



MINISTRY OF WATER, IRRIGATION AND ENERGY

MANUAL FOR ACCELERATING SELF SUPPLY PROGRAM

WATER SUPPLY & SANITATION DIRECTORATE



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This Self Supply Acceleration Manual is prepared by the Ministry of Water Irrigation and Energy to serve as guiding document for Regions, Zones, Woredas and stakeholders involved in the sector across the country.

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Acronyms

BSF	Bio Sand Filter
CDC	Center for Disease Control
CLTSH	Community Led Total Sanitation
CMP	Community Managed Project
ESIA	Environmental and Social Impact Assessment
FLOWS	Forum for Learning and Sharing on Water Supply & Sanitation
GTP	Growth & Transformation Plan
HDW	Hand Dug Well
HEW	Health Extension Worker
HWTS	Household Water Treatment System
ICM	Integrated Catchments Management
IWRM	Integrated Water Resource Management
M&E	Monitoring and Evaluation
MDG	Millennium Development Goal
ME	Micro Enterprise
MFI	Micro Finance Institution
MoTI	Ministry of Trade and Industry
MoWIE	Ministry of Water Irrigation and Energy
MSE	Micro and Small Enterprises
MUS	Multi Use Supply
NGO	Non Governmental Organization
O & M	Operation and Maintenance
PE	Poly Ethylene
PoU	Point of Use
R&D	Research and Development
RWH	Rain Water Harvesting
SNNPR	Southern Nations, Nationalities and People Region
SODIS	Solar Water Disinfection
SSA	Self Supply Acceleration
SSAP	Self Supply Accelerated Program
ToT	Training of Trainers
TVTEC	Technical and Vocational Training College
UAP	Universal Access Plan
UNDP	United Nations Development Fund
USD	United States Dollar
WaSH	Water, Sanitation and Hygiene
WHO	World Health Organization

DEFINITION OF SOME KEY TERMS

Community-led Total Sanitation (CLTS)

Is an approach that involves facilitating a process to *inspire and empower rural communities* to stop open defecation and to build and use Toilets, without offering external subsidies to purchase hardware such Sanitation Platforms (sanplats). They collectively realize the terrible impact of open defecation; that they quite literally will be ingesting one another's 'shit' so as long open defecation continues. This realization mobilizes them into initiating *collective action to improve the sanitation situation in the community*.

Enabling environment the overall enabling environment where sector policy, norms and regulatory frameworks are set, service levels are defined, and macro-level financial planning and development partner coordination takes place.

Hygiene Personal and Household practices such as hand washing, bathing and management of stored water in the home, all aim at preserving cleanness and health.

Multiple Use Service An approach to water services that considers the multiple needs of (poor) water users, who take water from a number of sources, and communities' own priorities as the starting point for investments in new infrastructure, management arrangements, the rehabilitation of existing infrastructure, or for improvements in management and governance.

Self Supply Is the improvement to household or community water supply through user investment in water treatment, supply, construction and upgrading, and rainwater harvesting. It is based on incremental improvements with technologies affordable to users. This self-help approach is complementary to conventional communal supply, which is generally government-funded and which forms the backbone of rural water supply.

Sanitation In the narrow sense, the safe disposal or re-use of human excreta management together with solid waste and storm water management.

FOREWARD

This Self Supply Acceleration Manual deals with a matter that is very close and important to achieve the target set by the Government of Ethiopia in its Growth and Transformation Plan (GTP). In the GTP target, the Government has placed considerable emphasis on the delivery of clean water to the people of Ethiopia. During the first three years period of the GTP (2003-2005E.C), over 22.2 Million people across the country were able to get access to clean water. This has significant developmental impact in improving their life in general and that of women and children in particular. The MoWIE has already achieved the MDG target as the current access in Ethiopia has already reached 68.4 % (June 2013 MoWIE report). But still more than 30 % of the population of the country has not got the minimum safe drinking water supply of 15 liters per day per person in a radius of 1.5 kilometers in rural areas and 20 liters per person per day in a radius of 0.5 kilometer from a potable water supply source in urban areas.

Beyond the provision of water for drinking, using water for productive use is a major issue that we also have to address. Our Constitution guarantees access to sufficient, safe, accessible and reliable water as a human right. It is self evident that water also plays a key role in food security. Poor people in particular also require water for food gardening, for small businesses, and other productive purposes. The poor and poor women in particular, draw multiple benefits from having access to water. The combination of the domestic and productive benefits can add up to an appreciable impact on livelihoods and poverty eradication. Therefore, poor households need to be enabled ‘to climb the water ladder’-the ladder of self supply.

This, however, poses significant challenges in terms of the delivery of water for both domestic and productive purposes to the poor. In Ethiopia we find ourselves facing such challenges and are grappling with the many questions as to how to meet the challenge. One of the ways out is effectively implementing the self supply acceleration program.

Thus, the Ministry has prepared this Manual to serve as a guiding document for Regional Water Bureaus, Zonal Water Bureaus, Woredas Water Offices and other stakeholders involved in the sector. The Manual addresses key issues that should be considered in the acceleration of self

supply. Most importantly, it has been made to incorporate the technologies and devices including water treatments tools that are available and easily implemented by users. Moreover, an important step is made towards identifying technical, institutional, and financing modes and tools to effectively address the wider needs of people for multi-use supply. Thus, Regional Water Bureaus are expected to use this manual as a guide to develop Region specific Self Supply Acceleration Manual in Regional working languages by taking in to consideration the specific condition of their Region.

It is my hope that this manual will help to contribute to the overall success of the GTP/UAP target, as the very objective of self supply acceleration program is to significantly contribute to increasing access to sustainable improved water supplies in Ethiopia for drinking, sanitation and hygiene and small-scale productive uses, with adequate inclusion of the poorest people.

H.E. Kebede Gerba, State Minister, Ministry of Water, Irrigation & Energy

1. INTRODUCTION

Universal access to potable water supply and improved sanitation is the target set in the growth and transformation plan. This target is beyond the MDG, where it is 70% access to potable water supply at the end of year 2015 G.C. MoWIE has already achieved the MDG target as the current access in Ethiopia is reached 68.4 % (June 2013 MoWIE report). But still more than 30 % of the population of the country does not get the minimum safe drinking water supply of 15 liters per day per person in a radius of 1.5 kilometers in rural areas and 20 liters per person per day in a radius of 0.5 kilometer from a potable water supply source in urban areas.

As per the assessment made for the preparation of one national WaSH plan, the total investment required to realize a universal access plan by 2015 is about 3 billion US dollars. Only 70 percent of this amount is estimated to be mobilized from federal and Regional governments and development partners. Therefore, there are two major challenges in the stride to achieving the GTP targets. The first challenge is the financing gap which amounts to be 30% (1 billion USD) of the total investment required. The second challenge is the scattered settlement patterns of rural Ethiopia where some villages are totally inaccessible to motor vehicles and implementation of conventional water supply schemes are nearly impossible. This makes self supply crucially important to ensure provision of WaSH services especially in remote and scattered rural settlements of Ethiopia.

Despite all these big challenges, it is the government's full commitment to realize the achievement of GTP target. The following are believed to be among the critical measures that the government needs to take to overcome challenges mainly related to finance and accessibility.

These are:

1. Community mobilization on self supply acceleration
2. Focusing on local and low cost water supply technologies
3. Strengthening community scheme management and ownership to reduce scheme down time and O & M costs

1.1. Objective of the Manual

The overall objective of the SSAP is to contribute for increasing access to sustainable improved water supplies in Ethiopia for drinking, sanitation and hygiene and small-scale productive uses, with adequate inclusion of the poorest people.

The specific objectives of this self supply manual is

1. To fill the financial gaps in achieving the GTP target through self supply acceleration program Nationally 1 billion USD budget gaps required to meet targets in the GTP covered by mobilizing community to invest in its WaSH services.
2. To create access to basic WaSH services for individuals and communities across the country in GTP time especially in rural areas and universal access to WaSH services realized.
3. To enable all Regions, Zones, Woredas and Kebeles for identifying and promoting appropriate low cost self supply technologies required for each community.

Outputs:

- i. Focal persons created at Region, zonal and Woreda level to identify, promote and organize community in implementation of self supply.
- ii. Awareness created on self supply technologies
- iii. Communities took a lead role in investing in their WaSH services ;
- iv. Artisans trained in each Woreda, and necessary tools are provided
- v. SME are created in all Woredas to provide services to communities and households
- vi. Integration between different stakeholders to ensure multiple use of self supply schemes
- vii. Necessary budget and support made by Regions, Woredas, and Zonal Water Offices to accelerate self supply.
- viii. Networking and partnership mechanisms to strengthen SSAP;
- ix. Scaling up knowledge and transfer of skills through various capacity building mechanisms;
- x. Financial and market linkage with different MFIs is created to small and micro enterprises.

- xi. Appropriate self supply technologies selected in all communities and contracts awarded to MEs.
- xii. Strong Monitoring and Evaluation activities in place;

1.2. What is self supply?

Self Supply in the context of Ethiopia is *‘Improvement to water supplies developed largely or wholly through user investment by households or small groups of households’*. Self-supply involves households taking the lead in their own development and investing in the construction, upgrading and maintenance of their own water sources, lifting and treatment devices and storage facilities.

There has been steady development and expansion of the understanding of the contribution of Self Supply approach in Ethiopia over the past decade. Self-Supply already happens across the country through private initiative and investment in well construction and upgrading, spring protection, rainwater harvesting, and HWTS. Centuries old “Ela “in low lands of Oromiya, Somali and Tigray are the best examples. Given the low-cost technology options, wealth and education are not pre-requisites to investment. Some Self Supply initiatives are undertaken by small groups but private ownership and shared use of groundwater sources is by far the commonest model at present, with owners wanting to keep control over their investment. This also allows them to use water for productive purposes whilst sharers have access to water for domestic uses, and sometimes also animal watering (so-called ‘Multiple Water Use Systems-MUS’). Study confirmed indeed that Self Supply has important potential to support (year-round) food security and poverty reduction. This in turn allows substantial returns on investment in Self Supply. Study further shows that full cost recovery for a family well can take six months to a year – less in areas where water can be used to irrigate a cash crop. Credit facilities (e.g. micro-credit, revolving funds, and savings schemes) can accelerate the take up of Self Supply.

Self Supply has been constrained by lack of consensus regarding its definition, with specific reference to subsidies and the role of government. In addition, progress of Self Supply acceleration was constrained by inadequate recognition of Self Supply’s contribution to water

supply coverage. However, Self Supply significantly increases Water Supply coverage as Self Supply wells tend to be shared by clusters of between 1-20 households. The inclusion of family wells which feature basic protection, including those fitted with rope and washer pumps, can also be justified in coverage calculations, assuming that due precautions are taken to reduce the risk of contamination.

An outstanding constraint in the acceleration of Self Supply thus far is the inadequate resources invested in stimulating both demand and supply sides (the latter in terms of the marketing of components and the provision of advice, training and information), which this proposal seeks to address and communicate to potential donors and WaSH Stakeholders.

Some Regional Water Bureaus have already developed self supply acceleration strategy documents. ***This Self Supply Acceleration Manual*** is meant to assist all Regions including those who have prepared similar guidelines so that a more or less nationally uniform approach can be followed in the acceleration of self supply.

2. OVERVIEW OF SELF SUPPLY IN ETHIOPIA

Government of Ethiopia, donors and implementing partners recognize the importance and the role that Self Supply can play in accelerating progress to achieve the Growth and Transformation Plan (GTP)/Universal Access Plan (UAP) goals. They built consensus that Self Supply is no longer to be considered as a stand-alone effort, but is to be embedded into government programs and addressed in the revised sector plan and framework (the Universal Access Plan and the WaSH Implementation Framework).

The policy guideline sets out the main principles of how such embedding may be achieved by providing suggestions how to standardize the process, and set financing, technical and sustainability requirements of Self Supply in order to facilitate its scaled implementation in Ethiopia.

The key characteristics are:

- ◆ Availability of low-cost technical options and information on source construction and upgrading rainwater harvesting and household water treatment;
- ◆ Management and maintenance based on strong ownership by individual (or community) and local skills;
- ◆ Demand built through government promotion and private sector marketing.
- ◆ Inclusion in to access only for self supply schemes which fulfill minimum potable water quality standards, for cased wells and equipped with safer lifting devices like rope pumps.

2.1. The need for accelerating self supply in Ethiopia

In the past, water sector professionals have either ignored or disapproved of self-supply initiatives. They still tend to focus on the perceived disadvantages poor water quality and construction quality, unreliability and lack of safety rather than the advantages to the users, namely ease of access, low cost, and ease of management. The conventional approach to water supply provision is externally driven by governments, donors, international agencies and NGOs.

Currently it is well understood that with more than 30% of the population of Ethiopia with no WaSH services, it is difficult to meet the GTP target following the conventional approaches of water supply.

And hence, the needs for accelerating self supply in Ethiopia arise from the following factual issues:

1. Meet the GTP target by minimizing the financing gap required for universal access to WaSH services through mobilization of communities to make investments in their own water supplies, four supporting pillars are required:
2. Overcome problems to provide WaSH services to remote and inaccessible areas by implementing locally available low cost technologies. By selection of appropriate technology and technical advice for users;
3. A developed private sector and transformed public sector able to support appropriate public-private partnerships and provide needed goods and services;
4. Avail adequate finance through government budget from federal, Regional and Woreda level for some industrial inputs as much as possible like well casing, hand pumps, tankers for schemes owned by a group of households, promotion and training services, choice and demonstration of technologies, site selection, community facilitator services and also through access to micro-credit or savings mechanisms, and NGOs.
5. An enabling environment of policies and practices which encourage individual initiatives (including creating demand).

2.2. Enabling Environment

Self Supply as a water supply service delivery model has been incorporated in national strategies for water supply. There is consensus that regulation and harmonization of Self Supply is essential. The following are the most important initiatives the government has taken to encourage ASSP in Ethiopia, such as:

- The development of self supply policy guideline;

- ◆ Recognition of acceleration of self supply in the GTP/UAP as a means of reaching the households in the water resources development activities;
- ◆ The political commitment of the leadership apex;
- ◆ The design of various water resources policies by the government;
- ◆ The consideration of water as a human right tools;
- ◆ The inclusion of self -supply in WIF & One -WaSH program;
- ◆ The development and implementation of Citizen Charter in the Ministry.

2.3. Challenges of Self supply Acceleration in Ethiopia

The self-supply accelerating program comes with some challenges, as depicted below:

- ◆ Government and NGO workers may need training because self supply is fundamentally different from the community-based model: instead of developing and financing supplies, government agencies offer advice and support so that users can develop their own service.
- ◆ Self Supply scheme types are not similar everywhere and identifying schemes appropriate to a locality may need skilled man power and resources.
- ◆ Accelerating self supply requires up-front public investment for promoting the idea, identifying appropriate technologies, establishing supply chains, and possibly providing incentives and subsidies yet the benefits may not appear in the short term if early uptake is slow.
- ◆ The existence of fully subsidized projects, like CMP in some Regions may hamper the acceleration effort of self supply;

2.4. Gender, Water and Sanitation

In most cultures, women are primarily responsible for the use and management of water resources, sanitation and health at the household level. Over the years, women have accumulated an impressive store of environmental wisdom, being the ones to find water, to educate children in hygiene matters and to understand the impact of poor sanitation on health. At the same time, women and girls are often obliged to walk many hours every day fetching water, while men are rarely expected to perform such tasks.

Despite their number and their prominent roles and responsibilities in relation to water and sanitation, women often have no voice and no choice in decisions about the kind of services they need or are receiving.

Gender considerations are at the heart of providing, managing and conserving our finite water resources and safeguarding health through proper sanitation and hygiene. The importance of involving both women and men in the management of water and sanitation has been recognized at the global level. Therefore this should be made practical in the self supply acceleration program of Ethiopia, in site selection, selecting appropriate technologies and modes of community contribution.

2.5. Water Supply and Sanitation for Disabled people

Access to water and sanitation services is a fundamental right of all people irrespective of their gender, physical ability, economic status or age. Therefore all water and sanitation program need to address the needs of all sections of society, including those living with impairments.

Conventional approach to increase coverage of basic services such as water and sanitation have largely marginalized or excluded the needs of disabled people. Government, Policy makers, donors and international organizations are now starting to address the issue of disability in development programs. This issue has been well addressed in the Constitution of the FDRE (Article 41, Sub-Article 5). Likewise, NGOs and development partners have taken this issue seriously and included in their development efforts. Close coordination of planning, designing and implementing among all the Stakeholders working in the Self Supply focusing on the issue of disability, creates more effective solutions to addressing the barriers faced by disabled people in accessing and using water and sanitation facilities.

Thus, in making a water supply and sanitation facility easy to access and use, the principles of inclusive design should be aimed for accelerated Self Supply programs, i.e. ease of use, freedom of choice and access to mainstream activities, diversity and difference, safety and predictability.

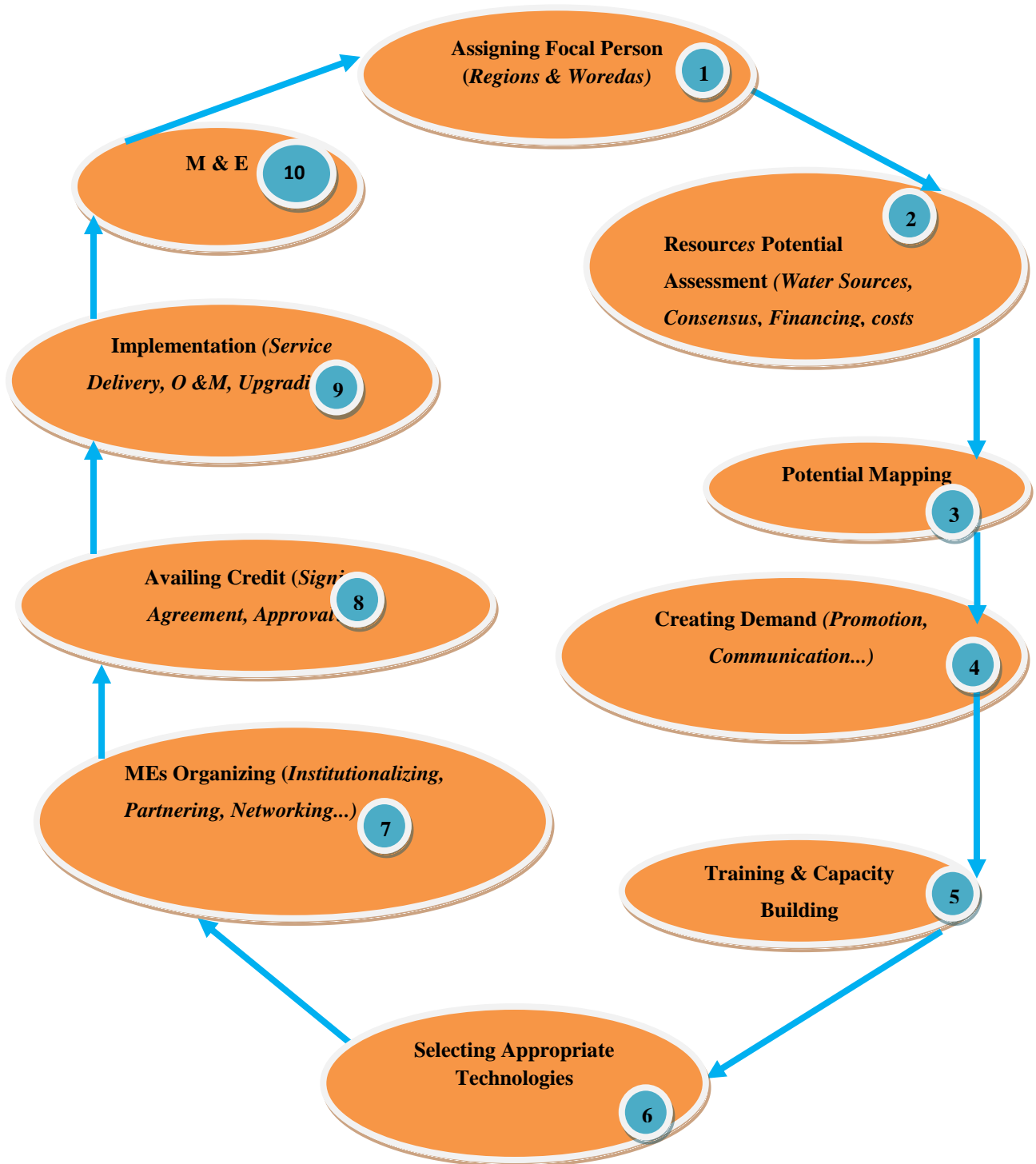
3. CONCEPTUAL FRAMEWORK OF SELF SUPPLY

3.1. Schematic Diagram of Accelerated Self Supply

Schematic Diagram 1: Pillars in Accelerating a Self Supply service delivery model



Diagram 2. Steps in self supply implementation



3.2. Approaches for Accelerating Self Supply

MoWIE and its partners are pursuing two approaches. The *first approach* (household-led investment) builds upon the widespread existing development of family wells through own investment and without subsidy. There is, however, a big challenge in operationalizing this Self Supply approach for the government. How to implement it? It requires a way of working that is completely opposite to how current water supply systems are planned and financed.

In community water supplies, we identify areas of need, identify the specific sites for new infrastructure and then finance the project so it gets built. But in Self Supply, it is households that decide what to do. They choose the sites, technologies and fund all the work themselves and decide when to do it. And they do this in small and affordable incremental steps to move up the Self Supply ladder from basic to improved sources. In many respects the approach needed is more like the implementation of Community-Led Total Sanitation.

Government can promote demand, promote safer and better technologies, build up capacities and the enabling environment at various levels and monitor the outcomes. There is a need to raise awareness in the safe development of household level sources and create demand; get Micro-Finance Institutions interested and lending to support new sources and upgrading; build up the private sector and related supply chains to provide more well digging services, protection for wells, and parts and pumps through their supply chains; to develop better technologies and make them more accessible; and to train Regional, Woreda level staff in the technical, financial and marketing knowledge needed to support individual households. The need then is for government to invest in software rather than hardware, and to provide support when requested.

This all represents a major paradigm shift, even for a complementary approach that will sit alongside community-managed water supplies. The *second approach* is ‘group-led investment’ and aims to develop a model for partially-subsidized community managed supplies which are better suited to rural areas with scattered populations than conventional community developed water supply systems. The idea is to provide a 50% subsidy to a group of households (around 10 households) that want to invest in a jointly-owned source.

4. ASSESSING & IDENTIFYING POTENTIAL FOR SELF SUPPLY

4.1. Assigning Focal Person for self supply

All Regions and Woredas must assign a focal person to coordinate potential mapping, availing appropriate technologies, undertaking promotional works to communities so that they take a lead role in implementation.

4.2. Assessing water resource information

The first step in Acceleration of self supply is to identify the resources available and appropriate technologies suitable to a locality to implement. This technologies could be a dug well, a manually drilled well, a spring on spot, a gravity spring with small pipe system, a roof water harvesting system, a pond/Birka or a sub surface dam or may be a river water to be treated at household level. On the other hand, Self-supply could also be promoted in areas where there is an interest in small-scale irrigation and well-developed markets for horticultural products. Hence, before entering into the practical implementation of Self-supply, Self-supply potential assessment have to be first carried out to decide in which areas (Kebeles, Woredas, and Zones etc) it could be feasible and where to focus our efforts.

Self-supply potential could be assessed based on knowledge of existing self-supply practices, water resources potential, the severity and type of gaps in water supply access (coverage) left unfulfilled by other water supply service delivery models.

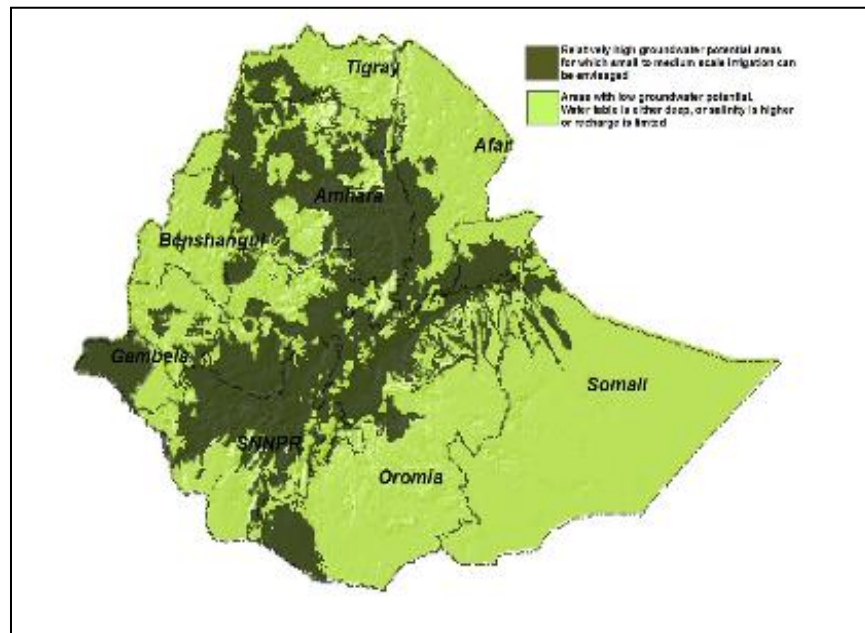
This assessment will be made by deploying a Woreda WaSH consultant team consisting of experienced hydro-geologist, who do mapping of available water resources.

Key types of data required for assessment are:

- (a) *Existing water sources*: springs, dug wells, ponds, Birkas, and rural pipe networks;
- (b) *If it is a well* : well depth, depth to water table, perennial or intermittent;
- (c) *Problem associated to existing source*: distance, quality, quantity, water unavailability throughout the year, breakdown, spare part;

- (d) *Type of source*: that community elders recommend for the future and the location;
- (e) *Type of scheme*: that the hydro-geologist recommend and why;
- (f) *Whether consensus*: is on the proposed source by the elders and the hydro-geologist;
- (g) *Estimated cost*: of the new scheme to be developed;
- (h) *Form of financing* – with subsidies, or technical assistance only;
- (i) *Whether consensus* is reached on cost sharing;
- (j) *Type of community contribution*
- (k) *Total number of users*: from existing source and also from the new source to be developed.

On the map shown below the dark green color shows areas of the country which have high shallow ground water potential and it is in this areas that self supply schemes which depend on ground water source could be accelerated.



Map 4.1 Ground water potential map of Ethiopia

4.3. Creating demand

Next to identification of water resources and technologies appropriate to the community in particular is to create demand. This could be done by:

- ◆ telling details of the technologies;
- ◆ benefits of safe drinking water in terms of health, productivity;
- ◆ contributions to be made by the users in terms of cash, labor, and material;
- ◆ detail of the cost of the technology selected;
- ◆ role of artisans, their availability;
- ◆ assistance that can be made by government;
- ◆ credit facilities, subsidies for group of households for industrial inputs;

Demand creation can be made by Woreda Water Office or a community facilitation team or a Woreda WaSH consultant or a self supply focal person.

5. TRAINING & CAPACITY BUILDING FOR ACCELERATING SELF SUPPLY

5.1. Developing Training Manual

Capacity building refers to specific activities which are undertaken to build up the skills, knowledge and confidence of professionals, practitioners, farmers, artisans, service providers with respect to self supply in general and the activities they are engaged in particular. A training course (on-line or face to face/ off the job or on the job) is the most common example.

Capacity building on Self Supply requires new roles and capacities in government to accelerate uptake given the significant differences between household-led investment in Self Supply and government-led investment in communal WaSH. The approaches are complementary but new competencies need to be developed within staff at Regional, zonal, Woreda and Kebele levels, including Health Extension Workers (HEWs) and agricultural development agents, especially in promotion and advisory services.

Capacity building activities to promote the development of private sector service suppliers such as well-digging, lining and head works construction by artisans and masons; manufacturers and suppliers of rope pumps and other lifting devices; and suppliers of HWTS products etc are very important.

Capacity building and training plan on self supply will be developed by self supply focal persons in each Region Water Resources Development Bureau for government officers and private sector development. In addition, a working group or learning alliance amongst government and private sector will be developed with regular meetings, trainings and other events. It is proposed that the Regional WaSH Technical Team will support the organization of learning occasions in Self Supply. Technical and Vocational Training Colleges (TVTC) are expected to play an important role in self supply acceleration by providing the necessary trainings on self supply technologies. In this regard, effort is being made by the Ministry to incorporate self supply technologies in the curriculum of TVTC.

Training that could be supported by TVTC at Regions may include:

- ◆ Manual drilling
- ◆ Manufacturing Technologies
- ◆ Operation and Maintenance (lifting device, roof top, drilling tools, etc)
- ◆ Supply Chains Management
- ◆ ToT for technicians on operation & maintenance of self supply schemes and etc

Specifically the water works micro-enterprises and private operators engaged in self supply could also be trained on manual well drilling technology, hand dug well construction, spring capping, concrete ring manufacturing, well lining and well head construction, roof catchment construction, Rope and Washer pump and hand pump installation and maintenance. By providing training and harnessing these local artisans to self-supply interventions, the cost and quality of construction could be improved and self-supply could be accelerated at a better pace.

5.2. Institutionalizing Micro enterprises

5.2.1. Water work Micro-enterprise (ME) Development

The definition of Enterprise can be based on size of employment, capital investment and scale of operation. According to this definition there are micro, small, medium and large enterprises. In Ethiopia, the former Ministry of Trade and Industry (MoTI) gives more emphases for capital investment as a yardstick to define Micro enterprise. According to the MoTI strategy document of 2001,” Micro enterprises are those businesses enterprises, in the formal and informal sector, with a paid up capital not exceeding Birr 50,000 and excluding high tech consultancy firms and other high tech establishments. while Small enterprises are those business enterprises with a paid up capital of above Birr 50,000 and not exceeding Birr 1.5 million and excluding high tech consultancy firms and other high tech establishments.

In the water sector micro enterprises can also play a great role to accelerate self-supply program through provision of water supply drilling services. The objective of establishing these micro enterprises in this sector is to create on-going wealth for artisans and technicians

within local communities thereby supporting acceleration of self-supply program through provision of water supply drilling services.

Based on the context and objectives of this manual the water works micro enterprise is defined as Business enterprises having members of 3-5 forming an association, running water work business activities operated, and managed by one owner.

In water works micro enterprises there are different self-supply development business activities. These business activities can mainly include manual well drilling, hand dug well construction, spring capping, construction of roof water catchments and rope and washer pump manufacturing, drilling tools manufacturing and spare part suppliers including supply of water treatment chemicals and equipments.

The Ministry of Water, Irrigation and Energy has been giving priority to establish water work micro-enterprise working on manual well drilling tools since 2005 Ethiopian fiscal year. The water works manual well drilling Microenterprise business is interlinked and supported by other water works activities. In general, steps to be considered during MEs development are depicted in the table below.

Table5.1: Establishment and Post-Establishment of Micro-Enterprise

No.	Steps	Responsibility	Remark
1	Selection of target Groups	Woreda Water Offices	The self-supply focal person to be assigned at Woreda level will establish selection criteria for selection of artisans. The criteria consider the local conditions.
2	Capacity building, provision of manuals and Guidelines	Federal and Regional Government; NGOs	Capacity building training will be delivered by trained personnel.
3	Certification	Regional Government	
4	Legal Licensing	Woreda Small and Micro Enterprise Offices	
5	Provision of drilling tools	Woreda Water Office, NGOs	
6	Create Market linkage	Woreda Water Office, NGOs	link the MEs with service beneficiaries
7	Implementation	Water Works MEs	Undergo contract signing with the beneficiaries
8	Monitoring and Evaluation	Federal and Regional Government	study the impact of MEs on Access to rural water supply
9	Award	Federal and Regional Government	Successful MEs will be awarded based on their performance and reputation on National water day celebration events

Details of water work microenterprises development, regulatory framework, market linkage, financial mechanism and institutional set up are explained in the following sub-topics. To establish a Micro Enterprise (ME), the artisans have to fulfill the criteria set by the Woreda Water Offices.

Criteria for the selection of artisans may include:-

- i. Commitment to share responsibility of the business
- ii. Socially accepted by the community
- iii. Permanent residence of that specific locality
- iv. Un-employed
- v. Strong interest on water works
- vi. Have a local capacity and experience on water development or willing to be trained
- vii. Completed at least 6th grade (education)
- viii. Consider the water work business as a livelihood for him/herself and for supporting his/her family.
- ix. Free from any addiction
- x. Age from 18-40 years

Intensive technical training on site selection, manual well drilling, installation of well casings and installation of water lifting devices will be delivered for artisans for three consecutive months. Finally, certification of participation is handed over to the participants who successfully accomplished the training.

5.2.2. Licensing & Registration

Once the artisans are certified in manual well drilling technology, they are ready to be licensed and registered. The service of registration and licensing for micro enterprises is provided by Small and Micro Enterprises' Development offices' located in the districts of the Regional states. It has to be understood that no artisan can participate in MEs businesses without being licensed.

5.2.3. Incentive scheme

In order to alleviate some of the financial problems and encourage the growth of water work MEs, the government will provide incentives. These measures would improve the competitiveness of MEs by reducing the cost of inputs and making their outputs competitive in price. In this regard, Micro enterprises shall be provided with manual well drilling tools through the zonal and Woreda Water Offices. This could be accomplished based on the internal agreement to be made between the established enterprises and Woreda Water Office.

Hence, the MEs have to properly manage and use the tools provided as per the agreement. In this context, clear discussions and consensus has to be reached with the MEs. Woredas and Zones of the Regions have to prepare themselves to accomplish these tasks.

5.3. Creating Market Linkage

In this regard, the Woreda Water Offices, Woreda agricultural offices, and the Woreda micro and small scale enterprises' development offices have to support the water works micro-enterprises. This support can be done by providing direct contracts award only to micro-enterprises on water works, rather than leaving them to compete with other private contractors in the market. This effort encourages the newly emerging enterprises. Besides; the Woreda Water Office shall provide them at least five water well drilling contracts, right after certification and licensing of the MEs.

Even though the market linkage services are intended to be provided by the relevant bodies located at the districts of the Regions, market competitions may arise from the enterprises organized in similar service sector. So, the service quality and price of the services have to be taken in to account. On the other hand, the market linkage services provided by the government are limited in access. Therefore, MEs are required to find and attract their customers for sustainable customer relations for their business.

6. THE ROLE OF STAKEHOLDERS IN ACCELERATING SELF SUPPLY

By the context of this manual, the term stakeholder comprises Ministry of Water, Irrigation and Energy, Regional Water Bureaus, Zonal and Woreda Water Offices, Agricultural Offices, Micro and Small Scale Enterprises Development Offices, Health Offices, Micro Finance Institutions, Kebeles and NGOs.

6.1. The Roles of Government Institutions

6.1.1. *The Ministry of Water, Irrigation and Energy*

The Ministry of Water, Irrigation and Energy provides supports for the success of the sector. These supports include:

- a. Preparation of manuals, guidelines, manuals and policy documents.
- b. Refreshment training for technicians/self-supply promoters and MEs.
- c. Undertake Research & Development activities for manufacturing and drilling equipment.
- d. Organize experience sharing visit
- e. Coordinate national forum for water works MEs to discuss on their successes and challenges. This forum helps to share best practices among MEs working in different Regional states.
- f. Carryout Monitoring and Evaluation of MEs to investigate their impact on water provision for rural community.

6.1.2. *The Regional Water Bureaus, Zonal and Woreda Water Offices*

The Zonal and Woreda Water Offices in collaboration with the Regional Water Bureaus supports MEs in the following aspects:

- a. Allocate annual budget for community mobilization and advocacy including capacity building for newly established MEs for procurement of tools and training.
- b. Demand creation through community mobilization
- c. Participating in artisan selection together with the Kebeles
- d. Providing technical supports for the water work MEs

- e. providing direct contracts award only to micro-enterprises on water works
- f. Organizing the service beneficiaries in group and household bases to provide services
- g. Based on the indigenous knowledge, identify potential ground water sources together with Woreda agricultural offices;
- h. Undertaking market linkage together with Woreda micro enterprises offices;
- i. Monitoring and Evaluation for proper performance of MEs.

6.1.3. *The Woreda Agricultural Offices*

- a. Participate to identify potential shallow ground water areas with Woreda Water Offices
- b. Assist user households get access to credit facility from MFI
- c. Prepare joint plan with Woreda Water Offices to enhance the multiple use service water (MUS);

6.1.4. *The Woreda Micro and Small Scale Enterprises' Offices*

- a. Selection of Artisans together with other stakeholders
- b. Licensing the Enterprises
- c. Business Development Service provisions
- d. Business Management Training for Water MEs
- e. Market linkage services

6.1.5. *The Woreda Health Offices*

- a. Awareness creation on sanitation and hygiene
- b. Prepare joint planning with Woreda health centers and health posts to ensure water quality management of individual well.
- c. Provide training on household water treatment techniques and environmental sanitation.

6.2. Roles of Non-governmental Organizations

- a. Provision of technical assistance through advisory service, resource mobilization in collaboration with the Woreda Water Office.
- b. Demand creation through community mobilization
- c. Provide collateral for financing the self-supply through micro-credit in their project vicinity
- d. Provide capacity building training for MEs on manual well drilling techniques and supply of spare parts.
- e. Provide awareness creation through workshops, newsletters, posters and so on.

6.3. The Responsibilities of Service Provider (MEs)

- a) Should be fully equipped with necessary tools
- b) Should deliver the service for the beneficiary which meets the quality standard based on their internal agreement.
- c) Provide warranty on the construction for three years period from the date of completion.
- d) Maintain the developed water well and correct any technical and operational problems in accordance with the conditions described in the warranty certificate.
- e) Should report the progress of the work to Woreda Water Office on quarterly basis. Reporting include number of well developed, challenges, success etc
- f) Since MEs are the seed-beds for entrepreneurship, one MEs is required to create two additional MEs within a year time after establishment. This could be done by making them provide trainings to newly established MEs, and government offices and other stakeholders are expected to play a key role in facilitating and coordinating this.

6.4. The Responsibilities of Households and Small group of Households

Households are the members of the community who has an interest of having their own hand dug water wells through self-supply. Group of households are informal groups established to jointly having communal water wells. According to policy guideline of self supply, the Government can provide up to 50% financial support based on predetermined conditions for a group of household (household more than 10 in numbers). Besides, capacity building training on maintenance of water lifting devices, sanitation of the water wells and water treatment at house hold level will be provided at communal level. The service providers both household and a group of households considers the following responsibilities in the process of contracting the water work enterprises.

- a) Undergo contractual agreement with the service provider (MEs); service charge, service delivery time, etc
- b) Supply of raw materials such as required amount of water, red soil or cow dung, cement, stone, sand and gravel for well development
- c) Supply of water lifting devices(such as rope and washer pump) and PVC
- d) Protect the water well from being accessed by animals and damaged by children.
- e) Promotion of benefits of their supply to others to encourage them to do similar self-supply system.

Budgeting for Self Supply acceleration activities is undertaken at Regional levels based upon the activities that are planned at Regional, Woreda and Kebele levels, so requiring well-informed personnel at all levels to include Self Supply in plans. To promote, upgrade and accelerate Self Supply both on demand and supply sides, resource mobilization is essential to sustain the significant software manual of advocacy and promotion, development of a menu of technological options, capacity building and training, private sector development, establishment of supply chains, subsidies by the government for industrial inputs, mobilization of micro-credit and saving schemes, quality control and water quality surveillance.

6.5. Role of Micro finance Institutions

Micro finance institutions have been established in consideration to provide banking services for low income groups. Currently, they are providing saving and credit services for the micro and small scale enterprises.

The micro finance institutions can allocate finance in the form of credit for the farmers who cannot afford to pay in cash for water well development. Hence, MFI can play a great role in providing finance to water works micro enterprises and household beneficiaries of water supply services. Thus, the roles of MFIs in accelerating self supply can be summarized as follow as:-

- a) Approving the feasibility of the business plans for micro enterprises jointly with Micro and Small Scale Enterprises Development offices;
- b) Approving the feasibility of the business plans for group and individual households jointly with the Woreda agricultural development offices and Woreda Water Office where appropriate;
- c) Facilitating saving and credit services for MEs, groups and individual households;
- d) Prepare sound loan payment and monitoring scheme.

The role of the government in this regard will be the organization of capacity building for the micro enterprises and the promotion and supply of hand tools for micro enterprises of which ownership will be transferred if at least 30 manual wells are constructed by the enterprises. Until that ownership will be maintained by the Woreda Water Office.

For group-led self supply, where 10 or more households are organized to develop their own self-supply scheme, government will support them by subsidizing up to 50% of the construction costs.

7. COMMUNICATION STRATEGY FOR ACCELERATING SELF SUPPLY

During the implementation of SSAP, all communications activities should contribute to the overall objectives of the program and the intended institutionalization and scaling up of Self Supply. Communications should not be viewed as subsidiary activity, but rather something fundamental to achieving the overall program objective and purpose through the adoption and application of Self Supply.

Key to the success of SSAP, in the end, will be the change in behavior at the household level. That is where a critical amount of the SSAP communications efforts (channeled through the local available structures and channels) should be focused at. It should be noted that communication is a process not a one time event/activity. Communications should be intensive and focused on those key aspects that will make the change. To make this strategy and communications even more targeted, it is suggested to clearly identifying which organizations and institutions under these stakeholder group headings are on board and which are not, and identify the names of the key decision makers within these institutions in order to focus advocacy activities.

As SSAP implementation will differ considerably per Region, and will require Region specific solutions, it is suggested to re-do the exercise of communication strategy development (together with the communications departments of Regional water bureau), as soon as the Regions start including SSA in their planning and budgets. Regionalized communication strategies, would result into Regionalized products and channels, adapted to the local languages and cultural context.

Development of communication products and using local available channels and platforms (local meeting platforms, local radio stations) will be done by Woreda level staff, with support with Federal and Regional support in terms of tools and templates.

8. TECHNOLOGIES AVAILABLE IN ETHIOPIA FOR ACCELERATING SELF SUPPLY

Self supply involves a manual of different technologies to avail adequate water supply to a community or individual households. In order to accelerate the implementation of self supply technologies and with the necessary techniques, it can be classified with respect to the type of water sources such as:

- i. Self supply technologies associated to development of water sources are
 - a. Groundwater sources
 - i. Spring development
 - ii. Construction of hand dug wells
 - iii. Construction of manually drilled wells
 - iv. Construction of drilled wells using rigs/drilling machines
 - b. Surface water sources
 - i. Construction of ponds/ Birkas/ hafir dams
 - ii. Collecting water from rivers
 - c. Rain water sources
 - i. Roof catchments
 - ii. Rock catchments
- ii. Self supply technologies associated to upgrading existing sources/ newly constructed.
 - a. Casing open wells
 - b. Construction of well head/apron/ sanitary protection
 - c. Installing lifting mechanisms- hand pumps (rope and washer pumps, Afridev pumps, Indian mark II pumps, solar pumps)

- iii. Treatment technologies at household and community levels currently available in Ethiopia
 - 1. Physical treatment technologies
 - a. Tulip
 - b. Bio sand filters
 - c. Em kit
 - d. Life-straw
 - e. Langano
 - f. Mena compacted treatment technologies
 - 2. Chemical treatment and disinfection technologies
 - a. Bishangari
 - b. Pure
 - c. Wuhagar
 - d. Aqua-tab
 - 3. Water De-fluoridation technologies
 - a. Bone char
 - b. Nalgonda
 - c. Activated alumina
- iv. Sanitation Technologies at household and communities level available in Ethiopia
 - a. Pit latrine
 - b. Latrine slab
 - c. Sun plat

In selecting appropriate self supply technologies to a particular area or community or household, the following has to be taken in to consideration:

- ◆ Availability and type of water sources and technology; e.g. availability of shallow groundwater that can be developed by hand dug well or manually drilled well, rainwater harvesting, spring development, etc.
- ◆ Economic feasibility both for initial investment cost as well as operation and maintenance cost.

- ◆ Technical feasibility: available water source shall be technically feasible for implementation.
- ◆ Social feasibility: the technology to be used and the source to be developed shall be socially acceptable by the user communities or households.
- ◆ Environmental feasibility.
- ◆ Water Chemistry

8.1. Ground water sources

8.1.1. Spring Development

Spring is underground water, which emerges to the surface where the groundwater table intersects the topography of the area. Thus, if spring water is properly protected and managed, it is safe for domestic uses. On-spot spring capping is a technology to develop, protect and supply spring water at the spot of the spring. In high land areas with better rain fall spring capping is common. Depending on the yield of the spring, on-spot spring scheme could serve significant number of beneficiaries.

Spring development consists of capturing an underground flow in a protective structure as it emerges on the surface. The process requires the construction of a cutoff wall to channel the flow into a collection gallery and then allowing the water to flow into a pipe for collection. The structure is usually built of concrete or masonry. Water may be collected at the spring or, if the topography is favorable, water may be piped long distances via gravity.

Technology selection criteria

On-spot spring scheme is a prior option in community water supply technology. The selection of this technology for community water supply should take into account the following:

- ◆ Availability of spring within 1.5 km distance from the residence of the community which could satisfy the demand of the community (15 l/c/d) particularly in the dry season,
- ◆ Technical and economical feasibility of the construction and its affordability by the community to share the construction cost,

- ◆ Availability of sanitary risk around the site of the spring for water contamination or availability of any other water quality problem which could not be easily treated at community level,
- ◆ Possibility of labor intensive participation of the community members in the construction to minimize the cost,
- ◆ The technology choice of the community among the schemes technically feasible for implementation and sharing the cost of construction.

Site selection criteria

The site of the spring box is predetermined by the location of the spring. However, the location of the collection chamber, water supply points, cattle trough and washing basin (if necessary) are determined within the area of the spring depending on the topography. The collection chamber could be constructed in conjunction with the spring box having a common wall or could be located in a distance from the spring box. Similarly the wall of the collection chamber could also serve as a structural element of the water supply point or the water supply point could be in a distance from the collection chamber. The location of all the scheme components including the cattle trough and washing basin should be determined taking into consideration the construction cost and sanitary conditions.

Main structural components of on-spot spring schemes

The main structural components of on-spot spring scheme include:

- i. **Spring box:** The spring box is used to contain the spring water emerging through the spring eye and divert it to the collection chamber. It is the key structural element of the scheme as its purpose is to capture the spring water effectively. Thus, effective operation of the scheme significantly depends on the proper design and construction of this element. The design of the spring box depends on the type of the spring. The walling of the spring box is usually made of masonry and the floor from reinforced concrete. The foundation of the walling should be deep enough to reach hard formation and to minimize the leakage of the spring water through the contact surface of the foundation and the formation.

For springs emerging from hill sides, the space inside the spring box is filled with river boulders and pebbles and the top of the spring box is sealed using sealing materials such as concrete slab, clay soil, grassing, etc. The spring box is provided with outlet pipes to the collection chamber. The position of these pipes should be below the level of the spring eyes to avoid back flow of water, which could result in leakage of the spring water. The runoff water from the vicinity should also be properly drained by constructing intercepting drainage ditches in order to avoid contamination of the spring water by runoff.

- ii. **Collection chamber:** The purpose of the collection chamber is to store the night flow of the spring and balance the peak hour demand. Depending on the site condition, it may be in conjunction to the spring box having common wall or in a distance from it. The walling is usually made of masonry whereas the floor and roof slab are made of reinforced concrete. However, depending on availability of material, availability of skill, and cost it could be made of different materials. It is provided with outlet, overflow and drain pipes. Overflow pipes could also be provided at the spring box to avoid the risk of back flow of water, which could result in failure of the scheme. The volume and geometrical dimension of the chamber is determined based on the yield of the spring capped (based on the yield of the dry season) and the demand. Usually, standard design with volume in proximity to the required volume is adopted.

- iii. **Water supply points:** This is the structural element from where the users could fetch water. It may be located in conjunction to the collection chamber or in a distance from it depending on the site condition. The design of the water point should consider the number of people to be served during the peak hour, the allowable maximum time to stand for the queue, the type of container used, etc to determine the number of faucets and the geometrical shape of the water point. The water supply point could be made of masonry or concrete. It should be remembered that maximum use of local construction material would make the scheme affordable to the community. In addition to water points, cattle troughs and cloth washing basins could be considered depending on the need. The area of the spring should be fenced, provided with lockable gates and protected from any possible causes of contamination.

The advantages of spring capping are:

- ◆ Process is well understood and commonly practiced
- ◆ good reliability of Water flow
- ◆ Water quality is generally good
- ◆ cost of construction is usually low
- ◆ maintenance costs are very low

The disadvantages are:

- ◆ Location of the spring may not be convenient or easily accessible
- ◆ Opportunities for spring capping are limited to few Regions
- ◆ Flow of the spring cannot be increased

8.1.2. Construction of Hand dug well (HDW)

It is manually dug well having circular shape with a diameter 1.5 to 2.0 m and a total depth usually up to 20 m. Depending on the type of the geological formation penetrated by the well, it may be unlined or lined with stone/masonry, concrete ring, or any other material which is durable and doesn't affect the water quality and properly sealed to protect pollution. It is also provided with raised well head from ground level. It may be equipped with traditional water lifting devices designed to avoid/minimize water contamination or rope pumps.

Technology selection criteria

Hand dug well fitted with pumps for household is selected taking into account the following:

- ◆ Availability of technically feasible site (availability of shallow ground water up to 20 m depth) within the private yard of the household or within 1.5 km distance from the residence of the household in the family's farm plot or any other land legally belonging to the family,
- ◆ Economical feasibility of the technology compared to the other household level technologies, which are technically feasible to be implemented by the household such as roof water harvesting, etc.

- ◆ Capacity of the technology to provide 15 l/d/c of water for the household members throughout the year,
- ◆ Availability of communal/community based water supply schemes within 1.5 km distance from the residence of the household or any plan to construct in the near future, which could serve as an option for the household water supply,
- ◆ Possibility of generating economical benefit to the household in conjunction with the use for domestic purposes is an added value.
- ◆ Free from sanitary risk around the site of the scheme for water contamination or availability of any other water quality problem which could not be easily treated at household level,
- ◆ Easiness of the geological formation for easy excavation
- ◆ participation of the household members in the construction to minimize the cost,
- ◆ preference to the technology by users

Site selection criteria

As stated above, household level technologies are constructed in the courtyard of the owner or at the plot of land legally belonging to the owner within a distance of 1.5 km from the residence of the household. Thus, the site of construction is selected in this context. From experience dug well potential is high in areas where the geologic and hydrological features are valleys of alluvial deposits of sand and gravel, river banks, lake shores, thick layer of weathered basement mainly of sandy or silty clay material, as well as gently sloping terrain (flat catchments). Greenery areas in a barren land also could be indicators of shallow ground water.

So far there is local knowledge to site hand dug well avoiding the following locations: on a hill or crest, near latrines or rubbish pits, near cemeteries, in flood prone areas and swampy ground. Sites where out crops of rock occur should also be avoided in site selection. The owner of the scheme household should finally decide the location of the scheme among the technically feasible site.

Main structural components of hand dug well

The main structural components of hand dug wells fitted with traditional water lifting devices or pumps include:

- i. Well tube:** The purpose of the well tube is to provide access to the groundwater. The tube of the well might have circular shape with 1.5 to 2.0 m diameter excavated manually either by the household members themselves or by artisans employed by the owners of the scheme. The depth of the well depends on the depth of the water level. The bottom of the well should be at least 2 meters below the water table having 2 m water column in it with maximum depth of 20 m. If the well is excavated in soft soil it may be excavated by arranging support to the wall of the well or with sloping wall tapering down to the well.
- ii. Well lining/ casing:** The purpose of the well lining is to protect collapsing of the wall of the well and protect the entrance of large particles from the wall of the well to the well along with the water. If the well tube is penetrating soft geological formation which could collapse easily or silt/fine particles could be easily washed away from the wall of the well to the water, well lining would be necessary. The lining could be full throughout the depth of the well or partial where there is collapsible soil, below the water table, or at the top few meters of the well. The lining could be made of masonry, concrete or any other material, which doesn't affect the water quality. In case of masonry, the lining below the water table would be dry masonry and above the water table it may be made of mortar or dry masonry. In case of concrete ring, the rings below the water table would have perforation to allow the water enter in to the well. The rings above the water table would be blind. Concrete rings are costly. Thus, they are not economical options for household hand dug wells. If the well is excavated in stable geological formation which doesn't collapse such as fractured rock, well lining will not be necessary throughout the depth of the well except for the top few meters of the well to protect entrance of pollutants. The cost of well lining is the major part of the overall construction cost of hand dug well. Thus, care should be taken in selection of the available options to reduce the cost of the scheme.

- iii. Gravel packing:** The purpose of gravel packing is to protect entrance of fine particles of the wall to the well along with the water. It is river pebbles or crushed gravels having average diameter of 5-20 mm placed in the gap between the lining and the wall of the well having around 100 mm thickness to a depth about 1 meter above the water level of the water column. The packing material should be free of chemicals which would be washed away by the water and adversely affect the water quality and be resistant for attrition.
- iv. Well sealing:** The purpose of the well sealing is to protect entrance of pollutants to the water from the areas around the scheme. Usually, clay soil is used as a sealing material for hand dug wells. Clay soil is filled in the gap between the well lining and the wall of the well having a thickness around 100 mm in the top 3 m of the well. Well sealing is the major component of hand dug well from sanitation point of view which requires due attention to ensure the safety of the water quality.
- v. Well head:** The purpose of the wellhead is to cover the well and protect the water from entrance of flood or any other materials to it. It is made of masonry or any other durable material rising at least 50 cm from the level of the ground to protect entrance of flood through the opening of the well. The opening of the well will be covered with concrete slab or any other durable material having manhole to access the well for cleaning and equipped with traditional manual water lifting devices or rope pump.
- vi. Riprap and drainage ditch:** The purpose of riprap and drainage ditch is to protect seepage of drainage to the well, collect and drain the water to safe place. Thus, it is a major component of hand dug well from sanitation point of view. For this purpose, around the well head riprap made of dry masonry or gravel pavement having width of at least 1.5 to 2.0 m and provided slope towards the ditch is constructed. At the periphery of the riprap drainage ditch is constructed ending up to soak away pit or any other depressions.

- vii. Soak away pit:** The purpose of soak away pit is to dispose drain water safely avoiding contamination of the well water. This is excavated pit having 1.0 to 1.5 m diameter in soft soil and filled with gravel or river pebbles. It is also an important component of hand dug well from sanitation point of view.

- viii. Water lifting device:** The purpose of water lifting devices is to extract water from the well avoiding contamination of the well water. Traditional manual water lifting devices designed to avoid contamination or rope pumps could be used for household level hand dug wells.

- ix. Fencing:** The well should be fenced with locally available materials and provided with properly locked gate in order to protect entrance of animals or any other objects if the well is not located in a private yard properly fenced.

8.1.3. Construction of manually drilled well

Manual Drilling

Manual drilling is an art and science of extracting groundwater using human means. It is a process that aims at creating a hole in the ground up to the water table with a good yield. It is also referred to as hand drilling. Hand drilling is also known as manual drilling; human powered drilling, and is sometimes referred to simply as low cost drilling. As the names suggest, hand drilling technologies primarily utilize human energy.

Manual Drilling Techniques

The major shallow groundwater development and use challenges that can be overcome by the application of manual well drilling techniques are:

The diversified soil conditions and profiles that causes collapsing,

- ◆ The tedious and labor intensive well digging for hand dug well,
- ◆ The disturbance of landscape due to excavation here and there (for well replacement or in need for more wells),

- The degree to which groundwater resources is exposed to surface contaminants is Also less as compared to dug wells that usually requires a minimum of 80 centimeter well Diameter as compared to 3.75 to 13.75 cm diameter for manual well drilling (the latter maximum well diameter for manual drilling is usually required if the well is to be installed With Afridev type hand pump for communal domestic water supply).

To drill through all these different types of formation (soil) a whole range of different manual drilling techniques have been developed and used around the world. In each case the drilling technique must (a) break or cut the formation, (b) remove the cut material (the soil) from the hole, and (c) if necessary provide support to the walls of the hole, to prevent collapse during drilling. A short overview of techniques;

Type of Manual Drilling

All existing manual drilling methods can be divided into four main drilling techniques: Hand Auger, Manual Percussion, Sludging and Jetting. Within these four main drilling principles, a wide range of variations have been developed in various countries. (*See the picture in Annex 2.*)

- i) **THE HAND AUGER** consists of extendable steel rods, rotated by a handle. A number of different steel augers (drill bits) can be attached at the end of the drill rods. The augers are rotated into the ground until they are filled, then lifted out of the borehole to be emptied. Specialized augers can be used for different formations (soil types).

Above the water table, the borehole generally stays open without the need for support. Below the water table a temporary casing may be used to prevent borehole collapsing. Drilling continues inside the temporary casing using a bailer until the desired depth is reached. The permanent well casing is then installed and the temporary casing must be removed. Augers can be used up to a depth of about 15-25 meters, depending on the geology.

Advantage: easy to use above groundwater table. Cheap-equipment

Disadvantage: it may be difficult to remove the temporary casing.

Geological application: Sand, silt & soft clay.

ii) **SLUDGING** (or Rota-sludging when the drill bit is rotated) uses water circulation to bring the drilled soil up to the surface. The drill pipes are moved up and down. On the down stroke, the impact of the drill bit loosens the soil and on the up stroke, the top of the pipe is closed by hand (or valve), drawing up the water through the pipe and transporting the cuttings to the surface. On the next down stroke, the hand (valve) opens the top of the pipe and the water squirts into a pit, in front of the well. In this pit, the cuttings separate from the water and settle out, while the water overflows from the pit back into the well. The borehole stays open by water pressure. Thickeners (additives) can be added to the water to prevent hole collapse and reduce loss of working water (drill fluid). Sludging can be used up to depths of about 35 meters.

Advantage: easy to use and temporary casing is not needed.

Disadvantage: working water has to be maintained during the drilling process. The level of the water table is not known during drilling.

Geological application: Sand, silt, clay, stiff clay and softer- consolidated rock formations (weathered laterite).

iii) **JETTING** is based on water circulation and water pressure. As opposed to sludging, water is pumped down the drilling pipes. The large volume of water has an erosive effect at the bottom and the 'slurry' (water and cuttings) are transported up between the drill pipe and the borehole wall. A motor pump is used to achieve an adequate water flow. The drill pipe may simply have an open end, or a drill bit can be added and partial or full rotation of the drill pipe can be used. Thickeners (additives) can be added to the water in order to prevent hole collapse and reduce loss of working water (drill fluid). Jetting (with rotation) is generally used up to depths of 35- 45 meters.

Advantage: very quick in sand.

Disadvantage: a lot of working is needed at once. The level of the water table is not known during drilling.

Geological application: limited to sand and thin layers of soft clay.

iv) **MANUAL PERCUSSION** uses a heavy cutting or hammering bit attached to a rope or cable and is lowered in the open bore hole or inside a temporary casing. Usually a tripod is used to support the tools. By moving the rope or cable up and down, the cutting or

hammering bit loosens the soil or consolidated rock in the borehole, which is then extracted by using a bailer. Just as with hand auguring, a temporary casing of steel or plastic may be used to prevent the hole from collapsing. When the permanent well screen and casing are installed, this temporary casing has to be removed. Manual percussion drilling is generally used up to depths of 25 meters.

Advantage: drills hard formations.

Disadvantage: the equipment can be heavy and expensive. The method is slow, compared to other methods.

Geological application: Sand, silt, stiff clays, sandstone, laterite, gravel and small stones.

Notes: Currently in Ethiopia *Sludging* and *Percussion* types of manual well drilling methods are the most familiar and widely used technologies.

8.1.4. Construction of Drilled well (using rigs/drilling Machine)

For the construction of safe groundwater points different well construction methods exist. Wells can be drilled with machines, drilled manually or dug by hand. The selection of the most appropriate method will depend upon geology, depth of the aquifer, yield and location. Machine drilled wells are very high in quality, but also very expensive. The cost of a machine drilled well varies but will generally be in the range of ETB 95,000 up to 290,000 for a 30 meter deep well. Hand dug wells are very useful in formations with low permeability due to their capacity to store water. They vary widely in terms of cost and quality. Machine drilled wells are very high in quality and a good way to construct safe water points for large communities and piped water supply schemes. However, the investment cost for an enterprise to purchase additional machines is high (estimated > ETB 1,910,000), making it difficult to rapidly scale -up the capacity in the local private sector.

8.2. Surface water sources

Surface water is relatively expensive when compared with other sources since it requires some form of treatment in order to be used for human consumption and thus stands as the last option in rural water supply development for small rural communities. However, in some situations (in arid and semiarid areas) it would become an important or a priority source of water where other

sources are unavailable or their development is prohibitory and expensive which makes the system eventually unaffordable.

8.2.1. Construction of Ponds

Construction of Ponds for rural water supply is self supply schemes consisting catchments area, conveyance and water collection (storage) made of earth works (excavation and/or fills). Depending on the size of the scheme it could be household level serving only one family or communal serving significant number of households. The household level pond is intended to serve 6 people or one family.

Catchments for rainwater (runoff water) harvesting using ponds could be courtyards, threshing areas, paved walking areas, plastic sheeting, trees, etc. In some cases, large rock surfaces are also used to collect water, which is then stored in large ponds at the base of the rock slopes. The runoff water is diverted to the ponds via a silt trap to minimize entrance of silt to the pond. Compared to rooftop catchments, ground catchments provide more opportunity for collecting water from a larger surface area. However, in ground catchments the water is more vulnerable for contamination. Thus, it strictly requires some sort of treatment before using it for domestic purposes. Treatments such as household biosand filtration, boiling, chemical or solar disinfection may be used. Instead of direct use of the water from ponds, for domestic uses a production well can be constructed, nearby at the down streamside of the pond, to tap the water recharged. These schemes are considered in water supply access coverage only if they are provided with natural or man-made filtration system along with disinfection and are free from contamination risk serving throughout the year.

Technology Selection Criteria

Runoff water harvesting using ponds is selected as household level scheme taking into account the following factors:

- ◆ Existence of suitable ground catchments belonging to the household or with a legal use permit which can drain water to a pond located in the courtyard of the household or a plot belonging to the household,

- ◆ Status of technical and economical feasibility of other options of water schemes such as roof water harvesting and hand dug wells which might be more favorable for use,
- ◆ The rainfall pattern of the area in terms of quantity and temporal distribution,
- ◆ Capacity of the technology to provide 15 l/d/c of water for the household members throughout the year or the dry seasons,
- ◆ Availability of communal/community based water supply schemes within 1.5 km distance from the residence of the household or any plan to construct in the near future, which could serve as an option for the household water supply,
- ◆ Possibility for use of the household technology for generating economical benefit to the household in conjunction with the use for domestic purposes,
- ◆ Availability of sanitary risk around the site of the scheme for water contamination or availability of any other water quality problem which could not be easily treated at household level,
- ◆ Possibility of labor-intensive participation of the household members in the construction to minimize the cost,
- ◆ The technology choice of the owner of the scheme among the schemes technically feasible for implementation covering all the costs of construction.

Site selection criteria

The site of the scheme for runoff water harvesting using ponds for household level is selected taking into consideration the legal issues to use the catchments area for the purpose if it is not the property of the household or if the household is not using his own courtyard as a catchment. Catchments with minimal seepage such as paved area, areas with grass covers, large rock surfaces, etc., which could drain water to the possible location of a pond inside the plot of the household, are ideal. Sanitary and environmental degradation risks also should be taken into account in selection of catchments and ponds locations. Experience of the pros and cons of the existing similar schemes around the area built for various purposes could also be used for planning and designing of the scheme.

Main Structural Components of Runoff Water Harvesting Schemes Using Ponds

The main structural components of the Runoff Water Harvesting schemes using ponds include catchments area, conveyance system, and water storage.

- i. Catchments area:** This is the area from where the rainwater is collected. In case of Runoff Water Harvesting scheme using ponds ground catchments such as courtyards, threshing areas, paved walking areas, etc. are used. Moreover, plastic sheeting and any other catchment covers are used to minimize seepage of runoff water. The efficiency of the catchment to collect rainwater (runoff water) depends on the seepage status and the slope of the area. The factor, which considers this efficiency in design, is called run-off coefficient. The catchment area should be free of sanitary risk and be under sanitary surveillance occasionally to minimize water contamination.
- ii. Conveyance System:** The runoff water from ground catchment is collected at the lowest point of the catchment using excavated trench and diverted to the location of the pond. The trench may be lined with dry stone riprap or any other locally available material in order to avoid silt transportation to the pond. Moreover, at the entrance to the pond the trench is provided with silt trap. Before a few days of the rain, the trench and the silt trap should be cleaned and maintained.
- iii. Storage:** As the name implies the storage for runoff water harvesting using ponds is earthen pond. It may be made of fill, excavation or both. It should be located in the courtyard or a plot of land legally belonging to the owner of the household scheme. If the water stored in the pond is required to be tapped through a well nearby downstream of the pond, the bottom of the pond will not be treated with impervious materials such as red clay. Otherwise, it should be treated with impervious materials if the natural ground is vulnerable for seepage. A thin layer of red clay is generally laid on the bottom of the ponds to minimize seepage losses. Trees, planted at the edges of the ponds also help to minimize evaporative losses from the ponds. The pond should be cleaned and maintained occasionally before rain comes. Algae growth and insect breeding is the main problem of

ponds since it is uncovered. Thus, these should be given due attention during planning and design to minimize their negative effects. The pond also should be fenced to prevent access of animals and children.

Sizing /dimensioning of rain water harvesting systems using ponds

Design of runoff water harvesting using ponds is basically the same as of roof water harvesting scheme described above. For the design of runoff water harvesting using ponds annual rainfall data of the area, runoff coefficient of the ground catchment, the area of the catchment, number of the beneficiaries, daily consumption rate, and the style of the water harvesting (for partial use or as a sole supply source) are required. Reliability, water quality to the desired purpose, environmental impact, and affordability of the scheme are the key factors to be given due attention in designing and implementation.

Based on the above design data, the Kebele Water Extension Worker or the Woreda Water Office technician would determine the geometrical dimensions of the collection ditch (trench), the silt trap, the shape (for simple ponds rectangular shape is quite adequate) and volume of the pond (length, width, and height), and its side slope. The seepage and the evaporation losses have to be considered in the determination of the volume of water. The depth of the pond is an important element in the design. Spillway to pass excess runoff may also be necessary.

As well, the pond water tapping well site and its size also will be determined, if the pond is used to enrich the ground water through percolation. For this purpose standard hand dug well having hydraulic connection to the pond water with the required depth could be used. Due attention should be given to the volume of the pond as it predominantly affects the overall cost of the scheme. Thus careful design is required to provide optimal storage capacity while maintaining the cost as low as possible. The soil to be used for construction of the pond should be impervious such as clay and appropriately placed and compacted to store water.

8.2.2. Construction of Birkas (Cisterns)

Birkas (Cisterns) are small to mid-size storage structures intended to harvest runoff water from a specific catchments area. The scheme include runoff collection structure and storage cistern

below the ground surface. Birkas (cisterns) differ from ponds that they are constructed underground. Depending on the size of the scheme it could be household level serving only one family or communal serving significant number of households. The household level runoff harvesting using Birkas is intended to serve 6 people or one family.

Catchments for rainwater (runoff water) harvesting using Birkas (Cisterns) could be courtyards, threshing areas, paved walking areas, plastic sheeting, trees, etc. In some cases, large rock surfaces are also used to collect water, which is then stored in Birkas at the base of the rock slopes. The runoff water is diverted to the Birkas via a silt trap to minimize entrance of silt to the Birka. Compared to rooftop catchments, ground catchments provide more opportunity for collecting water from a larger surface area. However, in ground catchments the water is more vulnerable for contamination. Thus, it strictly requires some sort of treatment before using it for domestic purposes. Treatments such as filtration, boiling, chemical or solar disinfection may be used.

Differing from ponds, Birkas could be provided with a cover to prevent sunlight from the water, which would cause algae in the water. Similarly to pond, instead of direct use of the water from Birkas, for domestic uses a production well can be constructed, nearby at the down streamside of the Birka, to tap the water recharged. Birkas could be constructed of masonry, bricks, concrete, with plastic sheeting, etc. having different shapes. Selection of the construction material should take into account among others material and skill availability to make the cost affordable.

The technology and site selection criteria and sizing of the scheme components are similar to runoff harvesting using ponds, which are discussed above. The main components of the scheme are also similar with the only difference that the storage is Birka or cistern. Birka is mainly constructed underground having different shapes. For relatively small volumes rectangular shape is quite good. The depth should be decided taking into consideration the required volume, available space, the geological condition of the ground, the hydrostatic pressure, accessibility for cleaning, water withdrawal system, etc.

These schemes are considered in water supply access coverage only if they are provided with natural or man-made filtration system along with disinfection and are free from contamination risk serving throughout the year.

8.2.3. Construction of Haffir dam

An underground dam or Haffir Dam is a technique that enhances natural water storage in an alluvial aquifer. It is intended to contain underground flow from a natural alluvial aquifer with an impermeable underground barrier. The dam wall intercepts the flow of underground and/or surface waters, creating and/or raising the water table within an alluvial area. Water in the artificially recharged aquifer can be extracted using a hand-dug well or a shallow drilled well with a hand pump.

The dam wall is the main component of this technology. It should extend from the bedrock or other subsurface impermeable layer up to the surface of the alluvial soil. It can be built of various materials, such as layers of compressed clay, packed mud, masonry, polyethylene or PVC plastic canvas; concrete; or a combination of materials. Underground dams are a simple technology, which does not require any particular level of training to operate or maintain. They are however quite costly to design and build, and are applicable only where other cheaper technologies are not applicable.

Technology Selection Criteria:

Small scale haffir dam scheme to be implemented by Woreda is selected taking into account the following factors:

- ◆ Existence of suitable water courses for the scheme construction,
- ◆ Status of technical and economical feasibility of other options of water schemes such as on-spot spring, spring with pipe system, hand dug wells, and roof water harvesting which might be more favorable for use,
- ◆ The rainfall pattern of the area in terms of quantity and temporal distribution,
- ◆ Capacity of the technology to provide 15 l/d/c of water for the community members throughout the year or the dry seasons,

- Availability of sanitary risk around the site of the scheme for water contamination or availability of any other water quality problem which could not be easily treated,
- Possibility of labor-intensive participation of the community members in the construction to minimize the cost,
- The technology choice of the user community among the schemes technically feasible for implementation with cost sharing commitment.

Site Selection Criteria

Site selection is critical. The site selection should be carried out by experienced hydrogeology and water supply specialists having a good knowledge on the area. Information on the soil distributions in an area is used to identify the best site. Sites with alluvial soils no more than 3 m to 4 m deep, of medium to coarse texture, and having a gradient of no more than 5% are preferable. Knowledge of the soil profile and the depth to the impermeable layer is necessary. As well, information on the bed rock foundation, the catchment area, and the soil condition are important to select the site.

Collecting water from River

Rivers and streams are often exposed to contamination by waste disposal, laundry, bathing, and animals, and may prove unsuitable for drinking unless treated. In Ethiopian condition it is difficult to find safely potable river water. But river water can be treated mechanically or chemically to make it potable. Therefore in areas where river water is recommended as the source of water supply, the treatment technology must be identified as well.

Intakes provide a dependable method of “harvesting” the clean river water from a river or stream and will be needed if rivers and streams are to be used for a water supply. Intakes can provide sufficient water to a water supply system but there are special considerations which must be recognized for effective planning. (*See the picture in Annex.2*).

8.3. Rain water sources

Rainwater harvesting is a technology used for collecting and storing rainwater floods. There are many types of systems to harvest rainwater. Notable systems are runoff rainwater (e.g. hillside run-off) and rooftop rainwater harvesting systems. These technologies can be used in areas having average annual rainfall 250 mm and above. Commonly used systems are constructed of three principal components; namely, the catchments area, the collection device, and the conveyance system.

Rainwater shall be harvested through the following methods:

- ◆ Capturing rain through roof tops (Roof catchments)
- ◆ Capturing runoff from ground catchments
- ◆ Capturing seasonal runoff from local streams, creeks (by surface dams, sand storage dams)

8.3.1. Roof catchment Water Harvesting (RWH)

Roof water harvesting scheme is used to collect, store and supply roof top rainwater to the beneficiaries. Depending on the size of the scheme it could be household level serving only one family or communal serving significant number of households. The household level RWH is intended to serve 6 people or one family. RWH technologies are simple to install and operate. Local people can be easily trained to implement such technologies, and construction materials are also readily available. RWH scheme is convenient in the sense that it provides water at the point of consumption, and family members have full control of their own systems, which greatly reduces operation and maintenance problems. Running costs, also, are almost negligible. Rainwater is mostly chemically fit for domestic purposes. Depending on the sanitary and other conditions of the rainwater catchments (rooftop) and storage reasonably safe water could be produced by roof water harvesting schemes.

Thus, roof water harvesting schemes are the better options compared to the other rainwater harvesting schemes in terms of risks of water quality. Water treatment methods such as boiling of water, chemical disinfections (using chlorine such as sodium hypo chlorite), solar

disinfections (placing of water filled plastic bottles painted black at the back in the sun for one full day), household biosand filtration etc. could be used to ensure the bacteriological safety of the water. Maintenance of RWH scheme is generally limited to the annual cleaning of the tank and regular inspection of the gutters and down-pipes. Maintenance typically consists of the removal of dirt, leaves and other accumulated materials. Such cleaning should take place annually before the start of the major rainfall season. However, cracks in the storage tanks also can create major problems and should be repaired immediately.

Technology selection criteria

Roof Water Harvesting water supply scheme is selected as household level scheme taking into account the following factors:

- ◆ Suitability of the household's roof top for rain water harvesting,
- ◆ Status of technical and economical feasibility of other options of water schemes such as hand dug wells which might be more favorable for use,
- ◆ The rainfall pattern of the area in terms of quantity and temporal distribution,
- ◆ Capacity of the technology to provide 15 l/d/c of water for the household members throughout the year or the dry seasons,
- ◆ Availability of communal/community based water supply schemes within 1.5 km distance from the residence of the household or any plan to construct in the near future, which could serve as an option for the household water supply,
- ◆ Possibility for use of the household technology for generating economical benefit to the household in conjunction with the use for domestic purposes,
- ◆ Availability of sanitary risk around the site of the scheme for water contamination or availability of any other water quality problem which could not be easily treated at household level,
- ◆ Possibility of labor-intensive participation of the household members in the construction to minimize the cost,
- ◆ The technology choice of the owner of the scheme among the schemes technically feasible for implementation covering all the costs of construction.

Site selection criteria

The water source for roof water harvesting scheme is the rain falling on the roof of a house. Thus, the site of the scheme is predetermined by the location of the house. Here, the most important issue is the selection of the location of the storage tank. The storage tank location is determined taking into considerations the factors such as risk of sanitary contamination, ground condition, proximity to the collection pipe, water evaporation from the tank, shadiness to avoid algae growth in the tank and keep the water cool, suitability for water withdrawal, etc. It is recommended to avoid trees overhanging around the house and the storage tank area to prevent contamination of the roof and the water by birds' droppings.

Main structural components of Roof Water harvesting schemes

The main structural components of the Roof Water Harvesting schemes include catchments area (roof), conveyance system, and water storage.

- i. Catchments area:** This is the area from where the rainwater is collected. In case of Roof Water Harvesting scheme as the name implies the catchments area is the roof of a house. The efficiency of the roof to collect rainwater depends on the type of the roofing material and the slope of the roof. The factor, which considers this efficiency in design, is called run-off coefficient, which varies in the range of 0.5 to 0.9 for roof water harvesting. The roofing material should be free of toxic materials (such as lead paint) and has no contamination and discoloring effect on the water. For domestic water supplies, roofs made of corrugated iron sheet, tile, asbestos cement, etc. could be used for collection of rainwater. As well, thatched roofs made of palm tree leaves with tight thatching also could be used. There should not be overhanging trees around the roof as birds and animals defecate would pollute the roof. The roof needs to be cleaned before few days the rain comes.

- ii. Conveyance System:** The rainwater collected by the rooftop is collected by gutter and conveyed to the storage tank by down pipes connected to the gutter. The down pipe could be directly connected to the storage tank or via settling tank (silt trap). The gutter and down pipes could be made of PVC, galvanized sheet metal, bamboos, etc. The pipes

should not have toxic paints, which affect the chemical quality of the water. As the first flush rainwater could contain debris, dirt, dust, bird droppings, etc. from the roof, coarse and fine mesh screens should be placed at the outlet of the gutter to the down pipes and at the inlet to the storage tank, respectively. For this purpose, a coarse sieve could be fitted in the gutter where the down-pipe is located. Such sieves are available made of plastic coated steel-wire or plastic, and may be wedged on top and/or inside gutter and near the down-pipe. A fine filter could also be fitted over the outlet of the down-pipe as the coarser sieves situated higher in the system may pass small particulates such as leaf fragments, etc. A simple and very inexpensive method is to use a small, fabric sack, which may be secured over the feed-pipe where it enters the storage tank. The first flush also should be diverted from the storage tank. This could be done manually by using flexible inlet pipe to the storage tank. During the first flush the inlet pipe is removed away from the tank inlet and then replaced again once the initial first flush has been diverted.

- iii. Storage Tank:** The storage tank is the main component of the scheme, which affects the overall costs of the scheme. Thus due attention should be given to the design of the tank to make the cost affordable. The storage could be a tank (above ground), cistern (below ground) or partial underground tank. Also small size multiple tanks (battery tanks) interconnected to each other may be used. Tanks may be made of masonry, brick, Ferrocement, concrete, PVC (plastic), metal, poetry etc. The choice of the type of the storage depends on available space for construction, available options, local tradition, cost, materials and skills available, ground condition, etc. The tank should be provided with overflow, by-pass, drainpipes and cover. Algae will grow on the water if the tank is uncovered and exposed to the sun. Fine mosquito mesh or any other screen should be placed at the inlet of the tank to control entrance of contaminants to the storage. The water withdrawal from the storage depending on the type would be using tap placed a little bit (10 cm) above the bottom of the tank or any lifting devices if it is a cistern (underground). The storage should be cleaned occasionally.

Sizing /dimensioning of rain water harvesting systems

Design of Roof Water Harvesting scheme could be carried out based on demand and supply basis. The demand based design basis on the water supply demand required as per the available water supply standards. The dimensions of the structures are sized based on the quantity of the water required. As per the rural water supply UAP, the standard water demand adopted for rural water supply is 15 liter per person per day. The supply based design basis on the quantity of the water that could be supplied by the scheme within a given context (roof type and roof area, rainfall pattern, etc.) regardless of the demand. Thus, the designer should have to consider both aspects, i.e. the demand and the supply side and optimize the design to be affordable at the same time meeting the demand of the beneficiaries.

For the design of Roof Water Harvesting schemes, annual rainfall data of the area, runoff coefficient of the roofing surface, the area of the roofing, number of the beneficiaries, daily consumption rate, and the style of the water harvesting (for partial use or as a sole supply source) are required. Reliability and affordability of the scheme are the two key factors to be given due attention in designing and implementation.

Based on the above design data, the Kebele Water Extension Worker or the Woreda Water Office technician would determine the geometrical dimensions of the gutter and down pipes (length, width and depth) and the storage tank (volume: length, width and height). Due attention should be given to the volume of the tank as it predominantly affects the overall cost of the scheme. Thus careful design is required to provide optimal storage capacity while maintaining the cost as low as possible. The types of the materials to be used for construction are also decided based on local availability of the material, the cost and availability of the skill. Depending upon household capacity and needs, both the water collection and storage capacity may be increased gradually as needed within the available catchments area.

8.3.2. *Rock catchment*

Technical Description:

Rock catchments are simple systems for the collection of rainwater. The placement of these structures should take into account ease of access of the users and the geological structure of the site. The best sites are found on the lower reaches of bare rock (without fractures or cracks), where runoff losses to the soil, vegetation and structures is minimized. The retention of runoff is made in natural hollows or a valley which is made into reservoirs by constructing a simple masonry wall. The reservoir should have a relative e high depth to surface ration to minimize evaporation. Stone and mortar gutters may be built across the rock face to channel the runoff into the dam. Storage may be provided in dams or open tanks. Other surfaces can also be used as catchment – e.g. concrete, plastic sheets, treated soils etc. (*See the picture in Annex 2.*)

Useful in:

Rock catchment systems are suitable in areas with geological suitable rock outcrops (granite, basalt or any other hard rock). It has been found useful particular in the following situation:

- ◆ Limited water resources for water supply – e.g. no perennial water sources and groundwater potential are low (low yield) or problematic (quality unacceptable).
- ◆ Unreliable water supply - caused by seasonal variation in normal water availability.
- ◆ Remote and difficult to reach areas.

Limitation:

- ◆ In areas with rainfall below 200 mm, the required catchment area/rock face can become too large and difficult to locate.
- ◆ In areas, where rainfall exceeds 1000 mm, water availability is normally sufficient to cater for conventional water supply techniques (rivers, lakes, sub-terrain aquifers etc.)

8.4. Upgrading of existing sources/ newly constructed

8.4.1. Associated to well

8.4.1.1. Casing open wells

To keep loose sand and gravel from collapsing into the borehole, it is necessary to use well casing and screen. The screen supports the borehole walls while allowing water to enter the well; un slotted casing is placed above the screen to keep the rest of the borehole open and serve as housing for pumping equipment. *(See the picture in Annex 2.)*

For a potable water well for use by a single household or a few households equipped with a rope pump or other low-cost hand pump, a deeper hole may be needed (to protect water quality, so preferably drilled to a second aquifer). In this case a self slotted 4-inch PVC pipe can be used (no maximum yield required). In doing so, the well stays affordable for the users.

8.4.1.2. Construction of well head/ apron (sanitary protection)

Any surface runoff and overflow/return flow during pumping need to be directed to the drainage and ultimately to soak pit or can be used for other productive purposes (nearby irrigation). As much as possible, any pool of water/mud including return flow to the well has to be avoided as this can have access to the water in the well for contamination.

Finally (after pump testing) the head works or concrete apron should be installed. This apron will prevent surface water and contamination to flow into the borehole directly. The apron also provides a solid and clean base for the hand pump and the collection of water. The apron is usually 2-3 meter in diameter with a (small) wall around the outside.

There are many different designs for the concrete apron and the choice may depend on factors such as: national standards, type of pump to be installed, price and need for protection against floods (in some areas), etc. Finally it is important that the users are comfortable with the design too. A fence can be constructed around the well to keep animals away and, in some places, to control access to the well. *(See the picture in Annex 2.)*

8.4.2. Installing lifting mechanisms-hand pump

(Rop & Washer pump, Afridev pump, Indian mark II pump, Solar pump and Fuel pump)

Water from hand dug wells can be abstracted using different mechanisms ranging from the traditional rope, pulley and bucket through different hand pumps (rope pump, Afridev hand pump, Nera, etc.) to engine pumps (fuel, solar, electric). Different criteria can be used to select what kind of pumps to use. The most common are depth to water level, type of water bodies and way of construction to pump from, quality, number of users (communal, family level), cost and desired operation and maintenance. Emphasis has been given to hand pumps of two types in this guideline: rope and washer pump, and Afridev hand pump. Hand pumps are generally manually operated mechanical water lifting devices that use either suction hand pumps or lifting hand pumps.

8.4.2.1.Rope pump

Rope pump is one of the lifting pump types that has been used worldwide, particularly in Africa, Asia and Latin America countries; and acknowledged for its simplicity for operation and maintenance as well as effectiveness. Its introduction to Ethiopia was only a recent development; however now robustly getting into the rural water supply technologies

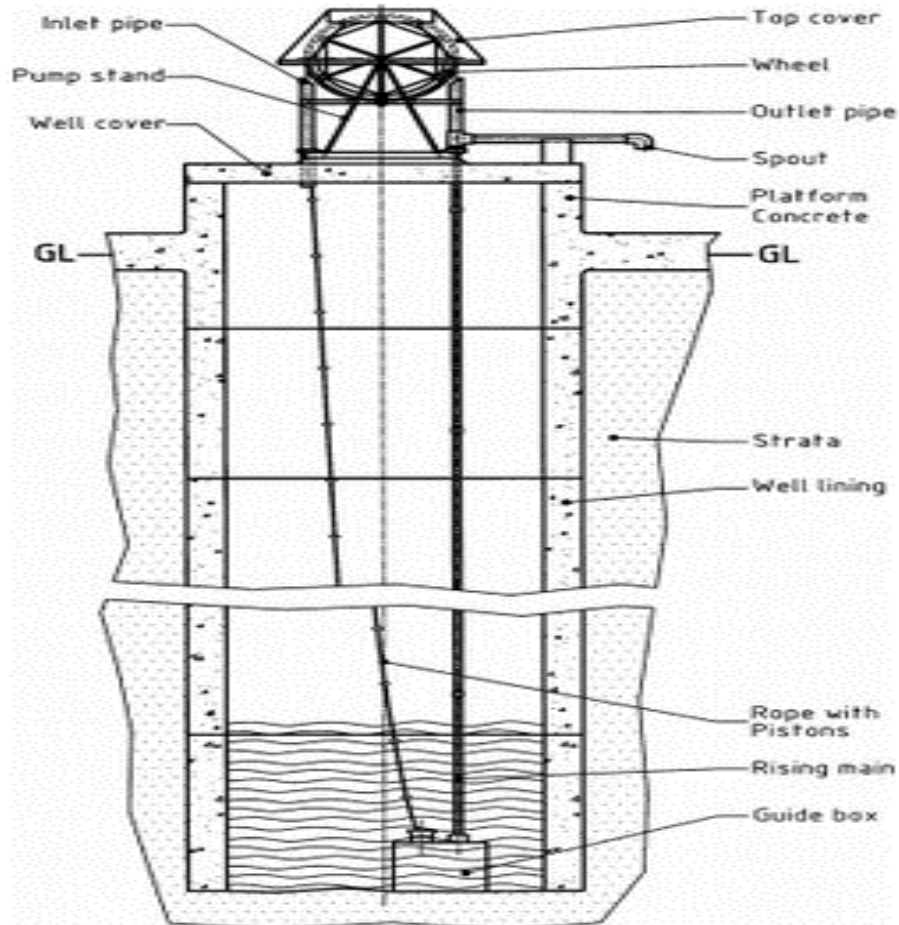


Figure 8.1. Rope and washer pump

Water is pulled up to the surface through a pump pipe by pistons and endless rope that are the basic pumping elements; and guided by guiding box to let water enter into the pump pipe. Water is lifted up by pulley wheel fitted with handling at the surface that is rotated manually. Continuous rotation Of the wheel keeps the pump elements to rotate continuously within the well through the pump pipe and surface maintain the continuous flow of water at surface through outlet pipe. It can be installed on both hand dug well and Drilled well. Though there are cases where rope pump can work at depth water level Up to 40m, for this guideline 30m is suggested. Amount of water that can be pumped basically depends on depth to water level and applied labor of pumping (adult or children).

Function

It is one of the water lifting devices from water well or other water bodies such as rivers, lakes, etc. for different water uses (domestic & other productive uses). For a hand pump to work it doesn't necessarily need vertical well; that is why it can be used to pump water from other water bodies such as pond, lake and river.

Installing Rope pump:

Planning and preparation for rope pump is the pre requisite for effective and proper installation. This includes tools, materials, equipment and man power required for the installation.

Riser pipe (pump pipe):

It is Poly Vinyl Chloride (PVC) -made pipe whose diameter depends on the depth to Water level in the borehole we want to install. Inner diameter shall be 28, 21 and 15mm for 5-10, 10-20, and 20-35m deep water Level respectively.

Piston:

Can be made of Poly Ethylene (PE) or rubber. PE-made with conical shape produced using injection mould is preferable for ease of work and efficiency. A clearance of 0.5-1mm is required between the riser pipe and the piston. Hence, on average a piston diameter of 26.5, 19.5 and 15.5mm can fit for 28, 21 and 17mm riser pipe respectively.



The rope pump is very well accepted and becoming increasingly popular. They are set on a sealed well, some with a concrete slab, some just with mud and timber. Where the pipes which house the rope and washers are set right up to the height of the wheel, there is little leakage of water or opportunity for contamination.

Standardization of Rope and Washer Pump

The MoWIE jointly with JICA has started to standardize the overall design and component of Rope and Washer pump which is currently widely in use and available in the market. The task of standardizing Rope and washer pump is being jointly exercised in collaboration with both manufacturers and suppliers of the technology. Therefore, all partners who are going to be involved in self supply acceleration manual are expected to be aware of this information in their planning and implementation of the technology.

8.4.2.2. Afridev pump

Afridev hand pump is also a lift pump that was the innovation for rural water supply through the initiative of World Bank/UNDP in Africa.

Particular features are:

- ◆ Up to 1300 liters/hour output at pumping lifts up to 45m.
- ◆ Heavy duty design suitable for continuous operation over long periods.
- ◆ Rugged all galvanized steel construction for corrosion resistance and long life.
- ◆ Simple to install, operate and maintain at the village level.
- ◆ Designed for ease of maintenance with basic tools and cheap, readily available spare parts

Specification

Pump Head: Fabricated throughout from mild steel hot dip galvanized for corrosion Protection. Long life nylon bushes are provided for the handle fulcrum and rod hanger bearing

Pump Stand: Option of free standing or concrete encased fabricated galvanized pump stand.

Cylinder: 50mm diameter single acting PVC cylinder with brass liner, plastic Plunger and plastic foot valve. Displacement per stroke is 0.44 liters.

Rising Main: 63mm O/D PVC rising main provided as standard in 3m lengths.

Pump Rods: Option of 10mm galvanized mild steel or stainless steel rods in standard Lengths of 3m.

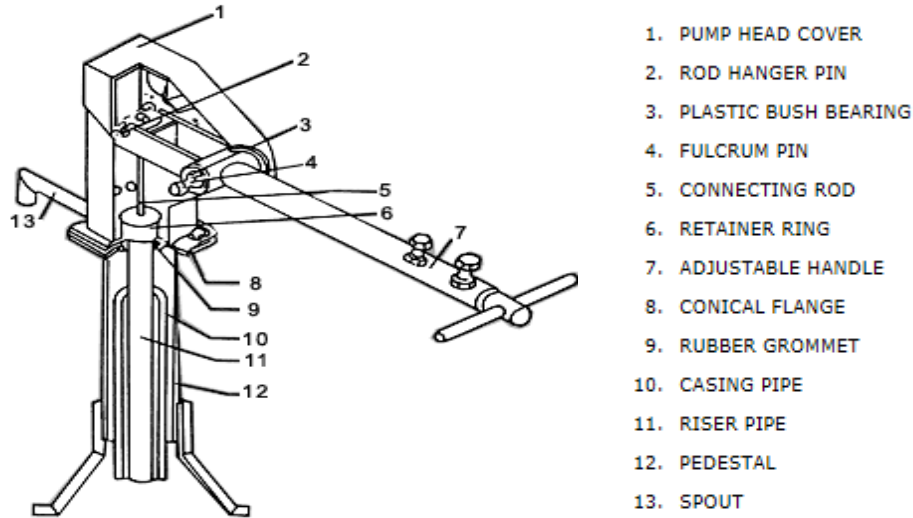


Figure 8.2. Afridev pump

8.4.2.3. Indian Mark II Pump

The INDIA Mark II Pump is a conventional lever action hand pump and is subject to Indian Standard IS 9301. This pump has a pump head, pump stand and a handle of galvanized steel. The down hole components exist of a brass lined cast iron cylinder with a foot-valve and a plunger of brass. The plunger has a double nitrile rubber cup seal, the rising main is a Ø32 mm GI pipe and the pump rods are of galvanized steel with threaded connectors. This pump is not corrosion resistant and should not be used in areas with aggressive water (pH value < 6.5).

Recommended for water level setting depth (meters): 20-45

Minimum ID of bore (millimeter): 100;

Approximate Discharge (Liters/Hour): 900

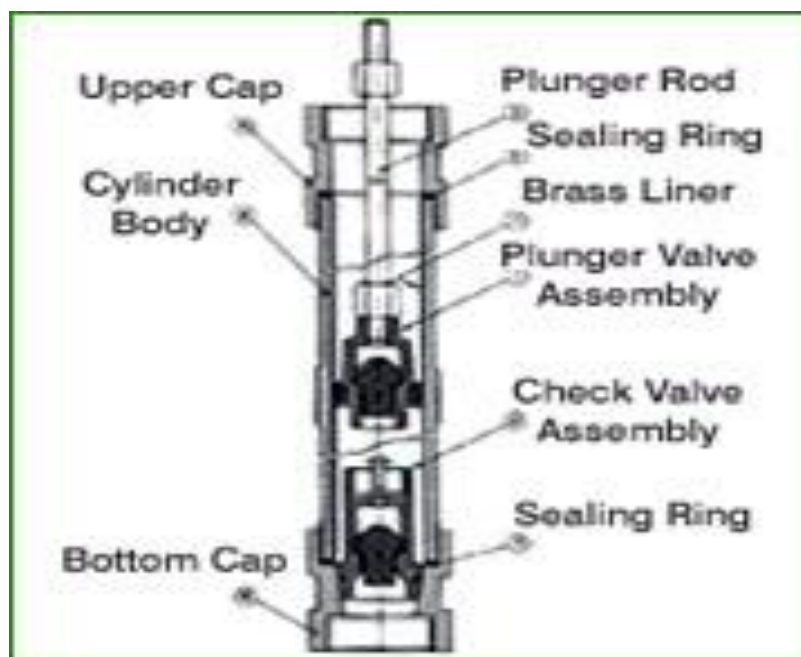


Figure 8.3. Indian Mark II pump

8.4.2.4. Solar power pump

Many solar pumps have been built and operated, so their technical feasibility is proven, but the technology is still immature with production running in dozens or hundreds of units per year rather than the thousands that must be manufactured before costs drop. Also, solar pumps tend to become economically viable in water-supply applications sooner than for irrigation, due to the much higher value that can be placed on drinking water; in fact an economic case can already be made for using solar pumps for village water supplies given favorable operating conditions.

Solar pumps for irrigation are only currently economically viable at very low heads where the power demand is extremely small. Nevertheless, significant technical developments coupled with cost reductions are being achieved and it can be expected that reliable and economically viable solar irrigation pumps will be available within the medium to long term.

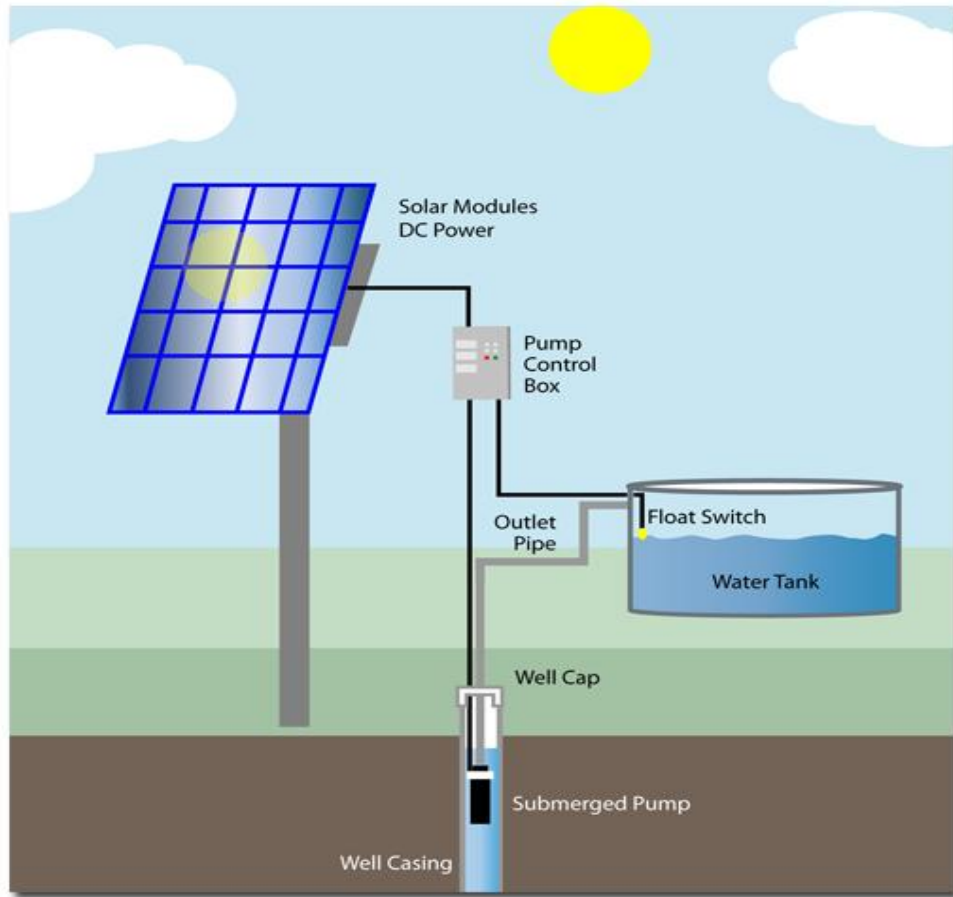


Figure 8.4. Solar Pump

8.4.2.5. Wind power pump

Most water supply wind pumps must be ultra-reliable, to run unattended for most of the time (so they need automatic devices to prevent overspending in storms), and they also need the minimum of maintenance and attention and to be capable of pumping water generally from depths of 10m or more. A typical farm wind pump should run for over 20 years with maintenance only once every year, and without any major replacements; this is a very demanding technical requirement since typically such a wind pump must average over 80 000 operating hours before anything significant wears out; this is four to ten times the operating life of most small diesel engines or about 20 times the life of a small engine pump.

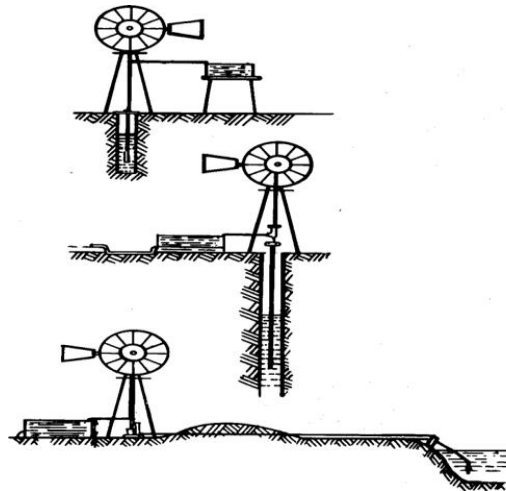


Figure 8.5. Wind power pump

8.4.2.6. Engine power pump

Power sources need energy, whether it is fuel for an engine, wind for a wind pump or sunshine for a solar pump. The main difference is that the provision of fuel can usually be arranged by the user, but nobody can make the wind blow or make the sun shine on demand. There is therefore an obvious qualitative difference between wind and solar powered devices which will only function under certain weather conditions and the rest which generally can be made to operate at any pre-planned time.

Pumps driven by diesel or gasoline engines are utilized when larger volumes of water are needed and/or significant depths or lifts are involved. Engines may be connected directly to pumps or generators may be used to power electrical pumps. Engines and pumps are available in sizes according to the volume of water to be moved.

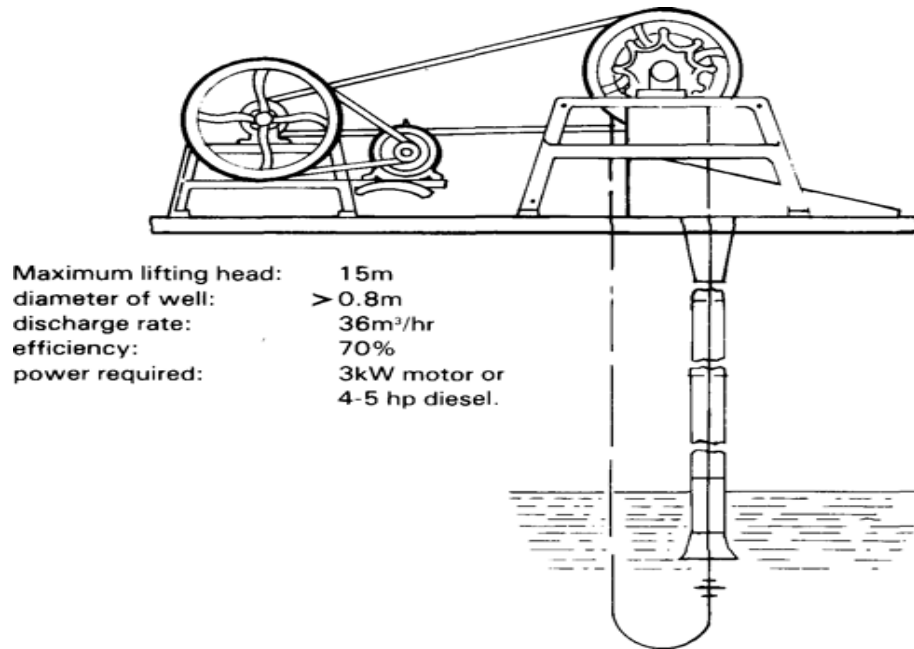


Figure 8.6. Engine powered pump

8.5. Treatment technologies at household and community levels

In Ethiopia, access to safe drinking water supply has gradually increased at the national level. Despite this tremendous effort, more than 30% of the rural population lack access to safe water for drinking and domestic use (MoWIE , 2013). In order to do away these problems, there are a wide range of household water treatment technologies available to provide safe water for the rural community at the household level.

Among these technologies, BSF (Bio-Sand Filter), Solar Water Disinfection (SODIS), Boiling, Ceramic Filters, Point-of-Use Chlorination, Combined Flocculation/Disinfection (PuR®) and de-fluoridation are the ones which are widely practiced in most of developing countries including Ethiopia. The systems have the potential to reduce waterborne and related disease thereby shows positive health impact by improving microbial and chemical quality of water (WHO, 2002).

These technologies are relatively inexpensive and require less technical skill for operation and maintenance. However, they have specific strengths and limitations during implementation. The strength and limitations can be seen in terms of their cost, availability of raw materials, and

technical performance. Particularly, the technical performance and operation of each technology is further explained below in the following sub-topics. i.e., Physical and Chemical treatment technologies (*See the picture in Annex 3.*)

💧 Physical treatment technologies

-Tulip

-Life-straw

-Biosand filters

-Langano

-Mena compacted treatment technologies

- Em kit

💧 Chemical treatment and disinfectant technologies

-Bishangari

-Pure

-Wuhagar

-Aquatab

-Solar Water Disinfection (SODIS)

💧 Water De-fluoridation technologies

- Activated alumina
- Nalgonda Technique
- Bone char
- Reverse osmosis

8.5.1. Physical treatment technologies

Ceramic Filter

Ceramic filter is used in various areas around the world as a means of treating drinking water at the household level. The filters depend on mainly mechanical processes to remove contaminants and reducing turbidity of raw water. In this process, small sediments and microbial life are trapped by filter media when the water passes through the pores so as to enhance the efficiency of pathogen removal. As Dies (2003) studies in Nepal, the microbial removal efficiency of the filter is range from 95%-99.9%.

In Ethiopia, the filter is distributed by some of private suppliers such as *Tulip Addis Water Filter*. The company filter is siphon device with ceramic filter element impregnated with colloidal silver. Similar to the filter of other developing countries, the ***Tulip*** product is simple to use, effective, affordable and convenient for the rural households. Based on the company's data and laboratory test result, Parasites (Protozoa) and bacteria removal efficiency of the filter is above 99.9% while turbidity removal capacity meets the WHO water quality Guideline. Besides, the data explained that the flow rate of the filter is above 5 liters per hour which is sufficient for the household having a family of five members for drinking and cooking.

One complete set of the filter costs about birr 368 while the filter media costs birr 80 which is replaced after one and half years of the service. The company holds about 80 sub- agents throughout Ethiopia ensuring sustained supply chain. The use of Ceramic Filter in combination with safe storage system was found to reduce diarrheal disease by 64% (CDC, 2005). There are different types of ceramic filters; Examples of such filters are *shown in Annex 3*.

Membrane Filter

Sawyer water filter is a hollow fiber membranes manufactured in USA and imported by sawyer water Filter Company in Ethiopia. The filter uses the same medical technology that was developed for kidney dialysis. According to the HYdreion microbial consulting research test result, the filter removes 99.9% of bacteria and Protozoa from the raw water. It has fast flow rate ranging from 259-466 gallon/day (www.sawyer.com). The flow rate is determined by a combination of Head Pressure (the distance from the top of the water to the filter), Altitude, cleanness of the filter, filter type.

Besides, it is long- lasting, no need of spare part, easy to use at household level. According to the company data, proper backwashing restores the filter to 99% of its original capacity. Since the filters and purifiers can continuously be backwashed and reused they have an extremely long life. The filter/purifier membrane may never need to be replaced, however when the flow rate slows or the filter clogs, simply backwash the unit with the provided backwashing device to clear out the pores.

The frequency of cleaning of the membrane depends on the extent of the turbidity of the raw water. With relatively clear water, backwashing may only be necessary every 1,000 gallons. With extremely turbid or muddy water, backwashing may be required every 10 gallons. Nevertheless, backwashing is an extremely simple process and only takes a minute. One complete set of the filter costs ETB 948. The company has local distributor in many part of the country.

Bio-Sand Filter

Bio-Sand Water Filter (BSF) is another appropriate, effective and environmentally benign water treatment technology to rural poor households. The filter was first used for water treatment in 1993 in Nicaragua (Donison, 2004). It was introduced to Ethiopia by Kalehiywot church since 1999. Many BSFs have been installed in different parts of the country, particularly in Ada'a Woreda (Oromiya Region) and Kucha Woreda (SNNP Regions) by the Church. The technology works on the basic principle of slow sand water treatment system. Varieties of the model are depicted under *Annex 3*.

8.5.2. Chemical treatment and disinfection technologies

Solar water Disinfection

SODIS is one of household water treatment techniques which have been used for centuries in various parts of the world. It is performed by filling raw water to transparent plastic bottle and exposed to full day light as indicated in the picture of Annex 3. The technique removes micro-organisms from the water with the help of solar radiation. This can be achieved through synergistic effect of both UV-A light (320-400nm) and heat of solar radiation (Meyer et al., 2001; McGuigan et al, 1998). It is reported that SODIS reduce feacal coli form and vibrio cholera to 99.9% In Laboratory setting (Sommer et al., 1997). This method is suitable for treating small volumes of water (less than 10 liter), having relatively low turbidity of less than 30 NTU. SODIS has been practiced in some water Technical Vocational Training colleges of Ethiopia for demonstration and educational purposes.

Boiling

Boiling is the other oldest water treatment method of producing safe drinking water at household level. Boiling of untreated water for one to ten minute can destroy disease-causing microorganisms found in water. According to WHO (2002), the method destroys all classes of waterborne pathogens such as viruses, bacteria, bacterial spores, fungi, protozoan and helminthes ova. This method can be effectively applied to all types of water, including those with high turbidity and dissolved constituents.

Boiling is commonly used in different part of the world especially during emergency situation such as out-break of diarrhea disease. This method provides quick solution to purify drinking water at household level during the destruction of water supply systems caused by natural disasters such as earthquake. However, this technique is unsustainable both economically and environmentally in most developing countries. According to Mintz et al., (1995) study to boil 2 liters of drinking water would require 10 kilograms of fire-wood. Boiling on this magnitude would significantly affect environment by increasing deforestation pressures. On the other hand, alternative fuel sources available in these countries, such as kerosene and other fossil fuels, are often expensive.

Point -of -use Chlorination (POU)

The sodium hypochlorite (NAOCL) solution with 1.25 - 5.0 % concentration is the other form of POU water treatment technique. It is stamped on a bottle with directions instructing users to add one full bottle cap of the solution to the raw water (or two caps to turbid water) in a standard-sized storage container. The volume and the concentration of the bleach are various in different countries. For instance in Ethiopia, the Chlorine bleach solution is in 150 ml plastic bottle (water Agar) with chlorine concentration of 1.25 % which can treat up to 1000 liters of water. Field tests have shown that POU chlorination can reduce the incidence of diarrhea disease in users by 22-84% (CDC, 2006).

Combined Flocculation/Disinfection

Combined Flocculation/Disinfection is also the other form of POU water treatment technique. For instance PuR® and Bishan Gari are widely known in Ethiopia. Both have a powerful mixture that removes pathogenic microorganisms and suspended matter. (See the picture in Annex 3.)

PuR® is comprised of ferrous sulfate as the chemical coagulant and calcium hypochlorite as the household disinfectant (Procter and Gambel, 2006). A single sachet of PuR® purifies 10 liters of drinking water (CDC, 2006). (See the picture in Annex 3.)

Bishan Gari is locally produced water purifying chemical with combined flocculent-disinfectant powder mixtures. Each Bishan Gari Sachet contains a mixture of aluminum sulphate, calcium hypochlorite and soda ash, in a 2.5 gm. chlorine (calcium hypochlorite) functions as disinfectant to kill bacteria and other pathogens. Aluminum sulphat functions as a coagulant for reducing turbidity of the raw water. The product has an efficiency to eliminate 99.9% of bacteria and other diarrhea causing pathogens (<http://www.bishanpurifier.com/>). (See the picture in Annex 3.)

A single sachet of Bishan Gari purifies 20 liters of drinking water that costs below 1.25 Ethiopian Birr per sachet. The product is simple to use and effective to purify turbid water. It can be stored for about 3 years in cool and dry place. The sachet and the procedure to purify the water are shown in Annex 3.

8.5.3. Water De-fluoridation Technologies

Fluoride is an essential element for humans with acceptable concentration. However, intake of high concentration exceeds the recommended range effects skeletal tissues (bones and teeth). It is known that the Great East African rift valley that crosses Ethiopia is the most fluoride affected area. De-fluoridation is the process of removing fluoride to the acceptable level of concentration in drinking water if there is no alternative water source; De-fluoridation technology needs to be identified and used based on appropriate selection criteria. There are several different De-fluoridation methods. What may work in one community may not work in another. What may be appropriate at a certain time and stage of development may not be at another. Therefore, careful selection of an appropriate De-fluoridation method should be in place.

Activated Alumina

It was previously considered that the activated alumina process, due to high chemical cost and non-availability in markets, was not a consideration for most developing countries including Ethiopia. This is no longer the case. Experience, mainly from India, Thailand and China, indicates that activated alumina may under certain conditions be affordable for low income communities. Activated alumina is a widely available industrial chemical. It is, however, not as widely distributed at the grass roots level as aluminum sulfate. Furthermore, its use has been limited by the difficulties of regeneration, the low capacity of less purified technical grade products and the relatively high price. Activated alumina has become less costly and more popular, especially where it is manufactured. Thus, it is appropriate to encourage local manufacturing of this product.

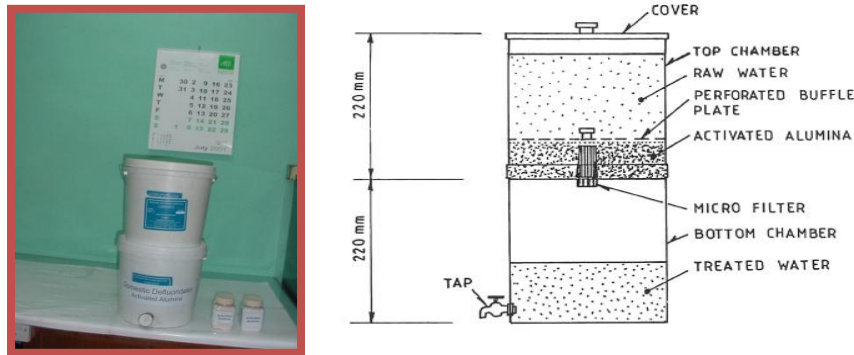


Figure 8.7. Domestic Activated Alumina De-fluoridation Units

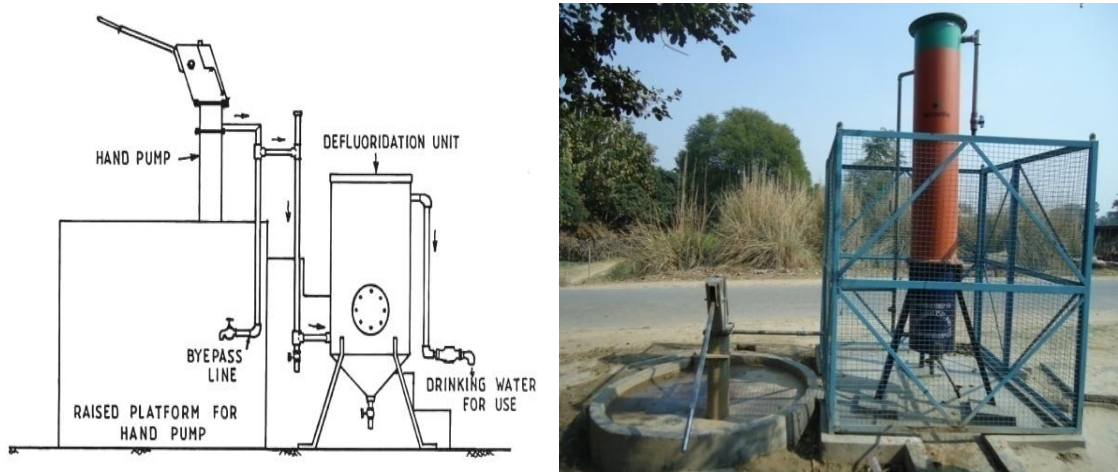


Figure 8.8. Hand pump attached Activated Alumina De-fluoridation Units

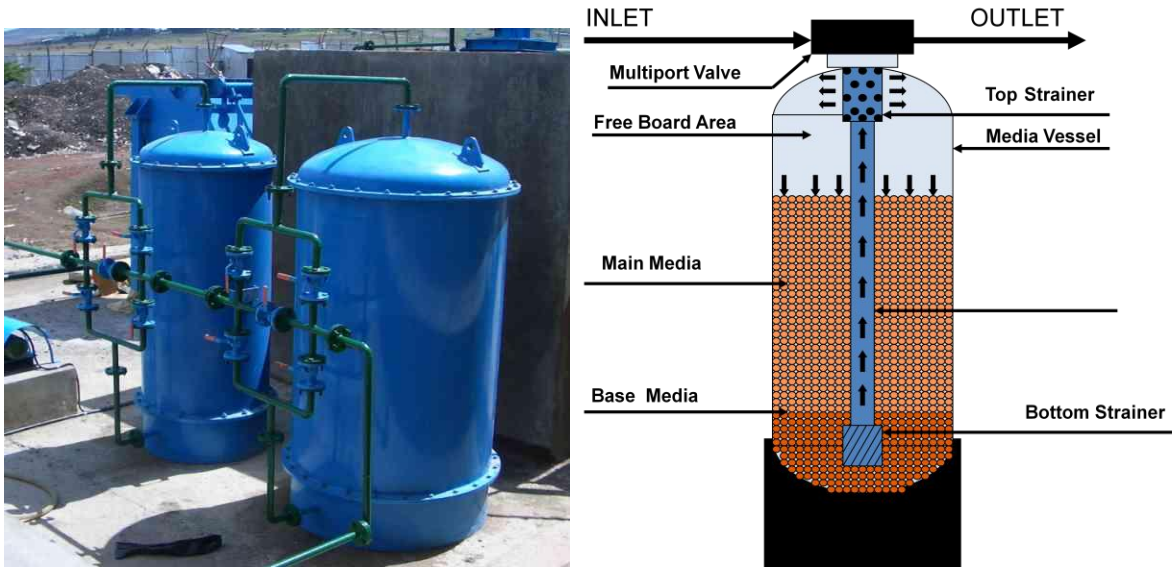


Figure 8. 9. Community Scale Activated Alumina De-fluoridation Units

Nalgonda Technique

In spite of the fact that the Nalgonda Technique has been introduced in many places, it has not yet been demonstrated to be the method of choice. It certainly has the great advantages of being relatively cheap, simple for local use and based on widely available chemicals and materials which are produced locally. Yet experience has shown that the following may play a role as negative factors:

- ◆ Treatment efficiency is limited to about 70 per cent. Thus the process would be less satisfactory in case of medium to high fluoride contamination in the raw water.
- ◆ Large dose of aluminum sulfate, up to 700–1,200 mg/L, may be needed. Thus it reaches the threshold where the users start complaining about residual sulfate salinity in the treated water. The large dose also results in a large sludge disposal problem in the case of larger scale treatment systems.
- ◆ When the users are not properly instructed, this can result in a large effort in terms of unnecessarily shorter long mixing times, both at household and community systems.

It is often stated that much care has to be taken to avoid the presence of aluminum in the treated water. This is because the WHO guideline value for aluminum of 0.2 mg/L is adopted as a compromise between the technical use in drinking-water treatment and the discoloration of distributed water.

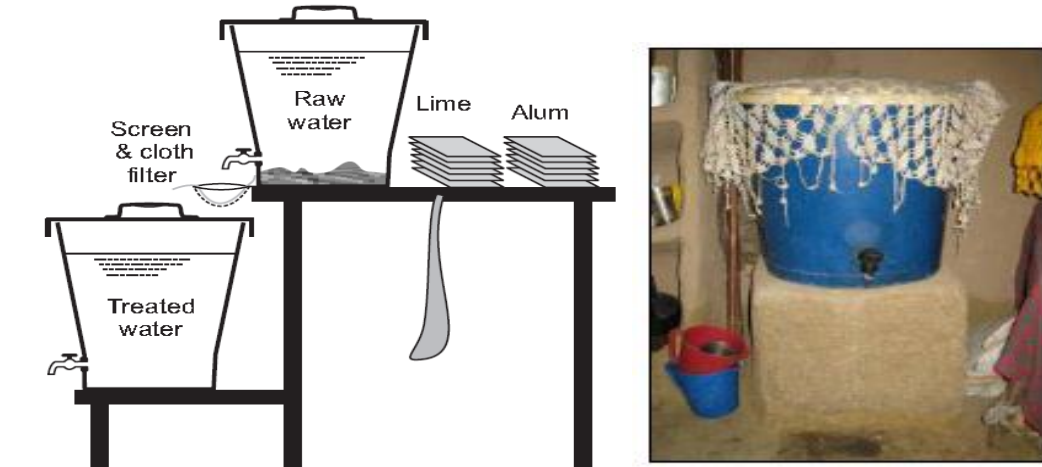


Figure 8.10. Household Nalgonda De-fluoridation Units

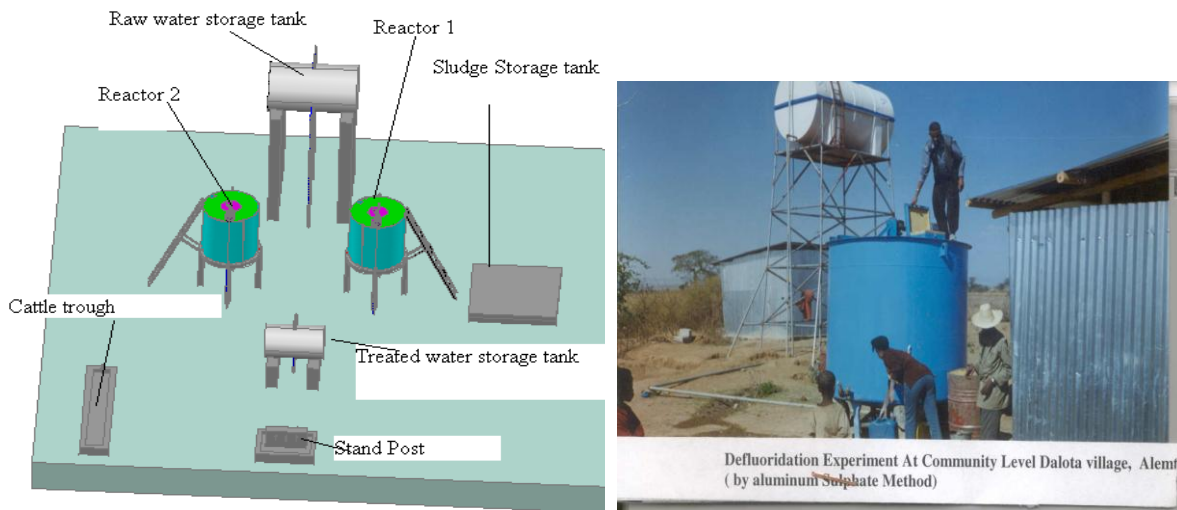


Figure 8.11. Community scale Nalgond Technique

Solar Electrolytic De-fluoridation

Electrolytic technology is a process in which active species of aluminum is produced by passing DC current through aluminum electrode. It involves the use of aluminum electrode that release aluminum ion by an anodic reaction and the ions react with fluoride that is found in water. In areas where continuous supply of electricity is not available, solar energy can be used.



Figure 8.12. Community scale solar electrolytic De-fluoridation unit

Bone char

Technologies based on bone char and contact precipitation are not included in the list, if there is satisfactory information acceptability and treatment performance, it may be possible to include those technologies into the list recommended technologies.

Technology based on synthetic ion exchange is not recommended at this stage due to high cost. However, efforts should be made to look for natural ion exchangers such as zeolites which can be obtained locally.

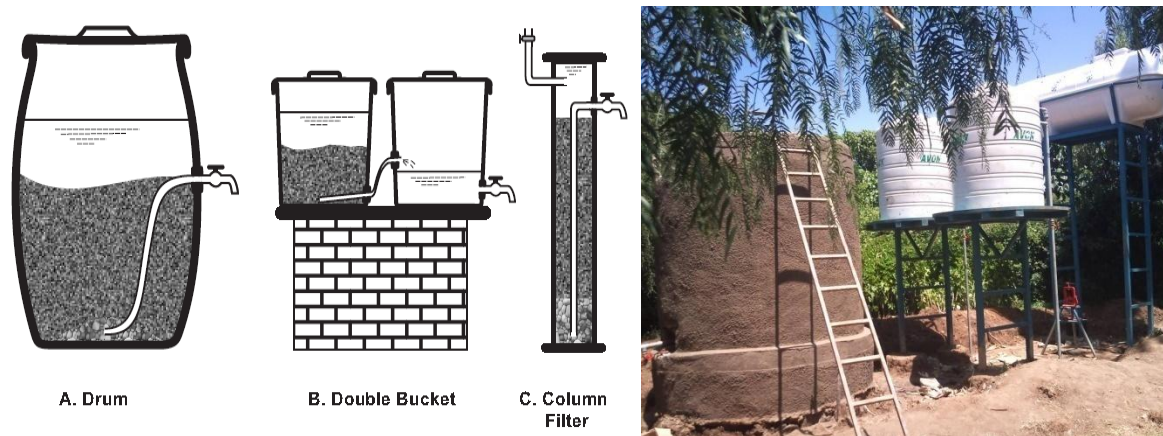


Figure 8.13. Household and community scale bone char De-fluoridation units

Reverse Osmosis

Reverse osmosis (RO) is the most effective treatment available for fluoride removal. The RO is well-studied and established technology for various kinds of water purification. It is a pressure-driven membrane process that uses a pressure gradient (between the water to be treated and permeate side) as the driving force to transport water across the membrane. The operating trans membrane pressure ranges from 20 to 100 bar, which results in increased energy cost. Nonetheless, it requires small amount of chemical and is one stop process for separation and disinfection.

The main disadvantage of commercially available RO technologies is the high rejection of water or low recovery (usually only 50 % recovery of the feed water). This resulted highly concentrated reject water that is not suitable for various purposes, particularly, in areas where is severe water scarcity. Experiences in Indian remote villages showed that people use the reject water for washing and bathing. To minimize the amount of reject water in the Ethiopian context it is recommended to use RO with minimum recovery of 75%.

Other new technologies

Technologies such as the aluminum oxide hydroxide that is being field tested in Ethiopia need to be included in the list of available technologies after sufficient field data and experiences are gathered. This material will lead to the potential of producing high capacity De-fluoridation material in Ethiopia.

Table8.1: Technology Selection Criteria

No.	Technology	Scale of application	Fluoride (mg/L)	TDS (mg/L)	Availability of Power	Remarks
1	Solar Electrolytic De-fluoridation	Community	< 10	<1000		Recommended
		Household				Not recommended
2	Activated Alumina	Community	< 10	<1000	Yes/No	Recommended
		Household			No	Recommended
3	Nalgonda Technique	Community	< 6	<1000	Yes	Recommended
		Household	< 6	<1000	No	Recommended
4	Reverse Osmosis	Community	>10	>1000	Yes	High cost
		Household	-	-	-	Not recommended
5	Bone char	Community	<6	-	No	Recommending
		Household	<6	-	No	Recommended

8.6. Sanitation and Hygiene Technologies

Sanitation and hygiene intervention requires the support and involvement of multi stakeholders such as government, non-government, social and religious organizations and influential community members to bring attitudinal change on the community on the safety of water supply. Thus participatory action plan is required for the intervention. The plan is preceded with preliminary survey on status on the safety of the water supply sources and the status of the people's knowledge and attitude on safe water supply.

The strategy for implementation of sanitation and hygiene intervention includes:

- ◆ Introduction of the intervention to the community
- ◆ Preliminary survey
- ◆ Participatory intervention planning
- ◆ Training

- ◆ Establishment of integration platform for all stakeholders
- ◆ High involvement of the health sector
- ◆ Motivating, educating and organizing community to bring behavioral change
- ◆ Use of local resources and demonstration methods
- ◆ Experience sharing and performance acknowledgement
- ◆ Monitoring and Evaluation of the intervention

The safety of water supply from bacteriological contamination is ensured by sanitation and hygiene intervention undertaken at the source, transportation, supply water point, and consumption levels. It is recommended to use safe water supply sources such as shallow and deep ground water, protected spring water, properly treated surface and rainwater sources. Even though ground water is usually safe for domestic water supply, it could be contaminated if the well is not properly sited, designed and constructed. Thus, ground water wells or boreholes should be located at least 30m away from the sources of contamination at the upper side and open defecation and latrines around the well should be avoided.

Untreated surface and rainwater sources are not safe for domestic water supply. Thus, they should be treated at the source by natural or manmade filtration or at a house using various household level treatments such as household biosand filtration, clarification using three pots method, chemical and solar disinfections, boiling, etc. If household level treatments are used, the source water (river, ponds, Birkas, etc.), which is usually, called raw water should be Zoned and the upper stream side should be secured only for household uses maintaining the surrounding clean in order to minimize the contamination at the source.

The household latrine used in low income communities varies enormously in design. Improved versions of the traditional pit latrine include a ventilation pipe or a cover plate for the squat hole. The collection chamber may vary from an unlined pit to a septic tank, a composting chamber or a connection into a sewer. The superstructure may be a crude shelter or an attractive brick or thatch construction with or without a vent pipe and with or without a seat. Ideally hand washing facilities should be associated with the latrine.

Space and ground conditions affect the choice of technology as do social and cultural preferences. The success or otherwise of sanitation program is often based on the appropriateness of technology being promoted and unfortunately is often either too prescriptive or based on little community consultation. Each variation of construction has advantages and disadvantages depending upon the local circumstances and therefore the choice of technology should, as far as reasonably possible be left to the household to determine. As household sanitation is seen as a household responsibility it is often difficult to get commitment or involvement from the utility or from other agencies such as the local authority. (*See the picture in Annex 4.*)

Method of human and waste water treatment

Wastewater can be treated *on-site* or *off-site*.

The common on-site treatments are:

- Pit latrine;
- composting toilets;
- septic tanks.

Ecological Sanitation: Water closet, aqua privy, double vault VIP latrines pour flush latrines,

Common off-site waste water treatment systems include:

- activated sludge treatment;
- trickling filtration; oxidation pond, Biological contractor

Pit latrines

Many latrine designs can be built in areas where more sophisticated sanitary systems are not possible. The simplest design is the pit latrine, with certain characteristics that are common to the many variations of this design. A latrine should always be dug at least 30 meters downhill from a well, if the well is the source of the family water supply. However, in areas where the water table is very high, the distance should be increased to 200 meters or more. The latrine should also be at least 10 meters from the nearest house or kitchen.

While a pit a little less than 1 meter in diameter is sufficient, an oval pit measuring 0.7 meters by 1.5 meters will provide more convenient space for the person digging. The depth is at least partially dependent on the stability of the soil, and therefore on how deep the hole can be dug without danger of a cave-in. While a depth of 4–5 meters is normal instable soil, an increase to 7

meters will reduce the problem of flies. In areas with a high water table, the depth may have to be decreased because, in order to avoid pollution, the bottom of the pit should be no less than 1 metro above the highest groundwater level. A pit with a diameter of 90 cm that is 5 meters deep will last for around five years if used by a family of six people.

The desired depth and the character of the soil will determine whether a stabilizing liner is necessary. Most latrines should have a block or brick liner for at least the top 1 meter. To install a stabilizing liner, a hole is dug a little less than 1 meter deep and approximately 1 meter in diameter, and lined with concrete blocks or bricks. After curing for a few days, the balance of the pit can be dug out, taking care not to make the diameter too large, allowing the blocks to sink. If the soil is sandy, a complete liner may be necessary. Bamboo is one possibility for lining the remainder of the pit sides. A simple floor to cover the pit can be made of bamboo or timber. However, cast concrete provides a much more durable and sanitary slab. The type of structure built above the slab to give privacy is largely a matter of personal preference. Bamboos, off cuts, concrete blocks or corrugated steel are all possibilities for wall construction. Corrugated iron sheets or thatch may be used for roofing.

Latrine slab

The latrine slab can be cast to provide a perfectly satisfactory two-piece slab that is easy to handle. First, a small mould is constructed to cast the footpads, which should be approximately 10 cm by 30 cm by 2 cm, with rounded corners. The foot pads are cast a few days prior to casting the slab and are stored in a bucket of water to cure. The form for the slab is then built using four boards measuring 7 cm by 120 cm and any convenient thickness. A round block 5 cm thick and 10–12 cm in diameter, and a rectangular block measuring 10 cm by 20 cm by 5 cm, are needed for the hole. If a vent pipe is to be installed, another 7 cm thick round block will be needed, with a diameter to match that of the pipe.

SanPlat

The word SanPlat stands for ***Sanitation Platform*** in the double sense of the word:

- ◆ It is a high quality squatting platform.
- ◆ It is a platform for a Demand Sustainable

A SanPlat is an improved latrine slab with the following features:

- ◆ Smooth and sloping surfaces which encourages regular cleaning.
- ◆ Elevated footrests to help the user find the right position, even at night.
- ◆ A drop hole that is both comfortable to use and safe even for the smallest children.

A SanPlat can be made with a tight fitting lid which effectively stops smell and flies. The small SanPlat 60x60 cm is easily made in an all-in-one plastic mould. For best results the first portion of concrete should be cement slurry. Later much stiffer concrete (1+2+2 volumes of cement, sand and stone) is added to absorb the excess water.

A latrine can be built in many ways. A few standard SanPlats will fit them all. Pits can be lined or unlined, round or rectangular. For the somewhat better off a small latrine slab can be integrated in a concrete slab for a VIP latrine. Small SanPlats are also ideal as squatting platforms in pour flush latrines. The superstructure can be built according to the owner's preferences and desired expenditure. Most families prefer the improved traditional latrine which is also the cheapest option.

Therefore, it is decisive to support the communities to improve their latrine conditions from simple pit to a higher level toilet (which is called “latrine” or “sanitation” “ladder”) and scaling up the program by institutionalizing CLTSH at village, Kebele and Woreda levels.

9. MULTIPLE USE SERVICE AND SELF SUPPLY

Multiple Use Services for water (MUS) is an approach which takes into account that people use water for multiple purposes, which can bring them multiple benefits. Self-supply for multiple uses is the one user-driven MUS modality. Here, users themselves invest in most infrastructure capital costs, often on an individual or household basis, although some communal arrangements may be included. Examples are self-financed wells, pumps, water harvesting techniques, gravity flows, drilling options, and water quality point of-use treatment devices. Users decide about the purchase, installation and uses, which are often multiple. Scaling up self-supply is largely through market-led supply chains which are often highly effective and sustainable.

Multiple Use Services (MUS) of water are facilitated by the advantage of family well proximity to the house (most are within 50 meters). Economic returns from small-scale irrigation, animal watering and crop processing may act as incentives for people to develop their own supplies, rapidly re-paying investment. Family wells are used for both domestic and productive uses, bringing major advantages in increased food security, health, school attendance and better child care, according to well owners. More easily accessible well water was found to have brought about major economic changes with increased animal watering (around 90% of wells in SNNPR and some parts of Oromiya are used for livestock, but only 35% in some other *Woredas*) and crop production (traditional wells being used for irrigation in 20-30% cases and with rope pumps and mechanized wells employed for irrigation in 43 and 68% cases respectively). These patterns of usage were found to have brought many family well owners from below subsistence level to having food all the year round and even some to sell.

Therefore, self supply focused activities like family wells, agricultural wells to be effective and sustainable, has to be linked with backyard agriculture so that it brings net benefit and raise family potential, particularly those of the poorest of the poor and women, to re-invest in other productive activities. In addition, this will contribute for poverty alleviation and self reliance.

10. MONITORING AND EVALUATION FOR ACCELERATING SELF SUPPLY

Monitoring is a continuing function that uses systematic collection of data on specific indicators to provide the management and the main stakeholders of an ongoing intervention with indications of the extent of achievement of objectives and progress in the use of allocated funds.

While evaluation is the systematic and objective assessment of ongoing and/or completed projects, program or policies, in respect of their:

- Design
- Implementation
- Results

In Self Supply acceleration, M&E is an important tool to track and assess progress of the acceleration with respect to the objectives set in this manual. Key aspects of monitoring should consider complementarities with conventional water supply systems, access to water, water quality and availability and protection of groundwater resources and quality. In order to have a reasonably simple and reliable basis for assessing achievements, change or performance of Self Supply acceleration, the following set of indicators will be used when undertaking monitoring activity.

- i. What is to be measured? /What is going to change? E.g. Number of self supply schemes constructed, improvement in health status of households and etc.)
- ii. Unit of measurement to be used (to describe the change, e.g., percentage)
- iii. Pre-programme status (sometimes called the “baseline”, e.g., National water supply coverage as of June, 2013 was 68.4%)
- iv. Size, magnitude or dimension of intended change (e.g., Attain water supply coverage of 98.6% by the end of 2015)
- v. Quality or standard of the change to be achieved (e.g., time spent on fetching water reduced, decline in water born diseases, improvement in school enrolments for girls and etc.)
- vi. Target populations(s) (e.g., rural households and communities)
- vii. Time frame (e.g., 2014 to by the end of 2015)

By the same token, objectives, efficiency, effectiveness, impact and sustainability are the major criterion applied while conducting evaluation of self supply acceleration.

Thus Regions, Zones and Woredas are expected to undertake a continuous monitoring and evaluation on the progress, outcomes and impacts of self supply acceleration using the monitoring framework provided on the table below and using every possible existing data collection channels available.

Table 10.1: Monitoring & Evaluation Framework

Indicator or Domains	<i>I</i>	<i>Inputs & processes</i>	<i>Outputs</i>	<i>Outcomes</i>	<i>Impact</i>	
	<i>N</i>	Delivery of tools and equipment	No. of wells	Productivity	Financial Capacity	
	<i>C</i>	Domestic water use efficiency	MUS	Production	Habit of saving	
	<i>R</i>	Public Awareness	Increase demand	Private investment	Financial Capacity	
	<i>E</i>	No. of women in the workforce	Distance & Amount	No. of jobs created in MWWEs	School enrollment Health Status	
	<i>M</i>			Work load education & access		
	<i>N</i>	No. of trainees	No. of trainees	No. of skilled workers	No. of cooperatives	
	<i>T</i>					
	<i>in</i>					
Data source	Reports, Field Visits, Assessment, Water Quality Test Results, etc					
Communication Strategies	Networking, Face to face Communications, Workshops, Seminars, on-job trainings					

11. IWRM AND ESIA FOR SELF SUPPLY

Integrated water resources management can take different forms and is examined best in specific situations. In the water-supply field, the term "integrated resource planning" has come into use to express concepts of integration in water supply development. The views of stakeholders in different locations must be balanced, introducing a geographic dimension of integration. Examples include issues between upstream and downstream stakeholders, issues among stakeholders in the same Region, and views of stakeholders in a basin of origin versus those in a receiving basin. IWRM should be applied at catchment level. The catchment is the smallest complete hydrological unit of analysis and management. Integrated catchment management (ICM), therefore, becomes the practical operating approach. Although this approach is obviously sound and finds wide acceptance, too narrow an interpretation should be avoided. It is critical to integrate water and environmental management. This principle is widely and strongly supported.

ESIA is concerned with identifying, predicting and evaluating the foreseeable environmental effects, alternatives and mitigating measures aimed at minimizing the adverse effects and maximizing the benefits obtained because of the intervention. Therefore, without an objective ESIA, informed decision making would be impossible. A Self supply practice should be formulated, designed and implemented in such a way that a practice should be economically, socially and environmentally sustainable for the well-being of the inhabitants (i.e. the community). From the Self Supply perspective ESIA should consider the type of data to be collected such as gully, flooding, sediment deposition, cattle track and etc. These are all components of the hydrology system in a given basin.

A true systems approach recognizes the individual components as well as the linkages between them, and that a disturbance at one point in the system will be translated to other parts of the system. Sometimes the effect on another part of the system may be indirect, and may be damped out due to natural resilience and disturbance. Sometimes the effect will be direct, significant and may increase in degree as it moves through the system. That is why it is found important to incorporate ESIA in this Self Supply Manual.

ANNEXES

Annex 1: Average Cost estimates of self supply technologies

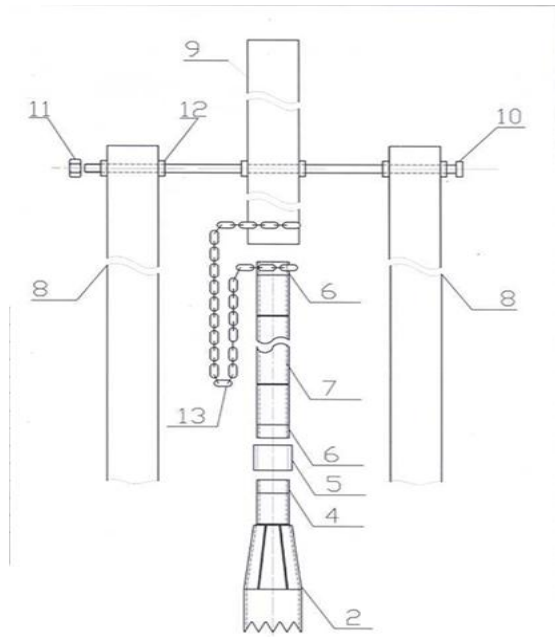
<i>Description of the activities</i>	<i>Unit</i>	<i>Total Cost (ETB)</i>	<i>Remark</i>
Earth Works			
• Excavation and soil removal	M	30-120	Only labour
Lining			
• Dry masonry/ stone	M	40-80	
• Brick	M	50-100	
• Concrete block	M	60-100	
• Concrete ring	M	750-1,000	80 cm external diameter
• PVC	M	3,200	1 m diameter
• Earth material (clay)	M	20-30	Only labour
Head works (apron, parapet, and drainage, soak away pit, etc.)			
• Concrete	LS	700-900	
• Stone and earth material	LS	150-300	Mainly labour
Manually-drilled well			
Drilling and well lining (4.5 inch well and 4 inch PVC)	M	140	
Head works	LS	460-550	
Rainwater harvesting			
Roof water harvesting	LS	900	Including factory material

Runoff water harvesting using ponds	LS	1080	Mainly labour
Lifting devices (Average depth to water level of 25 m)			
Rope, bucket and pulley	LS	180	
Rope, bucket and windlass	LS	140	
Rope and washer pump			
• Model 1(with bearing type)	set	2,280-3800	Total price per technology
• Model 2 (with bushing type)	set	1,520-3100	"
• Economy model	set	1,140-2500	"
• Windlass model	set	760-1700	"
• Afridev hand pump	set	12,000- 14,000	"
Household water treatment			
• Filtering	set	300-400	
• Boiling	Lit	120	On average 6 person leave per 1 household
• Chemical disinfection	Sachet /tablet	300-400	"
• Solar disinfection	set	36	On average 6 person leave per 1 household
• De-fluoridation	set	150-400	"
• Tulip	set	300	"
• life-straw	set	400	"

NB:- Price of the technologies indicated above is based on current price on the market and may vary depending on proximity to market centers or geographic location.

Source: iDE

Annex 2: Typical drawings of self supply technologies

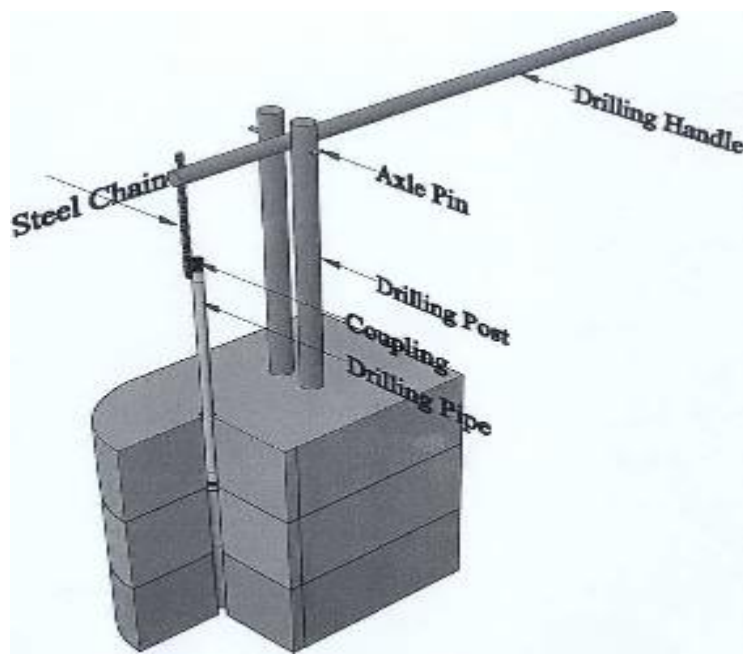


13	3	chain
12	3	bushing
11	1	stud nut
10	1	joining stud
9	1	handle
8	2	stand
7	1	extended pipe
6	1	screw bolt
5	1	connector
4	1	bushing
3	1	screw nut
2	1	punch
ITEM	Pcs.	COMPONENT PARTS

(a)

Source:iDE

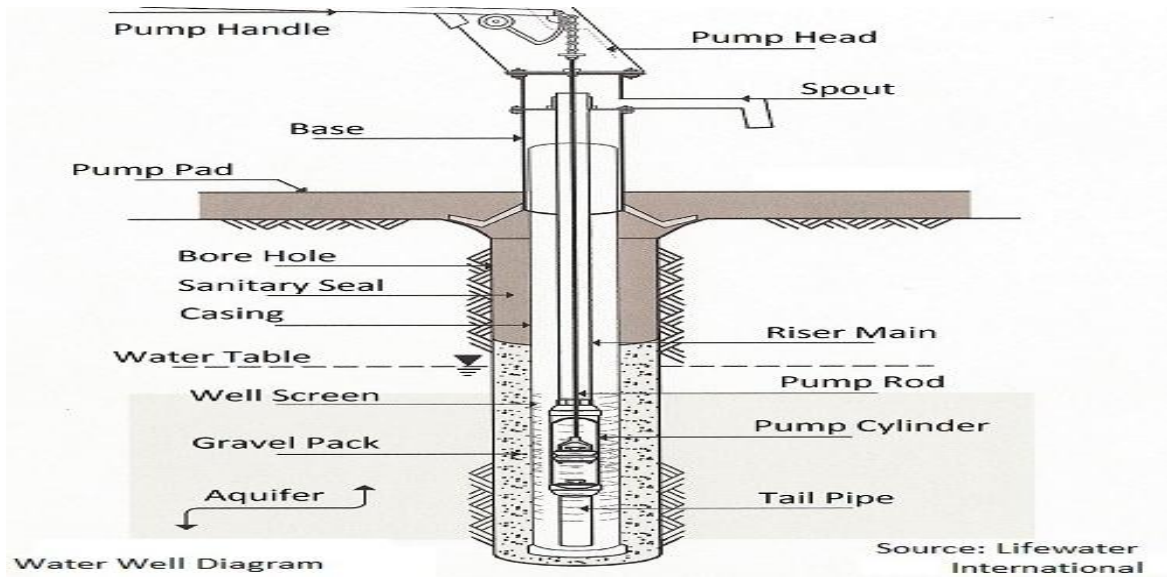
Sketch of Manual drilling tool (a)



(b)

Cross sectional view of manual drilling tool (b)

Source: iDE



Source: A concrete slab of 80-120cm diameter for Hand Dug well



(1)



(2)

Sludging (1) type of manual drilling & jetting (2)



(3)



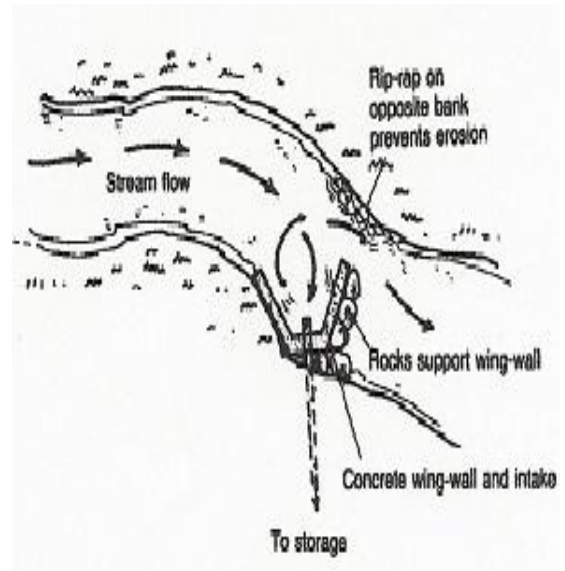
(4)

Hand Auger Manual drilling (3) & percussion (4)

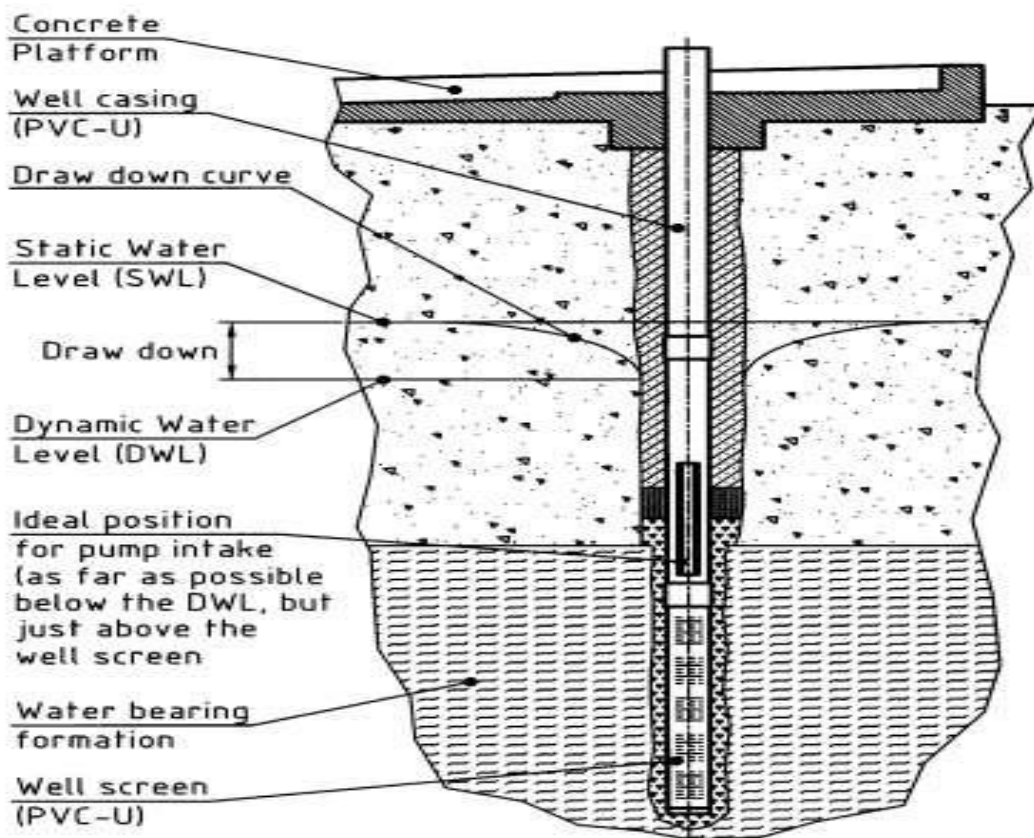
Source: iDE



(a) Rock catchment water harvesting



(b) River intake structure



(c) Well casing and head construction

Source: WWW icraf.org.net



(a) Model-1 (Bearing Type)



(b) Economic Model



(c) Model-2 (Bushing Type)

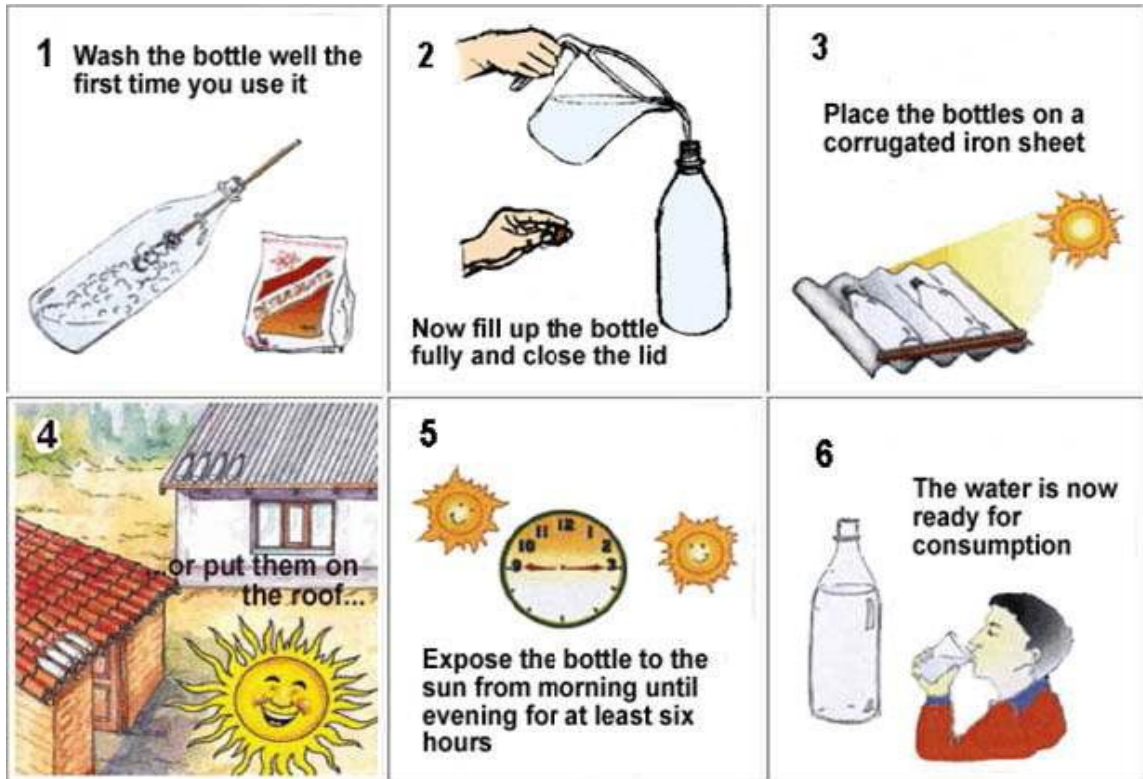


(d) Windlass Model

Source: JICA-WASRoPSS Project

Annex 3: Water treatment technologies

SODIS water treatment Technique



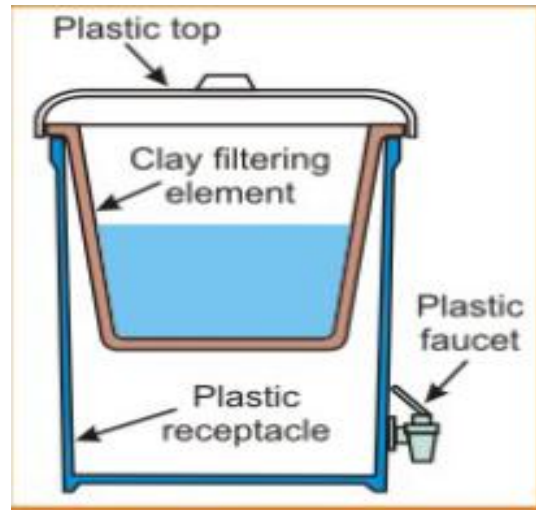
Source: SODIS, 2002 <http://www.sodis.ch/>

Ceramic Filters



The filter unit

Indian Ceramic Candle Filter



Filter set up

Terafil Ceramic

Filter



a. Filter unit



b. Filter element disk /

Source: Mattelet, 2005; Low, 2002

Tulip Water Filter



Yva water filters.

Filter media of the filter



Sawyer water Filter



Source: company document-Tulip Water Filter Manufacturer: tulipwaterfilters.com,

Procedure:

- ◆ Prepare a “clean” container to store purified water.
- ◆ Fill bucket with water from any source you get.
- ◆ Make sure clean container is lower than bucket and place filter tube into clean container
- ◆ In less than minutes you will have purified water that is safe to drink.
- ◆ It needs only back wash when the flow decreases.

Bishan Gari



Source: company profile of the Manufacturer

Procedure:

- ◆ Add 20 liters of raw water in a bucket
- ◆ Open the sachet and add the contents of the sachet into the bucket.
- ◆ Stir rapidly with a stick for 2 minutes and then stir slowly for an additional 5-7 minutes
- ◆ Wait for 30 minutes until the flocks settle and all of the germs die, the more the detention time the clearer the treated water
- ◆ Strain the water through a thick cotton cloth into another container and then bury the settled substances (i.e., sludge)

PUR Sachet water purifier



Source: company profile of the Manufacturer

Procedure:

- ◆ The content of the sachet is added into a bucket filled with 10 liters of water.
- ◆ The water is stirred with a large, clean spoon for mixing
- ◆ The mixture is left for five minutes to facilitate precipitation
- ◆ Allowed the mixture to precipitate and settle for five minutes.
- ◆ Finally, the water is decanted by pouring into a second safe storage container and it is ready for consumption.

Bio-Sand water treatment model

Davnor Plastic BSF



Source: Sagara, 2000; Lukacs, 2003

Concrete BSF



a) Concrete square



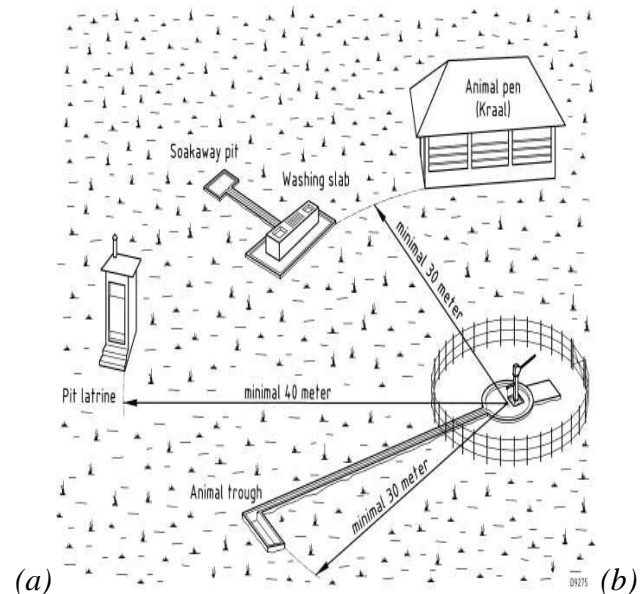
b) concrete round

Source- Murcott, 2005; Pincus, 2003

Procedure:

- ◆ Apply raw water with turbidity not more than 30 NTU
- ◆ Place a bucket at the out let of the filter device
- ◆ Collect the water from the out let
- ◆ Add water disinfectant to the filtered water such as Pur, Wuha agar or Bishangari for maximum safety of the water.

Annex 4: Sanitation and Hygiene Technologies



Different Hygiene practice level (a) and Ideal Environmental sanitation sketch (b)



Typical picture of sanplat (latrine slab)

Application:

- ◆ Personal hygiene is key to model household status (the availability of soap and water) to enable hand washing.
- ◆ The frequency of washing hands after defecation and after cleaning a child (after defecation) is also primarily with water should be widely practiced.
- ◆ A latrine should always be dug at least 30 meters downhill from a well and also washing slab and Animal pen should be considered the same distance.