

Unit Ten

DIVERSIONS

INTRODUCTION

Although all diversions are designed to reduce erosion, how they accomplish this goal depends on their location. If constructed above an area being developed, a diversion can intercept runoff before it enters the site, limiting the volume of storm water moving over the site. If constructed at the top of a fresh cut or fill slope, the diversion will prevent runoff from eroding the slope. If located at the bottom of a slope, it can protect structures, low areas, or bare surfaces from runoff and flooding. Diversions located at frequent intervals across long slopes and corridor-type developments, shorten the distance the runoff travels on exposed slopes, which slows the velocity of the runoff and reduces erosion. Diversions located down-gradient of a graded site will intercept sheet flow carrying sediment and, if diverted to a sediment basin or other stabilized area, will help minimize off-site sedimentation.

Diverted runoff should outlet to a sediment basin, detention or retention basin, or a well vegetated area. When movement of sediment into a diversion channel is a significant problem, consider installing a vegetated buffer/filter strip up gradient of the diversion.

Diversions may be temporary to control surface runoff and sediment during construction, or be part of the site's permanent storm water management strategy.

DESIGN CONSIDERATIONS

Soils

Soils are an essential factor in the successful design and construction of all diversions. A site-specific soil assessment is used to determine if a diversion may be effective. Table 1 summarizes the effectiveness of diversions, the rate of erodibility, the need for soil stabilization, and the channel sedimentation rate based on soil type.

**Table 1: Assessing the Effectiveness of Diversions
Based on Soil Type**

Soil Type	Effectiveness of Diversions	Rate of Erodibility	Need for Soil Stabilization	Channel Sedimentation Rate
Silty and Clayey	High	High	High	Low
Loamy	High	High	High	Moderate
Sandy	Low	Low	Moderate	High

The following general considerations based on soil type can aid in determining the proper use of diversions. Runoff potential affects the size of the channel that will be necessary to carry the flow. Settlement rate indicates the extent to which sediment will build up in the channel and reduce its capacity.

Silty and Clayey Soils

Since the rate of erodibility and storm water runoff is highest for these soil types, diversions are most effective and most important in capturing and in directing sediment-laden runoff to sediment basins and traps. Stabilization of the channels is mandatory. Vegetation is difficult to establish in these soils; therefore, mechanical stabilization should be considered in many areas. Since the channel settlement rate for these soil particles is low, sediment deposits in the channel are not normally a problem.

Loamy Soils

Diversions are of major importance in these soils to control sediment-laden runoff. Stabilization is important to prevent erosion of the channels, however, vegetative cover is relatively easy to establish in loamy soils, so mechanical stabilization is generally necessary only in critical areas. Sedimentation may occur within diversion channels where velocity is slowed, requiring periodic cleaning.

Sandy Soils

Fewer diversions are generally required in these soils since the rate of storm water runoff is low. Sandy soil particles that are eroded when runoff does occur will be deposited in the channel where the runoff water slows, reducing its capacity and effectiveness.

Diversion Design

The following information should be considered when designing diversions: Soil, Grade, Discharge, Permissible Velocities, Cross Section, Ridge Design, Outlets, and Vegetative Cover. Information on designing, constructing and maintaining diversions can be found in the MDEQ *Guidebook of Best Management Practices for Michigan Watersheds* and in the following NRCS publications:

- Conservation Practice Standards for Diversions (Appendix 10A).
- USDA, SCS, Engineering Field Handbook, Chapter 9 – Diversions
- USDA, SCS, Handbook of Channel Design for Soil and Water Conservation (SCS-TP-61)

Diversion (Feet) 362

DEFINITION

A channel constructed across the slope generally with a supporting ridge on the lower side.

PURPOSES

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- Divert water away from farmsteads, feedlots, pastureland, agricultural waste systems, and other improvements.
- Intercept surface and shallow subsurface flow.
- Reduce runoff damages from upland runoff.
- Reduce erosion and runoff on urban or developing areas and at construction sites.
- Divert water away from active gullies or critically eroding areas.
- Supplement water management on conservation cropping or stripcropping systems.

CONDITIONS WHERE PRACTICE APPLIES

This applies to all cropland and other land uses where surface runoff water control and/or management is needed. It also applies where soils and topography are such that the diversion can be constructed and a suitable outlet is available or can be provided.

CRITERIA

General Criteria Applicable To All Purposes

Diversions shall be planned, designed, and constructed to comply with all federal, state, and local laws, rules, or regulations.

Capacity. Diversions that protect agricultural land shall have a minimum capacity for the peak discharge

from a 10-year frequency, 24 -hour duration storm. Freeboard shall be not less than 0.3 feet (10cm).

Diversions designed to protect areas such as urban areas, buildings, roads, and animal waste management systems shall have a minimum capacity for the peak discharge from a storm frequency consistent with the hazard involved but not less than a 25-year frequency, 24-hour duration storm. The design storm shall not be less than that required in specified regulations. Freeboard shall be not less than 0.3 feet (10cm).

Cross Section. The channel may be parabolic, V-shaped, or trapezoidal.

The diversion shall be designed to have stable side slopes not to be steeper than a ratio of two horizontal to one vertical. Side slopes shall also be designed to accommodate the equipment anticipated to be used for maintenance and tillage/harvesting that will cross the diversion.

The ridge shall have a minimum top width of 4 feet (1.2m) at the design depth. The fill height shall include a settlement factor of not less than five percent.

Topsoil if needed for vegetative establishment.

Grade and Velocity. Channel grades may be uniform or variable. Channel velocity shall be non-erosive for the soil and planned vegetation or lining.

Maximum channel velocities for permanently vegetated unlined channels shall not exceed those recommended in the NRCS Engineering Field Handbook (EFH) Part 650, Chapter 7, or Agricultural Research Service (ARS) Agricultural Handbook 667, Stability of Grass-Lined Open Channels. When the capacity is determined by the formula $Q = A V$ and the V is calculated by using Manning's equation, an n value of 0.025 shall be used for bare channels.

Location. The outlet conditions, topography, land use, cultural operations, cultural resources, and soil type shall determine the location of the diversion.

Protection Against Sedimentation. Diversions are not applicable below high sediment producing areas unless land treatment practices or structural measures, designed to prevent damaging accumulations of sediment in the channels, are installed with or before diversions. This may include practices such as land treatment erosion control practices, cultural or tillage practices, vegetated filter strip, or structural measures. Install practices in conjunction with or

before the diversion construction. Refer to the Michigan NRCS Field Office Technical Guide (FOTG) Section IV for applicable practices.

If movement of sediment into the channel is a problem, the design shall include extra capacity for sediment or periodic removal as addressed in the operation and maintenance plan.

Outlets. Each diversion must have a safe and stable outlet with adequate capacity. The outlet may be a grassed waterway, a lined waterway, a vegetated or paved area, a grade stabilization structure, an underground outlet, a stable watercourse, a sediment basin, or a combination of these practices. The outlet must convey runoff to a point where outflow will not cause damage. Vegetative outlets shall be installed before diversion construction to ensure establishment of vegetative cover in the outlet channel. Refer to FOTG Section IV, Underground Outlet (620).

Vegetative Establishment. Disturbed areas that are not to be cultivated shall be seeded as soon as practicable after construction.

Seedbed preparation, seeding, fertilizing, and mulching shall be done in accordance with FOTG Section IV, Critical Area Planting (342).

Use vegetation adapted to the site that will accomplish the desired purpose. Preference shall be given to native species in order to reduce the introduction of invasive plant species; provide management of existing invasive species; and minimize the economic, ecological, and human health impacts that invasive species may cause. If native plant materials are not adaptable or proven effective for the planned use, then non-native species may be used. Refer to FOTG Section II, Invasive Plant Species for plant materials identified as invasive species.

Lining. If the soils or climatic conditions preclude the use of vegetation for erosion protection, non-vegetative linings such as gravel, rock riprap, cellular block, or other approved manufactured lining systems may be used. Refer to FOTG Section IV, Lined Waterway or Outlet (468) for design criteria.

CONSIDERATIONS

A diversion in a cultivated field should be aligned and spaced from other structures or practices to permit use of modern farming equipment. The side slope lengths should be sized to fit equipment widths when cropped.

At non-cropland sites, consider planting native vegetation in areas disturbed by construction.

Consider planning construction activities to minimize disturbance to wildlife habitat. Opportunities should be explored to restore and improve wildlife habitat, including habitat for threatened, endangered, and other species of concern.

Potential effects of installation and operation on cultural, historical, archeological, or scientific resources at or near the site need to be considered in planning.

Maximize wetland functions and values with the diversion design. Minimize adverse effects to existing functions and values. Diversion of upland water to prevent entry into a wetland could be a conversion of a wetland by changing the hydrology.

Use supplemental irrigation as necessary to promote establishment of vegetation.

Provide livestock and vehicular crossings as necessary to prevent damage to the diversion and its vegetation.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

Support data documentation requirements are as follows:

- Inventory and evaluation records
 - CONS-6 notes or special report
- Survey notes, where applicable
 - Design survey
 - Construction layout survey
 - Construction check survey
- Design records
 - Physical data, functional requirements, and site constraints, where applicable
 - Soils/subsurface investigation report, where applicable
- Design and quantity calculations
- Construction drawings/specifications with:
 - Location map
 - “Designed by” and “Checked by” names or initials
 - Approval signature
 - Job class designation
 - Initials from preconstruction conference

- As-built notes
- Construction inspection records
 - CONS-6 notes or separate inspection records
 - Construction approval signature
- Record of any variances approved, where applicable
- Record of approvals of in-field changes affecting function and/or job class, where applicable

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared for use by the client. The plan shall include specific instructions for maintaining diversion capacity, storage, ridge height, and outlets.

The minimum requirements to be addressed in the operation and maintenance plan are:

1. Provide periodic inspections, especially immediately following storms with a 10-year or greater return frequency.
2. Promptly repair or replace damaged components of the diversion as necessary.
3. Maintain diversion capacity, ridge height, and outlet elevations.
4. Mow the diversion between August 1 and August 20 to: encourage dense vegetation growth, control woody material, avoid peak nesting seasons and reduced winter cover for wildlife, and maintain capacity by reducing sediment deposition.
5. Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is at the lowest point. Inlets damaged by farm machinery must be replaced or repaired immediately.
6. Redistribute sediment as necessary to maintain the capacity of the diversion.
7. Vegetation shall be maintained and trees and brush controlled by hand, chemical, and/or mechanical means.
8. Keep machinery away from steep sloped ridges. Keep equipment operators informed of all potential hazards.
9. Do not use diversion as a field road. Avoid crossing wet areas with heavy equipment.