NJ650.1404 Interception Drainage

Interception drainage is used to intercept surface and subsurface water. The investigation, planning, and construction of surface interception drains follow the requirements and procedures given for surface drainage. Interception of subsurface water is discussed in part 624 (section 16) of the National Engineering Handbook.

a) Ground water movement

Ground water elevation and movement are needed for proper establishment of interceptor drains. Some of the more common conditions indicating the need for interception drainage are illustrated in figure 4–1, which is a sketch of a valley cross section extending beyond the ridge into the adjoining valley.

Most ground water for which drainage is required comes from recent rainfall that accumulates on the soil or within the upper part of the soil profile. After replenishing the soil to water-holding capacity, the excess water moves downward through the soil to the water table or builds up above restricting layers. Here it accumulates and moves laterally, often parallel with the land slope, toward an outlet. Its movement may reach the surface and return to the subsurface a number of times in its course to an outlet.

In a valley, barriers within 8 to 20 inches of the soil surface often cause a perched water table above the true water table. A true water table seldom is encountered until well down the valley side slopes or on the valley floor. For example, in figure 4–1, rainfall penetrating a permeable surface soil below the ridge at **A** may accumulate water over a less permeable subsoil during wet periods. Resistance to movement into the subsoil diverts most of the water over the less permeable layer to appear at the surface at location **B** as a wet weather seep. During the summer, such seep spots may completely dry out. Also, where soil is shallow over less permeable layers, a false water table close to the surface may accumulate sufficient water to pond at the surface in wet seasons and later completely disappear.

The same water movement also can develop seeps at point **C**. However, a larger collecting area and more complete interception by the impervious layer may accumulate sufficient water to produce a flowing spring, particularly if it is in a depression where the water converges and is confined in a small area. On the other hand, a rock ledge or compact layer may lie as a shelf with visible flow only at the depressions, even though this may be a small part of the total water coming to the surface along the same approximate contour.

Proceeding down into the valley trough, flow from adjoining watersheds can complicate the problem. Springs developed from these sources frequently have year-round discharge. When the flow is confined between impermeable layers, such as at **D**, it may build up a head of water a considerable distance above the point of issue. This can create an artesian supply that can discharge under pressure over an extended area. If the flow is not free but is covered by a mantle of moderately permeable to fine textured soil, artesian springs may saturate an extensive area at great depths by pressure and capillary action. Because of this, the location and treatment of these springs are difficult. Abrupt changes in grade of fine textured soils, shown in **E**, may slow water movement on the flatter slope enough to cause water accumulation and wetness at the surface.

On some sites, open observation wells or piezometers are necessary to locate the source and direction in which subsurface flow takes place.

b) Location of interceptor

In the planning and establishment of interceptor drains for both surface and subsurface water, the location of the outlet is of utmost importance. Insofar as possible, cross drains should be laid out to use the best natural outlet available. Because the interceptor may intercept other drainageways and add their discharge to the selected outlet, it is necessary to check the adequacy of the outlet to be used. Often, discharge can be spread over a well

Figure 4–1 Ground water movement

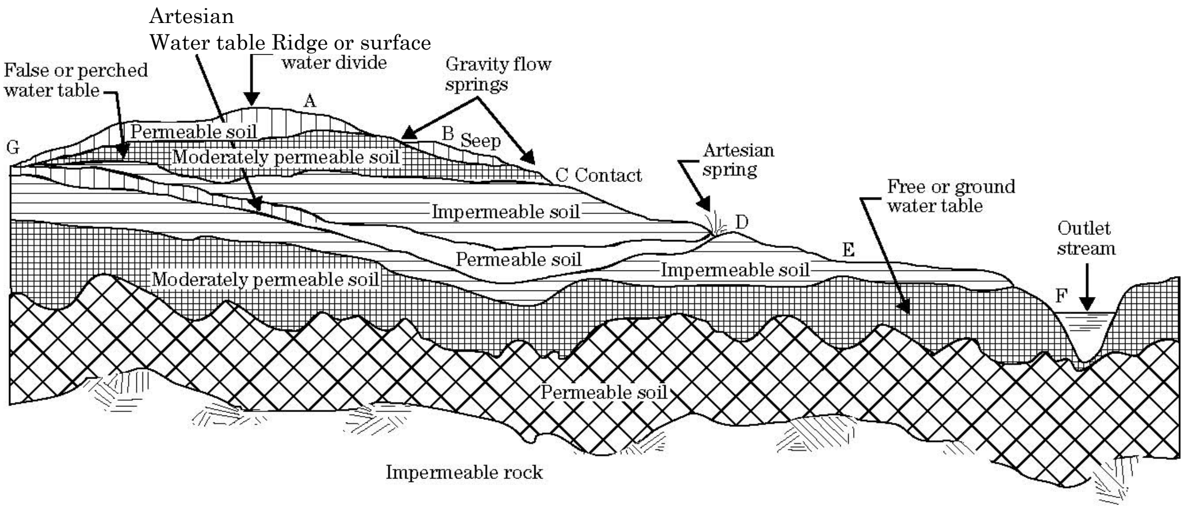
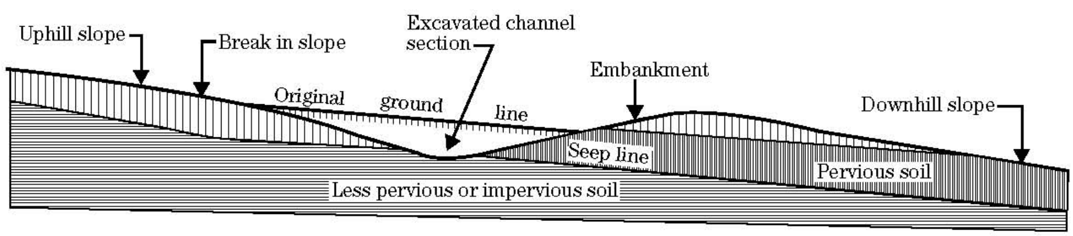
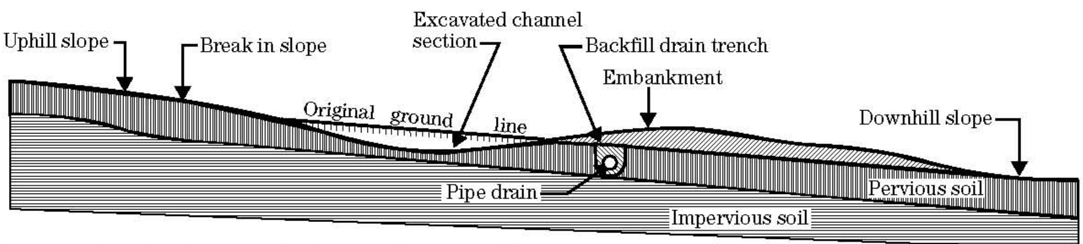


Figure 4-2 Typical interceptor installations

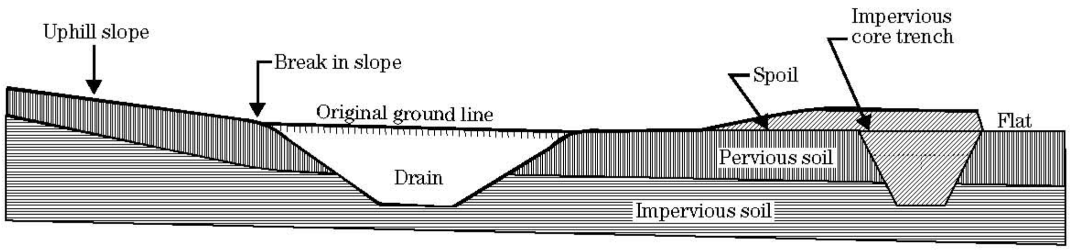


A. - **Cross section showing open drain as surface water diversion and interceptor of surface and subsurface water from sloping lands.**

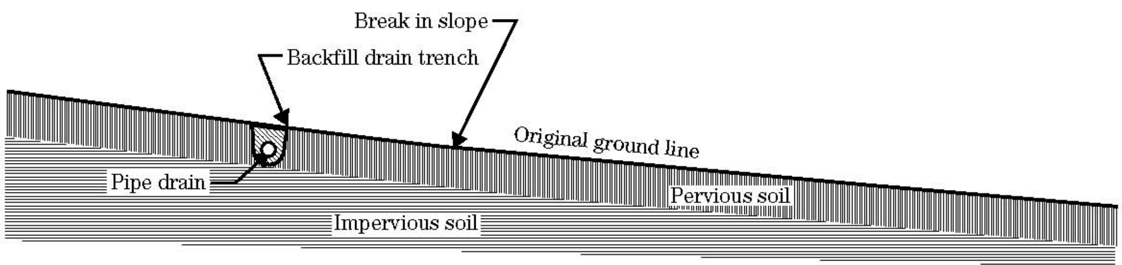


B. - **Cross section showing open drain as surface water diversion with pipe drain as subsurface interceptor.**

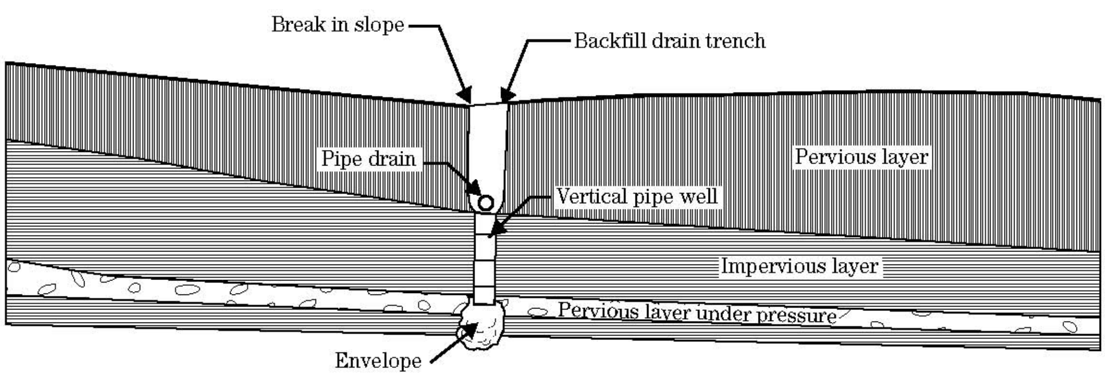
Figure 4-2 Typical interceptor installations (continued)



C. - **Cross section showing open drain as surface water diversion and subsurface water interceptor located at interface of sloping and flat lands.**



D. - Cross section showing drain as subsurface interceptor.



E. -Cross section showing relief well and interceptor drain.

Figure 4-3 Diversion system on moderate to steep slope

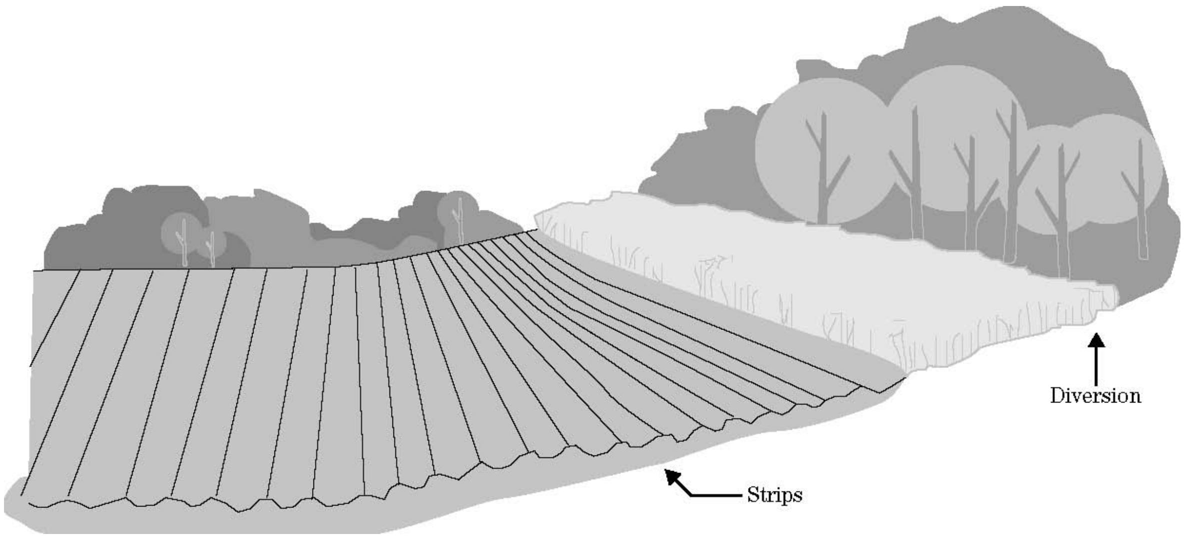
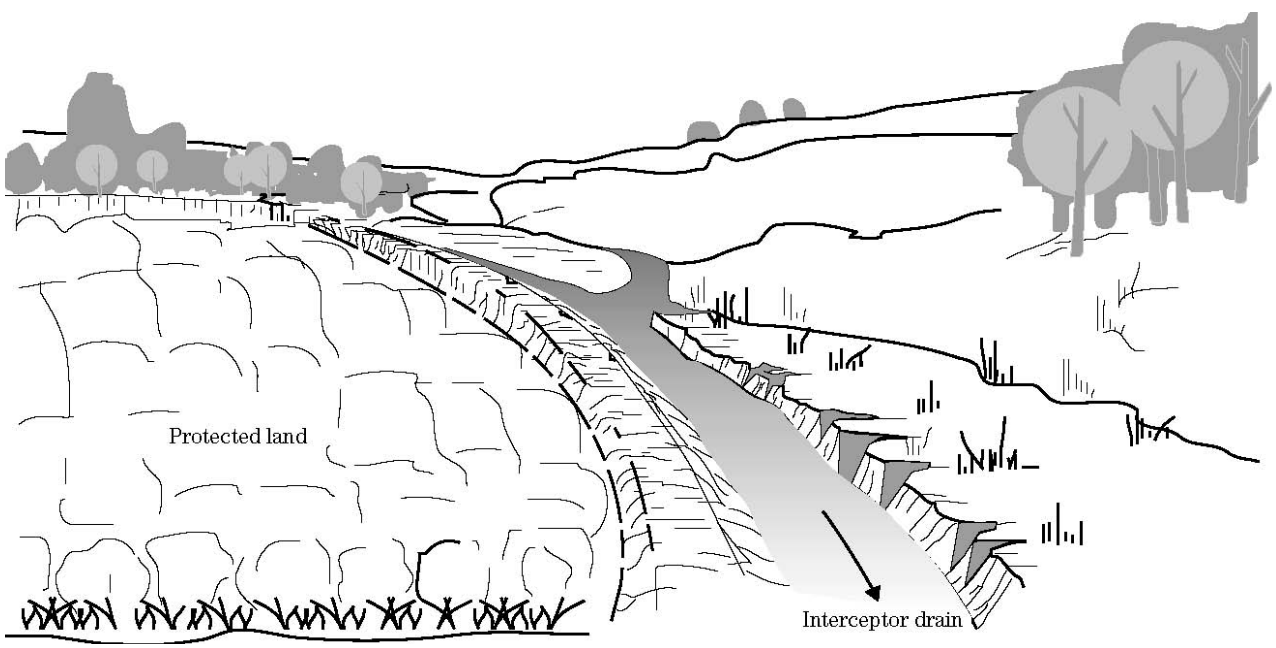


Figure 4-4 Interceptor drain on bottom land



sodded pasture, stony field, or into gently sloping woods.

If a satisfactory natural outlet is unavailable, special channels can be constructed. Vegetative outlets on slopes are preferred over masonry or similar channels because of their economy. They should be established well ahead of the interceptors so that the turf can safely handle the concentrated flow. If vegetative outlets must handle continuous flow, as supplied by springs, the center of the channel should be troughed to confine low flows.

If surface wetness is undesirable, subsurface drainage can be provided by a conduit placed along one side of the channel, well into the bank and away from possible surface wash. Subsurface drains should be vented at breaks in grade to reduce suction at the head of the slope and pressure at the base. In flats at the base of slopes, main or lateral ditches of trapezoidal or parabolic section can be used.

In planning and establishing an interceptor diversion, a few well placed lines at obvious seep planes and distinct changes in slope may be sufficient. In such cases, a detailed map may not be needed, and the line can be staked directly on the site. If subsurface interception must also be considered, the approximate location should be determined first from observations of surface conditions and preliminary borings.

After the line is staked, additional borings should be taken along and across the staked line and the alignment shifted until good interception is obtained. In irregular bowl-shaped areas, some changes in grade or shifting of the diversion lines upslope or downslope may be needed to obtain reasonably uniform farming strips, headlands, and access points for farming equipment.

If a uniform grade from one side to the other causes considerable divergence or location of the drain away from the approximate line of seepage and desirable pattern of farming strips, several parallel drains may be needed. If this is done, the least needed length of drain generally results from placing the shorter line at the higher elevation near the outlet. As an alternate, if an outlet is also available on the opposite side of the seep area, an alternate method is to break the grade along a single line so that the fall is in both directions. The most advantageous point of breaking grade may require several trials until grade and alignment provide the desired location, interception, and outlet points. Such sites often have so many irregularities and outlet location problems that a complete contour map may be needed as an aid to planning.

Interception drainage may be accomplished by open drains or subsurface pipe drains (figure 4–2). A channel used for controlling surface water (figure 4–3), commonly called a diversion, may be shallower than one required to intercept subsurface water movement. The open drain must have sufficient depth to intercept subsurface water movement. The drains are frequently V-shaped, with the bottom and top rounded by construction and cultivation so they nearly conform to parabolic sections.

Side slopes preferably should be 6:1 or flatter for ease of construction and farming. However, 4:1 or steeper side slopes may be necessary on land that has slopes of more than 12 percent.

Where a series of interceptor ditches is necessary to reduce the length of slope and contributing drainage area, spacing ordinarily should not exceed 200 feet for slowly permeable soils. More often, break in slope, location of spring or seep lines, and the necessary location of the top interceptor result in spacing of less than 200 feet. In more permeable soils, erosion control requirements may govern spacing.

If an interceptor open drain carries spring flow and elimination of continuous wetness in the open drain is desirable, a shallow diversion that has an auxiliary subsurface drain conduit can be used. The subsurface drain can be placed on either side of the surface drain; however, in most shallow soils, a location slightly downhill from the surface drain provides deeper interception and added cover from the embankment (figure 4-3).

The subsurface drain need not follow the course of the surface open drain throughout its length if topography warrants deviation.

An open drain that has a standard trapezoidal or parabolic cross section (figure 4–2C) can be used to intercept surface water at the base of a slope surrounding a depression or at the outer edge of a flood plain (figure 4–4). The depth of the open drain must be ample to provide:

- necessary subsurface interception,
- allowance for shrinkage where peat and muck are involved, and
- lateral movement of water if the drain is also used as an outlet for internal drainage of the protected area.

Spoil always should be placed on the downslope bank to permit free movement of upland water into the drain. It can also be used in diking to gain added channel capacity for overflow protection. If diking is not needed, spoil should be spread to blend into the surrounding landscape and to facilitate maintenance.

If drainage areas are small, subsurface drainage often can be used alone for interception of seeps and springs (figure 4–2D). The drainage lines are generally close to breaks in grades so that the drain has adequate cover and proper depth for intercepting the seepage. Added cover can be obtained on many sites by moving the lines slightly uphill above the break in slope where the impervious layer generally is at a greater depth. The bottom of the drain should be just within the impervious layer. If minimum cover is not available at this depth, the drain should be placed as far into the impervious layer as necessary to attain the needed cover. This may reduce the amount of flow into the pipe and its potential capacity, but deepening and widening the trench and installing 4 to 6 inches of envelope material around the pipe improve flow into the drain. In fine textured soils, permeable material should be used as backfill over the line to within plowed depth.

Isolated seeps at elevations above the drain can be tapped with stub relief drains to avoid additional long lines across the slope.

If pervious layers are considerably below normal drain depth or deep artesian flow is present, water under pressure may saturate an area well downslope. Vertical relief wells or pits can be installed at intervals along the cross drain down to an impervious layer or springhead, and the excess flow can rise through these vertical pipes and discharge into the cross drain (figure 4–2E). Open pits can be filled with bank run gravel or coarse sand, serving much as a French drain to permit water from deep-seated springs to rise into the cross drain. Construct by installing pipe and filling it with filter material; after which the pipe is withdrawn, leaving a vertical or chimney drain.

c) Use of surface or subsurface drains

Open drains can be used to lower or control the water table where subsurface drains are not feasible. They are used in shallow, hardpan soils where the depth of the soil does not permit satisfactory installation of subsurface drains. They are also used in deep soils in cultivated fields, either as temporary measures or permanent installations. Where the entrance of surface water can cause bank erosion, adequate devices, such as pipe inlets, should be considered.

Open drains may be used as temporary installations to intercept and monitor subsurface flow. Often an open drain is retained as a permanent installation if the flow is so great that a pipe drain installation would be too costly.

Drains must be deep enough to tap and provide an outlet for ground water that is in shallow, permeable strata or in water-bearing sand. The spacing of drains varies with soil permeability and drainage requirements. The capacity of the open drains generally is greater than required because of the required depth and the construction equipment used. Refer to Appendix II for spacing recommendations.

Advantages of using open drains:

- Nearly always have a smaller initial cost than subsurface drains.
- Are more easily inspected.
- Are applicable in many soils where subsurface drains are not recommended.
- Can be used on a very flat gradient where the permissible depth of the outlet is not adequate to permit the installation of

subsurface drains at the minimum required grade.
- Can be used in lieu of subsurface drains to avoid problems with iron ochre.
- Are generally more accessible by equipment for cleaning and maintenance purposes.

The disadvantages:
- Reduce the area of land available for farming, especially to unstable soils that require flat side slopes.
- Are more difficult and costly to maintain than subsurface drains.
- Limit access and interrupt farming patterns.
- Pose both social and environmental impacts.

d) Size of drains

Table 4–1 can be used to determine the required capacity of single random interception drains in some humid areas. If one line is insufficient, additional lines may be used.

Table 4–1 Interception drain inflow rates

Soil texture	Inflow rate per 1000 feet of line, cfs
Sand, gravel, muck (GP, GW, SP, SW, OH, OL, PT)	0.15 to 1.00
Sandy clay loam, sandy loam, loamy sand (SM, SC, GM, GC)	0.07 to 0.25
Silt loam, loam (CL, ML)	0.04 to 0.10
Clay, sandy clay, clay loam, silty clay loam (CL, CH, MH)	0.02 to 0.20

* Discharge of flowing springs or direct entry of surface flow through a surface inlet must be added. Such flow should be measured or estimated. Required inflow rates for interceptor drains on sloping land should be increased by 10 percent for 2 to 5 percent slopes, by 20 percent for 5 to 12 percent slopes, and by 30 percent for slopes over 12 percent.

e) Design and installation

Design considerations for grade and velocity, drain envelope, and appurtenances; and installation requirements for interceptor drains can be found in Chapter 3, Subsurface Drainage.