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Design Criteria For Underground Terrace Outlets

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An underground terrace outlet is used to dispose of runoff from terraces by means of an underground pipe conduit. Runoff is temporarily stored in the terrace channels and gradually drained off through the conduit. Because of the temporary storage, small diameter conduits can be used to carry the runoff.

Description

The underground terrace outlet consists of vertical intake risers (one located in each terrace channel) connected to an underground conduit (See Fig. 1). Water flows into the outlet through holes in the riser. An orifice plate in the bottom of the riser controls the flow to the conduit so that there is no reverse flow in the intake risers in lower terraces. Details of the intake riser are shown in Fig. 2. Terrace ridges must be high enough to provide the needed temporary storage. See UMC Guide 1526 "Design Criteria for Terrace Channel Storage."

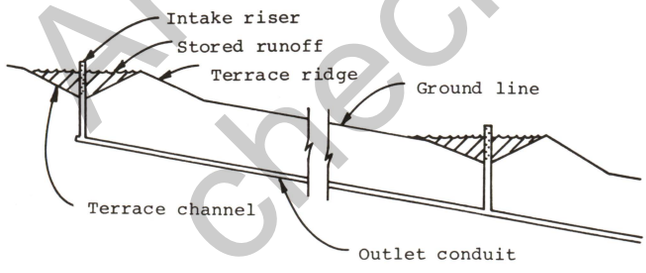

Figure 1. Profile sketch of underground terrace outlet and terraces

Advantages

1. Permit better alignment of terraces because terraces may be built across waterways rather than curving up to meet waterways on grade;
2. Eliminate the need for grass waterways;
3. Provide more cropland where the landowner has no need for the grass produced in the waterways;
4. Provide an outlet for underground drainage where it is needed because of seepy areas in the field;
5. Require less maintenance costs than for a grass waterway;
6. May eliminate the need for a stabilization structure at the lower end of the waterway.
7. Overcome hazard where use of herbicides for weed control on adjacent crops may be harmful to vegetation in grass waterways.

Limitations

1. Require more design consideration and lay out time than do grass waterways:
2. Require equipment to install the conduit that normally is not used in constructing a terrace system;
3. Require an appreciable amount of hand labor to install;
4. Cost more than a grass waterway intitally unless a stabilization structure can be eliminated;
5. May restrict crop growth and delay field operations on less permeable soils due to water stored in the terrace channel;
6. Occasionally holes in the riser or orifice clog with debris and cause overtopping of the terrace;
7. Limit the drainage area of the outlet system to about 20 acres: for larger drainage areas, the size of the conduit becomes larger and rather expensive;
8. Velocities in the clay tile may become excessive on steep grades and cause movement of soil near the openings between the tile. (If pipe with sealed joints is used to overcome this problem, there is an additional cost for the sealed pipe.)

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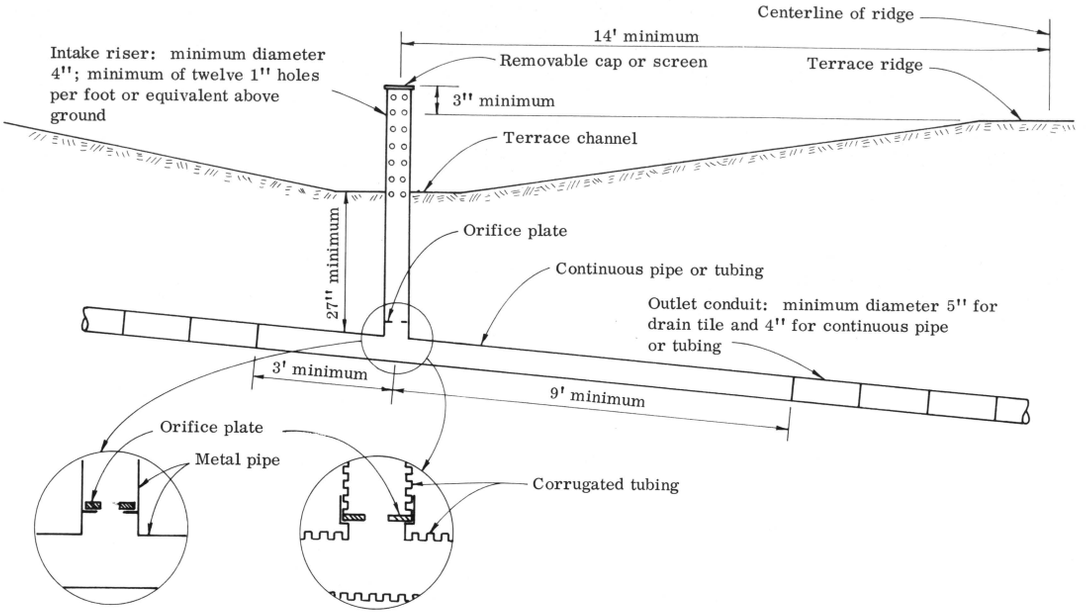


Typical orifice plate installations

Figure 2. Details of outlet conduit under terrace and intake riser

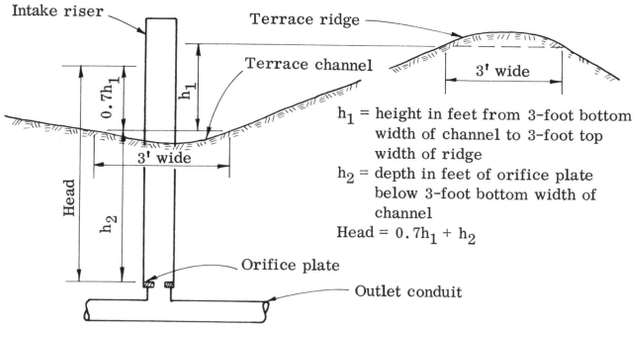
TABLE 1

DISCHARGE RATE FOR CIRCULAR ORIFICES IN CUBIC FEET PER SECOND

ORIFICE DIAMETER IN INCHES	HEAD IN FEET 1/						
	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1.50	.094	.103	.111	.119	.126	.133	.139
1.75	.128	.140	.151	.162	.172	.181	.190
2.00	.166	.182	.197	.210	.223	.235	.247
2.25	.210	.231	.249	.266	.282	.298	.312
2.50	.259	.284	.307	.328	.348	.367	.385
2.75	.314	.344	.371	.397	.421	.444	.466
3.00	.373	.408	.441	.472	.500	.527	.553
3.25	.438	.479	.518	.554	.587	.619	.649
3.50 2/	.508	.556	.600	.642	.681	.718	.753

1/ Head = $0.7h_1 + h_2$. See diagram below.

2/ A special design of the intake riser is required for orifice diameters over 3.50 inches.



Design

Intake Riser: Holes in the intake riser permit the water in the terrace channel to flow into the riser (See Fig. 2). Locate the riser in the lowest place in the terrace channel to provide positive drainage. It should be a minimum of 14 feet from the centerline of the terrace ridge. This distance will vary upward depending on the width of the farm equipment that is to pass between the riser and the top of the terrace ridge.

The joint between the intake riser and the tee on the outlet conduit should be slightly flexible to prevent breaking the joint in case the riser is hit by farm equipment. The top of the riser should be at least 3 inches higher than the top of the terrace ridge. It should be covered with a durable cap or screen which is removable so the riser can be cleaned in case the orifice plate becomes clogged. The openings in the screen should be no larger than 1 inch.

A specifically designed orifice plate at the bottom of the riser controls the discharge from the riser. Table 1 gives the discharge rates of orifices having specific diameters acting under given heads. The orifice capacity should not be less than 0.042 cubic feet per second per acre of drainage area. This is equivalent to removing 2 inches of runoff in 48 hours from the area. For soils having slow or very slow permeability such as those with claypans where prolonged wet conditions in the terrace channels might be detrimental to crops, it may be desirable to increase the orifice capacity so that the runoff will be removed from the terrace channel in less than 48 hours. The orifice plate should fit tightly against the seat at the bottom of the riser. It should have a smooth finish so as not to catch debris passing through the riser. Typical orifice details are shown in Fig. 2.

Pipe for the intake riser preferably should be smooth iron pipe or corrugated steel or aluminum pipe. Durable plastic

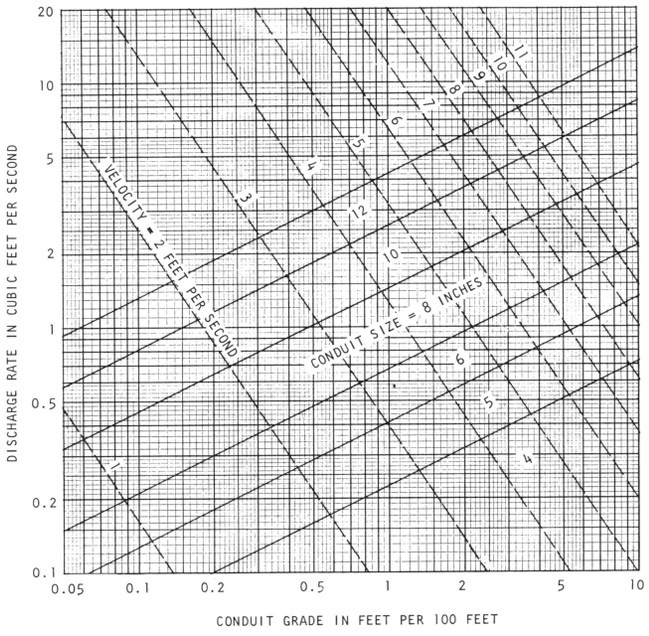
pipe or corrugated plastic tubing may be used providing it will withstand severe temperature conditions and wear and tear from livestock and farm equipment. Corrugated plastic tubing should be supported by steel fence posts or similar means.

Orifice plates should be made of durable plastic or metal that will withstand the pressure and flow of water through the riser.

Outlet Conduit: The outlet conduit may be a pipeline with sealed joints or field drain tile with unsealed joints. However, seal a short section of this conduit under the terrace channel to prevent a washout by excessive seepage of water from the terrace channel. Seal the upper end of the conduit with a durable material. Other details for the conduit are shown in Fig. 2.

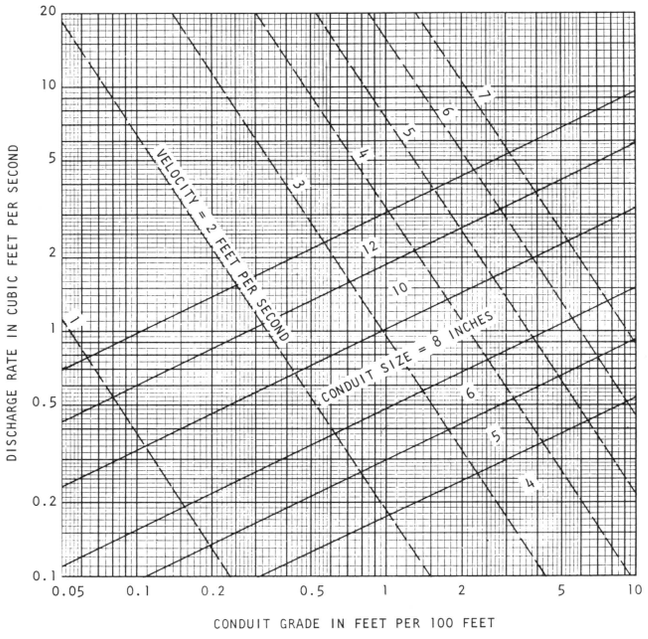
Discharge for any reach of the conduit is determined by adding the discharges through the intake riser above that reach. The size of the conduit is determined by using the curves shown in Fig. 3 and 4. The velocity in the conduit should not exceed that specified in Table 2.

Pipe for the outlet conduit should be substantial enough to withstand loads applied by earth cover and heavy farm equipment. Clay or concrete drain tile, clay sewer pipe, plastic pipe, corrugated plastic pipe, smooth iron pipe, corrugated steel or aluminum pipe, or asbestos cement pipe can be used for this purpose.



Smooth pipe or drain tile having good alignment

Figure 3. Discharge curves for outlet conduit



Corrugated plastic tubing or drain tile not having good alignment

Figure 4. Discharge curves for outlet conduit.

TABLE 2

MAXIMUM PERMISSIBLE VELOCITIES FOR OUTLET CONDUITS

In Feet Per Second

Soil Texture	Drain Tile With Unsealed Joints or Perforated Plastic Tubing	Drain Tile With Wrapped Joints 1/ or Bell-End Tongue & Groove Pipe	Continuous Pipe or Tubing or Sewer Pipe with Sealed Joints
Sand & Sandy loam	3.5	6.0	No limit
Silt & Silt loam	5.0	6.0	No limit
Silty Clay loam	6.0	7.0	No limit
Clay & Clay loam	7.0	9.0	No limit

1/ The tile should be laid with tight-fitting joints and each joint entirely wrapped with special filter material such as "tile guard" glass fiber filter or plastic sheeting material.

Outlet Section: The outlet section should have an inside diameter at least the same as the outlet conduit. It should be a rigid metal pipe at least 10 feet long. Attach a positive acting swing gate to the outlet end of the pipe to prevent rodents from entering. Other details for the outlet section are shown in Fig. 5.

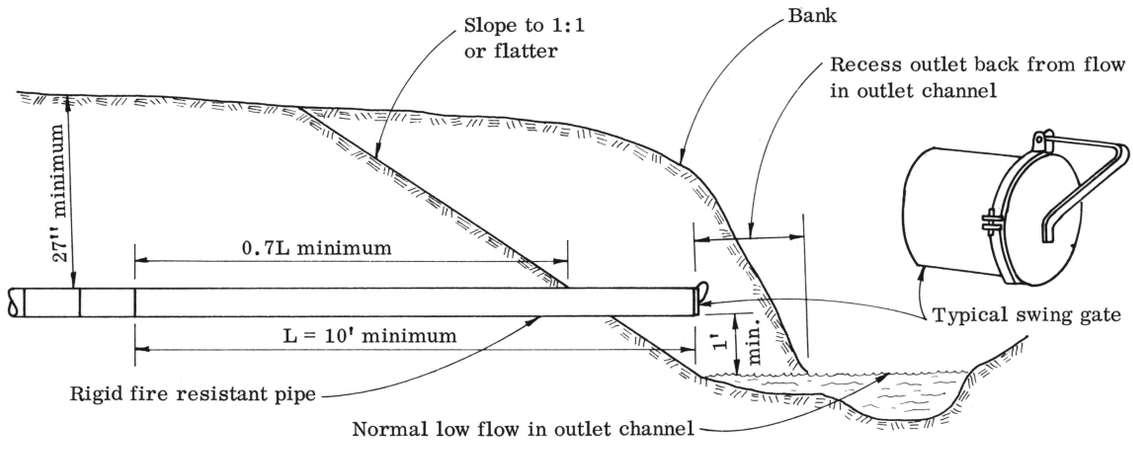
Pipe for the outlet section preferably should be smooth iron pipe or corrugated steel or aluminum pipe. Durable fire resistant plastic pipe may be used providing it will withstand wear and tear from livestock.

Construction Specifications

All material should be satisfactory for its intended use and should meet applicable specifications and requirements. Protect clay and concrete tile from moisture during freezing weather. Install all parts of the underground terrace outlet system to the proper grade and dimensions. Drain tile should be installed in good alignment and close fit. Install continuous sealed pipe properly with watertight connections. Place earth backfill material in the trench in such a manner that the conduit is not displaced. Place the backfill material in the trench in 6-inch layers and hand tamp it to a depth of at least 10 inches over the top of the conduit. The remainder of the trench may be backfilled and compacted by machine, except that portion of the trench that will be located under the terrace channels and ridges should be graded to a slope of one to one or flatter before backfilling and compacting by machine. Construction or farm equipment may be used for this compaction but take care not to damage the outlet conduit. Compact each terrace ridge over the conduit to the proper height.

Maintenance

All repair work should be done as soon as possible. Maintenance will include removing debris from the holes in the intake risers and from above the orifice plates, filling holes developed by water seeping from terrace channels to the outlet conduit, and repairing rills in terrace ridges caused by stored runoff overtopping the terraces.



In order to protect the outlet end of the pipe from damage due to high flood flows in deeper channels, the outlet section should be modified as follows: (1) The minimum length of the outlet section should be at least equal to the depth of the channel, but not less than 12 feet, (2) the outlet section need not be recessed back into the bank, but a minimum of 4 feet of the pipe should extend beyond the bank, (3) the bottom of the outlet section should be a minimum of 1 foot above maximum flood stage in the channel, (4) no swinging gate is needed.

Figure 5. Details of outlet section

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