



Turned Windrow Composting

Site Identification and Design Considerations

Turned Windrow Compost

Turned windrow composting is a simple and versatile method for managing the composting process. For this reason, windrows are utilized by composters of all scales for handling a wide variety of materials. Planning a turned windrow operation is an approachable process for many people, none-the-less; the quality of your composting site will have a significant impact on your efficiency, the ease of pile management, and the final quality of the compost produced on the site.

In addition, your compost site is the interface between the nutrient-rich feedstocks pro-

cessed by your operation and the surrounding ecology. Developing a site that meets your physical and logistical needs, is easily managed and accessed, and prevents the movement of nutrients and pathogens from entering surface or ground water requires effective planning and careful consideration. The purpose of this guide is to support the identification and planning of turned windrow composting sites. Operations composting food scraps (source-separated organics or SSO) in Vermont are the main focus of this guide, although many of the concepts will apply to composters of farm wastes and other materials, as well as composters in other states.

Additionally, sections on compost site permitting in Vermont will apply to other composting methods besides turned windrows.



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Companion
Resource:

**Turned Windrow
Composting:**
Sizing Your
Compost Pad

By far the most common technique for composting beyond home scale is the turned windrow method. A windrow is an elongated pile, which is generally turned or “rolled” from the side with a bucket loader, tractor, or a specially engineered machine called a windrow turner. Windrows can also be turned by hand by volunteers in human powered operations. The long shape of a windrow makes the piles easy to turn and provides surface area for passive airflow into the compost. Windrows also provide a simple means to organize a compost site, by combining and tracking materials of a similar age in a scalable volume.

From Growing Local Fertility: A Guide to Community Composting





Compost Site Identification

Sizing a Turned Windrow Composting Site

Your compost site's space requirements will significantly impact where you locate your site. While your site development process will balance a variety of factors, start your process by sizing the site so that you know what your baseline criteria for space is. Underestimating the spatial requirements for efficient operation at the site's target capacity is a common mistake and can be avoided.

For assistance sizing your site, see "Sizing a Turned Windrow Composting Facility" worksheet, and if needed, seek technical assistance. If you plan to utilize other methods of composting, such as the Aerated Static Pile (ASP) Method or an In-Vessel Compost System, in combination with or in place of a turned windrow system, proper sizing is equally as important.

In addition to sizing your active composting areas, the footprint of other infrastructure must be accounted for. A full list of likely SSO composting site improvements and components includes:

- Access Roads, Loading Areas, Truck Turn Around, Etc.
- Feedstock Storage Areas (Covered and/or Uncovered)
- Tipping Dock, Receiving, & Blending Area
- Improved Composting Pads (Windrows and Work Area)
- Compost Curing Area
- Finished Compost Storage
- Storm Water and Leachate Management Areas
- Compost Screening Area
- Compost Bagging Area
- Greenhouse for Plant Bioassays

Once you have a solid understanding of the scale of your operation and its target processing capacity, you will need to look at where the operation falls within your local regulatory framework. Tables 1 and 2 in the following section illustrate the general applicability of rules that govern composting in Vermont and cover the topics of scale and criteria for siting.

Regulatory Requirements and Site Compliance

In addition to having an adequate footprint for your operation, the site must meet siting and use criteria for applicable regulations. Several Permits or Registrations may be required for your composting site to operate and in most cases, prior to embarking on any site improvements. Depending upon the scale and complexity of your situation, you may benefit from consulting with a technical service provider or permit specialist for assistance identifying the applicable regulations. Composting agricultural byproducts (manures, plant matter, animal mortalities) on the farm from which the material originates does not require a permit in Vermont, however other organic materials, such as food scraps (SSO), sourced from off the farm will likely require that the site acquire a permit.

In addition to solid waste regulations, your facility may fall under several other regulatory jurisdictions. General applicability of the regulations that apply to composters in Vermont is outlined in Table 1. Table 2 provides an overview of the unique siting criteria for Small, Medium, and Large Compost Facilities in Vermont, as well as for exempt activities.



Table 1. Regulation Applicability of Vermont's Composters

Facility Scale	Total Processing	Food Scrap Processing	Yard Waste Processing	Management Area Footprint	General Siting & Design Requirements
Small	≤5000 Yards ³ /Year	≤2000 Yards ³ /Year	≤10000 Yards ³ /Year	≤ 4 Acres	<ul style="list-style-type: none"> • Manage leachate from the compost management area through the use of a vegetative area for the treatment of leachate and stormwater run off from the compost management area designed and maintained in the following manner: <ol style="list-style-type: none"> a) Equal to the area of the compost management area. b) Equal to the contributing length of the compost management area in the downslope direction c) Located on an area with a slope ≤ five percent and shall be managed to prevent the ponding or pooling of liquids in the area. • Composting on farms used for the cultivation of food, fiber, horticultural, or orchard crops that are exempt from Act 250 are not eligible, and will need to be permitted as a medium facility. • If composting slaughterhouse waste, mortalities, or offal, then a small registration is not applicable and a medium must be obtained. • Small composters must adhere to the ACPs. If ACPs can't be met, then medium must be obtained.
Medium	≤40000Yards ³ /Year	≤5000Yards ³ /Year	>10000Yards ³ /Year	<10 Acres	<ul style="list-style-type: none"> • Collect and treat all leachate from the active composting area in a lined pond, swale or lagoon. • Compost Management Area is on an improved surface. • A minimum setback of 10,000 feet of a runway used by turbojet aircraft, or 5,000 feet of a runway used only by piston-type aircraft. • Not within 1000 feet of a residential housing unit located within an area that has a residential housing density of 3 units per acre or greater.
Large	>40000Yards ³ /Year	>5000Yards ³ /Year	N/A	>10 Acres	Same as for Medium Compost Facilities Above
Exempt Activities	≤100 Yards ³ /Year	Not Specified	3000 Yards ³ /Year		<ul style="list-style-type: none"> • For a complete list of exemptions refer to 6-1103 of the SWMR

Table 2. Vermont Solid Waste Management Rules for Composting Facilities

Regulation of Composting in Vermont	General Applicability	Regulatory Body
Vermont Solid Waste Management Rules: Subchapter 11, Organics Management	Applies to Vermont composters handling solid wastes, which include: food and food processing "residuals", yard wastes, and clean wood. These rules do not apply to those composting solely manures or wastes generated on the farm, or to biosolids (sewage sludge or septage resides in VSWMR Subchapter 6).	Vermont Agency of Natural Resources Solid Waste Management Program
Vermont Stormwater Regulations	Applies mainly to commercial composting operations, although Construction Stormwater Permits are required for projects that disturb more than 1 acre of earth, including on farms. Other permits that apply to composting facilities include Operational Permits and Multi-Sector General Permits , both of which do not generally apply to farming activities, however, general advice is to consult with ANR if there are any question of applicability.	Vermont Agency of Natural Resources Stormwater Management Programs
Vermont Act 250	Applies to commercial composting activities and on-farm composters above a certain scale.	Vermont Act 250 Program
Local Zoning	Applies to commercial composting activities. Does not generally apply to composting where considered an "agricultural activity", however, food scraps composting may or may not fall into this category, depending upon the local zoning interpretation and rules. Local zoning varies greatly and composting may be considered "industrial", an "accessory to agriculture", or "agricultural processing".	Local Zoning Office
Compost Approved for Use on Organic Farms	Applies to composting where compost is intended for use in organic production.	Vermont Organic Farmers
Vermont Acceptable Agriculture Practices	Applies to on-farm manure and mortality management, including composting.	Vermont Agency of Agriculture Food & Markets
Food Safety Modernization Act (FSMA)	At the time of this writing, FSMA was not in effect, however, Biological Soil Amendments a class in which compost is included, will be regulated under the proposed rule. Treatment and usage standards (similar to organic standards) will likely apply to compost production for use on farms.	Food & Drug Administration



In addition, the following criteria apply to siting the compost management area and the area used to treat leachate and run-off for all three scales of composting facilities in Vermont:

- ≥ 300 feet from the nearest public or private water supplies not owned by the applicant
- ≥ 3 feet from seasonal high water table and bedrock
- ≥ 100 feet from surface water
- ≥ 100 feet from all property lines and edge of public roads
- ≥ 300 feet from all residences not owned by the applicant and from all public buildings
- Not within a 100 year flood plain as shown on the National Flood Insurance Maps
- Not within a class I or class II wetland or its associated buffer zone unless a conditional use determination has been issued by the Secretary.
- Not within a class III wetland unless authorized by the Secretary.
- No location within a municipality where that municipality has prohibited composting as a part of its zoning bylaws.
- Not within a designated downtown or village center, unless the municipality has expressly allowed composting in that area.

After thoroughly assessing your potential site to look at applicable solid waste permitting criteria, if the site appears suitable, contact your local solid waste permitting agency to discuss the process.

General Site Physical Characteristics

When siting your composting facility, in addition to having adequate space and a “permissible” location, consideration of other general characteristics is important. Site-specific features such as soil type and the existence of water Source Protection Areas, should be reviewed for determining a course of action specific to your site. While many permits will have requirements similar to these recommendations, the following are general physical considerations, applicable in most situations.

- Depth of soil to bedrock and seasonally high ground water of 3 Feet
 - Research soil type (USDA/NRCS) and topography (USGS maps)
 - Dig Test Pit (Work with NRCS to get test pit reports)
- Distance to property boundaries and public roads
 - 100' is a generally recommended minimum separation distance from boundaries. Larger separation distances are recommended for potentially sensitive neighbors, such as nursing homes, retail and food-related businesses, and schools, or if the volume and character of materials on the site poses a significant potential for odors. Neighbors can create significant roadblocks even if all permit requirements are met.
- Distance to wells, springs, surface waters or wetlands
 - 100 Feet (upslope or laterally) – 300 Feet (down slope) minimum and 300 feet to nearest water source not owned by the applicant.
- A site should not be located in an area with a potential for flooding (100 Year Flood Zone) or in a designated Source Protection Area
- 2-3% slope is ideal, a range of 1.5-6% is tolerable
- Seasonal workability and access for incoming feedstock and outgoing compost
- Observe natural drainage patterns
 - Identify sources of clean storm water that might enter the site
 - Identify conservation concerns, such as surface waters
 - Consider how dirty water will be managed
- Considers vicinity of site to critical infrastructure – roads, barns, water, electricity, etc.





Site Design Considerations

During the process of identifying your compost site, you will probably begin to develop a general design concept for the operation. Whether you are just beginning to assess potential sites or you already have a suitable location identified, it's never too early to begin considering what's involved in creating an effective design for your unique situation. For food scrap composters who receive the majority of their feedstocks from off-site, good access by delivery trucks and designated receiving and blending areas are particularly important.

The following section looks at some potential infrastructure components to consider when designing your site, including:

- Access Roads, Loading Areas, Truck Turn Around, Etc.
- Feedstock Storage Areas (Covered and/or Uncovered)
- Tipping Dock, Receiving, & Blending Area
- Improved Composting Pads (Windrows and Work Area)
- Compost Curing Area
- Finished Compost Storage
- Storm Water and Leachate Management

Additional infrastructure not covered, but which you might also consider include:

- Feedstock Preprocessing Equipment Area
- Compost Screening Area
- Compost Bagging Area
- Greenhouse for Plant Bioassays

Access Roads, Loading Areas, Truck Turn Around, Etc.

If your site frequently receives materials, such as weekly deliveries of food scraps and other feedstocks from off-site, improved access is a critical piece of infrastructure for your site. Likewise, good access and planned compost loading areas will increase the ease with which you distribute your end products. Plan appropriately for the level of traffic required to operate safely and efficiently, while protecting the environment. Roadways may be covered under your site's stormwater permits, in which case plans for roadways will be included in

your Stormwater Pollution Prevention Plan (SWPPP or similar), and need to include approved Best Management Practices (BMPs) for mitigating pollution.

Recommendations for planning and developing access to your compost site include:

- Improved roadway surfaces such as gravel, concrete, or asphalt
- Graded roadways that evenly shed moisture
 - Avoid pooling and channeling moisture
- Slow runoff as it exits the roadway and direct to vegetated infiltration zones
- Provide adequate space for trucks to maneuver and safely load and unload
 - Provide signage to direct traffic
 - At larger sites plan separate retail traffic and large truck traffic



- Plan for snow plowing in winter
 - Avoid plowing snow onto feedstocks and compost
 - Avoid blocking drainage for snow melt and rain with snow piles
- Leave as little land un-vegetated as possible surrounding your access-ways

Feedstock Storage Areas

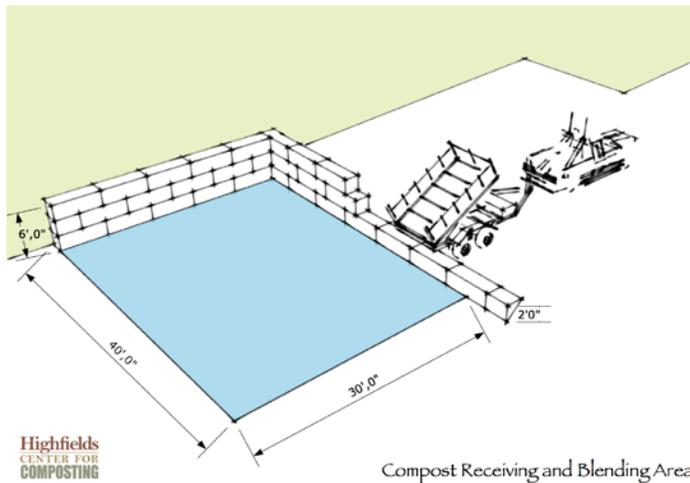
The ability to receive and store feedstocks (raw organic materials) efficiently is a critical component of any well-designed composting operation. Like the other infrastructure on the site, the first step in the design is considering the feedstocks storage capacity you need. For assistance sizing feedstock storage, see the “Sizing a Turned Windrow Composting Facility” guide, and if needed, seek technical assistance. Along with the total storage capacity, a sense of what types of feedstocks you will be working with is important. For example, if you have access to materials that you want to keep dry, covered storage will be a huge asset.

Design considerations for feedstock storage include:

- Locate feedstock storage in close proximity to blending area/s
- Plan for safe and efficient delivery access
- Keep dry matter dry
 - Develop or utilize existing covered spaces such as commodity sheds
- Design roof height with truck tipping access in mind
 - Use tarps if needed
 - Direct run-off away from feedstocks
- Stack outdoor materials to shed moisture
 - Stack neatly to create a smooth surface
 - Stack tall to reduce the surface to volume ratio
- Keep feedstock piles separated by source (and age where possible)
 - Create divider walls or bay type storage on space limited sites (make use of vertical space)
 - Create push walls in rear of piles
 - Maintain the ability to track material by source and age (date delivered)
- Locate large dry feedstock piles near water source in case of fire (only a concern for low moisture piles over 12’ tall). Meet with your local fire department to discuss tactics ahead of time if this is a risk at your site.



Tipping Docs, Receiving & Blending Area



Many compost sites, and food scrap composting sites in particular, plan designated infrastructure in which to receive and blend the operation's primary feedstock as it comes in. In the case of food scraps, this area of the site is distinct from storage for other feedstocks. Food scraps should be immediately incorporated with other materials



using a compost recipe, which will initiate conditions conducive to rapid aerobic decomposition. Plan for the development of an improved surface where receiving and blending takes place. The wet nature of food scraps (+/- 90% water) makes working on unimproved surfaces challenging at best and unworkable long-term in most cases.

Delivery of food scraps often involves large trucks dumping 5-10 Tons of material per load,

which is approximately 10-20 Yards³. It can be challenging for trucks to do this in a contained manner without the advantage of height, which is why a tipping doc above the receiving area can be advantageous. Plan tipping and receiving infrastructure with your hauler's needs in mind.

Design considerations for tipping docks, receiving, and blending areas include:

- Size receiving & blending areas according to "batch" size
 - Base "batch" volume assumptions on primary feedstock volume (e.g. food scraps) + other feedstocks (usually 3-5 times the volume of the primary feedstock)
 - Plan for tractor workspace on improved surface for blending of material, approximately equal to the footprint of the blended compost batch
- Improve surface with concrete or packed gravel (packed gravel will have a 2-4 year life with heavy use)
- Tipping docks are ideally 2-4 feet above the receiving & blending area
 - Place "bumper" curb at back or ramp to stop trucks
 - Design to meet OSHA Guidelines
- Design push walls in back and/or sides of receiving & blending areas to support blending and removal of material
 - Single and L shaped walls provide access from multiple angles, which can enable thorough and efficient blending
 - Waste concrete blocks are useful for push walls
 - Push walls can double as edge of tipping dock
- Locate receiving & blending area in dry location
 - Avoid and divert stormwater and snow melt
 - Consider locating in covered space
- Contain, absorb, and treat liquids and leachate in receiving & blending area
 - Design improved surface with slight slope to shed moisture to an approved catchment or treatment area
 - Small sites utilize woodchip berms or "compost filter socks" in combination with vegetative treatment areas to absorb and filter leachate



Improved Composting Pads (Windrows and Work Area)

Windrow composting pads are commonly improved for several reasons, including moisture management, permitting requirements, and workability. Managing site moisture is critical both in terms of site access and workability year-round, but also in terms of protecting ground and surface water quality. Management activities on the site will be affected by the grade and levelness of the site, as well as the quality of the materials used in improving pad surfaces. In addition to improving composting pads, the area surrounding the pads deserve careful consideration.

General pad improvement considerations include:

- Divert clean water before it enters compost site
- Improve your pad surface
 - Consider various pad materials to match your workability and regulatory requirements
 - Concrete
 - Packed gravel
 - ¾" minus gravel for surfaces with heavy tractor bucket wear

- VT ANR specifies meeting a conductivity of 1×10^{-7} cm/sec for Medium and Large Facilities
- Pack gravel with vibrating roller before use
- Do not install new asphalt – it reacts with acids in compost and degrades. Existing asphalt sites may be worthy of consideration, but will eventually need to be replaced.
- Maintain adequate vertical separation distances to ground water and bedrock (≥ 3 feet)
- Ideally drains easily (unless concrete)
- Ideally maintains a firm surface
- Grade site – 2-3% slope if possible
 - Terracing can be used to effectively reduce slopes
 - Break up long sloped pads (>150 ft) with lateral diversion swales
 - Utilize multiple slopes to decrease length of slope and size of leachate treatment areas
- In planning the site, orient piles with slope to prevent ponding at base of windrows
- Consider the infrastructure you will need – sheds, push walls, access roads, turn arounds, etc.
- Use swales, buffer strips and other conservation measures as needed to prevent pollution in both construction and operation
- Vegetate and stabilize disturbed surfaces



Compost Curing Area

After the active phase of composting, most composters finish their compost by “curing” it. The word “cured” is used to describe various levels of completeness and you should research the regulatory definitions of cured compost that apply to you and observe the qualities of your compost at different stages of curing to decide what’s right for your product’s end uses.

In general, curing compost can remain aerobic with only passive oxygen supplied by convection, as long as the compost is adequately porous and the windrows

General compost curing area considerations include:

- Adequately size curing area
- Improve curing pads (See Improved Composting Pads above)
- Divert/avoid leachate and pre-PFRP runoff from entering pad
- Consider cover for drying (sheds, tarps)
- Insure adequate access – may not need work alley for turning compost from side – instead access from windrow ends



are relatively small. For this reason, piles can be stacked toe-to-toe, without work lanes in between them, which conserves space. Curing piles will benefit from turning, but it is not a necessity (the larger the pile, the more frequent the need to turn). Use the “Sizing a Turned Windrow Composting Facility” guide, for assistance sizing your site’s curing area, and if needed, seek technical assistance.

Curing compost will need to have met any regulatory requirements that apply to you, including the Process to Further Reduce Pathogens or PFRP, which is a heat treatment that happens in the active phase of composting. For this reason, runoff from compost curing areas can be managed differently than “pre-PFRP” compost in Vermont and is no longer considered a pathogen concern. Look at suitable runoff treatment options in the Solid Waste Management Rules, before designing a strategy that will meet the regulatory criteria.

Finished Compost Storage

Similar to compost curing areas, finished compost storage areas are designed with access, but not regular turning in mind. The primary difference between design of compost storage and curing areas, is that “finished” compost, which has met your “curing criteria” can be stored in larger piles, because oxygen demand is minimal to maintain quality. Compost can be stored in piles >8 feet tall, so sizing of finished compost storage capacity is different than in other areas of the site. In Vermont, finished compost can also be stored in non-permitted areas. Other than these sizing (see “Sizing a Turned Windrow Composting Facility”) and regulatory factors, refer to design considerations in the Improved Composting Pads and Finished Compost Storage sections above and follow conservation control measures.





Stormwater and Leachate Management

Planning for moisture management at your facility is absolutely critical and goes hand in hand with adequate sizing of your facility's compost-processing infrastructure. Managing stormwater and leachate where it comes into contact with compost has been covered throughout this guide, but a well designed and permitable site will need a well planned strategy for treatment once it leaves your compost management and storage areas.

In Vermont, acceptable strategies for stormwater and leachate treatment from windrow composting facilities differ by facility scale.

In addition to the following general strategies, refer to Table 2. for leachate treatment strategies in Vermont and consult with solid waste regulators and technical service providers as needed.

- Divert clean water before it enters the site whenever possible
 - Gutters
 - Swales and Berms
 - Curtain and French drains
- Where leachate poses a risk of discharge, capture and treat this runoff effectively. Seek technical assistance to evaluate your risk potential and for estimating runoff from your site. Some runoff management systems include:
 - Evaporation ponds
 - Reapplication to active compost piles or field application
 - Manure or retention pits
 - On-site filtration and vegetative treatment areas.
- Site Management
 - Keep site free of ruts and other low spots where moisture will accumulate
 - Orient piles with slope to prevent ponding



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Photos

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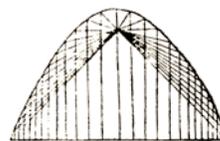
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