VERMONT

AGENCY OF NATURAL RESOURCES

Department of Environmental Conservation

Turned Windrow Composting

Sizing Your Composting Pad

Planning a windrow composting operation is a multistep process, which involves careful thought and consideration. The following guide has been created as part of a set of resources to help composters in Vermont effectively plan, develop, and manage local composting operations. The focus of this resource is to support you in determining the size of your windrow composting site. Operations composting food scraps (source-separated organics or SSO) in Vermont are the main focus of this guide, although most of the guide will apply to composters of farm wastes and other materials as well.

The guide will walk you through the following calculations and considerations:

Each phase is explained along with the necessary calculations and an example. Cumulatively, these steps will help you determine the total footprint required for your windrow composting activities. You will likely need to adjust the dimensions of specific features within the site, based on realities of the plot you are dealing with. If you are familiar with using spreadsheet software such as Microsoft Excel or Google Sheets, these tools can be very helpful in setting up a template calculator, which will automatically make calculations based on the assumptions you input. In addition,

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you may find it helpful to draw your design concept as you work, particularly if you already have a site in mind, but also just to help you to visualize the spatial relationships represented by the calculations. Working with a conceptual site layout as you go through the steps and calculations can ultimately make for a stronger and more efficient design process.

Notes on applicability of this guide:

a) The math in this guide is specific to designing rectangular sites; additional steps will be required to assess the processing capacity of non-rectangular locations

b) The math in this guide is specific to sizing the compost management, curing, and storage areas of turned windrow composting operations; does not address the sizing of infrastructure for other composting methods or of storm or wastewater management systems.

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Companion Resource:

Turned Windrow Composting: Site Identification & Design Considerations

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

PHASE ONE

Gathering Basic Information for Sizing a Windrow Composting Facility

Planning the scale of windrow composting infrastructure is a relatively simple process that uses math to think through how a specific volume of material will move through your facility in space and time. There are a few initial questions that need to be answered in order to start sizing your facility.

Question 1

What is the "problem" or "primary" feedstock you will be composting?

The first step is identifying the "problem" or "primary" material that will be composted. In this guide we focus on food scraps as the "primary" material, but it could be manure or any number of other feedstocks.

Question 2

How much "primary" feedstock will you process?
Or conversely,
How much finished compost do you wish to produce?

Often, future operators starting their planning process only know the answer to one of these questions. Luckily, by answering either one, you can use educated assumptions to answer the other, which will give you an initial estimate of both the inputs processed (primary and additional feedstocks) and outputs produced (finished compost) by your composting facility. Part 2: Two Approaches to Identifying Target Scale, will walk you through the simple math that will provide this complete picture.

Question 3

How often will you process the "primary" feedstock as it comes in?

Most composters receive or generate their primary feedstock on a regular time interval, daily, weekly, or monthly. For food scraps composters in Vermont, most collection routes service customers at least once per week, so weeks are a logical period of time to use in your calculations.

Question 4

What equipment will you use to turn compost at the facility?

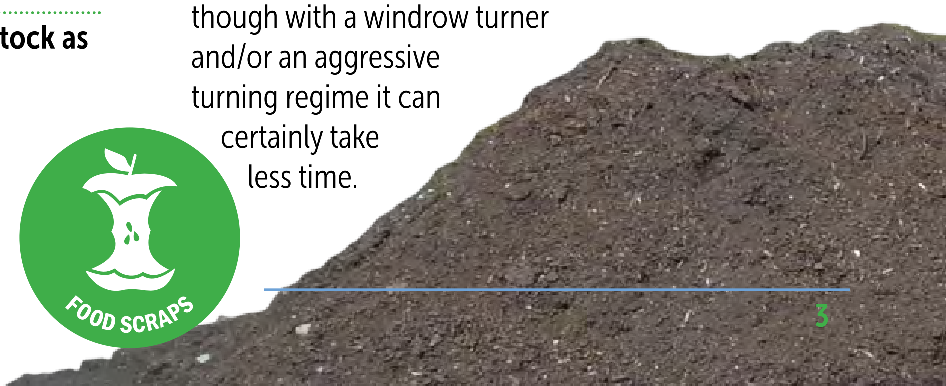
Compost windrow dimensions will in part be determined by your equipment's capacity to build and turn that windrow. For example, a tractor may be able to stack and turn a pile that's 6 feet tall, which is a good starting height for a windrow. Pile geometry would dictate that a 6 foot windrow would have a 12-14 foot wide base. These dimensions will be used to calculate the volume of a windrow on the site.

Question 5

How long will the active and curing phases of composting take at your operation?

Although there are numerous ways to describe the different phases of composting, for our purposes this guide differentiates only two basic stages of composting, active and curing. There are slightly different assumptions used to calculate the space requirements in each stage and efficiencies to be gained by calculating them separately. Turning practices and the common length of each phase are described below:

Active Phase – Once the compost is blended and stacked on the composting pad, the active phase of composting begins. This is where compost will meet the Process to Further Reduce Pathogens or PFRP, which is a heat treatment that involves turning the pile to insure all of the compost meets a minimum of 131 F for at least 3 days. The ability to actively and efficiently turn the compost will continue until the compost is ready to begin curing. Often this takes 8 or 9 months using the turned windrow method in Vermont, although with a windrow turner and/or an aggressive turning regime it can certainly take less time.



Curing Phase – After the active phase of composting, most composters finish their compost by "curing" it. 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 are relatively small. For this reason, piles can be stacked side by side, without work lanes in between them, which conserves space. Assuming the active phase of composting was successful, curing of compost usually takes between 1 and 3 months (although it can be stored indefinitely). A good rule of thumb is that the curing process starts when the temperature of the compost is between 90 and 100 F.

Estimating the duration of the composting process conservatively is recommended, which means planning for the maximum amount of time you think the process may take. Under sizing facilities is a very common mistake that can have real impacts on an operation's efficiency, flexibility, and long-term growth.

Question 6

How long will you need to store compost at your operation?

Compost that has met your "curing criteria" can be used or sold immediately, but most compost will leave the facility in spring or fall (and late winter for some bagged products). Most composters have a need to store significant volumes of finished compost for many months at a time between sales seasons. For example compost that is cured in late October may not be sold until April of the following year, so that batch will need to be stored for 5-6 months. More compost will continue to finish curing over that time, so effectively, the facility needs storage for 5-6 months of finished compost outputs.

Planning the space requirements for storing finished compost is different than for active or curing compost, although this guide combines curing and storage for sizing purposes (because it doesn't necessarily make sense to move a cured pile to a separate storage area, unless other factors deem it necessary). Finished compost can be stored in much larger piles than active or curing compost, so if you have the capacity to stack taller piles without driving on them, you can plan for taller average pile height in the curing and storage area. At this late stage of the composting process, oxygen demand is minimal, and large piles can maintain quality, even when stacked >8 feet tall. Worth noting, in Vermont, finished compost can be stored outside of the permitted compost management area.

In addition to these initial questions, other questions will be explained as they come up throughout this guide.

Steps 1-37 provide a relatively simple algorithm where you may use the assumptions specific to your operation to estimate your facility's required footprint. The examples given along with each step are based on a composting scenario with the following assumptions:

- Food scrap composter
- Processing 10 tons/week or ~20 yards^3/week food scraps
- Uses a ratio of 4 parts additional feedstocks to 1 part food scraps
- Active composting phase of 8 months
- Curing composting phase of 2 months
- Needs to store compost for ≤6 months
- Tractor turned windrows - can stack and turn a pile up to 6 feet tall
- Volume of raw compost will shrink by 20% at time of blending
- Volume of raw compost will shrink by an additional 40% during active composting and curing or a total of 60%
- The site has 25 foot work alleys between the active windrows
- The site has a 10 foot perimeter on three sides of the active pad (the forth side has a 25 foot work alley).
- The site does not have any additional travel lanes running perpendicular to the windrows.

PHASE TWO

Two Approaches to Identifying Target Scale

Sizing compost facility infrastructure is usually approached from one of two directions, with either a target input or a target output in mind. The following methods can be used to understand the volume relationship between inputs (primary and additional feedstocks) and outputs (finished compost) at your composting facility, with either target goal in mind:

1. Primary Feedstock Approach

Some operations have a specific volume of a "problem" or a "primary" organic material they desire to recycle and the facility's infrastructure is designed to effectively compost that material.

For operations basing their scale on inputs of their primary feedstock, or the Primary Feedstock Approach, output of finished compost can be calculated multiplying the total raw inputs within a given time period by the volume reduction over the composting process, using the following formula:

Important Terms

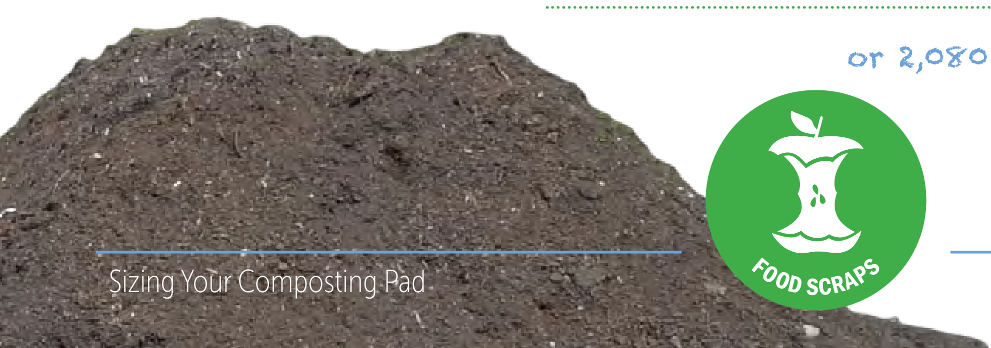
Bulk Density

The average weight of a particular volume of material. A common unit of bulk density for composters in the US is lbs/Yard³. Assume the bulk density of mixed food scraps is ~1000 Lbs/Yard³.

Note: Skip Step 1 if already using pounds.

	Formula	Example
Step 1	( ) Tons Primary Feedstock /( ) Time Period X 2000 (Lbs/Ton) ( ) Pounds/( ) Time Period	(10) Tons Primary Feedstock/(Week) Time Period X 2000 (Lbs/Ton) (20,000) Pounds/(Week) Time Period
Step 2	( ) Pounds/( ) Time Period ÷ ( ) Primary Feedstock Bulk Density (Lbs/Yard³) ( ) Total Yards³ Primary Feedstock/( ) Time Period	(20,000) Pounds/(Week) Time Period ÷ (1,000) Primary Feedstock Bulk Density (Lbs/Yard³) (20) Yards³ Primary Feedstock/(Week) Time Period
Step 3	( ) Yards³ Primary Feedstock/( ) Time Period X ( ) Ratio Additional Feedstock to Primary Feedstock (By Volume, Typically 3-5) ( ) Yards³ Additional Feedstock/( ) Time Period	(20) Yards³ Primary Feedstock/(Week) Time Period X (4) Ratio Additional Feedstock to Primary Feedstock (By Volume, Typically 3-5) (80) Yards³ Additional Feedstock/(Week) Time Period
Step 4	( ) Yards³ Primary Feedstock/( ) Time Period + ( ) Yards³ Additional Feedstock/( ) Time Period ( ) Total Yards³ Raw Feedstock/( ) Time Period	(20) Yards³ Primary Feedstock/(Week) Time Period + (80) Yards³ Additional Feedstock/(Week) Time Period (100) Total Yards³ Raw Feedstock/(Week) Time Period
Step 5	( )Total Yards³ Raw Feedstock/( )Time Period X ( )% Volume Reduction (Assume 60% so use .4) ( )Total Yards³ Finished Compost/( )Time Period	(100) Total Yards³ Raw Feedstock/(Week) Time Period x (.4) % Volume Reduction (Assume 60% so use .4) (40) Total Yards³ Finished Compost/(Week) Time Period

or 2,080 Yards³/Year Finished Compost and 5,200 Yards³/Year Raw Feedstock Processed and 520 Tons/Year Primary Feedstock Processed



2. Target Output Approach

Other operations start with a target finished compost production goal that fits their particular business model and the facility's production capacity needs to adequately produce that target volume.

With this approach, the volume of finished compost is divided by the estimated volume reduction within a given time period to arrive at the total raw inputs for that time period. The percentage of primary feedstock in relation to the total raw inputs can be either estimated or calculated in a compost recipe, but usually falls between a 1:3 and 1:5 ratio of primary to additional feedstock or 17-25% of the total mix. These two assumptions can then be used to get a solid estimate of the volume of primary to additional feedstocks your site will process.

Important Terms

Bulk Density

The average weight of a particular volume of material. A common unit of bulk density for composters in the US is Lbs/Yard³. Assume the bulk density of mixed food scraps is ~1,000 Lbs/Yard³.

Note: With this approach, the volume of the primary and additional feedstocks were known (or estimated) and used to estimate the volume of the finished product.

	Formula	Example
Step 6	( ) Total Yards³ Finished Compost/( ) Time Period ÷ ( ) % Volume Reduction (Assume 60% so use .4) ——— ( ) Total Yards³ Raw Feedstock/( ) Time Period	(40) Target Yards³ Finished Compost/(Week) Time Period ÷ (.4) % Volume Reduction (Assume 60% so use .4) ——— (100) Total Yards³ Raw Feedstock/(Week) Time Period
Step 7	( ) Total Yards³ Raw Feedstock/( ) Time Period X ( ) % Volume Primary Feedstock of Total Mix (Typically 17-25% or .17-.25) ——— ( ) Yards³ Primary Feedstock/( ) Time Period	(100) Total Yards³ Raw Feedstock/(Week) Time Period X (.2) % Volume Primary Feedstock of Total Mix (Typically 17-25% or .17-.25) ——— (20) Yards³ Primary Feedstock (Week) Time Period
Step 8	( ) Yards³ Primary Feedstock/( ) Time Period X ( ) Primary Feedstock Bulk Density (Lbs/Yard³) ——— ( ) Pounds Primary Feedstock/( ) Time Period	(20) Yards³ Primary Feedstock/(Week) Time Period X (1,000) Primary Feedstock Bulk Density (Lbs/Yard³) ——— (20,000) Pounds Primary Feedstock/(Week) Time Period
Step 9	( ) Pounds Primary Feedstock/( ) Time Period ÷ 2000 (Lbs/Ton) ——— ( ) Tons Primary Feedstock/( ) Time Period	(20,000) Pounds Primary Feedstock/(Week) Time Period ÷ 2000 (Lbs/Ton) ——— (10) Tons Primary Feedstock/(Week) Time Period

or 520 Tons/Year Primary Feedstock Processed
and 5,200 Yards³/Year Total Raw Feedstock Processed
and 2,080 Yards³/Year Finished Compost

PHASE THREE

Determining Total Volume of Feedstock on Active Composting Pad

From information generated in either Step 4 or Step 6, we can now calculate the average volume of material on your active windrow pads at any given time.

Note: Some compost sizing methodologies add an optional step of adding "shrink factor" during the active composting process into sizing the total volume of material on the compost pad. This guide recommends using a 20% blending shrink factor, but not an additional composting shrink factor for sizing the active pad. Additional shrink will be accounted for in sizing curing and storage areas.

Important Terms

Shrink Factor

The reduction in volume of compost as it is processed. Total cumulative volume of different raw feedstocks is reduced significantly as they are combined and blended (commonly by 20%). Volume also reduces significantly during the composting process. In this phase, we are estimating the shrink factor during blending and additional shrink during active composting will be used in sizing curing and storage areas. The shrink factor is used to calculate the remaining volume; a 20% shrink factor would result in a remaining volume of 80% or a multiplier of .8.

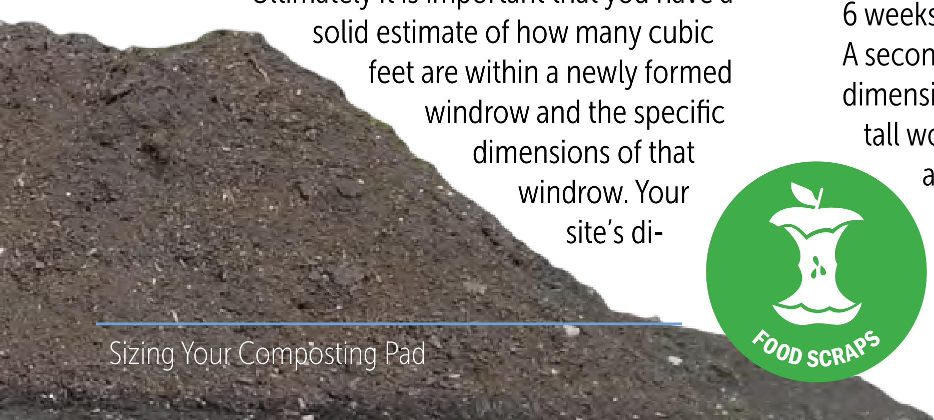
From either **Step 4 or Step 6**, use Total Yards^3 Raw Feedstock/Time Period as follows:

	Formula	Example
Step 10	( ) Total Yards^3 Raw Feedstock/( ) Time Period X ( ) # of Time Period ( ) in Active Composting ( ) Total Yards^3 Raw Feedstock Processed	(100) Total Yards^3 Raw Feedstock/(Week) Time Period X (32) # of Time Period (Weeks) in Active Composting (3,200) Total Yards^3 Raw Feedstock Processed
Step 11	( ) Total Yards^3 Raw Feedstock Processed X ( ) % Blending Shrink Factor (Assume 20% so use .8) X 27 (Feet^3 Per Yard^3) ( ) Total Feet^3 on Active Windrow Pad	(3,200) Total Yards^3 Raw Feedstock Processed X (.8) % Blending Shrink Factor (Assume 20% so use .8) X 27 (Feet^3 Per Yard^3) (69,120) Total Feet^3 on Active Windrow Pad

PHASE FOUR

Calculating Windrow Volume and Dimensions

Determining a functional windrow volume for your site can be approached from a number of directions. Ultimately it is important that you have a solid estimate of how many cubic feet are within a newly formed windrow and the specific dimensions of that windrow. Your site's dimensional limitations may be the final determinate of the volume that can fit in a windrow, but other factors are involved as well.



Since an individual windrow will typically be tracked and managed as its own distinct entity, it's important that the material in that windrow be of "like age". In practice this means that a new windrow should be started every 6 weeks at a maximum and ideally every 1-4 weeks. A second factor in determining windrow volume and dimension is how tall your tractor can pile material. 8 feet tall would be the maximum you'd want to initially stack a turned windrow and 5-7 feet tall is ideal. We'll use what we know about your operation to arrive at a windrow size that makes sense for your site.

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Use either **Step 12a. OR Step 12b-12bb** to determine the final number of Feet^3/Windrow. Unless you are processing incoming feedstocks daily, **Steps 12b-12bb** are recommended, in order to reduce the need to split batches between separate windrows. You may use trial and error with **Steps 12b-12bb**, adjusting the time period per windrow, to find dimensions that work well for the site, while maintaining windrows with material of "like age" (e.g. 2 weeks of raw feedstocks per windrow).

	Formula	Example
Step 12a	( ) Feet Windrow Length	(90) Feet Windrow Length
	X ( ) Feet Windrow Height	X (6) Feet Windrow Height Feet
	X ( ) Feet Windrow Width (Assume Height X 2)	X (12) Feet Windrow Width (Assume Height X 2)
	X .66 Cross Sectional Area (Assume .5 if Conservative)	X .66 Cross Sectional Area (Assume .5 if Conservative)
	( ) Average Feet^3/Windrow	(4,277 or call it 4,300) Average Feet^3/Windrow
Step 12b	( ) Total Yards^3 Raw Feedstock/( ) Time Period	(100) Total Yards^3 Raw Feedstock/(Week) Time Period
	X ( ) Average # of Time Period ( ) /Windrow	X (2) Average # of Time Period (Weeks)/Windrow
	X ( ) % Blending Shrink Factor (20% reduction means multiply by .8)	X (.8) % Blending Shrink Factor (20% reduction means multiply by .8)
	X 27 (Feet^3 Per Yard^3)	X 27 (Feet^3 Per Yard^3)
	( ) Average Feet^3/Windrow	(4,320 or call it 4,300) Average Feet^3/Windrow
Step 12bb	( ) Average Feet^3/Windrow	(4,320 or call it 4,300) Average Feet^3/Windrow
	X ( ) Feet Windrow Height	X (6) Feet Windrow Height
	X ( ) Feet Windrow Width (Assume Height X 2)	X (12) Feet Windrow Width (Assume Height X 2)
	÷ .66 Cross Sectional Area (Assume .5 if Conservative)	÷ .66 Cross Sectional Area (Assume .5 if Conservative)
	( ) Feet Windrow Length	(90.5 or call it 90 Feet) Windrow Length

PHASE FIVE

Calculating Number of Windrows on the Active Pad

To estimate the number of windrows on the active pad, simply divide the total volume of material on the active composting pad, by the volume per windrow as follows:

	Formula	Example
Step 13	( ) Total Feet^3 on Active Windrow Pad (Step 11)	(69,120) Total Feet^3 on Active Windrow Pad (Step 11)
	÷ ( ) Average Feet^3/Windrow (Step 11a or 11b)	÷ (4,300) Average Feet^3/Windrow (Step 11a or 11b)
	( ) # of Windrows on Active Pad (Round)	(16) # of Windrows on Active Pad (Round)

PHASE SIX

Determining Active Pad Workspace Needs

Turned windrow composting systems require "workspace" surrounding the pile. This space provides access for equipment used to turn the windrows and space to travel around and in between the windrows. Loader turned windrows are most efficiently turned by "rolling" them from the side, although they can be moved from their ends as well (this is not an efficient way to provide frequent aeration and mixing at any scale). Windrow turners and excavators typically require less workspace between piles than loaders with a similar capacity, although tractor pulled turners will require a larger space to turn around at the end of the pile. Estimate the "alley or aisle" width between windrows based on you loader's turning radius. Twice the length of the loader is going to be a comfortable and efficient pile spacing for most loaders, typically 20-30' depending upon your equipment. In addition, perimeter travel lanes around the edge of the windrows, need to be wide enough for equipment to drive down, about 10' for most loaders.

Most compost sites are going to have as many alleys as windrows, always turning the windrow from the same side. Some site's plan irregular spacing to try to gain spatial efficiencies by turning piles towards each other, however, this can lead to confusing site flow, crowding, and under sizing. For this reason, keeping the layout of windrows simple and consistent at the outset of your design is highly recommended.

In this step, simply identify the key pieces of information needed to size workspaces on the active pad:

What is the width of work alleys between windrows?

How many work alleys are required? Equal to the total number of windrows?

Does the site need a perimeter? What is the width of the perimeter?

Does the site need one or more travel lanes running across the pad and perpendicular to the windrows? What is the number and width of travel lanes?

This information will be used in determining the dimensions of the active pad in the following section.

PHASE SEVEN

Calculating Active Pad Footprint

To arrive at the required footprint of your composting pad, the combined width of windrows, work alleys, and perimeters, is multiplied by the length of the windrows and perimeters. If you have many windrows (in the example, we have 16), you may need to split the windrows into two or more rows to fit your site's spatial limitations or to limit the distance traveled on the site, as long sites tend to be less efficient. At this stage, making a sketch on graph paper that shows your math visually is extremely useful. Check your math against the drawing and adjust as needed.

Calculating the Width of the Pad

	Formula	Example
Step 14	( ) # of Windrows X ( ) Feet Width of Windrows ( ) Feet Combined Width of Windrows	(16) # of Windrows X (12) Feet Width of Windrows (192) Feet Combined Width of Windrows
Step 15	( ) # of Work Alleys X ( ) Feet Width of Work Alleys ( ) Feet Combined Width of Work Alleys	(16) # of Work Alleys X (20) Feet Width of Work Alleys (320) Feet Combined Width of Work Alleys
Step 16	( ) Feet Combined Width of Windrows + ( ) Feet Combined Width of Work Alleys + ( ) Feet Width of Additional Perimeter ( ) Feet Total Pad Width*	(192) Feet Combined Width of Windrows + (320) Feet Combined Width of Work Alleys + (10) Feet Width of Additional Perimeter (522 or call it 530) Feet Total Pad Width

Calculating the Length of the Pad

Step 17

Formula	Example
( ) Feet Window Length	(90) Feet Window Length
+ ( ) Feet Width of Additional Perimeter & Travel Lanes	+ (20) Feet Width of Additional Perimeter & Travel Lanes
( ) Feet Total Pad Length*	(110) Feet Total Pad Length*

Calculating the Pad Area

Step 18

Formula	Example
( ) Feet Total Pad Width	(530) Feet Total Pad Width
X ( ) Feet Total Pad Length	X (110) Feet Total Pad Length
( ) Feet² Total Active Pad Area*	(58,600) Feet² Total Active Pad Area*

58,600 ft² is the area of the active pad

**Note: The pad width assumes only one row of windrows running parallel to each other. The calculated width of the site can be split into multiple rows, for example a 16 windrow pad 532 feet wide could be split into 2 rows of 8 or 4 rows of 4. Make sure that you adjust the length, perimeter, and travel lanes accordingly, to arrive at the total pad width and length.*

PHASE EIGHT

Calculating Curing and Storage Area

Estimating the footprint required to cure and store compost, uses a similar method to that of sizing the active compost pad, although there are some key differences as well. The largest difference is in the need for workspace, which is minimal as access can be supplied from a perimeter. Another key difference is that stored finished compost leaves the site in large quantities at least twice a year during sales seasons. This means that there is a lot of empty space following these times that can be used for access and turning until the space gets crowded again. A windrow can be staged with space to turn the pile, eventually ending up toe to toe with other windrows.

This guide combines curing and storage for sizing purposes, because it doesn't make sense to move a cured pile to a separate storage area, unless other factors deem it necessary. Finished compost can be stored in much larger piles than active or curing compost, so if you have the capacity to stack taller piles without driving on them, you can plan for taller average pile height in the curing and storage area. At this stage of the composting process, oxygen demand is minimal, and large piles can maintain quality, even when stacked >8 ft. tall. Worth noting, in Vermont, finished compost can be stored outside of the permitted compost management area.

Calculating Curing & Storage Windrow Dimensions

Step 19

Formula	Example
( ) Total Yards³ Raw Feedstock/( ) Time Period	(100) Total Yards³ Raw Feedstock/(Week) Time Period
X ( ) # of Time Period ( ) in Curing and Storage	X (26) # of Time Period (Weeks) in Curing and Storage
( ) Total Yards³ Raw Feedstock Processed	(2,400) Total Yards³ Raw Feedstock Processed

Step 20

Formula	Example
( ) Total Yards³ Raw Feedstock Processed	(2,600) Total Yards³ Raw Feedstock Processed
X ( ) % Shrink Factor (Assume 60% so use .4)	X (.4) % Shrink Factor (Assume 60% so use .4)
X 27 (Feet³ Per Yard³)	X 27 (Feet³ Per Yard³)
( ) Total Feet³ in Curing and Storage Area	(28,080) Total Feet³ in Curing and Storage Area

Step	Worksheet	Example
Step 21	( ) # of Time Period ( ) in Curing and Storage ÷ ( ) Average # of Time Period ( )/Window (Step 12b) ( ) # of Windows in Curing and Storage Area	(26) # of Time Period (Weeks) in Curing and Storage ÷ (2) Average # of Time Period (Weeks)/Window (Step 12b) (13) # of Windows in Curing and Storage Area
Step 22	( ) Total Feet³ in Curing and Storage Area ÷ ( ) # of Windows in Curing and Storage Area ( ) Average Feet³/Windrow	(28,080) Total Feet³ in Curing and Storage Area ÷ (13) # of Windows in Curing and Storage Area (2,160) Average Feet³/Windrow
Step 23	( ) Average Feet³/Windrow ÷ ( ) Feet Windrow Height ÷ ( ) Feet Windrow Width (Assume Height X 2) ÷ .66 Cross Sectional Area (Assume .5 if Conservative) ( ) Feet Windrow Length	(2,160) Average Feet³/Windrow ÷ (6) Feet Windrow Height ÷ (12) Feet Windrow Width (Assume Height X 2) ÷ .66 Cross Sectional Area (Assume .5 if Conservative) (45.5 or call it 45) Feet Windrow Length

Curing & Storage Windrow Dimensions are 45' L x 12' W x 6' H

Calculating the Width of the Pad

Step	Worksheet	Example
Step 24	( ) # of Windrows X ( ) Feet Width of Windrows ( ) Feet Combined Width of Windrows	(13) # of Windrows X (12) Feet Width of Windrows (156) Feet Combined Width of Windrows
Step 25	( ) Feet Combined Width of Windrows + ( ) Feet Width of Additional Perimeter ( ) Feet Total Pad Width	(156) Feet Combined Width of Windrows + (20) Feet Width of Additional Perimeter (176 or call it 180) Feet Total Pad Width

Calculating the Length of the Pad

Step	Worksheet	Example
Step 26	( ) Feet Windrow Length + ( ) Feet Width of Additional Perimeter & Travel Lane ( ) Feet Total Pad Length*	(45) Feet Windrow Length + (20) Feet Width of Additional Perimeter & Travel Lane (65) Feet Total Pad Length *

Calculating the Pad Area

Step	Worksheet	Example
Step 27	( ) Feet Total Pad Width X ( ) Feet Total Pad Length ( ) Feet² Total Curing/Storage Pad Area *	(180) Feet Total Pad Width X (65) Feet Total Pad Length (11,700) Feet² Total Curing/Storage Pad Area *

11,700 ft2 is the area of the curing and storage area

**Note: The pad width assumes only one row of windrows running parallel to each other. The calculated width of the site can be split into multiple rows. For example: a 13 windrow pad 176 feet wide could be split into 2 rows of 7, but you would need to adjust the width to account for the 14th windrow. Make sure that you adjust the length, perimeter, and travel lanes accordingly, to arrive at the total pad width and length.*

PHASE NINE

Calculating Feedstock Storage

Non-putrescible raw materials can take up considerable storage space on the site, particularly when stockpiling for months at a time, as is often the case with non-food scrap materials. Plan ahead for adequate storage located close to the site's blending area and with good access by both delivery trucks and bucket loaders. Consider the need for covered space, which can be used to keep feedstocks dry. Covered storage is a large asset to composters who handle really wet feedstocks such as food scraps and some manures. Dry materials are usually costly, so commodity shed type storage for dry materials is often a good investment and can double as a drying space for compost if needed. If looking at potential sites, consider the value and location of existing sheds or barns for storage and drying purposes, as well as other parts of the composting process.

Note: Plan for access to feedstocks, including truck and loader access. Ideally this area provides other uses as well, such as workspace for your blending areas. In addition, walls for bays, such as bunker blocks, as well as roofs may add to the overall footprint by several feet in both dimensions.

	Formula	Example
Step 28	( ) Yards^3 Additional Feedstock/( ) Time Period X ( ) # of Time Period ( ) Feedstock Storage Capacity X 27 (Feet^3 Per Yard^3) ( ) Total Feet^3 Feedstock Storage	(80) Yards^3 Additional Feedstock/(Week) Time Period X (8) # of Time Period (Week) Feedstock Storage Capacity X 27 (Feet^3 Per Yard^3) (17,280) Total Feet^3 Feedstock Storage
Step 29	( ) Total Feet^3 Feedstock Storage ÷ ( ) Estimated # of Distinct Feedstock Piles ( ) Feet^3/Feedstock Pile	(17,280) Total Feet^3 Feedstock Storage ÷ (6) Estimated # of Distinct Feedstock Piles (2,880) Feet^3/Feedstock Pile

For stand-alone feedstock piles use Steps 30a-30aaaa, and for bay type feedstock storage (3 walls) use Steps 30b-30bbbb.

Stand-Alone Feedstock Piles

	Formula	Example
Step 30a	( ) Feet^3/Feedstock Pile ÷ ( ) Feet Pile Height ÷ [( ) Feet Pile Width - ( ) Feet Pile Height] ( ) Feet	(2,880) Feet^3/Feedstock Pile ÷ (6) Feet Pile Height ÷ [(20) Feet Pile Width - (6) Feet Pile Height] (34.3 or call it 34) Feet
Step 30aa	( ) Feet (Step 30a. Above) + ( ) Feet Pile Height ( ) Feet Pile Length	(34) Feet (Step 30a. Above) + (6) Feet Pile Height (40) Feet Pile Length
Step 30aaa	( ) Feet Pile Width X ( ) Feet Pile Length ( ) Feet^2 Footprint/Feedstock Pile	(20) Feet Pile Width X (40) Feet Pile Length (800) Feet^2 Footprint/Feedstock Pile
Step 30aaaa	( ) Estimated # of Distinct Feedstock Piles X ( ) Feet^2 Footprint/Feedstock Pile ( ) Feet^2 Footprint Feedstock Storage	(6) Estimated # of Distinct Feedstock Piles X (800) Feet^2 Footprint/Feedstock Pile (4,800) Feet^2 Footprint Feedstock Storage

Bay Type Feedstock Storage

	Formula	Example
Step 30b	( ) Feet³/Feedstock Pile ÷ ( ) Feet Pile Height ÷ ( ) Feet Pile Width ( ) Feet	(2,880) Feet³/Feedstock Pile ÷ (6) Feet Pile Height ÷ (20) Feet Pile Width (24) Feet
Step 30bb	( ) Feet (Step 30b. Above) - ( ) Feet ½ Pile Height ( ) Feet Pile Length	(24) Feet (Step 30b. Above) - (3) Feet ½ Pile Height (21 or call it 20) Feet Pile Length
Step 30bbb	( ) Feet Pile Width X ( ) Feet Pile Length ( ) Feet² Footprint/Feedstock Bay	(20) Feet Pile Width X (20) Feet Pile Length (400) Feet² Footprint/Feedstock Bay
Step 30bbbb	( ) Estimated # of Distinct Feedstock Piles X ( ) Feet² Footprint/Feedstock Bay ( ) Feet² Footprint Feedstock Storage	(6) Estimated # of Distinct Feedstock Piles X (400) Feet² Footprint/Feedstock Bay (2,400) Feet² Footprint Feedstock Storage

PHASE TEN

Calculating Receiving and Blending Area

One of the site's most important pieces of infrastructure will be its receiving and blending area. The combination of wet materials, heavy traffic, and loader bucket use, cause an enormous amount of wear-and-tear. Providing the operation with adequate space and improved surfaces to tip and blend materials as they come in, and a well thought out workspace for equipment to operate while mixing feedstocks, will foster efficiency and encourage the use of best management practices.

Note: If using concrete for Receiving & Blending Area (which is highly recommended), you may not need to pave all of the workspace, as well as the pad under the feedstocks that you are blending. Instead, travel and access space could be packed gravel to reduce cost. Concrete is ideal however, as it is the easiest to work on and maintain in this critical high traffic area.

	Formula	Example
Step 31	( ) Yards³ Primary Feedstock/( ) Time Period + ( ) Yards³ Additional Feedstock/( ) Time Period ( ) Total Yards³ Raw Feedstock/( ) Time Period	(20) Yards³ Primary Feedstock/(Week) Time Period + (80) Yards³ Additional Feedstock/(Week) Time Period (100) Total Yards³ Raw Feedstock/(Week) Time Period
Step 32	( ) Total Yards³ Raw Feedstock/( ) Time Period X 27 (Feet³ Per Yard³) ( ) Total Feet³ Raw Feedstock/( ) Time Period	(100) Total Yards³ Raw Feedstock/(Week) Time Period X 27 (Feet³ Per Yard³) (2,700) Total Feet³ Raw Feedstock/(Week) Time Period
Step 33	( ) Total Feet³ Raw Feedstock/( ) Time Period ÷ ( ) Feet Pile Height ÷ [( ) Feet Pile Width - ( ) Feet Pile Height] ( ) Feet	(2,700) Total Feet³ Raw Feedstock/(Week) Time Period ÷ (4) Feet Pile Height ÷ [(30) Feet Pile Width – (2) Feet ½ Pile Height] (24.1) Feet

Step 34	( ) Feet (From Step 33. Above) + ( ) Feet Pile Height ( ) Feet Pile Length	(24.1) Feet (From Step 33. Above) + (4) Feet Pile Height (28.1 or call it 30) Feet Pile Length
Step 35	( ) Feet Pile Width X ( ) Feet Pile Length ( ) Feet² Footprint Raw Feedstock/( ) Time Period	(30) Feet Pile Width X (30) Feet Pile Length (900) Feet² Footprint Raw Feedstock/(Week) Time Period
Step 36	( ) Feet² Footprint Raw Feedstock/( ) Time Period X ( ) Estimated Workspace Factor (1.5-2 X footprint of Feedstock) ( ) Feet² Footprint of Receiving & Blending Area	(900) Feet² Footprint Raw Feedstock/(Week) Time Period X (2) Estimated Workspace Factor (1.5-2 X footprint of Feedstock) (1,800 of call it 2,000) Feet² Footprint of Receiving & Blending Area

1,800 ft² rounded to 2,000 ft² or 40' x 50'

PHASE ELEVEN

Additional Infrastructure to Consider

There are a number of additional infrastructure elements that may be needed for your site, which you will need to adequately size and include when considering your operation's total footprint and location.

Although this guide does not cover the sizing of these infrastructure components, refer to its companion resource, Turned Windrow Compost Site Identification & Design Considerations, which does approach many of these topics. In addition, it is often beneficial to work with a compost technical assistance provider to help with your planning process.

Additional infrastructure elements may include:

- Additional vehicular access, roads, and turn-arounds
- Stormwater treatment areas and diversion swales
- Leachate storage and treatment areas
- Equipment sheds and offices
- Compost drying and bagging areas
- Parking and loading areas
- Greenhouse for plant bioassays

PHASE TWELVE

Calculating Total Site Footprint

The total area of the site will be the combined footprint of all of the site components you've calculated, as follows.

Formula

Core Processing Infrastructure

(   ) Feet² Total Active Pad Area (Step 18)
+ (   ) Feet² Total Curing/ Storage Pad Area (Step 27)
+ (   ) Feet² Footprint Feedstock Storage (Step 30aaaa or 30bbbb)
+ (   ) Feet² Footprint of Receiving & Blending Area (Step 36)

Additional Infrastructure

+ (   ) Feet² Additional Access, Roads, and Turn-Arounds
+ (   ) Feet² Stormwater Treatment Areas and Diversion Swales
+ (   ) Feet² Leachate Storage and Treatment Areas
+ (   ) Feet² Equipment Sheds and Offices
+ (   ) Feet² Compost Drying and Bagging Areas
+ (   ) Feet² Parking and Loading Areas
+ (   ) Feet² Greenhouse for Plant Bioassays

(   ) Feet² Total Estimated Site Footprint

Example

Core Processing Infrastructure

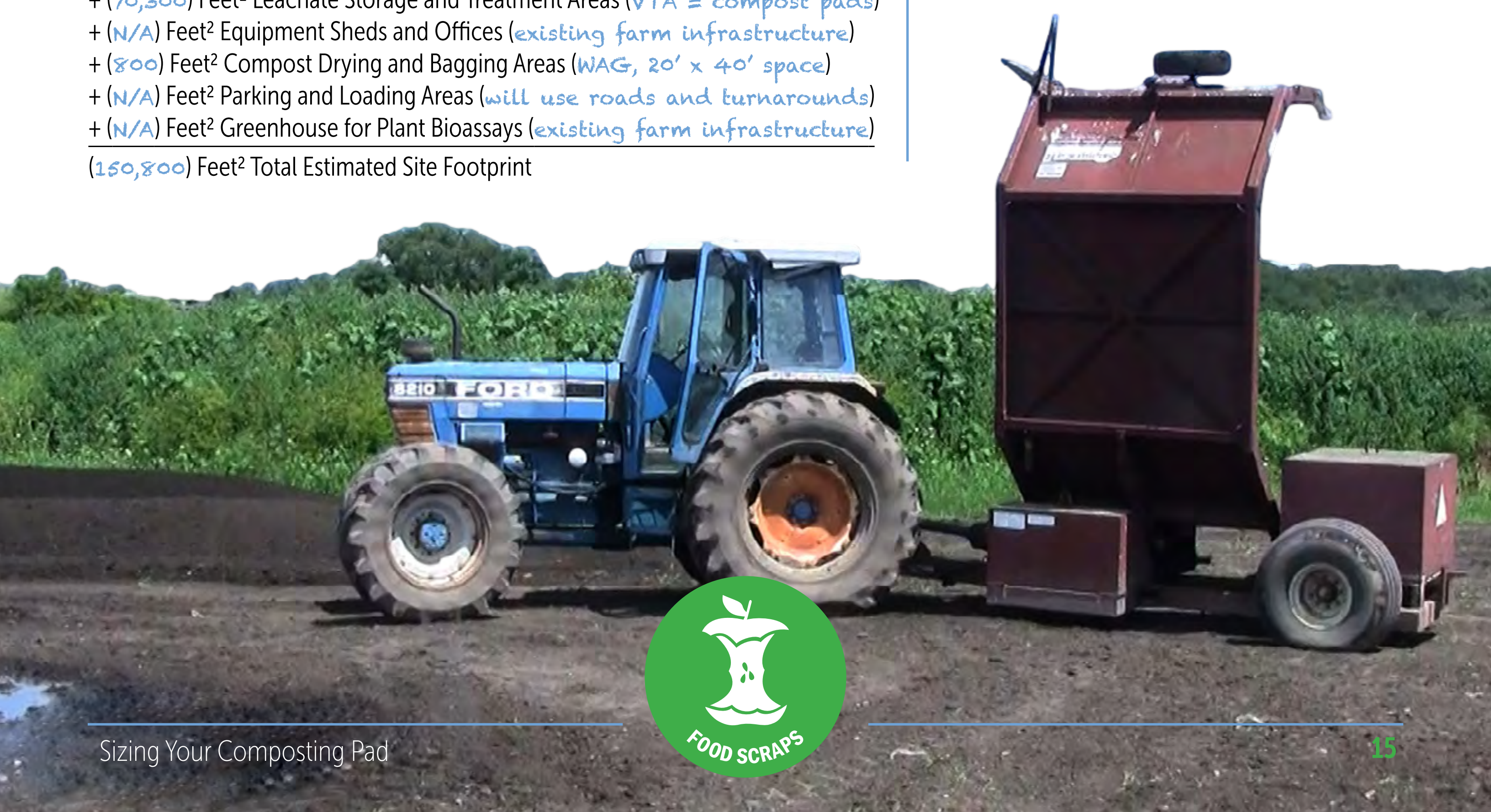
(58,600) Feet² Total Active Pad Area (Step 18)
+ (11,700) Feet² Total Curing/ Storage Pad Area (Step 27)
+ (2,400) Feet² Footprint Feedstock Storage (Step 30aaaa or 30bbbb)
+ (2,000) Feet² Footprint of Receiving & Blending Area (Step 36)

Additional Infrastructure

+ (5,000) Feet² Additional Access, Roads, and Turn-Arounds (WAG)
+ (N/A) Feet² Stormwater Treatment Areas and Diversion Swales
+ (70,300) Feet² Leachate Storage and Treatment Areas (VTA = compost pads)
+ (N/A) Feet² Equipment Sheds and Offices (existing farm infrastructure)
+ (800) Feet² Compost Drying and Bagging Areas (WAG, 20' x 40' space)
+ (N/A) Feet² Parking and Loading Areas (will use roads and turnarounds)
+ (N/A) Feet² Greenhouse for Plant Bioassays (existing farm infrastructure)

(150,800) Feet² Total Estimated Site Footprint

Step 37



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Photos

- Highfields Center For Composting
- Srise

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