# Inlet and Drainage Wells

## Introduction

This sheet presents the use of inlet wells for improving surface drainage and reducing erosion problems in fields. The information in this sheet provides instructions on how to install appropriate structures in simple cases. The sizing of inlet wells is the subject of a separate sheet.

Inlet well Source : Mikael Guillou (MAPAQ)

Drainage well Source : Mikael Guillou (MAPAQ)

## Definition

Inlet and drainage wells are surface drainage structures that remove surface runoff through underground piping. Inlet wells have higher inlets that allow flow control that promotes the sedimentation of the soil particles in the surface runoff before the runoff is removed (Figure 1). Drainage wells are characterized by a direct, unrestricted water inlet that is located at ground level, as well as large-diameter piping (Figure 2). Commercial inlet wells are generally made of PVC (Hickenbottom-type orange inlet wells), but homemade inlet wells are also possible. Most of the time, drainage wells are constructed of smooth, double-walled high-density polyethylene (HDPE) piping that has a smooth interior or of concrete pipes.

## When can these structures be useful?

- **Poor drainage of depressions**

An inlet well allows water to be drained from depressions that are too large to be filled in.

- Maximum area of the depression to be drained: 20 ha (inlet wells)
- For drainage of an area of less than 0.5 ha, an infiltration well or a permeable trench can also be used.
- Drainage wells have a high drainage capacity and are good when there are large areas to be drained. However, drainage wells are generally not as effective as inlet wells in terms of the sedimentation of eroded soil particles. Consequently, this solution is not very appropriate where erosion is a problem. The use of drainage wells will not be presented in this sheet.

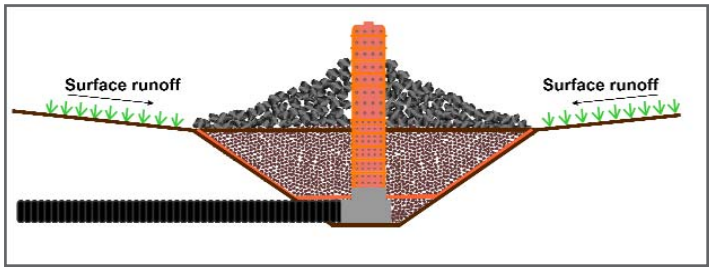


**Figure 1.** Inlet well

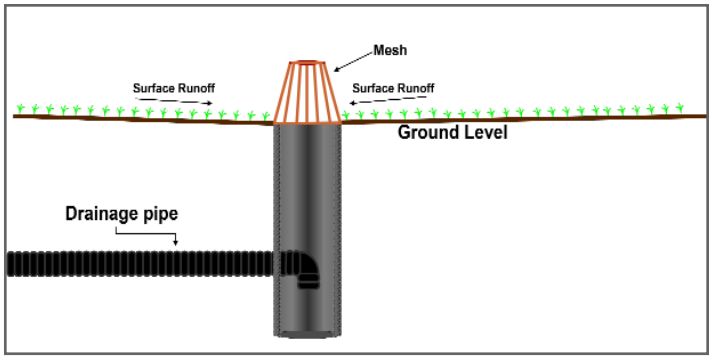


**Figure 2.** Drainage well

- **Erosion at confluences**

A drainage ditch with a rip-rapped spillway can generally replace a traditional confluence.

Drainage ditch — Source : Richard Lauzier (MAPAQ)

- **Field gullying or bank gullying**

A structure with an inlet well and berm can be installed to stop surface runoff and drain it through underground piping.

Inlet well with berm — Source: Georges Lamarre (MAPAQ)

**NOTE**

When the flow or volume of runoff is significant, a drainage specialist should install inlet wells. It is also recommended that a drainage specialist be used for setting up installations with a retention pond, because of the possible consequences of berm failure. The construction of retention ponds is not covered in this sheet.

**WARNING**

Inlet wells, infiltration wells and permeable trenches are preferred means of draining areas between fields and watercourses. Surface runoff drained using these structures is less filtered than water that enters drains after filtering through the soil profile or that runs through abundant vegetation cover. This lower level of filtration increases the risk of surface water contamination by soil particles, nutrients (phosphorus, nitrogen, etc.), pesticides and agricultural microorganisms. Consequently, these structures must be used wisely and, when they are installed, be accompanied by preventive measures, such as balanced fertilization, limited pesticide use and, ideally, the creation around the structures of a buffer zone where the soil is not worked and no fertilizers or pesticides are applied.

## How to determine where to place inlet wells

- **Poor drainage of depressions**

Inlet wells must be installed at the lowest point of depressions. If necessary, levelling work could be done to move this point slightly (e.g. towards a furrow) in order to make it easier for the machinery to get through. In some cases, it might also be a good idea to steepen the slopes to concentrate the surface runoff at the bottom of the depression.

- **Erosion at confluences**

The drainage ditches are generally installed between 6 and 30 m upstream from the junction between ditches or furrows and watercourses. This distance is determined based on the width of the buffer strip desired and the width needed to allow machinery to get through. In ditches with a steep slope, it is possible to install several drainage ditches in a row.

- **Field gullying**

To maximize the efficiency of inlet wells, the wells must be constructed—along with a retention pond—upstream from gullying zones.

- **Gullying of watercourse banks**

Inlet wells are placed along the bank, in line with the gullying points. A berm must be installed to hold back the surface runoff and protect the bank. This solution is generally used when the slope and height of the banks are significant.

## Sizing

The sizing of inlet wells depends on a series of factors pertaining to the drainage basin, climate, crops, and soil and water conservation objectives. Details on the sizing of inlet wells are presented in a separate sheet ("Calculating Sizing Inlet Wells").

## Installing inlet wells

It is recommended that inlet wells be equipped with piping and an outlet that are separate from the existing drainage network. The sometimes significant quantity of sediment drained by inlet wells and the often low slope of existing underground drains can cause sedimentation problems and the partial or complete blocking of drainage pipes.

In cases where this option is not viable, an inlet well can be installed on a short section of drain that is connected to an existing drain with a T-junction. It is then necessary to ensure that the capacity of the existing network is sufficient to drain the additional flow from the inlet well. The installation of an inlet well directly above an existing drain should be avoided.

### Installing separate conduits and a separate outlet

Figure 3 summarizes all the steps described in the following paragraphs.

**1) Choosing the location for the inlet well**
The placement of inlet wells was presented in the previous section.

**2) Choosing the location for the drain outlet**
The drain outlet must be located a minimum of 15 to 30 cm above the normal water level in the outlet.

The drain must always be covered by a layer of soil that is thick enough to reduce the risks related to freezing and the movement of machinery. The minimum recommended thickness is 80 cm for smooth-interior, double-walled drains and 90 cm for single-walled corrugated pipes.

**3) Having a land survey done to establish relative elevations and land slope**

Based on the inlet and outlet points and a precise surveying report, it is possible to establish the slope of the underground conduit.

Because of the quantity of soil particles present in the water drained by inlet wells, the minimum recommended slope for inlet well drains is 0.15%.

Perforated drains are used if the slope is less than the maximum slope indicated in Table 1. If the slope is too steep, a non-perforated pipe will be used to avoid surface runoff and erosion outside the drain.

**Table 1:** Limits for using perforated drains—maximum slope for the collectors

| Drain Diameter | Maximum Slope for Collectors (%) | | |
|---|---|---|---|
| (mm) | Sand | Loam | Clay |
| 100 | 4,8 | 10,1 | 17,4 |
| 150 | 2,8 | 5,9 | 10,2 |
| 200 | 2,1 | 4,5 | 7,8 |
| 250 | 2,0 | 4,1 | 7,1 |
| 300 | 1,5 | 3,2 | 5,6 |

Source: CRAAQ (2005)

**4) Choosing the appropriate machinery**

The drains can be installed using a mole plough, a hydraulic shovel or a backhoe. The mole plough is both more precise and quicker than the hydraulic shovel, but it may be difficult to hire a drainage contractor for small work such as installing an inlet well. The use of a backhoe is limited to cases where the length and diameter of the drain are small.

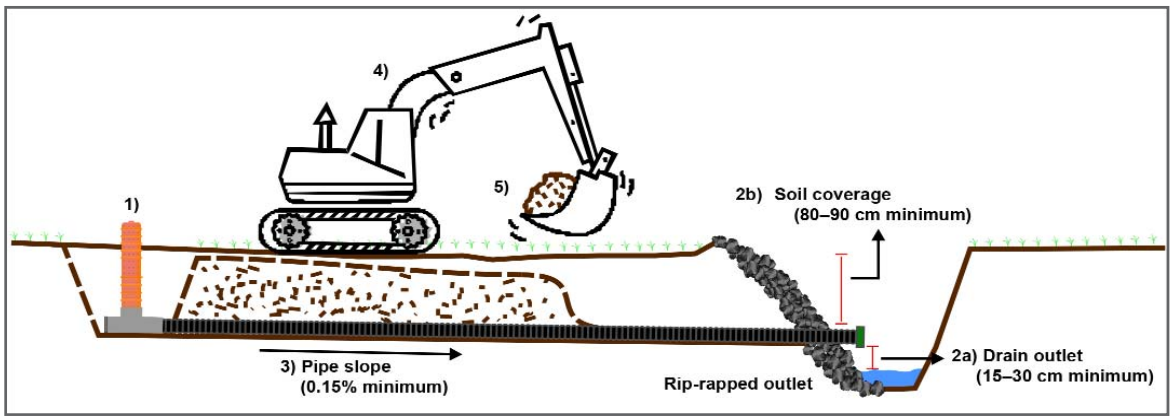


**Figure 3:** Inlet well with separate piping and drain outlet

### 5) Excavating the trench and installing the drain

Excavating and installing the drain. Source: Mikael Guillou (MAPAQ)

Excavating and installing the drain are done from the watercourse towards the location of the inlet well. The slope must be controlled using a precise guidance system (preferably a one with a laser).

The drain outlet is installed first. A non-perforated, rigid pipe at least 3 m in length is used. It is important that approximately 30 cm of the pipe stick out from the trench outlet to allow a geotextile membrane to be installed and the drain outlet to be rip-rapped. Once completed, the rip rapped outlet should be level with the bank.

The drain is connected to the rigid pipe by means of a sleeve. The connection is secured with drainage adhesive tape. If the drain is wrapped, the filter envelope must be attached to the drainage pipe using adhesive tape at the junction.

The drain is laid out along the bottom of the trench as the excavation moves forward. It is recommended that the drain be installed against one of the trench walls in order to improve the lateral support provided by the trench. Small quantities of loose, rocky soil are placed on the drain at regular intervals to keep it in place temporarily. The excavation continues up to the planned location of the inlet well. The trench is backfilled immediately after the inlet well is installed.

## Connecting an inlet well to an existing drainage network

If the inlet well cannot have a separate outlet, a T-connection is installed on the nearest drain, then a new section of pipe is directed towards the desired location, with the desired slope maintained (see the previous section for the recommended slopes), before the inlet well itself is installed.

## Installing an inlet well to drain a depression

### 1) Digging a cavity in the location chosen for the inlet well

The cavity is in the shape of a truncated cone, with a diameter of approximately 0.5 m at its base and a slope of 1.5:1 to 1:1 (horizontal:vertical ratio; Figure 4).

### 2) Attaching the inlet well to a T-connection

The inlet well and the T-connection are attached with drainage adhesive tape. Installing a diaphragm at the base of the inlet well is not recommended. Diaphragms increase the risks of crop residue blockages in the inlet well and are

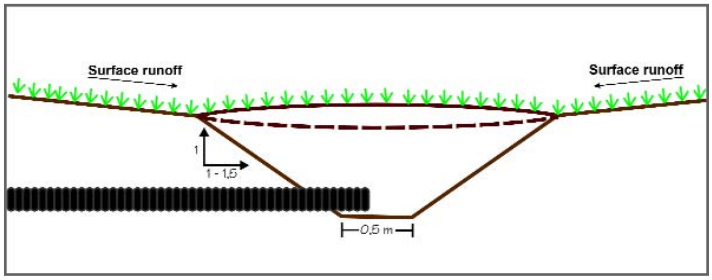


**Figure 4.** Digging a cavity at the chosen location

complicated to clean. The "orange" inlet well sections with small holes should only be used underground.

### 3) Connecting the inlet well to the drain

The drain is inserted into the T, and the junction is then secured with drainage adhesive tape. If the drain is wrapped, the filter envelope must also be taped to the drain at the T-connection. The drain and T-connection are then buried up to the base of the inlet well.

Source: Mikael Guillou (MAPAQ)
Installing an inlet well on a T-connection

Source: Mikael Guillou (MAPAQ)
Connecting the inlet well to the drain

### 4) Installing a geotextile membrane

A geotextile membrane—of the Texel 7609 or 7612 type—is fitted over the inlet well through an incision made at the centre of the membrane. The membrane is secured to the base of the inlet well with drainage adhesive tape. The membrane is used to prevent gullying and limit runoff along the exterior side of the drain.

### 5) Backfilling the excavation

The excavation is backfilled to ground level with loose soil, sand or small-diameter stone (19 mm).

Source: Mikael Guillou (MAPAQ)

Installing the geotextile membrane

### 6) Protecting the inlet well

It is important to prevent crop residues from blocking the inlet well. In order to do so, it is recommended that a cone of rocks that are 50 to 100 mm in diameter be constructed around the inlet well to a height of approximately 30 cm. Another option is to install meshing over a radius of approximately 1 m around the inlet well. The openings of the meshing should be no smaller than 2.5 cm by 2.5 cm. The meshing is secured using vertical rods inserted into the ground. A cone of rocks around the inlet well can promote heating of the inlet and melting of snow, thereby accelerating the thawing of the structure in the spring.

### 7) Finalizing the installation

If the depression is circular, a doughnut-shaped sedimentation basin is created around the inlet well.

The basin should be 30 to 40 cm deep and no less than approximately 1 m wide. This basin will help slow down the water arriving at the inlet well and reduce the quantity of sediment in the drained water. It is also possible to replace the sedimentation basin with sod placed over a minimum radius of 3 m around the inlet well (Figure 5).

Source: Mikael Guillou (MAPAQ)

Protecting the inlet well with meshing

If the water drained by the inlet well comes from an interception channel, a ditch or a linear depression, it is also advised that a sedimentation basin be installed to promote the deposition of suspended particles contained in the surface runoff. In that case, the basin is constructed only at the bottom of the channel (this also applies to ditches and depressions) and not around the inlet well. The basin should be 30 to 40 cm deep and 5 to 10 m long. A higher section must be left to act as a dike between the basin and the inlet well.

### Installing a drainage ditch at a confluence

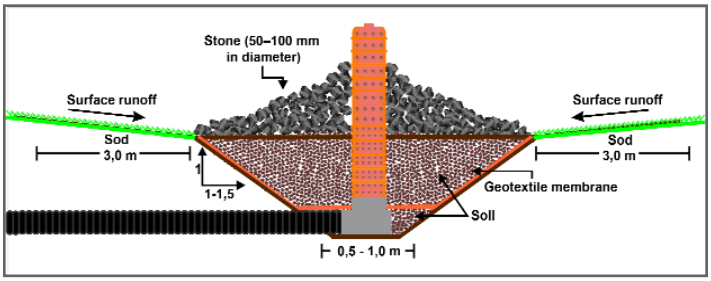


**Figure 5** : Sodding around the inlet well

### 1) Installing the drain

A smooth-interior, double-walled HDPE pipe (non-perforated) measuring at least 6 m long is installed at the confluence of the ditch and the outlet. The elevation of the bottom of the ditch in this section is adjusted so that the drain is located slightly lower than the bottom of the ditch upstream.

Source: Mikael Guillou (MAPAQ)

Inlet well with sedimentation basin in a [Sic]

The inlet pipe is secured to the drain with drainage adhesive tape.

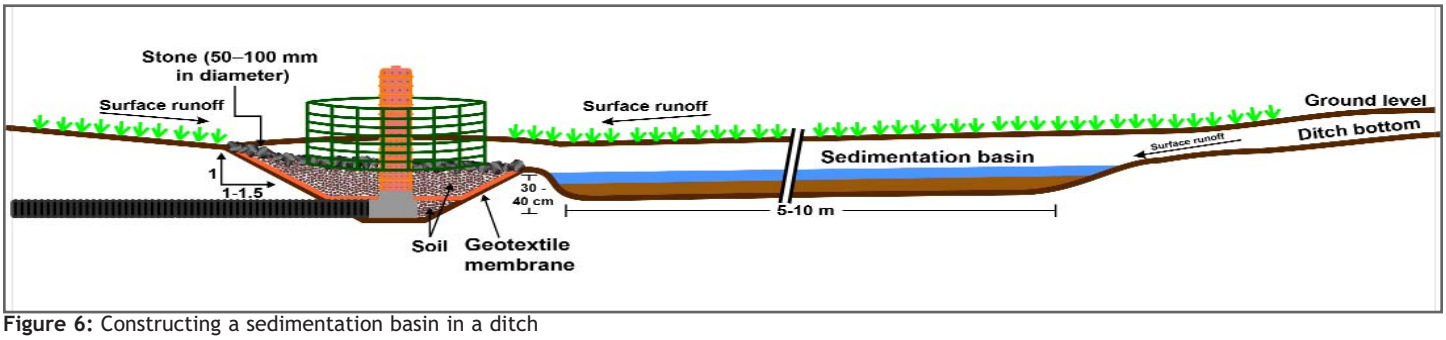


**Figure 6:** Constructing a sedimentation basin in a ditch

### 2) Backfilling the ditch

Source: Georges Lamarre (MAPAQ)

Installing the inlet well and piping

The ditch is backfilled over the drain. Since this section acts as an emergency overflow, it should be lower than the riparian fields. A difference in elevation of 30 cm is recommended to permit the drainage of flood waters and the movement of machinery. The top of the overflow must be grassed or, if very frequent movement of machinery is expected, rip-rapped.

### 3) Installing the geotextile membrane

A geotextile membrane is installed around the drain outlet. The membrane extends from the bottom of the outlet to the top of the overflow. An anchor trench is constructed to ensure that the membrane is stable. The membrane is covered by a layer at least 30 cm thick of stones measuring 100 to 200 mm in diameter or, if the flow can be quite significant, pit-run gravel measuring up to 300 mm.

In sandy or loamy soil, the upstream slope of the overflow is also covered by a geotextile membrane. The T-connection, the base of the inlet well and the upstream slope of the overflow are covered with approximately 15 cm of clean stones measuring 50 to 100 mm in diameter.

### 4) Finalizing the installation

Like the regular inlet wells, the drainage ditches should have a sedimentation basin. This basin should be 30 to 40 cm deep and 5 to 10 m long. Once again, it is important to maintain a higher section that will act as a dike between the basin and the inlet well.

The inlet well must be surrounded by rock or meshing to stop crop residues.

Figure 7 presents a summary of the drainage ditch components.

Source: Georges Lamarre (MAPAQ)

Rip-rapped overflow and inlet well outlet.

Source: Georges Lamarre (MAPAQ)

rip-rapped upstream slope drain of the overflow

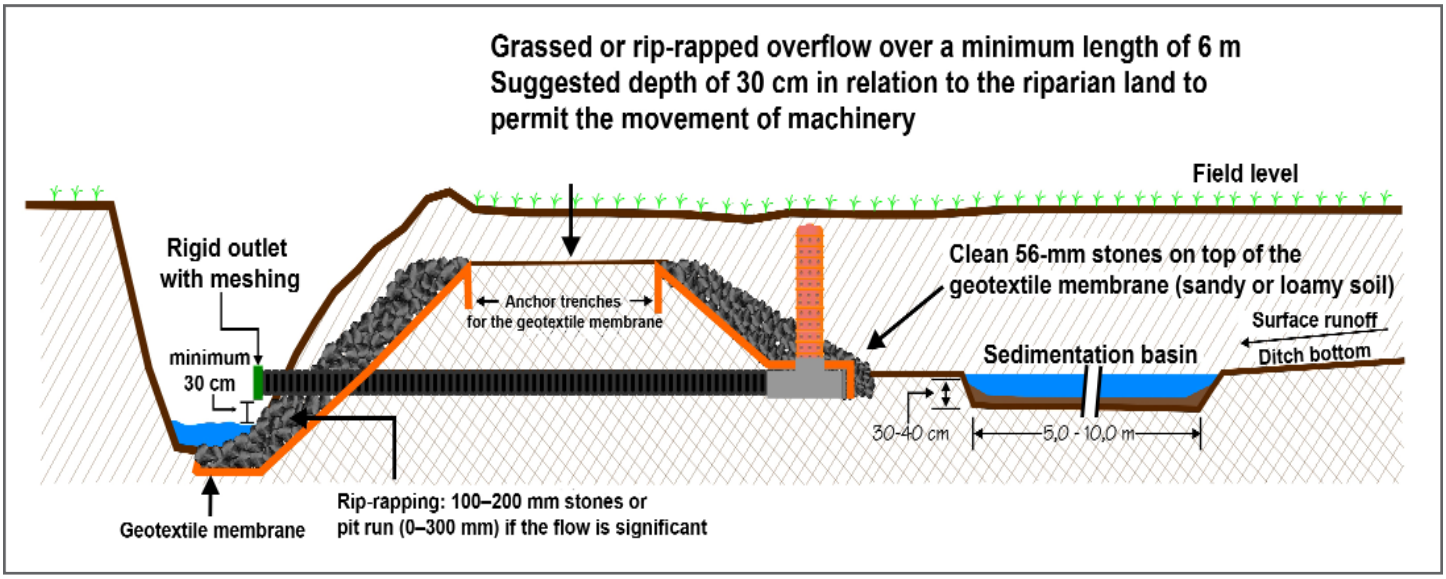


**Figure 7:** Drainage ditch

## Maintenance

The main problems with inlet wells are blocking of the inlet and blocking of the drainage pipes. These problems can be largely avoided through the proper use and regular maintenance of the structure.

When the inlet well is located in a field, there must be a minimum 3 m radius of grassed land around the inlet to promote the deposition of sediment contained in the surface runoff before the water is drained.

The inlet structures must be regularly inspected. Residues that have accumulated around the meshing or the cone of rocks must be removed, the inlet well perforations must be unclogged, and the sedimentation basin must be cleaned out periodically in order to maintain the effectiveness of the structures.
The drain outlets must also be inspected frequently to check their condition and operation and to evaluate the effectiveness of the inlet well and the underground piping.

### Homemade inlet wells

It is possible to construct, at a fraction of the cost, inlets for inlet wells that have characteristics similar to the inlets available on the market. In addition, these "homemade" inlet wells are very simple to put together.
The HDPE drainage piping is the cheapest material. Smooth-interior, double-walled piping can be used. Unused orange inlet well sections with small holes (Hickenbottom-type) or PVC piping can also be used.

The pipes are installed like conventional inlet pipes. After installation, however, additional perforations must be made to ensure that the surface area of the perforations is comparable to the surface area of the pipe section used. The following table indicates the recommended number of perforations over a diameter of 25.4 mm (1 inch). It should be noted that the density of perforations should be constant over the entire length of the inlet well.

| Pipe Diameter | Perforations Required per 30 cm of Height |
|---|---|
| 100 mm (4 inches) | 24 |
| 150 mm (6 inches) | 40 |
| 200 mm (8 inches) | 56 |
| 250 mm (10 inches) | 72 |

Adapted from Hickenbottom (2004)

In order to increase the rigidity of the structure, steel rods can be inserted into the ground then fastened to the pipe. Lastly, the upper end must be closed with a cap or meshing to prevent animals from getting into the inlet well.

Source : Mikael Guillou (MAPAQ)

Homemade inlet well

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