DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF WATER SUPPLY & DRAINAGE

NATIONAL WATER SUPPLY & DRAINAGE BOARD

SLUDGE MANAGEMENT POLICY FOR WATER TREATMENT PLANTS

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Sludge Management Policy for Water Treatment Plants

1.0 Introduction

Considerable amount of wastewater is produced in water treatment plants due to backwashing of rapid sand filters and release of accumulated sludge in sedimentation tanks. Treatment of the wastewater emanating from the water treatment plants has not been practiced in the past as a policy even in large scale water treatment plants such as Ambatale, causing pollution of the downstream environment. In water treatment plants the amount and the concentration of wastewater produced will depend on the raw water quality which may differ seasonally.

The National Environmental Act Number 47 of 1980 and amended Act Number 56 of 1988 and the latest amendment on 1st February 2008 specifies the requirements of compliance to “Tolerance Limits for the Discharge of Industrial Waste Into Inland Surface Waters” to meet the identified 31 parameters. The compliance for water treatment plant effluent is of no exception. The new standards dictate discharge criteria for colour (maximum spectral adsorption coefficient) of

- $7m^{-1}$ for wavelength for yellow (436nm)
- $5m^{-1}$ wavelength for red range (525nm)
- $3m^{-1}$ blue range (620nm)

to be achieved in order to obtain or renewal of the Environmental Protection License for Emission or Disposal of Wastewater which will become mandatory for all water treatment plants in the near future. In addition, chemicals used in water treatment contain trace concentrations of heavy metals which will ultimately end up in the water bodies.

In larger capacity water treatment plants (>4500 m^3/d), it is advantageous to reuse the backwash water in order to conserve energy. The additional energy consumed for backwash water recovery pumping would be comparatively less than the equivalent for raw water pumping. Thus it would be prudent to adopt backwash water recovery in large water treatment plants.

2.0 Treatment of Wastewater from Water Treatment Plants

2.1 Sludge Thickening

Sludge thickening is defined as the removal of water from the sludge to aim at substantial reduction of sludge volume. For example if sludge with 0.8% dry solids (DS) can be thickened to 4% DS; a five fold decrease in sludge volume is achieved. The objective of thickening is to produce a sludge that is as thick as possible which can be pumped without difficulty and a relatively solid free liquid supernatant.

The major advantage of sludge thickening is the cost saving in sludge handling processes. The design and operation as well as the performance of several subsequent processes are positively affected by a higher solid content of the input sludge. Stabilization as well as dewatering processes is improved at higher sludge concentrations.

Gravity sludge thickening is the method commonly adopted. Slope of the bottom of the gravity thickeners should be carefully selected in order to facilitate flow of thickened sludge towards the centre/collection pit. Gravity thickeners, usually circular in shape and provided with pickets or rakes to improve dewatering of sludge. A dry solids content of 2-2.5% can be expected from gravity thickening.

Polymer dosing to enhance performance of thickening process can increase the dry solids content at least to 4% and it will improve the efficiency of dewatering processes such as sludge drying beds, centrifuge which would follow thereafter. The centrate resulting from dewatering should not be recycled back into the water treatment plant. Instead it can be sent back to the sludge regulation tank under gravity to undergo thickening process

The thickener supernatant can be discharged to the environment if it complies with the CEA regulations or else suitable pre-treatment should be provided. Progressive cavity pumps can be used to transfer the thick slurry to an appropriate sludge dewatering process depending on the hydraulic profile of the treatment plant.

2.2 Sludge Dewatering

The alternatives for sludge dewatering systems are described below. Guidance for selection of an appropriate system is given in Table 1.

Table 1: Comparison of Sludge Dewatering Systems

Treatment Process	Advantages	Disadvantages	Land Requirement	Cost Per Unit of Treated Water
Sludge Drying Beds	Low cost	Lateral Clogging Rain can impede the drying process	High	Low
Solar Sludge Drying Beds	DS content of 80-85% possible	Capital Cost is slightly increased due to UV Protected Polythene	Considerably lower than conventional drying beds	High
Sludge Lagoons	Low cost	Rain can impede the drying process	Low	Low
Filter Press	DS content of 20-30% possible	High capital & O&M cost Polymer dosing is required Sand and grit can damage the belt	Low	High
Centrifuge	DS content of 15-20% possible	High capital & O&M cost Polymer dosing is required	Low	High

The filtrate from the selected dewatering system should be returned to the sludge regulation tank.

2.2.1 Sludge Drying Beds

Sludge drying beds are most favoured when lands are available in close proximity to the water treatment works. Areas where strong sunlight is available with average annual rainfall lower than 2200mm are appropriate. Filtrate of the sludge drying beds can be directed under gravity to sludge regulation tank for subsequent thickening and should not be discharged to the environment. However in areas having higher rainfall (average annual rainfall between 3000 to 6000 mm) in order to achieve higher dry solid contents solar sludge drying beds having a roof cover of UV protected polythene can be utilized..

Past experience in water treatment plants in Sri Lanka reveals that sludge emanating from dissolved air floatation technique which contain considerable amount of algae retard the drying process of the sludge drying beds. In such situations it may be more appropriate to adopt mechanical dewatering techniques such as centrifuge with polymer dosing. Such process selection may have to be verified through research. User friendly arrangement to be provided to collect dried sludge from sludge drying beds

2.2.2 Sludge Lagoons

Lagoons may be the cheapest method of sludge dewatering but large land area is required compared to mechanical dewatering techniques. However, compared to conventional sludge drying beds, lagoons require considerably lesser land extent. Lagoons can be lined or unlined or can be provided with under drain arrangement for better dewatering requirements.

Unlined earthen sludge lagoons are more effective in dealing with large volumes of sludge from higher capacity water treatment plants. However due consideration should be given to the following during planning of the water treatment plant layout to locate sludge lagoons

- Fluctuation of groundwater table (seasonal high groundwater table should be sufficiently below the bottom of the lagoon preferable below 2.5 m)
- Underlying soil characteristics should be investigated to see its suitability, soil percolation rate between 25 to 150 mm/hr being preferred.
- Annual precipitation preferably to be below 3000mm
- Access ramps to be provided for dumper/tractor/mini loader to collect dried sludge from the lagoon and final disposal as outlined in section 2.5.

2.2.3 Mechanical Sludge Dewatering

Important operational parameters to be considered in evaluation of these systems are: ***energy consumption, required polymer dosage and separation efficiency***. Further, mechanical dewatering systems such as Belt Filter Presses, Filter Presses and Centrifuges should operate continuously as far as possible in order to reduce usage of treated water for the cleaning operation required at the end of each operation cycle and to optimize utilization of equipments. These equipments require

- high skilled maintenance staff
- suitable polyelectrolyte with dosing arrangement
- electrical power for operation of the equipment

Therefore the process is usually attractive only in large sludge dewatering facilities with incoming flow > $0.3m^3/s$ ($25{,}920m^3/day$). As such correct assessment of sludge generation and selection of the capacity of each unit is very important.

After mechanical dewatering, the sludge is generally directed through a conveyer into a skip or a hopper. The filtrate from mechanical dewatering facility can be directed back to the sludge regulation tank. Most mechanical dewatering equipment can achieve 15-20% DS content but the actual performance needs to be verified from manufacturers.

Mechanical sludge dewatering is only recommended for

- major water treatment plants that generate large quantity of sludge
- treatments plants that do not have adequate land or
- areas that experience average annual rainfall in excess of 3000mm

2.3 Backwash Water Recovery

Backwash recovery is aimed to utilize water resources to its maximum potential, minimize energy consumption and thereby optimize production costs. The backwash recovery process should not cause any adverse impacts on the treated water quality. The possible health implications could be trace amounts of heavy metals that may be present in raw water or in water treatment chemicals as impurities, pathogenic microorganisms, algal toxins/THM which may be produced during physical/chemical processes of the treatment works or present in raw water.

In this context, reuse of thickener supernatant is not recommended as about 95% of the contaminants in raw water are removed from the sedimentation process and hence may contain pathogenic organisms such as C**ryptosporidium and Giardia Lamblia which is resistant to chlorination**. The presence of these organisms in major rivers in Sri Lanka has not been investigated as yet.

It is advantageous to reuse the backwash water in order to conserve energy by minimizing the utilization of low lift pumps and to recover 2-5% of water. Backwash water recovery has many advantages as indicated in Section 1. However, the introduction of backwash water recovery needs careful evaluation of the raw water quality, the proposed treatment process and the cost-benefits.

Therefore the recommended unit processes for backwash water recovery to be incorporated in the sludge treatment stream are as follows;

- ✓ Backwashed water is first directed to backwash recovery tank (minimum two tanks each having capacity at least to hold two backwashes) where it is allowed to settle for a selected time. After allowing for sedimentation, supernatant is gravity fed to backwash recirculation tank which is constructed with common wall to the backwash recovery tank to minimize construction cost as shown in Annex 1. The gravity feeding system should comprise of pontoon attachment at the surface of the inlet pipe (which needs to be covered with suitable mesh to prevent escaping of floating debris) and the bottom end supported by a hinged bend in order to facilitate rotation of the pontoon attached inlet pipe as water level drops up to the sludge thickening zone of the backwash recovery tank.

Moving inlet pipe with pontoon with hinged bend (Kalatuwawa WTP: 1954)

- ✓ Backwash recirculation tank should be equipped with two wet well submersible pumps, one duty one standby, to pump the supernatant from backwash recovery tank to the raw water regulation tank. The submersible pumps should be equipped with float switches suitable for automatic operation and will be provided with guide rails and lifting chains to facilitate maintenance. The pumping rate should be decided by giving due consideration to the hydraulic capacity of the treatment units.

- ✓ After supernatant (clear water) in the backwash water recovery tank is completely transferred to backwash recirculation tank, the sludge from the backwash recovery tank is then pumped to sludge regulation tank using submersible wet well pumps similar to the operation of backwash recirculation pumps.

- ✓ Sludge emanating from the sedimentation tank can be directly sent to sludge regulation tank. The mixer equipped inside the sludge regulation tank will agitate and mix the sludge from sedimentation and backwash recovery tanks to achieve homogeneous concentration and to keep the sludge under suspension.

Two wet well submersible pumps, one duty one standby, to be provided to lift sludge from the sludge regulation tank to the gravity thickener.

- ✓ From the gravity thickener, the sludge is directed to ultimate disposal which could be either sludge drying beds, sludge lagoons or mechanical dewatering facility preferably by utilizing progressive cavity pumps, one duty one standby operation.

2.4 Wastewater from Slow Sand Filters

During scraping operation of the biological layer called “schmutzdecke” of the slow sand filters, the removed sand can be washed using “hydro cyclone” and reused when “re-sanding” of the slow sand filters is required. The dirty water resulting from the hydro cyclone needs to be treated appropriately in line with the disposal standards. A sludge thickener can be used if the number of filters is higher and continuous type of treatment is needed as in larger scale water treatment plants. If the treatment plant is of small scale, it may be sufficient to have a roughing filter together with natural or constructed wetland to polish further to meet the discharge standards as this type of system may be suitable for intermittent operation as generally slow sand filters need to be cleaned once in two to three months depending on the raw water quality.

2.5 Disposal of sludge

The dried sludge resulting from different dewatering methods discussed above should be disposed in compliance to environmental regulations. The options available for disposal of sludge are as follows;

- Land Disposal
  - Forest
  - Land Reclamation
  - Landfill
- Incineration
- Melting

- Brick and roof tile construction (after mixing with other constituents to obtain the desired consistency)

Table 1: ***EU Council Directive 86/278/EEC for land application of Sludge***

Metal	**Limiting Value (g/ha/year)**	**Limiting Value (mg/kg DS)**
Cadmium, Cd	30	10
Copper, Cu	3000	1000
Nickel, Ni	900	300
Lead, Pb	2250	750
Zink, Zn	7500	2500
Mercury, Hg	30	10
Chromium, Cr	3000	1000

Note: Incineration and melting is extremely expensive and definitely not attractive to a country like Sri Lanka at least in the present context.

3 Recommendation

- Treatment of wastewater from water treatment plants has become mandatory in view of the requirements specified in the National Environment Act. The requirement of NWSDB to obtain a license from CEA to operate the treatment works will become mandatory in the near future.

- The treatment of wastewater from water treatment plants using conventional water treatment processes requires the following basic processes;

  - Backwash recovery system which includes backwash recovery tank, backwash recirculation tank, sludge regulation tank, sludge thickener, complete with equipment as stated in Section 2.3.

  - Sludge Disposal should be carried out using an appropriate method as outlined in Section 2.5.

  - If the raw water source is highly contaminated with algae, backwash water recovery should be revived in relation to physical/chemical treatment proposed and possibility of presence/development of algal toxins