Wastewater and Solid Waste Management in Provincial Centers

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MANUAL ON
OPERATION AND MAINTENANCE OF DECENTRALIZED WASTE WATER TREATMENT PLANTS

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Ministry of Construction – Hanoi

in cooperation with

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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INTRODUCTION & RATIONALE

"Wastewater and Solid Waste Management in Provincial Centers" (WMP) is an ODA program sponsored by the German Government. The objective of WMP is the enhancement of wastewater management and related services in six provincial urban cities and the contribution to better environmental conditions, the reduction of seasonal inundations, and the improvement of water quality in the adjacent drainage channels and rivers. WMP contains of two main modules:

- Financial Cooperation (FC), jointly financed by the German Development Bank (KfW) and the Government of Vietnam (GoV), and
- Technical Cooperation (TC), implemented by German Technical Cooperation Agency (GTZ) and the German Development Service (DED), in close cooperation with the Ministry of Construction (MOC).

Whereas the FC module focuses on the provision of new infrastructure facilities for wastewater and solid waste management in currently six provincial cities in Vietnam, the TC module consist currently of two components. These are

- TC Component 1: "Capacity Development for the MOC", and
- TC Component 2: "Capacity Development for Wastewater Management", also referred to as the "WWM project".

TC Component 2 commenced in February 2005 and officially launched its second phase in August 2008. The second phase is scheduled to be finalized in July 2011.

Until date, TC Component 2 (WWM), provides capacity building services to local governments and public wastewater companies (WWC) in six provincial urban centers in Vietnam, including the cities of Bac Ninh, Hai Duong, Vinh, Can Tho, Soc Trang and Tra Vinh. The capacity building activities focus, amongst operational fields, such as financial, customer, asset and human resource management and community awareness raising, predominantly on the re-organization of the WWCs and the creation of favorable institutional framework conditions at local government level for fostering effective and efficient wastewater management.

Furthermore, the construction of demonstration plants and the raising of awareness among decision makers on decentralized wastewater treatment (DWWT) approaches for urban or semi-urban areas in the outskirts of cities that are not served by large scale, centralized wastewater collection and treatment systems, is a major focus of the WWM Project.

The WWM Project has been introducing the approach to DWWT on national and local levels, through workshops, conferences, the construction of demonstration plants, O&M trainings etc.

This O&M Manual is supposed to give some practical advice to those who are in charge of daily operations and maintenance of DWWT plants. It does not cover the whole range of possible treatment technologies, but describes a number of applications as they are used in Vietnam today, with a focus on domestic waste water treatment.

REFERENCES

Valuable information has been taken from:
BORDA (2009): Decentralised Wastewater Treatment systems (DEWATS) and Sanitation in Developing Countries. A Practical Guide. 2009

Some pictures and graphics originate from:
EAWAG Aquatic Research (Tilley et. al.): Compendium of Sanitation Systems and Technologies.

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List of abbreviations

General

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
SS	Suspended Solids
d	Day
DM	Dry Matter
DWWT	Decentralized Waste Water Treatment
DWWTS	Decentralized Waste Water Treatment Systems
PE	Persons (person equivalent)
WW	Waste Water
WWM	Waste Water Management
WWTP	Waste Water Treatment Plant

Sanitation Systems

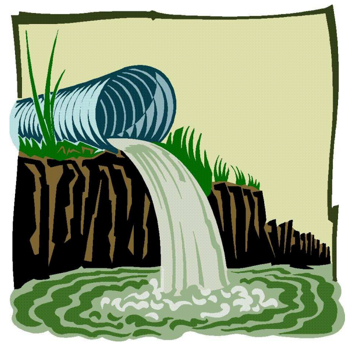
ABR	Anaerobic Baffled Reactor
AF	Anaerobic Filter
AP	Aerated Pond
AS	Activated Sludge
CW	Constructed Wetland
WSP	Waste Stabilization Ponds
An WSP	Anaerobic Waste Stabilization Ponds
FA WSP	Facultative Aerobic Waste Stabilization Ponds
A WSP	Aerobic Waste Stabilization Pond
FC	Filter Chamber
FWS CW	Free-Water-Surface Constructed Wetland
HSF CW	Horizontal Subsurface Flow Constructed Wetland
PDB	Planted Drying Beds
SBR	Sequencing Batch Reactor (belongs to AS)
ST	Septic Tank
TF	Trickling Filter
UASBR	Upflow Anaerobic Sludge Blanket Reactor
VF CW	Vertical Flow Constructed Wetland

1 Basic knowledge on waste water and waste water treatment

1.1 What is waste water and where does it come from?

Wastewater is:
(Definition in accordance with EN 1085)

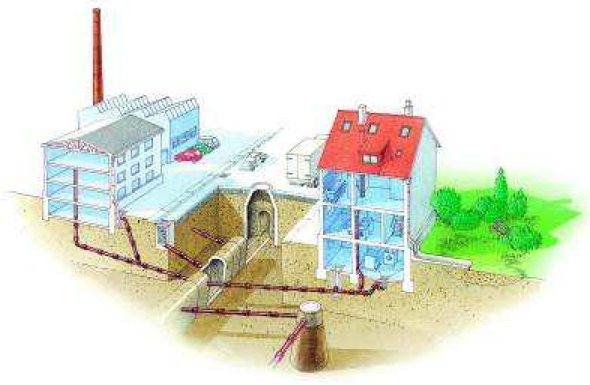
- water changed in its properties through domestic, commercial, agricultural or other usage (Wastewater).
- water flowing from built-up and sealed surfaces as a result of precipitation and/or melting (Storm water).



The wastewater flowing into a wastewater treatment plant is designated as raw sewage!

Source for waste water are:

- Domestic wastewater coming from the kitchen (cooking and washing-up water), toilets, baths, washing machines, general cleaning → as a rule biologically treatable
- Commercial wastewater often has a complex composition → capable of qualified biological treatment, in part also chemical treatment
- Infiltration water (spring- and groundwater)



1.2 What substances contents wastewater?

<u>Undissolved substances</u>

- Settleable solids
  e.g. sand, faeces, sludge
- Floating substances
  e.g. cotton buds, sanitary towels, condoms...
- Suspended solids
  e.g. fine dirt particles
- Greases and oils

These substances are in general removed through flotation, sedimentation or mechanical devices in the mechanical part of a treatment plant.

<u>Dissolved substances</u>

- Mineral nutrients (containing nitrogen and phosphorus)
- Biologically degradable solids (BOD)
- Chemically degradable solids (COD)

These substances are in general removed / reduced in the biological part of a treatment plant.

1.3 What character has raw domestic wastewater?

- Colouring: brown (-yellow)
- Turbidity: strong
- Odour: musty, not disturbing
- pH value: 6.5 to 7.5 (neutral)
- Temperature: 10 to 20 ℃ (higher in warm regions)

- 2/3 of the pollution are dissolved, 1/3 is settleable coarse solids.
- Black/grey colour and putrid, foul odour are signs of a lack of oxygen, e.g. due to too long standing times.
- Well-treated wastewater is almost odourless (or earthy), contains rarely any settleable solids and is transparent. A light yellow colouring is not abnormal (humid acid).

1.4 What are the basic monitoring parameters?

The basic monitoring parameters for waste water are:

- BOD: Biochemical Oxygen Demand Unit: mg/l (O2)
- COD: Chemical Oxygen Demand Unit: mg/l (O2)
- SS: Suspended Solids Unit: mg/l
  (incl. settleable solids and non-settleable or suspended solids)
- TNb: Total Nitrogen bound Unit: mg/l
  (incl. ammonia NH4-N, Nitrite NO2-N, Nitrate NO3-N, org. Nitrogen)
- P: Total Phosphorous Unit: mg/l
- pH: Unit: -
- Temperature: Unit: ℃

And the Quantity of wastewater per day.

Additional to these measurable parameters, color, odor and turbidity can also give valuable information about the state and source of the waste water.

Short definitions of the basic monitoring parameters:

Biochemical Oxygen Demand, BOD (BOD_5)

BOD_5 describes the portion of the wastewater which can be digested easily. It describes the amount of oxygen required to oxidise the biodegradable matter found in the water. It is the quantity of oxygen, which is consumed by the micro-organisms, in order to degrade the organically degradable substances in the water at 20℃ in the dark. The de termination of the Biochemical Oxygen Demand is, by agreement, broken off after 5 days.

The complete degradation is therefore as a rule not awaited. The thus obtained result is then designated as BOD5 and the oxygen consumed is given in mg/l. It is an important parameter for the loading of a wastewater with biologically degradable organic substances (organic carbon) and the most important parameter for dimensioning of WWTP.

Chemical Oxygen Demand, COD

COD describes the amount of oxygen required to oxidise all organic matter (partial also inorganic matter) found in the water. Additionally to BOD, the COD contains the organic substances which are hardly biologically degradable . The COD value must therefore always be higher than the BOD_5.

In municipal wastewater, the COD concentration is about twice the BOD5 concentration. The ratio COD : BOD5 comes at app. 2:1. A significantly higher ratio (e.g. COD : BOD5 = 4) suggests a larger share of compounds which are difficult to degrade. It may also suggest a remarkable concentration of toxic compounds in the wastewater.

In the effluent of biological wastewater treatment plants the degradable compounds (BOD_5) are extensively removed; those which are biologically difficult to degrade, remain.

Suspended Solids, SS

Suspended solids include settleable solids and non-settleable or suspended solids. SS are all the substances which are not water. Suspended solids are not dissolved in the wastewater. SS are “small particles” that can be removed / separated mechanical or by gravity from the water. Suspended solids and coarse materials can be removed in the mechanical part of a wastewater treatment plant.

Settleable solids also should be determinate in the effluent of a treatment plant, by using an “Imhoff cone” in order to know the quantity of these solids. There are no legal requirements regarding this value. However, this value is very much suitable to evaluate the performance of the plant
→ value less than 1 ml/l is to aspire.

Nitrogen, N

The nitrogen contained in domestic raw sewage in the main part comes from human excretions (urea) and the anaerobic decomposition of proteins. As ammonia nitrogen (NH4-N) in the receiving water it leads, through oxidation into nitrate (NO3-N), to unwanted oxygen depletion and to eutrophication.

The degradation of ammonia compounds takes place in 2 phases, by oxidizing first to nitrite (NO2-N) and then to nitrate (NO3-N). This step is called nitrification. In a third step, called de-nitrification, nitrogen is released into the atmosphere, when bacteria breath the oxygen from the nitrate compounds.

The monitoring parameter TNb is a sum-parameter of all forms of nitrogen compounds (organic and in-organic) in the waste water.

TNb = NH4-N + NO2-N + NO3-N + N org.

Phosphorous, P

In domestic wastewater, in the first instance, phosphorus originates from human excretions. In water bodies, phosphorus functions as plant fertiliser and encourages the growth of algae and therefore leads to eutrophication.

Orthophosphates (PO4+) get into wastewater and are in part broken down in biological processes – the remainder must be precipitated by dosing chemical substances (e.g. Iron or aluminium salts)

into the wastewater. The chemicals react with the phosphates, building non-dissolvable substances that sediment and become removed with the sludge.

Along with ammonia, phosphorus serves the microorganisms as cell substance –> this is the principle of biological phosphorus removal.

pH Value

The pH value indicates whether a liquid is acidic (sour) or basic (alkaline). Pure water is said to be neutral, with a pH close to 7.0 at 25 ℃. Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are basic or alkaline. Typical values for the pH at the inlet and outlet of a wastewater treatment plant range between 6,5 and 9,0.

Examples:

Gastric acid:	pH about 1,0
Lemon juice :	pH about 2,0
Black coffee:	pH about 5,0
Pure water:	pH about 7,0
Soapy water:	pH about 12,0
Bleach:	pH about 13,0

Temperature

Temperature at the inlet of a wastewater treatment plant ranges between 10 and 20℃ in cold and moderate warm climate zones. In warm regions the water temperature can be significantly above 20 ℃. Temperature is relevant for the activity of the micro-organisms and hereby for the efficiency of the treatment process. Highest temperature level for aerobic (aerated) systems can be considered 30 to 33 ℃. Above this value aeration becomes ineffectiv e.

“Anaerobic digestion requires minimal temperatures of 10 ℃; temperatures between 18 and 25 ℃ are good, 25 to 35 ℃ are ideal. Anaerobic processes ar e more sensitive to low temperatures than aerobic ones. The ambient temperatures in tropical and subtropical zones are ideal for anaerobic treatment. Higher temperatures are also favorable for the growth of aerobic bacteria, but disadvantageous for oxygen transfer… This is the reason why ponds may become anaerobic at the height of summer” [Abstract from “Decentralised wastewater treatment systems (DEWATS) and sanitation in developing countries”, BORDA, 2010]

Average of the basic monitoring parameters

At the inlet of the wastewater treatment plant:		At the outlet of the wastewater treatment plant*:		Unit
BOD5:	200 to 300	BOD5:	20 to 40	mg/l
COD:	400 to 600	COD:	30 to 120	mg/l
SS:	300 to 450	SS:	~ 35	mg/l
TNb:	30 to 80	TNb:	10 to 25	mg/l
P:	5 to 20	P:	~ 2	mg/l
pH:	6,5 to 9	pH:	6,5 to 9	-
Temp.:	10 to 20	Temp.:	10 to 20 ℃	℃
(up to 30 ℃ in warm climates)		(up to 30 ℃ in warm climates)		

* This values generally apply to aerobic treatment systems, with nitrification / de-nitrification and chemical P-removal.

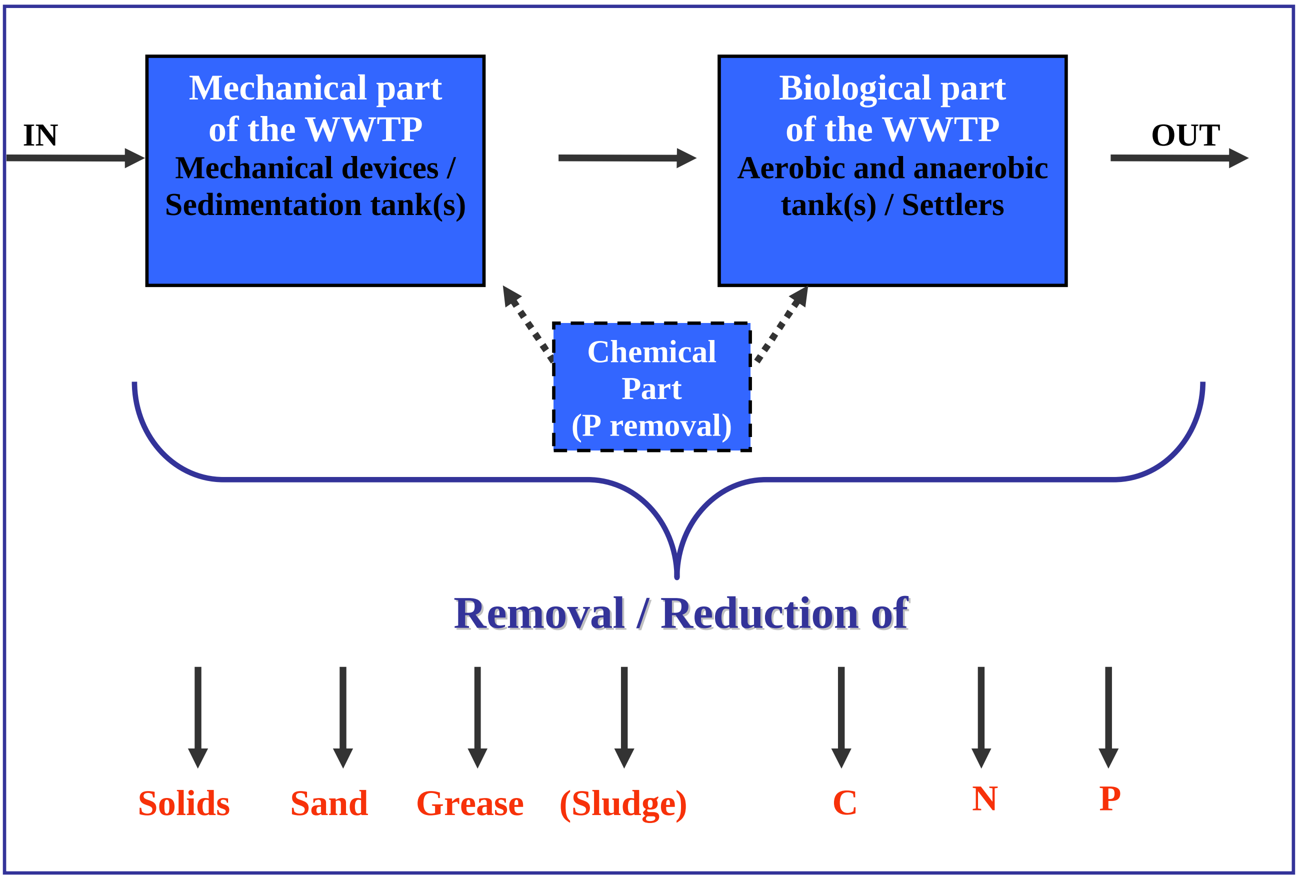
Treatment target should be:

Reduction of pollutants by 70 to 90 %.

2 The mechanism of wastewater treatment

Mechanical and biological wastewater treatment means: Imitating the nature.

It's all about using physical (chemical) and biological (natural) mechanisms like in streams and rivers (self cleaning effect) and turn it to intensified and optimized process by employment of technology



Carbon degradation / reduction

Carbon compounds (expressed as BOD) contained in the wastewater serve the micro-organisms as foodstuffs. With this, they convert the organic pollutants in part into inorganic end-products (e.g. water, carbon dioxide), in part they serve the micro-organisms as building material for their own body substance (build-up of cells). The “too many” bacteria need to be removed from the system as excess sludge (secondary sludge).

Simplified Reaction Mechanism

Substrate (bio-degradable BOD) and bacteria under aerobic conditions

Substrate (dissolved) + bacteria + oxygen
→ H_2O (Water) + CO_2 (Carbon-dioxide) + bacteria growth

Substrate (BOD / COD) and bacteria under anaerobic conditions

Substrate (dissolved) + bacteria
→ H_2O (Water) + CO_2 (Carbon-dioxide) + CH_4 (Methane) + bacteria growth

Nitrogen and Phosphorus reduction

Nitrogen and phosphorus serves the micro-organism as cell substance. The exceed is removed by nitrification/de-nitrification (N) and precipitation (P).

Nitrification (aerobic conditions = free oxygen is available)

NH_4-N (Ammonia) + O_2 (Oxygen) + Specialized Bacteria
→ NO_3 (Nitrate) + H_{20} (Water) + H_2 (Hydrogen)

De-nitrification (anoxic conditions = absence of free oxygen)

NO_3 (Nitrate) + H_2 (Hydrogen) + C (Carbon) + bacteria
→ CO_2 (Carbon-dioxide) + N_2 (Nitrogen) + H_2O (Water)

P - removal (precipitation with chemicals)

PO_4-P (Orthophosphate) + Chemical solutions (e.g. Iron-salts)
→ Insoluble iron-phosphate (settle in the tank) + other substances

Examples of waste water treatment systems

Aerobic Treatment Systems (generally highly mechanized)

- Activated sludge process
- Sequencing batch reactor
- Trickling filter
- Rotating disk reactor
- Fixed bed reactor
- Fluidized bed reactor

…

- Aerated / Aerobic ponds
- Aerobic / facultative planted gravel filter

Anaerobic Treatment Systems (generally non or low mechanized)

- Septic tank
- Imhoff tank
- Anaerobic Reactor (UASBR)
- Anaerobic baffled reactor
- Anaerobic filter
- Sedimentation ponds

3 Basic maintenance equipment for small and medium sized WWTP

3.1 Sludge level measuring equipment

- It is used for measuring the accumulated sludge level in sedimentation tanks.
- It helps to determine whether a tank has to be emptied. The maximum accepted level depends on the plant type and the according specifications in the O&M handbook.
- sludge level should be measured in all chambers of the tank.

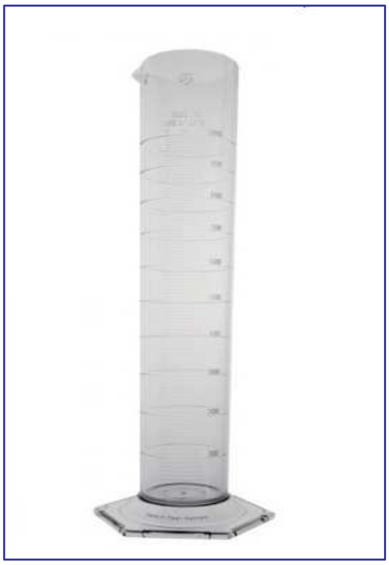
3.2 Sampling Rod

- It is used for taking water samples from the inlet and outlet chamber / tank.
- It is used for taking samples from the treatment tank (baffled chambers, filter chambers, or aerated tank).
- The sampling rod consists of a telescopic rod of about 2 m length and a plastic 1 liter beaker.

3.3 Imhoff Cone

- It is used for determination of the settleable solids in the effluent of the plant.
- Sampling from the last chamber of the plant; the final sedimentation chamber.
- 1 liter of effluent sample is poured into the Imhoff-cone. The cone must have a vertical position, and it must be placed in a vibration-free and shady place.
- After 2 hours settling time read the volume of settled solids in the Imhoff-cone. The settled solids are specified in ml/l.
- There are no legal requirements regarding this value. However, this value is very much suitable to evaluate the performance of the plant → value less than 1 ml/l should be aspired.

3.4 Graduated cylinder



- It is used for measuring the sludge quantity in the biological treatment tank. Generally it is used with aerated systems.
- This is one of the most important parameters of an activated sludge system.
- Definition: The volume of sludge in 1 liter well-mixed wastewater taken from the aerated tank, after 30 minutes of settling in a 1000 ml graduated cylinder. The sludge volume is specified in ml/l.
- Sludge volume less than 150 ml/l indicates organic under-loading or loss of organic sludge.
- Sludge volume more than 600 ml/l indicates organic overloading, an overloaded sludge storage or insufficient excess sludge return.

3.5 pH-value indicator strips

- pH should be measured at the inlet and outlet of the plant. Values below 6 or more than 9 at the inflow will disturb the biological wastewater treatment.
- pH-value of raw domestic wastewater is usually between 6,5 to 7,5.
- best pH-value for the biological treatment is between 7,0 and 8,0.

3.6 Dissolved oxygen meter

- One of the most important monitoring parameter with aerobic treatment systems
- The concentration of dissolved oxygen should be measured inside the aeration tank (and in the effluent). For proper operation at least 2 mg/l of dissolved oxygen are required in the aeration tank.

3.7 Multi - meter and Insulation tester

- Functional tests of varied devices e.g. pumps, aerator, control cabinets.
- Indispensable with automated and mechanized treatment plants or even when only pumping station is used for lifting the water into the plant.

3.8 Additional maintenance material

Additional to above mentioned tools a maintenance set should include

- Cleaning and disinfection material
- Protection gloves
- Mask
- Cover lifter or hook

4 General O&M procedures

4.1 What means the term "Operation"?

Ongoing recurring activities involved in the running of a technical facility, infrastructure, business etc. for the purpose of producing value for the stakeholders (clean environment, improved public health, profit, etc.)

4.2 What means the term "Maintenance"?

Any activity – such as tests, measurements, replacements, adjustments and repairs — intended to retain or restore a functional unit in or to a specified state in which the unit can perform its required functions.

All actions taken to retain material and assets in a serviceable condition or to restore it to serviceability. It includes inspection, testing, servicing, classification as to serviceability, repair, rebuilding, and reclamation.

The routine recurring work required to keep a facility (plant, building, structure, ground facility, utility system, or other real property) in such condition that it may be continuously used, at its original or designed capacity and efficiency for its intended purpose.

Maintenance activities are:

Maintenance of equipment	Controlling and monitoring
• to make sure that the plant is working and running constantly • control of the function. • removing sludge deposits • cleaning up	• control of the settings • inspection of the biological performance (analysis of parameters) • control of the point of discharge. • measurement of the sludge levels • pointing out desludging • writing of a maintenance report

4.3 Routine O&M and monitoring procedures

Weekly:	• Visual check, inlet, outlet, covers, tank, ventilation pipes, etc.
Every 3 to 6 months:	• Cleaning of mechanical parts
Every 6 months:	• Functional checks on mechanical and electrical devices • Determination of sludge level • Effluent sampling and analysis
Every 12 months and / or On demand:	• Removing of sludge
Every 3 to 5 years:	• Tightness control

* Detailed O&M procedures are described in the following chapters.

4.4 Additional monitoring and maintenance activities every 6 months

Every 6 months additional maintenance activities have to be carried out. Also every 6 months effluent should be sampled and analysed. Once per year or every 18 months additional analyses of the influent should be made and the treatment performance determinated.

The table below shows on a glance what the additional activities are and how and where they have to be carried out.

Parameter	**Where to sample?**	**Value**	**How to determine?**	**Where to determine?**
Sludge level	Sedimentation tank All chambers of the ABR or AF	< 50 % of volume < 40% of volume	Sludge level measuring pipe	On site
Settable solids	Outflow	< 1 ml/l	Imhoff cone	On site / Laboratory
Sludge volume	Aerobic Stage	150 – 600 ml/l	Graduated cylinder	On site
pH Value	Inflow / Outflow	7,0 – 8,0	pH strips	On site / Laboratory
Dissolved oxygen	Aerobic Stage	> 2 mg/l	O2 Meter	On site
COD	Outflow	< 120 mg/l	Sampling bottle	Laboratory
BOD5	Outflow	< 25 mg/l	Sampling bottle	Laboratory
TN	Outflow	< 25 mg/l	Sampling bottle	Laboratory
P	Outflow	< 5 mg/l (2 mg/l)	Sampling bottle	Laboratory
SS	Outflow	< 35 mg/l	Sampling bottle	Laboratory

5 Periodical self-monitoring and maintenance activities

5.1 General recommendations

The following recommendations refer to the surrounding and general construction of the WWTP.

Fencing/Posting

Periodically inspect the fencing to make sure that it is of an adequate height and condition to keep out livestock and the public. Warning signs should be legible and posted at the entrance gate and on all sides of the fence at a reasonable spacing interval.

Landscaping / Vegetation Over System Components

Keep all trees and bushes away. Do not plant trees or shrubbery over any of the system components. If a tree or bush has a strong root system, the roots can damage liners or berms and/or get into the tanks. Roots in the tank can reduce its capacity and block the inlet or outlet.

Concrete constructions

Keep all trees and bushes away. Water tightness of tanks has to be controlled at least every 5 years. Manholes and cover lids have to be kept free of rubbish. Vacuum trucks should not deploy on the cover slab of the tanks during desludging and cleaning works. Ventilation pipes and outlet pipes / manholes should be protected against animal access.

Earthwork

Maintain the top of the service berm in a weed-free condition to permit access for the facility's personnel, vehicles and equipment. The embankment sidewalls are to be maintained to prevent erosion and failure. Inspect the earthwork regularly for animal burrow holes, relocate the burrowing animals and then fill-in the holes as needed to prevent catastrophic berm failure.

Synthetic Liners

Synthetic liners (e.g., HDPE & PVC) generally offer superior leakage resistance over clay (bentonite). When the liner is properly anchored (keyed) into the berm, weed growth is reduced due to less exposed soil surface where weeds can take root. Periodically, the liners should be inspected to document UV (sunlight) damage and promptly repair any tearing or holes.

Earthen or Clay Liners

If present, implement regular inspections to check for erosion, burrowing animals and weed growth. Clay liners should be maintained wet at all times when in service to avoid surface cracking. Clay liners may have to be re-compacted with fresh clay material to repair holes and cracks.

5.2 Treatment plant components and systems; specific O&M activities

5.2.1 Grit chamber

The purpose of the grit removal chamber is to separate solids like sand, gravel, plastic, fiber, food particles, etc., from the waste water. The main purpose is to protect downstream following components e.g. pumps.

Screened solids have to be removed weekly. Sediments on the bottom of the chamber have to be removed monthly, at least every 6 months (depending on the settling volume for settable solids e.g. sand provided in the chamber and on the quantity of this solids in the influent).

Additional O&M tasks include regular checking of:

- inlet and outlet structures for obstructions and for the water level
- ventilation pipes for obstruction
- water tightness of the construction

5.2.2 Pumping station

Pumping stations are used where gravitational flow of the water is not realizable. The waste water is lifted by means of pumps to the plant level. In order to avoid pump damages a grit chamber and screen should always be supplied in front of the pumping station. Pump stations are made of plastic or concrete with one or two pumps inside. When water reaches a certain level pumping starts and water is conveyed to the plant.

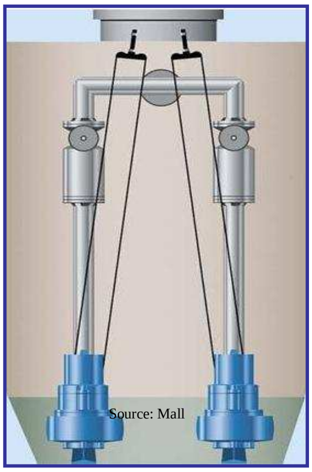
The primary O&M focus on the proper and continuous functionality of the pumps, floating switches, pressure pipe, etc. The functioning of the pumps has to be always guaranteed (power supply!). Further O&M activities are cleaning and removing of sediments from the station and components.

Additional O&M tasks include regular checking of:

- inlet and outlet structures for obstructions and for the water level
- ventilation pipes for obstruction
- water tightness of the construction

Caution:

Exercise extreme care when inspecting/enter the pumping station. Never inspect a pumping station alone. Toxic gases may be existent and these gases can kill in minutes.
Always disconnect pumps from the power supply when accessing the pumping station. Pumps have to be also power-off when maintained.



Always disconnect first from the power source before starting with the O&M. Skilled staff and proper tools are required for maintain and repair works. Ventilate proper the pumping station before stepping inside. A second person should be present when accessing the pumping station. Gases must be detected before any access to the station.

Pumping station: **Visual check, weekly, remove solid waste if there is any; remove of sediments from pump, floating switch and pumping station at least every 6 months or on demand.**

Functional test: **A functional test of the pump and floating switch should be carried out at least every 6 months.**

Pumps: **Have to be controlled and serviced in regular intervals according to the manufacturer's operating instructions.**

5.2.3 Septic tanks, anaerobic baffled reactors and filters

Septic tanks are used to treat and dispose wastewater from individual homes and buildings. Anaerobic Baffled Reactors and Anaerobic Filters – which are considerably improved septic tanks – are used to treat wastewater from building complex or neighborhoods. The treatment efficiency of these systems is also considerably higher than that of septic tanks.

These treatment systems are in general build underground concrete tanks. The connected households discharge through a pipeline to tank. Where groundwater levels are high, the elevation may be insufficient for gravity flow and pumps may be required. Pumps located before the septic tank require accurate maintenance because they may directly receive untreated wastewater (a bar screen or grid before the pumps is recommendable).

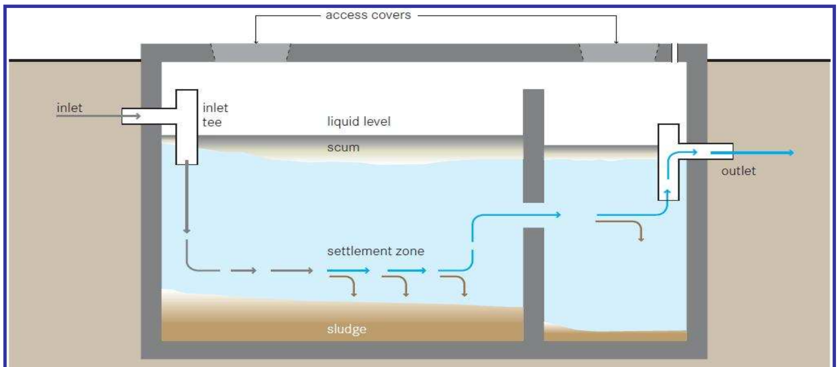
The primary O&M requirement for the tank systems is periodic removal of settleable solids. Check the sludge level in the tanks every 6 months to determine if solids need to be removed. There are two frequently used methods for measuring the solids and scum layers inside the tank.

a) Method 1: By using a sludge level measuring equipment as described above. The tube is pushed through the different layers to the bottom of the tank. When brought back up, the tube retains a sample showing a cross-section of the inside of the tank.
b) Method 2: By using a long stick. The solids layer is measured by wrapping cloth around the bottom of the stick and lowering it to the bottom of the tank. Insert the stick either through a hole in the scum layer or through the baffle or tee, if possible, to avoid getting scum on the cloth. The solids depth can be estimated by the length of solids sticking to the cloth.

When cleaning the tank, remove all contents, including scum, liquid, and solids. Use only the access ports on the tank for cleaning. Additional O&M tasks required for tanks include regular checking of:

- inlet and outlet structures for obstructions and for the water level
- ventilation pipes for obstruction
- water tightness of the construction

Septic Tank



Source: Eawag, CH

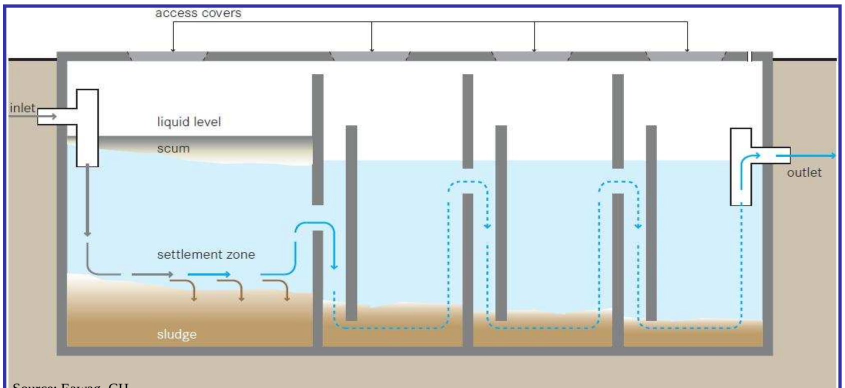
Sludge removing:
Every 1 to 3 years, respectively on demand.
When sludge level reach 50% of the volume of the ST, then desludging should be carried out.

How to be determined?
By using the sludge level measuring pipe. If the sludge level in the pipe is on the half of the total water column then desludge.

How to desludge?

- **Remove scum layer and the bottom sludge in both chambers of the ST. Empty completely the second chamber**
- **Leave 30 cm of sludge-water mix in the first chamber of the ST or alternatively if emptied complete then fill back sludge-water-mix from the truck in the first chamber.**
- **Fill up both chambers with water.**

Anaerobic Baffled Reactor



Source: Eawag, CH

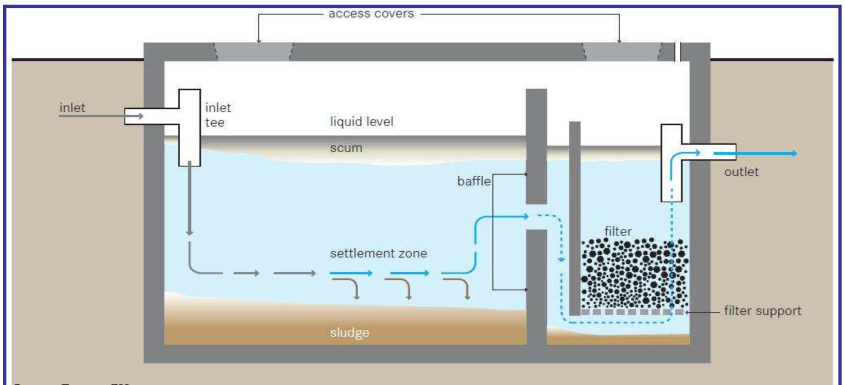
Sludge removing:
Every 1 to 3 years, respectively on demand.
When sludge level reach 50% of the volume of the first chamber, then desludging should be carried out.

How to be determined?
By using the sludge level measuring pipe. If the sludge level in the pipe is on the half of the total water column then desludge.

How to desludge?

- **Empty completely the first chamber of the ABR.**
- **Fill back sludge-water-mix from the truck in the first chamber up to 30 cm height of the chamber. Fill up with water.**
- **Remove sludge from the other chambers of the ABR only if the sludge level is higher then 30 - 40 % of height. DO NOT remove completely the sludge and water from this chambers. At least 10 cm of sludge should be left inside the baffle chambers.**

Anaerobic Filter



Source: Eawag, CH

Sludge removing:
Every 1 to 3 years, respectively on demand.
When sludge level reach 50% of the volume of the first chamber, then desludging should be carried out.

How to be determined?
By using the sludge level measuring pipe. If the sludge level in the pipe is on the half of the total water column then desludge.

How to desludge?

- **Empty completely the first chamber of the AF. Fill back sludge-water-mix from the truck in the first chamber up to 30 cm height of the chamber. Fill up with water.**
- **Remove sludge from the other chambers of the AF only if the sludge level is higher then 30 - 40% of height. Bottom sludge can be removed completely. Do not completely empty the water from the filter chambers.**
- **Back-wash filter media when cleaning efficiency decline or the filter media clogs. If necessary remove for cleaning the filter media from the tank.**

Caution:

Exercise extreme care when inspecting/enter the tank. Never inspect a septic tank alone or enter a tank. Toxic gases are produced by the natural treatment processes in septic tanks and these gases can kill in minutes.

5.2.4 Constructed wetlands

Constructed wetlands are man-made gravel-sand filter planted with different types of aquatic plants. Constructed wetlands are reliable treatment systems with very high treatment efficiencies for the removal of organic matter and pathogens, as well as for nutrients. Constructed wetlands can be considered as a secondary treatment step since suspended solids, larger particles including toilet paper and other rubbish as well as some organic matter need to be removed before wastewater can be treated in CWs. Pre-treatment over septic tank, baffled reactor, etc. is extremely important to avoid clogging of CWs, which is an obstruction of the free pore spaces due to accumulation of solids.

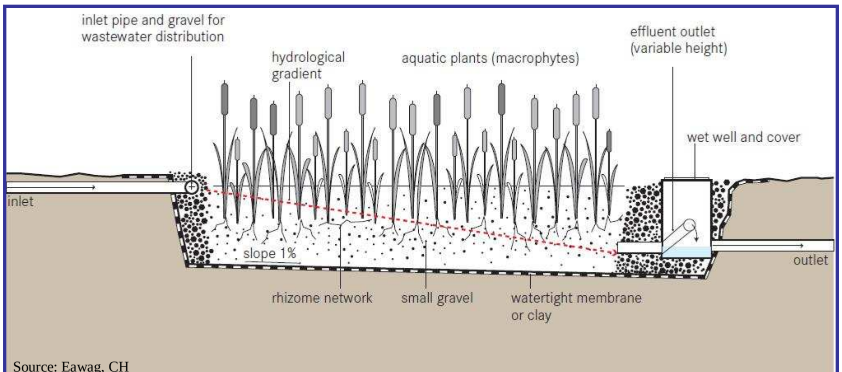
CWs lose their treatment capacity when they are overloaded for an extended period of time. Short loading peaks on the other hand do not cause performance problems. Overloading may occur if the pre-treatment system fails and suspended solids, sludge or fats pass into the CW.

O&M of constructed wetlands should focus on maintaining the pre-treatment systems in a proper functioning form. The effluent from the pre-treatment system should be analyzed for settleable solids by using an “Imhoff cone” in order to know the quantity of solids being transferred to the wetland. The sludge of the pre-treatment systems has to be removed regularly.

Additional O&M tasks required for the constructed wetland includes regular checking of:

- inlet structures for obstructions and for the water level
- outlet structures for the water level (swivel arm)
- hydraulic loading rate and pollutant loads, i.e. influent and effluent concentrations of BOD and SS as well as influent flow rate
- wetland vegetation for disease, insects, etc. (remove weeds and predatory plants until the wetland vegetation is fully established).

Constructed wetland



Source: Eawag, CH

Water level:
Water should not stand on the filter surface near the inlet.

How to?
Adjustment is done by lowering or heightening the swivel arm at the outlet. The water level should be 5 to 15 cm below surface.

Water distribution: **Optimal water distribution at the inlet side is important and must be controlled from time to time (3 to 6 months).**

Plants: **Vegetation must be cut back periodically.**

Filter media: **Replacement of the gravel filter might be necessary when treatment efficiency declines. Estimation of the time intervals for filter replacing: 8 to 15 years.**

Construction: **Outside storm water should not overflow the filter bed. Erosion trenches around the filter-bed should be always kept in proper functioning conditions.**

5.2.5 Biological ponds

Ponds are artificial lakes. Pond systems consisting of several ponds are reliable treatment systems with very high treatment efficiencies. Sedimentation tanks for removing of solids are not necessary when a deep sedimentation pond as a first pond of the treatment system is provided. Following ponds are in general shallow-built and used for removal of organic matter, nutrients and pathogens.

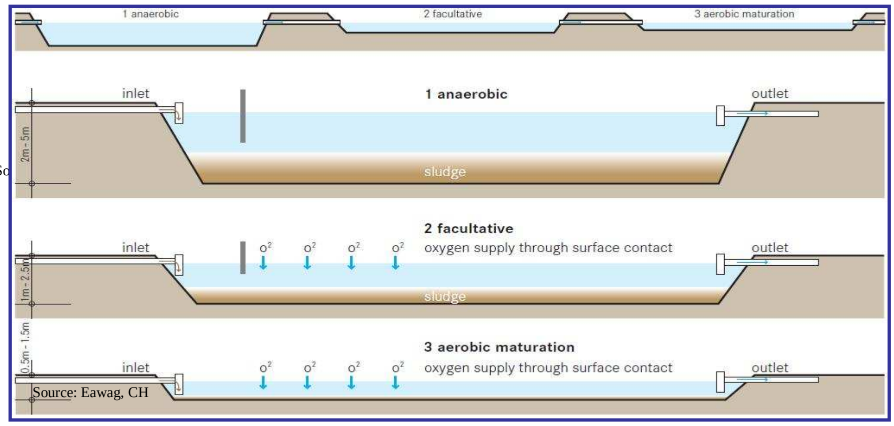
In general ponds system consists of three to four artificial lakes in series. The first one, as mentioned above, is deeper (2 to 6m) and has a smaller surface. This pond is used for sedimentation of solids and sludge (anaerobic pond). The following ponds - in general two or three – have bigger surfaces and only a water deepness of 0,9 to 1,2 m (aerobic ponds). By oxygen uptake over the surface and UV light nutrients and pathogens are reduced.

O&M should focus on maintaining the water surface of the aerobic ponds clean and shadow-free For proper aeration and wind mixing, vegetation, which overhangs onto or shades the water surface has to be removed (beneficial algae require also sunlight to produce oxygen). Remove any dead leaves or bushes from the water surface. Yearly, all aquatic vegetation is to be removed from ponds by cutting or burning. Also sludge level in the ponds should be checked on a yearly base.

Additional O&M tasks required for WSP include regular checking of:

- inlet structures for obstructions and for the water level
- outlet structures for the water level
- hydraulic loading rate and pollutant loads, i.e. influent and effluent concentrations of BOD and SS as well as influent flow rate

Waste stabilization ponds



Source: Eawag, CH

Water distribution: Inlet and outlet structures have to be controlled in regular intervals, at least every 6 months.

Sludge: The pond must be desludged when sludge level exceeds 20% of water height. At least once every 10 to 15 years.

Water surface: Has to be kept clean and shadow-free.

Vegetation: Aquatic vegetation is to be removed from ponds once a year.

5.2.6 Aerated ponds

Aerated ponds are artificially aerated lakes. Aeration is realized mechanically by use of current powered aerators. Aerated ponds are as constructed wetlands secondary treatment step since suspended solids, larger particles including toilet paper and other rubbish (as well as some organic matter) need to be removed before wastewater is transported to the pond. This pre-treatment is mainly necessary in order to avoid foul or damage of rotating mechanical equipments.

In general aerated ponds have a water deepness of 1,5 to 3,5 m. As sludge is kept suspended by the aeration unit, a sludge settling zone or an additional shallow pond should be provided before discharge.

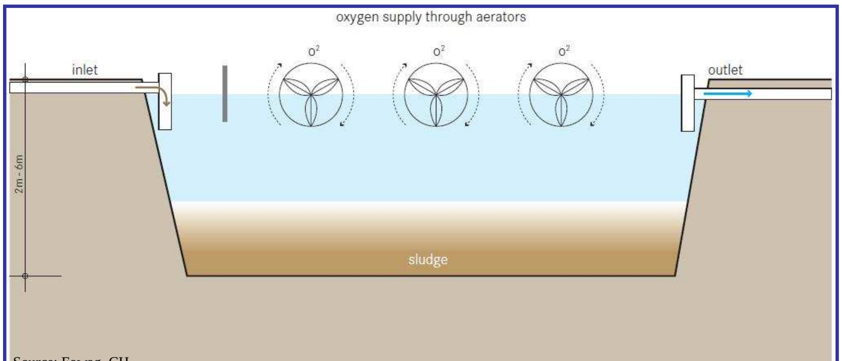
O&M should focus on maintaining the water surface of the ponds clean and shadow-free. The aerators have to be checked periodically. Also placement and anchoring have to be checked from time to time. Maintenance of the aerator should be according to manufacturer's instructions. Periodically dissolved oxygen should be measured. Also sludge level in the pond should be checked on a yearly base.

Additional O&M tasks required include regular checking of:

- inlet structures for obstructions and for the water level
- outlet structures for the water level
- hydraulic loading rate and pollutant loads, i.e. influent and effluent concentrations of BOD and SS as well as influent flow rate

Caution:
Always disconnect aerators from the power supply before servicing.

Aerated ponds



Source: Eawag, CH

Always disconnect first from the power source before starting with the O&M.

Skilled staff and proper tools are required for maintain and repair works of the aerators.

Aeration units: **Have to be controlled and serviced in regular intervals according to the manufacturer's operating instructions. Skilled staff is required for maintain and repair works.**

Water distribution: **Inlet and outlet structures have to be controlled in regular intervals, at least every 3 to 6 months.**

Sludge: **The pond must be desludged when sludge level exceeds 20% of water height. At least once every 2 to 5 years.**

5.3 Overview of self-monitoring and maintenance activities

The table below show self-monitoring and maintenance activities for commonly used decentralized treatment systems. As water often has to be pumped into plants, it is recommended that grit chambers and pumping stations be included. Pumps and technical plant components have to be serviced according to manufacturer's operating instructions.

No.	Control and maintaining activities	Weekly	Monthly	3 Months	6 months Maintenance	On demand	
1.	**GRID CHAMBER (GRIT CHAMBER)**						
1.1	**Visual check of the grid chamber** (open the cover lid and check without stepping inside) Check construction, any deficiencies?, accessibility?, bypass discharge? Check inlet and outlet pipe, water tightness of construction and pipes, check for sediments in the grit chamber and on the grid, remove if necessary.	X					
1.2	**Control of the grid chamber** (visual check and access the grid chamber) Check construction, check inlet and outlet pipe, check overflow pipe, check for water tightness of the construction and pipes, check grid for corrosion, clean and remove sediments from grid and bottom of the chamber. Wash and flush the grid chamber and the inner components.		X		X		

No.	Control and maintaining activities	Weekly	Monthly	3 Months	6 months Maintenance	On demand	
2.	**PUMP AND PUMPING STATION**						
2.1	**Visual check of the pumping station** (without opening the cover lid) Check construction, any deficiencies?, accessibility?, bypass discharge?	X					
2.2	**Visual check of the pumping station** (open the cover lid and check without stepping inside) Check outside and inside of the construction, any deficiencies?, Check inlet and outlet pipe, water tightness of construction and pipes, check for sediments in the pumping station and on pump and floating switch, remove if necessary.		X		X		
2.3	**Control of the pumping station** (visual check and access the pumping station) Check construction, check inlet and outlet pipe, check overflow pipe, check for water tightness of the construction and pipes, check gate and check valves, clean and remove sediments from pump, floating switch, pipes, bottom of the pump station. Wash and flush the pump station and				X		

	the inner components.						
2.4	**Function control of pumps, control unit and switches** Function control of the pumps by activating manually the pumps, manually activating of floating switch and check of functionality, control the outlet of the pressure pipe, is water coming? Check for unusual noises while running.		X		X		
2.5	**Cleaning of pumps** Pull out pumps, check for corrosion, sediments, clogging. Remove sediments from the impeller if necessary.				X		
2.6	**Maintaining works** according to manufacturer's instructions.					X	

No.	Control and maintaining activities	Weekly	Monthly	3 Months	6 months Maintenance	On demand	
3.	**SETTLING TANKS (SEPTIC TANK, BAFFLED REACTOR, ANAEROBIC FILTER)**						
3.1	**Visual check of the tanks** (without opening the cover lid) Check construction, any deficiencies?, accessibility?	X	X		X		
3.2	**Visual check of the tanks** (open the cover lid and check without stepping inside) Check inlet and outlet chambers, outside and inside of the construction, any deficiencies?, Check inlet and outlet pipe, check for clogging and sediment, water tightness of construction and pipes. Check ventilation pipe.		X		X		
3.3	**Control of the tanks** Check construction, check inlet and outlet pipe, check ventilation pipe, check for water tightness of the construction and pipes, check all chambers of the tank not only inlet and outlet, visual check of water level in the chambers. Remove clogging in-between the tank chambers if any / necessary. Check bottom sludge level and thickness of scum layer by using a sludge level measuring device. Remove scum and bottom sludge if necessary (vacuum truck). Remove garbage disposals discharged to the tank. Wash and flush if necessary the outlet manhole, remove sediments if any.				X		

No.	Control and maintaining activities	Weekly	Monthly	3 Months	6 months Maintenance	On demand	
4	**CONSTRUCTED WETLANDS**						
4.1	**Visual check water distribution chamber** (without opening the cover lid)	X	X		X		

No.	Control and maintaining activities	Weekly	Monthly	3 Months	6 months Maintenance	On demand	Yearly
	Check construction, any deficiencies?, accessibility						
4.2	**Visual check water outlet chamber** (open the cover lid and check without stepping inside) Check construction, any deficiencies?, accessibility. Check water level in the outlet chamber, color, odor, turbidity. Check for sediments.	X	X		X		
4.3	**Control of the water distribution and outlet chamber** (open the cover lids) Check outside and inside of the construction, any deficiencies?, Check distribution and outlet pipe, water tightness of construction and pipes. Remove sediments from water distribution chamber and from outlet. Check water level in the wetland, adjust if necessary. Wash and flush if necessary inlet and outlet chambers.				X		
4.4	**Visual check of the plant bed** Check for garbage disposal, water on the surface, smell, general condition of the bed.	X	X		X		
4.5	**Control of the plants and plant bed** Growth of the plants, check for vermin, check for dry plants, check if plants from the surroundings are growing into the filter, check for external plants growth in wetland. Remove unwished plants, cut back reed plants if necessary.				X	X	
4.6	**Control of the CW liner** Check synthetic liners if damaged by weeds, animals or sunlight. Check for erosion, burrowing animals and weed growth earthen or clay liners. Re-compact if necessary.		X		X		
4.7	**Control of feeding pipes (Vertical flow CW)** Check outside and inside of the construction, any deficiencies?, Check distribution and feed pipes, Wash and flush if necessary. Check distribution fittings, valves, check valves. Start feed pump and check for noises, check for unwished spraying from the feed pipes. Check for water on the surface after feeding. Check drainage pipes and outlet, check ventilation pipe. Wash and flush drainage if necessary.				X		
5	**WASTE STABILISATION PONDS / AERATED PONDS**						
5.1	**Visual check water inlet / water outlet** Check construction, water distribution, any deficiencies? Check water level.	X	X		X		
5.2	**Visual check construction / water surface** Check pond banks, remove bushes or plants growing on the berm, check earthwork after removing weeds, repair root damage, check fencing (if any) Remove leaves, plants or vegetation from the water surface, Remove garbage from the water surface. Check ponds surface color, odor.		X		X		
5.3	**Control of the pond liner** Check synthetic liners of the WSP if damaged by weeds, animals or		X		X		

	sunlight. Check for erosion, burrowing animals and weed growth earthen or clay liners. Re-compact if necessary.						
5.4	**Control of the WSP** Remove aquatic vegetation from ponds by cutting or burning (and/or herbicide application). Check bottom sludge level by using a sludge level measuring device.						X
5.5	**Control aeration units** Check functionality. Check anchoring and placement. Maintain aerator according to the manufacturer's recommendation, at least every 6 months.	X	X		X		

No.	Control and maintaining activities	Weekly	Monthly	3 Months	6 months Maintenance	On demand	
6	**CONTROL OF EFFLUENT VALUES, SAMPLING AND ANALYSE**						
6.1	**Sample effluent / Random sample** Determine pH, settable solids, color, odor, turbidity on site. Sample effluent and determine / analyze all relevant parameters (BOD, COD, TN, SS, P, pH) in a laboratory.				X		
6.2	**Sample influent** Determine pH, color, odor, turbidity on site.					X	

No.	Control and maintaining activities	Weekly	Monthly	3 Months	6 months Maintenance	On demand	
7	**OPERATIONS DIARY / LOG BOOK**						
7.1	**Self-monitoring record** Down-writing of undertaken activities.	X	X				
7.2	**Maintenance and control report (O&M report)** Prepare the O&M report. Down-writing of all control and maintenance activities undertaken. Down-writing of all occurrences, findings and repair activities undertaken. Down-writing of on site determined parameters.				X		
7.3	**Plant operation diary** Keeping of a plant operation diary where all self-monitoring records, all O&M reports are included. The operation diary should also include all analyses reports, all desludging reports, notice of defects, repair orders, etc.	X	X		X		

5.4 Trouble shooting

In case of malfunction and problems with the treatment plant, the following chapter should be consulted. The here listed symptoms and malfunctions are not extensively described and content-addressed. Purpose of this chapter is to help the operator to understand and remedy system faults as fast as possible. Personal experience with the operation of the plant is the key for right understanding of what has to be done in case of system failures.

Main parts of the following sections have been taken from the book “Decentralised wastewater treatment systems (DEWATS) and sanitation in developing countries, A practical guide”, published by BORDA, 2010.

5.5 Insufficient treatment of wastewater

Treatment of the wastewater is considered insufficient if it does not correspond to the desired discharge standards in one or several of the following categories:

- BOD_5
- COD
- Suspended solids
- Smell
- Faecal contamination

Symptoms

- Extensive plant growth in the discharge body
- Fish dying
- Turbid effluent
- Frothy discharge
- Biological and nutrient contamination in nearby wells or surface waters
- Smell
- High pH-value
- Color of water

PROBLEM	SOLUTION
Accumulated sludge within septic tank, anaerobic baffled reactor, Imhoff tank, anaerobic filter or pond system • This leads to a reduction of the hydraulic retention time for treatment.	**Determining sludge level** Remove sludge if necessary. Consult chapter 5.2 of this manual. If many non-biodegradable materials such as plastics, disposable nappies or sanitary towels are found in the sludge – awareness raising for proper use of the system is necessary.
Accumulated scum Soap suds and fat are floating on the wastewater surface within septic tank, anaerobic baffled reactor or Imhoff tank. Scum reaches the tank outlet and flows into subsequent treatment units, which are not designed to handle it. Extremely fast scum growth may be an indicator of excessive hydraulic loading.	**Measuring scum depth** Consult chapter 5.2 or: 1. attach a 15 cm square board to the bottom of a stick. 2. extend the stick through the scum to locate the bottom of the baffle or effluent pipe in tank – mark the stick to indicate the point. 3. raise the stick to locate (by feeling or seeing) the bottom of the scum layer – mark the stick again. 4. If the marks are less then 8 cm apart, or if the scum layer is less than 3 cm from the top of the outlet baffle, the tank requires cleaning. Treatment systems treating very greasy wastewater (for example from restaurants) should have a grease trap – remove grease from the surface with a shovel and deposit in grease pit twice weekly.
Excessive inflow quantity Caused by • Increased number of users • Changed user habits • Structural deficiencies This leads to a reduction of the hydraulic retention time; insufficient time for treatment can lead to low pH levels, caused by volatile fatty acids. It can also lead to backlogging water within the system, or extrusion of water at unforeseen places, if the filter velocity through wetland or filter is insufficient.	Uncontrolled inflow of ground- or storm water through leaking or damaged pipes or structures must be prevented by locating infiltration points and carrying out repairs. This can include leaking roofs of community sanitation centre shower or toilet rooms. Uncontrolled storm water inflow through maintenance openings must be prevented. Attaching waste water flow from more users than the system was designed for must be discouraged. If the waste water amount has grown beyond system capacity, a system upgrade is necessary or a parallel system must be installed. Alternatively, awareness-raising activities to promote water-saving habits or fixtures can be applied.

Daily peaks higher than expected	Consider an equalization tank.
Excessive inflow contamination Caused by • Inflow of wastewater sources unforeseen in the planning of the facility (e.g. industrial waste water connected to a domestic WWTP) • Excessive BOD and ammonia loadings. Can lead to increased accumulation of settleable solids, low pH-value due to volatile fatty acids or temperature shifts in anaerobic reactors (esp. in case of illegal industrial connection). Methanogenesis is sensitive to both high and low pHs and occurs between ph 6,5 and pH 8. Low pH-levels are inhibiting methanogenic organisms and causing smell.	Inflow of inappropriate wastewaters must be prevented. An appropriate facility or an upgrade of the existing treatment plant is required. **Anaerobic ponds**: adding lime (12 g/m^3 of the pond) may help to raise the pH. **Facultative ponds**: create multiple inlets to the pond. Periodically add sodium nitrogen as a supplement source of external oxygen supply. Where possible, public-awareness campaigns can help to minimize pollution through habit change, for example in cooking practice and handling of kitchen waste.
System short circuit Caused by: • Defective separation walls and baffles in tanks or reactors • Excessive aquatic vegetation in facultative ponds, reducing the area of flow across the system. This leads to less retained settleable solids and reduction of the hydraulic retention time (also see “incorrect retention time” below)	In most cases, draining the facility is necessary to carry out the required repairs or maintenance.
Incorrect retention time within the unit can create **smell or effluent quality problems** In grit chambers, a rotten-egg smell indicates sedimentation of organic matter, due to slow flow velocity / too long retention time. The removed sand is grey and contains grease. In anaerobic ponds, HRT longer than one day leads to fermentation – not only of the bottom sludge but also the liquid phase. A too-short HRT creates effluent with low pH and emits H2S odor. In facultative ponds, growth of filamentous algae and moss indicates underloading.	Adjustment of flow must be made: • Increasing flow velocity by using fewer parallel units, if available. • Lowering retention time by bypassing overloaded units if the following ones can handle the higher load. Ideally, upgrading of the facility. • Increasing retention time by reducing flow quantity or capping peak flow (equalization tank) Check inlets and distribution of flow to treatment units like ponds and wetlands: • **Anaerobic ponds**: distribution by

Poor flow distribution can be responsible for insufficient retention time and treatment.	perforated pipes on the bottom of the pond. • **Facultative ponds:** create several inlets with uniform distribution to each. • **Wetlands**: ensure influent distribution across the full width.
Incorrect water level in horizontal gravel filters, resulting in surface algae growth or insufficient treatment.	The water level should be just below the filter surface; the flow-regulation pipe should be adjusted accordingly, during weekly maintenance tasks.
Scum layer or floating material on ponds Can hinder some treatment processes.	**Anaerobic ponds**: no measure needs to be taken. The scum layer helps to maintain the absence of oxygen, controls the temperature and prevents the release of bad odors. Facultative ponds: remove scum layers, place scum into plastic bags and practice proper garbage disposal. Light and wind penetration of the pond surface should be ensured.
Growth of aquatic or terrestrial vegetation or algae in or on ponds. Can hinder the treatment process and create smell.	**Anaerobic ponds:** Vegetation on internal or external slops, as well as in shallow water should be removed completely and regularly. **Facultative ponds:** remove excessive algae growth on the surface, which is prohibiting passage of light, with sieves. Remove excessive aquatic plants. **Indicator ponds (polishing ponds):** Algae should be removed from the walls by a brush every 14 days.
High concentration of algae (SS) In the effluent of pond systems.	Install baffles to retain and remove algae.
Cloudy weather and low temperature Over long stretches of time reducing treatment efficiency in facultative ponds and causing bad odors.	Reduce the depth of the facultative pond temporarily. If possible put ponds in parallel operation.
Metal or concrete erosion In anaerobic reactors caused by **insufficient ventilation.**	Check and remove obstructions to the ventilation system, including chamber connection.

5.6 Reduced flow at the outlet of the facility

The effluent volume of a system does not always equal the influent volume – it depends on the amount of evaporation of constructed wetlands or pond systems. When the effluent of a system is far less than as expected, the system is either clogged at one or more locations and/or is discharging wastewater at unforeseen locations. All control openings should be checked to identify the location causing the irregularity in flow.

Symptoms

- Poorly draining toilets, showers, sinks or drains – nuisance to the users, easily to identify
- Extrusion of wastewater at unforeseen places – environmental and health hazard, likely to go unnoticed or to be disregarded. Noticeable as:
    - Pools of water in unexpected places
    - Lush, green vegetation, even during dry weather, in places where there should be none
    - Pathogen or nitrate contamination of nearby wells
    - Dying plants in a horizontal gravel filter, due to lack of water
- Reduced flow at the outlet or significant fluctuations – parameter should be monitored by maintenance personnel

PROBLEM	SOLUTION
Pump malfunction Hindering wastewater flow	If a pump is used, check for obstructions and remove them. Check whether the pump-level control is functioning and that the pump is adequately lubricated. Each pump differs slightly, so consult the maintenance manual of the pump for more information about pump maintenance.
Clogged pipes – anywhere between the households and location of effluent discharge, including wastewater treatment plant Possible causes include: • Improper system use as garbage disposal for non-biodegradable materials such as plastics, disposable nappies, sanitary napkins, etc. • Plant roots growing into the system	Obstructions at manholes should be removed with a shovel and bucket until normal flow is achieved. Pipes should be opened at all maintenance openings to check for backlogged water. The section of clogged pipe lies between the last control opening with backlogged water and its downstream opening. The intermittent section of piping is cleared using boiling water, a drain snake or long pole. Caustic drain openers should not be applied. The reason for pipe obstruction should be identified to prevent identical problems in the future: • Roots or saturated soils in the system indicate a damaged pipe. The section of pipe should be replaced. Reasons for pipe damage should be identified. Responsible trees should be removed and / or heavy loading of the pipe with machinery or vehicles should be prevented. • Future system misuse should be discouraged through awareness raising campaigns for users.
Damaged pipes Anywhere between the household and location of effluent discharge, including WWTP. Leaking pipes cause reduced flow in the system and pollute environment. At times of high groundwater during strong rainfall, inflow to the damaged pipe can lead to large fluctuation of flow. Possible causes include: • Plant roots growing into the system • Unforeseen heavy loading (vehicles or machinery) on laid pipes	Monitoring flow at various control openings helps to locate leaks. Damaged pipes must be replaced. The reasons for pipe damage should be identified to prevent identical problems in the future: • Trees responsible should be removed • Excessive loading of the pipe with machinery or vehicles should be prevented • Ensure compacted clean sand bed under the pipes and backfilling with clean granular sand, compacted in layers • During regular maintenance, check for leaking system components.

<table>
<tr><td>Leaking joints</td><td></td></tr>
<tr><td>Clogged anaerobic filter
Inefficient treatment – as discussed in the previous chapter – results in too many suspended solids reaching the filter.</td><td>Filter material must be washed with high hydraulic pressure. In most cases the filter material must be removed, cleaned and replaced. Personnel must wear mouth and skin protection.
A clogged filter is an indicator that prior treatment is insufficient and too many suspended solids reach the unit. To prevent identical problems in the future, the cause of insufficient treatment can be identified and corrected with the help of the previous section/table.</td></tr>
<tr><td>Clogged horizontal gravel filter
Plant growth on only certain parts of the filter can indicate irregular flow – leading to a reduction of retention time until the filter is totally clogged.

Possible causes include:
Any of the reasons listed in the section “inefficient treatment” – too many suspended solids reach the filter
Improper use of the system (great amounts of grease or cooking oils can solidify within the filter and cause clogging)
Dead plant matter or extensive weed growth on the filter surface can as well be responsible for filter clogging.</td><td>Inlet and outlet pipes and channels should periodically be checked for obstructions and cleaned, so that a uniform flow (vital for efficient treatment) can be guaranteed.
The plants growing on the filter should be trimmed regularly to not less than 1m. Dead-leaf litter in an around the filter should be manually removed every week. The area around the filter should be weeded regularly. If plants grow too densely, they should be thinned out.

Look for evidence that heavy equipment has been on the wetland, filter or drainage field, to locate areas of possible compaction and damage. Identification of the cause for clogging may require digging up a small portion of the wetland or drainage field.

Maintenance might require draining of the unit, material removal and cleaning.

A clogged filter is an indicator that prior treatment is insufficient and too many suspended solids are reaching the unit. To prevent identical problems in the future, the cause of insufficient treatment can be identified and corrected with the help of the previous section.</td></tr>
<tr><td>Structural deficiencies – cracks and leaks
Cracked or improperly sealed walls or floors of treatment units
Leaking pipes or pipe joints
Loss of water due to flaws in the liner of a horizontal gravel filter – indicated by drying plants</td><td>Testing for leaks or cracks:
Filling the unit with closed outflow; waiting for 24 hours to see if it loses water
Empty the unit with closed inflow; waiting for 24 hours to see if water infiltrates from the outside
If so, locate the leaks and repair them.</td></tr>
</table>

5.7 Other problems and nuisances

Symptoms

- Excessive mosquito breeding

PROBLEM	SOLUTION
Stagnant water turns into a breading ground for mosquitoes Which cause discomfort for those near the pond, and increase the likelihood of insect-borne diseases such as malaria.	Increase flow, so that water does not become stagnant. Alternative introduce lung-breathing fish into the pond (i.e. Gambusia spp.)

5.8 Template O&M report

Purpose of the following template is to show how an O&M report has to be set and what details should this report include.

Plant operators may need to develop individual O&M reports according to the plant type or technology which they have to service.

All technical parts and components of a WWTP should be included in a report. This means, if more pumps are used, or more aerators, all have to be included in the O&M report.

Findings should be written down as detailed as possible. For finding details, a separate sheet can be used which is than attached to the report.

O&M reports are an important monitoring tool. They provide valuable information on the “history” of the plant for a better understanding of the performance and potential problems.

They need the signature of both the technician (operator) and the plant owner (customer). Both parties shall keep a copy for later reference. Another copy should be handed over to the relevant water authority, if required.

Maintenance report

Customer:	Technician:	
	Date / Time:	
	Weather / Temp.:	
	Location:	
	Persons connected:	

Type of waste water treatment plant or functional unit (mark*)		Defect		**Findings** (short description, for detailed description use section further below or separate sheet)
		Structure	Function	
Septic Tank	☐	☐	☐	
Anaerobic Baffled Reactor	☐	☐	☐	
Anaerobic Filter	☐	☐	☐	
Constructed Wetland	☐	☐	☐	
Waste Water Pond	☐	☐	☐	

*if a combination of treatment systems than mark accordingly

Technical device	Defect		**Findings** (short description, for detailed description use section further below or separate sheet)
	Yes	No	
Pump (1,2,..) (control unit, switches, etc.)	☐	☐	
Aerator (1,2,..)	☐	☐	

Sludge level

Water depth	Chamber 1	Chamber 2	Chamber 3	Chamber 4		
m	m	m	m	m		

Determined parameter / On site

Effluent:	pH	Colour	Odour	Settable solids	Temperature
(periodically also for the influent)				ml/l	°C

Determined parameters / Effluent sampling and laboratory analyze

COD: mg/l	BOD5: mg/l	NH4-N mg/l	NO3-N mg/l	NO2-N mg/l	TNb mg/l	PO4-P mg/l	pH
Sludge vol.	Settable s.	Odour	Colour	Temp.			
ml/l	ml/l						

Arrange sludge removal Yes ☐ No ☐ **Order for defect correction** Yes ☐ No ☐

Remarks

Technician:

Customer:
