SEPTIC TANK GUIDELINE DOCUMENT

North-west Syria

IOM Türkiye Cross-border Programme
11-28-2022

IOM UN MIGRATION

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Preface

Septic tanks are traditional wastewater treatment units that offer water tight containment of wastewater and primary treatment. IOM Türkiye Cross-border Program piloted and implemented multi-chamber septic tanks in North-west Syria from 2020 to 2022. The document is developed to share experiences and offer a guiding framework in the design, construction, operation and maintenance of multi-chamber septic tanks in Northwest Syria by implementing partners and the WASH cluster. It should be noted that this document is to serve as a guide and not as a manual.

CONTENTS

Acronyms

ABR	-	Anaerobic Baffled Reactor
BOD	-	Biological Oxygen Demand
CCCM	-	Camp Coordination and Camp Management
COD	-	Chemical Oxygen Demand
FSM	-	Faecal Sludge Management
IDPs	-	Internally Displaced Persons
HLP	-	Housing Land Property
NWS	-	Northwest Syria
O&M	-	Operation and Maintenance
SS	-	Suspended Solids
TSS	-	Total Suspended Solids
TWiG	-	Technical Working Group
UASB	-	Upflow Anaerobic Sludge Blanket
WAWTTAR	-	Water and Wastewater Treatment Technologies Appropriate for Reuse
WWTP	-	Wastewater Treatment Plant

INTRODUCTION

IOM UN Migration owing to its prominent role in migration governance and management, is regularly involved in a diverse array of operations to uphold the dignity and well-being of migrants, in which access to WASH services plays a vital role. As part of its mandate, IOM is compelled to provide humanitarian assistance to migrants in need, be they refugees, displaced persons or other uprooted people. Ensuring the delivery of WASH services helps IOM to fulfil its mandate.

In 2019, IOM Türkiye Cross-border Programme started planning for long-term and sustainable WASH services in North-west Syria (NWS) in order to enhance recovery response of internally displaced persons (IDPs) given that the Syrian crisis has been ongoing for more than a decade. This is in line with its mandate to deliver high-quality and comprehensive WASH programming at scale, ensuring the human right to water and sanitation and empowering affected populations to meet their needs.

Early 2020, IOM Türkiye piloted a multi-chamber septic tank as a possible recovery and long-term wastewater treatment option NWS. The pilot was optimized, upgraded designs were adopted and upscaled in 2021. Building on the success of the multi-chamber septic tank, IOM conducted a 3-day workshop (8-10 November 2022) to share the experience and advocate for the septic tank as a technology of choice for North-west Syria. The guideline on the multi-chamber septic tank is part of IOM's strategy to strengthen and build capacity of its partners and counterparts in NWS contributing to standardize humanitarian responses and strategies. Therefore, the guideline is meant to offer guidance to NWS WASH cluster and partners on the possibilities to adopt the multi-chamber septic tank and its efficiency as a better containment and primary wastewater treatment option.

PART I

NORTHWEST SYRIA CONTEXT

CHAPTER 1

Northwest Syria Context

Syria remains a complex humanitarian and protection emergency characterized by over 11 years of ongoing hostilities and their long-term consequences including widespread destruction of civilian infrastructure, explosive ordnance contamination and the largest number of internally displaced people in the world[1]. The Syrian civil war displaced over 6 million people inside Syria since 2011 and 4.6 million in North-west Syria (NWS). The majority of IDPs, 1.8 million out of 2.8 million[2], live in Northwest Syria (NWS) under overcrowded conditions. Emergency WASH services, shelter and NFIs as well as road and drainage systems construction in NWS is carried out by the NWS S/NFI, Camp Coordination and Camp Management, and WASH clusters. The WASH cluster consists of over 40 NGOs (local NGOs, INGOs and UN-agencies) working and coordinating WASH interventions among others in NWS.

Heavy displacements and rapid influx of IDPs to NWS continuously occur, the highest record for 2022 being 19,545 new internal displacements, largely driven by the deteriorating economy. IDPs are highly dependent on continued humanitarian assistance. Despite, continued support for IDPs in NWS, there are gaps in service delivery and management of the infrastructure. Water trucking services are the only source of water for 73 per cent of IDP site residents and only 24 per cent households are connected to (simplified) sewer networks, indicating a continued need for medium-term investment in IDP sites infrastructure to provide more sustainable, affordable, and safer way to supply water and dispose wastewater. Despite the sector assistance, 24 per cent of IDPs in sites couldn't access one or multiple hygiene items, 23 per cent faced barriers to effective handwashing. Also, 35 per cent of households reported issues with toilet functionality or wastewater disposal. For people living in IDP sites, insufficient WASH infrastructure or services delivery exacerbates public health risks and impact other needs and require close collaboration between WASH and CCCM. For instance, household-level/shared family WASH facilities, currently a privilege for only around 40 per cent of households in IDP sites, may mitigate the GBV risks and vandalization of communal facilities

WASH services are insufficient in many facilities including in public hospitals and are further negatively affected by ongoing water and energy crises. Due to economic downturn unaffordability of some key hygiene supplies reported by up to 43 per cent of households in communities further deteriorate effectiveness of infection prevention and control. Across northern Syria, the prevalence of Leishmaniasis remains very high due to harmful garbage disposal practices and widespread use of unregulated dumpsites, especially in areas not targeted with vector control activities due to funding shortfalls. WASH needs in schools remain very high and could be linked with dysfunctional public water and sanitation systems the facilities are connected to, water crisis and economic downturn. Over 40 per cent of caretakers in households with children attending school received complaints from children on WASH-related issues, and such factors may contribute to the overall 2.4 million children out of schools (OCHA, 2022).

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[1] HNO report 2022

[2] OCHA North-west Syria Situation Report, 1 November 2022

NWS Wastewater Treatment History

Centralised wastewater treatment has been practiced in Syria since the 1970s. Several feasibility studies were conducted for big cities such as Damascus, 1976 and Aleppo in 1979. The 1990's saw to construction and operation of many wastewater treatment plants in cities. The activated sludge system being the common technology of choice and including other facilities such as the oxidation ponds in Al-Salamea and aerated lagoons in Ras Al-aien. The biggest treatment facility was in Damascus with a capacity of about 790, 000 m^3/day and second largest in Homs with a capacity of 295,000 m^3/day. The beginning of the 2000s saw to construction of more WWTPs, these include constructed wetlands in Harran Al-Awamed and from 2009, WWTPs were constructed at an accelerated pace. To date, due to the civil war, most centralised treatment facilities and sewer networks are either abandoned or unfunctional. In response to this gap, some WASH cluster members have piloted and constructed decentralised wastewater treatment systems (DEWATs) in NWS since 2018. These organizations include ACU, Amal Organization, GIZ, Syria Relief and IOM Türkiye among others. The majority of the DEWATs in NWS are anaerobic systems such as the Anaerobic Baffled Reactor (ABR), Upflow Anaerobic Sludge Blanket Reactor (UASB) and multi-chamber septic tank. Refer to annex 1 for more information on these technologies in NWS.

The Environmental Protection Agency of Syria (EPA), a local NGO, conducted studies for drinking water stations and wastewater treatment in NWS. Below is information with regards to wastewater treatment facilities in NWS, shown with blue dots.

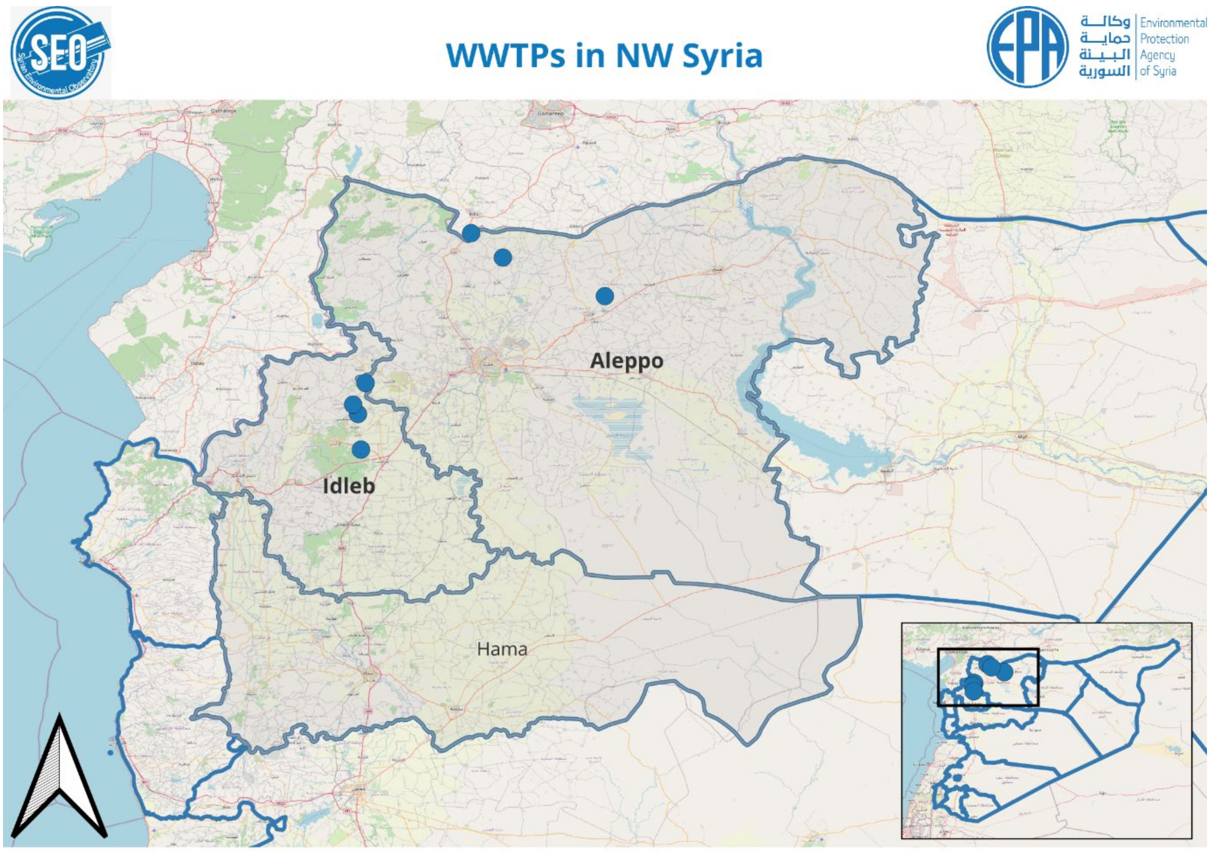


Figure 1: Wastewater Treatment Facilities in NWS and receiving water bodies, [Click here for source]

NWS Wastewater Management Challenges

The following challenges were identified by the WASH cluster during a 3-day workshop (8-10 November 2022) on wastewater treatment in NWS that was facilitated by IOM Türkiye Cross-border Programme.

Table 1: NWS Wastewater treatment challenges

Wastewater Management Challenges in Northwest Syria
1. Wastewater guidelines Lack of contextualized wastewater treatment and management guidelines for NWS (no Syrian code).
2. Poor coordination amongst NGOs Lack of unified approaches, no unified/standard designs, indicators, tools, and approaches. Although, there is coordination at Cluster level, coordination lacks amongst NGO's especially those working in the same target areas.
3. HLP issues NGOs do not have land rights, therefore it is sometimes difficult to acquire land or have permission to construct or setup WASH infrastructure. Acquiring land for WASH activities such as construction of wastewater treatment plants can take more than 6 months.
4. Vandalism of WASH infrastructure Unauthorized connections to sewer systems and vandalism are high in camps.
5. Water quality monitoring Lack of water quality monitoring for wastewater treatment plants (onsite and offsite systems) despite having a functional water quality laboratory in NWS operated by an organization known as ACU.
6. Desludging guidelines/standards and effective monitoring Desludging or disposal by emptying trucks is a common activity, however, concern is that there is lack of monitoring such that desludging contractors usually dispose to undesignated areas. They dispose anywhere they see fit or find convenient.
7. Health and safety concerns for desludging operators
8. Widespread of wastewater streams inside camps and surrounding areas Occurrence of manmade streams of wastewater inside camps is widespread. The discharge of wastewater (treated or untreated) into valleys is a common practice. The majority of camps have culverts or drainage systems conveying wastewater from camps to the valleys and also, desludging contractors' empty sludge/wastewater into these valleys.  *Figure 2: Wastewater stream in an IDPs camp*
9. Reuse of untreated wastewater for irrigation This is a common practice; farmers buy partially treated or untreated wastewater from desludging contractors. There are also, concrete irrigation canals making use of wastewater for irrigation.
10. Lack of electricity Lack of electricity hinders smooth operation and or adaptation of many effective WASH interventions, wastewater treatment facilities included. However, implementation of low-cost anaerobic treatment systems such as the ABR and multi-chamber septic tank is possible and highly recommended.
11. Emergency context Its challenging and a bit difficult to plan for the emergency context; there's high influx of IDPs and challenging to have designs reflective of these influxes and factoring population growth.
12. Topography challenges The steep terrain in NWS makes implementation of WASH interventions difficult.
13. Handover and governance of WASH projects Lack of defined and proper handover or existing strategies for IPs is a challenge believed to undermine the ownership and sustainability of WASH interventions as well as committees to follow-up on operation and maintenance of infrastructure after implementation.
14. Capacity building Capacity gaps in wastewater treatment and management, knowledge transfer amongst NGOs is also a critical gap within the sector.

Recommended Technologies for NWS

IOM Türkiye Cross-border Programme conducted a workshop (08-10 November 2022) to learn and share wastewater treatment experiences in NWS amongst WASH cluster members. One of the outputs of the workshop was the recommendation of suitable wastewater treatment technologies applicable in NWS. The recommended technologies are the Anaerobic Baffled Reactor (ABR) and the multi-chamber septic tank. These were recommended because they are cheap and simple to construct. In addition, they offer better containment and treatment of wastewater achieving 'the do no harm to the environment' objective. However, further treatment might be required depending on the end use of the effluent and or status of receiving water bodies. Drawings of the two technologies are shown below.

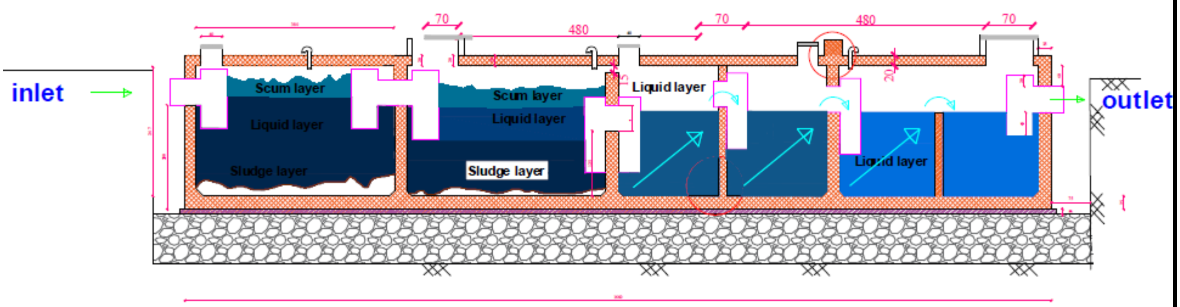


Figure 3:IOM multi-chamber septic design cross-section view

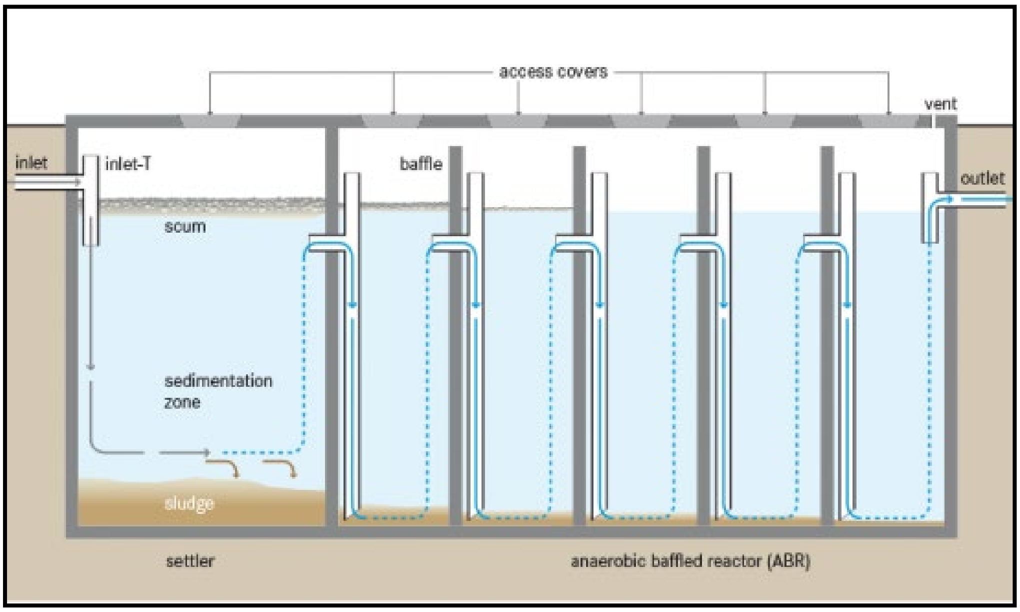


Figure 4: ABR technology cross-section view

Table 2: Guideline on ABR and Septic Tanks

Item	ABR	IOM Multi-chamber Septic tank
Start-up period	3-6 months but can be accelerated with cow dung	1-3 months
Land requirement (m^2/m^3)	0.97	0.87
Performance	BOD 65-75% COD 65-75% TSS 80-90% Low pathogen removal (*Refer to annex 5*)	BOD 30-60% COD 20-40% TSS 50-80% Low pathogen removal
Parameters to monitor	pH Temperature Total Suspended Solids Settleable Solids BOD COD	pH Temperature Total Suspended Solids Settleable Solids BOD COD
Required expertise	Expert in ABR designing (flow control and distribution)	Simple to adopt and design, some civil works/construction experience is necessary
Operation and Maintenance (O&M)	Less O&M requirements, general housekeeping once a week, periodical desludging after some years dependent on capacity/load	Less O&M requirements, general housekeeping once a week, periodical desludging dependent on capacity/load
Advantages	(+) Electrical energy is not required (+) High BOD reduction (+) Long service life (+) Low sludge production; sludge is stabilized (+) Moderate area requirement (can be built underground); small footprint (+) Can be constructed and repaired using locally available materials (+) No smells	(+) Simple and robust technology (+) No electrical energy is required (+) Low operating costs (+) Long service life (+) Small land area required (can be built underground). (+) Can be constructed and repaired using locally available (+) Can remove 50% of solids, 30 to 40% of BOD and a 1-log removal of E. coli can be expected in a well-designed and maintained septic tank. (+) Septic tanks can be installed in every type of climate, although the efficiency will be lower in colder climates.
Limitation	(-) Requires expert design and construction (-) Low reduction of pathogens and nutrients (-) Effluent and sludge require further treatment and/or appropriate discharge (-) Long start-up time (3 to 6 months) (-) Water is needed to flush	(-) Little to no room for optimization (-) Regular desludging must be ensured (-) Low reduction of pathogens and nutrients (-) Effluent and sludge require further treatment and/or appropriate discharge

Adopted from the FSM Technology and Financial Assessment Toolkit, 2018 and IOM experience 2020-21

PART II

SEPTIC TANK DESIGN & PERFORMANCE

CHAPTER 2

Septic Tank Treatment Mechanisms

A septic tank is a watertight chamber with at least two compartments, designed to perform primary wastewater treatment (high settleable solids removal and partial organic matter (BOD) removal). Septic tanks are basically sedimentation basins with no moving parts or added chemicals. It is the most common used type of primary treatment unit for onsite wet sanitation systems meant to receive and treat raw wastewater (largely domestic) in order to provide an effluent for disposal into the ground or by other means[3]. It can be used alone or in combination with other treatment systems such as waste stabilization ponds, constructed wetlands and UASB among others. Traditionally, it is used together with a soak away pit or drain field.

The septic tank is usually the suitable technology of choice in situations where the volume of generated wastewater is too large for disposal in pit latrines and or uneconomic or unaffordable to construct a centralized system (Harvey, 2007). Septic tanks are particularly suited to systems involving high water use, especially where water is used for flushing and anal cleansing. A two-chamber septic tank is usually suitable for small populations and multi-chamber septic tanks are ideal for high populations or institutions.

Septic tanks are usually rectangular in shape and sited just below ground level. There is liquid – solids separation in the tank, settleable solids settle at the bottom and digested anaerobically. The digestion depends on the characteristics of wastes, temperature and tank design. Light materials float to the surface where they form a thick layer called scum (comprising of grease and other floating materials). Scum helps in maintaining anaerobic conditions in the tank because it prevents and reduces the absorption of oxygen. Effluent from the tank is relatively clear but rich in pathogens, therefore further treatment is required after the tank. However, high retention times of about 20-30 days may have a significant reduction of some pathogens. A properly operating tank has three distinct layers; scum at the top, a middle zone of generally clear water relatively free of solids called the "clear space" and a bottom layer of sludge. The following are the treatment mechanisms active in a septic tank:

1. **Sedimentation and floatation:** Liquid-solid separation is the main treatment mechanism in septic tanks. About 80 per cent of suspended solids can be separated from the liquid in a well-designed tank through sedimentation. However, much depends upon the *retention time, the inlet and outlet arrangements, and the frequency of desludging*. Large surges of flow entering the tank may cause a temporarily high concentration of suspended solids in the effluent owing to disturbance of the solids which have already settled out(Franceys et al., 1992). Dense solids settle at the bottom of the tank forming sludge and floating materials such as fats and grease float to the top of the tank forming scum. The processes of sedimentation and flotation are responsible for the creation of the 3 layers inside the septic tank; top scum layer, bottom sludge layer and a clear liquid zone in the middle.
2. **Sludge digestion and consolidation:** The sludge at the bottom of the tank is compacted, becoming denser due to the weight of the liquid and the top layers of sludge. Organic matter in the sludge and scum layers is broken down by bacteria to simpler substances, carbon dioxide, water and methane, anaerobic digestion.
3. **Stabilization:** The liquid in the tank undergoes some natural purification but the process is not complete, anaerobic bacteria breaks down organic matter in the water to carbon dioxide, water and methane. However, the final effluent is anaerobic and will contain pathogenic organisms such as protozoa, helminthes, viruses and bacteria. Although, many micro-organisms grow, reproduce, and die in the tank, the final effluent from a septic usually has many pathogens. Therefore, it must be disposed of in an appropriate location such as a soak-away pit, infiltration field or other treatment systems. All septic-tanks require a system for removing the sludge and disposing of it hygienically.

[3] U.S EPA, 2002 Onsite Wastewater Treatment Systems Manual

Design of septic tank

For septic-tanks to function properly it is essential that they are designed and operated correctly. There are many standards and codes that guide the design of septic tanks. However, some standards may not be applicable to developing countries and or certain contexts, as such care must be taken in choosing appropriate guidelines since there isn't a global guideline.

Design objective

The primary objective of a septic tank is to receive and treat raw household wastewater in order to provide satisfactory effluent for disposal into the ground or other means (Polprasert and Rajput, 1982). It must be designed to ensure removal of almost all settleable solids and as high a degree as possible of anaerobic decomposition of the colloidal and soluble organic solids. The principal factor to achieving good sedimentation is maintaining quiescent conditions. This is accomplished by providing a long wastewater residence time in the septic tank. Tank volume, geometry, and compartmentalization affect the residence time (USEPA, 2002). To accomplish these design objectives, the tank must provide the following:

1. Stable quiescent hydraulic conditions for efficient settlement and flotation of solids.
2. A volume of liquid sufficient for a 24-hour liquor retention time at maximum sludge depth and scum accumulation(Franceys et al., 1992). It should provide sufficient retention time for the wastewater in the tank to allow separation of solids and stabilization of liquid.
3. Proper placement of inlet and outlet devices and adequate sludge and scum storage space to prevent the discharge of sludge or scum in the effluent.
4. Since the digestion process is anaerobic, no direct ventilation is necessary. However, provision should be made for the escape of the gases produced in the tank (adequate ventilation of gases).

The design stages for a septic-tank are outlined below:

1. Calculation of wastewater generation rate/volumes

Calculate volume of wastewater to be treated per day (m^3/day) – this can be determined by estimating toilet visits per day and water used per flush. If the quantity of water supplied to the toilet block or institution to be served is known then the daily wastewater flow can be taken as 80% of daily water supply.

2. Hydraulic retention time calculation

Decide on a retention time (R) – this is based on daily wastewater flow and can be determined from Table 3.

Table 3: Recommended septic tank retention times[4]

Daily wastewater flow 'Q' (m^3/d)	Retention time 'R' (hours)
Less than 6 m^3/d	24
Between 6 and 14 m^3/d	33-1.5Q
Greater than 14 m^3/d	12

[4] WHO, 1992: *A Guide to the Development of on-Site Sanitation*

3. Septic tank volume

Determine the tank volume (m^3) using prescribed formula/equation. This vary depending on the standard or code adopted.

4. Shape and dimensions of septic tanks

Having determined the overall capacity of the septic tank it is necessary to determine the depth, width and length. The aim is to achieve even distribution of flow so that there are no dead areas and no "short circuiting" (that is, incoming flow shooting through the tank in less than the design retention time).

A tank may be divided into two or more compartments by baffle walls. Most settlement and digestion may occur in the first compartment with some suspended materials carried forward to the second. Surges of sewage entering the tank reduce the efficiency of settlement but have less effect in the second compartment. A number of studies reported that septic tanks with more than one compartment performed more effectively than single-compartment tanks. Many surveys indicate that the first compartment should be twice as long as the second. Any advantage of more than two compartments has not been quantified.

The following guidelines can be used to determine the internal dimensions of a rectangular tank.

1. The depth of liquid from the tank floor to the outlet pipe invert should be not less than 1.2 m; a depth of at least 1.5 m is preferable. In addition, a clear space of at least 300 mm should be left between the water level and the under-surface of the cover slab.
2. The width should be at least 600 mm as this is the minimum space in which a person can work when building or cleaning the tank. Some codes of practice recommend that the length should be 2 or 3 times the width.
3. For a tank of width W, the length of the first compartment should be 2 W and the length of the second compartment should be W refer to Figure 5. In general, the depth should be not greater than the total length.

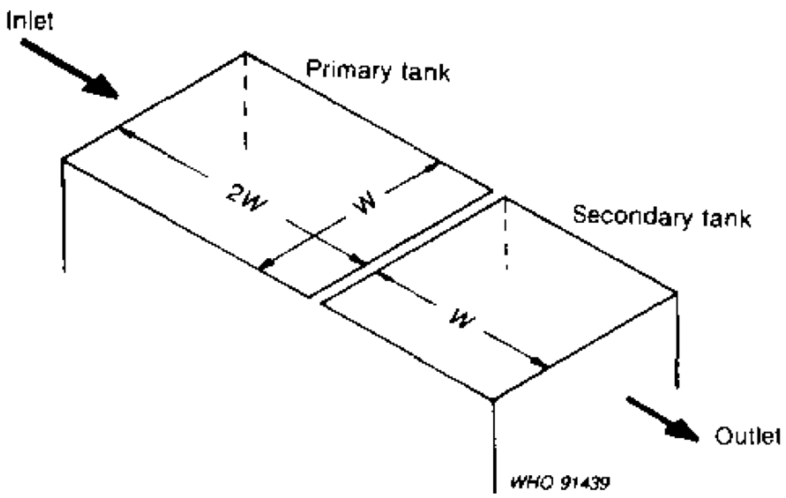


Figure 5: Septic tank dimensions

These guidelines give the minimum size of the tank. There is no disadvantage in making a tank bigger than the minimum capacity. It is possible to further split the second compartment or preceding compartments into two with baffles. This is what IOM practiced in designing the multi-chamber septic, refer to figure 6.

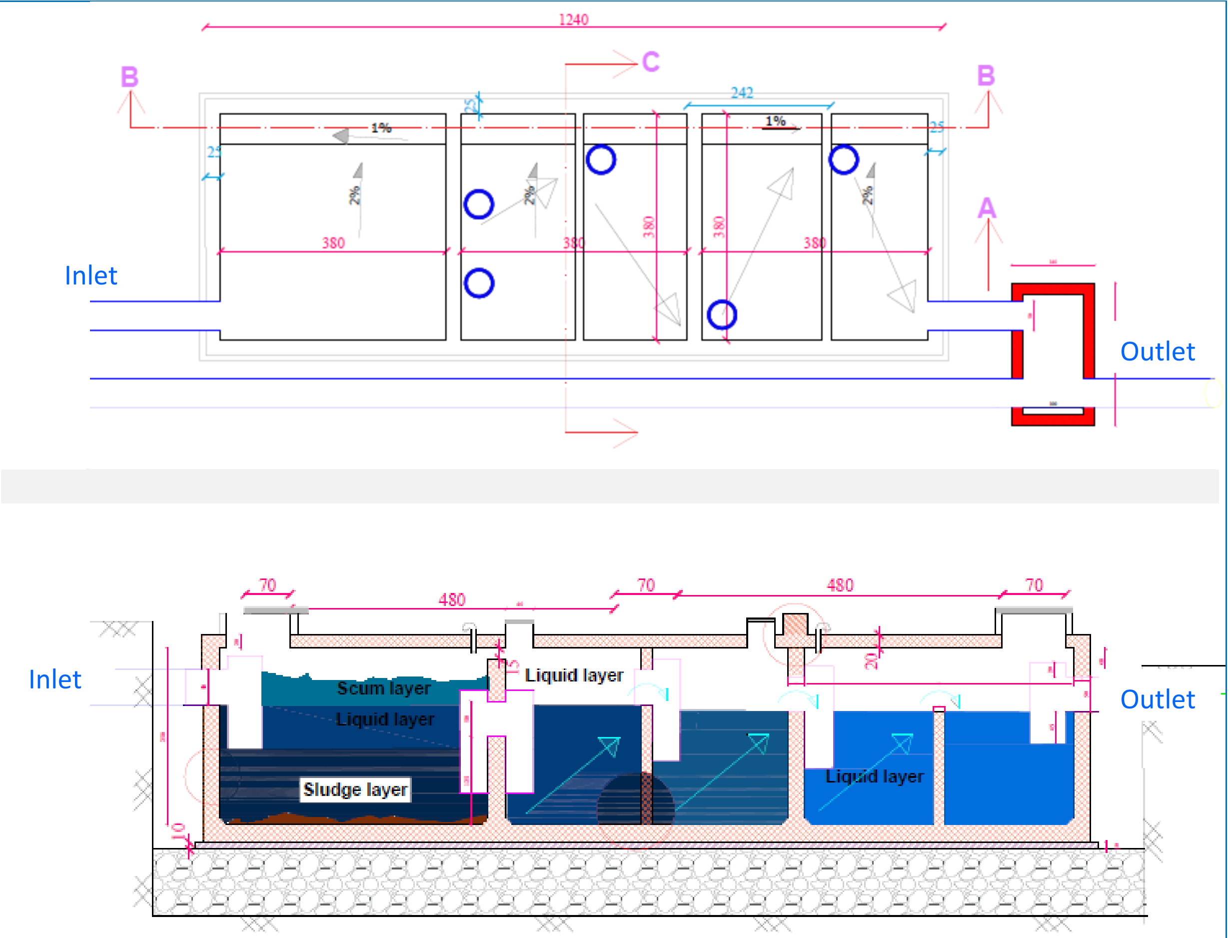


Figure 6: Multi-chamber septic tank drawings, the 2nd and 3rd chambers are equally split with baffles making the it a 5-chamber tank.

5. Siting - choose a suitable location

Septic tank should be located at a place open to sky, as far away as possible from the exterior of the wall of building and should not be located in swampy areas or areas prone to flooding. It should also be accessible for cleaning (Standards, 1993). This should be downhill from the source of sewage, at least 30m from the nearest water supply and at least 3m from the nearest building. Avoid areas where rainwater would stand or flow over the tank or vehicles could drive over it. The septic tank shall be located so that it is readily accessible. (Draw a plan showing the septic-tank and distances to dwellings, property lines, wells, water sources and any other prominent man-made or natural features. Show the ground slope.

6. Septic-tank construction

The construction of a septic tank usually requires the assistance and supervision of an engineer or at least an experienced construction foreman. The design of the inlet and outlet is critical to the performance of the tank. Careful checking of levels is particularly important for large tanks that include complicated inlet, outlet and baffle board arrangements. If the ground conditions are poor or the tank is large, the floor may have to be reinforced. The walls are commonly built of bricks, blocks or stone and should be rendered on the inside with cement mortar to make them watertight. Large reinforced concrete tanks serving groups of houses or institutions must be designed by a qualified engineer to ensure that they are structurally sound.

The tank cover or roof, which usually consists of one or more concrete slabs, must be strong enough to withstand any load that will be imposed. Removable cover slabs should be provided over the inlet and outlet. Circular covers, rather than rectangular ones, have the advantage that they cannot fall into the tank when removed.

Septic tanks have been constructed from a variety of prefabricated sections, including large-diameter pipes. Experience has shown that the problems involved in fixing the inlet and outlet outweigh the advantages of using pipes. A number of proprietary designs of tank are manufactured from asbestos cement, glass-reinforced plastic and other
materials and are sold commercially.

Inlet

The sewage must enter the tank with the minimum possible disturbance to the liquid and solids already in the tank. Surges and turbulence reduce the efficiency of settlement and can cause large amounts of solid matter to be carried out in the tank effluent.

Surges are caused by flushing of the WC and emptying of sinks and baths. Their effect can be minimized by using drainpipes of not less than 100 mm in diameter and ensuring that the gradient of the pipe approaching the septic tank is flatter than about 1 in 66. Sizes and gradients of pipes between the building and the septic tank may be specified in local building regulations.

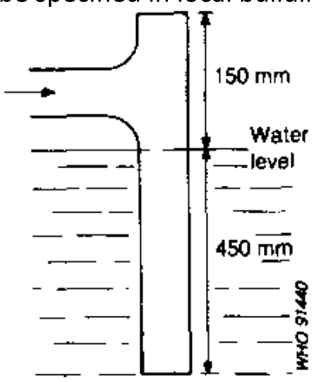


Figure 7: Septic tank inlet(Franceys et al., 1992)

Outlet

For septic tanks less than 1.2 m wide, a simple T-pipe arrangement can be used for the outlet. A removable cover above the T-pipe should be provided to permit clearance of any blockage. An alternative to the T-pipe is a baffle plate made of galvanized sheet, ferrocement or asbestos cement fitted round the outlet pipe (Fig. 6.22). A deflector may be provided below the outlet to reduce the possibility of settled sludge being resuspended and carried out of the tank. For tanks wider than 1.2 m, a full-width weir can be used to draw off the flow evenly across the tank. A scum board should be fitted to prevent the scum washing over the weir (F)

Dividing wall

If a tank is divided into two or more compartments, slots or a short length of pipe should be provided above the sludge level and below the scum level. At least two should be installed to maintain uniform flow distribution across the tank.

Ventilation of the tank

The anaerobic processes that occur in the tank produce gases which must be allowed a means of escape. If the drainage system of the house or other building has a ventilation pipe at the upper end, gases can escape from the septic tank along the drains. If the drainage system is not ventilated, a screened vent pipe should be provided from the septic tank itself.

The tank floor

Some codes of practice recommend that the floor of a septic tank should slope downwards towards the inlet. There are two reasons: firstly, more sludge accumulates near the inlet, so a greater depth is desirable; secondly, the slope assists movement of sludge towards the inlet during desludging. For a two-compartment tank, the second compartment should have a horizontal floor and the first compartment may slope at a gradient of 1 in 4 towards the inlet. When calculating the tank volume, it should be assumed that the floor is horizontal at the higher level. The effect of sloping the floor provides extra volume. The disadvantages of providing a sloping floor are that additional depth of excavation is required, the construction is made more complicated, and the cost of construction is increased.

The walls of the tank can be made of poured, reinforced concrete, stone masonry, brick or concrete blocks. The tank should be made water-tight with a 25mm coating of cement plaster, applied in two coats, in order to avoid infiltration around the tank and maintain an anaerobic space. The base should be at least 150mm thick and should be reinforced (except for very small tanks). The roof of the tank can be made of removable sections with lifting handles (for easy access) or a solid, reinforced concrete roof with round access holes (minimum diameter 0.6m). These provide access to the tank for desludging, checking wastewater levels and maintenance. If the tank will be below the groundwater level at any time the weight of the empty tank should be greater than the weight of water displaced, otherwise the tank may float. Inlet and outlet pipes consist of 'T' pipes. On the outlet this is to avoid scum or solids going into the soakfield. On the inlet this is to reduce turbulence. The base of the tank can slope down towards the inlet in a large tank to allow more sludge to be stored at the inlet end. The outlet on a larger tank can be a weir design. The inlet wastewater pipe should be ventilated above head height in order to allow the gases produced in the tank to escape.

Summarised design steps (WHO standard, 1992)

1. Volume of liquid entering the tank each day (A)

A = P x q

Where
A = volume of liquid to be stored in the septic tank
P = number of people using the tank
q = sewage flow = 80% of the daily water consumption per person (Q).

Table 4: Recommended retention time

Daily liquid volume (A)	Retention time (T)
If A < 6m3/day	T = 24 hours
If A is 6m3 – 14m3/day	T = 33 - 1.5 x A hours
If A > 14m3/day	T = 12 hours

2. The volume of sludge and scum (B)

B = P x N x F x S

Where
B = volume of sludge and scum
P = number of people using the tank
N = period between desludgings (1-3 years)
F = sizing factor (see Table 5)
S = sludge and scum accumulation rate

Table 5: sizing factors (F)

Desludge Period	Ambient Temperature		
	>20°C	10°-20°C	<10°C
1	1.3	1.5	2.5
2	1	1.2	1.5
3	1	1	1.3
4	1	1	1.2
5	1	1	1.1
6+	1	1	1

3. Total tank volume (C)

C= A+B

4. Determine tank dimensions: width, length and height

Assume a liquid depth, standard of practice is usually 1.2m-1.5m, however some regions may use 2m
L is equal to 3W (split equally or 2W+W for 2 compartments)
Calculate width of tank:
$V= W \times (2W+W) \times H$
$V= 3W^2 \times 1.5$
$V= 4.5W^2$
$W=((V/4.5)$ ^ $(1/2))$

IOM Turkiye adopted the UNHCR septic tank excel sizing sheet, the link is shared under Resources

Septic Tank Performance

A septic tank is a buried, watertight receptacle designed and constructed to receive wastewater from a home, to separate solids from the liquid, to provide limited digestion of organic matter, to store solids, and to allow the clarified liquid to discharge for further treatment and disposal. Settleable solids and partially decomposed sludge settle to the bottom of the tank and accumulate. A scum of light weight material (including fats and greases) rises to the top. The partially clarified liquid is allowed to flow through an outlet structure just below the floating scum layer. This partially clarified liquid can be disposed of through soil absorption systems, soil mounds, evaporation beds or anaerobic filters depending upon the site conditions(Polprasert and Rajput, 1982).

Sedimentation within the tank is the main mechanism of removal, at least of the helminthes and protozoan parasites. The settleable solids in sewage settle out and are retained in the septic tank, and others float and are captured in the scum layer. The effluent is generally high in BOD, bacteria, organic and ammoniacal nitrogen and phosphorus. Reduction in BOD of 25-50 percent has been observed. The high reduction in BOD and TSS can be obtained by prolonging the retention time. Efficient removal of BOD as high as 80% have been reported by providing a 20-day retention period in the septic tank. However, in practice this long retention time may not be practicable(M. Henze et al., 2008).

Table 6: Typical Septic Tank Performance Efficiency

Parameter	Optimum range	Low range	High range
pH	6.5-7.5	< 5	< 9
Removal Efficiency			
BOD_5	30-50 %	< 30 %	< 50 %
COD	30-50 %	< 30 %	< 50 %
Total Suspended Solids	50-70 %	< 50 %	> 70 %
Settleable solids	70 - 99 %	< 50 %	-
Total Coliforms	20 - 30 %	**Septic tanks have a low pathogen removal efficiency*	

The performance of a septic tank depends to a great extent on the retention time. When wastewater stands quiescent or moves at a very low velocity the suspended matter and the solids settle out gradually, with the heaviest portion settling first. After prolonged standing, a part of the suspended colloidal matter may settle down gradually through coagulation due to physical contact or changes in composition of the sewage, and eventually a part of the dissolved colloidal matter may be precipitated similarly. Other factors, apart from the retention time, which affect the performance of the septic tank are: ambient temperature, the nature of the influent wastewater, the organic matter content in the wastewater, and the position of the inlet and the outlet in the septic tank. The digestion of sludge and scum depends on the microbial population and the temperature. Sludge and scum decompose more slowly at lower temperatures. Digestion is accelerated by an increase in temperature up to about 35 degrees Celsius. It is a well-established fact for a sedimentation process that quiescent conditions are required, while for efficient digestion thorough mixing is useful. When the flow into the tank comes in surges, these surges disturb the whole liquid, especially in small tanks. In addition, the temperature of the incoming wastewater may be different from that of the liquid in the tank, which further disturbs the liquid.

PART III

SEPTIC TANK OPERATION & MAINTENANCE

CHAPTER 3

Operation and Maintenance (O&M)

Start-up

The process of anaerobic digestion of the sewage solids entering the tank can be slow in starting and it is a good idea to "seed" a new tank with sludge from a tank that has been operating for some time. This ensures that the necessary microorganisms are present in the tank to allow the digestion process to take place in a short time(Franceys et al., 1992).

Maintenance

Routine inspection is necessary to check whether desludging is needed, and to ensure that there are no blockages at the inlet or outlet. A tank needs to be desludged when the sludge and scum occupy the volume specified in the design. A simple rule is to desludge when solids occupy between one-half and or two-thirds of the total depth between the water level and the bottom of the tank. One of the difficulties with septic tanks is that they continue to operate even when the tank is almost full of solids. In this situation the inflow scours a channel through the sludge and may pass through the tank in a matter of minutes rather than remaining in the tank for the required retention time.

The most satisfactory method of sludge removal is by vacuum tanker. The sludge is pumped out of the tank through a flexible hose connected to a vacuum pump, which lifts the sludge into the tanker. If the bottom layers of sludge have cemented together, they can be jetted with a water hose (which may be fitted to the tanker lorry) or broken up with a long-handled spade before being pumped out. Care must be taken to ensure that sludge is not spilled around the tank during emptying. Sludge removed from a septic tank includes fresh excrete and presents a risk of transmission of diseases of faecal origin. Careful disposal is therefore necessary and if possible, disinfection with hydrated lime is highly recommended to avoid transmission and spread of disease outbreaks like cholera. A small amount of sludge should be left in the tank to ensure continuing rapid digestion(Franceys et al., 1992). To ensure optimal performance and optimization of the septic tank, regular water quality monitoring should be conducted refer to table 6 for some guidelines on when to sample and annex for the typical treatment performance achieved by a septic tank.

Table 7: Septic Tank Effluent Quality Monitoring Guide

Monitoring Guide	
Sampling points	Inlet and outlet (2 samples/septic tank)
Sampling frequency	Once a month for new projects, and
	Once a quarter (3 months) for old septic tanks
Parameters to monitor	
1. Operational	pH, Temperature, flow rate and hydraulic retention time
2. Performance	BOD_5, COD, Total Suspended Solids, Settleable Solids, Total Coliforms

Decommissioning plan

Septic tanks usually have a long lifespan when well-designed. However, they may be need to decommission old tanks or other reasons that may arise. Therefore, it is always necessary to have or develop a plan for dismantling and decommissioning excreta disposal facilities. The organization responsible for septic tank construction is normally also responsible for decommissioning.

Some key issues to consider in decommissioning are outlined below(Franceys et al., 1992):

1. Decommissioning should ideally be carried out during the 'dry' season when the tank contents will have had the most opportunity to dry out (decomposition rate is high in summer season).
2. Staff should be trained and provided with protective clothing in order to dismantle superstructures, remove latrine slabs and pipes, and backfill pits.
3. Lime or another form of disinfectant should be used to clean latrine slabs or pedestals that were connected to the septic tank, and to mitigate against unpleasant odours.
4. If the tank contents are wet it may be necessary to dig an overflow trench from the top of the pit or tank to absorb displaced fluids. This should be made large enough to allow a large quantity of material to be placed into the tank. The trench can either be dug around the top of the latrine or out as a single line drain to work as a leach field.
5. Cement debris from the latrine structure or other dismantled facilities can be thrown into the septic tank along with wood chips, ash or other available organic matter to aid decomposition. As these are added, fluids will overspill into the overflow trench; once the flow stops this can then be backfilled with soil and site rubble.
6. The tank should then be capped with a mound of soil and rubble to allow for further settling of contents.
7. Vegetation can be planted on the septic tank site, after its covered with soil mound, if in line with site rehabilitation. If not, a larger pile of debris should be placed over the filled pit to allow for further subsidence as the contents settle and decompose further. Capping with concrete should be considered if in a populated area where interference is possible.
8. If possible, the area should be fenced off to prevent it from being disturbed.

Health and Safety

The health and safety of septic tanks operators/workers and people living in nearby neighbourhoods should be preserved by following some these health and safety precautions.

Do' s	– Regularly inspect and maintain the septic tank; routine maintenance can lengthen its lifespan. – Leave tank cleaning and repairs to trained professionals and or experienced personnel. – Encourage users to be water wise; using less water may increase the lifespan of the septic tank and using too much water is a frequent factor in failed systems. – Always assume sewage/wastewater is hazardous and can spread infectious disease. Even exposure to sewage residues on clothing and equipment can result in illness. – Tools and equipment, including PPE, that come into contact with liquids or solids from the septic tanks must be cleaned and sanitized afterwards. It's recommended to wash hands with soap after inspecting or working at the septic tank and to shower/take a bath afterwards, even if you don't think you were exposed to sewage.
Don' ts	– Don't work alone at a septic tank: Falling into a septic tank or even leaning over a septic tank can be fatal. – Do not lean over a septic tank opening or stick your head into tank to examine its interior - gases (methane or hydrogen sulphide) from the tank can be fatal. – Do not use septic tank additives, these chemicals can do harm than good to the septic tank. – Don't ignite flames or smoke cigarettes at or near the tank - methane gas is explosive. – Do not drive over your septic tank or septic piping. It can collapse. – Do not allow children to play around the septic tanks and or play with the manhole covers/lids, there are risks to fall into the tank or suffocation if the lid is opened. – Do not allow garbage disposal into the septic tank, this may reduce its efficiency and life span. – Do not eat, drink, or smoke while inspecting the septic system. After the inspection is finished, be sure to wash your hands thoroughly with soap before eating, drinking, or smoking. – Avoid hand to face contact. Do not touch your eyes, nose, or mouth. Keep your hands below your shoulders so sewage does not drip on your head. – Cover open cuts or other wounds. Bacteria and viruses can enter the body through these openings and cause illness

PART IV

ANNEXES & RESOURCES

Annexes

Annex 1: DEWATs in NWS

Sequence Batch Reactor in Sijou Camp
Capacity: 450m^3/d
Year of construction: 2018
Constructed by: World Vision

UASB and Wetland in Ram Hamdan
Capacity: 1,000m^3/d
Year of construction: 2020
Constructed by: GIZ, ACU & Syria Relief

ABR in Kafer Yahmoul
Capacity: 250m^3/d
Year of construction: 2020
Constructed by: GIZ, ACU & Syria Relief

Simplified sewer and multiple-chamber septic tanks, over thirty camps
Capacity: 50-150m^3
Year of construction: 2020-22
Constructed by: IOM and its IPs

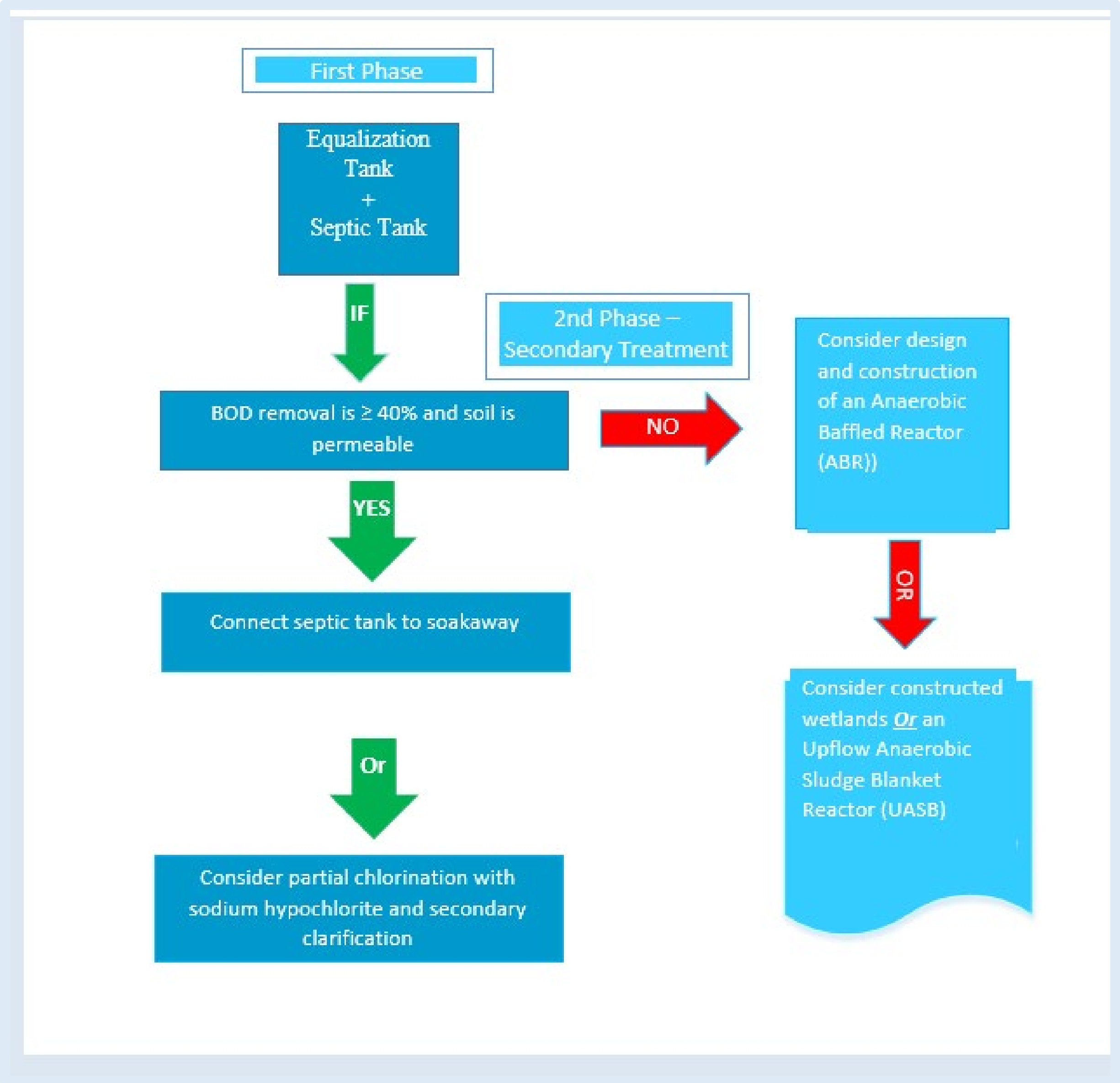
ABR in Batabo
Capacity: 400m^3/d
Year of construction: 2021
Constructed by: Amal Organization

ABR in Sarmin
Capacity: 400m^3/d
Year of construction: 2022
Constructed by: Amal Organization

ABR in Quabsin
Capacity: 1,200m^3/d
Year of construction: 2022
Constructed by: ACU

ABR in Suran
Capacity: 1,200m^3/d
Year of construction: 2022
Constructed by: Syria Relief

Annex 2: Possible Septic Tank Complementary Strategies



Annex 3: Septic Tank BOQs Example

BILL OF QUANTITY - SEPTIC TANK				
#	Works	الأعمال	Unit	QTY
1	Excavations in soil with diffirent types (dirt - rock) with backfilling And transfer the surplus to a place chosen by the supervisory with all necessaries	تنفيذ حفريات (ترابية - صخرية)مهما كان نوعها بالآليات الميكانيكية مع دة الردم وترحيل الفائض إلى مكان يختاره جهاز الاشراف مع كل ما يلزم	m3	300
2	Providing and installing polyethylene T with 50 cm diameter from and all necessaries(SN8)	تقديم وتركيب تيه بولي ايتيلين قطر 50سم من وكل ما يلزم (SN8)	Piece	8
3	Providing and instaling High Density Polyethylene (HDPE) pipes D500 mm SN8 with all materials and works	قديم وتركيب قساطل بولي ايتلين مضلع قطر 500 مم خاصة للصرف الصحي SN8 مع كل ما يلزم	m.l	35
4	Providing and pouring manholes with 100x100x(100-200) cm dimensions with pouring the floor and walls with ordinary concrete 20 cm thickness and the ceiling of	تقديم وصب حفرة تفتيش صرف صحي بأبعاد صافية 100×100×(100 - 200)سم مع صب الأرضية والجدران بالبيتون العادي سماكة 20سم والسقف من البيتون المسلح سماكة 20 سم مسلح بشبكتين تسليح 6قطر	Piece	2
5	Provide and implement submerged concrete with an area of 250 kg / m 3, provided that it does not include large stones (70%concrete /30% stones)and all necessary	قديم وتنفيذ بيتون مغموس بالأساس عيار 250 كغ/م3 على ان لا تتضمن حجار كبيرة (نسبة 70% اسمنت /30% احضارات)وكل مايلزم	M3	45
6	Normal concrete, ratio of 350 kg/m3 Sulfate-resistant cement and sealant materials and polishing Floors with all needs to get the work completely well done.	بيتون مسلح عيار350 كغ \ م3 باسمنت مقاوم للكبريتات ومواد مانعة للتسرب مع السقلة	m3	65
7	The implementation of cleaner concrete, caliber 150 kg / m3, thickness of 10 cm	تنفيذ بيتون نظافة عيار 150 كغ/م3 سماكة 10سم	m3	9
8	Providing and excuting cement plastering on two layers(Soft and rough) Sulfate-resistant cement and sealant materials and polishing Walls with all necessaries	قديم وتنفيذ زريقة اسمنتية عيار 500 كغ/م3على طبيقتين (خشنة و ناعمة)باسمنت مقاوم للكبريتات مع صقال ومادة مانعة للرشح مع كل ما يلزم	m2	210
9	Providing and installing metal carpentry for for covers and stairs and painting with all necessaries	ديم وتركيب منجور معدني للاغطية والسلالم والمصافي الخشنة مع لدهان وكل ما يلزم	kg	1000

Annex 4: IOM Multi-chamber Septic Tank Effluent Quality Results

The following table presents the latest effluent results from the multi-chamber septic tank, with a total suspended solids efficiency of 33%-91%, BOD from 50-96% and COD 60-93%. Other results from 2021-22 can be accessed here. This may help and guide on giving an indication of possible treatment efficiency that can be achieved with the multi-chamber septic tank.

Site Name	Date	TSS inlet (mg/l)	TSS Outlet (mg/l)	TSS Efficiency	BOD inlet (mg/l)	BOD Outlet (mg/l)	BOD Efficiency	COD inlet (mg/l)	COD Outlet (mg/l)	COD Efficiency
Jabal Al-Hos	04/11/2022	1200	800	33%	877.6	402	54%	2500	1000	60%
Afamya	04/11/2022	1050	94	91%	1166	50.8	96%	3100	380	88%
Aleis	04/11/2022	850	420	51%	966.6	143.6	85%	1960	650	67%
Shohada AL Janoub 1-2	04/11/2022	1200	111	91%	1322	202.3	85%	5600	400	93%
Saeed1	04/11/2022	2500	721	71%	1433	385	73%	6600	1080	84%

BOD - Biological Oxygen Demand
COD - Chemical Oxygen Demand
SS - Suspended Solids
TSS - Total Suspended Solids

Annex 5: ABR Effluent Quality Results

Site Name	Date	TSS inlet (mg/l)	TSS Outlet (mg/l)	TSS Efficiency	BOD inlet (mg/l)	BOD Outlet (mg/l)	BOD Efficiency	COD inlet (mg/l)	COD Outlet (mg/l)	COD Efficiency
ABR_1	04/09/2022	568	107	81%	589	60	90%	1375	240	83%
ABR_1	3/28/2022	432	108	75%	458	48.8	89%	870	240	72%
ABR_1	11/15/2021	308	42	86%	514	66	87%	916	173	81%
Site Name	**Date**	**TSS inlet (mg/l)**	**TSS Outlet (mg/l)**	**TSS Efficiency**	**BOD inlet (mg/l)**	**BOD Outlet (mg/l)**	**BOD Efficiency**	**COD inlet (mg/l)**	**COD Outlet (mg/l)**	**COD Efficiency**
ABR_2	10/25/2022	715	195	73%	793.9	185.7	77%	1500	350	77%
ABR_2	7/24/2022	700	135	81%	767	183.3	76%	2000	694	65%
ABR_2	09/11/2022	673	200	70%	612.3	180	71%	1700	763	55%
ABR_2	8/21/2022	900	200	78%	633.1	192	70%	1650	500	70%
Site Name	**Date**	**TSS inlet (mg/l)**	**TSS Outlet (mg/l)**	**TSS Efficiency**	**BOD inlet (mg/l)**	**BOD Outlet (mg/l)**	**BOD Efficiency**	**COD inlet (mg/l)**	**COD Outlet (mg/l)**	**COD Efficiency**
ABR_3	09/12/2022	950	126	87%	728.3	169.3	77%	2450	831	66%
ABR_3	7/21/2022	1250	246	80%	790.6	190.3	76%	2100	560	73%
ABR_3	07/01/2022	1350	150	89%	757.3	207.3	73%	2000	610	70%
ABR_3	08/03/2022	663	131	80%	621.5	187.6	70%	1100	558	49%

**** Results were provided by ACU for 3 ABR's in Northwest Syria under their responsibility***

BOD - Biological Oxygen Demand
COD - Chemical Oxygen Demand
SS - Suspended Solids
TSS - Total Suspended Solids

Resources

The following are manuals, website and sizing sheets that can assist in understanding design concepts and approaches for septic tanks and other low-cost anaerobic treatment systems as well as Syrian effluent guidelines.

1. Decentralised Wastewater Treatment Plant Operation and Maintenance Manual developed by ACU, Northwest Syria, 2021
2. Septic Tank Design Manual, developed by Environment and Public Health Organization (ENPHO), Nepal, 2020
3. Septic Tank Information Sheet, developed by IOM Turkey Cross-border Programme, 2020
4. Septic Tank Fact Sheet, developed by IOM Turkey Cross-border Programme, 2020
5. UNHCR Septic Tank Sizing Excel Sheet,
6. UNHCR Drain field Design Excel Sheet
7. Draft Syrian Standards: Allowable Wastewater Discharge to the Environment of Water Recipient Bodies, 2013
8. Treated Wastewater for Irrigation Use, Syrian Standard, (S.N.S: 2752 / 2008)
9. Access the octopus online platform here, Octopus is a platform for faecal sludge treatment and disposal in emergencies

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