L-10
Sedimentation
Part-I

Environmental Engineering-I

Contets

- Types of settling, Theory of settling

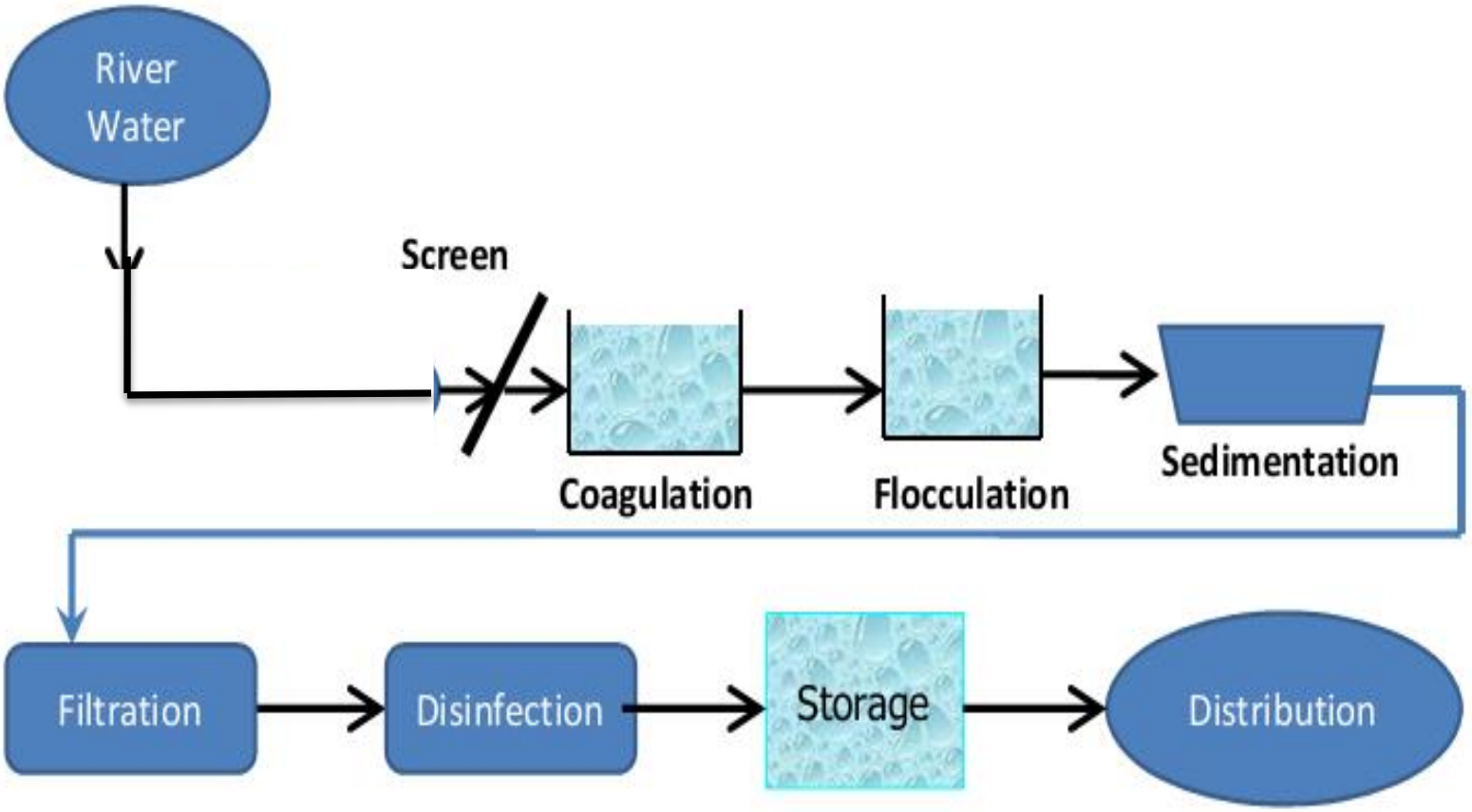


Figure 1: Filtration Treatment Plant (River Water)

Figure 5 : Rectangular sedimentation Tank

Figure 6 : Rectangular sedimentation Tank

Figure 7 : Circular sedimentation Tank

Fig. 1: Rectangular horizontal flow sedimentation tank

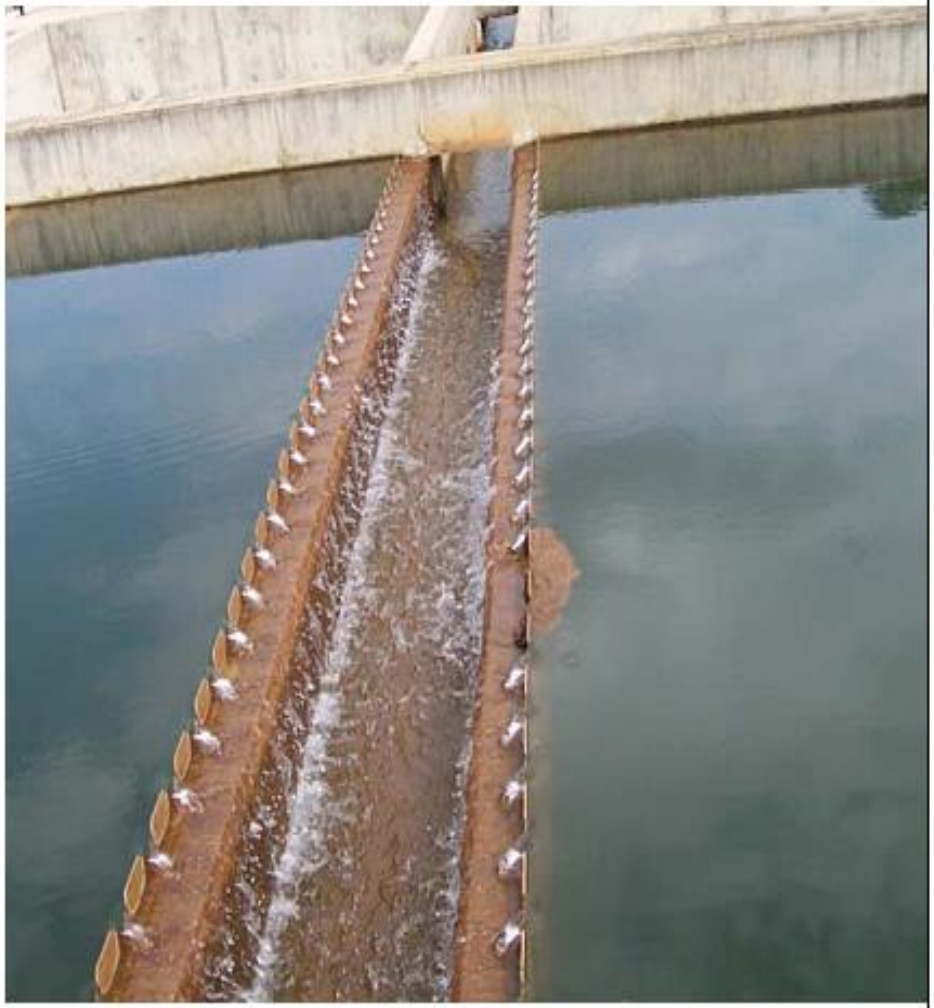


Fig. 3 Typical inboard weir arrangement to increase the weir length

Sedimentation

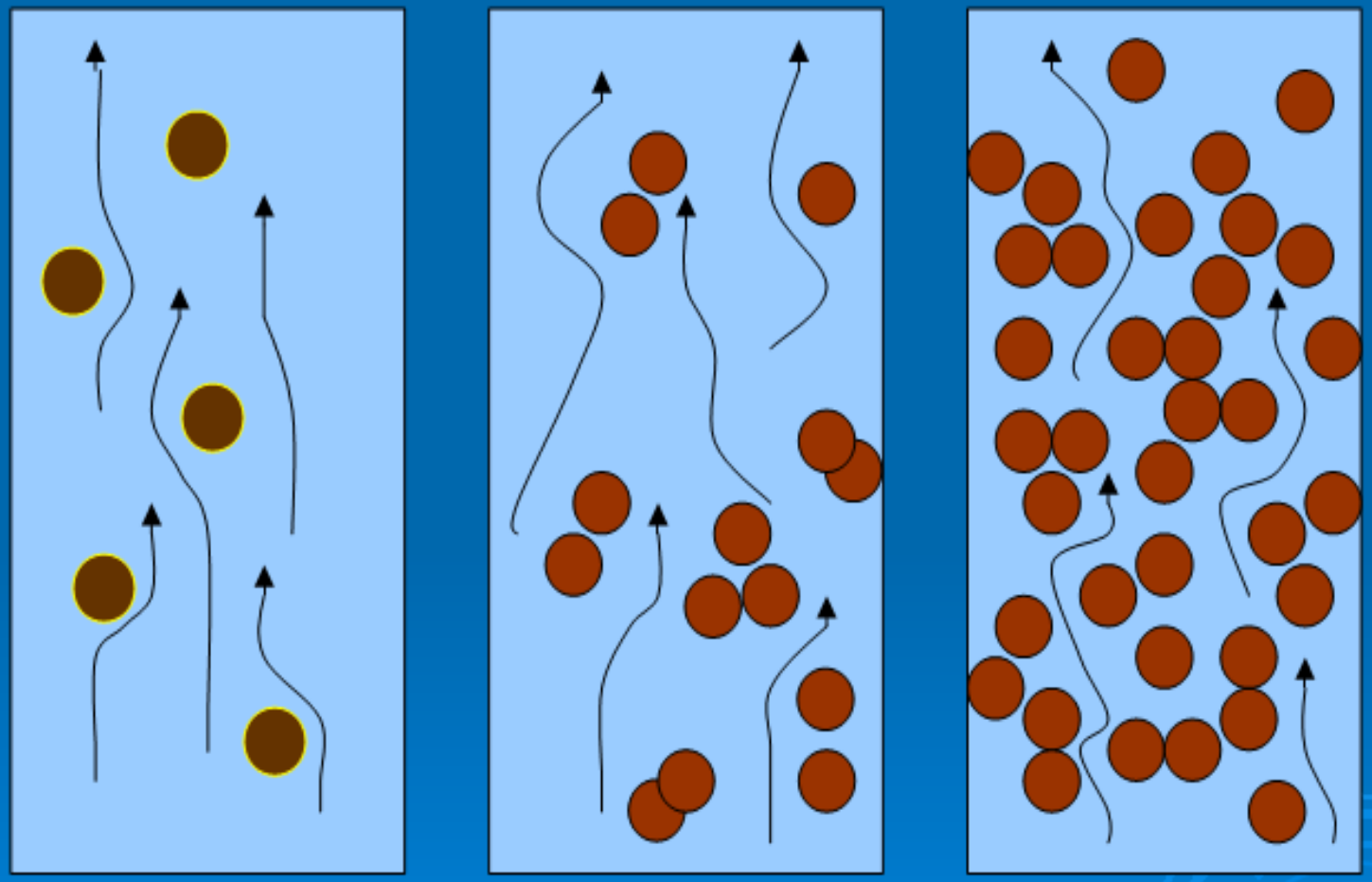
- **Sedimentation** is the gravitational accumulation of solids at the bottom of a fluid (air or water)

Types of Settling

Four types of sedimentation:

- Discrete settling
- Flocculant settling
- Hindered settling
- Compression

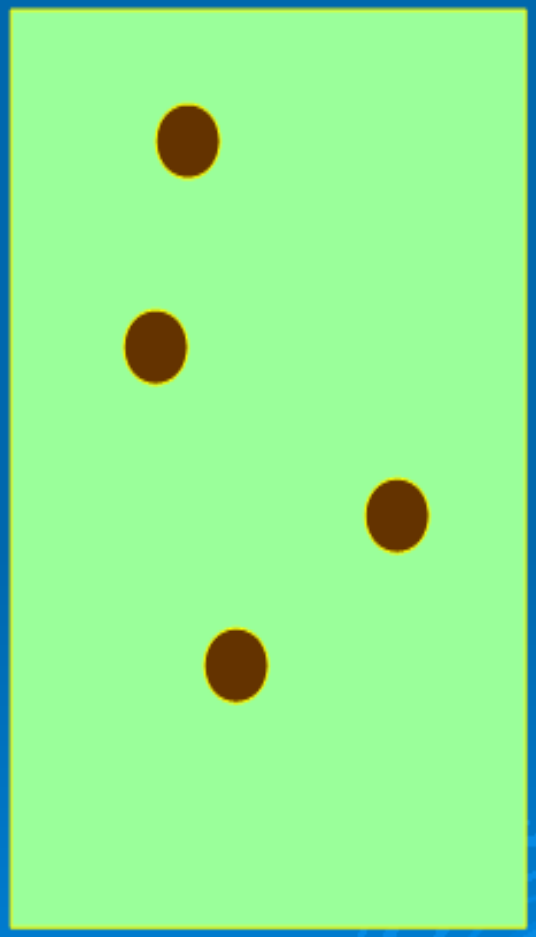
Examples of Settling Types



Discrete Flocculant Hindered

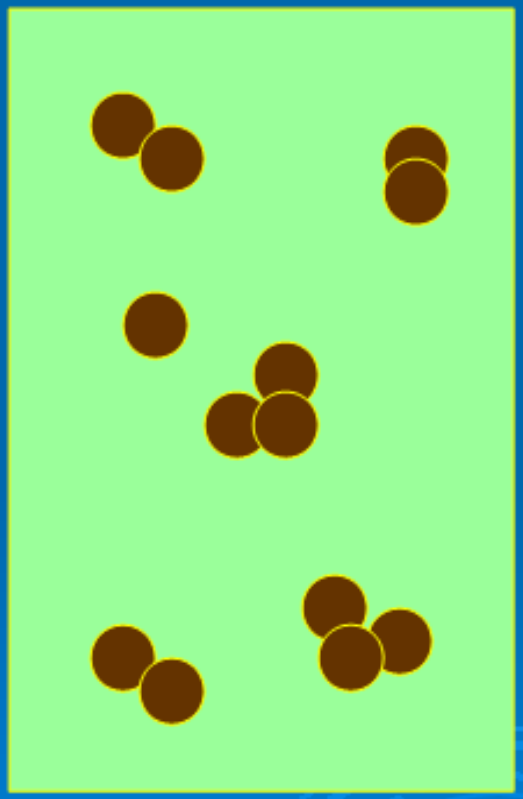
Types of Sedimentation

- In **discrete settling** individual particles settle independently
- It occurs when there is a relatively low solids concentration



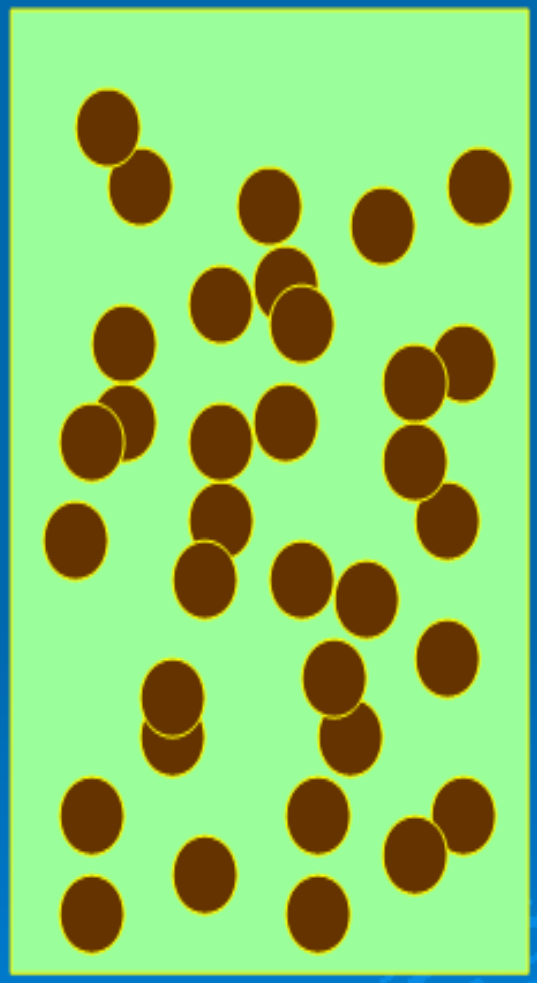
Types of Sedimentation

- In **flocculant settling**, individual particles stick together into clumps called flocs
- This occurs when there is a greater solids concentration and chemical or biological reactions alter particle surfaces to enhance attachment



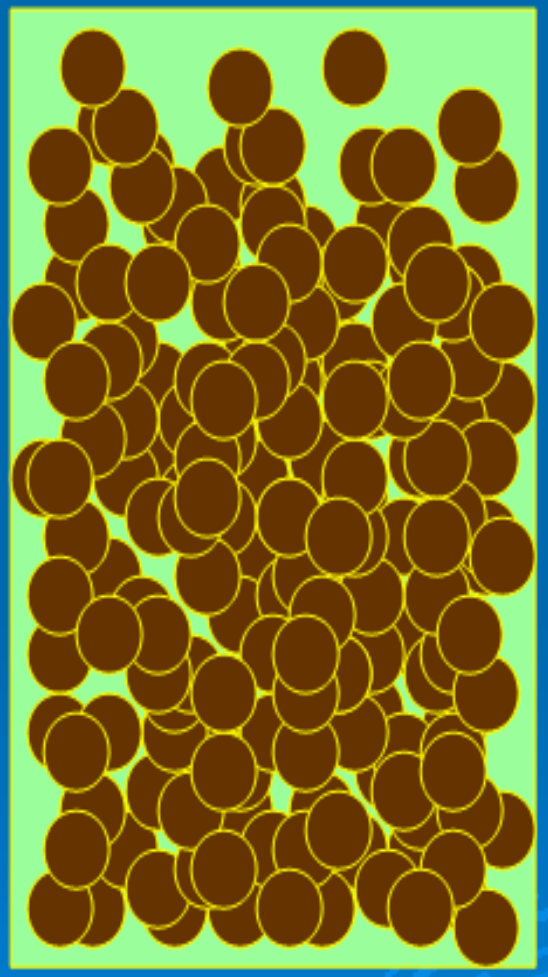
Types of Sedimentation

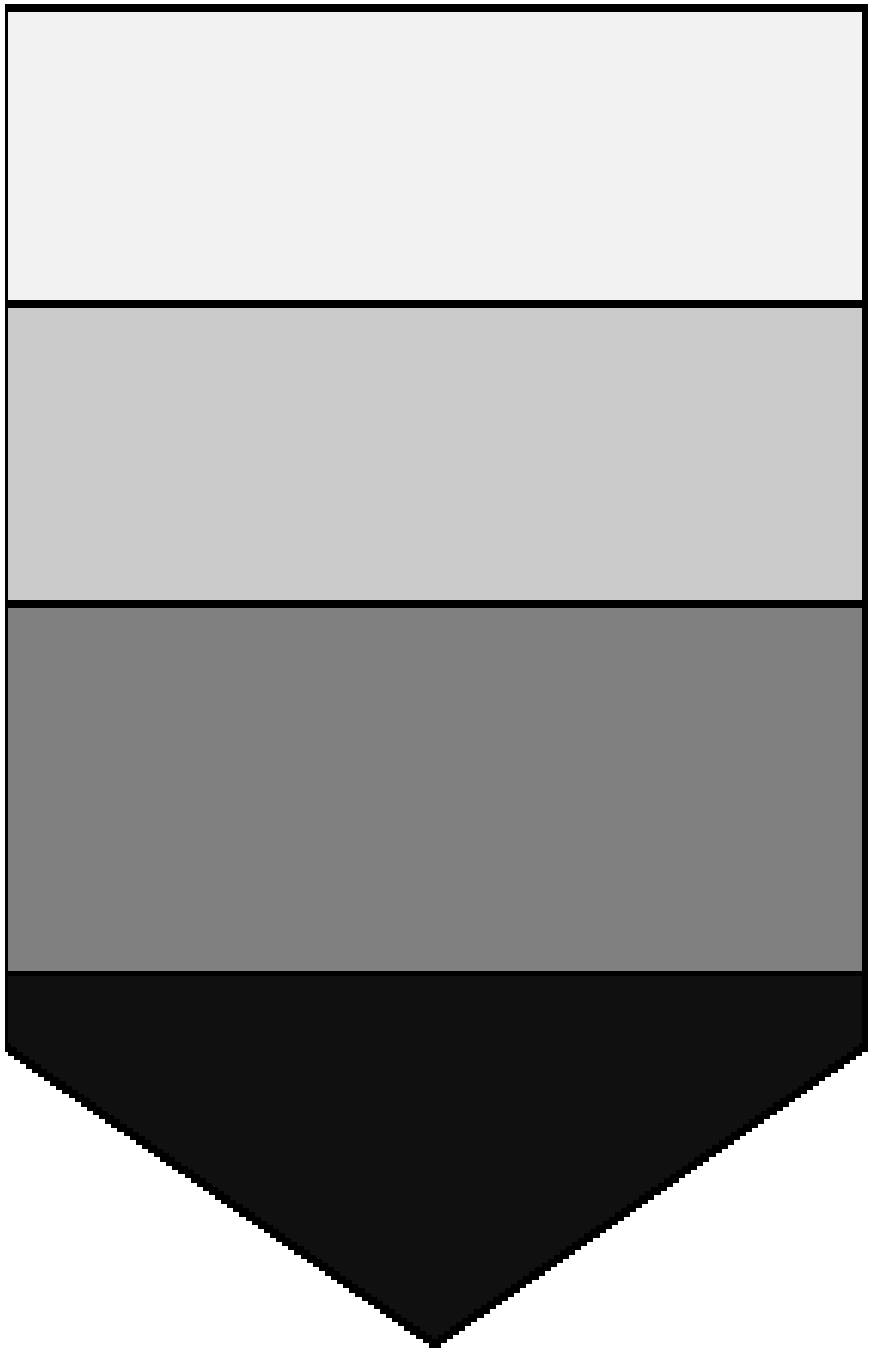
- In **hindered settling**, particle concentration is great enough to inhibit water movement
- Water must move in spaces between particles



Types of Sedimentation

- Compression settling occurs when particles settle by compressing the mass below





Discrete particle settling

Flocculent settling

Hindered (or zone) settling

Compression

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Part -II

Contents

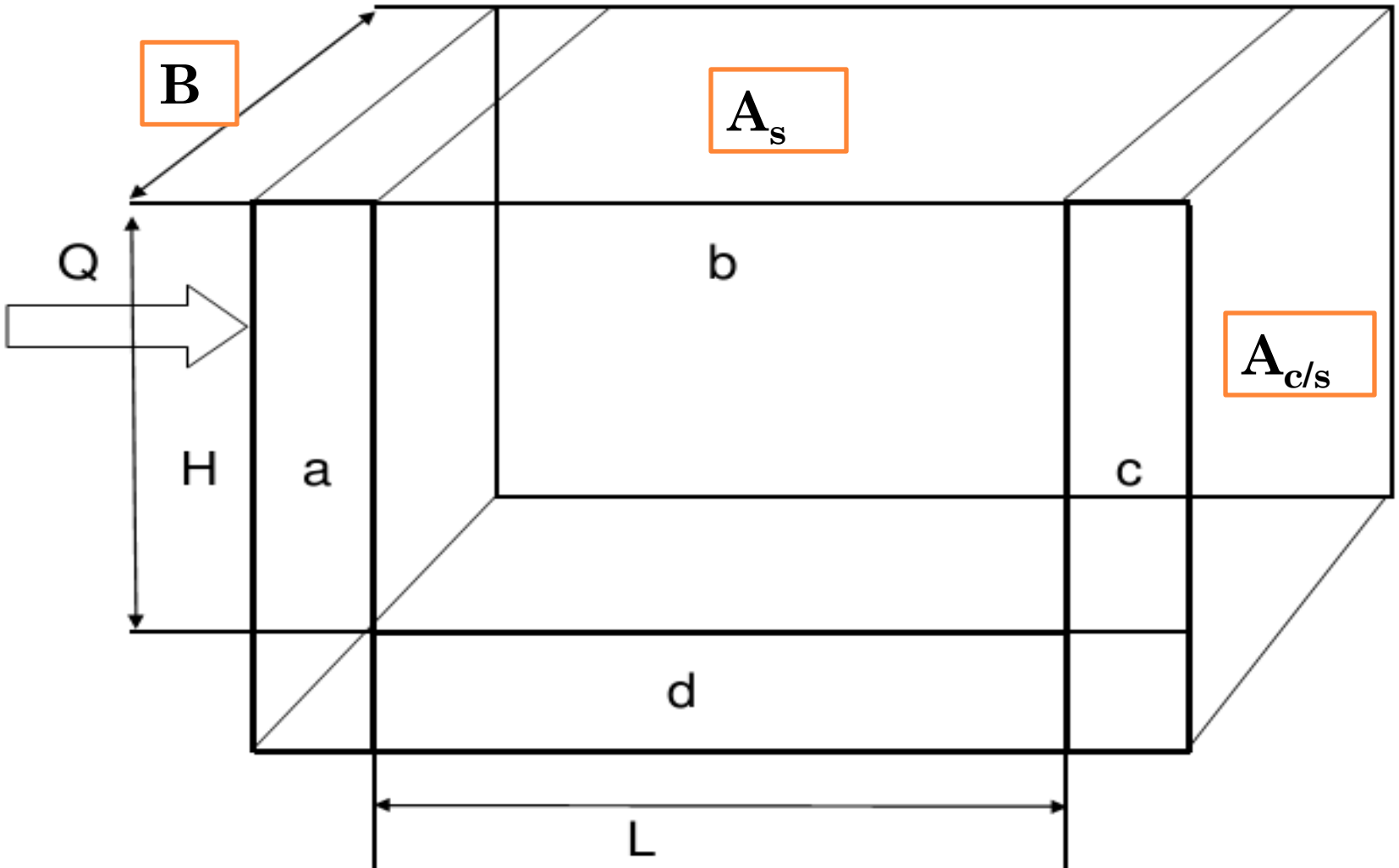
- Theory of settling (Continued…)

ZONES IN SETTLING TANK

$A_{c/s} = B \times H$

$A_s = B \times L$

$Vol = B \times L \times H$



a = Inlet zone; b = Settling zone;
c = Outlet zone; d =Sludge zone

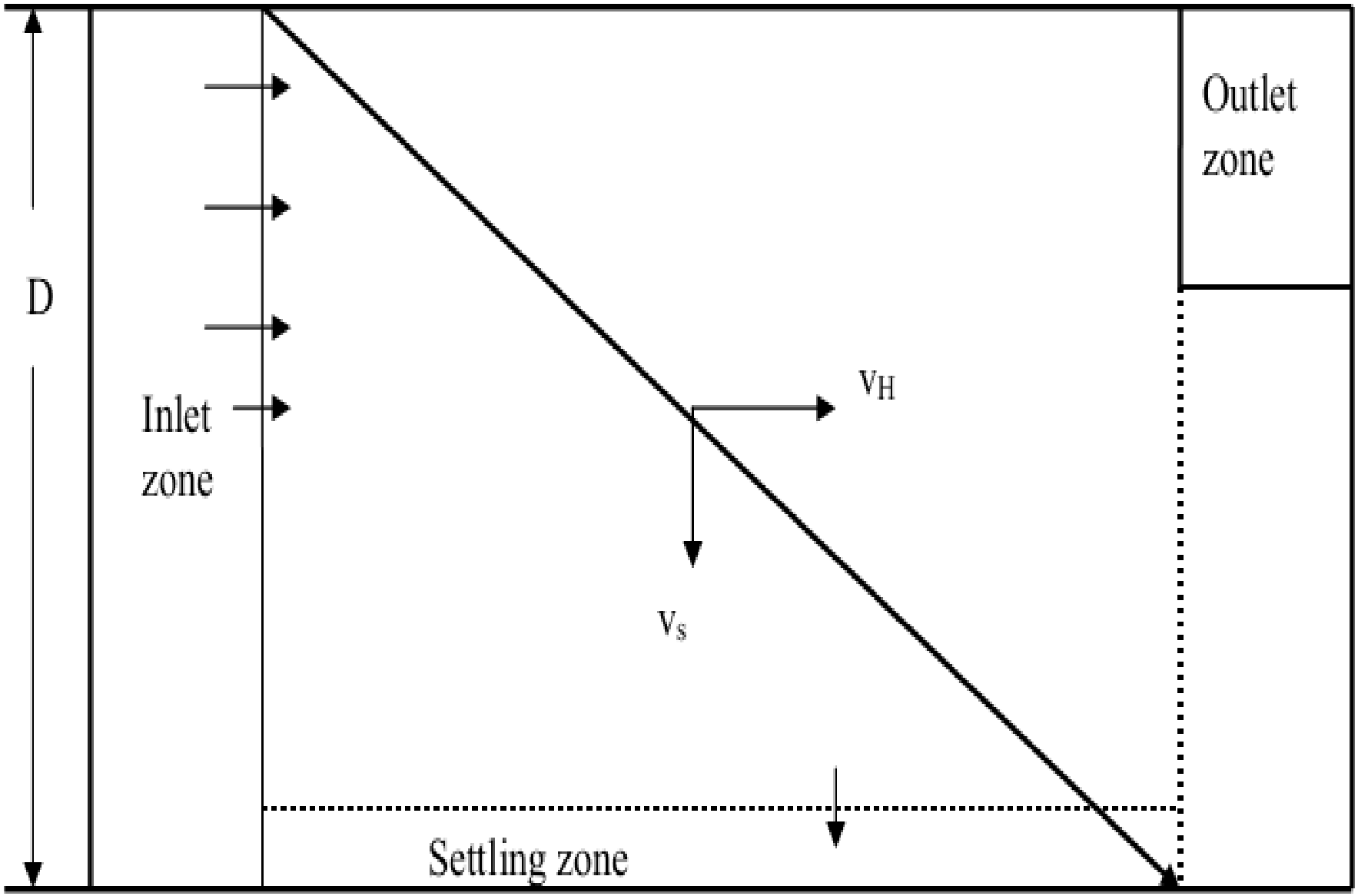
a. Inlet Zone
- Incoming flow is uniformly distributed over the cross section of the tank.

b. Settling Zone
- The concentration of each size particle is uniform throughout the cross section

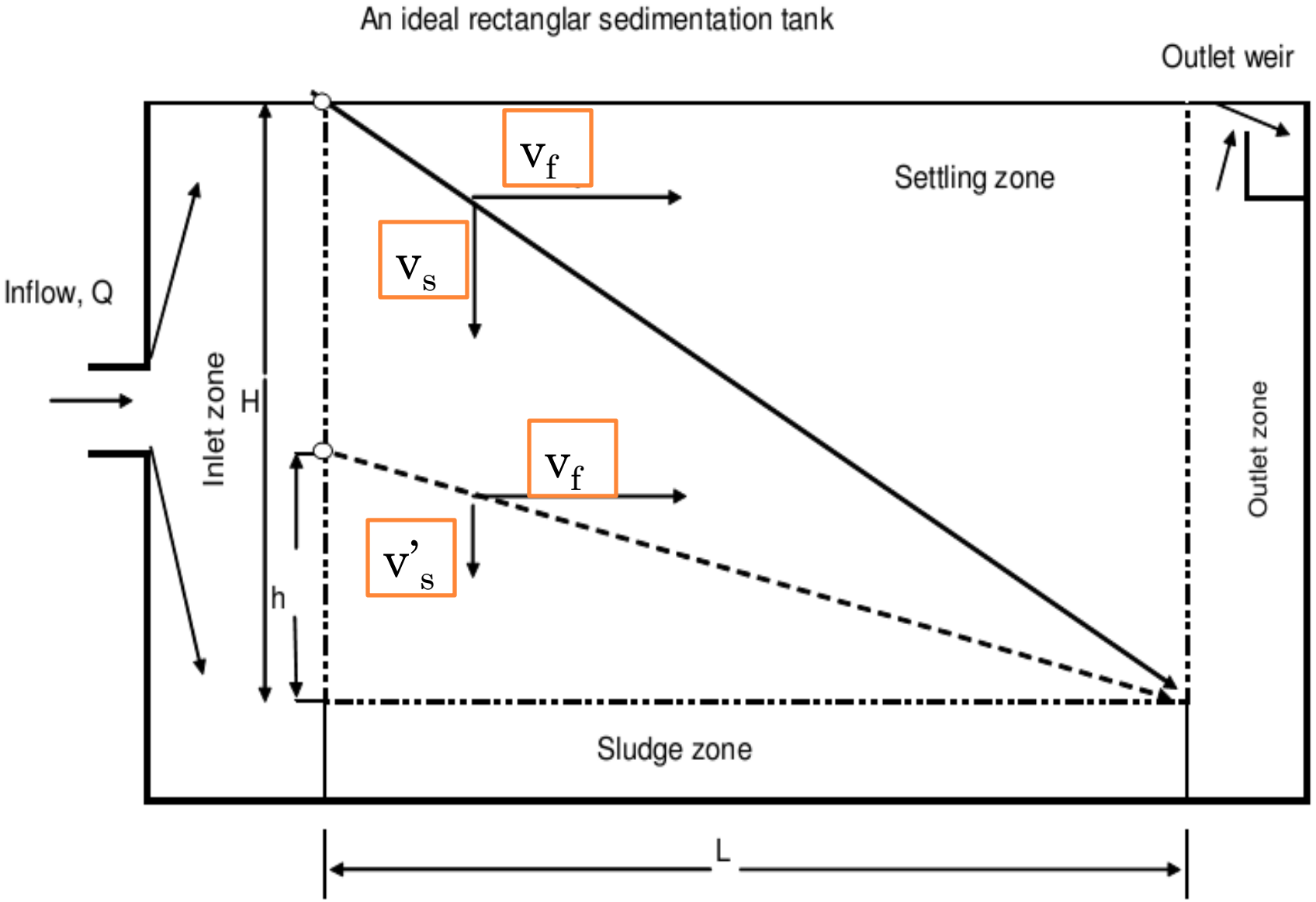
c. Outlet Zone
- Clarified effluent is collected and discharged through an outlet weir.

d. Sludge Zone
- Provides for the collection of particles removed from suspension.

Rectangular basins



Ideal Settling



v_f = flow velocity

v_s = terminal settling velocity of a particle that is just removed when it enters at the water surface (H).

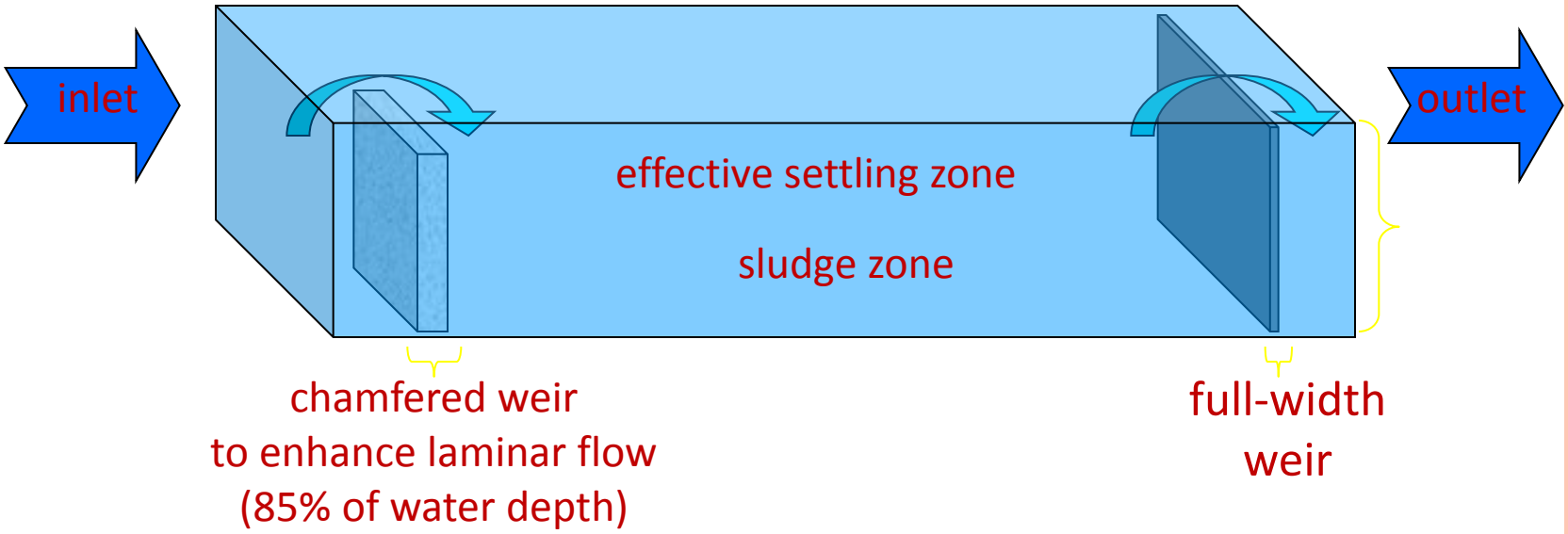
Note:

1) All particles with terminal settling velocity ≥ v_s are removed.

2) Only part of particles with settling velocity < v_s are removed.

Settling Basins

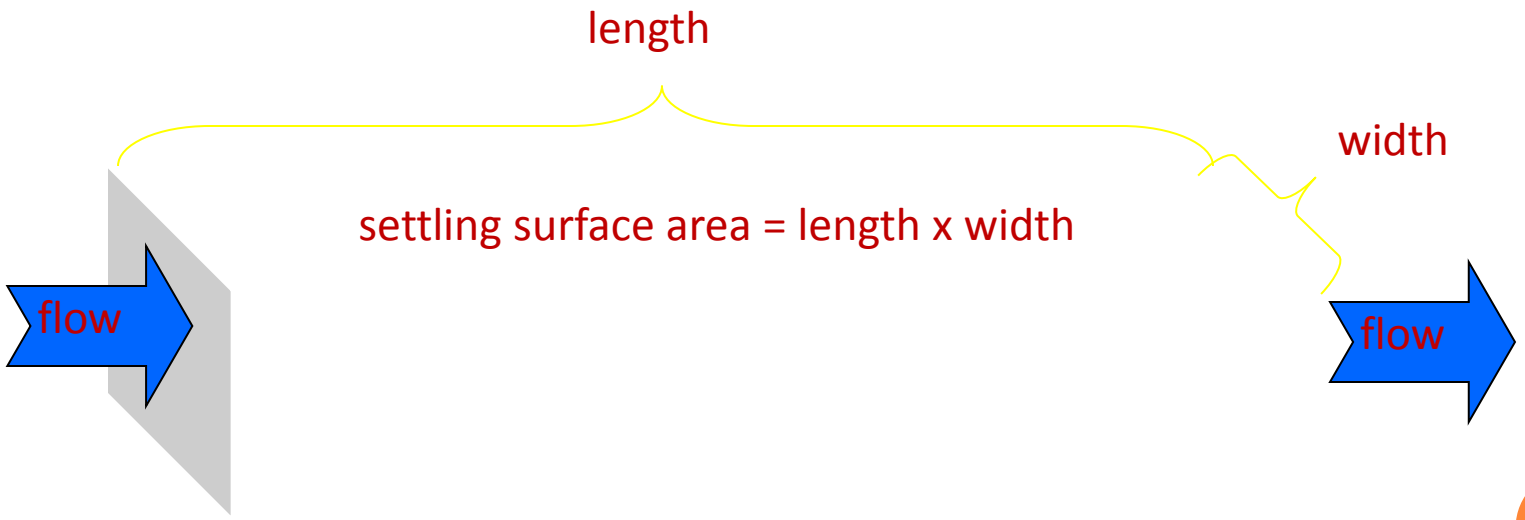
- Design to minimize turbulence:



Settling Basins

- Overflow rates are used for design: V_o

$$Overflow\,Rate = \frac{Flow\,Rate\,(m^3/s)}{settling\ \ surface\ \ area\,(m^2)}$$



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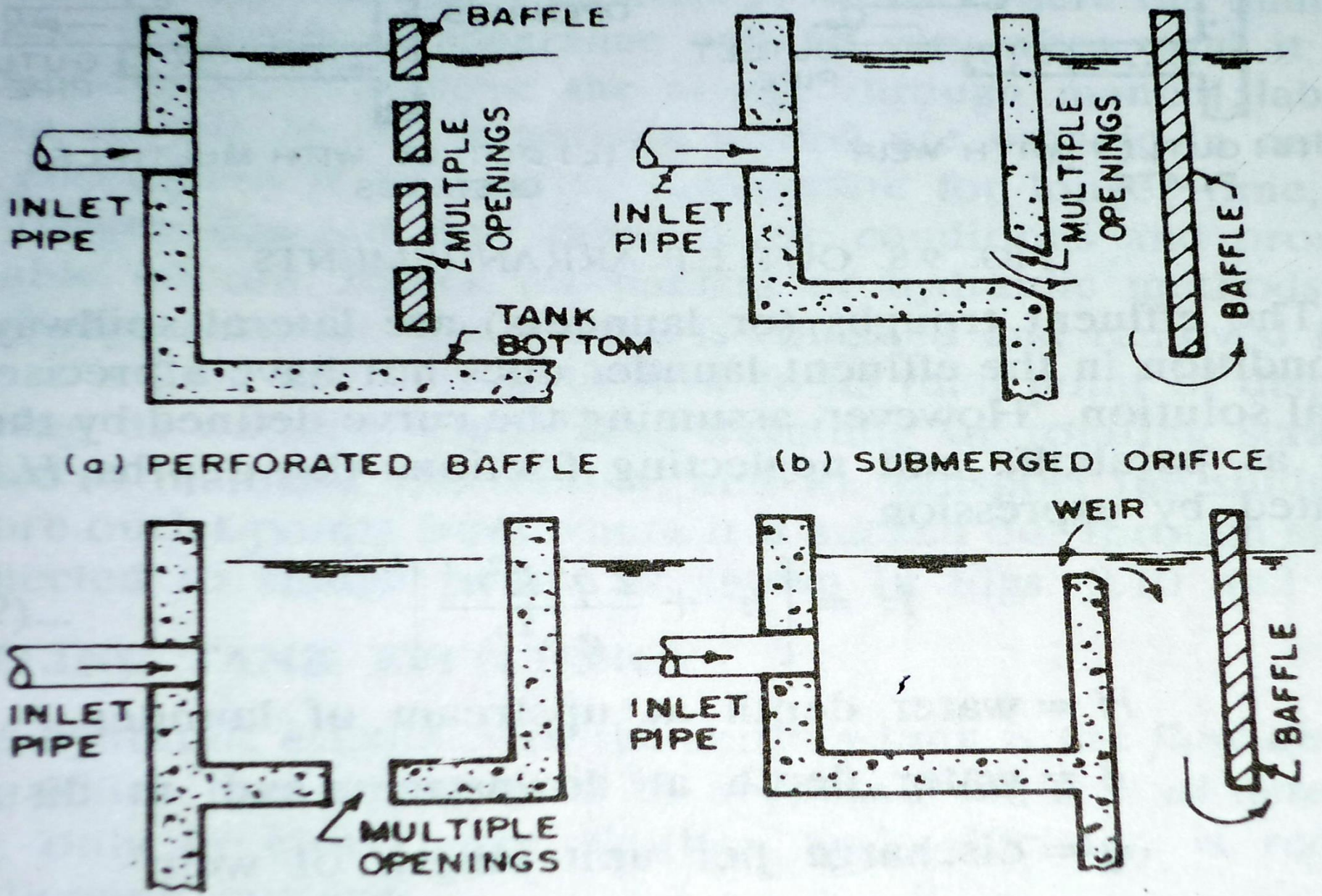
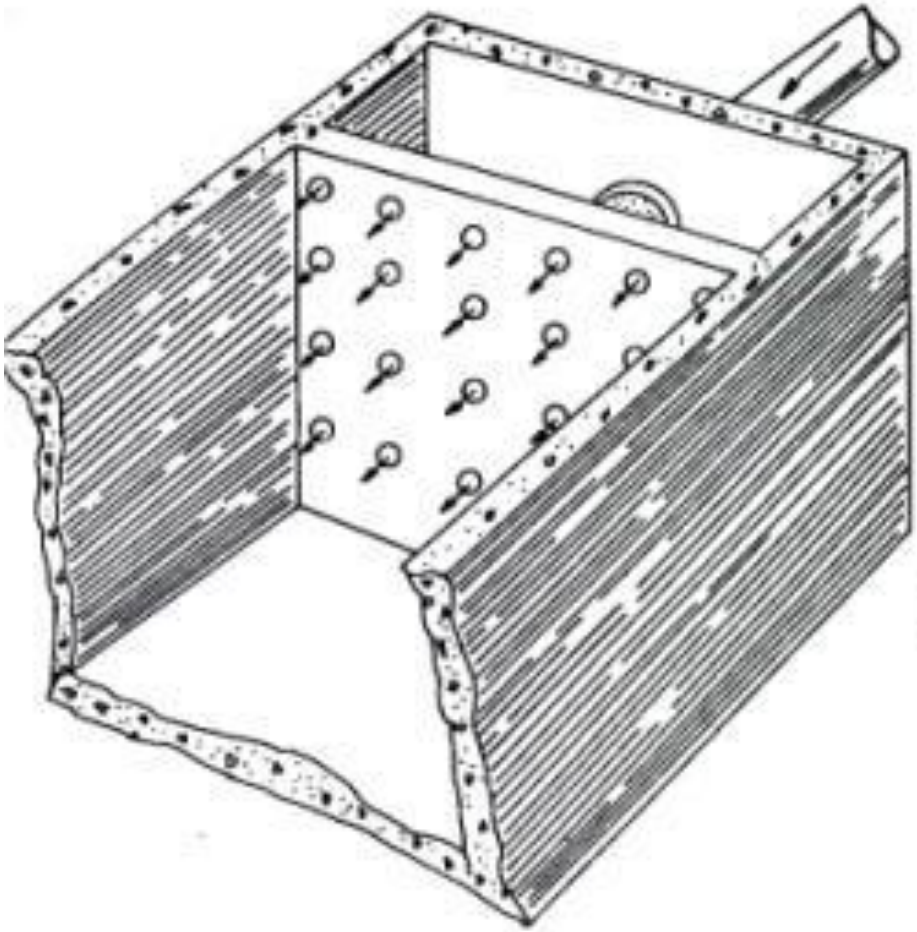
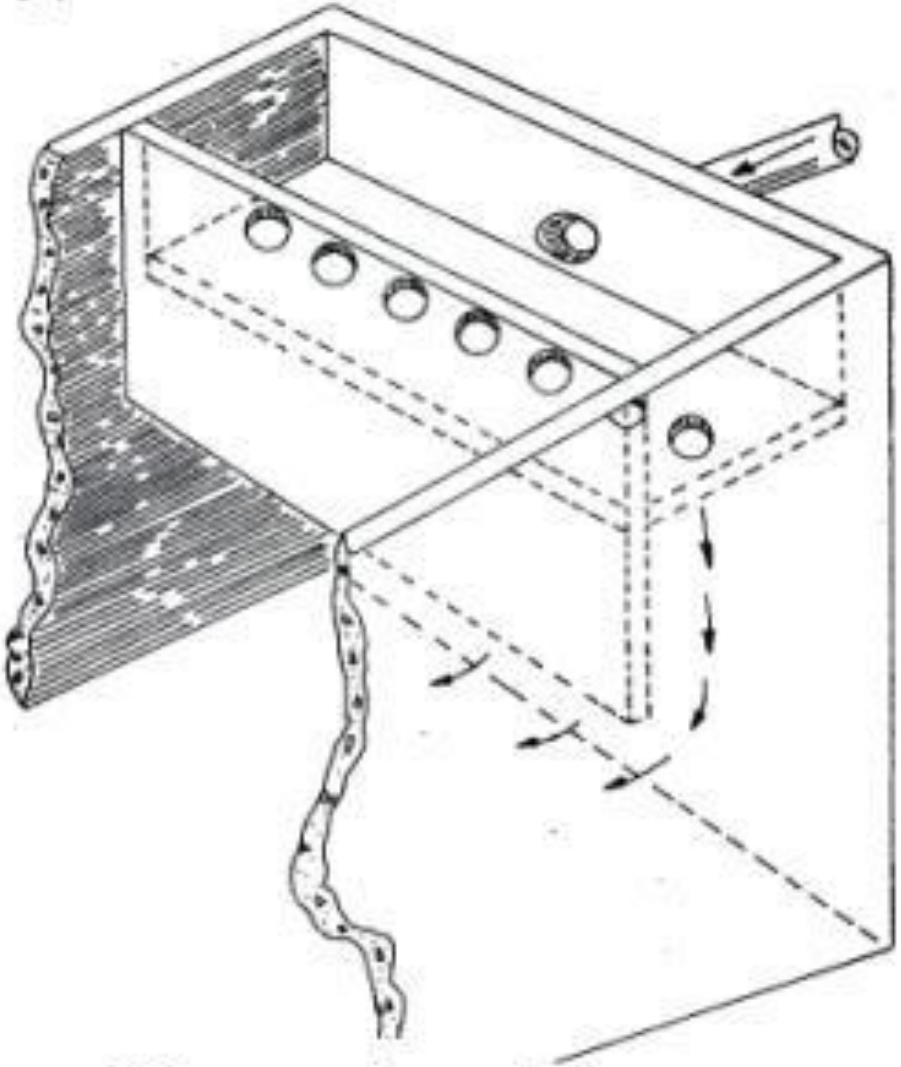
Part-III
Inlet and Outlet arrangements
Types of settling tanks

Inlet Arrangements


BAFFLE
INLET PIPE
MULTIPLE OPENINGS
TANK BOTTOM
(a) PERFORATED BAFFLE
INLET PIPE
MULTIPLE OPENINGS
BAFFLE
(b) SUBMERGED ORIFICE
INLET PIPE
MULTIPLE OPENINGS
(c) INFLUENT CHANNEL WITH BOTTOM OPENINGS
WEIR
INLET PIPE
BAFFLE
(d) OVER FLOW WEIR WITH BAFFLE

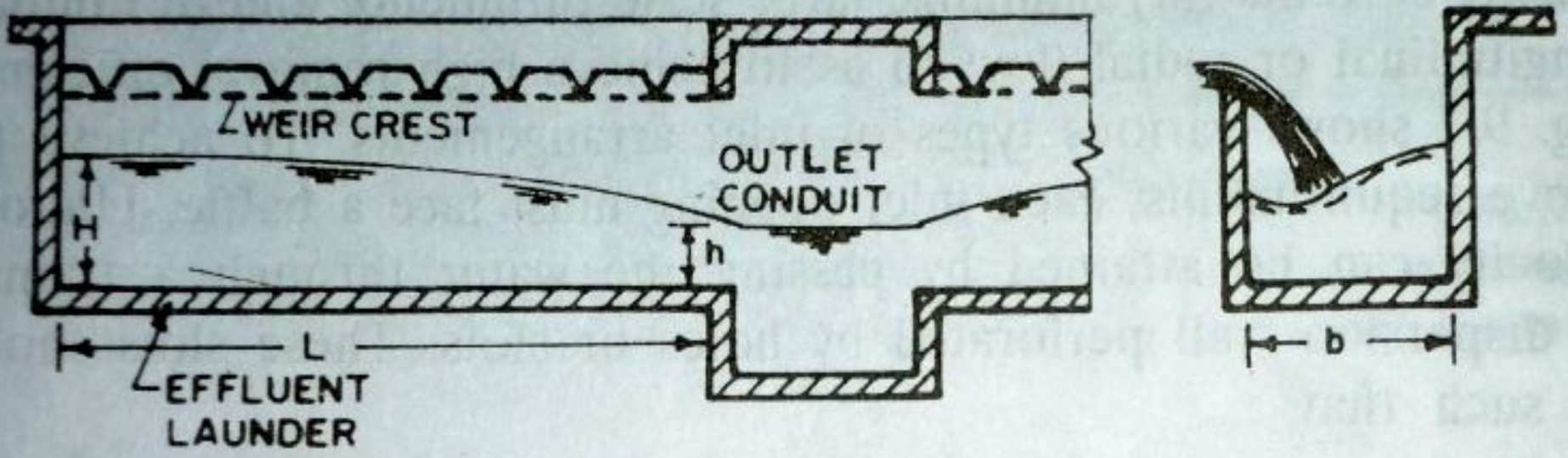


Stilling Wall

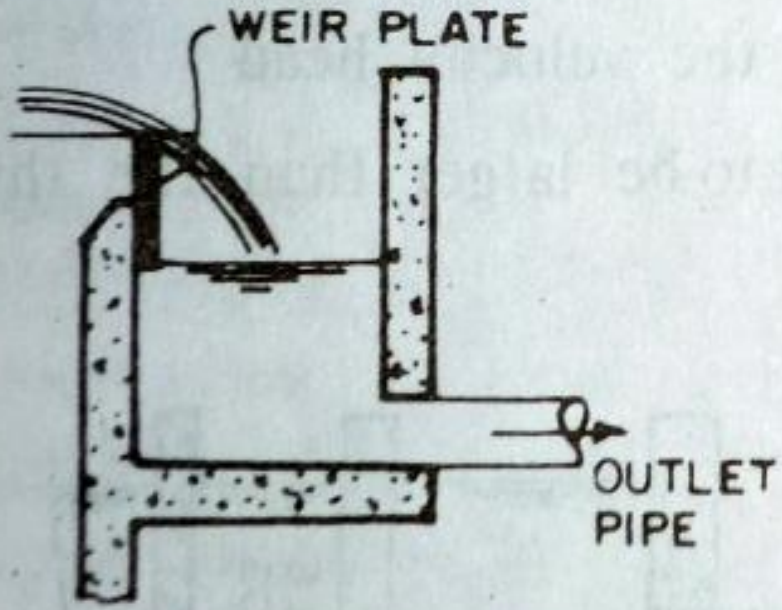


Channel or Flume

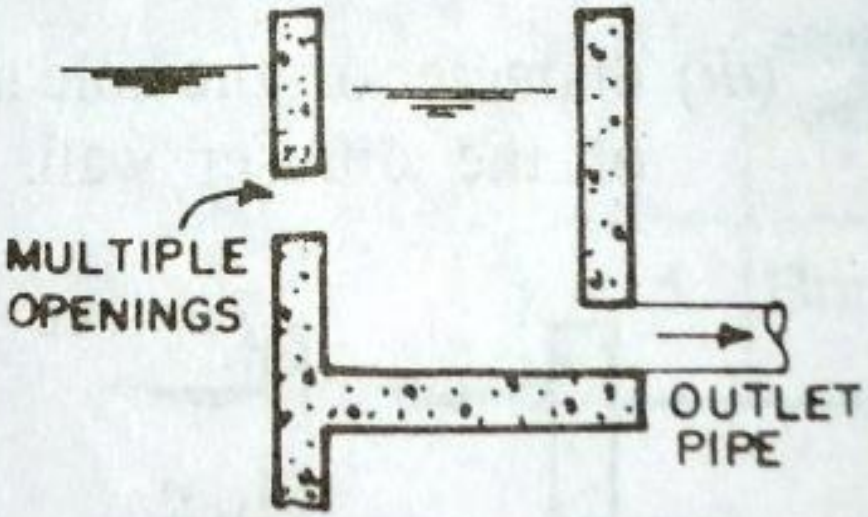
Outlet Arrangements



(a) OUTLET WITH EFFLUENT LAUNDER



(b) OUTLET WITH WEIR PLATE



(c) OUTLET WITH MULTIPLE OPENINGS

Types of Settling tanks

Types of settling tanks

1. Fill and draw
2. Continuous flow type

RECTANGULAR BASINS

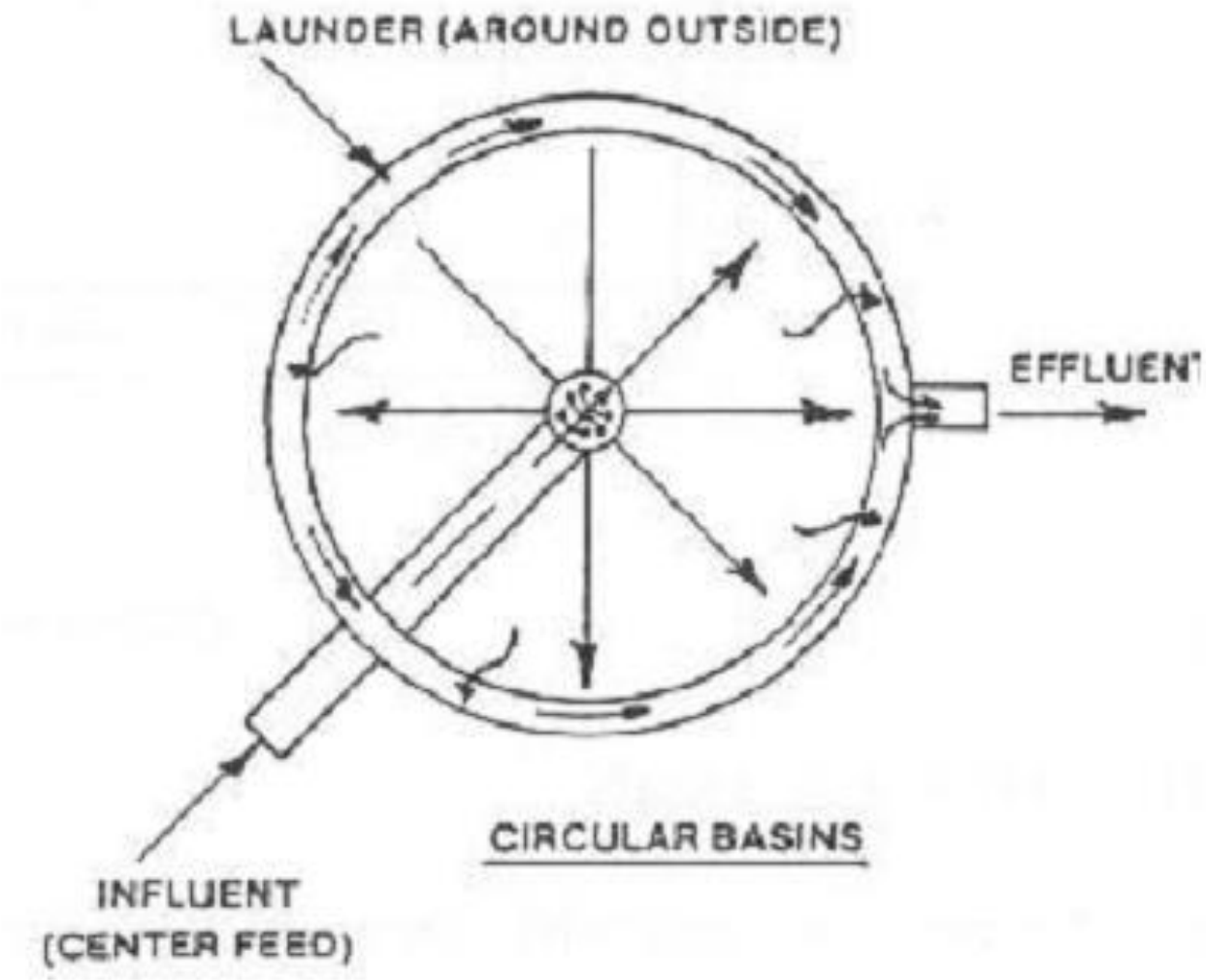
- Rectangular basins are commonly found in large- scale water treatment plants.
- Rectangular tanks are popular as they tend to have:

- **High tolerance to shock overload**
- **Predictable performance**
- **Cost effectiveness due to lower construction cost**
- **Lower maintenance**
- **Minimal short circuiting**

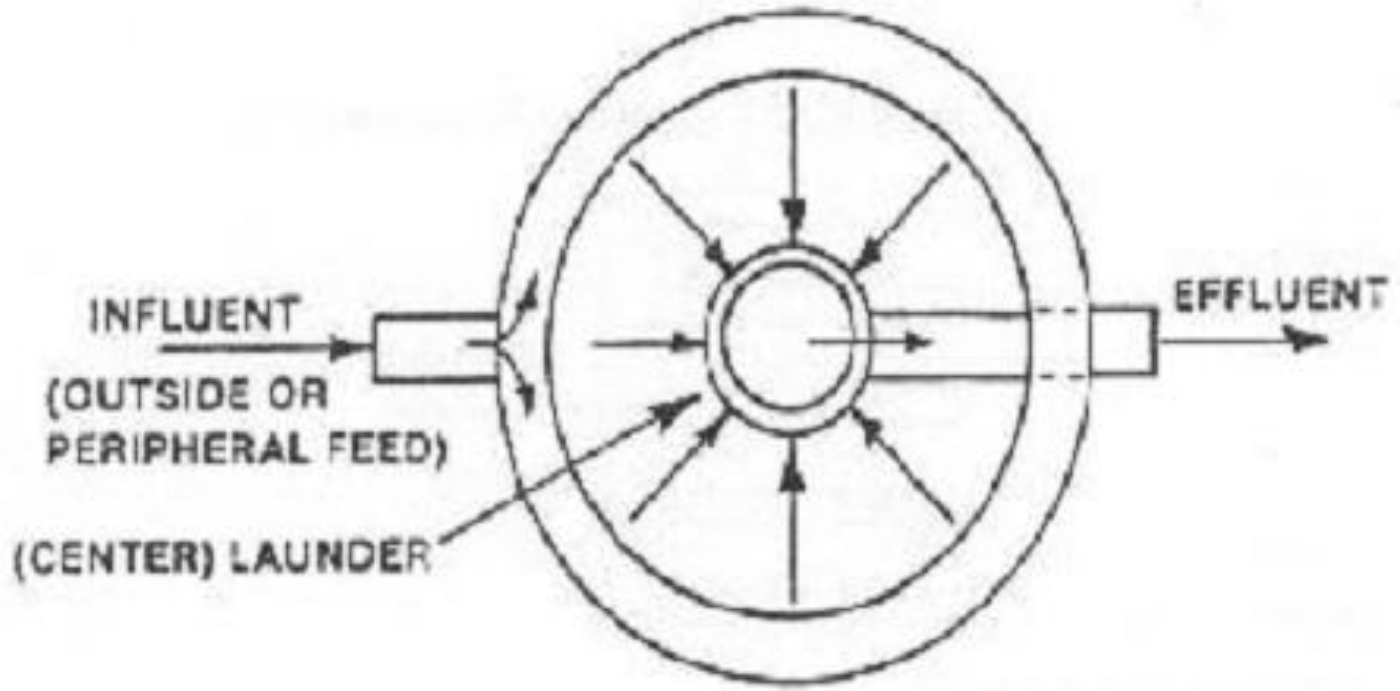
Circular basins

- Circular basins are often referred to as clarifiers.
- These basins share some of the performance advantages of the rectangular basins, but are generally **more prone to short circuiting and particle removal problems.**

Central inlet peripheral outlet



Peripheral inlet central outlet



SECTION OF RECTANGULAR TANK

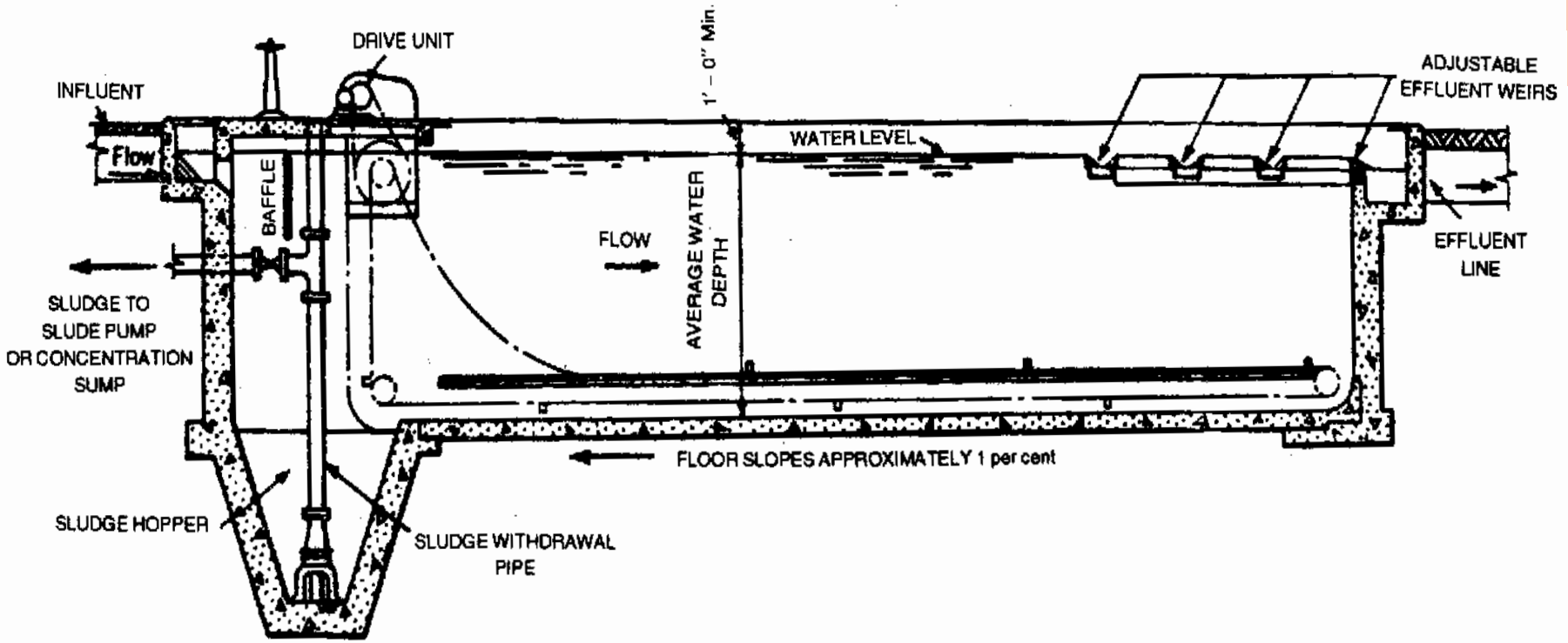
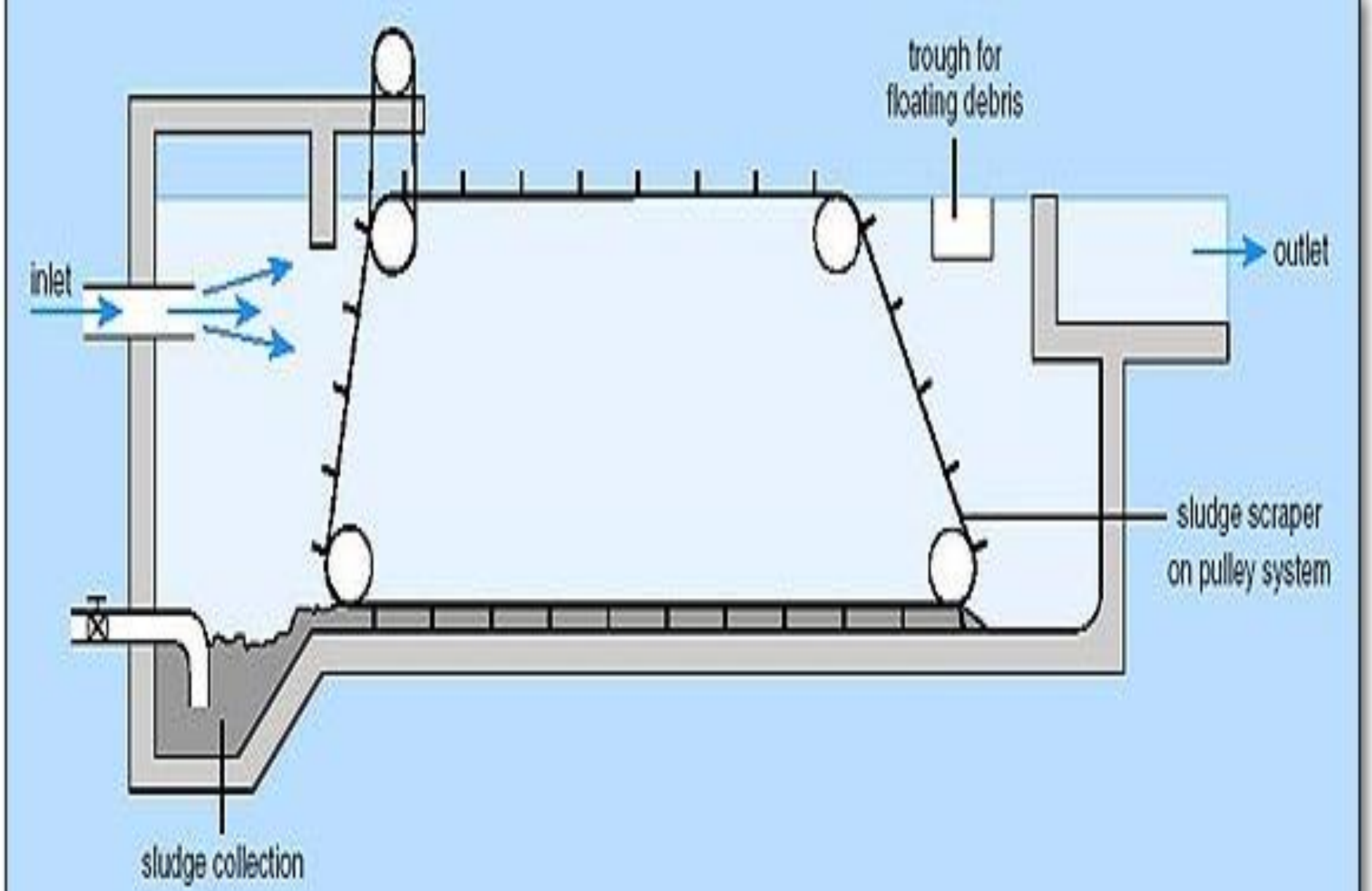


Fig. 9.3. Rectangular sedimentation tank (ideal horizontal flow tank).


trough for
floating debris
inlet
outlet
sludge scraper
on pulley system
sludge collection
(a)
decanting trough

Circular tank with central feed radial flow

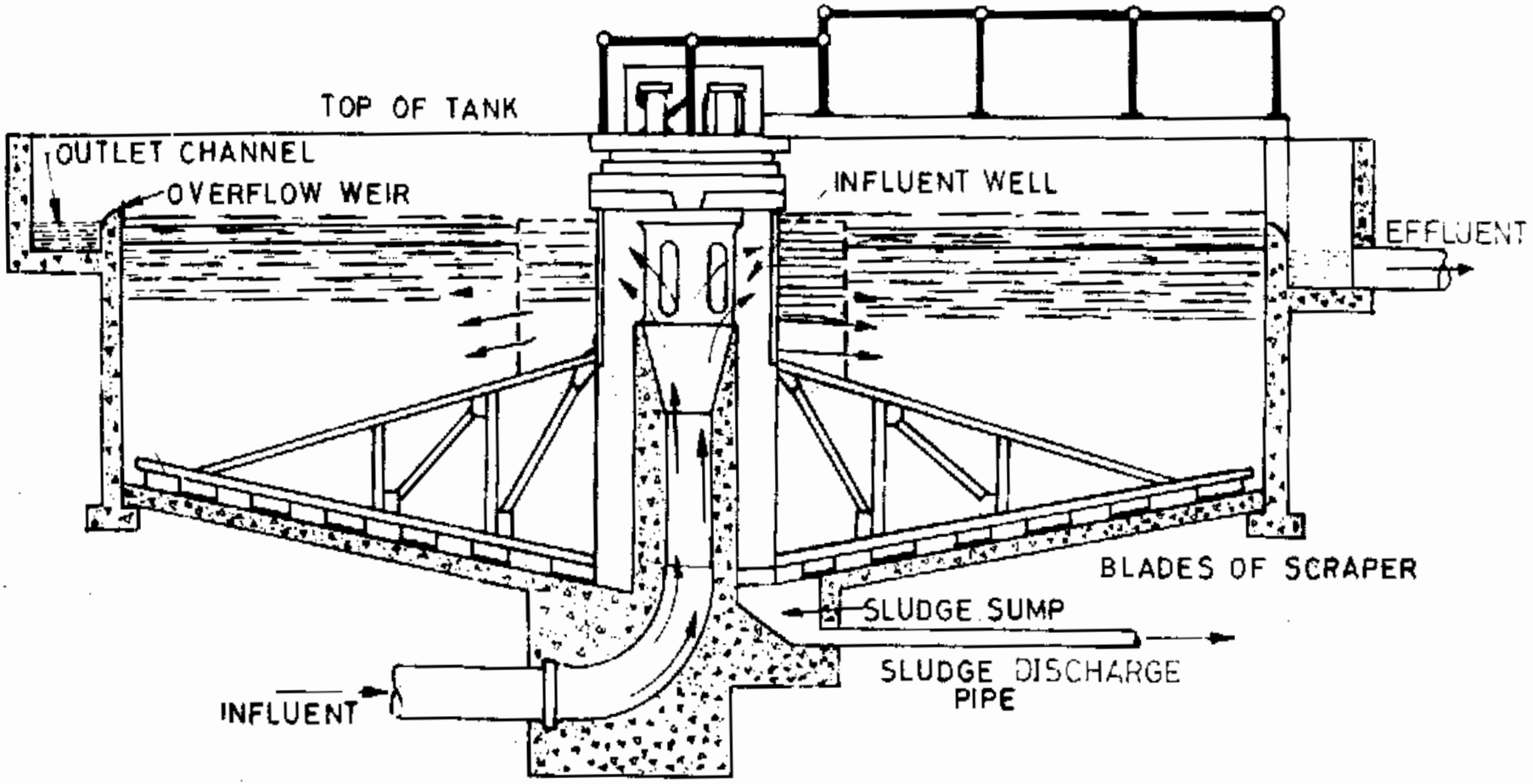
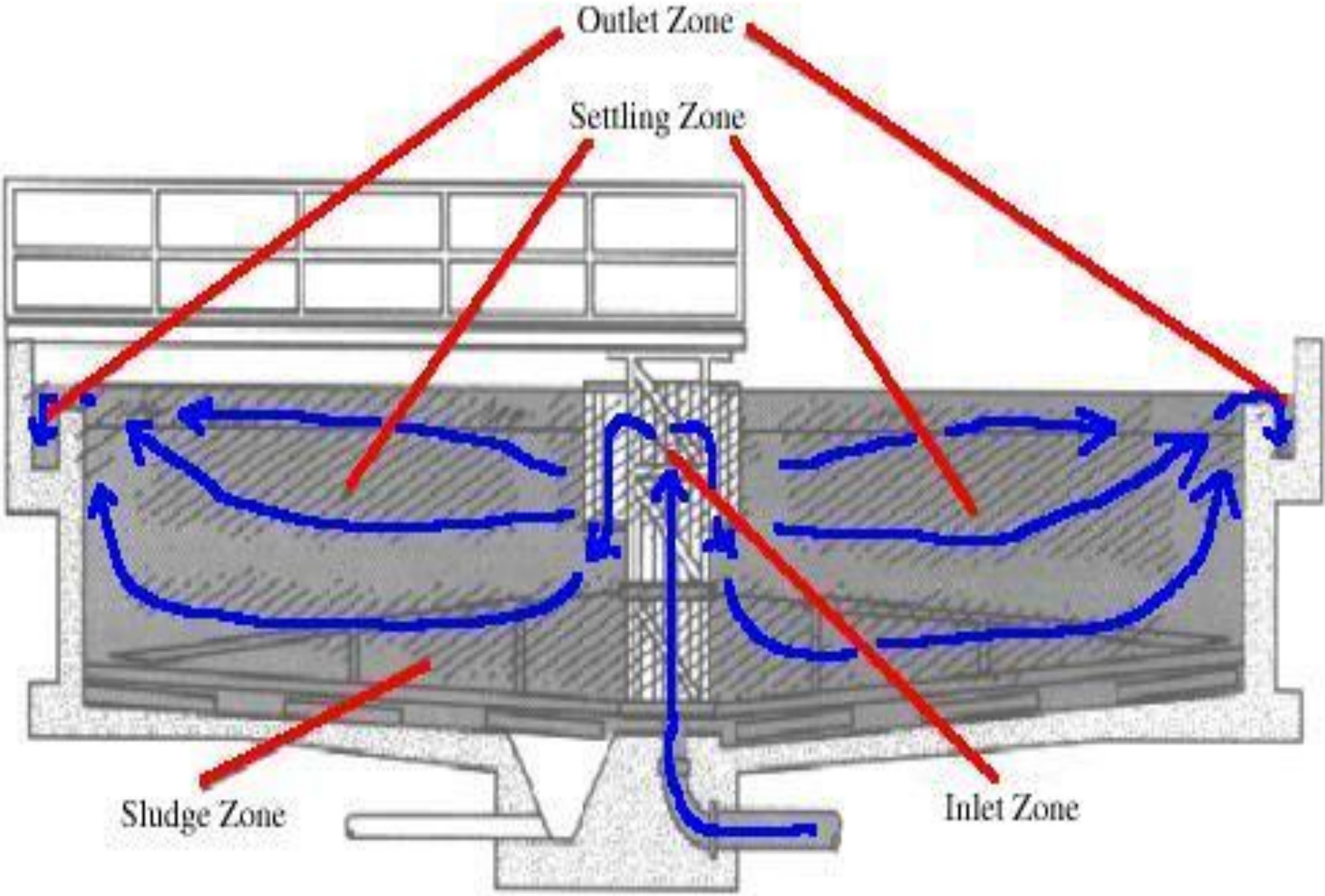


Fig. 9.4. Circular sedimentation tank (central feed) with radial flow.


Outlet Zone
Settling Zone
Sludge Zone
Inlet Zone

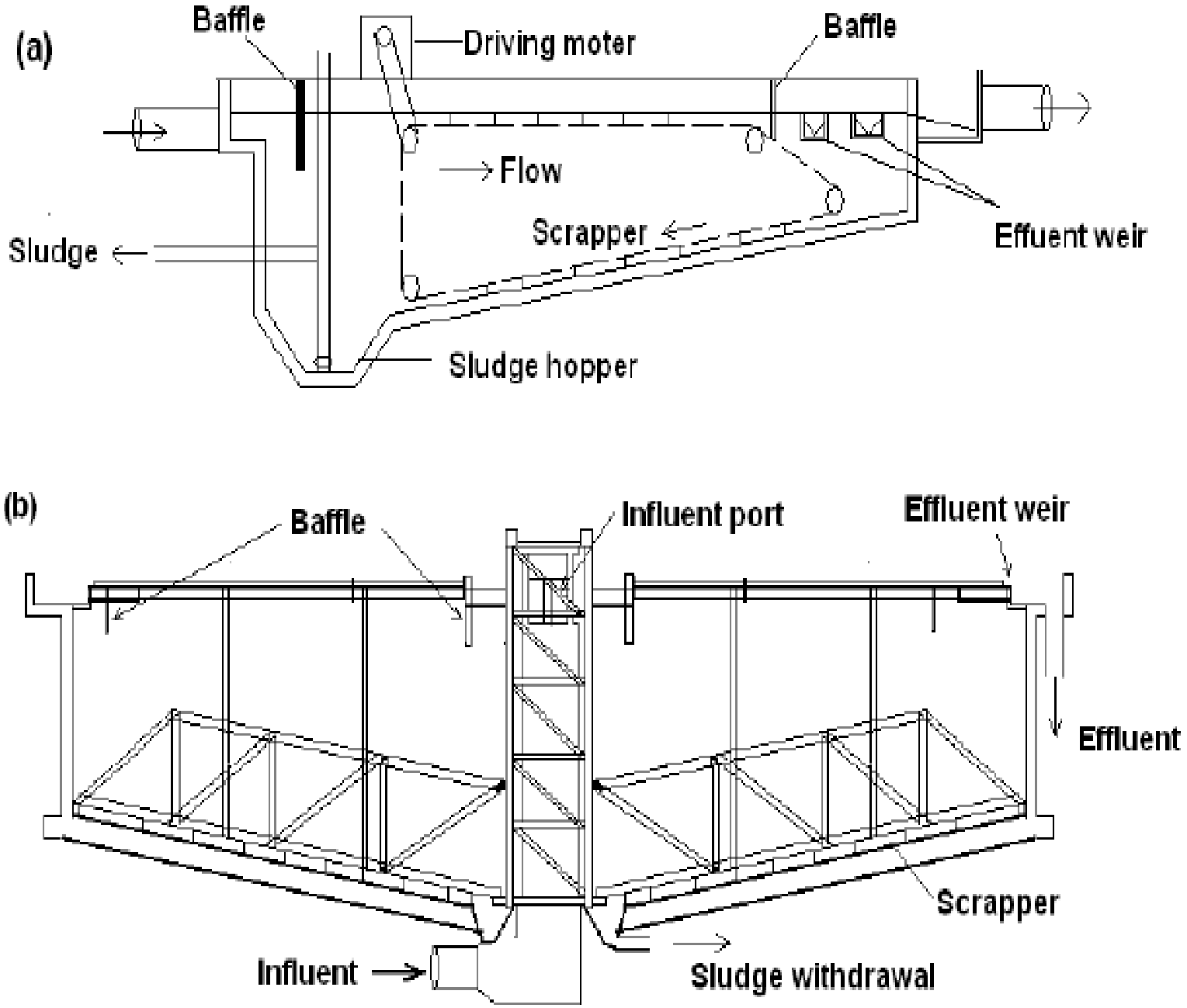
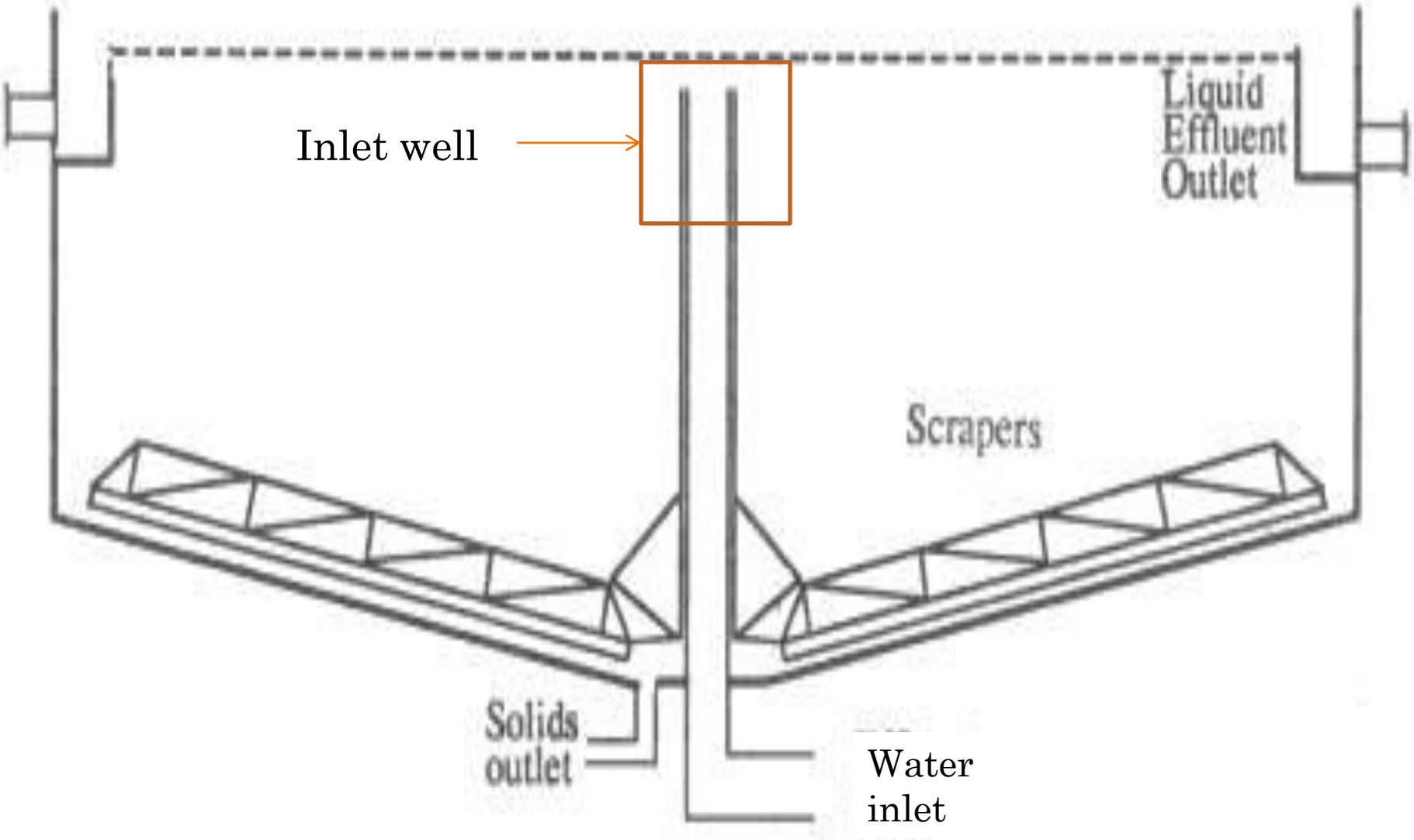
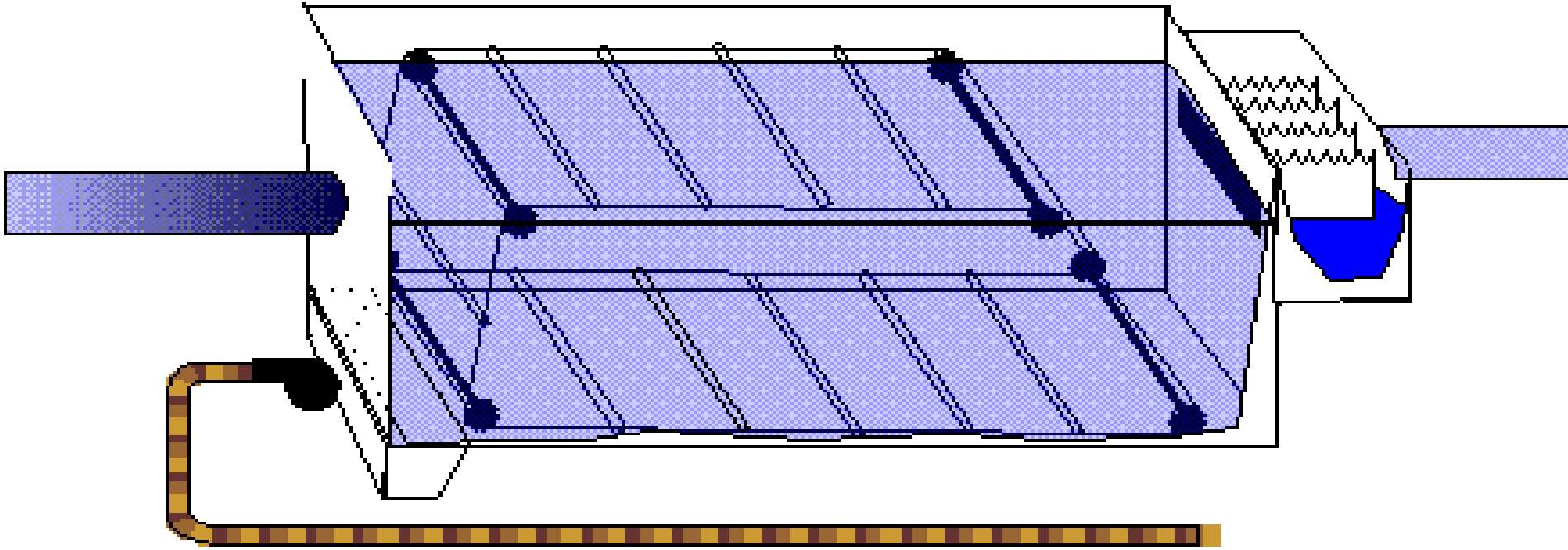


Figure 16.2 (a) Rectangular and (b) Circular primary sedimentation tank

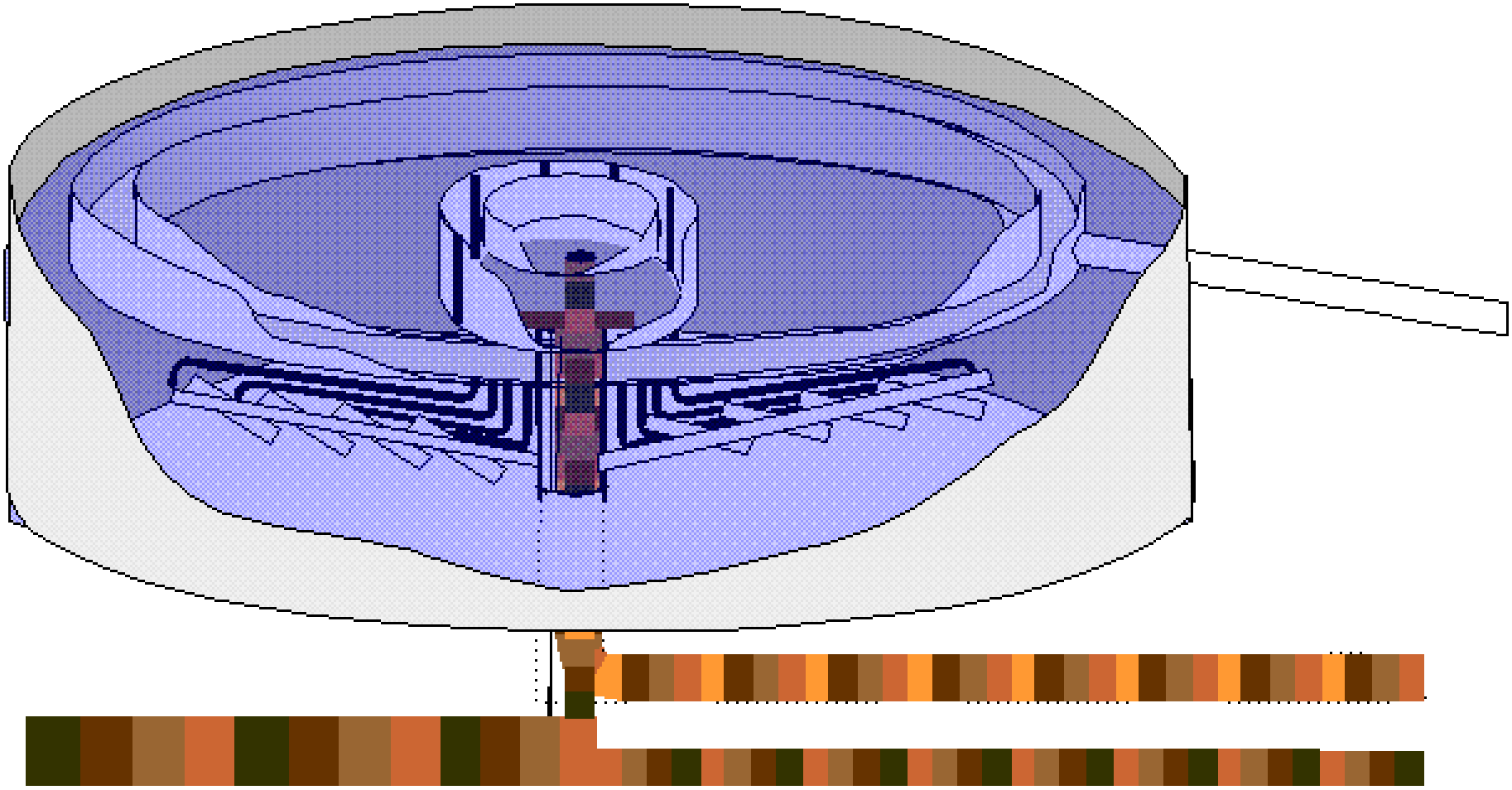
CIRCULAR TANK



Rectangular Tank



Circular Tank



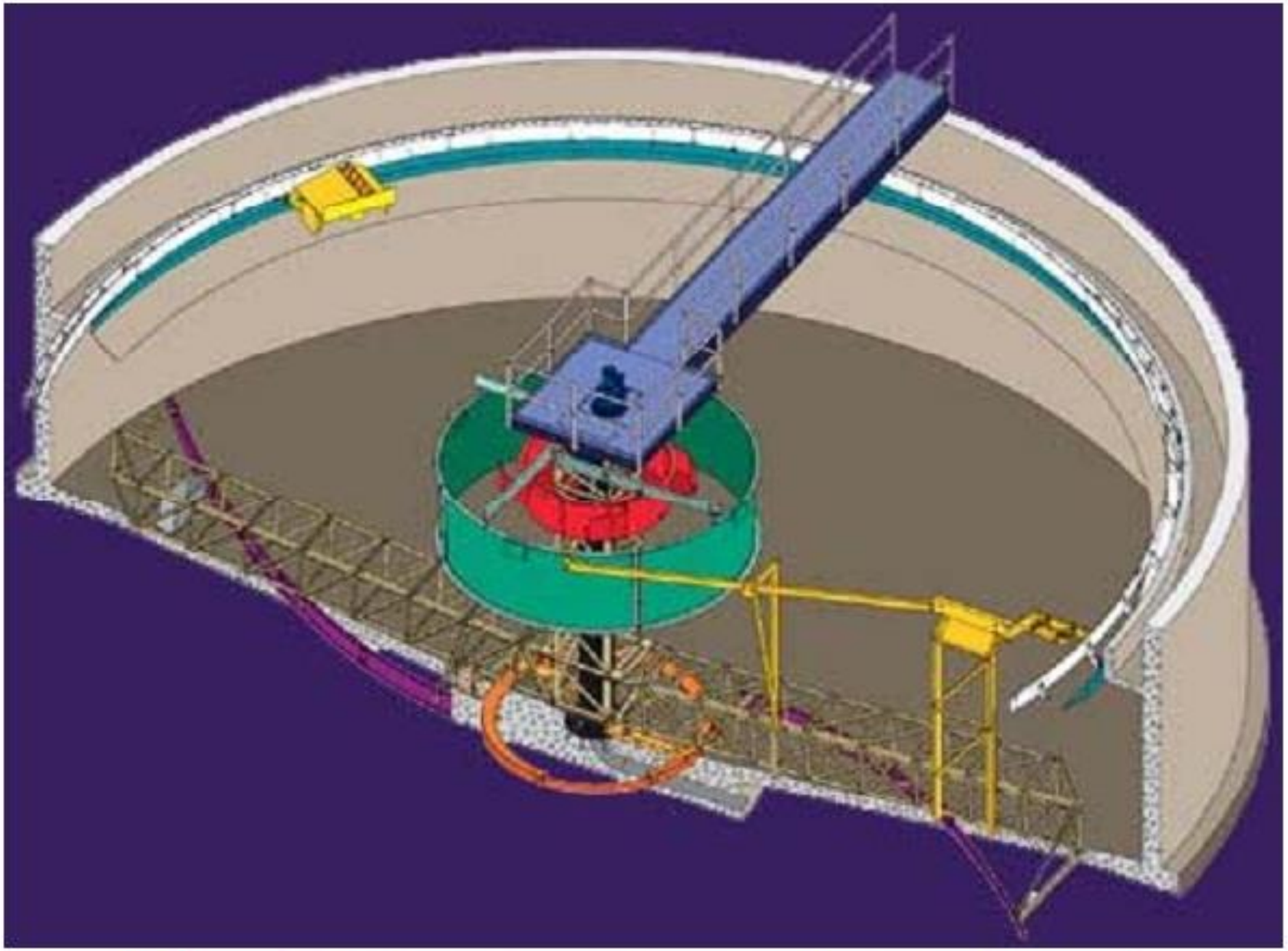


Figure 8 : Circular sedimentation Tank

Objective Questions

1. If settling tank is rectangular in shape having length L, width W and depth D, then for discharge Q, the settling velocity would be _____. (Q/WD, Q/LW, Q/DL, Q/LWD).
2. _____ sedimentation is concerned with the settling of non flocculating discrete particles. (Type I/Type II/Type III/Type IV).
3. Settling tank efficiency is reduced by _____. (eddy currents/ surface currents/ vertical convection/all of above).
4. Type III settling is known as _____ or _____ settling.
5. Efficiency of settling is independent of _____ and _____.

6. Unit of SOR is _____.
7. Unit of weir loading is _____.
8. Surface currents in settling tanks are due to _____.
9. Circular basins are often referred to as _____.

Theory Questions

Q1. The removal efficiency of settling tank reduces. Explain with factors affecting removal efficiency. (May 2012, 5 marks)

Q2. Write short notes on

i. Stokes law of settling (May 2012, 5 marks)
ii. Types of settling tanks (May 2012, 4 marks)

Q3.Explain the terms (Dec 2011, 4 marks)

i. Overflow rate
ii. Flow through velocity
iii. Detention time
iv. Settling velocity

Q4. Draw neat sketches for inlet and outlet arrangements for sedimentation tank. (May 2011, 8 marks).

Q5. In case of sedimentation tank, 'the efficiency is independent of the basin depth and detention period'. Prove this statement. (Dec 2010, 9 marks).

Q6. Write explanatory note on 'Types of settling'. (Dec 2009, 5 marks)

Q7. Explain design criteria for sedimentation tanks.

Q8. Discuss factors affecting efficiency of settling