Appendix E - Biosolids Recycling and Soil Conservation

Land recycling of biosolids should go hand-in-hand with sound soil conservation practices. All areas used for biosolids applications should be managed within the context of an effective erosion and sediment (E&S) pollution control plan. This chapter provides a brief overview of soil conservation concepts and planning considerations related to biosolids applications to the land.

Critical Control Points / Operational Controls

Biosolids recycling and soil conservation controls are related to operation of the site where land application activities take place. They include:

- inspection of fields to assure that practices have been implemented
- periodic review of site to assure practices and structures are being maintained
- identification of areas where erosion is occurring
- crop rotation and tillage methods

Soil Conservation

Accelerated soil erosion can dramatically reduce land quality and productivity. Sediment deposition of eroded soil (sedimentation) in water bodies diminishes aquatic habitats. Soil erosion also reduces the water carrying capacity of streams and the storage volume in lakes, ponds, and reservoirs. Agricultural field rilling and gullying from accelerated erosion reduces soil productivity and can eventually render a field unusable for farming. Another unwelcome result is the transport of pesticides and nutrients into surface waters. For example, phosphorus washed from agricultural fields exposed to accelerated soil erosion can lead to enrichment (eutrophication) of local water bodies.

Accelerated soil erosion is principally caused by man's activities disturbing the soil's natural vegetative protective cover. Farm managers apply soil conservation practices to provide for high level, sustained, agricultural production while at the same time conserving vital soil resources. The guiding principle of soil conservation is to manage the soil resource base to maintain productivity indefinitely.

Farm Conservation Plan and Biosolids Recycling

A number of states have regulations governing erosion control. In the case of agricultural plowing and tilling, the landowner is responsible for managing the soil resource base. In doing so, the landowner may develop and implement an Erosion and Sedimentation (E&S) control plan, commonly called a *soil conservation* or *farm conservation* plan. In most states, areas receiving biosolids must have an *implemented* farm conservation plan.

Farm conservation plans prepared for biosolids recycling activities generally address areas of the site used directly for processing, storage, and land application of biosolids, as a minimum.

However, it is reasonable to manage all land at a site within the context of an effective conservation plan.

Structural practices such as diversions, terraces, and waterways are common components of a conservation plan. After initial installation, these conservation practices must be monitored to assure continued satisfactory performance. They tend to gradually fill-in, reducing their effectiveness over time. Consequently, maintenance of conservation practices is essential. Conservation practices used for field application of livestock manure are generally suitable for biosolids recycling. The exception to this is isolation distances from certain site features and some public access limitations required by local, state or federal ordinances or regulations. These requirements are discussed in Chapter 8. Imposition of more stringent conservation practices or increased isolation distances for biosolids recycling areas are not appropriate or necessary.

The Soil Erosion Process

Both wind and water can cause accelerated soil erosion. This chapter focuses on water erosion, which is the predominant soil loss mechanism in the U.S.

Factors Influencing Water Erosion

The four major factors affecting water erosion are:

- climate
- soil
- vegetation
- topography

Climate factors include precipitation, temperature, wind, humidity, and solar radiation, with precipitation energy being the most important. Soil properties such as structure, texture, organic matter content, moisture content, density, and chemical and physical characteristics all affect erosion. Appendix C provides additional information about these soil properties. Silts are generally considered to be the most erosive soil texture. Vegetation reduces soil erosion by: intercepting rainfall, slowing of surface water flows, binding soil aggregates with roots, and improving soil structure and infiltration capacity. Topographic factors that influence erosion include slope, slope length, and the size and shape of the contributing watershed.

Types Of Water Erosion

Soil erosion involves two basic processes:

- soil particle detachment
- transport

Five categories of soil erosion are recognized: *raindrop erosion*, *sheet erosion*, *rill erosion*, *gully erosion*, and *stream channel erosion*. Raindrop erosion occurs as a result of raindrop impact directly on soil particles. Splash displaces the soil and begins the erosion process. Sheet erosion is the uniform removal of soil in a very thin layer. Studies have shown that this type of erosion is very rare. In most cases, what is commonly perceived as sheet erosion is actually rill erosion on a microscopic level. Rill erosion detaches and moves soil by water running in small, well-defined flow paths. Loosened or displaced soil particles from raindrop impact also add to rill water

flows, increasing the impact of this form of erosion. Rill erosion can be particularly severe in areas containing soils with a low infiltration rate. By definition, rill erosion is readily seen and easily traversed or removed by normal tillage equipment. Gully erosion is similar to rilling, but the resulting flow channels can not be traversed or repaired by standard tillage equipment. It is therefore an advanced form of rill erosion. Stream channel erosion detaches soil particles from stream banks.

Soil Loss Prediction

Soil erosion loss is usually associated with sheet and rill erosion. For many years soil scientists have estimated soil loss (erosion) with the Universal Soil Loss Equation (USLE). The current form of this method, the Revised Universal Soil Loss Equation (RUSLE), is based on a version originally developed in the 1960s. This method was developed after 40 years of field observations. The procedure is called "Universal" because it accommodates geographic differences. Earlier prediction approaches were not readily applied to different geographic regions. Today, the equation is widely accepted and has proven to be a valuable tool for soil conservation planning. The RUSLE method is now used by most of the Natural Resource Conservation Service (NRCS) offices throughout the nation.

Once soil loss predictions are computed, they are compared with acceptable levels of soil loss. Acceptable levels of soil loss, or tolerance levels (T), are based on a variety of factors. In general, T represents the rate at which soil can be replaced by natural soil forming processes. If erosion is limited to levels at or below T, the soil base will be sustained indefinitely, the goal of soil conservation. Soils in different settings, derived from various parent materials, have different T values. The T values of soils across the United State range from 2 to 5 tons per acre per year. Most soils have T values of 3 to 4 tons per acre per year. Thinner soils have a T value of 2 while thicker soils have a T value of 5 (Jarrett, 2000). Standardized T values have been developed for each soil series, which are available from the local NRCS office.

Revised Universal Soil Loss Equation (RUSLE)

Equation E.1 presents the RUSLE in its most commonly recognized form. The factors involved in the soil erosion process are readily apparent in the equation.

Equation E.1

$$A = R \times K \times LS \times C \times P$$

Where:

A = Average annual soil loss, expressed in tons per acre

R = Rainfall and runoff erosivity index by geographic location
K = Soil-erodibility factor
LS = Topographic factor
C = Cropping-management factor
P = Conservation practice factor

Preparation of Conservation Plans

Farm conservation plans are typically prepared by the local NRCS office, in cooperation with the Local Conservation District (LCD). A request for preparation of a conservation plan is normally directed through the LCD. Depending on workload and priorities set by the LCD, preparation may take as little as one month or up to 12 months (or longer). An alternative to going through the LCD is to hire a private consultant, who may be able to prepare a plan more quickly, but for a fee. No fee is charged for plans prepared by the NRCS.

The content of a farm conservation plan, as formalized by the NRCS in practice, generally includes the following components:

- Identification of the farm owner(s) and operator(s)
- Local municipality and State location
- NRCS Soil Survey Map showing the location of the farm and its property limits
- Identification of the Land Capability Class of soils contained on the farm property
- A non-technical soils description for soils contained on the farm property
- A conservation plan map of sufficient scale to show cropland areas and various existing and proposed conservation plan practices
- A conservation plan map legend
- A record of decisions and application of conservation practices including: cropland area identification, and; planned and applied conservation practice amounts, dates, and narrative record for each cropland area
- Certification of compliance with the federal programs, such as the Food Security Act (signed by the land owner, NRCS district conservationist, and LCD)
- Soil loss calculation/documentation worksheets demonstrating that T will be met when the selected conservation practices are applied

The Part 503 Rule does not require that biosolids recycling conservation plans be approved by the LCD, but it is a good practice for private consultants to interact with LCD and/or NRCS personnel to obtain concurrence when possible. Plans prepared by private consultants may not include every component listed above. However, at a minimum, all conservation plans for biosolids recycling fields should demonstrate that soil losses from land application fields will not exceed T.

Some conservation plans prepared by the NRCS and approved by LCDs in the last 10 years have not been designed to meet T. As such, these plans may not satisfy the local requirements of an effective E&S plan. It is the responsibility of the land applier to confirm that farm conservation planning has been designed to meet the local conservation planning requirements and that the planned practices have in fact been installed and maintained.

Soil Conservation System Options

Table E.1 provides a list and brief description of conservation practices commonly employed on, or in conjunction with, cropland used for biosolids recycling.

Table E.1. Common Conservation Practices*

Conservation Practice	Brief Description
Crop Rotations	Alternating crops grown in a field according to a planned sequence. Rotations may include annual and perennial crops as well as grasses and legumes.
Cross Slope Farming	Farming across the slope, nearly on the contour. This practice is not as effective as contour farming and may result in the need for more waterways.
Contour Farming	Conduct tillage, planting and harvesting operations around the hill, not up and down. Increasing the height of ridges after planting creates miniature terraces increasing the effectiveness of this practice.
Contour Stripcropping	Planting alternate bands of permanent vegetation across the slopes on the contour. Use this practice to minimize the potential for erosion.
Residue Management	Protecting the soil from erosion by limiting tillage of the prior year's crop residue on the soil surface. Includes no till, mulch till, and ridge till.
Pasture and Hay Plantings	Grasses and/or legumes are planted for use as pasture and/or to be harvested as forage. Species are selected based on soil properties and specific use.
Contour Buffer Strips	Planting bands of permanent vegetation across the slopes on the contour. Use this practice to minimize the potential for erosion.
Field Borders	A band of grass or legume at the edge of a field used in place of end rows.
Filter Strips	Bands of grass or legumes that filter runoff and other contaminants before they reach water bodies or sources.
Cover Crops	Close-growing crops that temporarily protect the soil where major crops don't provide cover.
Diversions	Cross-slope constructed channel seeded to permanent vegetation used to intercept and safely dispose of surface runoff. Concentrated flows and sheet flow may be intercepted. Hay may be harvested. Diversions also provide habitat for wildlife when managed for that purpose.
Terraces	Cross-slope constructed channels that are cropped similarly to adjoining fields. Terraces intercept sheet and concentrated flows. Collected water is held to allow for maximum infiltration or is carried to a suitable outlet away from the

* After NRCS, 1996

Prior to field application of biosolids, land appliers should conduct a field tour to ensure that conservation practices have been installed and maintained in accordance with the farm conservation plan. If planned practices or acceptable substitutions have not been installed, the field should not be used for biosolids application until effective erosion control measures have been planned and installed as necessary. When land appliers are uncertain as to whether the planned conservation practices have been installed, the LCD should be contacted for their opinion. Alternatively a qualified private consultant may be used to make the determination.

References

Jarrett, A.R., (2000), Water management, Second Edition, Kendall/Hurst Publishing Co. Dubuque, Iowa.

NRCS, (1996), *A conservation catalog for Pennsylvania*, Cooperative effort of the NRCS, Pennsylvania Department of Environmental Protection and Somerset and Westmoreland CCD's

United States Department of Agriculture, (various dates), "County Soil Survey" (for county of interest). Natural Resources and Conservation Service