TCEQ REGULATORY GUIDANCE
Waste Permits Division
RG-417
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Guidelines for Preparing a Surface Water Drainage Plan for a Municipal Solid Waste Facility*

*This guide is suitable only for permit applications that were administratively complete before March 27, 2006. The Chapter 330 rules referenced in this guide are the former Chapter 330 rules, which were amended by the 2006 Revisions.

Contents

Texas Commission on Environmental Quality • PO Box 13087 • Austin, Texas • 78711-3087

1 Introduction

This guide is suitable only for permit applications that were administratively complete before March 27, 2006. The Chapter 330 rules referenced in this guide are the former Chapter 330 rules which were amended by the 2006 Revisions. This guide is intended for those who operate or apply to operate Type I and Type IV municipal solid waste (MSW) facilities in Texas. The Texas Commission on Environmental Quality (TCEQ) regulates these facilities under Title 30 of the Texas Administrative Code (30 TAC), Section 330.56(f). These rules require Type I and Type IV municipal solid waste facilities to have a surface water drainage plan.

The purpose of this guide is to provide suggestions for preparing an adequate surface water drainage plan based on published sources and on staff knowledge and experience. The guide focuses on hydrology issues that can be used to demonstrate that there is no alteration in the drainage pattern at the MSW facility. Other drainage issues—such as compliance with floodplain location restrictions or the design of the final-cover erosion layer—are either addressed in the MSW rules or in other TCEQ guidelines.

1.1 How to Use This Guide

This guide is not intended to be used as rules or policy and does not include all acceptable practices. Stakeholder input has been incorporated into this guide.

For more information on applicable sections from rules in 30 TAC Sections 330.55 and 330.56 (Subchapter E), go to the TCEQ Web site, **www.tceq.state.tx.us**. Follow the “Rules, Policy & Legislation” link to “Rules and Rulemaking” and “Download Rules.”

1.2 Where to Get More Information

You can contact the Municipal Solid Waste Permits Section in the following ways:

Phone: 512/239-2334
Mail: Municipal Solid Waster Permits Section, MC-124
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087
Fax: 512/239-6000
Web: **www.tceq.state.tx.us/permitting/waste_permits/msw_permits/msw_contact.html**

2 Maintaining Natural Drainage Patterns

A goal of the surface water drainage plan is to show that the development of the MSW facility will not adversely alter to any significant degree the natural drainage patterns of the watershed that will be affected by the proposed development. You demonstrate this goal by comparing predevelopment conditions and postdevelopment conditions.

2.1 How to Evaluate Alteration in Natural Drainage Patterns

According to Section 330.56(f)(2) and (4), natural drainage patterns must not be significantly altered as a result of the proposed development of the facility. You can evaluate the significance of changes to drainage patterns based on the impacts of changes on the following:

- receiving streams or channels,
- downstream flooding potential,
- adjacent and downstream properties, and
- downstream water rights and uses.

There is no clear-cut number or percent of change that can be set to indicate a “significant” change. However, you should demonstrate that drainage patterns will not be significantly altered because of the effect of the site development on (1) peak flows, (2) volumes, and (3) velocities from each permit boundary discharge point. Each is discussed in the following sections.

2.1.1 Peak Flows

It is important to consider how alterations to drainage patterns will affect changes in the magnitude of peak flows. In order to properly evaluate the effects of changes in the magnitude of peak flows, you should consider the timing of peak flows from the site and their contribution to peak-flow rates in receiving streams or channels.

The meaning of “significantly altered” depends on the sensitivity of the area of study; some areas tolerate a change in drainage patterns better than others. For example, a 1-percent deviation of 1,000 cubic feet per second (cfs) is 10 cfs and may be considered “significant” if the area of the study is sensitive; whereas, 10 percent of 1,000 cfs is 100 cfs and may be considered an insignificant alteration in a different, less sensitive setting.

What is considered “significant” is a subjective term that cannot be defined as a specific, objective criterion. A significant change would be a large percent for the Brazos River, but a small percent for a 20-foot-wide creek that has intermittent flow. Therefore, the “significantly altered” issue is best determined on a case-by-case basis and is one of professional judgment.

2.1.2 Volumes

In preparing your drainage plan, you should also consider alterations to drainage patterns caused by increased or decreased volumes of water discharged at various points resulting from the design storm, along with the potential impacts resulting from such changes. The design storm is the 24-hour, 25-year storm event as delineated in 30 TAC Section 330.55(b)(3). While peak flow can be controlled by detention pond volumes, they are a function of the area draining to a discharge point, as well as the amount of precipitation losses for a given design storm.

The precipitation losses for solid waste facilities typically result in a comparison between the losses in the predevelopment condition and the expected losses from the final configuration of the proposed landfill. For example, for a greenfield site, the precipitation losses may be modeled using HEC-1, software developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers (**www.hec.usace.army.mil /software/legacysoftware/legacysoftware.html**). You can also use a similar program, the Curve Number Method—also known as the Soil Conservation Service, or SCS Curve Number Method. It was developed by the Natural Resources Conservation Service (formerly the Soil Conservation Service) of the U.S. Department of Agriculture. For more information, see the Texas Department of Transportation's *Hydraulic Design Manual* at **http://manuals.dot.state.tx.us/dynaweb/colbridg/hyd**. In Chapter 5, go to "Section 7, NRCS Runoff Curve Number Methods."

A greenfield site is a characteristic description of a proposed municipal solid waste site that has a natural condition or an undeveloped condition—for example, virgin land or land with no large permanent structures. A typical curve number for a greenfield site may vary between 65 for a sandy soil located near a coastal region, to 84 in a hilly region with clay soils in North Central Texas.

Typical curve number values for final-cover systems range from 85 to 90. Therefore, if the drainage subarea does not change for a specific discharge point, the expected volume increase could vary from 5 percent to 60 percent.

As an applicant, it is your responsibility to demonstrate that any volume increase (or decrease) is not "significant." Typical methods for addressing this issue are listed below:

- Demonstrate that there is no increase in volume at a discharge point.
- Demonstrate that the additional volume will be released at a rate that will not significantly affect the downstream receiving water body. For example, the total volume increase may be 30 percent more for the postdevelopment condition, compared to the predevelopment condition. However, this increase may be demonstrated to be "not

significant" if it can be shown that the additional volume of water will be released at a rate that will not adversely affect the downstream receiving water body.

- Use storm water retention ponds.
- Demonstrate that any change in the volumes of water discharged from the permit boundary discharge points will not have a significant adverse effect on downstream water rights and uses.

2.1.3 Velocities

Another important way to show that there is no significant alteration in natural drainage patterns is to demonstrate that the velocity of the flow exiting the site at the discharge point along the permit boundary does not cause an increase in erosion. For example, maximum velocities in grass-lined channels are typically set at 5.0 feet per second.

Velocities are a function of the following:

- flow rate,
- drainage way cross-section geometry,
- surface, and
- slope along the flow line.

Typically, the postdevelopment geometry of the drainage way at the permit boundary, as well as at the surface and flow-line slope, should be consistent with the predevelopment condition. Therefore, if the postdevelopment flow rate is equal to or less than the predevelopment flow rate at the discharge point, the postdevelopment velocity will also be less.

However, in cases where the postdevelopment flow rate is greater than the predevelopment flow rate (but not a "significant" increase), then the postdevelopment velocity at the discharge point may be increased over the predevelopment condition. Typically, an increase in flow rate will be acceptable as long as the velocity is not increased to a point considered erosive (over 5 feet per second).

A focus of a storm water management system design for an MSW facility should be to return the storm water flow to its predevelopment condition before it leaves the permit boundary—a goal that is also consistent with maintaining natural drainage patterns. To achieve this goal, locate detention pond outlet structures and other velocity-dissipation devices upstream from the storm water discharge point to allow flow to return to the predevelopment condition at the permit boundary.

2.2 How to Analyze Natural Condition

In designing a municipal solid waste facility, be sure to conduct an analysis of the natural condition of the site. This will give you a baseline for comparison with the postdevelopment condition of the landfill and a way to show that the natural drainage conditions have not changed. Please refer to rules in Sections 330.56(f)(4)(A)(iv) and 330.55(b)(5)(D). The predevelopment condition must be quantified in order to make a reasonable comparison. If the natural drainage condition has not been altered by previous development on the site, then the natural drainage condition—which is the same as the "existing" drainage condition that is required by 30 TAC 330.56(c) and is to be shown on Part III, Attachment 3 to the permit application—should be used as the predevelopment condition.

If the site has been previously altered by a well-established development such as an old sand mine or an existing permitted landfill, then consider evaluating the impacts of the proposed facility development by comparing conditions at the time of permit application with the proposed postdevelopment conditions. An exception to this could, for example, be if a relatively new sand or gravel mine exists on the site. In this case, the relevant predevelopment condition may be before the sand or gravel mine was developed.

2.2.1 Conditions to Be Analyzed

In analyzing the natural condition of sites where there has been no prior landfill development (greenfield sites), the appropriate comparison should be between the condition at the time the application is filed and the postdevelopment condition. For expansions of existing facilities, the appropriate comparison should be between the currently approved (permitted) site closure condition and the proposed postdevelopment condition.

2.2.2. Conditions for Permit Modifications

In analyzing the natural condition in cases where a permit modification is requested, the appropriate comparison is between the currently approved (permitted) site closure condition and the postdevelopment condition proposed by the requested permit modification. Permit modifications allow changes to improve drainage conditions for existing permitted or registered sites.

3 Defining Existing, Predevelopment, and Postdevelopment Conditions

The “existing” condition of a landfill site is described as topography and drainage conditions before grading, excavating, or filling operations, or any combination of these activities—30 TAC Section 330.56(c), the section entitled “Attachment 3, Existing Contour Map.” This is the naturally occurring drainage condition of the site.

The predevelopment condition is the condition of the drainage pattern at the time the application is submitted, reflecting any previous development activities on the tract that may have changed the natural drainage patterns. If no development has taken place, the predevelopment conditions are those that naturally occur, or the “existing” conditions.

If the application is to amend a permit, the predevelopment condition is the currently permitted condition (final landfill configuration at closure) at the time the permit amendment is submitted. The postdevelopment condition of a landfill site is the condition of the drainage patterns at the time of the landfill closure. The postdevelopment condition includes: the conditions of a site that are expected to be present at the time the landfill is fully developed to final elevations and closed; as well as on-site, nonlandfill changes to drainage patterns that are expected to occur before landfill closure (county or drainage district improvements to an existing stream or channel crossing the site).

4 Submitting an Application

When you submit an application for a Type I and Type IV MSW facility, you should usually provide the following information, in accordance with 330.56(f)(4):

- description of the hydrologic method and calculations used to estimate peak-flow rates and runoff volumes, including justification of necessary assumptions;
- the 25-year rainfall intensity used for facility design, including the source of the data, and all other data and necessary input parameters (documented and described) used in conjunction with the selected hydrologic method, hydraulic calculations, and designs for sizing the necessary collection, drainage, and/or detention facilities;
- discussion and analyses to demonstrate that natural drainage patterns will not be significantly altered as a result of the proposed landfill development;
- structural designs of the collection, drainage, and/or storage facilities, and results of all field tests to ensure compatibility with soils;
- maintenance plan for ensuring the continued operation of the collection, drainage, and/or storage facilities, as designed, along with

the plan for restoration and repair in the event of a washout or failure; and

- erosion and sedimentation control plan, including interim controls for phased development.

4.1 Checkpoints to Analyze

Use the following checkpoints to conduct a point-by-point analysis of the surface water:

1. Determine the specific discharge points for the runoff, or determine the overland (sheet) flow direction for predevelopment conditions from the permit boundary.
2. Determine drainage subareas, and calculate the peak flow rates—units in cfs or cubic meters per second (m^3/s)—for predevelopment conditions for each of the discharge points and/or the overland flow.
3. Calculate the volume of the runoff—units in cubic feet (ft^3), acre-feet, or cubic meters (m^3)—for the storm event for each of the discharge points for predevelopment conditions.
4. Determine the maximum velocity (ft/s or m/s) of the peak runoff at each of the discharge points for predevelopment conditions.
5. Determine the areas off site that contribute flows onto the permit boundary (run-on), and calculate the peak-flow rate, velocity, and volume of run-on from each off-site area onto the site for predevelopment conditions.
6. Determine discharge points for the postdevelopment condition at the permit boundary.
7. Determine drainage subareas, and calculate the peak flow rates for postdevelopment conditions for each of the discharge points.
8. Calculate the volume of the runoff for the storm event for each of the discharge points for postdevelopment conditions.
9. Determine of the maximum velocity of the peak runoff at each of the discharge points for postdevelopment conditions.
10. Determine the areas off site that contribute flows onto the permit boundary (run-on), and calculate the peak flow rate, velocity, and volume of run-on from each off-site area onto the site for postdevelopment conditions.
11. Compare the information for Item 1 to Item 6; Item 2 to Item 7; Item 3 to Item 8; and Item 4 to Item 9. Discuss differences in these values in terms of whether the changes are significant.
12. Determine the conveyance method to carry the runoff to the discharge points.
13. Determine the need for detention and retention of the excess runoff that is generated by the postdevelopment conditions.
14. Calculate the size of any pond, ditch, or other feature that will be used to reduce the peak-flow rate and runoff volume at each discharge point at the permit boundary.

15. Determine the need for feature(s) that will be used to control the velocity to maintain a discharge velocity that does not represent a significant alteration of the value from Item 4.
16. Determine the need for features that will be used to manage the off-site run-on flows that may be diverted around the filled area for Items 5 and 10.
17. Check to make sure that the drainage system is properly sized. Typical items to check are cross-sectional areas, ditch grades, flow rates, water surface elevation, velocities, and flow-line elevations along the entire length of each ditch.
18. Perform analysis of the significance of alterations of natural drainage patterns.

Any off-site drainage feature that is to be considered a component part of the facility drainage system must be accessible through an easement or restrictive covenant. This will allow the TCEQ to access the area for inspections during the active life of the landfill, as well as for the postdevelopment closure period.

5 Demonstrating That Drainage Is Not Significantly Altered

Consider using the following information to demonstrate that natural drainage patterns will not be altered significantly by your MSW facility. Please refer to rule Sections 330.56(f)(4)(A)(iv) and 330.55(b)(5)(D).

5.1 What to Include in Summary of Regional Drainage Information

In this portion of your demonstration, show how the site fits into the regional watershed. Show the percentage of area to be developed versus the watershed area. Also show the designation of downstream creeks and rivers.

5.2 How to Identify Site Drainage Patterns

Identify discharge points at the permit boundary for each condition. Identify drainage subareas for each discharge point at the permit boundary. Summarize the effect of the proposed landfill development on the drainage subareas. Show how each drainage subarea has been changed. Also include a discussion of how a change to a drainage subarea may affect a regional pattern, if it is appropriate.

5.3 How to Show Effects on Peak Flows, Velocities, and Volumes

Your demonstration should show peak flows, volumes, and velocities entering and leaving the site at each discharge point. Illustrate those items or discuss them in Attachment 6 of the permit application. Include discussion about how the proposed development of the landfill affects the shape and time to peak values of hydrographs for each condition at the permit boundary, as well as any relevant downstream analysis point, such as adjacent lands, downstream creeks, and downstream reservoirs.

6 Calculating Runoff

Several methods of calculating runoff are available and are appropriate to use. Some methods are more limited than others.

6.1 Rational Method Versus Computer Models

Because of the lack of volume runoff determination and hydrograph development, the Rational Method is recognized as being limited in providing information that is required to show that there is no significant change to natural drainage patterns. To compensate for the limitations of the Rational Method, determine the volume by using one of the methods from the NRCS *Technical Release 55* (*TR-55*). You can find it in TxDOT's *Hydraulic Design Manual*, which is available at **http://manuals.dot.state.tx.us/dynaweb/colbridg/hyd**. In Chapter 5, go to "Section 7, NRCS Runoff Curve Number Methods."

The Rational Method is needed for small drainage areas of less than 200 acres (note that the 200-acre standard applies to the total area of the watershed(s) above and including the proposed landfill permit boundary).

For areas larger than 200 acres, you can demonstrate that there is no significant alteration to natural drainage patterns using the HEC-1 or HEC-2 computer programs (**www.hec.usace.army.mil/software /legacysoftware/legacysoftware.html)** developed through the Hydrologic Engineering Center of the United States Army Corps of Engineers (**www.hec.usace.army.mil**). You can also use an equivalent or better method approved by the TCEQ executive director. The newer HEC computer models—found at the Web site for the Hydrologic Engineering Center previously listed—should be allowed and are simply not named in the rules. Both HEC-HMS and HEC-RAS are acceptable and preferred methods since they have superseded the old HEC-1 and HEC-2.

HEC computer models are named for the place where they were founded—the Hydrologic Engineering Center of the United States Army

Corps of Engineers. The HEC-HMS model is generally thought to supercede HEC-1, and the HEC-RAS model supercedes HEC-2.

The HEC-HMS or HEC-1 methods are more useful ways to demonstrate no significant change to natural drainage patterns because they model a watershed. The HEC-RAS method models rivers, ditches, and channels.

6.2 What Precipitation Data to Provide

Your drainage analysis should include precipitation design data, along with sources that are documented and described. Acceptable precipitation data references include *Technical Paper 40* (*TP-40*) and *Hydro-35*. *TP-40* presents maps of rainfall frequency in the Eastern U.S. for selected durations from 30 minutes to 24 hours, and for return periods from 1 to 100 years. *TP-40* is currently out of print and is superseded in part by two publications: *Hydro-35* and *Atlas 2* of the National Oceanic and Atmospheric Administration (NOAA). You can get copies and electronic

copies of *TP-40* from many sources, including the following Web sites: **http://manuals.dot.state.tx.us/docs/colbridg/forms/hyd_apxB.pdf** and **www.srh.noaa.gov/lub/wx/precip_freq/precip_index.htm**. .

For durations of 1 hour or less, *Hydro-35* supersedes *TP-40* for the eastern two-thirds of the United States; Texas is included in this area. NOAA *Atlas 2* supersedes *TP-40* for the western one-third of the U.S.

In Texas, *TP-40* is the most commonly used reference because it fits the rule requirements for the 24-hour duration and the 25-year return period specified in the rules, Section 330.55(b)(3). The *Hydraulic Design Manual* of the Texas Department of Transportation (TxDOT) Bridge Division also uses this precipitation data to compute "Rainfall Intensities" and to determine the "Rain Index." The TxDOT manual is referenced in the rules in Section 330.55(b)(5)(A).

The current version of the *Hydraulic Design Manual* of TxDOT's Bridge Division may be viewed or downloaded online from the TxDOT Web site, **http://manuals.dot.state.tx.us/dynaweb**, which also has links to many of the publications referenced in this guidance.

6.3 How to Determine Water Loss

An acceptable method for determining the volume of water lost and excess volume runoff is the Runoff Curve Method. It was established by the NRCS and was formerly known as the Soil Conservation Service (SCS) Method. You can find this method in the *TR-55*. .

6.4 How to Establish Direct Runoff

The method typically used in drainage analysis is the Kinematic Wave Method. It is one of the methods the HEC-HMS computer model uses to estimate peak flow and runoff volume. You can find it in the *TR-55* or the *HEC-HMS Reference Manual*.

Direct runoff methods—for example, both Kinematic Wave and Muskingum-Cunge methods—are applicable to small-water catchments with uniform slopes, channels, and drainage patterns. Landfill final-cover areas generally consist of relatively short overland flow lengths that drain into landfill final-cover swales.

Methods for estimating direct runoff are generally applicable to final-cover areas of landfills for the following reasons:

- Direct runoff methods were developed for uniform slopes that drain to collection channels. For a landfill final-cover area, this translates to an overland flow segment, which is typically a 4-horizontal to 1-vertical (4H:1V) slope that drains to a swale.
- Direct runoff methods were developed for a network of relatively small drainage subareas. In designing the various final-cover erosion control structures and perimeter channels, landfill drainage subareas need to be subdivided to obtain a peak flow at several points.
- Direct runoff methods are applied readily to small watersheds because they are based on physical parameters of the watershed, as opposed to other methods. Those other methods generally are developed empirically for various terrains in different climates, and are conservative because flow attenuation is not considered.

6.5 Incorporating Local Government Regulations

Where there are local government drainage regulations or manuals that pertain to a site, follow local government requirements in developing the landfill design, analysis, and demonstrations. In no case should less stringent local regulations supercede requirements of Chapter 330.

6.6 What Storm Event to Use

The design storm event established in the rules is a single 24-hour, 25-year storm event. The requirement is in Section 330.55(b)(3).

6.7 Routing Methods for Hydrographic Data

Two hydrographic methods for flood routing may be found in the TxDOT Bridge Division's *Hydraulic Design Manual*:

- storage routing, which is commonly used to account for inflow and outflow rates and significant water storage characteristics associated with reservoirs and detention; and

- channel routing, which is used when known hydrographic data are located somewhere other than the point of interest, or when the channel profile or plan is changed to alter the natural velocity or channel storage characteristics.

6.7.1 Hydrograph Storage Routing

Several hydrographic methods route flood runoff through reservoirs or other detention facilities. All of the methods require reliable descriptions of the following three items:

- an inflow runoff hydrograph for the subject flood;
- the storage capacity versus water elevation within the facility; and
- the performance characteristics of outlet facilities associated with the operation of the facility.

By definition, a steady-state condition exists when inflow and outflow from a reservoir or any type of storage facility are equal. If the inflow exceeds the outflow, the additional discharge is stored in the system. Conversely, when the outflow exceeds the inflow, water is taken from storage. Storage routing normally is used to account for inflow and outflow rates and significant water-storage characteristics associated with reservoirs and detention/retention.

6.7.2 Hydrograph Channel Routing

Routing of flood hydrographs by means of channel routing procedures is useful in instances where known hydrographic data are not at the point of interest. Also, channel routing can be used where the channel profile or plan is changed in such a way as to alter the natural velocity or channel storage characteristics. Routing analysis estimates the effect of a channel reach on an inflow hydrograph.

7 Designing Detention Ponds

The purpose of detention ponds in landfill drainage design is to accommodate and attenuate excess rainfall, and to provide a controlled release of that rainfall.

7.1 What Analysis Is Required

In designing a detention pond, the goal of your analysis should be to accommodate and attenuate values of velocity, flow rate, and volume of storm water that exceeds predevelopment conditions resulting from a 24-hour, 25-year storm event. Those three values for storm water being discharged at the point of interest should not change significantly when compared with predevelopment conditions.

7.2 How to Size Detention Ponds

There are many methods and models for sizing detention ponds, but the preferred methods include the Rational Method, as well as the following: HEC-1, HEC-HMS, HEC-2, and HEC-RAS. Other methods that are available through the public domain (not commercial) are also acceptable, such as the NRCS's *TR55*.

The following is an example of a typical approach to find the size of a detention pond.

1. Obtain the excess values of velocity, flow rate, and volume through a drainage analysis comparison using the Rational Method, HEC-1, HEC-HMS, HEC-2, or HEC-RAS models.
2. Calculate the velocity and flow rate.
3. Use the NRCS (or SCS) Runoff Curve Method to calculate the runoff volume.

The results will give adequate information to estimate the pond size. Although not required, a 1- to 2-foot freeboard should be added to the calculated pond size. Some typical input parameters for determining a typical detention pond are design areas, land types and characteristics, land slopes, rainfall intensity, rainfall index, and soil types.

Attachment A:
Rules on Surface Water Hydrology

§330.55. Site Development Plan.

(b) The Site Development Plan of the Application shall contain sufficient information to document compliance with the following.

- (1) A facility shall not cause:
  - (A) a discharge of solid wastes or pollutants adjacent to or into the water in the state, including wetlands, that is in violation of the requirements of the Texas Water Code, §26.121;
  - (B) a discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements, pursuant to §402 as amended;
  - (C) a discharge of dredged or fill material to waters of the United States, including wetlands, that is in violation of the requirements under the Federal Clean Water Act, §404, as amended; and
  - (D) a discharge of a nonpoint source pollution of waters of the United States, including wetlands, that violates any requirement of an areawide or statewide water quality management plan that has been approved under the Federal Clean Water Act, §208 or §319, as amended.
- (2) The owner or operator shall design, construct, and maintain a run-on control system capable of preventing flow onto the active portion of the landfill during the peak discharge from at least a 25-year storm.
- (3) The owner or operator shall design, construct, and maintain a run-off management system from the active portion of the landfill to collect and control at least the water volume resulting from a 24-hour, 25-year storm. The run-off from the active portion shall be discharged in compliance with paragraph (1) of this subsection or disposed of in an authorized manner.
- (4) Dikes, embankments, drainage structures, or diversion channels sized and graded to handle the design run-off shall be provided. The slopes of the sides and toe shall be graded in such a manner so as to minimize the potential for erosion.
- (5) Drainage calculations are as follows.
  - (A) Calculations for areas of 200 acres or less shall follow the rational method and shall utilize appropriate surface run-off coefficients, as specified in the Texas Department of Transportation Bridge Division Hydraulic Manual. Time of run-off concentration as defined within the said manual generally shall not be less than 10 minutes for rainfall intensity determination purposes.
  - (B) Calculations for discharges from areas greater than 200 acres shall be computed by using USES/DHT hydraulic equations compiled by the United States Geological Survey and the Texas Department of Transportation and Public Transportation (TxDOT Administrative Circular 80-76), the HEC-1 and HEC-2 computer programs developed through the Hydrologic Engineering Center of the United States Army Corps of Engineers, or an equivalent or better method approved by the executive director.
  - (C) Designs of all drainage facilities within the site area shall include such features as typical cross-sectional areas, ditch grades, flow rates, water surface elevation, velocities, and flowline elevations along the entire length of the ditch.
  - (D) Sample calculations shall be provided to verify that natural drainage patterns will not be significantly altered.
  - (E) The proposed surface water protection and erosion control practices must maintain low non-erodible velocities, minimize soil erosion losses below permissible levels, and provide long-term, low maintenance geotechnical stability to the final cover.
- (6) The owner or operator shall handle, store, treat, and dispose of surface or ground water that has become contaminated by contact with the working face of the landfill or with leachate in accordance with §330.139 of this title (relating to Contaminated Water Discharge). Storage areas for this contaminated water shall be designed with regard to size (verifying calculations included), treatment (supporting documentation and calculations included), locations, and methods and shall have an approved liner covering the bottom and side slopes. Other surface run-off water shall be handled in accordance with paragraph (3) of this subsection.

(7) The site shall be protected from flooding by suitable levees constructed to provide protection from a 100-year frequency flood and in accordance with the rules and regulations of the TWC and successors relating to levee improvement districts and approval of plans for reclamation projects or the rules of the county or city having jurisdiction under the Texas Water Code, §16.236, as implemented by §§301.31-301.46 of this title (relating to Levee Improvement Districts, District Plans of Reclamation, and Levees and Other Improvements).
  (A) Flood protection levees shall be designed and constructed to prevent the washout of solid waste from the site.
  (B) A freeboard of at least three feet shall be provided except in those cases where a greater freeboard is required by the agency having jurisdiction under the Texas Water Code, Chapter 16.236.
  (C) Such levees shall not significantly restrict the flow of a 100-year frequency flood nor significantly reduce the temporary water storage capacity of the 100-year floodplain.
(8) The final cover design shall provide effective long-term erosional stability to the top dome surfaces and embankment side slopes in accordance with the following.
  (A) Estimated peak velocities for top surfaces and embankment slopes should be less than the permissible non-erodible velocities under similar conditions.
  (B) The top surfaces and embankment slopes of MSWLF units shall be designed to minimize erosion and soil loss through the use of appropriate side slopes, vegetation, and other structural and non-structural controls, as necessary. Soil erosion loss (Tons/Acre) for the top surfaces and embankment slopes may be calculated using the Soil Conservation Service of US Department of Agriculture's Universal Soil Loss Equation, in which case the potential soil loss should not exceed the permissible soil loss for comparable soil-slope lengths and soil cover conditions.
  (C) Details for final cover shall be depicted on fill cross-sections and provided along with other information in accordance with §330.56(b) of this title (relating to Attachments to the Site Development Plan).

§330.56. Attachments to the Site Development Plan.

(a) Attachment 1—site layout plan.
  (1) This is the basic element of the site development plan consisting of a site layout plan on a constructed map showing the outline of the units and fill sectors with appropriate notations thereon to communicate the types of wastes to be disposed of in individual sectors, the general sequence of filling operations, locations of all interior site roadways to provide access to all fill areas, locations of monitor wells, dimensions of trenches, locations of buildings, and any other graphic representations or marginal explanatory notes necessary to communicate the proposed step-by-step construction of the site. The layout should include: fencing; sequence of excavations, filling, maximum waste elevations and final cover; provisions for the maintenance of natural windbreaks, such as greenbelts, where they will improve the appearance and operation of the site; and, where appropriate, plans for screening the site from public view.
  (2) A generalized design of all site entrance roads from public access roads shall be included. All designs of proposed public roadway improvements such as turning lanes, storage lanes, etc., associated with site entrances should be coordinated with the agency exercising maintenance responsibility of the public roadway involved.
  (3) This plan is the basis for operational planning and budgeting, and therefore shall contain sufficient detail to provide an effective site management tool.
(b) Attachment 2—fill cross-section.
  (1) The fill cross-sections shall consist of plan profiles across the site clearly showing the top of the levee, top of the proposed fill, maximum elevation of proposed fill, top of the final cover, top of the wastes, existing ground, bottom of the excavations, side slopes of trenches and fill areas, gas vents or wells, and groundwater monitoring wells, plus the initial and static levels of any water encountered.
  (2) The fill cross-sections shall go through or very near the soil borings in order that the boring logs obtained from the soils report can also be shown on the profile.
  (3) Large sites shall provide sufficient fill cross-sections, both latitudinally and longitudinally, so as to accurately depict the existing and proposed depths of all fill areas within the site. The plan portion shall be shown on an inset key map.

(4) Construction and design details of compacted perimeter or toe berms which are proposed in conjunction with aboveground (aerial-fill) waste disposal areas shall be included in the fill cross-sections.

(c) Attachment 3—existing contour map. This is a constructed map showing the contours prior to any grading, excavation, and/or filling operations on the site. Appropriate vertical contour intervals shall be selected so that contours are not further apart than 100 feet as measured horizontally on the ground. Wider spacing may be used when approved by the executive director. The map should show the location and quantities of surface drainage entering, exiting, or internal to the site and the area subject to flooding by a 100-year frequency flood.

(f) Attachment 6—Groundwater and surface water protection plan and drainage plan. These plans shall reflect locations, details, and typical sections of levees, dikes, drainage channels, culverts, holding ponds, trench liners, storm sewers, leachate collection systems, or any other facilities relating to the protection of groundwater and surface water. Adequacy of provisions for safe passage of any internal or externally adjacent floodwaters should be reflected here.

(1) A drawing(s) showing the drainage areas and drainage calculations shall be provided.

(2) Cross-sections or elevations of levees should be shown tied into contours. Natural drainage patterns shall not be significantly altered.

(3) The 100-year floodplain shall be shown on this attachment.

(4) As part of the attachment, the following information and analyses shall be submitted for review, as applicable.

(A) Drainage and run-off control analyses:

(I) a description of the hydrologic method and calculations used to estimate peak flow rates and run-off volumes including justification of necessary assumptions;

(ii) the 25-year rainfall intensity used for facility design including the source of the data; all other data and necessary input parameters used in conjunction with the selected hydrologic method and their sources should be documented and described;

(iii) hydraulic calculations and designs for sizing the necessary collection, drainage, and/or detention facilities shall be provided.

(iv) discussion and analyses to demonstrate that natural drainage patterns will not be significantly altered as a result of the proposed landfill development;

(v) structural designs of the collection, drainage, and/or storage facilities, and results of all field tests to ensure compatibility with soils; and

(vi) a maintenance plan for ensuring the continued operation of the collection, drainage, and/or storage facilities, as designed along with the plan for restoration and repair in the event of a washout or failure; and

(vii) erosion and sedimentation control plan, including interim controls for phased development.

(B) Flood control and analyses.

(I) Identify whether the site is located within a 100-year floodplain. Indicate the source of all data for such determination and include a copy of the relevant Federal Emergency Management Agency (FEMA) flood map, if used, or the calculations and maps used where a FEMA map is not available. Information shall also be provided identifying the 100-year flood level and any other special flooding factors (e. g., wave action) that must be considered in designing, constructing, operating, or maintaining the proposed facility to withstand washout from a 100-year flood. The boundaries of the proposed landfill facility should be shown on the floodplain map.

(ii) If the site is located within the 100-year floodplain, the applicant shall provide information detailing the specific flooding levels and other events (e.g., design hurricane projected by Corps of Engineers) that impact the flood protection of the facility. Data should be that required by §§301.33-301.36 of this title (relating to Approval of Levees and Other Improvements).

(iii) No solid waste disposal and treatment operations shall be permitted in areas that are located in a floodway as defined by FEMA.