

## Chapter 2

# Water intake to a field

In an irrigation scheme, water is taken from a water source, passes through a network of irrigation canals and is delivered to the farmers' fields. The entrance of water from the field channel to the farmer's field is called the field intake or the farm turnout. This chapter describes different types of field intake structures and discusses how they are matched to local conditions.

### 2.1 METHODS OF WATER INTAKE

The next four figures present four common methods of water intake from a field channel, with illustrations of a breach, a gated intake, syphons and spiles.

A breach is a temporary opening in the embankment of the field channel, made by a farmer whose field is to be irrigated (Figure 2). This method of water intake involves no capital cost, but it has disadvantages:

- frequent opening and closing of breaches weakens the embankment;
- opening and closing a breach changes the cross-sectional shape of the field channel; and
- there is no discharge control.

A gated intake structure is made of wood, masonry or concrete, and is equipped with a gate (Figure 2). Such a structure enables the farmer to control the water inflow, but, in comparison with a breach, it is expensive.

A spile is a short pipe, commonly made of a hard plastic such as PVC, but clay pipes are also used. The pipes are buried in the canal embankment (Figure 3). Good water intake control can be obtained either by adjusting the water level in the field channel, by use

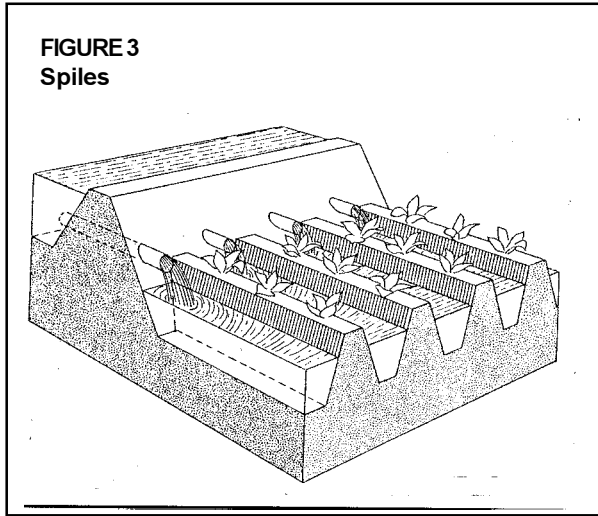
**FIGURE 2**  
**A breach**



of a water-level regulator, until it is above or below the opening of the spiles, or by closing off individual spiles with a plug or lid, or by a combination of the two methods. Disadvantages are that spiles can become blocked with mud or plant debris, and that the pipes can be expensive.

A syphon is a curved pipe, often made of a plastic such as PVC. The pipe is filled with water and laid over the channel bank at every irrigation (Figure 5). Good water flow control is possible by changing the number of syphons, the diameter of the syphons, or both. Their disadvantage is the price of the pipes. Also, for efficient operation, the water level in the field channel needs to be some 10 cm above the field.

**FIGURE 3**  
**Spiles**



**FIGURE 4**  
**A gated intake**



**FIGURE 5**  
**Syphons**



A fifth method of water intake to field is by pumping. Because of the high costs - capital costs for the equipment as well as operating costs - this is only justified if the water level in the field channel is lower than the level of the field to be irrigated. In order to allow efficient operation of the pump, the water depth and discharge in the field channel must be comparatively large + much larger than is required for the other four methods. For an illustration of pumping see Figure 10.

The choice of water intake method depends on local conditions. The factors that have to be considered include:

- the water level in the field channel;
- discharge control;
- the irrigation method(s) to be used;
- the scheduling of irrigation (duration of water delivery; whether continuous or rotational supply); and
- the location of the farmer's field in the canal system (upper or lower end).

## 2.2 SELECTION OF A METHOD

Which method to use depends on the local circumstances. The advantages and disadvantages of the different methods are considered here in relation to the factors that influence the decision, as listed above.

- **The water level in the field channel**

When the water level in the field channel is only slightly higher than the level of the field, say 5 cm or less, a gated intake of the type illustrated in Figure 4 is a good choice. Breaches are also used in these cases. If the difference in water level is small, either a large opening through which water is delivered or a long time of delivery is needed in order to get the required volume of water into the field.

When the difference in level between the water in the field channel and the field level is small, it is rather difficult to get syphons started, see Figure A-1.1-E in Annex 1.

Where the water level difference is large, say more than 15 cm, the use of a breach is **not** recommended, as the flow through a breach will be strong and will quickly erode the bank of the channel.

- **Discharge control**

Not only the difference between the water level in the field channel and the field level, but also the size of the intake opening determines the flow that enters the field: the larger the opening, the larger the flow.

In the case of breaches, control is almost impossible.

Control is good when gated intake structures are used, and also when syphons or spiles are used. When syphons or spiles are used, their number can be adjusted or different diameters used according to the discharge required.

- **Irrigation method**

The mode of water intake should match the irrigation method - whether basin, border or furrow.

For border or basin irrigation, the water can enter the field at one point. Furrow irrigation requires more delivery points, as each furrow should have its own delivery point. This means that border and basin irrigation can be practised by using breach or gate intakes, while furrow irrigation needs the use of spiles or syphons.

- **Irrigation schedule**

Two factors are important when considering the influence of the irrigation schedule on the choice of intake method: what is the duration and frequency of water supply to the field, and is only one field supplied or are two or more supplied simultaneously?

If the duration of water delivery to a field is short, then the use of a gated intake is the most practical because it can be opened and closed easily as many times as needed.

The opening and closing of a breach in a canal embankment will take some time, and, when a canal bank is opened and closed frequently, the cross-section of the field channel will be eventually become badly degraded.

For effective use of syphons, the duration of water delivery should be long in relation to the time it takes to get them all started.

For furrow irrigation, the use of spiles should be considered when the duration of water delivery is short.

When several farmers are taking water at the same time, each should have an equal share. The use of breaches in such a case is bad, since the discharges are not easy to control. The same applies to gated intake structures because, although gates may be equal in size, the water level in the channel in relation to the respective field levels may not be the same. To ensure equal water intake, syphons or spiles are recommended because the total discharge is determined by the number and diameter of tubes, and so is easier to control than when breaches or gated intakes are used.

- **Field location**

If the field to be irrigated is situated in the upper part of a channel, then the use of a breach should be avoided, because breaches can seriously damage the shape of a channel and thus affect the delivery of water to farmers downstream. When a large opening is needed, a gated intake is much more practical.

## 2.3 DISCHARGE

The volume of water that enters a field each second + the discharge + depends on the area of the opening through which water enters the field, and the difference in water level between the channel and the field. The larger the area of the opening, the larger will be the flow, and the greater the difference in water levels, the more the flow.

In most cases it is possible to control the flow by manipulating the water level in the field channel. This can be done by using check structures, as will be described in Chapter 3. The higher the water level is in the field channel, the greater will be the discharge. To reduce the discharge into the field, the water level in the field channel should be lowered.

Discharges through breaches or gated intakes may vary from 10 to 30 l/s. Discharge through a single syphon or spile is generally between 0.5 and 2-to-3 l/s. A method to determine the discharge through a field intake is given in Annex 1.

The discharges through water intakes are usually adapted to local circumstances by experience. Elements that play an important role in determining suitable discharges are

- the method of irrigation chosen, influenced by soil type, field slope, the size and area of the field, etc. (see Manual 5: *Irrigation Methods*);
- availability of water;
- the type of crop; and
- its stage of growth.

The table below summarizes the operational activities involved, problems, and quality of discharge regulation of the various options for water intake to the field.

	<b>Breach</b>	<b>Gated intake</b>	<b>Syphon</b>	<b>Spile</b>
<b>Operational activity</b>	<b>Opening and closing</b>	<b>Gate setting</b>	<b>Starting</b>	<b>None or opening</b>
<b>Problems</b>	<b>Bank erosion Channel damage Poor control</b>	<b>Cost</b>	<b>Head loss in the syphon (high water level required in the channel)</b>	<b>Blocked openings</b>
<b>Discharge regulation</b>	<b>Possible, but very rough</b>	<b>By manipulating the gate</b>	<b>By number and diameter</b>	<b>By number and diameter</b>



## Chapter 3

# Water level in field channels

The rate of the flow through water intakes, whether breaches in the field channel bank, gated intakes, syphons or spiles, is determined by the area of the opening of the inlet and by the difference between the water levels either side of the water intake.

The opening of the intake can be adapted to supply the discharge required: breaches can be made smaller or larger; gates can be opened partly or fully; and the number of syphons or spiles and their diameter can be reduced or increased.

The difference in water level between the channel and the field also affects the flow rate through the field intake, and can also be adapted to meet the need of water intake. Chapter 3 discusses this subject.

### 3.1 WATER LEVEL AND INTAKE DEVICE

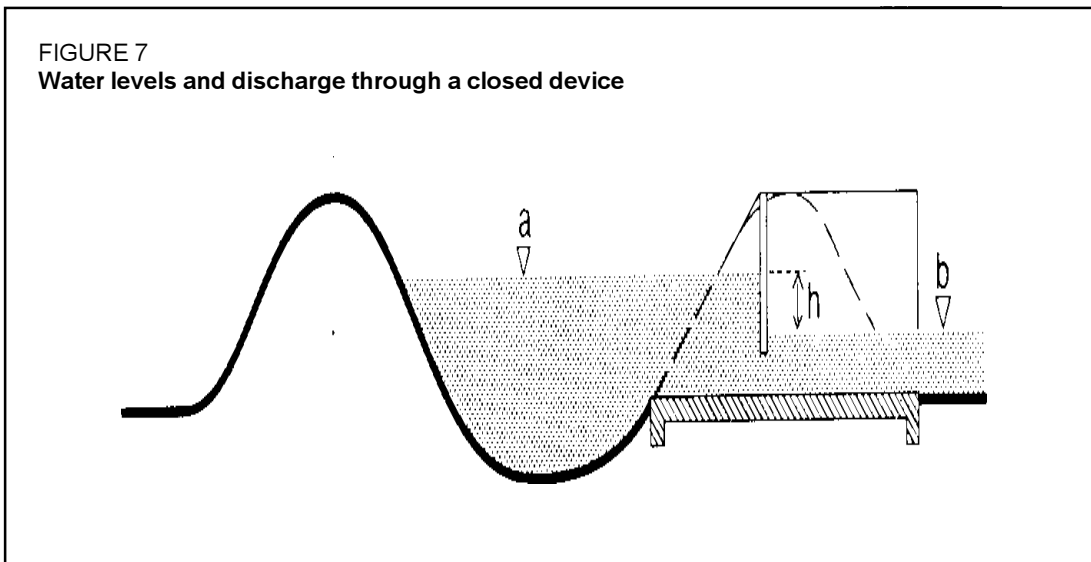
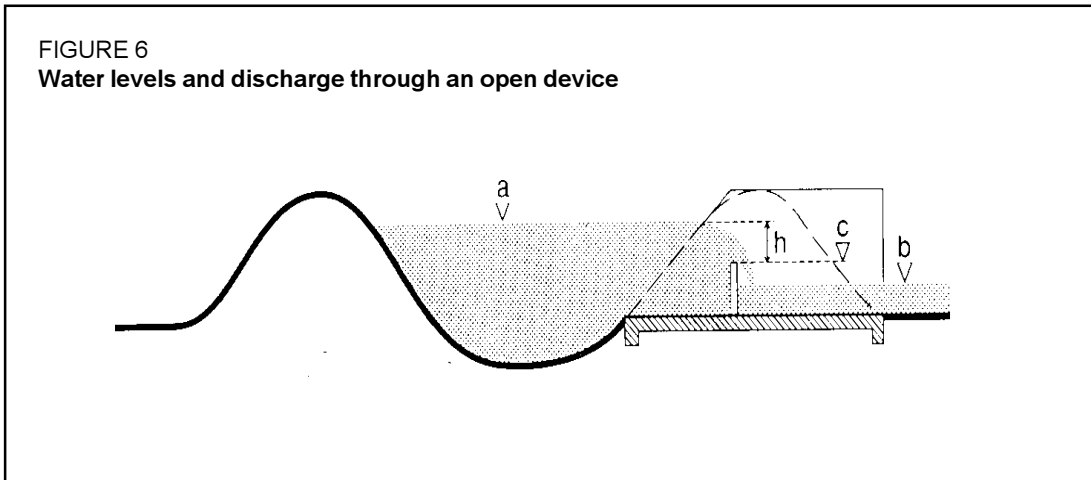
The effect of the water level difference on the discharge through a particular intake varies according to the type of intake used. When an open type of intake is used, then the upstream water level has a far greater influence on the discharge than when a so-called closed type is used.

Typical open-type devices are, for example, breaches, or an intake structure equipped with flash boards, as shown in Figures 2 and 4. In an open-type intake, water that enters the field stays in contact with the air, and one can see water flowing through the opening.

A closed-type device is a syphon, a spile or a structure equipped with a gated opening under the water surface. See Figures 3 and 5 for examples of closed devices. In a closed device water flows through an opening which is situated under the water surface, and which thus cannot be seen, and the water flow is not in direct contact with the open air.

Figures 6 and 7 present cross-sections of intake devices. In both cases the channel is on the left and the field on the right-hand side. Figure 6 is of an open device, a weir in this case, and Figure 7 shows a closed device, an intake structure with the opening below the water surface in the field channel.

The water level downstream of the intake device is determined by the topography of the field and by the irrigation method: border, basin or furrow irrigation, which means that this level is more or less fixed.



The upstream water level is marked 'a' and the downstream level is marked 'b' in both Figure 6 and Figure 7. The level of the crest of the weir in the open device is marked 'c'.

The difference in water levels + known as the hydraulic head + is expressed as 'h', where  $h = a - c$  for the open device, and  $h = a - b$  for the closed device. If  $h$  increases, then the discharge through the device will increase. For open types (Figure 6), one can say that if  $h$  increases by 10%, the discharge increases by some 15%. For closed types (Figure 7), if  $h$  increases by 10% the discharge will increase by only 5%. Thus the variation in discharge is larger with open devices than with closed devices.

### 3.2 WATER LEVEL CONTROL

If the discharge through a field intake is too low to satisfy the farmer's needs, he or she can either enlarge the opening of the intake, or raise the water level upstream of the intake, according to local conditions. When a concrete or masonry structure is used for an intake device, the opening cannot be enlarged. In this case another, larger structure should be constructed. When



FIGURE 8  
A series of permanent check structures

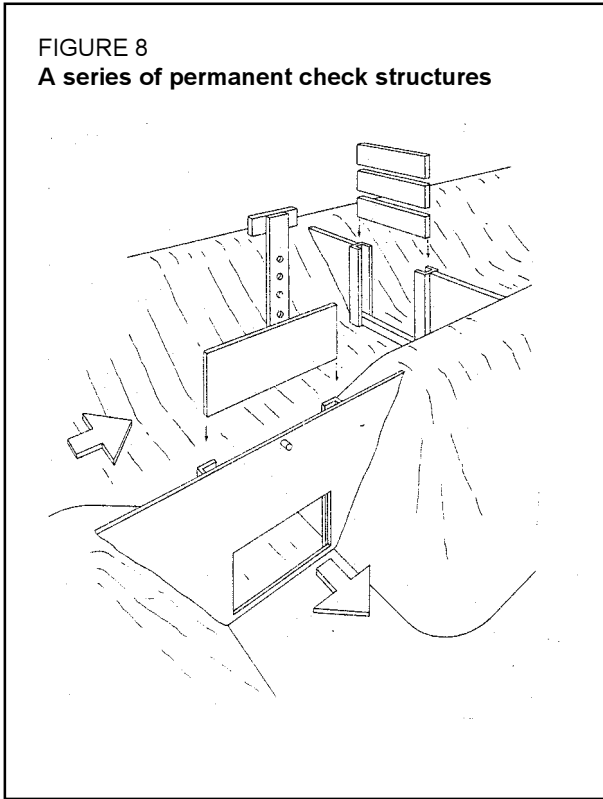


FIGURE 9  
A series of permanent check structures



a breach is used, the opening can be enlarged by excavating more out of the canal embankment. To obtain a higher total discharge using spiles or syphons, the number must be increased or larger diameter pipes used.

In most cases, however, the water level in the field channel is raised to increase the flow through an intake. By how much the level can rise depends on the circumstances: if the water level has already reached the freeboard level, a further rise is dangerous and must be avoided. See also Chapter 4 of Manual 7, *Canals*. If the water has not yet reached the maximum level possible in the channel, the level could be raised by using a so-called 'check structure'.

A check structure obstructs the flow in the canal and consequently the water level will rise. These check structures can be permanent or they can be temporary. See Figures 8 to 11 for some examples.

The check structures shown in Figure 8 and Figure 9 are permanent. The check shown in Figure 8 controls the water level for the field intake that is a short distance upstream of the check. The checks in Figure 9 can be closed with flash boards, as shown in the drawing in Figure 8, to allow the use of syphons in the canal sections in between the checks.

Figure 10 and Figure 11 show two transportable check structures. The one in Figure 10 consists of a wooden board that is installed in a trapezoidal, lined canal. The water level here is raised to enable the engine to pump. The transportable check in Figure 11 is made from jute and easily installed. Other materials, such as cloth

or plastic sheeting, can be used as transportable checks. In small canals, the use of sandbags is also a well-known method for raising the water level.

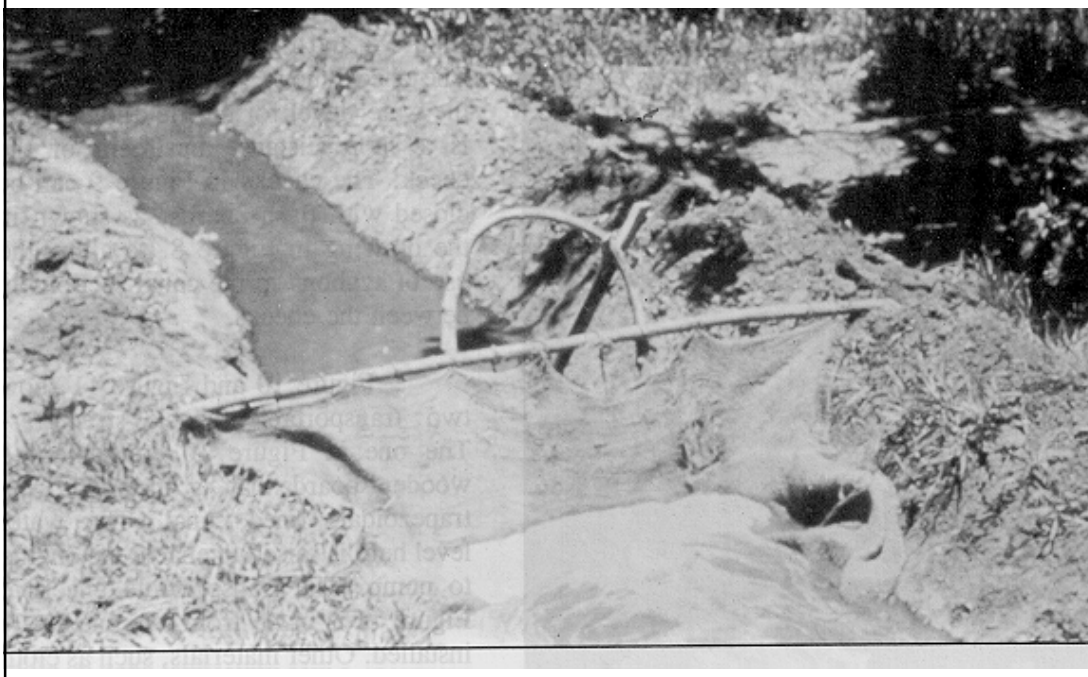
The decision to choose permanent, temporary or transportable check structures depends on local conditions. Typical questions that should be asked include:

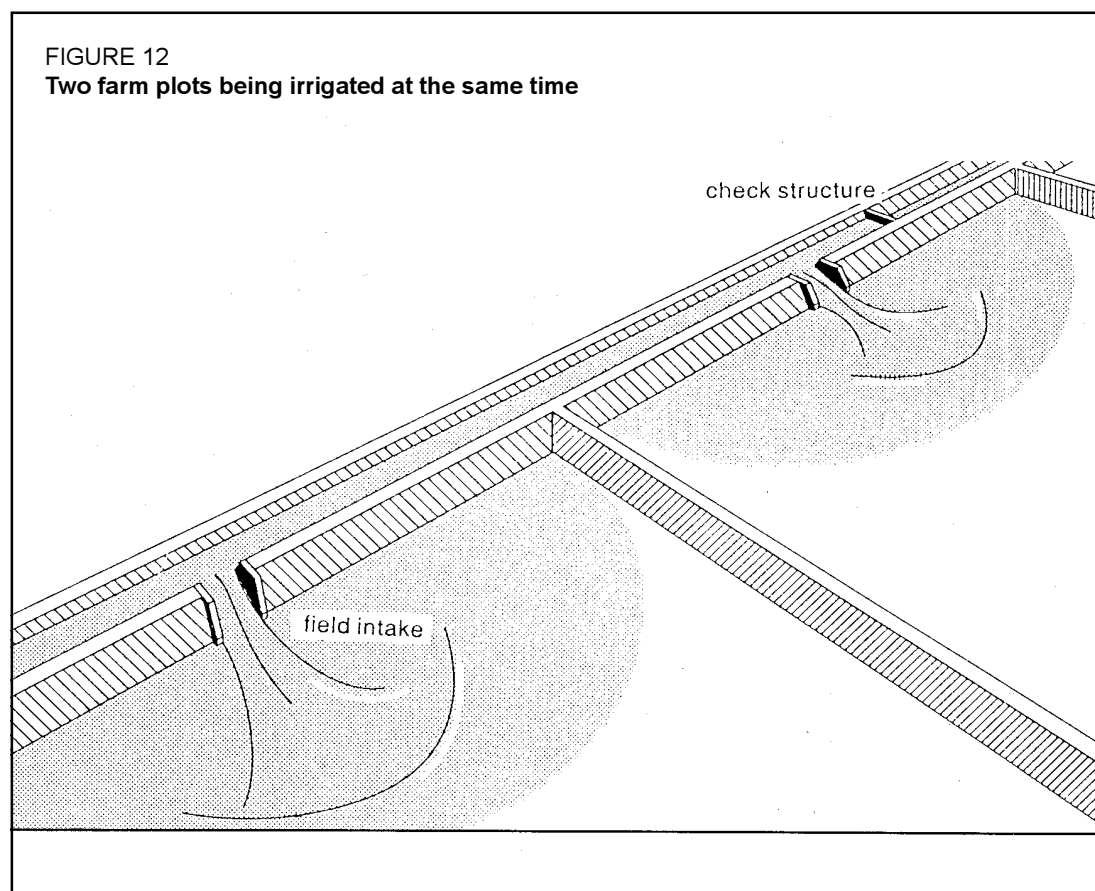
- What will be the function of the check?
- Should the water level rise be a few centimetres or some 10 to 20 cm?
- Is the field channel, in which the check structure is to be installed, a lined or an unlined canal?
- Is the check needed regularly? and
- Is the place of installation fixed?

FIGURE 10  
A transportable check structure (wooden board)



FIGURE 11  
A temporary check structure (cloth)





### 3.3 THE USE OF CHECKS

When flashboards in a check structure are down, when gates are closed or when transportable checks are installed, the water level upstream of the structure concerned will rise. This higher water level allows higher flow rates through field intake structures or spiles or it allows the use of syphons. As a result, the discharge in the field channel downstream of the check is seriously reduced or may even become zero.

Water in a field channel is most commonly distributed among the farmers in rotation. Check structures can be very useful, because the farmer whose turn it is can be given the full channel discharge. The discharge downstream of the check in such cases can be zero.

When the discharge in a field channel is large, several farm plots can be irrigated simultaneously (See 12).

For example, a discharge of 60 l/s can be shared by two farmers, each receiving 30 l/s, by using a check structure and maintaining the water level.

However, control of the water level and hence the flow into fields will be more difficult as the number of farmers irrigating at the same time increases.

### 3.4 SUMMARY

The table below presents a summary comparison between fixed and transportable checks with reference to the operational activities involved, water level rise obtained, and problems associated with particular check structures.

	Transportable checks	Fixed checks
Operational activities	Installed each time	Gate setting
Water level rise	5 to 10 cm	10 to 20 cm
Problems	Leakage	Erosion downstream