents	%	100			100		AwBA,Regional Water Bureau,Regional irregation bureau & BHC.
Enable Agricultural farms to have a functional drainage system	Assessment of Agricultural farms	Identification of type of farms	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
		Identify farms with and without drainage system	%	100		100			AwBA ,Regional irregation bureau,Regional Water Bureau, flowery cultur instituit & BHC.
	preparation of irrigation design guide line	Reviewing existing irrigation guideline	Doc.	4	x				MoAgN,AwBA ,Regional irregation bureau & BHC.
		Setting draft irrigation guideline	Doc	1		x			MoAgN,AwBA ,Regional irregation bureau & BHC.
		presenting the draft irrigation design guideline to stakeholder	Doc	1			x		MoAgN,AwBA ,Regional irregation bureau,users& BHC.
		Implementing the irrigation guideline	%	100			40	60	MoAgN,Investment Agencies,AwBA ,Regional irregation bureau,users& BHC.
	Construct irrigation drainage system	Construct irrigation drainage system for newly established irrigation farms	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
		Rehabilitate the existing drainage structure	%	100	25	50	25		Users,AwBA ,Regional irregation bureau & BHC.
Transfer new waste treatment technology to industries	adopt new waste treatment technology	Select exemplary treatment units	No	5	x				AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions, EFCCB & BHC.
		promote and apply to other industries	%	100		25	50	25	AwBA,Textil ,tanery , cotton , flowery cultur instituit, Higher institutions , EFCCB & BHC.
Ensure cities and big towns to have a sewerage and sewage treatment system	Assessment of sewerage and sewage treatment	Identify the status of sewerage and sewage treatment system	%	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
		Identify cities and big towns with and without sewerage and sewage treatment system	No	100		50	50		Minister of Urban Development,municipalities,AwBA & BHC.
	preparation of sewerage and sewege treatment design guide line	Reviewing existing sewerage and sewage treatment guideline	Doc	1	x				Minister of Urban Development,municipalities,AwBA & BHC.
		Setting draft sewerage and sewage treatment design guideline	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		presenting the draft sewerage and sewage treatment design guideline to stakeholder	Doc	1		x			Minister of Urban Development,municipalities,AwBA & BHC.
		Implementing the sewerage and sewage treatment guideline	%	100			100		Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.

		Construct sewerage and sewage treatment system for cities and big towns	No	2		x	x		Minister of Urban Development, cities and towns administration,municipalities,AwBA & BHC.
		Rehabilitate the existing sewerage and sewage treatment system	No	1	x	-	-	-	municipalities ,AwBA & BHC.
Ensure cities, industries and big towns to have a solid &Sludge waste manageme nt system.	Assessment of solid & Sludge waste management system.	Identify the status of solid waste management system.	%	100		50	50		MoEFCC,MoUD,City Administration ,AwBA, RegionalEnvairoment Forest and Climate changeAuthority & BHC.
		Identify cities and big towns with and without solid waste management system.	%	100		50	50		Minister of Urban Development, cities and towns administration,MoEFCC,Municipalities,AwBA & BHC.
	preparation of solid & Sludge waste management system design guideline .	Reviewing existing solid waste management guideline.	Doc	1		x			MoEFCC,MoUD,Regional Envairoment Forest and Climate change Authority , AwBA & BHC.
		Setting draft solid waste management system design guideline.	Doc	1		x			MoEFCC,MoUD, AwBA & BHC.
		presenting the draft solid waste management system design guideline to stakeholders.	Doc	1			x		MoEFCC,MoUD,City Administration ,Regional Envairoment Forest and Climate changeAuthority,AwBA,municipalities & BHC.
		Implementing the solid waste management system guideline	%	100			60	40	Minister of Urban Development, cities and towns administration,community, AwBA,Municipalities & BHC.
	Construct solid & Sludge waste disposal system.	Construct solid & Sludge waste management system for cities and big towns	No	2			x	x	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.
		Rehabilitate the existing solid waste management	No	1	-	x	-	-	Minister of Urban Development, cities and towns administration,municipalities,private sector,Higher institution,AwBA & BHC.

6. RISK MANAGEMENT

There are always expected challenges which could hinder the progress of the implementation and opportunities (possible solution) which enhance the smooth implementation of plans. Thus, it is very important to assess beforehand the expected challenges and possible solutions that exist or could emerge during the implementation of the plan and consider mitigation measures to minimize the challenges and efficiently utilize the solution. Accordingly, for the implementation of water quality strategic plan, it is important to consider the following expected challenges to be considered and mitigation measures planned for them to minimize their negative effects include: absence of accountability to implement regular measure and enforcement on waste discharge, occurrence of natural disaster, lack of awareness about water pollution, willingness problem to use new waste treatment and removal technologies, the cost for treatment plant construction is high and low implementation capacity.

6.1. Planning Assumption

The assumption has been taking for preparing the water quality strategic river basin plane is coordination of each sectors, funding from government and non government sectors, commitments of stakeholders, different research's output in the basin and Aqua-Chem water quality model results.

6.2. Expected Challenges

The main challenges to apply water quality strategic plan is described as follows:

- Lack of awareness about water pollution
- Staff turnover
- Budget problem
- Low implementation capacity
- Having of low or inferior standard or quality laboratory in the basin
- High cost for construction of waste water treatment plant in industries
- Having deficiency regular electric power in industries for treatment plant

- Lack of cooperation and coordination working together
- Deficiency of proper sewerage system in cities and towns
- Absence of modern/proper treatment facilities
- Poor maintenance of existing sewerage systems
- Absence of accountability to implement regular measure and enforcement on waste discharge
- Willingness problem to use new waste treatment and removal technologies

6.3. Possible Solution

The following possible solution for expected challenges which could create favorable environment for accelerated implementation of the plan:

- Availability of water resource and basin management legal packages
- Visible dedication of the government and community's demand, organization and participation
- Commencement of participation and coordination between governmental and nongovernmental stakeholders
- providing capacity building training for water quality experts
- The donation of local and international non-governmental organizations and private sectors in the implementation of the plan will be strengthened.
- Introduce publicity programs to make people aware of pollution measures.
- Form informative program for schools about water pollution.

7. MONITORING AND EVALUATION MECHANISM

Monitoring and evaluation can help organization extract relevant information from past and ongoing activities that can be used as the basis for programmatic fine-tuning, reorientation and future planning. Without effective monitoring and evaluation, it would be impossible to judge if work is going in the right direction, whether progress and success can be claimed, and how future efforts might be improved. Plans with strong monitoring and evaluation components tend to stay on track. Additionally, problems are often detected earlier, which reduces the likelihood of having major cost overruns or time delays later.

The monitoring and evaluation approach employs a continuous check on the progress and results (intermediate and final) obtained at stages through collection and analysis of data on the performance of implementation. This can be realized with detail and agreed monitoring and evaluation plan which have complete sketch of actors, indicators, criteria, budget and calendars.

The monitoring and evaluation task will be done by a multidisciplinary collectively established team from executing organs (action owners and collaborators – as per the plan). In this regards AwBA will hold the leading actor for initiating and implementing the monitoring and evaluation plan, and the team will be accountable to AwBA.

Periodical and seasoned reports on the achievements of sectorial and multi-sectorial goals, objectives or measures will be the hard element of the monitoring and evaluation plan finally, all essential information will be provided to the basin high council to fine tune the strategic basin plan with the national and regional growth and transformation plan.

8. REFERENCE

Alexakis, D.(2008) Geochemistry of Stream Sediment as a Tool for assessing Contamination by Arsenic, Chromium and other Toxic element; East Africa Region , Greece European Water, 21/22 ; 57-72

AWSSA, Addis Ababa Water and Sewerage Authority (2005, 2010 and EPA, Federal Environmental Protection Authority (2010). State of the Environment Report of Ethiopia, Addis Ababa, Ethiopia

AWSSA, Addis Ababa Water and Sewerage Authority (2011). State of the Environment Report of Ethiopia, Addis Ababa, Ethiopia

Ayenew T, Alemayehu T, Kebede S. 2006. Environmental Isotopes and Hydrochemical Studies as Applied to Water Resources Assessment in Central and Southern Afar and Adjacent Highlands. Ethiopian Science and Technology Agency. Unpublished Report of the International Atomic Energy Agency Project (ETH/8/008). Addis Ababa, Ethiopia. 128 pp.

Carpenter *et al* (1998) Non point pollution of surface waters with Phosphorus and Nitrogen Chapman, D. Ed. (1996). Water Quality Assessments - A Guide to Use of Biota, Sediments and Water in Environmental Monitoring-Second Edition, UNESCO/WHO/UNEP

CSA (2008). *Statistical Report of the 2007 Population and Housing Census*, Central Statistical Agency of Ethiopia, Addis Ababa, Ethiopia.

EC (2003), Guidance document no 10 River and lakes – Typology, reference conditions and classification systems.

Elleni A. (2009), Growing lake with growing problems: integrated hydrogeological investigation on Lake Beseka, Ethiopia, Dissertation, University of Bonn.

EPA, Federal Environmental Protection Authority (2003). State of the Environment Report of Ethiopia, Addis Ababa, Ethiopia

EPA, Federal Environmental Protection Authority (2003). State of the Environment Report of Ethiopia, Addis Ababa, Ethiopia

Gamvroula et al (2012) Diagnosis of ground water quality and assessment of contamination sources in the Megara basin.

Halcrow, 1983. Water Management Manual. Amibara irrigation project. Water Resources Development Authority, Ethiopia.

Halcrow. 1989. Master plan for the development of surface water resources in ten Awash basin, vol. 4, 5, 6, 9. Technical report of the Ministry of Water Resources, Addis Ababa.

http://forum.europa.eu.int/Public/irc/env/wfd/library?/framework_directive/guidance_documents

Korfali, SI, Jurdi, M.(2011) Suitability of surface water for domestic water use; Awali River case study; European water ; 35 ; 3-12.

Loukas ,A.(2010) Surface water quantity and quality assessment in Pinios River, Thessaly, Greece. Desalination. 250 ; 266-273

Mlideis et al (2007) Characterization of rain and roof drainage water quality in xanthi, Greece .

Mosley et al (2012) the impact of extreme low flow on the water quality of the lower Murray River and lake (South Australia) water resource manage 26 ; 3623 – 3946.

MoUDC (2012). Waste Management and Green Development and Beautification Strategy (in Amharic). Ministry of urban Development and Construction, Addis Ababa, Ethiopia

Naseem et al and Tsakiris et al (2009) Assessing the water potential of karstic saline springs by applaying afuzzy approach. The case of Almyros (Heroklion, crete).

Nigussie, Agizew (1999). Evaluation of water quality and suggested improvement measures: the case of the Little Akaki River, Addis Ababa, Ethiopia. Master of Science Degree Thesis No. 406, Stockhom: Division Of Hydraulic Engineering, The Royal Institute of Technology.

Nimah (1998) Water and water management for every body.

Planet IWRM PLC (2012). Human Right Based Approach to Integrated Water Resource Management

Tamiru. 2005. Ground water pollution in Africa

UNEP- United Nations Environment Program (2010). Clearing the Waters: A focus on water quality solutions. UNON, Publishing Services Section, Nairobi.

UNIDO, Ecological Sustainable Industrial Development Project, 2001: Situational Analysis the industrial sector; Addis Ababa, Ethiopia

UN-WATER (2007). Coping with Water Scarcity; Strategic Issue and Priority for System.

WHO (2011). Guidelines for Drinking-water Quality-Fourth Edition.

Wood RB, Talling JF. 1988. Chemical and Algal relationship in a salinity series of Ethiopian inland waters. *Hydrobiologia* 158: 29–67.

Zanettin B, Justin-Visentin E, Niccoletti M, Piccirllo EM. 1980. Correlation among Ethiopian volcanic formations with special references to the chronological and stratigraphic problems of the Trap series. Accademia Nazionale dei Lincei, Rome, Italy. 47: 231–252.

9. APPENDICES

9.1. Appendix I: 8 Years Water Quality Parameter Status of A wash Basin

Appendix Table 1. Water quality parameter status Awash Upstream Koka sub basin

Parameter	Maximum	Minimum	Mean
Turbidity	1050	1.8	573.34
Total dissolved Solid	1468	100	518.9
P^H	9.4	7.15	8.14
Ammonia	3.1	0.05	1.12
Potassium	11.9	4.1	8.075
Calcium	73.6	0.001	37.4
Magnesium	1056	4.8	143.7
Fluoride	0.63	0.34	0.48
Chloride	628.36	44.74	212.90
Nitrite	3.3	0.007	0.46
Nitrate	34.5	0.084	7.44
Carbonate	178.2	0	42.95
Bicarbonate	483.12	0	223.38

Appendix Table 2. Water quality parameter status Awash Awash sub basin

Parameter	Maximum	Minimum	Mean
Turbidity	247	43.6	162.53
Total dissolved Solid	2650	358	1426
P^H	9.27	7.35	8.5
Ammonia	0.24	0.21	0.23
Sodium	1467	58.22	616.41
Total Hardness	450	75	253.33
Calcium	31	6.58	21.01
Magnesium	6.92	2.38	5.34
Fluoride	14.1	0.72	4.28
Nitrite	0.105	0.028	0.069
Nitrate	0.57	0.087	0.28
Sulphate	150	56	110.67
Phosphate	107	30.8	70.93

Appendix Table 3. Water quality parameter status Eastern catchment

Parameter	Maximum	Minimum	Mean
Turbidity	1.01	0.01	0.206
Total dissolved Solid	1470	279	710.7
P^H	7.75	6.83	7.09
Ammonia	0.61	0.02	0.184
Total Hardness	650	140	358.67
Nitrite	0.016	0.001	0.006
Nitrate	6.05	0.16	2.31
Sulphate	190	0	70.27
Phosphate	27.4	0.01	15.68

Appendix Table 4. Water quality parameter status for Awash Halidebi

Parameter	Maximum	Minimum	Mean
Turbidity	0.59	0.01	0.23
Total dissolved Solid	1140	607	801
P^H	6.9	6.66	6.8
Ammonia	0.05	0.01	0.03
Sodium	100.2	61.55	80.875
Total Hardness	70	15	42.5
Calcium	84.24	33.06	58.65
Magnesium	7.84	6.66	7.25
Carbonate	70	15	42.5
Sulphate	51	47	49
Phosphate	29.2	20.7	24.95

Appendix Table 5. Water quality parameter status Awash Adaitu sub basin

Parameter	Maximum	Minimum	Mean
Turbidity	1413.1	1413.1	1413.1
Total dissolved Solid	415.7	415.7	415.7
Ammonia	0.7	0.7	0.7
Sodium	99.71	99.71	99.71
Potassium	7.40	7.40	7.40
Total Hardness	108.4	108.4	108.4
Calcium	33.1	33.1	33.1
Magnesium	16.93	16.93	16.93
Fluoride	1.46	1.46	1.46
Chloride	46.86	46.86	46.86
Nitrite	0.1	0.1	0.1
Nitrate	3.0	3.0	3.0
Carbonate	15.24	15.24	15.24
Bicarbonate	266.46	266.46	266.46
Sulphate	48.88	48.88	48.88
Phosphate	0.67	0.67	0.67

Appendix Table 6. Water quality parameter status Awash Terminal sub basin

Parameter	Maximum	Minimum	Mean
Turbidity	221	0.64	42.35
Total dissolved Solid	793	234	461.1
P^H	8.38	6.92	7.37
Ammonia	0.56	0.01	0.25
Total Hardness	350	40	213.57
Calcium	86	6	34.86
Fluoride	0.99	0.09	0.54
Nitrite	0.255	0.001	0.064
Nitrate	6.65	0.194	1.41
Carbonate	350	40	213.57
Sulphate	94	1	31.14
Phosphate	81.4	15.6	31.39

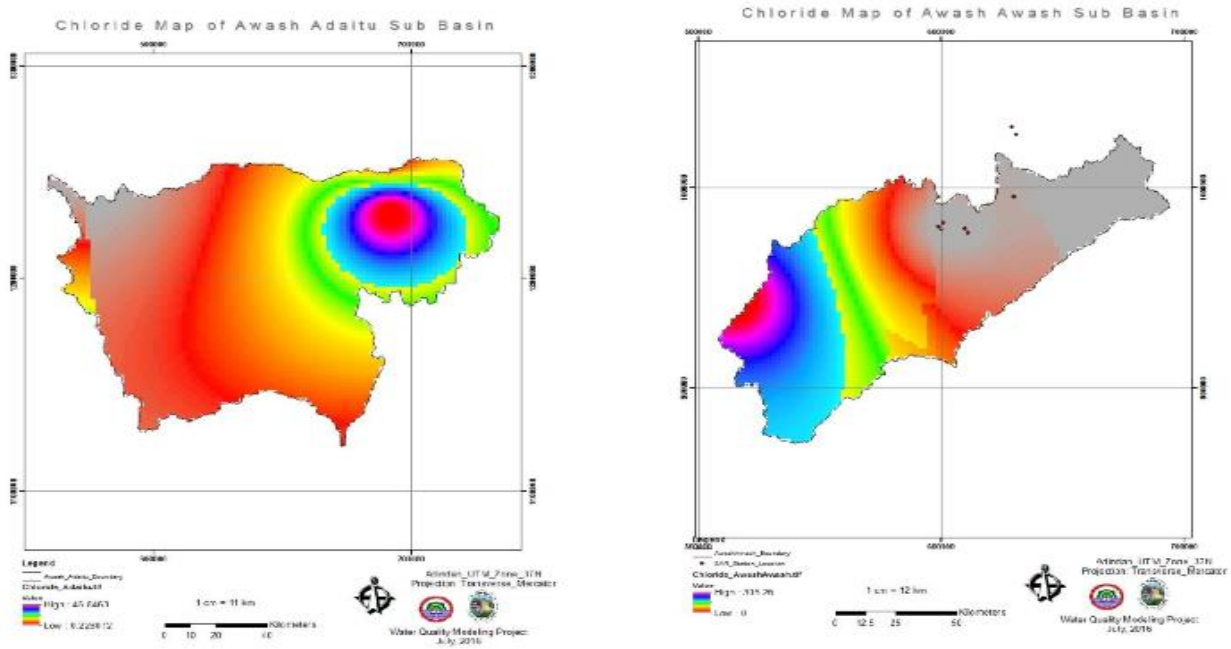
Appendix Table 7. Proposed towns to have sewerage and sewage treatment system

No.	Town Name	No.	Town Name
1	Adama	19	Mieso
2	Addis Abeba	20	Mojo
3	Asbe Teferi	21	Sebeta
4	Dubti	22	Sendafa
5	Awash	23	Shewa Robit
6	Debre Zeyt	24	Arerti
7	Dese	25	Debrebrhan
8	Dire Dawa	26	Dukem
9	Burayu	27	Gelan
10	Hayk	28	Gewane
11	Holota		
12	Jersa Weldiya		
13	Kembolsha		
14	Bati		
15	Asahita		
16	Loqiya		
17	Metehara		
18	Welenchiti		

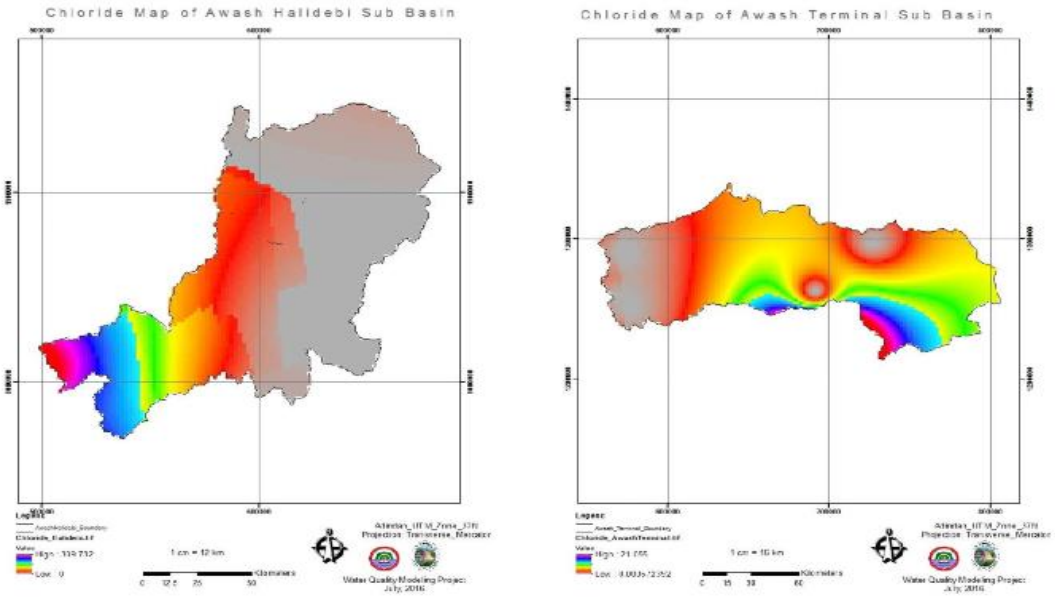
Appendix Table 8. Groundwater quality at selected sub-basins

Sub-basin	Temp	pH	EC	TDS	Na	K	mg	Ca	Mn	Fe	NH4	F	Cl	SO4	NO3	HCO3	CO3	PO4	Hardness	SAR
Awash Kunture	26.2	7.9	526.25	344.64	65.46	7.63	8.24	44.61	0.04	0.2	0.59	1.27	16.46	9.38	3.53	301.63	4.7	0.28	145.45	4.32
Akaki	28.5	7.2	1392.5	907.17	280.33	17.67	12.02	31.22	0.07	0.11	0.28	1.31	19.99	48.41	0.17	858.1	0	0.5	126.52	10.8
U/s of Koka	40.5	7.63	569.56	373.33	82.28	19.39	8.85	33.49	0.02	0.04	0.91	1.76	12.766	5.08	4.44	363.17	0	0.39	123.75	3.7
Mojo	31.67	7.76	690.06	456.78	98.56	13.51	10.04	51.9	0.01	0.05	0.35	2.9	29.39	25.88	5.29	399.3	0	0.48	202.57	5.04
Kesem	20	8.55	335	202.5	54.5	10	2.97	16.65		0.11	0.19	0.8	22.85	15.97	4.43	120.03	14.4	0.08	53.6	3.86
Awash Haledebi	33.23	7.85	1731.7	1213	289.84	12.8	32.87	102.58	0.01	0.02	0.13	3.05	255.07	158.96	34.82	458.96	46.3	2.4	394.62	12.6
Awash Awash	32.87	7.66	1613	1032.4	297.77	10.49	12.58	47.59	0.02	0.04	0.15	2.72	175.04	148.88	9.96	495.96	4.68	0.66	170.52	17.35
Eastern Catchment	31.55	7.76	1116.6	719.09	187.76	6.01	19.58	76.7	0.01	0.02	0.15	1.63	143.68	61.68	16.05	410.62	49.19	0.57	262.02	7.87
Najeso Gera	38.2	8.44	1182.5	706	257	9.9	1.35	4.45	0.02	0.03	0.11	1.95	110.4	85.15	6	385.75	14.4	0.2	16.65	28.72

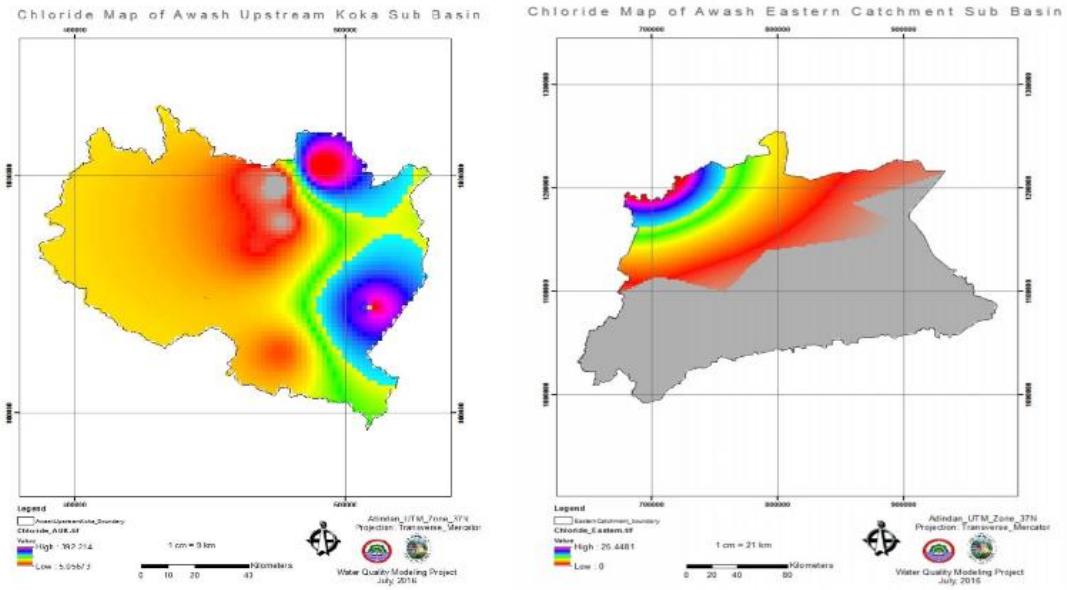
9.2. Appendix II: Sodium and Chloride Concentration Map of A wash Basin



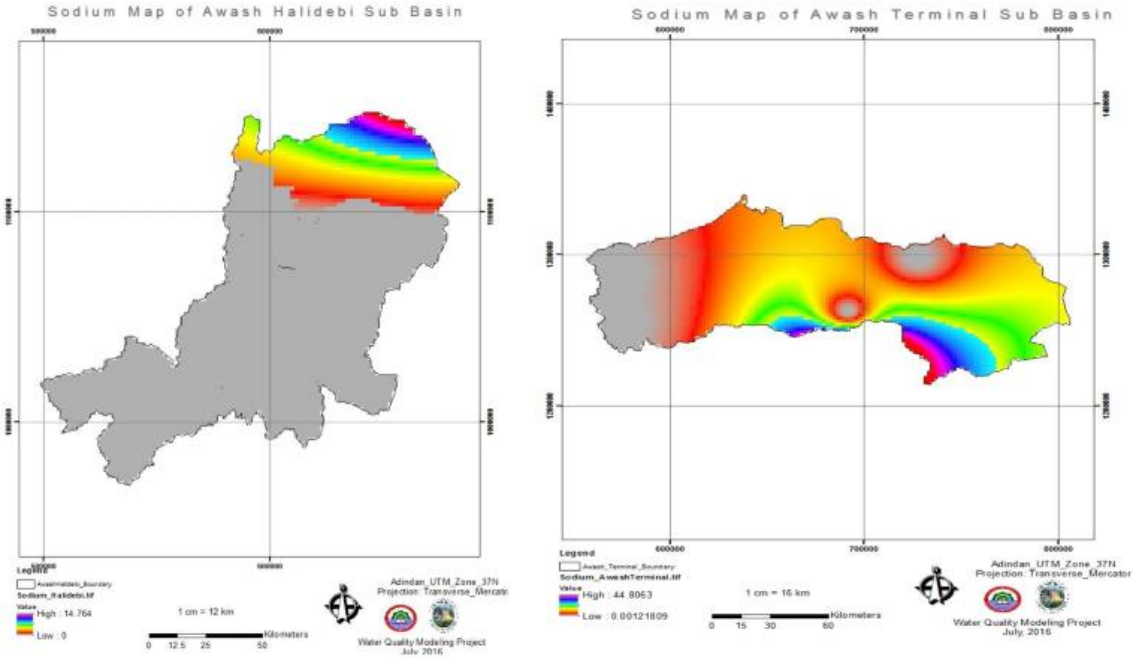
Appendix Figure 1. Chloride map of Awash Adaitu and Awash Awsh sub basin WHO water quality standard detection



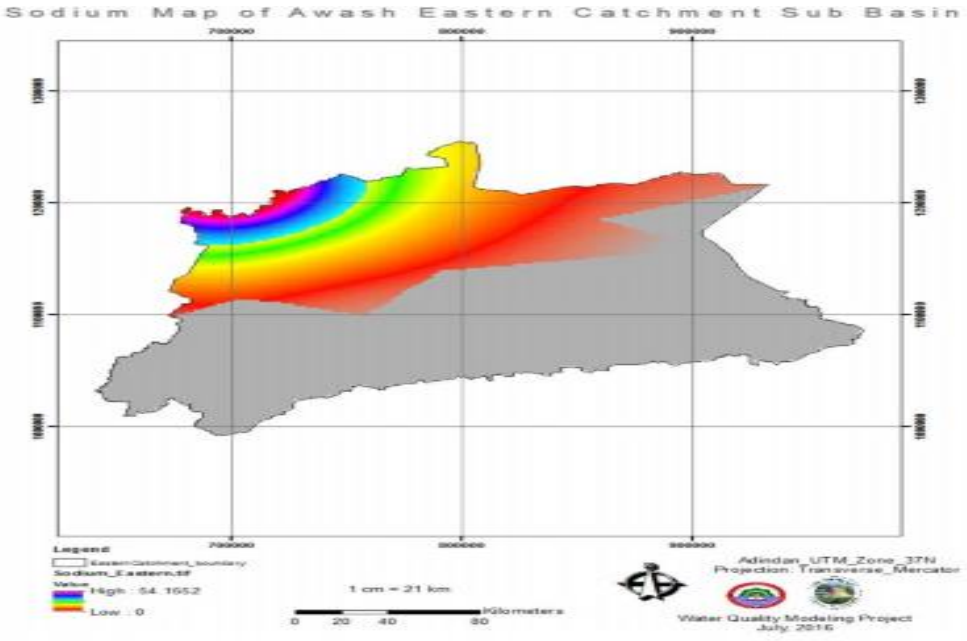
Appendix Figure 2. Chloride map of Awash Halidebi and Awash Terminal sub basin WHO water quality standard detection



Appendix Figure 3. Chloride map of Awash Upstream and Awash Eastern Catchment sub basin WHO water quality standard detection



Appendix Figure 4. Sodium concentration map of Awash Halidebi and Awash Terminal sub basin



Appendix Figure 5. Sodium concentration map of Eastern Catchment sub basin