CHAPTER 3
OVERLAND FLOW SYSTEMS

3-1. Process description. As the name implies, overland flow is a process where wastewater flows over land that is carefully graded to encourage sheet flow. Grass is planted on the land to take up nutrients and control erosion. As the wastewater flows over the soil surface it is renovated by various physical, chemical and biological mechanisms. Also, some of the wastewater is lost through evapotranspiration by the grass and by percolation into the soil. The remaining wastewater is collected at the toe of the slope and is usually discharged to a receiving stream. As a result, most overland flow systems must comply with a point source discharge permit.

a. The overland flow site can contain one or several slopes. A slope is a discrete section of the overland flow site where the grade is uniform. Each slope is bounded by the distribution pipe at the top, the runoff collection ditch at the bottom and berms or access roads at the sides. The reason for dividing the site into separate slopes is to allow shutdown of portions of the site for harvesting and during operation and maintenance (O&M).

b. Runoff water quality from an overland flow slope will depend on the amount of time wastewater is allowed to remain in contact with the soil surface. Generally, longer detention times can be expected to produce a better runoff water quality than shorter detention times. The operator can control detention time on an existing slope by adjusting the application rate. The average runoff water quality from a properly operated system with adequate detention time is shown in table 3-1. Since overland flow treatment depends on detention time, it is important to maintain each slope so that water flows uniformly. If channeling occurs water will flow too quickly and detention time will decrease.

Table 3-1. Average runoff water quality.

Constituent	Concentration (mg/L)
BOD	10
Suspended solids	10
Ammonia nitrogen as N	4
Total phosphorus as P	4

c. The slopes should be seeded with a perennial grass mixture that has a high moisture tolerance, a long growing season and a high nutrient uptake, and that is well suited for the local climate and soil conditions. The mixture should contain grasses whose growth characteristics complement each other, such as sod formers and bunch grasses, and early and late maturing types. One mixture used quite successfully is reed canarygrass,

tall fescue, redtop, dallisgrass and ryegrass. Although this mixture has proven to be effective in a variety of climates, it is always best to consult a county agricultural extension agent.

3-2. Staffing requirements. Figure 2-2 can be used to estimate staffing requirements for overland flow systems.

3-3. Initial startup. Wastewater should not be applied to an overland flow slope until the grass is well established. Premature wastewater application will cause erosion and channeling. As a general rule, wastewater should not be applied until the grass has grown high enough to be cut once. Grass from the first cutting may be left on the slope to help build an organic mat. Grass clippings should be short enough to quickly fall to the soil surface because long clippings tend to remain on top of the cut grass and retard growth. An acclimation period is usually necessary after initial startup; during this time the microbial populations on the soil surface are increasing and adapting to the wastewater environment. This initial acclimation period may be as long as 4 months, but 1-2 months is typical for primary effluent.

3-4. Process control and monitoring.

a. Compliance monitoring. Most overland flow systems will have a discharge permit and it will specify allowable concentrations of BOD and suspended solids in the runoff. Groundwater monitoring may be required if the soil is relatively permeable and the site is located above a protected aquifer. The parameters to be monitored and the sampling frequency will usually be specified in the permit. It is important to establish background quality levels by taking several samples from all monitoring wells before the application of wastewater to the site. More information on groundwater monitoring can be found in paragraph 2-8,f.

b. Process control monitoring.

(1) Preapplication treatment. The O&M manual will contain the basic monitoring needs for the particular preapplication treatment process.

(2) Storage ponds. The process control monitoring requirements for storage ponds are the same for both overland flow and slow rate systems. Refer to paragraph 2-9,b for further information.

(3) Disinfection. Disinfection prior to application is not necessary except in the unlikely case that general public access is permitted. However, the runoff may have to be disinfected if a discharge permit that has a fecal coliform limitation is required. If this is the case, the operator should follow standard monitoring procedures recommended by the manufacturer of the disinfection equipment.

(4) Application site. The primary method of controlling the performance of an overland flow system is to adjust the application rate. The O&M manual will specify the basic application rate for each slope in the system. However, if this information is not available, the operator can

calculate or adjust the application rate as outlined in appendix A. The operator can control the volume of wastewater applied to a slope by controlling the application cycle. The application cycle is simply the length of time wastewater is applied. The application cycles used most often in existing overland flow systems range from 6 to 12 hours of continuous operation per day, 5 to 7 days per week. Use of an application cycle within this range should produce a consistent runoff water quality. Longer application cycles can be used temporarily to handle diverted flows because of harvesting or maintenance. A 24-hour per day application cycle is not recommended because it may result in anaerobic conditions on the slope, which could cause odors.

3-5. Routine operating procedures.

a. Preapplication treatment. It is beyond the scope of this manual to address all the routine operating procedures associated with various preapplication treatment processes. The procedures required for the processes in use will be described in the site-specific O&M manual for each system.

b. Storage ponds. The basic operating procedures for a storage pond should be the same for an overland flow system as for a slow rate system (see para. 2-12). The storage pond should only be used in the winter during prolonged cold. Once the slopes are back in operation the storage pond should be bypassed, and the stored wastewater should be blended with the incoming wastewater for application to the site. This procedure will reduce pretreatment costs and minimize algae growth in the storage pond. Algae can be difficult to remove by overland flow, since removal is dependent on the type of algae present in the wastewater. The dominant type of algae often changes with the season and control by the operator is not possible.

c. Application site.

(1) Annual startup. In the southern U.S. an overland flow system can generally operate year-round, but temporary shutdowns of 1 or 2 weeks may be necessary during the coldest weather. In the northern U.S., however, the shutdown period may last for several months. It will take approximately 1 month for the system to reacclimate after a prolonged winter shutdown.

(a) If the system has been shut down over the winter it should be restarted whenever frost is out of the topsoil layer. Typically, this will be in the month of March or April. The system should not be restarted too early because poor runoff water quality will result. Experience will dictate the best time to begin operation at a particular site.

(b) Before wastewater is applied to the slopes, all pipelines should be checked for leaks. Distribution lines at the top of the slopes should be releveled to ensure even flow distribution. Obvious channels on the slopes should be filled in with fine topsoil and reseeded. Commercial sod can also be used in areas where the channels are deep. These channels

and other barren areas should be reseeded with a mixture of grasses containing a quick growing species such as ryegrass. Application to reseeded areas should not begin until the grass is about 2 inches tall. Premature application could wash topsoil and seeds downslope.

(c) It may be necessary to use a lower application rate than normal for about a month after a prolonged shutdown. Otherwise, the runoff water quality may not meet permit requirements. Wastewater application can then be increased to the recommended rate as discussed in paragraph 2-13.

(d) During the early spring, the runoff may have a slight greenish tinge due to the algae. An algal mat sometimes develops on the surface of some slopes. However, the algae usually disappears as soon as the grass is tall enough to shade the surface. Excessive grass and weed growth in unlined collection channels can be a problem since rank growth will impede the rate of runoff flow. Lined channels may be the best solution since killing the grass with herbicides may then cause soil erosion.

(2) Daily operation. All components (pumps, valves, flowmeters and distribution sprinklers or pipelines) should be checked daily for proper operation. Some gated pipe may have a tendency to clog, which results in uneven flow distribution. If several of the openings become clogged, the flow rate through the remainder will increase, causing channeling and flow short-circuiting on the slope. The application rates and cycles should also be checked and maintained in accordance with paragraph 2-13. Wastewater application to the slopes should be stopped during a heavy rainstorm because continued application may hydraulically overload the terraces and cause channeling. Application can continue during light rain or drizzle even though the hydraulic detention time will decrease. Rainfall runoff from overland flow slopes is at least equal to and usually better in quality than the treated runoff.

(3) Harvesting. The grass should be cut two or three times a year and removed from the slopes. The best time to cut is just after the grass goes to seed. This cutting practice will result in the highest yields and best quality forage. Depending on the local market, the sale of the hay can provide a modest economic return. Also, regular harvesting can improve nutrient removal and allow the operator to look for potential channeling problems on the slopes. Only part of the overland flow site should be harvested at any one time so that the system can keep working.

(a) Before harvesting, each slope must be allowed to dry out so that equipment can travel over the soil surface without leaving ruts. Ruts could develop into channels, especially if they are oriented downslope. The drying time necessary before mowing is usually about 1 to 2 weeks; however, this can vary depending on the soil and climatic conditions. After mowing, the hay should be dried before raking and baling. This may take another week or so depending on the weather. The total time that the slope can't be used for each harvest then is approximately 2 to 3 weeks. This time can be reduced by a week or more if green chop harvesting is practiced instead of mowing, raking and baling. However, local markets may not exist for this type of forage.

(b) The standard equipment recommended for harvesting is a good farm tractor, a rake and a baler. A stake-body truck with a flatbed is also needed to take the hay to market or to a storage area. All equipment should have flotation tires to reduce rutting. Harvesting should be done across the slope so that opportunities for downslope rutting are reduced. All exposed pipelines and collection ditches should be clearly marked to avoid damage.

(c) Suggested monitoring programs for soils and vegetation are the same for overland flow as for slow rate systems (see para. 2-8,a). If the grass is used as fodder, samples may be required during each harvest; they should be analyzed for various nutritive parameters such as protein, fiber, total digestible nutrients, phosphorus and dry matter. These analyses can be conducted by the agricultural department of most state universities.

(d) After several years of operation certain native grasses and weeds will begin to grow on the slopes. In most cases these plants will have no impact on treatment efficiency but could decrease hay yields. Certain annual species such as barnyardgrass should be eradicated before they dominate a slope. When these plants die in the fall, the slope is left bare and is susceptible to soil erosion. Herbicides should be used to control these plants and barren areas should be replanted with perennial grasses. The county agricultural extension agent may be able to give advice on the type and amount of herbicide to use.

(4) Winter shutdown procedure. In general, overland flow systems should be shut down whenever runoff water quality does not meet the discharge permit because of sustained low temperatures. Like any other biological process, the reaction rate slows down as the temperature decreases. The length of the shutdown period will vary with climate and required runoff water quality. Once the system is shut down, it should not be restarted until spring. All distribution lines should be drained after the system has been shut down for the season. Wastewater flows should be diverted to the storage pond and all pumps and valves should be made ready for winter.

3-6. Emergency procedures. Emergency situations that might be of concern on overland flow systems include intense rainstorms, sudden cold spells, insect infestations and shock loadings of toxic wastes. Intense rainstorms should not present a problem if the runoff collection ditches were adequately sized and constructed. The ditches are typically designed, as a minimum, to carry runoff from a storm with a 25-year return frequency. It is usually desirable to install a drainage channel around the perimeter of the site to divert off-site runoff. Insect pests such as mosquitoes and army worms have been reported on some overland flow sites. Mosquitoes should not be a problem if the site is kept free of breeding areas such as stagnant ditches. Army worms, which are harmful to the vegetation, can be controlled with a pesticide. A certified exterminator should be consulted on the proper use of pesticides.

3-7. Maintenance considerations.

a. The key to successful performance of an overland flow system is maintaining "sheet flow" down the length of each slope. If channels develop due to poor construction or hydraulic overloads they should be filled in and reseeded at the earliest convenience. Another maintenance consideration is the health of the vegetation on the slopes. A healthy and prolific grass stand is very important. Barren areas should be reseeded at the earliest possible time.

b. Experience has shown that if surface distribution methods such as gated pipe are used to apply raw or primary wastewater to the overland flow site, solids will eventually accumulate on about the top 10 feet of each slope. This buildup occurs because the shallow depth of water flow allows the suspended particles to settle out quickly. If allowed to accumulate, the solids may smother the grass and become anaerobic. However, this problem can be eliminated by disking-in the solids, which then decompose in the soil. This only has to be done infrequently.