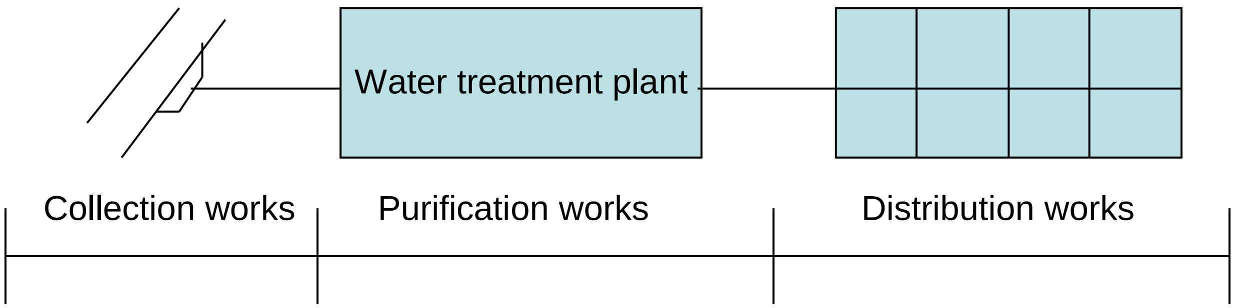
Water supply works

Water supply works consists of three main stages:

1- Collection works.
2- Purification works.
3- Distribution works.



Collection works for surface water

Collection works consists of:

1- Intake and intake conduit.
2- Sump.
3- Low left pumps.

1- Intake

It is a structure for suction the raw water from its source to the water treatment plant.

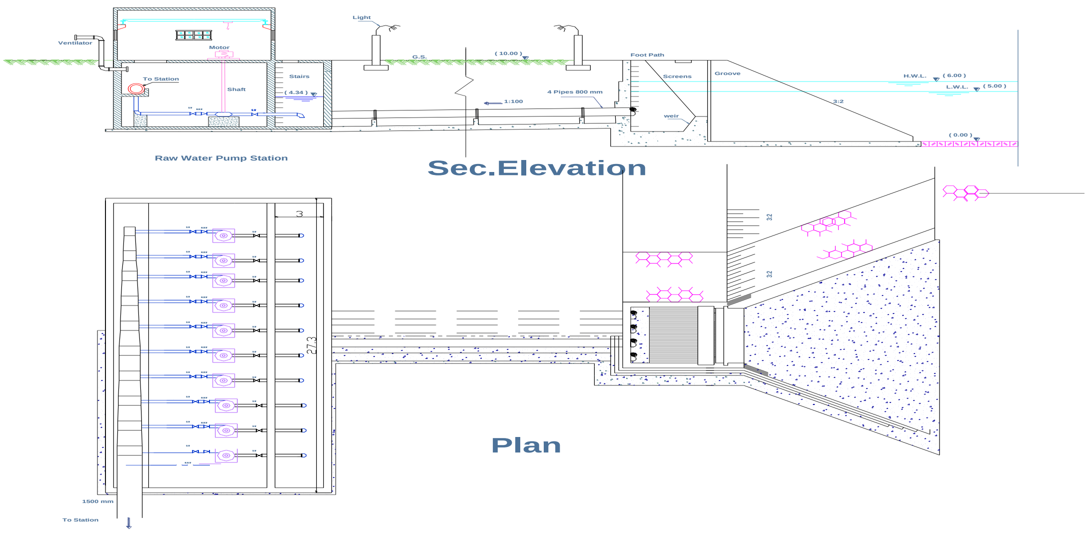
Types of intakes:

The type of intake depends on:

1- width of the water source. Narrow or wide.
2- Shore pollution. Polluted or non polluted.
3- Depth. Shallow or deep.
4- Navigation. Navigable or non navigable.

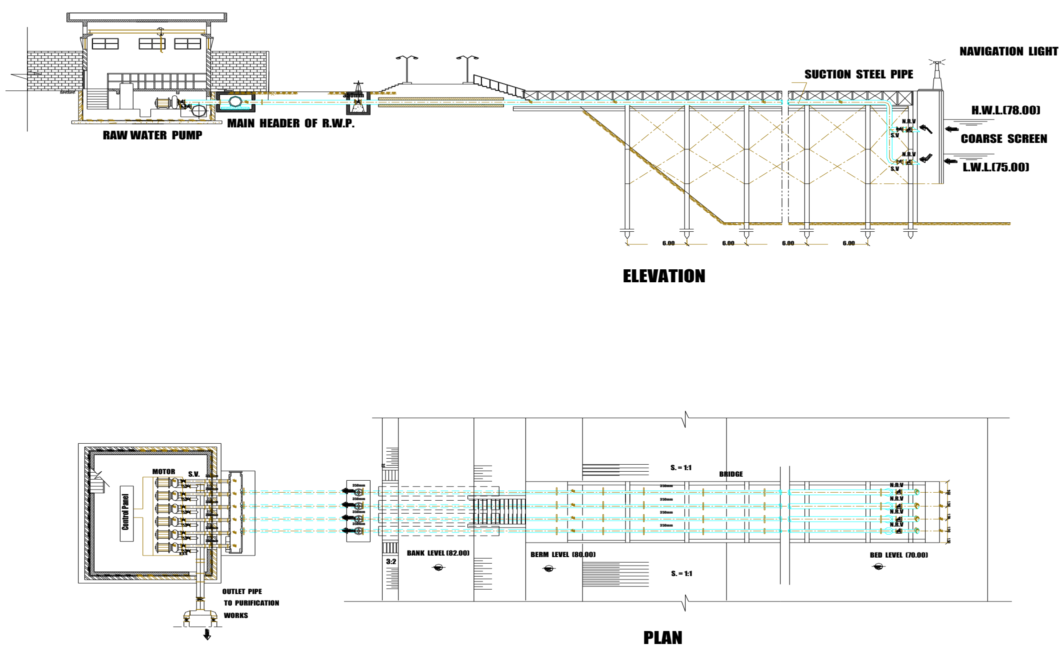
1- Shore intake

It is used in narrow, navigable water streams and the shore is not polluted.



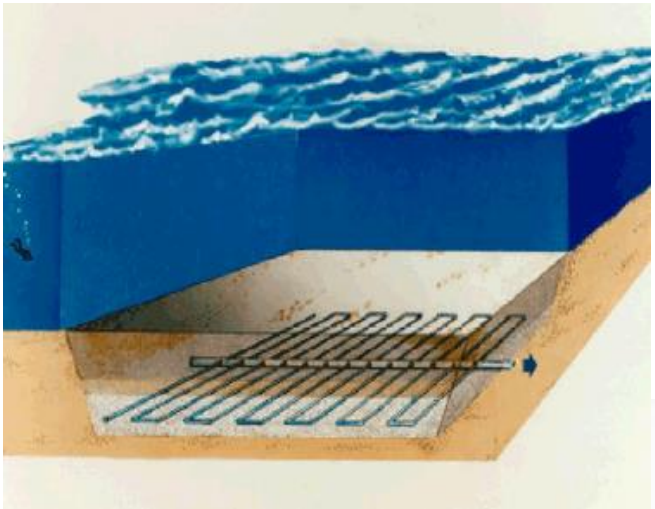
2- Pipe intake

It is used for wide, navigable water streams and the shore is polluted.



3- Submerged intake

It is used in narrow, deep canals if the shore is polluted.

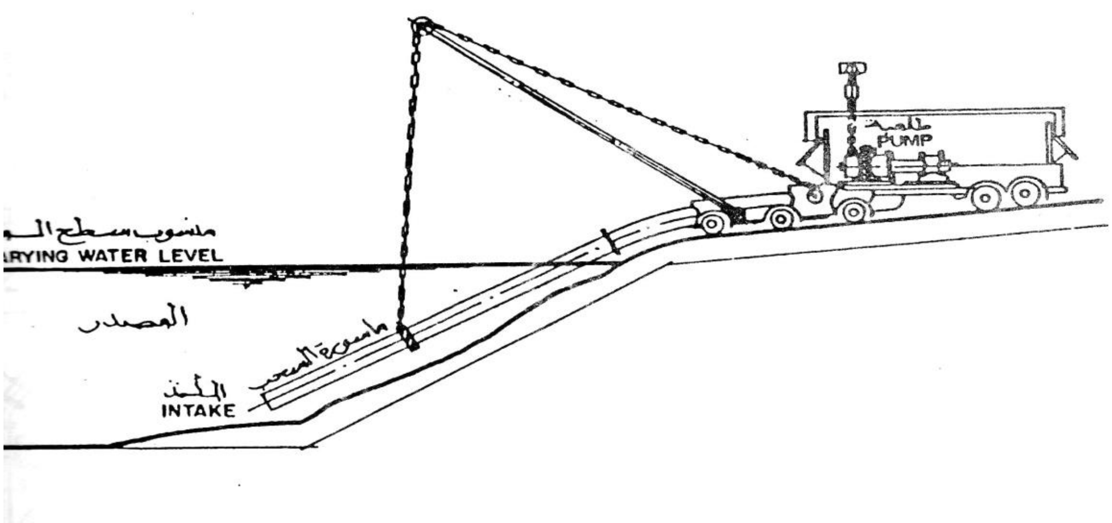


4- Tower intake

It is used in canals of fluctuated water levels.

5- Movable intake

It is used in temporary and emergency cases.

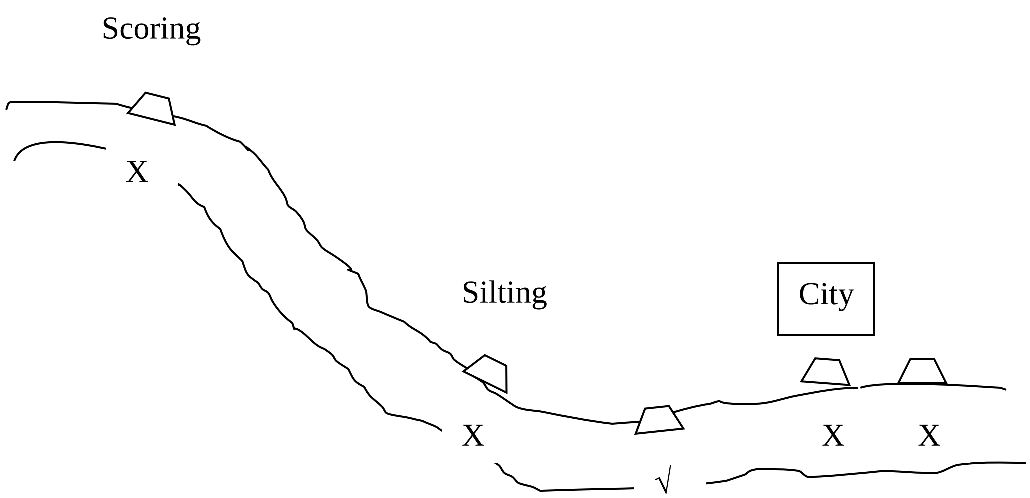


The factors affecting the choice of the location of intake:

1- It has to be constructed U.S the city.

2- Prohibited area of 150 m U.S the intake and 50 m D.S the intake to avoid pollution.

3- It has to be located at straight segment of the water stream to avoid scoring and silting.



1- Shore intake

1-1- Intake conduit:

Purpose:

To transmit raw water from source to low left pump (L.L.P).

Design criteria:

1- Qdesign = Qmax monthly x 1.1 and Qmin x1.1

Qmax monthly = 1.5 x Qave

2- v = 0.6 – 1.5 m/s

Maximum velocity $\leq$ 2 m/s

3- Number of pipes n $\geq$ 2

4- $$hf = \frac{4flv^2}{2gd}$$

f = 0.008

l = 30 – 50 m (for shore intake)

l = 50 – 100m (for pipe intake)

1-2- Suction well (sump – wet well)

Purpose:

Distribute the raw water uniformly on the total number of pumps.

Design criteria:

1- Length ≥ 5 times the diameter of the intake conduit.
2- Length = number of pumps x (1.5 – 2.5).
3- width 1 – 3 m.
4- depth ≥ (H.W.L – bed level) – hf + 0.5m
5- T = 5 minutes
 V = Qdesign x T m3
 A = V/d m2
 A = B x L

1-3- Low lift pump

Purpose:

To rise the raw water from the source level to water level in the first tank in water treatment plant.

Design criteria:

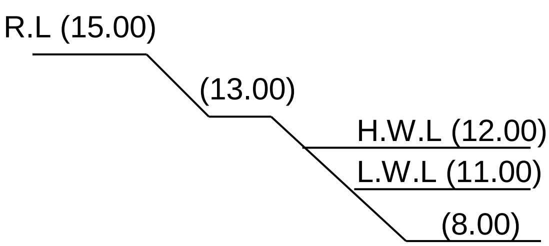
Qdesign = Qmax monthly x 1.1
Htotal = Hs + hf + hs
Hs = static head it is the difference between L.W.L. and the water level (W.L) in the first tank in the water treatment plant (W.T.P) ~ 5m above land level.
 = (G.L – L.W.L) + 5
hf = friction losses

$$hf = \frac{4flv^2}{2gd}$$

Hs = secondary losses
 = 10 % hf
HP = γ Q HT / 75 η
η = 0.7 mechanical efficiency
Electrical horse power (kw/hr) = HP x 1.1 / 1.34 η
η = 0.9 electrical efficiency

Example:

It is required to design the collection works for a city of present population 24,000 capita and average water consumption 180 l/c/d. If pumps work 20 hr/d. The source of water is narrow and navigable canal, its dimensions as shown.



Solution:

Qave = pop x qave

$$= \frac{24000 \times 180}{1000 \times 20 \times 60 \times 60} = 0.6 m^3 / s$$

Qdesign = Qmax monthly x 1.1

= 1.5 x Qave x 1.1

= 1.5 x 0.6 x 1.1 = 0.99 m3/s

Qmin = 0.7 x Qave x 1.1

= 0.7 x 0.6 x 1.1 = 0.46 m3/s

Intake conduit

Qdesign = A x v (v= 0.6 – 1.5 m/s)

Take v = 1 m/s

A = Qdesign / v

= 0.99 / 1 = o.99 m2

A = n π Φ2 / 4

Take n = 3

∴ Φ = 0.64 ~ 0.6 m

vact = Qd / Aact

= 0.99 / 3 π (0.6)2 /4 = 1.167 m/s <1.5 and >0.6 safe

When one pipe is broken

vmax ≤ 2.5 m/s

vmax = Qd / (n-1) π Φ2 / 4

= 0.99 / 2 π (0.6)2 /4 = 1.75 m/s <2.5 safe

At Qmin

vmin = Qmin / n π Φ2 / 4

= 0.46 / 3 π (0.6)2 /4 = 0.54 m/s   <0.6 unsafe

Close one pipe at the months of Qmin

vmin = Qmin / (n-1) π Φ2 / 4

= 0.46 / 2 π (0.6)2 /4 = 0.81 m/s   >0.6 safe

L.L.P

Htotal = Hs + hf + hs

Hs = (G.L – L.W.L) + 5

Hs = (13 – 11) + 5 = 7 m

$$hf = \frac{4flv^2}{2gd}$$

$$hf = \frac{4 \times 0.008 \times 50 \times (1.167)^2}{2 \times 9.81 \times 0.6} = 0.18m$$

hs = 10 % hf

= 0.1 x 0.18 = 0.018 m

HT = 7 + 0.18 + 0.018 = 7.198 m

Sump

V = Qd x T

= 0.99 x 5 x 60

= 297 m3

V = B x L x d

d = H.W.L – bed level – hf + 0.5

= 12 – 8 – 0.18 + 0.5

= 4.32 m

B = 1 – 3 m   take B = 2m

L = 297 / 2 x 4.32 = 34.375 m

Chick:

Length ≥ 5 times the diameter of the intake conduit

L = 5 x 3 x 0.6 = 9 m   safe