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# AFGHANISTAN RURAL WATER SECTOR

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## Developing Sector Strategies and Options to Support the Sector

**OUTPUT 1: AFGHANISTAN WATER AND SANITATION COVERAGE**

**Commissioned by World Bank- MRRD**

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SWS

# Afghanistan Rural Water Sector

## DEVELOPING SECTOR STRATEGIES AND OPTIONS TO SUPPORT THE SECTOR

## OUTPUT 3: TECHNICAL OPTIONS REPORT

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| ARTF | Afghanistan Reconstruction Trust Fund |
| BPHS | Basic Package of Health Services |
| CAP | Community Action Plan |
| CDC | Community Development Council |
| CHW | Community Health Worker |
| CP | Construction Partner |
| DACAAR | Danish Committee for Aid to Afghan Refugees |
| DALY | Disability Adjusted Life Years |
| GIS | Geographic Information Systems |
| GPS | Global Position System |
| HE | Hygiene Education |
| HEWG | Hygiene Education Working Group |
| HHV | House to House Visit |
| KAP | Knowledge, Attitude and Practice |
| MoE | Ministry of Education |
| MoF | Ministry of Finance |
| MoHaj | Ministry of Haj |
| MoPH | Ministry of Health |
| MoWA | Ministry of Women's Affair |
| MRRD | Ministry of Rural Rehabilitation and Development |
| NSP | National Solidarity Program |
| O&M | Operation and Maintenance |
| PIU | Project Implementation Unit |
| PSC | Project Steering Committee |
| RRD | Provincial Rural Rehabilitation and Development |
| RTSU | Regional Technical Support Unit |
| RuWatSIP | Rural Water, Sanitation and Irrigation Program |
| RWSSP | Rural Water Supply and Sanitation Project |
| UNHCR | United Nations High Commissioners for Refugees |
| UNICEF | United Nations' Children's' Fund |
| USAID | United States Agency for International Development |
| RuWatSIP | Water and Sanitation |
| WASH | Water, Sanitation and Hygiene |
| WHO | World Health Organization |
| WSG | Water and Sanitation Group |
| WSUC | Water and Sanitation Users' Committee |
| WSUG | Water and Sanitation Users' Group |
| WUA | Water Users Association |

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# EXECUTIVE SUMMARY AND CONCLUSIONS

**Ch. 1: INTRODUCTION**

The present technical report represents the "output n. 3" of the study for the **Developing Sector Strategies and Options to Support the Afghanistan Rural Water Sector,** whose objective is to "*develop a deeper understanding on the Afghanistan's rural water sector development needs and recommend actions to improve the sector and its agencies' performance*".

According with the Terms of Reference its aim is to provide a kind of action plan which will include:

Technical choices of water and sanitation sub-projects required for prioritized provinces – guidance note on designs, procurement and implementation.

Technical guidance + strategy on reviving or rehabilitating existing water points

Promoting sustainability – critical technical and institutional measures required

Geographical, environmental, institutional and social elements are synthetically described for the aspects that interest the process that could lead to a successful implementation of water points which includes: identification, feasibility, design, construction, operation and maintenance.

**Ch. 2: COUNTRY FRAMEWORK**

**Demography**

No population census has been conducted in Afghanistan since 1979. The last three decades have been times of war and conflict, making it not possible to take ahead plans for developing a sound statistical and census system. According to the UN World Population Prospects 2010 Revision, Afghanistan population is presently evaluated in about 31.000.000 inhabitants.

Based on National Risk and Vulnerability Assessment 2007/8 (NRVA), around 80 percent of the total population of Afghanistan is living in rural areas: 74% (around 18.5 million people) lives in rural areas and only 20 % (5.0 million) in urban areas, while 6% (1.5 million) is classified as nomadic Kuchi.

The total number of households in Afghanistan is estimated at around 3.4 million. This implies an average household size of 7.3 persons. These data are 20% inferior to the above mentioned data of the UN World Population Prospects 2010, but it can be justified with the population growth of the last 3 years. Only 11 provincial cities are considered urban (high populous urban).

According to NRVA, the majority of the poor people comes from rural areas. The main characteristic of the rural poverty is high food insecurity and a lack of access to water, infrastructure and basic public services.

**Morphology**

Afghanistan is a landlocked country of 652,000 square km. Over three quarters (approximately 75%) is mountainous. More than a quarter (27 per cent) of the national territory lies above 2,500 $m^3$. The Afghan landscape is mostly denuded – harsh desert . In the central highlands and the North-East, the Hindu Kush elevates its rugged, brownish and inhospitable slopes. Even when the relief is smoothing, the nature is not more generous. The geographers distinguish the 'lut', arid steps hostile to any cultivation from the 'dasht', steppes which turn green just after snow melt or rainfall in spring. and attract nomadic livestock.

The most extensive flatlands are located in the southwest of the country, centered around the drainage of the Hilmand basin and in the north of the country, between the northern foothills of the Amu Darya (Oxus) River (marking the border with Tajikistan and Uzbekistan). Both regions, the southwest in particular, include large areas of sand desert. These desolate landscapes contrast sharply with the exuberant and fertile alluvial irrigated plains generally surrounding the Hindu Kush mountains and the narrow irrigation strips bordering rivers that descend sinuous mountainous valleys.

**Hydrology**

The total amount of Afghanistan precipitation is estimated in 180 Billion cubic meters (BCM)/year. The 80% of this precipitation is concentrated in the areas above the 2000 m over the sea level. The snow reserve in the highest mountains provides a natural storage for water that descends along the river during spring and summer.

Recent estimates indicate that the country has around 80 BCM/year of potential water resources of which 58 BCM is surface water and 22 BCM is groundwater. The annual volume of water used for irrigation is estimated to be 30 BCM, while the total amount of domestic water demand for 31.000.000 inhabitants (considering a per capita need of 60 lt/day including in it all the domestic and public use except for irrigation) can be estimated about 0,8 BCM, so it is not too much relevant comparing with the total use. Total groundwater extraction (including irrigation and domestic use) amounts to some 3 BCM. Approximately 15 per cent of the total water volume used annually originates from alluvial groundwater aquifers (9 per cent) and springs (7 per cent), and almost 85 per cent from rivers and streams. Ground water used from deep wells counts for less than 0.5 per cent. In order to compare Afghanistan water availability with the availability in other Countries, it can be remarked that the annual per capita water availability in Afghanistan is approximately 2500 cubic meter, while for instance in Iran is 1400 cubic meter per capita per year and in Pakistan 1200 cubic meter per capita per year. A qualitative assessment shows that Afghanistan's water resources are still largely underused as it is shown by the data presented in Table 1 of the present report. This does not mean that surface water and groundwater can be used freely without any caution: first of all it must be analyzed in each area how much of this 'potential' resource can be accessed without damage to people and ecosystem. For example also if the general balance of groundwater is favorable it can happen that an intensive pumping in certain areas can cause a watershed drawdown or the withdraw of an excessive quantity of water from a river or a stream can affect the environment.

**Hydrogeology**

In Afghanistan due to complex geology different systems of aquifers are present.

Unconsolidated aquifer systems are comprised of Quaternary and Neocene Age sediments which are found along major river systems and in intermountain basins. These sediments comprise the most prolific aquifers in Afghanistan. Most of the irrigation from groundwater sources (springs, karezes, open wells and drilled wells) is derived from these aquifer systems. The geologic map of Afghanistan, shows the locations of the Quaternary and Neocene sediments.

Consolidated bedrock aquifer systems are not very documented in Afghanistan. The yield potential of the crystalline rocks (granites, schist, gneiss, etc) is expected to be significantly lower than the unconsolidated aquifer systems in the country. The sedimentary and igneous rock units, which underlie large parts of the country may have development potential, but as yet have not been explored in any detail

The unconsolidated aquifer system are generally well recharged but, according to the existing studies, there are some limited areas where drawdown problems has manifested themselves.

Particularly critical have been resulted certain areas in the basin of the tributaries of the Easter Helmand river and in the Kabul river basin, which are affected by drawdown of the unconsolidated watershed.

**Climatology**

There are two types of climate in Afghanistan:

1) In the northern and the southern valleys climate is typical of an arid or semiarid steppe, with cold winters and dry summers. The mountain regions of the northeast are subarctic with dry and cold winters. In the mountains bordering Pakistan, a divergent fringe effect of the monsoon, generally coming from the southeast, brings tropical air masses that determine the climate between July and September. At times, these air masses advance into central and southern Afghanistan, bringing increased humidity and some rain.
2) The Central Mountains, with higher peaks ascending toward the Pamir Knot, represent another distinct climatic region. From the Koh-e Baba Range to the Pamir Knot, January temperatures may drop to -15 C or lower in the highest mountain areas; July temperatures vary between 0 and 26 C depending on altitude. In the mountains the annual mean precipitation, much of which is snowfall, increases eastward and is highest in the Koh-e Baba Range, the western part of the Pamir Knot, and the Eastern Hindukush. Precipitation in these regions and the eastern monsoon area is about forty centimeters per year. The eastern monsoon area encompasses patches in the eastern border area with Pakistan, in irregular areas in eastern Afghanistan from north of Asmar to just north of Darkh-e Yahya, and occasionally as far west as the Kabul Valley. The Wakhan Corridor, however, which has temperatures ranging from 9 C in the summer to below -21 C in the winter, receives fewer than ten centimeters of rainfall annually. Permanent snow covers the highest mountain peaks. In the

mountainous region adjacent to northern Pakistan, the snow is often more than two meters deep during the winter months. Valleys often become snow traps as the high winds sweep much of the snow from mountain peaks and ridges.

## Ch. 3: RURAL WATER DEMAND AND NATIONAL OBJECTIVES

**Generals**

According with the information of the “Demography” chapter, the 80% of the 31.000.000 inhabitants of Afghanistan lives in rural areas.

The main factor of the localization of these 24.000.000 people is water availability, which involves the possibility of living and of practicing agriculture.

**Construction of water points/sources:**

According with the above reported data, in the Afghanistan exist about 50.000 rural water supply systems. The actual need can be evaluated in at least another 80.000.

**Sanitation facilities and hygiene education:**

The lack in the field of latrines is in percentage also more severe than the lack of water supply systems. Elaborating the data of the deficiencies percentage of the World Food Programme, the number of the necessary latrines in the whole Country can be evaluated in at least 1.500.000, while the total number of the existing latrines can be evaluated in about 500.000.

It has to be highlighted that in a desirable perspective of development, the realization and operation of septic tanks is highly advisable at least for the major settlements (over 3.000 inhabitants), in order to prevent health risks.

**Resource analysis**

As indicated in the Chapters “Hydrology” and “Hydrogeology”, the water resource in Afghanistan is quite rich, if you exclude some areas in the Kabul river’s basin and in the Easter Helmand’s basin where a drawdown of the unconsolidated superficial watershed has been observed.

It means that both surface water and groundwater can be used as long as each situation has to be studied in order to find out the most appropriate source also considering environmental aspects.

## Ch. 4: TECHNICAL CHOICES OF WATER AND SANITATION SUB-PROJECTS REQUIRED FOR PRIORIZATED PROVINCES

Also if a general need of water supply systems is present in the rural areas of the whole Country, according to the analyses of the priority of the rural water supply interventions developed by the USAID together with the Society for Sustainable Development of Afghanistan (SSDA), which is an indigenous, non-profitable and non-governmental organization, within the WASH cluster, the priority districts has been identified within the Northern Provinces. The selection has been done according to an evaluation of the water shortage for the population.

For the technology choices for rural water supply systems in the identified Provinces, the SSDA provides the following technological options, to be verified in each specific situation:

Takhar Province: Gravity piped Scheme, Bore Well, Dug Wells

Kunduz Province: Bore Wells

Baghlan Province: Bore Wells

Samangan Province: Dug Wells, Bore Wells

Jawzjan Province: Underground water tank, Deep wells

Sari Pul: Bore Wells

Badghis: Bore Wells

Kabul: Bore Wells

## Ch. 5: TECHNICAL GUIDANCE. STRATEGY ON REVIVING OR REHABILITATING EXISTING WATER SUPPLY SYSTEMS

**Generals**

Due to the many technical inconvenient occurred to the interventions in the sector of rural water supply in the Country, lately two technical manuals have been realized under commitment of the Public Administration:

The Water and Sanitation Group (WSG) manual, prepared by the Rural Water, Sanitation and Irrigation Department of the Ministry of Rural Rehabilitation and Development (first version in 2006).

The National Solidarity Program (NSP) of MRRD manual, prepared in 2010 with several updating until 2011.

These two manuals, that can be found in the Appendices, have reached a very good quality and contain a lot of indications and technical specifications covering every kind of intervention in the sector.

The two manuals are very detailed and they are addressed to specialized technicians stakeholders.

In the present technical report is described a synthetic technical guidance addressed to the local Communities responsible, with the aim to allow them in the design, implementation, operation, maintenance and eventually rehabilitation of rural water supply systems in Afghanistan.

It is anyway suggested that MRRD provides the Community with the necessary technical support by means of a special task force. Particularly the support is considered necessary during the phase of formulation and of design of the intervention. The task force must be composed by a sociologist, an hydro-geologist and an hydraulic engineer.

**Procurement**

In order to avoid the great number of inconvenient caused by insufficient technical following of Rural Water Supply Systems in the Country, a procurement tender has be done especially for majors water supply systems not only for the construction but also for the design and the supervision of them and a maintenance procedure has to be foreseen from the beginning.

A proposal is to manage these tenders at Regional level by the local MRRD technical structure that can address the general guidance of the interventions. The waters point to be implemented can be grouped in homogenous lots enough big to interest experienced Contractor (min. can be 15.000 Euro) but not too big to require the intervention of a foreign Contractor (max. can be 200.000 Euro). The tenders can be carried out or by Local Authorities or by the Central Administration.

**Implementation**

The main organizations operating in the WASH (DCAAR; USAID) have abandoned the direct implementation of the water point, the works are agreed to Contractors with closely supervision and monitoring of the works by independent technicians.

So the item to be utilized is the following:

The Local Communities present to the Regional Administration of MRRD (RA) the demand for an intervention for the realization of a Rural Water Supply system.

The RA by mean of its technical task force makes free of costs a first formulation of the intervention, determining the technical characteristics (water volume, water source, type of scheme, cost of the works, necessary local support for sustainability in terms of maintenance and operation).

Each Community deliberates the intervention and allocates the money also appointing a responsible for the village water supply (mirab).

The RA prepares and publish a tender to the minimum prize for the intervention works, in case grouping it with others. The design and the technical prescription can be prepared either freely by the RA or by an engineer paid by the Community.

The RA or the Community appoints and pay a Supervisor.

The work is executed by the Contractor, tested and delivered to the Community that engage itself to the maintenance and the operation by means of the local responsible.

**Strategy on reviving or rehabilitating existing water points**

Water well problems result from many causes including equipment failure, depletion of the aquifer, corrosive qualities of the water and improper well design and construction.

Correctly identifying the cause enables to select appropriate treatment or maintenance to fix the problem or to abandon the water source.

A working mechanism shall be developed within the prevailing governmental organizational set up for monitoring water source in the community and supporting the community in resolving problems, and in technical matters

Some organizations have made different systems to collect the data:

USAID through telephones that can be further augmented through spreadsheet information and that can be made available for viewing on the internet

Dacaar has set up a monitoring net with monthly controls of the quality and performance of the water points. The data are introduced in a GIS and they can easily controlled and crossed.
Their reports indicate that 30% to 50% of water points in different parts of the country are dysfunctional. Their failure are due to drying of water sources; falling water tables; damage from natural disasters; poor quality of construction materials and equipment; lack of standardization and oversight; poor operation and maintenance services; coordination issues with the private sector; and lack of community ownership.
In order to enable monitoring, information of all the wells shall be maintained in MRRD in a very simple format agreed by all the stakeholders and any new construction shall be reported in this format to RRD. RRD shall be provided with a simple database software for this and trained in its use. Similarly a second simple format shall be developed for updating the status of functioning of wells and the system of operation and maintenance while carrying out the monitoring work above.

**New technologies**
Some new technologies that can be useful in RWSS in the Country has been described:
**- Compact treatment plant**
At present compact treatment plants suitable for a peak water demand of a maximum 10 $m^3$/hour are available. This technologies are based on pre-mounted pumping – treatment units fully automatic.
Their advantage are: reduced cost, no installation works requirement, easy operating , low operating cost, easy maintenance, no chemical products need.
The system presents three stages of process:
1) Physical Filtration
2) Chemical filtration
3) Bacteriological treatment
**- Booster pump**
A booster pump pumps directly from a ground reservoir to the net by a group driven by an inverter.
This arrangement allows to save the money for the construction of an elevated tank and allows an important energy saving with economic and ecologic benefits, because the water is pumped at the pressure strictly necessary in the network.
Nevertheless it must be told that a booster system is more insecure from the point of view of the distribution network and the pump works in a less stable way, and for this reason is not suitable for big network.
**- Pumping systems fed by solar panels**
A solar panels system is able to provide energy for a pumping station which is able to feed a water supply network up to 3000 people.
Photovoltaic panels have been utilized recently in a UE project in the Sahel Countries in Africa for rural water supply systems pumping station with a power between 100 $m^4$/day (200 Wc) and 6.000 $m^4$/jour (12.000 Wc). The flow was included between 3 $m^3$/day and 300 $m^3$/day for a population between 50 and 5.000 inhabitants. For these water flow the solar panels allowed a pumping height between 20 m and 80 m.
When using photovoltaic systems all the hydraulic parameters for the design of the conduction pipe and the tank volume has to be reviewed.
**- Sanitary landfill**
Due to the occurred epidemic diarrheic disease, the health politic aims to improve the sanitation sector. One of the action was to favor people use of latrines instead of open defecation.
We have to underline that the increase of latrine number in a small area can be a possible source of contamination of the ground water.
Therefore the next step would be to realize sanitary landfill where to place the material derived. This site must be located downstream of the water sources. In the next picture is described a typical sanitary landfill.
**- Disinfection systems**
In order to prevent diarrheic diseases, in many case especially whit a superficial source, can be necessary to disinfect the drinking water. Different way of disinfection can be used; the main systems for small and medium systems are chlorination and Ultra Violet treatment; other low-cost method of disinfecting water that can be implemented with locally available materials is solar disinfection (SODIS).

A recent study has found that the wild Salmonella which would reproduce quickly during subsequent dark storage of solar-disinfected water could be controlled by the addition of just 10 parts per million of hydrogen peroxide. Disinfection is accomplished by filtering out harmful micro-organisms and by adding disinfectant chemicals.

**- Dehydratation latrines**

There are several technologies to realize latrines in ruarl areas. Each one presents advantages and disadvantages. Many of them are very well illustrated in the WATSAN manual. In our report most attention is given to the dehydratation system that is not mentioned in the manuals and that can be considered a good option for the lower areas. It has to be considered that the system effectivness is not high during the cold season, in which dehydratation is slow and a removal of major quantities has to be done.

In a dehydration toilet, the excreta inside the processing vault are dried with the help of sun, natural evaporation and ventilation. The toilet requires no flushing water. Dehydration toilets are increasingly popular in the developing world. They can be succesfully used in various climatic conditions and are most advatageous in arid climates where water is scarce and faeces can be effectively dried. The faeces are collected in a chamber below the toilet (or squatting hole) and are dried. High temperature in the chamber, together with suffiecient ventilation are the most important mechanisms in the drying process. The ventilation also reduces odours due to air currents, which flow towards the vent pipe out of the chamber. A moisture content below 25% facilitates rapid pathogen destruction.

Absorbents such as lime, ash, or dry soil should be added to the chamber after each defecation to absorb excess moisture, make the pile less compact and make it less unsightly for the next user. Addition of absorbents is also reported to reduce flies and eliminate bad odours. Moreover, depending on the additive, the pH may also be increased due to this addition, and hence enhance bacterial pathogen dieoff.

Once the chamber is almost full, the content may need to be removed. The contents are further stored, used as a soil conditioner, buried or composted (in home composting or at a local composting centre).

The product from the dehydration process, a crumbly cake, is not compost but rather a kind of mulch which is rich in carbon and fibrous material, phosphorous and potassium. Nutrients will be available to plants directly or after further decomposition of the dehydrated material. In warm environments (20°-35°) storage times of less than 1 year will be sufficient to eliminate most bacterial pathogens and substantially reduce viruses, protozoa and parasites. Further storage, sun drying, alkaline treatment or high-temperature composting may be recommended to further decrease health risks of utlization of the dehydrated faeces.

## Ch. 6: PROMOTING SUSTAINABILTY – CRITICAL TECHNICAL AND INSTITUTIONAL MEASURES REQUIRED

### Generals

Also if many RWS systems have been affected by design or implementation mistakes, the main factor of failure of the interventions is the lack of sustainability.

Generally speaking every system has severe problems of maintenance due to the lack of funds from a responsible organization. The problem involves the reorganization of the sector with a clear identification of all the actors power and responsibility.

To this aim s revision of the Water Law of 1991 has been undertaken.

Recent drafts of the Water Sector Strategy (WSS) and of the Water Law provide the main policy environment for water management. The July 2007 Draft WSS is focused on water pricing, while the February 2008 draft focused on poverty alleviation and did not discuss water pricing (although cost recovery for construction and services is still anticipated). Both versions have a strong focus on infrastructure rehabilitation and expansion and portray the existing mirab water system as dysfunctional and promote the WUA (Water Users Association) system to take its place, but they also admit that the mirab system has not been researched. The June 2008 Draft Water Law continues to focus on establishing a modern permit system, with the exception of right-of-way areas (areas that are protected and free from interventions) and has a section on river basin and sub-basin councils. There is no mention of the negative consequences that the withdraws might have for downstream riparian states.

Although the basic framework for basin organization is defined and roles are allocated, important questions about decision-making in the basin councils are not specifically articulated. The June 2008 Draft Water Law contains references to right-of-way areas and suggests that these areas will not be included in the basin

approach or represented in the councils. The implication is that there is no basin approach and no integrated water management with stakeholder participation. The right-of-way reference does reflect the reality on the ground. Nevertheless, why have a law on basin management if substantial parts of the basin are excluded?
In the June 2008 draft the issuing of permits depends on gauging, not only for extraction but also for drainage. Currently there is little if any gauging capacity; hence, it is questionable whether meaningful permits can be issued.

**Operation and maintenance**

Operation and Maintenance (O&M) of community water points is essential to ensure lasting service for the community members. Through basic O&M it will be ensured a lasting life of the water points and it will be delayed the need of a replacement to the time when the acceptable life duration is over.
A reduced current investment in skilled caretakers activity and in spare parts supply and maintenance of the critical system components can protect the whole initial investment that will last longer.
The Afghan Government with support of donors should provide a fund that can pay for the spare parts such as gaskets, special parts, valves, electromechanical devices, hand pumps, electro mechanical pumps and in case of natural disasters for the replacement and repair costs for systems. Each system must be endowed with a O&M book where the replacement of each component must be foreseen and where the system working data collected on the field must be recorded.
Presently the situation of O&M of rural water supply systems is very critical and can seriously affect the duration of the works and the sustainability of the investments.

**CONCLUSIONS**

The Rural Water Supply and Sanitation sector in Afghanistan is in a very critical situation from the technical point of view. Considering that in rural areas lives the 80% of the population (24.000.000 inhabitants) and that at least the 80% of them do not have access to safe drinking water and do not have acceptable sanitary conditions, which is probably the first two factor that allow a dignified condition of life, it clearly comes out the necessity of a strong intervention on it.
Besides it has to be considered the strategic relevance of the Country in the whole World political balance and the high costs that the International Community is bearing from military point of view, trying to reach the social stability in the area.
From all these reasons it descends the opportunity of a great international economic support to this sector.
Many efforts have been done. It has been provided two valid technical manuals to realize the interventions and many studies and conferences have been performed on the sustainability of the water supply systems.
The present report makes the point of the actual situation by giving an updated description of all the relevant phases, including advices and highlighting the weak points and the necessary changes.
Many weakness has been identified. Technical problems are always strictly tied with the institutional frame and to find a solution is necessary to make an integrated analyses. For example the identification of the competences of the basins Authorities or the procedural requirements for the design of the works, or the evaluation of the necessary funds and activity to support a correct operation and maintenance process, are all technical issues that are reflected in institutional procedures.
In particular in order to give to the Community responsible (that not necessarily is a technician) an easy and simplified access to the RWS systems implementation it has been provided a technical handbook with which he can program and follow all the phases of the intervention which are the following:

- Planning
- Formulation of the intervention
- Design
- Tender procedure for construction and supervision
- Construction
- Operation and maintenance

In fact only a correct execution of all these phases can guarantee the achievement of the objective to improve the Afghanistan Rural Water Supply and Sanitation sector.

# 1. INTRODUCTION

The present technical report represents the "output n. 3" of the study for the **Developing Sector Strategies and Options to Support the Afghanistan Rural Water Sector,** whose objective is to "*develop a deeper understanding on the Afghanistan's rural water sector development needs and recommend actions to improve the sector and its agencies' performance*".
According with the Terms of Reference its aim is to provide a kind of action plan which will include:

- Technical choices of water and sanitation sub-projects required for prioritized provinces – guidance note on designs, procurement and implementation.
- Technical guidance + strategy on reviving or rehabilitating existing water points
- Promoting sustainability – critical technical and institutional measures required

These three points come from the technical knowledge gaps identified in the Rural Water, Sanitation and Hygiene (WASH) Policy.
Technical indication related to the choice of the most suitable type of intervention will be analyzed and provided at regional level basing on the following factors:

a. Morphology
b. Climatology
c. Water resource and water balance
d. Actual infrastructures situation and water demand

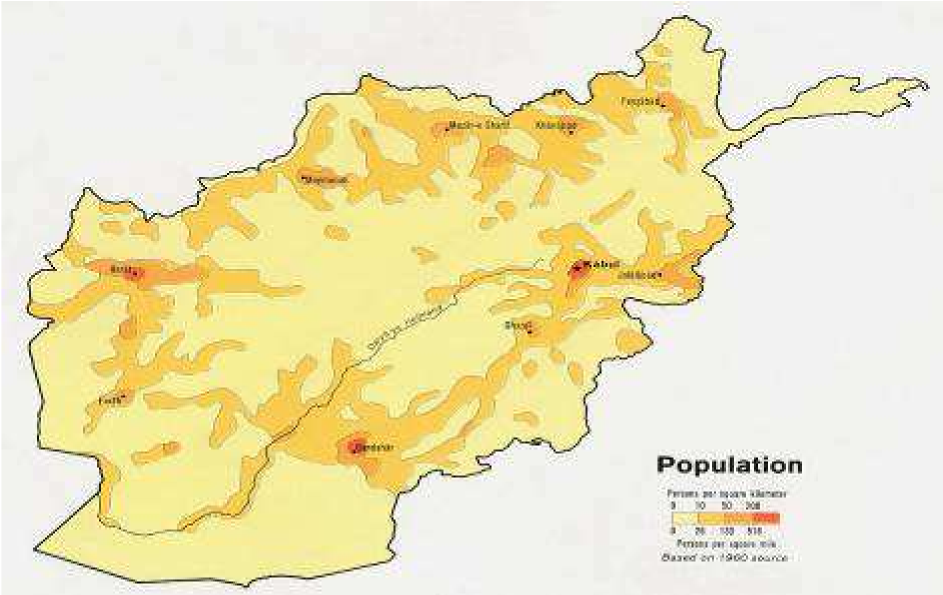
The present action plan is based also on existing information that the author could find thank to studies performed by the international consultants community. Each contribution will be mentioned.
A description of the Afghanistan context that conditions the technical choices is reported in the present chapter. Geographical, environmental, institutional and social elements are synthetically described for the aspects that interest the process that could lead to a successful implementation of water points which includes: identification, feasibility, design, construction, operation and maintenance.

# 2. COUNTRY FRAMEWORK

## 2.1 DEMOGRAPHY

No population census has been conducted in Afghanistan since 1979. The last three decades have been times of war and conflict, making it not possible to take ahead plans for developing a sound statistical and census system. According to the UN World Population Prospects 2010 Revision, Afghanistan population is presently evaluated in about 31.000.000 inhabitants.
The following map taken from http://www.foodsecurityatlas.org/afg/country/Reference-maps represents the distribution over the Country territory in 1982, after the last official census of 1979 (it was at that time 15.500.000 inhabitants).

**FIGURE- 1: AFGHANISTAN POPULATION DENSITY**




Based on National Risk and Vulnerability Assessment 2007/8 (NRVA), around 80 percent of the total population of Afghanistan is living in rural areas: 74% (around 18.5 million people) lives in rural areas and only 20 % (5.0 million) in urban areas, while 6% (1.5 million) is classified as nomadic Kuchi.

The total number of households in Afghanistan is estimated at around 3.4 million. This implies an average household size of 7.3 persons. These data are 20% inferior to the above mentioned data of the UN World Population Prospects 2010, but it can be justified with the population growth of the last 3 years. Only 11 provincial cities are considered urban (high populous urban).

According to NRVA, the majority of the poor people comes from rural areas. The main characteristic of the rural poverty is high food insecurity and a lack of access to water, infrastructure and basic public services.

## 2.2 MORPHOLOGY

The following information comes from the Study of the CA Water under the aegis of the Swiss Agency for Development and Cooperation.[1]

Afghanistan is a landlocked country of 652,000 square km. Over three quarters (approximately 75%) is mountainous. More than a quarter (27 per cent) of the national territory lies above 2,500 m[3]. It is strategically located at the cross-roads of three main regions; the Indian sub-continent to the east, central Asia to the north and the Middle East in the west. Afghanistan neighbors are the landlocked CIS countries (Turkmenistan, Uzbekistan, and Tajikistan) to the north, Pakistan to the east and south, the Islamic Republic of Iran to the west and China to the north-east. The Afghan landscape is mostly denuded – harsh desert . In the central highlands and the North-East, the Hindu Kush elevates its rugged, brownish and inhospitable slopes. Even when the relief is smoothing, the nature is not more generous. The geographers distinguish the 'lut', arid steps hostile to any cultivation from the 'dasht', steppes which turn green just after snow melt or rainfall in spring. and attract nomadic livestock.

The most extensive flatlands are located in the southwest of the country, centered around the drainage of the Hilmand basin and in the north of the country, between the northern foothills of the Amu Darya (Oxus) River (marking the border with Tajikistan and Uzbekistan). Both regions, the southwest in particular, include large areas of sand desert. These desolate landscapes contrast sharply with the exuberant and fertile alluvial irrigated plains generally surrounding the Hindu Kush mountains and the narrow irrigation strips bordering rivers that descend sinuous mountainous valleys.

[1] (http://www.cawater-info.net/afghanistan/pdf/afg_wat_atlas_part_1_2.pdf).

**FIGURE- 2: AFGHANISTAN MORPHOLOGY**

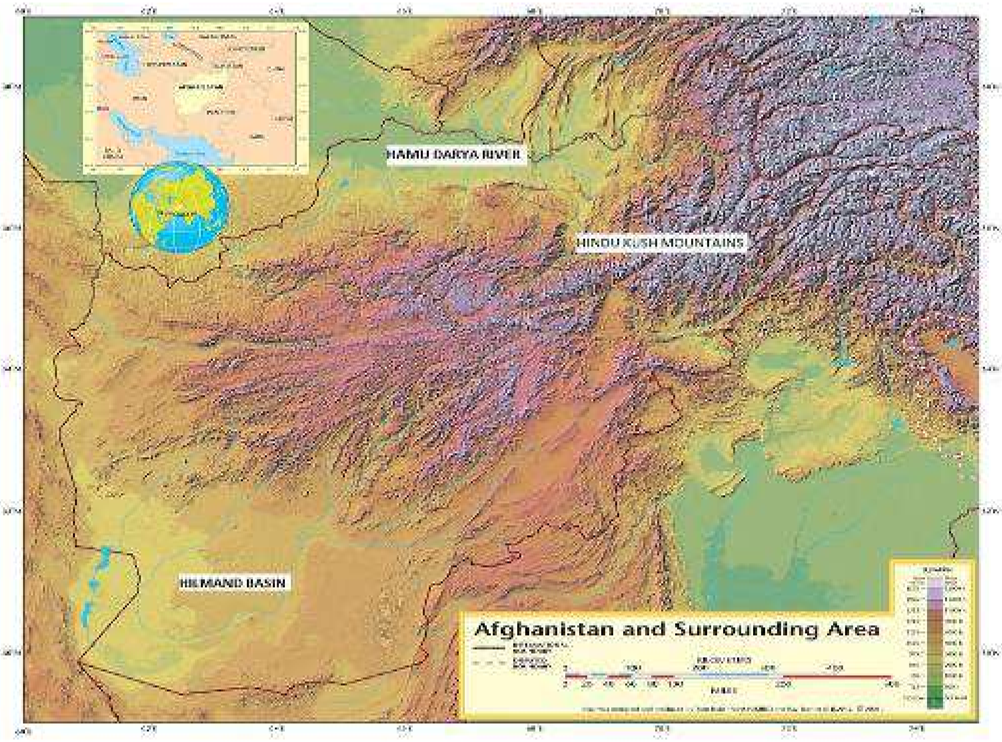
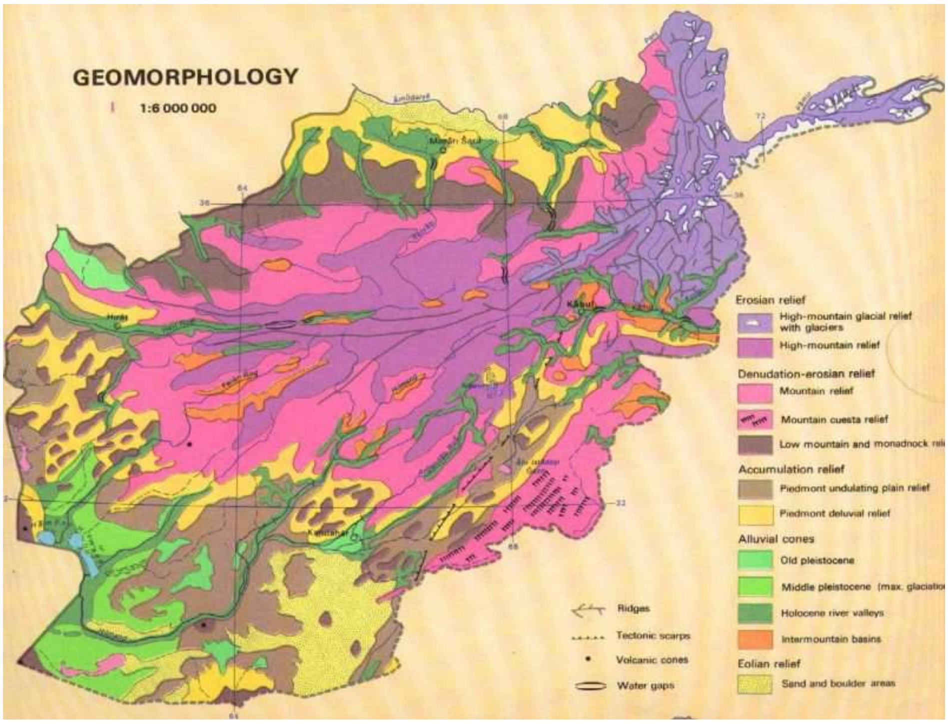



**FIGURE- 3: AFGHANISTAN GEOMORPHOLOGY**



## 2.3 HYDROLOGY

The aim of the following chapter is to describe the hydrological aspects that can affect the choice of the water source for rural water supply systems in the different areas. The following information comes from the CA Study[2]

The total amount of Afghanistan precipitation is estimated in 180 Billion cubic meters (BCM)/year. The 80% of this precipitation is concentrated in the areas above the 2000 m over the sea level. The snow reserve in the highest mountains provides a natural storage for water that descends along the river during spring and summer.

Recent estimates indicate that the country has around 80 BCM/year of potential water resources of which 58 BCM is surface water and 22 BCM is groundwater. The annual volume of water used for irrigation is estimated to be 30 BCM, while the total amount of domestic water demand for 31.000.000 inhabitants (considering a per capita need of 60 lt/day including in it all the domestic and public use except for irrigation) can be estimated about 0,8 BCM, so it is not too much relevant comparing with the total use. Total groundwater extraction (including irrigation and domestic use) amounts to some 3 BCM. Approximately 15 per cent of the total water volume used annually originates from alluvial groundwater aquifers (9 per cent) and springs (7 per cent), and almost 85 per cent from rivers and streams. Ground water used from deep wells counts for less than 0.5 per cent. In order to compare Afghanistan water availability with the availability in other Countries, it can be remarked that the annual per capita water availability in Afghanistan is approximately 2500 cubic meter, while for instance in Iran is 1400 cubic meter per capita per year and in Pakistan 1200 cubic meter per capita per year. A qualitative assessment shows that Afghanistan's water resources are still largely underused as it is shown by the data presented in Table 1:

**TABLE- 1: ESTIMATED SURFACE AND GROUND WATER BALANCE (BCM PER YEAR) IN THE WHOLE COUNTRY**

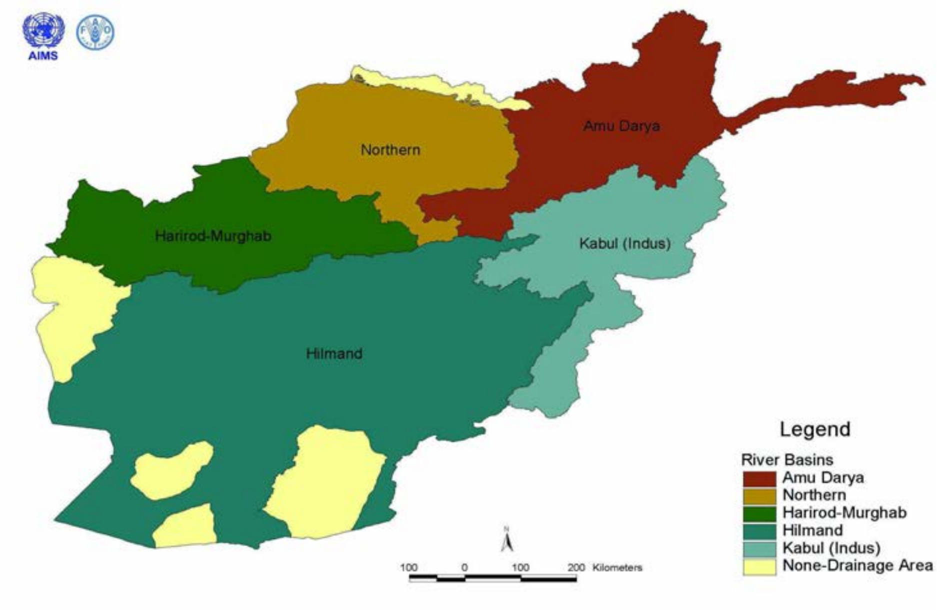
| Water Resources | Potential | Present use | Balance | Future use | Balance |
|---|---|---|---|---|---|
| Surface Water | 58 | 17 | 41 | 30 | 28 |
| Groundwater | 22 | 3 | 19 | 5 | 17 |
| Total | 80 | 20 | 60 | 35 | 45 |

This does not mean that surface water and groundwater can be used freely without any caution: first of all it must be analyzed in each area how much of this ‘potential’ resource can be accessed without damage to people and ecosystem. For example also if the general balance of groundwater is favorable it can happen that an intensive pumping in certain areas can cause a watershed drawdown or the withdraw of an excessive quantity of water from a river or a stream can affect the environment. That’s why, also in a general situation of water availability, a specific study for each intervention is recommended. In the following we try to give an indication of water balance at regional level.

From hydrological point of view Afghanistan can be divided in 5 large river basins ( seen on map xxx below): The Amu Darya basin and the Northern rivers basin in the North separated by the Hindu Kush mountain range from the Helmamd river basin and from the western rivers basins (Khash, Farharod, Aderskan, Harierod), and the Kabul and Indus basin in the East.

[2] Study of the CA Water under the aegis of the Swiss Agency for Development and Cooperation

**FIGURE- 4: AFGHANISTAN RIVER BASINS**




General characteristics of these four basins are shown in the following Table 2:

**TABLE- 2: CHARACTERISITCS OF MAJOR RIVER BASINS**

| River basin | Rivers included in this basin | Catchment area (Km2) | Storage capacity (Billion m3) | Annual runoff (km3) |
|---|---|---|---|---|
| Amu Darya and Northern basin | Wakhan, Kokcha, Kundz, Pamir/Panj, Marghab, Shrin Tagab, Sur pul, Bulkh, Kashan, Kushk, Gulran | 302.000 | 25 | 18,00 |
| Helmand river basin | Helmand, Arghandab, Ghazni, Trank, Arghastan, Musa Qala | 218.600 | 7 | 13,20 |
| Western rivers basin | Khash, Farharod, Aderskan, Harierod etc | 85.300 | 3 | |
| Kabul/Indus basin | Kabul, Kunar, Alishing, Alinegar, Logar, Pangshir, Shutol, Ghorbund, Laghman, Maidan | 72.000 | 23 | 24,00 |
| Total | | | **58** | |

There are plenty of individual discharge data of many of Afghanistan's rivers, particularly from the Kabul and the Helmand rivers as well as from their tributaries. However, no reliable documentation is available about the systematic quantification of surface water resources at watershed level. In Table 3, an attempt is made to quantify the annual surface water resources at watershed level. The limited reliability of data collected did not allow presenting the surface water resources potential at regional level. Most of the rivers listed in the table are perennial although many of them fall dry at their lower reaches during late summer due to the diversion of water for irrigation purposes. Discharges are rising continuously from March onward caused by snowmelt culminating in June/July before receding to a minimum in Dec./Jan. Most disastrous floods occur after heavy rainfall in March/April, especially when snowmelt is already well advanced.

Surface water quality is excellent in the upper basins of all rivers throughout the year and good in the lower basins in spite of large irrigated areas. As far as it is known, the presence of saline soils in irrigated areas is never caused by poor water quality but rather by over-irrigation (water logging) or eventually lack of water supply for salts leaching during irrigation (fallow fields and high ground water table).
The following table, indicating the breakdown of surface water potential at province level, can address in the choice of the source type in each area.

**TABLE- 3: ESTIMATED SURFACE WATER POTENTIAL**

| Name of River Basin | Drainage Area (km²) | Mean Ann. Vol. (mln m³) |
|---|---|---|
| **AMU DARYA BASIN** | | |
| **North-eastern river basins** | | |
| Panj | 27 800 (+ 29 000 in Tajikistan) | 35.000 |
| Kokcha | 21 100 | 5.000 |
| Kunduz | 37 100 | 6.000 |
| | | |
| **Northern river basins** | | |
| Murghab | 26 200 | 1000 |
| Kashan, Kushk, Gulran | 12 200 | 110 |
| Samangan (Khulm) | 8300 | 60 |
| Balkhab | 19 300 | 1200 |
| Saripul | 10 800 | 40 |
| Shirin Tagab | 12 100 | 100 |
| Amu Darya deserts | 27 100 | 30 |
| Total | 116 000 | 3000 |
| **Hari river (Harirud) basin** | 39 000 | 1100 |
| **DESERT BASIN** | | |
| South-western river basins | | |
| Farah | 27 800 | 1000 |
| Harut (Adraskan) | 23 800 | 210 |
| Gulistan (Bakwa desert) | 9100 | 40 |
| Khash | 10 500 | 170 |
| Kajrud | 20 800 | 60 |
| Helmand river basin | | |
| Ghazni | 19 200 | 350 |
| Helmand at Kajakai dam | 42 200 | 5000 |
| Musa Qala | 3700 | 220 |
| Arghandab | 53 000 | 820 |
| Lower Helmand | 47 900 | 110 |
| Southern river basins | 70 000 | 70 |
| **INDUS BASIN** | | |

| | | |
|---|---|---|
| South-eastern river basins | | |
| Gomal | 10 700 | 350 |
| Margo, Shamal, Kurm | 400 | |
| Total | 19 000 | 750 |
| Kabul river basin | | |
| Panjir | 11 000 | 3000 |
| Kunar | 13 000 (+ 14 000 in Pakistan) | 15000 |
| Kabul (without Panjir & Kunar) | 30 000 | 2000 |
| **TOTAL** | **642 000** | **80 000** |

*Source: Water Resources Management in Afghanistan: The Issues and Options by Asad Sarwar Qureshi IWMI, Working Paper 49*

## 2.4 HYDROGEOLOGY

### *2.4.1 General*

In Afghanistan due to complex geology different systems of aquifers are present. The principal aquifer systems include:

- Quaternary deposits in the major river valleys particularly in the Kabul River Basin,
- the river systems in the Helmand River Basin to the east (Ghazni, Tarnak, Arghistan and Arghandab),
- the Hari Rud River
- river systems within the Northern Flowing Rivers and Amu Darya Basins.
- The semi-consolidated Neocene Age deposits in the Kabul River and other river basins.
- Carbonate rock aquifer systems on the northern flank of the Hindu Kush Mountain Range and along portions of the Helmand River in Oruzgan Province.
- Carbonate rock systems at other locations.

The following consideration has been taken from Mr. Uhl Study “An overview of groundwater resources in Afghanistan” of 2003.

Unconsolidated Aquifer Systems are comprised of Quaternary and Neocene Age sediments which are found along major river systems and in intermountain basins. These sediments comprise the most prolific aquifers in Afghanistan. Most of the irrigation from groundwater sources (springs, karezes, open wells and drilled wells) is derived from these aquifer systems. The geologic map of Afghanistan, shows the locations of the Quaternary and Neocene sediments.

These aquifer systems are comprised of alternating layers of pebbles/gravels, sands, silts and clays. The sediments range from unconsolidated to partially consolidated (semiindurated).Adjacent to the mountains, the sediments are typically coarse grained and deposited, in many places, as alluvial fans.Along the major river systems, alluvial deposits are present which can be several tens of metres thick and coarse grained.

Carbonate rock systems occur within the Hindu Kush and at its northern and southern flanks. The carbonate massif to the north (Northern Flowing Rivers Basin and the western part of the Amu Darya Basin) is comprised of limestone and dolomite locally interbedded with sandstone and conglomerate. There are occurrences of sink holes, caves and caverns. Significant springs issue from the carbonate massif on the northern flank of the Hindu Kush Mountain range and some of these springs form the headwaters of the rivers in north central and northwest Afghanistan.

The principal carbonate rock aquifer systems include the Upper Cretaceous Age limestones that lie to the north of the Hindu Kush Mountain range and the older Permian and Jurassic Age carbonate rock aquifer systems in the Helmand River basin.

Consolidated bedrock aquifer systems - There is very little documentation on the groundwater development potential of the bedrock aquifer systems in Afghanistan. The yield potential of the crystalline rocks (granites, schist, gneiss, etc) is expected to be significantly lower than the unconsolidated aquifer systems in the

country. The sedimentary and igneous rock units, which underlie large parts of the country may have development potential, but as yet have not been explored in any detail

## 2.4.2 Aquifer recharge

Country wide exhaustive, evaluation of aquifer/groundwater recharge was not until now carried out. Studies were only conducted to evaluate the magnitude of groundwater recharge in specific areas.
The predominant groundwater recharge mechanisms is summarized as follow:

• The Quaternary and Neocene aquifers are recharged via infiltration from rivers and streams descending from the high mountains and infiltrating into the coarse grained alluvial fans. It is in these same geologically controlled locales (alluvial fans) that many karezes have been installed over the centuries. This recharge mechanism is probably highest during the snowmelt season. In some river valleys, direct recharge of precipitation in lowland areas occurs from snowmelt in the winter and spring seasons.
• A a component of recharge from the bounding higher elevation bedrock systems to the unconsolidated and semi-consolidated Quaternary and Neocene aquifers.
• The bedrock aquifer systems, which comprise a vast land area in Afghanistan, rely on the direct infiltration of precipitation for recharge. This recharge will vary depending on the degree of fracturing, altitude, and relative amounts of precipitation/evapotranspiration.
• The carbonate rock aquifer systems, from which large springs emerge, particularly on the northern flank of the Hindu Kush, are probably recharged from the direct infiltration of precipitation.
• The unconsolidated aquifer systems in the southern and northern desert parts of the country receive very little recharge due to the very low annual precipitation and high rate of evapotranspiration.

## 2.4.3 Groundwater Resources: Availability and Use

The following information comes from the 2003 Study “An Overview on Groundwater Resources and Challenges” [3]. It reports the analyses of the groundwater resource availability for the different river watershed.
The information is considered necessary in order to orientate the choice of the type of source: for the areas where the groundwater recharge is critical it is advisable to recur to surface water, maybe realizing basins or small lakes to storage the water, if it is not available during dry season

**Kabul River Basin**

While the estimates of groundwater recharge (FAO and Uhl/BAS study) indicate that groundwater recharge is in excess of irrigation withdrawals for the entire Kabul basin, the Uhl/BAS recharge estimate for the unconsolidated aquifer systems in the river valleys (380Mm3/yr) is less than the estimated groundwater withdrawal (450Mm3/yr) for irrigation purposes.
This is a river basin which requires an evaluation of the potential for additional groundwater withdrawals in each of the sub basins. For the southeastern tributaries of the Indus River Basin, the estimate of groundwater recharge for the unconsolidated aquifer systems (140Mm3/yr) is about double the estimated groundwater withdrawal estimate (80Mm3/yr) indicating the potential for modest additional withdrawals.

**Eastern Helmand Basin**

The estimated annual groundwater recharge (1,170Mm3/yr) is somewhat greater than the estimated usage (750Mm3/yr) However, as most of the irrigation usage is derived from unconsolidated aquifer systems, the estimated usage may well exceed the estimated annual recharge (530Mm3/yr) for the unconsolidated aquifer systems. The groundwater systems in the Eastern Helmand Basin require hydro-geological investigations and monitoring to assess sustainability at current and projected future rates of withdrawal.

**Western Helmand Basin**

The estimated annual recharge (1,310Mm3/yr) for the upper part of the Western Helmand River Basin is considerably larger than the estimated groundwater use for irrigation (750Mm3/yr). Overall, the middle and upper Helmand River Basin likely has the potential for additional groundwater development on the basis of

[3] Vincent W. Uhl of the Uhl, Baron, Rana Associates, Inc. Washington Crossing, PA, USA assisted by Eng. M Qasem Tahiri of the Basic Afghanistan Services Kabul, Afghanistan.

groundwater use and this recharge analysis. This is another basin where a detailed hydro-geologic assessment of groundwater use and sustainability should be given priority.

**Western Rivers Basin**

The recharge estimate (500Mm3/yr) for the basin at large is somewhat higher than the estimated irrigation groundwater use (300Mm3/yr). However, the estimated recharge for the unconsolidated aquifer units (340Mm3/yr), where much of the irrigation withdrawal takes place, is comparable to irrigation usage. Overall, this basin appears to have a limited potential for natural groundwater recharge primarily because of low annual average precipitation and high evapo-transpiration rates.

**Hari Rud**

The recharge estimate (640Mm3/yr) for this basin, when compared to the 160 Mm3/yr estimated irrigation usage, indicates the potential for additional groundwater development in this basin for irrigation purposes.

**Northern Flowing Rivers**

The estimated annual groundwater use for irrigation (210Mm3/yr) is considerably lower than the groundwater recharge estimate (2,140Mm3/yr) indicating the potential for developing significant additional groundwater for irrigation purposes in The Northern Basin.

**Amu Darya Basin**

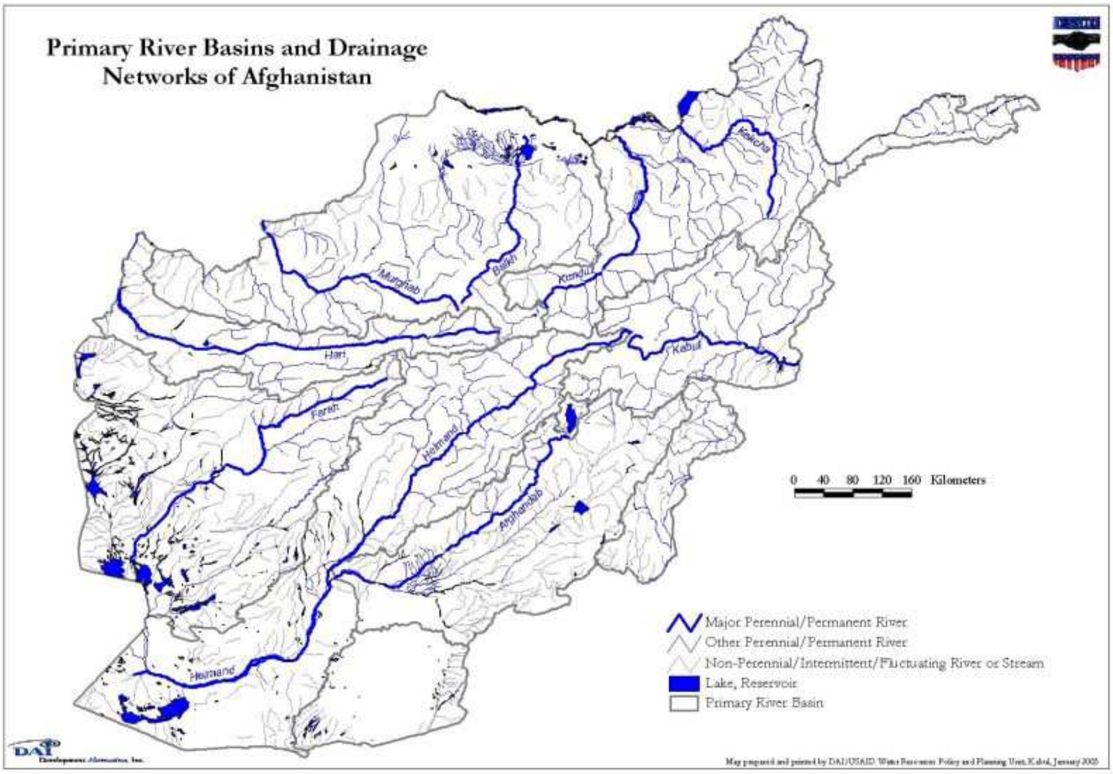
The estimated annual groundwater use for irrigation (100Mm3/yr) is minimal in comparison to the groundwater recharge estimate (2,970Mm3/yr) indicating a significant surplus of groundwater reserves in this river basin and the potential for future development of groundwater resources for irrigation in the Amu Darya Basin.

In the following table water balance data are summarized, according with Uhl Study

**TABLE- 4: RIVER BASINS WATER BALANCE DATA**

| **Groundwater recharge (10% precipitation)** | | | | | |
|---|---|---|---|---|---|
| BASIN | Surface (km2) | IRRIGATION (m3/year) | RECHARGE (m3/year) | Irrigation Area (has) | Drawdown problems |
| Kabul | 54.000 | 450.000.000 | 380.000.000 | 61.000 | X |
| Indus | 18.644 | 80.000.000 | 670.000.000 | 10.500 | |
| Easter Helmand | 72.200 | 750.000.000 | 1.170.000.000 | 100.000 | X (tributaries) |
| Western Helmand | 118.660 | 750.000.000 | 1.310.000.000 | 101.000 | |
| Rivers Khash, Farah, and Adraskan | 108.201 | 300.000.000 | 500.000.000 | 38.000 | |
| Hari Rud | 39.000 | 160.000.000 | 640.000.000 | 20.870 | |
| Northern Basins | 114.787 | 210.000.000 | 2.140.000.000 | 27.100 | |
| Amu Darya | 90.893 | 100.000.000 | 2.970.000.000 | 13.140 | |
| **TOTAL** | **616.385** | **2.800.000.000** | **9.780.000.000** | **371.610** | |

**FIGURE- 5: AFGHANISTAN MAJOR RIVERS WATERSHED**




## 2.5 CLIMATOLOGY

Climatologic aspects affect many factors of the water supply and sanitation project: for instance temperature and humidity influence the per capita water need and condition the possible solution for dejection disposal. That's why in the following a resume of the most relevant aspects are reported.

The information of this paragraph comes from the Study of the US Agency for the Development and Cooperation.[4]

The climate is typical of an arid or semiarid steppe, with cold winters and dry summers. The mountain regions of the northeast are subarctic with dry and cold winters. In the mountains bordering Pakistan, a divergent fringe effect of the monsoon, generally coming from the southeast, brings tropical air masses that determine the climate between July and September. At times, these air masses advance into central and southern Afghanistan, bringing increased humidity and some rain.

The Central Mountains, with higher peaks ascending toward the Pamir Knot, represent another distinct climatic region. From the Koh-e Baba Range to the Pamir Knot, January temperatures may drop to -15 C or lower in the highest mountain areas; July temperatures vary between 0 and 26 C depending on altitude. In the mountains the annual mean precipitation, much of which is snowfall, increases eastward and is highest in the Koh-e Baba Range, the western part of the Pamir Knot, and the Eastern Hindukush. Precipitation in these regions and the eastern monsoon area is about forty centimeters per year. The eastern monsoon area encompasses patches in the eastern border area with Pakistan, in irregular areas in eastern Afghanistan from north of Asmar to just north of Darkh-e Yahya, and occasionally as far west as the Kabul Valley. The Wakhan Corridor, however, which has temperatures ranging from 9 C in the summer to below -21 C in the winter, receives fewer than ten centimeters of rainfall annually. Permanent snow covers the highest mountain peaks. In the mountainous region adjacent to northern Pakistan, the snow is often more than two meters deep

[4] http://countrystudies.us/afghanistan/35.htm

during the winter months. Valleys often become snow traps as the high winds sweep much of the snow from mountain peaks and ridges.

The climate of the Turkistan Plains, which extend northward from the Northern Foothills, represents a transition between mountain and steppe climates. Aridity increases and temperatures rise with descending altitudes, becoming the highest along the lower Amu Darya and in the western parts of the plains.

Rainfall, occurs mostly in the winter months and particularly in the February/April period. The wet season is concentrated in winter and spring when the vegetative cover is low. In higher elevation, precipitation falls in the form of snow that is highly critical for river flow in summer. From June to October, Afghanistan receives hardly any precipitation. Precipitation generally fluctuates greatly during the course of the year in all parts of the country. Surprise rainstorms often transform the episodically flowing rivers and streams from puddles to torrents.

The southern part of Afghanistan (the valley from Herat to Ghazni) receives less than 300 mm of rain per year. The region south of Bust and Farah receives less than 100 mm of rainfall per year. The Central Highland and Northern Afghanistan receive between 300-400 mm of rain per year, while the highest mountains in these areas may receive some more (Koh-i Baba range, Band-i Baian, Safid Koh, Tirband-i Turkistan). The Hindu Kush mountains in the North-East and Eastern (western edge of summer monsoon from the Indian continent) receive above 400 mm rainfall per year.

**FIGURE- 6: AFGHANISTAN MEAN ANNUAL PRECIPITATION**

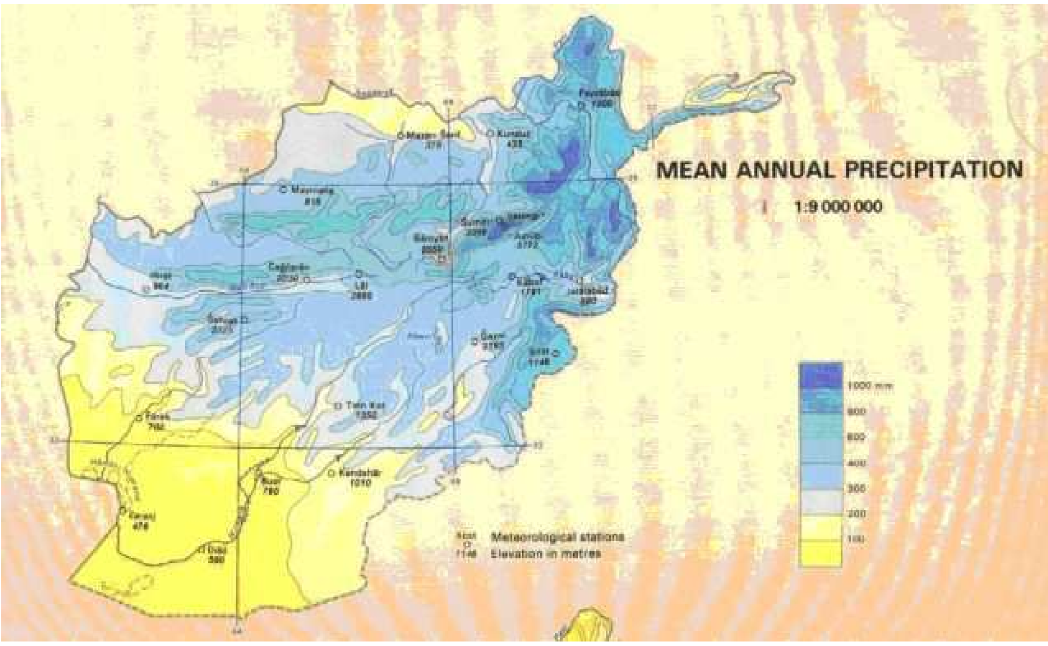


FIGURE- 7: TEMPERATURE OF THE COLDEST MONTH

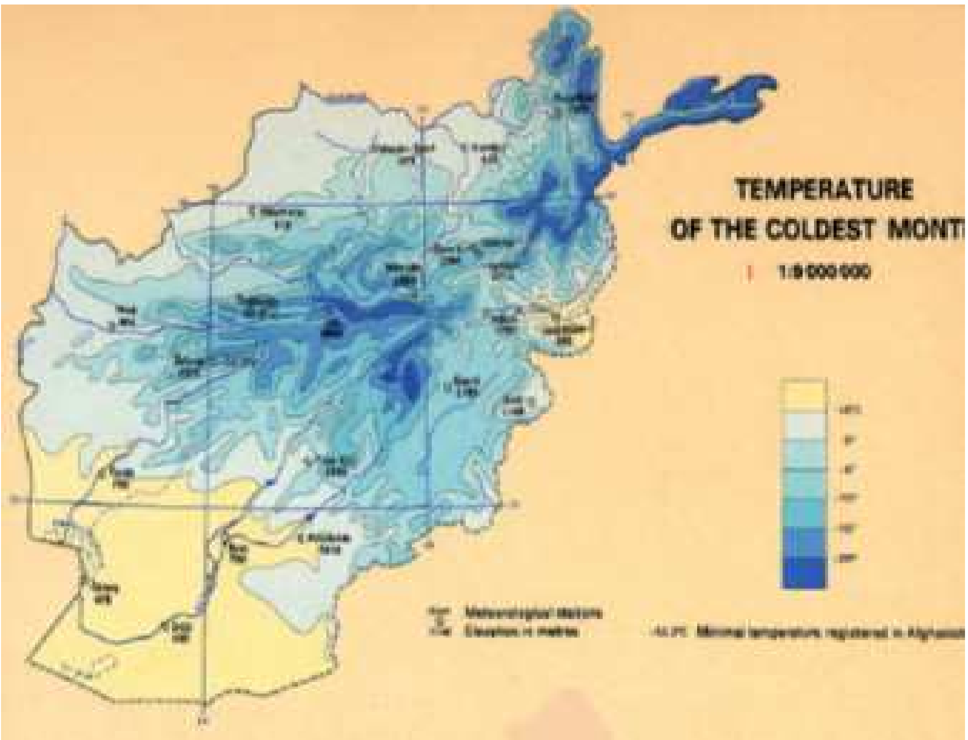
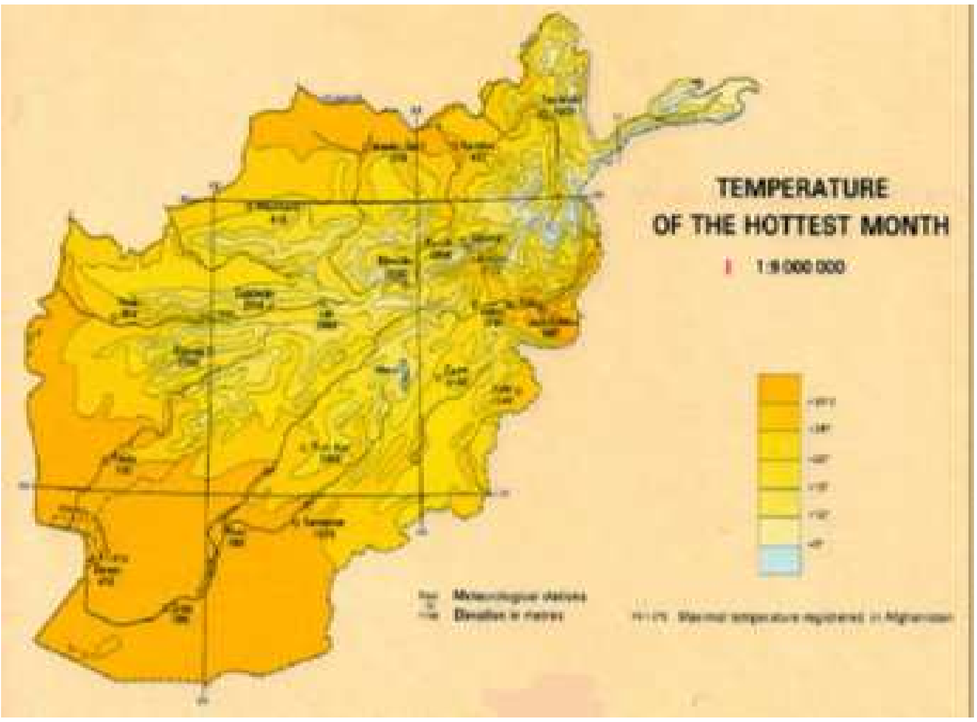



FIGURE- 8: TEMPERATURE OF THE HOTTEST MONTH



# 3. STATUS OF RURAL WATER SUPPLY SECTOR IN THE COUNTRY

## 3.1 RURAL WATER DEMAND AND NATIONAL OBJECTIVES

According with the information of the "Demography" chapter, the 80% of the 31.000.000 inhabitants of Afghanistan lives in rural areas.
The main factor of the localization of these 24.000.000 people is water availability, which involves the possibility of living and of practicing agriculture.
The sanitation indicator shows disparities: only 24% of household members in rural areas use an improved sanitation facility, while in urban areas 51% use an improved facility. Overall, 29% of household members use an improved sanitation facility.
In rural Afghanistan, sanitation coverage is low: half of rural Afghans use unimproved toilets and 20% have no toilets at all. Behind these national averages are stark disparities: between rich and poor, but also between regions in the country.
In the central Highland region, where this project took place, half of the residents have no choice but to defecate in open fields or sahrahis. Half million Afghans in this region live without access to an improved toilet, this makes the region experiencing the worst sanitation deficit in the country almost 15 times larger than the proportion in the North.
The rural water needs in a village is described in Paragraph 5.2.2 "Evaluation of flow rate".
The parameters have range of application and the calculation of the water demand in a village implies the evaluation of the livestock and of the conditions of life of the inhabitants, but applying an average value to the totality of the rural population of the Country these needs can be evaluated in a total of about 0,6 BCM/year.
Anyway MRRD has set the goal to provide over 15 million rural people in the whole Country with basic services for water supply (at least 25 liters of safe water per day per person) and sanitation facilities over the next 5 years. To achieve this target, MRRD aims to construct at least 100,000 water points across the country

## 3.2 EXISTING RURAL WATER SUPPLY SCHEMES

**Construction of water points/sources:**
According with the above reported data, in Afghanistan exist about 50.000 rural water supply systems.
The actual need can be evaluated in at least another 80.000.
**Sanitation facilities and hygiene education:**
The lack in the field of latrines is in percentage also more severe than the lack of water supply systems.
Elaborating the data of the deficiencies percentage of the World Food Programme, the number of the necessary latrines in the whole Country can be evaluated in at least 1.500.000, while the total number of the existing latrines can be evaluated in about 500.000.
It has to be highlighted that in a desirable perspective of development, the realization and operation of septic tanks is highly advisable at least for the major settlements with more than 2-3.000 inhabitants, in order to prevent health risks.

## 3.3 RESOURCE ANALYSIS

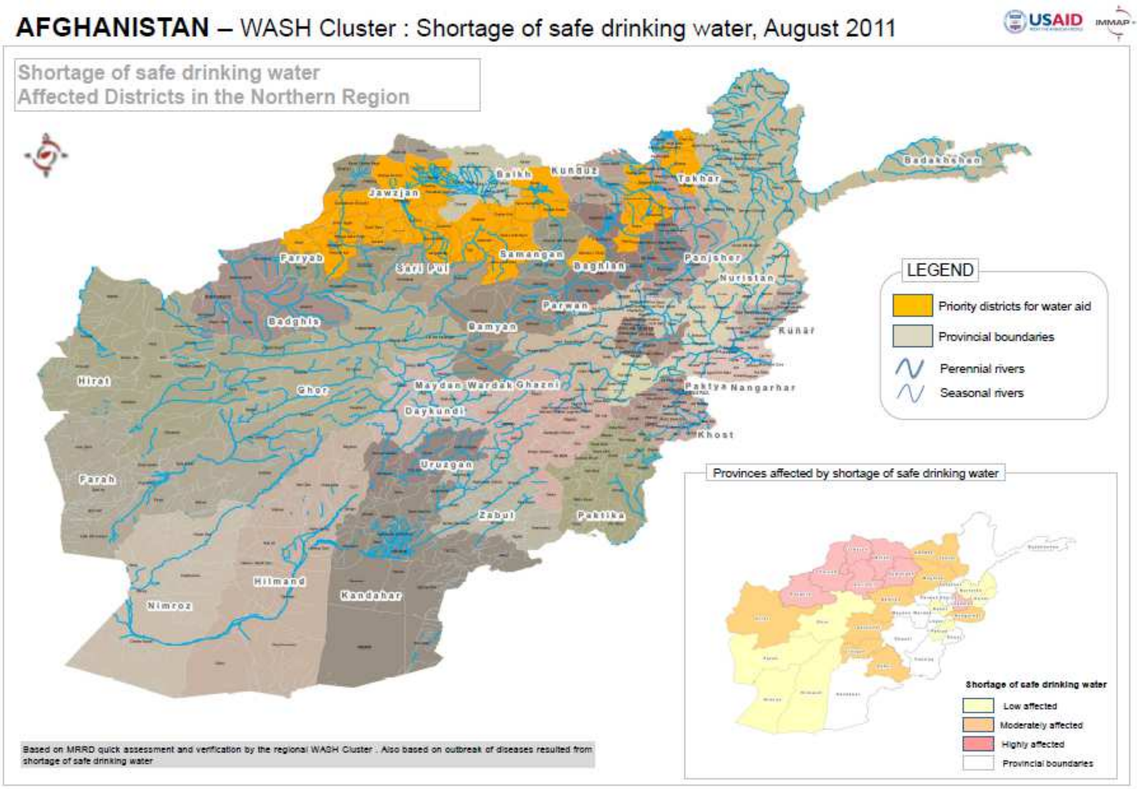
As indicated in the Chapters "Hydrology" and "Hydrogeology", the water resource in Afghanistan is quite rich, if you exclude some areas in the Kabul river's basin and in the Easter Helmand's basin where a drawdown of the unconsolidated superficial watershed has been observed.
It means that both surface water and groundwater can be used as long as each situation has to be studied in order to find out the most appropriate source also considering environmental aspects.

# 4. TECHNICAL CHOICES OF WATER AND SANITATION SUB-PROJECTS REQUIRED FOR PRIORIZATED PROVINCES

## 4.1 GENERALS

The analyses of the priority of the rural water supply interventions has been developed by the USAID together with the Society for Sustainable Development of Afghanistan (SSDA), which is an indigenous, non-profitable and non-governmental organization, within the WASH cluster.
The identified priority districts has been identified within the Northern Provinces. The selection has been done according to the water shortage for the population.

**FIGURE- 9: PRIORITY DISTRICTS FOR WATER AID IN DROUGHT AFFECTED PROVINCES (AUG 2011)**




For the technology choices for rural water supply systems in the identified Provinces, the SSDA provides the following technological options:

- Takhar Province: Gravity piped Scheme, Bore Well, Dug Wells
- Kunduz Province: Bore Wells
- Baghlan Province: Bore Wells
- Samangan Province: Dug Wells, Bore Wells
- Jawzjan Province: Underground water tank, Deep wells
- Sari Pul: Bore Wells
- Badghis: Bore Wells
- Kabul: Bore Wells

## 4.2 DUG WELLS

Generally speaking in the Unconsolidated sediments - Semi-consolidated Neocene Age along the major river's systems (Kabul river, Helmand River, Hari Rud, Amu Darya Basins) it is advisable to recur to dug wells when:

- the water table is higher than 50 meters
- the seasonal fluctuation of the water table in the area is less than 2 meters in a normal year.
- there are no roads in the area and the only transport is by animal, which is a common situation in mountain areas

## 4.3 BOREHOLES

In the Unconsolidated sediments and in the Semi-consolidated Neocene Age percussion drilling method or rotary systems are necessary as the groundwater level is too deep to be reached with dug wells.
This situation is typical of the Carbonate rock aquifer systems or in the basement rocks on the northern flank of the Hindu Kush Mountain Range and along portions of the Helmand River in Oruzgan Province.
In these areas there are lithoid formations and the depth of the well and the drilling method can vary considerably in relation to the aquifer depth and the rock consistency.

## 4.4 FLOWING WATER - KAZERES, SPRINGS

Karezes , the traditional hand dug tunnels, are ecologically sustainable, but highly vulnerable to pollution and to water shortage, being fed by the superficial watershed.
These are mainly used for irrigation in the south and southwest of the country and less in the northern areas, generally where there are long dry periods without surface water.
Because the vulnerability for this kind of catchment, water treatment (chlorination) has to be always foreseen for drinking purpose.
Spring water is a highly desirable source for a community water supply system, since it flows naturally to the surface, without the need of pumping it and as impurities and contaminants are filtered out naturally by soils, sand, and other subsurface media, obviating often the need for artificial purification methods.

## 4.5 SURFACE WATER

Rivers, lakes and other natural or artificial water bodies can be used to supply important quantities of water.
Because of the complexity of the hydraulic structure and the need of a quite complex
system of treatment this solution is advisable only for settlements of more than 10.000 inhabitants. The sustainability requires also a considerable need of funds.
In the following table is reported a census of the existing water supply schemes for civil and agricultural use in Afghanistan in the year 2002 [5].

[5] Water Resources Management in Afghanistan: the Issues and Options of Asad Sarwar Qureshi of International Water Management Institute (IWMI).

**TABLE- 5: CENSUS OF WATER SUPPLY SCHEMES IN 2002**

| No. | Province | Canals | Springs | Karez | Wells | Mills |
|---|---|---|---|---|---|---|
| 1 | Badakhshan | 212 | | 82 | 54 | 730 |
| 2 | Badghis | 120 | 50 | 30 | | 500 |
| 3 | Baghlan | 109 | 63 | | | 565 |
| 4 | Balkh | 250 | 92 | 3 | 82 | 912 |
| 5 | Bamyan | 179 | 137 | | 300 | 651 |
| 6 | Farah | 312 | 94 | 352 | 327 | 260 |
| 7 | Faryab | 157 | 79 | 960 | 867 | 1030 |
| 8 | Ghazni | 818 | 604 | 1516 | 636 | 994 |
| 9 | Ghor | 804 | 570 | 4 | 263 | 500 |
| 10 | Helmand | 227 | 135 | 276 | 60 | 516 |
| 11 | Heart | 302 | 153 | 228 | 450 | 1302 |
| 12 | Jawzjan | 382 | 87 | 2 | 443 | 475 |
| 13 | Kabul | 177 | 81 | 321 | 436 | 616 |
| 14 | Kandahar | 279 | 258 | 631 | 252 | 383 |
| 15 | Kapisa | 285 | 72 | 49 | 176 | 638 |
| 16 | Kunarha | 223 | 67 | | 13 | 681 |
| 17 | Kunduz | 88 | | | 55 | 363 |
| 18 | Laghman | 45 | 3 | | | 561 |
| 19 | Logar | 154 | 169 | 124 | 91 | 433 |
| 20 | Nangarhar | 274 | 210 | 495 | 15 | 1001 |
| 21 | Nimroz | 193 | 2 | 18 | 140 | 133 |
| 22 | Paktia | 625 | 392 | 528 | 800 | 171 |
| 23 | Parwan | 120 | 93 | 34 | | 756 |
| 24 | Samangan | 20 | 73 | 7 | 271 | 190 |
| 25 | Takhar | 316 | 288 | | 509 | 653 |
| 26 | Uruzgan | 363 | 429 | 84 | 210 | 1266 |
| 27 | Wardak | 589 | 519 | 336 | | 822 |
| 28 | Zabul | 199 | 756 | 743 | 148 | 373 |
| | **Total** | **7.822** | **5.558** | **6.741** | **6.598** | **17.475** |

# 5. TECHNICAL GUIDANCE. STRATEGY ON REVIVING OR REHABILITATING EXISTING WATER SUPPLY SYSTEMS

## 5.1 GENERAL INFORMATION

Due to the many technical inconvenient occurred to the interventions in the sector of rural water supply in the Country, lately two technical manuals have been realized under commitment of the Public Administration:

1. The Water and Sanitation Group (WSG) manual, prepared by the Rural Water, Sanitation and Irrigation Department of the Ministry of Rural Rehabilitation and Development (first version in 2006).
2. The National Solidarity Program (NSP) of MRRD manual, prepared in 2010 with several updating until 2011.

These two manuals, that can be found in the Appendices, have reached a very good quality and contain a lot of indications and technical specifications covering every kind of intervention in the sector.

The two manuals are very detailed and they are addressed to specialized technicians stakeholders.
In the following chapters is described a synthetic technical guidance that has the aim to provide a simplified "handbook" for the design, implementation, operation, maintenance and eventually rehabilitation of rural water supply systems in Afghanistan.
The easy use of this simplified "handbook" can help to avoid most of the inconvenient occurred in the past interventions.
For this reason it is suggested that MRRD provides the Community with the necessary technical support by means of a special task force, as better specified in Chapter 6. Particularly the support is considered necessary during the phase of formulation and of design of the intervention. The task force must be composed by a sociologist, an hydro-geologist and an hydraulic engineer.
It is pointed out that the analysis of the results of the rural water supply sector in the Country made it possible to identify, between the principal disadvantages, that:

- the design and the dimensioning of systems AEP are carried out without the necessary rigor and the desirable optimization;
- the harmonization and the follow-up of the interventions are insufficient regarding design, dimensioning, quality control of works and of supplied equipment.

## 5.2 GENERAL SCHEME OF A RURAL WATER SUPPLY SYSTEM

### *5.2.1 Fields of application*

The scheme we are describing is advisable for water supply system pumped with a power consume included between 100 $m^4$/day to 6.000 $m^4$/day.
It means a flow included between m $^3$ / day and 300 m $^3$ / day and a pumping height comprised between 20 m to 78 m.
In the following figure it is described the realization of a well, but all the specification related to the pumping station, the pipes and the tanks are valid also for other type of sources, like springs, karazes, rivers or small artificial lakes.

## 5.2.2 Evaluation of flow rates

The water in the villages must meet the following categories of the needs indicated in following table. Naturally, these values are indicative and each Community can review them if necessary.

**TABLE- 6: INDICATIVE WATER POINTS FLOW RATES NEEDS**

| Use | Consumption |
|---|---|
| People | 15-60 liters / inhabitant day |
| Animal feeding:<br>- horse<br>- cow<br>- lamb | <br>20 liters / day<br>20 liters / day<br>3 liters / day |
| Requirements for vegetable garden | 3 liters / day for $m^2$ |

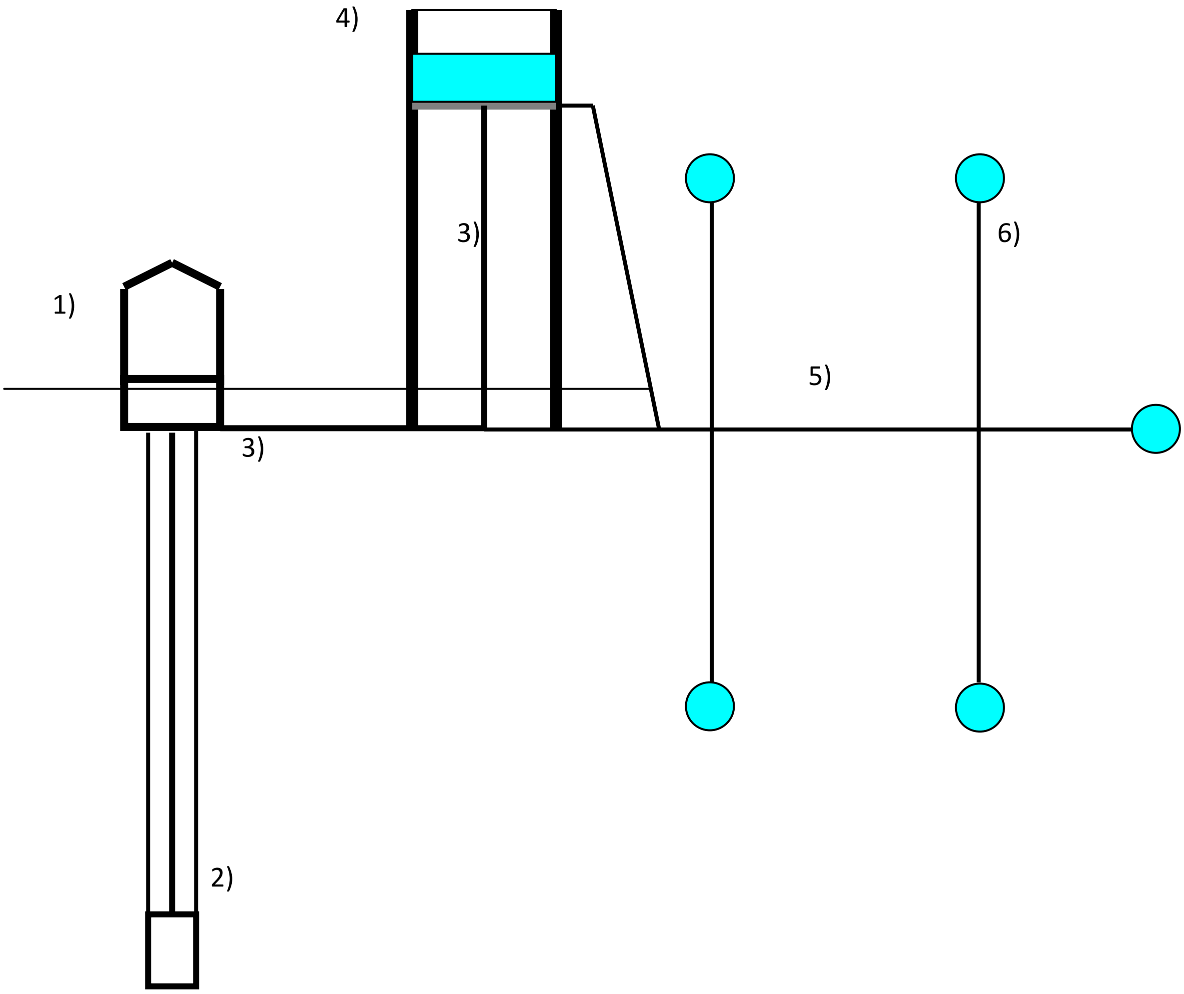
The sum of the total volumes of daily needs is the volume of the average day. The daily volume of pumping must be equal to the consumption of the peak day, which will be the average day multiplied by 1.5.
In total daily peak demand must be included losses (which, considering that networks are new, can be between 0 and 15%) and the possible increase necessary to consider the time horizon needs to 10 years .
The growth rate of population is between 0% and 4% and should be evaluated by the sociologist.
Therefore, we can estimate that, by limiting only to the people consumption, 3 $m^3$ / day can provide a village of about 50 people while 300 $m^3$ / day can provide for 5,000 inhabitants.
It has to be considered also that, since normally the limiting factor is the resource, it will be the availability of water that will give the size of the intervention and that determine the population served. In this case we cannot assume a growth rate since the system is already at the limit of its potential.

## 5.2.3 Description of scheme

The scheme of a rural water supply system is generally composed of the following components:

1. Pumping system;
2. Well;
3. Conduction pipe;
4. Water tower with chlorination and meter;
5. Distribution network;
6. Public fountains.

**FIGURE- 10: RURAL WATER SUPPLY SCHEME**




### 5.2.4 Design parameters

The standard methodology for the design of a rural water supply system is reported as follows:

a) A sociologist must assess the volume ($m^3$ / day) of the daily water need of the village making a census of the population and of other uses and multiplying for daily consumption and the leakage coefficient (K leakage ) of the system, evaluated by the hydraulic technician.

b) The sociologist must assess also the annual growth rate "c" for the population and for the other uses. With the growth rate we can evaluate c(10 years) which is the coefficient of growth in 10 years and c(20 years) which is the coefficient for growth in 20 years. These coefficients are necessary because the pumping system has to be designed for the next 10 years and the civil works for the next 20 years.

c) In case of groundwater source (wells) an hydro-geologist must assess the depth and the production of the aquifer.

d) An hydraulics technician must choose a pumping system in a condition to provide the volume of the daily requirement by c(10 years).

e) The conduction pipe will be designed basing on the maximum pumping flow.

f) The tank (water tower) volume will be evaluated making a balance with the EXCEL table in ANNEX 1, using the methodology described in par. 5.1.

g) The distribution system will be designed utilizing the flow obtained by multiplying the peak coefficient value of the hourly needs by the value of the average daily flow estimated for the 20 year horizon.

# 5.3. DRILLING

## *5.3.1 General*

In the following we describe the general aspects of the realization of a well, the choice of casing and the exploitation test. The depth of the well will be decided according to the hydro geologist opinion and it will be confirmed by the pumping tests. It is considered advisable to realize a perimeter of protection against pollution of 50 m radius to a minimum. The above mentioned precaution has to be adopted also when utilizing existing wells.

## *5.3.2 Technical characteristics of the filter pack, casing, implementation and sampling*

**Filter pack and apertures size**
The filter pack granular composition has to be suggested by the geotechnical expert according with the site geotechnical characteristics.
**Iron casing**
Diameter of the upper pump housing casing must provide sufficient clearance between the column pipe and casing to permit installation of a sounding tube or air line to measure depth to water. Extra clearance should be allowed for free operation of shaft driven pumps and the electric cable for submersible pumps. No well is exactly straight and operation will be unsatisfactory if there is misalignment. Additionally, consideration should be given to the possibility of corrosion product buildup which may lock the bowl to the casing. Consequently, pump housing casing should have a minimum diameter at least two inches greater than the nominal diameter of the most efficient pump required for the desired yield.

**TABLE- 7: REQUIREMENTS FOR IRON CASING DESIGN**

| CASING DIAMETERS | |
|---|---|
| Nominal Pipes Diameter (Inches - cm) | Minimum Casing I.D. (inches - cm) |
| 8” - 20 cm | 10” – 25 cm |
| 10 – 25 cm | 12” – 30 cm |
| 12” – 30 cm | 14” – 35 cm |
| 14” – 35 cm | 16” – 40 cm |
| 16” – 40 cm | 18” – 45 cm |

The well screen should have the largest possible apertures size consistent with retaining the filter pack in a gravel envelope well, or formation material in non-gravel envelope wells. Typically slots for metal screens could be “torch cut”, milled, wired, bridge shaped.
**PVC casing**
For smallest boreholes screen can be equipped with a PVC column endowed with centralizers equally spaced composed of elements with slots sized according to the results of the geotechnical analysis of the excavation. To achieve the best combination, it is necessary to have elements of 6 m and 3 m with original thread. Slotted elements must come from an approved manufacturing and have slots perfectly calibrated with an opening corresponding to the specification obtained in the size of the earth. In principle, for an average situation in the North of the Country, the largeness of slots could be of 0.5 mm. Drilling will be equipped with a minimum diameter of 4 ", screened to a height of 6 m, either a single element or two elements of 3 m.
The PVC column diameter should be compatible with the size of the pumps.
The base of the column will be provided with a settling tube of 3 m closed by a bottom plug.
The annular space between field and column will be gravel from the base of drilling up to 6m above the screens. The gravel should have a particle size of 2 to 5 mm. It will consist of a quartz material rolled to exclude any other material. Above the gravel, the annulus will be filled on 1m of sand and then with a 1 m cap of sobranite. Above this cap, the annular space is filled by the excavated soil taken from a depth > 5 m and

then cemented over 5 meters ahead. The casing pipe will exceed 0.50 m the soil surface. It will be temporarily closed by a PVC cap or metal padlocked. The drilling diameter for PVC casing will be between 6'' (15 cm) and 12'' (25 cm) to the depth defined by the study done, while the PVC pipe diameters will be between 4'' (10 cm) and 10'' (20 cm).
During drilling, cuttings will be collected every meter and every change of soil.
Samples will be kept on site in bags provided for this purpose and stored in a wooden box. The samples will be stored according with Supervision indication. Elements will be screwed for the half of their thickness. The thread will be square or trapezoidal, and with no eccentricities so that the handling of casing can be done without problem. The triangular thread is strictly prohibited. The PVC elements will be provided with guarantee certificate by a manufacturing factory . For the pipes the percentage of holes should be as large as possible and in every case greater than 7%. Tests must be conducted to demonstrate that casings is able to provide a resistance to external pressure of 10 bar.

**Cement**

Cement should be stored in the original bags, triple envelope, with the exclusion of any other packaging, away from contact with water or excessive moisture (in slatted pallets and covered with a stain canvas or plastic film. It may only be used after not more than three months of storage (even under the conditions defined above).
The composition of the cement mixture will be: 40 to 50 liters of water per 100 kg of slow Portland type cement. Another mixture can also be used by adding bentonite (70 liters of water, 3 to 5 kg of bentonite per 100 kg of cement).

**Gravel**

The gravel introduced into the annular space of the drilling will be clean quartz siliceous gravel, with the size of 2-5 mm for drilling in basement areas and 1-3 mm for drilling in the sedimentary area. The use of any other gravel such as round or crushed laterite is prohibited. In the annulus space above the gravel pack must be placed a sealed clay plug to prevent the risk of pollution and contamination from surface infiltration.

### *5.3.3 Drilling development*

The development will be done immediately after the completion of the drilling and of the well's equipment. The development will be performed by blowing air (with a column of air at least 40 mm) and then pumped with a submersible pump or can be done using only the electric pump. The development will be continued until clear water without sandy or clay particles will be obtained. The duration of the operation is expected to be in average 3 hours. In any case, it will be extended until clear water will be obtained. If defects of water production will be noted during the well development, the work will not be approved. Flow shall be measured every 15 minutes. The water level and depth of the work will be measured after development.

### *5.3.4 Pumping test*

The boreholes flow test will be conducted by an independent unit that will operate after the development and after the return to equilibrium level. It will be used an electric pump submerged with the design characteristics (nominal diameter, power, pressure and discharge). The water flow will be maintained constant during each phase utilizing an outlet valve on the pipe. The test duration will be in total 6 hours with three consecutive phases of pumping of 1 hour followed by an observation of the rise for 3 hours. The pumping flows will be approximately as follows:
1 st phase: 1/3 of the flow tested during the development,
2 nd phase: 2/3 of the flow tested during the development,
3 d phase: maximal flow of the pump.
Levels will be measured with a light probe for each step during the pumping and the recharging phases, according to the following pace:

- Every minute until 10 minutes,
- Every 2 minutes, from 10 to 20 minutes,
- Every 5 minutes from 20 minutes to 1 hour.

This test will allow to draw the borehole's characteristic curve and clarify the critical flow rate and the corresponding drawdown. It would be used, for a more wide interpretation, to determine the hydrodynamic parameters of the aquifer in the area. After testing, it has to be done in all cases a well disinfection (injection of bleach followed by a laying for 24 hours).

## 5.4. WATER ANALYSES

A 1 liter sample of water will be collected from each type of source (river, spring, or borehole) for the quality analysis that will help define the quality and the aggressiveness of the water, besides temperature, conductivity and pH that also will be recorded at the moment of sampling.
The Contractor shall be responsible for sampling, storage and transport to the laboratory attesting the compliance of the whole operations (sampling, storage, transport) in a note duly endorsed and signed also by the consulting engineer.
The analysis will be focused on the following characteristics:
a) Physical : temperature, turbidity, conductivity, pH;
b) Chemical : TA, CT, total hardness, calcium hardness, dry residual:

- Anions: bicarbonate, carbonate, chloride, nitrate, nitrite, phosphate, sulfate, fluoride ;
- Cation, calcium, iron , magnesium, manganese, sodium, potassium, zinc, ammonium.

c) Bacteriological : bacteriological analysis will focus on pathogenic microorganisms and will assess the potability compared to WHO standards.
The main parameters to be checked are are:

- Aerobic Mesophiles
- Escherichia Coli
- Total coliform
- Pseudomonas SPP

In case of suspected presence of other pollutants, specific investigations have to be performed, such as arsenic, chrome, lead testing etc.

## 5.5. CONDUCTION PIPE

### *5.5.1 Pipe design*

Once that the source for the required daily water volume (1,5 maximum daily consumption at the temporal horizon of 20th years) has been founded, the conduction pipe that connects the source with the tank has to be realized.
Typically the conduction pipe is fed by pumped water. Its layout is as direct as possible consisting of long lines connected by wide open corners.
Profile is studied considering to place the pipe in a trench on the ground and avoiding the flat (minimum 0.2% slope).
The pipe must work always under pressure.
The pipe diameter must be determined to be as economical as possible.
For preliminary design calculations, it can be used the Bresse formula:
$D = K\,Q^{0,5}$;
where
Q is the maximum pump flow (see part 2 paragraph 2.1) by considering the increase has come for the time horizon of 20 years in $m^3$ / sec.;
D is the diameter of the pipe in m;
K = 0,80 (constant).
The parameters for sizing the discharge pipe are pressure and flow. From the values of these two parameters we obtain the nominal pressure PN and the nominal diameter of the pipe DN.
For nominal pressure PN of the pipe must be considered a maximum value between the following values:

- 1.5 times the hydrostatic pressure with the destination tank (water tower) over the full load losses in the pipe;
- 1.5 times the hydrostatic pressure with the destination tank (water tower) considering also the water hammer for sudden stop of the pump.

It has also to be considered the water hammer that has to be subtracted to the hydrostatic pressure to check the pipe depressurization.
For water hammer has been adopted following formula:
$\Delta P = a * U / g$
where
$\Delta P$ is the pressure increase in m;
U is the velocity of water in m/sec;
g is the gravitational constant in m/sec$^2$;
a (m/sec) is the wave pressure propagation velocity that for sudden water stop, and takes the value $a = (e / \rho)$ ^ 0.5 / (1 + eD / Es) ^ $^{0.5}$ where
e is the modulus of compressibility of water (kg/m$^2$),
$\rho$ water density (kg/dm3),
E is the modulus of elasticity of the pipe (kg/m$^2$),
D is the diameter of the pipe (m),
s is the thickness of the pipe (m).
For the nominal diameter calculation it can be adopted several formulas that allow to calculate the energy loss along the pipe.
One of the most classical is the formula of Strickler Gaukler:
$i = \beta_r Q^2/D^5$
where
i is the pressure drop per meter;
$\beta_r = 10{,}3/(c^2 D^{1/3})$ ;
c, the coefficient of friction, and typically is considered 100 for the PVC pipe in good conditions and 90 for the steel pipes;
Q is the maximum pump in m $^3$ / sec.;
D is the diameter of the pipe in m.
To the line losses must be added the concentrate losses concentrated in the elbows, the changes in diameter and more generally in all points of irregular water flow, which can be expressed as:
$\delta = \alpha U^2 / 2g$
where
$\delta$ is the water loss in m;
$\alpha$ is a dimensionless coefficient which depends on the type of irregularity;
U is the water velocity in m / sec. ;
g is the acceleration of gravity (9.81 m / sec. $^2$).
The designer must verify that for all the flow conditions the piezometric line must be at least 1 m above the pipe for the entire length of the pipe, so that the water is under pressure everywhere.
Besides it should be foreseen valves for discharge in all the lower points of the layout and air vents valves at all the higher points.

### *5.5.2 Material*

The most common materials used for pipes are:

- Steel for high pressure, high flow, long distance. For steel pipes has to be considered a corrosion protection.
- Polyvinyl PVC for limited pressure, flow and distance. It has to be highlighted that the rural water supply interventions are generally included in this range.
- Polyethylene PEAD with the same performance of PVC.

The characteristics of each type will be treated in the chapter on distribution lines.

In the presence of highly mineralized water where acid is suggested to avoid the steel.

### 5.5.3 Complementary devices

In case that the water hammer would jeopardize the conduction pipe, it can be foreseen a reduction device realized with an air box with a valve that opens instantly when the pressure reaches a limit value, allowing the water entrance.

## 5.6. WATER TOWER

### 5.6.1 Design

**A) Volume**

To evaluate the usable volume of the water towers it should be considered the hourly water distribution rate in the village and the pumping hours during the typical day.

The hourly water distribution rate in the village is generally very similar everywhere. A suggested distribution that considers also a 15% of water losses in the distribution network is reported in the following table:

| Day hour | Consumption rate |
|---|---|
| 0-1 | 0,15 |
| 1-2 | 0,15 |
| 2-3 | 0,15 |
| 3-4 | 0,15 |
| 4-5 | 0,15 |
| 5-6 | 0,15 |
| 6-7 | 4,00 |
| 7-8 | 3,00 |
| 8-9 | 0,85 |
| 9-10 | 0,85 |
| 10-11 | 0,85 |
| 11-12 | 0,85 |
| 12-13 | 0,85 |
| 13-14 | 0,85 |
| 14-15 | 0,85 |
| 15-16 | 0,85 |
| 16-17 | 0,85 |
| 17-18 | 0,85 |
| 18-19 | 3,00 |
| 19-20 | 4,00 |
| 20-21 | 0,15 |
| 21-22 | 0,15 |
| 22-23 | 0,15 |
| 23-24 | 0,15 |
| Average value: | 1,00 |

Considering a 16 hours/day of pumping (including night time) the usable water volume of the tank should be the 55% of the peak daily volume increased by considering the needs assessed to the consumption in the next 20 years, which is generally bigger of the peak daily pumped volume pump that is assessed to the needs of the next 10 years.

Considering a 24 hours/day of pumping the usable water volume of the tank should be only the 35% of the peak daily volume of the next 20 years.

If the power is supplied to the pumps by solar energy (for which the energy production is limited to the sunshine hours) the usable water volume of the tank should be only at least the 65% of the peak daily volume of the next 20 years.

**B) Level**

To assess the optimal level of the bottom of the water tower in general must take into account the following technical and economic considerations:

- the cost of pumping energy that rises increasing the level of the water tower (the cost should be actualized as for an immediate investment);
- the cost of the conduction pipe and of the water tower itself that grows increasing the tank level;
- the cost of the distribution pipes diameters that decreases, increasing the tank level.

Theoretically it should be done the sum of these three costs in function of the tank level and it should be found the level value corresponding to the minimum of the function.

Normally one of the following two simplified procedures can be adopted:

1. Design based on velocity in the network

- design a distribution network with a velocity of the water in the pipes between 1 and 1.5 m / sec corresponding to the peak flow value [6] taking into account that the pipes should remain at a minimum pressure of 2 m;
- calculating the tank level necessary to ensure that velocity by gravity;
- then verify check the level with the height of the pump, the water loss in the conduction pipe and the level of the water tower.

2. Design based on the water tower level

- set the maximum possible level considering a reasonable height of the tank;
- calculate the diameters of the distribution network by considering the minimum pressure of 2 m.

The most common is the procedure 2, since the limiting factor is the height of the water tower.

**C) Structure**

The dimensions of the structure of the tank, either steel or reinforced concrete, shall be calculated by considering all the charges due under the technical standards of realization foreseen by the Public Works in Afghanistan considering the climatic situation, the wind and seismic actions.

The calculation should particularly focus on the design of the foundation, checking the necessity of piles and verifying all the possible buckling situations.

#### 5.6.2 Materials

The materials most commonly used for water towers are:

- Steel
- Reinforced concrete or masonry
- Plastic materials

The piping of the tank shall be conform to DIN, with certificate of origin and manufacturer's warranty.

In presence of highly mineralized and aggressive water (pH <6), steel tanks has to be avoided.

The requirements for each type of material will be described thereafter.

### *5.6.3 General characteristics of the water tower*

The water tower will normally be equipped with:

- a dead capacity below the level of making the distribution of a height of at least 5 cm;
- an alimentation pipe ending with a gooseneck inside the tank, operable from a platform, provided with a no return valve;
- a delivery pipe located 15 cm over the floor level, with a gate valves operated from the platform, and a water meter;

[6] The value of this water flow is reported in the chapter regarding the distribution network

- a bypass that will connect the alimentation with the distribution pipe, with a gate valve and a check valve;
- an overflow and an emptying pipe connected together below the slab;
- a ventilation shaft protected with fly screen;
- a metal ladder 0.40 m wide to access the reservoir, firmly sealed to the post; the lower part (by 1.80 m) will be removable, with a system for attaching to a support and soil sealed in a concrete foundation;
- a metal ladder 0.40 wide leading down inside the tank;
- an indicator of level of water in the tank, readable from the ground;
- a railing to access safely to the hatch, by extending the ladder on top of the tank;

The water tower will be covered. It must present sufficient thermal insulation characteristics. This particular problem will be considered for metal structures that will have a white external paint.
The water overflow will be channeled to natural drainage of the ground, making sure that delivery is at a minimum distance of 10 m from the foundation of the tank and 50 m from the water source head.

**Steel tanks**

For steel water towers, which cannot be used in the presence of aggressive water, there should be a passive cathodic protection with the realization of a double buried cathode.
Surfaces not in contact with water will be systematically coated with two coats of oil paint or good quality aluminum and colored on two (2) coats of rust protection. The interior surfaces of the tank that will be in contact with water will receive two coats of alimentary paint over the two coats for rust protection.
The alimentary paint should be of good quality: it is recommendable a basic primary MODIFIED EPOXY (ref. EP 235) or a primary EPOXY CHROMATE (ref EA 746 - EB 746).
All metal surfaces before receiving the first layer of anti-rust paint should be cleaned of rust and mill and a sand blasting will be made very carefully.
All paintings must be covered by a warranty of at least 15 years.
They should have characteristics sufficient thermal insulation. All surfaces in contact with water must be stable from chemical point of view.

**Reinforced concrete or masonry tanks**

For the water towers in concrete or masonry it should be provide a waterproof epoxy resin application in the internal side.

**Plastic tanks**

For prefabricated castles made of plastic they have to respect all functional and quality requirements listed below. The manufacturer will provide all the guarantees of mechanical strength, chemical stability to temperature and sun exposure, sealing, thermal insulation established by the International Norms for drinking water reservoir.
In addition plastic panels shall be realized to prevent the transmission of light and eliminate bacterial growth of algae in the tank.
The materials used to seal joints between panels shall be chemically stable.
These materials should not be toxic and should be tested for:
a) Tests of flavor, aroma, color and turbidity.
b) Existence of toxic metals.
c) "Cyto-toxicity"
d) Micro biological development.

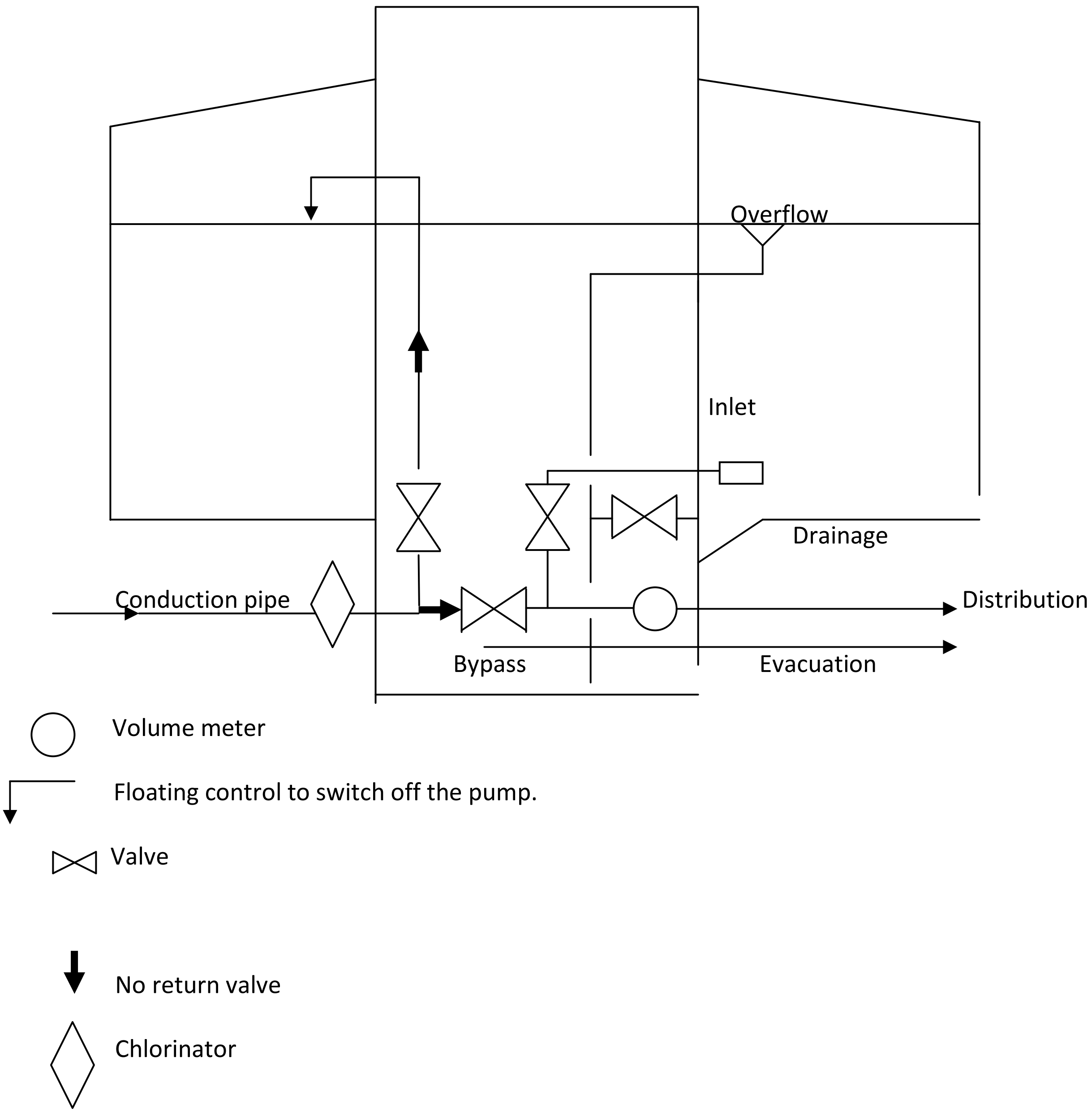
### *5.6.4 Maintenance of the tanks*

The water tower must be emptied, cleaned and disinfected every three months. For metal tanks, unless there is early degradation, every 15 years must be repeated all painting operations, including treatment with sandblasting. All equipment, valves, floats, meters, valves should be lubricated, all filters shall be cleaned and their operation should be checked every six months.

### *5.6.5 Equipment*

The water tower must be equipped with all the equipment listed in the following diagram:

**FIGURE- 11: WATER TOWER DESIGN**




In case water tests reveal the presence of organic contamination, unless major treatment has to be foreseen especially for surface water, a chlorination system at the entrance of the water tower must be foreseen.
It has to be highlight that in the experience of the author, the absence of the volume meter, of the gauge of the water level in the tank and of the floating control are often a weaknesses for the tanks in rural water supply systems.

## 5.7. PIPES OF DISTRIBUTION NETWORK

### *5.7.1 Design of the pipe*

For the pipes of the distribution network, the parameters for the design are pressure and peak flow Qp evaluated considering the needs within the next 20 years .

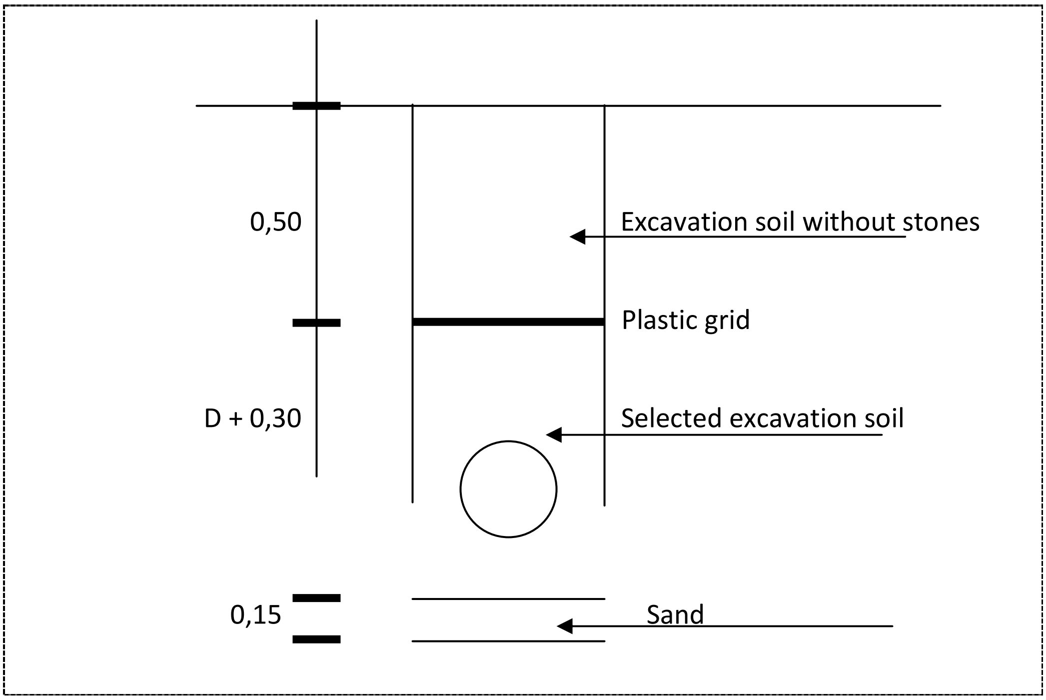
Since the time of consumption is highly concentrated in the morning and in the evening, it can be assumed that the peak flow Qp is four times the average flow of the peak day.
The network operates by gravity.
The pressure PN of the pipe must be considered superior to 1.5 times the hydrostatic pressure with the tank full and with no water flow in the pipe.
For the calculation of the nominal diameter, if the network is branched, it can be used the same formulas used for the conduction pipe proceeding from downstream to the tank.
When the network is meshed, but this is not frequent in rural water supply systems, it is better to use an automatic calculation program for meshed network.

## 5.7.2 Pipes installation in trench

**Trench preparation**

The trench must reach the level reported in the project profile. Normally the overlap should be at least 0.80 m over the pipe diameter, and should be increased to 1.20 m when crossing roads or streams. The minimum slope of the pipelines should be 0.2%)
The width of the trench should be as small as possible to limit the expropriation of land.
For small diameters (from 40 to 100 mm) is approximately 0.40 to 0.60 m. For larger diameters, there must be a clearance of 0.30 m on each side of the pipe in order to allow an easy installation.
The walls of the trench will vary depending on the longitudinal profile indications that must scrupulously respected. It must be carefully adjusted the bottom of the excavation with a constant slope between each slope change, where the pipes will be jointed with special parts.
Brushing should be done on a 2 m width, tree cutting should be done over a width of at least 5 m and grubbing for a width of 4 m.
In all cases it has to be eliminated hard bodies (like stones and masonry).
In clay soil it is recommended the pose of a bed of gravel. In shifting ground, pipes have to be put on a bed of sand or lean concrete with minimum thickness of 15 cm.

**FIGURE- 12: PIPE INSTALLATION DESIGN (CROSS-SECTION)**




All along the pipes layout cockpits are realized for the air vents and the valves or for the critical points of the pipes like at a beginning of a road crossing.
Earthworks can be done by hand or using mechanical excavators.

**Pipes handling**
Pipes must be handled with care, avoiding shocks.
Handling can be done to man's arm until 150 mm of diameter, beyond using lifting devices: goats, gantry cranes.
During the installation , pipes should be placed along the excavation, on the opposite side to the excavated soil, with the joint in the direction of the insertion.
**Pipes pose**
Before putting the pipes in the trench it has to be probed to ensure they are not cracked.
The descent is ensured to man's arm or using hoists.
To facilitate leveling, pipes are let down on clods of loose soil.
The alignment of the pipe is checked using novelettes.
After making the joints, it will be done a partial filling of the trench leaving the joint uncovered, to prevent any pipes displacement during the test.
0.30 m above the top of the pipe, it has to be placed a colored plastic mesh to alert of the presence of the pipe.
The special parts related to curbs, elbows or T must be contrasted by concrete blocks, capable to absorb all the static and dynamic effects of the water flow.
**Pipes testing**
Pressure test must be made before completing the filling of the trench, allowing to detect leaks and identify possibly seals poorly executed. The value of the pressure test should be the maximum working value multiplied by 1.5.
The test must be done on sections of moderate length (300 to 400 m). The testing pressure should be indicated in the specifications. After placing at each end of the pipe a flange for connection or insertion, each end will be closed by means of plates bolted on the flanges.
Each plate contains:

- at the upper end a air vent valve,
- at the lower end an orifice valve for filling with the connection to the pump and to the pressure gauge.

The pipe is filled slowly and completely purged before the pressure rise.
**Trench filling**
Filling must be done carefully, in layers and well groomed, using for bottom and sides of the pipes the same material as the bedding.
Backfilling is continued in the same way with the same material up to 20 cm above the pipe.
Next, over the plastic mesh, the operation ends with unselected materials.
It is recommended to backfill the trench soon after the tests to avoid leaving the joints exposed to temperature variations.
**Pipes filling**
Operating the pipes requires the following preliminary actions:

- Open the air vent devices,
- Slowly fill the pipe preferably from below with a flow rate of 1/20 of the normal expected flow,
- Close the air vent when it begins to come out only water,
- Wash the pipes several times to evacuate the earth that entered despite the precautions taken.

### *5.7.3 Equipments*

**Valves and sprinklers**
A network of water pipes is completed with valves and sprinklers which allow:

- the isolation of different parts of the network,
- the protection of pipes
- the operation of tanks and pumping stations.

**Gate valves**
In case of necessity of intervention in a single pipe of the distribution network it is useful to place valves in order to have the possibility to stop the water flow in a partial section.
In meshed networks, it is advisable to place them so as to be able to isolate each single branch.

Road and stream crossing

In case of crossing of a road or a river, the depth of the pipe must be increased until at least 1.20 m.

Crossing of major roads should be preferably realized with steel pipes inserted in a larger pipe reinforced concrete.

For crossings of streams it must be realized a protection gabion stone located downstream to the pipe, with the upper level higher to the upper level of the pipe and that has to be well lent against the bedrock.

Steel pipes

For steel pipes special precautions must be taken regarding the protection against external and internal corrosion.

The most used coatings are carboplast or specialty resins.

The joining of the pipes and of special parts can be done by autogenously welding with oxyacetylene torch or by electric welding utilizing coated rods or electrodes or can be done using bolted flanges with gaskets.

After connection by welding of pipes elements, it is essential to carefully restore the protective coating.

**PVC (Polyvinyl Chloride) pipes**

The assembly has to be done by gluing. The pipes must be prepared by scraping with a special product, then lightly coated with special glue recommended by the supplier. It should be used the amount strictly necessary, but not excessively; it has to be verified that pipes and connecting pieces are well wetted by the glue only on the parties to be in contact. No excess glue must be deposited inside the pipes, because then it is difficult to remove it. If there is some excess glue on the outside of the pipe, it must be removed immediately. This because glue excess can soften the plastic, and pipes can explode once in service.

This type of joint, that can be realized very easily, has to be considered nearly indestructible.

Manufacturers deliver pipes with preformed fitting in factory.

A toroidal compressed rubber seal ring should be placed between a metal connector and the pipe.

The PVC pipes can also be connected by welding operating at the melting point. This method is very tricky, and can be reliably be used only in a workshop by highly experienced workers, otherwise breakage of the welds is risked.

**Polyethylene pipes**

Polyethylene pipes are thermoplastic. Nevertheless they cannot be welded, as the material decomposes at the melting temperature.

Also the use of glue is not advisable for the material characteristic. The material is more expensive than PVC, it is sometimes used for the advantage of the flexibility that allows to transport great lengths of the pipe in rolled up crowns that can be posed without joints. The characteristics of this material force to use a joint system by pinching on the largest possible area carefully avoiding the cut effect, because polyethylene is more sensitive to this phenomenon than PVC.

### *5.7.4 Maintenance of pipes*

Water pipes must be emptied, cleaned and disinfected every six months.

All equipment, valves, floats, meters should be lubricated, the cleaning of the filters should be made and the operation of all the equipment should be checked every six months.

## 5.8. SUMMARY OF PARAMETERS FOR THE DESIGN

In the following parameters for the design are summarized:

a) Daily pumping volume:

$V_{pump}$ (m $^3$ / jour) = Σ ( sum of all the daily needs) x $K_{loss}$ x $K_{10years}$ ;

$K_{loss}$ : is the coefficient for losses. It is included between 1 and 1.15;

$K_{10\ years}$ : is the coefficient of growth in 10 years. It is included between 1 (growth 0) and 1.48 (growth 4% / year).

b) Flow of the conduction pipe (with 24 pumping hours/day):

$Q_{ref}$ (l / sec.) = $V_{Pump}$ K x $_{10\text{-}20ans}$ / 86.4;

$V_{Pump}$ is the volume consumed during the peak day multiplied by 1,5; $K_{10\text{-}U20}$ is the coefficient of growth from 10 to 20 years.

c) Usable volume of the tank:

$V_{tank.}$ ($m^3$) . = 35-70% (see the above chapter) of $V_{pump}$ x $H_{-10\ 20ans}$ ;

d) Flow of the distribution pipes:

$Q_{Distr}$ (l / sec.) = $V_{Pompe}$ K x $_{10\text{-}20ans}$ x $H_{distr}$ / 86.4;

$K_{Dist}$ is the coefficient of the peak value of the hourly distribution of water supply as above indicated. Value 4 is advisable.

## 5.9. PUBLIC FOUNTAINS

Public fountains are used to distribute water in the street, for residents whose houses are not supplied with water.

There are many types of fountains but they all consist essentially of a cast iron container with an iron standpipe inside, controlled by a valve communicating with the drainage. The valve is controlled from outside by means of a button, a lever or a wheel.

The floor of the standpipe should be done in concrete so to promote the flow of water to the drainage.

In order to foster the assumption of responsibility by the Community in water use, it is advisable that each hydrant has its own meter to be installed in a box closed by a concrete slab with steel padlocks.

Water drainage will be channeled to natural drainage of the ground or into a sump, taking care that the evacuation is a minimum distance of 50 m from the source.

**FIGURE- 13: FOUNTAIN MODEL ADAPT FOR SMALL TOWNS**

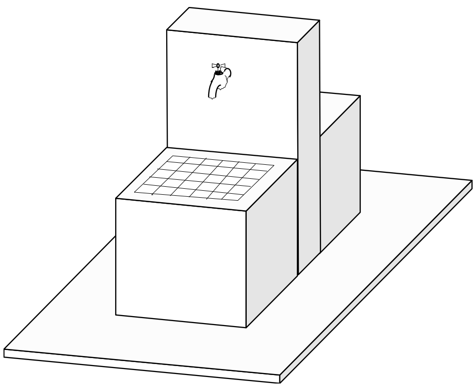
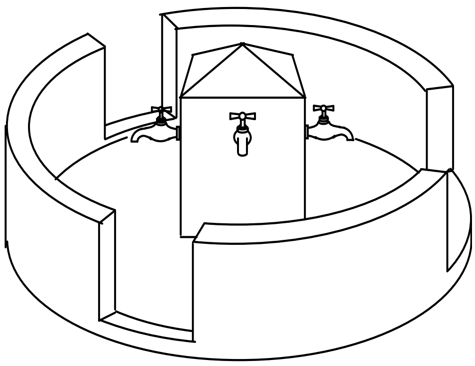


**FIGURE- 14: FOUNTAIN MODEL ADAPT FOR VILLAGES**



## 5.10. ANIMAL WATERING HOLE

Animal water holes are preferable in concrete than in steel for better resistance to solar heating. The cross section in contact with the water must be circular with a radius of curvature of maximum 20 cm, so that the level is sufficient to allow the livestock to drink without wasting water.

Access should be simple, the height between 50 and 65 cm from soil.

The longitudinal section must have a slope minimum of 2% with an opening in the part opposite the valve.

Around the watering hole until the distance of 2 meters in each direction, there must be a clean surface in masonry and concrete.

Also for animal water holes must be provided a counter to be installed in a box closed by a concrete slab with steel padlocks. Inside the box there should be also installed a valve.

The water supply of the watering hole should be done trough a free pipe placed above the water level. This to prevent any backflow into the network .

Water drainage will be channeled to natural drainage of the land, taking care that the evacuation is a minimum distance of 100 m from the source.

## 5.11 PROCUREMENT

The design and implementation of projects related to water and especially those related to groundwater, are almost always underestimated and entrusted to entities with little or no specific experience.
Bearing in mind that the handling of water is an extremely sensitive, a procurement tender has be done especially for majors water supply systems, either for the Design and Supervision either for the Construction works either for the Maintenance of the water systems.
A proposal is to manage these tenders at Regional level by the local MRRD technical structure that can address the general guidance of the interventions. The waters point to be implemented can be grouped in homogenous lots enough big to interest experienced Contractor (min. can be 15.000 Euro) but not too big to require the intervention of a foreign Contractor (max. can be 200.000 Euro).
The tenders can be carried out or by Local Authorities or by the Central Administration.

## 5.12 IMPLEMENTATION

From the point of view of the withdraw and lifting of the resource, water points can be of various types depending on the local situations and include hand pumps, gravity flow, pumping systems with overhead tanks, solar pumping systems with overhead tanks, etc-.
The main organizations operating in the WASH (DCAAR; USAID) have abandoned the direct implementation of the water point, the works are agreed to Contractors with closely supervision and monitoring of the Contractors work by an independent technician.

So the suggested item is the following:

- The Local Communities present to the Regional Administration of MRRD (RA) the demand for an intervention for the realization of a Rural Water Supply system.
- The RA by mean of its technical task force makes free of costs a first formulation of the intervention, determining the technical characteristics (water volume, water source, type of scheme, cost of the works, necessary local support for sustainability in terms of maintenance and operation).
- Each Community deliberates the intervention and allocates the money also appointing a responsible for the village water supply (mirab).
- The RA prepares and publish a tender to the minimum prize for the intervention works, in case grouping it with others. The design and the technical prescription can be prepared either freely by the RA or by an engineer paid by the Community.
- The RA or the Community appoints and pay a Supervisor.
- The work is executed by the Contractor, tested and delivered to the Community that engage itself to the maintenance and the operation by means of the local responsible.

## 5.13 STRATEGY ON REVIVING OR REHABILITATING EXISTING WATER POINTS

Water well problems result from many causes including equipment failure, depletion of the aquifer, corrosive qualities of the water and improper well design and construction.
Correctly identifying the cause enables to select appropriate treatment or maintenance to fix the problem or to abandon the well.
A working mechanism shall be developed within the prevailing governmental organizational set up for monitoring wells in the community and supporting the community in resolving problems, and in technical matters
Some organizations have made different systems to collect the data:

- USAID through telephones that can be further augmented through spreadsheet information and that can be made available for viewing on the internet
- Dacaar has set up a monitoring net with monthly controls of the quality and performance of the water points. The data are introduced in a GIS and they can easily controlled and crossed.

Their reports indicate that 30% to 50% of water points in different parts of the country are dysfunctional. Their failure are due to drying of water sources; falling water tables; damage from natural disasters; poor quality of construction materials and equipment; lack of standardization and oversight; poor operation and maintenance services; coordination issues with the private sector; and lack of community ownership.

**TABLE- 8: WATER POINTS FAILURE TYPES AND CAUSES, DACAAR**

| Failure type | Cause |
|---|---|
| Depletion of the source | Lack or deficiency of appropriate investigation |
| Well silted | Deficiency in construction |
| Well collapse | Deficiency in construction |
| Water polluted immediately after construction | Lack or deficiency of appropriate investigations |
| Water pollution in exercise | Deficiency in construction, sources of pollution close to the water point |
| Water table pollution | diffuse sources of pollution in the area |
| Pump break down | Lack of maintenance and/or/spare parts |

In order to enable monitoring, information of all the wells shall be maintained in MRRD in a very simple format agreed by all the stakeholders and any new construction shall be reported in this format to RRD. RRD shall be provided with a simple database software for this and trained in its use. Similarly a second simple format shall be developed for updating the status of functioning of wells and the system of operation and maintenance while carrying out the monitoring work above.

Strong operation and maintenance system, in a GIS form including help/support desks with internet connections at the provincial and district levels for CDCs and their facilitating partners should be provided to facilitate information sharing and consultative problem solving.

### *5.13.1 Rehabilitation or reviving water wells*

Henceforward, are illustrated the common symptoms associated with most water well failures:

- Reduced well yield
- Sediment in the water
- Change in water quality
- Dissolved gas in the water

In annexure 3 tables indicating the possible causes of these four symptoms are presented, together with indications on what has to be checked for and how to correct the inconvenient if the check identify one of the malfunctioning causes.

The guide has been produced by the Government of Alberta (CANADA) Agricultural and Rural Development Direction and can be found at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/wwg412 .

## 5.14 INTEGRATING OBSERVATIONS TO THE EXISTING MANUALS

### *5.14.1 Wells prescriptions*

The following suggestions and observations aim to complete and improve the two MRRD existing manuals mentioned in Chapter 5.1:

**Well location**

The location of a well is mainly determined by the well's purpose. For drinking water-production wells, groundwater quality and long-term groundwater supply are the most important considerations.

The hydro-geological assessment to determine whether and where to locate a well should always be done by a professional consultant.

Wells should be located above grade of all potential sources of pollution, and at least 100 m from any septic tank disposal areas, latrine, cesspools, or any livestock or barnyard areas and it must keep far rain or runoff that can transport bacteria inside the water.

Dug wells

The design proposed in the MRRD Implementation manual doesn't assure the protection from contamination being the ground around the well is not sloped, and not being foresee water tight lining.

The condition for a properly constructed dug well are:

- the dug well should be at least 3.6 m of depth to be protected by the runoff of the surface water.
- the space from the bottom of the well up to the liner bottom should be lined with rock, or small boulders
- a water-tight liner is needed for a depth of at least 3 m with the liner reaching at least
- 50 cm above the surface of the ground
- an overlapping, water-tight cover with a screened vent is needed (wooden covers should not be used as they harbour bacteria-carrying insects.)
- the ground around the dug well should be covered by a concrete slab sloped to direct surface water away from the well
- dip buckets should not be used as they can bring dirt and bacteria into a well
- where the discharge line connection is made below ground, the connection should be made water-tight with a strong, non-toxic sealing material
- the water service line should be about 1.5 m below the surface to protect it from pollution.

**FIGURE- 15: WELL WITH CONTAMINATION PROTECTION**

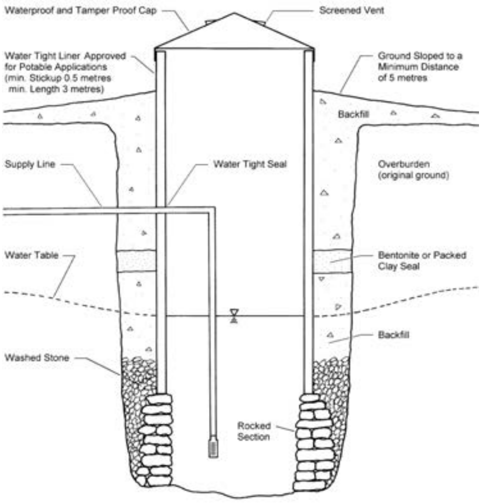
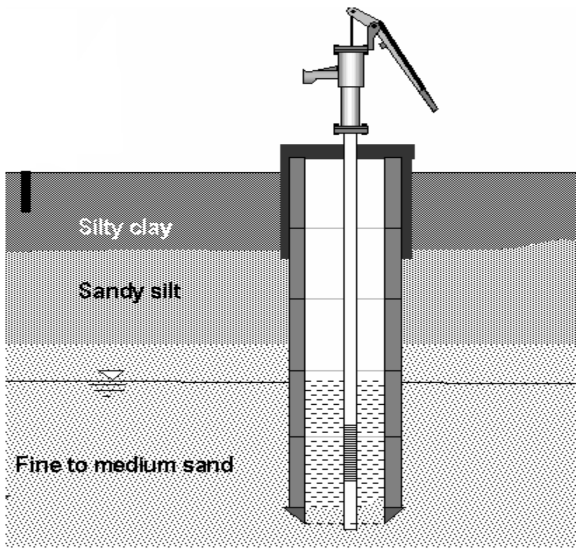



**FIGURE- 16: DUG WELL WITHOUT POLLUTION (MRRD MANUAL)PROTECTION**




A drilled well consists of a hole bored into the ground, with the upper part being lined with casing. The casing prevents the collapse of the borehole walls and (with a drive shoe or grout seal) prevents surface or subsurface contaminants from entering the water supply.

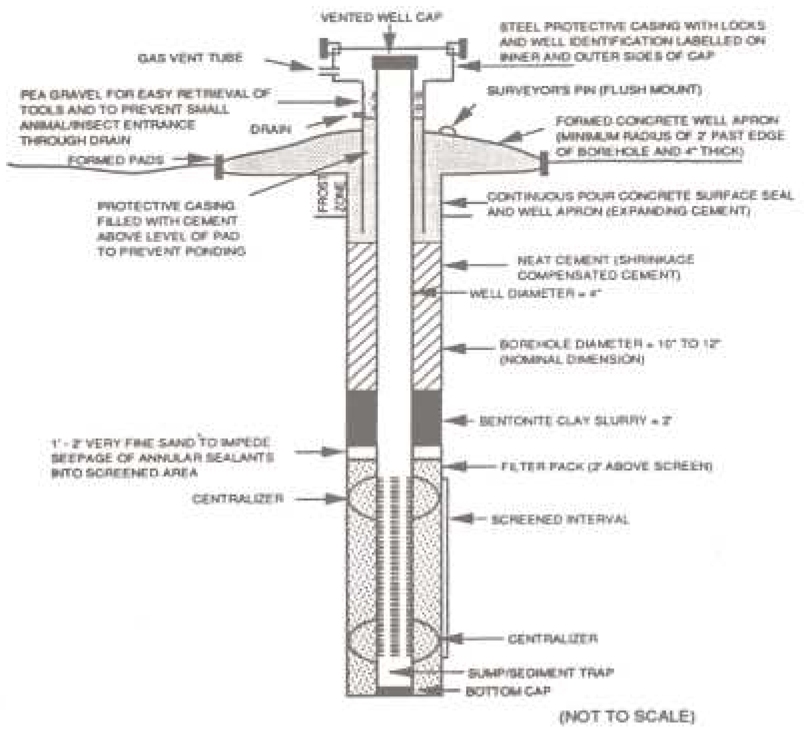
**Drilled wells**

The well shall be capped to provide sanitary protection. Well caps require an air vent, that must be shielded and screened to prevent the entry of foreign material such as insects into the well.

In Fig 16, taken from the MRRD manual, it  is not shown any grouting to prevent water infiltration from the surface and any air vent.

The correct devices are shown in the scheme below, taken from USEPA documents:

**FIGURE- 17: SUGGESTED DRILLED WELL DESIGN REVISION**




The following factors should be cared in the borehole construction:

- leave a sufficient annular space;
- to realize an accurate borehole alignment;
- to join the total depth of the hole including the slump trap and the bottom cap;
- to make a correct selection of backfill material;
- to correctly develop the well.
- The annular space is the gap between the outside of the casing and the borehole wall.
- The annular space should be large enough to allow clearance around the  external surface of the pipe where the filter pack and annular seal material will be placed.

Recommended annular space widths are as follows:

- between casing and borehole wall – 60 mm minimum;
- between well casing and conductor casing – 50 mm minimum;
- between surface conductor casing and borehole wall – 75 mm minimum;
- maximum annular space - 130.

Annular space widths larger than 130 mm may make difficult the well development, or may cause casing damage for heating during grout curing.

In situations where precise lithologic data are needed (e.g., dipping or folded strata), or the location of target zones is critical, borehole alignment becomes an important criterion for monitoring well screen placement.

**Casing and screen material general characteristics**

The selection of appropriate materials for monitoring well casings and screens should consider several site-specific factors including:

- Geologic environment,
- Geochemical environment (both soil and ground water),
- Anticipated well depth,
- Types and concentrations of suspected contaminants,
- Design life of the monitoring well, and
- Its potential to be brought into service for injection or extraction

In the following figure are reported the USEPA prescriptions for drilled wells casing.

**FIGURE- 18: DRILLED WELLS CASING PRESCRIPTIONS (USEPA)**

| | Do Not Use: | Use: |
|---|---|---|
| 1. | PTFE if well depth exceeds 225-375' (68.6-114m). | PVC, ABS, SS. |
| 2. | PVC or ABS if well depth exceeds 1200-2000' (366-610m). | SS. |
| 3. | SS if pH < 7.0. | PVC, ABS, or PTFE. |
| 4. | SS if D.O. > 2 ppm. | PVC, ABS, or PTFE. |
| 5. | SS if $H_2S \geq 1$ ppm. | PVC, ABS, or PTFE. |
| 6. | SS if T.D.S. > 1000 ppm. | PVC, ABS, or PTFE. |
| 7. | SS if $CO_2$ > 50 ppm. | PVC, ABS, or PTFE. |
| 8. | SS if $Cl^-$ > 500 ppm. | PVC, ABS, or PTFE. |
| 9. | PVC if a neat PVC solvent/softening agent* is present or if the aqueous concentration of the PVC solvent/softening agent exceeds 0.25 times its solubility in water. | SS, PTFE. |
| 10. | Solvent bonded joints for PVC casings. | Threaded PVC casings. |
| 11. | Welded stainless joints. | Threaded SS casings. |
| 12. | Any PVC well casing that is not NSF-ASTM approved – D-1785 and F-480. | ASTM-NSF approved PVC well casings – D-1785 and F-480. |
| 13. | Any stainless steel casing that is not ASTM approved – A312. | ASTM approved SS 304 and SS 316 casings – A312. |
| 14. | Any ABS well casing that is not ASTM approved. | ASTM approved ABS casings – F-480. |

*Known PVC solvents/softening agents include:
*Tetrahydrofuran, cyclohexane, methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, trichloromethane, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethylene, benzene, toluene, acetone, and tetrachloroethylene.*

**Strength related characteristics**

As many failures are due to casing collapse in order to prevent them it has been considered useful to add some technical advices.

Well casing and screen materials should maintain their structural integrity and durability in the environment that they are used over their operating life.

Well casings and screens should be able to withstand the physical forces acting upon them during and following their installation, and during their use, including forces due to suspension in the borehole, grouting, development, purging, pumping, sampling, and forces exerted on them by the surrounding geologic materials.

When casing strength is evaluated, three separate yet related parameters should be evaluated:

- Tensile strength,
- Compressive strength, and
- Collapse strength

Compressive strength of casing materials are presented in the following table according to USEPA:

**FIGURE- 19: COMPRESSIVE STRENGHT OF CASING MATERIALS (USEPA)**

| Material | Casing Tensile Strength (lb) | | Casing Collapse Strength (lb/in²) | |
|---|---|---|---|---|
| | 2-in. nominal | 4-in. nominal | 2-in. nominal | 4-in. nominal |
| Polyvinylchloride (PVC) | 7,500 | 22,000 | 307 | 158 |
| PVC casing joint[b] | 2,800 | 6,050 | 300 | 150 |
| Stainless steel (SS)[c] | 37,760 | 92,000 | 896 | 315 |
| SS casing joint[b] | 15,900 | 81,750 | No data | No data |
| Polytetrafluoroethylene (PTFE) | 3,800 | No data | No data | No data |
| PTFE casing joints[b] | 540 | 1,890 | No data | No data |
| Epoxy fiberglass | 22,600 | 56,500 | 330 | 250 |
| Epoxy casing joints[d] | 14,000 | 30,000 | 230 | 150 |
| Acrylonitrile-butadiene-styrene (ABS) | 8,830 | 22,000 | No data | No data |
| ABS casing joints[d] | 3,360 | 5,600 | No data | No data |

[a]Information provided by E. I. du Pont de Nemours & Company, Wilmington, DE.
[b]All joints are flush-threaded.
[c]Stainless steel casing materials are Schedule 5 with Schedule 40 joints; other casing materials (PVC, PTFE, epoxy, ABS) are Schedule 40.
[d]Joints are not flush-threaded, but are a special type that is thicker than Schedule 40.

## *5.14.2 Flowing and surface water*

**Spring and Karez implementation prescriptions**

Spring water, together with karez, is a highly desirable source for a community water supply system although their flow can be subject to drought effects.

The best time to construct a spring is in the late summer or early fall when low water tables facilitate construction.

This will allow a deep spring while minimizing muddy conditions and excavation cave-in.

Since springs and karezs can take water from the highest water level in the soil, they can be extremely sensitive to those land use activities that take place in their immediate vicinity.

The following protective distances are required or recommended when choosing a location for a spring water supply

a) Surface water and drainage culverts should not pass within 100 m of a spring; 150 m is recommended.

b) Animals should not be penned or tied within 30 m of a spring.

c) Latrines or septic tanks must not be located upstream of a spring or within 50 m distance.

Every 6 months water quality analysis should be realized and, when it is necessary, an appropriate treatment is recommended.

**Rivers, lakes, reservoirs, etc.**

One of the most critical aspect of rivers, lakes and other surface water recipients is the high necessity of water treatment that often limits the use of them because of the important civil works to be carried out for the treatment plant and consequently by the high costs, long construction period, management and maintenance.

## *5.14.3 New technologies*

**Compact treatment plant**

At present new technologies suitable for a peak water demand of a maximum 10 $m^3$/hour are available.

This technologies are based on pre-mounted pumping – treatment units fully automatic.

Their advantage are:

- reduced cost,

- no installation works required,
- easy operating ,
- low operating cost,
- easy maintenance,
- no chemical products needed

**FIGURE- 20: COMPACT TREATMENT PLAN**

This system has three stages of the process:
1) Physical Filtration
The physical filtration can be realized in three different ways:

A) By two separate filters with different degrees of filtration, which final effect would be the retaining of particles in suspension until 5 microns,
B) By a system of rotating disks, that also allows a high degree of mechanical filtration, (until 5 microns),
C) By sand filters through which it is possible to obtain degrees of filtration higher than 60/80 micron,

2) Chemical filtration
Chemical filtration through activated carbon can eliminate some chemical micro-pollutants, bad taste and smell and improve the degree of filtration of suspended particles smaller than 5 microns and decolourise.
3) Bacteriological treatment
The bacteriological treatment is generally done with a double plant UV sterilizers.

**Booster pump**

A booster pump pumps directly from a ground reservoir to the net by a group driven by an inverter.
This arrangement allows to save the money for the construction of an elevated tank and allows an important energy saving with economic and ecologic benefits, because the water is pumped at the pressure strictly necessary in the network.
Nevertheless it must be told that a booster system is more insecure from the point of view of the distribution network and the pump works in a less stable way, and for this reason is not suitable for big network.

**Pumping systems fed by solar panels**

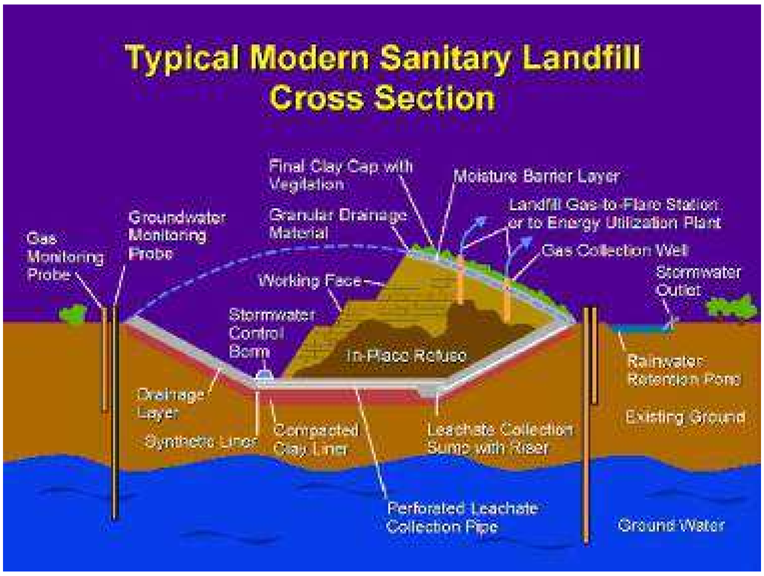
A solar panels system is able to provide energy for a pumping station which is able to feed a water supply network up to 3000 people.
Photovoltaic panels have been utilized recently in a UE project in the Sahel Countries in Africa for rural water supply systems pumping station with a power between 100 $m^4$/day (200 Wc) and 6.000 $m^4$/jour (12.000 Wc). The flow was included between 3 $m^3$/day and 300 $m^3$/day for a population between 50 and 5.000 inhabitants. For these water flow the solar panels allowed a pumping height between 20 m and 80 m.
When using photovoltaic systems all the hydraulic parameters for the design of the conduction pipe and the tank volume has to be reviewed.

**Sanitation**

The health politic aims to push the people to increase the latrine instead of open defecation.
We have to underline that the increase of latrine number in a small area can be a possible source of contamination of the ground water.

Therefore the water wells have to be built upstream of the villages and minimum at 100 m from the border of the village.
We must remember also that the latrines are to be emptied regularly. Therefore it is necessary draw up a sanitary landfill where to place the material derived. This site must be located  downstream of the water sources. In the next picture is described a t.

**FIGURE- 21: SANITARY LANDFILL DIAGRAM**




**Water Source Protection Measures**
By its nature, water supply sources and especially related works need to be protected against potential sanitary hazards. In the absence of a source protection plan and lack of implementation of its provisions most water supply works are prone to sanitary hazards.
Further some specific types of sources such as springs and shallow wells are more vulnerable to sanitary hazards. Source protection plans require understanding and attention to details.
Source protection plans lay the basis for any hazard mitigation measures such as spring fencing to ward off grazing animal and hence animal excreta. List of major sanitary hazards include presence in the watershed or close proximity of the scheme, of the following:

- Drainage ditches and latrine;
- Grazing animals, animal and human excreta defecated around ;
- Missing covers, open to sky reservoirs/spring box etc
- Leaking valves
- Broken seals allowing ingress of polluted waters

**Disinfection**
In order to prevent diarrheic diseases, in many case it is necessary to disinfect the water. Different way of disinfection can be used; the main systems for small and medium systems are chlorination treatment; other low-cost method of disinfecting water that can be implemented with locally available materials is solar disinfection (SODIS).
A recent study has found that the wild Salmonella which would reproduce quickly during subsequent dark storage of solar-disinfected water could be controlled by the addition of just 10 parts per million of hydrogen peroxide.
Disinfection is accomplished by filtering out harmful micro-organisms and by adding disinfectant chemicals. Water is disinfected to kill any pathogen component which pass through the filters and to provide a residual dose of disinfectant to kill or inactivate potentially harmful micro-organisms in the storage and distribution systems.

Following the introduction of any chemical disinfecting agent, the water is usually held in temporary storage in order to easy the solution of the agent.

- Chlorine disinfection

The most common disinfection method involves some form of chlorine or its compounds such as chloramines or chlorine dioxide. Chlorine is a strong oxidant that rapidly kills many harmful micro-organisms. Because chlorine is a toxic gas, there is a danger of a release associated with its use. This problem is avoided by the use of sodium hypochlorite, which is a relatively inexpensive solution that releases free chlorine when dissolved in water.

- Ultraviolet disinfection

Ultraviolet light is very effective at inactivating cysts, in low turbidity water. UV light's disinfection effectiveness decreases as turbidity increases, a result of the absorption, scattering, and shadowing caused by the suspended solids. The main disadvantage to the use of UV radiation is that, like ozone treatment, it leaves no residual disinfectant in the water; therefore, it is sometimes necessary to add a residual disinfectant after the primary disinfection process. This is often done through the addition of chloramines, discussed above as a primary disinfectant. When used in this manner, chloramines provide an effective residual disinfectant with very few of the negative aspects of chlorination.

- Solar water disinfection ,

It also known as SODIS is a method of disinfecting water using only sunlight and plastic PET bottles. SODIS is a free and effective method for decentralized water treatment, usually applied at the household level and is recommended by the World Health Organization as a viable method for household water treatment and safe storage. SODIS is already applied in numerous developing countries. FINOQUI

## *5.14.4 Latrines*

**Generals**

There are several technologies to realize latrines in ruarl areas. Each one presents advantages and disadvantages. Many of them are very well illustrated in the WATSAN manual. In the following most attention is given to the dehydratation system that is not mentioned in the manuals and that can be considered a good option for the lower sea level areas with warmer climate. It has to be considered that the system effectivness is not high during the cold season, in which dehydratation is slow and a removal of major quantities has to be done.

**FIGURE- 22: -VAULT DEHYDRATION TOILET WITH INCLINED LIDS TO INCREASE THE SOLAR HEATING EFFECT**

**Basic principles**

In a dehydration toilet, the excreta inside the processing vault are dried with the help of sun, natural evaporation and ventilation. The toilet requires no flushing water. Dehydration toilets are increasingly popular

in the developing world. They can be succesfully used in various climatic conditions and are most advatageous in arid climates where water is scarce and faeces can be effectively dried. The faeces are collected in a chamber below the toilet (or squatting hole) and are dried. High temperature in the chamber, together with suffiecient ventilation are the most important mechanisms in the drying process. The ventilation also reduces odours due to air currents, which flow towards the vent pipe out of the chamber. A moisture content below 25% facilitates rapid pathogen destruction.

Absorbents such as lime, ash, or dry soil should be added to the chamber after each defecation to absorb excess moisture, make the pile less compact and make it less unsightly for the next user. Addition of absorbents is also reported to reduce flies and eliminate bad odours. Moreover, depending on the additive, the pH may also be increased due to this addition, and hence enhance bacterial pathogen dieoff.

As breakdown of organic material in dehydrating conditions is slow, toilet paper or similar objects placed in the chamber will not disintegrate quickly.

Toilet paper can therefore either be handled separately, or be composted in a secondary treatment process.

Once the chamber is almost full, the content may need to be removed. The contents are further stored, used as a soil conditioner, buried or composted (in home composting or at a local composting centre).

The product from the dehydration process, a crumbly cake, is not compost but rather a kind of mulch which is rich in carbon and fibrous material, phosphorous and potassium. Nutrients will be available to plants directly or after further decomposition of the dehydrated material.

In warm environments (20°-35°) storage times of less than 1 year will be sufficient to eliminate most bacterial pathogens and substantially reduce viruses, protozoa and parasites. Some soil-borne ova (e.g. Ascaris lumbricoides) may persist. Alkaline treatment, raising the pH to >9 reduces the required storage time to about 6 months (Schönning and Stenström,
2004).

Further storage, sun drying, alkaline treatment or high-temperature composting may be recommended to further decrease health risks of utlization of the dehydrated faeces.

**Different technologies**

Dehydratation toilets

Many alternative ways of constructing dehydration toilets exist. Generally double-vault toilets with urine diversion have shown the most successful results and the highest popularity. Several modifications have been applied to enhance the dehydration process and to suit each region’s condition. The main distinguishing features are listed in the following.

- Urine diversion or non-urine diversion

Most dehydrating toilets require prior separation of urine to allow sufficient drying of faeces. Systems where urine and faeces are mixed only work properly in very dry climates. Some installations provide a drainage system for the chamber to improve dehydration of the solids. Urine diversion systems not only allow the separate collection of nutrient rich and virtually sterile urine, but also greatly reduce the odour problems associated with dry mixed systems.

- Use or disposal of urine

The use of separately collected urine as a fertiliser after appropriate storage is strongly recommended, due to its high nutrient concentration and the low associated health risks. However in certain circumstance urine use may not be acceptable or immediately possible and urine is infiltrated directly to the soil via a soakaway pit.

- Single vault or double vault

Dehydration toilets can be built with a single or a double chamber for collection of faeces. By using a doublevaults, handling of fresh excreta can be avoided, as the vaults are used alternately, with sufficient time allowed for the faeces to sanitaze. Most dehydration toilets therefore use double-vault technology. Single-vault systems may be less expensive to build, but need more labour to guarantee the same hygienic safety as double-vault systems.

- Ventilated vault or not

Ventilation is generally recommended to prevent odour and flies and to enhance the drying process. In some cases it can be omitted (e.g. in extremely dry climates, or if the toilet is far from housing). However, if the

toilet is constructed within the house, a vent pipe is strongly recommended due to the reduced smell and flies problems. Ventilation through installed pipes can be natural or enforced by windpropelled or electrical fans.

- Squatting or sitting

There are numerous technologies that suit both defecation styles (squatting or sitting) with simple drop holes or specially designed urine diversion squatting pans for squatting cultures.

- Dry or wet cleaning

Dehydration toilets can receive dry cleaning materials such as toilet paper (which however, will not decompose completely). Dehydration toilets can also be used for wet cleaning cultures, water then has to be drained in a separate pipe so that no liquid is led into the vault.

- Self-built or prefabricated

Most systems can be self-built by the users totally or partially using commercially available squatting pans or toilet seats. In some areas, complete systems including the toilet cabin and the substructure are available on the market.

This, of course, is only valid if design and climate allow a good functioning of the drying process. In cool and humid climates, a composting process might be easier to maintain than dehydration. The product of a dehydration toilet is drier than from a composting toilet and therefore easier to handle. Posttreatment of removed solids is recommended for both, composting and dehydration toilets.

<u>Pit latrines</u>

Pit and VIP latrines has the advantage that the temporary disposal is more remot (less odours) but present major risks of pollution in high water tables areas, as well as seasonal flooding. Besides they are difficult to realize in hard rocky surface. Also pits emptying presents more problems than the removal of small, dehydrated volume of faeces from the dehydration toilets. Otherwise pit latrines can only be used until the pit fills. The pit latrines system is correctly described in the WATSAN manual.

<u>Composting toilets</u>

This type of toilet, which is a dry toilet type, have some advantages. If well operated the composting process is more effective than the simple dehydration process by solar heath but the process is more sensitive and presents higher maintenance needs.

**Applicability**

<u>Climates</u>

Dehydration toilets are mainly suitable for regions with high average temperatures, long dry and short rainy seasons or arid climatic conditions with high evaporation rates. Nevertheless, with simple solar heaters, they can also work in a more humid climate.

Dehydration toilets are waterless systems that are particularly suitable for conditions where water is scarce as in the semi desertic areas of the south west of the Country like the valley from Herat to Ghazni and the region south of Bust and Farah.

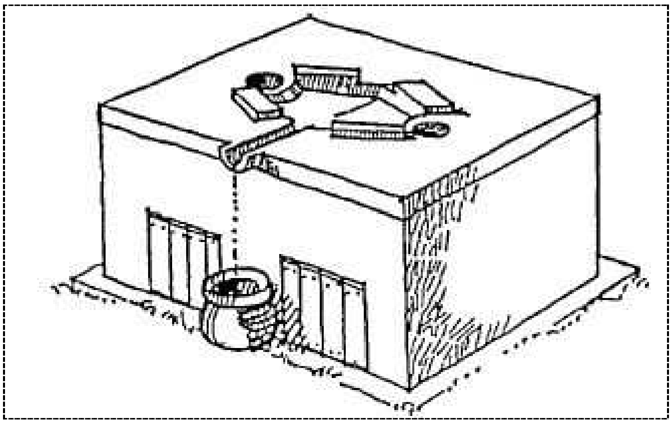
<u>Rural and urban areas</u>

Dehydration toilets can be placed outside the house, attached or even inside the house. Dehydration toilets are therefore suitable both for rural and densely populated urban areas.

<u>Different cultural settings</u>

As already stated dehydration toilets are suitable for different cultural settings: they can be designed to suit both sitting and squatting cultures and to cope with the use of water as well.

**FIGURE- 23: DOUBLE-VAULT DEHYDRATION TOILET WITH URINE DIVERSION (EASREY ET AL., 1998)**



**Careful handling required**

An important condition for the success of dehydration toilets is that sufficient user commitment to the operation and maintenance can be provided. Cleaning of a dehydration toilet seat or squatting pan has to be done carefully with little water, to avoid introduction of water into the vault. A bulking agent (absorbents such as lime, ash, or dry soil) should be added regularly to the faeces. The collection chamber has to be checked and emptied in regular intervals. In nonurine-diverting versions, the moisture content of the chamber should be visually monitored and the drainage corrected if necessary.

All those tasks require a certain level of responsibility and care from the users.

Neglected maintenance can quickly lead to malfunctioning of the process and may impair severely the appearance and hygiene of the toilet.

**User acceptance**

Like any new technology, dehydration toilets are only an option if they are accepted by the users. The handling and use of dry faeces and separated urine may prove particularly difficult to accept by users in certain cultural or socio-economic settings.

User acceptance often depends on the perception of status connected to the new facility. Compared to situations with open defecation, public toilets or pit latrines, dehydrating toilets generally compare favourably. If flush toilets are already established, dehydration toilets often are connected with lower status.

In such cases, education and strongly stressing the advantages of dehydration toilets may lead to acceptance.

The fact that men need to sit for proper urine separation may lead to acceptance problems that generally can be overcome by providing simple urinals for men.

**Reuse**

Regular reuse of urine and dry faeces is recommended for the sustainable operation of dehydration toilets. Reuse may even provide an incentive for proper operation and maintenance of the facility. Therefore, dehydration toilets are most succesful in rural and peri-urban areas, where the toilet users can directly use products from toilets in their gardens. This direct reuse is often not possible in urban areas, where no space for cultivation exists in close vicinity of the toilets. In such situations, management systems for collection, marketing and use of products from toilets, are very important for sustainable operation of dehydration toilets.

# 6. PROMOTING SUSTAINABILTY – CRITICAL TECHNICAL AND INSTITUTIONAL MEASURES REQUIRED

## 6.1 GENERALS

Also if many RWS systems have been affected by design or implementation mistakes, the main factor of failure of the interventions is the lack of sustainability.
Generally speaking every system has severe problems of maintenance due to the lack of funds from a responsible organization. The problem involves the reorganization of the sector with a clear identification of all the actors power and responsibility.
To this aim in 2002 it has been taken an international conference in Kabul, named "Kabul Understanding", in which it has been stated the bases for the development of the water sector in Afghanistan, which, beginning in 2004, was guided by the Strategic Policy Framework for the Water Sector. This framework described the way forward and defined the specific policies, laws, regulations and procedures to be formulated, as follows:
Revision of the Water Law of 1991

- A water resources management policy and related regulations
- The institutional structure for water resources management
- An irrigation policy and related regulations
- Regulations for water user associations (WUAs)
- National urban and rural water supply and sanitation policies and institutional
- Development
- A groundwater policy
- A hydropower development policy
- An environment law

Water sector reform is aimed at tackling the challenges highlighted in the Water Sector Strategy, as follows:

- A lack of the institutional, human and financial resources necessary to deliver water services properly to the population
- A lack of mechanisms to regulate water use for irrigation, domestic supply, sanitation
- and hydropower generation
- A lack of integrated water sector governance
- A lack of reliable hydrological and metrological data and data on water quality
- Inadequate infrastructure and poor coordination among water sector projects.

Actually, in theory, responsibility for management of water resources of Afghanistan is as follows:

- Groundwater Resources: Ministry of Mines and Industry
- Surface Water Resources: Ministry of Water and Power
- The Government, through MRRD, remains committed to the rural water supply and sanitation sector.

Actually there is some inconvenient due to lack of resources in the Public Administration. The system of permits or licensing drilling or water extraction in Afghanistan appears to be no effective. In this phase of regulatory necessity, the UN and some NGOs have accepted some responsibility for water resources:

- Urban water supply managed by Habitat (United Nations Shelter Program)
- Rural water supply managed by MRRD, NSP, UNICEF, DACAAR
- IDP camps managed by the Afghan Ministry for Martyrs and Repatriation, with significant input from UNICEF and various NGOs.

Anyway the result of the regulate the use of water resource in the Country is not fully achieved also if the various Agencies have been able to co-ordinate some activities of actors in the field of water supply.

In the following is reported a summary of the conclusions of Kay Wegerich of AREU in 2009 about the status of the revision of the Water Law and of the Water Sector Strategy in Afghanistan.

Recent drafts of the Water Sector Strategy (WSS) and of the Water Law provide the main policy environment for water management. The drafts of the WSS pay tribute to integrated water resources management (IWRM) by incorporating stakeholder participation at the local level (with a focus on water user associations or WUAs) and at the basin level (with a focus on river basin councils). This is also emphasized in the Draft Water Law, with its section on river basin councils and sub-basin councils. The law on WUAs, however, is less explicit. While the July 2007 Draft WSS focused on water pricing, the February 2008 draft focused on poverty alleviation and did not discuss water pricing (although cost recovery for construction and services is still anticipated). The June 2008 Draft Water Law continues to focus on establishing a modern permit system, with the exception of right-of-way areas (areas that are protected and free from interventions). All versions of the Draft WSS have a strong focus on infrastructure rehabilitation and expansion. The drafts highlight the role of NGOs and donors in achieving this, but not all of them deal with the negative consequences that these efforts might have for downstream riparian states.

The WSS drafts portray the existing mirab water system as dysfunctional and promote the WUA system to take its place, but they also admit that the mirab system has not been researched. Although the WSS draft emphasizes the necessity for river basin reorganizations, such as river basin councils (RBCs) and river basin agencies (RBAs), the July 2007 draft questions their feasibility. The February 2008 draft highlights the constraints of the water sector, thus also implicitly raising concerns about whether or not RBAs and RBCs are feasible. The July 2007 draft identifies river basins and sub-basins with maps, however, and even presents an organizational chart for how basin organizations should be set up. The latest draft of the WSS (February 2008) includes neither maps nor organizational charts and therefore reveals fewer details. The opportunities the basin approach provides for the end-user are frequently stated, and the organizational chart demonstrates the bottom-up nature of the basin councils. However, the main outline in the June 2008 Draft Water Law shows that the Ministry for Energy and Water is responsible for establishing the basin and sub-basin councils as well as basin agencies, which are supposed to facilitate and implement the decisions of the basin councils. Although the basic framework for basin organization is defined and roles are allocated, important questions about decision-making in the basin councils are not specifically articulated. It is not evident, therefore, who will be represented in the councils and how votes in the councils will be shared among different stakeholders. The June 2008 Draft Water Law contains references to right-of-way areas and suggests that these areas will not be included in the basin approach or represented in the councils. The implication is that there is no basin approach and no integrated water management with stakeholder participation. The right-of-way reference does reflect the reality on the ground. Nevertheless, why have a law on basin management if substantial parts of the basin are excluded?

While a previous draft of the Water Law made reference to the "praiseworthy customs and traditions of the Afghan people," the June 2008 draft uses weaker terminology, "considering the appropriate/suitable water use traditions and customs," which boils down to having a mirab (water master's assistant) or mirab bashi (water master) in a WUA. While previous drafts focused on "fair, effective and economical allocation of available water resources," the current draft only makes statements on cost recovery, but it has also a focus on irrigation norms and the establishment of a permit and license system. Currently, three terms are used within the law: permit (water use), license (for infrastructure) and water right.

The term water right is not defined and is used in the law to refer to individual as well as collective (canal-level) rights. It is foreseen in the Draft Water Law that currently existing water rights will be transformed into permits and that to be established WUAs will obtain permits only. No reference is made to licenses for traditional intakes. Since current water rights are not measured and depend on water availability in the river as well as on the construction of the intake, it is not evident what permits should entail. In any case, basin councils will be able to change or even cancel permits. Water rights can be cancelled if users do not pay. Permits are required both for water extraction and for drainage flows. This implies that WUAs have to have at least two permits (assuming one intake and drain only). The issuing of permits depends on gauging, not only for extraction but also for drainage. Currently there is little if any gauging capacity; hence, it is questionable whether meaningful permits can be issued. In addition to the problem of gauging, there is the problem of law enforcement, and this may explain the emphasis on right-of-way in the law. The February 2008 Draft WSS

therefore makes a distinction between urban and rural water supplies. The focus in urban areas is on rule enforcement, including building the capacity of the Ministry of the Interior, but in rural areas the focus is only on governance.

## 6.2 OPERATION AND MAINTENANCE

The following topics has been extracted from the Water Sector Group document Operation and Maintenance Strategy for community water points in Afghanistan (January 2012).

Operation and Maintenance (O&M) of community water points is essential to ensure lasting service for the community members. Through basic O&M it will be ensured a lasting life of the water points and it will be delayed the need of a replacement to the time when the acceptable life duration is over.

A not too big current investment in skilled caretakers activity and in spare parts supply and maintenance of the critical system components can protect the whole initial investment that will last longer.

The Afghan Government with support of donors should provide a fund that can pay for the spare parts such as gaskets, special parts, valves, electromechanical devices, hand pumps, electro mechanical pumps and in case of natural disasters for the replacement and repair costs for systems. Each system must be endowed with a O&M book where the replacement of each component must be foreseen and where the system working data collected on the field must be recorded.

The majority of the water supply systems either hand pumps as gravity flow systems are not well documented. Also the new interventions realized under the aegis of MRRD/ RuWaSIP, after a first phase in which basic technical data have been taken, are not documented now from the O&M activity's point of view.

This situation can seriously affect the duration of the works and the sustainability of the investments.

**Expected life span of systems**

The expected life span of the typical water points systems is the following:

- A good quality hand pump with a community of 20 families and good installation and O&M can last for 7 - 14 years.
- A gravity flow system, well laid down, good quality of piping and standard placement of pipes in trenches, a good O&M, can last for up to 30 years while taps, valves and other equipments need frequent replacement and leaks must be repaired when noted.
- A system with a pumping station and gravitation from overhead tank if well maintained will last up to 30 years for the civil works and 15 years for the electro mechanical equipement. The generator sets on the market are quiet different from very fast running systems of 3000 rpm that might last three years, while systems that run with 1500 rpm can last up to 10 years if well operated and maintained.
- The electronic components of a solar system to provide pumping energy, if well maintened and operated, can last from 5 to 15 years.

The need is to ensure that during the incoming years the Rural Water Policy will be active and economically supported in order to save the initial investment.

The strategy will cover the rural areas of Afghanistan and the small towns with less then 5,000 inhabitants with the assistance of the MRRD Rural Water Department (at present called RuWatSIP). Some of the hydraulic works can cover a whole districts or an extended area, as in the case of gravity flow systems of Logar, Kunar and Nangarhar.

The strategy of the department will have to be adjusted whenever there will be changes in the Rural Water Policy that is updated every four years or in the Afghanistan water law.

Changes may interest the approaches and work of the relevant Ministries and local Administration involved in the implementation and support of the sector.

**Actual situation**

O&M has been generally left to the Communities by the NGOs, NSP and Government agencies, without the necessary educational and technical support.

It has been monitored the O&M aspects in Balkh (Vijselaar, 2005 & 2006), Faryab and Kunduz provinces and it has been found that 50% of the pumps are not working after only three years. The results of the monitoring had highlighted significant differences between Balkh Province where an organization was active in the

application of an O&M procedure, compared to the Kunduz Province where no O&M has been realized and where the situation is of general decay of the WSS systems realized.
The dug wells systems appear to be the best selection from the point of view of a community O&M. Of course it is not always possible to recur to them, due to the lowering of certain groundwater table.
From the point of view of O&M sustainability ideal systems are gravity flow systems that are only possible in those areas endowed with springs with sufficient yields. The second best systems for rural communities are solar pumped systems, while the most expensive are the running costs of WS systems with submersible pumps with generators, considering the electricity availability is at present rare for most of rural Afghanistan. In that case probably it would be necessary a subsidize by the Government.

**Technical O&M requirements**
In the following tables are reported the O&M requirement for each WS component according to DACAAR Operation & Maintenance of Rural Water Supply Water and Sanitation Programme Human Resource Development Unit – 2007:

**FIGURE- 24: GENERAL WATER SUPPLY SYSTEM (DACAAR)**

| Activity | Frequency | Human resources | Materials and spare parts | Tools and equipement |
|---|---|---|---|---|
| Clean well surrounding | Weekly | From local Community | | Broom, bucket, hoe, machete |
| Check turbidity | After each flood | From local Community | | |
| Check water quality | Occasionally | From local Community | | Bucket, watch |
| Repair fence and clean surface | Occasionally | From local Community | Wood, rope, wire | Machete, axe, knife, hoe, spade, pickaxe |
| Check water quantity | Regularly | From Province Organization | Laboratory reagents | Laboratory equipment |
| Wash and disinfect the spring | Annually | From local Community | Chlorine | Bucket, wrench, brush |
| Repair piping and valves | Occasionally | From local Community or from Province Organization | Spare pipes and valves, cement, sand, gravel | Bucket, trowel, wrench, flat spanners |

- Concrete tank: all the interventions should be done by the local responsible which has to be named in case of complex water supply systems including electromechanical pumps, tanks and pipes.

**FIGURE- 25: CONCRETE TANK O&M REQUIREMETS (DACAAR)**

| Activity and frequency | Materials and spare parts | Tools and equipment |
|---|---|---|
| Regularly clean the surrounding From Province Organization. | | Broom, machete, hoe. |
| At least monthly open and close the valves. | | |
| Occasionally repair the valve; | Washer, spare valve. | Wrench, spanner, screwdriver. |
| Occasionally repair the screen; | Plastic or copper screen, wire. | Pliers, wrench, tin cutter. |
| Occasionally repair the concrete lining. | Cement, sand, gravel, additives. | Trowel, spade, bucket, wheelbarrow, ladder, rope. |
| Annually clean and disinfect the reservoir. | Chlorine. | Brush, broom, bucket, ladder. |

**FIGURE- 26: DRILLED WELL O&M REQUIREMENTS (DACAAR)**

| Activity | Frequency | Human resources | Materials and spare parts | Tools and equipment |
|---|---|---|---|---|
| Clean well site | Daily | From local Community | | Broom, bucket |
| Clean drain | Occasionally | From local Community | | Hoe, spade, wheelbarrow |
| Repair fence | Occasionally | From local Community | Wood, nails, wire etc. | Saw, machete, axe, hammer, pliers, etc. |
| Repair apron | Annually | From local Community | Cement, sand, gravel | Trowel, bucket |
| Rehabilitate well | Very rarely | From National Authority | Gravel, pipe material etc. | Various special equipment |

**FIGURE- 27: PUMPING STATION O&M REQUIREMENTS (DACAAR)**

| Activity | Frequency | Human resources | Materials and spare parts | Tools and equipment |
|---|---|---|---|---|
| Clean pump and site | Daily | From local Community | | Broom, brush |
| Grease bearings | Weekly | From local Community | Grease or oil | Lubricator |
| Check pump stand parts | Monthly | From local Community | | Spanner |
| Replace pump stand parts | Occasionally | From local Community | Nuts and bolts, bearings, pump handle | Spanners, screwdriver |
| Replace cupseals | Annually or less | From local Community or from Province Organization | Cupseals | Spanners, wrench, knife, screwdriver etc. |
| Redo threads in pump rod or main | Occasionally | From local Community or from Province Organization | Oil | Pipe threader, tackle |
| Replace footvalve, plunger or cylinder | Occasionally | From Province Organization | Footvalve, plunger or cylinder | Spanners, wrench |
| Replace pump rod or main | Occasionally | From Province Organization | Pump rods or main tubing | Spanners, wrench, pipe threader |
| Repair platform | Annually | From local Community | Gravel sand, cement | Bucket, trowel |

**FIGURE- 28: PUBLIC STANDPOSTS O&M REQUIREMENTS (DACAAR)**

| Activity | Frequency | Human resources | Materials and spare parts | Tools and equipment |
|---|---|---|---|---|
| Tap water maintenace | Daily | From local Community | | Jar, bucket, can, etc. |
| Clean site | Daily | From local Community | | Broom or brush |
| Inspect and clean drain | Daily | From local Community | | Hoe, spade |
| Repair or replace valve | Occasionally | From local Community | Rubber or leather washer, gland seal, Teflon, flax, spare valve | Spanners, screwdriver pipe wrench |
| Repair fence | Occasionally | From local Community | Wood, steel wire, nails | Machete, pliers, hammer |
| Repair valve stand, apron or drain | Occasionally | From local Community | Wood, nails, cement, sand, water, etc | Hammer, saw, trowel, bucket, etc. |
| Repair piping | Occasionally | From local Community | Pipe nipples, connectors, elbows etc., oil, Teflon, flax or plumbing putty | Pipe wrench, pipe cutter, saw, file, pipe threader |

- Hand pump: all the following intervention should be done occasionally when the inconvenient manifests itself and by the local Community personal

**FIGURE- 29: HAND PUMP O&M REQUIREMENTS (DACAAR)**

| Problem | Cause | Remedy |
|---|---|---|
| No water | - Rods disconnected<br>- Pipes disconnected<br>- Plunger seal defect<br>- Water level gone below the cylinder | - Pull out all rods and replace broken rods<br>- Join the pipes<br>- Replace seal<br>- Add pipes and rods |
| Delayed Flow | - Leaky valves<br>- Complete stroke not available<br>- Leakage in pipe joints<br>- Leaking foot valve "0" ring | - Replace the valve bobbins<br>- Adjust the length of the top rod<br>- Take out the riser mains and replace<br>- Replace "0" ring |
| Reduced discharge | - U seal tight<br>- Complete stroke not available<br>- U-seal worn out<br>- Valve bobbins worn out<br>- Pump cylinder cracked | - Replace U-seal<br>- Correct the stroke by adjusting length of rod<br>- Replace the worn U-seal<br>- Replace the bobbins<br>- Replace the cylinder |
| Pump handle shaking | - Cracked platform<br>- Loose flanges<br>- Worn out bearings<br>- Hanger pin loose<br>- Fulcrum pin loose | - Repair platform<br>- Tighten flange bolts and nuts<br>- Replace bearings<br>- Tighten fully both nuts |