Water Supply Engineering

Chapter 5

Intakes

Lecture 7 (Week 7)

Intakes, Definition, Site selection of an intake, Classification of intake, Characteristics of intake, River intakes, Reservoir intake, Spring intake

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Learning Objectives:

By the end of this lesson, students will be able to:

- Define what an intake structure is and explain its role in water supply systems.
- Explain the criteria for selecting a suitable site for constructing an intake.
- Classify the different types of intake structures based on source and function.
- Describe the general characteristics and components of intake structures.
- Differentiate between the types of intakes based on their features and applications.

5. Intakes

5.1 Definition

• An intake is a device or structure placed in a water source:

To permit the withdrawal of water from source and discharge it into an intake conduit through which it flows to the treatment plant; or discharge it into an intake

• An intake should allow continuous abstraction of the design flow from the source.

• The functioning of water supply scheme largely depends on the intake

Functions of an intake structure

- To help in safely withdrawing water from the source and then to discharge into withdrawal conduit.
- To check trash and debris entry along.
- To reduce sediment entry

- To secure entry of water with minimum disturbance.

5.2 Site selection of an intake

Should be located where

- Best Quality of water is available.
- Sufficient Quantity of water can be drawn.
- Approachable without any obstruction.
- Treatment plant distance is minimum.
- Expansion possibility in future is available.
- Concave bank(outer bank).

Shouldn’t not be located at

- Navigation channel
- Heavy current of water

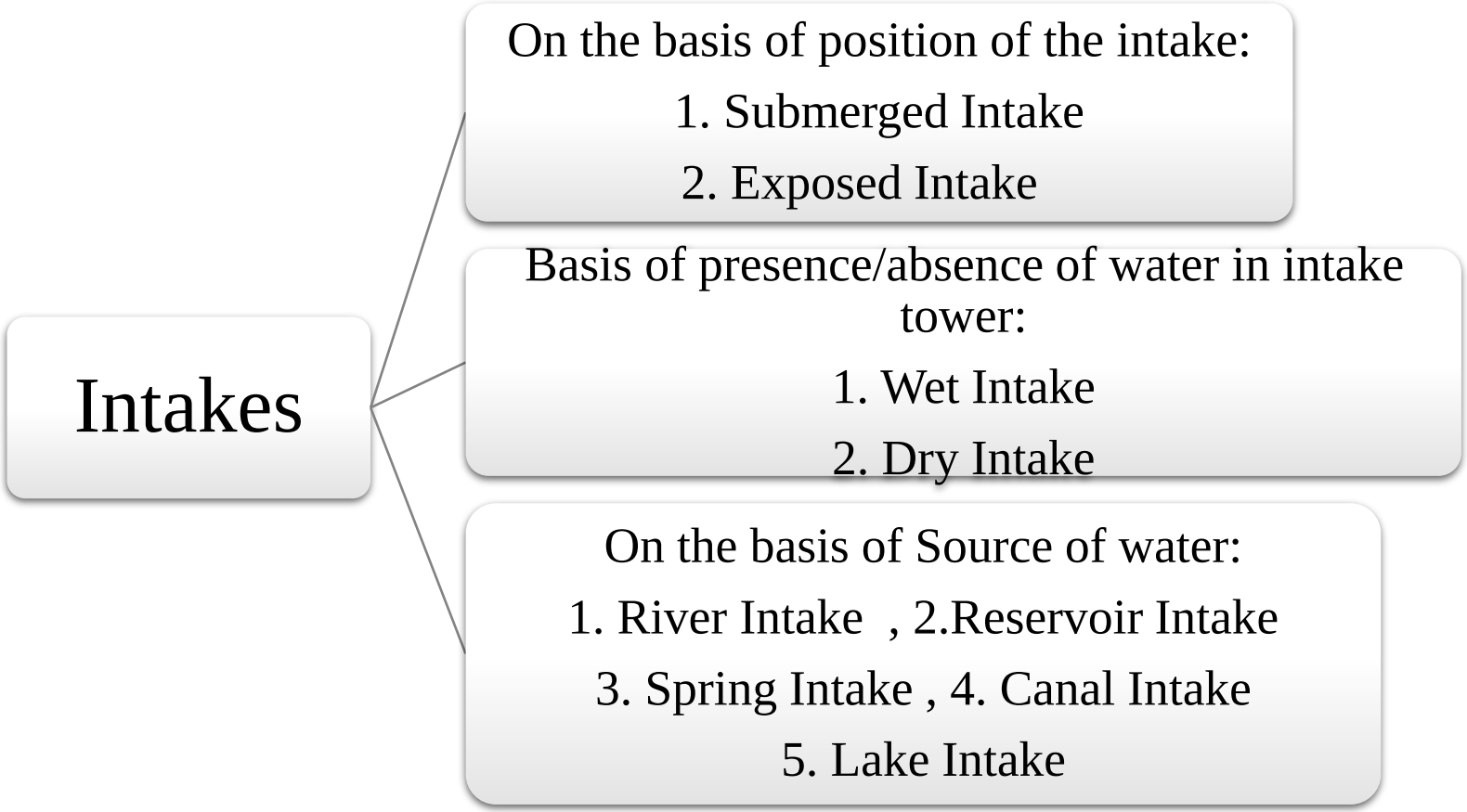
- Point of sewage disposal
- Curves and convex bank (inner bank)

Selection criteria for river intake

- It should be constructed near the treatment plant so as to reduce cost of conveying water to city.
- It should be constructed in a pure zone of water to reduce the load on a treatment plant.
- It must never be constructed near the downstream or in the vicinity of the point of disposals of wastewater.
- Intake side should remain easily accessible during flood and should not get flooded.
- It should be located at the place where it can withdraw the water even during the driest period of year.

- It should not be located on curves or at the least on sharp curves.

Classification of Intakes



Types of Intakes Based on Position

In water supply engineering, intake structures can also be classified based on their position in relation to the water surface. This classification helps in selecting the most suitable intake structure depending on water level fluctuation, safety, and ease of maintenance.

1. Submerged Intake

A submerged intake is one that is completely located below the water surface of the source (such as a river, lake, or reservoir) at all times.

Features:

- The intake opening is placed underwater, often at a certain depth to avoid floating matter and surface contamination.

- These intakes are usually connected to a pipe that leads to a treatment plant or pumping station.
- Designed with a grating or screen to block debris and aquatic life.

Suitability:

- Ideal for lakes and reservoirs where the water level remains relatively constant.
- Preferred when water needs to be collected from a specific depth to get better quality.
- Not suitable for locations with high fluctuation in water level.

Advantages:

Protected from damage by floating debris.

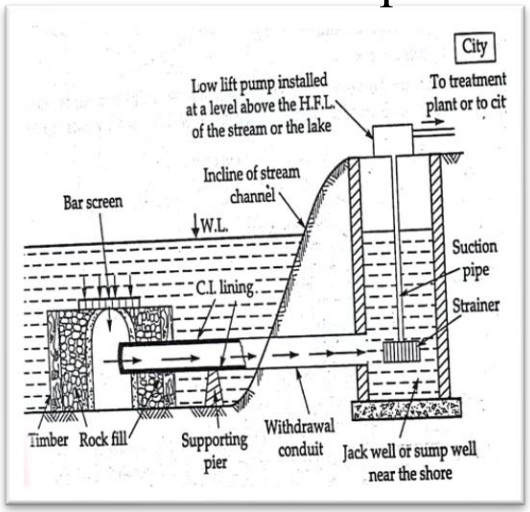


Figure:1. Rock filled Timber crib-submerged intake (www..wordpress.com, n.d.)

Less affected by surface pollution and temperature variations.

Disadvantages:

- Difficult to inspect and maintain.
- Can get clogged if not properly screened.

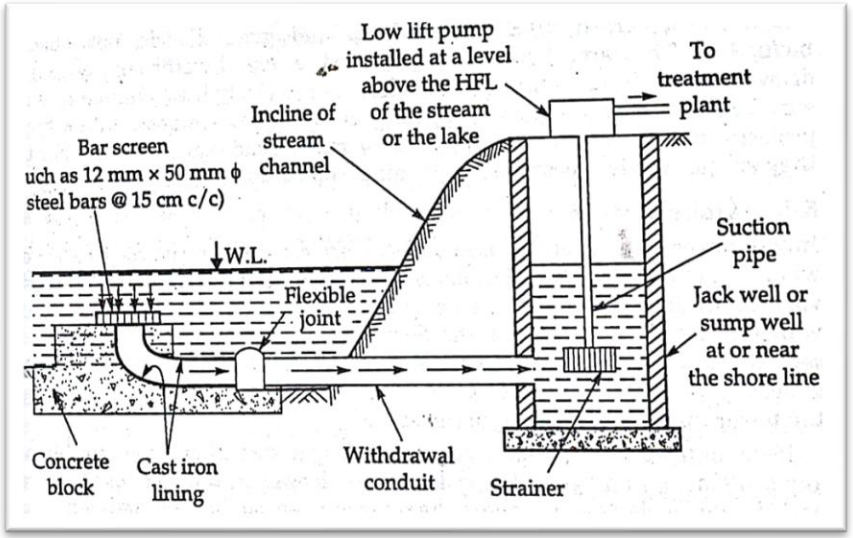


Figure 2: Fig. Simple concrete block-submerged intake

Source: (www..wordpress.com, n.d.)

2. Exposed Intake

An exposed intake (also called open or tower-type intake) is a structure that is partially or fully above the water surface, especially the operating platform or tower.

Features:

- Built on the bank or bed of the water source.
- The structure may have multiple inlets at different levels to allow intake from different water depths.
- Often provided with a platform or tower that remains above water for ease of operation and maintenance.

Suitability:

- Commonly used in rivers and reservoirs where water level varies seasonally.
- Suitable when easy access for operation and maintenance is required.

Figure 3: Exposed Intake (Source: Wikipedia, 2025)

Advantages:

- Easier to inspect, operate, and repair.
- Operator can monitor intake operation from above the water.

Disadvantages:

- More exposed to weather, floods, and vandalism.
- Needs more structural support to resist environmental forces.

Comparison Summary

Feature	**Submerged Intake**	**Exposed Intake**
Position	Always below water level	Partially or fully above water
Maintenance	Difficult	Easy and accessible
Water Quality Control	Good (less surface pollution)	Allows flexible intake depth

Suitability	Stable water bodies (lakes/reservoirs)	Variable water level (rivers/reservoirs)
Safety & Access	Less accessible	More accessible

Types of Intake Structures

Intakes can also be categorized based on how they are built and how they operate:

1. Wet Intake

The intake structure is always submerged in water. The water level inside the intake is the same as outside.

- Features:
  - Constant water availability.
  - Can be built in rivers, lakes, or reservoirs.
- Suitability:
  - Best for stable water levels.

- Suitable for permanent installations with consistent water source.

2. Dry Intake

The intake tower is constructed on the bank of a river or reservoir and remains dry, while the intake pipe or conduit is submerged.

- Features:
  - Water is drawn through the intake pipe into a dry chamber.
  - Pumps are used to lift water if needed.
- Suitability:
  - Useful when machinery needs to be protected from water.
  - Best in areas with fluctuating water levels.
  - Easier to inspect and maintain since the structure is dry.

5.4 Characteristics of intake

In a water supply system, an **intake** is the structure used to **draw water from a source** like a river, lake, or reservoir. It is the starting point of the entire water supply scheme, so it must be designed with certain key characteristics to ensure efficiency, safety, and reliability.

Main Characteristics of an Ideal Intake:

1. **Location in Clean Water Zone**

- The intake should be placed in a section of the water body where the water is **relatively clean and free from pollution**.
- It should be **away from sewage disposal points, drainage outlets**, and industrial waste.

2. **Adequate Water Depth**

- It should be situated in **deep water** so that it can draw water even during the **dry season** or periods of low flow.
- This ensures **uninterrupted supply** throughout the year.

3. **Protection from Floating and Suspended Matter**

- The intake should be equipped with **screens or grates** to stop debris, floating solids, and aquatic plants from entering the system.
- It also helps prevent damage to pumps and downstream structures.

4. **Stable and Strong Construction**

- The structure should be durable, resistant to water currents, and built with materials that withstand corrosion and erosion.
- It should not collapse or deform under pressure or during floods.

5. **Accessibility and Maintenance**

- The intake must be easily accessible for regular inspection, cleaning, and repair.
- Provisions like walkways or bridges can help workers reach the intake safely.

6. **Minimal Disturbance to Aquatic Life**

- It should be designed in such a way that it does not significantly disturb the aquatic environment or hinder fish movement.

7. **Economical and Efficient Design**

- The intake structure should be cost-effective while ensuring maximum efficiency in water collection.

8. **Prevention of Entry of Air**

- Air entering the intake pipe can cause loss of suction or damage to pumps, so the design should avoid air entrainment.

5.4.1 River intakes

- A river intake is a specially designed structure built to extract water from a river, primarily for supplying large volumes of water to sizable communities.

- It is typically constructed at locations where adequate water can still be accessed even during periods of low river flow.

- This type of intake generally includes a reinforced concrete or masonry intake tower, equipped with multiple openings known as penstocks. To help guide water from the upstream section of the river to the intake, an approach channel may also be constructed.

- Each penstock is fitted with a valve system that regulates the flow of water entering through them. These openings are positioned at various elevations to allow water collection regardless of fluctuations in river water levels.
- Water passing through the penstocks is then directed into the intake tower.
- When the intake is situated below the elevation of the area it serves, pumps are used to lift the water. Additionally, if the riverbed is soft or unstable, the intake foundation is placed slightly off the main riverbed for stability. The intake structure is designed to remain submerged below the lowest anticipated river level, and weirs or diversion channels are often constructed to ensure a continuous water supply under all flow conditions.

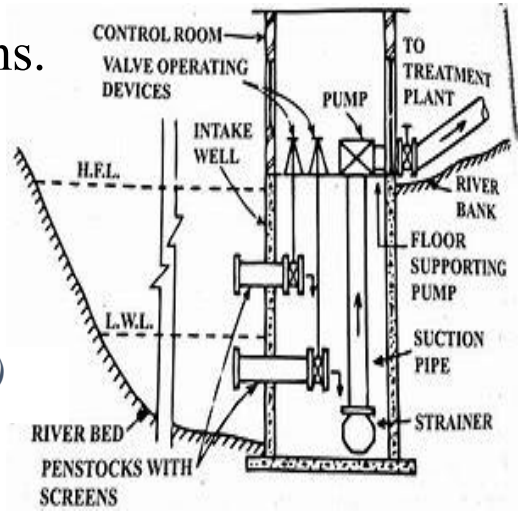


Figure 4: River intake source: (Kansakar, 2015)

5.1.2. Sources of intake

In water supply engineering, intake structures are constructed to draw water from natural water sources. These sources are mainly divided into surface water and groundwater categories. The choice of source depends on factors such as quantity, quality, and seasonal availability.

1. Rivers and Streams

- Description: Rivers and streams are natural flowing water bodies. Their flow may be perennial or seasonal.
- Intake Structure: A river intake is usually built along the riverbank or sometimes midstream, with multiple openings to manage seasonal flow and sediment levels.
- Suitability: Useful when rivers have a steady and clean flow.
- Example: Bagmati River Intake in Kathmandu Valley, Nepal.

2. Lakes and Reservoirs

- Description: Lakes and reservoirs are static water bodies; reservoirs may be created artificially using dams.
- Intake Structure: A reservoir intake typically has a tower with multiple levels to draw water from varying depths depending on quality.
- Suitability: Reliable source with consistent water supply.
- Example: Phewa Lake intake in Pokhara.

3. Canals

- Description: Canals are man-made water channels, often derived from rivers or reservoirs, mainly used for irrigation.
- Intake Structure: Includes screens, gates, and a chamber to draw water without disturbing canal flow.
- Suitability: Useful where irrigation canals run close to urban or rural settlements.

4. Springs

- Springs are natural outlets of groundwater found mainly in hilly regions.
- Intake Structure: A simple spring collection box is used to trap and store clean water before distribution.
- Suitability: Ideal for small communities in mountainous terrain.

(Punmia et al., 2016, p. 203)

5. Wells and Tube Wells

- These are groundwater sources accessed by digging or boring into aquifers.
- Intake Structure: Includes a casing pipe, strainer, and pump to extract and transport water.
- Suitability: Highly reliable where groundwater is abundant and of good quality.

River

Lake

Canal

Reservoir

5.4.2 Reservoir intake

- In an earthen dam reservoir, intake structures are used to draw water. A typical intake consists of a tower built on the dam's slope, positioned to access enough water even during dry periods.
- Intake pipes are placed at various levels to ensure water can be drawn regardless of changing water levels. These pipes connect to a central vertical pipe inside the intake tower.
- Screens are fitted at each pipe inlet to block floating and suspended debris. The collected water flows through the vertical pipe and is carried to the other side of the dam via an outlet pipe.

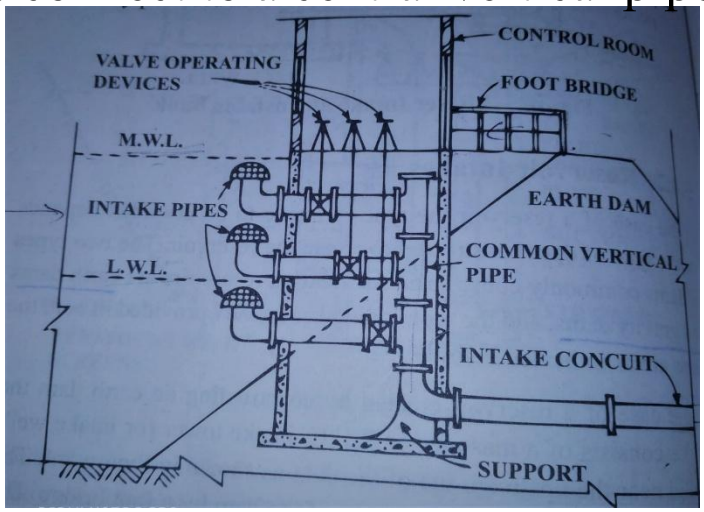


Figure 5:Reservour intake (Kansakar, 2015)

- Sluice valves are installed at the top of the intake tower to control water flow.
- Entry of water is through a single port and an intake well is provided in the main body of the dam.
- Water is withdrawn from the reservoir through the outlets and sluiceways.
- To control the flow of water through the outlets gates and valves are used.

5.4.3 Spring intake

- Spring intakes are provided to abstract water from a spring source.
- Intakes protect water from getting contaminated.
- Water outlet points should be identified properly before construction of intake.

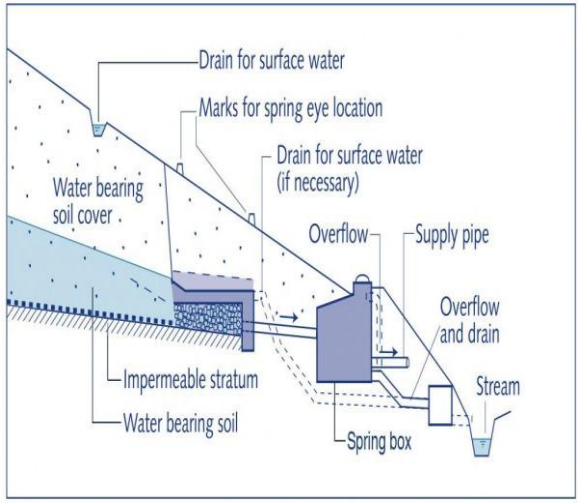


Figure 6: Spring intake (Source: https://sswm.info)

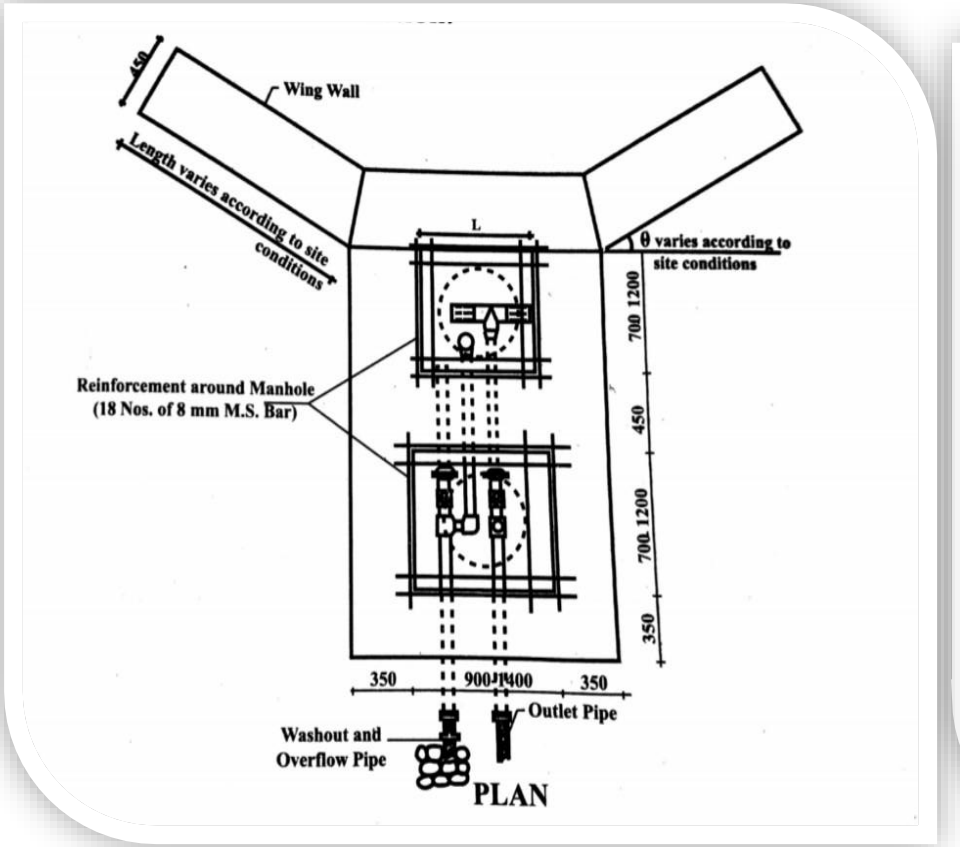


Figure 7: Spring intake (Plan view) (Kansakar, 2015)

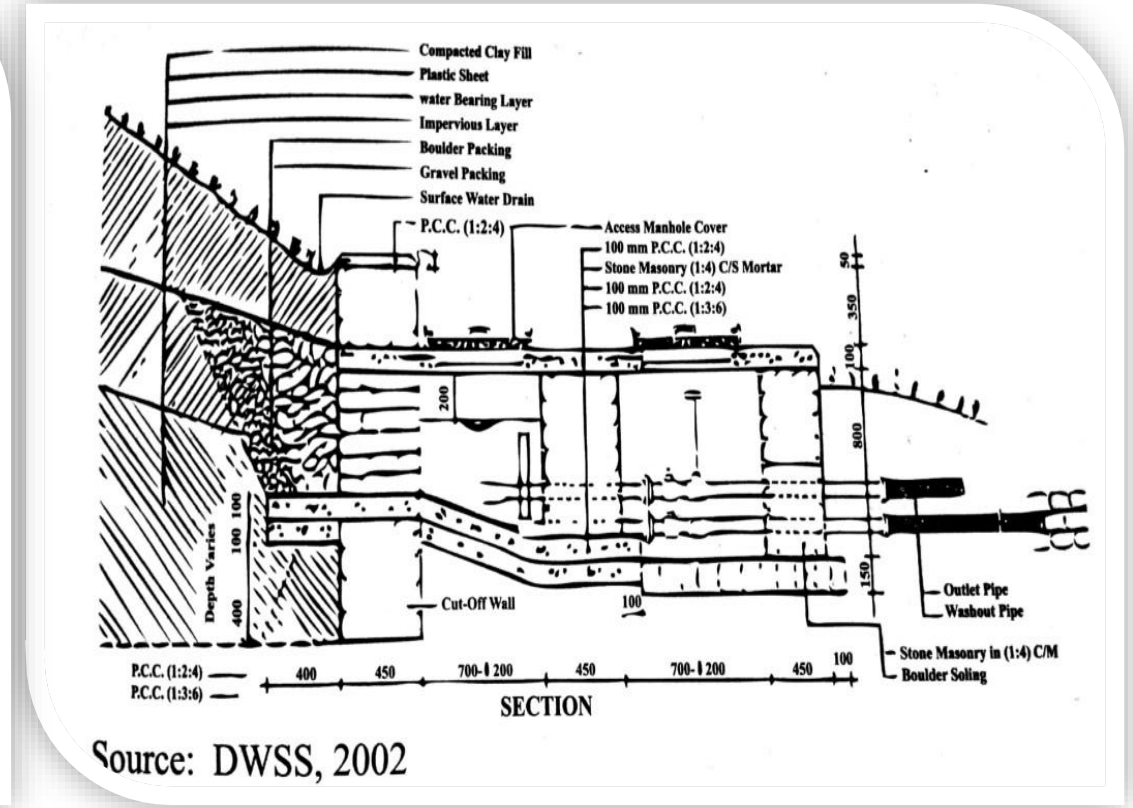


Figure 8: Spring Intake (Section View)

Spring intake generally consists of two chambers:

1. Collection Chamber

- The base is constructed using plain cement concrete to prevent any leakage. The walls surrounding the structure are built with stone masonry. To minimize the risk of settlement, a lightweight structural design is adopted.

- Wing walls are constructed on both sides of the intake to guide water from the natural source into the collection chamber. This chamber also functions as a sedimentation basin, helping to settle out suspended solids and reduce turbidity.

- To prevent coarse particles from entering the collection chamber, gravel packing is placed in the water-bearing layer upstream. This filtration layer helps maintain the quality of water entering the system.

- An overflow pipe is installed to avoid the reverse flow of water back toward the spring source, ensuring unidirectional movement.

- The outlet pipe, equipped with screening elements, is positioned approximately 10 to 15 cm above the chamber floor. This elevation helps in preventing the entry of settled solids into the transmission mains of the water supply system.

2.Valve chamber

- Valves are installed on both the outlet and washout pipes for operational control. Typically, the outlet valve remains open to allow continuous water flow, while the washout valve stays closed during normal conditions. The washout valve is only opened when it is necessary to flush out sediment that has settled within the collection chamber.

- Sufficient working space is essential around the chamber to ensure ease of access during inspections, repairs, and maintenance activities.

- A vent pipe is connected to the outlet line to release any trapped air, preventing pressure build-up within the system.

- To protect the collection and valve chambers, covers made from materials such as mild steel, reinforced concrete, or stone masonry are used, ensuring durability and safety.

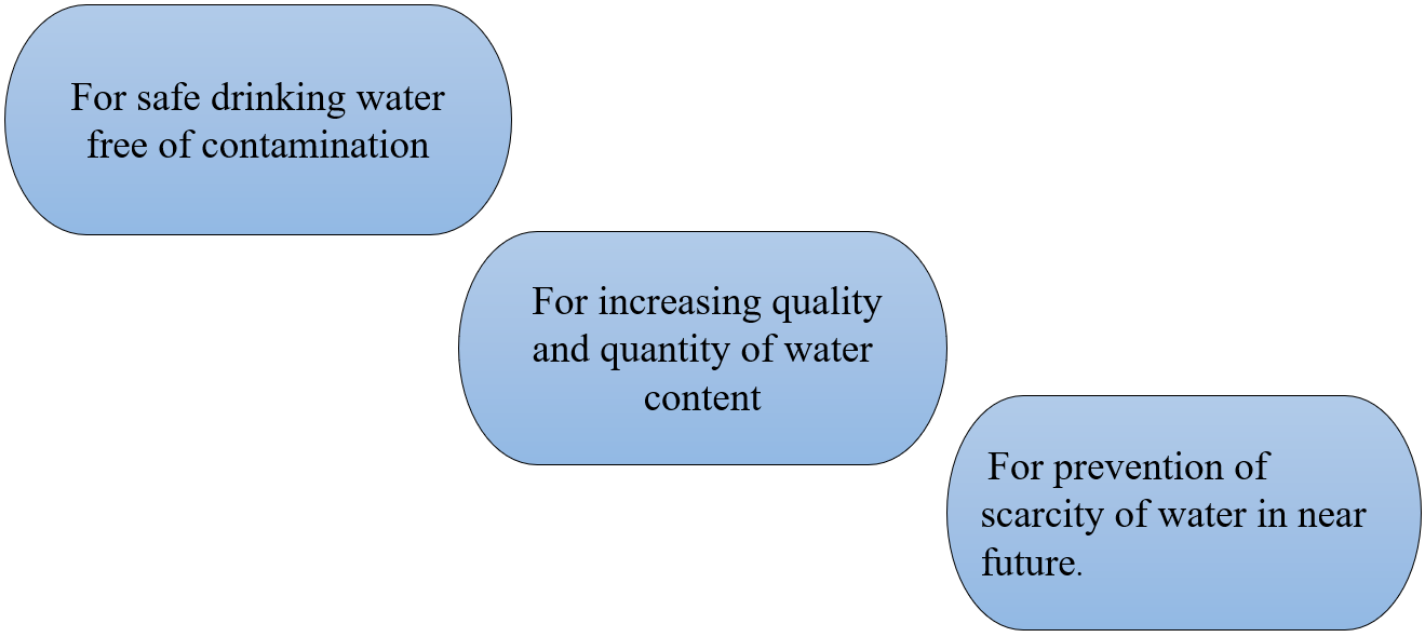
Site selection for the construction of spring intake

- The place should be close to the source.
- Should be above populated or farming areas.
- Should be above foot path, cattle watering and washing places.

- ❖Where surface water run-off during the monsoon can be easily drained off.
- ❖Location where terrain does not allow water logging.
- ❖Where the immediate surrounding above the spring is not easily accessible to people and livestock.

5.5. Protection of Spring Intake

Spring intakes should be protected because:



Elements for protection of spring intake

- Afforestation
- Plantation of Bush
- Surface water drain
- Barbed wire fence
- Concrete Cover
- Retaining structures
- Barbed wire fence

Afforestation

- Trees are planted above the spring so that rainwater is seeped(infiltrated) into the ground rather than surface run off, which eventually increases the capacity of spring.

Figure 9: Plantation (©Sunil Rakhal,2023)

Plantation of Bushes

- allow the water to seep and prevent the surface erosion and decrease run off.

Surface water drain

Figure 10:Surface water drain(©sunil Rakhal,2021)

- Surface water drain should be 8m above and around the spring to drain the surface water run off during monsoon.
- The ditch should be deep, and can be lined with dry stone masonry.

Concrete cover

- The catchment of a spring source can be roofed over with concrete slab and buried for further protection.
- concrete cover prevents the water from contamination.
- Provides intake further rigidity.

Figure 11:Concrete cover (© Sunil Rakhal,2024)

Retaining walls

- Retaining walls of gabion or dry-stone masonry are built to stabilize land around the intake.

Figure 12: Retaining Wall (©Sunil Rakhal,2024)

Barbed wire fence

- There should be no habitant and easy access to animals around springs up to a distance of 30 m to 90 m to avoid contamination.

- To prevent trespassing of humans and grazing animals and contamination of the spring water, barbed wire fencing at a 5 m distance from spring intake.

Figure 13: Barbed wire fence (©Sunil Rakhal,2024)

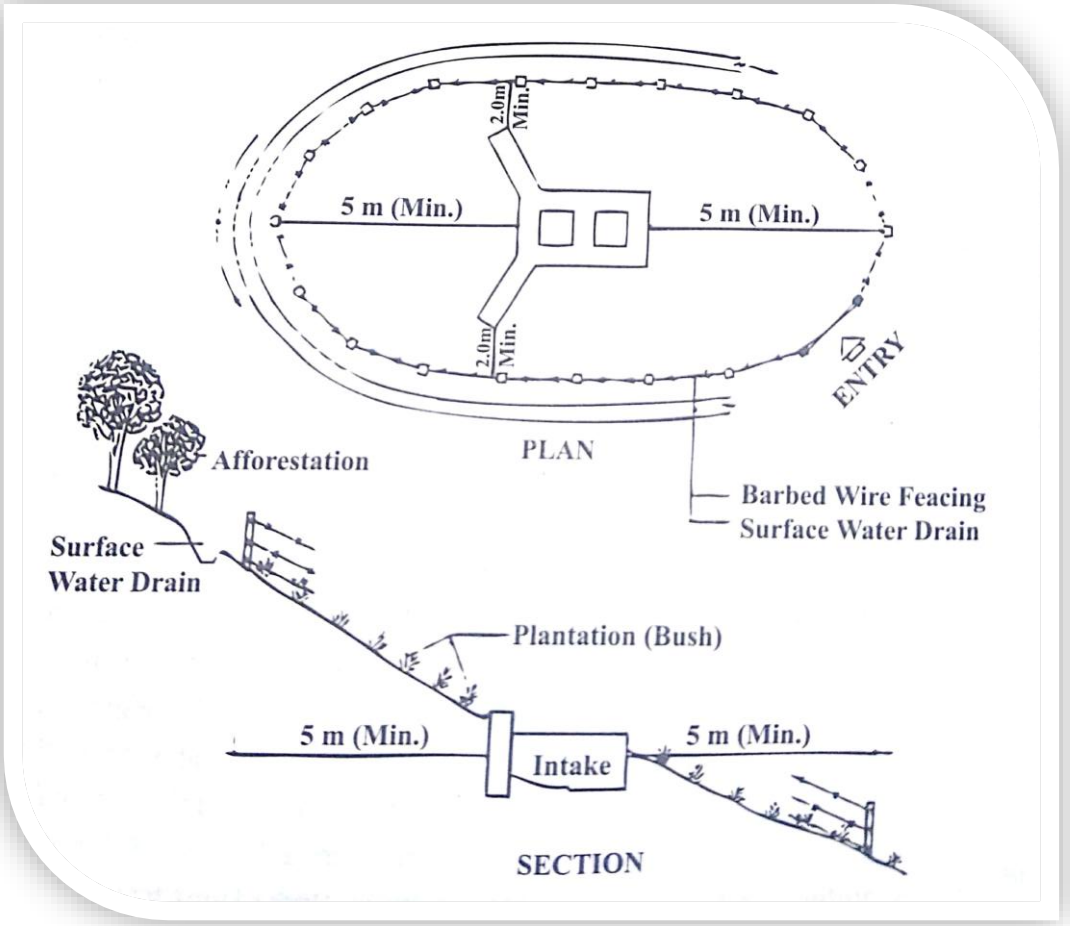


Figure 14: Spring intake protection measures (Source: (Kansakar, 2015)

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Thank You!!!