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Constructed Wetlands:
A Promising Technology for Septage Management and Treatment

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PRELIMINARY GUIDELINES FOR DESIGN AND OPERATION OF CONSTRUCTED WETLANDS TREATING SEPTAGE

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ABSTRACT

With respect to the experimental results obtained from 20-month operating period, treatment components and operating conditions of the AIT pilot plants have been varied and adjusted in order to obtain the optimum treatment efficiencies. This article summarizes some preliminary guidelines for the design and operating of vertical-flow constructed wetlands for treating septage. An example of process design and recommended features is also given in the context. However, to reassure these design guidelines and operating conditions, the long-term investigations are needed.

PRELIMINARY DESIGN GUIDELINES

Based on the results obtained from this study and characteristics of septage from Bangkok, the preliminary design guidelines and suggested features of constructed wetlands for septage treatment can be drawn as shown in Tables 1 and 2.

Table 1. Suggested design parameters of constructed wetlands treating septage

Design Parameter	Suggested Ranges	Unit
• Septage production rate	0.7 – 1.0	L/person/day
• TS content	8,000 – 18,000	mg/L
• Solid loading rate	125 – 250	kg TS/m^2.yr
• Septage application frequency	1 – 2	Times/week
• Percolate ponding period	2 – 6	Days

Table 2. Suggested features of constructed wetlands treating septage

Treatment component	Details	Remarks
• Bed slope	1:10 to 1:4	Depending on drainage system and dimensions of the constructed wetlands
• Side slope	1:1 to 1:2	Subjected to soil stability of each site
• Drainage system	Hollow concrete blocks or perforated pipes	Subjected to the wetland dimensions and length of percolate from one end to the outlet
	Ventilation pipes	Similar size to the drainage pipe and valve
• Substrata	Large gravel (dia. = 5 cm) @ 45 cm	Subjected to length of plant roots, e.g. cattails = 30 – 40 cm
	Medium gravel (dia. = 2 cm) @ 15 cm	
	Sand (dia. = 0.1 cm) @ 10 cm	
• Vegetation	Cattails, reeds or bulrushes	Preferable indigenous species to the wetland site
• Freeboard	0.8 – 1.0 m	For dewatered sludge accumulation for 4 – 5 years
• Feeding system	Uniforme distribution in the middle of wetland units	

Table 2 cont'd.:

Treatment component	Details	Remarks
• Pre-treatment	Coarse bar screen	Depending on the particle size
• Plant acclimatization	Startup with plant density of 8 – 10 shoots m^2.	Rainy or wet season is recommended
	Apply domestic wastewater and gradually feeding septage until the plant height of 2 – 2.5 m	
• Plant harvesting	Once to twice a year	Depending on plant wilting symptoms
• Post-treatment	AGWSP, free-water-surface wetlands, or land application	Depending on land area availability and effluent quality standards

Beside the long-term investigations is required to reaffirm the experimental results, the design guidelines and operating conditions, as suggested above, should result in the effective and promising treatment efficiencies.

DESIGN EXAMPLE

An example to demonstrate the calculation of the area requirement and the dried sludge production are as follow:

A municipality is to design constructed wetlands for septage treatment and having:

- Population = 10,000 persons;
- Annual septage production = 300 L/person; and
- Average TS content of raw septage = 15,000 mg/L (or 15 kg TS/m^3)

1. Determine the total volume of septage per year:

$$10{,}000 \text{ persons} \times 300 \text{ L/person} \times \frac{1}{1000 \text{ L/m}^3} = 3{,}000 \text{ m}^3\text{/yr}$$

2. Determine the total solids of septage per year:

$$3{,}000 \text{ m}^3\text{/yr} \times 15 \text{ kg TS/m}^3 = 45{,}000 \text{ kg TS/yr}$$

3. Determine the area required for the constructed wetland units:

Choose the TS loading rate = 250 kgTS/m^2.yr

Area required = 45,000 kgTS/yr x $\frac{1}{250\ kgTS/m^2.yr}$ = 180 m^2

Additional areas for bar screen, mixing tanks, percolate tanks and vacuum trucks are about 20% of wetland areas.

Therefore, total area = 220 m^2

4. Determine the sludge production:

Choose the ratio of solids in dried sludge : solids in loaded septage = 0.5 (Table 4.9)

Total dried weight of dried sludge production = 0.5 x 45,000 kg TS/yr

= 22,500 kg TS/yr

= 22.5 ton TS/yr

TS of dried sludge = 20 – 30%, select at 25%

Total wet weight of dried sludge production rate:

= 22.5 ton TS/yr x $\frac{1}{0.25}$

= 90 ton TS/yr

5. Cost estimation of the constructed wetlands:

Suggested costs (Heinss, 1999) = 75 – 95 US$/ton TS
(including investment and O&M costs)

The total costs for this wetland plant = 80 x 90 = 2,700 US$

However, this cost estimation depends on the billing figures from AIT pilot plant, which is designed for research purposes. Adjustments of the cost estimation should therefore be done according to local rates and practice.