Assabol Dam and adjoining Irrigation Scheme

Operation & Maintenance Management Package

# Tool 1

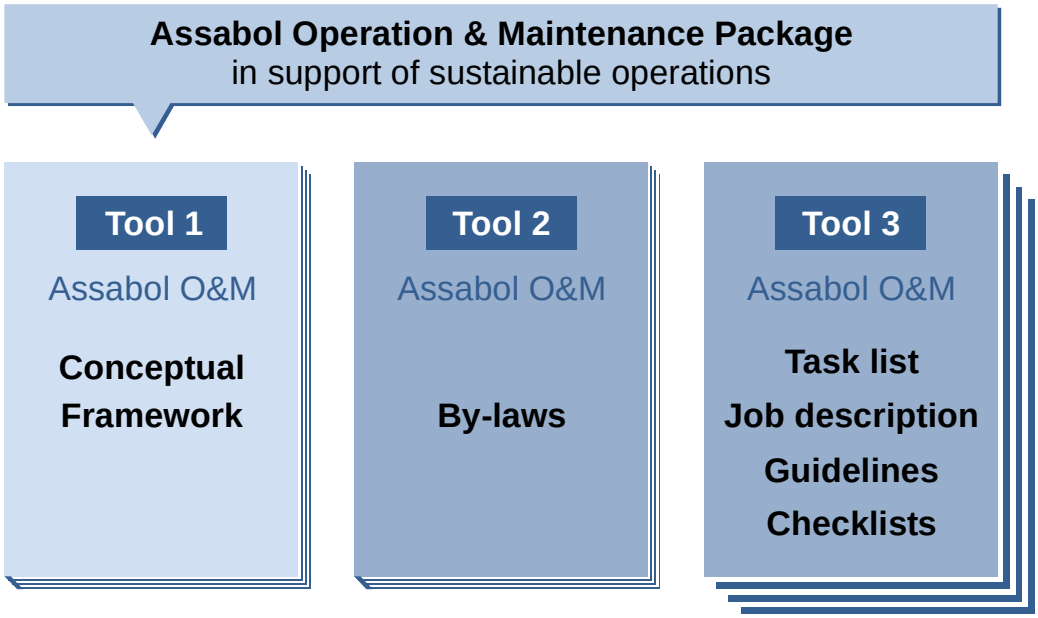
# Conceptual Framework

# Table of contents

# 1 Introduction

## 1.1 Operation & Maintenance (O&M) Management Package

The Assabol Operation & Maintenance (O&M) Management Package informs about how operation & maintenance of the dam and the adjoining irrigation scheme is organized and about roles and responsibilities of the various stakeholders concerned, it also provides the required regulatory framework and instructs in detail about how to implement operations and required maintenance. For practical reasons the O&M Management Package is composed of three tools as shown in graph below:




The content of the three Assabol O&M tools is in brief as follows:

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|---|---|
| **Tool 1** | **O&M Conceptual Framework**<br>It provides comprehensive information about Assabol scheme and in particular about how O&M management is designed and organized. |
| **Tool 2** | **O&M By-laws**<br>It provides the framework to support the implementation and enforcement of the officially legalized regulations. |
| **Tool 3** | **O&M Task list, Job description, Guidelines and Checklists**<br>This tool is composed of guidelines and checklists that instruct about all required O&M activities. |

## 1.2 Tool 1: Operation and Maintenance (O&M) Management Conceptual Framework

**Purpose** of this tool is to provide comprehensive information about the Assabol scheme and in particular about how O&M management is designed and organized. Hence it serves as a reference document for all stakeholders involved to understand and to be reminded about the reasons and principles that direct the particular set up of Assbol O&M management system. This may be of particular relevance when in future some changes in the organization may be considered. Additionally, the O&M framework will introduce any outsider or newcomer about the background, technicalities as well as principles and set up that direct Assabol O&M management system.

| **Content** of this element covers the following information: |
|---|
| *Background* section briefs about project history, context, project lay out & design and development of O&M management system |
| *Risks* are briefly assessed in the principal geographic areas of the scheme and ways of their management identified. |
| The *principal services to secure sustainable operations* are defined again separately for the principal geographic areas. |
| The *organizational and institutional framework* is presented that has been selected by considering sustainability principles such as subsidiary as well as existing contextual issues. Accordingly roles and responsibilities are defined. |
| The *financing* of required O&M activities is elaborated both regarding arising cost and how to cover these costs. |
| *Needs for regulatory framework* are assessed based on existing situation and formal requirements to implement and enforce the required O&M activities including collection of water tariffs. |
| *Needs for institution and capacity building* (including external monitoring and mid-term coaching) are assessed and mode of provision suggested. |

# 2 Background

## 2.1 Context and Location

The Assabol Scheme lies in north-eastern Ethiopia, in the Irob District (Irob Woreda, part of Region Tigray) forty kilometers north-east of the town of Adigrat, near to the border to Eritrea. The Irobland covers 850 square kilometers of semi-arid and rocky, mountainous land in the escarpment between the Tigrean plateau highlands (2'500 m above sea level) and the Danakil depression (152 m under sea level).

The area is a forgotten and remote corner of Ethiopia and it is the home of the ethnic/linguistic minority group of the Irob-Saho, former nomads with a population of 30'000 people. The entire area lies in the rain shadow of the Ethiopian highlands. Precipitation is low (200 mm to 500 mm per year), irregular and unevenly distributed over the wild mountains with steep slopes and high density of dissecting valleys.

The population is engaged in various farming and local trading activities. Land surface and land productivity are very limited, and the subsistence farming can not produce enough to feed the fast growing population. Absolute poverty is a common feature, and people survive since decades from external food aid and remittances from ex-migrated relatives.

Water scarcity is the most pressing need for the survival of people and challenges any sort of development. From an international development cooperation perspective, the Irobland has to be considered a "hopeless case". For many months during the year people and their livestock survive only on wild or cultivated cactus fruits and leaves.

## 2.2 Genesis and Objective of Assabol irrigation scheme

The idea of constructing the Assabol scheme goes back to the early seventies of last century, when the Tigray Famine has striken northern Ethiopia. During this time of drought and famine disaster, the local Catholic Church has requested Caritas Switzerland to assist in constructing a water retention dam in the very narrow gorge of Assabol. The first feasibility study, executed by Prof. Peter Widmoser from Switzerland, has found the project technical feasible, but not appropriate to the given framework and political situation. As an alternative, he proposed a project of soil and water conservation, what was the start of the Adigrat Diocesan Development Action (ADDA) in 1975, what is still ongoing until now and what has covered the entire watershed of Assabol River and its adjusting areas. The ADDA project has provided sustainable results and has drastically improved the ecology of the landscape and the live of the people.

The objective of the scheme is to harvest flood water from the vast watershed (450 km2) in the highlands from Adigrat (Tigray) to Senafe (Eritrea), and to store and supply reliable water even in time of drought and lack of rainfall. It was experienced that the flash floods from the highlands well exposed to monsoon rains are a much more reliable source of water than any other sources inside Irobland, often exposed to local droughts and irregularities of rainfall. Most water will be used for irrigation purposes for especially horticultural crops, what is considered the only way to improve the economy and the live of the growing Irob population. In addition, a generous and reliable source of water in the centre of Irobland will also be useful for domestic, industrial and many other purposes.

For the first time in history, the Irobland possesses a splendid source of fresh water. The local people call the reservoir the Sea of the Irob, what shows the importance of the innovation Assabol.

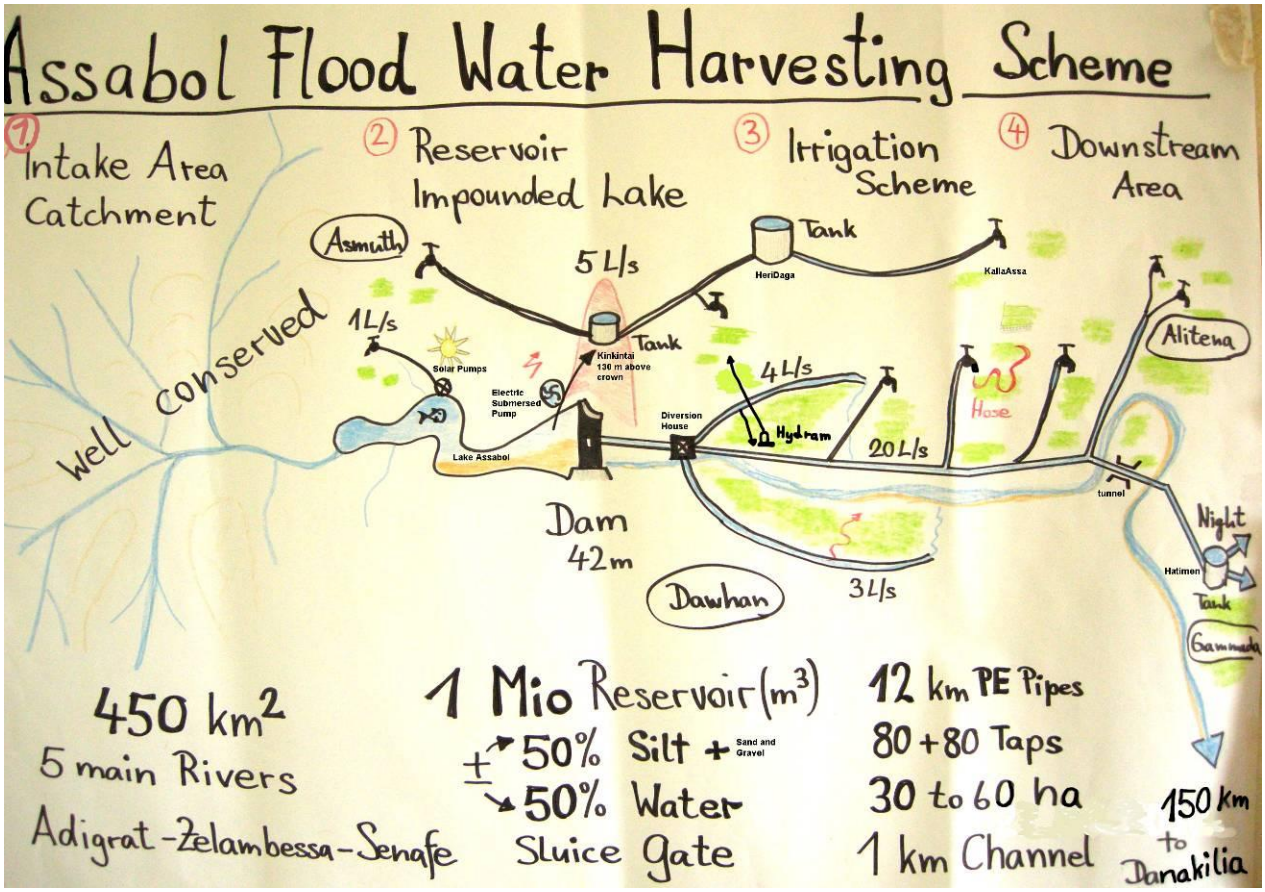
## 2.3 History of Project Implementation

After the finalisation of the civil war, the change of Government and the opening up of the Irobland by road, the idea of Assabol dam construction was taken up again. The short history of scheme implementation is as follows:

| | |
|---|---|
| 1995 | Elaboration of the original design as per „Detail Project“ of Andrea Pozzi and Bruno Strebel. Approval of the dam construction by the SEART Commission of the Regional Government of Tigray. |
| 1996-98 | Additional studies, plan amendments, establishment of basic infrastructure, blasting of access roads, blasting of abutments and casting of dam foundation. |
| 1998-2001 | Hostile occupation of the area by Eritrean forces has interrupted the construction work for more than two years. |
| 2002 | Dam construction up to a level of 5.00 m, construction of the two open irrigation channels. |
| 2003 - 2007 | Rising of dam to its final level of 42 meters, laying of main pipe (and many branches) for the gravity irrigation scheme. |
| 2008 | Construction of wing walls, jack tower, spill way and improve of access paths, inauguration in October 2008. |
| 2009 - 2011 | Expansion and improvements of the supply scheme, installation of lifting devices and pipe laying for lift water, intensified training activities, horticultural developments. |

The Dam was built mostly by hand and without involvement of contractors. It was built by blood, sweat and work of the Irob people them selves. Only little machinery such as Cement Mixer, Vibrators, Generator with Water Pumps and one Swiss Cable Crane and have been utilised. The rising dam in the narrow gorge was the only working platform for men and machinery, and often prone to unexpected floods. With the use of steel cables, plastic pipes, silent and explosive blasting powder, the self-built but on the job trained Assabol Crew managed to master the gorge.

## 2.4 Project Lay out and Design




The above sketch shows all major components of the Assabol Flood Water Harvesting Scheme. They can be described as follows:

### 1. Intake Area / Catchment

The catchment consists of five major watersheds with a total surface of 450 square kilometres, covering parts of the highlands and the adjacent valleys of the upper escarpment. The landscape consists of eroded and de-forestrated mountain ridges, steep slopes, and low gradient dry-valleys (Wadi), all with very high population pressure on land and with century old land degradation. The entire area is utilised for subsistence agriculture, animal husbandry and some rural settlements. No industry exists yet.

Compared to many other parts of Tigray, the landscape is relatively well conserved. Since 1975 farmers are very active in soil and water conservation, tree planting and trapping silt behind thousands of check-dams. Thanks to this conservation activities (Local Government, private initiatives, ADDA), the run-off of the catchment has much reduced (by 40%) and is today approx. 10% (of rainfall), while it was 18% only 35 years ago.

Flow of run-off in the watershed varies from 5 million to 25 million cubic meters of water per year. River flow occurs only occasionally and always in form of flash floods, during 20 to 50 storm-events per year. 90% of the river flow stems from the main-rainy season (Krempt) during July and August. Load of sediments in the floods are high and are around 3%. Sediments consist mostly of suspended load and are in form of sand and silt.

Despite the relatively advanced situation (in the context of Ethiopia) regarding soil erosion in the watershed area suggestions by outsiders have been repeatedly made to introduce additional measures (e.g. check dams) to reduce soil erosion. However, a brief assessment made in this regard indicates that the to be expected effects (benefits) will remain minimal. Hence further studies and investments in this regard have been postponed for the time.

## 2. Reservoir /Impounded lake

The main objective of the impounded lake is the harvesting and storage of flood water and its use for all year irrigation. As a side effect, the lake shall also be used for fish farming (control of mosquito and additional income/food security) and the collection of sediments and organic swimming matters. The operation of the lake has to focus mostly on storage of clean water, however, shall also assist authorized persons (user groups, cooperatives etc) in fish farming and the collection of sediments within given limitations.

The reservoir is created by an arch-dam in concrete with a total volume of 3750 m3 of dam body, and a height of 42.50 m above foundation. It is located in a very solid and narrow gorge of hard quartz porphyr rock. The dam is equipped with a sluice gate and its operational devices at the level of 22.50 meters above foundation. This allows easy drawdown of the lake and the flushing and sluicing of sediments. Every year, during the first half of the summer rainy season, the lake is emptied and sediments are washed out by the arriving floods. The gate will be closed towards the end of rains, and will be filled by one or two late floods.

The volume of the reservoir is 1 million cubic meters, thereby about 50% can be kept in form of an open water body, the other half of the volume will get occupied by trapped sediments. The lake is snake like canyon and has a total length of 1700 meters. The impounded lake covers a rocky valley with no former settlements or cropping land.

## 3. Irrigation Scheme

The storage capacity of the reservoir supplies the irrigation scheme with 40 litres per second of reliable supply of raw water throughout the year, even if no re-charge would take place outside the main rainy season (summer rains July/August). Topography and distribution of arable land and human settlements have demanded various types of water transport and water distribution systems.

The low lying hill slopes directly under the dam are irrigated by gravity water in two open channels on both sides of the river. Channels have a total length of 800 meters and may get expanded gradually. A total of 5 ha of land profit from perennial irrigation.

The lands further downstream of the river are supplied with water through 20 km long pipe net. The main pipe has a diameter of 160 mm and a length of 3858 meters. This gravity pipe net (PE plastic pipes) has many branches and a total of 100 tap stands, from where water saving hose irrigation is applied at the gardens. At the end of the main a night reservoir with a provisional volume of 260cubic meters collects pipe flow during the night, when most tap stands are closed in the upper grid. This allows additional gravity irrigation to the villages of Gammada and Daya, supplied with a 90 mm feeder pipe each site.

For higher lying command areas also lift irrigation is applied. It consists of three components: Water pumping (electricity from public supply, 110 m vertical lift, submersible pump) directly from the lake to Kinkintai reservoir, and from where supply to Asmuth and Kallaassa. In the middle of

the lake a solar pumping scheme is installed, supplying 40 small gardens upto 60 m level above the lake. Finally, for experimental purposes a Hydraulic Ram is pumping water to higher fields near the dam.

**4. Downstream Area**

The Wadi (dry-river bed) downstream from the dam has a length of 150 km, until it ends in the salt planes of the Danakil depression. The first 50 kilometres of the river bed consist of a rocky channel with very few human activities. On this way, the Wadi joins with many other dry rivers. At the foothill of the escarpment, various farming activities with river water for irrigation are taking place.

The hydraulic impact of Assabol Dam on the downstream area is considered positive. Due to natural seepages of dam and command areas, perennial flow is created all along the otherwise dry valley. This facilitates the domestic water supply for the migrating herdsmen and permits various irrigation activities. During the Rainy season, the reservoir absorbs only a little fraction (5 to 20%) of the cascading water. A negative impact on the foothill agriculture can be excluded.

## 2.5 Process of O&M Management System Development

The process for the development of an appropriate management system for sustainable operation & maintenance of the dam and irrigation scheme has been initiated together with the start of the dam construction. E.g. Craftsmen from the area have been employed and trained with the vision to become part of the operation and maintenance unit in future. - During a consultation workshop in August 2004 a paper was presented on “Provision and Practices related to irrigable land and use of water” by a legal advisor (Gaim W/G). On the same occasion it was decided to form a task force with the objective to facilitate the development of a participatory management system. Though the mandates and responsibilities of the task force were clearly laid down in respective Terms of Reference, it’s outputs remained limited. In 2009 the Task Force was given up and the Assabol Management committee was formed and officially recognised.

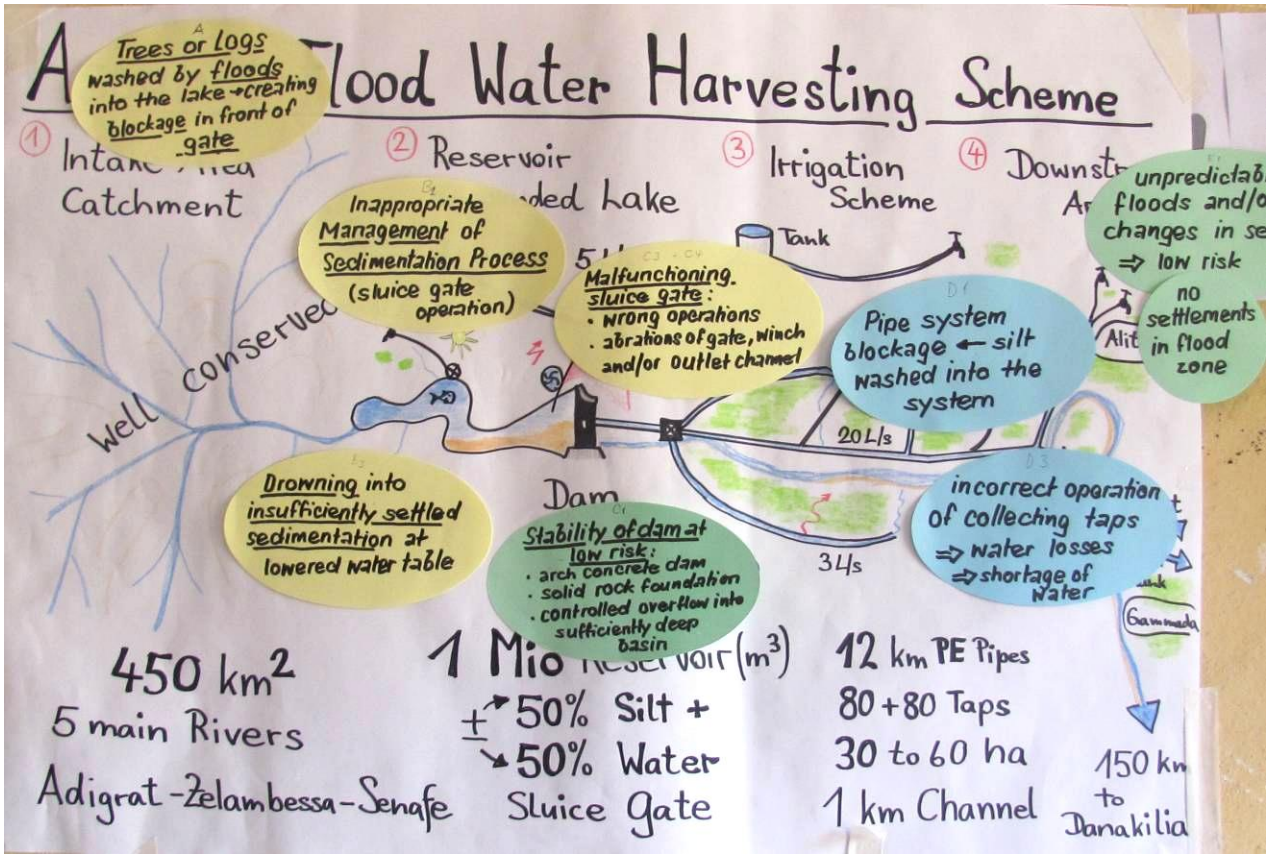
The efforts made over the years in developing an effective O&M management system for Assabol dam and irrigation scheme were consolidated, systematized and finalized in an “Operation & Maintenance Workshop” that was conducted from 23$^{rd}$ to 25$^{th}$ August 2010 at Dawhan, Irob. All key stakeholders (regional and local authorities, users association, members of O&M unit, ADCS and ADDA project personnel concerned, Swiss backstopper/experts) participated and contributed to the design of a tailored O&M management system that considers the local context, the risks involved, the technical and organizational requirements as well as the available capacities and means. The results of the workshop are documented and made available in the O&M management package in order to support effective O&M practices.

# 3 Risk assessment, prevention measures and management activities

On the occasion of the external expert mission in August 2010 the technical and operational risks have been assessed regarding the Assabol dam and irrigation scheme. Basis for the assessment have been existing designs and reports such as the study by Andreas Strebel, monitoring reports by Bruno Strebel, etc. The preliminary results of the assessment have been presented in the key stakeholder workshop for the purpose to complete the assessment as well as to provide recommendations regarding risk prevention and/or reduction measures as well as management requirements. Based on the feedback from the workshop the technical and operational risk assessment has been complemented. - The current state of assessment has to be considered as provisional. Although in its brought terms there are no substantial changes (e.g. additional major risks) to be expected the monitoring of the operation of the Assabol scheme is likely to provide additional information. This means that the risk assessment will have to be periodically reviewed based on the results and new insights from the monitoring.

The detailed results of the assessment are presented in table format in Annex 2 of this document.

The graph below indicates the key risks in the different geographical areas



The table below summarizes these key risks (* indicates risk level) and shows the prevention measures that are taken to minimize the risks as well as the how the remaining risks will be managed. (Additional and more detailed information can be drawn from Annex 2.)

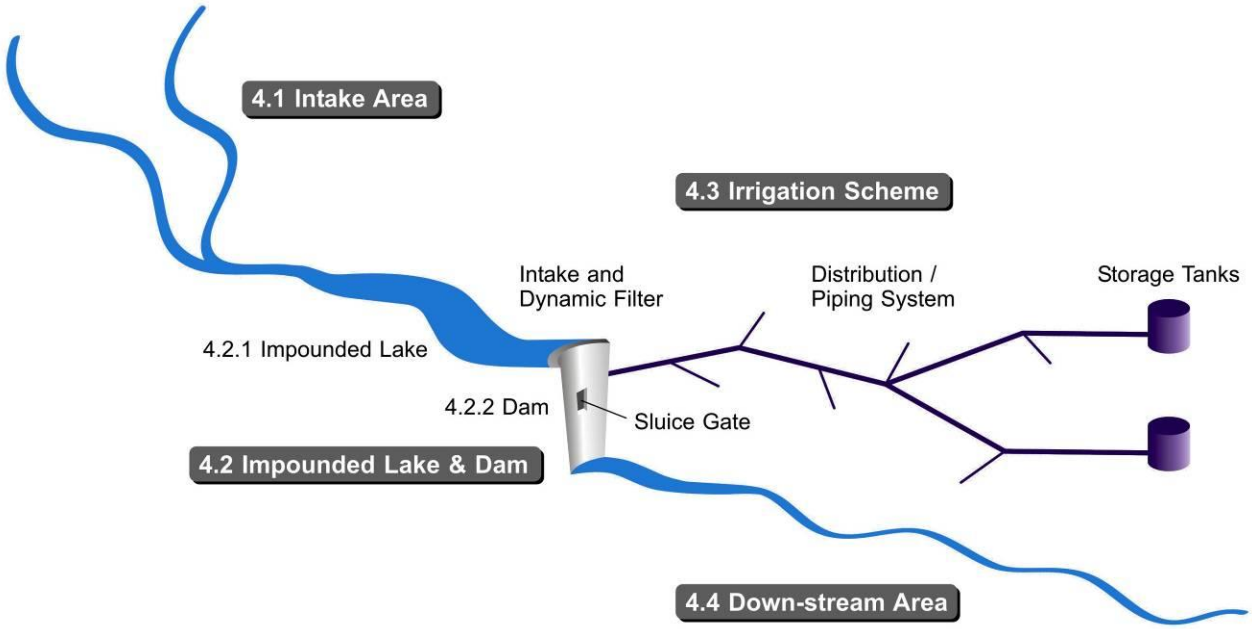
| | **Key Risks** | **Prevention measures and management activities** |
|---|---|---|
| **Catchment area** * | Trees or logs stored near the river banks washed away by floods, creating blockage in front of sluice gate | Installation of a grill net in the upper part of the lake plus regular observation of lake surface after flood and removal of any log; |
| **Reservoir** *** | Insufficient storage capacity of the lake caused by inappropriate management of the sedimentation process in the reservoir during rainy season | Appropriate operations of sluice gate to maintain optimal storage volume: i. flushing of siltation with first floods; ii. washing out of siltation in front of sluice gate during periods of running overflow in rainy season. Enabling of O&M team and management committee, through training/checklists and continued monitoring/backstopping over the next years. |
| **Dam site** ** | Inappropriate operation and maintenance of of spillway (creating high accumulation of remaining floating debris and/or too early lowering of water table) and/or of sluice gate (creating blockage, abrasion etc.) | Adequate and user friendly design and construction of spillway gate and sluice gate (high quality material). Appropriate training and instructions and guidelines for O&M unit coupled with regular external inspections and backstopping. |
| **Distribution system** *** | Pipe blockage because of silt accumulation in the pipelines | Prevention of silt inflow into distribution system through appropriate inflow device e.g. installation of filter fabric. Shutting off inflow during periods of high turbid lake water. Installation of flushing devices at all low points. Ensuring regular flushing, monitoring and inspections |
| **Down stream area** * | Flooding and sedimentation pattern are not substantially changed by Assabol dam, hence risks remain same as before Assabol dam construction | In any case warning sign boards are installed down streams and strict regulations applied regarding prohibition of settlements in flood prone areas. |

# 4 O&M Services required to secure sustainable operations

In this chapter an overview is provided regarding the key services that will be required for effective maintenance and reliable operations (including risk management). These services are considered each at the dam (including the impounded area and in a very remote sense also the intake area) as well as concerning the distribution system for irrigation and the downstream area. Beside the required services it is also proposed, who will be responsible for those services.

However, to make these services become efficient and effectively operational adequate bylaws and regulations as well as detailed job descriptions and manuals will need to be worked out (see by-laws and guidelines/checklists).

**Overview O&M Service Areas**




## 4.1 O&M Services concerning intake area

Activities and particular changes in the intake can have very significant effects on the functioning of the dam. However, the Assabol Water User Association (AWUA) will not have any direct influence or control on the intake area. That is why it will have through networking to attend to the following activities:

- Promote and to the extent possible support any soil and water conservation activities with special focus to check dams across the tributary (feeder) rivers or gullies. Advise not to put any structure across the main river since it will not withstand the upcoming high pressure stress from the collected erosion. Also promote any environmental rehabilitation works including area closures and forestry works

- Collect information and keep record from any regular rainfall gauging in the intake area.
- Keep informed about any upcoming dam constructions, understand their influence to the inflow into Assabol dam and adjust if necessary dam regime. (In general additional dams that may be located up-stream are expected to reduce peak flows and sedimentation).
- Discourage from any activities that create risk for hazardous contamination (landfills with hazardous waste, petrol stations without safety measures, etc.)
- Maintain a grill net in the upper part of the lake (with mesh of ca. 1 meter fixed with crossing cables that are not too tight) to keep back timber logs that may be washed down during floods.

## 4.2 O&M services regarding impounded lake and dam

### 4.2.1 Impounded lake

The impounded lake will be in a dynamic status: This means the level of water and state of sedimentation will change according to seasons, dam and irrigation regime. In order to secure a well functioning and reliable irrigation scheme an open lake with the least sedimentation hence maximal storage volume is desired with priority. Nevertheless sedimentation will always take place in different scales depending on the floods and dam regime. The following tasks will have to be attended to within the impounded lake area:

- Take all precautions that no accidents will happen e.g. by persons entering the water without swimming abilities and/or entering and sinking into the sedimentation before it is properly settled, etc.
  - Public information and awareness creation for community in the surrounding of the lake
  - Installation of sign boards by respective officials and announcement of periods of walk ability
- Manage reuse of organic swimming matters. (Removal of organic swimming matters is compulsory and has to be executed by the operation & maintenance unit).
- Manage controlled use of sedimentation by authorized persons. (Consider re-use of sedimentation for the development of additional farm/irrigation land)
- Allow for controlled fish farming by authorized persons (without guarantee for all year round availability of water)

- Observations of slopes (risks for landslide, rock-fall etc.) in particular close to dam site and taking adequate precautions in case of sings for increased risks (e.g. after heavy rain, earth quake)
- Appropriate operations of sluice gate to maintain optimal storage volume:
  - flushing of siltation with first floods (if necessary repetition before the last flood that is supposed to fill the lake up to the dam crest)
  - washing out of siltation in front of sluice gate during periods of running overflow in rainy season
- Regular monitoring regarding lake water table, sedimentation pattern, floods including overflow pattern, etc.

### 4.2.2 Dam

The dam consists of the dam structure and dam crest in concrete, the spillway with a timber gate and the sluice gate including opening and closing device. Since the dam structure is quite massive and of construction material (concrete with hard stone cover) that will be quite abrasion resistant maintenance of the dam can be expected to be minimal. However, operation and maintenance will be required for the spillway and even more for the sluice gate as follows:

- Annual checking of dam construction:
  - Check the positioning of the dam by re-measuring the triangulation to the fix points (refer to dam position control chart)
  - Look out for any leakages in the construction as well as in the rocks on the side of the dam.
  - Check for any abrasions in particular at the dam crest.
  - Check for any abrasions at and in front of the dam foot.
- Water storage and sedimentation management of the impounded lake through appropriate opening and closing of sluice gate (see 3.2.1).
- Management of mode of overflow (in particular to reduce swimming matters on the surface of the impounded lake in the stage when the lake will be filled to the top level) through appropriate operation of timber gate at the spillway.
- Operation and maintenance of air/water jetting device at sluice gate for loosening of siltation in front of sluice gate.

- Maintenance of sluice gate including the following activities:
  - Regular greasing of opening device (Screw Jack) that is located on the top of the dam
  - Annual maintenance of sluice gate at the time when the water level of the impounded lake will be at the bottom of the sluice gate:
    - Checking of anchorage of vertical operation bars of sluice gate (wearing, loose anchors, etc.)
    - Checking of surface of sluice gate opening in the dam (abrasions, loose stones, etc.)
    - Checking of sluice gate (abrasions, wearing of sealing, in particular smoothness in gliding when opening and closing through multiple operation)
    - Removal of any logs or rocks in front or proximity of the sluice gate (to prevent any blockage)

## 4.3 O&M services regarding the supply scheme for irrigation

Possible risks in the supply network are as follows: i.) pipe blockage because of silt accumulation due to in-appropriate operations of inflow (broken filter fabric, main valve open during flood/turbid water period) and/or mal operations of flushing devices; ii.) breakage of pipeline through landslides and/or rock fall, collapsing suspension cables, etc.; iii.) water losses due to inappropriate installations,leaking joints, valves, taps, etc.; iv.) rock reservoirs leakage through rock layers and cracks; v.) inappropriate operations

The O&M services regarding the supply scheme for irrigation concern the following four task areas and activities:

a) Maintenance:
   - Maintenance of intake filter pipes (cleaning and if necessary replacing of fabric)
   - Regular flushing of piping system in particular after each flood
   - Preventive maintenance and minor repairs (annual checking of distribution pipe coverage, condition of retaining and protection walls, crossings of rivulets, control and regulatory valves, etc.)
   - Major repairs that may become necessary in case of natural calamities possibly with the assistance of external expertise and utilization

- Rehabilitation that may become required for certain parts of the irrigation scheme possibly after 15 to 20 years of operation possibly with the assistance of external expertise and utilization

b) Operation:

- Operation of intake filter pipes including regular cleaning of fabrics
- Closing of main valve during periods of flood respective high turbid lake water
- Distribution of irrigation water according to agreed schedule (day use only
- of entire gravity scheme from Dawhan to Alitena).

c) Extensions:

- The original design of the Assabol irrigation scheme made provisions for limited extensions. However, the hydraulic capacity of the main gravity pipe is already at its limit. This means extensions may be only possible if the irrigation area near to Dawhan (before Kitra high point) is fed by gravity through extensions of the open concrete channels. The dam is also equipped with a reserve main pipe of 160 mm that could be used for the installation of a second supply main. Additional irrigation water may be made available through variations in the irrigation pattern (e.g. sharing of flow over 16 or 24 hours) and/or additional storage capacities.
- Extensions may be considered in case of clearly expressed needs, availability of sufficient irrigation water and capacity of supply system, available financial resources (in consideration of the provisions made in the original design).
- Implementation of extensions will have to meet with similar quality standard like for the original scheme in order not to put the entire scheme at risk.

d) Lay down and collection of water fee (based on right use of irrigation water):

- Lay down of water fee by Assabol Water User Association (AWUA) based on O&M cost and in consideration of maintaining a risk fund e.g. for major repairs.
- Regular collection of water fee (e.g. fort nightly)
- Maintaining of Assabol Project account including regular auditing

e) Financial requirements and actual running costs

(See chapter Financing)

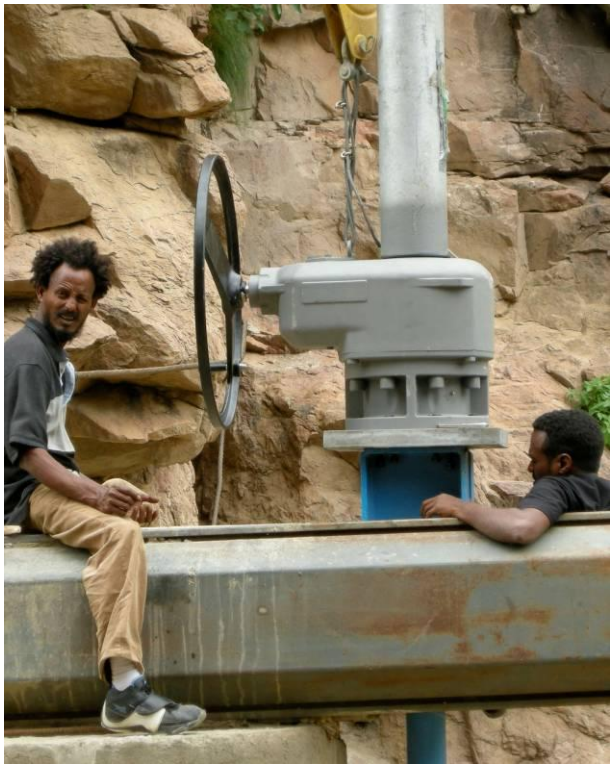
## 4.4 O&M services down stream area

It is important that the Assabol Water User Association (AWUA) considers effects that may occur down streams regarding the population that may be affected as well as the environment. Though flooding and sedimentation pattern are not likely to change dramatically, people may interpret the withholding of water by the dam at the begin of a flood wrongly (at full lake floods will similarly pass like without dam construction).

- Monitoring of effects of dam regarding people and nature concerned
- Ensuring of no settlements within risk area and within the Command Area through strict regulations and sign boards in risk zones.
- Maintaining dialogue with people concerned including possibly exploration of additional irrigation schemes based on experiences and lessons learnt from Assabol.

## 4.5 Maintaining adequate O&M service capacities

The required O&M services to secure sustainable operations are demanding and require adequate skill and discipline. Knowledge and know-how may slowly reduce over time due to turn over of staff or simply by reduced attention to risks that may not materialize during early years of operation. That is why the following mechanisms should be foreseen to maintain the required capacities for O&M:



- Regular (refresher) training for O&M team as well as for the responsible (supervision) persons of the AWUA
- Regular analysis of performance monitoring results and subsequent conclusion of lessons learnt including adjustments of task lists, guidelines and checklists.

# 5 Organisational and Institutional Framework

Aim of the organisational and institutional framework for Assabol is to provide an efficient and effective management for a reliable and sustainable irrigation scheme. This implies that certain guiding principles have to be considered that make such organizations work effectively as well as the existing and in particular legal context in Ethiopia (e.g. regarding ownership and legislation for public institutions). In the following sections some guiding principles are presented, the legal ownership is defined, the selected institutional and organizational set up presented and the roles and responsibilities of the various organs briefly explained.

## 5.1 Guiding Principles

Guiding principles for such an appropriate organisational and institutional set up have been collected from similar settings and are compiled in the box below.

| ***Guiding Principles for organisational and institutional set up*** |
|---|
| Subsidiary principle: This means that the lowest level, which will be capable (or can be trained for it), should solve the up-coming tasks. In case an outer level may be responsible by law for certain tasks or service provision, this outer level may delegate this task to an inner level if it is capable to implement it. The in-complete stakeholder map as shown below may provide an idea how this principle could be considered. |
| Transparency and accountability: The management system should be transparent, and the responsibilities of the different stakeholders should be known to everybody involved. The accountability of the "service providers" to the receivers is of utmost importance. Therefore, clear relationships have to be established. In addition, it will certainly not be helpful if the "service provider" sits far away in an office and is not readily approachable. |
| Appropriate flow of money: This means that the clients should pay for the services to the providers. Even if not in total, they should at least approve payment according to the satisfaction of the services provided. |
| Clear ownership: It goes without saying that clear ownership will be a crucial pre-condition for smooth operation and maintenance. |
| Appropriate rules and regulations (laws and by-laws), which provide the "rules of the game", clarify tasks and responsibilities and are officially approved. |
| *Promotion of gender equality/equity at all levels of the Assabol operation and maintenance systems:* Gender equality is everyone's responsibility that deserves special attention. Gender difference should be appeared all across the project activities for diagnosis that gender neutrality is not made. To involve both women and men in project interventions, it requires every effort be made to broaden women's participation at all levels of decision making. Treat all women and men fairly at work – respect and support their rights, check that both have equal access and control over project resource and befits |

## 5.2 Legal ownership and mandate/right for use of the dam and irrigations scheme

In accordance with Ethiopian law the **legal owner** of the dam and irrigation scheme is the regional respective **wereda government** at large and more specifically the regional and respective **wereda water, mines and energy offices**.

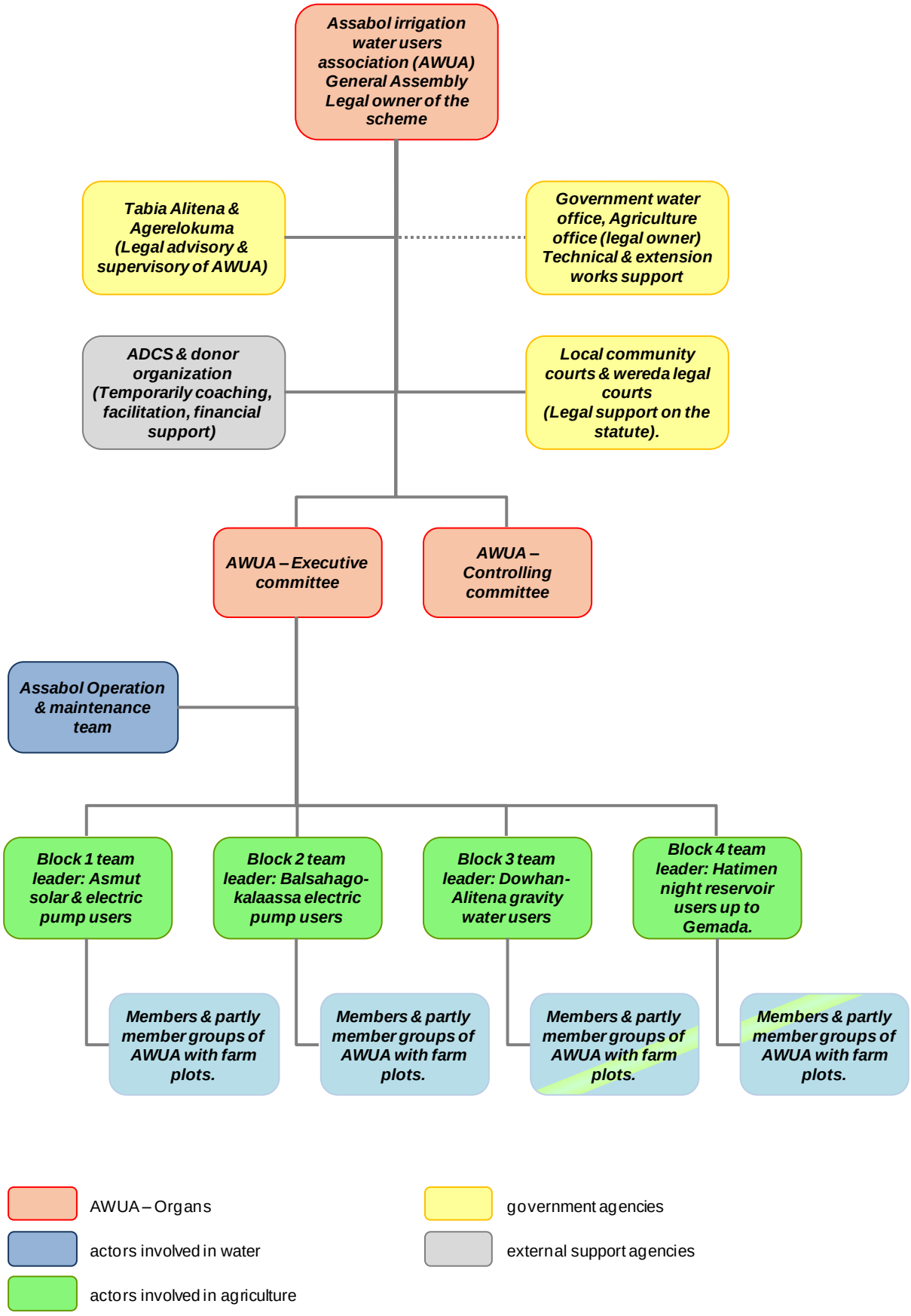
The legal owner of the scheme, together with the implementing partner (ADCS-ADDA) facilitates the establishment of Assabol Water Users Association (AWUA) as well as the approval of the respective by- laws in the office of cooperatives at Dowhan.

Under close supervision by Woreda and Tabia government administration offices, the to be established **AWUA** will be provided with **legal delegations, agreements, mandate and user rights** of the whole scheme by the legal owner of Assabol dam and irrigation scheme.

## 5.3 Selected Organizational and Institutional Set-up

Based on the (legal) context of Assabol and Ethiopia and in taking into account the above principles the institutional set-up as shown in the table below has been developed jointly with all key stakeholders involved.

## Selected Institutional and Organizational Set-up for Operation and Maintenance



### 5.3.1 Legal basis for selected institutional and organizational set up

Based on agricultural cooperative proclamation number 85/1994 (if there is latest proclamation at all we go for it), farmers who have been using water resources for irrigating their farm land through traditional organization or who will be engaged in using water for small scale irrigation could be organized in to Water Users Association(WUA), Water Users Cooperative (WUC).

According to a guideline on small scale irrigation projects for institutional WUA, 1997 of Ethiopian Social Rehabilitation And Development (ESRDF); water users association are organized on internationally accepted cooperative principles of voluntary and open membership, democratic management & control, limited returns on share capital, patronage refunds in proportion to their individual turnovers, continuation of education to members and cooperation among cooperative which are explicitly stated in agricultural cooperative proclamation number 85/1994 or the up dated one (if any).

### 5.3.2 Roles and Responsibilities of the various organs/stakeholders

The roles and responsibilities of the various organs/stakeholders of Assabol irrigation scheme are summarized below. Their **rights and duties** are clearly laid down in the Assabol Water Users Association **(AWUA) By-laws** while the **specific tasks** are defined in the respective **job description** and/or Terms of Reference.

1) ***AWUA General Assembly:*** The general assembly will be composed of the users of the irrigation scheme. It forms the highest organ of the institutional framework for the Assabol irrigation scheme. It will assemble annually, decides about policy and strategic issues, the by-laws (by-laws) and the (cost covering) water tariff, approves the annual report, plan of operation and budget for the coming year, (re-)elect the AWUA Executive Committee and the controlling committee, etc.

2) ***AWUA Executive Committee:*** The Executive Committee is elected by the general assembly. It is composed of seven members including one representative each of wereda and Tabia government (water, mines and energy offices) plus four members from the various user groups. Additional Governement as well as ADDA/ADCS representatives may participate at this level as advisors and resource persons according to needs. The principal function of the Executive Committee is to manage the operation and maintenance of the Assabol dam and irrigation scheme. This management includes the project administration regarding personnel and finances, supervision of O&M implementation by the AWUA O&M team, ensuring that rights and obligations of AWUA members are correctly observed and implemented, organisation of meetings and annual reporting to AWUA general assembly etc.

3) ***AWUA Controlling Committee:*** The AWUA Controlling Committee is elected by the general assembly. It is composed of three members. AWUA Controlling Committee's principal function is to control/audit the Executive Committee in carrying out its duties and responsibilities according to job descriptions and by-laws. This means in particular to audit the project administration including the bookkeeping and reliable service provision, solving of problems concerning members' complaints and/or offending by-laws, etc.

4) ***AWUA Operation and Maintenance Unit:*** The O&M unit consists of 4 technicians who have been recruited from the former implementation crew of the Assabol dam and irrigation scheme. The O&M unit is administered and supervised by AWUA Executive Committee. Accordingly the O&M unit reports directly to the AWUA Executive Committee. The O&M technicians are assigned to specific tasks regarding the O&M requirements as described in chapter 4 and more specifically in the Job Description as well as in the respective guidelines and checklists.

5) ***Block Team Leaders:***

For practical reasons the irrigation / command area is divided into four user groups/blocks based on the closeness to the source of water and the means of water delivery system to the farm plots, as follows: Block I: Asmut - Agerelokuma (solar and electrical pumped command area); Block II: Balsahago – Kallaassa (Alitena electrical pumped area); Block III: Dawhan – Zegarut (Alitena gravity area); Block IV: Lower Daya – Gamada (Alitena – Daya Hatimen night reservoir area).

As an immediate subordinate to the AWUA Executive committee, there will be block leaders in charge who are very close to the command area. The block team leaders will be assigned by the General Assembly to each of the blocks. The number of team leaders to be assigned will vary from 2-3 individuals according to the size of farms to be irrigated and number of beneficiaries grouped in to each of the blocks. These block team leaders, in particular will have some earnings from the beneficiaries that will be stated in the bye-law of AWUA. The four sub-command areas and tasks of the block leaders are specified in the by-laws and in the respective job descriptions.

6) ***Government Agencies concerned:***

- Regional and Woreda water, mines and energy offices
- Regional and Woreda agriculture and rural development offices
- Woreda Justic office and court
- Agerelokuma and Dawhan/Alitena Tabia Administration Offices

7) ***Adigrat Catholic secretariat (ADCS) & Donor Organization:*** ADCS/ADDA in cooperation with Caritas Switzerland played in the realization of the Assabol dam and irrigation scheme a typical BOT (Build – Operate – Transfer) role. During the last period of the construction work the second and last part (operation and transfer phase) became most important and urgent. However, the required organizational and institutional change process requires additional time for its establishment and consolidation. Accordingly ADCS/ADDA in cooperation with Caritas Switzerland will temporary for the next 5 to 7 years support the AWUA association in the operation and maintenance of the irrigation scheme. This support will mainly consist of institution and capacity building and specific technical advise in order to consolidate the inputs already made and finally to enable AWUA association to manage the scheme on their own (see also chapter 8).

# 6 Financing

## 6.1 Operation, routine maintenance and repairs

### 6.1.1 Cost for operation, routine maintenance and repairs

As a principle, cost for operation, routine maintenance and minor repairs will have to be covered by the users of the irrigation scheme. This is considered to be the minimum of local contribution to **assure sustainability** of the scheme. However, these minimal costs will already challenge the profitability of the production on the small garden plots. As long gardens produce only cereals, it will remain difficult to collect the required amount of fees for O+M. A drastic change towards horticultural production would increase income from gardening up to factor 10, what would allow farmers to cover fees with approx. 10% of their incomes from irrigated gardens.

The projected Costs and the Income Comparison are as follows:

| Costs or Income per Item and per Year | Income | Expenditures |
|---|---|---|
| Employment costs for the Operation and Maintenance Unit (salaries and other benefits), 4 staff members | | 60’000 Birr |
| Other Salaries for Committee etc. | | 20’000 Birr |
| Small repairs and improvements (costs of materials; per diem costs for specialists) | | 30’000 Birr |
| Contribution to reserve fund | | 41’000 Birr |
| fund for replacement of pumps (total value invested 800’000 Birr; devaluated over 15 years = 53’000/a) | | 55’000 Birr |
| Electricity for water pumping (100’000 $m^3$ per year) | | 70’000 Birr |
| Water provided by gravity in open channels (flat rate per 28’409 $m^2$ x 0.04 Birr x 11 months) | 12’500 | |
| Flat rates per water tap, 90 Permission Hangers in circulation (150 Birr per month in average, 11 months) | 148’500 | |
| Pumped water from Hydraulic Ram, Solar Pumps and Electric Pumps (1 Birr per $m^3$, total 115’000 $m^3$ consumption) | 115’000 | |
| Total cost | 276’000 | 276’000 Birr |

### 6.1.2 Water Tariffs

Above estimation has been based on the following tariff structure:

- Water that is provided by **gravity in open channels** will be charged with a monthly rate of 0.04 Birr per square meter (what equals 220 Birr per year / 20 Birr for each of the 11 months for standard plot sizes of 500 m2).

- Water that is provided by **gravity through pipe-net and taps** can only be used if the tap is marked with a "Permission Hanger", what allows the full use of the tap supply during day times (14 hours; throughout the year, except during month of Hamle, when flushing of sediment occurs) or actual regulation. These taps are grouped in three categories according to their hydraulic capacity: high yielding taps (with blue colour mark), medium yielding taps (with red colour marks) and low yielding taps (with yellow colour mark). The fees for the monthly rent of "Permission Hangers" are as follows:

| | |
|---|---|
| Blue Hangers for high yielding taps: | 200 Birr per month |
| Red Hangers for medium yielding taps: | 150 Birr per month |
| Yellow Hangers for low yielding taps: | 100 Birr per month |

  The leaser of a Permission Hanger can use or sub-contract his/her water rights at any tap of his or of a lower category. The number of Permission Hangers is limited according to the hydraulic capacity of the pipe branches. The months of Hamle (empty lake, no supply) and Pagumen (5 or 6 days lip-month) are free.

- **Water that requires pumping** will be charged according to quantity of water used

  (1.-- Birr per cubic meter). Each tap (or each pipe branch to a sequence of tap stands) with pumped water is equipped with a water meter.

Consumption of small amounts of water like filling a bottle or a bucket is free of charge, provided the daily consumption is not exceeding 10 litres per person. The leaser (tenant) of tap-stands with Permission Hangers or Water Meters are entitled and encouraged to sell water to other consumers and to share thereby costs. However, he/she has to obey the law of the country and an eventual price ceiling of the AWUA committee.

### 6.1.3 Ideas for Alternative payments of salaries for O&M team

It may be possible that the O&M technicians (or other staff) can be at least partly compensated for their work through contributions in kind.

This might be e.g.:

- irrigated land (or one tap-stand) provided free of charge to the O&M technicians, or
- wood logs and organic matter collected from the lake with an annual value of 20'000 Birr is collected and directly sold, or

- free-lance income is created by offering technical services (plumbing work, pipe expansions), or
- boat service for “taxi-lake-travel” are offered (financial potential 50x Birr 150 per year), or
- that a share of net-income from lake fishery is earmarked as a tax for AWUA funds.

However, such arrangements will have to be based on clear and written contracts. All precautions must be taken that no claims can be made after the technician may resign from his duty as O&M technician. In any case it is recommended to include still some cash payment in order to control and reward the O&M technicians according to their performance.

## 6.2 Extensions

Provision for extensions has been made in the design of the Assabol irrigation scheme. However, upcoming extensions are subject to meet with the following three requirements before implementation can be started:

1) *Technical approval:* Capacity of supply main, sufficient pressure, etc.
2) *Administrative approval:* Acceptance by general assembly of Assabol Water User Association (AWUA), agreement on rules and regulations of Assabol dam and irrigation scheme.
3) *Financial approval:* Financial means for the extension must be made available (e.g. through external assistance / co-financing) by the users of the extension.

## 6.3 Replacement and Risk Funds for Major repairs and rehabilitation

Designs and constructions including selection of construction material have been done by giving priority to highest quality to achieve long-term durability. Accordingly rehabilitation requirements may only come up after 25 to 30 years. However, natural calamities such as landslides etc. and/or wrong operations may call for major repairs to bring the system into operations again (c.f. Annex 2: Risk assessment – Risk prevention – Risk management). It is likely that cost for such major repairs will go beyond the capacities of the Assabol Water User Association (AWUA). However, there is currently limited experience and understanding existing concerning the need and management of a risk fund especially at local level. That is why a pragmatic approach shall be implemented for the time being as follows:

- **Stock of spare parts and tools:** A reasonable stock of spare parts including a certain amount of pipes, fittings and valves shall be established by the project and handed over to AWUA association. Additionally, a set of appropriate tools shall be provided for professional operations and maintenance. The mode of management (including refurbishing) of the spare part stock and tools shall be clarified in the by-laws.
- **Reserve fund:** A reserve fund shall be established by AWUA as proposed with the financing model. Purpose of the reserve fund is to make the financial means available for the replacement of the wearing parts (e.g. pumps) within Assabol irrigation scheme as well as for repairs that will become necessary in the normal operations of the scheme. Mode of reserve fund management will be clarified and laid down in the by-laws.

- **Voluntary work:** In the case of un-expected events/interruptions in supply (e.g. breakage of supply main because of landslide, etc.) the members of AWUA are expected to provide free labor to rectify the situation. The provision and organization of free labor shall be regulated in the by-laws
- **Risk fund:** In cases of un-expected events (e.g. events that cause repair or replacement cost that go beyond the capacity of AWUA) government of Ethiopia and for a limited period Caritas are expected to be prepared to step in with the required support. This preparedness for back-up is required and justified in the view of the limited experience in the management of an irrigation scheme in scale of Assabol.

# 7 Regulatory Framework

## 7.1 Relevant existing regulatory framework

Based on agricultural cooperative proclamation number 85/1994 (if there is latest proclamation at all we go for it), farmers who have been using water resources for irrigating their farm land through traditional organization or who will be engaged in using water for small scale irrigation could be organized in to Water Users Association(WUA), Water Users Cooperative (WUC).

According to a guideline on small scale irrigation projects for institutional WUA, 1997 of Ethiopian Social Rehabilitation And Development (ESRDF); water users association are organized on internationally accepted cooperative principles of voluntary and open membership, democratic management & control, limited returns on share capital, patronage refunds in proportion to their individual turnovers, continuation of education to members and cooperation among cooperative which are explicitly stated in agricultural cooperative proclamation number 85/1994 or the up dated one (if any).

## 7.2 By-laws for Assabol Dam and Irrigation Scheme

Based on the existing regulatory framework the establishment of a user association in form of a cooperative is most appropriate. This form facilitates the required legal back up and at the same time it provides a institutional and organisational framework for effective and sustainable management of the scheme.

The by-laws for Assabol dam and irrigation scheme provide the legal basis for the functioning of its organs as well as clarify the roles and responsibilities. The specific tasks are specified in separate job descriptions and where essential supported with additional guidelines and checklists.

Bylaws have been established for the following three levels:

- ***By-laws for the Assabol Water User Association (AWUA),*** that regulates the organisation of the association including the responsibilities and competences of its various organs.

- ***By-laws concerning the Assabol Dam and the Irrigation scheme*** that regulates the ownership, rights and responsibilities regarding the use, operation and maintenance of the dam and water distributions system.
- ***Water Tariff*** that lays down the connection- / water tariff, mode of payment, measures in case of non payment etc

## 7.3 Guidelines, checklists, job descriptions

In order to facilitate smooth and effective operations the by-laws are complemented where necessary with guidelines, checklists and/or job descriptions. These complementary documents are very practical oriented and may be adapted to flexibly to additional needs arising or based on lessons learnt. They also serve as supporting documents during training and instruction sessions. Checklists may be even established in a format that they serve at the same time as monitoring forms.

Guidelines, checklists are compiled in a separate package.

# 8 Institution and Capacity Building, external Monitoring and mid-term Coaching

ADCS / ADDA in cooperation with Caritas Switzerland played in the realization of the Assabol dam project a typical BOT (Build – Operate – Transfer) role. During the last period of the construction work the second and last part (operation and transfer phase) became most important and urgent. However, the required organizational and institutional change process requires additional time for its establishment and consolidation. Accordingly institution and capacity building requires further inputs post project implementation.

In addition to these change process requirements it has to be taken into account that operation and maintenance of dams and impounded lakes in the scale of Assabol are quite new and neither extended experience nor appropriate regulatory framework is available in this geographical context. Additionally, there remain a number of opportunities to optimize operations and use of precious irrigation water. Finally, the risk assessment showed that it will be essential to consider some additional prevention measures.

It is expected that the required institution and capacity building inputs will be at least partially provided by the respective government offices. However, considering above remaining challenges and the still limited capacities at government offices it will be absolutely essential to continue external monitoring and mid-term coaching for the next 5 to 7 years possibly in a different form than during implementation (e.g. increasingly advisory role and sole focus on capacity and institution building). It will be important that this continuation of external support is planned in phases considering a well managed exit.

# Annex 1

# Assabol Dam & Irrigation Scheme
# Detailed Irrigation Map and Hydraulic Profile

# Details Pipe Network Section Dam – Hatimen Reservoir

| Item | ∆ Alt. (m) | Altitude (m) | ∆ Dist. (m) | Dist. (m) | Diam. (mm) | Location Name | Remarks |
|---|---|---|---|---|---|---|---|
| **Dam Crown** | | 1842.50 | | 0 | 225 | Assabol | |
| Flusher 1 | | | 10 | 1 | 225 | Near dam | |
| Distr. House / Air Valve 1 | - 23.58 | 1818.92 | 76 | 86 | 225/160 | Gorge Exit | Reduction of Pipe Diameter |
| 3 TS | | | | | | after road bridge | |
| Flusher 2 | - 22.80 | 1796.12 | 730 | 816 | 160 | Tsieto | |
| 16 TS | | | | | | | |
| Air Valve 2 | + 6.61 | 1802.73 | 280 | 1’096 | 160 | Endearto | |
| Flusher 3 | - 5.85 | 1796.88 | 93 | 1’189 | 160 | Endearto | |
| 8 TS | | | | | | | |
| Air Valve 3 | + 14.14 | 1811.02 | 241 | 1’430 | 160 | Annute Bulema | |
| Flusher 4 | - 5.73 | 1805.29 | 163 | 1’593 | 160 | Adolabok | |
| Air Valve 4 | + 4.91 | 1810.20 | 229 | 1’822 | 160 | Adolobo | Pipebridge towards Workiligolo L = 75.4m |
| Flusher 5 | - 13.56 | 1796.64 | 121 | 1’943 | 160 | Workiligolo | |
| Air Valve 5 | + 12.61 | 1809.25 | 343 | 2’286 | 160 | Kitra | Pipebridge towards Saganla Daga L = 179.8m |
| 6 TS | | | | | | after pipebridge | |
| Flusher 6 | - 44.78 | 1764.47 | 476 | 2’762 | 160 | Saganla Daga | |
| **Fork Alitena/ Gammada** | + 12.37 | 1776.84 | 214 | 2’976 | 160 | | Pipebridge towards Munsea L = 126m |
| Air Valve 6, Tunnel Entr. | + 17.59 | 1794.43 | 135 | 3’111 | 160 | Munsea | |
| Tunnel Exit | - 0.12 | 1794.31 | 25 | 3’136 | 160 | Munsea | Pipebridge towards Hatimen L = 171m |
| 11 TS | | | | | | Munsea side | |
| 8 TS | | | | | | Hatimen side | |
| Flusher 7 | - 43 93 | 1750.38 | 518 | 3’654 | 160 | Dagarehot | |
| **Hatimen Reservoir Top** | + 62.16 | 1812.54 | 204 | 3’858 | 160 | | Vol. Res.: 200m$^3$ |
| Hatimen Reservoir Outlet | - 1.74 | 1810.80 | | | | | ∆ H. Top-Outlet: 1.74m |
| Hatimen Reservoir Bottom | - 2.73 | 1809.81 | | | | | ∆ H. Top-Bottom: 2.73m |
| | | | | | | | |
| **Option lower Kitra** | | | | | | | |
| Air Valve Kitra | | 1809.25 | | | | | |
| Lower Kitra option | - 7.75 | 1801.50 | | | | | |

Dauhan, February 15, 2011

# Details Pipe Network Sections Hatimen – Gammada and Fork Munsea/Alitena – Alitena

| Item | Δ Alt. (m) | Altitude (m) | Δ Dist. (m) | Dist. (m) | Diam. (mm) | Location Name | Remarks |
|---|---|---|---|---|---|---|---|
| **1. Hatimen - Gammada** | | | | | | | |
| Hatimen Reservoir Outlet | | 1810.80 | | 0 | 90 | | |
| 2 + 6 TS | | | | | | | |
| Flusher 1 | - 52.37 | 1758.43 | 325 | 325 | 90 | Akokegolo | |
| Air Valve 1 (to be installed) | + 15.57 | 1774.00 | 175 | 500 | 90 | Akokegolo | |
| 1 TS | | | | | | | |
| Flusher 2 (start of bridge) | - 12.65 | 1756.69 | 100 | 600 | 90 | | Pipebridge towards Gammada L = 133.4m |
| Air Valve 2 | + 26.13 | 1782.82 | 150 | 750 | 90 | Gammada | |
| 4 + 5 TS | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| **2. Fork Munsea/Alitena - Alitena** | | | | | | | |
| Fork Munsea/Alitena | | 1776.84 | | 2’976 | 160 | | |
| | | | 193 | 3’169 | 160/110 | | Reduction of Pipe-Diameter |
| 10 TS | | | | | | | Left valley side |
| 10 TS | | | | | | | Right valley side (crossing with pipebridge) |
| Flusher 1 | - 14.75 | 1762.09 | 243 | 3’412 | 110/90 | Silalegade | Reduction of Pipe-Diameter |
| 16 TS | | | | | | | Left valley side |
| 5 TS | | | | | | | Right valley side (crossing with pipebridge) |
| Air Valve 1 | + 7.85 | 1769.94 | 581 | 3’993 | 90 | Alitena | |
| End of pipe | | | 27 | 4’020 | 90 | (road bridge) | |
| Marker for continuation | + 0.34 | 1770.28 | | | | | |

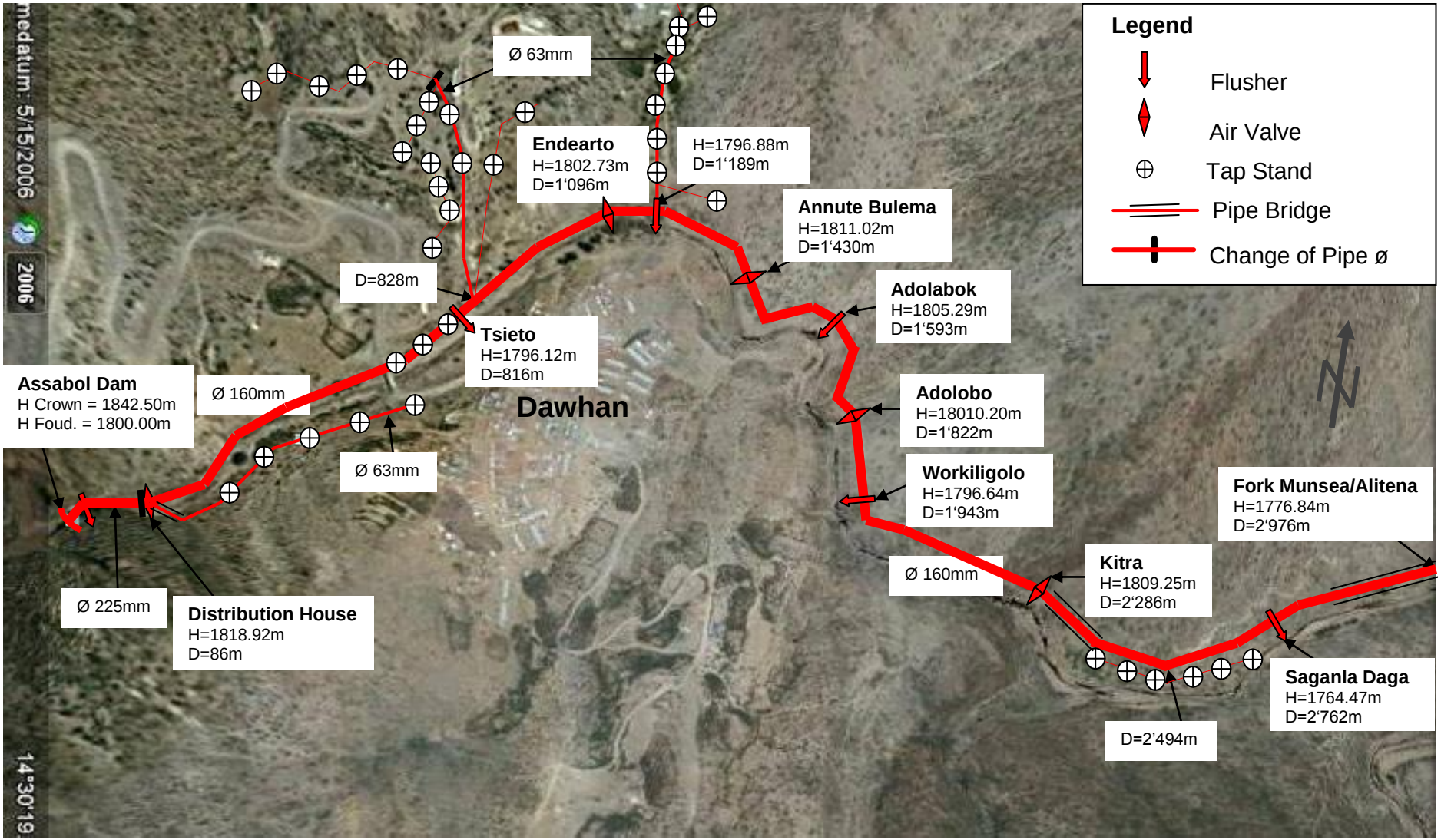
Dauhan, February 15, 2011

# Details Pipe Network Sections Kinkintai – Hedidaga and Kinkintai – Asmut

| Item | Δ Alt. (m) | Altitude (m) | Δ Dist. (m) | Dist. (m) | Diam. (mm) | Location Name | Remarks |
|---|---|---|---|---|---|---|---|
| **1. Kinkintai - Hedidaga** | | | | | | | |
| Kinkintai Outlet Kallaassa | | 1955.23 | | 0 | 90 | | |
| 2 TS | | | 1'750 | 1'750 | | | |
| 2 TS | | | | | | | |
| Flusher (to be installed) | | | | | 90 | Balsahago | |
| 2 TS | | | | | | | |
| Hedidaga Reservoir Top | + 19.91 | 1935.32 | 650 | 2'400 | 90 | | |
| Hedidaga Reservoir Bottom | - 1.47 | 1933.85 | | | | | |
| Hedidaga Reservoir Outlet | - 1.27 | 1934.05 | | | | | |
| | | | | | | | |
| **2. Kinkintai - Asmut** | | | | | | | |
| Kinkintai Outlet Asmut | | 1955.29 | | 0 | 63 | | |
| Air Valve 1 | | | 5 | 5 | 63 | Kinkintai | |
| Flusher 1 (to be installed) | | | | | 63 | Road Culvert | |
| 1 TS | | | | | | | |
| Air Valve 2 | - 31.28 | 1924.01 | 862 | 867 | 63 | Above Road | |
| Flusher 2 | - 28.35 | 1895.66 | 362 | 1'229 | 63 | Farm Guaulay | |
| 1 TS | | | | | | | |
| Pipebridge | | | | | 63 | | |
| 7 TS | | | | | | | |
| 1 TS/End of pipe | + 31.92 | 1927.58 | 678 | 1'907 | 63 | Farm Desta | |
| Outlet for extension | | 1927.67 | 0 | 1'907 | | | |
| | | | | | | | |
| **3. Distr. House – South Side** | | | | | | | |
| Distribution House | | 1818.02 | | | 63 | | Pipebridge to south side of Assabol river |
| End crossing valley (high pipe) | + 7.42 | 1826.34 | | | 63 | | |
| 5 TS | | | | | | | |

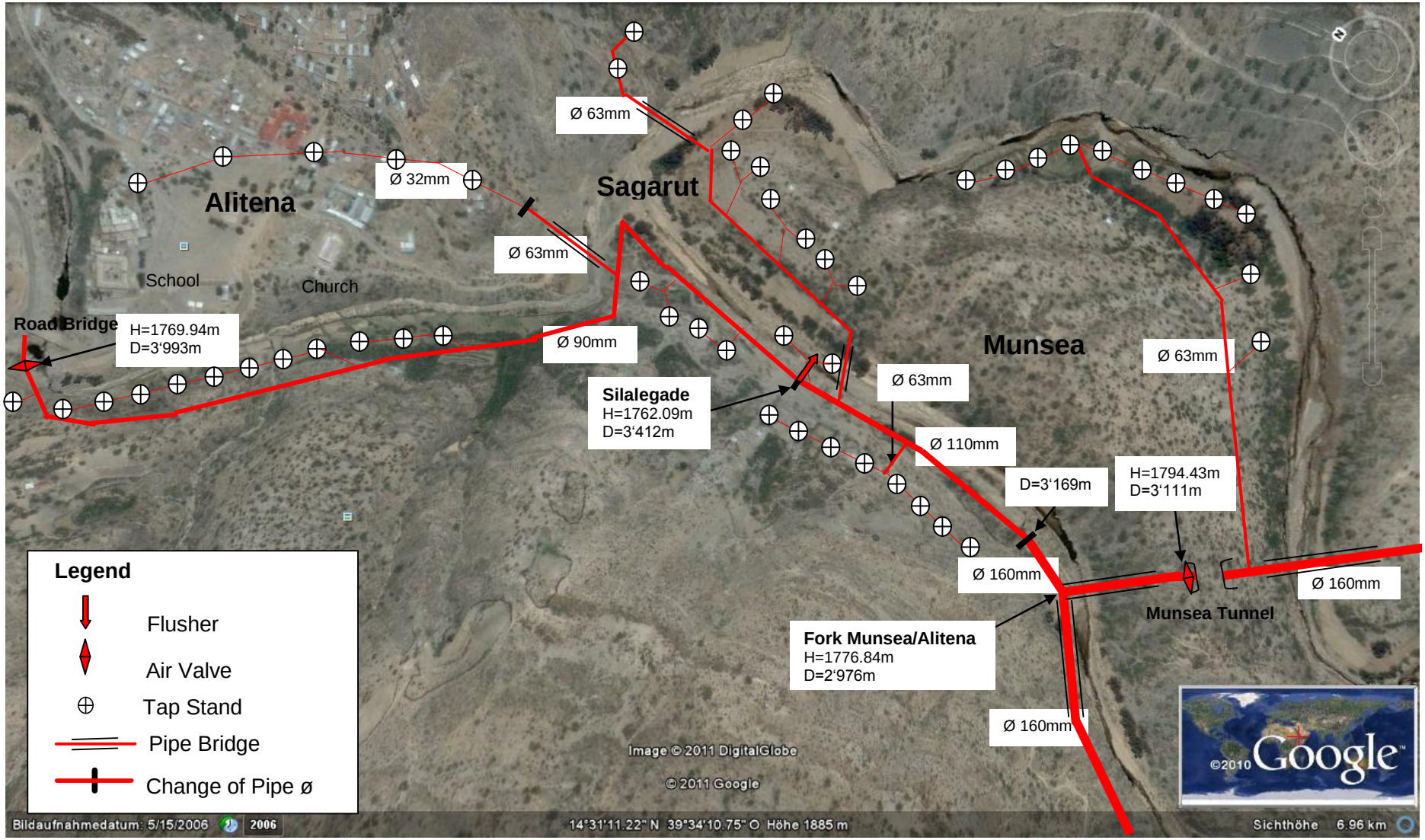
Dauhan, February 16, 2011

## Section Assabol Dam - Fork Munsea/Alitena



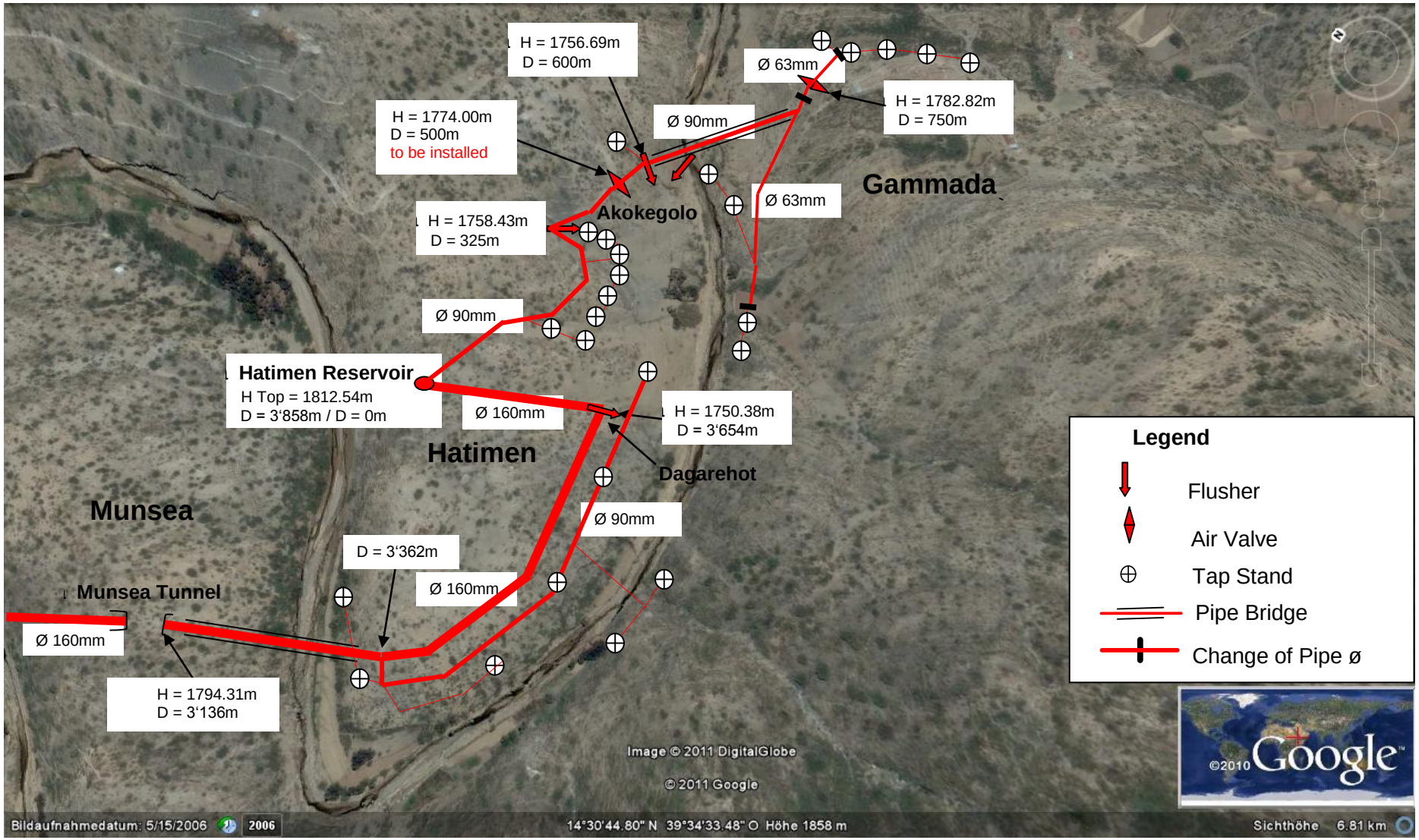

**Remark:** The pipe branches to tap stands are of ø32mm

## Section Fork Munsea/Alitena – Alitena & Munsea side



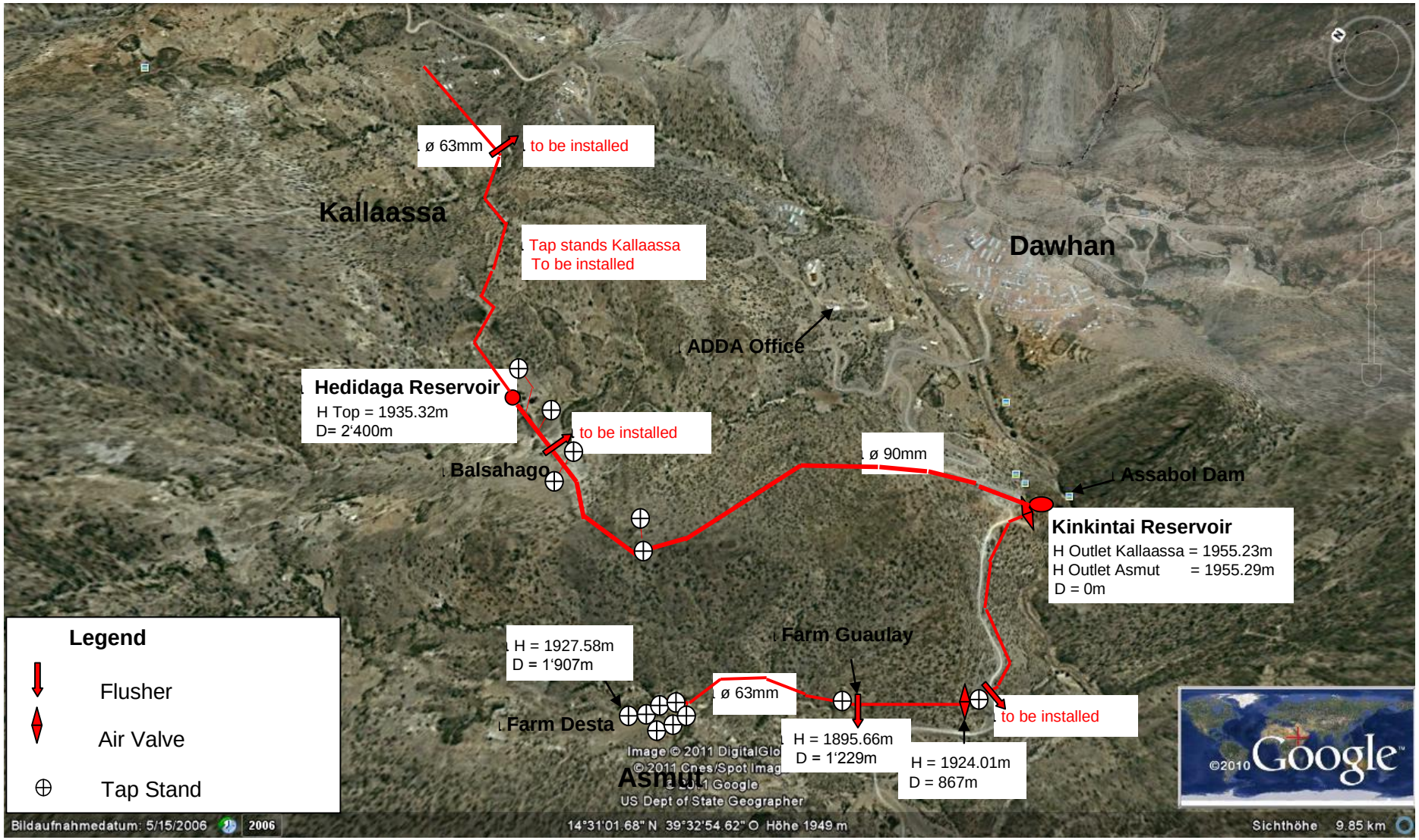

**Remark:** The pipe branches to tap stands are of ø32mm

## Section Munsea – Gammada




**Remark:** The pipe branches to tap stands are of ø32mm

## Section Kinkintai – Asmut and Kinkintai Hedidaga




**Remark:** The pipe branches to tap stands are of ø32mm

## Annex 2

# Risk Assessment – Risk Prevention Measures – Risk Management Activities

## Introduction

On the occasion of the external expert mission in August 2010 the technical and operational risks have been assessed regarding the Assabol dam and irrigation scheme. Additionally, a key stakeholder workshop has been conducted to discuss and agree on management issues regarding operation and maintenance of the scheme. Basis for the assessment have been existing designs and reports such as the study by Andreas Strebel, monitoring reports by Bruno Strebel, etc. The assessment in the field has been conducted jointly by the external expert team (Andreas Huber, Karl Wehrle) including Bruno Strebel and the concerned team members of ADDA. The preliminary results of the assessment have been presented in the key stakeholder workshop for the purpose to complete the assessment as well as to provide recommendations regarding risk prevention and/or reduction measures as well as management requirements. Based on the feedback from the workshop the technical and operational risk assessment has been complemented.

The result of the assessment is presented in table format on the next pages. In the current form it is intended to serve for the following dual purpose:

- Tool for the implementation of the required follow up actions
- Information to make aware all key stakeholders concerned about risks involved

The current state of assessment has to be considered as provisional. Although in its brought terms there are no substantial changes (e.g. additional major risks) to be expected the monitoring of the operation of the Assabol scheme is likely to provide additional information. This means that the risk assessment will have to be periodically reviewed based on the results and new insights from the monitoring.

The presentation of the risk assessment on the next pages provides a quick overview and summary of the various risks in the principal areas of the Assabol water scheme (A. Intake/Catchment area; B. Impounded lake (reservoir); C. Dam site; D. Distribution system; E. Down stream area). Additional and more detailed information can be drawn from the following reports:

- “Integral and Global Assessment Table (Key Issues) per December 2005
- “Assabo Flood Water Harvesting Scheme Risk Assessment” (regarding pipe system operation and management of reservoir and sedimentation flushin) 2008
- “Assabol River Basin Development Plan” (regarding water related issues) per June 2008

**Table: Risk Assessment – Risk Prevention Measures – Risk Management Activities**

| | ***Risk Assessement*** | | ***Recommendations*** | | ***Follow up activities*** | |
|---|---|---|---|---|---|---|
| | ***Objective/ Technical Risks*** | ***Human/ Operative Risks*** | ***Measures to prevent/ reduce Risks*** | ***How to manage the risks*** | ***What?*** | ***by Whom? and When?*** |
| ***A. Intake / Catchment Area*** | A.1 Landslides and rock-falls blocking the feeding rivers creating impulse waves | no influence by Assabol authority | | Prevent people from staying on the lake during heavy rainfall periods;<br>Support to maintaining of indigenous alarm system | implementation of recommended risk management measures | O&M team in cooperation with AWUA management committee |
| | A.2 Trees or logs stored near the river banks washed away by floods, creating blockage in front of sluice gate | limited influence by Assabol authority | grill net in the upper part of the lake (with mesh of ca. 1 meter fixed with crossing cables that are not too tight) | regular observation of lake surface after flood and removal of any log;<br>installation of devices to ease removal of logs either from the grill net or in front of sluice gate | construction of grill net and installation of removal devices | during next dry season and pilot testing by O&M team |
| | | | | | regular observations | after floods by O&M team |
| | A.3 Constructed earth dams may break/collapse creating washing down of additional sediments respective buried logs (see A.2) | limited influence by Assabol authority | Regular observations, according to need providing advisory service (warning) and/or reporting to responsible authority | | implementation of recommended measures to reduce risks | O&M team in cooperation with AWUA management committee |
| | A.4 Pollution by hazardous waste (oil, chemicals, etc.) | limited influence by Assabol authority | like A.3 | Shut off any supply to irrigation area | implementation of recommended measures to reduce and manage risks | O&M team in cooperation with AWUA management committee |
| ***B.Impounded Lake*** | B.1 Landslides and/or rock-falls creating impulse waves: While smaller incidents may occur (e.g. blockage of sluice gate by boulders), larger, dangerous cases are very unlikely to happen | | | Observation of slopes in particular close to dam site and taking adequate precautions in case of signs for increased risks (after heavy rains and/or earthquakes e.g. removal of loose rocks above the dam site) | implementation of recommended risk management | O&M team in particular after heavy rain and thorough assessment annually e.g. at the end of rainy season |
| | B.2 Maintaining sufficient storage capacity in the lake during rainy season being available for irrigation in dry | Inappropriate management of sedimentation process | Appropriate operations of sluice gate to maintain optimal storage volume:<br>flushing of siltation with first | Thorough training of O&M unit and management committee, provision of stringent checklists | Continued external support (monitoring and training) | ADCS / Caritas |
| | | | | | Strict and appropriate implementation | O&M team |

| | Risk Assessement | | Recommendations | | Follow up activities | |
|---|---|---|---|---|---|---|
| | ***Objective/ Technical Risks*** | ***Human/ Operative Risks*** | ***Measures to prevent/ reduce Risks*** | ***How to manage the risks*** | ***What?*** | ***by Whom? and When?*** |
| | season | | floods<br>washing out of siltation in front of sluice gate during periods of running overflow in rainy season | Monitoring of sedimentation process over next 5 to 7 years and conclusion of additional learning (including external guidance) | Tight supervision and monitoring | AWUA management committee (followed up by external support agency) |
| | B.3 | Drowning by animals and human being into insufficiently consolidated sedimentation at lowered water table in the lake | Event. construction of fences at highly critical sites | Public information and awareness creation for community in the surrounding of the lake<br>Installation of sign boards respective official announcement of periods for walkability | Implementation of recommended preventive measures and management of risks | O&M team with support by AWUA management committee |
| ***C. Dam site*** | C.1 Stability of Dam: The well designed and constructed arch concrete dam positioned into a solid rock formation places Assabol dam at very low risk for breakage or collapse.<br>Additionally, the overflow falls in sufficient distance from the dam foot into a water pool so that erosion seems to prevented | | | Despite the very low risk regular monitoring of construction and position of dam as well as observation of dam footing (introduction of bench marks and clear checklist) | implementation of recommended risk management | O&M team annually (followed up by external support agency) |
| | | C.2 Inappropriate operation of spillway creating high accumulation of remaining floating debris and/or too early lowering of water table | Adequate and user friendly construction of spillway gate<br>Appropriate training and instructions (guide) of O&M unit | Strict implementation by O&M unit<br>Exploration of re-use of floating matters for soil improvement | implementation of recommended risk management | O&M team |
| | | C.3 Inappropriate operation and/or blockage of sluice gate (see B.2 and A.2) | Adequate and user-friendly construction of platform for sluice gate | Strict implementation of right sluice gate operation by O&M unit | implementation of recommend risk management | O&M team |

| | Risk Assessement | | Recommendations | | Follow up activities | |
|---|---|---|---|---|---|---|
| | ***Objective/ Technical Risks*** | ***Human/ Operative Risks*** | ***Measures to prevent/ reduce Risks*** | ***How to manage the risks*** | ***What?*** | ***by Whom? and When?*** |
| | | | operation<br>Installation of gauge devices for observation of lake water table and sluice gate position.<br>Permanent and user-friendly installation of air/water jetting device for loosening of siltation in front of sluice gate<br>Development of operation guide including do's and don'ts based on continued monitoring and learning | Close monitoring and continued adaption of operation practices including training by external support agency | Close monitoring and continued adaption of operation practices including training | external support agency |
| | C.4 Abrasion of sluice gate construction, lifting device and/or outlet channel | Neglecting regular maintenance | | Keeping spare parts of wearing parts;<br>periodical monitoring and checking at empty lake and dry or diverted river followed by timely maintenance | Implementation of recommend risk management | O&M team, annually |
| | C.5 Insufficient performance of filter outlet into distribution network (e.g. broken filter fabric) | Neglecting regular maintenance especially after floods | Design optimization (e.g. additional filter pipes, floating inlet below lake surface) | Shutting off inflow into distribution system during periods of high turbid lake water.<br>Regular cleaning of inlet filter pipe's fabrics | Implementation of recommended risk management measures | O&M team |
| | | | | | Development of design optimization / alternatives | external support agency |
| ***D. Distribution Scheme*** | D.1 Pipe blockage because of silt accumulation | Shutting off highly turbid water especially during and/or after floods<br>Neglecting regular flushing | Installation of flushing devices at all low points<br>Ensuring sufficient water velocity during flushing (> 2 m/sec) | Shutting off inflow into distribution system during periods of high turbid lake water.<br>Regular monitoring and flushing | Implementation of recommended risk management | O&M team |
| | D.2 Breakage of pipeline through landslides and/or rock fall, collapsing of suspension cables, etc. | | | Regular observation of risk areas, especially after heavy rains | Implementation of recommended risk management | O&M team |

| | Risk Assessement | | Recommendations | | Follow up activities | |
|---|---|---|---|---|---|---|
| | ***Objective/ Technical Risks*** | ***Human/ Operative Risks*** | ***Measures to prevent/ reduce Risks*** | ***How to manage the risks*** | ***What?*** | ***by Whom? and When?*** |
| | | D.3 Water losses: inappropriate installations, leaking joints, valves, taps, etc. | Strict regulations regarding qualification requirements of professionals for pipeline and fitting installations | Appropriate training and supervision, appropriate tools and equipment | Implementation of recommended prevention and risk management measures | O&M team, AWUA management committee supported by external support agency |
| | | Inappropriate operations | Strict regulations regarding operations | Introduction of appropriate management system<br>Appropriate training and supervision | | |
| | D.3 Rock reservoir leakage through rock layers and cracks | | Mortar alignments of floor and rock (possibly reinforced with chicken wire mesh) | Regular monitoring of water losses (observation of water table during periods of non consumption) | | O&M team |
| | | | | | | |
| ***E. Down Stream Area*** | E.1 Flooding and sedimentation pattern are not substantially changed by Assabol dam, hence risks remain same as before Assabol dam construction | Neglecting required precautions by people being active in flood prone area downstream | Installation of warning sign boards | Strict regulations regarding prohibition of settlements in flood prone area | | O&M team, AWUA management committee supported by Woreda authority |
| | | | | | | |
| | | | | | | |

This table is subject to further completion during the December Meeting by the Swiss Team (especially regarding follow up actions).

## Annex 3

# Tasks & Responsibilities of Government Bodies

## Introduction

In the following the roles, tasks and responsibilities of the various government institutions that are concerned with the Assabol scheme, are described. This compilation reflects not only what already common practice is but suggests also what should be done by the various stakeholders. Hence institution and capacity building may be required during the consolidation phase to fill the existing caps.

## Tasks and Responsibilities

### 1. Regional and Woreda water, mines and energy offices

The bureau of water, mines & energy; and more specifically the office of water resources, mines and energy in Dawhan is the official and legal owner of the scheme. ADCS is going to officially hand over the whole scheme to this legal owner government institution as per the schedule and program of the project. This supreme organ will have the following role in assuring sustainable management of the Assabol irrigation scheme:

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| Prepare the required formats and give delegations and use rights to the AWUA, to its full and partly members. |
| Give priority and support and mobilize the community on the catchment treatment works of the upstream area of Assabol dam so as to minimize the sediment transport and allow relatively cleaner water to the reservoir. |
| Keep regular records of rainfall data from all nearby rainguages and allow for any interested to make use of the data for up grading of the whole irrigation scheme. |
| Give regular practical trainings to the executive body of AWUA and its subordinates about sustainable use of water, fee collections, the need of close follow up on such operation and maintenance works. |
| Design some expansion and up grading mechanisms of the whole scheme, discuss with the AWUA and find funds from any direction. Use mobilized community labor for expansion and improvement of command area. |
| Check for any open and unprotected interventions that can be hazardous and risk to the whole irrigation infrastructure along the intake of the lake, take controlling mechanism in collaboration any responsible body from the stake holders. |

## 2. Regional and Woreda agriculture and rural development offices

The bureau of Agricultural and rural development; and more specifically the office agricultural and rural development in Dawhan has the following role in assuring sustainable management of the Assabol irrigation scheme:

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| Give priority and support and mobilize the community on the catchment treatment works of the upstream area of Assabol dam so as to minimize the sediment transport and allow relatively cleaner water to the reservoir. |
| Keep regular records of rainfall datas from all nearby rainguages and allow for any interested to make use of the data for up grading of the whole irrigation scheme. |
| Provision and make available of agricultural inputs and other extension services to the AWUA in a relatively fair price. |
| Together with other stakeholders, facilitate and fully finalize the process of establishing AWUA in a formal way based on the regional proclamations to do so. |
| Motivate beneficiaries to make use of the fine sediments and other organic materials from the dam reservoir for making the farm plots more fertile and productive. |
| Support and strengthen the executive body of AWUA in properly cultivating the irrigated farms according to the approved cropping pattern and materialize the statute in the bye-law in case of any miss-use through out the scheme. |

## 3. Woreda Justice office and courts

These institutions should play its great role in putting in to practice each and every article of the biding bye-laws on those individuals who abuse the management rules and regulations from any angle, through the legal power they posses by law. Accordingly:

| |
|---|
| Support in every aspect for the executive body and its subordinates in performing their duties and powers. |
| Teaching the beneficiaries about the whole Assabol management systems and specifically the statute from the perspective of law, its impact on the sustainable use of the irrigation scheme. |
| Facilitate the whole process of provision of complains and getting faster and fairer decisions by the responsible bodies. |
| Support the local courts at tabia level in properly interpreting and facilitating the process of materializing the bye-law. |

### 4. Agerelokuma and Dawhan/Alitena Tabia administration offices & respective local social courts.

These bodies, as the lowest legal entity of the government at grass root level, is a legal advisory and supervisor of the AWUA as a main owner of the irrigation scheme. In particular sense, these bodies will have the greatest role of all the other playing partners in supervising the whole process of Assabol scheme management. To more specific, these grass root level administration offices and local social courts shall play the following role in properly managing the scheme:

| |
|---|
| Play a very great role in identifying the whole beneficiaries and farm plots that are with in the boundary of the command area of the Assabol and providing to all the other stakeholders for facilitation purposes. |
| Mobilizing the community in to activities of communal land rehabilitation works, more specifically to the Assabol upstream watershed protection works and other maintenance and extension works of the infrastructure. |
| Give out rights / authorise for for the use of sediments and for fish farming in the lake to organized groups and in accordance to the water supply and storage goals of Assabol scheme. |
| Together with the other stakeholders; organize, grouping and regrouping of beneficiaries to form a legal entity, AWUA as a cooperative and its executive committees with its subordinates so as to hand over and properly manage the irrigation scheme. |
| Support and strengthen the general assembly and its executive body in properly managing the scheme, alleviating any complains from beneficiaries. |

## Annex 4

# Detailed Explanations for Water Tariffs and Operation Costs

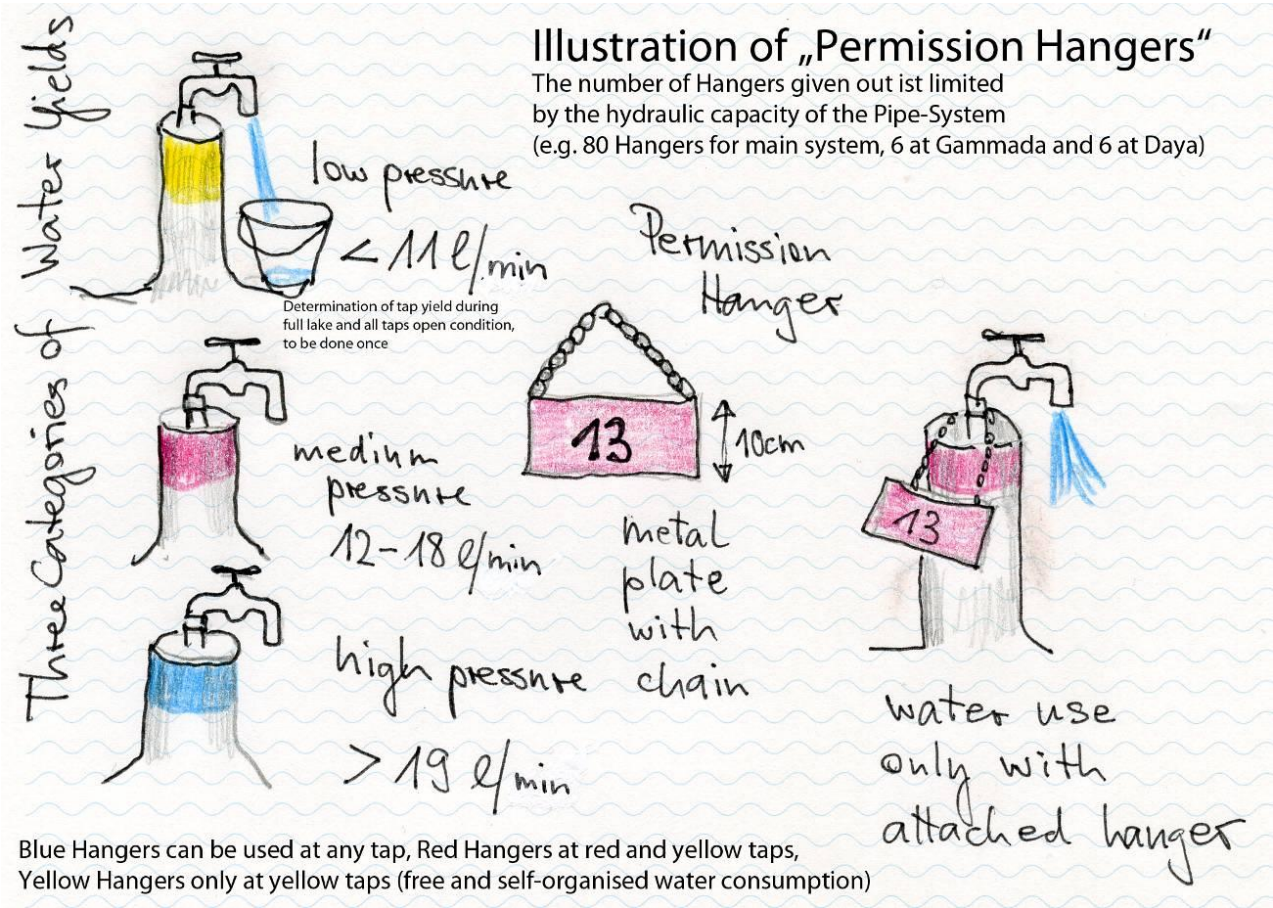
## Detailed Explanations for Water Tariffs and Operation Costs

The most correct and just way for collecting water fees would be based on a tariff for actual consumed water, as it is done with pumped water. However, the use of water from channels can not easily be measured and water meters at all tap stands would be very costly and the dirty water could easily harm the performance of the meters. Therefore, a compromise needs to be applied. In the following it is explained, that the three different tariffs are situated within the same order of magnitude.

A standard size garden of 500 m2 under the open channels requires 500 m3 of water for a all-year irrigation. The gravity supply through channels is the most simple way and requires the least operation costs. The annual user fee is 220 Birr, what equals to a water price of 44 Ethiopian Cents per 1 m3.

The different costs for the three categories of “Permission Hangers” are calculated according to their all-year supply. The medium yielding taps deliver the following amount of water: 15 litres per minute times 10 hours a day and times 330 days a year: 15x60 minutes x 10 x 330 = 2’970 m3. The annual costs are 1’650 Birr, what equals 55 Ethiopian Cents per cubic meter. Above estimates have to be rectified and amended by a field level test and the yield measuring of all taps. Also the number of categories need to be evaluated, and eventually be reduced to only two. One tap (medium yielding) can easily irrigate 3’000 m2 of land, if efficiently used, and 5 to 7 gardeners can profit from the same source of water. It is expected that the costs of one “Permission Hanger” will be shared among a group of users in a self-organised way and will not require a complicated control and administration. This is e.g. possible by leasing out the “Permission hanger” on a daily or half-daily bases. Costs per day are in the range of 4 to 8 Birr.

The costs for pumped water are by nature much higher than for gravity water. Thereby no difference shall be made between the Hydraulic Ram, the Solar Power and the Electric Pumping from public supply, because differences appear only due to different levels of subsidies. In reality, pumping with solar pumps is the most costly way of water supply. Actual costs for the solar supply are as follows: Investment costs for one set are 200’000 Birr, depreciation is 8 years for the pump and 16 years for the solar panels, what is approx. 16’000 Birr per year. Annual water supply is in the range of 11’000 m3, what equals to costs of approx. 1.45 Birr per cubic meter.




The fee collecting system with “Permission Hangers” is expected to stabilise the hydraulic performance of the pipe-net, to promote tap-sharing among neighbours and to overcome the prevailing problems with too many tap-stands. For efficient use of the by nature given Hydraulic Capacity of the main-pipe, a constant 14 hours day-flow (with 80 taps being open full day, but properly utilised with hose-coupling) is highly desirable. Water in the reservoir (Assabol lake) is abundant, the proper balancing between full day consumption along the pipe net, and full night flow to Night Reservoir at *Hatimen* is required, to allow later 24 hrs supply to Gammada and lower Daya. It is believed that the control of proper utilisation and rule application is not too complicated, if the system is properly introduced.

It is recommended to **collect water fees** during the last week of every month (during 11 months, excluding Hamle and Pagumen). Thereby the paying water users (200 persons in total) have to come to the office at clearly communicated and convenient times (e.g. at 8.00 a.m. till 12.00 a.m, and 2.00 p.m. till 6.00 p.m., on Thursday and Friday, what allows a time allocation of 5 minutes per user) and have to submit their fees. The reading of the water meter shall also be done by the users themselves. However, every second month the reading of the water meters needs to be cross-checked by the O+M Unit. Every financial transaction needs to be entered into an account book and a cash receipt will be issued. The “Permission Hangers” need to be carried to the office and a sticker with date and amount paid will be attached at its backside at every paying day.

In case the water fee is not paid on the agreed time, the user will be entered into a list of debtors. He or she will be visited at home within the next three weeks by a member of the O+M Unit and has to pay an admonition fee (penalty) of 20 Birr on top of the regular fee. In case the fee will not

be paid before a period of two months, the user will lose his/her right for water supply. His or her case has to be settled in front of the AUWA committee, prior to use again water from the scheme.

The use of the following Receipt Voucher is recommended:

| | | | |
|---|---|---|---|
| Assabol Water User | | | |
| **Fee Payment Receipt** | | | |
| Month of | | Eth. Calendar Year | |
| Name of user in-charge: | | | |
| **Fee for size of land under open channel** | | | |
| Size of land | $m^2$ | à 0.04 Birr = | Birr |
| **Fee for "Permission Hanger"** | | **Number:** | |
| Blue 200 Birr | Red 150 Birr | Yellow 100 Birr | |
| **Fee for Pumped Water** | | Number of Water Meter: | |
| Today New Reading | | $m^3$ | |
| Last Month Reading | | - $m^3$ | |
| Consumed | | = $m^3$ | |
| times 1.00 Birr | | Birr | |
| Penalty for | | | Birr |
| Total Amount paid: | | | Birr |
| Date, stamp and signature AWUA | | | |
| | | | |